TEACHING ABOUT WEATHER

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VSSI

July, 2012

Behold Mother Earth:

Sun energy goes through, everything is recycled

types, changes,
patterns

common storms &
weather phenomena

weather

Interrelationships
in Earth-
Space Systems

Science
SOLs
Grade 2

uses/importance of measuring,
recording,interpreting data

uses/importance of
tracking data over time

SOL
2.6

2010 Virginia Standards of Learning for Grade 2 Science

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Board of Education. (2010, 2003, 1995). *Standards of learning for Virginia public schools.* Richmond, VA: Author.

2010 Virginia Standards of Learning for Grade 2 Science

What causes the weather?

Weather: the condition of the air at a place and time.

This condition and how it acts to create weather is influenced primarily by – heat (the Sun) and water.

The Sun warms the atmosphere and causes:

1. Water to evaporate into the air
2. The warmer air mass to rise

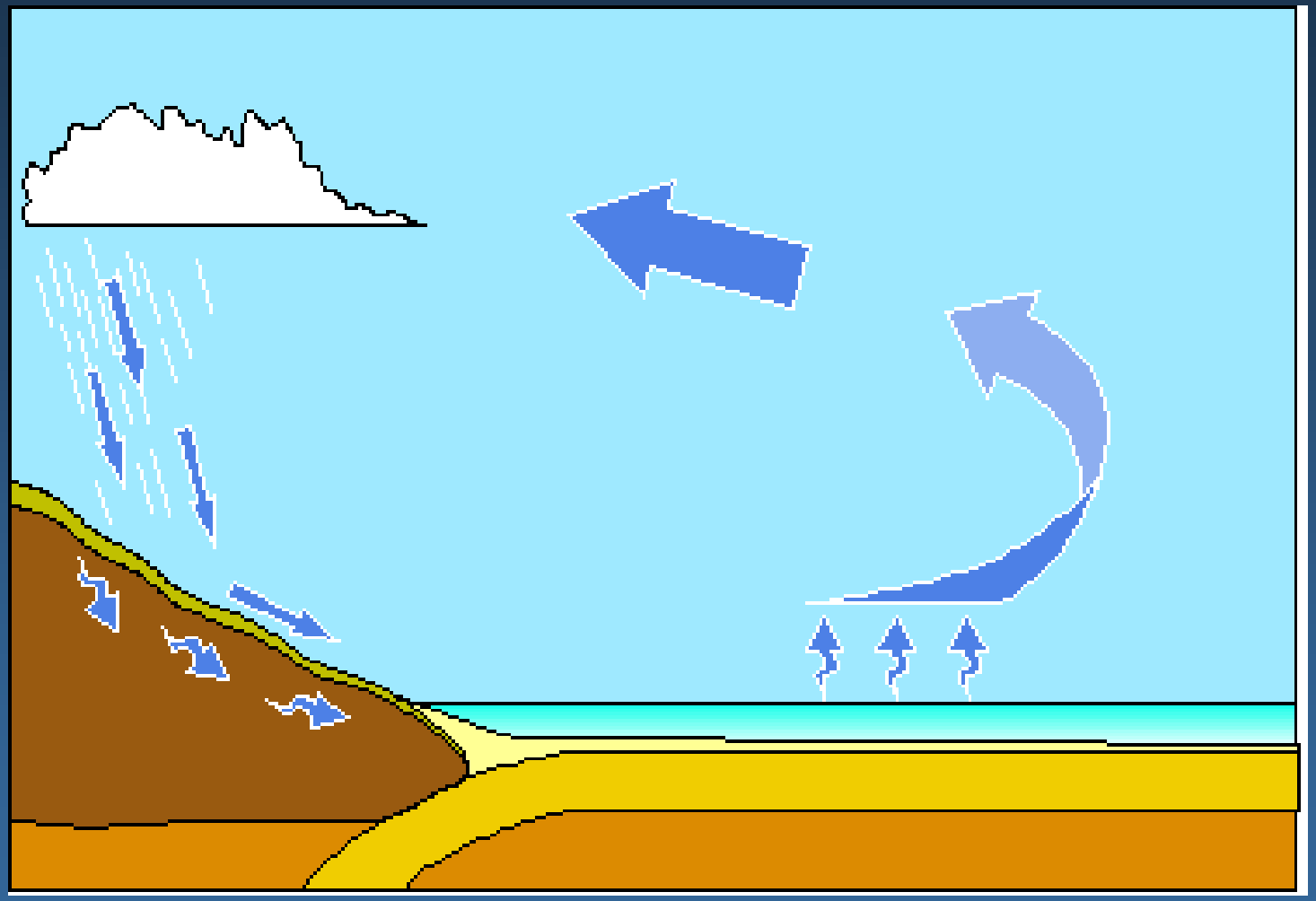
As air rises, its temperature drops. Its moisture cools, condenses into tiny suspended droplets, forming clouds.

Inside the clouds droplets get larger as more moisture is evaporated. Drops fall as precipitation when too heavy to remain suspended.

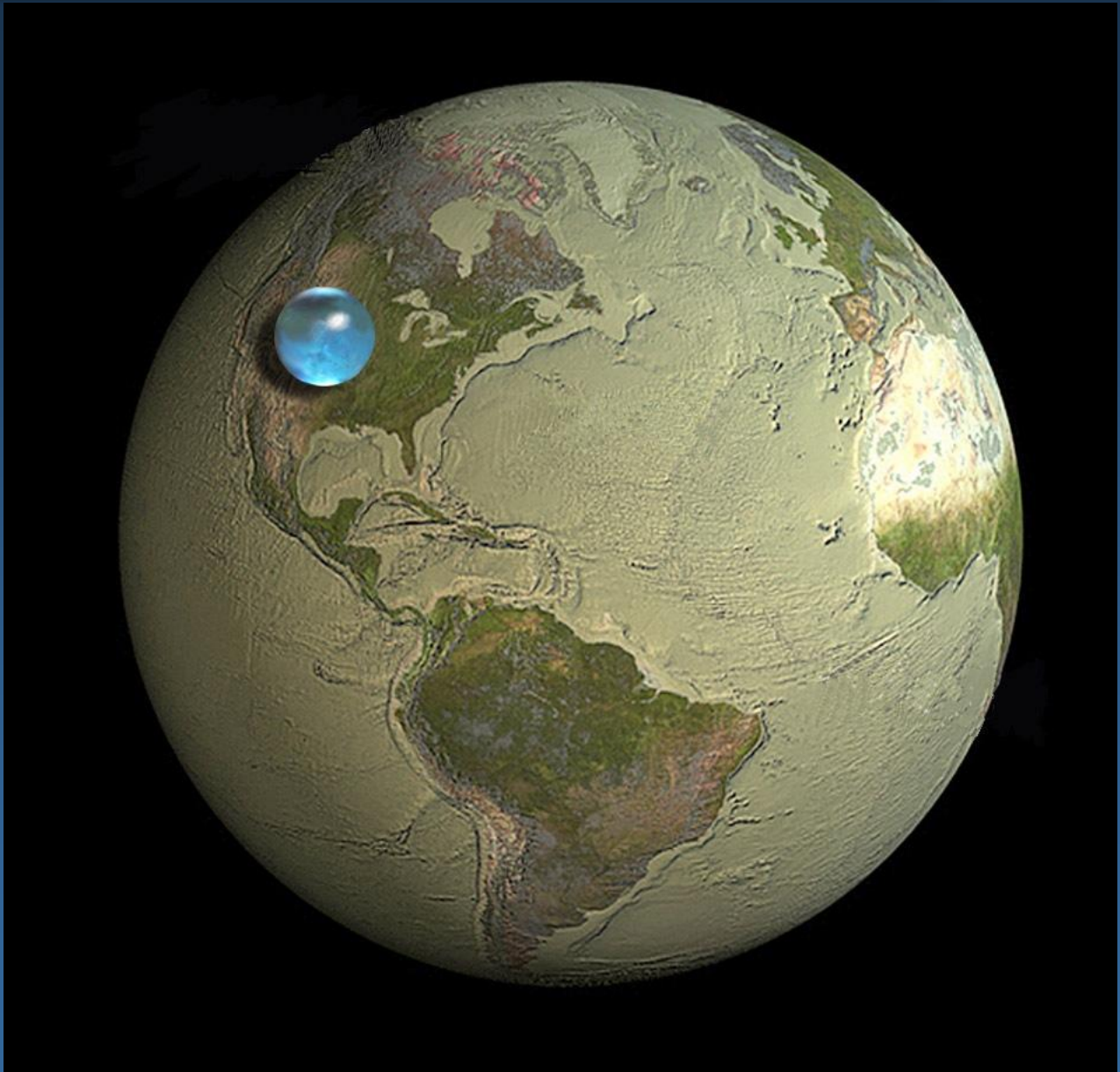
Water on the Earth

Water cycle involves several processes

(SOL 3.9)



Water on the Earth



Water in proportion

Measuring weather

Observable phenomena include:

- Cloud type
- Precipitation type

Measurable phenomena and related instruments:

- Temperature: Thermometer
- Humidity: Hygrometer
- Atmospheric Pressure: Barometer
- Wind speed: Anemometer
- Wind direction: Wind vane
- Cloud cover: Naked eye estimation
- Precipitation: Rain gauge

Instruments

Can you identify them?

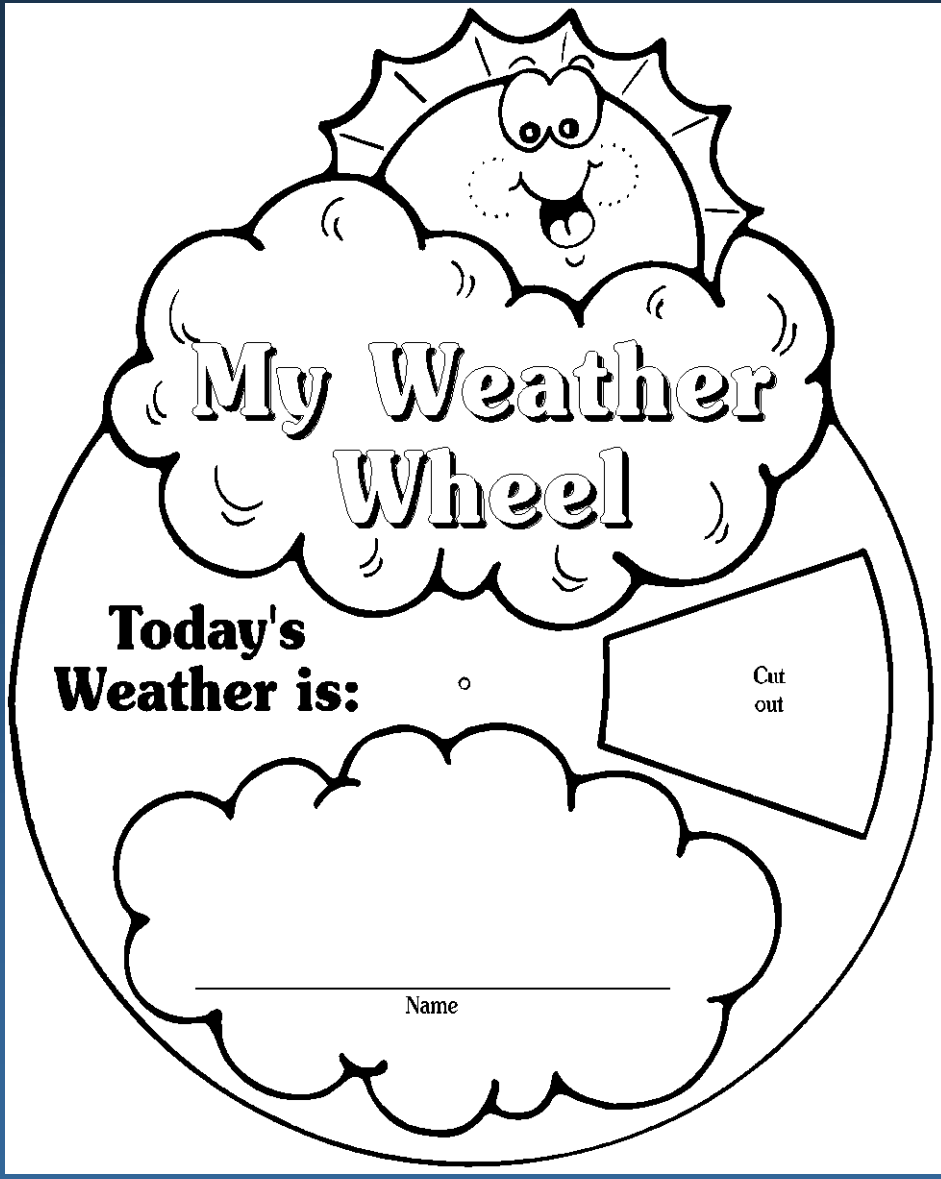
Observing weather

Observing weather

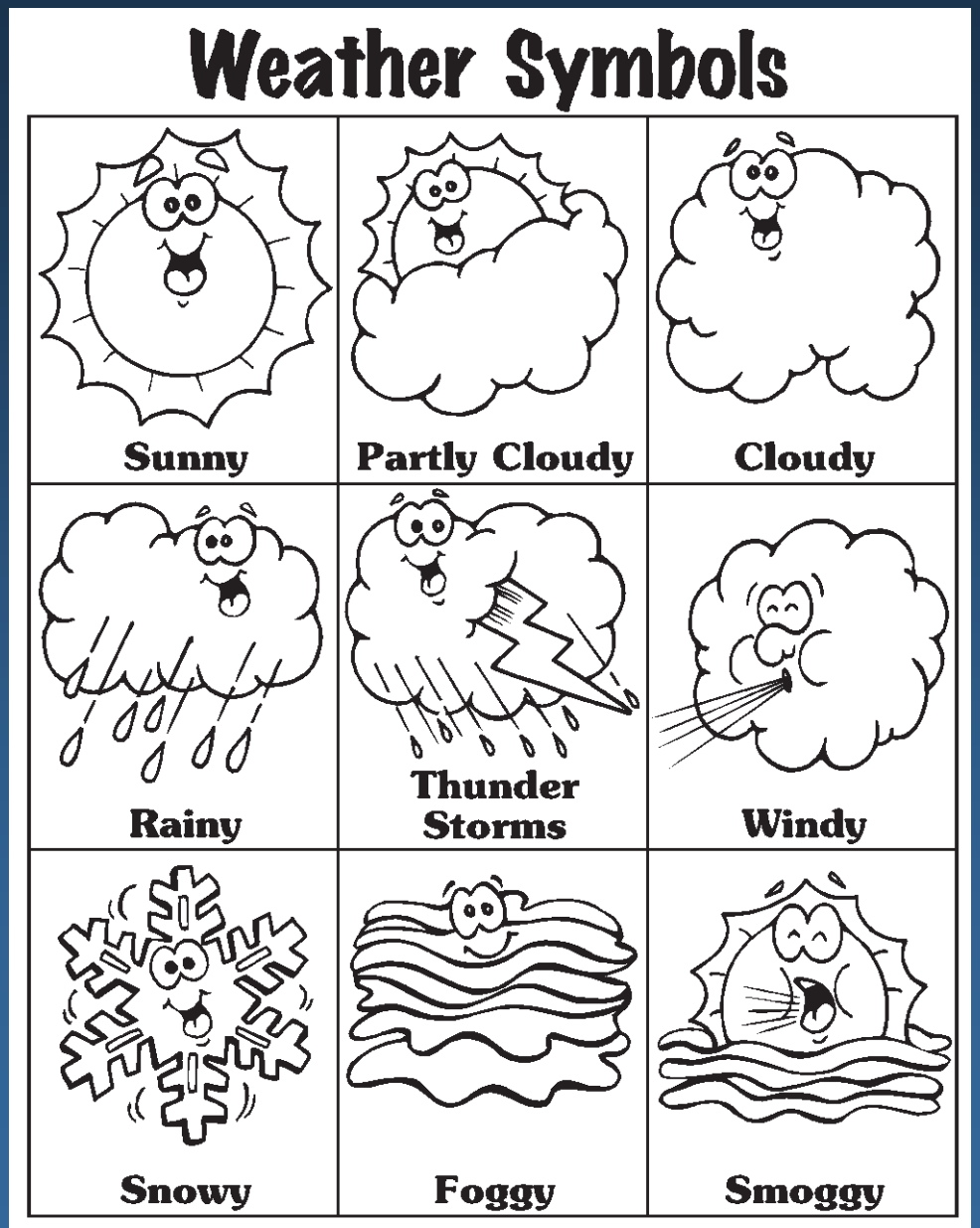
Observing weather

My Weather Report!

Date	Day of the Week	Weather	Temperatures High	Temperatures Low	Rain-fall	Sun-rise	Sun-set



Observing weather



Observing weather: Clouds

Clouds: What type is it?

What type is it?

What type is it?

What type is it?

What type is it?

What type is it?

What type is it?

What type is it?

Classifying clouds

- In 1803, Luke Howard devised the system still used today of cloud classification based on Latin names
- Two parts to a cloud's name:

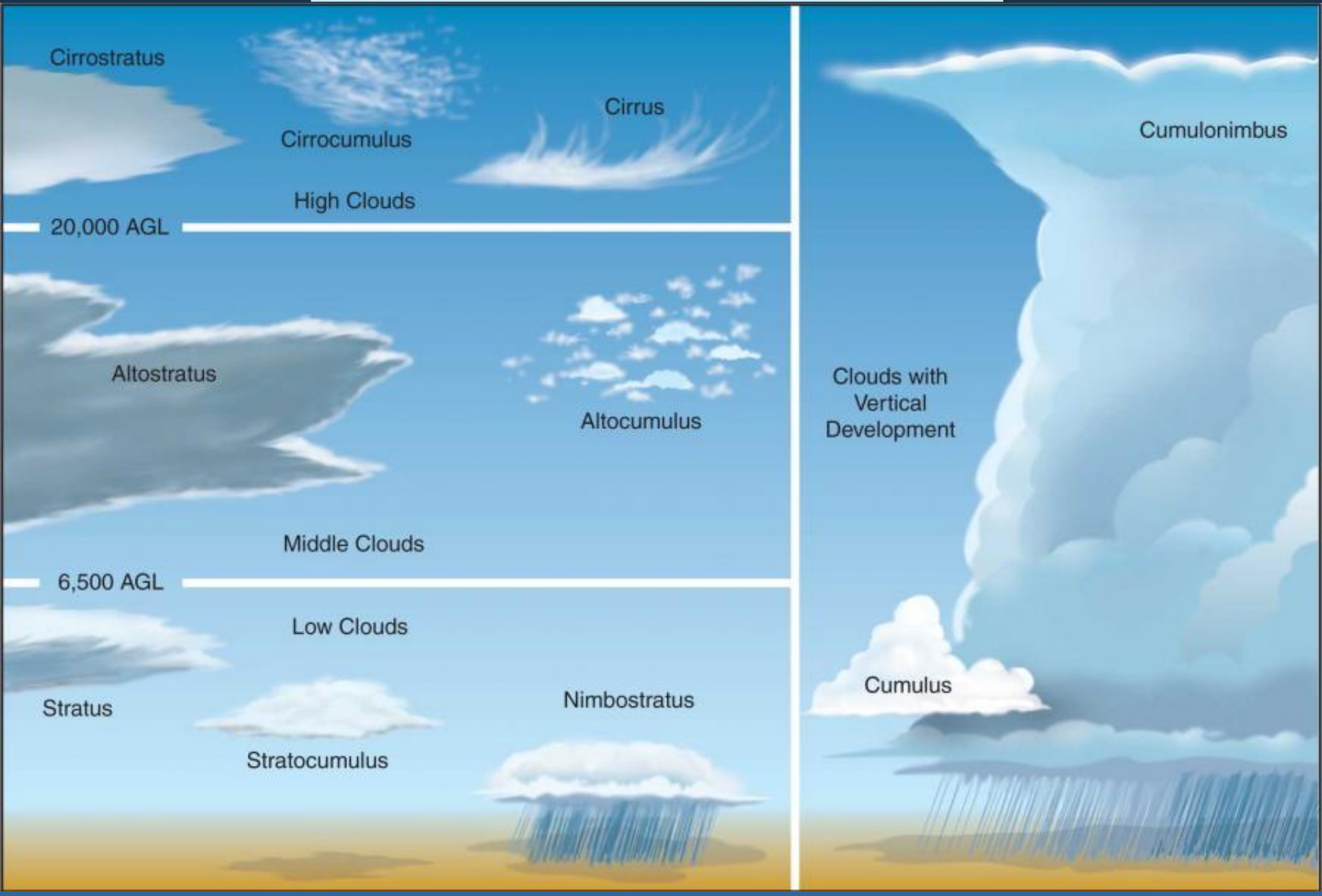
  - Shape (ex: cirrus, stratus, cumulus)

  - Height (cloud base & vertical extent)

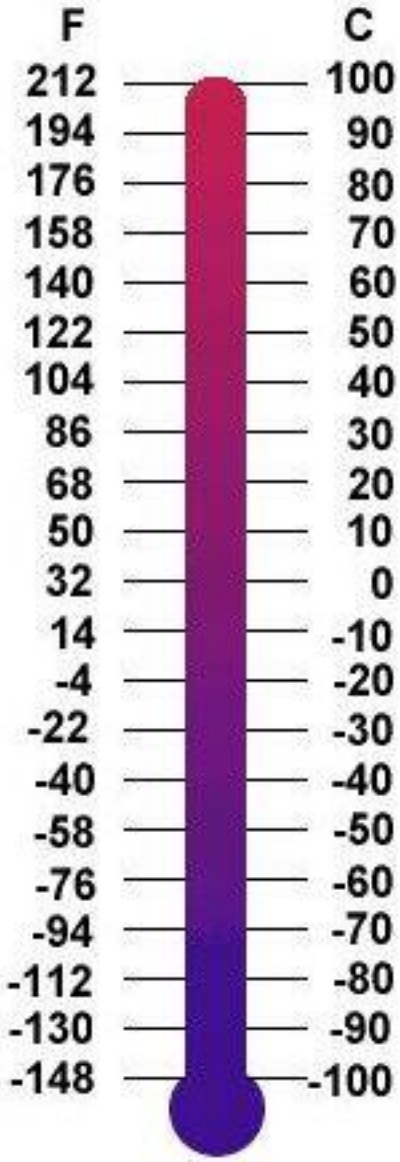
Classifying clouds

- Shapes
  - Cirrus = curly and wispy
  - Stratus = layered or stratified
  - Cumulus = lumpy or piled up
- Heights
  - Cirro = high (bases above 20,000 ft)
  - Alto = mid level (bases 7,000-20,000 ft)
  - Nimbo = producing precipitation

Clouds


Cirrostratus
Cirrus
Cirrocumulus
High Clouds
20,000 AGL
Altostratus
Altocumulus
Middle Clouds
6,500 AGL
Low Clouds
Stratus
Nimbostratus
Stratocumulus
Cumulonimbus
Clouds with Vertical Development
Cumulus

Temperature scales



Boiling point of water

Highest Temp. (58C) 136F Recorded.
(El Azizia, Libya, Sep., 1922)

Average body Temp. 37C (98.6F)

Freezing (melting) point of water.

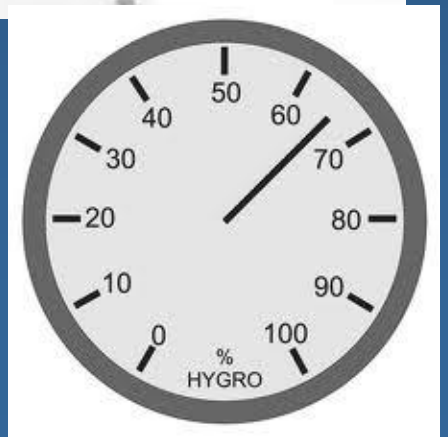
Lowest Temp. -89C (-129F) recorded.
(Vostok, Antarctica, July, 1983)

Measuring Humidity

Humidity: the amount of water vapor or moisture in the air.

Measurement can be either absolute or relative; absolute measurement deals with the weight per unit of volume of water vapor whereas relative measurement deals with the condition of saturation, stated in percent.

At 100% RH, the air is completely saturated with water and no evaporation is taking place.



Dew point & Relative humidity

RELATIVE HUMIDITY (RH)

The ratio of the amount of moisture in the air at a specific temperature to the maximum amount that the air could hold at that temperature, expressed as a percentage.

DEW POINT

Dew point temperature is defined as: "the temperature at which dew begins to form." The current dew point will never be higher then the current temperature. The higher the dew point temperature the more moisture that is in the air.

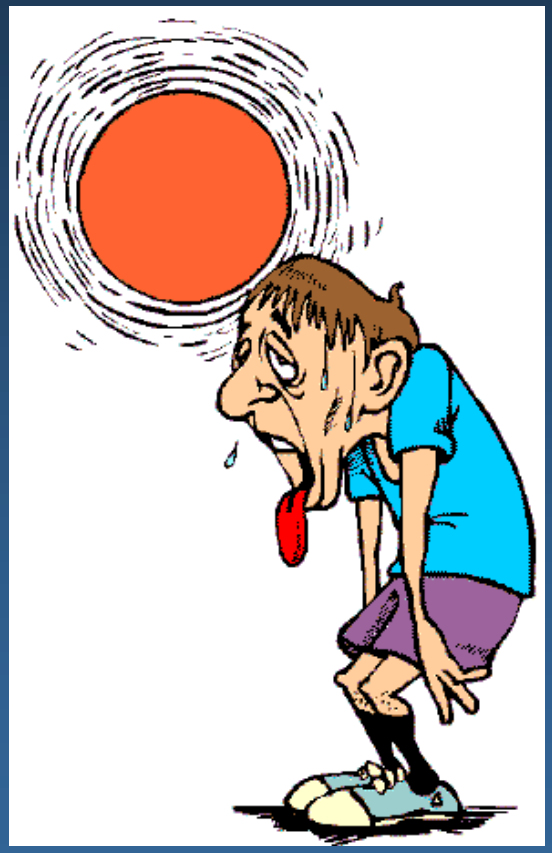
Other Measures

HEAT INDEX

The heat index (HI) combines air temperature and relative humidity to indicate the human-perceived equivalent temperature — how hot it ***feels***.

WIND CHILL

Wind chill (often called the wind chill factor) is the felt air temperature on exposed skin due to wind. It measures the effect of wind on air temperature. The wind chill temperature is usually lower than the air temperature.



Heat Index

how hot the combination of temperature and humidity feels

Relative humidity (percent)

Air Temperature (°F)	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
140	125																				
135	120	128																			
130	117	122	131																		
125	111	116	123	131	141																
120	107	111	116	123	130	139	148														
115	103	107	111	115	120	127	135	143	151												
110	99	102	105	108	112	117	123	130	137	143	150										
105	95	97	100	102	105	109	113	118	123	129	135	142	149								
100	91	93	95	97	99	101	104	107	110	115	120	126	132	138	144						
95	87	88	90	91	93	94	96	98	101	104	107	110	114	119	124	130	136				
90	83	84	85	86	87	88	90	91	93	95	96	98	100	102	106	109	113	117	122		
85	78	79	80	81	82	83	84	85	86	87	88	89	90	91	93	95	97	99	102	105	108
80	73	74	75	76	77	77	78	79	79	80	81	81	82	83	85	86	86	87	88	89	91
75	69	69	70	71	72	72	73	73	74	74	75	75	76	76	77	77	78	78	79	79	80

- Extreme Danger (130°F or higher). Heatstroke or sunstroke likely.
- Danger (105 - 129°F). Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
- Extreme Caution (90 - 105°F). Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
- Caution (80 - 90°F). Fatigue possible with prolonged exposure and/or physical activity.

Copyright 2000, Oklahoma Climatological Survey.

Wind Chill Chart

Wind (mph)	Temperature (°F)																	
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	29	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Forecasting

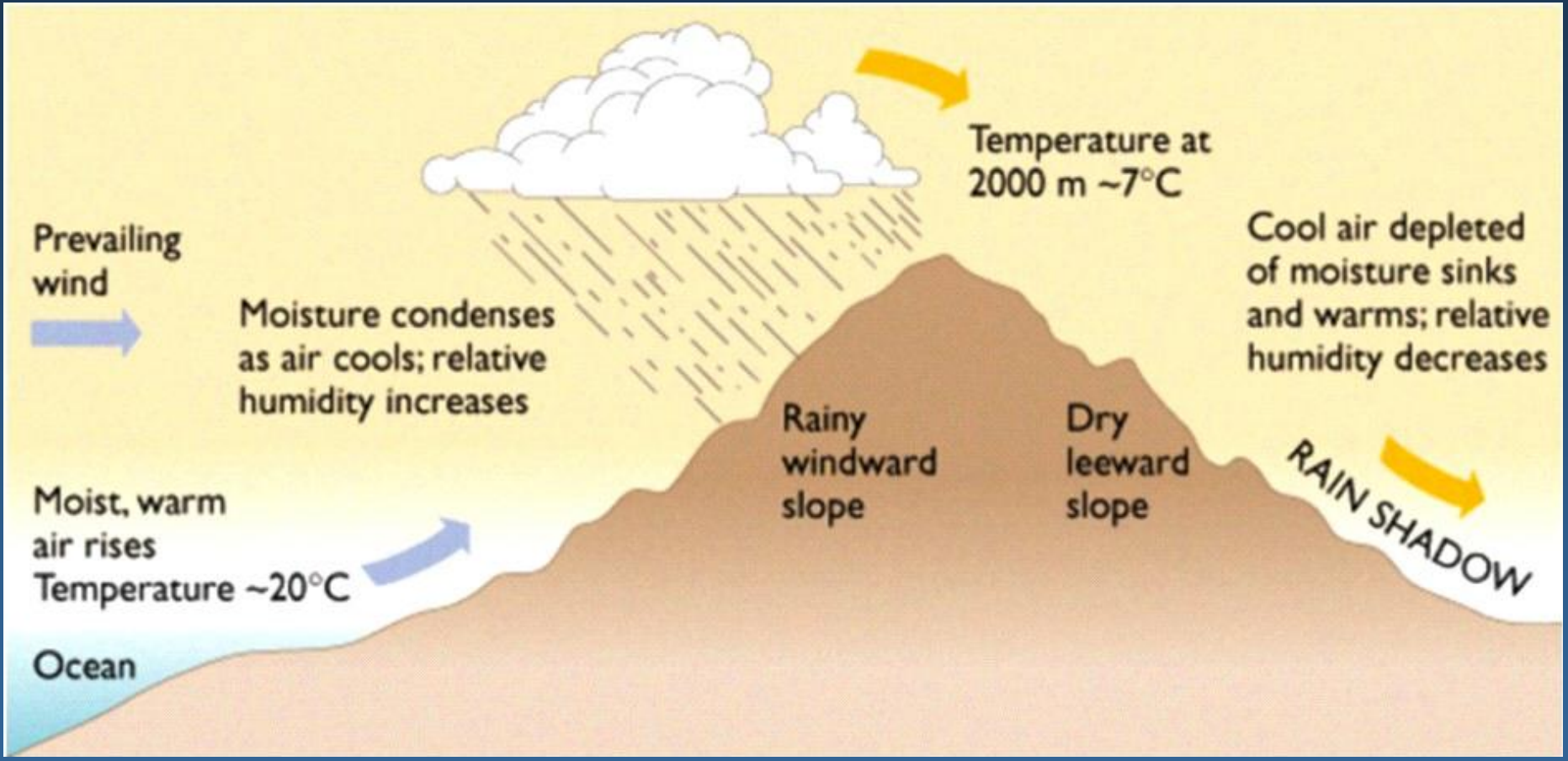
Fronts are responsible for most changes in weather.

- The front is the zone along which the different air masses come into contact with each other.
- Moving weather conditions are due to wind patterns.
- Most weather conditions across the US move from **west to east**.
- Clue to tomorrow's weather? Look at the weather to the west.
- Geographic features as large **bodies of water** and **mountains** can affect local weather.

Forecasting: Geographical effects

- **coastal areas** - more moderate temperatures than inland areas, warmer in winter and cooler in summer.
- cool air usually blows inland during the day and out to sea at night.
- **mountains** – warmer air moves up slopes during day, down at night. Rising air expands, pressure lowers, causing the air parcel to cool. The rate for dry air is about 0.98° C/100 m of rise (5.4° F/1000 ft). Moisture in cooler parcel condenses, may form clouds.
- **high altitudes** - usually colder. Get more precipitation than low areas.
- **cities** – air above often warmer than surrounding, can create artificial low pressure system.

Forecasting: Geographical effects



Satellite Data

Satellites can view large weather systems, show cloud formations, & events like hurricanes. Forecasters can access weather worldwide: oceans, continents, and poles. Recent satellite data is very detailed.

Satellites carry two types of sensors:

(1) a **visible light sensor** ("imager") -works like a camera; information on cloud movements and patterns, but only during daylight. Water reflects little light, appears black on the satellite image, land masses as shades of gray, depending on their temperature and moisture.

(2) the "sounder" - **an infrared sensor** that reads temperatures. The higher the temperature of the object, the more energy it emits. The sensor measures the amount of energy radiated by the surface, clouds, oceans, air, etc. Infrared sensors can be used at night.

Satellites

The Synchronous Meteorological Satellite was the first geosynchronous weather satellite. This design evolved into the GOES series of spacecraft.

New satellite

Latest GEOS instrument, the Goddard Climate Satellite. In 2010, due to cost overruns and delays, a task force led by the President's Office of Science and Technology Policy recommended against continuing.

Satellite Image

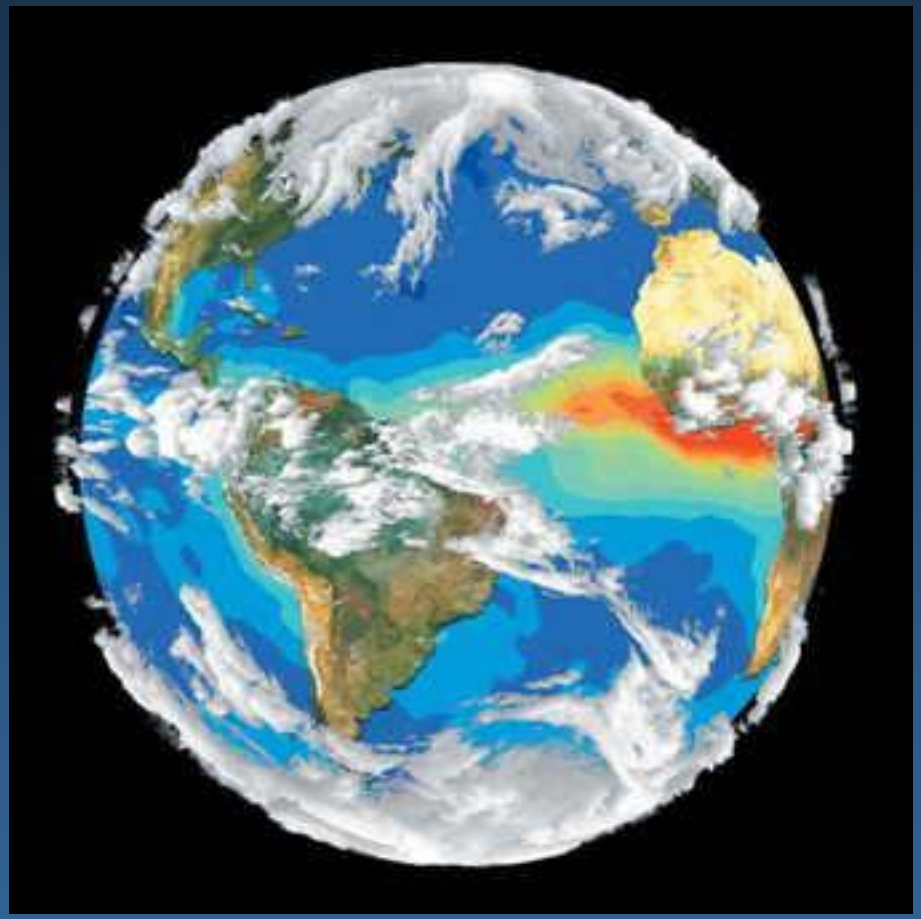
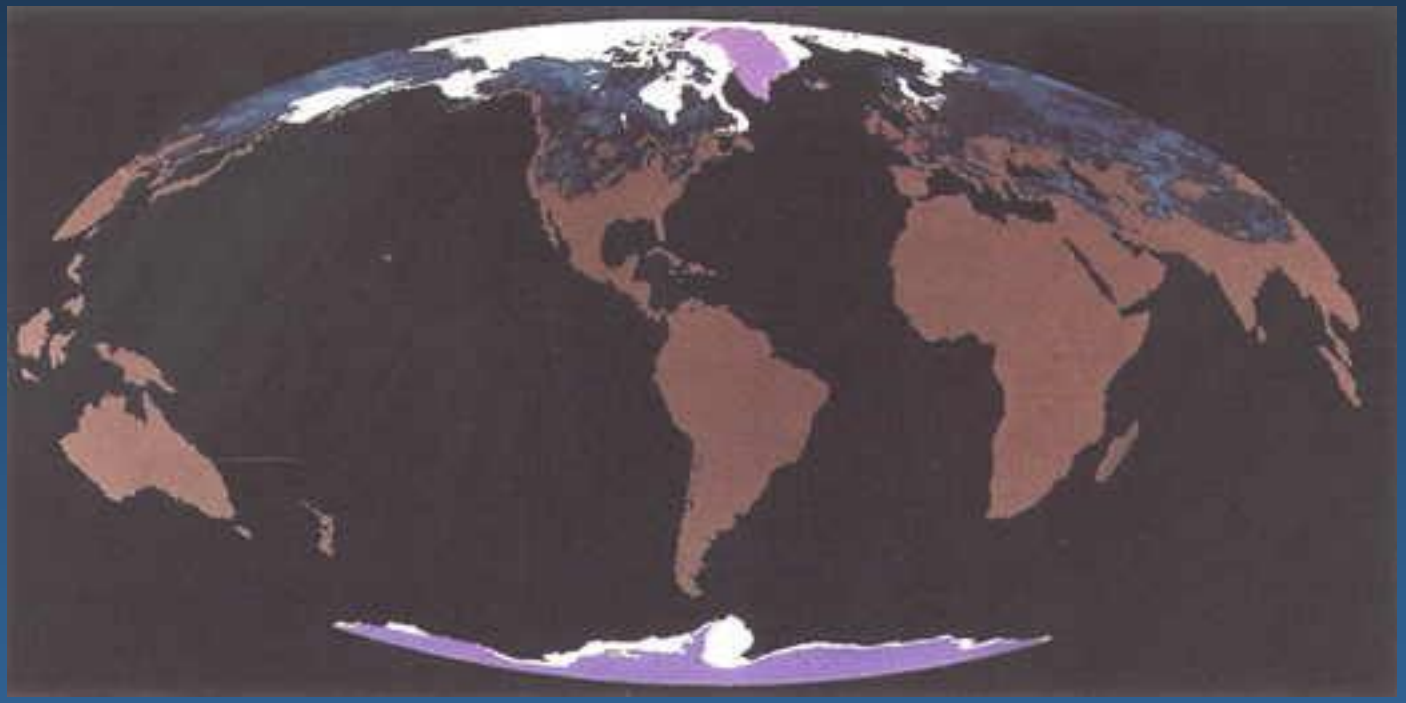


Image of Earth created using data from four different satellites: shows fires burning on land areas (red dots) & a large aerosol cloud over the Atlantic ocean formed by the burning biomass in Africa. It also indicates dust and cloud cover around the globe.

Satellite Image



Satellite image of snow and ice over the poles. Current weather satellite images can be accessed at http://goes.gsfc.nasa.gov/.

Doppler Radar

An essential meteorological tool; **Doppler radar** works differently from satellite sensors, measures reflected sound waves. Sound waves are broadcast from a radar antennae and will detect objects in their path, e.g. dust particles, ice crystals. The waves will be reflected back at an increased or decreased frequency (the number of waves reflected back in a time period). Effect discovered in 1842 by Christian Doppler and later applied to weather radar. Meteorologists can “see” precipitation and track it over time.

Doppler radar images

Photo of Jarrell tornado

Doppler radar image of F-5 tornado over Jarrell, TX in 2009: http://youtu.be/3PAa7H0AZKk.

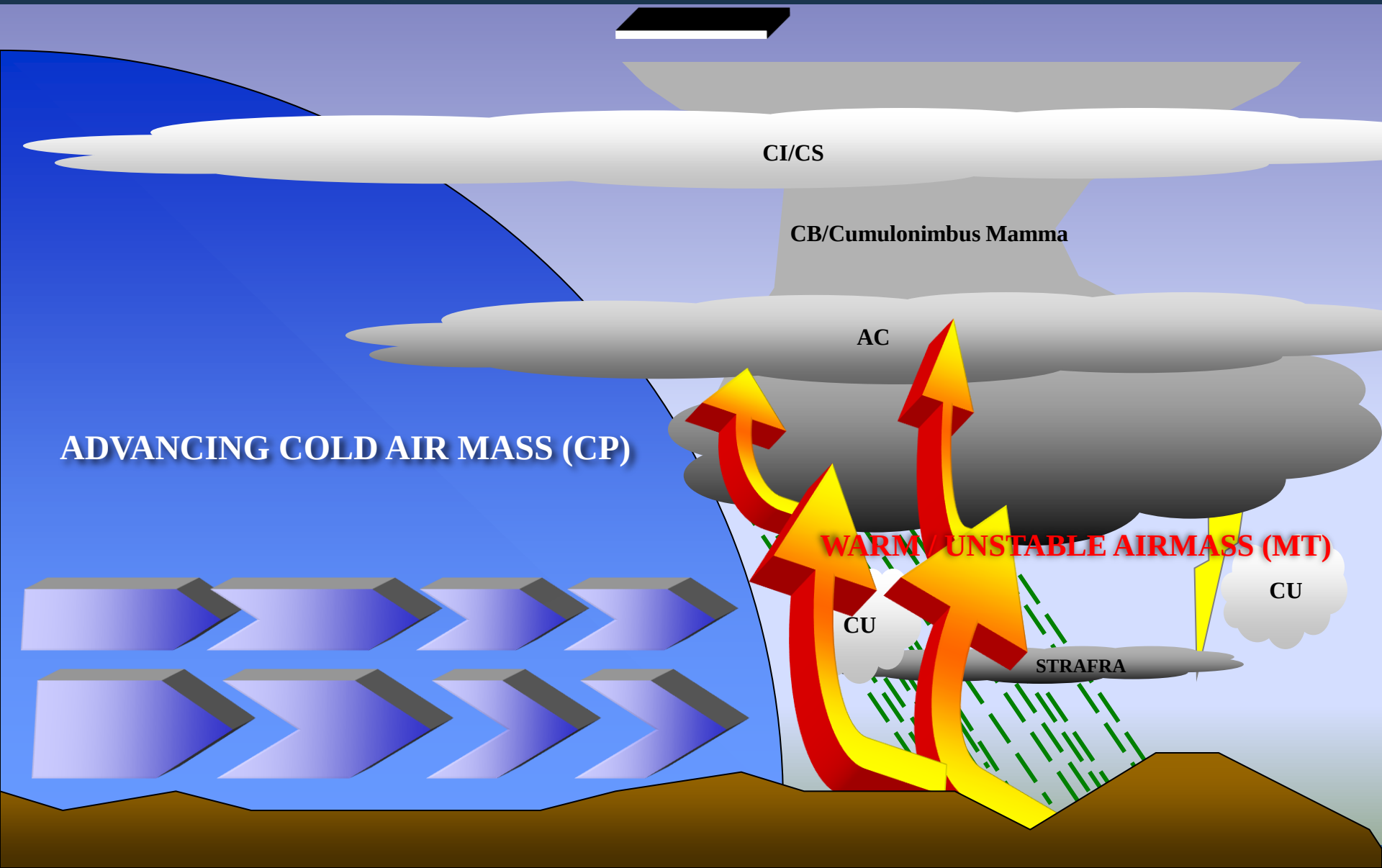
A word about *Fronts*: The weather makers

An **air mass** is a large body of air that has similar properties. Air masses move, so can be tracked over time. They help predict the future temperature, moisture level and air pressure of the area into which they are moving.

When one air mass meets another, the air in the different masses usually does not mix because the properties of the air are different. A boundary, or front, forms between the two air masses. **Stormy weather often occurs along fronts**.

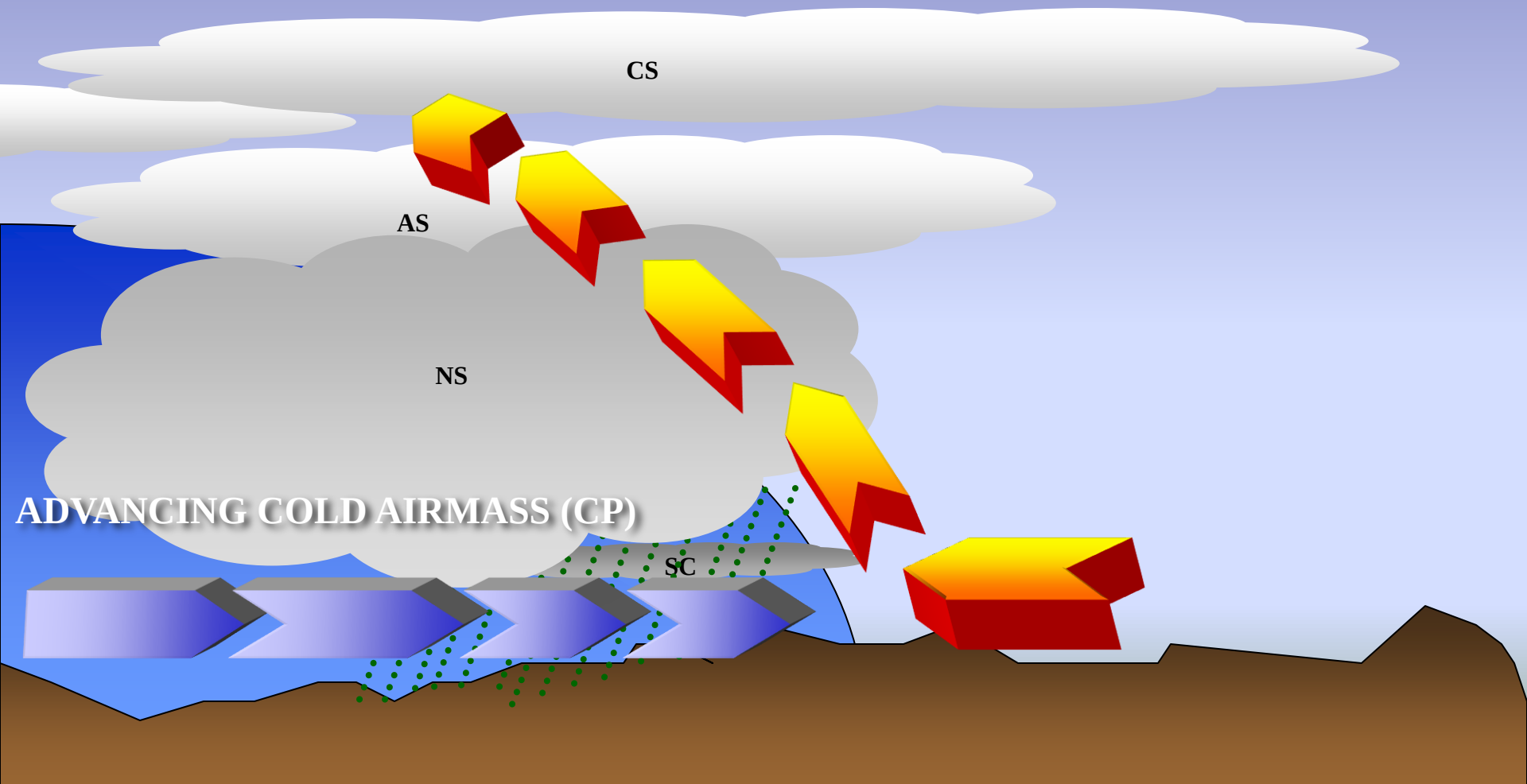
COLD FRONT

(FAST MOVING/IN -ACTIVE)

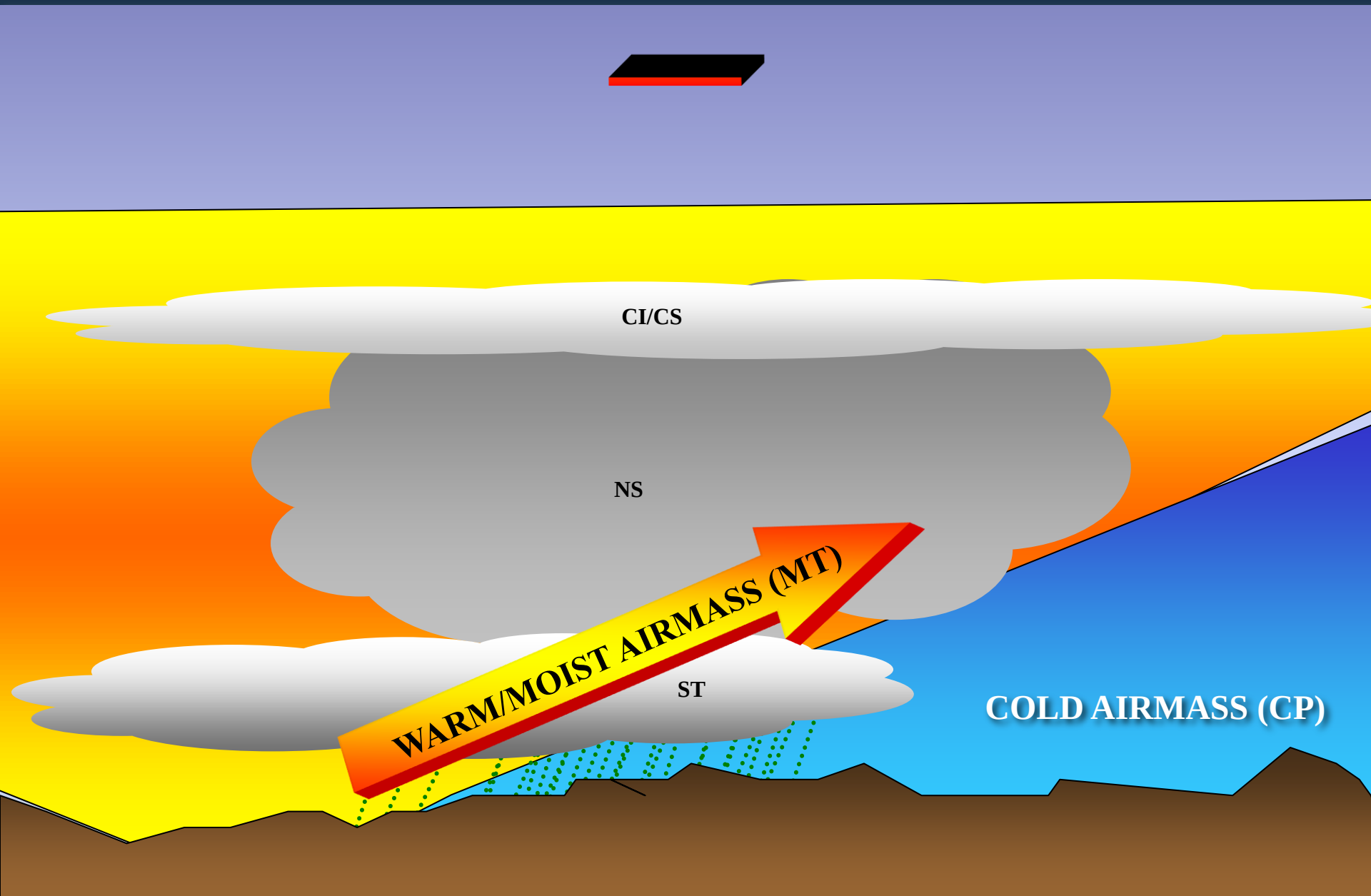


COLD FRONT

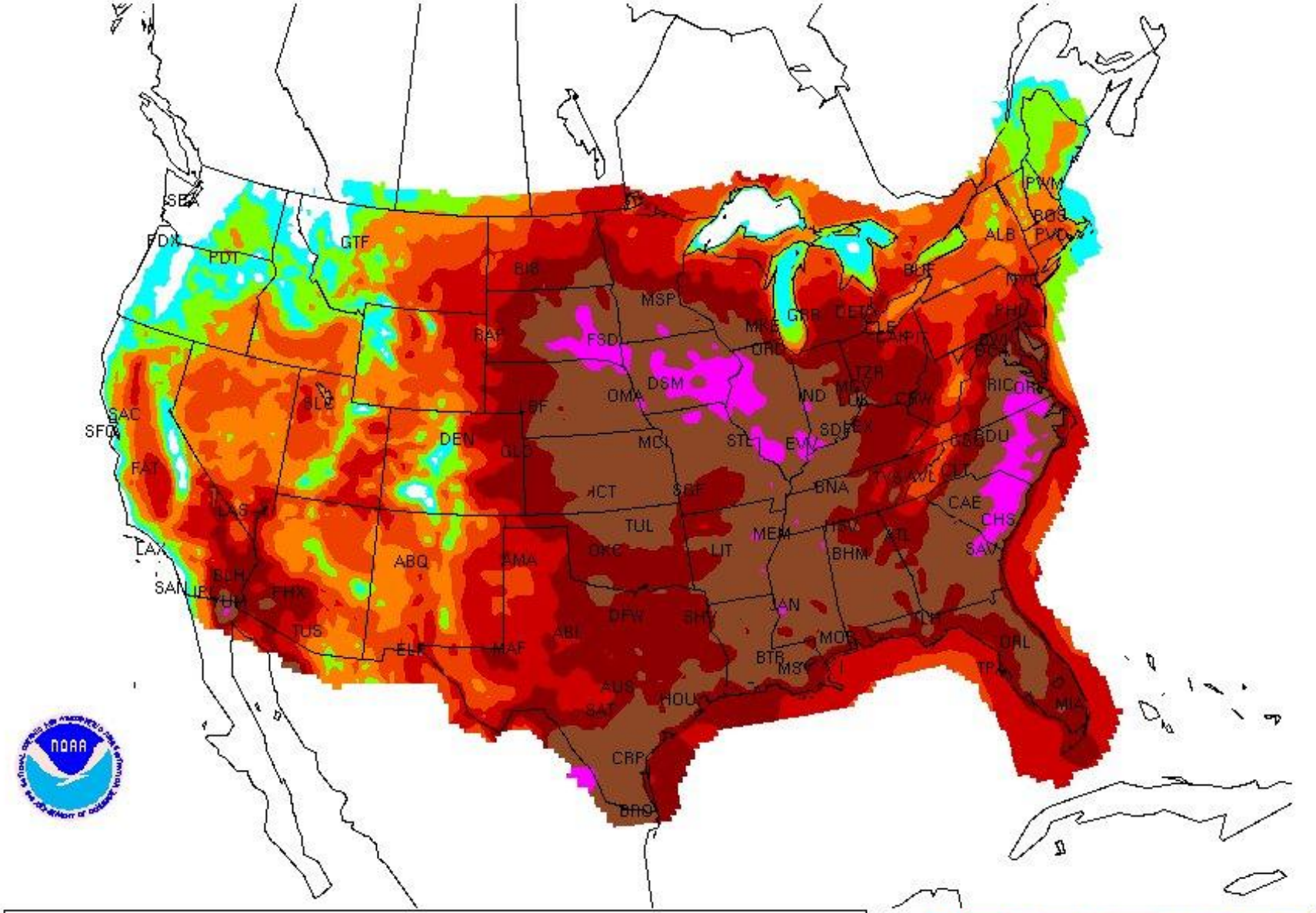
(SLOW MOVING/ACTIVE)



WARM FRONT

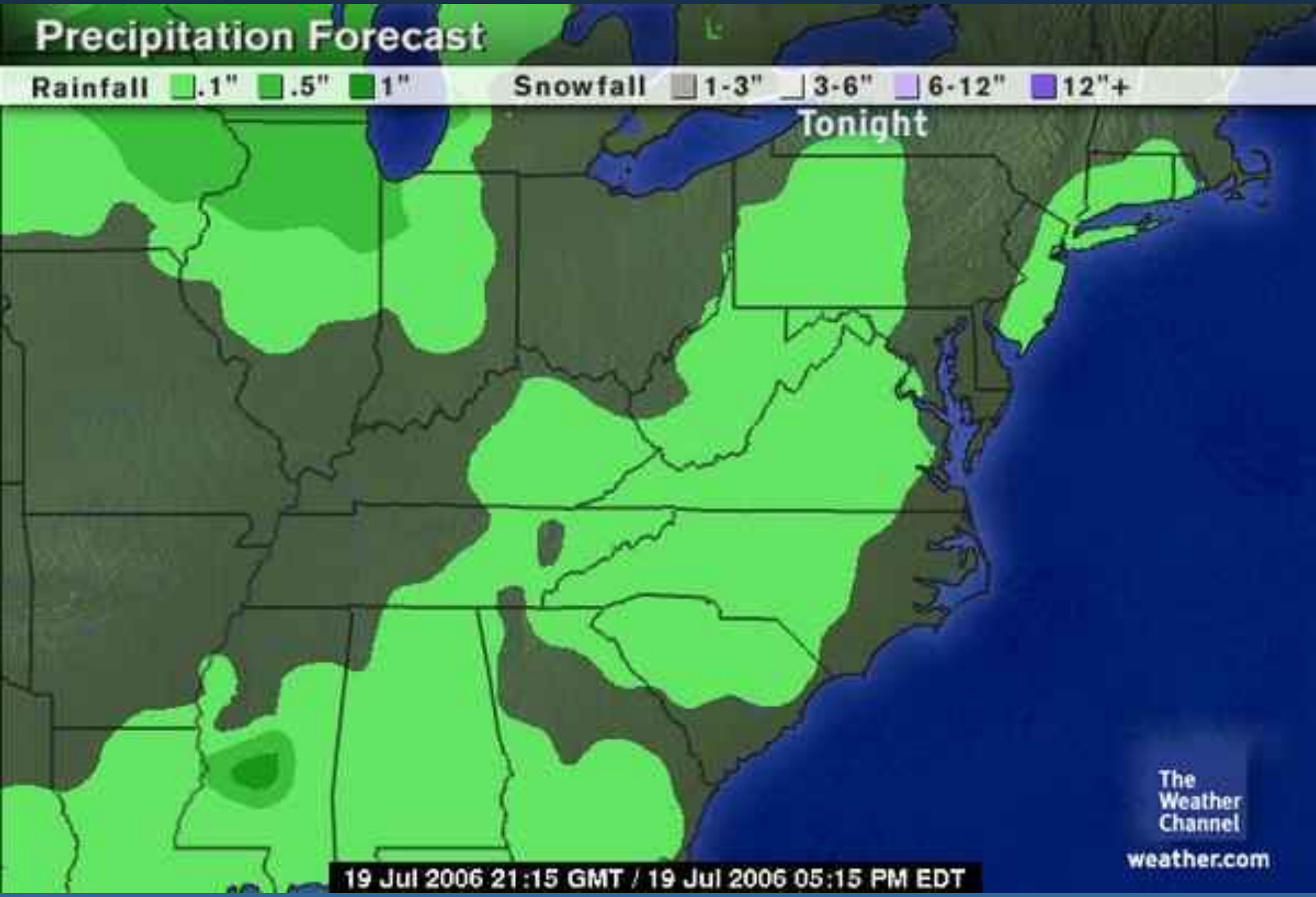


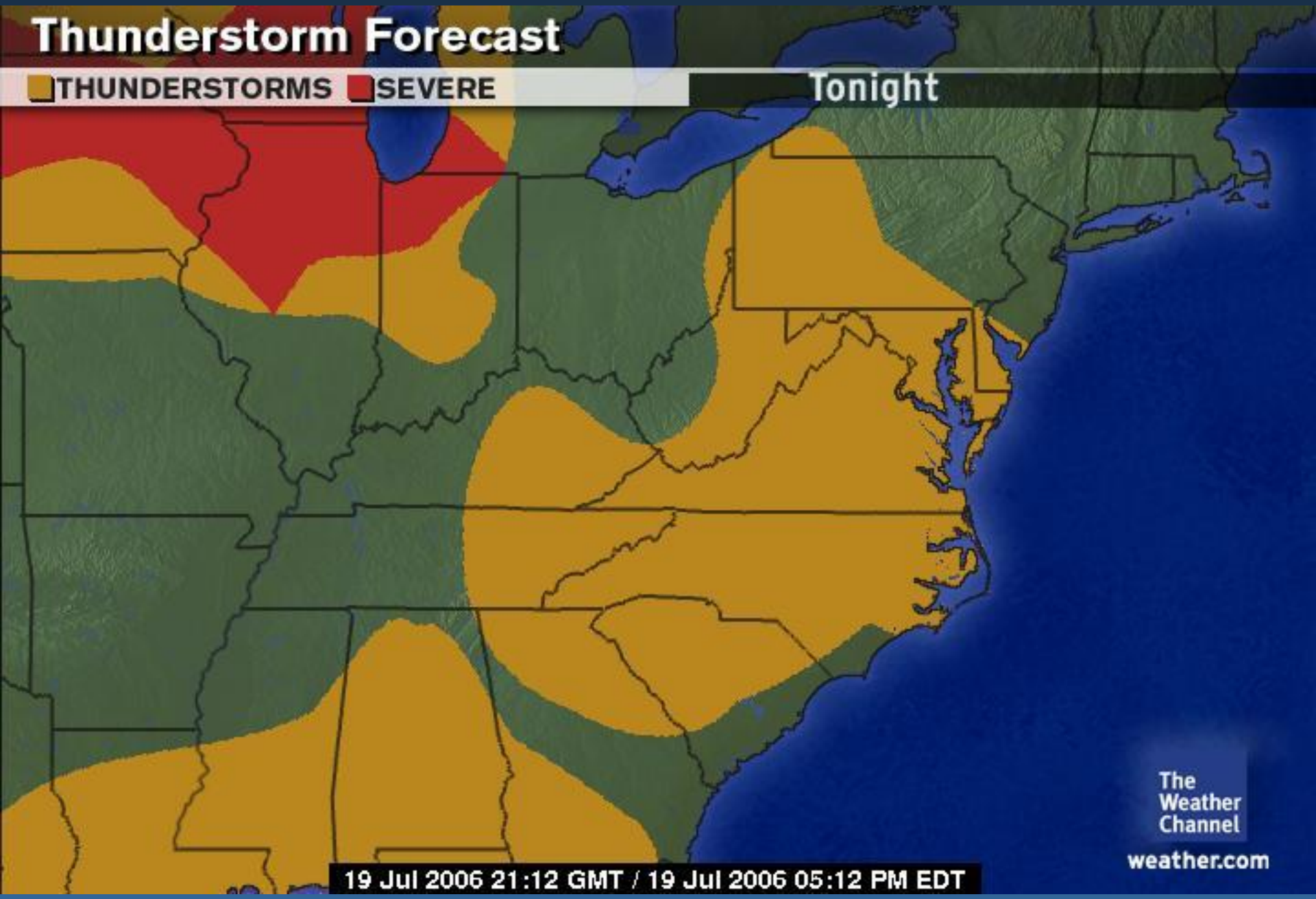
CLICK ON A CITY CODE FOR A TABLE OF FORECAST VALUES

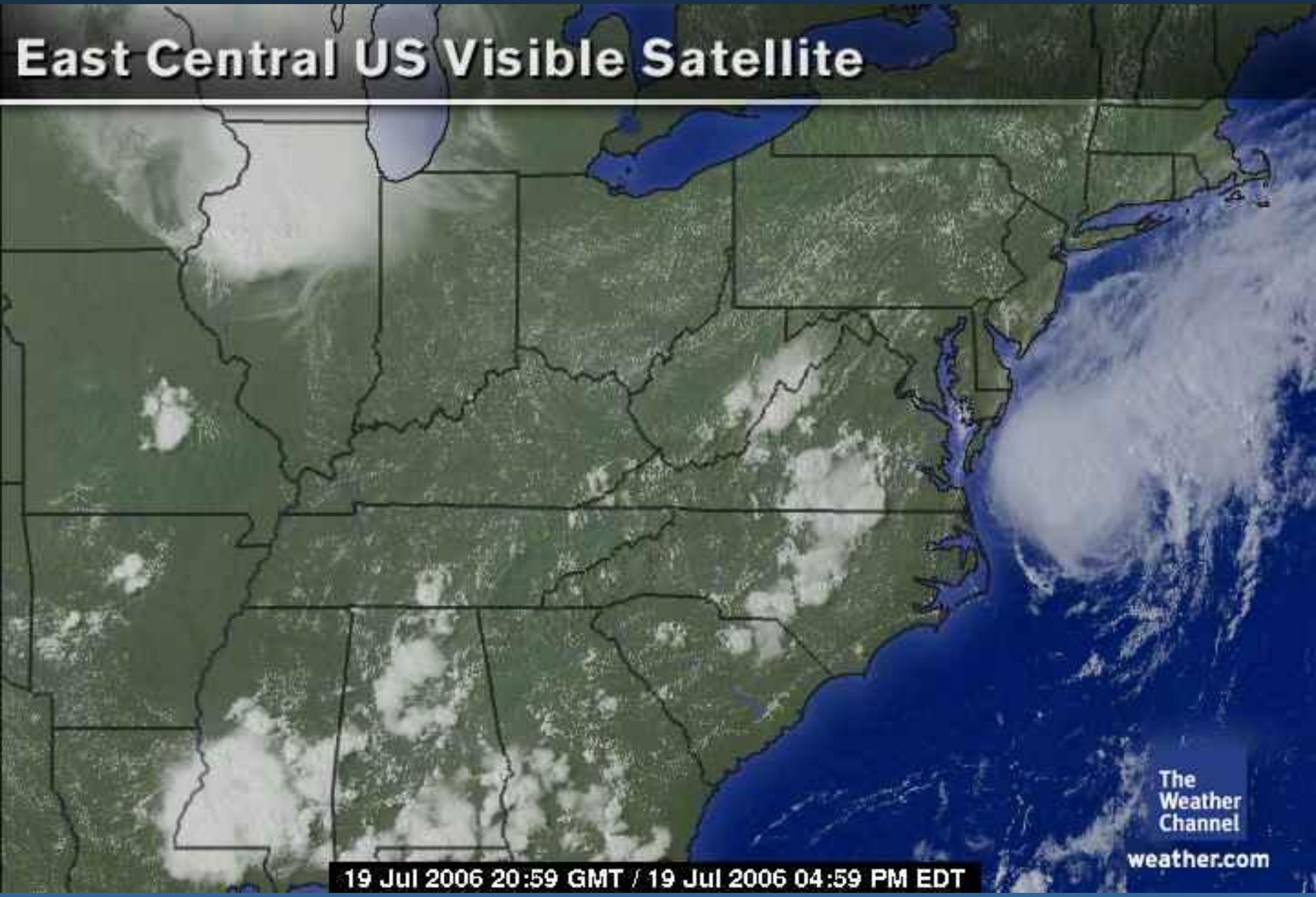


DAY 4 FORECAST DAILY MAXIMUM HEAT INDEX (DEG F)
ISSUED: 1839 UTC SAT JUN 30 2012
VALID: WED JUL 04 2012
DOC/NOAA/NWS/NCEP
HYDROMETEOROLOGICAL PREDICTION CENTER

70 75 80 85 90 95 100 105 110 115


Precipitation Forecast
Rainfall .1" .5" 1"
Snowfall 1-3" 3-6" 6-12" 12"+
Tonight
The Weather Channel
weather.com
19 Jul 2006 21:15 GMT / 19 Jul 2006 05:15 PM EDT


Thunderstorm Forecast
THUNDERSTORMS
SEVERE
Tonight
The Weather Channel
weather.com
19 Jul 2006 21:12 GMT / 19 Jul 2006 05:12 PM EDT


East Central US Visible Satellite
19 Jul 2006 20:59 GMT / 19 Jul 2006 04:59 PM EDT
The Weather Channel
weather.com

Thursday Forecast
July 20, 2006
RAIN
RAIN/SNOW
SNOW
ICE/MIX
FOG
STRONG STORMS
The Weather Channel
weather.com
19 Jul 2006 20:15 GMT / 19 Jul 2006 04:15 PM EDT

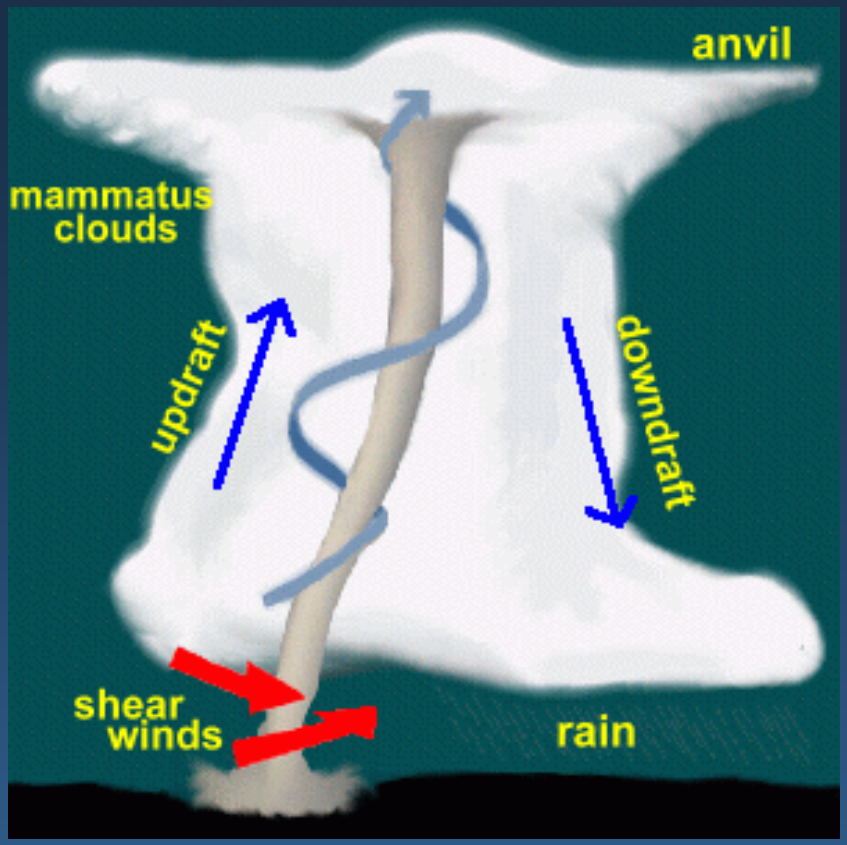
Severe weather phenomena

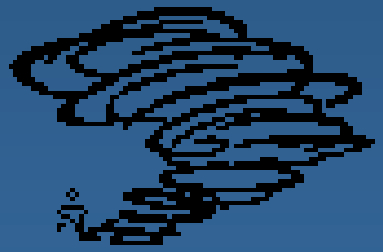
Hurricanes:

High speed windstorms accompanied by torrential rains that begin over the ocean where air rising from warm seas creates a strong low pressure zone that draws air to it with rotating winds around the core (the eye); may be up to a few hundred miles in diameter.

Tornados:

Among most destructive natural phenomena are swirling winds that spin at speeds of up to 400 mph. Like hurricanes, are caused by severe low pressure zones that attract winds with force. They have relatively small bases, greatly magnifying their destructive power. Difficult to predict; often strike with little warning.





Formation of T-cell thunderstorm

Other weather phenomena

Lightning:

Strong currents inside storm clouds cause water droplets & ice crystals to crash into one another continually and friction between the particles creates static electricity. Opposite charges build between the top & bottom of the cloud, and the bottom of the cloud & the earth. A spark occurs (lightning) when opposing charges become intense and jumps the gap between cloud and earth. Thunder accompanying lightning is noise produced by the discharge.

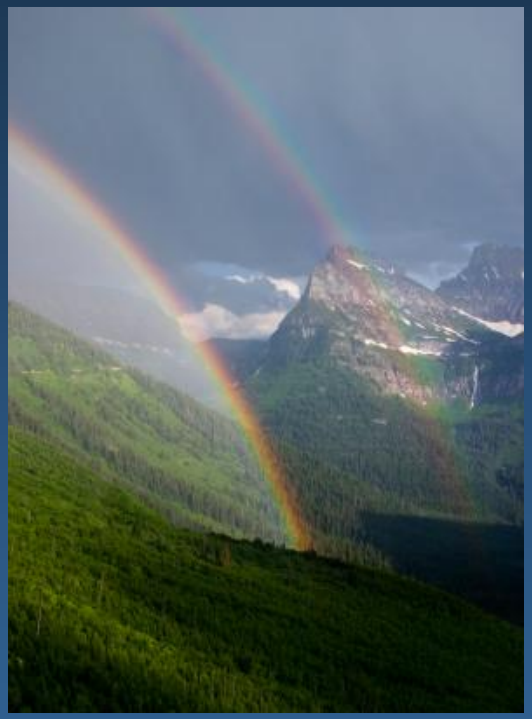
Rainbows:

Rainbows are caused when sunlight penetrates drops and is broken into bands of red, orange, yellow, green, blue, indigo and violet.

Observing weather phenomena

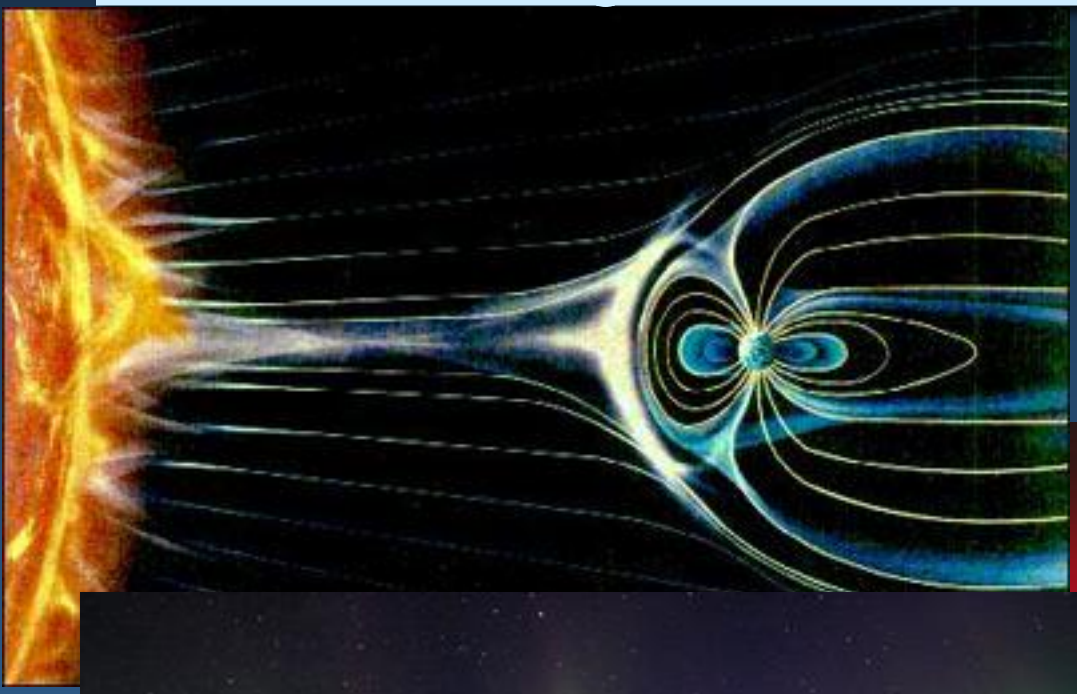
Lightning

Observing weather phenomena



Rainbows

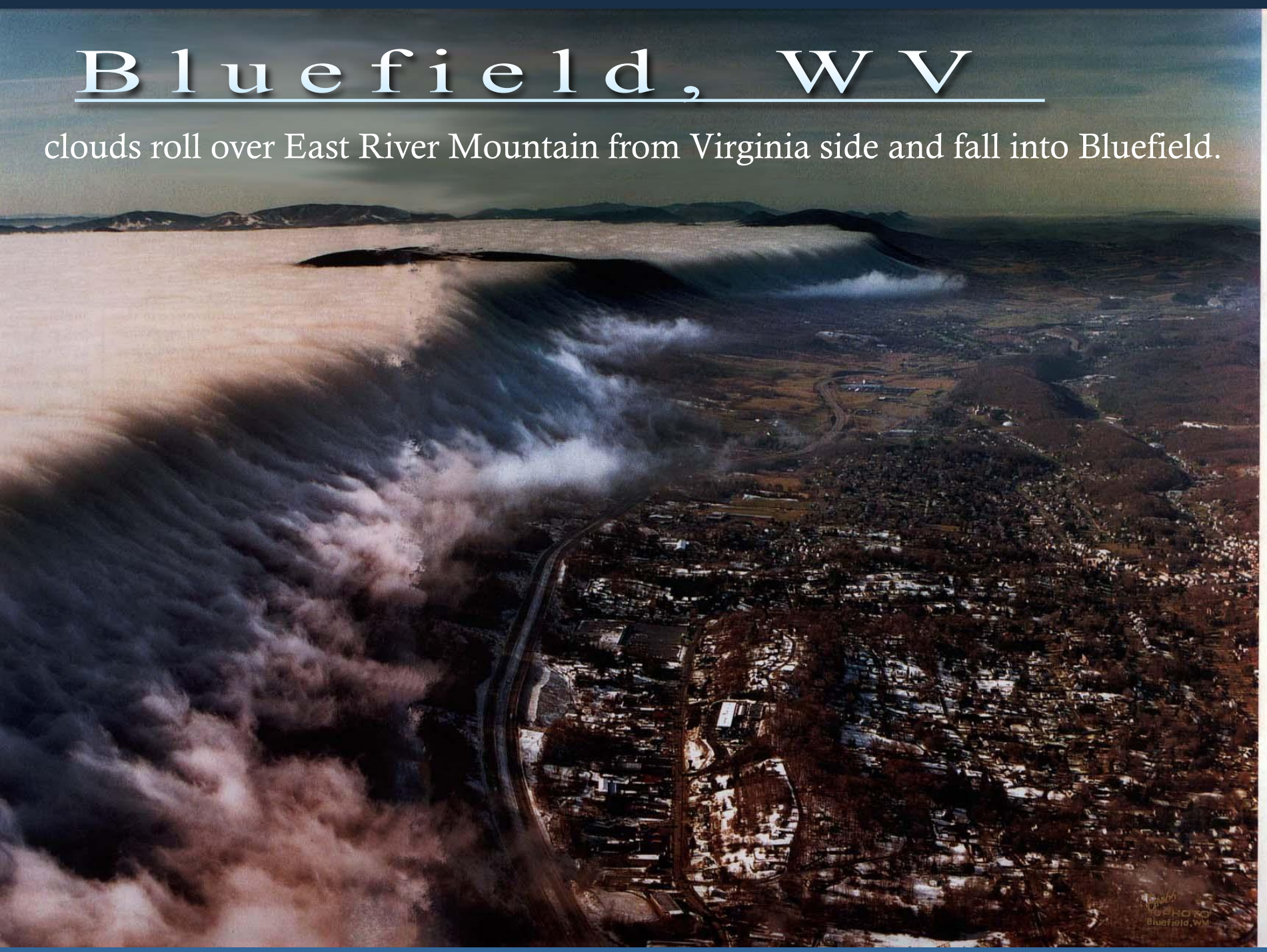
Observing weather phenomena



Aurora

Bluefield, WV

clouds roll over East River Mountain from Virginia side and fall into Bluefield.



Weather and Climate

The **difference** = a measure of **time**:

Weather = the condition of the atmosphere over a short period
People think of weather in terms of temperature, precipitation, humidity, cloudiness, visibility, wind, and atmospheric pressure.

Climate = how the atmosphere "behaves" over long periods; the long-term pattern of weather in an area.

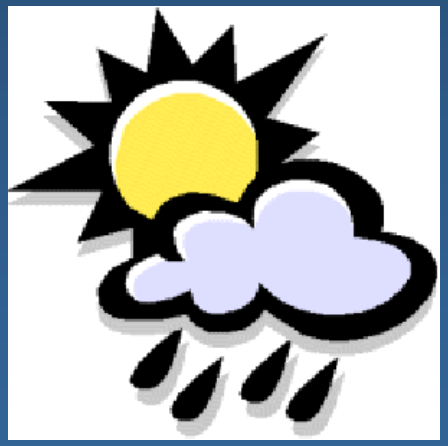
Climate change is about changes in long-term averages of daily weather.

Positive proof of climate change

resources

Scholastic
http://printables.scholastic.com/printables/

Web Weather for Kids
http://eo.ucar.edu/webweather/



discussion?

Slides on fronts adapted from Weather Service Instrument Ground School Web presentation, 10-22-05