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Infrared Sky Imager Takes a Shot in the Dark

Imaging technologies help scientists correlate and compare visual data with the non-visual data retrieved by instruments such as remote sensors (for example, radar and lidar systems). The total sky imager (TSI) is an imaging technology used at all the ACRF sites. It generates real-time color images of daytime sky conditions, and estimates of the fraction of the sky covered by clouds (cloud fraction) and cloud type can be derived from these images. Unfortunately, the TSI is a daylight-only instrument, and therefore cannot meet a critical variable in climate analyses – the complete evolution of cloud life cycles, including nighttime data.

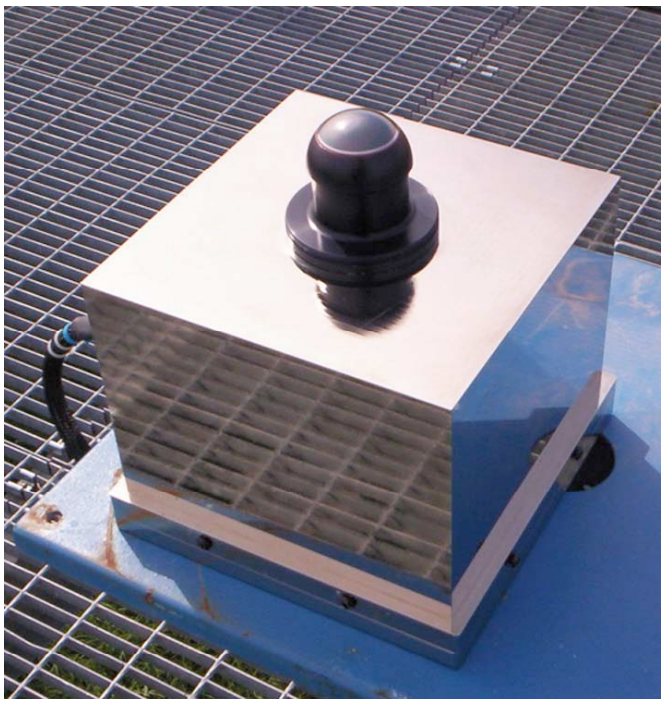

Figure 1. The infrared sky imager on the deck outside the Guest Instrument Facility at the SGP site (ARM photo).

Consequently, in July 2005, a new infrared sky imager (IRSI) system was installed at the ACRF Southern Great Plains (SGP) site. The IRSI system captures a nearly full hemispheric view (a 160-degree field) of infrared images of the sky during both daytime and nighttime. The IRSI images can be used to calculate the fraction of clear sky or the percentage of cloud cover. The addition of a nighttime cloud fraction

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measurement fills a major data void (continuous, accurate measurements of hemispheric cloud coverage) for ARM researchers.

The IRSI operates at thermal wavelengths (the infrared range from 8 to 14 micrometers), by using high-speed, precision optics to form images of low- and mid-altitude clouds. The images are captured by a thermal infrared detector. Unlike classical infrared sensors that had to be cooled by a cryogenic system, this detector operates at room temperature and is inherently more reliable and maintenance free.

To improve the IRSI's signal-to-noise ratio, discreet images can be combined by the sensor electronics before data transmission to a remote computer. The instrument software automatically identifies cloudy and clear regions and calculates the percentage of cloud.

Figure 2 compares TSI and IRSI images acquired at the same time of the afternoon at the SGP site. Both images clearly show the same basic cloud structures, a good first-order test of the accuracy of the IRSI. A significant benefit of the IRSI is that its nighttime image will have similar detail, whereas the TSI nighttime image is essentially all black.

Figure 2. Images at 15:31 on October 19, 2005. Left: True-color image from total sky imager, showing white clouds against blue sky background. Right: Image from infrared sky imager, with whites and grays indicating clouds (warmer temperatures) and black indicating colder temperatures (clear sky) (ARM image).

Operational testing and evaluation of the IRSI during the last year have resulted in some operational design changes. Continued testing and comparison of the IRSI's cloud fraction results with those from other systems such as the TSI will give SGP operations personnel an understanding of both the reliability and maintenance requirements of the IRSI system and also the characteristics of the resulting data. Depending on the IRSI's technical performance, additional systems may be deployed at all of the ACRF sites.