National Aeronautics and Space Administration

Interpreting Ozone

The Tropospheric Emission Spectrometer (TES) is one of the instruments aboard the Earth-observing Aura satellite. TES focuses on the layer of atmosphere from the ground to about 20 kilometers (or 12 miles) high. With high precision, TES data is used to infer a variety of atmospheric gases, including ozone, carbon monoxide, water vapor, and methane at different altitudes. These measurements are important in understanding global warming and climate change, the water cycle, and air pollution on local, regional, and global scales.

Earth's global climate is warming.
The major cause of global warming is the increase in atmospheric greenhouse gases. Greenhouse gases trap some of the energy that Earth radiates after being warmed by the Sun. Human activity is responsible for unprecedented rises in the concentrations of the four major greenhouse gases in the atmosphere—carbon dioxide (CO_2), methane (CH_4), nitrogen dioxide (N_2O), and ozone (O_3). This activity indirectly affects the distribution of water vapor, which is the most potent greenhouse gas. For example, as the ocean surface warms from increasing human-made greenhouse gases, more water evaporates into the atmosphere, which in turn traps more heat , and subsequently amplifies the increase in global surface temperatures.

Both pollution and greenhouse gases are produced locally, but exported globally.
Atmospheric pollutants, which harm humans and plant health, are frequently emitted from the same sources—such as factories and automobiles—as greenhouse gases. However, they do not confine themselves to their region of origin; instead, they get redistributed by weather around the globe. That is why instruments to measure these gases need to be "above it all," observing their global movements from space.

Ozone affects both pollution and climate.
Scientists are still learning how ozone can directly and indirectly affect climate and air quality. High in the stratosphere, at around 50 kilometers (30 miles), ozone shields us from the Sun's harmful ultraviolet rays. Lower, at the top of the troposphere where commercial airliners fly, ozone is a greenhouse gas and contributes to global warming. Mid-troposphere, ozone is key to a chemical process that cleans the air of certain pollutants. At the bottom of the troposphere, where we live and breathe, ozone contributes to smog and is toxic to plants and animals—including humans. Not only do ozone-damaged plants grow less and produce less food, they do not absorb as much carbon dioxide as do healthy plants, thereby allowing more carbon dioxide to accumulate in the atmosphere. Although ozone is a short-lived greenhouse gas, remaining in the atmosphere for only 2 to 4 weeks, carbon dioxide sticks around for more than 100 years. So, even though ozone is transient, its effects can last a long time.

TES looks for the "fingerprints" of global ozone and other greenhouse gases.
After the Sun warms the Earth, the planet radiates that energy back into space in a range of infrared wavelengths. But before reaching space, the energy passes through the atmosphere, where various gases absorb and re-radiate portions of the energy—in effect stamping it with each gas's own spectral signature or fingerprint, which varies slightly with altitude. TES infers precise concentrations of ozone, carbon monoxide, carbon dioxide, water vapor and methane at various altitudes from these gas's unique fingerprints.

TES provides valuable information on climate and pollution.
The ability of TES to make three-dimensional maps of greenhouse gases in the troposphere will greatly help in developing and constraining predictive climate models and can be uniquely valuable for local and regional air-pollution analysis and forecasting.