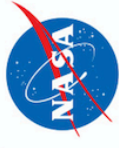


# AIRCRAFT, SCIENCE AND ATTREX

NASA's Airborne Tropical Tropopause Experiment (ATTREX) used unmanned aircraft to observe small-scale dynamics within the tropical tropopause layer (TTL), the gateway to the stratosphere, that satellites and ground instruments alone could not.



National Aeronautics and  
Space Administration

## HOW DOES WATER GET INTO THE STRATOSPHERE?

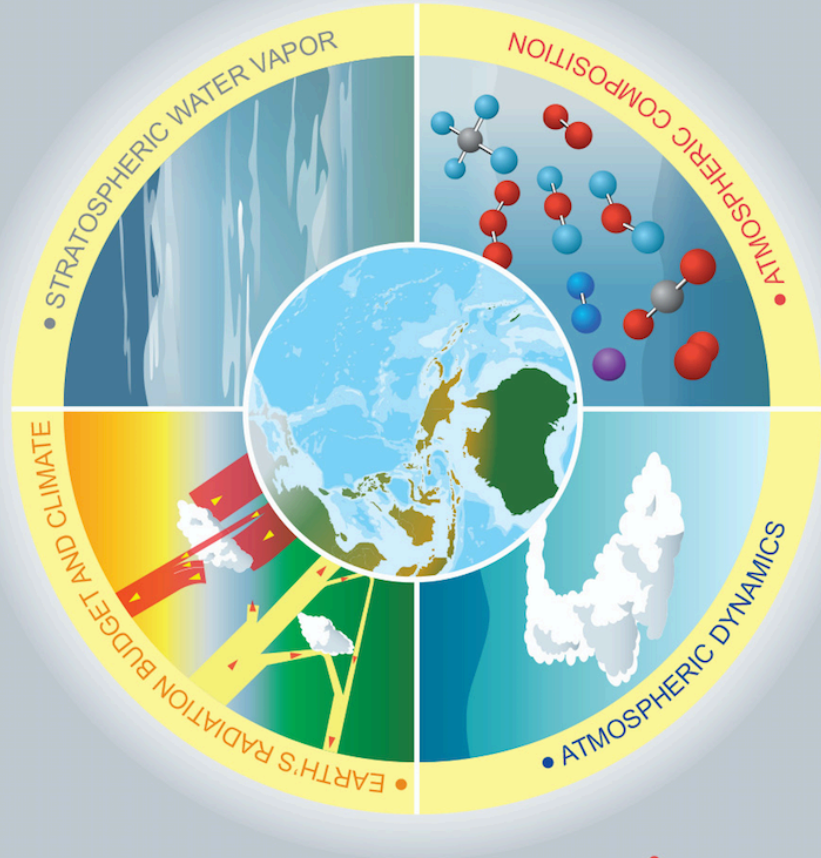
Earth is commonly referred to as the "Goldilocks" planet because it is not too hot and not too cold. It maintains this "just right" temperature by absorbing and expelling radiation, or energy, from the sun. How much energy is regulated by many factors, including the amount of water in the stratosphere, which contributes to higher surface temperatures as well as lower ozone concentrations.

ATTREX used its aerial view to better understand the microphysical, chemical and dynamic processes involved in regulating stratospheric water vapor, such as cloud formation and wind fluctuations, that satellites can't see.

Here are three things we wouldn't know without ATTREX aircraft data:

- **THE TROPICAL TROPOPAUSE LAYER IS LEAKING:** The TTL is supposed to dehydrate, or remove water from, the air before it reaches the stratosphere. It does this by freeze drying it and trapping water within ice particles that make up cirrus clouds. However, ATTREX data show the TTL is not as efficient at nucleating ice particles as models currently assume, allowing more water to enter into the stratosphere.
- **GRAVITY WAVES ALSO CONTROL WHEN AND WHERE CIRRUS CLOUDS FORM:** ATTREX provided the first extensive vertical profiles of the TTL, and showed that wave phases, or whether a region of air is in peak or trough formation, affects the creation of cirrus clouds—not just temperature. As the waves propagate through the TTL, they both warm and cool the air. ATTREX showed that cirrus clouds are more likely to form in the cold phase of atmospheric waves, reducing the amount of water that makes it into the stratosphere.

- **VERTICAL MIXING PLAYS A MINOR ROLE IN STRATOSPHERIC WATER VAPOR:** Vertical mixing occurs in the atmosphere when two adjacent air masses contain differing amounts of water or other gases. ATTREX data show this process occurs only in localized, shallow layers often caused by breaking waves, and it actually contributes little to the transport of water vapor into the stratosphere.



### SENSORS

- FCDP ●
- NOAA-H2O ●
- 2D-S ●
- MMS ●
- CPL ●
- UCATS ●
- HUPCRS ●
- mini-DOAS ●
- DLH ●
- MTP ●
- SSFR ●
- AWAS ●
- CPI ●
- NOAA-ozone ●●

### PLATFORM

Global Hawk

