PINEAPPLE EXPRESS - GEOGRAPHY

NEWS: *A powerful **atmospheric river** known as the **Pineapple Express** is currently affecting **northern and central California**, bringing extreme weather conditions.*

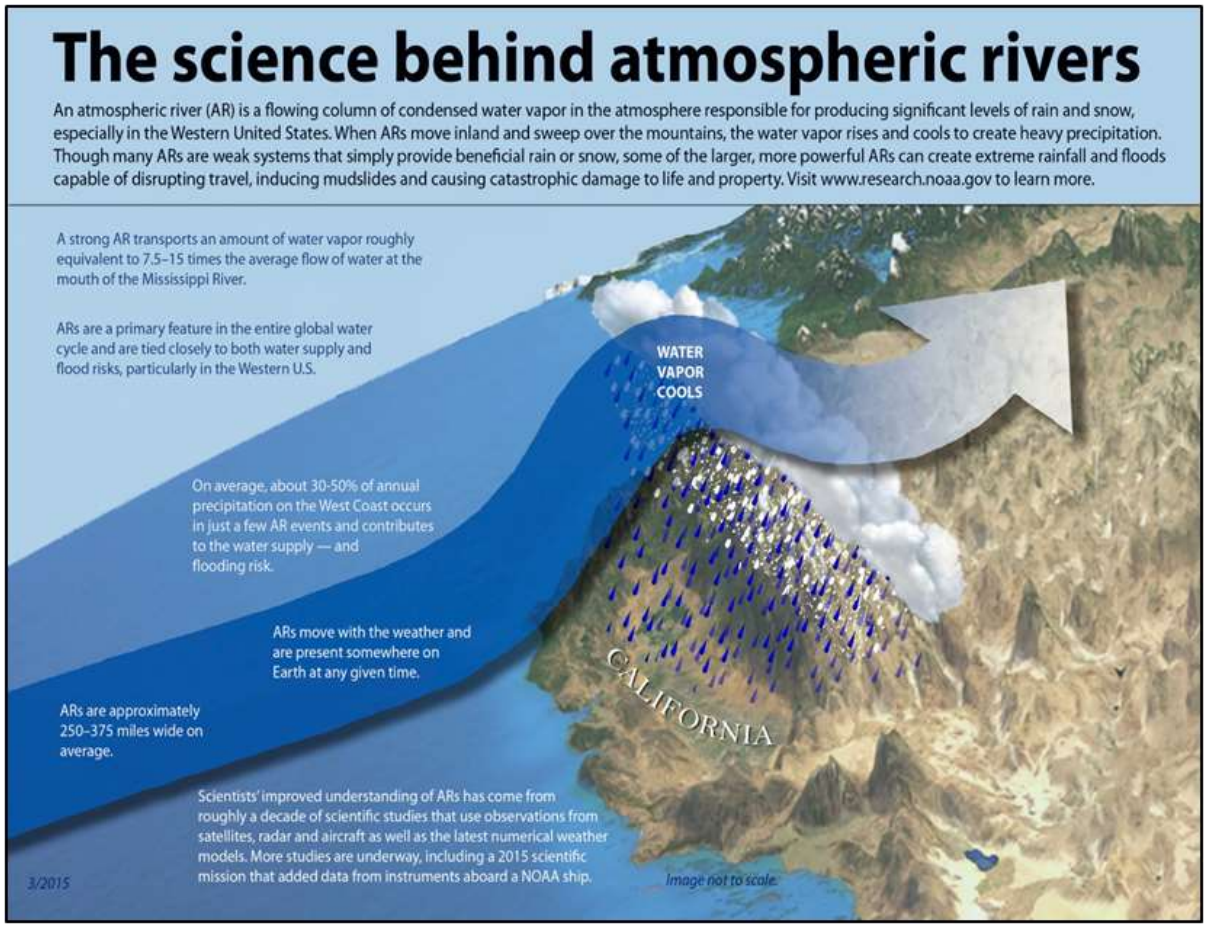
WHAT'S IN THE NEWS?

- An **atmospheric river** is a narrow band of concentrated moisture in the sky that can cause heavy rainfall and strong winds when it reaches land.
- The **Pineapple Express** is a specific type of atmospheric river that originates near **Hawaii** and moves toward the **U.S. West Coast**.

- This weather system is bringing **strong winds, heavy rainfall, and snowfall** to elevated areas.
  - Strong winds can cause **power outages, property damage, and falling trees**.
  - Heavy rainfall increases the risk of **flooding, mudslides, and road closures**.
  - In higher elevations, snowfall can contribute to **hazardous travel conditions and avalanche risks**.
- Meteorologists predict that by **Wednesday**, the storm will start to **weaken**, leading to lighter rainfall across **southern California**, including **Los Angeles**.
  - While the **intensity of the storm will decrease**, lingering rain showers may still cause **localized flooding and minor disruptions**.

Pineapple Express: A Type of Atmospheric River

- The **Pineapple Express** is a narrow, fast-moving band of **moisture-laden air** in the atmosphere, often referred to as a **"river in the sky."**
  - It transports large amounts of **water vapor** from the **tropical Pacific Ocean** toward the **U.S. West Coast**.
  - Because it carries **warm, moist air**, it can produce **intense and prolonged rainfall** when it reaches land.
- The **origin** of the Pineapple Express is near **Hawaii**, a tropical region known for **pineapple production**, hence its name.
  - The moisture-rich air mass is drawn from the **warm waters of the central Pacific**, creating a **direct connection** between Hawaii and the **West Coast** of the U.S.
  - This phenomenon occurs when **strong westerly winds** push the moisture-laden air toward the mainland.
- When this moisture reaches land, it interacts with local **weather systems** and results in **heavy precipitation**.
  - The **uplifting of warm air** over mountains and coastal regions enhances **rainfall and snowfall**, leading to **flooding risks and increased snowpack accumulation**.



Atmospheric Rivers and Their Role

- **Atmospheric rivers** are long, narrow corridors in the atmosphere that transport vast amounts of **water vapor** from the **tropics** toward higher latitudes.
    - These moisture-rich air streams are responsible for **significant precipitation events** along coastal and mountainous regions.
- The **National Oceanic and Atmospheric Administration (NOAA)** states that atmospheric rivers can vary in **size and intensity**, but on average, they carry a volume of moisture comparable to the **Mississippi River's outflow** at its mouth.
    - The **Mississippi River discharges** approximately **600,000 cubic feet of water per second** into the Gulf of Mexico, and atmospheric rivers transport a similar amount—but in **vapor form**.
- Exceptionally strong atmospheric rivers can transport up to **15 times** the volume of water compared to the Mississippi River's outflow.
    - These intense systems can bring **record-breaking rainfall**, leading to **major flooding events**.
- When an atmospheric river reaches land, it releases its moisture as **rain or snow**, sometimes covering vast regions.
    - The **intensity of precipitation** depends on factors such as **temperature, topography, and wind patterns**.
- These rivers play a **dual role** in the environment:
    - **Positive Effects**: They contribute to the **Earth's water cycle**, replenishing **reservoirs, lakes, and underground water supplies**.

    - **Negative Effects**: They can cause **severe flooding, landslides, and infrastructure damage** in affected regions.
- While atmospheric rivers **increase flood risks**, they also play a crucial role in building **snowpack in mountains**, which serves as a **natural water reservoir** for the dry season.
    - The **Sierra Nevada snowpack**, for example, provides a significant portion of **California's water supply** as it melts in the spring.
- **Categories:**
    - **Category 1 (Weak):** A Category 1 atmospheric river would be a milder and briefer weather event with **primarily beneficial effects, like 24 hours of modest rainfall.**
    - **Category 2 (Moderate):** A Category 2 atmospheric river is a moderate storm with mostly beneficial effects, but **also somewhat hazardous.**
    - **Category 3 (Strong):** A Category 3 atmospheric river is **more powerful and longer lasting**, with a balance of beneficial and hazardous impacts. For example, a storm in this category could bring 5-10 inches of rain over 36 hours, enough to **help replenish reservoirs but also pushing some rivers close to flood stage.**
    - **Category 4 (Extreme):** A Category 4 atmospheric river is mostly hazardous, though also with some beneficial aspects. A storm of this rating could dump enough heavy rain over several days to bring many rivers to flood stage.
    - **Category 5 (Exceptional):** A Category 5 atmospheric river is primarily hazardous.
        - An atmospheric river that lasted over 100 hours over the Central California coast during the 1996-97 New Year's holiday period. The heavy rain and runoff caused over USD 100 billion in damage.
- **Significance:**
    - They play a crucial role in **replenishing water supplies,** particularly in regions like the western United States. The heavy precipitation they bring can contribute significantly to reservoir levels, helping to alleviate drought conditions and ensuring water availability for agricultural, industrial, and domestic use.
    - Given their importance for water supply, understanding atmospheric rivers is essential for **effective water resource management and planning.** This includes strategies for water storage, flood control, and allocation of water resources to meet various demands.
    - Atmospheric rivers contribute to **maintaining a balance in the hydrological cycle** by transporting **large amounts of water vapor** from the tropics to higher latitudes. This helps to redistribute **moisture across different regions, supporting ecosystems** and agricultural productivity.

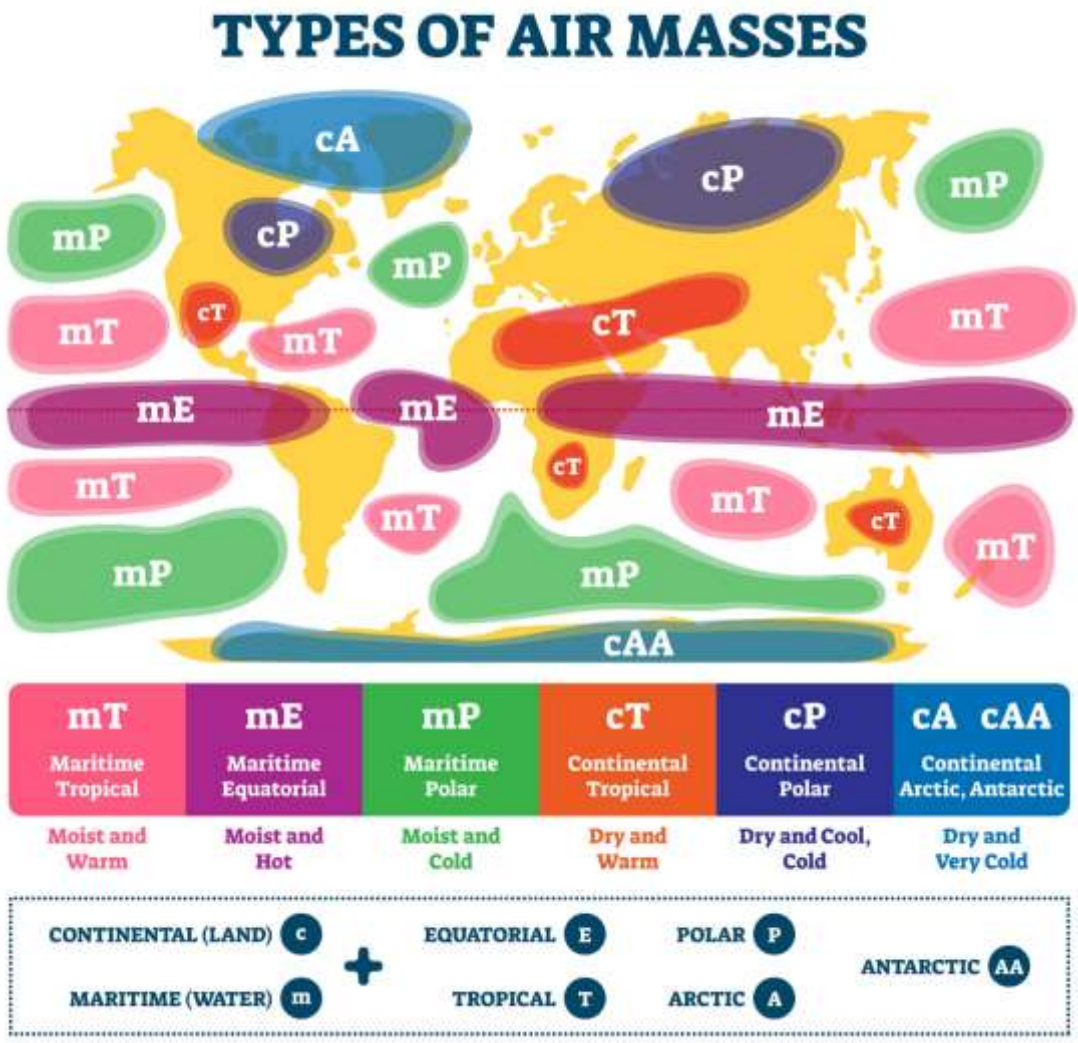
Is the Pineapple Express a Common Weather Phenomenon?

- **Atmospheric rivers** are frequent occurrences along the **West Coast** of North America, but they can also occur in other regions, including the **eastern U.S.**, where they pull moisture from the **Caribbean**.
    - The **Caribbean-fed atmospheric rivers** typically bring **heavy rain and snow** to the **eastern U.S. and Canada**.

- These moisture-laden systems interact with **local weather patterns**, leading to **rainfall or snowfall**, depending on **temperature and elevation**.
    - At **warmer temperatures**, they produce **intense rainstorms**.
    - At **colder temperatures**, they generate **heavy snowfall**, contributing to snowpack.
- Not all atmospheric rivers are **Pineapple Express systems**—a system qualifies as a **true Pineapple Express** only if its **moisture source is near Hawaii** and it extends continuously to the **U.S. West Coast**.
    - This geographic **connection to Hawaii** distinguishes it from other atmospheric rivers.
- Climate scientists warn that **climate change** could intensify atmospheric rivers, leading to **heavier rainfall, stronger storms, and increased flooding risks**.
    - Rising global temperatures **increase atmospheric moisture content**, making storms **more extreme**.
    - Lower-elevation regions may see **more rainfall instead of snow**, reducing **snowpack** and affecting **water availability** in dry months.

What is Air Mass?

- **About**:
    - An air mass is **a large body of air with relatively uniform temperature,** humidity, and pressure characteristics. These masses of air form over source regions, where they take on the characteristics of the surface below due to low wind speeds.
    - When air masses move, they can **influence weather patterns in the regions** they move into, potentially leading to the formation of storms when they interact with other air masses.
- **Types of Air Masses:**
    - **Continental Tropical (cT):** These air masses originate over hot and dry continental regions. They are characterized by **high temperatures and low humidity.**
    - **Continental Polar (cP):** Originating **over cold and dry continental** regions, cP air masses are **characterized by cold temperatures** and low humidity.
    - **Maritime Tropical (mT):** These air masses form over **warm and moist oceanic regions.** They are characterized by warm temperatures and high humidity.
    - **Maritime Polar (mP):** Originating over cold oceanic regions, mP air masses are characterized by cool temperatures and high humidity.
    - **Continental Arctic (cA):** cA air masses originate over extremely cold Arctic regions. They are characterized by frigid temperatures and very low humidity.



- **Characteristics of Air Masses:**
    - Air masses originate over vast flat surfaces having uniform temperature and humidity.
    - Air masses travel slowly over hundreds of kilometers from their source regions.
    - As the air masses move away from source regions their chief characteristics of temperature and humidity undergo large-scale changes.
    - They affect the weather conditions of the areas visited by them.
    - When two air masses of different temperature and humidity approach each other, they do not intermingle but **a front is formed** between them.
        - Weather conditions change abruptly at the front.
        - The front keeps two approaching air masses separate from each other.

Beyond the Pineapple Express

Polar Vortex

- The **polar vortex** is a **large, low-pressure system** that contains **cold air** circulating around **both poles** of the Earth.
    - It is **strongest in winter** and plays a key role in **Arctic and Antarctic climate patterns**.

- There are **two types of polar vortices**:

1. **Tropospheric Polar Vortex**:
    - Occurs in the **lowest layer of the atmosphere** (troposphere), extending from the **surface to about 10-15 km high**.
    - It directly influences **weather patterns**, including **cold air outbreaks and winter storms**.
2. **Stratospheric Polar Vortex**:
    - Exists at **higher altitudes** (15-50 km) in the **stratosphere**.
    - It is **strongest in autumn and winter**, but **disappears during the summer** as the atmosphere warms.

Santa Ana Winds

- The **Santa Ana winds** are strong, dry winds that occur seasonally in **California**, typically from **October to January**.
    - These winds originate from **high-pressure systems** over the **Great Basin**, a region between the **Rocky Mountains and Sierra Nevada**.
    - The **low-pressure system** over the **California coast** draws these winds westward.
- The **pressure difference** between the inland deserts and the Pacific Ocean generates **strong winds** that move toward **Southern California**.
    - These winds can reach speeds exceeding **50-70 mph**, creating **hazardous conditions**.
- As the winds descend from higher elevations, they **compress and heat up**, causing a **rapid drop in humidity**—sometimes to below **10%**.
    - This extremely **dry air** increases the risk of **wildfires**, as it dries out vegetation and makes it more flammable.
    - The **high winds** can also spread fires rapidly, making firefighting efforts **more challenging**.
- The Santa Ana winds can also contribute to **dust storms, power outages, and transportation disruptions** due to **strong gusts and debris movement**.