

Evaluation of an Infrared Sky Imager at the ARM Southern Great Plains Site

Victor R. Morris

Pacific Northwest National Laboratory

Introduction

To obtain retrievals of fractional sky cover over its research sites, the ARM Climate Research Facility uses Total Sky Imagers (TSI), which provide real-time processing and visible images of daytime sky conditions. However, for a continuous picture of cloud life-cycles, a nighttime visual technology is needed. Therefore, a new Infrared Sky Imager (IRSI) system was installed at the Southern Great Plains (SGP) site that captures full-hemisphere infrared images of the sky during both the day and night.

Objectives

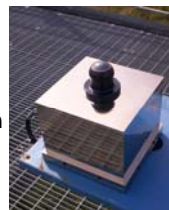
- Produce nighttime cloud fraction product at multiple fields-of-view
- Evaluate reliability and maintenance requirements of the system
- Compare cloud fraction data with TSI retrievals at 160° and 100° fields-of-view

System Configuration

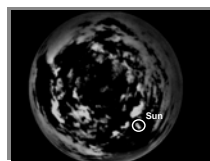
- Processing software incorporates four user-definable field-of-view retrievals centered on zenith
- Ferroelectric thermal infrared detector does not need cryogenic cooling
- Detector is resistant to direct solar illumination
- Orthographically-projected images are produced to make direct comparison with satellite images
- Data acquisition employs image averaging of 5 frames captured each 30-second sampling interval

Operational Testing

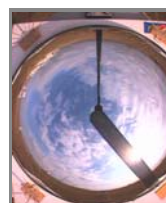
- Installed in October 2005 at SGP Guest Instrument Facility
- Failed after 3 weeks due to moisture intrusion
- Modified by manufacturer to minimize internal condensation
- Reinstalled in August 2006
- Evaluated reliability of system and characteristics of data



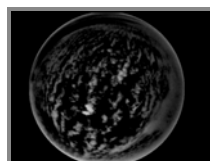
- Cloud images compare favorably with those from TSI



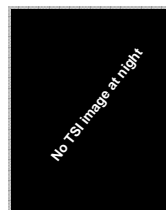
Daytime IRSI image
2/23/2007 at 11:27:22 AM



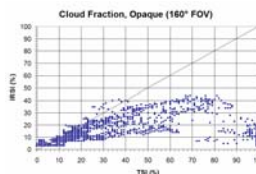
Daytime TSI image
2/23/2007 at 11:27:30 AM



Nighttime IRSI image
2/23/2007 at 02:47:52 AM



- Cloud fraction data underestimate TSI values, especially when sky is overcast



Opaque cloud fraction in percent from the IRSI and TSI at SGP from 10/30 to 11/6/2006

Summary

- The improved IRSI has been tested since August 2006
- Hardware upgrades appear to prevent moisture accumulation
- Daytime images compare well the TSI
- Cloud fraction data underestimate TSI values
- Evaluation period will continue after the manufacturer makes necessary software modifications
- Alternate systems may be investigated
- Additional systems may be deployed to all the ARM sites

Infrared Sky Imager

Provides hemispheric infrared images of the sky, during both day and night, and cloud fraction for four fields-of-view

Instrument: Blue Sky Imaging 320C All-Sky Thermal Infrared Camera

Spectral response: 8 to 14 μm

Detector: uncooled ferroelectric

Lens: diamond-coated Germanium

Image Resolution: 320 x 240 pixels

Temperature sensitivity: ~ 0.1 K

Minimum temperature detected: 240 K

Optical field of view: 180°

Angular resolution: 0.75°

Sample rate: 25 Hz

Operational temperature: -30° to +50°C

Acknowledgements

Lynne Roeder of PNNL for public information support
Jimmy Voyles of PNNL for engineering and operations support
Stuart McMuldloch of Blue Sky Imaging Ltd. for vendor representation