« Improved Sea-Ice Thickness records from satellite altimeters : Towards new sea ice volume estimates and application to climate change studies »

Fellowshing starting date : 01/11/2020

Florent Garnier

Under the supervision of
Dr Sara Fleury

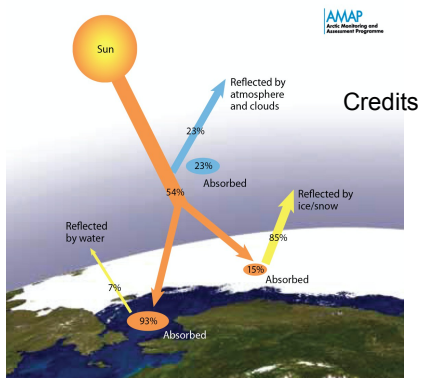
LIVING PLANET FELLOWSHIP

CRYOSPHERE

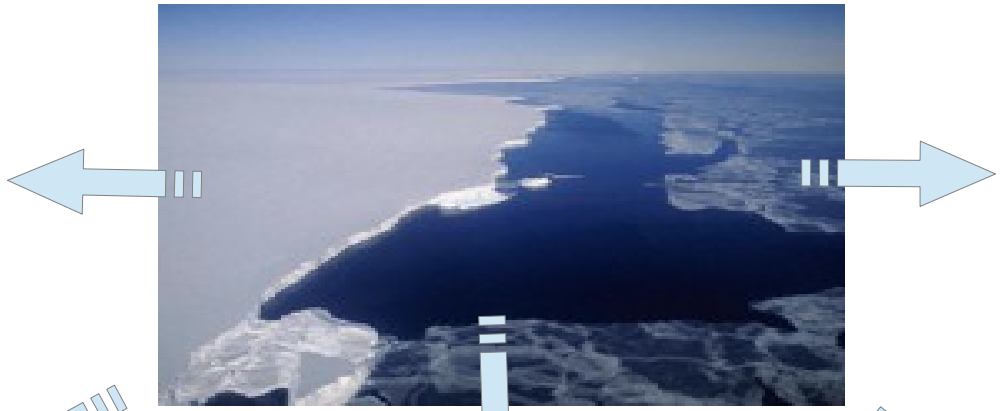
1) Why observing Sea Ice

Sea ice is a key component in climatic processes

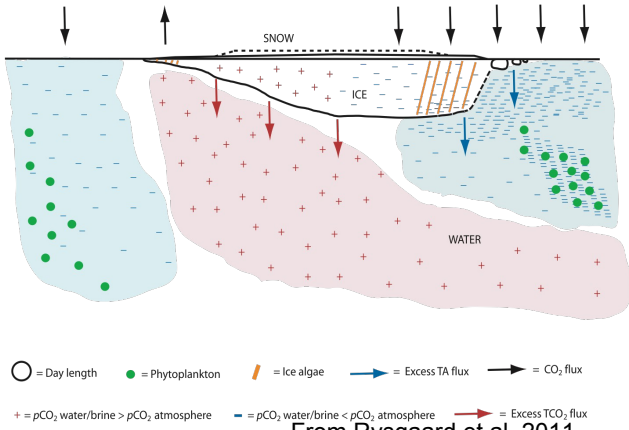
→ Albedo



Credits : AMAP

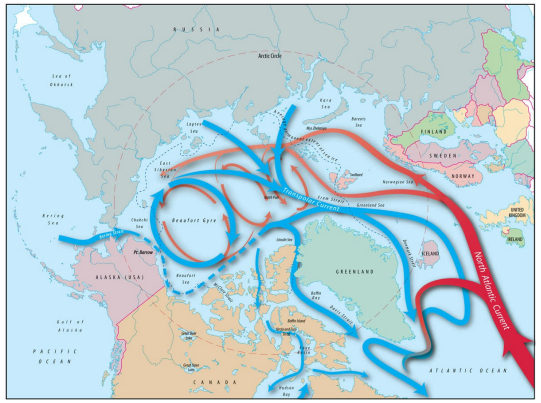


→ Ocean/atmosphere exchanges



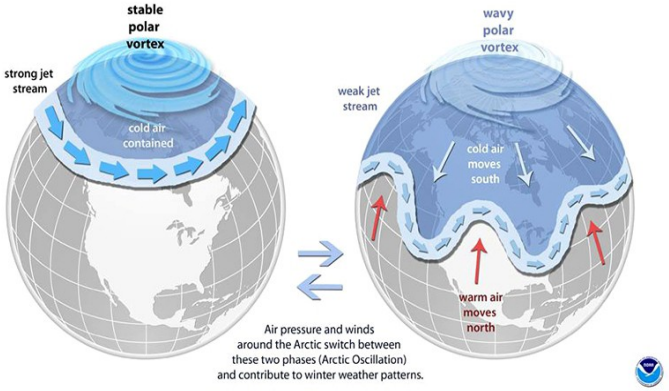
From Rysgaard et al, 2011

→ Ocean salinity and circulations



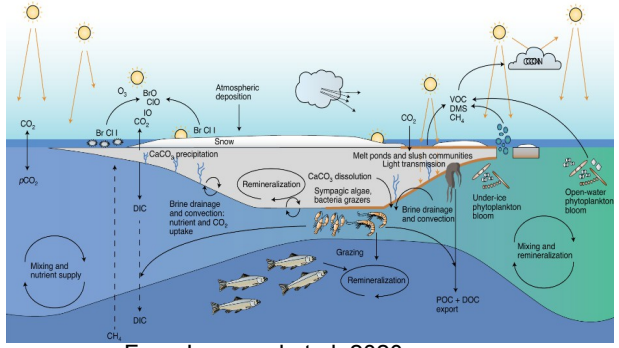
Credit Jack Cook, WHOI

→ Weather conditions



Credits NOAA

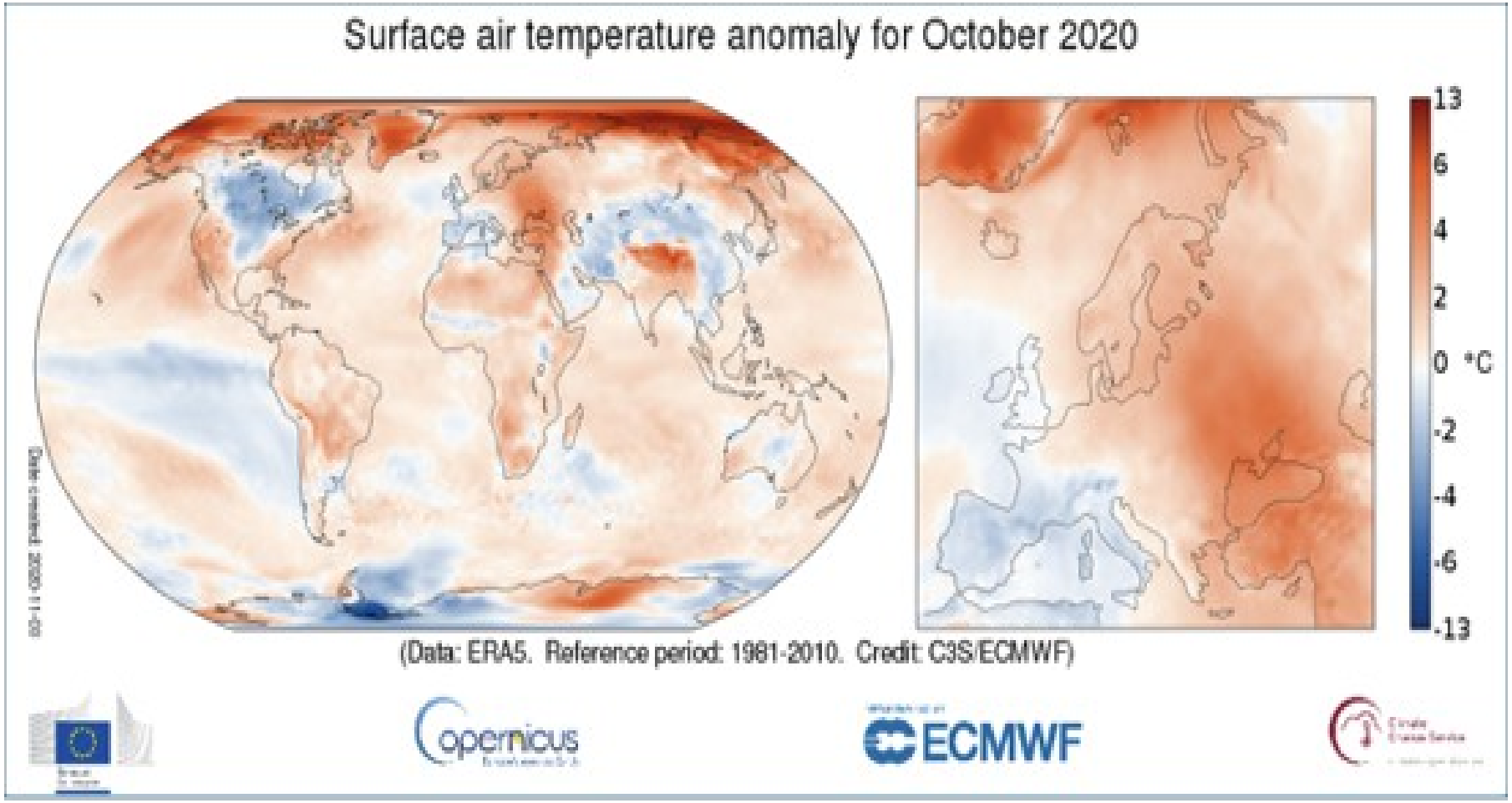
→ Biogeochemistry



From Lannuzel et al, 2020

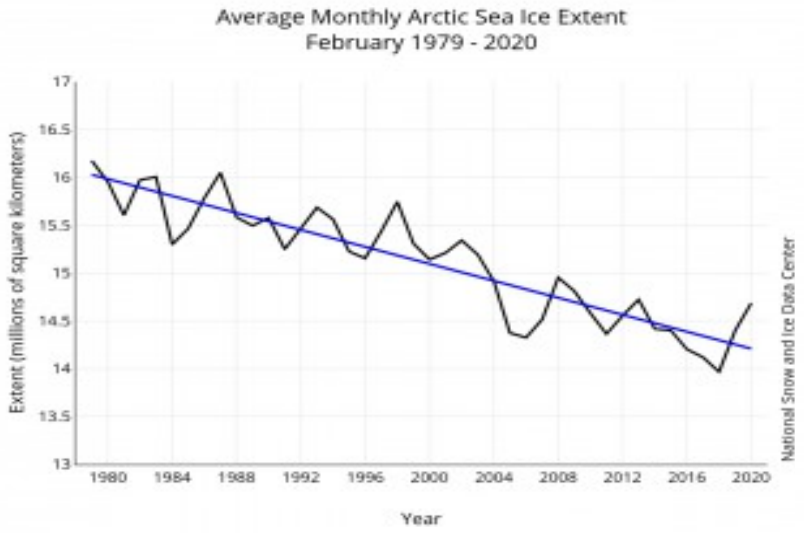
1) Why observing Sea Ice

Polar regions are among the first witnesses of the global warming

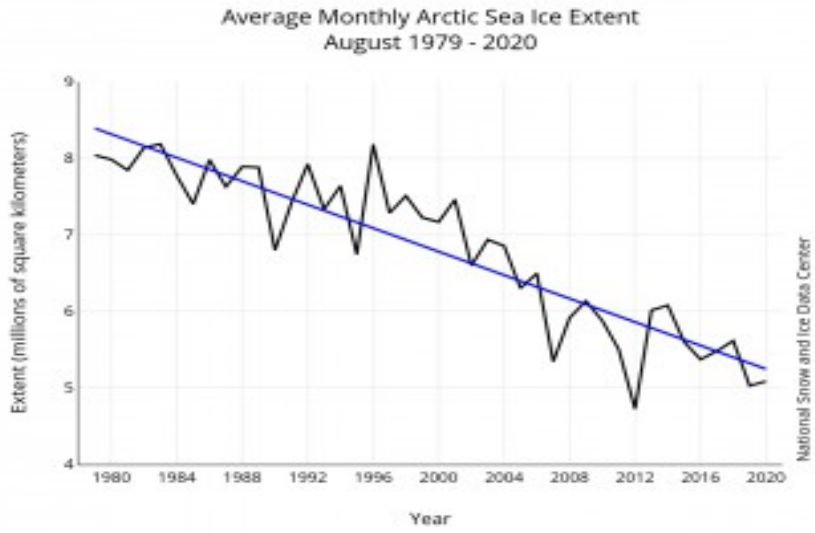


1) Why observing Sea Ice

Credits NSIDC



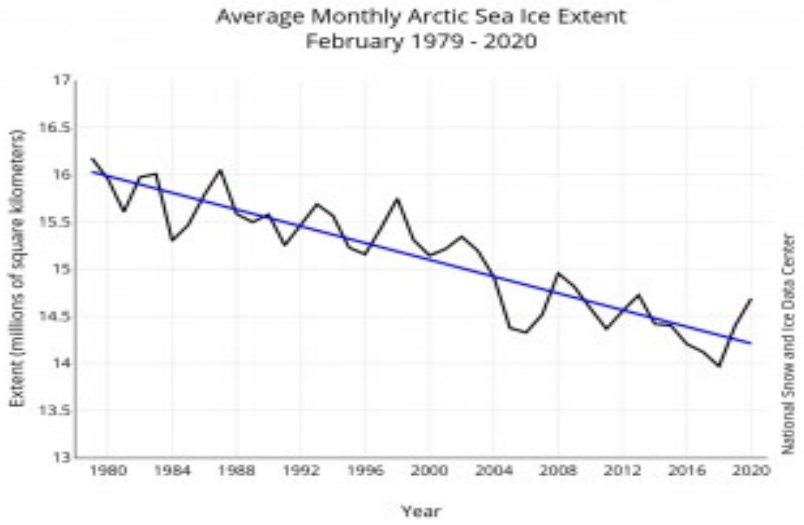
Winter :
About -3% per decade



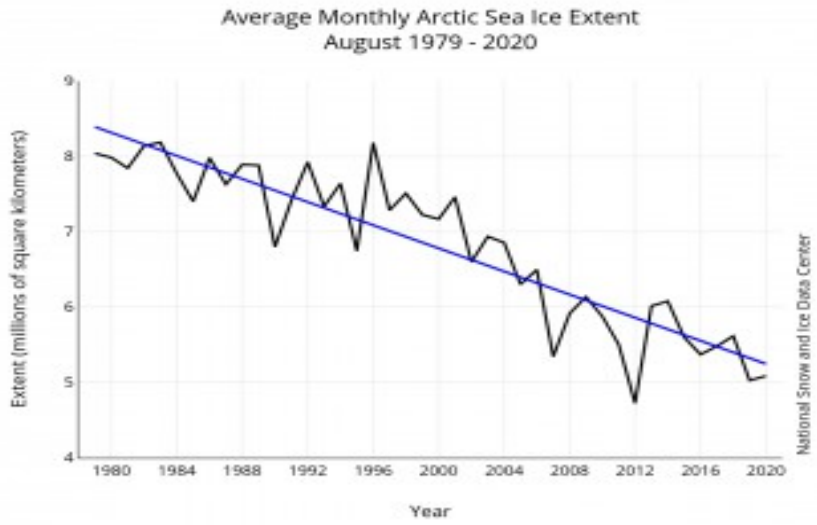
Summer :
about -11% per decade

1) Why observing Sea Ice

Credits NSIDC

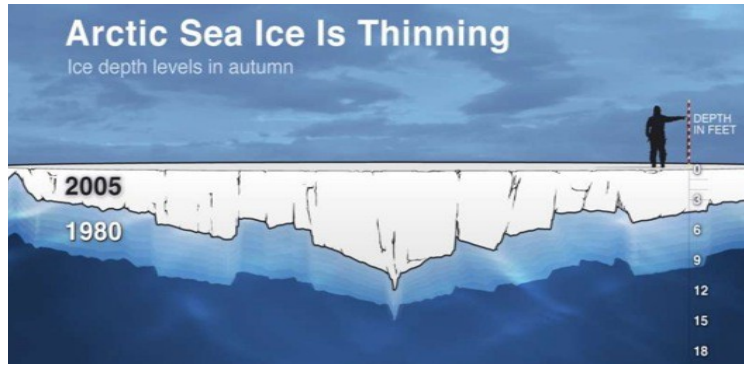


Winter :
About -3% per decade



Summer :
about -11% per decade

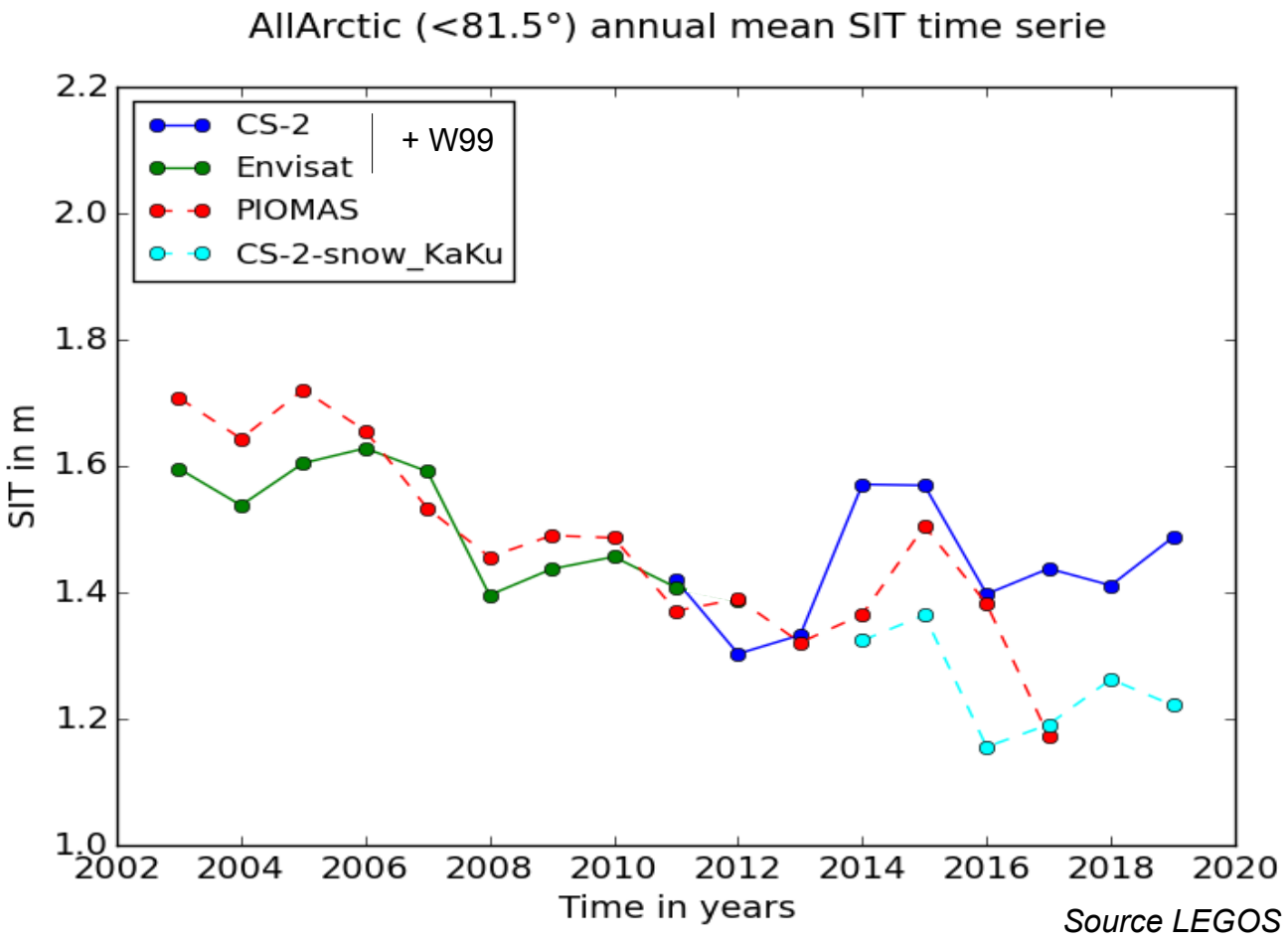
Sea ice is also thining



Source Nasa, US navy

1) Why observing Sea Ice Thickness

But Sea Ice Thickness (SIT) is still insufficently known !!!

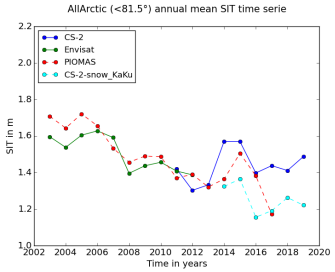


Source LEGOS

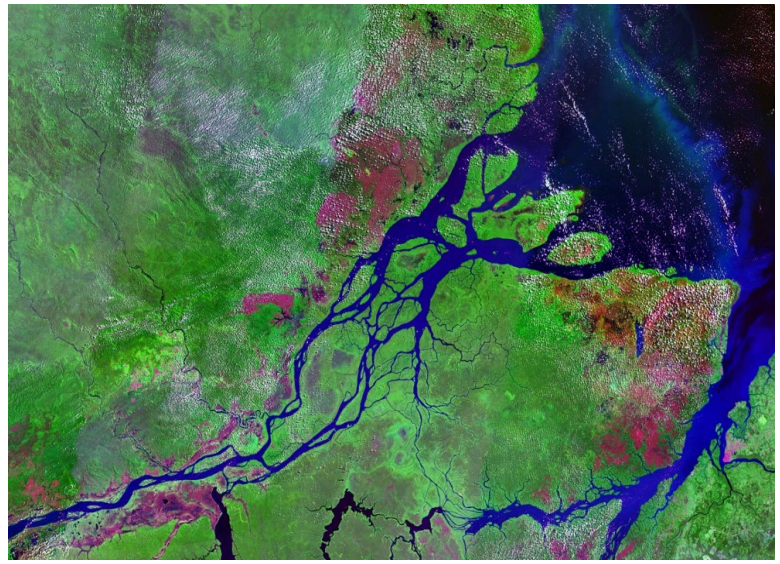
- Data nearly only in Arctic
- Impact of snow depth
- Deviations with models/uncertainties

1) Why observing SIT

But Sea Ice Thickness (SIT) is still insufficently known !!!



Deviations with models/uncertainties



10 cm of error (less than 10% error)

→ About a thousand billion liters (1.10^12) of **freshwater** (in Arctic)

→ 2 months of the Amazon water discharge

Sea ice variations are crucial for the freshwater budget

2) Objectives

Improve freeboard (the emerged part of the ice) and SIT estimations to better understand the role of sea ice in the climate system

Through 4 « WP »

WP1 : Snow depth and SIT in Antarctica.

WP2 : Towards a generalization of physical retracking methodology for sea ice.

WP3 : Synergy between altimetry and sea ice CMEMS model.

WP4 : Sea ice volume variations and impacts of the freshwater budget of polar oceans.

3) Content of the fellowship:WP1

WP1 : Snow depth and SIT in Antarctica

ESA SI-CCI : lack of snow depth and validation data

Tasks :

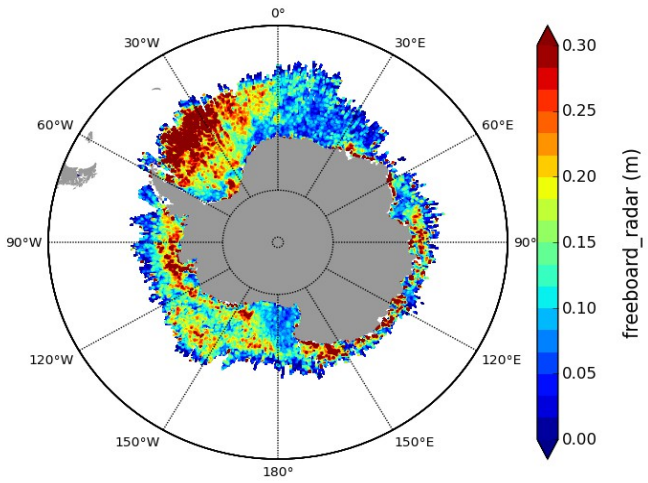
1) Compute bi-frequency KaKu snow depth and freeboards over the entire 2013-2019(20) period (*nearly done ; also supported by ESA CSAO+ project*)

2) Compare with ICESAT-2 (at least)

3) Re-calibrate Envisat LRM data with CryoSat-2

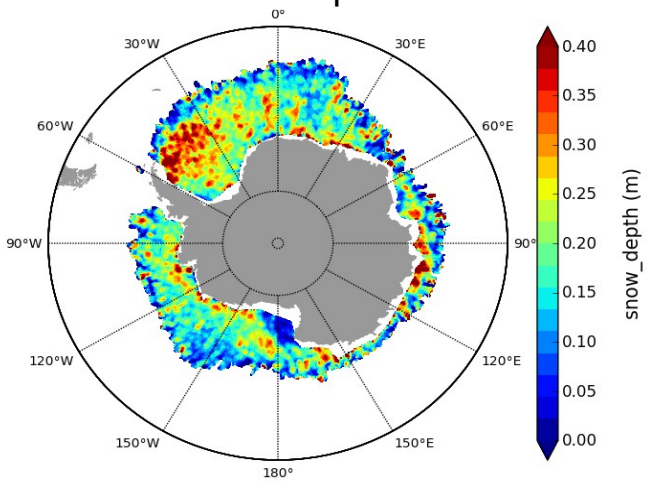
4) Produce a 2002-2019(20) SIT product in Antarctica

Radar freeboard 08-2015



std: 0.108495 mean: 0.1258

Ka-Ku snow depth 08-2015



std: 0.0917048 mean: 0.170976

3) Content of the fellowship:WP2

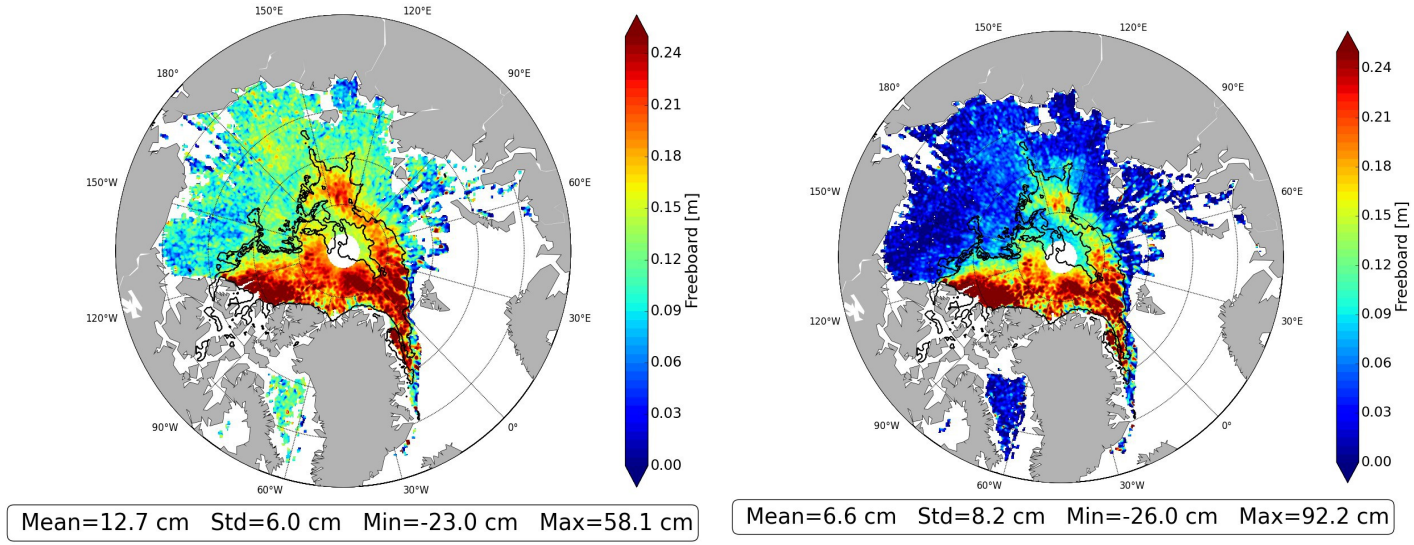
WP2 : Towards a generalization of physical retracking methodology for sea ice

Empirical retrackers (% of the maximum peak of the Waveform) vs **Physical retackers** (heights from modelized waveforms)

ESA CryoseaNiceproject :
freeboard calculations from the ESA SAMOSA+ retracker outputs in Arctic

- SLA calculations

- Biases compare to empirical approaches



Monthly gridded freeboard maps of December 2016 for the SAMOSA+ retracker (left) and the TFMRA60 (right)

3) Content of the fellowship:WP2

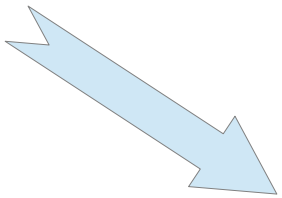
WP2 : Towards a generalization of physical retracking methodology for sea ice

Tasks :

1) Compute SLA and freeboard estimations during the CS-2 period in Antarctica

2) Recalibrate Envisat on the CS-2 freeboard solution computed from SAMOSA+ (*in both hemispheres*)

3) Produce Envisat/CS-2 2002-2019(20) SLA and SIT products in Arctic and Antarctica

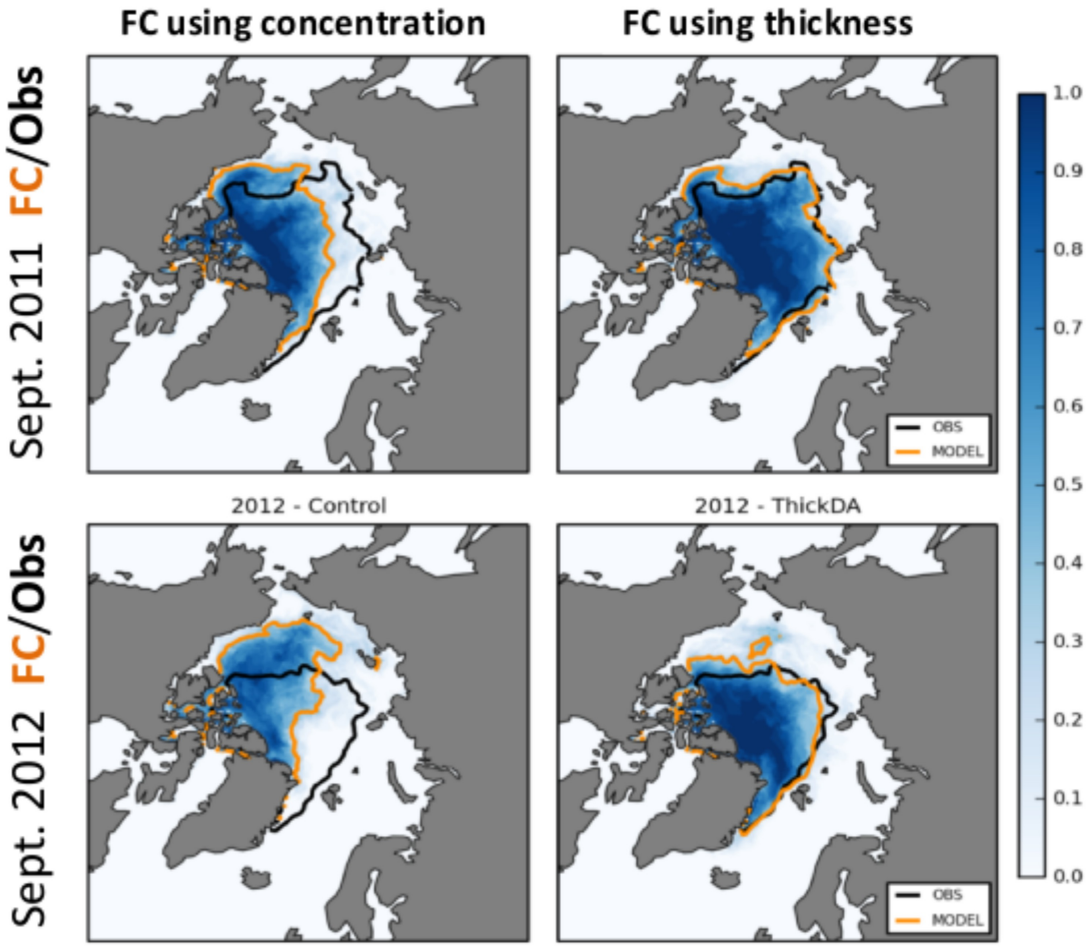


SAMOSA+ outputs have been calculated (GPOD, **ESA CSAO+ projec**t)

→ freeboard and SLA calculations are on-going

3) Content of the fellowship:WP3

WP3 : Synergy between altimetry and sea ice CMEMS model



Sea ice thickness observations are crucial for model forecasts

4 month (may to september) forecasts (in orange) of sea ice extent performed with **sea ice concentration observations (left panels)** and with **sea ice thickness observations (right panels)**. Results are shown for 2011 (top panels) and 2012 (bottom panels). (*Source Blockley et al, 2018).*

3) Content of the fellowship:WP3

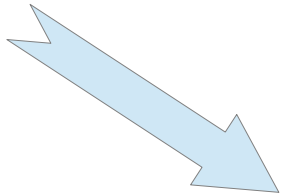
WP3 : Synergy between altimetry and sea ice CMEMS model

Currently, operational systems in CMEMS only assimilate sea ice extent and concentration

Tasks :

1) Evaluate the model abilities to provide sea ice freboard and thickness variability and trends

2) Prepare along track freebard data assimilation



- Interactions about **uncertainties** with Emma Woolliams (**ESA *FDR4ALT project***)
- I will work with Gilles Garric at **MERCATOR Ocean** next year for about **6 months**

3) Content of the fellowship:WP4

WP4 : Scientific analysis: Sea ice volume variation and impacts on the freshwater budget of polar oceans

→ ***will start in 2022***

Tasks :

1) Evaluate inter-annual to decadal sea ice volume variations from the results of the previous WP

2) Correct the variation in global freshwater content (land ice contribution) measured from salinity measurements by the freshwater variation from sea ice

Collaboration with Benoît Meyssignac and Anny Cazenave from the LEGOS

4) Conclusions

« Improved Sea-Ice Thickness records from satellite altimeters : Towards new sea ice volume estimates and application to climate change studies »

- 4 WP's

→ consider Antarctica
→ Improve model/observation synergy
→ geophysical application

- Strong links with current ESA project

- Aim to provide results to support the future CRISTAL mission

THANK YOU FOR YOUR ATTENTION