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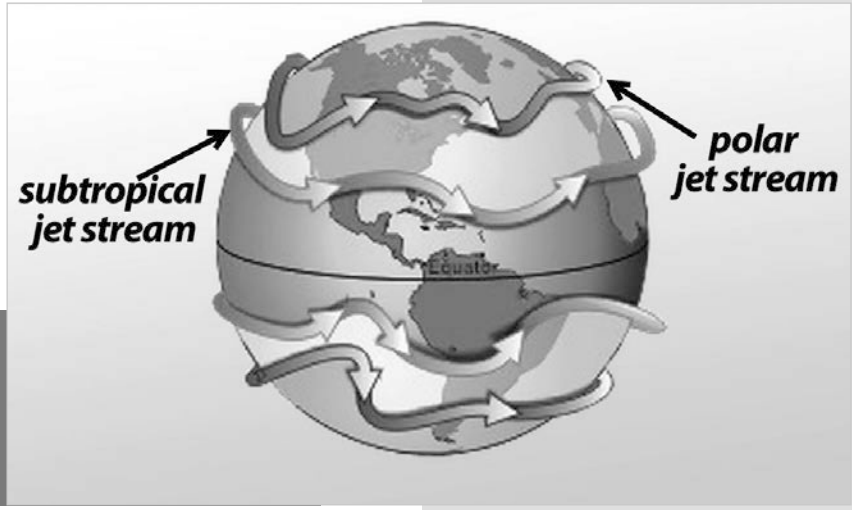
Rivers of Wind



Jet streams circle Earth in both hemispheres.

Credit: National Weather Service

Scientists studying the jet stream over Europe discovered that it has contributed to the extreme weather seen across the continent in the last 50 years.

Jet streams are rivers of wind, 5 to 9 miles up, in the high atmosphere. They're caused by solar radiation heating rising air, which is then deflected sideways by Earth's rotation.

They can move up to 275 miles an hour and are strong enough to push weather around and carry moisture, dust, or volcanic ash across oceans.

There are four jet streams on Earth: a polar and subtropical jet in both the Northern and Southern Hemispheres. And their paths can fluctuate.

When they drift toward the pole, they pull warmer air with them, causing hot summers and droughts in the middle of continents and rain in the subtropics.

When they drift toward the equator, they pull cold air from the pole, causing harsher winters in the midcontinent.

Scientists in Europe studied tree rings in the UK and the Mediterranean to analyze patterns of temperature and rain.

They found that, since 1960, the northern polar jet had drifted more frequently than in any period in the last 300 years, bringing droughts to the south and floods to the west in some years, and the opposite the next.

Climatologists theorize that a generally warming planet may be influencing the path of the jet stream. But most scientists agree that we really don't know the cause.

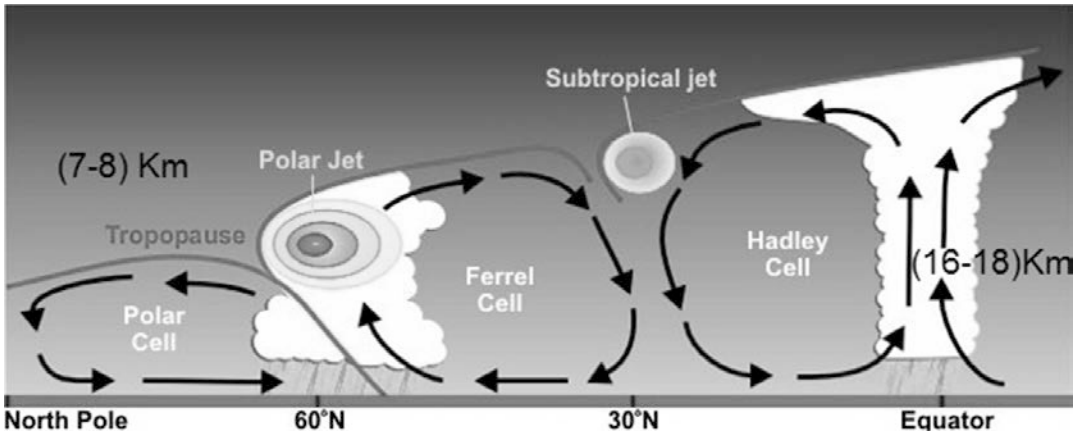
It's one more of those big mysteries blowing around, right here on Earth.

Bureau of Economic Geology

Background: Rivers of Wind

Synopsis: Jet streams are rivers of wind in the troposphere that influence your weather, and air travel, every day.

- Jet streams, narrow bands of strong winds in the upper levels of the atmosphere where jet airliners normally cruise, are sometimes called *atmospheric rivers*.
  - Jet streams blow west to east at an average speed of 110 mph, following boundaries between hot and cold air.
  - Because jet-stream winds can reach up to 275 mph, pilots take advantage of them, especially when they can use a tailwind while flying eastward to increase speed and save fuel.
    - Pilots avoid flying directly in these rivers of wind when flying westward, to prevent struggling against a strong headwind.
  - Jet streams blow faster when temperature differences are greater, usually in winter.
  - Unpredictable twists and turns of the jet stream can cause turbulence and a bumpy flight even in a clear blue sky.
- Early pilots discovered jet streams in the 1930's and during World War II, but long before that, scientists noticed their effect on volcanic ash clouds.
  - The first man to circumnavigate the globe was an American pilot named Wiley Post, who completed the trip in 1933. He pioneered high-altitude flight in his own pressurized suit and noticed that sometimes his speed over the ground was faster than the air speed he registered.
  - World War II bomber pilots made repeated flights and discovered that in certain areas they could take advantage of 100 mph tailwinds to make their missions speedier or to quickly retreat from trouble.
  - Volcanic ash becomes visibly dispersed when it reaches certain levels of the atmosphere, making the jet-stream flow visible to us. This phenomenon was noticed as long ago as during Krakatoa's eruption in 1883.
    - A more recent example is the 2009 eruption of the Icelandic volcano Eyjafjallajokull, which fouled the air with ash that was distributed by the jet stream at the same levels that commercial jetliners normally travel. Glass shards in the ash posed a risk of freezing jet engines in flight, causing flights all over Europe to be rerouted and grounded.



Northern Hemisphere cross section showing jet streams and tropopause elevations.

Credit: National Weather Service

References: Rivers of Wind

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What Is a Jet Stream? | LiveScience.com
Jet Stream | Wikipedia
Jet Stream Changes since 1960s Linked to More Extreme Weather | ScienceDaily.com
Scientists Say a Fluctuating Jet Stream May Be Causing Extreme Weather Events | NPR
What Are Jet Streams and How Do They Influence the Weather We Experience? | AccuWeather.com

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Background: Rivers of Wind

- Earth's jet streams occur from 6 to 9 miles above Earth in the troposphere, a layer of the atmosphere.
  - The Northern and Southern Hemispheres each have a polar and a subtropical jet stream, which are stronger in the Northern Hemisphere.
    - Polar jets are stronger and tend to occur from 30,000 to 39,000 ft.
    - Subtropical jets are weaker and occur from 33,000 to 52,000 ft.
    - Other jet streams can form if winds are higher than 58 mph and occur from 6 to 9 miles above Earth's surface.
- Earth's jet streams are caused by solar radiation and planetary rotation.
  - Solar radiation causes atmospheric heating. The rotation of Earth results in the Coriolis force, which deflects air to the right in the Northern Hemisphere and to the left in the Southern Hemisphere.
  - The radiation and rotation spin up three large atmospheric circulation cells in each hemisphere: the *Polar cell* at high latitudes, the *Ferrel cell* at mid-latitudes, and the *Hadley cell* at low latitudes.
  - The *polar jet* occurs where rising air from the Polar and Ferrel cells converges; the *subtropical jet* forms where falling air from the Ferrel and Hadley cells meets.
  - Jet streams shift northward in the Northern Hemisphere spring because of Earth's seasonal tilt. In the fall, they move southward.
  - Jet streams have also been observed on Jupiter and Saturn, but these are driven by a different mechanism—the internal heat of these planets.
- Jet streams impact weather by pushing high- and low-pressure air masses around, and by moving weather systems along as they flow west to east.
  - Jet streams direct Earth's weather; without them, weather systems would not circulate around the globe, just stall in place.
  - Jet streams can fend off mighty hurricanes, or relentlessly drag brutally dry air into regions, causing drought.
  - Jet streams often meander. When flowing northward, meteorologists call the excursions "ridges"; when flowing southward, "troughs."
    - When a ridge occurs, the jet stream turns poleward, dragging warmer weather in that direction. Extreme summer heat in the midwestern United States is an example.
    - When a trough occurs, the jet stream dips toward the equator and pulls cooler temperatures with it. Recent southward excursions of the polar vortex brought frigid Canadian air into the central and eastern United States.
  - On the equatorial side of a jet stream, the air is warmer than average; on the polar side, the air is cooler. Stronger temperature contrasts result in stronger jet-stream winds.
  - Jet streams can go up and down, start or stop, and split and recombine; sections may even curl around to flow the opposite direction of the main jet stream.
- Recently, scientists studied tree rings dating back to 1725 to better understand the meanderings of the polar jet in Western Europe.
  - As the polar jet turns south, it pulls the Polar vortex southward, stunting tree growth in the cold that results. As it turns north, the region warms and trees flourish, making wider rings.
  - Since 1960, the jet stream has made many more strong excursions to both the north and the south than in the previous 235 years, resulting in an increase in extreme weather events like floods, droughts, and heat waves.

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