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EOCap 4Africa

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## 1 Fundamentals of Remote Sensing

### Definition, Historical Background and Applications

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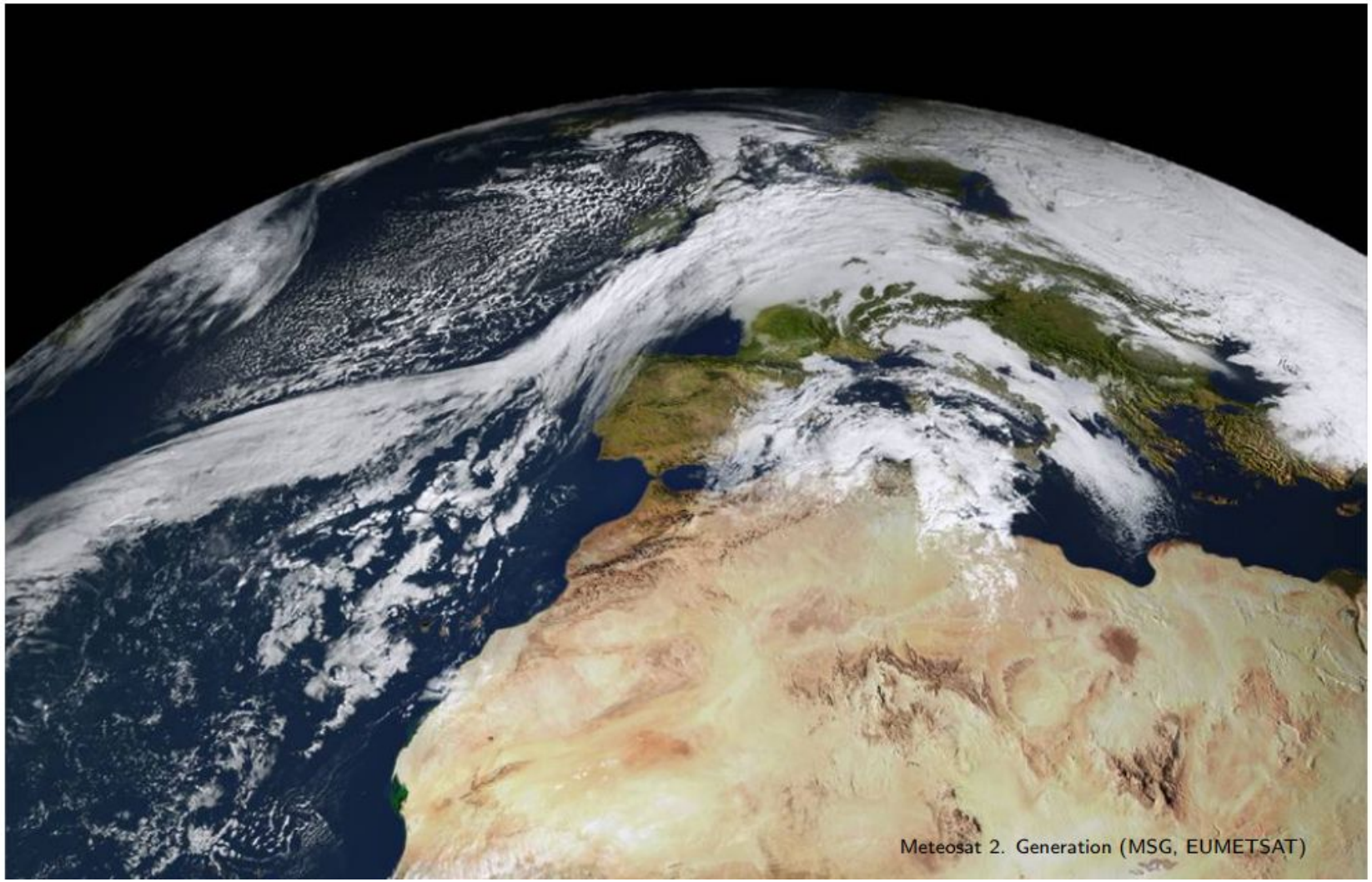
EARTH OBSERVATION RESEARCH

# Definitions

# Earth Observation



# Earth Observation

**Earth Observation** – the gathering of information about planet Earth's physical, chemical and biological systems

*Group on Earth Observations, 2020*

# What is Remote Sensing?

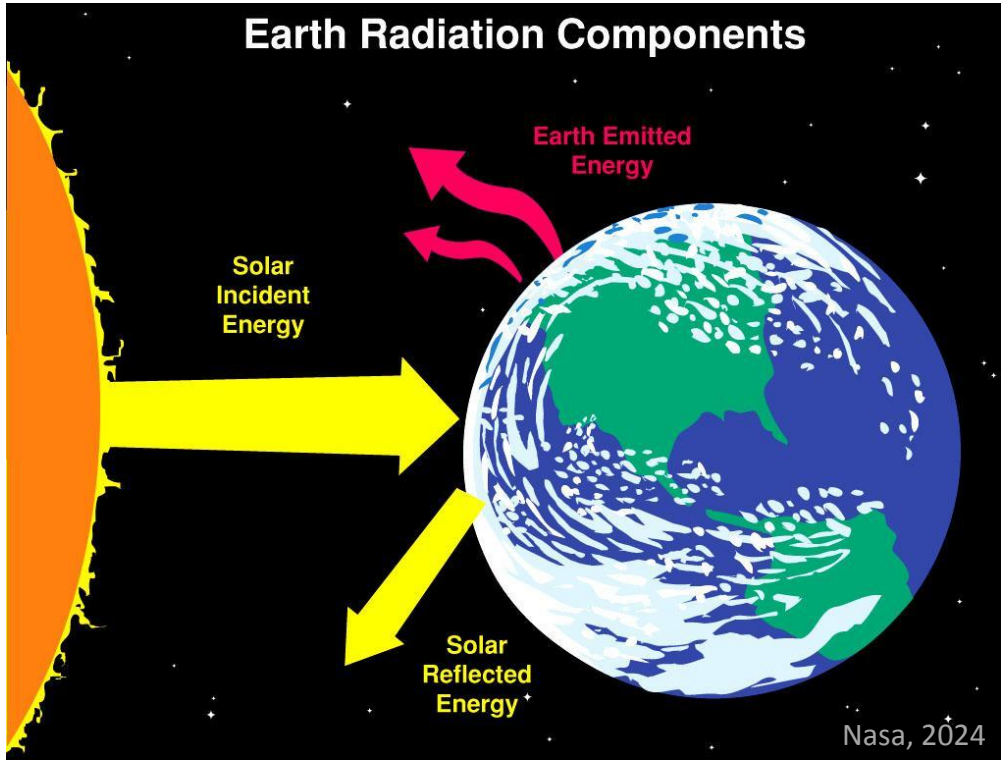
- Remote Sensing is obtaining information about an object from a distance
- Photography is a very common form of remote sensing
- There are different ways to collect data, and different sensors are used depending on the application
- Some methods collect ground-based data, others airborne or spaceborne.
    - What information do you need?
    - How much detail?
    - How frequently do you need the data?

# What is Remote Sensing?

**Remote Sensing** – the art and science of obtaining information about an object without being in direct physical contact with the object.

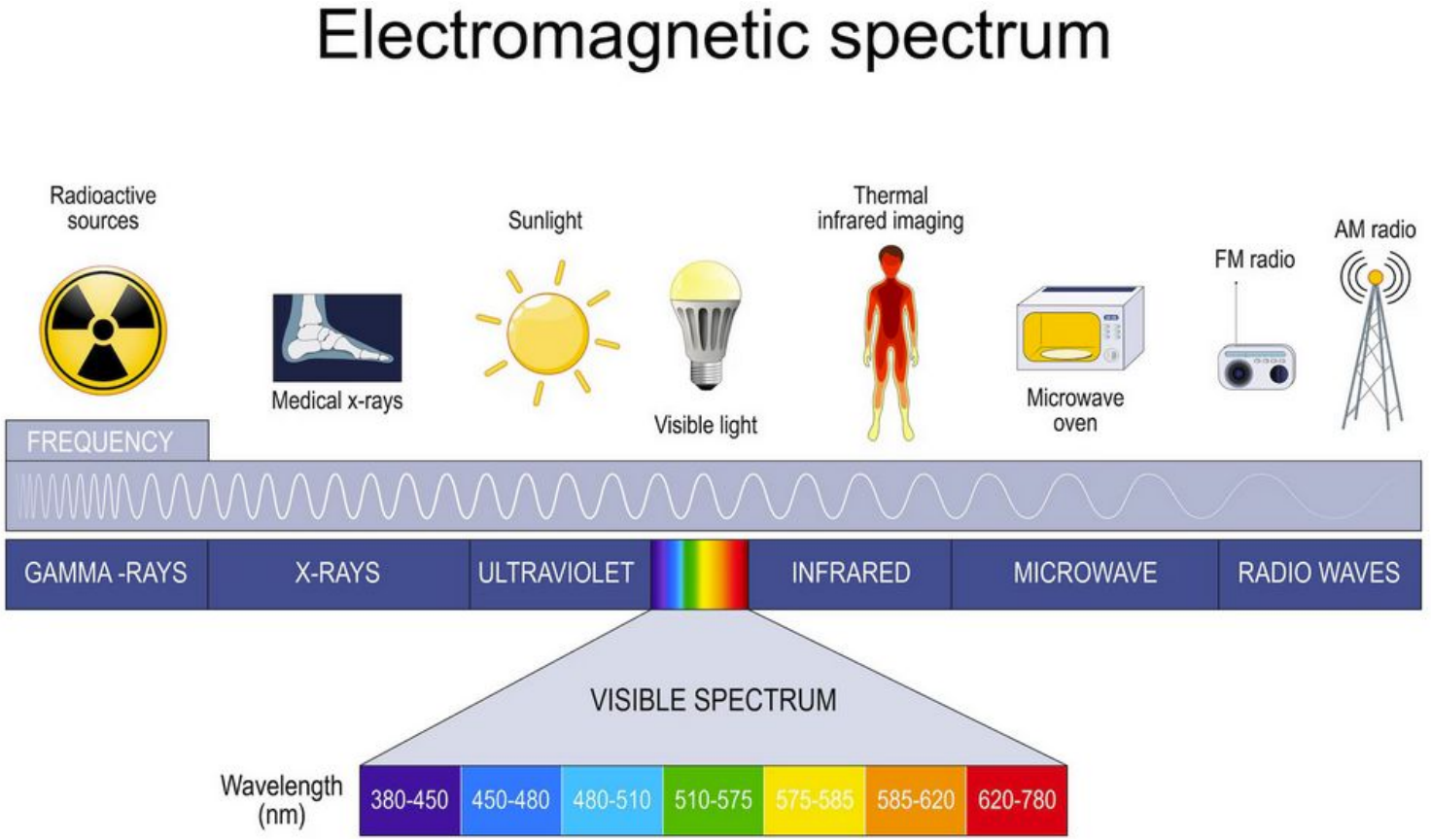
*Jensen, 2000*

# What is Remote Sensing?



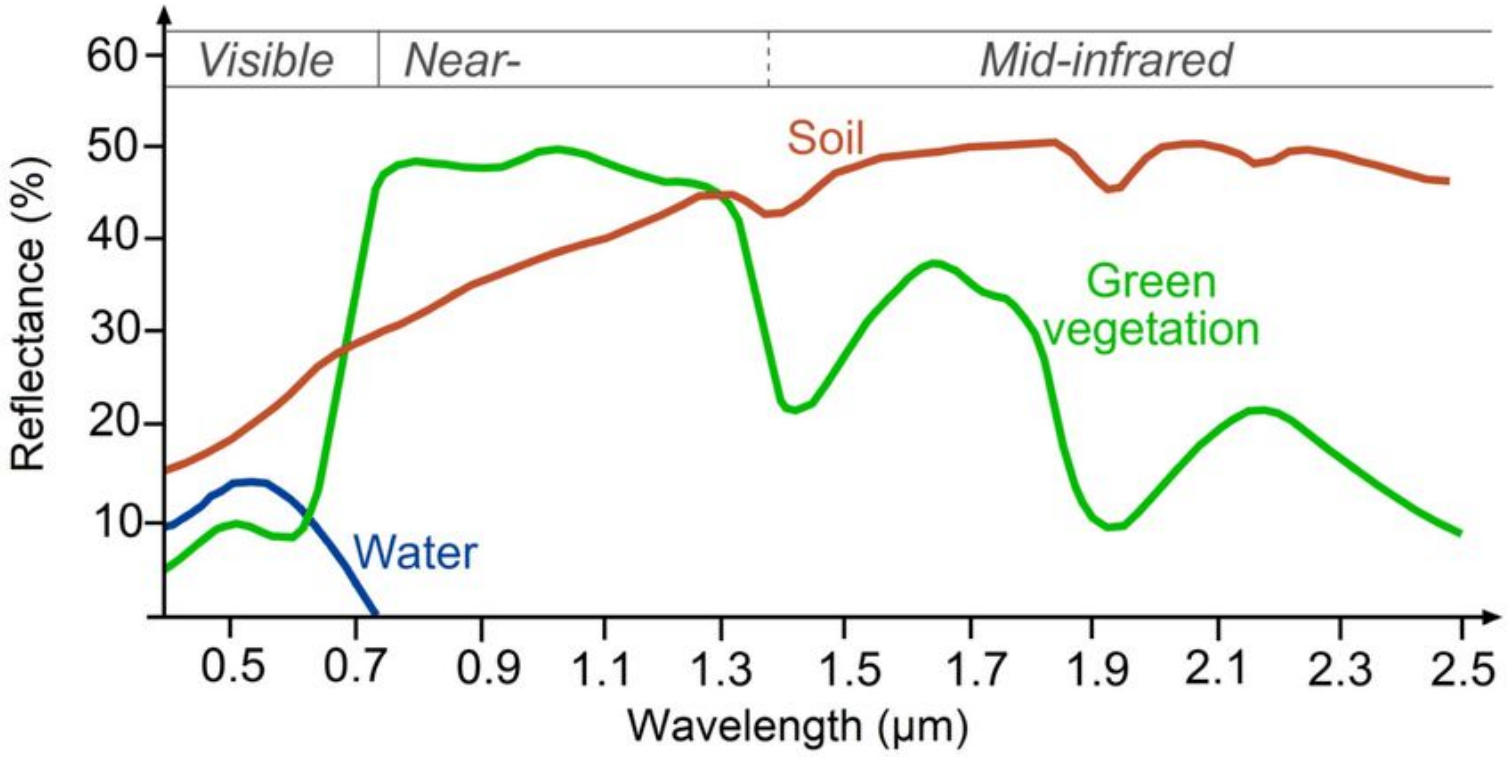

- The energy Earth receives from the sun is called electromagnetic radiation.
- Radiation is reflected, absorbed, and emitted by the Earth‘s atmosphere or surface (Figure left).
- Satellites carry instruments or sensors that measure electromagnetic radiation reflected or emitted from both terrestrial and atmospheric sources.
- With calibrated instruments, scientists (we) can measure the height, temperature, moisture content (and more) for nearly every feature of the Earth‘s atmosphere, hydrosphere, lithosphere, and biosphere.

# What is remote sensing?



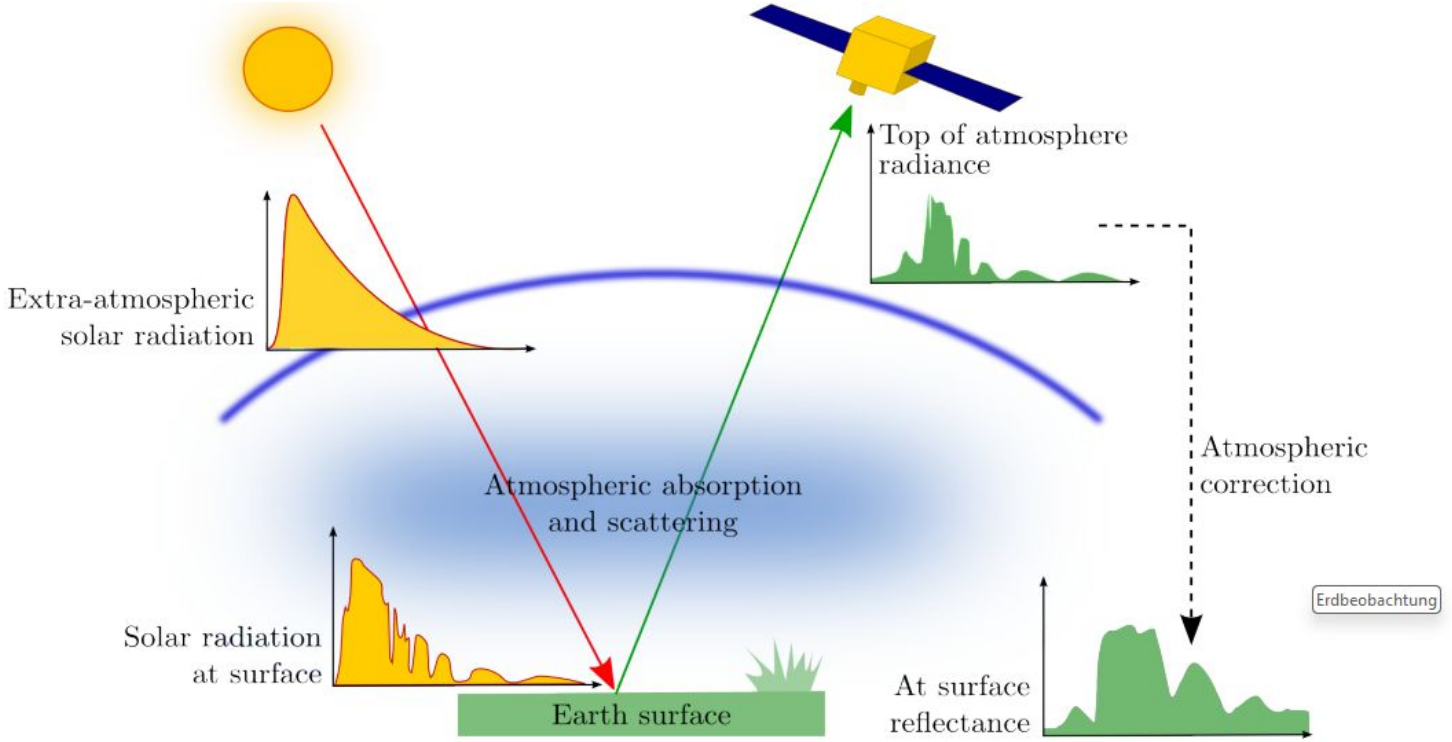

- The electromagnetic spectrum is the full range of **wave frequencies** that characterizes solar radiation.
- Although we are talking about light, most of the electromagnetic spectrum cannot be detected by the human eye.
- Even satellite detectors only capture a small portion of the entire electromagnetic spectrum.

# What is Remote Sensing?




- Different materials reflect and absorb different wavelengths of electromagnetic radiation.
- You can look at the reflected wavelengths detected by a sensor and determine the type of material it reflected from. This is known as a spectral signature.

# What is Remote Sensing?
## Atmosphere

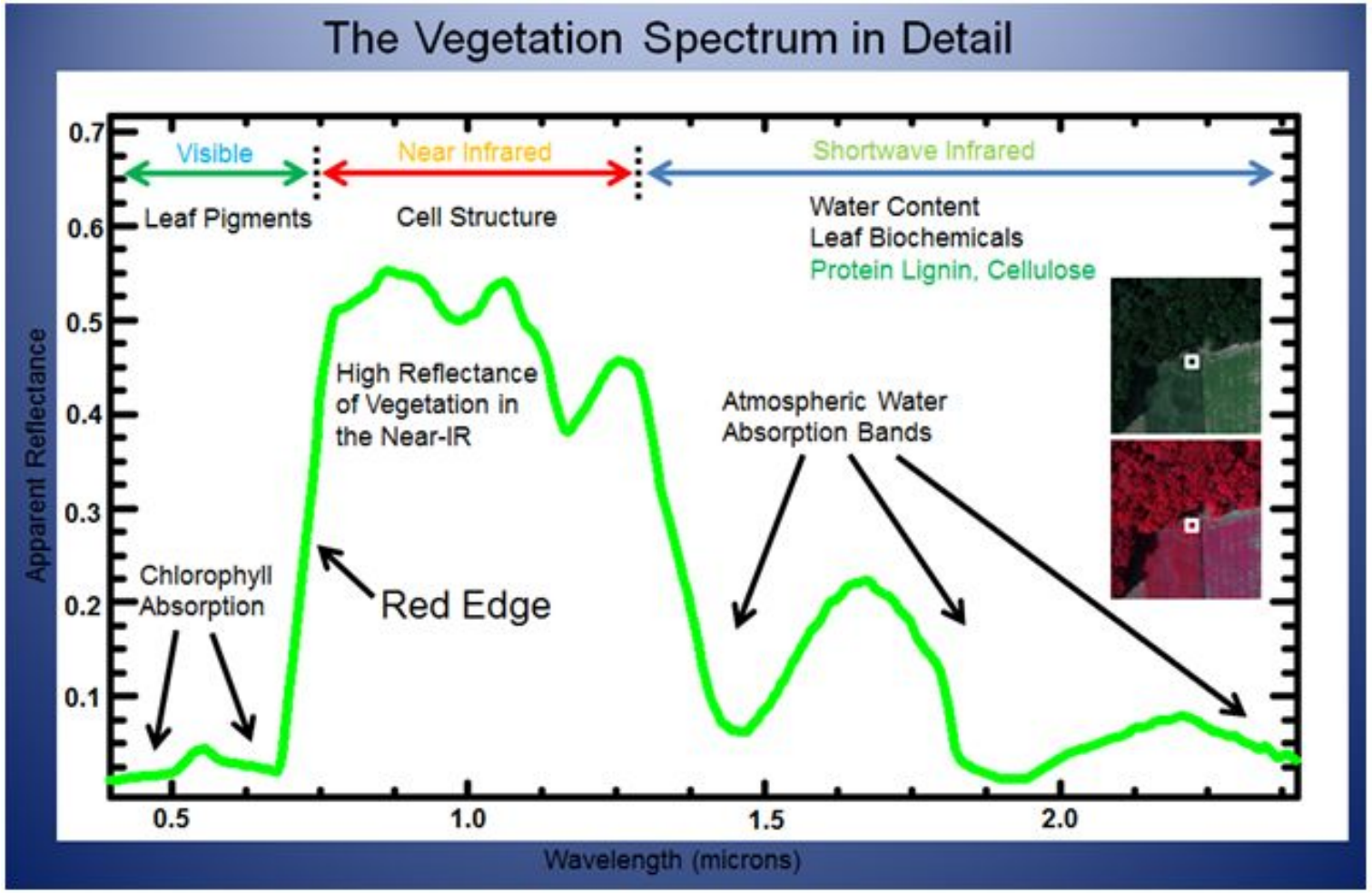



(7) Basic physical principle of passive optical remote sensing

- From the sun to the Earth and back to the sensor, electromagnetic energy passes through the atmosphere twice.
- Much of the incident energy is absorbed and scattered by gases and aerosols in the atmosphere before reaching the Earth's surface.
- Atmospheric correction removes the scattering and absorption effects from the atmosphere to obtain the surface reflectance characterizing surface properties.

# What is Remote Sensing?

## Vegetation

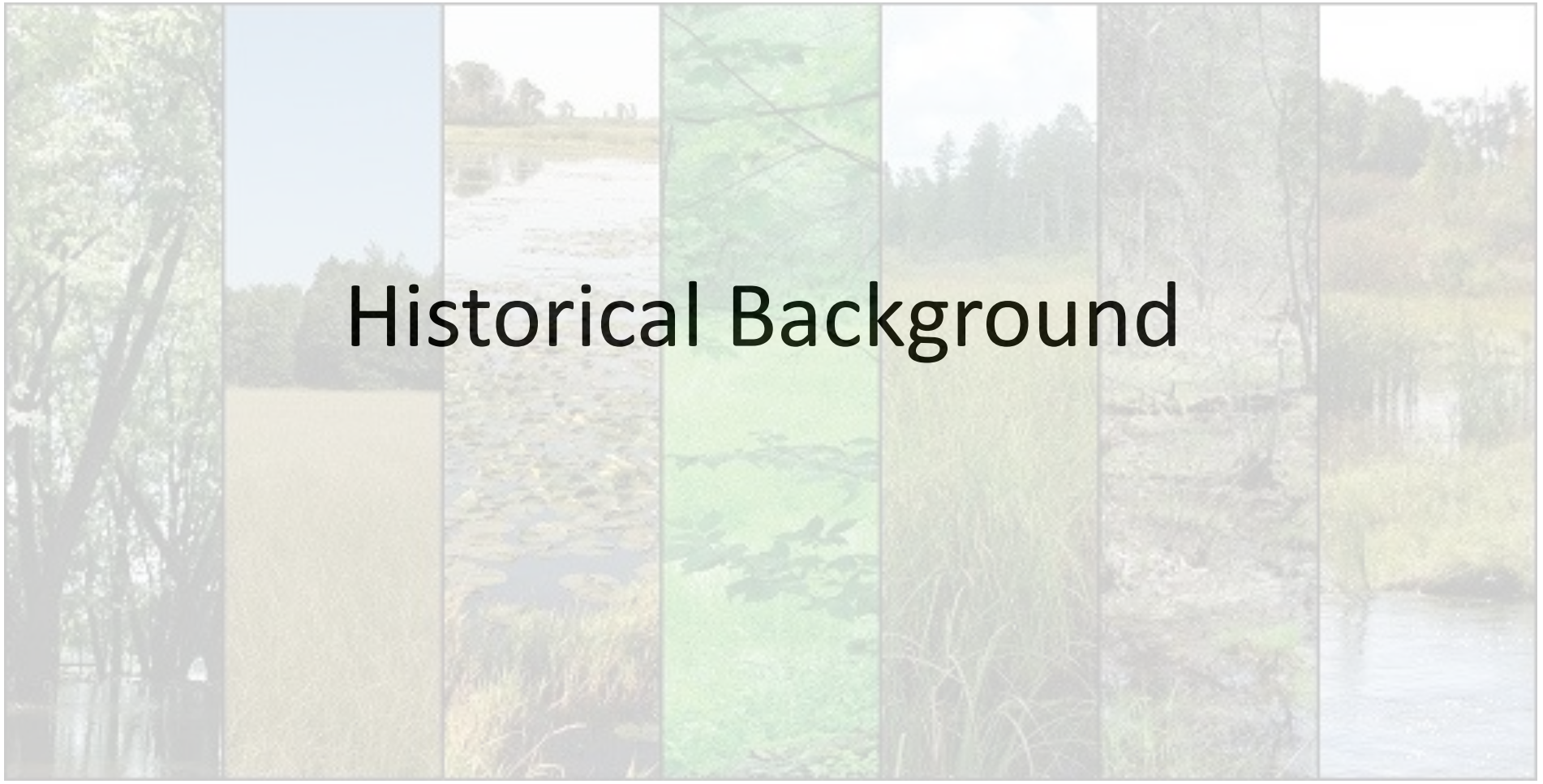



- Certain pigments in plant leaves strongly absorb wavelengths of visible (red) light.
- The leaves themselves strongly reflect wavelengths of near-infrared light, which is invisible to human eyes.
- As a plant canopy changes from early growth to late-season maturity and senescence, these reflectance properties also change.
- Since we can't see infrared radiation, we see healthy vegetation as green.

# What is Remote Sensing?

## Water


- Longer visible wavelengths (green and red) and near-infrared radiation are absorbed more by water than shorter visible wavelengths (blue)—so water usually looks blue or blue-green.
- Satellites provide the capability to map optically active components of the upper water column in inland and near-shore waters.

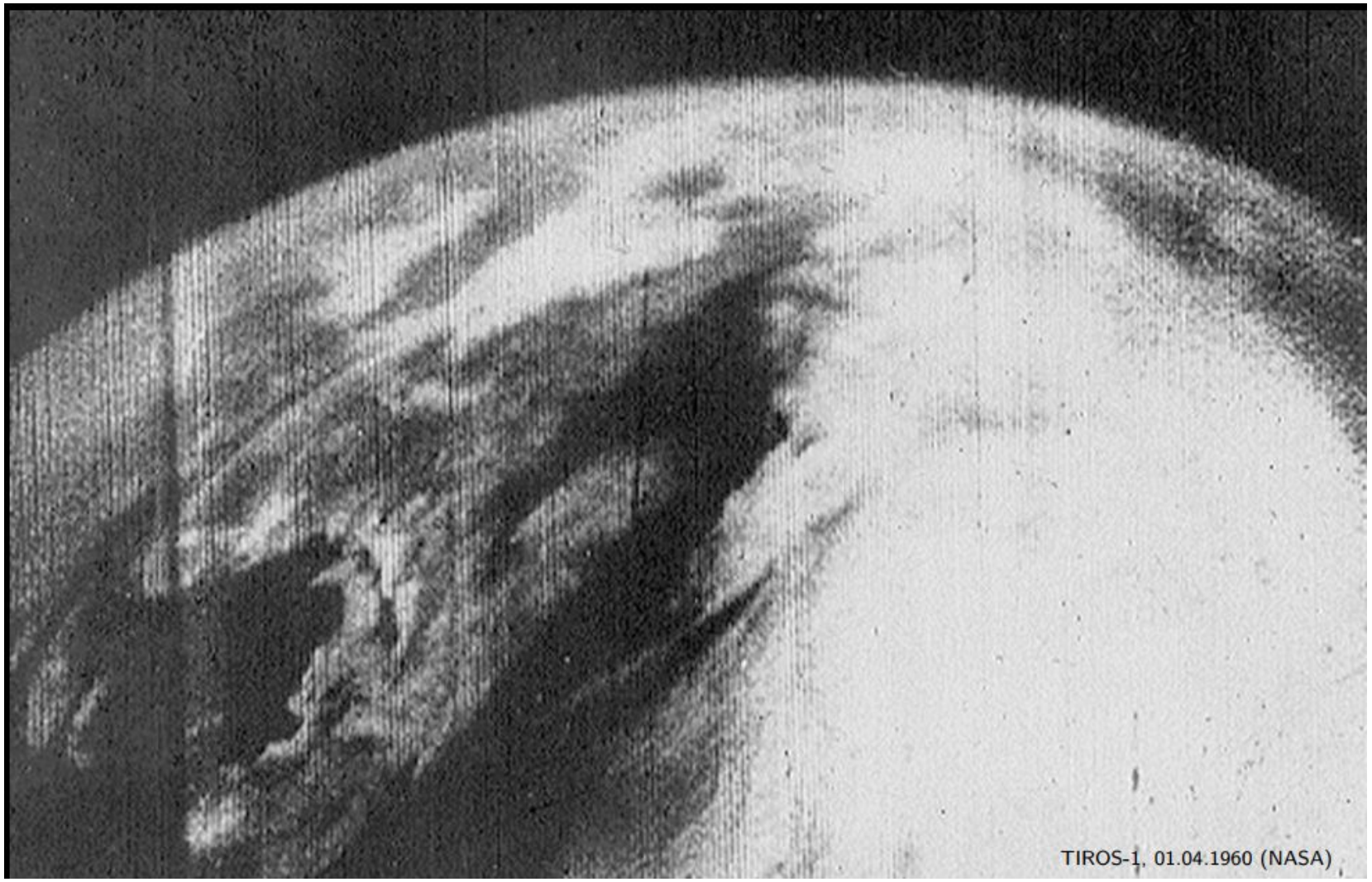


# Historical Background

# Historical Background

- Earth Observation began just after the invention of photography
- The first known aerial photograph was captured in 1858 from balloon by Gaspar Felix Tournachon (known as “Nadar”) - French photographer and balloonist.
- The very first view was taken over the French village Petit-Becetre from 80 meters above the ground.


# Historical Background – Satellite Remote Sensing




- **NASA's first program, TIROS-1** started in **1960**
- first full-scale weather satellite  first television footage of cloud patterns from space was produced
- This mission provided the first accurate weather forecast based on satellite data.
- Shortly after the first weather mission in **1962**, **TIROS began providing continuous coverage of Earth's weather**

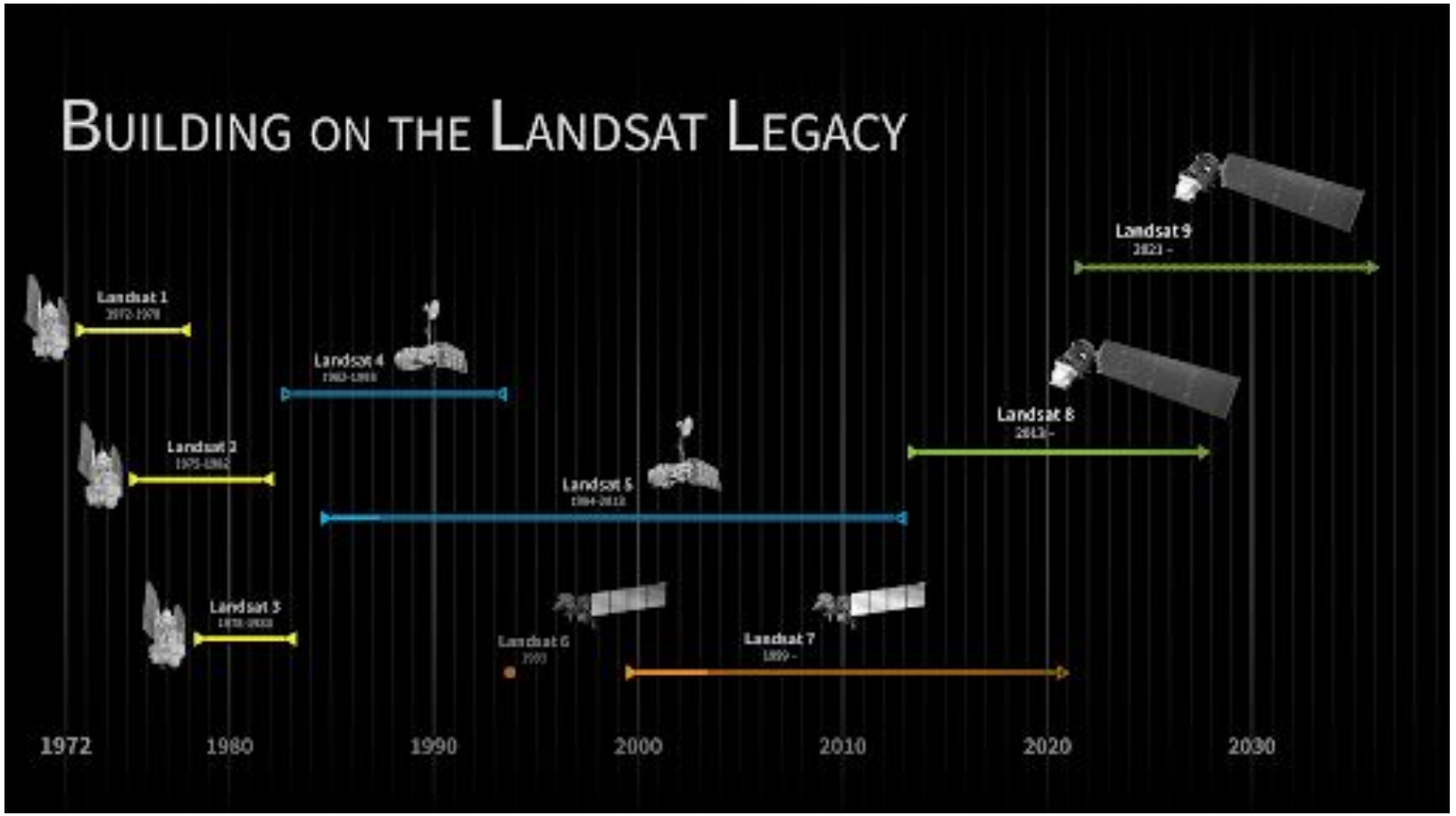
# Historical Background – Satellite Remote Sensing

- **In 1968 with mission Apollo 8 three astronauts were sent to space, into the Moon and returned safely**
- With that event, the new era of satellite missions observing planet Earth starts
- More and more sophisticated instruments are developed to observe the Earth, using not only visual light but also other wavelengths of the electromagnetic spectrum.


NASA/Bill Anders

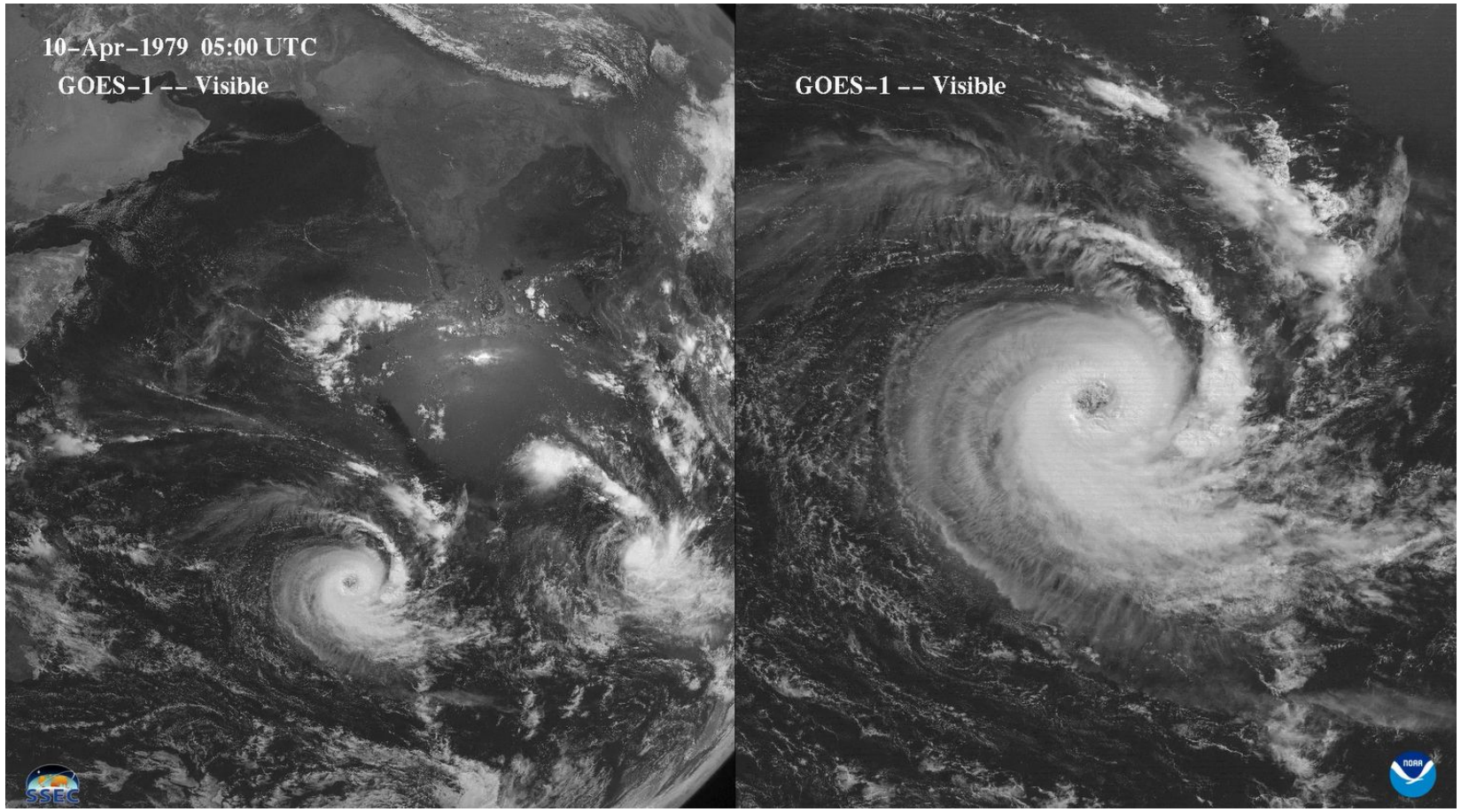
# Earth Observation today

**In 1972 NASA** launched the satellite named **Earth Resources Technology Satellite (ETRS-1)**, renamed later to **Landsat**. With this mission, a long-running series of multispectral remote-imaging satellites began.



# Earth Observation today

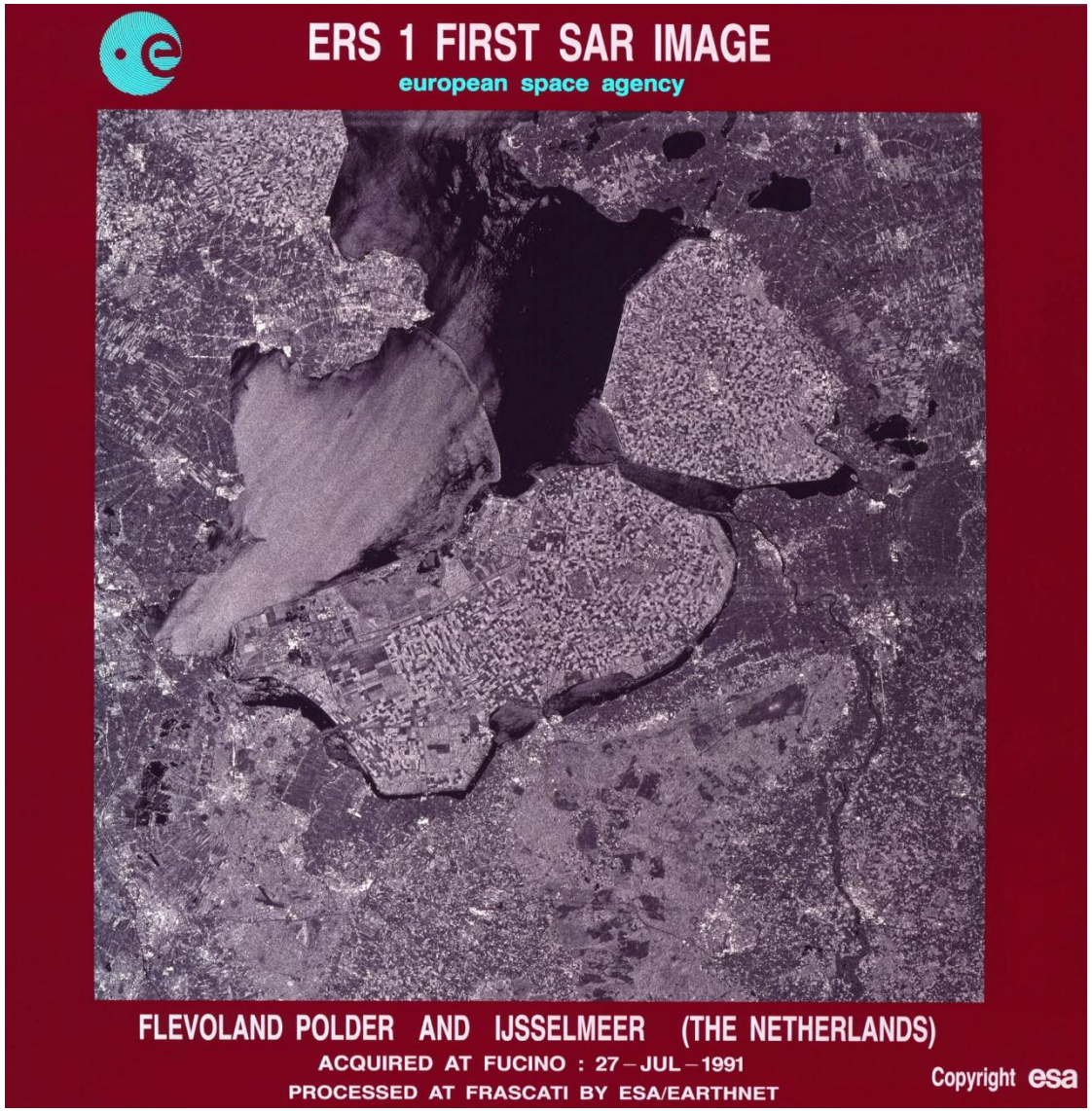
**In 1974** NASA launches the Synchronous Meteorological Satellite, the first spacecraft to observe Earth from geosynchronous orbit and the forerunner of today's GOES (Geostationary Operational Environmental Satellite) series, leading to improved data for weather forecasters.



# Earth Observation today

**In 1978 t**he Nimbus-7 satellite was launched carrying the Total Ozone Mapping Spectrometer, which eventually confirms the existence of the Antarctic ozone hole, leading to international restrictions on the use of chlorofluorocarbon chemicals.

# Earth Observation today




**1991:** The European Space Agency launches its first Earth-observing satellite, **ERS-1**.

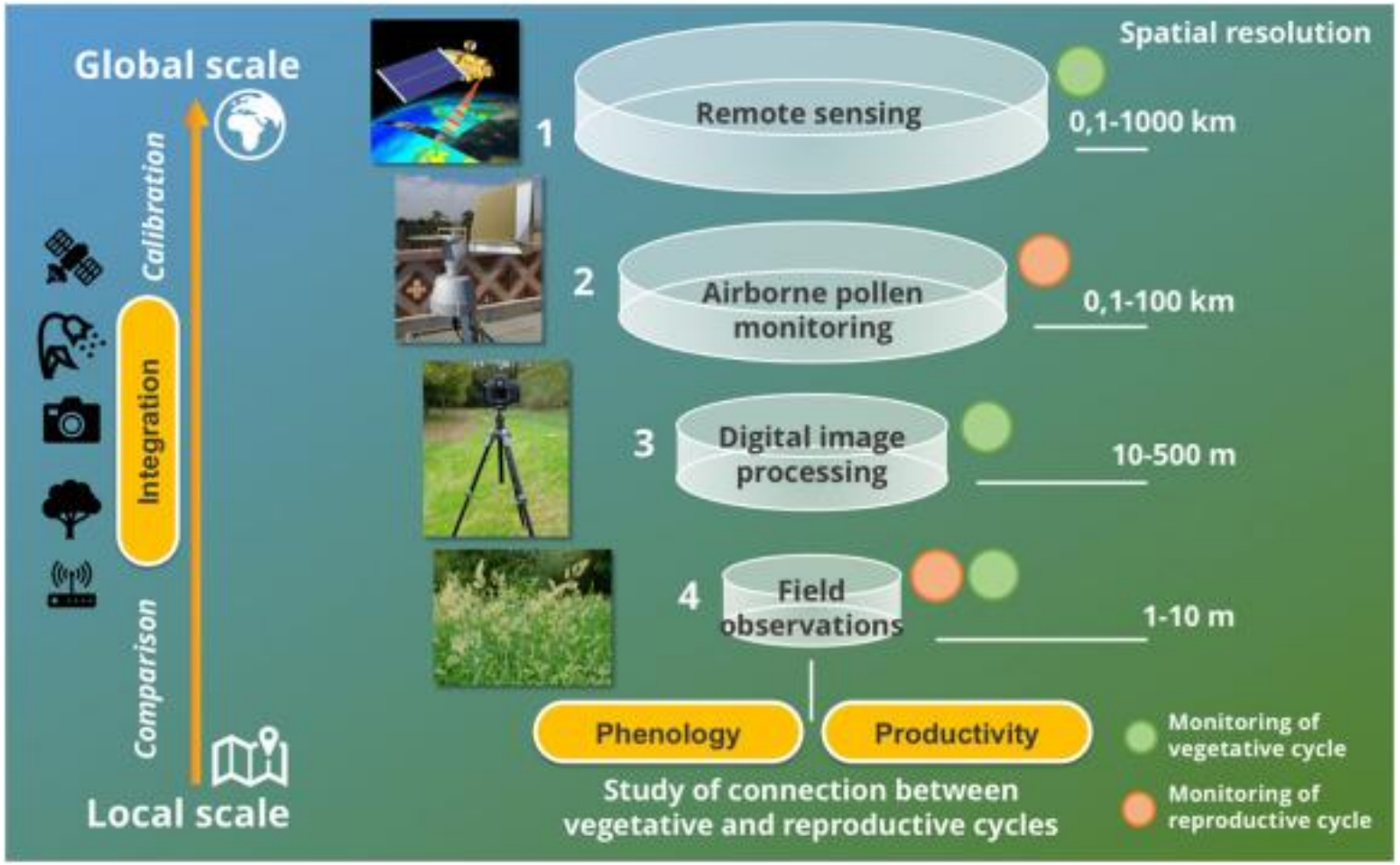
# Earth Observation today

**2003:** International governments launch the Global Earth Observation System of Systems (GEOSS), a worldwide network meant to knit together the international Earth-monitoring capabilities.

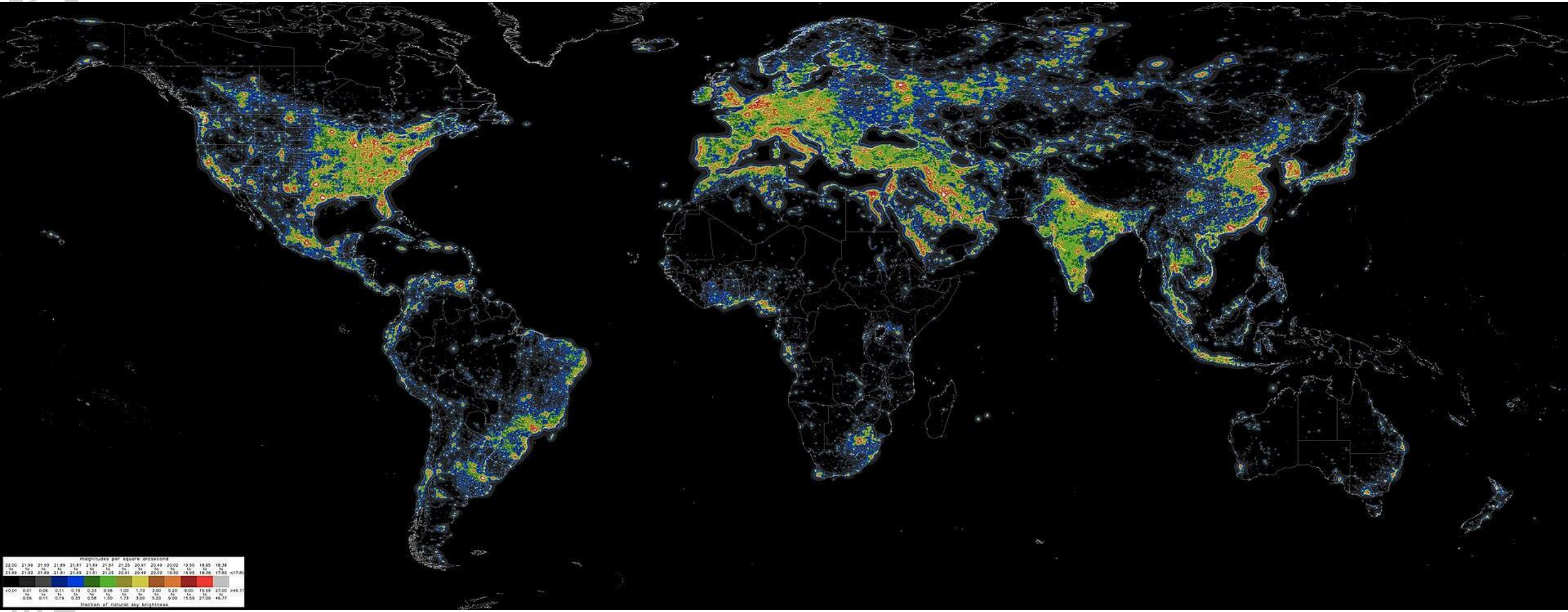
# Applications

# Applications
## Disasters

# Applications
## Health



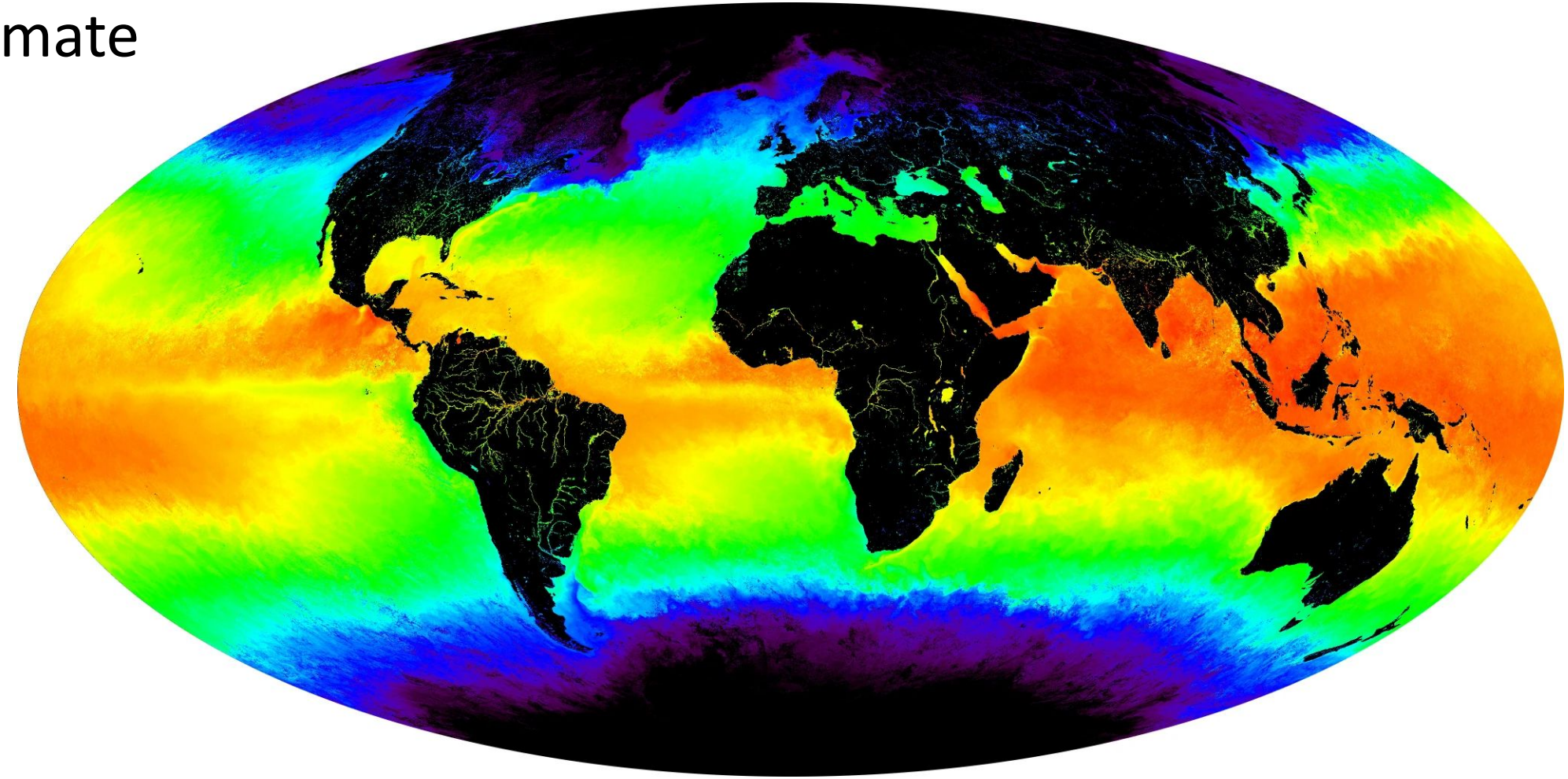

# Applications
## Energy




Global light pollution. Lorenz, 2020.

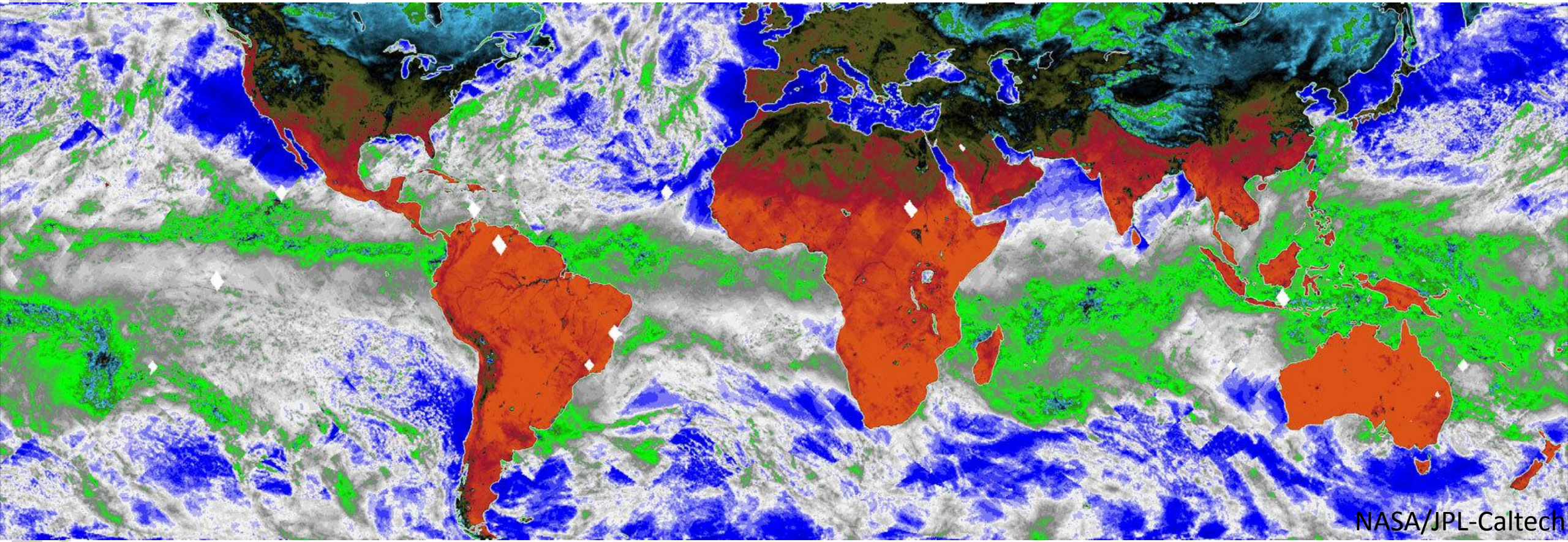
# Applications

## Climate



**Modis SST**. This mosaic shows global sea surface temperatures for May 2001 and was derived from many images from a NASA satellite instrument called MODIS. As the oceans cover 70% of the planet measuring sea surface temperature is important for monitoring global heating

# Applications
## Weather

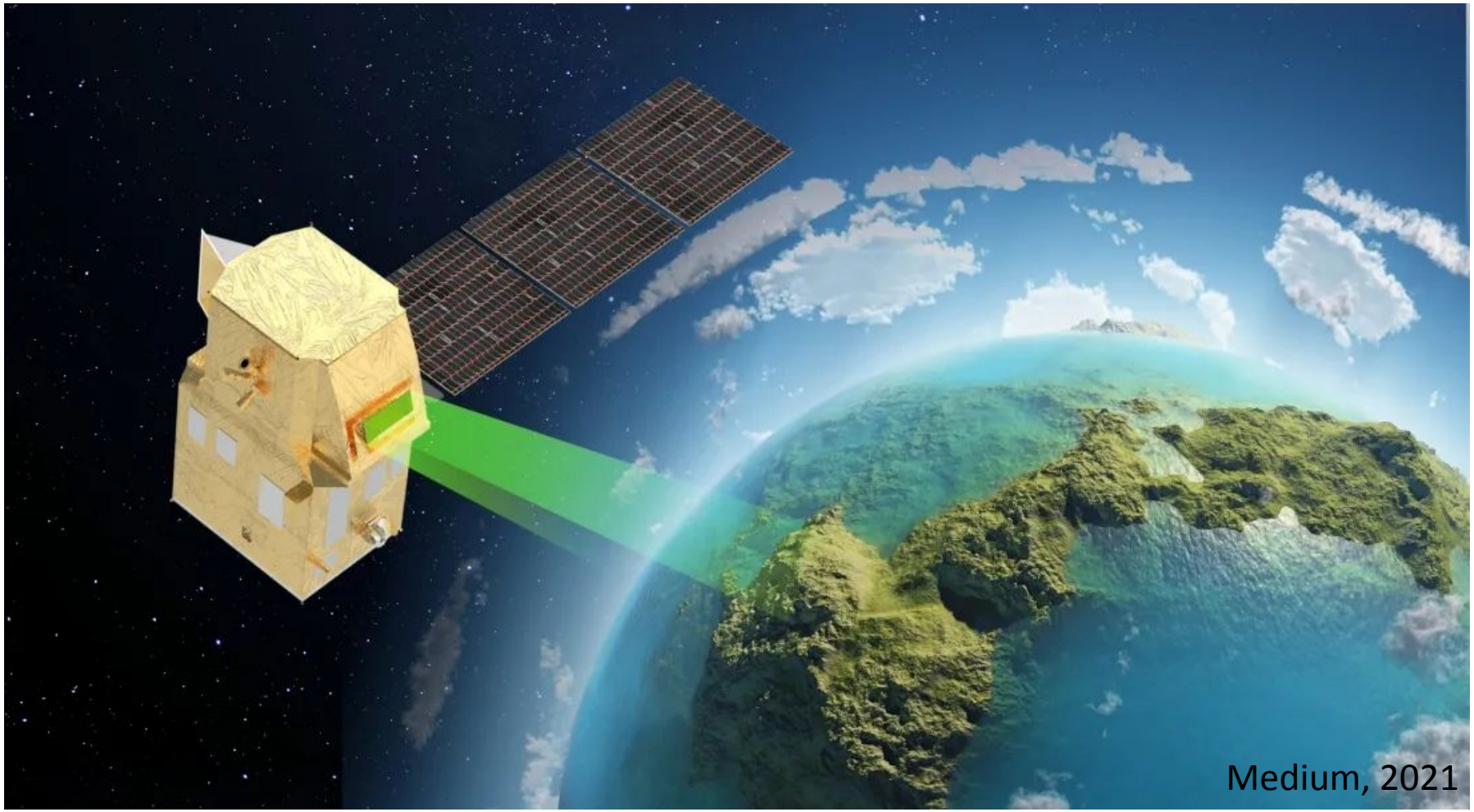



This new map, made using COWVR's new observations, shows Earth's microwave emissions at a frequency that **provides information on the strength of winds at the ocean surface**, the **amount of water in clouds**, and the **amount of water vapor in the atmosphere**.

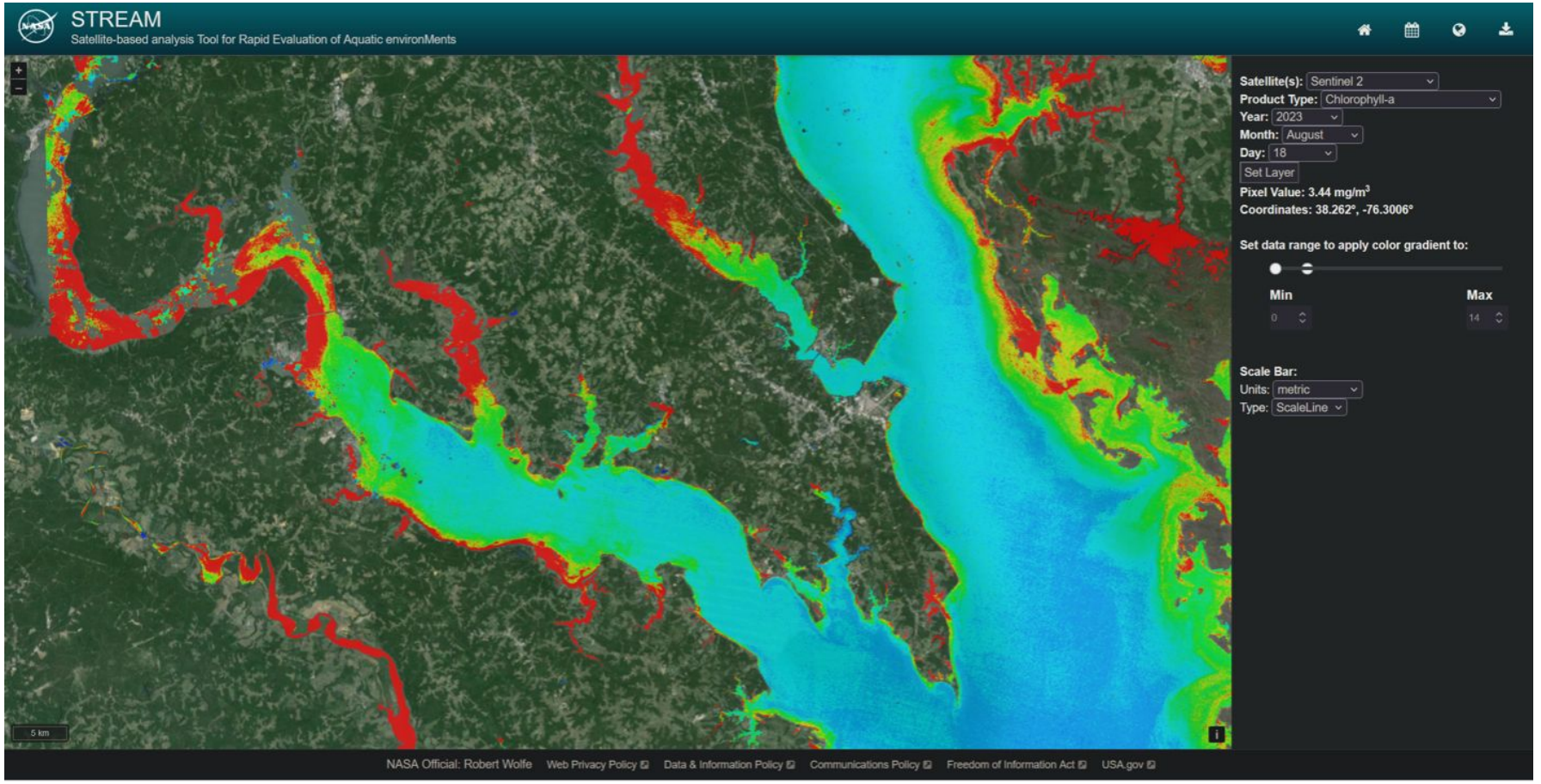
# Applications
## Agriculture

Full sized image of Grand View, Idaho agricultural region acquired by SSTL S1-4 satellite 25th June 2020 at sub 1m.

# Applications
## Ecosystems



# Applications
## Water




STREAM interface showing Chlorophyll-a pigment (mg/m3) concentrations in the Chesapeake Bay and Potomac River obtained from Sentinel-2 MultiSpectral Instrument (MSI) measurements on August 18, 2023.

# Applications
## Wetlands


Lake County, Illinois, taken in 2015 by the USDA National Agriculture Imagery Program to assess the condition of wetlands.

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# Thank you for your attention!

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