Week – 2 – April 08, 2015

Visible Satellite Imagery

Spring 2015

ARSET - AQ

Applied Remote Sensing Education and Training – Air Quality

A project of NASA Applied Sciences

Today's Speakers

Pawan Gupta

Research Scientist

NASA Goddard Space Flight Center/USRA

Email: pawan.gupta@nasa.gov

Guest Speak:

Adam Voiland
Science Writer, NASA's Earth Observatory

NASA Goddard Space Flight Center, USA

adam.p.voiland@nasa.gov

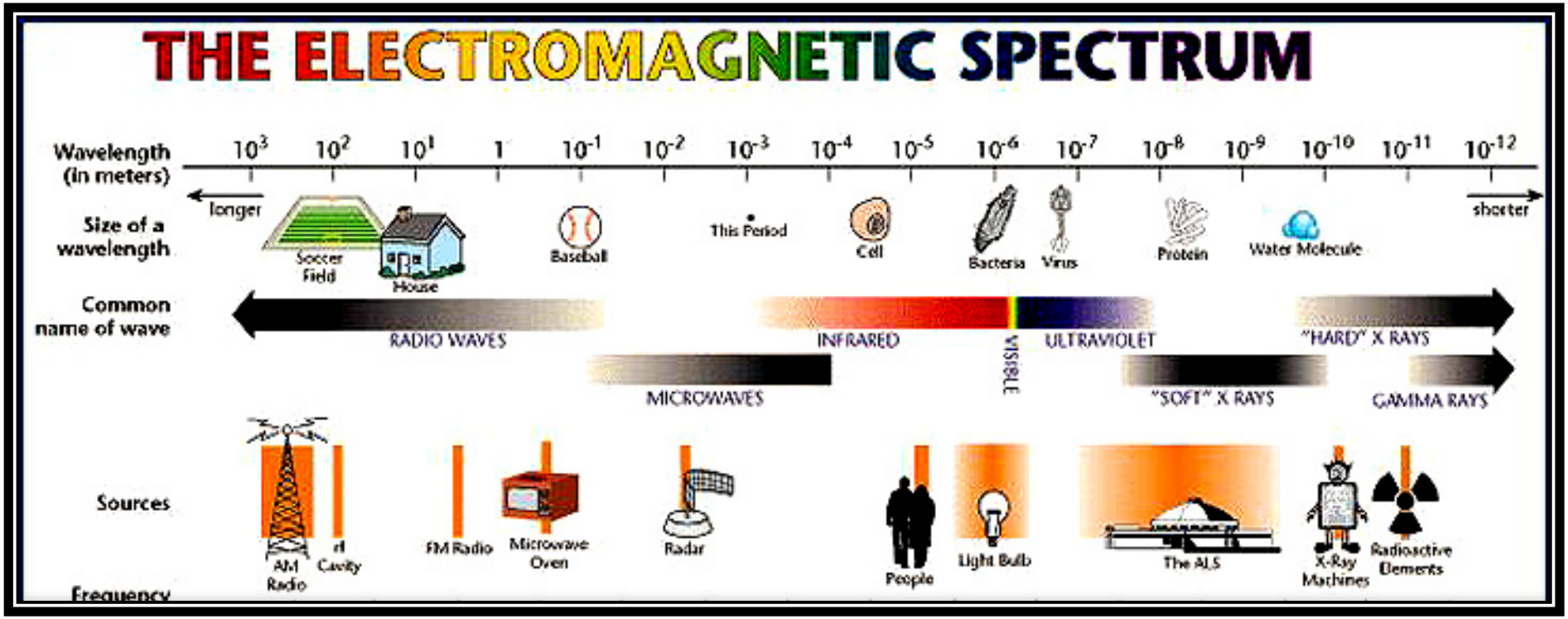
Session 2 – Outline

1. What are true and false color images?
2. What can we learn from images?
3. Near real time image visualization
4. A tour of useful image archives.

Visible Image Science

- Visible satellite images are essentially photographs taken from space.
- All of the energy collected by the visible sensors (cameras) on board the satellite is light energy from the sun reflected by the Earth.
- The reflectance is a measure of albedo, which is the percentage of light energy reflected by the earth.
- The higher the albedo the more light reflected back into space whereas the lower the albedo, the more light energy absorbed.

Wavelength Selection



Earth-observing satellite remote sensing instruments typically make observations at many discrete wavelengths or wavelength bands.

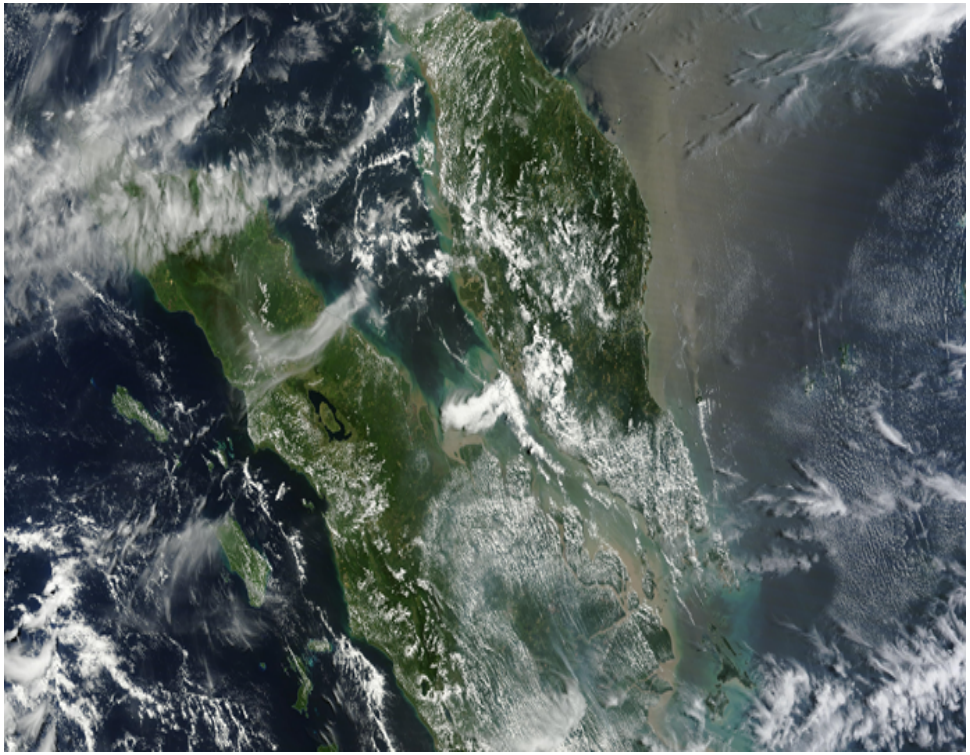
RGB Images

- Red, Green and Blue correspond to the three color receptors in the human eye.

- These 3 colors are also the basis for all color display technologies from LCD sub-pixels to television color “guns”.

RGB Images Cont…

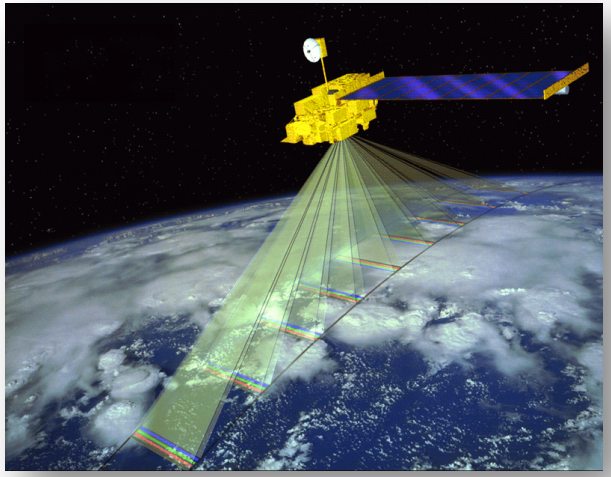
We can create an image by selecting any three bands and load them into the "Red" "Green" and "Blue" display channels.



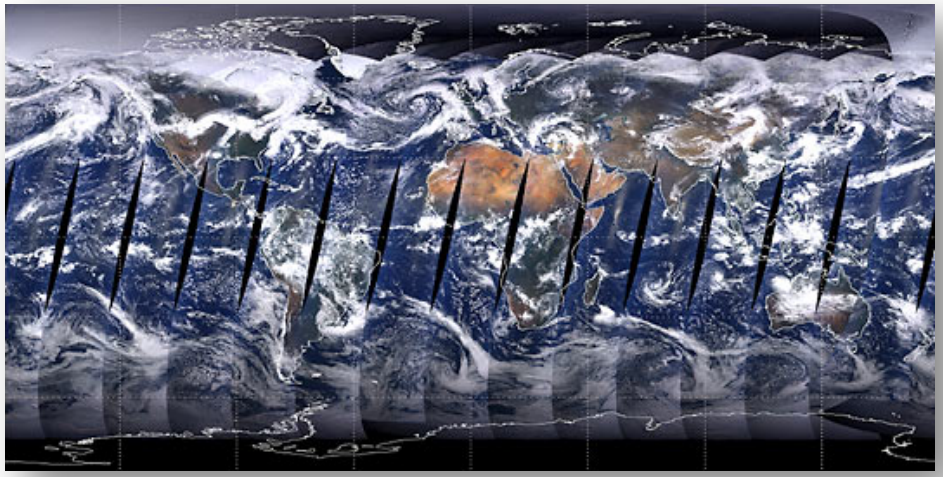
True Color Image

To simulate what the human eye sees we load the red, green and blue satellite bands into the corresponding display channels.

MODIS (Moderate Resolution Imaging Spectroradiometer)



- Spatial Resolution
  - 250m, 500m, 1km
- Temporal Resolution
  - Daily, 8-day, 16-day, monthly, quarterly, yearly
  - 2000-present
- Data Format
  - Hierarchal data format – Earth Observing System Format (HDF-EOS)



- Spectral Coverage
  - 36 bands (major bands include Red, Blue, IR, NIR, MIR)
    - Bands 1-2: 250m
    - Bands 3-7: 500m
    - Bands 8-36: 1000m

MODIS Reflected Solar Bands

250 M

500 M

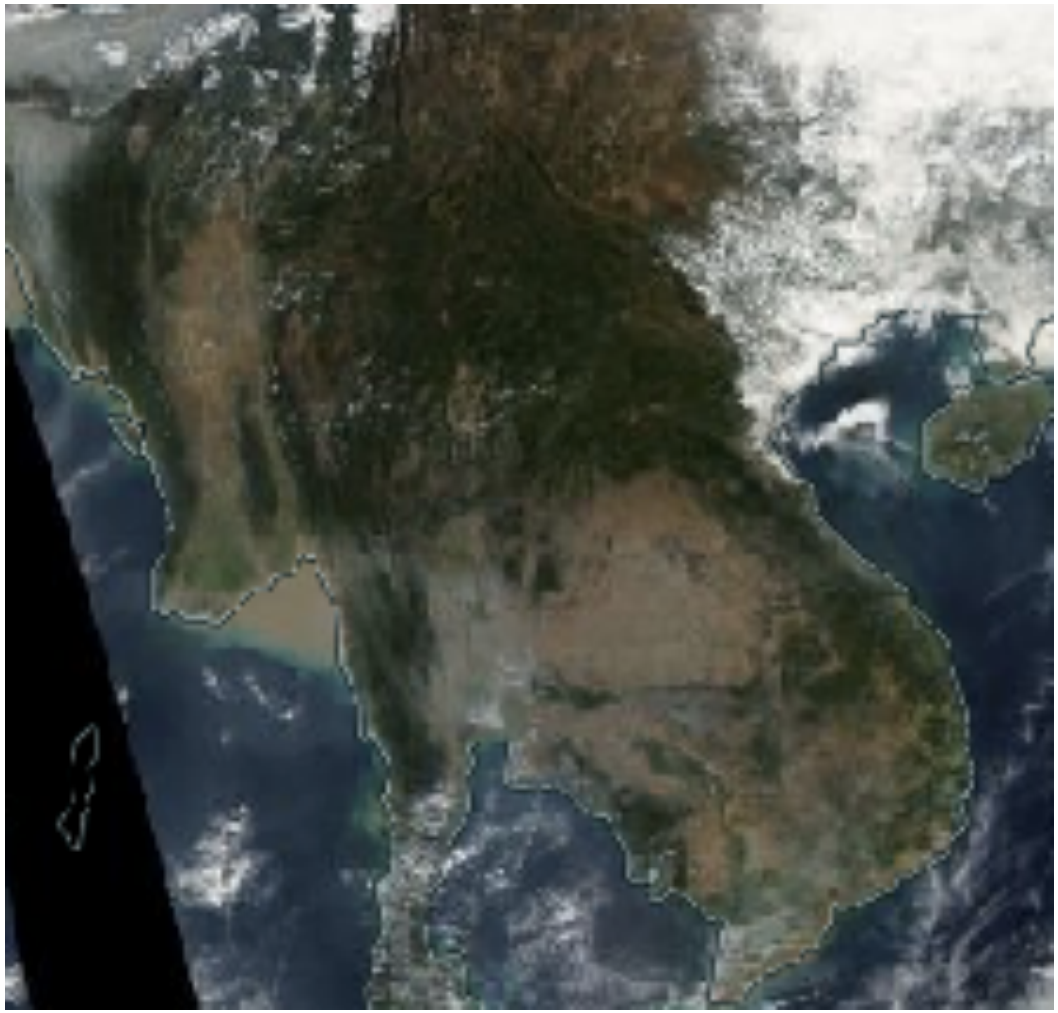
Primary Use	Band No.	Bandwidth (nm)
Land/Cloud Boundaries	1**	620-670
	2**	841-876
Land/Cloud Properties	3*	459-479
	4*	545-565
	5*	1230-1250
	6*	1628-1652
	7*	2105-2155
Ocean Color/ Phytoplankton/ Biogeochemistry	8	405-420
	9	438-448
	10	483-493
	11	526-536
	12	546-556
	13	662-672
	14	673-683
	15	743-753
	16	862-877
Atmospheric Water Vapor	17	890-920
	18	931-941
	19	915-965

* 500m Spatial Resolution
** 250m Spatial Resolution

MODIS Thermal Bands

Primary Use	Band	Bandwidth (μm)
Surface/Cloud Temperature	20	3.660-3.840
	21	3.929-3.989
	22	3.929-3.989
	23	4.020-4.080
Atmospheric Temperature	24	4.433-4.498
	25	4.482-4.549
Cirrus Clouds Water Vapor	26	1.360-1.390
	27	6.535-6.895
	28	7.175-7.475
	29	8.400-8.700
Ozone	30	9.580-9.880
Surface/Cloud Temperature	31	10.780-11.280
	32	11.770-12.270
Cloud Top Altitude	33	13.185-13.485
	34	13.485-13.785
	35	13.785-14.085
	36	14.085-14.385

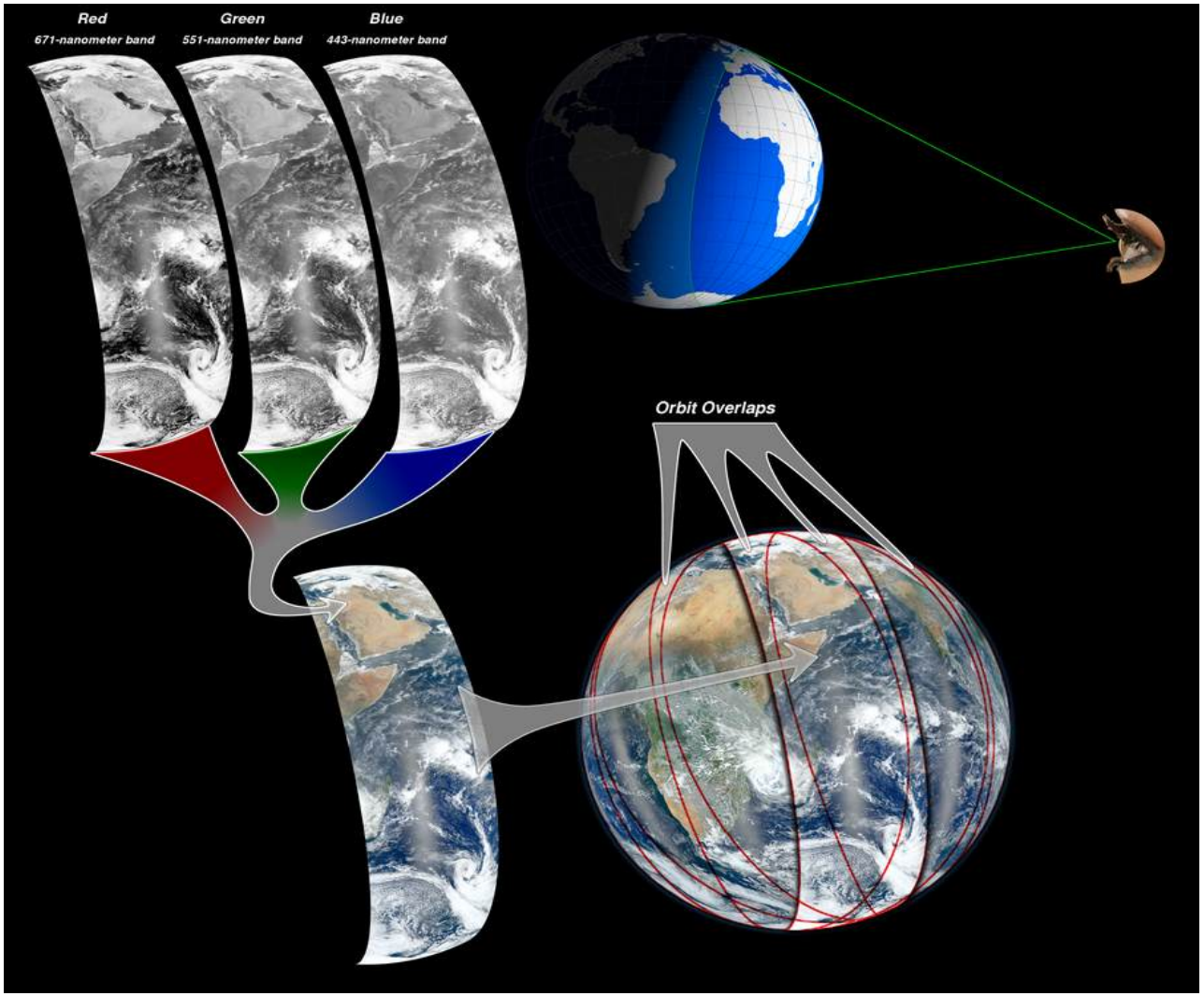
MODIS True Color Image



A MODIS "True Color Image" will use MODIS visible wavelength bands 1-4-3

R = 0.66 μm
G = 0.55 μm
B = 0.47 μm

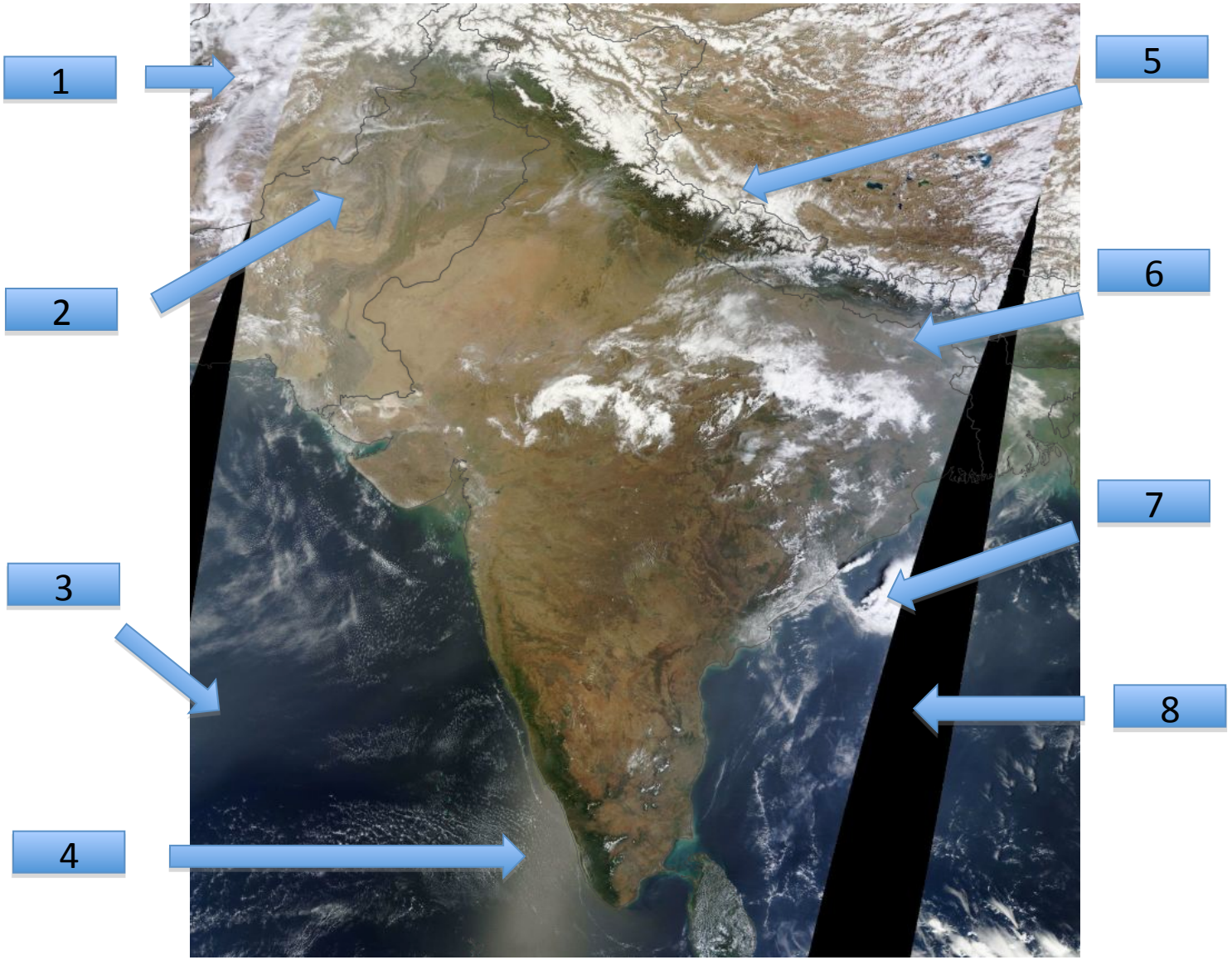
True Color Image from VIIRS



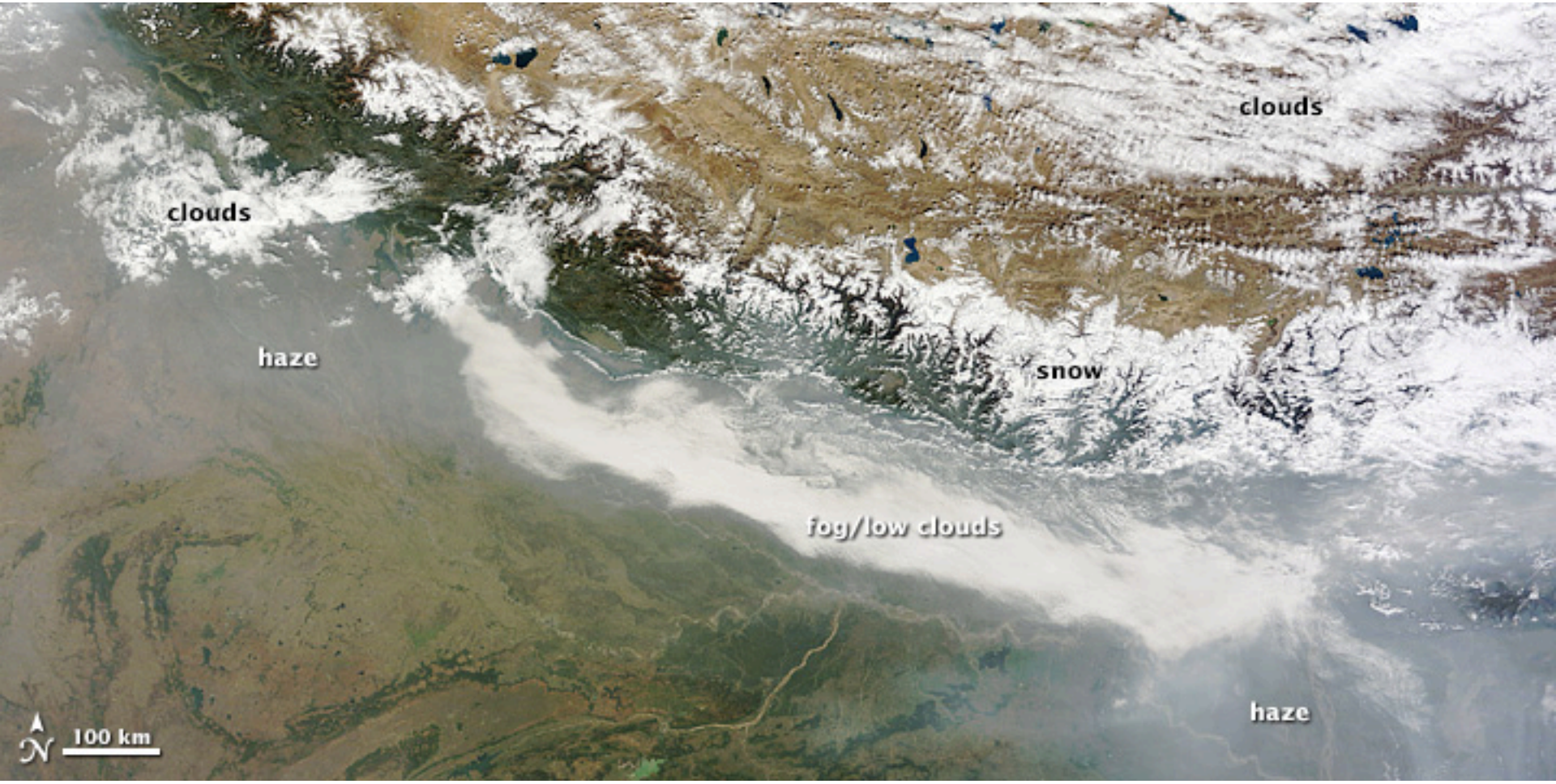
VIIRS also provides MODIS like true color images over global regions

What can we learn from true color imagery?

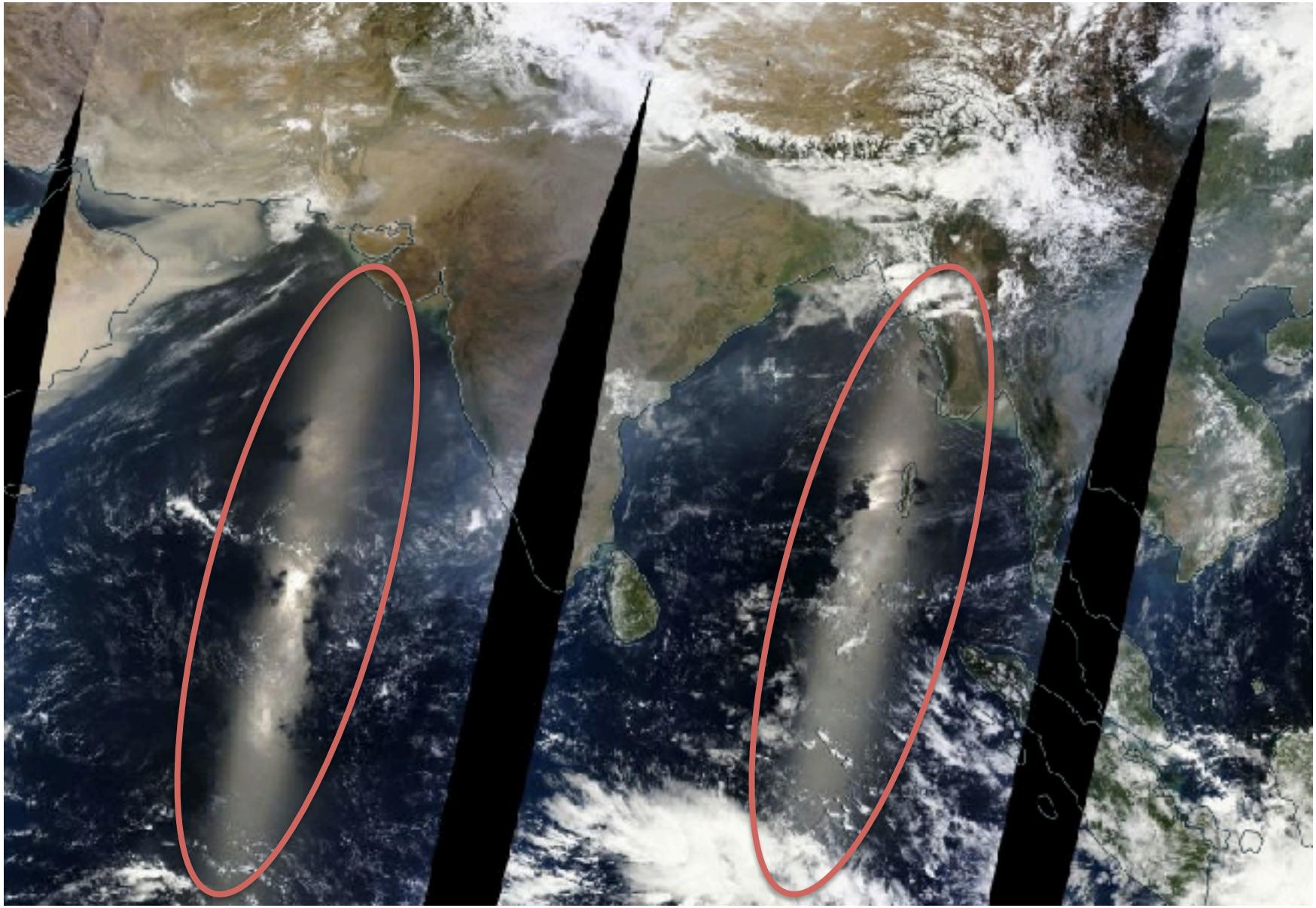
MODIS Terra Image from April 19 2013 http://1.usa.gov/1cNFDQh



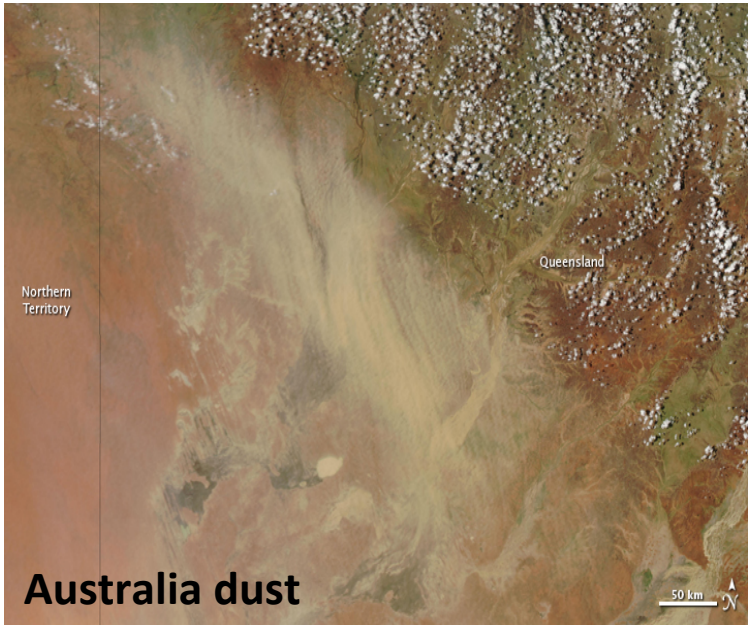
Features In True Color Image (Atmosphere)



Glint



Feature Identification is more reliable when a clear source can be seen in the image.



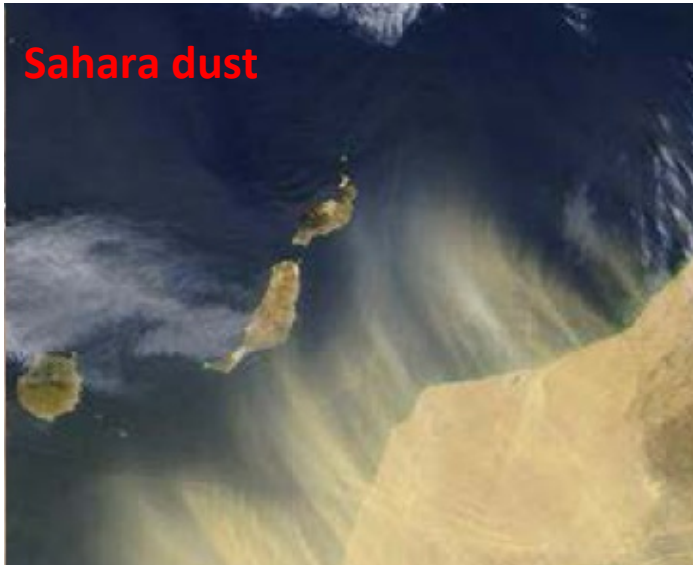
Australia dust

Sangeang Api, Indonesia eruption

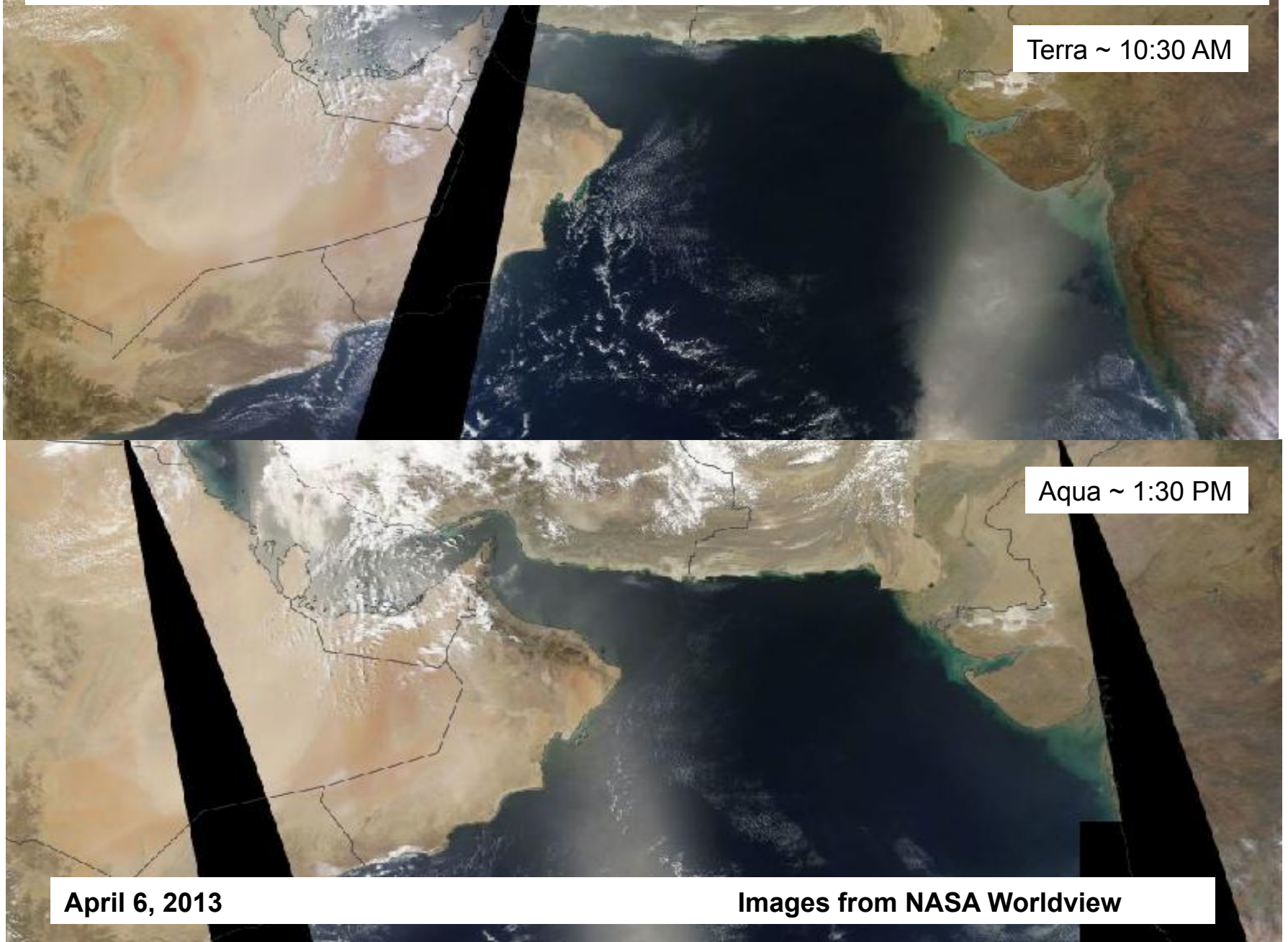
Urban-industrial/smoke pollution?

Indian oil fires

Feature Identification is more reliable when a clear source can be seen in the image.

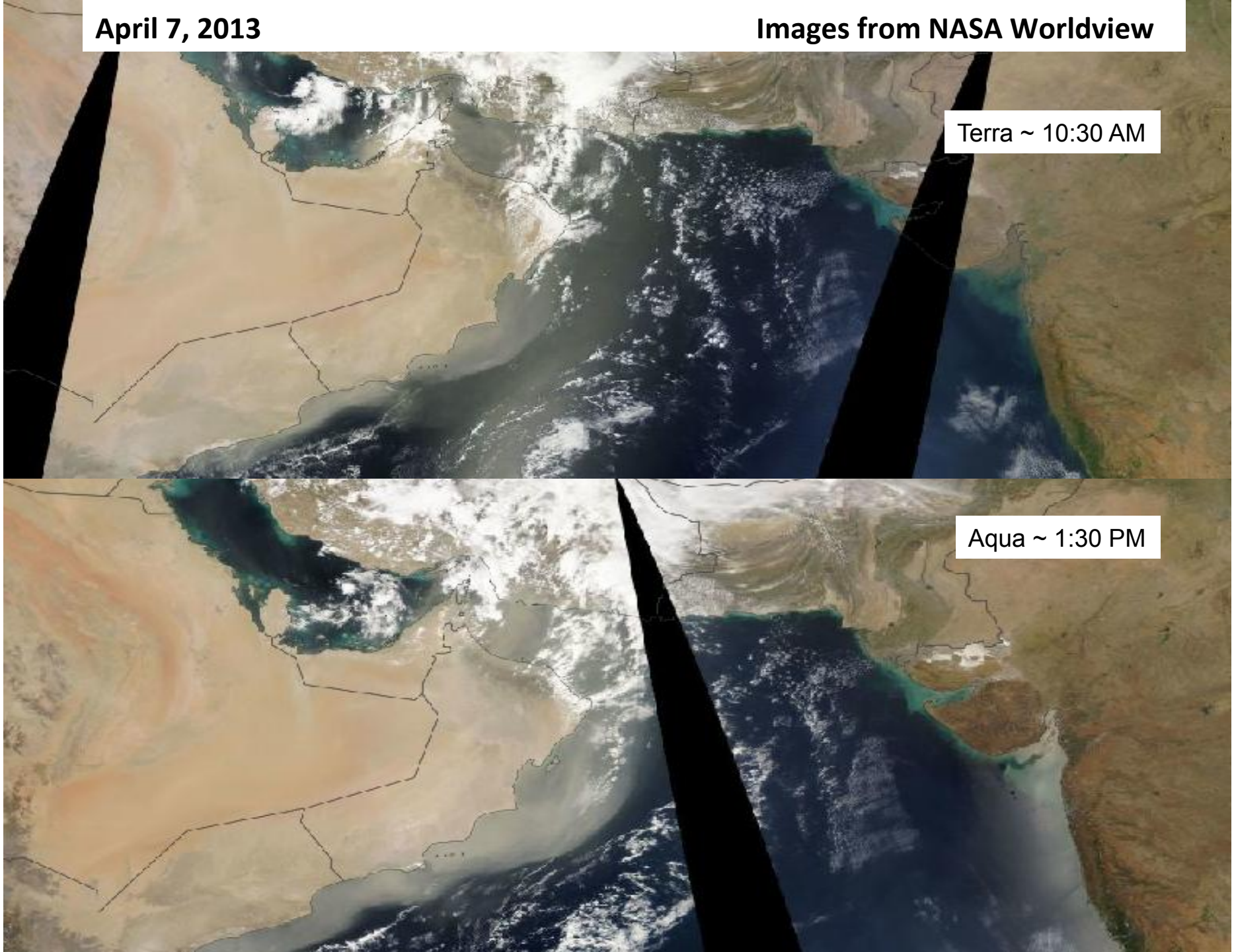


Using Time Series Imagery - Dust Transport

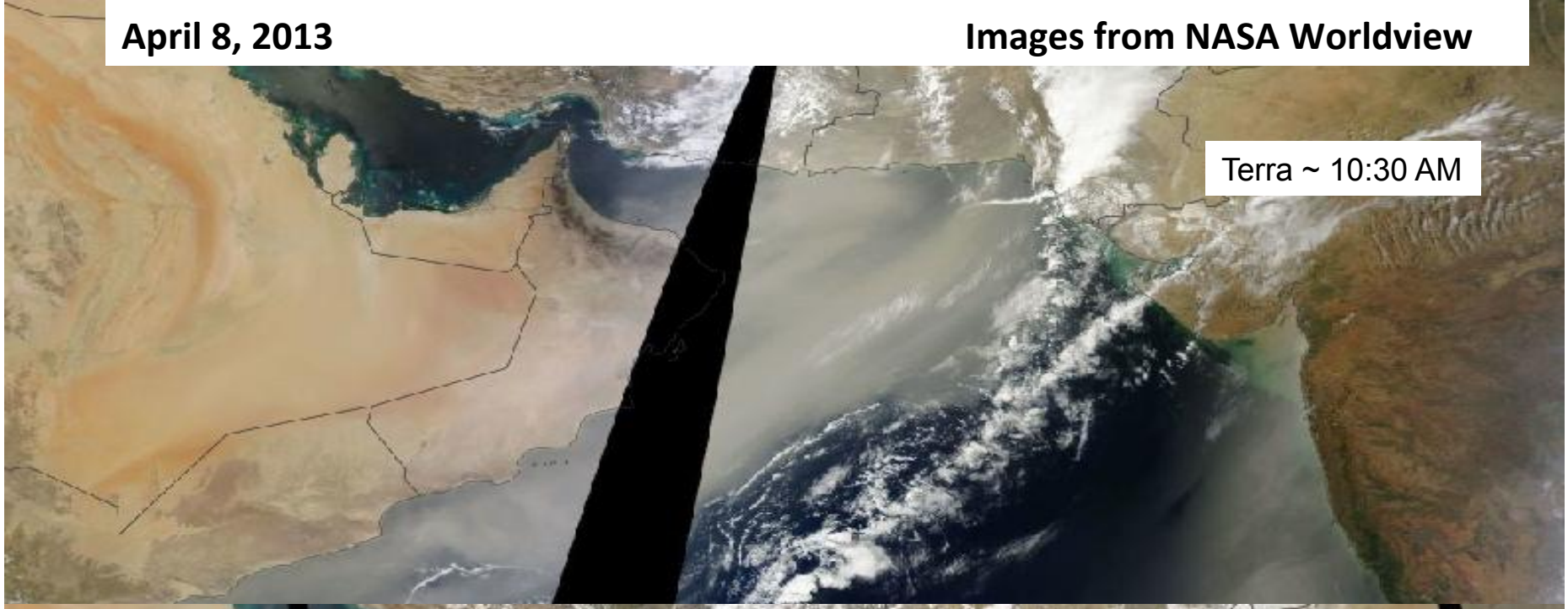


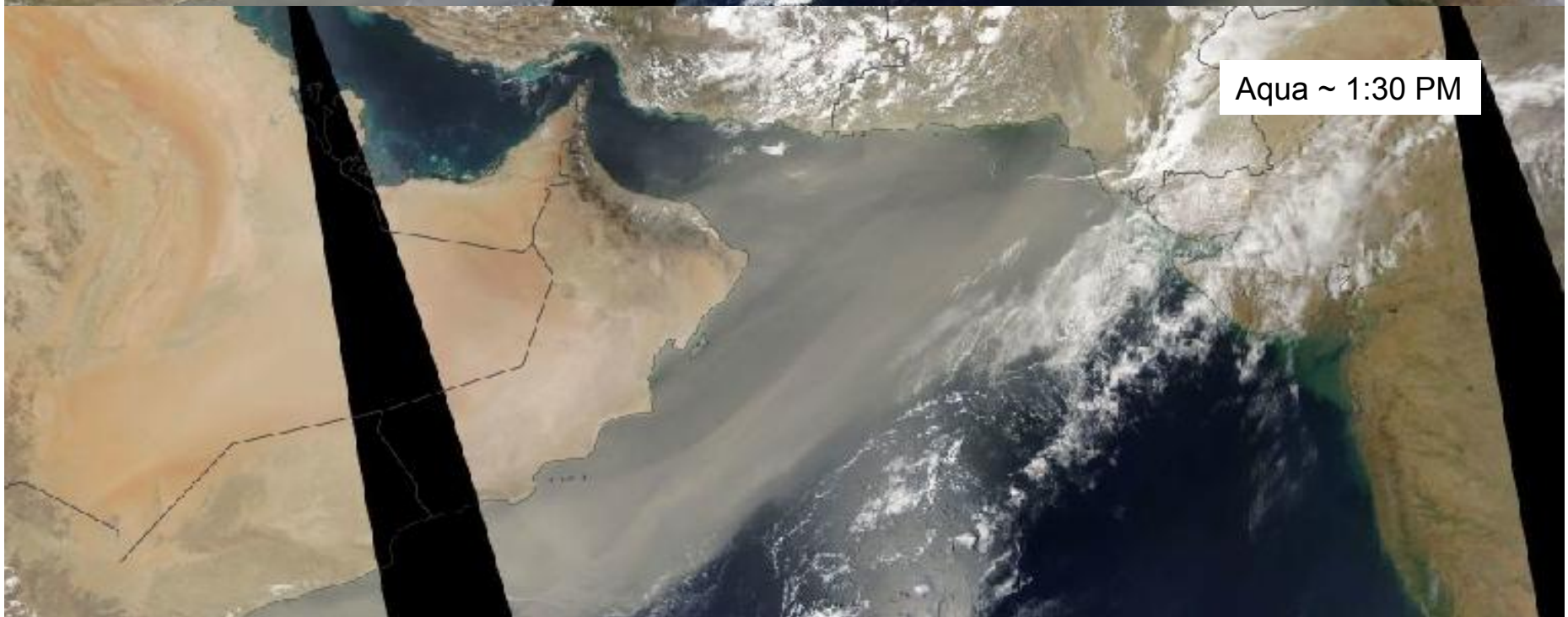
April 6, 2013 **Images from NASA Worldview**

April 7, 2013 **Images from NASA Worldview**

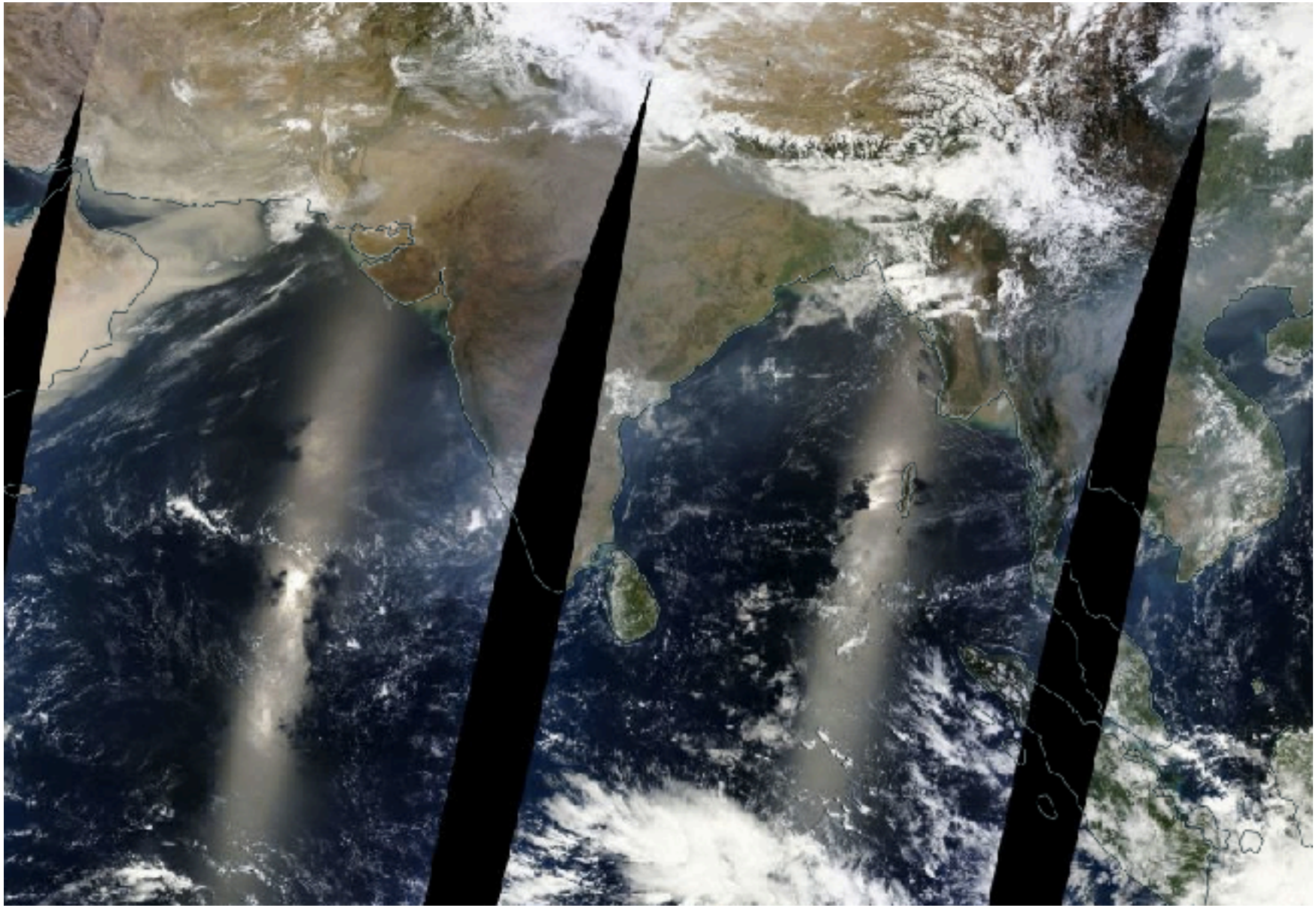


April 8, 2013 **Images from NASA Worldview**





Color, texture and shape

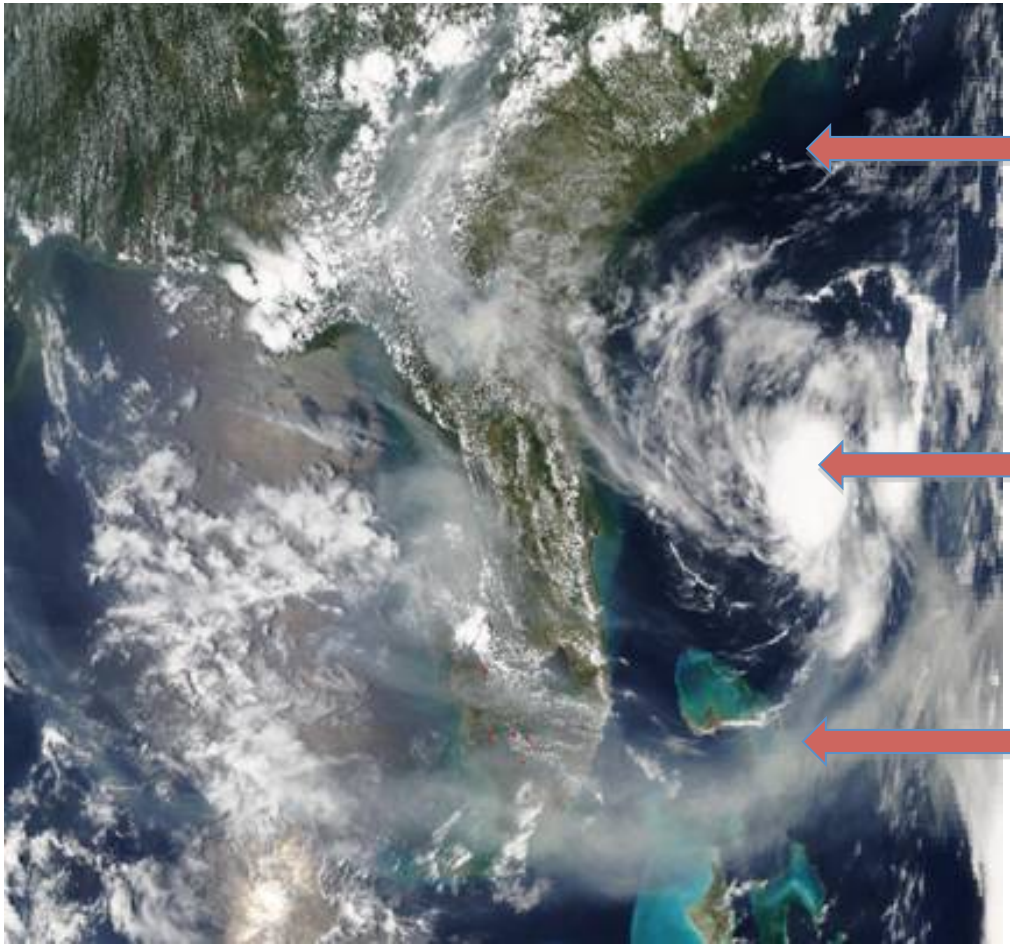


Earth Observatory Story on Feature Detection in an Image

http://earthobservatory.nasa.gov/Features/ColorImage/page2.php

Doing More with Satellite Imagery

If we understand the physics of how particular wavelengths interact with objects in the world we can create images to emphasize what we want to see



In visible imagery water is dark because it absorbs most of the energy.

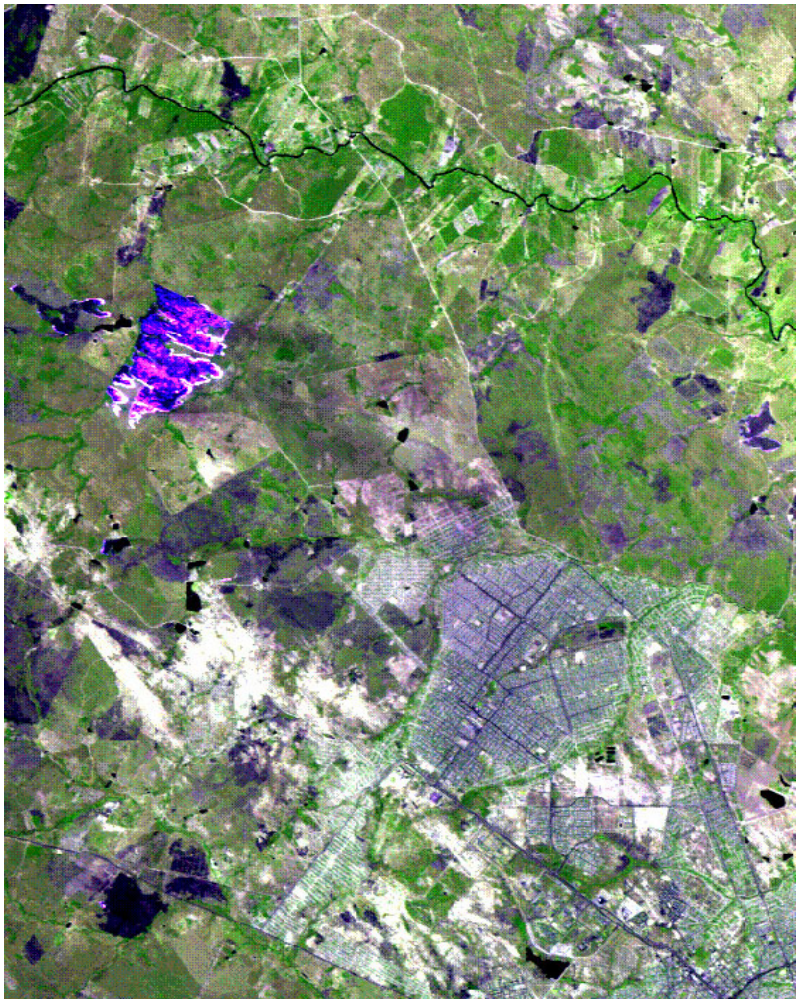
Clouds are white because most of the incoming energy is reflected

Pollution is hazy depending upon its absorptive properties

False Color Images

"False Color Image"

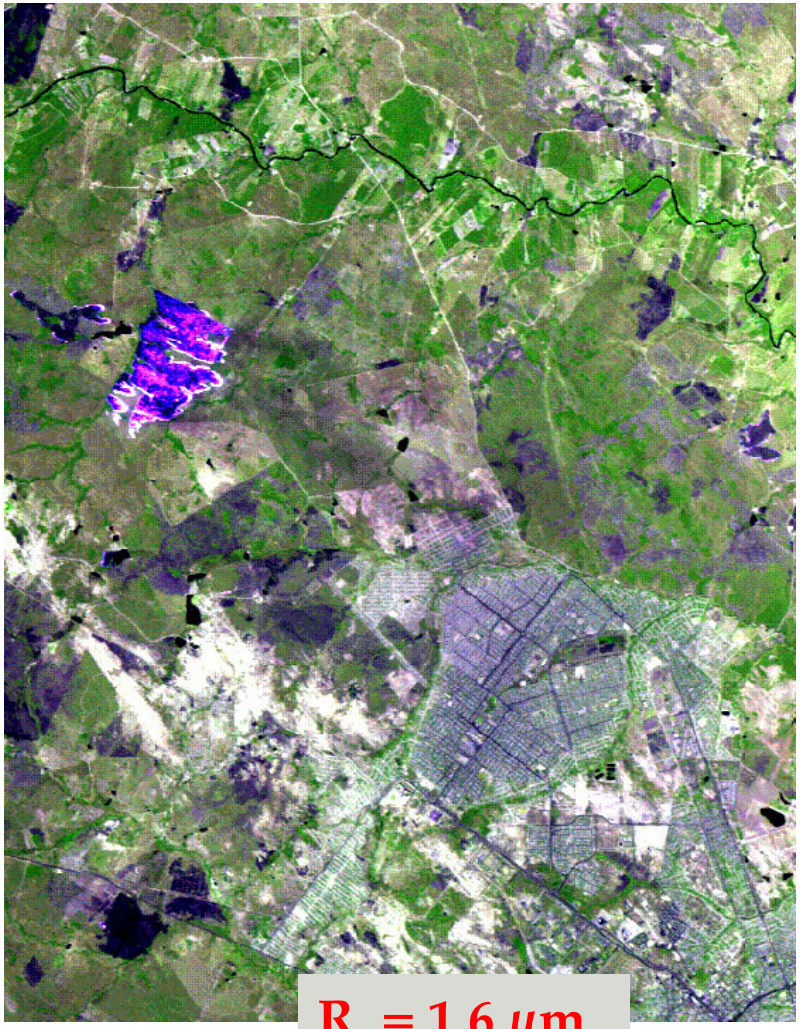
To enhance particular features we want to see in an image we load bands into the red, green and blue display channels which do not correspond to the visible red, green, and blue wavelengths.



R = 1.6 μm
G = 1.2 μm
B = 2.1 μm

True vs False Color Images

R = 0.66 μm
G = 0.55 μm
B = 0.47 μm



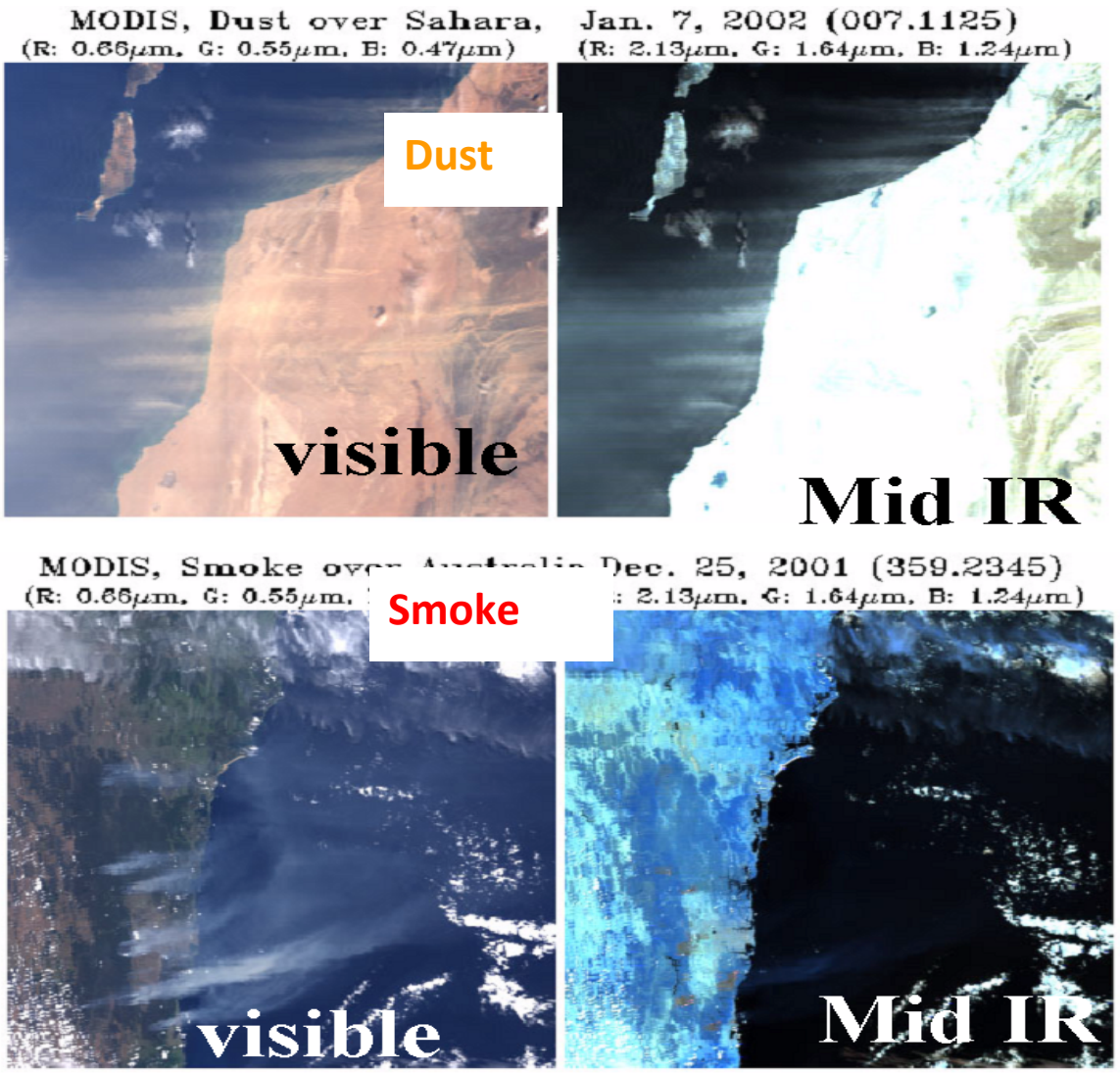
R = 1.6 μm
G = 1.2 μm
B = 2.1 μm

Spectral optical properties of aerosol

The distinction of aerosol types is made possible by:

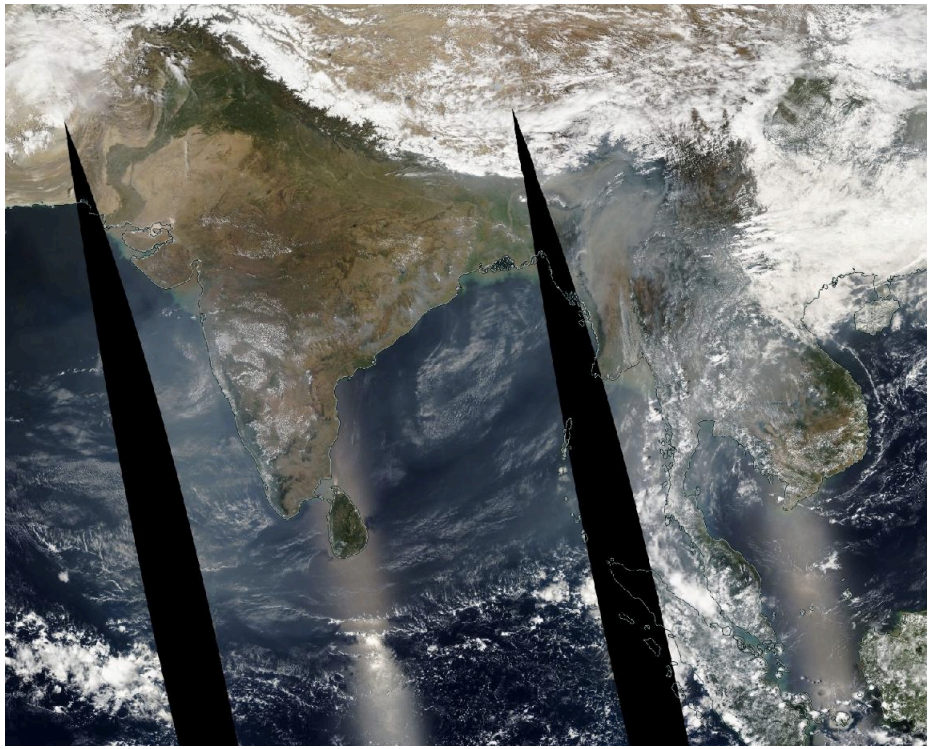
1. The wide spectral range of the MODIS sensor.

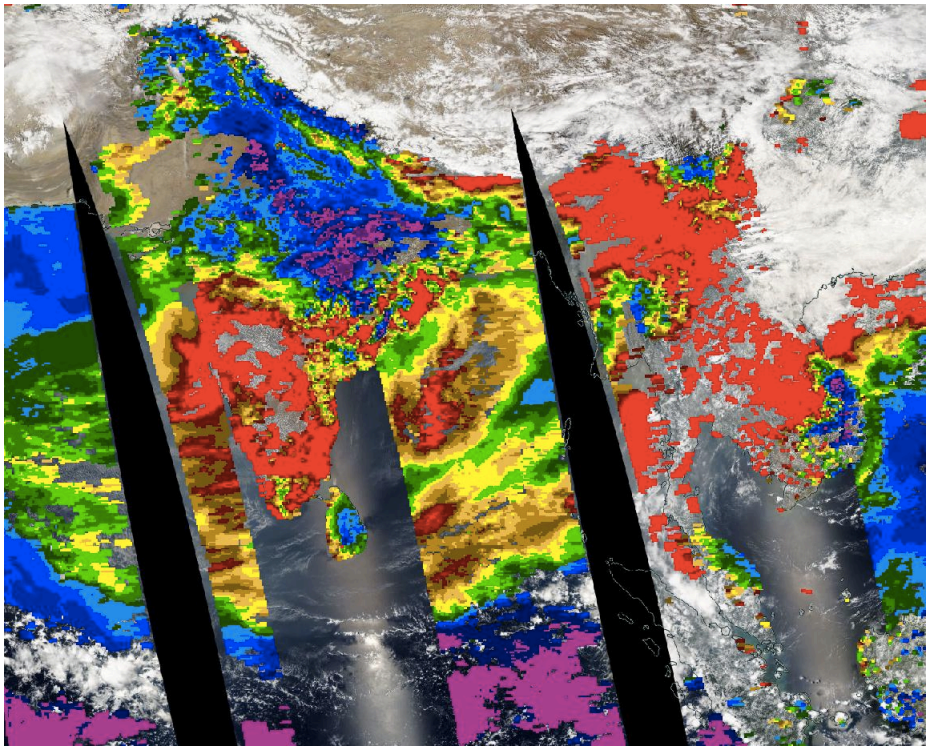
2. Understanding how light interacts with the particles, gases and surfaces it interacts with.



from Y. Kaufman

True Color Image vs Color Map





A Brief Tour of Some Useful Image Archives

Earth Observatory – Events & More
http://earthobservatory.nasa.gov/

World View - Near Real Time
http://earthdata.nasa.gov/labs/worldview/

Image Archive and Gallery Links

ARSET Satellite Imagery Overview and links
http://airquality.gsfc.nasa.gov/index.php?section=64

MODIS Rapid Response Site
http://earthdata.nasa.gov/data/near-real-time-data/rapid-response

NASA's Visible Earth
http://visibleearth.nasa.gov

NASA's Earth Observatory
http://earthobservatory.nasa.gov

NASA Earth Observations (NEO)
http://neo.sci.gsfc.nasa.gov

MODIS- Atmos (MODIS Atmosphere Product Reference Site)
http://modis-atmos.gsfc.nasa.gov/IMAGES/index.html

•GLIDER Tool
http://www.ssec.wisc.edu/hydra/

Identify Feature