MODIS/Snow Project
Quarterly Report (January-March 1993)
Submitted by D.K. Hall/974

Work continued in several areas of research including the development of the snow-cover algorithm, snow mapping in Alaska using both passive microwave and AVHRR data and use of DEM data on a MODIS Airborne Simulator (MAS) Sierra Nevada scene; progress was made in defining computer hardware to order, and MODIS and associated meetings were attended. Work continued on the preparation of 2 papers that will be presented at the Eastern Snow Conference in June, and published in the Proceedings following the meeting.

Snow-Mapping in Alaska, January-June 1989

SSMI passive microwave data from the period January - June 1989 have been mapped at a resolution of 1/4 latitude X 1/4 longitude resolution. Brightness temperatures have been assigned colors. 18 color-coded brightness temperature maps have been produced. The data show clearly the changes in microwave brightness temperature with changes in snow temperature. The data also show the dissipation of snow cover during the spring. In the future, passive microwave data will be important for snow mapping, because of the ability to "see" through most clouds using sensors operating in the microwave part of the spectrum. Thus it is anticipated that the best snow maps will be produced using data from both the reflective and microwave parts of the electromagnetic spectrum.

AVHRR data of Alaska covering the same period as covered by the SSMI data (January - June 1989) have been received from Jim Tucker/923. Some of the scenes have been displayed on our SGI system. A time series of AVHRR data of Alaska is currently being produced to match the dates of the time-series of SSMI data. Following this, the two data sets will be registered. Elevation contours and the location of the boreal forests will also be registered to the data sets.

Two additional data sets have been purchased from the EROS Data Center in Sioux Falls, SD. The first, called the "Greenness Index" provides AVHRR data of the State of Alaska in several bands of AVHRR data during a 2-week time period in July of 1989. The second data set provides data of topographic contours of the entire United States. The greenness data, along with ancillary data from the National Atlas, permit the location of the boreal forests and tundra areas to be identified. The topographic data provide contours at better than 1000-m contour intervals for the State of Alaska.

Together, these ancillary data sets will allow us to improve our understanding of the passive microwave signatures of snow, because the passive microwave brightness temperatures are clearly influenced by factors other than snow depth and snow temperature.

Snow-Mapping Algorithm Results as applied to TM Data

The Glacier National Park (GNP) TM scene from 14 March 1991 was imported into EASI/PACE and coded with the snow cover algorithm as a model in easi pace. The snow cover model was tested and analyzed on a subset (1024 X 1024 pixels) of the GNP image. It was also run on the entire image. Visually, results look good, but there is not yet any way to verify the resuts of this scene.

Validation of Snow-Mapping Algorithm

For his master's degree thesis at the University of California at Santa Barbara (UCSB), Walter Rosenthal mapped the snow cover on a TM scene of the Sierra Nevada Mountains, CA using a spectral mixture model, and compared his results with aerial photography. His accuracy was determined to be nearly 100 percent relative to the aerial photography. He sent the TM scene and snow map to us. We have displayed the scene and plan to employ our snow-cover algorithm on this scene and compare our results with his snow map. Thus we will be able to calculate the accuracy of our snow-mapping algorithm for that particular scene. This will be our first step toward quantifying the accuracy of our snow-mapping algorithm.

DEM data as applied to October 1991 MAS scene

Work has been progressing very slowly on registering the U.S.G.S. DEM data to the MAS scene of the Sierra Nevadas. This is because of the difficulty in locating landmarks common to the MAS and DEM data such that the data can be registered.

Meetings

On 24 February, a meeting was held among D. Hall, J. Barker and V. Salomonson to discuss the progress of the snow-cover algorithm development efforts, and to identify the respective roles of MCST and the snow project for snow mapping using MODIS data. At that meeting it was decided that two algorithms would be developed both of which would be capable

of mapping snow using MODIS data. Since then, D. Hall and J. Barker have decided that we will try to work together to develop and validate one algorithm that will be capable of global-snow mapping using MODIS data.

On 24-26 March, the MODIS Team Meeting was held in Lanham, MD. D. Hall attended the MODLAND and plenary meetings. Within MODLAND, several important issues were discussed. The use of the Long-Term Ecological Research sites as intensive-study sites for MODIS algorithm validation was discussed. Two sites in Alaska and one site in Montana appear to be useful for validation of the snow algorithm. In addition, the BOREAS sites will be useful for validation of the snow algorithms. Also discussed was the need to define the expected errors in our snow (and other MODLAND) product. Currently, we are anticipating an absolute error of 10 percent.

Also at the meeting, we were notified that we will need to turn in a document that discusses in detail the theoretical basis for our algorithms. This will be an approximately 20-page report that is due July of 1993. As part of this document, we will define the errors associated with our algorithms. Also required is a plan for MODIS science computing facilites due in May.

Future Work

In the next 6 months we expect to make progress in a number of areas: validation of the results of our snow-cover algorithm over a TM scene in the Sierra Nevadas, snow mapping in Alaska using a multisensor approach and acquisition of additional MODIS Airborne Simulator data over our test site in the Sierra Nevadas. We also plan to present 2 papers at the Eastern Snow Conference.

Our snow-cover algorithm will be applied to a Landsat TM scene acquired over the Sierra Nevadas, and compared to results obtained from another algorithm that was developed specifically for that TM scene. This will help us to verify our algorithm and to determine errors.

AVHRR (visible and near infrared) and SSMI (passive microwave) data of Alaska for the time period January through June 1989 have been received. These data are being analyzed jointly with Dr. Carl Benson from the University of Alaska. Dr. Benson will visit during the week of April 12 to discuss this work. We have also received vegetation data of Alaska from EROS Data Center and have displayed those data. We have ordered topographic data of Alaska from EDC, but those data have not yet been received. We plan to register the AVHRR, SSMI, vegetation and topographic data. Some of the

brightness temperatures appear to be affected by vegetation and perhaps topography and analysis of the registered data sets should help us to quantify this.

Ken Brown/925 has helped to arrange an overflight of the ER-2 with the MAS over our study site in the Sierra Nevadas. There will be a test flight in April and the mission manager, Andy Roberts, has agreed that he will attempt to obtain snow data for us during that overflight. Those data, if obtained, will be analyzed in conjunction with the October 1991 MAS data, and the DEM data that we have of the same area.

Papers

MODLAND scientists have completed a paper entitled "Terrestrial remote sensing science and algorithms planned for EOS/MODIS" with S. Running as the first author. The paper was submitted to International Journal of Remote Sensing.

Two papers are being prepared for the 50th Annual Eastern Snow Conference to be held 7-10 June 1993 in Quebec City, Canada. The papers, which will be turned in at the meeting, will be published in a Proceedings volume following peer review. The titles and authors of the papers are: "Analysis of DMSP/SSMI and ERS-1 data of snow in central and northern Alaska," by D.K. Hall and C.S. Benson, and "The developing moderate resolution imaging spectroradiometer (MODIS) snow-cover algorithm," by G.A. Riggs, D.K. Hall, V.V. Salomonson and J.L. Barker.