

Direct Broadcast Terascan Operations in the U.S. Antarctic Program

Andrew B. ArcherJune 10-12**U.S. Antarctic Program**





What is Terascan

What does it do? Why do we need it?



USAP Defined Terascan



Terascan is a satellite ground station and a product of SeaSpace Corporation, it is an integration of hardware and software components that can accurately track and collect telemetry from meteorological polar orbiting satellites. These satellites broadcast signal that is converted into high or medium resolution imagery that is used for weather research and forecasting that is directly used for aviation support, vessel navigation and field movement planning in the U.S. Antarctic Program.

The USAP Terascan systems hold a unique position in that they cover very remote locations on the planet and provide real time imagery to weather forecasters for critical field movement support. Real Time or Near Real Time is the key element. Rapid collection and dissemination of the satellite imagery, on site, is needed for operational decision makers. All other available imagery data carries with it a certain amount of latency.



Operational Assets



- McMurdo Station: Two X-L-S-band tracking ground stations, real time tracking and collecting of NOAA, DMSP, AQUA, TERRA, MetOp-B and NPP(1). Installed 2005 and 2011. Terascan operations started in 1987.
- Palmer Station: One tracking ground station collecting NOAA and DMSP (L and S-band). MetOp is not possible without upgrade. The original antenna at Palmer was installed in 1994 with subsequent upgrades to the computer and receiver in 1999/2003.
- RVIB Nathanial B. Palmer: One moving platform system with collection of NOAA, DMSP and MetOp-B. Installed 1999, upgraded computer systems 2012 (L and S-band).

SPAWAR: Forecasting work stations, two work stations at Charleston, SC, two work stations in Denver.

Antarctic Support Contract: Backup forecasting and administration systems, two work stations, Denver. DHQ acts as a fallback location for the Charleston forecasters to come and perform flight support if SC is impacted by severe weather.

Academic (O-202-M/P): NPP push, MODIS push, NOAA & DMSP through clock and data O-202-M/P.



McMurdo Station



Two 2.4m tracking antennas operating 24x7. Collecting satellite imagery processed onsite, delivered locally and remotely for general weather forecasting and aviation support

Seven computer systems support this function all Linux based. The systems are SeaSpace based equipment. Licensed and Supported by ASC and SeaSpace Corp.







McMurdo's footprint



The basic footprint available from McMurdo Station





Example of Austral Summer Visible channel imagery







Example of an Austral Summer Infrared Forecast Image





The forecasters provide overlays and destinations within the Terascan software to more accurately position weather concerns at sites we are flying to in the field



Austral Winter





This image is showing the Katabatic winds coming down off of the Polar plateau. This image is an Infrared product taken on May 25th 2013 from the McMurdo Ground Station.

Animating a series of images that cover this region showing the 'Katabatic winds' behavior is one of the more spectacular observable weather features we see during the winter months.



McMurdo Station



Radom's and cargo vessel in perspective





Palmer Station



Shots from the other side



Palmer Station's Terascan has been collecting and processing data for many years. The pedestal needs a bit of paint, but overall the system performs very well.



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Another View on Palmer Station's Terascan Antenna







Palmer's Footprint

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Palmer Station coverage





Palmer Station Winter data NOAA-19 AVHRR Ch_4 Infrared





This is a typical imagery product that is tracked, captured, processed and delivered to forecasters from the Palmer Station Terascan system





RVIB Nathanial B. Palmer System



The RVIB Nathanial B. Palmer is the only USAP vessel with an operational Terascan system on board (Antenna Radome on the right {Starboard} side of the Ice Tower). The ARSV Laurence M. Gould is supported by the Palmer Station Terascan system.

To the right is a NOAA pass captured by the NBP Terascan system, processed and displayed on the ships bridge for weather monitoring. Note KGI weather effect: King George Island (KGI) was reporting severe weather and suspending operations, the image to the right shows the weather system effecting King George Island.



The satellite image is a NOAA-19 Static RGB Terascan product, captured while in port at Punta Arenas May 9^{th} 2013



Data processing



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"Configproc" is a set of tools that SeaSpace has created to provide us with easy access to post processing capabilities.

There are also a host of custom configured post processing scripts resident on the Terascan system to provide redundancy and data dissemination that falls outside of the SeaSpace/ Terascan construct. NPP raw data delivery is a prime example.





USAP Terascan Network Diagram



—Data Flow→ All Terascan data flows to SPAWAR forecasting work stations in McMurdo and Charleston SC, Denver and one instance in Christchurch.





Terascan Systems Science Network







What is the outlook for polar orbiters?







What are we tracking now

NOAA-18, NOAA-19 DMSP (F13, F-17, F18) AQUA, TERRA NPP MetOp-B





Forecasting systems



McMurdo Forecaster Layout





Dual monitor layout for the MCM Forecaster to be able to display multiple images for cross compare capability. Mirrored monitors for ease of briefing pilots, science parties and operations folks.

Aviation support is the most critical component of the Terascan systems



SPAWAR Forecaster Site in Charleston SC ROF Remote Operations Facility







It all looks very quiet now, but these work stations become a hive of activity during flight support. All of our flights to the ice are dependent on whether we can get data to the forecasters or not.





Other Remote Sensing work

- Vessel navigation with remote sensing assist is an increasing requirement. Not only for navigation through Sea Ice, but how Polar weather effects our ability to operate within a safe and cost effective methodology. Example: Falklands cruise, Sea state, winds and swell.
- · Vessel weather forecasts when outside of polar regions
- SPAWAR/AMRC have been great assets to ships requests
- Again: Increase of importance due to high fuel costs and adding a safety margin to all field operations

Here is a list of resources that we are now using:

- 1.) Local Terascan ground receiving station at Palmer and McMurdo, onboard the NBP.
- 2.) http://lance-modis.eosdis.nasa.gov/imagery/subsets/?project=antarctica > NASA MODIS
- 3.) http://www.polarview.aq/ > PolarView SAR data provided by the BAS; ENVISAT is down, Sentinel-1 to come online in 2013
- 4.) http://www.iup.uni-bremen.de:8084/amsr2/ or http://www.iup.physik.uni-bremen.de:8084/ssmis/ > University of Bremen Germany SSMIS sea ice products and AMRS-2
- 5.) http://www.agic.umn.edu/ Polar Geospatial Center Paul Morin's group. High resolution data with high quality/high resolution GIS interpretation
- 6.) http://www.sailwx.info/shiptrack/shipposition.phtml?call=WBP3210 > ships positions
- 7.) http://amrc.ssec.wisc.edu/data/ > weather charts
- 8.) SPAWAR forecasters > listservice for WX forecasts
- 9.) https://www.fnmoc.navy.mil/wxmap_cgi/cgi-bin/wxmap_DOD_area.cgi?area=fnmoc_s_hemi&set=All > For the Southern ocean this site is a nice reference for both sea state and weather behavior
- 10.) National Ice Center http://www.natice.noaa.gov/ Standard Ice charts and some RadarSat-2





Sea Ice and land masking issues



Weather coupling with Sea ice conditions and sea state can make for interesting navigation





Interesting SAR/Weather imagery



We have come across some challenging problems with imagery interpretation and surface roughness – is this surface wind?



Green Algae detected



As a side product from providing sea ice images from NASA MODIS website to the RVIB NBP, a "green tint" was detected in some of the sea ice where the vessel was operating (Terra Nova Bay) and relayed the below images to the crew.



These images occurred during the months of February and March, provided by NASA and complied by Archer/ASC. These are all TERRA and AQUA True Color images.



Other Remote Sensing activities; GIS products, WX overlays would be very welcomed as an inclusion into these products





What weather forecast products come in geotiff format?



Overview of Data Delivery



- Standard weather products delivered to SPAWAR for aviation support and general weather forecasting. USAP Terascan systems are set to automatically do this. Both McMurdo and Palmer "feed" the SPAWAR systems.
- Raw data delivered to O-202-M/P (AMRC) for their research.
- Backup forecasting in Denver.
- Data archiving is now under a heading of "operational continuity checks" What do we do with collected data?
- Question: What are the community's thoughts regarding the recent 'big data' initiative relative to the data products generated by these operational observing systems? Community engagement with the NSF Antarctic Sciences Section and Polar Programs Cyberinfrastructure program managers might be a way forward. "Cyberinfrastructure (CI) refers to computing systems, software, data acquisition, storage, and retrieval systems, and visualization environments—all linked by high-speed networks and supported by expert professionals." Dr. Marco Tedesco {http://polarpower.org/PTC/2013_pdf/PTC_2013_Tedesco.pdf}





- Terascan systems have been operating in the Antarctic since 1987. 26 years.
- We have several instances of Terascan systems operating in the field that have been delivering NRT (Near Real Time) data to interested parties consistently for a very long time and under some very extreme weather conditions. We are striving to determine and deliver the most important products to the most critical decision support issues.
- What we need is feedback from the operational and research communities concerned with the Antarctic mission telling us what they need, when they need it and how best to provide it. Satellite remote sensing has become an important tool for both operations and research. How can we move in a direction that best benefits both?



Questions?







And thank you for your attention