Clouds Brighten Up the Sky Near Them

Research Highlight

A few years ago researchers noticed that the sky is slightly brighter near clouds than farther away from them. Scientists studying atmospheric aerosols got especially interested in this observation, because the brightness of sky is often used for measuring the amount of aerosol particles. Does the enhanced brightness indicate that the air near clouds contains larger and/or more particles, which then scatter extra sunlight toward the observer? Recent lidar measurements revealed that the swelling of aerosol particles in the humid air near clouds is certainly an important factor—but is it the only factor? Could clouds also contribute by scattering extra sunlight to the air surrounding them (Figure 1)?

Scientists involved in ARM have studied this question using ground-based instruments looking up; now they are taking a second look using satellite instruments looking down. They analyzed statistics for hundreds of satellite images of the North East Atlantic Ocean that were taken by the Terra satellite's MODIS (MODerate-resolution Imaging Spectroradiometer) instrument. They found that even though swelling should be similar on both sides of clouds, the brightness of sky increases more near the sunlit side of clouds (which can scatter more sunlight) than near the shadowy side (Figure 2, top panel). Moreover, they also found that the sky gets especially bright near thicker clouds, which contain more droplets and can scatter more sunlight toward surrounding regions (Figure 2, bottom panel). The results suggest that clouds scattering sunlight to nearby clear air plays an important role in brightening the sky near clouds.

This finding has implications for aerosol measurements that rely on observing the amount of scattered sunlight, using either satellites looking down or ground-based instruments looking up. Since current methods interpret clear-sky observations without considering the enhanced illumination from nearby clouds, they attribute the observed brightness enhancements entirely to changes in aerosol properties, and so their estimates of aerosol content near clouds can be inaccurate. Several ARM scientists have already begun exploring new data interpretation methods for alleviating this problem. By providing more accurate aerosol measurements, such new methods could improve our understanding of the radiative effects of atmospheric aerosols and the effects of aerosols on cloud properties.

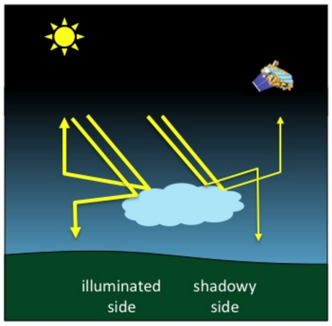

Figure 1. Illustration of clouds enhancing the brightness of sky in nearby clear areas. In cloud-free areas light is scattered mainly by air molecules, but aerosols also contribute.

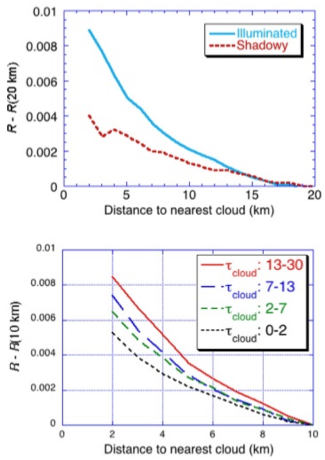

Figure 2. Top: Average increase in MODIS clear-sky reflectivity (R) near clouds. The difference between areas near illuminated and shadowy cloud sides can be attributed to more intense light scattering at illuminated cloud sides. Bottom: Average increase in MODIS clear-sky reflectivity near clouds having various optical thickness (#) values. The increase is larger near thicker clouds because they can scatter more sunlight to nearby areas. Both panels are for blue light at 0.47 µm wavelength.

Reference(s)

Varnai T and A Marshak. 2009. "MODIS observations of enhanced clear sky reflectance near clouds." Geophysical Research Letters, 36, L06807, doi:10.1029/2008GL037089.

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Radiative Processes

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