PLANT COVER, SOIL TEMPERATURE, FREEZE, WATER STRESS, AND EVAPOTRANSPIRATION CONDITIONS

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Science and Education Administration
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P. O. Box 267
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September 1979

TYPE II Quarterly Progress Report
for Period September 1, 1979 to December 1, 1979

Prepared for

GODDARD SPACE FLIGHT CENTER
Greenbelt, MD 20771
We have investigated procedures to edit cloud-contaminated pixels from those pixels representing earth surface features. Because clouds are more reflective than earth features and are also colder than earth features most of the year at our test site latitude (26°N), either a raw digital count ratio or a ratio of reflectance percentage for the VIS band to the temperature (°C) from the thermal band works well. The procedure should make scenes that would otherwise be discarded at least partially usable for analysis.

Twenty-two procedures for processing the CCT to extract information for meeting investigation objectives have been developed and applied to at least one scene. Seven scenes are on hand in 800 bpi format we can analyze and another seven scenes have either been returned to Goddard for reformatting from 1600 to 800 bpi or are on order.

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**Abstract**

We have investigated procedures to edit cloud-contaminated pixels from those pixels representing earth surface features. Because clouds are more reflective than earth features and are also colder than earth features most of the year at our test site latitude (26°N), either a raw digital count ratio or a ratio of reflectance percentage for the VIS band to the temperature (°C) from the thermal band works well. The procedure should make scenes that would otherwise be discarded at least partially usable for analysis.

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A. Problems:

All CCT received since the first shipment have been 1500 bpi in spite of the fact that we clearly specify the 800 bpi format on each order. We trust phone calls and letters have corrected this error.

Our batch process mode IBM 1800 system has been down periodically due to core malfunctioning and the data backload has reduced access time to it to process HCMM CCT. We have adjusted the working hours of one key analyst to approximately double our access to the system.

Six of seven CCT received to date covering our Rio Grande Valley HCMM Synoptic test sites have 40 percent or more cloud cover. Thus, these test sites will be clear, partly clear, or obscured depending on the cloud distribution on each date. Consequently, we are formulating several procedures for automatic detection of cloudy data within HCMM scenes so that we can utilize as much of the clear pixel data as possible.

B. Accomplishments:

1. Automatic cloud detection within HCMM scenes.

The cloud detection problem differs among the three types of data we are now receiving; (a) Day-IR, (b) Day-VIS, and (c) Night-IR. The scatter diagram shown in Figure 1 illustrates a typical clustering of HCMM Day-IR and Day-VIS data for cloud (C), land (L), and water (W). The digital count data for the emissive and reflective bands have been converted to degrees centigrade and percent reflectance at the top of the atmosphere, respectively, using calibration procedures given in the HCMM User's Guide (December, 1978). The cloud detection objective for all three data types is to distinguish cloud data from the earth surface land and water data.

Considering Day-IR data only (Fig. 1), it is difficult to separate water and clouds as their temperature ranges tend to overlap. Similarly, for Day-VIS data, cloud and land data ranges tend to overlap. Therefore, one possible cloud detection scheme involves using both Day-IR and Day-VIS data together with pattern recognition techniques such as the maximum likelihood or parallelepiped classification procedures.
The approach we have implemented for daytime data is the ratio of VIS to IR data. The ratio can be either a raw digital count ratio, or a ratio between reflectance percentage and temperature (°C). For the June 12, 1978, data shown in Figure 1, the ratio of reflectance to temperature is displayed. A pixel with a VIS to IR ratio greater than 1.1 will be classified as obscured by clouds and a pixel with a ratio less than 1.1 will be classified as clear. We still need to determine the ratio threshold that is appropriate for each observation date. The procedure also requires that the data from the two wavelengths be registered so that it will overlay. We think our geometric corrections are good to within about a pixel.

The VIS to IR ratio approach will not work for the Night-IR data because there are no corresponding Night-VIS data. For this case, the ratio of the center pixel value to the mean of a moving 9x9 pixel window appears to show promise. For scene areas with scattered clouds this ratio fluctuates wildly, but for clear areas the ratio remains close to 1. The use of a moving 9x9 pixel window for cloud detection will be reported on more fully in the next quarterly report.

Ultimately, we believe these cloud detection procedures will allow us to determine those test sites that are clear or partly clear from those that are obscured. This result will permit us to more fully utilize the clear HCMM data for each ground site of interest and avoid erroneous interpretation due to cloud contamination.

2. CCT processing procedures.

The following will be applied to each HCMM scene:

a. Locate test site in magnetic tape, by referring to transparencies and/or Dicomed display.

b. Determine digital count range of the test site.

c. Prepare IR gray map on line printer--invert daytime data to match nighttime record sequence (because of opposite direction of satellite travel).

d. Find georeference sites in IR data and produce location equations that relate pixel line and sample to latitude and longitude. Cut and try to obtain minimum error of fit by discarding poorly identified georeference site as indicated by computer analysis.

e. Assign the IR value of the nearest pixel to each coordinate cell (20-seconds latitude x 20-seconds longitude). Store these data on disc.
f. Repeat steps a through f with VIS data.

g. Graphically represent six parallel IR (and VIS) transects that cross the test site.

h. Select and apply "threshold" values to the IR data so as to exclude all cloud contaminated data from further analysis. Determine threshold value by plot of individual IR cell values vs corresponding VIS cell values, and by examination of IR (and VIS) transect graphs.

i. Prepare IR gray map of test site using only retained, noncontaminated data.

j. Printout mini-maps of thermal environment surrounding all sites (Intensive sites, Synoptic sites, Weather Sta. sites). Identify which cells in the 9x9 cell scene were cloud contaminated.

k. Calculate mean temp. and std. deviation of the 9x9 cell area surrounding (or comprising) the site. Include only cloud-free cells in the calculations.

l. Prepare histogram of temperatures in the 9x9 cell areas, excluding cloud contaminated cells.

m. Prepare summary table of surface temperatures at all sites for 1x1, 3x3, 5x5, 7x7 and 9x9 cell areas. Tabulate mean values and number of cloud-free cells in each size area.

n. Compare surface temperatures with air temperatures measured at the weather stations.

o. Determine the mean temperatures and standard deviations of the 34 soil associations of the test area (exclude cloud contaminated data from analysis).

p. (Required to be done only once). Determine the centroid of the area of each soil association. Info. to be used in adjusting for marine influences.

q. Determine histograms of agricultural area and rangeland area.

r. Using the frequency distribution of the agricultural area (excluding cloudy cells), determine the temperature limits for Cold, Medium, and Warm areas, such that one-third of the area falls in each classification.
s. Prepare map of test site showing areas of Warm and Cold classification.

t. Overlay selected daytime IR maps of test site and show the frequency of recurrence of warm (cold) conditions at each cell location. Exclude from consideration all cloud contaminated cell values. Represent the percentage of occurrence of the warm (cold) condition at each cell location by printing the following symbols on a map of the test site:

\[
\begin{align*}
2 &= 15 \text{ to } 25\% \text{ of the time} \\
3 &= 25 \text{ to } 35 \\
\ldots &\ldots \\
9 &= 85 \text{ to } 95 \\
0 &= 95 \text{ to } 100\% \text{ of the time}
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u. Overlay selected nighttime IR maps in similar manner to item t.

v. Using selected pair of day/night IR scenes prepare a disc file of temp. differences, cell by cell. Process this "difference" data according to the procedures of steps g, i, j, k, l, m, n, q, r and s.

These processing steps are extensive but are necessary to derive the data to meet the various objectives of the contract. The programs to perform these processing steps have all been written and the procedures through u have been executed for at least one scene. During the next quarter work will proceed in earnest to process additional scenes according to these procedures. To date we have 7 scenes in 800 bpi format and another 7 scenes either ordered or CCT have been returned to Goddard for reformatting to 800 bpi.

C. Significant Results:

Since most of our scenes are at least partly cloudy, we have investigated procedures to edit cloud-contaminated pixels from those pixels representing earth surface features. Because clouds are more reflective than earth features and clouds are colder than earth surface features most of the year at our latitude (26°N), either a raw digital count ratio or a ratio of reflectance percentage for the VIS band to the temperature (°C) from the thermal band works well. For this procedure, the two bands of data need to be registered to the ground scene; we think we are doing that to about ±1 pixel. The procedure should make scenes that would otherwise be discarded at least partially usable for analysis.

D. Publications:

None.
E. Recommendations:

Be sure to have data processors that have access to the format specifications on the data product orders.

F. Funds Expended: (through Sept. 30, 1979)

<table>
<thead>
<tr>
<th>FY 78</th>
<th>FY 79</th>
<th>FY 80</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>$45,240.00</td>
<td>$59,760.00</td>
<td>$20,000.00</td>
<td>$125,000.00</td>
</tr>
</tbody>
</table>

Location and Indirect Program Costs: $26,959.00

Salaries: $61,601.00

Travel and transportation: $4,441.00

Transportation of things: $21.00

Services and Supplies: $11,461.00

Equipment: $4,392.00

Total: $108,875.00

Balance: $16,125.00

G. Data Utility:

CCT received and on order should be adequate to test the objectives of the experiment.
Fig. 1. Day Visible (Reflectance) versus Day IR (Temperature) for a sample of the June 12, 1978, overpass data for clouds (C), land (L), and water (W). The procedure is used to edit cloud-contaminated pixels from those for earth surface features.
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GODDARD SPACE FLIGHT CENTER
Greenbelt, MD 20771
Subject: Type II Quarterly Progress Report #8
September 1, 1979 to December 1, 1979
HCMM NASA Contract S-40198B
Goddard ID: HCM-002

To: HCMM Investigations Support, Code 902.6
Goddard Space Flight Center
Greenbelt, MD 20771

Ten copies of subject Type II Quarterly Progress Report #8 are
enclosed in fulfillment of contract provisions.

Craig Wiegand
Principal Investigator

Enclosures

cc: H. W. Gausman
    E. A. Taylor
    P. R. Nixon

Original Report sent to:
✓ NASA Scientific and Technical Inform. Facility
   6571 Elkridge Landing Road
   Linthicum, Maryland 21090
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