

Derek Morris Jr.
CERSER
01/05/17

ECSU TeraScan Training

SeaSpace was founded in 1982. They were the first to have the low-cost remote sensing satellite ground station. The earliest installation was in Antarctica to support flight operations. In 1990 the TeraScan software was released. SeaSpace got there CE Certification of 2.4m X/L-Band System and 50th MODIS acquisition and processing system sold in 2008. When SeaSpace opened a new headquarter they Introduction of next-generation web-based products with release of TeraCat™ and StormTracker™ and SeaSpace purchased remote sensing solutions division of Vexcel. By the time 2012 hit SeaSpace acquires and processes first direct broadcast image from NPP VIIRS of California. That was when ECSU partnered with them.

SeaSpace Corporation Inc. based in Poway, California is a provider of remote sensing ground stations. In order to provide an east coast training site and data center and to continue to foster established research collaboration, SeaSpace on February 7th, 2012 entered into a partnership with Elizabeth City State University. This east coast satellite data collection facility includes the hosting of a 2.4m X/L Polar Orbiter antenna system and a 3.7m C-Band antenna and their associated acquisition and processing servers.

In 2013, the Center of Excellence in Remote Sensing Education and Research (CERSER) added more satellite receiving hardware to its current National Oceanic and Atmospheric Administration (NOAA) satellite system. The program now processes both NOAA satellite images as well as Geostationary Operational Environmental Satellite (GOES) satellite images. This new imaging capability required the development of scripts on the TeraScan system to process satellite data received and produce an image file with overlay features such as latitude/longitude lines and political map outlines.

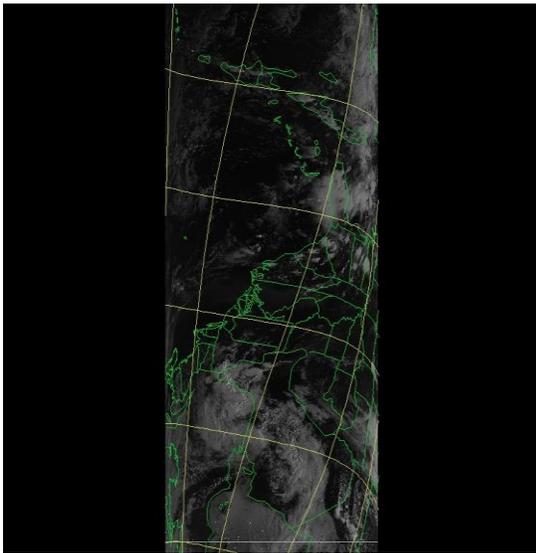
TeraScan is a combination of hardware and software designed for automated reception of data from meteorological/environmental satellites and for processing the data into images and data overlays. Images and overlays are of a special format called TeraScan Data Format (TDF) and can be displayed with the TeraVision. These data files can be used to produce images in various formats. Different types of satellite data can be received from both the hardware and software that is installed on the computer.

These satellite data types include: X - Band Data from Polar - Orbiting Satellites, L - /S - Band Data from Polar - Orbiting Satellites, and L - Band Data from Geostationary Satellites. There are several different structures of hardware for the TeraScan system in how it receives and processes data. In the system, there is an antenna, receiver, bit synchronizer, frame synchronizer, computer workstation with TeraScan software, Global Positioning System (GPS), and an uninterruptible power supply (UPS). Different antennas are used for different satellite signal interception. For high - resolution data reception from geostationary satellites, a fixed - direction antenna is used. For high - resolution data reception from polar - orbiting satellites, a tracking antenna is used. The receiver is used for tuning to the correct satellite signal frequency and separating the sensor data (the baseband) from the RF carrier (the latter function is known as demodulation). The bit synchronizer regenerates the bit stream against noise, and if necessary,

extracts the clock, which is a timing pulse added to the signal on the satellite to enable synchronization of the reception system with the satellite transmitter. The frame synchronizer divides the continuous bit stream into meaningful data blocks called frames. Finally, the GPS supplies position and time to the system and the UPS protects the system from power surge.

The Center of Excellence in Remote Sensing Education and Research (CERSER) on the campus of Elizabeth City State University was currently task with the responsibility of receiving remotely sensed data from orbiting National Oceanic and Atmospheric Administration (NOAA) Polar Operational Environmental Satellites (POES) and the Geostationary Operational Environmental Satellites (GOES). This data is collected by SeaSpace TeraScan systems installed in the CERSER labs in Dixon-Patterson Hall. Now ECSU is hosting training where we learn about how to use TeraScan system is implemented.

The program shows us how to use lspass. Lspass is a command that checks to see if we are receiving passes from the server. After taking a look at the file we created two directories called goes2 and noaa. The command to make a directory is “mkdir”. Then we created a command call gvarin. Gvarin creates a TeraScan TDF dataset from raw GOES GVAR telemetry data. The dataset contains two-dimensional imaging or sounding data from visible and infrared sensors. The raw data can be read from the pass disk, from tape, or from the UNIX file. Raw data on tape must be in TeraScan Archive Format (TAF). After processing the data we used tvview and the data point for we can take a look at the image we process like in Figure 1:



Figure

Mr. David Mobley explained to us how the satellite operates off five different channels. That way you can see different visuals and sensors. You have visible, thermal, and infrared. Visible can detect cloud cover. Infrared detects low fog and water vapor. The thermal detects surface and carbon dioxide. These different faces operates off of these channels:

- Channel 1 (visible) - Cloud cover and surface features during the day
- Channel 2 (Infrared) - Low cloud/fog and fire detection
- Channel 3 (Infrared) - Upper - level water Vapor
- Channel 4 (Thermal Infrared) - Surface or cloud top temperature
- Channel 6 (Thermal Infrared) - Carbon dioxide band: Cloud detection

Once explained we opened a program called TeraVision. TeraVision is the TeraScan GUI for basic image viewing. It provides zooming and panning, animation, color enhancement, and value query capabilities. As I said previous we created directories, inside the directories were NOAA data and goes data. To get the images opened you to go to file-open data shelf, edit data library, go to the file created with the imaged saved in file, and hit accepted and done. Then go to the data type of the file you created, time of the images that came thru, and select the variables you wanted to opened. By using TeraVision we were able to open these file we enhance the image capabilities by changing the color, changing the color and see the animation of all the images like shown in the figure 2:

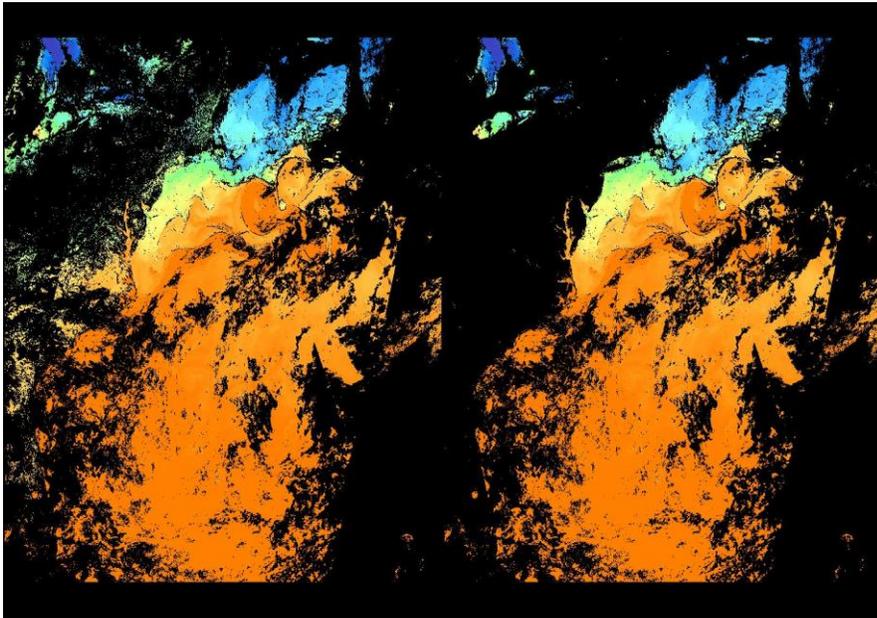


Figure 1

Mr. David show us a new command tool It gives us a good explanation on how to use other commands and gives a detail step for step example. With that being said Mr. David had us create a master. A master is used to create master files that define areas of interest for pass data ingest. Master files also define the map backgrounds used during registration. Then we created another directory

call conus. Then we used a command call hrptin. Hrptin creates an TeraScan Advanced Very high Resolution Radiometer(AVHRR) dataset from HRPT telemetry data. Input telemetry can be read from the pass disk. After that we used fastreg2. Fastreg2 registers variables from input datasets to a user-defined base map and projection. For each input dataset, a corresponding output dataset is created to hold the re-mapped variables. Then we used grep to grab every line with NOAA or any other satellite of your choice. Fastreg function takes all of the data within an input dataset and interpolates the data onto the grid that is defined by a master dataset. Emath, or Emath2 is only one expression parameter, which can be broken into one or more sub-expressions using semicolons. Such as this:

```
X1 > 10 && x3 < 0 ? 1 : 0 "gives us the cloud index"
land && y1 == 0 ? (x2-x1)/(x2+x1) : badval "vegetation"
```

We used contents lists for the definitions of all dimensions and variables as well as the definitions and values of the global and variable attributes of a TeraScan dataset. Then we use this formula $\frac{ch2 - ch1}{ch2 + ch1}$ to find Normalized Difference Vegetation Index (NDVI). Then use a command called audit. Audit reports the history of one or more TeraScan datasets. The history of a given dataset consists of the names and parameters of each function used to produce the dataset plus the history of all input datasets.

This is in contrast to session, which produces a chronological report of all TeraScan processing. So basically it shows all the commands that were used to create the data set.

Once we finished with our files we cat some points. Cat is a yes/no indicator of whether or not an archived pass was or will be logged into the online catalog. So to cat you “cat > points.csv” that puts you inside a editor. Inside the editor you input some points. These points will show up once you fix the settings. To get out the cat you have to “ctrl + D”, that will save and exit you out of cat. Then you have to impasc, expasc, and sample. Impasc produces TeraScan datasets from free format ASCII files. impasc can import 1-D, 2-D or 3-D data. Several variables can be imported at once; each variable must have the same dimensions. In order to import variables with different dimensions, impasc must be run more than once; the resulting datasets must then be combined using the assemble function. Expasc exports TeraScan dataset variable data to ASCII UNIX disk files. Sample takes one or more input datasets and samples them using the list of points in a point_file dataset. When we were performing the impasc and expasc commands we were required to change the extension.

To impasc you type impasc and what shows is:

```
in/out files : char(255) ? points.csv points.tdf
dim_sizes   : int ( 3) ? 2
dim_names    : char( 31) ? [points]
var_names    : char(255) ? latitude longitude name
var_units    : char( 95) ? [- - -]
var_types    : char( 47) ? fl fl str10
var_badvals  : real( 3) ? [0 0 0]
start_fields : int ( 3) ? [1^3]
fields_per_var : int      ? [1]
delimiter    : char( 1) ? []
```

Then we use sample to take all the points:

```
in/out files : char(255) ? n15.15161.2158.avhrr n15.15161.2158.avhrr.pts
point_file   : char(255) ? points.tdf
points_are   : char( 8) ? [points]
include_vars : char(255) ? []
output_coords : char( 3) ? [no] yes
```

Then we use the expasc command to take the .pts file and convert them to .asc file for we see the points.

```
in/out files : char(255) ? n15.15161.2158.avhrr.pts n15.15161.2158.avhrr.asc
include_vars : char(255) ? []
all_same_dim : char( 3) ? [yes]
list_dims    : char( 3) ? [yes]
```

Previously I said that we cat to input points. So now we want to see these points that we input because we adjust the setting in the terminal that way it is visual on the map. Now we open TeraVision to output the points we input in cat. This is what showed up on TeraVision in figure 3:

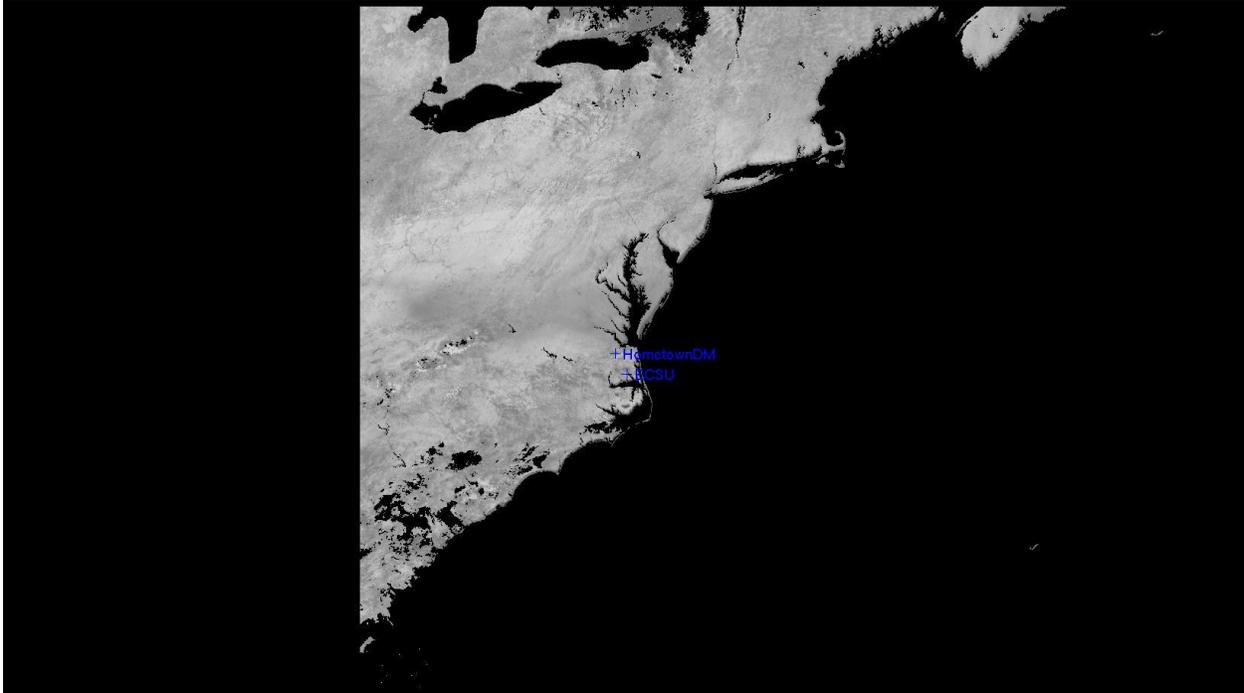


Figure 2

We used the lat and long of our current resident and the school we going to. To do that we did file-open data shelf- ndvi2 for the data types- time file we edit- NDVI image- open. Then we do the same sets over again but we just choose lat and long file and open it on top of the map and that is what you see in the image above.