Geophysical Research Abstracts, Vol. 8, 06156, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06156

Influence of cloud cover changes on solar dimming and brightening over Europe

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Multidecadal changes in surface downward shortwave radiation flux and cloud cover are examined over Europe during 1965-2004 using Global Energy Balance Archive (GEBA) measurements, synoptic cloud reports, and International Satellite Cloud Climatology Project (ISCCP) data. In order to quantify the radiative impact of cloud cover changes in the pre-satellite era, shortwave radiation anomalies caused by cloud cover anomalies are estimated from synoptic cloud reports. This is accomplished by multiplying monthly cloud cover anomalies by the ratio of climatological shortwave cloud radiative forcing divided by climatological cloud cover. The correlation between pan-European shortwave radiation anomalies estimated from synoptic cloud reports and measured by GEBA is 0.90, indicating that cloud cover variability dominates radiation variability on monthly to subdecadal time scales. On longer time scales, GEBA measurements show that downward shortwave radiation flux was less during the late 1970s through the mid 1980s than it was during the 1960s and 1990s. Previous studies have attributed this "dimming" followed by "brightening" to changes in anthropogenic aerosol concentration, but we find that cloud cover trends also play a substantial role. In particular, enhanced cloud cover during the late 1970s contributed to smaller values of downward shortwave radiation flux whereas diminished cloud cover in the 1990s contributed to larger values of radiation flux. After removal of cloud cover effects, the residual in GEBA downward shortwave radiation flux more strongly decreases until 1984 and more weakly increases thereafter than does the original GEBA time series. These residual changes may be associated with changes in aerosol or cloud optical properties.