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 focused on the connection of the solar cycle with climatic variables at specific geographic locations. We have investigated the influence of the 11-year solar cycle on extensive climate variables, the semi-permanent centers 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 locations of the semi-permanent pressure systems in the North Pacific. The Aleutian Low moves westward during solar maximum conditions and the Hawaiian High moves northward. Also, the area-weighted surface pressure of the Aleutian Low is significantly higher near the solar maximum. As a result large anomalies in regional 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 pathways 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 destruction of ozone. Absorption of solar ultraviolet radiation by ozone is the primary heating mechanism leading to the maximum in temperature at the stratopause. Variations of solar ultraviolet radiation on both the 27-day solar rotation period and the 11-year solar cycle affect 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 heating 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 photolysis. The increase in ozone at solar maximum enhances the uv heating. The processes are understood and supported 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 troposphere. 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, previous work has documented the response of the upper stratosphere and lower mesosphere to solar UV variations. This response is largely a result of direct photochemical and radiative forcing. Recent work, however, indicates an additional response to 27-day UV forcing in the lower stratosphere, including the tropical tropopause region. The thermal response maximizes 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 induced 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 approximately in phase with the solar UV flux during the period since 1979 when continuous global satellite measurements 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 observed 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 consequences 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

Robert F. Cahalan (301-614-5390; Robert.F.Cahalan@nasa.gov)

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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 instrument 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 instrument characterization. The corrected NOAA-9 solar spectral irradiance data between 170 and 400 nm extend 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 averaged) at 200-205 nm for solar cycle 22. This is consistent 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 amplitude of $\Delta F_{245-250} = 5.7(\pm 1.8)\%$. These data were used to investigate whether there was a trend in absolute 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 considered 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 vantage point at L1 allows uninterrupted observations of the Sun, 24 h a day and 365 days an 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 operational channels is dominated by instrumental degradation 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 information about variability with periods up to about 4–500 days. Time series with the long-term variation removed and the corresponding periodogram show many similarities between the three channels and total solar irradiance. Details about the spectral redistribution during changes of TSI are investigated by multivariate spectral analysis. Furthermore, comparison of the spectral analysis of the cleaned 1-minute sampled time series during solar minimum (1996/7) and maximum (2001/2) allows to asses the variation of power with the activity cycle in a range from about 30 nHz (about 1 year period) up to 8 mHz (5-minute oscillations). 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 between 0.8 and 2.5 nm during non-flaring periods, but with rather uncertain flux calibrations, while simultaneous observations by the NRL Solrad series of ionization chambers provided broadband and instrumentally stable flux coverage. We have combined these two types of observations to obtain in-flight calibration 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 emission 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 distributions rather than for the "gray body" radiation used originally. The resulting absolute integrated flux values were then applied to the spectrometer observations 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 circulations. Variations of solar irradiance have been a major concern of scientists both in solar physics and atmospheric 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 spectral solar irradiance (SSI) [e.g., SOLSTICE on UARS and VIRGO on SOHO]. Observations over a long time period reveal the connection between variations in solar irradiance and surface magnetic fields of the Sun [Lean1997]. This connection provides a guide to scientists 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 analysis. This paper focuses on predictability of solar spectral irradiance using observed SSI from SOLSTICE .