Changes in TOA Net Flux over South Asia and Pakistan with changing Cloud Radiative Effect (CRE) and Aerosols

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Abstract

The presence of elevated levels of greenhouse gases in the atmosphere have caused an imbalance in energy flows in and out of the earth system at the top of the atmosphere (TOA). Furthermore, clouds exhibit a key role in the earth's climate system by influencing atmospheric radiative heating, surface energy balance, general circulation and resulting precipitation. The main control on incoming top-of-atmosphere (TOA) solar radiation aside from the sun-Earth geometry is the planetary albedo, which can change as clouds or aerosols change. Simultaneously, clouds control outgoing longwave radiation (OLR) and absorb solar radiation (ASR). The Clouds and the Earth's Radiant Energy System (CERES) satellite data for cloud properties and Net Flux with a spatial resolution of 1x 1has been used for analysing the changes in the atmospheric energy balance over Pakistan and South Asia. The parameters have been studied at the seasonal scales to better understand the relationship of these parameters with climatic trends. Results depict a decreasing trend in TOA Net Flux over South Asia (-0.15 w/m^2/year) and Pakistan (-0.12 w/m^2/year) implying either a decrease in absorbed shortwave radiation or an increase in outgoing longwave radiation in cooling at the TOA. Cooling in the winter season whereas warming in other seasons is observed in Pakistan. Furthermore, besides winter, all other seasons have increasing trend in Net Flux , implying an increase in absorbed radiation and decline in outgoing radiation. Shortwave CRE is observed to have decreased (-0.14 w/m^2/year) whereas as longwave CRE has increased (+0.13 w/m^2/year), both being most pronounced in the pre-monsoon seasons. These findings point towards an increase in warming properties of clouds and decrease in the cooling effect. The radiation and cloud properties would be further correlated with the increasing aerosols in the region, specifically during pre-monsoon and post-monsoon events of haze and smog.

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