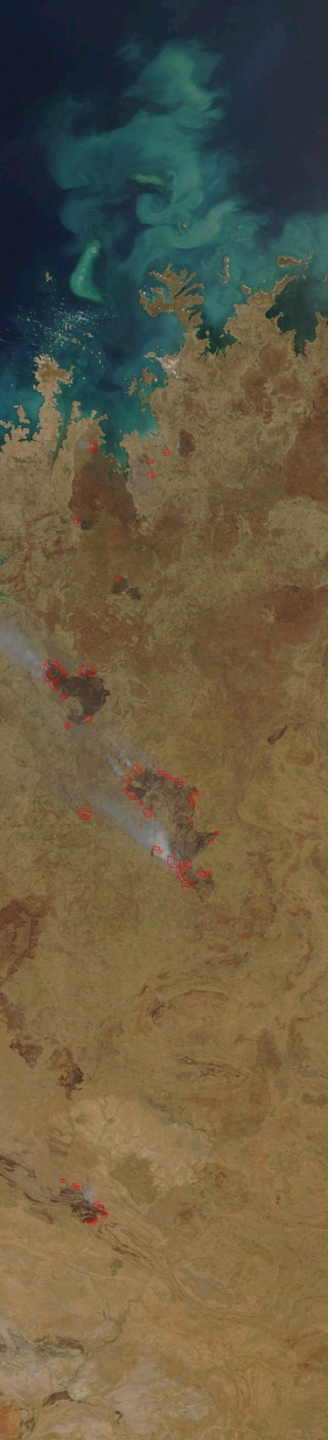

National Aeronautics and Space Administration

ARSET
Applied Remote Sensing Training
http://arset.gsfc.nasa.gov
@NASAARSET

Introduction to Satellite Remote Sensing for Air Quality Applications

Webinar Session 2 – July 13, 2016

Visible Satellite Imagery

Session 2 - Outline

1. **What are true and false color images?**

2. **What can we learn from images?**

3. **A tour of useful image archives**

Today's Instructor: **Pawan Gupta**
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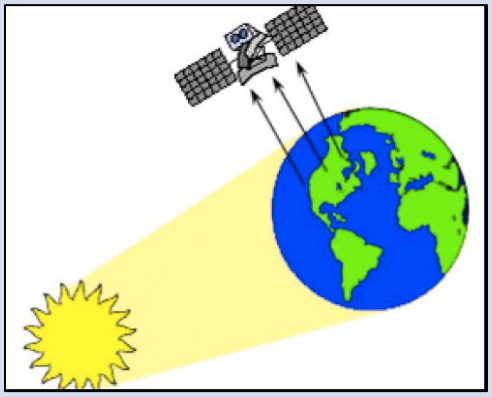
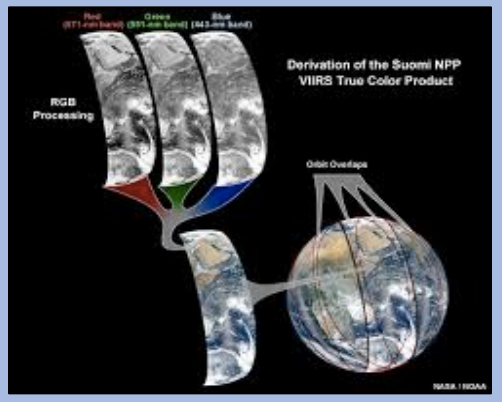
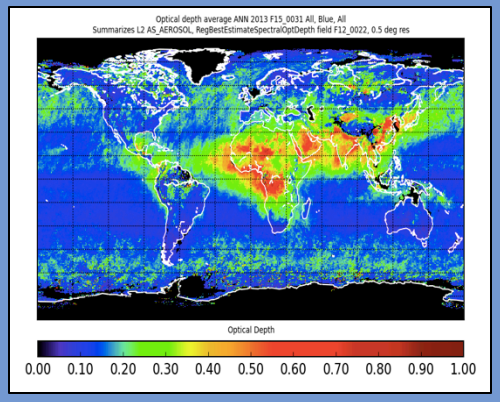
5 Weeks Webinar Series: Agenda



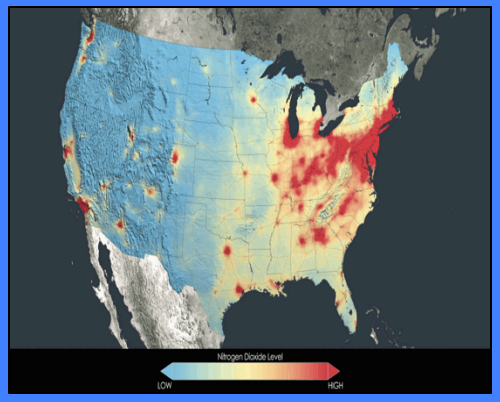
Week 1: Fundamental of Remote Sensing



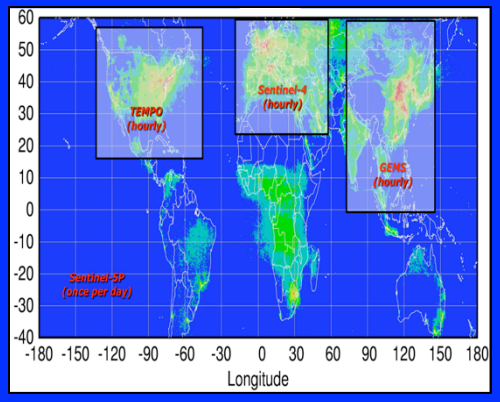
Week 2: Satellite Imagery



Week 3: Aerosol Data



Week 4: Trace Gas Data

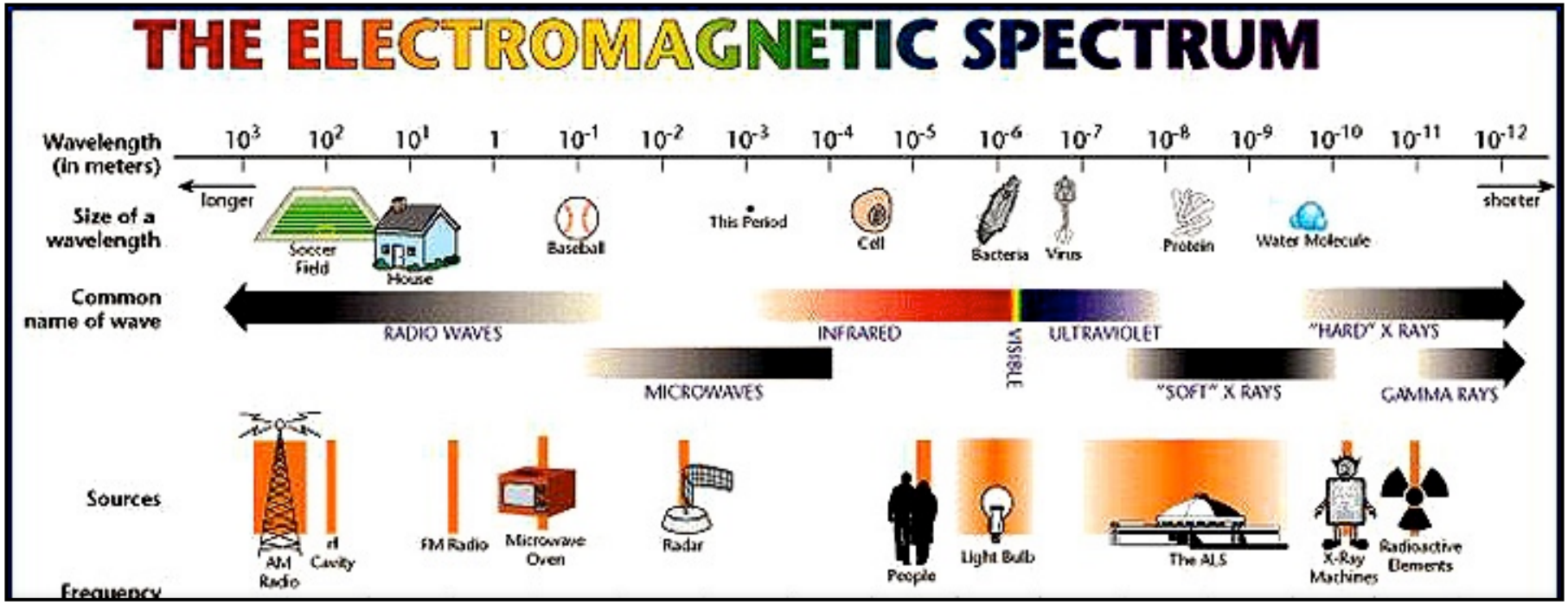


Week 5: Future Capabilities

Visible Image Science

- Visible satellite images are essentially photographs
- All 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 (i.e. cloud appears bright)
- The lower the albedo, the more light energy is absorbed (i.e. water appears dark)

Wavelength Selection



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

RGB Images

- Create an image using any 3 bands
- Load red, green, and blue satellite bands into corresponding display channels
- Simulates what the human eye sees

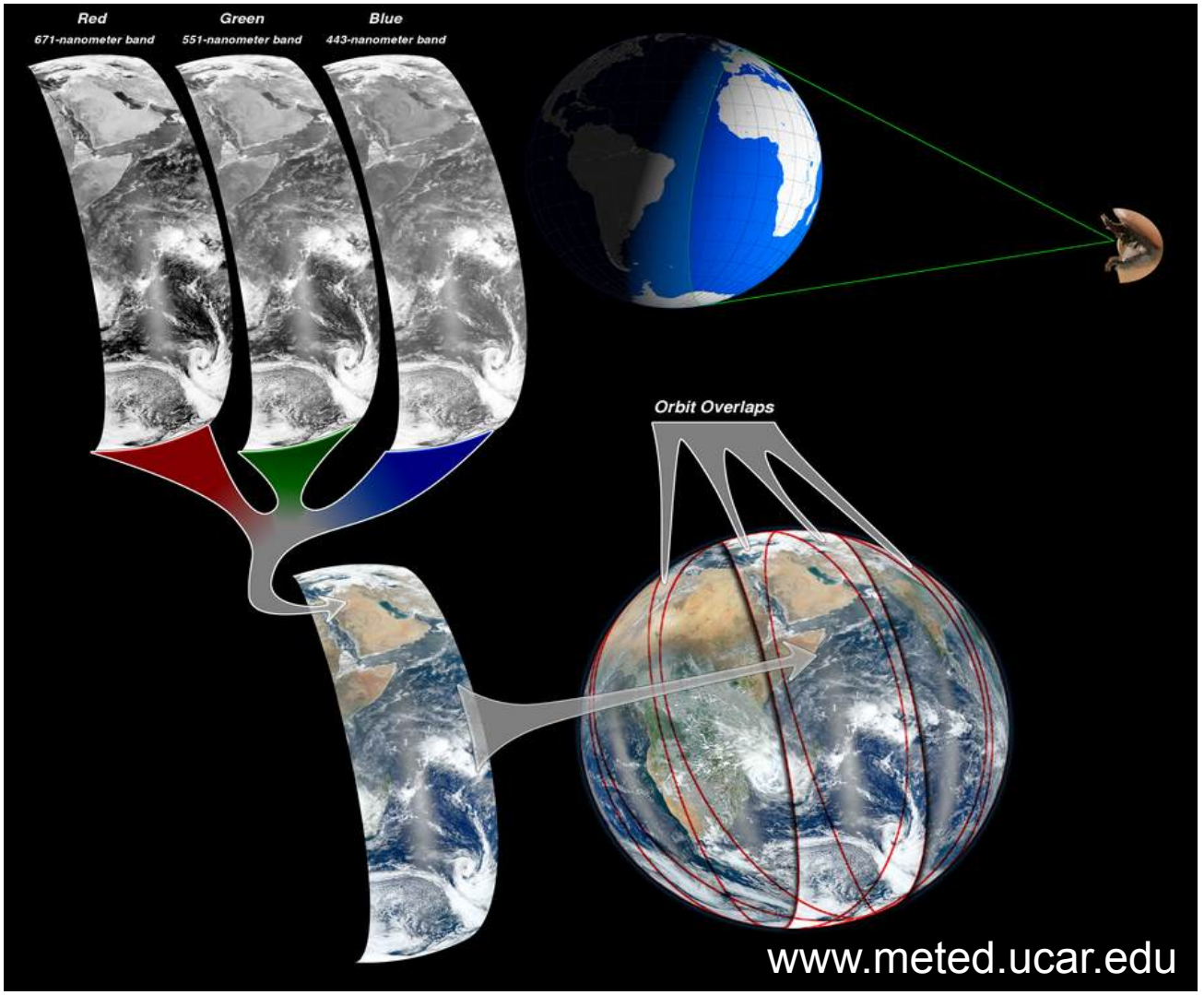
True Color Image (or RGB)

A MODIS “true color image” will use MODIS visible wavelength bands 1, 4, 3

R = 0.66 µm

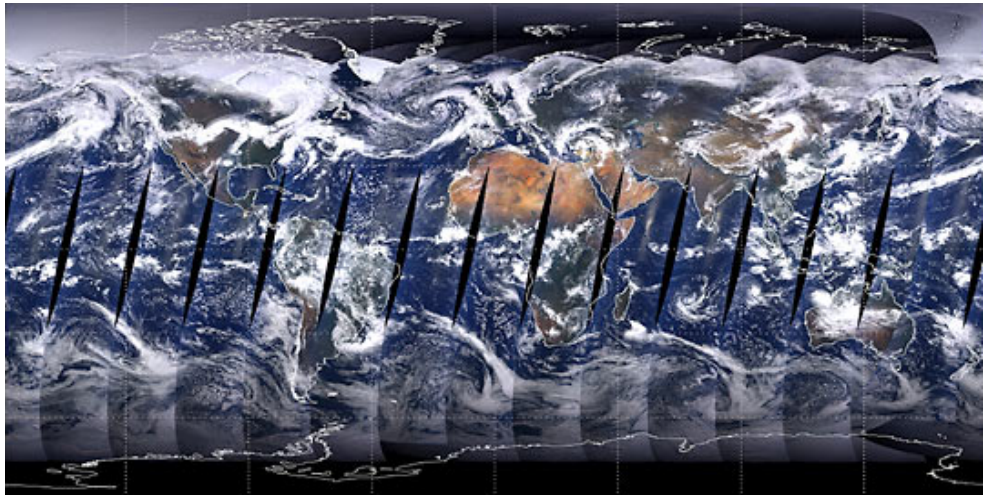
G = 0.55 µm

B = 0.47 µm



Moderate Resolution Imaging Spectroradiometer

MODIS



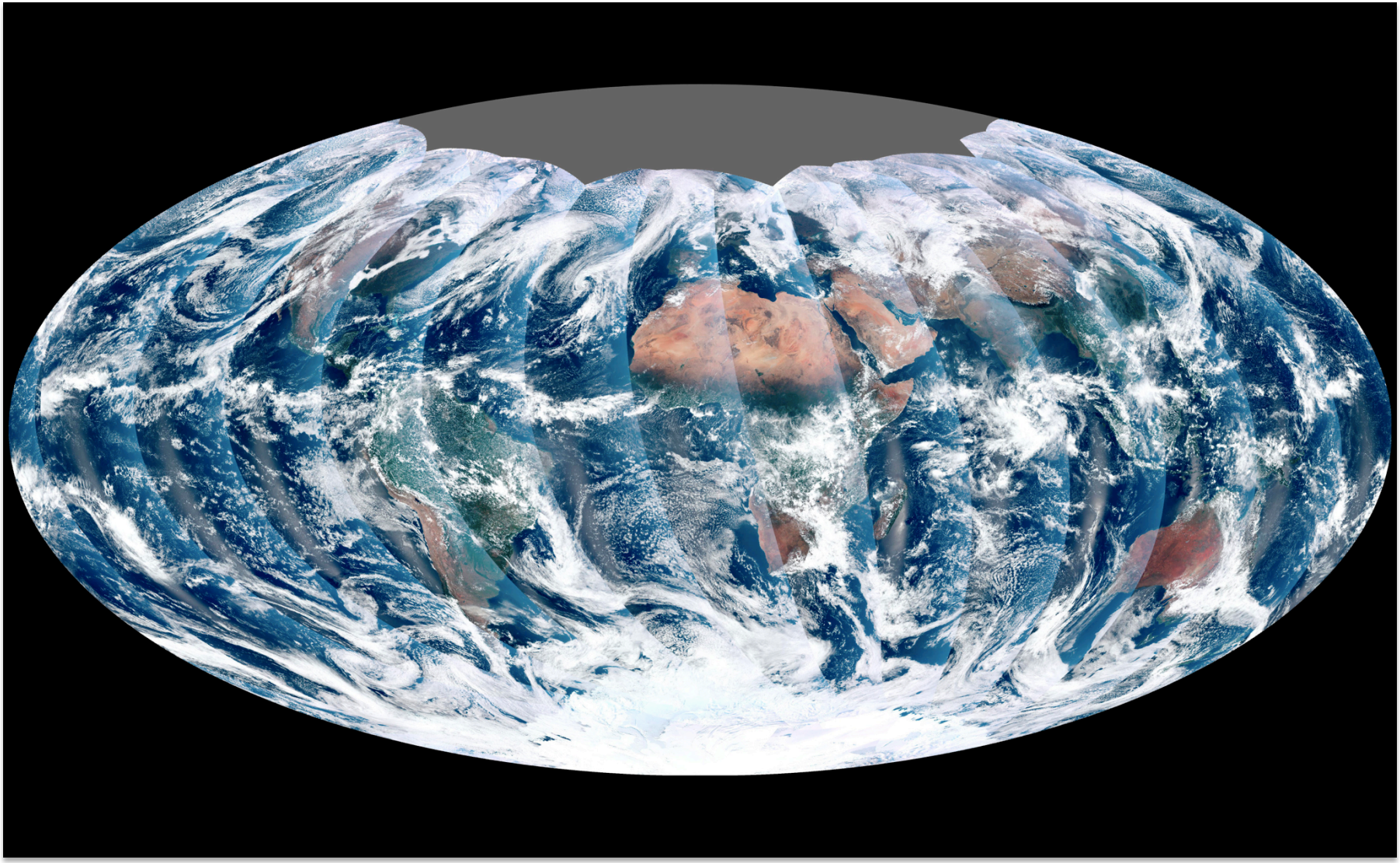
- **Spatial Resolution**
  - 250m, 500m, 1km
- **Temporal Resolution**
  - Daily, 8-day, 16-day, monthly, quarterly, yearly
  - 2000 – present
- **Platform**
  - Terra & Aqua
- **Data Format**
  - Hierarchal Data Format – Earth Observing System Format (HDF-EOS)
- **Spectral Coverage**
  - 36 bands (major bands include red, blue, IR, NIR, MIR)
    - Bands 1-2: 250m
    - Bands 3-7: 500m
    - Bands 8-36: 1000m

MODIS Reflected Solar Bands

	Primary Use	Band No.	Bandwidth (nm)
250m	Land/Cloud Boundaries	1**	620-670
		2**	841-876
500m	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

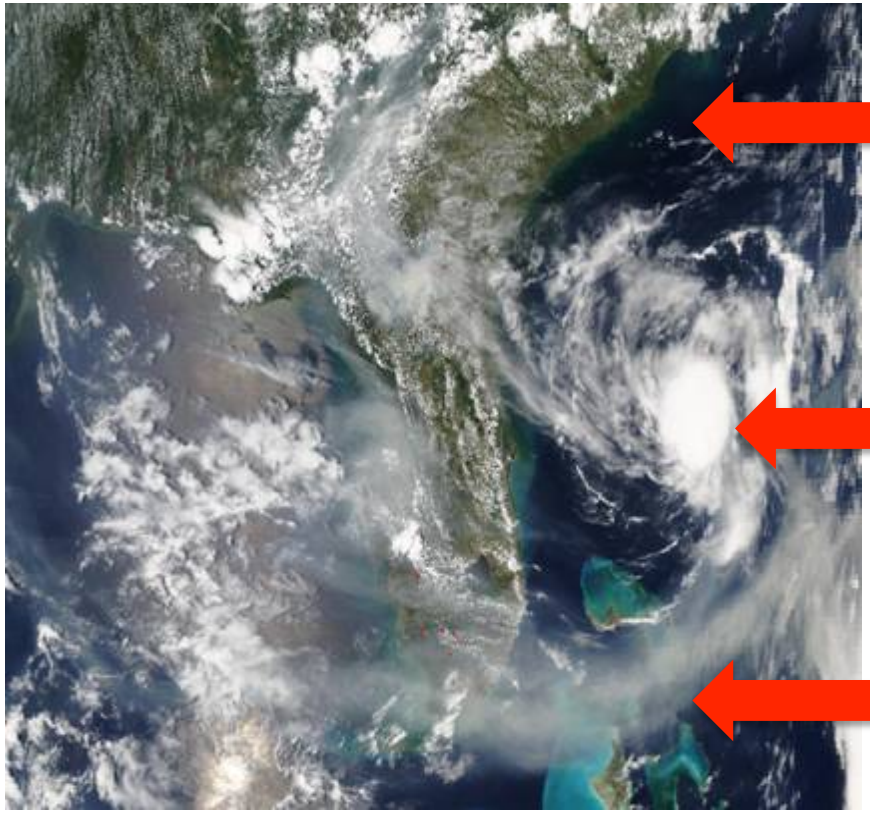
* 500m Spatial Resolution
** 250m Spatial Resolution

VIIRS Image



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

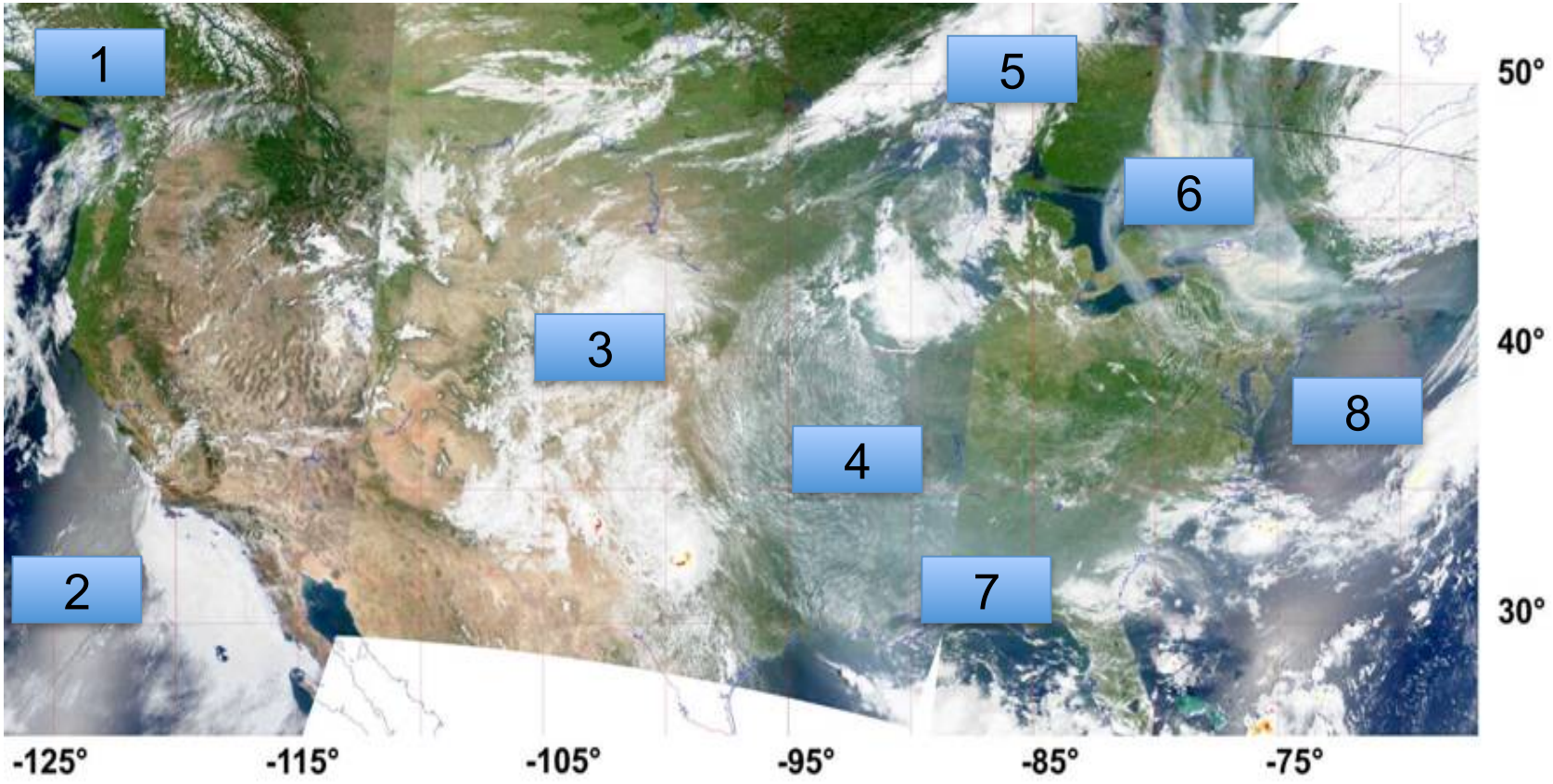


Visible imagery water is dark because it absorbs most of the energy

Clouds are white because most incoming energy is reflected

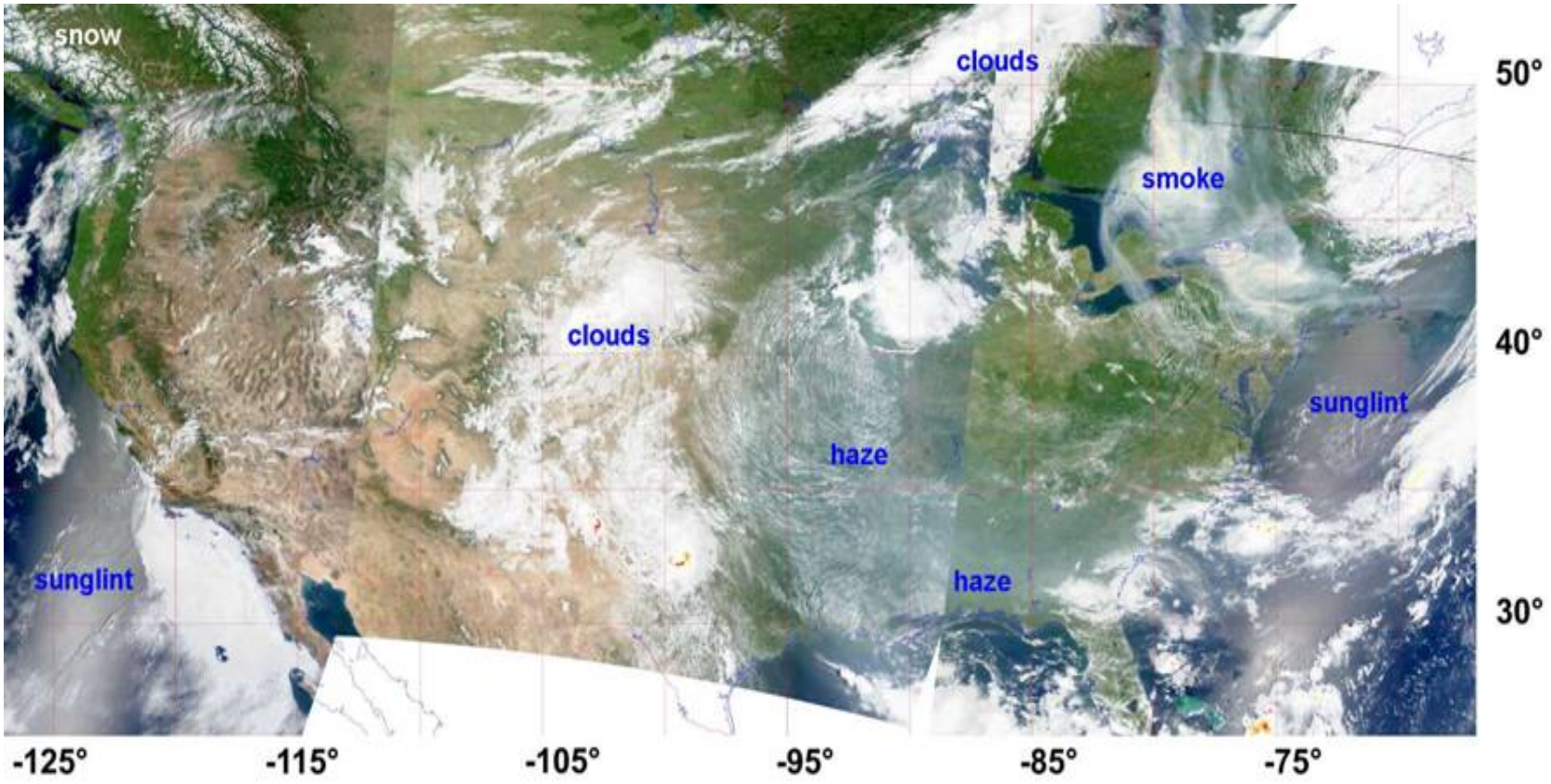
Pollution is hazy depending on its absorption properties

What can we learn from true color imagery?



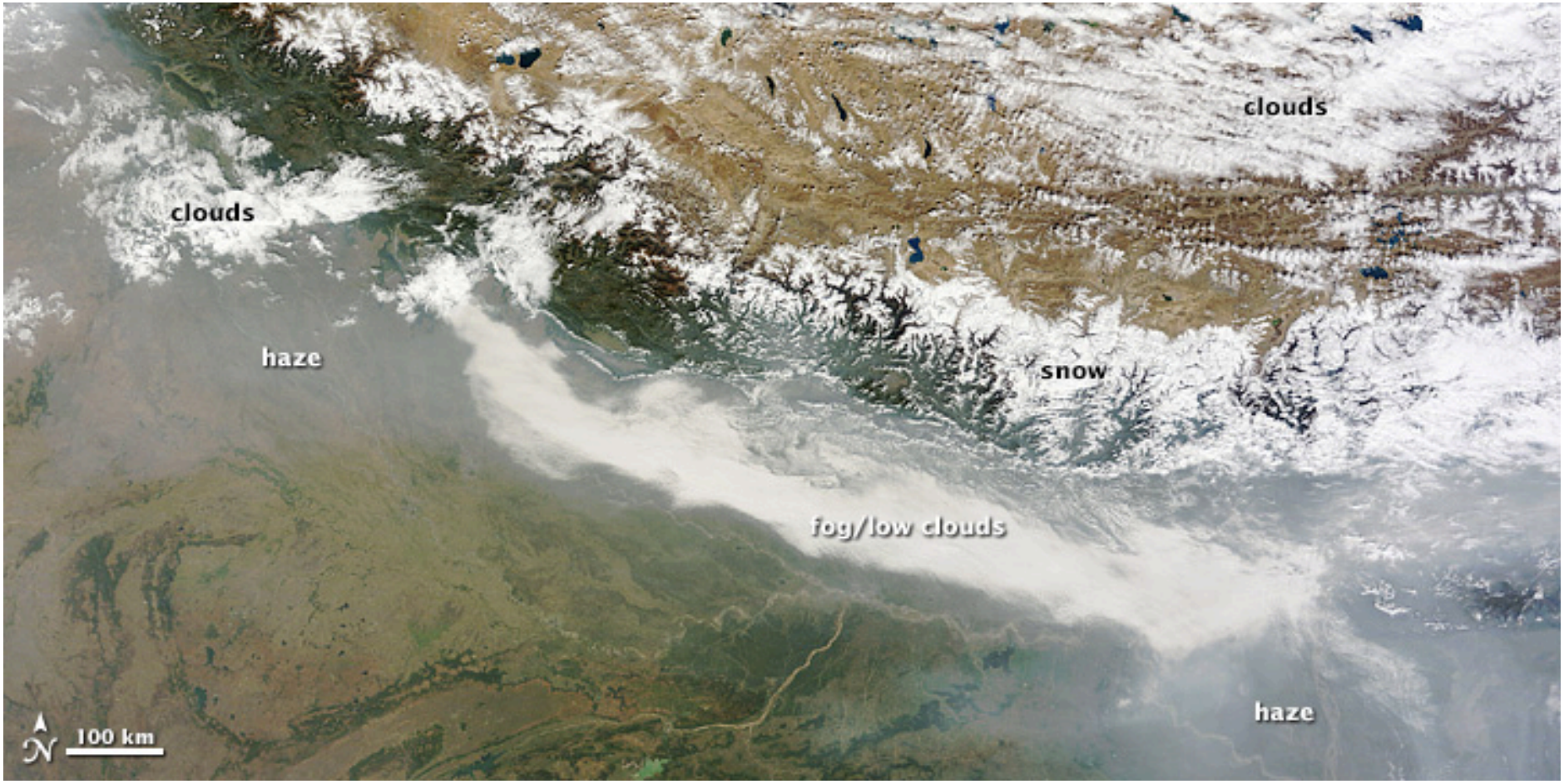
(Possible) Identification of land, ocean, and atmosphere features

What can we learn from true color imagery?

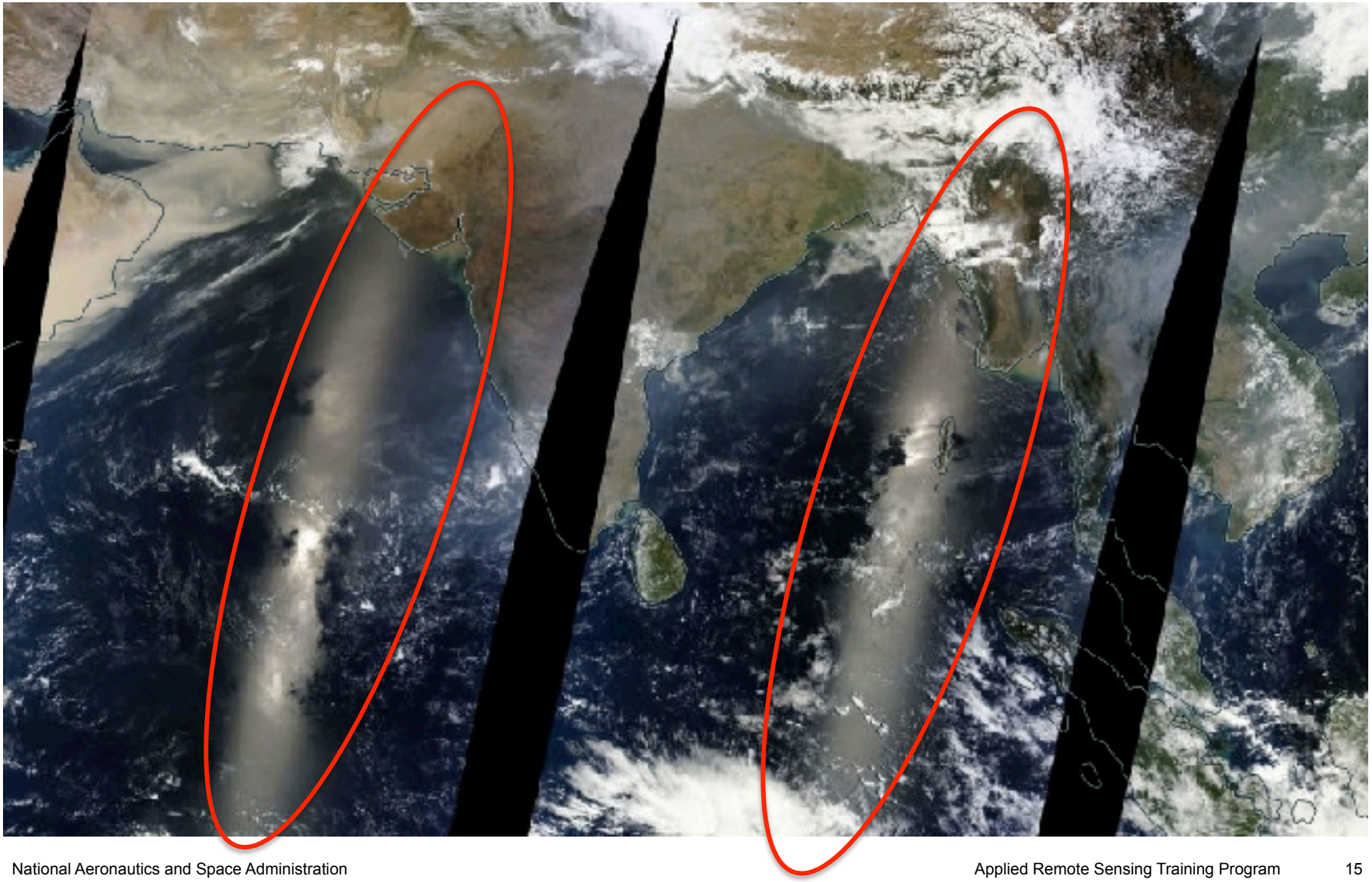


(Possible) Identification of land, ocean, and atmosphere features

Features in True Color (Atmosphere)



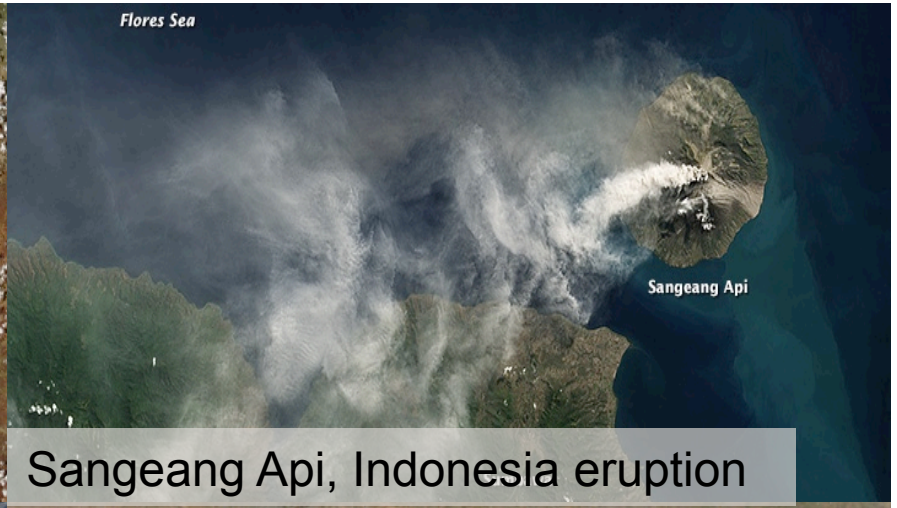
Glint



Feature Identification

More reliable when a clear source is in the image

Australian dust



Sangeang Api, Indonesia eruption

Urban-industrial/smoke pollution?

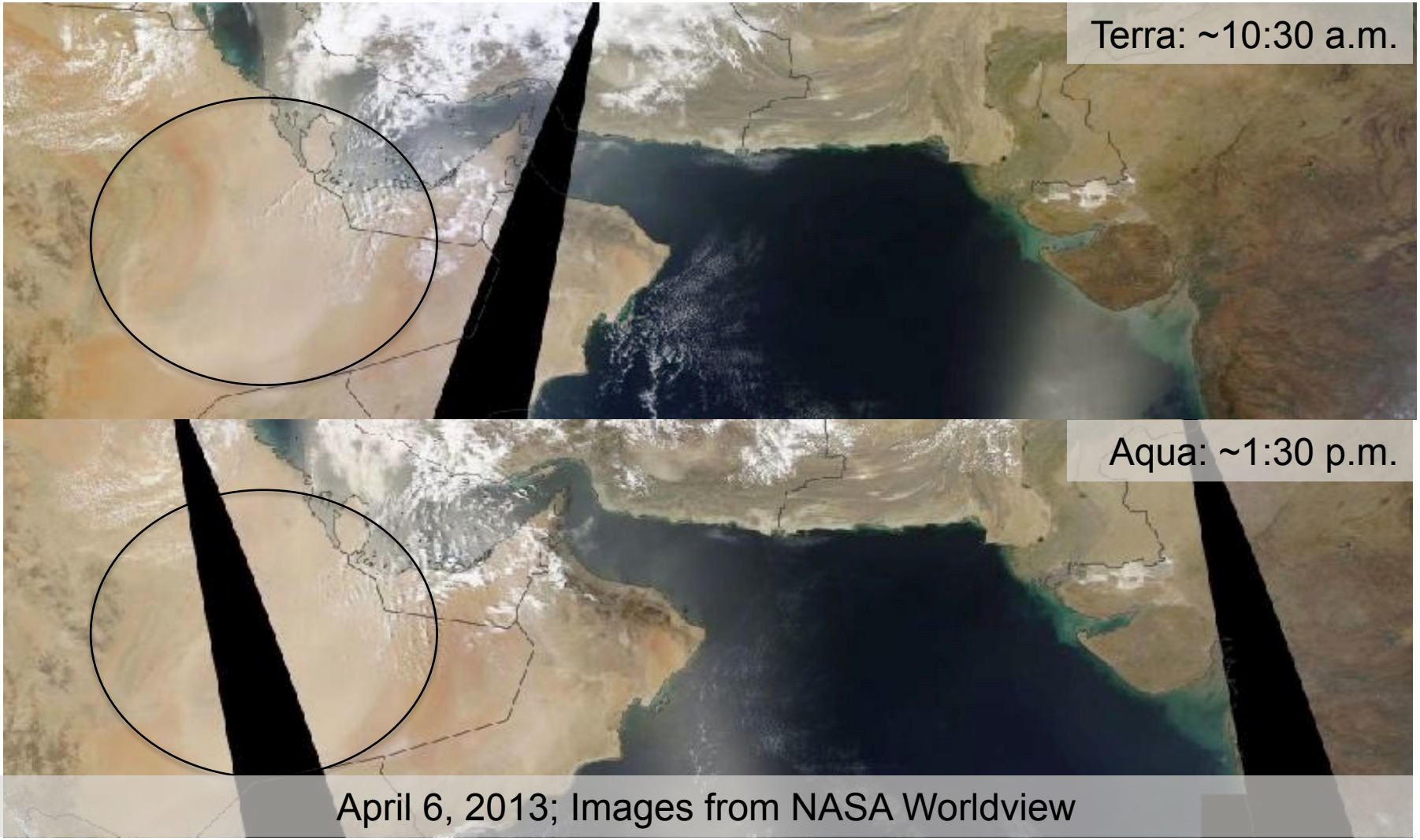
Indian oil fires

Feature Identification

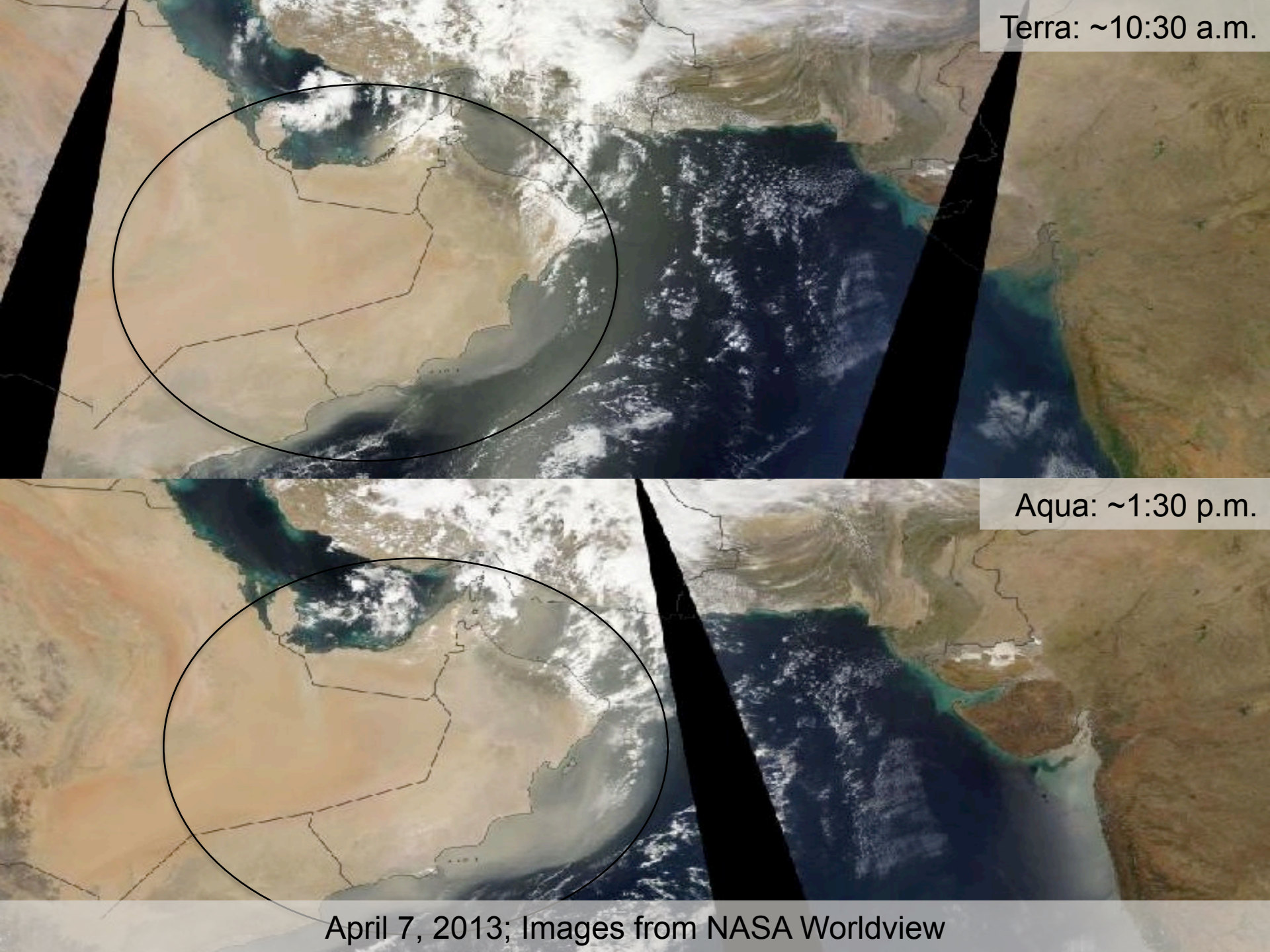
More reliable when a clear source is in the image

Using Time Series Imagery

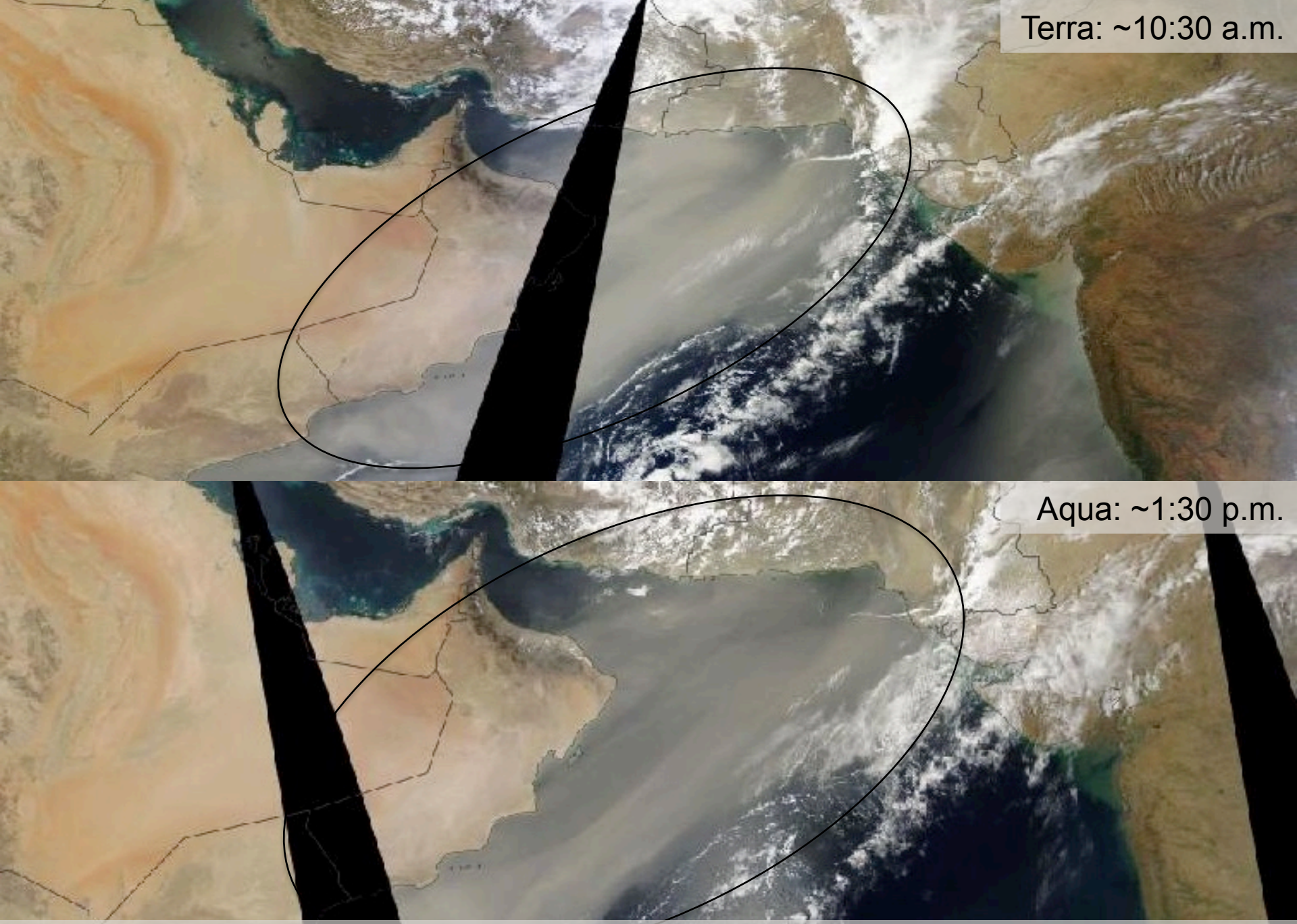
Dust Transport



April 6, 2013; Images from NASA Worldview



April 7, 2013; Images from NASA Worldview



April 8, 2013; Images from NASA Worldview

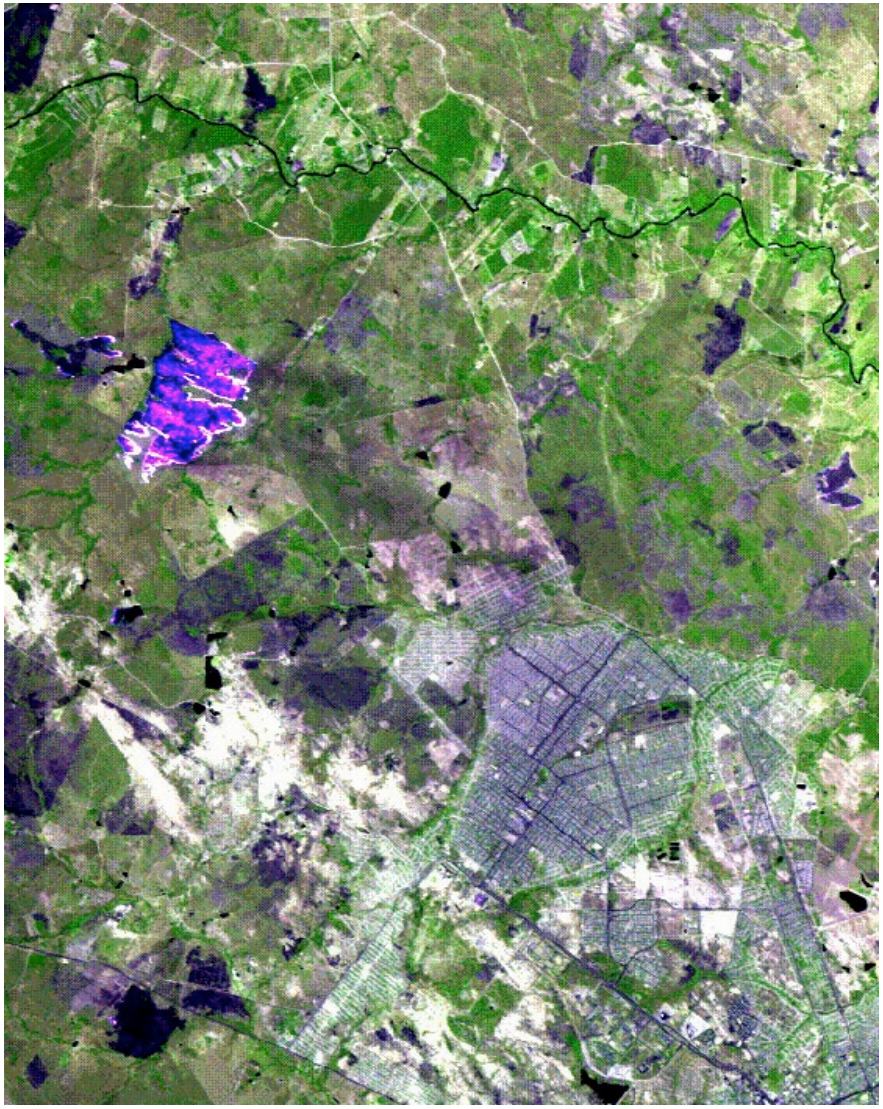
False Color Images

- Load bands into the red, green, and blue display channels
- Do not correspond to the visible red, green, and blue wavelengths

R = 1.6 µm

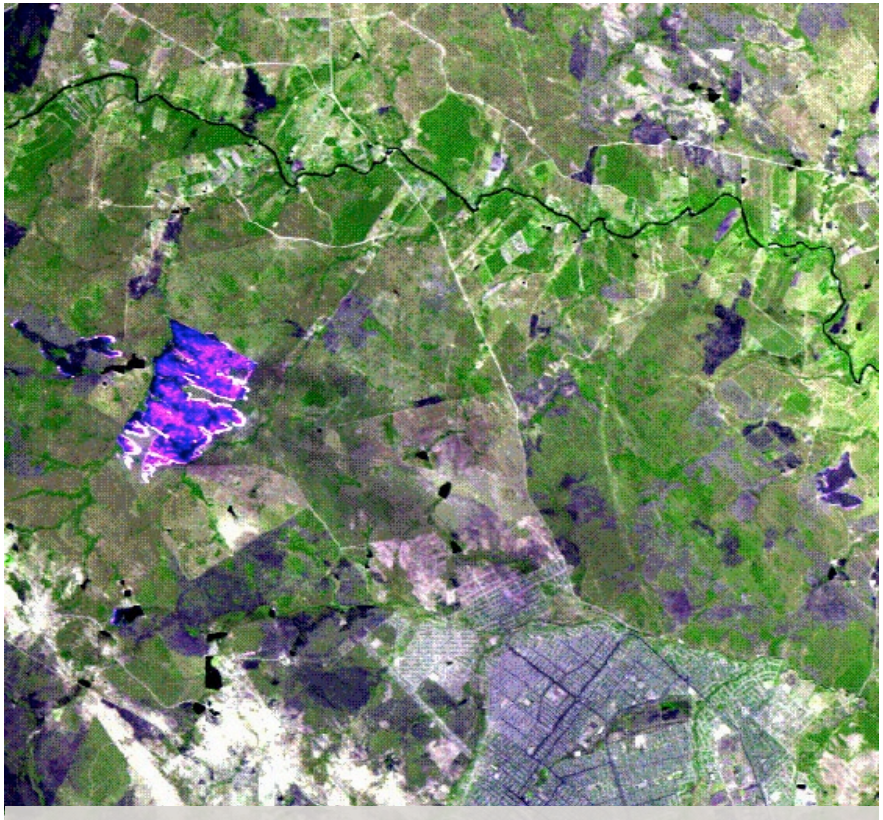
G = 1.2 µm

B = 2.1 µm



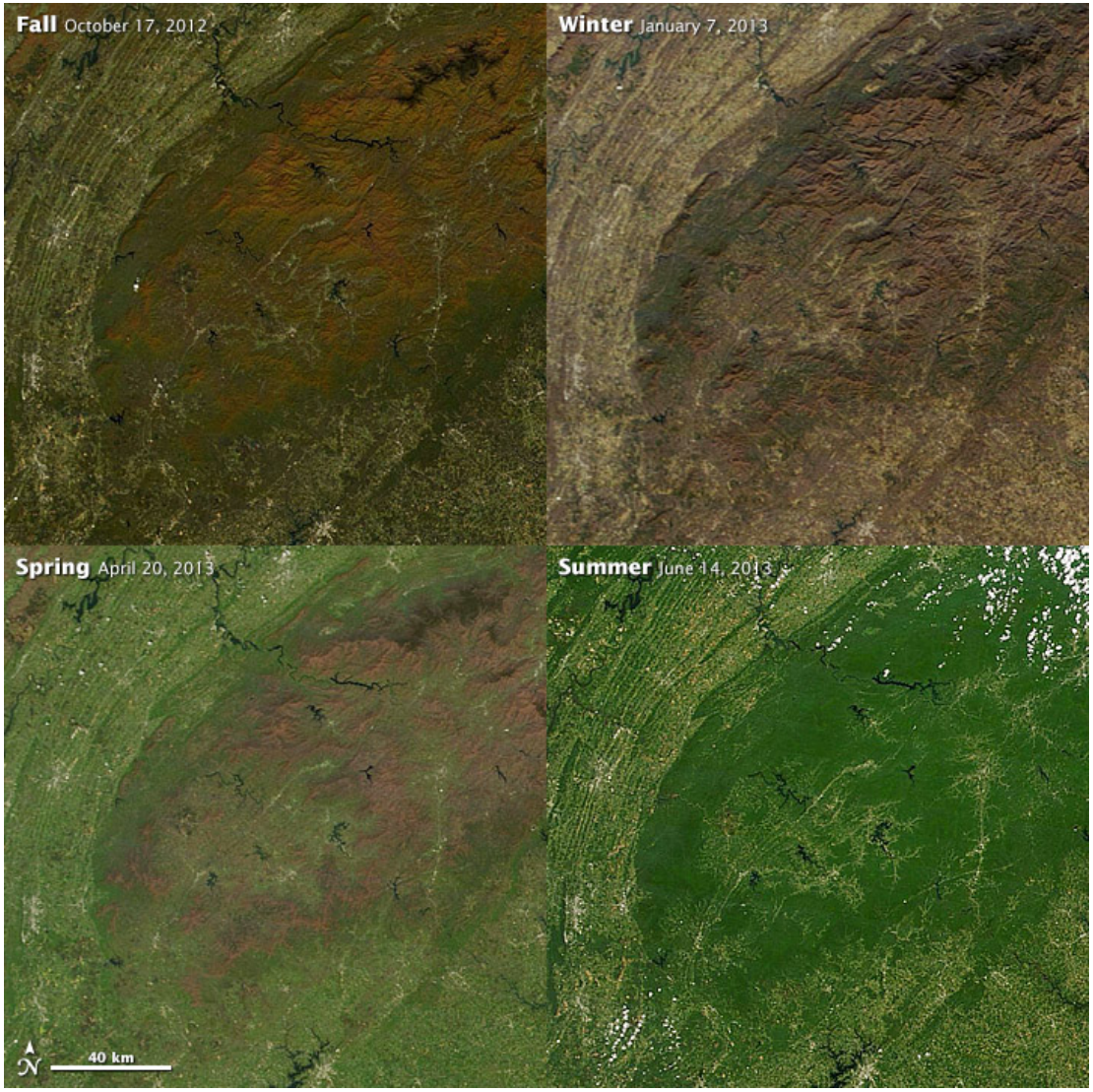
True vs. False Color Images

R = 0.66 µm
G = 0.55 µm
B = 0.47 µm



R = 1.6 µm
G = 1.2 µm
B = 2.1 µm

Change in vegetation color from space



http://earthobservatory.nasa.gov/

Earth Observatory Story

An article on feature detection in an image

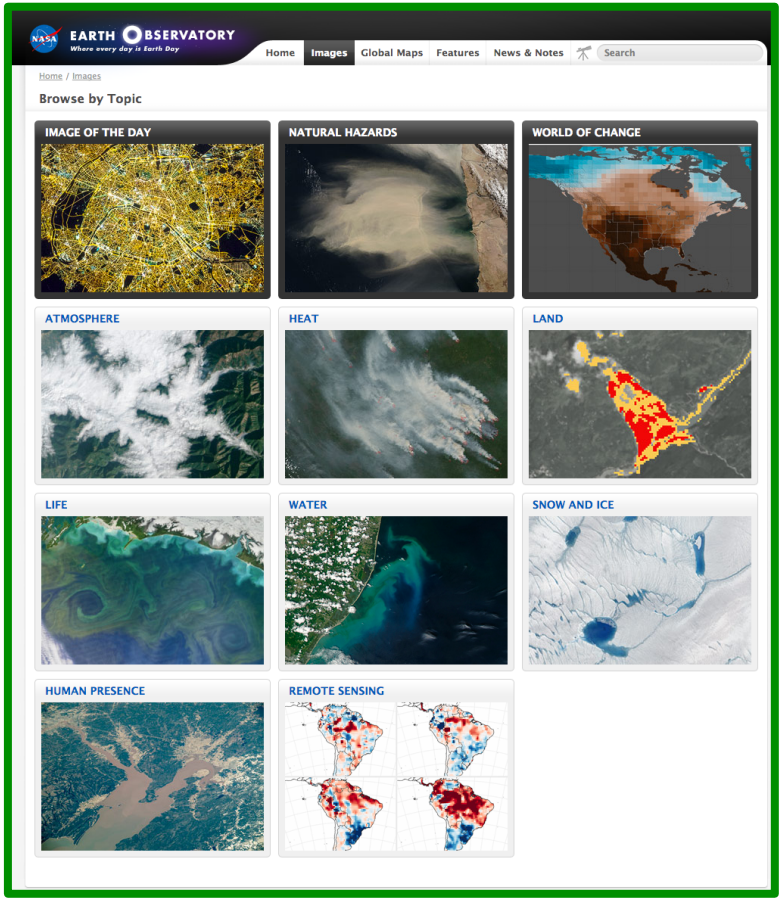
http://earthobservatory.nasa.gov/Features/ColorImage/page2.php

Image Archive and Gallery Links

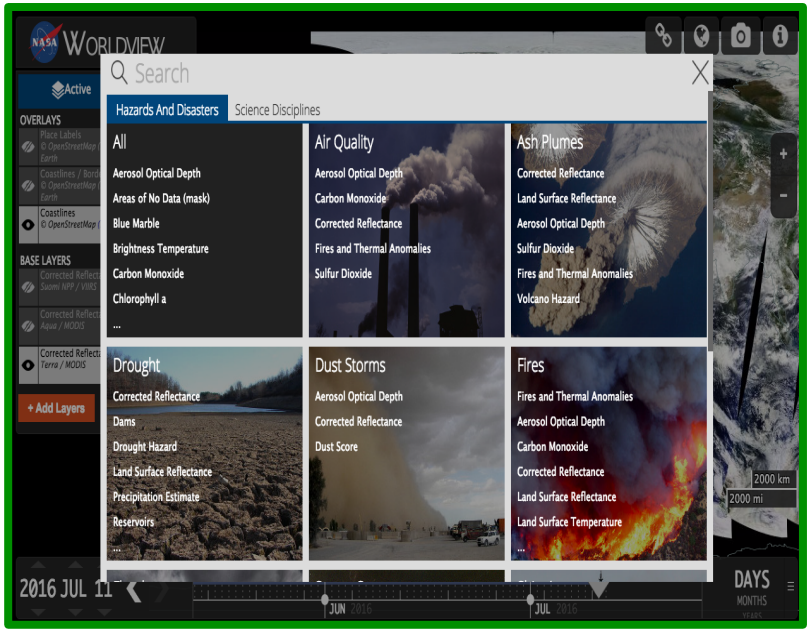
- ARSET Satellite Imagery Overview and links
  - http://airquality.gsfc.nasa.gov/index.php?section=64
- MODIS Rapid Response Site
  - http://earthdata.nasa.gov/data/near-real-time-data/rapid-response
- NASA's Visible Earth
  - http://visibleearth.nasa.gov
- NASA's Earth Observatory
  - http://earthobservatory.nasa.gov
- NASA's 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

Tour of Some Useful Image Archives

- **Earth Observatory**
  - http://earthobservatory.nasa.gov



- **Worldview: Near Real-Time**
  - http://earthdata.nasa.gov/labs/worldview

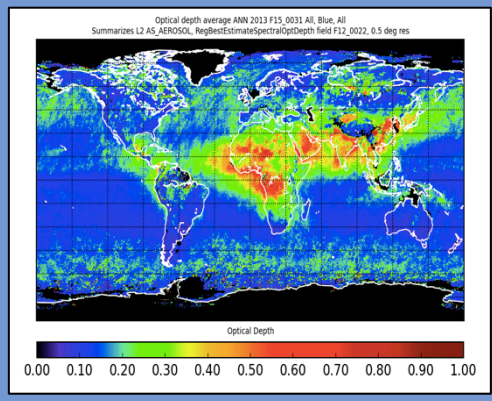



NO ASSIGNMENTS

Next Week

NASA Aerosol Products for Particulate Matter Air Quality

- Remote sensing of aerosols,
- NASA satellite aerosol products, and
- Aerosol products as a surrogate for PM2.5



Week 3: Aerosol Data

All the materials and recordings will be available at

http://arset.gsfc.nasa.gov/airquality/webinars/introduction-satellite-remote-sensing-air-quality-applications

Contact

- Pawan Gupta (pawan.gupta@nasa.gov) for the technical questions
- Brock Blevins (brockbl1@umbc.edu) for material access, future trainings, and other logistic