Earth Observation from Space
A tool to combat climate change

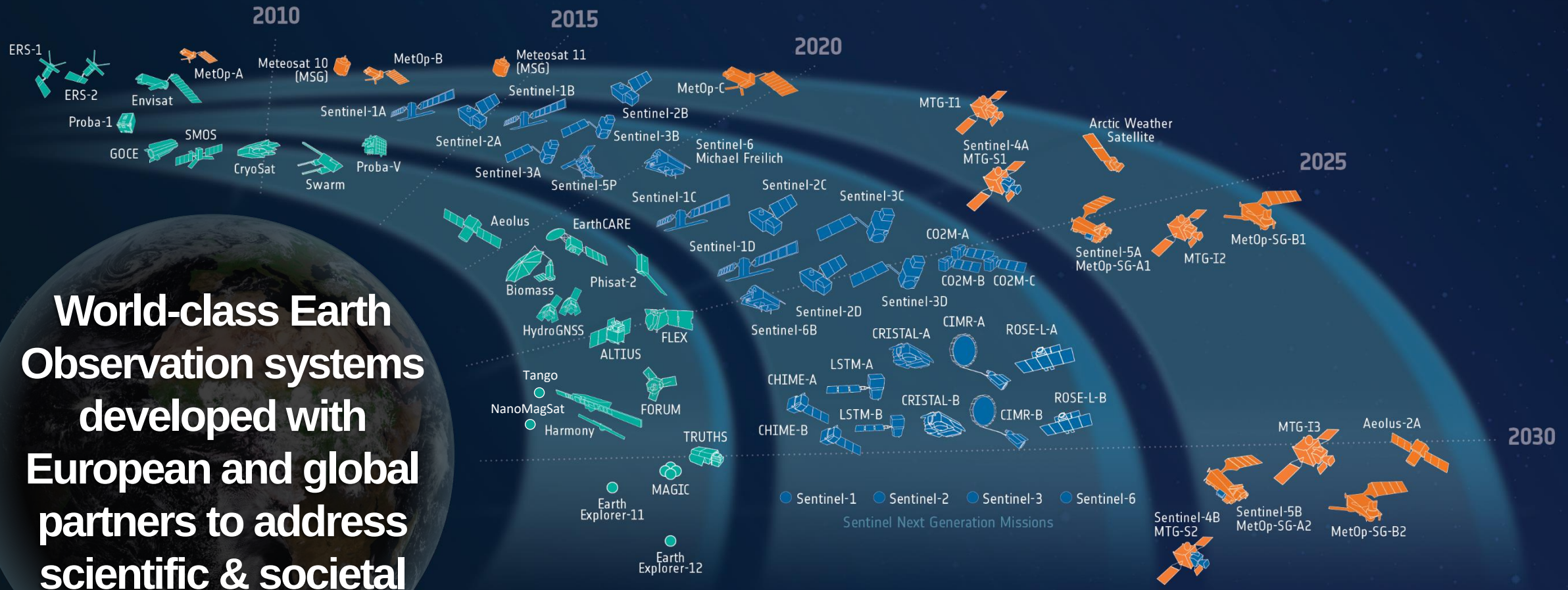
Need for an urgent and collective response…

Science is the bedrock for building sustainable solutions…

*The unique set of **grand challenges** that humankind is facing require more than ever that scientists advance their understanding of the planet, its processes and its interactions with human activities and translate that knowledge into novel solutions for society.*

ESA's Earth Observation Missions

Satellites: Heritage **08 /** Operational **16 /** Developing **40 /** Preparing **22 /** Total **86**



World-class Earth Observation systems developed with European and global partners to address scientific & societal challenges

Science esa | Copernicus European Union | Meteorology EUMETSAT

Next Earth Explorer Mission

cryosat
ICE

goce
GRAVITY FIELD

smos
WATER

swarm
MAGNETIC FIELD

aeolus
WIND

earthcare
CLOUD AND AEROSOL

biomass
FOREST CARBON

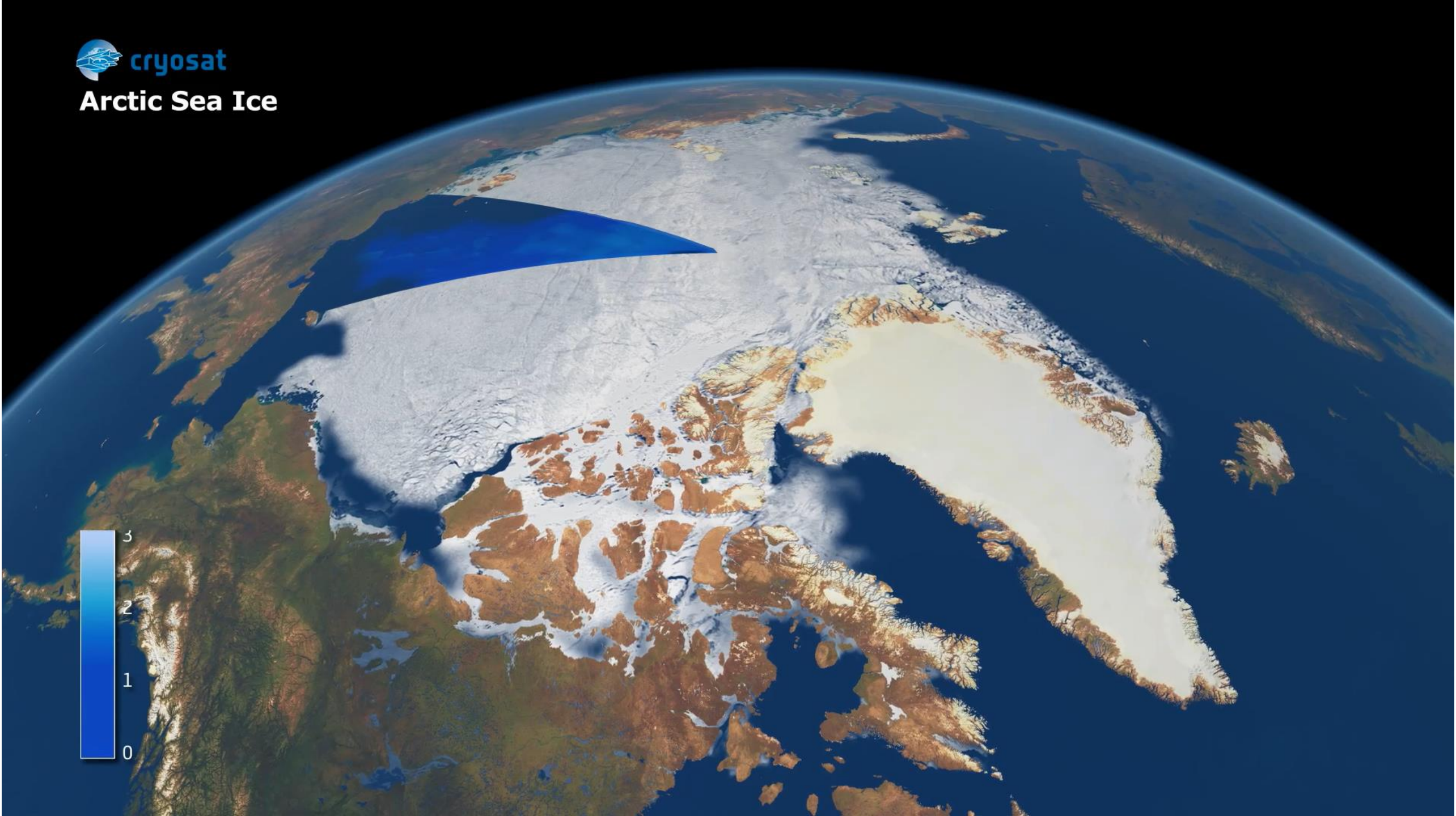
flex
PHOTOSYNTHESIS

forum
THERMAL RADIATION

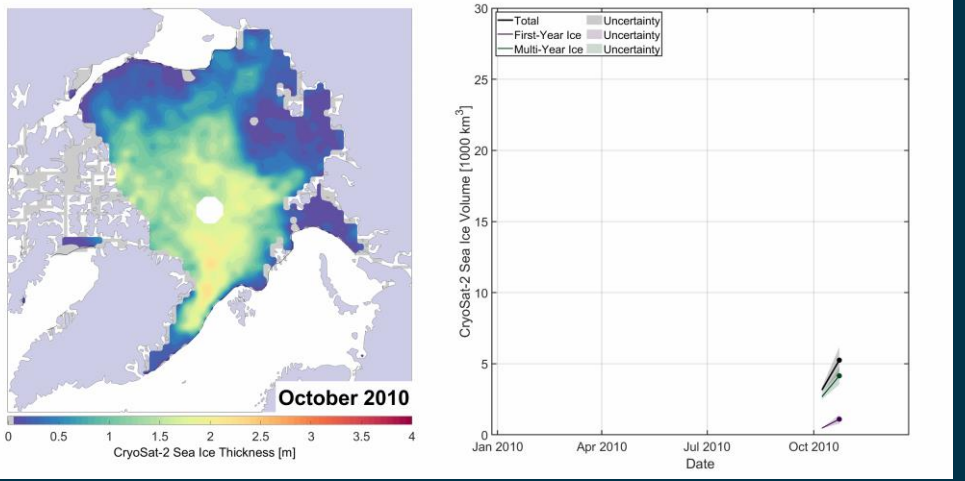
harmony
SURFACE DYNAMICS

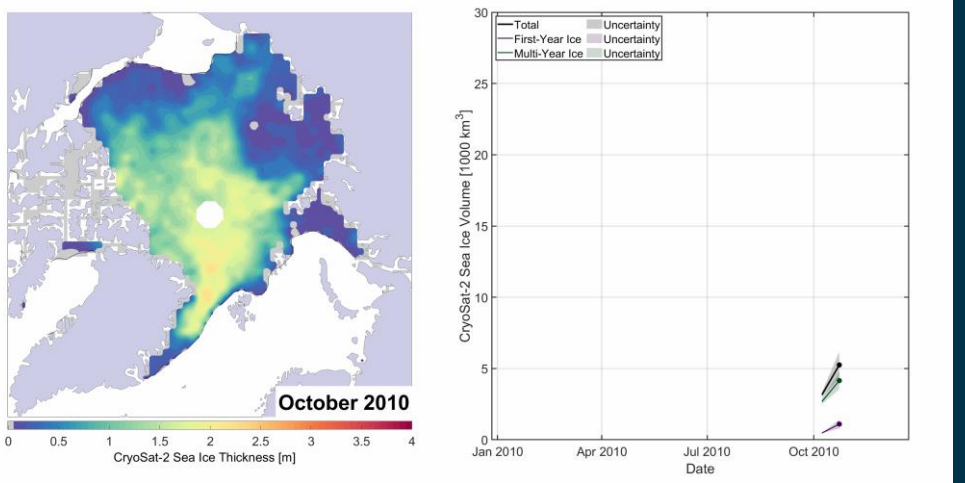
EE11

EE12

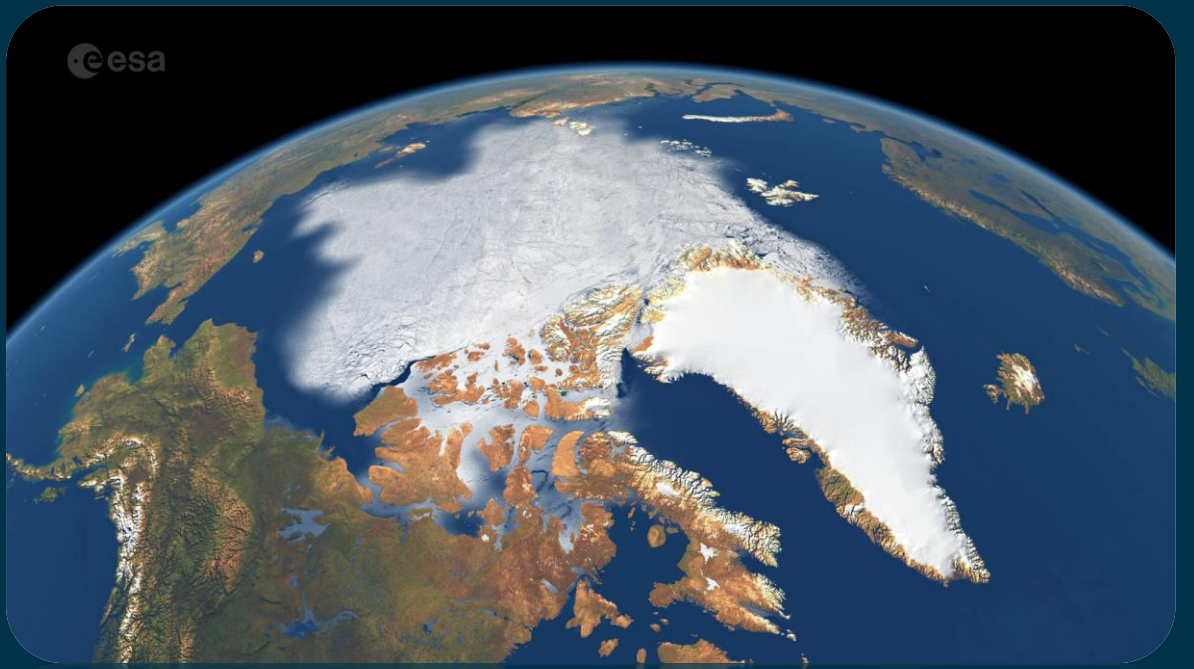

cryosat
Arctic Sea Ice
3
2
1
0

First summer Arctic sea-ice thickness from Cryosat

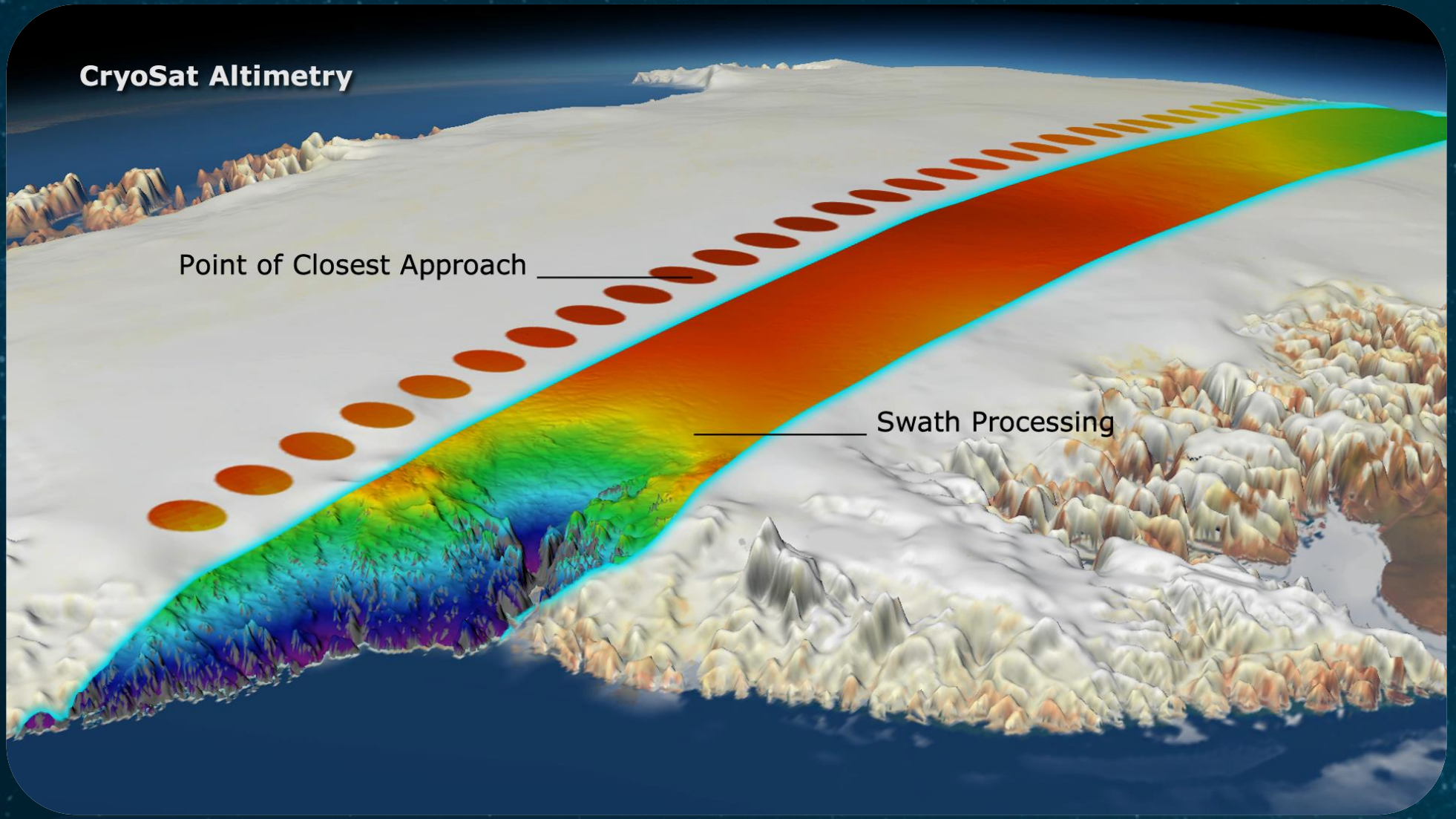




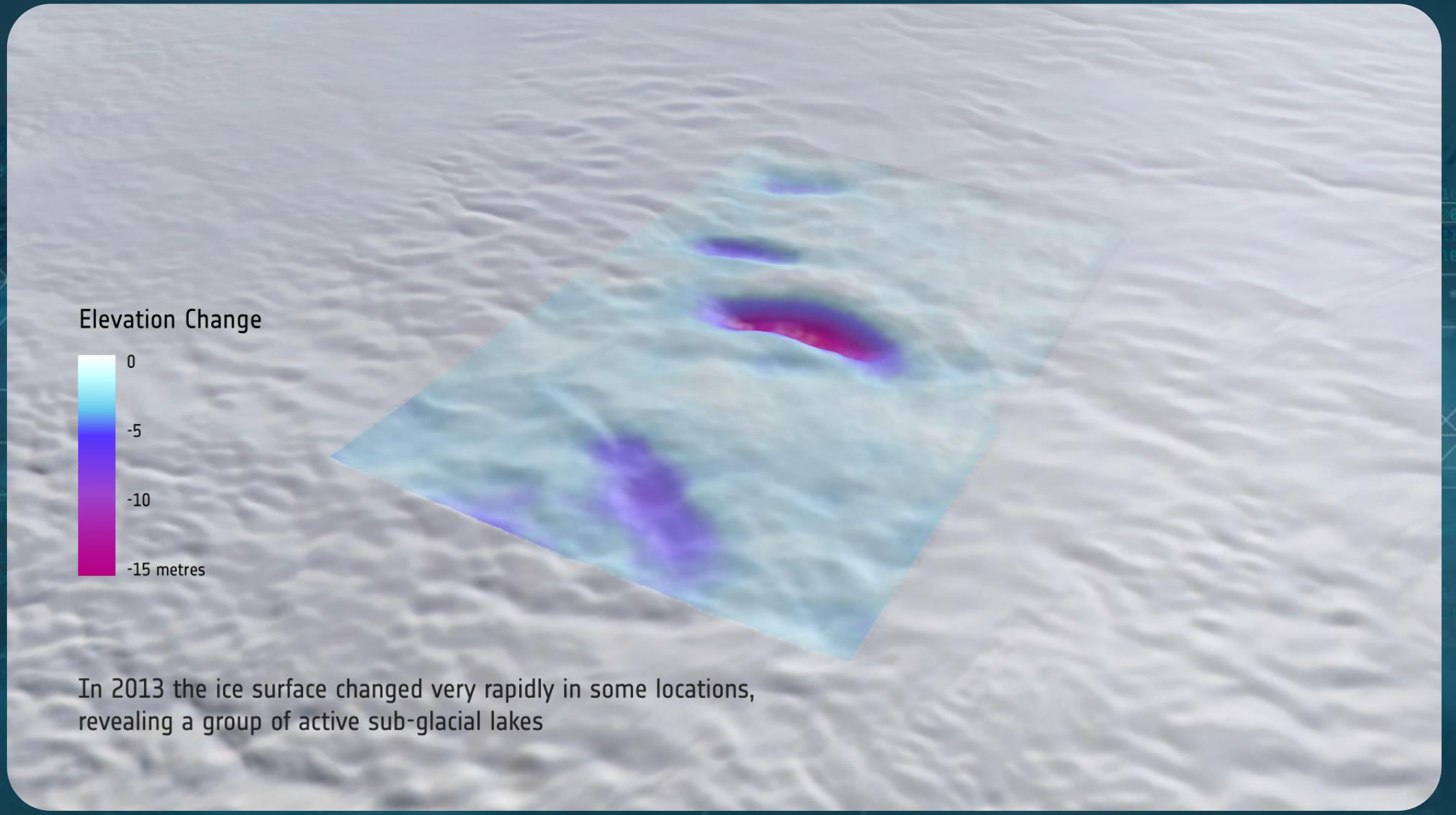
Landy, J.C., Dawson, G.J., Tsamados, M. et al.
A year-round satellite sea-ice thickness record from CryoSat-2. *Nature (2022).*



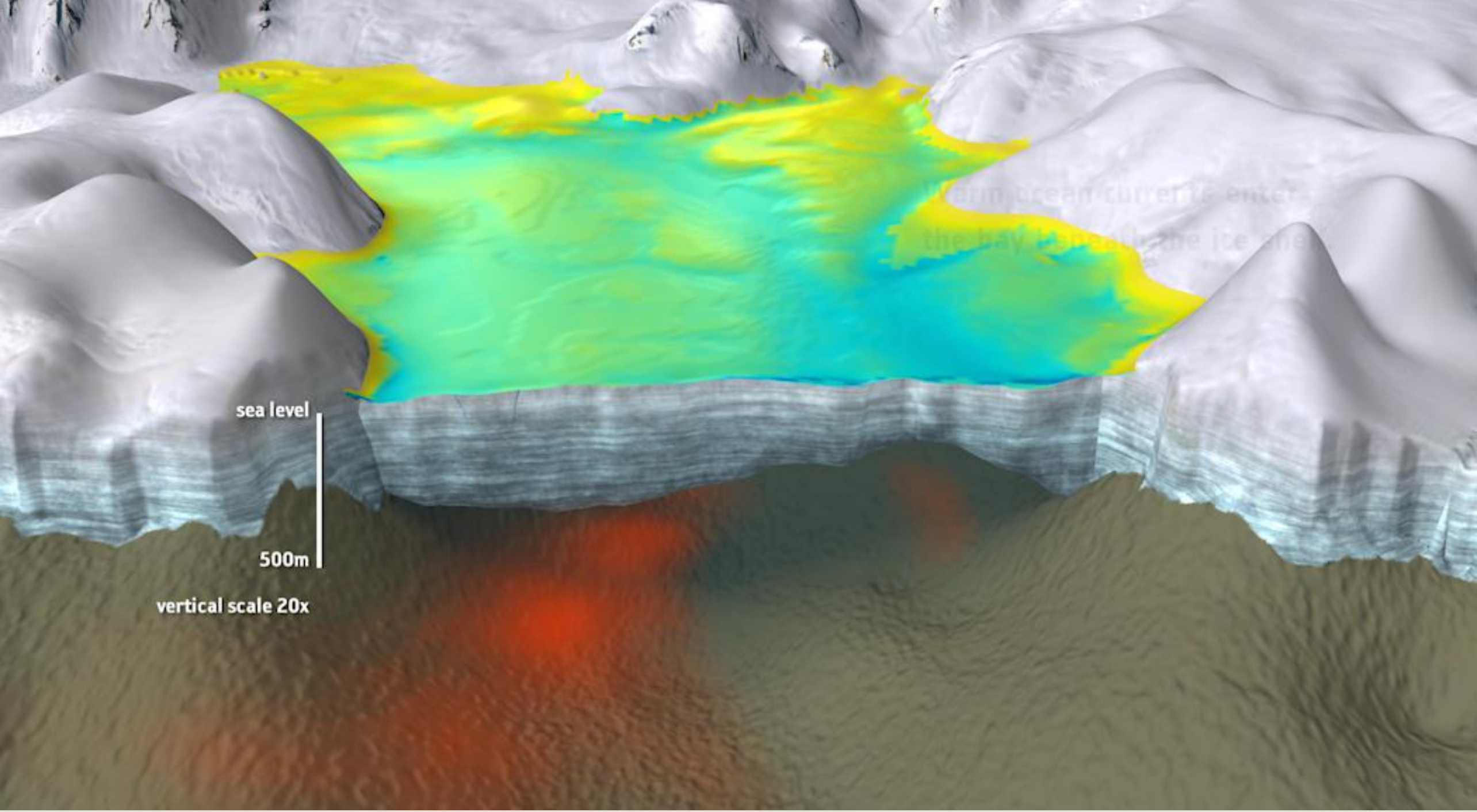
CRYOSAT OPEN NEW OPPORTUNITIES



Subglacial lakes (4DAntarctica team)



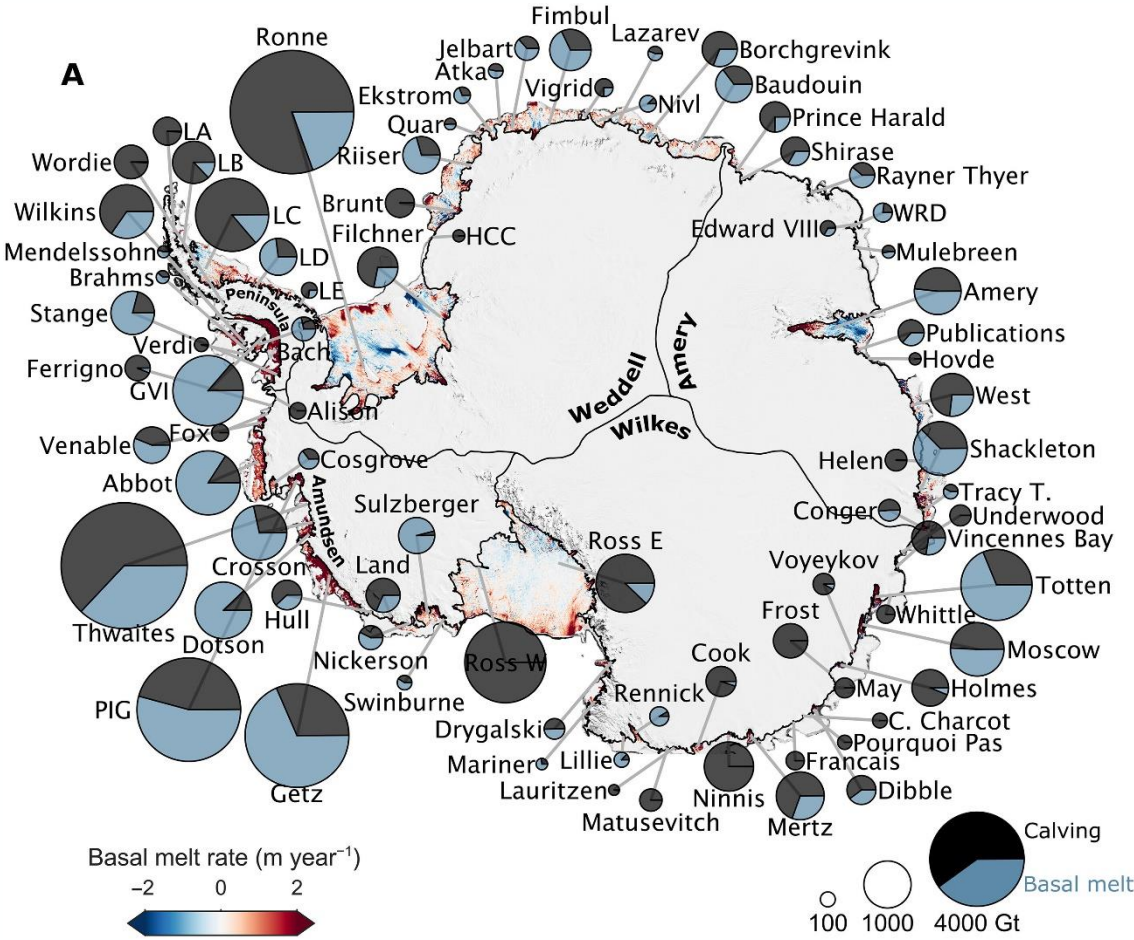
In 2013 the ice surface changed very rapidly in some locations, revealing a group of active sub-glacial lakes


sea level
500m
vertical scale 20x

Advances in Ice Shelves Pan-Antarctic Assessment
Polar+ IceShelves team

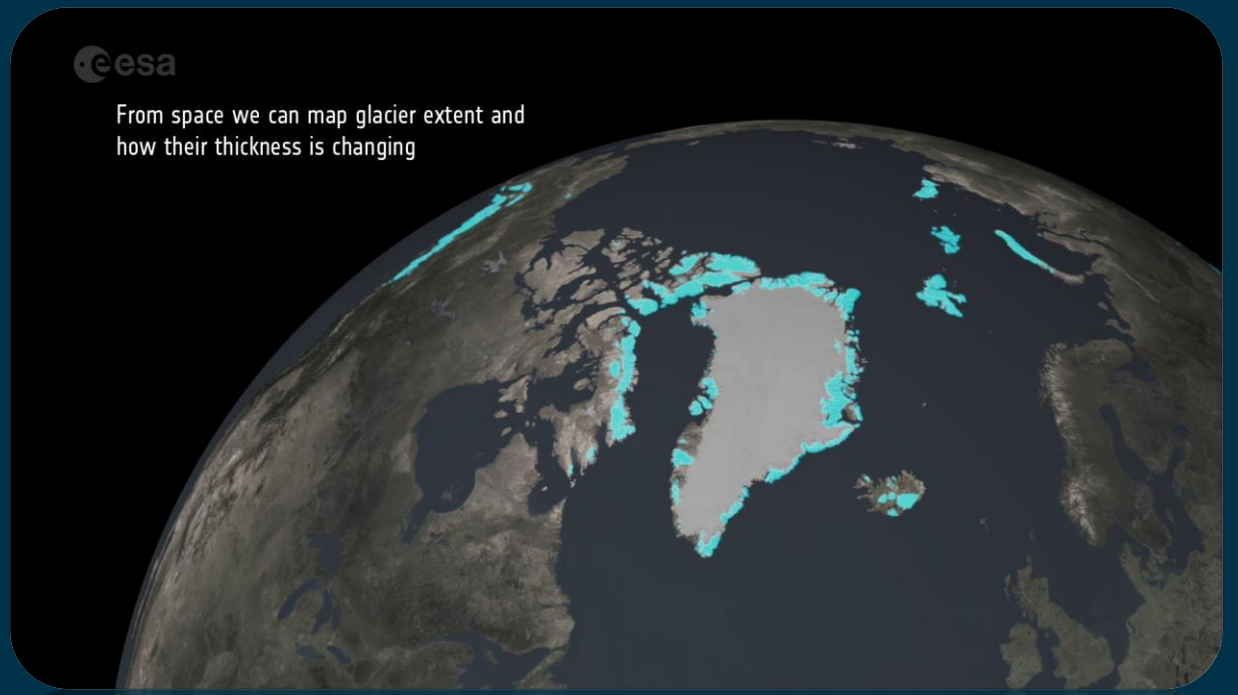
Davison et al. Annual mass budget of Antarctic ice shelves from 1997 to 2021. *Science Advances* (2023)

Out of 162 ice shelves, 71 lost mass, 29 gained mass, and 62 did not change mass significantly.



Davison et al., (2023)

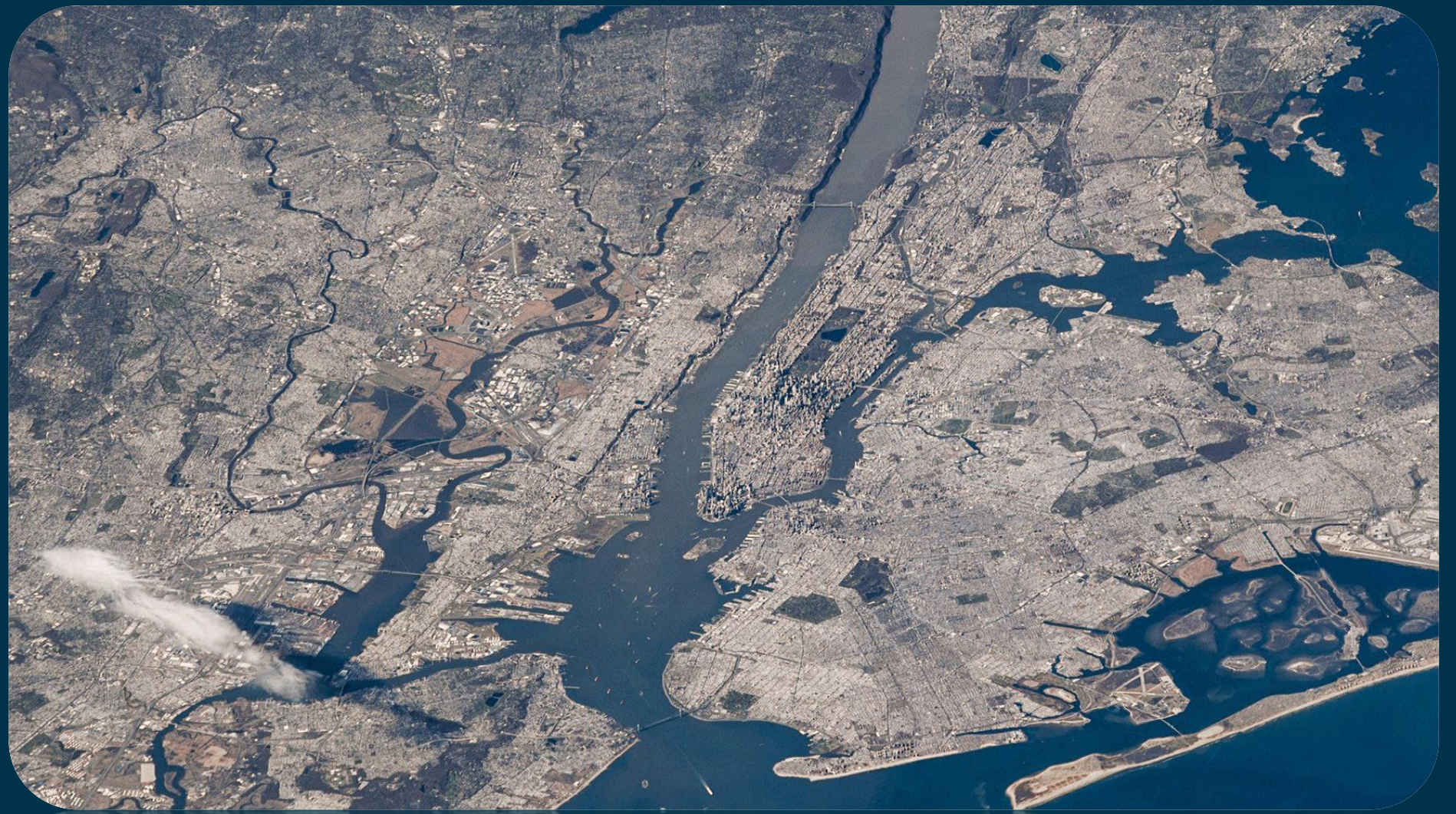
First global assessment of glaciers mass balance and its drivers from Cryosat



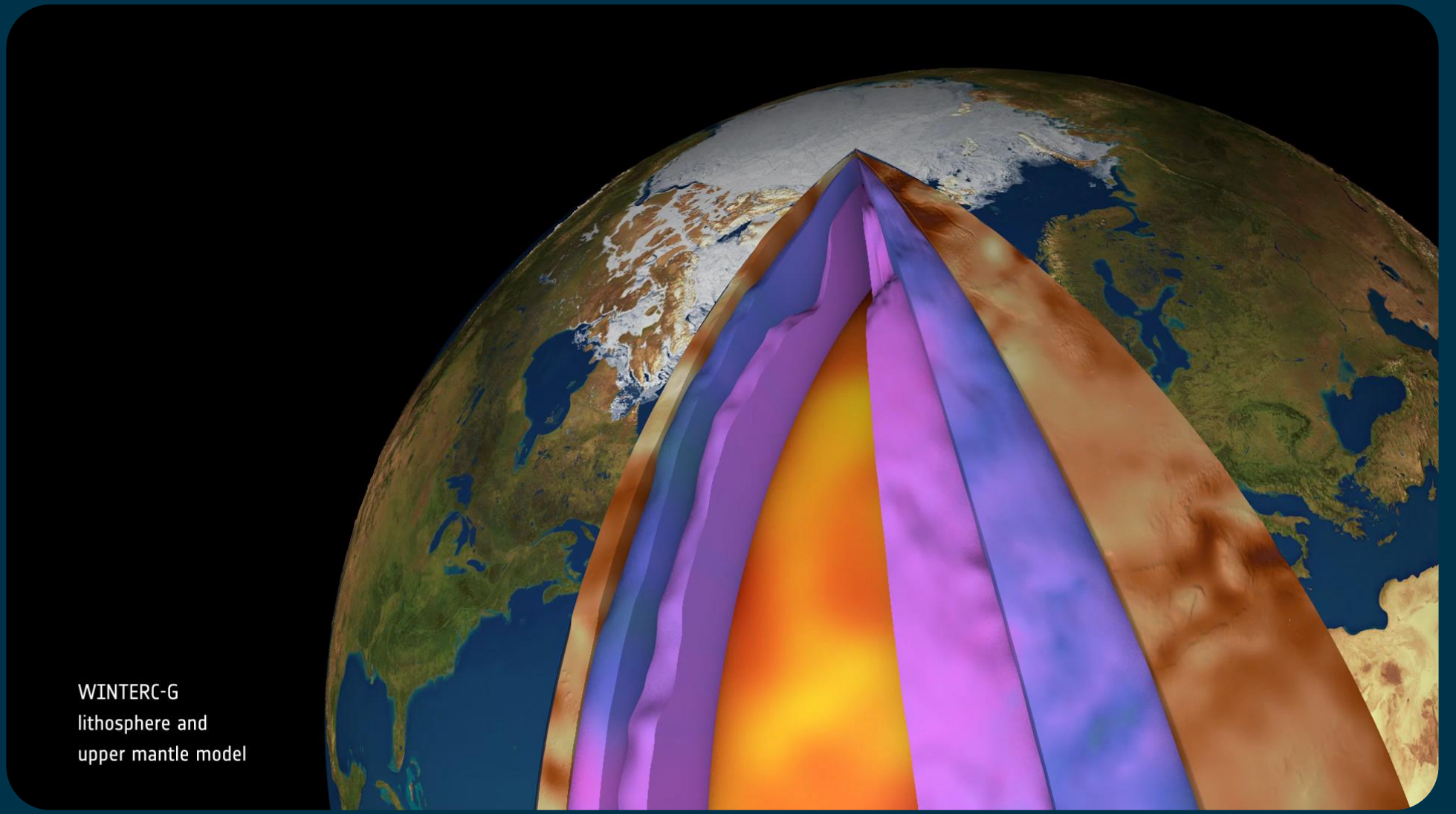
Jakob, L., & Gourmelen, N. (2023).Glacier mass loss between 2010 and2020 dominated by atmospheric forcing. Geophysical Research Letters,50, e2023GL102954.

This study provides the first ever assessment of glacier mass loss globally from satellite radar altimetry, showing that glaciers have lost 2% of their volume between 2010 and2020. In addition, for the first time, the study gives a global picture of the drivers of this glacier ice loss. The findings indicate that globally nearly 90% of all the loss in ice is due to interaction with the atmosphere, and that the ocean drives 10% of the loss. However, in regions where the ocean is changing rapidly, such as the Barents and Kara Seas or around Antarctica, ocean interaction is responsible for the majority of the ice loss.

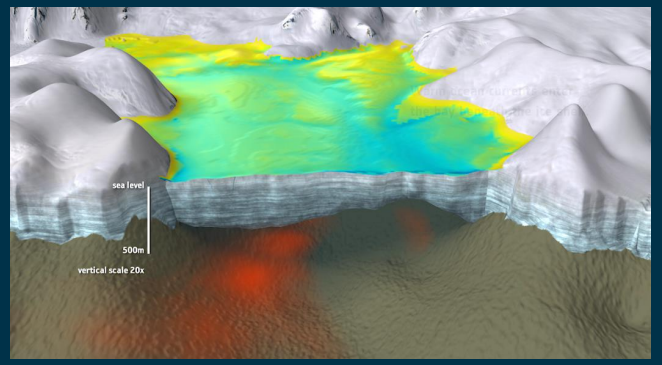
In overall…. Around 1 trillion tons per year…

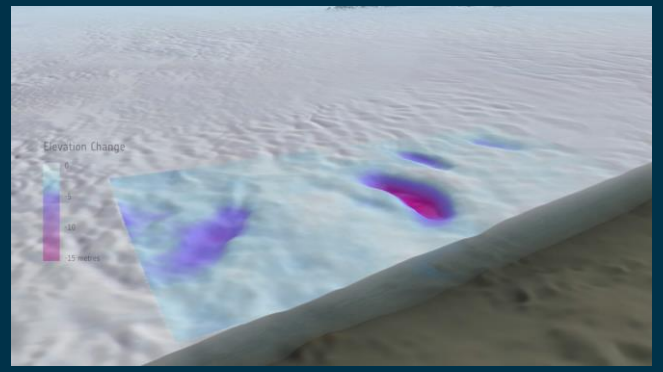


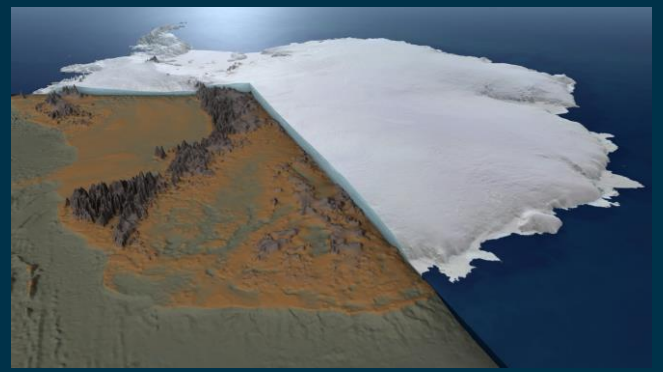
GOCE and SWARM sensing the Earth interior…



An example: An integrated approach in Polar sciences







Snow grain size

Snow Albedo

Snow melting

Supraglacial lakes

Surface elevation & elevation change

Glacier velocity

Calving Fronts

SST, OC, Sea state

Ocean salinity

Surface mass balance

Ice shelves dynamics

Snow on sea ice

Sea ice thickness

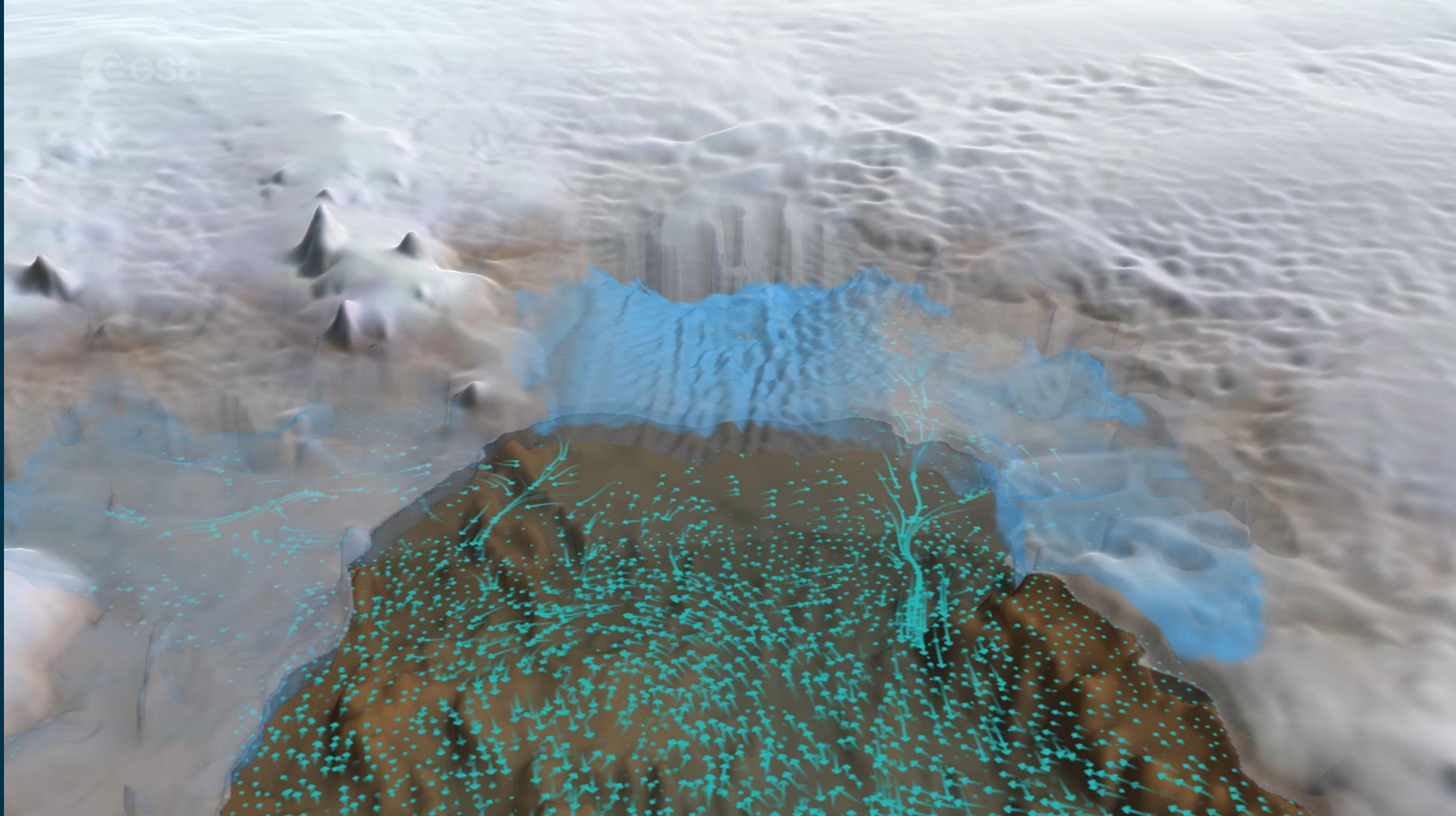
Ocean Currents

Ocean Bathymetry

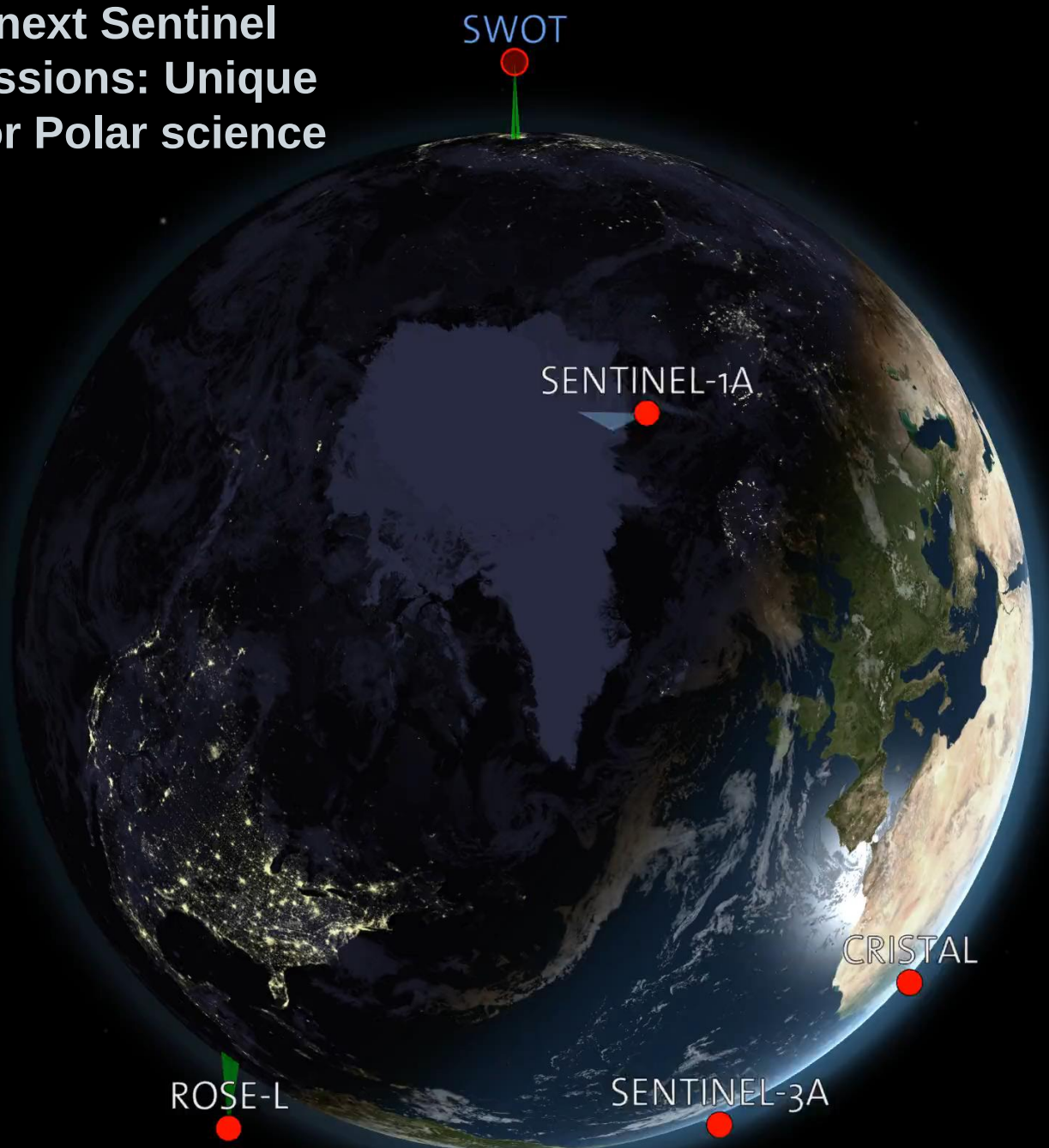
Ice sheets T profiles

GIA, heatflux

Subglacial water discharge



Preparing for next Sentinel Expansion missions: Unique opportunity for Polar science



esa

UTC 2021-01-03 11:32:05.353
Speed: 1000x

CIMR
Orbit Number: 10410
Time Since ANX: 5034.760
Lat: 60°S 49' 59"
Lng: 112°E 48' 48"
Alt: 844.423 km
Daylight

CRISTAL
Orbit Number: 5314
Time Since ANX: 3401.558
Lat: 25°S 10' 18"
Lng: 0°E 34' 34"
Alt: 748.961 km
Daylight

MetOp-SG-B
Orbit Number: 10408
Time Since ANX: 4597.867
Lat: 81°S 02' 56"
Lng: 135°W 22' 35"
Alt: 849.308 km
Daylight

ROSE-L
Orbit Number: 1601
Time Since ANX: 2925.978
Lat: 1°N 55' 54"
Lng: 82°W 45' 26"
Alt: 698.486 km
Daylight

SENTINEL-1A
Orbit Number: 35973
Time Since ANX: 1371.835
Lat: 79°N 36' 27"
Lng: 46°E 02' 02"
Alt: 708.115 km
Daylight

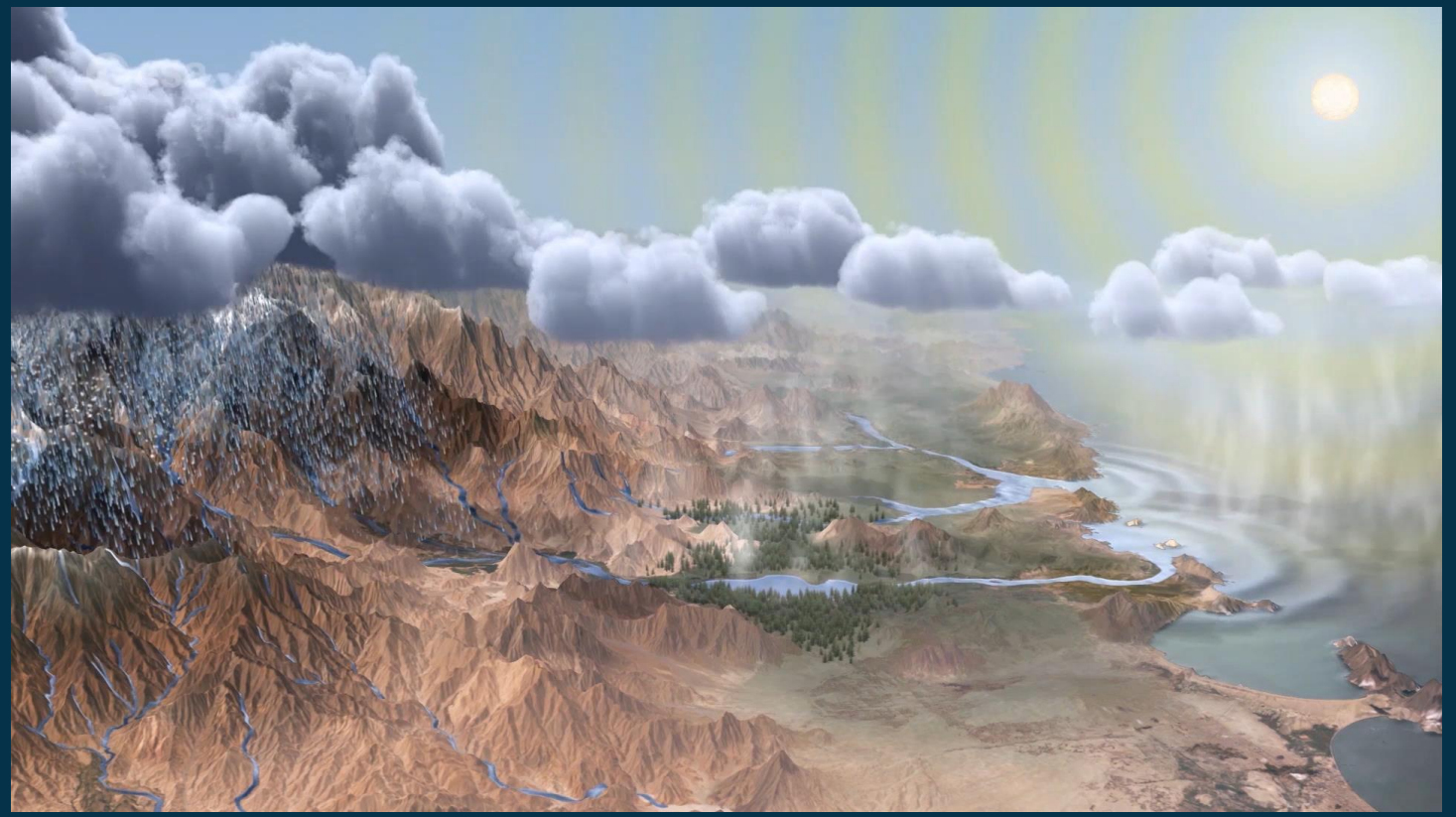
SENTINEL-1B
Orbit Number: 24989
Time Since ANX: 4383.121
Lat: 81°S 08' 38"
Lng: 149°W 34' 26"
Alt: 724.914 km
Daylight

SENTINEL-3A
Orbit Number: 25420
Time Since ANX: 3534.148
Lat: 29°S 59' 46"
Lng: 27°W 59' 54"
Alt: 814.284 km
Daylight

SENTINEL-3B
Orbit Number: 14026
Time Since ANX: 5902.512
Lat: 9°S 15' 30"
Lng: 158°E 22' 33"
Alt: 807.385 km
Eclipse

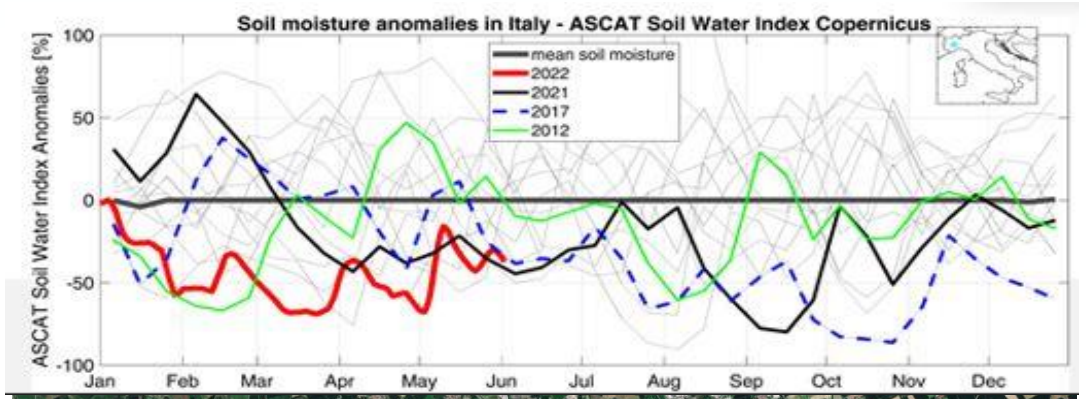
SWOT
Orbit Number: 5147
Time Since ANX: 2404.437
Lat: 38°N 37' 41"
Lng: 127°E 47' 46"
Alt: 897.675 km

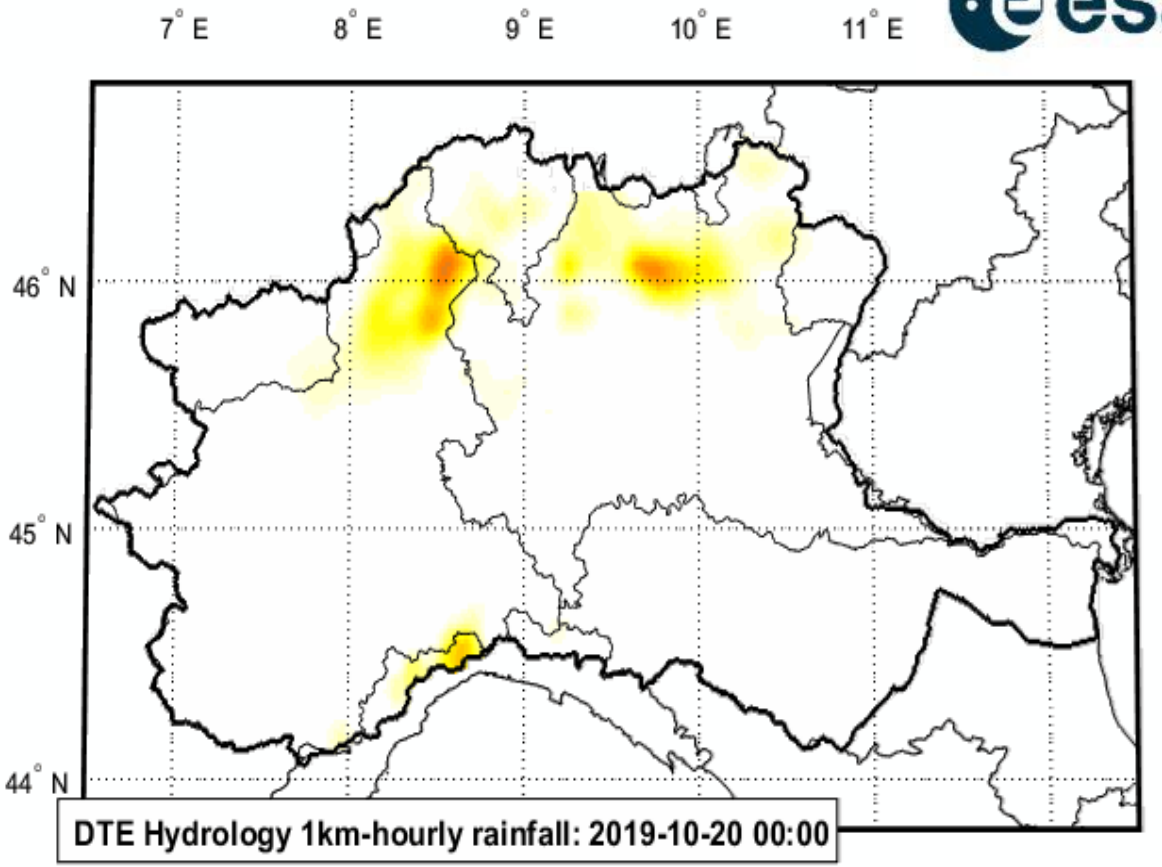
The Mediterranean: A Hot-Spot for Climate Change



- The water cycle in the Mediterranean is experience changes due to human intervention and climate change
- In the next years more frequent and intense extremes are expected to occur: e.g., draughts, floods, heatwaves, storms…
- It is critical we develop the capacity to better understand and assess the risk and impacts of such events

Advancing EO for Hydrology






esa

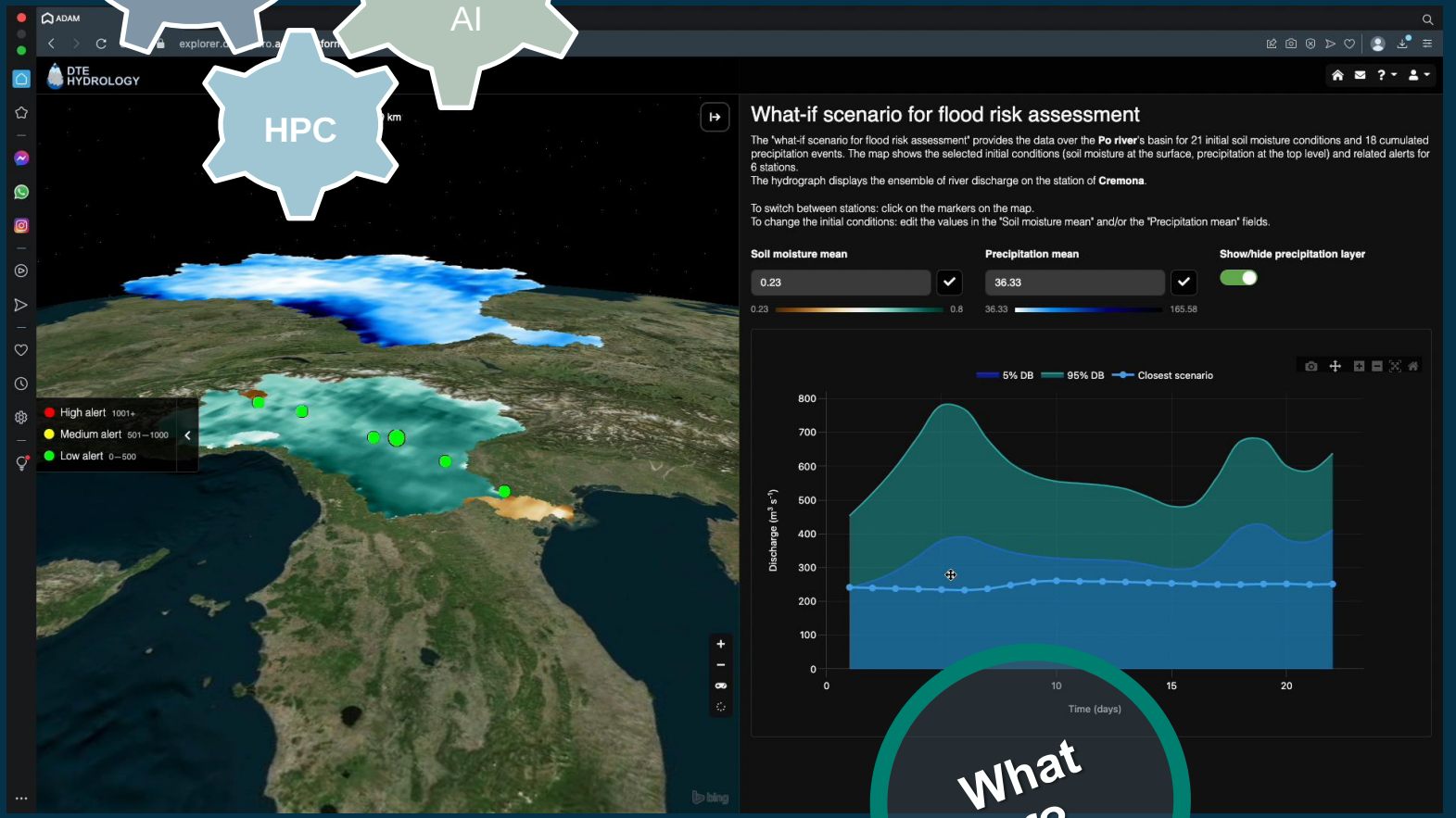
An Example: Digital Twin Hydrology

4D Data Reconstruction

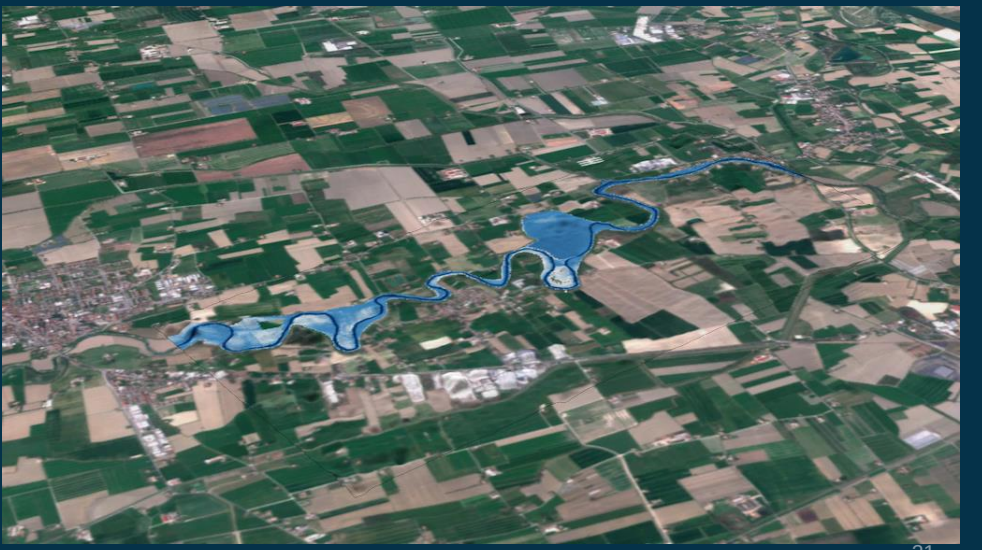
Models AI

HPC

Past, Present and Future



What if?



What-if scenario based on an historical reconstruction of the hydrological cycle at 1Km resolution Hourly for the last 7 years.

ESA’s Digital Twins

ESA delivers actionable climate and environmental information, as well as green solutions for society, while fostering disruptive innovations and business ideas.

- Support climate and environmental policies from local to international level
- Build strategic partnerships for space applications
- Enable understanding of impacts of policy actions using digital twin models of Earth’s systems