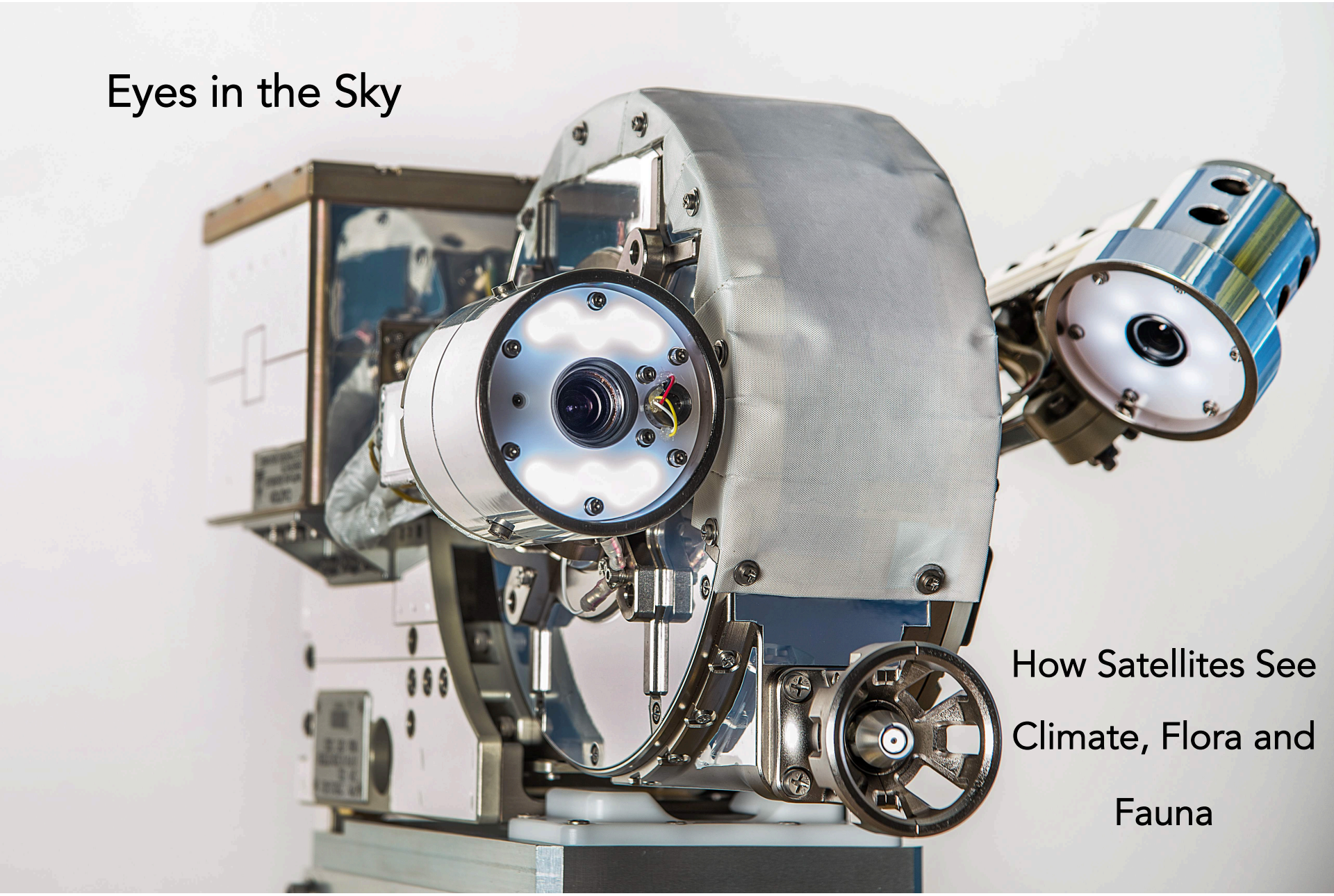
Eyes in the Sky



How Satellites See Climate, Flora and Fauna

Before we get started

- Install HomeBrew from http://brew.sh/
- Download ImageJ from http://rsbweb.nih.gov/ij/download.html
  - Select the installation bundled with Java

Let's access some data!

- On Firefox, go to glovis.usgs.gov
  - Username: ase2016
  - Password: space2016
- On **Map Layers,** select **All Layers**

Set an Intention

- There's a lot of data in these archives, so we want to focus on an interesting place and time period.
- Focus on the area you've lived in for most of the last 5 years.
- Was there a hurricane, earthquake, or other short-term event there recently?
- Was there a forest, or other type of fire? An explosion at a power plant?
- What month and year was this event?

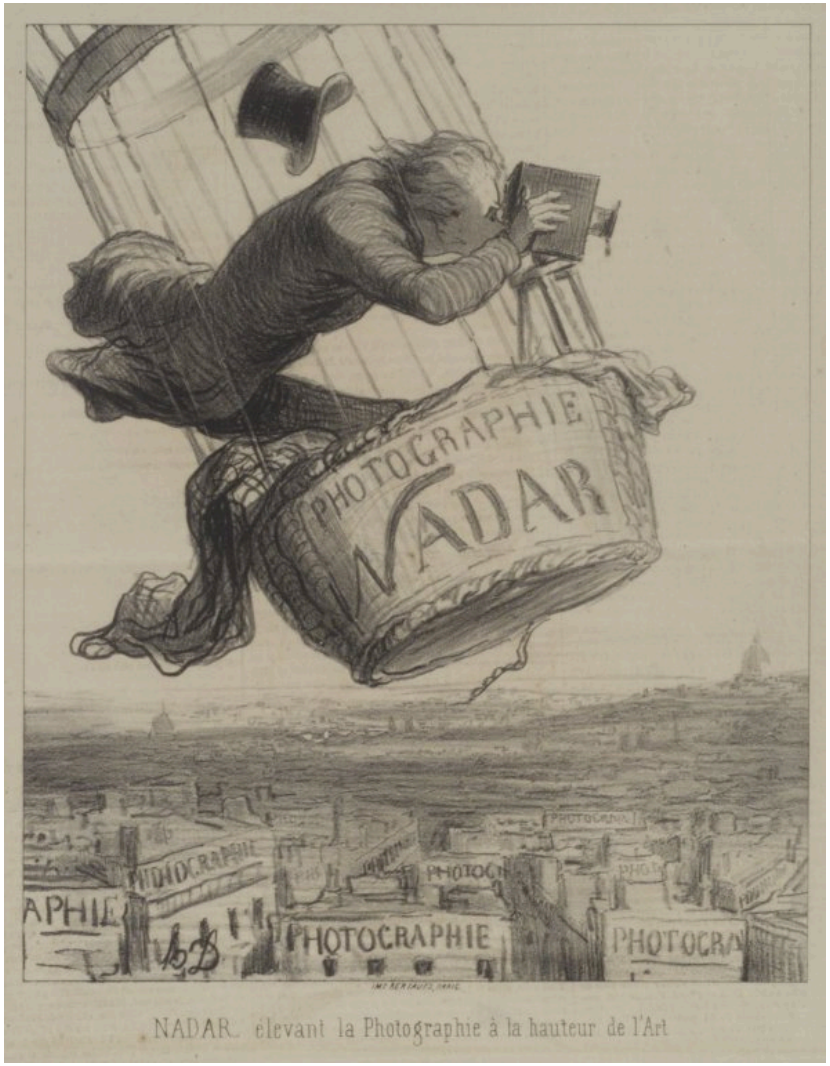
Sorry to be forcing you to remember sad events – but that's where this short tutorial will be most useful. And with these tools, you can help in the future!

Let's access some data!

- On Map Layers, click on "Search for Address"
  - Enter the name of the city and country where you came from
  - In **Tools**, select **Search Limits**
    - Select "Show only downloadable scenes"
  - Select the month of interest.
  - On the bottom left, click "Add"
  - Repeat for 1 scene before and your selected date
- Click **Send to Cart**
- Download everything. The TIFF files will take ~10 min each

Story time!

The Lure of a Bird's Eye View



- Earliest aerial images were taken from balloons, such as *Le Geant* built by Spanish polymath Nadar in 1854
- Key principle: $\theta = \frac{s}{d}$
  - Our eyes always cover a constant **angular** size
  - So if we look farther away, we see more things
- **Field of view** is larger at farther distances

Le Geant

196 foot tall balloon

Sewn by over 300 seamstresses from 220,000 yards of silk

Reached altitude of 4000 ft = 1.22 km

This is how it saw Paris in 1867

More Balloon Photos

"Boston, as the Eagle and the Wild Goose See It"
James Wallace Black, 1860

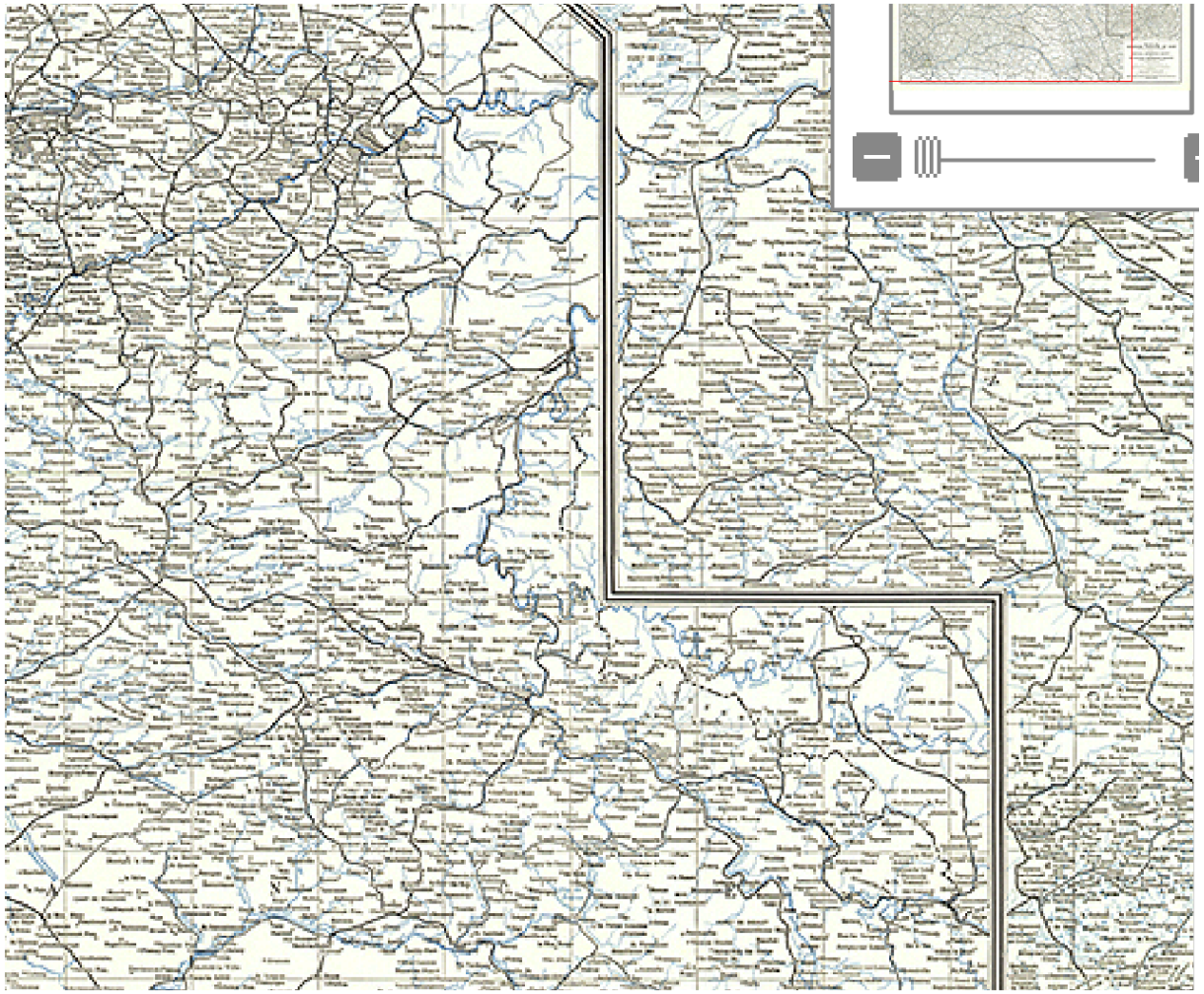
The Giza Pyramid Complex
Eduard Spertelini, 1904

Adding Depth to Width: Stereoscopy

Activity Break – Let's Make a Stereograph!

Wide field + depth = great maps!

During World War I, people realized that aerial images enhanced cartography

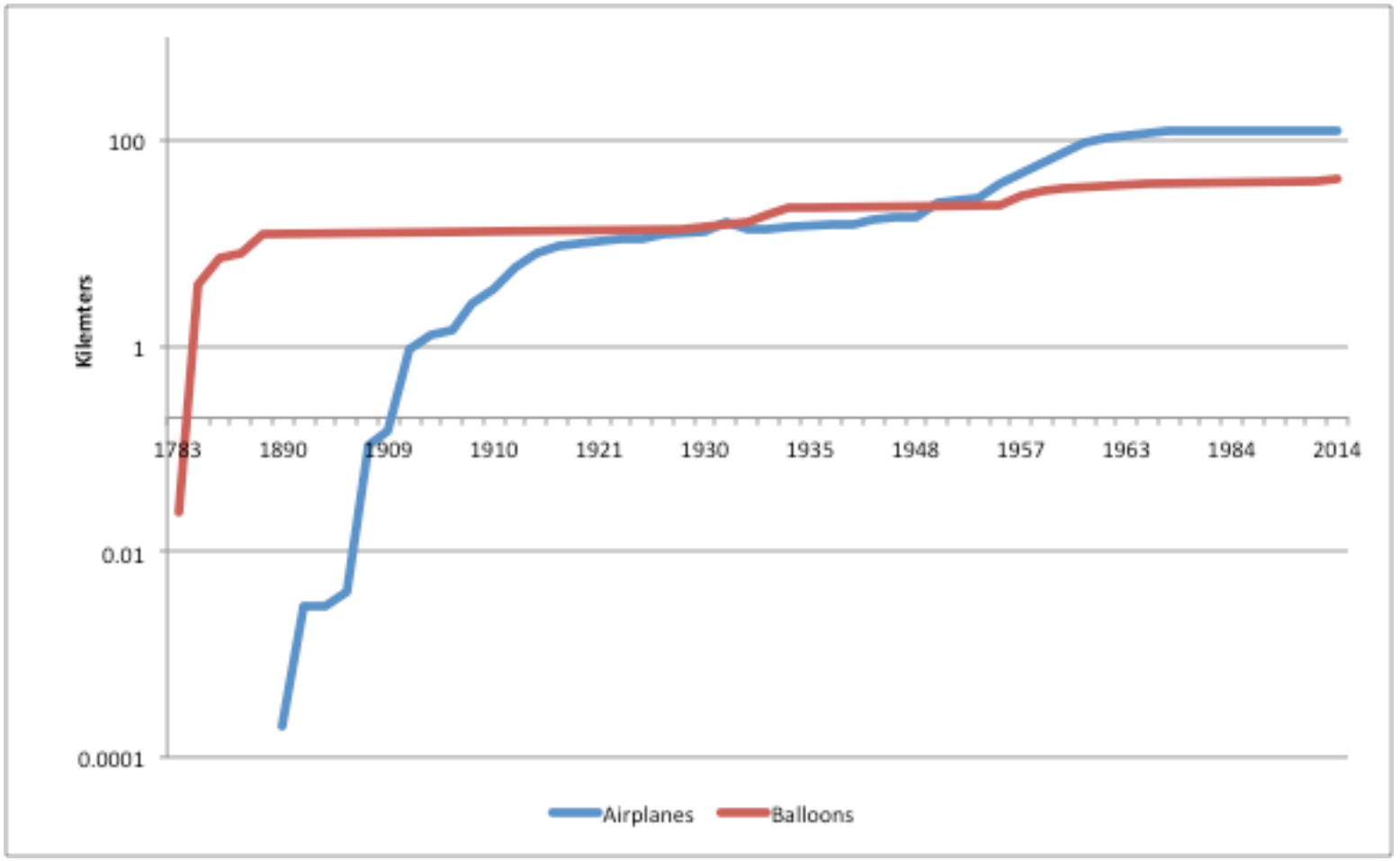


Checkpoint 1

Aerial Imaging Allows us
Width **and** Depth
of Perception

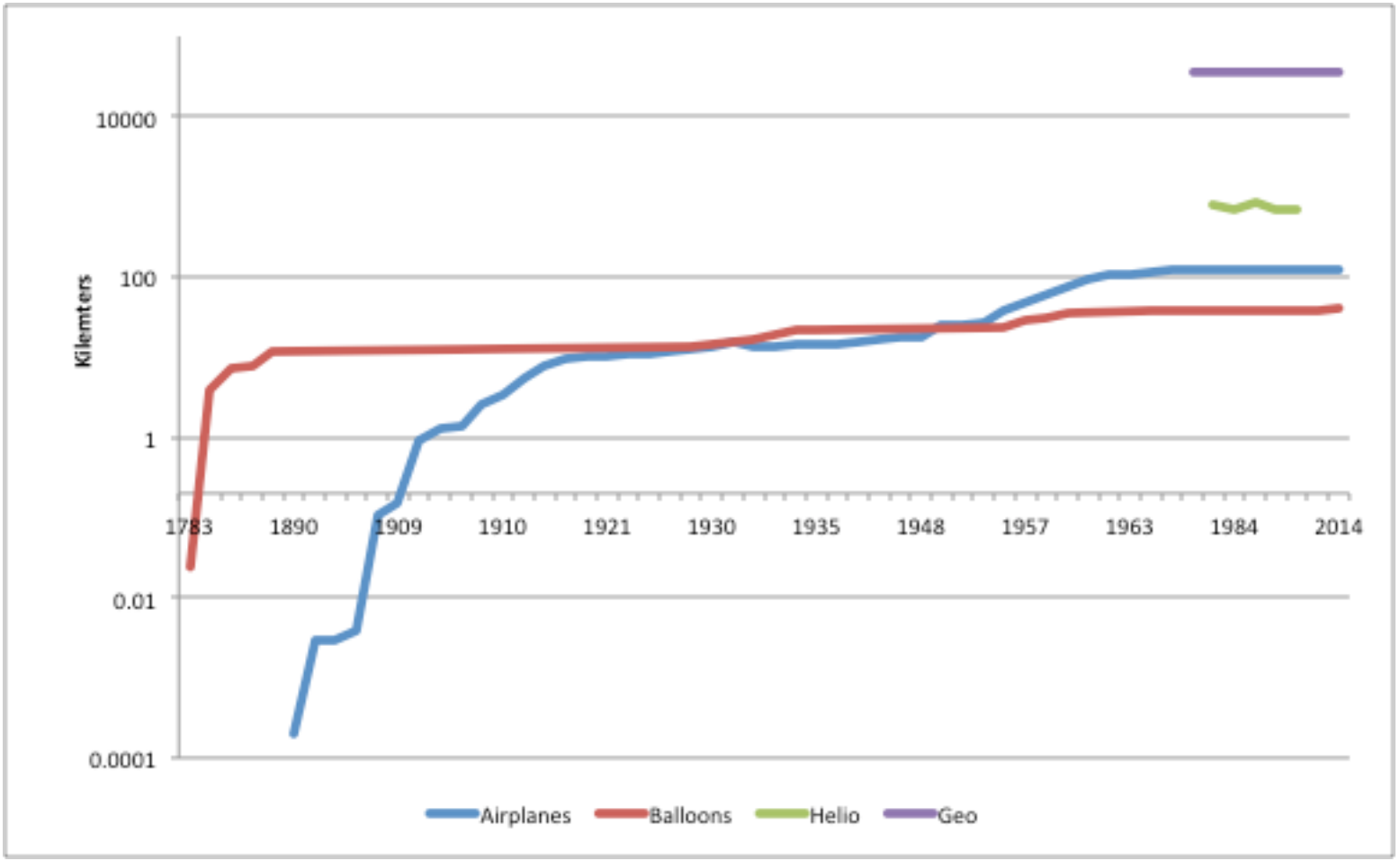
Dwarfing the Giant

So we've learned that higher is better.



Dwarfing the Giants

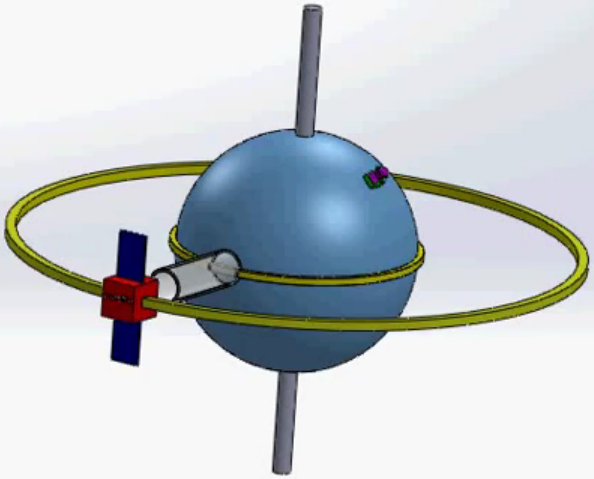
So we've learned that higher is better.



- ~600-800 km above Earth
- Orbital period 96-100 min
- Great for relatively shallow coverage of large areas

Just how much can we see from space?

2. Geo-synchronous satellites



Orbital period equals that of earth

$$F_{centripetal} = F_{gravity}$$

$$\frac{v^2}{r} = \frac{GM_{\oplus} m_{sat}}{r^2}$$

$$P = \frac{2\pi r}{v} = P_{\oplus}$$

$$\left(\frac{2\pi r}{P_{\oplus}}\right)^2 = \frac{GM_{\oplus}}{r} \Rightarrow r = \sqrt[3]{\frac{GM_{\oplus} P_{\oplus}^2}{4\pi^2}}$$

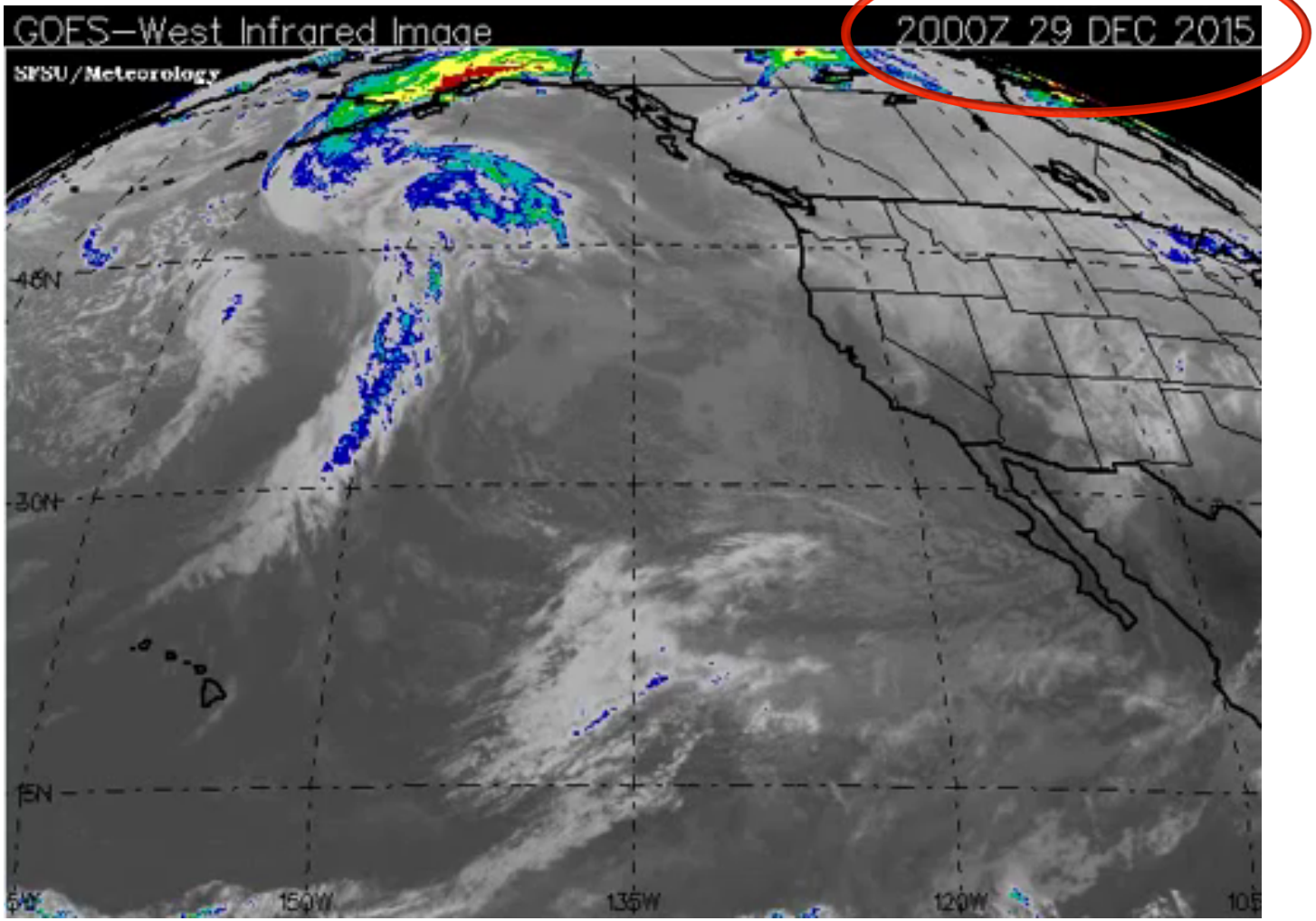
r = 42160km

Altitude = r – radius of Earth

= 35, 800km

Just how much can we see from space?

2. Geo-synchronous satellites



Who operates remote sensing satellites?

- Government agencies

Also, any country with a space mission!

- Private Sector Firms

Checkpoint 2

Government and private agencies operate helio-synchronous (polar) and geo-stationary satellites

A Little Inspiration – Urbanization

Fake color image of the Portland, OR area 1984-2007

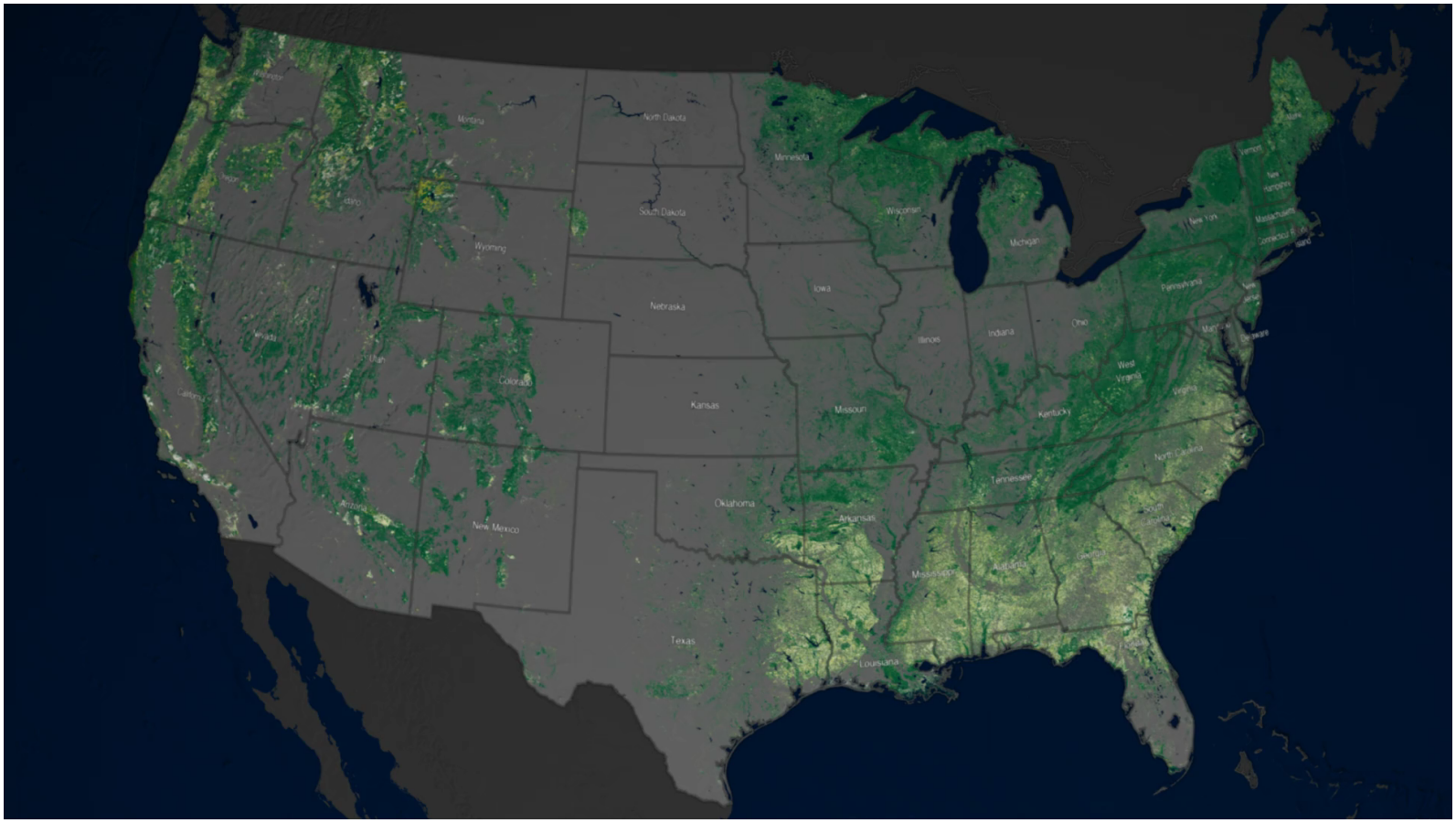
Time to make composites!

- Tutorial: pages 13-14
  http://landsat.gsfc.nasa.gov/wp-content/uploads/2013/05/Make-Your-Own-Landsat-Image-Tutorial.pdf
- The different bands are used to track different things
  - Combinations are named by band # used as R, G and B
  - True color = 3-2-1. What you would see from an airplane.
  - False color or NIR = 4-3-2. The green vegetation reflects infrared (band 4), so shows up as red in these images.
  - Pseudo Natural Color or SWIR = 7-4-2. Bare soil and burn marks show up as purple and pink.

Which Filter Why

Ground Cover Type:	**In Natural Color (3,2,1), appears:**	**In False Color: (4,3,2), appears:**	**In Pseudo Natural Color (7,4,2), appears:**
Trees and bushes	Olive Green	Red	Shades of green
Crops	Medium to light green	Pink to red	Shades of green
Wetland Vegetation	Dark green to black	Dark red	Shades of green
Water	Shades of blue, green, and brown	Shades of blue	Black to dark blue
Urban areas	White to light blue	Blue to gray	Lavender
Bare soil	White to light gray	Blue to gray	Magenta, Lavender, or pale pink

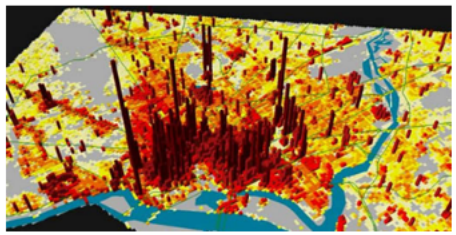
A Little More Inspiration – Deforestation



True color images of protected areas in the US, 1986-2008

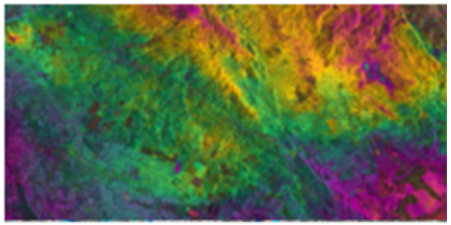
Summary

- Satellites take images of large areas of land
  - Over long time scales
  - In different filters
- Combinations of these filters can track

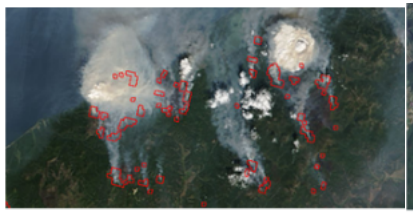


Population

Emergency Response



Free Satellite Data



Forest Fires

Landslides

- These images can be accessed from space agency archives
- Time-lapses help build perspective on large scale phenomena!

Questions? Ideas!