eo kids

earth observatory for kids

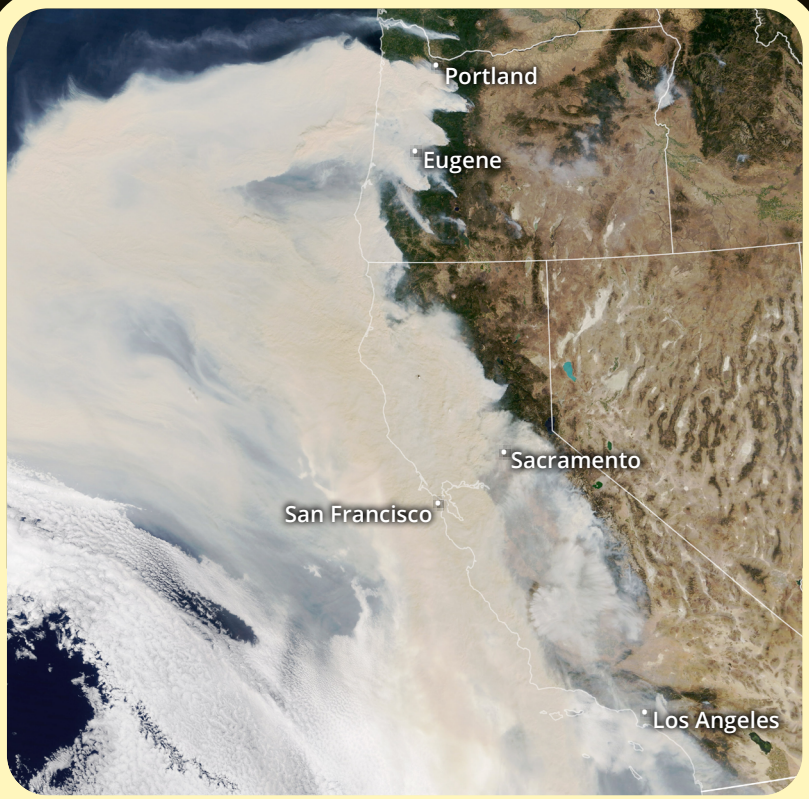
Smoky Skies and Satellites

Wildfires can have immediate effects on our lives and local environments. They can also have lingering effects on our health and the weather – even when we live far from the fire itself. Satellites help measure wildfire smoke and its impact.

In 2020, California, Oregon, Washington, and other western states lit up with forest fires. More than 5.9 million acres burned in just the coastal states. Smoke blanketed the West, and the air became dangerous for people to breathe.

One acre is about the same size as 10 basketball courts.

People near and far from the flames could see daily evidence of fires in the colors of the sky, particularly at sunset. The colors came from smoky **aerosols** floating in the air. Smoke particles scatter sunlight and make the sky appear yellow, orange, and red.



This satellite view shows smoke covering the U.S. West Coast in September 2020. The total area burned was larger than the country of Slovenia.

Image credit: Lute Yang

San Francisco skies turned orange due to fires. This photo was taken at 9:30 a.m. on September 9, 2020.

Vocabulary

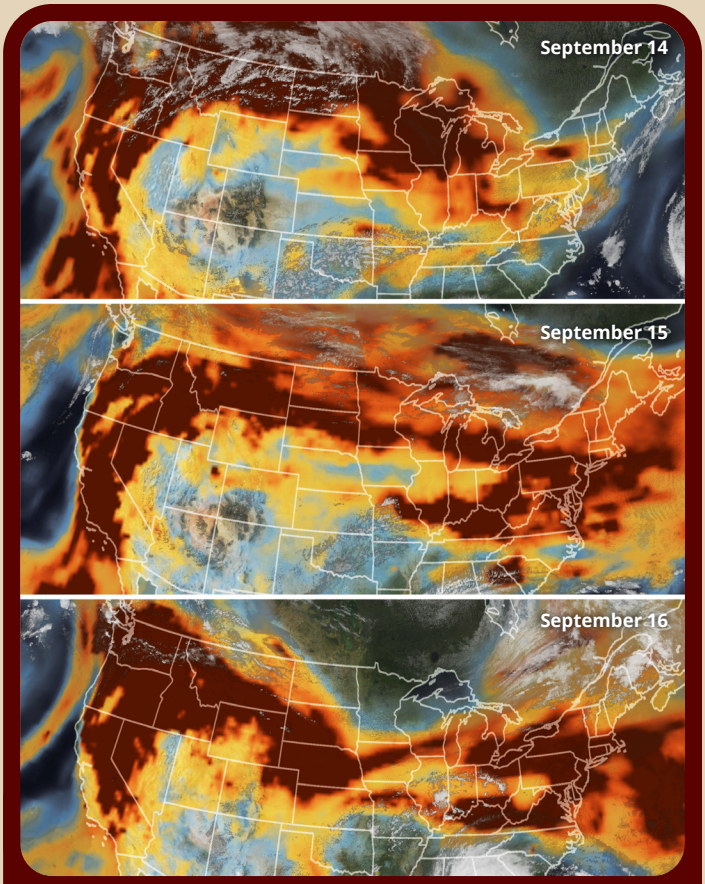
aerosols — Tiny solid or liquid particles in the air; they can be natural- (smoke, sea spray, volcanic plumes, dust storms) or human-caused (pollution).

High in the Sky

Much of the wildfire smoke in 2020 was rich in **black carbon**, which can block sunlight. Not only did the smoke darken skies near the fires, it also darkened skies across the United States (see maps on the right). When smoke rises high into the atmosphere, it can travel very quickly due to strong winds found there. This is known as smoke transport.

Smoke also rose high into the atmosphere during the Australian bushfires of 2019-2020 – so high that thunderclouds formed. Fires that burn really hot can quickly send super-heated air and smoke to the top of the troposphere and beyond. As the hot air rises and spreads out, it cools. This causes water vapor to condense around the smoke particles and form storm clouds known as pyrocumulonimbus. These storms are hazardous for airplanes because of strong, erratic winds; they also hinder firefighting on the ground.

Smoke often has a tan color when viewed from above. Pyrocumulonimbus clouds are bright white.



Black Carbon Column Mass Density (mg/m²)

0 5 ≥10

High-level winds carried wildfire smoke from the West Coast to the eastern United States in September 2020.

Vocabulary

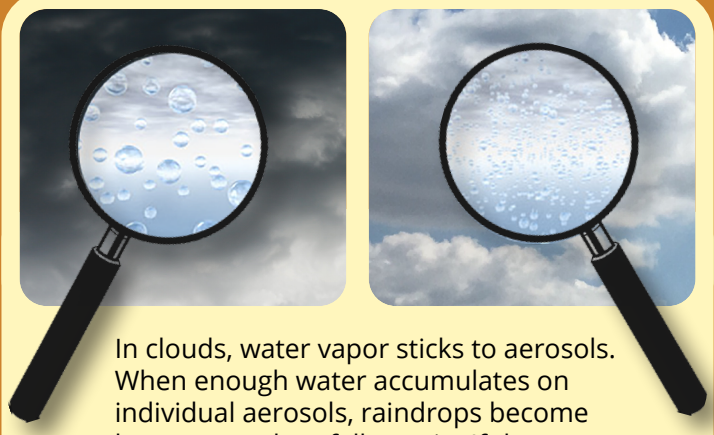
black carbon — Sometimes called soot, this fine, dark particulate matter is dangerous to our health. It is released when trees and fossil fuels do not burn completely.

Image credit: Jean Beaufort

The fires in Australia burned more than 40 million acres of forest. About three billion animals were displaced, including kangaroos, pygmy possums, and koalas.

Less Rain Down in Africa

Smoke in the atmosphere does not always help create clouds. Scientists found evidence that human-caused fires in Africa can reduce rainfall. This is because smoky skies (and their aerosols) can keep rain from falling. When there is a lot of smoke, water vapor is spread around on too many aerosols. This does not allow the water droplets to grow large enough to make rain.



In clouds, water vapor sticks to aerosols. When enough water accumulates on individual aerosols, raindrops become heavy enough to fall as rain. If there are too many smoke aerosols competing for water, the drops may not get heavy enough to fall.

More fires burn in Africa than anywhere else on Earth. In Africa, fire is often used to clear areas for crops, to fertilize land, and to hunt.

Smoke and Your Health

Smoke affects our environment in many ways. It can also affect our health.

Smoke may make us sneeze or make our eyes itch, which is a minor problem. However, due to their tiny size, smoke particles can also get into our lungs and bloodstream. This affects our bodies in ways that can aggravate asthma or, after long-term exposure, cause lung cancer.

People with respiratory conditions, the elderly, infants, and pregnant woman should take extra precautions during any fire event. It is usually best to stay indoors.

According to the World Health Organization (WHO), one in eight deaths each year can be connected to air pollution. This makes it the world's largest environmental health risk.

The Environmental Protection Agency's Air Quality Index was designed to help people quickly understand how air quality is related to health risks.

During the U.S. West Coast fires of 2020, the Air Quality Index reached extremely unhealthy levels – over 700 in places.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 - 50	Air quality is considered satisfactory, and air pollution poses little or no risk.
Moderate	51 - 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 - 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 - 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 - 300	Health alert; everyone may experience more serious health effects.
Hazardous	> 300	Health warnings of emergency conditions. The entire population is more likely to be affected.

Table courtesy of AirNow

Data Viz
Tracking Transport

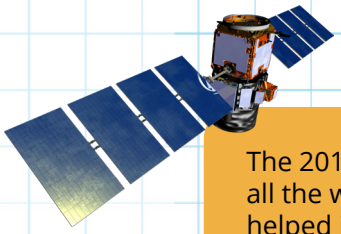
You can track the movement of smoke in the atmosphere by creating a flipbook.

Materials:

- Small binder clip
- Scissors
- Cardstock
- Color printer

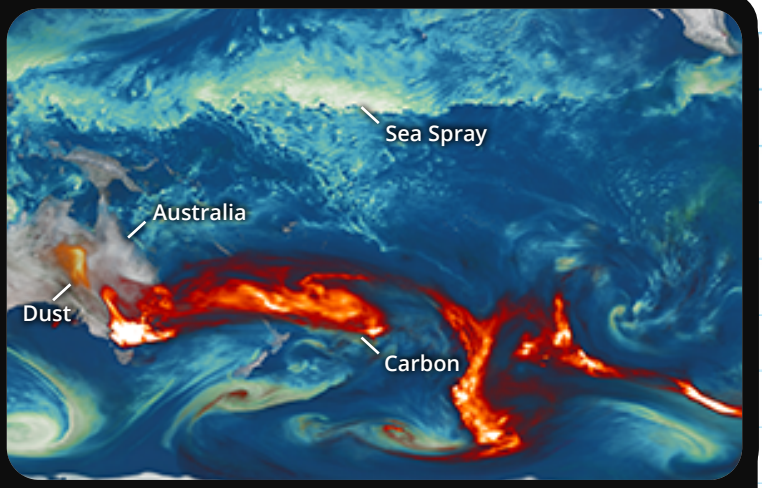
Instructions:

1. Print pages 5 and 6 on cardstock and cut along the dotted lines.
2. Stack the 36 cutouts from pages 5 and 6 in order.
3. Clip the stack of cards together with the binder clip.
4. Flip through the stack quickly and watch smoke move around the Southern Hemisphere.



The 2019-20 Australian fires lofted smoke all the way up into the stratosphere. That helped it travel around the Southern Hemisphere. The images in the flipbook come from satellite observations and computer models of aerosols from those Australian bushfires.

On January 6, 2020, smoke from Australian fires rose as high as 25 kilometers (15 miles) into the atmosphere. It was one of highest wildfire-caused plumes ever tracked by the CALIPSO satellite.



Carbon Aerosol Optical Depth (550 nm)
0.0 — 2.0

Dust Aerosol Optical Depth (550 nm)
0.0 — 0.5

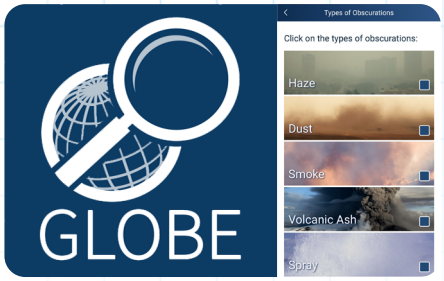
Sea Spray Aerosol Optical Depth (550 nm)
0.0 — 0.3

This color key defines some aerosols detected in Earth's atmosphere by satellites in 2019/2020. Red indicates smoky black carbon (mostly from Australian wildfires). Orange shows particles lofted by desert dust storms. Blue-green shows where salty ocean spray has been picked up by winds.

Extension Activity

You can use the NASA GLOBE Observer mobile app to make and submit your own smoke observations. By doing so, you can help researchers study the effects of smoke on our atmosphere.

Download the free app here:
https://observer.globe.gov/about/get-the-app



Binder Clip Here

EO Kids: Flipbook

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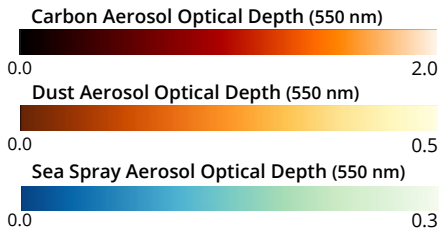
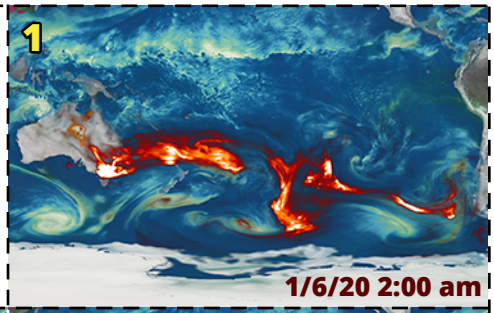
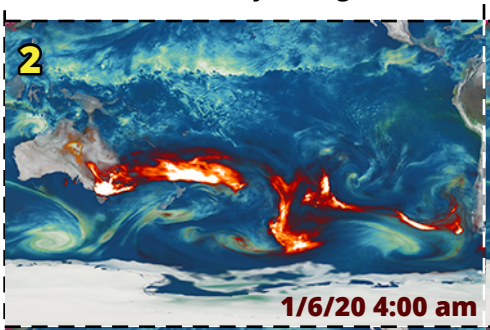
Tracking Transport

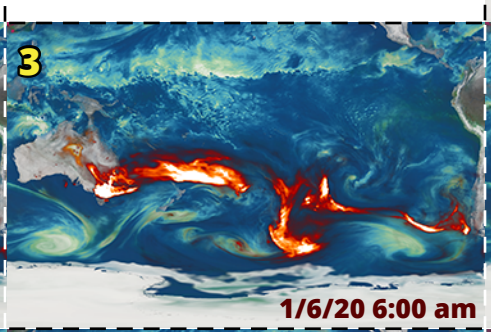
January 6 - 8, 2020

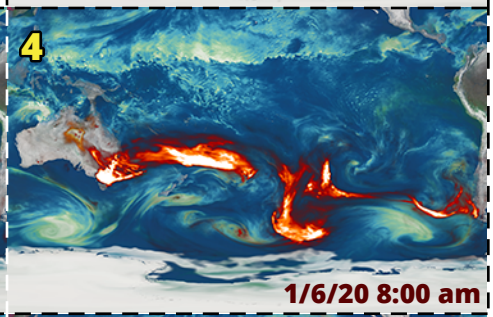
earthobservatory.nasa.gov/eokids

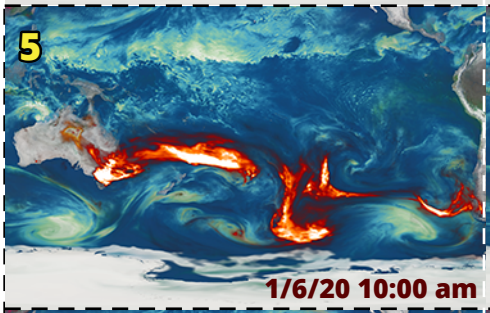


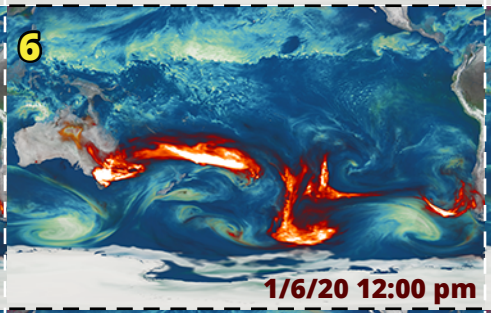


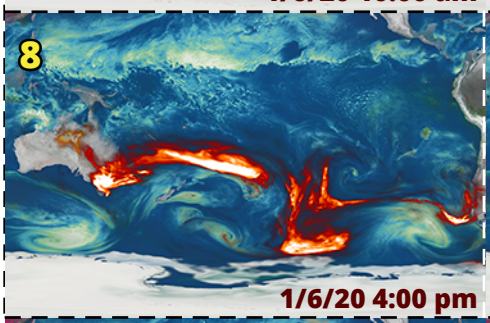


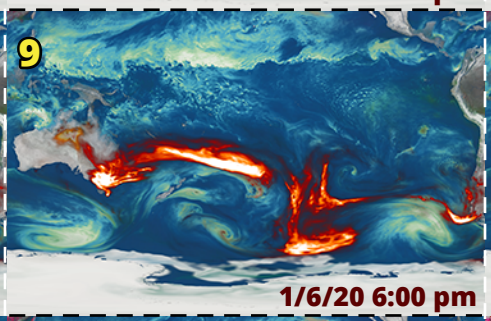


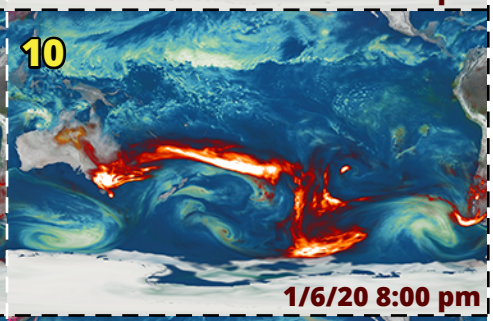


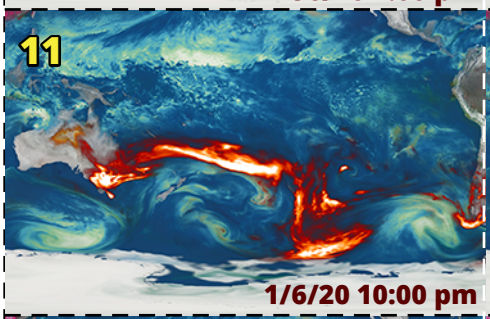


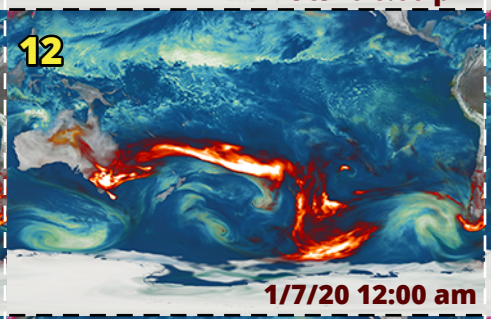


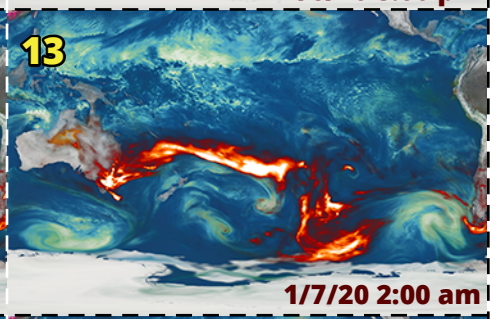


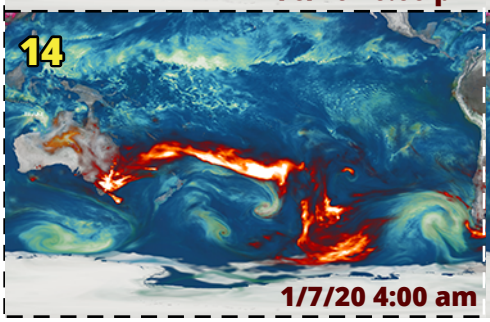


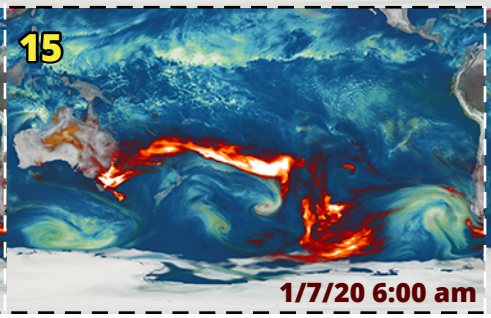


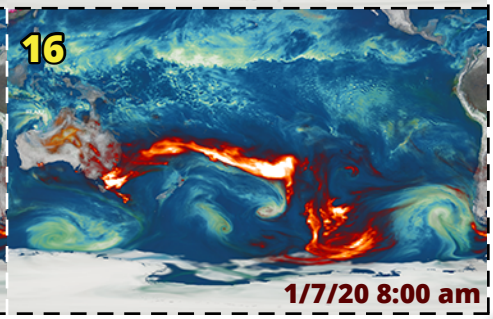


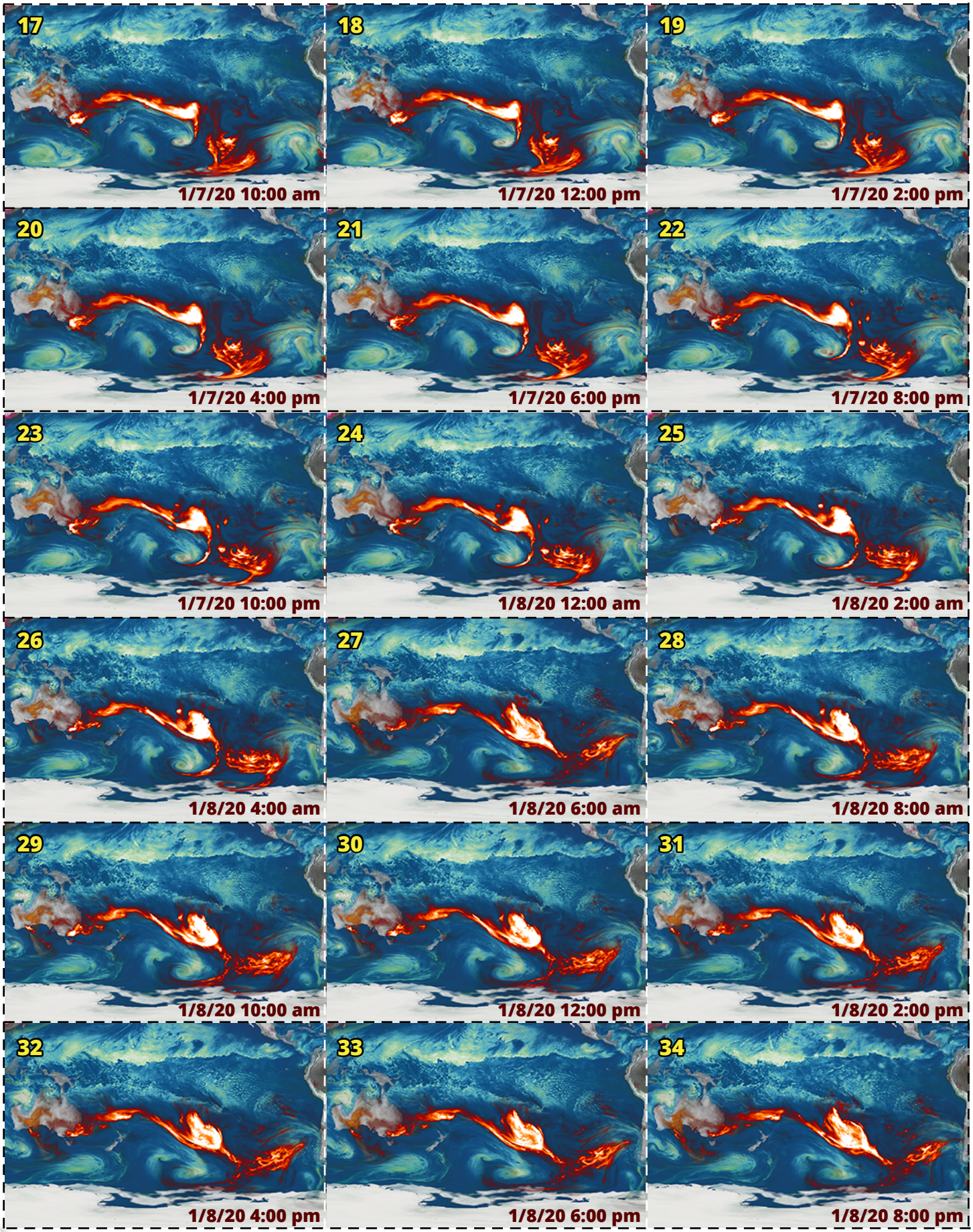








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