Wide Angle Infrared Imaging for Measuring Clouds for Earth-Space Optical Communications

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The Infrared Cloud Imager (ICI) is a radiometrically calibrated thermal infrared imaging instrument developed at Montana State University to measure cloud statistics. This instrument was developed originally as part of a joint U.S.-Japan effort to study the arctic atmosphere. The ICI provides localized high-resolution data relative to satellites images and, in contrast to visible imaging systems, provides continuous day and night operation.

In collaboration with the Optical Communications Group at NASA's Jet Propulsion Laboratory, we have begun to develop more compact, wide-angle systems for characterizing Earth-space optical communication paths. These new instruments expand the field of view, 50° in one version and 100° in the latest version, reduce instrument size, and reduce instrument cost.

These systems provide measurements through the following method: radiometrically calibrated images of the overhead sky are obtained, atmospheric emission is calculated and removed to isolate the cloud emission, and a multi-level threshold is used to provide a measurement of cloud presence and cloud type. The figure below shows an example of data measured at Bozeman, MT, with cloud-detection levels of: 0 no clouds, 1 very thin cirrus (2 W $m^{-2}sr^{-1}$), 2 cirrus clouds (5 $Wm^{-2}sr^{-1}$), 3 mid-level clouds (10 $Wm^{-2}sr^{-1}$), and 4 thick clouds (20 $Wm^{-2}sr^{-1}$).

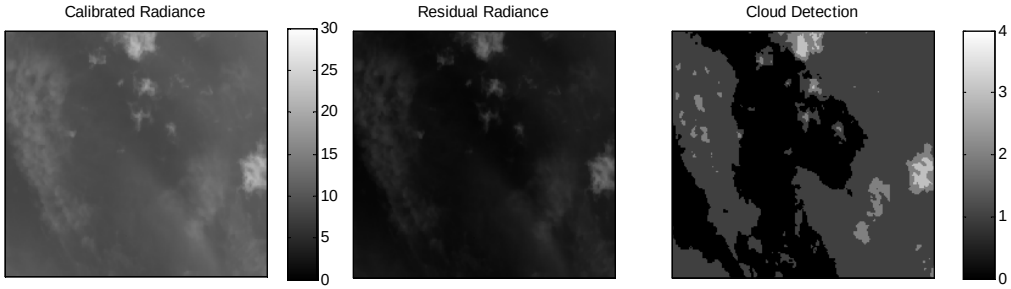

Figure 1. Cloud detection diagram from the 50° FOV Infrared Cloud Imager during a deployment in Bozeman MT. The panels are as follows: calibrated total sky radiance (left), residual sky radiance after removing atmospheric emission (center), and detected clouds (right).