



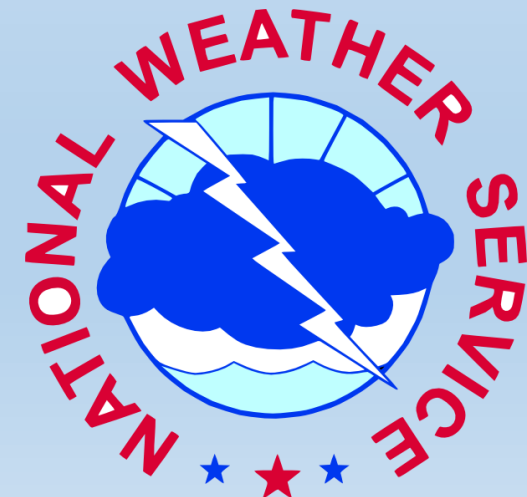
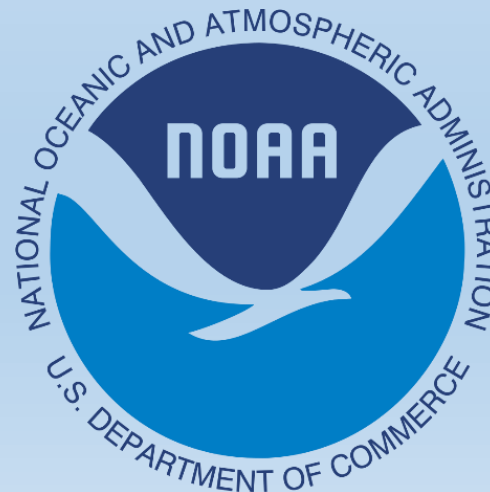
# Introduction to Meteorological Monitoring

February 8 & 10 2022

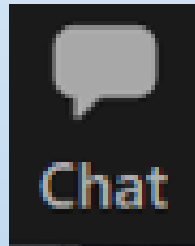
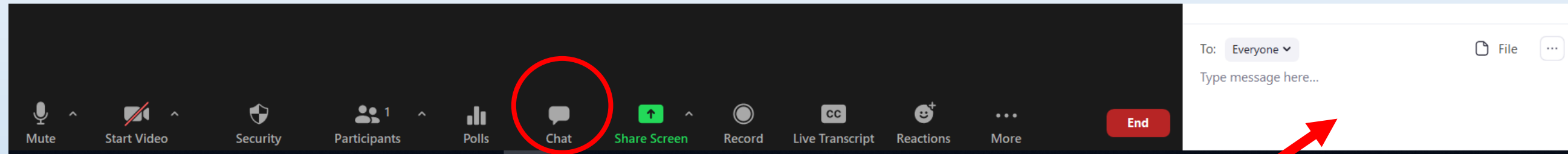
**Tribal Air Monitoring**



**Support Center**



# Webinar Logistics



Click on the “Chat” icon to submit questions in the “Chat” pane

Click raise “Hand” icon if you would like to be unmuted

This webinar is being recorded – URL for the recording will be shared in post webinar email



Presented by the Institute for Tribal Environmental Professionals  
American Indian Air Quality Training Program  
Questions? Contact [Christal.Black@nau.edu](mailto:Christal.Black@nau.edu)



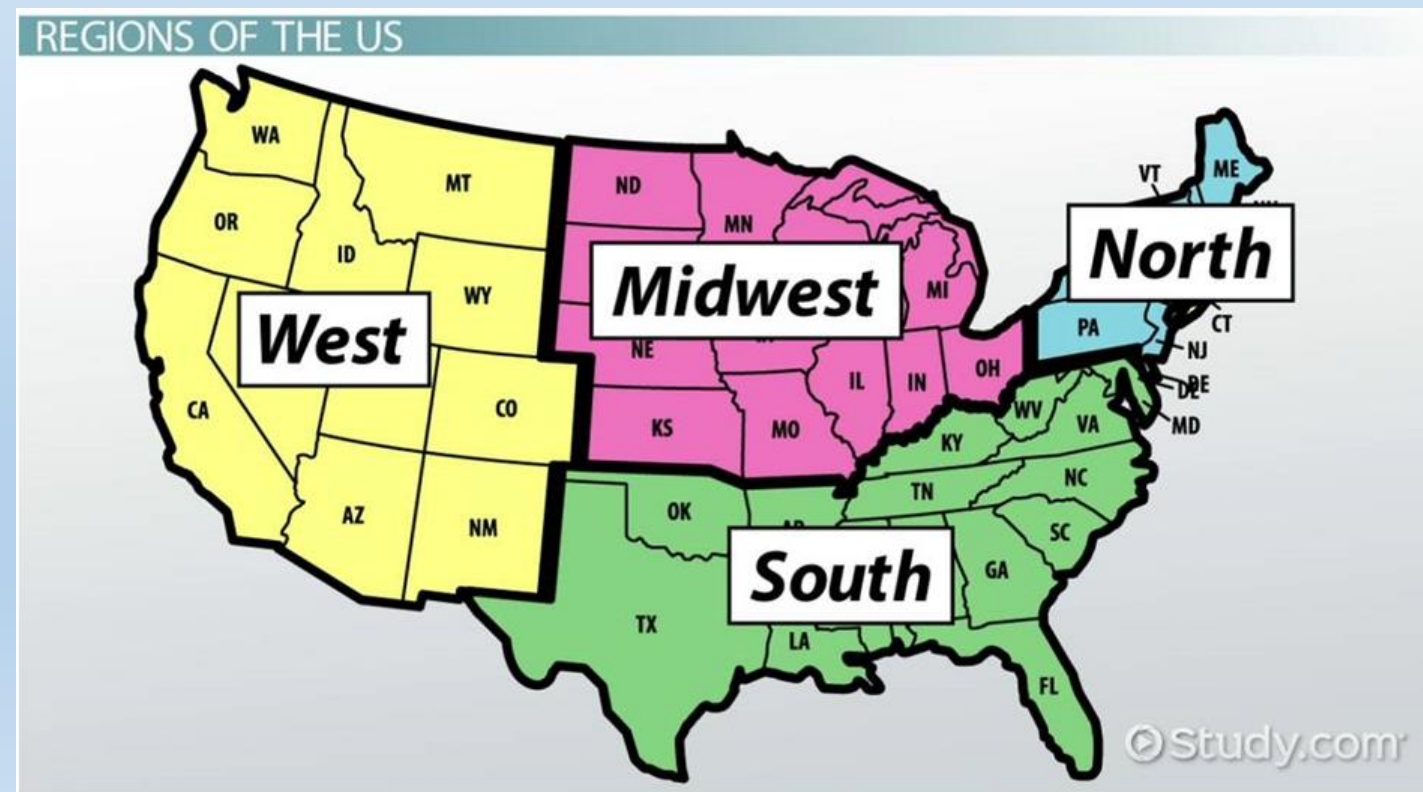
# Polling Question



# Poll Question 1

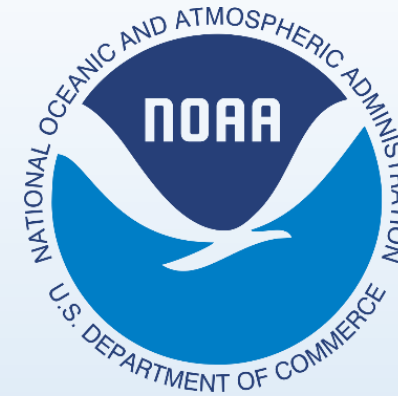


- Climate and weather changes in different areas. What part of the U.S. do you reside?
  - Alaska
  - West
  - Midwest
  - North
  - South





# Presenters



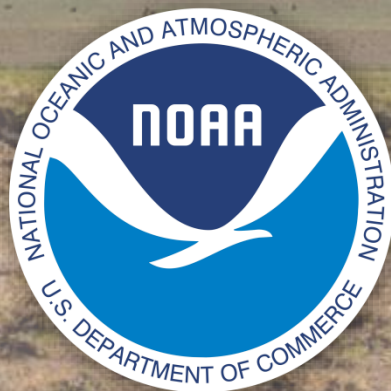
**Michael King**  
NAU ITEP TAMS Center  
[michael.king@nau.edu](mailto:michael.king@nau.edu)



**Daniel Berc**  
National Weather Service, NOAA  
[daniel.berc@noaa.gov](mailto:daniel.berc@noaa.gov)



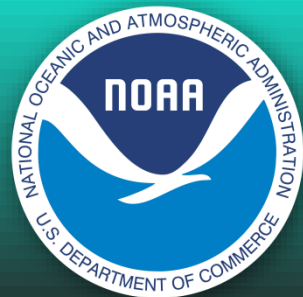
# Introduction to Meteorology



**Dan Berc**

**WARNING COORDINATION METEOROLOGIST  
NATIONAL WEATHER SERVICE - LAS VEGAS, NV**





- WELCOME
- WEATHER
- THUNDERSTORMS
- HAZARDS
- RESOURCES

# WHO WE ARE







# Why do we need the NWS?

- Since 2010...
- More than 500 Americans die each year in weather and flood events
- More than 5,000 are injured
- Weather damages cost Americans more than \$87 Billion each year



WELCOME

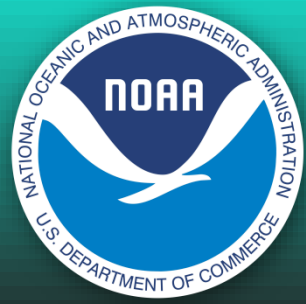
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HAZARDS

RESOURCES





# Climate vs. Weather

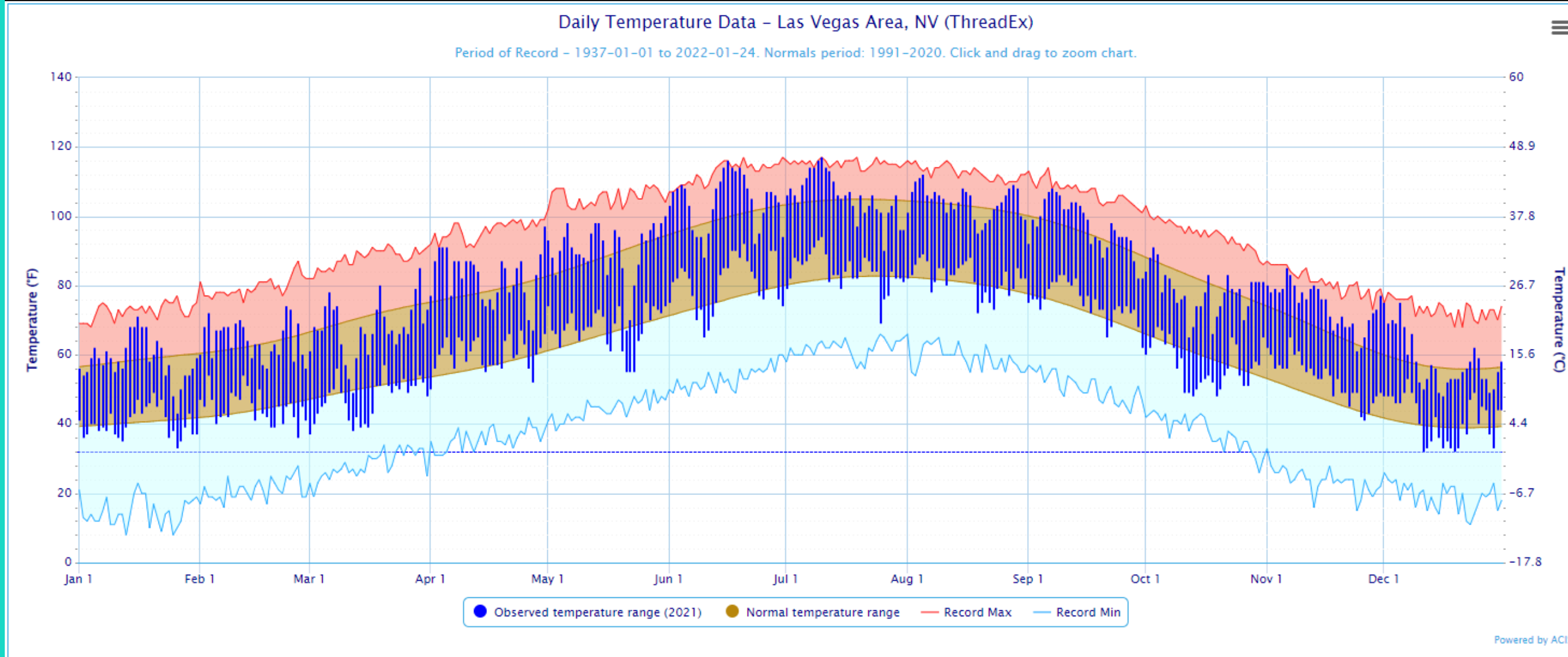
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12 daily record highs set or tied in 2021

Last daily record low in Las Vegas: June 4, 1999



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# METEOROLOGY





# The Atmosphere

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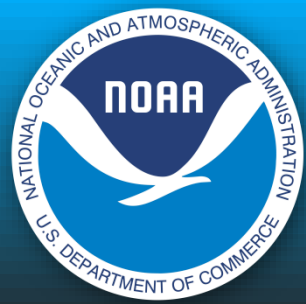
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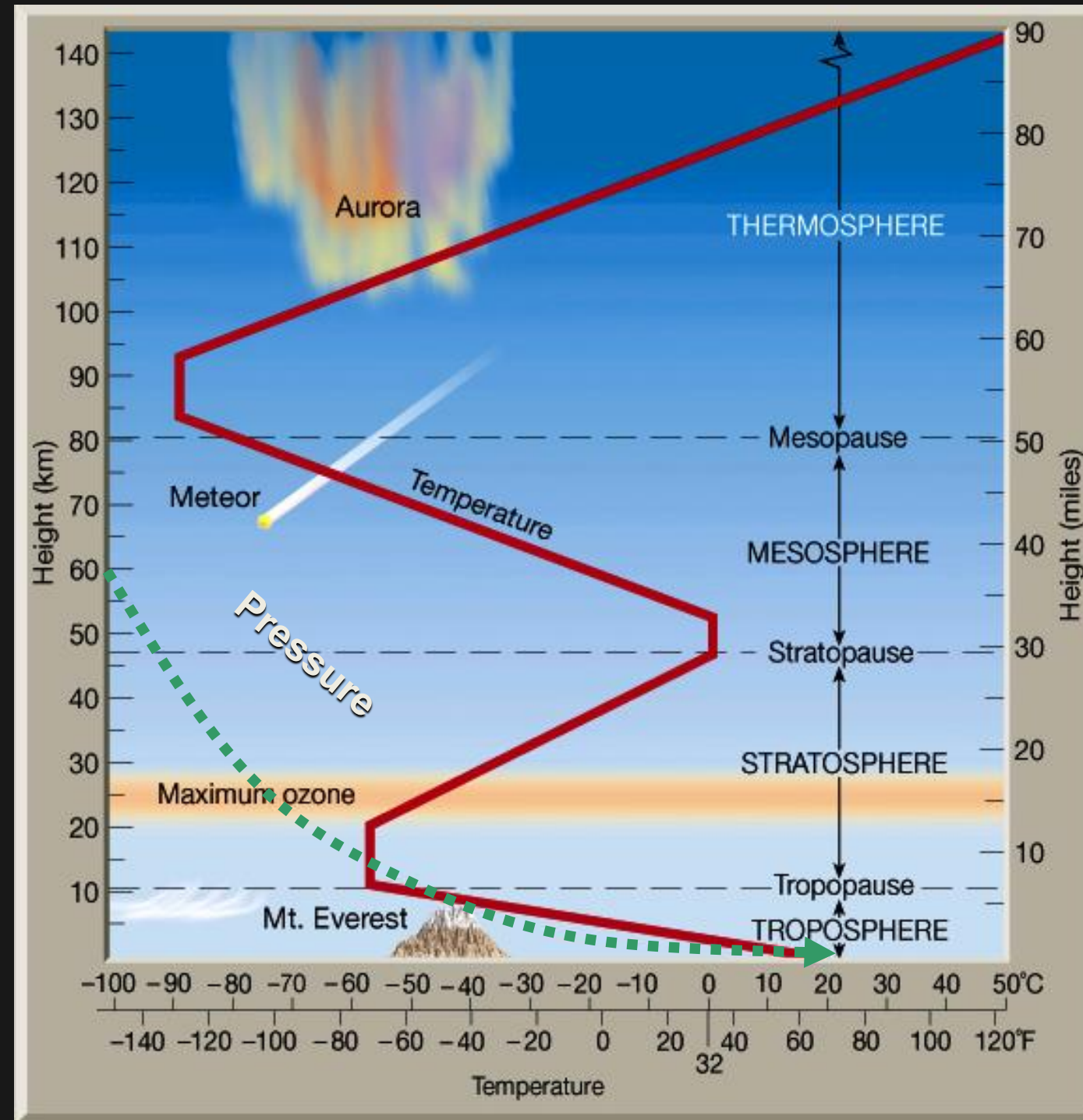
# Composition of the Atmosphere

Gas	Symbol	Content
Nitrogen	N <sub>2</sub>	78.084%
Oxygen	O <sub>2</sub>	20.947%
Argon	Ar	0.934%
Carbon Dioxide	CO <sub>2</sub>	0.033%
Neon	Ne	18.20 parts per million
Helium	He	5.20 parts per million
Krypton	Kr	1.10 parts per million
Sulfur dioxide	SO <sub>2</sub>	1.00 parts per million
Methane	CH <sub>4</sub>	2.00 parts per million
Hydrogen	H <sub>2</sub>	0.50 parts per million
Nitrous Oxide	N <sub>2</sub> O	0.50 parts per million
Xenon	Xe	0.09 parts per million
Ozone	O <sub>3</sub>	0.07 parts per million
Nitrogen dioxide	NO <sub>2</sub>	0.02 parts per million
Iodine	I <sub>2</sub>	0.01 parts per million
Carbon monoxide	CO	trace
Ammonia	NH <sub>3</sub>	trace

**+ Water vapor!**



# Profile of the Atmosphere



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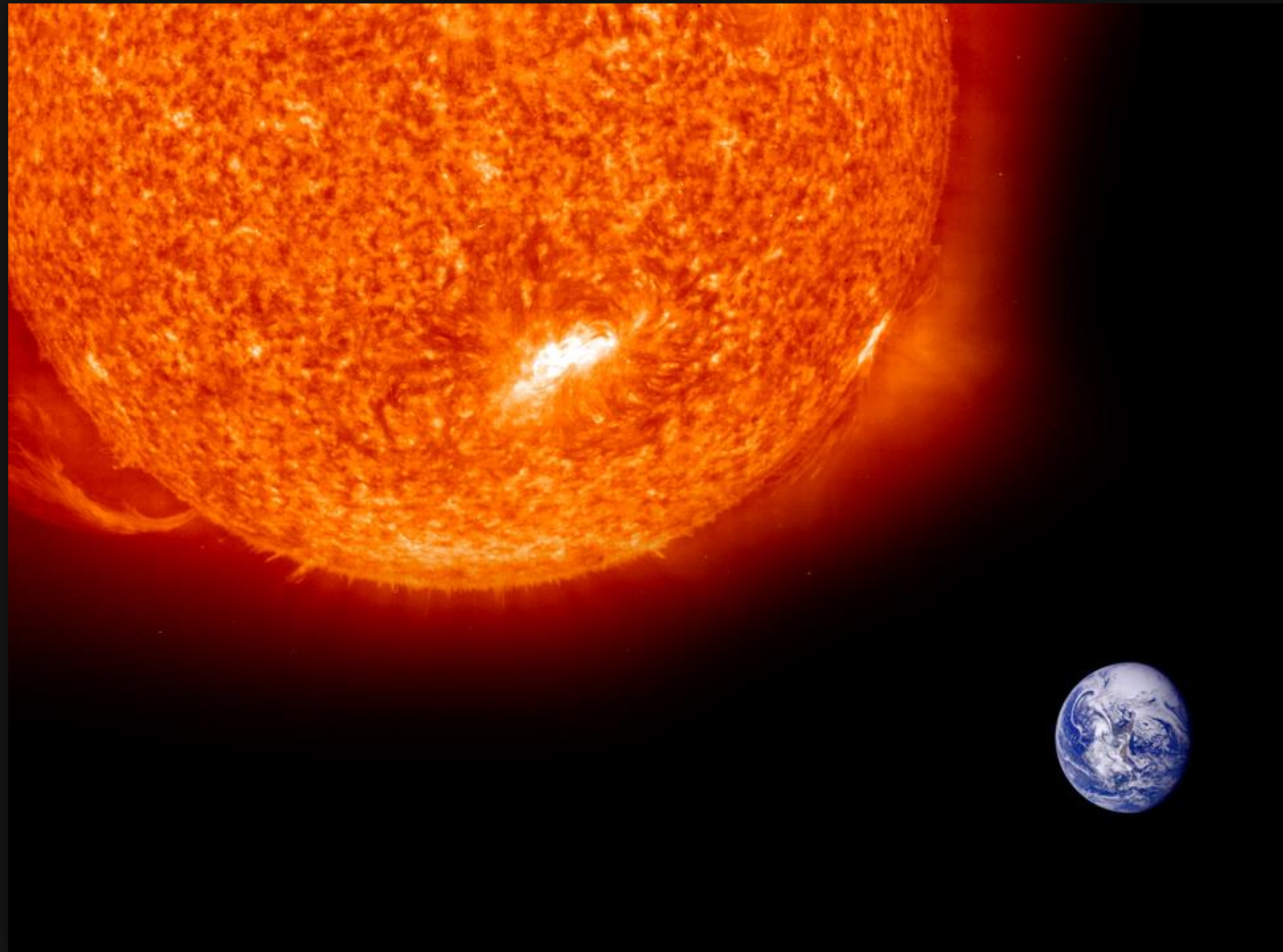
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# The Source of all Weather!



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# Heat Transfer

- Conduction: Transfer of heat from molecule to molecule within a substance (i.e. metal spoon)
- Convection: Transfer of heat by mass movement of a fluid (such as water and air) through currents (i.e. boiling water)
- Radiation: Transfer of heat by waves, by a source emitter and received by a cooler body

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# Heat Transfer

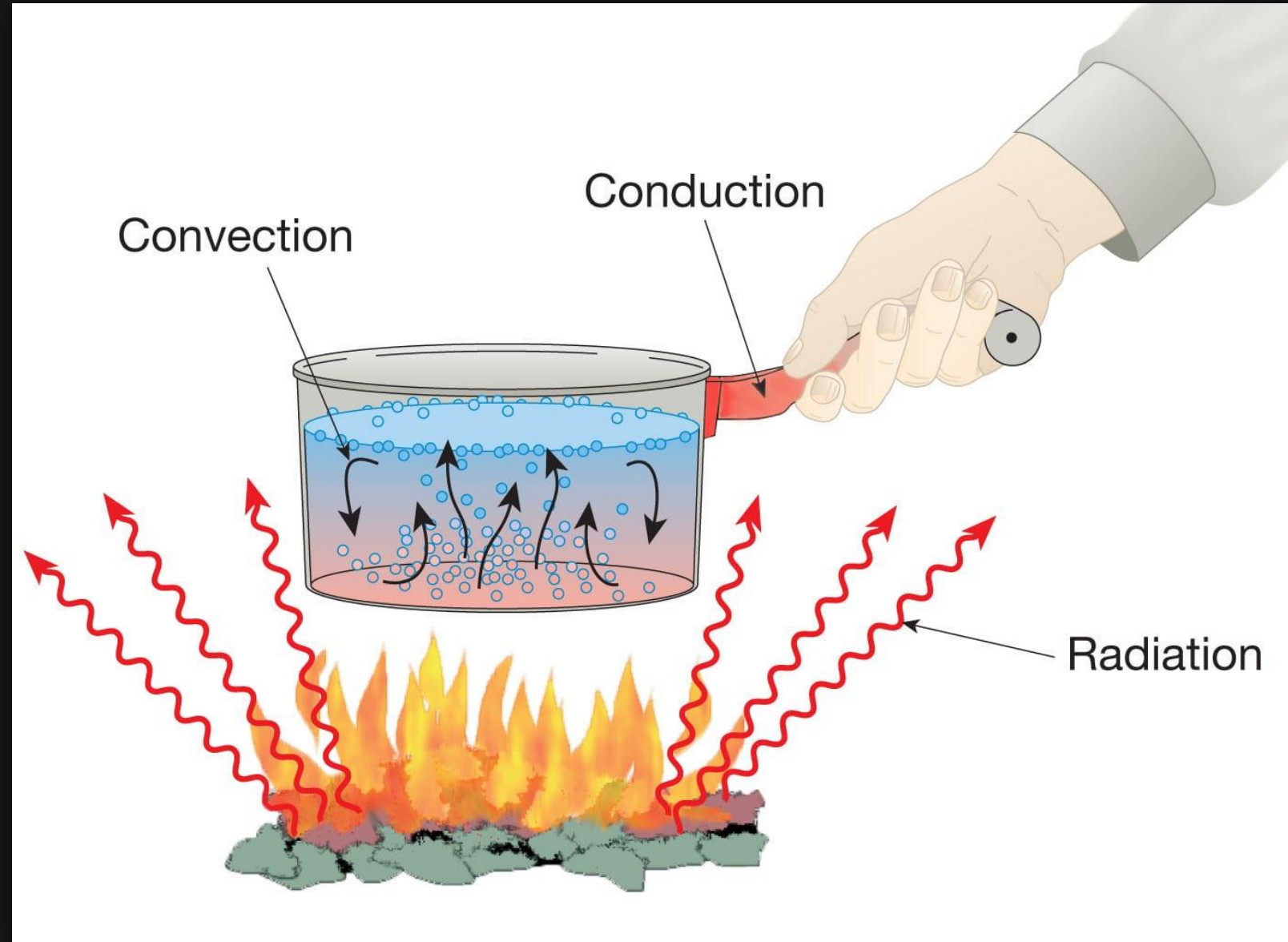
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# Outgoing vs. Incoming Radiation

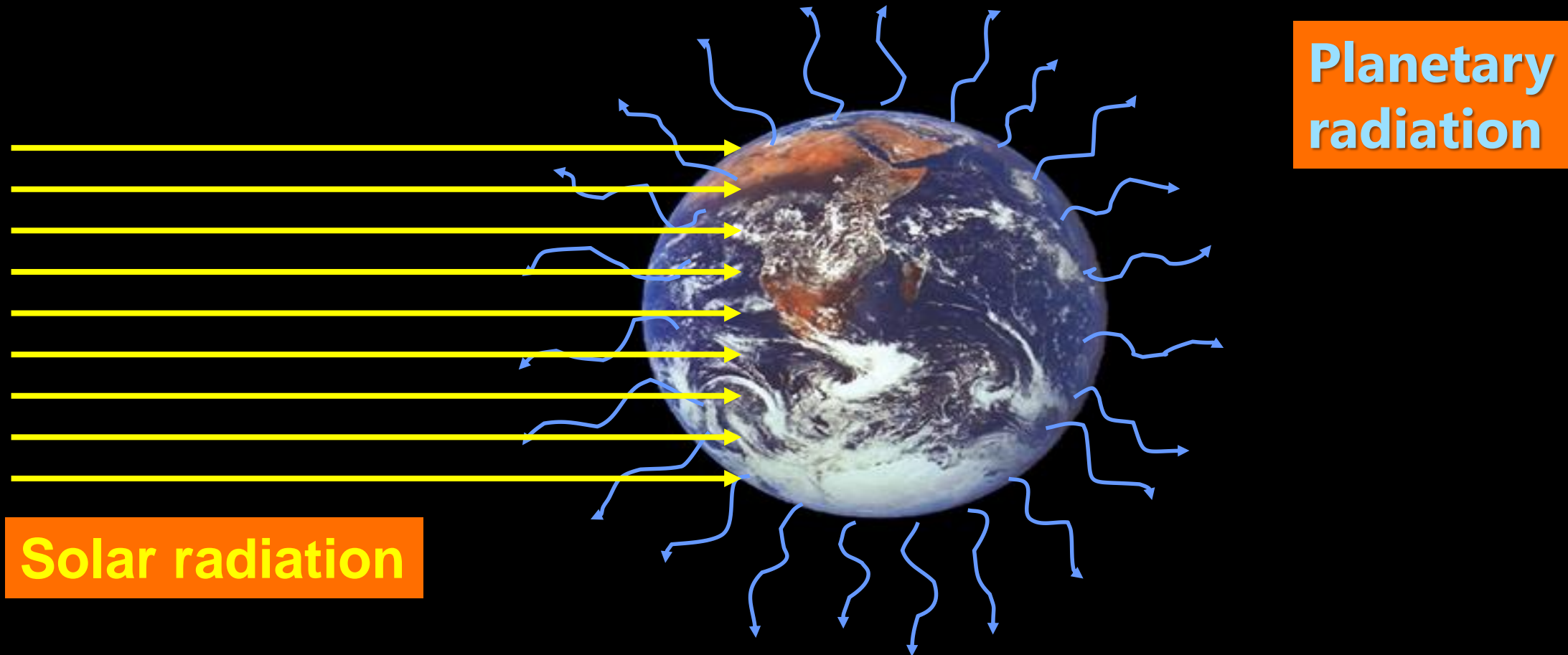
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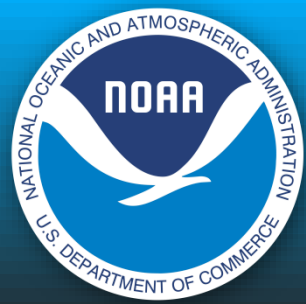
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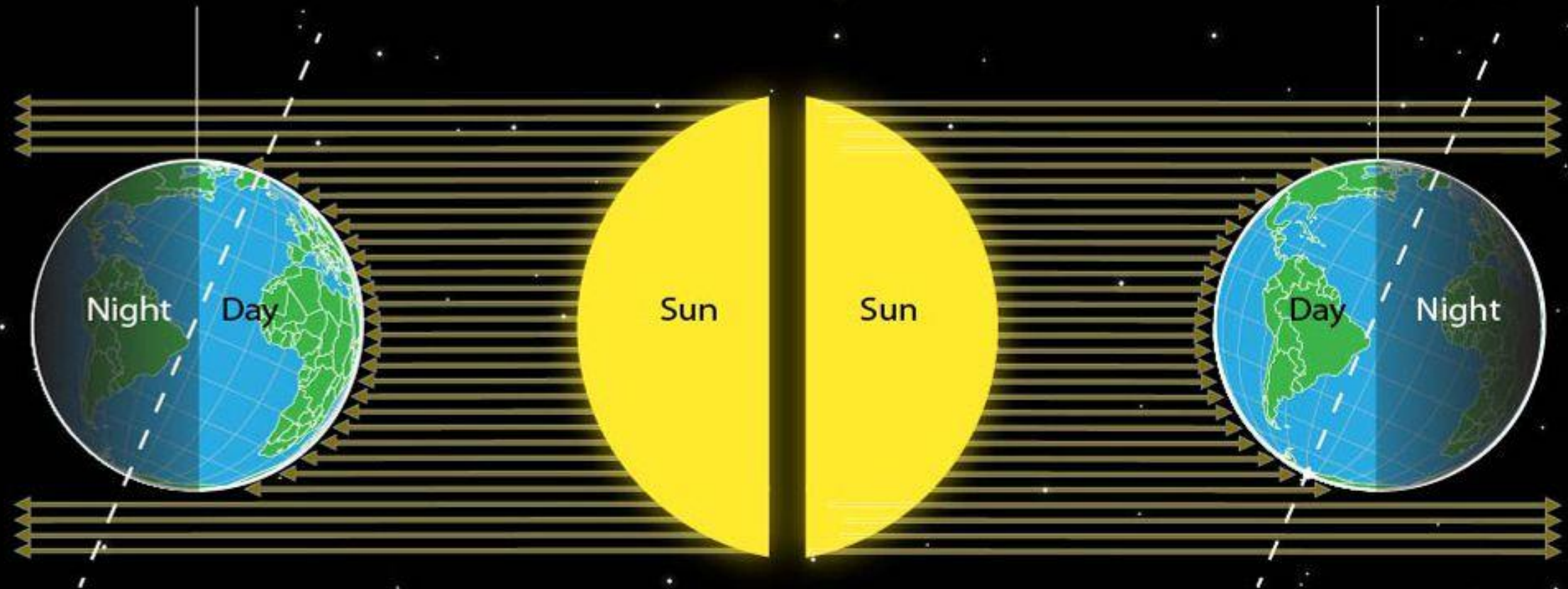
**Outgoing thermal radiation = Incoming solar radiation**



# Seasons

Summer in Northern Hemisphere  
Winter in Southern Hemisphere

Winter in Northern Hemisphere  
Summer in Southern Hemisphere



(not to scale)

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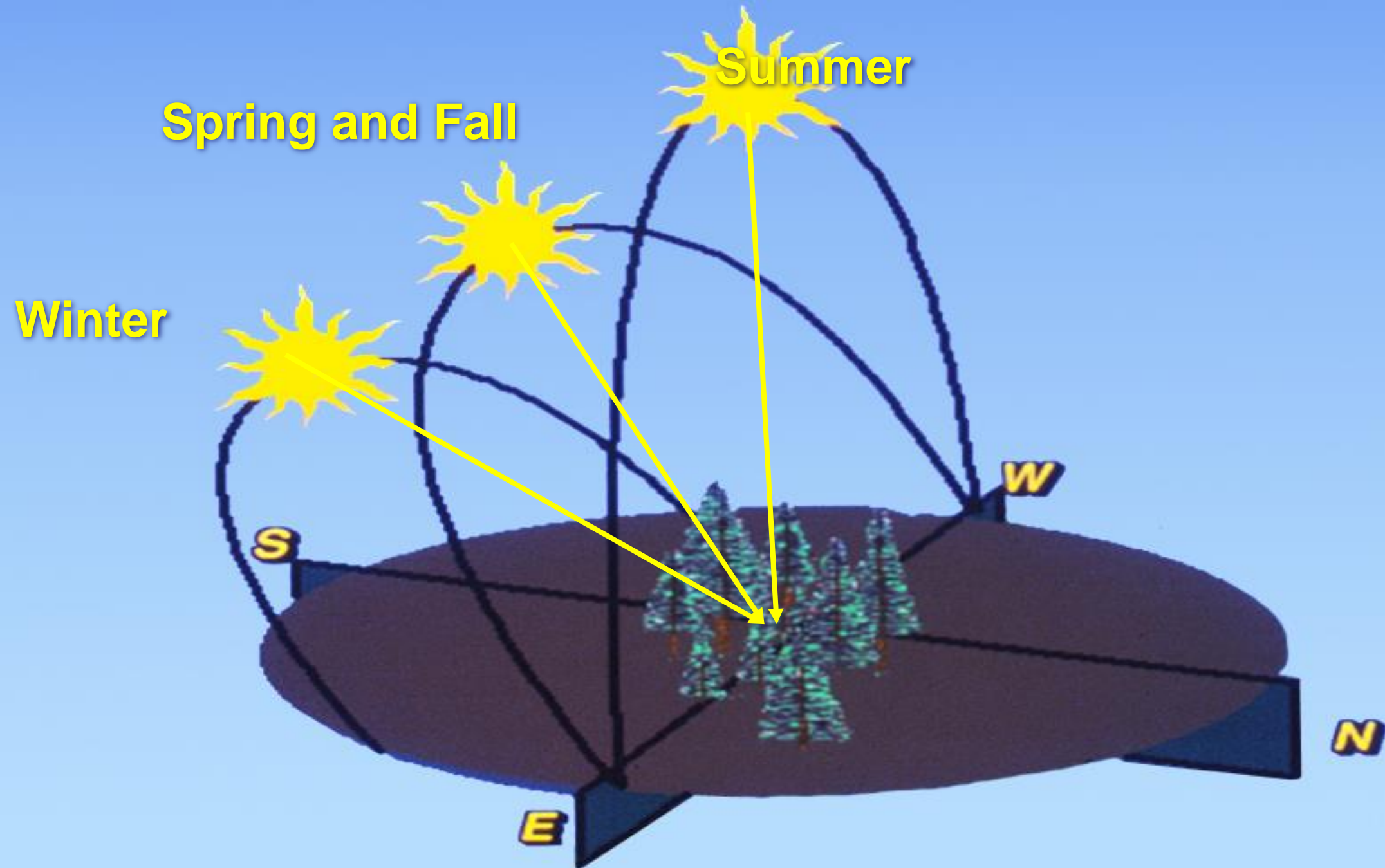
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# Solar Angles by Season



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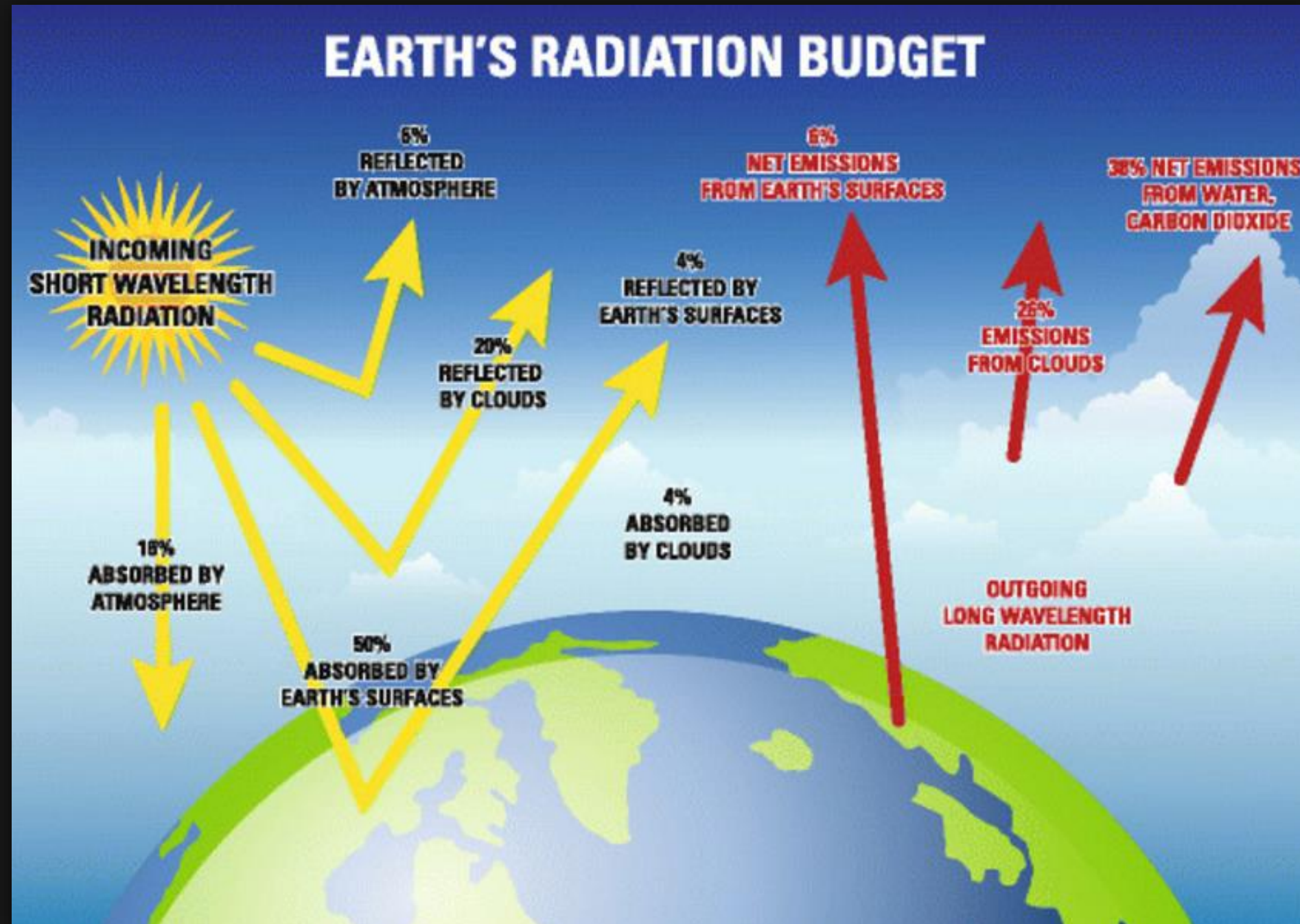
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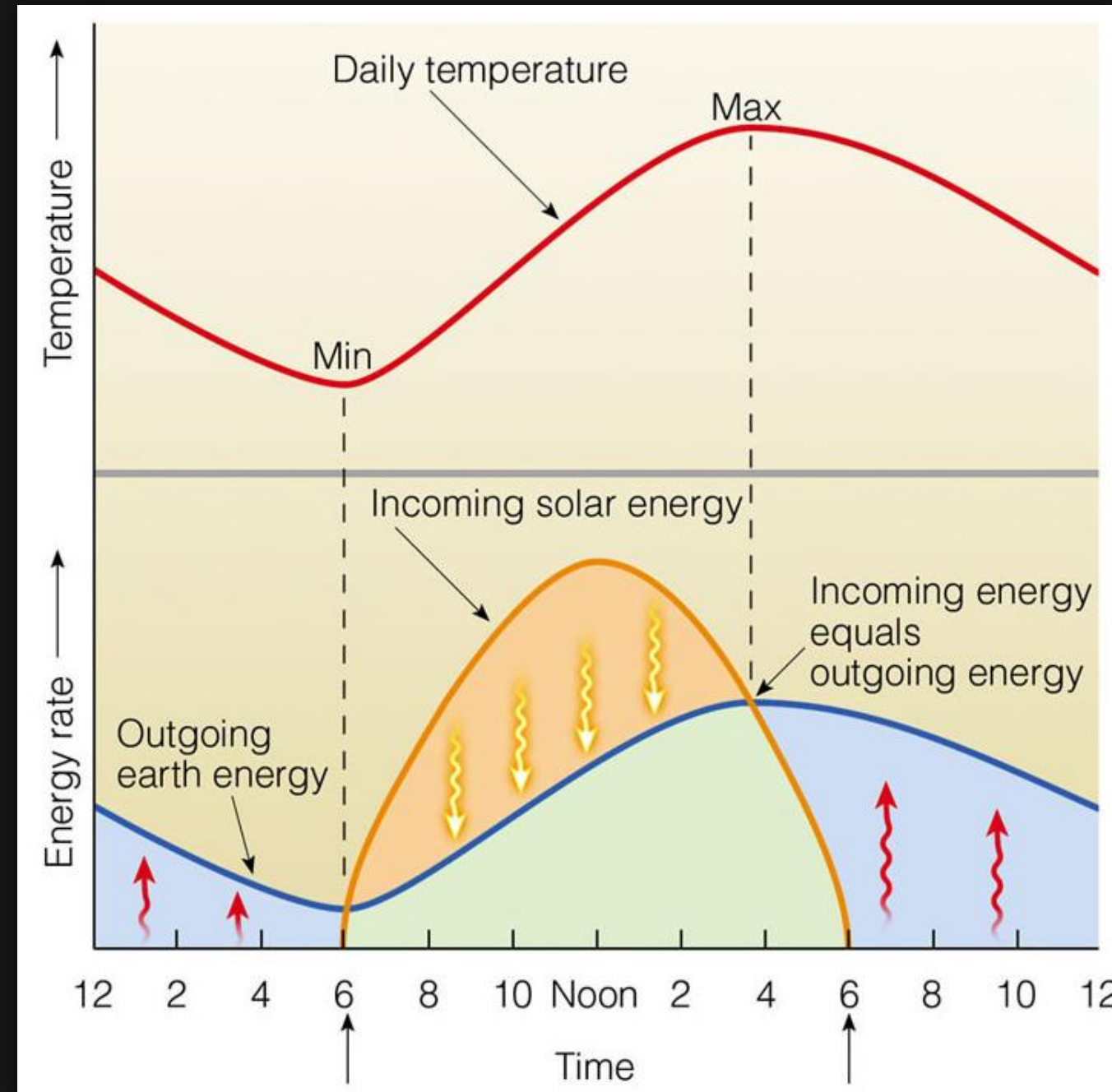
# The Solar Radiation Budget



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- RESOURCES



# The Solar Radiation Budget



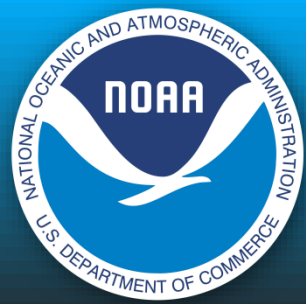
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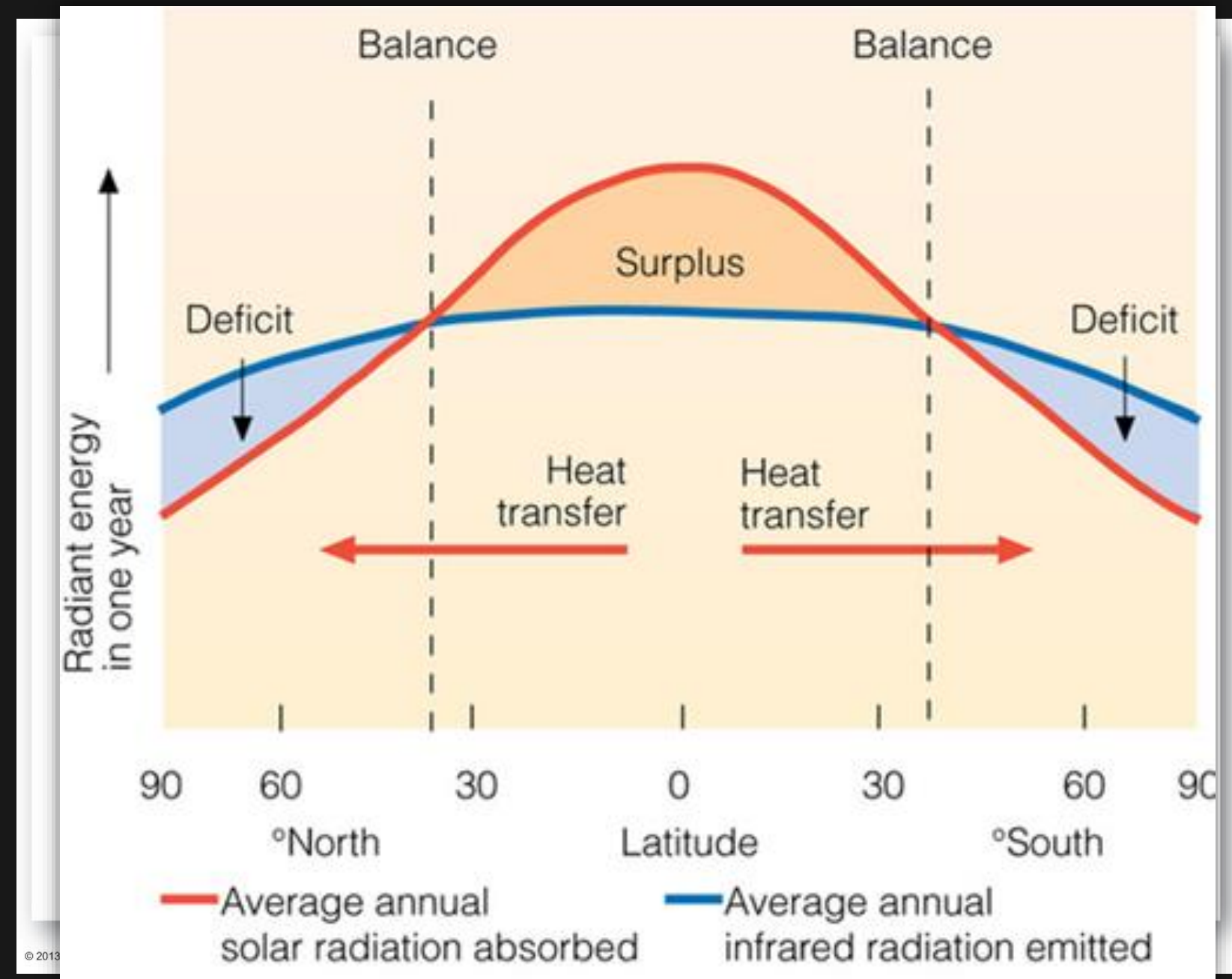
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# Outgoing vs. Incoming Radiation







# Differential Heating

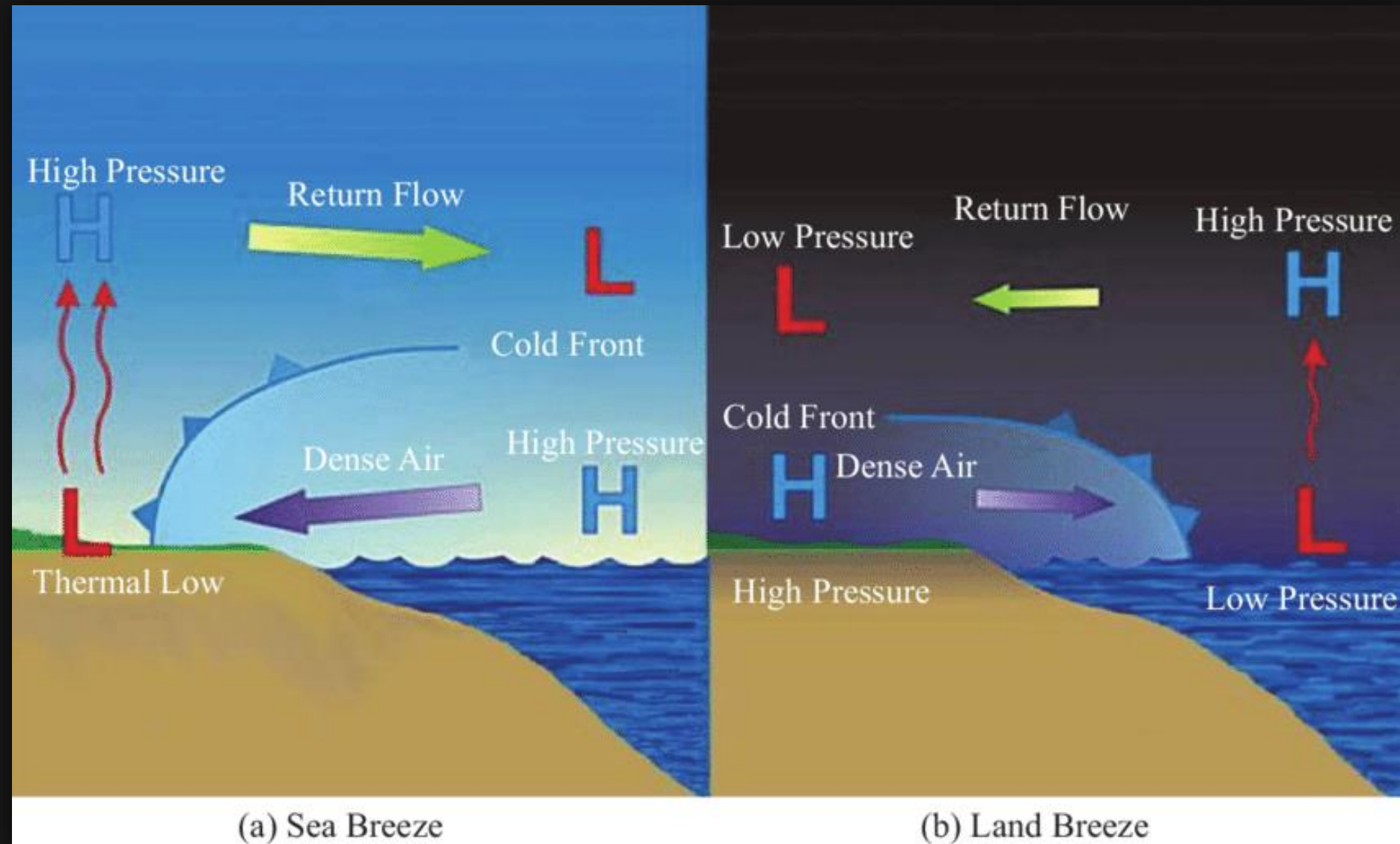
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# Global Air Circulation

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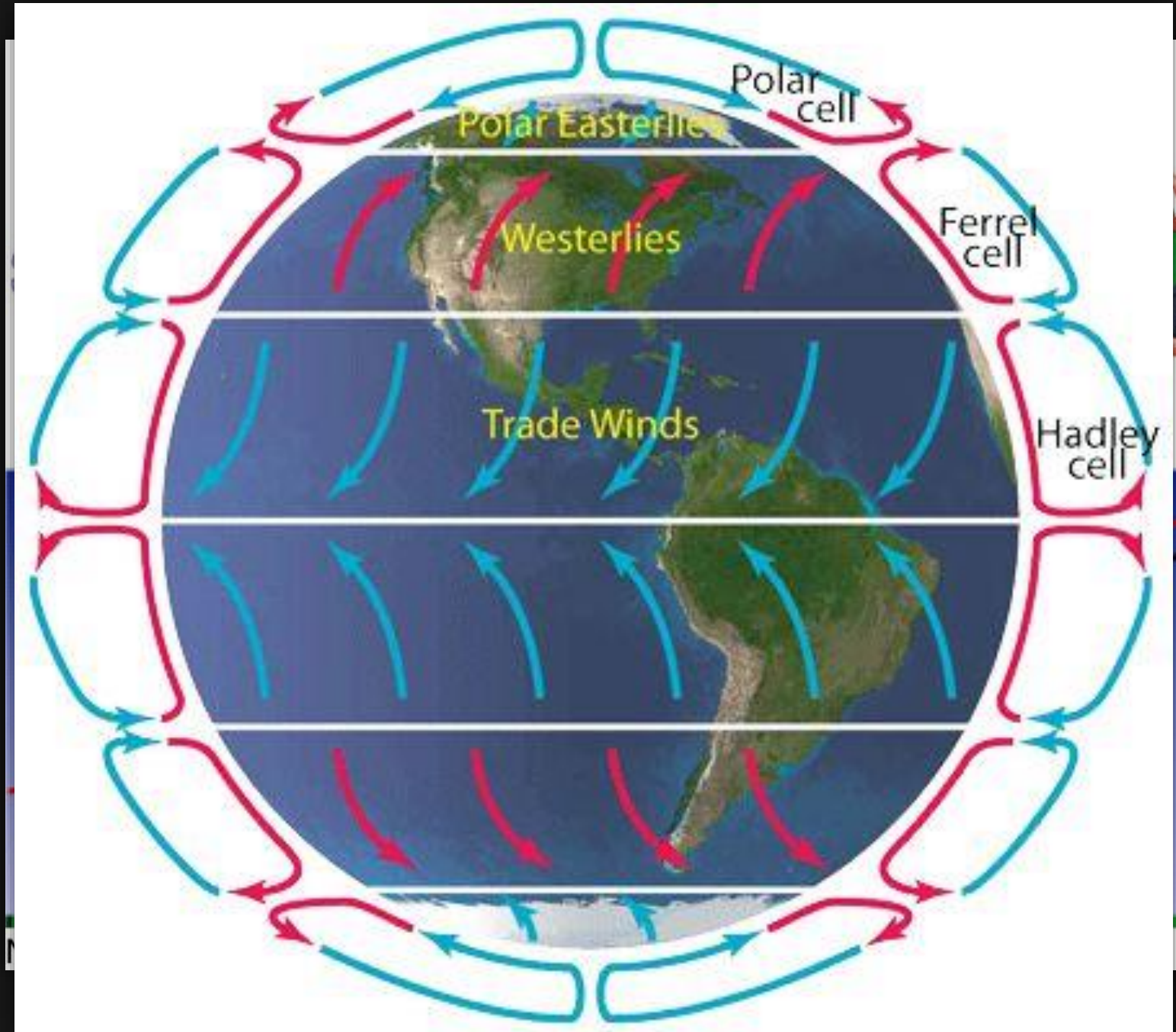
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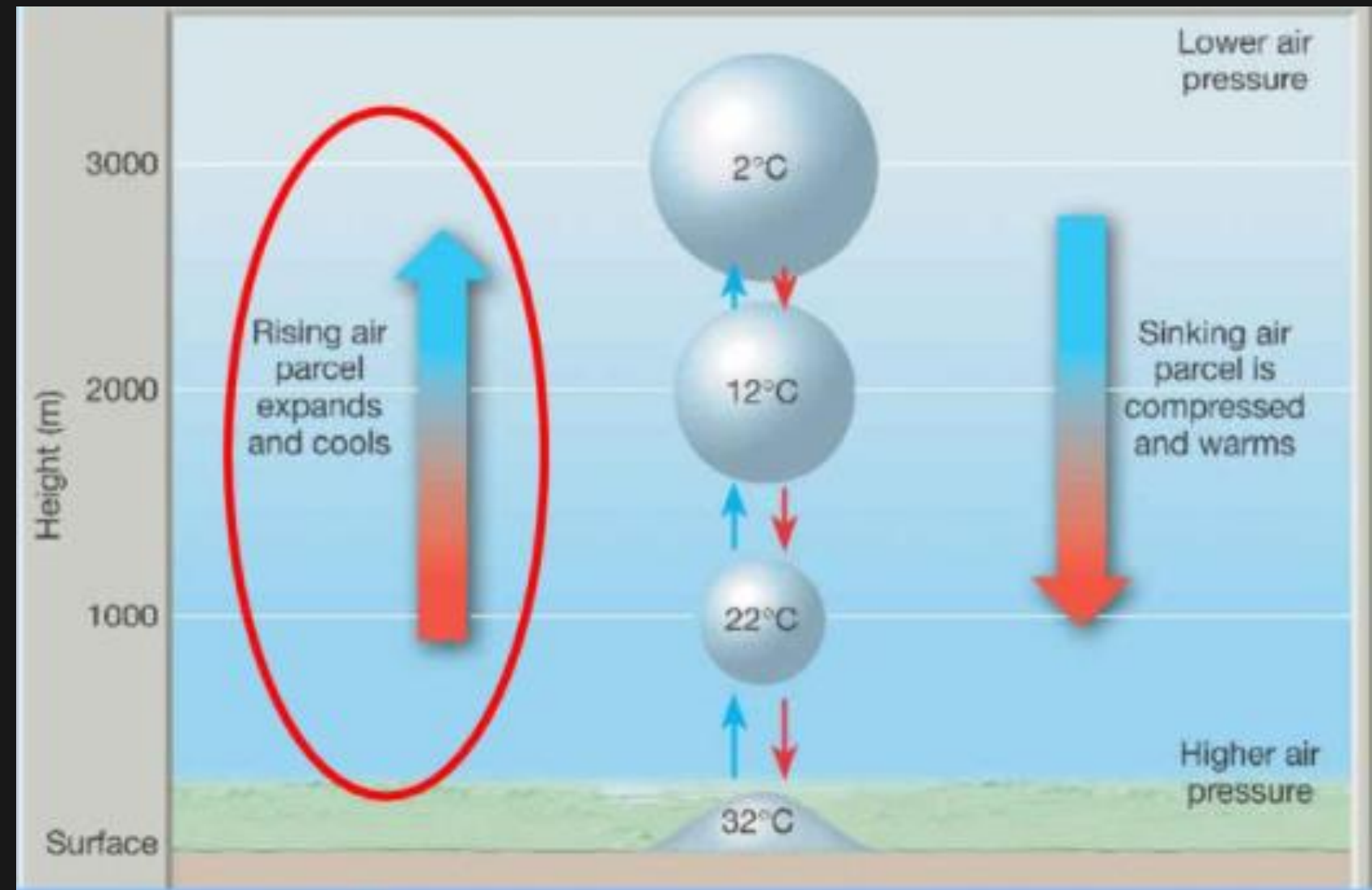
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1. **Hadley cell** - Low latitude air movement toward the equator that with heating, rises vertically, with poleward movement in the upper atmosphere. This forms a convection cell that dominates tropical and sub-tropical climates.
2. **Ferrel cell** - A mid-latitude mean atmospheric circulation cell for weather named by Ferrel in the 19th century. In this cell the air flows poleward and eastward near the surface and equatorward and westward at higher levels.
3. **Polar cell** - Air rises, diverges, and travels toward the poles. Once over the poles, the air sinks, forming the polar highs. At the surface air diverges outward from the polar highs. Surface winds in the polar cell are easterly (polar easterlies).





# Expansion/Cooling of Air



- As air rises, it cools and expands
- As air descends, it warms and compresses
- Cold air is denser than warm air

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# Moisture

**Dew Point:** Temperature to which air must be cooled to reach saturation point

**Wet Bulb:** Lowest temperature to which air can be cooled by evaporating water into it at constant pressure

**Relative Humidity:** Ratio of amount of moisture actually in air to amount of moisture air could hold at same temperature, if saturated. Expressed as percent





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# Dew Point

The temperature to which air must be cooled to reach saturation (i.e. 100% relative humidity)

- This is the best measure of how much moisture is in the atmosphere.





# Relative Humidity

Ratio of the amount of moisture currently in the air to the amount the air could hold at the same temperature if completely saturated

- Tends to be highest at night and early morning
- Tends to be lowest in the afternoon
- This is due more to the change in temperature from night to afternoon than to any significant change in moisture in the atmosphere

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# Sources of Moisture

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# Relative Humidity

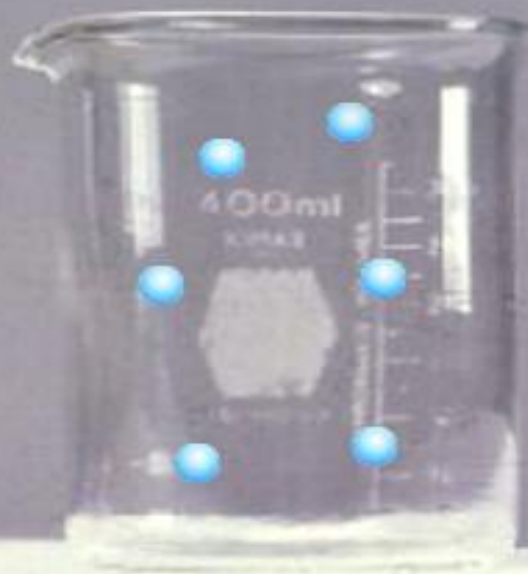
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**warm**



**warmer**



**even warmer**

**The warmer the air, the more water vapor it can hold**





# Temperature vs. RH



40° F

100%



60° F

48%



80° F

24%

**Relative humidity decreases as temperature increases, even though the actual amount of water vapor in the containers doesn't change. Thus, the term "relative."**

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# Air Pressure

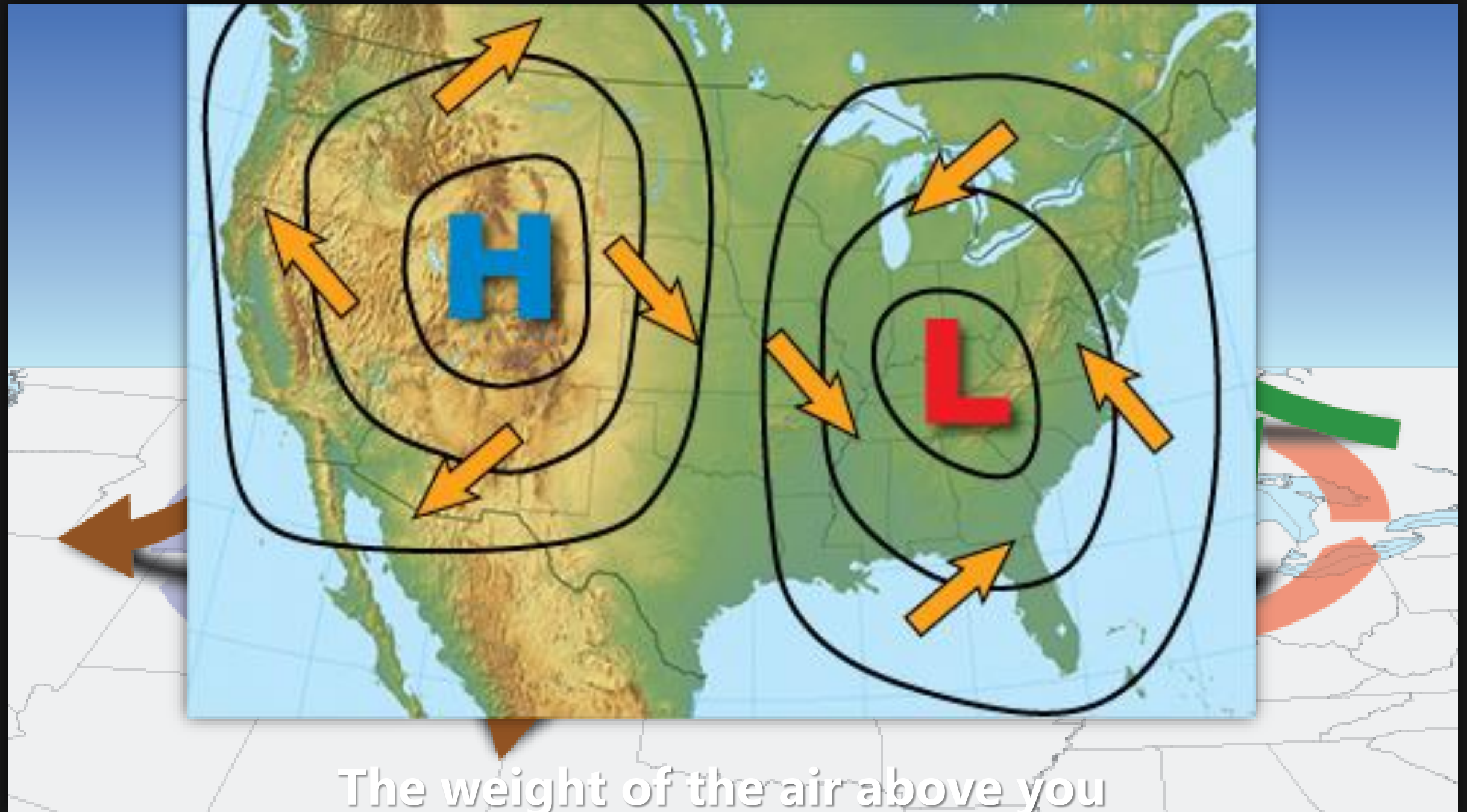
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The weight of the air above you





# Atmospheric Stability



**STABILITY**

**Stability is the atmosphere's resistance to vertical motion**

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# Atmospheric Stability

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**STABILITY**



**WIND**

**Stability = vertical motion**

**Wind = horizontal motion**





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# Inversions

Inversion: Layer in atmosphere where temperature increases with height. Essentially: Warm air over cold air.

This is opposite of the normal situation where temperatures decrease with height





# Inversions

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In fires burning under inversions, smoke undergoes limited rise, then flattens out as it reaches inversion

Inversions are areas of very stable air



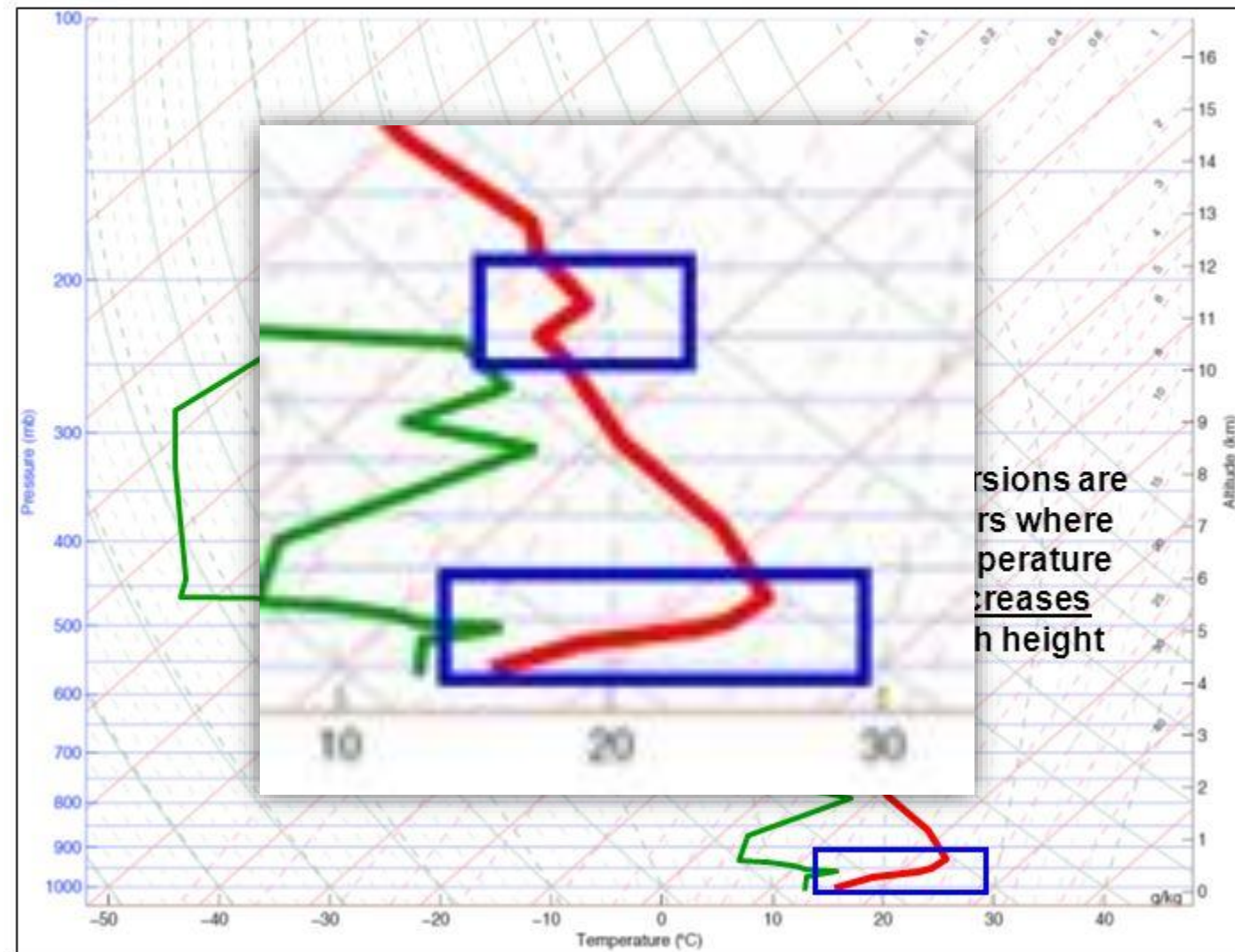




# Inversions

## Skew-T Applications

Identify Temperature Inversions





# Inversion Types

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- Radiational or nighttime – form because the ground cools off faster at night than the air above it.
- Frontal – form as a cold front undercuts warmer air.
- Marine – form due to cooler marine air moving onshore, displacing warmer air above it.
- Subsidence – form as air underneath high pressure systems aloft sinks and warms.





# Valley Inversions

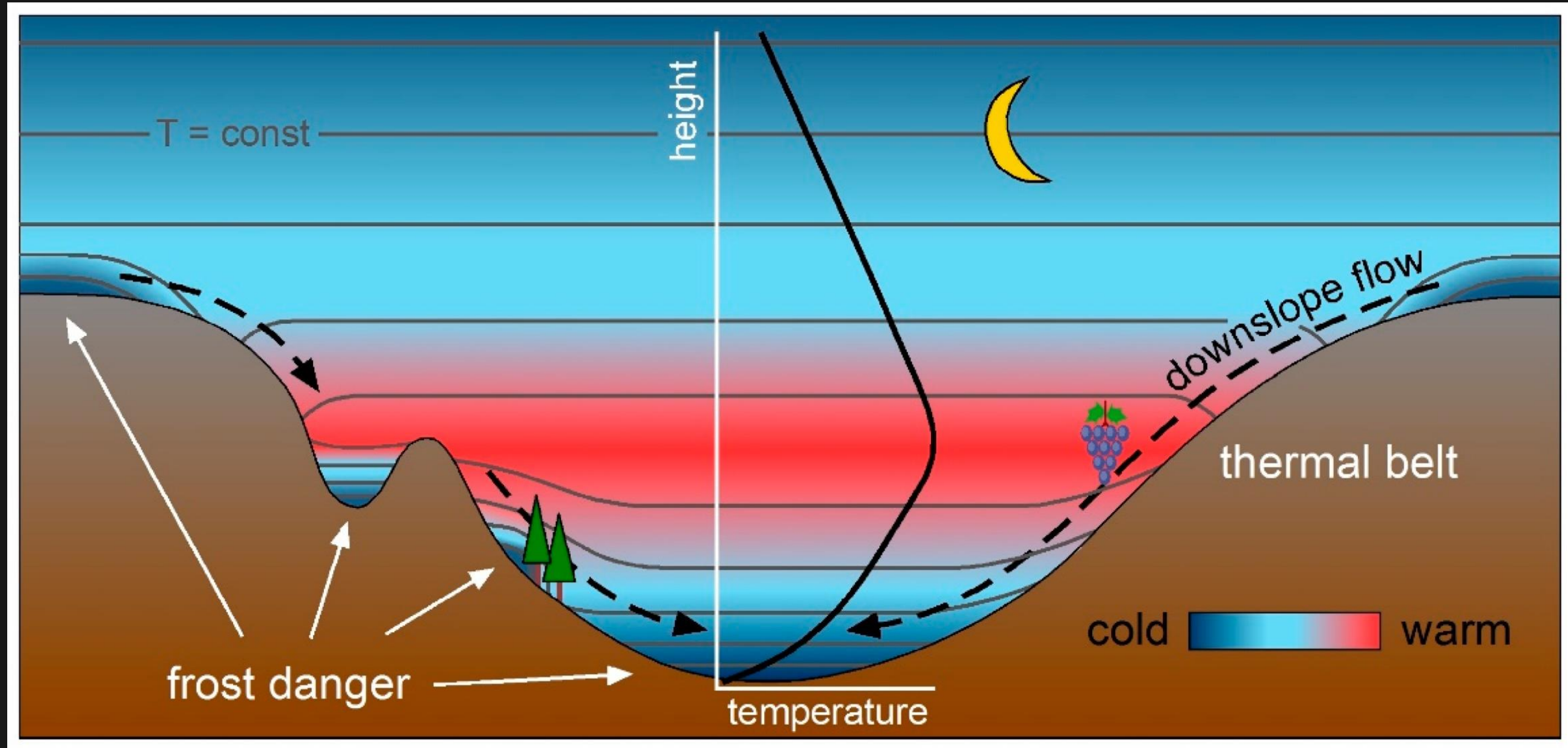
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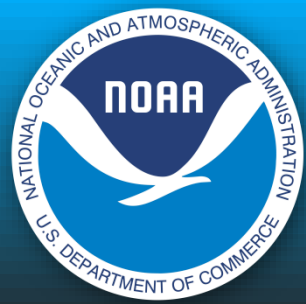
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# Wind

## Horizontal movement of air

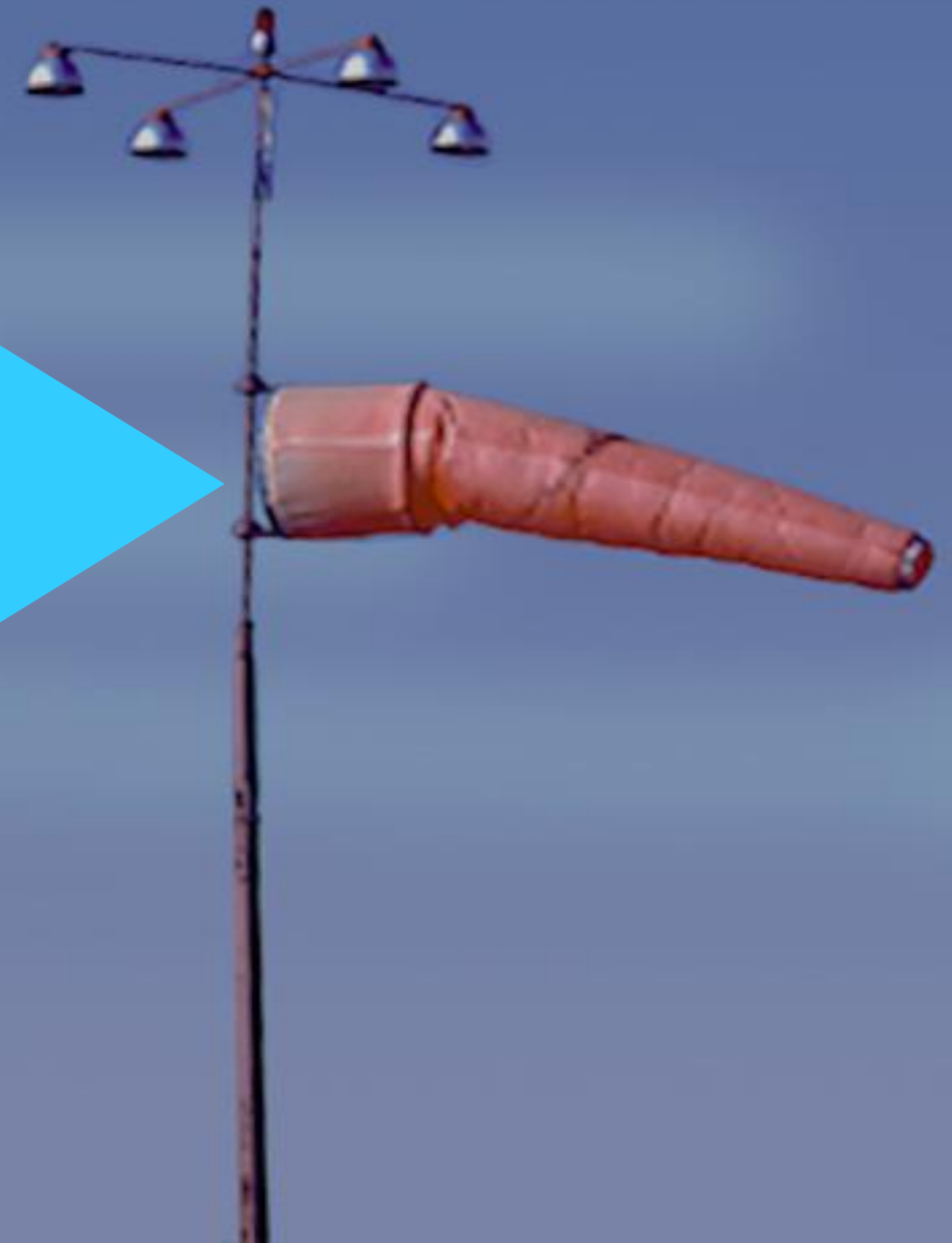
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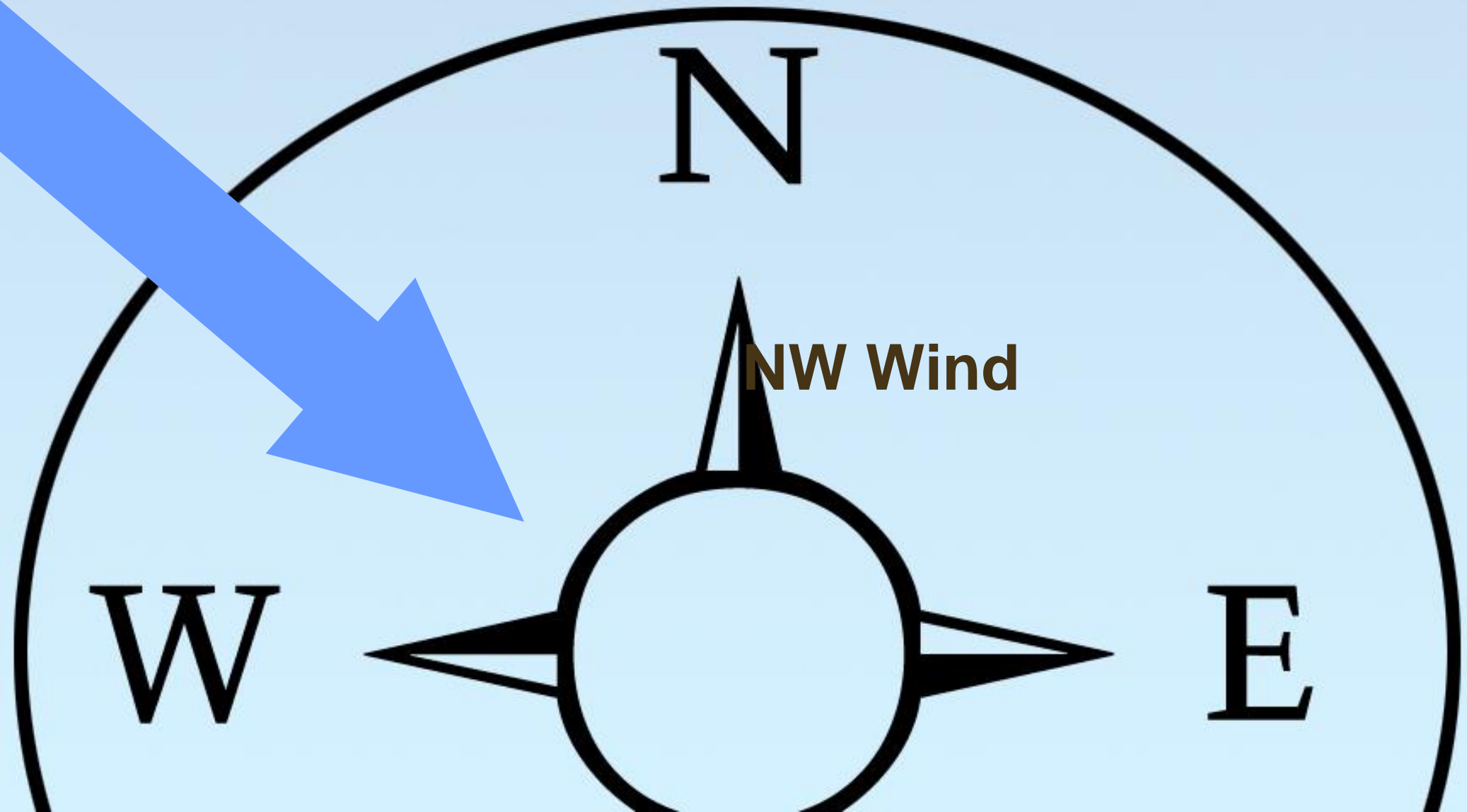






# Wind

**The direction from which the wind blows!**



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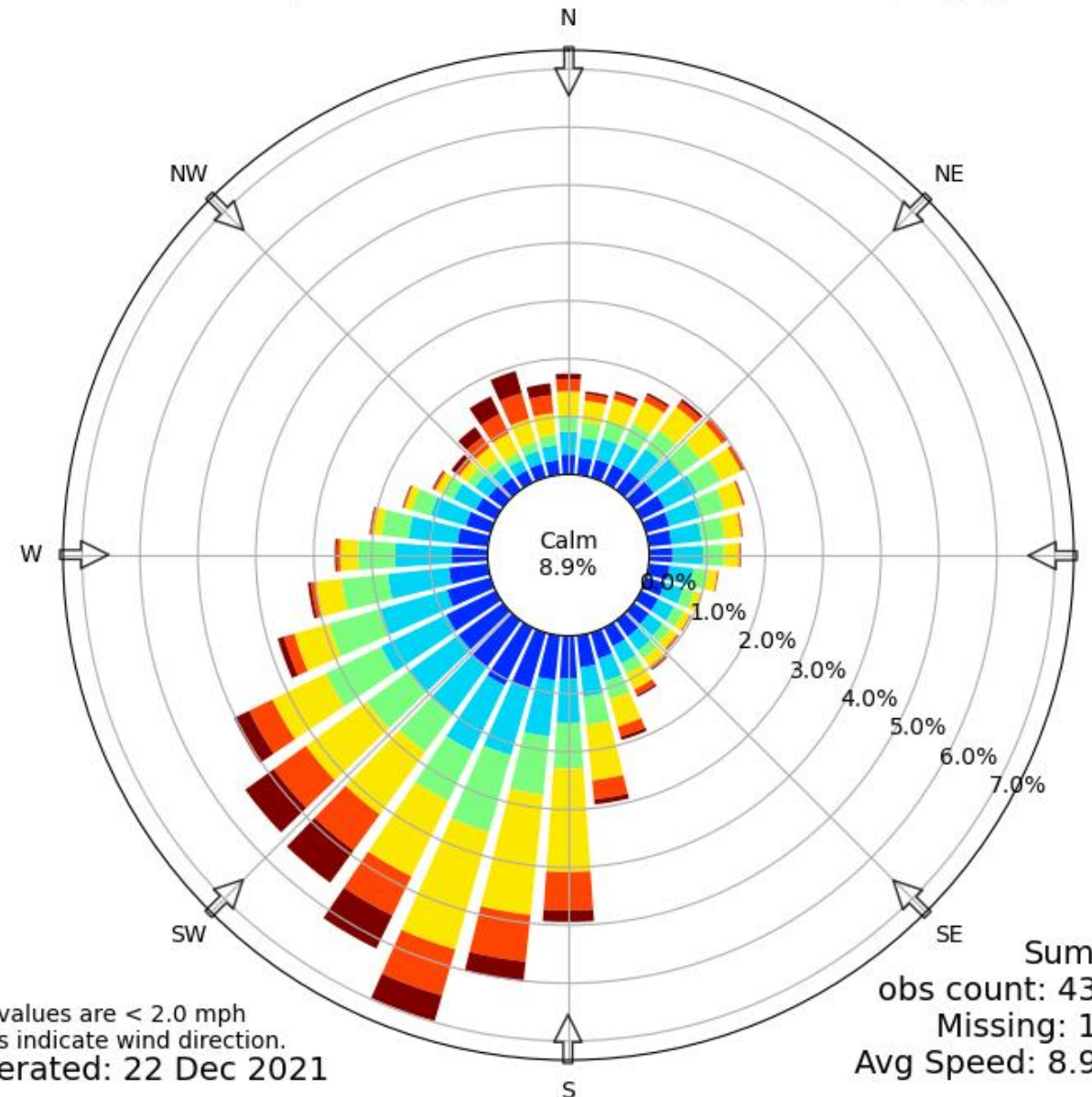
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# Wind Rose

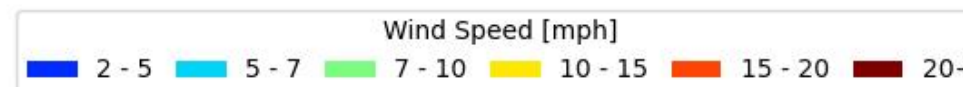


[LAS] LAS VEGAS/MCCARRAN  
Windrose Plot  
Time Bounds: 01 Jan 1970 01:00 AM - 21 Dec 2021 11:56 PM America/Los\_Angeles



Calm values are < 2.0 mph  
Arrows indicate wind direction.  
Generated: 22 Dec 2021

Summary  
obs count: 434292  
Missing: 13187  
Avg Speed: 8.9 mph







# Wind Rose

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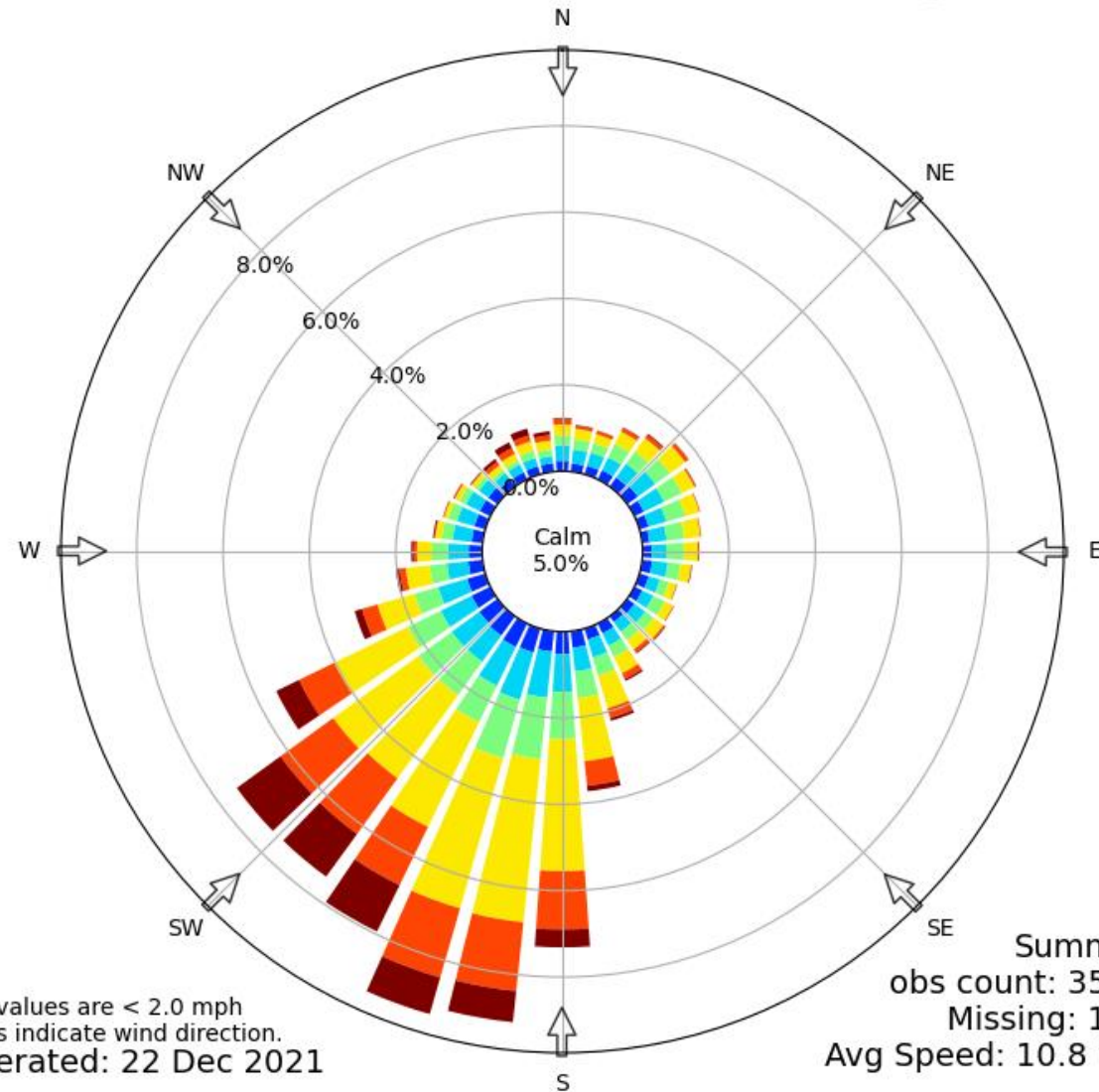
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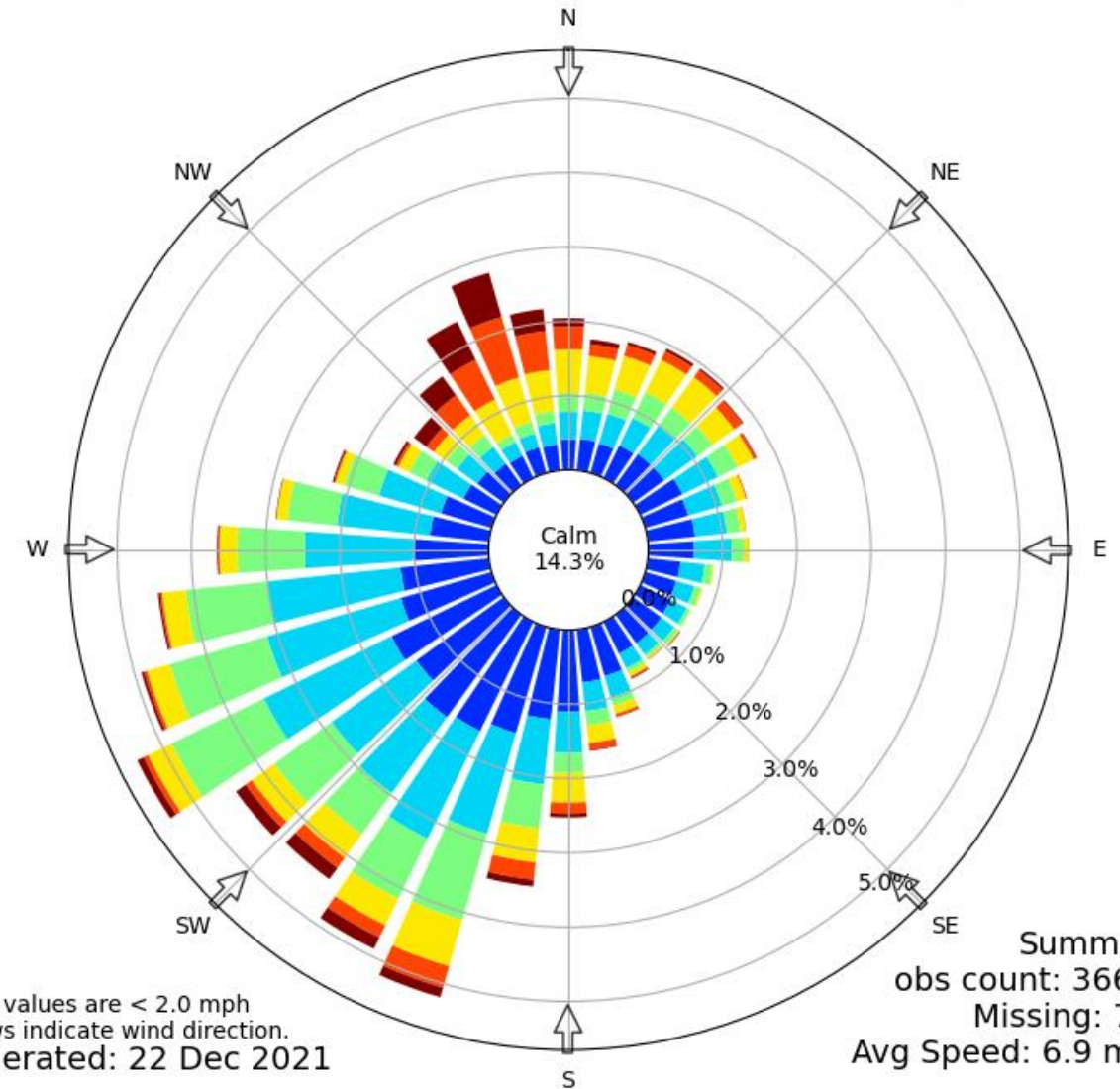
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[LAS] LAS VEGAS/MCCARRAN  
Windrose Plot [Time Domain: Jun,]  
Time Bounds: 01 Jun 1970 02:00 AM - 30 Jun 2021 11:56 PM America/Los\_Angeles



[LAS] LAS VEGAS/MCCARRAN  
Windrose Plot [Time Domain: Dec,]  
Time Bounds: 01 Dec 1970 01:00 AM - 21 Dec 2021 11:56 PM America/Los\_Angeles





# Gradient Wind

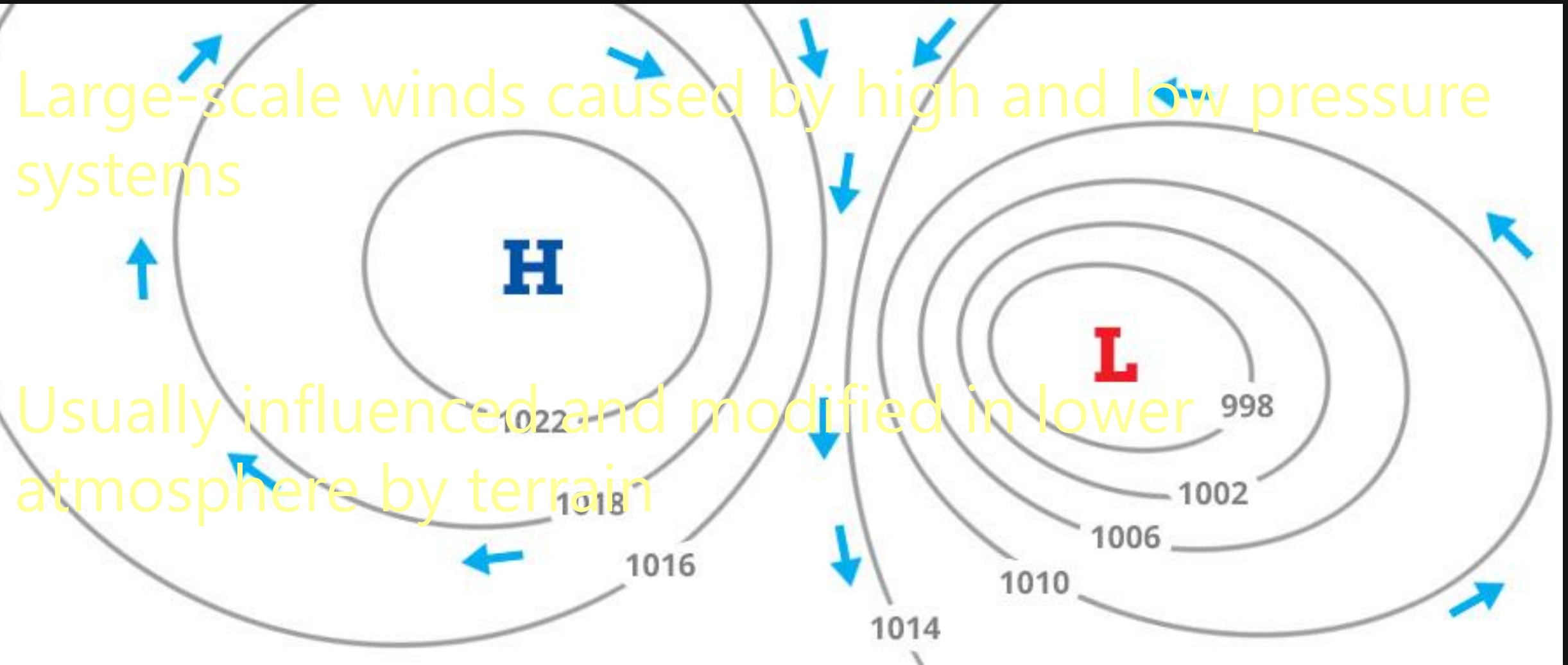
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# Large-Scale Pressure Systems and Fronts

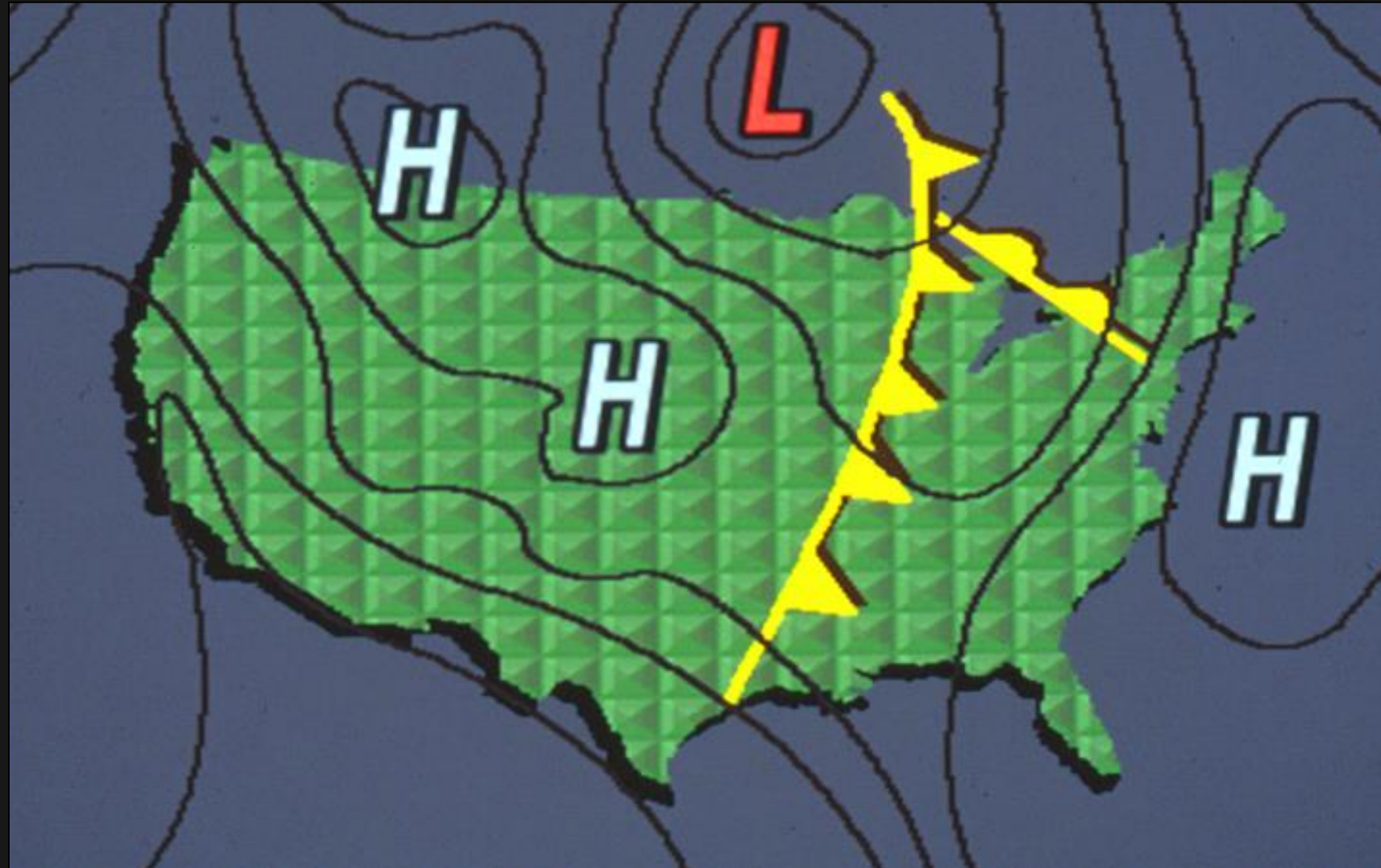
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# Air Masses

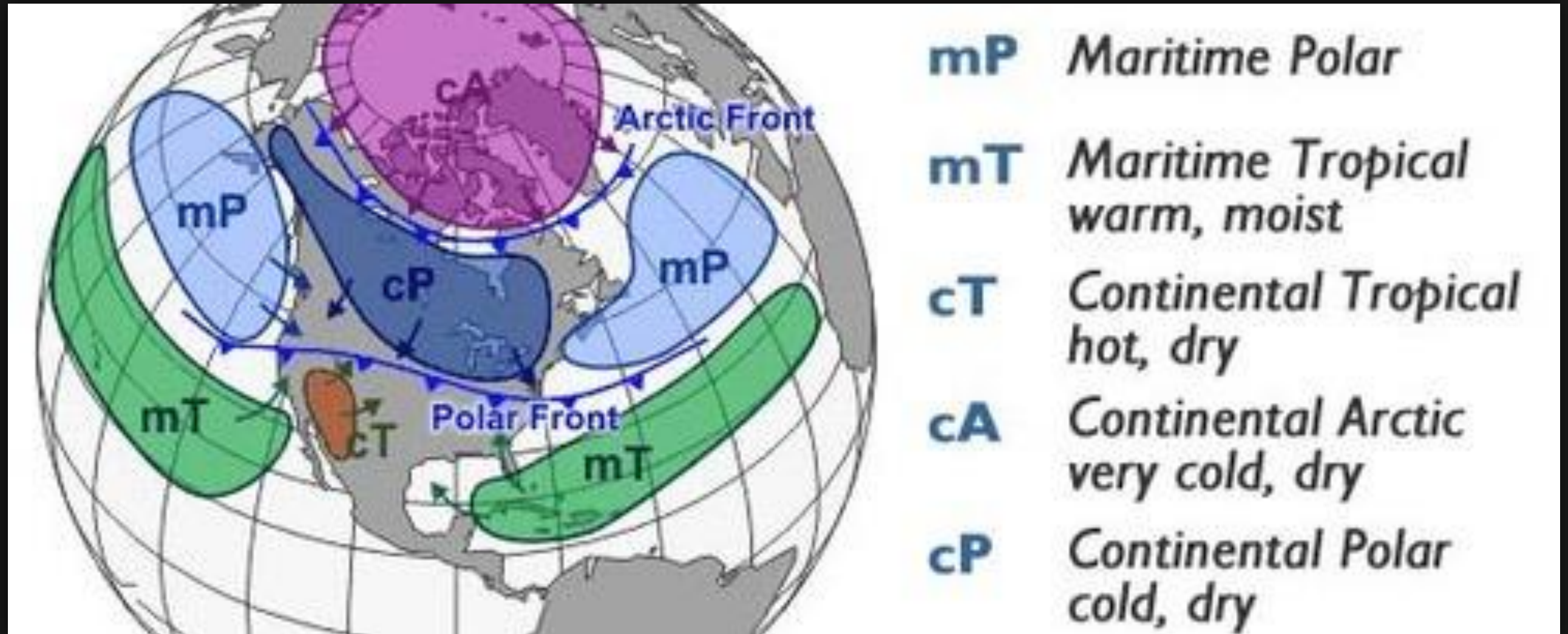
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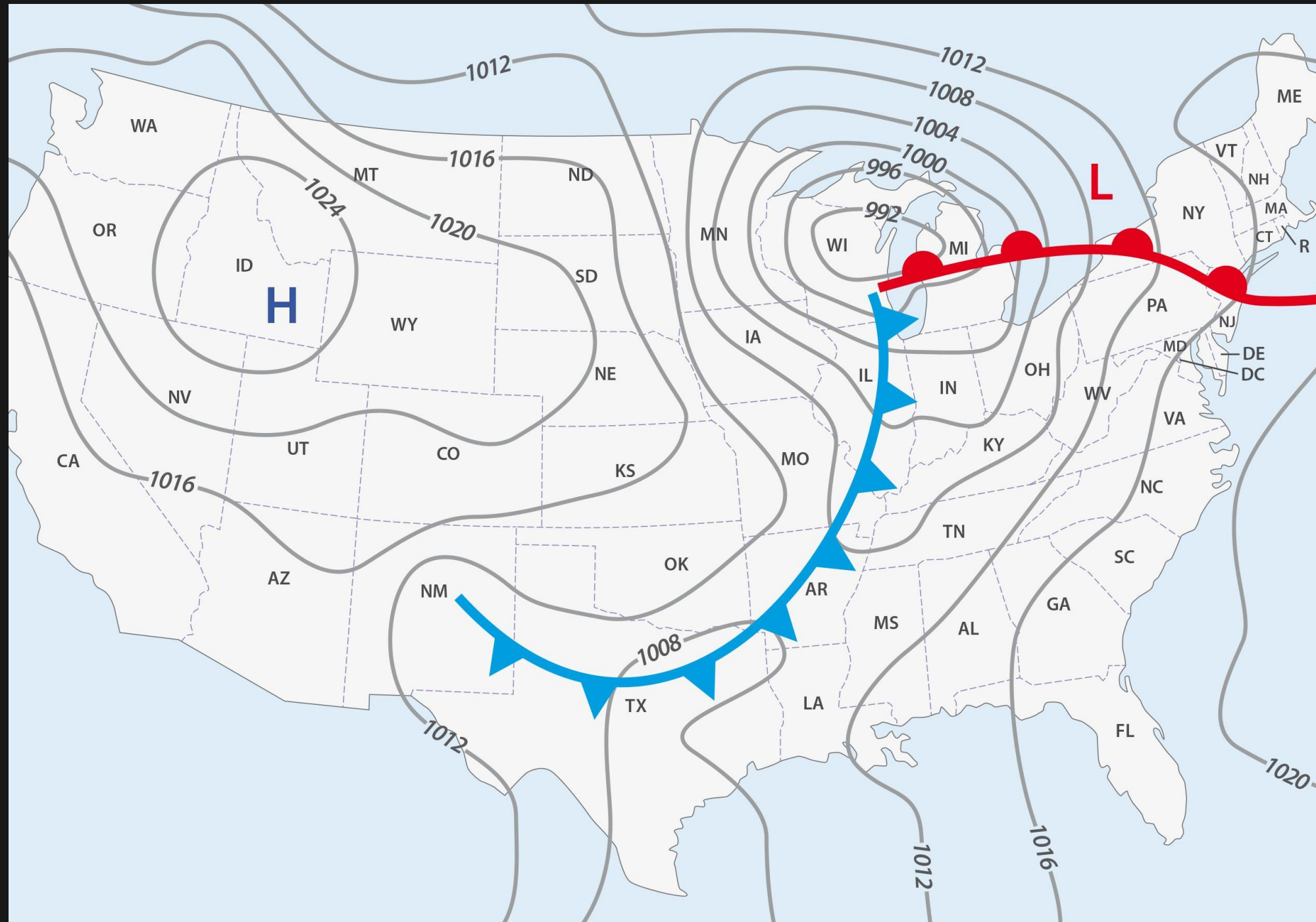
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# Pressure Systems and Fronts



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# Frontal Wind Patterns

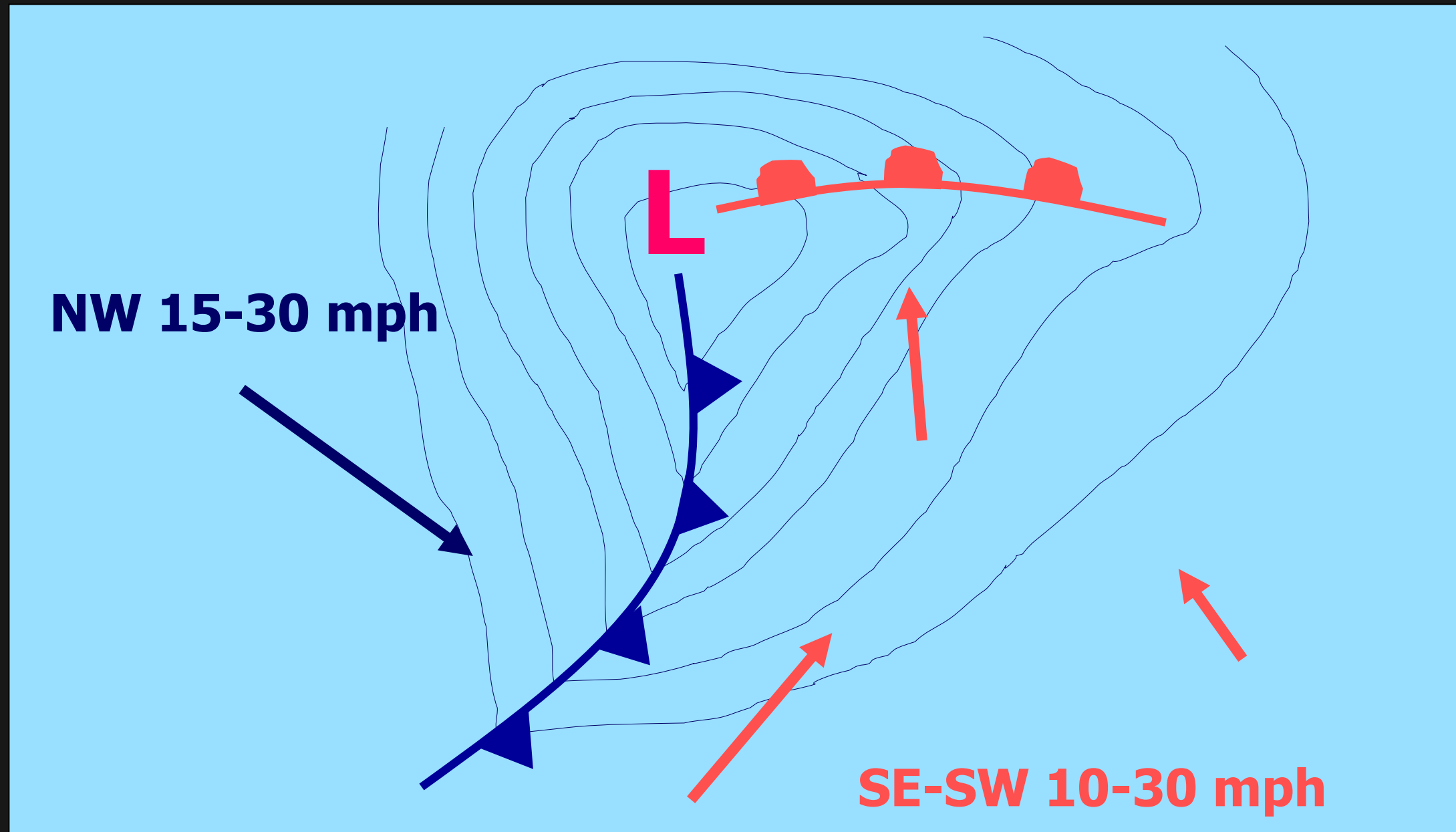
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# DATA COLLECTION



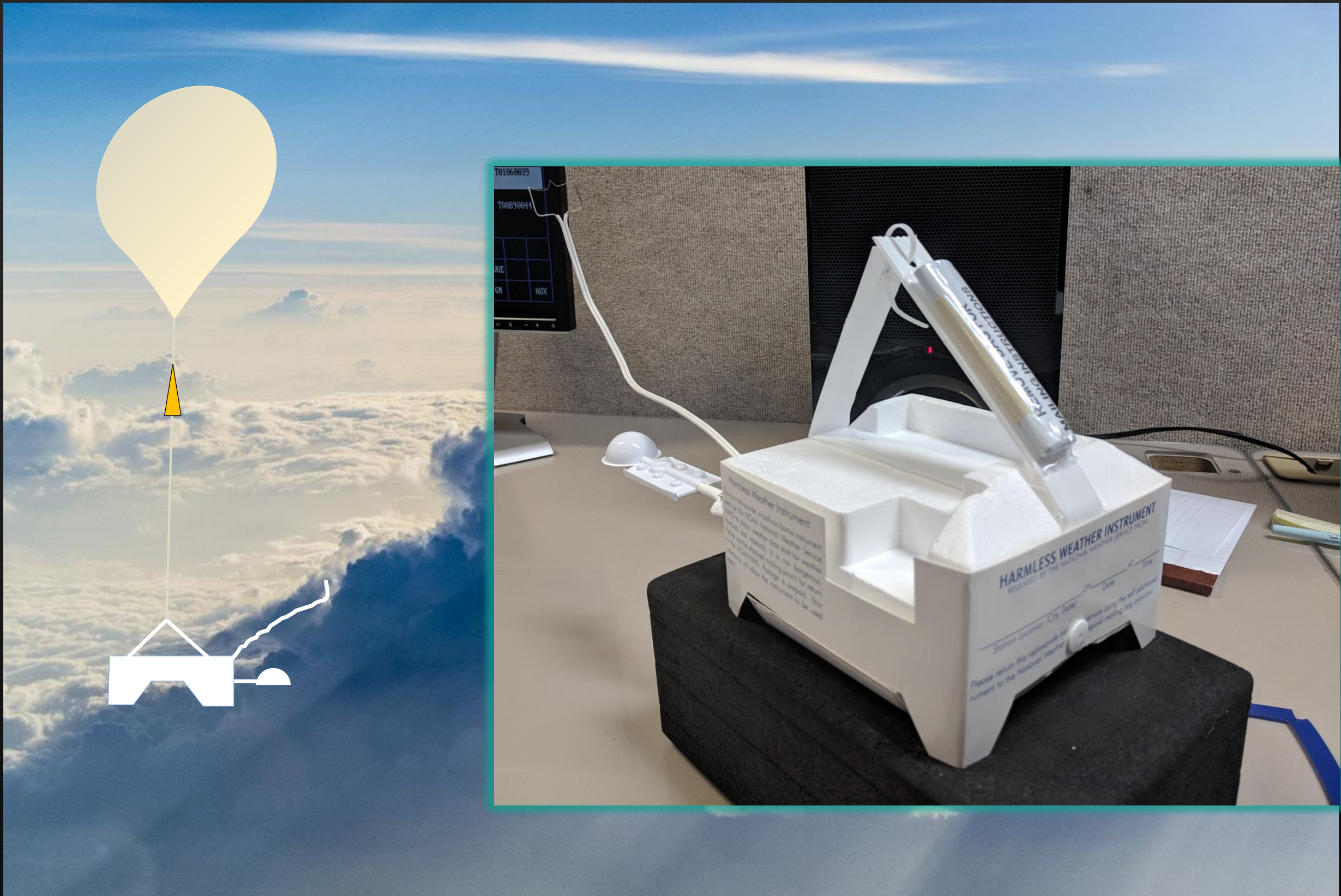
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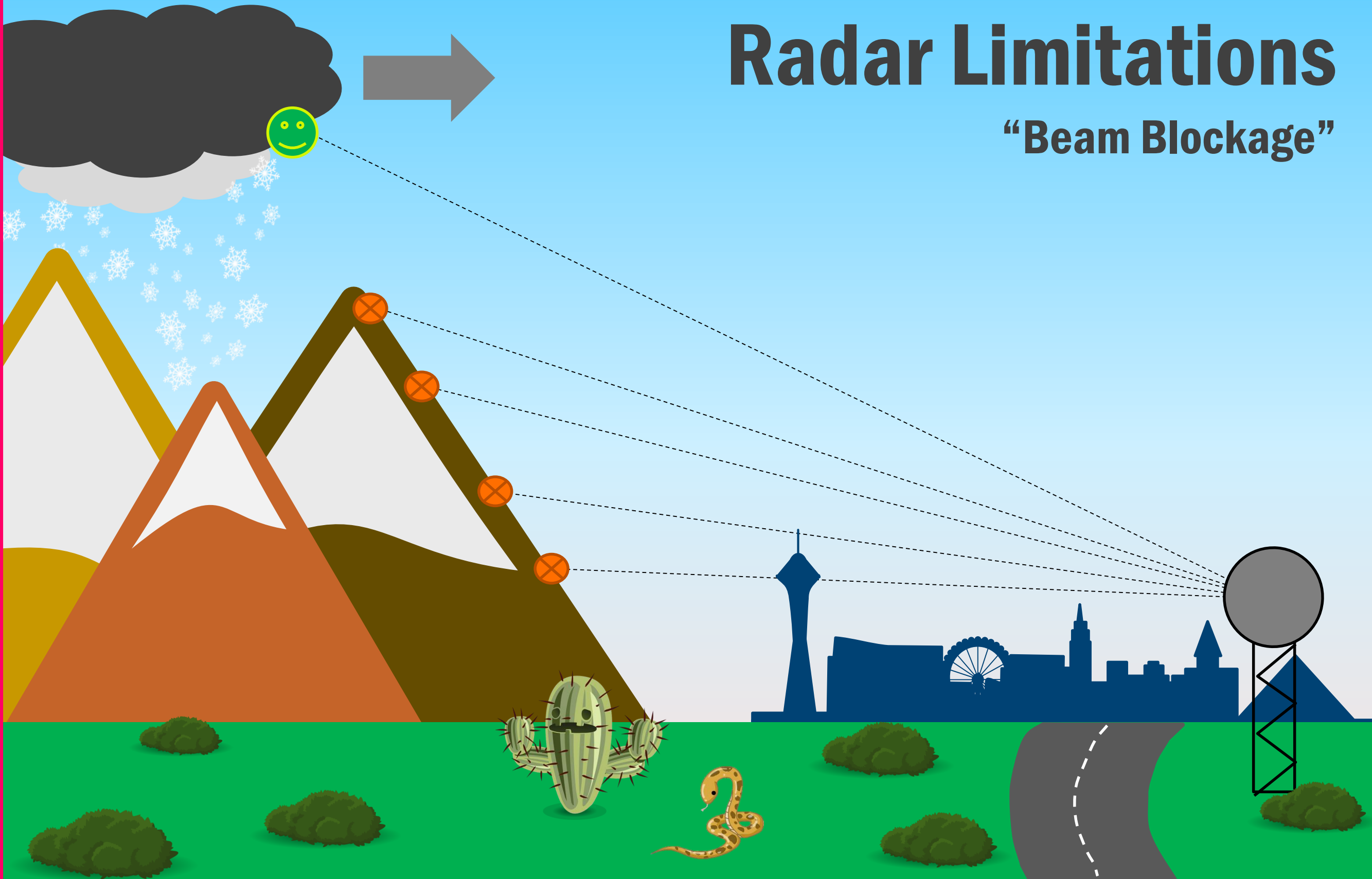
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# Radar Limitations

“Beam Blockage”





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**HAZARDS**

RESOURCES

# HAZARDS





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# Hazards Out West



## Flash Floods

## Hail



## Extreme Heat



## Dust Storms

## Microbursts



## Lightning



# Thunderstorms

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## How do thunderstorms form?





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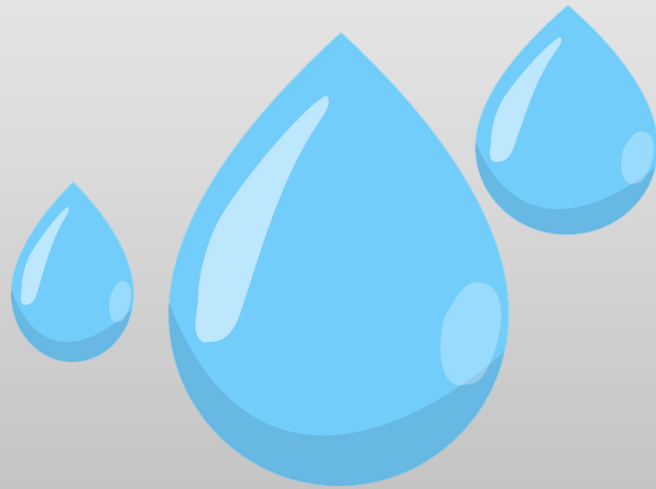
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# Ingredients



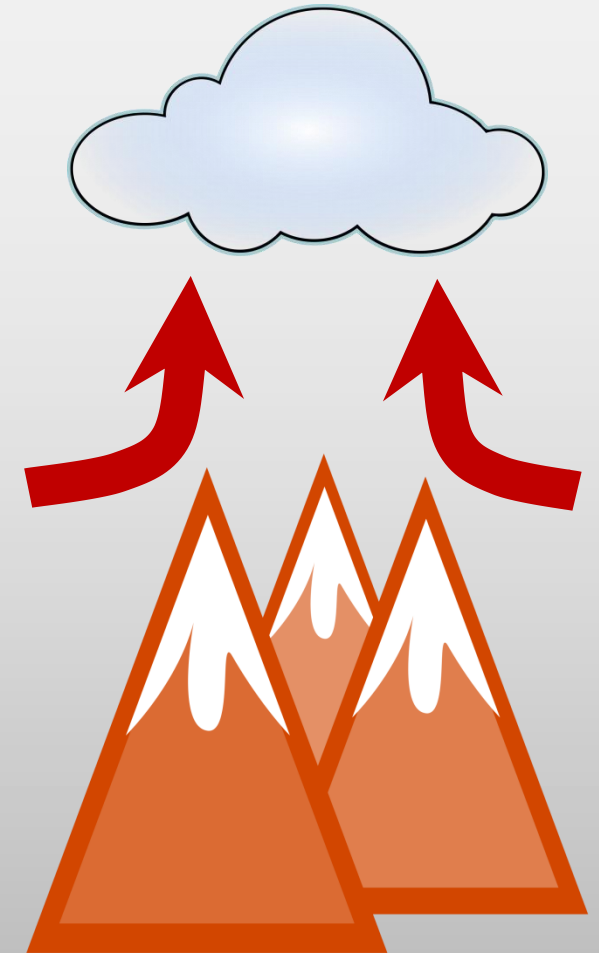
## Moisture

**“Fuel” source for thunderstorms.**



## Instability

**The tendency for air to rise on its own.**



## Lift

**Mountains, fronts, low pressure systems, and thunderstorm outflows.**



# Severe Thunderstorms

## Wind Shear

A change in wind speed or direction with altitude







# Thunderstorm Frequency

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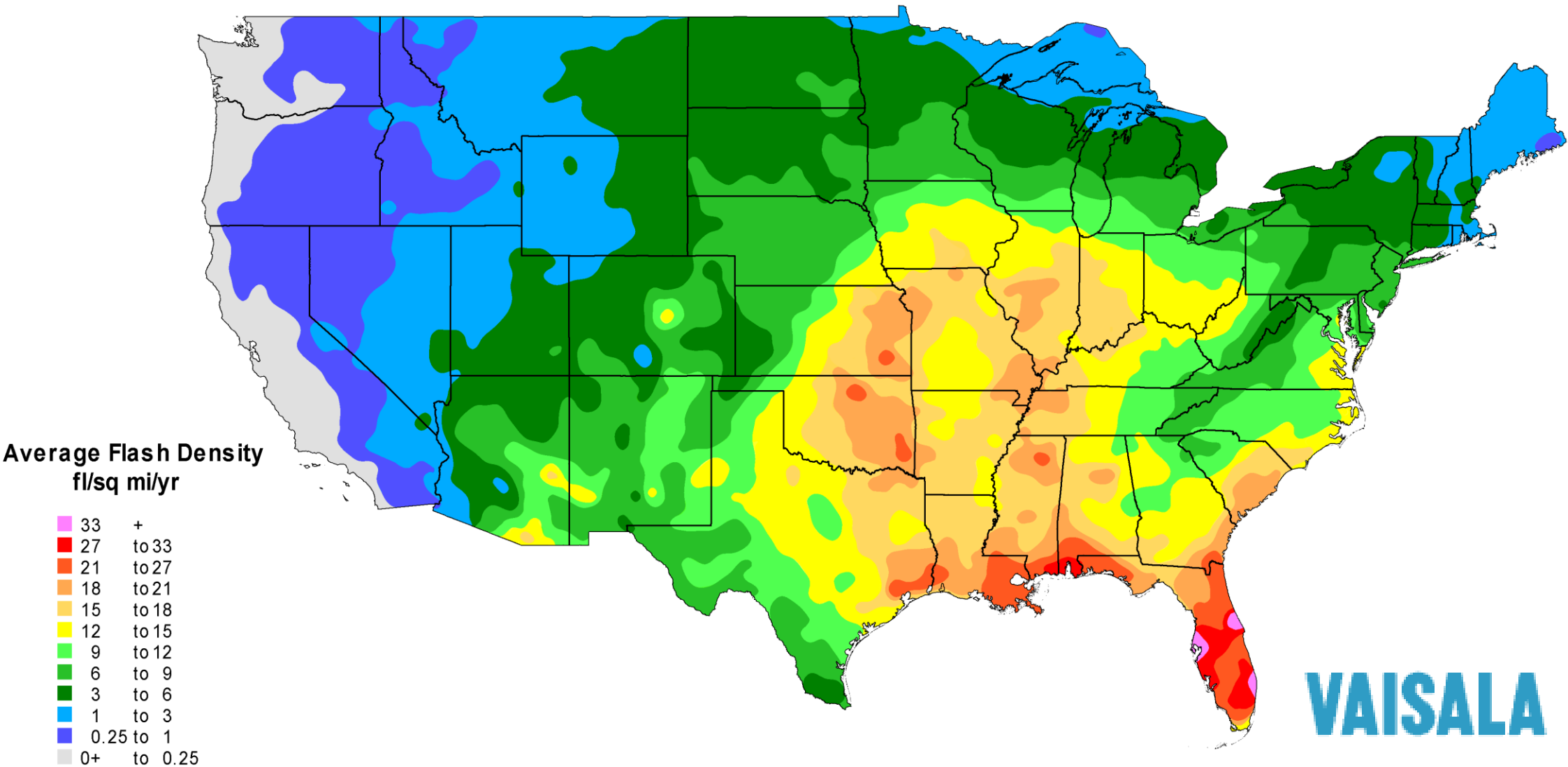
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## Vaisala's National Lightning Detection Network® (NLDN®)

Cloud-to-Ground Lightning Incidence in the Continental U.S. (1997 - 2010)





# Lightning

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THUNDERSTORMS

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REVIEW



**Lightning strikes over the Las Vegas Valley. Photo by Caleb Steele.**





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# Lightning Safety

- **Seek shelter if you hear thunder.**
- **There is no “safe” place outdoors.**
- **Vehicles with the windows rolled up are the safest alternative if a solid structure is not available.**
- **If you can’t get to a shelter or vehicle, avoid tall trees, power lines, or tall objects.**
- **Be the lowest point.**





# Hail



**Jan 2016 – Largest hailstone in California, observed in Red Bluff, CA. 3" diameter**

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# Flash Floods

## #2 Weather-Related Killer



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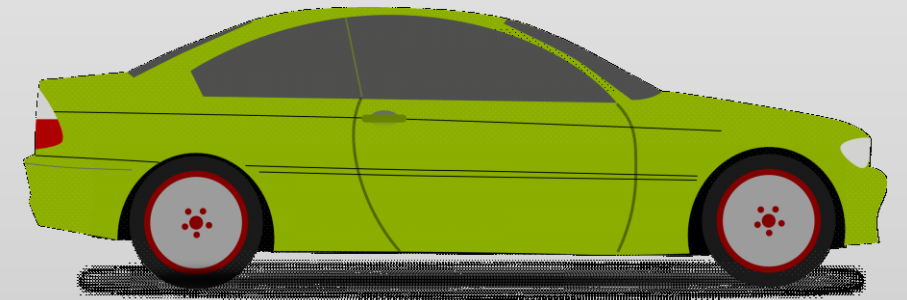
HAZARDS

REVIEW

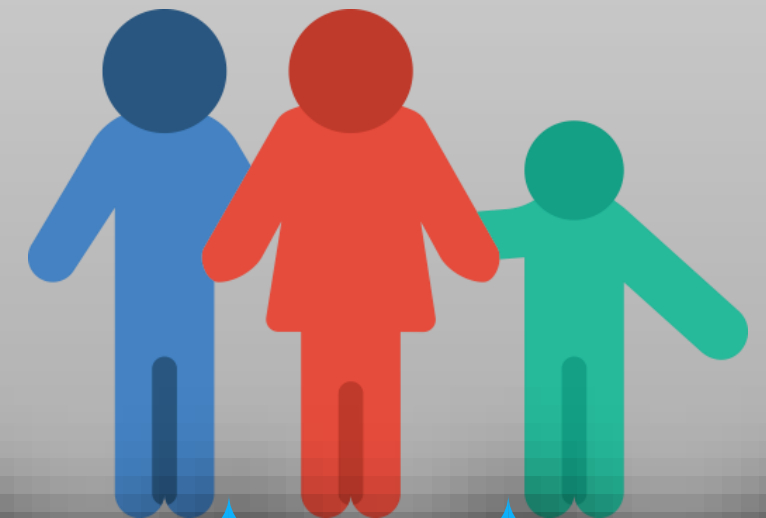


# Flash Floods

**2 feet** of flowing water  
can wash away most  
cars



**6 inches** of flowing  
water can wash away  
people







# Flash Floods

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**Flash Flood near Moapa, NV**



# Microburst

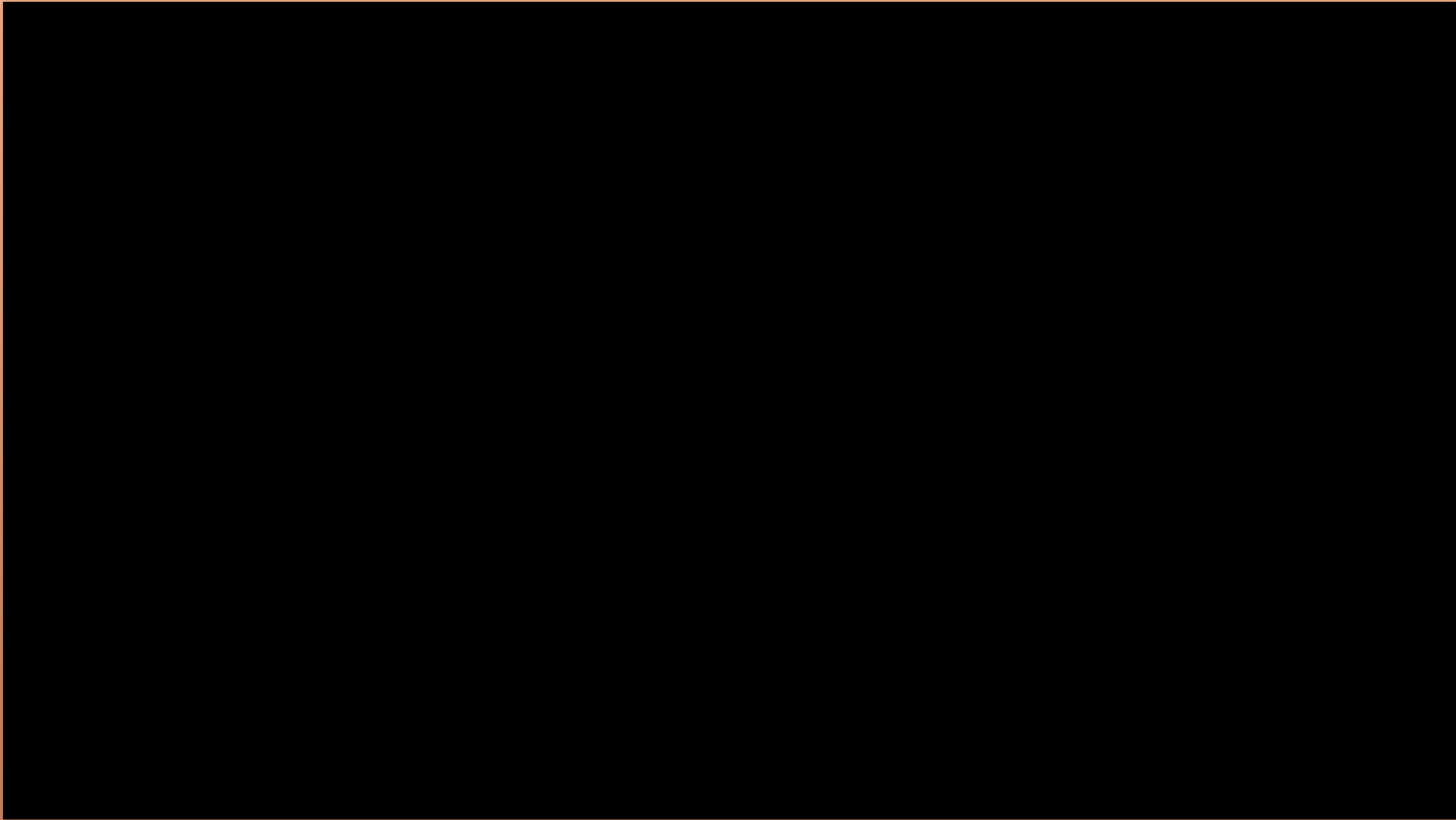
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THUNDERSTORMS

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REVIEW







# Tornadoes

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**Tornado near Desert Center, CA (Brigitte Jerke, April 21<sup>st</sup>, 2015)**



# Tornadoes – Owens Valley 3/3/2018

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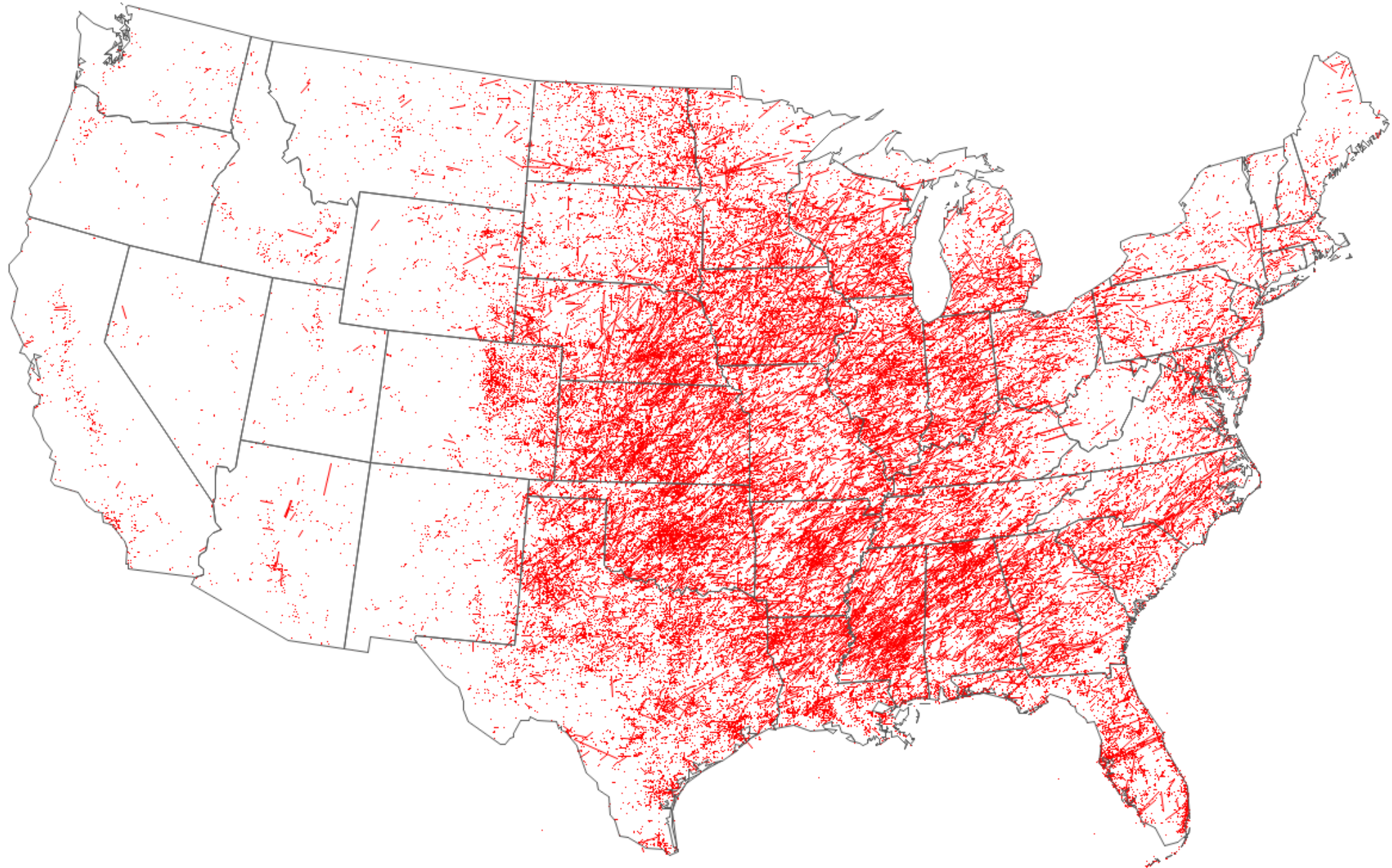






# Tornado Alley

**U.S. Tornado Map**  
years 1950 to 2013



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# Weather Alerts

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## Watch

Occurrence, location and/or timing uncertain

## Warning

Is occurring or imminent

## Advisory

May cause serious inconvenience





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# RESOURCES



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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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Local forecast by  
"City, St" or ZIP code

Enter location ...

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## Windy in Montana; Dry and Quiet Across CONUS

Strong winds will develop across northern Montana on Monday. Gusts up to 80 mph are expected along the Rocky Mountain Front. Other than a few instances of light precipitation along the east coast and upper Midwest, the CONUS will remain relatively dry over the next three days. [Read More >](#)



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ACTIVE ALERTS

FORECAST MAPS

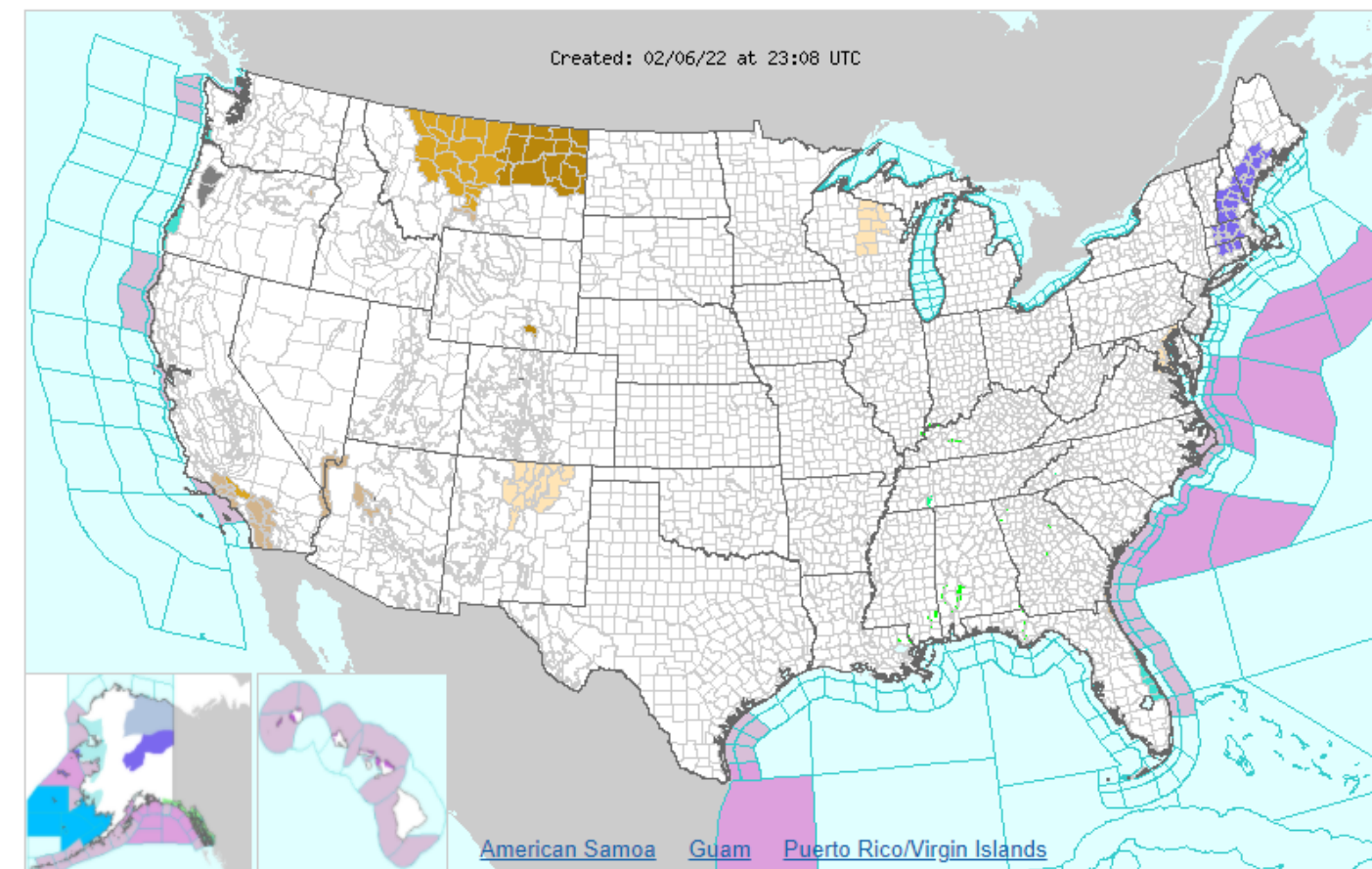
RADAR

RIVERS, LAKES, RAINFALL

AIR QUALITY

SATELLITE

PAST WEATHER



Click on the map above for detailed alerts or

Warnings By State

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[Public Alerts in XML/CAP v1.1 and ATOM Formats](#)

Winter Storm Warning

High Wind Warning

Gale Warning

Wind Chill Warning

Winter Weather Advisory

Wind Chill Advisory

High Surf Advisory

Heavy Freezing Spray  
Warning

Small Craft Advisory

Brisk Wind Advisory

Lake Wind Advisory

Wind Advisory

Rip Current Statement

Beach Hazards  
Statement

Hazardous Seas Watch

High Wind Watch

Fire Weather Watch

Special Weather  
Statement

Marine Weather  
Statement

Air Stagnation Advisory

Hydrologic Outlook





- weather.gov
- HeatRisk

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## EXPERIMENTAL NWS POTENTIAL HEAT RISKS

Click map for potential heat risks and official NWS forecast for a location.

Mon 6/19	Tue 6/20	Wed 6/21	Thu 6/22	Fri 6/23	Sat 6/24	Sun 6/25
-------------	-------------	-------------	-------------	-------------	-------------	-------------

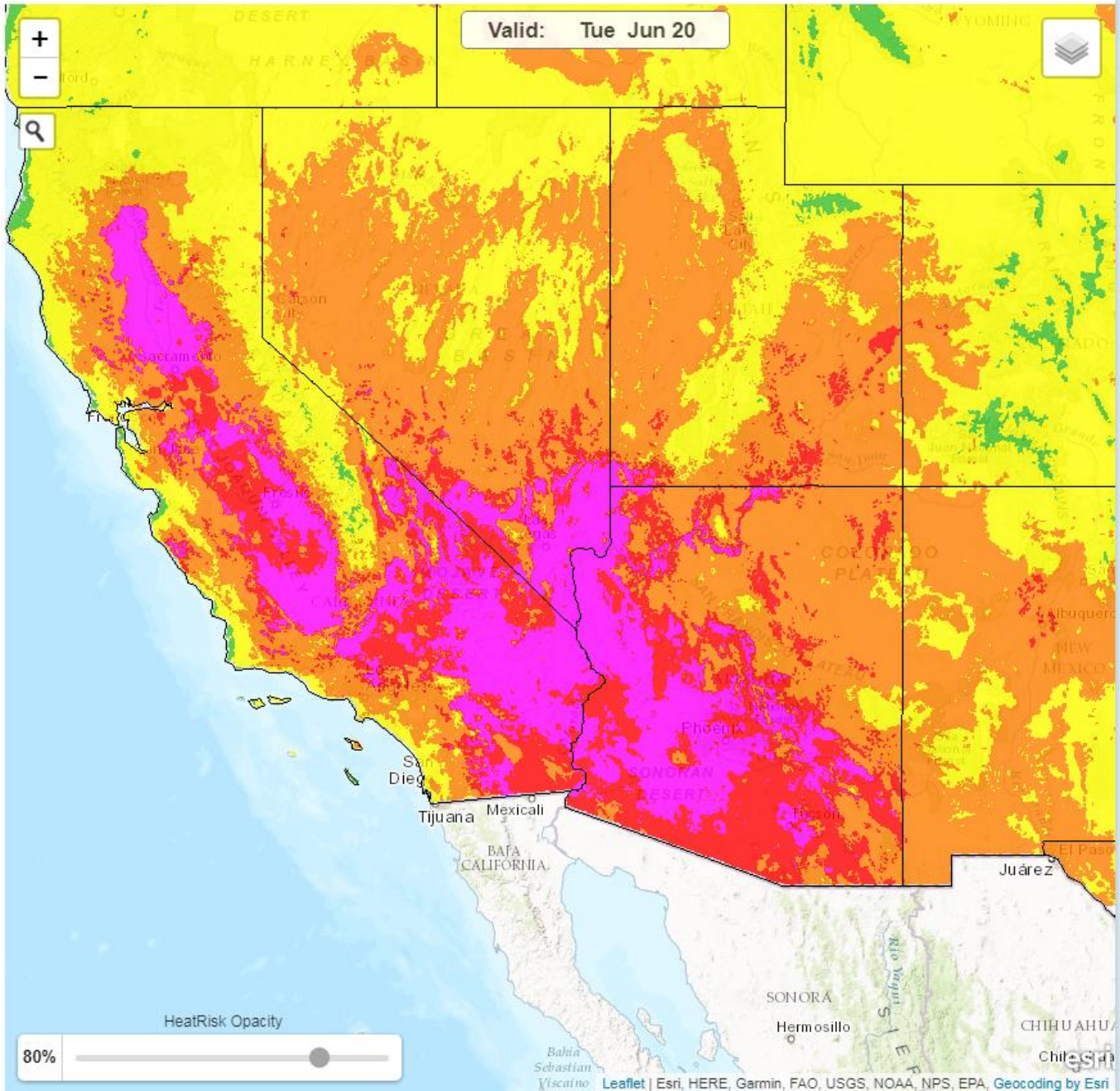
Click map for potential heat risks and NWS forecast for a location.

### HeatRisk

[More Information](#)

Heat affects everyone differently. In order to better address heat risk and allow you to prepare for upcoming heat events, the NWS has developed the experimental HeatRisk forecast. The NWS HeatRisk forecast provides a quick view of heat risk potential over the upcoming seven days. The heat risk is portrayed in a numeric (0-4) and color (green/yellow/orange/red/magenta) scale which is similar in approach to the Air Quality Index (AQI) or the UV Index. In a similar way, it provides one value each day that indicates the approximate level of heat risk concern for any location, along with identifying the groups who are most at risk. This product is supplementary to the official NWS heat watch/warning/advisory program and is meant to provide continuously available heat risk guidance for those decision makers and heat sensitive populations who need to take actions at levels that may be below current NWS heat product levels.

Category	Level	Meaning
Green	0	No Elevated Risk
Yellow	1	Low Risk for those extremely sensitive to heat, especially those without effective cooling and/or adequate hydration
Orange	2	Moderate Risk for those who are sensitive to heat, especially those without effective cooling and/or adequate hydration
Red	3	High Risk for much of the population, especially those who are heat sensitive and those without effective cooling and/or adequate hydration
Magenta	4	Very High Risk for entire population due to long duration heat, with little to no relief overnight



risk/?wfo=vaf#

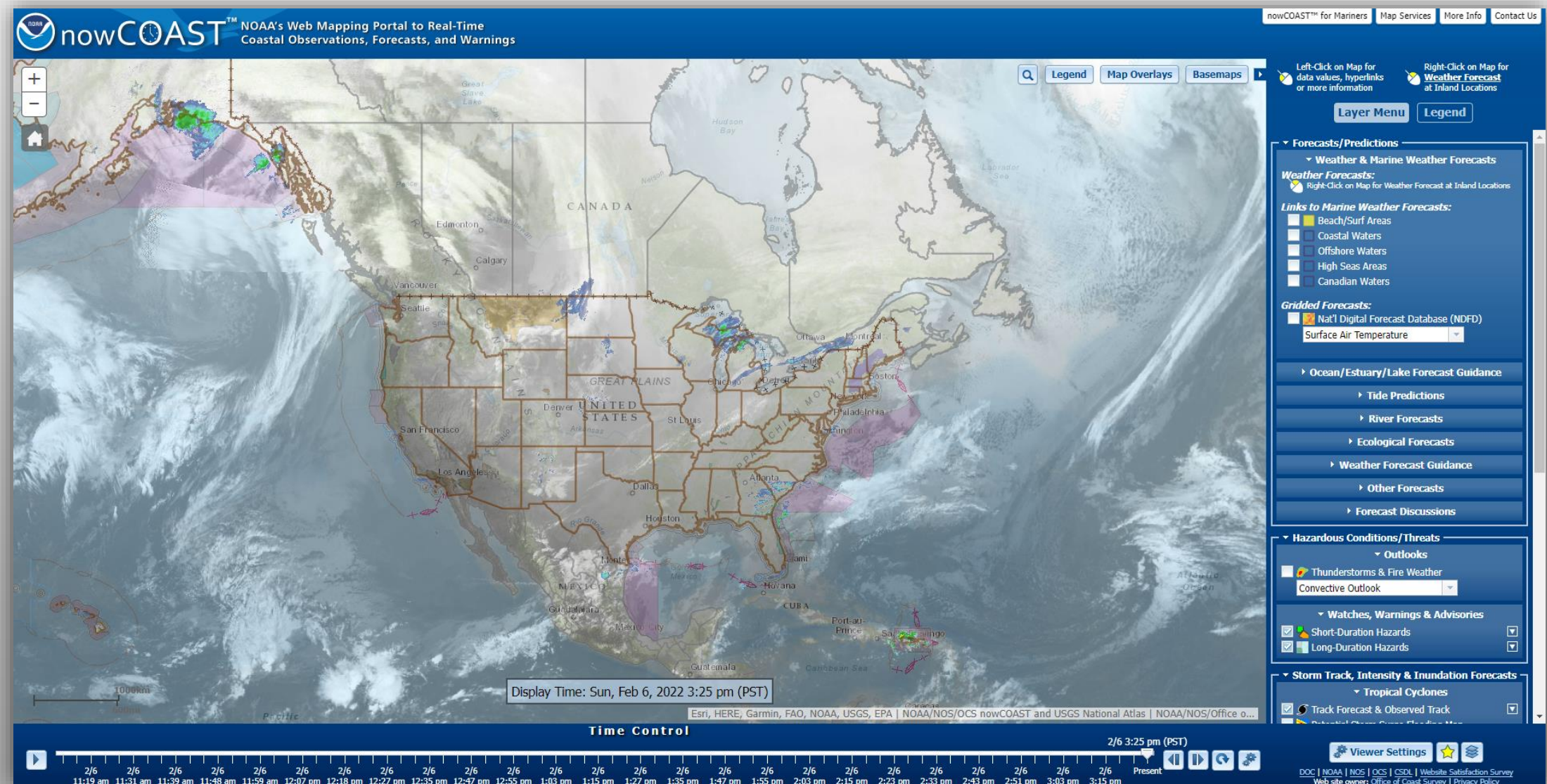
Leaflet | Esri, HERE, Garmin, FAO, USGS, NOAA, NPS, EPA, Geocoding by Esri





- weather.gov
- HeatRisk
- NowCoast

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- **weather.gov**
- **HeatRisk**
- **NowCoast**
- **StormReady**
- **WRN Ambassador**



## WRN Ambassador



### Your Organization

- ✓ Promotes Weather-Ready Nation (WRN) messaging
- ✓ Demonstrates commitment to public safety
- ✓ Collaborates on innovation opportunities with NOAA
- ✓ Shares success stories
- ✓ Takes ownership by using the WRN Ambassador Logo



### NOAA/NWS

- ✓ Provides outreach content & training opportunities
- ✓ Explores collaboration opportunities with your organization
- ✓ Assists with StormReady opportunities for communities
- ✓ Recognizes your organization as a WRN Ambassador
- ✓ Provides means of two-way communication with NOAA



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MetEd is a free collection of **hundreds of training resources** intended for the **geoscience community**. Whether you're an experienced meteorologist honing existing skills or a student looking for new geoscience topics of interest, we have something for you. Learn more about MetEd in this short [video](#).

Recent Publications

NGS Webinar Series

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### National Geodetic Survey - Webinar Series

NOAA's National Geodetic Survey (NGS) provides the framework for all positioning activities in the nation. The foundational elements of latitude, longitude, elevation, and shoreline information impact a wide range of important activities. Our primary end-users...

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News and Updates

University Course Support

Posted on: 2021-05-12

The [University Course Support](#) resource has newly added the capability to download images and animations from the MetEd lessons.

COMET welcomes your feedback on the [University Course Support](#) Resource: [Take the Survey](#)

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# Thank You!

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