

The NASA Genesis spacecraft was launched in August 2001 with the primary operational goal of collecting pristine samples of the solar wind (SW) in ultra-pure materials and returning these samples to Earth in 2004 for precision elemental and isotopic analysis in ground-based laboratories. It is well known that there can be compositional variations in the solar wind, depending on the origin of the plasma flows. What is not certain is if there are also isotopic variations that can be tied to flow type. To help resolve this question, Genesis has three SW regime-specific collectors that are either shielded or exposed to the SW flow, depending on the type of wind flowing past the spacecraft. The three SW regimes the different collectors sample are coronal hole, coronal mass ejection and interstream flows. Changes in the SW regime are autonomously determined in real-time using plasma parameters (proton speed and temperature, helium abundance and counterstreaming electron signatures) obtained from plasma ion and electron spectrometers onboard the spacecraft, and the collectors are then deployed accordingly. The question we wish to address in this talk is: do the solar wind regime determinations based on plasma parameters correlate with distinct variations in SW elemental abundances? The answer to the question of whether there are isotopic variations among the different SW regimes will have to wait for analysis of the SW samples once they are returned to Earth next year. As the Genesis plasma spectrometers were not designed to measure compositional variations in the SW, we will utilize the abundance and charge state measurements for O, Mg, Fe, etc. that have been made by the SWICS instrument on the ACE spacecraft and correlate these with the three SW flow types as determined by Genesis. Attempting a correlation of these two data sets is thought to be valid for a large percentage of the study period as both Genesis and ACE are located near the L1 point and likely sample the same flows. Preliminary analysis of the data suggests that there is no distinct compositional transition that divides the slow and fast SW regimes, and that CME composition is independent of flow speed and most resembles that of the slow solar wind. Further results of our attempts to correlate elemental abundance variations with solar wind regime type will be presented at the meeting.

## SH11D-1148 0830h POSTER

### Modeling of an Energetic Particle Event Focused on Evolutionary Behavior in Low-Energy Range of a Proton Flux

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Energetic particle acceleration events are thought to be associated with coronal mass ejection (CME)-driven shock waves. In our previous paper (Den, et al., 2001), we insisted that there are at least two types in gradual solar energetic particle (SEP) events. One is that the peak intensities of accelerated particles are below 10 MeV, they often coincide with the shock passage, and behavior of gradual enhancement of a particle flux preceding the shock passage indicates that a particle transport process is not apparent, namely an acceleration close to the sun is ineffective, and certainly no large X-ray flares are related with the source CMEs. The other is that the particles are accelerated to larger than 10 MeV, the large X-ray flares are correlated with the source CMEs very well and feature of a particle flux depends on the solar longitude where the source CME or associated large flare occurred. In this paper, using EPAM data on board the ACE spacecraft, we study time evolution of an energy spectrum of a proton flux in the range of 47 - 4750 keV for the energetic particle event occurred on 255 DOY in 1999, which is regarded as one of typical events of the former type. It is found that the energy spectrum in lower energy range, less than 0.5 MeV, enhanced faster, that is, the spectrum gets softer, which means that the acceleration mechanism is ineffective, and this behavior may give a key concerned with the seed population of the shock acceleration. In order to find energy dependence of a diffusive coefficient, we analyze the magnetic field data observed by MAG on board the ACE and obtain correlation function of the magnetic field. Our result shows that the diffusive coefficient is in proportion to a particle energy. We perform modeling this event including this consequence by numerical simulations using stochastic differential equation method. Our simulation results indicate that insufficiently accelerated particles may exist around 1 AU to explain the evolutionary behavior of the energy spectrum obtained by the observational data.

## SH11D-1149 0830h POSTER

### Solar Energetic Particle Event Onset as Analyzed From Simulated Data

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Solar energetic particle (SEP) event onset is analyzed using simulated data. A large number of simulations using different coronal and interplanetary (IP) scattering conditions are performed. Protons in the energy range of 0.13–57 MeV are considered. The simulated data are analyzed employing a velocity dispersion analysis (VDA) to the proton-flux onset times in 16 energy channels. As a result of the analysis, the apparent coronal release time,  $t_0$ , and the apparent IP path length,  $s$ , of the first-observed particles are obtained. It is shown that typical IP scattering conditions, i.e., 1-GV radial mean free path of  $\Lambda_{rr} = 0.1$ –1 AU with a  $\propto P^{1/3}$  rigidity dependence, lead to apparent path lengths of  $s \sim 1$ –2 AU, consistent with observations. Thus, SEP events with  $s \sim 2$  AU can simply be explained as a result of IP scattering. Models with coronal mean free paths small enough to enable shock acceleration to high energies close to the Sun are shown to yield VDA results in agreement with observations, at least with  $\Lambda_{rr} > 0.3$ . As a result of IP scattering, the inaccuracy of the release times is tens of minutes in events with  $s > 2$  AU, which may prevent accurate timing of particle release using the VDA method in such events. Low contrast between the time-of-maximum intensity of the studied SEP event and the pre-event background intensity and/or large difference between the forms of the respective energy spectra may also lead to errors in derived onset times. Best timing results (with errors typically less than 10 min) are obtained for large IP mean free paths,  $\Lambda_{rr} > 0.3$  AU (typically resulting in small values of  $s < 1.5$  AU), and large intensity contrast between the SEP event and the pre-event background.

## SH11D-1150 0830h POSTER

### Transport of solar energetic particles in non-uniform heliospheric magnetic fields: comparison between test particle simulations and the diffusion approximation

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Solar energetic particles are highly anisotropic, so it is necessary to use an anisotropic equation to study their transport. The simulations of charged particle orbits in the Parker field with model turbulence will be used to study the properties of the magnetic focussing effect, adiabatic cooling, and diffusive transport in pitch angle distribution of solar energetic particles. A derived formula will be shown for the adiabatic cooling effect of particles with an anisotropic distribution. The time profile of particles' pitch angle will be obtained from the numerical computations in order to study the magnetic focussing effect and the particle pitch angle diffusive transport due to turbulence. The time profile of particle momentum will also be obtained from the numerical simulations to study the adiabatic cooling effect; and it will be compared with analytic formulae of the adiabatic cooling rate. This work is partly supported by NSF SHINE Grant 0203252 and NASA Grant NAG5-13514.

## SH11E MCC: 2008 Monday 1020h

### The Sun's Spectrum and Life on Earth I (joint with A, SA, GC)

Presiding: J Lean, Naval Research

Laboratory; T Woods, Laboratory for Atmospheric and Space Physics, University of Colorado

## SH11E-01 1020h INVITED

### Measurement of the Solar Spectral Irradiance and its Variability

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Solar electromagnetic radiation is the dominant direct energy input to the terrestrial system. Studies of the Earth's atmosphere, land surface, and ocean require a detailed knowledge of this radiation in order to fully understand the global climate system – and in particular to separate natural influences from possible human induced change. Irradiance measurements made today provide the time variations that are necessary input for today's climate studies. Furthermore, future global change research will rely on today's observations as an essential component of the long-term climate forcing. Measurement of solar irradiance variability can only be conducted from space. In the 1970s and 1980s space radiometers provided a first insight that total solar irradiance (TSI) varies on the order of 0.1 to 0.2%. At the same time spectrometers established that the ultraviolet spectral irradiance varies by 10% decreasing to 1% between 200 and 300 nm, and by much larger factors at shorter UV wavelengths. However, at wavelengths longer than 300 nm, in the visible and near infrared, the solar irradiance variation is much less than 1% (as constrained by the TSI observations), and with the exception of a few selected wavelengths, spectral observations had never been capable of establishing the true solar variability for this important part of the solar spectrum. In January 2003 the NASA Solar Radiation and Climate Experiment, SORCE, was launched. This satellite carries four scientific instruments including one that measures TSI and two that measure the solar ultraviolet irradiance. These observations continue the data records of UARS, ACRIMSAT, ERBE, TIMED, and SOHO. Moreover, SORCE carries a new instrument specifically developed to measure the Sun's visible and near-infrared irradiance with sufficient precision and accuracy to detect wavelength dependent variability. This talk describes the SORCE mission and provides an overview of the first nine months of SORCE observations.

## SH11E-02 1040h INVITED

### Role of Sun in the Forcing of Climate

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Solar irradiance variations and change constitute an important forcing for the Earth's climate system. Sufficiently precise satellite-based measurements in the recent decades have provided information on the total solar irradiance and its variability over the 11-year activity cycle. Variations over longer periods, extending back to the pre-industrial era, are more difficult to quantify. According to the IPCC (2001) assessment, the solar forcing of climate over the period 1750 to present is about one-eighth of that due to the increase in the well-mixed greenhouse gases. Coupled three-dimensional atmosphere-ocean model simulations have been employed to determine the climatic effects of solar irradiance changes, and compare it with the effects due to the well-mixed greenhouse gases and other forcings. Important issues in this regard are: dynamical response of the climate system to different radiative perturbations; climate sensitivity due to solar forcing versus other natural, and anthropogenic forcing agents; response in the vertical profile of climate change; changes induced in stratospheric circulation, stratosphere-troposphere interactions and effects at the polar latitudes.

## SH11E-03 1100h INVITED

### Displacements of the Aleutian Low and the Hawaiian High Pressure Systems During the Solar Cycle.

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Most empirical studies undertaken in the past fo-  
cused on the connection of the solar cycle with climatic  
variables at specific geographic locations. We have in-  
vestigated the influence of the 11-year solar cycle on  
extensive climate variables, the semi-permanent cen-  
ters of action. Based on analysis of more than one  
hundred years of sea level pressure data we conclude  
that extremes in solar variability as measured by the  
annual sunspot numbers correlate highly with the lo-  
cations of the semi-permanent pressure systems in the  
North Pacific. The Aleutian Low moves westward dur-  
ing solar maximum conditions and the Hawaiian High  
moves northward. Also, the area-weighted surface pres-  
sure of the Aleutian Low is significantly higher near  
the solar maximum. As a result large anomalies in re-  
gional climatic conditions in North America and East  
Asia are generated in the extreme phases of the solar  
cycle. Concomitant displacements of planetary waves  
in the troposphere and the stratosphere suggest path-  
ways that couple solar variations to surface climate.

## SH11E-04 1120h INVITED

### Ultraviolet Radiation and Stratospheric Ozone

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Ultraviolet radiation from the sun produces ozone  
in the stratosphere and it participates in the destruc-  
tion of ozone. Absorption of solar ultraviolet radiation  
by ozone is the primary heating mechanism leading to  
the maximum in temperature at the stratopause. Vari-  
ations of solar ultraviolet radiation on both the 27-day  
solar rotation period and the 11-year solar cycle af-  
fect ozone by several mechanisms. The temperature  
and ozone in the upper stratosphere respond to solar  
uv variations as a coupled system. An increase in uv  
leads to an increase in the production of ozone through  
the photolysis of molecular oxygen. An increase in uv  
leads to an increase in temperature through the heat-  
ing by ozone photolysis. The increase in temperature  
leads to a partially-offsetting decrease in ozone through  
temperature-dependent reaction rate coefficients. The  
ozone variation modulates the heating by ozone photol-  
ysis. The increase in ozone at solar maximum enhances  
the uv heating. The processes are understood and sup-  
ported by long-term data sets. Variation in the upper  
stratospheric temperatures will lead to a change in the  
behavior of waves propagating upward from the tropo-  
sphere. Changes in the pattern of wave dissipation will  
lead to acceleration or deceleration of the mean flow  
and changes in the residual or transport circulation.  
This mechanism could lead to the propagation of the  
solar cycle effect of solar uv variation from the upper  
stratosphere downward to the lower stratosphere. This  
process is not well-understood and has been the subject  
of an increasing number of model studies. I will review  
the data analyses for solar cycle and their comparison  
to model results.

## SH11E-05 1140h INVITED

### Effects of Solar Ultraviolet Variability on the Stratosphere: A Sun-Climate Connection

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Solar ultraviolet radiation at wavelengths near 200  
nm is responsible for photodissociation of molecular  
oxygen and ozone production in the stratosphere. On  
the time scale of the 27-day solar rotation period, pre-  
vious work has documented the response of the upper  
stratosphere and lower mesosphere to solar UV varia-  
tions. This response is largely a result of direct pho-  
tochemical and radiative forcing. Recent work, how-  
ever, indicates an additional response to 27-day UV  
forcing in the lower stratosphere, including the tropi-  
cal tropopause region. The thermal response maxi-  
mizes near the 100 hPa level and amounts to 0.24 +/-  
0.07 Kelvin for a 4% change in the solar UV flux near  
200 nm (typical of UV variations occurring on this time  
scale under solar maximum conditions). The phase lag  
is 2 +/- 2 days. Parallel analyses using other solar-  
correlated variables (total solar irradiance, Galactic  
cosmic ray flux, etc.) verify that the solar UV flux is  
the most probable forcing mechanism. It is suggested  
that the observed thermal response near the tropical  
tropopause is caused by changes in upwelling rates in-  
duced by the direct effects of solar UV forcing in the  
upper stratosphere. On the time scale of the 11-year  
solar cycle, stratospheric total column ozone and lower  
stratospheric temperature are also observed to vary ap-  
proximately in phase with the solar UV flux during the

period since 1979 when continuous global satellite mea-  
surements began. Most of the column ozone variation  
occurs in the lower stratosphere (85% below 16 hPa), a  
result that contrasts with most prior model predictions.  
At low latitudes, there is evidence that the observed  
ozone and temperature variation is caused by changes  
in upwelling rates that are, in turn, probably due to ob-  
served decadal changes in extratropical wave forcing.  
The latter may be modulated by the direct effects of  
solar UV variations in the upper stratosphere. These  
observed lower stratospheric dynamical effects of solar  
UV variations and their secondary tropospheric con-  
sequences must be understood to allow more accurate  
model simulations of solar-induced climate change.

## SH11E-06 1200h INVITED

### Energy Balance, Climate, and Life – Work of M. Budyko

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This talk will review the work of Mikhail I. Budyko,  
author of "Climate and Life" and many other works,  
who died recently at the age of 81 in St. Petersburg,  
Russia. He directed the Division for Climate Change  
Research at the State Hydrological Institute. We will  
explore Budyko's work in clarifying the role of energy  
balance in determining planetary climate, and the role  
of climate in regulating Earth's biosphere.

## SH12A MCC: Level 2 Monday 1330h

### The Sun's Spectrum and Life on Earth II Posters (*joint with A, SA, GC*)

**Presiding: G Rottman**, Laboratory for  
Atmospheric and Space Physics,  
University of Colorado; **E Hilsenrath**,  
NASA Goddard Space Flight Center

## SH12A-1151 1330h POSTER

### Observations of Solar Spectral Irradiance Change During Cycle 22 from NOAA-9 SBUV/2

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The NOAA-9 Solar Backscatter Ultraviolet, model 2  
(SBUV/2) instrument is one of a series of instruments  
providing daily solar spectral irradiance measurements  
in the middle and near ultraviolet since 1978. This in-  
strument did not have onboard monitoring of all time-  
dependent response changes that affect the solar data.  
Thus a combination of internal and external techniques  
was used to derive the instrument's long-term instru-  
ment characterization. The corrected NOAA-9 solar  
spectral irradiance data between 170 and 400 nm ex-  
tend from March 1985 to May 1997, spanning two solar  
cycle minima with a single instrument. The NOAA-9  
data show an amplitude of 9.3(±2.3)% (81-day aver-  
aged) at 200-205 nm for solar cycle 22. This is con-  
sistent with the result of  $\Delta F_{200-205} = 8.3(\pm 2.6)\%$   
for cycle 21 from Nimbus-7 SBUV and  $\Delta F_{200-205} =$   
 $10(\pm 2)\%$  (daily values) for cycle 23 from UARS SUSIM.  
NOAA-9 data at 245-250 nm show a solar cycle ampli-  
tude of  $\Delta F_{245-250} = 5.7(\pm 1.8)\%$ . These data were  
used to investigate whether there was a trend in ab-  
solute solar spectral irradiance between the solar cycle  
21 and 22 minima. We find an irradiance difference of  
±1% or less between the two minima. The observed  
differences are less than the uncertainty in the long-  
term instrument calibration and should not be consid-  
ered statistically significant. NOAA-9 SBUV/2 data  
can be combined with other instruments to create a  
25-year record of solar UV irradiance.

## SH12A-1152 1330h POSTER

### Spectral Solar Irradiance Variability from VIRGO on SOHO: 1996 to present

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Since February 1996 VIRGO filterradiometers on  
SOHO monitor spectral solar irradiance at 402, 500  
and 862nm with a bandwidth of 5nm. SOHO's van-  
tage point at L1 allows uninterrupted observations of  
the Sun, 24 h a day and 365 days a year. Besides  
the 3-month gap during the SOHO vacation in summer  
1998 and a few other minor gaps the record covers more  
than 99% of the period up to now of almost 8 years of  
observations. The long-term behaviour of the opera-  
tional channels is dominated by instrumental degrada-  
tion masking the solar variability signature. However,  
comparisons with the back-up channels allows to take  
off some of the instrumental long-term variation, and  
the resulting time series can now provide reliable infor-  
mation about variability with periods up to about 4-  
500 days. Time series with the long-term variation re-  
moved and the corresponding periodogram show many  
similarities between the three channels and total so-  
lar irradiance. Details about the spectral redistribu-  
tion during changes of TSI are investigated by multi-  
variate spectral analysis. Furthermore, comparison of  
the spectral analysis of the cleaned 1-minute sampled  
time series during solar minimum (1996/7) and max-  
imum (2001/2) allows to assess the variation of power  
with the activity cycle in a range from about 30 mHz  
(about 1 year period) up to 8 mHz (5-minute oscilla-  
tions). The variability with activity of the three colours  
is compared with the one of TSI.

## SH12A-1153 1330h POSTER

### The Solar Soft X-ray Irradiance and its None-flare Variability

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The interval from 1965 to 1970 represents a unique  
period of time during which full-disk solar soft X-ray  
spectral observations and broadband soft X-ray flux  
measurements were made concurrently. Bragg crystal  
spectrometers flown on sounding rockets and orbiting  
spacecrafts provided data on spectral distributions be-  
tween 0.8 and 2.5 nm during non-flaring periods, but  
with rather uncertain flux calibrations, while simultane-  
ous observations by the NRL Solrad series of ion-  
ization chambers provided broadband and instrumen-  
tally stable flux coverage. We have combined these  
two types of observations to obtain in-flight calibra-  
tion of the crystal spectrometer data taken over a wide  
range of solar activity. The Chianti spectral program  
was used to derive solar spectra matching the emis-  
sion line distributions observed by the spectrometers  
and these theoretical spectra (with derived continua)  
were applied to the Solrad ion chamber measurements  
to recalculate their sensitivities for actual spectral dis-  
tributions rather than for the "gray body" radiation  
used originally. The resulting absolute integrated flux  
values were then applied to the spectrometer observa-  
tions to obtain absolute fluxes in specific emission lines.  
Changes in individual line fluxes between 0.8 and 2.5  
nm as a function of the 2800 Mhz (F10) radio flux have  
also been determined and will be presented.

## SH12A-1154 1330h POSTER

### Time Series Analysis of SOLSTICE Measurements

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Solar radiation is the major energy source for the  
Earth's biosphere and atmospheric and ocean circula-  
tions. Variations of solar irradiance have been a ma-  
jor concern of scientists both in solar physics and at-  
mospheric sciences. A number of missions have been  
carried out to monitor changes in total solar irradiance  
(TSI) [see Fröhlich and Lean, 1998 for review] and spec-  
tral solar irradiance (SSI) [e.g., SOLSTICE on UARS  
and VIRGO on SOHO]. Observations over a long time  
period reveal the connection between variations in so-  
lar irradiance and surface magnetic fields of the Sun  
[Lean1997]. This connection provides a guide to sci-  
entists in modeling solar irradiances [e.g., Fontenla et al.,  
1999; Krivova et al., 2003].

Solar spectral observations have now been made over a  
relatively long time period, allowing statistical analy-  
sis. This paper focuses on predictability of solar spec-  
tral irradiance using observed SSI from SOLSTICE .