UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HEAT CAPACITY MAPPING MISSION (HCMM) THERMAL SURFACE WATER MAPPING AND ITS CORRELATION TO LANDSAT

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Memorandum for the Record (EC-74-Landsat)

By: EROS Coordinator, National Mapping Division

Subject: Heat Capacity Mapping Mission (HCMM) thermal surface water mapping and its correlation to Landsat

The Heat Capacity Mapping Mission (HCMM) involves a relatively simple satellite recording the radiation from the Earth in the thermal band (10.5 to 12.5 μm) using an instantaneous field-of-view (IFOV, "footprint" or pixel) of 600 x 600 m. The enclosed graphics illustrate HCMM thermal mapping of water bodies as applied to Lake Anna. The HCMM digital data were produced by NASA and processed by the National Oceanographic and Atmospheric Administration/National Environmental Satellite Service (NOAA/NESS) into image and line-printer form for the U.S. Geological Survey. A Landsat image of Lake Anna illustrates the relationship between the Landsat multispectral scanner (MSS) and the HCMM data as now processed by NASA through their Image Processing Facility (IPF) which transforms the data to the same distortion-free Hotine Oblique Mercator (HOM) map projection. Spatial correlation of the two images is relatively simple by either analog or digital means and the HCMM image has a potential accuracy (root-mean-square error--rmse) approaching the 80 m of the original Landsat data.

Lake Anna was built and filled during 1968-72 to provide cooling for a nuclear power plant. The lake covers about 5,300 hectares (13,000 acres), but because of its dendritic shape, it is hard to find open reaches of more than 2 or 3 km. Approximately 1,200 hectares (3,000 acres) comprise the actual cooling ponds for the nuclear reactors, and they again are broken into odd shapes with open reaches generally limited to 1 or 2 km. The HCMM IFOV is a nominal 600 x 600 m, and the data have been resampled by cubic convolution which alters original IFOV response both geometrically and radiometrically. Thus it is difficult to get a thermal reading of the cooling ponds which has not been diluted by radiation from the considerably cooler adjacent land areas.

On the graphic that displays both image and line-printer HCMM data, the image form fails to display the subtle temperature differences because of the range and contrast used in the reproduction process. However, the digital data as indicated by the line printer displays five different temperatures, all of which represent open-water areas. Again, the narrow portions of the lake fail to show suitable readings because the land area dilutes the response of the 600- x 600-m footprints near the shoreline.

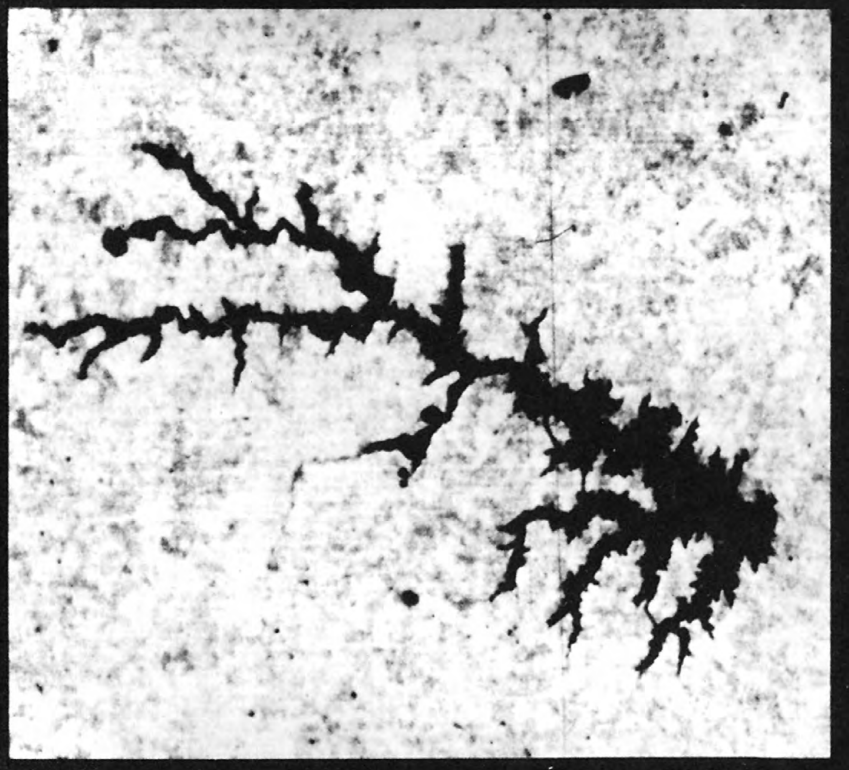
On June 11, 1978, when the HCMM data were obtained, thermometers were recording temperatures (surface, mid- and bottom depths) at no fewer than nine locations distributed throughout the lake. The thermometer readings clearly indicated that the pre-launch HCMM calibration data could not be applied directly to Lake Anna readings. Where thermometers indicated surface temperatures of 23.7° C, the HCMM reading based on pre-launch calibration recorded 14.3° C. Thus, 9.4° C were added to the pre-launch-based values. The resulting correlation indicates that, where the water-surface response was not diluted by land areas, the temperature difference recorded by the HCMM correspond to the in situ temperature readings with rmse on the order of 1° C. Thus, the temperature gradients in the larger areas of cooling ponds and main lake body are recorded in useable and relatively accurate form.

Other sites of known surface-water temperature must be tested before conclusions can be reached as to the areal and temporal frequency of calibration needed to effectively map water-surface temperature with HCMM data. Moreover, the atmosphere and surface conditions under which such thermal sensing is or is not practical remain to be defined. It is considered significant that a satellite with as coarse a footprint as the HCMM can provide meaningful data of a water body as small and irregular as Lake Anna and that the data can be spatially correlated with other data sets such as those of Landsat.

Alden P. Colvocoresses

Enclosures 2

CORRELATION OF HCMM AND LANDSAT DATA
LAKE ANNA, VA.



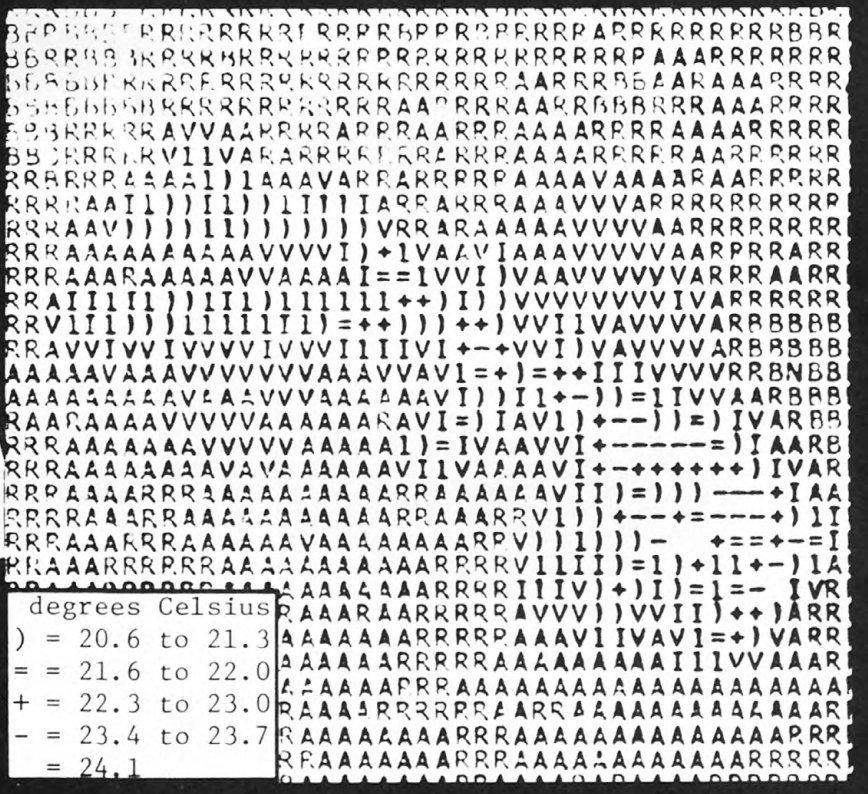
LANDSAT MSS BAND 7
JULY 8, 1973
80 X 57M PIXEL

HCMM*
JUNE 11, 1978 NIGHT
600 X 600M PIXEL

5 0 5 10 15 20 KILOMETERS

*HCMM data furnished by NOAA/NESS

HCMM THERMAL MAPPING OF LAKE ANNA, VA.



degrees Celsius	
)	= 20.6 to 21.3
=	= 21.6 to 22.0
+	= 22.3 to 23.0
-	= 23.4 to 23.7
	= 24.1

IMAGE FORM

LINE PRINTER PLOT

5 0 5 10 15 20 KILOMETERS

Time and Date of Imagery, 03:29 EDST, June 11, 1978