



Atmospheric Controls on Climate Variability of Surface Incident Solar Radiation

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The Earth's climate system is driven by surface incident solar radiation (Rs). Direct measurements have shown that Rs has undergone significant decadal variations. However, large areas are not covered by these observations. Satellite-derived Rs that has global coverage is of low accuracy in its depictions of decadal variability. This paper shows that daily to decadal variations of terrestrial Rs, from both aerosols and cloud properties, can be accurately estimated using globally available measurements of Sunshine Duration (SunDu). We find that cloud cover variation controls Rs at a monthly scale but aerosols contribute most of the variability of Rs at a decadal time scale. In particular, since the late 1980's it has brightened over Europe due to decreases in aerosols and dimmed over China due to increases in aerosols. Because of its global availability and long-term history, SunDu provides an accurate and continuous proxy record of Rs that fills in the blank areas not covered by direct measurements. By merging direct measurements of Rs with those derived from SunDu, we obtain a good coverage over the Northern Hemisphere. The average increase from 1982 to 2008 is estimated to be 0.87 Wm⁻² per decade.