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The impacts of an observationally-based cloud fraction and condensate overlap parameterization on a GCM's Cloud Radiative Effect

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It has been shown that the details of how cloud fraction overlap is treated in GCMs has substantial impact on shortwave and longwave fluxes. Because cloud condensate is also horizontally heterogeneous at GCM grid scales, another aspect of cloud overlap should in principle also be assessed, namely the vertical overlap of hydrometeor distributions. This type of overlap is usually examined in terms of rank correlations, i.e., linear correlations between hydrometeor amount ranks of the overlapping parts of cloud layers at specific separation distances. The cloud fraction overlap parameter and the rank correlation of hydrometeor amounts can be both expressed as inverse exponential functions of separation distance characterized by their respective decorrelation lengths (e-folding distances). Larger decorrelation lengths mean that hydrometeor fractions and probability distribution functions have high levels of vertical alignment. An analysis of CloudSat and CALIPSO data reveals that the two aspects of cloud overlap are related and their respective decorrelation lengths have a distinct dependence on latitude that can be parameterized and included in a GCM. In our presentation we will contrast the Cloud Radiative Effect (CRE) of the GEOS-5 atmospheric GCM (AGCM) when the observationally-based parameterization of decorrelation lengths is used to represent overlap versus the simpler cases of maximum-random overlap and globally constant decorrelation lengths. The effects of specific overlap representations will be examined for both diagnostic and interactive radiation runs in GEOS-5 and comparisons will be made with observed CREs from CERES and CloudSat (2B-FLXHR product). Since the radiative effects of overlap depend on the cloud property distributions of the AGCM, the availability of two different cloud schemes in GEOS-5 will give us the opportunity to assess a wide range of potential cloud overlap consequences on the model's climate.