Potential Decadal Variations in Surface Solar Irradiance

E.G. Dutton[1], D. Longenecker[1,2], D. Nelson[1], and R. Stone[1,2]

[1]NOAA Climate Monitoring and Diagnostics Laboratory, 325 Broadway, Boulder, CO 80305;
303-497-6660, Fax: 303-497-5590, E-mail: Ellsworth.G.Dutton@noaa.gov
[2]Cooperative Institute for Research in Environmental Sciences, University of Colorado, Boulder 80309

Did variations in the surface solar irradiance dominate over greenhouse forcing in the global surface energy budget in recent decades? Numerous papers over the past decade show significant decreases in surface solar irradiance at a wide variety of sites between 1960 and 1990. One of the earliest of these papers was from CMDL and was based on solar radiation at the South Pole for 1976-1990. Many of the other time series extend to pre-1976 into an era of uncertain absolute radiometer calibrations. There are also records that do not show the decrease, and there are no records for large portions of the Earth. Surface solar radiation is subject to large temporal and spatial variations making the determination of global climatologically representative trends extremely difficult. However, given the preponderance of observations indicating a significant decrease (up to 15%) in surface irradiance between the 1960s and 1990s, the validity of these records and the potential impact on the global surface energy budget and climate should be considered. Some estimates of the multi-decadal decrease in surface solar energy are several times larger than the increase in the downwelling infrared irradiance because of greenhouse forcing over the same period of time. A global cooling did actually occur during the first portion of the period but turned to a warming period in about 1979. The component of the surface energy budget that can account for this discrepancy is surface evaporation. There is conflicting observational evidence as to whether the necessary variations in surface evaporation actually occurred. General circulation model (GCM) calculations have shown that if surface solar irradiance decreases because of increased cloud or aerosol, this mechanism is a plausible explanation of the observed global temperature increase driven by reduced global evaporative cooling plus greenhouse warming. After 1990 there is little evidence for a continued widespread decrease in solar irradiance, and available global cloudiness records suggest a decrease leading to increasing solar heating of the surface. Records since 1990 are under evaluation for an expected turnaround or leveling of the earlier trends.

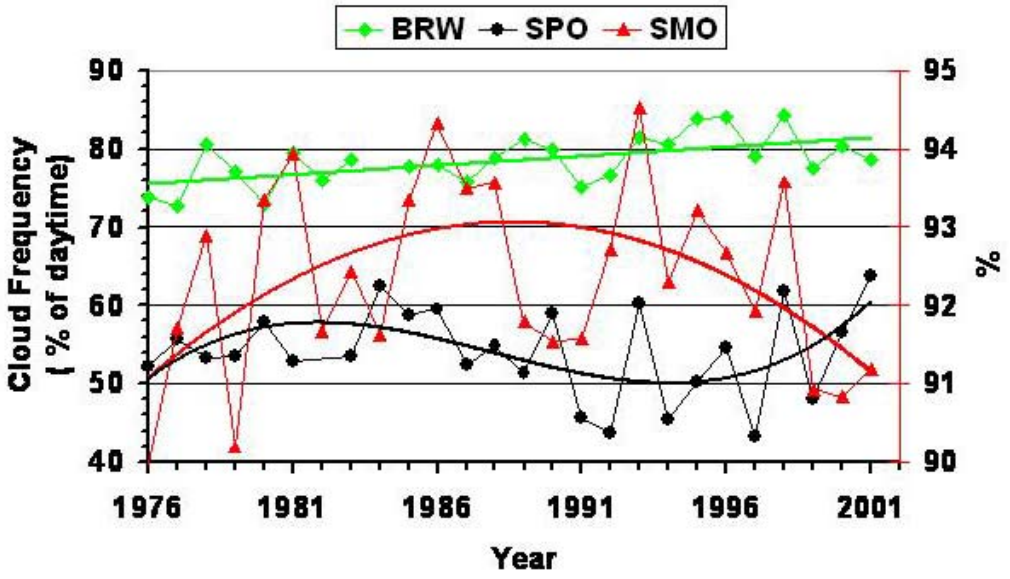

Figure 1. Time series of cloud frequencies of occurrence at three CMDL sites that show a statistically significant (> 95%confidence) variations over the past 28 years.