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Dependence of cloud properties derived from spectrally resolved visible satellite observations on surface temperature

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Abstract. Cloud climate feedback constitutes the most important uncertainty in climate modelling, and currently even its sign is still unknown. In the recently published report of the intergovernmental panel on climate change (IPCC), 6 out of 20 climate models showed a positive and 14 a negative cloud radiative feedback in a doubled CO_2 scenario. The radiative budget of clouds has also been investigated by experimental methods, especially by studying the relation of satellite observed broad band shortwave and longwave radiation to sea surface temperature. Here we present a new method for the investigation of the dependence of cloud properties on temperature changes, derived from spectrally resolved satellite observations in the visible spectral range. Our study differs from previous investigations in three important ways: first, we directly extract cloud properties (effective cloud fraction and effective cloud top height) and relate them to surface temperature. Second, we retrieve the cloud altitude from the atmospheric O_2 absorption instead from thermal IR radiation. Third, our correlation analysis is performed using 7.5 years of global monthly anomalies (with respect to the average of the same month for all years). For most parts of the globe (except the tropics) we find a negative correlation of effective cloud fraction versus surface-near temperature. In contrast, for the effective cloud top height a positive correlation is found for almost the whole globe. Both findings might serve as an indicator for an overall positive cloud radiative feedback. Another peculiarity of our study is that the cloud-temperature relationships are determined for fixed locations (instead to spatial variations over selected areas) and are based on the "natural" variability over several years (instead the anomaly for a strong El-Nino event). From a detailed comparison to cloud properties from the International Satellite Cloud Climatology Project (ISCCP), in general good agreement is found. However, also systematic differences occurred indicating that our results provide independent and complementary information on cloud properties. Climate models should thus aim to reproduce our findings. Recommendations for the development of a "processor" to convert model results into the cloud sensitive quantities observed by the satellite are given.

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