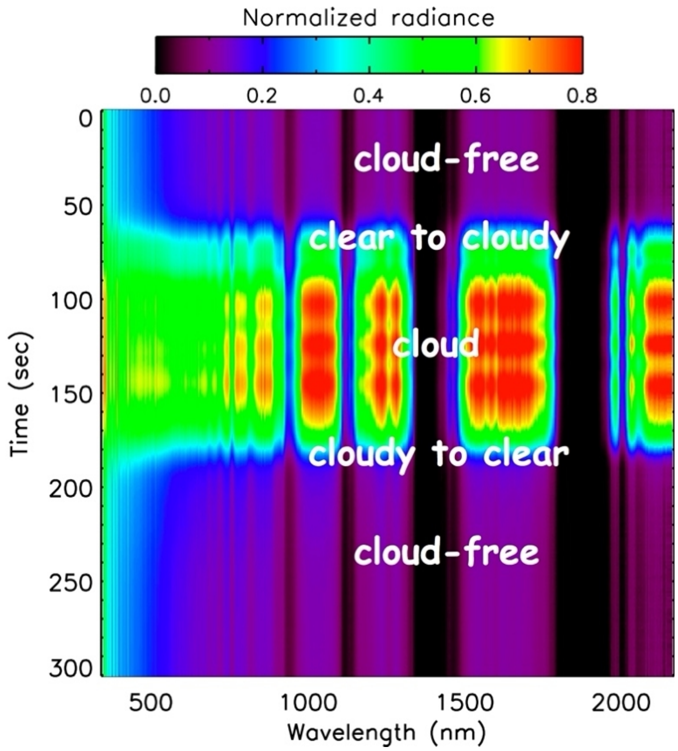
What's going on around cloud edges: interpretations of spectral measurements of the overhead radiance

ARM shortwave spectrometer



Although clouds seem to have a distinct boundary, it has been difficult to define the boundary from remotely-sensed measurements. This problem has major climatic consequences, in particular on studies of aerosol-cloud interactions, which require a precise separation of cloudy and cloud-free air. The image at the left shows the new Atmospheric Radiation Measurement (ARM) program Shortwave Spectrometer (SWS) that provides rich information for studying aerosol and cloud properties in the transition zone between cloudy and cloud-free areas. The SWS, deployed in March 2006, looks straight up and measures overhead radiance at 418 wavelengths in the visible and infrared spectral region, with an unprecedented 1-sec sampling resolution. The image at the right panel (time versus wavelength) shows how overhead radiances change when a cumulus cloud passed by at the ARM Oklahoma site. At each wavelength the radiance has been normalized by the radiance at the top of the atmosphere. During the first minute and the last two minutes, low radiance (blue, purple color) indicates that the sky is cloud-free. During the remaining two minutes (60 to 180 sec.), high radiance (red color) indicates that the cumulus cloud has passed by. It is evident that there are two transition periods (green color) between cloudy and cloud-free periods. Click here to see the time series of total sky images for this case. Analyzing spectral behavior of the overhead radiance measured by the SWS helps us to learn more about radiative properties of aerosols and clouds, including optical depth and particle (droplet) size, in the transition zone between cloudy and cloud-free areas. Knowledge of aerosol and cloud properties corresponding to SWS-observed radiative signatures will advance our understanding of physical processes such as evaporation and activation of cloud droplets, rising humidity, and humidification of aerosols as well as modeling aerosol-cloud interactions and predicting cloud evolutions.

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