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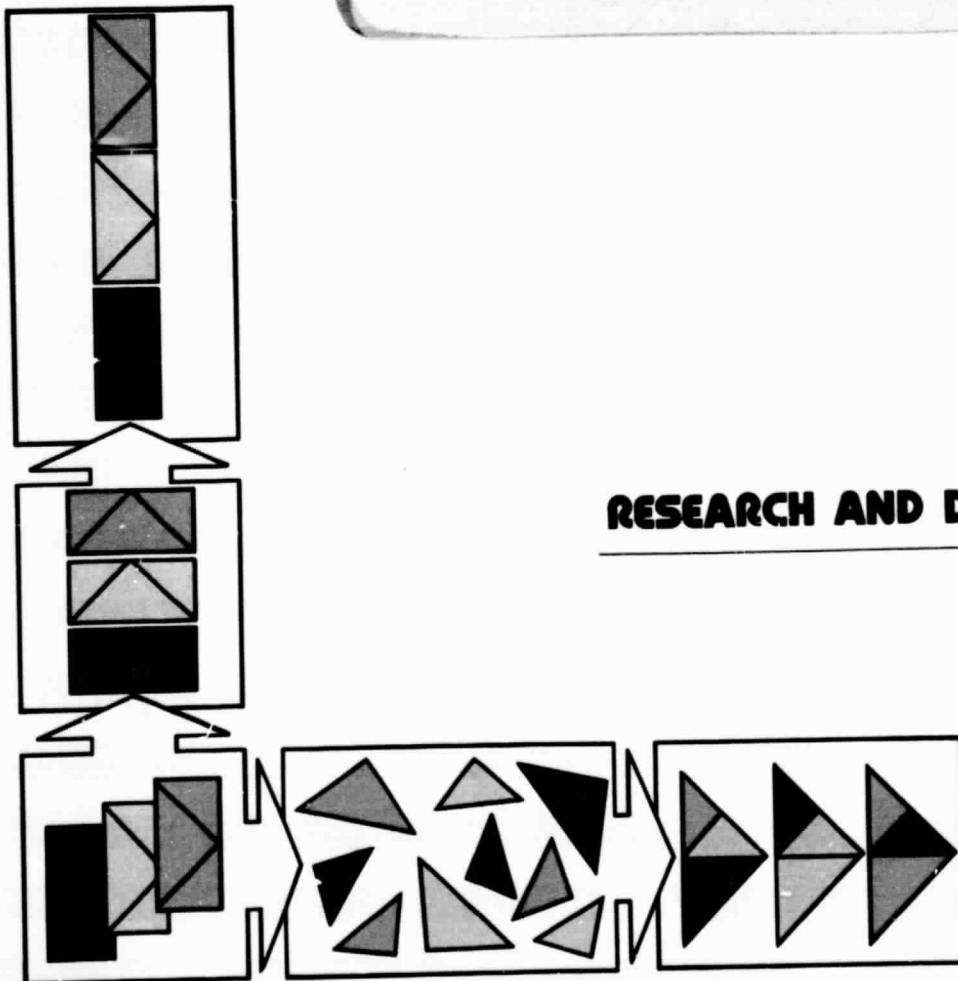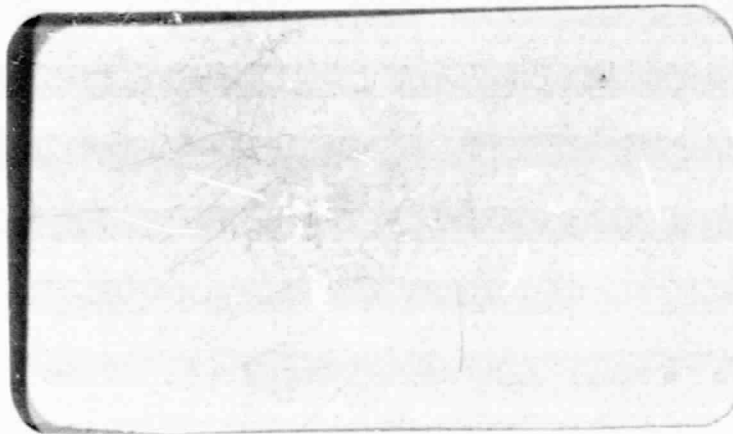INFORMATION AS POSSIBLE

# NASA CR- 1667<del>tt</del>6

**RDS**

## RESEARCH AND DATA SYSTEMS, INC.

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## THERMAL ALGORITHMS ANALYSIS

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Final Report

Prepared For

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

Under

CONTRACT NO.  NAS 5-25786

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# I. INTRODUCTION

Satellite radiometric measurements in the infrared yield valuable information about the earth-atmosphere system. Recently the application of satellite-based visible and infrared measurements to determine the properties of the sub-surface soil has been initiated with the advent of the Heat Capacity Mapping Mission Satellite (HCMM). The Heat Capacity Mapping Radiometer on board the spacecraft senses the earth's surface within a 12-hour interval at times when the temperature variation is maximum. The day/night temperature measurements are used to determine the 'thermal inertia' which defines the response of a material to a time-varying heat flux. A numerical model of the variation of the surface temperature under a time varying solar energy input and meteorological conditions has been developed by Dr. John C. Price. This model provides a framework for the interpretation of observations of the earth's surface from satellites. Within the past few years high resolution visible and infrared data have been acquired by Landsat-C, HCMM and TIROS-N satellites. The basic objective of contract NAS 5-25786 was to provide programming and analysis support to the Technical Officer in his efforts to develop a thermal model of the earth's surface from detailed analysis of day/night registered data sets from the Heat Capacity Mapping Mission (HCMM) satellite.

# II. PARTIAL LIST OF PROGRAMMING AND ANALYSIS TASKS

A partial list of the tasks completed under this contract are given below as samples of the programming and analysis tasks allocated under this contract.

## 1. HCMM - REMAP PROGRAM

Modified 'Boundary' program, which is a part of 'REMAP' program, so that it satisfies the following two special cases:

      (a) Geometry type is '7' but there is no side '2' and

      (b) Geometry type is '0' but there are no sides '1', or '4', or '5' or

        '8'.

The new version has been verified on 12 samples, and copies have been distributed to users.

## 2. HCMM - REGISTER

Ran 'HCMM-TAPE READ' program, which dumps the tape, for the tape pair #2-AA003410170p and pair #11-AA008710040p.

Identified tiepoints for the above set of remapped elongated HCMM images, and then registered them by the 'REGIST' program. Also identified and registered HCMM-AAHD800389 (pair #12) DAY-VIS and NIGHT-IR by the G.E. Image 100 and IBM 360/75.

## 3. HCMM - Images

Generated stretched and unstretched DICOMED pictures and negatives of HCMM-AA0087/0040 images for DAY-VIS, DAY-IR, remapped NIGHT-IR, $\Delta T$ and ATI.

Generated 1000 x 1100 DICOMED pictures and negatives from HCMM images of ICELAND and Mississippi area.

## 4. HCMR - Calibration

Submitted the HCMR calibration program, which was corrected for cold operation of the HCMR during 1980. Discontinuation of the NAPS-HCMM support eliminated this potential means of calibrating 1980 HCMM data.

## 5. HCMM - DAY/NIGHT REMAP

Debugged several failed HCMM DAY/NIGHT remapping programs for Mr. Jan Schmidt from Code 500. (Mr. Schmidt is in charge of the HCMM remapping production runs). The errors occurred while creating remapping triangles. The errors were corrected by (1) increasing the number of tiepoints or (2) reordering the tiepoints (if, incorrectly ordered) or (3) making up the boundary tiepoints.

Tapes: AAHDG8029401

AAHDG8101403

AAHDG8102601

## 6. Tell-us Model

Modified Tell-us program into three versions: (1) This version uses an IMSL subroutine called 'DRFBS', a differential equation solver, and Wolfplot to plot Temperature vs. Time. (2) This version has a modified OUTPUT format, along with some change in 'ROOT' and 'BUDGET'. (3) This version is similar to the previous one, but had less varying angles and thermal inertias and uses Wolfplots to plot the Angles vs. the Temperature guess produced by the angle.

The 3 versions of Tell-us Model have been modified with new interpolation routine for atmospheric resistance and new integrator for temperature profile.

Several tested runs of new models by varying roughness, albedo, and emissivity, have been done.

## 7. RADIATIVE TRANSFER PROGRAM

Have completed modification and overall restructuring of the radiative transfer program, (RADTRA). The final version has been duplicated, and 32 copies have been distributed to users.

8. NS001

    A. Reformat Tape

        Specific NS001MS imagery universal format raw data tapes were
selected, for reading by the G.E. Image-100. Errors occured while matching
channels. A tapescan (by IBM 360/91) was made to check a tape format.
Incorrectly used header record was found. (Tapes were created by people at Texas
A&M. They put more than one header record on a tape, and some header records
did not go to the beginning of the tape). Therefore, these tapes were reformatted
by IBM 360/91.

        Tapes:
            (1) Created from JSC 001644
                LINE #11   RUN #1
                August 16, 1980 at 14:00
                DALHART, TEXAS
            (4 tapes)

            (2) Created from JSC 001652
                LINE #12   RUN #1
                August 16, 1980 at 14:00
                DALHART, TEXAS
            (4 tapes)


    B. Statistics

        Twenty fields of NS001MS imagery universal format raw data
tape at DALHART, TEXAS were selected. The hard copies, minimum, maximum,
mean and histograms of VIDEO data for those twenty training site statistics were
carried out by the G.E. Image-100.

            Tapes:
            (1) DALHART   LINE 11   RUN 1                    (4 tapes)
                August 16, 1980   14:00

            (2) DALHART   LINE 12   RUN 1                    (4 tapes)
                August 16, 1980   14:00

4

(3) DALHART  LINE 13  RUN 1                                (2 tapes)
       August 16, 1980  15:00


(4) DALHART  LINE 11  RUN 1                                (4 tapes)
       August 16, 1980  16:00


(5) DALHART  LINE 12  RUN 1                                (4 tapes)
       August 16, 1980  16:00


(6) DALHART  LINE 13  RUN 1                                (2 tapes)
       August 16, 1980  17:00


(7) DALHART  LINE 11  RUN 1                                (4 tapes)
       August 14, 1980  14:00


(8) DALHART  LINE 12  RUN 1                                (4 tapes)
       August 14, 1980  14:00


(9) DALHART  LINE 13  RUN 1                                (2 tapes)
       August 14, 1980  15:00


(10) DALHART  LINE 11  RUN 1                               (4 tapes)
       August 18, 1980  20:00


(11) DALHART  LINE 12  RUN 1                               (4 tapes)
       August 18, 1980  20:00


(12) DALHART  LINE 13  RUN 1                               (2 tapes)
       August 18, 1980  21:00


9. Dicomed Images

   Contrast stretched 16 LANDSAT subset images by the G.E. Image-100
and VICAR, IBM 360/91.  B/W and color Dicomed pictures and negatives were made
by Dicomed machine.  Processed tapes are L13130, L13175 and VICR81.  (Band 4,
5, 6, 7 of LANDSAT, 1972 & 1977 at Taipei, Taiwan).

## 10. SAR/LANDSAT

A. Flip flopped and rotated the SAR sub-images by either FORTRAN-H or VICAR routines.

Tapes: SAR-03080083

SAR-03220079

B. Extracted a specified area from LANDSAT CCT tape and wrote the image data to a tape in band sequential and then corrected striping (line noise) in 4 Bands.

Tapes: LANDSAT - 83013421455X0

## 11. RAINFALL-CELL TAPE

Modified 'Testsite' program and generated DAY/NIGHT histograms of rainfall for cell tapes.

Tapes: CORTB1

CORTB2

CORTB3

CORTB4

## 12. Wolfplot

Modified 'Convection' program such that including Wolfplot option and also double dimensioning of some parameters as indicated.