May 28, 1985

Digital Image Analysis Laboratory
University Computing Center
University of Massachusetts
Amherst MA 01003

Dr. Oliver Strimpel
The Computer Museum
300 Congress Street
Boston MA 02210

Dr. Strimpel,

I am writing to confirm our phone call of May 21st regarding the donation of our newest LANDSAT mosaic of New England by ourselves and the National Geographic Society.

Duncan Chesley and I met at the Geographic last week with Jon Schneeburger, the editor of illustrations for the 'Atlas of North America' project. This publication (a large format, hardcover book) will be available to Society members in November 1985. The Atlas will be a showcase for remotely-sensed data and digitally processed imagery. Our laboratory was commissioned to create the New England mosaic specially for the Atlas.

The Atlas is currently in the final stages of completion and will go to the printers at the end of July. During the period from July through November, the Geographic will be publicizing the Atlas to it's members and in the popular press. As part of this scheme, they are excited about the possibility of creating a very large reproduction of the New England mosaic and donating it to the Museum.

I have enclosed a print of the mosaic for your inspection. This print is, unfortunately, not exceptionally high quality. However, it does give you a good view of the geographic scope of the image. The image contains 11 full-resolution LANDSAT MSS scenes from Fall 1978. As with the southern New England mosaic, all the scenes are from different dates, and were gathered by two LANDSATs (II and III). The total data volume is 390 megabytes. Approximately 25 individual processes were used to create the final image.

The major new feature in this image is the extensive fall foliage color in northern Vermont and New Hampshire. This lends the yellow and orange coloration to the mountain areas. Note that we were again able to find coverage with no cloud cover - quite lucky for this part of the country.

This print is made from a 2x2 reduction of the actual data - the full-resolution image is thus 4 times as detailed.

While we were unable to lay any concrete plans during our first meeting, I believe the Geographic is anxious to cooperate with the museum. I will be in contact with their public relations staff during the next several months, and will have them contact you as soon as it is appropriate.

I, too, am excited about the idea of cooperating with the museum. We are very pleased that you consider our work of display quality. I look forward to working with you in the near future.

Sincerely,

David M. Oliver
DIAL / UCC

cc: C. Wogrin, UCC director
D. Chesley, DIAL head
J. Heckman, NGS NA Atlas project

Page 1

No #1-4 Progression from traditional graph of F(x) to many F(x)'s. Then the same data plotted as a digital image.

No #5 Electron microscope data plotted in two ways. (see printed description #1-2)

No #6-7 Plots of mathematical functions. High values are white, low are blue.

No #8 Example of photographic film vs. digital detectors.

#9-16 See desc. #3-7. Only if chlorophyll is shown

Page 2

Maybe land on Cape Cod ?

#1-5 Steps in the classification process. This is what most remote sensing data is used for.

#6-8 Thematic maps showing landcover types.

#9-10 Formation of composite (3-band) color images.

#11-18 Composite color images of Boston and Pioneer Valley. Picture of Oxbow shows smoke from power plant blowing toward the NW.

what do colors stand for. If bit values because one could go there easily

#19 Hawaii

#20 Egypt

Page 3

#1-2 Shows the effect of contrasting enhancing original Landsat data.

#3-4 Shows the effect of destriping (sensor balancing).

#5 X-ray diffraction pattern.

#6 See desc. #11 (no sproket holes).

#7 Microscope picture of sugar crystals.

#8 See desc. #10. Angiogram - what is revealed ?.

#9-10 Original and enhanced X-ray. of skull - "

#11 School of fish from an airplane at night. Brightness is the luminescence in the water stirred up by the movement of the fish.

#12 Temperature image of the Atlantic coast.

Digital Image Analysis Laboratory
University Computing Center / GRC
University of Massachusetts
Amherst, MA 01003
Ph. (413) 545-2690

October 18, 1984

Oliver Strimpel
Computer Museum
Museum Wharf
300 Congress St.
Boston, MA 02210

Dear Mr. Strimpel:

Enclosed are the pictures illustrating the basic steps in performing a classification on Landsat data. The sequence starts with the raw data in one band (band 7 IR) and shows destriping and geocorrection in black and white. Then three bands are combined to make the typical red composite color image. Finally the classified result is the green color image of the cape. I ahve attached a more complete description of the films.

Today I have copied part of the 6250 bpi TM tape to a 1600 bpi tape. I will be mailing that shortly under a separate cover with a detailed explanation of the process.

I am glad to be able to help you out. Will these films be in time for the Museum opening ? Let us know if you need any more information.

Sincerely,

ıncan M. Chesley

Picture Descriptions

Note: For the black and white pictures I am referring to the hardcopy images when I say bright or dark, not to the film negatives.

Image 1 (BADCAP6 and the magnified version)

This image is the "raw" data for Landsat band 7 as it is received and preprocessed by NASA and EDC. The incoming data stream has been reformatted into an image, and some radiometric corrections have been applied in order to make a useable image. (We actually artificially enhanced the stripes because this particular image was quite clean to begin with.)

Because the MSS scans 6 lines simultaneously with 6 different detector systems, there is still some residual horizontal striping in the image due to the improper calibration of the sensors. In the full cape image the stripes appear to be narrow bright lines in the ocean and dark lines in the land. The magnified version reveals the true nature of the stripes. Three sensors are matched quite well, one is too bright, and two are too dark.

Image 2 STCAPE7

The first processing algorithm removed these stripes. The program assumes that the histograms for each of the sensors should be identical. It calculates the histograms, computes the adjustment, and adjusts each line according to which sensor the line came from. In this way the stripes are removed as shown in this image. (The small amount of left over striping is due to the hardcopy device.) All the four bands must be destriped before further analysis.

Image 3 GEOCAP7

The next step is to geometrically correct the image to remove the distortion due to the scanner optics, the satellite motion in its orbit, and the curvature of the earth. If this is done exactly it is one of the most expensive parts of the analysis. Here we have done an approximate version which should be adequate for display purposes. All four bands must be geometrically corrected.

NOTE: NORTH is 9.2 degrees counter-clockwise from UP in all the rest of the images (and in the MOSAIC we sent also).

Band 7 on MSS is very sensitive to water. In this band wet areas on the land show up significantly darker than dry land, and the ocean is very dark compared to the land. Note the marsh area on the north side of the cape at the lower right. This is dark because it is wet.

Image 4 GEOCAP4

This is a destriped, geometrically corrected Landsat Band 4 image taken at the same time as the band 7 image. Band 4 is a blueish filter. It is sensitive to turbidity in the water. The ocean and the land appear roughly the same brightness here. Note that the urban areas and Otis AFB stand out very clearly in band 4 but not at all in band 7. Note also that the marsh area on the cape looks brighter than its surroundings.

Image 5 (red cape)

In order to simultaneously view features in the different bands we have made the traditional Landsat composite color image. We have printed band 4 as the blue in the film, band 5 (green) as green, and band 7 (IR) as red. The result is a photograph that looks something like a color IR photo. Green vegetation appears bright red. The major color is a duller red because of the season.

The ocean is blue because it was brightest in band 4 and very dark in the other two bands. The beaches and surf are white because they are highly reflective and equally bright in all three bands.

Every color we see can be produced as a combination of blue, green, and red light. With some practice a researcher can look at the colors in an image like this and determine the amounts of blue, green, and red light that make up a particular color. The researcher then knows the relative brightness of the object in the three original bands.

By finding regions of the same color in this image the researcher is performing a manual, visual classification of the image pixels into categories or classes of ground cover. This means saying, for example, that every place that is dark blue is water.

Image 6 (green cape)

The human eye is only moderately good at this grouping. One problem is that the decomposition of colors only allows the use of three input bands. Another problem is that everyone sees color differently, and consistency of color perception is nearly impossible. Landsat researchers use a computer program to perform this same task using 4 or sometimes 5 different bands as input, and a statistical algorithm to assure consistency in results.

This image was produced by the classification program. It shows the cape divided into 6 broad categories of ground cover. These are:

- dark blue - deep water
- light blue - shallow water
- red - tidal flats
- yellow - wetlands
- dark green - softwoods
- light green - hardwoods
- white - dry grasses

Using classified images such as this it is very easy for a computer to add up all the spots that are white (for example) to get an acreage count for all dry grasses in this part of New England. It would be very difficult (or impossible) to gather the same information with the same accuracy with more traditional manual site surveys.

This image was produced as part of a survey of all the salt water marshes on the east coast from Cape Hatteras to Maine. The images and original Landsat data were supplied by the CHARM Project of the National Marine Fisheries Service, and the Department of Fisheries and Wildlife Management at the University of Massachusetts. Image enhancement, processing, and display were done at the Digital Image Analysis Laboratory, UMass.

Digital Image Analysis Laboratory
UCC / Lederle GRC / UMass
Amherst, MA 01003
Ph. (413) 545-2690

September 19,1984

Dr. Oliver Strimple
Computer Museum
Boston, MA

Dear Dr. Strimple:

Thank you very much for your great interest in our work. I hope that some of these slides may be useful in your exhibit. While there isn't time to do anything fancy, there may be some simple things we could do to add to the slides included here, or to improve some of them.

ndo

I have enclosed the large Ektachrome of the New England mosaic, and a booklet containing most of our slides and some descriptions. Because of the time frame for your project I have been forced to include some slides for which there is no other copy. Please be very careful with the slides. There are 54 in all.

to Len

I have also enclosed a poster which we have recently printed. Would you like to sell some of these in the Museum store? We have about 500 of them, and could print more. I suggest a retail price of $10. We can generate other similar posters of images shown in the slides. We can also replace the University's name and logo with other information.

At the top of page 1 of the slides I have 8 slides which "introduce" the idea of a digital image as a way to plot any function F(x,y). Up to a million points in such a function can be displayed simultaneously.

Next, I have included several examples of display manipulations that make the data easier to interpret.

The classification sequence at the top of page 2 shows the most common type of processing done with satellite imagery. Classification is the way we (and everyone else) find out how well the world's wheat crop is going to turn out each year.

Page three, slides 1-4 are the only examples I have of processing being done to change an image. To fill this gap I will make some filtered images for you. Using the CZCS image as the original I will generate a smoothed image and an edge enhanced image using some filtering techniques. I'll give a call when I get something that looks good.

Good luck with the mosaic. I can hardly wait to see the finished mural. Let me know if you need more information about any of the slides. A brief description follows. The printed descriptions are old and may not be completely accurate. I number my slides from upper-left to lower-right in the sleeves.

#13 Glowing gas around a hot star as seen with a radio telescope.

#14 Galaxy.

#15 Image from a data base of health statistics for Mass. Shows which towns have gotten much worse as far as heart disease is concerned.

#16 Data base on ocean temperatures during the year.

#17 Data base of climatological data.

#18-20 See description #12-14.

One last plea to be very careful with my slides. Some are not reproducible.

Sincerely,

Duncan M. Chesley
Head, DIAL

P.S. Please have the credit line read:

Images furnished by the Digital Image Analysis Laboratory, University Computing Center, University of Massachusetts at Amherst.

DMC

this image is not
to be copied or
duplicated or used
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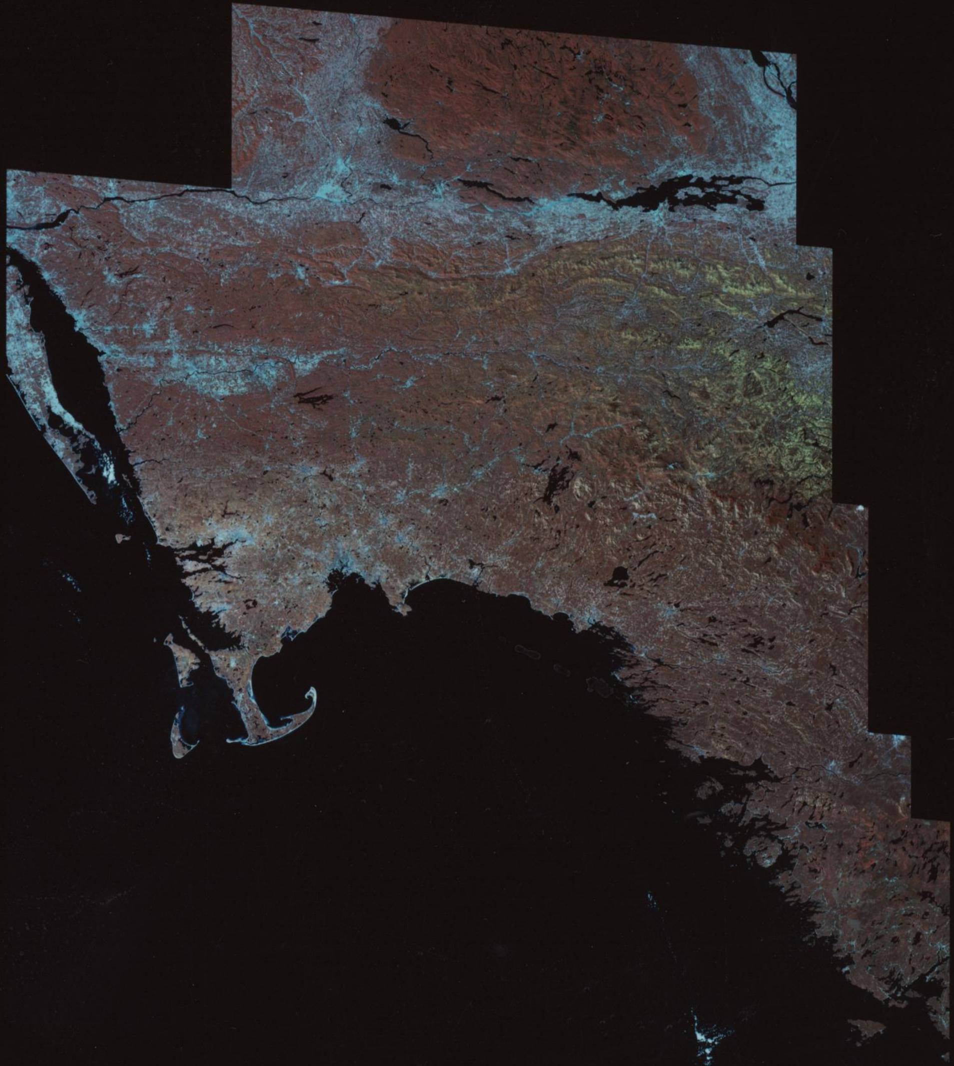

magnified BADCAP6
IMAGE 1

BADCAPG

IMAGE 1

PROPT

STCAPE7 -50,200

IMAGE 2

IMAGE 3

GEO CAP 7 50, 200

IMAGE 4

GEOCAP 4