

A satellite image of Europe and surrounding regions, with a vibrant green color overlay across the landmasses. The text is centered over the map.

# Earth Observation from satellites

University of Worcester

Geography Taster Session



# Who am I?

Dr Fleur Visser

Senior Lecturer Physical Geography  
University of Worcester

specialist subjects: Earth Observation, GIS, Soil  
Erosion and Aquatic Plants

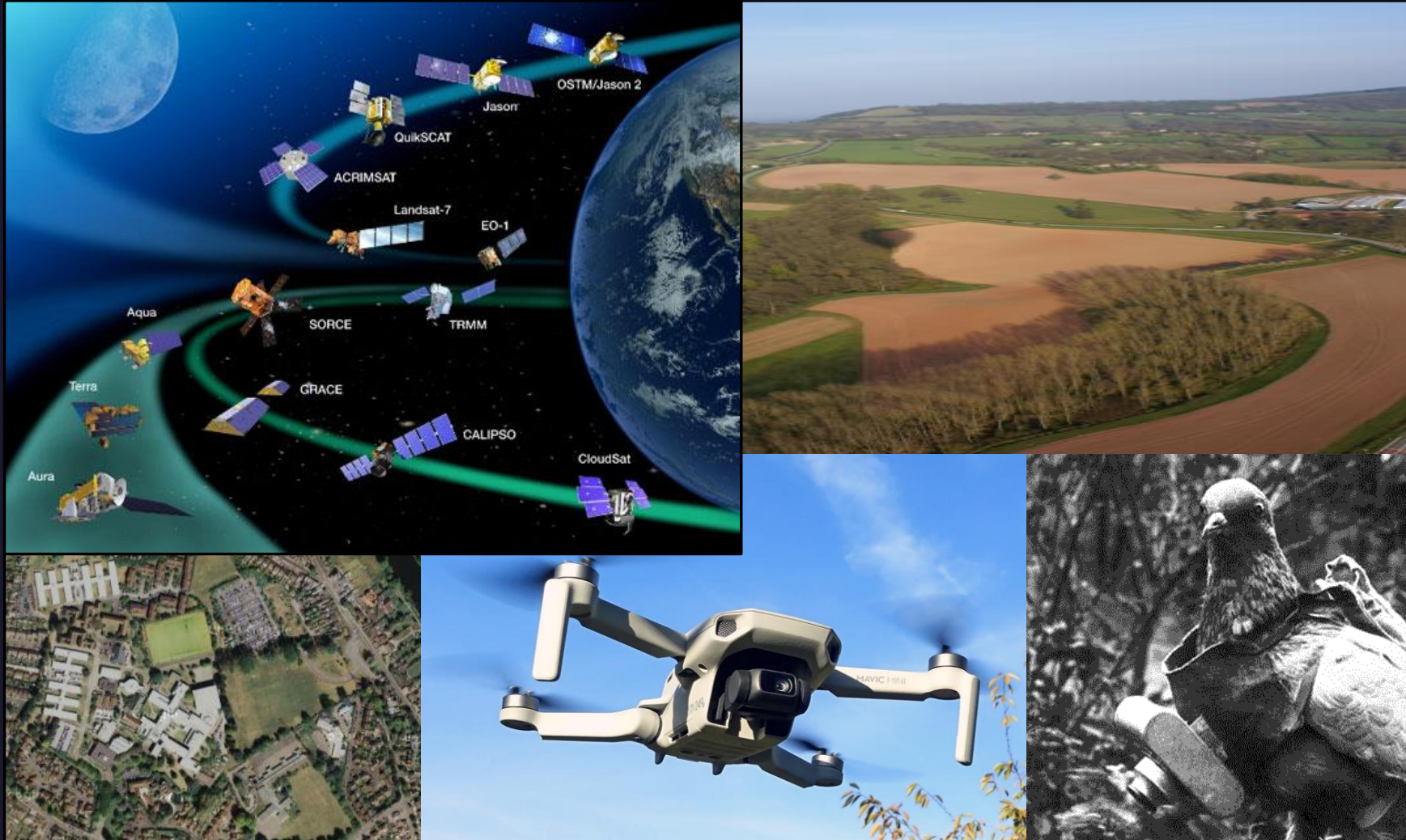


My background:

Undergraduate – University of Amsterdam  
PhD – Australian National University



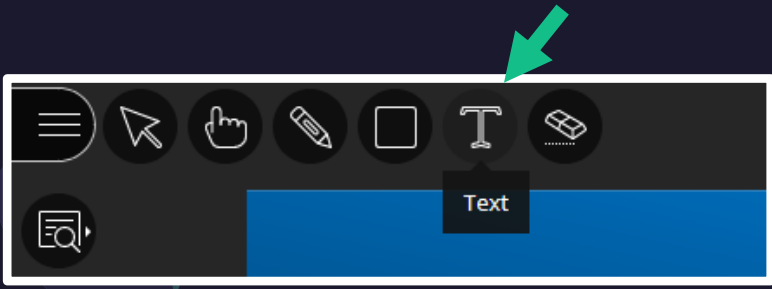
# What is Earth Observation?



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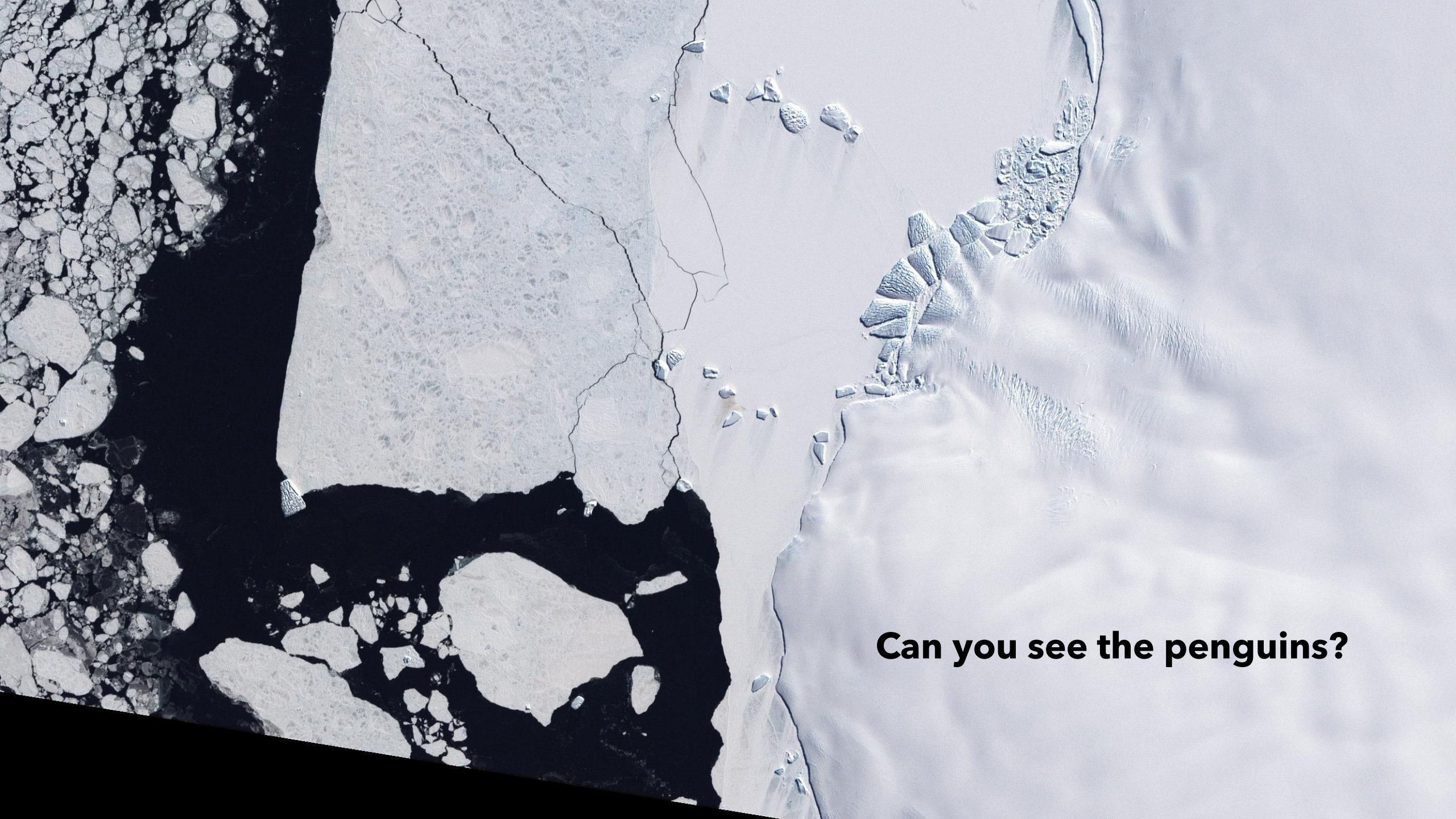






# Why Earth Observation?

Please, write your thoughts here.



**Can you see the penguins?**



sea ice

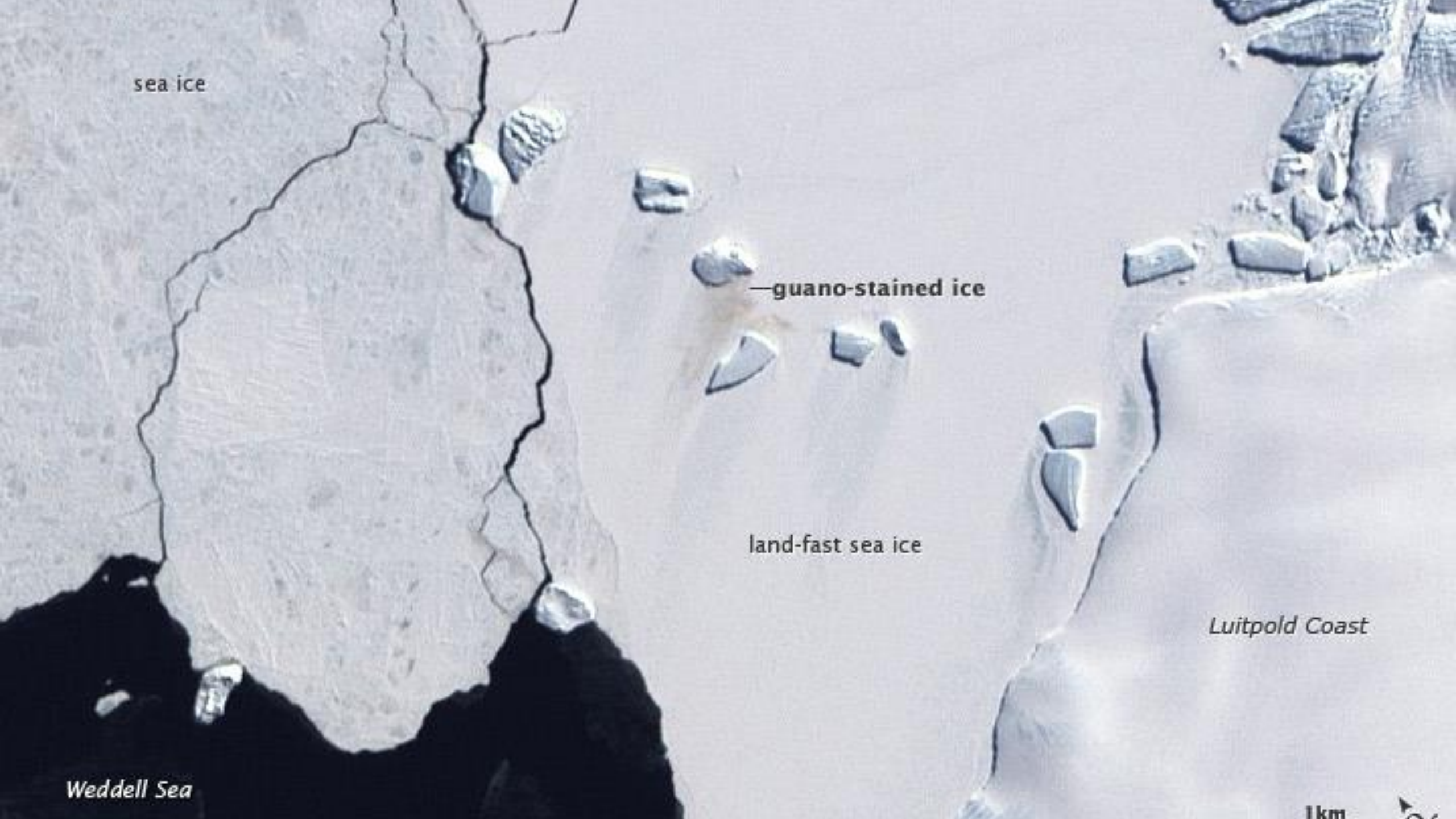
—guano-stained ice

land-fast sea ice

*Luitpold Coast*

*Weddell Sea*

1km











Penguins from space: Faecal stains reveal the location of emperor penguin colonies (British Antarctic Survey)  
[https://www.esa.int/Applications/Observing\\_the\\_Earth/Copernicus/Sentinel-2/Discovering\\_new\\_penguin\\_colonies\\_from\\_space](https://www.esa.int/Applications/Observing_the_Earth/Copernicus/Sentinel-2/Discovering_new_penguin_colonies_from_space)



Why Earth  
Observation?  
  
Survey  
inaccessible areas





# Why Earth Observation?

**Survey large and inaccessible areas**

Does not disturb people or the environment

Produces reliable and objective datasets

Produces repeat-coverage and historic records

**Provides information beyond what we can see with our eyes**





# Earth Observation - Key Concepts

The 'target' is your feature of interest (e.g. penguin colonies, deforestation, glacial retreat, etc.)

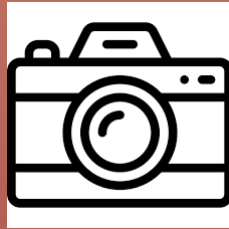
Sensors can range from a basic rgb camera to sophisticated hyperspectral spectroradiometers

Platforms that carry the sensor can be satellites in space, or much closer to the ground (e.g. drones)

Target



Sensor

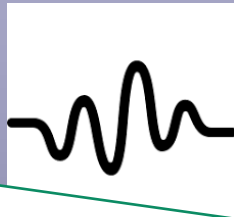


Platform



Light or Electromagnetic radiation interacts with the surface of your target. Any reflected light will be sensed by your sensor.

Light



Radiation picked up by the sensor will be recorded as images. With each pixel representing the amount of surface reflectance from a particular location

Image data



Data processing

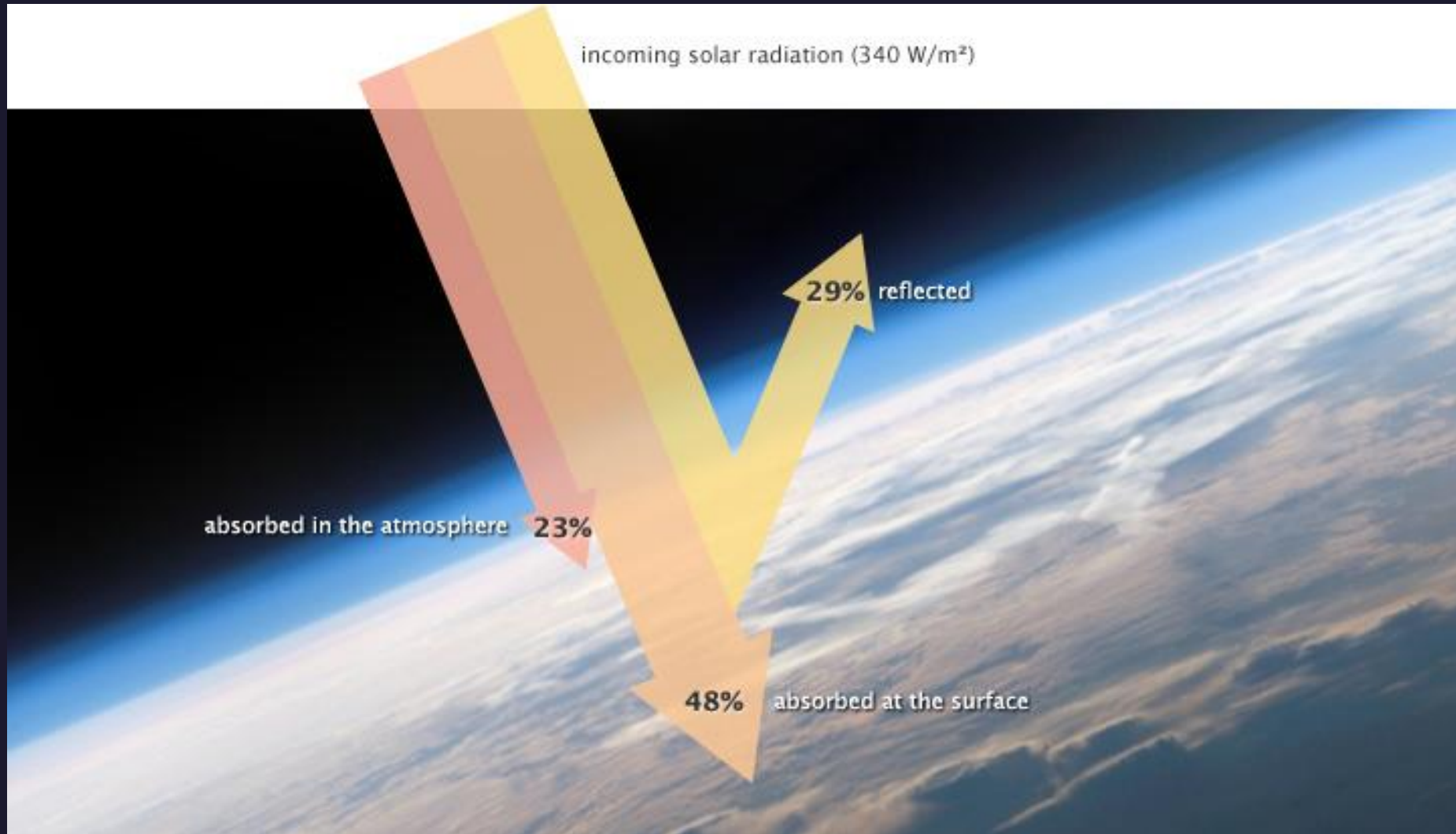


Raw image data can next be processed and interpreted to obtain information about your target.



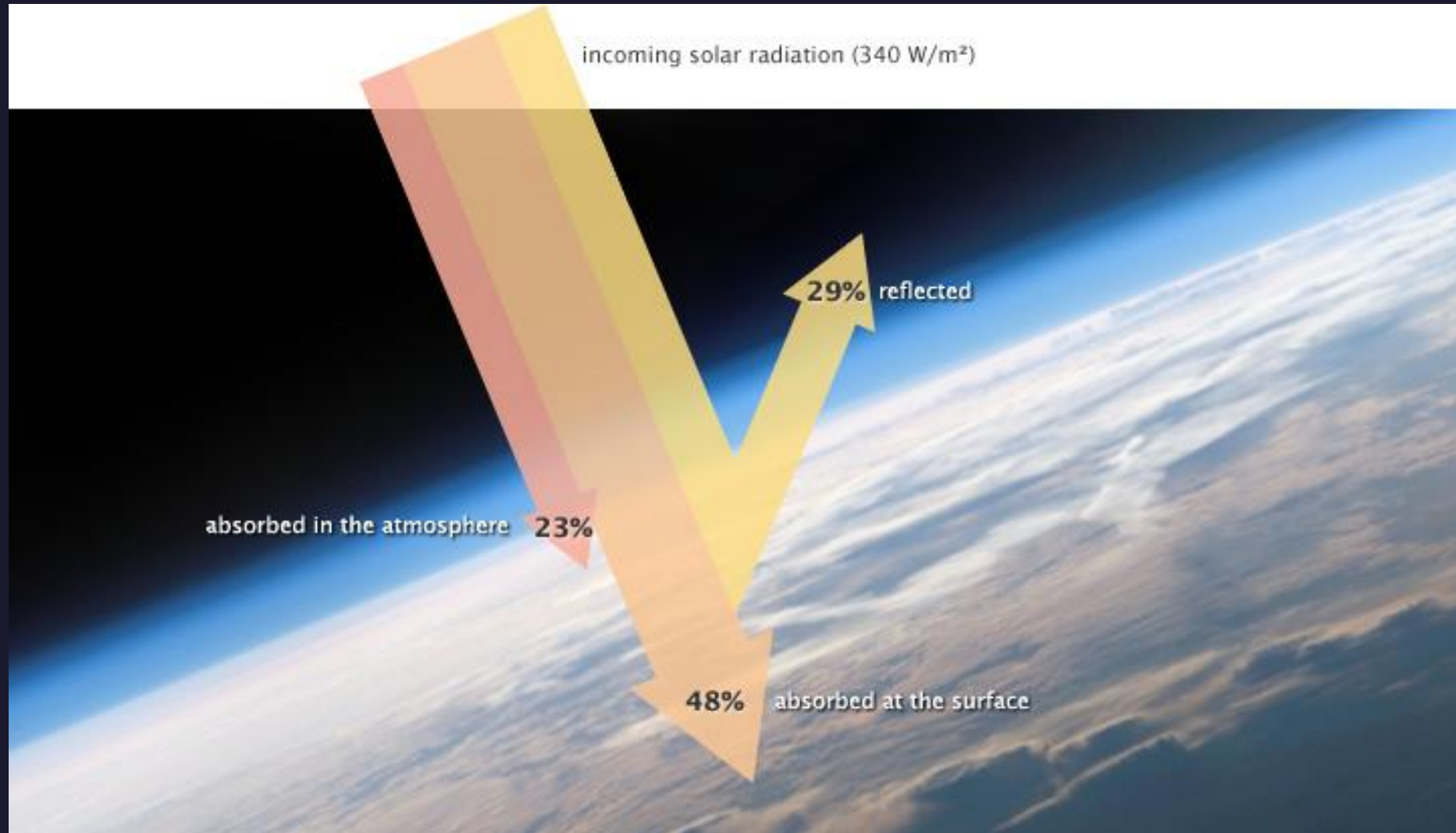
# Light => Electro Magnetic (EM) radiation

## Arrives in a range of wavelengths



# Light => Electro Magnetic (EM) radiation

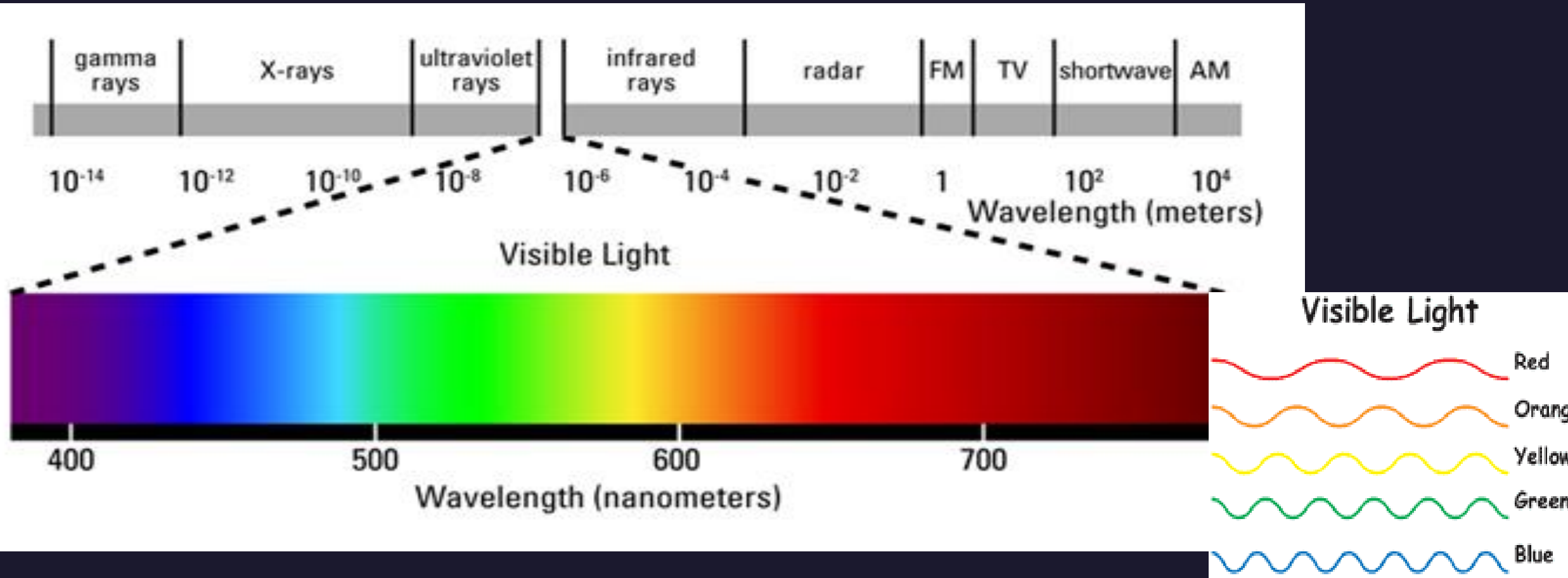
**Interacts with the surface: some wavelengths are absorbed, some reflected**



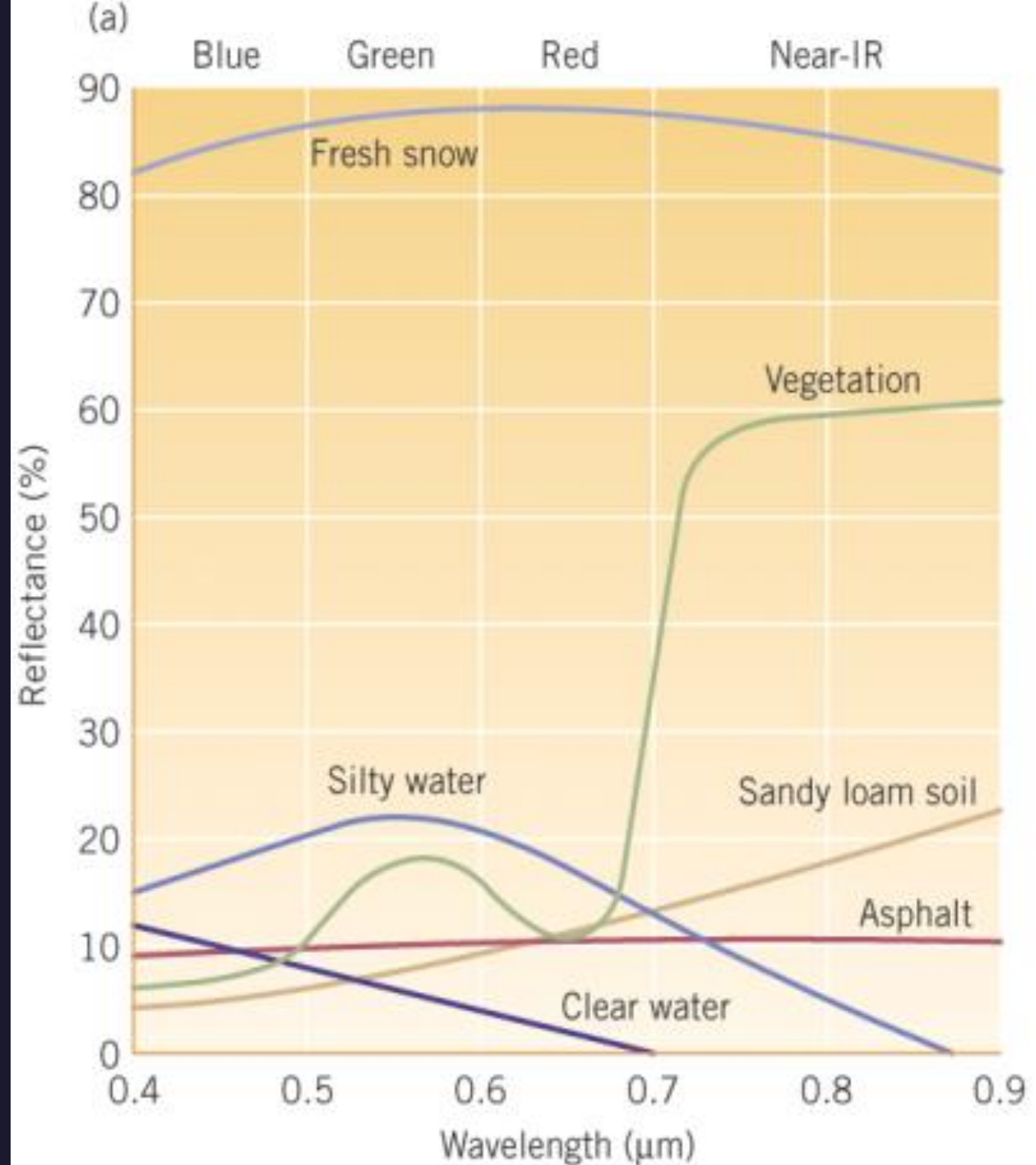


# Electro Magnetic (EM) radiation

**Most wavelengths can be used for Earth Observation**



**Spectral Signatures**  
show variation in  
absorption and  
reflectance across  
the visible spectrum  
and beyond.





# ***We see can see a red car because:***

- A. All sunlight in the visible wavelengths reflects from it's surface
- B. Mostly red light reflects from its surface, blue and green light are absorbed
- C. Green light reflects from its surface, red light is absorbed.



# Which object in this photo reflects more light?

A. The child's shirt

B. The child's hat

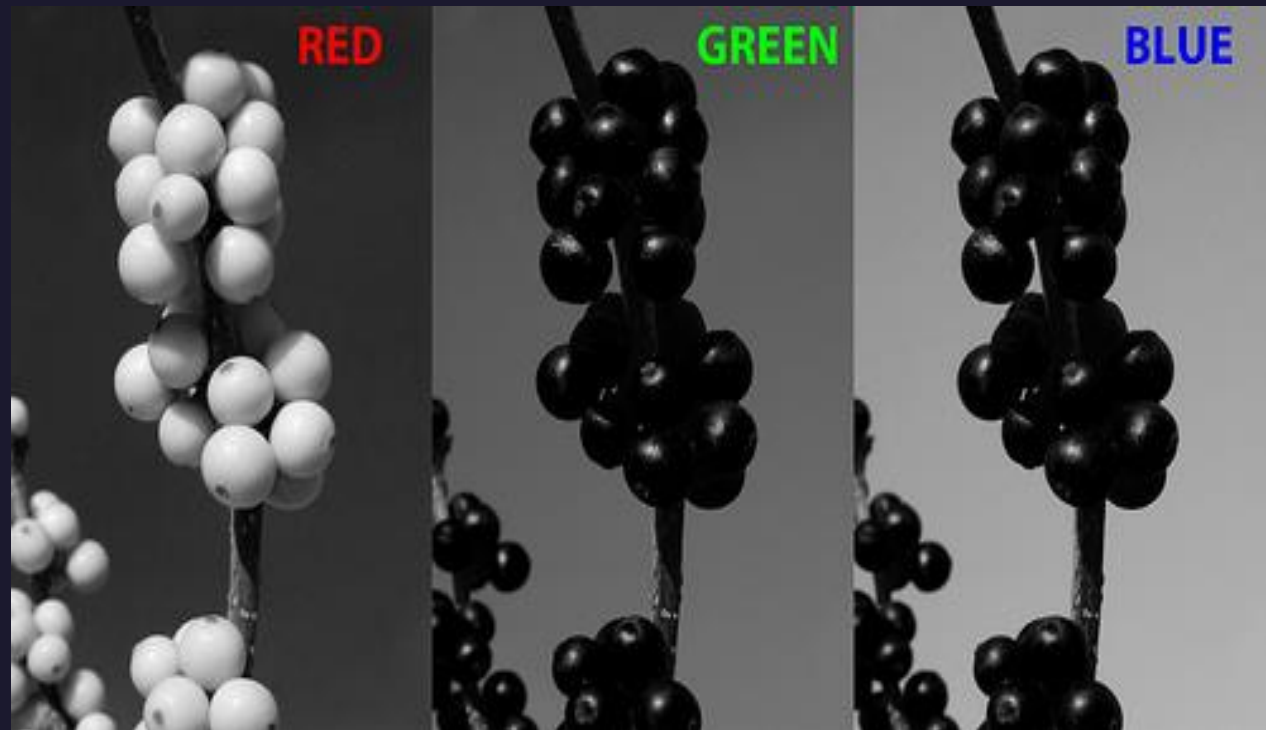
C. The fence





# ***What colour do these berries have?***

- A. Red
- B. Yellow
- C. Black

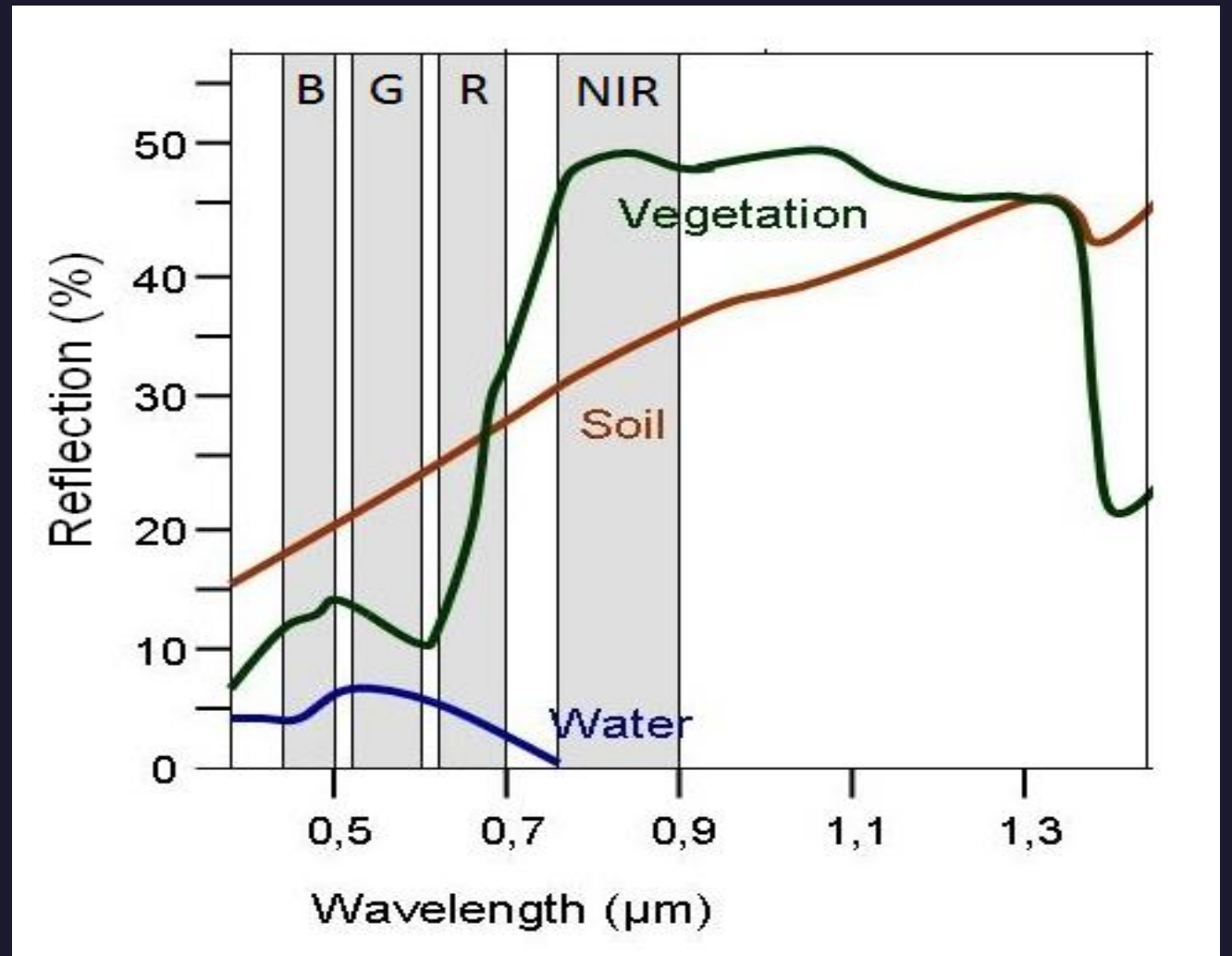


**Radiation of which wavelength is reflected most strongly from a vegetation surface?**

A. Red (R)

B. Green (G)

C. Near Infrared (NIR)





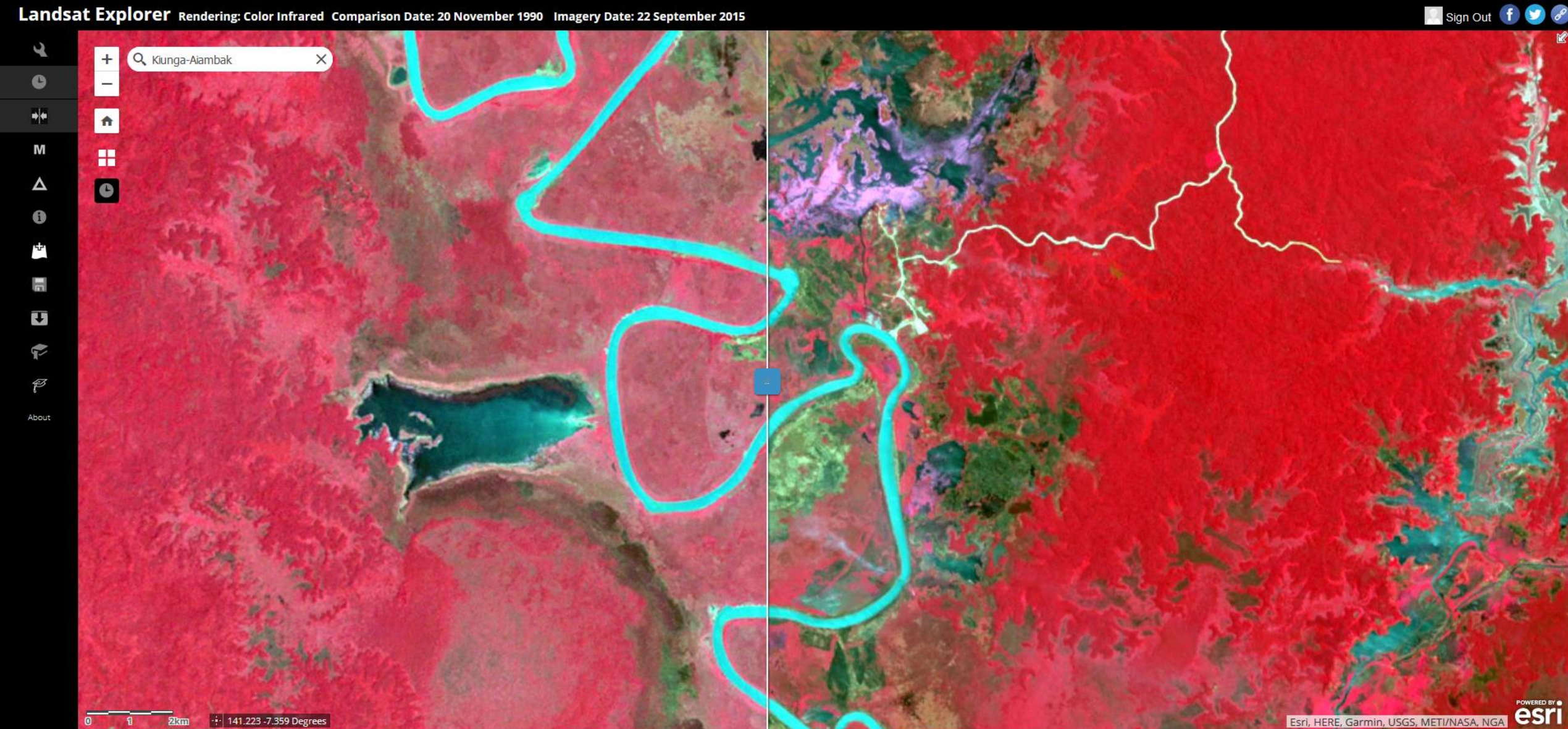
By making reflectance beyond the visible light visible, we can better monitor Earth's processes

## Two Examples

- Deforestation – Indonesia (West Papua) case study
- Glacial retreat – Switzerland (Aletsch Glacier) case study
- (Sea ice extent as seen by ICESat-2)

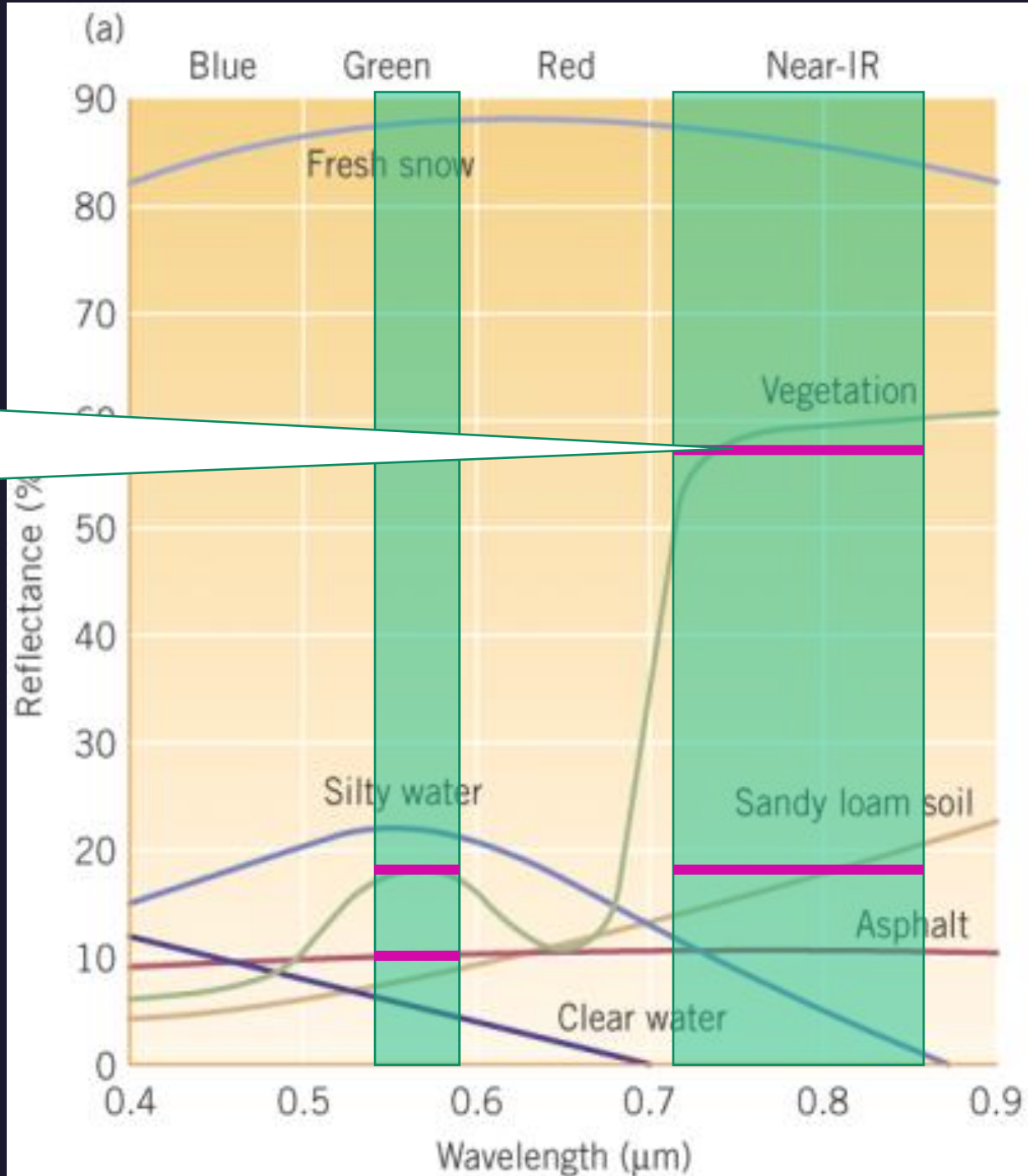


# Deforestation - Indonesia (West Papua)





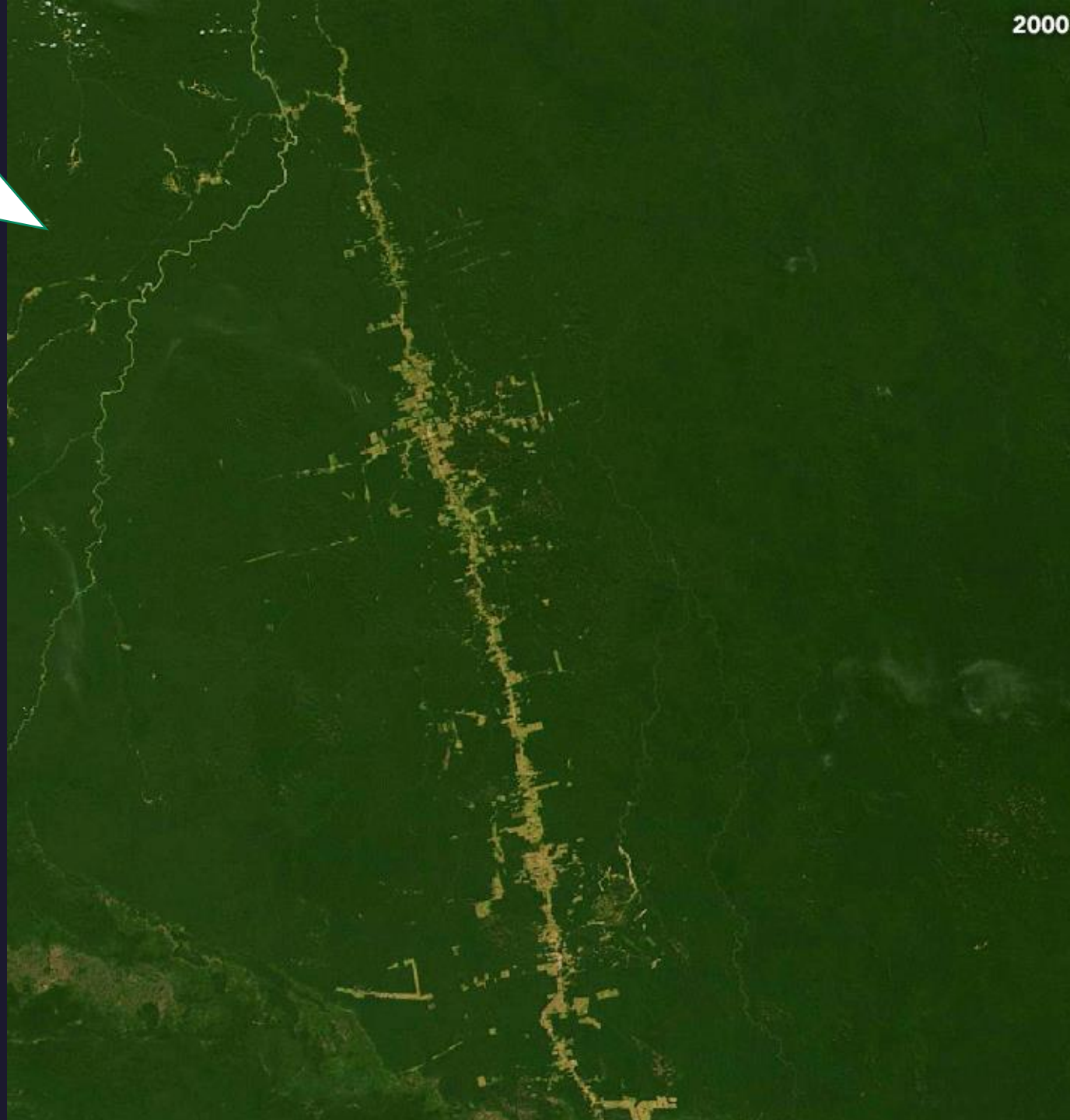
Note the how the difference between light reflectance from soil and vegetation is much greater in the Near Infrared, compared to the green wavelengths.



2000

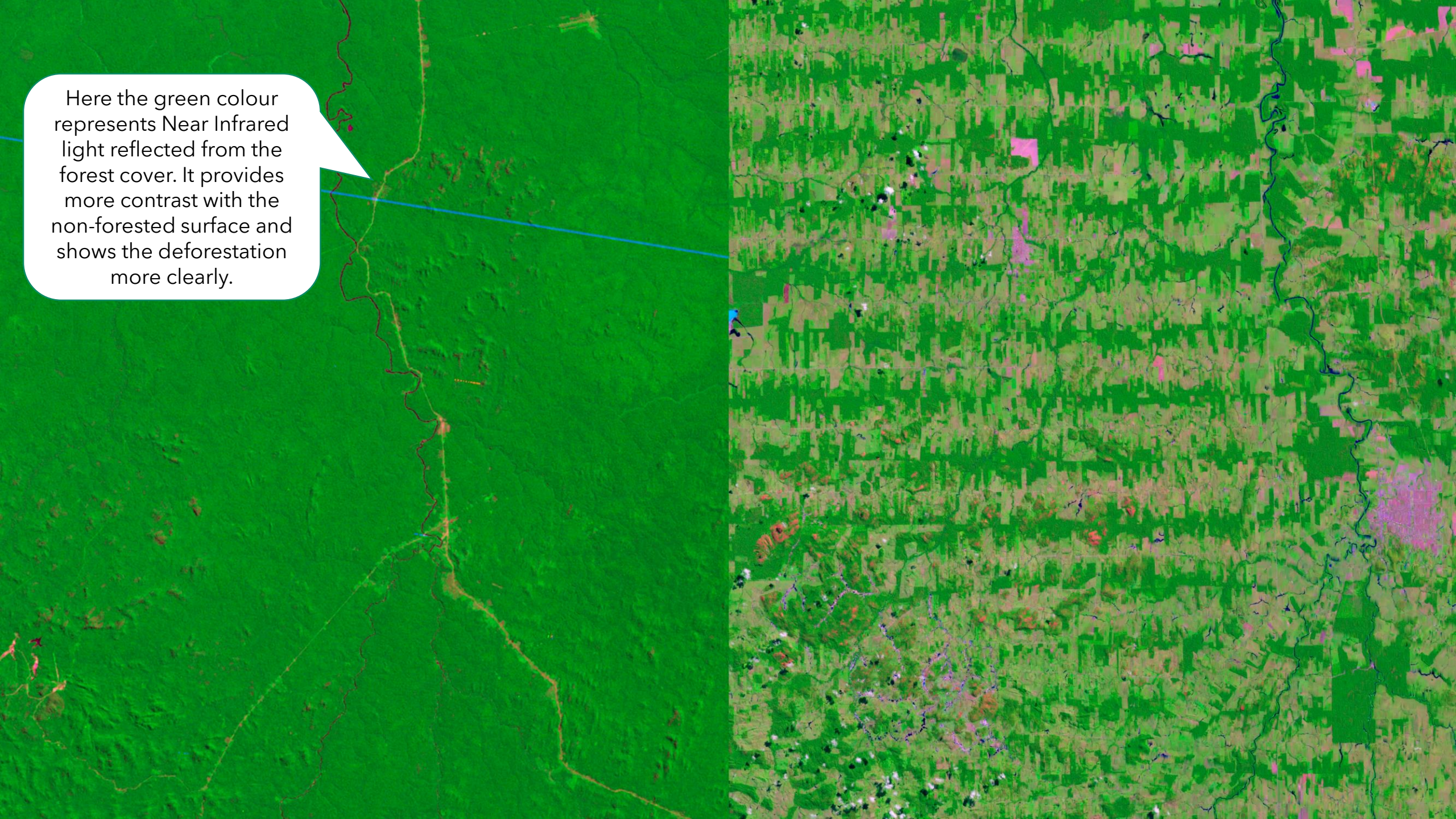
This animation shows deforestation using a 'true colour' display of Landsat satellite data, which is similar to a colour photograph.

<https://visibleearth.nasa.gov/images/145988/tracking-amazon-deforestation-from-above/146010w>





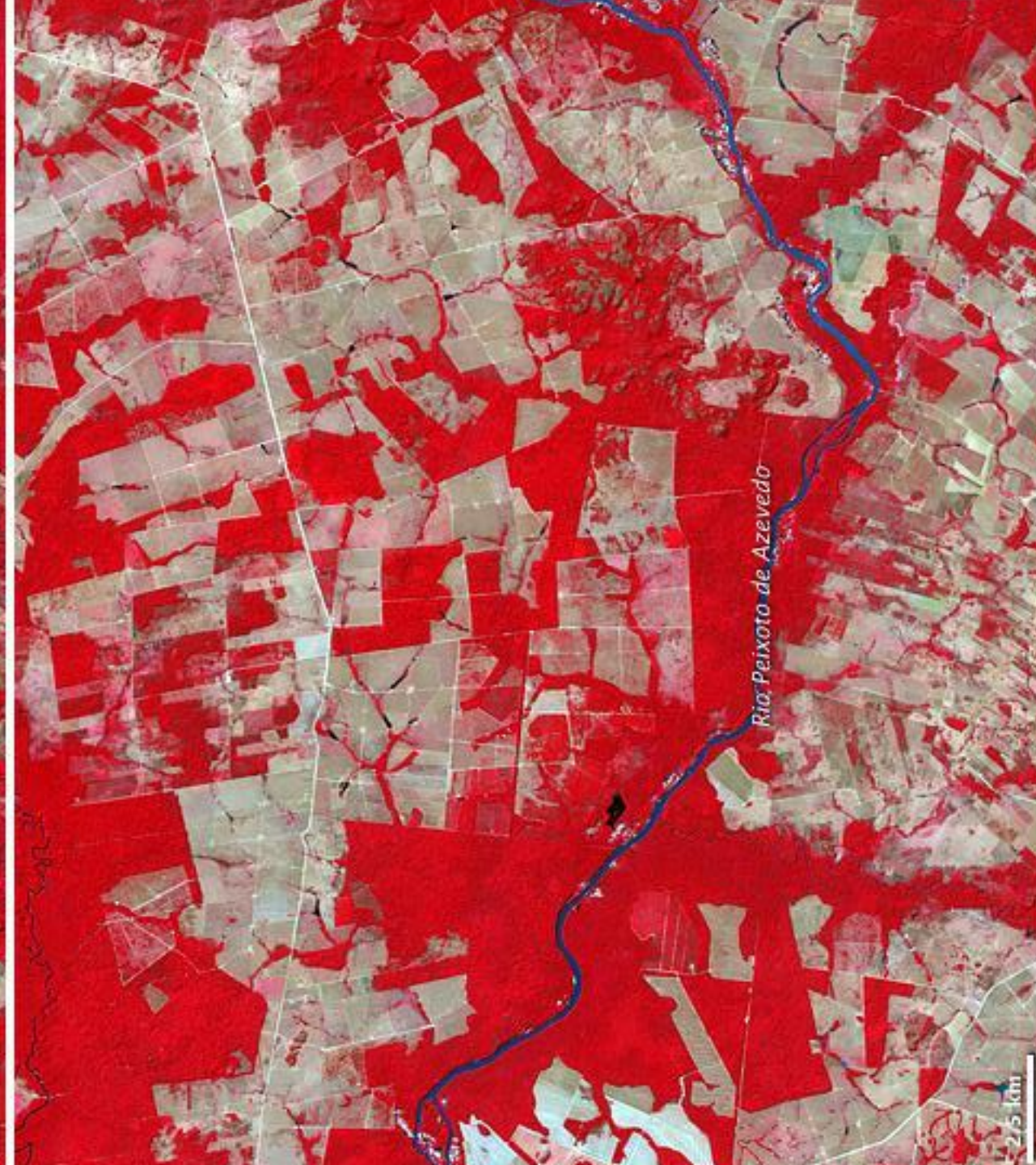
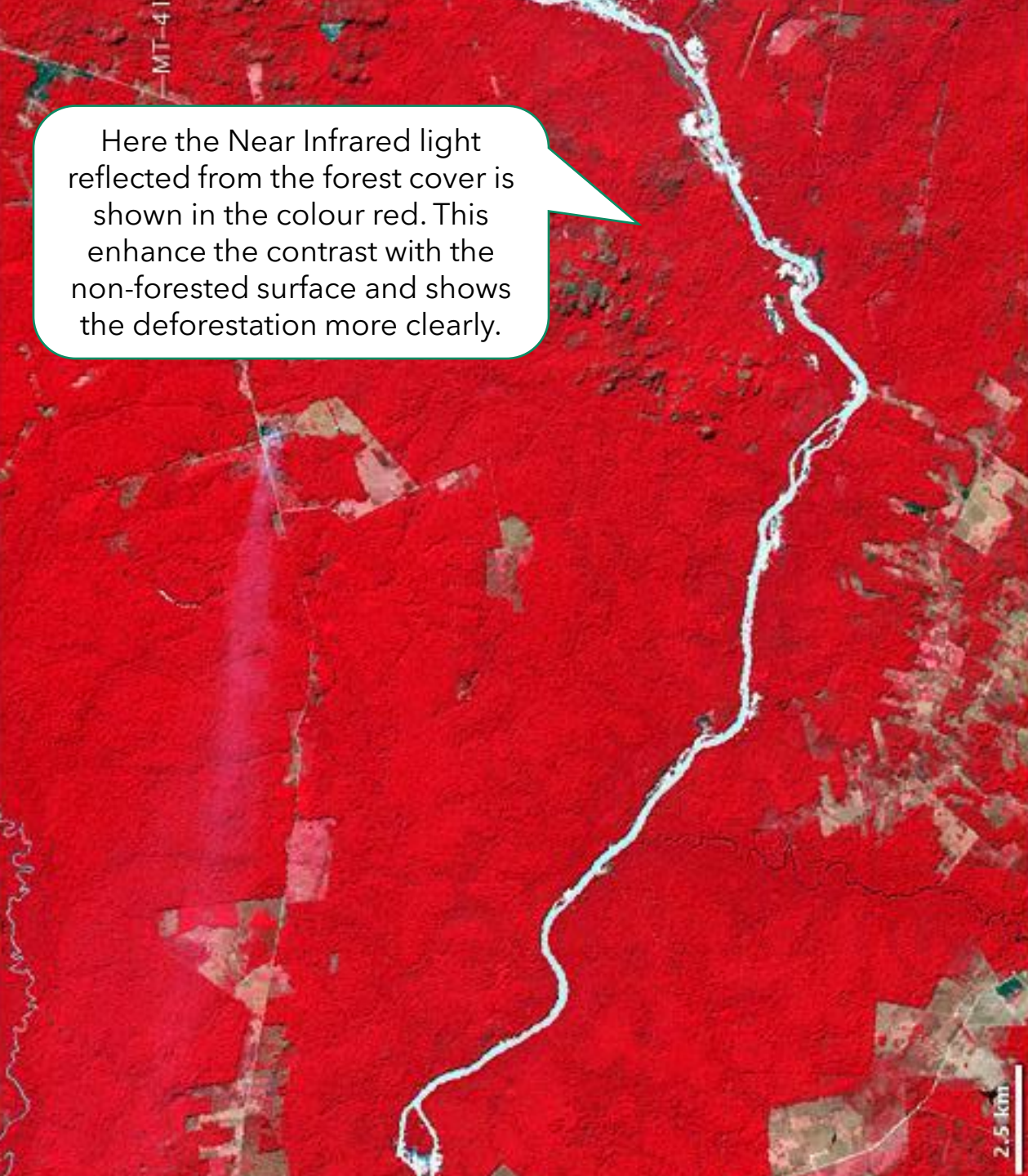
Here the green colour represents Near Infrared light reflected from the forest cover. It provides more contrast with the non-forested surface and shows the deforestation more clearly.





—MT-41

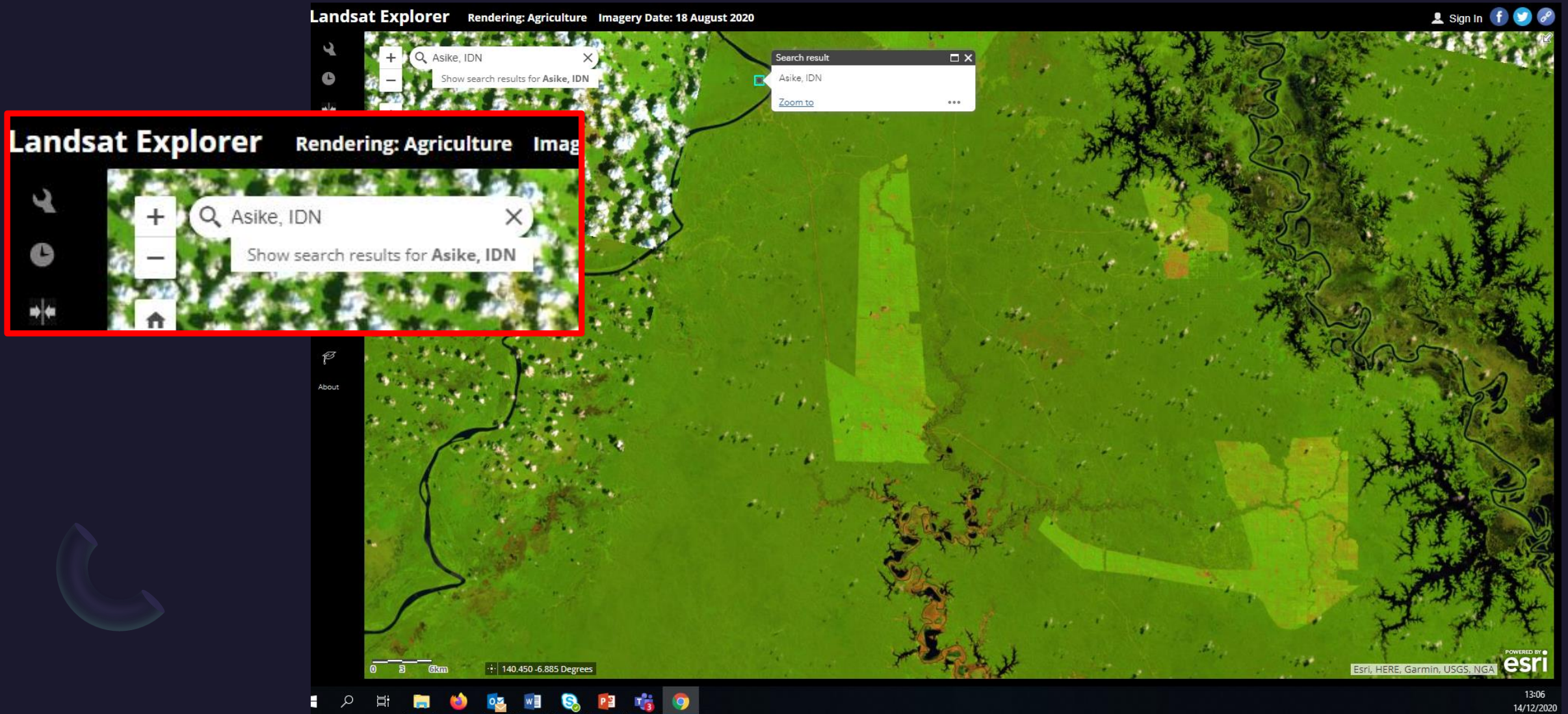
Here the Near Infrared light reflected from the forest cover is shown in the colour red. This enhance the contrast with the non-forested surface and shows the deforestation more clearly.






# Deforestation - Asike, Indonesia

Open: [landsatexplorer.esri.com](https://landsatexplorer.esri.com)

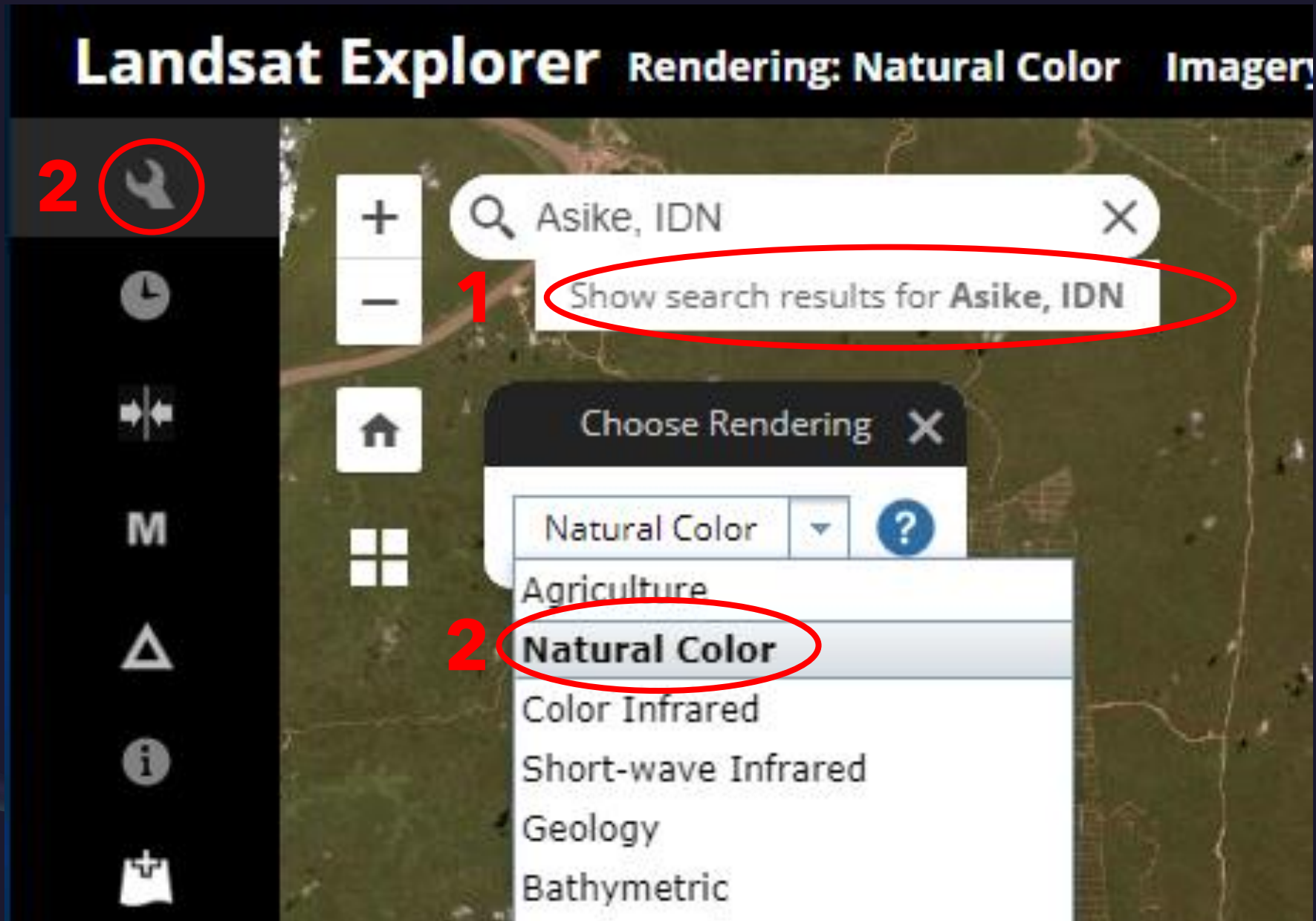




A satellite view of Earth from space, showing a vast expanse of white clouds over a dark blue ocean. The horizon line is visible at the top of the frame, with a thin blue line representing the atmosphere. A green rectangular box is overlaid on the left side of the image, containing white text.

What will be a major obstacle for  
observing tropical deforestation  
from satellites?  
(Clouds)





# Landsat Explorer

Rendering: Color Infrared Imagery Date: 18 A

3

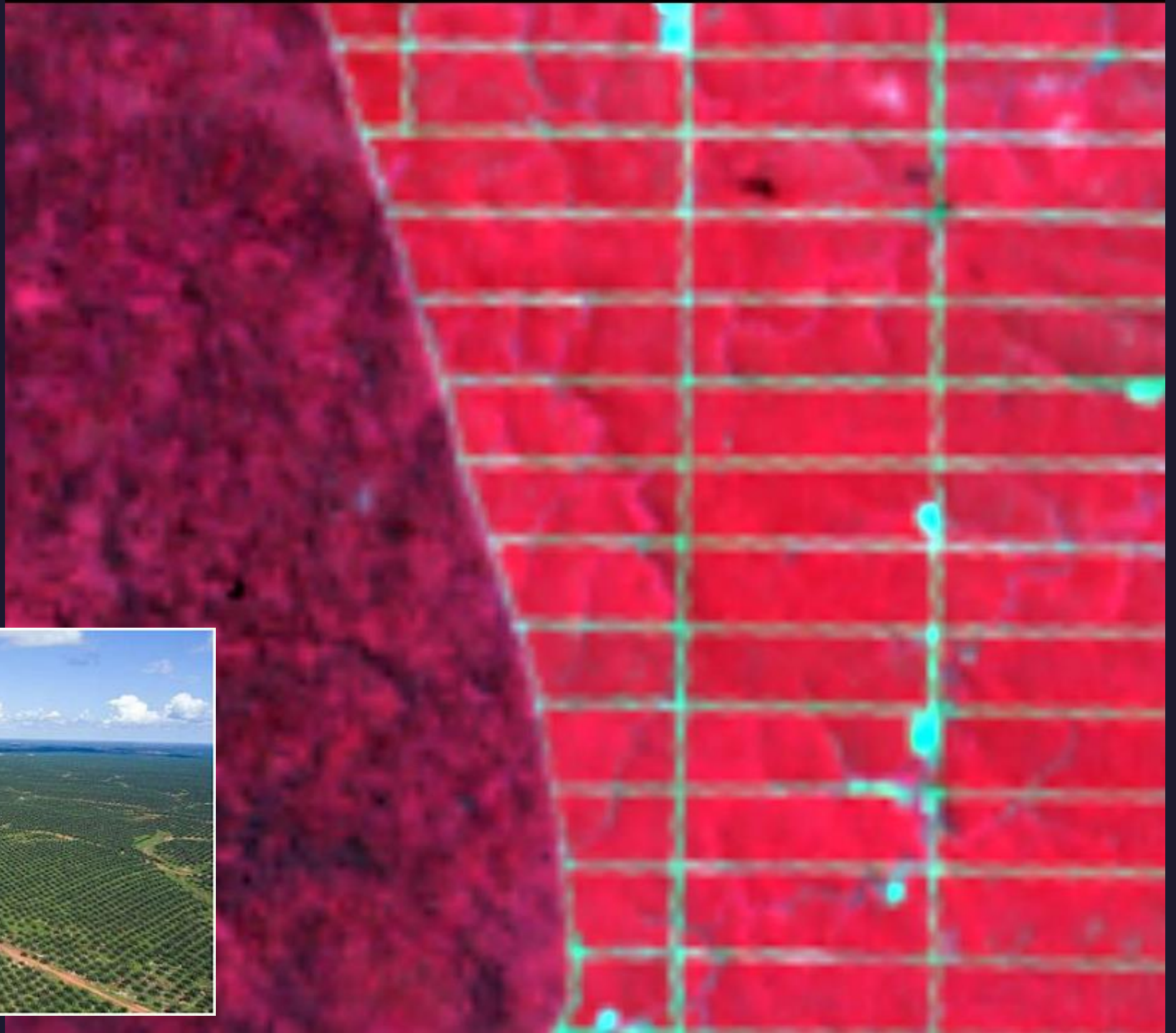


4

Color Infrared



NIR enhances differences in forest structure. The smoother appearance of the trees on the right indicates mature plantation crops.



# Landsat Explorer

Rendering: Color Infrared

Imagery Date: 20 November 1990

5



Asike, IDN



6



Image Date: 20 November 1990



Cloud Filter: 10% Cloud



Season Filter: All



Pick a point on the map to get the temporal profile for that point.



## Landsat Explorer Rendering: Color Infrared Imagery Date: 20 November 1990

7



M



Asike, IDN



Time Selector

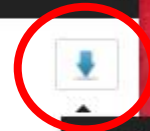
Image Date: 20 November 1990

Cloud Filter: 10% Cloud

Season Filter: All

Pick a point on the map to get the temporal profile for that point.

8



Set Current as Secondary Layer.

## Landsat Explorer Rendering: Color Infrared Imagery Date: 18 August 2020

9



M



Asike, IDN



Time Selector

Comparison at 20 November 1990

Image Date: 18 August 2020

Cloud Filter: 10% Cloud

Season Filter: All

Pick a point on the map to get the temporal profile for that point.



The previous example showed how Earth Observation allows us to observe changes in vegetation cover. Particularly when we use light in wavelengths beyond the visible light. more clearly and that way monitor the occurrence of deforestation.

## Further examples:

The burning scar: Inside the destruction of Asia's last rainforests

<https://www.bbc.co.uk/news/world-asia-54798452>

World's largest palm oil trader linked to rainforest destruction twice the size of Paris

[https://www.greenpeace.org/static/planet4-international-stateless/2018/06/Report-GP\\_IND\\_Rogue\\_v6.1\\_Pages.pdf](https://www.greenpeace.org/static/planet4-international-stateless/2018/06/Report-GP_IND_Rogue_v6.1_Pages.pdf)

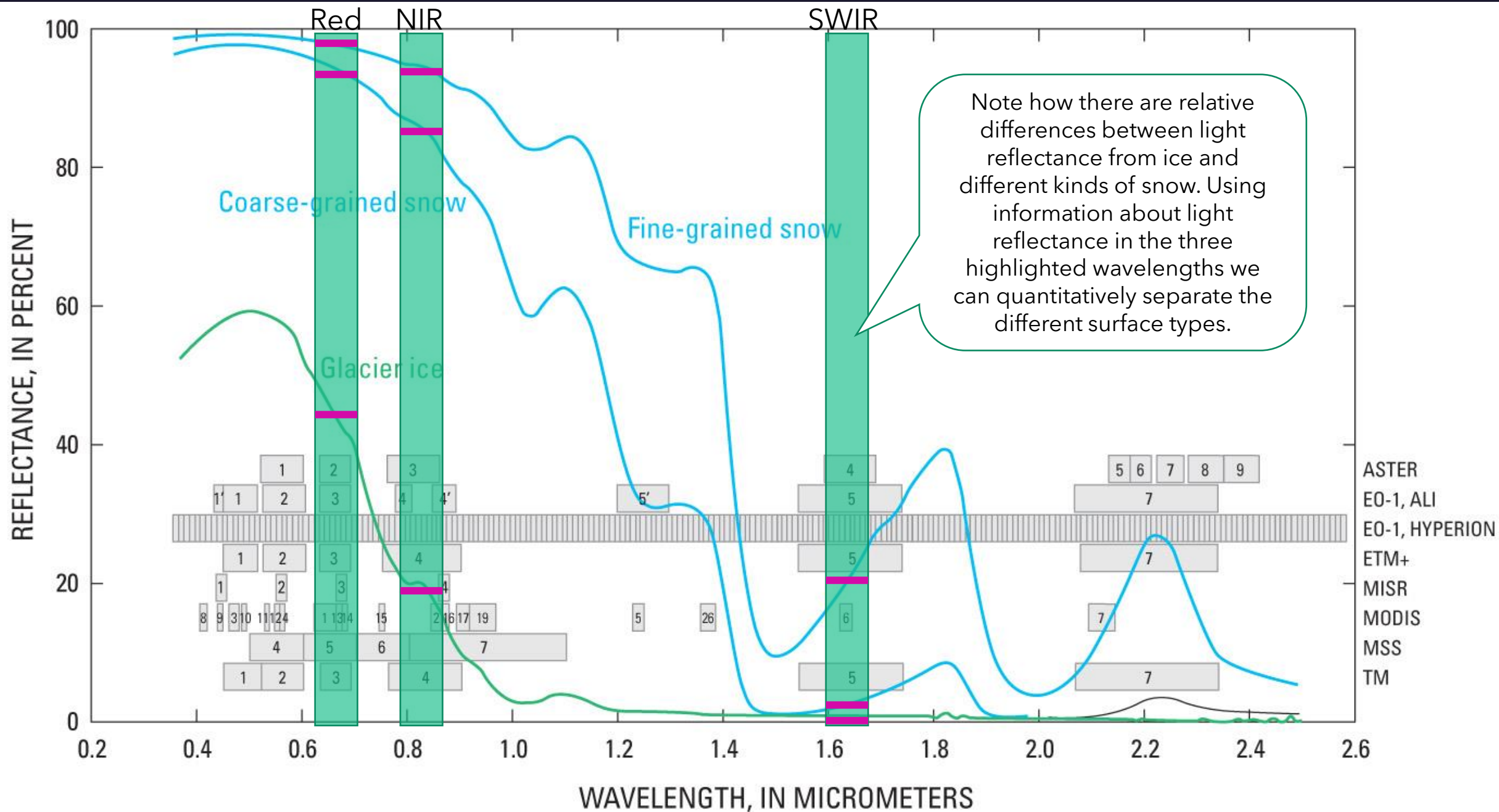




# Glacial retreat - Switzerland (Aletsch Glacier)

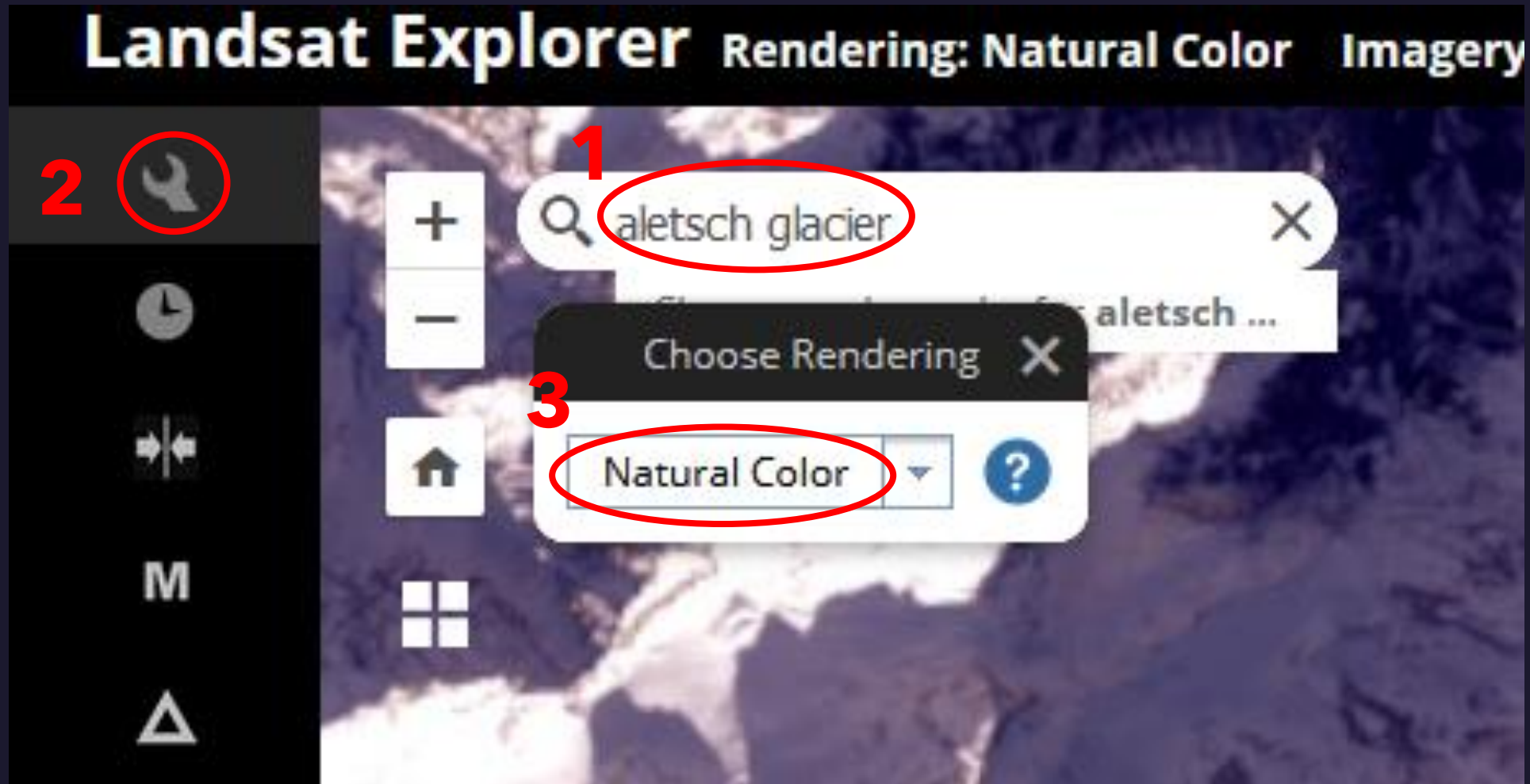








landsatexplorer.esri.com



An aerial photograph showing a large glacier flowing through a rugged mountain range. The glacier is a bright white, winding ribbon that cuts through dark, rocky terrain. The surrounding peaks are also covered in snow or ice, with some areas showing exposed rock. The lighting creates strong shadows, emphasizing the steep slopes and the texture of the ice and rock.

What will be the best time of the year  
to observe the extent of a glacier?  
(summer)



# Landsat Explorer

Rendering: Natural Color   Imagery Date: 25 August 2019

4



5



Image Date: 25 August 2019



Cloud Filter: 10% Cloud



Season Filter: Summer



Pick a point on the map to get the temporal profile for that point.

# Landsat Explorer

Rendering: Stretch with Bands - 6,5,4 Imagery

6



+



aletsch glacier

X

-



M



7

Choose Rendering

X

Custom Bands



RGB Composite:

SWIR1(6)



NIR(5)



Red(4)



Stretch:

0.1% Clip



Gamma:

1



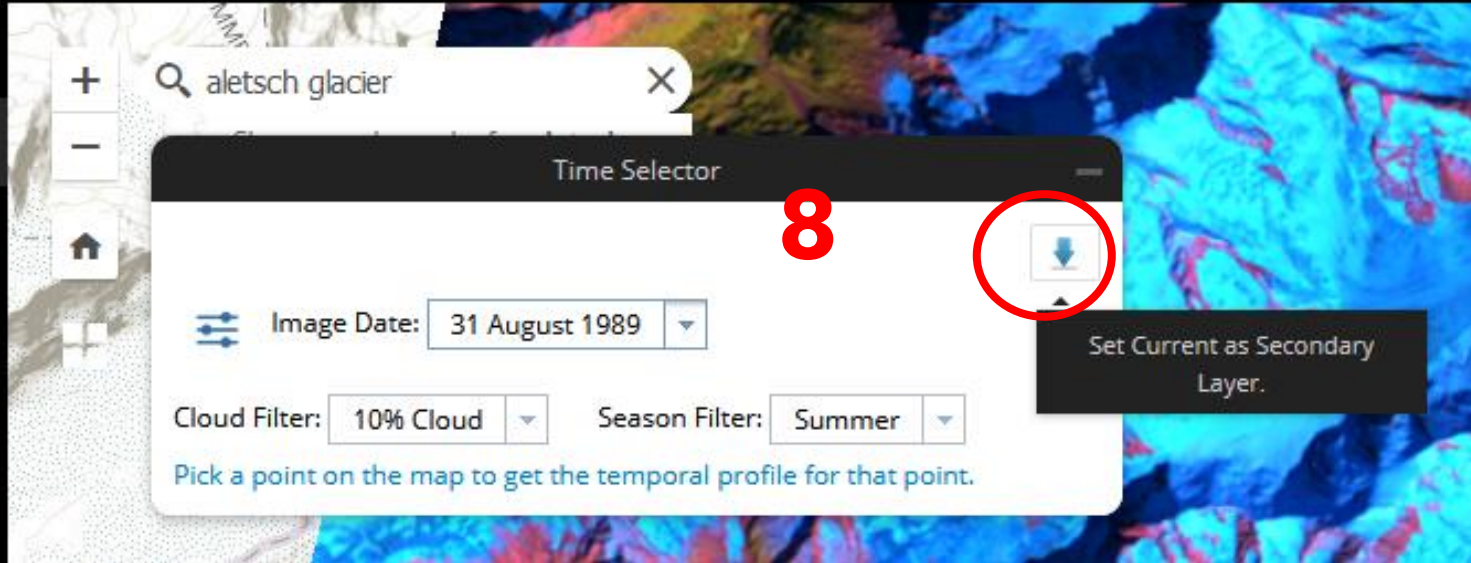
Apply

Reset



# Landsat Explorer Rendering: Natural Color Imagery Date: 31 August 1989

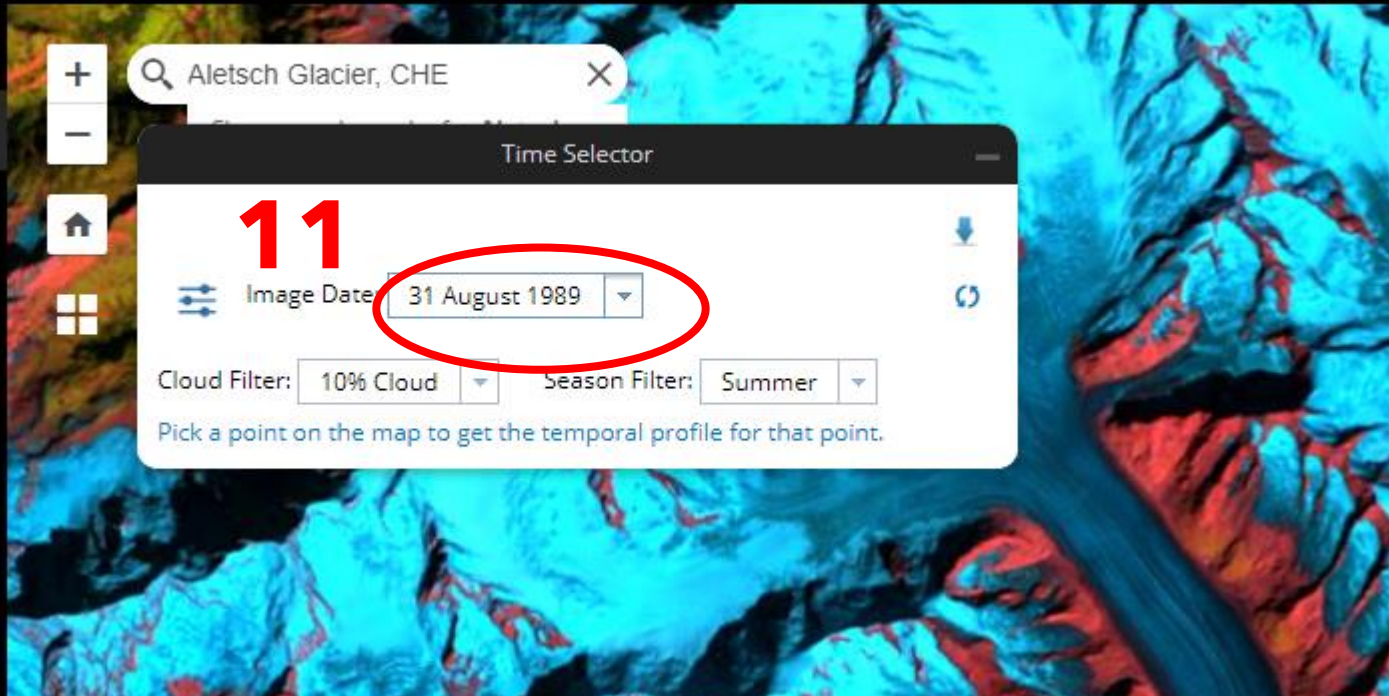
8



8

# Landsat Explorer Rendering: Stretch with Bands - 6,5,4 Imagery Date: 31 August 1989

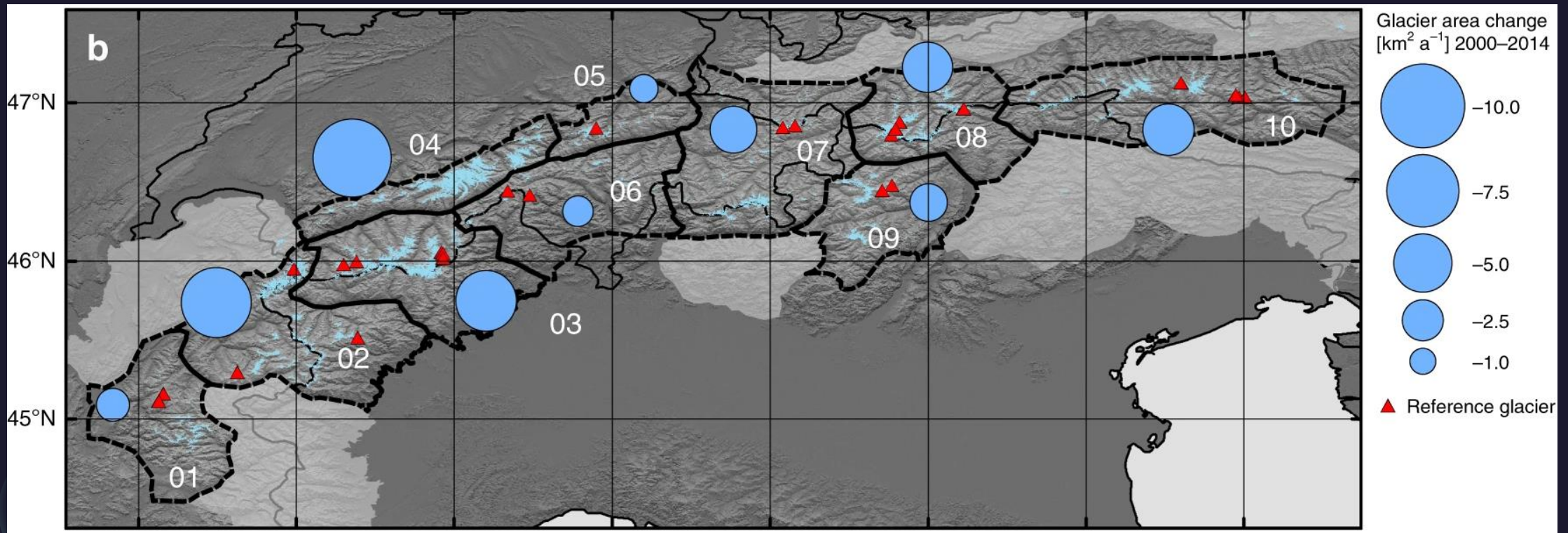
10



11

# Further reading:

Rapid glacier retreat and downwasting throughout the European Alps in the early 21<sup>st</sup> century. *Nat Commun* 11, 3209 (2020)



<https://www.nature.com/articles/s41467-020-16818-0>





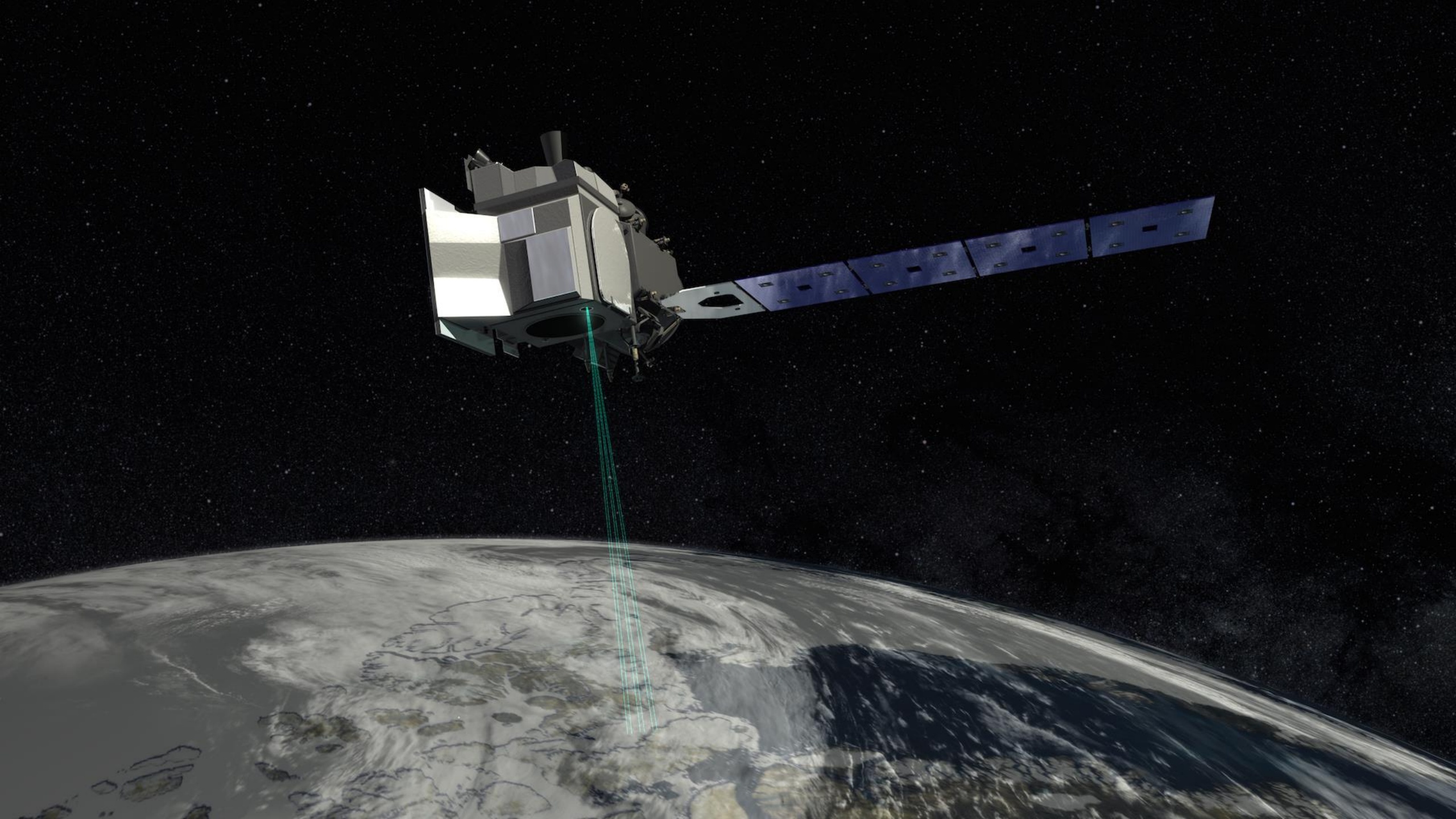
# **Measuring the height of a changing planet, one laser pulse at a time**

NASA's Ice, Cloud and land Elevation Satellite-2 -  
ICESat-2,

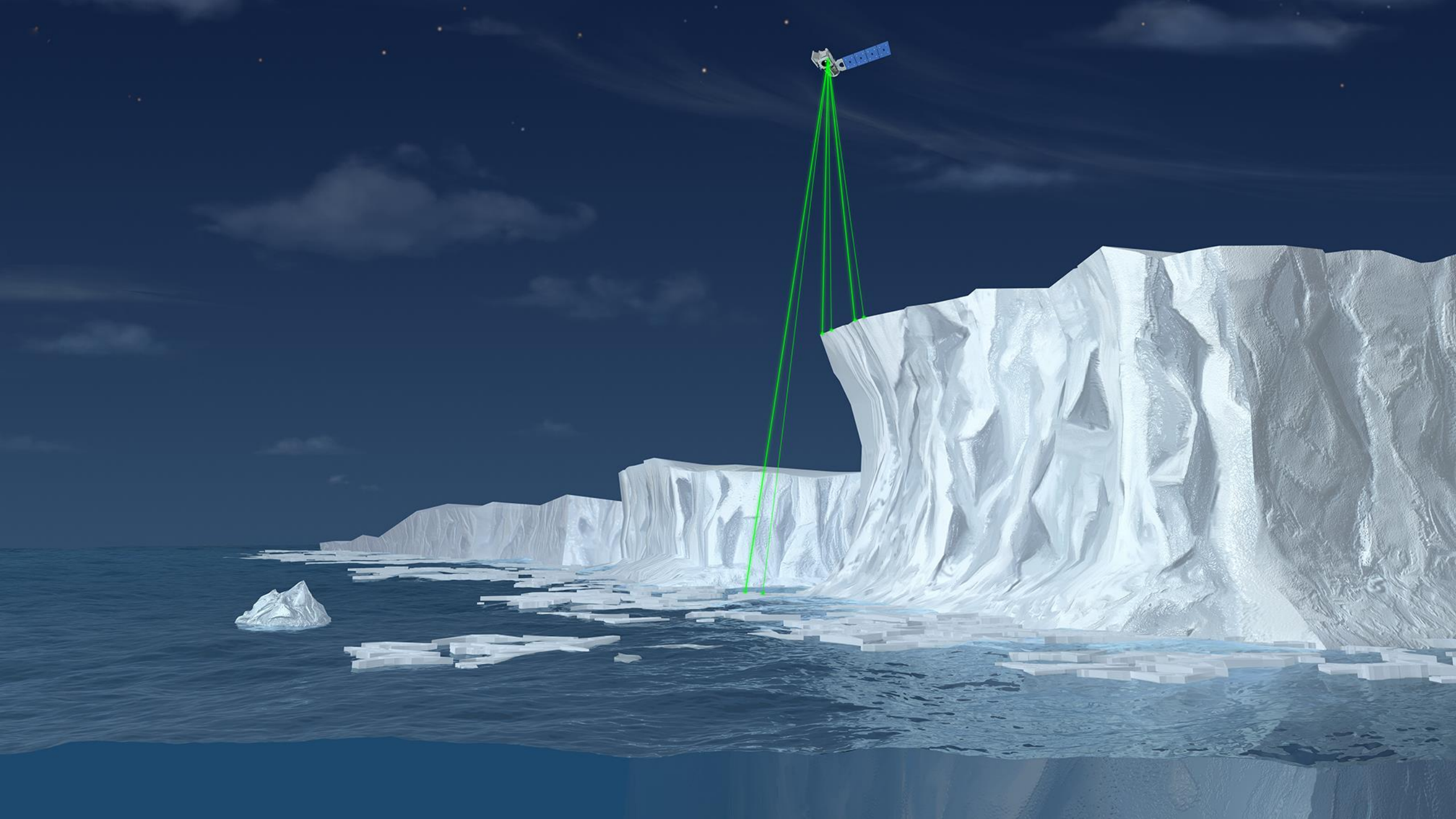
launched September 2018

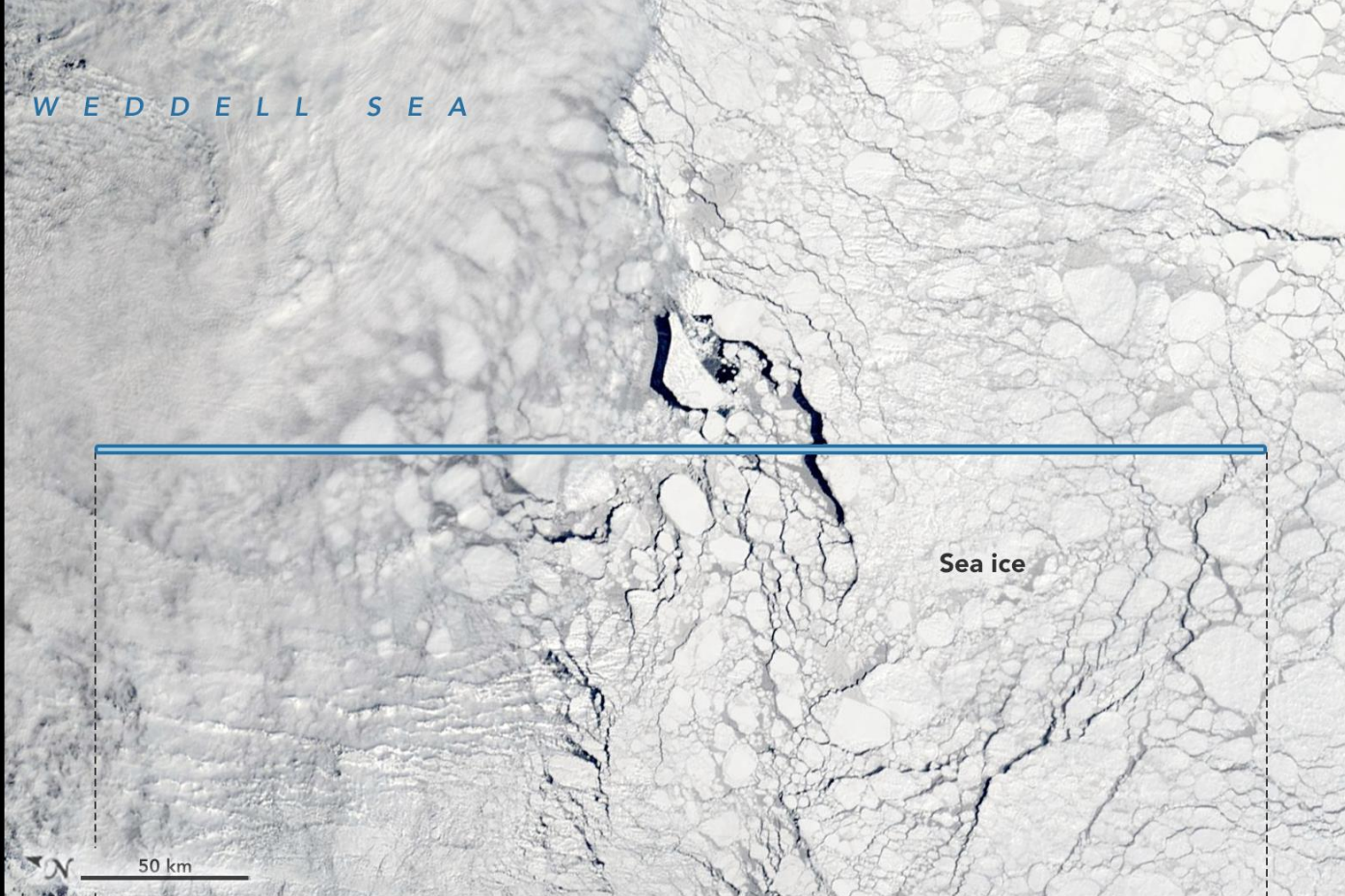
<https://svs.gsfc.nasa.gov/13124>



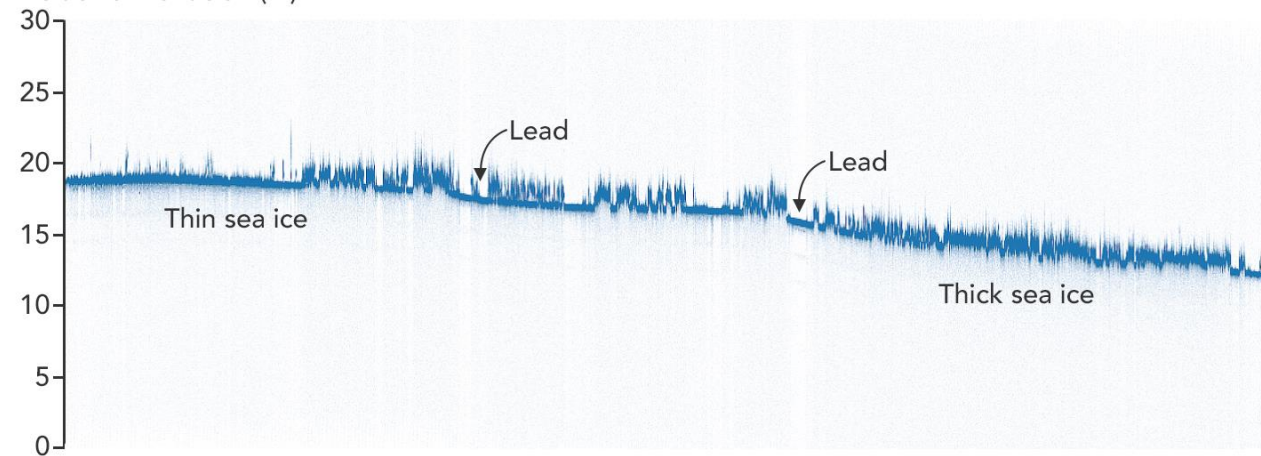








Relative Elevation (m)





3 m



22.4 m  
above sea level

21.8 m  
above sea level

812.8 m  
above sea level



Sep 13, 2017







# Earth Observation is awesome!

## **Survey large and inaccessible areas**

Does not disturb people or the environment

Produces reliable and objective datasets

Produces repeat-coverage and historic records

**Provides information beyond what we can see with our eyes**



# Learn more about EO:

Earth Resources Observation and Science (EROS) Center

'Eyes on Earth' podcast

- [https://www.usgs.gov/centers/eros/science/eyes-earth?qt-science\\_center\\_objects=0#](https://www.usgs.gov/centers/eros/science/eyes-earth?qt-science_center_objects=0#)

ESA 'Observing the Earth' news stories

- [http://www.esa.int/Applications/Observing\\_the\\_Earth](http://www.esa.int/Applications/Observing_the_Earth)