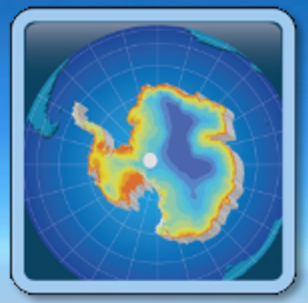
ESA CCI+ Phase 2 – Cryosphere

sea ice cci

greenland ice sheet cci



antarctic ice sheet cci

glaciers cci

snow cci

permafrost cci

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Thomas Lavergne, Frank Paul

Colocation Meeting - 26 October 2022

Science questions in Cryosphere

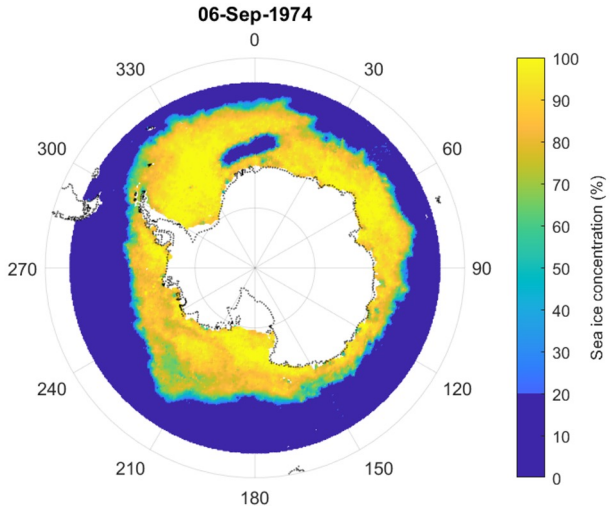
Earth's cryosphere is the most responsive element of the climate system and has most of the climate tipping points identified so far. But it is still the most uncertain element of sea level projections and remains as one of the most poorly represented in climate models.

Science questions include

- How can we optimize cryosphere ECV products for spurring the diagnostic and predictive skills of climate models and reduce the uncertainty in sea level projections?

Sea Ice

Continuation of Sea Ice Concentration (SIC) & Thickness (SI



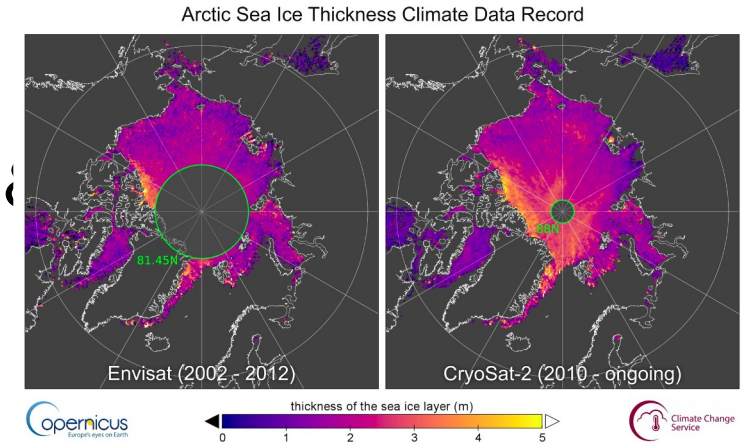
SIC from precursor mission ESMR.

For SIC, we focus on the challenges of the summer melt period:

- Develop a melt-onset / freeze-up CDR;
- Validate SIC against optical-based melt-pond fraction produc
- We also improve our early-70s SIC (1972-77) dataset, and conduct a thorough intercomparison against 10 other CDRs.

For SIT, three lines of research:

- Better consistency with the early altimeter missions ERS-1&
- Improve snow cover information (using modelling).
- Develop a drift-aware SIT dataset.



SIT from Envisat and CryoSat-2.

Use Cases:

Sea Ice R&D transfers directly to OSI SAF, C3S & CMEMS.

Greenland ice sheet

Science

- Response of the Greenland ice sheet to climate forcing
- Sea level contribution of the Greenland ice sheet
- High temporal change detection
- Freshwater storage in supraglacial lakes

R&D Missions

- Sentinel-3
- ICESat-2
- GRACE-FO

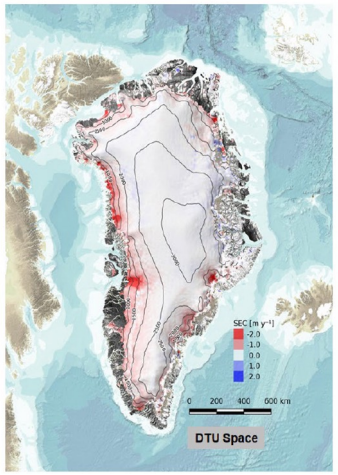
R&D Products

- GRACE mass balance with improved GIA
- Height changes of higher temporal resolution
- Ice discharge based on new height change product
- Multi-technique ice velocity maps

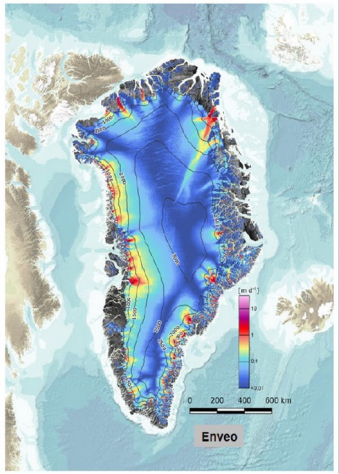
Case studies

- Focus on demonstrating the value of the developed algorithms for use in climate research/climate modelling, carried out in close collaboration with the CRG.

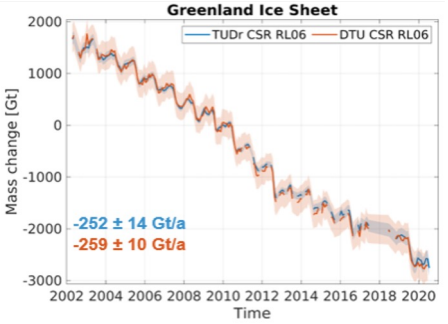
Elevation change



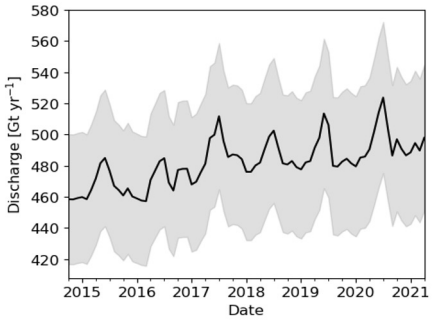
Ice velocity



Gravimetric mass balance



Mass flux ice discharge



Antarctic ice sheet

antarctic ice sheet cci

Science

- Response of the Antarctic ice sheet to climate forcing
- Sea level contribution of the Antarctic ice sheet
- Detecting and quantifying ice dynamical imbalance
- Freshwater input to the Southern Ocean

R&D Missions

- Sentinel-3
- ICESat-2
- SAOCOM
- GRACE-FO

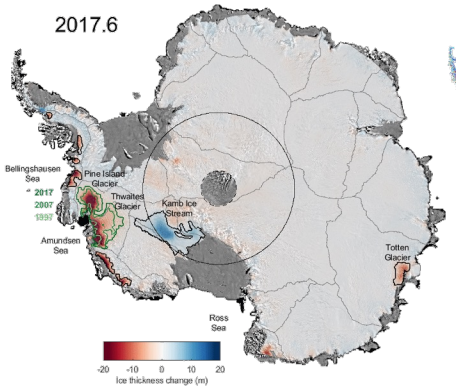
R&D Products

- Ice velocity change
- Grounding line change
- Annual DEM's
- Calving Front Location
- Mass flux & ice discharge

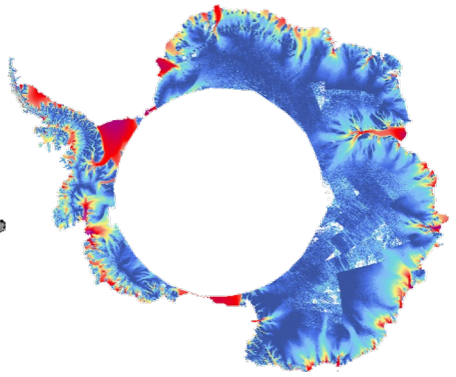
Case studies

- Quantifying ice dynamical imbalance of the Bellingshausen Sea Sector
- A spatially resolved reconciled ice sheet mass balance

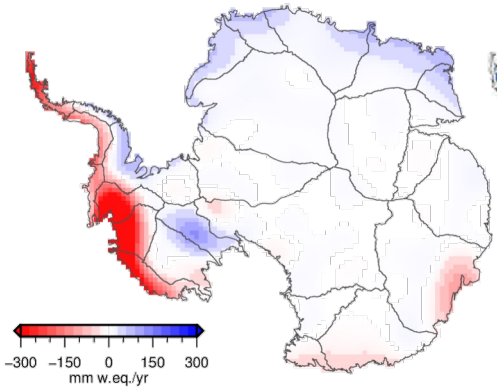
Elevation change



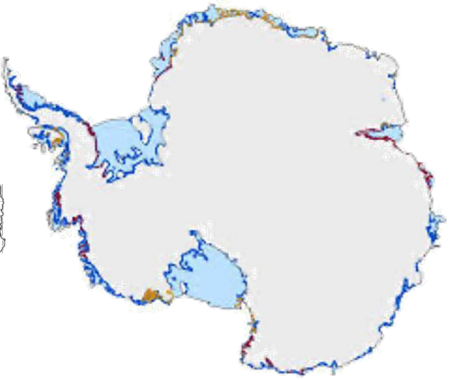
Ice velocity



Mass balance



Grounding line



Glaciers

Main research question

Where, how and why do glaciers surge?

R&D topics

- Detect/characterize glacier surges globally
- Create/analyze time series of snow cover & velocity evolution
- Extending glacier change CDRs in time & space (Keyhole)

Products

- Inventory and early detection of surging glaciers (Sentinel-1)
- Extended time series of glacier length/area changes since 1960s
- Elevation changes from e.g. Sentinel-3, ICESat-2 & Cryosat-2
- Glacier flow velocities from SAOCOM/ICEYE, S-1/2, L8/9, Planet ...

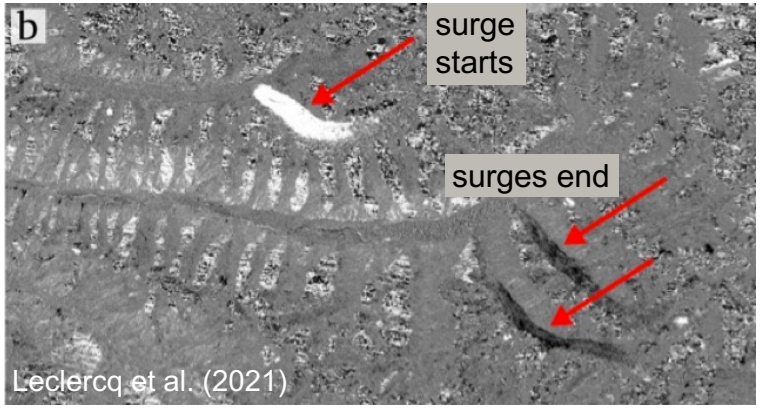
The use cases are located in four regions

- Ongoing: surging glaciers in Svalbard and the Karakoram region
- Planned: globally (surge inventory) & Greenland's local glaciers (dh/dt)

Link to IPCC AR6 WG I:
'Secondary processes such as ... surges or glacier collapse ... are not represented in global glacier models, resulting in both underestimated and overestimated sensitivity to warming that is currently not possible to quantify.'

Sentinel-1 maximum backscatter winter 2018

Normalized difference in backscatter 2018/19



Snow

Main Science Question addressed in CCI+ Phase-2

Change of global snow cover and snow mass as an indicator of climate change and impact on water resources.

R&D topics

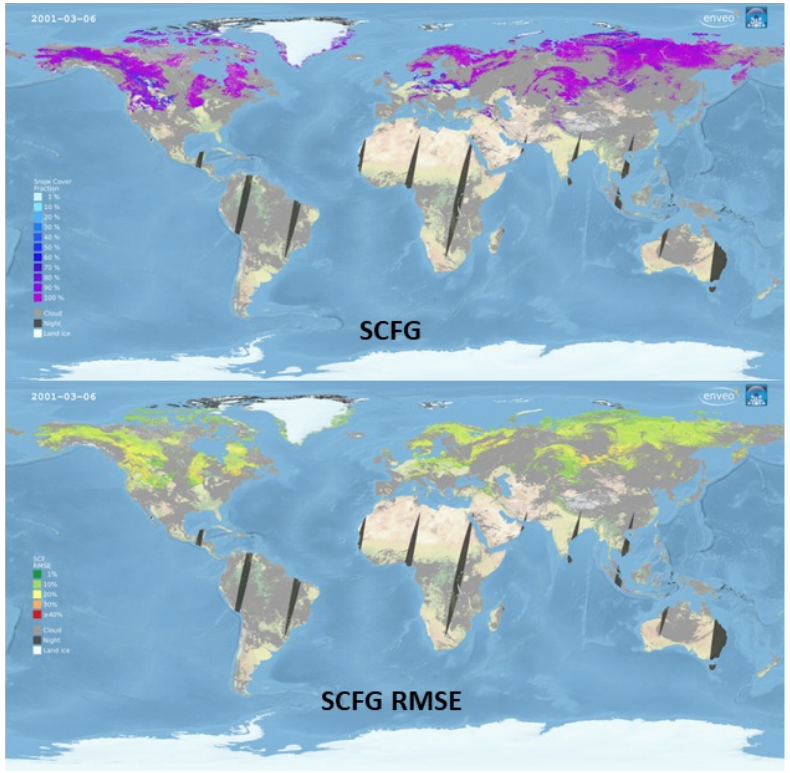
Improving snow retrieval algorithms and associated uncertainty including cloud screening; melt extent in mountains from SAR; snow mass in mountains;

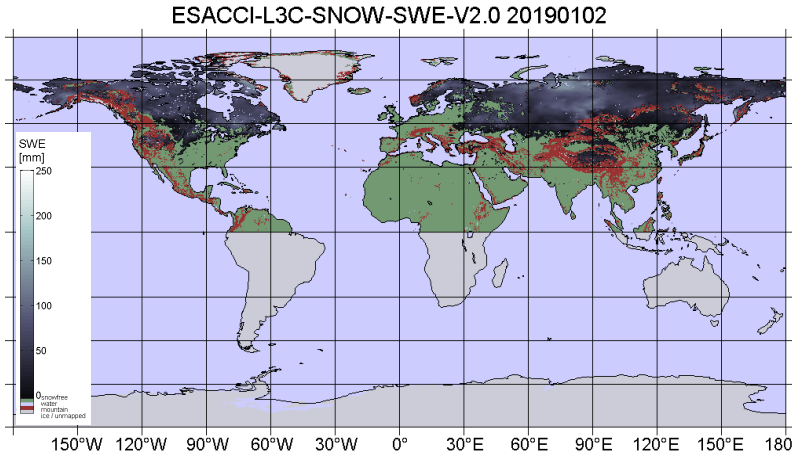
Products

- Snow Cover Fraction products, separating in forests snow viewable on the canopy and snow on ground,
- Snow Water Equivalent products
- Snow CRDPs v3.0 to be released in July 2023

Use Cases

- Trends of snow extent and snow mass
- Integrating *snow* products in hydrological & climatological models
- Impact of assimilating snow product into ECMWF reanalysis model





Permafrost

ECV specific Main Science Question:

Trends, uncertainties, consistency of lowland permafrost & rock glaciers

R&D topics

LST / snow_cci use, landcover for uncertainties, extension rock glacier inventory

Products to be generated in CCI+ Phase 2:

Extension to 2023 at end (next update Q3 2023)

Use Cases (Planned):

Permafrost degradation/ AMPAC; climate modelling;
Level 5 product generation with respect to stakeholder needs