Earth Science
Chapter 16 and 17

Weather and Climate

Goal

- Prediction
- Old way
  - Groundhog
  - Color of the sky
- Modern way
  - satellites
  - instruments
  - computers

Weather Factors

- Studied by meteorologists
- Several factors influence the weather
- Heat energy
- air pressure
- winds
- moisture

Heat Energy

- Almost all the earth's energy comes from the sun
- Visible and invisible waves
  - Infrared and ultraviolet
- As light hits the earth
  - some is reflected back into space by dust particles and water droplets
  - Some is absorbed in the atmosphere, in the ozone layer

Heat Energy

- Ozone layer protects us from dangerous ultraviolet radiation.
- The energy that does hit the earth is converted to heat energy.
- Heat is then spread through the atmosphere
  - Conduction
  - Convection
  - Radiation

Conduction

- Direct transfer of heat
- From one molecule to the next
- Air above the pavement is slightly hotter.
- Not a big effect on the atmosphere

Convection

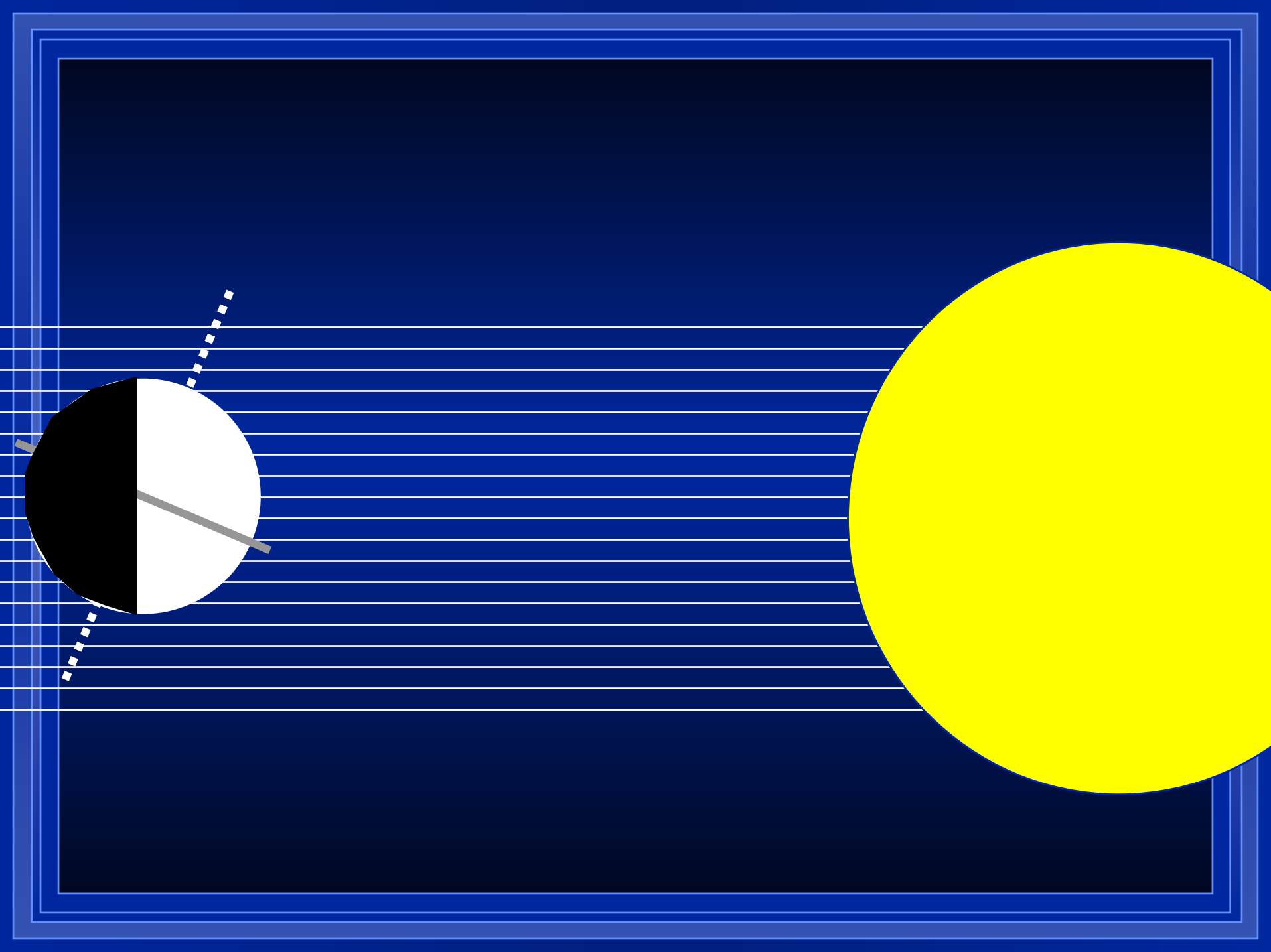
- Transfer of heat in a fluid
- Heated air is less dense, it rises
- Cooler air is more dense, it sinks
- Makes convection currents in the atmosphere
- Circular movement of air caused by uneven heating.
- Big impact on the atmosphere

Radiation

- Transfer by waves
- Energy transferred by infrared waves.
- Infrared waves get trapped by carbon dioxide and other gases in the atmosphere
- Called the greenhouse effect.
- If there is too much carbon dioxide, the earth will warm up
- affect the world's weather

Variations of temperature

- Why are the tropics hot, and the poles cold?
- The angle of the sun's rays.
- Near 90° at the equator
- Becomes smaller as you get farther from equator closer to the poles



Measuring temperature

- Device is called a thermometer
- As the temperature rises, liquid inside the bulb expands and rises up the thin tube.
- Units are called degrees
- Scientist use the Celsius scale
- Water boils at 100 °C
- Water freezes at 0 °C
- Body temperature is 37 °C

Air Pressure

- Caused by air molecules hitting you.
- We are at the bottom of a “sea” of air
- We can feel the pressure of all that air above us
- Dense air has more mass, so it causes a higher pressure
- Three factors that influence air density and air pressure

Temperature

- Air expands as it is heated.
- Higher temperature
- lower density
- less pressure

Water Vapor

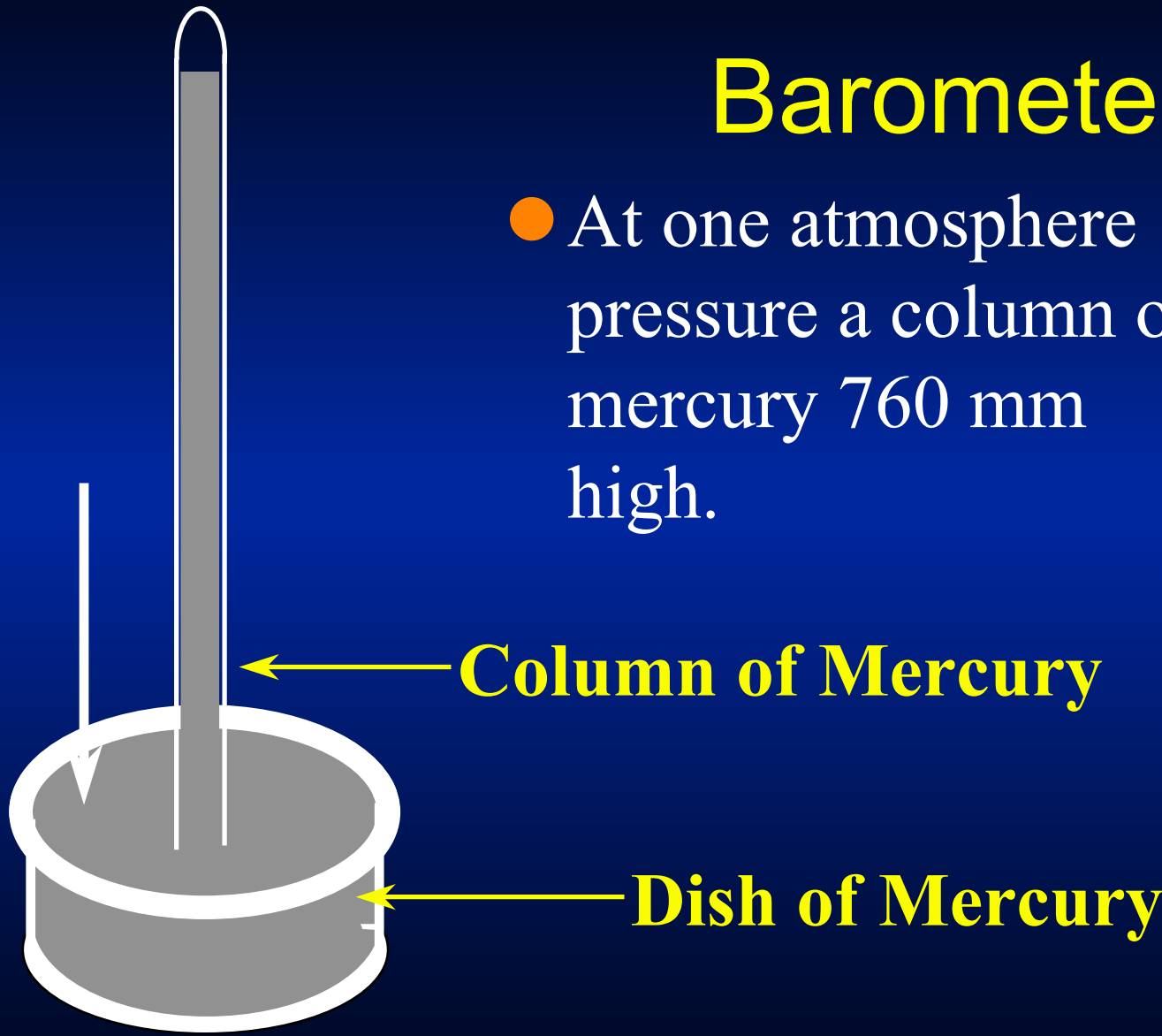
- Water molecules have less mass than air molecules.
- More water vapor
- less mass
- lower density
- Less pressure
- Moist air has lower pressure than dense air

Elevation

- Higher elevations air is thinner
- fewer air molecules above
- less dense
- lower pressure.
- We need to set a standard
- Measure 1 atmosphere at 0°C at sea level

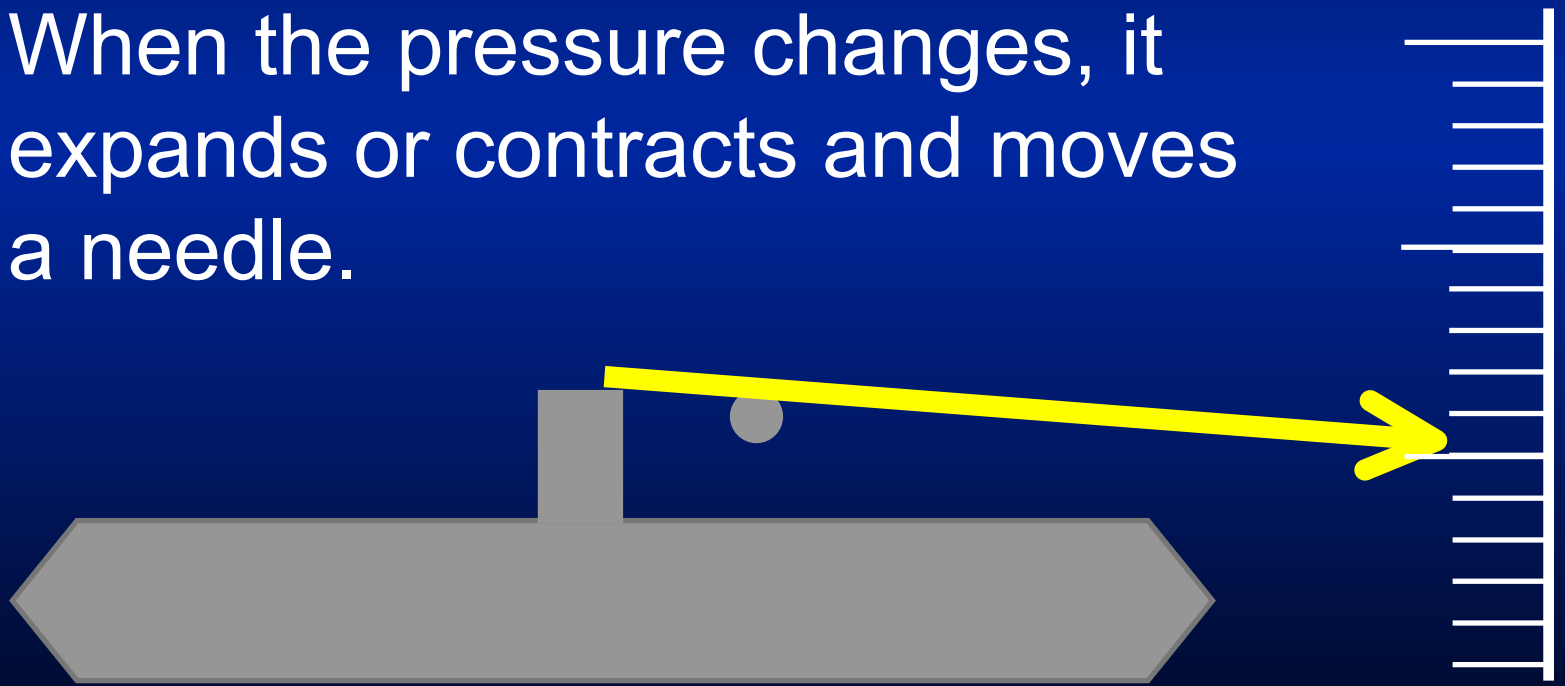
Barometer

- At one atmosphere pressure a column of mercury 760 mm high.



Another barometer

- An aneroid barometer
- Airtight metal container
- When the pressure changes, it expands or contracts and moves a needle.



Wind

- The movement of air
- Caused by warm air rising, less dense, lower pressure
- Cooler air sinking, more dense, higher pressure
- Cooler air moves under warmer air.
- Two types of winds
  - local
  - global

Local Wind

- Blow from any direction, over short distances
- Sea breeze
- During the day, land heats up faster
- Warm air over land rises.
- Cool air from over ocean or lake replaces
- Air blows from the sea, called a sea breeze

Land Breeze

- During night
- Land cools off faster
- Warmer air over sea rises
- Cooler air from the land replaces it
- Wind is from land, called a land breeze
- Winds are named by the direction they come from.
- A northern wind comes from the north

Monsoon

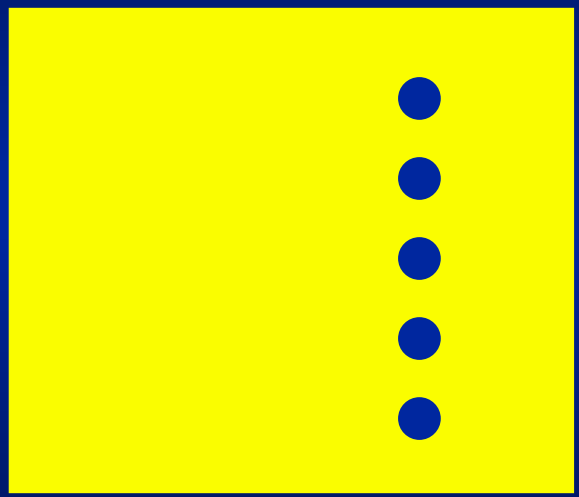
- A major land or sea breeze
- a seasonal wind
- One part of the year the wind blows from the continent to the ocean
- The rest of the year it blows from the ocean to the continent.
- Makes for two seasons, rainy and dry

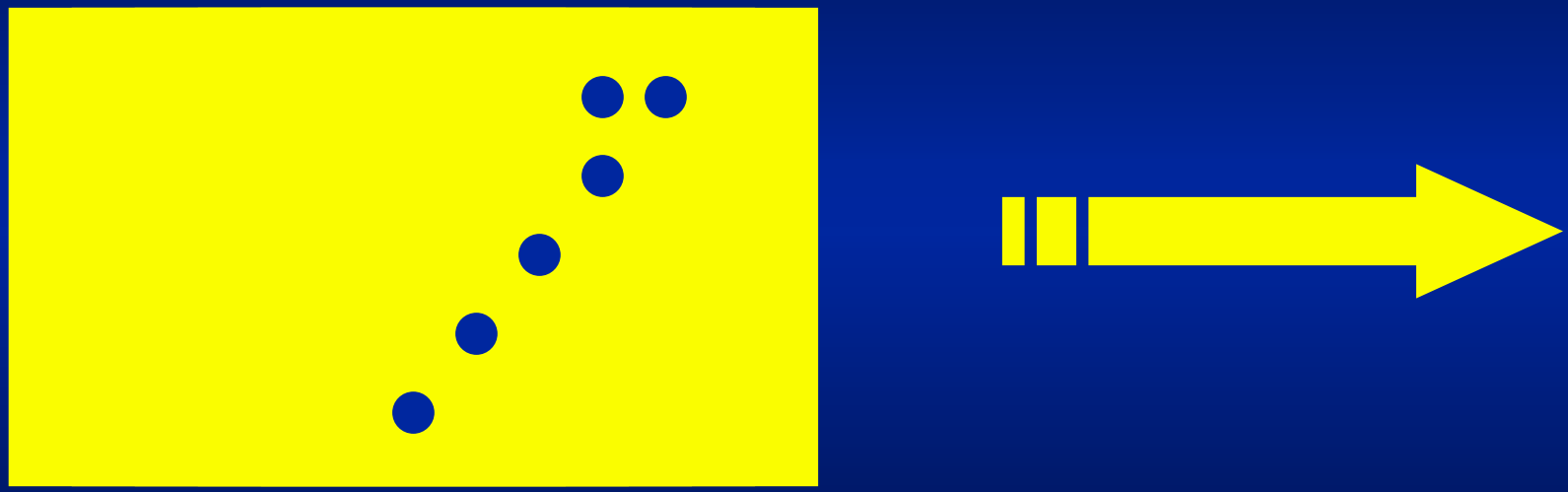
Global Winds

- Caused by unequal heating
- Near the equator air is hot
- At the poles it is cold
- Air moves from the poles to the equator
- Not directly north or south, because the earth rotates.

Coriolis Effect

- Apparent shift (or curve) in movement caused by the rotation of the earth
- In the Northern Hemisphere they curve to the right
- In the Southern Hemisphere they curve to the left.



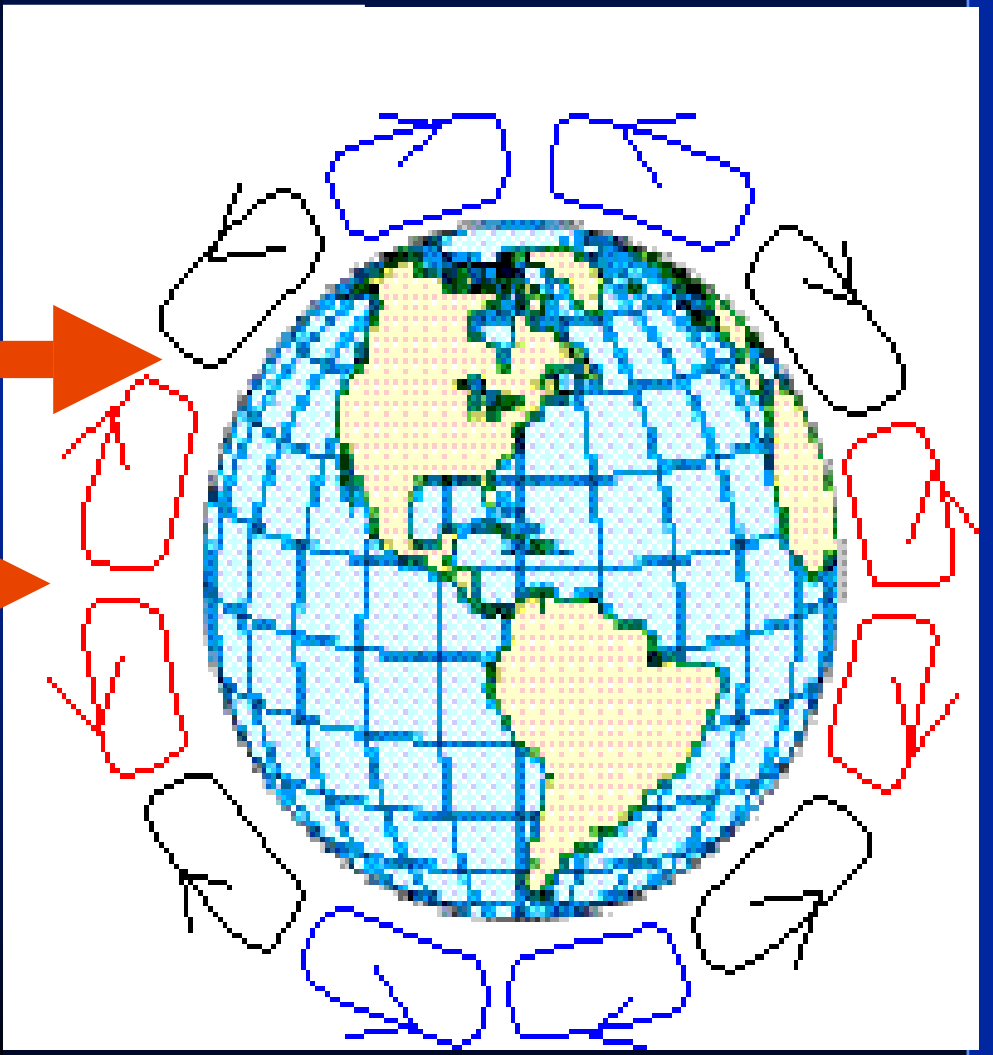


Global Winds

- Doldrums-
- At the equator the winds are calm
- Caused by rising, low pressure, warm air
- Problem for sailors
- Horse latitudes- at 30° Latitude air from the equator cools and sinks
- air is calm here

Horse Latitudes

Doldrums



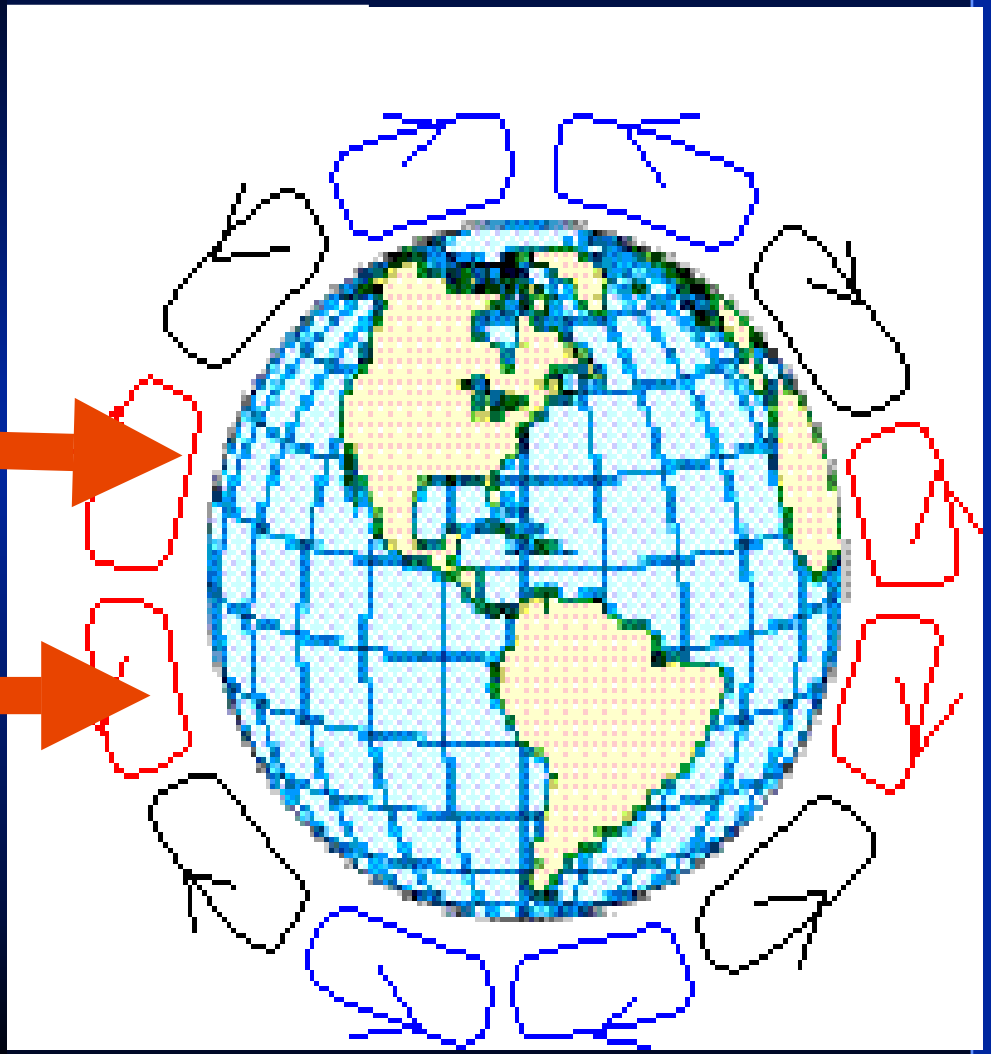
Global Winds

- Trade winds
- Some sinking air moves towards the equator
- Makes steady winds from the east in the Northern hemisphere
- From the east in the Southern Hemisphere
- Usually weak winds

Global Winds

Trade Winds

Trade Winds

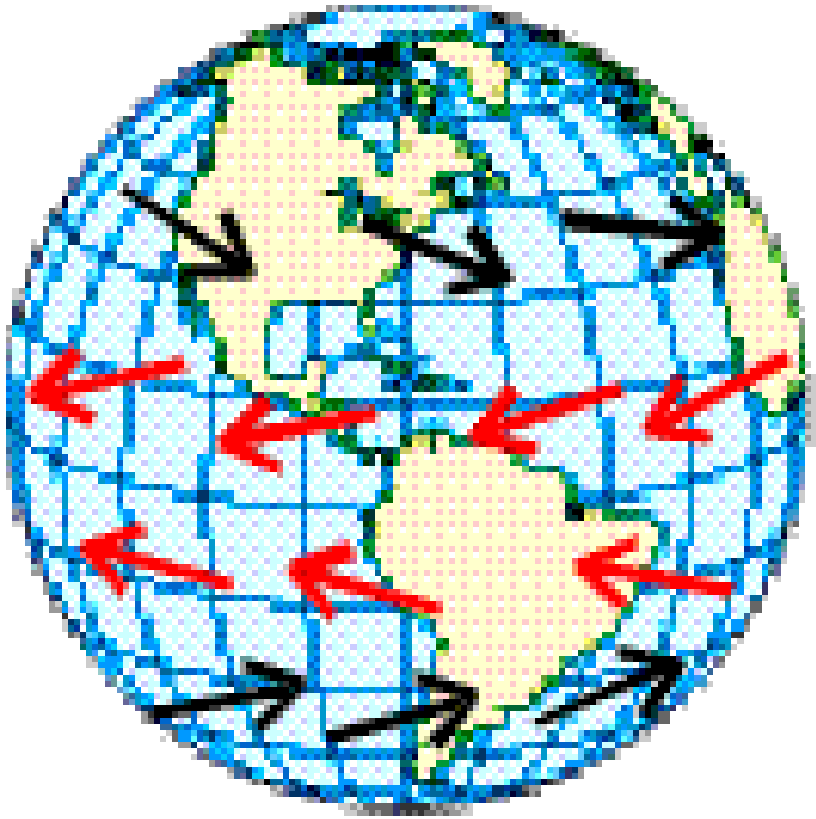


Global winds

- Sinking air moves toward pole 40° to 60°
- Bends to right in Northern Hemisphere
- goes east
- Prevailing Westerlies
- Why our weather moves to east
- Bends to left in Southern Hemisphere
- goes east

Global Winds

- Used by sailors to the New World and back



Global Winds

- North and south of 60° the air flows from the poles then rises.
- Turn right in the Northern Hemisphere
- Polar Easterlies
- Turn left in the Southern Hemisphere
- Cold weak winds
- Local winds may be different than global winds

Jet Streams

- Not Discovered until the 1940's
- High Pressure belts of air high in the atmosphere
- Move from west to east at 180 to 350 kilometers per hour
- Wander as they circulate
- Can move weather systems

Measuring wind

- Use wind vane to measure direction
- An anemometer to measure wind speed.
- Rotating cups
- Faster rotation, higher wind speed

Moisture

- Water vapor in the atmosphere is called humidity,
- Comes from evaporation from oceans, lakes, rivers, soil, plants, animals
- Varies from place to place
- Higher temperature air can hold more moisture

Relative Humidity

- Comparing how much water vapor there is in the atmosphere to how much it could possibly hold.
- Given as a percentage.
- At 100% the air is saturated
- As warm air is cooled, it can hold less, so it condenses out.
- The temperature that water condenses out is called the dew point.

Clouds

- Form when moisture condenses on small particles of dust.
- Clouds are tiny water droplets.
- Categorized two ways
- Shape
- Altitude

Shape

- Cumulus - puffy, flat bottom good weather
- Can turn into cumulonimbus clouds which produce thunderstorms.
- Stratus- layer clouds, grey, light rain
- Close to ground called fog
- Turn into Nimbostratus which bring rain or snow

Shape

- Cirrus- Feather clouds at high altitudes
- Ice crystals
- Appear when the weather is clear but often are followed by rain or snow

Altitiude

- Stratus- Low level <2.5 km
- Cumulus- Mid level 2-6 km
- Cirrus- high level Higher than 6-12 km
- Cumulonimbus clouds can rise to heights of 13 km

Cirrus

Cirrostratus

Cirrocumulus

Altocumulus

Stratus

Stratocumulus

Cumulus

Cumulonimbus

Precipitation

- Caused by water condensing in the clouds and falling to earth
- Water droplets must get bigger to fall
- Combine with other droplets
- Raindrops are 1 million times bigger than cloud droplets
- Gravity pulls them to earth
- Sleet- rain freezes as it falls to earth

Other types

- Snow- moisture forms ice crystals as it condenses
- Hail- chunks of ice formed in an updraft
  - Ice crystals form
  - falls through moisture
  - Wind blows it back up
  - Freezes and falls again
  - Repeats
  - Layers, up to 5 inches across

Measuring Precipitation

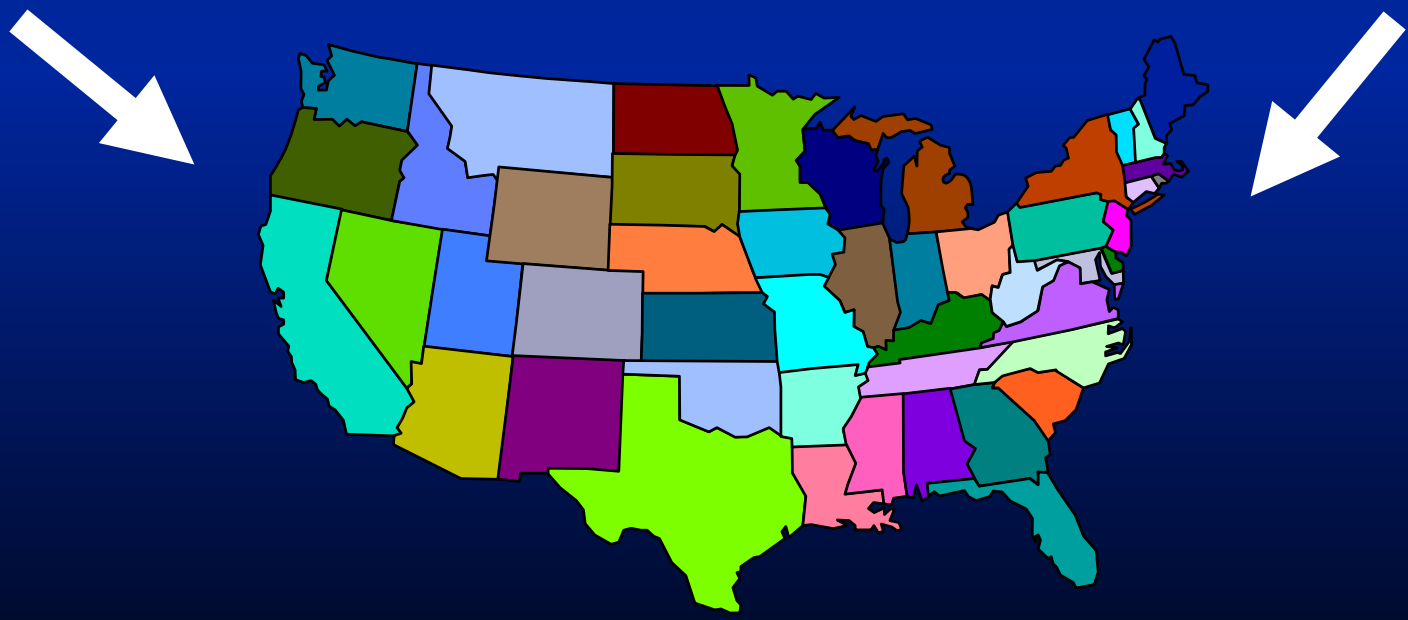
- Use a rain gauge
- Straight sided, flat bottom container that fills up with water

Weather Patterns

- Weather is caused by large air masses
- Areas with the same temperature and humidity
- Continental- dry - low humidity
- Maritime - wet - high humidity
- Polar- cold
- Tropical- hot
- Four possibilities

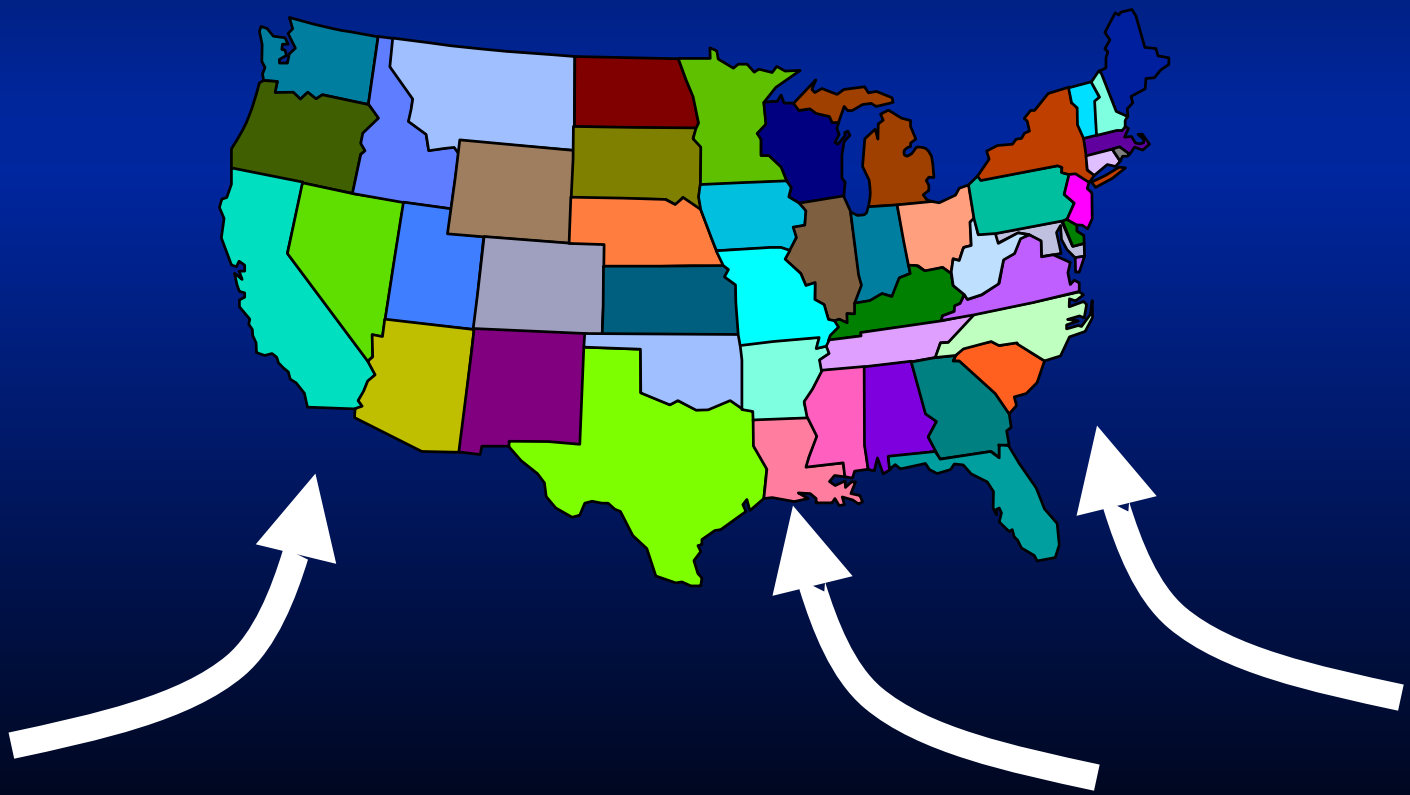
Maritime Polar

- Forms over cold water
- Causes fog in California



Maritime Tropical

- Forms over warm water
- Hot humid days



Continental tropical

- Forms over Mexico
- Dry hot air to Southwest

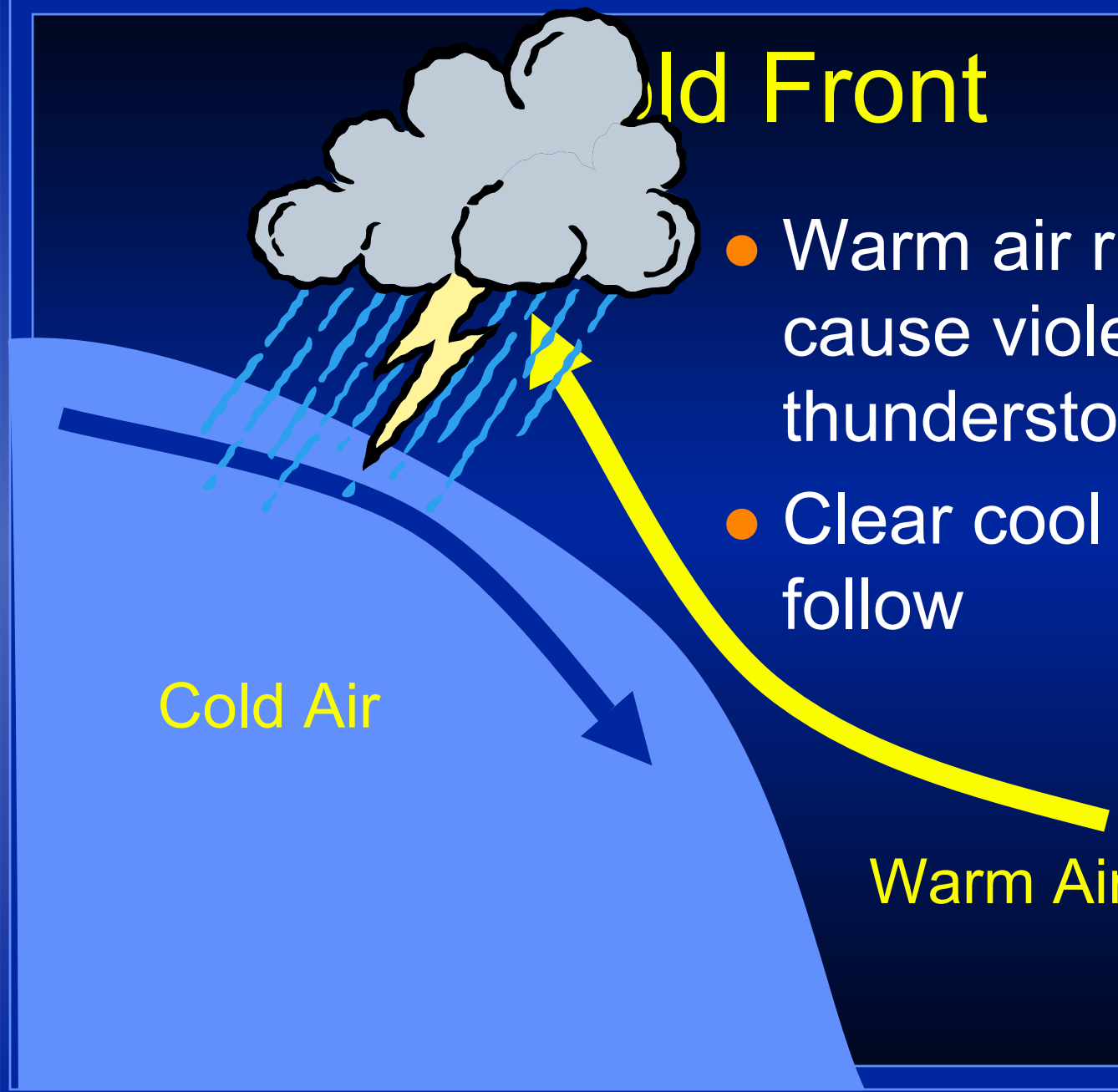
Continental Polar

- Forms over Canada
- Very cold winter days

Fronts

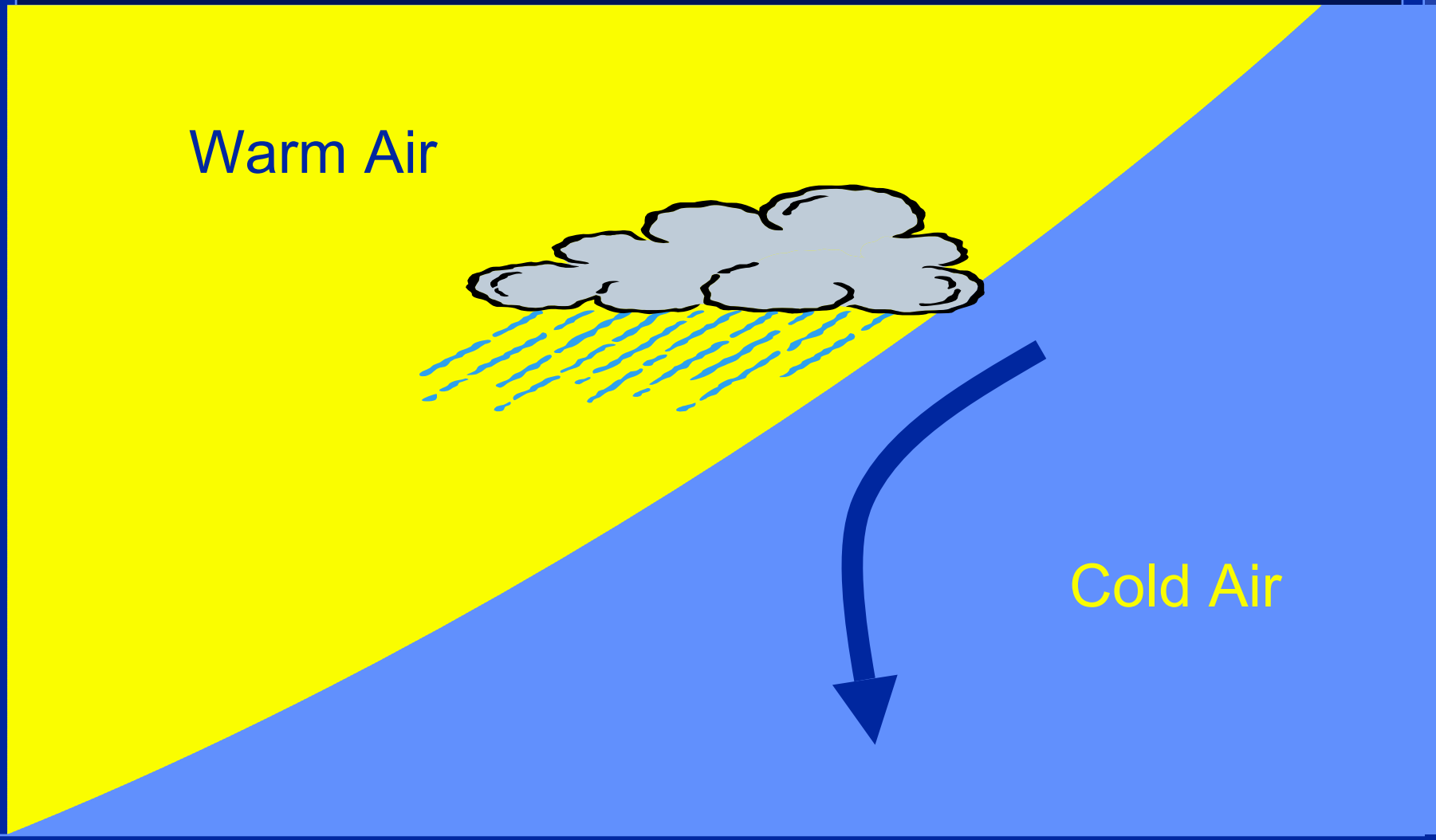
- Where two air masses meet
- Cold front when cold air replaces warm air
- Warm front when warm air replaces cold air
- Occluded front- when a cold front catches up with a warm front
- Stationary front- no movement occurs when cold and warm air meet.

ld Front



- Warm air rising cause violent thunderstorms
- Clear cool days follow

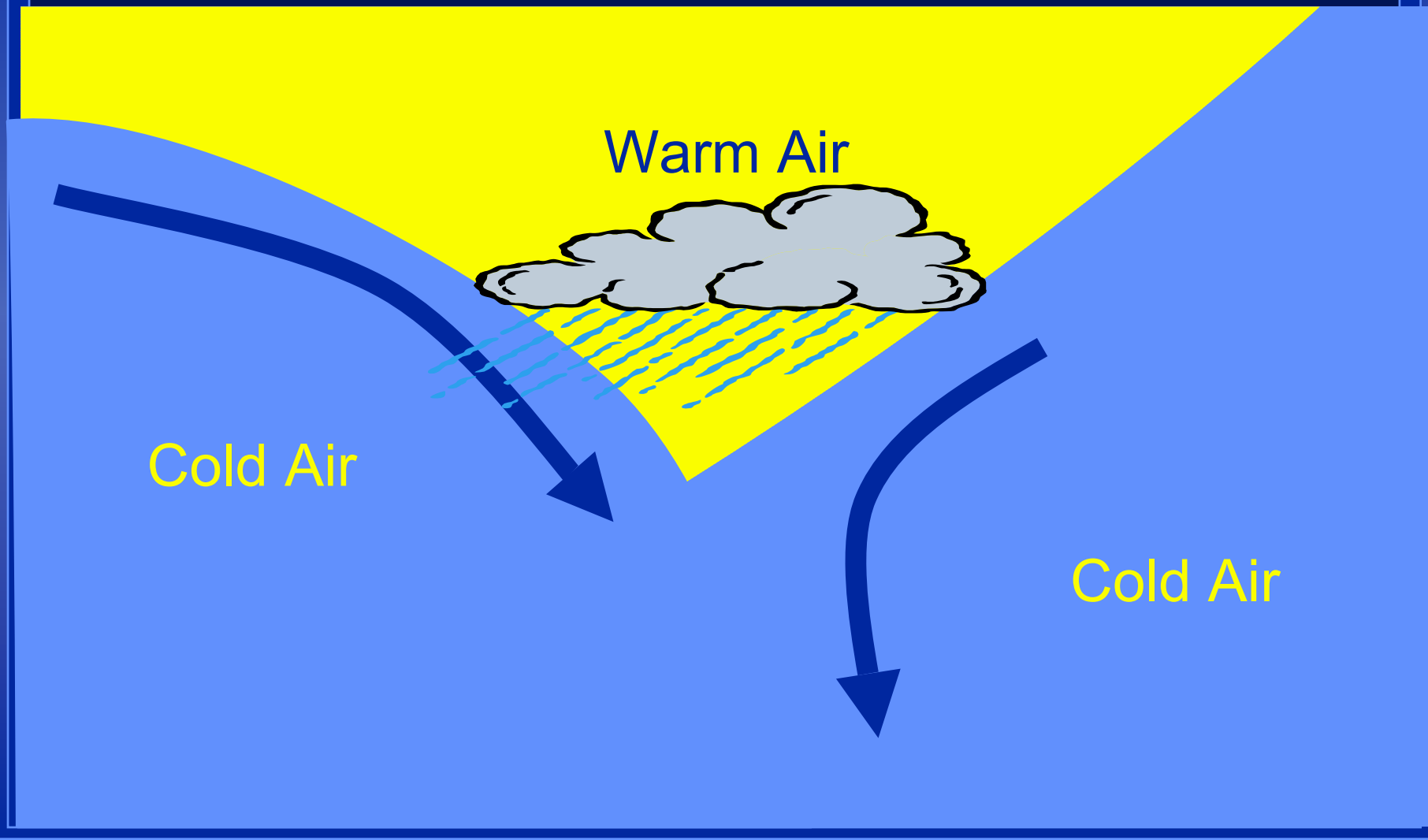
Warm Front



Warm Front

- Rain and showers are caused by warm fronts
- Followed by hot humid days

Occluded Front



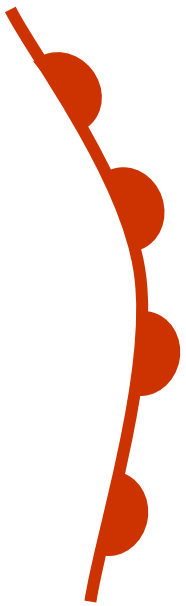
Occluded Front

- Less violent weather than a cold front.

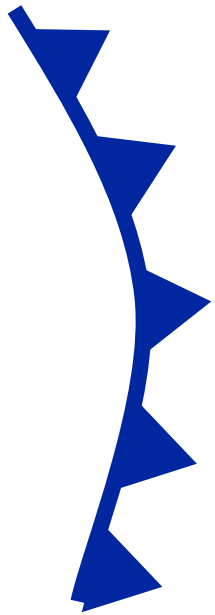
Stationary Front

- Cold air meets warm air and no movement occurs
- Rain can fall in the same place for days

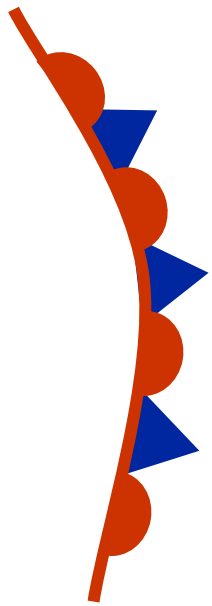
Symbols



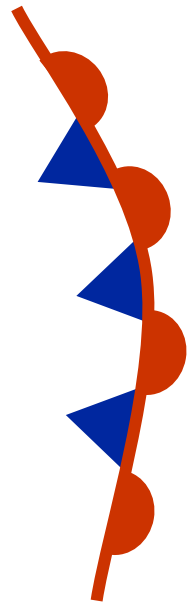
Warm Front



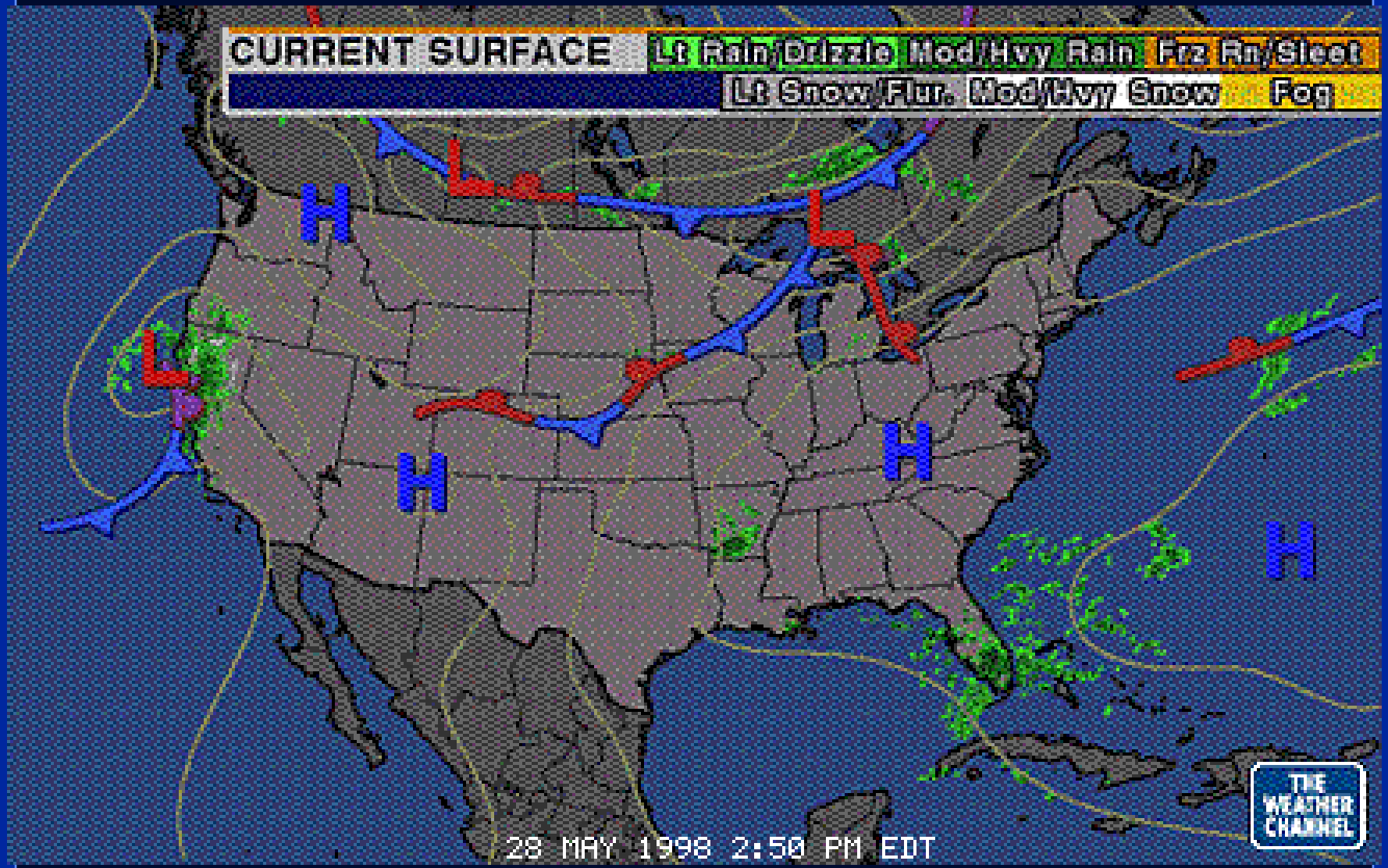
Cold Front



Occluded Front



Stationary Front


CURRENT SURFACE
Lt Rain/Drizzle
Mod/Hvy Rain
Frz Rn/Sleet
Lt Snow/Flur.
Mod/Hvy Snow
Fog
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H
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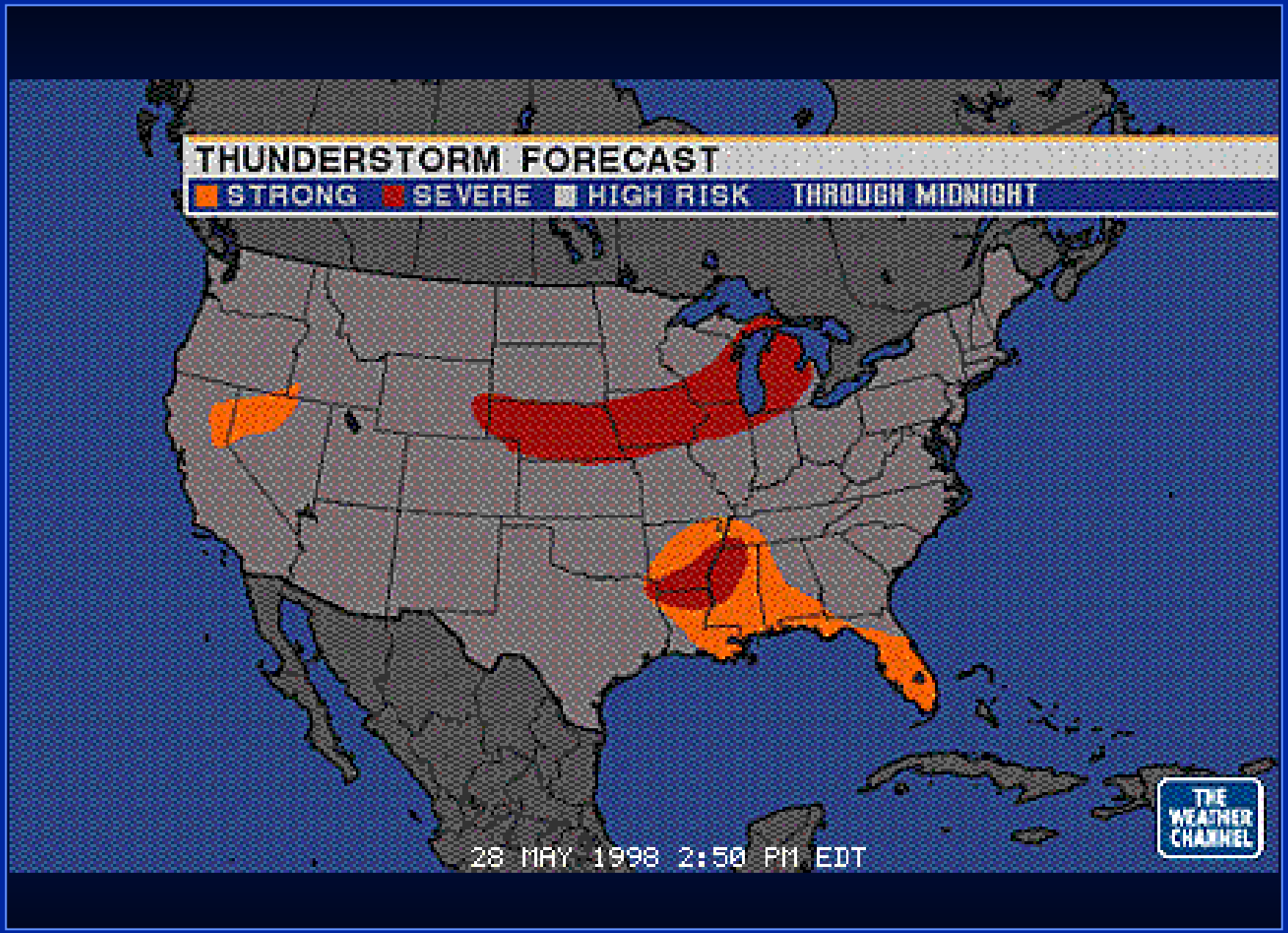
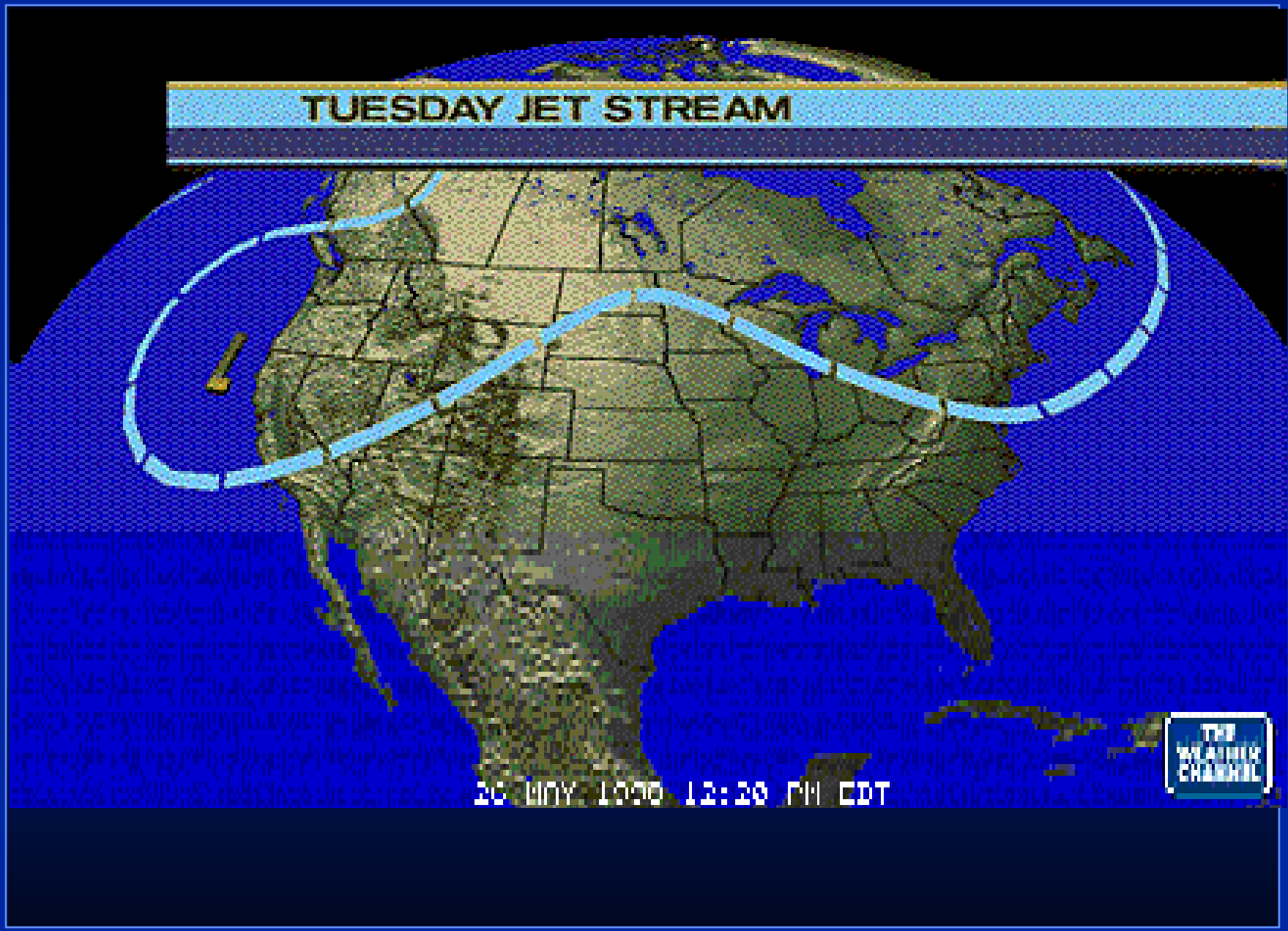
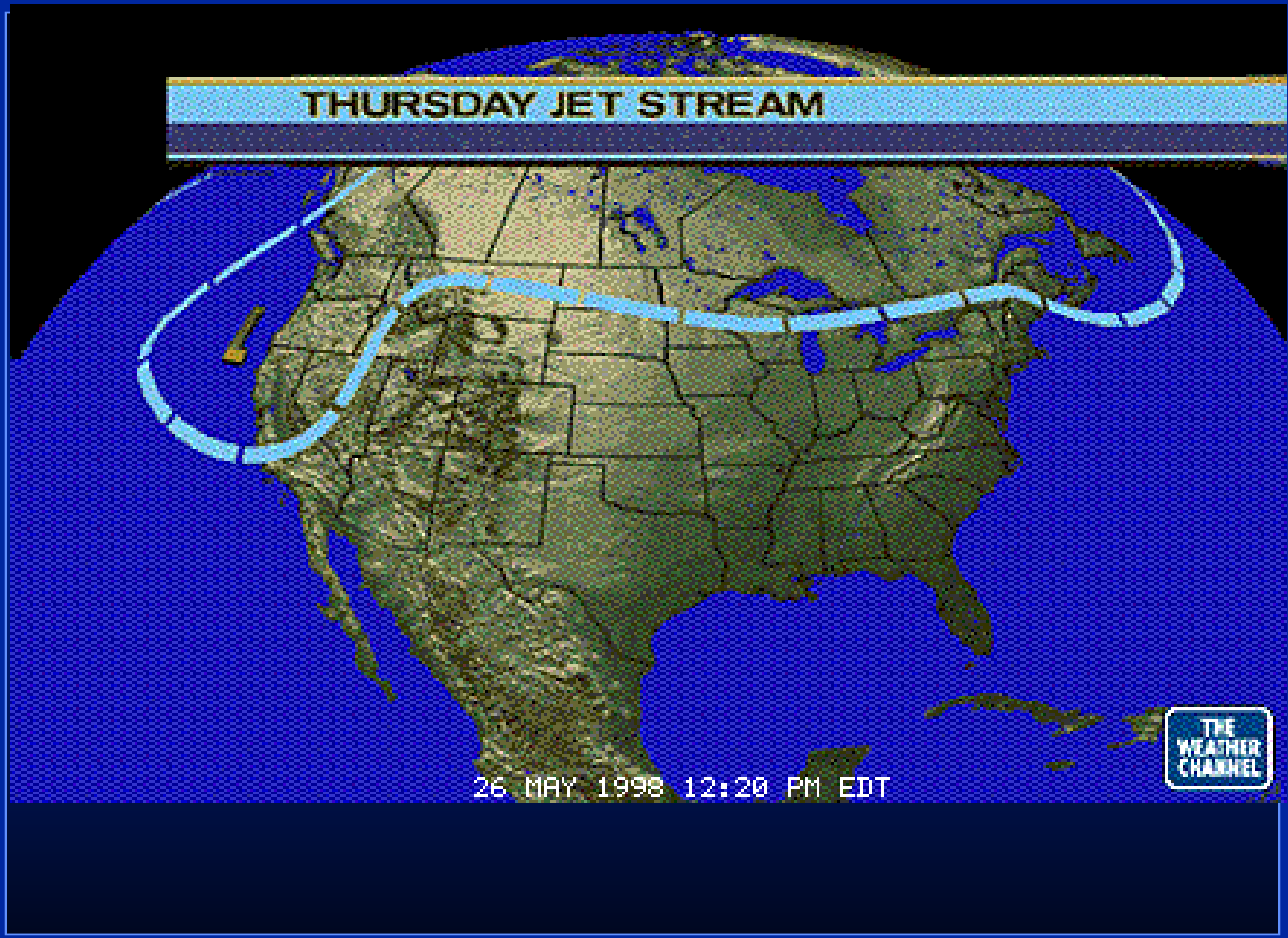
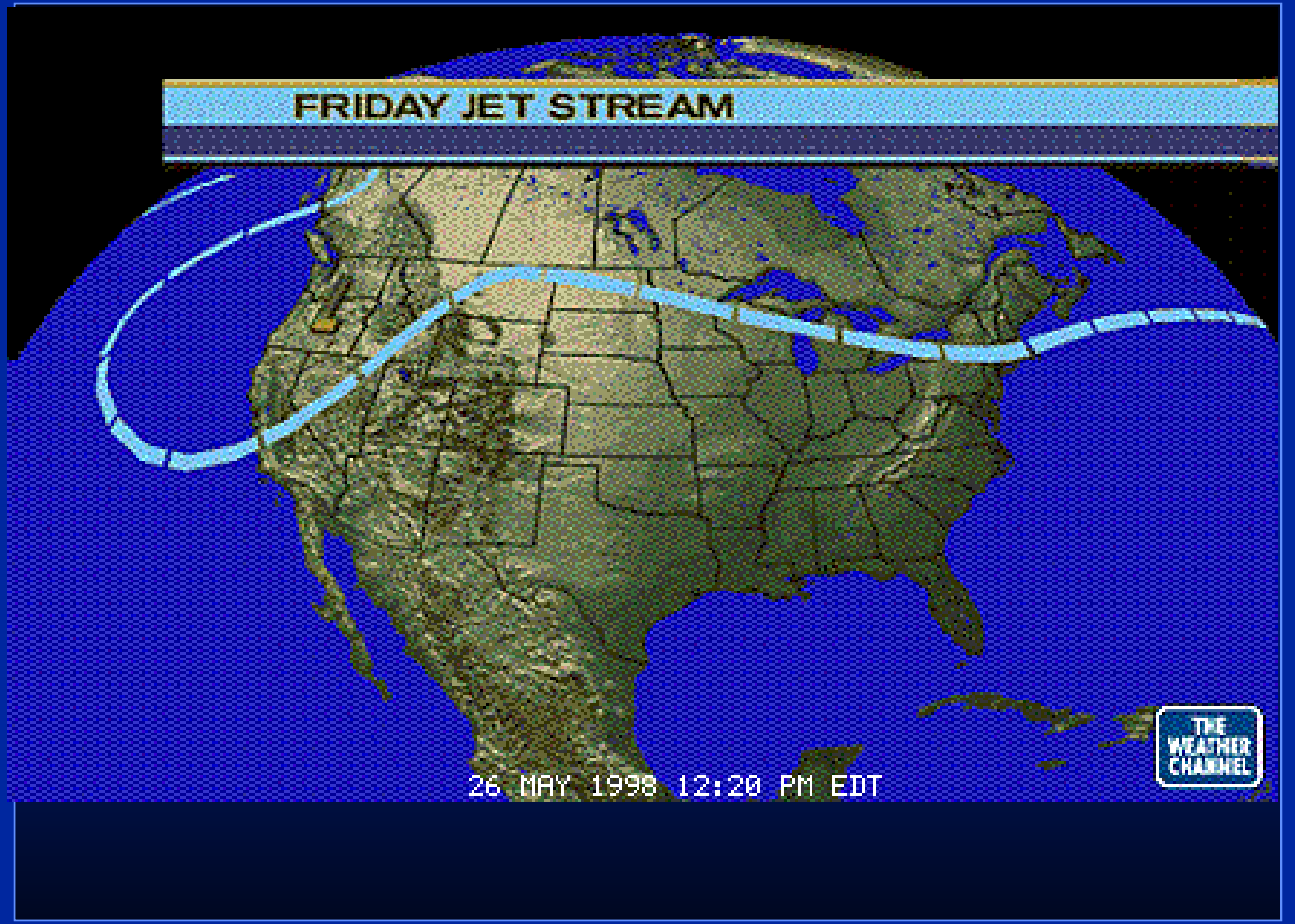
28 MAY 1998 2:50 PM EDT
THE WEATHER CHANNEL


THUNDERSTORM FORECAST
STRONG
SEVERE
HIGH RISK
THROUGH MIDNIGHT
28 MAY 1998 2:50 PM EDT
THE WEATHER CHANNEL


MONDAY JET STREAM
26 MAY 1998 12:20 PM EDT
THE WEATHER CHANNEL


TUESDAY JET STREAM
26 MAY 1996 12:20 PM EDT


THURSDAY JET STREAM
26 MAY 1998 12:20 PM EDT
THE WEATHER CHANNEL


FRIDAY JET STREAM
26 MAY 1998 12:20 PM EDT
THE WEATHER CHANNEL

Weather from Fronts

- Warm fronts form nimbostratus clouds
- Cause steady rainfall that lasts for hours
- or snow
- Cold fronts can form cumulonimbus
- Produce thunderstorms and hail

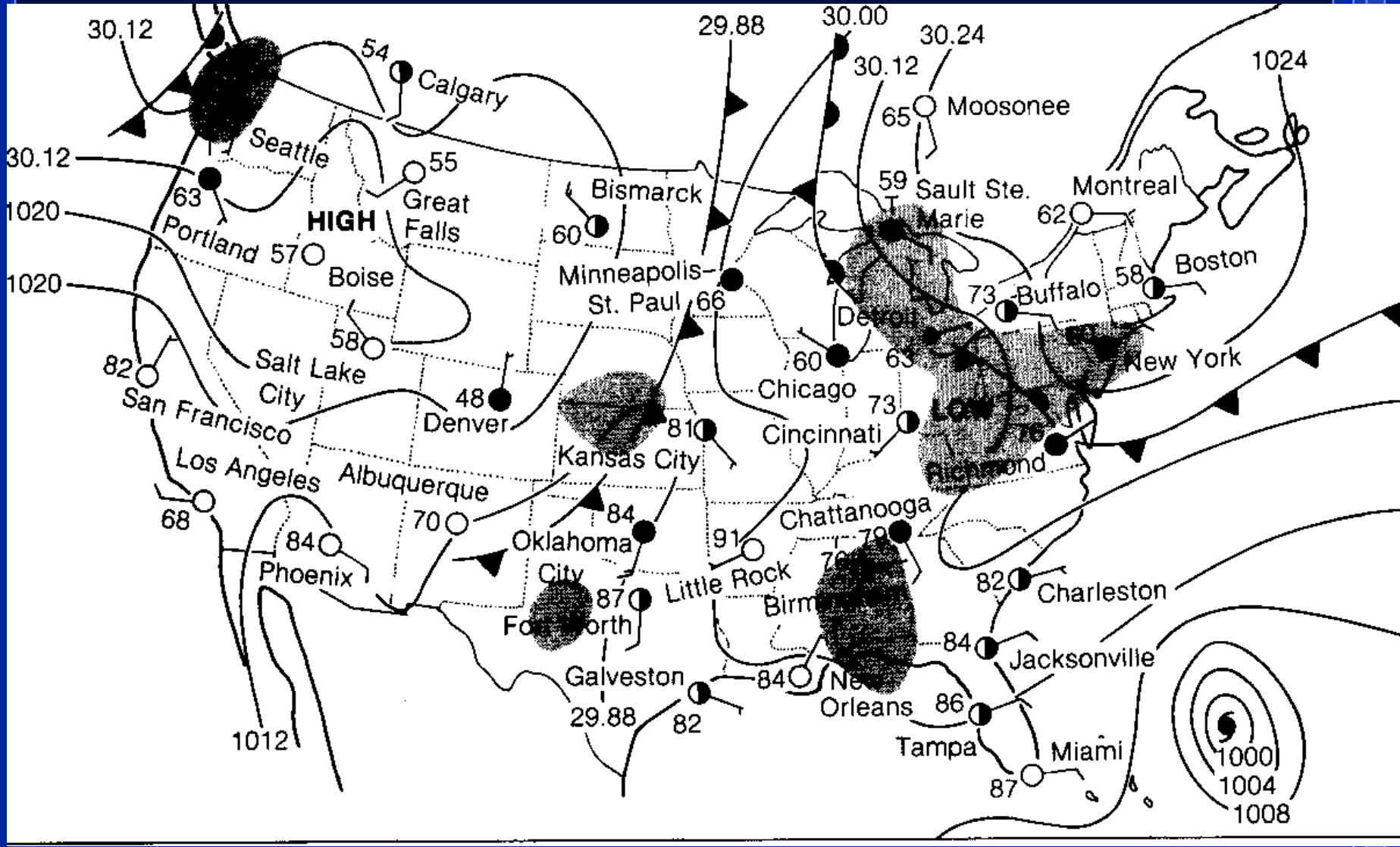
Cyclones

- An area of low pressure.
- Warm air is rising
- Wind spins around counter clockwise in the Southern Hemisphere
- Cause stormy rainy weather

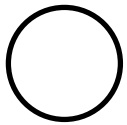
Anticyclones

- High pressure area
- cold air sinks and spirals outward
- Move in a clockwise direction in the Northern Hemisphere
- Usually bring clear dry weather

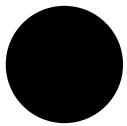
Reading Maps



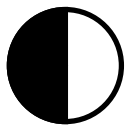
Reading Maps



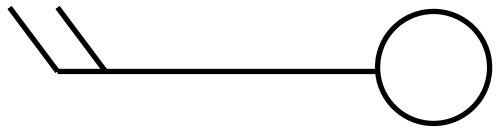
Clear



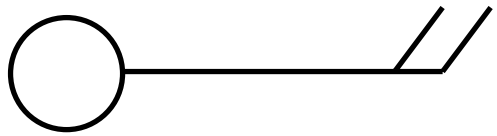
Cloudy



Partly Cloudy



West Wind



East Wind

Hurricanes

- A powerful cyclone
- Forms over tropical oceans
- Late summer or early fall
- Warm moist air rises
- Starts to spin, then spins faster
- Forms a cylinder of strong winds around the center, which is calm
- Called the eye

Hurricanes

- Wind speeds reach 120 to 320 km/hr
- Lose energy when they hit land, but heavy rains and large waves cause damage
- This year expect 21 named storms
- 1 or 2 major

Tornadoes

- Whirling funnel shaped cloud
- Develops inn cumulonimbus clouds
- In the center of the funnel there is low pressure, which acts like a vacuum cleaner
- Tornadoes over water are called water spouts
- Winds can reach speeds of 350 km/hr

Predicting Weather

- Allows people to plan their days
- Warns people of severe weather
- Meteorologists interpret weather information from a variety of sources
  - observers
  - balloons
  - satellites
  - weather stations around the world

Predicting Weather

- Draw a weather map
- use the symbols we have studied
- Add curved lines called isotherms which connect areas with the same temperature
- Other curved lines called isobars connect areas with the same pressure

Controlling the Weather

- Could save money and lives
- Only success has come from “seeding” clouds
- Sprinkling dry ice to condense moisture
- or silver iodide to cool clouds enough to form crystals
- Used to remove fog around airports
- Or tried to increase the snow pack in the Sierras