Laboratory for **A**tmospheric and **S**pace **P**hysics

Activity Report
2000
University of Colorado at Boulder

Cover. The LASP Space Technology Building, formally dedicated on September 5, 1991. This facility is located off-campus in the Research Park at 1234 Innovation Drive, Boulder, Colorado.

Laboratory for Atmospheric and Space Physics

University of Colorado at Boulder

Campus Box 590

1234 Innovation Drive

Boulder, Colorado 80303-0590

(303) 492-6412

http://lasp.colorado.edu

Introduction

This report describes activities of the members of the Laboratory for Atmospheric and Space Physics (LASP) from January 2000 through December 2000. LASP is an institute of the Graduate School of the University of Colorado. LASP conducts basic theoretical and experimental research in planetary, atmospheric, magnetospheric, and solar physics. LASP also conducts research to explore the potential uses and development of space operations and information systems, as well as to develop scientific instrumentation. Through LASP's research programs, University faculty, staff members, and students are able to participate in national space programs. In particular, students from the Department of Astrophysical and Planetary Sciences, the Department of Atmospheric and Oceanic Sciences, the Department of Physics, the Department of Geological Sciences, and the College of Engineering pursue research interests under the auspices of the Laboratory. A coordinated, multi-objective research program has evolved that uses remote sensing spectroscopic and in situ techniques.

LASP has taken part in major space exploration missions. This work has demonstrated LASP's ability to conceive, design, fabricate, test, and operate space vehicles and instruments and to exploit the data from space experiments. Research and development programs at LASP provide new techniques for data manipulation and image processing, as well as new instruments and sensors for space applications. Members of LASP examine basic concepts for space operations and information systems and develop tools and approaches to evaluate and support these concepts. In response to the increasingly complex needs of operating spacecraft and handling data, LASP is developing prototype operations systems for the Space Station, EOS, and for other future missions. The OASIS system (Operations and Science Instrument Support) is evolving into a multi-purpose operating system that will be used on NASA's Space Station testbed, by many NASA centers, by the European Space Agency, and by several aerospace companies as well.

A number of the research associates at LASP hold joint appointments in the Department of Astrophysical and Planetary Sciences, in the Department of Atmospheric and Oceanic Sciences, in the Department of Physics, in the Department of Aerospace Engineering Sciences, and in the Department of Geological Sciences. The large scientific community at the University and in Boulder provides opportunities for members of LASP to enjoy substantial collaboration and communication with experts in related fields. LASP has also actively conducted experimental and theoretical work in cooperation with other universities in the United States and abroad. In recent years joint programs have been carried out with institutions in Belgium, Canada, England, Finland, France, Germany, Japan and Russia.

Please visit LASP's Website for the latest developments: **http://lasp.colorado.edu**

A Message from the Director

In 1946-47, a handful of American universities joined with the military and with industry to initiate the era of space exploration. The University of Colorado was one of those pioneering universities. The first experiments to be performed in space were lofted by sounding rockets. A key obstacle to these first rocket flights was providing a stabilized platform for cameras and other experiments. With support from the Naval Research Center and the Air Force Cambridge Research Laboratory (now the Air Force Research Laboratory), the University of Colorado formed a research group called the Upper Air Laboratory (UAL) to solve this problem. Their solution — called the biaxial pointing platform — cleared the way for some of the first major scientific discoveries made in space. Researchers and engineers from the UAL flew experiments into space on over 50 rocket flights before Sputnik. By 1965, the UAL had grown substantially. Along with this growth came a new building on campus and a new name: the Laboratory for Atmospheric and Space Physics. LASP has come a long way in the past 50-plus years.

The successes of SNOE, QuickScat, and other programs in the last year are quite exciting. Newer programs under development such as SORCE are also a great challenge. We are actively pursuing new opportunities in the NASA UNESS, SMEX, and Discovery programs. Recent success in the MESSENGER project (with Johns Hopkins Applied Physics Laboratory) under the Discovery program auspices, whets our appetite for new experimental challenges. New studies are under way for SURGE, AIM, and JMEX in the smaller spacecraft arena.

New mission activity accompanies the excitement and importance of science data coming back from such ongoing missions as Galileo, Cassini, UARS, ISTP/POLAR, SAMPEX, FAST, and other programs. Also, laboratory developments in dust detection systems, results from Space Shuttle missions (COLLIDE and MGM) and new research in the Astrobiology program have made the past year very exciting. The theoretical and modeling efforts that develop hand-in-hand with the hardware, data analysis, and operations work makes for an exceptionally complete program in LASP.

We at LASP express our appreciation to the University, to the local Boulder community, and to the national agencies for their continuing support. We look forward to working actively with the broad space research community in many new endeavors. Thank you to the students, staff, and faculty of LASP for all their hard work. Special thanks to Ann Alfaro for her tireless efforts in preparing this report.

Daniel N. Baker

LASP Appropriated Funding

During the period 1/1/2000 to 12/31/2000 LASP appropriated funding totaled $64,130,763 for support of 138 grants and contracts.

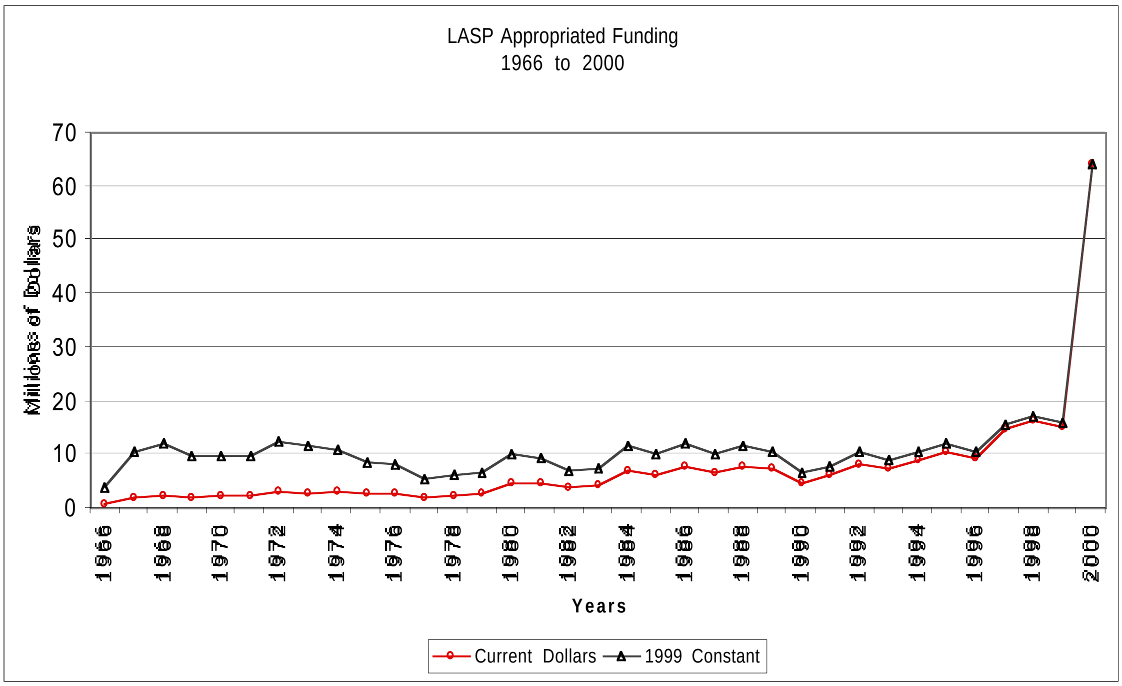
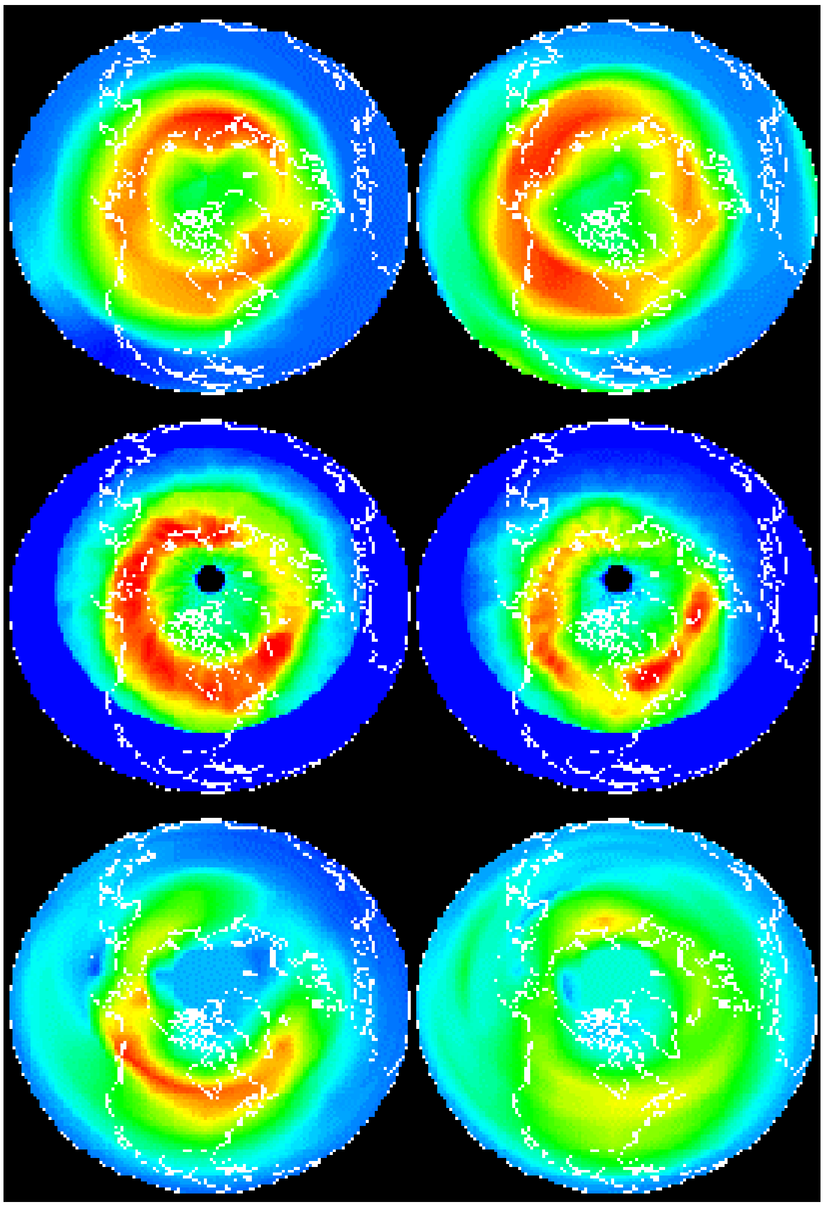


TABLE OF CONTENTS

CURRENT PROGRAMS

Student Nitric Oxide Explorer (SNOE)

SNOE has had a successful third year of operation, completing another year of upper atmosphere sampling. The spacecraft was launched in February 1998, into a polar sun-synchronous orbit. The Principal Investigator is Charles Barth, and a team of scientists, engineers, and students continue to work on mission operations and data analysis of the craft.



The mission operations side of the craft has been sampling the atmosphere in a new mode during the third year of operations. SNOE is now limb-scanning both in front of and behind it providing higher time and spatial resolutions of the Nitric Oxide bands surrounding the polar regions from 60 to 70 degrees geomagnetic latitudes.

The science team has continued to make new discoveries about Nitric Oxide in the upper atmosphere, and has been collaborating with several other space physics missions. The SNOE team had a very successful Spring AGU Meeting in 2000, presenting numerous talk and papers.

The figure above, presented at the Spring 2000 AGU Meeting, is from a paper entitled "Comparison of SNOE, POLAR and SAMPEX Observations of Magnetosphere-Thermosphere Interaction during the 1998 Geomagnetic Storms" by Kenneth Mankoff. This paper was awarded the "Outstanding Student Paper Award" in the Space Physics and Aeronomy section. The first column is a two-day average of 1998.122 (yyyy.ddd) + 1998.123, and the second column is 1998.124 + 1998.125. The top row is data from the LICA instrument on the SAMPEX satellite, the middle from the PIXIE instrument on POLAR, and the bottom row from the UVS on SNOE, which has a day lag calculated into data.

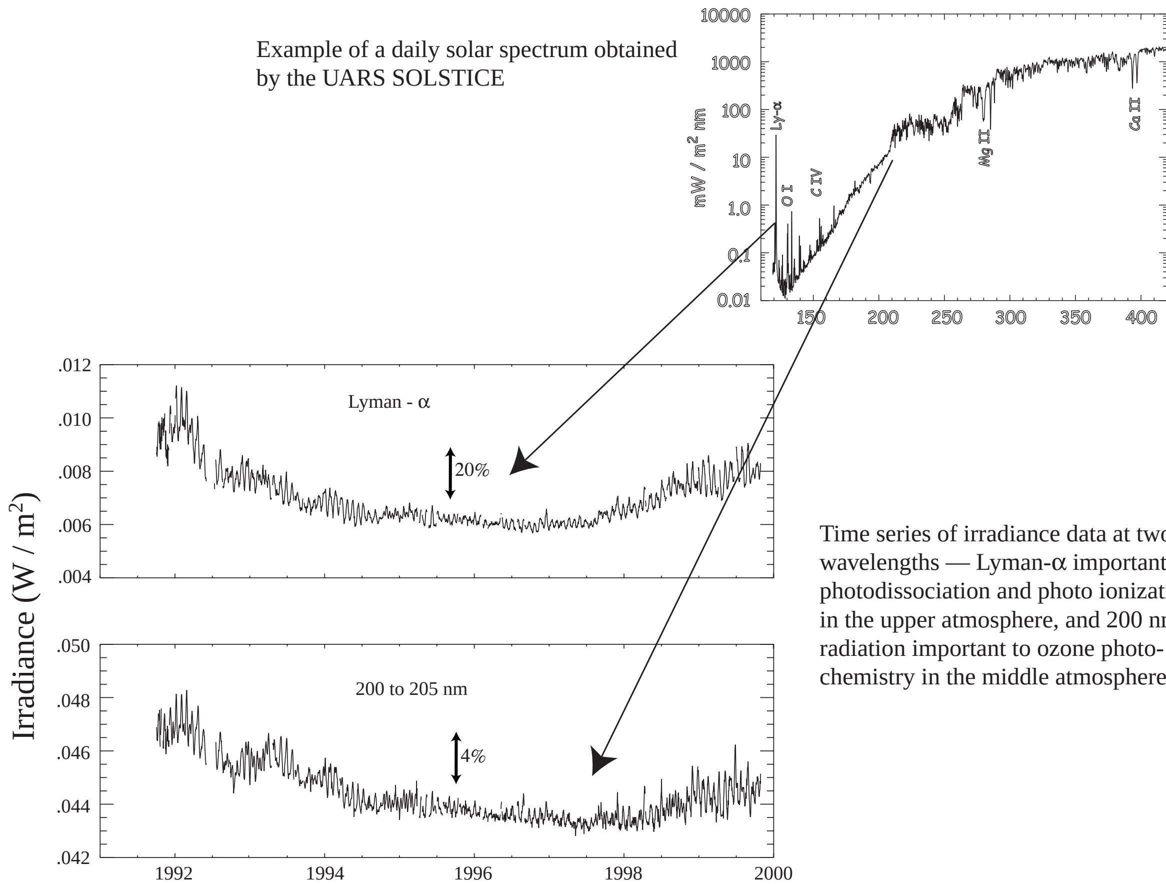
The images show the relationships between the precipitating high energy electrons (SAMPEX), medium energy x-rays (PIXIE), and NO (SNOE). The NO is produced in the thermosphere by the ionization, dissociation, and excitation of the atoms and molecules by the precipitating electrons. A full description of this poster can be viewed at *http://lasp.colorado.edu/snoedata/SM51B-11/*.

Solar Stellar Irradiance Comparison Experiment (SOLSTICE)

NASA's Upper Atmosphere Research Satellite (UARS) was launched in September 1991, and is a mission dedicated to improving our understanding of ozone in the Earth's middle atmosphere. The spacecraft carries ten instruments to measure the composition and structure of the middle atmosphere with additional instruments to collect information on atmospheric dynamics and energy input. Special emphasis has been given to the measurement of ozone and other key gases that influence ozone concentration and distribution.

The Sun is the dominant direct energy input to the middle atmosphere, and changes in the solar radiation, primarily ultraviolet radiation with wavelengths shorter than 300 nm, will lead to changes in atmospheric composition, temperature, and dynamics. In order to study atmospheric processes, for example those involving ozone photochemistry, the UARS observations include precise and reliable measurements of solar ultraviolet radiation. The UARS solar observations must be of sufficient quality and accuracy to allow valid comparisons to past and, especially, to future observations. The Solar Stellar Irradiance Comparison Experiment, SOLSTICE, was developed by LASP, and has been operated from an instrument control center on campus for the past nine years.

The SOLSTICE measures solar ultraviolet irradiance from 120 nm to 420 nm, with a spectral resolution better than 1nm. In order to track changes in the instrument sensitivity, SOLSTICE, as its name implies, has the unique capability of directly observing stars with the very same optics and detectors used for the solar observations. These stars become the “standard candles” against which the Sun is compared, and assuming that the stars are constant over long time periods they provide a method of directly relating today’s UARS observations to all future solar measurements. The stability of the special stars (early type O, B, and A) selected for comparison is a reasonable assumption based on the theory of stellar evolution.

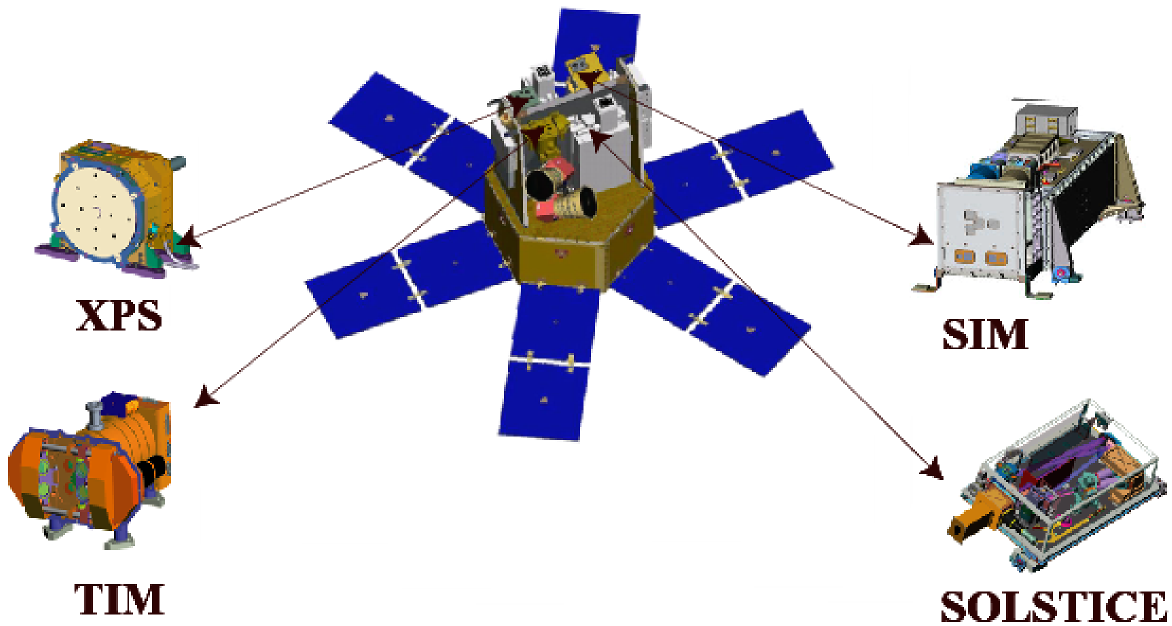


Example of a daily solar spectrum obtained by the UARS SOLSTICE

Time series of irradiance data at two wavelengths — Lyman-α important to photodissociation and photo ionization in the upper atmosphere, and 200 nm radiation important to ozone photochemistry in the middle atmosphere

Solar radiation was at high levels early during the UARS mission, decreased to low values in 1996, and has now regained the higher levels seen early in the mission. In addition to this longer term, solar-cycle variability, the data also display a striking higher frequency variation with a period of about 27 days – the rotation period of the Sun. Both types of variation are related to the storage and release of magnetic energy in the Sun. The UARS SOLSTICE data are widely used by the scientists studying atmospheric processes and climate, and by those studying the Sun as the source of the varying radiation.

Solar Radiation and Climate Experiment (SORCE)



Mission Goals

The total solar irradiance, or TSI, along with Earth's global average albedo, determines Earth's global average equilibrium temperature. Because of selective absorption and scattering processes in the Earth's atmosphere, different regions of the solar spectrum affect Earth's climate in distinct ways. Approximately 20-25% of the TSI is absorbed by atmospheric water vapor, clouds, and ozone, by processes that are strongly wavelength dependent. Ultraviolet radiation at wavelengths below 300 nm is completely absorbed by the Earth's atmosphere and contributes the dominant energy source in the stratosphere and thermosphere, establishing the upper atmosphere's temperature, structure, composition, and dynamics. Even small variations in the Sun's radiation at these short wavelengths will lead to corresponding changes in atmospheric chemistry. Radiation at the longer visible and infrared wavelengths penetrates into the lower atmosphere, where the portion not reflected is partitioned between the troposphere and the Earth's surface, and becomes a dominant term in the global energy balance and an essential determinant of atmospheric stability and convection. Therefore, it is important to accurately monitor both the TSI and its spectral dependence.

Variations of the solar radiation field are still largely unknown, but in the visible they are likely far less than one percent. The observations therefore require precision and accuracy that can only be achieved from space. Although the ultraviolet radiation from the Sun varies by much larger factors, its measurement also requires access to space since the radiation does not penetrate the atmosphere. Precise space measurements obtained during the past 20 years imply that TSI varies on the order of

0.1% over the solar cycle, but with greater variations on a short-term basis. For example, the passage of sunspots over the disk produces 2-4 times that amount. The variation apparently occurs over most time scales, from day-to-day variations up to and including variations over the 11-year solar cycle. How TSI variations are distributed in wavelength is still poorly understood. The largest solar variations are factors of two or more at ultraviolet and shorter wavelengths, but the greater total energy available at visible and longer wavelengths makes their small variations of potential importance.

Assuming climate models include a realistic sensitivity to solar forcing, the record of solar variations implies a global surface temperature change on the order of only 0.2° C. However, global energy balance considerations may not provide the entire story. Some recent studies suggest that the cloudy lower atmosphere absorbs more visible and near infrared radiation than previously thought (25% rather than 20%), which impacts convection, clouds, and latent heating. Also, the solar ultraviolet, which varies far more than the TSI, influences stratospheric chemistry and dynamics, which in turn controls the ultraviolet radiation that leaks through to the surface.

SORCE Science Objectives

1. Make precise and accurate measurements of the Total Solar Irradiance (TSI), connect them to previous TSI measurements to form the long-term climate record. Provide TSI with an absolute accuracy of 0.01% (100 parts per million) based on SI units and with a long-term relative accuracy of 0.001%/yr.
2. Make daily measurements of the solar ultraviolet irradiance, 120 to 300nm, with a spectral resolution of 1 nm, and achieve this measurement with an absolute accuracy of better than 5%, and with a long-term relative accuracy of 0.5%. To use the solar/stellar comparison technique to relate the solar irradiance to the ensemble average flux from a number of bright, early-type stars (same stars used by the UARS SOLSTICE program.)
3. Make the first precise measurements of the visible solar irradiance suitable for future climate studies. Obtain a daily measurement of the solar irradiance, between 0.3 and 2μm, with a spectral resolution ($\Delta\lambda/\lambda$) of at least 1/30, an absolute accuracy of 0.03%, and a precision and relative accuracy of better than 0.01%/year.
4. Improve our understanding of how and why the variability occurs at the Sun and how the variable irradiance affects our atmosphere and climate. To use this knowledge to estimate past and future solar behavior and climate response.

Mission Description

The SOlar Radiation and Climate Experiment (SORCE) consists of a small, free-flying satellite carrying four instruments to measure solar radiation incident at the top of the Earth's atmosphere. This NASA mission is one element of the Earth Observing System (EOS) and is scheduled for launch in mid-2002. It will continue the precise measurements of total solar irradiance (TSI) that began with the ERB instrument in 1979 and have continued to the present with the ACRIM series of measurements, and will also provide measurements of the solar spectrum from 1 nm to 2000 nm. SORCE will carry four instruments, including the Total Irradiance Monitor (TIM), Solar Stellar Irradiance Comparison Experiment (SOLSTICE), Spectral Irradiance Monitor (SIM), and the XUV Photometer System (XPS).

LASP has full programmatic responsibility for the SORCE mission, which is under the direction of Principal Investigator Gary Rottman. LASP will develop, calibrate, and test the four science instruments, and then integrate them onto a spacecraft provided by Orbital Sciences Corporation. After launch, science and mission operations will be conducted by LASP from a mission operation center on campus. LASP also has responsibility for the acquisition, management, processing, analysis, validation, and distribution of the SORCE mission data.

TIM will provide a measurement of Total Solar Irradiance (TSI) directly traceable to SI units with an absolute accuracy of 0.03% and relative accuracy of 0.001% per year. The sensor incorporates four cavities (cones) and adheres the basic concepts of Electrical Substitution Radiometers (ESR's), but employs modern, state-of-the-art electronics and materials. The four cavities provide redundancy and added duty-cycling capability. The TIM will look at the Sun every spacecraft orbit. Each measurement consists of multiple samples taken over the course of a single orbit, providing 15 measurements per day. The instrument will typically operate in a normal solar-viewing mode, but will periodically point to a dark region of space for the purpose of characterizing the thermal contributions of the internal baffles and shutter mechanisms. In its normal operational mode, the TIM shutter is cycled 50% open and 50% closed every 100 seconds throughout the orbit. We will additionally perform periodic (approximately once per week) field of view maps by offset pointing the spacecraft by ±15° about the sun vector.

The SIM will measure spectral irradiance from 200 nm to 2000 nm with a resolution varying from 1 nm to 34 nm, an absolute accuracy of 0.03% and a relative accuracy of 0.01% per year. This prism spectrometer is a variant of the optical design first described by Féry in 1910. The prism has a concave front surface and a convex, aluminized back surface, and is therefore self-focusing. The instrument contains two completely independent and identical (mirror-image) spectrometers, which are fully interchangeable. This dual-spectrometer design provides the redundancy, self-calibration capability, and duty cycling required to meet the scientific objectives. In normal operation, one spectrometer is used for daily solar irradiance measurements while the other is used to make solar measurements on a much lower duty cycle (once per month). Additionally, a periscope system couples the two spectrometers and is used in conjunction with two photodiodes to provide an in-flight measurement of prism transmissivity.

SOLSTICE is a second generation of the UARS SOLSTICE also built and operated by LASP. This grating spectrometer will measure spectral irradiance from 115 nm to 300 nm with a resolution of 1 nm, an absolute accuracy of better than 5% and a relative accuracy of better than 1%. The instrument has the unique capability of observing the Sun and bright, early-type stars using the very same optics and detectors. The stellar targets are essential because they establish long-term corrections to the instrument sensitivity. The ensemble average flux from these 20 or stars should remain absolutely constant (intrinsic variability of less than one part in ten thousand over thousands of years). This in-flight calibration technique thereby establishes the instrument response as a function of time throughout the SORCE mission, and yields time series of solar data that are fully corrected for instrumental effects to an accuracy of about 1 percent. Moreover, the SOLSTICE technique provides a method of directly comparing solar irradiance measurements made during the SORCE mission with previous (e.g., UARS SOLSTICE) and future observations. If the SOLSTICE was limited to a single star for its calibration, the technique would be questionable,. However, a clear advantage is that a large number of stars is selected, and it is the ensemble average of these stars that is used to derive the trends in the instrument response. For UARS the final selection of stable stars has been based on repeated observations throughout the nine year (1991to the present) mission and stars that were found to vary excessively compared to the other stars in the ensemble have been eliminated. This same set of stars will be used for the SORCE mission.

The XPS will measure six broadband samples of the Solar XUV irradiance from 1-31 nm and at Lyman- (121.6 nm) with an absolute accuracy of 12% and a relative accuracy of 4%. This package includes twelve silicon photodiodes, each with a filter to provide an approximately 5 nm spectral bandpass. These thin film filters are deposited directly on the photodiode to avoid using delicate metal foil filters which are difficult to handle, prone to develop pin holes, and degrade with time. The photometers are packaged together with a common filter wheel mechanism, which can rotate a closed aperture, a fused silica window, or an open aperture in front of any given photometer. The closed and window positions permit accurate subtraction of the background signal, if any, from visible and near UV light. While nine of the XUV photometers have thin film filters for making solar XUV irradiance measurements, the other three photometers are used in tracking the transmission of the fused silica windows. Of the nine filtered XUV photometers, one photodiode has a Lyman-alpha filter for a redundant measurement of the important Lyman-alpha irradiance. For in-flight calibration purposes, three of the nine XUV photometers are redundant and will be used with a lower duty cycle (approximately once per week) for tracking instrument degradation.

SORCE Mission Objectives

1. Successfully operated and obtain data from the SORCE spacecraft for a period of 5 years (6 year goal), and process and analyze all engineering data to insure the health and safety of the spacecraft.
2. Within 48 hours of data capture, process all science data with the associated instrument and spacecraft engineering data to derive the Level 3 science data products. Calibrate the data for all SORCE channels, converting instrument signals to standard geophysical units (W/m^2 or W/m2/nm).
3. Characterize the operation of SORCE instruments, analyze and correct the science data as appropriate for changing instrument performance. Provide validated data to the scientific community in a timely fashion, and collaborate with users to

ensure that these data are used in an appropriate and conscientious manner, with special emphasis on conveying information of data quality and uncertainty.
4. Obtain a complete observation set with SORCE on at least ten of the fifteen spacecraft orbits per calendar day. The Level 3 data are 6-hour averages representing the appropriately weighted mean of the orbit-by-orbit measurements. The higher time resolution data are available to meet secondary science objectives, for example, studying the passage of faculae and sunspots across the solar disk.
5. Validate the SORCE data against other simultaneous space observations (if they are available), against previous spectral irradiance observations, and against our best known models of solar radiation.
6. Refine and improve our understanding of the instruments and the data they return throughout the development and operation phase of SORCE.

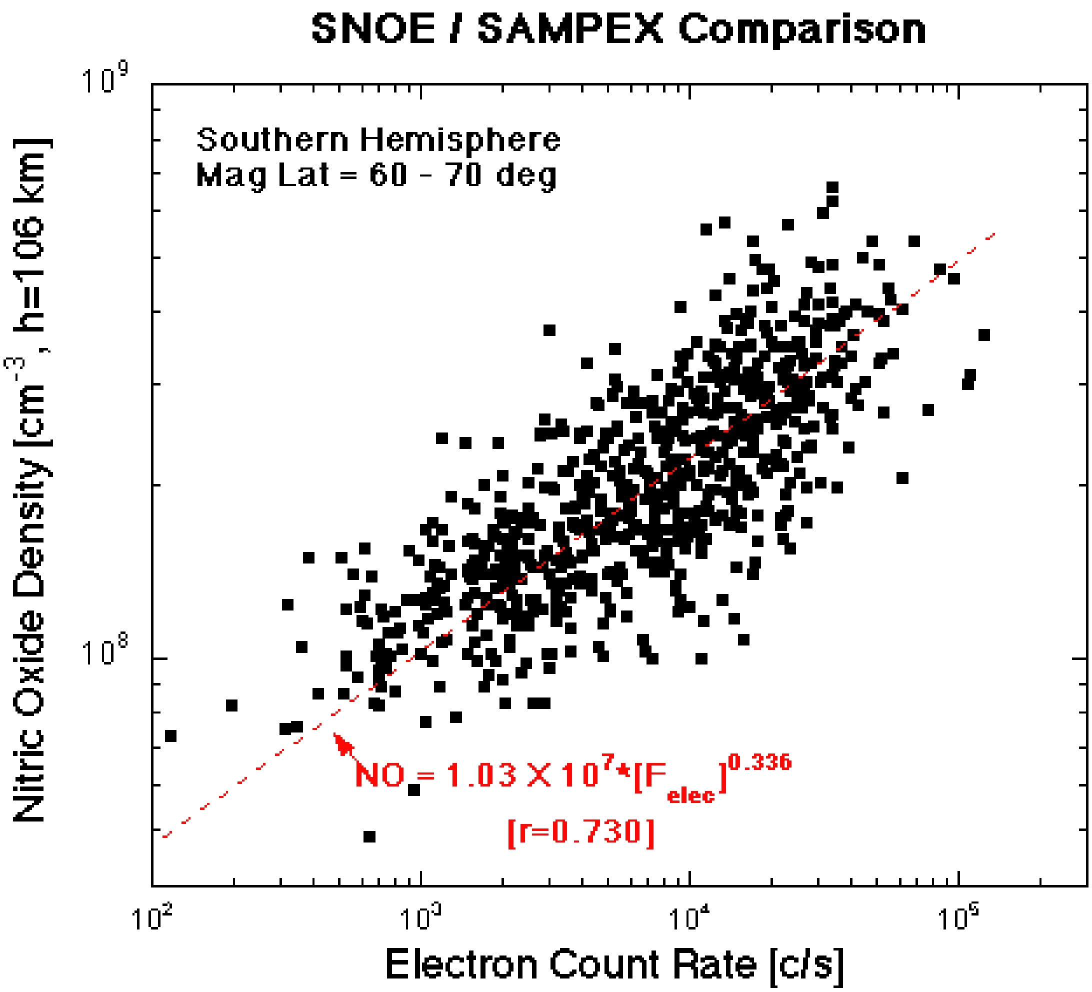
Medium Energy Particle Precipitation Effects on the Mesosphere and Lower Thermosphere

LASP Research Associate Frank Eparvier, in collaboration with M. V. Codrescu of NOAA-CIRES, Scott Bailey of Hampton U., and D. E. Siskind of NRL, has been developing a climatology of ionization rates in the upper atmosphere caused by precipitating medium energy (>30keV) electrons. Medium energy electrons penetrate deeper into the atmosphere than the lower energy auroral electrons, becoming a source of energy input to the mesosphere and lower thermosphere at high latitudes that is not captured by most atmospheric models which only include auroral precipitation. The climatology being developed uses the medium energy electron precipitation patterns developed from the NOAA-TIROS MEPED observations and the GLOW electron transport model to generate three dimensional ionization rates for O_2, N_2, and O. Studies are underway using the NRL two-dimensional CHEM2D model and the NCAR three-dimensional TIME-GCM to determine the effects of the additional source of ionization on the chemistry of the mesosphere and thermosphere, in particular, the effects on odd nitrogen.

The Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) Mission

SAMPEX carries a payload of four scientific instruments that study solar particles, anomalous cosmic rays, and magnetospheric electrons and ions. It has been operating since July 1992. The SAMPEX instruments have sensitivities >100 times greater than previous low-Earth orbit spacecraft, and these have led to new discoveries such as a new radiation belt of interstellar material and rare hydrogen and helium isotopes trapped in the radiation belts. SAMPEX provides routine global maps of magnetosphere energetic particles, and has given new insights into the processes by which radiation levels through the entire magnetosphere can become greatly enhanced.

The figure below shows a SAMPEX/SNOE comparison. It is a correlation analysis between SNOE nitric oxide densities and >25keV electrons measured by sensors onboard SAMPEX. A strong correlation is found between auroral electron fluxes and NO production in the lower thermosphere.



LASP scientists Daniel N. Baker and Xinlin Li are working on magnetospheric data from SAMPEX. New results have been obtained by comparing relatively low-energy (E>25keV) electrons measured by SAMPEX with SNOE measurements of nitric oxide in Earth's upper and middle atmosphere. This collaborative work is being carried out with Charles Barth and Ken Mankoff.

International Solar Terrestrial Physics (ISTP) Program

The International Solar-Terrestrial Physics (ISTP) program is comprised of several spacecraft measuring the hot, high-speed plasmas flowing past the Earth from the expanding solar corona. There is a large armada of spacecraft within the Earth's magnetosphere examining many aspects of the plasmas that change as the sun disturbs the geospace environment. There is also an international web of ground stations that is recording the magnetospheric and ionospheric signatures of the interaction of the variable sun with the terrestrial environment. ISTP has greatly expanded our knowledge of Sun-Earth Connections and continues to reveal the nature of the sun, the interplanetary medium, and the magnetosphere-ionosphere system. Daniel N. Baker, William Peterson, Petri Toivanen, and Xinlin Li are actively working on data from the ISTP program.

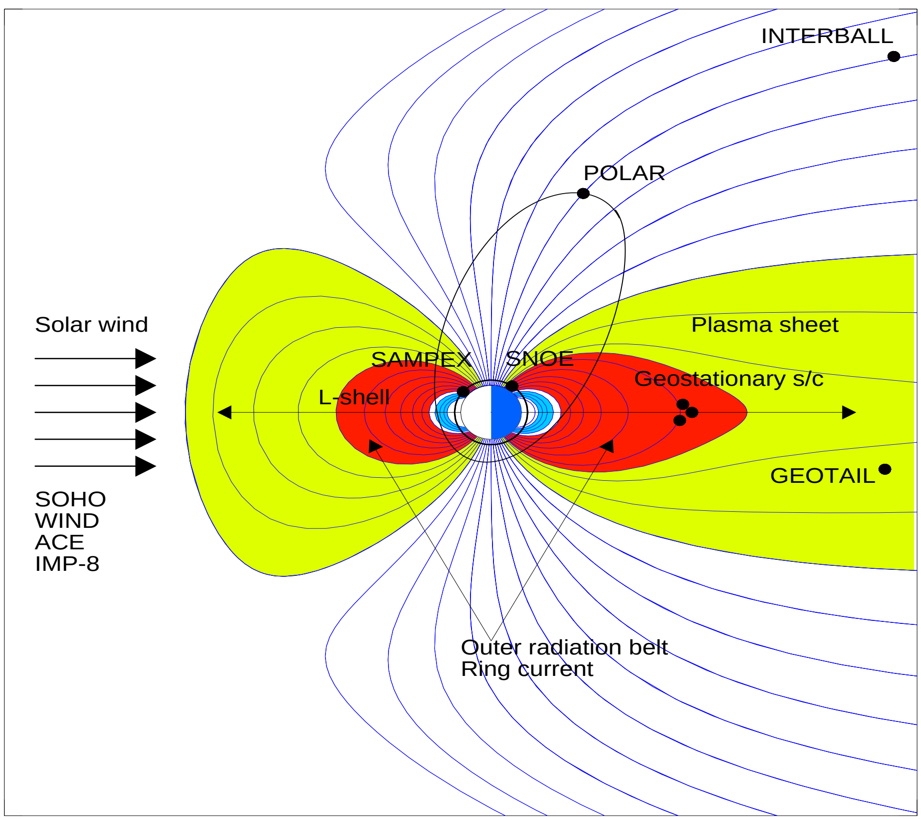
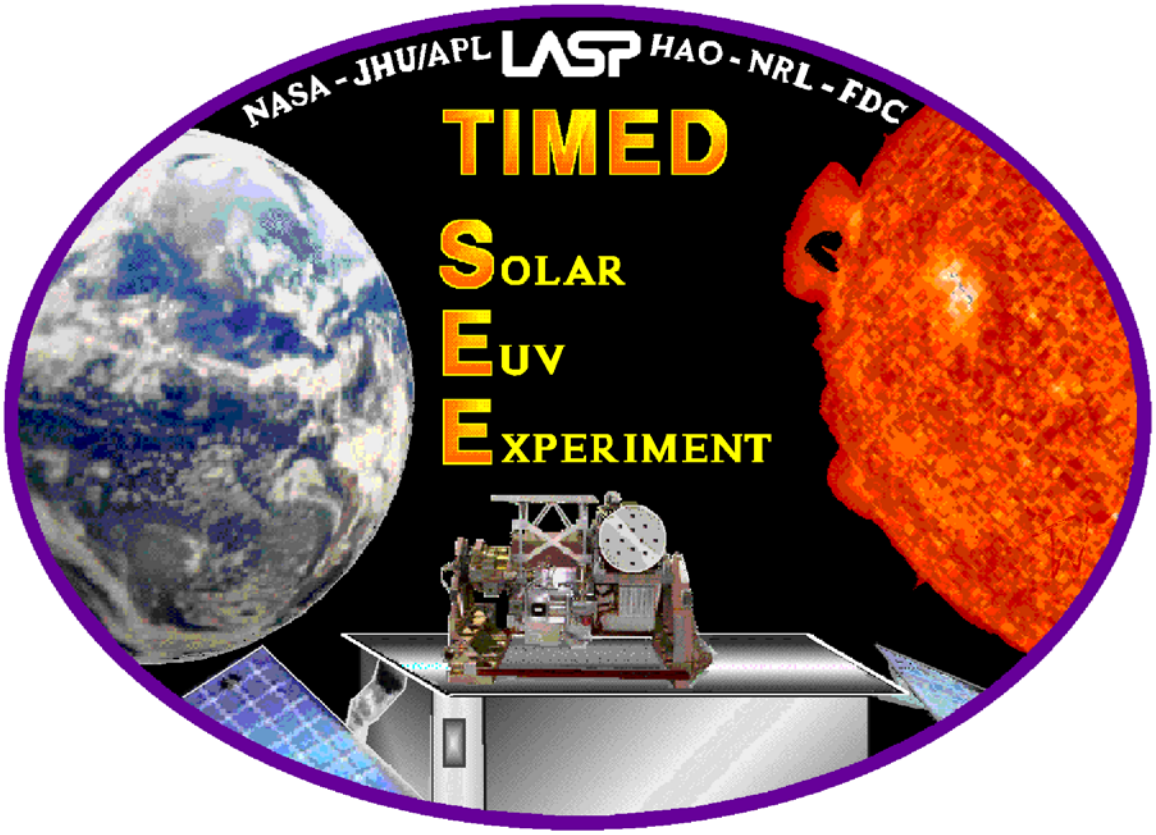
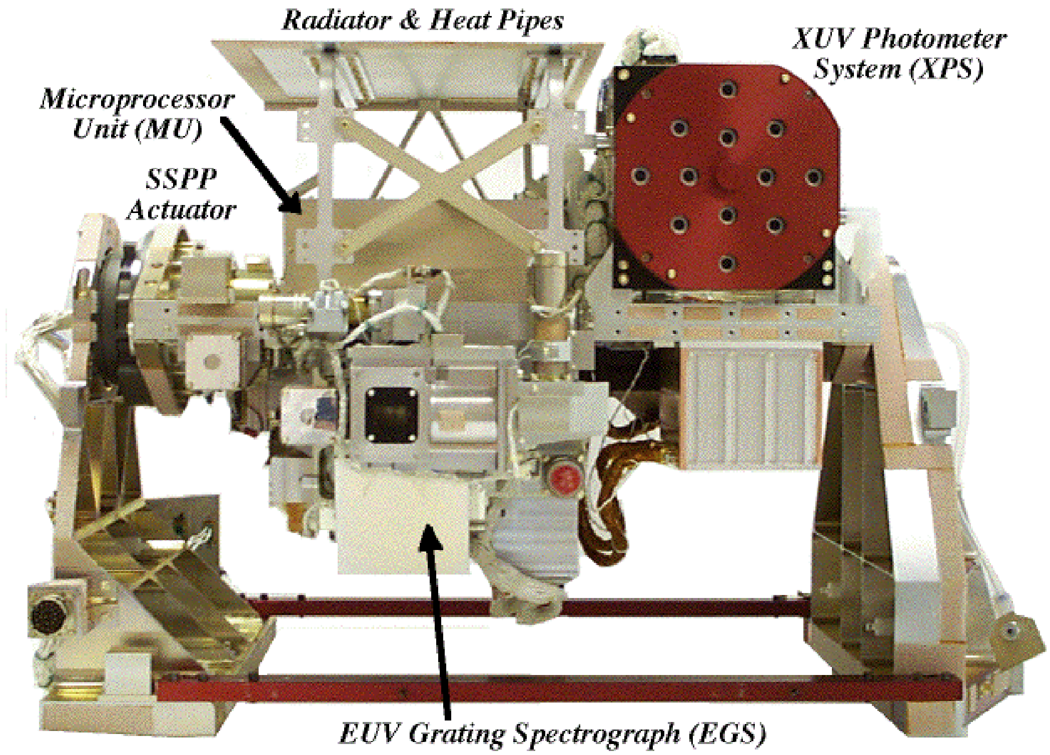


Image: Several of the spacecraft of the ISTP constellation along with SAMPEX and SNOE and an illustration of their respective orbits within and near Earth's magnetosphere.

TIMED Solar EUV Experiment (SEE)



The Solar EUV Experiment (SEE) is one of the four scientific instruments on the NASA Thermosphere-Ionosphere-Mesosphere-Energetics-Dynamics (TIMED) spacecraft. The SEE instrument will determine the irradiance of the highly variable, solar extreme ultraviolet (EUV) radiation, one of the major energy sources for the upper atmosphere. The SEE measurements are fundamental for the TIMED mission's investigation of the energetics in the tenuous, but highly variable, layers of the atmosphere above 60 km. Solar radiation below 200 nm is completely absorbed in the Earth's mesosphere and thermosphere. Changes in the amount of solar radiation, which range from 20% at the longer wavelengths to factors as much as 100 at the shorter wavelengths, result in corresponding changes in the photochemistry, dynamics, and energy balance of the upper atmosphere. A detailed quantitative understanding of atmospheric radiative processes, including changes in the solar ultraviolet irradiance arising from flares, solar rotation (27 day), or the 11 year solar cycle, is fundamental to the TIMED investigations. The primary science objectives for SEE are to accurately and precisely determine the solar VUV absolute irradiance and variability during the TIMED mission, to study the solar-terrestrial relationships utilizing atmospheric models, and to improve proxy models of the solar VUV irradiance.

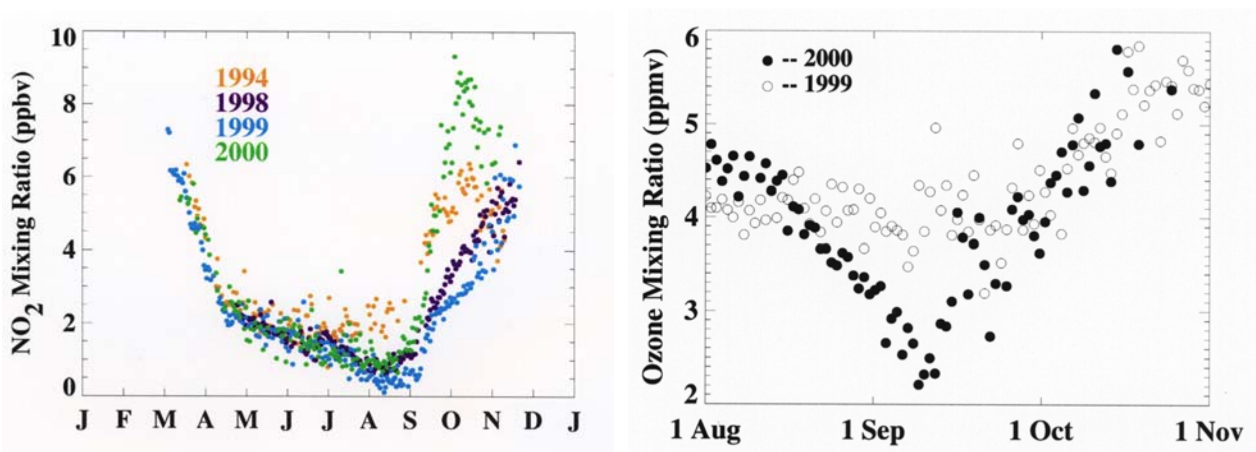


Pictured above is the TIMED SEE instrument. The EUV Grating Spectrograph (EGS) measures the solar EUV irradiance from 26 to 195 nm with 0.4 nm spectral resolution. The XUV Photometer System (XPS) measures the solar soft x-rays (XUV) from 0.1 to 35 nm using 9 XUV photometers, each having a spectral bandpass of about 6 nm. The solar sensors are designed to let the Sun drift through their field of view once per orbit, so only a one-axis pointing platform is employed for SEE. This control system is called the SEE Solar Pointing Platform (SSPP).

The Johns Hopkins University (JHU) Applied Physics Laboratory (APL) has developed the TIMED spacecraft. The SEE instrument was delivered to the TIMED spacecraft in June 1999 for Integration and Test (I&T) at JHU/APL. The I&T was completed in February 2000. The TIMED launch is planned as a shared launch on August 10, 2001 on a Delta vehicle. The TIMED mission is being planned as a two-year mission with a circular orbit altitude of 630 km and an orbit inclination of 74°. Dr. Thomas N. Woods is the Principal Investigator on the SEE instrument.

Polar Ozone and Aerosol Measurement (POAM II and III) Scientific Investigations

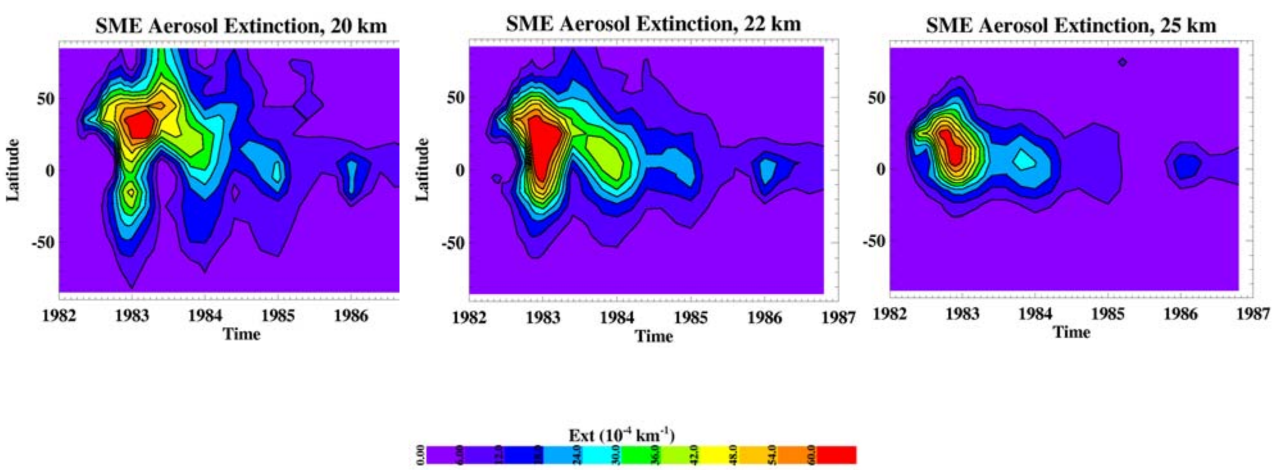
The Polar Ozone and Aerosol Measurement (POAM II and III) instruments are Department of Defense satellite instruments designed to measure profiles of water vapor, ozone and nitrogen dioxide (NO_2) densities, aerosol extinction and temperature in the polar stratosphere. LASP research associates Cora Randall and Dave Rusch are POAM team members, and are involved in all aspects of the data analysis, from validation to scientific investigations. POAM II operated from 1993 to 1996; POAM III, an improved version of POAM II, was launched in 1998 and is currently operational. Ongoing investigations include validation of the data as well as comparison of the POAM II and III measurements of ozone and NO_2 to output from two-dimensional chemistry-transport models. We are also studying the impact of interannual variations in vortex dynamics on the polar distribution of ozone and NO_2. As part of the SOLVE campaign (see below) we are working to quantify ozone loss in the Arctic lower stratosphere. Finally, because of high solar activity, 2000 was an exceptional year in terms of particle impacts on the upper atmosphere. We have used POAM III and Halogen Occultation Experiment (HALOE) data to show that NO_x (NO and NO_2) produced after solar proton impacts in the mesosphere descended to the stratosphere in record amounts during the 2000 Austral winter, causing significant loss of middle stratospheric ozone.



The left panel of the figure above shows the temporal variation in NO_2 measured by POAM III inside the southern hemisphere polar vortex in 1998, 1999 and 2000, at an altitude of about 30 km. NO_2 in 2000 reached levels that were higher by more than a factor of two compared to the previous two years. Also plotted are POAM II NO_2 mixing ratios from 1994, which had the highest NO_2 enhancements of any year measured by POAM II or III prior to 2000. The ozone mixing ratios in 2000 and 1999 are plotted in the right panel of the figure, and show the dramatic decrease that occurred in September of 2000 as the NO_2 mixing ratios steeply increased.

Global Aerosol Climatology Project (GACP)

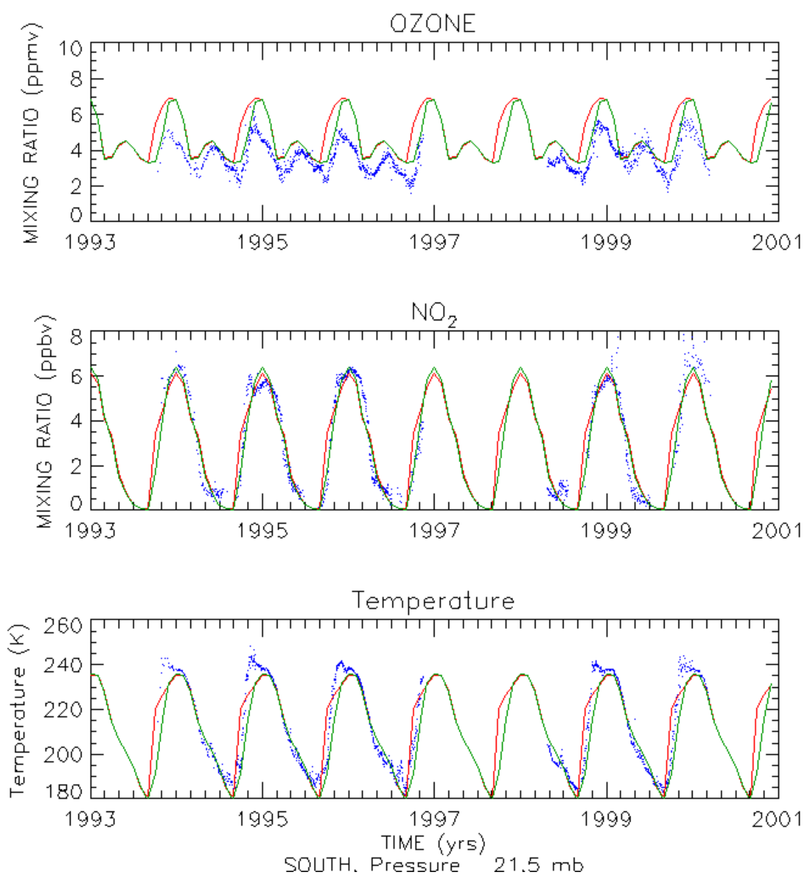
As part of NASA's Global Aerosol Climatology Project (GACP), LASP investigators Cora Randall, Dave Rusch, Frank Eparvier and Mike Callan are "resurrecting" data from the Solar Mesosphere Explorer (SME) satellite. The goal is to provide the climate modeling community with information regarding stratospheric aerosol forcing after the eruption of El Chichón in 1982. The SME data are the only global satellite measurements of stratospheric aerosol profiles during the 2.5 years immediately following El Chichón. The database provided by this work will enable climate modelers to derive the radiative effects of aerosols in the visible, near infrared and thermal infrared spectral regions. SME radiance data from the 440-nm, 1.27 µm, 1.87 µm and 6.8 µm channels are being used to derive extinction, mass and size distribution information pertaining to aerosols in the lower stratosphere. The figure here shows the variations in aerosol extinction at 1.27 µm derived from SME data at several different altitudes, after the eruption of El Chichón.



Solar Influences on Global Change

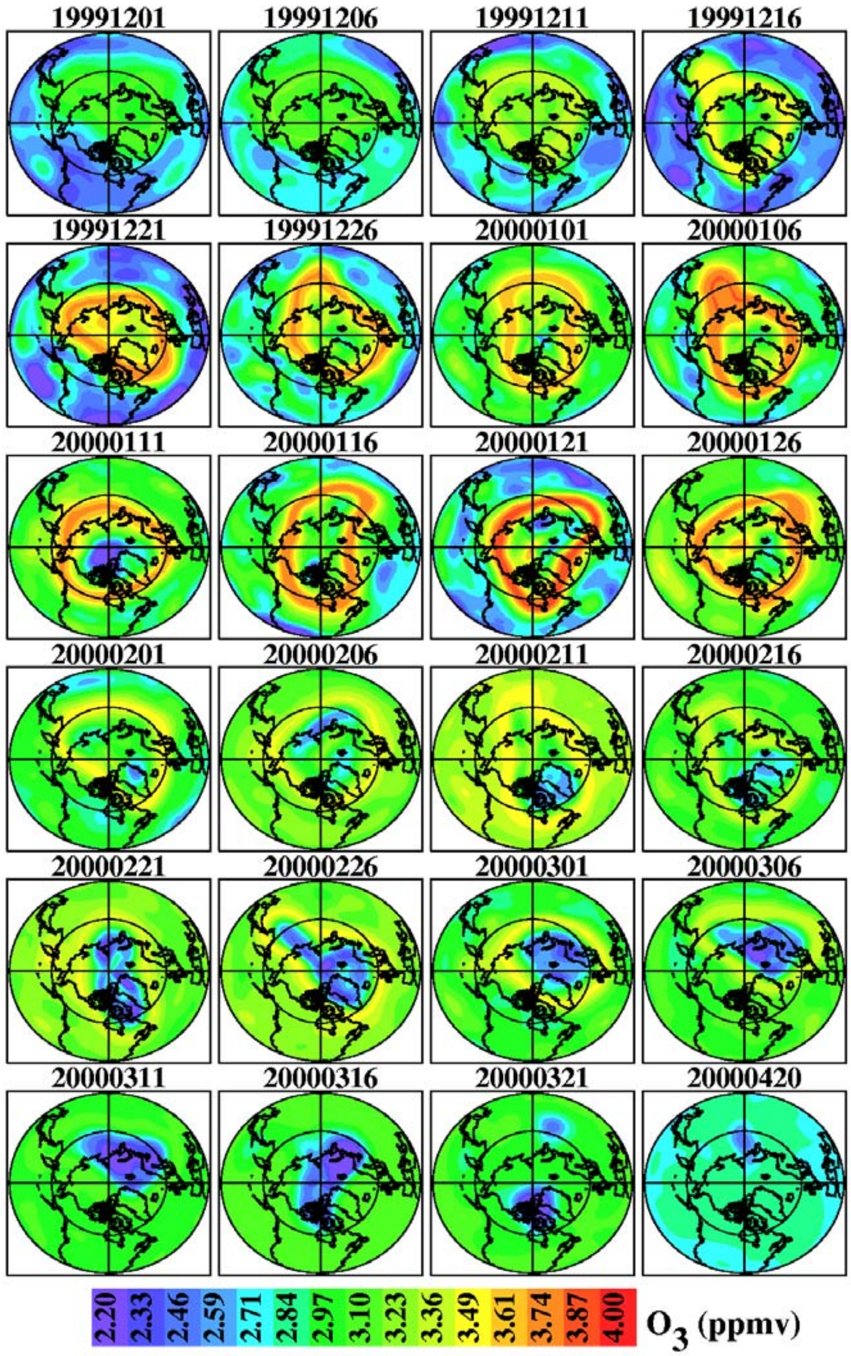
LASP scientists Dave Rusch, Cora Randall and Dan Baker are participating in NASA's program focused on solar influences on global change. As part of this program, they are investigating the effects of particle ionization on the earth's middle atmosphere and its role in global change. Specifically, the coupling between the upper and middle atmosphere by the production and transport of nitric oxide, its subsequent reaction with stratospheric ozone, and the ensuing impact on climate are being studied. The program utilizes data from several satellite missions and ground-based instruments, as well as 2- and 3-dimensional models to study the long-term consequences of solar particle effects on the global odd nitrogen content of the middle atmosphere. It involves collaboration with scientists from the Naval Research Laboratory. The work addresses the significance of solar-generated particle impacts affecting the atmospheric densities of odd nitrogen and ozone, a key question in separating the effects of solar and anthropogenic forcing of the Earth's climate. The results pertaining to particle impacts will be compared to the expected climate forcings from other natural and anthropogenic processes to assess the significance of the solar energetic particle input on the global system.

The figure shows the results of the NRL 2D model run for ozone, NO_2 and temperature compared to data from the POAM (Polar Ozone and Aerosol Measurement) II and III instruments in the southern hemisphere at 21.5 mbar. The POAM instrument measures atmospheric parameters only at latitudes near the Earth's poles. The two models (solid lines) differ in the amount of drag introduced into the calculated atmospheric winds. In this preliminary comparison, the model results compare favorably with the measurement. This comparison is one of the first between a model and a long term high latitude data set.



SAGE III Ozone Loss and Validation Experiment (SOLVE) Campaign

SOLVE is a large measurement campaign dedicated to studying ozone loss in the Arctic region, and to validating the Stratosphere Aerosol and Gas Experiment (SAGE) III satellite instrument. A number of LASP scientists are involved in the campaign, which took place in Kiruna, Sweden between October of 1999 and March of 2000.



Unfortunately, due to launch delays, the SAGE III instrument was not launched in time for the campaign. However, the Polar Ozone and Aerosol Measurement (POAM III) satellite instrument is very similar in concept to SAGE III, so some of the measurements made during the campaign are being used to validate POAM III. POAM III will then be used to help validate SAGE III once it is launched. LASP research associate Cora Randall participated as part of the POAM team in the SOLVE field campaign. The POAM measurements are also being used to calculate ozone loss in the Arctic region. The goal here is to use the large volume of aircraft, balloon and ground-based measurements to improve the validity of deriving ozone loss information from satellite data such as POAM and SAGE in years when campaigns are not feasible.

One of the other main roles of POAM in the SOLVE campaign is to provide a more global picture of the Arctic region than is available from field campaign measurements. Using a technique which takes advantage of the fact that ozone can often trace the structure of the polar vortex, we have generated semi-global ozone fields from the POAM measurements. These fields are being used by theoreticians to improve calculations of photochemistry along the aircraft flight paths, and to initialize global models. The figure on the previous page depicts the evolution of 20-km ozone over the course of the 1999-2000 winter, as derived from POAM. The areas of blue in the February and March plots signify chemical ozone loss, similar to that which occurs in the Antarctic ozone hole every September and October.

Tropospheric Ozone and Tracers from Commercial Aircraft Platforms (TOTCAP)

NASA's Atmospheric Effects of Aviation Program (AEAP) is charged with the effects of aircraft on climate and on the chemistry of the atmosphere. Much of this effort has been dedicated to interpretation of atmospheric observations and prediction of the impact of future aircraft fleets using two- and three-dimensional models. However, some of the information needed to assess aircraft impacts is lacking. In response, the Tropospheric Ozone and Tracers from Commercial Aircraft Platforms (TOTCAP) project was conceived as a means to gather a long-term data set that would address transport in the tropopause region. Students in Linnea Avallone's group and LASP technical staff have designed and tested a suite of instruments that measures several trace gases. Although ultimately this instrument package will be flown on commercial (revenue) aircraft, it was initially deployed on NASA's DC-8 "flying laboratory" during the SOLVE campaign to study ozone loss in the northern hemisphere. Four independent chemical sensors are packaged into a single unit that operates autonomously. Measurements of ozone (by ultraviolet absorption), water vapor (by near-infrared tunable diode laser spectroscopy), carbon dioxide (by near-infrared absorption), and short-lived halocarbons (by gas chromatography) are made continuously during aircraft flight, every second for O_3, H_2O and CO_2, and every four minutes for halocarbons. The wide range of lifetimes and source/sink processes for these compounds provide the means to assess the relative importance of various transport processes in determining the chemical composition of the tropopause region. A more complete understanding of these processes (e.g., convection, stratosphere-troposphere exchange) is essential to the construction of realistic atmospheric models that are used to assess the impact of aviation. Until applications on commercial aircraft become a reality, the instruments will be used in other projects to study chemistry and transport in the troposphere.

Measurements of Halogen Oxides in the Troposphere

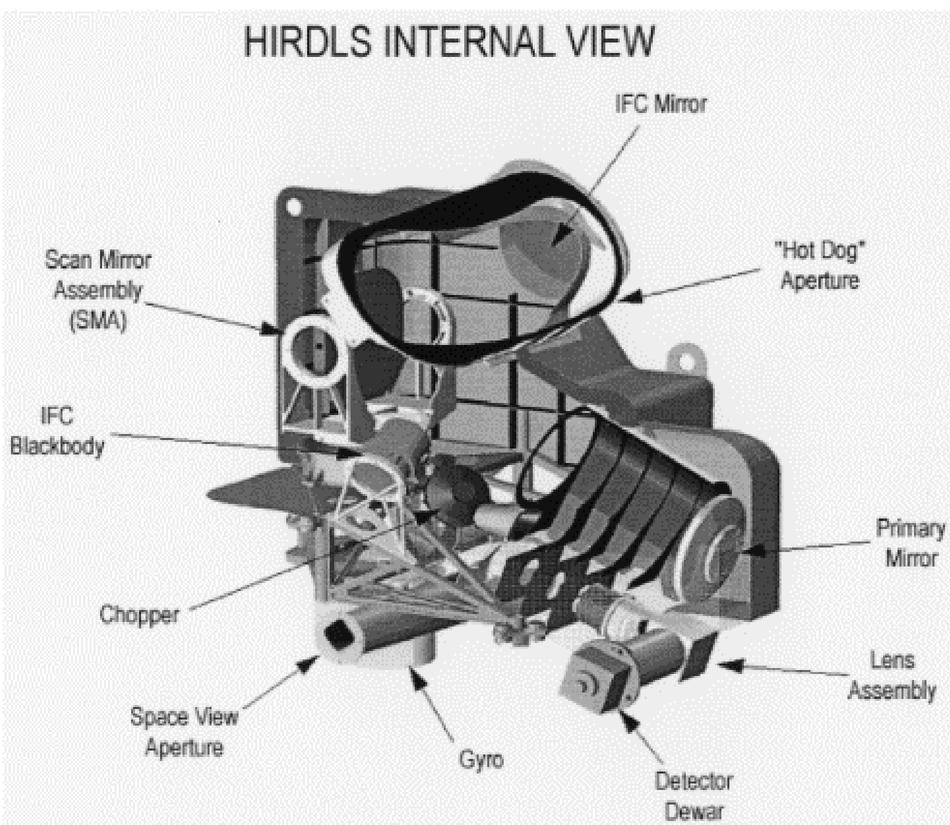
Ozone depletion events occur not only in the stratosphere (the Antarctic "ozone hole"), but also near the Earth's surface at high latitudes in springtime. While the mechanism for these boundary layer ozone losses is not completely understood, it is believed that they are caused by enhancements in reactive gas-phase bromine species. Linnea Avallone participated in the Alert 2000 Polar Sunrise Experiment in Alert, Nunavut, Canada during April-May 2000 to further assess the causes of the sudden ozone loss phenomenon. The radical species chlorine oxide and bromine oxide (ClO, BrO) were measured using vacuum ultraviolet resonance fluorescence techniques that have been previously employed for stratospheric observations of the same species. The results from this study indicate that the snow-covered surface is indeed a source of bromine to the atmosphere. The data will also be used to explore the relationship between bromine and mercury vapor in the Arctic, which has implications for the lifetime and transport of mercury through the environment.

There is mounting evidence that halogens have an effect on ozone and hydrocarbons in regions of the atmosphere other than the high-latitude boundary layer. To investigate this possibility, we will make a series of measurements in regions likely to see impact from halogens. For example, the Great Salt Lake, as well as several chemical plants on its shores, are large sources of chlorine to the atmosphere. Salt flats are thought to influence the atmospheric chemistry of Mexico City as well. Measurements in these two locations will be made in the next two years, in addition to a trip to Antarctica to study halogen chemistry in that remote, unpolluted location.

High Resolution Dynamics Limb Sounder (HIRDLS)

The High Resolution Dynamics Limb Sounder, HIRDLS, is a joint project between the University of Colorado and Oxford University. It is planned to be launched on the Earth Observing System AURA satellite in 2003. LASP scientists Linnea Avallone, Cora Randall, Dave Rusch and Brian Toon are HIRDLS science team members. HIRDLS is an infrared limb-scanning radiometer designed to sound the upper troposphere, stratosphere, and mesosphere to determine: temperature; the concentrations of O_3, H_2O, CH_4, N_2O, NO_2, HNO_3, N_2O_5, CFC11, CFC12, $ClONO_2$, and aerosols; and the locations of polar stratospheric clouds and cloudtops. The goals are to provide sounding observations with horizontal and vertical resolution superior to that previously obtained; to observe the lower stratosphere with improved sensitivity and accuracy; and to improve understanding of atmospheric processes through data analysis, diagnostics, and use of two- and three-dimensional models.

HIRDLS performs limb scans in the vertical at multiple azimuth angles, measuring infrared emissions in 21 channels ranging from 6.12 to17.76 microns. Four channels measure the emission by CO_2. Taking advantage of the known mixing ratio of CO_2, the transmittance is calculated, and the equation of radiative transfer is inverted to determine the vertical distribution of the Planck black body function, from which the temperature is derived as a function of pressure. Once the temperature profile has been established, it is used to determine the Planck function profile for the trace gas channels. The measured radiance and the Planck function



profile are then used to determine the transmittance of each trace species and its mixing ratio distribution.

Winds and potential vorticity are determined from spatial variations of the height of geopotential surfaces. These are determined at upper levels by integrating the temperature profiles vertically from a known reference base. HIRDLS will improve knowledge in data-sparse regions by measuring the height variations of the reference surface with the aid of a gyro package. This level (near the base of the stratosphere) can also be integrated downward using nadir temperature soundings to improve tropospheric analyses.

Theoretical Studies of Stratospheric Aerosols

This work has two facets - investigations of stratospheric aerosols and studies of polar stratospheric clouds.

We have constructed a numerical model of stratospheric volcanic aerosols over the past two decades. The model was initially one-dimensional, approximating Earth as a vertical column of air. As computational tools have improved we expanded to a two dimensional framework, and now are moving to a fully three-dimensional global model. Currently we are working to combine our microphysical model with the Goddard dynamical models so that detailed predictions can be made. This work will be done by Dr. Michael Mills, a LASP Research Associate, and Mr. Matt Treble, a graduate student. These calculations should aid in the analysis of remote sensing information, as well as being useful to studies of stratospheric ozone loss and to studies of climate change. We are currently on the SAGE II satellite team for global scale modeling of volcanic aerosols and applications to SAGE data analysis. Dr. Toon is also a Co-Investigator on HIRDLS, an instrument that will fly in 2003 as part of NASA's Earth Observing System. My role is to understand aerosol observations from this instrument.

Investigations of polar stratospheric clouds are based upon analyses of data collected during various field programs. The goal is to determine the physical and chemical properties of the clouds so that they can be better represented in models that assess the role of polar clouds in stratospheric ozone loss. This work is supported by several NASA programs. During 1999-2000 NASA's SOLVE program collected a vast array of new data on PSCs. We are currently working with the data set to better understand how large denitrifying particles form, and to determine the composition of these clouds.

Theoretical Studies of Tropospheric Clouds, Aerosols and Radiative Transfer

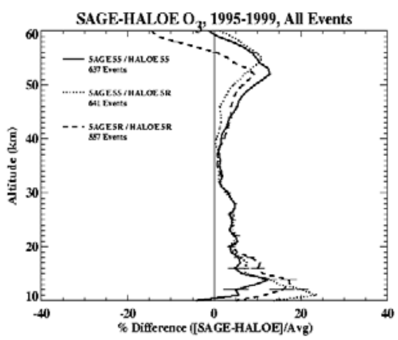
Numerical simulations of the interactions between tropospheric aerosols and clouds are being conducted. One goal is to determine if the indirect effects of aerosols on clouds is a significant feature of Earth's climate system. Another goal is to simulate the life cycle of tropospheric aerosols and clouds in detail. During the last year we developed a three-dimensional large eddy simulation model including detailed microphysics. The eventual goal is to be able to model tropospheric aerosols, marine boundary layer clouds and cirrus clouds including three-dimensional dynamics, atmospheric chemistry, and detailed microphysics. We are collaborating with Dr. Andy Ackerman of NASA's Ames Research Center on marine stratus models. Mr. Peter Colarco, a graduate student at the University of Colorado, is studying the three-dimensional distribution of Saharan desert dust aerosols in the earth's troposphere. We are using these simulations in conjunction with NASA's TOMS satellite instrument to constrain the optical properties of the dust and to better understand its transport. Mr. Lansing Madly is beginning similar studies of smoke clouds from biomes burning. Ms. Kari Klein, a graduate student, is currently investigating the formation of new particles in the upper atmosphere. New data from SOLVE on the Heckle volcanic eruption of 2000 is helping constrain models of the formation of new particles in the stratosphere. Ms. Brandy Gamblin, a graduate student in the CU Chemistry Department is developing a model of nitric acid condensation on cirrus ice crystals. SOLVE data, and new lab data will help to constrain this problem, which is potentially important for the nitrogen budget of the upper troposphere.

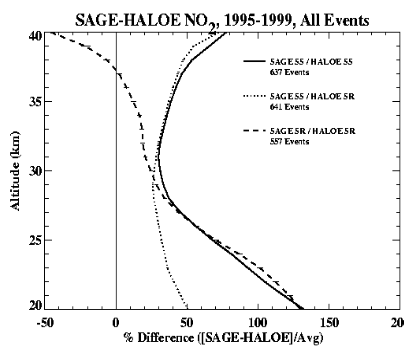
Experimental Investigations of Stratospheric and Tropospheric Phenomena

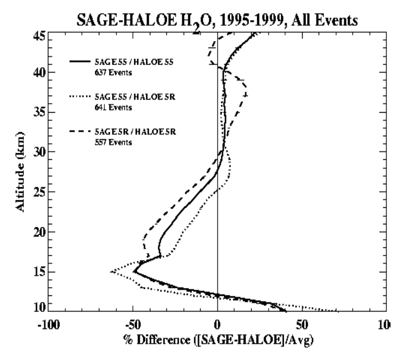
For many years Dr. Brian Toon has been involved in using NASA aircraft to address various issues in stratospheric and tropospheric science. In the past these studies have dealt with volcanic clouds, stratospheric ozone loss, stratospheric transport processes, searching for evidence of heterogeneous chemistry in the troposphere, as well as investigating the formation and radiative properties of cirrus clouds and the sensitivity of cirrus clouds to emissions from aircraft. The Subsonic Aircraft Contrail and Cloud Effects Special Study took place during April and May of 1996. This mission, for which Dr. Toon was the project scientist, involved the NASA DC-8, 757, ER-2 and T-39 aircraft. It cut across two project offices within NASA and interacted with Department of Energy studies using remotely piloted aircraft in the same area. The aircraft carried a large variety of instruments designed to investigate the radiative and microphysical properties of clouds, the chemistry of aircraft exhaust and heterogeneous chemistry in the upper troposphere. Dr. Toon edited a special issue of Geophys. Res. Lett. on this mission. More recently, Dr. Toon was a co-Project scientist for SOLVE (SAGE III ozone loss and validation experiment). This multi-aircraft project attempted to better understand polar ozone loss during the winter of 1999-2000. Several CU graduate students participated in this project, and their data is now being analyzed. Currently, Dr. Toon has been asked to serve in a scientific management role for CRYSTAL/FACE. This project is aimed at understanding the role of deep convection in forming high altitude cirrus, and their role in influencing the energy budget of Earth. The first field mission is planned for the summer of 2002.

Stratosphere Aerosol and Gas Experiment (SAGE) II

LASP research associate Cora Randall is a member of the SAGE II science team, responsible primarily for validating the SAGE II data, and for analyzing the SAGE II NO_2 measurements to quantify any stratospheric NO_2 enhancements arising from the descent of mesospheric NO_x across the stratopause. SAGE II is a solar occultation instrument designed to measure ozone, NO_2, H_2O and aerosol extinction profiles in the stratosphere. It has been operational since 1984, and is often considered a standard against which other satellite measurements of ozone are compared. The SAGE II data are currently being reprocessed, so the new retrieval products require a full validation. LASP's involvement is to compare the new SAGE II data to data from other satellite instruments, primarily POAM and HALOE (the HALogen Occultation Experiment which is onboard the Upper Atmosphere Research Satellite). The figures below show the average differences between SAGE and HALOE coincident events for O_3 (left), NO_2 (middle) and H_2O (right). Whereas the new ozone retrievals compare quite well to HALOE and other measurements, and the H_2O retrievals have been improved compared to previous SAGE versions, there are clearly still issues to be resolved regarding the NO_2 and H_2O retrievals.







Model Predictions of Interactions between Solar and Anthropogenic Perturbations in the Earth's Atmosphere

LASP research associate Dave Rusch is teamed with scientists Guy P. Brasseur (now at the Max Planck Institute fir Meteorology), Anne Smith, XuiXi Tie, at the National Center for Atmospheric Research and Kunihiko Kodera with the Japanese Meteorological Research Agency.

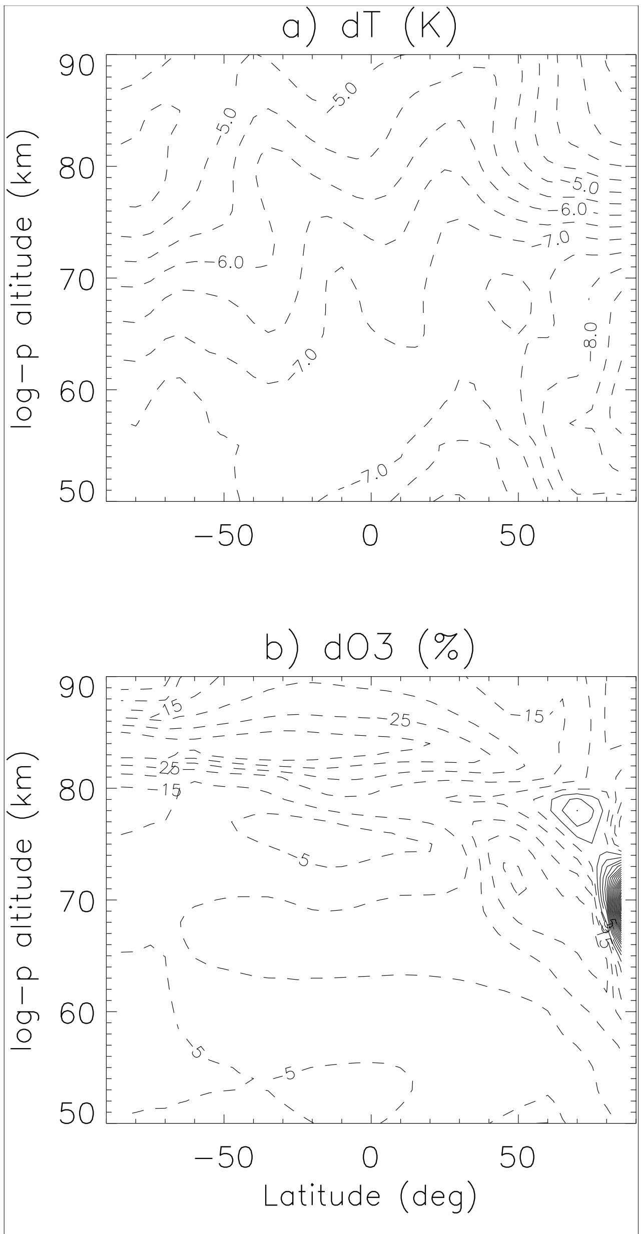


Figure 2; Present−Preind

Significant results from this study are contained in a paper[1] to be submitted to *J. Geophys. Res.* in March 2001. The paper uses the SOCRATES 2D atmospheric model to describe the effects of CO_2 changes in the Earth's mesosphere and compares these changes to those calculated from solar variability. The changes in mesospheric temperature and ozone are quite different for CO_2 changes than for solar flux changes

In the figure (Figure 2 from Khosravi et al.), we show the calculated changes in mesospheric temperature and ozone from the pre-industrial era to the present time. Note that, due primarily to the increase in carbon dioxide associated with industrialization, the temperature of the mesosphere has decreased. The ozone density in response to this cooling has also decreased.

The study also concludes that the combined perturbations (CO_2 increase + Solar variability) do not substantially interact and are therefor additive.

[1]. Khosravi, R., et al., Response of the mesosphere to human-induced perturbations and solar variability calculated by a 2-D model, to be submitted to *J. Geophys. Res*, March, 2001.

Experimental Studies of Impacts in Space

Three experimental programs are underway at LASP to study the physics of low energy collisions in space. Planetary ring systems, protoplanetary disks, the asteroid belt, and the Kuiper belt are all collisionally evolved systems. Dust released in these collisions is an important observable tracer of the dynamics of the larger particles. However, little is known about the dissipation of energy, production of ejecta, and accretion in the low speed collisions that occur between objects with low surface gravity, such as planetary ring particles. Experimental studies at LASP are underway to understand these low energy collisions.

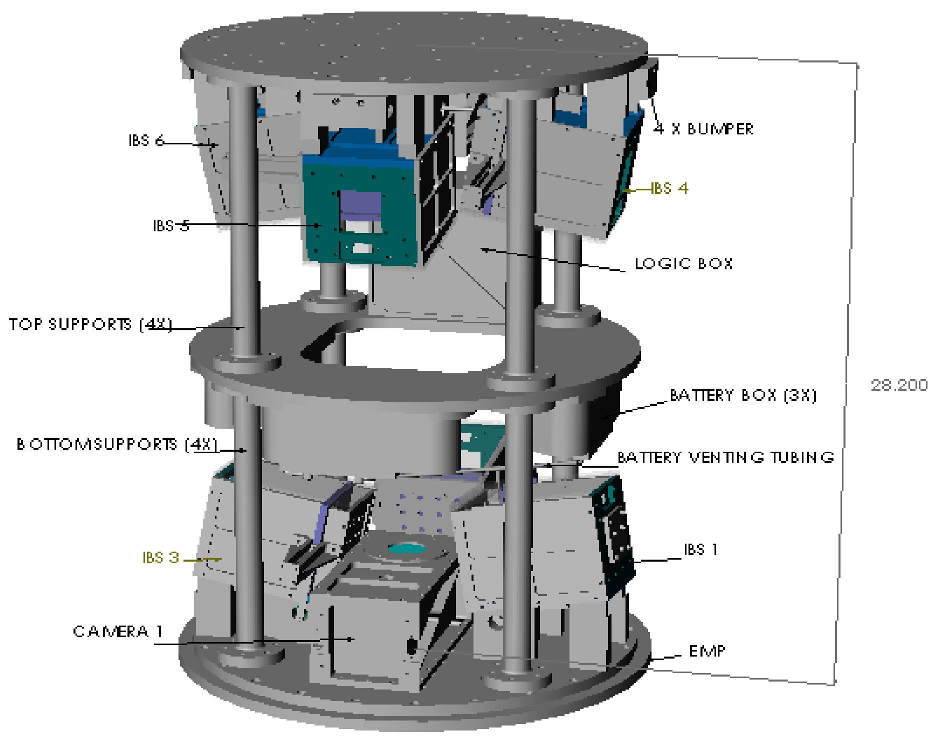


Figure: COLLIDE-2, showing the major experiment components, including the six IBS containers where low-velocity microgravity impact experiments take place.

A ground-based program focuses on impacts into various types of simulated planetary regolith, or dust, at speeds from 1 to 10 m/s. This program provides a point of comparison for other experiments performed in reduced gravity environments, and also provides a valuable database on the behaviors of different types of regolith in low energy impacts. Michael Mellon and Josh Colwell conduct these experiments in LASP's Planetary Soils Laboratory.

The Collisions Into Dust Experiment (COLLIDE) has undergone improvements and modifications for a re-flight on the Space Shuttle. COLLIDE-2 is a Complex

Autonomous Payload (CAP) for the shuttle and will perform six microgravity impact experiments in orbit. The impacts are at speeds ranging between 1 and 100 cm/s and are videotaped for later analysis. COLLIDE was designed and assembled primarily by LASP students. Josh Colwell is the Principal Investigator; Larry Esposito and Mihaly Horanyi are co-investigators.

The Physics of Regolith Impacts in Microgravity Experiment (PRIME) will study the same process as COLLIDE with impact experiments in NASA's KC-135 reduced gravity airplane. These experiments will be at speeds from 10 cm/s to 10 m/s and help bridge the gap between the ground-based experiments and the space-based experiments. PRIME will generate more data than COLLIDE, but in a different reduced gravity environment and at generally higher energies. Work on PRIME began in 2000. Josh Colwell is the Principal Investigator with Co-Investigator Stein Sture.

The combined results and insights gained from these experimental programs, together with numerical and theoretical analyses will help us understand the origin and evolution of planetary ring systems and the early stages of planet accretion.

Theoretical Investigations of Planetary Atmospheres and work under the Astrobiology Program:

The focus of this work is to understand the clouds and climates of the terrestrial planets including Venus, and Mars, and to better understand the habitability of planets. A graduate student, Kevin McGouldrick, is studying the lower clouds of Venus to explain the clearings in the clouds that occasionally occur at near infrared wavelengths as observed, for example, by Galileo spacecraft instruments. Another student, Elinor Newman, is investigating the optical properties of Martian dust. Early work used infrared spectra of Mars to deduce the size of Martian dust particles, and compared the spectra with calculations using optical constants of various terrestrial analogs. The present effort is aimed at directly determining the optical constants of the dust so that more accurate remote sensing and radiative transfer studies can be done. During the past Dr. Toon has also investigated the environmental perturbations that would occur on Earth if it were struck by asteroids or comets of various sizes. Dr. Toon found that distinctly different phenomena occur in various size ranges. This study is designed to help guide astronomical searches for dangerous objects, and to shed further light on past impacts such as the one at the K-T boundary. Ms. Teresa Segura is applying these ideas to Mars, to determine if an impact there might have caused the Martian rivers. Mr. Tony Colaprete, now a Resident Research Associate at NASA Ames, has completed studies of the formation of carbon dioxide clouds in the atmosphere of Mars. These studies show that snowstorms occur on Martian wave clouds, and that ancient CO_2 clouds were not efficient at warming the surface. He has also developed a model of water-ice clouds on Mars and applied it to Pathfinder, and Mars Global Surveyor data. Ms. Jennifer Heldmann, a student in the Geology Department is working on studies of small rivers that have been observed on steep slopes on Mars and may be of recent origin. She is also studying similar spring in the Arctic as an analog. Mr. Tina Fen is beginning to study the ancient atmosphere of Earth. Of interest in this case is the degree to which reducing gases may have been present. Ms. Erica Barth is conducting studies of the hydrocarbon clouds on Titan to support Cassini observations. This work is being augmented by relevant laboratory studies in the chemistry department. Similar lab studies are being initiated on Mars CO2 clouds, and on hydrocarbon clouds in the early atmosphere of Earth.

Center for Astrobiology

CU is one of the member institutions in NASA's Astrobiology Institute. The NAI brings together researchers and institutions from around the country to address the broadest issues related to understanding whether life exists elsewhere in the universe. The CU Center for Astrobiology, housed within LASP, is in itself a microcosm of the entire field – faculty participate from a half-dozen departments in the physical and biological sciences, and even from the humanities. Research funded through the program involves understanding the formation of stars and planets and the distribution of planets in the galaxy, the climate and habitability of Earth-like planets, the chemistry of RNA and the origin of life, microbial ecology and life in extreme environments. The early history of life on Earth, major events in the evolution of life on –Earth, the nature of environments on planets in our solar system and elsewhere and their potential for life, and philosophical aspects of the search for life elsewhere.

In addition to the broad research program, we are creating a graduate "certificate" program in astrobiology, in order to provide broad training of graduate students without taking away from the education that they receive in their home departments. We also are creating a presence in outreach at all levels, including to the University community (via undergraduate non-major courses, monthly colloquia and discussion groups) and to the public (with public talks and symposia). The major outreach event of the year was a public symposium on the possibility of there being intelligent life elsewhere in the Universe.

This year, we added Asst. Prof. Stephen Mojzsis as a new faculty member in Geological Sciences. Steve is a geologist, emphasizing the earliest rock record of life and climate on Earth.

One goal of the program is to use the interest in astrobiology to bring together otherwise-disparate components of the University academic environment and to bridge across the wide gulf between disciplines. We also intend to use the excitement of the search for life elsewhere as a "hook" to engage both undergraduates and the public in learning about the nature of science and the role of science in society.

Faculty members who are carrying out research in connection with the program include Bruce Jakosky (LASP and GEOL; PI of program), Brian Toon (LASP and ATOC), John Bally (APS), Michael Yarus (MCDB), Norman Pace (MCDB), Steve Mojzsis (GEOL), Shelley Copley (MCDB), William Friedman (EPOB), and Carol Cleland (PHIL).

Mars Global Surveyor

In March of 1999 the Mars Global Surveyor spacecraft began mapping the planet Mars with a suit of geologic remote sensing instruments. In early 2001 the primary mapping mission will end, marking one full martian year of mapping the red planet. Through Bruce Jakosky's Interdisciplinary Scientist investigation, researchers at LASP are participating in the data analysis from this mission. The emphasis is currently on surface-atmosphere interactions that include seasonal cycles and their effects on the atmosphere, the implications of MGS mission results for past life on Mars, and planning for future Mars landings.

Specific analysis (with Michael Mellon) is focused on deriving and mapping the thermal inertia of the martian surface at high (3 km) spatial resolution using remotely measured surface temperatures and other data from the Thermal Emission Spectrometer. Thermal inertia is a measure of a planet's surface-temperature response to changes in solar heating throughout the day. Low values of thermal inertia are typical of fine grained, loosely packed, soils like dust and fine sand that indicates windblown deposits. High values are typical of expanses of exposed bedrock or heavily cemented (lithified) rock units. Intermediate values of thermal inertia would indicate a coarse sandy or rocky surface. Through mapping of the thermal inertia, the physical character of the surface can be estimated and, in comparison with images and geologic unit maps, a more complete view of the geologic history can be attained.

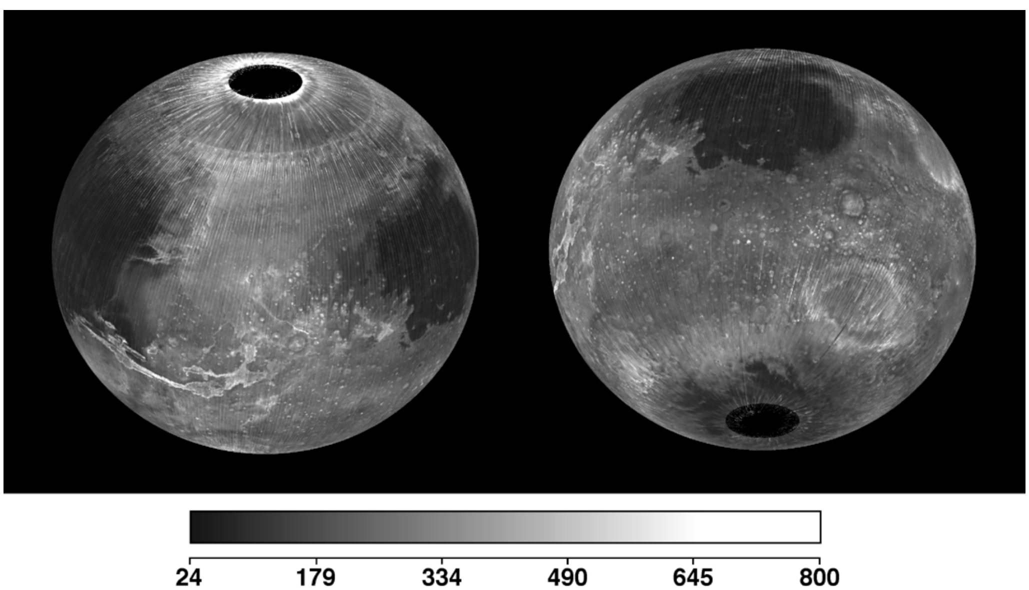


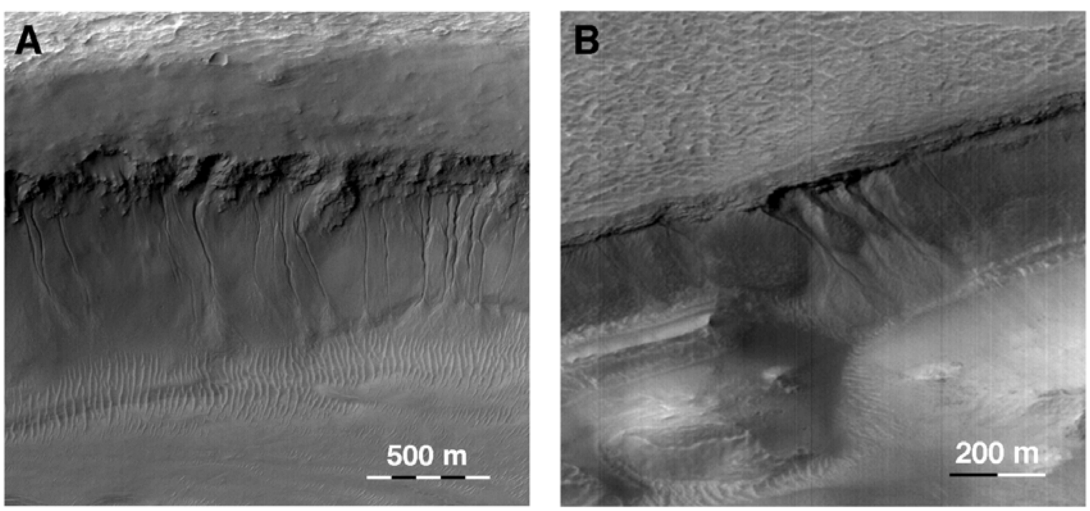
Image: The global distribution of thermal inertia of the martian surface determined from Thermal Emission Spectrometer data from mapping orbits 1583 to 9382 (acquired during April 1999 through November 2000). Thermal inertia units are $J/m^2\ K\ s^{1/2}$.

Analysis of thermal inertia data has focused on understanding the global the nature of the martian surface soil and local characteristics of wind streaks, future landing sites, and other areas of geologic and mineralogical interest. Initial global-scale results have revealed a previously undetected type of soil surface on Mars. This surface type is characterized by intermediate values of thermal inertia and albedo (surface brightness) and is thought to represent a crusted or salt-cemented soil.

Permafrost of Earth and Mars

One of the long-standing questions of the martian climate involves the history of water. Current martian surface conditions allow water to be stable only in a frozen state at the polar surface or as subsurface ground ice within the regolith at mid and high latitudes. Water in the equatorial regions of Mars would rapidly freeze, then sublimate (evaporate) into the dry atmosphere. Research is being carried out by Michael Mellon to investigate the behavior of ground ice and the relationship between subsurface ice, subsurface water, and small-scale geologic features.

Of particular interest are features now being observed in high resolution Mars Global Surveyor images, namely small polygonal networks and young, apparently water-carved, gullies. Polygonal networks of fractures that are ubiquitous in terrestrial ice-rich permafrost and are now observed on Mars in relative abundance. Fractures form in ice rich soils when seasonal cooling causes contraction. The presence of these features on Mars indicates the presence of subsurface ice, which previously has been only theoretically predicted to be there.



Images: Gullies on Mars. These small scale features are thought to be carved by liquid water based on morphological evidence and Earth analogs. Yet they occur in regions on Mars where the ground temperatures are continuously well below freezing. Researchers at LASP are investigating the origin of these features.

Small geologically young gullies have also been discovered, that indicate surface water erosion in regions of Mars where surface water is unstable, and should rapidly freeze. These features raise questions about where liquid water could originate in the current martian climate. In collaboration with Roger Phillips (visiting from the Washington University), Michael Mellon has developed a possible solution to this paradox. Shallow aquifers may exist as a result of global average geothermal heating and thermal insulation from unusually dry loose surface soil.

Additional research includes the study of analogous geologic features in the Antarctic Dry Valleys these valleys are among the coldest and driest places on Earth and are therefore similar in condition to the martian climate. The study of these terrestrial geologic features, may help us to better understand the processes that possibly form similar structures on Mars. A combination of field work in the Antarctic Dry Valleys, laboratory analysis of permafrost samples, and theoretical study of ice stability and polygon formation are being employed.

Ulysses

The Ulysses spacecraft has been studying the solar environment since its launch in 1990. In order to reach high solar latitudes, Ulysses flew over the North pole of Jupiter and used Jupiter's gravity to send it over the poles of the sun in 1994 and 1995 during solar minimum. A solar maximum pass over the solar poles will occur in 2000 and 2001. Comparing the two passes will provide insights into the solar cycle and its effect on the space environment.

LASP is actively involved in the Ulysses mission. John Brandt of LASP worked as a Ulysses Guest Investigator, using comets as a tracer for solar wind activity. Wayne Pryor of LASP and Joseph Ajello of JPL are currently Ulysses Guest Investigators working with Manfred Witte of the Max-Planck Institute for Aeronomy. They have demonstrated that the background signal in a helium atom detector (the Interstellar Gas Experiment, or GAS) due to interplanetary Lyman alpha can be used to remote sense hydrogen in the inner solar system. This hydrogen flows through the solar system from interstellar space. Models of the GAS data suggest that the hydrogen distribution is quite different at different parts of the solar cycle. During solar minimum, the large solar wind mass flux in the current sheet near the ecliptic plane carves a distinct "groove" in the hydrogen distribution. (Solar wind protons and hydrogen atoms exchange charges, producing a fast population of hydrogen atoms invisible to the GAS detector because they have been Doppler-shifted away from the solar Lyman alpha line that normally illuminates the hydrogen with solar photons.) At solar maximum the solar wind distribution, and the hydrogen distribution, is found, on average, to be somewhat more symmetric in solar latitude.

Galileo

On December 7 of 1995, NASA's Galileo spacecraft entered orbit around Jupiter and the LASP-built Ultraviolet Spectrometer (UVS) and Extreme Ultraviolet Spectrometer (EUV) instruments on board the Galileo spacecraft began observations of Jupiter, the Io torus, and the four innermost, Galilean moons of Jupiter: Io, Europa, Ganymede and Callisto. During 1996-1997, the Galileo Nominal Mission successfully completed eleven close encounters with these moons yielding exciting new data. NASA then funded the Galileo Europa Mission, GEM, for fourteen very close encounters with the four inner moons for two additional years, ending in November of 1999. The Galileo Millennium Mission, GMM, yielded data on four additional orbits that concentrated on the Jupiter Magnetospheric environment. GEM extended through Orbit 29 and December of 2000. One more Galileo mission has been announced that may provide five additional remote sensing orbits and finish the mission with using the Galileo spacecraft as a probe, entering into Jupiter's atmosphere. This 'final' mission has not been fully funded at this time.

Detection of Rapidly Varying H_2 Emissions in Jupiter's Aurora

Recent analysis of the H_2 band emissions in Jupiter's northern auroral region at 1240 Å indicated they were highly variable on time scales of a few seconds. On November 5, 1996 – during the Callisto-3 (C3) orbit – the UVS observed Jupiter,s main auroral arc and the polar cap region, both on the dayside. The UVS measurements indicated the emission at 1611 Å was much weaker than the 1240 Å emission, but varied in phase with it. The 1240 Å and 1611 Å variability is evidence that the precipitating particles have a highly variable flux. The estimated 1611 Å/1240 Å photon flux ratio of 1.82±0.07 (after background subtraction) is consistent with auroral penetration of a slant column depth in CH_4 of (3.5±0.2) x 10^{16} cm^{-2}. The slit-averaged brightness at 1240 Å and 1611 Å increased by almost a factor of two on 2 occasions with durations (full-width at half-maximum) of the order of 100 seconds. A similar observation of Jupiter's south polar aurora near the dawn terminator during orbit Ganymede-8 found both the 1240 Å and 1611 Å emissions to be more steady and gradually increasing. The variable 1240 Å and 1611 Å emissions seen on orbit C3 may be similar to variable polar cap "flares" reported in recent Hubble Space Telescope ultraviolet images of Jupiter from the new Space Telescope Imaging Spectrograph.

Milestones

Galileo Launch: October 18, 1989 EST=1653:40 UTC
Instrument Power On: EUV: 1989-361/17:54:58 UTC
UVS: 1989-361/19:11:49 UTC
Close Approach (C/A) dates
Venus C/A: February 10, 1990 041/05:59:00 SCE UTC Earth 1 C/A: December 8, 1990 342/20:34:34 SCE UTC Gaspra C/A: October 29, 1990 302/22:39:02 SCE UTC Earth 2 C/A: December 8, 1992 343/15:09:?? ERT UTC Ida C/A: August 28, 1993
240/16:52:00 SCE UTC

Shoemaker Levy-9 July 16-22, 1994 197/19 - 203/ Jupiter Orbit Insertion December 8, 1995 342/00:27:00.0 UTC Ganymede 1 C/A June 29, 1996
180/10:02:00.0
Ganymede 2 C/A September 7, 1996 250/19:00:00.0 Callisto 3 C/A November 7, 1996 311/13:32:00.0 Europa 4 C/A December 20, 1996 354/06:58:00.0 Orbit Raise (J5) January 16, 1997 016/23:40:00.0 Europa 6 C/A February 22, 1997 053/17:03:00.0 Ganymede 7 C/A April 5, 1997
095/07:10:00.0
Ganymede 8 C/A May 9, 1997
129/15:59:00.0
Callisto 9 C/A = "Tail Petal orbit"
June 25, 1997 176/13:49:00.0
Callisto 10 C/A September 18,1997 261/00:22:00.0

End Nominal Mission November 5, 1997

Galileo Europa Mission

Europa 11 C/A November 6, 1997
Europa 12 C/A December 16, 1998
Europa 13 C/A February 10, 1998
Europa 14 C/A March 29, 1998
Europa 15 C/A May 31, 1998
Europa 16 C/A July 21, 1998
Europa 17 C/A September 26, 1998
Europa 18 C/A November 22, 1998
Europa 19 C/A February 1, 1999 - final Europa C/A Callisto 20 C/A May 5, 1999
Callisto 21 C/A June 30, 1999
Callisto 22 C/A August 14, 1999
Callisto 23 C/A September 15, 1999
Io 24 C/A October 11, 1999
Io 25 C/A November 25, 1999

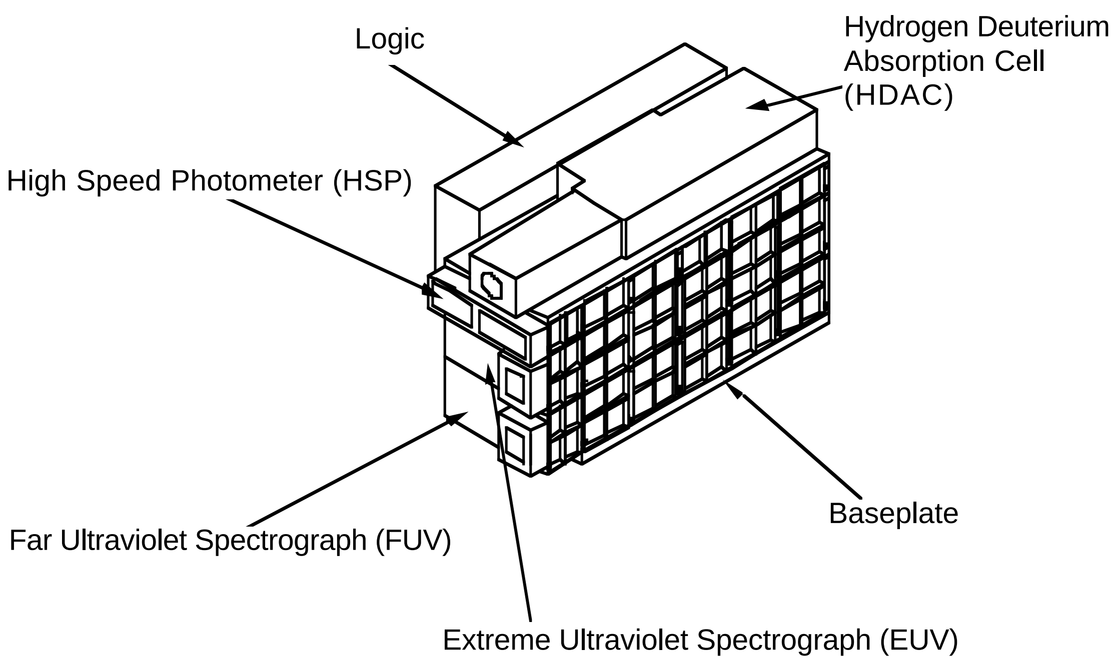
Galileo Millennium Mission

Europa 26 January 1, 2000
Io 27 February 25, 2000
Ganymede 28 May 19, 2000
Ganymede 29 February 3, 2001
Callisto 30 May 26, 2001
Io 31 ? August 7, 2001
Io 32 ? October 18, 2001
Io 33 ? January 19, 2002
Io 34 ? November 8, 2002

Cassini

LASP built the UltraViolet Imaging Spectrograph for the Cassini orbiter spacecraft, part of the NASA-ESA mission to Saturn. It was launched in October 1997 and will arrive at Saturn in June 2004. The instrument is working well and on the way to Saturn. We are analyzing observations of stars, Venus, and the Earth's Moon from 1999, and from Jupiter in 2000.

The LASP UVIS was built with the participation of the Max Planck Institute of Lindau, Germany. It measures the composition of the atmospheres of Saturn and Titan, their clouds, thermospheres, and heavy hydrogen abundances. Dynamical waves and wakes in the rings of Saturn and the upper atmospheric structure will be measured by observing stellar and solar occultations.

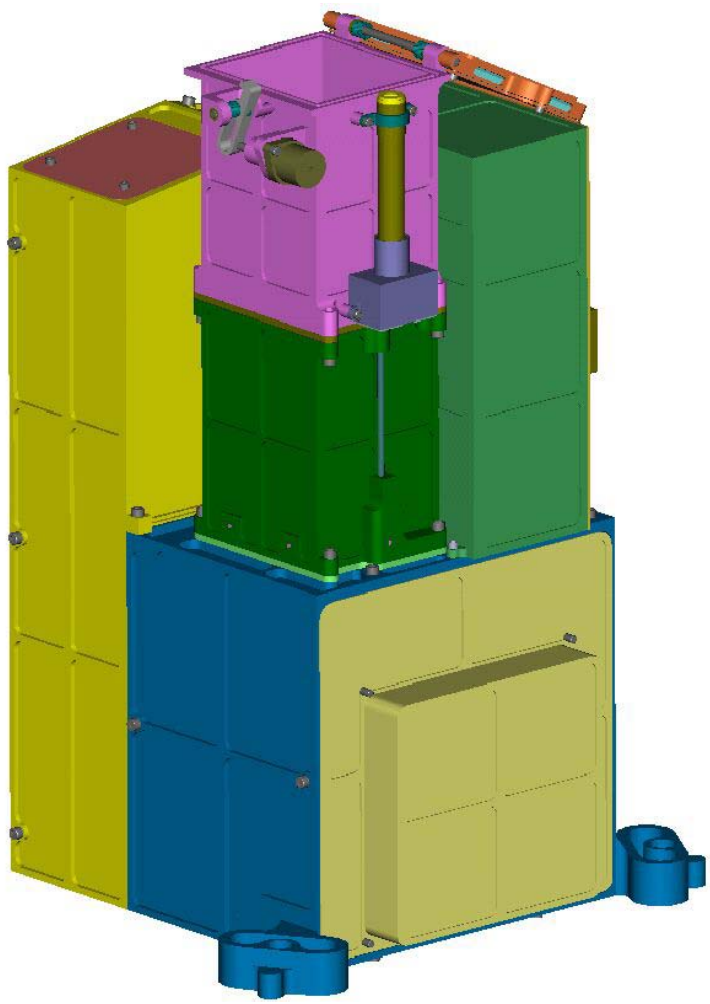


The Cassini spacecraft (2,500 kilograms of hardware and 3,000 kilograms of propellant) will deliver the European-built Huygens probe to Saturn’s moon Titan and then tour the Saturnian system for nearly four years. Approximately 1,300 academic and industrial partners in 16 European countries are participating in the Cassini mission. In addition, there are more than 3,000 participants in 32 different states in the US. The mission is managed for NASA by the Jet Propulsion Laboratory in Pasadena, California, and for ESA by the European Space Technology and Research Center in Noordwijk, the Netherlands. The Italian Space Agency contributed the orbiter’s 4-meter-diameter high-gain antenna for communications and portions of other orbiter science experiments. The United States supplied batteries and two science instruments for Huygens.

In 2000, Cassini observed Jupiter, its atmosphere, moons, and glowing Io torus. These observations complement and extend those from the LASP Galileo UVS.
The LASP UVIS Science team includes Principal Investigator Larry Esposito, Co-Investigators George Lawrence, Bill McClintock, Charles Barth, Joshua Colwell, and Ian Stewart. Alain Jouchoux is the Operations Team Leader, assisted by Michelle Kelley and Darren Osborne.

MESSENGER (MErcury: Surface, Space ENvironment, GEochemistry, and Ranging): A Mercury Orbiter Mission

The Mariner-10 flybys of Mercury in 1974 and 1975 found a strong planetary magnetic field and an active magnetosphere similar in many ways to that of Earth. Based upon the small size of the planet, Mercury's interior was expected to have cooled and solidified long ago. The presence of an intrinsic magnetic field, however, implied an internal dynamo in a fluid core, posing numerous, unresolved questions concerning the origin, composition, and thermal history of Mercury. The Mariner-10 spacecraft also detected intense particle bursts and magnetic field disturbances, indicating that magnetospheric substorms occur at Mercury. The Mariner-10 images revealed a number of surface features unique to Mercury, including large-scale thrust faults apparently associated with crustal compression as the planet cooled and contracted.



The MESSENGER mission is under development in the NASA Discovery program. This mission to Mercury will provide unique measurements that are not possible at other planets due to the constraints of orbital mechanics and the large dimensions of other magnetospheres relative to their planetary bodies. The MESSENGER mission will provide the essential data necessary to formulate the next generation of theories and models for terrestrial-type planetary structure and dynamics. The mission will also return critical measurements necessary for the understand-ing of not just the surface hist-ory and internal structure of Mercury but the formation and chemical differentiation of the Solar System as a whole.

MESSENGER is a large collaboration of 11 different institutions. It is led by Sean Solomon from the Carnegie Institution in Washington, DC and managed by the Applied Physics Laboratory at the Johns Hopkins University. It will study the planet's surface morphology and composition, interior structure and magnetic field, and atmospheric and magnetospheric composition. Included in this suite is the Mercury Atmospheric and Surface Composition Spectrometer (MASCS), which will be designed, built, and operated by the Laboratory for Atmospheric and Space Physics. William McClintock and Daniel Baker are both Co-Investigators on the MESSENGER science team.

MarsQuest – Museum Exhibit Begins National Tour

MarsQuest, a 5000 square foot traveling museum exhibit, accompanied by a planetarium show and an education and public outreach program, began its three year tour in October, 2000. The exhibit opened at the McWane Center in Birmingham, Alabama, moved to the Orlando Science Center (Orlando, FL) in February 2001, and will travel to science museums in Tucson, AZ and Hickory, NC later in 2001. Scenes of the MarsQuest opening in Orlando are shown.

The Informal Science Education Program of the National Science Foundation and NASA funded the development of MarsQuest. Paul Dusenbery, of the Space Science Institute (SSI) in Boulder, CO, is project director. Steve Lee, of LASP, is the science content coordinator. Scientific and educational advisors from many different universities and government laboratories, most of whom are directly involved in the active and planned Mars missions, helped ensure the scientific accuracy, timeliness, and relevance of the key concepts presented in the exhibition and the accompanying programs. In addition, educators, planetary scientists, and engineers played an active role in expanding the educational impact of the exhibition through public programs, visits to schools, and the dissemination of field-tested educational materials developed for *MarsQuest.*

MarsQuest examines several key concepts in planetary science: physical scales, how physical systems interact, planetary formation, planetary climate, the possibility of life on other planets, etc. Specific attention has been paid to new results from the suite of NASA missions to Mars. The exhibition is designed according to the continuing progression of our understanding of Mars, and features four interrelated themes:

An Historical Perspective of Mars: Visitors encounter the many literary and mythical views of Mars that have been developed by societies over the centuries, including cultural perspectives, science fiction, and early telescopic observations.

Modern Exploration of Mars: A broad suite of technologies, from telescopes to spectrometers to surface samplers have been used to learn about our nearest planetary neighbor. This area introduces the devices and strategies employed in the ongoing spacecraft exploration of Mars. Included is a large Mars globe, models of current mission spacecraft, and displays of the latest data from active missions.

The World of Mars: Numerous interactive displays and photo-realistic dioramas lead to a series of first-hand investigations of Martian weather, topography, and geology by the visitors. Centerpieces of the exhibit are a full-scale recreation of the Pathfinder Sojourner rover and a portion of its surroundings, detailed views of Valles Marineris, Olympus Mons, and the Pathfinder landing site, a "drive it yourself" rover testbed, and a mini-theater featuring a MarsQuest video in High Definition TV. A series of issues are addressed concerning both the similarities and the striking differences between Earth and Mars. Interactive displays will be updated frequently with the latest Mars observations.

The Future Mars: Where do we go from here? What outstanding scientific questions should we focus on answering? Where should our national — and global — priorities lie with respect to this kind of scientific exploration and research? Displays/models/animations of planned missions (through the middle of this decade) are featured.

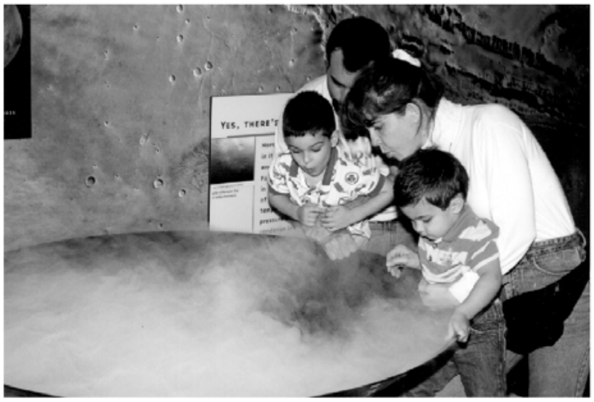
The traveling exhibit is the primary element of the *MarsQuest* project. The exhibition experience, carefully keyed to current events in Mars exploration, transports visitors to the surface of the Red Planet. There they have the opportunity to share in the spirit and thrill of exploration, and come to appreciate the similarities and differences between Earth and Mars.

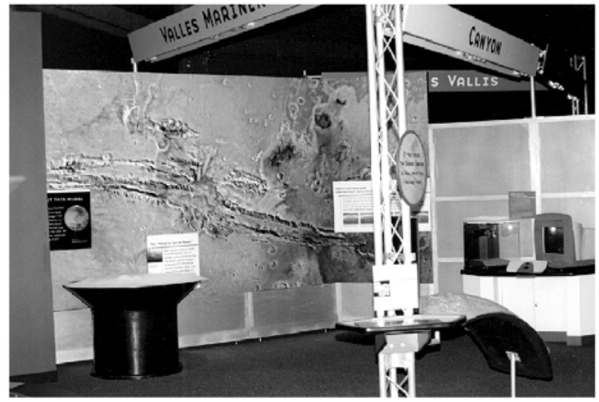
A planetarium show, geared to the goals of the *MarsQuest* project, is an important sensory addition to the traveling exhibit. The planetarium/star-theater venue presents a unique environment where audience members can literally be surrounded by Mars images. This show was produced by Loch Ness Productions and narrated by Patrick Stewart. In addition, a small theater utilizing a large-screen High Definition Television (HDTV) display is being supported by donations of hardware by Mitsubishi Digital Electronics. A 15-minute HDTV video program for this theater was produced by Steve Lee and edited by CBS.

Education and outreach programs comprise the remainder of the *MarsQuest* project. The goal of these is to make scientific concepts and scientific and engineering processes understandable to the ordinary person. *MarsQuest* takes advantage of the many educational resources currently available or in the planning stages. The exhibition content will be disseminated to teachers through pre/post-visit materials, presentations at annual and regional education meetings, and the World Wide Web. Current information from the missions and the exhibition, as well as updated lesson plans, will be available via the WWW.

The *MarsQuest* development staff works with educators and staff of the host museums to develop a broad spectrum of education activities. These range from public lectures/demonstrations on various space topics, special seminars for science teachers, and workshops to explain the use of the curriculum supplements developed to accompany the exhibit.

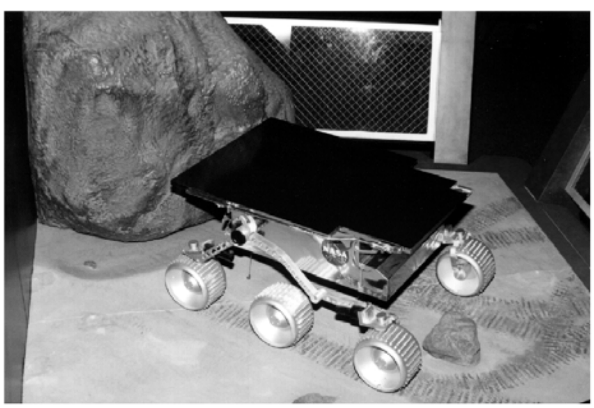
MarsQuest will travel to nine science centers throughout the United States and reach an estimated three million children and adults during its planned three-year tour. Plans are underway to add an additional three years to the tour, and to develop a "*Mini-MarsQuest*" to allow exhibition in smaller museums.

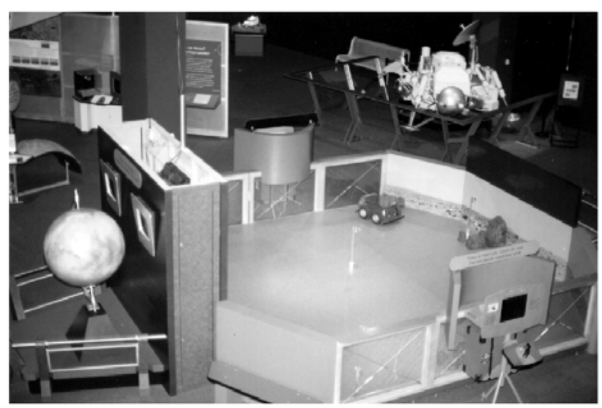




CANYON

MARS
QUEST
EXPLORING THE RED PLANET
WELCOME TO MARS!





PROGRAMS IN DEVELOPMENT

Aeronomy of Ice in the Mesosphere (AIM)

In October, 2000, a team of LASP scientists (Dave Rusch, Cora Randall, Gary Thomas, and Mihaly Horanyi) won a competitive Phase A study award scheduled to begin on May 1, 2001. The team also includes scientists from Hampton University (James Russell III, PI), the Naval Research Laboratory, Utah State University, GATS, BAS, Ball Brothers Aerospace Division, and LaRC.

The overall goal of the Aeronomy of Ice in the Mesosphere (AIM) experiment is to resolve why polar mesospheric clouds (PMCs) form and why they vary. By measuring PMCs and the thermal, chemical and dynamical environment in which they form, we will quantify the connection between these clouds and the meteorology of the polar mesosphere. In the end, this will provide the basis for study of long-term variability in the mesospheric climate and its relationship to global change. The results of AIM will be a rigorous validation of predictive models that can reliably use past PMC changes and present trends as indicators of global change. This goal will be achieved by measuring PMC abundances, spatial distribution, particle size distributions, gravity wave activity, dust influx to the atmosphere and precise, vertical profile measurements of temperature H_2O, OH, CH_4, O_3, CO_2, NO, and aerosols. These data can only be obtained by a complement of instruments on an orbiting spacecraft (S/C).

Over the last 30 years ground based observations from NW Europe of the number of noctilucent clouds (NLCs) show dramatic increases. These clouds, known more recently to satellite observers as Polar Mesospheric Clouds (PMCs), are believed to respond dramatically to even small changes in their environment. Since cooling of the upper atmosphere (PMCs occur near 85 km) is expected to accompany the possible warming of the lower atmosphere due to an increased greenhouse effect, an increase in mesospheric cloudiness could be one consequence of mesospheric climate change.

Pluto and Outer Solar System Explorer (POSSE)

LASP, along with NASA's Jet Propulsion Laboratory and Lockheed Martin Astronautics in Denver, has proposed a complete mission to Pluto, the Pluto and Outer Solar System Explorer (POSSE). POSSE is a complete, affordable mission to explore Pluto, Charon, Kuiper Belt Objects and dust in the outer Solar System. It includes a remote sensing package, a radio science investigation, and other experiments to characterize the global geology and morphology of Pluto and Charon, map their surface composition, and characterize Pluto's neutral atmosphere and its escape.

No new technologies are planned. Proven scientific investigations, propulsion and management are key to the low cost and low risk.

POSSE's EPO program will create exciting personal connections to NASA's journey of exploration and discovery for educators, students, and the general public. The science team and mission staff will actively participate. POSSE includes collaboration among missions to primitive bodies and Origins missions, museum events, and a planetarium show. The education activities are aligned with national standards and aid underserved students. Comprehensive evaluation is integral to this program.

NASA may select a Pluto mission in Summer 2001. L.W. Esposito is the Principal Investigator for POSSE. W.E. McClintock is the Co-Investigator. M.D. Anfinson and R.L. Davis have key roles for instrument management and science operations.

Daniel N. Baker
Director

LASP Faculty

Linnea M. Avallone
Frances Bagenal
Charles A. Barth
Mark A. Bullock
Antonio Canas
Joshua E. Colwell
Giuliana De Toma
Erica Ellingson
Francis G. Eparvier
Robert Ergun
Larry W. Esposito
Robert E. Grimm
Jerald W. Harder
Amanda Hendrix
Mihály Horányi
Hiroyuti Kosai
Bruce M. Jakosky
George M. Lawrence
Steven W. Lee
Xinlin Li
William E. McClintock
Michael Mellon
Michael Mills
Daniel Moorer, Jr.
Keiji Ohtsuki
Wayne R. Pryor
Cora E. Randall
Gary J. Rottman
David W. Rusch
Brian Schaible
Nicholas M. Schneider
Barkley Sive
Martin Snow
Stanley C. Solomon
A. Ian F. Stewart
Glen R. Stewart
Yi-Jin Su
Gary E. Thomas
Henry B. Throop
Petri K. Toivanen
O. Brian Toon
Niescja E. Turner
Thomas N. Woods

Visiting Scholars

Mr. Mazen Al-Sliety, University of Central Florida
Dr. Scott Bailey, Hampton University
Dr. Anthony Chan, Rice University
Dr. Geoff Crowley, Southwest Research Institute, San Antonio, TX
Dr. Paul Feldman, Johns Hopkins University
Mr. Jason Glover, Hampton University, Virginia
Dr. Matthew Golombek, Jet Propulsion Laboratory
Dr. Min-Hwan Jang, Kyung Hee University, South Korea
Dr. Eric Jensen, Ames Research Center
Dr. R. P. Kane, Instituto Nacional de Pesquisas Espaciais, Brazil
Dr. Judith Lean, Naval Research Laboratory
Ms. Adele Luta, University of Central Florida
Dr. John J. Olivero, Embry-Riddle Aeronautical University, Florida
Dr. Roger Phillips, Washington University, St. Louis
Mr. Dhowlyn Samuel, Hampton University, Virginia

Dr. Theodore Sarris, Greece
Dr. Donald Shemansky, University of Southern California
Dr. Michael Temerin, University of California at Berkeley
Dr. W. Kent Tobiska, Federal Data Corporation, NASA Jet Propulsion Lab
Dr. Gerhard Wurm, University of Jena, Germany

Research/Technical/Administrative Support Staff

Christina Alba
Ann B. Alfaro
Gregg Allison
Kathryn F. Anderson
Michael D. Anfinson
Judy Antman
Richard Arnold
Dennis L. Baker
Susan Batiste
Helmut P. Bay
Robert P. Biro
Bryan D. Boyle
John Boynton
James Brault
Lisa Braun
Nancy Brooks
Ronald Brown
Nancy M. Byers
Ione Caley
Michael T. Callan
Zachary G. Castleman
Zhangzhao Chen
Randy Coleman
John A. Daspit
Randal L. Davis
Kip W. Denhalter
Robert Doyle
Michael Dorey
Virginia Drake
Neil Duchane
Phillip L. Evans
Jack Faber
Tawnya Ferbiak
Kurt Filsinger
Rachel Freeman
Daniel R. Gablehouse
Judith (Dede) Gleason
Jeanne Gregory
Bonnie Kae Grover
Roger Gunderson
Joshua A. Hadler
Christine Hathaway
Karl Heuerman
Caroline Himes
Timothy Holden
Bonnie W. Hotard
James Howard
Andrew Hunt
Alain J. Jouchoux
David E. Judd
Michelle Kelley
Marjorie K. Klemp
Barry Knapp
Richard Kohnert
Gregory Kopp
Kraig Koski
Bret Lamprecht
Stephen C. Lane
Mark R. Lankton
Kathy Lozier
Karen M. MacMeekin
Sherry McGlochlin
Michael McGrath
Russell Meinzer
Steve P. Monk
Jeffrey Oatley
Christ Pankratz
Heather Reed
Thomas Reese
Randy Reukauf
Cynthia Russell
Sean Ryan
Karen Simmons
John Simpson
Artemis Sohrt
Thomas Sparn
Stephen Steg
Gail Tate
Daniel Taylor
Janet Tracy
Nicole Troutman
Jennifer Turner-Valle
Gregory Ucker
Stacy Varnes
Douglas Vincent
Jeffrey Weber
Paul Weidmann
James Westfall
Neil White
Ann Windnagel
Peter Withnell
Donald Woodraska
Lisa Young
Patti Young

Recent Graduates

Anthony Colaprete, Ph.D., Astrophysical and Planetary Sciences Department
August 2000
"Clouds on Mars"
Thesis Advisor: O. Brian Toon

James Bradley Dalton III, Ph.D., Planetary Geophysics, May 2000
"Constraints on the Surface Composition of Jupiter's Moon Europa based on Laboratory and Spacecraft Data"
Thesis Advisor: David Harry Grinspoon

Stefanie Lyn Lawson, Ph.D., Astrophysical and Planetary Sciences Department
May 2000
"Brightness Temperatures of the Lunar Surface: Calibration and Analysis of Clementine Long-Wave Infrared Camera Images"
Thesis Advisor: Bruce M. Jakosky

Henry Blair Throop, Ph.D., Astrophysical and Planetary Sciences Department
May 2000
"Light Scattering and Evolution of Protoplanetary Disks and Planetary Rings"
Thesis Advisor: Larry W. Esposito

Niescja Evonne Turner, Ph.D., Astrophysical and Planetary Sciences Department
May 2000
"Solar Wind-Magnetosphere Coupling and Global Energy Budgets in the Earth's Magnetosphere"
Thesis Advisor: Daniel N. Baker

Graduate Students

Janice Armellini
Erika Barth
David Brain
Sarah Brooks
Shawn Brooks
Matthew Burger
Jeff Cadieux
Aaron Cannon
Anthony Colaprete
Peter Colarco
Brian Damiani
Sarah Earley
Stacy Varnes Farrar
John Fulmer
Brandi Gamblin
Amelia Gates
David Gathright
Anna G. Hallar
James Harr
Keith Harrison
Jason M. Hasker
Kristi Hines
Timothy Holden
Gregory Holsclaw
Stephen Johnstone
Olga V. Kalashnikova
Byoungsoo Kim
Kari Klein
Corinne Krauss
Stefanie Lawson
Mark C. Lewis
Kevin McGouldrick
Eric Mahr
Aimee Merkel
Daniel Moorer
Gregory Mungas
Elinor Newman
Michael Ondrey
Laura Patrick
Shannon Pelkey
Ana Lia Quijano
L. Jeremy Richardson
Erica Rodgers
Timothy Rood
Teresa Segura
Sean Sherrard
Patrick Shriver
Amanda Sickafoose
Bryon Smiley
Peter Smith
Andrew Steffl
Abhishek Tripathi
John Weiss
Erin Whitney
Christina Winckler
Jason Woodward
Jason Young
Christopher Zeller

Undergraduate Students

Kara Achen
Jim Adams
Ashley Anderson
Anderson, Brett
Brian Anderson
Karl Brown
Thomas Calihan
Aaron Cannon
Yong-San Casarez
Robert Chick
Christopher Connolly
Jennie Crook
David Crotser
Shaun Cummings
Darren Curtis
Tony Darnell
Eugene DeVito
Andrew Diaz
Cory Dixon
Jared R. Ethier
Brian Evans
Richard Falardeau
Jennifer Faraci
Ted Fisher
Lauren Fitzpatrick
Jason Fraze
Aaron Fromm
Jason Glover
Jeffrey Gonder
Kenneth Griest
Brian Ickler
William Kalinowski
Jill Kamienski
Matthew Kanter
Daniel Klein
Nantawadee Kungsakawin
Erin Lahr
Timothy Leisy
Holly Lewis
Hung Loui
David Luber
Hong Luong
Kenneth Mankoff
Brian Marotta
Patrick Meagher
Christopher Miksovsky
Nathaniel Miller
Naomi Mosser
John Murphy
Gregory Mungas
Sandor Nemethy
Michael Nielsen
Darren Osborne
Cary Olson

Marshal Olson
Albert Park
Yeagor Plam
Barbara Rage
Alexi Rakow
Nichole Ramos
Daniel Ravenscroft
Jennifer Ray
David Reichle
Tim Rood
Dhowlyn Samuel
Beth Shaner
Laura Shaner
Richard Shidemantle
Patrick Shriver
David Simmons
Patrick Smith
Daniel Stashak
Nicole Troutman
Jason Van Pietersom
Denys Van Renen
Kenneth Wan
Jordan Weisman
Joshua Wells
Angela Williams
Seth Wilson
Jason Woodward
Dylan Yaney
Trent T. Yang
Sean Yarborough
Scott Zipke
Torsten Zorn

Faculty Research Interests

Linnea Avallone

Experimental and theoretical studies of tropospheric and stratospheric chemistry, particularly of halogens and related species. Analyzing measurements of chemical species to understand dynamical processes in the stratosphere and troposphere. Development of instrumentation for autonomous in situ measurements of trace species related to understanding the lifetimes of anthropogenic pollutants.
avallone@miranda.colorado.edu (303) 492-5913

Frances Bagenal

Magnetic fields and plasma environments of solar system objects – mainly Jupiter and the Sun, but more recently, other planets, comets and asteroids.
bagenal@colorado.edu (303) 492-2598

Daniel N. Baker

Research in space instrument design and calibration, space physics data analysis, and magnetospheric modeling. Study of plasma physical and energetic particle phenomena in the magnetospheres of Jupiter and Mercury, along with the plasma sheet and magnetopause boundary regions of the Earth's magnetosphere. Analysis of large data sets from spacecraft; involvement in missions to Earth's deep magnetotail and comets; the study of solar wind-magnetospheric energy coupling; theoretical modeling of magnetotail instabilities. Study of magnetosphere-atmosphere coupling; applying space plasma physics to study of astrophysical systems. Research to understand magnetospheric substorms. Teaching of space physics and public policy, as well as public outreach to space technology community and general public.
daniel.baker@lasp.colorado.edu (303) 492-4509

Charles A. Barth

Planetary ultraviolet spectroscopy; observation and theory of nitric oxide in the Earth's upper atmosphere; research on planetary atmospheres.
charles.barth@lasp.colorado.edu (303) 492-7502

Joshua E. Colwell

Origin and evolution of planetary rings, observational and theoretical studies of planetary rings, comets, and satellites including Earth's moon. Impact processes on asteroids, satellites, and ring particles. Dynamics of dust in ring-satellite systems. Dusty plasma dynamics. Thermal models of airless bodies.

josh.colwell@lasp.colorado.edu (303) 492-6805

Erica Ellingson

The study of the evolution of galaxies, galaxy clusters, and quasars. Investigation of dark matter in distant galaxy clusters, the evolution of the galaxies in these clusters, and the properties of the intra-cluster gas. Observations with ground-based telescopes and use of several orbiting space observatories, extensive computer analysis and modeling.

erica.ellingson@lasp.colorado.edu (303) 492-6610

Francis G. Eparvier

Research interests include the aeronomy of the upper atmosphere, the effects of solar irradiance and particle flux variability on the upper atmosphere, and the sources of that solar variability. Approaches include rocket and satellite measurements of the solar outputs and of the atmosphere, and data analysis and theoretical modeling. Currently Co-Investigator on the Thermosphere- Ionosphere-Mesosphere Energetics and Dynamics (TIMED) satellite Solar EUV Experiment (SEE).

eparvier@colorado.edu, (303) 492-4546, http://stripe.colorado.edu/~eparvier

Larry W. Esposito

Observational and theoretical studies of planetary atmospheres and rings; chemistry and dynamics of the Venus clouds; waves in Saturn's rings; numerical methods for radiation transfer.

espo@lasp.colorado.edu (303) 492-7325

Jerald Harder

Measurement and interpretation of solar spectral irradiance; Development of space-borne prism spectrometers.

jerry.harder@lasp.colorado.edu (303) 492-1891

Mihaly Horanyi

Dusty space and laboratory plasmas. Electrodynamic processes and their role in the origin and evolution of the solar system. Comets, planetary rings, plasma surface interactions at moons and asteroids. Aerosol charging, in situ and remote observations of dust.

mihaly.horanyi@lasp.colorado.edu (303) 492-6903

Bruce M. Jakosky

Teaching and research activities focus on understanding the nature of planetary surfaces and atmospheres and the possibility for the existence of life in the universe. Specific activities include teaching undergraduate and graduate courses, training graduate students, research and grant activity pertaining to planetary science and exobiology, leading the campus effort in astrobiology, and outreach to the public.

jakosky@argyre.colorado.edu (303) 492-8004

George M. Lawrence

Physical chemistry, laboratory spectroscopy, experiment design and analysis, signal conditioning, vacuum technology, IR detectors, UV detectors, imaging detectors, microchannel plates.

george.lawrence@lasp.colorado.edu (303) 492-5389

Steven W. Lee

Development of computer techniques for analysis and correlative study of multiple remote-sensing data sets; Digital image processing techniques; Physics of atmosphere/surface interactions; Mechanisms and rates of eolian sediment transport; Effects of topography on regional atmospheric circulation; Educational outreach: incorporating planetary science into K-12 curricula.

steve.lee@lasp.colorado.edu (303) 492-5348

Xinlin Li

Space physics, data analysis and modeling. Especially interested in understanding the dynamics of relativistic electrons in the magnetosphere: the source, loss, and transportation of these MeV electrons; also interested in charged particle injections into inner magnetosphere during magnetic storms and substorms, and magnetosphere-atmosphere coupling due to energetic particle precipitations.

lix@lasp.colorado.edu (303) 492-3514

William E. McClintock

Observational Astrophysics - Ultraviolet observations of the outer atmospheres of cool stars and the very local (d<20pc) interstellar medium. Ultraviolet Observations of Planetary Atmospheres. Development of state-of-the-art instrumentation for high resolution spectroscopy for the 900-2500/ wavelength range.

bill.mcclintock@lasp.colorado.edu (303) 492-8407

Michael Mellon

The history of water on Mars, the martian permafrost, surface-atmosphere interactions and the martian climate. Periglacial geology and geophysics on Earth and Mars. Searching for subsurface water on Mars. Antarctic analogs to martian geomorphology. Laboratory research in transport processes in frozen soils, including gas diffusion and solute migration and the effects of water vapor, ice, and adsorbate on transport physics. Remote sensing and thermophysical properties of planetary

regoliths, with specific emphasis on martian surface material. Planetary surface temperature behavior and geothermal heat flow.
mellon@argyre.colorado.edu (303) 492-1711

Michael Mills

Research has focused on stratospheric sulfate aerosol. The current research tool is a 2D microphysical model of the troposphere, stratosphere, and mesosphere. A primary goal has been to assess the sources of the nonvolcanic stratospheric sulfate layer, and understand anthropogenic contributions. Because of the role of aerosol in stratospheric chemistry and radiative balance, this knowledge of its sources is critical to understanding global change. Recent efforts have attempted to understand discrepancies between observed and calculated aerosol mass at the top of the layer. Other work has examined the causes of observed particle nucleation in polar winter, the implications for aerosol of recently measured photolysis rates for H2SO4 and SO3, and volcanic aerosol as a potential source for polar mesospheric clouds.
mills@colorado.edu (303) 492-7767

Keiji Ohtsuki

Theoretical studies of planet formation; origin and dynamical evolution of ring-satellite systems.
ohtsuki@lasp.colorado.edu (303) 492-0260

Wayne R. Pryor

Planetary ultraviolet spectroscopy; outer planet auroras, gases, and aerosols; and interplanetary hydrogen and helium. Projects involve use of Galileo, Cassini, Hubble Space Telescope, Pioneer Venus, Voyager, McDonald Observatory, UARS, and Ulysses data.
wayne.pryor@lasp.colorado.edu (303) 492-1259

Cora E. Randall

Primary interests include atmospheric chemistry and dynamics, mainly of the stratosphere, and secondarily of the mesosphere and troposphere. Work is experimental in nature, relying on data from remote sensing satellites. The emphasis is on ozone, NO2, and aerosol data from the Polar Ozone and Aerosol Measurement (POAM) instrument as well as from the Stratosphere Aerosol and Gas Experiment (SAGE). Measurements from instruments on the Upper Atmosphere Research Satellite (UARS) and the Solar Mesosphere Explorer (SME) are also used. Other interests include the spectroscopy of comets and laboratory polarization measurements.
cora.randall@lasp.colorado.edu (303) 492-8208

Gary J. Rottman

Accurately measure the solar spectral irradiance (Principal Investigator on sounding rockets, UARS, EOS, and TSIM and Co-Investigator on SME and TIMED). Special emphasis is given to solar variability on all time scales and to comparisons of

the solar irradiance with the output of other late type stars. Past work has concentrated on the ultraviolet (l<300 nm) irradiance, but emphasis has now extended to the visible and near-infrared. Application of ultraviolet spectroscopy and the development of new instrumentation for remote sensing.
gary.rottman@lasp.colorado.edu (303) 492-8324

David W. Rusch

The general fields of spectroscopy and aeronomy, emphasizing the measurements of minor constituents and aerosols in planetary atmospheres such as nitric oxide and ozone and the physical and chemical phenomena which determine their densities and temporal variations. Research in the atmospheric sciences including stratospheric, mesospheric, and thermospheric data analysis and modeling. Application of the principles of molecular and atomic spectroscopy in the measurement of ultraviolet, visible, and near-infrared emission and absorption features to obtain understanding of atmospheric phenomena. Current research involves the determination of atmospheric processes affecting ozone and the reevaluation of ozone trends from long-term satellite measurements.
rusch@sertan.colorado.edu (303) 492-8627
http://lasp.colorado.edu/~rusch/dwr.html

Nicholas M. Schneider

The physics of planetary magnetospheres, particularly the interactions between planetary plasmas and the satellites of the outer planets. Extensive groundbased observations of the Jupiter/Io system, especially imaging and spectroscopy of the Io atmosphere and plasma torus. Program has been expanded to include Hubble Space Telescope observations. Designing and building of a spacecraft to study the Jupiter/Io system.
nick.schneider@lasp.colorado.edu (303) 492-7672
http://ganesh.colorado.edu/nick

Martin Snow

Current research interests involve ultraviolet spectroscopy and comets. Results from the Goddard High Resolution Spectrograph have provided information about a variety of astronomical objects, including cool star chromospheres, quasars, and hot star winds. Cometary research has been on the large-scale phenomena in plasma tails. Observations from the Ulysses Comet Watch involving amateur astronomers from around the world have greatly aided this research.
marty.snow@lasp.colorado.edu (303) 492-3744

A. Ian F. Stewart

The investigation by ultraviolet emissions of the aeronomy of planetary and satellite atmospheres, cometary comae, and Io's plasma torus.
stewart@viralf.colorado.edu (303) 492-4630

Glen R. Stewart

Origin and evolution of the solar system, with an emphasis on modeling the solid-body accretion of the terrestrial planets and the solid cores of the giant planets. Accretion of the Moon after a giant impact on the Earth. Modeling of satellite wakes and spiral density waves in planetary rings. Nonlinear dynamics of the three-body problem as applied to problems in solar system dynamics.

glen.stewart@lasp.colorado.edu (303) 492-3737

Gary E. Thomas

Research concerning the middle atmosphere of Earth, in particular the mesosphere (50-100 km). Of interest are noctilucent clouds which occur in the high-latitude summertime mesopause region, around 83 km. These clouds were observed for five years by a CU LASP ultraviolet experiment onboard the LASP SME satellite, and more recently by instruments onboard the POAM II and UARS (Upper Atmosphere Research Satellite) spacecraft. In the last decade, interest involves global change in this region, possibly caused by anthropogenic emissions and by climate changes in the troposphere. Critical parameters studied are solar UV flux, water vapor, temperature and ozone which are being monitored by instruments onboard the UARS.

gary.thomas@lasp.colorado.edu (303) 492-7022
http://lasp.colorado.edu/noctilucent_clouds

O. Brian Toon

Theoretical studies of stratospheric aerosols; investigations of volcanic aerosols and studies of polar stratospheric clouds; theoretical studies of tropospheric clouds, aerosols and radiative transfer; experimental investigations of stratospheric and tropospheric phenomena; theoretical investigations of planetary atmospheres.

btoon@lasp.colorado.edu (303) 492-1534

Thomas N. Woods

Observational studies of the solar ultraviolet (UV) radiation, its variability, and its interaction with Earth's atmosphere. Principal investigator of the Solar EUV Experiment (SEE) on the TIMED mission. Co-investigator of the Solar Stellar Irradiance Comparison (SOLSTICE) experiment currently making solar UV irradiance measurements on the Upper Atmosphere Research Satellite (UARS). Co-Investigator and project scientist for the Solar Radiation and Climate Experiment (SORCE) satellite as one of the Earth Observing System (EOS) missions.

tom.woods@lasp.colorado.edu (303) 492-4224

FACULTY ACTIVITIES

Linnea M. Avallone

Advisor to Anna Gannet Hallar, ATOC; Erin Whitney, Chemistry; Amelia Gates, ATOC
Advisor to Laura (Chesney) Patrick, ATOC; received MS, December 2000
Advisor to Lauren Fitzpatrick, chemistry, summer 2000
Advisory Panel Member, National Aeronautics and Space Administration, Global Tropospheric Experiment, "Future Directions"
Built and deployed autonomous airborne gas chromatograph; makes real-time in situ measurements of chlorofluorocarbons (CFCs) 11, 12, and 113; carbon tetrachloride (CCl4); methyl chloroform (CH3CCl3); and Halon 1211, every 4 minutes.
Chair, PAOS Graduate Student Concerns Committee (spring semester)
Co-advisor for Kristi Hines, ATOC; received MS, Dec 2000
Elected: American Geophysical Union, Atmospheric Sciences Section secretary
Interviewed and provided technical information for a school project to Ben Gass, student at New Vista High School
Led a bi-weekly research seminar and journal club (discussion of journal articles) for my research group.
Manuscript Reviewer: *Journal of Geophysical Research, Journal of Atmospheric and Ocean Technology, Global Biogeochemical Cycles*.
Member of Comps II committee for Laura Patrick, ATOC.
Member of PAOS Admissions Committee (spring semester)
Member of PAOS Curriculum Committee (fall semester)
Member of Strategic Plan committee for PAOS PRP
Member, American Geophysical Union, 2001 Spring Meeting Program Committee
Member, American Geophysical Union, Atmospheric Sciences Section, Atmospheric Chemistry Technical Committee.
Member, Arts & Sciences Core Curriculum Task Force (spring semester only)
Member, Arts & Sciences Curriculum Committee (spring semester only)
Member, College of Arts and Sciences Degree Audit Task Force (spring semester only)
Member, Dean's Fund for Excellence Committee (spring semester only) Accompanied University representatives (Rich Harpel, Associate VP for Federal Relations and Pauline Hale, Office of the Chancellor) to the Science Coalition's Science Day; Made presentations to legislative staff of seven members of Colorado delegation (2 senators, 5 congress people).
Panel review participant for Stratospheric Processes and their Role in Climate (SPARC) Water Vapor Assessment (WAVAS) document.
Participated in field studies: - Rocket Impacts on Stratospheric Ozone (RISO) as PI for in situ measurements of carbon dioxide from NASA WB-57 during Space Shuttle plume intercept; - Alert 2000 Polar Sunrise Experiment, as PI for in situ ground-based measurements of the halogen oxides BrO and ClO; - SAGE III Ozone Loss and Validation

Principal Investigator for Experiment (SOLVE) in situ measurements of ozone, gas-phase and particulate water, carbon dioxide, and halocarbons on the NASA DC-8 aircraft.
Proposal Reviewer: National Science Foundation, Atmospheric Sciences Division, Review of Scientific Instruments, National Aeronautics and Space Administration, Global Tropospheric Experiment
Public Lecture about instrumentation for atmospheric research to the CU Chapter of the Society of Environmental Engineers, 21 September 2000.
Received Presidential Early Career Award for Scientists and Engineers (PECASE)
Taught ATOC 3500, Air Chemistry and Pollution, 15 students, Fall 2000

Frances Bagenal

Associate Chair, Astrophysical and Planetary Sciences Department
Associate Editor, Geophysical Research Letters
Chair, Library, Audio-Visual and Slide Collection
Chair, Solar System Panel and TAC member for HST Cycle 10
Fiske Director Search Committee
Guest Special Section Editor, J. of Geophysical Research/Space Physics
Member of Dissertation/Thesis Committee for Chris Boozer, Matt Burger, Shawn Brooks, Beau Bierhaus, Amy Barr, Hersh Gilbert, Tony Colaprete, and Niescja Turner
Member, AGU Space Physics and Aeronomy Web Site Committee
Member, ATLAS Steering Group
Member, Committee on International Space Programs, Space Studies Board, National Academy of Science
Member, Core Curriculum Task Force
Member, Course Scheduling committee
Member, Executive Committee
Member, LASP Faculty search committee
Member, Price Committee of the AAS Division of Planetary Science
Member, Space Studies Board Exploration for the National Research Council/National Academy of Sciences
Member, Technology and PR Committee
Principal Dissertation/Thesis Advisor for Hilary Justh, David Brain, Tian Feng and Andrew Steffl
Proposal reviewer
Recipient, President's 2000 Faculty Excellence Aware for Advancing Teaching and Learning through Technology
Student Advisor to 12 APS minors
Taught ASTR 1010, Introduction to Astronomy: Solar System (with lab)
Taught ASTR1100, Introduction to Astronomy: Solar System

Daniel N. Baker

Advisor, Sun-Earth Connections (NASA) Roadmap committee
Chair, Air Force Technical Applications Center (AFTAC) Advisory Committee, continuing
Chair, Research/Creative Works Task Force
Chair, Space Studies Board Task Group on "Assessment of Mission Size Trade-offs"
Chair, STEP Results, Applications, and Modeling Phase (S-RAMP), continuing
Chair, USRA Council Nominating Committee
Co-Chair, SCOSTEP 10th Quadrennial Meeting Committee
Consultant: USRA Astrophysics and Space Physics Council, Washington, DC, SAIC, Inc., Ball Aerospace Corporation
Convenor, NATO Advanced Study Institute Summer Meeting (Crete)
Convenor, Special session at American Geophysical Union Fall Meeting
Deputy Director, Center for Limb Atmospheric Sounding
Director of LASP/Chair of Executive Committee
Honored with two sectional awards from the American Geophysical Union
Major press reports: *Time magazine, Science magazine, Scientific American, New York Times, Rocky Mountain News, Daily Camera, Space News, Denver Post, San Francisco Chronicle, Associated Press, ABC News/Associated Press, LA Times and San Francisco Examiner, French Press Agency, Gannett News Service, Sapporo (Japan) News.*
Member, APS Graduate Student Concerns Committee
Member, Chancellor's Federal Relations Advisory Committee
Member, Chapman Conference on Space Weather Organizing Committee
Member, Dissertation/Thesis Committee, Stephanie Lawson (GEOL), Jeremy Richardson (PHYS), Amanda Sickafoose (APS), Eric Roden (ASEN)
Member, External Advisory Board, Aerospace Engineering Department
Member, Global Geospace Science Working Team, continuing
Member, Graduate School/Institute Directors Group
Member, International Conference on Substorms (St. Petersburg) Organizing Committee
Member, MESSENGER/Mercury Orbiter Science Working Team
Member, NASA Magnetospheric Multiscale Mission, Study Team
Member, National Academy of Sciences/Space Studies Board
Member, National Academy of Sciences/Space Studies Board Executive Committee
Member, Nominations Committee, American Geophysical Union
Member, Organizing Committee, Chapman Conference on Storm-Substorm Relations, Lonavala, India
Member, Organizing Committee, Workshop on Radiation Belts, Queensland, New Zealand
Member, SAMPEX Science Working Team, continuing
Member, SCOSTEP International Bureau, continuing
Member, Space Station Advisory Panel, American Geophysical Union
Member, University Space Research Association (USRA) Council of Institutes Representative, continuing
Member, USRA Astrophysics and Space Physics Council

Oversaw LASP PRP review process
President-Elect, American Geophysical Union
Principal Dissertation/Thesis Advisor for Daniel Moorer, Niescja Turner, and Joshua Rigler
Public lecture: New views of the Sun and Planets, Mountain Shadows School, Boulder, CO, 10 April 2000
Public lecture: The Sun and the Planets, Invited public lecture, Clermont, IA, 24 August 2000
Published articles in: *Equinox* magazine, *Inventing Tomorrow*, several other newspapers
Regional Editor of *Journal of Atmospheric and Solar Terrestrial Physics*
Student Advising: Sean Yarborough (ASEN) and Ken Mankoff (APS)
U.S. Representative, International Association for Geomagnetism and Aeronomy, continuing
U.S. Representative, International Union of Geophysics and Geodesy, continuing

Joshua E. Colwell

Journal referee for *Journal of Geophysical Research, Icarus, Science*
Member, American Geophysical Union, American Astronomical Society, Division of Planetary Science
Member, Cassini Rings Working Group
Member, Cassini UVIS Team
Principal Investigator, COLLIDE-2
Principal Investigator, PRIME
Taught ASTR 3750
Thesis advisor – Amanda Sickafoose

Francis G. Eparvier

Chair, LASP Library Committee
Manuscript Reviewer, Journal of Geophysical Research
Member, American Geophysical Union
Member, Astronomical Society of the Pacific
Member, LASP EPO Planning Committee
Member, NASA TIMED Science Team
Member, PAOS Graduate Admissions Committee
Member, SPIE International Society for Optical Engineering
Proposal Reviewer, NASA
Volunteer, Wild Bear Science School

Larry W. Esposito

Chair, Baker Re-Appointment Committee
Chair, Bally Promotion Committee

Chair, National Academy of Sciences, Task group on the Forward Contamination of Europa
Chair, Planetary Sciences Search Committee
Deputy Scientific Organizer, COSPAR 33 Planetary Atmospheres Sessions
Group Chief, NASA Planetary Atmospheres Review Panel
Member, AAU Space Science Working Group
Member, APS Chair Nominating Committee
Member, Arts and Sciences Reinvestment Advisory Committee
Member, Dissertation/Thesis Committee for Amanda Sickafoose, Erika Barth, Mark Lewis, Brad Dalton, and David Brain
Member, Hubble Second Decade Advisory Committee
Member, NASA Discovery Mission Science Panel
Participant, (Subject: Cassini UVIS Jupiter Io Torus) various press releases, movie production, press conferences, 'brown bag' lunch presentation, outreach webcast, NASA 'Select TV' broadcast
Principal Dissertation/Thesis Advisor for Henry Throop, Jeremy Richardson, and Shawn Brooks
Supervisor, Rings Study Group
Taught ASTR 1110; General Astronomy-Solar System
Taught ASTR/GEOL 5820; Formation and Dynamics of Planetary Systems

Mihaly Horanyi

Associate Editor, JGR-Space Physics
Chair, Physics Department Comps Committee
Dissertation/Thesis advisor for L. Jeremy Richardson (Physics), Corrine Krauss (APS), and Colin Mitchell (Physics)
Manuscript reviewer: Journal of Geophysical Research, Icarus, Geophysical Research Letters, Nature, and Physics of Plasmas
Member, dissertation/thesis committee for Shawn Brooks (APS), Byron Smiley (Physics), and Amanda Sickafoose (APS)
Member, LASP Library Committee
Member, LASP Planetary Geology position Search Committee
Member, LASP Planetary Origins position Search Committee
Member, NASA Micro-Gravity Fluids Science Review Panel
Member, NASA Planetary Atmospheres Program Science Review Panel
Member, NASA Planetary Geology and Geophysics Program Science Review Panel
Member, Physics Department Graduate Committee
Proposal reviewer: NASA, NSF, and DOE
Taught PHYS-2140: Mathematical Methods
Taught PHYS-3070: Energy in a technical society

Bruce M. Jakosky

Chair, Astrobiology faculty search committee, GEOL, Spring 2000

Chair, Science Organizing Committee, First Annual Conference on Astrobiology, NASA/Ames Research Center, 3-5 April 2000
Colloquium Chair, GEOL, Spring 2000
Convenor, MGS Science Workshop on Mars Water and Atmosphere, 12-14 June 2000
Editorial Board, *Geobiology, Astrobiology*
Executive Committee, LASP
Graduate School Advisory Committee: The search for life elsewhere
Manuscript reviewer, *Icarus, Geochimica et Cosmochimica Acta, Geophysical Research Letters, Proceeding of the National Academy of Sciences*
Member, American Geophysical Union Committee on Public Affairs
Member, Dissertation Committee for Brad Dalton and Anthony Colaprete
Member, NASA Mars Exploration Program Analysis Group
Member, NASA Mars Missions Synthesis Group
Member, NRC/NAS Task Group on Europa Planetary Protection
Moderator, Graduate School Symposium on "Life in the Extreme"
NASA Astrobiology Research Laboratory Science Definition Team
NASA Solar System Exploration Subcommittee
Numerous press conferences and interviews with print and electronic media
Planetary faculty search committee, LASP
Principal Thesis Advisor for Sarah Earley, Shannon Pelkey, Stacy Varnes, and Stephanie Lawson
Proposal reviewer, National Science Foundation Life in Extreme Environments, NASA Planetary Atmospheres, Planetary Instrument Development and Definition, and Mars Data Analysis Programs
Science Advisor, NASA/Ames Mars Quest
Taught GEOL 1010, Introduction to Physical Geology, Spring 2000, 165 students
Taught GEOL 3810/APS 3810, Extraterrestrial Life, Fall 2000, 65 students

Steven W. Lee

Journal referee for Journal of Geophysical Research, and Icarus
Participant in one Space Scientists Online "web chat" sponsored by NASA's Quest project.
Peer reviewer for NASA Planetary Geology, Planetary Atmospheres, and Mars Data Analysis Programs
Produced MarsQuest – Exploring the Red Planet – a high-definition television (HDTV) video about Mars exploration; project was sponsored by Mitsubishi Digital Electronics and CBS Broadcasting Corp.
Public Lectures on Mars: Presentation to CU Chancellor's Community Lecture Series (Boulder, CO); presentations to meetings of Rotary Clubs and Optimist's Clubs in Colorado and Montana; presentation to Denver Area Science Fiction Association; presentation at MileHiCon science fiction convention (Denver, CO); presentations to high school and middle school classes (Butte, MT, Montrose, CO, Boulder, CO); presentation for "CU in Residence" Program (Montrose, CO); presentations to church groups (Louisville, CO); presentation to "Friends of the Lafayette Public

Library (Lafayette, CO); presentation at McWane Science Center during opening of MarsQuest exhibit (Birmingham, AL).
Science Content Coordinator for the MarsQuest museum exhibition

Xinlin Li

Co-Investigator of the Inner Magnetosphere Explorer (IMEX)
Journal referee for *JGR, GRL, Advanced Space Sciences*
Member, CEPPAD science team on POLAR spacecraft
Member, NASA Magnetospheric Constellation Science and Technology Definition Team
Member, SAMPEX spacecraft science team
Proposal review for NASA, NSF

William McClintock

Member, AGU, Astronomical Society of the Pacific, Society of Photo-Optical Instrumentation Engineers, Sigma Xi Member, Cassini UVIS Science Team
Member, LASP Executive Committee
Member, MESSENGER Science Team
Member, SORCE Science Team
Proposal Reviewer, NASA
Science Lead, Mercury Atmosphere and Surface Composition Spectrometer for MESSENGER

Michael T. Mellon

Chair: Planetary Journal Club Seminar Series
Manuscript Reviewer: Journal of Geophysical Research-planets, Science, Nature, Journal of Geophysical research-Solid Earth
Member: Shannon Pelkey's APS Comprehensive Exam II Committee
Member: Stacey Varnes' Geology Preliminary Exam Committee
Member: Stefanie Lawson's Thesis Defense Committee
Participating Scientist: Mars Team On Line, education and outreach program, NASA Ames.
Proposal Reviewer: NASA Planetary Geology and Geophysics and Mars Data Analysis Programs
Session Chair: Mars Global Surveyor Science Workshop on Mars Water and Atmosphere, 12-14 June

Cora E. Randall

Co-Chair: Langley DAAC UWG, since March 1998.
Global Aerosol Climatology Project team member, since 1998.
HIRDLS team member, since 1997.

ILAS II team member, since 1999.
Member, EOS-CHEM aerosol working group, since spring, 1999.
Member, EOS-CHEM education/outreach working group, since fall, 1998.
Member, LASP executive committee.
Participant, Chancellor's Committee on Women focus group, 14 March 2000.
POAM team member, since 1994.
Reviewer, Arctic Natural Sciences program, October, 2000.
Reviewer, *JGR atmospheres*.
Reviewer, NASA Earth System Science Fellowship proposals, May 2000.
Reviewer, NASA New Investigator Program, September, 2000.
Reviewer, NASA OMI team leader proposals, January, 2000.
SAGE II team member, since 1999.
SOLVE campaign participant, winter 1999-2000.

Gary J. Rottman

Associate Director of LASP
Attended and presented papers at eleven scientific meetings (three international)
Chair of the LASP Projects Steering Committee
Chair of the SORCE Science Team
Gave two guest lectures in ASEN courses.
Member of the EOS Investigator's Working Group
Member of the LASP Executive Committee
Member of the UARS Science Team.
Organized a special session at the Spring AGU (2000).
Organized special session of the CALCON 2000 Conference in Logan, Utah.
Participant of NRC workshop examining the future direction of the NPOESS
Presented seminars at LASP (May 11), ASP NCAR, and NOAA SEL
Principal Investigator for the EOS SORCE Mission
Principal Investigator for the UARS SOLSTICE Mission
Reviewed three NASA proposals
Reviewed two scientific papers
Thesis co-advisor for Chris Pankratz (The Johns Hopkins University)

David W. Rusch

Invited participant in the Solar Influences Workshop sponsored by OSS, March 5, 2000.
Judged science fair for 3rd, 4th, and 5th grade classes at St. Louis School, May 00.
Member of Living With a Star Science Architecture Team (SAT); invited by George Withbroe.
Member, LASP Executive Committee.
Member, LASP internal review committee.
Member, LASP Research Professor Committee
Member, proposal evaluation panel for the Living With A Star program

Member, SPARC international committee on ozone trend assessment.
Reviewed 8 papers for scientific journals, 5 proposals for NASA

Nicholas M. Schneider

Advisor to two students for observing projects in ASTR 3020, our majors observing class
APS Minor Advisor
Chair, Admissions Committee
Chair, LASP Graduate Students Concerns
Curriculum coordinator for planetary science
Editor, electronic newsletter for Division for Planetary Sciences of the American Astronomical Society
Faculty Search Committee Planetary scientists
Manuscript reviewer
Member of Dissertation/Thesis Committee for Mark Lewis, APS
Member, APS Major Committee
Mentor to Albert Park and Seth Wilson, undergraduate students working in my research group
Principal Dissertation Advisor for John Weiss and Matt Burger, APS
Proposal reviewer for NASA and NSF
Taught ASTR 5835, Planetary Science on Moon and Mercury

Glen R. Stewart

Academic visitor for two weeks at Tokyo Institute of Technology, Japan.
Journal referee for Icarus, Astrophysical Journal
Member, search committee for director of PeakArts Academy, Boulder.
Principal thesis advisor for Mark Lewis
Proposal reviewer for NASA

Brian Toon

Associate Editor, Journal of Geophysical Research
Chair, PAOS admissions committee
Director, Program in Atmospheric and Oceanic Sciences
Member, LASP PRP review committee
Member, PAOS executive committee
Mentor to one Postdoctoral Researcher
Organizer, Special Session of Spring AGU Conference
Taught Course: Planetary Atmospheres
Taught graduate level seminar course on clouds and aerosols

Thomas N. Woods

Chair, LASP Computer Systems Advisory Committee (CSAC)
Manuscript Reviewer, *Astronomy and Astrophysics, Journal of Geophysical Research*
Member, American Astronomical Society, Solar Physics
Member, American Geophysical Union
Member, LASP Executive Committee
Member, NASA EOS Science Team
Member, NASA TIMED Science Team
Member, NASA UARS Science Team
Member, SPIE International Society for Optical Engineering
Proposal Reviewer, NASA, NOAA, NSF, USDA

2000 Seminar Series

Giuliana de Toma, Chair, Spring
Amanda Hendrix, Chair, Fall

Jan 13	Don Shemansky USC	X-Rays from comets and implications for other objects
Jan 14	Georgi Golitsyn Russian Acad Sci	50-year changes in temperature and dynamic regimes in the mesosphere and upper stratosphere
Jan 20	Scot Elkington Dartmouth	MHD/particle simulations of radiation belt dynamics during geomagnetic storms
Jan 27	Ray Roble NCAR	Yearly variations of mesospheric and thermospheric properties as simulated by the TIME-GCM model
Feb 2	Robert Strangeway UCLA	Maxwell and Newton in Space plasmas: The role of Poynting flux in coupling different plasma regimes
Feb 3	Gary Thomas LASP	Global change in the upper atmosphere: Further evidence for the Chicken-Little hypothesis
Feb 10	William Peterson Lockheed	Energetic ion composition observations and their use in studies of magnetospheric plasma transport processes
Feb 17	Dana Anderson JILA	Holographic information processing
Feb 17	Jim Slavin NASA/GSFC	The 2000 NASA Space Science Strategic Plan
Feb 24	Sasha Madronich NCAR/ACD	Climatology and trends in surface UV radiation

	NCAR/ACD	
Mar 2	Brian Toon LASP	Polar stratospheric clouds and ozone loss
Mar 7	Christopher Barrington-Leigh Stanford	Photometric imaging of mesospheric and ionospheric flashes above thunderstorms
Mar 8	Yi-Jiun Su LANL	The fate of plasmaspheric material: Satellite observations
Mar 9	Glen Stewart LASP	Can Planet-Disk Interactions Facilitate Planet Formation?
Mar 16	Tim Fuller-Rowell NOAA/SEC	Modeling storm-time changes in the upper atmosphere
Mar 20	Derek Richardson U. of Washington	Adventures with Rubble piles: The evolution of fragile planetesimals
Mar 23	William Moore UCLA	Does Europa's Mantle Melt?
Mar 24	John Worden AER	The tropospheric emission spectrometer: Approach for Ozone Limb Retrievals
Apr 3	Caroline Terquem Inst. d'Astro Paris	Disks, extrasolar planets and migration
Apr 6	Gregory Hoppa U. of Arizona	Tidal tectonic processes on Europa
Apr 10	Mark Marley NMSU	Clouds and chemistry in atmospheres of extrasolar giant planets
Apr 13	Robert Pappalardo Brown Univ.	Europa: Role of the ductile layer
Apr 19	Tony Canas Imperial College	Measurements by the Tropospheric airborne Fourier transform spectrometer (TAFTS)
Apr 20	George Born CU/Aerospace	Altimeter data in the marine environment
Apr 27	Wayne Pryor LASP	Jupiter's aurora from Galileo and HST
May 4	William Emery Engr/LASP	Computing Ocean surface currents and ice motion from sequential satellite images
May 8	Robert Cahalan GSFC	Earth Observing in Y2K: TRIMM, Landsat 7, QuickScat, ACRIMsat and Terra
May 11	Gary Rottman LASP	The SORCE mission
May 18	Robert Grimm LASP	Electromagnetic exploration for water on Mars and the Galilean satellites

	LASP	the Galilean satellites
May 25	Mihaly Horanyi LASP	Heroes of space physics: Hannes Alfven
Aug 24	Stefan Eriksson Royal Inst. Stockholm	Large-scale convection: Response to the interplanetary magnetic field and lobe cell convection
Aug 31	Xinlin Li LASP	Quantitative Prediction of MeV Electrons at Geostationary Orbit on the Basis of Solar Wind Measurements
Sept 7	David Klaus BioServe	Bioastronautics
Sept 21	Veronica Vaida Chem/CIRES	Atmospheric organic aerosols: Agents for chemical complexity
Sept 28	Charles A. Barth LASP	Nitric Oxide and the Aurorae: Two years of SNOE
Oct 12	Shijie Zhong Physics	The origin for the hemispherically asymmetric structures on the Moon and Mars
Oct 17	R.P. Kane Inst. Nac. de Pesquisas Espacias Brazil	Prediction of the sunspot maximum for solar cycle 23 and Periodicities in the time series of solar emissions at different solar altitudes
Oct 19	Dave Mitchell UC Berkeley	The Lumpy Bumpy Jumpy Martian Ionosphere: Crustal magnetocylinders and response to solar activity
Oct 26	Bob Schutz U. Texas	Spaceborne Laser Altimetry From ICESat
Nov 2	Matthew Golombek JPL	Erosion Rates at the Mars Pathfinder Landing Site and Climate Change on Mars
Nov 9	Brad Dalton USGS	Compositional Mapping of Europa
Nov 16	Michael Mellon LASP	Permafrost and recent gullies on Mars
Nov 30	Michael Mills LASP	
Dec 7	Bruce Jakosky LASP	Martian volatile history: Water the real constraints?

LASP Technology Colloquium Series

Jerald Harder, Chair

Feb 8	Greg Kopp LASP	Terrestrial planet finder: What can you do with half a photon per square meter per second?
Mar 14	Ben Balsley CIRES	Atmospheric measurements using tethered lifting systems
June 13	Darin Toohey Linnea Avallone LASP	Technology for measurements of atmospheric free radicals by resonance fluorescence
Aug 15	William McClintock LASP	The Atmospheric and Surface Composition Spectrometer (ASCS) for the MErcury: Surface, Space

Planetary Journal Club Seminar Series

Michael T. Mellon, Chair

Jan 31	Joshua Colwell	Oort cloud comets and planet X
Feb 7	Shawn Brooks	Europan icebergs and chaos: The latest results from Galileo
Feb 14	Mark Bullock	Meridional circulation and the formation of clouds on Venus
Feb 21	Shannon Pelkey	New views of Mars aeolian activity and materials: MOC results
Feb 28	Gerhard Wurm	The early stages of planet formation – experiments on dust growth
Mar 20	Larry Esposito	Emissivity and the fate of Pluto's atmosphere
Apr 3	Mark Lewis	Simulating planetary accretion
Apr 10	Matt Burger	An introduction to the lunar atmosphere
Apr 17	Tony Colaprete	Martian impact crater lakes
Apr 24	Steve Lee	Geological differences between the residual polar caps on Mars
Sept 11	Glen Stewart	A new explanation for narrow eccentric planetary rings
Sept 18	Henry Throop	Life on Titan: What's for dinner?
Sept 25	Fran Bagenal	Evidence of a global ocean on Europa from magnetometer measurements

Oct 2	Andrew Steffl	Titan's hydrogen and nitrogen tori
Oct 16	Amanda Sickafoose	Evidence of reactivity in martian soil
Oct 30	Corinne Krauss	NEAR-Shoemaker measurements of the asteroid 433 Eros
Nov 6	Bruce Jakosky	Ancient Martian nitrogen
Nov 13	Stacy Varnes	Photosynthesis on a snowball Earth
Nov 20	David Brain	Are Love and Fear really all that different? Similarities between Eros and Phobos
Nov 27	Erika Barth	Solar gardening and seasonal changes on Triton

Center for Astrobiology Seminar Series

Bruce J. Jakosky, Chair

Feb 18	David Grinspoon SwRI	Is the truth out there? SETI and the Science Wars and Why; New values vs. Science
Mar 10	Dr. Tom Yulsman CU Journalism	What Makes Headlines in Science and Why: News Values vs. Science Values
Apr 7	Sarah Early LASP	Paradigm Shifts in Astrobiology
May 5	Dr. Alan Lester GEOL	An Amateur's Look at the Fossil Record: Cultural misconceptions of evolution and implications for life on other worlds
Sept 11	Frances Westall LPI	Life on Mars
Oct 9	Donald Brownlee U. Washington	Stardust mission to return samples from a comet
Nov 13	Paul Hoffman Harvard	The snowball Earth hypothesis
Dec 11	Jonathan Lunine U. Arizona	Titan: Organic chemistry and astrobiological potential

Publications

Ackerman, A.S., O. B. Toon, D. E. Stevens, A. J. Heymsfield, V. Ramanathan, and E. J. Welton, Reduction of tropical cloudiness by soot, Science, 288, 1042-1047, 2000.

Ackerman, A.S., O. B. Toon, J.P. Taylor, D. W. Johnson, PV. Hobbs, and R. J. Ferek, Effects of aerosols on cloud albedo: Evaluation of Twomey's parameterization of cloud susceptibility using measurements of ship tracks, J. Atmos. Sci., 57, 2684-2695, 2000.

Avallone, L.M., and D.W. Toohey, Tests of halogen photochemistry using in situ measurements of ClO and BrO in the lower polar stratosphere, J. Geophys. Res., in press, 2000.

Bailey, S. M., T. N. Woods, C. A. Barth, S. C. Solomon, L. R. Canfield, and R. Korde, Measurements of the solar soft X-ray irradiance from the Student Nitric Oxide Explorer: first analysis and underflight calibrations, J. Geophys. Res., 105, 27,179-27,193, 2000.

Baker, D.N., and J. Allen, Confluence of natural hazards: A possible scenario, Eos, p. 254 and 259, June 6 2000.

Baker, D.N., D. Vassiliadis, A.J. Klimas, and J.A. Valdivia, The nonlinear dynamics of space weather, Adv. Space Res., 26, 197-207, 2000.

Baker, D.N., Effects of the Sun on the Earth's environment, J. Atmos. and Solar-Terr. Physics, 62, 1669-1681, 2000.

Baker, D.N., et al., Nonlinear dynamical feedback and outer radiation belt electron depletion following the May 1999 solar wind disappearance event, Geophys. Res. Lett., submitted, 2000.

Baker, D.N., N.E. Turner, and T.I.Pulkkinen, Energy transport and dissipation in the magnetosphere during geomagnetic storms, J. Atmos. and Solar-Terr. Physics, in press, 2000.

Baker, D.N., S.G. Kanekal, J.B. Blake, and T.I. Pulkkinen, The global efficiency of relativistic electron production in the Earth's magnetosphere, J. Geophys. Res., accepted, 2000.

Baker, D.N., S.G. Kanekal, J.B. Blake, B. Klecker, G.M. Mason, and R.A. Mewaldt, Magnetospheric electron response to magnetic cloud events of 1997, Adv. Space Res., 25, 1387-1392, 2000.

Baker, D.N., Satellite anomalies due to space storms, in Space Storms and Space Weather Hazards, NATO ASI series, edited by I.A. Daglis, Kluwer Academic Publishers, in press, 2000.

Baker, D.N., The occurrence of operational anomalies in spacecraft and their relationship to space weather, IEEE Transactions on Plasma Science, in press, 2000.

Baker, D.N., The role of magnetospheric substorms in high-energy particle production within the Earth's magnetosphere, International Conference on Substorms-5, edited by O. Troshichev, and V. Sergeev, ESA Publications Division, St. Petersburg, Russia, ESA Publications Division, ESA SP-443, p. 419, July 2000.

Barbara, J.M., and L.W. Esposito, Moonlet collisions and the effects of tidally modified accretion in Saturn's F-ring, Icarus, submitted, 2000.

Blake, J.B., R.S. Selesnick, D.N. Baker, and S. Kanekal, Studies of relativistic electron injection events in 1997 and 1998, J. Geophys. Res., in press, 2000.

Bouchez, A.H., M.E. Brown, and N.M. Schneider, Eclipse spectroscopy of Io's atmosphere, Icarus, 148, 316-319, 2000.

Brekke, P., W. T. Thompson, T. N. Woods, and F. G. Eparvier, The extreme-ultraviolet solar irradiance spectrum observed with the Coronal Diagnostic Spectrometer (CDS) on SOHO, Astrophys. J., 536, 959-970, 2000.

Christensen, P. R., Banfield, Hamilton, Ruff, Kieffer, Titus, Malin, Morris, Lane, Clark, Jakosky, Mellon, Pearl, Conrath, Smith, Clancy, Kuzmin, Roush, Mehall, Gorlick, Bender, Murray, Dason, Greene, Silverman, Greenfield, The Mars Global Surveyor Thermal Emission Spectrometer experiment: investigation description and surface science results, J Geophys. Res, in press, 2000.

Crary, F., and F. Bagenal, Ion cyclotron waves, pickup ions, and Io's neutral exosphere, J. Geophys. Res., 105, 25, 279-289, 2000.

Drake, V. A., W. E. McClintock, R. A. Kohnert, T. N. Woods, and G. J. Rottman, Photomultiplier tube detector performance and stability for the Earth Observing System's SOLSTICE II instrument, SPIE Proceedings, 4139, in press, 2000.

Esposito, L.W., et al., The Cassini ultraviolet imaging spectrograph, Space Science Rev., in press, 2000.

Fabian, A., C. Krauss, A. Sickafoose, M. Horanyi, and S. Robertson, Measurements of electrical discharges in Martian regolith simulant, IEEE Trans. Plasma Sci., submitted, 2000.

Friedel, R.H.W., G. Reeves, D. Belian, T. Cayton, C. Mouikis, A. Korth, B. Blake, J. Fennell, R. Selesnick, D. Baker, T. Onsager, S. Kanekal, A Multi-spacecraft synthesis of relativistic electrons in the inner magnetosphere using LANL, GOES, GPS, SAMPEX, HEO and POLAR, Adv. Space Res., 26, 93-98, 2000.

Ganashkina, N. Yu., T.I. Pulkkinen, D.N. Baker, et al., Entry of plasma sheet particles into the inner magnetosphere as observed by POLAR/CAMMICE, J. Geophys. Res., in press, 2000.

Ganashkina, N. Yu., T.I. Pulkkinen, V.F., Bashkirov, D.N. Baker, and X. Li, Formation of intense nose structures, Geophys. Res. Lett., submitted, 2000.

Graps, A., E. Grün, H. Svedhem, H. Kruger, M. Horanyi, A. Heck and S. L Sammers, Io as a source of the Jovian dust streams, Nature, 405, 48, 2000

Grün, E., H. Kruger, R. Srama, M. Horanyi Unique Conjunction of Planetary Probes, EOS, 81, 627, 2000.

Grün, E., M. Landgraf, M. Horanyi, J. Kissel, H. Kruger, R. Srama, H. Svedhem and P. Withnell, Galactic dust measurements near the Earth, J. Geophys. Res., 105, 10403, 2000.

Harder, J. W., G. M. Lawrence, G. J. Rottman, and T. N. Woods, Spectral Irradiance Monitor (SIM) for the SORCE mission, SPIE Proceedings, 4135, 204-214, 2000.

Harder, J., G. Lawrence, G. Rottman, and T. Woods, The solar Spectral Irradiance Monitor: SIM, Metrologia, 37, 415-418, 2000.

Hill, S.M., S.C. Solomon, D.D. Cleary, and A.L. Broadfoot, Temperature Dependence of the Reaction N2(A3Su+) + O in the Terrestrial Thermosphere, J. Geophys. Res., 105, A5, 10,615-10,629, 2000.

Horanyi, M., and G. Lawrence, Charged dust currents on the surface of Mars, Physica Scripta, submitted, 2000.

Horanyi, M., Dust Streams from Jupiter and Saturn, Physics of Plasmas, 7, 3847, 2000.

Horanyi, M., Dusty plasmas in planetary magnetospheres, Astrophys. and Space Sci., in press, 2000.

Horanyi, M., Dusty Plasmas in the Solar System, Magyar Fizikai Szemle (Hungarian Physical Review) 8, 285, 2000.

Horanyi, M., Magnetospheres: Plasma-Ring/Dust Interactions, in Encyclopedia of Astronomy, edited by E. Priest, et al., Institute of Physics and Macmillan Publishing, 2000.

Horanyi, M., S. Robertson, B. Smiley, J. Gumbel, G. Witt and B. Walch, Rocket-borne mesospheric measurement of heavy (m >> 10 amu) charge carriers, Geophys. Res. Lett. 27, 3821, 2000.

Horanyi, M., S. Robertson, Dust charging in the laboratory and in space, Physics of Dusty Plasmas II, edited by J. Nakamura and P. Shukla, Elsevier Science, in press, 2000.

Howard, J.E., H. R. Dullin, and M. Horanyi, Stability of Halo Orbits, Phys. Rev. Lett. 84, 3244, 2000.

Jakosky, B. M., and M. T. Mellon, Thermal inertia of Mars: Sites of exobiological interest, J. Geophys. Res., in press, 2000.

Jakosky, B.M., and M.P. Golombek, Planetary science, astrobiology, and the role of science and exploration in society, EOS (Trans. Amer. Geophys. Union) Forum, 81, No. 6, 58, 2000.

Jakosky, B.M., M.T. Mellon, H.H. Kieffer, P.R. Christensen, E.S. Varnes, and S.W. Lee, The thermal inertia of Mars from the Mars Global Surveyor Thermal Emission Spectrometer, J. Geophys. Res., 105, 9643-9652, 2000.

Jakosky, B.M., Philosophical aspects of astrobiology, in "Bioastronomy '99: A New Era in Bioastronomy", G.A. Lemarchand and K.J. Meech, eds., Astron. Soc. Pac., San Francisco, 661-666, 2000.

Kalashnikova, O., M. Horanyi, G.E. Thomas, and O.B. Toon, Meteoric smoke production in the atmosphere, Geophys. Res. Lett., 27,3293-3296, 2000.

Klimas, A.J., J.A. Valdivia, D. Vassiliadis, D.N. Baker, M. Hesse, and J. Takalo, Self-organized criticality in the substorm phenomenon and its relation to localized reconnection in the magnetospheric plasma sheet, J. Geophys. Res., in press, 2000.

Klimas, A.J., V. Uritsky, J.A. Valdivia, D. Vassiliadis, and D.N. Baker, On the compatibility of the coherent substorm cycle with the complex plasma sheet, in International Conference on Substorms-5, edited by O. Troshichev, and V. Sergeev, ESA Publications Division, St. Petersburg, Russia, 2000.

Kueppers, M.E., and N.M. Schneider, Discovery of chlorine in the Io torus, Geophys. Res. Lett., 27, No. 4, 513-516, 2000.

Lawrence, G. M., G. J. Rottman, G. Kopp, J. W. Harder, W. E. McClintock, and T. N. Woods, Total Irradiance Monitor (TIM) for the EOS SORCE mission, SPIE Proceedings, 4135, 215-224, 2000.

Lawrence, G. M., G. Rottman, J. Harder, and T. Woods, The solar Total Irradiance Monitor: TIM, Metrologia, 37, 407-410, 2000.

Lawson, S. L., B. M. Jakosky, H.-S. Park, and M. T. Mellon, Brightness temperatures of the lunar surface: Calibration and global analysis of the Clementine long-wave infrared camera data, J. Geophys. Res., 105, No. E2, 4273-4290, 2000.

Lewis, M.C., and G.R. Stewart, Collisional dynamics of perturbed planetary rings I., Astron. J., 120, 3295-3310, 2000.

Li, X., D.N. Baker, M. Temerin, W.K. Peterson, and J.F. Fennell, Multiple discrete-energy ion features in the inner magnetosphere: Observations and simulations, Geophys. Res. Lett., 27, No. 10, 1447-1450, 2000.

Li, X., et al., Sudden injections of energetic particles into the inner magnetosphere associated with an isolated substorm, a shock impact, and a shock-induced nightside magnetic field dipolarize, submitted, J. Geophys. Res., 2000.

Li, X., Modeling particle injections – test particle simulations, International Conference on Substorms-5, edited by O. Troshichev, and V. Sergeev, ESA Publications Division, St. Petersburg, Russia, 2000.

Lissauer, J.J., L. Dones, and K. Ohtsuki, Origin and evolution of terrestrial planet rotation, In Origin of the Earth and Moon (R.M. Canup and K. Righter, editors), pp. 101-112, Univ. of Arizona Press, 2000.

Malin, M.C., J.F. Bell, W. Calvin, R.M. Haberle, P.B. James, S.W. Lee, P.C. Thomas, and M.A. Caplinger, The Mars Color Imager (MARCI) on the Mars Climate Orbiter, J. Geophys. Res., in press, 2000.

McClintock, W. E., G. J. Rottman, and T. N. Woods, SOLar STellar Irradiance Comparison Experiment II (SOLSTICE II) for the NASA Earth Observing Systems Solar Radiation and Climate Experiment (SORCE) mission, SPIE Proceedings, 4135, 225-234, 2000.

McIlwaine, S.K., and L.M. Avallone, A study of the entrainment of midlatitude air into the lower tropical stratosphere, submitted to J. Geophys. Res., 2000.

Mellon, M. T. A frozen martian landscape, in Icy Bodies in the Solar System, P. Dasch, editor, in press Cambridge Univ. Press, 2000.

Mellon, M. T., and R. J. Phillips, Recent gullies on Mars and the source of liquid water, J. Geophys. Res., submitted, 2000.

Mellon, M.T., B.M. Jakosky, H.H. Kieffer, and P.R. Christensen, High-resolution thermal-inertia mapping from the Mars Global Surveyor Thermal Emission Spectrometer, Icarus, 148, 437-455, 2000.

Moncuque, M., F. Bagenal, and N. Meyer-Vernet, The latitude structure of the Io plasma torus: Density and temperature from a kinetic collisionless model, in preparation, 2000.

Moorer, D.F., and D.N. Baker, Specification of energetic electrons and ions, in Space Weather, (ed. by P. Song, G. Siscoe, and H. Singer), AGU Monograph Series, in press, 2000.

Nakamura, R., M. Isowa, Y. Kamide, D.N. Baker, J.B. Blake, and M. Looper, SAMPEX observations of microbursts in the outer radiation belt, J. Geophys. Res., 105, 15875-15886, 2000.

Otsuki, K., and H. Emori, Local N-body simulations for the distribution and evolution of particle velocities in planetary rings, Astron. J., 119, 403-416, 2000.

Otsuki, K., Evaluation of collision and stirring rates in circumplanetary particle disks based on three-body orbital integrations, Planet. Space Sci., 48, 553-568, 2000.

Peeters, P., et al., Using GOME high resolution solar measurements for MgII index computation, Geophys. Res. Lett., submitted, 1998.

Pelkey, S. M., B. M. Jakosky, and M. T. Mellon, Thermal in inertia of crater-related wind streaks on Mars, J. Geophys. Res., submitted, 2001.

Pulkkinen, T.K., N. Ganushkina, D.N. Baker, N.E. Turner, J.F. Fennell, J. Roeder, T.A. Fritz, M. Grande, B. Kellett, and G. Kettmann, Ring current ion composition during solar minimum and rising solar activity: POLAR/CAMMICE/MICS results, submitted to J. Geophys. Res., 2000.

Pulkkinen, T.K., N. Ganushkina, D.N. Baker, N.E. Turner, J.F. Fennell, J. Roeder, T.A. Fritz, M. Grande, B. Kellett, and G. Kettmann, Ring current ion composition during solar minimum and rising solar activity: POLAR/CAMMICE/MICS results, International Conference on Substorms-5, edited by O. Troshichev, and V. Sergeev, ESA Publications Division, St. Petersburg, Russia, 2000.

Quijano, A.L., I.N. Sokolik, and O.B. Toon, Influence of the aerosol vertical distribution on the retrievals of aerosol optical depth from satellite radiance measurements, Geophys. Res. Lett., 27, 3457-3460, 2000.

Quijano, A.L., I.N. Sokolik, and O.B. Toon, Radiative heating rates and direct radiative forcing by mineral dust in cloudy atmospheric conditions, J. Geophys. Res., 105, 12207-12219 2000.

Randall, C.E., D.E. Siskind, and R.M. Bevilacqua, Stratospheric NO_x Enhancements in the Southern Hemisphere Polar Vortex in Winter and Spring of 2000, submitted to Geophys. Res. Lett., 2000.

Randall, C.E., R.M. Bevilacqua, J.D. Lumpe, K.W. Hoppel, D.W. Rusch, and E.P. Shettle, Comparison of Polar Ozone and Aerosol Measurement (POAM) II and Stratosphere Aerosol and Gas Experiment (SAGE) II aerosol extinction measurements from 1994 to 1996, J. Geophys. Res. 105, 3929-3942, 2000.

Robertson, S., M. Horanyi, B. Smiley, A rocket-borne detector for charged atmospheric aerosols, Physics of Dusty Plasmas II, edited by J. Nakamura and P. Shukla, Elsevier Science, in press, 2000.

Rottman, G. and T. Woods, Solar UV and EUV irradiance: measurements and results, J. Atmos. and Solar-Terr. Phys., in press, 2000.

Rottman, G. J., Variations of Solar Ultraviolet Irradiance Observed by the UARS SOLSTICE - 1991 to 1999, Space Science Reviews, 94, 83-91, 2000.

Rottman, G. J., Variations of Solar Ultraviolet Irradiance Observed by the UARS SOLSTICE - 1991 to 1999, in Solar Variability and Climate, p. 83, Kluwer Academic Publishers, Dordrecht, Netherlands, 2000.

Rottman, G.J., Solar UV Irradiance Measurements: the UARS and EOS SOLSTICE, Physics and Chemistry of the Earth, Part C, Solar-Terrestrial and Planet. Sci., 25, 401-404, 2000.

Ruff, S. W., P. R. Christensen, R. N. Clark, H. H. Kieffer, M. C. Malin, J. L. Bandfield, B. M. Jakosky, M. D. Lane, M. T. Mellon, and M. A. Presley, Mars' "White Rock" feature lacks evidence of an aqueous origin: Results from Mars Global Surveyor, J. Geophys. Res., in press, 2000.

Saka, O., H. Akaki, G.F. Reeves, and D.N. Baker, Erratum to "Magnetic fields and particle signatures in the vicinity of nightside geosynchronous altitudes in the first one-minute-interval of Pi 2 onset: A case study", J. Atmos. Solar Terr. Phys., 62, p.395, 2000.

Saka, O., H. Akaki, G.F. Reeves, and D.N. Baker, Magnetic fields and particle signatures in the vicinity of nightside geosynchronous altitudes in the first one-minute-interval of Pi 2 onset: A case study, J. Atmos. Solar Terr. Phys., 62, 17-30, 2000.

Schneider, N.M., and M. Küppers, Discovery of chlorine in the Io torus, Geophys. Res. Lett., 27, 513-516, 2000.

Sickafoose, A., J. Colwell, M. Horanyi, S. Robertson, B. Walch, Photoelectric charging of dust particles, Physics of Dusty Plasmas II, edited by J. Nakamura and P. Shukla, Elsevier Science, 367-372, 2000.
Sickafoose, A.A., J.E. Colwell, M. Horanyi and S. Robertson, Photoelectric Charging of Dust Particles in Vacuum, Phys. Rev. Lett. 84,6034, 2000
Sickafoose, A.A., J.E. Colwell, M. Horanyi, and S. Robertson, Experimental investigations on photoelectric and triboelectric charging of dust, J. Geophys. Res., submitted, 2000.
Sickafoose, A.A., J.E. Colwell, M. Horanyi, and S. Robertson, Photoelectric and Triboelectric Charging of Dust Grains on Planetary Surfaces, Bull. Amer. Astron. Soc., 32(3), 1084, 2000.
Siskind, D.E., G.E. Nedoluha, C.E. Randall, M. Fromm, and J.M. Russell III, An assessment of Southern Hemisphere stratospheric NO_x enhancements due to transport from the upper atmosphere, Geophys. Res. Lett., 27, 329-332, 2000.
Sitnov, M.I., A.S. Sharma, K. Papadopoulos, D. Vassiliadis, J.A. Valdivia, A.J. Klimas, and D.N. Baker, Phase transition-like behavior of the magnetosphere during substorms, J. Geophys. Res., 105, 12955-12974, 2000.
Stewart, G.R., and S. Ida, Velocity evolution on planetesimals: Unified analytical formulas and comparisons with N-Body simulations, Icarus, 143, 28-44, 2000.
Stewart, G.R., Outstanding questions for the giant impact hypothesis, in Origin of the Earth and Moon, edited by R.M. Canup and K. Righter, Univ. of Arizona Press, pp. 217-223, 2000.
Thomas, G.E., Global change in the mesosphere: Temperature and composition, Intl. Workshop on Long-term changes/Trends in Atmosphere, in press, 2000.
Tobiska, W. K., T. Woods, F. Eparvier, R. Viereck, L. Floyd, D. Bouwer, G. Rottman, and O. R. White, The SOLAR2000 empirical solar irradiance model and forecast tool, J. Atmos. Solar-Terr. Phys., 62, 1233-1250, 2000.
Toivanen, P.K., D.N. Baker, W.K. Peterson, H.J. Singer, N.E. Turner, X. Li, K. Kauristie, M. Syrjäsuo, A. Viljanen, T.I. Pulkkinen, A. Keiling, J.R. Wygant, and C.A. Kletzing, Reconciliation of the substorm onset determined on the ground, and at the POLAR spacecraft, Geophys. Res. Lett., in press, 2000.
Toivanen, P.K., D.N. Baker, W.K. Peterson, X. Li, E.F. Donavan, A. Viljanen, A. Keiling, and J.R. Wygant, Plasma sheet dynamics observed by the POLAR spacecraft in association with substorm onsets, J. Geophys. Res., in press, 2000.
Toon, O. B., and A. Colaprete, The radiative effects of Martian water ice clouds on the local atmospheric temperature profile, Icarus, 145, 524-532, 2000.
Toon, O.B., A. Tabazadeh, E.V. Browell, and J. Jordan, Analysis of lidar observations of Arctic polar stratospheric clouds during January, 1989, J. Geophys. Res., 105, 20589-20616, 2000.
Toon, O.B., Perspective: How pollution suppresses rain, Science, 287, 1763-1765, 2000.
Uritsky, V.M., A.J. Klimas, J.A. Valdivia, D. Vassiliadis, and D.N. Baker, Fast field annihilation as a consequence of self-organized criticality in a magnetic field reversal, J. Geophys. Res., submitted, 2000.
Vassiliadis, D., A.J. Klimas, J.A. Valdivia, D.N. Baker, A Nonlinear Dynamical Model of Dst Geomagnetic Disturbances from High-Time Resolution Data, J. Geophys. Res., in press, 2000.

White, O. R. and G. J. Rottman, Solar Variability Observations, in Solar Variability and Climate, p. 93, Kluwer Academic Publishers, Dordrecht, Netherlands, 2000.

White, O. R. and G. J. Rottman, Solar Variability Observations, Space Science Reviews, 94, 93-97, 2000.

Wilhelm, K., T. N. Woods, U. Schühle, W. Curdt, P. Lemaire, and G. J. Rottman, The solar ultraviolet spectrum from 1200 Å to 1560 Å: a radiometric comparison between SUMER/SOHO and SOLSTICE/UARS, Astron. & Astrophys., 352, 321-326, 1999.

Woods, T. N., G. J. Rottman, and S. C. Solomon, Solar extreme ultraviolet irradiance measurements from sounding rockets during solar cycle 22, Physics and Chemistry of the Earth, Part C: Solar-Terrestrial and Planetary Science, 25, 393-396, 2000.

Woods, T. N., P. D. Feldman, and G. J. Rottman, Ultraviolet observations of comet Hale-Bopp (C/1995 O1) by the UARS SOLSTICE, Icarus, 144, 182, 2000.

Woods, T. N., S. Bailey, F. Eparvier, G. Lawrence, J. Lean, B. McClintock, R. Roble, G. J. Rottman, S. C. Solomon, W. K. Tobiska, and O. R. White, TIMED Solar EUV Experiment, Physics and Chemistry of the Earth, Part C: Solar-Terrestrial and Planetary Science, 25, 397-399, 2000.

Woods, T. N., W. K. Tobiska, G. J. Rottman, and J. R. Worden, Improved solar Lyman-alpha irradiance modeling from 1947 through 1999 based on UARS observations, J. Geophys. Res., 105, 27,195-27,215, 2000.

Woods, T., E. Rodgers, S. Bailey, F. Eparvier, and G. Ucker, TIMED Solar EUV Experiment: pre-flight calibration results for the XUV Photometer System, SPIE Proceedings, 3756, 255-264, 2000.

Woods, T., G. Rottman, J. Harder, G. Lawrence, B. McClintock, G. Kopp, and C. Pankratz, Overview of the EOS SORCE mission, SPIE Proceedings, 4135, 192-203, 2000.

Papers Presented at Scientific Meetings

Avallone, L.M., and A.G. Hallar, Trace gas correlations in the tropopause region as observed from the NASA DC-8 during SOLVE, talk and poster presented at the SOLVE-THESEO Science Team Meeting, Palermo, Italy, September 2000.

Avallone, L.M., and J.D. Fuentes, In situ observations of bromine oxide at two high latitude surface sites during springtime ozone depletion episodes, talk presented at the Fall American Geophysical Union Meeting, San Francisco, CA, December 2000.

Avallone, L.M., D.R. Blake, A.M. Gates, R.D. May, B.C. Sive, D.W. Toohey, and E.S. Whitney, The Tropospheric Ozone and Tracers from Commercial Aircraft Platforms (TOTCAP) Instrumentation: First Results, poster presented at the 2000 Atmospheric Effects of Aviation Annual meeting, Snowmass, CO, June 2000.

Avallone, L.M., In situ measurements of BrO and ClO for Polar Sunrise 2000, Polar Sunrise Experiment Alert 2000 Science Team Meeting, Rome, Italy, October 2000.

Bagenal, F., and F. Crary, Information tools for introductory astronomy and planetary science, talk presented at the Fall American Geophysical Union Meeting, San Francisco, CA, December 2000.
Bagenal, F., The Io plasma torus observed from nearby and afar, Physics of Space: Growth points and Problems, Obs. of Paris, Jan 10-14, 2000.
Bagenal, F., Review of plasmas around comets, moons, and Planets, Physics of Space: Growth points and Problems, Obs. of Paris, Jan 10-14, 2000.
Bagenal, F., et al., Comparison of Torus conditions observed by HST and Galileo, DPS, Pasadena, Nov 2000.
Bagenal, F., et al., Comparison of Torus conditions observed by HST and Galileo, talk presented at the Fall American Geophysical Union Meeting, San Francisco, CA, December 2000.
Bailey, S. M., T. N. Woods, C. A. Barth, and S. C. Solomon, Validation and analysis of 1.5 years of solar soft X-ray irradiance measurements from the SNOE satellite, Spring AGU Meeting, Washington, DC, 2000.
Baker, D.N., A program of NASA advanced technology development for universities, Space Technology MOWG, Dulles, Virginia, 7 June 2000.
Baker, D.N., and D.F. Moorer, Jr., Specification and forecast of energetic magnetospheric electrons and ions, 1st S-RAMP Conference, Sapporo, Japan, 2-6 October 2000.
Baker, D.N., and D.F. Moorer, Jr., Specification of Radiation belt electrons and ions, Space Weather: Progress and Challenges in Research and Applications, AGU Chapman Conference, Clearwater, FL, 22 March 2000.
Baker, D.N., C.A. Barth, K. Mankoff, S.C. Solomon, S.G. Kanekal, J.G. Luhmann, S. Petrinec, D.L. Chenette, G.M. Mason, and J.E. Mazur, Large solar disturbances and their geospace impacts: SNOE, SAMPEX, and POLAR observations, Spring AGU Meeting, Washington, DC, 2 June 2000.
Baker, D.N., C.A. Barth, K. Mankoff, S.C. Solomon, S.G. Kanekal, S. Petrinec, J.G. Luhmann, G.M. Mason, and J.E. Mazur, Solar disturbances and their geospace impacts; SNOE, SAMPEX and POLAR observations, 1st S-RAMP Conference, Sapporo, Japan, 2-6 October 2000.
Baker, D.N., Dynamics of outer radiation belt electronics as observed with the SAMPEX and POLAR spacecraft, Spring AGU meeting, Washington, DC, 30 May 2000.
Baker, D.N., Dynamics of outer radiation belt electrons as observed with the SAMPEX and POLAR spacecraft, 1st S-RAMP Conference, Sapporo, Japan, 2-6 October 2000.
Baker, D.N., Electron radiation belt disappearance, NASA/Goddard Space Flight Center, Greenbelt, MD, 30 March 2000.
Baker, D.N., et al., MESSSENGER, A new look at the magnetosphere and atmosphere of Mercury, Spring AGU meeting, Washington, DC, 2 June 2000.
Baker, D.N., Hiro Nishida – Recounting a most outstanding career, Honorary Symposium, NASA/Goddard Space Flight Center, Greenbelt, MD, 27 March 2000.
Baker, D.N., Low-cost NASA missions and future space exploration, WCCO (CBS) Radio, St. Paul, MN, 11 June 2000.

Baker, D.N., Near-Earth space weather concerns in the Sun-Earth connection, Workshop on Sun-Earth Connections, NATO Advanced Study Institute, Hersonnisos (Crete), Greece, 23 June 2000.

Baker, D.N., S.G. Kanekal, D.F. Moorer, X. Li, D. Vassiliadis, and A.J. Klimas, Radiation belt electrons: A major issue for the Living With a Star Program, Fall AGU Meeting, San Francisco, CA, 15-19 December 2000.

Baker, D.N., Satellite anomalies due to space storms, Tutorial Lecture, NATO Advanced Study Institute, Hersonnisos (Crete), Greece, 24 June 2000.

Baker, D.N., Space Missions and Advanced Technologies at LASP, Air Force Technical Applications Center, Cocoa Beach, FL, 16 March 2000.

Baker, D.N., The day the solar wind ran out of gas, Invited Lecture, Sigma Xi Honorary Society, U. of Colorado, Boulder, CO, 4 April 2000.

Baker, D.N., The day the solar wind ran out of gas, Invited science presentation, Sun-Earth Connections Advisory Subcommittee, NASA HQ, Washington, DC, 14 June 2000.

Baker, D.N., The proper size mix of space and Earth science missions – NAS Report, Briefing to Office of Management and Budget, New Exec. Office Building, Washington, DC, 30 March, 2000.

Baker, D.N., The proper size mix of space and Earth science missions – NAS Report, Office of Earth Sciences briefing, NASA Headquarters, Washington, DC, 31 March, 2000.

Baker, D.N., The proper size mix of space and Earth science missions – Briefing to House Science Subcommittee Staff – U.S. Congress, Capitol Hill, Washington, DC, 5 June 2000.

Baker, D.N., The role of magnetospheric substorms in highly relativistic electron production within Earth's magnetosphere, International Conference on Substorms-5, St. Petersburg, Russia, 16-20 May 2000.

Brain, D., et al., Martian magnetic field morphology from MGS MAG data, DPS, Pasadena, Nov 2000.

Brooks, S.M., L.W. Esposito, H.B. Throop, and M.R. Showalter, Photometric Analysis of Jupiter's main ring with Galileo SSI and NIMS imaging, in preparation, 2000.

Bullock, M. A., J. M. Moore, M. T. Mellon, C. Woosley, Experimental Studies of Brines and Evaporites as Applied to Mars, Astrobiology Workshop, Boulder, 2000.

Colwell, J. E., M. T. Mellon, S. Sture, Experimental Studies of Low Velocity Impacts into Dust, 32nd meeting of the Div. Planet. Sci. of Amer. Astro. Soc., Pasadena, 2000.

Crary, F., et al., Solar wind structure on 1000 Re scales: Correlations between Deep Space One and WIND measurements, Spring AGU meeting, Washington, DC, 2 June 2000.

Drake, V. A., W. E. McClintock, R. A. Kohnert, T. N. Woods, and G. J. Rottman, Photomultiplier tube detector performance and stability for the Earth Observing System's SOLSTICE II instrument, *SPIE*, San Diego, August, 2000.

Elkington, S.R., P. Buehler, D.F. Moorer, D.N. Baker, M.K. Hudson, M.J. Wiltberger, and J.F. Fennell, Data assimilation in initializing MHD/particle simulations of the radiation belts, Fall AGU Meeting, San Francisco, CA, 15-19 December 2000.

Fabian, A., A.A. Sickafoose, S. Robertson, and M. Horanyi, Measurements of Electrical Discharges in a Simulated Martian Dust Storm, 8th Annual Workshop on the Physics of Dusty Plasmas, Santa Fe, NM, 26-28 April 2000.

Gates, A.M., L.M. Avallone, D.W. Toohey and S.A. Vay, The Tropospheric Ozone and Tracers from Commercial Aircraft Platforms (TOTCAP) carbon dioxide measurement during the SOLVE campaign: Data comparison and a dynamical study, Poster presented at the SOLVE-THESEO Science Team Meeting, Palermo, Italy, September 2000.

Gates, A.M., L.M. Avallone, D.W. Toohey, A. Rutter, A.R. Hopkins, P.D. Whitefield, D. E. Hagen, and M.N. Ross, In situ carbon dioxide measurements in rocket plumes during ACCENT, talk presented at the Fall American Geophysical Union Meeting, San Francisco, CA, December 2000.

Gurnett, D., F. Bagenal, et al., Electron densities in the Io plasma torus and near to Io from the Galileo plasma wave instrument, Spring AGU meeting, Washington, DC, 2 June 2000.

Harder, J. W., G. M. Lawrence, G. J. Rottman, and T. N. Woods, Spectral Irradiance Monitor (SIM) for the SORCE mission, *SPIE*, San Diego, August, 2000.

Hines, K.M., D. Toohey and L. Avallone, Seasonal patterns of ozone variability in the lower stratosphere and upper troposphere, talk presented at the Fall American Geophysical Union Meeting, San Francisco, CA, December 2000.

Horanyi, M., Charged dust dynamics, Colloidal Plasmas Conference, Trieste, Italy, July 2000.

Jakosky, B. M., L. Braun, M. T. Mellon, Mars Surface Properties: Sites of Exobiological Interest, Astrobiology Workshop, Boulder, 2000.

Jakosky, B. M., L. R. Braun, M. T. Mellon, S. M. Pelkey, High-Resolution Thermal-Inertia Mapping of Mars: Sites of Exobiological Interest, 31st Lunar Planet. Sci. Conf., Houston, 2000.

Jakosky, B. M., M. T. Mellon, High-Resolution Thermal-Inertia Mapping of Sites of Exobiological Interest, 32nd meeting of the Div. Planet. Sci. of Amer. Astro. Soc., Pasadena, 2000.

Jakosky, B.M. and M.T. Mellon, High-Resolution Thermal-Inertia Mapping of Sites of Exobiological Relevance on Mars, DPS meeting, Pasadena, CA, 2000.

Jakosky, B.M. and R.J. Phillips, Mars volatile and climate history, MGS MOLA science team meeting, Breckenridge, 2000.

Jakosky, B.M. and R.J. Phillips, Water the many mysteries of Mars?, Fall Amer. Geophys. Union meeting, San Francisco, 2000.

Jakosky, B.M., Astrobiology: What is it and why do we care, MCDB Graduate Student Annual Symposium, CU, 23 September 2000.

Jakosky, B.M., Extraterrestrial life? So what? Philosophical and societal aspects of astrobiology, Univ. of Washington, Astrobiology Program, 11 May 2000.

Jakosky, B.M., Mars volatile evolution: Water the real constraints?, LASP seminar, 7 December 2000.

Jakosky, B.M., Mars volatiles, water, and climate, Lunar and Planetary Institute, Houston, 6 September 2000.

Jakosky, B.M., Mars: Oceans, climate, and life, Univ. of Washington, Dept. of Oceanography, 10 May 2000.

Jakosky, B.M., Searching for life in the universe, colloquium at Center for Space Engineering and Space Sciences, Colorado State Univ., 8 February 2000

Jakosky, B.M., Searching for life in the universe, Keynote lecture, "Liftoff" annual teachers' workshop, Lunar and Planetary Institute, Houston, 17 July 2000.

Jakosky, B.M., The Moon--30 years after Apollo, CU Heritage Center, Alumni Assoc., 7 September 2000

Jakosky, B.M., The search for life elsewhere, CU Graduate School Advisory Committee, 27 October 2000.

Jakosky, B.M., The search for life in the universe, Idaho Academy of Sciences, Twin Falls, ID, 30 March 2000.

Jakosky, B.M., The search for life on Mars, Eberly College of Science spring seminar series, Penn. State University, 12 February 2000.

Jakosky, B.M., The search for life on Mars, Idaho Academy of Sciences, Twin Falls, ID, 31 March 2000.

Jakosky, B.M., What is astrobiology and why do we care?, Lunar and Planetary Institute, Houston, 5 September 2000

Jakosky, B.M., What is astrobiology and why do we care?, Southwest Research Institute, Boulder, 3 November 2000.

Jakosky, B.M., What is astrobiology?, Teacher and student astrobiology workshop, First Annual Astrobiology Science Conference, NASA/Ames Research Center, 3 April 2000.

Jakosky, B.M., Constructing a viable Mars architecture: Plans are worthless, planning is essential, Mars Missions Workshop, Houston, 2000.

Jakosky, B.M., L.R. Braun, M.T. Mellon, and S.M. Pelkey, High-resolution thermal-inertia mapping of Mars: Sites of exobiological interest, Lunar Planet. Sci. Conf., Houston, 2000.

Jakosky, B.M., Mars climate evolution: Synthesis of MGS observations, Mars Global Surveyor Science Workshop on Water and Atmosphere, Boulder, CO, 2000.

Jakosky, B.M., Thermal inertia of water-related sites on Mars: Aeolian or not?, Mars Global Surveyor Science Workshop on Water and Atmosphere, Boulder, CO, 2000.

Kanekal, S.B., D.N. Baker, and J.B. Blake, The May-1997, March-Sept-October 1998 geomagnetic storms: Observational overview of outer zone energetic particles, Spring AGU Meeting, Washington, DC, 1 June 2000.

Kanekal, S.G., D.N. Baker, and J.B. Blake, Magnetospheric relativistic electron enhancement events: High speed solar wind streams vs. coronal mass ejections, Fall AGU Meeting, San Francisco, CA, 15-19 December 2000.

Kanekal, S.G., D.N. Baker, J.B. Blake, and M.L. Looper, Global coherence of relativistic electron enhancement during the solar cycle number 23. 1st S-RAMP Conference, Sapporo, Japan, 2-6 October 2000.

Klimas, A.J., J.A. Valdivia, V. Uritsky, D. Vassiliadis, and D.N. Baker, On the compatibility of the coherent substorm cycle with the complex plasma sheet, International Conference on Substorms-5, St. Petersburg, Russia, 16-20 May 2000.

Klimas, A.J., V. Uritsky, D. Vassiliadis, and D.N. Baker, Multiscale turbulence produced by MHD-kinetic-scale coupling in an idealized current sheet model, 1st S-RAMP Conference, Sapporo, Japan, 2-6 October 2000.

Klimas, A.J., V.M. Uritsky, D. Vassiliadis, and D.N. Baker, Multi-scale turbulence in a 2-dimensional current sheet model, Fall AGU Meeting, San Francisco, CA, 15-19 December 2000.

Lawrence, G. M., G. J. Rottman, G. Kopp, J. W. Harder, W. E. McClintock, and T. N. Woods, Total Irradiance Monitor (TIM) for the EOS SORCE mission, *SPIE*, San Diego, August, 2000.

Lawson, S.L. and B.M. Jakosky, Clementine LWIR and UVVIS images: Characterizing lunar surface thermophysical properties, New View of the Moon III Conf., Houston, 2000.

Lawson, S.L. and B.M. Jakosky, Comparison of Clementine LWIR and UVVIS images of the lunar surface, DPS meeting, Pasadena, 2000.

Lawson, S.L. and B.M. Jakosky, Comparison of Clementine LWIR and UVVis images: Factors controlling surface temperatures, Lunar Planet. Sci. Conf., Houston, 2000.

Li, X., D.N. Baker, M. Temerin, G.D. Reeves, R.D. Belian, J.B. Blake, and H.J. Singer, Sudden injections of energetic particles into the inner magnetosphere associated with an isolated substorm, a shock impact, and a shock-induced nightside magnetic field collapse, International Conference on Substorms-5, St. Petersburg, Russia, 16-20 May 2000.

Li, X., Energetic particle dynamics in the Earth’s magnetosphere, European Geophysical Society, XXV General Assembly, Nice, France, 25-29 April, 2000.

Li, X., M. Temerin, D.N. Baker, G. Reeves, and D. Larson, Quantitative prediction of MeV electrons at geostationary orbit on the basis of solar wind measurements, Fall AGU Meeting, San Francisco, CA, 15-19 December 2000.

Li, X., Modeling particle injections-test particle simulations, International Conference on Substorms-5, St. Petersburg, Russia, 16-20 May 2000.

Li, X., Predicting MeV electron variations at geosynchronous orbit from a physics-based diffusion model using solar wind as the only input, COSPAR-Colloquium, Space Weather Study using Multi-Point Techniques, Taipei, Taiwan, 27-29 September, 2000.

Li, X., Quantitative prediction of MeV electrons at geostationary orbit on the basis of solar wind measurements, Seminar presented at LASP/U. of Colorado, 31 August, 2000.

Li, X., Quantitative prediction of MeV electrons at geostationary orbit on the basis of solar wind measurements, Seminar presented at Center for Integrated Plasma Studies, Univ. of Colorado, 10 November, 2000.

Li, X., Quantitative prediction of MeV electrons at geostationary orbit on the basis of solar wind measurements, Seminar presented at Space Environment Center/NOAA, 12 October 2000.

London, J., and G. J. Rottman, International observational program for the measurement of total and spectral solar irradiance, talk presented at the International Radiation Symposium, St. Petersburg, RU, July 2000.

Mankoff, K.D., C.A. Barth, D.N. Baker, A.W. Merkel, S.M. Petrinec, D.L. Chenette, W.I. Imhof, J.G. Luhmann, S.G. Kanekal, G.M. Mason, and J.E. Mazur, Comparison of SNOE, POLAR, and SAMPEX observations of the magnetosphere-thermosphere interaction during the 1998 geomagnetic storms, Spring AGU Meeting, Washington, DC, 2 June 2000.

McClintock, W. E., G. J. Rottman, and T. N. Woods, SOLar STellar Irradiance Comparison Experiment II (SOLSTICE II) for the NASA Earth Observing Systems Solar Radiation and Climate Experiment (SORCE) mission, *SPIE*, San Diego, August, 2000.

McIlwaine, S.K., and L. M. Avallone, Studies of stratospheric tropical-midlatitude transport using UARS data, poster presented at the American Meteorological Society Annual Meeting, Long Beach, California, January 2000 (won best student paper award)

Mellon, M. T. B. M. Jakosky, H. H. Kieffer, P. R. Christensen, High-Resolution Thermal Inertia Mapping from the Mars Global Surveyor Thermal Emission Spectrometer, 31st Lunar Planet. Sci. Conf., Houston, 2000.

Mellon, M. T., Locating Subsurface Ice on Mars, Astrobiology Workshop, Boulder, 2000..

Mellon, M. T., Permafrost and Ground Ice on Mars, Amer. Geophys. Union, Fall Meeting, San Francisco, 2000.

Mellon, M.T., B.M. Jakosky, H.H. Kieffer, and P.R. Christensen, High-resolution thermal inertia mapping from the Mars Global Surveyor Thermal Emission Spectrometer, Lunar Planet. Sci. Conf., Houston, 2000.

Moorer, D.F., and D.N. Baker, Data assimilation in radiation belt modeling, Fall AGU Meeting, San Francisco, CA, 15-19 December 2000.

Moorer, D.F., Jr., and D.N. Baker, Specification of outer belt electrons through data assimilation, COSPAR, Warsaw, Poland, 15-22 July, 2000.

Nakamura, R., D.N. Baker, S.R. Elkington, M. Hudson, J.B. Blake, M. Looper, and T. Nagai, Ulf Oscillations at the dawnside magnetosphere during March 10, 1998 Storm, Spring AGU Meeting, Washington, DC, 1 June 2000.

Nakamura, R., W. Baumjohann, G. Haerendal, B. Klecker, E. Georgescu, S.R. Elkington, T. Nagai, D.N. Baker, J.B. Blake, and M. Looper, Relationships between ULF wave and radiation belt electrons during a magnetic storm, COSPAR, Warsaw, Poland, 15-22 July, 2000.

Ohtsuki, K., G.R. Stewart, and S. Ida, Semi-analytic formulas of velocity stirring rates in particle disks, IAU Symposium on Planetary Systems in the Universe, Manchester, U.K., 2000.

Ohtsuki, K., G.R. Stewart, and S. Ida, Stirring rate of planetesimals based on three-body orbital integrations, 31st DDA meeting, Yosemite, CA 2000.

Ohtsuki, K., H. Tanaka, and S. Ida, Gap formation in self-gravitating rings by an embedded moonlet, 32nd DPS meeting, Pasadena, CA, 2000.

Olivero, J.J., C.E. Randall, and G.E. Thomas, Randall, C.E., Increases in PMC and NLC occurrence rates: What role does water vapor play, Fall AGU meeting, San Francisco, CA, 2000.

Oliverson, R., F. Bagenal, et al., HST/STIS visible sodium and oxygen images of Io in Eclipse, Spring AGU meeting, Washington, DC, May 2000.

Patrick, L.C., and L.M. Avallone, Suitability of the zonal mean for use in climatologies and atmospheric chemistry models, poster presented at the Fall American Geophysical Union Meeting, San Francisco, CA, December 2000.

Pelkey, S.M., B.M. Jakosky, and M.T. Mellon, High-resolution thermal-inertia mapping of Mars: Aeolian features, Lunar Planet. Sci. Conf., Houston, 2000.

Peterson, W.K., P. Toivanen, X. Li, D.N. Baker, A. Keiling, J. Wygant, C.A. Kletzing, and C.T. Russell, POLAR observations of strong transverse convection events in the inner magnetosphere 10 minutes before substorm onset, International Conference on Substorms-5, St. Petersburg, Russia, 16-20 May 2000.

Petrinec, S.M., D.L. Chenette, W.I. Imhof, C.A. Barth, K.D. Mankoff, D.N. Baker, and J.B. Luhmann, Comparisons of X-ray mappings from PIXIE and nitric oxide emissions from SNOE for magnetospheric storm intervals, Spring AGU Meeting, Washington, DC, 2 June 2000.

Petrinec, S.M., D.L. Chenette, W.I. Imhof, C.A. Barth, K.D. Mankoff, D.N. Baker, and J.B. Luhmann, Comparisons of X-ray mappings from PIXIE and nitric oxide emissions from SNOE for magnetospheric storm intervals, Spring AGU Meeting, Washington, DC, 2 June 2000.

Petrinec, S.M., D.L. Chenette, W.L. Imhof, C.A. Barth, K.D. Mankoff, D.N. Baker, and J.G. Luhmann, Comparing energetic auroral precipitation as observed by PIXIE and nitric oxide observed by SNOE, 1st S-RAMP Conference, Sapporo, Japan, 2-6 October 2000.

Pulkkinen, T.I., K. Kauristie, M. Wiltberger, J.G. Lyon, D.N. Baker, T. Mukai, and S. Kokubun, Flow channels in the magnetotail: Tail and ionospheric observations compared with global MHD simulations.

Pulkkinen, T.I., N.Y. Ganushkina, V.F. Bashkirov, D.N. Baker, J.F. Fennell, J. Roeder, T.A. Fritz, M. Grande, B. Kellett, and G. Kettmann, Ring current enhancement due to substorm-associated inductive electric fields, International Conference on Substorms-5, St. Petersburg, Russia, 16-20 May 2000.

Randall, C.E., and G.E. Thomas, POAM observations of PMCs, AIM SMEX team meeting, October, 2000.

Randall, C.E., Descent of NO_x in the polar vortex, POAM Science team meeting, October, 2000.

Randall, C.E., et al., Construction of 3D Ozone Fields Using POAM III During the SOLVE Campaign, Fall AGU meeting, San Francisco, CA, 2000.

Randall, C.E., Global Aerosol Profiles from PV Relationships, Comparison of SAGE and HALOE Data, AURA Education and Public Outreach, HIRDLS science team meeting, June 2000.

Randall, C.E., Ozone loss and Aura Validation campaigns, HIRDLS team meeting, October, 2000.

Randall, C.E., POAM III Aerosol Validation, POAM Science team meeting, October, 2000.

Randall, C.E., POAM III NO_2 Validation, POAM Science team meeting, October, 2000.

Randall, C.E., PV/O_3 Reconstruction Technique with POAM III Data, POAM Science team meeting, October, 2000.

Randall, C.E., The Stellar Interferometer and Seismic Probe, a new program development concept presented to LASP, April 2000.

Retherford, K., F. Bagenal, et al., Io's UV aurora, DPS, Pasadena, Nov 2000.

Robertson, S., A. Sickafoose, J. Colwell, and M. Horanyi, Dusty Plasma Dynamics Near Surfaces in Space, Abstracts of the Fifth Microgravity Fluid Physics & Transport Phenomena Conference, 97, 2000.

Robertson, S., Z. Sternovsky and M. Horanyi, Experiments on the Charging of Water Cluster Molecules, 8th Workshop on the Physics of Dusty Plasma, Santa Fe, April 26-28, 2000.

Robertson, S., Z. Sternovsky, and M. Horanyi, study of water cluster molecules with relevance to mesospheric clouds, Bull. Am. Phys. Soc., 45, 35, 2000.

Rottman, G., Solar Ultraviolet Irradiance, talk presented at the Meeting on Comparative Aeronomy, Yosemite, CA, February 2000.

Rottman, G.J. and T. N. Woods, Long-term variations in solar ultraviolet irradiance, Spring AGU Meeting, Washington, DC, May 2000.

Rottman, G., G. Lawrence, T. Woods, J. Harder, W. McClintock, and J. London, Measurement of the total and spectral solar irradiance from NASA's SORCE mission: 2002 to 2007, talk presented at the International Radiation Symposium, St. Petersburg, Russia, July 2000.

Rottman, G., T. Woods, and T. Sparn, The Solar Radiation and Climate Experiment - SORCE, talk presented at COSPAR XXXIII Warsaw Poland, July 2000.

Rottman, G., T. Woods, M. Snow, and G. DeToma, The Solar cycle change in UV irradiance, talk presented at COSPAR XXXIII Warsaw Poland, July 2000.

Rottman, G., Thomas Woods, and Julius London, UARS SOLSTICE measurements of solar ultraviolet irradiance: Solar-Cycle variations, talk presented at the International Radiation Symposium, St. Petersburg, Russia, July 2000.

Ruff, S. W, P. R. Christensen, R. N. Clark, H. H. Kieffer, M. C. Malin, J. L. Bandfield, B. M. Jakosky, M. D. Lane, M. T. Mellon, and M. A. Presley, Mars' "White Rock" Feature Lacks Evidence of an Aqueous Origin, 31st Lunar Planet. Sci. Conf., Houston, 2000.

Rusch, D.E., C.E. Randall and D.E. Siskind, An investigation of the effect of particle ionization on the Earth's middle atmosphere using a two-dimensional model, Fall AGU meeting, San Francisco, CA, 2000.

Schneider, N.M., A. Hendrix, F. Herbert, and the HST8 Torus Team, HST observations of the Io Torus during the Galileo encounters, Spring AGU Meeting, Washington, DC, 31 May 2000.

Schneider, N.M., A.H. Park, and M.E. Kueppers, Spectroscopic studies of the Io Torus during Galileo encounters: Remote plasma diagnostics and the detection of Cl++, DPS, Pasadena, CA, October 2000.

Schneider, N.M., Jupiter's magnetosphere: A volcano-powered nebula, invited talk at Nebraska Star Party, Merritt Reservoir, Nebraska, 3 August 2000.

Schnieder, N.M., The discovery of Chlorine from Io, colloquium presented at the University of Michigan, 10 November 2000.

Sickafoose, A.A., J.E. Colwell, M. Horanyi, and S. Robertson, Experimental Photoelectric Charging of Dust Particles, Bull. Amer. Phys. Soc., 45(7), 35, 2000.

Sickafoose, A.A., J.E. Colwell, M. Horanyi, and S. Robertson, Experimental Studies on the Photoelectric Charging of Dust Particles, 8th Annual Workshop on the Physics of Dusty Plasmas, Santa Fe, NM, 26-28 April 2000.

Sickafoose, A.A., S. Robertson, J.E. Colwell, and M. Horanyi, Experimental Photoelectric Charging of Dust Particles, National Radio Science Meeting (URSI) 4-8 January, 339, 2000.

Sickafoose, A.A., S. Robertson, J.E. Colwell, and M. Horanyi, Laboratory Measurements on the Photoelectric Charging of Dust, IAU Colloquium 181: Dust in the solar system and other planetary systems, 24, 2000.

Slavin, J.A., M.H. Acuña, A. Szabo, D.N. Baker, G. Gloeckler, T. Zurbuchen, T.M. Krimigis, and R.L. McNutt, Solar wind conditions at 0.3-0.5 AU: Implications of Mercury's magnetosphere, Spring AGU Meeting, Washington, DC, 31 May 2000.

Smiley, B., S. Robertson, M. Horanyi, J. Gumbel, and G. Witt, Dusty Plasma experiments relating to mesospheric aerosols, 8th Workshop on the Physics of Dusty Plasma, Santa Fe, NM, April, 2000.

Sparling, L.C., and L. Avallone, Small scale variability and the problem of data validation, talk presented at the Spring American Geophysical Union Meeting, Washington DC, May 2000.

Stevens, M. H., R. R. Conway, D. E. Siskind, F. G. Eparvier, and R. G. Roble, MAHRSI NO Observations in the Polar Summer Mesosphere and Comparisons with Model Results, presented at the Spring American Geophysical Union Meeting, Washington, D.C., May 2000.

Thornton, B., L. Avallone, W. Brune, D. Toohey, H. Harder, M. Martinez-Harder, and J. Simpas, Latitudinal and seasonal variability of ClO in the lowermost stratosphere, poster presented at the Fall American Geophysical Union Meeting, San Francisco, CA, December 2000.

Throop, H.B., J. Bally, L.W. Esposito, and M.J. McCaughrean, Evidence for dust grain growth in young circumstellar disks, Science, submitted, 2000.

Tobiska, W. K., S. D. Bouwer, R. Viereck, and T. N. Woods, Nowcasting by SOLAR2000 using recent solar irradiance observations, COSPAR Session E2.3, 2000.

Tobiska, W. K., T. N. Woods, F. G. Eparvier, and S.D. Bouwer, Validation of the E10.7 proxy produced by SOLAR2000, COSPAR Session C1.1, 2000.

Toivanen, P.K., D.N. Baker, N.E. Turner, X. Li, R.E. Ergun, W.K. Peterson, H.J. Singer, K. Kauristie, M. Sryjäsuo, A. Keiling, C.A. Kletzing, and C.T. Russell, A substorm onset observed by the POLAR spacecraft in conjunction with the MIRACLE network, International Conference on Substorms-5, St. Petersburg, Russia, 16-20 May 2000.

Toivanen, P.K., D.N. Baker, W.K. Peterson, H.J. Singer, N.E. Turner, X. Li, K. Kauristie, M. Sryjäsuo, C.A. Kletzing, and A. Keiling, Miniature dipolarization events during the late growth phase: Pseudobreakups or pre-cursors of the main onset?, Spring AGU Meeting, Washington, DC, 1 June 2000.

Toohey, D., and L. Avallone, Technology for measurements of atmospheric free radicals by resonance fluorescence, LASP Technology Colloquium, 13 June 2000.

Toohey, D., and L. Avallone, The Tropospheric Ozone and Tracers from Commercial Aircraft Platforms (TOTCAP) Instrumentation: First Results, NASA Ames Earth Science Seminar, 10 August 2000.

Toohey, D., and L. Avallone, Trace Gas Observations at the High Latitude Winter Tropopause with a New Aircraft Instrument, Atmospheric and Oceanic Sciences Seminar, University of Wisconsin, 31 October 2000.

Toohey, D., and L. Avallone, Trace Gas Observations at the High Latitude Winter Tropopause with a New Aircraft Instrument, PAOS seminar, 17 November 2000.

Turner, N.E., D. Knipp, D.N. Baker, and F. Chun, Magnetospheric energy content over the solar cycle, Fall AGU Meeting, San Francisco, CA, 15-19 December 2000.

Turner, N.E., D.N. Baker, T.I. Pulkkinen, J.L. Roeder, J.F. Fennell, and R.L. McPherron, Relationship of the ring current to Dst, 1st S-RAMP Conference, Sapporo, Japan, 2-6 October 2000.

Turner, N.E., D.N. Baker, T.I.Pulkkinen, J.L. Roeder, J.F. Fennell, G. Lu, and V.K. Jordanova, Global magnetospheric energy distribution during storms, Spring AGU Meeting, Washington, DC, 2 June 2000.

Vassiliadis, D., A.J. Klimas, D.N. Baker, and S. Kanekal, The electron disappearance event on May-July 1999: Linear MA filter analysis, Fall AGU Meeting, San Francisco, CA, 15-19 December 2000.

Whitney, E.S., L.M. Avallone, J.R. Podolske, R. Herman, G. Sachse, E. Jensen, R.D. May, and B. Anderson, An examination of "total water" measurements from a closed-path tunable diode laser hygrometer aboard the NASA DC-8 aircraft during the SOLVE campaign, poster presented at the SOLVE-THESEO Science Team Meeting, Palermo, Italy, September 2000.

Woods, T. N., G. J. Rottman, and W. K. Tobiska, Long-term solar Lyman alpha irradiance measurements, Spring AGU Meeting, Washington, DC, 2000.

Woods, T. N., G. Rottman, J. Harder, G. Lawrence, B. McClintock, G. Kopp, and C. Pankratz, Overview of the EOS SORCE mission, SPIE, San Diego, August, 2000.

Yarborough, S., D.N. Baker, X. Li, N.E. Turner, S.G. Kanekal, A.J. Klimas, D. Vassiliadis, and H.J. Singer, A nonlinear dynamical feedback mechanism for outer radiation belt electron depletion following the May 1999 solar wind disappearance event, Spring AGU Meeting, Washington, DC, 2 June 2000.

CONTRACTS AWARDED

Avallone, Linnea	In Situ measurements of Halogen oxides in the Troposphere
Avallone, Linnea	Development of lightweight instrumentation for measurements for long-lived trace gasses
Avallone, Linnea	Measurements of long-lived trace gasses from commercial aircraft platforms
Avallone, Linnea	Studies of tropical/mid-latitude exchange using UARS observations
Avallone, Linnea	In situ measurements of carbon dioxide in the upper troposphere and lower stratosphere
Bagenal, Frances	Information technology tools for introductory astronomy
Bagenal, Frances	Evolution and Activity in the Solar Corona
Bagenal, Frances	MHD Simulations of the coupling between Io and Jupiter

Bagenal, Frances	HST-Galileo Io campaign
Bagenal, Frances	Deep Space 1: Analysis of Particles and Fields Observations on a Spacecraft using Electric Propulsion
Bagenal, Frances	Galileo: Interdisciplinary Study of the Io Plasma Torus
Bagenal, Frances	Martian Surface Magnetic Field (GSRP- D. Brain)
Baker, Daniel N.	IMEX (Inner magnetospheric explorer)
Baker, Daniel N.	GGS (CEPPAD)
Baker, Daniel N.	Nonlinear modeling of high-latitude electrodynamics
Baker, Daniel N.	Space weather specifying outer belt electrons by data assimilation
Baker, Daniel N.	Outer belt modeling by assimilation of real-time satellite flux data
Baker, Daniel N.	Mercury MESSENGER
Baker, Daniel N.	SAMPEX data analysis
Baker, Daniel N.	Radiation Belt Modeling
Baker, Daniel N.	CAMMICE Investigation Team – GGS POLAR
Barth, Charles A.	Student Nitric Oxide Explorer
Colwell, Joshua	Collisions into dust
Colwell, Joshua	Dusty plasma dynamics near surfaces in space
Colwell, Joshua	SOA observation design and testing
Colwell, Joshua	CASPER/PDT interface and Jupiter science development
Colwell, Joshua	Physics of regolith impacts in microgravity experiment (PRIME)
Davis, Randal	ICES mission operations
Davis, Randal	ARGOS/OASIS
Davis, Randal	Mission operations of the NASA Quikscat satellite
Davis, Randal	Development of Mission Analysis tools for Gravity Probe B mission Stanford
DeToma, Giuliana	Study of anomalous variation of total solar irradiance at the beginning of solar cycle 23
Eparvier, Francis	Application of SOHO data to soft x-ray and EUV irradiance modeling
Eparvier, Francis	Medium energy particle precipitation effects on the mesosphere and lower thermosphere

Eparvier, Francis	Modeling and Analysis of UARS Data
Ergun, Robert	Fast Satellite operations and data analysis
Ergun, Robert	STEREO phase A and bridge phase study of stereowaves accommodation
Ergun, Robert	Development of a Radio Tomography Mission for investigation of the Earth's magnetosphere
Ergun, Robert	Investigation of radio tomography imaging of the magnetosphere
Esposito, Larry	Photometry and evolution of Jovian ring
Esposito, Larry	UV imaging spectrograph for Cassini
Esposito, Larry	Atmospheric modeling
Esposito, Larry	Hubble Pre-Cassini studies of Titan
Esposito, Larry	Mars 03 Orbiter
Esposito, Larry	Photometric analysis of the Jovian ring system and modeling of ring origin and evolution
Esposito, Larry	Cassini mission operation and data analysis
Grimm, Robert	Lithospheric dynamics of Venus and Mars
Hendrix, Amanda	UV photometric parameters of the Icy Galilean satellites and the moon
Hendrix, Amanda	Galileo Multi-spectral analysis of the Galilean satellites
Hendrix, Amanda	Multi-wavelength analysis of asteroids
Horanyi, Mihaly	Dusty plasma interaction
Horanyi, Mihaly	Charged particulates in the Polar Mesosphere instrument development
Horanyi, Mihaly	Fundamentals of dusty plasma
Horanyi, Mihaly	Dusty plasma in planetary magnetosphere
Jakosky, Bruce	Center for Astrobiology
Jakosky, Bruce	Characterization of martian surface physical properties
Jakosky, Bruce	Interdisciplinary Scientist for Surface-atmosphere interactions
Jakosky, Bruce	2001 Mars Orbiter Thermal Emission Imaging System (THEMIS)
Jakosky, Bruce	Remote sensing of planetary surfaces
Jakosky, Bruce	Mars Global Surveyor mission for surface-atmosphere interactions

Lawrence, George	Camera hand lens microscope (CAMP)
Lee, Steven W.	Development of the MarsQuest Museum Exhibit
Lee, Steven W.	Infrared Studies of Condensates and Dust in the Martian Polar Regions
Lee, Steven W.	Ozone, Condensates, and Dust in the Martian Atmosphere
Lee, Steven W.	Multi-decade Observations of Martian Surface Variability and Sediment Transport: Integrated Analyses of Mariner 9 through Mars Global Surveyor Data
Lee, Steven W.	Mineralogy and weathering history of Mars
Lee, Steven W.	Mars Color Imager (MARCI) Science team
Lee, Steven W.	MarsQuest
Lee, Steven W.	Infrared, Imaging and modeling studies of condensates and dust in the Martian polar regions
Li, Xinlin	Source of radiation belt electrons
Li, Xinlin	Energetic particle dynamics during geomagnetic storms and magnetospheric substorms
Li, Xinlin	Energetic electron environment
McClintock, William	Build and test and FUV CODACON detector for laboratory applications
McClintock, William	MESSENGER Science Team Phase B
McGrath, Michael	Mechanics of Granular Materials Microgravity Experiment
Mellon, Michael	Study of Antarctic permafrost and periglacial geology
Mellon, Michael	Small-scale polygons and the history of ground ice on Mars
Pryor, Wayne	UV studies of Jupiter's hydrocarbons and aerosols
Pryor, Wayne	Planetary atmospheres (Jovian auroral chemistry)
Pryor, Wayne	Imaging interplanetary hydrogen with Ulysses
Pryor, Wayne	UV spectroscopy of Jupiter’s aurora from the Galileo orbiter
Randall, Cora	Solar Mesosphere Explorer: Measurements of El Chichon aerosols
Randall, Cora	POAM III measurements during SOLVE

Randall, Cora	Impact of descending polar mesospheric NOx on stratospheric ozone
Randall, Cora	Validation of POAM III data
Randall, Cora	NOGAPS assimilation of ozone
Rottman, Gary	UARS SOLSTICE
Rottman, Gary	EOS SOLSTICE
Rottman, Gary	SORCE/EOS SOLSTICE
Rusch, David	An investigation of the effects of particle ionization on the Earth's middle atmosphere and its role in global change
Rusch, David	Model predictions of interactions between solar and anthropogenic perturbations in the Earth's atmosphere
Schneider, Nicholas	Jupiter Magnetospheric Explorer (JMEX)
Schneider, Nicholas	A comparative analysis of Galileo-era IO Torus and Atmosphere
Schneider, Nicholas	EUVE observations of the Jupiter system
Schneider, Nicholas	The structure of the Io plasma torus: Implications for energy supply
Schneider, Nicholas	Satellite atmospheres and Io Torus observations
Seebass, Richard	Aerospace engineering degree program
Simmons, Karen E.	Voyager 2 PPS Data Archiving
Solomon, Stanley	Energy transfer in the thermosphere and mesosphere
Solomon, Stanley	Space physics new mission concepts program
Solomon, Stanley	Thermospheric odd-nitrogen response to auroral energy
Stewart, A. Ian	UV spectrometer investigation – Galileo Orbiter
Stewart, A. Ian	UVS/EUV participation in Galileo Europa mission and Galileo prime mission
Stewart, Glen	Dynamics of planetesimals and the Kuiper comet belt
Stewart, Glen	Late stages of accretion or Uranus and Neptune
Thomas, Gary	Polar Mesospheric Clouds and their atmospheric environment
Thomas, Gary	Cyclic and long-term trends in the mesosphere
Toon, Brian	Comparisons of 3-D numerical simulations
Toon, Brian	Contrail persistence and aircraft exhaust impacts of cirrus clouds

Toon, Brian	The role of clouds in the long-term habitability of planets
Toon, Brian	IR optical constants of particles in lower stratosphere and upper troposphere
Toon, Brian	Theoretical studies of feedbacks between microphysics and dynamics in marine stratocumulus clouds
Toon, Brian	Theoretical studies of stratospheric clouds and aerosols (SOLVE)
Toon, Brian	Comparisons of 3-Dimensional numerical simulations of ambient and volcanic stratospheric aerosols with SAGE II observations
Toon, Brian	Earth Observing System (EOS)
Toon, Brian	Modeling time-dependent optical properties of the multicomponent aerosols in the marine boundary layer
Toon, Brian	Investigations of clouds and aerosols on Mars and Venus
Woods, Thomas N.	Solar EUV spectral irradiance experiment for the TIMED mission
Woods, Thomas N.	Airglow rocket

Proposals Submitted, 2000

Linnea Avallone	Measurements of long-lived trace gases from commercial aircraft platforms: Instrument development
Linnea Avallone	Clouds, Subvisible Cirrus, and Particles Experiment (CSCAPE),
Linnea Avallone	Measurements of CO2 and H2O for CSCAPE
Daniel N. Baker	GGS (CEPPAD)
Daniel N. Baker	The physics of space weather
Daniel N. Baker	Inner magnetosphere explorer (IMEX)
Daniel N. Baker	Solar, Anomalous, and Magnetospheric Particle Explorer (SAMPEX) Mission
Daniel N. Baker	A radiation belt condition index
Charles A. Barth	Energy glow from the magnetosphere to the thermosphere: PIXIE x-rays and SNOE nitric oxide
Charles A. Barth	Student Nitric Oxide Experiment Extended Mission
Joshua E. Colwell	Collaborative research: Experimental study of the collisions between macroscopic preplanetary dust aggregates
Joshua E. Colwell	Continued development of the CASPER science planning software tool
Joshua E. Colwell	Experimental and numerical studies of collisions and impacts into regolith
Joshua E. Colwell	Physics of Regolith impacts in microgravity experiment
Joshua E. Colwell	Experiments on collisions and impacts in regolith
Joshua E. Colwell	Development support, testing, and documentation of SOA
Joshua E. Colwell	Collisions into Dust Experiment 2
Randal L. Davis	ARGOS/OASIS
Randal L. Davis	Mission operations of the Extreme Ultraviolet Solar Spectroscopic Explorer (ESSEX)
Randal L. Davis	QuikSCAT mission operation launch delay
Randal L. Davis	QuikSCAT mission operations 3rd year option
Randal L. Davis	QuikSCAT mission operations 3rd year extension
Randal L. Davis	ICESAT mission operations

Randal L. Davis	ICESAT mission operations: Delta costs for New Nominal Program
William Emery	OWLS3
Robert E. Ergun	STEREO Phase A and Bridge
Robert E. Ergun	Characterization and numerical simulation of fast solitary waves in the auroral ionosphere
Robert E. Ergun	Investigation of Radio Tomography Imaging of the Magnetosphere
Robert E. Ergun	Fast Auroral Snapshot (FAST) data analysis and fields instruments operations
Robert E. Ergun	Boundary Layer Acceleration Snapshot (BLAST) small explorer mission
Robert E. Ergun	Advanced cross enterprise technology development for NASA missions
Robert E. Ergun	Development of Radio Tomography Instrument and Plasma Sensors for small spacecraft
Robert E. Ergun	GEM: Investigation of the formation and evolution of electron phase-space holes in space plasmas
Robert E. Ergun	Investigation of the formation and evolution of two- and three-dimensional electron phase – space holes in space plasmas
Robert E. Ergun	STEREO Phase A and Bridge
Robert E. Ergun	STEREO Phase B
Larry W. Esposito	Mars 2003 Orbiter: Ultraviolet Spectrometer/Imager
Larry W. Esposito	Pluto occultation imaging spectrograph experiment (POISE)
Robert E. Grimm	Lithospheric dynamics of Mars: Water, flow, and failure
Robert E. Grimm	Origin of magnetic lineations on Mars
Amanda R. Hendrix	Galileo multi-spectral analysis of the Galilean satellites
Amanda R. Hendrix	Multi-wavelength analysis of asteroids: A search for evidence of space weathering
Mihaly Horanyi	Cassini CDA Investigations
Mihaly Horanyi	Pluto-Kuiper Express Dust experiment (KPED)
Mihaly Horanyi	Dusty plasmas at Jupiter and Saturn
Mihaly Horanyi	Dusty plasmas in planetary magnetospheres

Bruce M. Jakosky	Physical properties of potential Mars landing sites
Bruce M. Jakosky	Planetary Geology and Geophysics
Bruce M. Jakosky	Molecular survey of microbial diversity in hypersaline ecosystems
Bruce M. Jakosky	Remote sensing of planetary surfaces
Bruce M. Jakosky	Mars Global Surveyor (MGS) Mars data analysis
Bruce M. Jakosky	NASA IPA as Senior Scientist in Astrobiology
Alain Jouchoux	On-call Technical support
Steven W. Lee	Multi-decade observations of Martian surface variability and sediment transport: Integrated analyses of Mariner 9 through Mars Global Surveyor Data
Steven W. Lee	Ozone, condensates, and dust in the Martian atmosphere
Xinlin Li	Energization of outer radiation belt electrons
Xinlin Li	Detailed study of the magnetic storms selected for GEM Inner Magnetosphere and Storms Campaign
Xinlin Li	Solar wind fluctuations and their consequences on the magnetosphere
William E. McClintock	MESSENGER Science Team Phase B
William E. McClintock	MESSENGER: The atmospheric and surface composition spectrometer
William E. McClintock	Modeling and exploring thermophysical surface properties and effects on surface-bound exosphere
Michael T. Mellon	High Resolution thermal inertia of Mars
Michael T. Mellon	The distribution of near-surface ground ice on Mars
Michael T. Mellon	Small-scale polygons and the history of ground ice on Mars
Keiji Otsuki	Dynamical evolution of ring-satellite systems
Keiji Otsuki	Growth and orbital evolution of protoplanets
Wayne R. Pryor	Heliospheric hydrogen and helium models
Wayne R. Pryor	Models of the carbon monoxide airglow on Venus
Wayne R. Pryor	High resolution UV spectroscopy and temporal variability of Jupiter's aurora
Wayne R. Pryor	Advanced aerobot formation flying
Wayne R. Pryor	Radiative transfer work for Cassini ISS

Wayne R. Pryor	Solar Irradiance forecasting: Data assimilation and visualization
Wayne R. Pryor	Time variability in Jupiter's auroras from Galileo UVS and HST STIS
Cora E. Randall	Derivation of ozone photochemical loss by combining satellite data and a 3-Dimensional chemical transport model
Cora E. Randall	Assimilation of ozone data sets
Cora E. Randall	Investigation of the temporal variation in Polar NO_2
Cora E. Randall	Reanalysis of Solar Mesosphere Explorer 1.27 micron data
Cora E. Randall	Influence of tropospheric and solar forcing on the circulation and composition of the middle atmosphere
Gary J. Rottman	Continuation of the science analysis and data validation of the UARS SOLSTICE
Gary J. Rottman	Solar Radiation and Climate Experiment (SORCE)
David Rusch	Aeronomy on ice in the mesosphere (AIM)
David Rusch	Tropospheric aerosol experiment (TRAX)
Nicholas M. Schneider	Satellite atmosphere and Io torus observations
Karen E. Simmons	Voyager 2 PPS data archiving
Stanley Solomon	Student Nitric Oxide Experiment (SNOE)
Stanley Solomon	Thermospheric odd-nitrogen response to auroral energy
Glen R. Stewart	Dynamics of planetesimals and planetary accretion
Glen R. Stewart	Late stages of accretion of Uranus and Neptune
Glen R. Stewart	Dynamical models of solar system formation and evolution
Stein Sture	Mechanics of Granular Materials (MGM)
Stein Sture	Mechanics of Granular Materials (MGM) Test of the PSU II Board
Gary E. Thomas	Polar Mesospheric Cloud Studies
Gary E. Thomas	Search for possible solar cycle and long term trends in the PMC from SBUV and SBUV2
O Brian Toon	Stratospheric clouds and aerosols
O. Brian Toon	Contrail persistence and aircraft exhaust impacts on cirrus

O. Brian Toon	Theoretical investigations of clouds and aerosols in the stratosphere and upper troposphere
O. Brian Toon	Investigations of desert dust and smoke in the North Atlantic in support of the TOMS instrument
O. Brian Toon	Numerical simulations of atmospheric aerosols to aid in the interpretation of EOX data
O. Brian Toon	Numerical simulations of atmospheric aerosols: Focus on the tropical Atlantic
Thomas N. Woods	Solar extreme ultraviolet experiment (SEE)
Thomas N. Woods	Design, calibration and test services for EUV photodiodes