



# Climate Cycles

# How do Scientist Study Long-Term Climate Cycles?

- 1. Ice Cores
- 2. Fossilized Pollen
- 3. Ocean Sediments
- 4. Tree Ring Growth





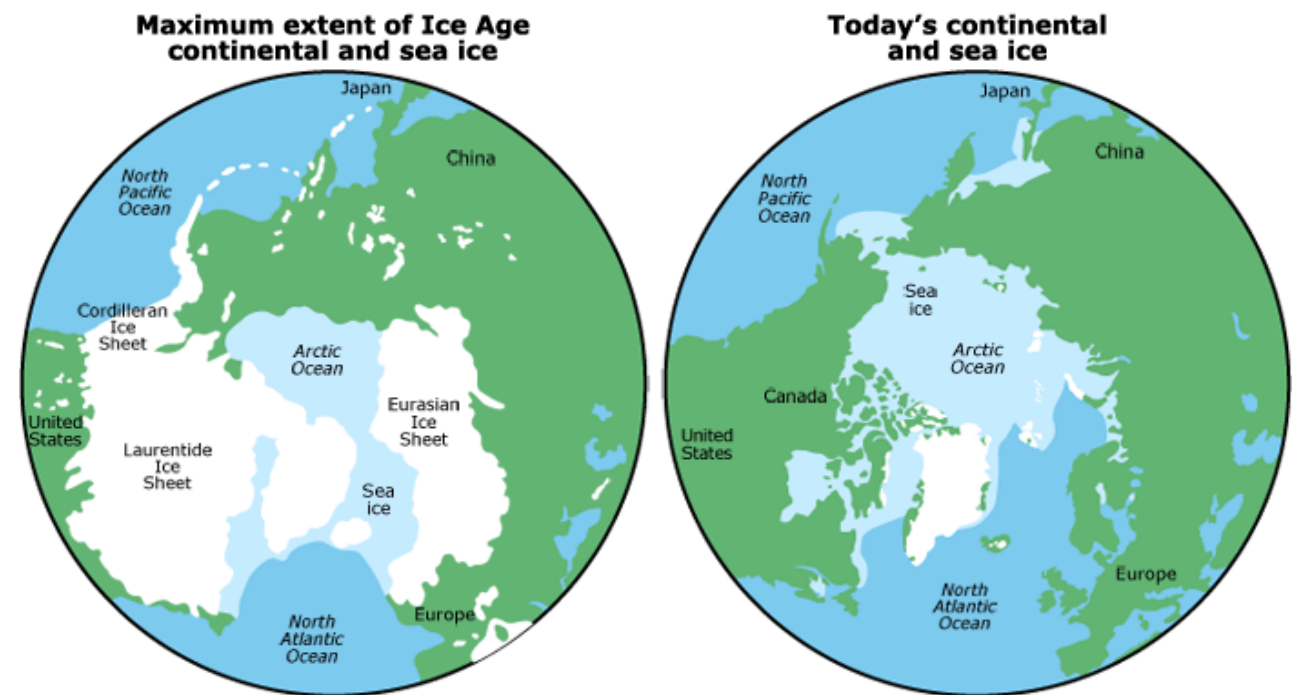
# What is an Ice Age?

- A cooling period of in which the enormous sheets of ice advance getting bigger and covering a larger area. Sea levels decrease.



# Interglacial Periods

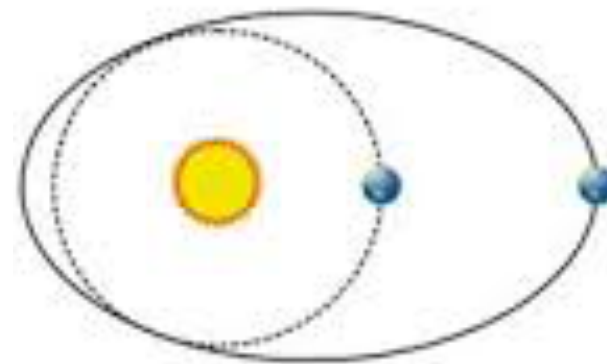
- A warming period, the ice begins to melt and the sea level rises again.
- The Great Lakes formed at the beginning of the current interglacial period.



# Milankovitch Cycle

- The Earth experiences alternations of cooling and warming periods due three changes in Earth's Orbit

## Milankovitch Cycles



Eccentricity



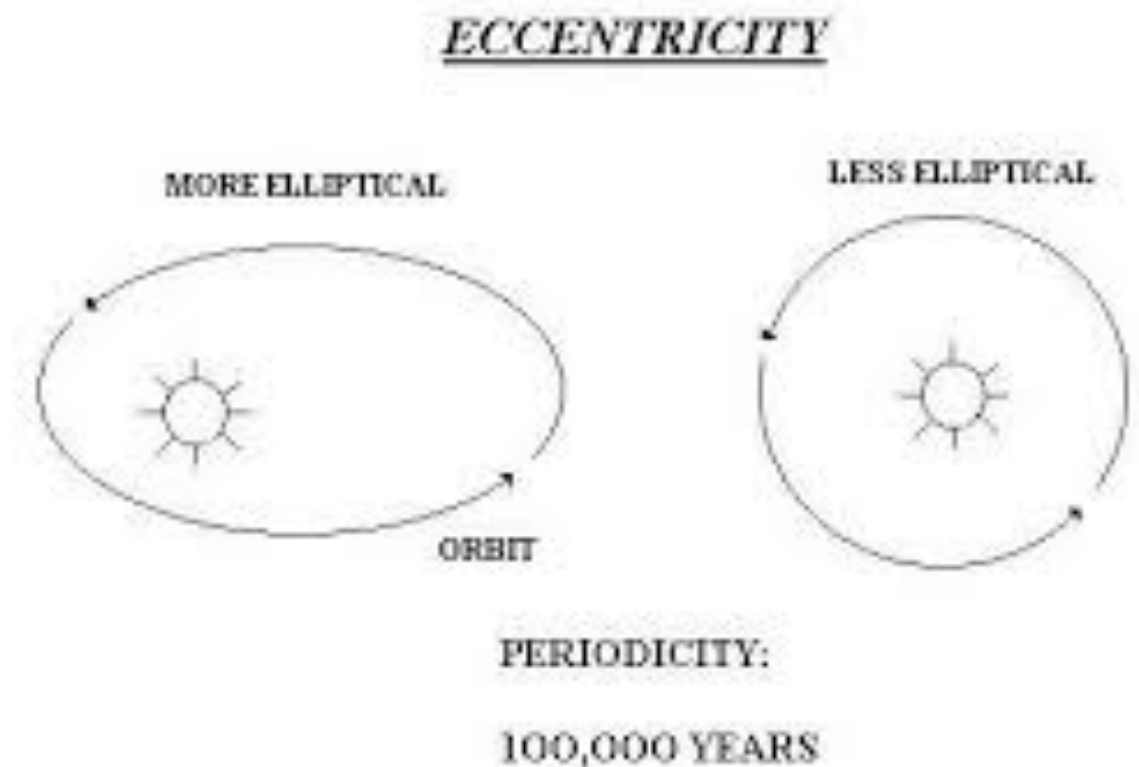
Obliquity



Precession

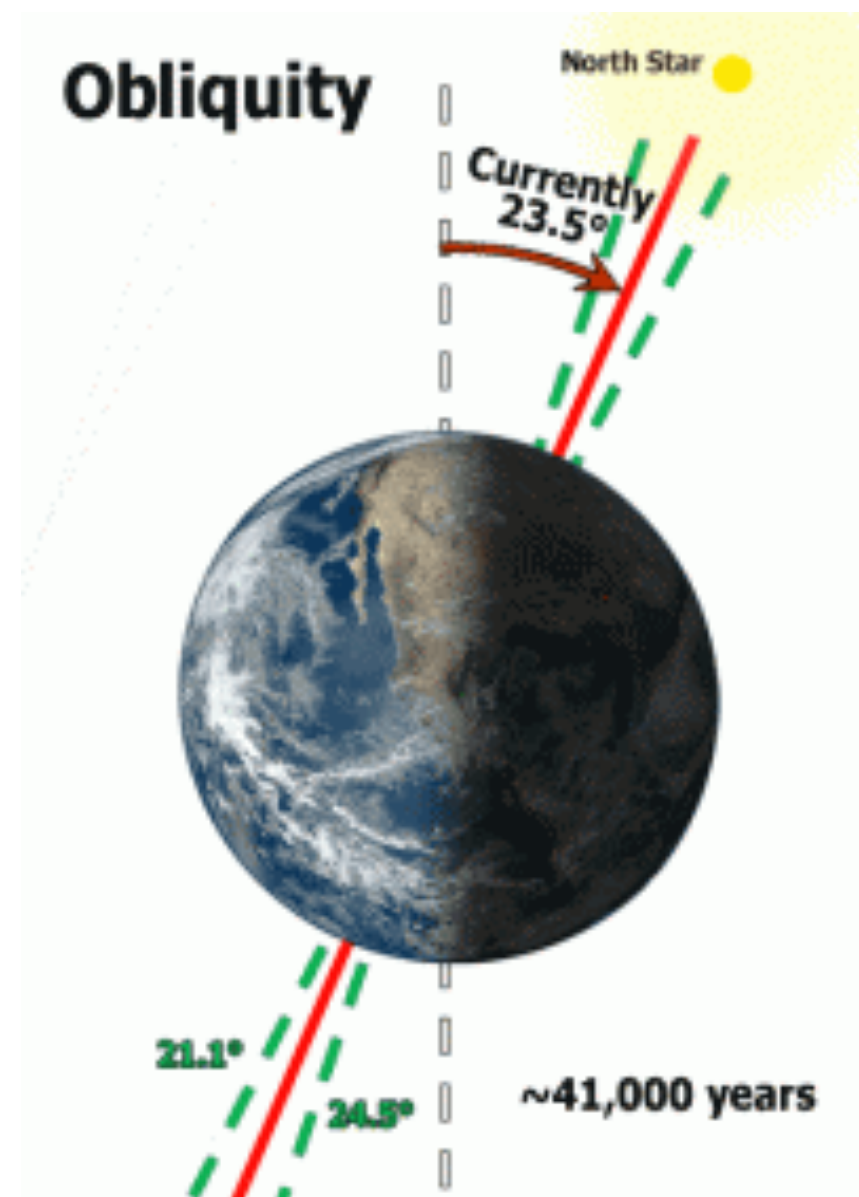
# Shape of the Orbit (Eccentricity)

- Cycles over a period of 100,000 years the Earth changes orbital shape, from a more circular shape to an elliptical shape. When the orbit is circular the seasons are more moderate, during elliptical periods the seasons are more extreme.



# Axial Tilt (Obliquity)

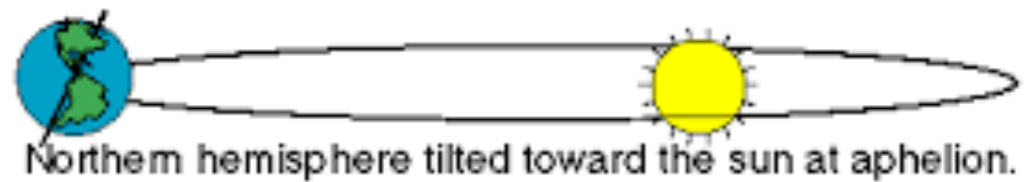
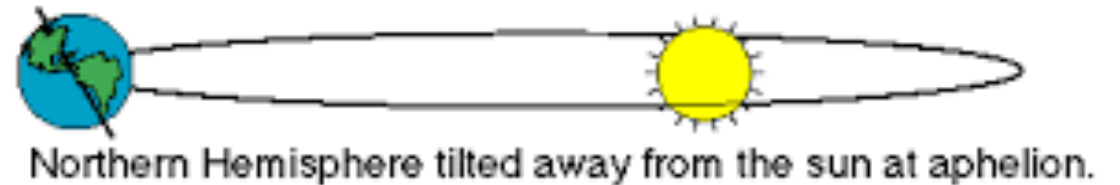
- Cycles over 41,000 years the axis tilt varies between  $21.8^\circ$  and  $24.4^\circ$ , , At  $24.4^\circ$ , the poles receive more solar energy.



# Axial Motion (Precession)

- Cycles every 26,000 years, the circular motion of Earth's Axis determines the time of the year a region gets more/less direct sunlight.

Precession of the Equinoxes (19 and 23 k.y.)





# What are Short Term Climate Cycles?

- 1. Seasons
- 2. Solstices and Equinoxes
- 3. El Niño/ La Niña
- 4. Monsoons
- 5. Droughts, Heat Waves, and Cold Waves



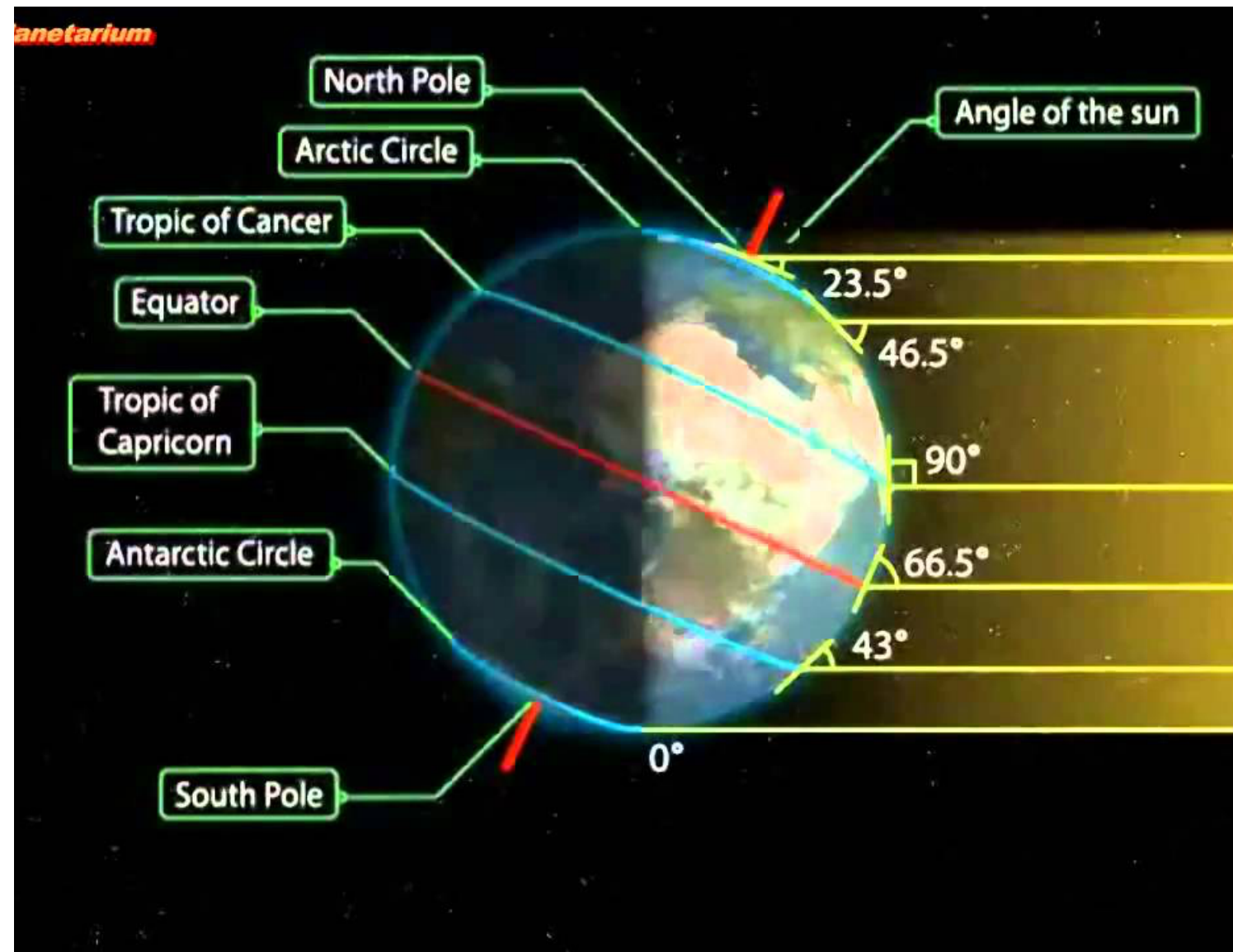
# What are Seasons?

- Changes in the amount of sunlight received at different latitudes during different times of the year.
- Seasonal changes include temperature changes and the number of hours of day and night.



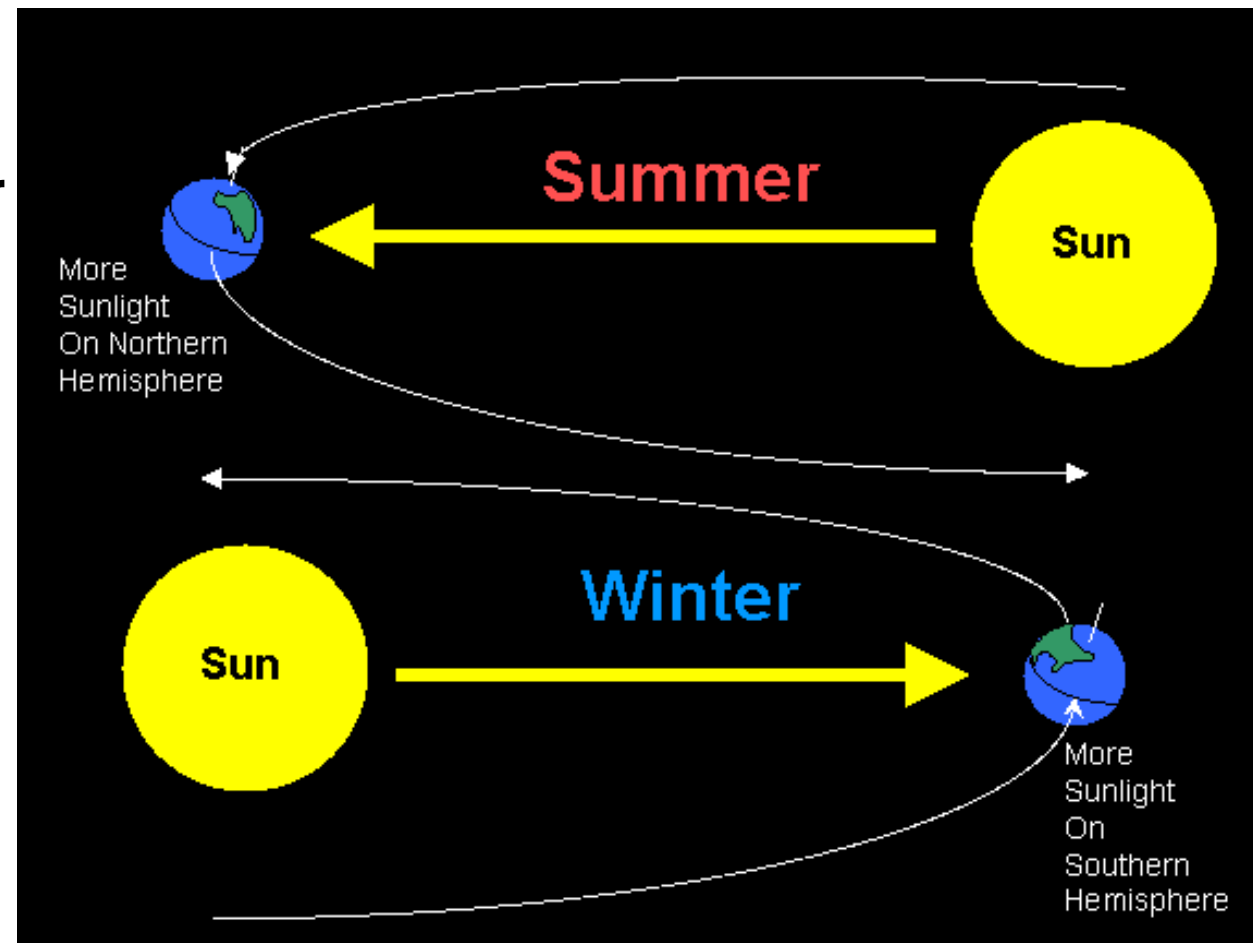
# What are Seasons?

- During the summer the northern hemisphere is tilted towards the sun and receives more direct sunlight and the southern hemisphere is tilted away from the sun and receives less direct sunlight.
- During the winter the northern hemisphere is tilted away from the sun and receives less direct sunlight and the southern hemisphere is tilted toward the sun and receives more direct sunlight.



# What are Solstices

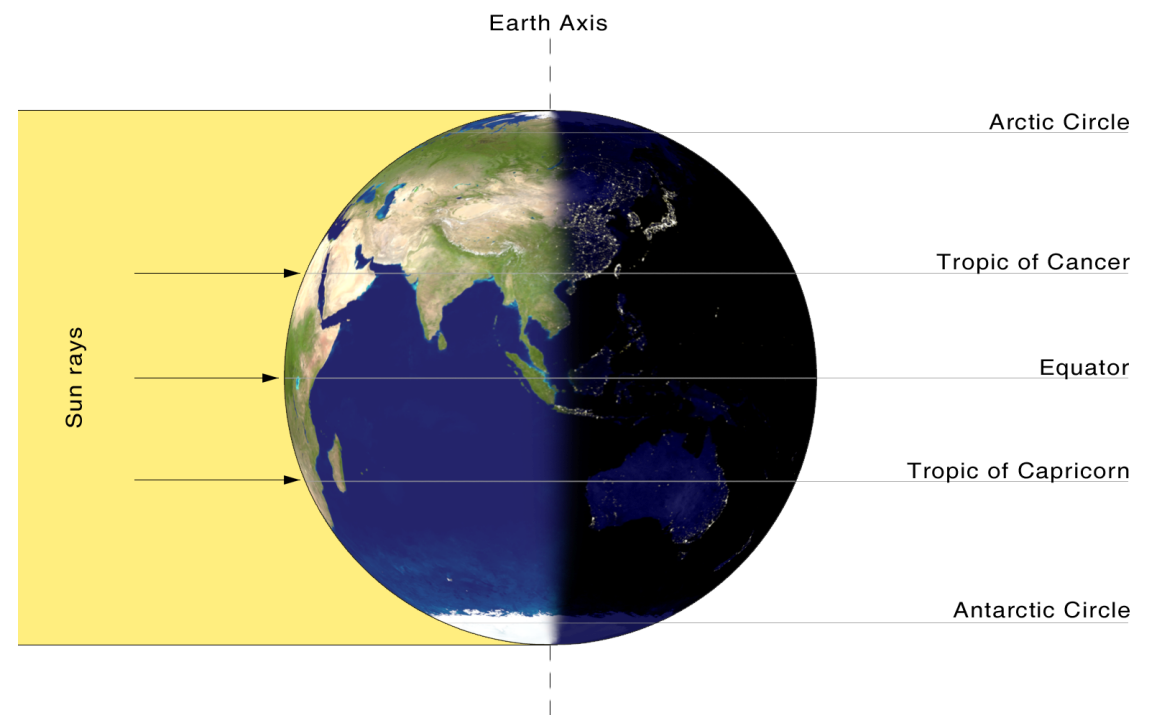
- The solstice marks the beginning of winter and summer. There is a larger difference of sunlight between the northern and southern hemisphere.





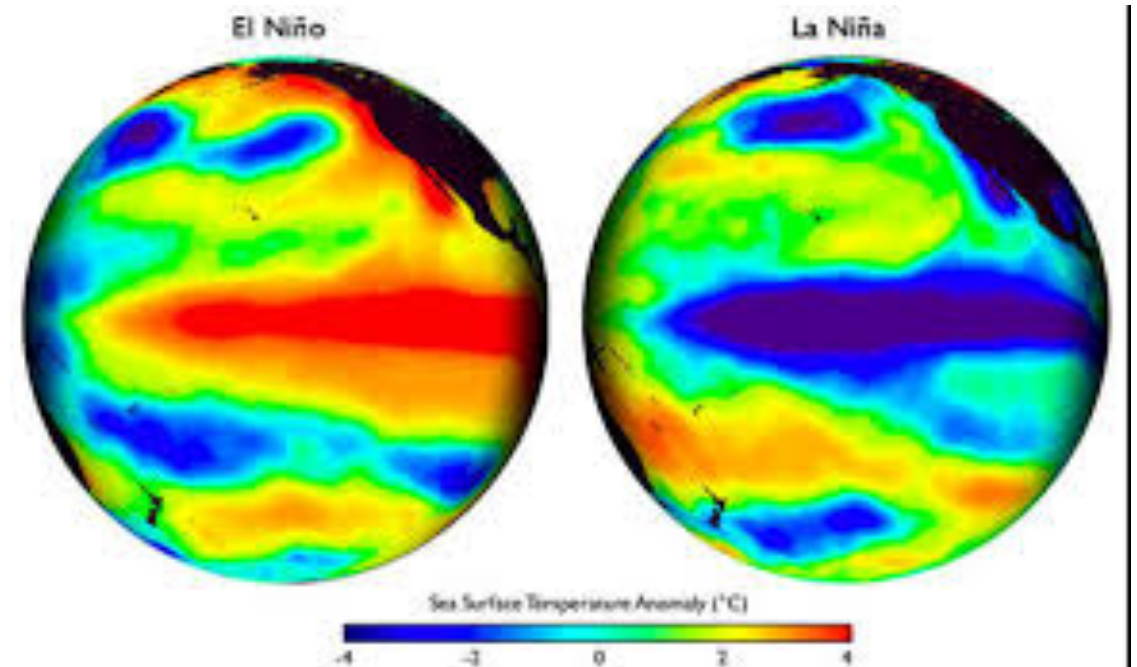
# What are Equinoxes

- The Equinox marks the beginning of spring and autumn. There is an equal amount of sunlight between the northern and southern hemisphere.



# What is El Niño and the Southern Oscillation?

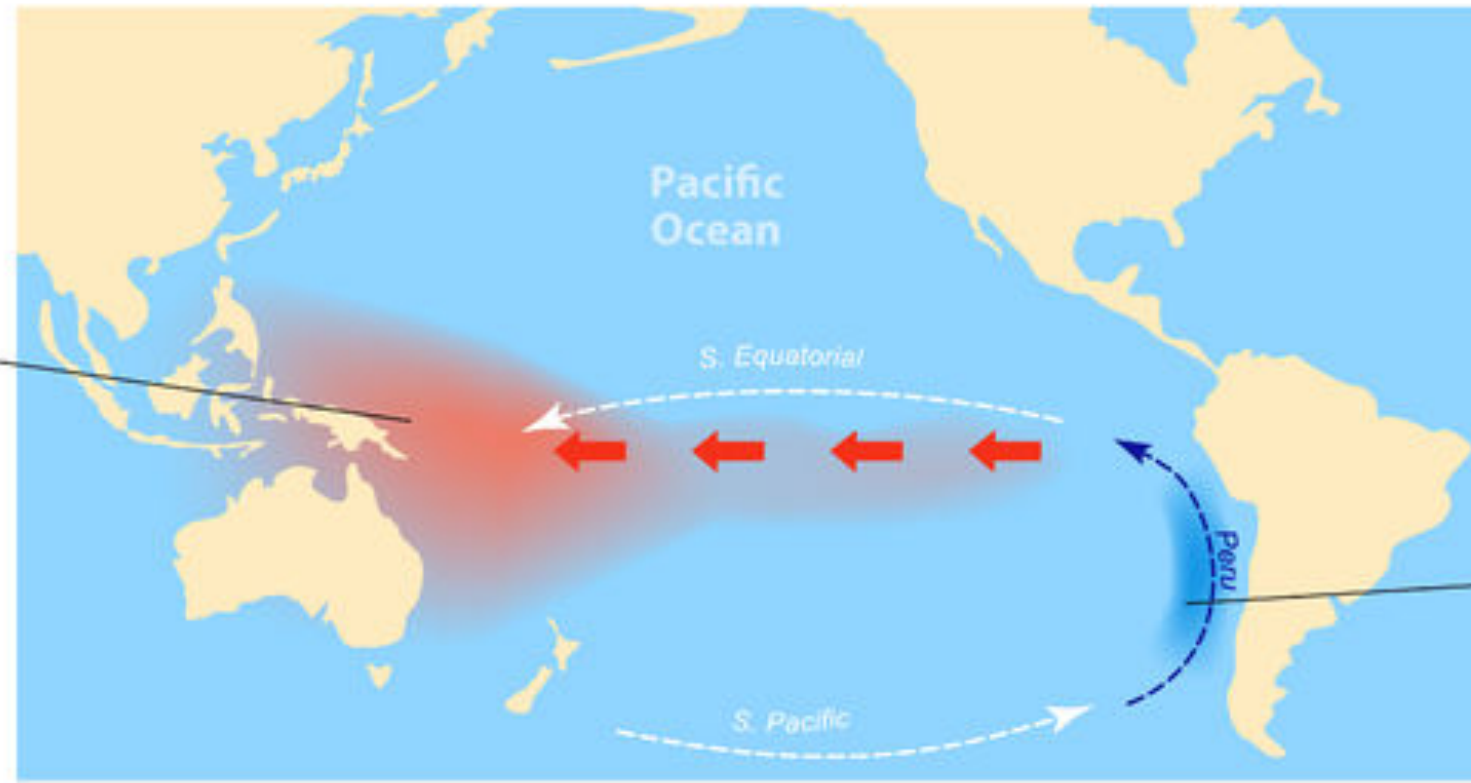
- The weakening of the trade winds, reversing the normal pattern of high and low pressures across the Pacific Ocean. Warm Water surges back toward South America, preventing cold water from upwelling.



# THE EL NIÑO PHENOMENON

## NORMAL YEAR

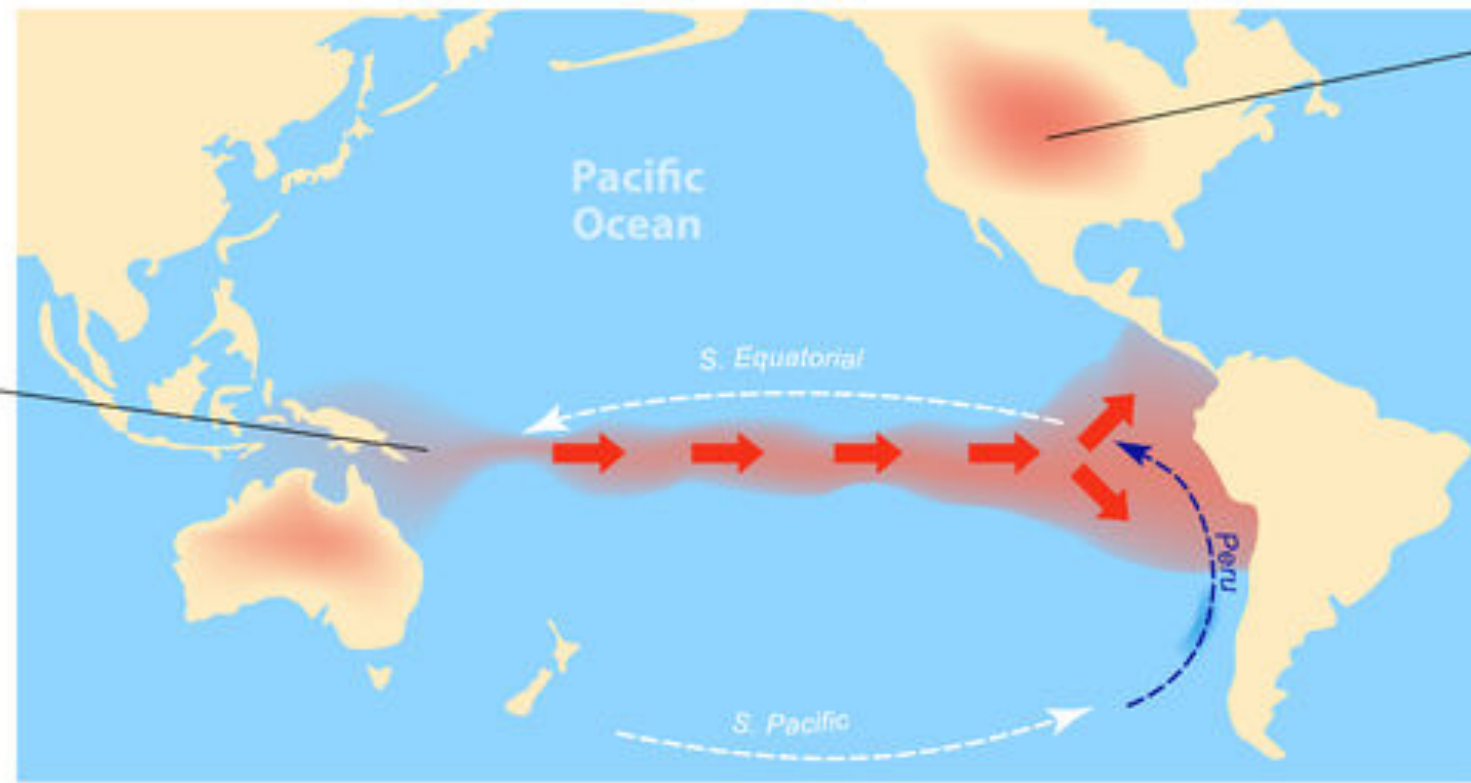
Equatorial winds gather warm water pool toward the west.



Cold water along South American coast.

## EL NIÑO YEAR

Easterly winds weaken. Warm water to move eastward.



Warmer winter

# How does El Niño affect the climate?

- Precipitation increases in drier areas and droughts occur in normally wet areas.





# What are Monsoons?

- A wind circulation pattern that changes direction with the seasons. Brings heavy rainfall during the summer months.



# What are droughts?

- A period with below-average precipitation. Caused when hot air masses sit over an area for extended period of time.

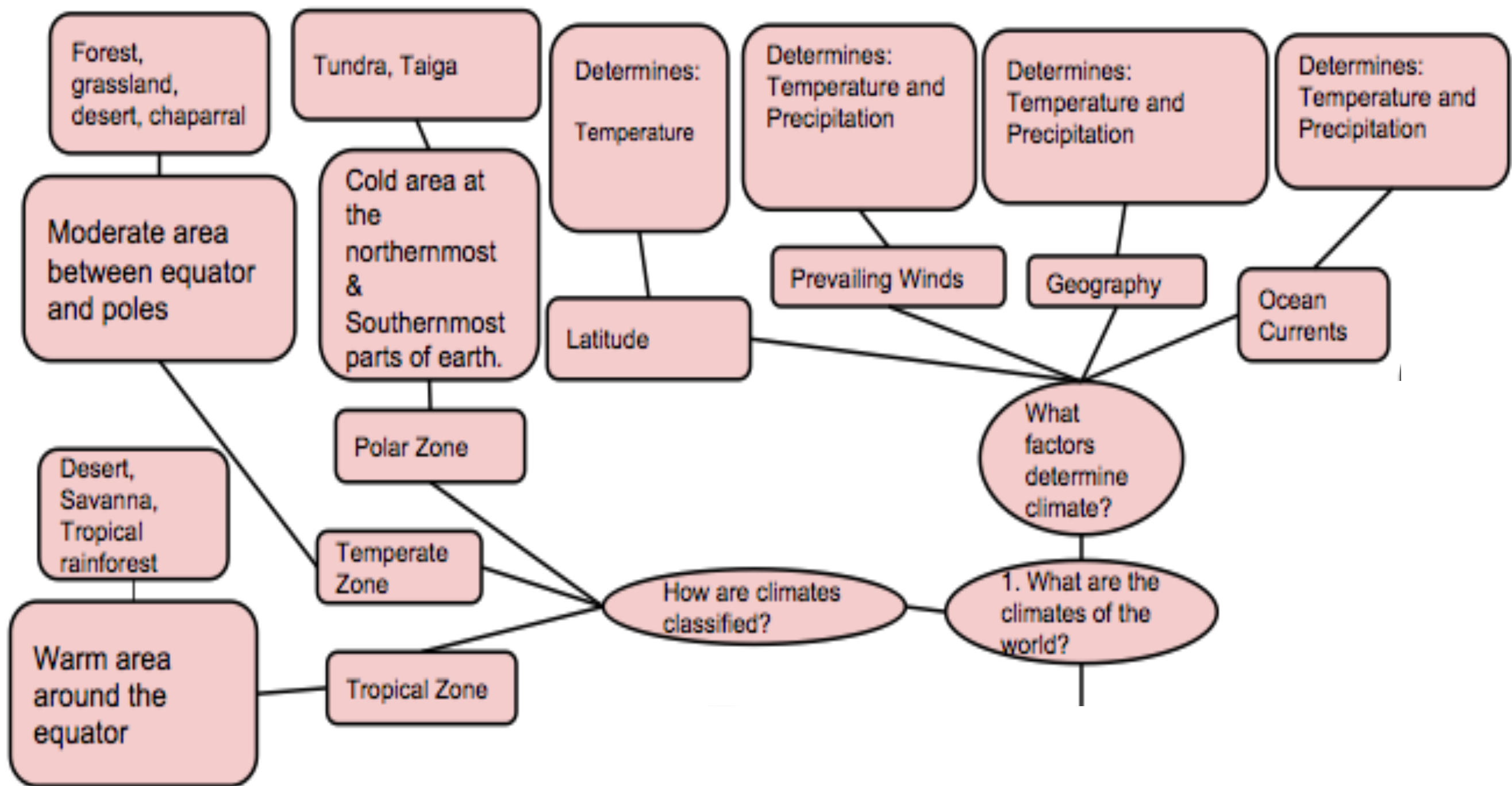


# What are Cold Waves?

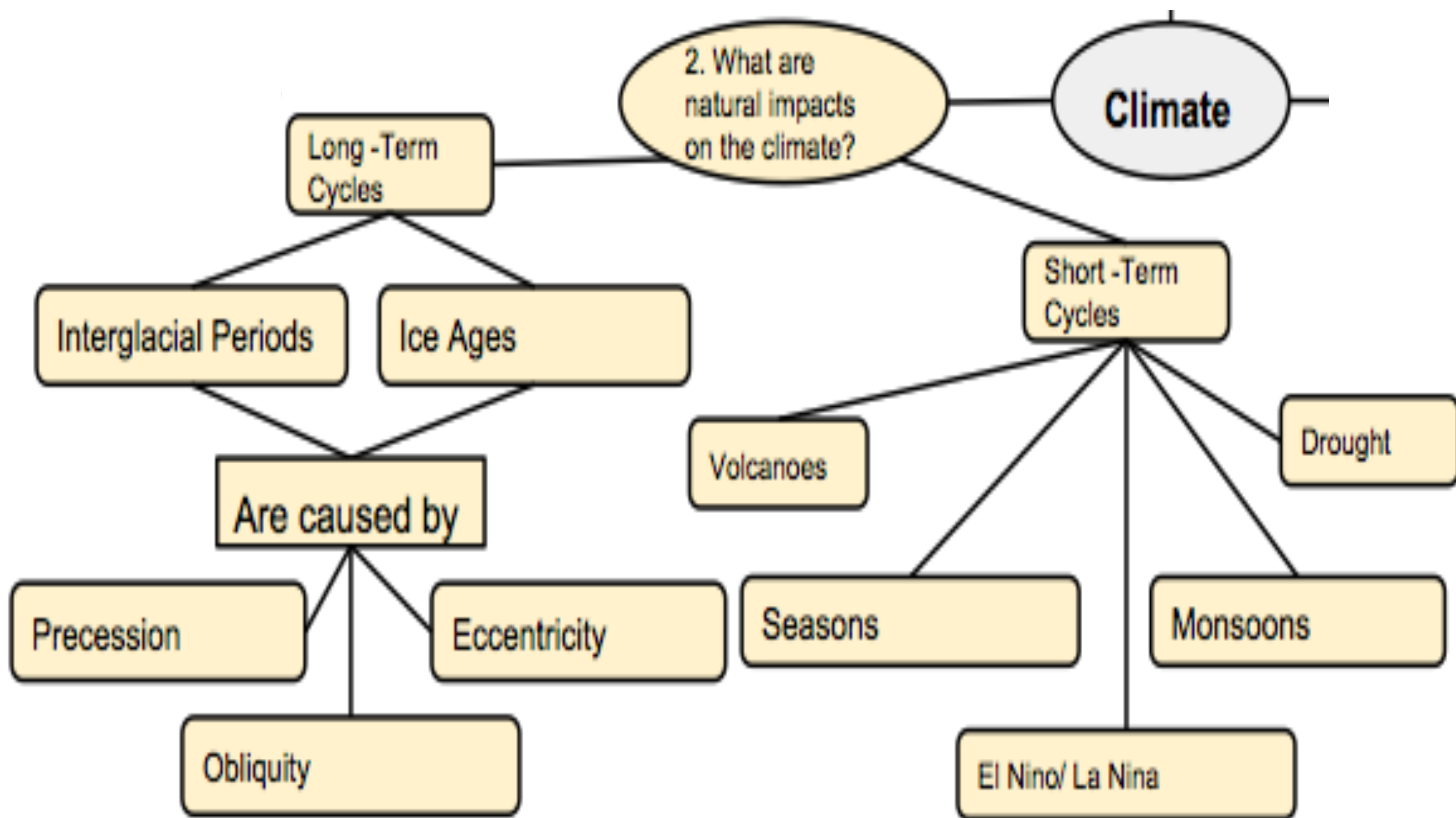
- Long periods of unusually cold temperatures. Occurs when a continental polar air mass stays over a region for an extended period of time.



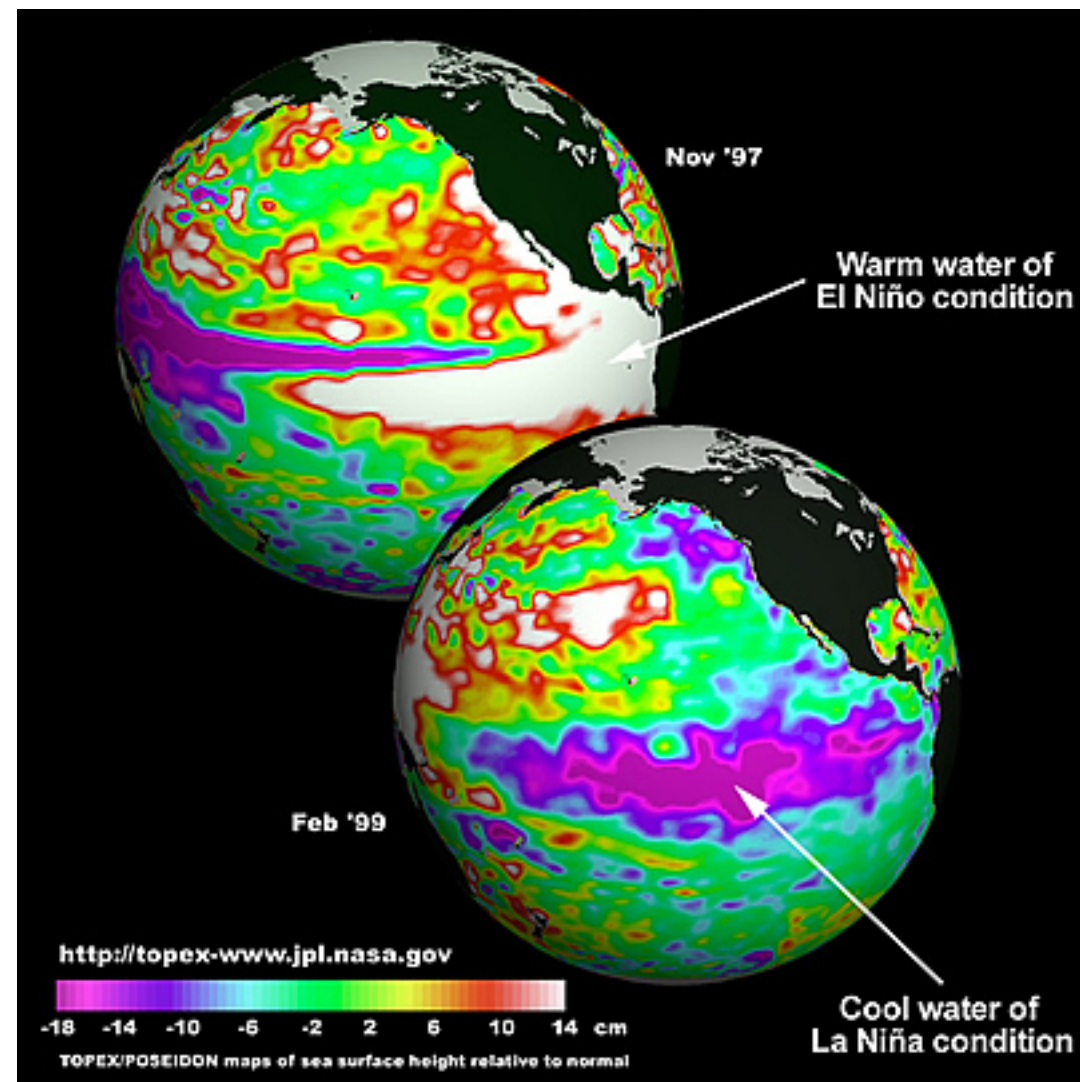








# Intro to El Niño



# El Niño-Southern Oscillation

- Floods and mudslides in Ecuador, droughts and wildfires in Australia, and extreme California rainstorms – could all of these events be triggered by the same thing? Yes they can. It's the El Niño-Southern Oscillation (ENSO), a combination of changes in the ocean and atmosphere that affect weather in many areas of the world.
- Normally, trade winds move water at the ocean surface from the eastern tropical Pacific towards the western Pacific. This creates upwelling of cold nutrient-rich water off the coast of Peru and Chile, which supports a diversity of marine life. The western Pacific is in a low pressure system and has wet weather. The eastern Pacific, in a high pressure system, is dry. But every 3 to 7 years the atmosphere and ocean change during El Niño and La Niña events – the two extremes of ENSO.

- During El Niño, air pressure rises in the western Pacific and falls in the central and eastern Pacific. Without the strong pressure gradient, the trade winds weaken. Without the trade winds there is less upwelling near the coast of South America and the warm and nutrient-poor water of the western Pacific spreads east, piling up water in the eastern tropical Pacific. Not as much marine life can survive in the warm water as can in the cool nutrient-rich waters. The warm water in the Pacific evaporates faster than cool water, leading to more water vapor in the air which can cause high humidity and storms in areas that are usually dry.
- During La Niña, the cold phase of ENSO, the trade winds grow stronger across the Pacific because the low pressure over the western Pacific strengthens, as does the high pressure over the central and eastern Pacific. This causes more upwelling of ocean water off the coast of Peru and Chile, making the surface water of the eastern tropical Pacific unusually cold.
- Both El Niño and La Niña events can have far-reaching effects on the weather. Intense rainstorms and flooding, extreme droughts, the strength of the Atlantic hurricane season, and winter storms in many areas of the world are affected by ENSO events. ENSO may also have an impact on the North Atlantic Oscillation as it has an effect on the Arctic troposphere. These impacts are called teleconnections.



# Reflection Questions

1. How often do El Niño and La Niña events change?

Every 3-7 years

2. What happens during an El Niño year?

There is less upwelling near the coast of South America and the warm and nutrient-poor water of the western Pacific spreads east, piling up water in the eastern tropical Pacific. This causes an increase in high humidity and storms in the Eastern Pacific.

3. What happens during an La Niña year?

Trade winds grow stronger causing more upwelling of ocean water off the coast of Peru and Chile, making the surface water of the eastern tropical Pacific unusually cold.

4. How can El Niño and La Niña effect weather and climate?

Both El Niño and La Niña events can have far-reaching effects on the weather. Intense rainstorms and flooding, extreme droughts, the strength of the Atlantic hurricane season, and winter storms in many areas of the world are affected by ENSO events

# January 2000 SST anomaly map

Image 1

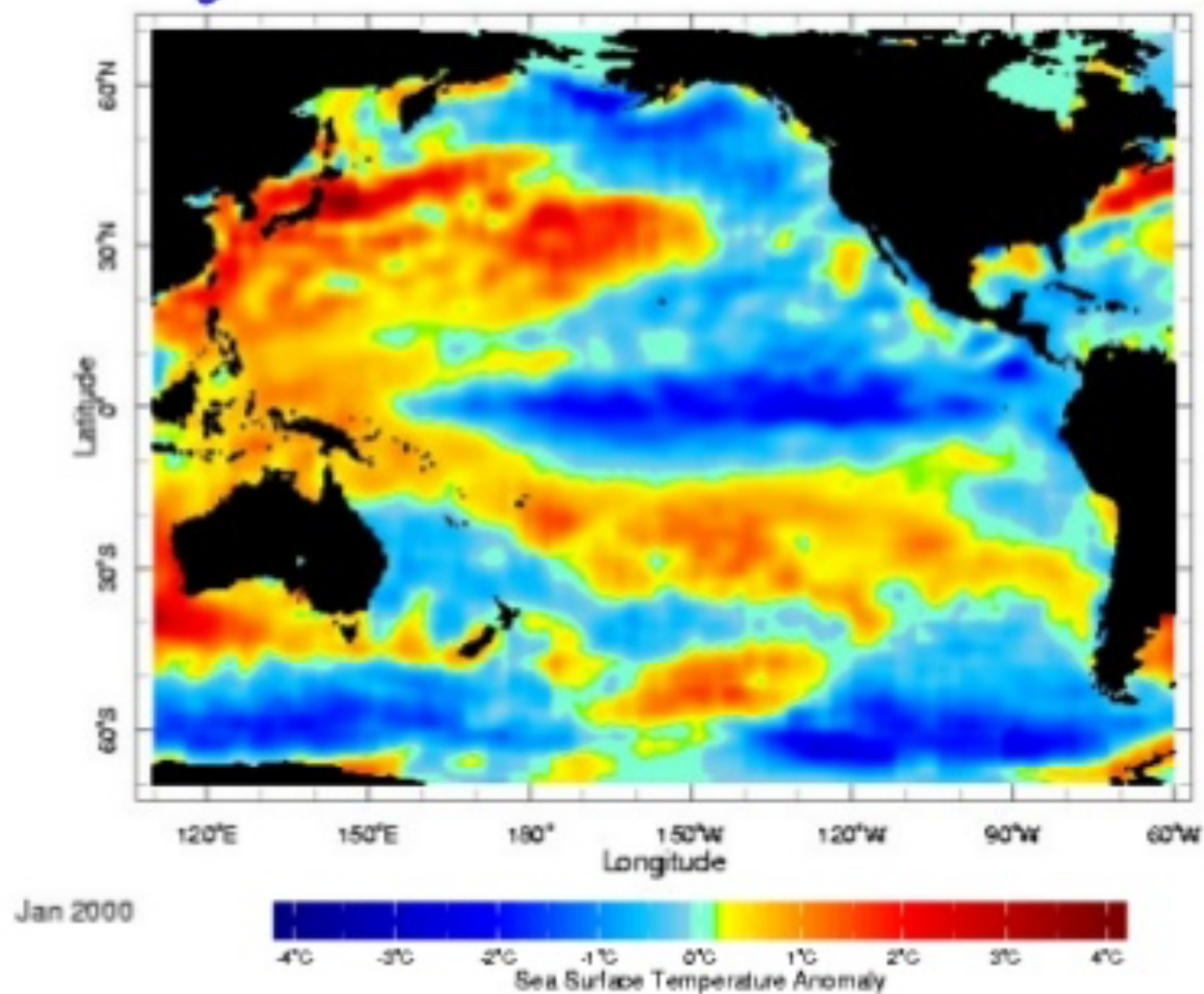


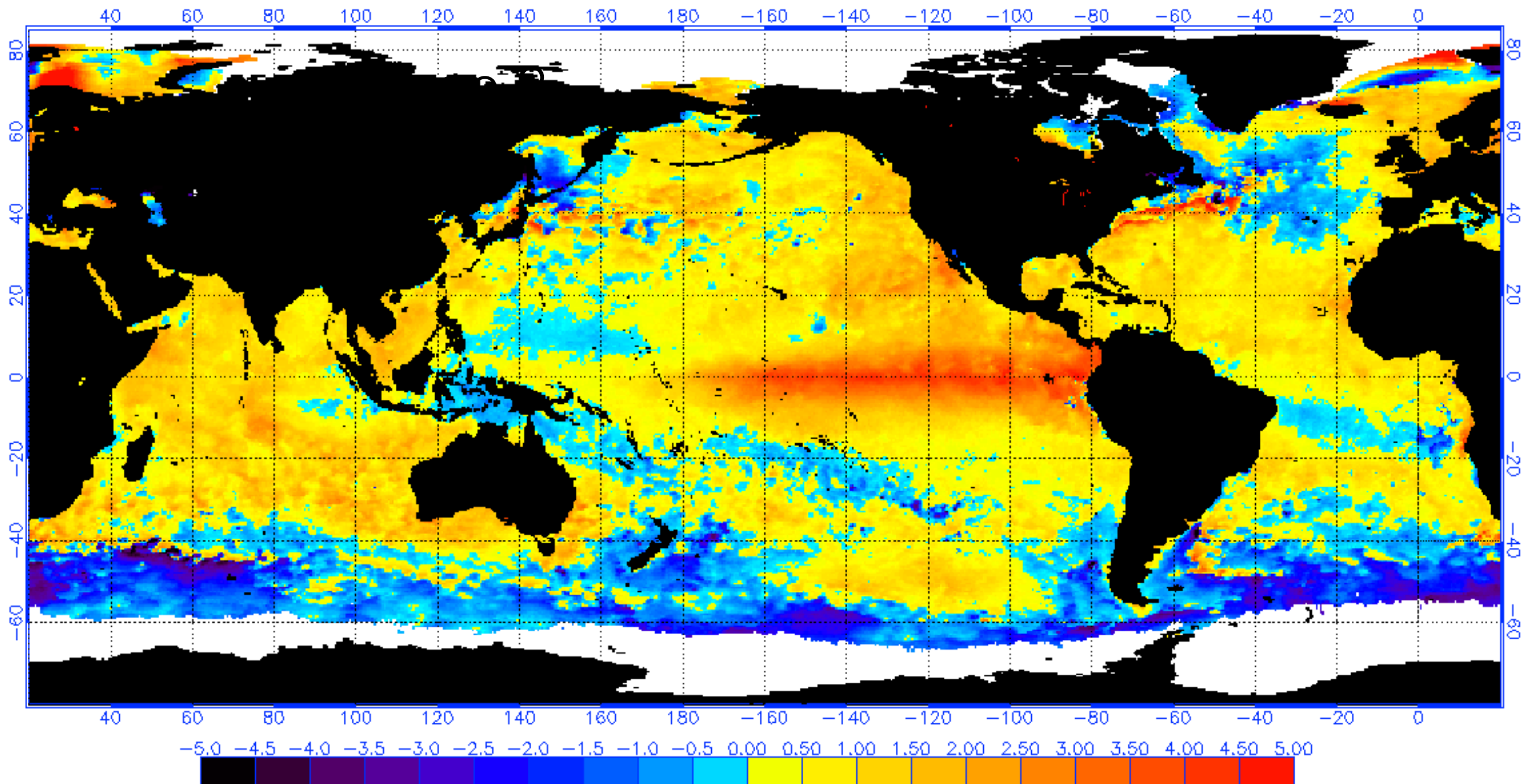
Figure 7-19b

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the western Pacific, Most of the cold water is in the Eastern Paci

NOAA/NESDIS 50 KM GLOBAL ANALYSIS: SST Anomaly (degrees C), 11/9/2015

(white regions indicate sea-ice)



the Eastern Pacific, Most of the cold water is in the Western Pac

- [Understanding El Nino](#)

- Describe what El Nino is:

**A phase in which; Equatorial Pacific Water heats up, surface wind decreases and rainfall increases in central and eastern pacific.**

- Describe the change in precipitation to the United States during an El Nino year.

**Wetter than average in the southern half of the United States and Dryer than average in the Northern Half of the United State**

- Describe the change in temperature to the United States during an El Nino year.

**Below average temperatures in the Southern United States, and warmer than average part of the country**