Surface Radiation at Globally Remote Sites: From Dimming and Brightening to Warming

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Consistent, long-term, surface radiation observations have been acquired by ESRL from a remote, globally-distributed and climatically-diverse network for more than 30 years for the solar component and 15 years for the thermal IR. The downwelling solar and IR irradiances are major components of the net surface energy budget and are indicative of variations in atmospheric composition as well as the resulting impacts on atmospheric energetics influencing weather and climate. Each of the records, solar and IR from this and other networks have previously indicated interesting variations that warrant further monitoring. The solar irradiance records have indicated larger than anticipated decadal variations, first decreases in the early portion of the record, prior to the mid 1980s, then changing to increases. These features that have been referred to as "Global Dimming then Brightening", where the term "global" was originally intended to refer to the observed quantity at a particular site. Because a majority of reporting sites around the world appeared to be seeing a similar phenomenon, discussions arose at to whether the term "Global" could be appropriately applied in planetary or worldwide sense. An update on the most recent worldwide surface-base data as it applies to a possible extension of the brightening phase will be provided. The potential role of aerosols and recently suggested aerosol trends in explaining these variations will also be considered. However, taken over the entire period of record not net change in surface solar irradiance can be seen in the longest ESRL data. These variations also have a potential impact on renewable solar energy applications. Regarding the thermal or IR irradiance records, the continued evaluation of the anticipated and previously observed upward trends have now been compared to related results from 22 of the IPCC AR-4 GCM models. The relative agreement between the range of individual models and the observations can be used as one indicator of the model performance given that the comparison is appropriate considering spatial representativeness differences. The globally remote surface IR observations suggest a best-estimate rate of growth that exceeds the consensus of the 22 AR-4 models but that is in close agreement with a small subset of the models displaying the highest IR growth rates over the period of the observations, as shown in Fig. 1.

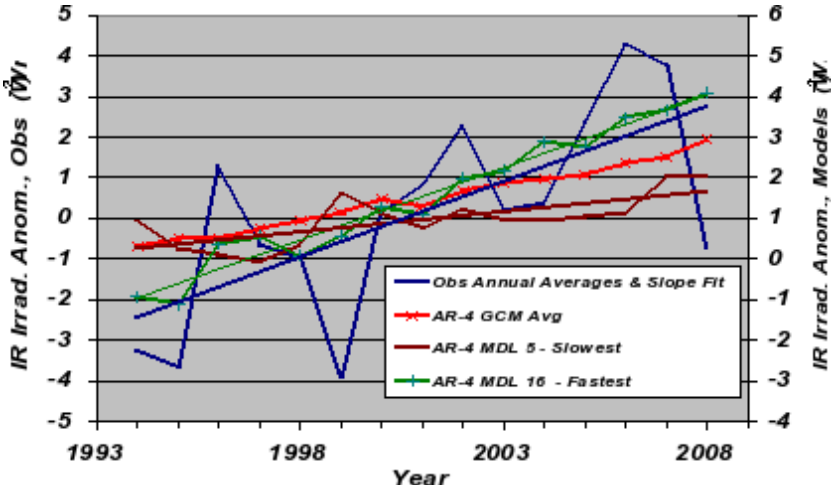

Figure 1. Comparison of IPCC AR4-modeled and ESRL-observed surface downwelling IR radiation, annual average anomalies averaged over 5 globally remote surface sites and corresponding model grid boxes. Right Y-axis shifted to account for different anomaly base periods.