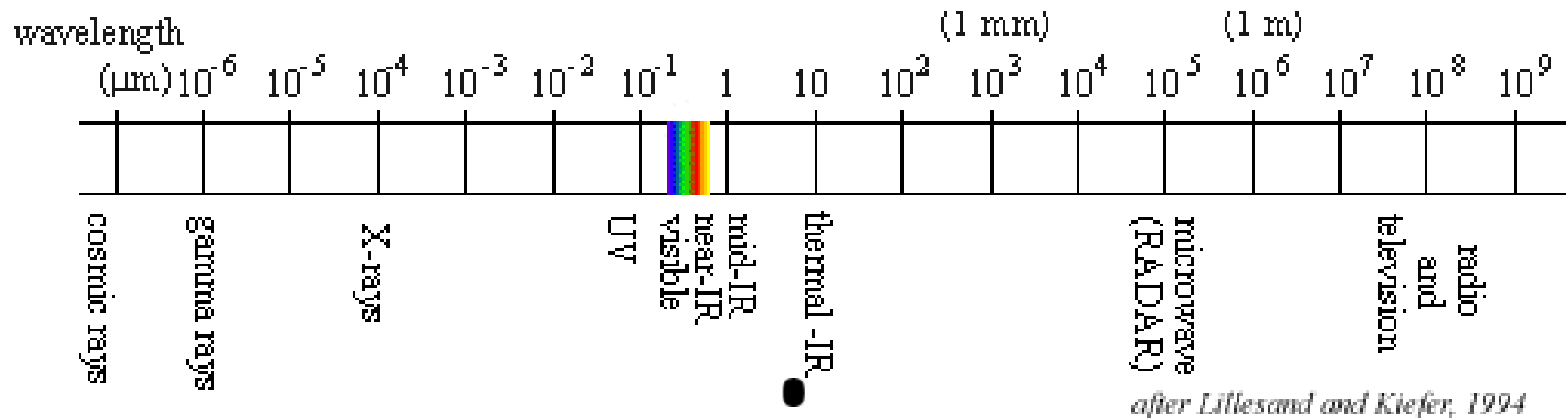


Remote sensing: review

The Electromagnetic Spectrum



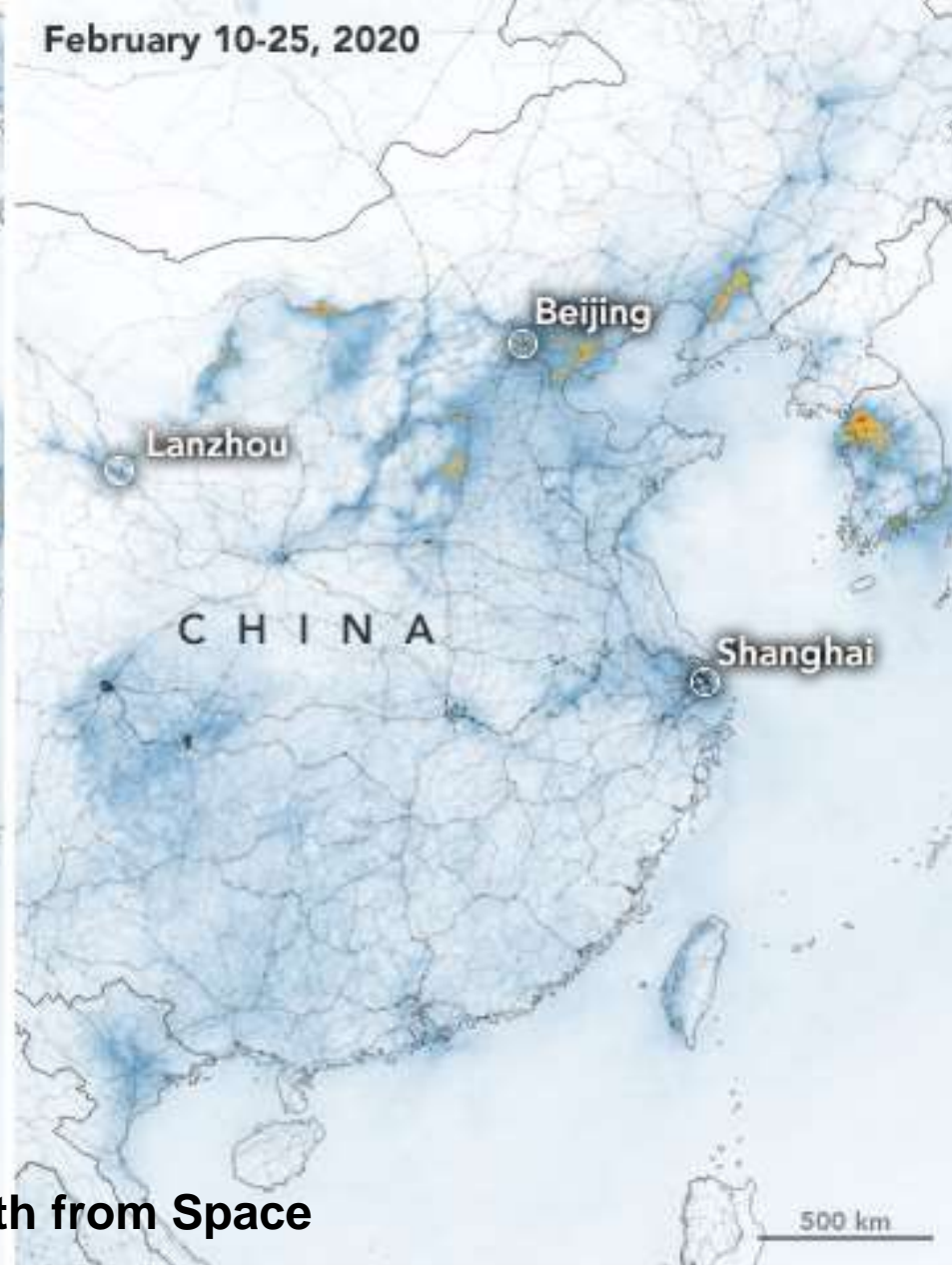
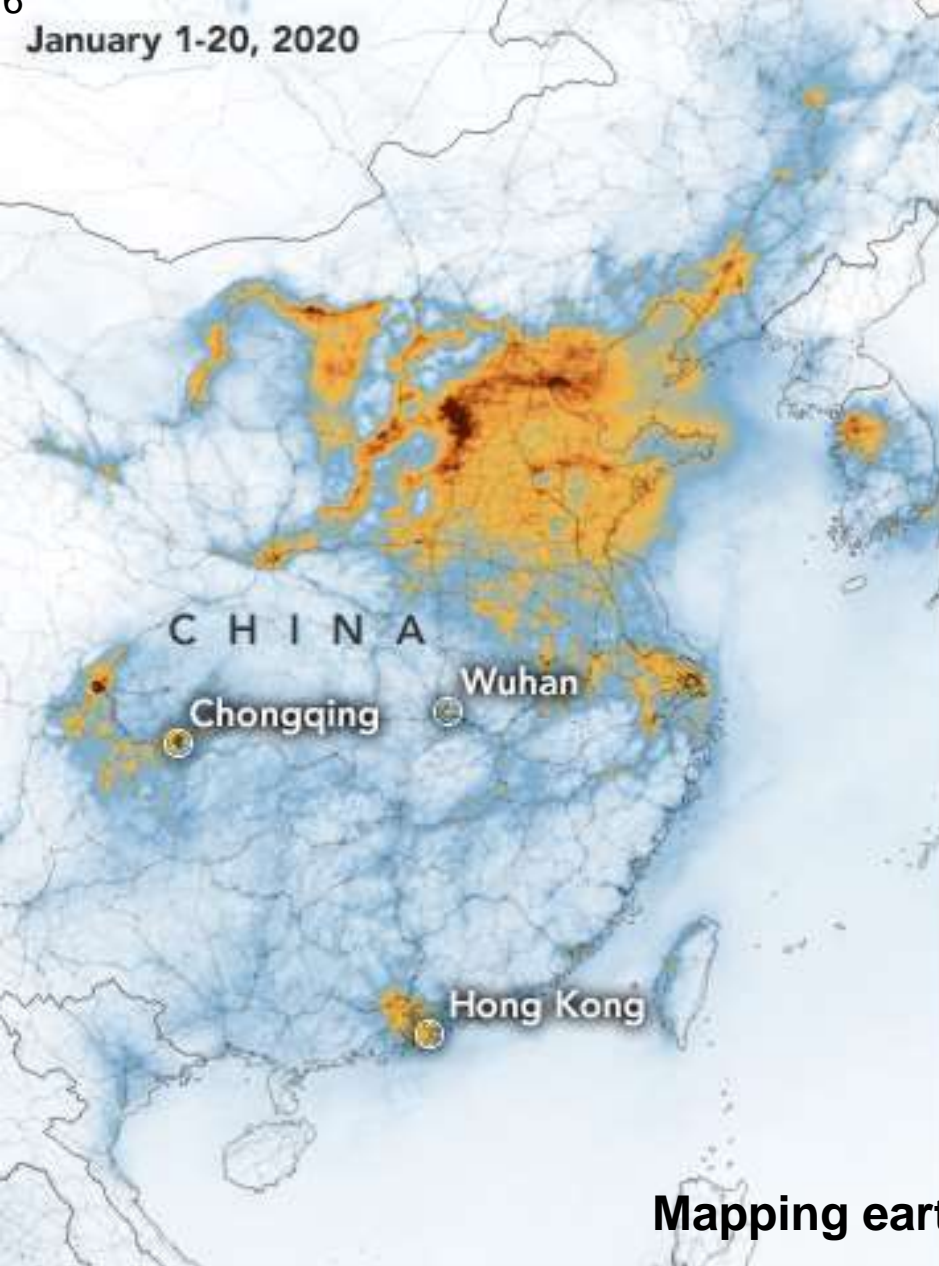
Visible: reflected 'natural colour' – what we see

Near/mid-IR: reflected from earth = vegetation; moisture

Thermal IR: emitted from earth = temperature

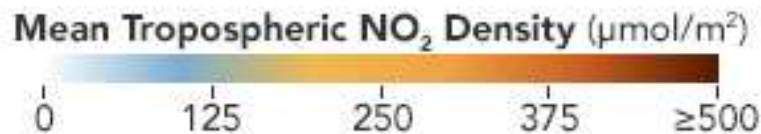
Microwave: unaffected by clouds – includes RADAR

RADAR and LiDAR are ACTIVE systems; the rest are PASSIVE



Mapping earth from Space

Airborne Nitrogen Dioxide
Plummets Over China



from industrial reduction
Post-coronavirus

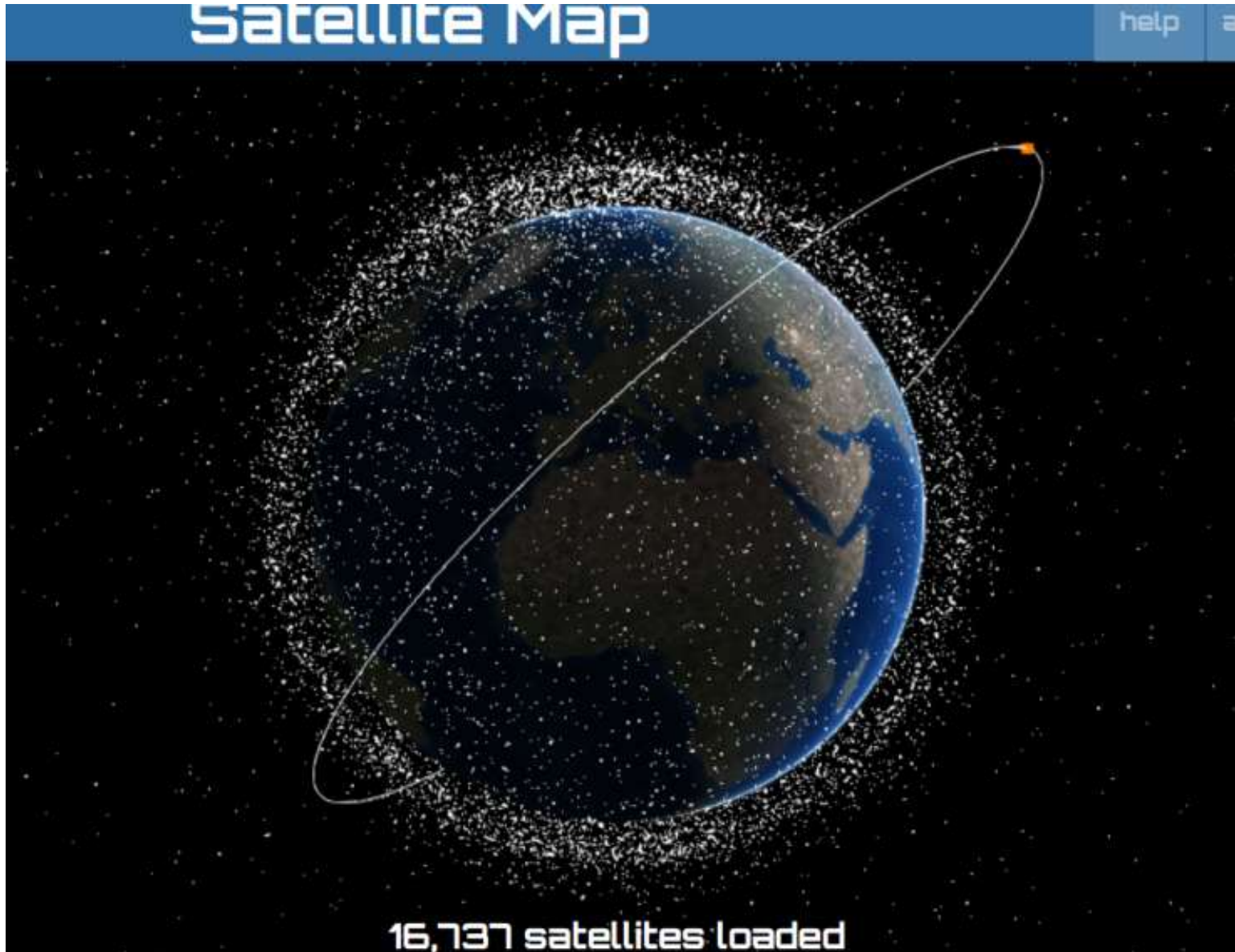


Deforestation in Papua



<https://earthobservatory.nasa.gov/images/148021/deforestation-in-papua>

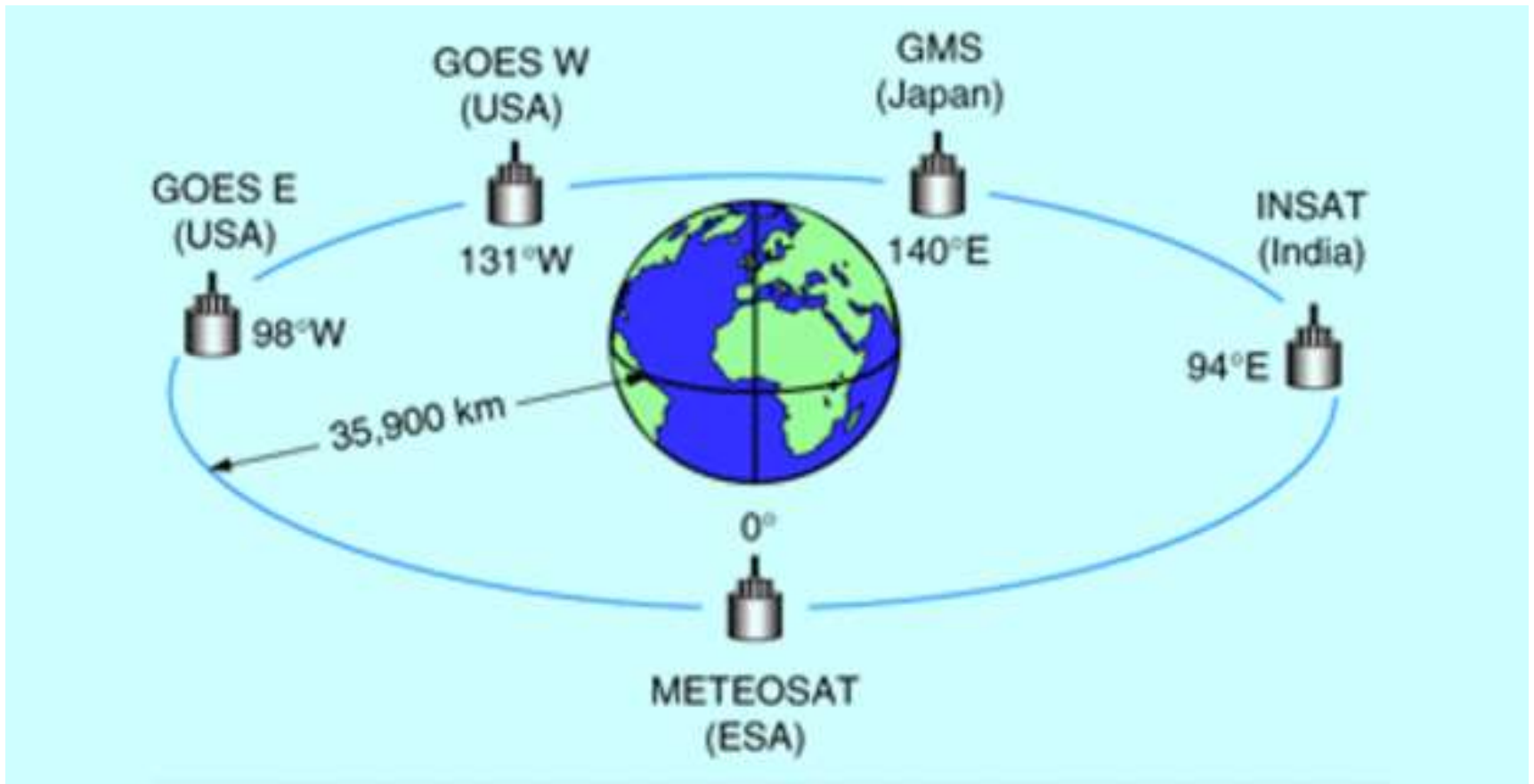
Earth from Space: satellite images



<https://www.youtube.com/watch?v=cfSaztUiw5s>

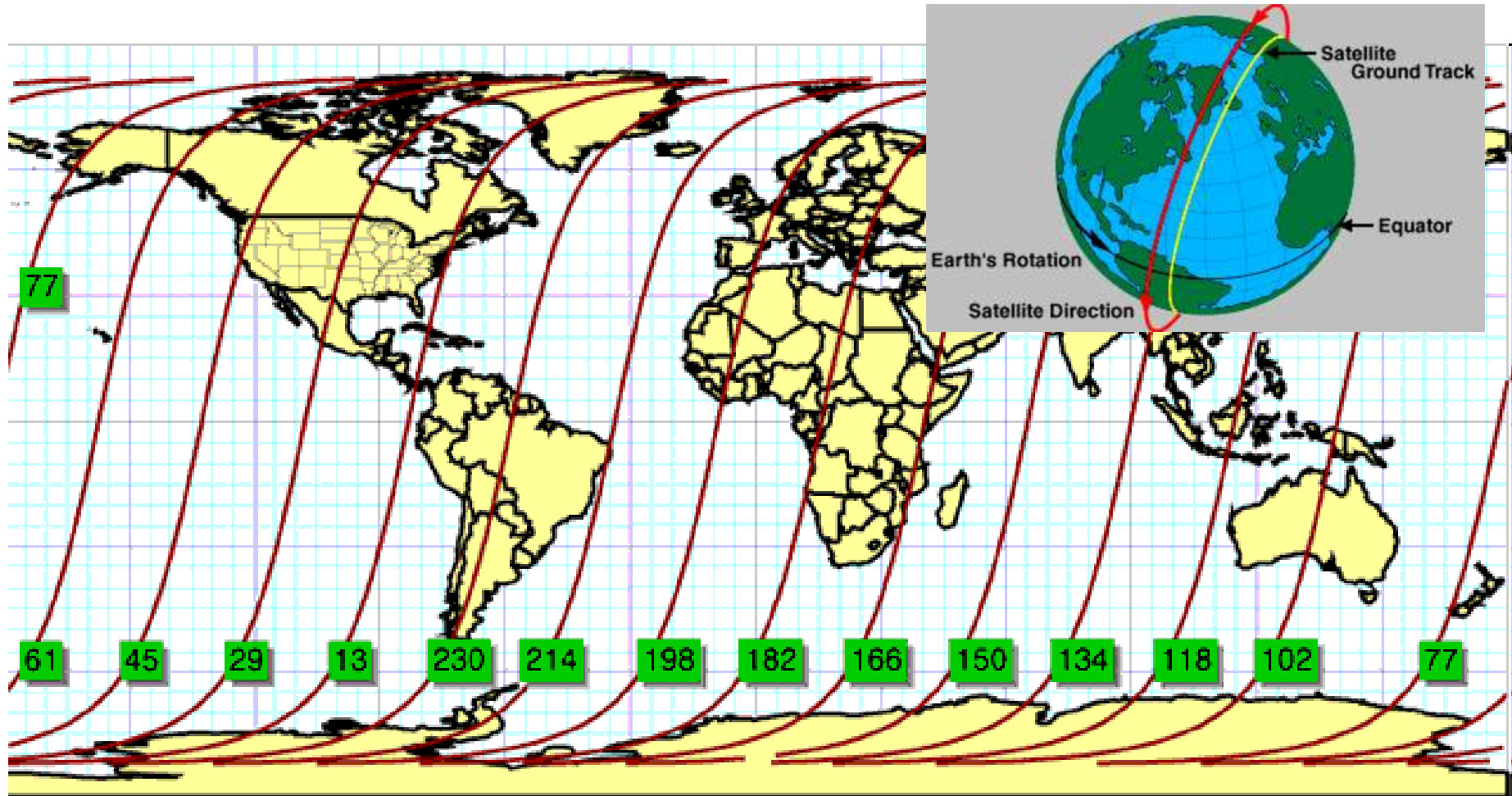
Satellites have two types of orbit (GPS satellites include both types):

1. Geostationary: 36,000 km above equator, stay vertically above the same spot, rotate with earth - weather images, e.g. GOES (Geostat. Operational Env. Satellite)



2. Sun-synchronous satellites: Earth Observation

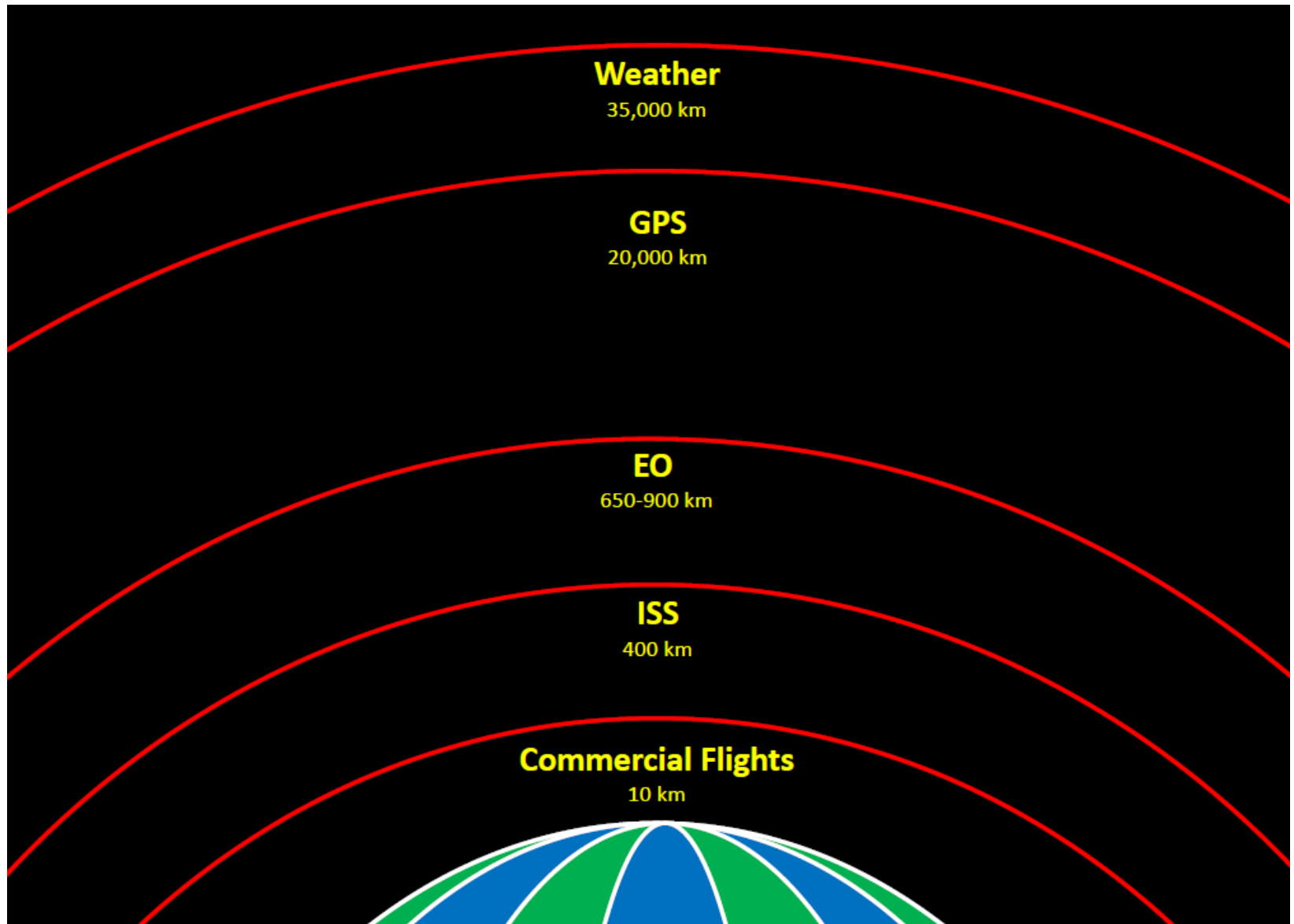
650-900 km altitude, orbit at ~ 81 - 82 degree angle to the equator (= near polar): captures imagery \sim same time each day ($\sim 10 - 11$ am)



[Landsat:](http://landsat.usgs.gov)

<http://earthnow.usgs.gov>

Earth from Space: Earth Observation (EO) satellites



Myth #1: Most satellite images are **not** photos; they are scanned except...

Alberta, BC and Rocky Mountain Trench, from International Space Station, Sept 06, 2014



ISS orbit: 400km, 51 degree angle

Earth from Space

Satellite Images for mapping

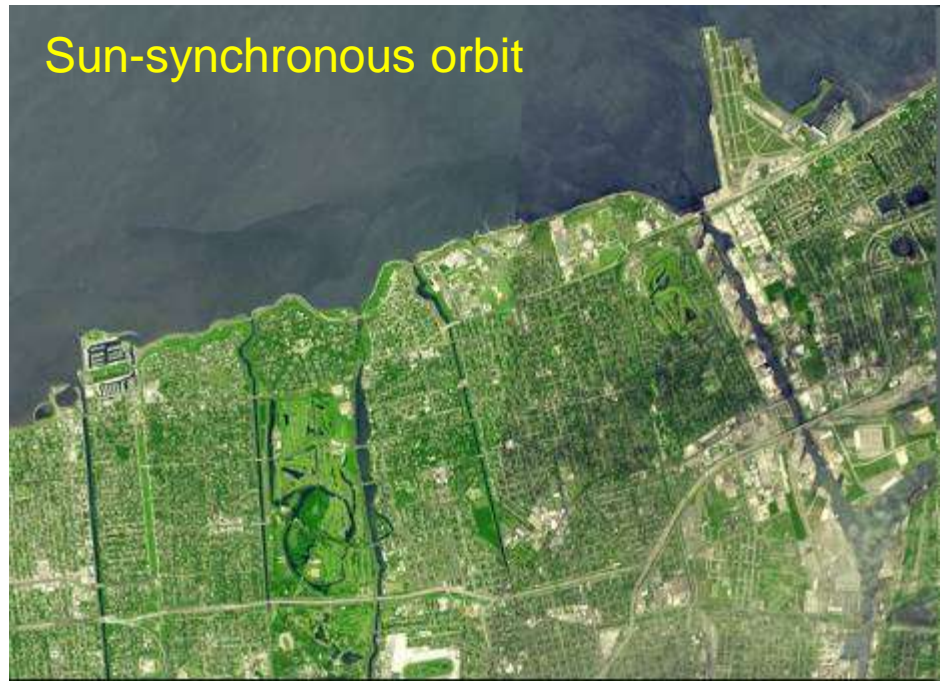
from low resolution 10km
(weather satellites) to very high
capable of detecting objects <1 metre

Hurricane Katrina



Geostationary satellite orbit

Sun-synchronous orbit



New Orleans, before and during Hurricane Katrina

Spatial Resolution (pixel size) <1 metre to >10 kilometres

Low resolution (free) 1km - 10km (international) -small scale

Medium resolution (free) 100m - 500m (national) - < 1:250,000

High resolution (mostly free) 10 -50 m (regional) - 1:50,000

Very High resolution (costs \$\$) 25cm - 5m (Local) - > 1:20,000

Landsat – 30m pixels



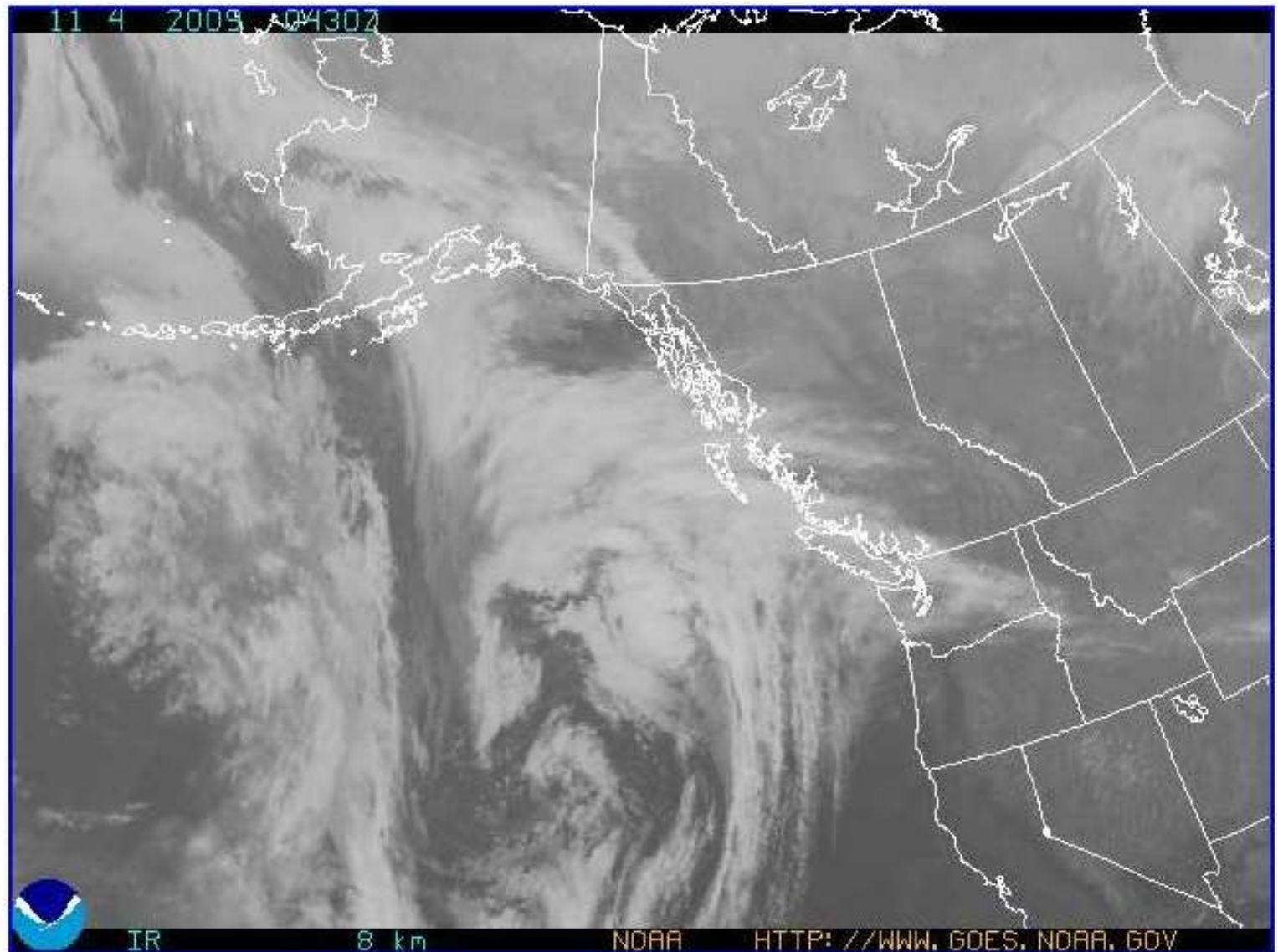
Air photo: <1m pixels



Small scale satellite images (10km pixels) <http://www.goes.noaa.gov/>

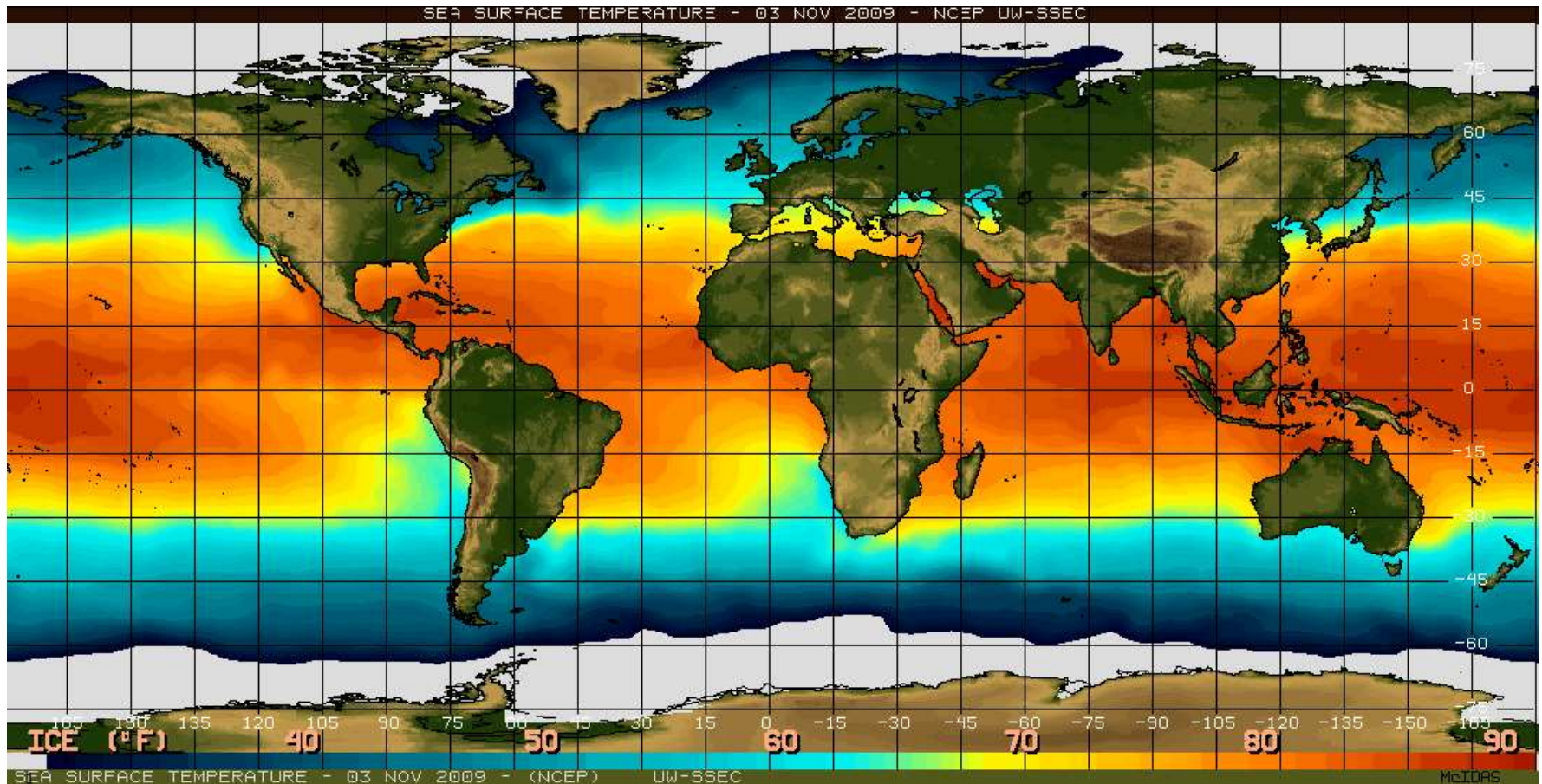
~70% clouds

GOES Alaska SECTOR IR Image



Low resolution imagery (~10km pixels)

Daily sea surface temperatures using **Microwave** wavelengths - cloud free



‘Isarithmic thematic map’

Medium
resolution:

MODIS

(since 2000)

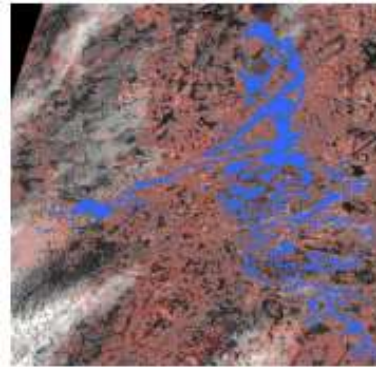
500m - 1km



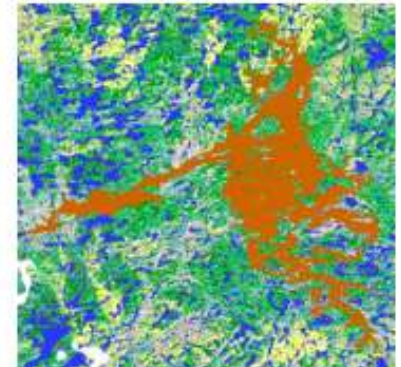
Medium -High resolution: Landsat (NASA-1972)

Satellites 1,2,3 had a Multi-Spectral Sensor (MSS) with a pixel size 80 metres in resolution.

First Landsat image: San Francisco 1972



MSS Image 16/22 (09 Jul 1978)



EOSD Image 15/22 (15 June 2001)



Before flooding of reservoir



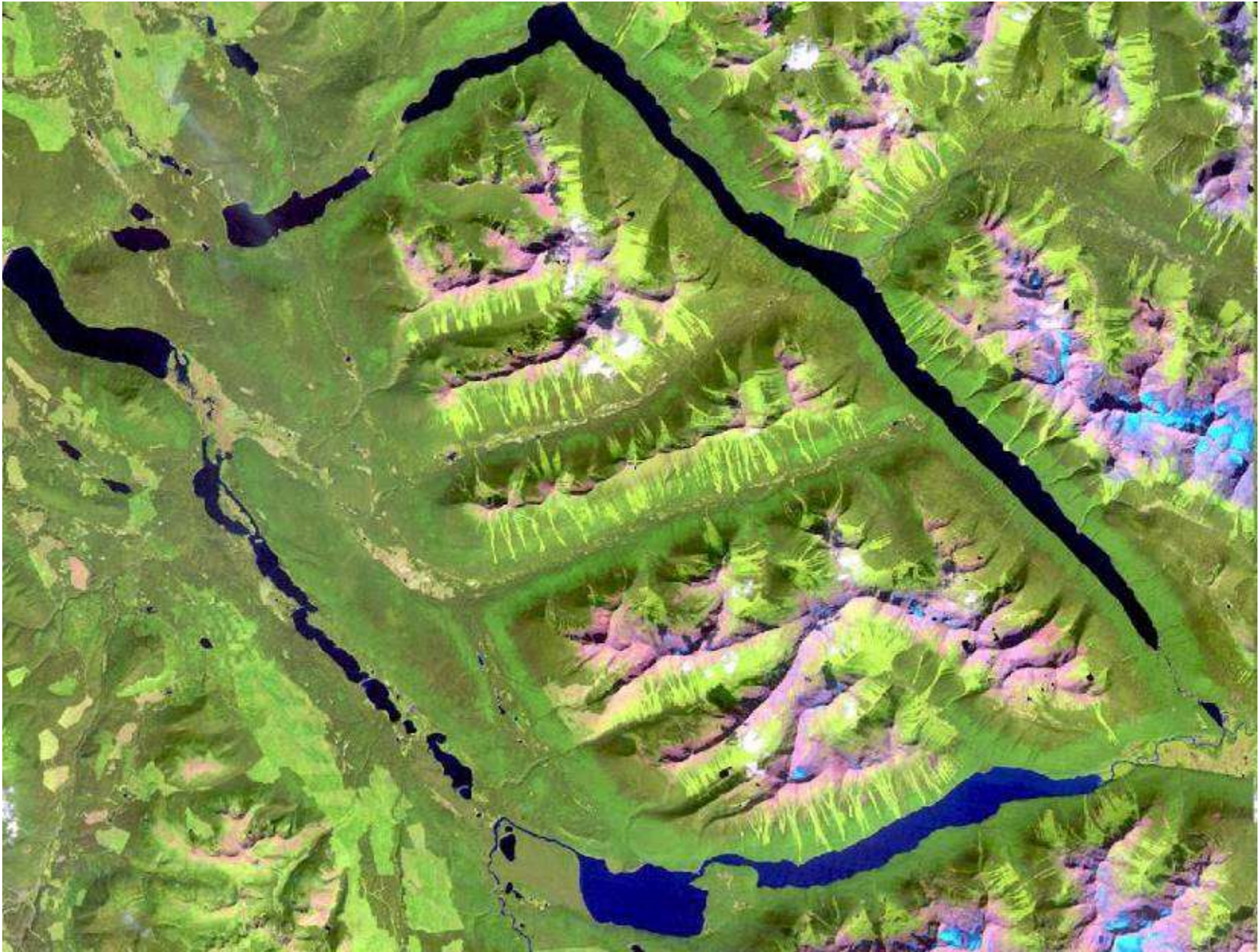
After flooding of reservoir



Difference highlighted in brown

Reservoirs in Quebec 1975-2000

High resolution (the Next generation) Landsat 5 Thematic Mapper (TM): 1984
Pixel size: 30 metres; display is Red band - Near IR - mid IR



Bowron Lakes -Landsat natural colour composite RGB (e.g. Google maps / Earth)



Google Earth Time Lapse 1984-2021

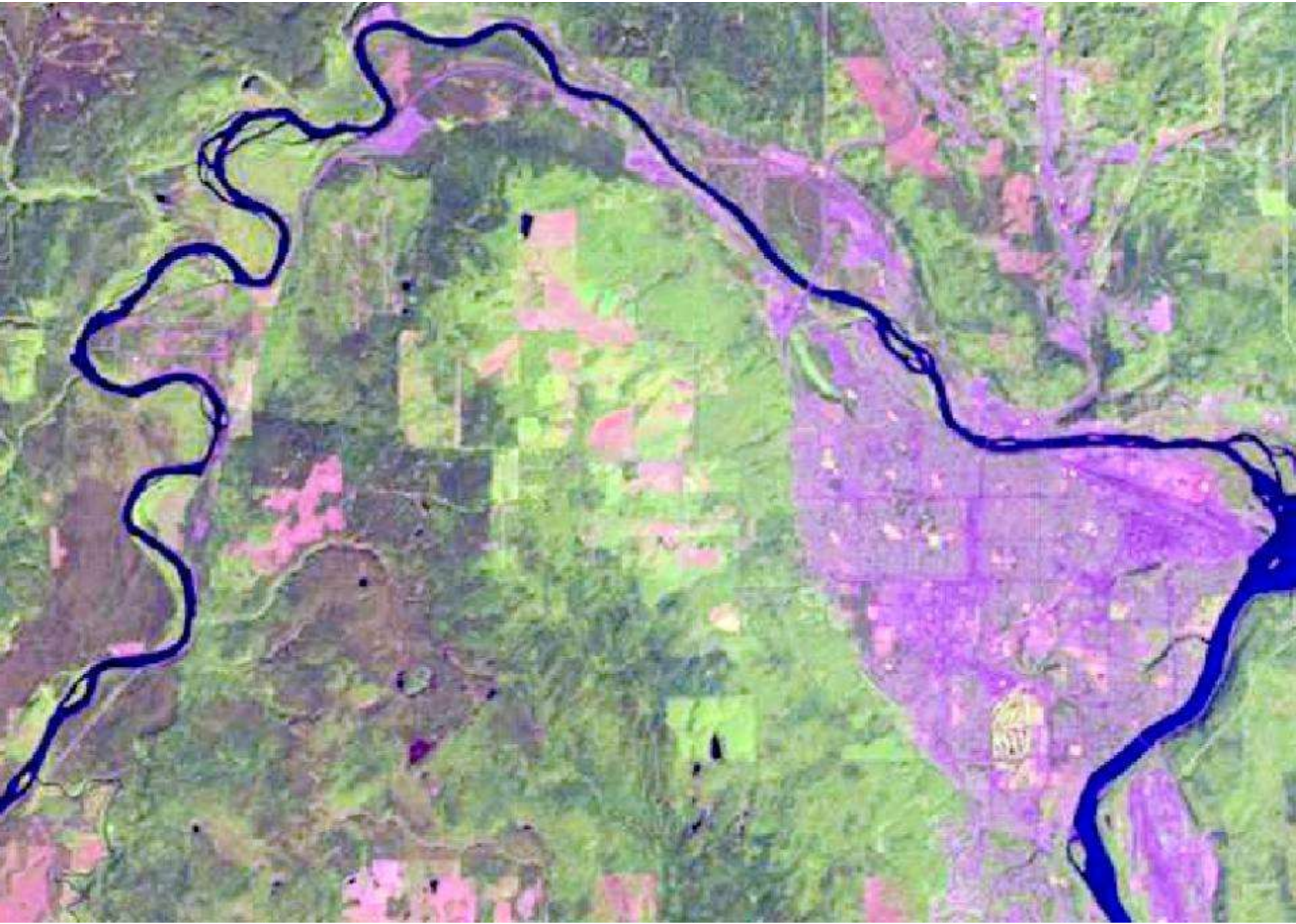
38 years of Landsat images; 65,000 images - >1 petabytes of data

<https://earthengine.google.com/timelapse/>

Note: mountain areas comparison are less effective due to seasonal snow



1984



2003

