







# Supporting Direct Broadcast Systems using CSPP and TeraScan Software

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# Company Background



-  Founded in 1982
-  Located in San Diego, California
-  Leading provider of satellite remote sensing and TT&C ground stations and software
-  Comprised of scientists and engineers

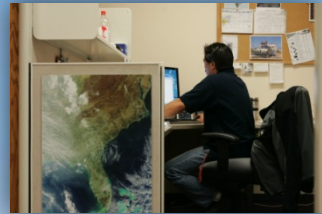




# End-to-End Capabilities



Product and Software Design



Service and Support

Site Planning



Training

Manufacturing



Installation

Testing



# SeaSpace Product Users



## Marine



## Defense



## Research



## Antenna

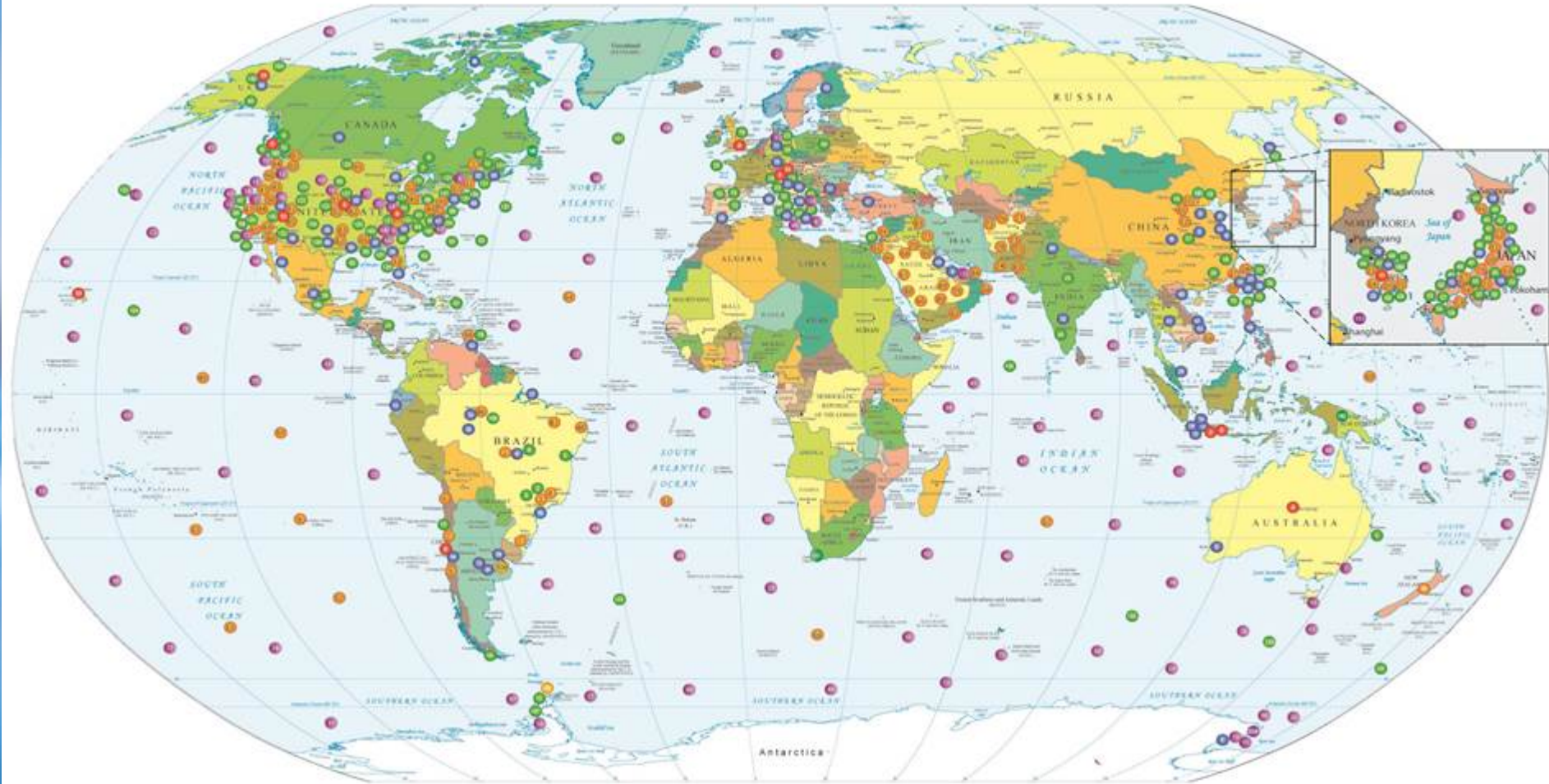


## Operational

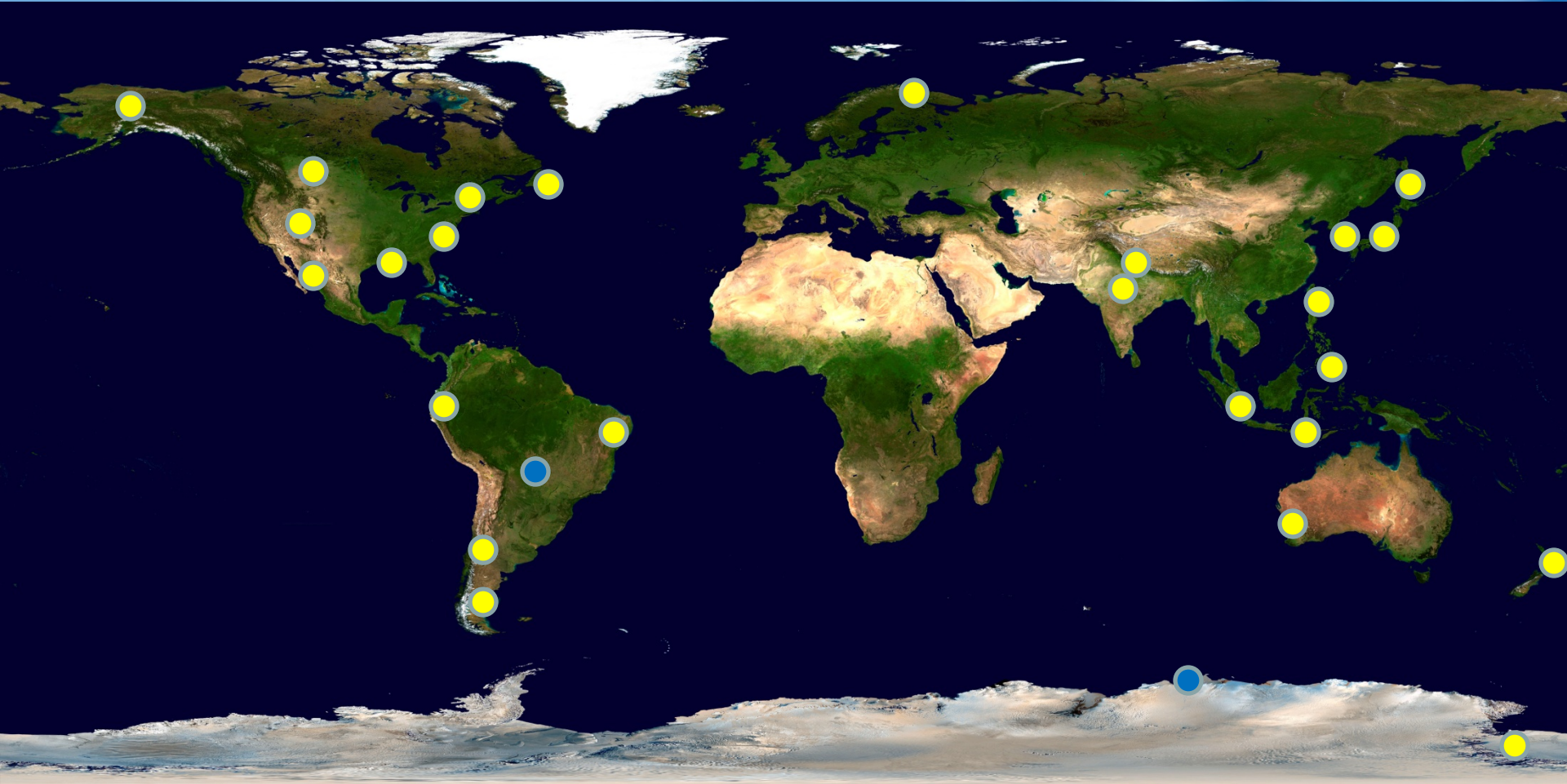




## Worldwide SeaSpace Ground Station Installations



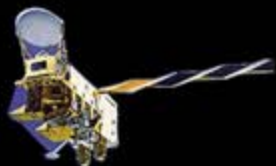
# SeaSpace NPP installation sites



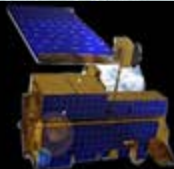


# Direct Broadcast Environmental Satellite Constellation

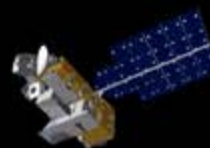
Aqua



Terra



Aura



NPP



FY-3



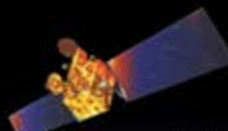
DMSP series



METOP



Oceansat-2



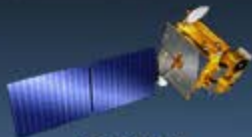
NOAA series



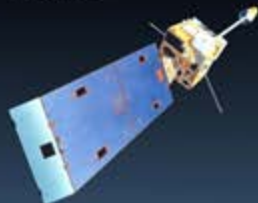
~~FY-1D~~



COMS



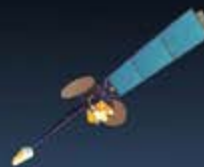
GOES series



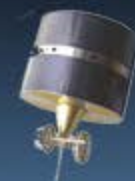
MSG



MTSAT

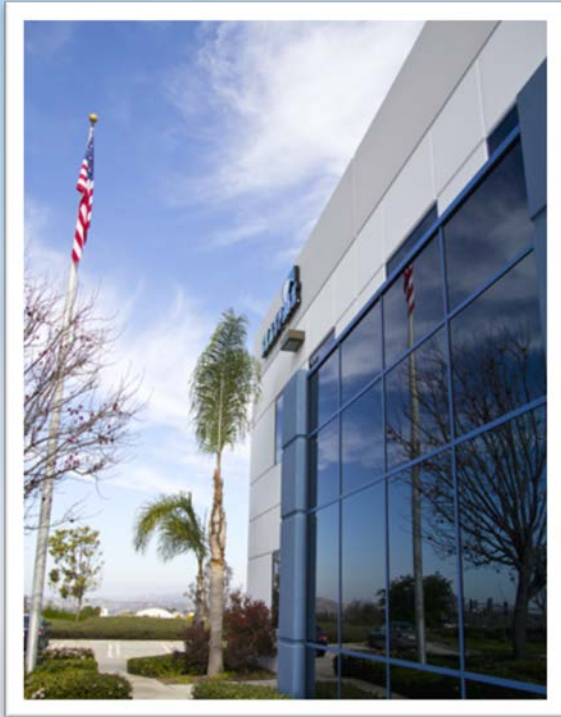


FY-2D/E





# What is TeraScan® ?



- TeraScan® is the ultimate remote sensing software tool box that fulfils your requirement for *automated* satellite data acquisition and processing.
- The TeraScan common Data Format (TDF) is an extremely versatile file format capable of assimilating a wide variety of *data types, shapes and sizes*. For example, a single dataset could contain *satellite image data, random in-situ data, and 3-D model data*. The TDF also allows applications to access data without any knowledge of the physical layout of that data.





# MODIS versus NPP VIIRS

Comparison of 22-band NPOESS VIIRS with MODIS bands

NPOESS VIIRS		MODIS	
Band number	Central wavelength (μm)	Band number	Central wavelength (μm)
M1	0.412	8	0.412
M2	0.445	9	0.443
M3 (blue)	0.488	3 (blue)	0.469
M4 (green)	0.555	4 (green)	0.555
M5 (red)	0.672	1 (red)	0.645
M6	0.746	15	0.748
M7	0.865	2	0.858
M8	1.240	5	1.240
M9	1.378	26	1.375
M10	1.61	6	1.640
M11	2.25	7	2.13
M12	3.7	22	3.959
M13	4.05	23	4.05
M14	8.55	29	8.55
M15	10.763	31	11.03
M16	12.013	32	12.02
DNB	0.7	No equivalent width	No equivalent width
I1	0.64	1 (red)	0.645
I2	0.865	2	0.858
I3	1.61	6	1.64
I4	3.74	22	3.959
I5	11.45	31	11.03



# System requirements for NPP Processing

## Operating System Compatibility:

RedHat Enterprise Linux Version 5.x x86\_64

CentOS Version 5.x x86\_64

## Hardware Prerequisites

	Minimum	Maximum
Total Disk Space	1.0 TB	2.8 TB
Memory	16 GB	96 GB
CPU Cores	8	24





# Suomi NPP Products generated currently using CSPP and TeraScan

VIIRS TDF Datasets	Data Resolution	VIIRS Channels
<i>pass.npp.SVM</i>	750m	<i>Daytime passes only:</i> all moderate-resolution radiance variable (channels 1 through 16).
<i>pass.npp.SVMr</i>	750m	<i>Daytime passes only:</i> moderate-resolution reflectance variables (channels 1 through 11).
<i>pass.npp.SVMb</i>	750m	<i>Daytime passes only:</i> moderate-resolution brightness temperature variables (channels 12 through 16).
<i>pass.npp.SVI</i>	375m	<i>Daytime passes:</i> fine-resolution radiance variables (channels 1 through 5).  <i>Nighttime passes:</i> fine-resolution radiance variables (channels 4 and 5).
<i>pass.npp.SVlr</i>	375m	<i>Daytime passes only:</i> fine-resolution reflectance variables (channels 1 through 3).
<i>pass.npp.SVlb</i>	375m	<i>Daytime passes:</i> fine-resolution brightness temperature variables (channels 4 and 5).  <i>Nighttime passes:</i> fine-resolution brightness temperature variables (channels 4 and 5).
<i>pass.npp.DNB</i>	750m	One Day/Night channel.
<i>pass.npp.RGB</i>	750m	<i>Daytime passes only:</i> 3 moderate-resolution variables that can be used to create an RGB composite: red_variable=ch05, green_variable=ch04, blue_variable=ch03.



# Suomi NPP Products generated currently using CSPP and TeraScan

## Quicklooks

<i>pass.npp.master_name</i> .rgb	RGB JPEGs from the moderate-resolution channels: red_variable=ch05, green_variable=ch04, blue_variable=ch03. Files are written to the directory <b>\$DATADIR/products/images/viirs.</b>
<i>pass.npp.master_name</i> .rgb	JPEGs of the ch05 fine-resolution channel with an HSL256 palette applied. Files are written to the directory <b>\$DATADIR/products/images/viirs.</b>





# Suomi NPP Products generated currently using CSPP and TeraScan

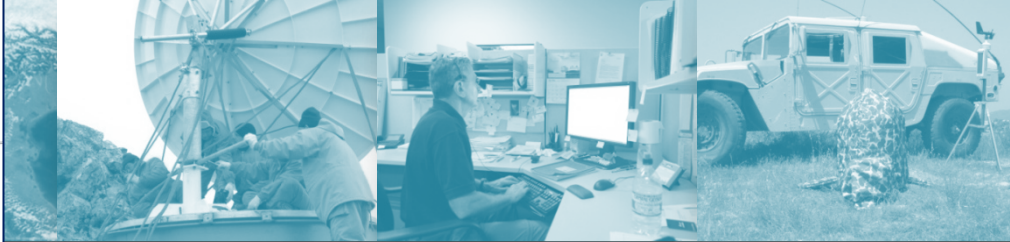
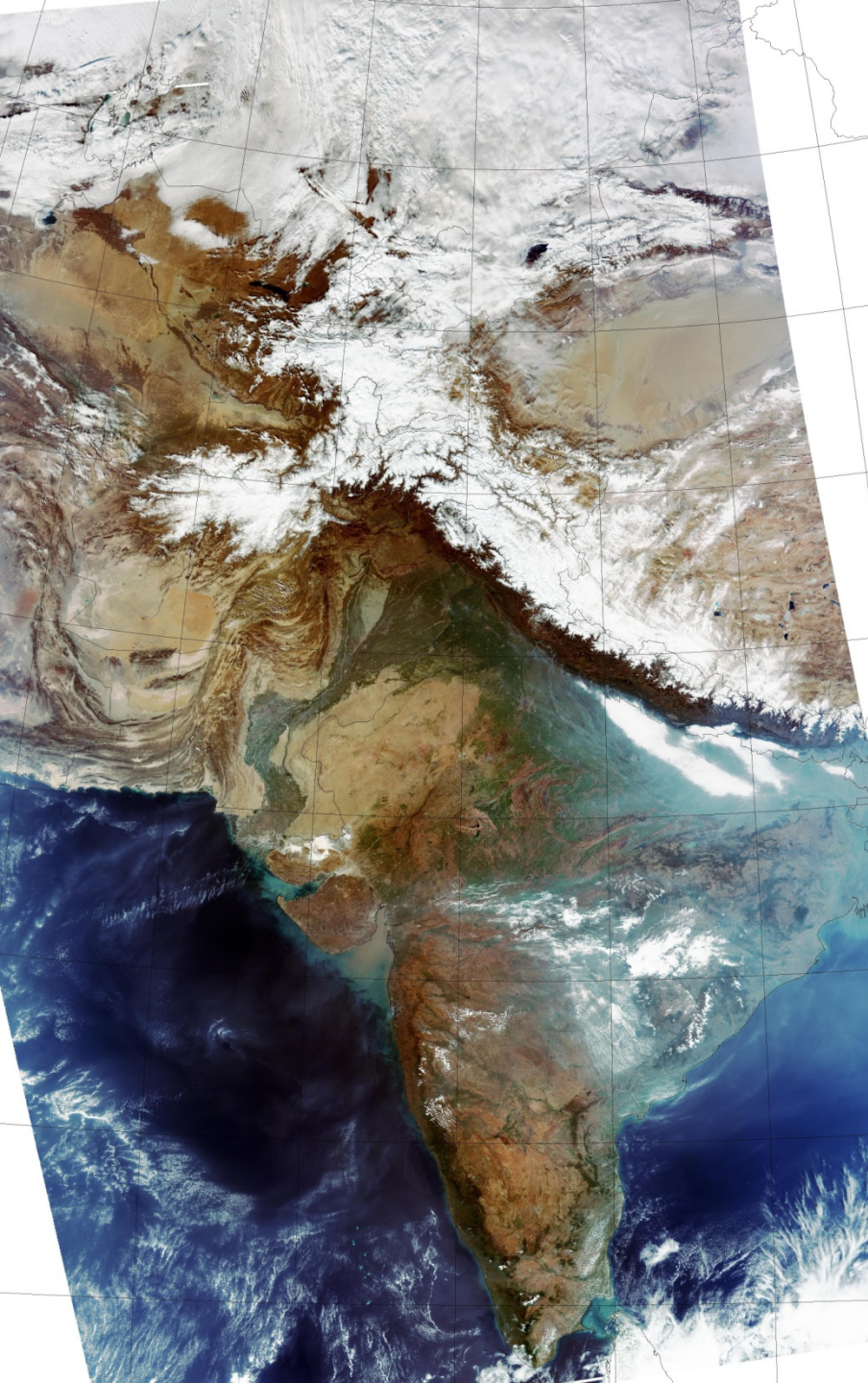
## VIIRS Level2 products

VIIRS	Sea Surface Temperature	SST (will be included in the next release)
VIIRS	Ocean Color (Chl), Remote Sensing Reflectances, K490, Aerosol Optical Thickness	chlor_a, Rrs_410-Rrs_671, Kd_490, aot_862
VIIRS	Active fires, including a post overlay file for fire points	latitude, longitude, tracks
VIIRS	Cloudmask	QF1_VIIRSCMIP (thru QF6)
VIIRS	NDVI	ndvi



# CrIS Retrieval Products

Sensor	Product	Variable
<b>CrIS Atmospheric Retrievals:</b>		
CrIS	atmospheric temperature [K] at 101 pressure levels - from forecast files	GDAS_TAir_pressure-level <i>(values interpolated to sounder grid)</i>
CrIS	atmospheric temperature [K] at 101 pressure levels - from model	TAir_pressure-level
CrIS	atmospheric humidity [g/kg] at 101 pressure levels	H2OMMR_pressure-level
CrIS	atmospheric ozone [ppmv] at 101 pressure levels	O3VMR_pressure-level
CrIS	atmospheric relative humidity [%] at 101 pressure levels - from forecast files	GDAS_RelHum_pressure-level <i>(values interpolated to sounder grid)</i>
CrIS	atmospheric relative humidity [%] at 101 pressure levels - from model	RelHum_pressure-level
CrIS	atmospheric dew point temperature [K] at 101 pressure levels	Dewpnt_pressure-level
CrIS	surface skin temperature [K]	TSurf
CrIS	total precipitable water (vertically integrated from 100 hPa to surface) [cm]	totH2O
CrIS	precipitable water 1 (vertically integrated from 900 hPa to surface) [cm] - from model	H2Ohigh
CrIS	precipitable water 2 (vertically integrated from 700 to 900 hPa) [cm] - from model	H2Omid
CrIS	precipitable water 3 (vertically integrated from 300 to 700 hPa) [cm] - from model	H2Olow
CrIS	total ozone amount (vertically integrated) [Dobson units]	totO3
CrIS	lifted index [deg celsius]	Lifted_Index
CrIS	CO2 amount [ppmv]	CO2_Amount
CrIS	cloud top pressure [hPa]	CTP
CrIS	cloud top temperature [K]	CTT
CrIS	cloud optical thickness	COT
CrIS	cloud mask (values: 0 clear, 1 cloud)	Cmask
<b>CrIS Atmospheric Stability:</b>		
CrIS	Atmospheric Stability products	Total_Totals and K_index

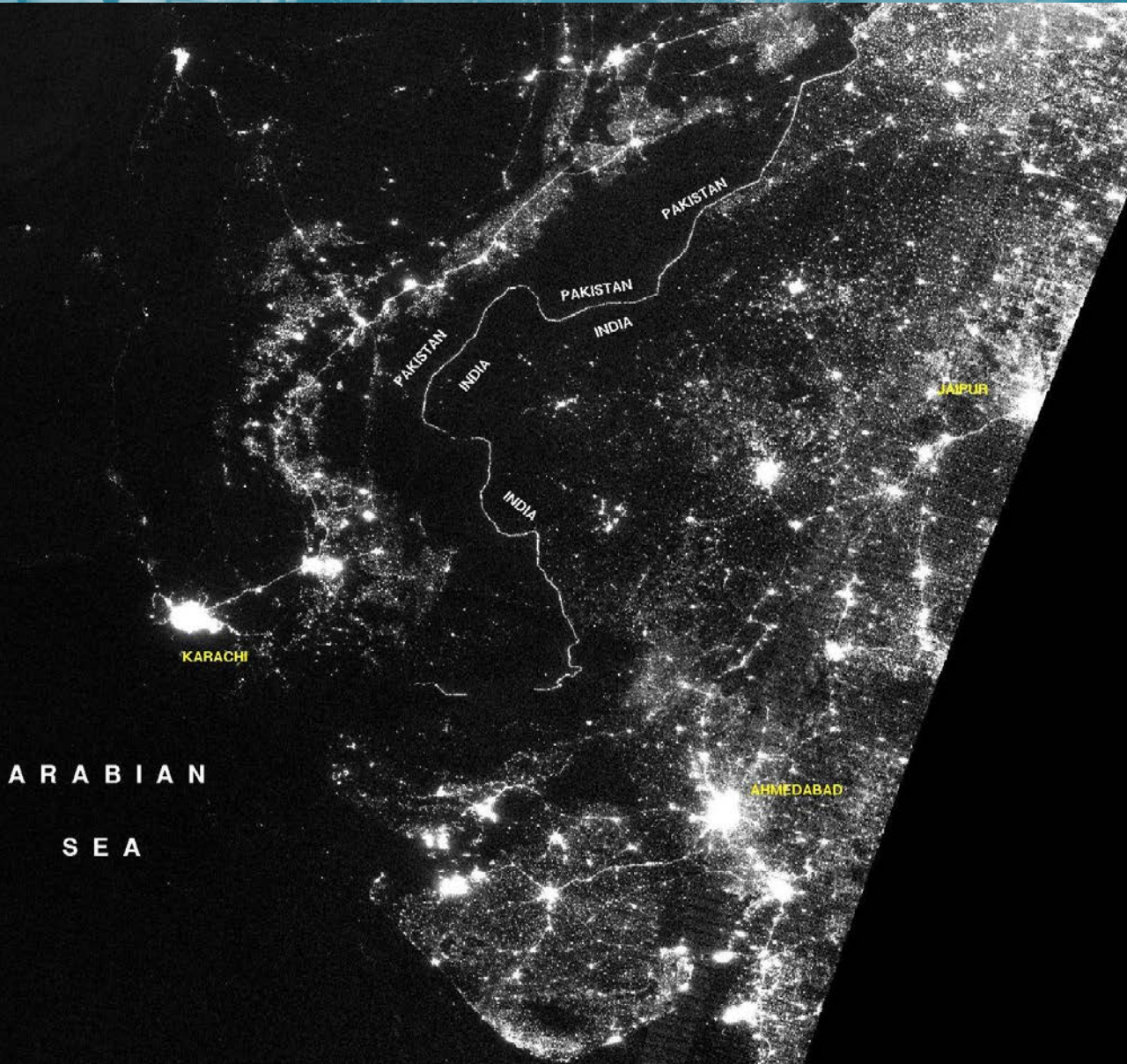


# NPP VIIRS Indian Agriculture Research Institute, New Delhi

*R – Ch5, G – Ch4, B – Ch43*

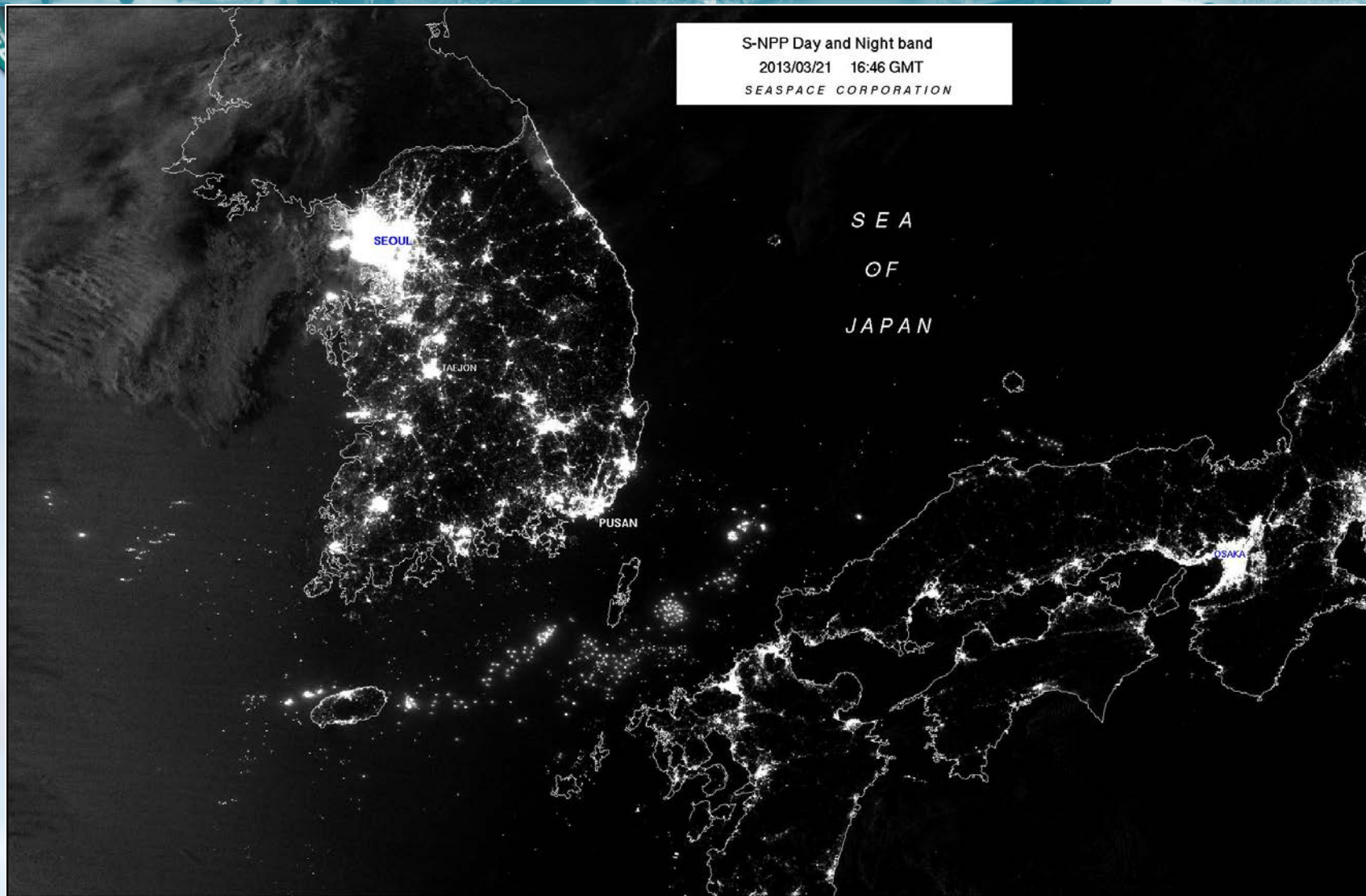


# Day Night Bands – India Pakistan border

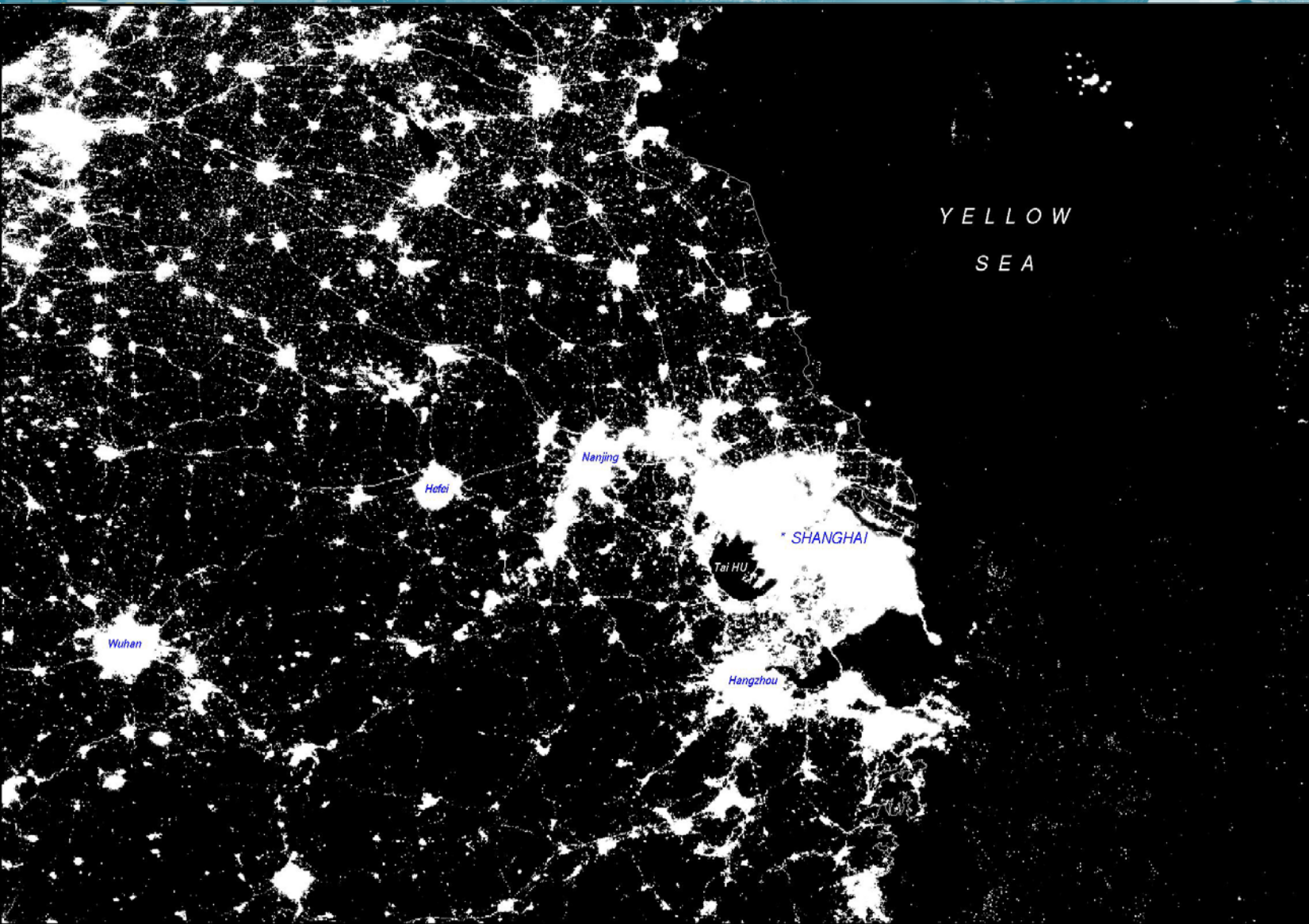




# Day Night Bands – S. Korea Japan



# Day Night Bands - Shanghai

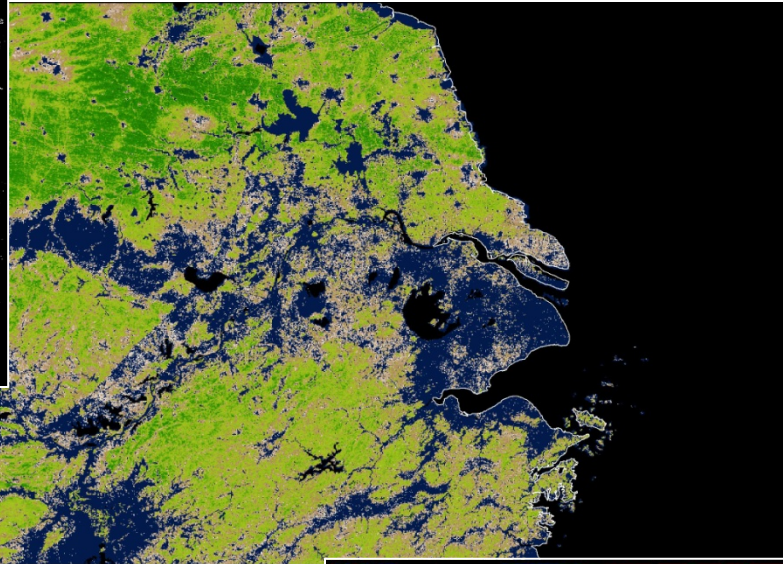




# Day Night Bands – Shanghai region

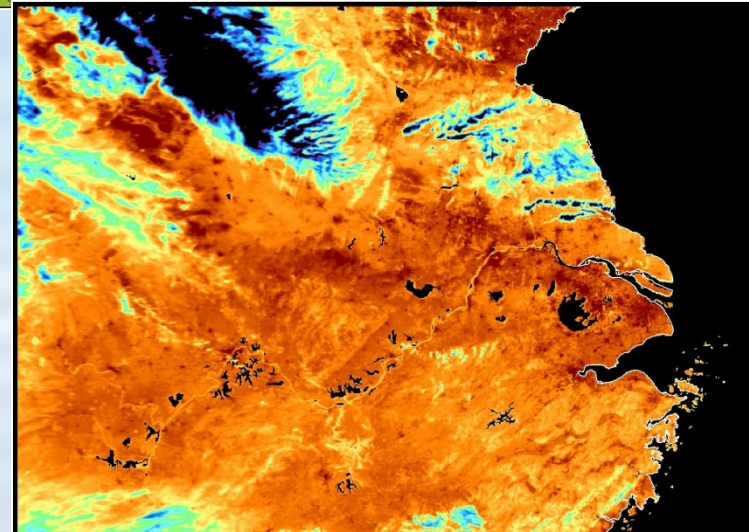


**DNB night lights**



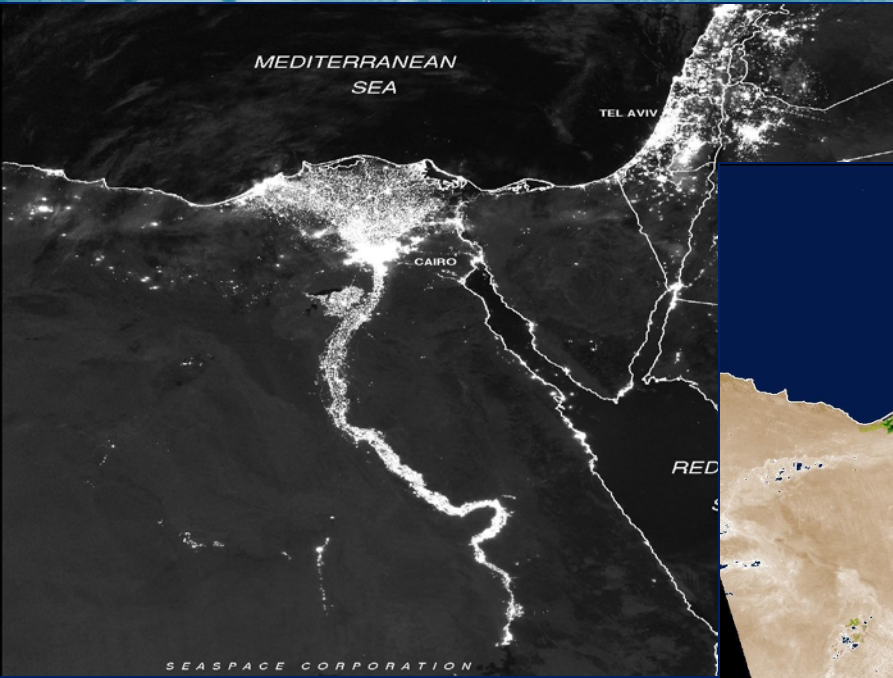
**NDVI**

**Land Surface Temperature**





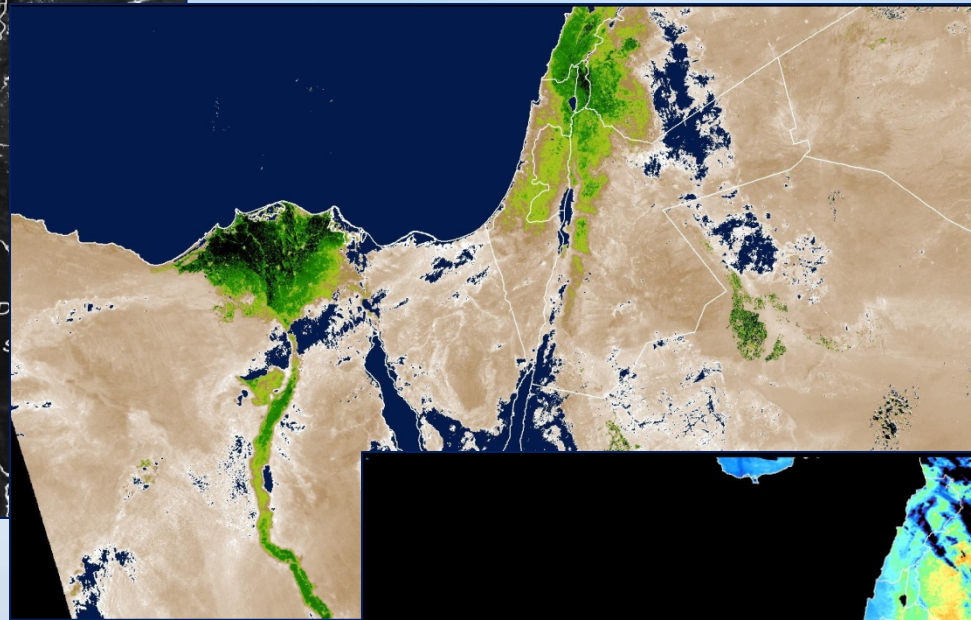
# Day Night Bands – Nile River Valley



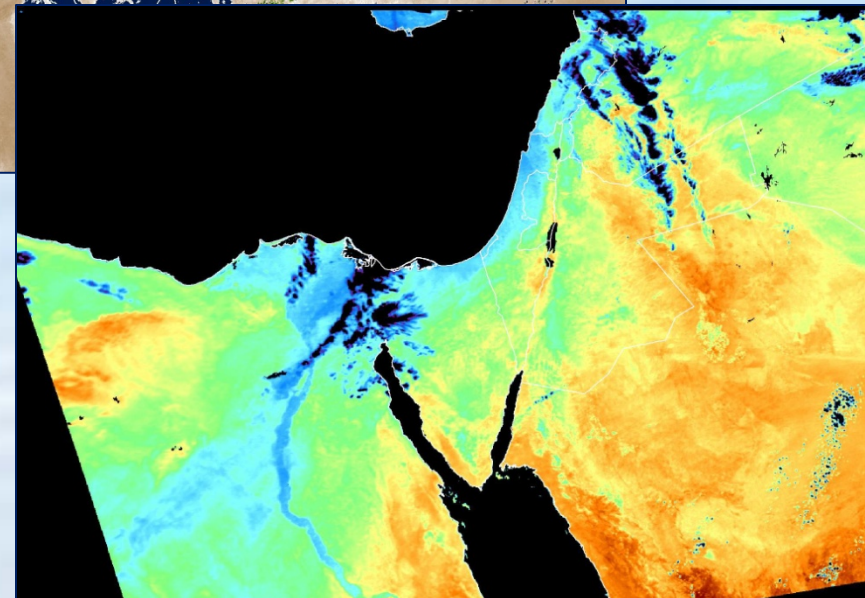
**DNB night lights**



**NDVI**

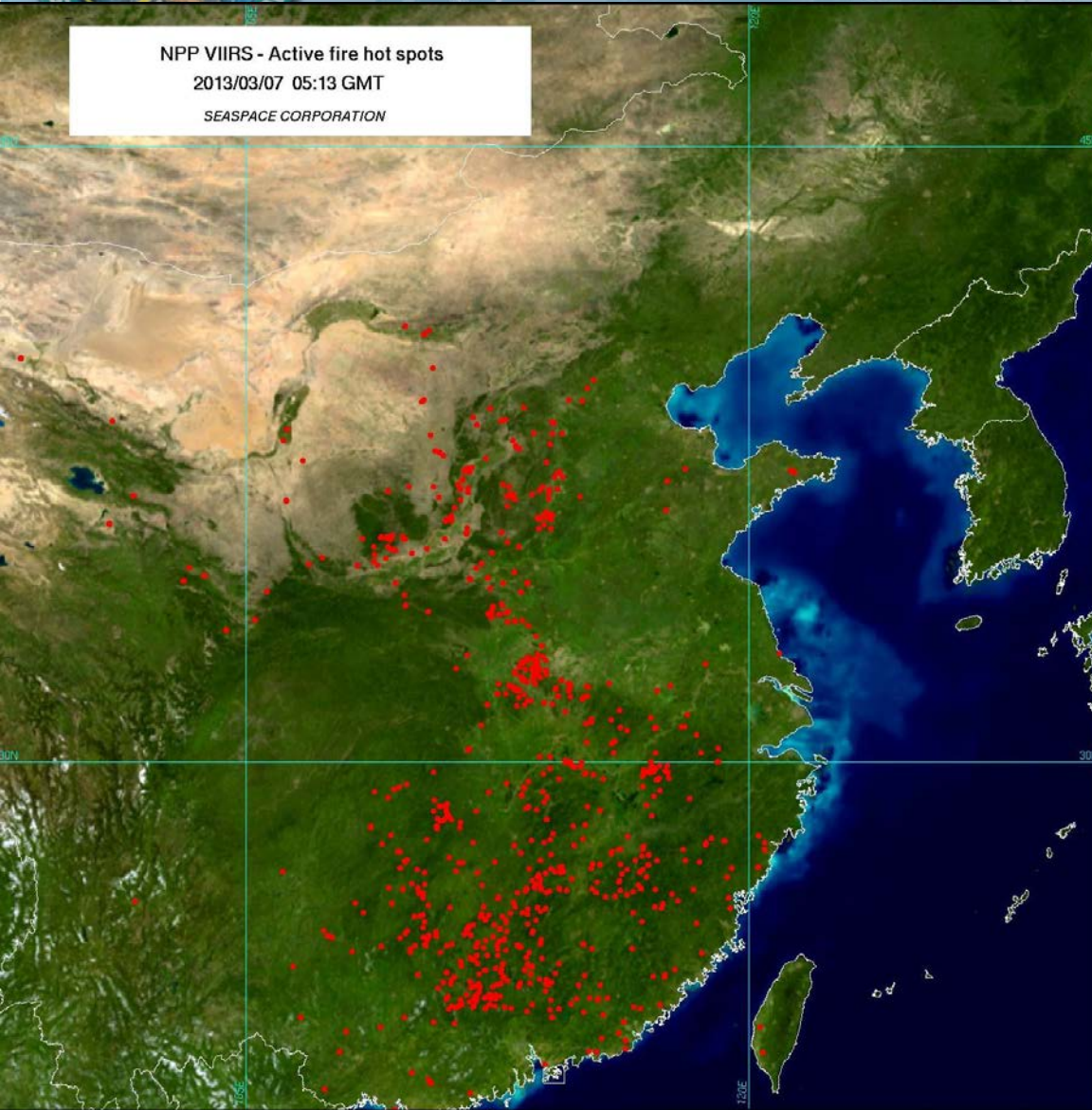


**Land Surface Temperature**





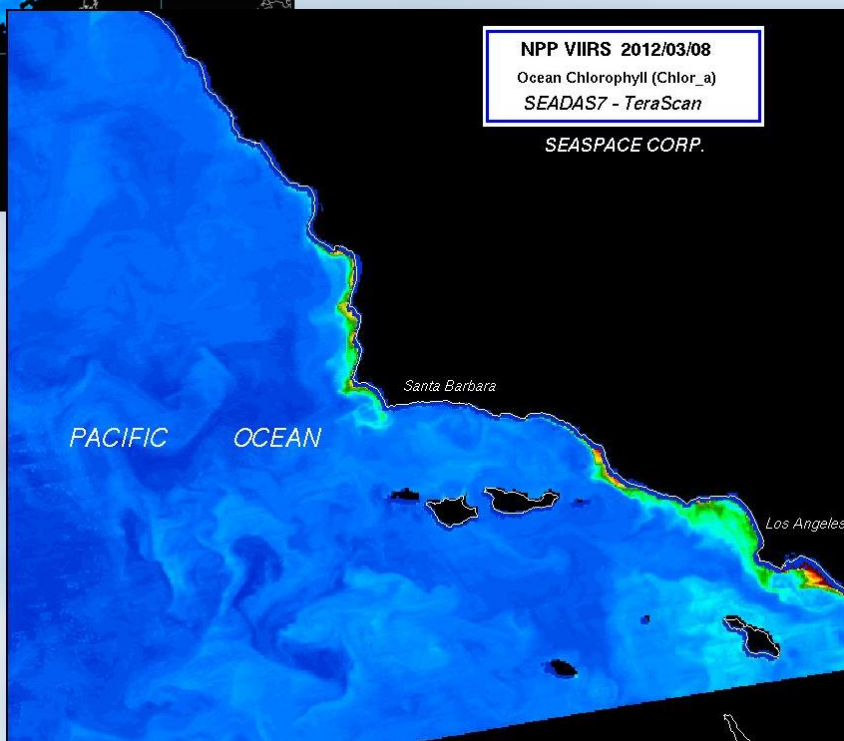
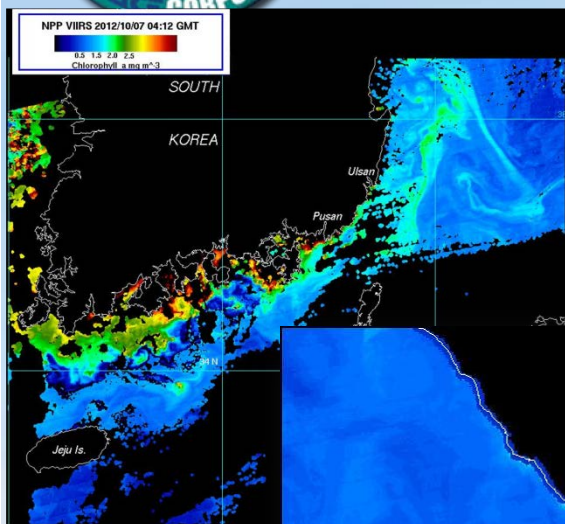
# NPP VIIRS FIRE POINTS



Agriculture biomass burning ?



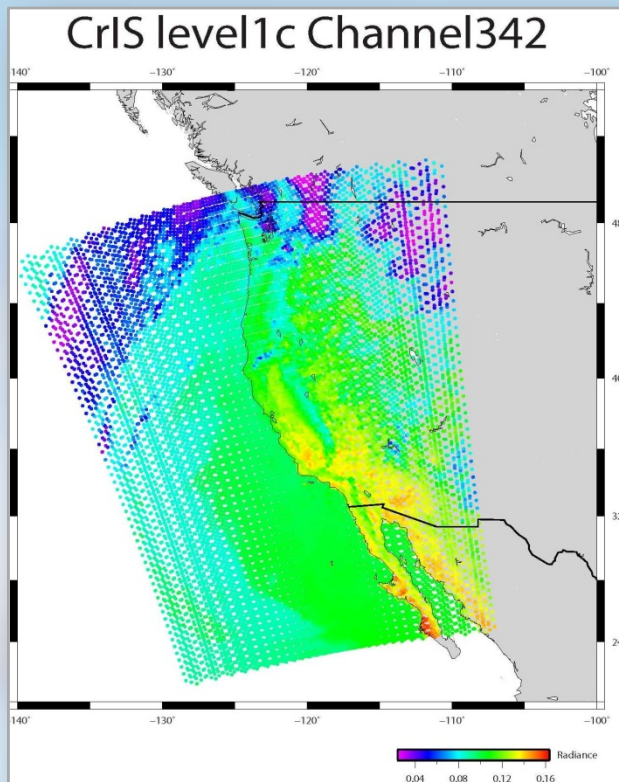
# Visible Infrared Imaging Radiometer Suite (VIIRS) Ocean Color integration



- Generate SDRs using CSPP
- Generate Ocean Color products using SeaDAS7
- Generate TeraScan Data Format file
- Forward remap to mercator proj.
- Land mask and apply color palette
- Standard "l2gen" ocean color product support for Water-leaving radiance and bio-optical retrieval products



# Cross-track Infrared Sounder (CrIS) integration



- Generate SDRs using CSPP
- Convert to AAPP format using `cris_sdr`
- Concatenate granules if required
- Plot with 20 km footprint at Nadir
- Radiance plot of Channel 342
- Total of 1305 spectral channels over 3 wavelength ranges; LWIR (9.14 - 15.38 $\mu$ m); MWIR (5.71 - 8.26 $\mu$ m); and SWIR (3.92 - 4.64  $\mu$ m)

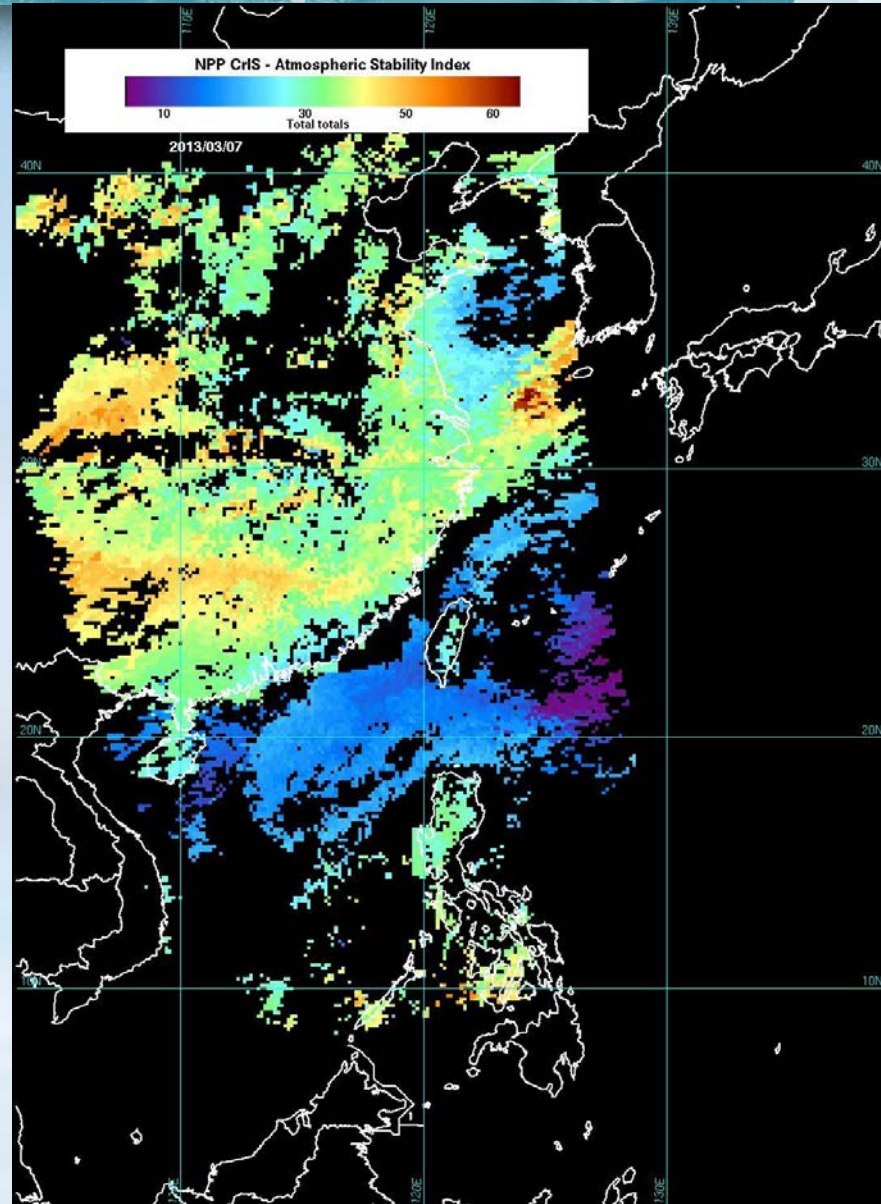


# Atmospheric Stability – K Index & TT



Total totals (TT) index from NPP CrIS (Cross-track Infrared Sounder) retrieval China. A TeraScan value added product from CrIS direct broadcast data.

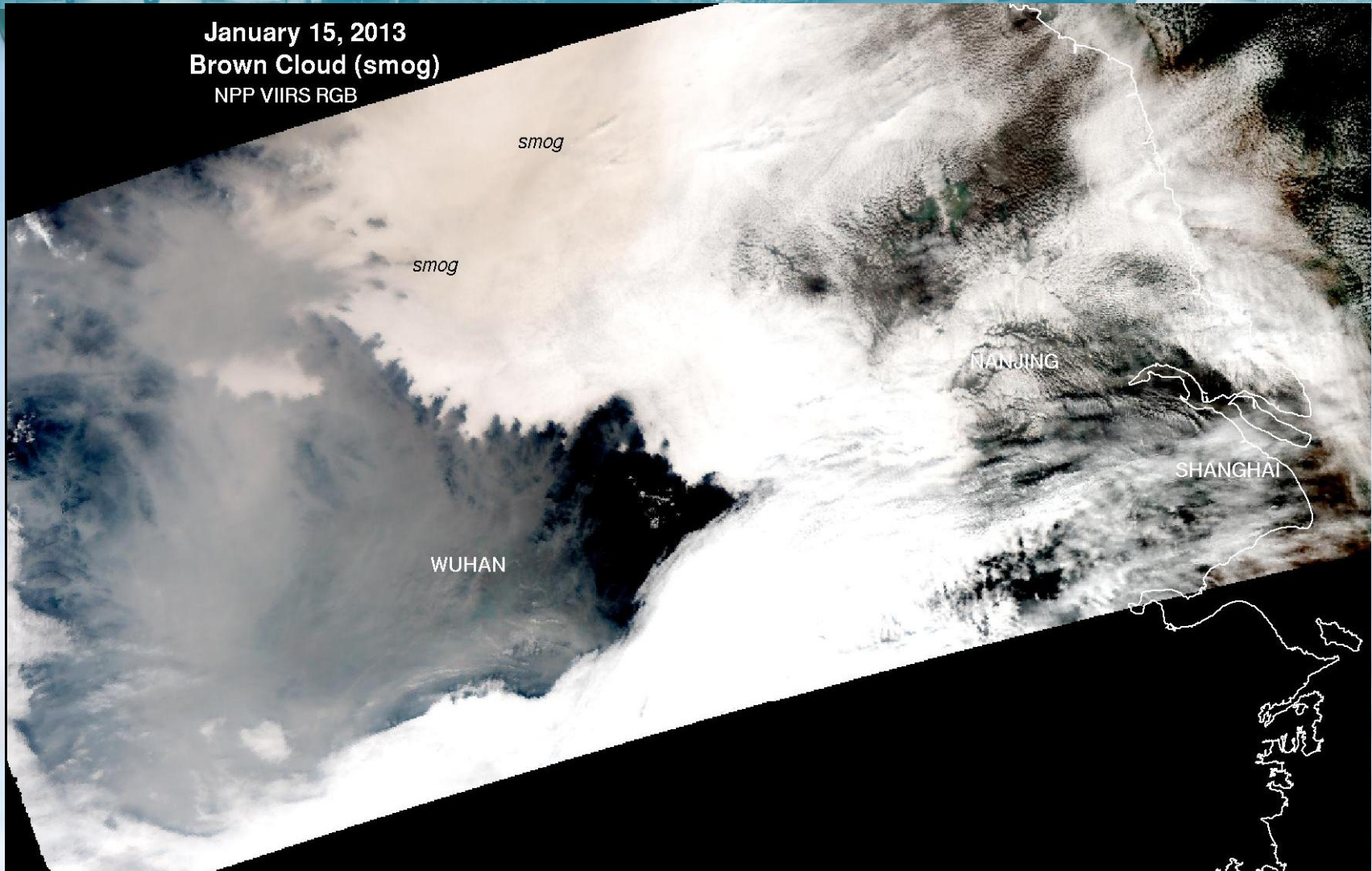
A Total Totals (TT) of greater than 48 indicates favorable conditions for development of severe thunderstorms, a value of 55 indicates favorable conditions or tornadoes.





# Air Pollution monitoring using NPP

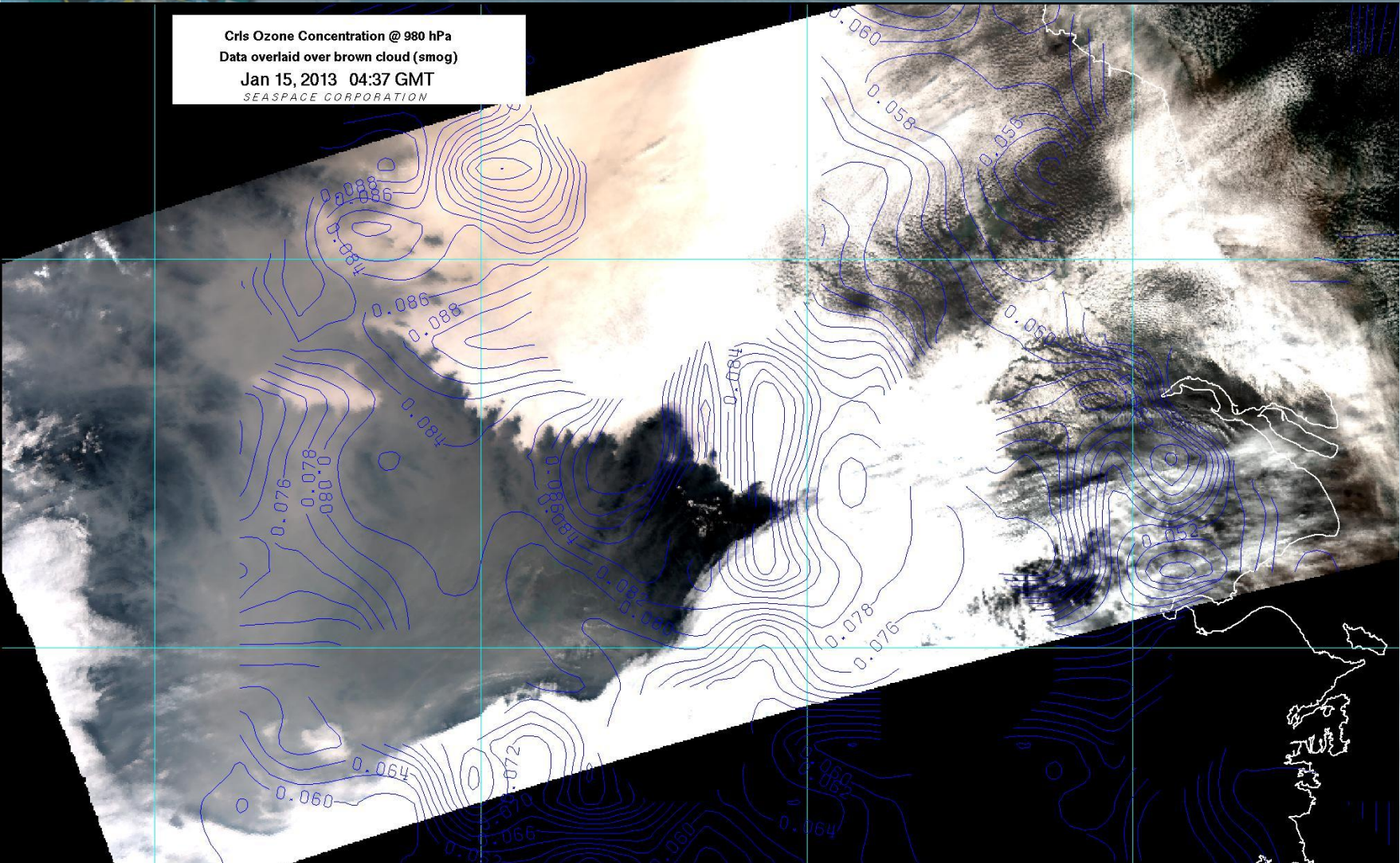
January 15, 2013  
Brown Cloud (smog)  
NPP VIIRS RGB





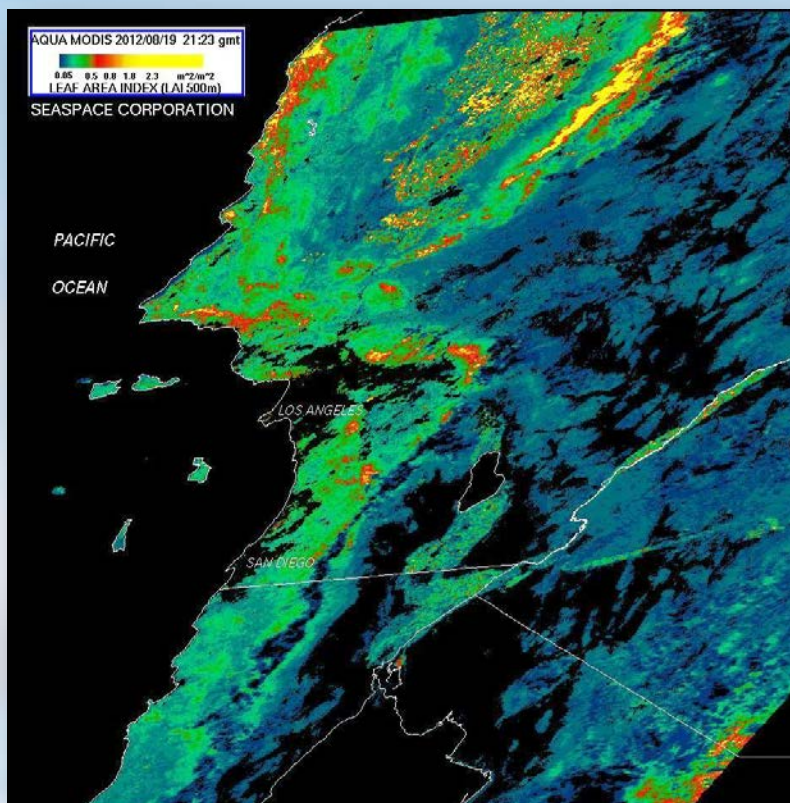
# Cross-Track Infrared Sounder - Ozone

CrIs Ozone Concentration @ 980 hPa  
Data overlaid over brown cloud (smog)  
Jan 15, 2013 04:37 GMT  
SEASPACE CORPORATION





# MODIS Leaf Area Index (LAI) and FPAR algorithm for Direct Broadcast applications



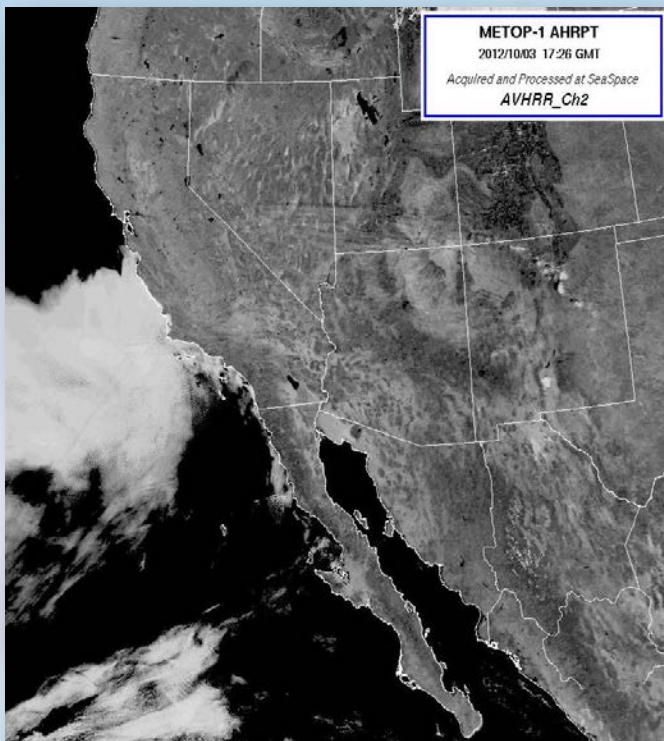
- Works with DB BRDF and surface reflectance input files
- Requires MODIS landcover files to cover Area of Interest
- Outputs include LAI and FPAR at 500m resolution in sinusoidal projection
- TeraScan generates modland\_tiles based on the input LAI tiles
- Remaps using master or master2 in sinusoidal map projection



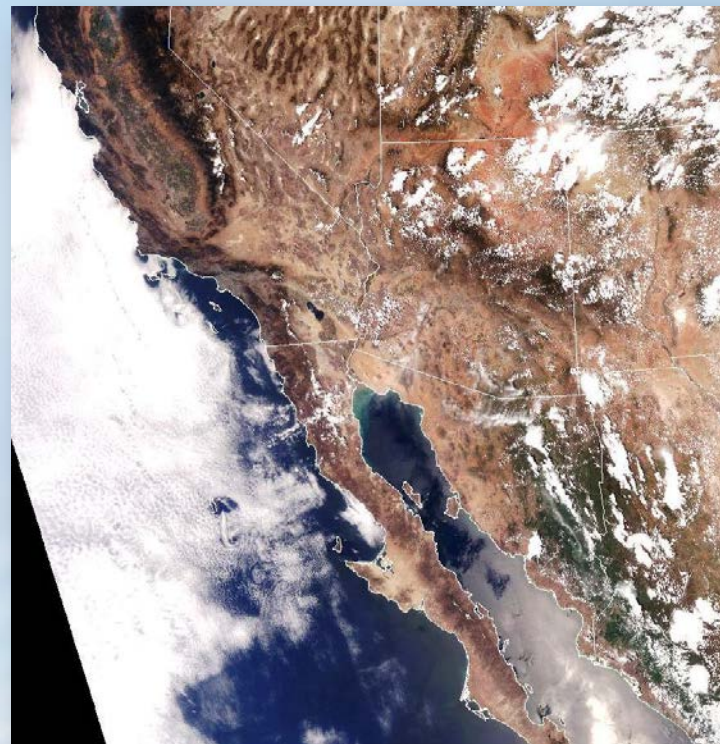


# METOP-B and FY3-B MERSI DB

METOP-B

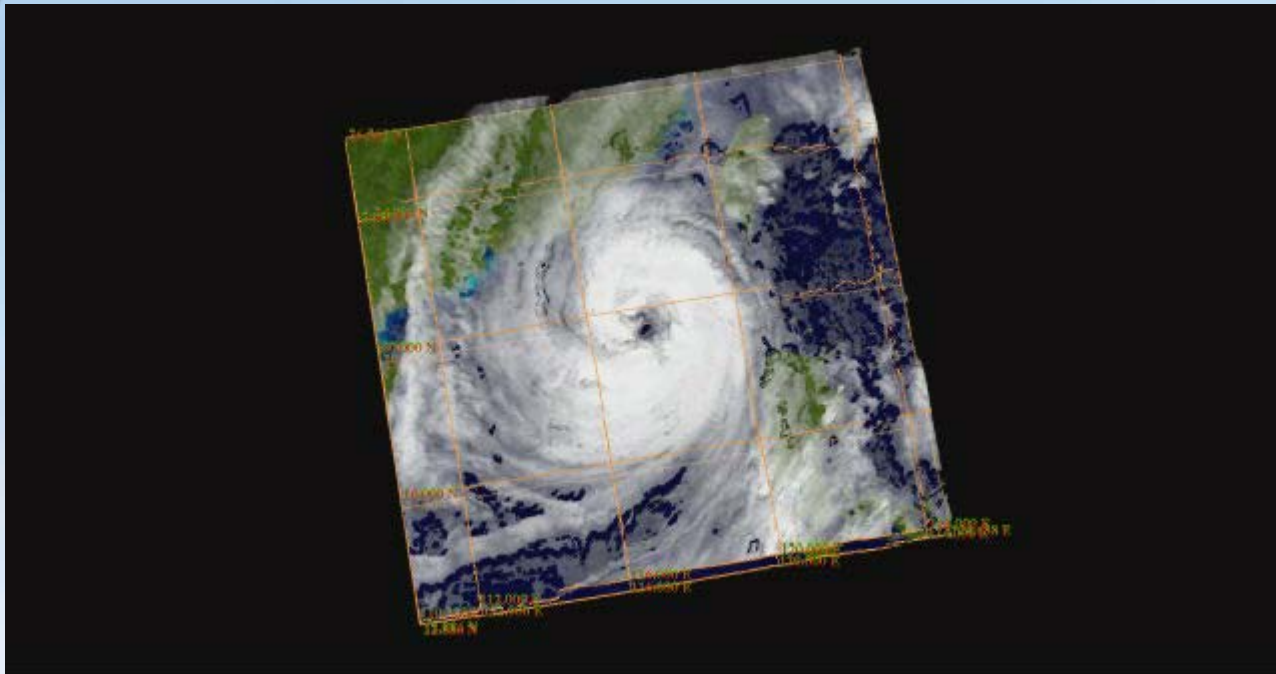


FY3-B MERSI





# Cloud3DViewer



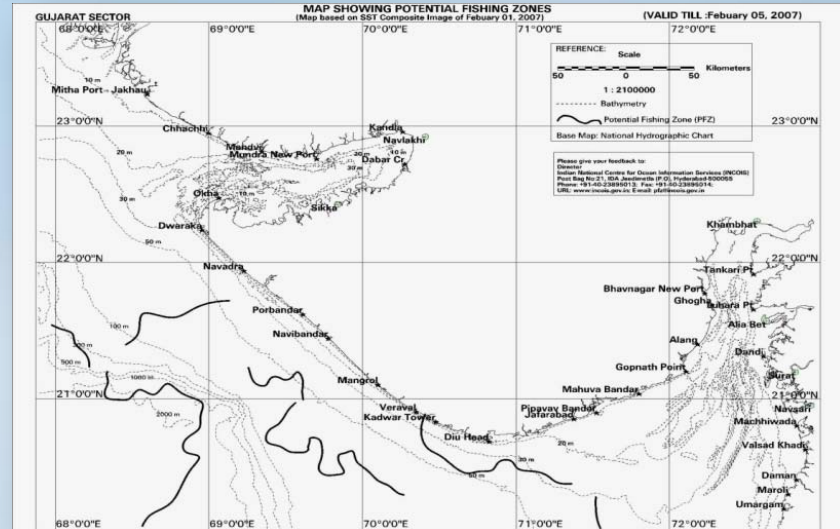
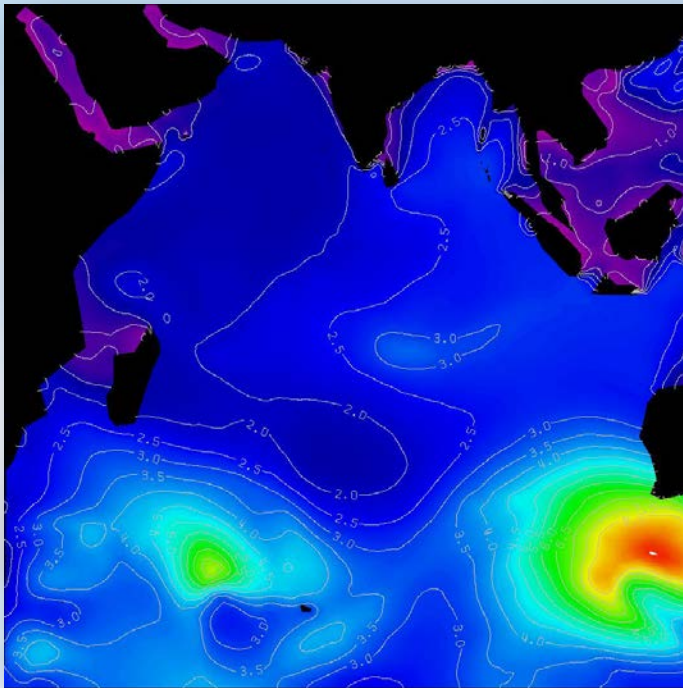
- CloudView3D is a OpenGL program that renders TDF generated cloud data in 3D.
- Program permits scene rotation, interactive perspective edit controls.
- Renders 3-Dimensional data-surfaces with latitude/longitude grids.
- Renders GIS lines/boundaries
- Allows interactive data queries
- Allows multi-frame time-series animations and more.





# Ocean modeling and fisheries applications

Significant wave height modeling

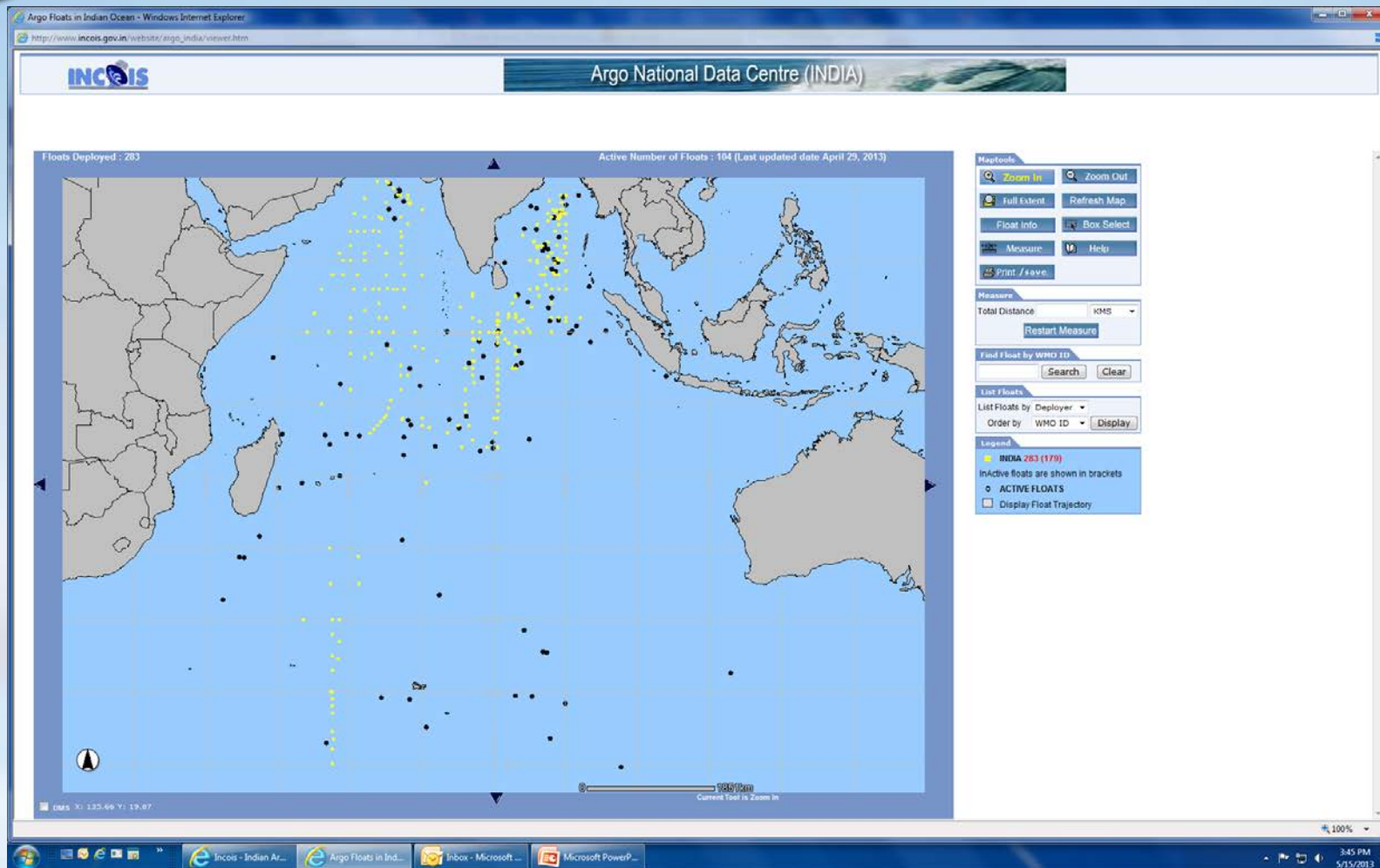


Potential Fishing Zone map from NOAA HRPT and ocean color data



# NOAA DCS and ARGO Applications

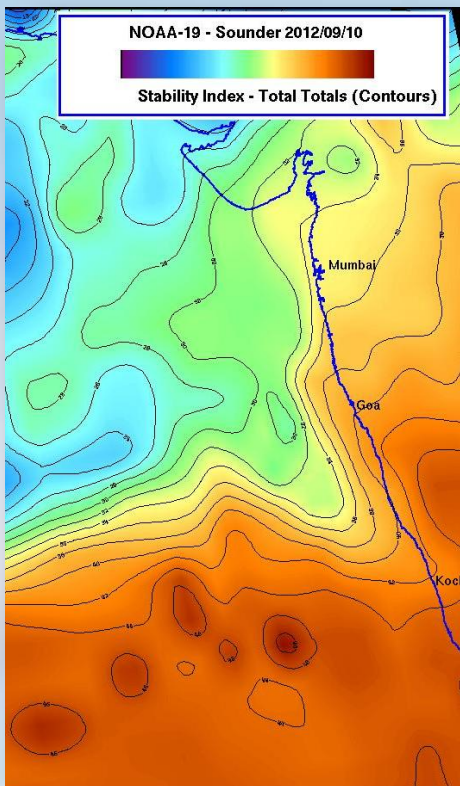
(No. of Floats deployed: **283**; Active Floats as on 29-Apr-2013: **104**;  
Floats completed their mission: **179**)







# AAPP7 integration

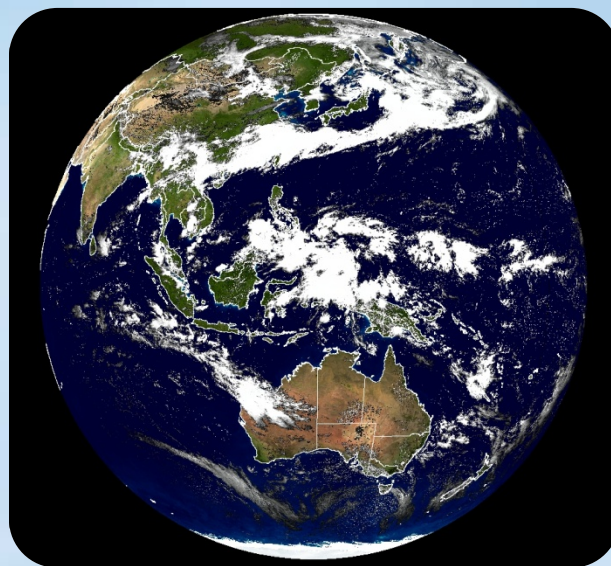


- Calibration updates for NOAA and Metop
- Retrievals from IAPP
- CrIS and ATMS pre-processing
- Retrievals of dew\_point, Water\_vapor, Temperature, (42 pressure levels),
- Ozone, Total precip water, Total Totals etc
- Enhanced burst function to handle various levels in TeraScan Data Format
- Skew-t support

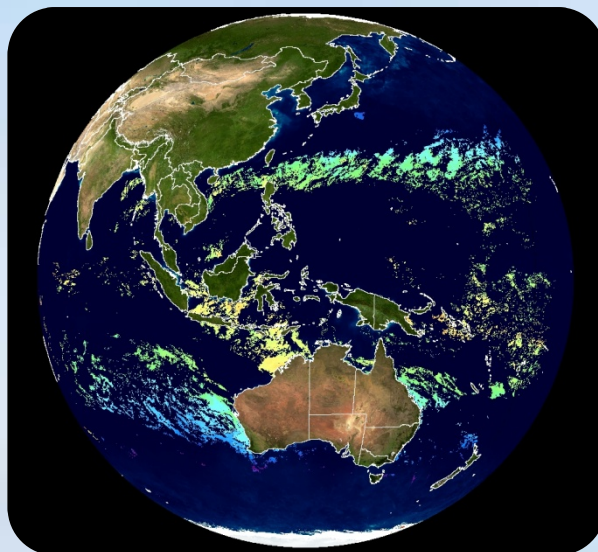


# Communication, Ocean and Meteorological Satellite (COMS)

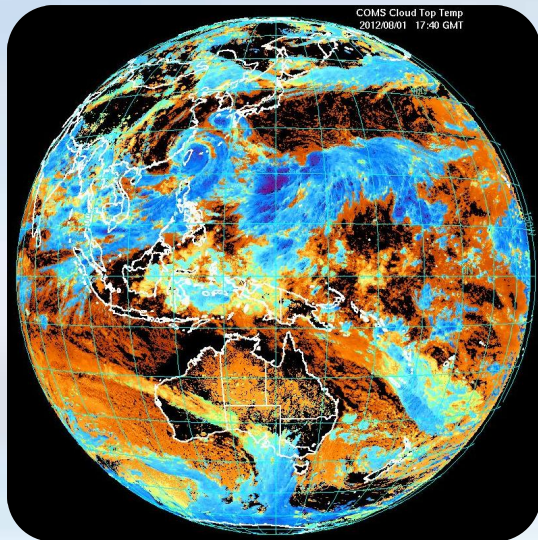
Vis Channel with Blue- marble background



Sea Surface temp.



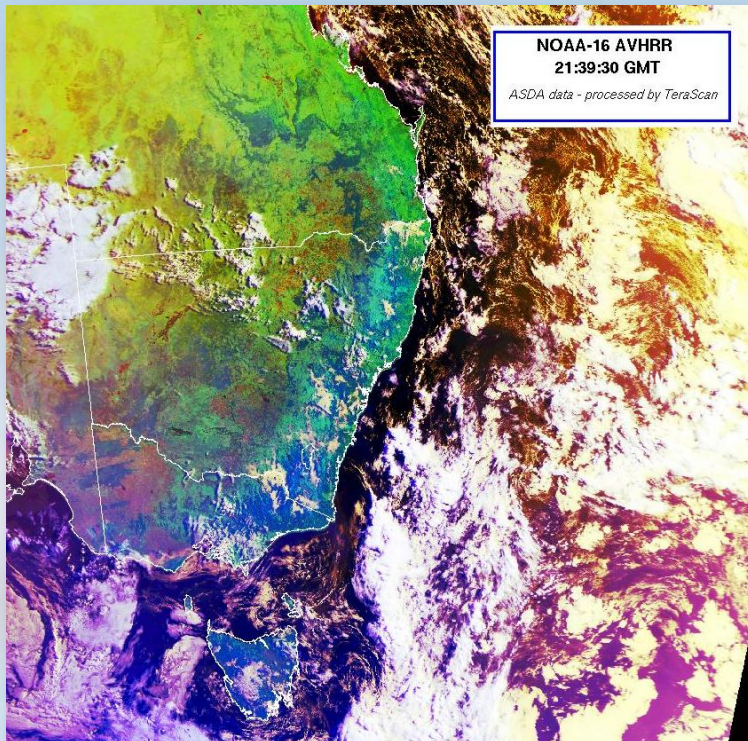
Cloud top temp.







# ASDA HRPT integration



- NOAA HRPT support for Australian Satellite Data Archive (ASDA) format files
- Extended level2 support
- Support customers in New Zealand and Australia

# TeraCAT III



Logged in as user aa

Account management

Restore default layout

Remember this layout

Time/date filtering

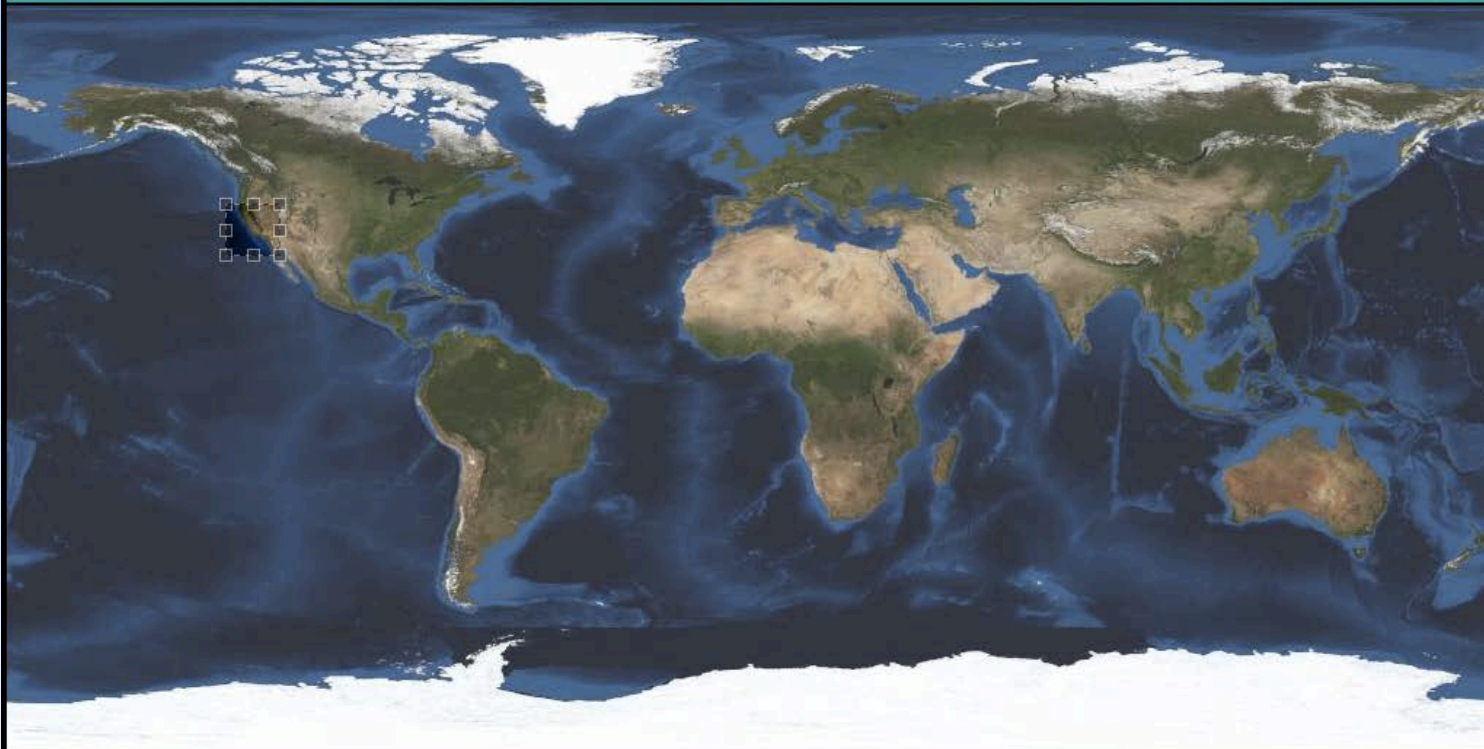
Retrieve data

UI Help

log out

TeraCat Help

Zoom level: 1X



## My areas

Default area

Set as default

Manage my areas

## Data source(s)

- Geosynchronous
- Polar
  - FY1
  - MODIS
    - Terra-1
    - Aqua-1
  - NOAA Series
  - DMSP Series

W -127.42 N 42.188 E -113.90 S 29.375 CtrLat 35.781 CtrLon -120.66

Width 13.516 Height 12.813

Projection: (applied to Quicklooks)

rectangular



# TeraCATIII



user aa  
 Restore default layout  
 Remember this layout

## Database query results

File names preceded by  have

Order by:

- 2010.0222.0305.noaa-17.avcloud 100%
- 2010.0306.2132.noaa-19.ndvi 100%
- 2010.0306.2132.noaa-19.sst 100%
- 2010.0306.2132.noaa-19.avhrr 100%
- \* 2010.0307.0959.noaa-19.sst 100%
- \* 2010.0307.0959.noaa-19.avhrr 100%
- \* 2010.0309.0845.noaa-18.sst 100%
- \* 2010.0309.0845.noaa-18.avhrr 100%
- \* 2010.0309.0937.noaa-19.sst 100%
- \* 2010.0309.0937.noaa-19.avhrr 100%
- \* 2010.0309.0937.noaa-19.avhrr 100%
- \* 2010.0309.0937.noaa-19.sst 100%

### Filename filter

Exclude "covered"

### Filetypes to include

tdf  hdf  geotiff

Minimum cover 1

Testing coverage: 375 of 375

Total fileCount would be 8 of 500 Total download size:618.03 MB

### Click on a filename for metadata and available preview options

- 2010.0307.0959.noaa-19.sst (100%)
- 2010.0309.0937.noaa-19.sst (100%)
- 2010.0306.2132.noaa-19.sst (100%)
- 2010.0309.0845.noaa-18.sst (100%)
- 2010.0309.0937.noaa-19.avhrr (100%)
- 2010.0306.2132.noaa-19.avhrr (100%)
- 2010.0309.0845.noaa-18.avhrr (100%)
- 2010.0307.0959.noaa-19.avhrr (100%)

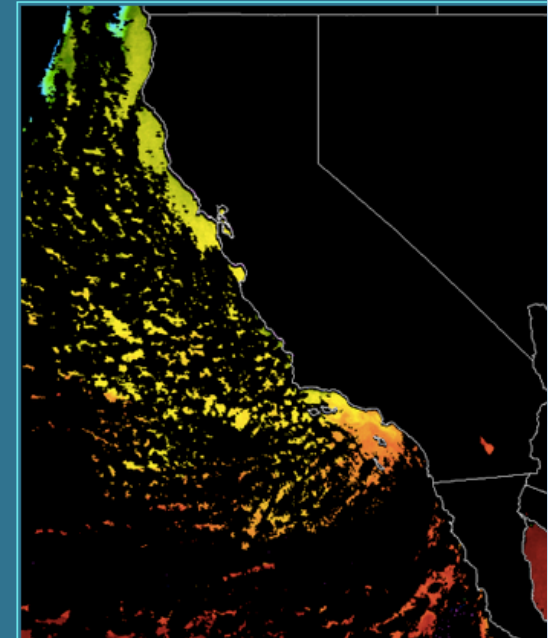
### Passfile metadata (db ref:257287)

Full path:	/nexus/data2/products/tdf/Global/avhrr/sst/2010.0309.19.sst
Satellite:	noaa-19
Time stamp:	2010-03-09 09:37:00
File size:	17.17 MB
Center Lat/Lon:	32N / -117W
Projection:	utm

### QL/browse imagery access

Available channels:	<input type="text" value="mcsst"/>
QL Palette:	<input type="text" value="aaa.sst"/> <input type="checkbox"/> Invert palette
<input type="button" value="Generate Quicklook Image"/>	

### mcsst - rectangular

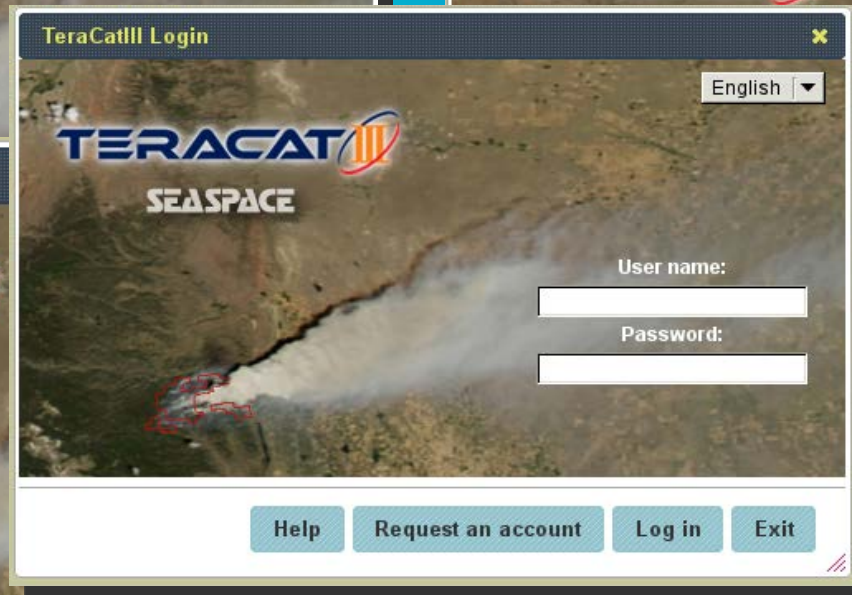


Discovered browse files for the available dataset  
 Right-click to view in new window

- 2010.0307.0959.noaa-19.avhrr\_ch4.jpg
- 2010.0309.0937.noaa-19.avhrr\_ch4.jpg
- 2010.0309.0845.noaa-18.avhrr\_ch4.jpg
- 2010.0309.0937.noaa-19.avhrr\_ch4.jpg



# System Login



Multi-language support is available and can be selected on a per-login basis



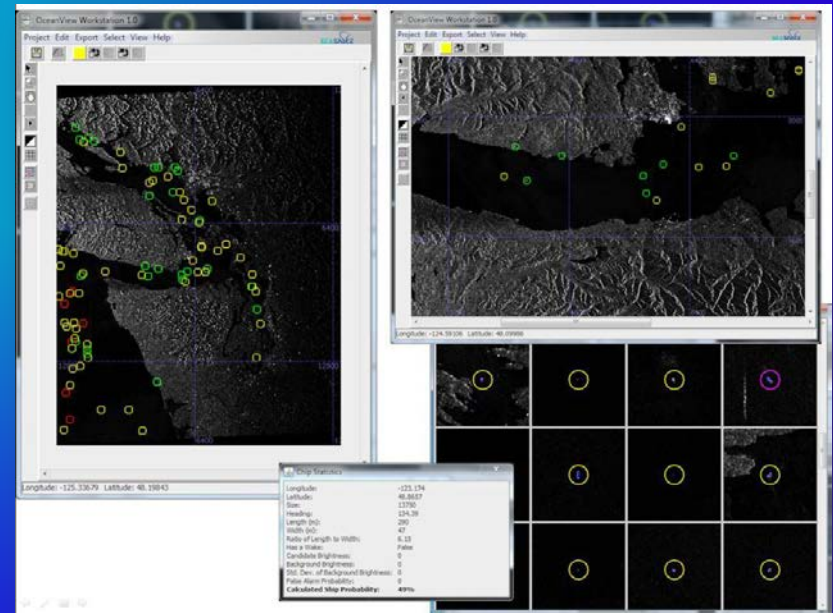
# RADARSAT-1 tests at SeaSpace



Vancouver



Radarsat-1  
Pass acquired using a 3.0m antenna



Ship detection using SeaSpace's OceanView - maritime awareness software



Thanks to *JPSS* and the *UW SSEC CSPP Team* for the NPP DB processing algorithms !

Email: *kprasad@seaspace.com*