Course: Basics of Environmental Engineering (Climatology)

Week 7

Main topic: **Atmospheric Pressure**

Lecturer: RUTAYISIRE Theoneste

Content

Introduction

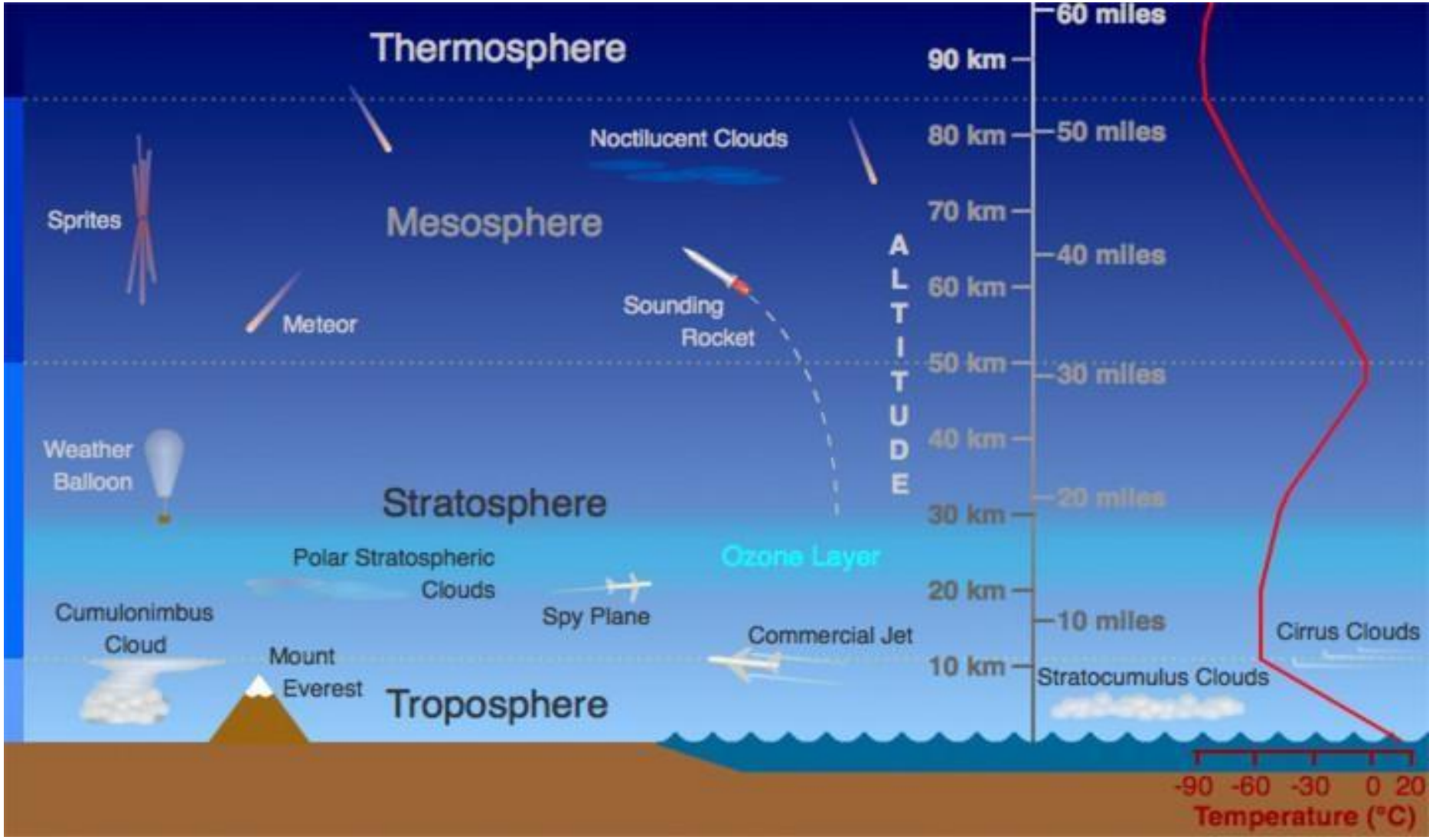
Pressure, the force applied to a surface per unit area, influences various geographical processes and events, including tectonic plate movements, ocean currents, and weather patterns, with low-pressure systems characterized by clouds and storms.

Then let’s dive into deep and see more about Atmospheric pressure.

❖ The atmosphere:

The atmosphere comprises Earth's gases, including carbon dioxide, nitrogen, oxygen, and argon, and is primarily water vapor, affecting precipitation and weather patterns. Scientists use five main layers to explain our atmosphere.

LAYERS OF ATMOSPHERE



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- **Troposphere:**

It ranges between 0-14 km. The troposphere, comprising nearly 80% of Earth's total atmospheric mass, is the part of the atmosphere we experience daily and is responsible for most of Earth's weather.

- **Stratosphere:**

It ranges between 14- 50 km. The stratosphere's dry air, characterized by few clouds, forms the crucial ozone layer, which protects us from harmful UV radiation from the Sun.

- **Mesosphere:**

It ranges between 50 - 85 km. The mesosphere, derived from the Greek word "meso," is where most meteors burn up, and reddish lightning called "sprites" can occasionally be seen above thunderstorms.

- **Thermosphere:**

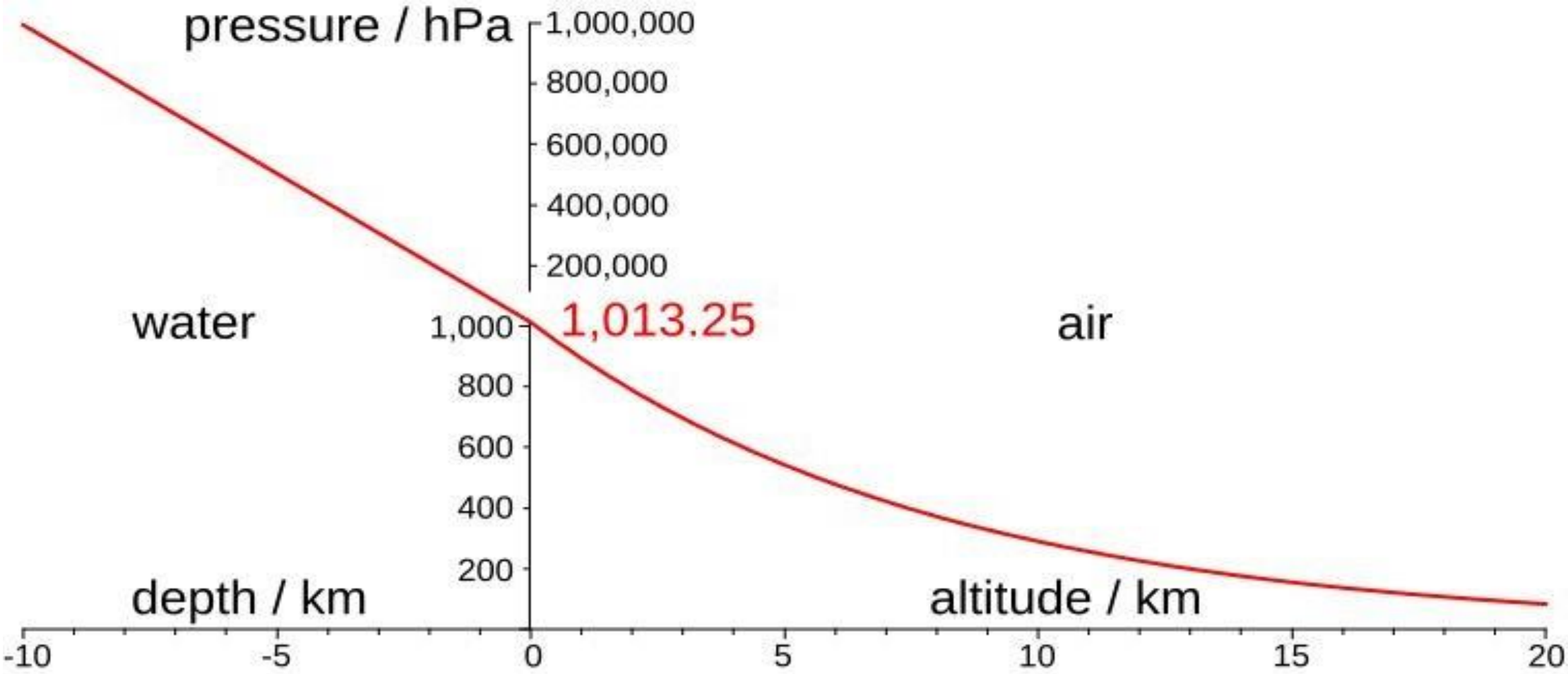
It ranges between 85 - 600 km. The International Space Station orbits within the thermosphere, which is where the events occur.

- **Exosphere:**

It ranges between 600 - 1000 km. The exosphere, located far from Earth's surface, contains gas molecules like hydrogen and helium, and occasionally experiences Auroras due to their distance.

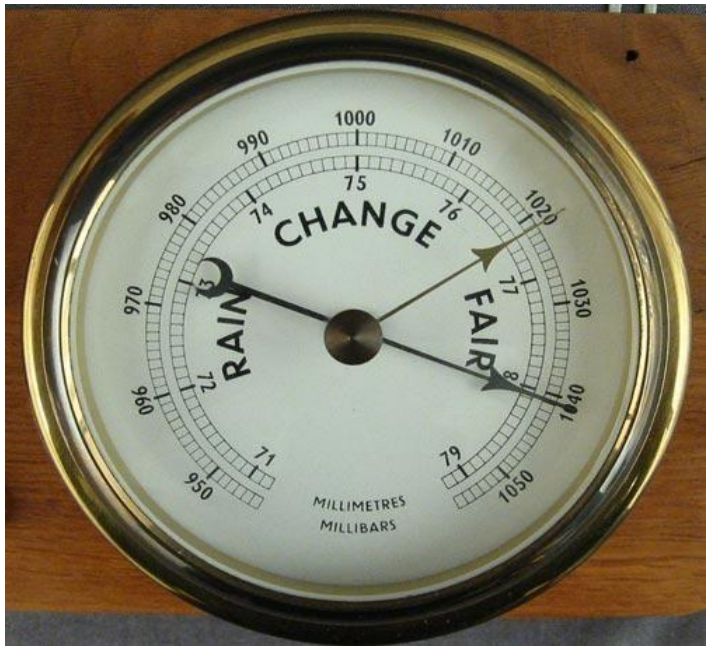
❖ Atmospheric Pressure

The atmosphere, composed of weightless gases, significantly influences wind patterns and weather. Atmospheric pressure, produced by air molecules, determines the precise weight of an air column, which can weigh around 10,000 kg.



https://commons.wikimedia.org/w/index.php?title=File:Pressure_water_air_(en).svg&oldid=796575405.

Air is composed of gas molecules, with higher molecular count leading to increased density, pressure, and weight. Lower air pressure results from fewer molecules, while higher temperatures cause more movement and spread of molecules. Conversely, lower temperatures result in higher air pressure and closer molecules.



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An instrument known as a barometer is used to measure air pressure.

Atmospheric pressure, the weight of air above Earth's surface, significantly impacts weather and climate, with various elements affecting its source and dynamics. Those elements include:

1. **Solar Heating:**

Solar radiation drives atmospheric circulation, causing temperature gradients due to uneven heating of Earth's surface. Low-pressure zones form in the equator, while high-pressure zones form at the poles.

2. Coriolis Effect: The Coriolis effect, influenced by Earth's rotation, deflects air masses to the left and right in the Southern and Northern Hemispheres, influencing wind direction and pressure systems.

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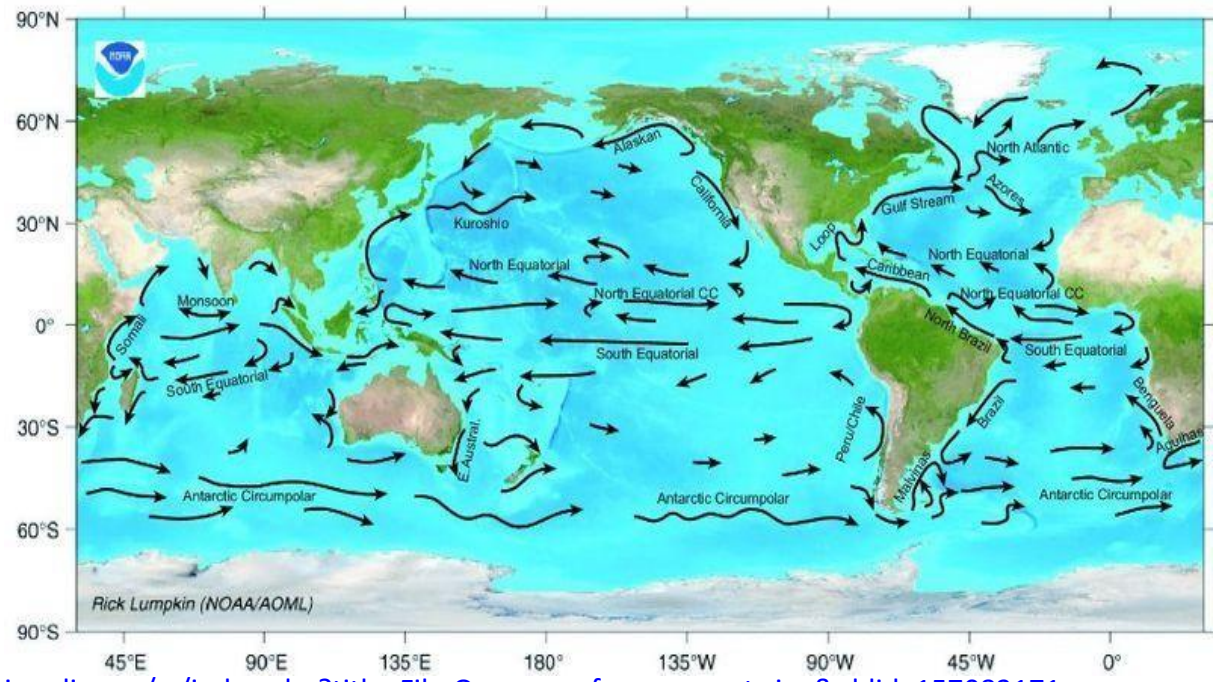
3. Topography:

Mountain ranges and water bodies can impact atmospheric pressure patterns, creating isolated pressure pockets and causing sea breezes in coastal regions due to temperature differentials.

4. Ocean Currents: Ocean currents significantly impact atmospheric moisture content and temperature, influencing air pressure patterns and weather systems like El Niño and La Niña.



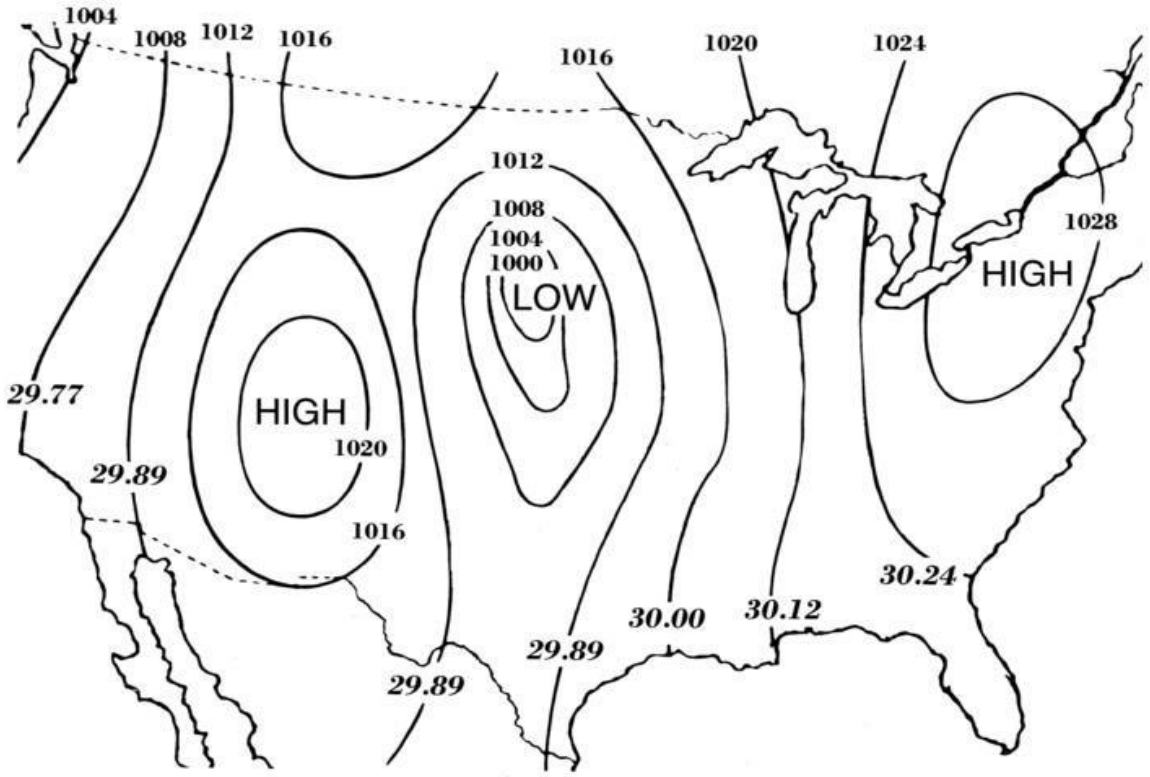
https://commons.wikimedia.org/w/index.php?title=File:Ocean_surface_currents.jpg&oldid=157083171.

5. Weather Fronts: Weather fronts are boundaries that separate air masses with varying humidity and temperature, signaling changes in wind, cloud cover, and precipitation patterns due to a shift from high-pressure to low-pressure systems.

Cold fronts Colder air masses move towards warmer ones, forcing less dense, warmer air upward. As it cools, air condenses, causing thunderstorms and showers.

Warm fronts Warm front-induced precipitation occurs when warmer air moves towards colder air, causing condensing and precipitation. This type of precipitation lasts longer than cold front-induced precipitation.

ISOBAR- It is defined as “the imaginary line drawn connecting the points of equal pressure”.



https://commons.wikimedia.org/w/index.php?title=File:Isobar_Map_(PSF).png&oldid=511137803

BASIC ATMOSPHERIC PATTERS

High and Low Pressure.

Atmospheric pressure changes from day to day and from place to place. You might hear a weather forecaster talk about a **pressure system** or **pressure area**.

A **low pressure system also known as cyclone**
is an area of low pressure surrounded by higher pressure. Air with low density and high temperature is surrounded by air with high air density and low temperature. This causes the air to form an inward **spiral**.

https://commons.wikimedia.org/w/index.php?title=File:Low_pressure_system_over_Iceland.jpg&oldid=752359576

Low pressure systems typically have warm, humid air, causing clouds and precipitation when they encounter high pressure systems.

Features of a Cyclone

Eye: Cyclones' eye, a calm center with 20-40 mile diameter, is the clean, calm center of a storm, typically lacking clouds due to sinking air.

Eyewall: The eyewall, a ring of towering thunderstorms, influences wind speed and storm severity. Double eyewalls in strong cyclones can steal moisture from the central eyewall.

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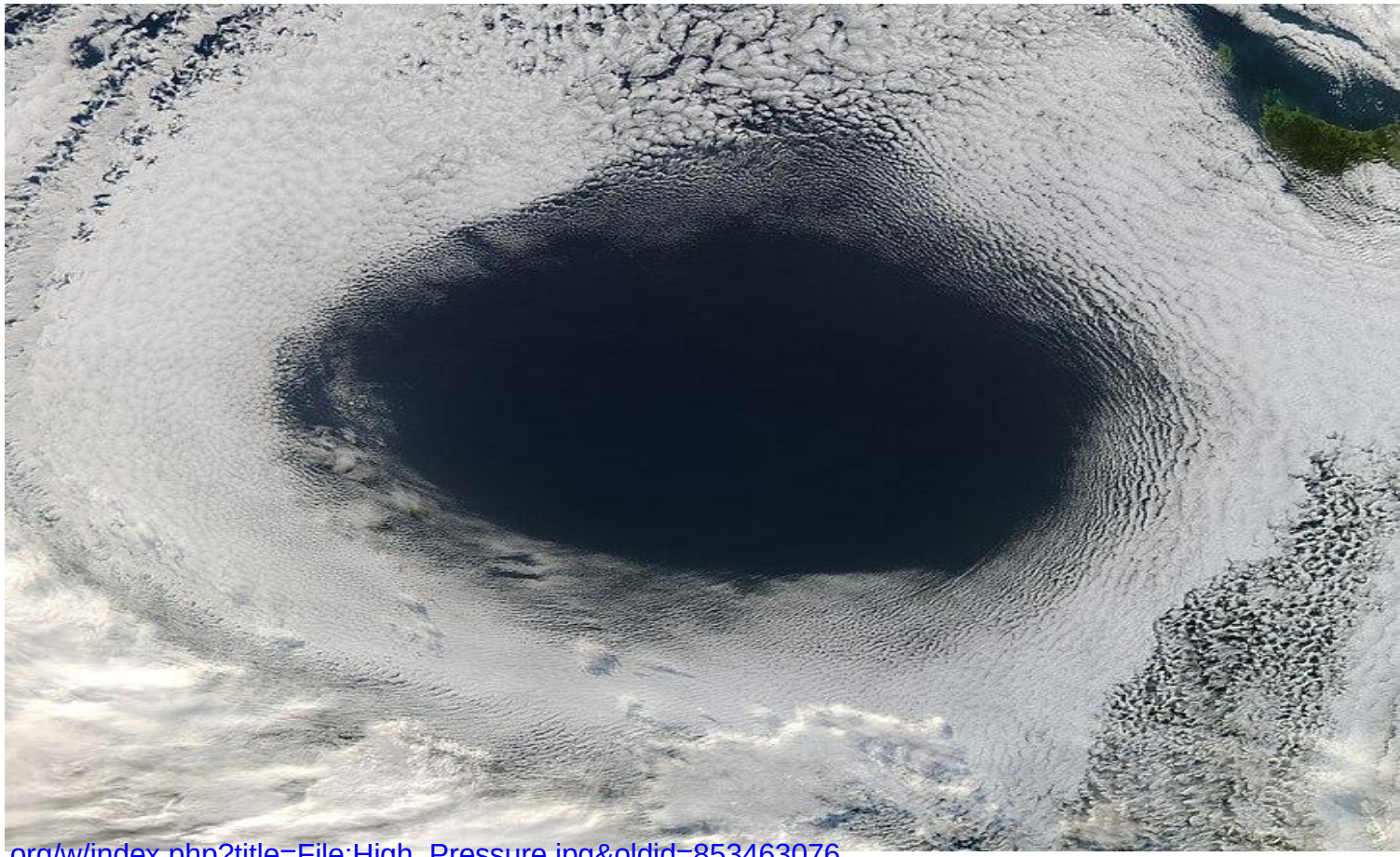
Rain bands:
Rain bands, curved thunderstorms and clouds, produce tornadoes, powerful winds, and heavy rain. As they approach a cyclone's center, mild rain is mixed with heavier downpours and gusts.

Size:
Cyclones vary in size, with hurricane-force storms over 300 miles wide. Intensity and size are not necessarily correlated, with some being powerful but smaller.

To sum up a cyclone has an eye encircled by an eyewall filled with powerful winds and thunderstorms, radiating spiral rainbands. Its magnitude can vary, and bigger storms are stronger.

A **high pressure system also known as anticyclone** is an area of high pressure surrounded by lower pressure. This means there is cold, dense air surrounded by warmer, less dense air. This causes the air to form a spiral outward. High pressure systems usually cause weather with cool temperatures, dry air and few clouds.

Take a look on following image:



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Anticyclone characteristics

Large-scale circulation systems known as anticyclones are distinguished by a high centre atmospheric pressure. Key characteristics of anticyclones are as follows:

1. High Pressure: Areas of high pressure, or anticyclones, cause stable atmospheric conditions as the air descends.

2. Clockwise (Northern Hemisphere) / Anticlockwise (Southern Hemisphere) Rotation: Anticyclones in the Northern Hemisphere circulate in a clockwise manner around the core area of high pressure. The circulation is anticlockwise in the Southern Hemisphere, in contrast.

3. Clear sky: Because descending air suppresses cloud formation, anticyclones are linked to clear sky.

4.Cooler, Drier Air: Because anticyclones sink, the air becomes cooler and less humid due to adiabatic warming.

5.Calm Weather: Because anticyclones have minor pressure gradients, the weather is calm with little winds.

6.Blocking Highs: By delaying or rerouting storm systems, anticyclones can function as blocking highs, preventing the passage of depressions and affecting weather patterns.

7.Stability: Anticyclones produce weather patterns that are stable and can endure for several days or weeks, which helps to prolong extended stretches of settled weather.

8.Effects on Temperature: Anticyclones can cause seasonal fluctuations in temperature, such as warm, dry summer weather or chilly winter weather with fog and frost.

9. Cloud Formation: Light winds and stagnant air at the heart of an anticyclone can lead to the formation of fog or the buildup of pollutants.

10.Precipitation: While anticyclones typically shield the area from precipitation, on rare occasions they may produce light snowfall or drizzle.

11.Regional Influence: Anticyclones can affect different areas differently based on the topography of the region and the predominant wind patterns.

In conclusion, anticyclone characteristics include strong pressure, stable atmospheric conditions, clear skies, light winds, and seasonal fluctuations in temperature.

Self-assessment

Choose the correct answer:

1. What is the primary characteristic of a cyclone?
   A) Clockwise rotation
   B) Anticlockwise rotation
   C) Clear skies
   D)High-pressure system
   Answer: B) Anticlockwise rotation

2. Which of the following is typically associated with an anticyclone?
   A) Low atmospheric pressure
   B) Cloudy weather
   C) Strong winds
   D)Fair weather
   Answer: D) Fair weather

3. What is the direction of wind circulation in the Northern Hemisphere cyclones?
   A) Clockwise
   B) Anticlockwise
   C) Parallel to the equator
   D) Random

❖ Impacts of Atmospheric pressure on crops:

Atmospheric pressure significantly impacts farming operations, particularly for crops, affecting factors like crop growth, yield, and overall productivity.

1. Precipitation Patterns:

Atmospheric pressure significantly influences precipitation patterns, affecting crop growth. Low-pressure systems produce rain, while high-pressure systems prevent it. Variations affect soil moisture, irrigation requirements, and crop health.

2. Temperature Regulation: Atmospheric pressure significantly influences temperature, with high-pressure systems causing clear skies and warmer days, while low-pressure systems may cause cloudy and chilly weather, impacting crop development and frost risk.

3. Wind and Air Circulation: Atmospheric pressure changes affect air circulation patterns, influencing wind directions in agricultural regions. Low-pressure systems can harm crops, while high-pressure systems aid in pollination and prevent rising illness and humidity levels.

4. Pest and Disease Dynamics: Atmospheric pressure in agricultural ecosystems indirectly influences pest and disease dynamics, with low-pressure systems promoting fungal illnesses, and high-pressure systems increasing the likelihood of pest infestations or disease outbreaks.

5. Harvest Timing and Crop Management: Farmers track atmospheric pressure patterns to optimize crop management, make informed decisions about irrigation, fertilisation, and pest control, and minimize risks.

In summary, farming operations are significantly impacted by atmospheric pressure. Temperature, wind, precipitation, disease and pest dynamics, and harvesting timing are all impacted. By understanding these connections, farmers may respond to changing atmospheric pressure patterns by maximising crop yield and minimizing dangers.

❑ ***Self-assessment 2:***

Choose correct answer:

1. What is the primary consequence of uneven pressure distribution on horse hooves (clops)?

A) Improved balance

B) Enhanced performance

C) Increased risk of discomfort and injuries

D) Greater flexibility

Answer: C) Increased risk of discomfort and injuries

2. Which of the following hoof conditions can result from excessive pressure on clops?

A) Hoof growth acceleration

B) Hoof hardening

C) Laminitis

D) Increased circulation

Answer: C) Laminitis

3. What role does proper shoeing play in managing pressure on clops?

A) Exacerbates pressure-related issues

B) Provides protection and support, distributing pressure evenly

C) Reduces the need for regular trimming

D) Has no impact on pressure distribution

Answer: B) Provides protection and support, distributing pressure evenly

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