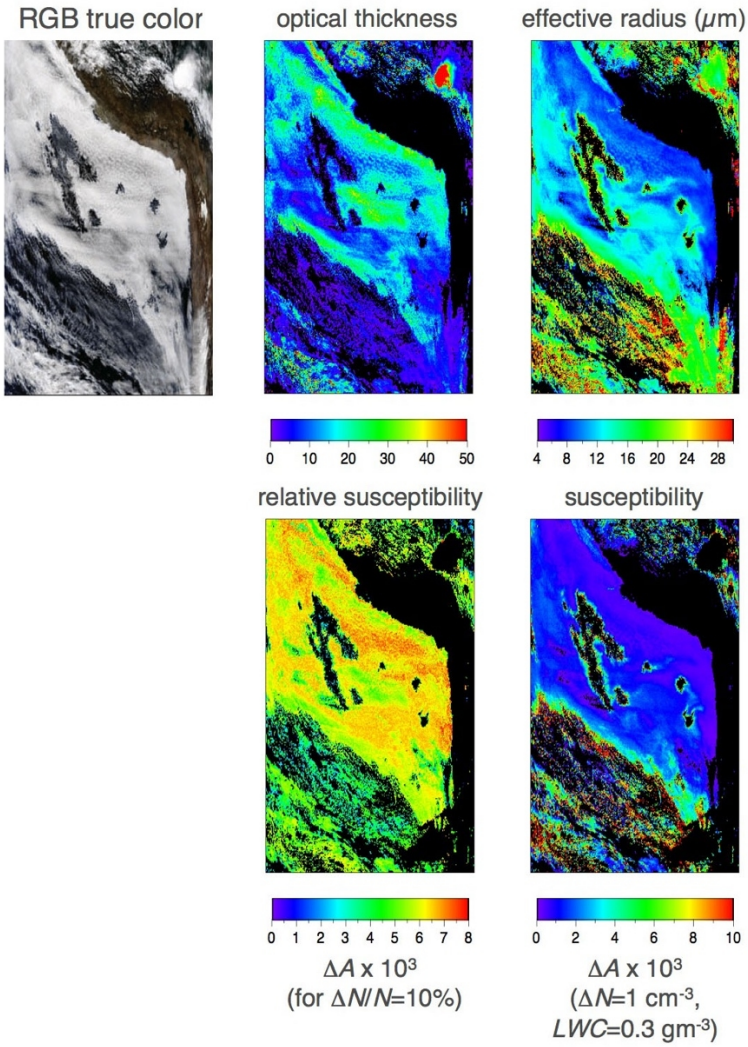
Observations of Cloud Susceptibility



The sensitivity of the top-of-atmosphere (TOA) albedo to changes in liquid water cloud droplet number concentration derived from MODIS Terra operational cloud retrievals (MOD06) of extensive marine stratocumulus clouds off the coasts of Chile and Peru on 18 July 2001. This droplet concentration sensitivity, also known as “cloud susceptibility”, is a measure of the potential effect of aerosols on cloud radiative properties, i.e., the 1st indirect effect of aerosols or the “Twomey effect”. The MODIS data granule (5 minutes of data) true color composite is shown in the upper left image. In the northern part of the image, a convective system of predominantly ice phase clouds is seen over the Amazon basin along with some liquid phase clouds. Two susceptibilities are calculated from the MODIS retrievals. The standard susceptibility dA/dN, where A is albedo and N is droplet concentration, is approximated with a broadband radiation model by calculating the radiative effect from increasing the absolute concentration by 1 cm-3 with liquid water content being held to a constant value of 0.3 gm-3. This is shown in the lower right image in terms of the resulting broadband TOA perturbation ΔA, which includes surface albedo and atmospheric effects. A relative susceptibility (perturbation due to a relative change in the droplet concentration) is shown in the lower left image for ΔN/N=10%. Note that the two susceptibilities have different dependencies on the cloud effective radius (top right) and optical thickness (top middle). The ability to calculate cloud susceptibilities directly from observational data allows for realistic assessments of 1st indirect effect radiative forcing scenarios, as well as a means for validating global susceptibilities from climate models.

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