Quarterly Eos Contract Report -- Report #3

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Remote Sensing Group, Optical Sciences Center (OSC), University of Arizona

Principal Investigator: P. N. Slater

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Report compiled by: K. J. Thome

Task Progress:

...S.F. Biggar and P.N. Slater attended an ASTER Science team meeting at JPL in Pasadena, Calif. from January 20-23, 1992. Biggar presented details of the 0.4-1.0 micrometer cross-calibration radiometer. Slater presented results of a signal-to-noise ratio (SNR) study of the SWIR camera as a function of gain and aperture. He later recalculated the SNRs, based on new quantum efficiencies from Mitsubishi Electrical Company (MELCO), for consideration at the Accommodation meeting during the week of January 27, 1992. The calibration plan for ASTER was reviewed at the Science Team meeting and suggestions made for improving the onboard calibration schemes being considered by NEC and MELCO for the VNIR and SWIR cameras. Biggar and Slater reviewed the 34-page ASTER Calibration Requirement Document and telefaxed 11 pages of comments, as well as those of F. Palluconi of JPL, to the author, A. Ono.

...D.E. Flittner and P.N. Slater reviewed the MODIS-N bandpass modifications suggested by SBRC. Comments and recommendations were E-mailed to appropriate members of the MODIS technical and science teams. Slater sent resampled Kitt Peak National Observatory solar-spectrum data to S. Pellicori, consultant to SBRC, in response to questions about repositioning MODIS-N filters. He also sent a recent paper published by Flittner and Slater entitled, "Stability of narrow-band filter radiometers in the solar reflective range," (Photogrammetric Engineering and Remote Sensing, 1991, Vol.57, pp 165-171).

...Design of the silicon detector cross-calibration radiometer was completed by Biggar. Mechanical parts machined by OSC machine shop personnel were black oxide coated with the invar bars left uncoated. Biggar ordered the following materials for the radiometer: detector and filter heaters; platinum resistance thermometers; vacuum-compatible thermal-conductive adhesive; operational amplifiers, feedback resistors, and capacitors for the detector amplifier(s); filter wheel; and main power supply. He performed preliminary SNR calculations for various detector

and amplifier temperatures and nominal wavelengths and bandpasses. Biggar measured directional reflectance of anti-static coated and uncoated Spectralon samples supplied by C.J. Bruegge of the MISR calibration team at JPL. He also installed the new Sun SPARCstation 2GS on the local network.

A Cary 14 spectrophotometer was targeted for refurbishing by J.M. Palmer. The entrance optics were completed and exposed to "first light." Palmer designed and procured the majority of the drive system, put in place the short-wave detector system optics, and finished 80% of the preamplifier and computerized control system design. He also completed 80% of the exit/sample optics design and identified appropriate spectral transmittance standards.

Palmer performed thermal infrared studies concerned with field measurements and data acquisition. He defined the nature and scope of the task. A survey of the literature disclosed some 80 pertinent references. Most were obtained and one-third to one-half were read. Initial LOWTRAN7 calculations served to satisfactorily bound the problem and identify critical aspects. Commercially available hand-held thermal infrared radiometers were surveyed, and the three best choices identified. An old radiometer was located for preliminary emittance measurements. Its power system was updated and an initial calibration run performed.

M.W. Smith performed the following work on the SWIR spectrometer. The sapphire end windows of the fluoride glass fiber optic bundle and sapphire window for the PtSi detector dewar were broadband anti-reflection coated. Bandpass interference filters, to be used to test the PtSi detector's quantum efficiency, were ordered and received. Smith designed a mount for these filters and designed and built a focussing mount for the entrance slits and shutter. The custom F/2 holographic diffraction grating was received as was a vibration resistant shutter for use on helicopter flights. Smith revised data collection software to allow scan averaging, and he measured the following parameters of the PtSi detector: electronic gain, full-well capacity, dark current, and electronic noise.

Work on the BRDF meter concentrated on studies of the fisheye lens and interference filters. M.R. Brownlee examined some aspects of the lens performance in the near-infrared. She also examined and found the system's performance acceptable when used with interference instead of absorption filters and made calculations of the spectral shift of the interference filters at oblique incident angles. Brownlee investigated system resolution degradation due to the added thickness of the interference filters. She received notification of being awarded a NASA Graduate Researchers Fellowship to conduct work on the BRDF meter. Funds from this contract will be used for capital equipment and operation support for the BRDF meter.

K.J. Thome modified an existing water vapor retrieval code and statistically-based water vapor band model. The radiative transfer code was modified for enhanced flexibility and ease of use. The effects of a non-lambertian, homogeneous surface were included into the code. A thorough examination of the code was performed by H. He in preparation of converting it from FORTRAN to C. Thome converted the Langley method program to C and upgraded it as well. He also partially developed and implemented the rules-based algorithms for processing the Langley data.

The reflectomobile, to be used for surface reflectance measurements, was designed by D.I. Gellman. He originally designed the reflectomobile as an all-terrain vehicle with a space frame to hold the equipment, but the proposed vehicle could not support the space frame. Current plans have a trailer and space frame pulled by a leased vehicle. Gellman ordered the trailer and commercially available hardware for the space frame, and submitted drawings of the custom hardware to OSC machine shop personnel. Gellman also planned a White Sands field experiment. He made plans to calibrate SPOT-2 HRV cameras, Landsat 5 Thematic Mapper, and the Along Track Scanning Radiometer. The trip was to be used for model and code development since the first two sensors have ground footprints similar to ASTER and the third similar to MODIS-N. Biggar, Gellman, and Thome, accompanied by M.S Moran and T.R. Clarke of the U.S. Water Conservation Lab and S.L. Ustin of the University of Calif. at Davis, participated in the March 6-9 field trip. Cloudy weather prevented the collection of any usable data, but equipment and retrieval techniques were tested.

S.A. Recker and A.J. McKinney performed all necessary office administration tasks.

Problems/Corrective Actions:

Problems encountered this past quarter included the previously mentioned reflectomobile design troubles. Gellman rectified this problem by redesigning the reflectomobile as mentioned above. The electronic noise of the PtSi detector for the SWIR spectrometer is six times greater than reported by the manufacturer. The source of this noise is being investigated. The response of the PtSi detector was found to be non-linear in integration time, most likely due to the charge-storage architecture chosen by the manufacturer. Attempts will be made to characterize the non-linearity. If unsuccessful, the system will be operated only in the linear regime. An observed memory effect will also be investigated.

Difficulties were encountered in the reflectance measurements of the coated and uncoated Spectralon samples supplied to JPL by Labsphere. Biggar repeated the measurements with respect to a pressed Halon sample made in our laboratory. By examining the results, he determined that the

Spectralon samples were neither flat nor of constant thickness. The solution to this problem is to carefully check all Spectralon samples for smoothness and uniformity.

We are pleased to note that the Technical Team Minutes for March 26, 1992 announce that, in the future, the dates of all known MODIS-related meetings and conferences will be listed well in advance. Apart from the six-monthly Science Team meetings, we have felt rather detached from decisions and discussions related to MODIS.

Lastly, the question of whether to make the cross-calibration radiometer vacuum compatible was raised again. At this point, it is still possible to redesign the radiometer if NASA decides that it is necessary. Further delays on this decision will increase the cost and difficulty of this modification.

Anticipated Activities:

Once further system performance data are made available by MELCO, Slater, in conjunction with H. Fujisada, plans to continue work to determine optimum gain changes for ASTER's SWIR camera. Biggar and Slater will attend the Cal/Val meeting in Boulder, Colorado from April 6-10 and a MODIS Science team meeting in Washington D.C. from April 13-17. Slater and Smith will attend a meeting in Washington, D.C. related to the SWIR spectrometer and Smith's NASA Fellowship May 12-15 and Slater will be in Japan June 15-26 for the ASTER Accommodation/Science Working Group meeting.

Biggar will select filters for the cross-calibration radiometer based on input solicited from calibration team members of expected calibration source radiances. He will assemble and test the radiometer and start writing control and data acquisition code. Smith will begin spectral and radiometric calibration of the SWIR spectrometer, determine the quantum efficiency, and quantify stray light. The instrument field housing is to be designed and built.

The Cary 14 spectrophotometer's design will be completed by Palmer. He will complete all optical systems' fabrication and 80% of the entire system. The scope of the thermal infrared cross-calibration radiometers will be defined, as will the requirements for the radiometer and calibration systems. Design of the blackbody calibrator for the TIR radiometer will be initiated. Palmer will also complete ground emittance studies in the thermal infrared. Atmospheric parameters for LOWTRAN7 calculations in the thermal infrared are to be determined and the calculations completed. A new hand-held thermal infrared radiometer and associated data acquisition equipment will be purchased.

Brownlee will perform final spatial resolution tests on the BRDF meter and order the CCD array detector system. Interference filters will be

specified and ordered. Construction and testing of the meter will be started.

Reflectomobile assembly will begin. Gellman will also begin writing data acquisition code and test both the code and the assembled reflectomobile. Possible field experiments to White Sands Missile Range and Edwards Air Force Base are being planned for late April and early May. Field experiments at Walnut Gulch, Arizona, in support of Moran, are also being arranged. Gellman will update the calibration of the reflectance of Spectralon and barium sulfate panels and three solar radiometers used for field measurements.

Thome will complete the Langley retrieval code, including the rules-based data selection portion. He will convert the water vapor and ozone retrieval programs to C and link them to the Langley program. The inversion of spectral optical depth to aerosol size distribution will be reviewed, and its conversion to C begun. The radiative transfer code will be converted to C and image display software installed on the Sun 2GS by H. He.