## *Press Information*

# SOLVE II

### Stratospheric Aerosol and Gas Experiment (SAGE III) Ozone Loss and Validation Experiment

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| **WHAT** | SOLVE II is an international field campaign designed to measure ozone and other atmospheric gases in the Arctic using aircraft, large and small balloons, ground-based instruments and satellites.<br><br>The instruments will examine the processes controlling ozone levels at mid- to high latitudes.<br><br>The mission will also acquire data needed to validate the third Stratospheric Aerosol and Gas Experiment (SAGE III) satellite measurements that will be used to quantitatively assess high-latitude ozone loss.<br><br>Scientists will also work toward ensuring that measurements from other current Earth-observing satellites are accurate. They will take measurements of the stratosphere using a large suite of instruments aboard three aircraft: NASA's DC-8, the European M55 Geophysica, and the German DLR Falcon. |
| **WHO** | NASA researchers will work in close collaboration with the VINTERSOL (Validation of International Satellites and study of Ozone Loss) campaign sponsored by the European Commission and national agencies. More than 350 scientists from the United States, the European Union, Canada, Iceland, Japan, Norway, Poland, Russia, and Switzerland will participate in this joint effort. |
| **WHEN** | During the winter of 2002-2003: The DC-8 phase of this Arctic campaign will run from January 8 through February 6, 2003. Flights of large balloons will augment the aircraft campaign, extending the measurement period from late November 2002 to late March 2003. |

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| **WHERE** | Measurements will be made in the Arctic high-latitude region of Kiruna, Sweden, the site of the first international effort, SOLVE I, and the Third European Stratospheric Experiment on Ozone (THESEO 2000), during the winter of 1999-2000. |

**BACKGROUND**

**Mission Goals**

The joint SOLVE II – VINTERSOL campaign will further understanding of the process of ozone loss in the Arctic and verify that satellite observations of the ozone layer are accurate from space. The satellite observations are the primary measurements used by the international scientific community to follow and understand changing stratospheric ozone levels.

This international field campaign is designed to acquire data needed to validate the Meteor-3M/ SAGE III satellite mission, atmospheric chemistry instruments onboard the National Space Development Agency of Japan's Advanced Earth Observing Satellite (ADEOS-II), and the European Space Agency's environmental satellite (ENVISAT) missions.

These additional satellite observations both enhance comparisons and improve ozone loss studies. Measurements will be made in the Arctic in winter using the NASA DC-8 aircraft, balloon platforms, and ground-based instruments.

Teams from the French space agency, Centre National d'Etudes Spatial, will launch European and NASA Research balloons that carry payloads weighing up to several hundred pounds. An internationally based network of over 30 stations of ground-based instruments will take atmospheric readings over a wide area that will show how the chemical composition of Arctic stratosphere evolves through the whole winter.

SOLVE II will take place in close collaboration with the VINTERSOL campaign that includes the German Falcon and Russian Geophysica M55 aircraft, other balloon platforms and ground-based instruments. VINTERSOL is a pan-European campaign involving researchers supported by the European Commission and national research agencies.

## NASA's Science Objectives

The first SOLVE campaign was conducted during the winter of 1999-2000. Both the observations from that campaign and research over the last few years have improved our understanding of Arctic ozone losses, but have also revealed new areas of concern.

During SOLVE II the NASA DC-8 aircraft will be used to pursue five basic science objectives. These objectives are:

***SAGE III instrument validation***

- Ozone, aerosol, water vapor, and nitrogen dioxide measurements from the DC-8 will be compared to SAGE III measurements in order to prove the quality of satellite observations. The satellite observations are key components of the international effort to determine the current state of the ozone layer, and in order to determine how it will evolve into the future.

***Understanding polar ozone loss rate in early to mid-winter***

- Observations during the first SOLVE campaign showed a larger than expected loss of ozone during the January-February period. During SOLVE II DC-8 flights and balloon observations will be designed to measure ozone losses during January 2003.

***Improving our understanding of polar stratospheric clouds***

- Observations during the first SOLVE campaign revealed the unexpected presence of very thin polar stratospheric clouds composed of large particles in the high Arctic region. These large particles were shown to be composed of nitric acid and water and contribute to ozone depletion. However, the formation of these large particles is not understood.

***Improving our understanding of the chemistry of ozone loss***

- Stratospheric ozone is destroyed by chlorine and bromine gases that primarily come from human-produced compounds. Measurements of these compounds in the Arctic during the first SOLVE campaign showed that the observed decrease of ozone was in reasonable agreement with the observed levels of chlorine and bromine. During with the observed levels of chlorine and bromine. During the SOLVE II campaign we also will be comparing our observed ozone losses against these chlorine and bromine levels.

***Meteorological impacts on polar ozone levels***

- Over the course of the winter, ozone typically increases in the polar region as ozone-rich air at higher altitudes in the mid-latitudes and the tropics is carried pole ward and downward by the winds. This motion also acts to warm the polar region. Because meteorological conditions vary widely between winters, this transport of ozone rich air must be carefully quantified during this winter's campaign.

## SAGE III Instrument

The validation of the SAGE III observations is a principal goal of SOLVE II. SAGE III is a fourth generation satellite instrument designed to observe the long-term health of the upper atmosphere. It was launched onboard a Russian Meteor-3M spacecraft on December 10, 2001.

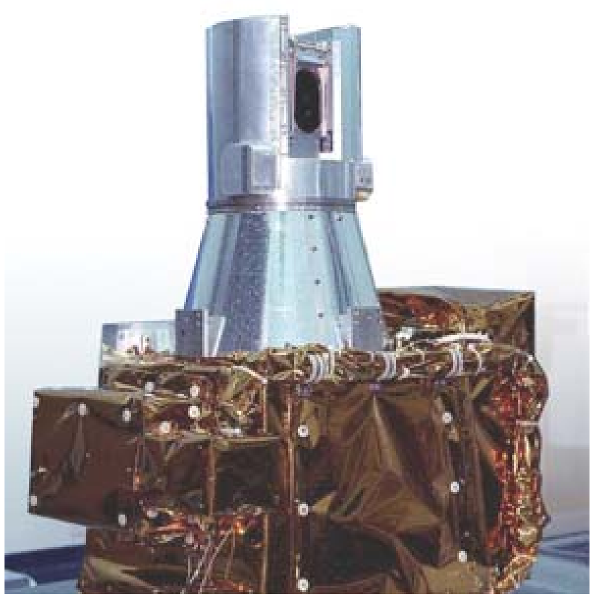
The goal of SAGE III is to measure high-resolution vertical profiles of key components of the upper atmosphere—the most important being ozone, aerosols (suspended particles) and water vapor. These measurements will enhance our understanding of climate and how human activities influence it. This information will enable national and international leaders to make informed policy decisions on climate change.

The SAGE III instrument measures sunlight and moonlight at a variety of wavelengths that extend from the ultraviolet through visible regions of the light spectrum and into the near-infrared wavelengths. It relies upon the flight-proven designs used in the Stratospheric Aerosol Measurement (SAM II) and SAGE I and II instruments.

As the Meteor-3 satellite orbits the Earth 14 times per day, the SAGE III instrument observes the sun (or moon) setting and rising. The sunlight passes through the edge of the Earth's atmosphere, and the absorption of that light reveals information on concentrations of various gases and particles. This space-based remote sensing technique, known as occultation, provides scientists with global samples of Earth's atmospheric composition.

The SAGE III sensor assembly consists of pointing and imaging subsystems and a UV/visible spectrometer. The pointing and imaging systems are employed to acquire light from either the Sun or Moon by vertically scanning across the object during the Sun and Moon sets and rises. This configuration enables SAGE III to make multiple measurements of absorption by various gases and aerosols.

The SAGE III instrument was developed and managed by NASA Langley Research Center, Hampton, Va., and was built by Ball Aerospace and Technologies Corporation in Boulder, Colo.



**Specifications**

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| Weight | 76 kg, 167 pounds |
| Power | 80 W on-orbit average Data Rate 115 Kbit/s |
| Dimensions | 73 cm x 45 cm x 93 cm, 29 inches x 18 inches x 37 inches |

## NASA DC-8 Airborne Laboratory Program

The NASA DC-8 was a primary measurement platform for the first SOLVE mission and is being used again for SOLVE II. The DC-8 provides for a wide variety of experiments and data collection in support of scientific projects, serving the world scientific community. Included in this community are NASA, federal, state, academic, and foreign investigators. Data gathered at flight altitude and by remote sensing from the DC-8 have been used in many studies including: archaeology, ecology, geology, hydrology, meteorology, oceanography, volcanology, atmospheric chemistry, soil science, biology, and other Earth science disciplines.

The DC-8 aircraft used for this campaign is a medium altitude, moderate to high speed aircraft flying up to 41,000 feet above sea level between 425 and 490 knots True Air Speed (TAS). The DC-8 is capable of precise flight line navigation by means of integrated inertial and GPS navigation systems from which line guidance is provided to the pilots. The aircraft and its complement of on-board sensors provide a readily deployable remote sensing platform that supports scientific research throughout the contiguous United States, Alaska and Hawaii. Additionally, the aircraft has been deployed in support of research in Australia, Bermuda, France, Germany, Austria, Italy, South America, and Africa.

The NASA DC-8 Airborne Laboratory Program is based at NASA's Dryden Flight Research Center, Edwards, Calif.

## SOLVE I Campaign

NASA scientists and researchers from Europe, Russia, and Japan mounted the largest field measurement campaign ever, SOLVE I, to measure ozone amounts and changes in the Arctic upper atmosphere during the winter of 1999-2000.

This NASA sponsored campaign was conducted jointly with the European Commission sponsored THESEO 2000 campaign. These collaborative campaigns obtained measurements of ozone and other atmospheric gases using satellites, airplanes, heavy-lift and small balloons, and ground-based instruments. Researchers examined the processes that control ozone amounts at mid to high latitudes during the Arctic winter.

The SOLVE/THESEO-2000 campaign represented a new level of active cooperation between U.S., European, Russian, and other national research scientists. Such scientific collaboration has been encouraged under the 1998 European Union/United States Science and Technology Cooperation Agreement. More than 350 scientists, technicians and support workers were involved in the SOLVE/THESEO-2000 experiment.

The SOLVE II campaign will add to the body of knowledge gained during the campaign of 1999-2000, when record ozone losses of 70 percent were observed at altitudes around 18km (11 miles) and more was learned about the processes leading to the fast ozone loss in the Arctic.

## Why Study Ozone?

Ozone studies are important because the ozone layer prevents the sun's harmful ultraviolet radiation from reaching the Earth's surface. Ultraviolet radiation is a primary cause of skin cancer. Without protective upper-level ozone in the atmosphere, there would be no life on Earth. In addition, ozone is also a greenhouse gas. Stratospheric ozone losses are believed to cool the Earth’s surface, while ozone changes in the lower atmosphere will act to warm the Earth’s surface.

More than 17 years ago, scientists detected an "Ozone Hole" over the South Pole that has reappeared each year during the Southern Hemisphere's winter and spring. Researchers from around the world recognized more than a decade ago that ozone depletion is caused primarily by human-produced chemicals such as chlorofluorocarbons (CFCs) containing chlorine and halons containing bromine. The chlorine compounds have been produced for use as refrigerants, aerosol sprays, solvents and foam blowing agents, while bromine-containing halons have been used in fire extinguishing. Production of CFCs ceased in 1996 in developed countries under the terms of the Montreal Protocol and its Amendments.

### *Aerosols and volcanic eruptions*

Aerosols have many natural and human-induced sources such as volcanic material, smoke from forest fires, wind-blown dust, and pollution. When present in large concentrations, aerosols can reflect significant amounts of solar radiation back to space and cause cooling at the Earth’s surface.

Depending upon the chemical composition of aerosol particles, they can absorb radiation from the Sun or emitted from the Earth, causing the atmosphere to warm. Aerosols can also strongly influence atmospheric chemical processes, including those that control ozone. Because the characteristics of aerosols can vary considerably, understanding how aerosols affect climate is one of the major problems confronting atmospheric scientists.

The SAGE III instrument will measure the distribution of aerosols from the middle troposphere through the stratosphere.

For example, the SAGE II satellite instrument—the predecessor to SAGE III launched in 1984—observed the dispersal of volcanic aerosols following the massive eruption of Mt. Pinatubo in 1991. These measurements were crucial in linking a decline in the globally averaged surface temperature in mid-1992 of about 1 degree Fahrenheit to the large aerosol concentrations from the volcanic eruption. Aerosols from Mt. Pinatubo also strongly influenced the observed ozone trend—an effect that would not have been detected without measurements like those from SAGE II. The data also provided unique insight into the complex flow of air in the stratosphere that is needed to gain a better understanding of how the upper atmosphere will respond to climate change.

***Ozone in the upper atmosphere***

In the stratosphere, ozone shields life at the surface from harmful solar ultraviolet radiation and plays an important role in controlling the circulation of air in the upper atmosphere. Changes in ozone distribution, like the ozone hole that forms in the spring over Antarctica, are also a concern to health officials because of the possibility for increased cases of melanoma and other skin cancers, cataracts and immune deficiencies in humans. Scientists now realize that ozone is being destroyed over the Arctic during late winter and more slowly over middle latitudes.

A primary objective of the SAGE III instrument is to make accurate, long-term measurements of the concentration of stratospheric ozone and other chemical species that control the distribution of ozone.

***Water vapor observations***

Atmospheric water vapor plays an important part in the Earth’s energy balance, in many chemical cycles and in tracing the exchange of air between the upper and lower atmosphere. Water vapor is the most abundant, naturally occurring greenhouse gas and traps outgoing energy in the atmosphere that is radiated from the Earth. Precise measurements of water vapor by SAGE III will provide important contributions to understanding how this process warms the Earth's atmosphere. Evidence also indicates that water vapor in the upper atmosphere is increasing. This increase is not understood, and it could affect climate, alter circulation patterns and allow ozone loss in the Arctic to occur more easily. Measurements by SAGE III will provide a crucial new understanding of how water vapor is circulated in the atmosphere and how it is increasing with time.

## Sweden as Deployment Site

Kiruna, Sweden, was chosen as the deployment site for the SOLVE II campaign for two reasons. First, the Arena Arctica facility at the Kiruna airport is a superb hangar for DC-8 aircraft and the European aircraft operations and will house many of the scientific instruments.

Second, Kiruna's extreme northern latitude is ideally located for measurements of the lower stratospheric polar vortex. Kiruna is located about 200km (124 miles) north of the Arctic Circle and it is the northernmost municipality in Sweden, in the region known as Lapland. The town of Kiruna is approximately 500 m (3-tenths of a mile) above sea level and has a population of about 25,000.

Balloons will be launched from Esrange, a balloon and rocket launch facility approximately 45 km (28 miles) from Kiruna. Esrange is managed by the Swedish Space Corporation and the balloon and rocket activities are coordinated and financed by the Esrange Andöya Special Project within the European Space Agency.

Wintertime conditions can be very severe, and during the coldest months, December, January and February, the average temperature is normally around minus 15 degrees Celsius (5 degrees Fahrenheit).

## Management

SOLVE is co-sponsored by the Upper Atmosphere Research Program, Atmospheric Chemistry Modeling and Analysis Program, and Earth Observing System of NASA's Earth Science Enterprise as part of the validation program for the SAGE III instrument. NASA's Earth Science Enterprise is dedicated to better understanding and protecting our home planet.

## More Information

For general information and images:

**http://www.gsfc.nasa.gov/topstory/20020930solve.html**

**http://svs.gsfc.nasa.gov/stories/solve/**

For information about the SOLVE II Mission:

**http://cloud1.arc.nasa.gov/solveII/index.html**

For information about SAGE III:

**http://www-sage3.larc.nasa.gov/**

For information about the VINTERSOL program:

**http://www.ozone-sec.ch.cam.ac.uk**

**Contact:**
**Cynthia O'Carroll**
**Goddard Space Flight Center, Greenbelt, Md.**
**Phone: 301/614-5563**
**Cynthia.M.Ocarroll@nasa.gov**