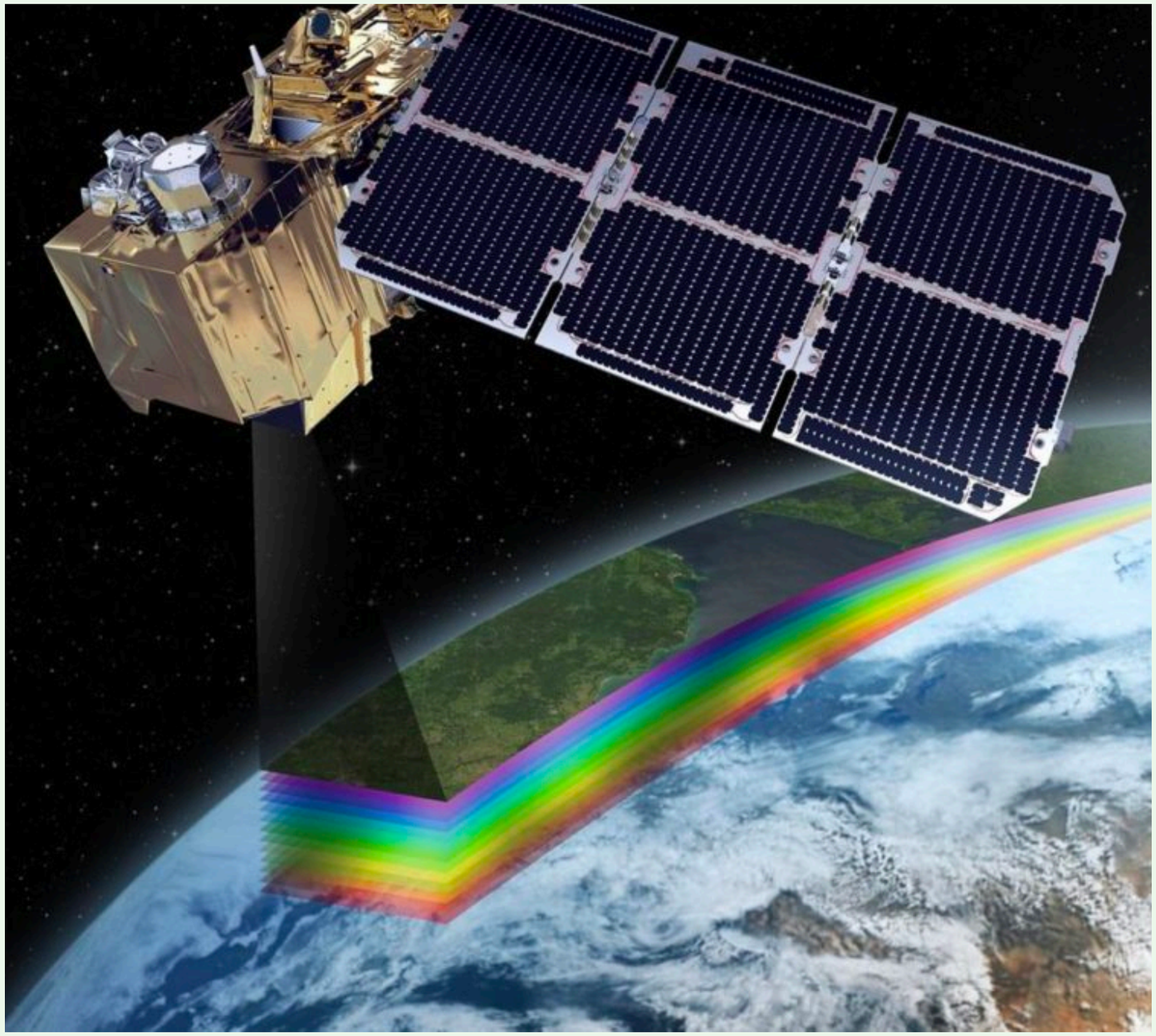
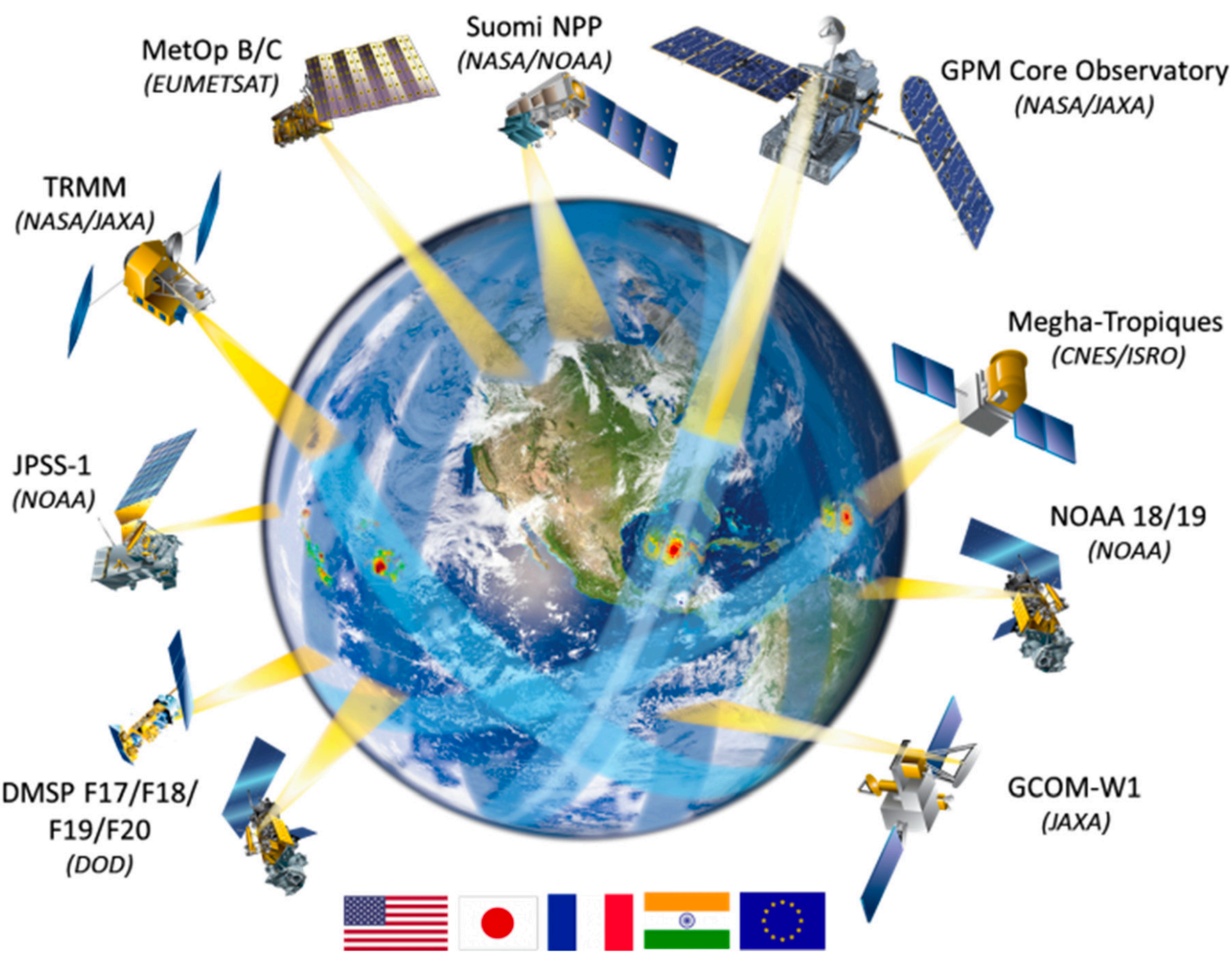
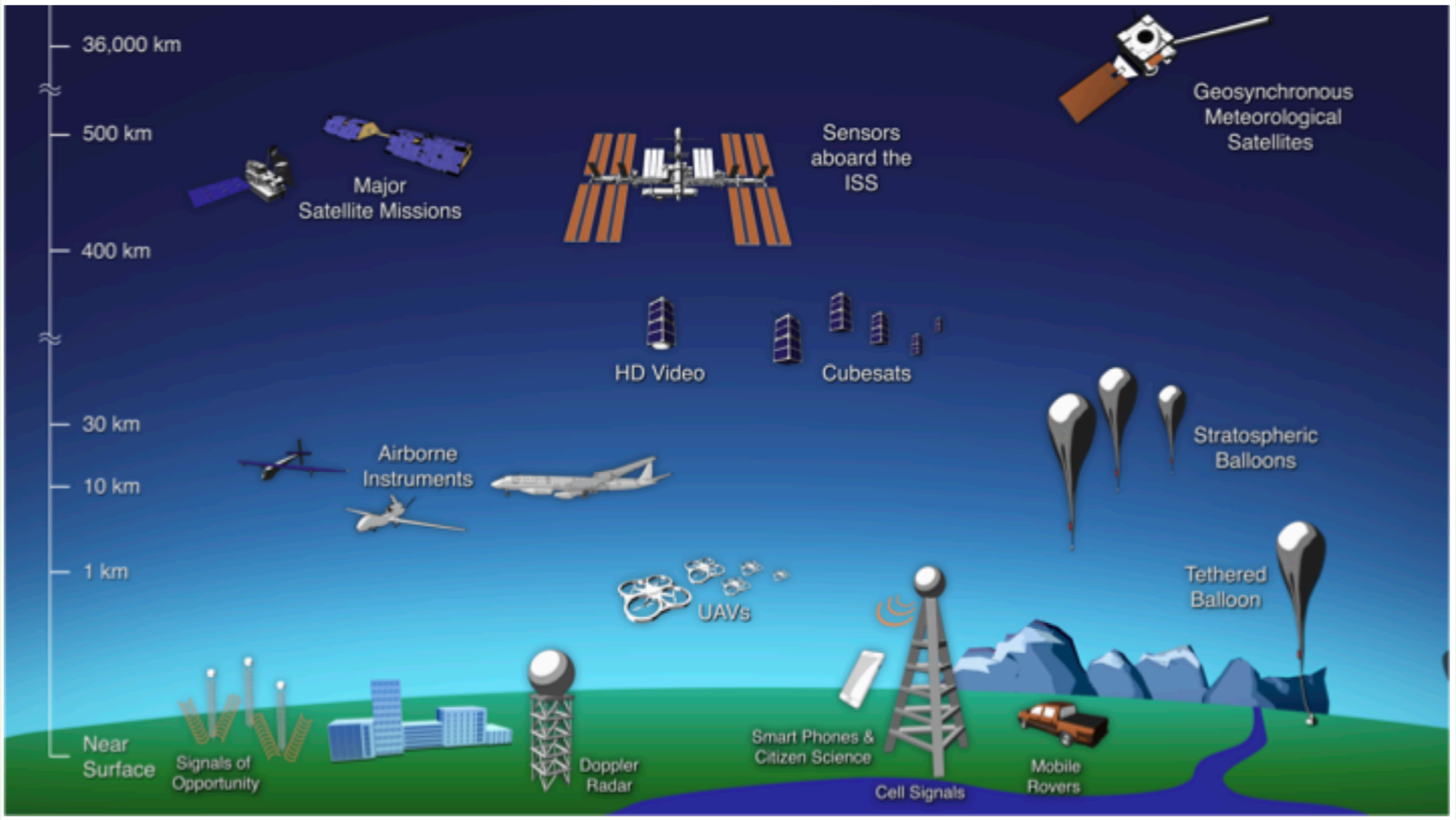
GEOG 358: Introduction to Geographic Information Systems

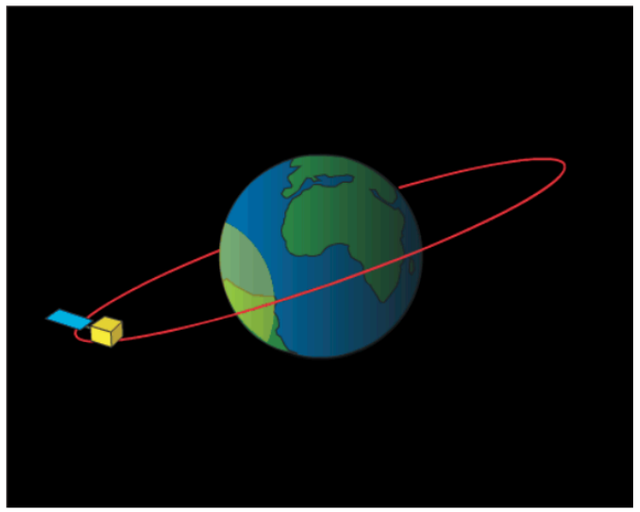
Remote Sensing

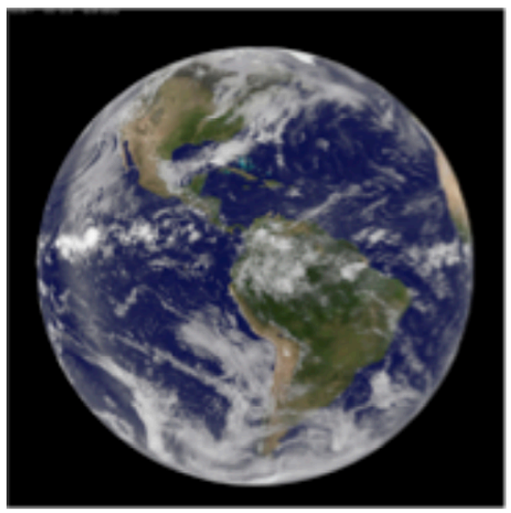



MetOp B/C
(EUMETSAT)
Suomi NPP
(NASA/NOAA)
GPM Core Observatory
(NASA/JAXA)
TRMM
(NASA/JAXA)
Megha-Tropiques
(CNES/ISRO)
JPSS-1
(NOAA)
NOAA 18/19
(NOAA)
DMSP F17/F18/
F19/F20
(DOD)
GCOM-W1
(JAXA)


36,000 km
500 km
400 km
30 km
10 km
1 km
Near Surface
Major Satellite Missions
Sensors aboard the ISS
Geosynchronous Meteorological Satellites
HD Video
Cubesats
Airborne Instruments
Stratospheric Balloons
UAVs
Tethered Balloon
Signals of Opportunity
Doppler Radar
Smart Phones & Citizen Science
Cell Signals
Mobile Rovers

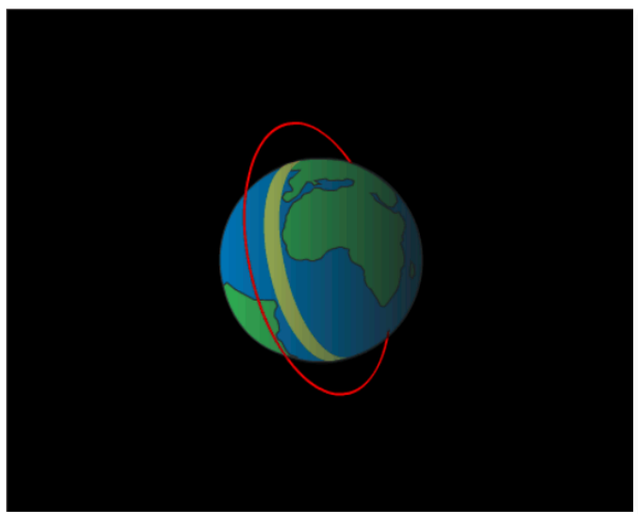
Common Orbit Types

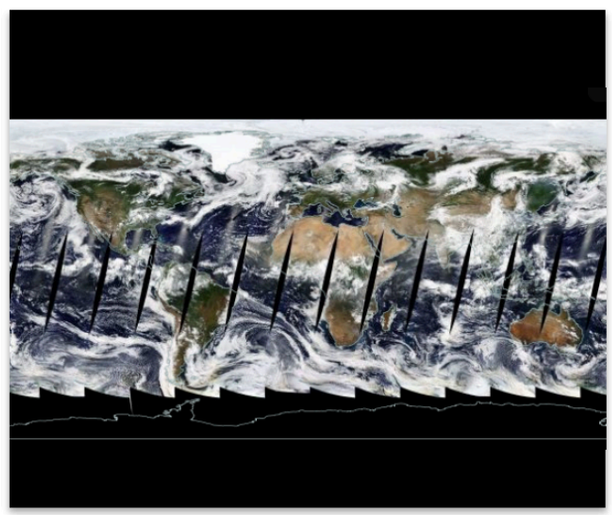




Geostationary Orbit

- Has the same rotational period as Earth
- Appears ‘fixed’ above Earth
- Orbits ~36,000 km above the equator





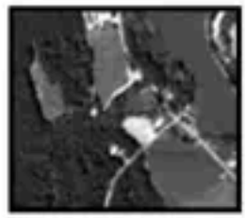
Polar Orbit

- Fixed, circular orbit above Earth
- Sun synchronous orbit ~600-1,000 km above Earth with orbital passes are at about the same **local solar time** each day

Resolution

Spatial resolution
(pixel size)

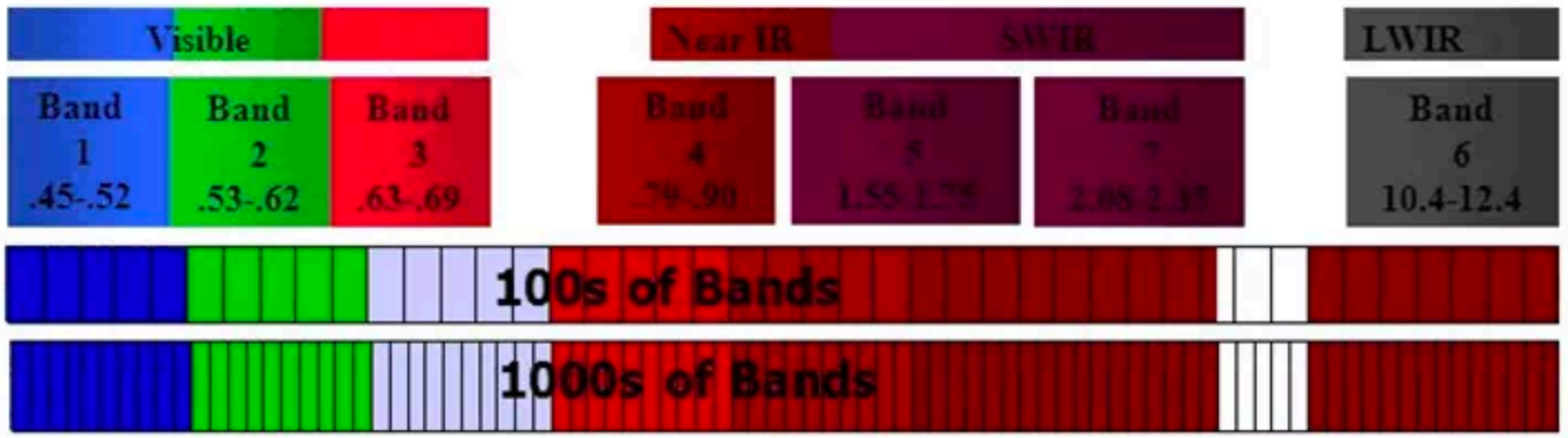
Landsat 30m



IKONOS 4m

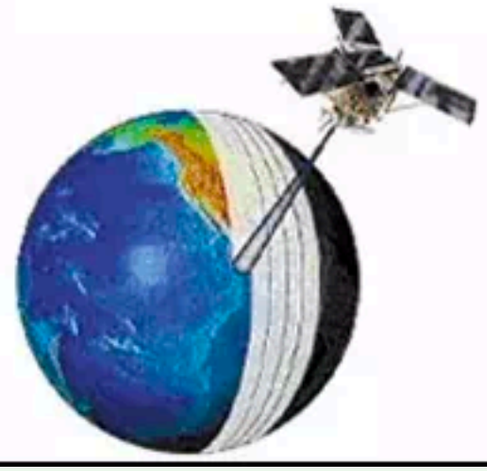
Orthophoto 0.5m

Spectral resolution
(# bands)



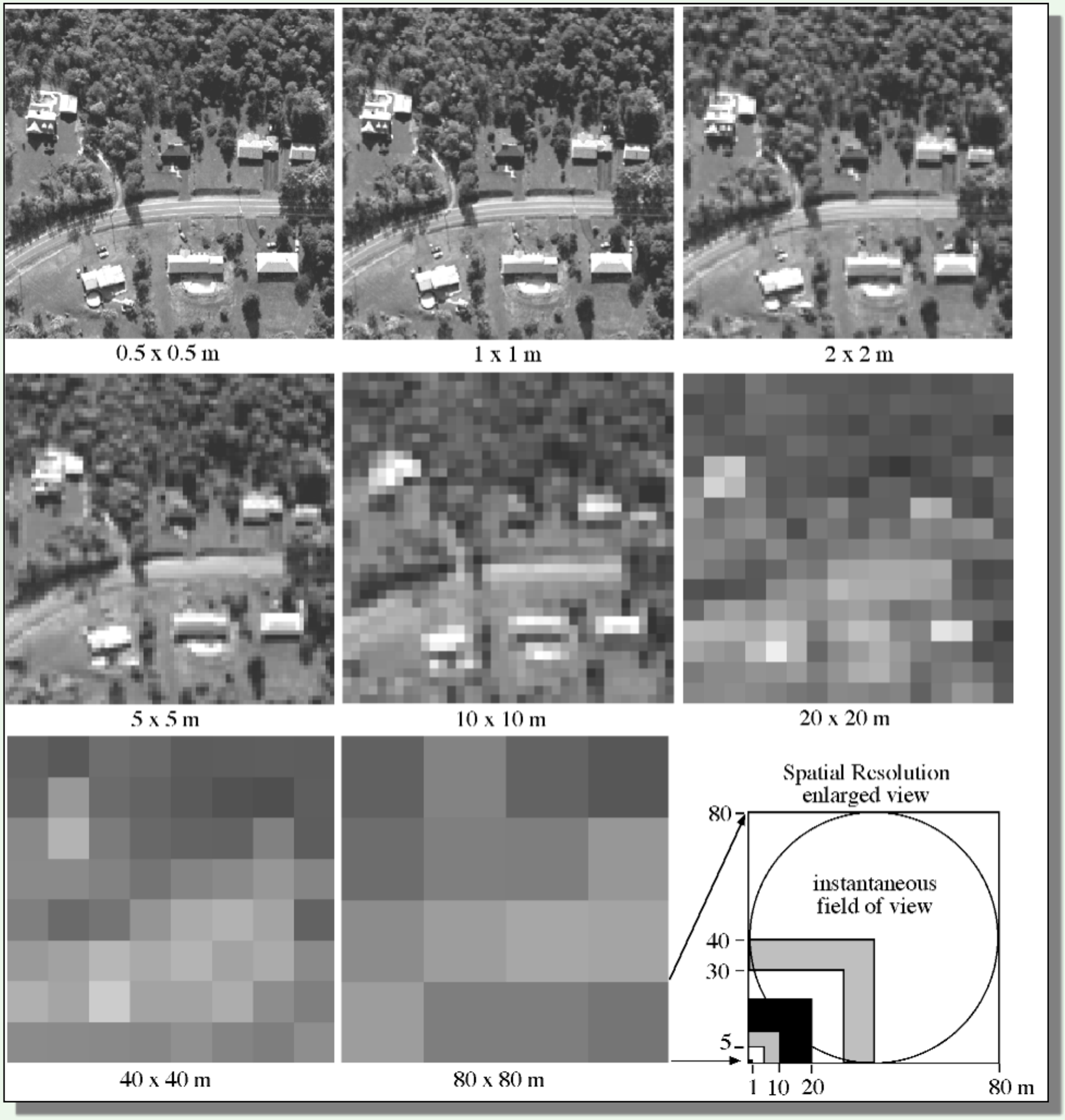
Radiometric resolution – bit depth

Temporal resolution – orbital period
(return rate)



Spatial resolution

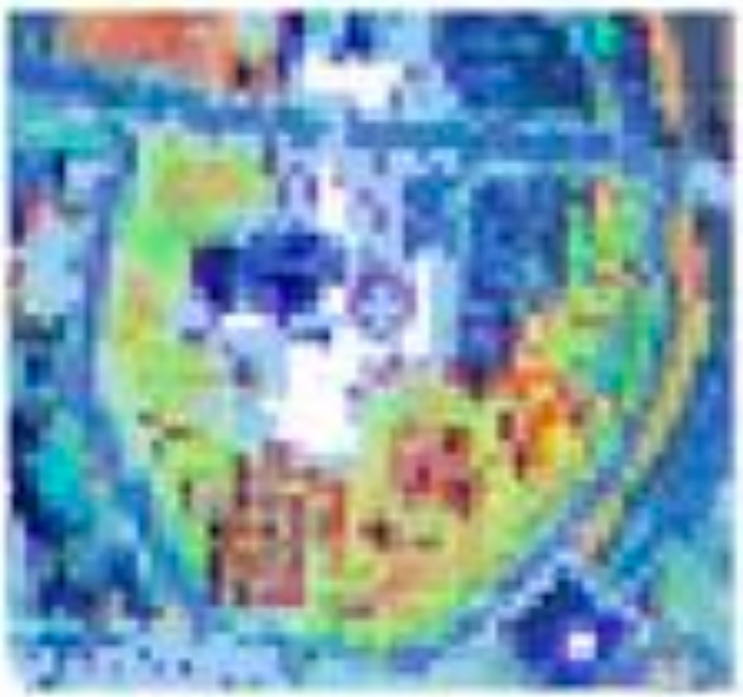
- High spatial resolution
  - < 4 m
  - Some are equivalent to aerial images
  - WorldView, …
- Mid spatial resolution
  - 5 ~ 100 m
  - SPOT, Landsat, Sentinel, …
  - Earth resources mapping satellites
- Coarse spatial resolution
  - > 100 m
  - MODIS, GOES (weather satellites), …



Different Spatial Resolutions

Spatial resolution

Panchromatic Orthophotograph
2 foot (0.6 meter) resolution

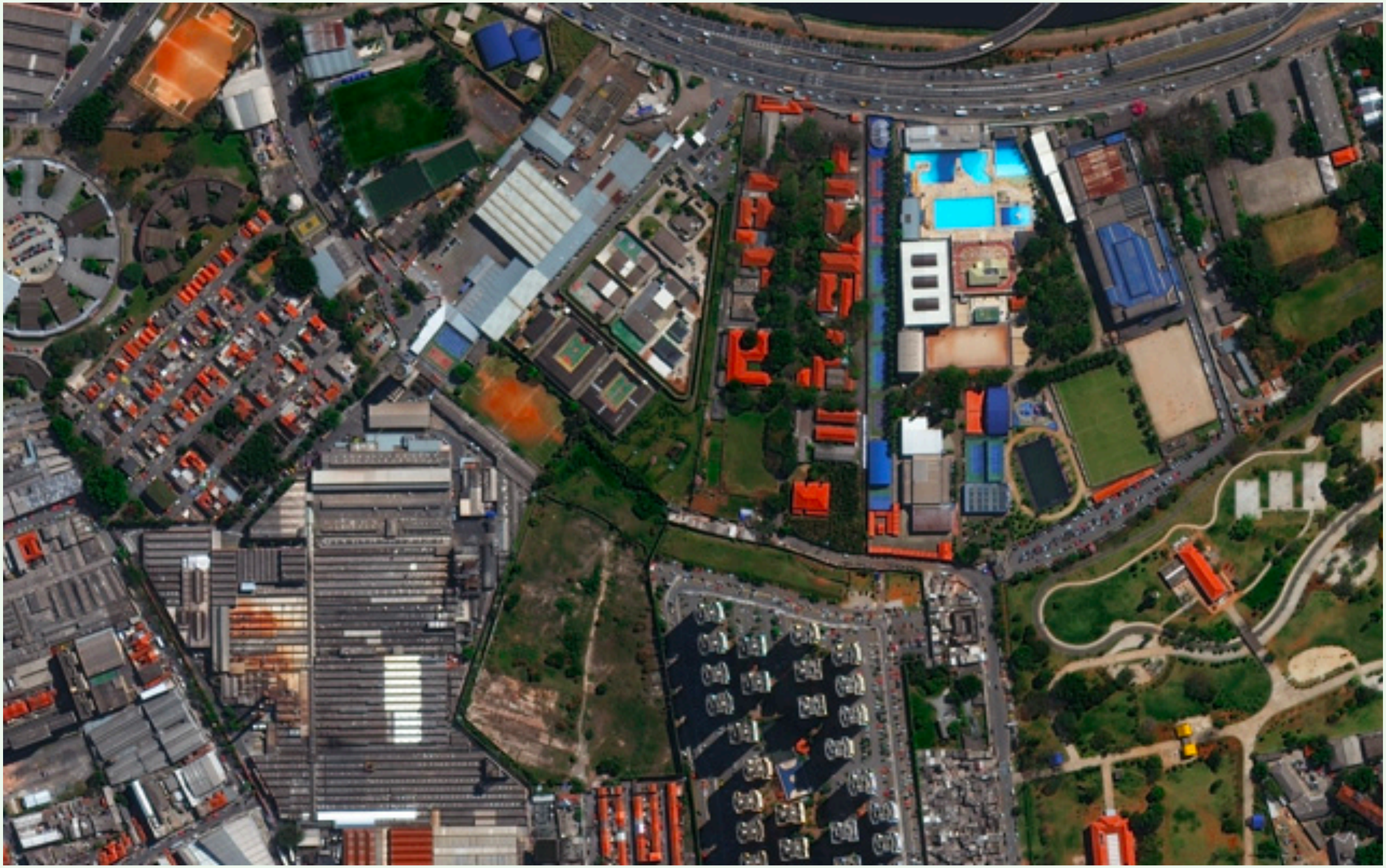


Advanced Terrestrial Applications Sensor
7.5 meter resolution

Landsat Enhanced Thematic Mapper Plus
30 meter resolution

High spatial resolution

WorldView-3 (30 cm)

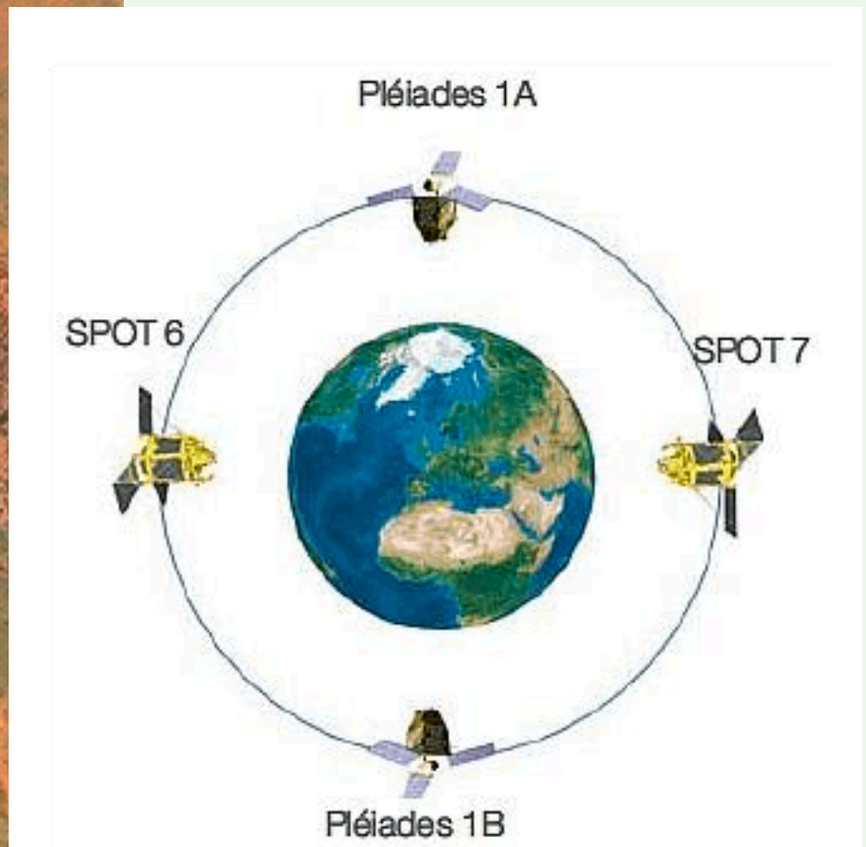


Medium spatial resolution

Landsat (30 m)

Medium spatial resolution

SPOT (6 m)

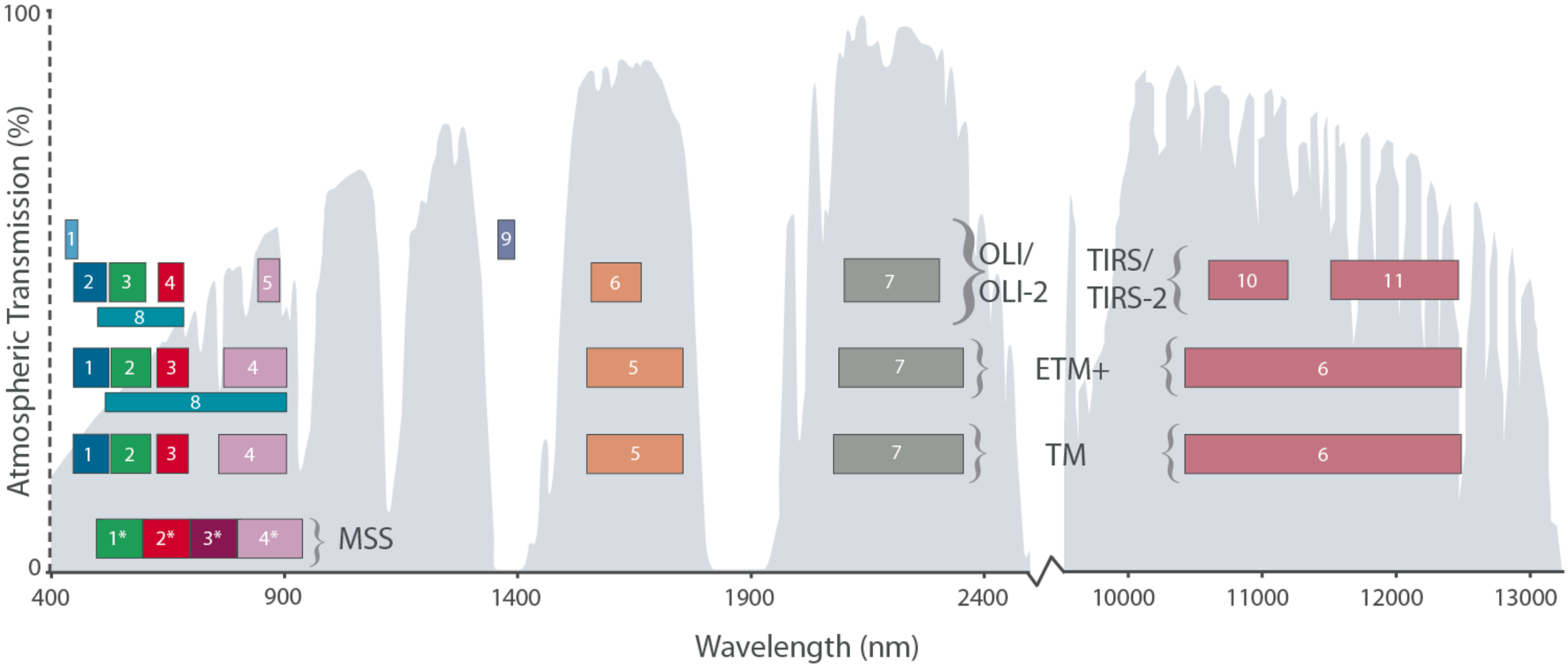


Bissagos Islands, Guinea-Bissau © 2013 Astrium Services

Low spatial resolution

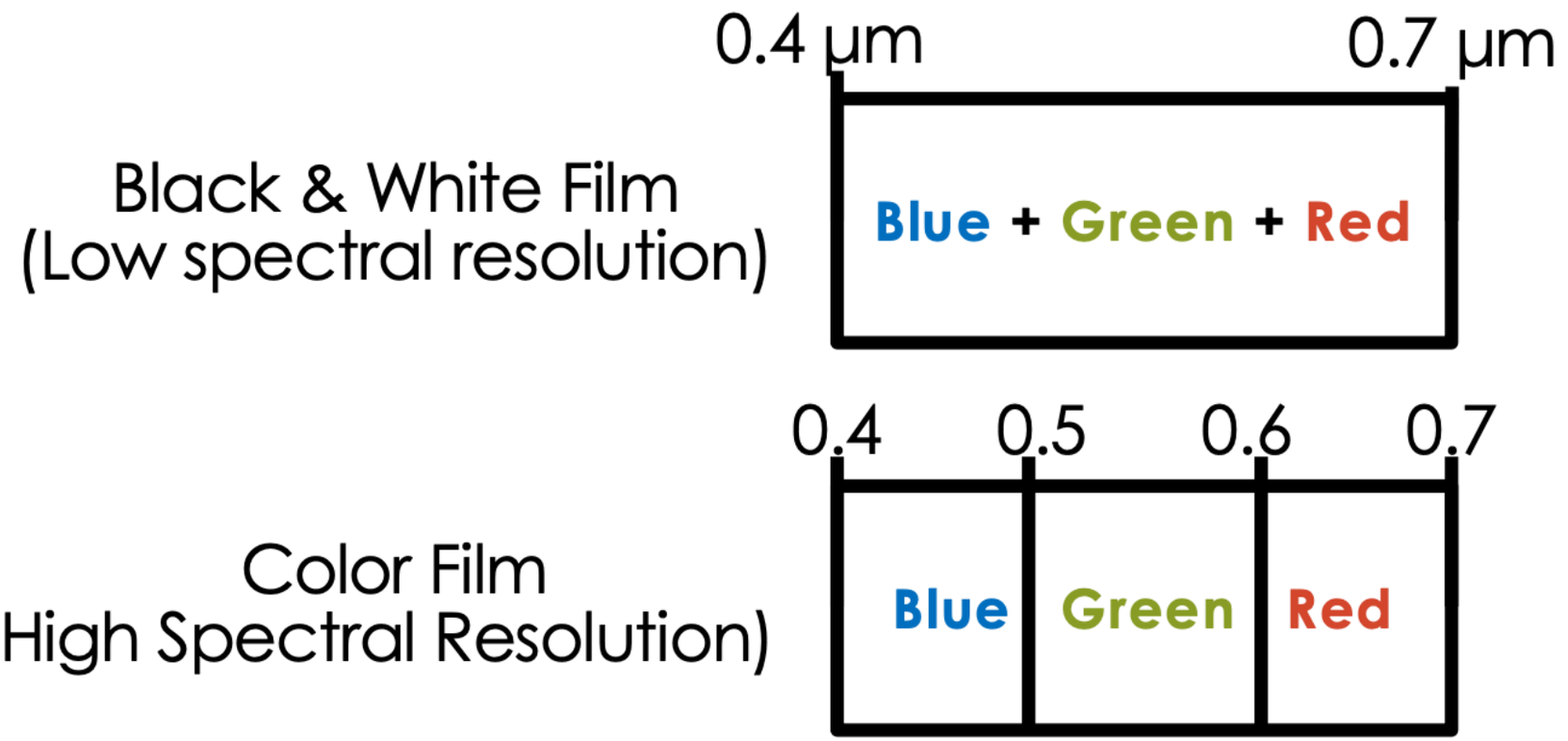
MODIS (250 & 500 m)

Spectral resolution

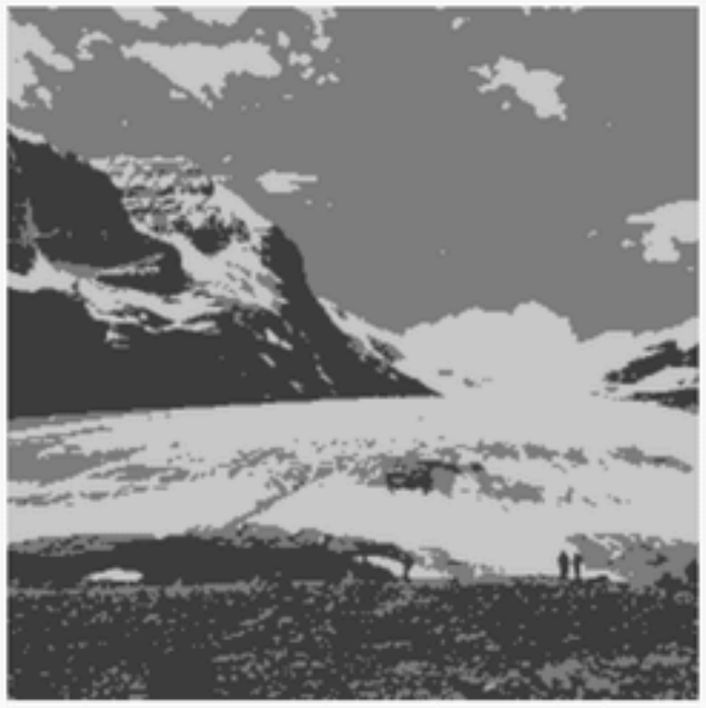
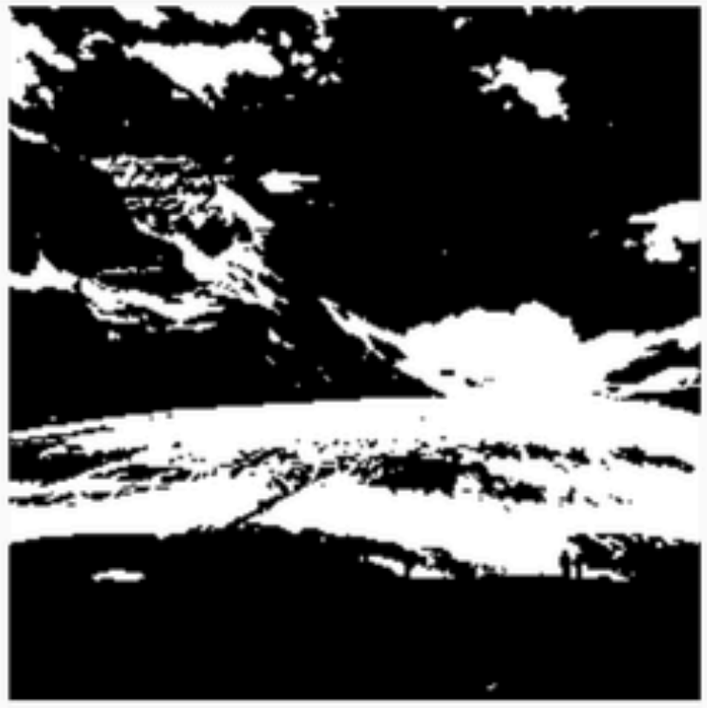


Spectral resolution

	Bands	Wavelength (micrometers)	Resolution (meters)
Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) **Launched February 11, 2013**	Band 1 - Coastal aerosol	0.43 - 0.45	30
	Band 2 - Blue	0.45 - 0.51	30
	Band 3 - Green	0.53 - 0.59	30
	Band 4 - Red	0.64 - 0.67	30
	Band 5 - Near Infrared (NIR)	0.85 - 0.88	30
	Band 6 - SWIR 1	1.57 - 1.65	30
	Band 7 - SWIR 2	2.11 - 2.29	30
	Band 8 - Panchromatic	0.50 - 0.68	15
	Band 9 - Cirrus	1.36 - 1.38	30
	Band 10 - Thermal Infrared (TIRS) 1	10.60 - 11.19	100
	Band 11 - Thermal Infrared (TIRS) 2	11.50 - 12.51	100


0.4 µm
0.7 µm
Black & White Film
(Low spectral resolution)
Blue + Green + Red
0.4
0.5
0.6
0.7
Color Film
(High Spectral Resolution)
Blue
Green
Red

Radiometric resolution

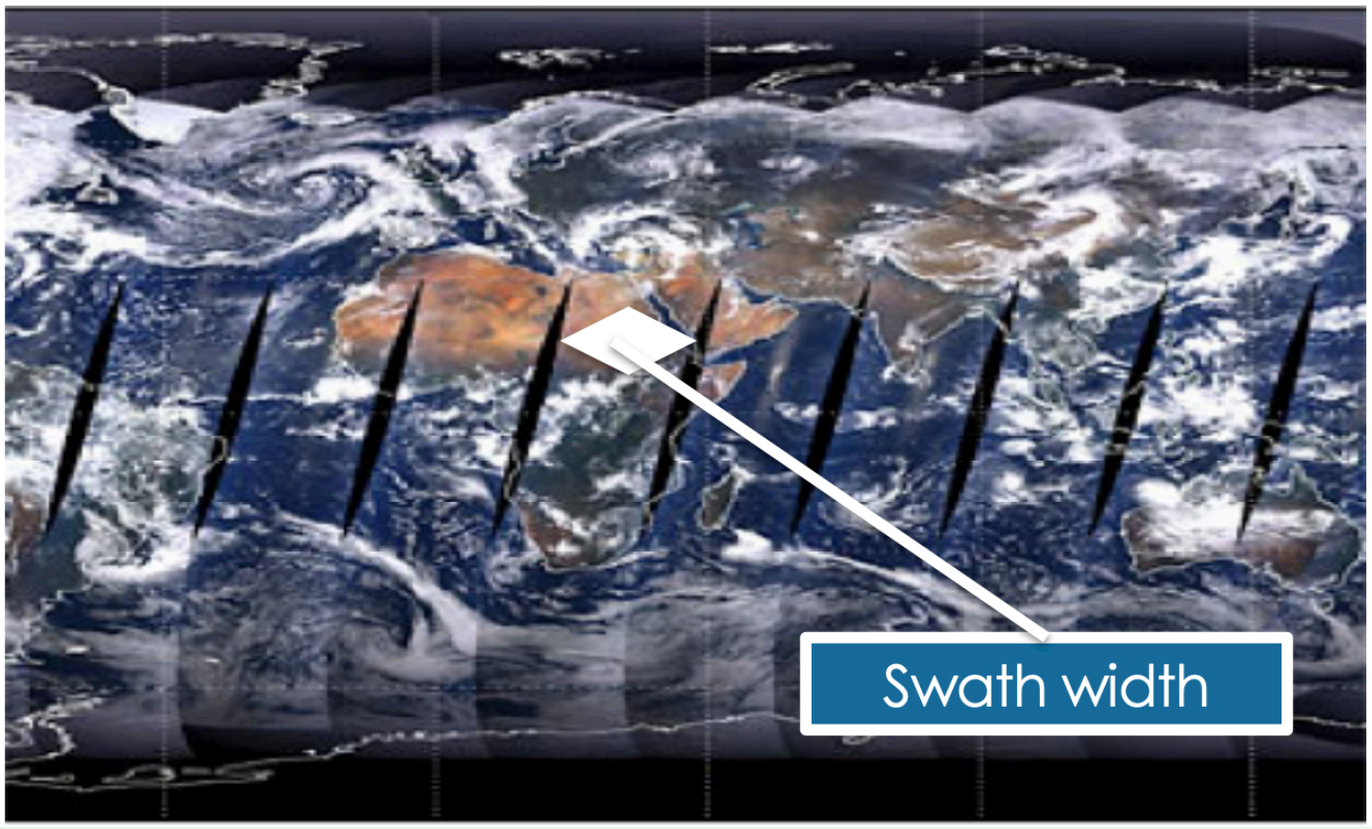
8 bit Resolution 2^8 = 256 levels	2 bit Resolution 2^2 = 4 levels	1 bit Resolution 2^1 = 2 levels
		

Radiometric resolution

Bits	Values	Gray Values
1Bit	$2^1 = 2$ (0-1)	0 … 1
4Bit	$2^4 = 16$ (0-15)	0 … 15
8Bit	$2^8 = 256$ (0-255)	0 … 255

Temporal resolution

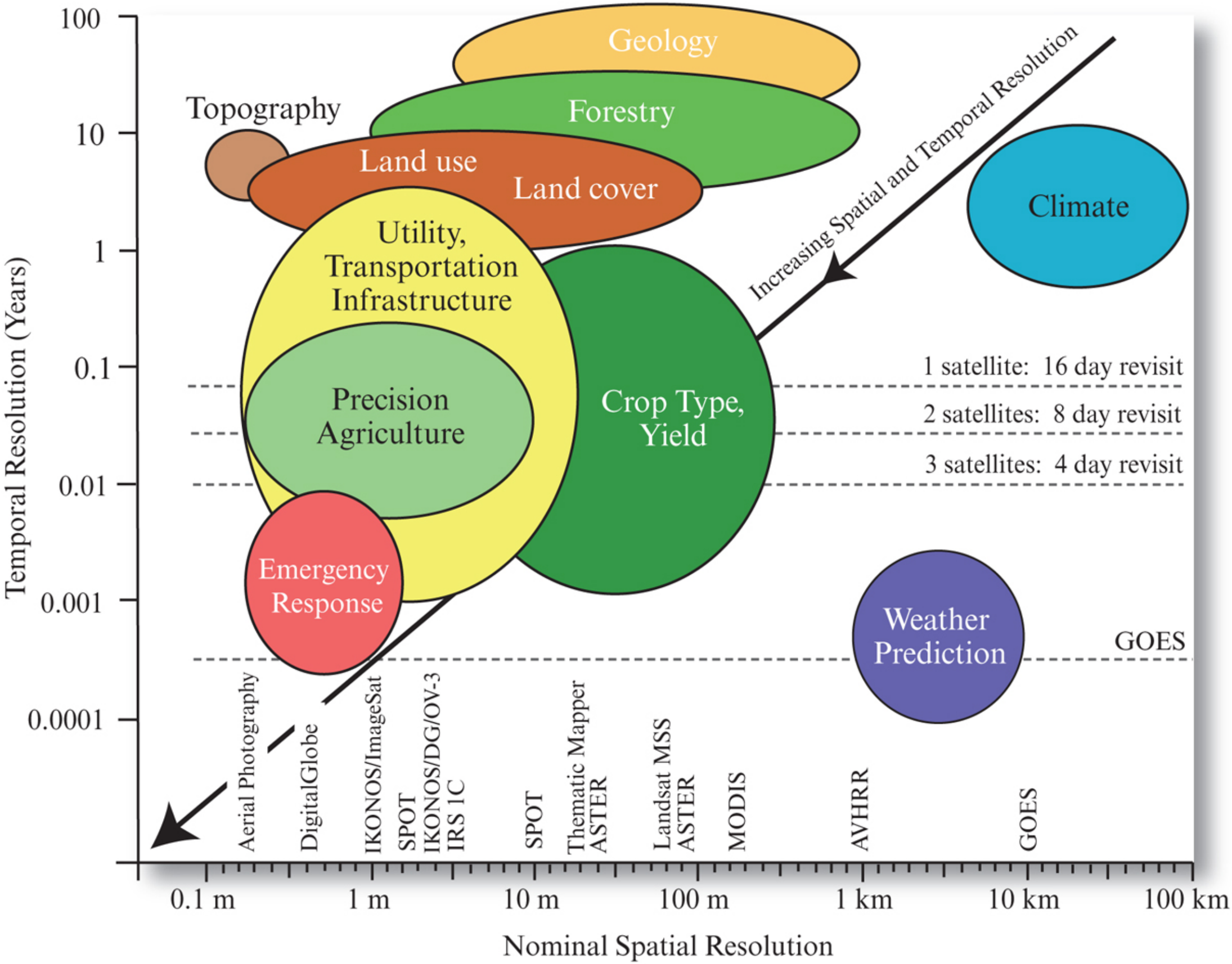
- How frequently a satellite can provide observation of the same area on the earth
  - It mostly depends on the swath width of the satellite – the larger the swath – the higher the temporal resolution



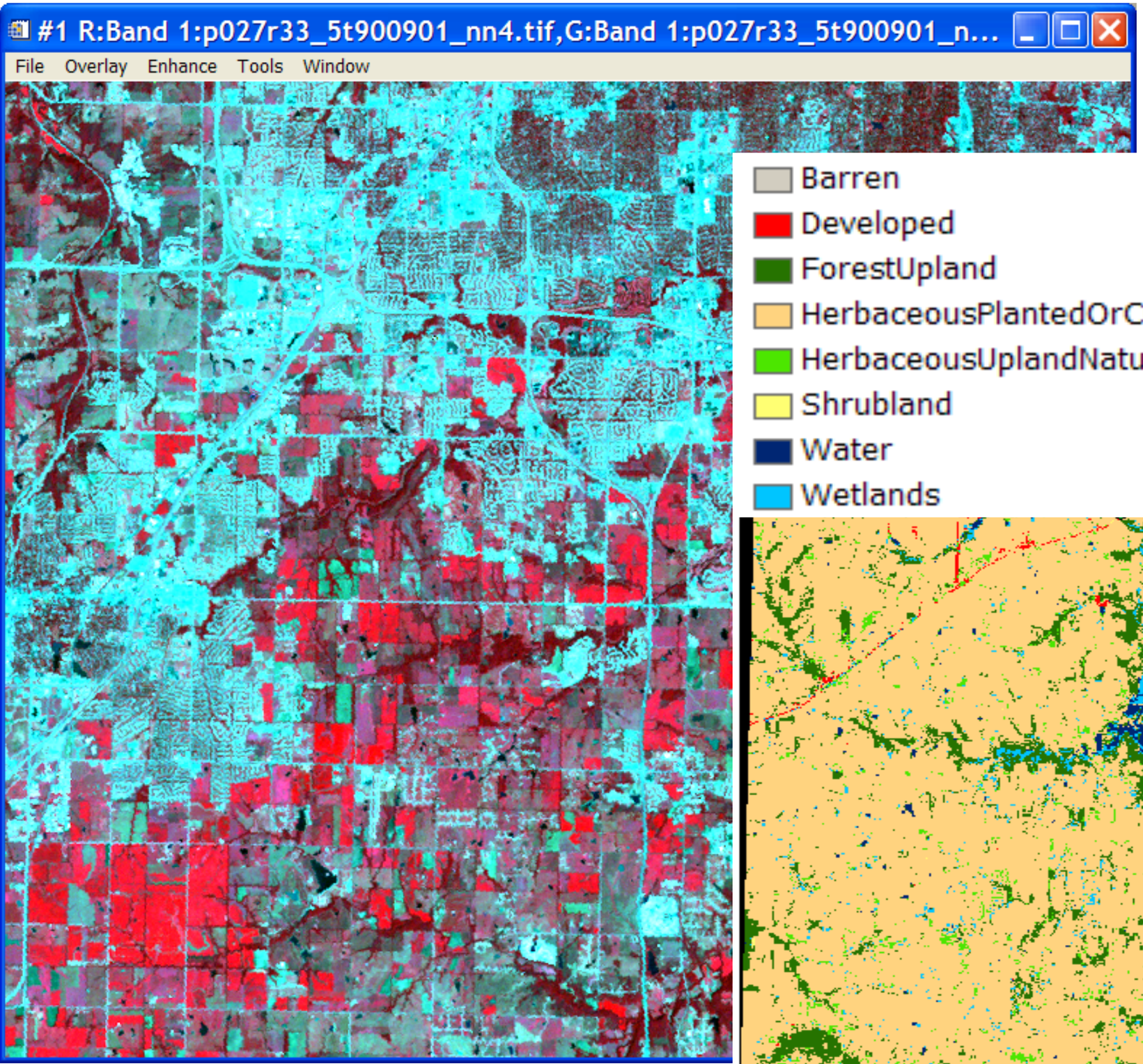
Global coverage in….

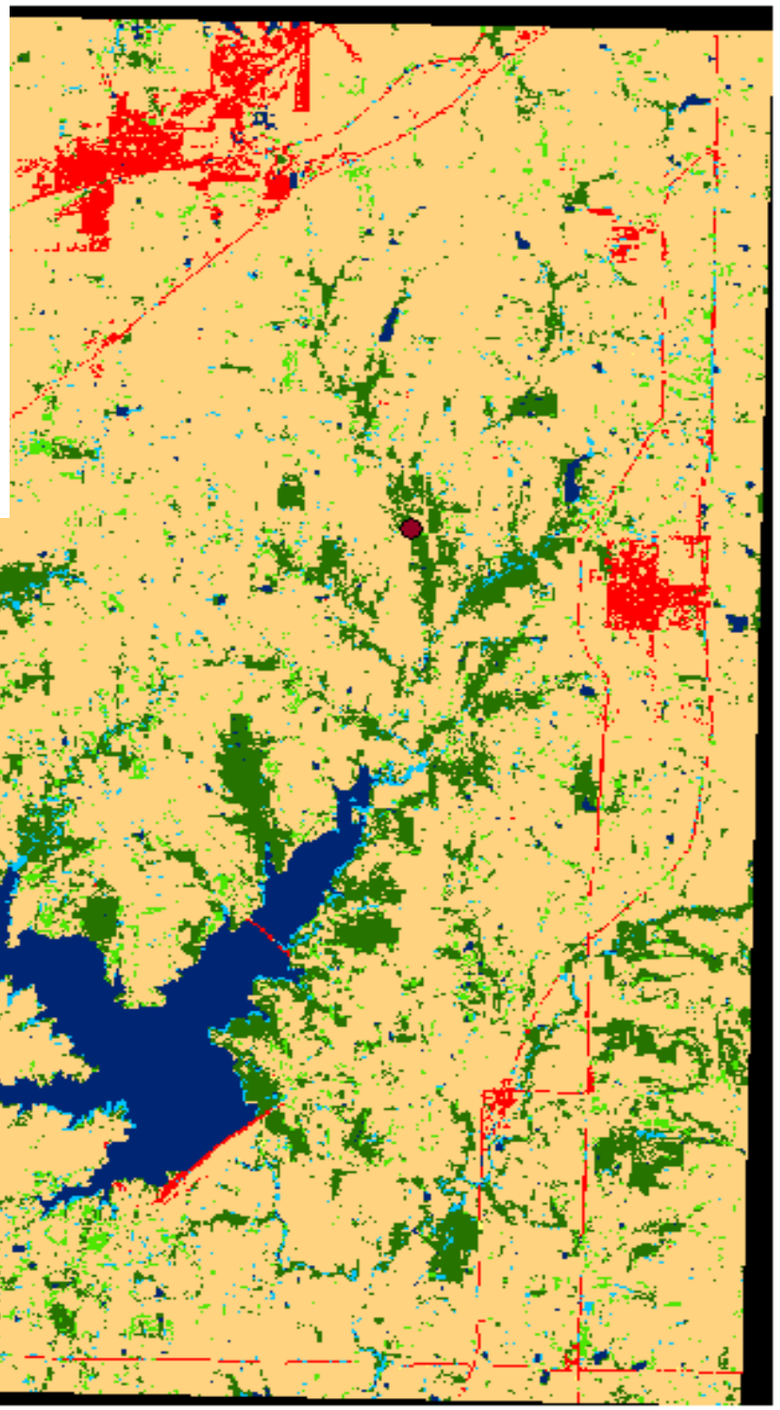
- MODIS
  - 1-2 days
- OMI
  - 1 day
- MISR
  - 6-8 days
- VIIRS
  - 1 day
- Geostationary
  - 30 sec – 1 hr

Spatial and Temporal Resolution for Selected Applications



How to Make Sense of “Sensing” ?





Turn Data into Information

- Photo interpretation
  - High resolution images (aerial or satellite)
  - Too much noise to be fully automatic
  - Machine learning development (especially deep learning)
- Pixel-wise image classification
  - Mid and coarse resolution images
  - Land cover mapping

Visual Image Interpretation

- Manually extract information from images
- Visual clues: size, shape, color, texture, location
  - View from above (not very familiar with)
  - Local knowledge
- Image enhancement may help
- Some are relatively easy (water body) and some are more challenging (crops)

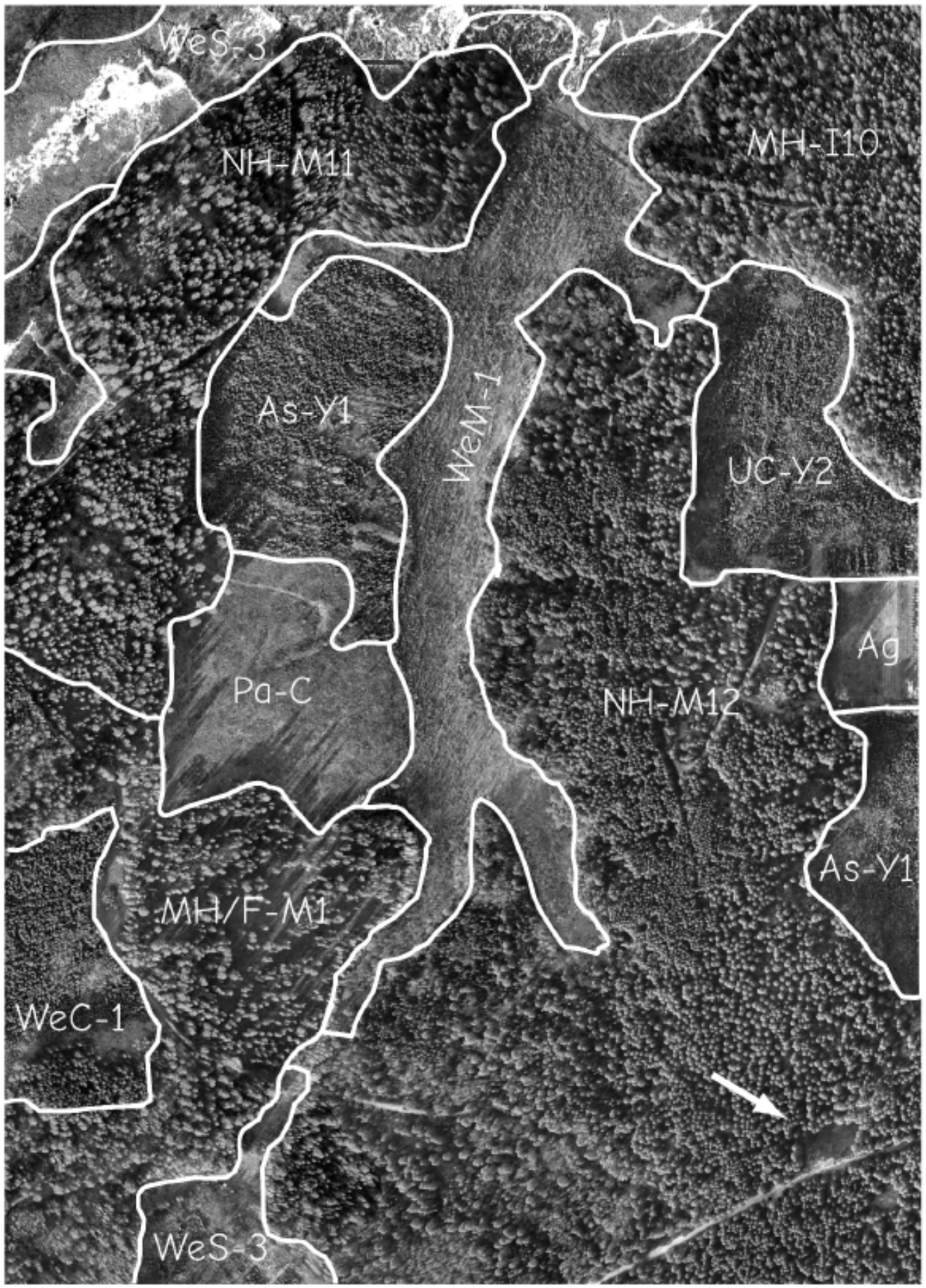


Figure 6-29: Photo interpretation is the process of identifying features on an image. Photo interpretation in support of GIS typically involves digitizing the points, lines, or polygons for categories of interest from a georeferenced digital or hardcopy image. In the example above, the boundaries between different vegetation types have been identified based on the tone and texture recorded in the image. The arrow at the lower right shows an "inclusion area", not delineated because it is smaller than the minimum mapping unit.

Manual Image Interpretation

Automatic Image Classification

- Traditionally pixel-wise classification
- Use other clues
  - Texture, …
- Object-oriented classification
  - Machine learning methods

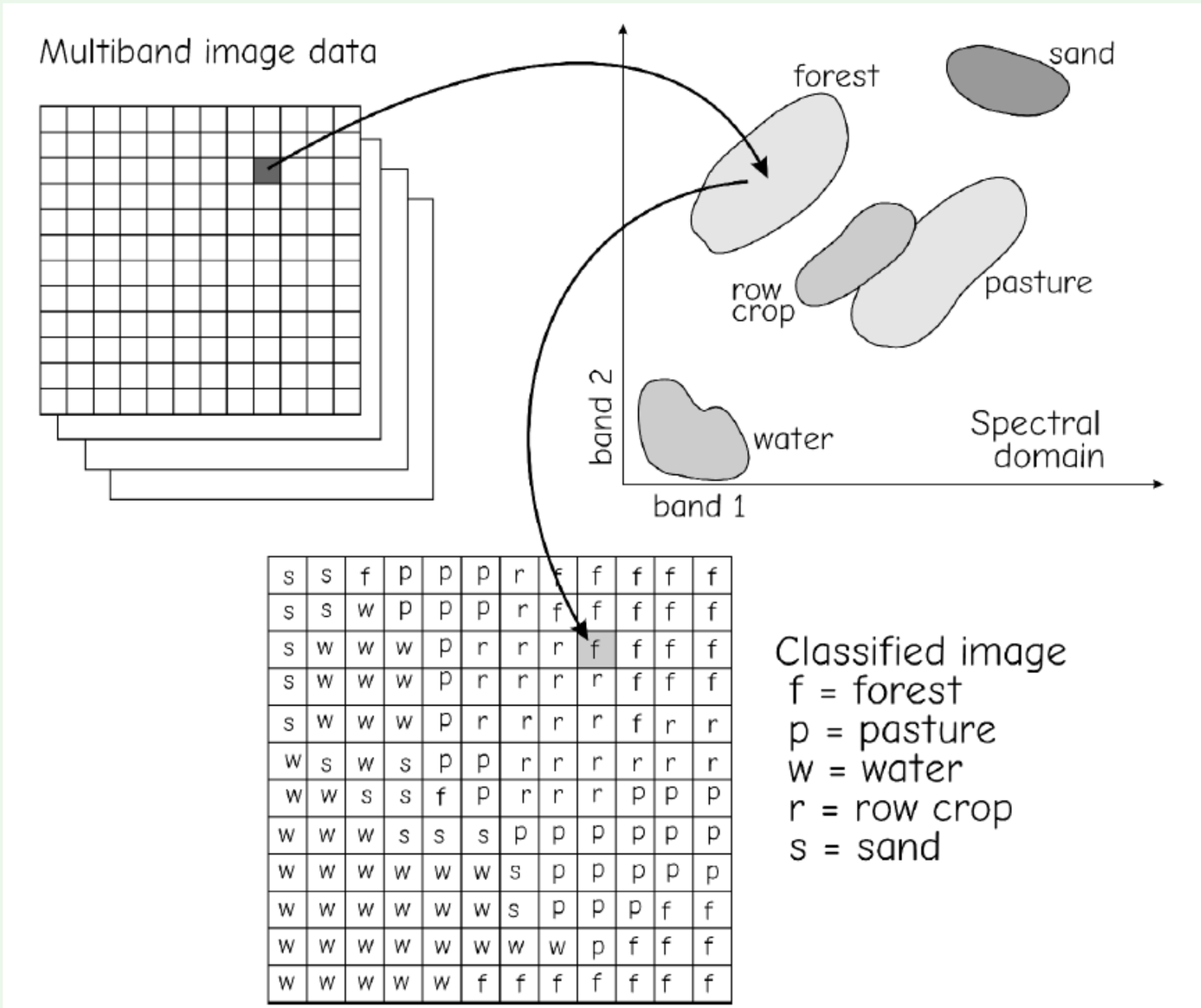
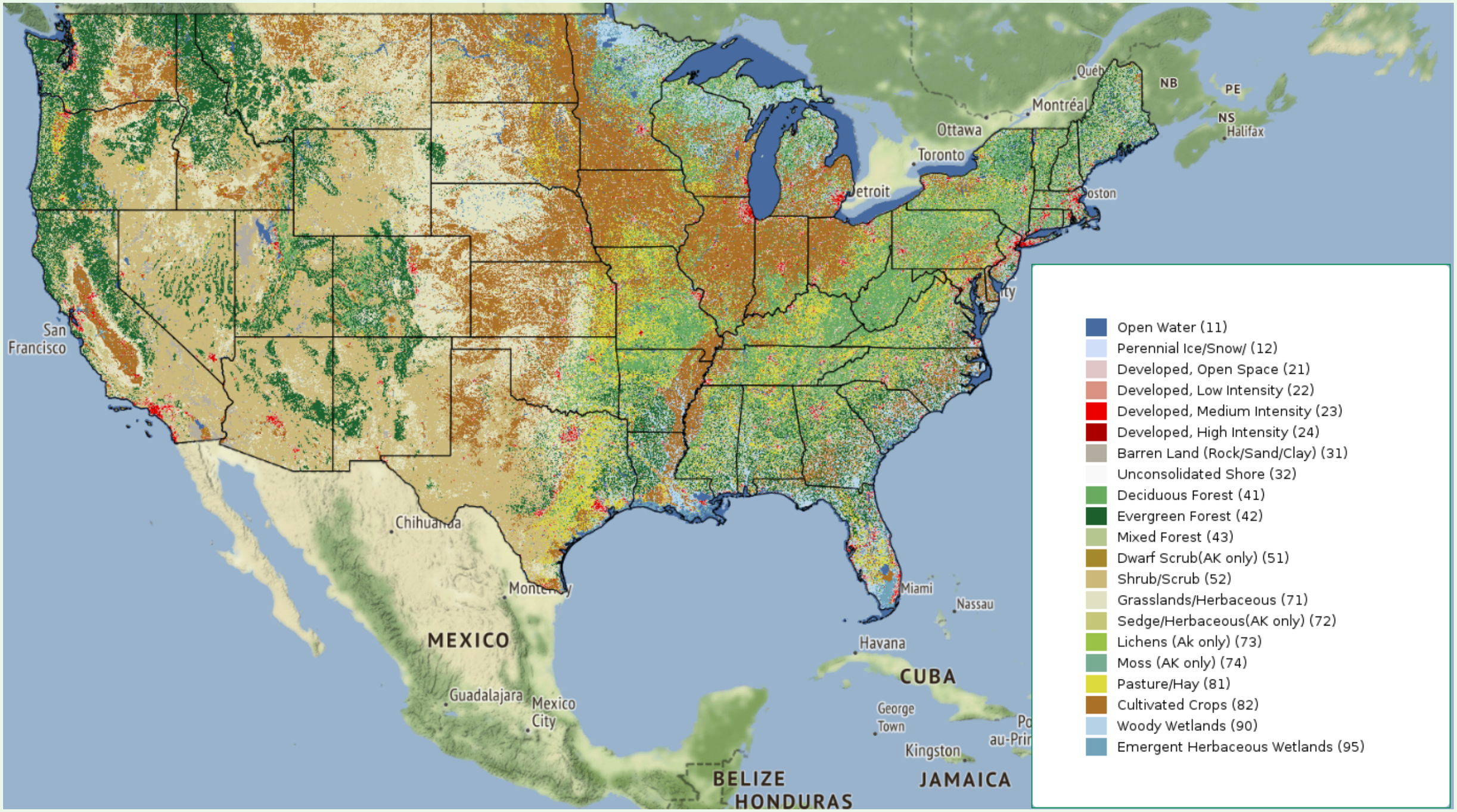


Figure 6-42: Landcover and land use classification is a common application of satellite images. The spectral reflectance patterns of each cover type are used to assign a unique landcover class to each cell. These data may then be imported into a GIS as a raster data layer.

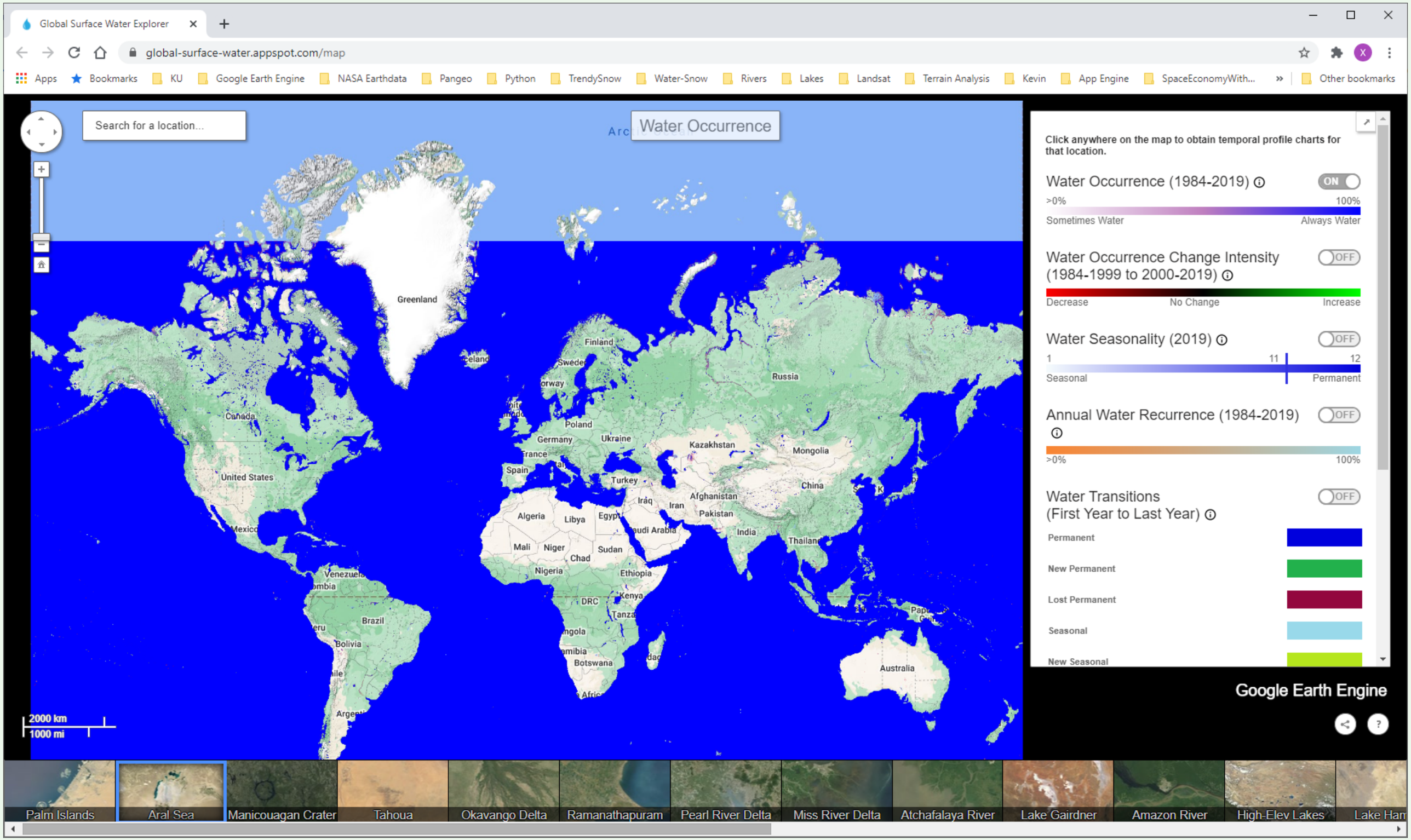
NLCD—National Land Cover Dataset

- The Multi-Resolution Land Characteristics (MRLC) consortium is a group of federal agencies who coordinate and generate consistent and relevant land cover information at the national scale
- Based on Landsat imagery (30-m resolution)
- 1992, 2001, 2006, 2011, 2016

NLCD—National Land Cover Dataset



JRC Global Surface Water



LEGEND ANALYSIS

Tree cover gain - 2001-2012

Tree cover gain

Tree cover loss - 2001-2020

Tree cover loss

Displaying Tree cover loss with > 30% canopy density

2001 2004 2007 2011 2014 2017 2020

Tree cover loss is not always deforestation.

Tree cover - 2010

Tree cover

Displaying Tree cover with > 30% canopy density

Displaying Tree cover for 2010

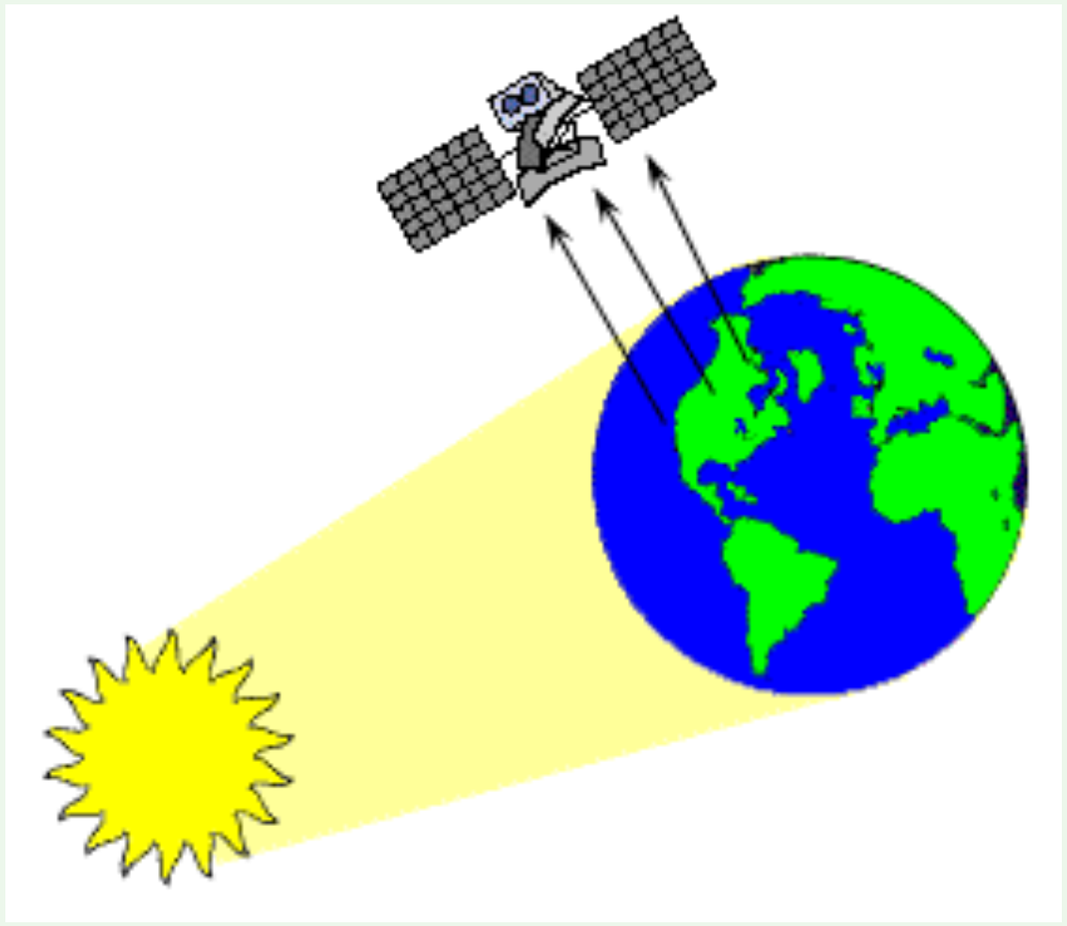
PLANET SATELLITE IMAGERY *(TROPICS)*

Remote sensing & national datasets

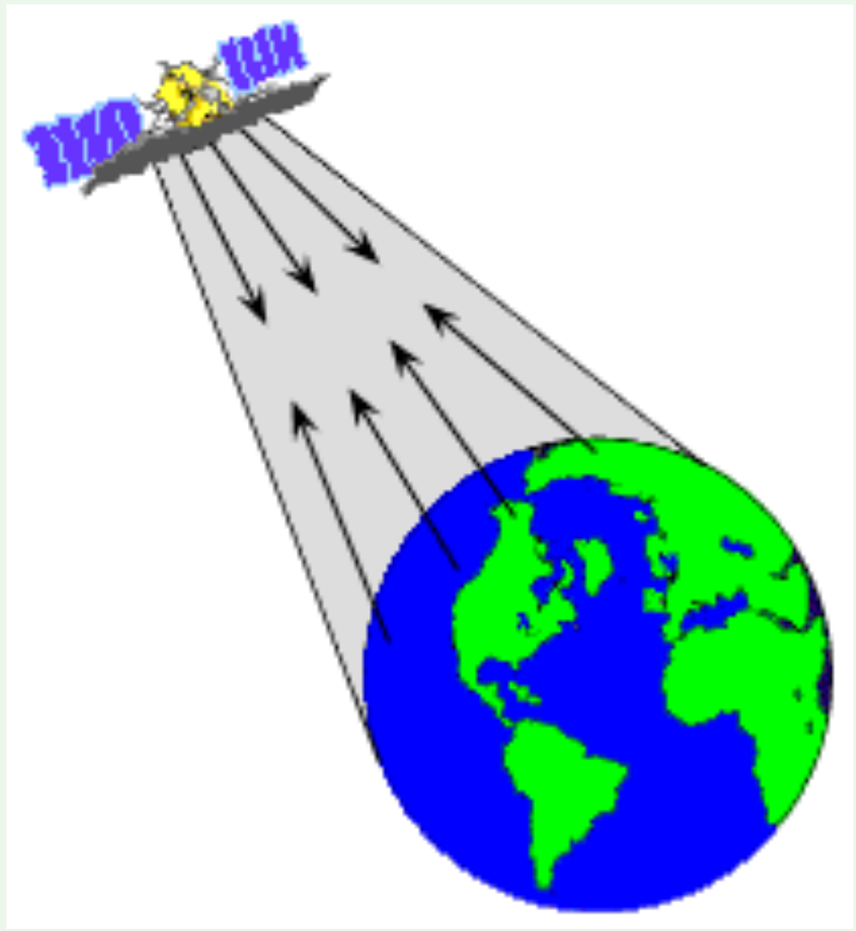
- USGS National Land Cover Datasets (NLCD)
- USGS topographic maps
  - USGS Digital Raster Graphics (DRG)
  - USGS Digital Line Graphs (DLG)
- USGS Digital Orthophoto Quadrangles (DOQ)
- USGS Digital Elevation Models (DEMs)
- USFWS National Wetlands Inventory (NWI)

Passive and Active Remote Sensing Systems

- Passive sensor

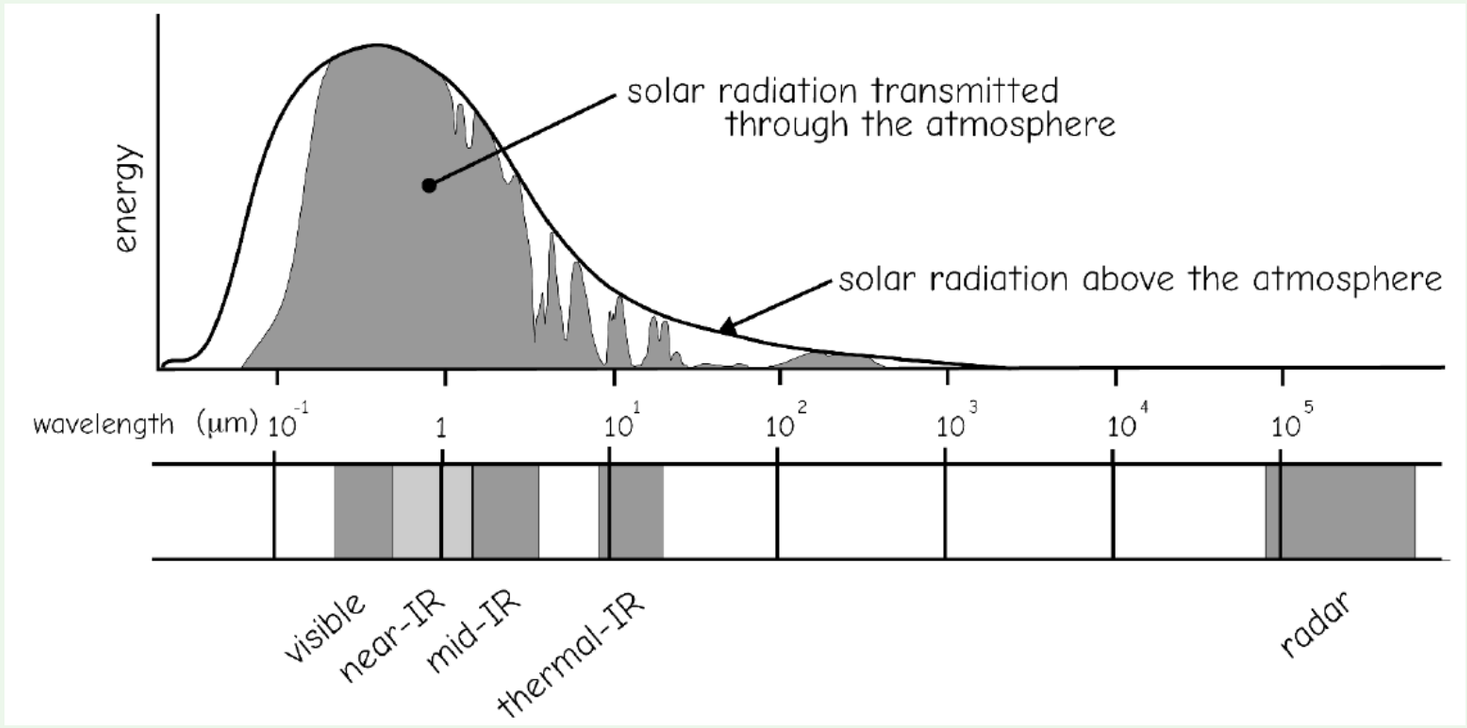


- Active sensor



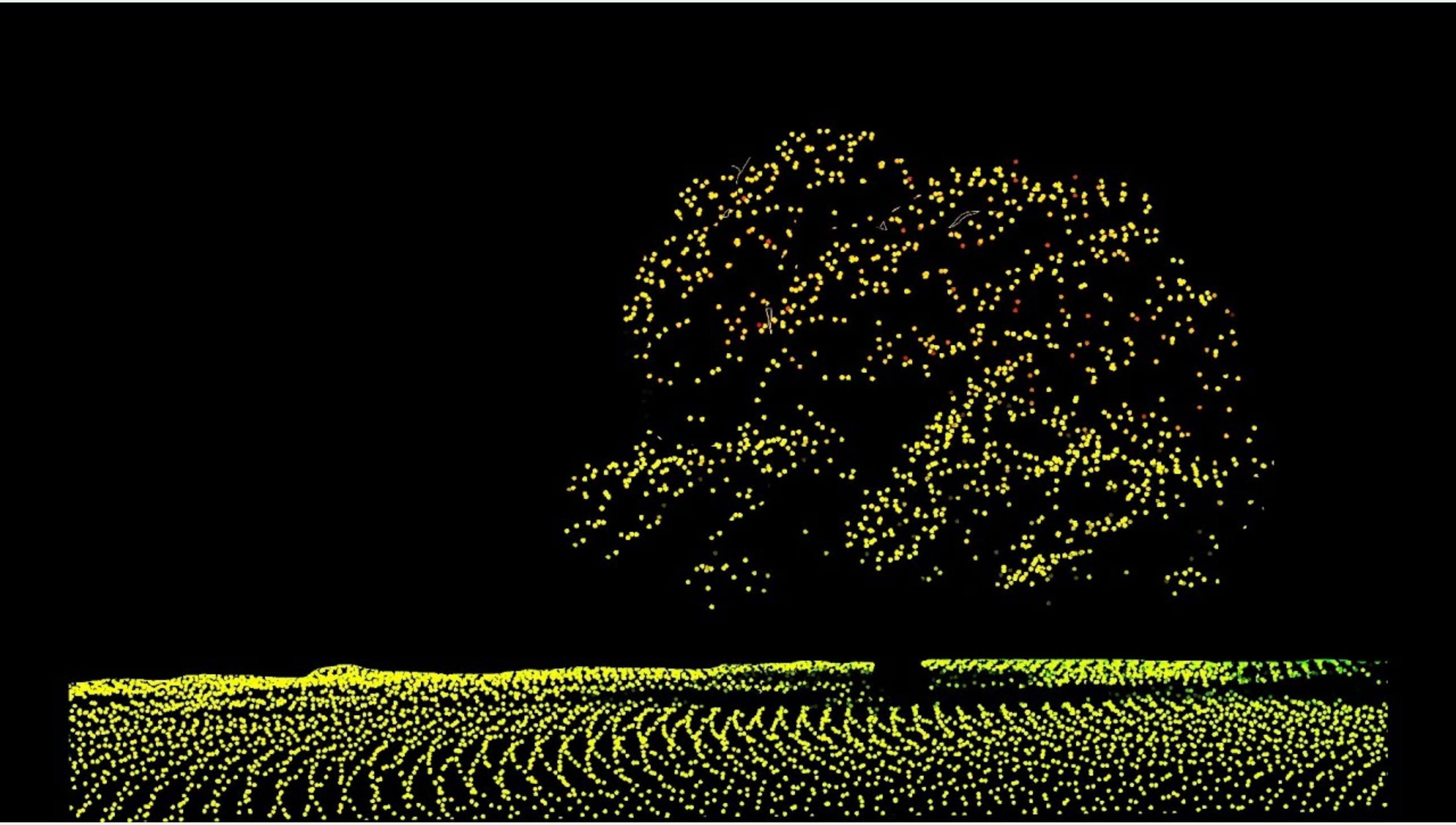
Radar and LiDAR

- Active remote sensing system
- Radar (radio detection and ranging)
- LiDAR (light detection and ranging)
- Different wavelength
  - Lidar: 0.9 and 1.5 um (eye-safe)
  - Radar: $10^{5\sim6}$ um
- Lidar has limited ability to penetrate clouds, smoke and haze



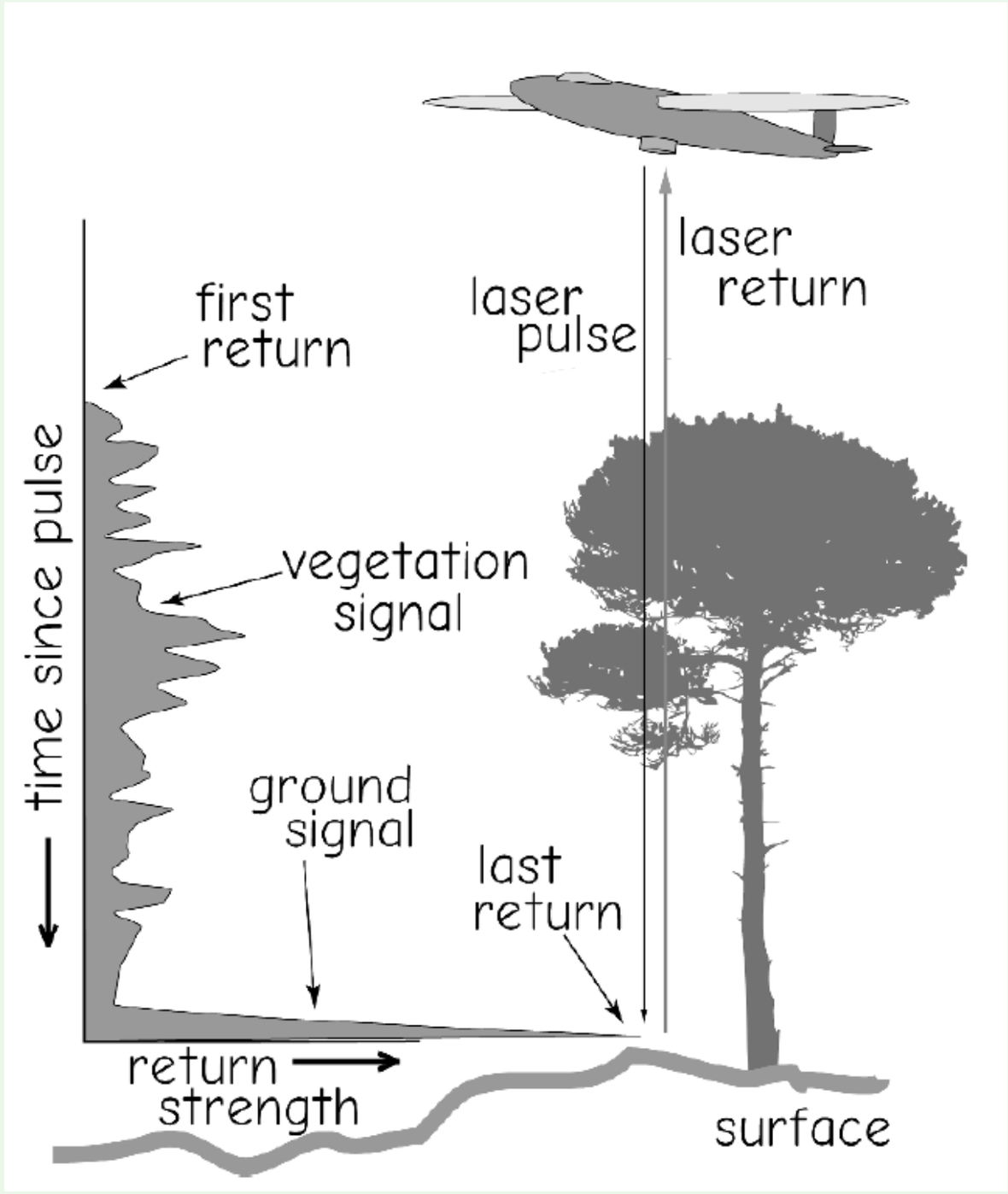
Radar

- Weather and daylight independent
- Can be ground penetrating



Light Detection and Ranging (LiDAR)

- Primary for mapping elevation
  - 10 to 50 cm accuracy
- Operating altitude: 400 - 2,000 meters.
- Swath width: up to 1,500 meters at 2,000 meter altitude.
- Several returns can be used to detect land covers at different heights



LIDAR Data (Point Clouds)

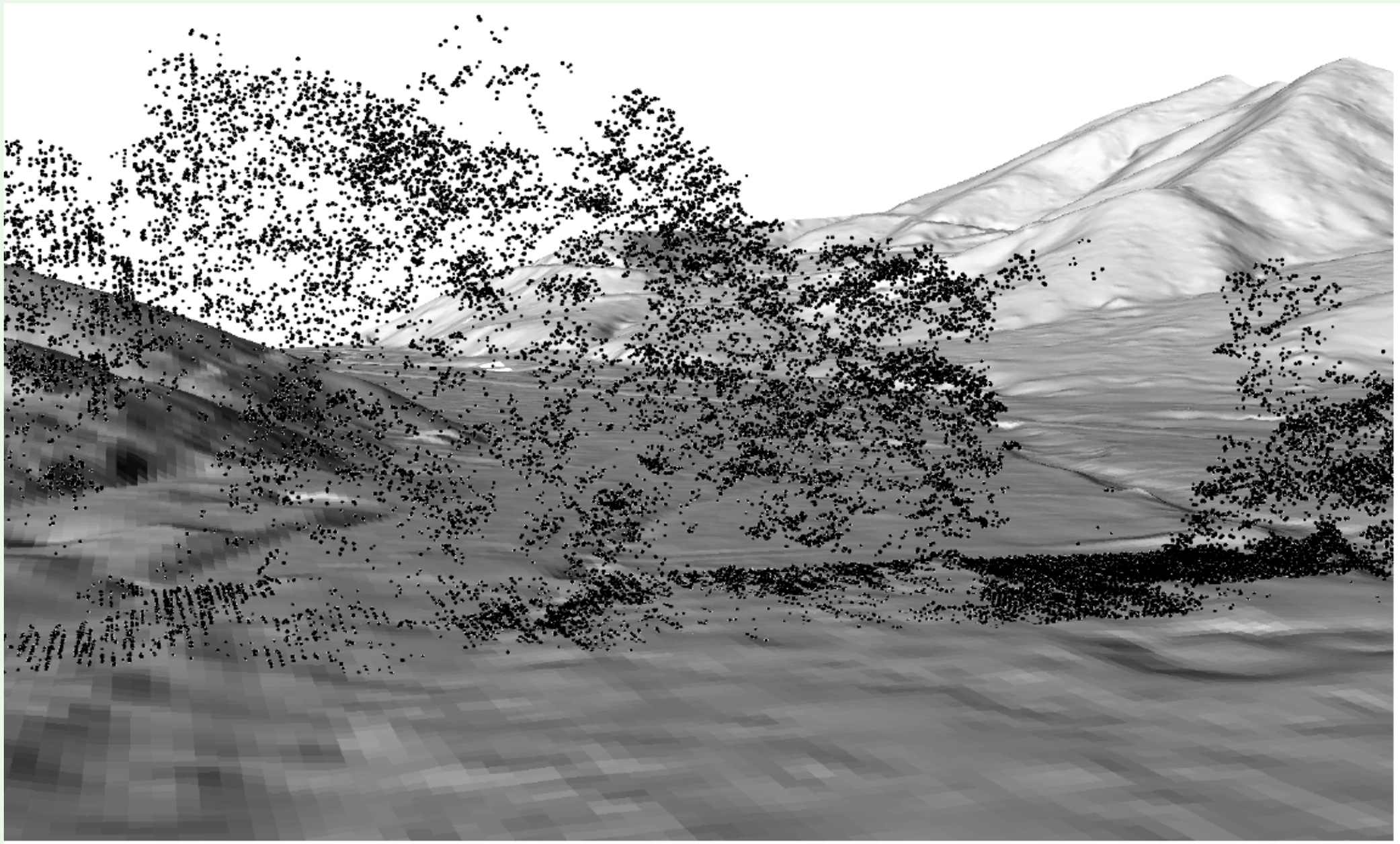


Figure 6-45: An example of a LiDAR point cloud, here a swath through a forested area, displayed over a terrain model. Each point represents a LiDAR return, showing returns from the canopy and taller trees, sub-canopy branches and shrubs, and dense ground returns in canopy gaps.

LIDAR Data

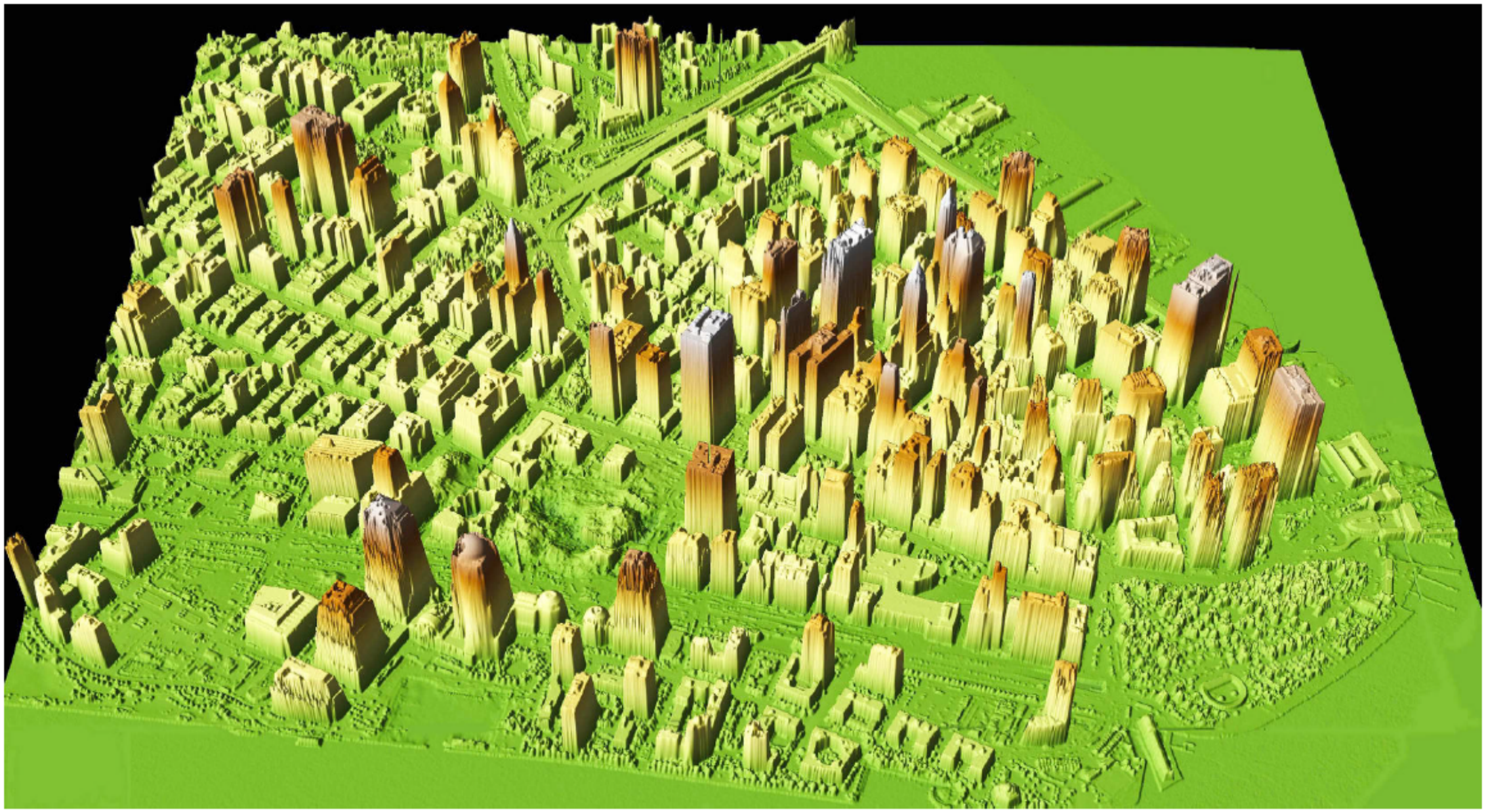
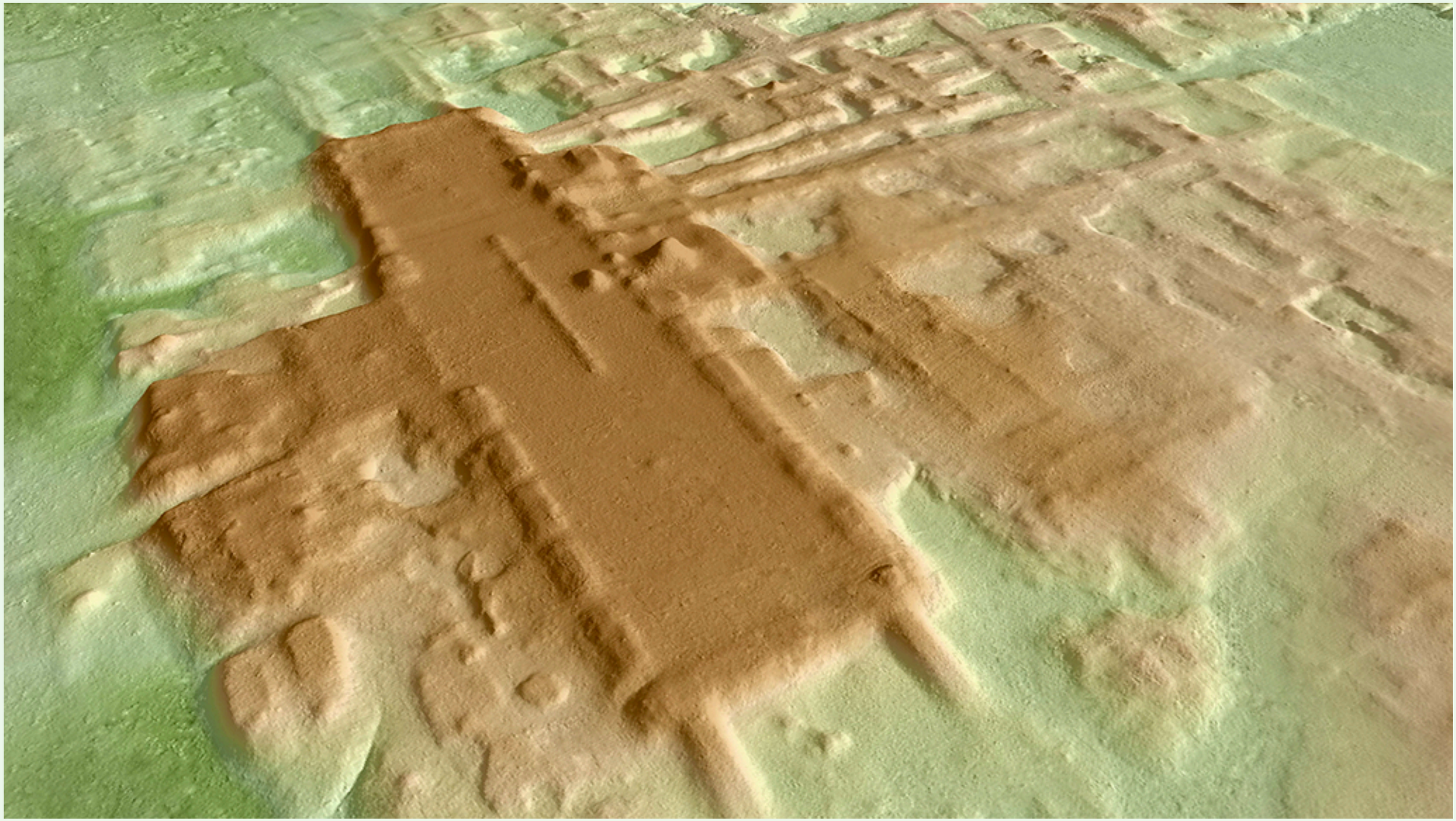


Figure 6-47: An example of LiDAR data and depiction of building heights. This image shows lower Manhattan, New York in late 2001. Tallest buildings are shown in white, and the land and water surfaces in green (courtesy NASA).



Surface Water and Ocean Topography

- Cm accuracy launch planned for 2022
- 2 height observations per 21 days for inland water bodies

Data

Local vs Web Data

- Local data has full control and analysis possibility
- Web data
    - Especially useful for reference and background
    - Save local storage
    - Some only viewable (cannot perform analysis)
    - Need internet connection
- Web services
    - Standard way of serving geospatial data over the Internet
    - Open Geospatial Consortium
    - Web Mapping Service (display)
    - Web Feature Service (display and analysis for vector data)
    - Web Coverage Service (display and analysis for raster data)

Big Geospatial Data and Cloud-Based Systems

- Increasing capability of collecting data at finer spatial and temporal resolutions
- Expanding spatial coverage and temporal archives
- Data size and processing time become a barrier for conventional desktop GIS and data analysis software
- Cloud computing (or CyberGIS) makes geospatial data storage and analysis possible

Google Earth Engine (GEE)

- Google Earth Engine is a massive data warehouse (2+ petabytes) of remote sensing imagery including Landsat and MODIS data
- Provides data analysis functions through Python and JavaScript APIs

Meet Earth Engine

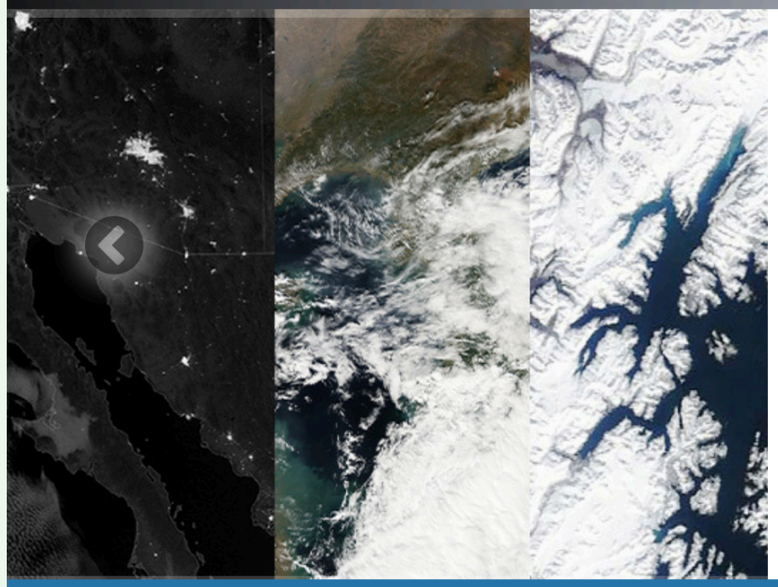
Google Earth Engine combines a multi-petabyte catalog of satellite imagery and geospatial datasets with planetary-scale analysis capabilities and makes it available for scientists, researchers, and developers to detect changes, map trends, and quantify differences on the Earth's surface.

EARTHDATA
OPEN ACCESS FOR OPEN SCIENCE

Feedback

ABOUT DATA COLLABORATE LEARN

Search datasets, news, articles, and information



Webinar: Learn How to Access and Acquire NASA Level-1 Data and Atmosphere Products from NASA's LAADS DAAC

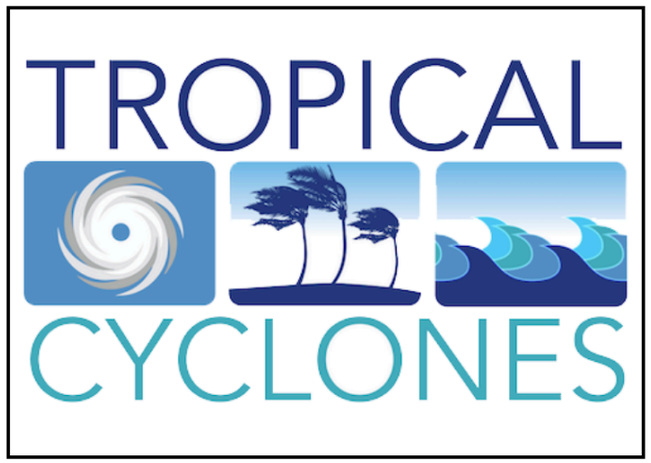
Join us on Wednesday, September 22, 2021, at 2:00 pm EDT (UTC/GMT-4) for an overview of NASA's Level-1 and Atmosphere Archive and Distribution System Distributed Active Archive Center (LAADS DAAC), its Level-1 and atmospheric data products, and to explore different options to search, discover, and acquire the data. For information or to register

ACCESS NASA EARTH SCIENCE DATA

GET STARTED | VISUALIZE DATA | FIND DATA

NASA's data policy ensures that all NASA data are available fully, openly, and without restrictions. Here's what this means to you.

ATMOSPHERE | CALIBRATED RADIANCE & SOLAR RADIANCE | CRYOSPHERE | HUMAN DIMENSIONS | LAND | OCEAN



LATEST ARTICLES

STATE OF KANSAS GIS DATA ACCESS & SUPPORT CENTER

YOUR RESOURCE FOR GEOSPATIAL DATA FROM THE STATE OF KANSAS

user name / email | Log in

Need login help? New here? **Register.**

Welcome to the DASC web site.

Most recent **catalog** entries:

- **2019 NAIP** (added Jan 2, 2020 to the *Imagery and Raster* category)
- **2021 Tax Units** (added Ju1 21, 2021 to the *Administrative Boundaries* category)
- **LiDAR 2018** (added Aug 11, 2021 to the *Elevation* category)
- **KDHE Storage Tanks** (added Oct 27, 2020 to the *Environmental Resources* category)

Data Catalog Search :

Search

Announcements :

Registration is open for the Kansas Association of Mappers (KAM) Annual Conference - October 26-29 in Topeka.

The 2022 MAGIC **Symposium** will be held April 10-14 in Branson, MO.

2021 NG911 Imagery QA - We need our local and state partners to help inspect the new imagery. **Sign up** today! (click the imagery tab)

Positions Open :
Application Developer/Programmer, Kansas Geological Survey/DASC

COVID-19 Resource Links

1930 Constant Ave, Lawrence, KS 66047
(785) 864-2000
dasc@kgs.ku.edu

KGS - Kansas Geological Survey

XHTML 1.0

Details Add Basemap Analysis Save Share Print Directions Measure Bookmarks Find address or place

About Content Legend

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It's easy to make your own map. Just follow these steps:

1. Choose an area.

Pan and zoom the map to an area or search by its name or address.

2. Decide what to show.

Choose a Basemap then Add layers on top of it.

3. Add more to your map.

Add map notes to draw features on the map.

Display descriptive text, images, and charts for map features in a pop-up.

4. Save and share your map.

Give your map a name and description then share it with other people.

Data and Tools

OVERVIEW

DATA AND TOOLS TOPICS

REAL-TIME DATA

APIS

SCIENCE DATA CATALOG

SCIENCE DATASETS

DATA MANAGEMENT

DATA MANAGEMENT TOOLS

GIS DATA

WEB APPLICATIONS

GIS Data

USGS is a primary source of Geographic Information Systems (GIS) Data. Our data and information is presented both spatially and geographically including The National Map, Earth Explorer, GloVIS, LandsatLook, and much more. Start exploring by topic below.

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Date published: SEPTEMBER 1, 2021

Massachusetts Shoreline Change Project: A GIS Compilation of Vector Shorelines (1844-2018)

This updated dataset strengthens the understanding of shoreline position change in Massachusetts. It includes U.S. Geological Survey vector shorelines edited for quality control from the mid-1800s to 1989, 1994, 2001, 2007–9, and 2010–14; and one new shoreline from 2018.

Attribution: Natural Hazards, Coastal and Marine Hazards and Resources Program, Woods Hole Coastal and Marine Science Center

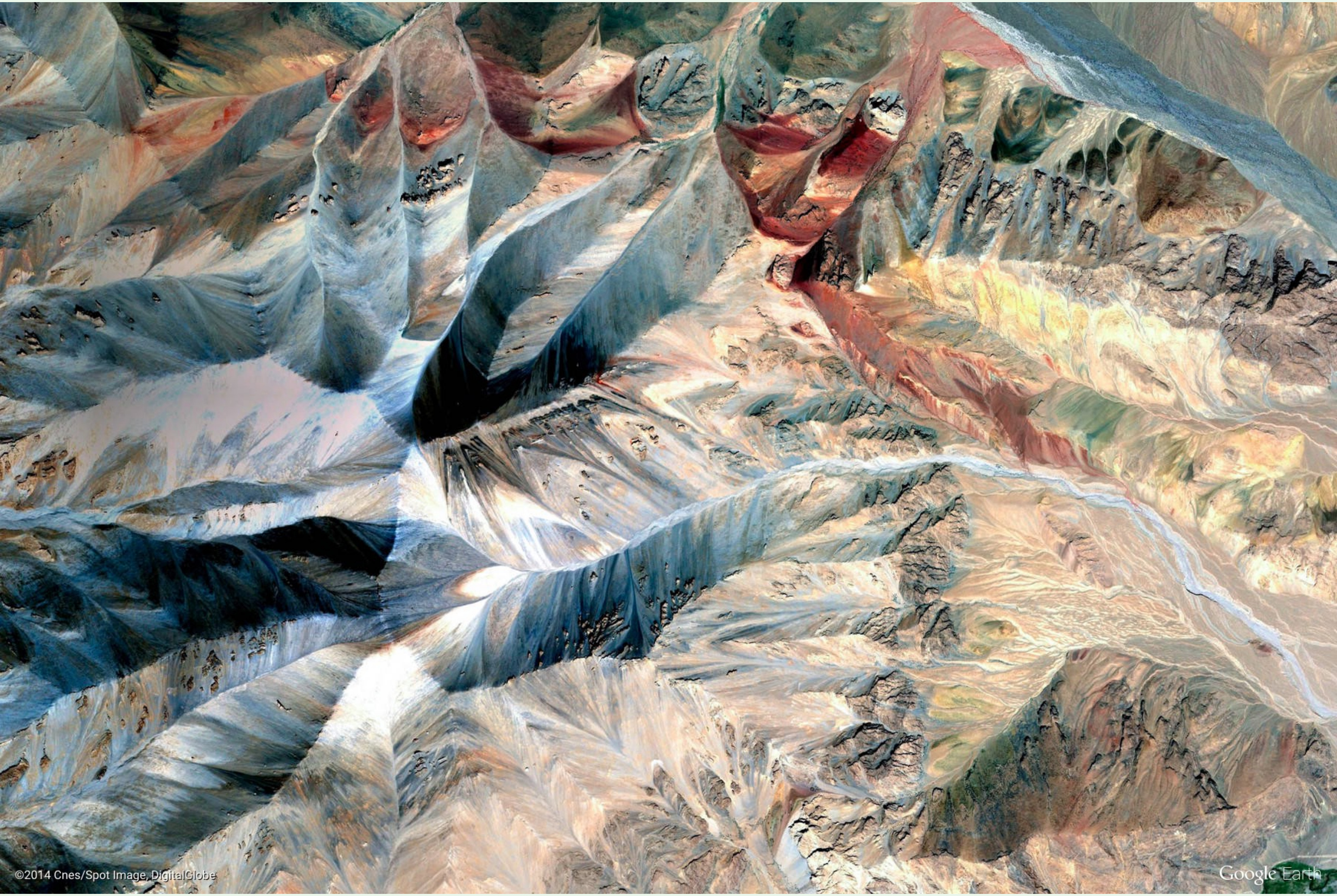
Date published: SEPTEMBER 1, 2021

Massachusetts Shoreline Change Project, 2021 Update: A GIS Compilation of Shoreline Change Rates Calculated Using Digital Shoreline Analysis System Version 5.1, With Supplementary Intersects and Baselines for Massachusetts

This 2021 data release includes rates that incorporate one new shoreline extracted from 2018 lidar data collected by the U.S. Army Corps of Engineers Joint Airborne Lidar Bathymetry Technical Center of Expertise , added to the existing database of all historical shorelines (1844-2014), for the North Shore, South Shore, Cape Cod Bay, Outer Cape, Buzzard's Bay, South Cape, and the islands.

Attribution: Natural Hazards, Coastal and Marine Hazards and Resources Program, Woods Hole Coastal and Marine Science Center

Date published: MAY 28, 2020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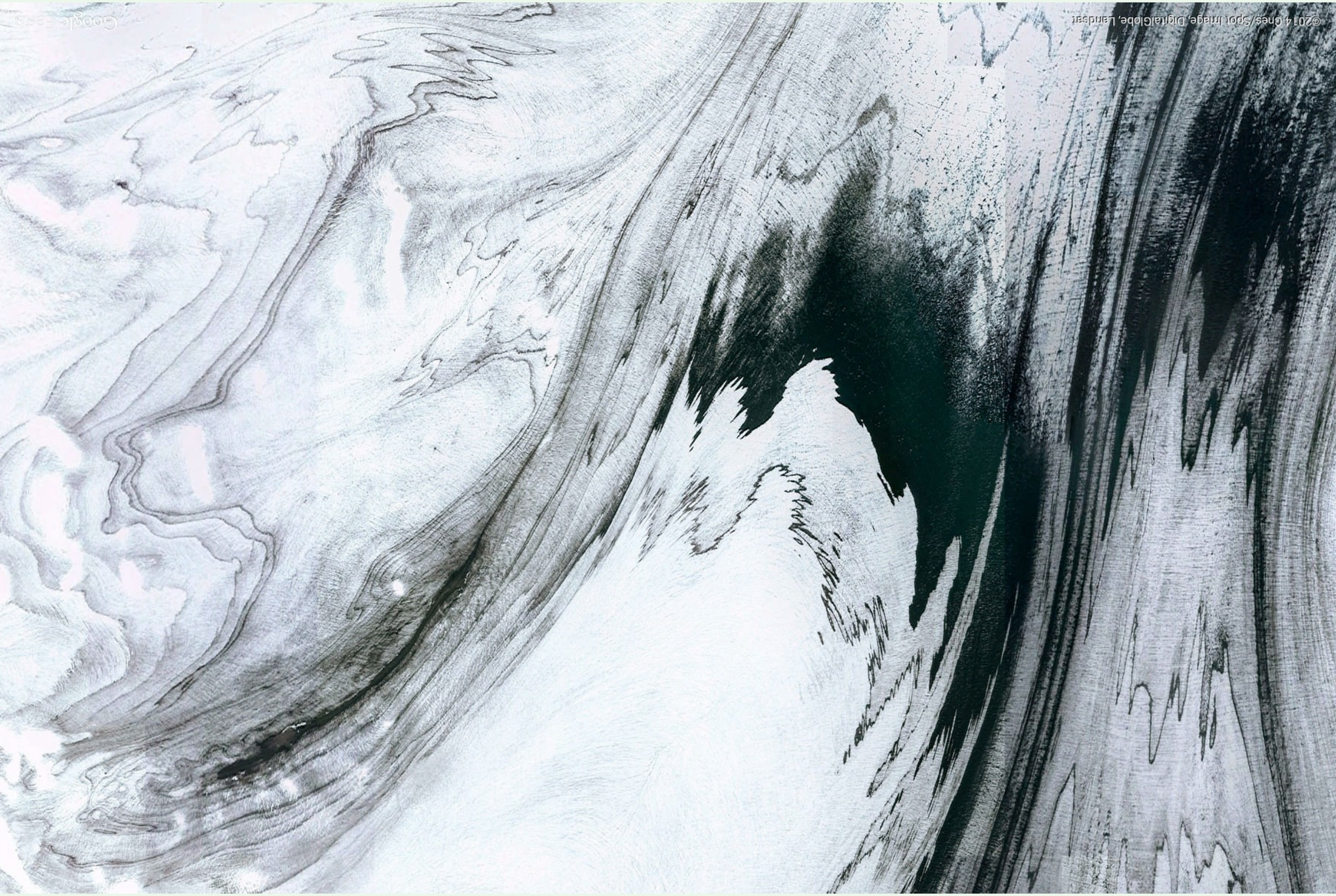
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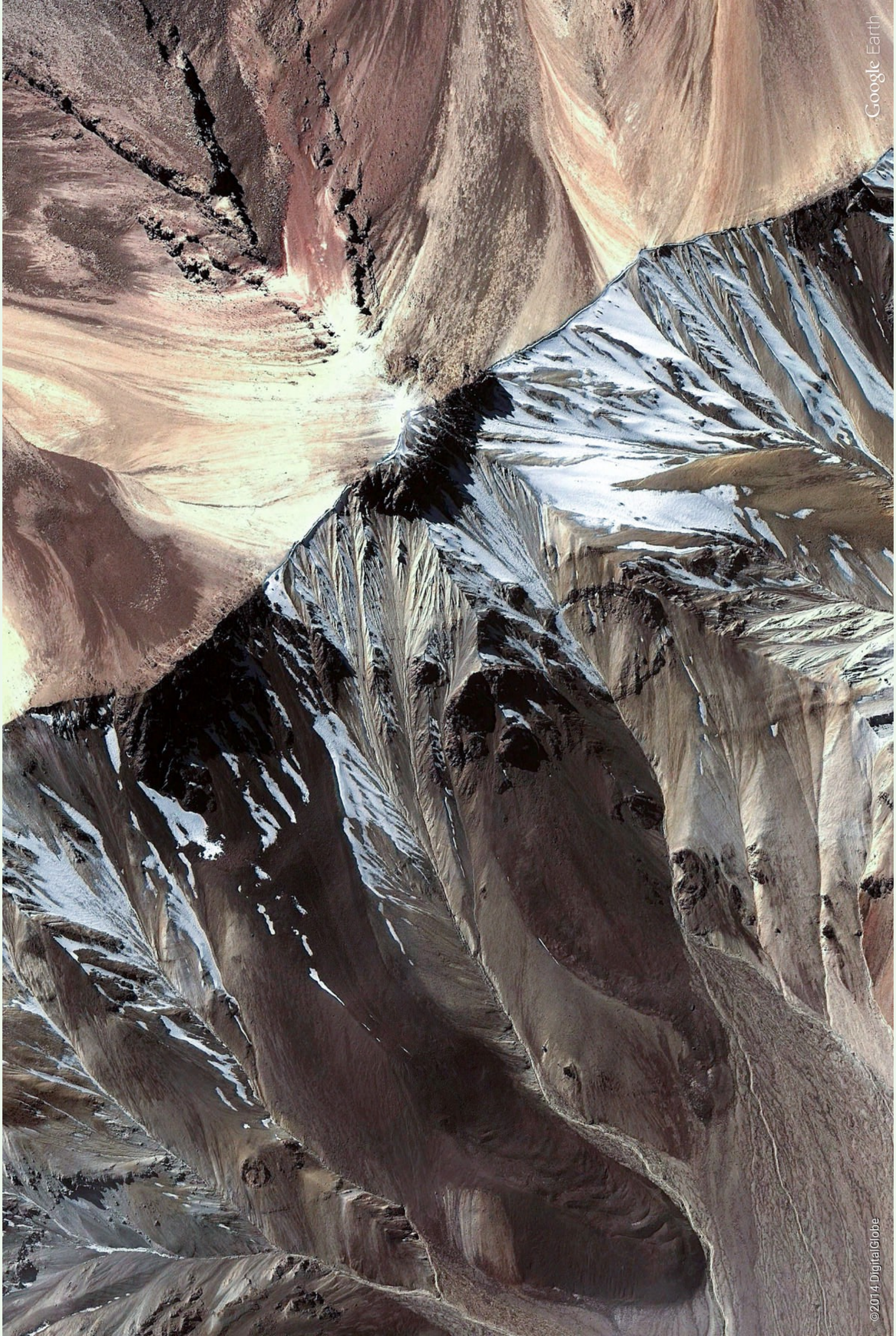
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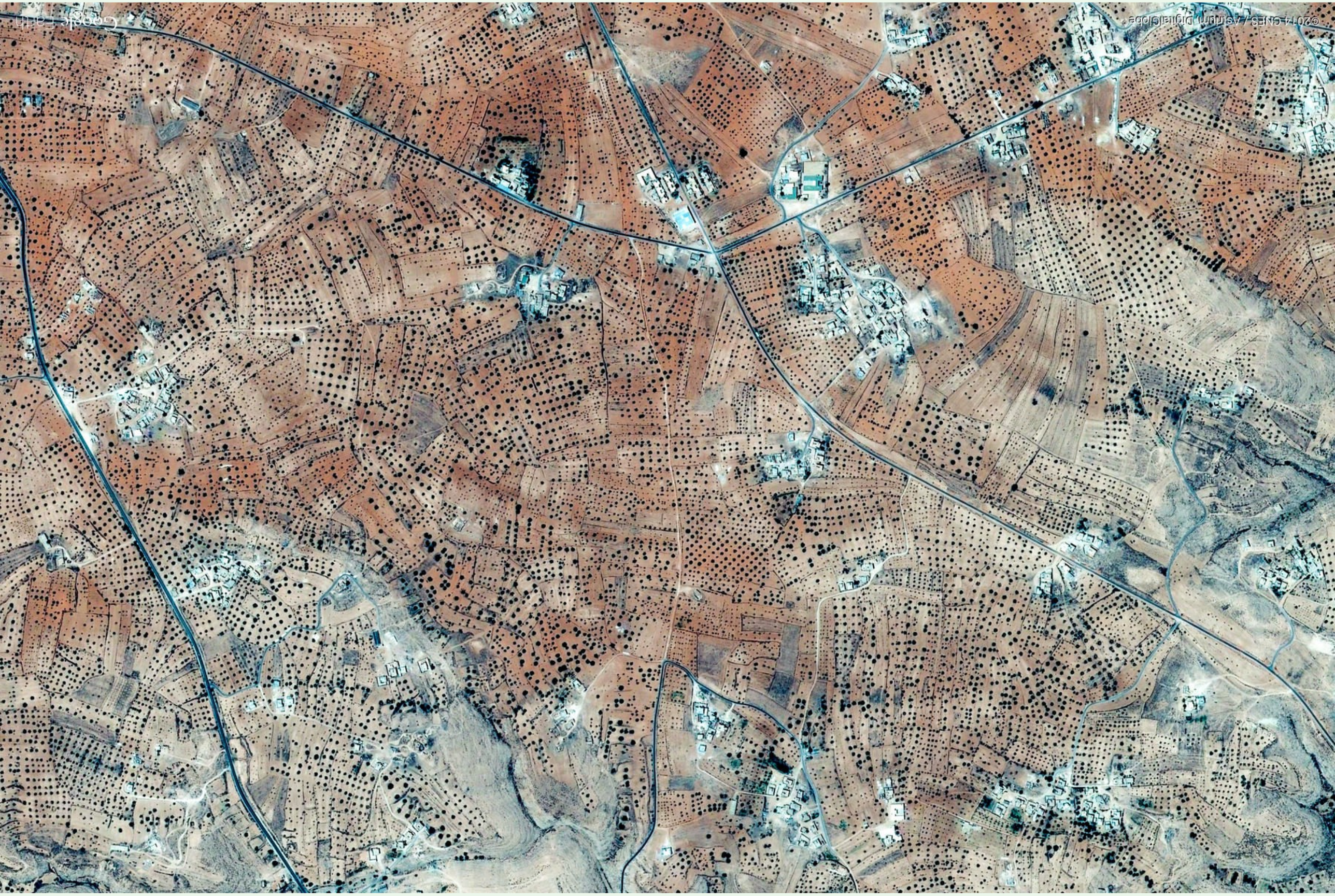
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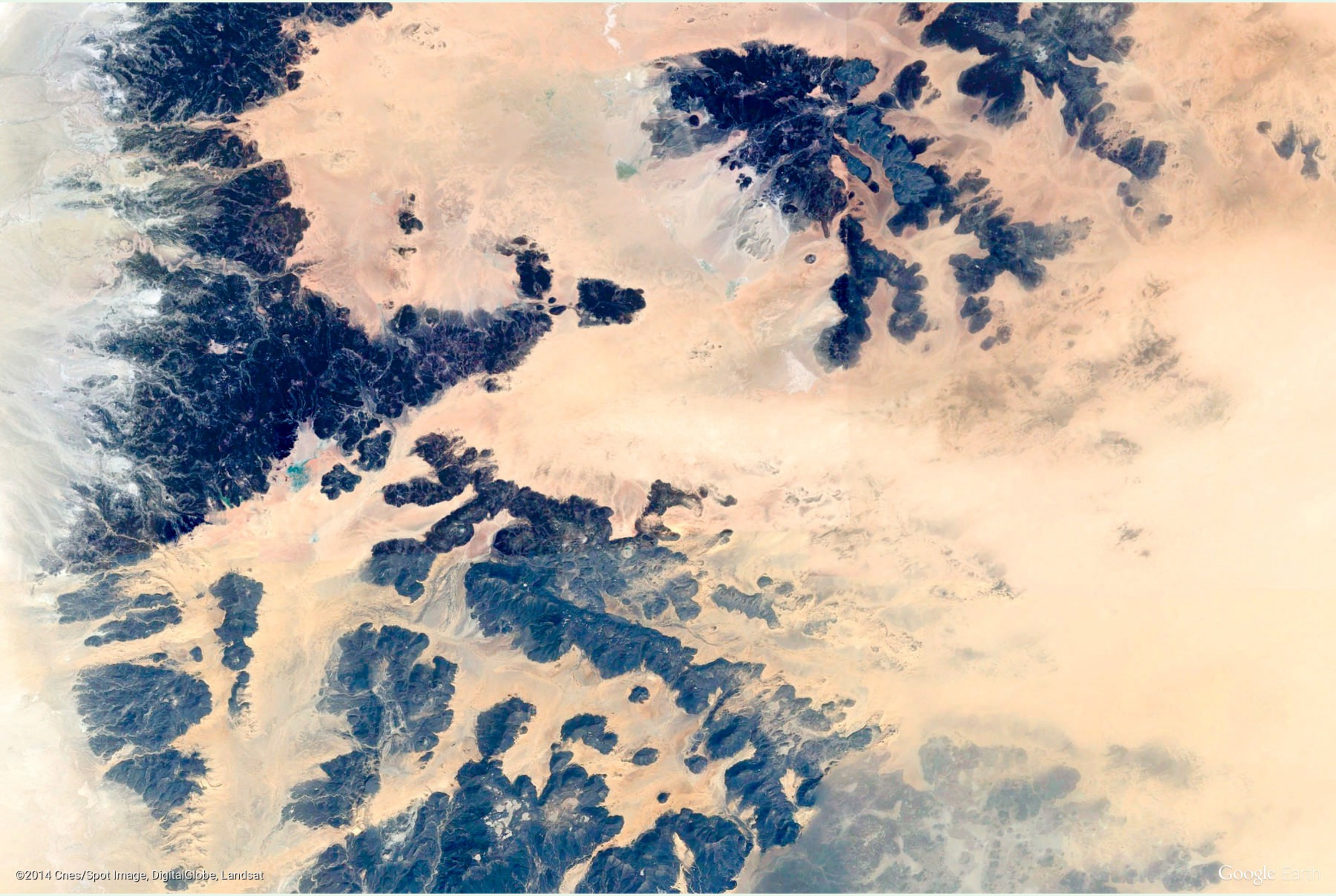
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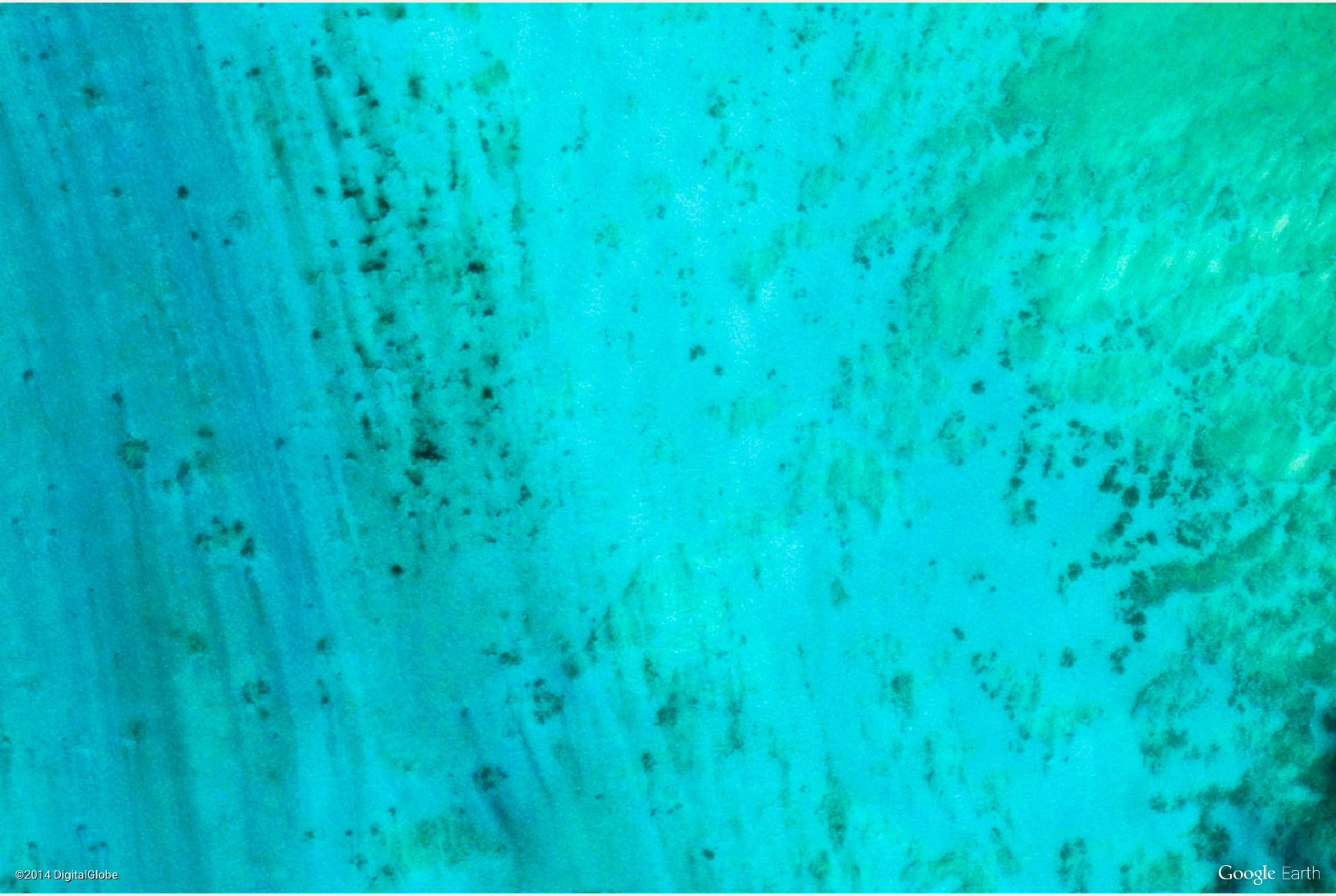
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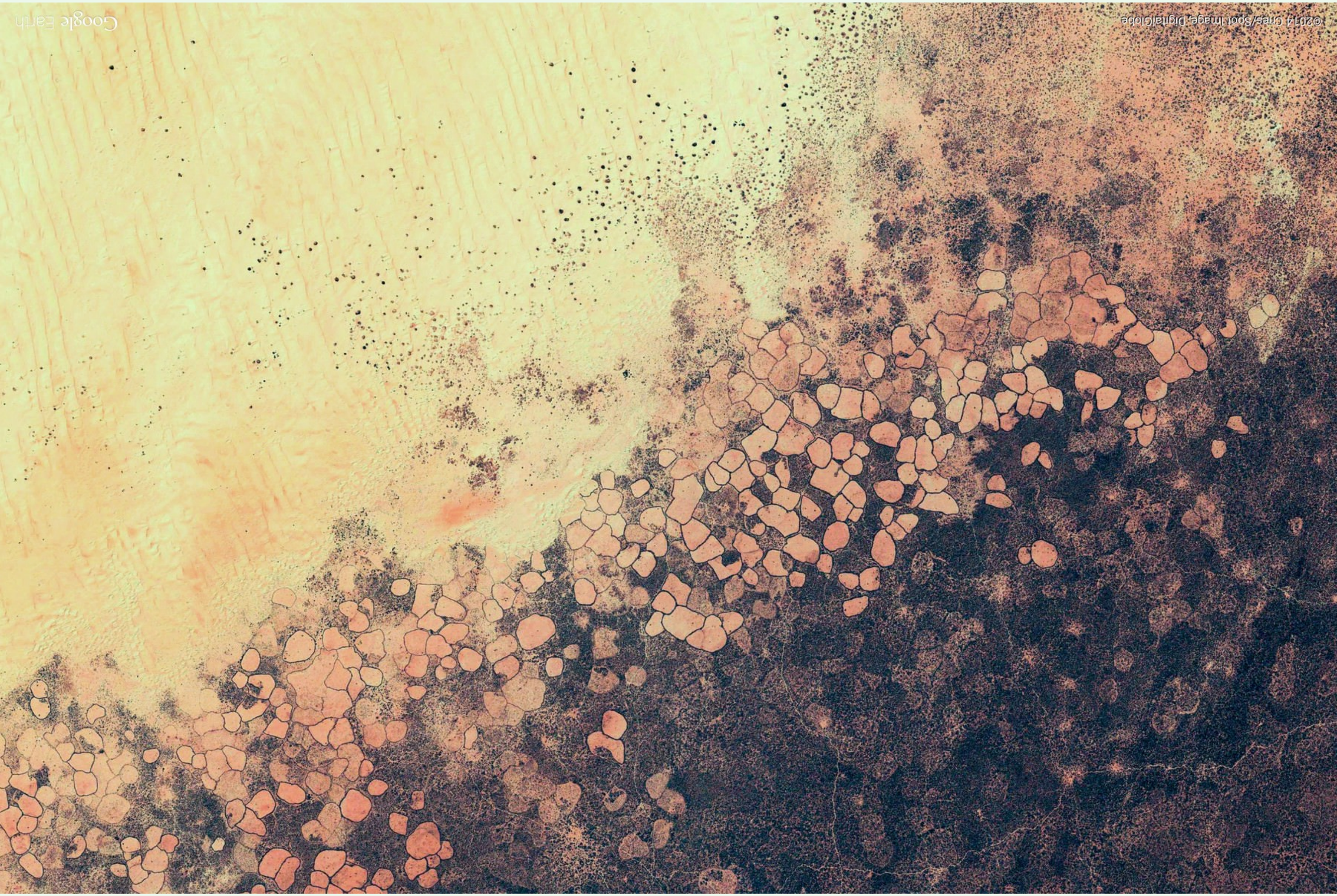
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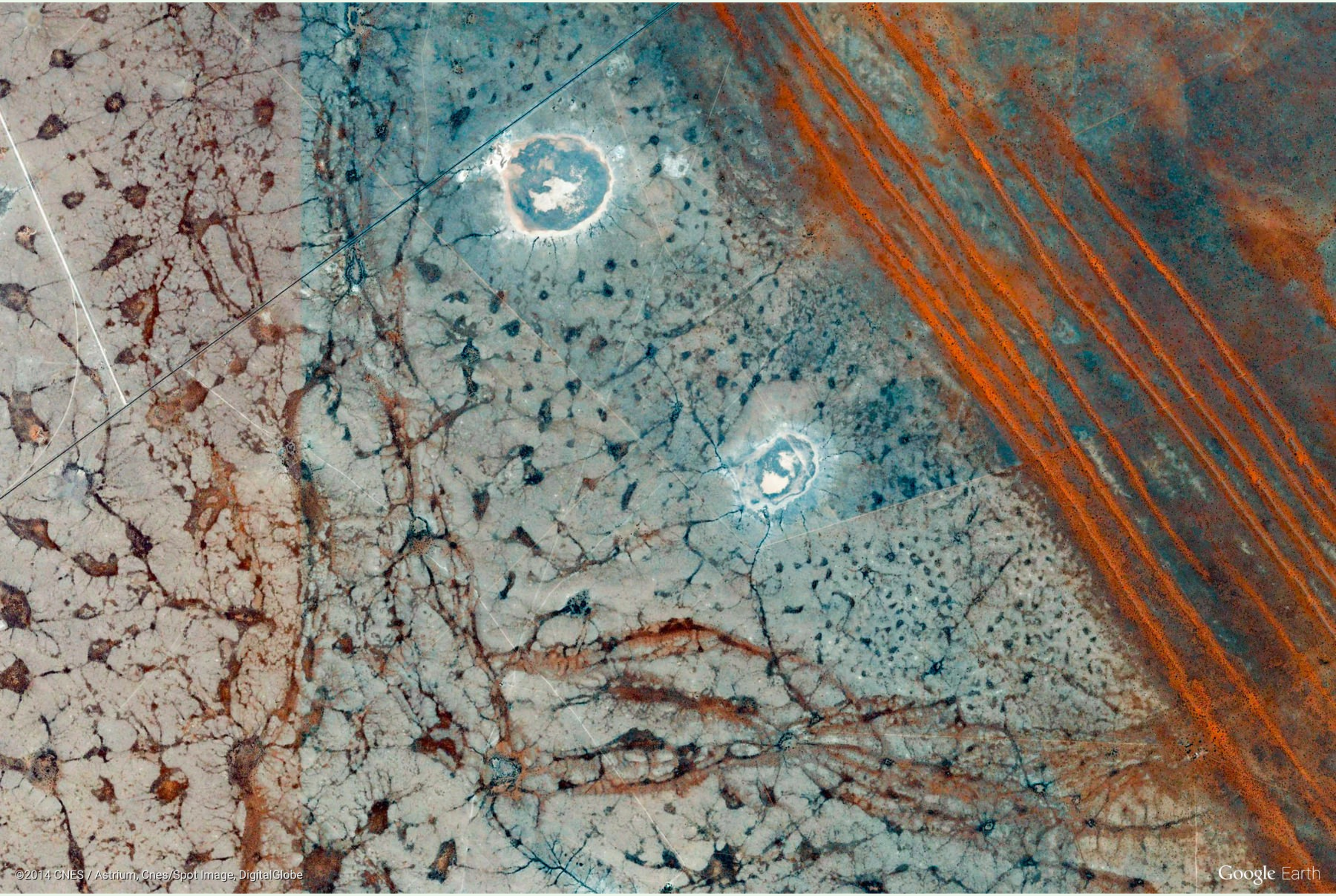
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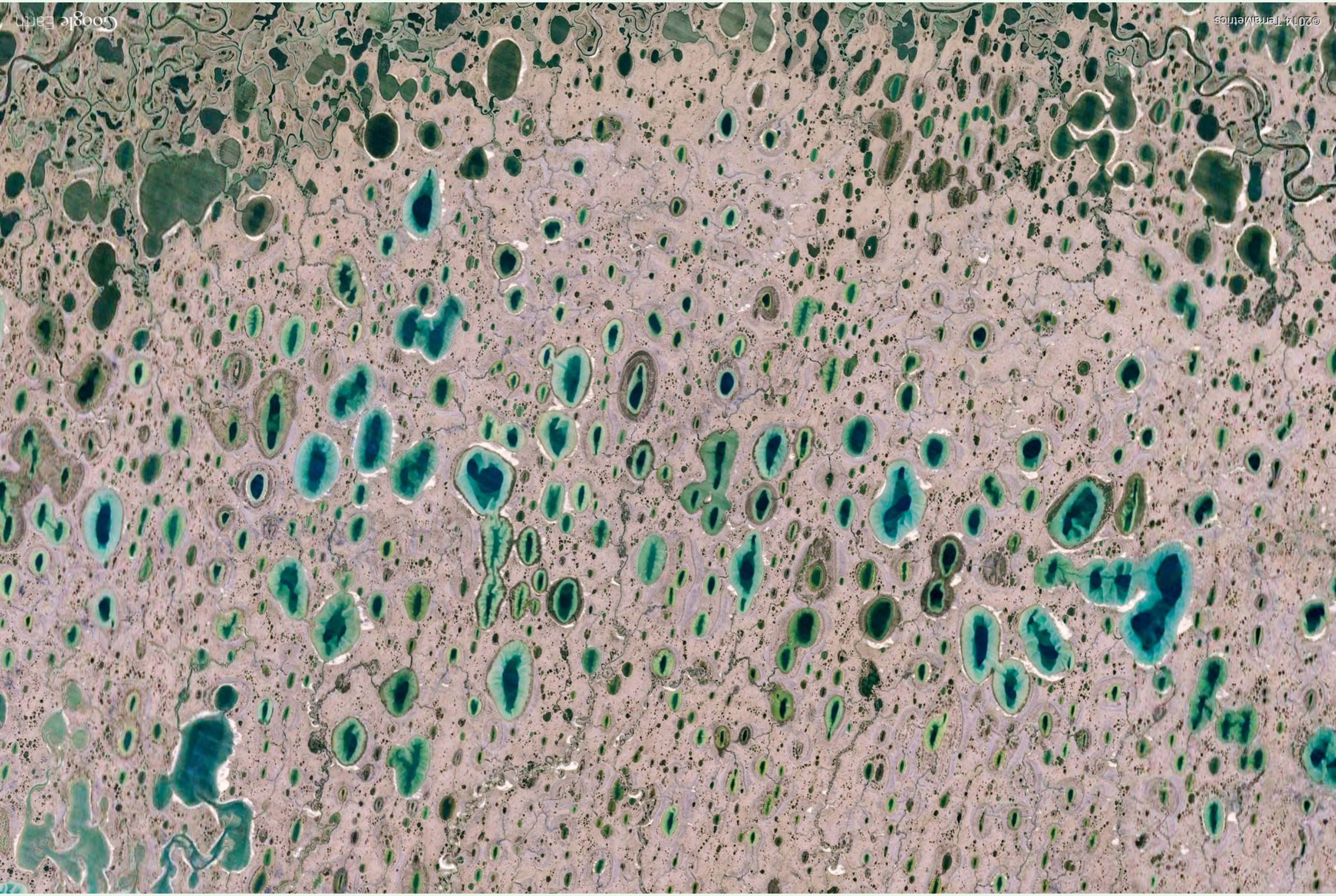
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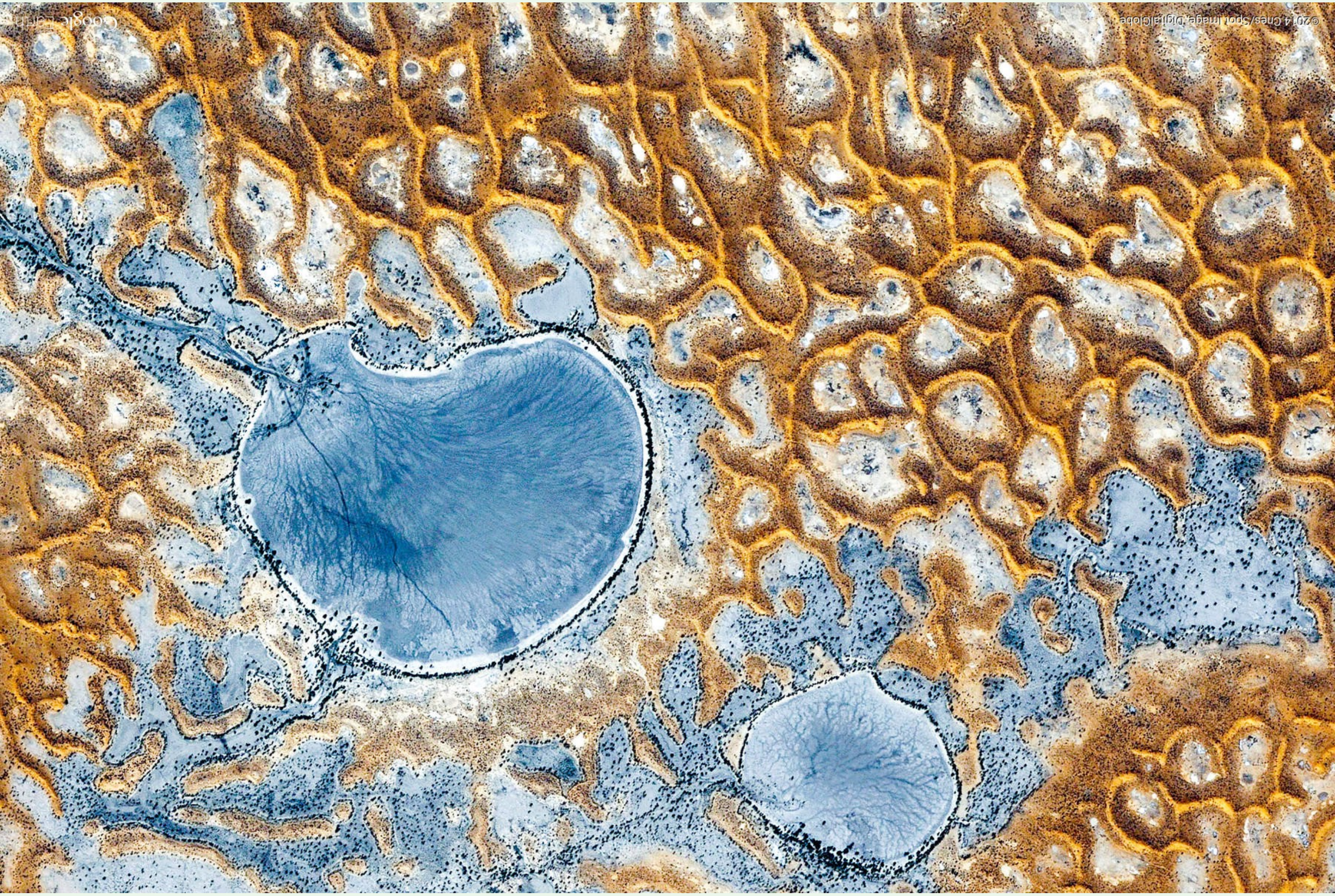
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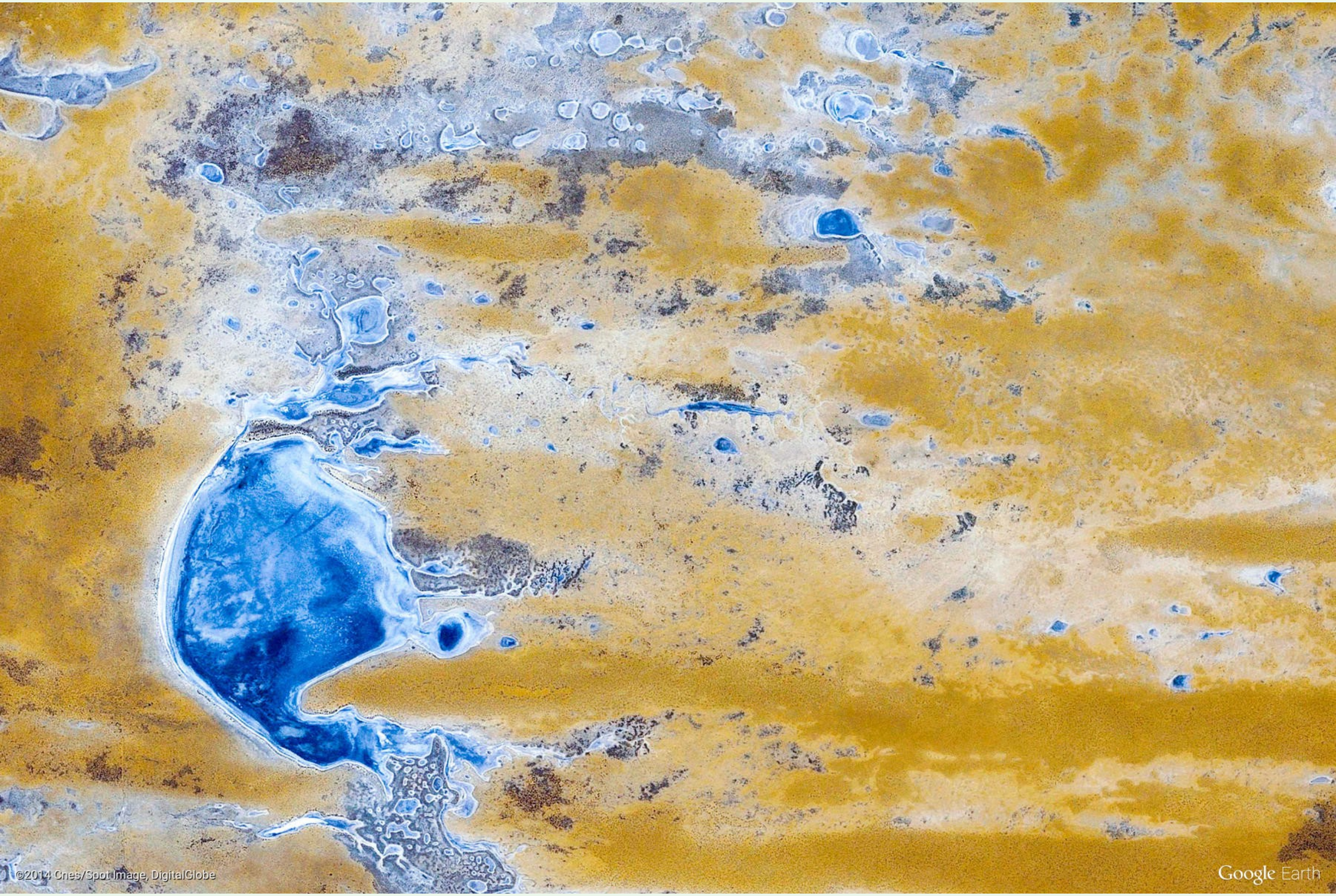
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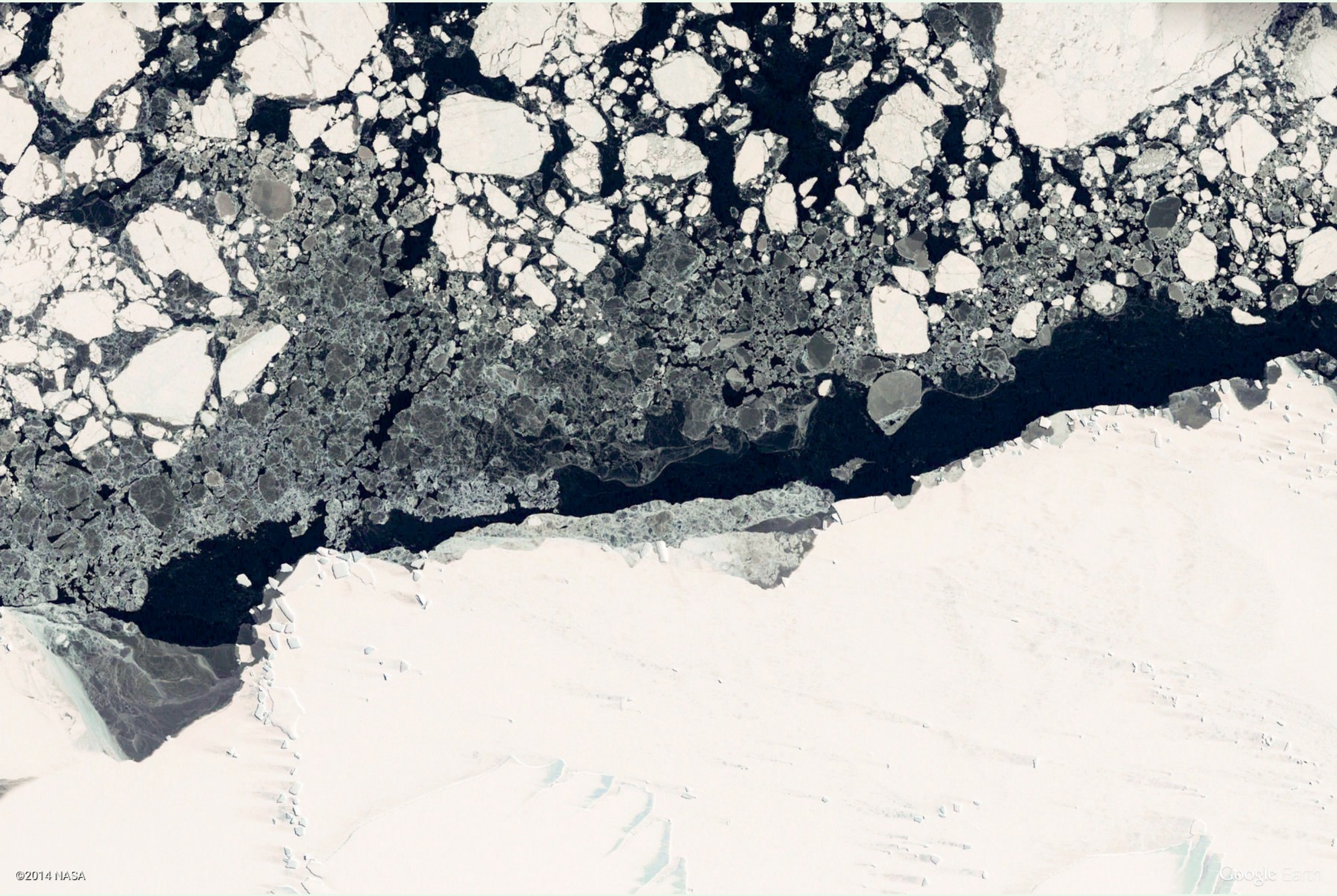
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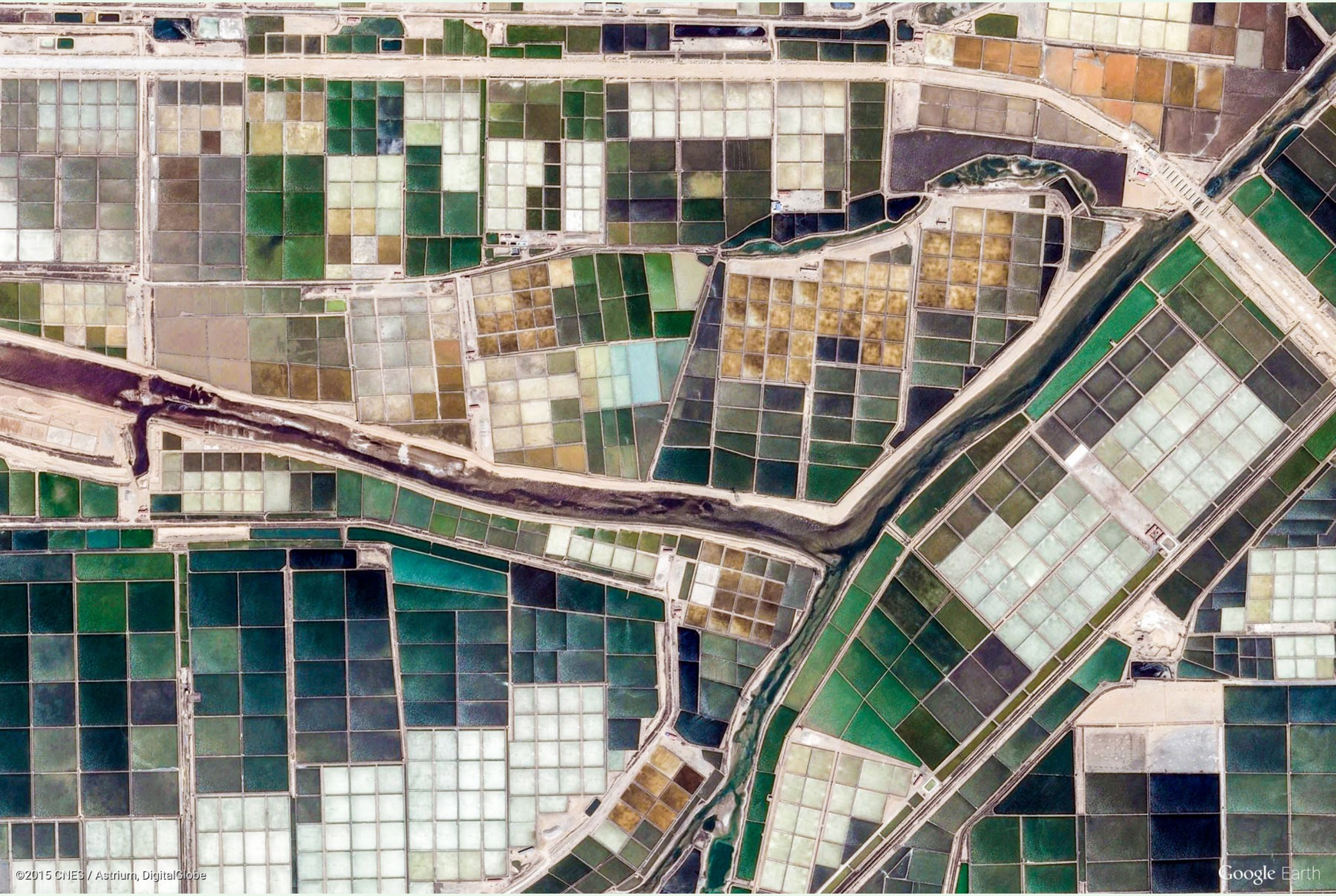
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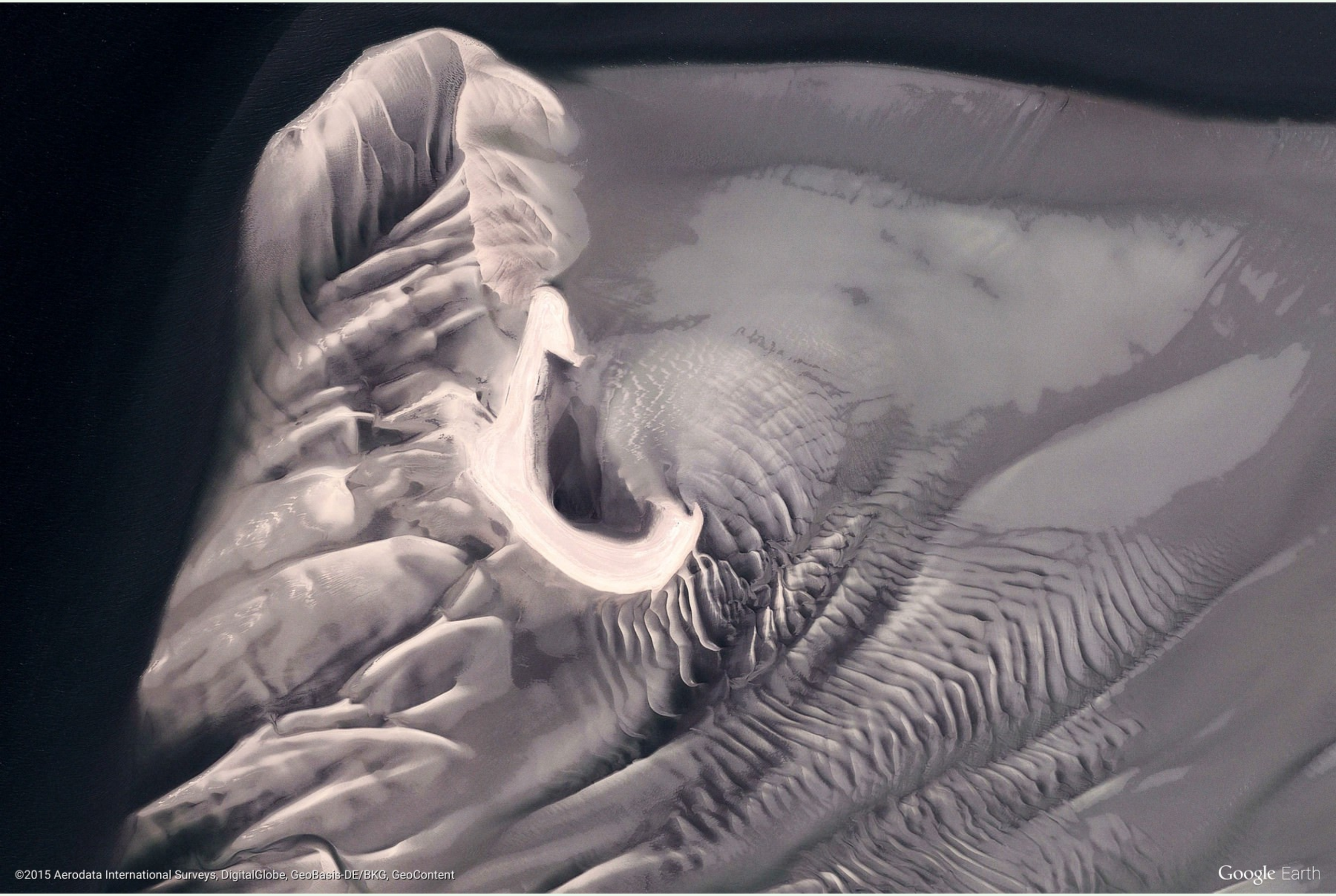
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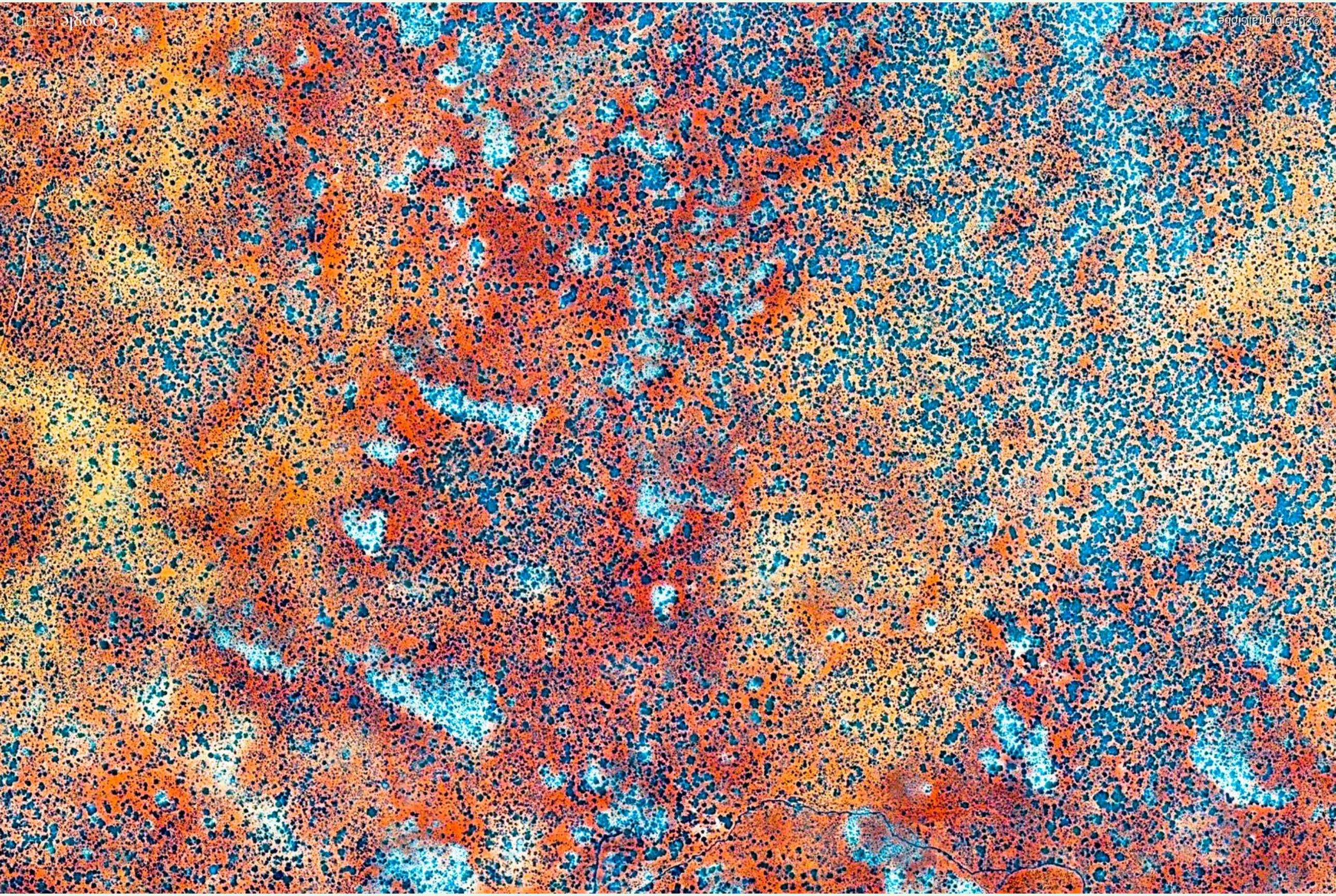
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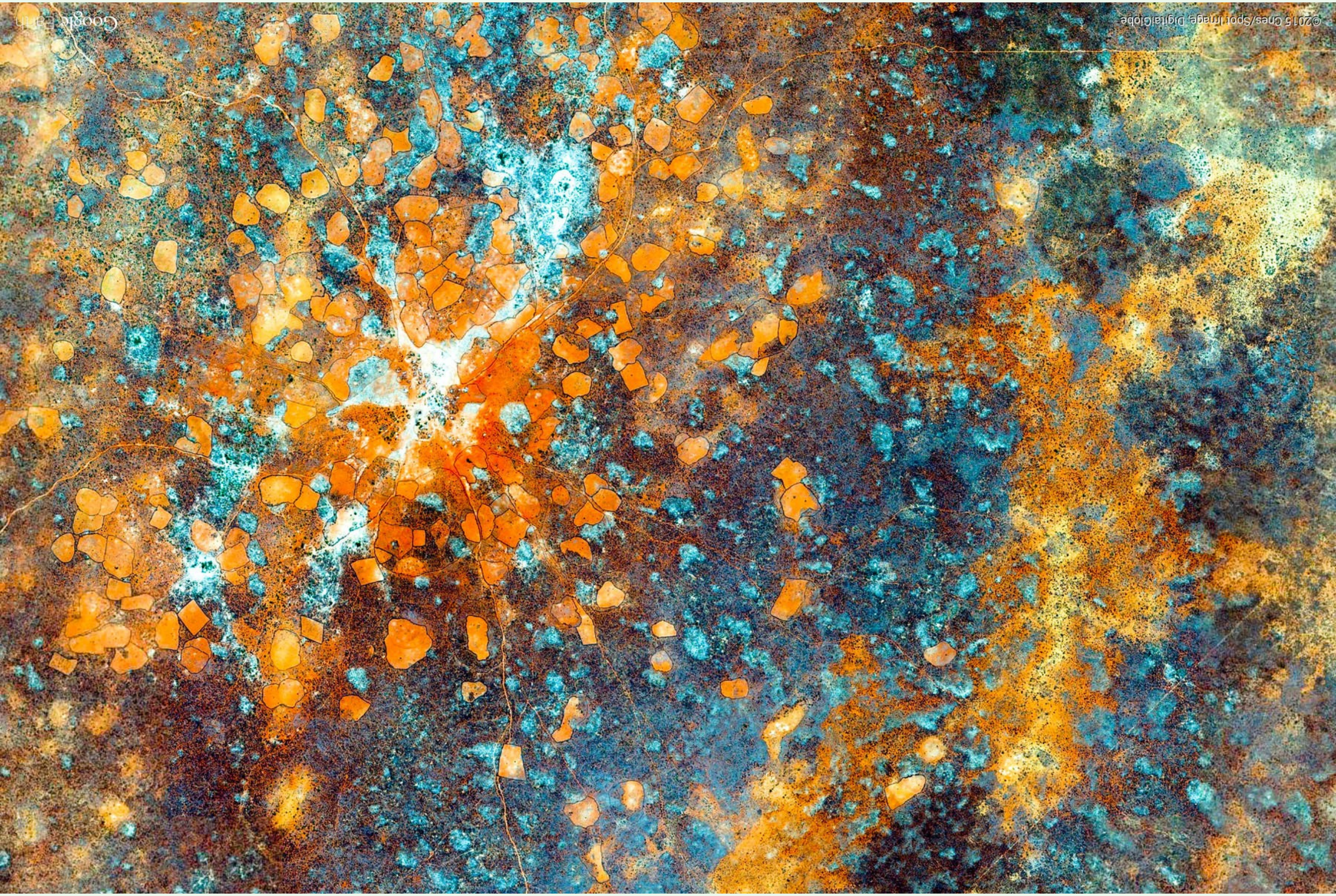
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