Remote Sensing 1: GEOG 4/585

Lecture 7.1.

History and future of remote sensing

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

Required reading:
Earth Engine 101 - Introduction to the API

Early aerial photography

- The term "remote sensing" is relatively new
  - First used to describe the field in the 1960s

- Aerial photography (1850s) is the earliest form of remote sensing

- Mostly from balloons (“Balloonimania”)

- Photographs from the basket of a gas balloon looking vertically downwards

NADAR, élevant la Photographie à la hauteur de l'Art

Balloons (1850s-1900s)

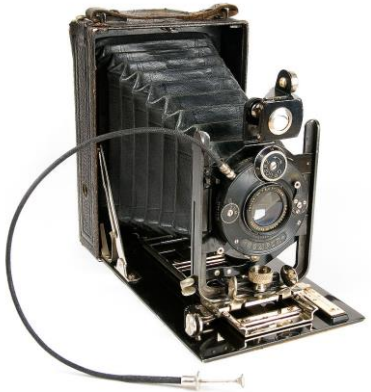
- The term "remote sensing" is relatively new
  - First used to describe the field in the 1960s
- Aerial photography (1850s) is the earliest form of remote sensing
- Mostly from balloons (“Balloonimania”)
- Photographs from the basket of a gas balloon looking vertically downwards

Pigeons (1900s)

- Cameras mounted on pigeons
- Small lightweight cameras were attached to the birds
- Photos were automatically taken every 5 minutes

WWI (1914-1918)

- Aerial photography matured during WWI with the development of reconnaissance aircraft
- Special cameras developed for taking aerial photographs of enemy positions



Dust Bowl Era (1930s)

- The Agricultural Adjustment Administration (AAA) began its aerial photography program in 1937 during the “Dust Bowl Era”

- By 1941 the AAA acquired aerial photographs of more than 90% of the agricultural land in the US

The Space Race (1950s/60s)

- United States and Soviet Union sought to prove superiority of political-economic system through technology
- 1957 Soviet Union launched Sputnik 1
- 1960 USA launched Explorer
- 1968 “Earthrise” taken from Apollo 8

Earthrise (1968)

Earth observation satellites (1970s)

- Photography from Apollo missions inspired the development of an Earth observation program
- 1972 Landsat 1 launched
- Heralded a new age of remote sensing of land from space and started the Earth observation “bandwagon”

Satellites currently orbiting Earth

UCS Satellite Database

In-depth details on the 4,550 satellites currently orbiting Earth, including their country of origin, purpose, and other operational details.

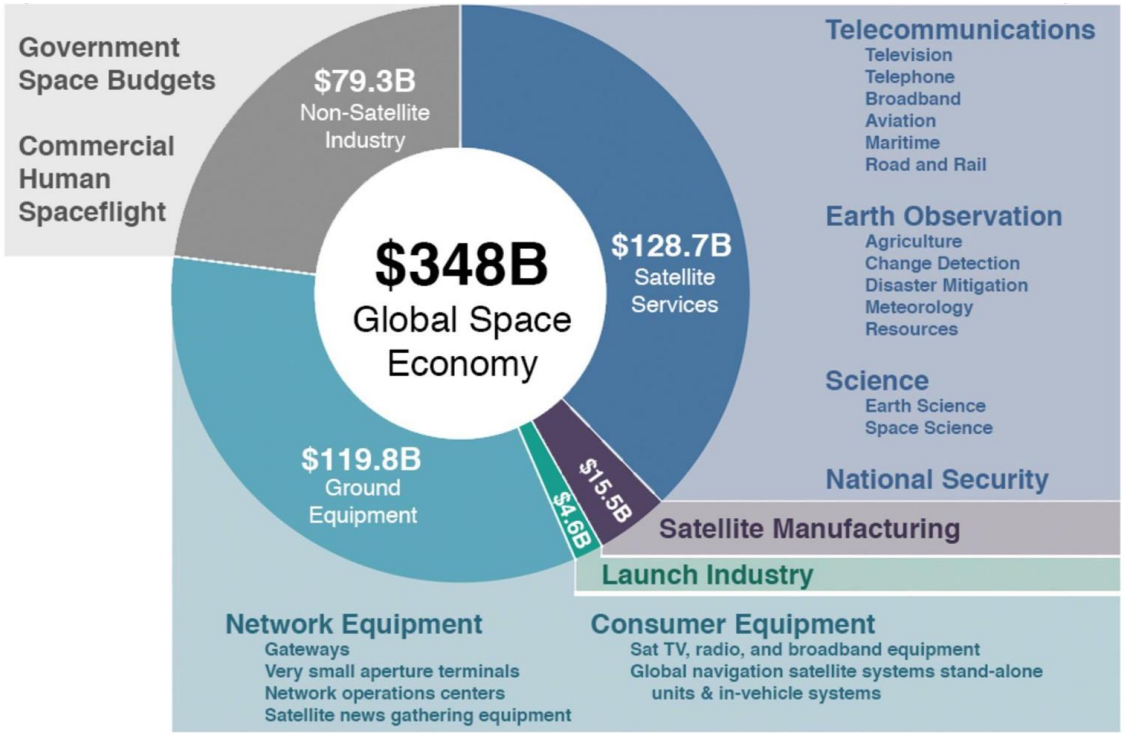
Published Dec 8, 2005 | Updated Sep 1, 2021

Union of concerned scientists' maintain a database that is updated three times per year

- 2,867 communications
- 1,028 Earth observation
- 150 navigation/positioning
- 109 space science/observation
- 376 technology development

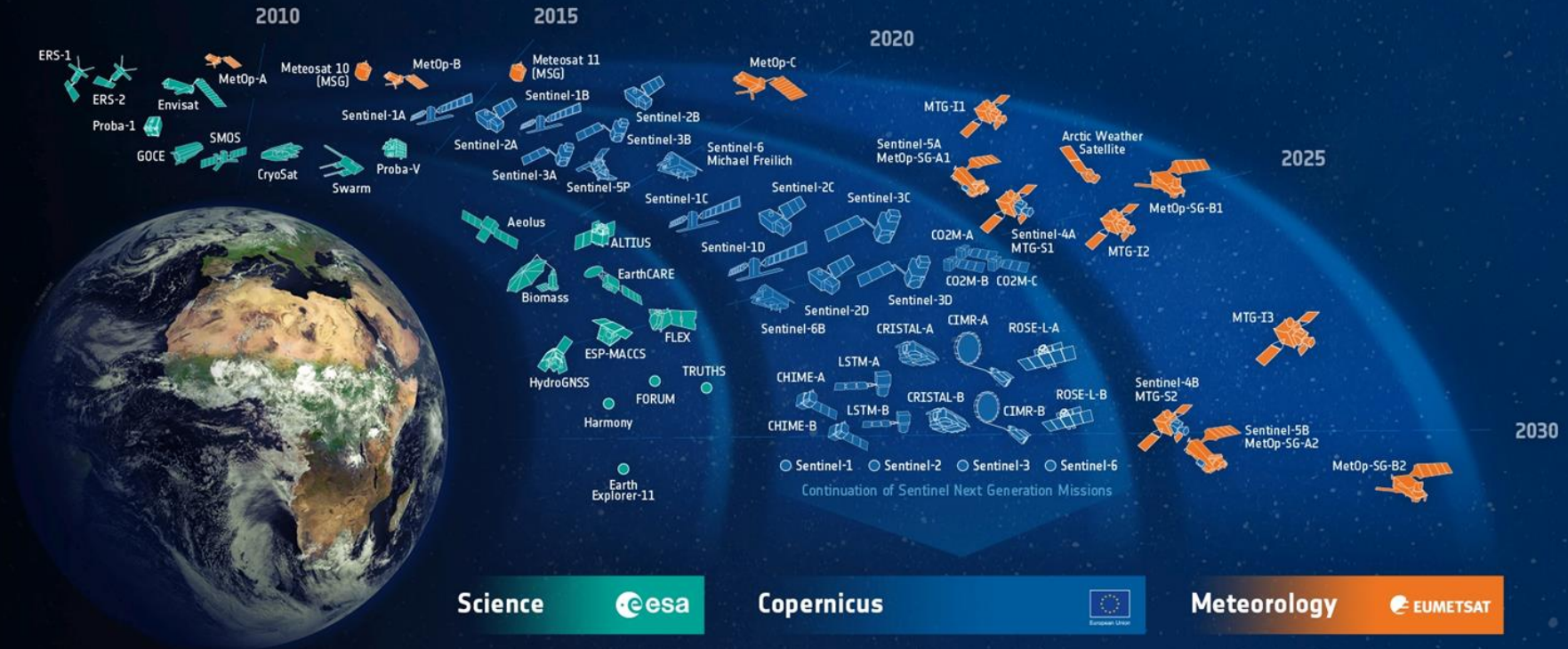
Satellites currently orbiting Earth

- Of the 1,028 Earth observation satellites:
  - Commercial: 487
  - Government: 303
  - Military: 211
  - Civilian: 26




OSTM/Jason 2
(NOAA)
Aquarius
QuikSCAT
TRMM
Terra
ISS-RapidScat,
CATS
EO-1
Landsat 7
(USGS)
SMAP
Aqua
Suomi NPP
(NOAA)
Landsat 8
(USGS)
SORCE,
TCTE (NOAA)
Aura
GPM
GRACE (2)
CALIPSO
CloudSat
OCO-2

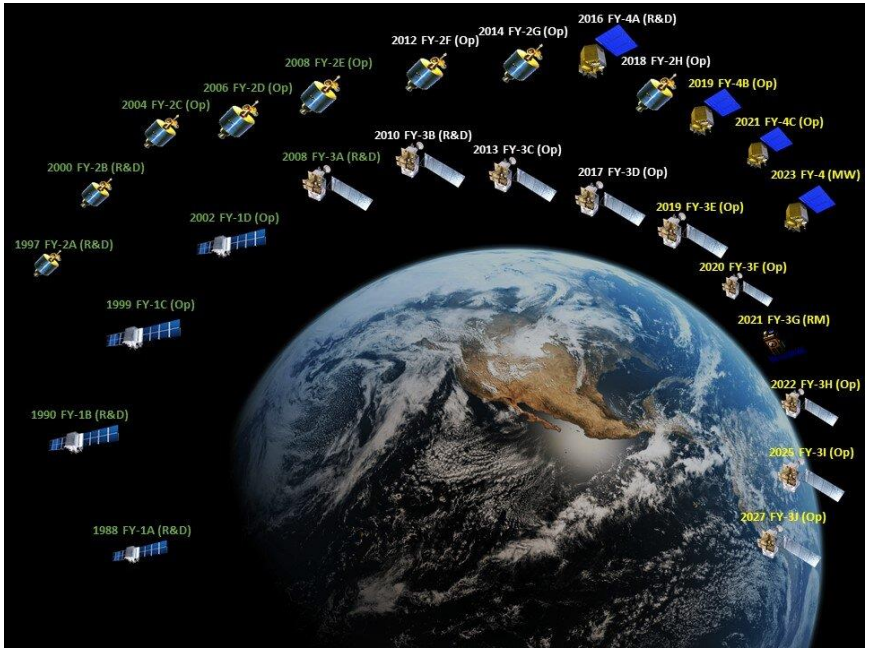
ESA-DEVELOPED EARTH OBSERVATION MISSIONS



Chinese Earth observations satellites

There are 94 Earth observations satellites operated by Chinese government

- China Meteorological Administration
- China National Academy of Sciences (CNSAS)
- China’s Ministry of Land and Resources, Ministry of Environmental Protection, and Ministry of Agriculture
- Chinese Ministry of National Defense
- Shanghai Academy of Spaceflight Technology
- China Academy of Space Technology (CAST)



Quiz!

Of the satellites currently orbiting Earth...

1. Where were they most commonly launched from in the US?

a) Kennedy Space Center/Cape Canaveral, FL
b) Vandenberg Air Force Base, CA
c) Wallops Island Flight Facility, VA

2. Where is Baikonur Cosmodrome?

a) Russia
b) Kazakhstan
c) Russia/Kazakhstan

3. When was the oldest *working* satellite launched?

a) 1974
b) 1984
c) 1994

Quiz!

4. Which country developed the Soyuz-2.1b launch vehicle?

a) China
b) Russia
c) USA

5. Where are most European Space Agency satellites launched from?

a) Guiana Space Center, French Guiana
b) Kennedy Space Center, USA
c) Vostochny Cosmodrome, Russia

6. How much do SpaceX charge to launch satellite into space?

a) $60M
b) $120M
c) $180M

Quiz!

Of the satellites currently orbiting Earth...

1. Where were they most commonly launched from in the US?

a) Kennedy Space Center/Cape Canaveral, FL
b) Vandenberg Air Force Base, CA
c) Wallops Island Flight Facility, VA

2. Where is Baikonur Cosmodrome?

a) Russia
b) Kazakhstan
c) Russia/Kazakhstan

3. When was the oldest *working* satellite launched?

a) 1974
b) 1984
c) 1994

Quiz!

Of the satellites currently orbiting Earth...

1. Where were they most commonly launched from in the US?

a) Kennedy Space Center/Cape Canaveral, FL
b) Vandenberg Air Force Base, CA
c) Wallops Island Flight Facility, VA

2. Where is Baikonur Cosmodrome?

a) Russia
b) Kazakhstan
c) Russia/Kazakhstan

3. When was the oldest *working* satellite launched?

a) 1974
b) 1984
c) 1994

Quiz!

Of the satellites currently orbiting Earth...

1. Where were they most commonly launched from in the US?

a) Kennedy Space Center/Cape Canaveral, FL
b) Vandenberg Air Force Base, CA
c) Wallops Island Flight Facility, VA

2. Where is Baikonur Cosmodrome?

a) Russia
b) Kazakhstan
c) Russia/Kazakhstan

3. When was the oldest *working* satellite launched?

a) 1974
b) 1984
c) 1994

Quiz!

4. Which country developed the Soyuz-2.1b launch vehicle?

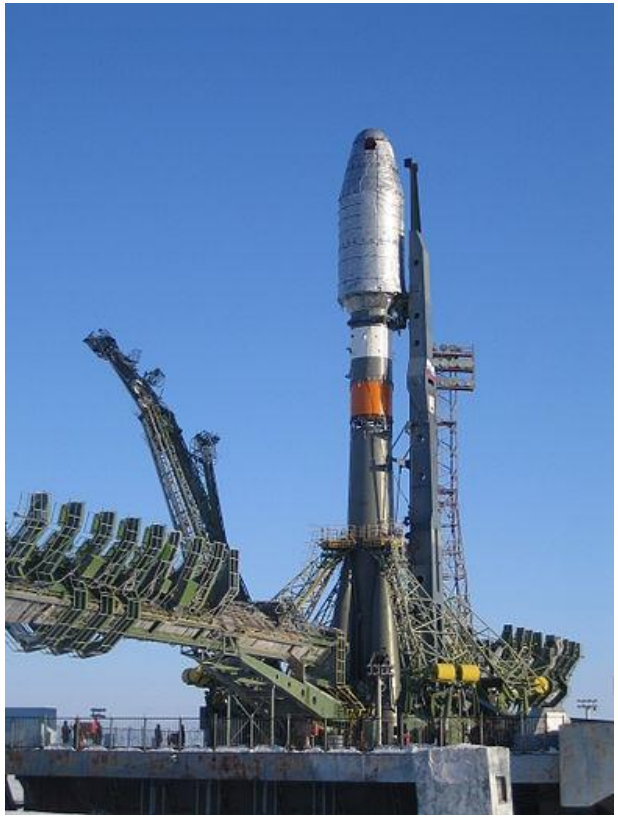
a) China
b) Russia
c) USA

5. Where are most European Space Agency satellites launched from?

a) Guiana Space Center, French Guiana
b) Kennedy Space Center, USA
c) Vostochny Cosmodrome, Russia

6. How much do SpaceX charge to launch satellite into space?

a) $60M
b) $120M
c) $180M



Quiz!

4. Which country developed the Soyuz-2.1b launch vehicle?

a) China
b) Russia
c) USA

5. Where are most European Space Agency satellites launch from?

a) Guiana Space Center, French Guiana
b) Kennedy Space Center, USA
c) Vostochny Cosmodrome, Russia

6. How much do SpaceX charge to launch satellite into space

a) $60M
b) $120M
c) $180M

Quiz!

4. Which country developed the Soyuz-2.1b launch vehicle?

a) China
b) Russia
c) USA

5. Where are most European Space Agency satellites launche from?

a) Guiana Space Center, French Guiana
b) Kennedy Space Center, USA
c) Vostochny Cosmodrome, Russia

6. How much do SpaceX charge to launch satellite into space

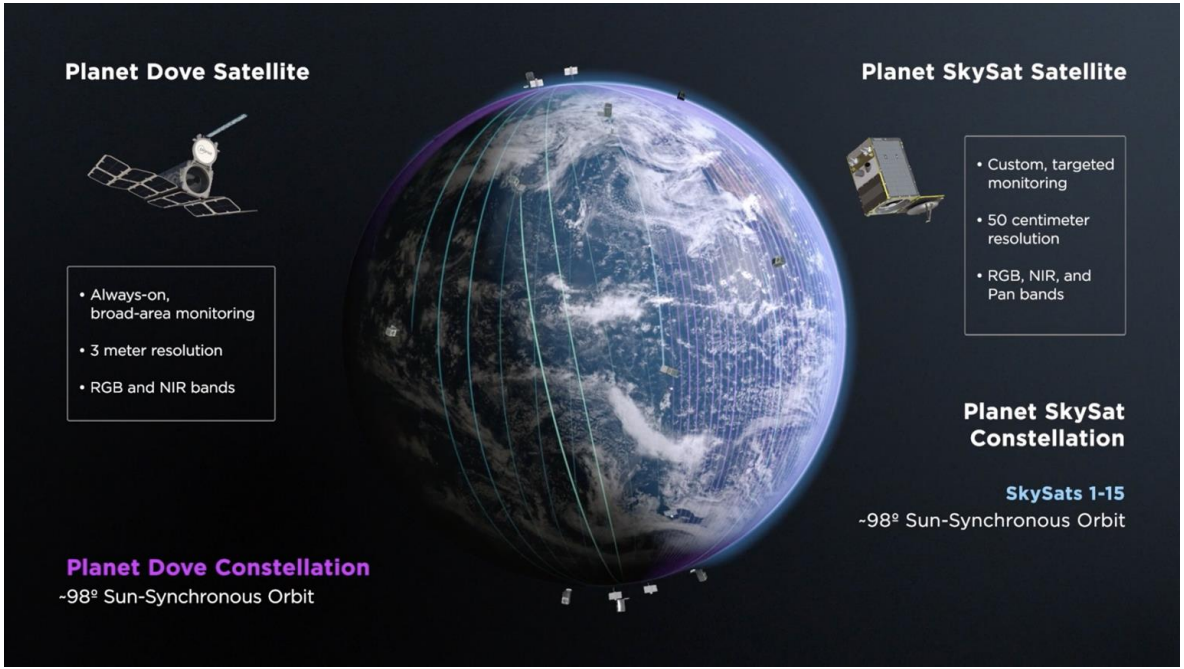
a) $60M
b) $120M
c) $180M

Active spaceports

Commercial space sector

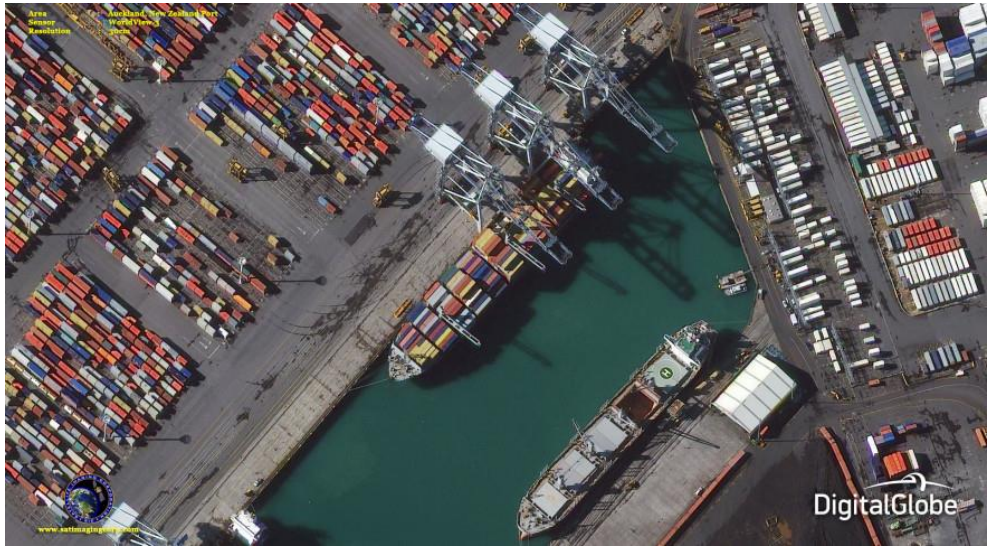
Commercial space sector

- Planet Labs (USA) have 167 Dove and 21 SkySat satellites
  - Provide visible/NIR imagery at 3 m and 0.5 resolution



Not just Planet Labs...

- Maxar Technologies (USA) operate GeoEye-1(2008), WorldView-1 (2007), WorldView-2 (2009), and WorldView-3 (2014), WorldView-4 (2016-2019)
  - Provide high spatial resolution visible/NIR imagery of 0.31 m
  - Intends to deploy six “Worldview Legion” satellites in 2022 to replace its aging spacecraft

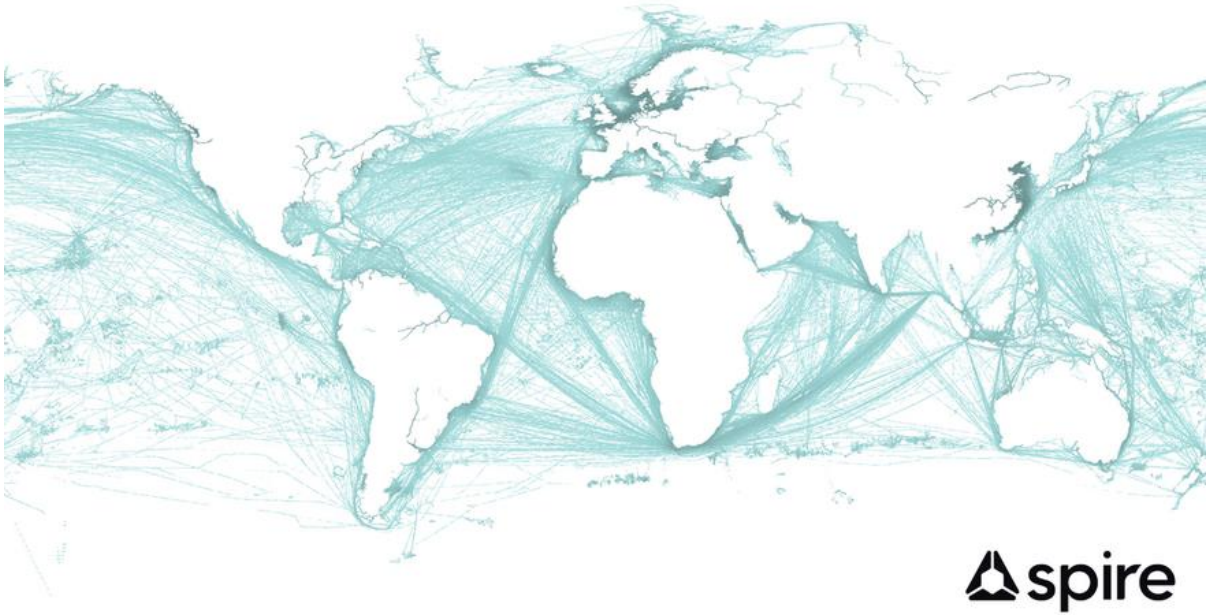


Not just Planet Labs...

- BlackSky Global (USA) operate 8 smallsats that provide 1 m resolution visible/NIR imagery
- AstroDigital (USA) operate 7 Landmapper-BC satellites providing 22 m resolution visible/NIR imagery
- Satellogic (Argentina) operate 20 ÑuSats provide 1 m visible/NIR imagery and 30 m hyperspectral imagery
- Host of other companies that operate a handful of CubeSats

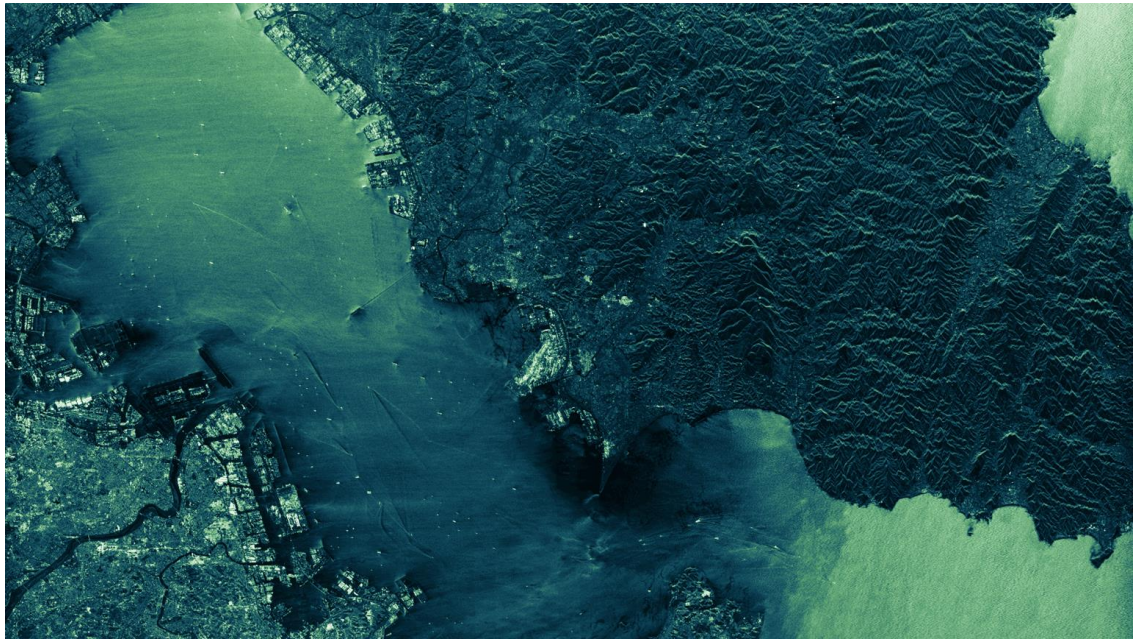
Not just Planet Labs...

- Spire Global Ltd. (USA) operate 120 Lemur-2 satellites
  - Carry a STRATOS GPS radio occultation payload and the SENSE AIS-receiver



Not just Planet Labs...

- ICEYE Ltd. (Finland) operate 12 ICEYE-X satellites
  - Provide X-band SAR imaging available at 0.25 m resolution as Spot, 3 m resolution as Strip, and 15 m resolution Scan imaging mode.



ICEYE SAR imagery

Future?

- Learn to work with “big data”
  - Cloud computing
  - Multiple instruments
  - Machine learning

- Ask interesting questions
  - Go beyond monitoring
  - Think outside-the-box
  - Make interdisciplinary connections
  - Consider human dimensions

- Learn to process and/or interpret SAR imagery