

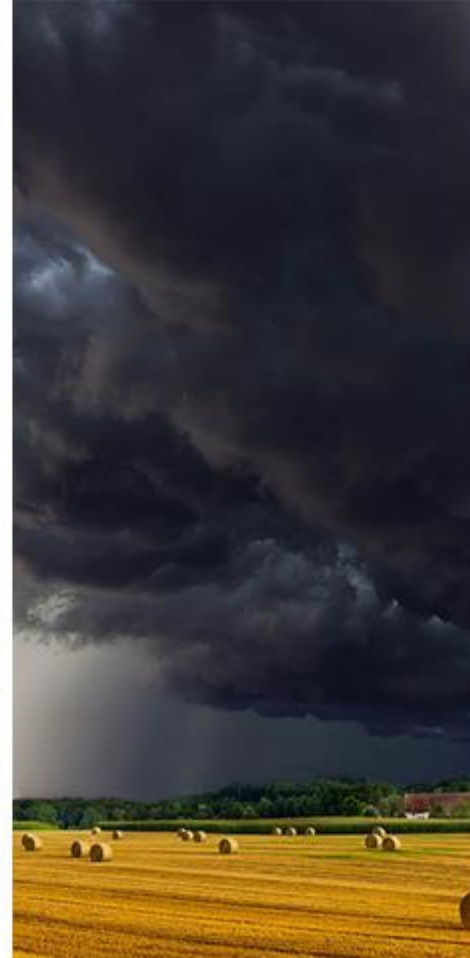
**COURSE: GEO-INFORMATICS IN EARTH SCIENCE,  
TECTONIC HAZARD AND INFRASTRUCTURE  
MANAGEMENT**

**LECTURE 6 – Weather and Climate - Meteorology**

Lecturer: Dr. Tingneyuc Sekac, Ph.D. PNG University of Technology

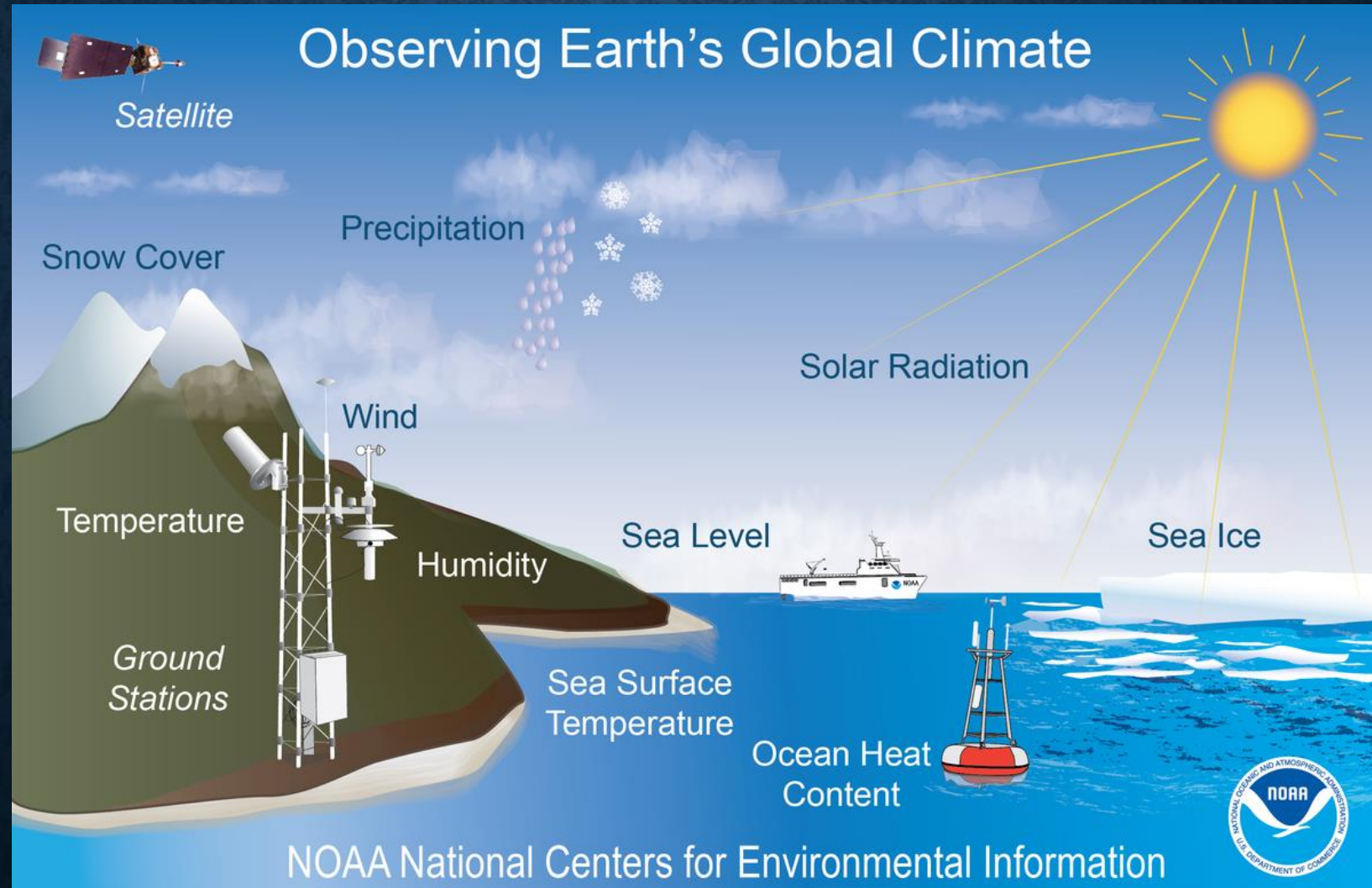
# What is Weather and Climate

Climate is what you expect, weather is what you get



# What is Weather and Climate

Climate is what you expect, weather is what you get



NOAA National Centers for Environmental Information

# What is Weather and Climate

Weather refers to the conditions of the atmosphere at a particular place and time:

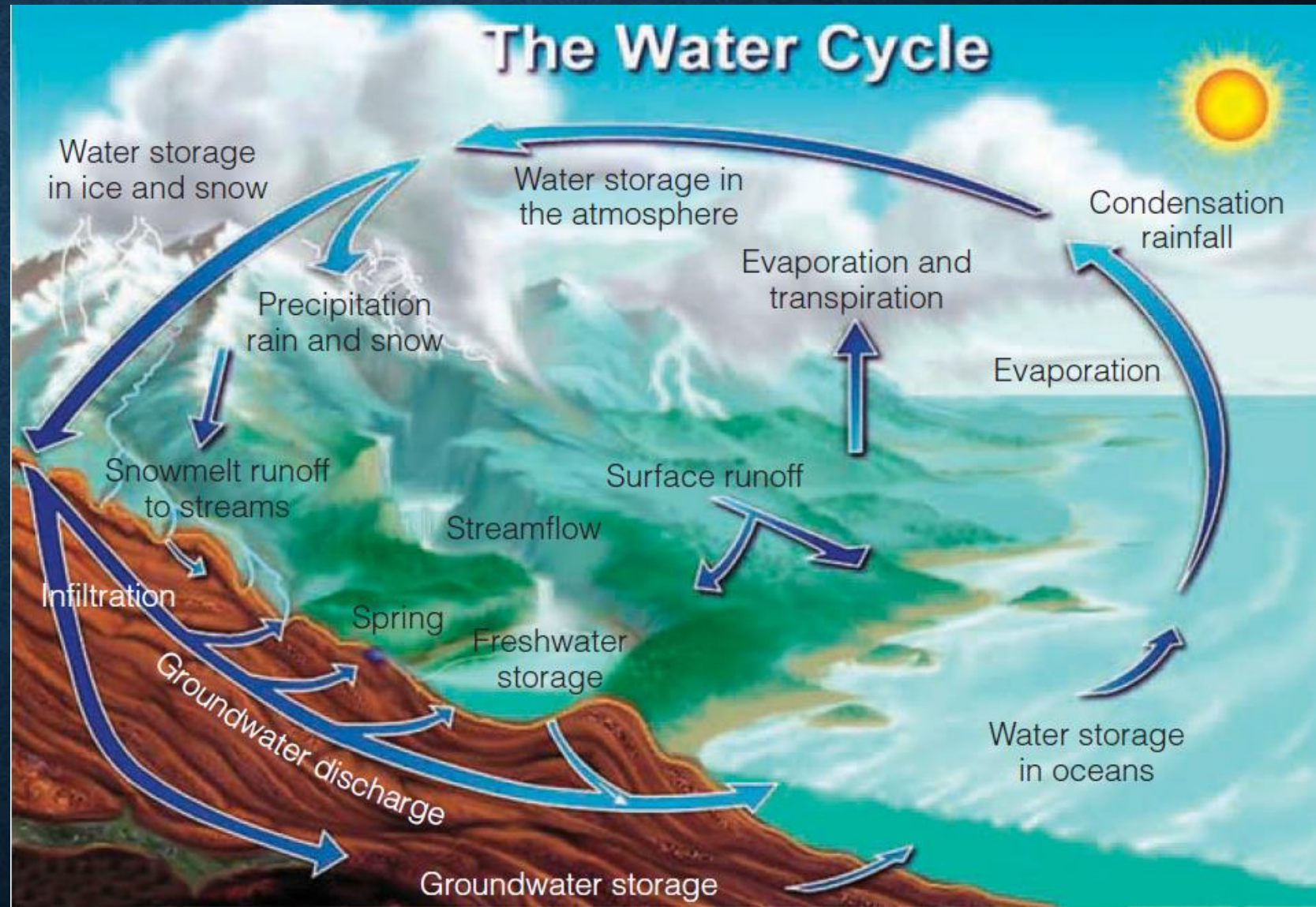
- temperature,
- air pressure,
- humidity,
- precipitation, and
- air motion/pressure.

# What is Weather and Climate

- ❖ Climate is the weather of an area averaged over a long period of time.
- ❖ Climate and Weather have significant effects on the hazards involving;
  - coastal erosion,
  - hurricanes,
  - thunderstorms,
  - tornadoes, and
  - wildfires.
  - Drought

# Hydrologic Cycle

- ❖ Most of the rain that is not taken up by plants soaks in to become groundwater.
- ❖ That groundwater seeps back to the surface into lakes and rivers and ultimately flows back into the sea.
- ❖ This is called the hydrologic cycle
- ❖ Variations in the hydrologic cycle are responsible for droughts and floods.



Source: Hyndman, D., and Hyndman, D., (2007).

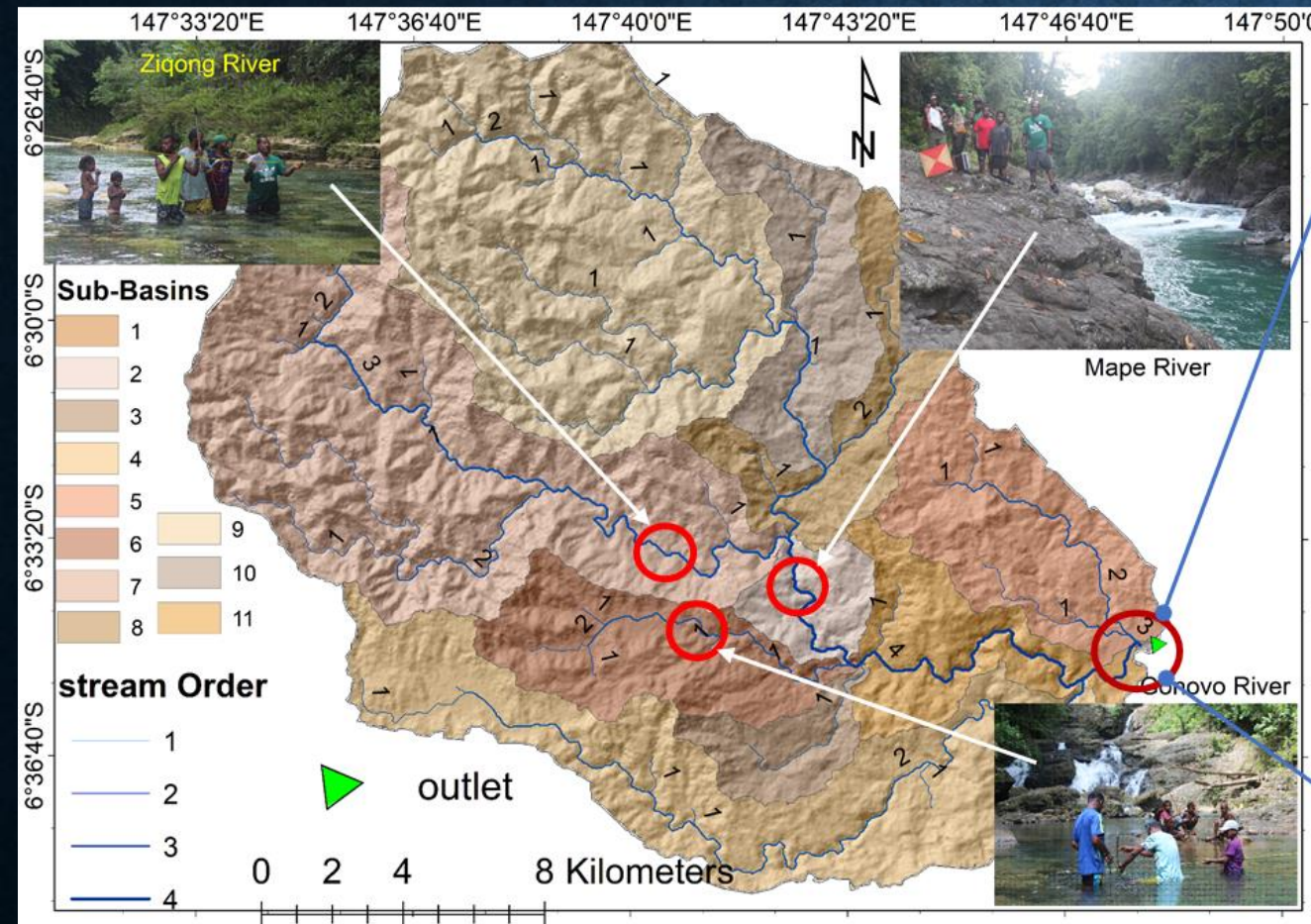
# **Stream or River Development Through Hydrological Process**

## **River Development:**

Over time, the river continues to grow as it collects water from its catchment area.

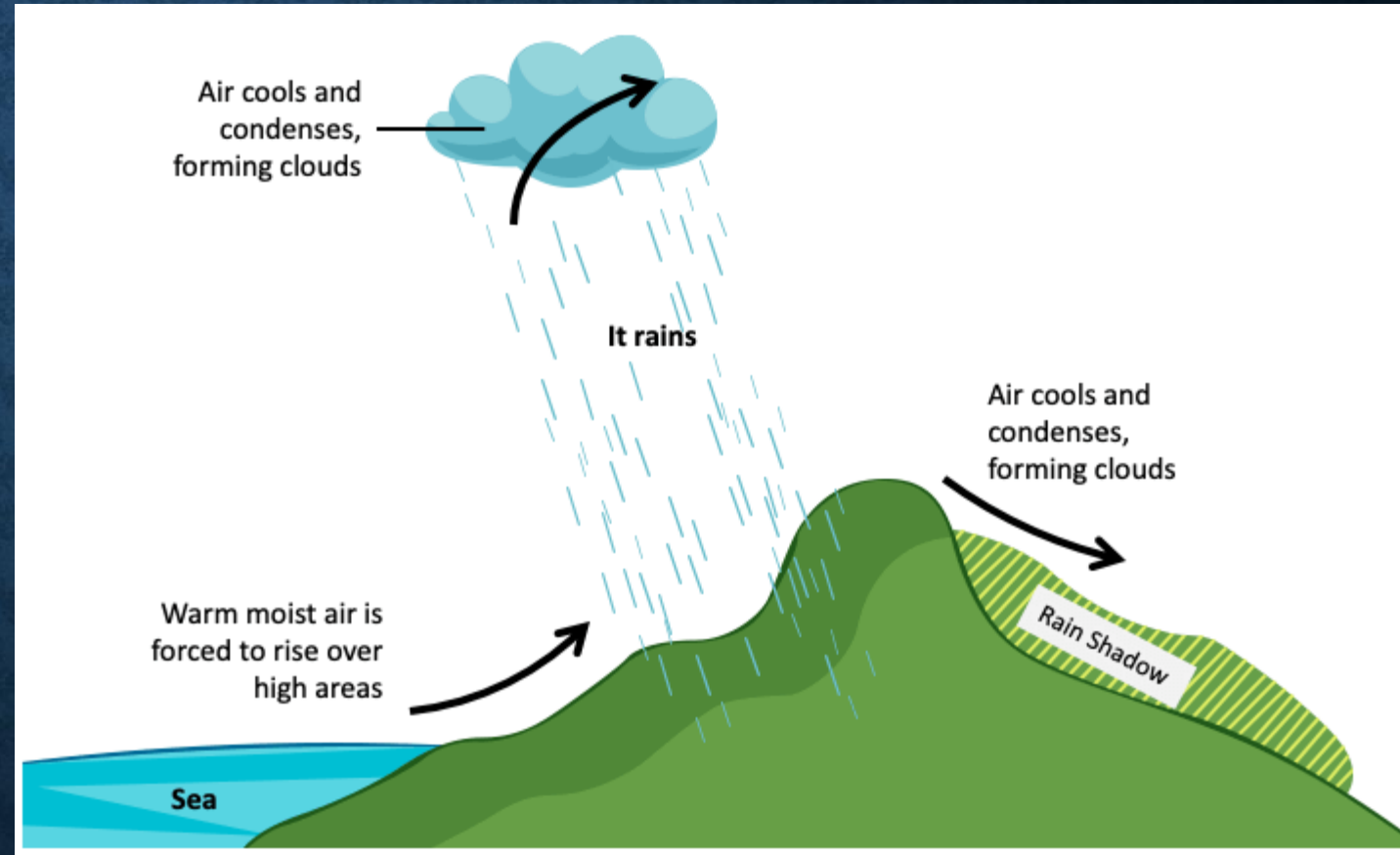
It gains volume and strength, creating a well-defined river with a significant flow of water.

# Stream or River Development Through Hydrological Process



# Hydrological Cycle – Cloud Formation and Rainfall

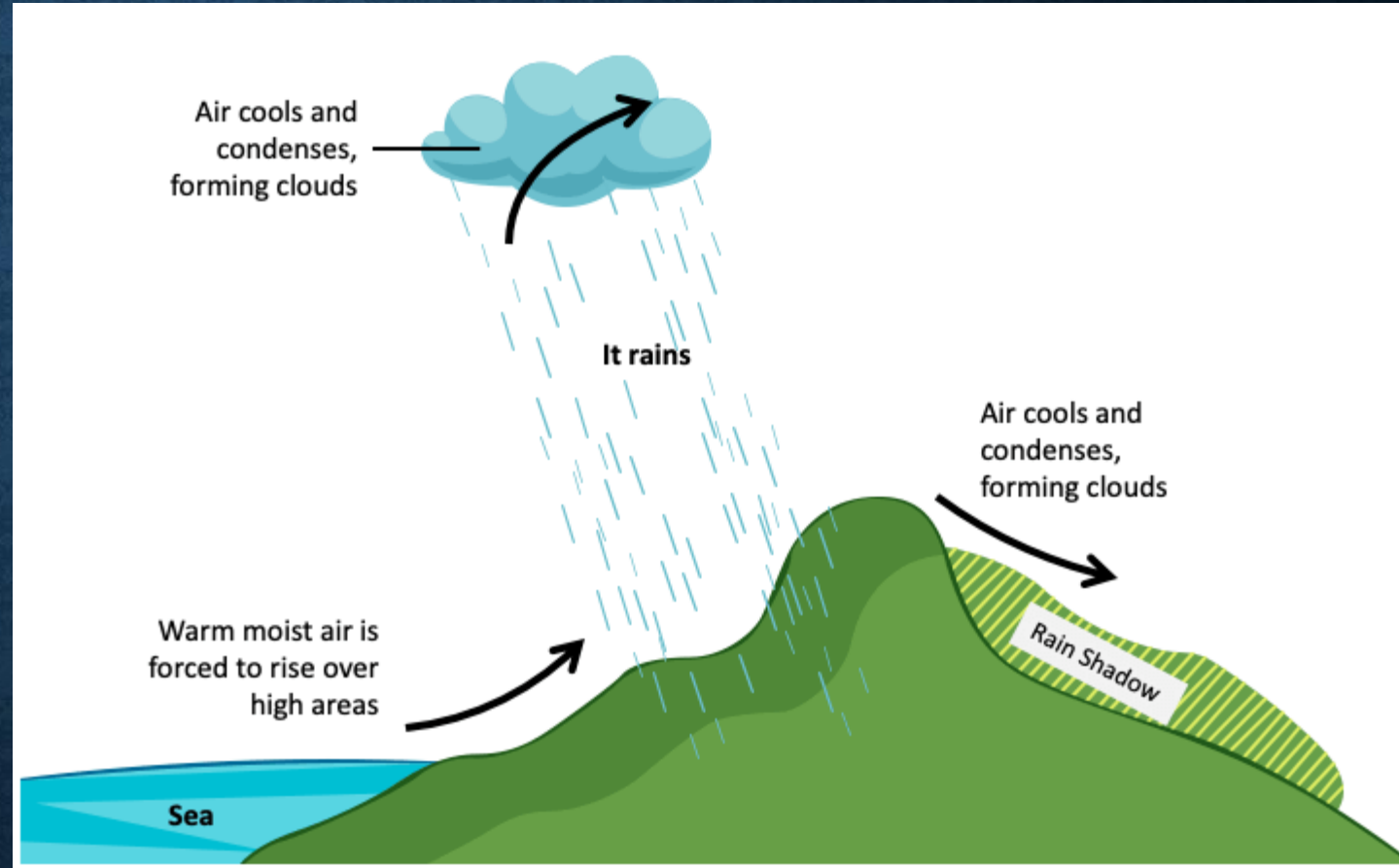
- ❖ Air can dissolve water vapor.
- ❖ The amount of water vapor that can be dissolved in air depends on its temperature;
  - cold air can dissolve little water vapor,
  - warm air can dissolve a lot.
- ❖ When air dissolves the maximum that it can hold, it is saturated with water vapor, result in high **relative Humidity**.



Source: BYJU'S. Retrieved: <https://www.sketchbubble.com/en/presentation-cyclonic-rainfall.html>

# Hydrological Cycle – Cloud Formation and Rainfall

- ❖ More the cooling, More the water vapour, and condense into tiny water droplets and form clouds or fog.
- ❖ If enough water droplets form, they come together and combine into larger droplets and eventually, fall as rain or snow.



Source: BYJU'S. Retrieved: <https://www.sketchbubble.com/en/presentation-cyclonic-rainfall.html>

# Hydrological Cycle

## Influence on Weather:

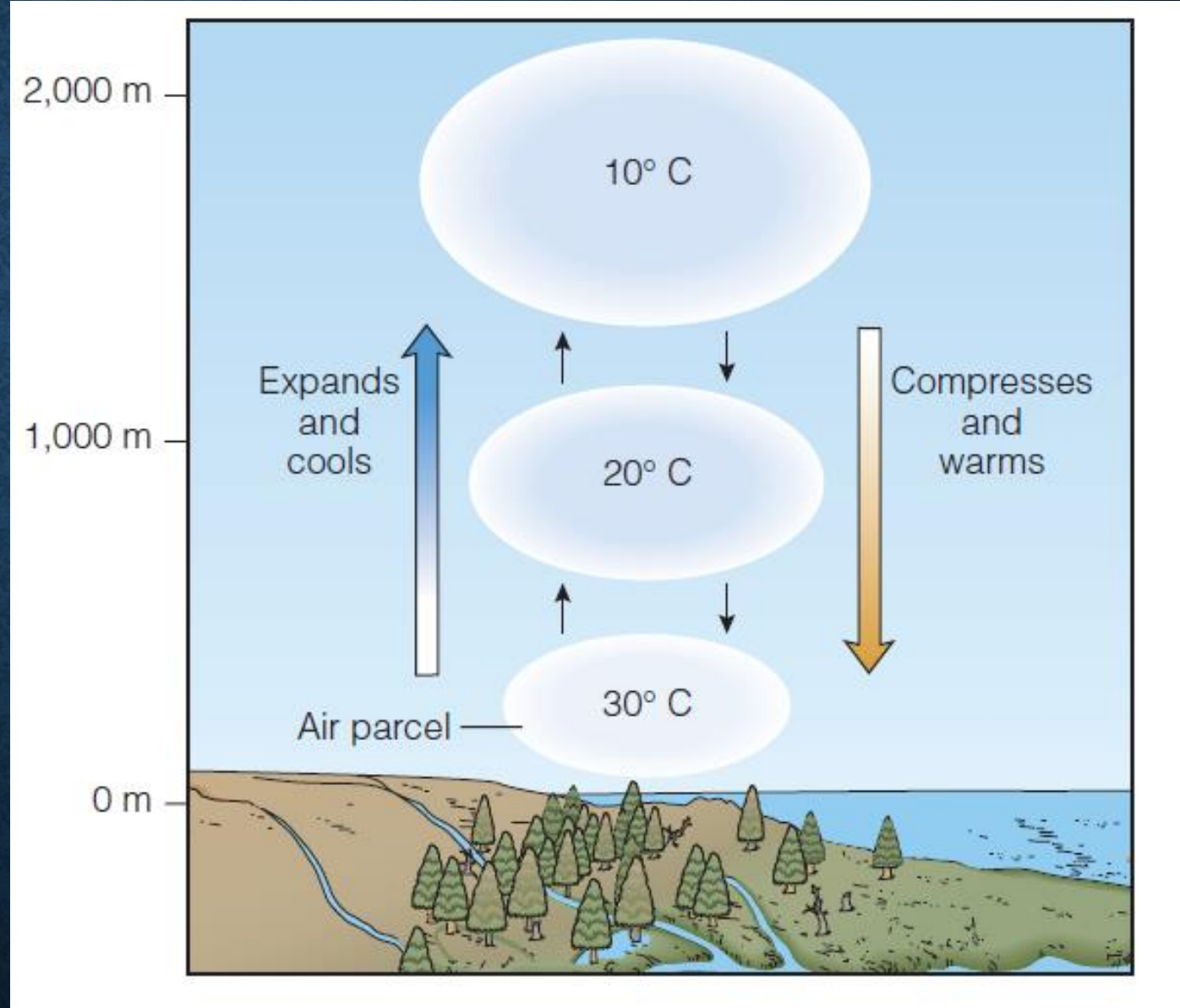
- ❖ Relative humidity affects weather conditions. When the relative humidity is high (e.g., 80% or more), the air is close to being saturated with moisture, and this can lead to the formation of clouds, precipitation (like rain or snow), and a feeling of mugginess.
- ❖ Low relative humidity (e.g., 30% or less) can make the air feel dry and contribute to arid conditions.

# Adiabatic Cooling and Condensation- Orographic Effect

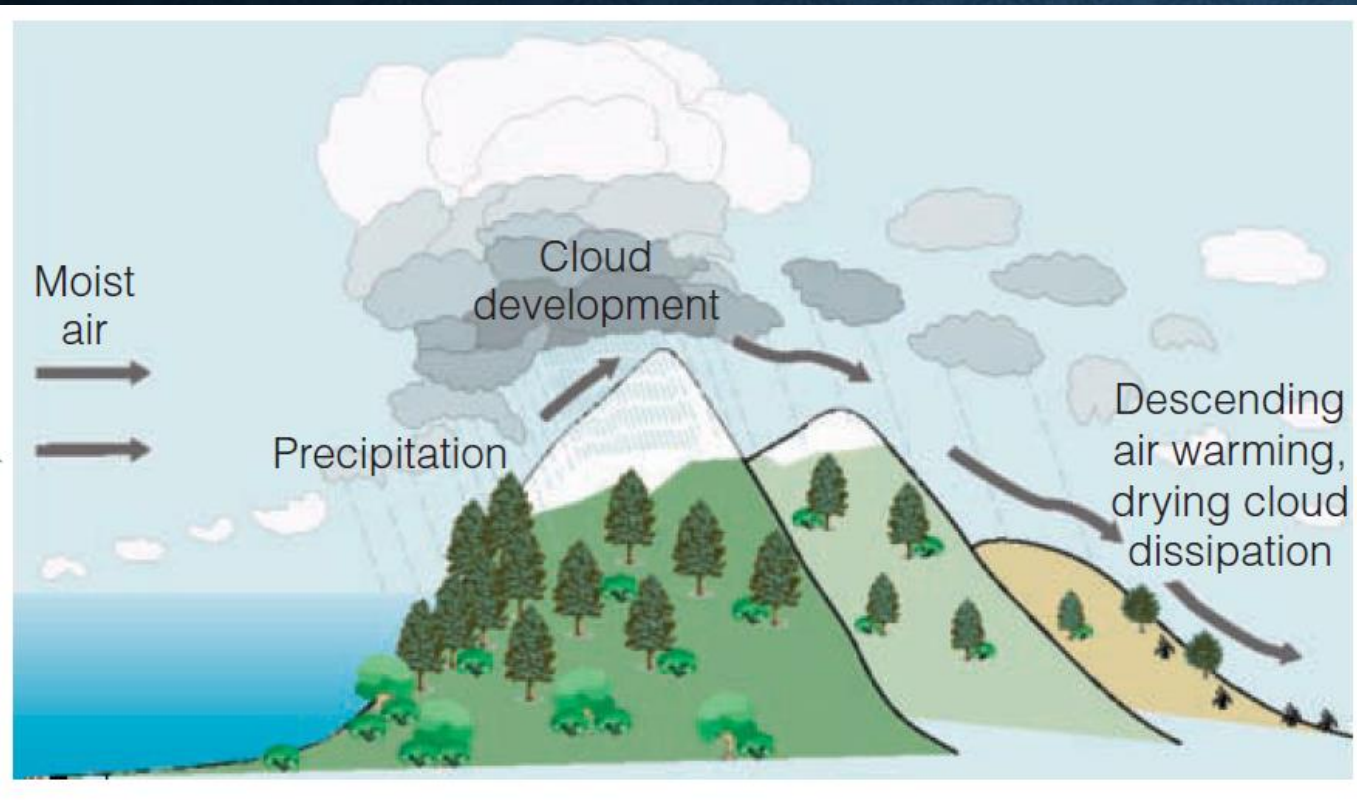
Adiabatic cooling.

Atmospheric pressure is less at higher altitudes, so rising air expands and cools, while falling air compresses and warms.

Under dry conditions, an air parcel will change temperature by  $10^{\circ}\text{C}$  per 1,000 meters of altitude change.



# Adiabatic Cooling and Condensation- Orographic Effect



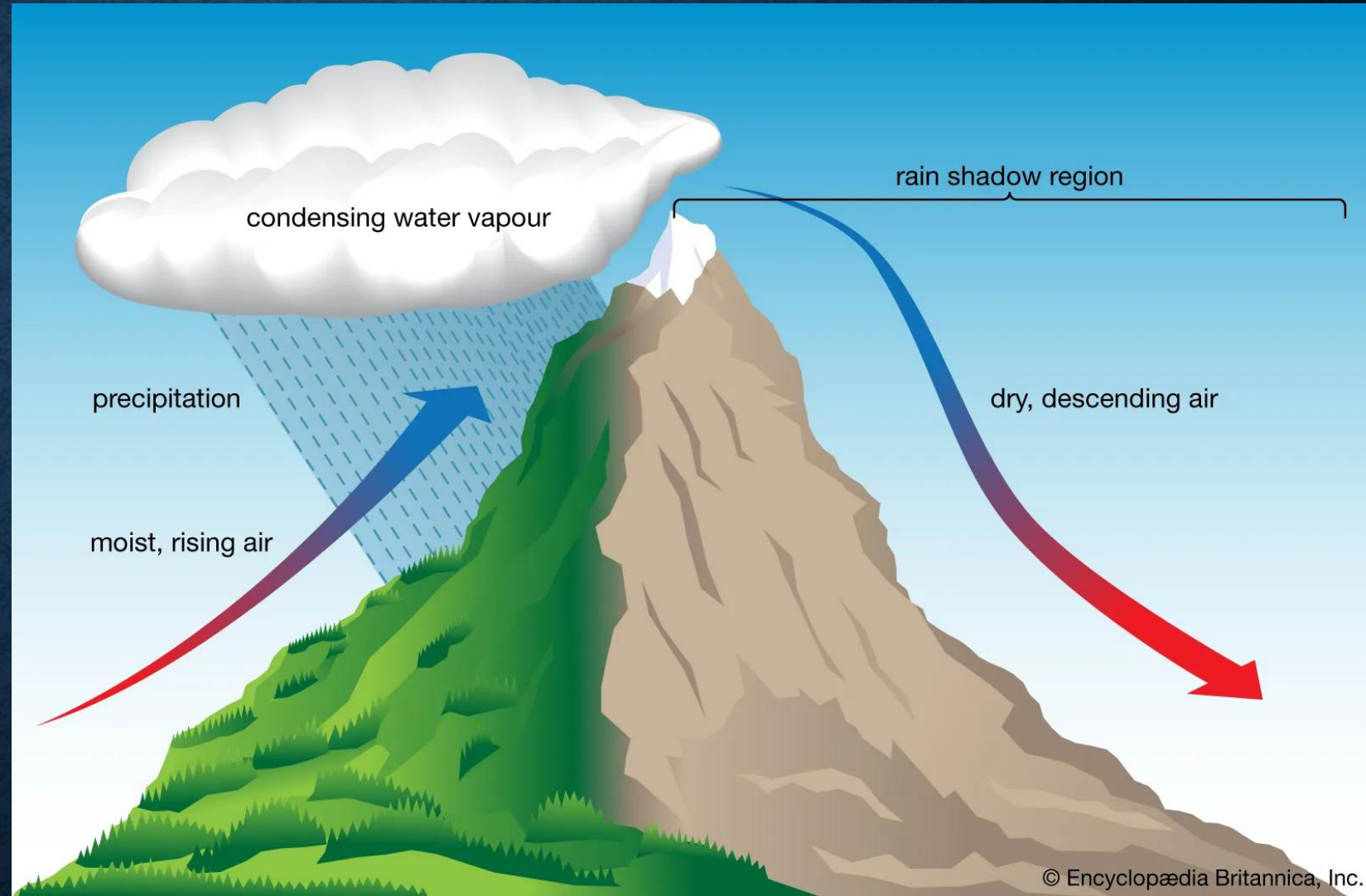
Source: Hyndman. D., and Hyndman. D., (2007), Jim O'Connor & John Costa, USGS.

- ❖ The orographic effect shows how warm moist air rises, expands, cools, and dumps precipitation.
- ❖ Descending on the other side of the mountains, it contracts, warms, and dries out. b. Clouds rising from the west evaporate to the east as the air descends and dries out.

Source: Hyndman. D., and Hyndman. D., (2007).

# Adiabatic Cooling and Condensation- Orographic Effect

- ❖ Orographic precipitation, rain, snow, or other precipitation produced when moist air is lifted as it moves over a mountain range.
- ❖ As the air rises and cools, orographic clouds form and serve as the source of the precipitation.



Source: Encyclopædia Britannica, (2023)

<https://www.britannica.com/science/orographic-precipitation#/media/1/433062/140263>

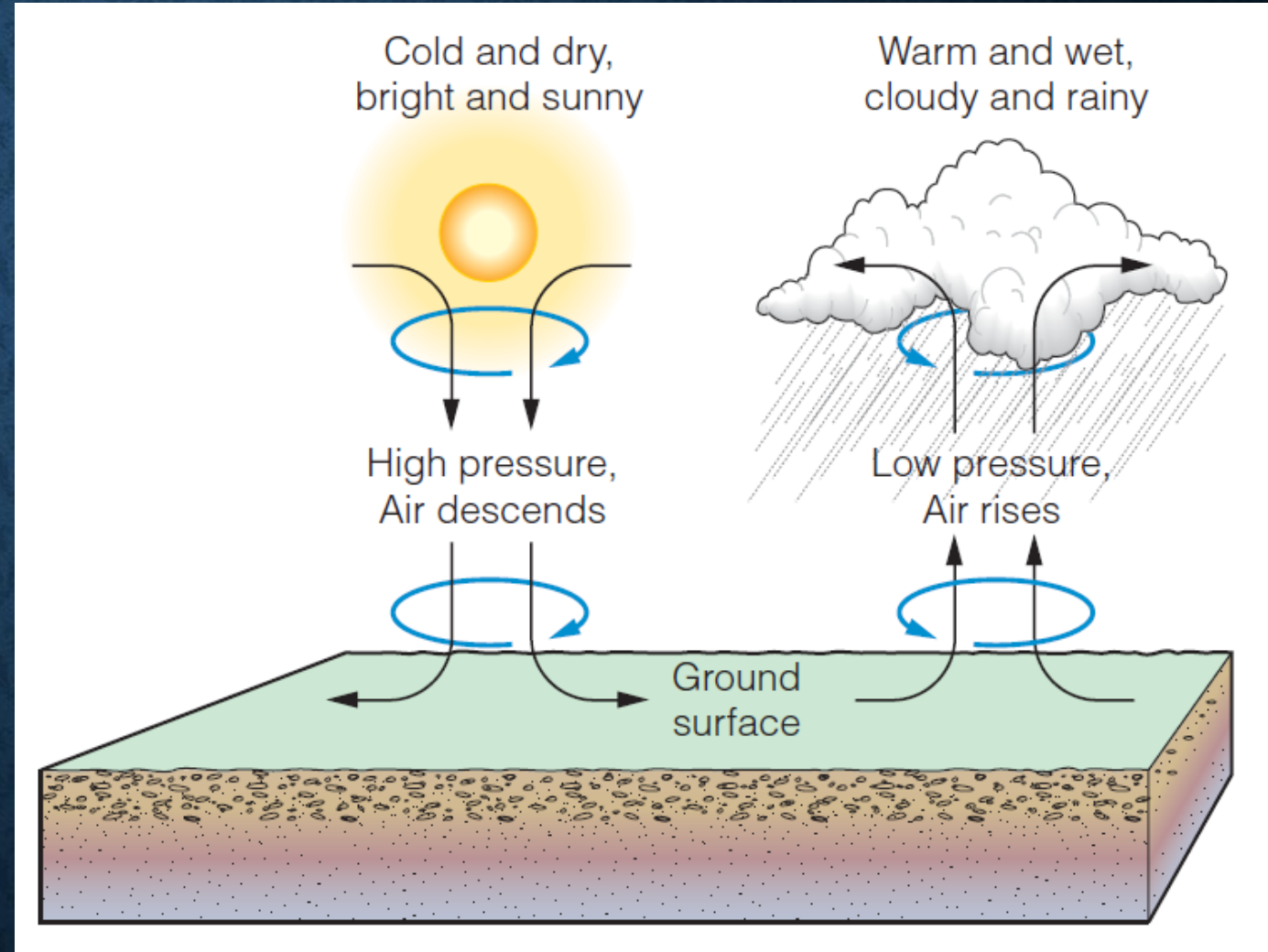
# Atmospheric Pressure and Weather

Air pressure is related to the weight of the column of air from the ground to the top of the atmosphere.

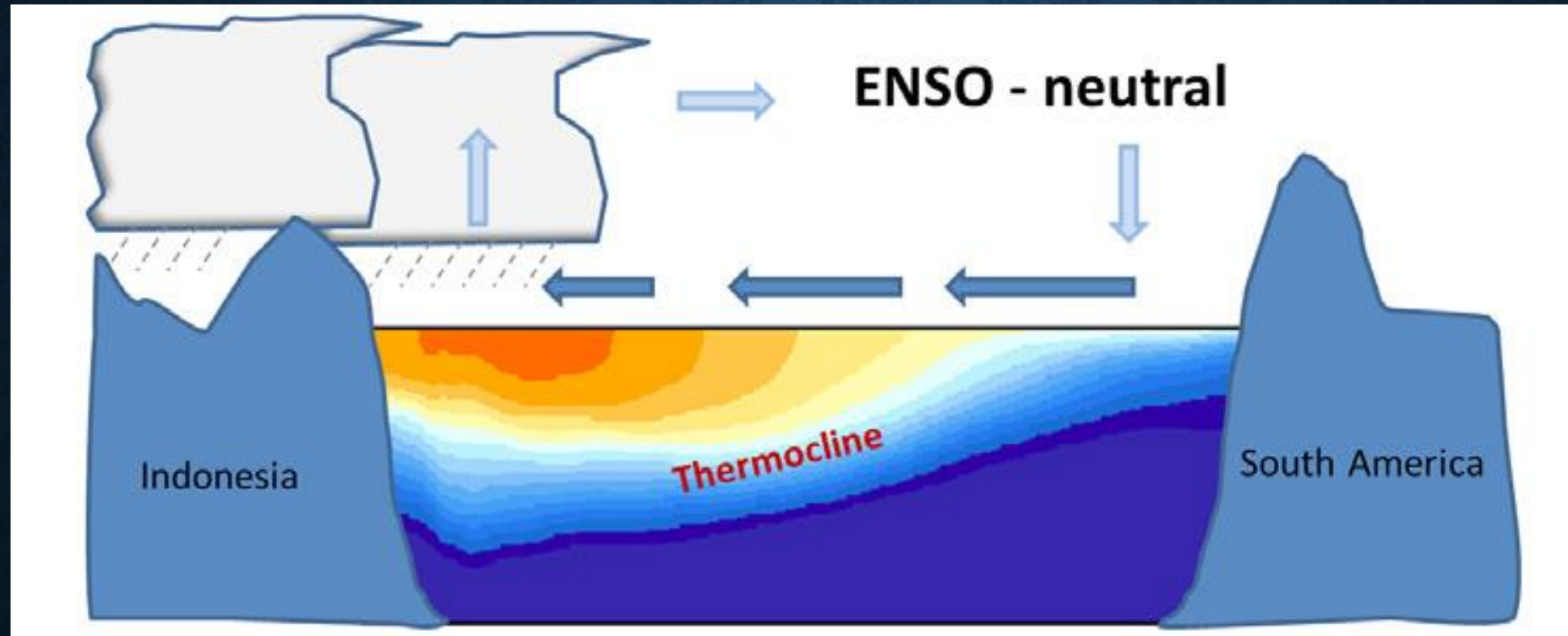
Differences in atmospheric pressure drive air movements and winds, that is Air flows from high- to low-pressure areas, causing winds.

# Atmospheric Pressure and Weather

- ❖ Cold dry air descends to create high atmospheric pressure areas and spreads out as it sinks to the land surface.
- ❖ Relatively warm, humid air rises to create low atmospheric pressure areas.
- ❖ Near the land surface, the air is drawn in from the sides, rises, and eventually condenses to form clouds and rain



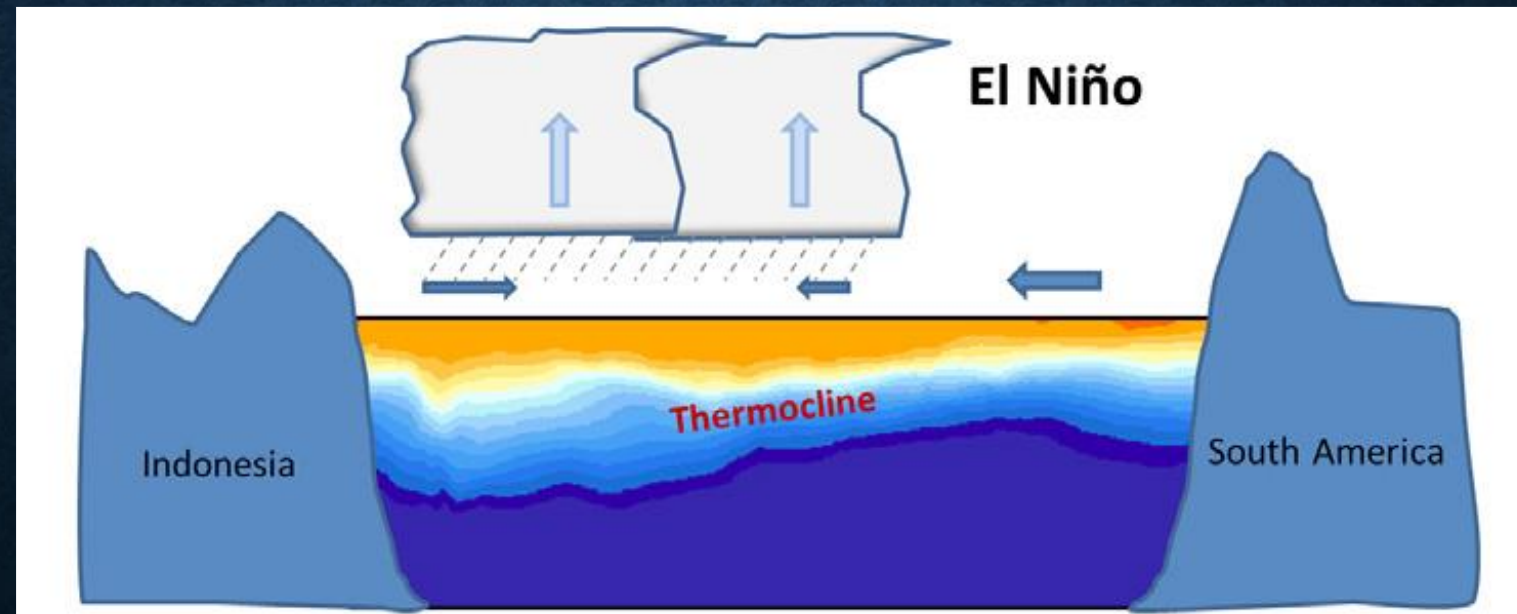
# El-Nino and La Nino Weather Pattern



- ❖ ENSO-neutral: Normally, strong trade winds blow from the east along the equator, pushing warm water into the western Pacific Ocean

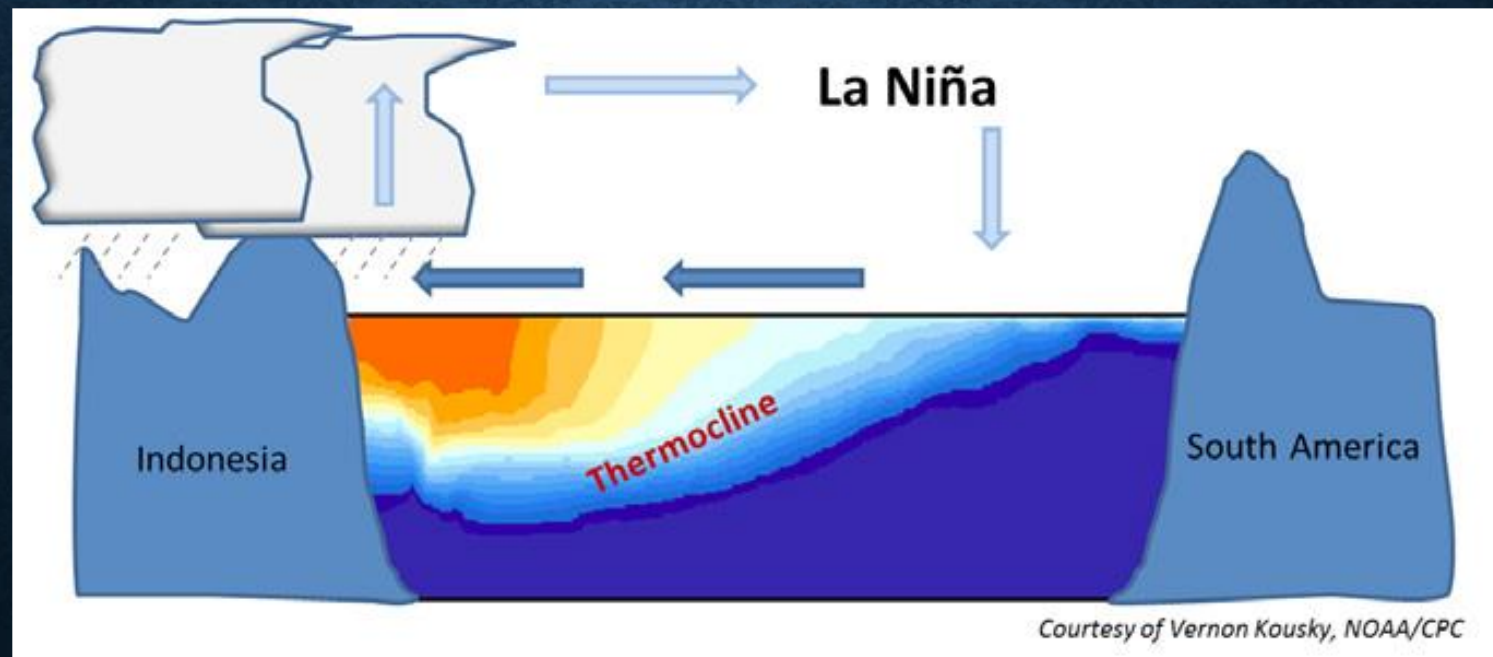
# El-Nino and La Nino Weather Pattern

- ❖ El Niño conditions occur when abnormally warm waters accumulate in tropical latitudes of the central and eastern Pacific Ocean associated with a weakening of the low-level easterly winds.
- ❖ Consequently, tropical rains that usually fall over Indonesia shift eastward.



# El-Nino and La Nino Weather Pattern

- ❖ La Niña conditions occur when cooler-than-average waters accumulate in the central and eastern tropical Pacific, associated with a strengthening of the low-level easterly winds over the central tropical Pacific.
- ❖ Heavy rainfall occurs over Indonesia, Malaysia, PNG.



# Climate Change and Impact

- ❖ Climate change can be seen as the changes in weather patterns/climate variance over a long period of time and is caused by either natural or human-made processes and activities.
- ❖ However, most are from human activities.
- ❖ The impacts are enormous and dangerous, and viewed in:
  - ✓ human inhabitants,
  - ✓ agricultural sector,
  - ✓ hydrological sector,
  - ✓ Biodiversity.

# Climate Change and Impact

❖ When experiencing climate change impacts - 3 approaches;

1. Minimized causes,
2. adapt
3. facing risk and extinct

# Climate Change and Impact

## ➤ What brings concern about climate change and its impact

- ✓ Increasing emission of greenhouse gasses
- ✓ increase temperature and precipitation variance and
- ✓ changes in land use.

## ➤ Climate related study involves assessments and analyzing:

- climatic and geographic variables
- Related impacts

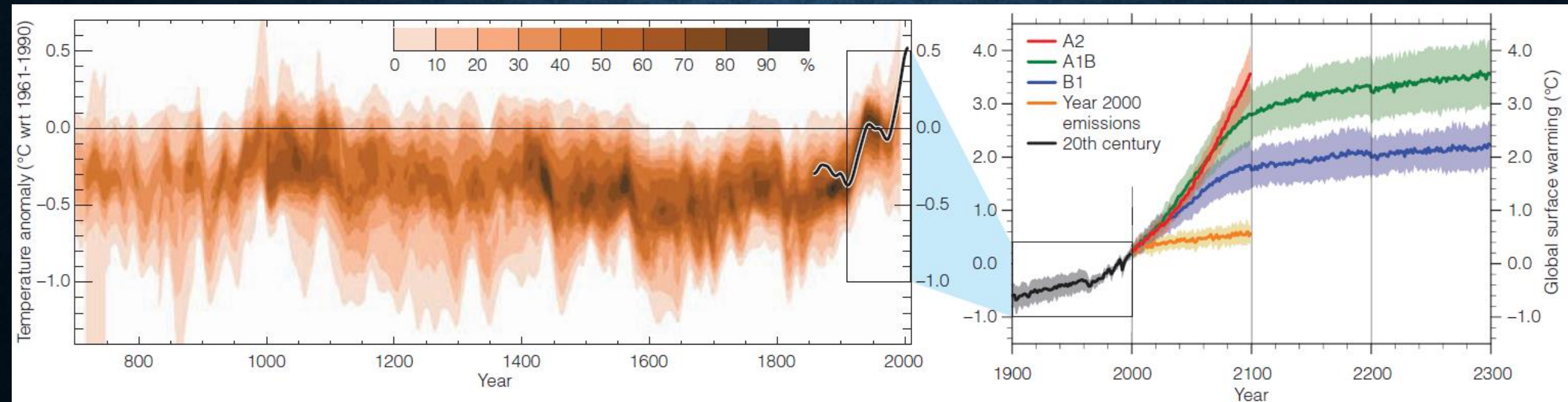
These are done in different disciplinary wise and approaches.

# Global Warming and the Greenhouse Gas

- ❖ Earth's average surface temperature has been rising since the Industrial Revolution began in the late 1700s.
- ❖ The temperature increased by about  $1^{\circ}\text{C}$  over the past century, with the most dramatic increase since 1970.
- ❖ The IPCC in 2007 estimated that the Earth's average surface temperature will likely rise by  $1.6^{\circ}\text{--}3.4^{\circ}\text{C}$  over the next century.

# Global Warming and the Greenhouse Gas

- ❖ Changes in Earth's surface temperature since 1850 and projected future increase in Earth's surface temperature. The increase through the twentieth century is well known from measurements.
- ❖ Projected increases for the twenty-first century depend on various scenarios for amounts of fossil-fuel burning and various feedback mechanisms.
- ❖ Even with no additional greenhouse gas content in the atmosphere (orange line), temperatures will increase very slowly because of heat slowly released from the oceans.

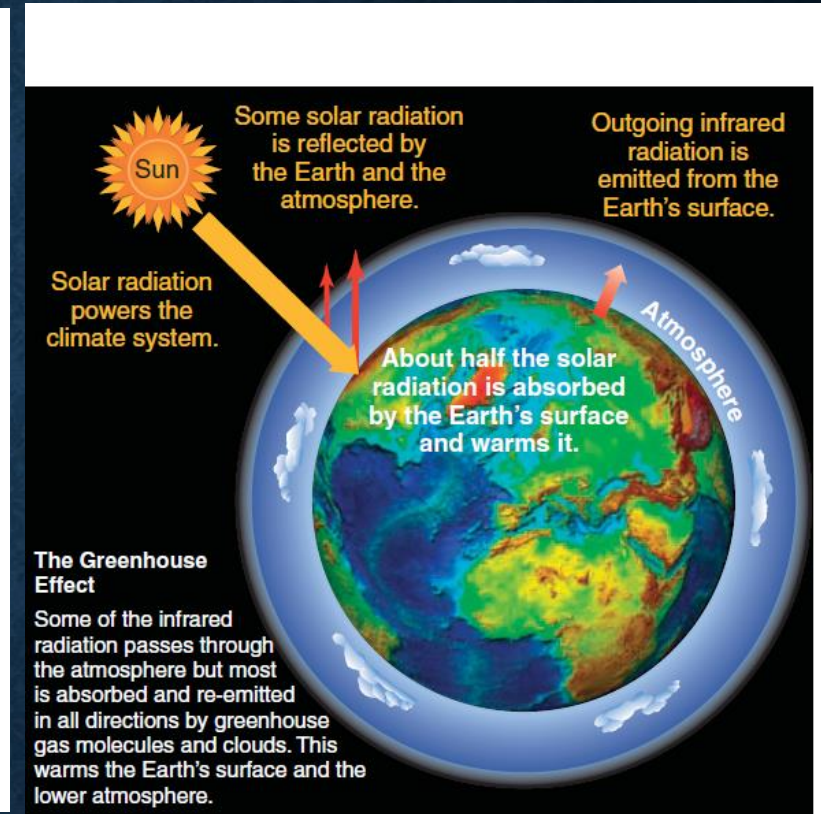


# Global Warming and the Greenhouse Gas

- ❖ Most recent rise in temperature is due to increases in atmospheric greenhouse gases;
  - carbon dioxide (CO<sub>2</sub>),
  - Methane
  - (CH<sub>4</sub>), chlorofluorocarbons (CFCs),
  - ozone (O<sub>3</sub>), and
  - nitrous oxide (NO<sub>2</sub>).

# Global Warming and the Greenhouse Gas

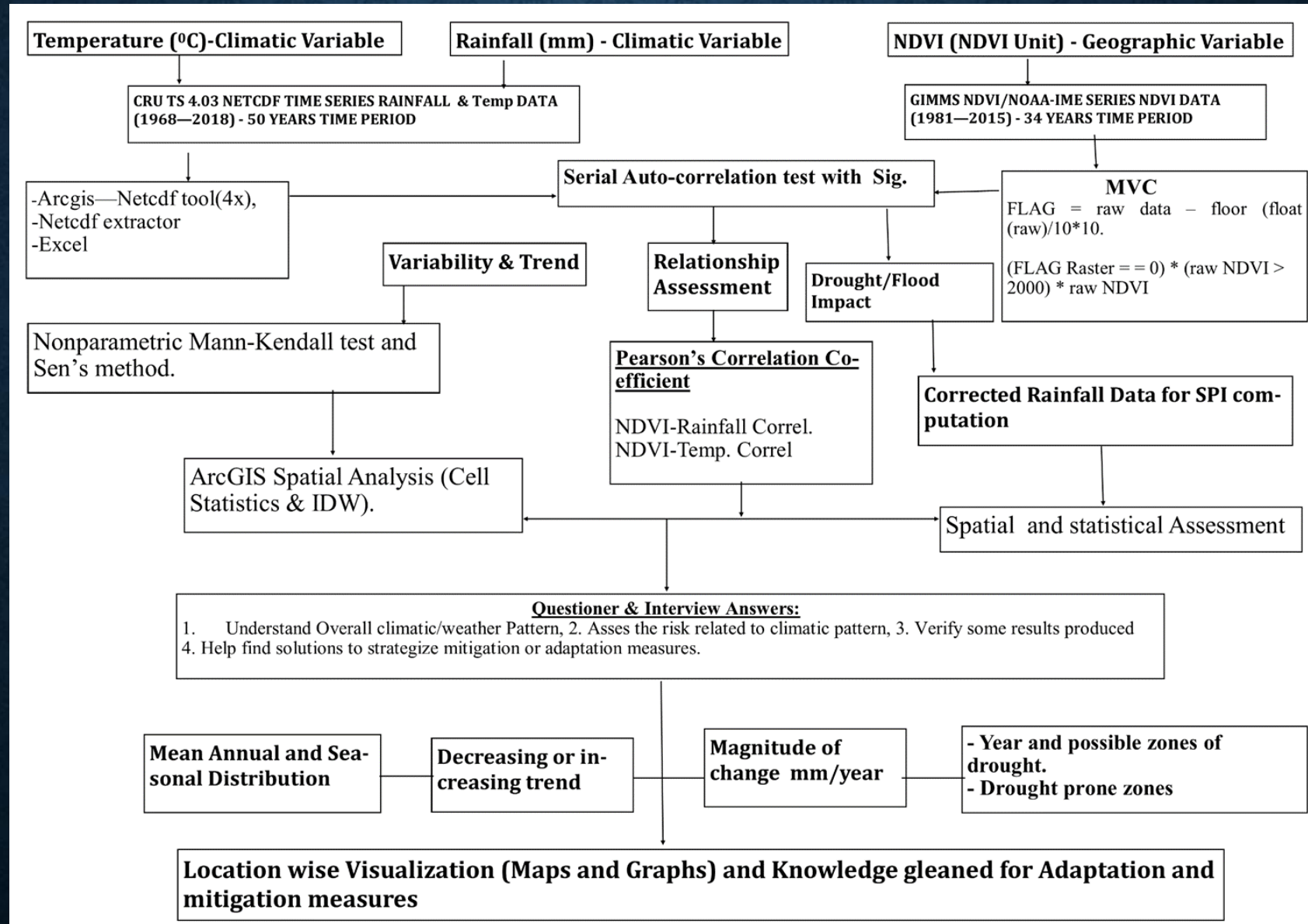
❖ Most greenhouse gases trap heat in the atmosphere in about the same way that a greenhouse permits the sun to shine through glass, but prevents much of the heat from escaping, in a phenomenon called the **greenhouse effect**.



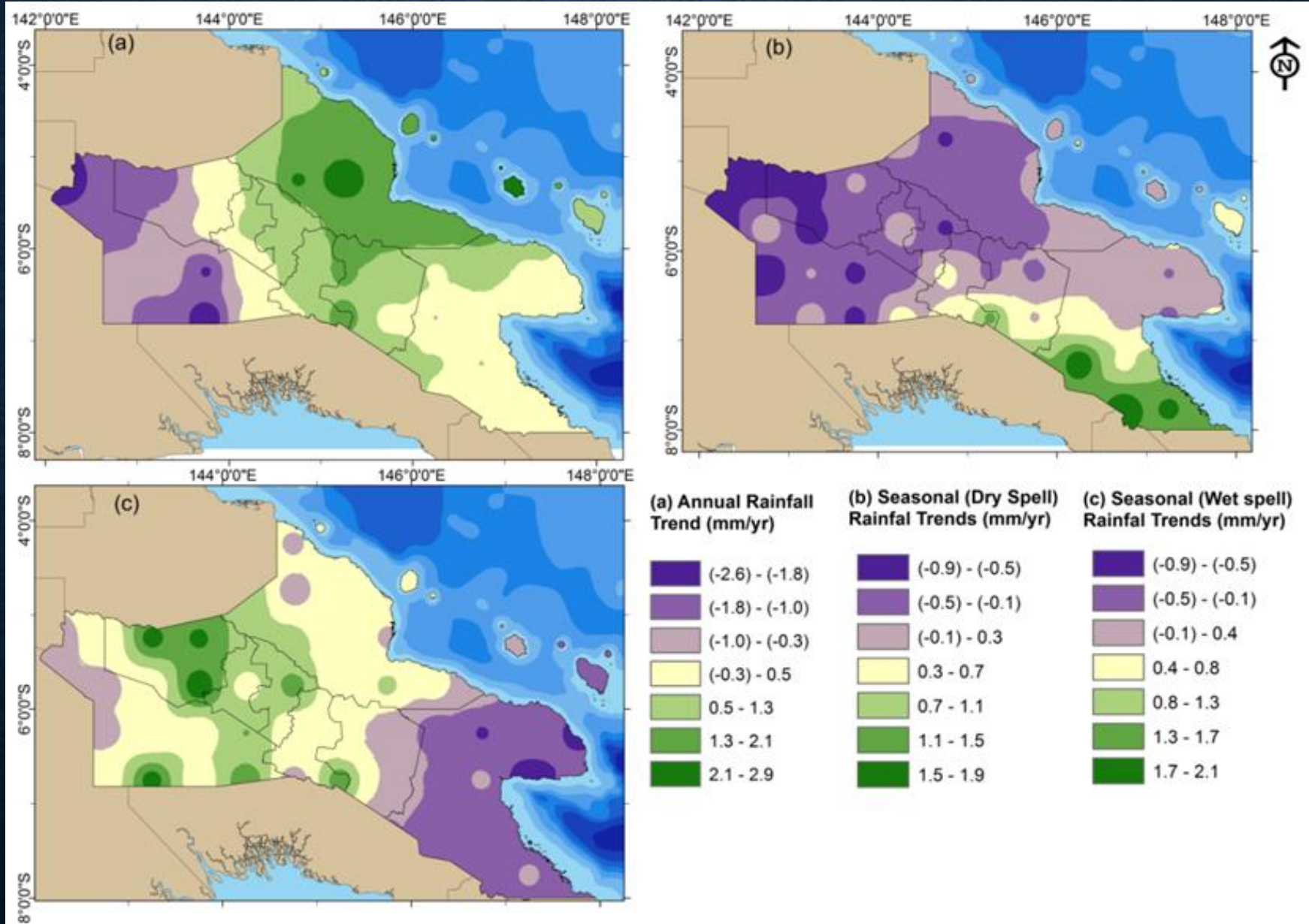
Source: USGCRP.gov.

❖ Surface temperatures rise on the Earth as greenhouse gases enter the atmosphere and insulate our planet.

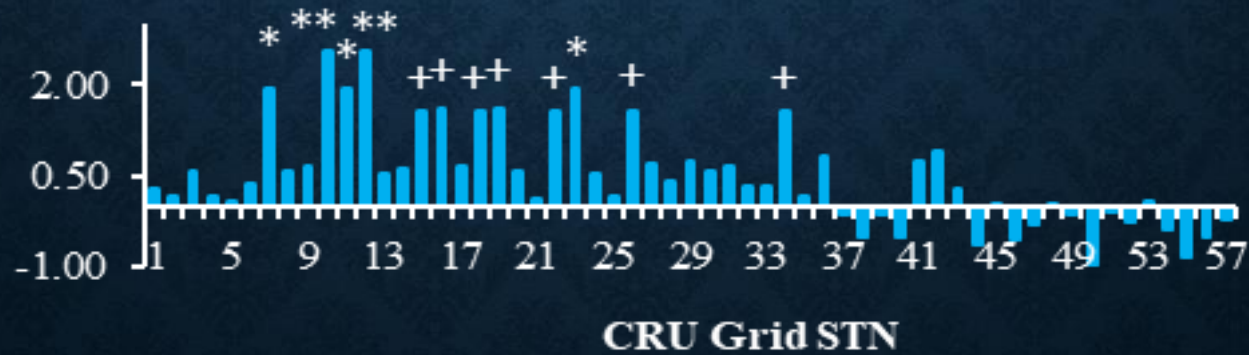
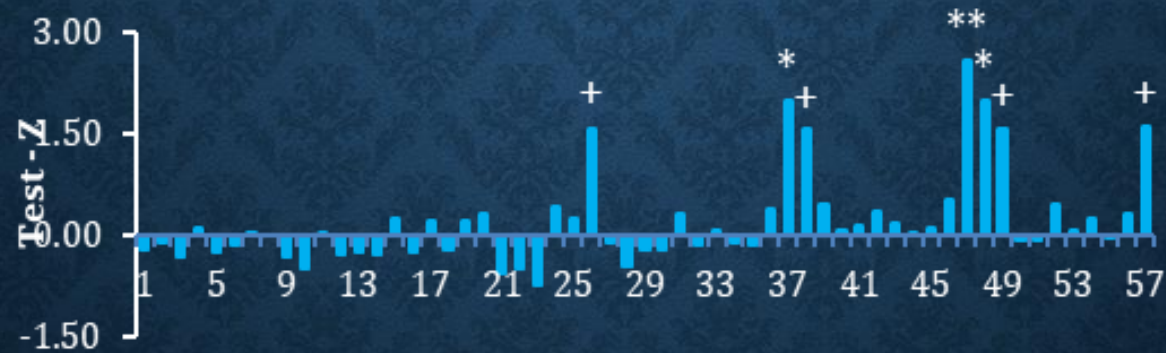
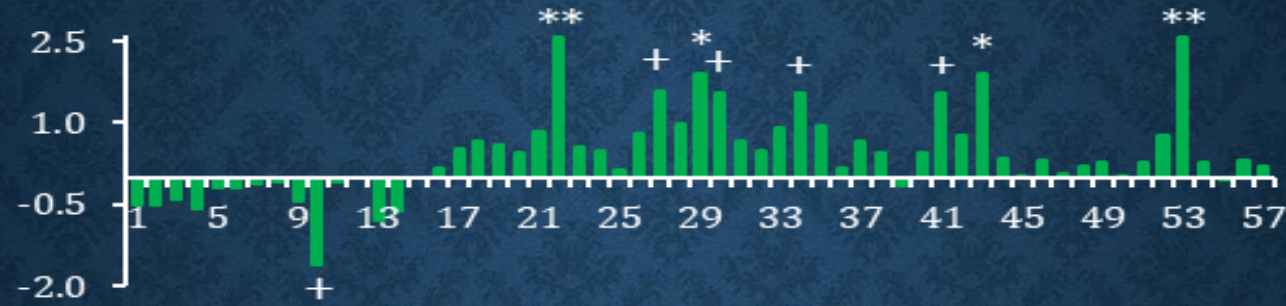
# Climate Change and Impact Assessment



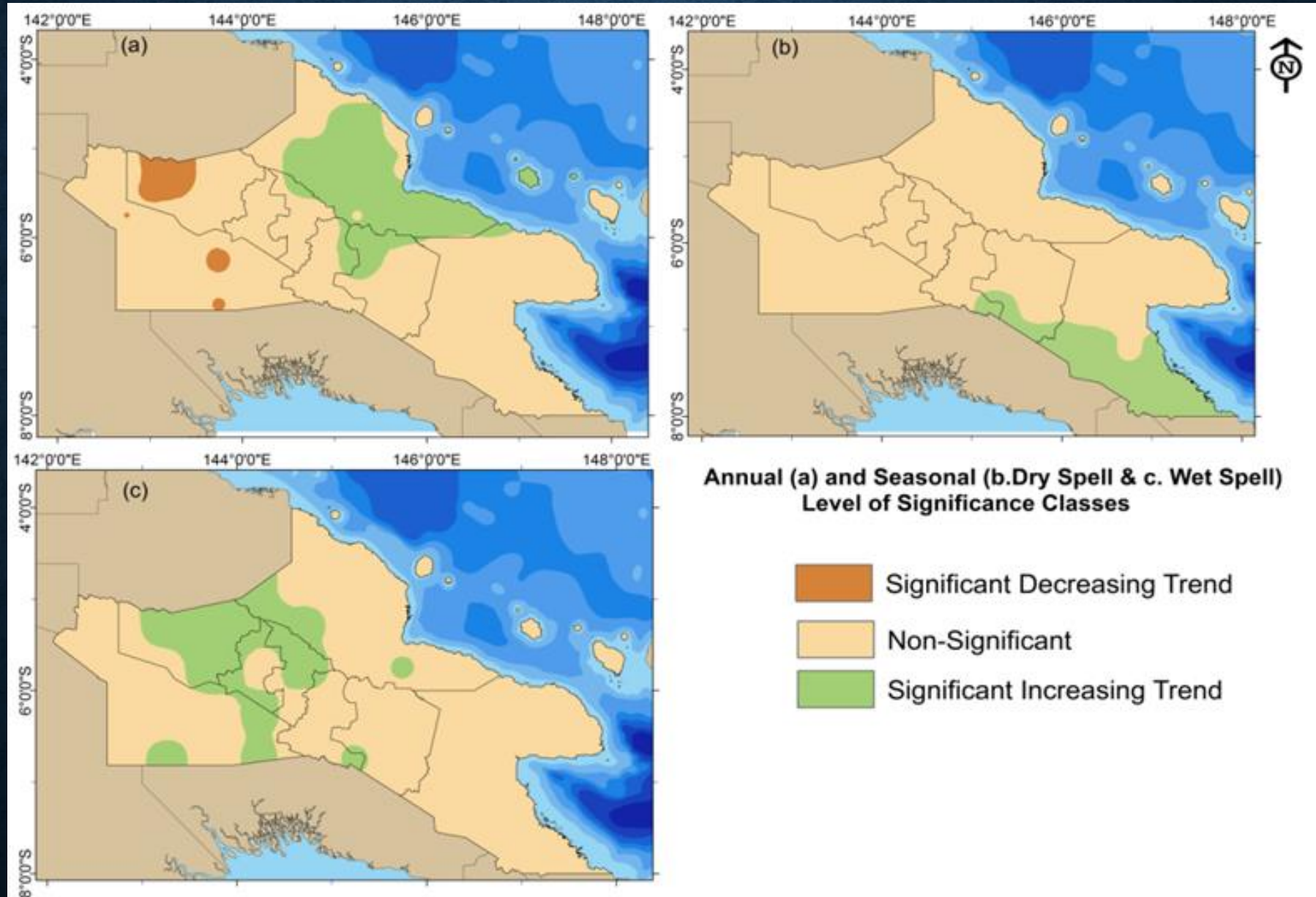
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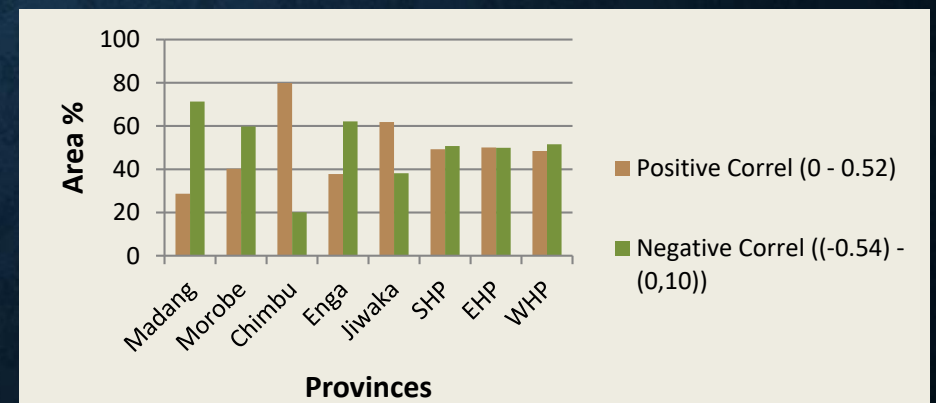
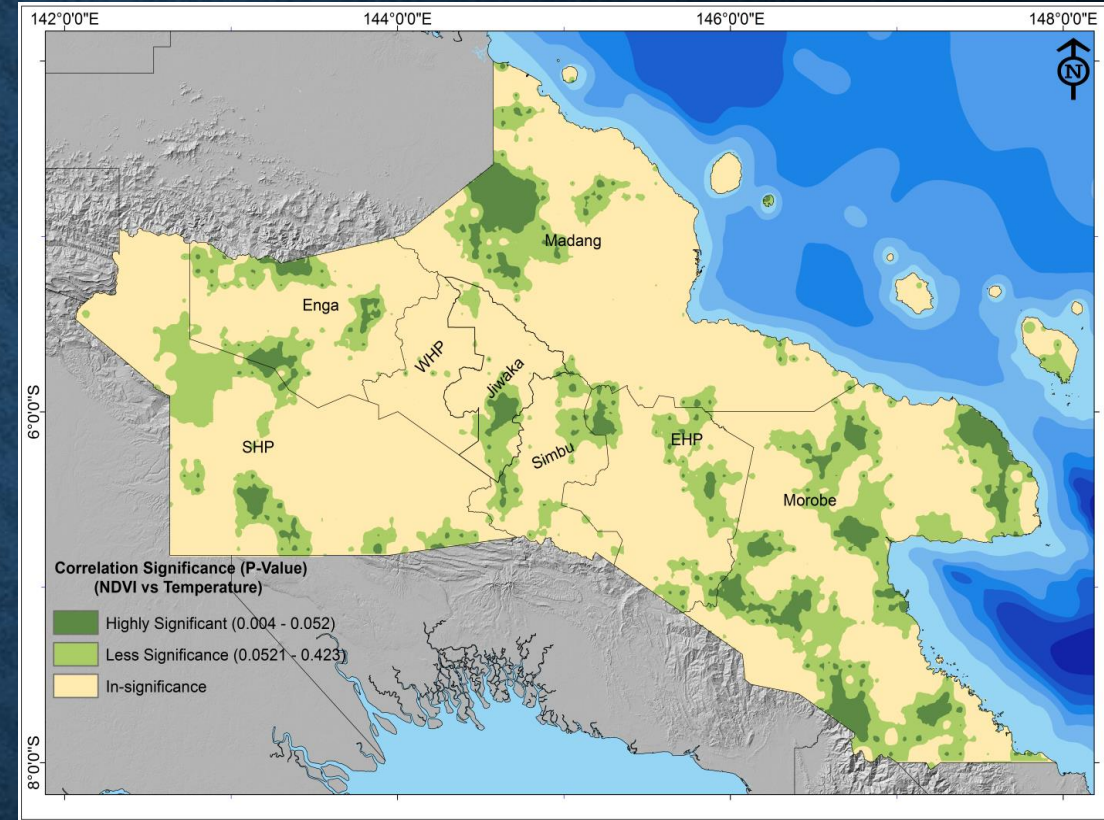
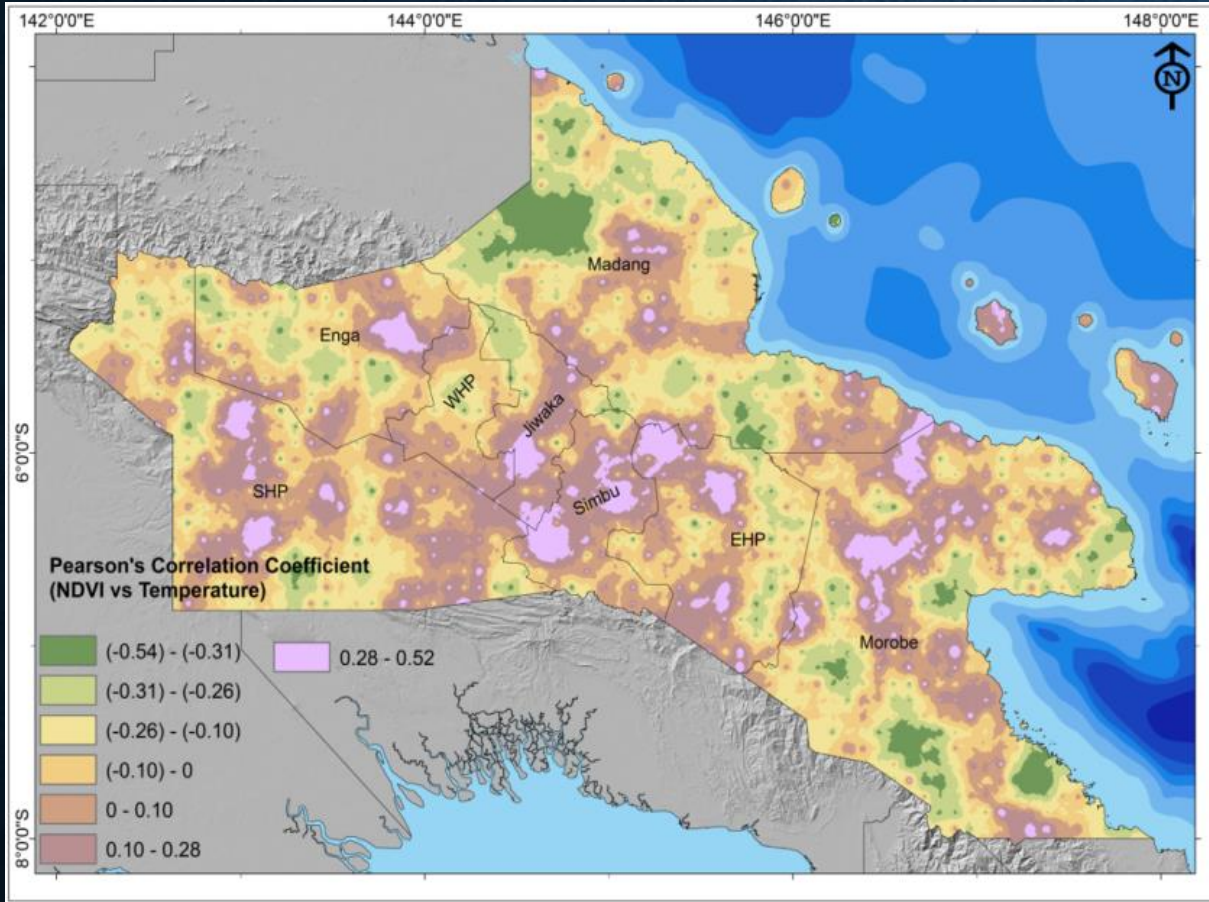
# Climate Change and Impact Assessment



# Climate Change and Impact Assessment



# Climate Change and Impact Assessment



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