Eyes on the Sky: The National Weather Service and the Protection of Life and Property

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Early Beginnings of the NWS
Local Influence Into The Birth of An Agency

• In February 1871, the first official weather report of the U.S. Army was compiled and delivered by Cleveland Abbe, the director of the Cincinnati observatory. These first observations came from Pike’s Opera House in Cincinnati, the location of the U.S. Signal Service.

• Abbe ensured that every forecast contained at least four main meteorological elements: weather (clouds/precipitation), temperature, wind direction, and barometric pressure.

• In 1872, Abbe sent over 500 sets of daily maps and bulletins oversees in exchange for European meteorological data.

Cleveland Abbe: Founder of Modern-Day NWS

Event Timeline
First official weather report of U.S. Government 1870s
U.S. Weather Bureau Formed 1891
Abbe Meteorological Observatory 1910s
Lunken Field Weather Observations Suspended 1930s
Weather Bureau Offices at Dayton, Columbus 1930s
Weather Bureau becomes National Weather Service 1970
NWS offices in Cincinnati, Dayton, Columbus consolidate into NWS Wilmington 1994
NWS Wilmington OH remains in operation to this day. Today
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- The weather service is first identified as a civilian agency when Congress, at the request of President Benjamin Harrison, passes an act transferring the meteorological responsibilities of the U.S. Army Signal Service to the newly-created U.S. Weather Bureau in the Department of Agriculture.

- The transfer officially took place July 1, 1891, which marked the beginning of the United States Weather Bureau.

United States Weather Bureau

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- The U.S. Weather Bureau built a weather observatory on Lafayette Circle, which opened in 1915. It was named after former observer Cleveland Abbe and was the only weather station with a commemorative name.

- Weather instruments were located on the roof, and the chief meteorologist of the station lived in the house.

- Ownership of the building was transferred from the Weather Bureau to the University of Cincinnati in 1965. Today it serves as a private residence.

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A weather observing station was operated by the Weather Bureau at Lunken Airport from 1930 to 1949.

However, floods on the nearby Ohio and Little Miami Rivers interrupted observations in 1937 and 1945.

Flooded Lunken Field in 1937

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- Weather Bureau offices were established at Dayton and Columbus early in the 1930s.

- On the left, the Administration building (in the foreground) housed the Weather Bureau Airport Station at Port Columbus Airport from May of 1930 to October of 1958.

Columbus Weather Bureau (building in foreground)
Early Beginnings of the NWS
Local Influence Into The Birth of An Agency

As part of a government reorganization plan, President Franklin D. Roosevelt advocated transferring the Weather Bureau from the Department of Agriculture to the Department of Commerce. This process took awhile after his passing, but eventually it took shape.

This process led to the subsequent relocation of the organization to the Department of Commerce from the Department of Agriculture. This also led to the renaming of the organization from the U.S. Weather Bureau to the National Weather Service.

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In the early 1990s, the National Weather Service went under a massive reorganization effort which resulted in the relocation of hundreds of Weather Service Offices (WSOs) into consolidated Weather Forecast Offices (WFOs).

The WSOs in Cincinnati, Columbus, and Dayton all closed their doors in the early to mid 1990s as principle observation, warning, and forecast responsibilities were undertaken by the new National Weather Service in Wilmington, OH.

This brought the total number of local NWS field offices to 122, a number which remains today.

Today

NWS Wilmington, OH remains in operation to this day.
Modern-Day NWS
Serving The Tri-State Region Since 1994

U.S. Weather Bureau Office: 1926

NWS Wilmington, OH (ILN): Present Day

The National Weather Service office in Wilmington, OH has been serving northern Kentucky, southeastern Indiana, and southwestern, west-central, central, and south-central Ohio for the past 25 years.

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NWS Mission: To provide weather, hydrologic, and climate forecasts and warnings for the protection of life and property and the enhancement of the national economy.
National Weather Service
Organizational Structure: National to Local Levels

- **National Headquarters**
  - NWS policy
  - IT support
  - Science/technology support

- **Regional Headquarters**
  - Administrative and operational support
  - Meteorological and hydrological support
  - Research and development support
National Centers for Environmental Prediction

- Climate Prediction Center
- Environmental Modeling Center
- Weather Prediction Center
- Aviation Weather Center
- College Park, Maryland
- Storm Prediction Center
- Ocean Prediction Center
- NCEP Central Operations
- National Hurricane Center

Space Weather Prediction Center
Boulder, Colorado

Kansas City, Missouri

Norman, Oklahoma

Miami, Florida
Climate Prediction Center (CPC)
Silver Spring, Maryland

- Extended outlooks
  - Monthly
  - Seasonal
- ENSO
  - El Nino
  - La Nina
- Trends in sea surface temperatures
- Global/regional atmospheric pressure anomalies

CPC is responsible for issuing forecasts and updates on current and expected trends in global weather patterns and developing trends.

Forecasting the weather starts at a global level before working its way down to the local level. Every meteorologist must have a grasp on the hemispheric weather pattern before trying to focus on a state or local domain.
Aviation Weather Center (AWC)
Kansas City, MO

AWC Active PIREPs From In-Flight Pilots

- Issue forecasts for
  - Areas of turbulence
  - Areas of icing

- Monitor incoming PIREPs (Pilot Reports) on turbulence and icing mid-flight

- Issue forecasts on expected areas of turbulence and in-flight icing for commercial aircraft.

- Relay necessary information to national and regional FAA air route traffic control centers.

- Facilitate the retrieval and proper dissemination of Pilot Reports (PIREPs) to necessary TRACON (Terminal Radar Approach Control) facilities.
National Hurricane Center (NHC)  
Miami, Florida

- Marine Forecasts
  - Atlantic Basin
  - Eastern Pacific Basin
- Forecasts
  - Wave heights
  - Wind speeds and direction
- Swells
  - Monitor potential tropical storm or hurricane activity
  - Provide detailed forecasts on hurricane intensity and forecast tracks

- NHC maintains a constant watch of the weather over the entire Atlantic Basin and the eastern Pacific ocean, issuing routine forecasts on wave heights, wind speed and directions, etc.
  - Merchant sailing routes
- NHC is best-known for their monitoring, tracking, and forecasting of tropical storm or hurricane development in these basins. These forecasts are heavily-relied upon, especially upon initial development of a tropical storm or hurricane
  - Busiest time of the year: July to November
Weather Prediction Center (WPC)
Silver Spring, Maryland

- Current surface analysis
- Precipitation patterns
- Outlooks for excessive rainfall or snowfall
- Forecast surface low/high positions

- WPC is responsible for maintaining a national overview of current and forecast hazards across the country over the next 7 days.

- WPC also performs model diagnostic analyses and distributes discussions on model diagnostics to the other national centers as well as the local offices.

- Collaboration of winter storm watches and warnings across local and regional boundaries.
Organizational Structure: National to Local Levels

Storm Prediction Center (SPC) Norman, Oklahoma

- Monitor nationwide thunderstorm threats, including severity and coverage.
- Issue routine and non-routine discussions on environments for thunderstorm development and maintenance.
- Issue severe thunderstorm and tornado watches.
- SPC is responsible for observing and forecasting thunderstorm development across the entire country, with an emphasis on forecasting areas of severe thunderstorms and the biggest threat with the potential for storms (i.e. hail, gusty winds, tornadoes, etc.).
- Issue thunderstorm outlooks out to day 7 (including severity category outlooks).
- In collaboration with local WFOs (such as NWS Wilmington OH), SPC will issue severe thunderstorm and tornado watches across the country.
Each of the 122 Weather Forecast Offices (WFOs) has their own area of responsibility, called their County Warning Area (CWA). The CWAs fit together like pieces in a giant puzzle, with each CWA having responsibility for anywhere from 20 to 60 counties. Some WFOs also have marine zones in which forecasts and advisories/watches/warnings are issued for the Great Lakes as well as waters extending 25 miles away from U.S. coastlines.
WFO Wilmington, OH is staffed by 24 full-time employees

- The office is staffed around the clock - 24/7/365
- Staffing levels can vary from one day to another, depending on the weather situation
- As many as 8-10 meteorologists are on site at one time during severe weather events
• The National Weather Service partners with a variety of agencies ranging from the local level to the federal level:

  – **County and State Emergency Management Agencies**
    • The NWS provides customized weather briefings before, during, and after major weather events to local and state emergency management agencies to help facilitate the flow of crucial weather information in preparedness, and response to, major weather events.

  – **American Red Cross**

  – **Federal Aviation Administration (FAA)**
    • The NWS provides aviation forecasts for all major airports across the United States and the territories.

  – **Department of Defense**

  – **U.S. Army Corps of Engineers (USACE)**
    • The NWS works directly with USACE to collaborate streamflows and river levels of minor and major tributaries across the country. These levels are carefully regulated to help river levels and flow rates from becoming too low or too high.

  – **U.S. Geological Survey**

  – **Media**
The National Weather Service continues to partner with local, state, and national Emergency Management Agencies (EMAs) in the mutual effort to maintain public safety.

- This includes frequent weather briefings, especially leading up to major weather events
  - Web briefing
  - Verbal briefings
  - Conference calls/telecommunication
- Support for hazardous material (HAZMAT) incidents
  - Initiate plume modeling
- Coordinate relief efforts and storm surveys following significant weather events
- Support for large outdoor events (especially during the summertime)
  - Create custom weather briefings for specific events for use by emergency managers and other local officials (such as sheriffs/police departments, event organizers, etc.)
The National Weather Service also partners with local media in a joint effort to keep the public as safe as possible.

- The media has efficient avenues (particularly TV and radio) for getting the message about severe and/or hazardous weather out to the public and into the hands of the people who need to hear it the most.

- So even though we issue the warnings (seen on the TV screen capture), it’s important to have the media as a valued partner for relaying this information as quickly as possible.
NWS Wilmington OH is responsible for monitoring the weather and issuing forecasts, advisories, watches, and warnings 24/7/365 for 52 counties across central, west-central, south-central and southwestern Ohio, southeastern Indiana, and northern and northeastern KY.

- 8 counties in Indiana
- 12 counties in Kentucky
- 32 counties in Ohio
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Aviation Forecasts

- Wind speed/direction
- Cloud cover/heights above ground
- Wind shear
- Precipitation
- Visibility

- Forecasts are routinely issued 4x daily, or more often if necessary.

- Forecasts go out 24 hours and are issued for Cincinnati/Nrthrn Kentucky Airport, Lunken Field, Dayton Cox Airport, Wilmington Air Park John Glenn Airport, and Rickenbacker Airport.

- Our forecasts dictate whether airlines flying in/out of these airports need to carry extra fuel in accordance with FAA guidelines.
Public Forecasts

- Wind speed/direction
- Cloud cover
- Temperature
- Probability of Precipitation
- Precipitation type
- Visibility
- Weather type
- Dewpoint
- Apparent temperature

Forecasts are routinely issued every 3 hours (or more often if changing weather conditions dictate so).

At any given time, each local office has at least 1 meteorologist (and sometimes 2 meteorologists) putting together the forecast.

- Short term forecaster (now through the next 48 hours)
- Long term forecaster (48 hours through day 7).
Advisories, Watches, Warnings

**Advisories**
- Winter Weather Advisory
- Dense Fog Advisory
- Wind Advisory
- Areal Flood Advisory
- Heat Advisory

**Watches**
- Winter Storm Watch
- Flood/Flash Flood Watch
- High Wind Watch
- Severe Thunderstorm Watch (in collaboration with SPC)
- Tornado Watch (in collaboration with SPC)
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November 5, 2017
8 “Operational” Shifts Per Day That are Covered

<table>
<thead>
<tr>
<th>Shift</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10 PM to 6 AM</td>
</tr>
<tr>
<td>2</td>
<td>11 PM to 7 AM</td>
</tr>
<tr>
<td>3</td>
<td>5 AM to 1 PM</td>
</tr>
<tr>
<td>4</td>
<td>7 AM to 3 PM</td>
</tr>
<tr>
<td>5</td>
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* 2 “Flex” Shifts On Weekdays – Help With Active Weather
Our shifts include weekends, holidays, etc.

5-week rotation of shifts

<table>
<thead>
<tr>
<th>Day Of The Week</th>
<th>Week 1</th>
<th>Week 2</th>
<th>Week 3</th>
<th>Week 4</th>
<th>Week 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>OFF DAY</td>
<td>12p – 8p</td>
<td>7a – 3p</td>
<td>11p – 7a</td>
<td>8a – 4p</td>
</tr>
<tr>
<td>Tuesday</td>
<td>12p – 8p</td>
<td>OFF DAY</td>
<td>8a – 4p</td>
<td>10p – 6a</td>
<td>8a – 4p</td>
</tr>
<tr>
<td>Wednesday</td>
<td>3p – 11p</td>
<td>OFF DAY</td>
<td>OFF DAY</td>
<td>10p – 6a</td>
<td>8a – 4p</td>
</tr>
<tr>
<td>Thursday</td>
<td>3p – 11p</td>
<td>8a – 4p</td>
<td>OFF DAY</td>
<td>10p – 6a</td>
<td>8a – 4p</td>
</tr>
<tr>
<td>Friday</td>
<td>3p – 11p</td>
<td>8a – 4p</td>
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Always staffed by at least 2 meteorologists (24/7/365), but as many as 10 can be in the operations area during particularly hazardous weather.
Time For A Quick Break?
National Weather Service
Weather Forecasting – We Must Observe What We Are Predicting

Surface Observing Stations
RADAR
Satellite Data
Computer Weather Models
Surface Observing System/Station

- Surface observing stations provide frequent (1-minute updates) data on:
  - Wind speed/direction
  - Humidity (%)
  - Temperature
  - Dewpoint
  - Cloud Cover
  - Cloud Heights
  - Pressure
  - Precipitation (type/intensity)
  - Precipitation Accumulation
  - Visibility

- Many stations can also detect lightning (overhead and in the distance) and can determine the amount of freezing rain that has accumulated on a flat surface.

- The computers monitoring and collecting the data also track when precipitation began and when it ended.
These systems disseminate weather data in a variety of ways:

• A computer generated voice message which is broadcast via radio frequency to pilots in the vicinity of an airport.
• The message is updated at least once per minute, and this is the only mandatory form of weather reporting for these systems.

These systems are owned and operated by the FAA, but are maintained by the National Weather Service through a mutual contract/agreement.
National Weather Service
We Must Be Able To Observe What We Are Trying To Predict!

Surface Observing System/Station

Station ID = FDY (Findlay, OH)
- Temperature (°F) = 39°F
- Dewpoint (°F) = 24°F
- Sky/Cloud Cover (quadrants) = no cloud cover
- Air Pressure (hPa) = 270 (1027 hPa)
- Wind Speed (kts) = 5kts (6 MPH)
- Wind Direction (wind coming from) = west-southwest

Over 900 ASOS Stations Nationwide

If there was precipitation occurring or low cloud cover or visibility restrictions, additional numbers and symbols would appear within this observation.
Weather Balloon Data

Weather balloons are launched twice a day, every day at 92 stations across the U.S. and the territories (including NWS Wilmington OH).

- The attached instrument takes measurements of:
  - Temperature
  - Moisture/Dewpoint
  - Wind Speed/Direction (through GPS)
  - Atmospheric Pressure

- These balloons typically ascend at approximately 1,000 ft./minute and can be in flight for up to 2 hours before bursting. Most balloons reach an altitude of more than 100,000 ft above ground level before bursting!
- More than 200 balloons are launched daily in the United States and over 1500 balloons are sent into flight across the world each day.
Weather Balloon Data: The Radiosonde

Thermistor
(a small electric current is transmitted across the wire and the resistance of the current is measured which is a function of temperature)

Humidity Sensor
(there is a direct relationship between relative humidity and sensor capacitance. This relationship is at the base of the operation of a capacitive humidity instrument)

Pressure Cell
(contained within the radiosonde body unit)

Wind
(both the direction and speed are calculated by change in location per unit of time)
National Weather Service

We Must Be Able To Observe What We Are Trying To Predict!

Weather Balloon Data

Wind

Temp

Moisture

Pressure
Weather Balloon Data

This data through the depth of the column of the atmosphere gives meteorologists a unique view of the profile and composition of the atmosphere above them at that given time. Balloon data is particularly useful in identifying:

- **Instability**
  (the tendency for air parcels to move upward)

- **Precipitation Type**
  (can identify elevated warm layers that may be more conducive to producing freezing rain or sleet opposed to snow)

- **Wind Shear**
  (how the wind changes direction and speed with a change in height)

- **Dry Air Aloft**
  (can strongly indicate the potential for clouds to develop or be maintained)
Weather Balloon Data

- Air near the surface (in the bottom 500 feet) is below freezing.
- Air just above the surface is much above freezing.
  - Any snowflake that falls into this elevated layer is going to melt into liquid then fall to the ground and freeze on contact. This is a classic freezing rain sounding.

Temperature

Moisture

Surface temperature below 0°C (freezing)

Freezing Line

Air temperature is 48°F!
Weather Balloon Launch Sites

Launched twice daily at 1100 UTC and 2300 UTC (the meteorology community runs on universal time coordinates (UTC))

- 92 launch sites across the U.S. and territories
- About 1200 balloons launched daily across the world.
Weather Balloons are launched in all weather types except **lightning**. And yes, that includes high winds.
• Wind typically increases with height, resulting in something called the jetstream.

• The jetstream is a “river” of air moving across the earth (generally at about 25,000 ft. above ground level) where winds often are well over 100 MPH.

• The jetstream often separates different airmasses
  • Airmass = a region of air with similar thermodynamic (temperature/moisture) characteristics
• As the jetstream moves and constantly changes shape, the corridor of high wind aloft helps foster the development of large storm systems.
Satellite imagery helps meteorologists identify large-scale storms systems and the corresponding frontal zones that are developing as a result.

**Infrared Satellite Imagery**
- The satellite is able to "sense" the temperature of an object (such as clouds) and assign a color to each sense temperature.
- On the right, the **brighter colors** correspond to colder clouds, which usually means the clouds are deeper and thus more likely to produce heavier precipitation.
Visible satellite is only useful during the day because it uses the sunlight that is reflected off of clouds. Cannot be used at nighttime.

Infrared channel senses temperature and assigns different colors to different temperatures. Does not rely on sunlight, so can be used day or night.

Senses radiation emitted within a layer. A weighting function is applied to distinguish dry airmasses from moist airmasses. Does not rely on sunlight, so can be used day or night.

Uses the fact that liquid and ice have different reflective properties so is able to distinguish between clouds composed of ice vs. water. Cannot be used at nighttime.

38 Different Bands/Channel Differences/Derived Data Sets That Stem From Each Satellite
GOES-16 was successfully launched on November 19, 2016 and provides continuous imagery and atmospheric measurements of Earth’s Western Hemisphere, total lightning data, and space weather monitoring to provide critical atmospheric, hydrologic, oceanic, climatic, solar and space data.

GOES-16 offers 3x more types of imagery with 4x greater resolution than previous satellites, and available 5x faster updates than ever before.

- The satellites can scan the entire Western Hemisphere every 15 minutes, the entire Continental U.S. every 5 minutes and can be put in Super Rapid Scan Operations (SRSO) in which new imagery arrives every 30 seconds. All of this can be accomplished simultaneously.

- The satellite’s revolutionary Geostationary Lightning Mapper (GLM) is the first-ever operational lightning mapper flown from geostationary orbit.
• An airmass can begin to move as a result of a developing high or low pressure system.

• The atmosphere is a constant state of searching for stability and equilibrium.
  - As such, the natural tendency of the atmosphere is to move warm air north and cold air south (in the northern hemisphere) to create a unified thermal field across large areas.

• The atmosphere’s tendency to balance everything yields storm systems which begin to move air in different directions. This often leads to the formation of frontal boundaries.
NEXRAD Coverage Below 10,000 Feet AGL

VCP12 Coverage
- 4,000 ft above ground level*
- 6,000 ft above ground level*
- 10,000 ft above ground level*

* Bottom of beam height (assuming Standard Atmospheric Refraction). Terrain blockage indicated where 50% or more of beam blocked.

0 125 250 500 750 Miles
National Weather Service
NEXRAD Radar: The Best Way to Track Precipitation

RADAR
(Radio Detection And Ranging)

Inside The Radome
NWS Doppler radar enables us to estimate:

**Reflectivity**
(amount or strength of the signal)

**Velocity**
(direction in which the air is moving)

However, there are some significant limitations...
Radar beam cannot see the lower portion of storm B. Resolution is poor at distances far from the radar.
• Reflectivity essentially represents the proportion of the energy returned to the radar from back scatterers such as:
  • Raindrops
  • Hailstones
  • Birds
  • Insects
  • Dust
  • Debris
• The brighter the colors on the scale (such as the yellows, oranges, reds, and pinks), the more energy is being returned to the radar.
  • This can be a sign of heavier precipitation but, such as in the case displayed on the left, can mean there is an abundance of hail (hail is particularly efficient at backscattering energy to the radar)
Only components of motion directly toward or away from the radar can be detected. This is called radial velocity.

- Motion perpendicular to the radar beam cannot be estimated/detected.
- In a velocity image, such as the one on the right, the “gray” area is called the zero isodop, which represents the point in which the wind is directly perpendicular to the “line” inferred by the gray shading.
National Weather Service
NEXRAD Radar: The Best Way to Track Precipitation

RADAR Lets Us “See” Into A Storm

Green: motion toward the radar
Red: motion away from the radar

The lowest radar scan provides a picture of basic low level wind field and is useful for determining ground-relative wind speed and changes. This can help identify fronts, downbursts, gust fronts, and straight-line winds.
RADAR Lets Us “See” Into A Storm

- Bright green & red close together on adjacent radials indicates winds blowing strongly in opposite directions.

- This is indicative of a strong circulation!
RADAR Lets Us “See” Into A Storm

- Bright green & red close together on adjacent radials indicates winds blowing strongly in opposite directions.
- This is indicative of a strong circulation!

Can issue tornado warnings based on radar data alone (especially at nighttime or in areas where population density may preclude receiving a real-time report).
RADAR Lets Us “See” Into A Storm

- But in warning operations, we are only responsible for issuing warnings within our area of responsibility. In fact, the system is designed so that we cannot actually issue a warning for a location that is not within our service area.

- In this case, the original warning drawn by NWS Wilmington OH extends into the service areas of NWS Cleveland, NWS Pittsburgh, and NWS Charleston.

- As soon as we hit the send button, the system “snaps” the warning to our border so that the warning cannot physically extend into another office’s region.

Sometimes, in the warning decision process, we will intentionally leave out a county (especially since some counties still have county-wide alert systems), so the system will also snap the warning around the specific county. This is sometimes how oddly shaped warnings are born.
When we decide a warning needs to be issued, we pull up a program called WarnGen (“Warning Generation”).

1) Draw your “polygon” for your storm.
2) Select the type of warning
3) Select the duration (how long the warning will be in effect for)
4) Select the options for the warning, indicating what wind to expect, what hail size is possible, if a tornado has been spotted.
5) Hit “create text” which will generate the warning text, including cities impacted (which is populated automatically from the warning box that has been drawn).

Hit “Send” Less than 30 seconds!
National Weather Service

Computer Models: The Future of Weather Forecasting

Surface Observations
Satellite-Derived Data
Balloon-Borne Data
Radar Data

NOAA Supercomputers

Can make 8 quadrillion calculations per second!

NOAA’s supercomputers ingest and analyze billions of data points taken from satellites, weather balloons, airplanes, buoys and ground observing stations around the world each day!
This graphic illustrates the huge number of variables that go into a weather forecast.

Using 10-kilometer spatial resolution globally, or about 5 million grid points, with 100 vertical levels and 10 physical prognostic variables (like temperature, humidity and wind) in the equations, produces a model with a dimension of 5 billion (5 million grid points x 100 vertical levels x 10 variables).

5 billion calculations for each hour of a weather model. Most models go out at least 240 hours.

5 billion x 240 hours = over a trillion calculations needed for one model run!
The atmosphere behaves like a fluid. Therefore, the motions within the atmosphere are modeled (or simulated) by widely-accepted physical equations of fluid motion.

These equations are often used to simulate how fluids behave in a fixed volume and are applied to a very large scale to model the atmosphere. Therefore, there are literally hundreds of equations within a computer model that are meant to simulate fluid dynamics.

Omega = vertical motion (tendency of air to move up or down vertically in the atmosphere)

Vorticity = the amount of “spin” or tendency to “spin” of an air parcel
Once all of the satellite, ground, water, and air observations are received, the **number crunching begins**!

And the end result is a model solution (depiction) of what the **weather** is going to be in the **future**. This includes areas of low pressure, high pressure, frontal positions, precipitation, temperatures, wind speed, wind direction, humidity, air pressure tendencies, apparent temperatures, thicknesses, etc.

**But is this solution correct? In what ways is it right? In what ways is it wrong?**
To help meteorologists see the “realm of possibilities” within a weather pattern, we use many different computer models and compare solutions!

The differences between computer models can be attributed to different:

- Horizontal grid spacing
- Vertical grid spacing
- Temporal domain
- Spatial domain
- Equations of motion (kinematic, thermodynamic, etc.)
- Methodology for ingestion of observations

Let’s not forget about ensembles!

Global Forecast System (GFS)
North American Mesoscale (NAM)
European Model (ECMWF)
Canadian Model (CMC)
Japan Meteorological Agency (JMA)
Advanced Research WRF (ARW)
Nonhydrostatic Mesoscale Model (NMM)
High-Resolution Rapid Refresh (HRRR)
Model “ensembles” are different “runs” of the same model with either initial conditions/input or equations that are varied slightly from the parent model.

Ensemble solutions, like the one pictured on the right, are useful in terms of giving a meteorologist a sense of the entire “range of possibilities” for, in this case, accumulated rainfall over the next 5 days. If the lines are clustered together, that gives increased confidence in the forecast because it means that most of the different ensemble solutions (no matter the input or equation being used) are showing the same outcome.

It is rare, although not impossible, for the actual solution to fall outside the lower and upper bounds of ensemble solutions.

Ensemble solutions are sometimes called “spaghetti plots.”
What happens if the National Weather Service in Wilmington, OH issues a tornado warning that includes the very office in which the warning was issued from?

1. Wilmington
2. Telephone call
3. Jackson, KY
4. Tornado shelter
5. Approval

Warning Operations Means Keeping Ourselves Safe, Too
What happens if the National Weather Service in Wilmington, OH issues a tornado warning that includes the very office in which the warning was issued from?
SPC Issues A Tornado Watch

SPECIAL WEATHER STATEMENT
NATIONAL WEATHER SERVICE WILMINGTON OH

304 PM EST FRI MAR 2 2012

…TORNADIC THUNDERSTORMS SPREADING TOWARD THE TRISTATE…

A CLUSTER OF THUNDERSTORMS WITH A HISTORY OF PRODUCING TORNADOES AND LARGE HAIL WILL SPREAD INTO THE TRISTATE AREA OF NORTHERN KENTUCKY…SOUTHEASTERN INDIANA…AND EXTREME SOUTHWEST AND SOUTH-CENTRAL OHIO AFTER 330 PM.

THIS IS A VERY DANGEROUS SITUATION. PREPARE NOW FOR POSSIBLE TORNADO WARNINGS DURING THE LATE AFTERNOON AND EARLY EVENING.

$$

1:05 PM EST
SPC Issues A Tornado Watch

3:04 PM EST
NWS Wilmington, OH issues a Special Weather Statement

4:03 PM EST
NWS Wilmington, OH issues a Tornado Warning for Piner and North Crittenden for northern Kentucky.

4:30 PM EST
A tornado touches down near I-75

Lessons From March 2, 2012

NWS Services Are Only One Part of The Equation!
Officials at Piner Elementary maintained their weather-awareness during the afternoon hours.

Officials decided to shelter students rather than release them on buses and allow them to leave the school.

This decision helped keep children and drivers out of harm’s way.

Spotters are volunteers who relay real-time severe weather reports to NWS.

NWS relies on spotter information to issue warnings.

Spotters keep our communities safe during hazardous weather!

“I see a possible funnel cloud right now. I’m 3 miles west-southwest of downtown Columbus. Storm is moving to the northeast at approximately 40 MPH.”

2019 Spotter Training Schedule

https://www.weather.gov/iln/spottertrainingschedule
What we see:

• The ONLY way for us to know ground truth is from spotter reports!
• Real-time verification adds credibility, enhances public response, and improves warning accuracy.

What you see:

Vs.
Thank You For Attending!
Any Questions?

NOAA / NWS Wilmington, Ohio
Weather Forecast Office

Remember that being prepared may save a life. And that life may be yours.