



NPOESS VIIRS: Design, Performance Estimates and Applications

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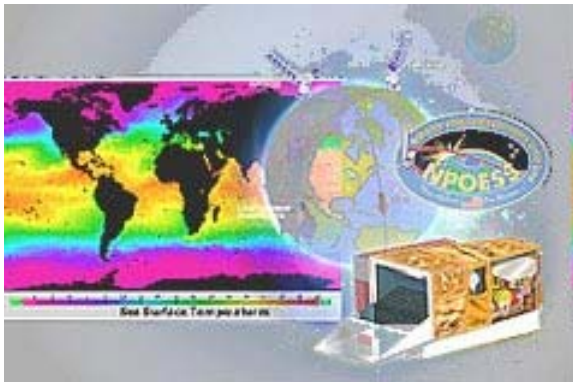
Science Applications International Corporation, San Diego, California



Overview



- **The National Polar-orbiting Operational Environmental Satellite System (NPOESS) Visible Infrared Imaging Radiometer Suite (VIIRS) will offer dramatic spatial, spectral, and radiometric performance improvements over current operational capabilities**
 - **NOAA Advanced Very High Resolution Radiometer (AVHRR) offers 1 km nadir spatial resolution in 5 spectral bands**
 - **The Defense Meteorological Satellite Program (DMSP) Operational Line-scanning System (OLS) offers near constant contrast 1.8km day-night cloud imaging and visible and thermal imagery**





VIIRS

-
- **VIIRS offers 22 band spectroradiometry comparable to NASA's MODerate-resolution Imaging Spectroradiometer (MODIS).**

-
- **On NPP and NPOESS**
 - **3000 Km Swath**
 - **Day-night cloud imagery (constant contrast 750 m resolution)**
 - **4:1 better edge-of-scan spatial resolution than AVHRR or MODIS**





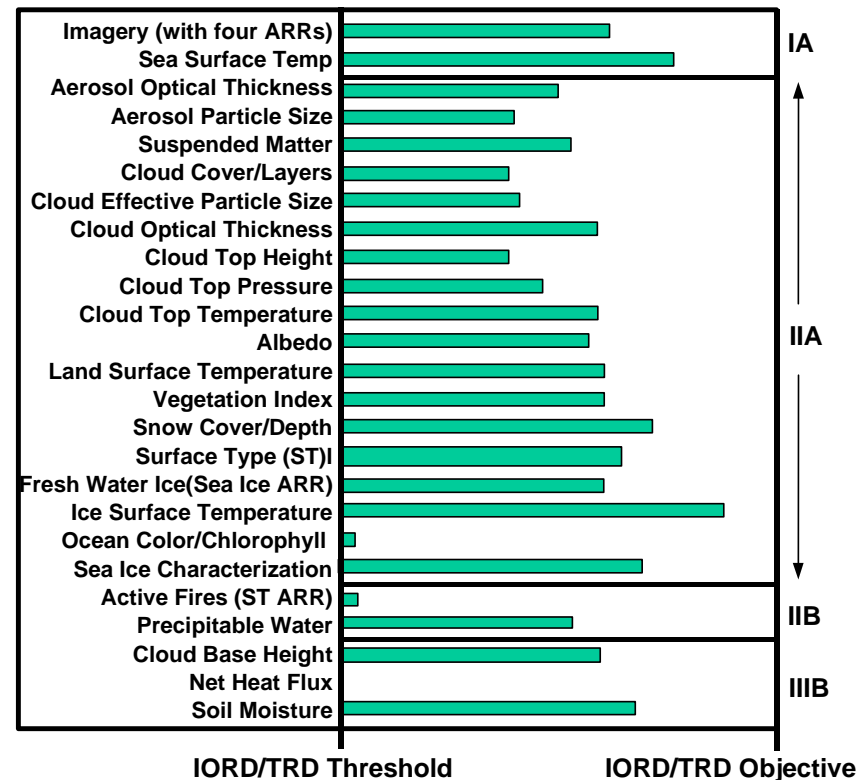
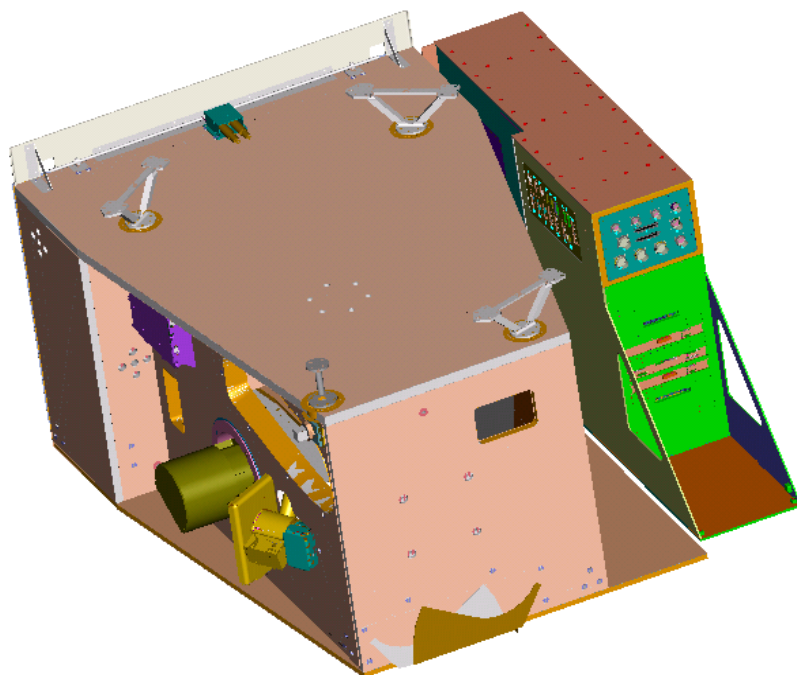
NOAA AVHRR Contributions to VIIRS Subpoint Spatial Resolution

	AVHRR	VIIRS	
• .63 μm			Imagery, Clouds, Snow, Dust
• .86 μm			Terrain, vegetation, water
• 1.6 μm			Snow, Cirrus Properties
• 3.7 μm			Fires, Low Clouds, SST
• 10.8 μm			Images, Cloud height, SST
• 11.8 μm			Volcanic Ash, Split Window
	1.1 km	0.37 km	





VIIRS System Provides Excellent Environmental Data Records (EDRs)

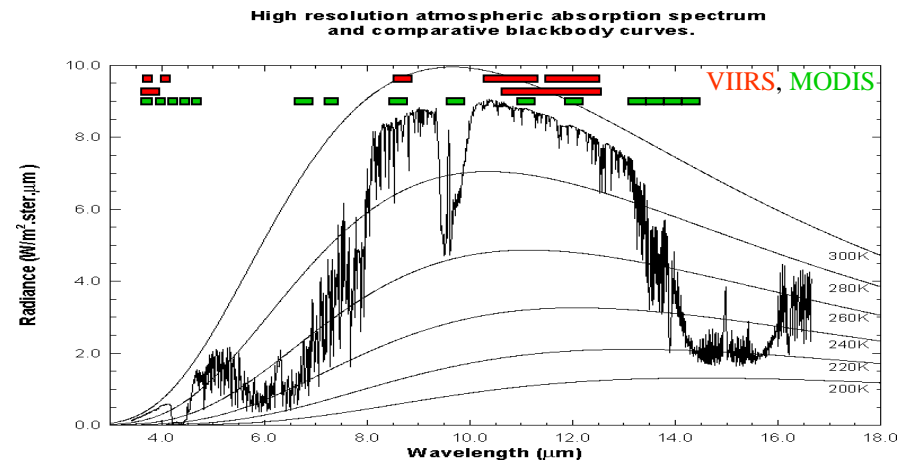
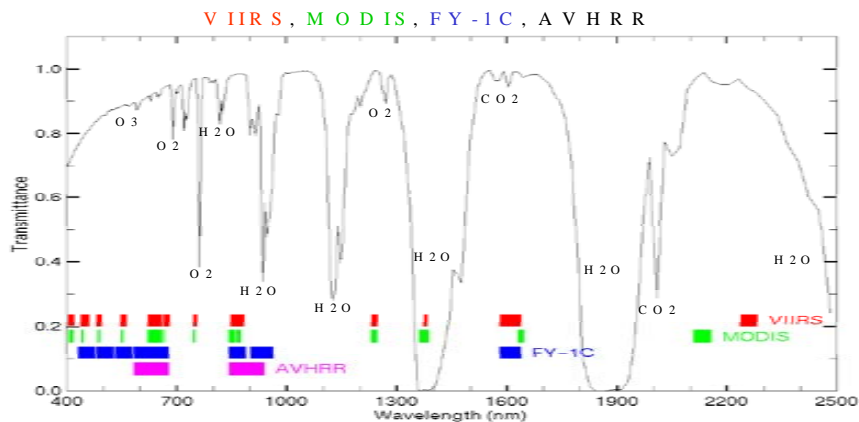


- VIIRS System Design based on integrated Sensor and Algorithms
- Engineering Development Unit (EDU) approaching integration
- EDR Science Algorithms developed, documented, and publicly released by Raytheon Technical Services Company (RTSC) Information Technology and Scientific Services (ITSS)





VIIRS VIS/NIR & IR Bands

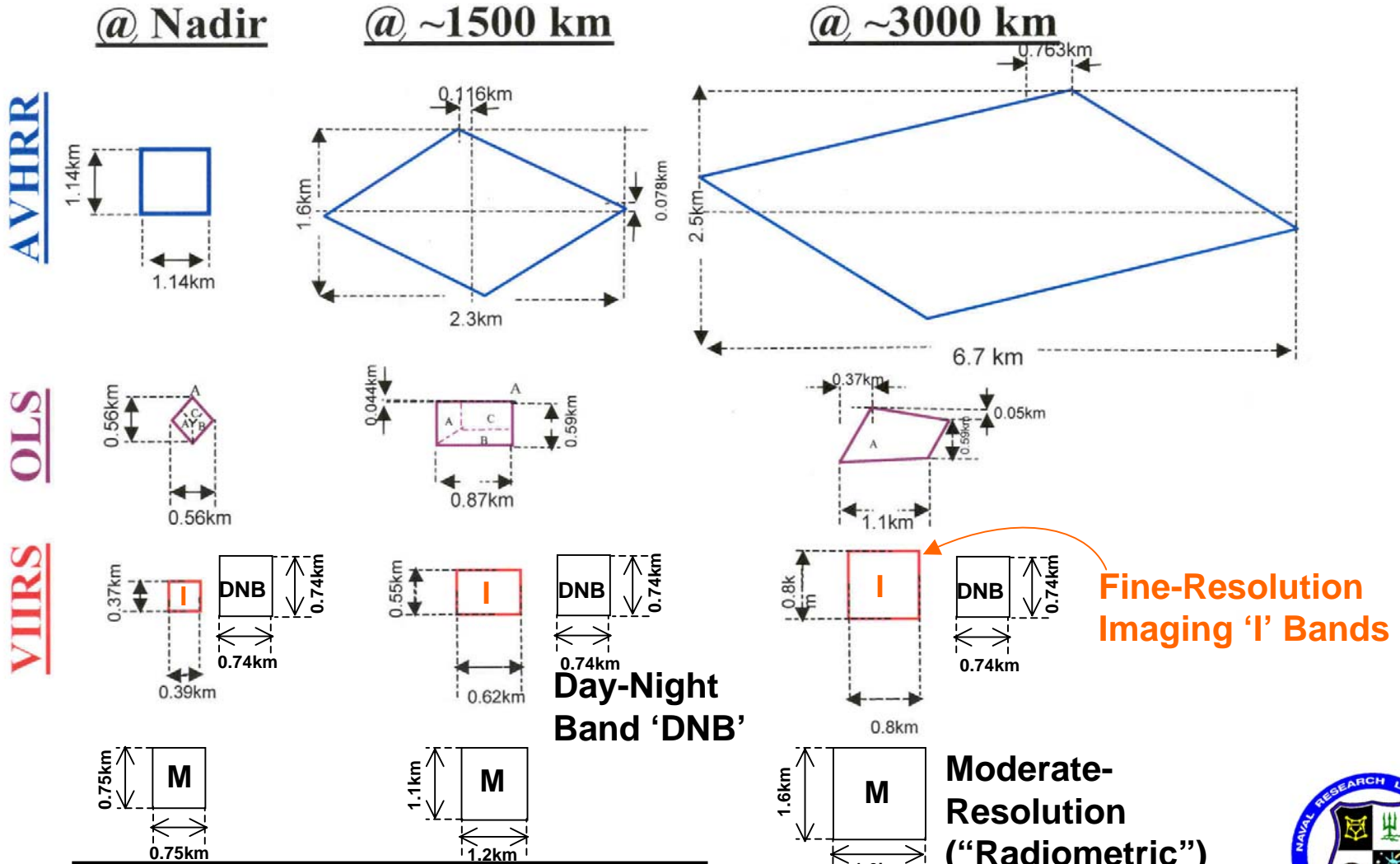


	Band No.	Wave-length (μm)	Horiz Sample Interval (km Downtrack x Crosstrack)		Driving EDRs	Radiance Range	Ltyp or Ttyp
			Nadir	End of Scan			
VIS/NIR FPA Silicon PIN Diodes	M 1	0.412	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	44.9 155
	M 2	0.445	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	40 146
	M 3	0.488	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	32 123
	M 4	0.555	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	21 90
	I1	0.640	0.371 x 0.387	0.80 x 0.789	Imagery	Single	22
	M 5	0.672	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	10 68
	M 6	0.746	0.742 x 0.776	1.60 x 1.58	Atmospheric Corr'n NDVI	Single Single	9.6 25
	M 7	0.865	0.742 x 0.259	1.60 x 1.58	Ocean Color Aerosols	Low High	6.4 33.4
CCD	DNB	0.7	0.742 x 0.742	0.742 x 0.742	Imagery	Var.	6.70E-05
SMWIR PV HgCdTe (HCT)	M 8	1.24	0.742 x 0.776	1.60 x 1.58	Cloud Particle Size	Single	5.4
	M 9	1.378	0.742 x 0.776	1.60 x 1.58	Cirrus/Cloud Cover	Single	6
	I3	1.61	0.371 x 0.387	0.80 x 0.789	Binary Snow Map	Single	7.3
	M 10	1.61	0.742 x 0.776	1.60 x 1.58	Snow Fraction	Single	7.3
	M 11	2.25	0.742 x 0.776	1.60 x 1.58	Clouds	Single	0.12
	I4	3.74	0.371 x 0.387	0.80 x 0.789	Imagery Clouds	Single	270 K
	M 12	3.70	0.742 x 0.776	1.60 x 1.58	SST	Single	270 K
	M 13	4.05	0.742 x 0.259	1.60 x 1.58	SST Fires	Low High	300 K 380 K
LWIR PV HCT	M 14	8.55	0.742 x 0.776	1.60 x 1.58	Cloud Top Properties	Single	270 K
	M 15	10.763	0.742 x 0.776	1.60 x 1.58	SST	Single	300 K
	I5	11.450	0.371 x 0.387	0.80 x 0.789	Cloud Imagery	Single	210 K
	M 16	12.013	0.742 x 0.776	1.60 x 1.58	SST	Single	300 K





Finer Sampling, Spatial Resolution & Better Sensitivity

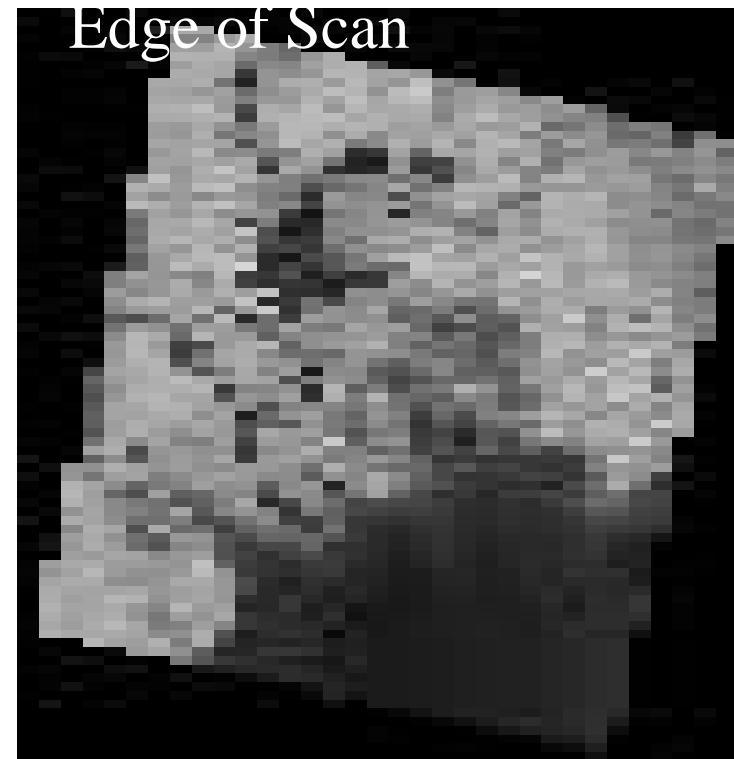
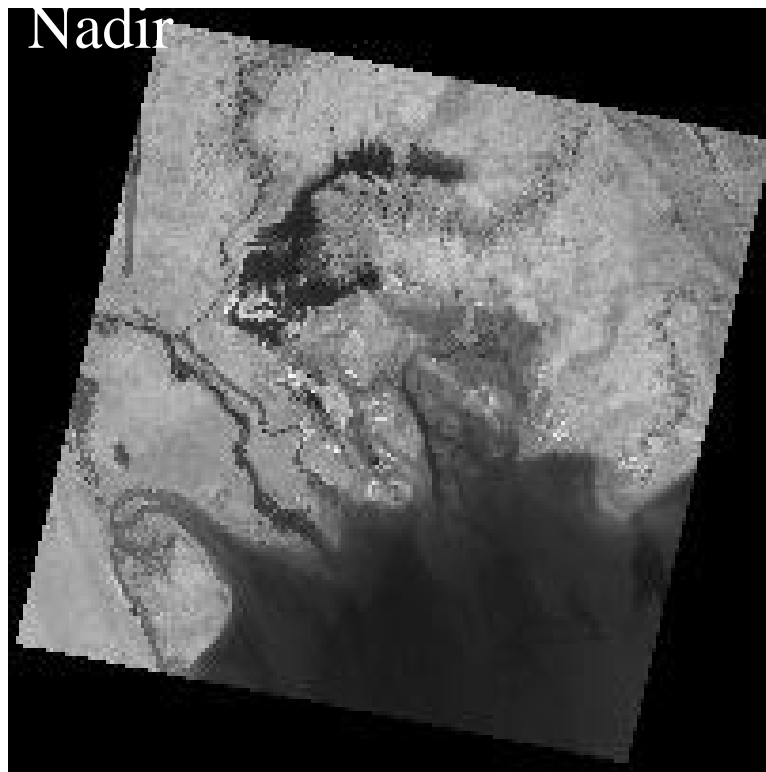


SNR predicted and specified at worst-case edge of scan:
~60% better nadir SNR and finer spatial resolution



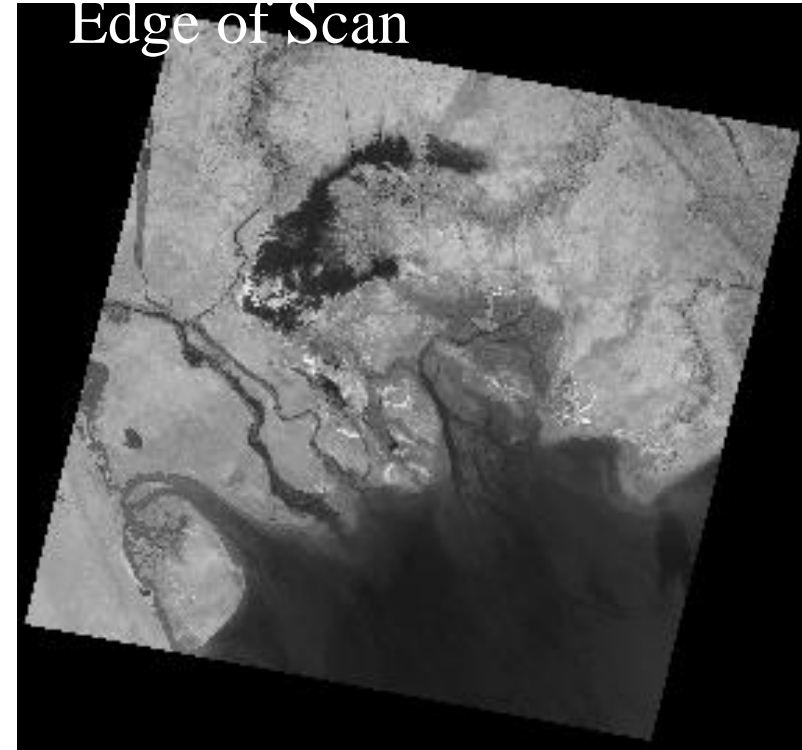
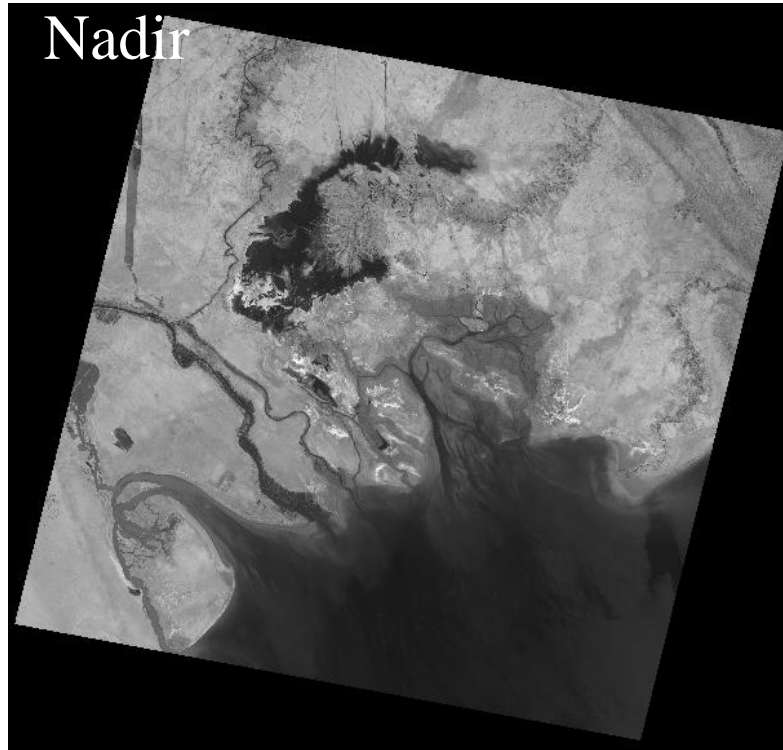


AVHRR VISIBLE SIMULATION



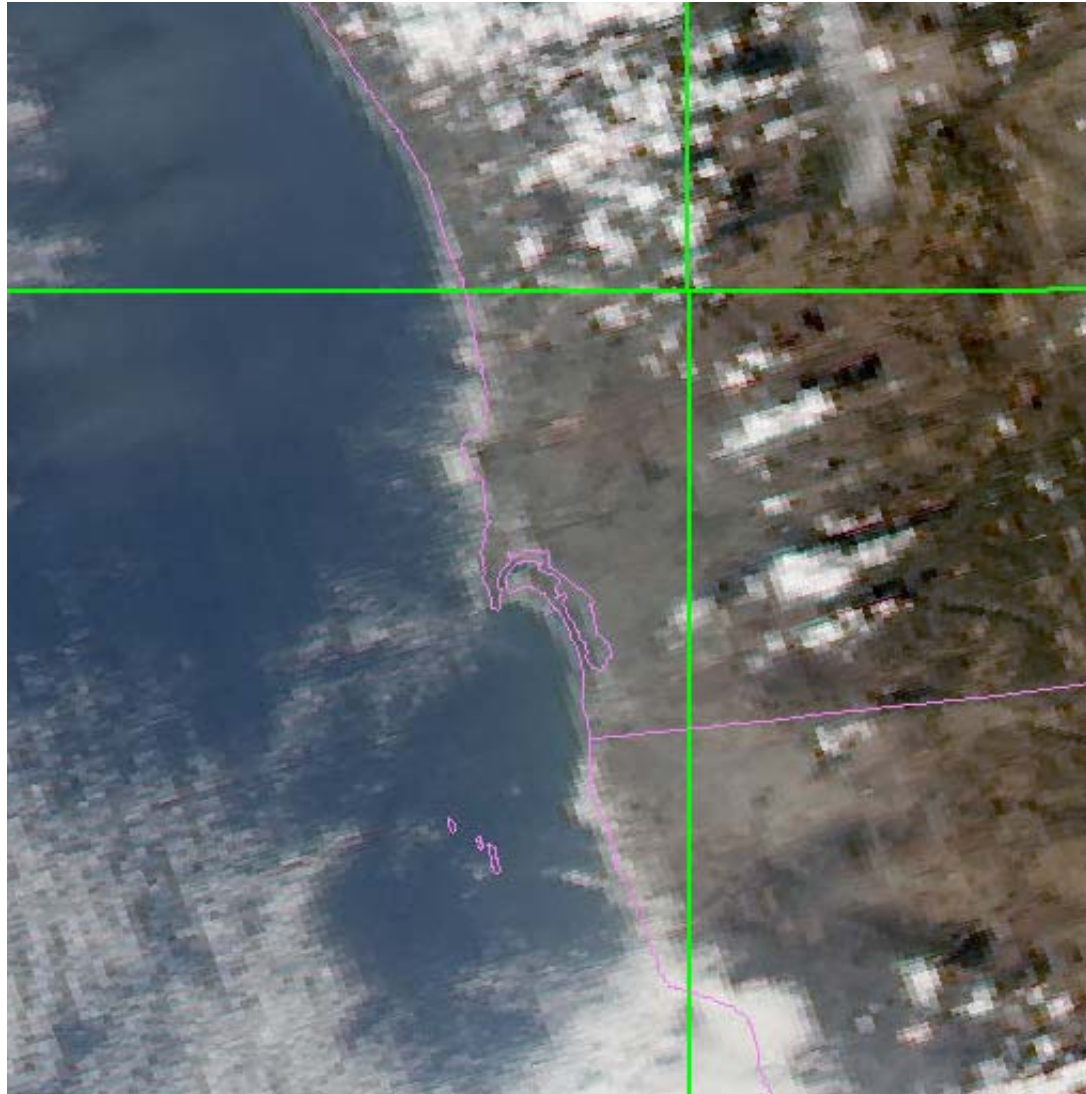


VIIRS VISIBLE SIMULATION





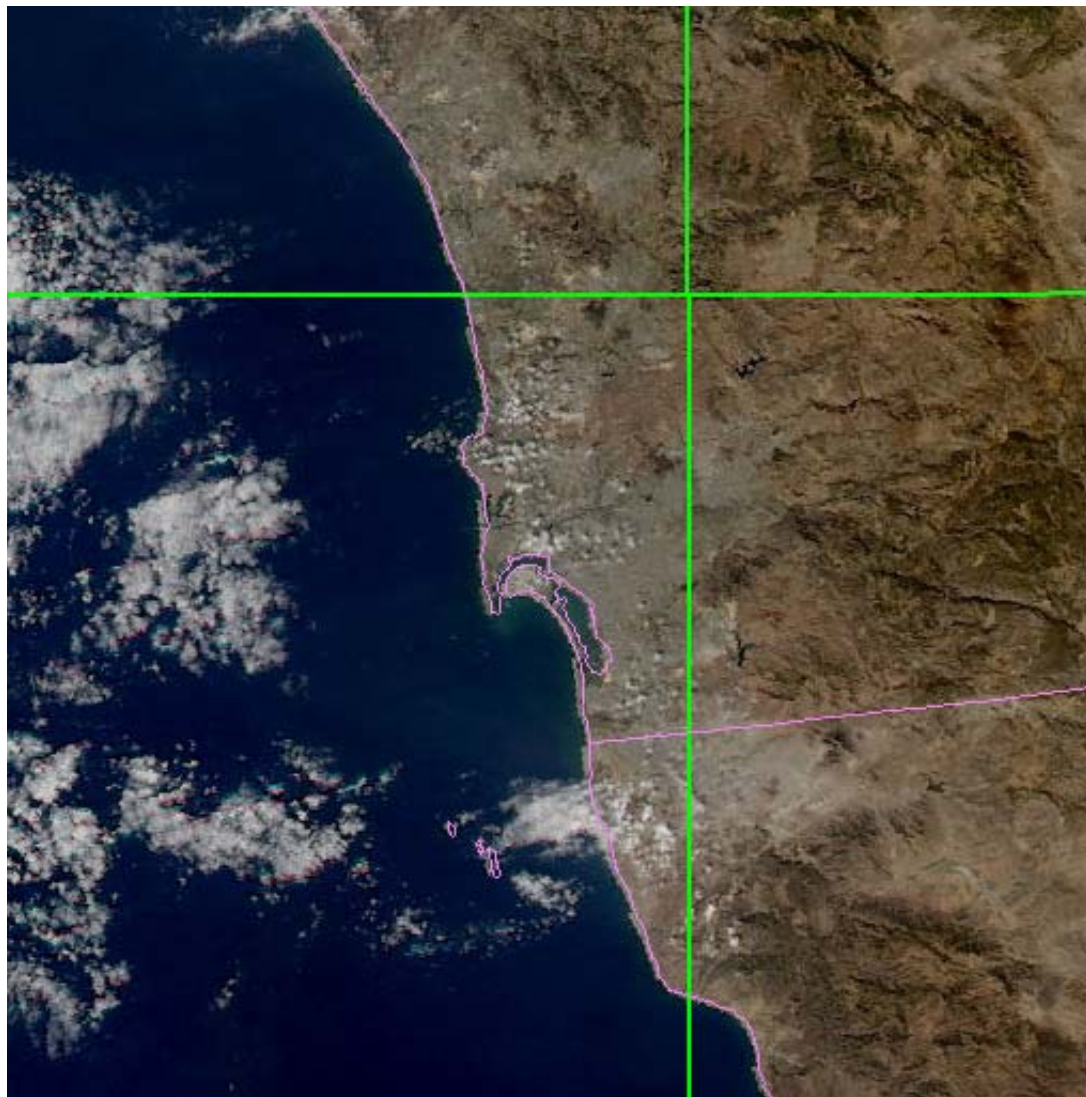
San Diego – MODIS Edge





San Diego – MODIS Nadir

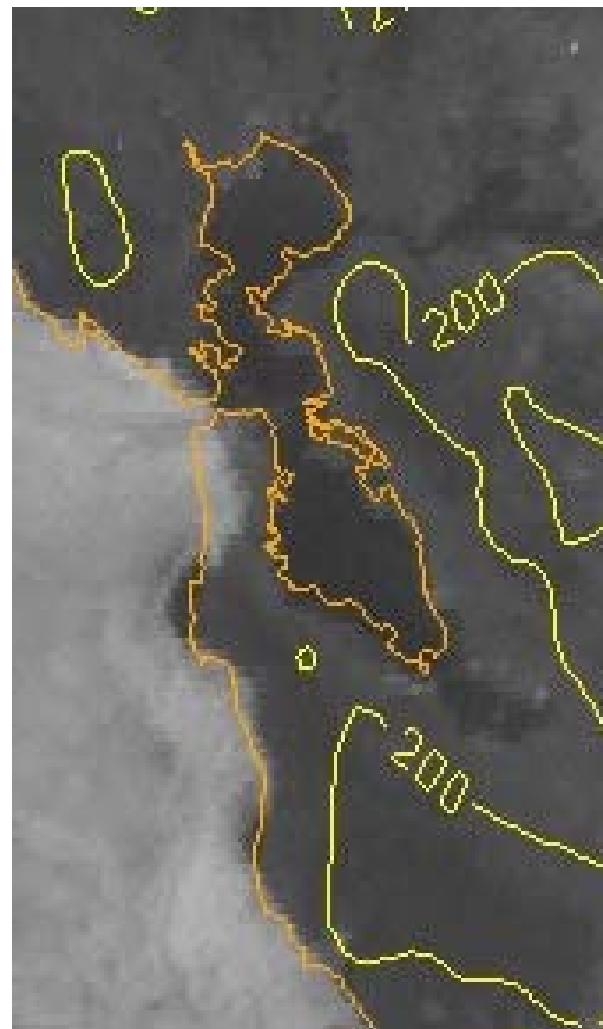
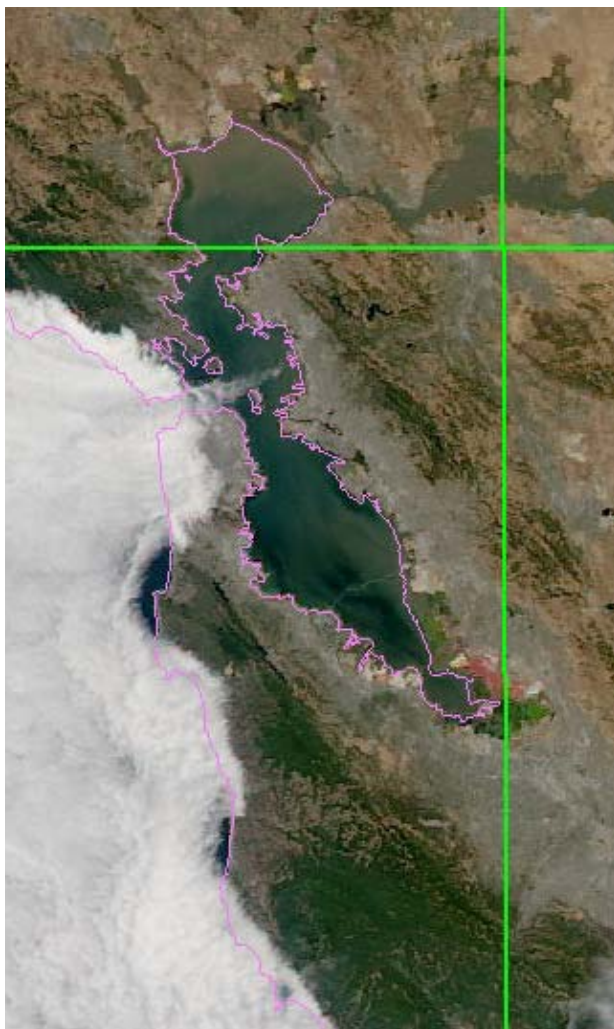
Raytheon





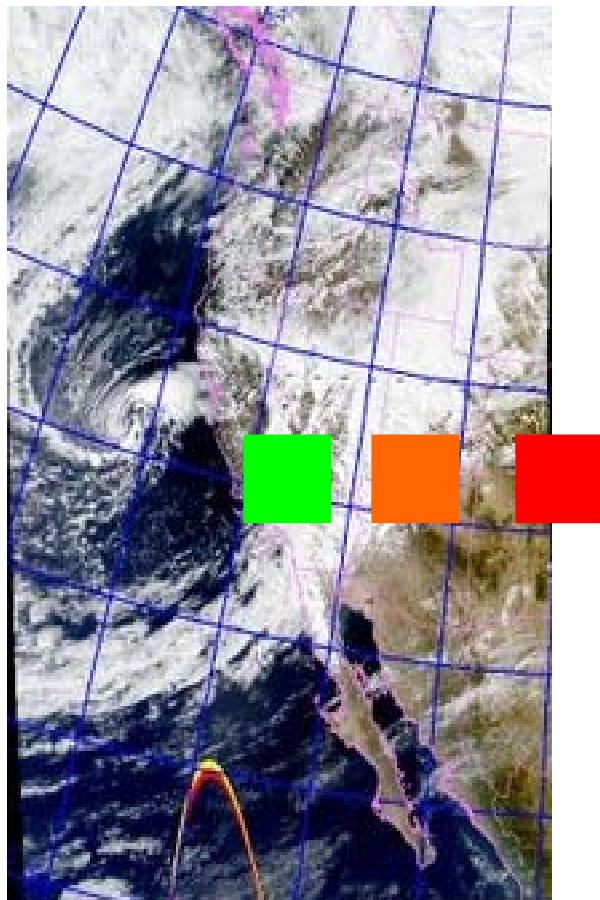
GOES versus MODIS

Raytheon



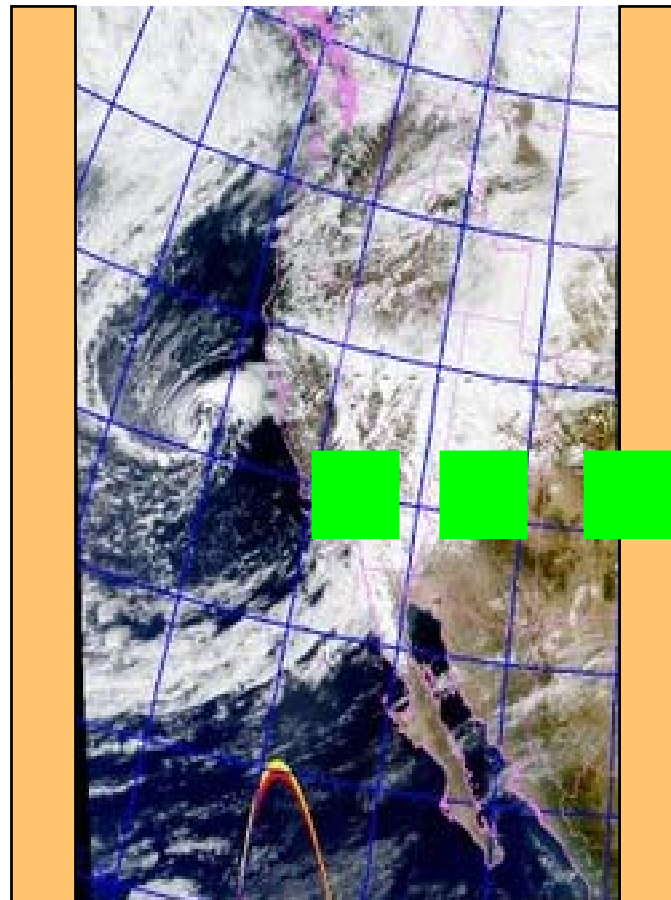
Quality of Subsectors

MODIS



← 2300 km →

VIIRS



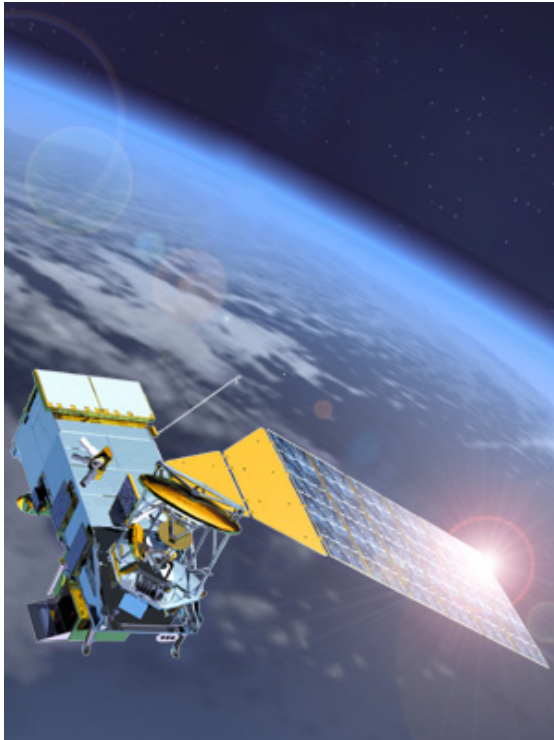
← 3000 km →



VIIRS value to forecasters multiplied by efficient data delivery!

NORTHROP GRUMMAN
Space Technology

Raytheon



- 95 % of data delivered within 28 min to central processing stations
- Average delivery time 10.5 min
- Current prototypes using MODIS have latency 2-3 hours





NexSat WebPage: Audience and Scope

Publicly accessible demonstration of Satellite Products over the continental United States:

1. Simulate future NPOESS capabilities in public forum
2. Near-realtime display of products, some not previously available (e.g., nighttime visible)





NexSat: Web Design



Area Navigation

Satellite Pass Predictor

NexSat

NRL/NPOESS Next-Generation Weather Satellite Demonstration Project

Region/Sector
East/Overview
Sat. Passes

Sequential Thumbnails of Terra.modis.true1KM.East_Overview.COMP_1715.
0908.1030.Terra.modis0907.1330.Aqua.modis 0907.1030.Terra.modis0906.1330.Aqua.modis

Products

- Visible
- Infrared
- Vapor
- True_Color
- Cld_Tops
- Cld_Props
- Cld_Layers
- Cirrus
- Snow
- Lightning
- Contrails
- BioMass
- Aerosol
- Low_Cld
- Model_Ovr
- Night_Vis

Age <= 12 hr.

Age <= 24 hr.

Age > 24 hr.

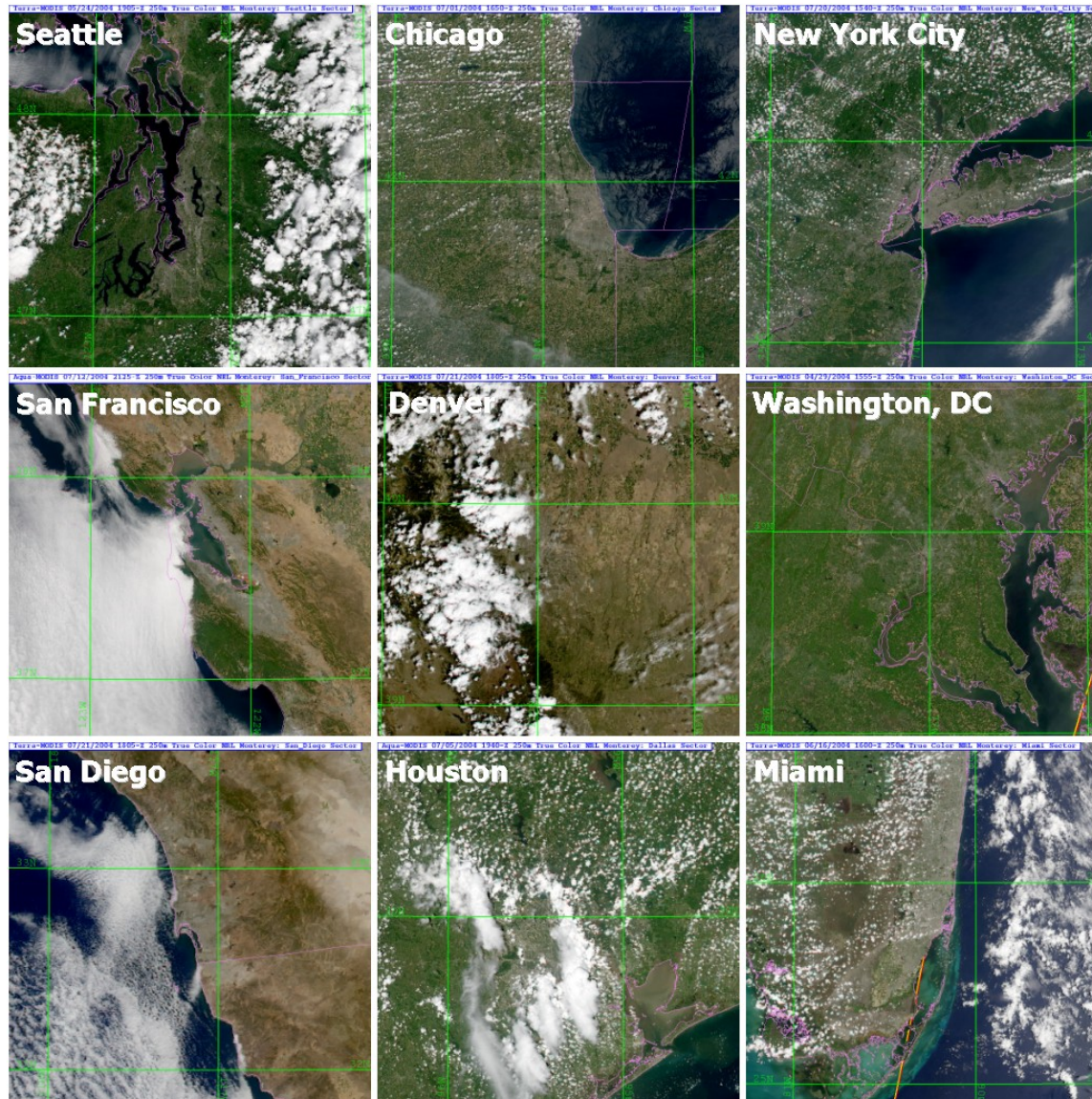
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Latest
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Animate
Tutorial





NexSat: 250m City Zooms



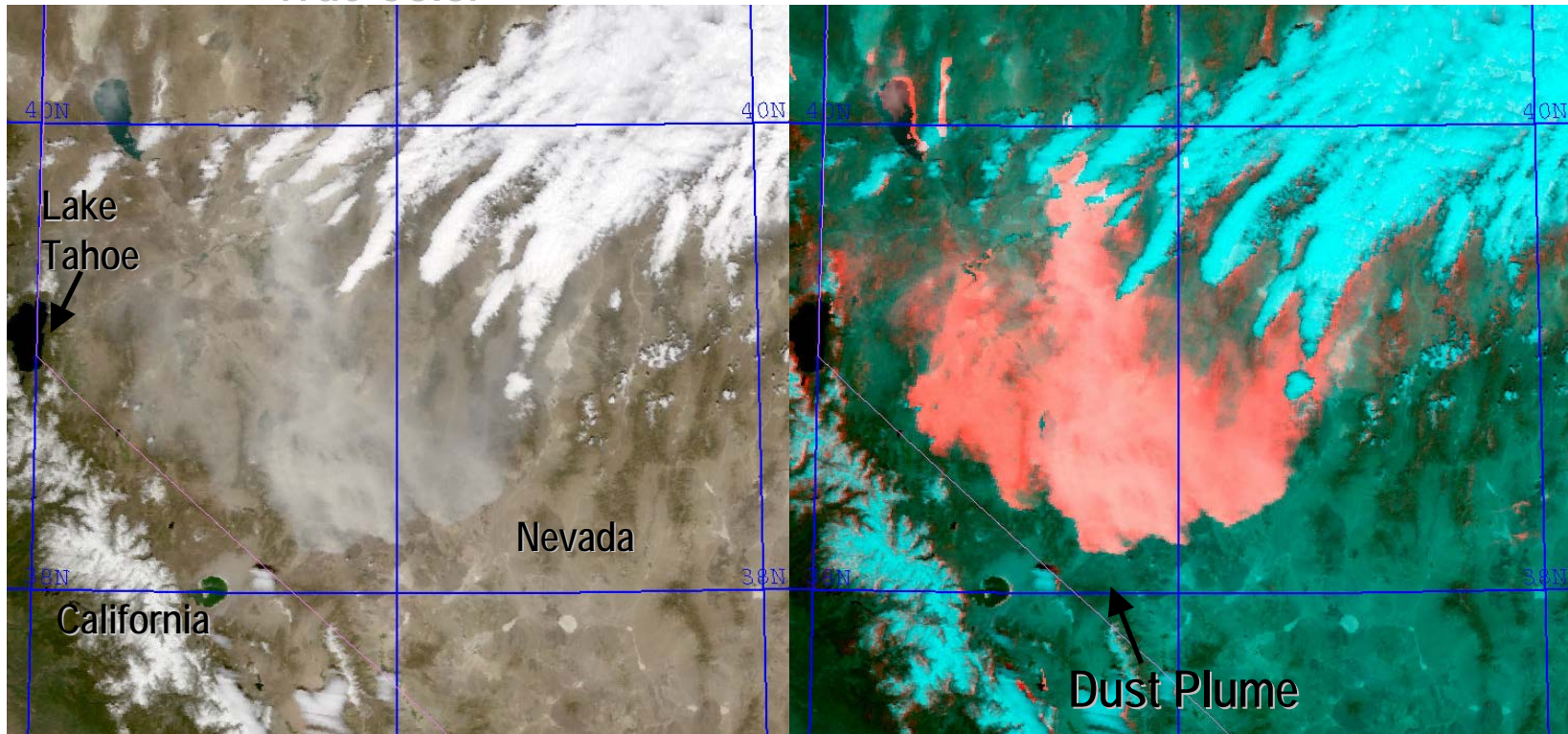


NexSat: Dust Storms



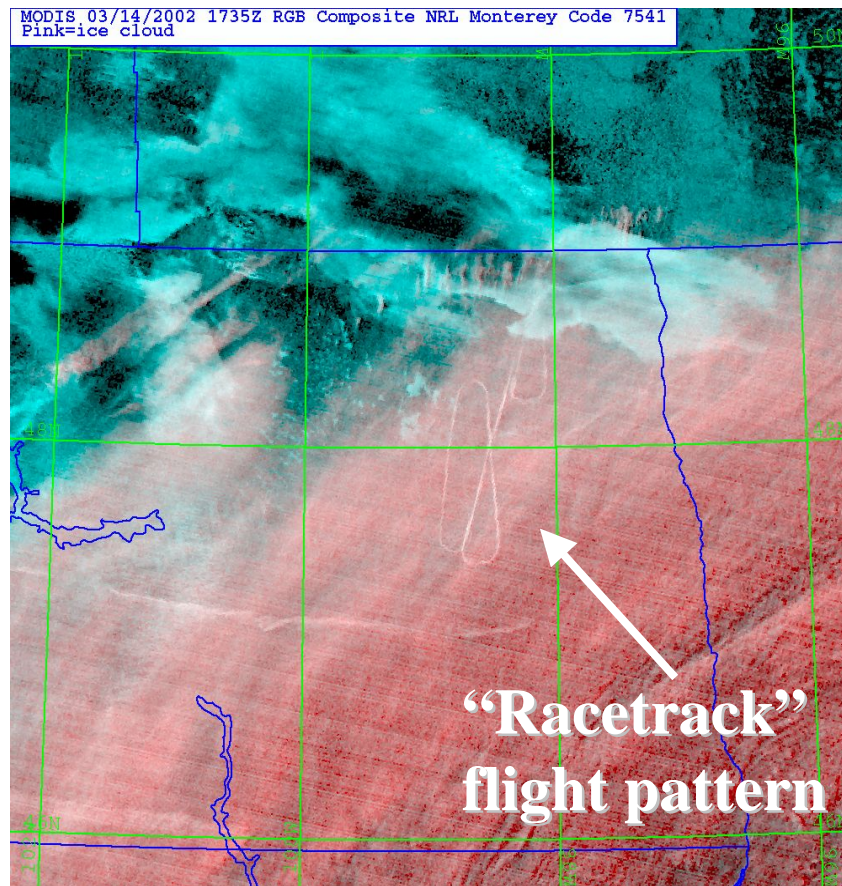
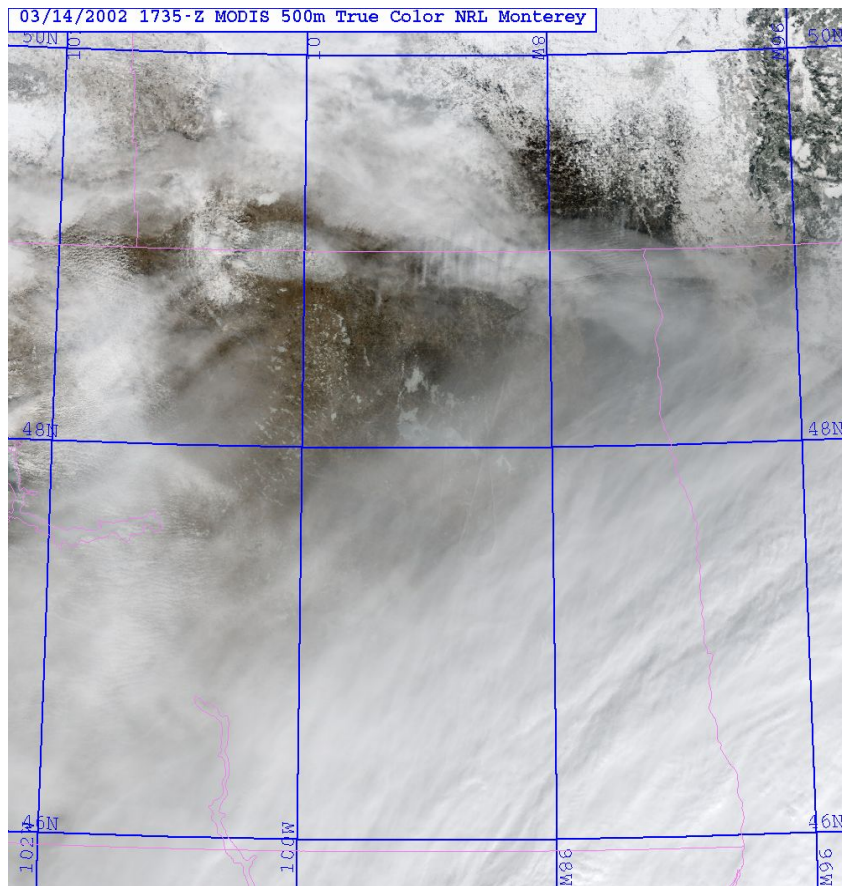
True Color

Dust Enhancement





NexSat: Aircraft Contrails





NexSat: Fire Detection

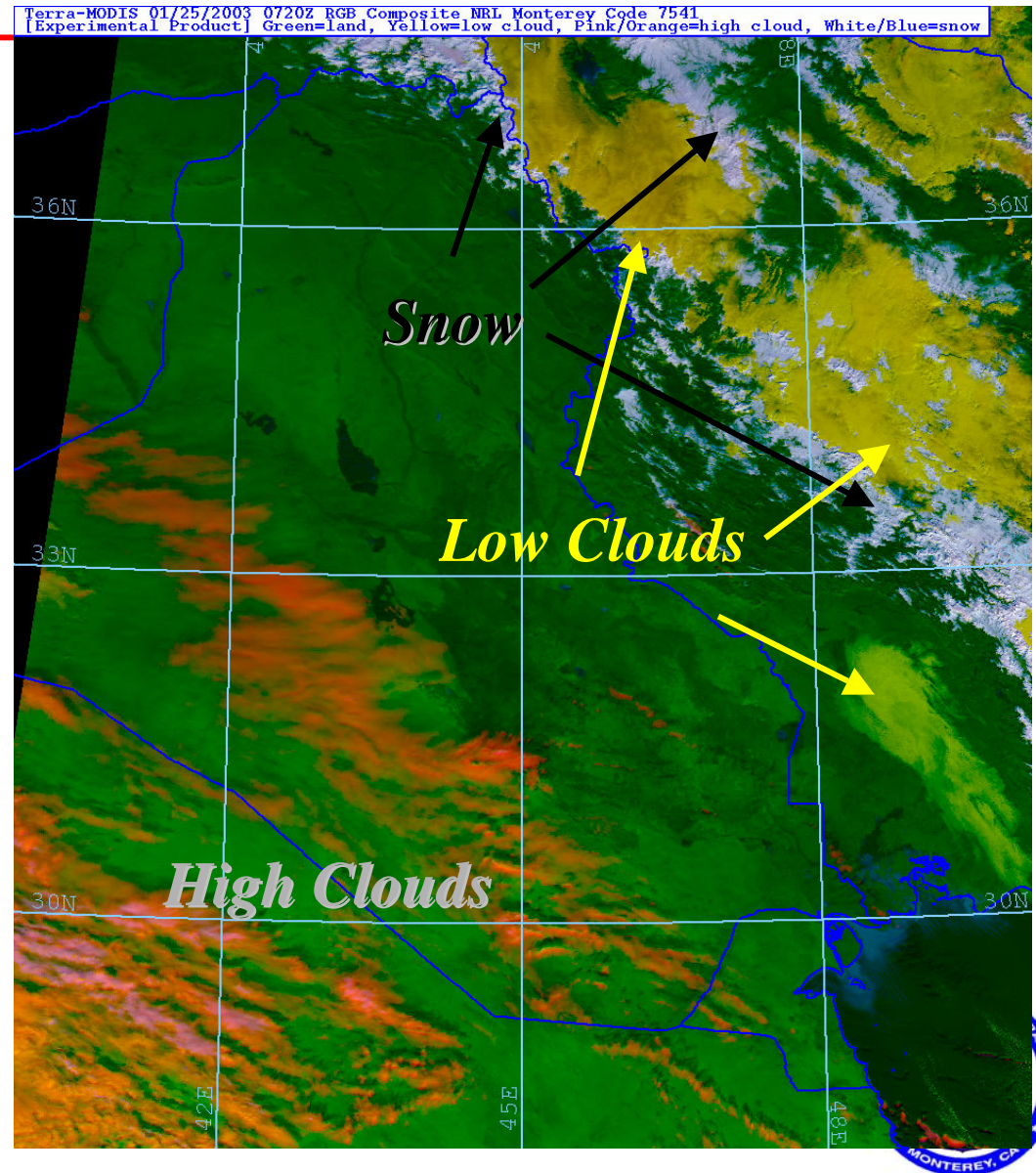




NexSat: Cloud/Snow Discrimination

Raytheon

- Complex snow/cloud scenes during winter in Southwest Asia
- Difficult to distinguish clouds from snow in single visible and window-infrared channels
- The ability to determine the presence of cloud over a snow field is useful to targeting, surveillance, navigation, etc.





DayNight Band (DNB) Constant Resolution

- Purpose: Replicate OLS capability but with updated technology and improvements
- 0.5 -- 0.9 μm broadband visible
- Detectors are aggregated to produce near-constant resolution
- More detectors aggregated near nadir for high SNR; fewer aggregated near edge for lower SNR





DNB “Constant Contrast”



Three Gains	Relative Gain
High	119,000
Medium	477
Low	1

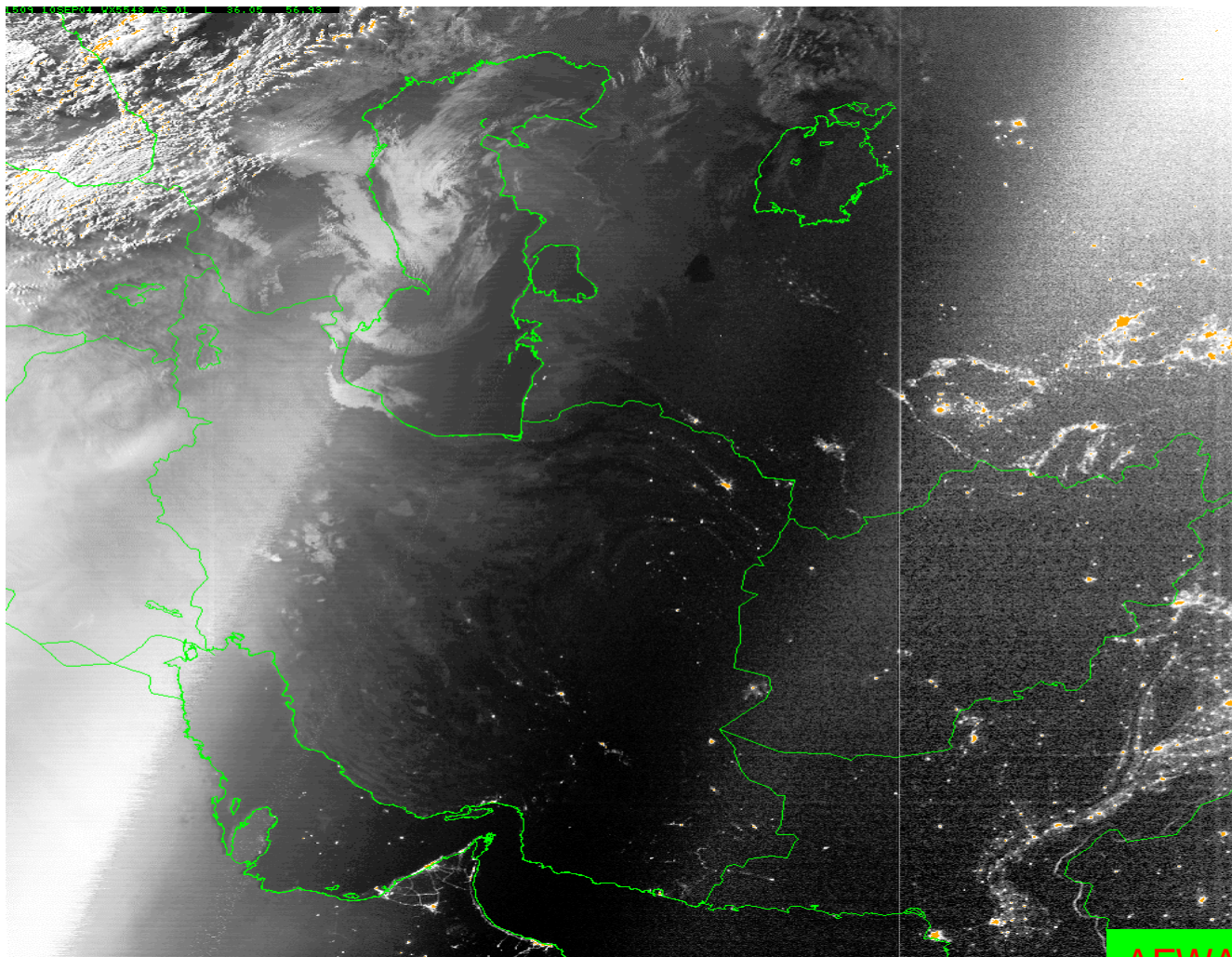
- Improves SNR at low radiances
- All pixels are imaged with all three gains
- Onboard processing selects the most sensitive gain setting without saturation for transmission to the ground
- Goal is “constant contrast” imagery





DMSP (F14) Terminator Image

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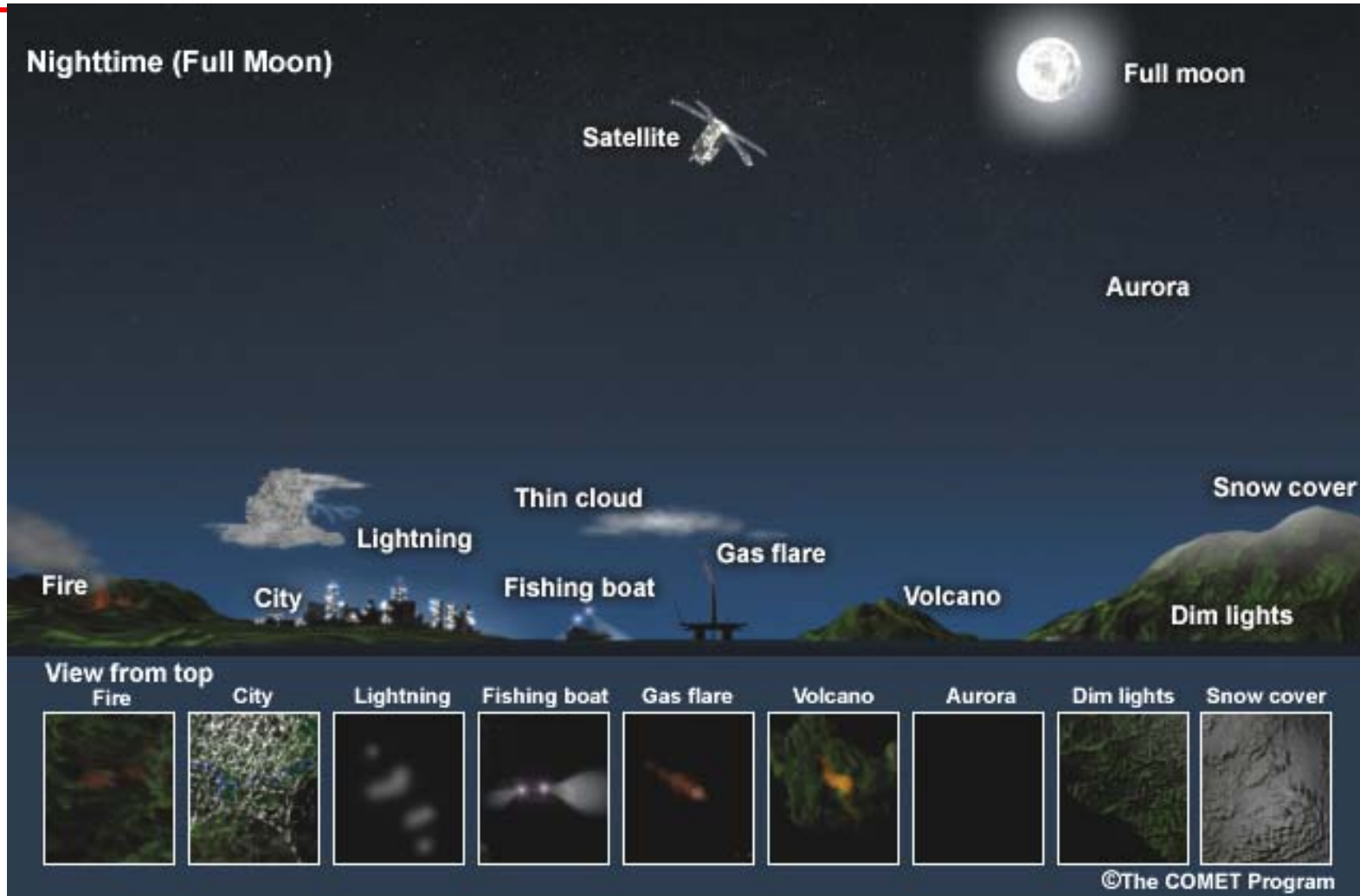
AFWA





Full Moon

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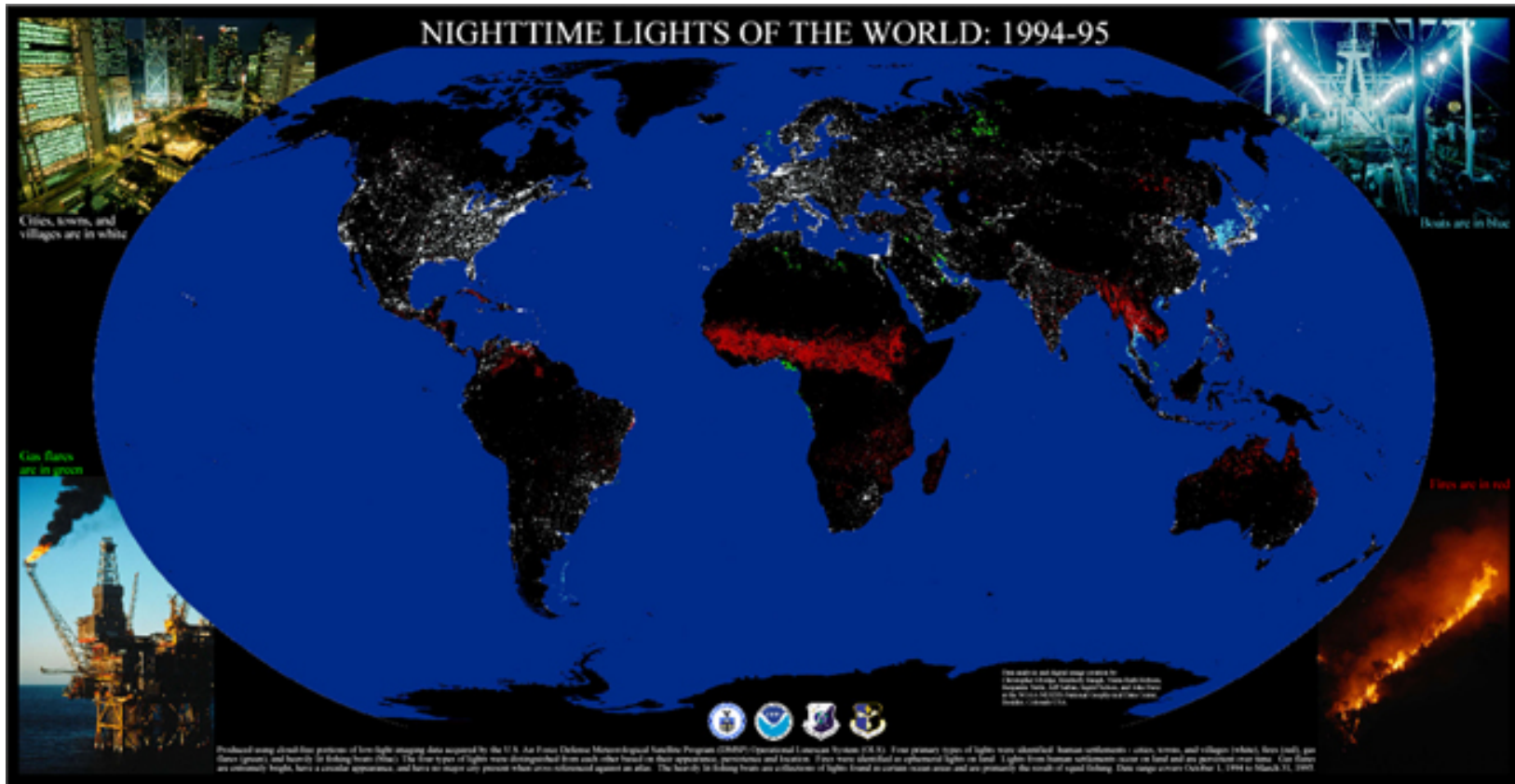




DMSP OLS

Raytheon

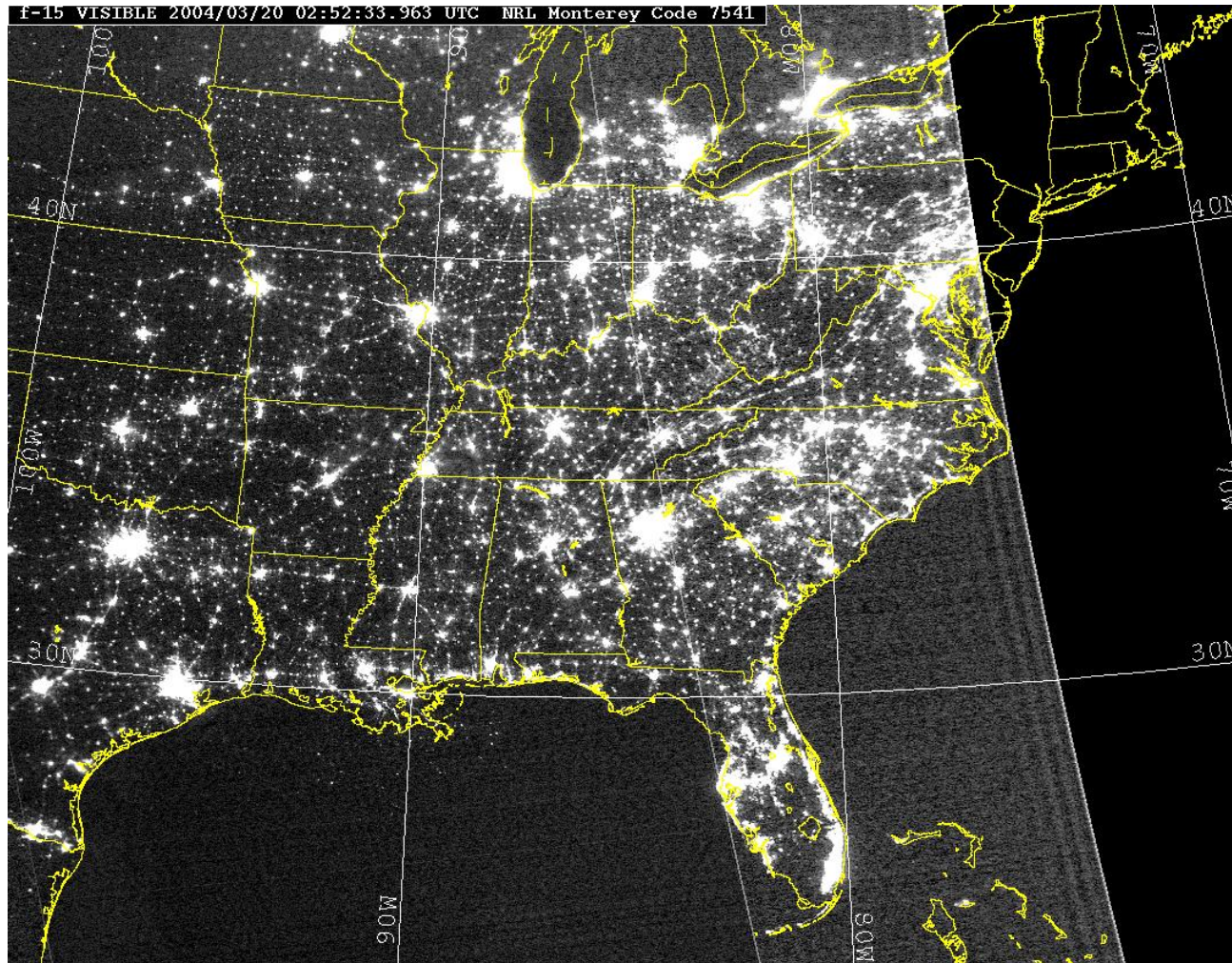
NGDC Poster





No Moon

Raytheon

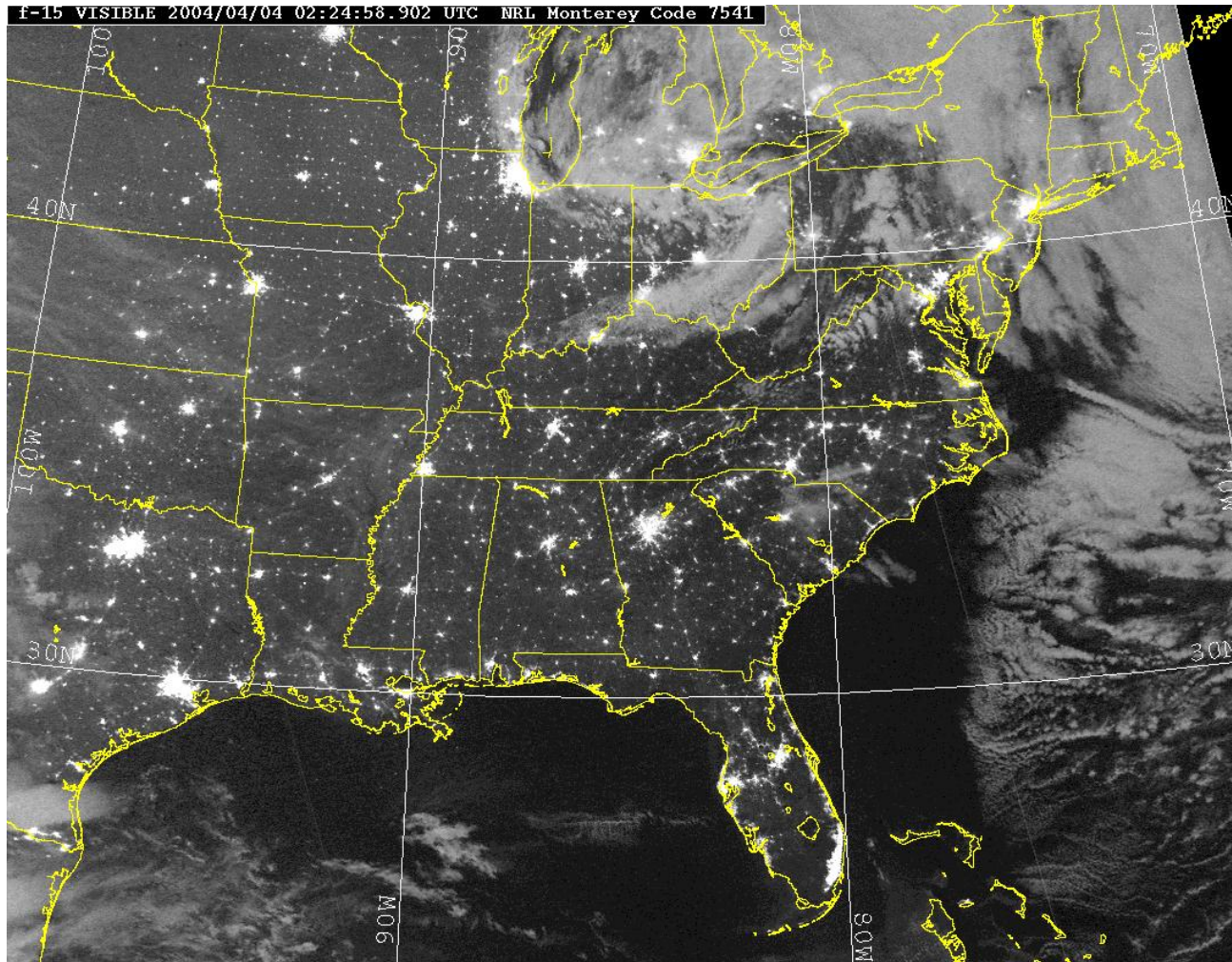




Full Moon

98% full, 48.1° Elevation

Raytheon





VIIRS Improvement for DNB

DMSP OLS

1. 64 Gray shades
2. 2.2 km Field of View
3. Limited Pixel Expansion
4. Numerous Image Artifacts

NPOESS VIIRS

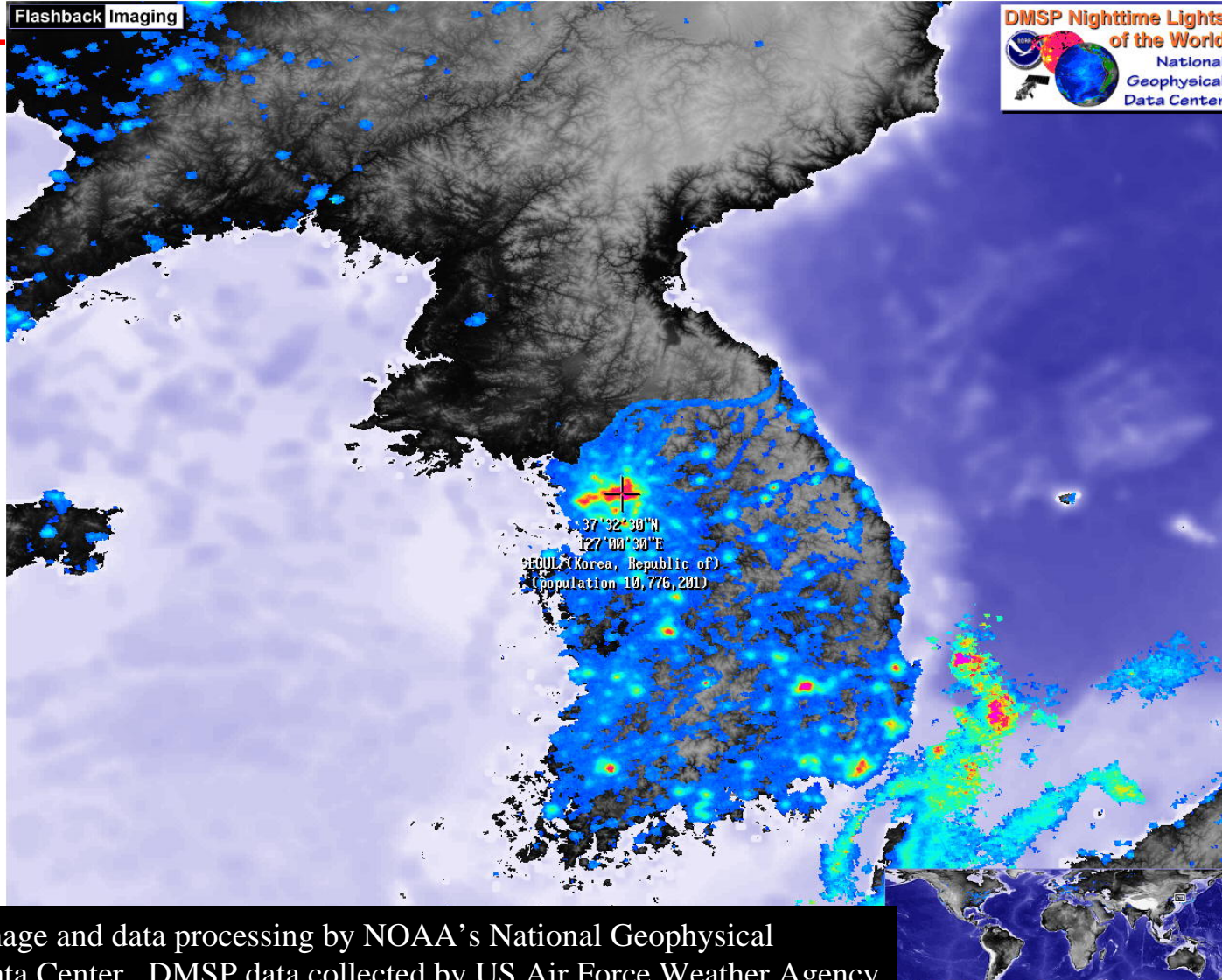
- 64 X = 4096 Gray shades
- 0.75 km Field of View
- No Pixel Expansion
- Artifacts Eliminated





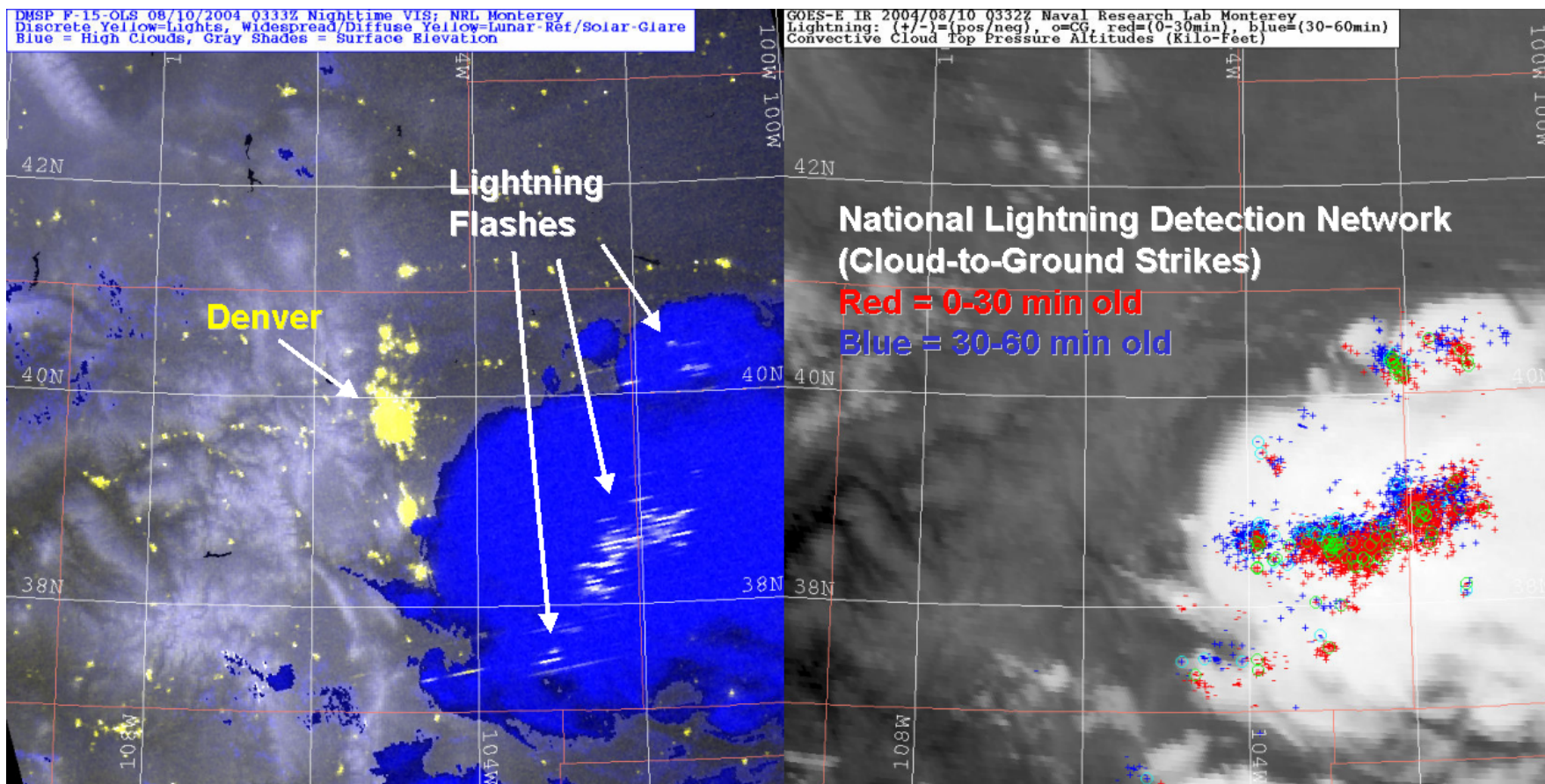
Lights over Korea

Raytheon





OLS Lightning Detection





Near-Realtime Polar Products from NexSat

NexSat
NRL/NPOESS Next-Generation Weather Satellite Demonstration Project

Region/Sector Full/Overview Sat. Passes

Products

- Visible
- Infrared
- Vapor
- True_Color
- Cld_Tops
- Cld_Props
- Cld_Layers
- Cirrus
- Snow
- Lightning
- Rain
- Contrails
- BioMass
- Low_Cld
- Model_Ovr
- Night_Vis**

night_vis/ols_composite
20040828.2112.F-15.ols.vis.Full_Overview.COMP_1235_NGT.jpg

Widespread/Diffuse yellow-lunar-ref/Solar-glare glare
by Shades = Surface Elevation

Latest Archive Thumbs Animate Tutorial

http://www.nrlmry.navy.mil/nexsat_pages/nexsat_home.html





Conclusions

- VIIRS adds advanced capability not available from MODIS
- NPOESS will truly be a forecaster's system
- Constant-Contrast/Constant-Resolution Data will produce vivid, information-rich images for DNB
- Preservation of footprint size will facilitate much more usable images
- VIIRS fine channels replicate the capability of AVHRR
- Many products in addition to EDRs
- True color capability preserved for VIIRS

