INFRARED LAND SURFACE EMISSIVITY RETRIEVAL FROM HIGH-SPECTRAL RESOLUTION UPWELLING RADIANCE

Robert O. Knuteson, Brian Osborne, Henry Revercomb, Bill Smith*, and David Tobin
Space Science and Engineering Center, University of Wisconsin-Madison; *NASA Langley Research Center

SUMMARY

Preliminary comparisons are presented between spectral emissivity

i) derived from airborne high spectral resolution infrared spectrometers (S-HIS and NAST-I) during the Oct-Nov 2000 ARM/FIRE Water Vapor Experiment (AFWEX), and

ii) derived from the ground-based University of Wisconsin Scanning-AERI (S-AERI) instrument.

A 4-wheel drive vehicular survey was used to characterize land

cover use in the region to create an appropriate averaging

mechanism for key representative S-AERI measurements, thus

improving the value of comparisons between ground

and airborne instrument emissivities.

RESEARCH METHODOLOGY

1. A library of spectral data was collected with the S-AERI

positioned on the roadside adjacent to a selection of fields

(including bare soil, wheat, sorghum, pastureland).

2. A corresponding cataloging of field types found alongside

22

miles of road near the CART site was undertaken by 4-wheel

drive vehicle.

3. The combination of the spectral library and statistical

information on the relative proportion of field type in the area

gives us the ability to determine a theoretical average emissivity

over a broader spatial scale permitting legitimate comparisons

with aircraft data, satellite, and GCM model data.

SURFACE AND ATMOSPHERIC EMITTED RADIANCE INTERFEROMETER (S-AERI)

0.5 cm⁻¹ resolution over 3.3 – 18 µm

COMPARISON OF SURFACE AND AIRBORNE EMISSIVITY MEASUREMENTS

THEORY

The radiative transfer equation used to describe the upwelling radiance at the top of the atmosphere under dry clean atmospheric conditions is shown in equation (1). This equation is undefined in the case where the surface emission is higher than the atmospheric emission, requiring the use of a nonequilibrium relationship (from equation (2) here).

\[ \int_{\nu} h(\nu, T) d\nu = \int_{\nu} \frac{1}{\pi} \int_{\nu} R_{\text{atm}}(\nu, T_{\text{atm}}) d\nu + \int_{\nu} \int_{\nu} R_{\text{surf}}(\nu, T_{\text{surf}}) d\nu + \int_{\nu} i(\nu) \int_{\nu} R_{\text{bed}}(\nu, T_{\text{bed}}) d\nu + \int_{\nu} i(\nu) \int_{\nu} R_{\text{wall}}(\nu, T_{\text{wall}}) d\nu + \int_{\nu} i(\nu) \int_{\nu} R_{\text{air}}(\nu, T_{\text{air}}) d\nu \]

Surface temperature can be obtained independently of surface emissivity with the Scanning-AERI measurements of upwelling and downwelling radiance. Eight representative sample sites within several miles of the CART site were visited with the S-AERI instrument.

AIRBORNE OBSERVATIONS

The S-HIS has a about a 1 km field of view spot size on the ground while the NAST-I FOV is about 2km.

CONCLUSIONS

- Progress has been made toward making a quantitative assessment of the infrared land surface emissivity of the SGP CART Site.
- A survey of the land surface categories and their emissivities was performed in Late November 2000 using the University of Wisconsin Scanning-AERI instrument during the AFWEX experiment and repeated during TX-2001 in March 2001.
- Preliminary comparison with airborne infrared spectrometers (NAST-I and Scanning-HIS) show reasonable agreement with the surface based measurements.
- Emissivity spectral variations (from 8 to 12 microns) of > 10% are observed in bare soil. These are reduced to about 5% when area averaging is taken into account.
- High spectral resolution allows the separation of surface skin temperature and surface emissivity.