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Retrieving CCN column density from single-channel measurements of reflected sunlight over the ocean: A sensitivity study

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ABSTRACT

The Twomey effect is an increase of the cloud albedo with increasing concentration of tropospheric aerosols serving as cloud condensation nuclei (CCN). Confirmation and quantification of this effect on a global basis requires accurate satellite retrievals of CCN concentrations. We present a theoretical study of the ability of passive satellite remote sensing techniques to provide reliable estimates of tropospheric aerosol column densities over the ocean. We show that a retrieval algorithm based on single-channel single-viewing-angle radiance measurements is incapable of accurately determining CCN column densities and that an algorithm based on multiangle radiance measurements provides much better retrievals. However, even for the latter algorithm the errors in retrieving CCN column densities can exceed a factor of 5. The poor performance of single-channel radiance-only algorithms is explained by the strong dependence of the extinction cross section and weak dependence of the phase function on aerosol effective radius. In contrast, high-precision multiangle polarization measurements, which are much more sensitive to aerosol

microphysics, are capable of constraining CCN column densities to within a few tens of percent.