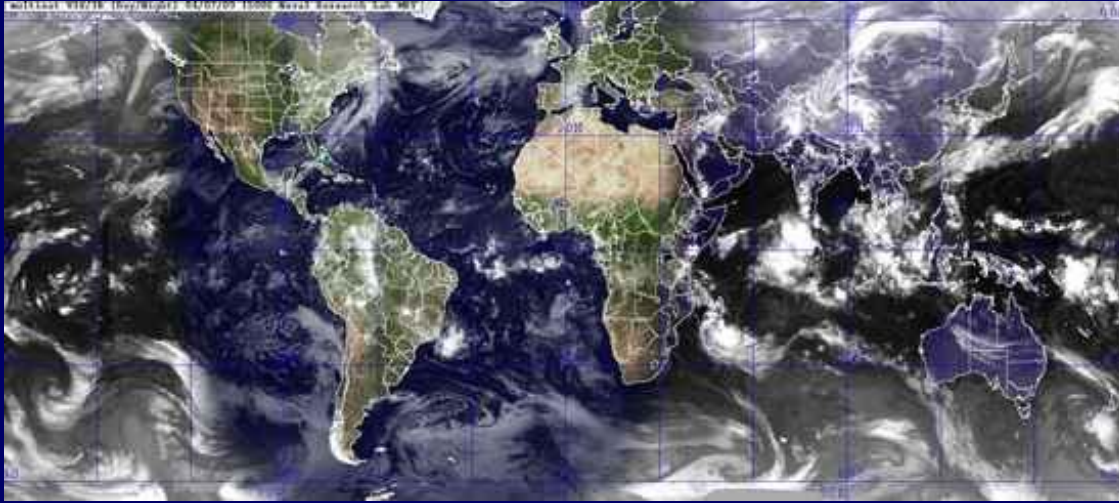




# NexSat Ushering in the VIIRS Era



Arunas Kuciauskas<sup>1</sup>, Steven Miller<sup>2</sup>, Thomas Lee<sup>1</sup>,  
Jeffrey Hawkins<sup>1</sup>, Jeremy Solbrig<sup>1</sup>,  
Kim Richardson<sup>1</sup>, Richard Bankert<sup>1</sup>, Mindy Surratt<sup>1</sup>,  
and John Kent<sup>3</sup>

<sup>1</sup> Naval Research Laboratory (Monterey)

<sup>2</sup> Cooperative Institute for Research in the Atmosphere

<sup>3</sup> Science Applications International Corporation

*IGARSS 2011, 24 – 29 July, Vancouver B.C.*



# Introduction

NexSat: Next generation weather satellite demonstration program

*[www.nrlmry.navy.mil/NEXSAT.html](http://www.nrlmry.navy.mil/NEXSAT.html)*

Public-access website providing state of the art weather satellite products globally

## ❖ **Preparing for VIIRS**

- ✓ **Launch: Oct. 25**
- ✓ **Display products several weeks later**

## ❖ **NexSat: Ideal VIIRS web resource**

- ✓ **Illustrate first results**
- ✓ **Train and motivate users**



# NexSat Website Interface

## Current version



[Training](#) **NexSat** [Feedback?](#) [About Nexsat](#)

[Global\\_Map](#) [CONUS](#)

<http://www.nrlmry.navy.mil/NEXSAT.html>



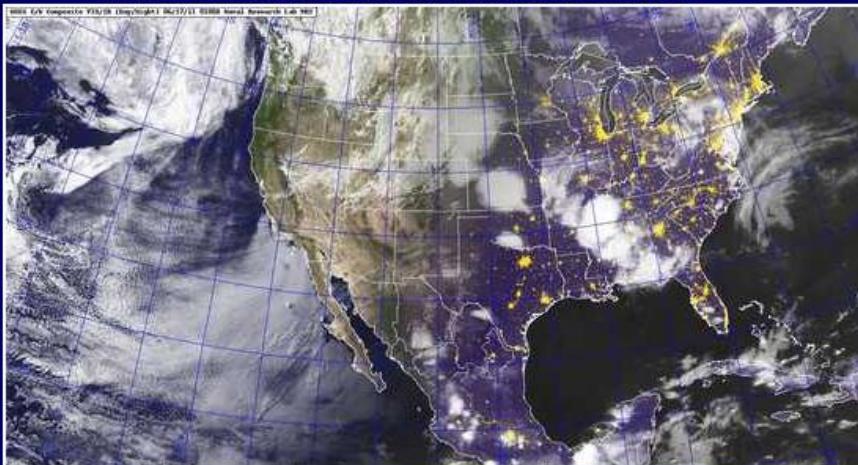
### Products

- Visible
- Infrared
- Vapor
- True Color
- GEO-Color
- Cloud Tops
- Cloud Layers
- Cirrus
- Snow Cover
- Rain Rates
- Rain Totals
- Contrails
- BioMass
- CloudSat
- Winds
- Aerosol
- Low Cloud
- Model Overlays
- Night Visible

[Latest](#) [Archive](#) [Small](#) [Large](#) | [Single](#) [Multi](#) [Animate](#) [Google Earth](#)

[vis\\_ir\\_background/goes/20110617.0100.goes\\_11.visir.bckgr.\\_DAYNGT.jpg](#)  [UTC](#)

(This is the Latest image. Click thumb to view Full-Sized image. )



[Latest](#) [Archive](#) [Small](#) [Large](#) | [Single](#) [Multi](#) [Animate](#) [Google Earth](#)

[NRL\\_Home](#)[|Sat\\_Home](#)[|JPSS](#)[|COMET](#)[|Search](#)

Nexsat: 3.14.02 (Released: 8 Jun 2011)  
Page Generated: Fri Jun 17 01:51 2011 GMT  
Approved for public release by: Superintendent NRL Monterey  
Technical POC: **Nexsat Lead**  
Webmaster: **contact**

**Headlines!**







# NexSat Website Interface

## "Day 1" of VIIRS



[Training](#) **NexSat** [Feedback?](#) [About Nexsat](#)

[Global\\_Map](#) [CONUS](#)

Check out the latest  
in satellite technology

**VIIRS**  
resource



### Products

- Visible **VIIRS**
- Infrared **VIIRS**
- Vapour
- True Color **VIIRS**
- GEO-Color
- Cloud Tops **VIIRS**
- Cloud Layers **VIIRS**
- Cirrus **VIIRS**
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[Latest](#) [Archive](#) [Small](#) [Large](#) | [Single](#) [Multi](#) [Animate](#) [Google Earth](#)

vis\_ir\_background/goes/20110617.0100.goes\_11.visir.bckgr\_DAYNGT.jpg 01:52:53 [UTC](#)  
(This is the Latest image. Click thumb to view Full-Sized image. )



[Latest](#) [Archive](#) [Small](#) [Large](#) | [Single](#) [Multi](#) [Animate](#) [Google Earth](#)

[NRL\\_Home](#) | [Sat\\_Home](#) | [JPSS](#) | [COMET](#) | [Search](#)

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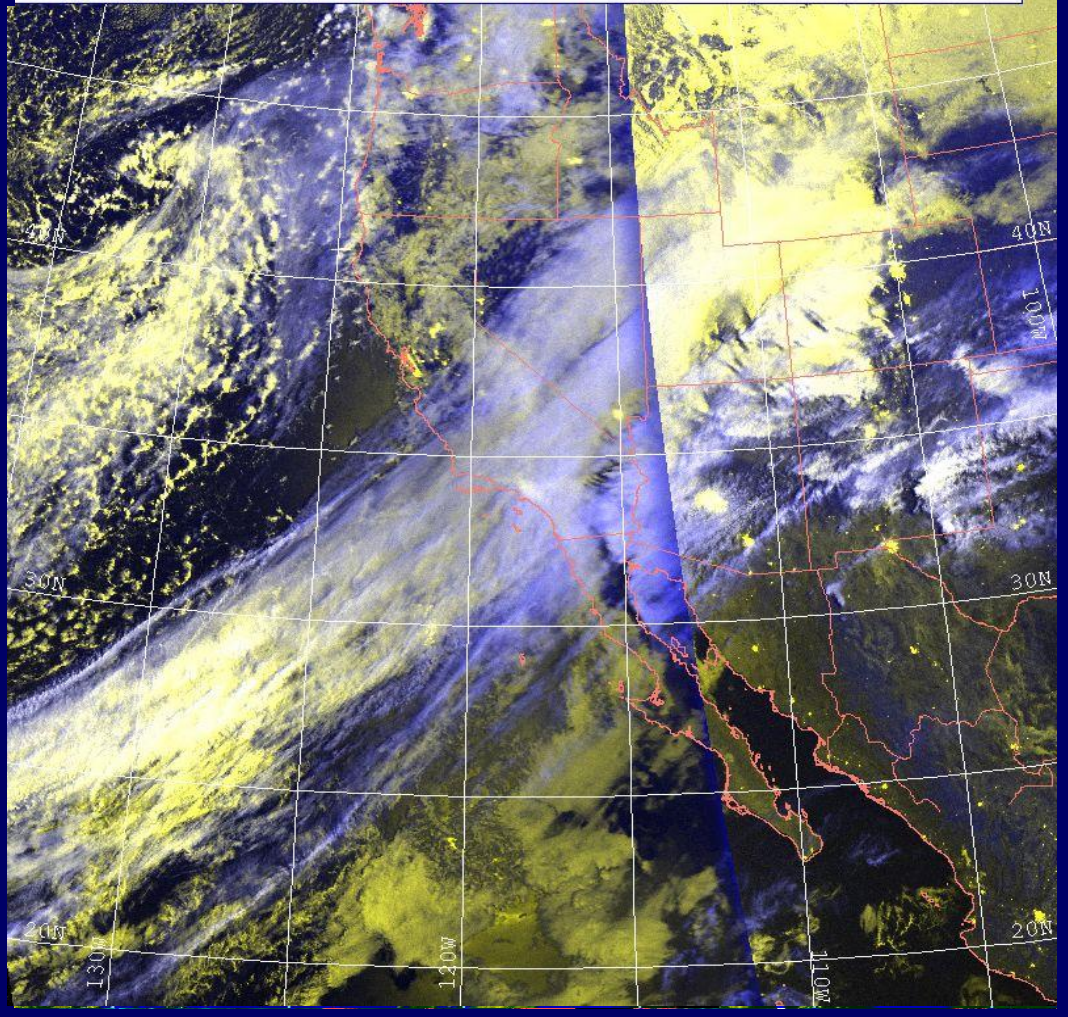


# NexSat Product Examples

## Will be applied to VIIRS

Visible (night)

DMSP F-18-OLS 12/20/2010 Nighttime COMPOSITE (2000 Local Time) NRL Monterey  
Most Recent Addition: 12/21/2010 0414 GMT  
Discrete Yellow= City Lights, Widespread Diffuse Yellow=Lunar-Reflection/Solar-Glare  
Blue=High Clouds, Gray Shades=Surface Elevation  
SE=-42.1 SI=0.0000 LE=43.5 LP=1.00 LF=0.8847 LC=1





# 1<sup>st</sup> Results of NPP-VIIRS

## NexSat VIIRS resource

### Training

- Description
- Links to training
- Product training via NexSat
- 22 channel views

### Sensor comparisons

- VIIRS vs
- AVHRR
  - MODIS
  - OLS
    - Night visible

### Feedback

- User input
- Web stats
- Outreach





# NexSat Strengths Satellite Constellation

## Polar Orbiting Satellites (30)

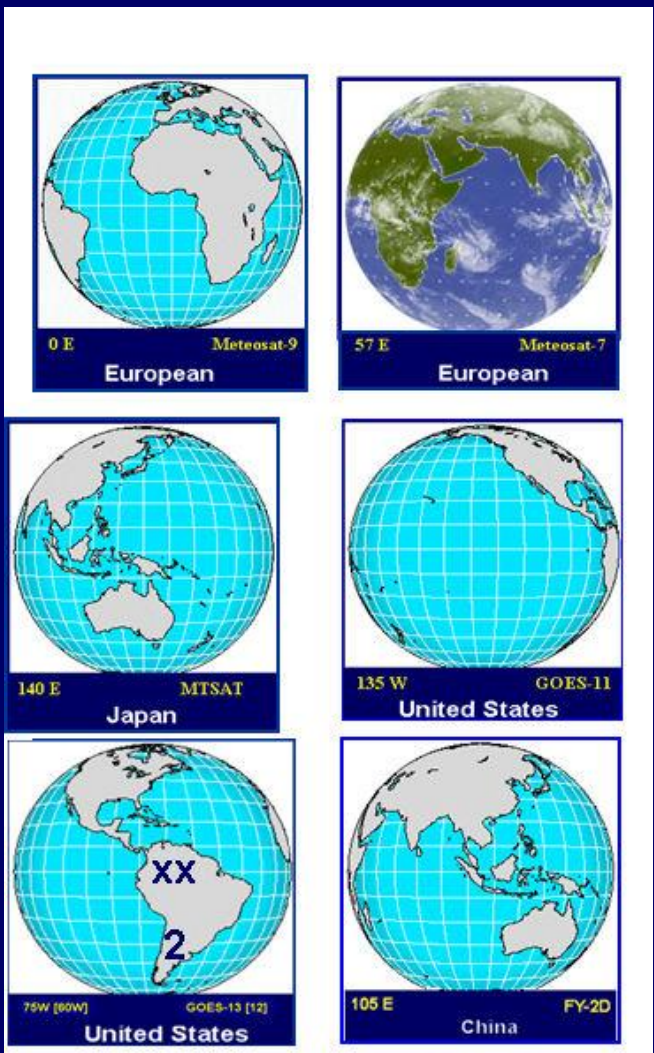
<b>Imagers (Vis/IR):</b>	<b>NOAA - AVHRR (5)</b>
	<b>METOP - AVHRR (1)</b>
	<b>DMSP - OLS (5)</b>
	<b>NASA - MODIS (2)</b>

<b>Microwave Imagers:</b>	<b>DMSP</b>	<b>SSM/I (2), SSMIS (3)</b>
	<b>NASA</b>	<b>TMI, AMSR-E</b>
	<b>NRL</b>	<b>WindSat</b>
<b>Micro Sounders:</b>	<b>NOAA/MetOp</b>	<b>AMSU-B (3), MHS (2)</b>
<b>Microwave Radar:</b>	<b>NASA</b>	<b>TRMM PR, CloudSat,</b>
	<b>EUMETSAT</b>	<b>ASCAT, ERS-2</b>

**Collaborations: FNMOC, AFWA, NASA, NOAA, NAVO, CIRA**

**Data latency: GEO < 1 hour**  
**LEO 0.5 - 3 hours**  
**Data volume: 250-300 GB/day**  
**VIIRS ingest: 2.25 TB/day, 7 day storage**

## GEO Orbiting Satellites (7)



Courtesy: Johnson & EUMETSAT



# Catalog of NexSat Products

## Standard Products

Visible (daytime)

Visible (night time)

Infrared

Water Vapor

True Color

Pseudo/GEO True Color

Rain Rates

Rain Totals

- 3, 6, 12, 24 hours
- 2, 3, 4, 5, 6, 7, 10, 12, 14 days

\*Winds

- speed and direction
- low level
- middle level
- upper level

## Cloud Products

Cloud layers (snow, low-middle, high)

CloudSat (cloud profile)

Cirrus cloud detection

Contrail detection

Low cloud detection (night)

Convective cloud top height

Cloud properties

- effective radius
- optical depth
- cloud top temperature
- cloud top height
- cloud type

## Environmental Products

Aerosol amounts (optical depth)

Biomass (vegetation type)

Dust detection

Fire detection (hot spots)

Lightning detection

Snow cover (surface)

## \*NWP model overlays

Sea Level Pressure

500 mb Heights

sfc, 700 500 300 mb Winds

1000-500 mb Thickness

Surface Temperature

Jet Stream

\* NOGAPS and COAMPS<sup>®</sup>





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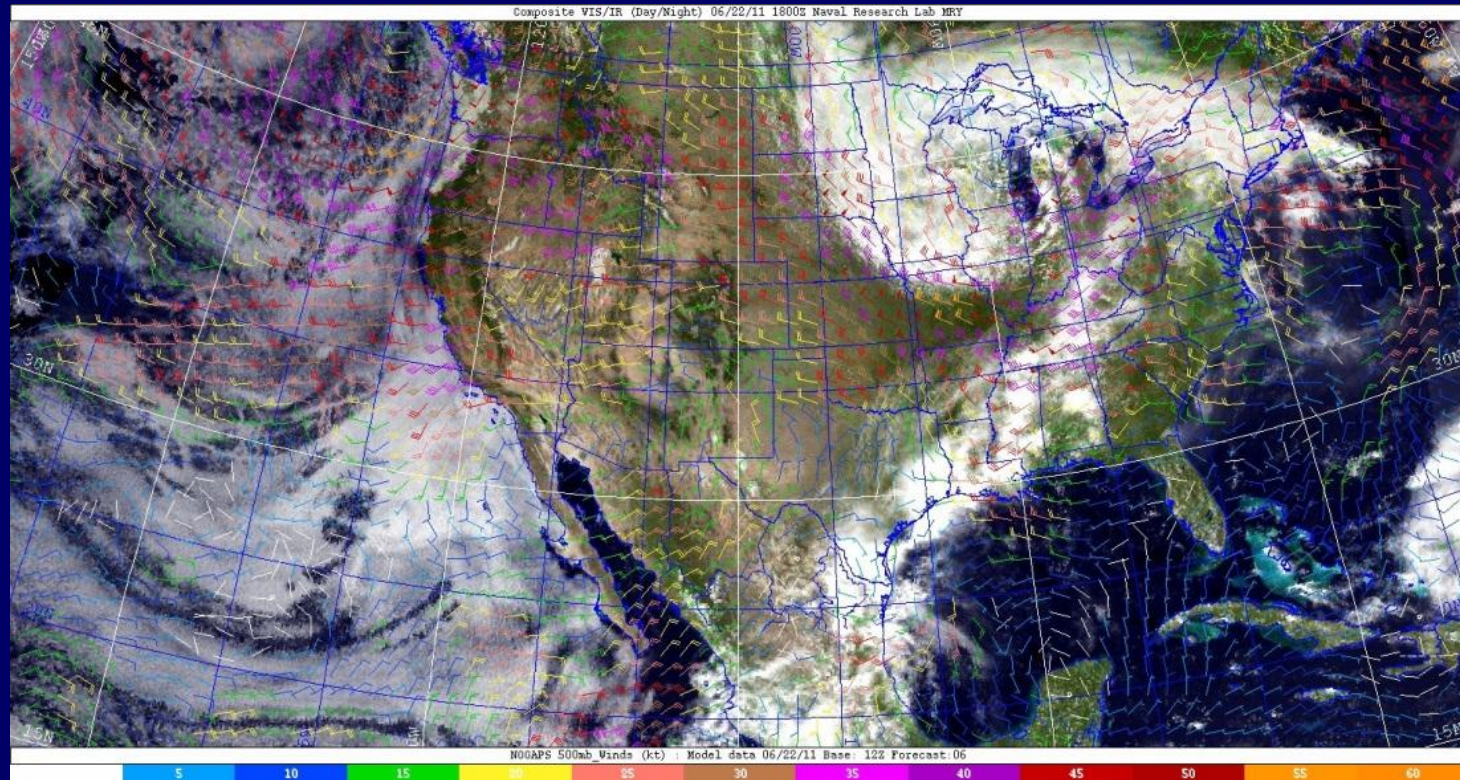
*VIIRS products in orange*



# Data Fusion

## Applying ancillary products

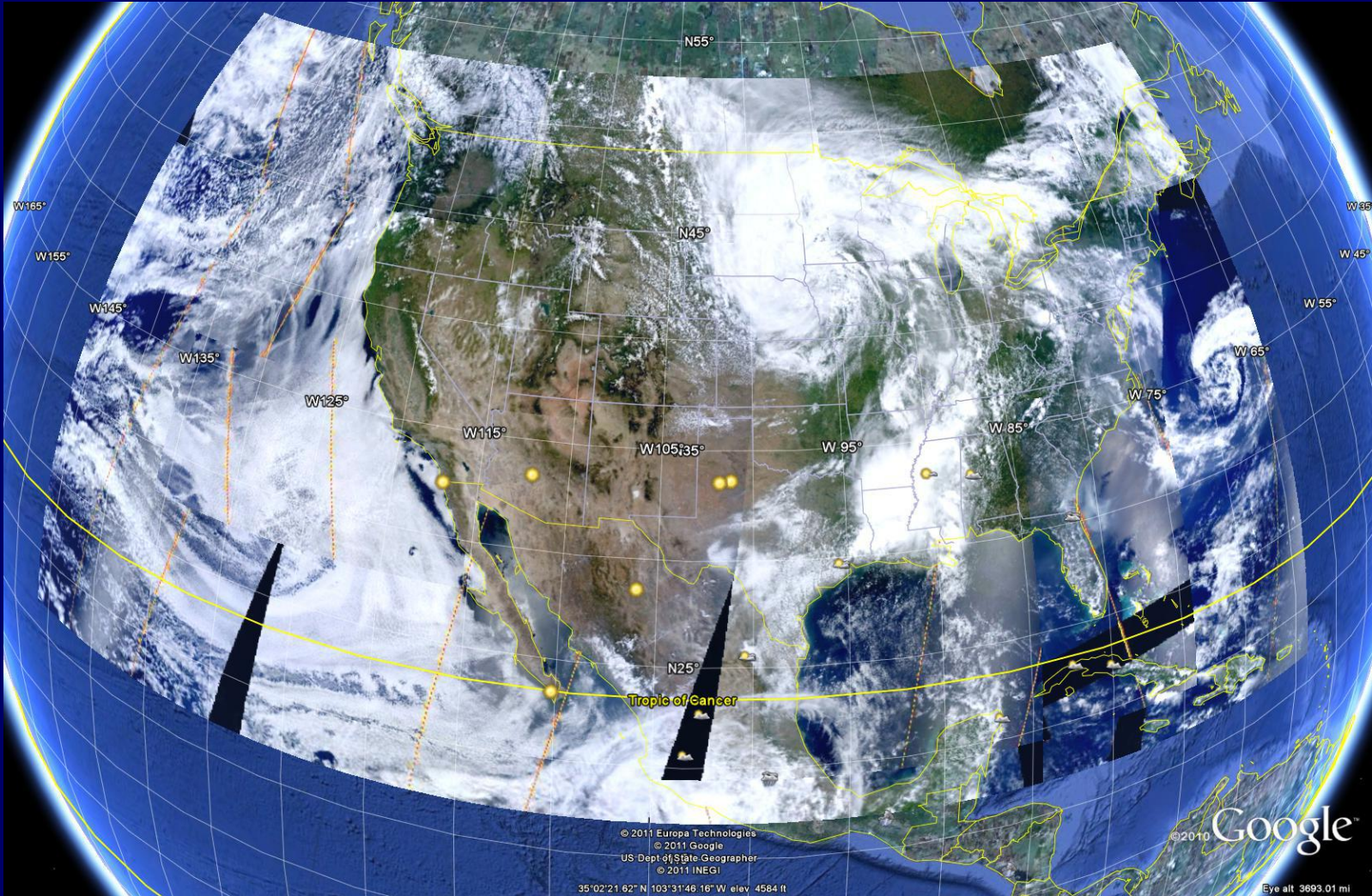
### NOGAPS 500 mb Winds







# Google Earth Views



VIIRS true color simulation using MODIS



# VIIRS Capabilities/Improvements Shown on NexSat

- ❖ Unprecedented Day/Night Band
- ❖ Improved resolution near edge of scan
- ❖ Wider swath
- ❖ Higher resolution Imager channels vs MODIS





# Sensor Channel Suite

## VIIRS & MODIS

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

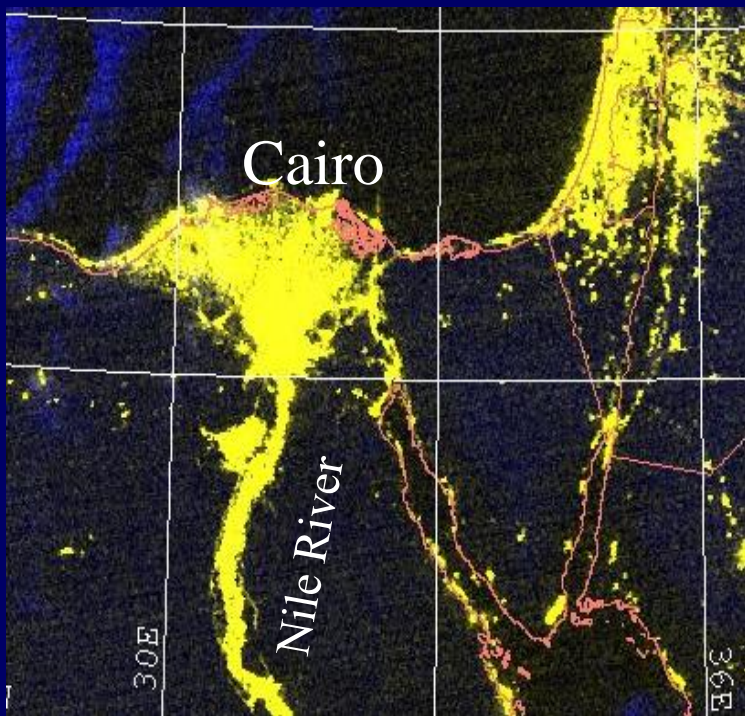
night visible

M: Moderate resolution band (0.74 km) "smooth"  
 I: Imaging band (0.37 km) "fine"  
 DNB: Day night band



# VIIRS DNB

## Viewing Cairo at night



DMSP OLS



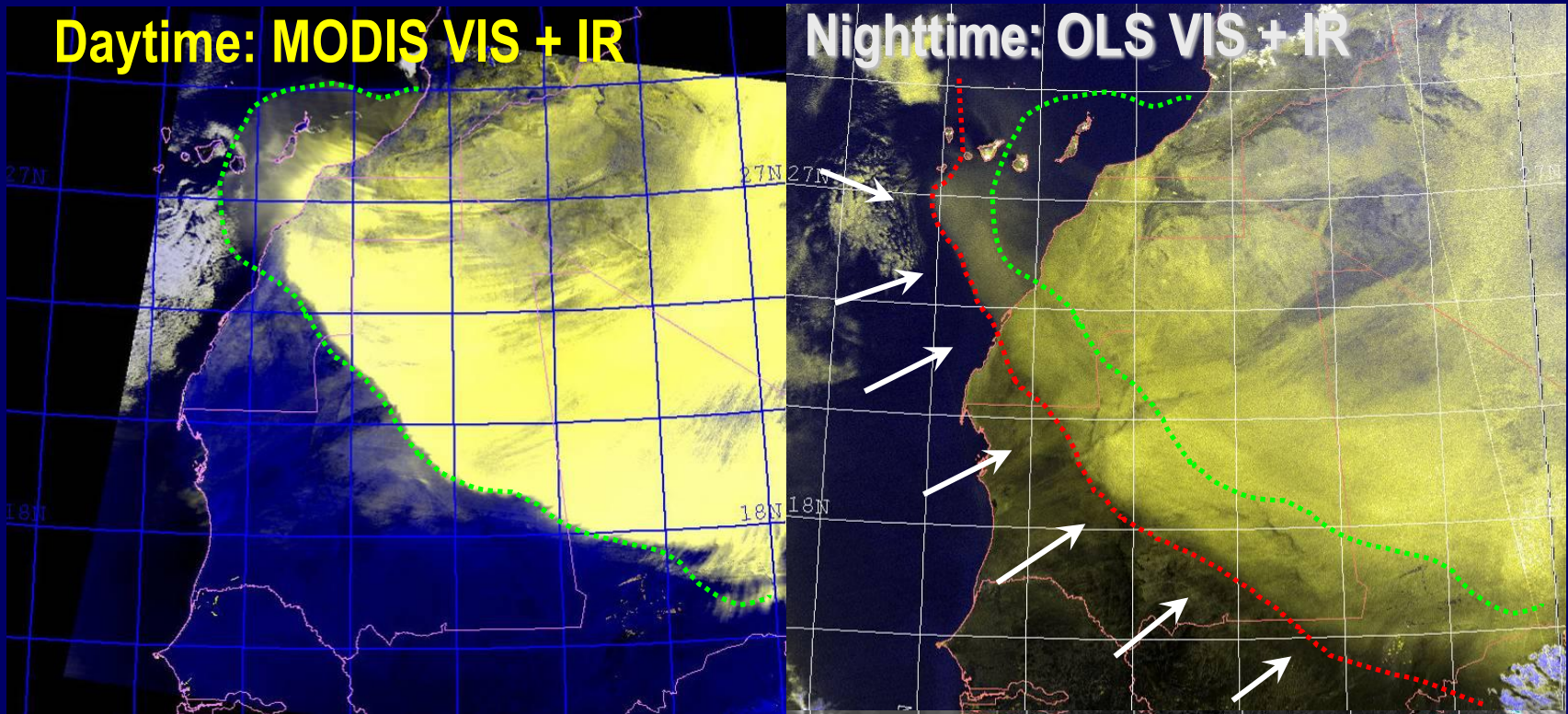
Simulated VIIRS  
NASA Space shuttle photo





# Recent NexSat Efforts

Demonstrating VIIRS DNB dust detection at night



3 March 2004, 1110 GMT

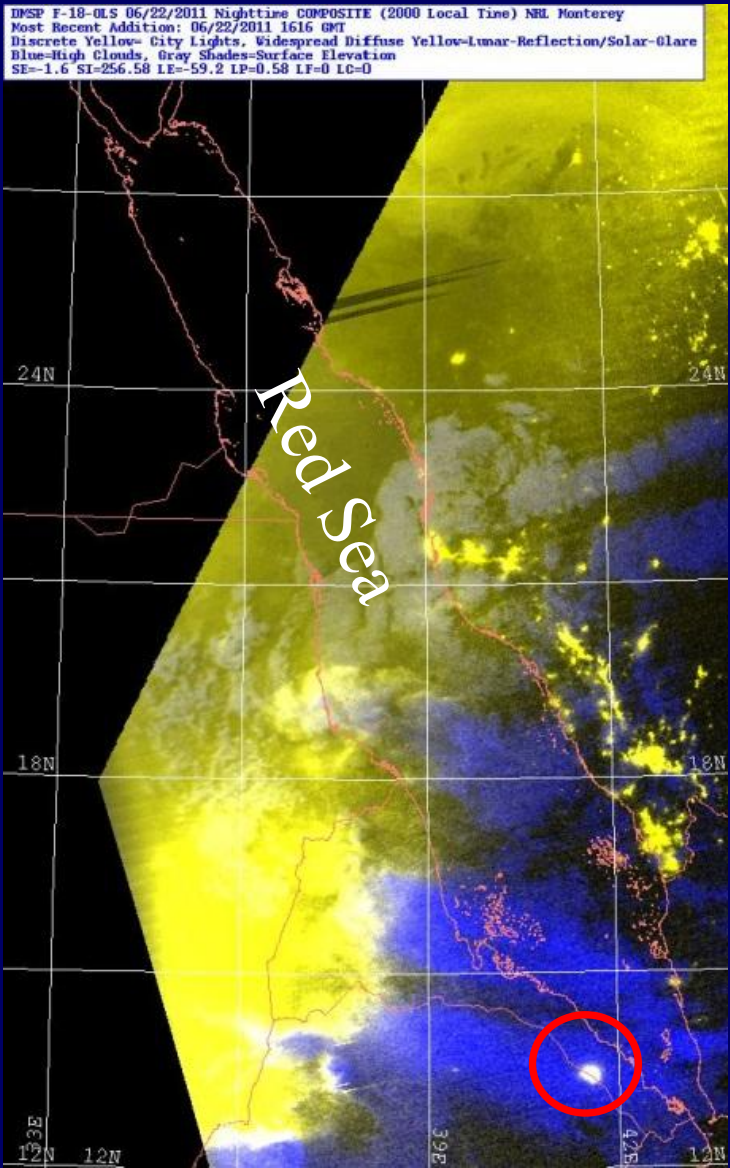
3 March 2004, 2017 GMT

→ Moonlight reflectance highlights dust plumes at night.



# Previewing VIIRS DNB

## Volcanic "glow" source at night



**Volcano  
Nabro**





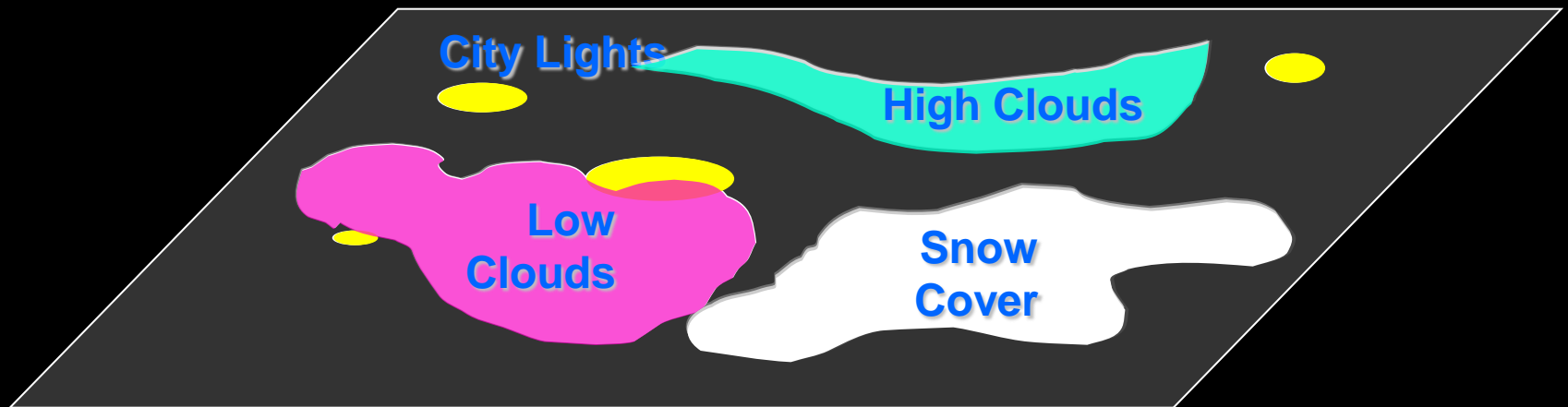
# Recent NexSat Efforts

## Snow Cover at Night



*Ambient Moonlight*

- Nighttime Visible Band Only (DMSP/OLS)
- Add **Stable Nighttime Lights Mask** (OLS)
- Add **High/Low** Cloud Detection (GOES)

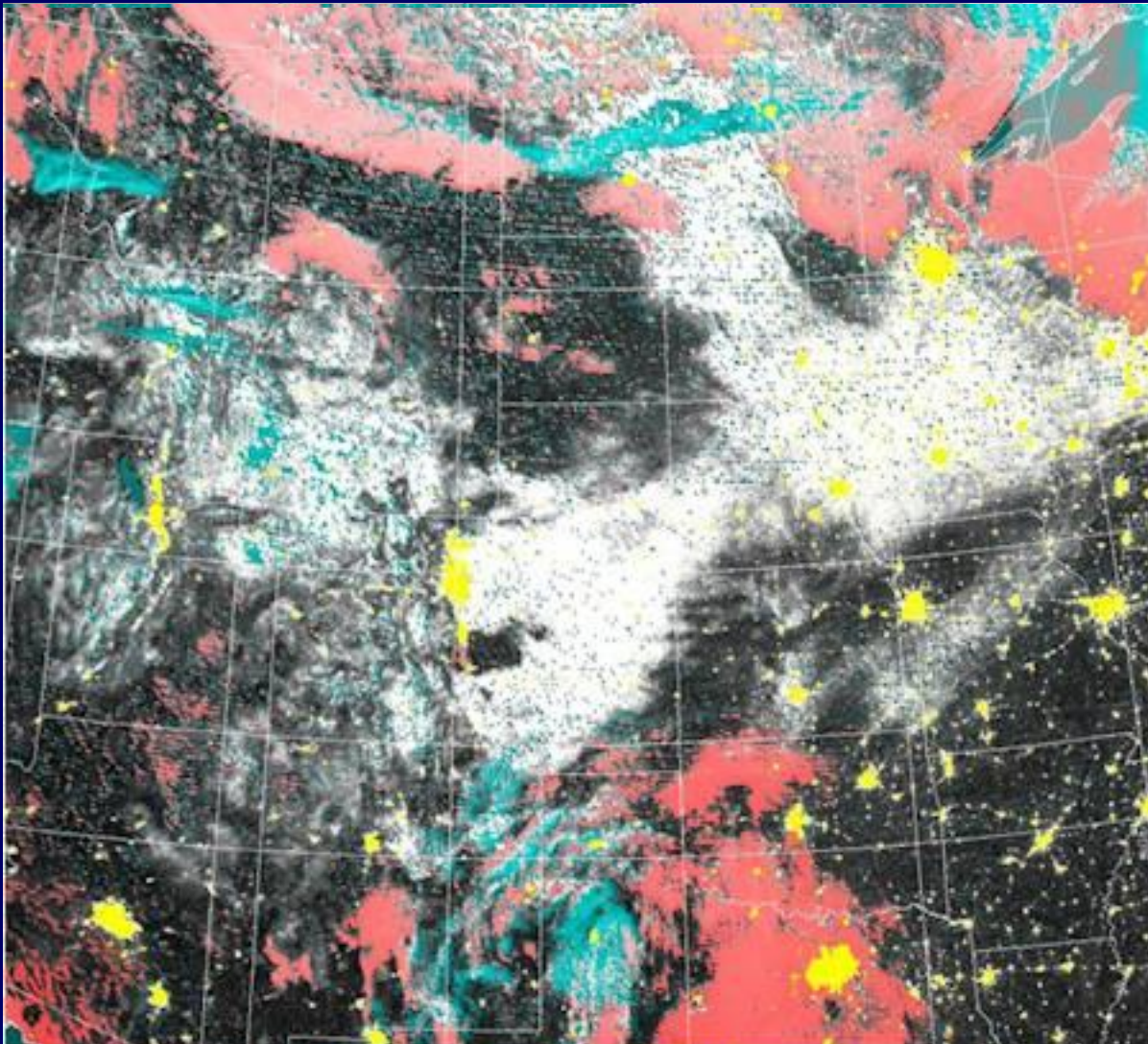


→ Combine LEO and time-matched GEO obs to provide augmented channel suite for improved discrimination.



# Recent NexSat Efforts

## Snow/cloud detection at night



Low  
Cloud

High  
Cloud

City  
Lights

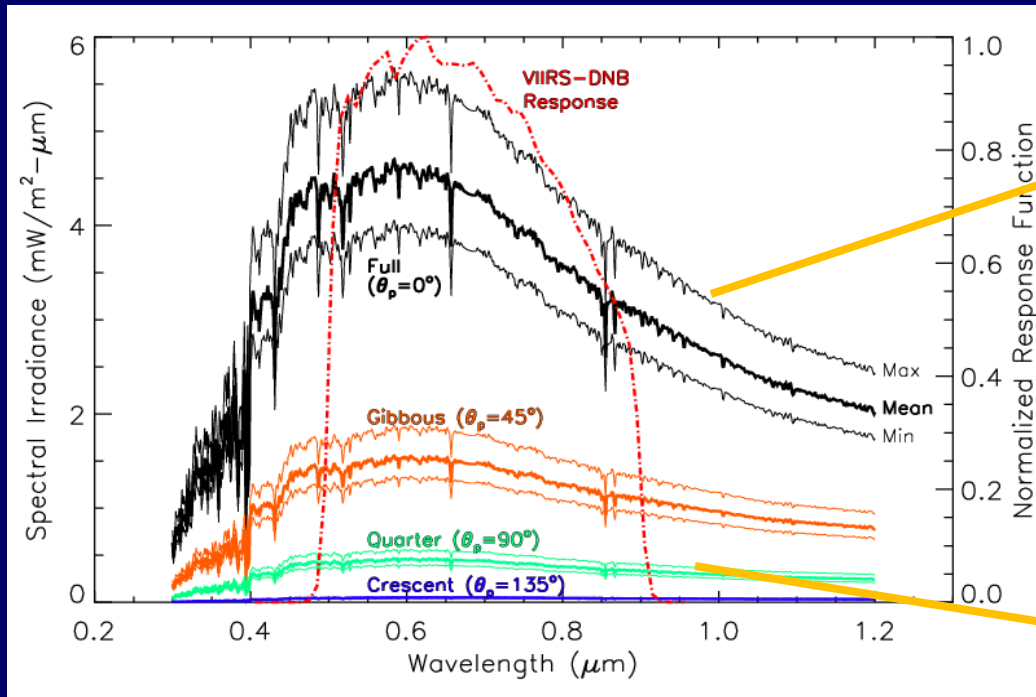
Snow  
Cover



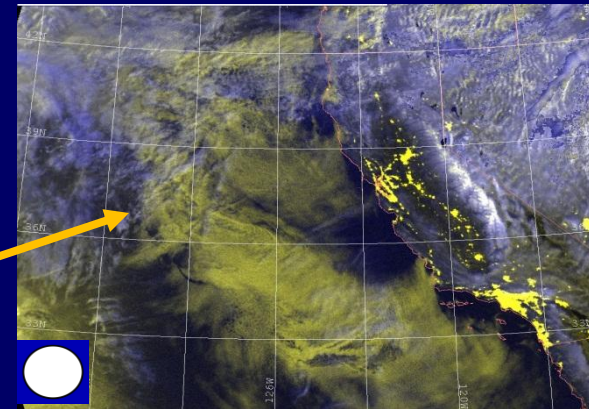


# Lunar Model

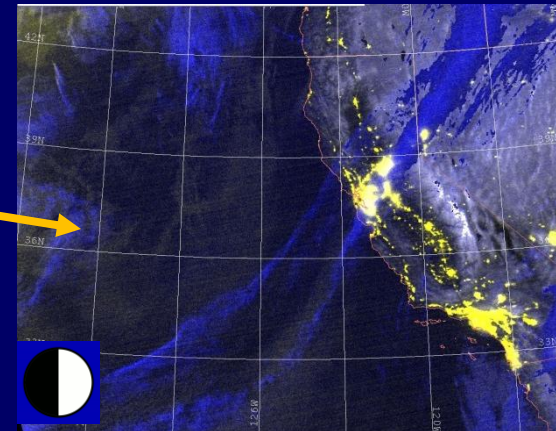
Key to a quantitative approach



Assess and Improve our ability to detect and quantify clouds at very low lunar illumination.



Full



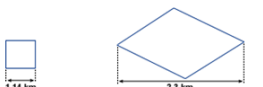
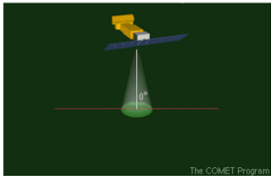
1<sup>st</sup> Quarter (Half Full)



# Improvements with VIIRS

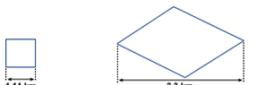
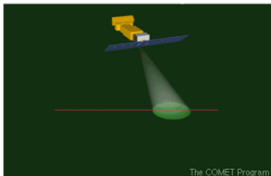
## Spatial resolution and sampling

AVHRR Footprint & MODIS



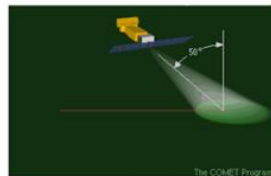
1.14 km Nadir 2.3 km 750 km 6.7 km 1500 km ©The COMET Program

AVHRR Footprint



1.14 km Nadir 2.3 km 750 km 6.7 km 1500 km ©The COMET Program

AVHRR Footprint



1.14 km Nadir 2.3 km 750 km 6.7 km 1500 km ©The COMET Program

VIIRS Footprint



VIIRS Day/Night Channel Footprint



Nadir 750 km 1500 km ©The COMET Program

*maintains shape and resolution*

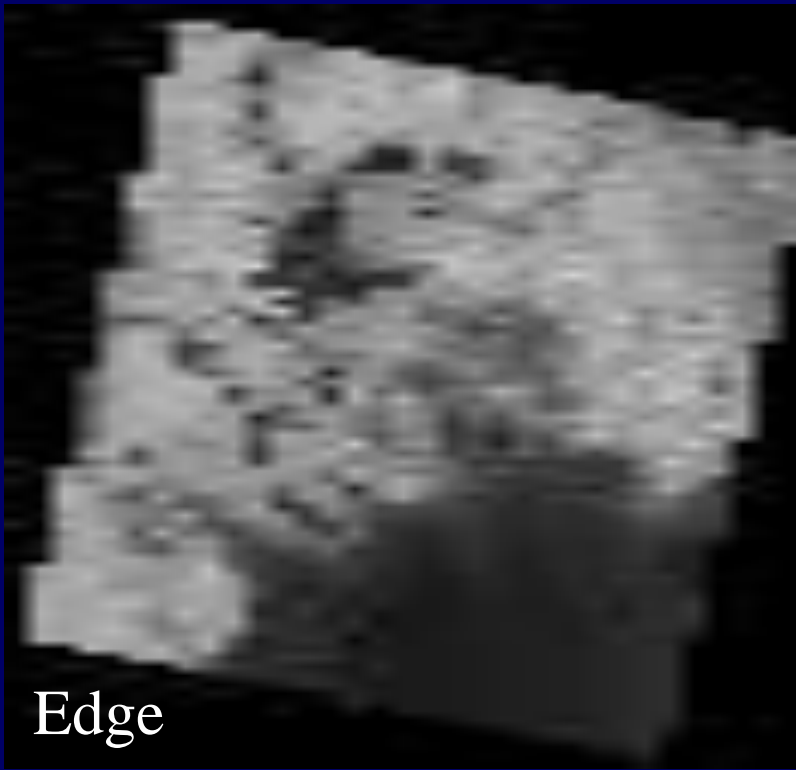




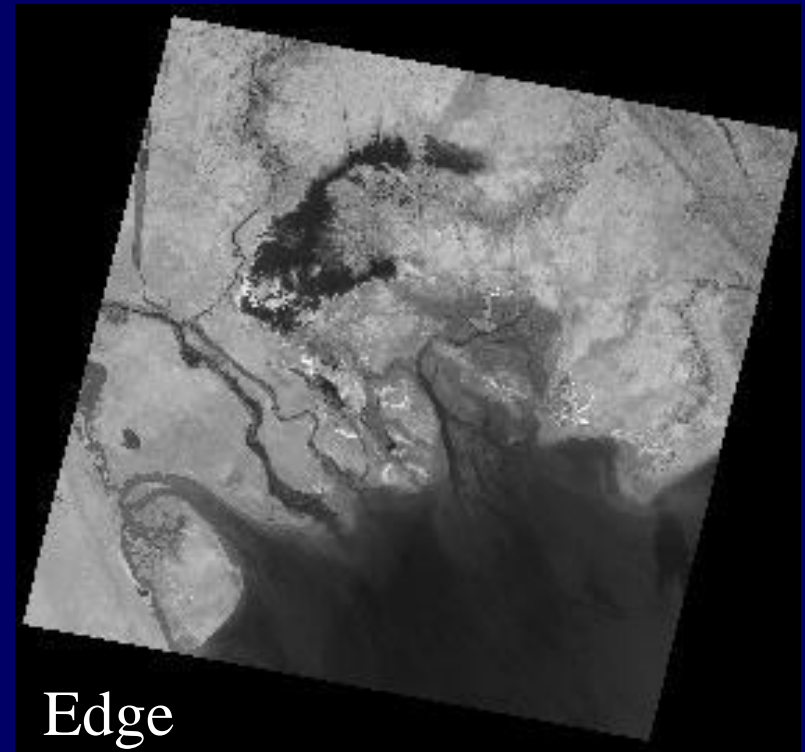
# Improvements with VIIRS

## Edge of scan sensing

AVHRR VISIBLE  
SIMULATION



VIIRS VISIBLE SIMULATION  
Imager Band (Visible)

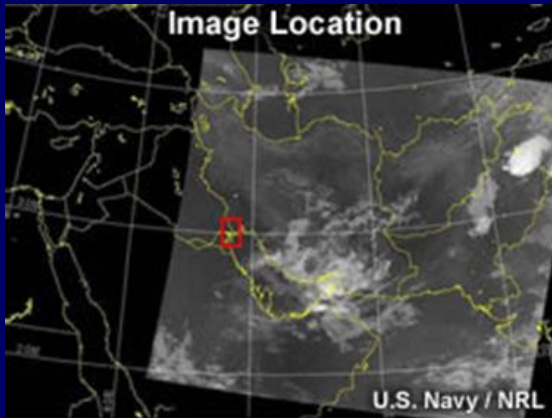




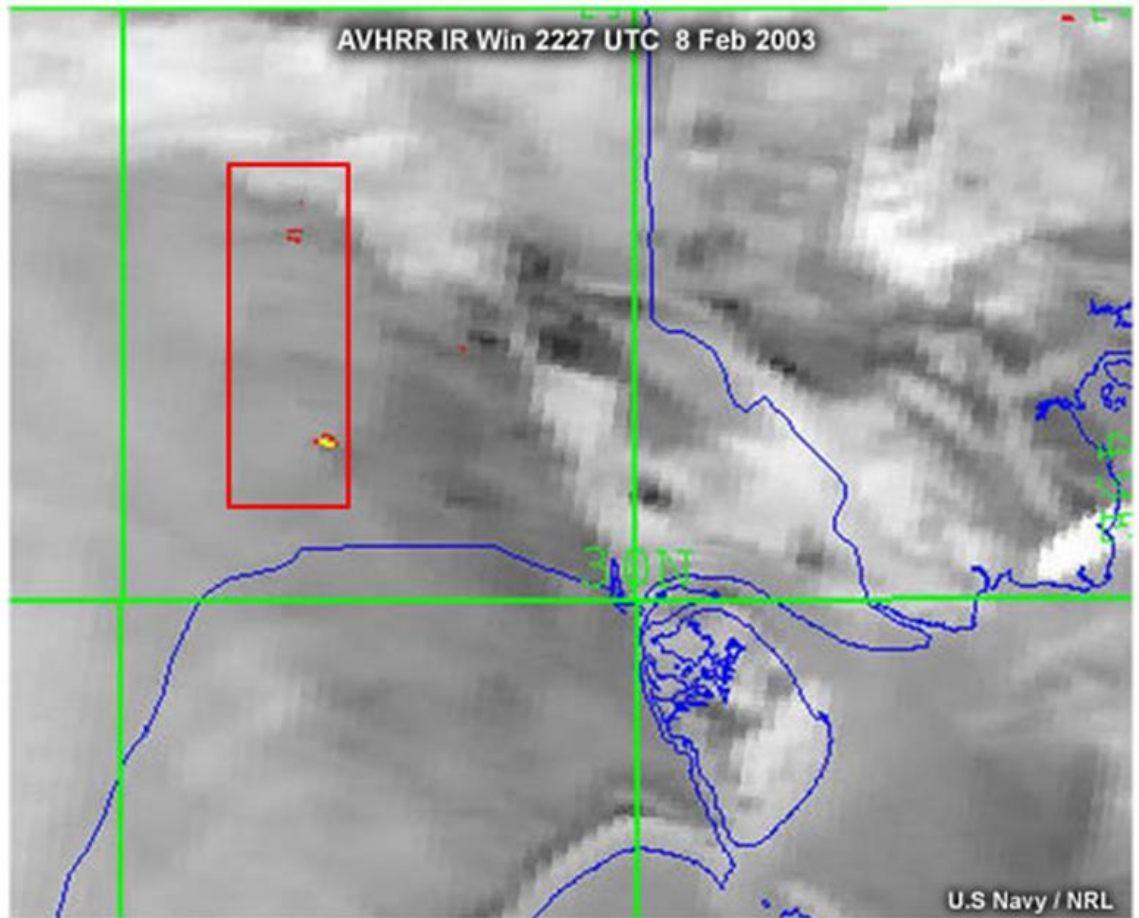
# Previewing VIIRS

## Improved fire detection

oil refineries



Edge of Scan

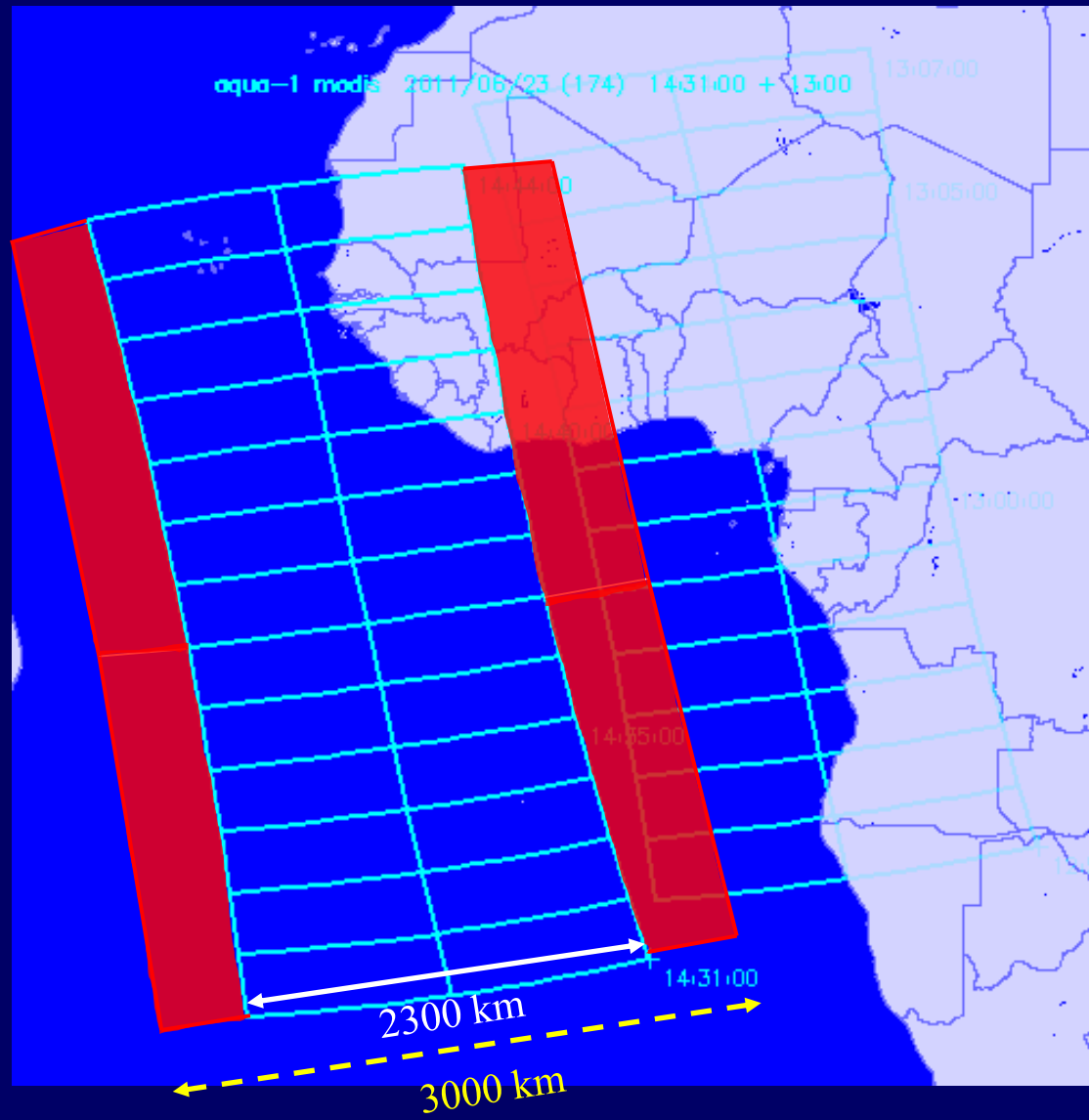






# Increased Swath Coverage

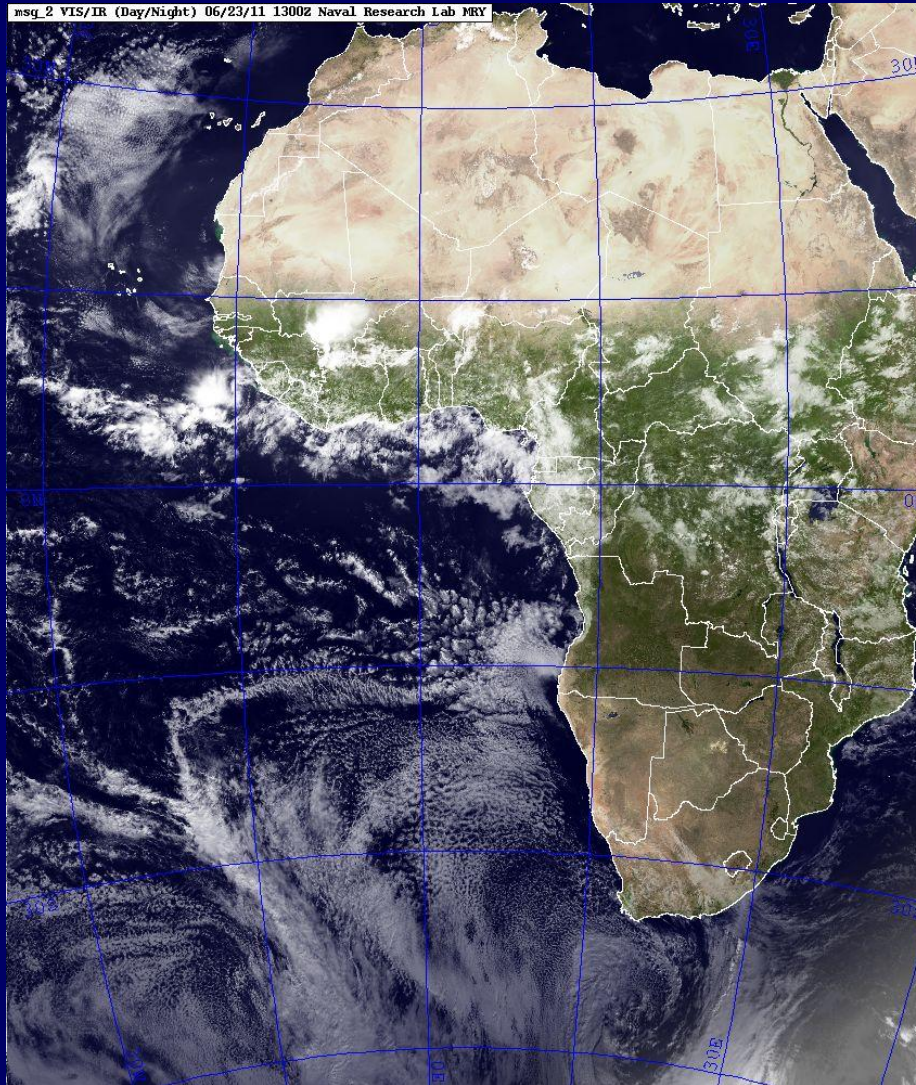
## MODIS 2300 km vs VIIRS 3000 km





# Increased Swath Coverage

## MODIS 2300 km vs VIIRS 3000 km



MSG  
simulation

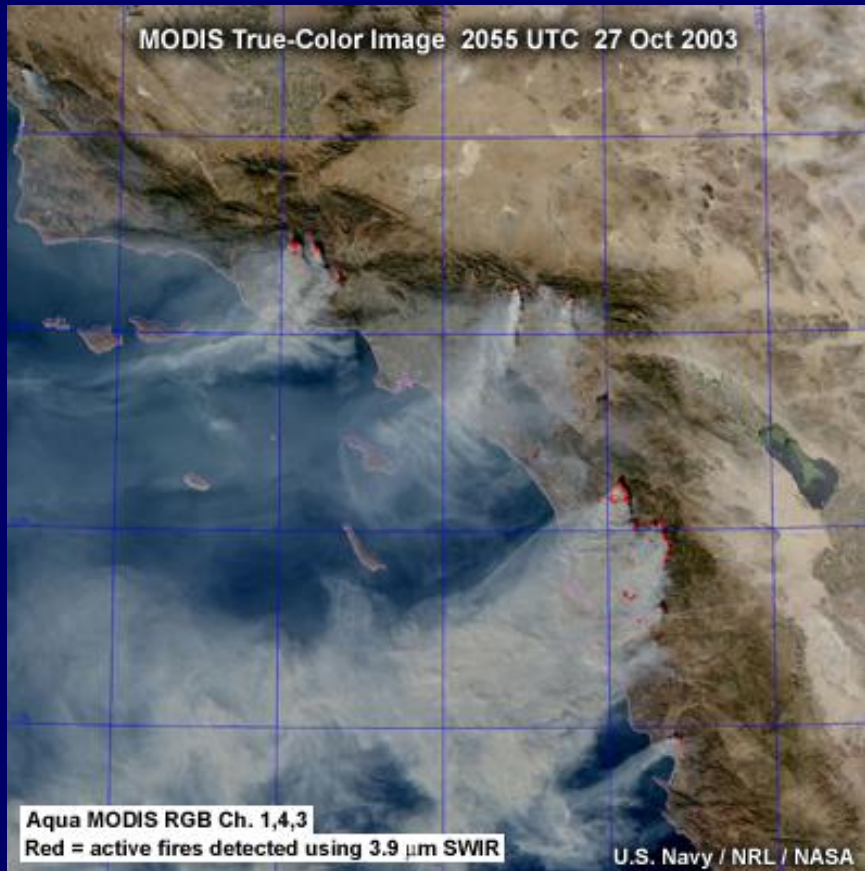
*no more gaps between adjacent granules*



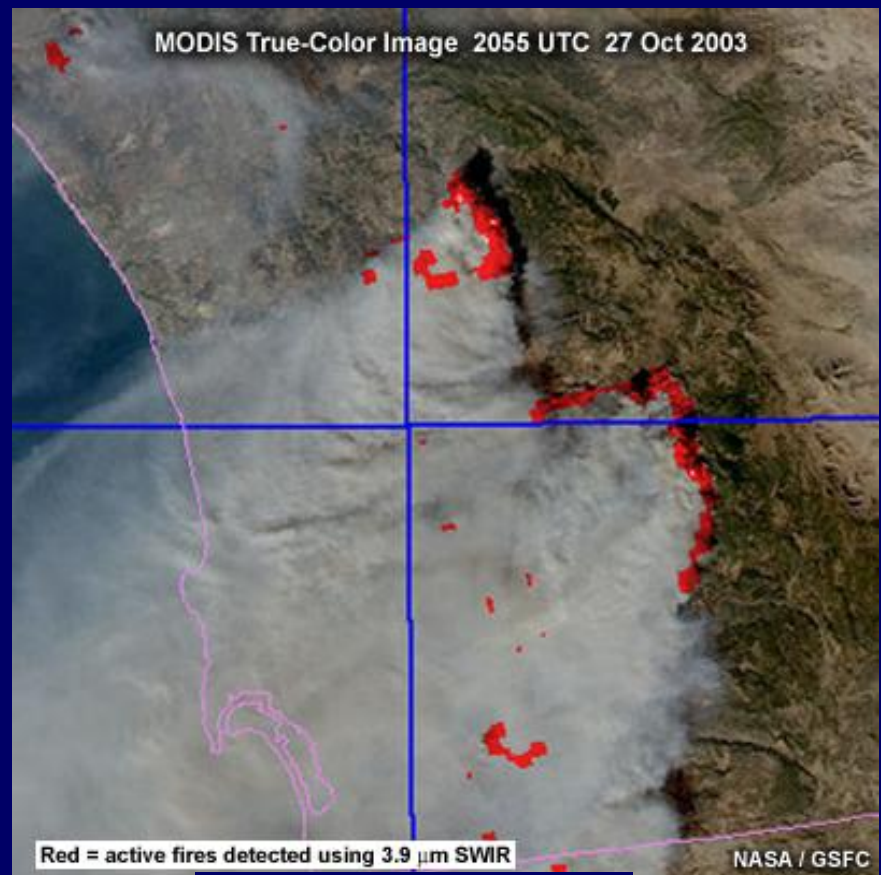


# Multi-spectral Improvements

## Greater detail



MODIS true color



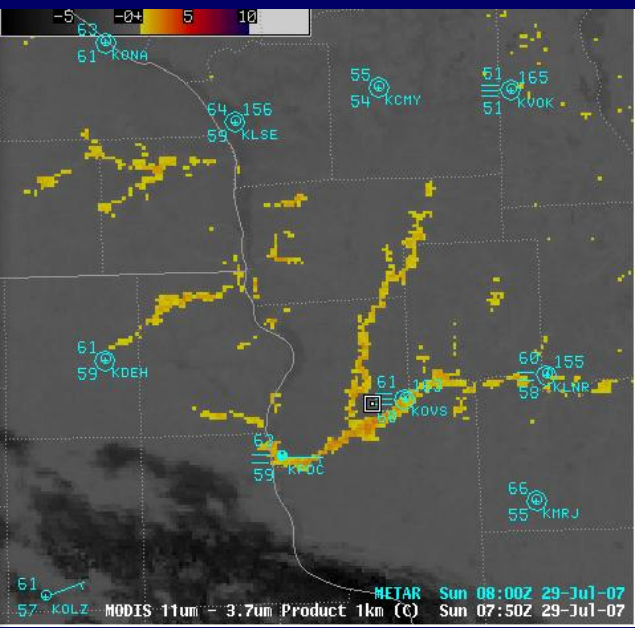
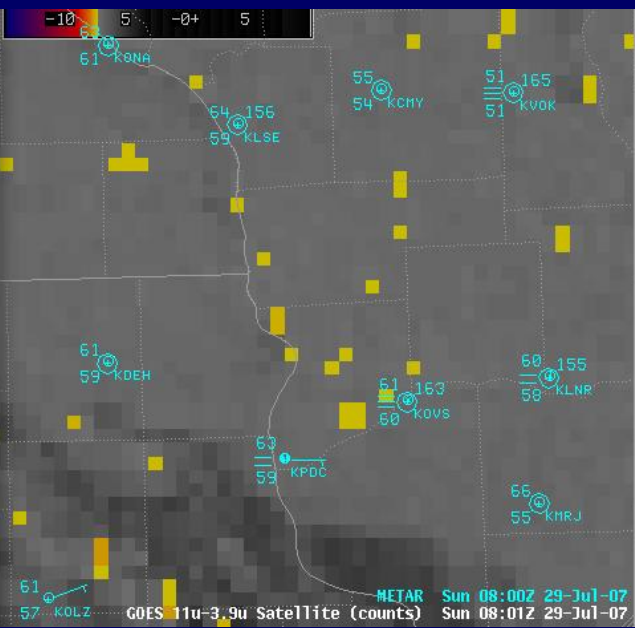
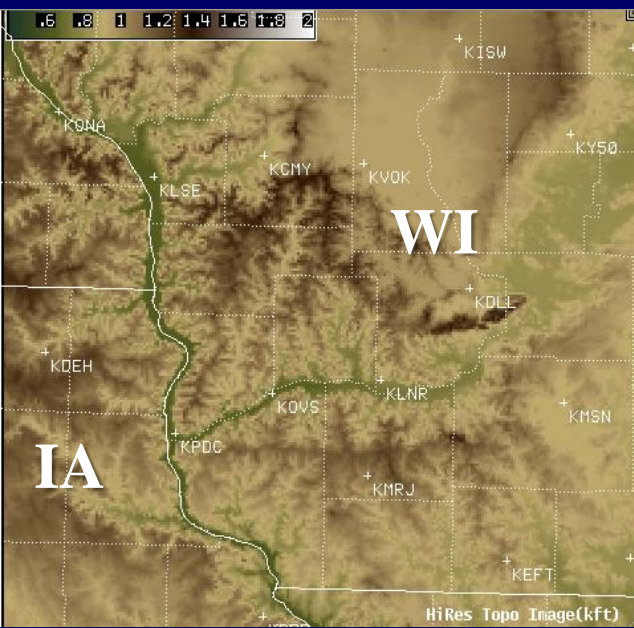
MODIS true color  
fine res.



# Improvements in IR Sensing Low clouds/Fog

### GOES 4 km IR

### MODIS 1 km IR



*courtesy: Bachmeier/CIMSS*

**VIIRS 0.37 km  
Imager channels**

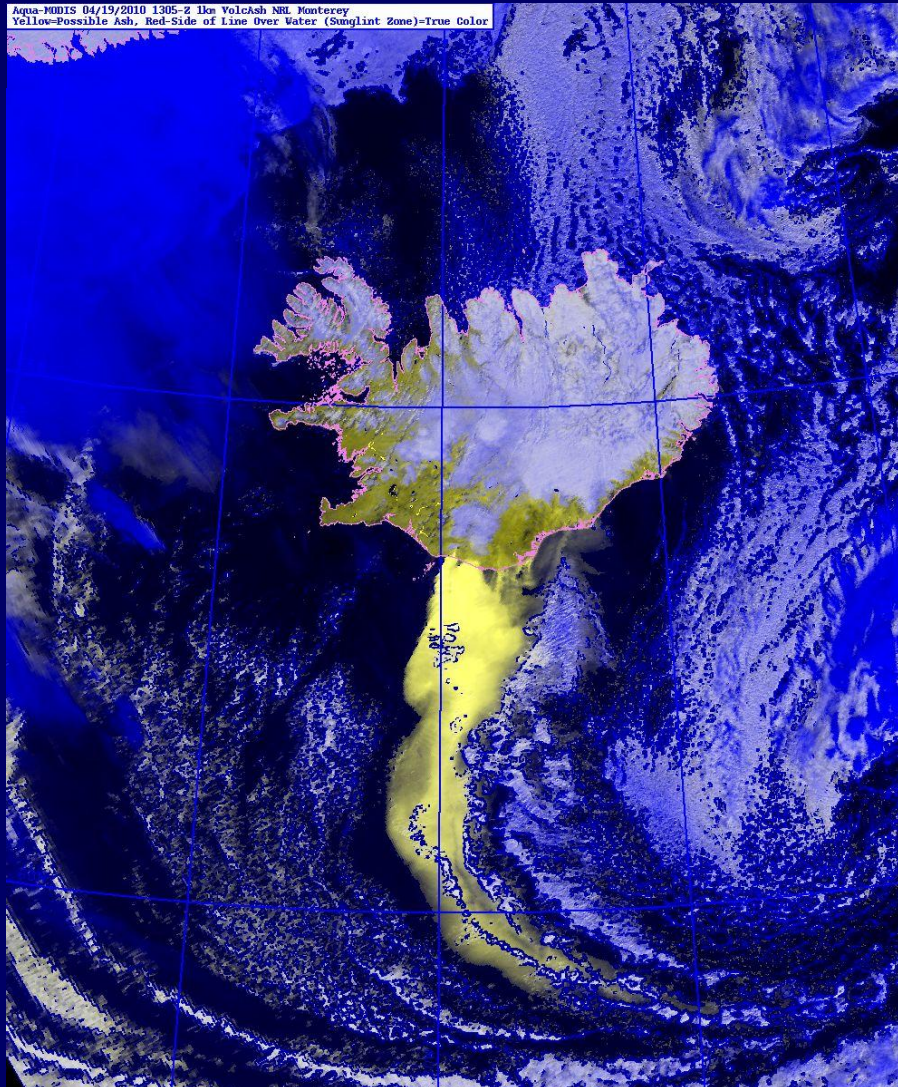




# Volcano Monitoring

## Eyjafjallajökull

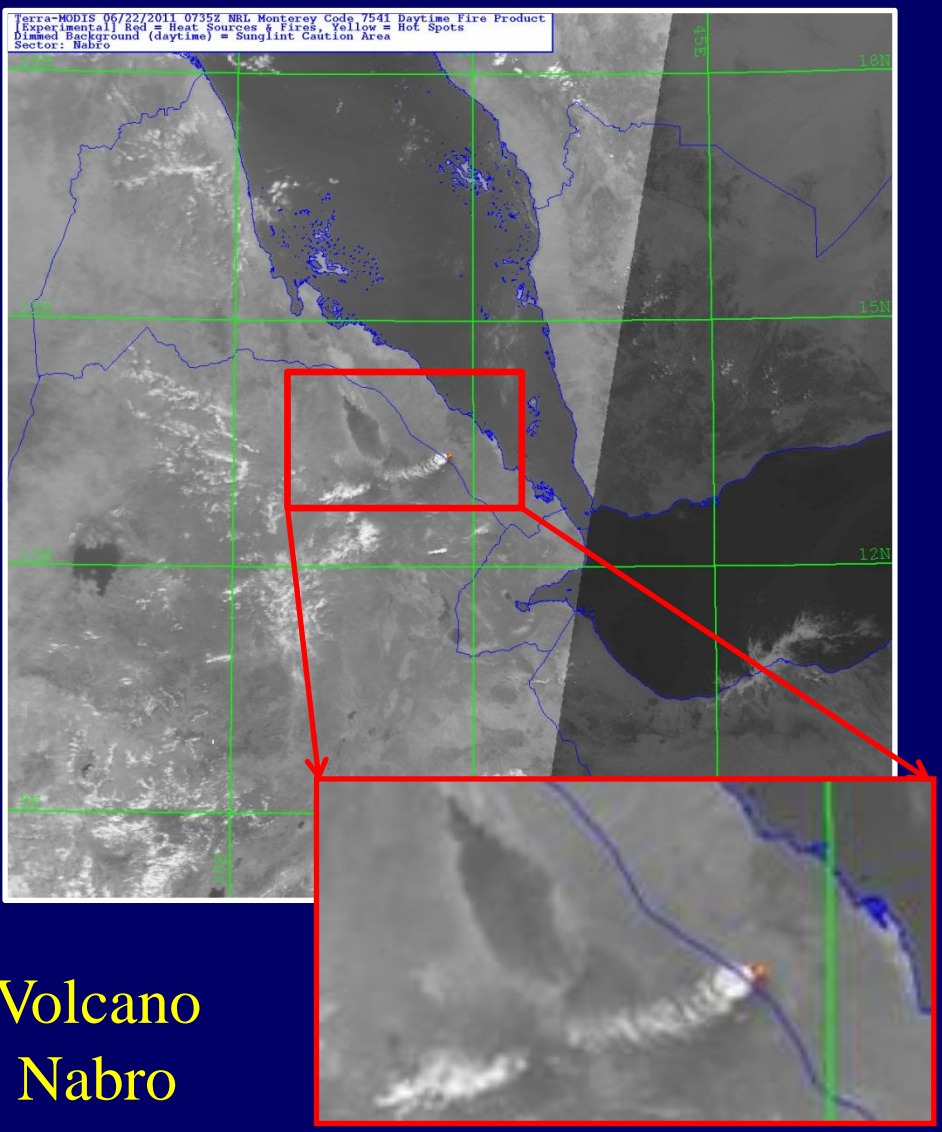
volcanic ash



April 19, 2010



# Volcano Monitoring Hotspots during the day

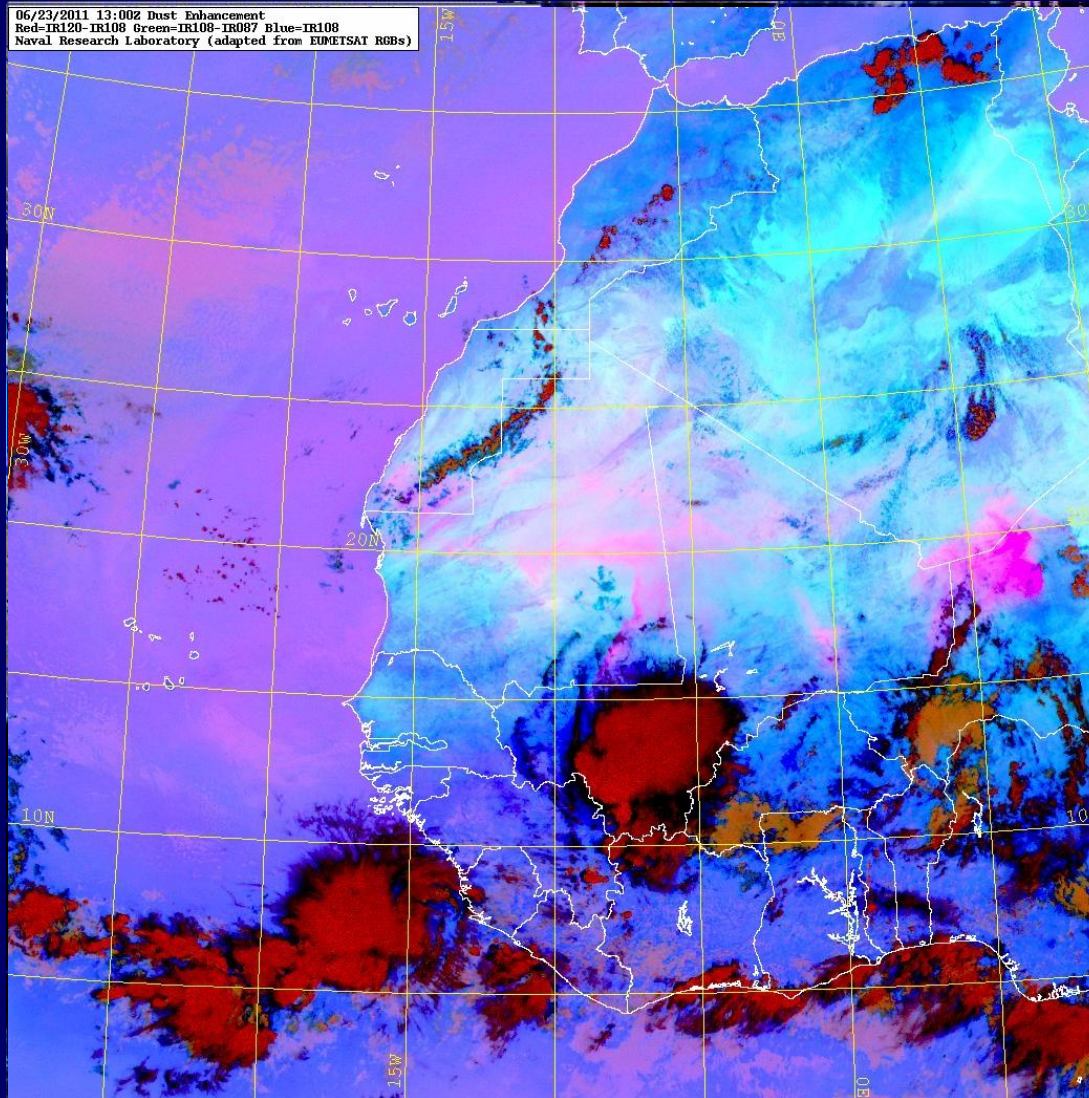


Volcano  
Nabro





# Saharan Dust







# NexSat on-line product training

## NexSat

Preparing Users for the NPOESS / VIIRS Era

Produced by the COMET® Program  
Part of the NPOESS Education & Training Series

Begin

Download Version

MetEd Home

COMET Home

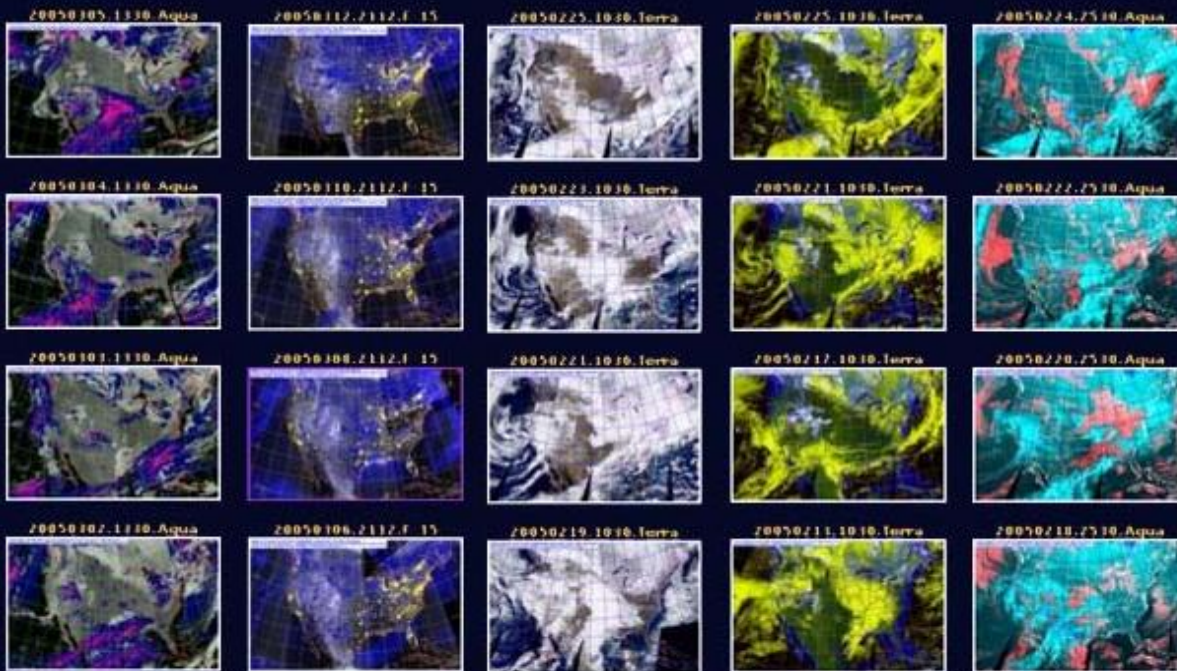
NPOESS Userport

Contributors

Links

Tech Notes

User Survey



U.S. Navy / NRL

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*NRL – COMET collaboration*





# Summary

## NexSat hosting VIIRS

[www.nrlmry.navy.mil/NEXSAT.html](http://www.nrlmry.navy.mil/NEXSAT.html)

- **Demonstrate first products from VIIRS after launch**
  - educate scientists and public
- **Provide comparisons between VIIRS vs heritage sensors**
- **Provide training and web links for further information**



# Extra Slides

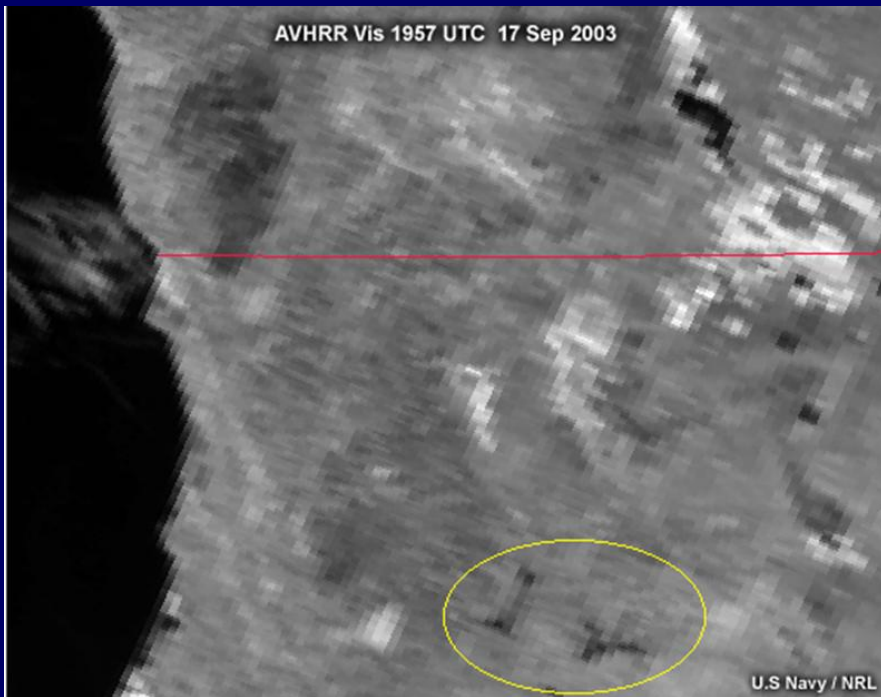




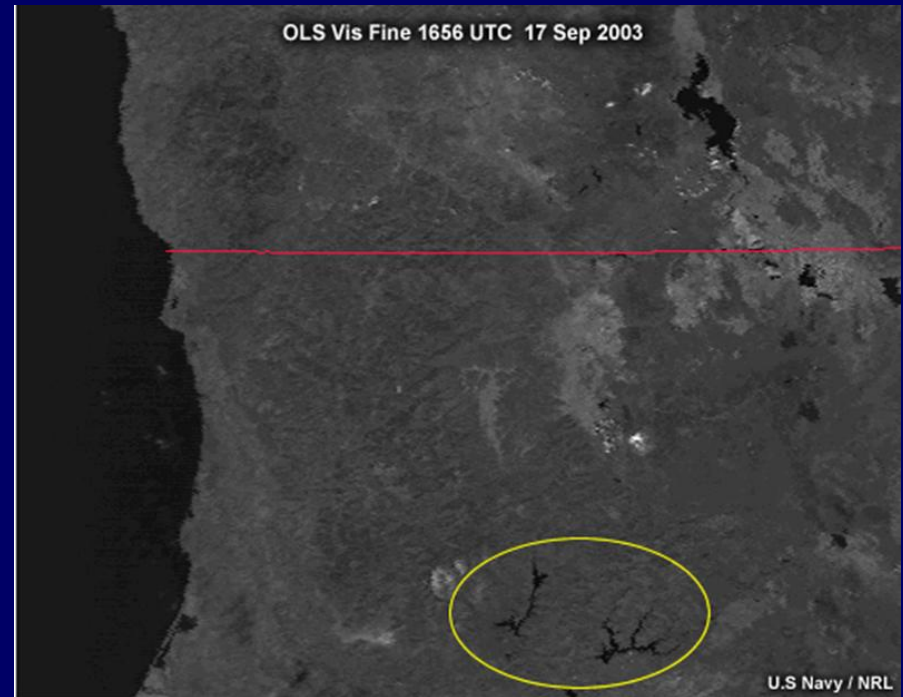


# Improvements with VIIRS

edge of scan sensing



AVHRR visible



VIIRS simulation (OLS)

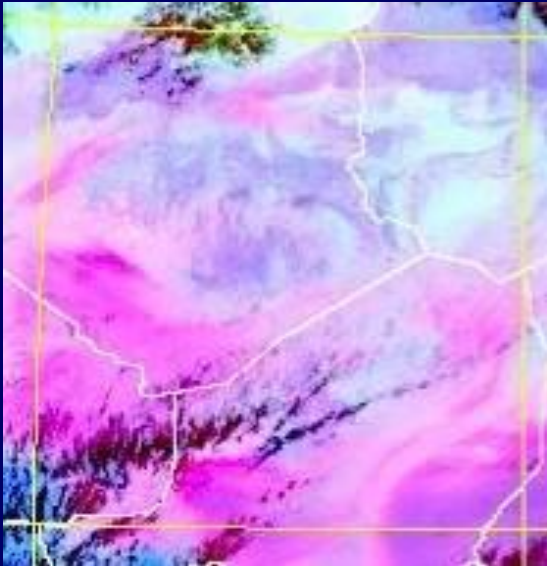


# Recent NexSat Efforts

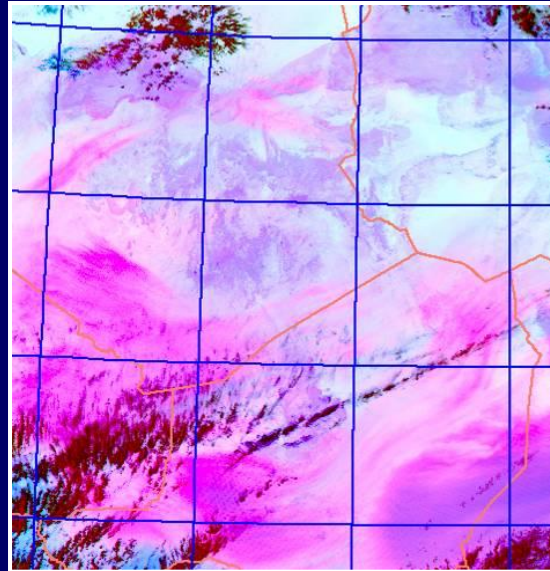
## Day and night dust monitoring

### EUMETSAT-MSG and NRL-MODIS RGB dust algorithms

20100318 - 13:30 GMT  
Northern Africa



MSG 3 km  
(hourly)



MODIS 1 km  
~4 times daily

better detail  
spatially  
radiometrically  
result: better for  
quantifying products  
across image

VIIRS 0.74 km  
~2 times daily





# Previewing VIIRS

## Improved product quantification

