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Analysis of the decrease in the tropical mean outgoing shortwave radiation at the top of atmosphere for the period 1984-2000

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Abstract. A decadal-scale trend in the tropical radiative energy budget has been observed recently by satellites, which however is not reproduced by climate models. In the present study, we have computed the outgoing shortwave radiation (OSR) at the top of atmosphere (TOA) at 2.5° longitude-latitude resolution and on a mean monthly basis for the 17-year period 1984-2000, by using a deterministic solar radiative transfer model and cloud climatological data from the International Satellite Cloud Climatology Project (ISCCP) D2 database. Anomaly time series for the mean monthly pixel-level OSR fluxes, as well as for the key physical parameters, were constructed. A significant decreasing trend in OSR anomalies, starting mainly from the late 1980s, was found in tropical and subtropical regions (30° S-30° N), indicating a decadal increase in solar planetary heating equal to 1.9±0.3Wm^{-2}/decade, reproducing well the features recorded by satellite observations, in contrast to climate model results. This increase in solar planetary heating, however, is accompanied by a similar increase in planetary cooling, due to increased outgoing longwave radiation, so that there is no change in net radiation. The model computed OSR trend is in good agreement with the corresponding linear decadal decrease of 2.5±0.4Wm^{-2}/decade in tropical mean OSR anomalies derived from ERBE S-10N non-scanner data (edition 2). An attempt was made to identify the physical processes responsible for the decreasing trend in tropical mean OSR. A detailed correlation analysis using pixel-level anomalies of model computed OSR flux and ISCCP cloud cover over the entire tropical and subtropical region (30° S-30° N), gave a correlation coefficient of 0.79, indicating that decreasing cloud cover is the main reason for the tropical OSR trend. According to the ISCCP-D2 data derived from the combined visible/infrared (VIS/IR) analysis, the tropical cloud cover has decreased by 6.6±0.2% per decade, in relative terms. A detailed analysis of the inter-annual and long-term variability of the various parameters determining the OSR at TOA, has shown that the most important contribution to the observed OSR trend comes from a decrease in low-level cloud cover over the period 1984-2000, followed by decreases in middle and high-level cloud cover. Note, however, that there still remain some uncertainties associated with the existence and magnitude of trends

in ISCCP-D2 cloud amounts. Opposite but small trends are introduced by increases in cloud scattering optical depth of low and middle clouds.

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