Looking at Ozone From a New Angle

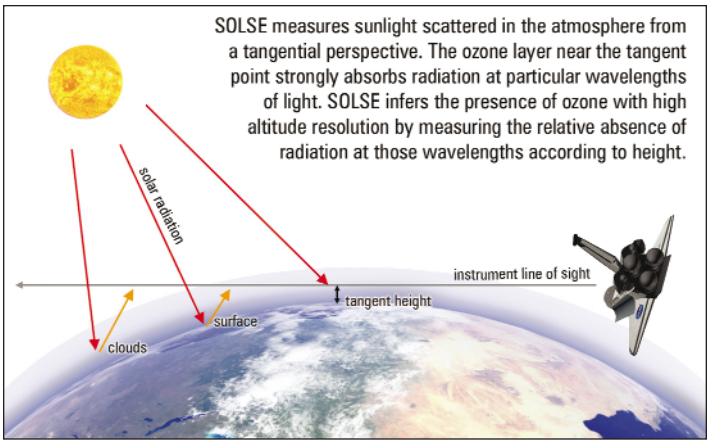
Shuttle Ozone Limb Sounding Experiment–2 (SOLSE–2)

The ozone layer above Earth is our planet's fragile sunscreen, protecting people, vegetation, and wildlife. NASA has been measuring ozone for more than 20 years by looking down, but SOLSE–2 will show that more information is available by looking at ozone from the side, at Earth's limb or atmospheric boundary.

When the ozone layer is compromised, increased ultraviolet (UV) levels from the sun cause health problems ranging from severe sunburns to skin cancer and cataracts. A concerted global effort has been made to reduce or eliminate the production of chemicals that deplete ozone, but the ozone layer is not expected to recover for many decades because these chemicals can remain active in the atmosphere for up to 100 years.

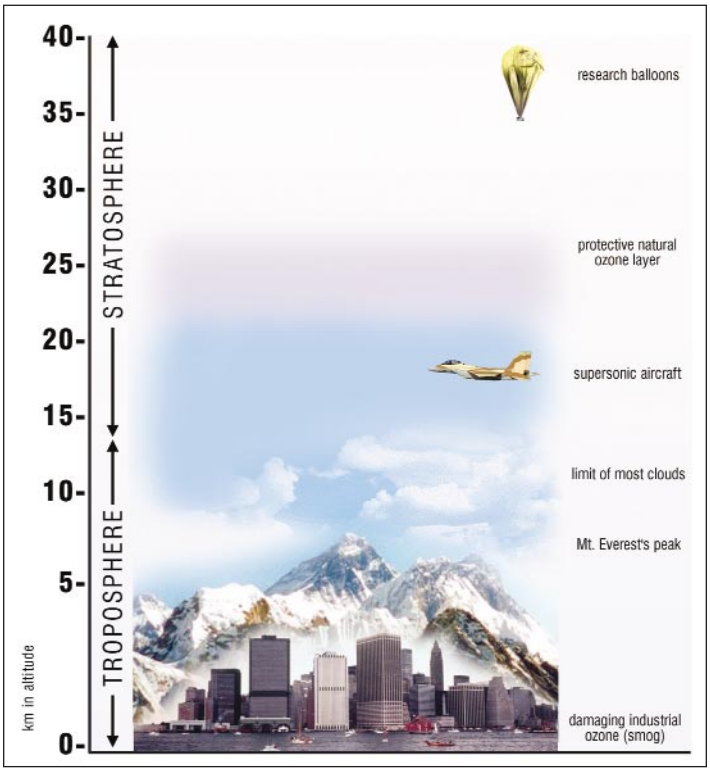
We know now that ozone monitoring needs to be focused in the lower stratosphere. The discovery of the ozone hole in 1985 demonstrated that very large changes in ozone were occurring in the lower stratosphere near 20 km, instead of the upper stratosphere as first expected, and where current ozone instruments are focused. Measuring ozone from a tangential perspective that is centered at the limb provides ozone profiles concentrated in the lower stratosphere.

The first flight of SOLSE proved that this technique achieves the accuracy and coverage of traditional measurements, and surpasses the altitude resolution and depth of retrieval of conventional techniques. Results from the first flight convinced the science community to design the next generation ozone monitoring satellite based on SOLSE. The Ozone Mapping and Profiling Suite (OMPS) is currently being built for the NPOESS satellite. The primary objective of SOLSE–2 is to confirm the promising results of the first flight over a wider range of viewing conditions and spectral wavelengths.



This illustration shows how ozone is seen using light scattered from the Earth's limb.

Sometimes a really hard problem can be solved when you look at it from a different angle! While scientists conduct research, protect yourself by observing the UV index and spend less unprotected time outdoors.



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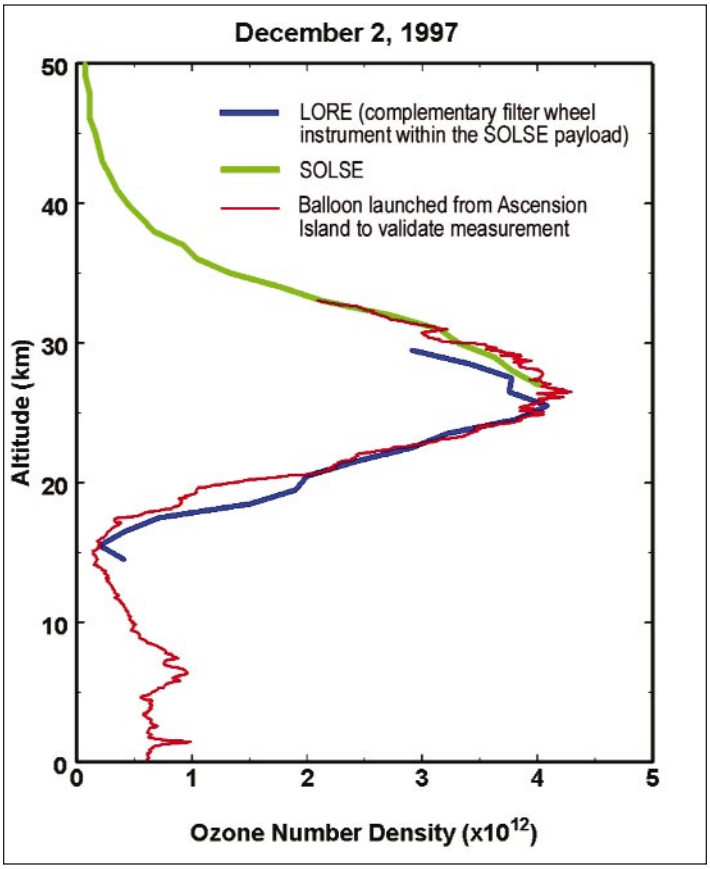
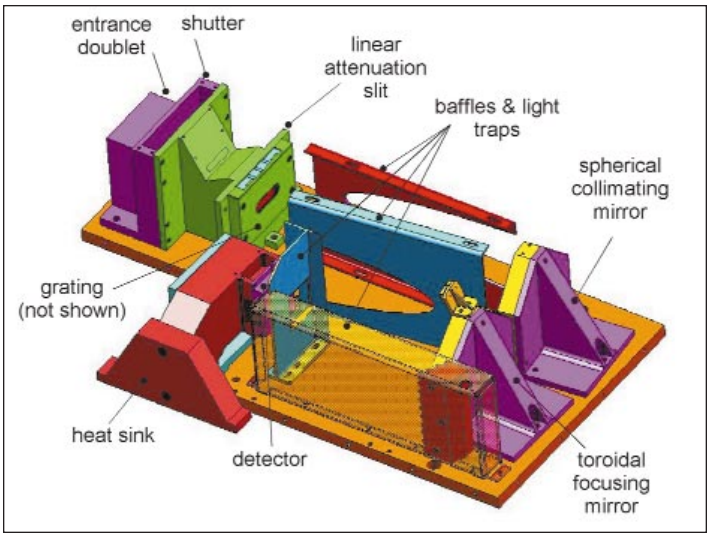
Background Information

Science

SOLSE demonstrates a conventional ozone measuring technique from a new perspective in order to focus on the stratosphere. The atmosphere scatters UV radiation from the sun back into space. When viewed from above, as current ozone monitoring instruments do, this is called "backscatter." Backscattered measurements cannot resolve ozone down to the lower stratosphere where ozone levels are changing the most. Limb scattered sunlight varies with altitude, so that SOLSE can distinguish the altitude distribution with high resolution into the lower stratosphere. Stratospheric ozone depletion is a global concern because the ozone layer there keeps 95 percent of the UV radiation from striking the Earth. High altitude resolution and global coverage are necessary to reduce the uncertainty of the ozone trends derived from the measurement. Limbscattered measurements will also increase the capability of atmospheric models to evaluate other factors in ozone depletion.

The Shuttle provides the perfect testbed to demonstrate new technology and measurement techniques without committing the funds for a flight instrument. Once proven over a wider range of viewing conditions, the SOLSE technique will be used to routinely measure ozone by the next generation weather satellites. NASA, NOAA, and the Department of Defense form the Integrated Program Office (IPO) that funds the SOLSE–2 demonstration as a risk reduction for OMPS.





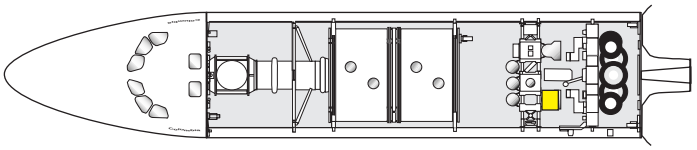
SOLSE instrument is a Czerny-Turner imaging spectrometer.

Hardware

SOLSE is an imaging spectrometer designed to produce high quality 2-dimensional images of the limb in visible and UV light while minimizing internal stray light. A holographic grating disperses the image of the limb into a spectrum that is focused onto a CCD array of 1024 × 1024 pixels. The back-thinned array is sensitive to UV and visible wavelengths. The optical slit is masked with a linear attenuation filter that normalizes the intensity of the limb that varies by a factor of 100 from top to bottom. A shutter controls the exposure of each frame. The Limb Ozone Retrieval Experiment (LORE) is a complementary filter wheel imaging photometer with a linear diode array detector. The filter wheel housing encloses 6 ion-assisted deposition filters at UV and visible wavelengths. Together, SOLSE and LORE retrievals span the atmosphere from 15 to 50 km above Earth's surface.

Previous Results

SOLSE and LORE provided the first retrieval of stratospheric ozone by limb scattering as a Shuttle payload on STS–87 in 1997. The results from the first flight demonstrated that limb sounding of ozone can achieve 1–3 km altitude resolution down to 15 km. The spectral coverage of SOLSE was changed for the reflight to include visible wavelengths in addition to UV to achieve LORE's depth of retrieval, which clearly detected the edge of the troposphere. The ground track of STS–107 is limited to 39° latitude north and south, but higher latitude coverage will be simulated with Shuttle maneuvers to observe the poles and seasonal patterns to verify the limb-viewing technique over wider viewing conditions.



Approximate location of SOLSE payload aboard STS–107.