



Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Introduction to Change Detection

Lecture 2: Image Correction

Instructor: Lila Leatherman (they/them)

November 17-18, 2021

Course Agenda

- Day 1 – Morning
 - 10:00-10:45 – Presentation: Course overview and image selection and preparation
 - 10:30-10:45 – Demonstration: Overview of GEE
 - 11:00-11:10 – Break
 - 11:10-11:30 – Presentation: Image correction
 - 11:30-12:00 – Demonstration: Creating cloud-free composites in EE

Tasks to complete before the next session: Exercise 1 + 2

- Day 1 – Afternoon
 - 2:00-2:30 – Presentation: Band ratios and image transformations
 - 2:30-3:00 – Demonstration: Identifying significant landscape change
 - 3:00-4:00 – Q&A and Exercise Help

Tasks to complete before next session: Exercise 3

Lecture outline:

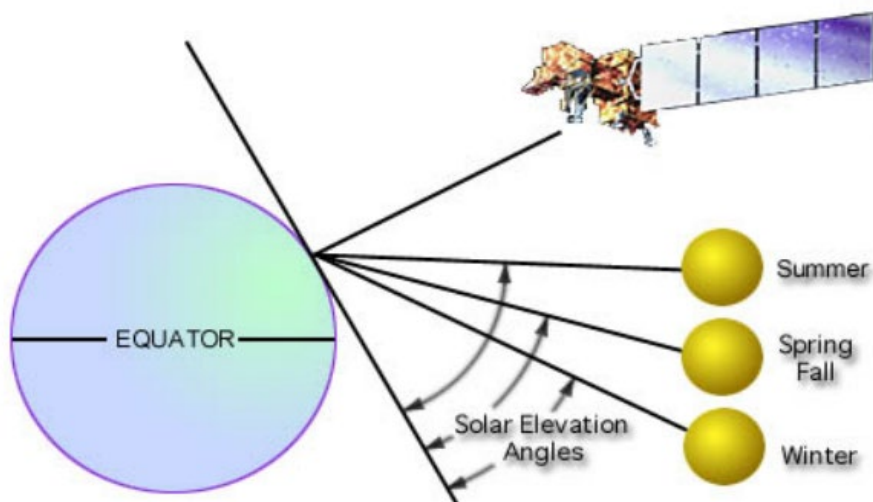
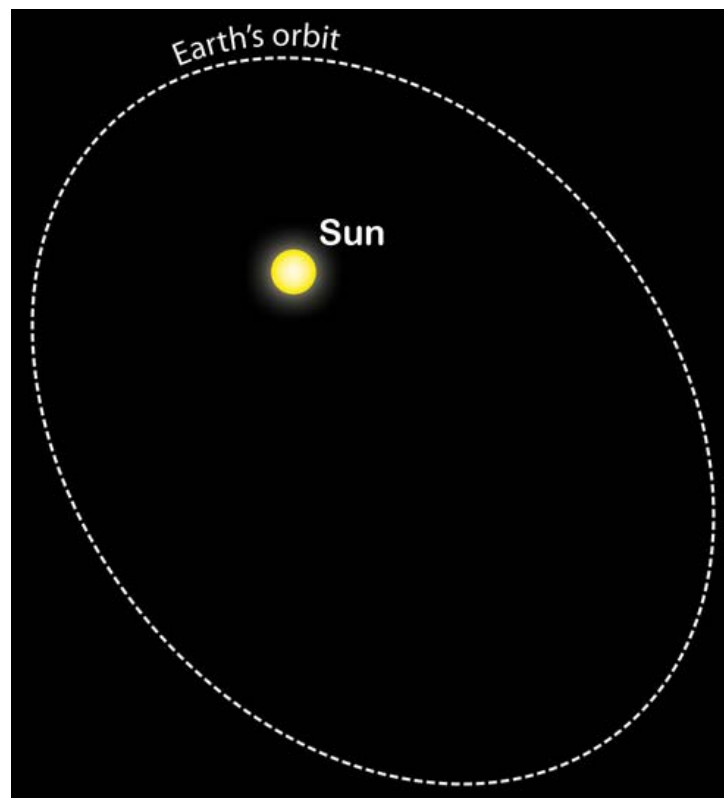
- Goals of image correction
- Components of image correction
 - Earth-sun-sensor relationships
 - Atmospheric effects
 - Surface reflectance
 - Cloud-masking
- Demo of image correction in GEE

Image Pre-processing

- **Goal:** Ensure that each pixel records the same type of measurement at the same geographic location through time
 - **Assumption:**
 - Spectral properties of non-changed areas are stable
 - **Motivation:**
 - Inadequate pre-processing results in false positives

Earth-Sun-sensor relationships

- Variable through time
- Influence incident EMR
 - Earth-sun distance
 - Solar incident angles
 - Sensor position



Reflectance at Top-of-atmosphere

- First correction:

Digital Numbers → Radiance → Reflectance (TOA)

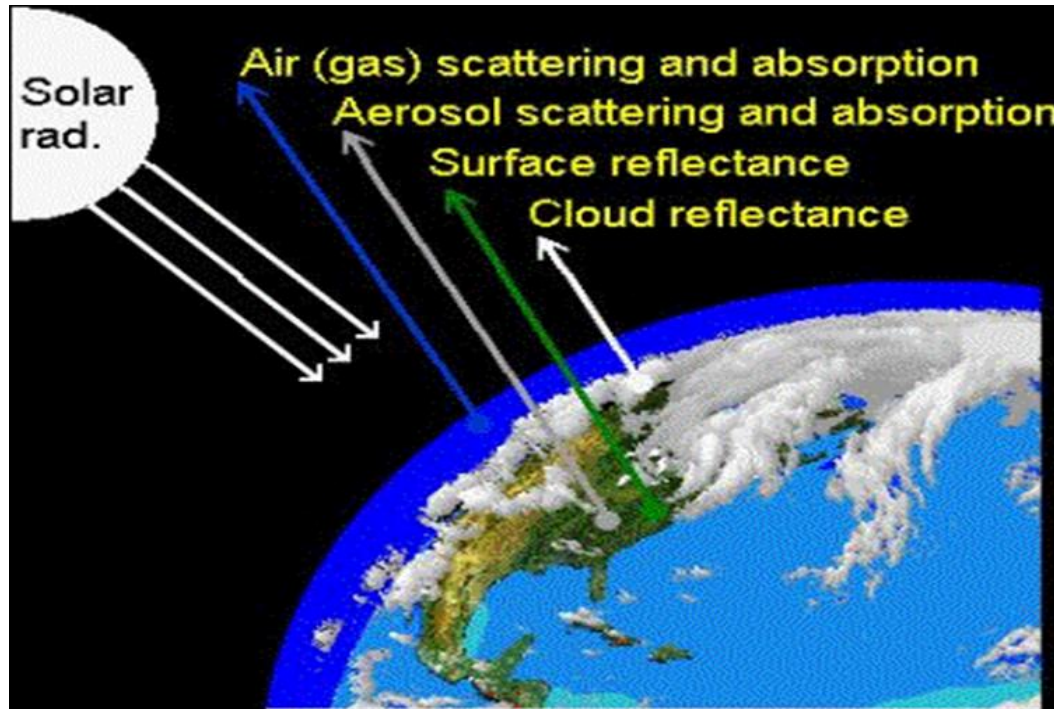
- Calculated using:

- Sensor calibration coefficients
- Earth-sun distance
- Mean solar exo-atmospheric irradiance
- Solar zenith angle

Top of atmosphere reflectance differs from surface reflectance...

Atmospheric Effects

- Another source of 'noise'
- Atmosphere selectively scatters, absorbs and transmits light



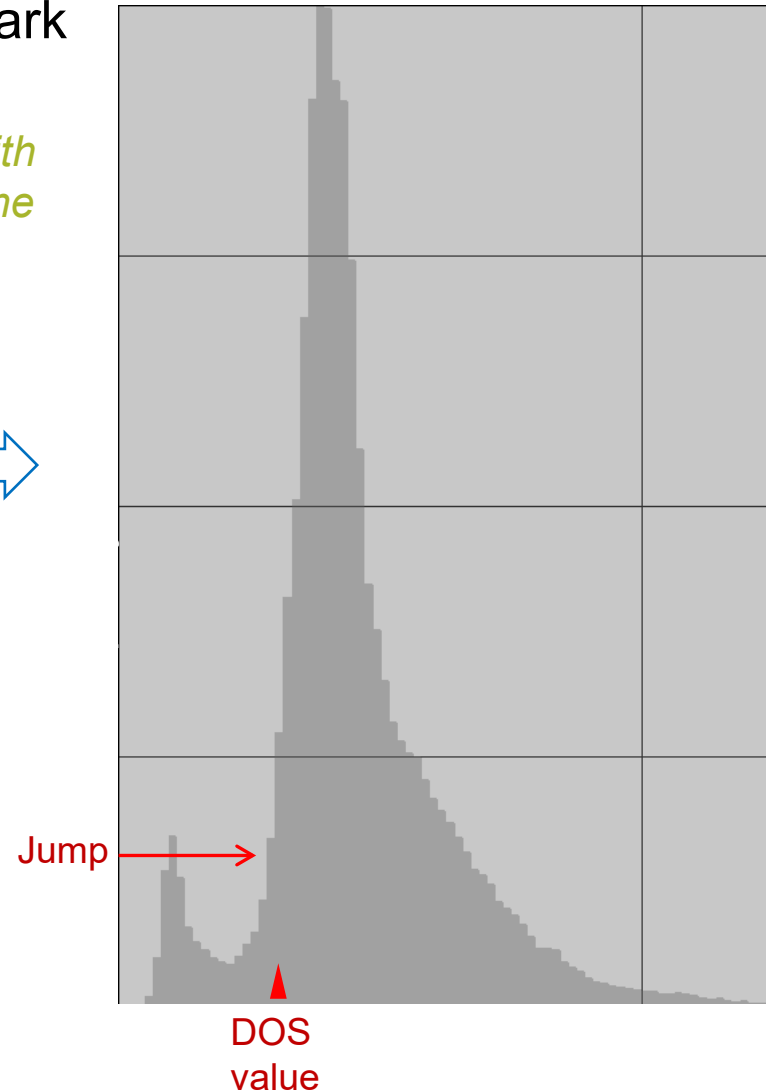
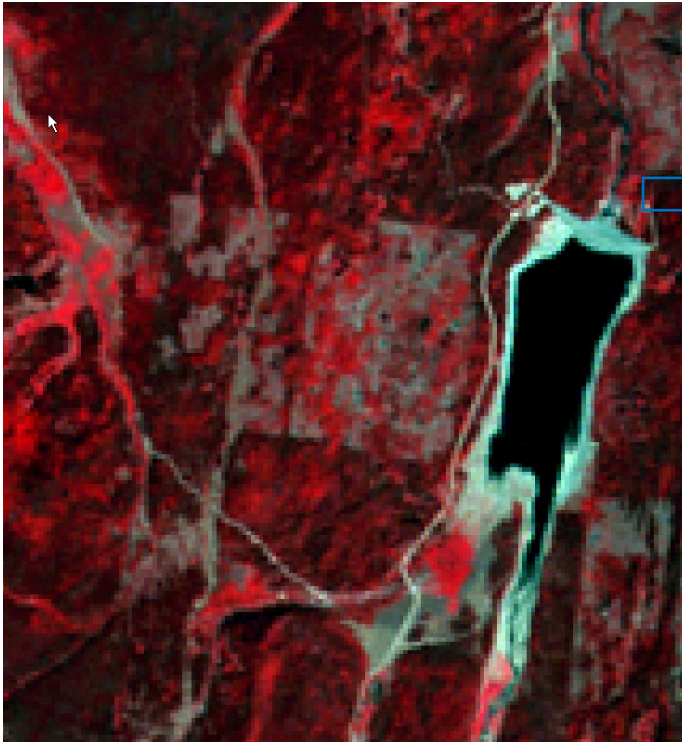
Surface Reflectance Correction Methods

- A few approaches:
 - Dark object subtraction (DOS)
 - Atmospheric modeling
 - Radiative transfer models
 - Image-to-image normalization
 - Histogram matching
 - Regression using pseudo-invariant features

Dark object subtraction (DOS))

- Dark objects can be deep lakes or very dark shadows

DOS involves identifying the value associated with these areas and subtracting it from all pixels in the image.





Masking

- Clouds and their shadows
 - Lead to false positives in change detection.
- Snow and water
 - Seasonal variation
 - Result in false positives (If not part of your research question)

Masking

Cloudy Landsat image

-  **Clouds**
-  **Shadows**

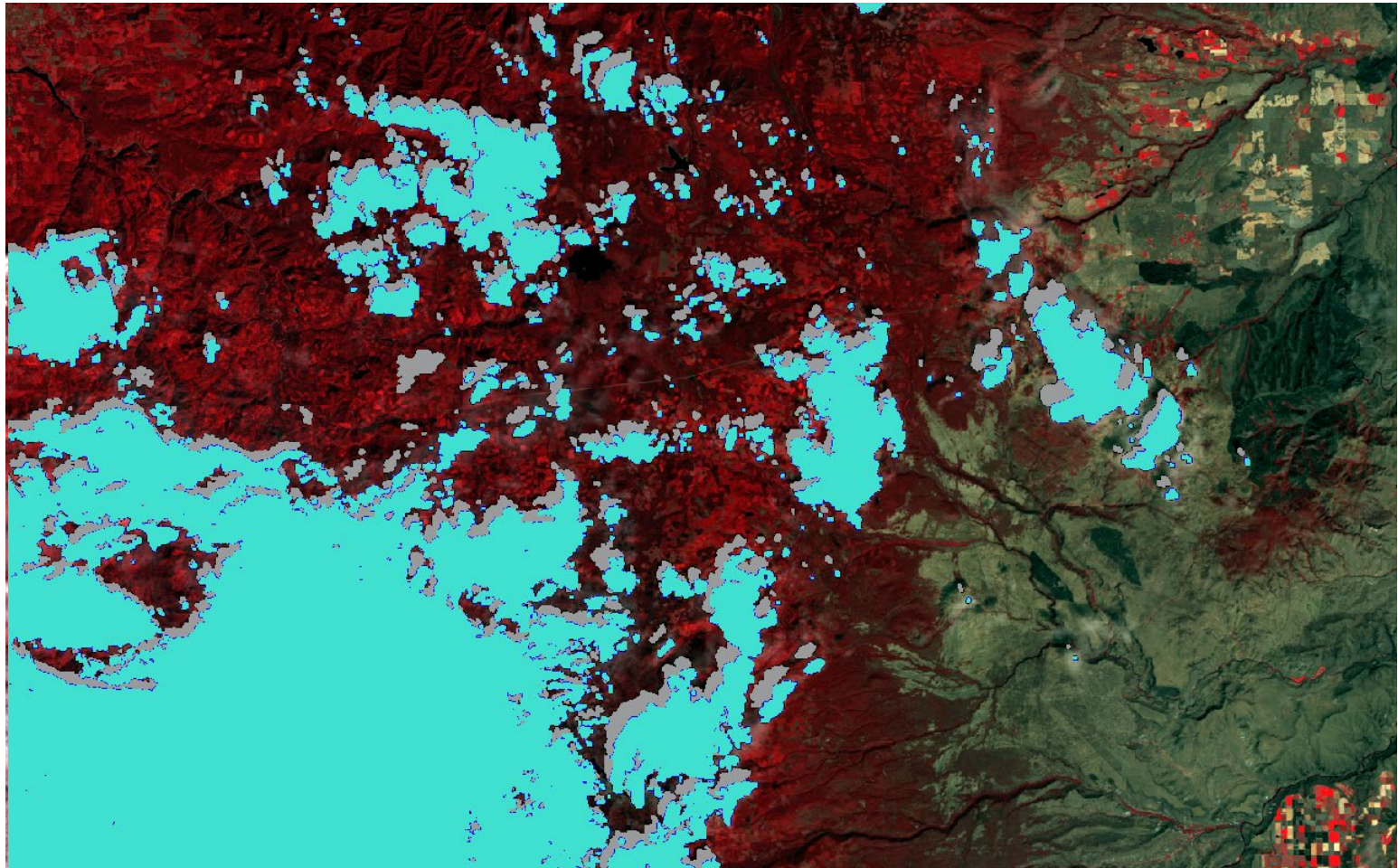


Image preprocessing

- Function Mask (fmask)
 - Apply a function to identify clouds, shadows and water- *Memory intensive process*
 - Available in GEE, Matlab, Python, etc.
- GEE Landsat cloudscore algorithm
 - Function applied in GEE
- GEE Sentinel-2 Cloud probability layer
 - Dataset stored in GEE

Image pre-processing

- Google Earth Engine can do all of the heavy lifting for us!
- Eliminates the manual processing steps
- Exercises 1 + 2 – creating cloud-free composites in GEE



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Demonstration

Exercise 2: Cloud-free composites in GEE