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Regime based investigation of aerosol-cloud interactions

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Atmospheric aerosols have been shown to have an important effect on the climate, both by interactions with radiation and by indirect processes modifying cloud properties. Recent studies have suggested an aerosol effect on convective clouds, but it is not necessarily clear to what extent these observed correlations are due to aerosol effects. For example, these correlations may be due to meteorological co-variation, with similar atmospheric conditions giving rise to high cloud cover and increased aerosol optical depth. 'Cloud contamination' of aerosol retrievals may also play a role generating the observed correlations.

Further difficulties in studying aerosol-cloud interactions comes from the lack of time resolution, so that a correlation between aerosol and cloud properties indicates that they tend to occur at similar times, not necessarily that aerosols are correlated with cloud development. This 'snapshot' view of the aerosol and cloud properties makes it difficult to separate out different possible effects on cloud development.

In this study we apply an objective method of separating clouds into different regimes using a k-means clustering method for satellite retrieved cloud optical depth - cloud top pressure histograms. Defining high and low aerosol optical depth on a gridbox by gridbox basis to reduce possible spurious correlations caused by climatological spatial gradients, we see large changes in the frequency of occurrence of these cloud regimes with changing aerosol optical depth.

We use a time resolved satellite product (ISCCP) to study how aerosols are correlated with the development of clouds. Selecting clusters of clouds with similar properties, we can study their development in high and low aerosol environments for the 3hrs following the aerosol measurement. By studying correlations of aerosols with cloud development rather than the 'snapshot' correlations, we can reduce retrieval errors associated with cloud contamination and gain further insight into aerosol effects on the cloud development, which is of particular relevance for convective cloud properties.