12-18-92

PROGRESS REPORT

MULTI-SATELLITE ESTIMATES OF LAND-SURFACE PROPERTIES FOR DETERMINATION OF ENERGY AND WATER BUDGETS:

Contract no: NAGW-2973

The National Aeronautics and Space Administration
Office of Space Science and Applications

For the period April to December 1992

Submitted by:

Cooperative Institute for Meteorological Satellite Studies (CIMSS)
at the University of Wisconsin-Madison

In cooperation with the NOAA

National Severe Storms Laboratory (NSSL)

National Environmental Satellite Data and Information Service (NESDIS)

and with the

Utah State University

W. Paul Menzel
Principal Investigator

Robert W. Erickson
Director, Research Admin.-Financial

The study has focused on regions in the central U.S. (approximately 1000 x1000 km horizontal extent) where significant spatial variability in vegetation is prevalent. The Mississippi Valley was chosen as a region for study because surface data are plentiful and readily available for a landscape of mixed crops, rangeland, prairie and forest which has been significantly altered by human intervention. Also, this region is a portion of the continental scale water basin to be studied under the international GCIP project. Two growing seasons of contrasting precipitation, 1987 and 1988, are under study. The latter year experienced a very dry growing season with severe consequences to the vegetation cover.

The following tasks have been completed or are underway to meet the goals of the project.

Task 1. An inventory of relatively cloud-free days has been made from available GOES-visible imagery during the June-July 1988 period. Candidate days were selected approximately every 2 weeks for application of the surface layer/mixed-layer model of Diak (1990). A preliminary evaluation of the surface fluxes of sensible and latent heat at appropriate radiosonde sites has been made for three of these days using this model with the input data consisting of radiosonde measurements of the change of height of the planetary boundary layer and satellite-measured surface skin temperatures. The character of these results is being evaluated and the surface sensible and latent heat fluxes from the model will be compared with the surface wetness patterns derived from SSM/I (see task 3). We are currently selecting other candidate days from 1988 and other years for which to obtain radiosonde and satellite surface temperature data and perform similar evaluations of surface turbulent fluxes.

Task 2. In conjunction with a complementary study funded by the NOAA Climate and Global Change Program (Application of Satellite Data Bases to Determine the Influence of Vegetation and Moisture on Clouds and Regional Energy Budgets), the radiative flux components at the top of atmosphere and their relation to the land surface characteristics have been investigated for June-July 1988 over the central U.S. The following results are pertinent to this project:

A. Preliminary estimates of the correlation between GOES/IR equivalent black body temperature and the Normalized Difference Vegetation Index (NDVI) have been completed from a nearly clear scene. As expected, the temperature is negatively correlated with NDVI. The

correlation is most significant around mid-day when surface temperatures are highest. Roughly half of the total variance in surface temperature appears to be explained by spatial variations in NDVI. The effect of API variations on temperature are now being investigated.

B. Using the techniques of Minnis, Young and Harrrison, estimates of broad band longwave (OLR) and shortwave fluxes (and albedo) at the top of the atmosphere have been made from GOES visible and IR data. The results compare favorably with ERBE measurements for an individual scene and for the July 1988 monthly mean. Differences in OLR and albedo are evident between national forests and cultivated land. The effect of antecedent precipitation and surface available water will be evaluated using the SSM/I products.

C. A simple algorithm has been developed to detect daytime shallow cumulus clouds from GOES visible and IR imagery. Images of monthly frequency of cumulus have been produced on an hourly basis for July 1988. Maximum cumulus frequency is at about local noon. Cumulus frequency appears to be related to relatively small topographical features. Examples are narrow ridges (10 km) and along the front slope of the Ozark Plateau. In general, cumulus are more numerous over relatively high ground and over forests. Clouds are markedly less frequent over the Mississippi Delta, a 100-200 km wide flood plain in eastern Arkansas and surrounding states. Also, the frequency of cumulus clouds appear inversely related to NDVI in agricultural areas of the Midwest. For example, the clouds are locally maximum where a local minimum in vegetation is observed in the southern third of Illinois. The significance of this region lies in forests, most of which have been cut there since the early 1800's, and the soils, which are older and less fertile than those to the north. In the drought year of 1988, NDVI is depressed and cumulus clouds enhanced over the old-soil region. This is similar to the pattern observed in a previous study over the harvested wheat belt in Oklahoma.

D. The coupled surface/PBL cumulus cloud model of Wetzel (PLACE) has been obtained for use in quantifying the impact of surface wetness on cumulus formation. Testing of the model on a local workstation has begun and the model may be used in a complementary fashion to the Diak (1990) model used to evaluate surface sensible and latent heat fluxes.

Task 3. Analyses of antecedent precipitation index (API) and SSM/I surface wetness products are being developed at the Utah State University (Christopher Neale). The progress on related sub-tasks are as follows:

A. Prepare gridded (0.25 degrees latitude/longitude) data files for the 1987 and 1988 period of study merging SSM/I, climatic (precipitation and temperature) data and estimated API values.

Climatic and SSM/I data and estimated API have been gridded to 0.25 degree boxes. Data corresponding to particular events (discussed below) have been electronically transferred to Wisconsin. Surface soil moisture fields resulting from the application of the existing surface moisture algorithms to SSM/I data will be forthcoming.

B. Identify additional storm events for the 1989-1992 period and obtain the necessary SSM/I and climatic data for these periods. Use these data to improve the surface moisture retrieval algorithms. Also obtain AVHRR data for the major storms during that period.

Storms have been identified. SSM/I data has been ordered and received. Climatic data has been ordered.

C. Obtain concurrent AVHRR full resolution data sets with Kevin Gallo and work on surface moisture algorithm improvement with him using combined AVHRR and SSM/I data sets.

Outstanding: Identify available AVHRR data concurrent with SSM/I data.

D. Study effects of vegetation density on surface moisture retrievals using radiative transfer modeling and comparison with higher resolution AVHRR data. Also, study the effects of water bodies on SSM/I footprint signatures and run a sensitivity analysis.

The radiative transfer model is presently being developed. It has compared very well with actual SSM/I data and is undergoing further testing.

BUDGET

1 January 1993 - 31 December 1993

I. Labor	Hours	Rate	Cost	
a) Scientist	130	32.51	$4,227	
b) Research Specialist	350	25.62	8,967	
c) Research Assistant	675	18.00	12,150	
d) Secretary	60	19.41	1,165	
Subtotal				$26,509
II. Travel				
1 trips/1 person/3 days - Logan, UT			$895	
1 trips/1 person/3 days - Ashford, NC			895	
				1,790
III. Computing				
IBM McIDAS				2,000
IV. Data Purchase				1,000
V. Publications				1,500
VI. Subcontracts				
a) Utah State University			$47,665	
b) NESDIS			9,004	
c) NSSL			5,729	
				62,398
VII. Indirect Costs - 44% I. - V., first $25,000 of each subcontract				31,914
VIII. Equipment Rental				1,730
IX. Tuition remission for Research Assistant - 26% of salary				3,159
Total				$132,000

diak2.xls