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II

Applications of HCMM Satellite Data to the Study of Urban Heating Patterns

Toby N. Carlson
Dept. of Meteorology
The Pennsylvania State University
University Park, PA 16802

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16. Abstract

Research in this quarter has been directed toward model improvement and software development for data handling. Model improvement consisted of formulating a more reliable surface heat flux/temperature scheme, particularly the night time component. Software development has involved writing programs to process U-2 and HCMM data tapes for joining these products to the TOBYGRAF data processing system and for display in BAT files as color images on RAMTEK.

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Introduction

Research continues to be directed toward the application of HCMM satellite infrared measurements to the analysis of urban temperature patterns with a goal being to derive the surface energy budget using a surface temperature/heat flux model in conjunction with ground temperature measurements. Generally, the past three months has seen a period of development in which the surface heat flux model has been greatly improved, particularly for the night time case, and applied in some test cases using real ground (or near ground) temperature measurements as input in the model inversion scheme. Computer routines have been written to handle U-2 and HCMM satellite information so that these data can be meshed with our data analysis system (called TOBYGRAF) which we have been developing for over two years. We have also succeeded in utilizing the RAMTEK[1] color density display module in our analyses by accessing directly BAT files of image data.

We have received one series of passes made by a U-2 aircraft flying over St. Louis during May, 1976 and are presently involved in analyzing ground temperature measurements obtained by that aircraft.

Currently, we are ready to begin systematic processing of HCMM data, although we anticipate a brief period for debugging of one untested computer program designed to access the HCMM computer compatible satellite tapes.

Current Research

Our satellite research can be divided into two general categories:

[1]Belonging to the Office of Remote Sensing of Earth Resources (ORSER) at Penn State.

model improvement and software development for remotely-sensed data. Both of these approaches are integral parts of our original objective - to use ground temperature measurements obtained remotely to quantify the ground characteristics (notably soil moisture and conductivity) and ultimately to predict the surface heat budget (Carlson and Boland, 1978).

A significant improvement was made in our 1-dimensional surface temperature/heat flux model, particularly the night time component. Using the improved version of the model we are able to obtain, by graphical inversion of the model, reasonable estimates of the ground conductivity and moisture availability, using, as input, some aircraft measurements of ground temperature made by Dabberdt and Davis (1974) at one location over St. Louis.

A necessary set of conditions for inverting the model to yield these two parameters is the ground temperature at two times on the 24-hr cycle of ground temperature, preferably near noon and during the early morning hours. HCMM will be the first polar orbiting satellite capable of providing infrared ground temperature measurements at these two critical times, approximately 12 hours apart.

We have, as yet, not received any HCMM computer tapes, but we have been able to obtain some peripheral aircraft measurements in the form of U-2 data. One U-2 flight, which we received early this summer, consisted of three aircraft passes made over St. Louis on 25 May 1976. Subsequently, we have written a modified version of our original NOAA satellite extractor routine (RECSTRA 3) which is able to access the U-2 tapes and write segments of each file to a storage tape, thereby joining with the system (TOBYGRAF) which further writes smaller files or to BAT storage and ultimately (as

described in the first quarterly report) to graphics. Acquisition of the U-2 data has been helpful in exercising the use of the TOBYGRAF system, for giving the principal investigator and two new graduate students further experience in handling remotely sensed data, as well as in serving as a future check on the reliability of satellite temperature measurements. Additional aircraft flights by U-2 and by the NASA WB 57 have been made in recent weeks or are anticipated for the coming months.

One especially gratifying advance in our satellite data processing and display routine has been in the incorporation of color graphics using the ORSER RAMTEK system. Currently, we are able to display our 130 x 130 BAT file images with up to 16 different colors (although, customarily we find that six or seven is sufficient).

In anticipation of receiving HCMM satellite data tapes we have taken an original program of J. Price and have modified it to conform with the TOBYGRAF System. This routine (RESTRA 4), yet untested, will serve as the extractor routine for the HCMM satellite tapes.

A recent article (July, 1978) bearing on the combined satellite-model analysis procedure has been published in the Journal of Applied Meteorology by the P.I. and a former graduate student (Carlson and Boland, 1978).

Future Program

We anticipate processing large amounts of HCMM satellite data tapes during the coming quarter. Because of the lag between the start of NAS5-24264 and the dissemination of satellite data tapes, we have requested an eight month extension to the termination date of this project.

HCMM data will be sent for our four urban sites (St. Louis, Los Angeles, Washington, D. C., and Houston) plus one additional location over Tennessee (for August 1978 only), the latter being a focal point for a multi-agency field operation involving EPA and Penn State, which is called the sulfate transport and transformation in the environment (STATE) project, the purpose of which is to study plumes emitted from a power plant complex.

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