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Aerosol-cloud interaction inferred from MODIS satellite data and global aerosol models

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Abstract. We have used the MODIS satellite data and two global aerosol models to investigate the relationships between aerosol optical depth (AOD) and cloud parameters that may be affected by the aerosol concentration. The relationships that are studied are mainly between AOD, on the one hand, and cloud cover, cloud liquid water path, and water vapour, on the other. Additionally, cloud droplet effective radius, cloud optical depth, cloud top pressure and aerosol Ångström exponent, have been analysed in a few cases. In the MODIS data we found, as in earlier studies, an enhancement in the cloud cover with increasing AOD. We find it likely that most of the strong increase in cloud cover with AOD, at least for AOD<0.2, is a result of aerosol-cloud interactions and a prolonged cloud lifetime. Large and mesoscale weather systems seem not to be a cause for the increase in cloud cover with AOD in this range. Sensitivity simulations show that when water uptake of the aerosols is not taken into account in the models the modelled cloud cover mostly decreases with AOD. Part of the relationship found in the MODIS data for AOD>0.2 can be explained by larger water uptake close to the clouds since relative humidity is higher in regions with higher cloud cover. The efficiency of the hygroscopic growth depends on aerosol type, the hygroscopic nature of the aerosol, the relative humidity, and to some extent the cloud screening. By analysing the Ångström exponent we find that the hygroscopic growth of the aerosol is not likely to be a main contributor to the cloud cover increase with AOD. Since the largest increase in cloud cover with AOD is for low AOD (~0.2) and thus also for low cloud cover, we argue that cloud contamination is not likely to play a large role. However, interpretation of the complex relationships between AOD and cloud parameters should be made with great care and further work is clearly needed.

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