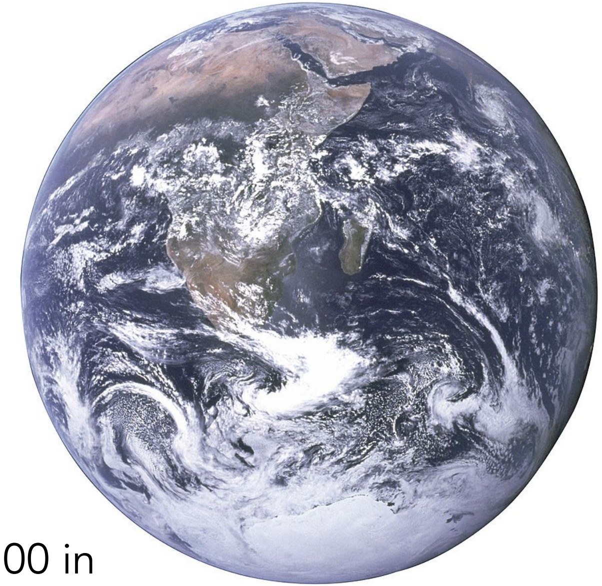
Remote Sensing 1: GEOG 4/585

Lecture 1.1.

Introduction



Johnny Ryan (he/him/his)
jryan4@uoregon.edu
Office hours: Monday 15:00-17:00 in
165 Condon Hall

Welcome

Dr. Johnny Ryan, Assistant Professor of Geography

- BSc in Geography at University of Nottingham, UK
- MPhil in Polar Studies at University of Cambridge, UK
- PhD in Geography at Aberystwyth University, UK

- I'm brand new!

- Researching glaciology, hydrology, remote sensing

- Outside of work... running, cycling, exploring the outdoors, my dog

Email: jryan4@uoregon.edu
Office: 165 Condon Hall
Office hours: Monday 15:00-17:00 (or by appointment)

Welcome

Adriana Uscanga Castillo (GE)

- Email: adrianau@uoregon.edu
- Office: 247 Columbia
- Office hours: Monday 10:00-11:00 (or by appointment)

COVID Policies

- All classes will be held in person in accordance with the latest university policies
- Mask wearing is mandatory indoors for all students
- Please do not come to class or lab if you are feeling sick or have been notified of a close COVID exposure.
- Let me and/or your GE know if this happens and we will work with you to make up the missed materials.

COVID Policies

Time to get to know your neighbors!

- Please introduce yourself with:
  - your name
  - your year
  - where you’re from
  - your favorite place to eat in Eugene

Overview

- What is remote sensing?
    - Sensors, platforms, and data
    - Some applications

- What happens in class?
    - Objective, schedule
    - Prep, lectures, assignments

- Course overview
    - Lecture structure

- Labs and grading

- Some basic remote sensing concepts

What is remote sensing?

"Remote sensing is the science of obtaining reliable information about a physical object or phenomenon without making physical contact with it"

- Broadly there are two types of remote sensing:
  - "Passive" when the energy emitted by an object is detected by the sensor
  - "Active" when the sensor provides its own source of energy to illuminate an object and measures its reflected properties
- And while we most of this class will focus on electromagnetic energy (visible, thermal, microwave), we can also use acoustic (sonar, ultrasound) and gravitational energy.

Remote sensing instruments are everywhere

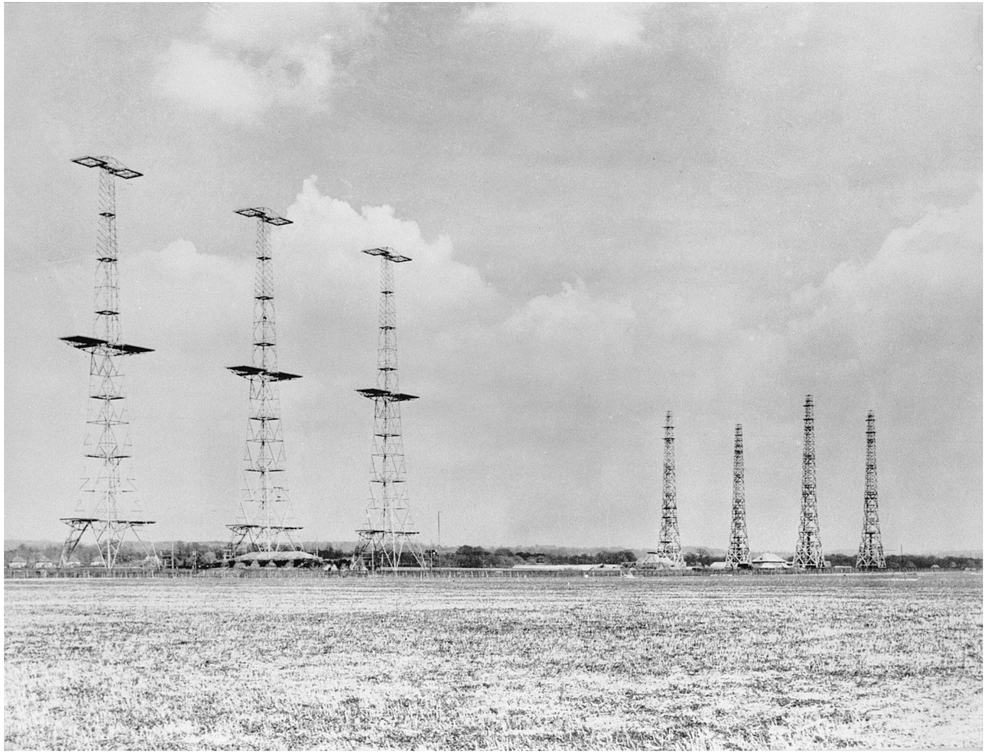
Passive remote sensing

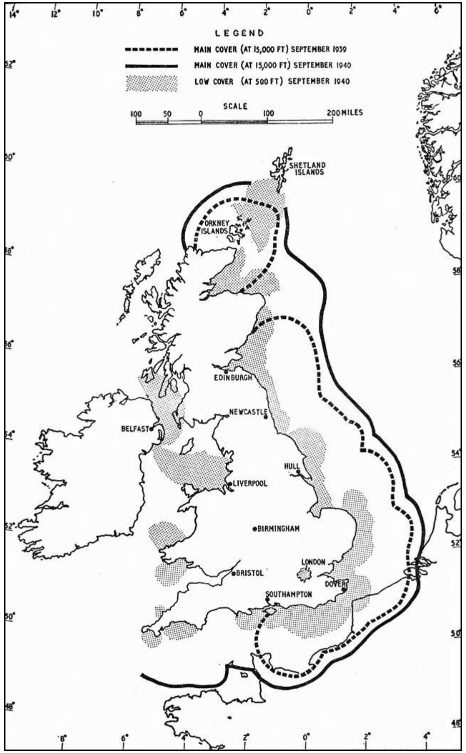
Active remote sensing

Active or passive remote sensing?

Infrared thermometer

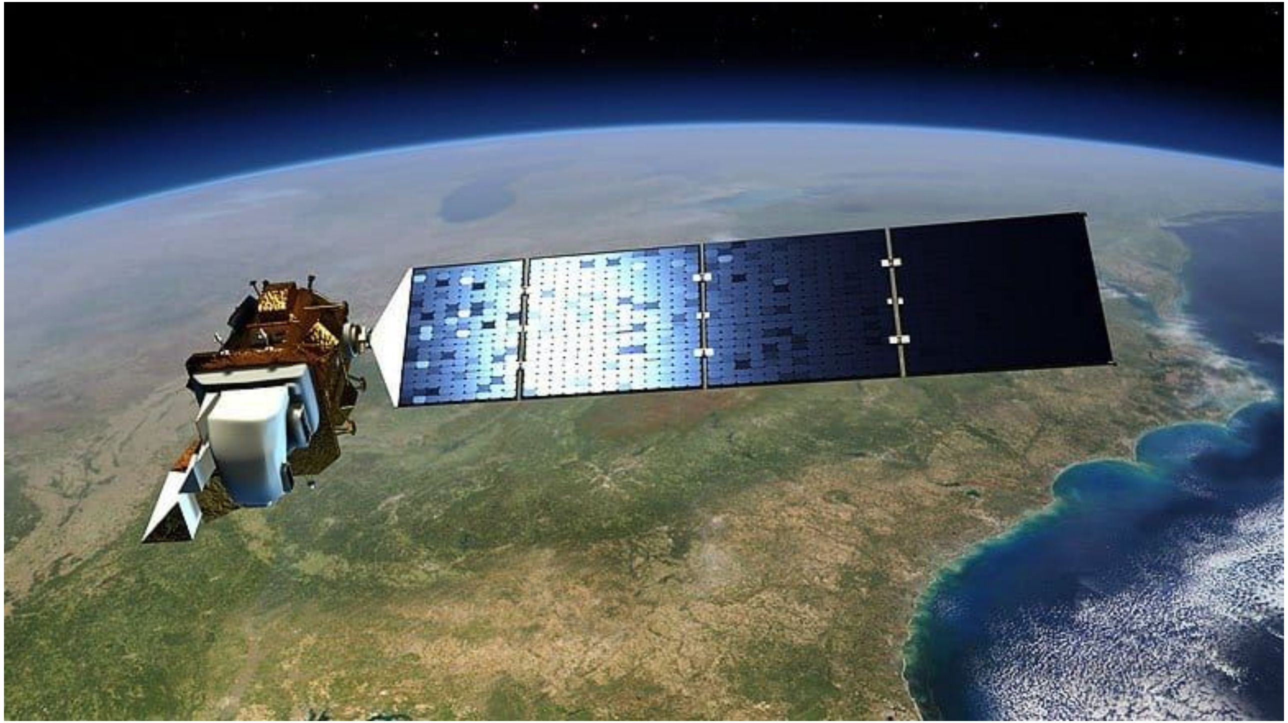
Active or passive remote sensing?





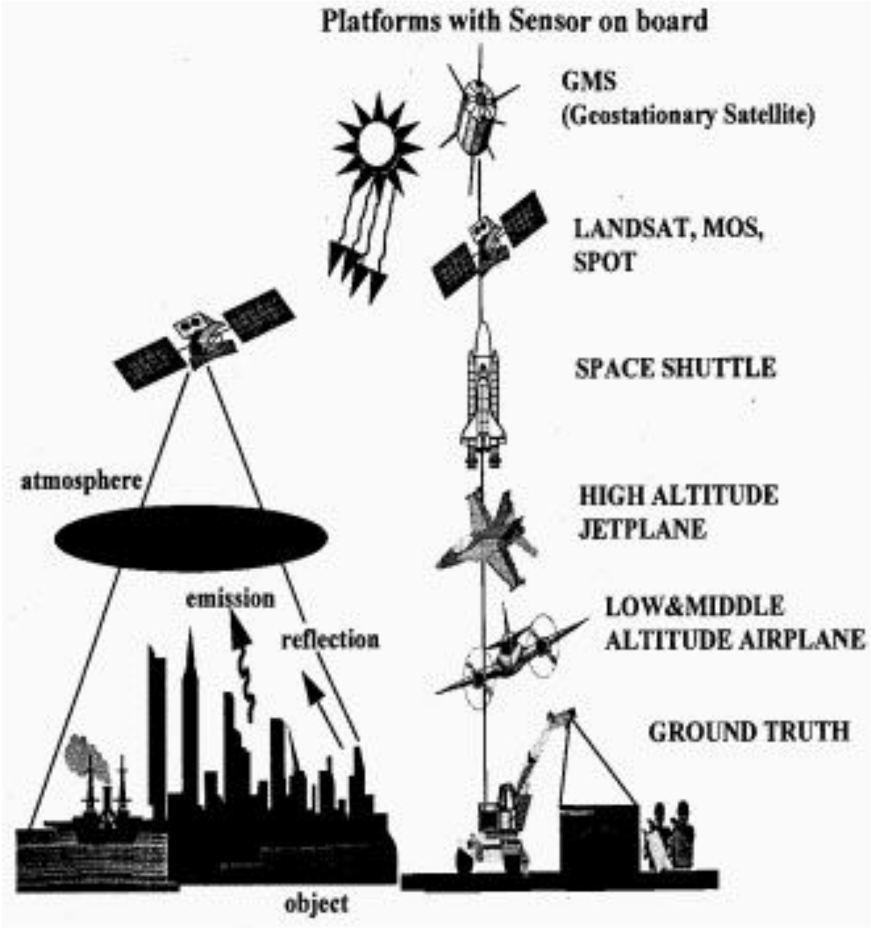
Chain Home radar installation, Sussex (1945)

Active or passive remote sensing?

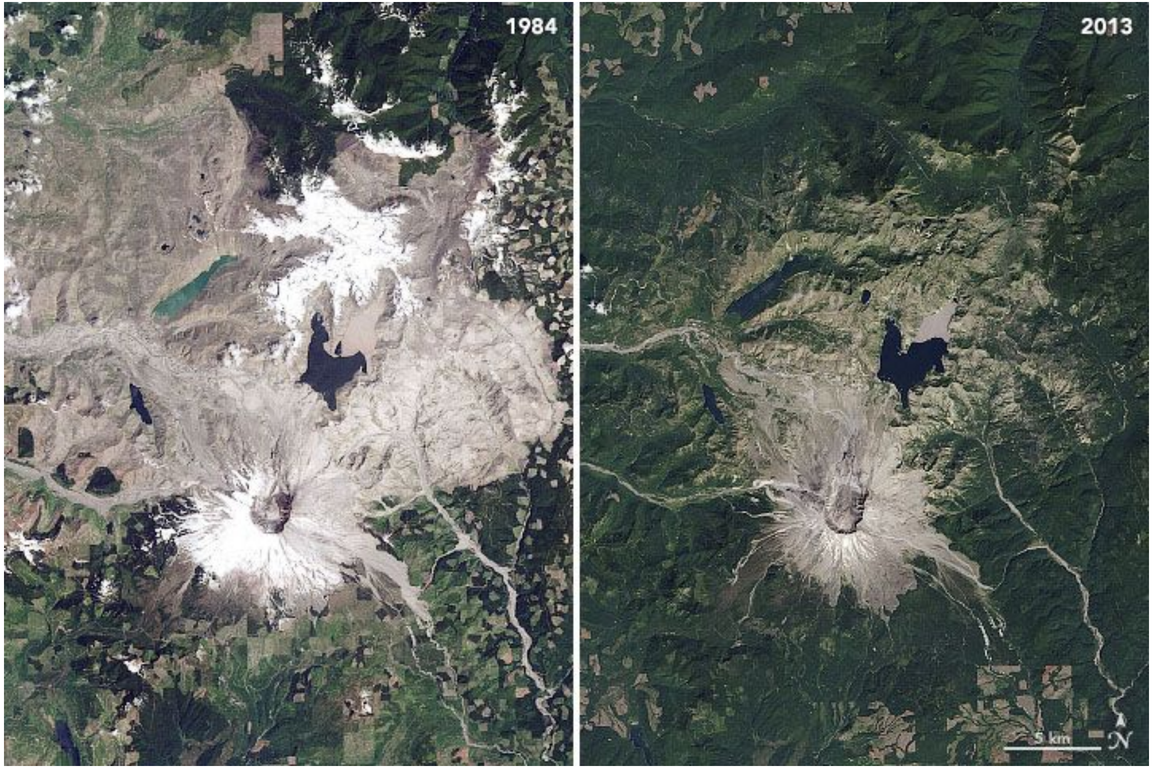


NASA’s Landsat 8

Remote sensing platforms

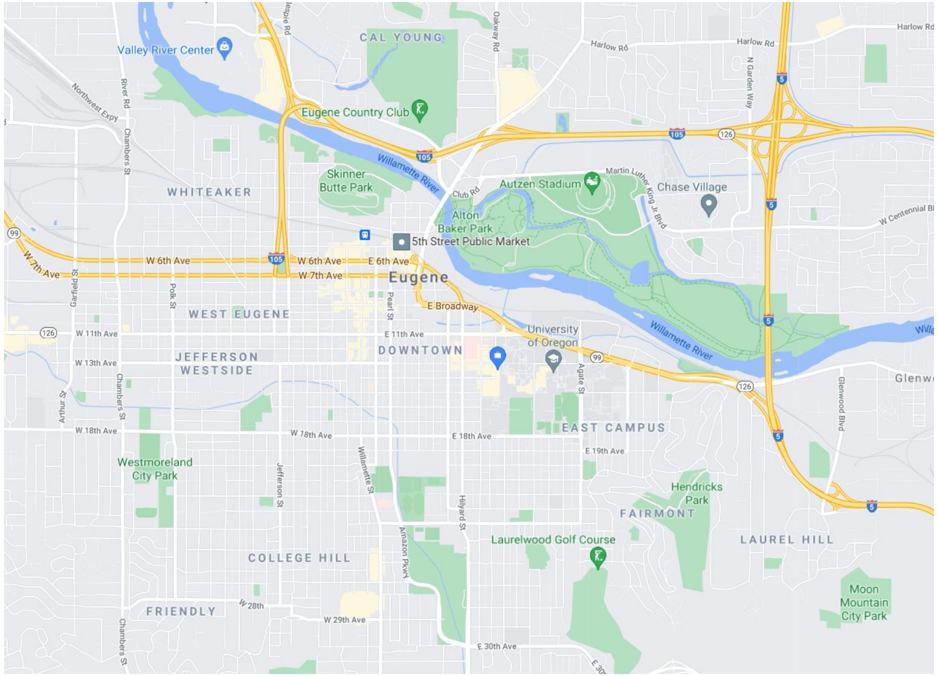


Remote sensing data



Mount St. Helens in 1984 and 2013

Cartography vs. remote sensing



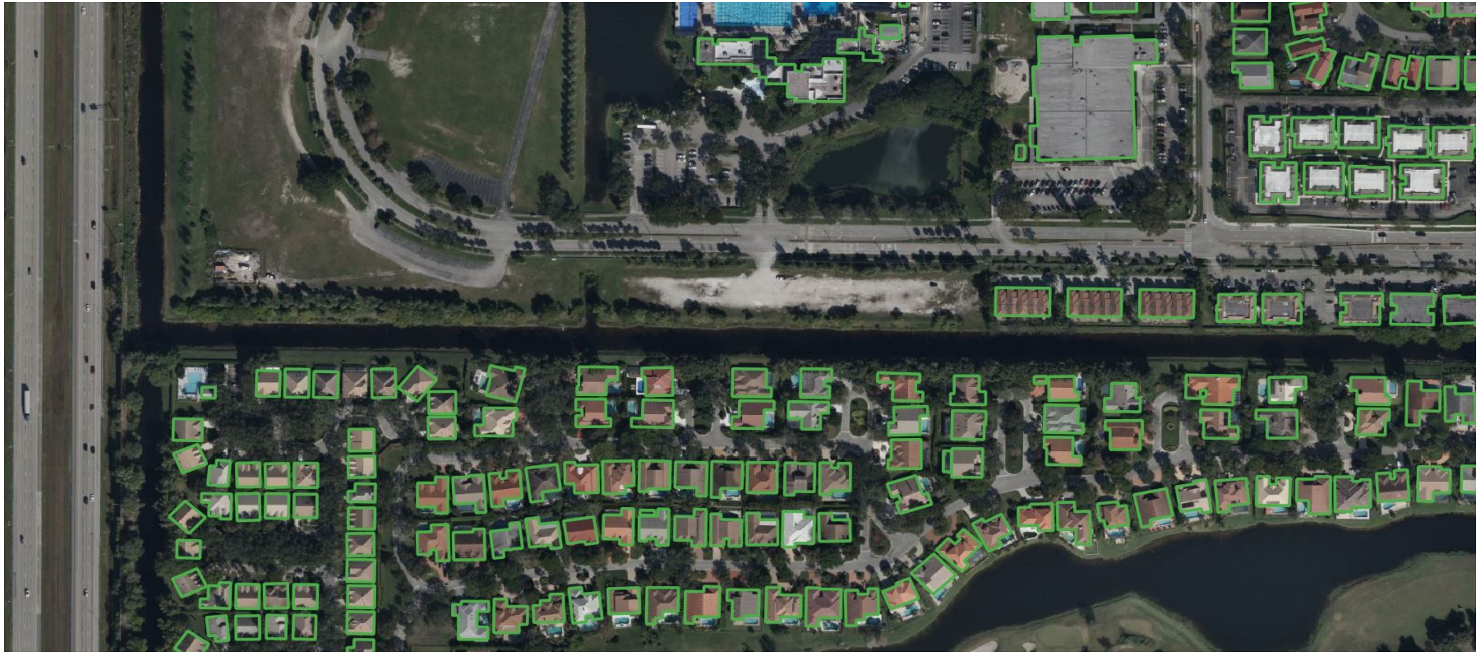
Google Maps 'Default'

Google Maps 'Satellite'

Remote sensing applications: Ecology

- Conservation (e.g. identifying penguin colonies, counting seals etc.)

Remote sensing applications: Built environment



- Development studies (e.g. urban growth, refugee camps)
- Disaster relief (e.g. property at risk of wildfires, flooding and other natural disasters)

Remote sensing applications: Night-time lights

- Conservation (e.g. monitoring fishing effort, illegal logging)
- Socioeconomic studies (e.g. economic activity from industrial development)
- Disaster relief (e.g. power outages after hurricanes)

What happens in this class?

- Reading - become familiar with concepts and prepare questions
- Lectures - learn about remote sensing concepts with your peers, opportunity to ask questions about the course materials
- Labs - applied work using a variety of datasets with short questions
- Exams - three quizzes, one final
- Grad student project

Reading

- Principles of Remote Sensing: an Introductory Textbook.
  - K. Tempfli, G.C. Huurneman, W.H. Bakker, L.L.F. Janssen, et al.
    Fourth edition

- Link to PDF on Canvas (Assignments → Reading for Week 2)

- Download and save somewhere accessible, it is a large file.

Lectures

- Monday and Wednesday 9:00-9:50 in 285 LIL
- 17 lectures, 2 grad student presentations, 1 missed due to Thanksgiving
- Lectures will be posted on Canvas in the same week

Labs

- Wednesday at 10:00-11:50 <u>or</u> 13:00-14:50 in 442 MCK

- Lab assignments are due Tuesday 11:59 pm (i.e. before the start of the next lab)

- Software
  - QGIS, open-source GIS software

- Online remote sensing services
  - Earth Explorer
  - Google Earth Engine

- Please let one of the instructors know if you are having any problems at all in time, technology, or space access to the needed materials and computing resources for the class!

Exams

- Three quizzes posted on Canvas given at the beginning of Week 3, 5 and 7
- Also due Tuesday 11:59 pm (i.e. before the start of the next lab)
- One final exam at the end of the quarter

Grading

- Labs (50%): Turn in assignments on Canvas.
    - Due Tuesday 11:59 pm (i.e. before the start of the next lab)
    - 10% of the total possible score will be deducted for every day late.

- Quizzes (20%):
    - Three quizzes will be given during the quarter (see Schedule).
    - Due Tuesday 11:59 pm (i.e. before the start of the next lab)
    - Quizzes will be handed out at the end of the lab (Wednesday)

- Final (20%):
    - The final exam at the end of the quarter

- Participation (10%):
    - Half graded by GE and half by the Professor.
    - Credit can be earned through attendance in lectures, participation in class discussion, visiting Professor and GE during office hours, and helping other students in labs.

Grad student project

- Please discuss your plans with the course instructor before the end of Week 7 (Nov 12) before you start any major work.

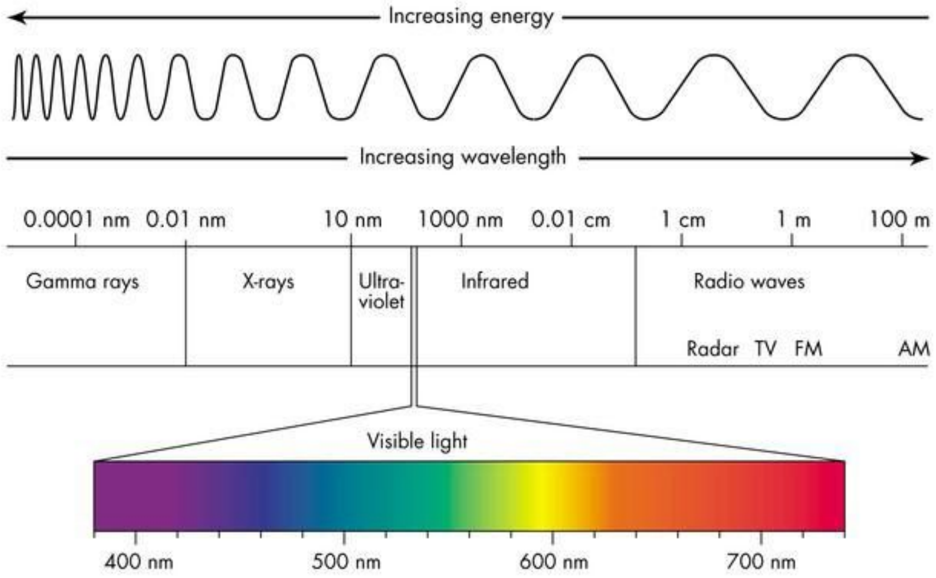
- Task 1:
  Present your project to the class during Week 10 (Nov 29 or Dec 2) of the term. This should consist of around 10-15 slides illustrating the project purpose, methods, and results (or anticipated results). Presentations should be 12-15 minutes long. Please upload slides to Canvas by Nov 28 11:59pm.

- Task 2:
  Submit a write-up to Canvas by Dec 5 11:59 pm describing the input data, analysis steps, summary of the results, and suggestions for improving the project through better data or more effective analysis (or a literature review on a specific remote sensing topic). This report should be no longer than 2,000 words (excluding references) and contain at least the following sections:

Course schedule: Weeks 2-3

- Physics of remote sensing
  - Electromagnetic energy
  - Electromagnetic energy interactions with atmosphere and surface

- Sensors and platforms
  - Basics of image sensing
  - Satellite and airborne
  - Orbits
  - Ground systems



Course schedule: Weeks 4-5

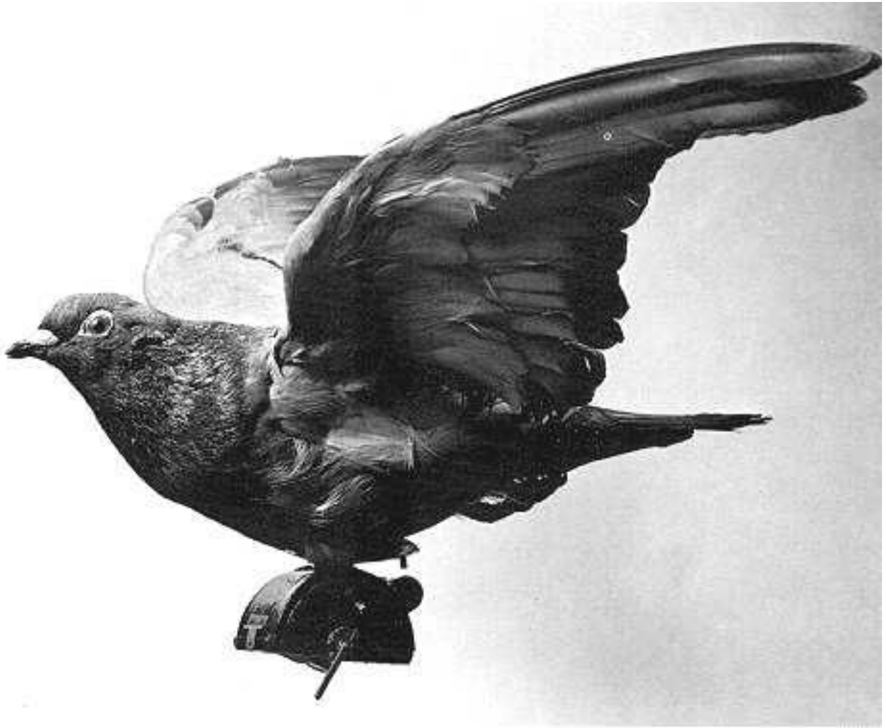
- Image classification
  - Supervised, unsupervised
  - Accuracy assessment

- Atmospheric correction and change detection
  - Haze correction
  - Cloud detection
  - Radiance, top-of-atmosphere, surface reflection

Course schedule: Weeks 6-7

- Other types of remote sensing
  - LiDAR
  - Radar

- History and future of remote sensing
  - Google Earth Engine
  - Landsat program
  - Commercial space sector



Course schedule: Weeks 8-9

- Uncrewed aerial vehicles
  - Design, capabilities, applications
  - Stereophotogrammetry

- Remote sensing of snow and ice
  - Intro to my research

Course schedule: Week 10

- Grad student project presentations

Basic remote sensing concepts

Basic remote sensing concepts

<u>Spatial resolution</u>

- Linear dimension on the ground represented by each pixel or the size of the smallest feature that can be detected

<u>Spectral resolution</u>

- Number of dimensions (or bands) of a specific electromagnetic wavelength to which a remote sensing instrument is sensitive; also, range of those channels

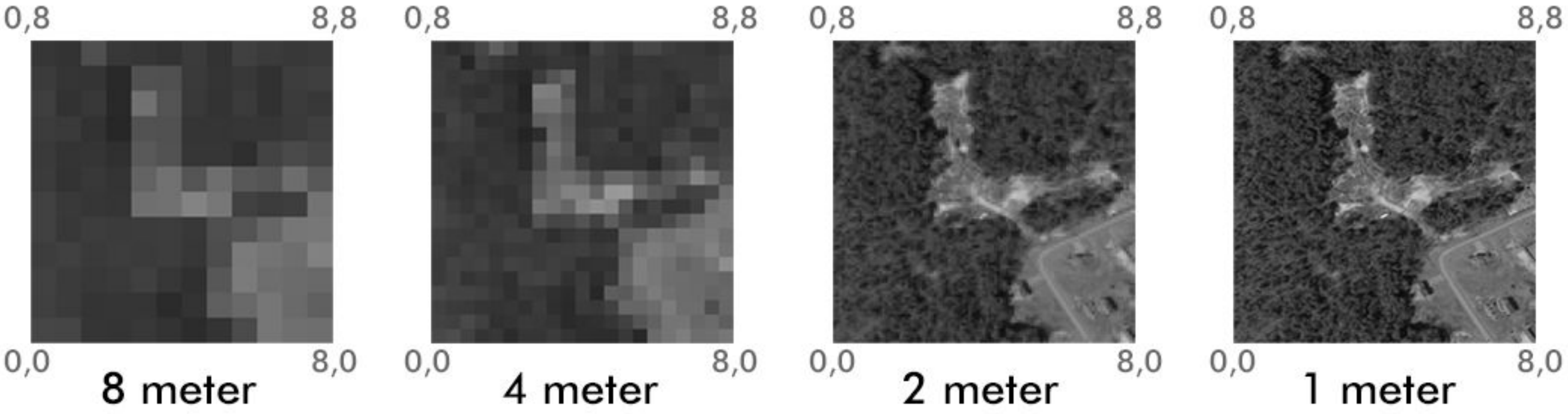
<u>Radiometric resolution</u>

- Ability to detect fine energy differences (precision, e.g., like the number of marks on a ruler)

<u>Temporal resolution</u>

- Time interval between image acquisitions of a particular area (i.e. revisit time)

Spatial resolution



- Low resolution: over 60m/pixel
- Medium resolution: 10 – 30m/pixel
- High to very high resolution: 30cm – 5m/pixel

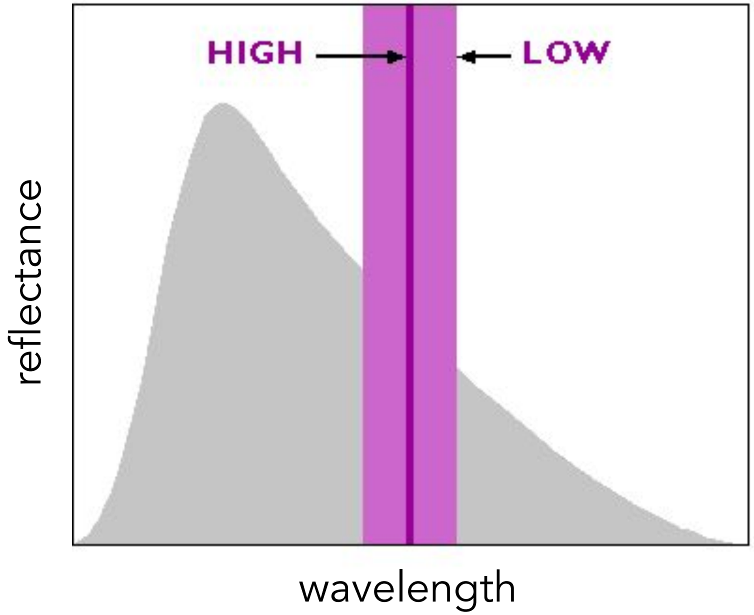
0.5 m	20 m
Better resolution	*Worse resolution*

Spectral resolution

- Number and width of a specific wavelength to which a remote sensing instrument is sensitive

- Ranges from 1 to literally thousands for an instrument

36 bands	4 bands
10 nm bandwidth	100 nm bandwidth
Better resolution	*Worse resolution*



Spectral resolution

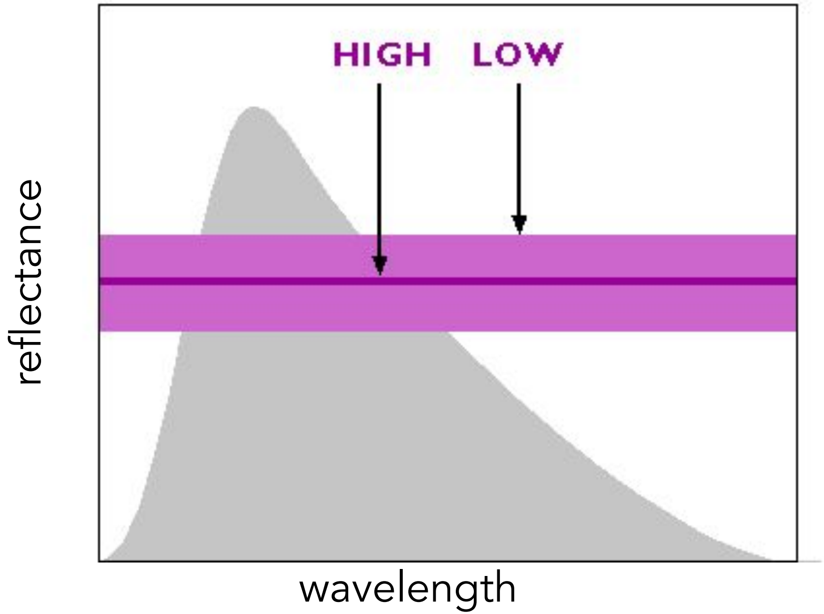
Good spectral resolution

Poor spectral resolution

Radiometric resolution

- Sensitivity of a detector to differences in signal strength
- Ability to discriminate very slight differences in energy
- Usually the binary system is used

8-bit	2-bit
Better resolution	*Worse resolution*



Radiometric resolution

Digital numbers/information can only be stored in a false (0) or true (1) scheme

- 1-bit; $2^1 = 2$
- 2-bit; $2^2 = 4$
- 8-bit; $2^8 = 256$
- 12-bit; $2^{12} = 4096$

2-bit ($2^2 = 4$ digital numbers, 4 gray scales)

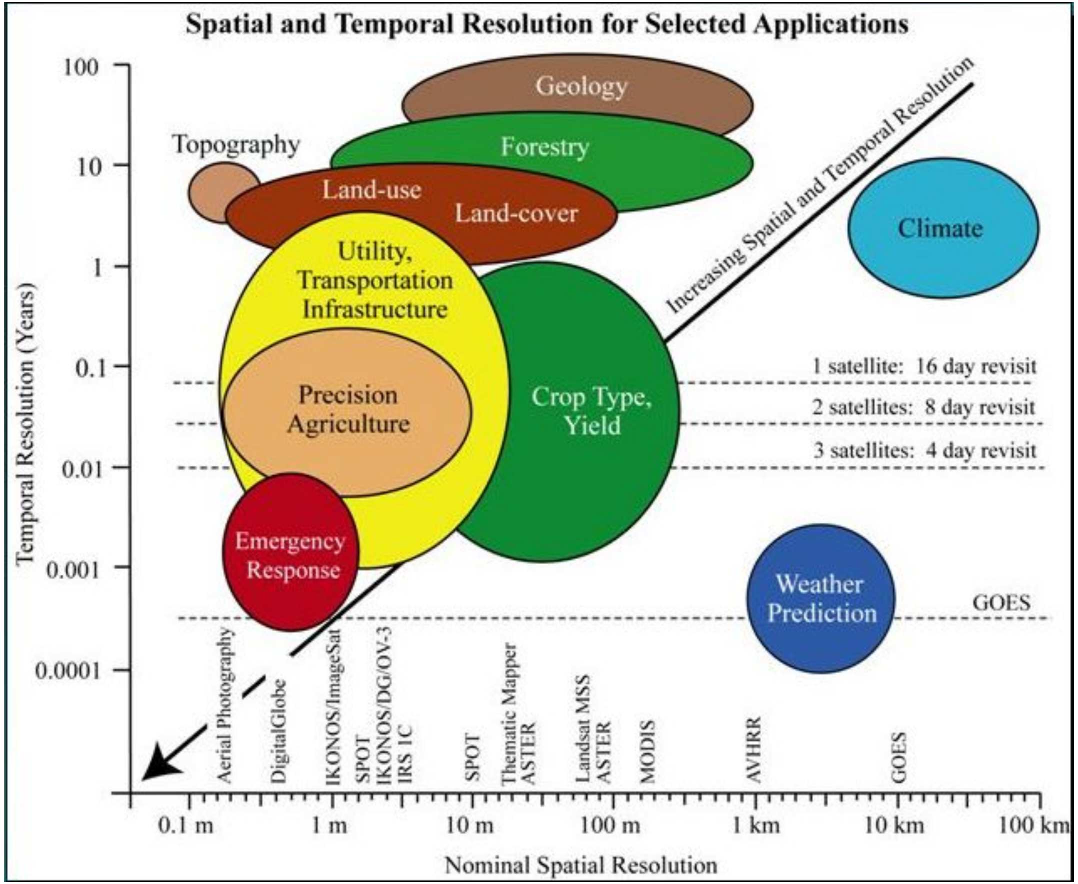
8-bit ($2^8 = 256$ digital numbers, 256 gray scales)

Temporal resolution

- Time interval between image acquisitions of a particular area
- Especially important for meteorological observations, natural hazards or other rapidly changing phenomena
- Factors determining temporal resolution: satellite/sensor capabilities, swath overlap, latitude.
- Factors affecting <u>actual</u> temporal resolution also include clouds, sunglint, failures

1 day	1 month
Better resolution	*Worse resolution*

Trade-off between spatial and temporal resolution



Summary

- Spatial resolution: pixel size
- Temporal resolution: revisit time
- Spectral resolution: number and range of bands
- Radiometric resolution: sensitivity; shades of grey

BUT:
We can't have it all!
Trade-offs between resolutions

- Better spatial resolution = less light collected = worse radiometric resolution
- Better temporal resolution = less time spent collecting light = worse spatial resolution

- Better spatial and spectral resolution = larger file sizes
- Data size = # images * # rows * # columns * bit depth
- Data storage limitation