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15 June 1973

TO: Contracting Officer, Code 245, NASA/GSFC
Technical Officer, Code 651, NASA/GSFC

FROM: Thomas O. Haig
Executive Director

REFERENCE: Contract NAS5-21798

SUBJECT: Monthly Progress Report for "Studies of Soundings and Imaging Measurements from Geostationary Satellites"

Task A <u>Investigation of Meteorological Data Processing Techniques</u>

During the past month the development and applications of processing techniques for correcting line start errors in ATS images has continued. The main activity has been in the software area, resulting in the writing of two new programs.

The first of these is an implementation of a generalized edge detection and line start correction algorithm for the Datacraft 6024/5, the McIDAS computer. This program allows for line start corrections without the necessity of rewriting data tapes. In the execution of this program the Datacraft reads one line of image data from the raw data tape (actually a 9-track copy), detects the position of the earth edge on this line, compares the detected position to the position predicted by the navigation program, and, using the difference between them to define a line shift, loads the line of image data on the McIDAS digital disk (and, eventually, on the analog disk as well) with appropriate line start corrections included. Thus, the display and digital data are simultaneously corrected while the raw data is being read in a line at a time. Tests of this software are now in progress.

The second program is designed to aid in achieving a better theoretical understanding of the limb radiance profile. The program uses navigation results to define the geometrical earth edge and can average limb radiance profiles from one to several hundred adjacent lines with shifts between lines defined by the navigation predicted earth edge curvature. This program is currently being used to determine the altitude of the threshold detection, as well as its latitude, sun angle, and cloud cover dependence. Results to date are only preliminary.

Task B <u>Sun Glitter</u>

No significant effort on this task during the reporting period. See previous quarterly report.

Task D <u>Cloud Growth Rate</u>

A theoretical multiple scattering program is being obtained from James Hansen of NASA's Goddard Institute for Space Studies. This program will be used to generate data on cloud brightness for an improved normalization scheme. The final copy of the master's thesis outlining the requirements of a normalization procedure has been completed and will be included in the annual report.

In the final copy, the part on the possible effects of horizontal inhomogeneties which are smaller than the camera's resolution has been expanded somewhat over the preliminary copy. A simple two dimensional analytical model was constructed. The model had square clouds with vertical sides as is shown by Figure 1. The cloud tops and sides were assumed to be white Lambertian reflectors with an albedo of one. The lower surface was also assumed to be Lambertian, but the albedo (g) could be changed from zero to one. With an albedo of zero (g=0), the model would simulate breaks in the clouds with the dark sea showing between the clouds. When the albedo of the lower surface was one (g=1), texture in a cloud deck could be simulated. The shadows produced by the clouds were assumed to be completely black.

The total light reflected was the sum of the light reflected by the top, sides, and bottom surface. Figure 2 shows the results of the model for a 66% cloud cover with various cloud heights and surface albedos. As can be seen from the figure, one effect which inhomogeneties can cause is a decrease in the overall brightness. Another effect is that the clouds will appear brightest just before local noon.

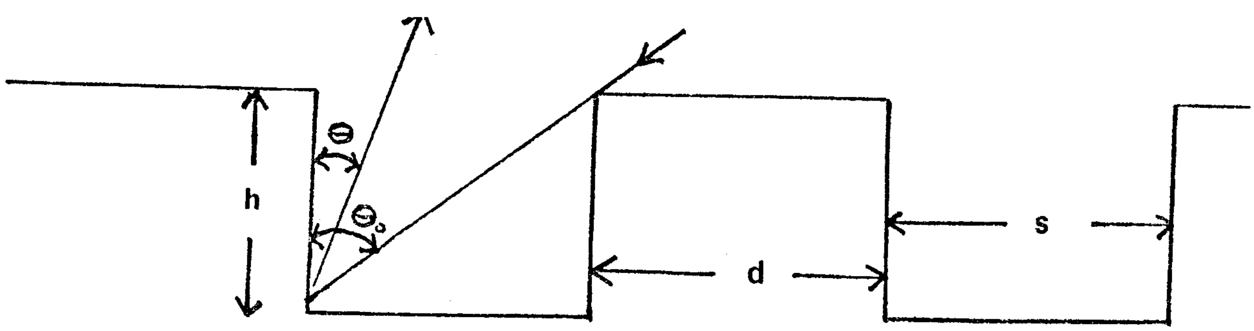

Figure 1. Geometry of study.

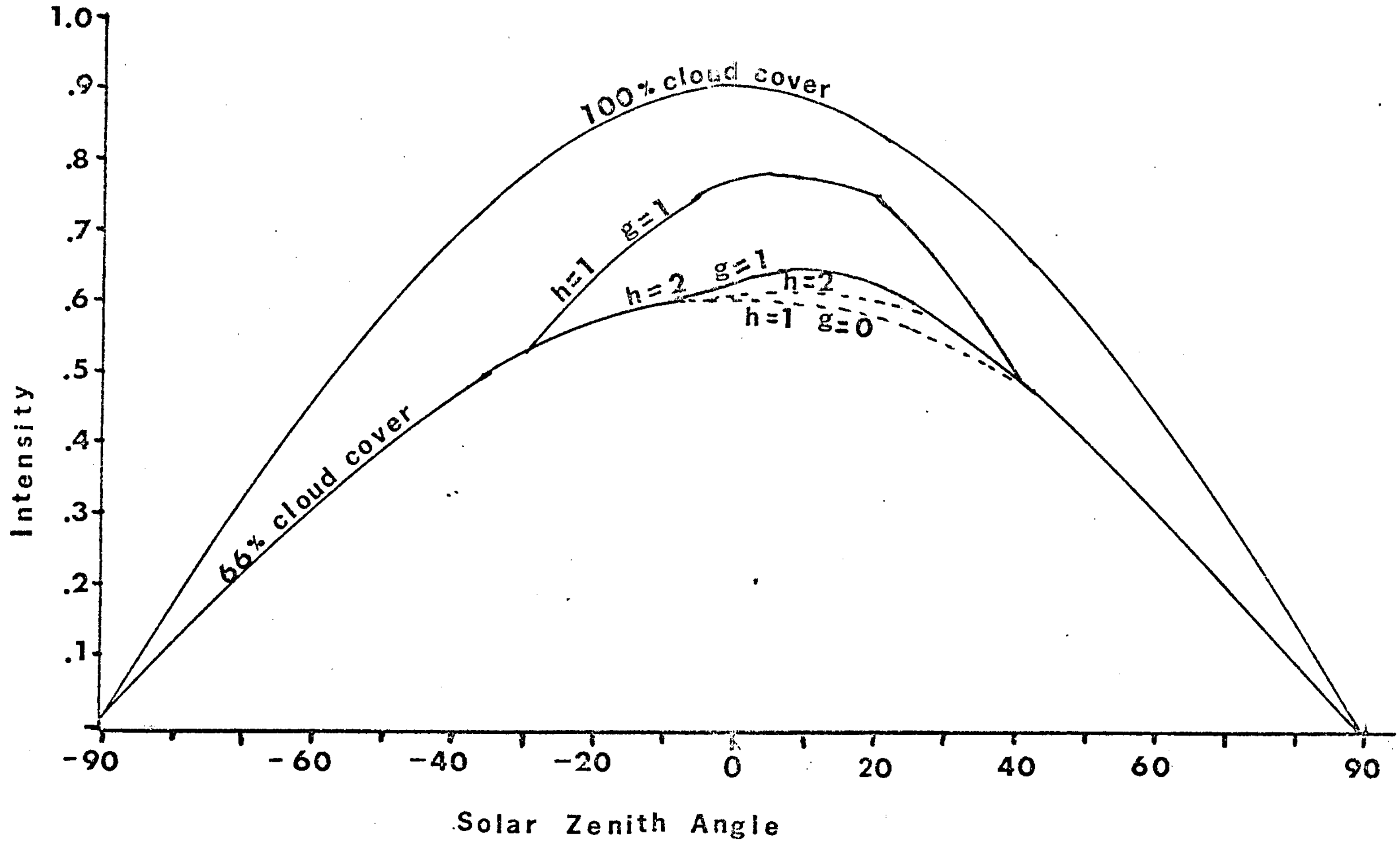

Figure 2 . Effects of inhomogeneities in a Lambertian reflecting surface for a stationary observer at 24° zenith angle. The albedo of the lower surface was varied from zero (dashed lines) to one (solid lines). The 66% cloud cover has a cloud diameter of 2 and a spacing between the clouds of 1. The height was varied from 1 to 2.

Task E Comparative Studies in Satellite Stability

The coding of the model is proceeding well and is expected to be completed by 15 July 1973.

The following elements have been coded, debugged and tested:

1. The stability criteria for single-body satellites.
2. The stability criteria for dual-spin satellites.
3. The zeroth order response for single-body satellites without control.
4. The zeroth order response for dual-spin satellites without control.
5. Determination of the lengths of the transient zone and the perturbation parameters for both single-body and dual spin satellites.
6. The zeroth order structural response for single-body satellites without control.
7. The zeroth order structural response for dual-spin satellites without control.

The elements of the program which are yet unfinished, are:

1. Simulation of the control system and incorporating it in items Nos. 3, 4, 6 and 7 above.
2. The first order responses corresponding to items Nos. 3, 4, 6 and 7 above.

The effect of the second order response is less than one percent of the zeroth order response; therefore, the second order response will be coded later as time permits.

The work completed so far contains six main programs and nearly a hundred subprograms. The main programs are merely different sequences of calling the subprograms, which are stored in a fastrand drum file. The data generated by a program is written on tapes. The next program begins by reading the required portions of these tapes.

The main programs have been broken into up to ten segments. Only two segments reside in the drum memory at any instant of time. This allows the programs not to exceed the storage capacities of the Univac 1108.

Task F High Resolution Optics Study

In two days of briefings in mid-May, the students in Professor Suomi's seminar on mesoscale monitoring and prediction communicated to SSEC scientists the bulk of their work on determining the key pieces of meteorological knowledge required to adequately determine a number of mesoscale phenomena known to have great economic and social impact on the general public. The SSEC group is now at work to sharpen the definition of the physical observations, to quantitatively define the necessary measurements which must be made, and to develop an observing system concept into which SEOS might fit. This system concept must have three aspects: (1) data gathering (in which SEOS will play a large part); (2) information extraction (requiring both the knowledge of exactly what we are looking for and the ability to recognize it quickly); and (3) communication (having the ability to act on the information and transmit reliable forecasts to the public).

At the discussion following the last seminar presentation, it became clear that knowledge of vertical stability was a nearly unanimous requirement for describing mesoscale phenomena. The characteristics of a large telescope such as SEOS are ideal for making the low noise, high resolution soundings required. An infrared sounding capability should be added to SEOS.

The next step in our analysis brought out this point even more forcefully. We set up a computer "sieve" to aid in analyzing the knowledge requirements and measurement parameters by classifying and sorting into various categories. By requesting searches for common denominators and clusterings, we hope to better identify the most useful types of measurement to make and to learn what key questions to ask as the analysis proceeds.

We have begun with a qualitative evaluation of the frequency with which certain knowledge requirements (such as vertical stability) occur, and in what portion of the atmosphere they must be measured. Two key pieces of information emerged, only one of which we expected: (1) the second largest cluster of observations is of the motion field, thermal field, and moisture field from 1000-200 mb. The measurements must be made at high temporal resolution consistent with the development of mesoscale systems. SEOS is ideal for this monitoring aspect, and we will be able to develop a good set of sounder specifications. (2) A surprisingly large number of observations (over 40%) must be made in the boundary layer--a region not very accessible to remote satellite sensing. This emphasizes the need for high spatial resolution in the vertical and ground truth probably only obtainable from balloon soundings and in situ sensors. We now know that we shall have to pursue the remote platform interrogation and systems aspects most vigorously.

The month of June will be devoted to further shaping the quantitative measuring requirements and developing the systems aspects of SEOS. We will expand the computer sieve program to make it more responsive to our needs and more quantitative in its answers; i.e., we need to determine the most useful questions to ask. We will develop a reasonable (if possible) observing system for getting needed boundary layer parameters. And, finally, we need to speed up the recognition and response time of any SEOS system so that the information that it gathers can be utilized within the 2-6 hour lead time for mesoscale weather development in order to adequately warn of approaching dangers or rapidly changing weather conditions.