Mastering the Mesonet

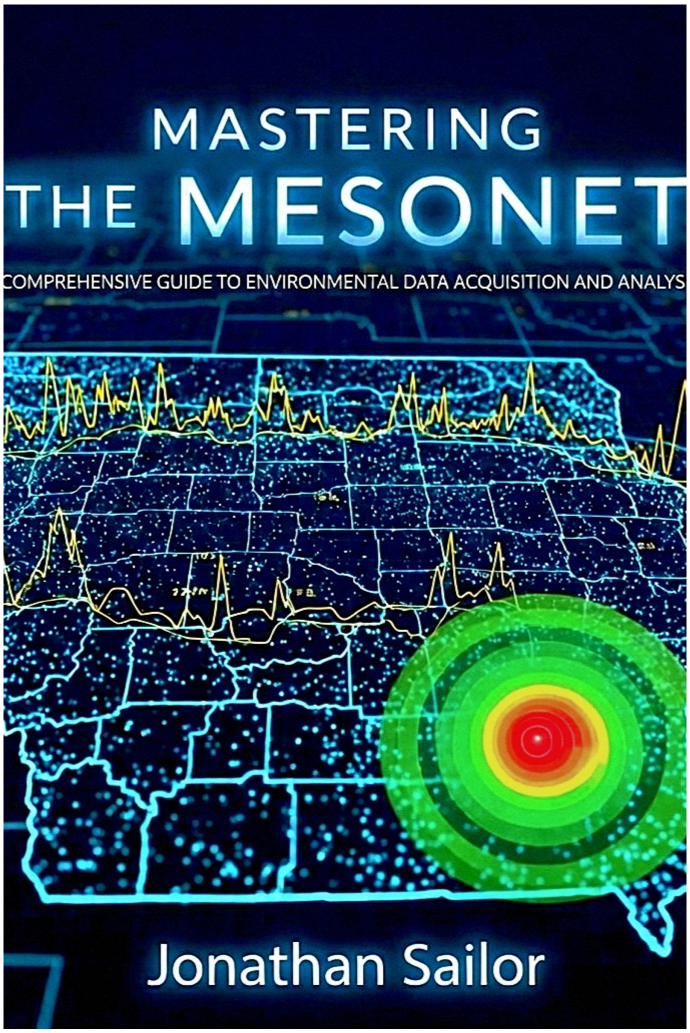
A Comprehensive Guide to Environmental Data Acquisition and Analysis

Jonathan Sailor

March 2026

Table of contents

Preface



Mastering the Mesonet
A Comprehensive Guide to Environmental Data Acquisition and Analysis

Author: Jonathan Sailor
Date: March 2026

Source: mesonet.agron.iastate.edu

This guide is a comprehensive reference to the Iowa Environmental Mesonet (IEM), a free public weather and climate data platform operated by Iowa State University that most weather enthusiasts have only begun to explore.

The IEM ingests data from dozens of observing networks, preserves records that in some cases extend back to the 1800s, and makes them available through hundreds of tools, download portals, and data services. Most regular users still rely on only a small fraction of what it offers. This guide maps the whole thing.

How to Use This Book

The chapters follow a logical progression from orientation to detailed reference, but each one is also designed to stand alone. Practical workflows are embedded directly in the chapters where the relevant tools are introduced, so that when you finish reading about a tool, you immediately see it applied to a real problem.

The back matter is designed as working reference material:

- The **Glossary** defines 39 IEM-specific terms used throughout the book
- **Appendix A** is a network quick reference table you will return to repeatedly
- **Appendix B** is a complete URL directory — 166 verified links organized by category
- **Appendix C** is the full Autoplot chart reference — all 260 charts across 10 categories
- **Appendix D** covers the GIS shapefile download endpoints

A Note on Data Quality

Throughout the book you will encounter callout boxes flagging data quality issues at the exact point where they are relevant. These are not buried in a later chapter; they appear when you first encounter the data they affect. Chapter 10 provides the full technical treatment; the callout boxes are the early warning signs.

A Note on URLs

Every URL in this guide was verified against the live IEM site in March 2026. In the HTML and EPUB versions, all URLs are live hyperlinks.

License

Introduction

For more than two decades, a website run by the Agronomy Department at Iowa State University has been quietly doing something remarkable: making a genuinely professional-grade weather and climate data system freely available to anyone who wants to use it.

If you have spent time on weather forums, you have almost certainly seen its charts. Someone posts a plot showing sixty years of daily high temperatures at their local airport, with the period-of-record average overlaid and the current year highlighted in red. Someone else shares a map of every tornado warning polygon issued over a five-state region across the past twenty years. Another person pulls up a chart showing that last Tuesday's dew point reading at their station was the highest ever recorded for that date in March. All of those charts came from the same place: the Iowa Environmental Mesonet, known as the IEM.

The problem with the IEM is not that it is hard to use — most of it is point-and-click. The problem is that it is enormous, and the sheer scale of it means most people only ever use a small corner of what is available. The navigation menu has eight top-level categories. Behind those eight categories are hundreds of individual tools, download portals, data viewers, and applications. Some of the most useful features on the entire site are not in any menu at all — they exist at direct URLs that you only find if someone points you to them.

This guide is an attempt to fix that. It covers the IEM from the outside in: what the site is, how it is organized, what each section actually contains, and how to get the most out of the tools that matter most for serious weather hobbyists. It does not assume you are a beginner. It does assume you have not spent years mapping every corner of the IEM the way a researcher or developer might. Somewhere in between is exactly the reader this guide is written for.

A few things this guide is not: it is not a programming tutorial, it is not a manual for scraping data in bulk with Python scripts, and it is not a guide for forecasters or agricultural scientists, even though the IEM serves those audiences too. For those topics, the IEM's own documentation is actually quite good. This guide is for the enthusiast who wants to understand the weather record at their station, research past events, analyze patterns, and know where to look for whatever question they happen to be asking on any given day.

Throughout the guide, URLs are provided as direct links. In the HTML and EPUB versions, every URL is live — click it and you go directly to that page on the IEM website. The IEM is an actively maintained site and things occasionally move, but the core structure has been stable for years. The URLs verified for this guide reflect the site as of March 2026.

One last note before getting started. The IEM is operated by a small team at Iowa State, led by developer Daryl Herzmann, who has been building and maintaining the system for over twenty years. It runs on public university resources. When you use the IEM, use it thoughtfully — the server handles over 2,000 requests per second from users worldwide, and it keeps running because the people behind it care about keeping it available. If you download data in bulk, be polite about it. If you find a bug or a data quality issue, report it. The IEM's own QC ticket system is public, and the team actually reads and responds to it.

With that, let's start at the beginning.

Part I.

Part I — Understanding the IEM

1. Chapter 1 — What Is the IEM?

1.1. The Short Version

The Iowa Environmental Mesonet is a free, public weather and climate data platform operated by Iowa State University. It ingests data from dozens of observing networks, archives it, and makes it available through a collection of web applications, download portals, and data services. The archive goes back in some cases to the 1800s. The tools range from simple current-conditions displays to sophisticated charting systems with hundreds of configurable parameters. It is free to use for any lawful purpose, including commercial use.

That is the functional description. The more interesting question is how something like this came to exist at a land-grant university in Iowa — and why understanding that history helps you use the site better.

1.2. Where It Came From

The IEM grew out of the Iowa Environmental Mesonet project, which began in the 1990s as an effort to collect data from a variety of observing networks in Iowa and make them available in a unified form. At the time, weather data from different networks — airport ASOS stations, NWS cooperative observers, agricultural weather stations — lived in separate systems that did not talk to each other. The IEM was built to aggregate them.

Over time, the project expanded well beyond Iowa. The network coverage now includes stations across the entire contiguous United States and internationally. The tools evolved from simple data displays into a full research and analysis platform. The Daily Feature — a chart or analysis published almost every day since February 2002 — became a kind of running meteorological journal that demonstrates what the data can show when you ask it the right questions.

The key figure throughout this history has been Daryl Herzmann, a developer at Iowa State who has been the primary architect and maintainer of the IEM for over two decades. His name appears on the contact page, his GitHub repository contains the source code for the entire site (it is open source), and his Twitter handle is linked from the footer. This is not a faceless institutional project — it is one person's life work, supported by Iowa State's infrastructure and a small team of collaborators. Understanding that helps explain both the remarkable depth of the system and the occasional rough edges that come with a project of this scale maintained by a small team.

1.3. What "Mesonet" Means

A mesonet — short for mesoscale network — is a network of weather stations designed to observe atmospheric conditions at a scale smaller than the traditional synoptic weather observation network but larger than a single point. The classic example is the Oklahoma Mesonet, a statewide network of automated stations spaced roughly 30 kilometers apart, designed to capture the mesoscale variability in temperature, humidity, and wind that drives severe weather in that region.

The IEM is not itself a physical observing network in that sense — it does not own and operate a set of weather stations across Iowa. What it does is aggregate data from observing networks that do exist: the ASOS airports, the NWS cooperative observers, the Iowa State agricultural weather network, river gauges, roadway sensors, and many others. The "mesonet" in the name reflects the original ambition to build an integrated view of environmental conditions across the state at mesoscale resolution. It has since grown into something considerably larger.

1.4. The Homepage

When you navigate to mesonet.agron.iastate.edu, the homepage has a specific structure that is worth understanding because it reveals how the IEM thinks about its own audience.

At the top is a red navigation bar with a search box and a hamburger menu. The search box accepts natural-language queries in a specific format — the placeholder text shows `'DSM'` `'autoplot 100'` as an example, which means you can search for a station ID, an application name, or a combination. It is a useful shortcut once you know what you are looking for.

Below the header, three audience buttons appear: **Ag Weather**, **NWS Users**, and **Researchers**. These are portal buttons that take you to curated entry points for each audience. Ag Weather leads to the agricultural weather and climate information pages. NWS Users leads to the NWS data mainpage. Researchers leads to the archive mainpage. If you are a weather enthusiast coming to the IEM for the first time, none of these three buttons is exactly right for you — the closest is probably Researchers, because you want the archive and the analytical tools. But do not get too attached to these portal labels. They reflect the IEM's primary funding audiences and do not define the limits of what the site can do for someone with a general weather interest.

The center of the homepage is dominated by the **IEM Daily Feature** — a chart and short explanation published most days, tied to whatever is happening meteorologically. On the day this guide was verified, the feature covered an all-time March temperature record set at Cedar Rapids, with a chart showing the monthly maximum temperature records by month for that station. Below the current feature is a list of previous years' features for the same calendar date, going back to 2002. This is one of the most underrated features of the entire site: you can see what the IEM was tracking on this exact date in every year going back over two decades, which gives you an immediate sense of what the tools can produce and what kinds of questions they answer.

The right column of the homepage has two sections worth noting. The **Most Popular** sidebar lists the seven most-accessed applications on the site at any given time — currently Automated Data Plotting, Climodat Reports, Iowa Mesonet Plot, IEM One (RADAR + Warnings), IEM GIS Rainfall, Sortable Currents, and Winter Storms of 2025–2026. This is a real-time list and changes with the season and with whatever weather is happening. It is a reasonable proxy for "what do most users actually come here for."

The **Current Website Performance** panel is a small but revealing feature. It shows live bandwidth usage and request rates. When this guide was verified, the IEM was handling 2,259 requests per second across the entire site and 224 requests per second specifically to the API and data services, with 100% API success rate. On a busy weather day — a significant severe weather outbreak, a record-breaking heat event — these numbers spike considerably. The fact that this performance data is displayed publicly on the homepage is characteristic of the IEM's general transparency about its own operations.

At the bottom of the homepage, three map widgets show current soil temperatures (from the Iowa State soil moisture network), a current precipitation analysis, and a current surface observation plot. These are live products that update automatically and give you a quick read on current conditions across the Midwest.

1.5. The Navigation Structure

The main navigation menu — accessible via the hamburger icon in the top right corner on mobile, or expanded on desktop — contains eight top-level categories: **Apps**, **Areas**, **Datasets**, **Info**, **Networks**, **NWS Data**, **Services**, and **Webcams**. Each has a dropdown with subcategories.

Understanding the distinction between these eight categories is the first step to using the site efficiently, because the names are not always intuitive:

Apps contains interactive web applications — things you use in a browser to produce charts, displays, and analyses. Automated Data Plotting (Autoplot) lives here, as do Climodat, IEM Explorer, the Time Machine, and Wind Roses.

Areas contains topic-based portals that aggregate content by subject rather than by tool type. The Climate Mainpage, Severe Weather Mainpage, GIS Mainpage, and Drought Monitor all live here. Think of Areas as the "I want to browse by topic" menu.

Datasets contains entry points to the major data archives — Daily Climatology, Daily Observations, IEM Reanalysis, Model Output Statistics, the NEXRAD Mosaic, and others. If you know what kind of data you want and want to go directly to it, start here.

Info contains documentation, news, quality control information, the station metadata lookup, the variables reference, and the past Daily Features archive. This is the section that explains how the site works.

Networks contains the observing network pages — ASOS airports, COOP stations, CoCoRaHS, DCP/HADS river gauges, RWIS roadway stations, and others. If you want to browse stations within a network or understand what a specific network measures, start here.

NWS Data contains everything related to National Weather Service operational products — warnings, watches, advisories, local storm reports, text products, SPC outlooks, and the VTEC browser. This is one of the deepest sections on the site and gets its own full chapter.

Services contains the technical access points — the API, bulk data download portals, Gibson Ridge placefiles, OGC webservices, and the LDM data feed. This is where you go when you want data programmatically rather than through a web interface.

Webcams contains the camera viewer, time-lapse tools, and the cool lapses archive.

One important caveat: the navigation menu is not a complete map of the site. A number of useful pages exist at direct URLs that do not appear in any menu. These include IEM One (a combined RADAR and warnings view), Sortable Currents (a real-time cross-network observation table), and the full archive of raw text files. Where these hidden pages exist and what they do is covered throughout the relevant chapters.

1.6. The Daily Feature Archive

The IEM Daily Feature deserves more attention than the one paragraph most visitors give it. Since February 2002, someone at the IEM — almost always Daryl Herzmann — has published a chart or map tied to whatever is currently interesting in the weather record, with a short explanation of what the chart shows and why it matters. These are not press releases. They are the kind of quick analysis a meteorologist does when something catches their attention: an all-time record, an unusual pattern, a new tool worth demonstrating, a climatological pattern that puts the current weather in context.

The archive is at mesonet.agron.iastate.edu/onsite/features/past.php and is organized by month. Every entry links to the chart, includes the short write-up, and — critically — includes a "Generate This Chart on Website" link when the chart was produced by Autoplot. That link takes you directly to the Autoplot configuration that produced the chart, with all the parameters already set, so you can run it yourself, change the station, change the year, and immediately start exploring.

The archive is also searchable by tag at mesonet.agron.iastate.edu/onsite/features/tags/. Tags include things like `winter2526` (the current winter storm season), `blizzard`, `thunder`, `aridity`, `warmfront`, and dozens of others going back years. If you are trying to find examples of a particular type of analysis — say, how the IEM has visualized cold air damming events, or how it handles precipitation type verification — the tag archive is a fast way to find representative examples.

There is a practical tip buried here for new users: if you do not know where to start with the IEM, start with the Daily Feature archive. Read a month's worth of entries. Every one links to a live chart that you can immediately run for your own station. By the time you have worked through a few dozen entries, you will have a much more concrete sense of what the tools can do than you would get from reading any amount of documentation.

1.7. What the IEM Is Not

A few clarifications that save confusion later.

The IEM is not the official government archive. NCEI (the National Centers for Environmental Information) is the official custodian of US climate records. The IEM draws on some of the same underlying data — GHCND stations, ASOS observations, NWS COOP reports — but the IEM's processed products are explicitly labeled as unofficial. This means the IEM's period-of-record records for your station may not exactly match what NOAA would cite in an official publication. This is not a flaw; it is an honest acknowledgment that different processing choices produce slightly different results, and the IEM's choices are optimized for usability and currency rather than archival certification.

The IEM is not primarily a forecast site. You will not find model output, forecast soundings, or ensemble guidance here. What you will find is historical data, climatology, and analysis tools built on the observational record. The one exception is Model Output Statistics (MOS), which is a statistical bias-correction of model forecasts archived at the station level — but even MOS on the IEM is an archive product, not a live forecast display.

The IEM is not a real-time alerting service. It archives NWS warnings and processes them in real time, and it operates iembot — a service that posts warning text to social media — but it is not designed to be the source you rely on for life-safety alerts during an active severe weather event. Use the NWS directly for that. Use the IEM afterward to research what happened.

The IEM is not always Iowa. Despite the name, the data coverage extends nationwide and internationally. The observing networks, the Autoplot charts, the warning archive, the MOS data — all of it works for stations across the contiguous US and in many cases beyond. The Iowa-specific products (the Iowa flood center precipitation maps, the ISU Soil Moisture Network data) are a subset. Do not let the Iowa branding lead you to conclude the site is only useful if you care about Iowa weather.

1.8. A Note on the "Unofficial" Label

Throughout the IEM, you will encounter the word "unofficial" applied to climate records and statistics. This is worth understanding precisely, because it means something specific and does not mean what it might first appear to mean.

The IEM computes daily records and climatological statistics directly from the data it ingests. Because its processing pipeline may handle missing data, duplicate reports, and timing offsets differently than NCEI's official climatological procedures, the numbers do not always agree exactly. The IEM calls its results "unofficial" to clearly signal that they should not be cited in official government reports or legal proceedings as the authoritative value.

What "unofficial" does not mean is inaccurate or unreliable for practical purposes. For the kind of analysis a weather enthusiast does — comparing this year's precipitation to the historical average, finding out what the coldest temperature on record was for your station on a given date, tracking how many days above 90°F a station has had over the past decade — the IEM's unofficial numbers are entirely appropriate. The differences from official values, when they exist, are typically small and stem from defensible methodological choices rather than errors.

The label is also a form of legal protection for the university. It keeps the IEM from becoming the de facto cite in every insurance claim or agricultural contract dispute that touches weather data. That is a reasonable position for a free public service to take.

1.9. Key URLs — Chapter 1

Page	URL
IEM Homepage	mesonet.agron.iastate.edu

Page	URL
Daily Feature Archive	mesonet.agron.iastate.edu/onsite/features/past.php
Feature Tags	mesonet.agron.iastate.edu/onsite/features/tags/
Feature Titles (full list)	mesonet.agron.iastate.edu/onsite/features/titles.php
Daily Bulletin Signup	groups.google.com/g/iem-dailyb
IEM News	mesonet.agron.iastate.edu/onsite/news.phtml
RSS Feed	mesonet.agron.iastate.edu/rss.php
GitHub Source Code	github.com/akrherz/iem
Contact	mesonet.agron.iastate.edu/info/contacts.php

Next: Chapter 2 — Station Networks: The Foundation of Everything

---

2. Chapter 2 — Station Networks: The Foundation of Everything

Everything the IEM does starts with a station. A chart of daily temperature departures needs a station. A warning search needs a county or a Weather Forecast Office (WFO). A precipitation download needs to know which network you want and which observer. Before you can use any of the IEM's tools effectively, you need to understand how it organizes the raw material — the observing stations — and what each network actually represents.

The IEM ingests data from more than a dozen distinct observing networks, each with its own history, its own measurement standards, its own strengths, and its own quirks. This chapter covers the networks you will actually encounter when doing weather research: what they measure, how far back they go, where their limitations are, and how to navigate them on the IEM.

2.1. Finding Any Station

Before diving into specific networks, the most important page to know is the station locator at mesonet.agron.iastate.edu/sites/locate.php. Type a city, a station ID, or a ZIP code, select a network from the dropdown, and the IEM returns a list of matching stations with their coordinates, elevation, archive start date, and a link to that station's full data page. This is your entry point whenever you need to identify the right station ID before pulling data.

If you want to browse all stations in a given network, the Network Tables page at mesonet.agron.iastate.edu/sites/networks.php lists every network the IEM tracks — from Alabama ASOS to Zimbabwe ASOS, and everything in between. For a given network you can generate the station list as an HTML table, CSV, shapefile, GEMPAK table, or MADIS table. Each station entry links to its individual station page, which shows its attributes — including things like whether it has 1-minute data, whether it has TAF forecasts, what its GHCNH identifier is for cross-referencing with NCEI, and when the archive officially begins.

Station IDs on the IEM follow a few different conventions depending on the network. ASOS stations use 3-character domestic identifiers (DSM for Des Moines, MDT for Harrisburg) or the full 4-character ICAO identifiers with the K prefix (KDSM, KMDT). COOP stations use IEM-internal identifiers like IATDSM or station codes from the GHCND database (USC00######, USW000######). DCP stations use the 5-character NWS Location Identifiers (NWSLI) that appear in SHEF product headers. The station page for any station shows all the relevant identifiers in one place, which avoids a great deal of confusion when cross-referencing data between systems.

2.2. ASOS and AWOS: The Airport Backbone

The Automated Surface Observing System — ASOS — is the workhorse of the IEM for weather hobbyists. These are the automated weather stations at airports across the United States, operated jointly by the NWS, the FAA, and the Department of Defense. They report continuously, have long records, and measure the variables most users care about: temperature, dew point, wind speed and direction, visibility, ceiling, precipitation, and pressure.

⚠ Data Quality Note — ASOS Temperature Rounding

ASOS stations record temperature in whole degrees Fahrenheit internally, but transmit via the METAR format, which requires Celsius. The conversion introduces a rounding artifact: 78°F becomes 25.56°C, transmits as 26°C, then converts back to 78.8°F — which rounds to 79°F. A full degree of phantom warming can enter the record purely from the transmission pipeline.
If you are doing precise temperature analysis, especially around record extremes, look for the supplemental T-group in the raw METAR feed; it carries the unrounded value. This is covered in depth in Chapter 10.

The IEM's ASOS mainpage is at mesonet.agron.iastate.edu/ASOS/. From there you can get to current conditions, recent METAR reports, monthly precipitation tables, download portals, and the 1-minute archive.

A few points are worth keeping in mind before you rely heavily on ASOS data:

Archive depth varies considerably by station. The major airport stations — places like Des Moines (DSM, January 1928), Burlington (BRL, September 1931), Mason City (MCW, October 1940) — have records stretching back decades before ASOS hardware was even invented. That is because those stations were manually observed airports before being converted to automation. Smaller stations came online in the mid-1990s when ASOS was deployed nationally; most of those have archives starting between 1994 and 1996. When you pull ASOS data for a station, always check the archive begin date in the station metadata before assuming the record goes back as far as you need.

ASOS is not AWOS, and the distinction matters. The Automated Weather Observing System (AWOS) is a slightly older, less capable automated system found at smaller airports. AWOS stations generally report less frequently than ASOS, do not always report precipitation, and have less rigorous quality control. The IEM lumps ASOS and AWOS together under the same network category, but when you look at a station's attributes you will see `IS_AWOS=1` on AWOS stations. For serious precipitation analysis, you want ASOS stations — specifically the ones with `HAS_PHOUR=1` (hourly precip bucket) or `HAS1MIN=1` (1-minute archive). Those attributes appear in the station table and on each station's page.

Temperature is stored internally in whole-degree Fahrenheit. This is a design limitation of the original ASOS sensors. For most purposes it makes no difference, but if you are doing analysis that requires sub-degree temperature precision — onset of freezing at a specific threshold, for example — use the T-group from the raw METAR string when it is available. The IEM's hourly download includes the raw METAR field, so you can parse the T-group yourself.

The precipitation record has a well-known gap around the ASOS transition. When ASOS replaced manual observers at airports in the early-to-mid 1990s, precipitation measurement changed. The original ASOS tipping-bucket gauges had documented problems with snowfall and light precipitation. A program to install All-Weather Precipitation Accumulation Gauges (AWPAG) at ASOS sites addressed some of these issues, but the install dates varied by station and the improvement was gradual. For precipitation analysis at ASOS stations that spans the pre- and post-automation period, treat the data on either side of that transition with awareness that the measurement method changed.

The 1-minute ASOS archive is one of the IEM's more useful hidden features. The National Center for Environmental Information (NCEI) maintains a 1-minute resolution dataset for many US ASOS sites going back to approximately 2000. The IEM processes this archive daily — it is not real-time, with a delay of 18–36 hours — and makes it available for download at mesonet.agron.iastate.edu/request/asos/1min.phtml and for plotting via Autoplot chart q=211. This is the right data source when you want to look at the precise timing of a temperature drop, a pressure jump, or a precipitation onset during an event. Not every station has it, and the coverage gets thinner the further back you go, but for the past ten to fifteen years at most major ASOS sites it is quite complete.

2.3. NWS COOP: A Century of Daily Observations

The NWS Cooperative Observer Program — universally called COOP — is where the IEM's real historical depth lives. These are the cooperative observer stations: human volunteers, mostly private citizens, who take daily readings of temperature and precipitation. They read a max-min thermometer once a day, measure whatever fell in the rain gauge, and call or submit it to the NWS. Some stations have been doing this continuously since the 1880s.

That longevity is exactly why the data has quirks that any serious user needs to understand.

The IEM's COOP mainpage is at mesonet.agron.iastate.edu/COOP/, and it is one of the more feature-rich network pages on the site. It gives you access to current observations, the full historical download, the normals download, freezing date statistics, snow depth duration tools, the growing season plotter, and the daily extremes table. But before using any of those, understand what the raw data actually is.

COOP reports are once-daily observations, not instantaneous readings. An observer reads the maximum and minimum thermometer at a fixed time each day — traditionally 7 AM, though some observe at other times — resets the thermometer, and records whatever accumulated in the gauge since the previous reading. This means a "daily" high temperature reading is the maximum over a roughly 24-hour period ending at the observation time, and a "daily" precipitation reading is the accumulation over that same period. This is fundamentally different from the way airport ASOS stations measure daily summaries, where the day runs midnight to midnight.

This observation time offset matters enormously when comparing COOP data to ASOS data, when looking at events that span observation times, and when computing things like monthly totals that might not add up the way you expect. The IEM processes COOP data into its **Climodat** dataset, which applies quality control and attempts to handle some of these timing issues, but you should be aware that the raw COOP and the processed Climodat are two different things. The Climodat download is at mesonet.agron.iastate.edu/request/coop/fe.phtml (quality-controlled) and the raw COOP observations are at mesonet.agron.iastate.edu/request/coop/obs-fe.phtml.

The COOP network is also where you get access to the IEM's **daily normals and records** — the period-of-record daily statistics that underpin most of the climatology tools. The extremes table at mesonet.agron.iastate.edu/COOP/extremes.php shows daily records going back as far as the station record allows, all labeled as unofficial in the IEM's standard convention. The normals download at mesonet.agron.iastate.edu/COOP/dl/normals.phtml gives you the full 366-day normal climatology for any station, including average high, average low, average precipitation, record values, growing degree days, and solar radiation.

Two COOP sub-tools deserve special mention. The **freeze date tool** at mesonet.agron.iastate.edu/COOP/freezing.php gives you the statistics of first and last freeze dates across stations — a question that comes up constantly in discussions of growing seasons, late-season snow events, and climate trends. The **snow depth duration tool** at mesonet.agron.iastate.edu/COOP/snowd_duration.phtml shows, for a given date, how long snow cover typically persists — useful context when you are watching an early season snowfall and wondering whether it is likely to stick around.

One thing to watch for in COOP data: **gaps are common and are not always flagged.** Observers miss days. Stations go inactive for months or years and then restart. Equipment changes. The longer the record, the more of this you will encounter. When you pull COOP data for a long period and compute statistics, always check the count of valid observations — the IEM reports this in the normals table as the "years" field — before drawing conclusions from stations with thin records in certain time periods.

2.4. CoCoRaHS: The Precipitation Dense Network

The Community Collaborative Rain, Hail and Snow Network is the largest precipitation observing network in the United States by station count, and it is built almost entirely on volunteers with a standard gauge, a training module, and an internet connection. CoCoRaHS observers report daily precipitation, snow, and hail at a much finer spatial density than either ASOS or COOP — a typical metro area might have dozens of CoCoRaHS stations compared to one or two ASOS airports and a handful of COOP sites.

The IEM's CoCoRaHS page is at mesonet.agron.iastate.edu/cocorahs/, with current observations at mesonet.agron.iastate.edu/cocorahs/current.phtml and an observation listing at mesonet.agron.iastate.edu/cocorahs/obs.phtml.

For precipitation research, CoCoRaHS data is most useful when you want to map the spatial distribution of a specific event — how much fell where during a particular storm, whether the radar QPE estimate was close to what gauges measured, how much a lake effect band produced along its axis versus a few miles off it. The IEM integrates CoCoRaHS into its precipitation maps and has it available in the daily summary download portal alongside ASOS and COOP data.

The limitation is consistency. CoCoRaHS observer density varies dramatically by region, and individual observers join and leave the network constantly. A station with a 2012 start date might have had one observer from 2012 to 2018 and a completely different person since then. This is fine for event-specific analysis but makes CoCoRaHS difficult to use for long-term trend work.

2.5. DCP/HADS: Rivers, Reservoirs, and Remote Gauges

The GOES Data Collection Platforms — DCP — are a diverse collection of automated sensors that transmit data via GOES satellite. On the IEM, the DCP section at mesonet.agron.iastate.edu/DCP/ covers the Hydrometeorological Automated Data System (HADS) network, which is essentially the NWS's aggregation of river gauges, reservoir sensors, snow depth sensors, and other remote automated observations from hundreds of different operating agencies.

The data from DCP stations is encoded in the Standard Hydrometeorological Exchange Format — SHEF — a coding system that assigns two-letter physical element codes to each variable. River stage is `HP`. Streamflow is `QR`. Precipitation cumulative is `PC`. Air temperature is `TA`. When the IEM displays DCP data, it shows these SHEF codes alongside the values. If you are looking at a river gauge and wondering what `HP` means, that is your answer: height primary, the stage in feet or meters above a local datum.

The most useful DCP tool for weather hobbyists is the **interactive current map** at mesonet.agron.iastate.edu/DCP/map.php, which lets you select a SHEF code and see the current value at every DCP station that reports that variable. Selecting `HP` gives you a map of current river stage across the network — a quick way to assess which rivers are elevated in your region during or after a heavy rain event.

The DCP section also has a "tomb" page at mesonet.agron.iastate.edu/DCP/tomb.phtml — a list of NWSLI identifiers that the IEM has received data for but cannot identify because they do not appear in the NWS Location Identifier database. This is a data quality artifact, not a crisis, but it is the kind of honest transparency about data limitations that characterizes the IEM throughout.

2.6. RWIS: Roadway Weather and Pavement Sensors

Roadway Weather Information Systems (RWIS) are operated by state departments of transportation to support winter road maintenance decisions. They measure not just standard atmospheric variables but pavement-specific sensors: pavement surface temperature, subsurface temperature, pavement condition (dry, wet, ice, snow), and sometimes chemical sensors for detecting ice-melting agents.

The IEM's RWIS mainpage is at mesonet.agron.iastate.edu/RWIS/, with current observations at mesonet.agron.iastate.edu/RWIS/current.phtml and road camera feeds at mesonet.agron.iastate.edu/RWIS/camera.phtml.

For weather enthusiasts, RWIS is most useful in two situations. First, during winter weather events, RWIS pavement temperature data tells you something that no atmospheric sensor can: whether the road surface is actually at or below freezing, which is what determines whether precipitation falls as rain or accumulates as ice. A 34°F air temperature with a 29°F pavement is a very different scenario from 34°F air over a 36°F pavement. Second, RWIS stations often fill geographic gaps in the ASOS network — they are typically sited on highways in areas between airports, so they can give you surface temperature and wind readings in locations that would otherwise have no automated coverage.

The limitation is that RWIS stations were designed for road maintenance, not climatological research. Quality control is less rigorous than ASOS, sensors drift, and stations are sometimes moved when highway construction changes the relevant road segment. Use RWIS for current conditions and event analysis; do not build a long-term climatology from it.

2.7. Specialty Networks

Several other networks appear in the IEM's menu and are worth knowing about even if you use them less frequently.

ISU Soil Moisture Network at mesonet.agron.iastate.edu/agclimate/ is an Iowa-specific agricultural weather network operated by Iowa State University. Beyond the obvious agricultural applications, the soil moisture and temperature data from this network is genuinely interesting during transition-season events — it shows you whether soils are frozen or saturated, which affects how precipitation moves into rivers and whether spring warmth is penetrating the ground. The soil temperature maps that appear on the IEM homepage are generated from this network.

SCAN (Soil Climate Analysis Network) at mesonet.agron.iastate.edu/scan/ is the USDA NRCS equivalent — a national network of automated stations at agricultural research sites measuring soil temperature and moisture at multiple depths, along with standard atmospheric variables. Coverage is thinner than ASOS but the data quality is high.

USCRN (US Climate Reference Network) at mesonet.agron.iastate.edu/uscrn/ is NOAA's gold-standard reference network, designed specifically to detect long-term climate trends without the site-change and urbanization issues that affect longer ASOS and COOP records. USCRN stations are in pristine, undisturbed locations, triple-redundant, and meticulously maintained. The network has been operational since the early 2000s and the data quality is exceptional. The downside is coverage — there are only about 130 stations across the contiguous US, so your nearest USCRN site may be 100 miles away.

CoCoRaHS was covered above. **NLAE Flux** at mesonet.agron.iastate.edu/nstl_flux/ covers flux tower data from the National Laboratory for Agriculture and the Environment — specialized eddy covariance measurements of energy and carbon exchange that are not likely to be part of most weather hobbyists' workflows. The **Other** network page at mesonet.agron.iastate.edu/other/ aggregates miscellaneous networks including TV station weather networks (KCCI SchoolNet, KELO WeatherNet, KIMT StormNet) and specialized institutional networks.

2.8. Station Metadata and the Network Table

Every station on the IEM has a page that shows its full metadata. You reach it either by clicking the station ID in a network table or by going to mesonet.agron.iastate.edu/sites/locate.php and searching. The station page shows coordinates, elevation, archive dates, network membership, and a set of attribute flags that tell you what data is available:

- `HAS1MIN=1` — 1-minute ASOS data available
- `HASTAF=1` — Terminal Aerodrome Forecasts (TAF) issued for this station
- `HAS_PHOUR=1` — hourly precipitation bucket data available
- `IS_AWOS=1` — this is an AWOS station, not ASOS
- `GHCNH_ID` — the GHCN-Hourly identifier for cross-referencing with NCEI
- `FLOOR` — the earliest reliable date for data from this station (overrides archive begin in some cases)
- `SHEF_6HR_SRC` — which DCP gauge is used to supplement 6-hour precip data

These attributes are not just metadata — they tell you what you can actually do with a station. Before building a long analysis pipeline around a specific ASOS station, pull its station page and confirm it has the coverage you need. The `FLOOR` attribute in particular is worth checking: some stations have archive dates that go back further than the data is actually reliable, and the FLOOR reflects the IEM's judgment about where the trustworthy record begins.

The Network Tables page also offers direct export of any network's station list as a CSV or shapefile, which is useful when you want to do spatial analysis on a full network rather than looking up stations one at a time.

2.9. Key URLs — Chapter 2

Page	URL
Station Locator	mesonet.agron.iastate.edu/sites/locate.php
Network Tables	mesonet.agron.iastate.edu/sites/networks.php
ASOS/AWOS Mainpage	mesonet.agron.iastate.edu/ASOS/
ASOS Current Conditions	mesonet.agron.iastate.edu/ASOS/current.phtml
ASOS 1-Minute Download	mesonet.agron.iastate.edu/request/asos/1min.phtml
ASOS Monthly Precip Tables	mesonet.agron.iastate.edu/ASOS/reports/mon_prec.php
COOP Mainpage	mesonet.agron.iastate.edu/COOP/

Page	URL
COOP Daily Records/Extremes	mesonet.agron.iastate.edu/COOP/extremes.php
COOP Normals Download	mesonet.agron.iastate.edu/COOP/dl/normals.phtml
COOP Freeze Date Statistics	mesonet.agron.iastate.edu/COOP/freezing.php
COOP Snow Depth Duration	mesonet.agron.iastate.edu/COOP/snowd_duration.phtml
COOP Hourly Precip (HPD)	mesonet.agron.iastate.edu/COOP/hpd.php
Climodat Download (QC'd)	mesonet.agron.iastate.edu/request/coop/fe.phtml
COOP Raw Obs Download	mesonet.agron.iastate.edu/request/coop/obs-fe.phtml
CoCoRaHS Mainpage	mesonet.agron.iastate.edu/cocorahs/
CoCoRaHS Current Obs	mesonet.agron.iastate.edu/cocorahs/current.phtml
DCP/HADS Mainpage	mesonet.agron.iastate.edu/DCP/
DCP Current Map (by SHEF code)	mesonet.agron.iastate.edu/DCP/map.php
DCP Tomb (unknown station IDs)	mesonet.agron.iastate.edu/DCP/tomb.phtml
RWIS Mainpage	mesonet.agron.iastate.edu/RWIS/
RWIS Current Conditions	mesonet.agron.iastate.edu/RWIS/current.phtml
RWIS Road Cameras	mesonet.agron.iastate.edu/RWIS/camera.phtml
ISU Soil Moisture Network	mesonet.agron.iastate.edu/agclimate/
SCAN Network	mesonet.agron.iastate.edu/scan/
USCRN Network	mesonet.agron.iastate.edu/uscrn/
Other Networks	mesonet.agron.iastate.edu/other/

3. Chapter 3 — Current Conditions: What's Happening Right Now

The IEM is primarily known for its historical archive and analytical tools, but it has a capable real-time layer that most users never fully explore. The current conditions section is not one page — it is a collection of distinct tools scattered across several URLs, each serving a different purpose. Some are in the navigation menu. A few are not. This chapter covers all of them and explains when to reach for each one.

3.1. The Current Mainpage

The entry point is mesonet.agron.iastate.edu/current/, which functions as a menu of real-time map products rather than a display in itself. From here you select a variable — Air Temperature, Humidity, Precipitation, Pressure, Snow, Soil Temperature, Station Plot, Sounding, Wind, or Visibility — and the IEM generates a map product for that variable across its observation network.

These maps are static images that refresh on a schedule, not interactive layers. They are generated from the combined IEM network, blending ASOS, COOP, RWIS, and other stations into a single visualization. The station plot option produces the classic surface analysis plot format — the circular station model with temperature, dew point, wind barb, sky coverage, and pressure all encoded around a central point — which is the most information-dense view available and the one most familiar to anyone who has spent time looking at surface analyses.

The precipitation map at `/current/index.phtml/precipitation` is worth bookmarking specifically during active weather events. It aggregates current precipitation reports from across the network and gives you a quick ground-truth check against whatever the radar is showing.

3.2. Sortable Currents: The Cross-Network Observation Table

The most useful real-time tool on the IEM for a weather enthusiast is Sortable Currents, reached from the navigation menu at mesonet.agron.iastate.edu/my/current.phtml. Despite the "My Favorites" label in the URL, this page is far more than a favorites list — it is a full cross-network observation hub that lets you view current conditions from every network the IEM tracks in a single sortable table.

The page opens with a set of network tabs at the top: ASOS, CoCoRaHS, COOP, Cellular COOP, DCP, ISU Soil Moisture, Other, SCAN, My Favorites, By State, RWIS, RWIS Surface, RWIS Traffic, RWIS Soil, By NWS WFO, and USCRN. Each tab loads the current observations for that network in a table where every column header is clickable for sorting. Click the temperature header and every station in the network sorts from hottest to coldest. Click precipitation and you instantly see which stations are reporting the most rain right now. Click dew point and you can immediately identify where the moist boundary sits.

The "By State" tab is particularly useful for regional situational awareness. It lets you select a state and see all ASOS observations across that state simultaneously — a faster and more flexible view than the map products when you want to compare readings across a region rather than look at one variable spatially.

The "My Favorites" functionality requires no login. Visit any network's current conditions page, find a station you want to track, and add it to your favorites with a single click. The favorites list is stored in your browser's local storage, so it persists across sessions without requiring an account. A custom favorites list combining your regional ASOS stations, a nearby CoCoRaHS observer, and a RWIS pavement sensor gives you a tailored real-time dashboard that no commercial weather site can replicate with this combination of networks.

The "By NWS WFO" tab at mesonet.agron.iastate.edu/nws/obs.php deserves separate mention. It lets you select a Weather Forecast Office and see all current ASOS observations within that WFO's area of responsibility in a single table. For mid-Atlantic users, selecting CTP (State College) pulls up every airport station from central Pennsylvania — MDT, CXY, LNS, THV, SCE, IPT, RDG and more — in one sortable view. This is exactly what you want when a front is moving through and you are watching temperatures fall or dew points rise from west to east across a region.

3.3. IEM One: Radar and Warnings in a Single Interface

mesonet.agron.iastate.edu/one/ is a modern interactive mapping application that combines radar imagery with live NWS warnings in a single interface. It is one of the most polished tools on the IEM and, for real-time severe weather monitoring, the best starting point the site offers.

IEM One has two modes: Real-time and Archive. In Real-time mode it displays the current NEXRAD composite radar loop alongside any active watches, warnings, and advisories overlaid as color-coded polygons. The warning panel on the right side lists every active warning by WFO with the phenomena, significance, and expiration time. Click any polygon on the map and you get the full warning details.

Archive mode is where IEM One becomes genuinely powerful for post-event analysis. You can navigate to any date and time and replay the radar and warning sequence exactly as it unfolded. The time navigation controls at the bottom let you step through the archive at whatever pace you want. This is the tool to use when you want to understand the timing of a warning relative to the radar evolution during a past event — something that takes considerable effort to reconstruct from text archives alone.

The layer controls, accessible via the hamburger menu in the top left, give you options that go beyond basic radar and warnings. You can toggle on webcam imagery from the IEM camera network, Iowa DOT truck dashcams (available back to 2014), Iowa DOT RWIS road cameras (back to 2010), and RWIS surface observations with a choice of which variable to label on the map — air temperature, or any of the four pavement temperature sensors. Overlaying RWIS pavement temperatures on a radar loop during a winter precipitation event is a combination that no commercial weather site offers and that is genuinely useful for understanding where ice is forming on road surfaces in real time.

IEM One also supports URL parameters for deep linking into specific views. If you want to share a specific location and zoom level, you can construct a URL with `zoom=`, `lat=`, and `lon=` parameters. You can also pre-configure which layers are visible: `radar=1`, `warnings=1`, `rwis=1`, `webcam=1`, `dashcam=1`, `sps=1`. This makes it easy to set up a bookmark that opens directly to your region with your preferred layer configuration.

3.4. The Severe Weather Mainpage

The Severe Weather Mainpage at mesonet.agron.iastate.edu/current/severe.phtml is less a real-time monitoring tool and more a hub connecting the IEM's severe weather resources — both current and archived. It is worth understanding what is on it because some of the most useful links on the entire site are buried here rather than in the main navigation.

For current conditions, the page provides a link to the iembot monitor for watching text products arrive in real time, the current NEXRAD storm attributes shapefile (a point shapefile updated every minute with hail estimates, rotation, and storm top heights for every tracked cell in the country), a convective watches overview showing the last ten SPC watch locations, and GIS-ready downloads of the current 24-hour LSR reports and active warning polygons.

For operational situational awareness, the current SPC and WPC outlooks are displayed side-by-side with IEM's own rendering of the same data pulled from its archive — a simple visual check that the IEM's ingest is working and matching the official products. On a day with active outlooks this is a useful confirmation that the IEM's warning and outlook archive is current.

The archived tools linked from this page — IEM Cow, IEM Raccoon, the VTEC browser, the warning search — are covered in depth in Chapter 7. What is worth noting here is that this is where you find them when approaching from the "current severe weather" angle rather than from the NWS Data menu.

3.5. The Precipitation Current Page

For active precipitation events, mesonet.agron.iastate.edu/current/index.phtml/precipitation gives you the combined network precipitation map — all reporting stations from ASOS, COOP, and CoCoRaHS plotted simultaneously. This is the IEM's equivalent of a real-time gauge analysis map. It updates as new reports come in and gives you an immediate sense of where precipitation is heaviest and how gauge reports compare to what the radar is showing.

For more detailed precipitation tracking, the Hourly Precip application at mesonet.agron.iastate.edu/rainfall/obhour.phtml shows the precipitation reported by each ASOS station in the last hour alongside a running 24-hour total. It is narrower in scope than the combined map but more precise in timing, and it includes the hourly bucket readings directly rather than the summarized daily totals. Chapter 4 covers this in more detail under the Apps section.

3.6. What "Current" Actually Means on the IEM

One subtle but important point about the IEM's current conditions tools: observation age varies by network, and not everything labeled "current" is equally fresh.

ASOS stations report every hour at minimum, with special observations triggered by significant changes in conditions. The data reaches the IEM within minutes of the observation time for most stations. When you load the ASOS sortable currents table, the observations you see are typically less than an hour old, and often much less.

COOP observations are once-daily by design. The "current" COOP display shows the most recent morning report, which was probably submitted between 6 and 8 AM local time. Mid-afternoon, that observation is six to eight hours old. During an active precipitation event, the COOP numbers you see are not telling you what is happening right now — they are telling you what accumulated since the previous morning.

DCP river gauge data varies by station and reporting interval. Most gauges report every hour or every few hours. During flood events, reporting may intensify. But some gauges have longer reporting intervals or telemetry delays, so a "current" stage reading on the DCP map might be two to four hours old.

RWIS stations generally report every 20 minutes or every hour, with variation by state DOT configuration.

The IEM does display observation timestamps alongside each reading, so you can always check how old a value is. But knowing the typical reporting cadence for each network helps you interpret the current display correctly, especially during rapidly evolving weather situations.

3.7. Key URLs — Chapter 3

Page	URL
Current Mainpage	mesonet.agron.iastate.edu/current/
Current Temperature Map	mesonet.agron.iastate.edu/current/index.phtml/air_temperature
Current Precipitation Map	mesonet.agron.iastate.edu/current/index.phtml/precipitation
Current Station Plot Map	mesonet.agron.iastate.edu/current/index.phtml/station_plot
Sortable Currents (all networks)	mesonet.agron.iastate.edu/my/current.phtml
Sortable Currents by WFO	mesonet.agron.iastate.edu/nws/obs.php
Sortable Currents by State	mesonet.agron.iastate.edu/current/all.phtml
ASOS Current Conditions	mesonet.agron.iastate.edu/ASOS/current.phtml
RWIS Current Surface	mesonet.agron.iastate.edu/RWIS/currentSF.phtml
RWIS Current Traffic	mesonet.agron.iastate.edu/RWIS/traffic.phtml
IEM One (Radar + Warnings)	mesonet.agron.iastate.edu/one/
Severe Weather Mainpage	mesonet.agron.iastate.edu/current/severe.phtml
Hourly Precip (current)	mesonet.agron.iastate.edu/rainfall/obhour.phtml
Convective Watches Overview	mesonet.agron.iastate.edu/current/sel.phtml

Page	URL
Current NEXRAD Storm Attributes	mesonet.agron.iastate.edu/data/gis/shape/4326/us/current_nexattr.zip
Current Warning Shapefile	mesonet.agron.iastate.edu/data/gis/shape/4326/us/current_ww.zip
Current 24-hr LSR Shapefile	mesonet.agron.iastate.edu/data/gis/shape/4326/us/lsr_24hour.zip

Part II.

Part II — Tools and Applications

4. Chapter 4 — Apps: IEM's Interactive Tools

The Apps menu is where the IEM shifts from archive and network infrastructure to tools you can actually use to answer questions. It contains the tools that produce the charts you see shared on weather forums, the applications that let you explore a station's full historical record interactively, and several tools that most users never fully discover because the menu entry gives little hint of what lies inside.

This chapter covers all of them, with most of the space devoted to Automated Data Plotting — Autoplot — the single most powerful and underutilized tool on the IEM.

4.1. The Application Index

The Application Index at mesonet.agron.iastate.edu/apps.php is the complete catalog of everything IEM has built. It is organized by category and lists well over a hundred individual applications with short descriptions. If you ever find yourself lost on the site wondering whether a tool exists for a specific task, start here. Browse it once in a dedicated session — not to memorize it, but to build a mental map of the categories and where things live. It will save you significant time later.

4.2. Automated Data Plotting (Autoplot)

mesonet.agron.iastate.edu/plotting/auto/

Autoplot is the IEM's chart generation engine. It is a single application with 260 chart types, each capable of producing publication-quality graphics from the IEM's full data archive. It is the source of the overwhelming majority of charts you will ever see posted from the IEM — temperature records, departure analyses, warning climatologies, MOS verification, snowfall timelines, and dozens of other chart types that simply do not exist anywhere else for free.

Understanding Autoplot requires three things: knowing how to find the right chart, how the URL structure works, and how to export the data.

4.2.1. Finding the Right Chart

The Autoplot interface has a large dropdown selector at the top — Step 1: Select a Chart Type. The full list of 260 charts is in that dropdown, grouped into sections: Daily, Monthly, Yearly, Hydrology/Drought, METAR/ASOS Special Plots, Agricultural, NWS/Warnings, and a miscellaneous section for things that do not fit neatly. Each chart has a name and a number in parentheses.

Below the dropdown, the page shows a visual gallery of thumbnails — one sample image for each chart, organized by the same category groups. This is the fastest way to browse if you know roughly what kind of chart you want but do not know which number. The trending section at the top of the gallery shows which charts are being requested most heavily in the past six hours, which is a useful indicator of what the active weather is prompting people to look at.

When you select a chart from the dropdown or click a thumbnail, the interface loads Step 2: Configure Chart Options. What you see here changes completely depending on which chart you selected. Some charts ask only for a station and a year. Others have a dozen parameters covering network, station, date range, variable, threshold, output format, and display options. All of this configuration happens in the same interface — the form updates dynamically when you change the chart type.

4.2.2. How the URL Works

This is where Autoplot becomes genuinely powerful. Every chart you configure generates a direct URL that can be bookmarked, shared, or used to pull data programmatically. Once you understand the URL structure, you often do not need the dropdown at all — you can construct charts directly in the address bar.

The base URL is `https://mesonet.agron.iastate.edu/plotting/auto/` and every individual chart follows the pattern `?q={number}` for the interactive interface. The chart image itself — the actual PNG — is served at a different path that encodes all the parameters directly in the URL.

The image URL pattern looks like this:

```
https://mesonet.agron.iastate.edu/plotting/auto/plot/{q}/{param1}:{value1}::{param2}:{value
```

For example, chart q=99 (Daily High + Low Temperatures with Departures) for Harrisburg Airport in 2025 would be:

```
https://mesonet.agron.iastate.edu/plotting/auto/plot/99/network:PACLIMATE::station:PA5703::
```

The parameters are separated by `::` (double colons) and each parameter is formatted as `name:value`. The chart number follows `/plot/` directly. This URL is stable — if you bookmark it, it will always produce the same chart updated with whatever data the IEM currently has for that station and year.

To change a parameter, change the value in the URL. Want 2024 instead of 2025? Change `year:2025` to `year:2024`. Want sigma departures instead of absolute? Change `delta:abs` to `delta:sigma`. This makes Autoplot URLs composable — you can modify any parameter by editing the URL directly, which is far faster than navigating the form when you know what you want.

The `_r:t` parameter that appears in many Autoplot URLs tells the server to render the page with a data-download link included. You can also retrieve data by replacing `.png` in the image URL with `.csv` or `.xlsx` to get the underlying data directly.

4.2.3. Getting the Data Out

Every Autoplot chart that is based on tabular data — which is most of them — can export that data. On any chart's page, after the chart is generated, you will see links for CSV Data and Excel Download directly below the image. These export the exact data points used to draw the chart.

This is one of Autoplot's most underappreciated features. You are not just getting a picture — you are getting a reproducible data pipeline. The IEM calculates the statistics, applies its QC, draws the chart, and then hands you the same numbers in a spreadsheet-ready format. For any analysis that starts with one of these charts, you can pull the data directly rather than downloading raw observations and computing statistics yourself.

4.2.4. The Curated Charts: What a Weather Enthusiast Actually Needs

The 260 charts divide into roughly three groups for weather hobbyist purposes: indispensable tools you will use regularly, useful tools you will pull out for specific questions, and niche tools (mostly agricultural and crop-specific) that you can safely ignore unless you have a specific reason to care.

What follows is a tour of the most valuable charts organized by the kind of question they answer.

4.2.4.1. Understanding Your Station's Climate Record

Chart 99 — Daily High + Low Temperatures with Departures The single most-used climatology chart on the IEM. For any given year at any station, it plots every day's high and low temperature as a colored bar above or below the 1991-2020 NCEI climatological average. Days above average are warm-colored, days below are cool-colored. At a glance you can see which months ran warm or cold, how persistent any anomalies were, and how the year compares to the baseline. The departure can be shown as absolute degrees or as sigma units, which is useful when comparing the same departure across different seasons where variability differs. Link: q=99

Chart 32 — Daily Departures / Percentiles / Ranges for One Year A related chart to q=99 but using period-of-record climatology rather than the fixed 1991-2020 baseline. This one overlays the current year's observed temperatures against the full envelope of what has been recorded, showing the record high, record low, and shaded percentile bands. Useful when you want to know not just "was it above average" but "how unusual was it by historical standards." Link: q=32

Chart 113 — Daily Climatology The simple, clean version: the period-of-record normal high, normal low, and average precipitation for every day of the year for a single station. No current year overlay, no departures — just the baseline climatology plotted as smooth curves. This is what you want when you need to explain to someone what "normal" is for a location or when you want a reference chart to annotate with observed values. It accepts a user-defined date range, so you can compute climatology for a specific sub-period rather than the full record. Link: q=113

Chart 100 — Temperature / Precip Statistics by Year One of the most useful charts for long-period analysis. For any station and any variable, it produces a bar chart showing the yearly value across the full period of record, with the annual average overlaid. Want to see every year's total precipitation since 1888? This is the chart. Want to see how 2012's drought compares to every prior dry year? This chart ranks them immediately. The breadth of available variables is extensive: annual total precip, annual average temperature, number of days above any temperature threshold, growing degree day totals, and more. Link: q=100

Chart 5 — Daily Records for Each Month of Year Shows, for each month of the year, when the all-time daily records were set. A horizontal bar for each month, with dots indicating which days hold the current records and whether they were set by a more recent year. This is the chart that shows you how old your station's records are and which months still have records from the early 20th century that have never been broken. Link: q=5

Chart 63 — Records Set by Year The inverse question from q=5: for each year in the record, how many new daily high temperature records, daily low temperature records, and daily precipitation records were set? This chart is revealing when interpreted carefully.

Years with many records set are often either extreme weather years or years immediately following a gap in the record (where the newly resumed record can set "records" against a thin baseline). When you see a year like 1936 dominating the high temperature record count, that is real. Link: q=63

4.2.4.2. Precipitation Analysis

Chart 75 — Precip Totals by Season/Year Simple and essential: total precipitation for each year or season across the full record, with a trend line option. This is your first chart when someone asks "is it getting wetter or drier?" — it puts the full record in context immediately. Link: q=75

Chart 172 — Accumulated Year-to-Date Precipitation For any station, shows the accumulated precipitation from January 1st through whatever date you select, with the current year highlighted against the envelope of all prior years. The wettest and driest years are labeled. This is the chart you want during an ongoing drought or a wet spring — it tells you exactly where the current year sits in the historical distribution at any point in the season. Link: q=172

Chart 108 — Accumulated Departures from Average (Long Term Climate) Plots accumulated growing degree day, precipitation, and stress degree day departures from climatology for a season. The running sum format shows you whether the year is trending wetter or drier as it progresses, and how abrupt the transitions are. This is one of the charts highlighted on the IEM homepage as trending. Link: q=108

Chart 207 — LSR + COOP Snowfall/Rainfall Analysis Maps Produces a gridded analysis map of snowfall or rainfall for any event using Local Storm Reports, NWS COOP data, and CoCoRaHS combined. This is the chart for reconstructing what fell where during a specific storm — the IEM blends three data sources into a single analyzed map. Link: q=207

4.2.4.3. Departures, Trends, and Comparisons

Chart 55 — Daily Climatology Comparison Compares multiple 30-year climatological normals at the same station on a single plot: the 1971-2000 normals, the 1981-2010 normals, and the 1991-2020 normals, all plotted together. This is the intellectually honest chart for showing climate change signals in the observational record — you can see directly whether the baseline has shifted and by how much. Link: q=55

Chart 215 — Compare Daily Temp Distributions over Two Periods Select two user-defined year ranges and see the full distribution of daily high or low temperatures compared between them as a kernel density estimate. Set period 1 as 1950-1979 and period 2 as 1990-2019 and you can directly visualize whether the tails have shifted. This is the chart for rigorous period-to-period comparison rather than visual inspection of time series. Link: q=215

Chart 128 — Comparison of Yearly Summaries Between Two Stations For any two long-term climate stations, plots their annual summary statistics side by side across all shared years. This is the right tool when analyzing station homogeneity, comparing nearby stations with different exposures, or validating bias correction work. Only years where both stations have adequate data are included. Link: q=128

Chart 104 — Trailing X-Day Temp/Precip Departures (Weather Cycling) Shows the time series of trailing-N-day departures from climatology expressed in sigma units. The result is a plot that looks like a slowly varying signal showing whether the recent past has been persistently warm/cold/wet/dry. Useful for contextualizing current conditions without anchoring to calendar months. Link: q=104

4.2.4.4. MOS Forecast Verification

Chart 37 — MOS Forecast Ranges + ASOS Observations This chart overlays the archived MOS forecast ranges against what actually occurred at a station. For any ASOS station and any date range, it shows the MOS forecast spread for temperature (or other variables) alongside the observed value, making it easy to see whether observations fell within the forecast range and where systematic biases occurred. This is the gateway chart for the IEM's MOS verification capabilities and the most relevant Autoplot chart for anyone interested in forecast verification. Link: q=37

4.2.4.5. Warnings and Severe Weather Climatology

Chart 109 — WFO/State VTEC Event Counts by Period (Map) Generates a map showing the count or coverage of any type of watch, warning, or advisory issued by each WFO or across each state for a user-defined time period. Want to see which WFOs issued the most tornado warnings over the past decade? This chart. Want to see how the warning load shifted during a particular season? This chart. It was the most requested chart on the IEM on the day this guide was verified. Link: q=109

Chart 52 — Gantt Chart of Watch/Warning/Advisories by WFO or UGC Produces a timeline showing when each type of VTEC product was active for a specific WFO or county/zone. The Gantt format makes it easy to see overlapping events, gaps between events, and the seasonal pattern of different warning types across multiple years. Link: q=52

Chart 92 — Days Since Last Watch/Warning/Advisory by WFO A map showing, for each WFO coverage area, how many days have elapsed since the most recent warning of a specific type was issued. This is the "quiet period" chart — useful for contextualizing whether a region is overdue for a particular hazard based on historical frequency. Link: q=92

Chart 44 — NWS Office Accumulated Warning Totals For a specific WFO, plots the accumulated count of severe thunderstorm plus tornado warnings across the season, updated daily, with historical season comparisons overlaid. This is the chart for tracking how active a severe weather season is relative to the historical average at any point during the year. Link: q=44

4.2.4.6. Hourly and Event-Based Analysis

Chart 43 — Recent Timeseries (Meteogram) A standard meteogram for any ASOS station covering the past 2-3 days: temperature, dew point, wind speed, and precipitation plotted as hourly time series. This is the IEM's equivalent of the meteogram you see in commercial weather apps, but for any station in the archive. Link: q=43

Chart 87 — Frequency of METAR Code by Week or Hour Shows the annual frequency of any present weather code — thunder, fog, freezing rain, snow, blowing snow — organized as a heatmap by week of year and hour of day. This chart answers questions like "when does fog typically form at my local airport" and "what time of day do thunderstorms most commonly occur at this station across the full record." Link: q=87

Chart 18 — Long Term Observation Time Series Plots any ASOS variable as a raw time series across the full station record. Want to see every temperature observation ever recorded at your airport plotted in sequence? This chart. It is the most direct view of the raw archive and useful for spotting data quality issues, regime changes, and long-term trends that are visible in the hourly data but get averaged away in daily summaries. Link: q=18

4.2.5. Tips for Using Autoplot Efficiently

A few patterns that make Autoplot faster to use once you know them:

The `_r:t` URL parameter forces the page to render in a stripped-down format optimized for sharing and embedding. When you copy a chart URL from the address bar, it typically includes this parameter already.

The `dpi` parameter controls output resolution. The default of 100 DPI produces a sharp web-scale image. For presentations or publications, set `dpi:200` or `dpi:300` in the URL.

The `_fmt:png` parameter can be changed to `_fmt:pdf` or `_fmt:svg` for different output formats. SVG is particularly useful if you want to edit the chart further in vector graphics software.

Below the generated image, each chart page shows a list of IEM Daily Features that have used that chart type in the past. These are real examples from real weather events, with the "Generate This Chart" link pre-configured. If you are trying to understand what a chart shows, these historical examples are often the fastest way to grasp it.

4.3. Other Apps Menu Tools

4.3.1. Climodat

mesonet.agron.iastate.edu/climodat/

Climodat is the IEM's processed version of the COOP climate dataset, cleaned and organized for easy retrieval. The main interface lets you select a station and pull monthly and yearly climate summaries going back to the station's full record. Unlike the raw COOP download, Climodat presents data in a formatted report view with totals, departures, and period-of-record context already computed. The Climodat Monitor at mesonet.agron.iastate.edu/climodat/monitor.php adds a live dashboard showing current-month and current-year departures across all monitored stations.

4.3.2. IEM Explorer

mesonet.agron.iastate.edu/explorer/

IEM Explorer is a simplified station-centric interface that aggregates data, charts, and metadata for a single station into one page. It is described as a simplified version of Autoplot — you select a station, and the Explorer presents a curated set of standard charts and recent observations without requiring you to know which Autoplot number you want. If Autoplot's 260-chart dropdown feels overwhelming, start with IEM Explorer for your local station to see what the data looks like before going deeper.

4.3.3. Time Machine

mesonet.agron.iastate.edu/timemachine/

Time Machine lets you replay any IEM map product at any past date and time. The interface has a dropdown of available products — the Iowa Mesonet surface plot, various RADAR composites, precipitation analyses, soil temperature maps, and others — and a date/time selector. Navigate to any past date and see what the IEM was displaying at that moment. This is useful for quickly reconstructing surface conditions during a past event without pulling raw data.

Product 1 is the Iowa Mesonet surface plot. Product 82 is the Iowa Flood Center precipitation analysis. Both of these are linked from the IEM homepage as the "Iowa Mesonet Plot" and "More Precipitation Maps" entries in the Most Popular sidebar.

4.3.4. Wind Roses

mesonet.agron.iastate.edu/sites/windrose.phtml

The Wind Rose application generates a standard meteorological wind rose for any ASOS station: the percentage of observations from each direction, with speed categories shown as color-coded rings. You can filter by month, season, or a custom date range, and filter by a specific weather condition (e.g., show the wind rose only for hours when visibility was below 1 mile). The standard wind rose is the starting point for understanding the dominant flow patterns at a station, which is prerequisite knowledge for interpreting temperature biases, precipitation anomalies, and fog climatology at any specific location.

4.3.5. Hourly Precip

mesonet.agron.iastate.edu/rainfall/obhour.phtml

The Hourly Precipitation application shows precipitation reported by ASOS stations in the last hour alongside the 24-hour running total. It is the most detailed real-time precipitation view the IEM offers at the hourly resolution. For event analysis, the more powerful tool is the archived hourly precip download at mesonet.agron.iastate.edu/request/asos/hourlyprecip.phtml, which lets you pull the hourly bucket readings for any station and date range in CSV format.

4.3.6. Interactive Radar

mesonet.agron.iastate.edu/GIS/apps/rview/warnings.phtml

What the IEM calls Interactive Radar in the nav menu is actually a GIS-based warnings overlay application — it shows the current radar composite alongside active NWS watch and warning polygons in an interactive map interface. For more capable radar visualization, IEM One (Chapter 3) is the preferred tool. This application is the older, simpler alternative, but it remains the most popular entry point in the menu because the label says "radar" and that is what people are looking for.

4.3.7. Pest Maps and Forecasting

mesonet.agron.iastate.edu/topics/pests/

Built for agricultural applications but genuinely useful for weather enthusiasts interested in phenology: maps of accumulated growing degree days and forecasts of when specific GDD thresholds will be reached. The GDD framework is the same math that drives seasonal phenology questions — when do insects emerge, when do plants leaf out, when do first freezes typically occur — so the pest mapping application is a practical interface to those questions even if you have no interest in the specific pest models it was designed for.

4.4. Workflow 2 — Building and Bookmarking a Custom Autoplot Chart

Question: How does this year's accumulated precipitation at KMDT compare with the historical average, and how do I save that chart so I can return to it in six months?

Start here: https://mesonet.agron.iastate.edu/plotting/auto/

The Autoplot interface opens with a dropdown selector for chart type and a rendering area below it. The dropdown is organized by category — temperature, precipitation, climatology, NWS/VTEC, and so on. For this example, you want Autoplot q=7, which plots accumulated precipitation departure from average. You can either scroll through the categories to find it or type "7" directly into the chart number field if you know it.

Once you select q=7, the form below the chart selector shows the parameters for that specific chart: network, station, start year, and options for the baseline period. Set the network to PA_ASOS, set the station to MDT, and leave the other parameters at their defaults for a first look. Click the button to generate the chart.

The chart renders as an image. Now look at your browser's address bar. The URL has changed to something like:

```
https://mesonet.agron.iastate.edu/plotting/auto/plot/7/network:PA_ASOS::station:MDT::...
```

This URL is the chart. Every parameter you set — network, station, year range, chart type — is encoded in the path. Copy this URL and bookmark it, share it in a forum post, or save it to a spreadsheet. When you load the URL six months from now, IEM will regenerate the chart with the same parameters against the current data. The chart updates automatically; the URL does not need to change.

To download the underlying data rather than the image, replace the `/plot/` segment in the URL with `/json/`, or add `_fmt=json` to the end of the parameter string. The API will return the chart's source data as a JSON object — the same values plotted in the chart, available for your own analysis. This works for the majority of Autoplot charts, though a small number of charts produce images that do not have a corresponding data endpoint.

A practical tip for finding the right chart: the Autoplot landing page shows a thumbnail and one-line description for all 260 charts. If you are not sure which chart answers your question, scroll through the thumbnails in the relevant category rather than trying to guess the chart number. The precipitation category and the climatology category together cover most of the questions weather enthusiasts bring to IEM Autoplot.

4.5. Workflow 5 — Building a Wind Rose for Your Airport

The question: What does the wind climatology at KMDT look like during winter months? From which direction does the prevailing flow come, and at what speeds?

Start here: https://mesonet.agron.iastate.edu/sites/windrose.phtml

The wind rose tool opens with a network and station selector. Set the network to PA_ASOS and the station to MDT. The date range fields default to a multi-year span; leave them as-is for a first look at the full period of record, which for KMDT extends back to the early 1970s.

The tool offers three ways to filter the data used to build the rose. First, you can restrict to a specific month or season — for a winter wind climatology, set the month filter to December, January, and February. Second, you can restrict to a specific hour of the day, which is useful for understanding diurnal wind patterns or for aviation purposes (morning versus afternoon wind regimes differ significantly at valley airports like MDT due to drainage flow). Third, you can set a start-hour to end-hour window. For a climatological picture of winter winds generally, leave the hour filter open.

You can also specify up to six custom wind speed bins in units of your choice. The default bins work fine for a first look, but if you are interested in a specific threshold — severe wind criteria, aviation minimums, wildfire spread conditions — adjusting the bins to bracket that threshold gives you a more actionable result.

After you click Submit, the tool takes a moment to process: it is querying the full ASOS archive for your station across your time filter, which depending on the date range and station can mean several hundred thousand observations. The site itself notes that generation can take up to a few minutes for large requests; this is normal, not a timeout. The resulting image shows the wind rose with spoke lengths proportional to frequency from each direction and coloring indicating speed category within each directional bin.

The image and the underlying data are both in the public domain. Below the rendered rose you will find a link to the backend data as a JSON file — the raw frequency counts and speed distributions by direction, available for custom plotting or analysis in your own tools. The wind rose image itself can be embedded or shared directly; a stable URL for the plot is generated after the image renders, bookmarkable in the same way as an Autoplot URL.

For KMDT specifically, the winter wind rose will show the dominant west-to-northwest fetch that characterizes cold air advection events in the Susquehanna Valley, with a secondary signature from the south-southwest during pre-frontal warm advection. The MDT wind record is long enough that these patterns are statistically robust; this is not a pattern inferred from only a few seasons of data.

4.6. Key URLs — Chapter 4

Page	URL
Application Index	mesonet.agron.iastate.edu/apps.php
Autoplot Main Interface	mesonet.agron.iastate.edu/plotting/auto/
Autoplot — Daily Departures (q=99)	mesonet.agron.iastate.edu/plotting/auto/?q=99
Autoplot — Daily Climatology (q=113)	mesonet.agron.iastate.edu/plotting/auto/?q=113
Autoplot — Yearly Totals (q=100)	mesonet.agron.iastate.edu/plotting/auto/?q=100
Autoplot — YTD Precipitation (q=172)	mesonet.agron.iastate.edu/plotting/auto/?q=172
Autoplot — Daily Records by Month (q=5)	mesonet.agron.iastate.edu/plotting/auto/?q=5

Page	URL
Autoplot — Records Set by Year (q=63)	mesonet.agron.iastate.edu/plotting/auto/?q=63
Autoplot — Precip Totals by Year (q=75)	mesonet.agron.iastate.edu/plotting/auto/?q=75
Autoplot — Climatology Comparison (q=55)	mesonet.agron.iastate.edu/plotting/auto/?q=55
Autoplot — Two-Period Distribution (q=215)	mesonet.agron.iastate.edu/plotting/auto/?q=215
Autoplot — MOS vs Observations (q=37)	mesonet.agron.iastate.edu/plotting/auto/?q=37
Autoplot — VTEC Counts Map (q=109)	mesonet.agron.iastate.edu/plotting/auto/?q=109
Autoplot — Warning Gantt (q=52)	mesonet.agron.iastate.edu/plotting/auto/?q=52
Autoplot — Days Since WWA (q=92)	mesonet.agron.iastate.edu/plotting/auto/?q=92
Autoplot — Accumulated Warnings (q=44)	mesonet.agron.iastate.edu/plotting/auto/?q=44
Autoplot — Meteogram (q=43)	mesonet.agron.iastate.edu/plotting/auto/?q=43
Autoplot — METAR Code Frequency (q=87)	mesonet.agron.iastate.edu/plotting/auto/?q=87
Autoplot — Snowfall Map (q=207)	mesonet.agron.iastate.edu/plotting/auto/?q=207
Autoplot — Accumulated GDD/Precip (q=108)	mesonet.agron.iastate.edu/plotting/auto/?q=108
Climodat	mesonet.agron.iastate.edu/climodat/
Climodat Monitor	mesonet.agron.iastate.edu/climodat/monitor.php
IEM Explorer	mesonet.agron.iastate.edu/explorer/
Time Machine	mesonet.agron.iastate.edu/timemachine/
Wind Roses	mesonet.agron.iastate.edu/sites/windrose.phtml
Hourly Precip (current)	mesonet.agron.iastate.edu/rainfall/obhour.phtml
Hourly Precip (archived download)	mesonet.agron.iastate.edu/request/asos/hourlyprecip.phtml
Interactive Radar / Warnings	mesonet.agron.iastate.edu/GIS/apps/rview/warnings.phtml
Pest Maps + GDD Forecasting	mesonet.agron.iastate.edu/topics/pests/

Page	URL
Plant Hardiness Zones	mesonet.agron.iastate.edu/topics/hardiness/

5. Chapter 5 — Areas: Topic Portals

The Areas menu is the IEM's subject-matter navigation layer — not a collection of tools, but a set of entry points organized around what you are trying to do rather than what kind of data you are looking at. Where the Networks menu asks "which observing network?", Areas asks "which topic?": climate, archive, GIS, drought, or agriculture. Each entry in the menu opens into a substantially different part of the site, and some of them open into entire sub-systems that could support a chapter on their own. This chapter maps the territory.

The Areas menu currently has eight entries: Ag Weather/Climate Info, Archive Mainpage, Climate Mainpage, Current Mainpage, Drought, GIS Mainpage, NWS Mainpage, and Severe Weather Mainpage. Current Mainpage and Severe Weather Mainpage were covered in Chapter 3, and NWS Mainpage anchors Chapter 7. What remains — the Archive, GIS, Drought, and Ag/Climate portals — is the subject of this chapter.

5.1. The Archive Mainpage

mesonet.agron.iastate.edu/archive/

The Archive Mainpage is worth understanding as a concept before you start clicking into it. It is not primarily an interface — it is an annotated directory. The IEM uses it as a curated index of archival resources, both internal (hosted at Iowa State) and external (third-party archives the team considers worth pointing to). If you are trying to find raw historical data and you do not know whether the IEM has it, this is the place to start your search.

5.1.1. The Raw File Archive

The deepest layer of the IEM's own archive is the flat-file tree at mesonet.agron.iastate.edu/archive/data/. It is organized by UTC date: `/archive/data/YYYY/MM/DD/`. Within each date directory are subdirectories for different data types — `GIS/uscomp/` for NEXRAD composite files, `GIS/sat/` for GOES satellite products, `bufkit/` for model point soundings, `text/` for NWS text products, and others. The directory schema is documented at mesonet.agron.iastate.edu/archive/schema.php, which is a useful reference before you start navigating the tree directly.

The raw file archive is how you get data that is not available through any download portal or API endpoint. If you want the actual NEXRAD base reflectivity composite GeoTIFF for a specific hour during a specific event, it is in here. If you want the raw METAR observations for all ASOS stations in their original text format, that is in `/archive/raw/` organized by network. The trade-off is that navigating raw files requires knowing what you are looking for — there is no form to fill out, just directory trees.

For the IEM's NEXRAD archive specifically: composite reflectivity in GIS-friendly raster format goes back to 1997, making it one of the longer continuous radar archives available at no cost. The individual station NIDS products for the seven Iowa-coverage radars (DMX, DVN, OAX, FSD, ARX, MPX, EAX) are archived back to approximately mid-2002, with base reflectivity going back further. If you need Level II (full-resolution, dual-polarization) files, those are not hosted at the IEM — you want the Amazon S3 NEXRAD Level II archive, which the Archive Mainpage links to directly.

5.1.2. NWS Text Products Archive

The IEM archives an enormous volume of NWS text products — essentially everything transmitted on NOAAPORT going back to the mid-2000s. The dedicated text archive is covered in depth in Chapter 7, but the Archive Mainpage links to it and serves as the entry point for users who arrive from the "what historical data exists" direction. Key things the text archive contains: AFDs, LSRs, CLIs, CFRs, METs, TAFs, hydrologic text products, and the full record of watches, warnings, and advisories. All of it is searchable by AWIPS identifier (PIL), WFO, and date.

5.1.3. BUFKIT and Sounding Archives

The Archive Mainpage lists two sounding-related resources worth knowing about. BUFKIT point sounding archives for Iowa locations (and later for many more sites via MTarchive) start from January 2006 and run through the present via mtarchive.geol.iastate.edu. MTarchive, maintained at Iowa State's geology department, is a companion archive that holds model data (GFS, NAM, RAP, RUC, ETA going back to 2001 for some products) in GEMPAK format. If you work with BUFKIT for model sounding analysis, MTarchive is the source you want for anything before the current operational archive.

The IEM's own sounding archive for upper-air RAOB data lives at mesonet.agron.iastate.edu/archive/raob/, with a listing interface at /archive/raob/list.phtml. The RAOB archive will be covered more thoroughly in Chapter 6 under Datasets, but it belongs in the archive discussion as one of the IEM's genuinely deep historical resources.

5.1.4. What the Archive Mainpage Links Out To

One of the more useful things about this page is its curated list of external archives. The IEM has no interest in reinventing resources that already exist elsewhere — the Archive Mainpage is honest about what is better found at NOAA, NCEI, Unidata, or elsewhere. Current external links include the USGS Instantaneous Data Archive (historical river gauge records), the NOAA NOMADS model data archive, the WPC daily weather map archive going back to 1872, and NCEI's severe weather data inventory. These links are maintained by the IEM team and, unlike a general web search, represent resources they have personally used and found reliable.

5.2. The GIS Mainpage

mesonet.agron.iastate.edu/GIS/

The GIS Mainpage is the hub for spatial data services at the IEM. If you work with any GIS platform — QGIS, ArcGIS, Google Earth, Gibson Ridge, or anything that can consume WMS, WFS, or TMS layers — this is where you find out what the IEM can feed into it. The page is organized around a simple premise: the IEM handles a lot of spatially referenced data, and most of that data can be served in standard GIS formats rather than proprietary ones.

5.2.1. NEXRAD Mosaics: The IEM's Biggest GIS Product

The single highest-traffic GIS product the IEM produces is its NEXRAD composite mosaic. The IEM has been generating GIS-friendly radar mosaics since 2003 — first the 4-bit N0R product, then the 8-bit N0Q composite added in 2010 when the NWS moved to higher-resolution imagery. The current operational mosaic uses N0Q (base reflectivity) and is available in multiple formats: as static GeoTIFFs in the archive tree, as WMS (Web Map Service) layers at mesonet.agron.iastate.edu/cgi-bin/wms/nexrad/n0q.cgi, and as TMS tiles suitable for slippy-map web applications.

The temporal WMS endpoints are particularly powerful: the Historical CONUS NEXRAD Base Reflectivity WMS-T service lets a WMS client request any archived radar composite back to 1997 by specifying a timestamp in the request. For a GIS user doing post-event analysis, this means you can overlay archived radar data on any spatial context — county polygons, road networks, station locations, warning polygons — without downloading and processing raw files. The IEM's NEXRAD mosaic documentation at mesonet.agron.iastate.edu/docs/nexrad_mosaic/ explains the production chain, the color tables, and the limitations of each product version.

The RadView application at /GIS/radview.phtml is the older interface for accessing NEXRAD data in GIS format — it predates IEM One and Time Machine and serves primarily as a reference page for the WMS endpoint URLs and TMS tile server addresses. If you want to configure a GIS client to consume live or archived IEM radar, this is where you find the connection strings.

5.2.2. GOES Satellite GIS Products

The IEM processes GOES-East imagery from the GOES-R/S series into GIS-ready formats. The GOES products page at /GIS/goes.phtml documents the current product suite: the imagery is sourced from Unidata NIMAGE products, stored in a geostationary satellite projection, and served as WMS layers. All 16 GOES-East channels are available, both for CONUS and sector views, via the WMS at `https://mesonet.agron.iastate.edu/cgi-bin/wms/goes_east.cgi`. The same structure exists for GOES-West.

The GOES archive is organized by UTC date in the same flat-file tree as the radar archive: `/archive/data/YYYY/MM/DD/GIS/sat/`. Today's satellite files are accessible from the GOES products page with the path pattern documented there. For anyone doing multi-source overlay analysis — radar, satellite, surface observations, and warning polygons simultaneously in a GIS — the IEM's combination of archived products accessible via standard OGC services is genuinely hard to match elsewhere.

5.2.3. The RadMap API

mesonet.agron.iastate.edu/GIS/radmap_api.phtml

The RadMap API is one of the IEM's more remarkable hidden tools. It is a map-generation service that takes a URL with parameters describing what you want — a geographic bounding box, a timestamp, and a set of layers — and returns a rendered map image. The layers available include NEXRAD reflectivity, NWS warning polygons (current and archived storm-based warnings), SPC watches, county outlines, state outlines, and CWAS.

A RadMap URL looks like this:

```
https://mesonet.agron.iastate.edu/GIS/radmap.php?
  ts=20241115_1930&
  width=640&height=480&
  tz=EST&
```

```
bbox=-80.5,39.5,-75.5,42.5&
layers[]=uscounties&
layers[]=nexrad&
layers[]=sbw
```

That URL would produce a 640×480 map of the central Pennsylvania region at 7:30 PM Eastern on November 15, 2024, showing county boundaries, NEXRAD composite reflectivity, and storm-based warning polygons — as a static PNG, directly embeddable in a forum post or web page. For the mid-Atlantic region, the bounding box above covers essentially everything from the Harrisburg CTP WFO's area.

This is the tool that enables the animated radar loops embedded in many weather forum posts. The IEM Radar Warnings page in the GIS section generates these loops at user-specified bounding boxes and time ranges, producing animated GIFs directly. The interface for this is at /GIS/apps/rview/warnings.phtml.

5.2.4. GIS Data Downloads

Beyond the live services, the GIS section offers several download products worth knowing about:

GeoTIFF rasters — archived radar and analysis products in GeoTIFF format are accessible from `/GIS/tiff` and via the rasters page at /GIS/rasters.php. The metadata on how to interpret the raster values (the lookup tables for converting pixel values to dBZ for radar, or to temperature units for analysis products) is documented at the Raster Lookup Tables page linked from the GIS mainpage.

COOP GIS applications — the `/GIS/apps/coop/` sub-section contains duration plot applications that generate maps of COOP-derived statistics for user-specified date ranges. You select a state, a variable (temperature, precipitation), a start and end date, and the application computes the period totals for all stations in the network and produces both a rendered map and a GIS-importable CSV of station values. This is a direct path to getting spatially organized COOP summary statistics without touching the download portals.

Freeze and Warning viewers — the Freeze Map at /GIS/apps/iem/freeze.phtml maps the current freeze status and first/last freeze date observations across the ASOS network, useful in the shoulder seasons. The Warnings Viewer at /GIS/apps/rview/warnings.phtml and Watches Viewer at /GIS/apps/rview/watch.phtml are the interactive map-based alternatives to the VTEC browser covered in Chapter 7, useful when you want a visual map interface rather than a search form.

NEXRAD by Year — /GIS/rad-by-year-fe.phtml lets you compare radar mosaics for the same geographic area and same clock time across multiple years simultaneously. Want to see what the composite reflectivity looked like at 6 PM on November 15 across the last twenty years? This is the tool. It is more specialized than Time Machine but produces a more direct visual comparison of the same meteorological setup across years.

5.3. Drought Monitoring

mesonet.agron.iastate.edu/dm/

The IEM's Drought Monitoring portal is a focused section rather than a large tool suite. Its primary function is to provide access to US Drought Monitor data — the weekly classification maps that categorize drought severity from D0 (Abnormally Dry) through D4 (Exceptional Drought) — in formats and contexts the IEM can connect to its own observational data.

The USDM is produced jointly by the National Drought Mitigation Center, NOAA, and the USDA, and is released every Thursday. The IEM archives these releases and provides GIS download access to current and historical shapefiles. The current Drought Monitor layer is also available as a WMS endpoint for GIS integration — useful when you want to overlay drought classification on the same map as station observations or radar.

The IEM's value-add here is primarily contextual: placing drought classification alongside the same station's precipitation record, CDD/HDD tallies, and departure-from-normal data that live in the same system. An Autoplot chart showing a station's year-to-date precipitation departure against the weekly drought classification trend is the kind of combined view that requires no special API work — you can produce it by combining Autoplot chart q=172 (YTD precipitation) with drought awareness from this portal.

5.4. Ag Weather/Climate Info

mesonet.agron.iastate.edu/agweather/

The Ag Weather section is where the IEM's Iowa State roots show most clearly. A significant fraction of the site's funding and operational rationale comes from agricultural applications, and this section reflects that. But even if you have no interest in corn or soybeans, the Ag Weather and AgClimate sections contain tools that are genuinely useful for any weather analyst who cares about soil conditions, phenology, or growing-season climate analysis.

5.4.1. The ISU AgClimate Network

The core of this section is the Iowa State University Agricultural Climate Network, a set of automated weather stations at Iowa State research farms that have been operating since 1986. The AgClimate stations are full-featured: they measure standard atmospheric variables plus soil temperature at multiple depths (2-inch, 4-inch, 8-inch, and deeper at some sites) and volumetric soil moisture. The data is available in daily and hourly formats going back to the network's inception.

For a weather enthusiast, the soil temperature data is the most useful variable here. First and last freeze probability is one application — but more interesting for mesoscale analysis is how soil temperature modulates sensible heat flux and influences the surface energy budget during spring and fall transitions. The 4-inch soil temperature in particular tracks the transition between frozen and thawed soil with a lag that is valuable for interpreting precipitation type and snowmelt timing.

The AgClimate data download is at mesonet.agron.iastate.edu/agclimate/hist/dailyRequest.php for daily summaries and /agclimate/hist/hourlyRequest.php for hourly. Coverage is Iowa-focused; these stations are not spread across Pennsylvania. But the methodology and data structure are the same as what you would want if your state had a comparable network.

5.4.2. Soil Temperature Maps and Probabilities

The soil temperature display maps at /agclimate/soilt.php show current observations across the AgClimate network for any selected depth. The soil temperature probability tool at /agclimate/soilt-prob.php lets you ask when a station's soil temperature at a given depth has historically reached a given threshold — useful for phenology questions like when to expect the first significant thaw at root depth or when late-season soil cooling drops below 40°F. The soil moisture time series application at /agclimate/smts.php provides the volumetric moisture data across the network for any date range.

5.4.3. The Broader Ag Weather Portal

The Ag Weather entry in the Areas menu leads to /agweather/, which is a portal page linking to several additional resources: the pest forecasting and GDD maps covered in Chapter 4, the evapotranspiration analysis, and the ISUSM (ISU Soil Moisture) network metadata. For users primarily interested in Pennsylvania weather, most of these resources are Iowa-specific in their observational depth but the conceptual framework — and the Autoplot charts that draw on AgClimate variables — works wherever the underlying data exists.

5.5. What the Areas Menu Does Not Contain

A practical note before leaving this chapter: the Climate Mainpage at /climate/ is listed in the Areas menu but functions primarily as a navigation hub linking to the COOP, Climodat, and IEM Reanalysis tools covered in Chapters 2, 4, and 6 respectively. It is not a tool in itself — if you arrive there expecting a distinct application, you will find a menu of things covered elsewhere. Think of it as a bookmark for users who approach the site from the climate-analysis angle and want a curated set of entry points.

Similarly, the NWS Mainpage at /nws/ is listed in both Areas and the NWS Data menu. It consolidates the warning archive, text product search, river summary tools, and the IEM Cow verification application. Since that section has enough depth to anchor Chapter 7, the discussion here stops at noting that it exists and pointing forward.

5.6. What to Watch Out For

The Archive raw file tree is not a backup for disappeared portal data. If a specific observation does not appear in a download portal result, it is not necessarily in the raw file archive either. The raw files represent the IEM's original ingest stream, which has had gaps and processing failures over the years just like any operational system. The absence of data in a portal is not always resolvable by going to the raw archive — sometimes the data simply was not ingested.

GIS services have no SLA. The IEM's WMS and TMS services are provided without warranty and have changed over the years. The N0R mosaic WMS, for example, was updated when the IEM transitioned from N0R to N0Q in 2021. If you build a workflow against one of these endpoints and it breaks, the RadMap API documentation and the NEXRAD mosaic documentation page are the first places to check for what changed.

The AgClimate archive starts in 1986 — but not all stations do. The Iowa State soil moisture network has grown over time. If you are building a long climatological analysis on soil temperature, check when each station's record actually starts rather than assuming the full 1986-present span. The metadata page at /agclimate/info.phtml lists the active stations and their archive start dates.

The Drought Monitor section does not contain real-time station data. The drought classification is updated weekly and represents an expert synthesis, not an automated product. Do not expect it to reflect last night's rainfall; the USDM process has a deliberate lag built in.

5.7. Key URLs — Chapter 5

Page	URL
Archive Mainpage	mesonet.agron.iastate.edu/archive/
Archive Data Tree	mesonet.agron.iastate.edu/archive/data/
Archive Directory Schema	mesonet.agron.iastate.edu/archive/schema.php
Raw Network Data Archive	mesonet.agron.iastate.edu/archive/raw/
RAOB Sounding Archive	mesonet.agron.iastate.edu/archive/raob/
RAOB Listing	mesonet.agron.iastate.edu/archive/raob/list.phtml
GIS Mainpage	mesonet.agron.iastate.edu/GIS/
NEXRAD Mosaic Documentation	mesonet.agron.iastate.edu/docs/nexrad_mosaic/
GOES GIS Products	mesonet.agron.iastate.edu/GIS/goes.phtml
NEXRAD RadView	mesonet.agron.iastate.edu/GIS/radview.phtml
RadMap API	mesonet.agron.iastate.edu/GIS/radmap_api.phtml
Radar + Warnings Viewer	mesonet.agron.iastate.edu/GIS/apps/rview/warnings.phtml
Watches Viewer	mesonet.agron.iastate.edu/GIS/apps/rview/watch.phtml
COOP GIS Duration Apps	mesonet.agron.iastate.edu/GIS/apps/coop/
Freeze Map	mesonet.agron.iastate.edu/GIS/apps/iem/freeze.phtml
NEXRAD by Year	mesonet.agron.iastate.edu/GIS/rad-by-year-fe.phtml
GeoTIFF Rasters	mesonet.agron.iastate.edu/GIS/rasters.php
Drought Monitoring	mesonet.agron.iastate.edu/dm/
Ag Weather Portal	mesonet.agron.iastate.edu/agweather/
AgClimate Network	mesonet.agron.iastate.edu/agclimate/
AgClimate Daily Download	mesonet.agron.iastate.edu/agclimate/hist/dailyRequest.php
AgClimate Hourly Download	mesonet.agron.iastate.edu/agclimate/hist/hourlyRequest.php
Soil Temperature Map	mesonet.agron.iastate.edu/agclimate/soilt.php

Page	URL
Soil Temp Probabilities	mesonet.agron.iastate.edu/agclimate/soilt-prob.php
Soil Moisture Time Series	mesonet.agron.iastate.edu/agcli-mate/smts.php
Climate Mainpage	mesonet.agron.iastate.edu/climate/

6. Chapter 6 — Datasets: The Full Archive Explained

The Datasets menu is where the IEM stops being a collection of tools and starts being a data warehouse. Everything in the previous five chapters — the networks, the current conditions displays, the Autoplot charts, the GIS services — ultimately draws from datasets that live here. This chapter maps those datasets: what each one actually contains, how far back it goes, how the data is structured, and when you should reach for one over another. Two of them — MOS and IEMRE — get extended treatment because they are genuinely complex and genuinely underexplained elsewhere.

The Datasets menu currently has twelve entries: Daily Climatology, Daily Observations, Dataset Documentation, IEM Reanalysis, Model Output Statistics, NEXRAD Mosaic, PIREP - Pilot Reports, Roads Mainpage, RADAR & Satellite, Rainfall Data, Sounding Archive, and Soil Moisture Satellite. NEXRAD Mosaic and RADAR & Satellite were covered in Chapters 5 and 6 respectively. Roads and PIREPs are specialized enough to note briefly and move on. That leaves the core analytical datasets, which are the heart of this chapter.

6.1. Daily Climatology: COOP Records and the Extremes Tool

mesonet.agron.iastate.edu/COOP/extremes.php

> ⚠ Data Quality Note — COOP Time of Observation Bias (TOBS)
>
> COOP observers take readings at self-selected times — some at 7 AM, some at 5 PM. This creates a systematic bias: a 5 PM observer who records a 95°F peak on Tuesday will still see that peak on Wednesday's max-min thermometer if a cold front moved in overnight. Wednesday gets logged as 95°F even though the actual high was 75°F. The 24-hour observation window double-counts the extreme.
> If you are building consecutive-day heat wave analyses or comparing stations with different observation times, account for TOBS offsets before drawing conclusions. The full correction methodology is in Chapter 10.

The Daily Climatology entry in the Datasets menu points to the COOP extremes tool, which is the surface-level entry point to the IEM's deepest historical climate dataset. The underlying data is the NWS Cooperative Observer network — the same observations covered in Chapter 2 — but through the Datasets lens, the question shifts from "how do I find a station" to "how do I work with a century of daily records."

The COOP extremes tool at `/COOP/extremes.php` lets you select a state, a station, and a date, then browse the period-of-record statistics for that date: the all-time high and low temperatures, the highest and lowest precipitation totals, the record snowfall, and the years in which each record was set. For any station with a long record — Pennsylvania COOP stations routinely extend to the 1890s — this tool surfaces historical context that is otherwise buried in raw data files.

The companion download tool for normals is at mesonet.agron.iastate.edu/COOP/dl/normals.phtml, which outputs the 366-day climatological normals for any station in CSV format. These normals are computed by the IEM from the full period of record rather than the official 1991–2020 NCEI normals, which matters when you want a station-specific baseline that uses all available data rather than the most recent 30-year window. For stations with 80 or 100 years of record, the IEM's period-of-record normals tend to be slightly more conservative (less influenced by recent warming) than the NCEI 1991–2020 normals — a meaningful difference when you are analyzing trend departures.

The Climodat application at mesonet.agron.iastate.edu/climodat/ builds on the same underlying COOP data and generates a series of pre-formatted climate reports — monthly summaries, annual rankings, first and last freeze dates, precipitation frequency statistics, and more — for any station in the network. Climodat is covered in Chapter 4 as an App, but it is worth noting here as the primary user interface to the COOP climatological dataset.

6.2. Daily Observations: The IEM Summary Dataset

mesonet.agron.iastate.edu/request/daily.phtml

The Daily Observations download portal is the IEM's unified single-day-per-row summary product. Where the COOP download gives you raw cooperative observer reports and the ASOS download gives you hourly observations, this portal gives you a one-line-per-station-per-day summary computed by the IEM across multiple networks.

The variables available vary by network. For ASOS/AWOS stations, the daily summary includes high temperature, low temperature, average temperature, dew point high and low, peak wind gust and direction, average wind speed, precipitation total, snowfall (where reported), and sky condition. For COOP stations, the set is different: max/min temperature, precipitation, snowfall, snow depth, and observation time. The portal lets you select a network, a date range, and a set of stations, then download in CSV, Excel, or HTML.

The key distinction between this portal and the raw ASOS download at `/request/download.phtml` is aggregation level. The daily summary portal gives you IEM-computed daily statistics — a single row capturing the whole day. The ASOS download gives you individual hourly observations that you aggregate yourself. For most climatological analysis, the daily summary is faster and easier. For any analysis that requires sub-daily timing — hourly temperature evolution, precipitation start and end times, wind shift timing — go to the raw hourly download.

6.3. Dataset Documentation

mesonet.agron.iastate.edu/info/datasets/

This page is the IEM's own reference documentation for its data products. It is written for developers and researchers rather than casual users, but it contains information that is genuinely hard to find elsewhere: the variable definitions, the units and encoding conventions, the processing pipeline for each dataset, and the known limitations. The Variables reference page at /info/variables.phtml is an essential companion — if you pull data from any IEM portal and see a column header you do not recognize, this is where you look it up.

Before building any serious analysis pipeline against IEM data, spend twenty minutes with the dataset documentation for the network you are using. The encoding choices are occasionally counterintuitive — wind direction in MOS, for example, is stored as the raw encoded value multiplied by 10 for the true degree value — and some variables have historical processing changes that affect how you interpret early versus recent data. The documentation catches these.

6.4. IEM Reanalysis (IEMRE)

mesonet.agron.iastate.edu/iemre/

IEMRE is one of those datasets where the IEM's own description is so direct it is worth engaging with directly. The page says: *"IEMRE is nothing special. It was cool maybe 15 years ago, but now days there are superior products available. Use those instead!"* That is a remarkable thing for a data product to say about itself, and it tells you something important about both the product and the people behind it.

Here is what IEMRE actually is, why it exists despite that disclaimer, and when it is still the right choice.

6.4.1. What IEMRE Is

IEMRE is a gridded analysis product — meaning it takes point observations from across the IEM's station networks and interpolates them onto a regular grid, producing spatially continuous fields of temperature, precipitation, dew point, wind speed, snowfall, soil temperature, and solar radiation. The current CONUS grid resolution is 0.125×0.125 degrees (roughly 8–14 km depending on latitude). The archive runs from 1950 to real-time, with hourly and daily temporal resolution. As of July 2025, non-CONUS domains have been added for South America, Europe, and Southeast Asia/China.

The honest version of why this exists: the IEM needed a gridded analysis product to drive agricultural modeling work — specifically the Daily Erosion Project, which requires spatially continuous precipitation and temperature fields to compute soil loss estimates across Iowa. Building IEMRE was solving that operational need. Once it existed, the IEM made it public.

6.4.2. The Data Flow

The intelligence in IEMRE is in how it sources each variable and handles the transition between real-time operational products and longer-term reanalysis products. For the CONUS domain, the precipitation chain works like this: hourly values are initially sourced from NCEP Stage IV (radar-estimated precipitation bias-corrected by gauges), then replaced with Stage IV adjusted by PRISM for dates more than eight days old, then replaced by ERA5-Land for dates before 1997. For temperature, the near-real-time source is RTMA (the NWS's Real-Time Mesoscale Analysis) for post-2010 data, falling back to a cruder ASOS grid analysis for older data and ERA5-Land before 2010. Solar radiation as of January 2023 uses HRRR for the most recent eight days and ERA5-Land for anything older.

The practical implication of this layered sourcing is that IEMRE values for a given location will change retroactively as better analysis products become available. A precipitation estimate from last week may look different in six months once the Stage IV/PRISM adjustment cycle catches up. This is appropriate behavior — the system is improving its estimates with time — but it means you should not treat IEMRE values as fixed the way you would treat a station observation.

6.4.3. When to Use IEMRE

The disclaimer on the IEMRE page points to four alternatives: ERA5-Land, DayMet, GridMet, and PRISM. Those are all genuinely good products, and for research requiring defensible, peer-reviewed, stable gridded climate data, they are better choices. IEMRE's advantages are narrow but real:

Real-time currency. IEMRE updates within about ten minutes of each hour. ERA5-Land has a five-day lag for near-real-time data, and DayMet and PRISM do not provide near-real-time at all. If you need gridded analysis for an event that happened yesterday or last week, IEMRE is the only free option.

IEM-native variables. IEMRE includes snowfall, snow depth, and soil temperature variables that are sourced from the IEM's own network data. ERA5-Land does not include observed snowfall the way COOP observers report it.

Seamless API access. The IEMRE JSON API at `/iemre/daily/{date}/{lat}/{lon}/json` and `/iemre/multiday/{date1}/{date2}/{lat}/{lon}/json` is simple to call and returns clean JSON with no authentication required. If you want gridded climate data at a specific location and you are building something that needs to run programmatically, IEMRE's API is considerably easier to work with than the NetCDF interfaces of ERA5-Land or PRISM.

Point sampling as spatial interpolation. The IEM uses IEMRE to backfill climate station values for the Climodat product — when a COOP station has missing data, the system samples from the IEMRE grid at that location as a fill value. This is documented and flagged in the output, but it means IEMRE and Climodat are tightly coupled in ways that matter for quality analysis.

6.4.4. Accessing IEMRE

The cleanest way to use IEMRE for a specific location is the JSON API. For a Pennsylvania example — say, the location of the Harrisburg airport at 40.19°N, 76.76°W — a daily query for 2024 looks like:

```
https://mesonet.agron.iastate.edu/iemre/multiday/2024-01-01/2024-12-31/40.19/-76.76/json
```

That returns a JSON object with daily values for all available IEMRE variables at the grid cell nearest to those coordinates. The output includes `high_tmpf`, `low_tmpf`, `precip_in`, `snow_in`, `snowd_in`, `rstage4_precip_in` (Stage IV precipitation), `soil4t_f` (4-inch soil temperature), and several others.

For raw gridded access, annual NetCDF files for the CONUS domain are available at mesonet.agron.iastate.edu/onsite/iemre/. These are the source files the IEM uses internally — xarray or any NetCDF-aware library can open them directly.

6.5. Model Output Statistics (MOS)

mesonet.agron.iastate.edu/mos/

MOS is one of the most useful datasets in the IEM archive for serious weather analysis, and also one of the most misunderstood. Most people who have heard of MOS think of it as "a forecast." That is true but incomplete in ways that matter for how you use the archive.

6.5.1. What MOS Actually Is

Model Output Statistics is a statistical post-processing technique applied to numerical weather prediction model output. The NWS runs a deterministic forecast model — the GFS, the NAM — which produces gridded fields of atmospheric variables at regular intervals out to some forecast horizon. Those raw model fields have systematic biases: the model might run consistently too warm at certain stations, or too wet in complex terrain, or have poor skill at certain forecast lead times for certain variables. MOS corrects for those biases by developing statistical regression equations at each forecast station that relate the model's large-scale output fields to the observed surface conditions at that station.

The equations are developed separately for each station, each variable, each season, and each forecast projection (the 6-hour, 12-hour, 24-hour, 48-hour forecast, and so on). The result is a station-specific bias correction that gives you a statistically calibrated point forecast at each location, derived from the model run but adjusted for that station's historical relationship with the model.

The practical difference between a raw GFS temperature forecast and GFS-MOS at Harrisburg: the raw GFS is interpolating from a large-scale grid cell that may not capture the Susquehanna Valley's cold-air pooling behavior in winter. The GFS-MOS equations learned from years of GFS runs and Harrisburg observations that the model needs to be adjusted downward by X degrees on calm clear nights in January, and the output reflects that. For temperature, precipitation type, and ceiling/visibility forecasts at ASOS locations, MOS has historically been competitive with or better than human forecasters at 12–24 hour lead times.

6.5.2. What the IEM Archives

The IEM's MOS archive covers nine model configurations, with the following active archive dates confirmed as of March 2026:

Model	Abbreviation	Archive Start	Status
AVN	AVN	1 June 2000	Ended 16 Dec 2003
ETA	ETA	24 Feb 2002	Ended 9 Dec 2008
GFS	GFS	16 Dec 2003	Real-time
GFS LAMP	LAV	12 Jul 2020	Real-time
GFS Extended	MEX	12 Jul 2020	Real-time
NAM	NAM	9 Dec 2008	Real-time
NBS	NBS	7 Nov 2018	Real-time
NBE	NBE	23 Jul 2020	Real-time

The GFS archive is the deepest operationally useful record, running continuously from December 2003 to present. The older AVN archive (predecessor to GFS) pushes the continuous record back to June 2000, meaning you have over two decades of consistent GFS-lineage MOS forecasts at every ASOS station in the country. That is a substantial verification dataset.

GFS vs. NAM vs. LAMP vs. NBS/NBE — what is each for?

The GFS MOS is the standard medium-range product, with projections from 6 hours out to 192 hours at 6-hour intervals for the first 72 hours and 12-hour intervals beyond. It is the workhorse.

The NAM MOS covers shorter projections — out to 60 hours — at the same 6-hour interval. NAM MOS tends to outperform GFS MOS at short ranges (6–24 hours) in complex terrain situations because the NAM runs at higher horizontal resolution over the CONUS and its mesoscale features are better resolved.

GFS LAMP (Local Analysis and Prediction System, abbreviated LAV in the IEM archive) is a very-short-range product, producing hourly projections out to 25 hours, updated every hour. It bridges the gap between the 6-hourly MOS guidance and the current observation. If you are doing hour-by-hour forecast verification or want the most frequently updated statistical guidance, LAMP is what you want.

NBS (National Blend of Models Statistics) and NBE (National Blend of Models Extended) are the successors to the GFS and MEX products respectively, blending multiple model inputs rather than relying on a single model. NBS runs from 2018 and represents the NWS's current operational statistical guidance. It uses the same MOS framework but with a multi-model ensemble as input rather than a single deterministic run.

MEX (GFS Extended) covers projections beyond 72 hours, out to 192 hours (eight days), at 12-hour intervals. Useful for extended-range verification work.

6.5.3. Using the MOS Archive

The most intuitive interface is the Interactive MOS Tables at mesonet.agron.iastate.edu/mos/table.phtml. You enter a four-character station identifier (KMDT for Harrisburg, KIPT for Williamsport, etc.), select a model, select a variable, and choose a date range. The table shows you how the model's forecast for that variable evolved across successive model runs for that period — each row is a different run time, each column is a different forecast projection. This is the interface to use when you want to see how a specific forecast evolved in time: did the GFS MOS temperature guidance for the day of a major winter storm flip dramatically 48 hours out? Did it nail the precipitation type, or was it wrong all the way through?

The raw ASCII MOS data is accessible through the text archive via the AFOS/AWIPS identifier system. Every MOS product is assigned a six-character identifier following the pattern `<model><3-char station>`. For GFS MOS at Harrisburg (MDT), that is `GFSMDT`. For NAM MOS at Harrisburg, `NAMMDT`. For LAMP at Harrisburg, `LAVMDT`. You pull these through the same text archive interface used for any NWS text product, covered in Chapter 7.

For programmatic access, the API endpoint at `/api/1/mos.json` accepts station, model, and runtime parameters and returns clean JSON. An example call pulling the most recent GFS MOS run for Harrisburg:

```
https://mesonet.agron.iastate.edu/api/1/mos.json?station=KMDT&model=GFS
```

The MOS data download form at `/fe.phtml` (linked from the MOS mainpage) lets you pull the raw MOS data for any station and time period in CSV format, with all variables for all forecast projections in a flat table. This is the format to use for bulk verification work.

Autoplot chart q=37 (MOS Forecasts vs. Actual Observations) gives you a visual monthly comparison of any MOS variable against the observed values at any ASOS station. For temperature verification, this is an excellent way to spot seasonal bias patterns — GFS MOS has historically run warm in winter at inland mid-Atlantic stations during cold-air damming events, for reasons that are directly legible in the chart when you look at January and February.

6.5.4. A Note on MOS Wind Direction Encoding

The MOS archive documentation flags one encoding issue worth knowing: wind direction (`wdr` in the database) is stored as the raw value from the text product, which is the true direction divided by 10. A `wdr` value of 27 means 270 degrees (west). This is documented in the MOS mainpage notes, but it is easy to miss if you are parsing the data without reading the documentation first.

6.6. Sounding Archive (RAOB)

mesonet.agron.iastate.edu/archive/raob/

The IEM's sounding archive covers rawinsonde (RAOB) data for US and Canadian upper-air stations, twice-daily. The primary source is the Storm Prediction Center's sounding archive, supplemented by additional backfill sources that extend some station records to the 1940s. The standard archive depth for most active stations runs from approximately the 1950s to real-time, with the twice-daily 00Z and 12Z launches from each upper-air station.

The download form at the archive URL accepts a station identifier (three or four characters — for Pittsburgh's sounding site, that is PIT; for Wallops Island, WAL; for Albany, ALB), a start time, and an end time, and returns a CSV file with all available pressure levels. The columns are station, valid UTC time, pressure in millibars, height in meters, temperature in Celsius, dew point in Celsius, wind direction, wind speed in knots, and optional balloon bearing and range where available.

The JSON API endpoint at `/json/raob.py` offers the same data with additional query flexibility. You can pull a specific pressure level across a date range — useful for examining, say, 500 hPa temperature anomalies at Albany over a specific season — rather than downloading full sounding profiles and filtering yourself.

For mid-Atlantic upper-air work, the relevant stations are DIX (Upton/New York), IAD (Sterling/Washington DC), PIT (Pittsburgh), and WAL (Wallops Island, VA). The Pittsburgh and Wallops soundings together bracket central Pennsylvania, with Pittsburgh capturing the western approach flow and Wallops representing the coastal marine environment. The IAD sounding at Sterling is particularly useful for mid-Atlantic cold-air damming analysis — the 850 hPa temperature inversion structure at Sterling during CAD events has been studied and is directly readable in the IEM sounding archive.

Special soundings — launches outside the standard 00Z and 12Z schedule issued during severe weather events — are included in the archive where available.

6.7. Rainfall Data and MRMS

mesonet.agron.iastate.edu/rainfall/

The Rainfall Data entry in the Datasets menu points to the IEM's GIS Rainfall portal, which provides access to gridded precipitation analysis products at hourly and daily time steps. The primary source is NCEP Stage IV, the NWS's multi-sensor precipitation analysis that blends NEXRAD radar estimates with rain gauge observations and quality-controls the result.

Stage IV data is available from approximately 2002 onward. The IEM archives the hourly Stage IV grib files at `/archive/data/YYYY/MM/DD/` under the `stage4/` subdirectory, and provides derived daily and multi-day accumulation maps through the Autoplot interface (q=84 for precipitation maps, q=86 for daily gridded variable maps). For precipitation analysis during a specific event, the combination of Stage IV from the IEM and gauge observations from CoCoRaHS and ASOS gives you the most complete picture available from free sources.

The MRMS (Multi-Radar/Multi-Sensor) dataset is also archived. MRMS is the successor to Stage IV for real-time QPE — it runs at higher resolution (0.01 degree, roughly 1 km) and updates every 2 minutes rather than hourly. The IEM archives MRMS daily totals in NetCDF format at `/onsite/mrms/`, and the IEMRE system uses MRMS as a supplemental precipitation source. For event analysis where sub-hourly precision matters — a convective storm with sharp gradients — the MRMS archive is substantially more useful than Stage IV.

6.8. Soil Moisture Satellite

mesonet.agron.iastate.edu/smos/

The SMOS (Soil Moisture and Ocean Salinity) satellite dataset entry is a niche product for most weather enthusiasts — it provides passive microwave-derived soil moisture estimates from ESA's SMOS satellite. The IEM archives and displays these for agricultural and hydrological research applications. For climate hobbyists, this is a dataset to know exists rather than one you will use regularly.

6.9. What to Watch Out For

The MOS archive has a backfill boundary. The IEM news post announcing MOS archiving in January 2009 noted that the archive was complete back to December 2008 at that point, with the possibility of further backfill. The GFS archive ultimately extends to December 2003. There is no MOS data at the IEM for anything before that, and the period between late 2003 and late 2008 may have occasional gaps depending on when different models entered the archive. For verification studies that need to go back before 2003, the NWS MDL maintains its own archives through a separate access pathway.

IEMRE values change retroactively. As noted above, the IEMRE pipeline replaces provisional estimates with better analysis products as they become available. If you download IEMRE data today for a date six months ago, the values may differ slightly from what you would have downloaded six months ago for that same date. This is by design but it matters for reproducibility — if you are building a research pipeline, either snapshot the data at a point in time or use a stable product like ERA5-Land where retroactive updates are versioned and documented.

RAOB data is not radar-verified. The sounding archive represents what the radiosonde actually measured as the balloon ascended. It is not quality-controlled against radar wind profilers or other independent measurements. Gross outliers do exist in the record — occasional instrument failures, balloon drift issues, or data transmission errors. For research applications involving the sounding archive, independent QC is good practice.

Daily summaries and COOP observation time. The IEM's daily summary dataset uses a fixed 24-hour UTC period for its computations, which does not always match the observation time of the COOP reporter at that station. A COOP observer who takes their reading at 7 AM local time is reporting the 24-hour period ending at 7 AM, not the calendar day. This can create apparent discrepancies between the IEM daily summary and the raw COOP observation, particularly for precipitation and temperature extremes on days with overnight events. The COOP observation time (TOBS) is documented in the station metadata and is the key to resolving these discrepancies when they appear.

6.10. Workflow 1 — Looking Up Period-of-Record Daily Extremes for a COOP Station

The question: What is the all-time record high temperature for January 17th at your local COOP station? What year did it occur?

Start here: https://mesonet.agron.iastate.edu/COOP/extremes.php

The page presents a simple form: select a state and a date. The state dropdown defaults to Iowa — change it to Pennsylvania (or whichever state you are working in). Set the month and day to January 17. Submit.

What you get back is a table of every COOP station in that state with records for that date — station ID, station name, record high temperature, record low temperature, record precipitation, and the year each record was set. The table is sortable by any column, which is useful if you want to quickly scan for the most extreme values across the state rather than looking at a specific station.

To get the full annual record for a single station, click the station ID in the table. This takes you to a station-specific view showing every calendar day of the year with its record high, record low, and record precipitation, all drawn from the COOP archive for that station. For a station like Harrisburg with records going back to the late nineteenth century, this is a genuinely rich historical document — you can see the depth of the record and the years in which the extremes were set.

A few things to watch for: this tool covers the COOP network, not ASOS. The COOP record at a given location may extend back further than the ASOS record, but it is a once-daily observation rather than hourly. If you are looking for extreme hourly values — record hourly precipitation, record sustained wind — you will need Autoplot rather than this tool. Also note the "unofficial" label: these are IEM-computed records from the COOP archive, not the formally certified NWS climate records for the station.

6.11. Key URLs — Chapter 6

Page	URL
Daily Climatology / COOP Extremes	mesonet.agron.iastate.edu/COOP/extremes.php
COOP Normals Download	mesonet.agron.iastate.edu/COOP/dl/normals.phtml
Daily Observations Download	mesonet.agron.iastate.edu/request/daily.phtml
Dataset Documentation	mesonet.agron.iastate.edu/info/datasets/
Variables Reference	mesonet.agron.iastate.edu/info/variables.phtml
IEM Reanalysis (IEMRE)	mesonet.agron.iastate.edu/iemre/

Page	URL
IEMRE CONUS NetCDF Files	mesonet.agron.iastate.edu/onsite/iemre/
IEMRE Daily API	mesonet.agron.iastate.edu/iemre/daily/{date}/{lat}/{lon}/json
IEMRE Multiday API	mesonet.agron.iastate.edu/iemre/multiday/{date1}/{date2}/{lat}/{lon}/json
Model Output Statistics	mesonet.agron.iastate.edu/mos/
MOS Interactive Table	mesonet.agron.iastate.edu/mos/table.phtml
MOS API (JSON/CSV)	mesonet.agron.iastate.edu/api/1/docs#/default/service_mos___fmt___get
MOS Raw Download	mesonet.agron.iastate.edu/fe.phtml
MOS vs. Observations Chart (q=37)	mesonet.agron.iastate.edu/plotting/auto/?q=37
Sounding Archive	mesonet.agron.iastate.edu/archive/raob/
RAOB JSON API	mesonet.agron.iastate.edu/json/raob.py?help=
Rainfall / Stage IV Portal	mesonet.agron.iastate.edu/rainfall/
MRMS NetCDF Archive	mesonet.agron.iastate.edu/onsite/mrms/
Stage IV Archive	mesonet.agron.iastate.edu/onsite/stage4/
NEXRAD Mosaic Documentation	mesonet.agron.iastate.edu/docs/nexrad_mosaic/
Soil Moisture Satellite (SMOS)	mesonet.agron.iastate.edu/smos/
Climodat Reports	mesonet.agron.iastate.edu/climodat/

7. Chapter 7 — NWS Data: Warnings, Forecasts, and Official Products

Every other chapter in this guide has been about observational data — what the atmosphere actually did, as measured by sensors and reported by observers. This chapter is different. The NWS Data section of the IEM is an archive of decisions: what forecasters thought was happening, what they warned the public about, when they issued those warnings relative to the event, and what language they used to justify the call. That is a fundamentally different kind of record, and it requires a different frame of mind to use effectively.

The NWS Mainpage at mesonet.agron.iastate.edu/nws/ is the hub for all of it. It is one of the most link-dense pages on the IEM — dozens of individual tools organized by category — and one of the easiest places to feel lost. This chapter works through it systematically, with the deepest treatment reserved for VTEC, which is the structural backbone that makes almost everything else here possible.

7.1. VTEC: The Backbone of the Warning Archive

Before touching any individual tool, you need to understand VTEC — not because it is complicated, but because once you do understand it, every warning archive tool on the IEM suddenly makes sense.

VTEC stands for Valid Time Event Code. It is the structured metadata system the NWS began embedding in its watch, warning, and advisory products in 2005. Before VTEC, a tornado warning was just a text product with a start time and a geographic area. There was no systematic way to track whether that warning was extended, updated, cancelled, or superseded by a new issuance. Post-event analysis required reading each text product manually and reconstructing the timeline by hand.

VTEC changed that by requiring each significant weather product to carry a machine-parseable code block that encodes everything needed to track the full lifecycle of that event. A typical VTEC string looks like this:

```
/O.NEW.KCTP.TO.W.0012.240615T2031Z-240615T2200Z/
```

Reading left to right: the `/O.` indicates this is an operational (not test) product. `NEW` is the action code — this is a new issuance. `KCTP` is the four-character WFO identifier (State College, Pennsylvania). `TO` is the phenomena code — tornado. `W` is the significance — Warning (as opposed to A for Watch, Y for Advisory, or S for Statement). `0012` is the Event Tracking Number (ETN) — the twelfth tornado warning issued by CTP in this calendar year. `240615T2031Z` is the event begin time in UTC, and `240615T2200Z` is the initial expiration time.

When forecasters update a warning — to extend its coverage, extend its time, or cancel it before the original expiration — they issue a follow-up product with its own VTEC string using action codes like `CON` (continued), `EXT` (extended), `CAN` (cancelled), or `EXP` (expired naturally). The IEM tracks all of these and links them together by ETN, giving you the complete lifecycle of every VTEC event in its archive rather than a pile of disconnected text products.

7.1.1. What the ETN Tells You

The Event Tracking Number is unique per WFO, per phenomena/significance combination, per calendar year. CTP's twelfth tornado warning of 2024 is always CTP-TO.W-0012-2024, regardless of which county it covered or which day it was issued. This means ETNs reset on January 1 of each year, which has an important practical implication: when you are searching across a year boundary, you need to specify the year explicitly. A search for "CTP tornado warnings" without a year constraint will return results across all years, and the ETN numbering starts over each time.

The maximum ETN issued by a WFO in a given year is a rough proxy for event frequency. The IEM has a page at /vtec/maxetn.php that shows the highest ETN reached by each WFO each year for any phenomena/significance type. If you want to know whether 2024 was an unusually active tornado warning year for a specific WFO, this is the fastest way to check.

7.1.2. Phenomena and Significance Codes

The phenomena code is always two letters. The most common ones for weather enthusiasts: `TO` (Tornado), `SV` (Severe Thunderstorm), `FF` (Flash Flood), `FA` (Areal Flood), `FL` (Flood), `WS` (Winter Storm), `WW` (Winter Weather), `BZ` (Blizzard), `IS` (Ice Storm), `ZR` (Freezing Rain), `WI` (Wind), `SC` (Small Craft), `FW` (Fire Weather), `HU` (Hurricane), `TS` (Tropical Storm), `SS` (Storm Surge). The significance codes: `W` (Warning), `A` (Watch), `Y` (Advisory), `S` (Statement), `O` (Outlook), `N` (Synopsis), `F` (Forecast).

So `SV.A` is a Severe Thunderstorm Watch, `WS.W` is a Winter Storm Warning, `FF.W` is a Flash Flood Warning, and `ZR.Y` is a Freezing Rain Advisory. Once you have internalized this two-part structure, every IEM warning search interface becomes immediately legible.

7.2. The VTEC Browser

mesonet.agron.iastate.edu/vtec/

The VTEC Browser is the IEM's event-level interface to the warning archive. It was substantially rewritten in June 2025, so if you have used it before and things look different, that is why. The interface asks you to select a WFO, a phenomena type, a significance, and a year and event number, then loads a complete event record with six tabs: Help, Event Info, Text Data, Interactive Map, Storm Reports, and List Events.

The power is in what each tab shows. **Event Info** gives you the structured metadata: issue time, expiration time, the full list of counties/parishes/zones included in the product, the polygon geometry if it is a storm-based warning, and the area in square kilometers. **Text Data** shows you the full raw text of every product associated with that event — the initial issuance and every subsequent update or cancellation in chronological order. **Interactive Map** overlays the warning polygon on an archival radar composite at the time of issuance — the IEM fetches the appropriate NEXRAD mosaic for the event time automatically. **Storm Reports** shows all Local Storm Reports within the warning's political coverage area (the zone or county), and — for storm-based warnings — also filters the subset of LSRs that fall within the actual warning polygon. **List Events** shows every event of the selected type and year for that WFO, so you can browse and click through the season's entire record.

The URL structure for a specific event is clean and bookmarkable: `/vtec/YYYY-O-NEW-KWFO-PH-SIG-NNNN` where KWFO is the four-character WFO, PH is phenomena, SIG is significance, and NNNN is the zero-padded ETN. For CTP's twelfth tornado warning of 2024: `/vtec/2024-O-NEW-KCTP-TO-W-0012`. That URL takes you directly to that event — no navigation required. This makes it easy to construct links to specific events when discussing them on a forum.

7.3. Warning Search

mesonet.agron.iastate.edu/vtec/search.php

Where the VTEC Browser navigates event by event, the Warning Search is how you query the archive at scale. You can filter by WFO, phenomena type, significance, date range, and geography — either by selecting a state and county or by clicking a point on the map. Results return a table of matching events with their issue time, expiration, ETN, and area, each row linking directly into the VTEC Browser for that event.

The geographic point search is particularly powerful for personal-use questions: "how many tornado warnings have covered my town in the last twenty years?" Click your location on the map, set the date range and the phenomena filter, and the IEM returns every VTEC event whose polygon or county/zone coverage included that point. This is the tool to reach for when a forum discussion turns to "how warning-prone is this area" and you want to answer with actual data rather than anecdote.

The search also supports the reverse question: "show me everything CTP issued in June 2024." Set the WFO to CTP, leave geography open, set the date range to June 2024, and select all warning types. The result is a complete operational log of that month's warning activity for that office, sortable by time, type, or area.

7.4. Storm-Based Warnings and IEM Cow

Before October 1, 2007, NWS warnings were issued for entire counties. A tornado warning for Lancaster County, Pennsylvania covered all 946 square miles of it, regardless of where the storm was actually tracking. On that date, the NWS switched to Storm-Based Warnings (SBW) — polygonal areas drawn to cover the actual storm track, typically much smaller than a county, updated in real time as the storm moves. The IEM archives both the pre-SBW county-based warnings and the post-SBW polygon warnings, and the distinction matters enormously for verification work.

IEM Cow (Convective Warning Verification) at mesonet.agron.iastate.edu/cow/ is the tool built specifically to work with the SBW polygon archive. Its name is not an acronym — it is just a cow. The tool lets you select a WFO, a date range, and a warning type, and it computes verification statistics by comparing issued warning polygons against Local Storm Reports.

The core metrics Cow produces: probability of detection (POD, the fraction of LSRs inside a warning polygon), false alarm ratio (FAR, the fraction of warnings with no confirming

LSR inside the polygon), and critical success index (CSI, which combines both). It also reports lead time — the median number of minutes between warning issuance and the first confirming LSR — and the area-weighted coverage statistics. These are the same metrics used in published NWS verification studies, so Cow results are directly comparable to the peer-reviewed literature on warning performance.

A few things to understand about interpreting Cow results. LSRs are the verification ground truth, which means Cow inherits all the limitations of the LSR network: spotter coverage is uneven, nighttime and rural events are underreported, and some event types (particularly wind damage) are systematically under-LSR'd in low-population areas. A high FAR on a rural WFO's tornado warnings may reflect poor spotter coverage as much as it reflects poor warning skill. Cow is an excellent tool for trend analysis and comparative studies, but interpreting the absolute numbers requires contextual judgment about the LSR network's completeness in the area being studied.

Cow works for dates after June 8, 2005, with the SBW polygon verification only meaningful after October 2007 when polygons became the operational standard. For dates before October 2007, the application runs in county-based mode.

The companion tool IEM Raccoon at mesonet.agron.iastate.edu/raccoon/ generates Microsoft PowerPoint presentations of storm-based warning records for a WFO and radar site, useful for training materials or post-event briefings where you want visual documentation of the full warning sequence.

7.5. Local Storm Reports

mesonet.agron.iastate.edu/lsr/

Local Storm Reports are the NWS's real-time field observations of weather impacts: tornado touchdowns and paths, hail size and location, measured or estimated wind gusts, wind damage, flooding, waterspouts, and other significant phenomena. They are issued by WFO meteorologists and their spotter networks throughout an event and archived by the IEM in real time.

The LSR App at `/lsr/` lets you query the archive by WFO, date range, event type, magnitude thresholds (minimum hail size, minimum wind speed), and geographic extent. Results display on an interactive map and in a sortable table, with each report showing the reporting source (trained spotter, law enforcement, public, emergency management, etc.), the time, the location, and any magnitude values.

For archived LSRs as shapefiles — useful for GIS analysis — the download portal is at /request/gis/lsrs.phtml, which covers the archive back to 2003. For the past 24 hours, a live shapefile, CSV, and GeoJSON are always available at static URLs in the IEM data directory:

- Shapefile: `/data/gis/shape/4326/us/lsr_24hour.zip`
- CSV: `/data/gis/shape/4326/us/lsr_24hour.csv`
- GeoJSON: `/data/gis/shape/4326/us/lsr_24hour.geojson`

These files update every five minutes and are the fastest way to get a current snapshot of field reports during an active event.

What LSRs are not: they are not a complete record of impacts. They reflect what spotters and observers happened to report, which means sparsely populated areas, events that happen at night, and event types that do not produce easily visible damage are all systematically underrepresented. The IEM's LSR Snowfall Analysis (Autoplot q=207) is one of the more instructive examples of this gap — the snowfall LSR map for any given winter storm will show dense reporting near population centers and conspicuous holes in rural areas where snowfall may have been just as heavy but no one submitted a report.

7.6. The Text Archive

mesonet.agron.iastate.edu/nws/text.php

The IEM archives essentially the full NOAAPORT text product feed — every text product transmitted by the NWS, going back to the mid-2000s for most product types. This includes Area Forecast Discussions (AFDs), Public Information Statements, Special Weather Statements (SPS), CLI daily climate summaries, CF6 monthly climate reports, hydro products, terminal forecasts, and the full body of watch and warning text. If the NWS transmitted it over NOAAPORT, there is a high probability the IEM has it.

7.6.1. The AFOS/AWIPS Identifier System

Every text product in the archive has an AFOS/AWIPS identifier — a 3 to 6 character code that uniquely identifies the product type and issuing center. The pattern is `TTSSSS` where the first two or three characters identify the product type and the remaining characters identify the WFO or center. Examples: `AFDCTP` is the Area Forecast Discussion from State College (CTP). `TORDMX` is a Tornado Warning from Des Moines (DMX). `CFWCTP` is a Coastal Flood Watch from CTP. `RWRKCI` is the Regional Weather Roundup from Kansas City.

The IEM assigns its own longer internal identifier to each product in the format `YYYYmmddHHMM-CCCC-TTAAII-AFOSID`, where the timestamp is UTC, CCCC is the issuing center, TTAAII is the WMO header, and AFOSID is the AFOS identifier. You can paste this full identifier directly into the IEM search box and land immediately on that product — useful when someone shares a specific product ID and you want to pull it up quickly.

7.6.2. The AFOS Product Finder

The primary interface for text retrieval is the AFOS Product Finder at mesonet.agron.iastate.edu/wx/afos/. You enter an AFOS identifier and optionally a date range, and it returns all matching products in reverse chronological order, each one displaying the full raw text. For AFD research — reading what CTP forecasters were thinking during a specific event — this is the tool. Enter `AFDCTP`, set a date range around the event, and read every AFD issued during the period.

The bulk retrieval API at `/cgi-bin/afos/retrieve.py` accepts date-range queries by AWIPS ID and returns the raw text, making it straightforward to collect a full season's AFDs for text analysis without clicking through hundreds of individual products.

The List Products by WFO page at /wx/afos/list.phtml shows all products issued by a given WFO on a given date, organized by product type. If you know the date but not which specific products you want, this is the browsable starting point.

7.6.3. Area Forecast Discussions

AFDs deserve special mention because they are arguably the most valuable product in the text archive for weather enthusiasts trying to understand not just what happened but why. The AFD is where the forecaster exposes their reasoning — the synoptic pattern they are tracking, the model guidance they trust and distrust, the mesoscale features they are watching, the uncertainty in the forecast, and the specific thresholds that would trigger a warning or advisory upgrade. Reading AFDs for an event you lived through is the closest thing to sitting in the forecast office with the meteorologist.

For the Pennsylvania forecast region, CTP's AFDs at `AFDCTP` are the primary product. Events that spanned multiple WFO boundaries — a major nor'easter, a line of severe thunderstorms moving east from the Ohio Valley — are illuminated by reading adjacent office AFDs alongside CTP's: `AFDPHI` (Mount Holly, NJ), `AFDPBZ` (Pittsburgh), `AFDLWX` (Baltimore/Washington), `AFDBGM` (Binghamton). The AFD record for the most operationally interesting storms in the mid-Atlantic region is one of the richer archives of applied mesoscale reasoning that exists in any publicly accessible form.

7.6.4. CLI and CF6: Daily Climate Products

Two text product types are particularly useful for historical climate research. The CLI (Climate Report) is issued daily by each WFO for its primary ASOS stations and summarizes the previous day's temperature, precipitation, and snowfall against the normal and record values. The IEM parses these and provides interactive tables and maps: the CLI interactive map is at /nws/climap.php and the text table at /nws/clitable.php. For any ASOS station that a WFO designates as a climate site, the CLI provides the official daily climate summary including the departure from normal and the record comparison.

The CF6 (Monthly/Daily Climate Data) is the monthly version, summarizing the calendar month's climate statistics at each climate site. The IEM parses CF6 products and makes them available in tabular form at /nws/cf6table.php. For Harrisburg (KMDT), the CF6 archive going back through the IEM's text product archive gives you the official monthly climate summary — maximum and minimum temperature, heating and cooling degree days, precipitation total and departure, snowfall total — in a consistent format across years.

7.7. SPC Products

The NWS Data section gives substantial coverage to Storm Prediction Center products, and for weather enthusiasts focused on severe weather climatology, these are essential.

Convective outlooks are archived in shapefile format at /request/gis/spc_outlooks.phtml. The outlook search by point at /nws/spc_outlook_search/ answers the question "when was my location last under a Moderate or High risk?" — which is a surprisingly hard question to answer from any other free source. Set your location, select the outlook category, and the IEM returns every instance going back through the archived record.

Mesoscale Convective Discussions (MCDs) are available as shapefiles at /request/gis/spc_mcd.phtml. MCDs are the products SPC issues when conditions are evolving and they want to flag forecasters and the public ahead of a potential watch. Reading the MCD text alongside the subsequent watch issuance (or non-issuance, when the situation does not materialize) gives you the SPC's real-time situational awareness for a given event.

SPC Watches are archived at /request/gis/spc_watch.phtml and displayed interactively at /GIS/apps/rview/watch.phtml. The watch archive includes the polygon geometry, the issue and expiration times, and the watch type (Tornado Watch, Severe Thunderstorm Watch, PDS Watch). A listing of all SPC watches by year with their ETNs is at /nws/watches.php, and PDS watches specifically are listed at /nws/pds_watches.php.

The WPC (Weather Prediction Center) has analogous products for the precipitation side of operations. WPC Mesoscale Precipitation Discussions (MPDs) are at /request/gis/wpc_mpd.phtml, and the WPC outlook search by point at /nws/wpc_outlook_search/ answers the equivalent question for excessive rainfall outlooks.

7.8. Special Weather Statements and Warning Tags

Two additional tools on the NWS Mainpage that are easy to overlook:

Special Weather Statement (SPS) search at /nws/sps_search/ lets you find SPSs by point, which is useful because SPSs are not VTEC-coded and therefore not searchable through the main warning archive tools. SPSs cover significant weather that does not meet warning criteria — an approaching squall line, an area of locally dense fog, a wind event that is significant but below advisory thresholds. They often contain the most operationally useful text for understanding borderline events.

SVR and TOR warning tags at /nws/list_tags.php lists the damage indicator and tornado rating tags embedded in Severe Thunderstorm and Tornado Warnings by WFO and year. When the NWS began tagging tornado warnings with the expected maximum EF scale, hail warnings with the maximum expected hail size, and severe thunderstorm warnings with the maximum expected wind speed, the IEM began archiving those tags. This page lets you browse what tags a specific WFO has used, which provides a quick proxy for event severity distribution across years.

7.9. Verification Autoplot Charts

Several Autoplot charts work directly with the VTEC archive for warning climatology analysis:

q=44 — Accumulated WFO Watch/Warning/Advisory totals. Plots the cumulative count of a specific warning type by WFO over a season or date range. Useful for comparing how active a particular warning type has been relative to prior years.

q=52 — Warning Gantt chart. Shows the timeline of all warnings of a given type from a WFO across a season, one row per event, colored by phenomena. The Gantt format makes patterns in warning clustering and seasonal distribution immediately visible.

q=92 — Days since last VTEC product. A map showing, for each WFO, how many days have elapsed since a specific warning type was last issued. Useful during quiet periods to contextualize how long the current stretch of inactivity is relative to the climatological distribution.

q=109 — Number of VTEC events by WFO. A choropleth map of warning counts by WFO for any selected type and time period — the fastest way to visualize the geographic distribution of warning activity across the country.

q=211 — Warning lead time distribution. A histogram of lead times (minutes between issuance and first confirming LSR) for tornado or severe thunderstorm warnings, by WFO and year. This is the visualization most directly connected to the Cow verification statistics.

7.10. River and Hydrology Products

The NWS Mainpage has a hydrology section that is often overlooked by severe weather-focused users but is valuable during flood events.

The **River Forecast Point Monitor** at mesonet.agron.iastate.edu/river/ summarizes Flood Stage Forecasts (FLS statements) by river and by WFO or state. It provides a tabular view of all river forecast points, their current stage versus action/flood/major/record stage, and the trend. For a flooding event, this is the IEM equivalent of the NWS's Advanced Hydrologic Prediction Service (AHPS) viewer — organized differently but drawing from the same FLS product archive.

HML (Hydrometric Message Language) data is available as archived processed products at /request/hml.php, giving you the numeric river forecast data behind the FLS text products. Autoplot q=160 renders these as interactive plots of forecasted versus observed stage at any river forecast point — the same view the hydrologist at the WFO is looking at when they issue a flood statement.

7.11. What to Watch Out For

Pre-2005 warnings lack VTEC. The NWS began operational VTEC in 2005. Products before that date are in the text archive but have no structured VTEC metadata, meaning the Browser and Cow tools do not work with them. For historical warning research before

2005, you are working with raw text files and NCEI's Storm Events Database, not IEM's structured tools.

Pre-2007 polygon geometry. Storm-Based Warning polygons became operational in October 2007. Before that date, even post-VTEC warnings are county-based, and the polygon geometry in the VTEC Browser will show the county boundary rather than a storm-tracking polygon. Cow treats this correctly — it runs in county mode for pre-October 2007 dates automatically — but be aware of the shift when working across that boundary.

ETN resets and year-boundary searches. As noted above, ETNs reset on January 1. A search that spans December into January will return warning events with ETNs that restart at 1 in the new year. This is expected behavior, not a data error, but it can confuse automated analysis if you are not handling it explicitly.

LSR incompleteness as a verification floor. Because Cow and the VTEC Browser both use LSRs as the ground truth for verification, every caveat about LSR completeness applies to all derived statistics. An unusually high FAR for a specific WFO or year may reflect poor spotter coverage as much as poor warning accuracy. Context always matters.

The text archive has product type gaps. Not every product type has been archived continuously since 2005. Some product categories have gaps, particularly for the period 2005–2008 during the IEM's early text archiving work. If you cannot find a specific product that you know was issued, check the IEM news archive for notes about that product type's ingestion history.

7.12. Workflow 3 — Researching a Past Warning Event End to End

The question: On a specific date, a Tornado Warning was issued for Dauphin County, Pennsylvania. What was the lead time? What did the polygon look like? Were there any storm reports? What did the warning text say?

Start here: https://mesonet.agron.iastate.edu/vtec/search.php

The VTEC search page lets you find NWS warnings by county or by geographic point, filtered by phenomena type and date range. To find a Tornado Warning for Dauphin County, PA: select Pennsylvania from the state menu, select Dauphin County from the county menu, set the phenomena to Tornado Warning (TO.W), and set your date range. Submit.

The results table shows every Tornado Warning that touched Dauphin County within your date range — each row shows the issuing WFO (PHI or CTP for central Pennsylvania), the event date, the VTEC Event Tracking Number (ETN), the issuance time, the expiration time, and whether it was a storm-based warning with a polygon. Click the event link to go to the individual event page.

The event page is where the full picture assembles. At the top you get the warning metadata: issue time, expire time, phenomena and significance codes, WFO, ETN. Below that is the storm-based warning polygon rendered on a map, showing exactly what area was under the warning. Below the map is the raw NWS text product — the warning as it was originally transmitted, in full, with the original VTEC line intact.

From the event page, two additional tools are one click away. The IEM Cow link (at https://mesonet.agron.iastate.edu/cow/) provides verification statistics for that warning — whether a storm report fell within the polygon, what the lead time was to any confirmed tornado, and how the warning's performance compares to the WFO's averages. The Local Storm Reports link takes you to all LSRs within a user-specified buffer radius of the warning polygon around the time of the event, giving you the observed tornado touchdowns, hail reports, or wind damage reports that the warning was issued for.

One important constraint to know before you start: the IEM VTEC archive has no known gaps since November 12, 2005. Before that date, coverage depends on what was available for retroactive assignment. Tornado and Severe Thunderstorm Warnings before 2005 are partially present — IEM retroactively assigned VTEC identifiers using available data — but the completeness of pre-2005 warning events is variable and should not be assumed complete for any specific event.

7.13. Key URLs — Chapter 7

Page	URL
NWS Mainpage	mesonet.agron.iastate.edu/nws/
VTEC Browser	mesonet.agron.iastate.edu/vtec/
Warning Search by Point/County	mesonet.agron.iastate.edu/vtec/search.php
IEM Cow (SBW Verification)	mesonet.agron.iastate.edu/cow/
IEM Raccoon (SBW PowerPoints)	mesonet.agron.iastate.edu/raccoon/
Local Storm Report App	mesonet.agron.iastate.edu/lsr/
LSR Archive Download	mesonet.agron.iastate.edu/request/gis/lsrs.phtml
Text Archives Mainpage	mesonet.agron.iastate.edu/nws/text.php

Page	URL
AFOS Product Finder	mesonet.agron.iastate.edu/wx/afos/
Products by WFO by Date	mesonet.agron.iastate.edu/wx/afos/list.phtml
AFOS Bulk Retrieve API	mesonet.agron.iastate.edu/cgi-bin/afos/retrieve.py?help
CLI Interactive Map	mesonet.agron.iastate.edu/nws/climap.php
CF6 Monthly Climate Table	mesonet.agron.iastate.edu/nws/cf6table.php
SPC Outlook Search by Point	mesonet.agron.iastate.edu/nws/spc_outlook_search/
SPC Outlook / MCD Shapefile	mesonet.agron.iastate.edu/request/gis/spc_outlooks.phtml
SPC Watch Shapefile	mesonet.agron.iastate.edu/request/gis/spc_watch.phtml
SPC Watches by Year	mesonet.agron.iastate.edu/nws/watches.php
SPC PDS Watch Listing	mesonet.agron.iastate.edu/nws/pds_watches.php
SPC MCD Shapefile	mesonet.agron.iastate.edu/request/gis/spc_mcd.phtml
WPC MPD Shapefile	mesonet.agron.iastate.edu/request/gis/wpc_mpd.phtml
WPC Outlook Search by Point	mesonet.agron.iastate.edu/nws/wpc_outlook_search/
SPS Search by Point	mesonet.agron.iastate.edu/nws/sps_search/
SVR/TOR Warning Tags by WFO	mesonet.agron.iastate.edu/nws/list_tags.php
Max ETN by WFO by Year	mesonet.agron.iastate.edu/vtec/maxetn.php
VTEC Events by Year Table	mesonet.agron.iastate.edu/vtec/yearly_counts.php
Tornado/FF Emergency Listing	mesonet.agron.iastate.edu/vtec/emergencies.php
PDS Warning Listing	mesonet.agron.iastate.edu/vtec/pds.php
Warning Polygons (current WWA)	mesonet.agron.iastate.edu/request/gis/watchwarn.phtml
River Forecast Monitor	mesonet.agron.iastate.edu/river/
HML Data Download	mesonet.agron.iastate.edu/request/hml.php
HML Forecast/Obs Plot (q=160)	mesonet.agron.iastate.edu/plotting/auto/?q=160
Autoplot — Warning Gantt (q=52)	mesonet.agron.iastate.edu/plotting/auto/?q=52

Page	URL
Autoplot — VTEC Counts Map (q=109)	mesonet.agron.iastate.edu/plotting/auto/?q=109
Autoplot — Days Since WWA (q=92)	mesonet.agron.iastate.edu/plotting/auto/?q=92
Autoplot — Accumulated WWA (q=44)	mesonet.agron.iastate.edu/plotting/auto/?q=44

Part III.

Part III — Data Access and Quality

8. Chapter 8 — Downloading Data: Every Portal Explained

At some point, browsing the IEM's interactive tools stops being enough. You want the numbers — a CSV you can open in Python or Excel, a time series you can run statistics on, a dataset you can join against something else. The IEM has more download pathways than almost any free weather data source, which is its strength and also its main source of confusion. Knowing which endpoint to use for a given task is not always obvious, because several of them overlap, several of them are labeled for something slightly different from what they actually do, and a few of the most powerful ones have no front-end interface at all.

This chapter provides a working taxonomy. The goal is not to document every parameter of every endpoint — the IEM's own help pages already do that, and they are genuinely good. The goal is to give you a mental model so that when you have a specific data need, you immediately know which pathway to reach for and why.

8.1. The Four Tiers

The IEM's download infrastructure divides into four tiers, each with a different character:

Tier 1 — UI download portals. These are web forms — select a station, choose a date range, pick your variables, click Get Data. No programming required. The output is a CSV or Excel file that downloads to your browser. Most IEM users never leave this tier.

Tier 2 — CGI/bulk services. These are the backends that power the UI portals, exposed directly as scriptable HTTP endpoints. They take the same parameters as the web forms, but via URL query strings instead of form fields. You can call them from Python, R, curl, or anything that makes HTTP requests. Output is CSV. This is where serious workflow automation starts.

Tier 3 — JSON/GeoJSON ad-hoc services. A large collection of JSON endpoints, most serving structured metadata, current conditions, or event-based data. Not all of these have UI wrappers. Many are used internally by IEM applications and have never been prominently advertised, but they all have help pages at `?help=`.

Tier 4 — API v1. The formal REST API, built on FastAPI with Swagger documentation at mesonet.agron.iastate.edu/api/1/docs. Designed for smaller, fast requests — MOS data, station metadata, VTEC events, soundings. Returns JSON Table Schema responses. This is the cleanest, most stable interface, but it covers a narrower range of datasets than the CGI tier.

The IEM's own API documentation page is refreshingly honest about the hierarchy. It notes the CGI services are "2000s era" and not amenable to sub-second response times, and it points to Tier 4 for anything that needs to run fast. That honesty is useful: if you need a year of hourly ASOS data, you want Tier 2. When you need the current MOS guidance for a station, you want Tier 4.

8.2. Tier 1: The UI Download Portals

8.2.1. ASOS/AWOS/METAR Download

mesonet.agron.iastate.edu/request/download.phtml

This is the portal most people mean when they say they downloaded data from the IEM. It covers the global ASOS/AWOS/METAR archive — airport weather stations across the entire world, not just the US — with hourly and special observations going back in some cases to 1900, though the continuous reliable record for most US stations starts in the early 1970s. The UI walks you through seven steps: network selection, station selection, variable selection, date range, timezone, output format, and report type filtering.

The variable list on this portal is comprehensive and worth reading once in full. The standard set is temperature in Fahrenheit or Celsius, dew point, relative humidity, wind direction and speed, altimeter and sea level pressure, 1-hour precipitation, visibility, wind gusts, sky coverage at up to four levels with cloud base heights, present weather codes, ice accretion at 1/3/6 hours, peak wind gust with direction and time (from the PK WND METAR remark), snow depth, and the raw METAR string. All of these are available simultaneously with the "All Available" option, or you can select a subset.

A few variable-specific notes that matter for real analysis:

Precipitation (`p01i`) is the one-hour incremental bucket reading — the amount that fell in the hour preceding the observation time. It is not a daily total. Summing `p01i` across 24 hours gives you a daily total, but the effective reset timing can vary slightly by station, and missing observations can create holes that are not always obvious in a simple sum. The trace precipitation convention — 0.0001 inches — is used when precipitation is reported as Trace in the original METAR.

Sky coverage (`skyc1` through `skyc4`) uses METAR codes: CLR, FEW, SCT, BKN, OVC, VV (vertical visibility). The corresponding height fields (`skyl1`–`skyl4`) are the cloud base altitudes in feet AGL. These are the raw decoded values from the METAR remark, not derived ceiling values — if you want a ceiling field, you need to derive it yourself as the lowest BKN or OVC layer.

Present weather codes (`wxcodes`) are space-separated strings of METAR weather codes: RA (rain), SN (snow), FG (fog), BR (mist), TS (thunderstorm), FZRA (freezing rain), PL (ice pellets), GR (hail), and their intensity modifiers (+, -) and descriptors (MI, BC, DR, BL, SH, TS, FZ, PR). For precipitation-type analysis, these codes are the closest thing to ground truth in the archive, combining automated sensing with human observation when available.

Report type filtering (Step 6 in the UI) is worth paying attention to. The options are MADIS HFMETAR/5-Minute ASOS, Routine/Once Hourly, and Specials. For most analysis, you want both Routine and Specials — specials are the intermediate observations triggered by significant changes in conditions (a rapid temperature drop, a wind shift, the onset of precipitation). Excluding specials gives you a cleaner hourly record but loses the precise timing of significant weather events. The 5-Minute ASOS data is a separate product from MADIS and covers US stations from approximately 2000 onward; it is not available for international stations.

The aggregate request limit is 1,000 station-years. For context, that means one station for 1,000 years, or 100 stations for 10 years, or 1,000 stations for one year. This is a generous limit but it is enforced, so queries asking for many stations over long periods will fail if they exceed it.

8.2.2. ASOS 1-Minute Download

mesonet.agron.iastate.edu/request/asos/1min.phtml

Separate from the standard ASOS portal, the 1-minute data archive covers US ASOS stations from approximately 2000 to present. At this resolution, you can see the actual minute-by-minute wind, temperature, and precipitation evolution within an event. For post-chase analysis, front-passage timing, or extracting the exact minute of a convective peak wind observation, this is the dataset. The Iowa AWOS 1-minute archive covers a different set of stations (Iowa AWOS only) for the period 1995–2011 and is at a separate portal at /request/awos/1min.php.

8.2.3. COOP / Climodat Download

mesonet.agron.iastate.edu/request/coop/fe.phtml

The Climodat download portal serves the long-period daily climate record from the NWS COOP network and the IEM's processed Climodat stations. This is the dataset for any analysis that needs daily max/min temperature, precipitation, and snowfall going back decades. Climodat data at some stations extends to the 1880s. The download provides the IEM's QC'd and processed daily values, not raw COOP observer submissions — station moves, missing observations, and some systematic biases have been addressed in the processing.

The companion portal for truly raw COOP observations — the daily reports as submitted by observers before IEM processing — is at /request/coop/obs-fe.phtml. If you are doing your own QC or want to understand exactly what the observer reported (including the observation time, which is essential for TOBS-aware analysis), use the raw portal. If you want the IEM's processed daily climatology, with missing values filled where applicable and QC already applied, use the Climodat portal.

8.2.4. Daily Observations (IEM Computed Summaries)

mesonet.agron.iastate.edu/request/daily.phtml

Covered in Chapter 6 as a dataset — this is the UI wrapper for the IEM's computed daily summaries across all networks. One row per station per day, with the IEM's derived max/min temperature, precipitation, peak wind, and other variables. The network selector is the key: choose PA_ASOS for Pennsylvania airport stations, PACLIMATE for Pennsylvania COOP climate stations, and so on.

8.2.5. RWIS Download

mesonet.agron.iastate.edu/request/rwis/fe.phtml

Roadway Weather Information System observations — atmospheric variables plus up to four pavement temperature sensors plus subsurface temperature and pavement condition codes. Separate portals exist for the soil data at /request/rwis/soil.phtml and traffic data at /request/rwis/traffic.phtml.

8.2.6. DCP / HADS Download

mesonet.agron.iastate.edu/request/dcp/fe.phtml

River gauge and DCP station data, organized by SHEF variable codes. If you want river stage or discharge data from the IEM's DCP archive rather than USGS, this is the portal. The SHEF variable selection is extensive — the HADS CGI endpoint also handles this dataset programmatically.

8.2.7. Other Network Portals

Additional UI download portals cover USCRN (/request/uscrn.php), Hourly Precipitation (/request/asos/hourlyprecip.phtml), and TAF forecasts (/request/taf.php). The Temperature and Winds Aloft portal at /request/tempwind_aloft.php gives you the NWS winds aloft forecast data for any station and date range.

8.3. Tier 2: CGI/Bulk Services

The CGI services are the scriptable equivalents of the UI portals, all documented at mesonet.agron.iastate.edu/api/. Each one has a `?help` parameter that returns the full parameter documentation. These are the endpoints to use when you are automating a workflow, running a pipeline, or pulling data for more stations or longer periods than you want to click through in a form.

> Non-Programmer's Bridge — Using Tier 2 and Tier 3 Without Code
>
> The CGI and JSON endpoints in Tiers 2 and 3 look like code, but you do not need to be a programmer to use them. A URL like:
> `https://mesonet.agron.iastate.edu/cgi-bin/request/asos.py?station=MDT&year1=2023&month1=1&`
> is just a web address with instructions attached. Paste it directly into Chrome, Firefox, or Edge and hit Enter — your browser acts as the API client and downloads the CSV file to your desktop. No Python, no terminal, no setup required.
> If you later decide to automate repeated downloads, these three lines of Python are all you need to start:
>
> ```python
> import requests
> url = "https://mesonet.agron.iastate.edu/cgi-bin/request/asos.py?station=MDT&year1=2023&mo
> open("mdt_2023.csv", "wb").write(requests.get(url).content)
> ```

> That is the entire download. You do not need to understand it to use it — copy, paste, change the station ID and dates, run it.

The most important ones for weather hobbyists:

`/cgi-bin/request/asos.py` — the backend for the ASOS download portal, accepting all the same parameters as the UI form via query string. The help page at `/cgi-bin/request/asos.py?help` documents every parameter. A typical programmatic call for a year of Harrisburg hourly data in UTC looks like:

```
https://mesonet.agron.iastate.edu/cgi-bin/request/asos.py?
  station=MDT&
  data=tmpf&data=dwpf&data=sknt&data=drct&data=p01i&data=vsby&
  year1=2024&month1=1&day1=1&
  year2=2025&month2=1&day2=1&
  tz=UTC&
  format=onlycomma&
  latlon=no&
  missing=M&
  trace=T&
  direct=no
```

The `data=` parameter can be repeated for multiple variables, or `data=all` returns everything. The `format=onlycomma` option returns clean CSV without the debug headers; `format=comma` includes headers that explain the data but are messier to parse.

`/cgi-bin/request/coop.py` — IEM Climodat (COOP) data programmatically. Accepts network, station, date range, and variable selection. The equivalent of the Climodat download portal as a callable endpoint.

`/cgi-bin/request/daily.py` — IEM computed daily summaries for any network, programmatically.

`/cgi-bin/request/hads.py` — HADS/DCP/SHEF data, accepting SHEF variable codes. This is the scriptable path to river gauge data.

`/cgi-bin/request/hourlyprecip.py` — hourly precipitation data specifically, useful when you want the precipitation record without all the other ASOS variables.

`/cgi-bin/request/raob.py` — RAOB sounding data programmatically, equivalent to the archive portal covered in Chapter 6.

`/cgi-bin/request/gis/watchwarn.py` — NWS watch/warning/advisory polygons as shapefile output, parameterized by date range, WFO, and phenomena type. The programmatic path to the warning archive that powers much of Chapter 7.

`/cgi-bin/request/mos.py` — MOS data as CSV for any station, model, and date range.

The full CGI service list on the API page also includes endpoints for RWIS, SCAN, USCRN, NLAE flux, Iowa soil moisture (ISUSM), SPC outlooks, SPC watches, MCDs, WPC MPDs, PIREPs, SIGMETs, G-AIRMETs, CWAs, LSRs, NEXRAD storm attributes, TAFs, temperature/winds aloft, and climate normals. Each has its own `?help` page. The pattern is consistent: understand the ASOS CGI endpoint well and you understand all of them.

8.4. Tier 3: JSON/GeoJSON Ad-Hoc Services

The JSON services catalog at mesonet.agron.iastate.edu/api/ lists roughly 50 endpoints organized by category: IEM data and metadata, aviation, NWS products, NWS warnings, and miscellaneous. Unlike the CGI services, these return structured JSON or GeoJSON rather than CSV, making them appropriate for mapping applications, real-time pipelines, and programmatic workflows where you want to parse structured data rather than parse CSV.

Several of these are particularly useful for weather enthusiasts:

Current observations (`/json/current.py`) returns the most recent observation for any station in JSON format. The equivalent of the sortable currents table, but as machine-readable structured data.

Network GeoJSON (`/geojson/network.py`) returns station metadata for any IEM network as a GeoJSON FeatureCollection — station IDs, names, coordinates, and attribute flags. The fastest way to get a complete station list with coordinates for spatial analysis.

VTEC events — a family of endpoints: by point (`/json/vtec_events_bypoint.py`), by UGC (`/json/vtec_events_byugc.py`), by WFO (`/json/vtec_events_bywfo.py`), by state (`/json/vtec_events_bystate.py`). These return structured warning event data in JSON, the programmatic equivalent of the VTEC Browser.

Storm Based Warnings GeoJSON (`/geojson/sbw.py`) returns the actual polygon geometry for storm-based warnings for a given time window, making it straightforward to plot or analyze warning coverage spatially without downloading shapefiles.

SPC outlooks, watches, and MCDs (`/json/spcoutlook.py`, `/json/spcwatch.py`, `/json/spcmcd.py`) return structured JSON for SPC products — useful for building automated pipelines around convective outlook data.

RAOB data (`/json/raob.py`) returns sounding data in JSON format with query flexibility for specific pressure levels across date ranges, complementing the CSV portal.

Stage IV and PRISM (`/json/stage4.py`, `/json/prism.py`) return point-sample values from gridded products at specified coordinates — the programmatic equivalent of clicking on a map to get a precipitation estimate.

8.5. Tier 4: API v1

mesonet.agron.iastate.edu/api/1/docs

The formal API is built on FastAPI and exposes its full Swagger documentation at the docs URL. It is the right choice when you need fast, small responses — pulling the current MOS run for a single station, querying VTEC events for a specific county, retrieving station metadata. It returns JSON Table Schema responses with consistent structure, and the Swagger docs include a live request tester you can use directly in the browser.

The API v1 endpoints of most relevance to weather enthusiasts include MOS data (covered in Chapter 6), VTEC event data, station metadata and neighbor searches, and RAOB data. The source code for all of these lives in the iem-web-services repository on GitHub, which is worth knowing about if you want to understand exactly what a query is doing or if you find a bug and want to report it precisely.

8.6. Two Special Services Worth Knowing

8.6.1. MaxCSV

mesonet.agron.iastate.edu/request/maxcsv.py?help

MaxCSV is a single-variable snapshot tool — it returns the current value of one variable for all stations in a network as a CSV with station ID, latitude, longitude, and the variable value. One HTTP request, one variable, all stations simultaneously. For real-time mapping or quick tabular situational awareness, this is often faster than any other pathway. Example: current temperature for all PA ASOS stations in one call:

```
https://mesonet.agron.iastate.edu/request/maxcsv.py?network=PA_ASOS&var=tmpf
```

8.6.2. Gibson Ridge Placefiles

mesonet.agron.iastate.edu/request/grx/

If you use GR2Analyst, GRLevel3, or any other Gibson Ridge radar application, the IEM's placefile service provides live IEM data feeds that load directly into the radar display. Placefiles are available for current ASOS observations, RWIS pavement temperatures, active warning polygons, LSRs, HADS river data, CoCoRaHS precipitation, and others. The placefile URL for each product auto-updates; you configure it once in GR2Analyst and it stays current. For real-time storm analysis overlaying IEM network data on radar imagery, this is the pathway with no programming required.

8.7. A Decision Framework

When you need data from the IEM, the question to ask is: **what kind of data, at what time resolution, for how many stations, and in what format?**

If you want **hourly or sub-hourly observations from ASOS** for one to a few stations, the UI portal at `/request/download.phtml` is fastest. For many stations or automation, use the CGI endpoint `/cgi-bin/request/asos.py` directly.

If you want **daily climate data going back decades**, use the Climodat portal at `/request/coop/fe.phtml` for processed data, or the raw COOP portal at `/request/coop/obs-fe.phtml` if you need observation times or unprocessed values.

If you want **a derived statistic** — a trend, a period average, a comparison to normals — check Autoplot first. Download the chart's CSV export rather than doing the computation yourself.

If you want **warning or NWS event data** in a programmatic format, the JSON VTEC services or the CGI watchwarn endpoint are the right paths, depending on whether you need polygon geometry (JSON GeoJSON path) or tabular event metadata (CGI or API v1).

If you want **gridded data** sampled at a point, the IEMRE JSON API (`/iemre/daily/`) and the Stage IV or PRISM JSON endpoints are the fastest paths.

If you want **real-time current observations** in bulk, MaxCSV is the fastest single-request option. For a structured streaming workflow, iembot or the LDM feed are the appropriate tools.

8.8. What to Watch Out For

Time zone handling is not uniform across portals. The ASOS download portal lets you specify any timezone, and the timestamps in the output reflect that choice. Some JSON services return timestamps in UTC with explicit `Z` suffixes. Others return local standard time without a timezone indicator. Always check the timestamp format in the output before assuming UTC or local time. For any analysis that spans a DST transition, using UTC throughout and converting only at the final display step is the only safe approach.

Precipitation requires accumulation, not just download. The `p01i` variable in ASOS data is an incremental one-hour bucket reading, not a daily total. Gaps in the hourly record — missing observations, station outages — will silently undercount daily totals if you simply sum across 24 hours. A daily total computed from hourly ASOS data should be treated with suspicion at any station with frequent missing observations. The IEM's daily summary portal computes these totals using its own methods, which may handle gaps differently from a naive sum.

The 1,000 station-year limit is a real constraint. A request for all US ASOS stations (roughly 1,700) for even a single year exceeds the limit. For multi-station bulk downloads, use the CGI endpoint in batches by state or network, or consider whether the daily summary portal — which aggregates to one row per station per day — reduces the data volume enough to fit within a single query.

CGI services are not versioned. The IEM's statement on API stability is accurate but sobering: they try not to break things, but they make no guarantee. If you are building a pipeline against a CGI endpoint, build in error handling and periodic checks that the output format has not changed. The API v1 endpoints are more stable but cover a narrower range of data.

Missing data representations vary. The ASOS download portal lets you choose whether missing values are represented as `M`, `null`, or blank strings. Trace precipitation can be `T`, `null`, blank, or `0.0001` (the numeric equivalent). These choices affect how you handle missing data downstream. Set them explicitly when you configure the download, and document which convention you used.

8.9. Workflow 4 — Downloading a Year of Hourly ASOS Data

The question: You want the full 2023 hourly record for KMDT — temperature, dew point, wind speed, wind direction, and precipitation — in a CSV file you can open in Excel or analyze in Python.

Start here: https://mesonet.agron.iastate.edu/request/download.phtml

The ASOS download portal opens with a network selector at the top. From the network dropdown, select PA_ASOS (Pennsylvania ASOS). The station list on the left will populate with all Pennsylvania ASOS stations. Click MDT (Harrisburg International) to select it; it will move to the selected stations panel on the right.

Set the date range. For a full calendar year of 2023, enter January 1, 2023 as the start date and December 31, 2023 as the end date. The portal defaults to UTC timestamps; if you want observations in local time, look for the timezone selector and switch it to America/New_York (Eastern time). Be aware that ASOS stations operate on local standard time year-round, so during daylight saving time the apparent local timestamps will be one hour off civil clock time — the data is internally consistent, but the relationship to calendar dates requires care if you are computing daily totals.

In the variable selection panel, check the variables you want. For temperature and dew point: `tmpf` (temperature in °F) and `dwpf` (dew point in °F). For wind: `sknt` (wind speed in knots) and `drct` (wind direction in degrees). For precipitation: `p01i` (precipitation accumulation over the past hour, in inches). Check the box to include the station identifier and timestamp in the output.

Select CSV as the output format. Click the download button. For a full year at a single station, expect a file with somewhere around 8,700 rows — one per hour, with some additional rows from special observations (SPECIs) triggered by significant weather changes. This is a normal ASOS archive; do not be alarmed by rows between the standard hourly marks.

A few variables worth knowing about in the ASOS download: `vsby` is visibility in statute miles, `wxcodes` carries the present weather group from the METAR (which encodes precipitation type, fog, thunderstorm, etc.), and `peak_wind_gust` and `peak_wind_drct` capture the peak wind speed and direction within each observation period when they were recorded. If you are doing wind analysis, the peak gust columns are more useful than the instantaneous wind reading for capturing convective or frontal wind events.

The download portal has a practical rate limit: a request for more than 1,000 station-years worth of data will be rejected with an HTTP 422 response. For a single station over a single year this is irrelevant. For large bulk downloads across many stations, you will need to either split the request or use the CGI scripting interface at `https://mesonet.agron.iastate.edu/cgi-bin/request/asos.py` directly.

8.10. Key URLs — Chapter 8

Portal / Service	URL
ASOS/AWOS/METAR Download (UI)	mesonet.agron.iastate.edu/request/download.phtml
ASOS CGI Backend (scriptable)	mesonet.agron.iastate.edu/cgi-bin/request/asos.py?help
ASOS 1-Minute Download	mesonet.agron.iastate.edu/request/asos/1min.phtml
Iowa AWOS 1-Minute Download	mesonet.agron.iastate.edu/request/awos/1min.php
Climodat / COOP Download (processed)	mesonet.agron.iastate.edu/request/coop/fe.phtml
COOP Raw Observations Download	mesonet.agron.iastate.edu/request/coop/obs-fe.phtml
Daily Summaries Download	mesonet.agron.iastate.edu/request/daily.phtml
Hourly Precip Download	mesonet.agron.iastate.edu/request/asos/hourlyprecip.phtml
RWIS Download	mesonet.agron.iastate.edu/request/rwis/fe.phtml
RWIS Soil Download	mesonet.agron.iastate.edu/request/rwis/soil.phtml
DCP/HADS Download	mesonet.agron.iastate.edu/request/dcp/fe.phtml
USCRN Download	mesonet.agron.iastate.edu/request/uscrn.php
TAF Forecast Download	mesonet.agron.iastate.edu/request/taf.php
Temp/Winds Aloft Download	mesonet.agron.iastate.edu/request/tempwind_aloft.php
HML River Data Download	mesonet.agron.iastate.edu/request/hml.php
Warning Polygons (GIS shapefile)	mesonet.agron.iastate.edu/request/gis/watchwarn.phtml
LSR Archive Download	mesonet.agron.iastate.edu/request/gis/lsrs.phtml
NEXRAD Storm Attributes Download	mesonet.agron.iastate.edu/request/gis/nexrad_storm_attrs.php

Portal / Service	URL
SPC Outlook Shapefile	mesonet.agron.iastate.edu/request/gis/spc_outlooks.phtml
SPC Watch Shapefile	mesonet.agron.iastate.edu/request/gis/spc_watch.phtml
SPC MCD Shapefile	mesonet.agron.iastate.edu/request/gis/spc_mcd.phtml
WPC MPD Shapefile	mesonet.agron.iastate.edu/request/gis/wpc_mpd.phtml
PIREP Shapefile	mesonet.agron.iastate.edu/request/gis/pireps.php
API Mainpage (all tiers)	mesonet.agron.iastate.edu/api/
API v1 Swagger Docs	mesonet.agron.iastate.edu/api/1/docs
MaxCSV (quick network snapshot)	mesonet.agron.iastate.edu/request/maxcsv.py?help
Gibson Ridge Placefiles	mesonet.agron.iastate.edu/request/grx/
OGC Web Services	mesonet.agron.iastate.edu/ogc/

9. Chapter 9 — Webcams

The IEM webcam tools are a small corner of the site, but they fill a gap that most weather data platforms never bother with: the ability to go back and *see* what conditions looked like at a specific place and time. Not inferred from sensor readings, not reconstructed from radar — actually see it, the way a camera sees it. If you have ever wanted to settle a dispute about when snow started accumulating on a particular stretch of highway, or verify what the sky looked like during the warm sector of a winter storm, this is where you go.

The webcam system is not glamorous. The cameras are not high-definition streaming feeds. The coverage is heavily weighted toward Iowa and the upper Midwest, which means if you are primarily a Mid-Atlantic observer the network will feel thin. But the archival depth and the integration with other IEM tools — particularly RWIS station data — make it genuinely useful when the conditions are right.

9.1. What the Network Actually Is

The IEM webcam archive draws from several distinct sources. The core of it is the Iowa DOT Roadway Weather Information System (RWIS) network, which the IEM has been archiving since December 2009. Beyond RWIS, the network has historically included feeds from several Iowa television stations — KCRG-TV's CityCam network, KCCI-TV, and KELO-TV — along with select ISU campus cameras. The TV station cameras are notable because they skew toward populated areas and scenic vantage points rather than highway infrastructure, which means they occasionally catch dramatic storm shots that the RWIS network misses entirely.

The whole thing is federated. IEM is not operating these cameras — it is archiving their outputs and making them searchable. This matters because camera availability changes without notice and individual feeds go offline permanently without any announcement. What you find when you navigate to the viewer on any given day reflects what the source operators have kept running, not what IEM has decided to maintain.

Archiving cadence is worth understanding. Under normal conditions, IEM captures an image from each camera every five minutes. During active weather events, the interval drops to one minute. The practical implication is that if you are stepping through archived frames and find a gap, it is almost certainly a five-minute interval, not missing data — unless you are in a period of interesting weather, in which case the archive may be dense enough to reconstruct several events per hour.

9.2. The Webcam Viewer

The main interface is the IEM Webcam Viewer at https://mesonet.agron.iastate.edu/current/viewer.phtml. This is the tool you want for both real-time viewing and archive browsing.

The viewer runs in two modes. In **realtime** mode, it refreshes automatically and shows the most recent available image from each camera along with a live NEXRAD composite and any active NWS warnings for the area. In **archive** mode, you set a specific date and time and the viewer assembles the scene as it appeared at that moment — archived webcam image, radar composite, warning overlays, and an indication of which direction each camera was pointed. The archived views generate stable URLs you can bookmark or share, which is useful when you want to point someone in a forum thread to a specific moment.

Camera selection is handled through an interactive map. Cameras show up as icons indicating their pointing direction, though the site notes with admirable candor that the pointing arrows are sometimes wrong. Clicking a camera loads its image history and lets you step forward or backward in time. The RWIS cameras are particularly well represented because of the long continuous archive; for many Iowa RWIS stations you can pull imagery going back to December 2009.

The viewer also maintains a separate page for ISU campus cameras at https://mesonet.agron.iastate.edu/current/isucams.phtml, which covers a handful of fixed vantage points around the Ames campus. These see heavy use during convective events because the ISU Agronomy Hall rooftop camera has produced some memorable tornado shots over the years.

9.3. RWIS Cameras and the Data Combination

The most meteorologically useful cameras in the IEM archive are the RWIS feeds, and the reason is not the images themselves — it is the pairing. Every RWIS station that has a camera also has sensors reporting air temperature, pavement temperature, surface condition (dry, wet, snow-covered, icy), and in many cases wind speed and precipitation intensity. IEM integrates all of this. You can look at a camera image and simultaneously see the pavement temperature from the co-located sensor.

In winter weather operations, this combination is unusually powerful. Radar tells you where precipitation is falling. Surface observations tell you temperature. The RWIS camera tells you what is actually happening on the pavement — and there is often a meaningful lag between when radar shows a band moving over an RWIS location and when the road surface transitions from wet to snow-covered. That lag is not consistently captured by any sensor reading alone. The visual confirmation fills the gap.

The dedicated RWIS camera page at https://mesonet.agron.iastate.edu/RWIS/camera.phtml provides access specifically to the RWIS archive, with the start date of each individual camera's archive shown in the selection menu. For Midwest-focused research, this is a cleaner entry point than the main viewer if you know which station you want.

9.4. Building Time-Lapse Loops

The Webcams menu links to a lapse builder at https://mesonet.agron.iastate.edu/current/bloop.phtml. This tool lets you specify a camera and a time window and generates an animated sequence from the archived frames — essentially reconstructing the visual record of any period the camera was active. The interface is UI-driven; you pick a camera from the available list, set your start and end times, and the lapse assembles from the archive.

There is also a separate page for recent pre-built movies at https://mesonet.agron.iastate.edu/current/camlapse/. For the TV station camera networks — KCCI, KCRG, and KELO — IEM generates five standard timelapses per day automatically, covering specific periods that match the morning, afternoon, and evening news cycles. These are used by the stations on-air, and the most recent lapse from each is available online. The camlapse page is where you find those pre-built loops without having to construct your own.

If you want to reconstruct something specific — a squall line passage, an overnight snowfall accumulation sequence, the onset of freezing rain — the bloop builder is the right tool. Start with the archived still images in the main viewer to find your camera and confirm the archive coverage for your time window, then move to the lapse builder to assemble the sequence.

9.5. The Cool Lapses Archive

The Cool Lapses page at https://mesonet.agron.iastate.edu/cool/ is a curated collection of the best lapse sequences produced from the IEM archive over the years. These are linked to Daryl Herzmann's YouTube channel rather than hosted directly on the IEM servers. The collection includes some genuine showpieces — a gravity wave sequence from near Tama, Iowa has accumulated over a million views on YouTube, and the 2005 tornado captured from the ISU Agronomy Hall rooftop camera is the kind of footage that gets cited in teaching materials.

The Cool Lapses page is not updated constantly, but the historical catalog is worth knowing about. If you are looking for specific weather phenomena on camera and your target event was somewhere in Iowa over the past fifteen-plus years, there is a reasonable chance a lapse of it exists in this collection. It is also a useful benchmark for what the camera system can capture when everything comes together — good camera placement, active weather, one-minute archive intervals, and someone paying attention.

9.6. Coverage Limitations

For readers who are primarily Mid-Atlantic or Northeast observers, the honest assessment is that the IEM webcam system will rarely be your primary resource. The RWIS archive is concentrated in Iowa and the upper Midwest. The TV station camera networks are similarly Iowa-centric. Pennsylvania and the surrounding region have dedicated DOT camera resources — PennDOT's 511PA system maintains an extensive network — that are not integrated into the IEM archive and will almost always offer better coverage of your target area.

Where the IEM system earns its keep for non-Iowa users is in post-event research on significant nationwide events, in the RWIS pavement sensor integration that few other platforms attempt, and in the archival depth going back to 2009 for the RWIS network specifically. If your event happened in Iowa or you need the sensor-plus-visual combination for a winter weather case, it is the right tool. For real-time situation awareness in Pennsylvania, treat it as a supplemental resource rather than a primary one.

9.7. What to Watch Out For

Camera availability is unstable. Individual feeds go offline permanently, sometimes entire network partnerships end, and there is no notification system. The pointing direction arrows in the viewer are sometimes wrong; take them as approximate guides rather than precise indicators. Timestamp accuracy is generally good, but image intervals can be irregular near the transition between five-minute and one-minute archiving cadence — you may see a gap that looks like missing data but is simply the standard inter-frame interval.

The lapse builder can be slow to assemble sequences from older archive dates, particularly if you are spanning more than a few hours. Start with a short window to confirm the archive is present for your camera and time period before querying a longer sequence.

9.8. Key URLs — Chapter 9

Tool	URL
Webcam Viewer (realtime + archive)	https://mesonet.agron.iastate.edu/current/viewer.phtml
RWIS Archived Webcam Imagery	https://mesonet.agron.iastate.edu/RWIS/camera.phtml
Lapse Builder	https://mesonet.agron.iastate.edu/current/bloop.phtml
Recent Pre-Built Lapses	https://mesonet.agron.iastate.edu/current/camlapse/
Cool Lapses Archive	https://mesonet.agron.iastate.edu/cool/
ISU Campus Webcams	https://mesonet.agron.iastate.edu/current/isucams.phtml
Webcam Project Overview	https://mesonet.agron.iastate.edu/projects/webcam.php

10. Chapter 10 — Understanding Data Quality

Every piece of data on the IEM carries an implicit question: how much should you trust it? The answer is not uniform. It depends on the network, the variable, the time period, and sometimes a specific quirk in how a particular station's data has been ingested, processed, or stored. This chapter is about developing the instincts to ask that question productively — and knowing where on IEM to look for the answer.

This is not a catalog of everything that can go wrong. That would be both exhausting and discouraging. It is a practical orientation to the most consequential data quality issues you are likely to encounter as a serious weather enthusiast working with IEM data, with enough explanation of the underlying mechanics that you can recognize problems when you see them rather than waiting to be surprised.

10.1. The "Unofficial" Label

The word *unofficial* appears throughout the IEM — in chart titles, in download headers, in the daily features on the homepage. It is worth understanding precisely what it means and, equally importantly, what it does not mean.

IEM is not a National Weather Service office. It is not NCEI. It is an academic mesonet operated out of Iowa State University, and the data it archives, processes, and displays has not gone through the formal QC and certification pipeline that transforms raw observations into the official climate record. When IEM applies its own computed products — daily summaries, areal averages, derived statistics — those products are labeled unofficial because they are: they reflect IEM's best processing of available data, not a federally certified observation.

What unofficial does *not* mean is wrong, or unreliable, or experimental. The raw observations feeding IEM's archive are the same observations flowing to NCEI and NWS. The ASOS data ingested by IEM comes from the same NOAAPort satellite feed and NCEI data sources that official archives draw from. The processing IEM applies is documented, the methods are published in journal papers, and the results have been used in peer-reviewed research. Unofficial is a legal and institutional designation, not a quality judgment.

The practical implication is simple: if you are doing research that will be cited, published, or submitted to a formal climate record, cross-check your IEM-derived results against NCEI's official products. For forum discussions, personal research, forecast verification, and operational awareness — which covers the vast majority of what weather enthusiasts do with this data — the unofficial label should not give you pause.

10.2. How IEM Handles Quality Control

IEM runs automated QC checks on incoming data from its various networks. The specific checks vary by network, but the general approach includes range testing (is this temperature physically plausible?), rate-of-change testing (did this sensor just jump 30 degrees in five minutes?), and spatial consistency testing (does this station's reading agree with its neighbors within reasonable bounds?).

Beyond automated checks, IEM participates in the MADIS (Meteorological Assimilation Data Ingest System) QC framework for several networks. The MADIS QC page at https://mesonet.agron.iastate.edu/QC/madis/network.phtml lets you browse QC status by network, showing you which stations are currently flagged and for what reason.

The QC mainpage at https://mesonet.agron.iastate.edu/QC/ provides links to all the QC products IEM generates. The most immediately useful for a working weather enthusiast is the offline station list at https://mesonet.agron.iastate.edu/QC/offline.php, which shows stations that are currently not reporting or have been flagged as having data problems.

10.2.1. The Public QC Ticket System

IEM maintains a public trouble ticket log at https://mesonet.agron.iastate.edu/QC/tickets.phtml. This is worth knowing about for two reasons. First, it is a window into the kinds of problems the IEM team actually encounters and how they handle them — which gives you a more realistic picture of data reliability than any documentation page alone. Second, it is genuinely bidirectional: the IEM team reads submissions, and if you identify what looks like a data quality problem while working with a specific station, you can flag it there.

The tickets range from straightforward sensor outages to more complex ingestion problems — cases where data was received but processed incorrectly, or where a network partner changed their data format and the IEM ingestor had not yet caught up. Reading through a few months of tickets gives you a healthy sense of the kinds of edge cases that exist even in well-maintained systems.

10.3. ASOS Temperature Storage: The Whole-Degree Problem

This is the single most counterintuitive data quality issue in the ASOS record, and it trips up experienced analysts who do not know to look for it.

Here is the chain of events, as IEM's own dataset documentation describes it. ASOS stations in the United States internally record temperature in whole degrees Fahrenheit. A sensor reading of 78°F is stored as 78. This is not ideal precision for climate analysis, but it is the base reality. The problem arises during transmission. METAR format transmits temperature in degrees Celsius. When the station converts 78°F to Celsius for the METAR, it gets 25.56°C, which it rounds to 26°C for transmission. Now IEM receives 26°C and converts it back to Fahrenheit: 26°C = 78.8°F, which rounds to 79°F. The station observed 78°F; the database records 79°F. A one-degree error has been introduced entirely by the round-trip unit conversion.

The fix is the METAR T-group — a supplemental field in METAR format that provides temperature to one-tenth of a degree Celsius precision. When the T-group is present, IEM can convert back to Fahrenheit with enough precision to recover the original whole-degree value reliably. IEM's processing explicitly prioritizes data sources that include the T-group, and the NOAAPort feed — IEM's primary ASOS source — does include it for most US stations most of the time.

What this means in practice: for most routine ASOS observations at most US airports, the temperature record in IEM is accurate to the original whole-degree Fahrenheit. But "most of the time" is doing real work in that sentence. In older archived data, in observations from certain auxiliary sources, and particularly in data from the MADIS high-frequency feed (which transfers temperature in Celsius without adequate precision), you may encounter the one-degree-off error. For a forum discussion about yesterday's high temperature, this is irrelevant. For research computing climatological normals or extreme temperature statistics, it is something to be aware of and to validate against authoritative sources.

The one-minute ASOS data available through IEM carries an additional version of this problem: the NCEI one-minute data files are processed with a known Celsius precision issue in the FAA data transfer chain. IEM has documented this explicitly in its news archive. If you are pulling one-minute ASOS data for temperature analysis, read the dataset documentation at https://mesonet.agron.iastate.edu/info/datasets/metar.html before you begin.

10.4. COOP Data and Time of Observation

The NWS Cooperative Observer network has been taking daily temperature and precipitation readings since the 1880s at some stations. That longevity is exactly what makes COOP data irreplaceable for climatological research — and exactly why TOBS (Time of Observation) matters so much.

COOP observers take their readings once per day, at a time they choose. Some observe at 7 AM. Some at 5 PM. Some at midnight. The recorded high and low temperatures for a given calendar date represent the extremes during the 24-hour period *ending* at observation time, not the calendar midnight-to-midnight period. An observer who takes readings at 7 AM on the 15th is recording the high and low that occurred between 7 AM on the 14th and 7 AM on the 15th — and attributing those values to the 15th.

This creates what climate scientists call the time-of-observation bias. Morning observers (7 AM) are less likely to inadvertently count the same extreme twice across adjacent calendar days than afternoon observers (5 PM). The 5 PM observer who records an exceptionally hot afternoon might count that same hot afternoon in two consecutive daily records if the heat lingered past midnight. At a network scale, these observation time differences can inflate or suppress apparent monthly means by a fraction of a degree — enough to matter for trend analysis over long records.

IEM's COOP pages note this directly. The COOP daily observations page warns that for observations made at 7 AM, the data covers a 24-hour period ending at that time, not the local calendar date. This is not IEM's choice or problem to fix — it is the fundamental structure of how COOP data is collected. But it is something to know when you are comparing COOP daily records to ASOS records, which observe on a different and more consistent time basis, or when you are comparing COOP stations to each other across different observation time regimes.

For most forum-level discussions — "what was the daily high at this COOP station?" — TOBS is background noise. For research examining trends across long periods, or for comparing COOP against other networks, it requires either awareness or explicit correction.

10.5. Trace Precipitation

Across IEM's download portals, you will encounter precipitation values stored as `0.0001` inches. This is not a measurement artifact or a rounding error. It is a deliberate encoding convention meaning *Trace* — precipitation was observed but too small to measure. In the COOP and ASOS networks, a Trace is officially defined as measurable precipitation below 0.005 inches (the minimum readable increment of a standard rain gauge).

When you download COOP or ASOS precipitation data from IEM and see 0.0001 in your spreadsheet, treat it as a qualitative flag — precipitation occurred — not as a quantitative measurement. Summing these values, computing monthly totals that include trace days, or doing statistics that treat 0.0001 as a real measurement will introduce errors that compound across long records.

The practical test: if you are computing wet-day frequency, a 0.0001 is correctly counted as a wet day. If you are computing seasonal totals, it should either be set to zero or excluded from the numeric sum. Most research-grade precipitation analyses use a threshold (often 0.01 inches) that naturally excludes trace amounts, but if you are working with raw IEM downloads, the convention is worth knowing explicitly.

10.6. Missing Data Codes

The specific value used to indicate missing data in IEM downloads varies by format and by download portal, and this inconsistency has caught many users off guard.

In CSV downloads from the ASOS download portal, missing temperature and dew point values typically appear as a blank field or as the string `M`. In the daily summary download, they may appear as `None` (Python-style null) or as an empty string depending on the output format selected. In JSON API responses, missing values are usually returned as `null`. In some older COOP archive formats, `999.9` or `-99` appear as sentinel values for missing data — a legacy of pre-digital encoding conventions that occasionally survived into digitized records.

The safest approach when writing any code or script that processes IEM data: do not assume you know what the missing value sentinel will be. Check the first few rows of your download for unexpected values before computing statistics, and review the dataset documentation at https://mesonet.agron.iastate.edu/info/datasets/ for the specific format you are working with.

10.7. What a Real Data Quality Investigation Looks Like: MDT and CXY

Abstract discussion of data quality issues only goes so far. Here is what it looks like when you actually find something.

Harrisburg, Pennsylvania has two ASOS stations within a few miles of each other: KMDT (Harrisburg International Airport, in Middletown) and KCXY (Capital City Airport, in New Cumberland). Both have long continuous records. Both are official FAA ASOS installations. On paper they should agree reasonably well for most variables, given their proximity and shared climate regime.

A comparison of precipitation records between these two stations over a multi-year period reveals a persistent and substantial difference: KCXY runs approximately 11% wetter than KMDT on an annual basis. This is not noise. Eleven percent is well outside what you would expect from two stations separated by a few miles in flat valley terrain with no significant orographic difference between them.

What causes this? The most likely explanation is gauge siting and local exposure differences rather than instrument malfunction. ASOS tipping-bucket rain gauges are sensitive to wind effects at the orifice — a gauge in a more sheltered location will catch slightly more precipitation than one exposed to stronger winds, all else equal. Small differences in nearby obstructions, prevailing wind direction during precipitation events, and gauge height above grade can all contribute to systematic biases that are real, repeatable, and entirely invisible to automated QC systems that are checking for gross errors rather than subtle inter-station biases.

The lesson is not that one of these stations is wrong. Both stations are reporting what their gauges observe. The lesson is that gauge measurements are *point observations of a physical process that has local variability* — and that two official ASOS stations a few miles apart can have genuinely different precipitation climatologies that reflect their specific exposure rather than instrument error.

This kind of investigation — running a long-period comparison between nearby stations and looking for systematic divergence — is exactly the type of work IEM makes straightforward. Autoplot chart q=12 (precipitation summary comparisons), the daily summary download portal, and Climodat all provide the raw material. The MDT/CXY comparison illustrates both the power of having dense, long-record station networks and the caution required when interpreting any single station's record in isolation.

10.8. Station Metadata: Moves, Equipment Changes, and Archive Gaps

A station's observational record is not just its data — it is the history of its physical location, its equipment, and its observation practices. ASOS stations have been relocated. Their shelter configurations have changed. The transition from manual to automated observation happened at different times for different stations. COOP observers change, and with them, the specific protocols a station follows.

IEM's station information page, accessible through the Station Locator at https://mesonet.agron.iastate.edu/sites/locate.php, provides metadata for every station in the network — location history, network membership, archive start and end dates, and any documented notes about the station's history. For research involving long records, this page is where you start, not where you end up accidentally after finding something strange in your data.

When a COOP station moves even a fraction of a mile, its exposure to local drainage, cold air pooling, or orographic effects can change enough to introduce a detectable discontinuity in its temperature or precipitation record. These discontinuities are documented in the station metadata when they are known, but not all station moves are formally recorded in every archive. The variables reference at https://mesonet.agron.iastate.edu/info/variables.phtml is the companion document — it explains what each variable in IEM's database actually represents, which is its own form of data quality documentation.

10.9. What to Watch Out For

A few practical rules that have come out of the issues covered in this chapter:

When computing temperature statistics from ASOS data, especially extremes, validate against the official CF6 climate summaries or NCEI monthly reports for the same station when the result seems surprising. A one-degree discrepancy from the whole-degree storage issue can occasionally push a computed extreme in or out of record territory.

When working with long COOP records, be aware that apparent trends may partially reflect changes in observation time rather than actual climate change. The TOBS adjustment is well-studied in the scientific literature, and the GHCN dataset applies it; raw COOP data as downloaded from IEM does not.

When comparing precipitation between nearby stations, an 11% systematic difference is not automatically a QC problem — it may be a real exposure difference worth understanding rather than correcting. But a 50% difference sustained over multiple years probably warrants a closer look at the gauge siting and maintenance history.

When you encounter an anomalous value in any IEM download, the QC ticket system at https://mesonet.agron.iastate.edu/QC/tickets.phtml is the right place to report it. The IEM team is small, they cannot actively audit every observation across every network, and user-flagged issues have led to real corrections in the archive.

10.10. Key URLs — Chapter 10

Resource	URL
QC Mainpage	https://mesonet.agron.iastate.edu/QC/
QC Trouble Tickets (public)	https://mesonet.agron.iastate.edu/QC/tickets.phtml
Currently Offline Stations	https://mesonet.agron.iastate.edu/QC/offline.php
MADIS Network QC	https://mesonet.agron.iastate.edu/QC/madis/network.phtml
METAR/ASOS Dataset Documentation	https://mesonet.agron.iastate.edu/info/datasets/metar.html
Dataset Documentation Index	https://mesonet.agron.iastate.edu/info/datasets/
Variables Reference	https://mesonet.agron.iastate.edu/info/variables.phtml
Station Locator / Metadata	https://mesonet.agron.iastate.edu/sites/locate.php

11. Chapter 11 — Getting the Most Out of IEM: Putting It All Together

The preceding chapters have covered the IEM from the outside in — what it is, how it is organized, what each section contains, and how to get data out of it. The practical workflows that demonstrate these tools in action have been embedded directly in the chapters where the relevant tools live:

- **Workflow 1 — COOP Daily Extremes** is in Chapter 6, immediately after the Daily Climatology section
- **Workflow 2 — Building a Custom Autoplot Chart** is in Chapter 4, at the end of the Autoplot section
- **Workflow 3 — Researching a Past Warning Event** is in Chapter 7, following the VTEC Browser section
- **Workflow 4 — Downloading a Year of Hourly ASOS Data** is in Chapter 8, at the end of the download portals chapter
- **Workflow 5 — Building a Wind Rose** is in Chapter 4, alongside Workflow 2

This chapter steps back and addresses the broader question: once you know how the individual tools work, how do you combine them effectively?

11.1. Using the IEM as a Research System

The IEM's real power emerges when you stop treating its tools as isolated point-and-click applications and start treating them as components of a connected research pipeline. A typical investigation moves through several layers:

Orientation — Start with current conditions or the Daily Feature archive to understand what the IEM is showing you about the present moment or a recent event. The Daily Feature in particular is worth browsing regularly — it demonstrates what the tools can produce and gives you directly re-runnable Autoplot configurations for every chart.

Event identification — Use the VTEC Browser or the NWS warning search to pin down the exact timing, polygon, and metadata for a past event. The ETN gives you a unique handle on the specific warning that you can carry forward into every subsequent query.

Data retrieval — Use the appropriate download tier for what you need. Tier 1 portals for straightforward single-station CSV downloads. Tier 2 CGI endpoints for bulk or multi-parameter pulls. The API for programmatic access. Remember the 1,000 station-year processing limit on the ASOS download portal and plan your queries accordingly.

Quality assessment — Before drawing conclusions, review the data quality caveats relevant to your network. ASOS temperature data carries the whole-degree rounding artifact described in Chapter 2 and Chapter 10. COOP data carries TOBS offsets described in Chapter 6 and Chapter 10. Cross-check your downloaded values against Autoplot charts of the same station and period — discrepancies often surface systemic issues before they contaminate an analysis.

Visualization and verification — Use Autoplot to visualize what you downloaded. The chart library covers nearly every combination of variable, time scale, and network that the IEM supports. If you cannot find a chart that shows what you need, the JSON output format from most CGI endpoints will feed directly into a Python or R visualization pipeline.

11.2. A Note on Using These Tools Together

The IEM's tools were not designed as a unified application — they grew organically over two decades as separate modules addressing specific needs. This means there is no single dashboard that connects everything. The connection happens in your head and in your workflow.

The most effective IEM users develop a personal map of the site: a set of bookmarked Autoplot configurations, a saved set of CGI URL templates, a mental model of which download portal serves which data type. Building that map takes time. The Daily Feature archive, browsed regularly over months, is probably the fastest path to it — every entry is a demonstration of a tool applied to a real problem, with a re-runnable link attached.

11.3. Key URLs — Chapter 11

Resource	URL
IEM Homepage	https://mesonet.agron.iastate.edu/
Daily Feature Archive	https://mesonet.agron.iastate.edu/onsite/features/past.php
Daily Feature Tags	https://mesonet.agron.iastate.edu/onsite/features/tags/
Autoplot	https://mesonet.agron.iastate.edu/plotting/auto/

Resource	URL
VTEC Browser	https://mesonet.agron.iastate.edu/vtec/
ASOS Download Portal	https://mesonet.agron.iastate.edu/request/download.phtml
IEM API v1	https://mesonet.agron.iastate.edu/api/1/

Part IV.

Back Matter

Glossary

The following terms appear throughout this guide. Definitions are written in the IEM context — what each term means for someone using this website, not as standalone meteorological or regulatory definitions.

AFOS — Automation of Field Operations and Services. The legacy message-routing system the NWS used before the internet era, and whose product identifiers it never stopped using. On IEM, you will encounter AFOS whenever you are working with raw NWS text products. Every product — Area Forecast Discussion, Hazardous Weather Outlook, Local Storm Report, public zone forecast — has an AFOS PIL (see *PIL*) that uniquely identifies it. IEM's text product archive at `/wx/afos/p.php` is organized around these identifiers. If you know the PIL, you can retrieve any NWS product IEM has ever received.

ASOS — Automated Surface Observing System. The primary airport weather observation network in the United States, operated jointly by the NWS, FAA, and Department of Defense. ASOS stations report every hour and, at most sites, every minute, measuring temperature, dew point, wind speed and direction, visibility, precipitation, sky condition, and pressure. On IEM, ASOS is the workhorse: it is the network behind most of the hourly download portals, most of the climate charts in Autoplot, and most of the long-term station records available for your airport. The IEM ASOS archive runs from approximately 1973 at the longest-serving stations. Understanding ASOS's known limitations — particularly its tendency to undercount light snowfall and its whole-degree Fahrenheit internal temperature storage — matters when you are doing precision climatology.

AWOS — Automated Weather Observing System. A family of FAA-operated automated stations at smaller airports that do not qualify for full ASOS instrumentation. AWOS stations vary significantly in what they measure: AWOS-1 gives only wind and altimeter;

AWOS-3 adds visibility and sky; AWOS-3P adds a precipitation sensor. IEM ingests AWOS data alongside ASOS but the two networks have different capabilities, different QC histories, and different archive depths. When you pull data from a small general aviation airport and find gaps or suspect readings, the first question is whether it is an AWOS site and which tier.

CAI — Climate Averages and Indices. A term IEM uses for the derived climatological products computed from long-period COOP station records. When you are working with IEM's normals data — 30-year averages for temperature, precipitation, heating degree days — you are working with CAI products. The distinction matters when you are downloading data: CAI fields are computed summaries, not raw observations.

CF6 — NWS Climate Form 6. The monthly summary climate product that NWS forecast offices issue at the end of each month for each of their official climate stations. A CF6 contains the daily maximum and minimum temperature, precipitation, snowfall, snow depth, and departures from normal for every day of the month, plus monthly totals and records. IEM archives CF6 products as text and in database form. When there is a discrepancy between what a station officially reported in a given month and what appears in ASOS hourly data, the CF6 is often the authoritative record because it reflects any observer corrections applied after the automated data was ingested.

CDD — Cooling Degree Day. A measure of how much cooling demand a day creates, calculated as the number of degrees by which the daily mean temperature exceeds a base of 65°F. A day with a mean temperature of 80°F produces 15 CDDs. On IEM, CDDs appear in Autoplot charts focused on agricultural and energy applications, alongside HDDs and GDDs. IEM computes daily degree days from ASOS and COOP station data and archives them in the daily summary database, accessible through the daily download portal at `/request/daily.phtml`.

CLI — CLImatological report. The daily climate product issued each morning by NWS forecast offices for their official climate stations. A CLI includes yesterday's high and low temperature, precipitation, snowfall, and comparisons to the record and normal for that date. IEM receives and archives CLI products as they come off the LDM. The text products are retrievable by AFOS PIL (typically CLI followed by the three-letter city identifier, such as CLIMDT for Harrisburg).

CoCoRaHS — Community Collaborative Rain, Hail and Snow Network. A citizen science precipitation observation network operated through Colorado State University, in which volunteers take daily precipitation readings using standardized gauges at precise measurement times. On IEM, CoCoRaHS data is ingested from the national CoCoRaHS database and presented alongside the COOP and ASOS networks. The key advantage of CoCoRaHS is density: in a typical Pennsylvania county there may be one ASOS station and two COOP stations, but twenty or more CoCoRaHS observers. For studying spatial variability in precipitation — particularly snowfall, which ASOS notoriously undermeasures — CoCoRaHS is often the most valuable network IEM aggregates.

COOP — Cooperative Observer Program. The NWS volunteer observer network that has been collecting daily temperature and precipitation data across the United States for well over a century. COOP observers take a once-daily reading — at a locally consistent time, traditionally early morning — of maximum temperature, minimum temperature, precipitation, snowfall, and snow depth. The network's value on IEM is its historical depth: COOP stations in Pennsylvania often have continuous records back to the 1880s, far predating any ASOS data. That longevity comes with tradeoffs: observer changes, station relocations, instrument upgrades, and time-of-observation differences all create inhomogeneities that require care when building long-period trends.

DCP — Data Collection Platform. The generic term for NWS-operated automated river, stream, and environmental monitoring sites that transmit data via GOES satellite. On IEM, DCP refers to the network of hydrological observation stations — stream gauges, reservoir sensors, soil moisture sites — that report through the HADS system. DCP data on IEM includes river stage, streamflow, precipitation from co-located rain gauges, and in some cases soil temperature and moisture. Archive depth varies widely by station: some Pennsylvania DCP sites have continuous records going back to the 1970s; others are recently installed.

ETN — Event Tracking Number. The sequential number assigned by a WFO to each VTEC event within a phenomena-significance category within a calendar year. An ETN resets to 1 every January 1 at each office. On IEM's warning search, an ETN is what allows you to track a single warning event across multiple WFO-issued updates — the initial issuance, any extensions, and the cancellation or expiration all share the same ETN. Combining WFO identifier + phenomena code + significance code + ETN + year gives you a globally unique identifier for any NWS warning event, which is why IEM's VTEC search is far more powerful than searching by date or county alone.

GDD — Growing Degree Day. A heat accumulation unit used in agricultural science to predict crop and pest development. Calculated as the number of degrees by which a day's mean temperature exceeds a crop-specific base temperature (commonly 50°F for corn, 32°F for wheat), subject to minimum and maximum caps that prevent extreme days from distorting the calculation. IEM is deeply invested in GDD data because of its land-grant agricultural mission: the Autoplot chart library includes multiple GDD charts, and the IEM Pest Maps and Ag Weather tools are built directly on accumulated GDD values. For weather enthusiasts in Pennsylvania, GDD also serves as a proxy for seasonal progression — you can compare GDD accumulation to normal as a way of quantifying how "behind" or "ahead" a spring is running.

G-AIRMET — Graphical AIRMET. The graphical successor to the text-format AIRMET (Airman's Meteorological Information) product issued by the NWS Aviation Weather Center for significant en-route flight hazards below 18,000 feet MSL. G-AIRMETs cover turbulence, icing, and instrument meteorological conditions across geographic polygons rather than the textual regions used in the legacy format. On IEM, G-AIRMETs are available as downloadable GIS shapefiles at `/request/gis/awc_gairmets.phtml`, making them useful for anyone studying aviation weather patterns or correlating flight delay data with atmospheric conditions.

HADS — Hydrometeorological Automated Data System. The NWS system that ingests, processes, and distributes GOES-transmitted DCP observations to end users. HADS is the plumbing behind the DCP network: when a stream gauge transmits its reading to a

GOES satellite, HADS routes that data to NWS systems and eventually to IEM. On IEM, references to HADS typically appear in the DCP network context — if data is tagged as coming through HADS, it originates from a GOES-transmitting sensor site.

HDD — Heating Degree Day. The mirror of CDD: the number of degrees by which a day's mean temperature falls below the 65°F base. A day with a mean of 30°F produces 35 HDDs. HDD accumulation through a winter is a standard proxy for heating energy demand. IEM archives HDDs in the daily summary database and includes them in Autoplot temperature and energy charts. Like CDDs and GDDs, HDDs are available for download at `/request/daily.phtml`.

IBW — Impact-Based Warning. An NWS warning format introduced in the early 2010s that adds structured tags to tornado and severe thunderstorm warnings indicating the expected intensity, likely damage, and who is at risk. IBW tags appear in the text of the warning product and are also coded in the VTEC header. On IEM, IBW tags are captured in the warning database, so Autoplot charts and VTEC searches that work with tornado and severe thunderstorm warnings can filter or color-code by tag level. If you are doing post-event analysis and want to know whether a warning that produced significant damage was tagged accordingly, IEM's VTEC archive is where to check.

IEMRE — IEM Reanalysis. IEM's own gridded analysis product, which blends station observations from the ASOS, COOP, and other networks onto a 0.125×0.125 degree grid covering the contiguous United States. IEMRE is updated daily and extends back to 1950, making it one of the longer gridded datasets covering the period before the modern reanalysis era. It is most useful when you need a gridded estimate of temperature or precipitation at a location without a nearby station — or when you want to compare a specific station's recent values against a regional background field. IEMRE's resolution and methodology differ from products like PRISM and ERA5; it is an IEM-specific product, which means its strengths and limitations are distinct from more widely used gridded datasets.

LDM — Local Data Manager. The Unidata software system that powers IEM's real-time data ingestion. The LDM is a distributed data subscription and relay network: IEM subscribes to feeds from the NWS Family of Services, ASOS networks, and other providers, and the LDM delivers those data streams in real time to IEM's database systems. From a user perspective, the LDM is invisible — it is the reason IEM has NWS products within seconds of issuance and ASOS observations within minutes of the observation time. For advanced users, IEM exposes a data request interface at `/request/ldm.php` that allows bulk retrieval of LDM-delivered product streams.

LSR — Local Storm Report. The structured NWS text product issued by forecast offices to document significant weather observations: storm damage, large hail, measured wind gusts, tornadoes, flash flooding, heavy snowfall. LSRs are issued in real time during events and are the primary source for IEM's storm event database. On IEM, LSRs are searchable at `/lsr/` and downloadable as shapefiles at `/request/gis/lsrs.phtml`. Because LSRs are issued by human forecasters making real-time decisions about what to document, they are a qualitative record rather than a complete inventory: an unmeasured hail event in a cornfield gets no LSR; a 1.75-inch stone that breaks a windshield in a parking lot often does.

MCD — Mesoscale Convective Discussion. The Storm Prediction Center's real-time product issued when a watch is possible or a developing weather situation warrants detailed analysis but does not yet rise to the level of a watch. MCDs are the SPC forecasters' running commentary during active weather — often dense with technical meteorological reasoning about shear profiles, CAPE, and boundary locations. On IEM, MCDs are archived and downloadable as GIS shapefiles at `/request/gis/spc_mcd.phtml`. They are particularly useful for post-event analysis because they document SPC's thinking at the time, not after the fact.

MOS — Model Output Statistics. A statistical post-processing technique that translates raw numerical model output into station-specific forecast guidance by applying regression equations derived from years of matched model-output/observation pairs. On IEM, MOS is the entire content of the Datasets → MOS section: a deep archive of operational MOS guidance going back decades, covering multiple NWS forecast models. What makes IEM's MOS archive genuinely useful is its historical depth — you can retrieve GFS-MOS guidance issued on any date back to the 1990s and compare it against what actually happened, which is the foundation of any serious forecast verification project. Models archived include AVN, GFS, ETA, NAM, NBS, NBE, ECM, LAV (LAMP), and MEX.

OGC — Open Geospatial Consortium. The standards body that defines interoperability protocols for geographic information systems, including WMS (Web Map Service), WFS (Web Feature Service), and WCS (Web Coverage Service). On IEM, OGC refers specifically to the `/ogc/` endpoint that exposes IEM's spatial data layers in standard OGC formats. If you use QGIS, ArcGIS, or any other GIS software that can consume WMS or WFS feeds, the IEM OGC service lets you load live and historical IEM data — warning polygons, NEXRAD composites, station observations — directly into your mapping environment.

PDS — Particularly Dangerous Situation. An NWS designation applied to tornado watches when atmospheric conditions suggest an elevated risk of long-track, violent tornadoes — EF4 and EF5 events. PDS watches carry the phrase "Particularly Dangerous Situation" in the watch product text and are coded in the VTEC header. On IEM, PDS status is captured in the VTEC warning database, so you can filter the historical tornado watch archive to identify PDS events for any WFO's area. They are rare: a PDS tornado watch in a mid-Atlantic WFO's area may appear only once or twice per decade.

PIL — Product Identifier Locator. The AFOS identifier that uniquely identifies any NWS text product: a six-character string combining a three-character category code (such as AFD for Area Forecast Discussion) and a three-character location identifier (such as CTP for State College). On IEM, PILs are how you retrieve specific NWS text products from the archive. The text product search at `/wx/afos/p.php` takes a PIL and returns the full text of the product, including historical versions. Knowing the PIL structure — and the fact that it is consistent across all NWS offices — is what makes IEM's text product archive navigable rather than a flat dump of thousands of files.

PIREP — Pilot Report. An aviation weather observation made by a flight crew and transmitted to the NWS Aviation Weather Center. PIREPs report actual in-flight conditions: turbulence intensity and altitude, icing conditions and altitude, sky condition, and visibility aloft. Unlike surface observations, PIREPs provide direct measurement of atmospheric conditions at altitude — which is why they remain valuable for verifying numerical model forecasts of upper-tropospheric turbulence and icing. On IEM, PIREPs are available as a GIS shapefile download at `/request/gis/pireps.php` and appear in the Datasets menu.

QC — Quality Control. In the IEM context, the suite of automated and manual processes applied to incoming observation data to detect and flag erroneous values. IEM uses multiple QC layers: automated range checks, consistency checks between neighboring stations, MADIS network QC from the NWS, and human review logged in the public QC ticket system at `/QC/tickets.phtml`. Data that has failed one or more QC checks is flagged rather than deleted; the flag allows downstream users to decide whether to include or exclude the value. Understanding IEM's QC flags — and the distinction between "flagged" and "removed" data — matters whenever you are building a dataset for analysis.

SHEF — Standard Hydrometeorological Exchange Format. The data encoding format used throughout the NWS hydrology community to transmit river and environmental sensor observations. SHEF encodes time series of observed values with physical element codes and quality flags in a compact text format. On IEM, SHEF appears primarily in the DCP/HADS context: river gauge and soil sensor data often arrives at IEM encoded in SHEF, and some IEM download portals allow retrieval in SHEF format for users whose analysis software expects it.

SIGMET — Significant Meteorological Information. An aviation weather advisory issued by the NWS Aviation Weather Center for meteorological conditions considered hazardous to all aircraft: severe or extreme turbulence, severe icing not associated with thunderstorms, widespread dust storms or sandstorms, and volcanic ash. In the U.S., SIGMETs also include Convective SIGMETs for large convective areas, embedded thunderstorms, and tornadoes. On IEM, SIGMETs are archived and downloadable as GIS shapefiles at `/request/gis/awc_sigmets.phtml`.

SPC — Storm Prediction Center. The NWS national center in Norman, Oklahoma, responsible for convective outlooks, tornado and severe thunderstorm watches, and mesoscale discussions. On IEM, SPC products are woven throughout: Autoplot has multiple charts derived from SPC watch and outlook data, the GIS shapefile downloads include SPC convective outlooks, SPC watches, and SPC MCDs, and the VTEC archive integrates SPC-issued watch polygons alongside WFO-issued local warnings. The IEM VTEC system treats SPC watches as VTEC events in their own right, with ETNs that track each watch from issuance through cancellation.

SPS — Special Weather Statement. The NWS text product used for weather situations that are significant but do not rise to the level requiring a formal watch or warning. An SPS might cover a brief period of locally dense fog, a wind advisory situation that does not quite meet advisory thresholds, or significant but not severe weather. On IEM, SPS products are in the text archive and are also downloadable as GIS shapefiles at `/request/gis/sps.phtml`. The shapefile version is useful because SPS polygons, like all VTEC-encoded NWS products, carry geographic boundaries that let you map where the statement applied.

TAF — Terminal Aerodrome Forecast. The NWS aviation point forecast issued for airports, covering a 24- or 30-hour period in a structured format that specifies expected wind, visibility, weather phenomena, and sky condition in coded groups. TAFs are issued by NWS Weather Forecast Offices four times daily and are the primary aviation forecast product for instrument flight planning. On IEM, TAF data is archived and downloadable at `/request/taf.php`, making it possible to retrieve historical TAF guidance for any airport and compare forecast conditions against the ASOS observations that were actually recorded.

Trace — The IEM convention for precipitation amounts too small to be measured but not zero. IEM represents trace precipitation as 0.0001 inches in numerical fields — enough to be nonzero in calculations and queries, and distinguishable from missing data, but below the 0.01-inch threshold of measurability. This convention is important when you are working with precipitation frequency statistics: days with trace amounts should typically be excluded from analyses of "measurable precipitation" but should not be treated as dry days. When you download ASOS or COOP precipitation data from IEM and see 0.0001 in a daily or hourly column, that is a trace observation, not a rounding artifact.

UGC — Universal Geographic Code. The NWS coding system for identifying the forecast zones and counties to which warnings and advisories apply. A UGC code is a six-character identifier: a two-letter state abbreviation, a one-letter type indicator (Z for forecast zone, C for county/parish), and a three-digit number. On IEM, UGC codes are the mechanism by which VTEC warnings are linked to geographic areas: when you search IEM's warning archive by county or zone, you are querying on UGC codes. Understanding UGC is important when you want to analyze warning statistics for a specific county or group of counties, because the county and the forecast zone do not always overlap cleanly.

USCRN — U.S. Climate Reference Network. The NWS network of high-precision automated climate monitoring stations sited specifically to provide long-term climate change detection with minimal siting bias and no urban heat island contamination. USCRN stations use triple-redundant temperature sensors, weighing-bucket precipitation gauges, and solar radiation sensors, and are sited in rural locations away from human infrastructure. On IEM, USCRN data is available at `/uscrn/` and downloadable at `/request/uscrn.php`. For climate trend analysis where siting quality matters, USCRN is the most defensible network IEM provides access to — the tradeoff is that there are far fewer stations than ASOS or COOP.

VTEC — Valid Time Event Code. The structured coding system the NWS embeds in every watch, warning, and advisory product. A VTEC string encodes the issuing office, the action being taken (new issuance, update, cancellation, expiration), a two-letter phenomena code (TO for tornado, SV for severe thunderstorm, FF for flash flood), a one-letter significance code (W for warning, A for advisory, Y for watch), and an Event Tracking Number. On IEM, VTEC is the backbone of the entire warning archive: every event has a unique identifier assembled from these components, which is what makes it possible to search for all tornado warnings issued by a specific office in a specific year, or to retrieve the full lifecycle — issuance, updates, verification, expiration — of any individual warning event. Understanding VTEC is what separates using IEM's warning tools from just reading storm reports on a news site.

WFO — Weather Forecast Office. The local NWS offices responsible for issuing watches, warnings, advisories, and forecasts for their county warning areas. The contiguous U.S. has 122 WFOs. On IEM, the WFO is the fundamental unit of the warning archive: every VTEC event belongs to one WFO, warnings are organized by WFO, and most Autoplot charts that show warning statistics present data at the WFO level. Pennsylvania falls under four WFOs — State College (CTP), Philadelphia (PHI), Pittsburgh (PBZ), and Mount Holly, NJ (PHI) — with BWI occasionally relevant for southernmost counties. Knowing your WFO's identifier is the starting point for most VTEC searches on IEM.

WPC — Weather Prediction Center. The NWS national center in College Park, Maryland, responsible for national quantitative precipitation forecasts (QPF), excessive rainfall outlooks, and Mesoscale Precipitation Discussions (MPDs). On IEM, WPC products appear in two places: the MPD shapefiles, downloadable at `/request/gis/wpc_mpd.phtml`, which are essential for analyzing the forecaster reasoning around significant precipitation events; and the Autoplot chart library, which includes charts derived from WPC QPF data. For anyone studying heavy precipitation events in Pennsylvania — a region where WPC watches closely because of its complex terrain and frequent high-impact rainfall — the WPC MPD archive on IEM is a frequently underused resource.

Appendix A — Network Quick Reference

This table covers the major observing networks accessible through the IEM. Network IDs follow IEM conventions (state-prefixed where applicable; the examples below use Pennsylvania). Archive depth reflects typical record start dates; individual stations vary. Use the station locator at mesonet.agron.iastate.edu/sites/locate.php to check the actual begin date and coverage flags for any specific station.

Network ID (PA example)	Full Name	What It Measures	Archive Depth	Update Frequency	Key IEM URL
PA_ASOS	Pennsylvania ASOS	Temp, dew point, wind, visibility, ceiling, precipitation, pressure	~1928 at major airports; ~1994–1996 at most stations	Hourly (plus specials); 1-minute archive at select sites	/ASOS/
PACLIMATE	PA Long-Term Climate (COOP)	Daily max/min temp, precipitation, snowfall, snow depth	~1888–present at longest-running stations	Once daily (observer-reported)	/COOP/
PA_COCORAHS	PA CoCoRaHS	Daily precipitation, snowfall, hail	~2007–present	Once daily (observer-reported)	/cocorahs/
PA_DCP	PA Data Collection Platforms (HADS)	River stage, streamflow, soil temp/moisture, remote precip	Varies by station; some back to 1970s	Hourly; varies by station	/DCP/

Network ID (PA example)	Full Name	What It Measures	Archive Depth	Update Frequency	Key IEM URL
PA_RWIS	PA Roadway Weather Information Systems	Temp, wind, pavement temp, pavement condition, road cameras	~2000–present	Every 20–60 minutes	/RWIS/
PA_AWOS	Pennsylvania AWOS	Temp, wind, altimeter; precipitation and sky at AWOS-3P sites	~1993–present	Varies by tier; typically hourly	/AWOS/
IACLIMATE (Iowa example)	Iowa COOP Long-Term	Same as COOP; Iowa-specific archive	~1873–present	Once daily	/COOP/
ISUSM	ISU Soil Moisture Network	Soil temp and moisture at multiple depths, air temp, solar radiation, ET	~2012–present	Hourly	/agclimate/
SCAN	USDA NRCS Soil Climate Analysis Network	Soil temp and moisture at multiple depths, air temp, wind, solar radiation, precipitation	~2000–present at most sites	Hourly	/scan/

Network ID (PA example)	Full Name	What It Measures	Archive Depth	Update Frequency	Key IEM URL
USCRN	U.S. Climate Reference Network	Triple-redundant temp, precipitation, solar radiation, wind, soil temp/moisture	~2002–present	Hourly	/uscrn/
NLAE	NLAE Flux Tower Network	Eddy covariance flux measurements (energy, CO , water vapor), micromet	Varies by tower	Sub-hourly	/nstl_flux/
SCHOOL-NET	TV Station Schoolnet / WeatherNet	Temp, dew point, wind, precipitation; varies by station	~2000–present at oldest stations	Typically hourly	/other/
HADS (national)	Hydrometeorological Automated Data System	River stage (HP), streamflow (QR), precip (PC), soil temp (TS); SHEF-coded	Varies	Hourly to 6-hourly	/DCP/
IEMRE (gridded)	IEM Reanalysis	Gridded temp, precipitation, solar radiation — ¼° grid, CONUS	1893–present	Daily update	/iemre/

Notes on Network Coverage Flags

When you pull up any ASOS or AWOS station page, the attribute flags below tell you what data is actually available beyond the basic hourly observation. These flags appear in the station metadata and matter when you are deciding which station to anchor an analysis on.

Flag	Meaning
`HAS1MIN=1`	1-minute ASOS archive available (download at /request/asos/1min.phtml)
`HAS_PHOUR=1`	Hourly precipitation bucket data available
`HASTAF=1`	Terminal Aerodrome Forecasts issued for this station
`IS_AWOS=1`	Station is AWOS, not ASOS — check tier for capability
`GHCNH_ID`	Corresponding GHCN-Hourly identifier (NCEI cross-reference)
`FLOOR`	Earliest date IEM considers reliable for this station — may differ from archive begin
`SHEF_6HR_SRC`	DCP gauge used to supplement 6-hour precipitation totals

---

Network Comparison at a Glance

Network	Historical Depth	Spatial Density	Precip Quality	Best Use Case
ASOS	High (80+ years at major airports)	Low–Medium (airports only)	Good; known snowfall undercount	Hourly climatology, event timing, standard obs
COOP	Very High (130+ years at oldest sites)	Medium	Good; observer-consistent	Long-term climate trends, daily extremes, normals

Network	Historical Depth	Spatial Density	Precip Quality	Best Use Case
CoCoRaHS	Low (~2007)	Very High (volunteer density)	Good; standardized gauge	Precipitation spatial variability, storm totals
DCP/HADS	Medium (1970s–present)	Low (river/remote sites)	Variable	River stage, hydrology, remote area obs
RWIS	Medium (~2000)	Low–Medium (highway sites)	Poor	Pavement conditions, winter event analysis
USCRN	Low (~2002)	Very Low (~130 national sites)	Excellent	Climate trend detection, reference quality obs
SCAN	Low (~2000)	Very Low (research sites)	High	Soil temperature and moisture, agricultural research
IEMRE	Very High (1893; gridded)	Complete (¼° grid)	Derived	Gap-filling, regional background fields

---

Finding Network Station Lists

Every IEM network has a station table listing all member stations with coordinates, archive dates, and attributes. The network tables are at mesonet.agron.iastate.edu/sites/networks.php — select your state and network from the dropdown. The full table can be exported as CSV or shapefile for use in GIS software or analysis scripts.

For single-station lookup by name, coordinates, or state, use the station locator at mesonet.agron.iastate.edu/sites/locate.php.

Appendix B — Complete URL Directory

All URLs verified March 2026. The IEM base URL is `https://mesonet.agron.iastate.edu`. Paths below are relative to that base unless noted otherwise. In the HTML and EPUB versions, every entry is a live hyperlink.

URLs are organized by function, not by menu location. Where a tool appears in multiple contexts throughout the guide, it is listed under its primary use category.

---

1. Current Conditions

Description	URL
Current Mainpage	mesonet.agron.iastate.edu/current/
Current Temperature Map	mesonet.agron.iastate.edu/current/index.phtml/air_temperature
Current Precipitation Map	mesonet.agron.iastate.edu/current/index.phtml/precipitation
Current Station Plot Map	mesonet.agron.iastate.edu/current/index.phtml/station_plot
Sortable Currents / My Favorites	mesonet.agron.iastate.edu/my/current.phtml
Sortable Currents by NWS WFO	mesonet.agron.iastate.edu/nws/obs.php
Sortable Currents by State	mesonet.agron.iastate.edu/current/all.phtml
ASOS Current Conditions	mesonet.agron.iastate.edu/ASOS/current.phtml
RWIS Current Surface Conditions	mesonet.agron.iastate.edu/RWIS/currentSF.phtml
RWIS Current Traffic	mesonet.agron.iastate.edu/RWIS/traffic.phtml
IEM One (Radar + Warnings)	mesonet.agron.iastate.edu/one/
Severe Weather Mainpage	mesonet.agron.iastate.edu/current/severe.phtml
Convective Watches Overview	mesonet.agron.iastate.edu/current/sel.phtml

Description	URL
Hourly Precip (current)	mesonet.agron.iastate.edu/rainfall/obhour.phtml
DCP Current Map (by SHEF code)	mesonet.agron.iastate.edu/DCP/map.php
River Forecast Monitor	mesonet.agron.iastate.edu/river/
Current Warning Shapefile (live)	mesonet.agron.iastate.edu/data/gis/shape/4326/us/current_ww.zip
Current NEXRAD Storm Attributes (live)	mesonet.agron.iastate.edu/data/gis/shape/4326/us/current_nexattr.zip
Current 24-hr LSR Shapefile (live)	mesonet.agron.iastate.edu/data/gis/shape/4326/us/lsr_24hour.zip

2. Station Networks

Description	URL
Station Locator	mesonet.agron.iastate.edu/sites/locate.php
Network Tables	mesonet.agron.iastate.edu/sites/networks.php
ASOS/AWOS Mainpage	mesonet.agron.iastate.edu/ASOS/
ASOS Monthly Precip Tables	mesonet.agron.iastate.edu/ASOS/reports/mon_prec.php
ASOS Recent Observations	mesonet.agron.iastate.edu/ASOS/recent.phtml
AWOS Mainpage	mesonet.agron.iastate.edu/AWOS/
COOP Mainpage	mesonet.agron.iastate.edu/COOP/
COOP Current Observations	mesonet.agron.iastate.edu/COOP/current.phtml
COOP 12Z Daily Reports	mesonet.agron.iastate.edu/COOP/12z.php
COOP Station Map	mesonet.agron.iastate.edu/COOP/map/
COOP Daily Records / Extremes	mesonet.agron.iastate.edu/COOP/extremes.php
COOP Freeze Date Statistics	mesonet.agron.iastate.edu/COOP/freezing.php

Description	URL
COOP Snow Depth Duration	mesonet.agron.iastate.edu/COOP/snowd_duration.phtml
COOP Hourly Precip (HPD)	mesonet.agron.iastate.edu/COOP/hpd.php
COOP Period Analysis	mesonet.agron.iastate.edu/COOP/periods.phtml
COOP Station Catalog	mesonet.agron.iastate.edu/COOP/cat.phtml
CoCoRaHS Mainpage	mesonet.agron.iastate.edu/cocorahs/
CoCoRaHS Current Observations	mesonet.agron.iastate.edu/cocorahs/current.phtml
CoCoRaHS Observation Listing	mesonet.agron.iastate.edu/cocorahs/obs.phtml
DCP/HADS Mainpage	mesonet.agron.iastate.edu/DCP/
DCP Current Observations	mesonet.agron.iastate.edu/DCP/current.phtml
DCP Station Site Page	mesonet.agron.iastate.edu/DCP/site.phtml
DCP Tomb (unidentified stations)	mesonet.agron.iastate.edu/DCP/tomb.phtml
RWIS Mainpage	mesonet.agron.iastate.edu/RWIS/
RWIS Current Conditions	mesonet.agron.iastate.edu/RWIS/current.phtml
RWIS Road Cameras	mesonet.agron.iastate.edu/RWIS/camera.phtml
ISU Soil Moisture Network	mesonet.agron.iastate.edu/agclimate/
SCAN Network	mesonet.agron.iastate.edu/scan/
USCRN Network	mesonet.agron.iastate.edu/uscrn/
NLAE Flux Tower Network	mesonet.agron.iastate.edu/nstl_flux/
Other Networks	mesonet.agron.iastate.edu/other/
Wind Rose by Station	mesonet.agron.iastate.edu/sites/windrose.phtml

---

3. Historical and Climate Data

Description	URL
Climate Mainpage	mesonet.agron.iastate.edu/climate/
COOP Normals Download	mesonet.agron.iastate.edu/COOP/dl/normals.phtml

Description	URL
Climodat Application	mesonet.agron.iastate.edu/climodat/
Climodat Monitor (departures)	mesonet.agron.iastate.edu/climodat/monitor.php
IEM Explorer (interactive station browser)	mesonet.agron.iastate.edu/explorer/
Autoplot (all charts)	mesonet.agron.iastate.edu/plotting/auto/
IEM Reanalysis (IEMRE)	mesonet.agron.iastate.edu/iemre/
IEMRE CONUS NetCDF Files	mesonet.agron.iastate.edu/onsite/iemre/
IEMRE Daily API	mesonet.agron.iastate.edu/iemre/daily/{date}/{lat}/{lon}/json
IEMRE Multiday API	mesonet.agron.iastate.edu/iemre/multiday/{date1}/{date2}/{lat}/{lon}/json
Model Output Statistics (MOS)	mesonet.agron.iastate.edu/mos/
MOS Interactive Table	mesonet.agron.iastate.edu/mos/table.phtml
MOS API (JSON/CSV)	mesonet.agron.iastate.edu/api/1/docs#/default/service_mos___fmt___get
Sounding Archive (RAOB)	mesonet.agron.iastate.edu/archive/raob/
RAOB Listing	mesonet.agron.iastate.edu/archive/raob/list.phtml
RAOB JSON API	mesonet.agron.iastate.edu/json/raob.py?help=
Archive Mainpage	mesonet.agron.iastate.edu/archive/
Raw File Archive (date tree)	mesonet.agron.iastate.edu/archive/data/
Archive Directory Schema	mesonet.agron.iastate.edu/archive/schema.php
Raw SAO/METAR Text Archive	mesonet.agron.iastate.edu/archive/raw/sao/
NEXRAD Mosaic Documentation	mesonet.agron.iastate.edu/docs/nexrad_mosaic/
MRMS NetCDF Archive	mesonet.agron.iastate.edu/onsite/mrms/
Stage IV Archive	mesonet.agron.iastate.edu/onsite/stage4/
Rainfall / Stage IV Portal	mesonet.agron.iastate.edu/rainfall/
Soil Moisture Satellite (SMOS)	mesonet.agron.iastate.edu/smos/
MTarchive (BUFKIT / model data)	mtarchive.geol.iastate.edu
Dataset Documentation	mesonet.agron.iastate.edu/info/datasets/
Variables Reference	mesonet.agron.iastate.edu/info/variables.phtml
Daily Feature Archive	mesonet.agron.iastate.edu/onsite/features/past.php
Daily Feature Tags Index	mesonet.agron.iastate.edu/onsite/features/tags/
Time Machine (replay any IEM product)	mesonet.agron.iastate.edu/timemachine/

Description	URL
Drought Monitor	mesonet.agron.iastate.edu/dm/
Ag Weather Portal	mesonet.agron.iastate.edu/agweather/
AgClimate Network	mesonet.agron.iastate.edu/agclimate/
Soil Temperature Map	mesonet.agron.iastate.edu/agclimate/soilt.php
Soil Temp Probabilities	mesonet.agron.iastate.edu/agclimate/soilt-prob.php
Soil Moisture Time Series	mesonet.agron.iastate.edu/agclimate/smts.php
AgClimate Daily Download	mesonet.agron.iastate.edu/agclimate/hist/dailyRequest.php
AgClimate Hourly Download	mesonet.agron.iastate.edu/agclimate/hist/hourlyRequest.php
Freeze Map	mesonet.agron.iastate.edu/GIS/apps/iem/freeze.phtml
Plant Hardiness Zones	mesonet.agron.iastate.edu/topics/hardiness/
Pest Maps / GDD Forecasting	mesonet.agron.iastate.edu/topics/pests/
COOP GIS Duration Apps	mesonet.agron.iastate.edu/GIS/apps/coop/
NEXRAD by Year	mesonet.agron.iastate.edu/GIS/rad-by-year-fe.phtml
IEM Data in Published Research	mesonet.agron.iastate.edu/info/refs.php

---

4. NWS / Warnings / VTEC

Description	URL
NWS Mainpage	mesonet.agron.iastate.edu/nws/
VTEC Browser (event view)	mesonet.agron.iastate.edu/vtec/
Warning Search by Point / County	mesonet.agron.iastate.edu/vtec/search.php
IEM Cow (SBW Verification)	mesonet.agron.iastate.edu/cow/
IEM Raccoon (SBW PowerPoints)	mesonet.agron.iastate.edu/raccoon/
Local Storm Report App	mesonet.agron.iastate.edu/lsr/
Text Archives Mainpage	mesonet.agron.iastate.edu/nws/text.php
AFOS Product Finder	mesonet.agron.iastate.edu/wx/afos/
Products by WFO by Date	mesonet.agron.iastate.edu/wx/afos/list.phtml

Description	URL
AFOS Bulk Retrieve API	mesonet.agron.iastate.edu/cgi-bin/afos/retrieve.py?help
CLI Interactive Map	mesonet.agron.iastate.edu/nws/climap.php
CF6 Monthly Climate Table	mesonet.agron.iastate.edu/nws/cf6table.php
SPC Outlook Search by Point	mesonet.agron.iastate.edu/nws/spc_outlook_search/
SPC Watches by Year	mesonet.agron.iastate.edu/nws/watches.php
SPC PDS Watch Listing	mesonet.agron.iastate.edu/nws/pds_watches.php
WPC Outlook Search by Point	mesonet.agron.iastate.edu/nws/wpc_outlook_search/
SPS Search by Point	mesonet.agron.iastate.edu/nws/sps_search/
SVR/TOR Warning Tags by WFO	mesonet.agron.iastate.edu/nws/list_tags.php
Max ETN by WFO by Year	mesonet.agron.iastate.edu/vtec/maxetn.php
VTEC Events by Year Table	mesonet.agron.iastate.edu/vtec/yearly_counts.php
Tornado / Flash Flood Emergencies	mesonet.agron.iastate.edu/vtec/emergencies.php
PDS Warning Listing	mesonet.agron.iastate.edu/vtec/pds.php
HML River Data Download	mesonet.agron.iastate.edu/request/hml.php
HML Forecast vs. Obs Plot (q=160)	mesonet.agron.iastate.edu/plotting/auto/?q=160
Autoplot — Warning Gantt (q=52)	mesonet.agron.iastate.edu/plotting/auto/?q=52
Autoplot — VTEC Counts Map (q=109)	mesonet.agron.iastate.edu/plotting/auto/?q=109
Autoplot — Days Since WWA (q=92)	mesonet.agron.iastate.edu/plotting/auto/?q=92
Autoplot — Accumulated WWA (q=44)	mesonet.agron.iastate.edu/plotting/auto/?q=44
Autoplot — Lead Time Dist. (q=211)	mesonet.agron.iastate.edu/plotting/auto/?q=211

---

5. Downloads

Description	URL
ASOS/AWOS/METAR Download (UI)	mesonet.agron.iastate.edu/request/download.phtml
ASOS CGI Backend (scriptable)	mesonet.agron.iastate.edu/cgi-bin/request/asos.py?help
ASOS 1-Minute Download	mesonet.agron.iastate.edu/request/asos/1min.phtml
Iowa AWOS 1-Minute Download	mesonet.agron.iastate.edu/request/awos/1min.php
Climodat / COOP Download (processed)	mesonet.agron.iastate.edu/request/coop/fe.phtml
COOP Raw Observations Download	mesonet.agron.iastate.edu/request/coop/obs-fe.phtml
Daily Summaries Download	mesonet.agron.iastate.edu/request/daily.phtml
Hourly Precip Download	mesonet.agron.iastate.edu/request/asos/hourlyprecip.phtml
RWIS Download	mesonet.agron.iastate.edu/request/rwis/fe.phtml
RWIS Soil Download	mesonet.agron.iastate.edu/request/rwis/soil.phtml
RWIS Traffic Download	mesonet.agron.iastate.edu/request/rwis/traffic.phtml
DCP/HADS Download	mesonet.agron.iastate.edu/request/dcp/fe.phtml
USCRN Download	mesonet.agron.iastate.edu/request/uscrn.php
TAF Forecast Download	mesonet.agron.iastate.edu/request/taf.php
Temperature / Winds Aloft Download	mesonet.agron.iastate.edu/request/tempwind_aloft.php
WMO BUFR Surface Download	mesonet.agron.iastate.edu/request/wmo_bufr_srf.php
Warning Polygons Shapefile	mesonet.agron.iastate.edu/request/gis/watchwarn.phtml
LSR Archive Shapefile	mesonet.agron.iastate.edu/request/gis/lsrs.phtml
NEXRAD Storm Attributes Download	mesonet.agron.iastate.edu/request/gis/nexrad_storm_attrs.php
SPC Outlook Shapefile	mesonet.agron.iastate.edu/request/gis/spc_outlooks.phtml

Description	URL
SPC Watch Shapefile	mesonet.agron.iastate.edu/request/gis/spc_watch.phtml
SPC MCD Shapefile	mesonet.agron.iastate.edu/request/gis/spc_mcd.phtml
WPC MPD Shapefile	mesonet.agron.iastate.edu/request/gis/wpc_mpd.phtml
Special Weather Statement Shapefile	mesonet.agron.iastate.edu/request/gis/sps.phtml
CWA Shapefile	mesonet.agron.iastate.edu/request/gis/cwas.phtml
SIGMET Shapefile	mesonet.agron.iastate.edu/request/gis/awc_sigmets.phtml
G-AIRMET Shapefile	mesonet.agron.iastate.edu/request/gis/awc_gairmets.phtml
PIREP Shapefile	mesonet.agron.iastate.edu/request/gis/pireps.php
Miscellaneous GIS Downloads	mesonet.agron.iastate.edu/request/gis/misc.phtml
GeoTIFF Rasters	mesonet.agron.iastate.edu/GIS/rasters.php
MaxCSV (quick network snapshot)	mesonet.agron.iastate.edu/request/maxcsv.py?help
Gibson Ridge Placefiles	mesonet.agron.iastate.edu/request/grx/

---

6. Services and APIs

Description	URL
API Mainpage	mesonet.agron.iastate.edu/api/
API v1 Swagger Docs	mesonet.agron.iastate.edu/api/1/docs
OGC Web Services	mesonet.agron.iastate.edu/ogc/
GIS Mainpage	mesonet.agron.iastate.edu/GIS/
GOES GIS Products	mesonet.agron.iastate.edu/GIS/goes.phtml
NEXRAD RadView	mesonet.agron.iastate.edu/GIS/radview.phtml
RadMap API	mesonet.agron.iastate.edu/GIS/radmap_api.phtml

Description	URL
Radar + Warnings GIS Viewer	mesonet.agron.iastate.edu/GIS/apps/rview/warnings.phtml
Watches GIS Viewer	mesonet.agron.iastate.edu/GIS/apps/rview/watch.phtml
Station Comparison GIS	mesonet.agron.iastate.edu/GIS/apps/rview/compare.phtml
RAOB JSON API	mesonet.agron.iastate.edu/json/raob.py?help=
MOS API	mesonet.agron.iastate.edu/api/1/docs#/default/service_mos___fmt___get
MOS Raw Download	mesonet.agron.iastate.edu/fe.phtml
iembot (real-time data feed)	mesonet.agron.iastate.edu/projects/iembot/
LDM Data Request	mesonet.agron.iastate.edu/request/ldm.php

---

7. Webcams

Description	URL
Webcam Viewer (realtime + archive)	mesonet.agron.iastate.edu/current/viewer.phtml
Webcam Project Overview	mesonet.agron.iastate.edu/projects/webcam.php
RWIS Archived Webcam Imagery	mesonet.agron.iastate.edu/RWIS/camera.phtml
ISU Campus Webcams	mesonet.agron.iastate.edu/current/isucams.phtml
Lapse Builder	mesonet.agron.iastate.edu/current/bloop.phtml
Recent Pre-Built Lapses	mesonet.agron.iastate.edu/current/camlapse/
Cool Lapses Archive	mesonet.agron.iastate.edu/cool/

---

8. Admin, Info, and Site Resources

Description	URL
IEM Homepage	mesonet.agron.iastate.edu/
About / Applications Mainpage	mesonet.agron.iastate.edu/apps.php
QC Mainpage	mesonet.agron.iastate.edu/QC/
Public QC Ticket Log	mesonet.agron.iastate.edu/QC/tickets.phtml
MADIS Network QC Overview	mesonet.agron.iastate.edu/QC/madis/network.phtml
Currently Offline Stations	mesonet.agron.iastate.edu/QC/offline.php
Variables Reference	mesonet.agron.iastate.edu/info/variables.phtml
Dataset Documentation	mesonet.agron.iastate.edu/info/datasets/
IEM Data in Published Research	mesonet.agron.iastate.edu/info/refs.php
IEM News Archive	mesonet.agron.iastate.edu/onsite/news.phtml

Appendix C — Autoplot Chart Reference

All 260 Autoplot charts, organized by the category groupings used in the IEM's own interface. Charts are numbered q=1 through q=262, with gaps at q=214 and q=222 (retired). Descriptions are drawn directly from the chart source code.

Access any chart at: `https://mesonet.agron.iastate.edu/plotting/auto/?q={number}`

To download the data behind any chart, replace `.png` with `.csv` or `.xlsx` in the chart image URL, or look for the CSV Data / Excel Download links below any generated chart.

Charts marked are highlighted in the guide as particularly useful for weather hobbyists.

Daily

q	Title	Description
51	Accumulated Station Departures of Precip/GDD/SDD (Automated Stations)	This plot presents accumulated totals and departures of growing degree days, precipitation and stress degree days.
108	Accumulated Station Departures of Precip/GDD/SDD (Long Term Climate)	This plot presents accumulated totals and departures of growing degree days (GDD), precipitation and stress degree days (SDD).
172	Accumulated Year to Date / Period Precip / Snowfall / CDD / GDD / HDD	This chart presents year to date accumulated variable for a station of your choice.
149	Aridity Index (High Temperature minus Precip Departures)	This plot presents a time series of Aridity Index.

q	Title	Description
11	ASOS Daily Min/Max Dew Point/Temp/Feels Like/RH for a Year	This plot presents the range between the min and maximum observation of your choice for a given station and a given year.
94	Bias of 24 Hour High+Low Computation by Hour	This plot looks at the effect of splitting a 24 hour period at different hours of the day.
96	Bias of 24 Hour Precip Computation by Hour	This plot looks at the bias associated with computing 24 hour precipitation totals using a given hour of the day as the delimiter.
82	Calendar of Daily Observations from Automated or Climate Sites	This chart presents a series of daily summary data as a calendar.
218	Daily NWS CLImate Report Infographic	This produces an infographic with some of the information found presented in NWS CLI reports.
180	Daily Temperature/Precip/Snowfall Climatology	This application plots daily climatology for a location or two of your choice.
32	Daily Departures / Percentiles / Ranges for One Year	This plot presents a daily time series of variable of your choice.
21	Change in NCEI 1991-2020 Daily Climatology over X Days	This autoplot intends to show the spatial distribution of the change in temperature or precipitation climatology over a given period of days.
174	Compare Daily High/Low Temps for ASOS Stations	This application generates a comparison of daily high and low temperatures between two automated ASOS sites of your choosing.
215	Compare Daily High/Low Temps Distributions over Two Periods of Years	This autoplot generates some metrics on the distribution of temps over a given period of years.

q	Title	Description
91	Consecutive Day Statistics of High+Low Temps / Precip	This plot produces statistics on min, max, and average values of a variable over a window of days.
66	Consecutive Days Frequency by DOY for High/Low/Precip Above/Below Threshold	This chart presents the daily frequency of the given date having the prescribed number of previous days above or below some provided treshold.
216	Consecutive Days by Year with Daily Summary Variable Above/Below Threshold	This chart presents the longest daily streaks of having some threshold meet.
9	Cooling/Growing/Heating/Stress Degree Day Daily Values and Climatology	This chart produces the daily climatology of Degree Days for a location of your choice.
49	Daily/Multi-Day Frequency of Some Threshold/Range (snow, precip, temps)	This plot presents the observed frequency of some daily event happening.
113	Daily Climatology	Presents the simple daily climatology as computed by period of record data.
176	Daily/Monthly/Yearly Records Beat Margin	This chart shows the margin by which a new daily high and low temperatures record beat the previously set record.
5	Daily Records for each month of year	This plot displays the dates with the monthly record of your choice displayed.
31	Extreme Jumps or Dips in High/Low Temperature over X days	This chart attempts to assess by now much the high temperature can change between two or three periods of time.

q	Title	Description
147	Frequency of One Station Warmer/Wetter than Another	This plot presents the daily frequency of the first station having a higher value than the second station.
205	Frequency of Daily Summary Variables for Automated Stations	The IEM computes daily summaries of ASOS station data based on available station summaries and computed summaries based on available hourly data.
252	Frequency of Daily Variable Above/Below Threshold over period of days (map)	This autoplot generates a map of the frequency of having at least one day at-or-above or below a given threshold between an inclusive period of days.
7	Growing Degree Day Periods for One Year by Planting Date	This plot presents the period over which growing degree days were accumulated between the two thresholds provided by the user.
240	Growing Degree Day Obs + Near Term Forecast	This autoplot combines growing degree day observations along with a near term forecast from the deterministic GFS and NWS NDFD models.
204	Heatmap of Daily / Trailing Daily Temperature / Precip	This app generates a heatmap-like presentation of daily climate data of your choice.
225	Heatmap of Distribution of Trailing Departures	Departure from climatology metrics have an annual signal that is a function of the climatology.
61	High/Low Temp above/below avg OR dry streaks by NWS CLI Sites	This plot presents the current streak of days with a high or low temperature above or at-below the daily average temperature.

q	Title	Description
19	Histogram (weathergami) of Daily High/Low Temps + Ranges	This chart displays a histogram of daily high and low temperatures for a station of your choice.
35	Histogram of X Hour Temp/RH/Dew/Pressure Changes	This plot presents a histogram of the change in some observed variable over a given number of hours.
60	Hourly Variable Frequencies/Min/Max by Week of Year	This plot presents hourly variable metrics from automated stations.
86	IEMRE Daily Reanalysis Plots	This map presents a daily IEM ReAnalysis variable of your choice.
249	IEMRE Hourly Reanalysis Plots	This map presents an hourly IEM ReAnalysis variable of your choice.
139	Largest / Smallest Local Calendar Day Temperature Differences	This table presents the 10 largest or smallest differences between the lowest and highest air temperature for a local calendar day.
168	Latest Date of Year for High Temperature	This chart presents the last date of fall or first date of spring that a given temperature threshold was last or first reached.
255	Leaky Bucket Model for Daily Precip + Evaporation	This autoplot implemments a simple model known as the leaky bucket model.
229	Lightning Stroke Density Maps	This data is courtesy of Vaisala NLDN .
262	Top 15 Events for Daily Variables after Offset Days of certain event	This autoplot lists out daily climate observation extremes for a given combination of variable threshold and day offset.

q	Title	Description
207	Local Storm Report + COOP Rainfall/Snowfall/Ice Analysis Maps	Generates an analysis map of rainfall, snowfall, or freezing rain data based on NWS Local Storm Reports, NWS COOP Data, and CoCoRaHS.
206	Map of Daily Automated Station Summaries	Generates analysis maps of ASOS station data for a given date.
97	Map of Departures/Stats over One Period of Days	This application plots an analysis of station data for a period of your choice.
34	Max Stretch of Days with High/Low Above/Below Threshold or Climatology	This plot displays the maximum number of consec days above or below some threshold for high or low temperature.
26	Min Daily Low after 1 July / Max Daily High for year	This plot presents the climatology and actual year's progression of warmest to date or coldest to date temperature.
126	Mixing Ratio / Vapor Pressure Deficit Climatology and Yearly Timeseries Plot	This plot presents one of two metrics indicating daily humidity levels as reported by a surface weather station.
84	MRMS / PRISM / Stage IV / IFC / IEM Reanalysis Estimated Precip (multiday summaries/departures)	This application generates maps of precipitation daily or multi-day totals.
185	Number of Days to Accumulate an Amount of Precip (MRMS)	This application will make a map with the number of days it takes to accumulate a given amount of precipitation.

q	Title	Description
256	NWS Regional Temperature and Precipitation (RTP) Reports by IEM	Due to various software and support issues at the National Weather Service, they generally stopped the generation of Regional Temperature and Precipitation (RTP) reports during 2024.
164	Percentage of NWS CLI Sites Reporting Daily Above/Below Temps or Precip/Snow	This chart presents a simple accounting of the percentage of first order NWS climate sites that are either above or below average or reporting precipitation / snow each day.
22	Percentage of Years within Temperature Range from Averages	This plot displays the frequency of a daily high or low temperature being within a certain bounds of the long term NCEI climatology for the location.
83	Period Averages or Totals of X days around a given day of the year	This plot compares a period of days prior to a specified date to the same number of days after a date.
140	Period Statistics of Temp/Precip/Wind for a date period each year [ASOS/Automated Stations]	This plot presents statistics for a period of days each year provided your start date and number of days after that date.
107	Period Statistics of Temp/Precip for a date period each year [COOP/Climate Sites]	This plot presents aggregate statistics by year for a date period of your choice.

q	Title	Description
182	Precip (MRMS) Coverage Efficiency by State	This application attempts to assess the effectiveness of a calendar day's rainfall based on where the rain fell in relation to a previous period of days departure from climatology.
110	Precip Frequency Bins by Climate Week (climodat)	This plot presents the weekly percentage of precipitation events within a given rainfall bin.
241	Real-Time Mesoscale Analysis (RTMA) Max/Min Air Temperature	NCEP's Real-Time Mesoscale Analysis (RTMA) provides a fine scale hourly or in the case of the RTMA Rapid-Update (RTMA-RU), 15 minute interval analysis of a number of atmospheric variables.
43	Recent (Past 2-3 Days) Timeseries (Meteogram)	This plot presents a time series of observations.
157	Relative Humidity, Feels Like, Dew Point Climatology by Day of Year	Based on available hourly or better observations, the IEM computes local calendar day statistics for variables like relative humidity, dew point, and feels like (read: windchill or heat index) temperature.
62	Snow Depth	This chart presents the daily snow depth reports as a image.
199	ISU Soil Moisture Network Daily Plots	This application generates maps of daily ISU Soil Moisture Network Data.
38	Solar Radiation Estimates ERA5Land, HRRR, MERRAv2, NARR	This plot presents daily estimates of solar radiation for a given year for the 'climodat' stations tracked by the IEM.

q	Title	Description
25	Spread of Daily High and Low Temperatures	This plot displays the distribution of observed daily high and low temperatures for a given day and given state or station.
137	Start Date of Spring/Fall with Statistics	This plot displays some metrics about the start date and duration of the spring or fall season.
4	State Areal Coverage of Precip Intensity over X Days	Using the gridded IEM ReAnalysis of daily precipitation.
89	State Areal Coverage/Efficiency of Precip	This is a complex plot to describe! For each 24 hour period (roughly ending 7 AM), the IEM computes a gridded precipitation estimate.
81	Standard Deviation of Daily Temperatures	This chart presents two measures of temperature variability.
28	Trailing Number of Days Precip Total Rank	This plot presents trailing day precipitation metrics.
228	Trailing Standardized Precip (SPI) + Drought Monitor	This visualization mashes up the US Drought Monitor and three trailing day standardized precipitation index of your choice within a map presentation for a single state.
142	Trailing X Number of Days Temp/Precip Departures	This plot presents the trailing X number of days temperature or precipitation departure from long term average.
132	Top 10 Precip/Temperature Values by Month/Season	This plot displays the top ten events for a given site and period of your choice.

q	Title	Description
190	Year of Daily High/Low Temperature Record	This chart presents the year that the present day climatology record resides.

Monthly

q	Title	Description
130	Average High/Low Temperature with/without Snowcover	This chart presents violin plots of the distribution of daily high and low temperatures on dates with and without snow cover by month.
125	Climatological Maps of Period Averages	This application produces map analysis of climatological averages.
1	Comparison of Multi-Month Totals/Averages	This app allows the arbitrary comparison of months against other months.
55	Daily Climatology Comparison	This plot displays a comparison of various daily temperature climatologies.
17	Daily High/Low Temps or Precip with Climatology	Daily plot of observed daily summary variables along with the daily climatology for the nearest (sometimes same) location.
129	Daily Observation Percentiles/Frequencies by Month	This chart plots the monthly percentiles that a given daily value has.
15	Daily Temperature Change Frequencies by Month	This plot displays the directional frequency of day to day changes in high or low temperature summarized by month.

q	Title	Description
71	Daily Wind Speed, Gust, and Direction for Single Month	This plot displays daily average wind speeds for a given year and month of your choice.
98	Day of Month Frequency of meeting temp/precip threshold	This plot produces the daily frequency of a given criterion being meet for a station and month of your choice.
65	Day of the Month with the coldest/warmest temperature	This plot displays the frequency of a given day in the month having the coldest high or low temperature of that month for a year.
161	Days per month/season above/below some threshold	This application plots the number of days for a given month or period of months that a given variable was above or below some threshold.
29	Frequency of Hourly Variable within Range by Month	This plot presents the frequency of a given hourly variable being between two inclusive thresholds.
116	Cooling/Heating Degree Days monthly totals	This chart presents monthly cooling degree days or heating degree days for a 20 year period of your choice.
42	Consecutive Hours / Streaks Above/Below Threshold	Based on hourly or better METAR reports, this plot displays the longest periods above or below a given temperature threshold.
154	Hourly Temperature Averages by Month	This chart presents an average hourly value for a given month or season over the years covering the period of record for the site.

q	Title	Description
85	Hourly Frequencies / Last Occurence by Month	Based on IEM archives of METAR reports, this application produces the hourly frequency of a given variable at or above or below a threshold.
20	Hours of Precip by Month	This chart displays the number of hourly observations each month that reported measurable precipitation.
177	ISU Soil Moisture Network Timeseries Plots	This application generates time series charts using data from the ISU Soil Moisture Network.
115	Monthly Heatmap of Summary Totals	This reports presents simple monthy and yearly summary statistics.
2	Month Precip vs Month Growing Degree Day Departures	This plot compares the growing degree day vs precipitation departure for a given month and station.
223	Monthly/Seasonal Partition of Temperature/Precip Reports	This chart presents the monthly/seasonal partition of how a daily observed climate variable is observed.
57	Monthly Precip/Temperature Records or Climatology	This plot displays the monthly records or climatology for a station of your choice.
95	Monthly Precip/Temperature with El Nino SOI Index Relationship	This chart displays the combination of average temperature and total precipitation for one or more months of your choice.
24	Monthly Precip/Temperature Climate District / Statewide Ranks/Aridity	The map presents IEM computed climate district or statewide values for a metric of your choice.

q	Title	Description
3	Monthly/Yearly Precip/Temperature Statistics by Year	This plot displays a single month's worth of data over all of the years in the period of record.
6	Monthly Precip/Temperature Distributions	This application plots out the distribution of some monthly metric for single month for all tracked sites within one state.
8	Monthly Precip Reliability	This plot presents the frequency of having a month's preciptation at or above some threshold.
23	Monthly Station Departures + El Nino 3.4 Index Time Series	This plot presents the combination of monthly temperature or precipitation departures and El Nino index values.
36	Month warmer/wetter than other Month for Year	This plot summarizes the frequency of one month being warmer/wetter than another month for that calendar year.
58	One Day's Precip Greater than X percentage of Monthly Total	Displays the number of times that a single day's precipitation was greater than some portion of the monthly total.
41	Quantile / Quantile Plot of Daily Temperatures for Two Months/Periods	This plot compares the distribution of daily temperatures for two months or periods for a single station of your choice.
47	Snowfall vs Precip Total for a Month	This chart displays the combination of liquid precipitation with snowfall totals for a given month.

q	Title	Description
39	Scenarios for this month besting some previous month	This plot compares the month to date average temperature of this month against any previous month of your choice.
138	Wind Speed and Wind Direction Monthly Climatology	This graph presents monthly average wind speed values along with vector-averaged average wind direction.
173	Wind Speed Hourly Climatology by Month or Period	This chart presents the hourly average wind speeds by month of the year or by custom periods.

Yearly

q	Title	Description
135	Accumulated Days with High/Low Above/Below Threshold	This plot displays the accumulated number of days that the high or low temperature was above or below some threshold.
246	Accumulated GDD/Precip Threshold Frequency by Day of Year	This autoplot generates a probability of a specified accumulation threshold being reached by the given calendar date.
76	Dew Point / Vapor Pressure Deficit / RH Distributions by Year or Season	Simple plot of yearly average dew points by year, season, or month.
125	Climatological Maps of Annual/Monthly Averages	This application produces map analysis of climatological averages.

q	Title	Description
151	Difference between two periods or single period of years [map]	This autoplot can either produce a plot of averages for a given period or annual over a period of years; or a difference between a second set of years.
187	Compare one station yearly summary vs entire state	This chart presents the rank a station's yearly summary value has against an unweighted population of available observations in the state.
244	Compare NCEI Climdiv to IEM Climodat Statewide Values	The IEM attempts to create areal averaged climate values akin to what NCEI has with its "Climdiv" dataset.
128	Comparison of Yearly Summaries between two stations	This chart compares yearly summaries between two long term climate sites.
99	Daily High + Low Temperatures with Departures	This plot produces a time series difference between daily high and low temperatures against climatology.
12	Days per year and first/latest date above/below given threshold	This plot presents the yearly first or last date of a given high or low temperature along with the number of days that year above/below the threshold along with the cumulative distribution function for the first date! When you select a low temperatur
184	Days per year with High Temperature above temperature thresholds	This plot shows the number of days with a high temperature at or above a given threshold.

q	Title	Description
74	Days per year by season or year with temperature above/below threshold	The number of days for a given season that are either above or below some temperature threshold.
181	Days per year with temp/precip/snowfall within ranges	This application plots frequencies of a variable of your choice for five bins of your choice.
13	End/Start Date of Summer (warmest 91 day period) per Year	This chart presents the start or end date of the warmest 91 day period each year.
27	First Fall Temp Below Threshold (First Freeze/Frost)	This chart presents the date of the first fall (date after 1 July) temperature below threshold 1 and then the number of days after that date until threshold 2 was reached.
165	First / Last Date of Air/Soil Temperature Threshold [map]	This app generates a map showing either an explicit year's first or last date or the given percentile (observed frequency) date over all available years of a given temperature threshold.
119	Frequency of First/Last Fall High/Low Temp by Day of Year	This chart presents the accumulated frequency of a temperature threshold being the first time observed or last time observed during the fall season.
120	Frequency of Last Spring High/Low Temperature by Day of Year	This chart presents the accumulated frequency of having the last spring temperature at or below a given threshold.
189	General yearly totals with trend line fitted	Create plots of yearly totals and optionally fit a linear trendline.

q	Title	Description
179	Growing Degree Day Scenarios For This Year	This application creates two 2-D histograms of GDD accumulation frequencies.
152	Growing Season Differences Map between Two Periods	This map produces an analysis of change in the number of days for the growing season.
148	Holiday or Same Day Daily Weather Observations each year	This plot presents a daily observation for a site and year on a given date / holiday date each year.
53	Hourly Frequency of Variable within Certain Ranges	Based on hourly observations, this plot displays the frequency of a given variable falling within a set of thresholds.
10	Last Spring and First Fall Date above/below given threshold	This plot presents the period between the first or last date for spring and fall season that the temperature was above or below some threshold.
64	Last or First Snowfall of Each Winter Season	This chart displays either the first or last date of the winter season with a snowfall of a given intensity.
33	Maximum Low Temperature Drop	This plot presents the largest drop in low temperature during a period between 1 July and 30 June of the next year, but not including the July data of that year.
188	Max/Min High/Low after first temperature exceedence of season	This plot presents the yearly minimum temperature after the first spring temperature above a given value or the maximum temperature after the first fall temperature below a given value.

q	Title	Description
105	Maximum Period between Precip Amounts	This plot presents three precipitation metrics for a site of your choice.
46	Minimum Wind Chill / Max Heat Index Temperature	This chart presents the frequency of observed minimum wind chill or maximum heat index over the period of record for the observation site.
30	Monthly Temperature Range	This chart presents the range between the warmest high temperature and the coldest low temperature for a given month for each year.
44	NWS Office Accumulated SVR+TOR Warnings	This plot displays an accumulated total of office issued watch, warning, advisories.
69	Percentage of Days each Year Above/Below Average	The frequency of days per year that the temperature was above/below average.
77	Period between Last and First High Temperature for Year	For each year, the average first and last date of a given temperature is computed.
134	Period each year that was warmest/coldest/wettest/driest	This plot displays the period of consecutive days each year with the extreme criterion meet.
75	Precip Totals by Season/Year	Simple plot of seasonal/yearly precipitation totals.
63	Records Set by Year (Max High / Min Low / Max Precip)	This chart plots the number of daily maximum high temperatures, minimum low temperatures and precipitation records set by year.

q	Title	Description
144	Soil Temperature Periods Above/Below Threshold in Spring	This plot uses hourly 4 inch depth soil temperature observations from the ISU Soil Moisture Network.
145	Soil Temperature / Moisture Daily Time Series by Year	This chart presents daily timeseries of soil temperature or moisture.
175	Snow Coverage Percentage for State For One Winter	This chart displays estimated areal coverage of snow cover for a single state.
133	Snowfall Season Totals Split by Date within Season	This plot displays the total reported snowfall for a period prior to a given date and then after the date for the winter season.
103	Step Ups in High Temp / Step Downs in Low Temp by Year	This plot analyzes the number of steps down in low temperature during the fall season and the number of steps up in high temperature during the spring season.
100	Temperature / Precip Statistics by Year	This plot displays a metric for each year.
136	Time per Winter Season below Wind Chill Threshold	This plot displays the number of accumulated hours below a given wind chill temperature threshold by season.
104	Trailing X day temp/precip departures (weather cycling)	This plot presents the time series of trailing X number of day departures evaluated every Y days forward in time.
14	Yearly Precip Contributions by Daily Totals	Using long term data, five precipitation bins are constructed such that each bin contributes 20% to the annual precipitation total.

Hydrology / Drought Monitor Plots

q	Title	Description
160	River Gauge Obs and Forecasts from HML Products	This page presents a sphagetti plot of river stage and forecasts.
178	NWS RFC Flash Flood Guidance Plots	This application plots Flash Flood Guidance for a time of your choice.
183	US Drought Monitor Areal Coverage by State	This plot presents a time series of areal coverage of United States Drought Monitor for a given state of your choice.
186	US Drought Monitor Change in Areal Coverage by State	This plot shows the weekly change in drought monitor intensity expressed in terms of category change over the area of the selected state.
194	US Drought Monitor Time Duration over Period Maps	This application generates a heatmap of the frequency of a given drought classification.
193	US Drought Monitor + Weather Prediction Center (WPC) Forecast Rain (QPF)	Generates a map of WPC Quantitative Precipitation Forecast (QPF) and most recent US Drought Monitor to the date choosen to plot the WPC forecast
231	Weekly Statewide SPI Changes and Drought Classification	This autoplot produces an infographic for a given state with some diagnostics on the weekly change in Standardized Precipitation Index (SPI) over a given day interval.

METAR ASOS Special Plots

q	Title	Description
78	Average Dew Point/RH% by Air Temperature by Month or Season or Year	This plot displays the average dew point at a given air temperature along with the envelope between the 5th and 95th percentile.
40	Cloud Amount and Level Timeseries / Visibility for One Month	This chart is an attempted illustration of the amount of cloudiness that existed at a METAR site for a given month.
88	Cloudiness Impact on Hourly Temperatures	This plot attempts to show the impact of cloudiness on temperatures.
214	Combos of Hourly Observations Var Vs Var	
59	Daily u and vs Wind Component Climatologies	This plot presents a climatology of wind observations.
79	Dew Point Distribution by Wind Direction by Month or Season or Year	This plot displays the average dew point at a given wind direction.
54	Difference between morning low or afternoon high temperature between two sites	This application plots the difference in morning low or afternoon high temperature between two sites of your choice.
250	Difference between two ASOS/METAR stations for a given hourly variable	This autoplot presents some metrics when comparing a single variable between two airport weather stations.
167	Flight / Aviation Condition (VFR, MVFR, IFR, LIFR) hourly for one month	This chart summarizes Flight Category by hour and day of a given month.
87	Frequency of METAR Code (Thunder, etc) by week or day by hour	Frequency plot partitioned by hour and day or week of the year for a given METAR code to appear in the present weather.

q	Title	Description
131	Frequency of Overcast Clouds / Clear Skies by Air Temperature by month/season	This plot displays the frequency of having overcast or clear sky conditions reported by air temperature.
93	Heat Index / Temperature / Dew Point / Wind Chill Hourly Histogram	Caution: This plot takes a bit of time to generate.
192	Hourly Analysis Maps of ASOS/METAR Stations	Generates analysis maps of ASOS station data.
153	Hourly Extremes by Month/Season/Day Period/Year	This table presents the extreme hourly value of some variable of your choice based on available observations maintained by the IEM.
159	Hourly Frequency / Histogram by year and by hour of day	Based on available hourly observation reports by METAR stations, this application presents the frequency of number of hours for a given month or season at a given threshold.
106	Hourly variable distributions on days exceeding threshold	This plot displays hourly variable distributions on dates that meet the criterion for having at least one observation at the given threshold.
202	Hourly variable comparison between two hours on one day	This application presents daily comparisons of an automation station's hourly data.
169	Largest Rise/Drop in Temp/Dew Point/Pressure over X Hours	This chart presents the largest change in some observed variable over a given number of hours.
18	Long term observation time series	This chart displays a simple time series of an observed variable for a location of your choice.

q	Title	Description
45	Monthly Frequency of Overcast Conditions	Computes the frequency of having an overcast sky reported.
170	Monthly Frequency of Present Weather Code in METAR Report	This chart totals the number of distinct calendar days or hours per month that a given present weather condition is reported within the METAR data feed.
67	Monthly Frequency of Wind Speeds by Air Temperature	This plot displays the frequency of having a reported wind speed be above a given threshold by reported temperature and by month.
37	MOS Forecast Ranges + ASOS Observations	This chart displays the combination of Model Output Statistics (MOS) forecasts and actual observations by the automated station the MOS forecast is for.
211	One Minute Interval Plots	This application generates charts of 1 minute interval ASOS data, where available.
222	One Minute Precip During Severe Weather	
162	Cloud Ceilings 2D Histogram (Level by Week)	This plot presents a 2-D histogram of reported cloud ceilings as inferred by the METAR cloud amount reports of at least BKN (broken) or OVC (overcast) from the automated sensor.
213	Percentiles of Hourly ASOS Data by Day, Week, Month, or Year	This application generates percentiles based on available data from the selected station.

q	Title	Description
146	Temperature Frequency by Week During Precip	This chart displays the frequency of having measurable precipitation reported by an ASOS site and the air temperature that was reported at the same time.
155	Top 10 / Most Recent Hourly Reports from ASOS Stations	Based on available hourly observation reports by METAR stations, this application presents the top 10 events for a given metric of your choice.
16	Wind Rose when specified criterion is meet	This application generates a wind rose for a given criterion being meet.

NASS Quickstats (USDA Crop Statistics)

q	Title	Description
238	NASS County Yield Maps	This app generates maps of yearly USDA NASS county yield estimates.
239	NASS County Yields + Weather Station Summaries	This autoplot combines the USDA NASS county yield estimates with summarized weather variables from a single weather station.
156	NASS Crop Condition by Year for Six States	This chart presents crop condition reports from USDA/NASS.
127	NASS Crop Progress by Year	This chart presents the crop progress by year.
197	NASS Crop Progress State Average Map	This generates a map showing USDA NASS weekly statistics.

q	Title	Description
209	NASS Crop Progress Weekly Change	This plot presents the weekly change in a given USDA NASS Crop Progress report variable.

NWS Warning Plots

q	Title	Description
196	ASOS/METAR Heat Index / Wind Chill Frequencies by NWS Alert Headline	This plot presents a frequency of having either a heat index or wind chill advisory/warning active for a given computed feels like temperature.
232	ASOS/METAR Time Series during NWS Alert Headline (Blizzard / Fire / Fog / Wind / Heat / Wind Chill)	This app plots ASOS/METAR data during a period of your choice and overlays NWS Watch, Warning, and Advisory data.
191	Calendar Plot of Watch/Warn/Adv Daily Counts	This application presents a calendar of daily counts of the number of watch, warning, advisories issued by day.
253	NWS Damage Assessment Toolkit (DAT) Tornado Tracks + Lead Time	This autoplot combines NWS Damage Assessment Toolkit (DAT) tornado tracks (lines) with Tornado Warning (polygons) to provide along track estimates of lead time.
92	Days since Last Watch/Warning/Advisory by WFO	This map depicts the number of days since a Weather Forecast Office has issued a given VTEC product.

q	Title	Description
72	Frequency of Watch/Warning/Advisories by Time of Day	This chart presents a histogram of the Watch, Warning, Advisory valid time.
50	Frequency of Hail/Wind Tags used in Severe TStorm Warnings	This app produces a table of frequencies of wind and hail tags used in NWS Severe Thunderstorm Warnings.
52	Gantt Chart of Watch/Warning/Advisories by WFO or UGC	Gantt chart of watch, warning, and advisories (WaWa) issued by an NWS Forecast Office for a start date and number of days of your choice.
245	Local Storm Reports by Month/Year + Top 10 Daily	This chart presents the total number of Local Storm Reports disseminated by the NWS by month and year.
234	Local Storm Reports Calendar Counts	This autoplot generates a calendar showing calendar day Local Storm Report totals by NWS Weather Forecast Office (WFO) or State.
163	Local Storm Reports Issued by WFO/State [map]	This application generates a map displaying the number of LSRs issued between a period of your choice.
102	Local Storm Report Source Type Ranks by Year	The National Weather Service issues Local Storm Reports (LSRs) with a label associated with each report indicating the source of the report.
237	Map of WFO/CWSU Miscellaneous Event Counts (SPS/CWA)	This autoplot is a bit of a catch-all for mapping event counts at a WFO or CWSU map unit.

q	Title	Description
260	Map of WFO Watch/Warning/Advisories over a Time Period	This autoplot maps out the issued NWS Watch/Warning/Advisory events over a given time period of your choice.
44	NWS Office Accumulated Watch/Warning/Advisories by Year	This plot displays an accumulated total of office issued watch, warning, advisories.
68	Number of Distinct Phenomena/Significance VTEC per Year	This chart shows the number of VTEC phenomena and significance combinations issued by a NWS Forecast Office for a given year.
73	Number of Watch/Warning/Advisories Issued per Year	This chart displays the number of products issued by a NWS Office or state by year for a given watch, warning, or advisory of your choice.
171	Number of Watch/Warning/Advisories Issued per Year per Month + Top 10 Daily	This chart displays the monthly number of distinct NWS Office issued watch / warning / advisory product.
247	NWS Watch Warning Advisory (WaWa) Map + Population Stats	This autoplot generates a map of active NWS Watch, Warnings, and Advisories active at the given timestamp.
251	NWS Warning Load Time Series	The purpose of this autoplot is to generate a time series of NWS warning load with time for short fuse warnings.
70	Period between First and Last VTEC Product Each Year	This chart attempts to display the period between the first and last VTEC enabled watch, warning or advisory issuance by year.

q	Title	Description
248	Period between First and Last SPC/WPC Outlook each Year	This chart displays the period each year between the first and last SPC/WPC outlook type for a given NWS forecast office, state or county.
224	Population/Area under NWS Watch/Warning/Advisory at Time	This autoplot attempts to estimate the number of people or area in the US under a given NWS Watch/Warning/Advisory (WaWA).
203	Storm Based Warning Polygon Visual Summary	This application generates a visual summary of polygons issued for a given UTC date.
195	Storm Motion distribution based on NWS Warnings	Some of the warnings that the National Weather Service issues includes a storm motion vector.
201	SPC Convective/Fire Wx or WPC Excessive Rainfall Outlook Calendar	This application presents a calendar of Storm Prediction Center or Weather Prediction Center outlooks by state, WFO, or county.
258	SPC Convective/Fire Wx or WPC Excessive Rainfall Outlook Progression for Lat/Lon	This tool generates an info-graphic with the progression of outlooks for a given point and date.
230	SPC Convective/Fire Wx or WPC Excessive Rainfall Last Event Infographic	This application presents an infographic showing the most recent date of a given SPC outlook threshold as per IEM unofficial archives.
200	SPC + WPC Outlook Heatmap	This application generates heatmaps of Storm Prediction Center convective outlooks.

q	Title	Description
143	Special Weather Statements (SPS) Polygon Count by Year by Month	The NWS issues Special Weather Statements (SPS) products that often cover events that are just below severe limits and/or not covered by other headline products.
233	Special Weather Statements (SPS) Polygon Calendar of Daily Counts	This calendar presents the number of Special Weather Statements that contain polygons issued per day.
166	Storm Prediction Center (SPC) Watches per Year for a State	This plot presents a summary of the number of year to date watches issued by the Storm Prediction Center and the percentage of those watches that at least touched the given state, county warning area, or fema region.
210	Text Product Frequency Maps	This application generates a map of the per WFO office usage of a given text product identifier based on unofficial IEM archives of NWS Text Product data.
235	Text Product Issuance Counts by Month + Year	This autoplot presents the total number of text products issued by UTC month and year.
261	Text Product Issuance Heatmap by Hour / Day	This chart presents a heatmap of the issuance hour of a given NWS Text Product.
48	Time of Day Frequency for Given Warning / UGC	For a given watch/warning/advisory type and forecast zone, what is the frequency by time of day that the product was valid.

q	Title	Description
80	Time Duration of a Watch/Warning/Advisory for a UGC/WFO	This plot presents the accumulated frequency of duration for a given NWS VTEC Watch, Warning, Advisory product.
243	Top 10 VTEC Event Days/Multi-Day by Year/Month	This autoplot prints out the top 10 dates for number of VTEC events issued.
101	Top 25 Most Frequent VTEC Products by Office/NWS	This chart displays the relative frequency of VTEC products.
259	UGC Geometry Change Diagnostic	This tool generates a diagnostic plot of how a given NWS UGC geometry has changed over time.
56	Weekly/Daily/Monthly Frequency of a Watch/Warning/Advisory	This chart shows the time partitioned frequency of having at least one watch/warning/advisory (WWA) issued by the Weather Forecast Office (top plot) and the overall number of WWA issued events (bottom plot).
109	WFO / State VTEC Event Counts/Time Coverage Percent/Num Days for a Given Period (map)	This application generates per WFO or state maps of VTEC event counts.
208	WFO VTEC Single Event Map Plot (map)	This application generates a map showing the coverage of a given VTEC alert.
90	UGC or Polygon SBW Statistics for Watch/Warning/Advisory by state/wfo	This application has a considerable and likely confusing amount of configuration options.

Tall Towers Plots

q	Title	Description
158	Tall Towers - 1 Second Interval Time Series	This plot presents one second data from the Iowa Atmospheric Observatory Tall-Towers sites overseen by Dr Gene Takle.

Upper Air / RAOB Sounding Plots

q	Title	Description
198	Monthly Max/Min/Avgs for Sounding Parameter or Variable at Given Level	This plot presents a simple average of a given sounding variable of your choice.
150	Single Sounding Mandatory Level Percentile Ranks	This plot presents percentiles of observations from a given sounding profile against the long term record for the site.
212	Sounding Parameter / Variable Yearly Timeseries	This plot presents the daily climatology range of a sounding variable along with a given year's values.

Miscellaneous

q	Title	Description
226	Center Weather Advisory (CWA) Map	This plot is not meant for interactive use, but a backend for CWA plots.
257	HRRR Comprehensive Climate Index (CCI)	This tool plots the Comprehensive Climate Index (CCI) based on HRRR model data.

q	Title	Description
221	HRRR Time-Lagged Ensemble Reflectivity Plot	The NCEP deterministic HRRR model forecast produces a post processed field that is meant to resemble RADAR reflectivity.
242	Local Storm Report (LSR) Simple Map	Presently, this autoplot is a backend for generating Local Storm Report social media graphics.
254	NEXRAD Level III Latency over NOAAPort	Map of NEXRAD Level III Latencies over NOAAPort or Realtime-ness.
227	NWEM / NWS Non-VTEC Products containing a polygon	This plot is not meant for interactive use, but a backend for NWEM plots.
236	PIREP Daily Counts by ARTCC / Alaska Zone	This autoplot presents a time series of UTC daily PIREP totals by ARTCC or Alaska Zone.
220	SPC Convective / Fire Weather / WPC Excessive Rainfall Outlook Graphics	This app generates infographics for the Storm Prediction Center or Weather Prediction Center outlooks.
217	SPS Special Weather Statement Maps	This plot is not meant for interactive use, but a backend for SPS plots.
219	Terminal Aerodrome Forecast (TAF) Infographic	This app generates infographics for Terminal Aerodrome Forecasts (TAF).

Appendix D — GIS Shapefile Download Reference

All 13 IEM GIS download endpoints under `/request/gis/`, plus related spatial download resources. These portals produce shapefiles, CSVs, and GeoJSON files suitable for use in QGIS, ArcGIS, Python (geopandas), R (sf), or any GIS-capable application.

All endpoints are at `https://mesonet.agron.iastate.edu` + the path shown.

/request/gis/ Endpoints

Endpoint	Data Type	Output Format	Date Range	Notes
/request/gis/watch-warn.phtml	NWS Watch / Warning / Advisory polygons	Shapefile	2005–present (VTEC era)	Includes full VTEC metadata: phenomena, significance, ETN, WFO, issuance and expiration times. Pre-2007 events use county boundaries rather than storm-based polygons.

Endpoint	Data Type	Output Format	Date Range	Notes
/request/gis/lsrs.phtml	Local Storm Reports	Shapefile / CSV	2003–present	Point data. Filterable by event type (tornado, hail, wind, flood, snow, etc.), magnitude threshold, WFO, and date range.
/request/gis/spc_outlooks.phtml	SPC Convective Outlooks	Shapefile	~2002–present	Includes Day 1, Day 2, Day 3 categorical and probabilistic outlooks. Also covers Fire Weather outlooks. One shapefile per outlook day/category.
/request/gis/spc_watch.phtml	SPC Tornado and Severe Thunderstorm Watches	Shapefile	1986–present	Includes ETN, issuance and expiration times, watch type, and PDS flag. Watch polygons are the county-list-based areas, not the parallelogram watch boxes.

Endpoint	Data Type	Output Format	Date Range	Notes
/request/gis/spc_mcd.phtml	SPC Mesoscale Convective Discussions	Shapefile	~2003–present	Polygon boundaries of each MCD with issuance time and MCD number. Text of the discussion is not included in the shapefile but retrievable from the IEM text archive by PIL.
/request/gis/sps.phtml	Special Weather Statements	Shapefile	~2007–present	Polygon-bearing SPS products only. Not all SPS products contain polygons; this endpoint captures those that do.
/request/gis/wpc_mpd.phtml	WPC Mesoscale Precipitation Discussions	Shapefile	~2003–present	Polygon boundaries with issuance time and MPD number. Pairs well with the WPC QPF data for precipitation event analysis.

Endpoint	Data Type	Output Format	Date Range	Notes
/request/gis/cwas.phtml	Center Weather Advisories	Shapefile	~2008–present	Aviation product. Polygons issued by ARTCCs for significant in-flight weather. Useful for correlating flight delays with atmospheric hazards.
/request/gis/awc_sigmets.phtml	SIGMETs	Shapefile	~2008–present	Aviation product. Covers both domestic and international SIGMETs, including Convective SIGMETs. Polygon or line geometry depending on product type.
/request/gis/awc_gairmets.phtml	G-AIRMETs	Shapefile	~2008–present	Aviation product. Graphical AIRMETs for turbulence, icing, and IFR conditions below 18,000 feet MSL. Replaced text AIRMETs operationally in 2017.

Endpoint	Data Type	Output Format	Date Range	Notes
/request/gis/nexrad_storm_attrs.php	NEXRAD Storm Attributes	Shapefile / CSV	~2010–present	Point data. One point per tracked storm cell per volume scan, with attributes including estimated hail size, probability of severe hail (POSH), storm top height, and rotation (azimuthal shear). Updated approximately every 5–6 minutes during active periods. Also available as a live shapefile at `/data/gis/shape/4326/us/curre`
/request/gis/pireps.php	Pilot Reports	Shapefile / CSV	~2005–present	Point data at the reported aircraft position. Attributes include altitude, turbulence intensity, icing intensity, sky condition, and visibility.

Endpoint	Data Type	Output Format	Date Range	Notes
/request/gis/misc.phtml	Miscellaneous GIS Products	Various	Varies	A catch-all for spatial products that do not fit the other categories. Contents vary; check the page directly for current offerings.

Related Spatial Downloads

These endpoints produce spatial data but live outside the `/request/gis/` tree.

Resource	URL	Format	Notes
Current warning polygons (live)	/data/gis/shape/4326/us/current_ww.zip	Shapefile	Updated continuously. All currently active NWS watch/warning/advisory polygons in a single file.
Current 24-hr LSRs (live)	/data/gis/shape/4326/us/lsr_24hour.zip	Shapefile	Rolling 24-hour window of Local Storm Reports. Updated as new LSRs arrive.
Current NEXRAD storm attributes (live)	/data/gis/shape/4326/us/current_nexattr.zip	Shapefile	Current volume scan storm attributes for all active NEXRAD sites. Updated every ~5 minutes.

Resource	URL	Format	Notes
GeoTIFF rasters	/GIS/rasters.php	GeoTIFF	NEXRAD composites, GOES satellite products, and MRMS fields available as georeferenced raster files for GIS import.
OGC Web Services	/ogc/	WMS / WFS / TMS	Standard OGC service endpoints for loading IEM layers directly into QGIS, ArcGIS, or any WMS-capable GIS client. Covers NEXRAD mosaics, warning polygons, station observations, and GOES channels.
IEMRE NetCDF files	/onsite/iemre/	NetCDF	Annual gridded files for the IEMRE reanalysis product. Loadable with xarray, QGIS (via GDAL), or any NetCDF-aware tool.

Coordinate System

All IEM shapefiles use **EPSG:4326** (WGS84 geographic coordinates, decimal degrees). No reprojection is needed for web mapping or for loading into GIS software that handles projection on-the-fly. If your workflow requires a projected coordinate system (e.g., for area calculations or distance measurements), reproject after download.

Attribute Fields

Shapefile attribute field names are truncated to 10 characters per the DBF format specification. The IEM's own dataset documentation at /info/datasets/ and variables reference at /info/variables.phtml are the authoritative references for field name definitions when the truncated names are not self-explanatory.

For the warning polygon shapefile specifically, the key fields are: `PHENOMENA` (2-letter code), `SIGNIFICANCE` (1-letter code), `ETN` (event tracking number), `WFO` (4-character office ID), `ISSUED` and `EXPIRED` (UTC timestamps), and `WINDTAG`, `HAILTAG`, `TORNTAG` for impact-based warning tags where applicable.