Final Technical Report

NASA Cooperative Agreement NCC 5-32

Department of Geography

Columbia University

DEVELOPMENT OF A GROUND HYDROLOGY MODEL SUITABLE FOR GLOBAL CLIMATE MODELING USING SOIL MORPHOLOGY AND VEGETATION COVER, AND AN EVALUATION OF REMOTELY SENSED INFORMATION

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The Department of Geography at Columbia University has conducted NASA-funded research in cooperation with scientists at the Goddard Institute for Space Studies (GISS) since 1975. From July 1984 through May 1988, this activity was carried out under NASA Cooperative Agreement NCC 5-32. Studies under this cooperative agreement have focussed on hydrologically significant land surface variables for climate modelling. The long-term purpose of this work has been to contribute to scientific understanding of the role of the planet's land surfaces in modulating the flows of energy and matter which influence the climate, and to quantify and monitor human-induced changes to the land environment that may affect global climate. The work funded under this agreement was carried out in cooperation with GISS and Goddard Space Flight Center scientists and staff, and scientists at the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratories (CRREL).

Highlights of the cooperative effort include the following:

1. Production of a geocoded, digitized World Soil Data file for use with the GISS global climate model. This file was extracted from the UN-FAO Soil Map of the World. The data are recorded in unit areas of 1 degree by 1 degree cells. Two guides for using the file were prepared. One describes the data characteristics and data collection methodology (Zobler 1986). The other describes the data computer tape (Staub and Rosenzweig 1987).

2. Contribution to the development of a numerical physically-based model of ground hydrology. This model includes the processes of transpiration, evaporation, infiltration, soil water flow, and runoff, and is suitable for

use in a general atmospheric circulation model. The model and preliminary tests of its accuracy are described in Abramopoulos and Rosenzweig 1988.

3. Assessment of the utility of remote sensing for providing data on hydrologically significant land surface variables. This work includes:

a. A literature review of the utility of satellite radar imagery for observing hydrological surface conditions (Wilson 1986).

b. Preliminary assessment of the utility of both ground-based and remotely sensed measurements from the First International Satellite Land Surface Climatology Project (ISLSCP) Field Experiment (FIFE) data as input to and validation of the GISS ground hydrology model (see 2. above). This work anticipates a future study in which the FIFE data will used with the model.

c. Preliminary analysis of the utility of passive microwave radiometer data for estimating soil moisture in an agriculturally vegetated landscape. The study site is located in Hancock County, Iowa, an area in which primarily corn and soybeans are grown. The aircraft remotely sensed data were acquired in August, 1987 as part of that summer's FIFE effort. The data for the study include aircraft microwave and multispectral scanner observations, SPOT imagery, and surface moisture measurements. The quality of the microwave observations have been assessed and the microwave data have been geometrically adjusted. The

microwave footprints which correspond to surface point measurements have been located and initial assessment of the correlation between brightness temperatures and surface gravimetric measurements undertaken. Work continues on methods for characterizing the effect of vegetation (primarily mature corn and soybean canopies) on the microwave moisture signal, with particular focus on the use of remotely sensed vegetation index information to aid in interpretation of moisture conditions from the microwave observations.

d. A study of the utility, in a mid-latitude, mixed land use setting, of Landsat vegetation index data for estimating the fraction of green vegetation cover, an important variable in hydrological modelling. This research is being completed as part of a Geography Ph.D. thesis.

Elements of the remote sensing work described above will be continued under NASA Cooperative Agreement NCC 5-36.

REFERENCES

Abramopoulos,, F., C. Rosenzweig, and B. Choudhury. 1988. Improved Ground Hydrology Calculations for General Circulation Models -- Soil Water Movement and Evapotranspiration. Journal of Climate. (In press).

Staub, Brad and C. R. Rosenzweig. 1987. Global Digital Data Sets of Soil Type, Soil Texture, Surface Slope, and Other Properties: Documentation of Archived Data Tape. NASA Technical Memorandum 100685.

Wilson, Helene. 1986. The Utility of Spaceborn Imaging Radar for CRREL Applications. CRREL Internal Report 924. Hanover, N.H.: Cold Regions

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Zobler, Leonard. 1986. A World Soil File for Global Climate Modeling. NASA Technical Memorandum 87802.