

“Observing Weather: Making the Invisible Visible”

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What Is Weather?

“Weather” refers to the conditions of the atmosphere at a certain place and time.

Weather differs from “Climate,” which deals with long-term conditions in the atmosphere—patterns, averages, and extremes (most/maximum and least/minimum).

We Can't See Air, So What Can We Measure?

- Temperature
- Pressure
- Wind direction and speed
- Moisture—Humidity and Dew Point
- Clouds—coverage and type
- Precipitation—type and amount
- Special Conditions and Changes

Temperature

- Temperature is a measure of how much heat energy the air molecules possess
- Thermometers can measure heat by expanding and contracting metal coils (left) or liquids (right)



[Source: www.weatheraffects.com]

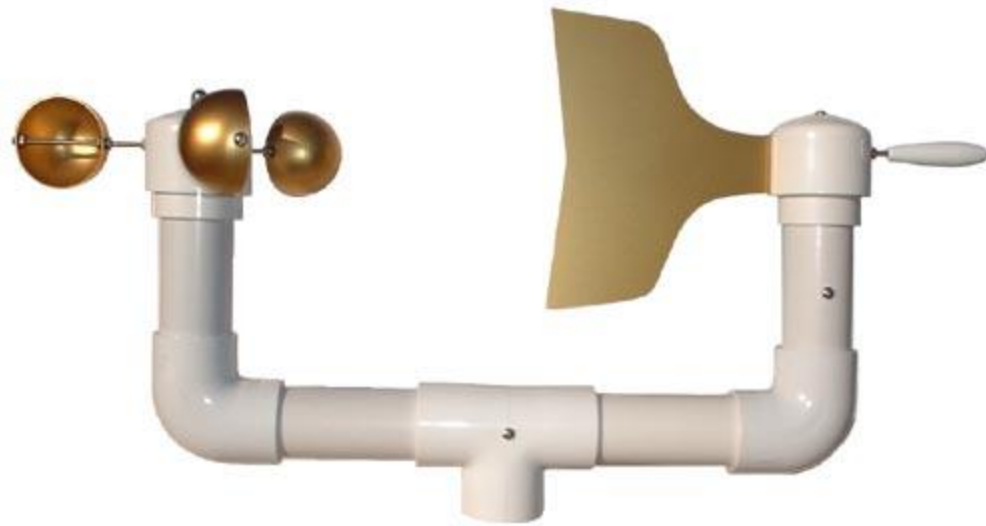
Pressure



- Air molecules push down on objects—including you—with a force that we call the “barometric pressure.”
- Metal coils in barometers, as in thermometers, respond to differences by expanding or contracting, causing a dial to move or change the LED display

Wind Direction and Speed

- When air moves—
"wind"—we feel both its
direction and speed
(force.)
- Direction is measured
with a "vane"—an arrow
or other shape that
points into the wind.
- Speed is measured with
an "anemometer." The
faster the cups spin, the
faster the wind.



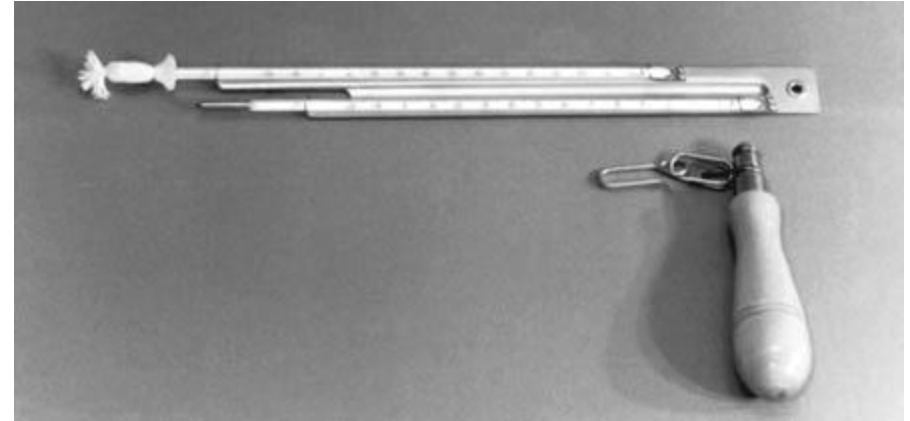
[Source: www.fascinatingelectronics.com]

Atmospheric Moisture--Humidity

- Water vapor molecules evaporate and enter air, mixing among the N₂, O₂, and other gases.
- The amount of water in air compared with the amount that it could hold at that temperature is called “relative humidity.”
- If air holds all the water vapor it can, it is at 100% RH and is said to be “saturated.”

Measuring RH

- “Sling psychrometers” have “dry bulbs” and “wet bulbs.”
- Using the difference between the two (“wet bulb depression”) and charts allow calculation of the relative humidity.
- “Hygrometers” also measure RH



[Sources: www.novalynx.com and www.accumall.com]

“Dew Point”

- As air cools, its relative humidity rises until reaching 100% and saturation.
- You are familiar with this because when you have an iced drink in the summer, droplets form on the outside of the glass as the air right next to the glass is cooled.
- The temperature at which saturation occurs is called the DEW POINT.

Measuring Precipitation

- Rain is easy to measure—all you need is an “open tube with a ruler”—a RAIN GAUGE.
- “Tipping bucket” rain gauges can measure rainfall outside and connect to show a display inside.



Measuring Snowfall

- Measuring how much snow falls is trickier than measuring rain, because wind can carry it away or pile it up in drifts.
- Meter sticks or rulers in carefully selected locations are used to record how deep the snow lies.
- Meteorologists may also melt snow to find its “water equivalent”—what it would have been had it fallen as rain.

Clouds

Meteorologists monitor clouds in several ways:

- How much of the sky do they cover?
- What kinds of clouds are they?
- What kinds exist at different levels (low, middle, and high altitudes)?
- In which direction are they moving?

Types of Clouds

In the early 1800s, Luke Howard (a science teacher in England) published a system to describe different types of clouds.

He used the term
CUMULUS for
“fluffy” clouds.



[<http://inspire.ospi.wednet.edu:8001/curric/weather/pricloud/>]

“Cirrus” and “Stratus” Clouds

- CIRRUS are the high “feathery” clouds



- STRATUS are flat clouds
- A stratus cloud at the ground is called FOG



Representing Weather with a “Station Model”

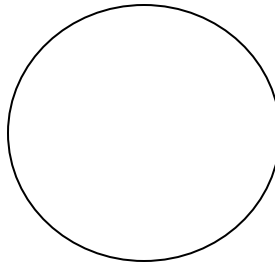
National Weather Service (NWS) meteorologists use a simple system to represent the weather at a location. A circle on a map identifies the location. Numbers and symbols added to the circle indicate the kind of weather instruments at that station have measured.

The next set of slides will explain how this is done.

Temperature

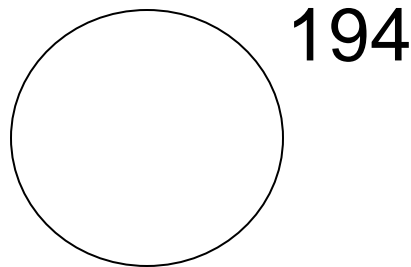
- Air temperature is shown in Fahrenheit degrees by the number to the upper left of the circle.

75



Pressure

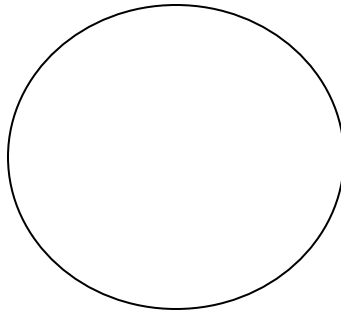
- Pressure—measured in mb (millibars)—is given by the number to the upper right of the circle
- For example, suppose it's 1019.4 mb
- Only the 10s/1s/0.1s are shown—so it is represented as 194



- Pressures below 1000 mb would start with high numbers, such as 964 for 996.4 mb

Dew Point Temperature

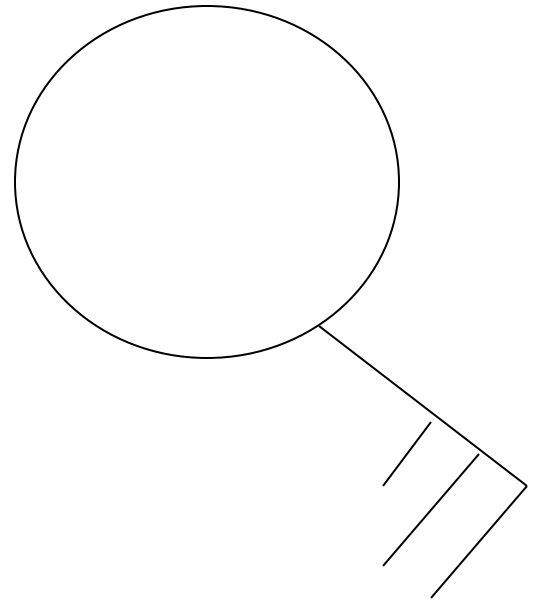
- The dew point temperature in Fahrenheit degrees is shown to the lower left of the circle.



57

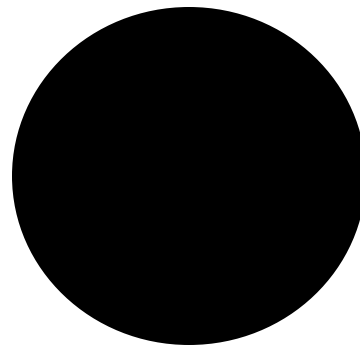
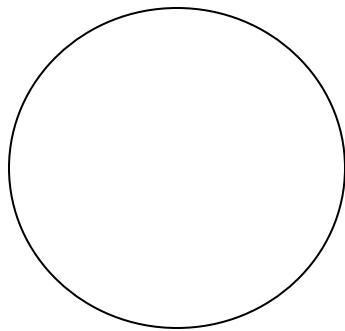
Wind Direction and Speed

- Wind direction is shown by an “arrow” going into the circle. The example shows wind blowing from the lower right, so this is a southeast wind.
- Each long “feather” represents 10 mph and each short “feather” 5, so the wind speed is 25 mph.



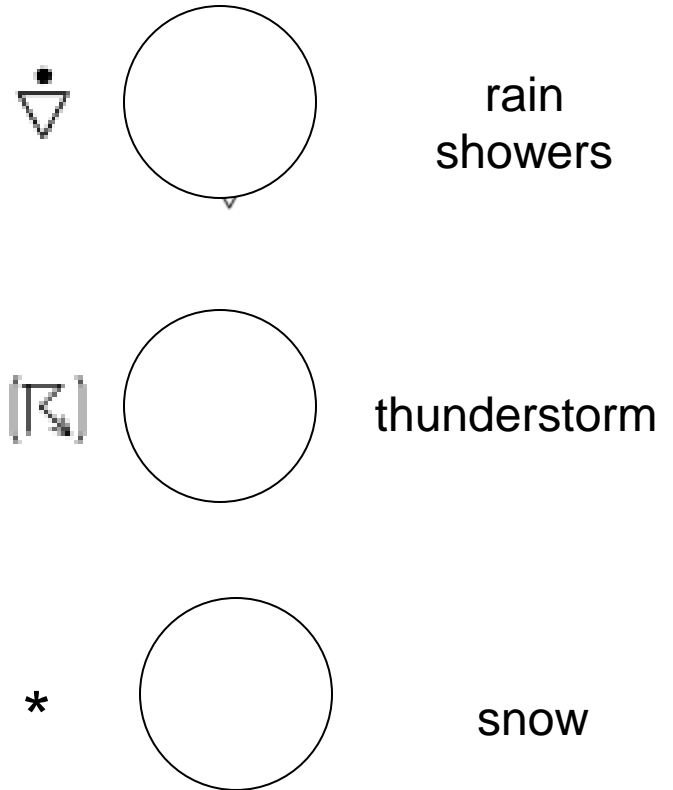
Cloud Cover

- The amount of the circle that is filled in indicates how much of the sky is covered by clouds.
- It may range from “clear” (left) to “overcast” (right).



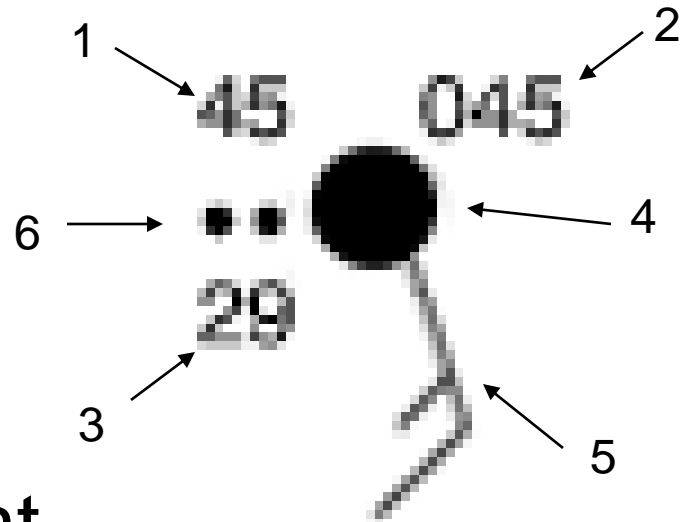
“Present Weather”

- When rain, snow, or other forms of precipitation, lightning, and special weather conditions exist, these are shown by symbols to the left of the circle between air temperature and dew point temperature



Try to interpret this station model

1. Temperature: 45 ° F
2. Pressure: 1004.5 mb
3. Dew Point: 29 ° F
4. Clouds: overcast
5. Wind: from southeast at 15 mph
6. Precipitation: light rain



- You can learn more about weather station models through the “DataStreme Atmosphere” web site created by the American Meteorological Society
<http://64.55.87.13/dstreme/extras/wxsym2.html>
- “DStreme” also provides access to current weather maps which use station models to represent conditions at many NWS weather stations:
http://64.55.87.13/dstreme/images/sfc_map.gif

Weather Conditions above the Surface

- What we have discussed so far deals only with weather variables at the surface, but weather is 3-dimensional
- To measure weather above the surface, NWS releases weather balloons with an attached instrument package called a “radiosonde.”

Radiosondes contain

- Temperature sensor
- Relative humidity sensor
- Barometer
- Radio transmitter
- Battery
- Parachute
- String to attach to balloon



Weather balloons and radiosondes are launched twice a day

- at 00Z and 12 Z (7 pm and 7 am EST)
- Ground antennas receive the radioed signals as the balloon rises
- Computers interpret the signals and send them to the NWS network



Upper air information is crucial for

- Aircraft flying across the country and round the world
- Forecasters who need information about the 3-dimensional characteristics of the atmosphere
- Upper air data, like surface data, can be represented in charts for different pressure levels

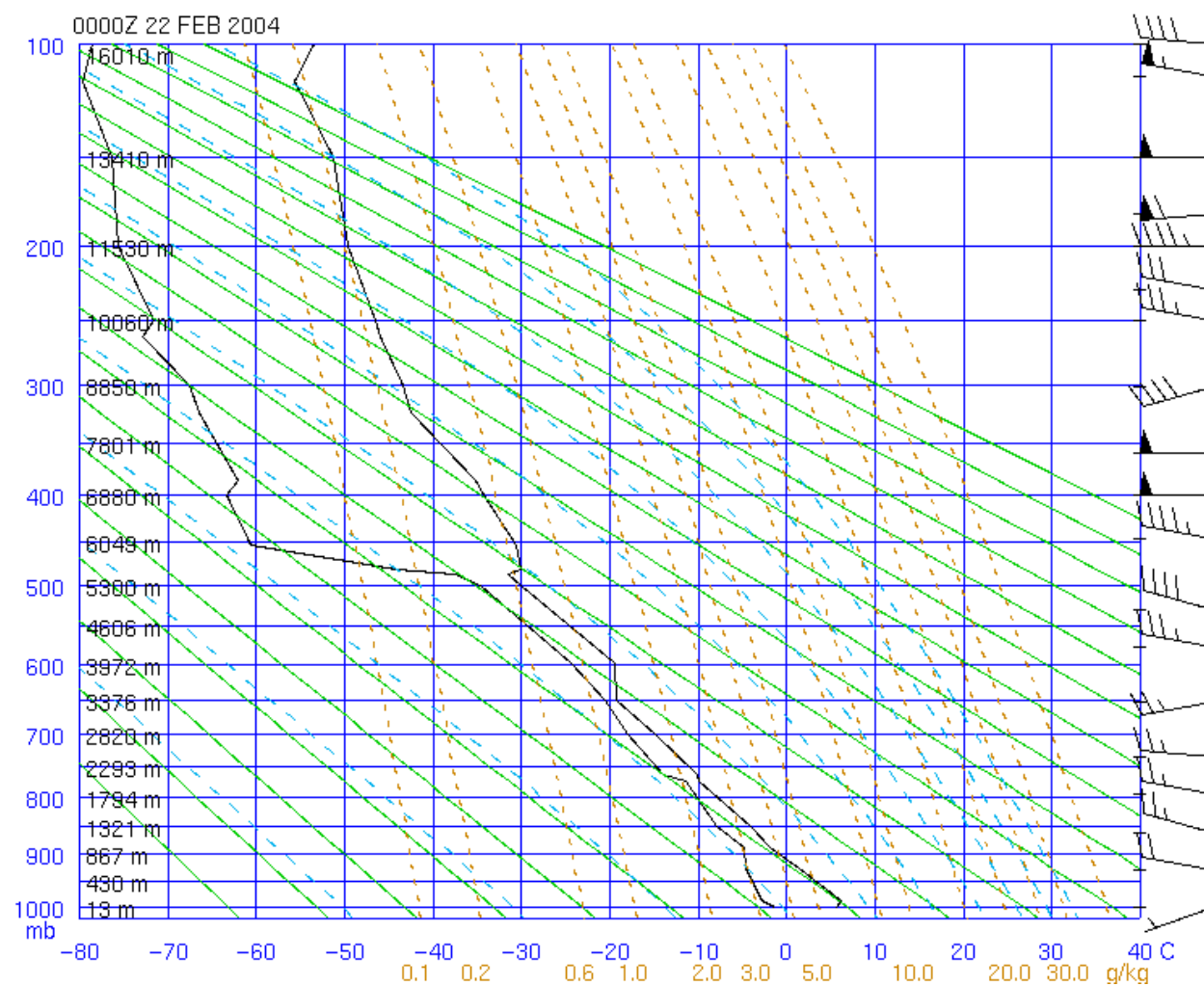
The “Stuve” Chart on the next slide

- represents conditions measured by a radiosonde launched from the NWS station on Long Island
- Horizontal lines indicate the height for each 50 mb decrease in pressure
- The right-hand curve is air temperature and the left-hand curve is the dew point
- Winds at each level are shown by the right axis. These are coming from the west at 5 mph near the ground to about 60 (triangle and one feather) at about 12000 m.

OKX (72501) Sounding

TROP: 263
LCLP: 896.7 LIFT: 6.7 TOTL: 48.2

0000Z 22 FEB 2004

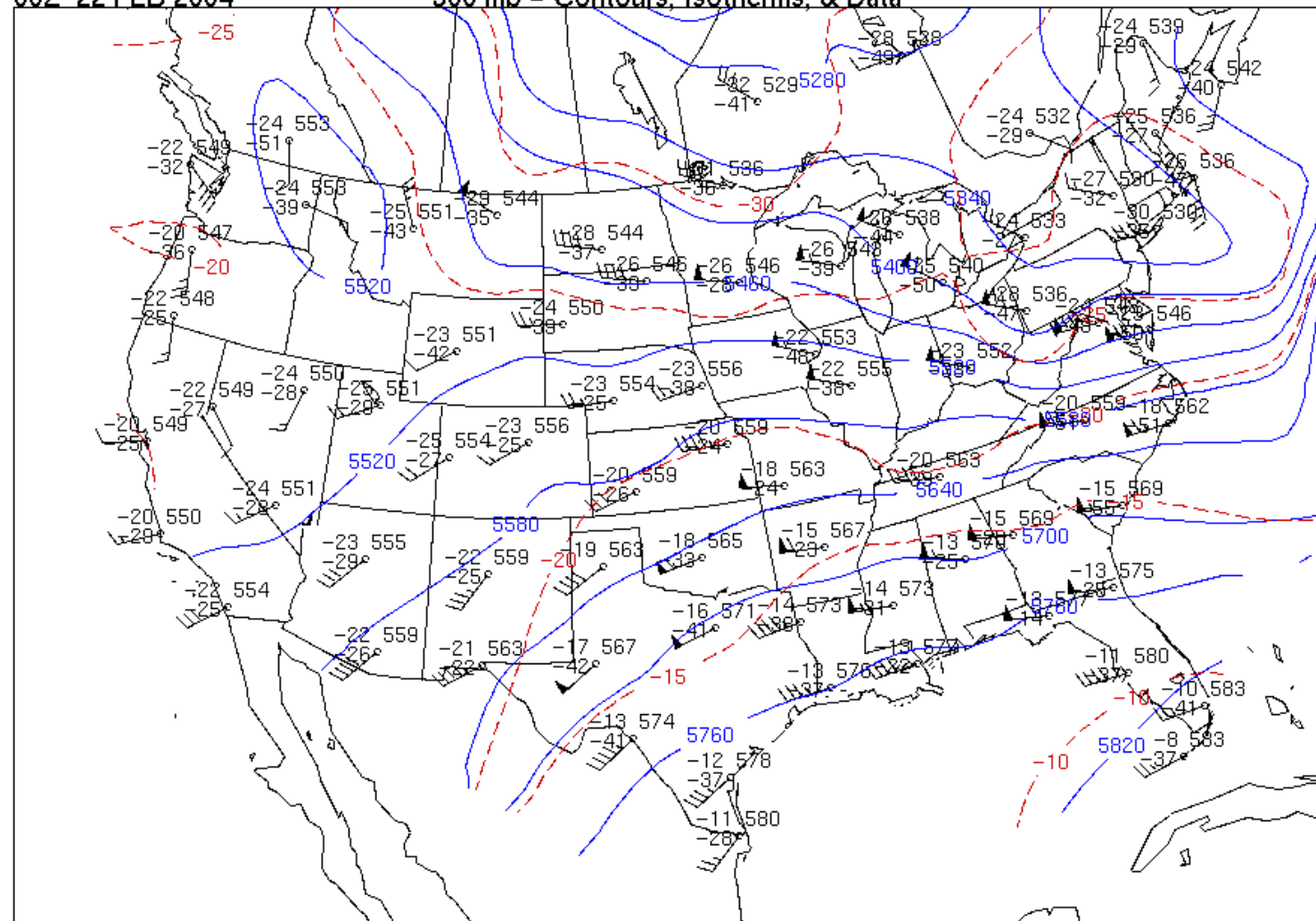


The next slide shows a typical upper air chart

- This chart indicates conditions where the air pressure was 500 mb, about half that at sea level.
- Blue lines represent height contours, which range from about 5760 m (17500 ft) in the south to about 5280 m (16000 ft) in the north. Actual height at a station is given to the upper right of the circle. Ex. “554” = “5540 m”
- The strong winds are the “jet streams.”
- Notice how cold are the air and dew point temperatures at these altitudes.

00Z 22 FEB 2004

500 mb - Contours, Isotherms, & Data

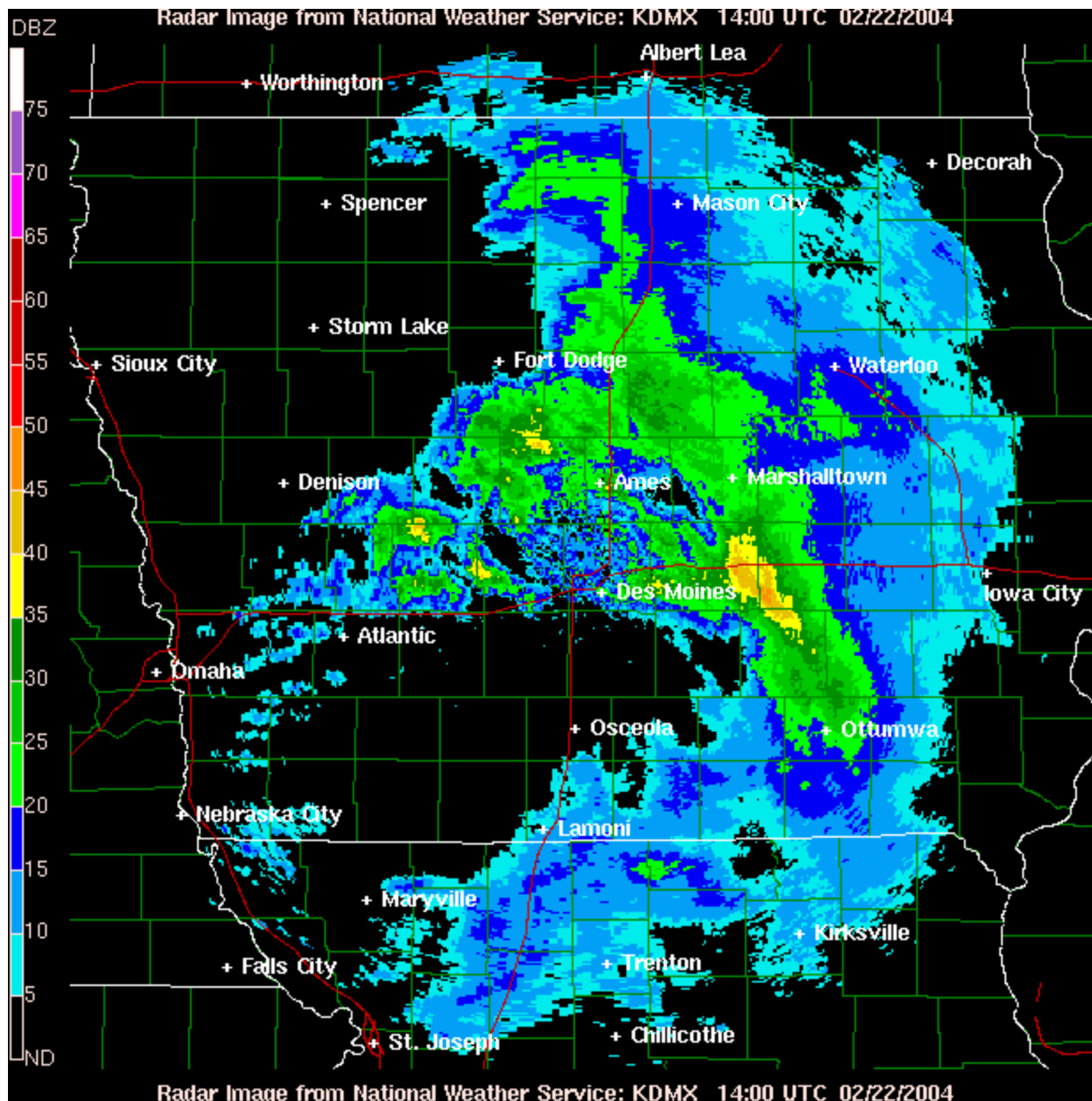


Blue (Solid) - Contours of Height (60 m)

Red (Dash) - Isotherms (5C)

Modern weather observation also includes radar and satellite

- Advanced radar observation technologies were installed at NWS and other stations to create a network that monitors clouds, precipitation, and even wind motions in a 320-km (200-mile) radius circle around the station
- Weather satellites provide even larger views of weather systems

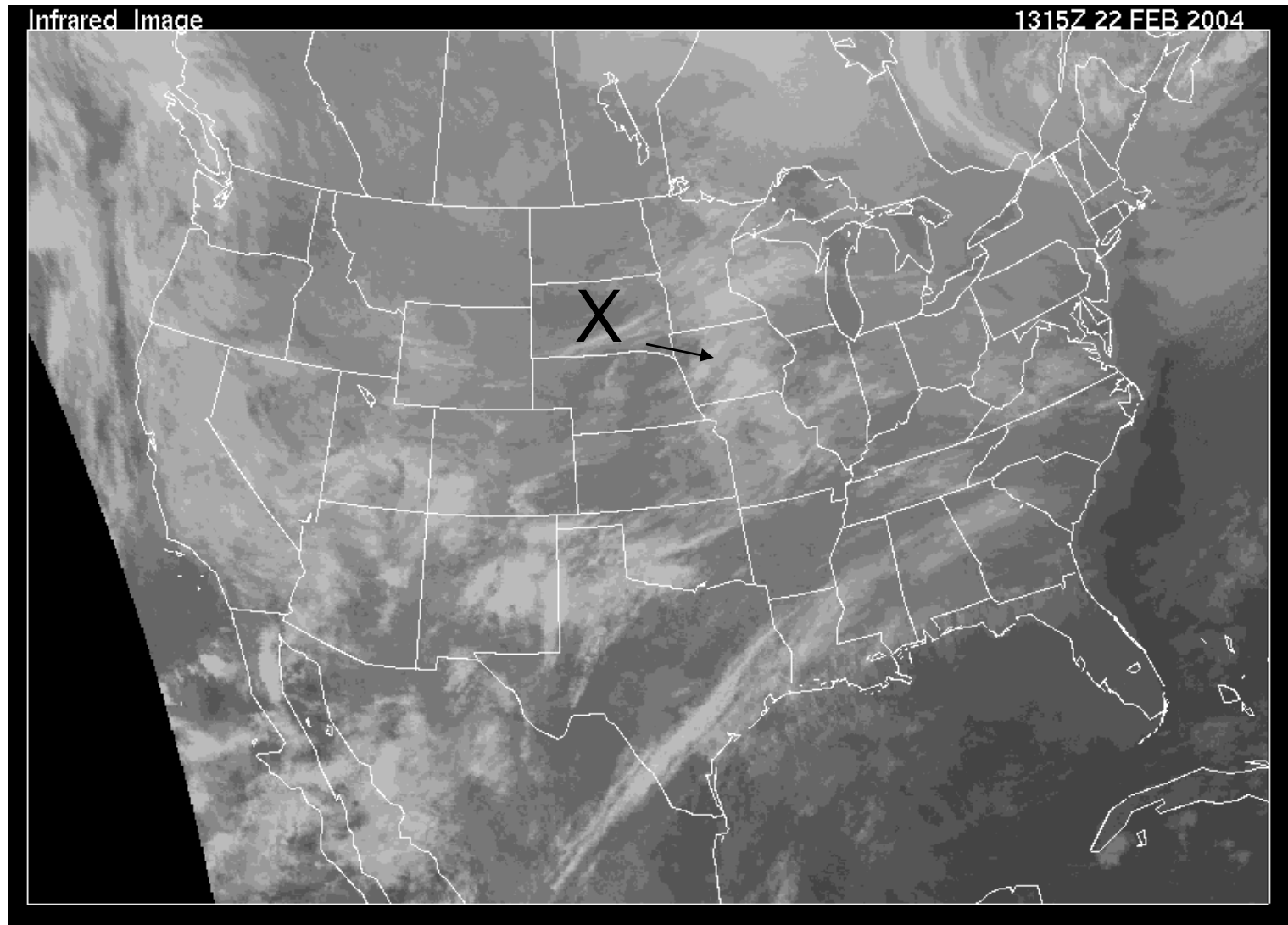


This color-enhanced image shows a storm passing Des Moines, Iowa.

Heavier precipitation is shown by yellows and greens.

<http://radar.weather.gov/radar/latest/DS.p19r0/si.kdmx.shtml>

Here is a satellite image for the same time. "X" shows the area where the storm in the radar image was located



http://64.55.87.13/dstreme/sat/sat_ir.gif

Conclusions

- Weather occurs at local, regional and global scales
- So modern weather observation and forecasting uses simple instruments and the most advanced technologies
- Even so, “Some People Are Weatherwise, But Most Are Otherwise” (as Ben Franklin wrote in “Poor Richard’s Almanac”)
- Which will you be?