SPACE
SCIENCE AND
ENGINEERING
CENTER

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THE UNIVERSITY OF WISCONSIN

7 August 1975

Dr. John Theon
Code 911
NASA/GSFC
Greenbelt, Maryland 20771

RE: Progress Report - NAS5-21798

Dear John:

I apologize for, and must attempt to explain, our oversight which has delayed this mid-term report. As you know, the work being done under this contract is performed largely by graduate students under Professor Suomi's direction. Prof. Suomi keeps close track of the students and their work, but he expects his staff to take care of administrative matters; a category in which he places progress reports. There is nothing unusual in this, and it works well nearly all of the time, however, the staff member responsible for this report left the center, and I did not pick up the ball. Thank you for reminding me and for remaining so patient.

Three separate efforts are in progress at this time:

A. Graduate Student, Kenneth Yuen, is investigating severe convective systems in great detail on McIDAS. He started by making as many quantitative measurements as he could from SMS/GOES images of a small set of severe storms and then investigating the measurements for significance. From this start he has developed a study program to identify tornadic storms before the tornado actually forms. His preliminary findings from the small sample of cases indicate that: 1) the rate of vertical growth of tornadic cells is much more rapid than for non-tornadic thunderstorms, and 2) just prior to tornado formation the convective cells forms a "dome" at the top which can be seen in visible images. Yuen is generating mesoscale wind vector sets in the field surrounding convective cells using SMS images at six minute intervals. Using these he will look for signatures in the wind, vorticity and convergence fields which are different for tornadic cells. The final step in his study will be to organize a set of criteria against which image measurements can be screened to identify tornadic cells.

B. Graduate Student, George Diak, is nearing completion of his study to develop a method to measure soil moisture from SMS/GOES images. The abstract of his paper in progress follows:

A method of soil moisture assessment has been developed based on the solution of the Fourier heat transfer equation of a semi-homogeneous solid undergoing slow release of heat. Variations of soil density, conductivity and heat capacity with moisture have been researched for the three main soil types and it has been found possible to describe this variation linearly in each case.

Substituting these linear relationships in the solution of the Fourier equation, it is possible to solve for the water content of the soil as a function of the soil type, reflecting the density and heat capacity and change in conductivity with change in moisture content, and also as a function of net radiation at the surface and drop in surface temperature with time.

With an empirical correction, the method has yielded good agreement with reality in experiments both with ground and satellite data.

C. Drs. David Martin and David Suchman have conducted a study into the accuracy and reliability of cloud motion vectors produced on McIDAS. The abstract of their first paper on this subject follows:

In this study we explore the usefulness and limitations of tracer winds generated by tracking clouds in SMS images displayed on the University of Wisconsin's Man-computer Interactive Data Access System (McIDAS). Two major questions are addressed: (1) How accurately can the cloud displacements be measured, and (2) To what extent do the cloud displacements represent the wind field?

Accuracy is evaluated in terms of data characteristics, McIDAS precision and consistency. We find that for full resolution visible data neither navigation nor resolution errors significantly affect the tracking of clouds. An examination of consistency, defined as similarity of wind sets independently produced by several scientists tracking clouds from the same set of images, yields a RMS reproducibility of 2 $m \cdot s^{-1}$ for cirrus level and 1.3 $m \cdot s^{-1}$ for cumulus level winds.

The discussion of representativeness centers about cloud height determination, and relating cloud motion to winds. Representativeness is examined through: (1) the internal consistency of consecutive sets; (2) the consistency of the cloud wind field, including divergence and vorticity with such features as clusters, vortices, and clear areas; and (3) the difference between proximate satellite and ship winds. These differences were all under 3 $m \cdot s^{-1}$ which is close to the noise level of ship winds and better than radiosonde-radiosonde comparisons. We conclude that the representativeness of cloud tracers to cumulus and cirrus level flow is good to within the accuracy of currently available ground truth data.

With the start of the fall term, we expect to start one or two more studies in the general area of mesoscale analysis and prediction using SMS/GOES data. Exactly which aspects will be addressed depends upon the capabilities and interests of the students.

I hope this report is satisfactory and that our work meets with your approval. I would appreciate receiving your comments.

Sincerely,

Thomas O. Haig
Executive Director

TOH:mt