

A11A CC: 520 D Monday 0830h

Magnitude and Causes of Decreasing Surface Solar Radiation: The Global Picture (*joint with B, H, GC*)

Presiding: S Cohen, Institute of Soil, Water and Environmental Sciences, Agricutural Research Organization of Israel; B G Liepert, Lamont-Doherty Earth Observatory

A11A-01 0830h

Magnitude and Causes and Consequences of Decreasing Surface Solar Radiation in the Last Decades

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This paper presents an overview of the session's topic. A history of published papers on observed reductions of surface solar radiation will be presented and reviewed. Possible causes will be discussed and put into perspective. The role of anthropogenic aerosols and greenhouse gases versus natural changes in cloudiness and surface albedo is subject of this session and will be introduced. Climate simulations with general circulation models provide information on consequences of surface solar flux changes for the hydrological cycle. These processes and other possible consequences will be discussed.

A11A-02 0845h INVITED

Global Reduction of Solar Radiation by Absorbing Aerosols and Its Implications to Climate and Hydrological Cycle

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The Indian Ocean Experiment has clearly documented the large reduction in solar radiation reaching the surface due to absorbing aerosols, particularly black carbon and dust. The INDOEX data are combined with other field observations to estimate aerosol induced reduction worldwide. We have integrated the MODIS aerosols data with available field campaigns and emission sources to evaluate the globally averaged reduction in solar radiation. Regionally, the seasonally averaged reduction reaches values as large as 10 to 30 Wm⁻². Using coupled ocean-atmosphere model developed at NCAR, we explore the implications of this reduction to the hydrological cycle. The main result is that the reduction leads to a significant reduction in land averaged rainfall. In addition the reduction has implications to frequency of deep convection and subsequent impacts on the aerosol life times and changes in vertical lapse rates.

A11A-03 0915h

Do satellites detect trends in surface solar radiation?

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Scarcity of environmental observations, both in time and space, hinder the ability to detect signals of climate change. The most frequently used parameter to test climate change hypotheses is shelter temperature, for which long term records are available. The major forcing function that determines the surface temperature is the solar radiation. Global trends in this

parameter are very difficult to establish from ground observations due to instrument quality, small number of observing stations, and instrument maintenance and calibration. Most available estimates of large or global scale distributions of radiative fluxes come from synthesis of ground observations and from model estimates. At present, several efforts are underway to use satellite observations of the PATHFINDER type to estimate radiative fluxes both at the surface and at the top of the atmosphere. In addition to the methodology used to infer such fluxes, the accuracy of the derived values depends on the quality of the satellite data, instrument calibration, the spatial and temporal resolution of the satellite observation *s* that enter the computations, and the spatial and temporal resolution to which these estimates are amalgamated. There is a need for a systematic evaluation of all of the above issues and their impact on the large-scale estimates obtained. In this presentation, an attempt will be made to present large and global scale statistics of radiative fluxes derived with an inference scheme developed at the University of Maryland as driven with about twenty years of satellite observations from the NOAA/NASA Pathfinder IS-CCP data at 2.5 degree spatial resolution at 3 hourly time resolution and optimally interpolated, using an EOF approach. The record will be analyzed for trends and ability to detect strong climatic signals within the twenty-year period.

A11A-04 0930h

Changes in the earth's reflectance over the past two decades

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Since 1998, earthshine measurements of the Earth's reflectance have been routinely carried out at Big Bear Solar Observatory. We correlate the overlapping period (1999 through mid-2001) of these observations with satellite observations of global cloud properties to construct from the latter a proxy measure of the Earth's global shortwave reflectance. This proxy shows a steady decrease in the earth's reflectance from 1984 to 2000, with a strong drop during the 1990's. During 2001-2003 only earthshine data are available, and they indicate a complete reversal of the decline. The radiative forcing implied by either of these decadal changes in reflectance is climatologically significant, and could explain the observed variability in surface solar radiation reported in the literature. Understanding how these changes are apportioned between natural variability, direct forcing and feedbacks, is thus fundamental to confidently assessing and predicting climate change.

A11A-05 0945h INVITED

Evidence for Trends, and Lack Thereof, in Surface Solar Irradiance as Seen in Calibration-error-free Records of Cloud Shortwave Transmission for the Past Three Decades at Five Globally Diverse Sites

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Prior to the mid 1970's there did not exist a method of making observations of solar irradiance to an absolute accuracy better than a few percent. Until the mid 1980s, even that low level of accuracy was only achievable through extraordinary effort because commercial pyranometers are known to drift in sensitivity by up to several percent per year under some conditions. To maintain a stable measurement it is necessary to physically relate routine field measurements to international reference standards using transfer standards. Prior to the early 1980s many of these transfer standards were of less than desirable stability, especially in some countries, and while at the same time international reference standards were just undergoing development. Since the early 1990's considerable effort has gone into maintaining the absolute accuracy of ground-based solar irradiance observations. A brief review of this documented history will be presented for background along with the long-term variability in a number of surface irradiance records. To further analyze long-term observational records extending back into the period of dubious calibration pedigree, rationing or differencing methods are often utilized where the parameter of interest is the short term change in radiation, often over

diurnal cycles or between periods of clear and cloudy skies. These short term changes can be expressed in percent or as the ratio of the irradiance and hence only the linearity and zero of the irradiance sensor are required to be known and not sensor's correspondence to an absolute irradiance scale. In this manner, conditions that contribute to affecting the amount of solar irradiance reaching the ground can be monitored over the long term. Using this general differencing procedure, we have examined the long-term changes in clear sky and cloudy sky irradiance relative to closely associated reference irradiances thereby having a tool to continuously monitor the solar transmission of clouds or clear skies over the extended periods. We examine three decades of typically calibrated pyranometer data at five globally diverse sites and nearly 45 years of direct solar beam irradiance record at one site using these techniques and find interesting but small variations in cloud and clear sky transmittance over this time period. The surface records examined are from: Barrow, Alaska; Boulder, Colorado; Mauna Loa, Hawaii; American Samoa; and the South Pole. Since the early 1990s considerable effort has been expended by the international irradiance measurement community to greatly increase the routine accuracy of surface solar irradiance observations so that direct analysis of long term changes in irradiance will be more readily verifiable. The second portion of this paper summarizes a related recent paper in JGR/Atmos. by the author.

A12A CC: 520 D Monday 1030h

Magnitude and Causes of Decreasing Surface Solar Radiation: More Evidence (*joint with B, H, GC*)

Presiding: R T Pinker, University of Maryland; M L Roderick, Research School of Biological Sciences, Australian National University

A12A-01 1030h INVITED

Solar Forcing at the Earth's Surface : Extending the Record

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The small number, short duration and uneven spatial distribution of pyranometer measurements impose an important limitation to our understanding of changes in solar forcing at the Earth's surface; this contribution explores the methods available to extend the data base. The first approach discussed is the exploitation of hitherto unused pyranometer records some of which date from the beginning of the last century. The second approach uses long term series of widely measured parameters such as evaporation from open water surfaces, diurnal temperature range and visibility known to be causally and statistically related to global irradiance. The third approach discussed in some detail concerns the potentials and limitations in the use of sunshine duration records as a proxy for global and possibly direct solar irradiance. Preliminary results from analyses of the 20th century USA and Japanese national data bases and other, individual long term series are presented to show a common sensitivity of approximately 1.5 MJ m⁻² per sunshine hour. The accuracy and limitations of estimates of annual changes based on sunshine duration measurements are discussed.

A12A-02 1045h

Means and Trends of Shortwave Irradiance at the Surface Estimated From GEBa and WRDC Data.

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