Quarterly Report

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A) Near-term Objective

1. To complete a design/performance analysis of thermal infrared spectrometers, to submit a purchase request, and to make a purchasing order of a spectrometer which meets basic requirements for land-surface emissivity and temperature measurements in the field.

2. To develop experimental and data processing procedures for land surface emissivity and temperature measurements in the field.

B) Task Progress

1. I have contacted more than ten companies in the last two years in order to find a spectroradiometer suitable for my applications. There are three types of optic designs (interferometry, grating and CVF, i.e., circular variable filter) for thermal spectrometers. I have received free demonstrations from CI Systems Inc. and MIDAC Corp., but I could not have a demonstration from BOMEM unless I travel to BOMEM in CANADA. After analyzing signal-to-noise ratios (SNR) of demonstration data, I decided to select a MIDAC M2401, which is a infrared interferometer, although other systems such as BM155, Optronic 750D and CI SR-5000 may work in wider spectral ranges and have more options. The main reasons to select MIDAC M2401 with an InSb/MCT detector are 1) it is relatively less expensive, 2) it is more portable (only 27 lbs, it is less than half weight of others), 3) it has a high spectral resolution in the 2.5-16 micron range, 4) it has a good performance (SNR > 25 at 3.75 micron, SNR > 500 at 8.55 and 11 micron, according to the statistics of 16 spectra collected by a LN2 cooled MCT detector. An InSb/MCT sandwich detector may improve the SNR at 3.75 micron by a factor of about four).

2. After making comparisons of performance, weight, and price between blackbodies from several different companies, I selected one blackbody from CI Systems Inc. It is priced at $9.9K and has a clear aperture 7" by 7"

for temperature range 5-75 degree C in a resolution 0.01 degree C, and weight of 26 lbs (additional 33 lbs for controller).

3. Although the solar beam can be used as a radiation source in the the field for the medium wavelength infrared range (in the four-step- method described in my second semi-annual report in 1992), a portable infrared radiation source is still needed for comprehensive measurements of spectral emissivity and reflectance patterns. The basic requirement for this portable infrared source is that it should provide just enough infrared radiation in the wavelength range from 3 to 14 microns so that the target surface will not be overheated and the effect of surface reflectance change by 0.5% could be detected. A high-temperature blackbody equipped with some filters appears to be a good choice, but it will be very expensive. We have to know the actual values of spectral emissivity, nonuniformity and temperature-dependence of the filter's spectral transmission function. So a cheap commercial infrared heater may be a good alternative. Then the challenging issues will be (1) how to make it stable, and (2) how to fully characterize it.

4. Practical and accurate procedures for land-surface emissivity and temperature measurements in the field are being developed. Numerical simulations show that an iterative method could improve the accuracy. Numerical simulations also show that angular-dependent temperature changes due to the illumination condition change could be accurately estimated in combination with deriving spectral surface emissivity under Lambertian assumption. It will be more difficult to solve a general case where angular-dependent temperature changes are coupled with bidirectional reflectance characteristics of the surface.

C) Anticipated Activities During the Next Quarter

1. To start spectral emissivity measurements for simple land-surface covers in the field and refine the procedures for measurement and data processing.

2. To complete Algorithm Theoretical Basic Documents for land-surface temperature and emissivity algorithms by July 30, 1993.

D) Problems/Corrective Actions (None)

E) Publications

1. An abstract titled "Effects of uncertainties in water vapor continuum absorption on remote sensing of the earth surface temperature" was submitted to IGARSS'93, which will be held in Japan from August 18 to 21, 1993.

2. An abstract, titled "A urgent need of validating water vapor absorption coefficients for the development of EOS's earth surface temperature algorithms" by Z. Wan and J. Dozier, was submitted to the 16th Annual Review Conference on Atmospheric Transmission Models. The conference will be held at the Geophysics Directorate, Phillps Lab., Hanscom AFB, Bedford, MA in June 8-9, 1993.