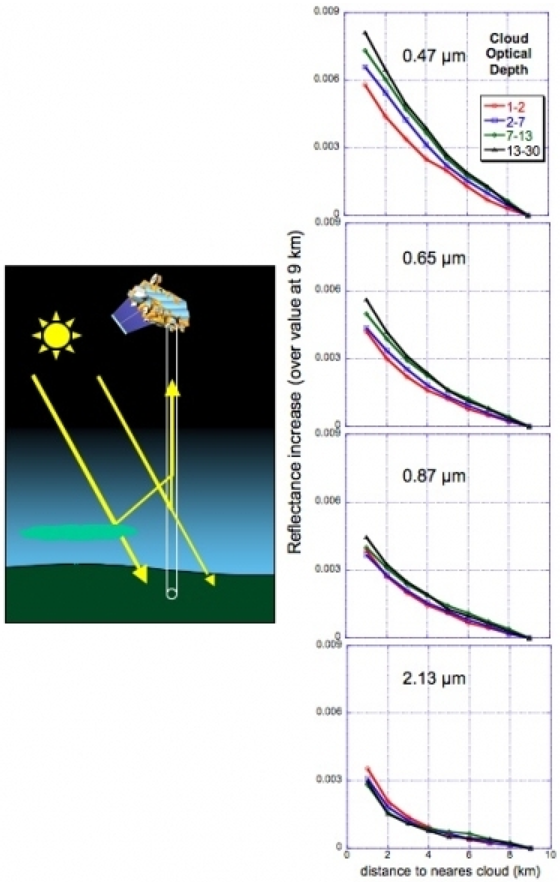
Cloud-Free Air is Brighter at Shorter Wavelengths Around Thicker Clouds



These images illustrate a recent study on aerosol-cloud interactions, a problem that scientists at the NASA/Goddard Space Flight Center's Climate and Radiation Branch have studied extensively. To understand these interactions and their effects on climate, researchers often use satellite measurements of aerosol near clouds. However, the vicinity of clouds introduces a number of complications into space-based aerosol measurements; three-dimensional (3D) radiative interactions between clouds and their surroundings is one of them. The left panel illustrates the main mechanism of such 3D interactions: clouds reflect sunlight toward nearby cloud-free areas, thus enhancing the illumination of air molecules that scatter light toward our satellites. Theoretical studies suggest that ignoring this 3D enhancement risks overestimating the amount of light-reflecting aerosol near clouds. The right panels show satellite observations which confirm that 3D effects are indeed important at the shorter wavelengths visible to the human eye. For each wavelength, a separate panel summarizes hundreds of images taken by the Terra satellite's MODIS instrument over the North-East Atlantic Ocean (click here for the location). As the 3D mechanism on the left suggests, average clear-sky brightnesses increase near clouds. The top panels even show that at the shorter wavelengths where air molecules are effective scatterers, the increase is stronger if the nearby clouds are thicker and reflect more sunlight toward cloud-free areas. At longer wavelengths, however, weak scattering by air molecules makes 3D effects negligible, and this makes clear-sky brightnesses independent from cloud thickness. We note that at longer wavelengths, the modest increase near clouds is caused by a slight blurring due to instrument imperfections, the presence of small undetected cloud puffs, and changes in aerosol properties (for example swelling in the humid air near clouds). Analyzing 3-D effects will help improve the accuracy of space-based aerosol measurements and will help better understand the way aerosols (including human emissions) influence clouds and climate.

Tamas Varnai, Alexander Marshak