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Shallow cumulus to fair weather transition: cloud radiative effects and relation to dynamic atmospheric conditions

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Cloud properties strongly depend on the variability of dynamic and thermodynamic atmospheric conditions. To better understand cloud properties and their effect on the earth's radiative balance, it is important to study distinct atmospheric weather regimes and their variability and understand how this variability relates to the corresponding meteorological conditions. Clustering technique uses the properties of the cloud field to define distinct groupings of cloud types that form distinct cloud systems corresponding to particular regimes. A recent study [Tselioudis et al. 2013] applies a statistical clustering technique to ISCCP data over the global domain to joint cloud optical depth-cloud top pressure histograms of cloud amount and identify dominant weather states (WSs) of cloud variability. Time trend analysis of the WSs shows a sharp increase of the fair-weather WS in the 1990s and a flattening and even a small decrease in the 2000s, while the shallow cumulus state shows the exact opposite time behaviour. The dynamic environment and the radiative signature of these weather state changes are derived and their variability is examined. We find that the weather state changes correlate strongly with SW radiation with a SW warming of 3.5W/m2 in the 1980s and 1990s followed by a shortwave cooling of about 2W/m2 in the 2000s. Furthermore, variability and trends in Sea Surface Temperature (SST) and midtropospheric vertical velocity are correlated with the variability and trends of the two cloud-defined weather states in order to examine potential mechanisms that may be responsible for the weather state trends. We show that the changes in the fair weather conditions may have been caused by changes in tropical SSTs, but also that the cloud changes may have provided a positive feedback to the surface temperature changes. In addition, changes in large-scale subsidence in accordance with the changing SSTs appear to force the changes in the tropical cloud conditions.