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

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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)
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
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

<table>
<thead>
<tr>
<th>Primary Use</th>
<th>Band No.</th>
<th>Bandwidth (nm)</th>
<th>Spatial Resolution</th>
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<tbody>
<tr>
<td><strong>Land/Cloud Boundaries</strong></td>
<td>1**</td>
<td>620-670</td>
<td>500m</td>
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<td>2**</td>
<td>841-876</td>
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<td><strong>Land/Cloud Properties</strong></td>
<td>3*</td>
<td>459-479</td>
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<td>4*</td>
<td>545-565</td>
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<td>5*</td>
<td>1230-1250</td>
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<td>6*</td>
<td>1628-1652</td>
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<td>7*</td>
<td>2105-2155</td>
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<td><strong>Ocean Color/Phytoplankton/Biogeochemistry</strong></td>
<td>8</td>
<td>405-420</td>
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<td>438-448</td>
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<td>862-877</td>
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<td><strong>Atmospheric</strong></td>
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<td>890-920</td>
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<td><strong>Water Vapor</strong></td>
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<td>931-941</td>
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<td></td>
<td>19</td>
<td>915-965</td>
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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

Sahara dust
Wildfire smoke
Urban-industrial/smoke pollution?
Smoke from Alaskan wildfires (2004)
Using Time Series Imagery

Dust Transport

April 6, 2013; Images from NASA Worldview
Terra: ~10:30 a.m.

Aqua: ~1:30 p.m.

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

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\begin{align*}
R &= 1.6 \, \mu m \\
G &= 1.2 \, \mu m \\
B &= 2.1 \, \mu m
\end{align*}
\]
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

• MODIS Rapid Response Site

• NASA’s Visible Earth
  – http://visibleearth.nasa.gov

• NASA’s Earth Observatory
  – http://earthobservatory.nasa.gov

• NASA’s Earth Observations (NEO)

• MODIS-Atmos (MODIS Atmosphere Product Reference Site)

• 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
All the materials and recordings will be available at


Contact
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- Brock Blevins (brockbl1@umbc.edu) for material access, future trainings, and other logistic