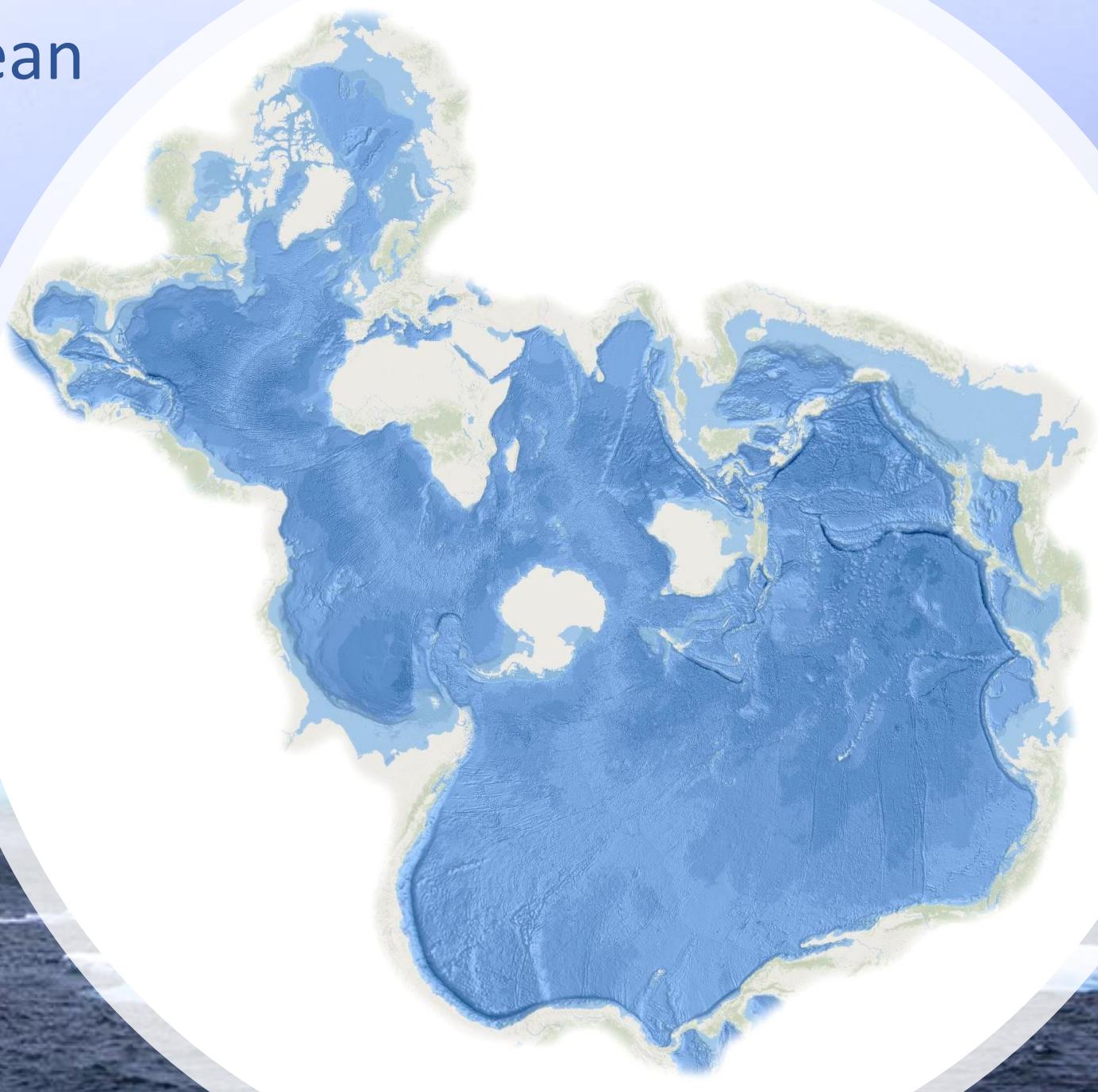


# Polar Symposium 2022: Ocean

François Fripiat (ULB)  
Bruno Delille (ULiège)

with inputs from:

S. Allende-Contador, S. Arndt, W. Boone,  
U. Braeckman, T. Fichefet, H. Goosse,  
T. Gkritzalis, F. Massonnet, L. Ponsoni,  
J.-L. Tison, and S. Van de Velde



# Ocean and Climate Change

71% of the Earth's surface – Blue planet



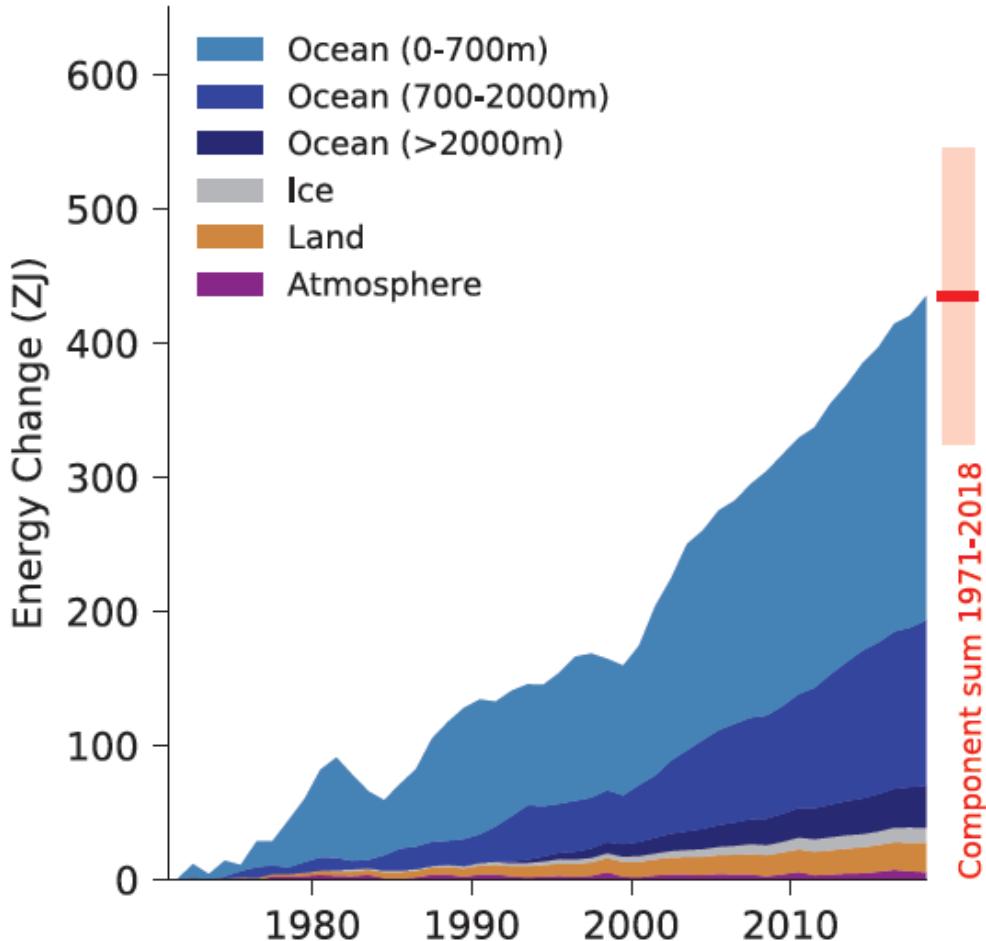
## Oceans

- Regulate our climate
- Feed us
- Generate most of the oxygen we breathe
- Transportation
- Economy
- ...

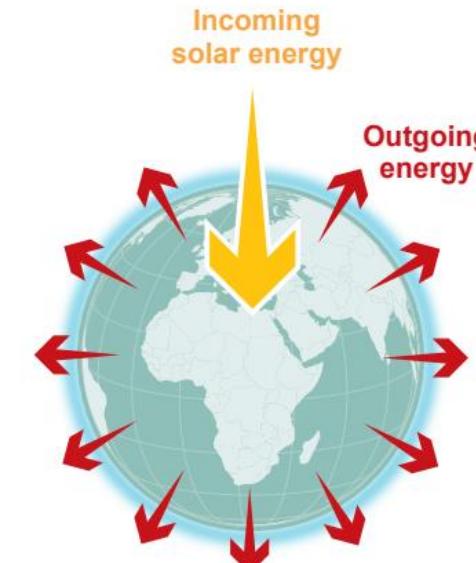
**Atmosphere** =  $4.2 \cdot 10^{18} \text{ m}^{-3}$  and  $5.2 \cdot 10^{18} \text{ kg}$

**Ocean** =  $1.4 \cdot 10^{18} \text{ m}^{-3}$  and  $1071 \cdot 10^{18} \text{ kg}$

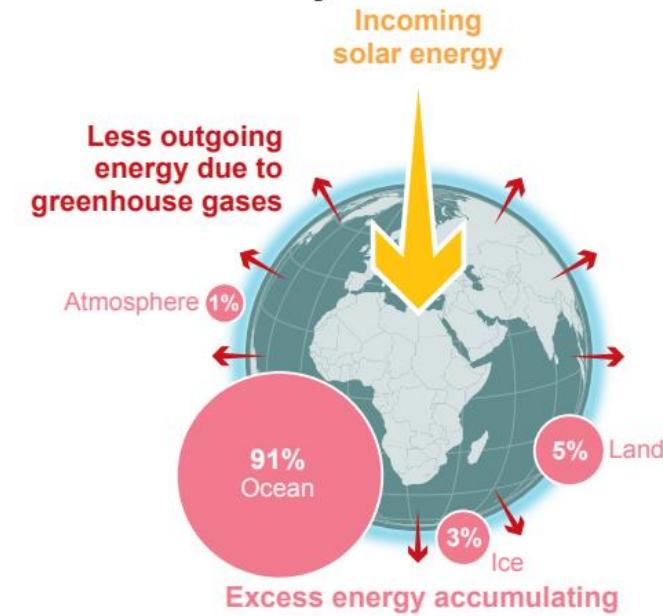
# Ocean and Climate Change



Stable climate: in balance

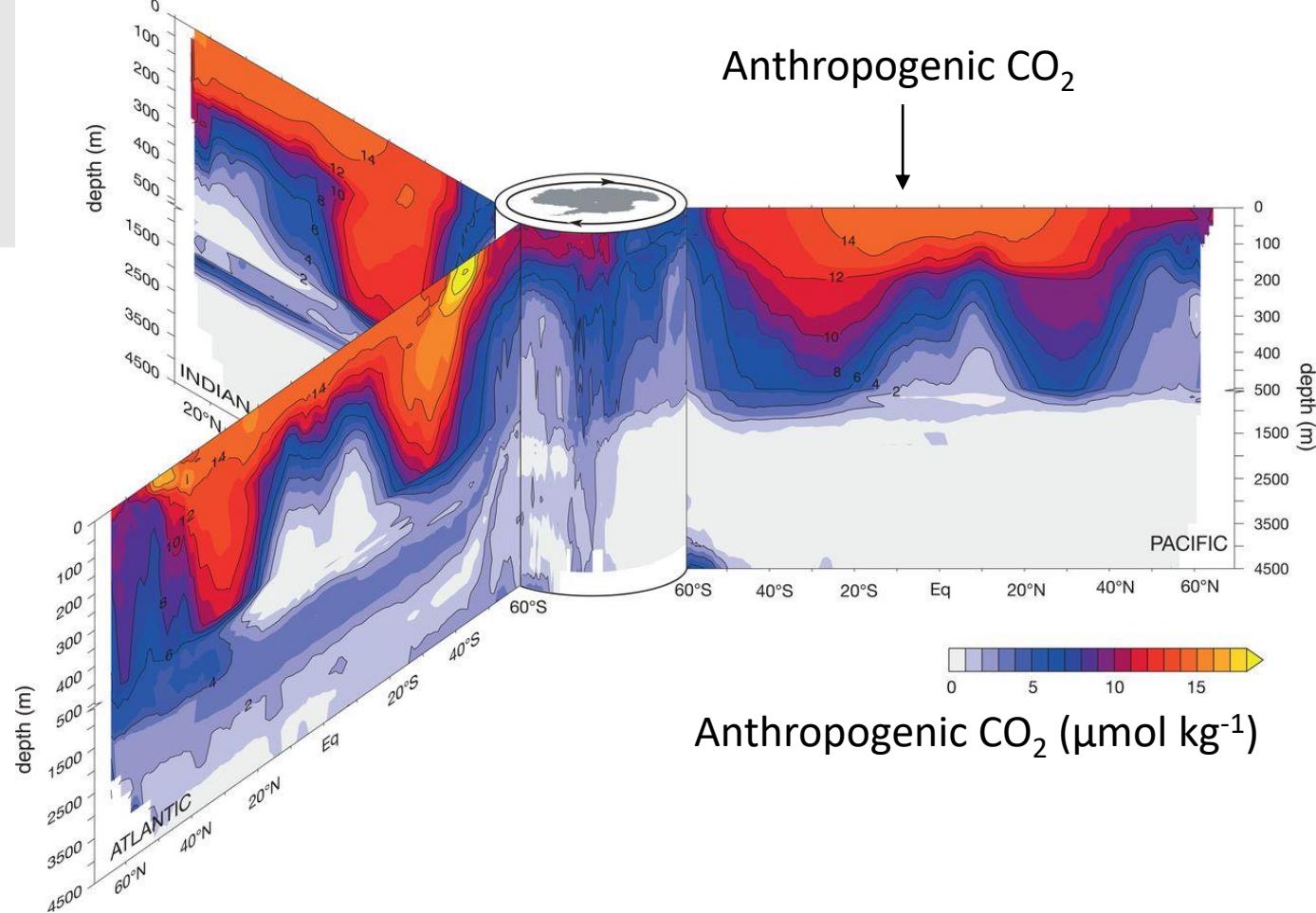
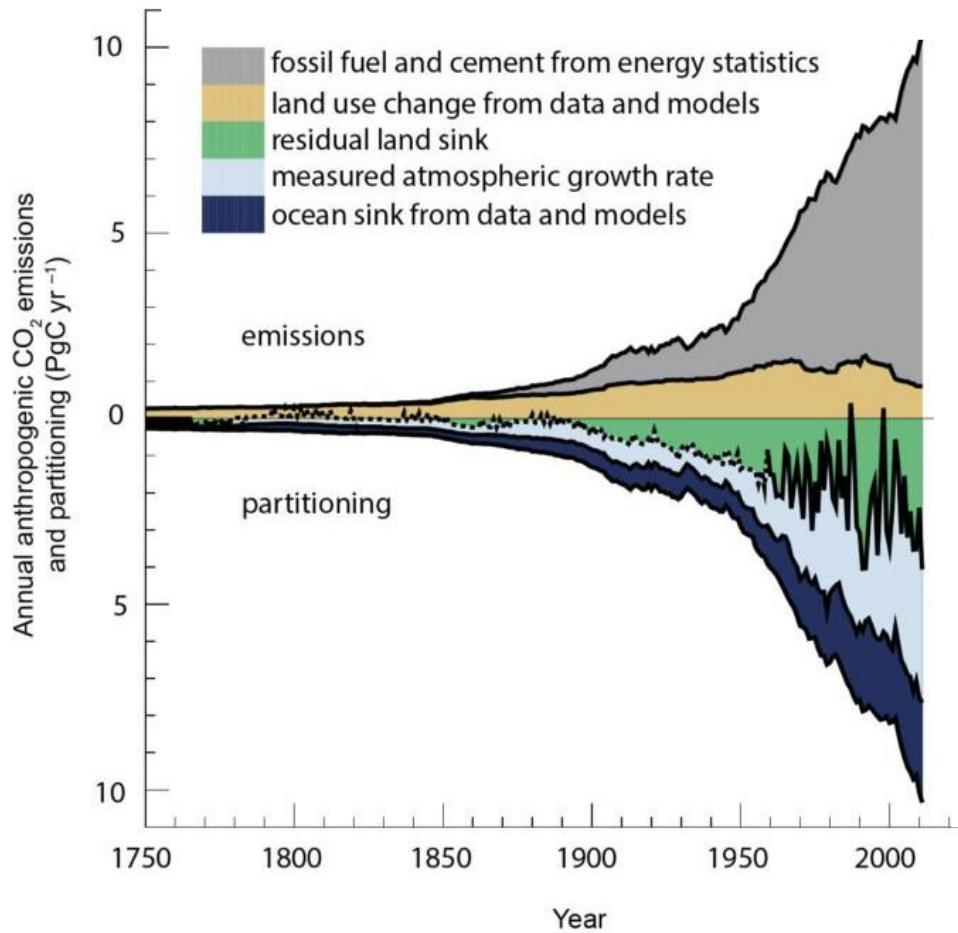


Today: imbalanced



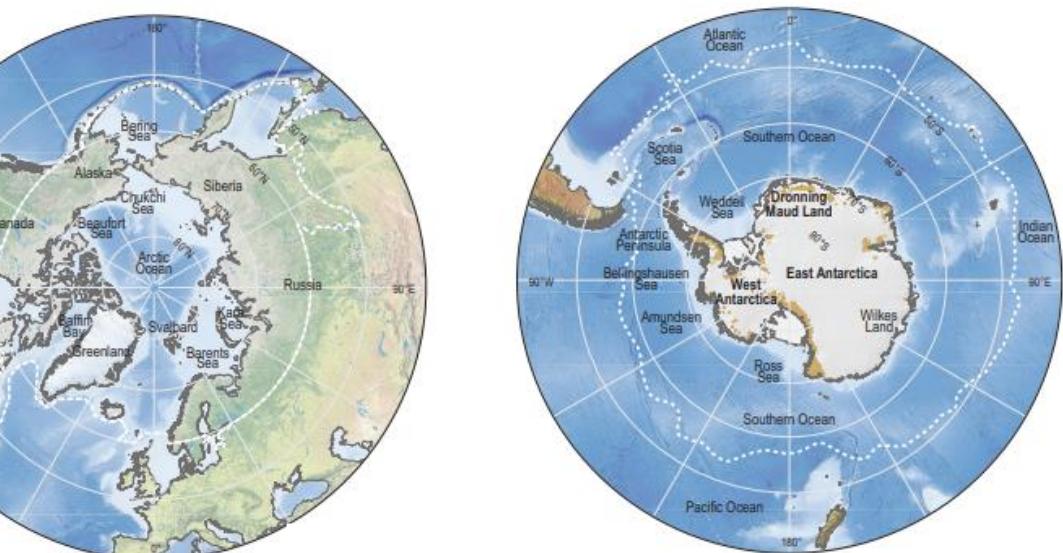
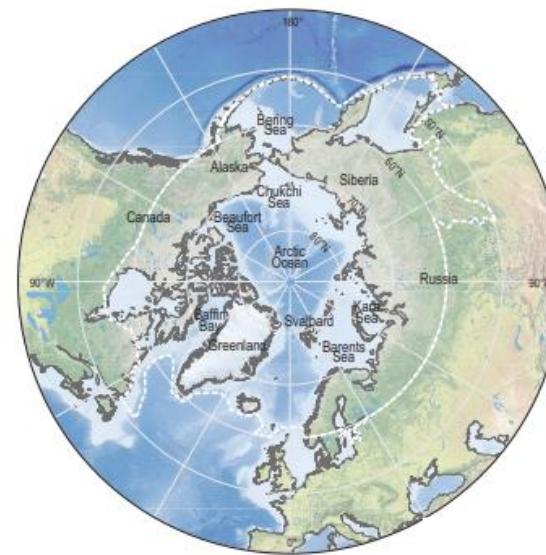
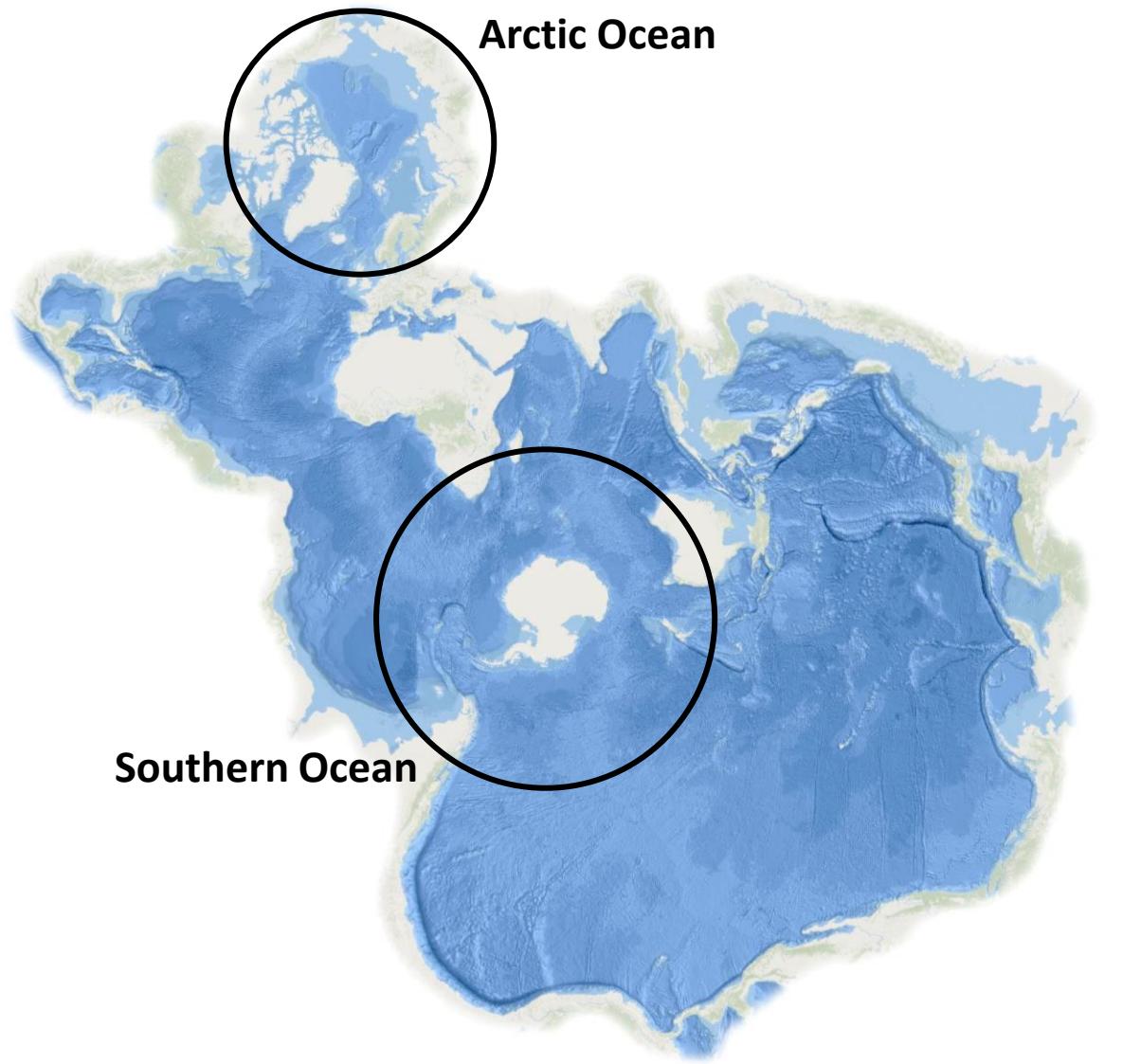
Oceans heat uptake accounts for 91% of the total energy change

# Ocean and Climate Change

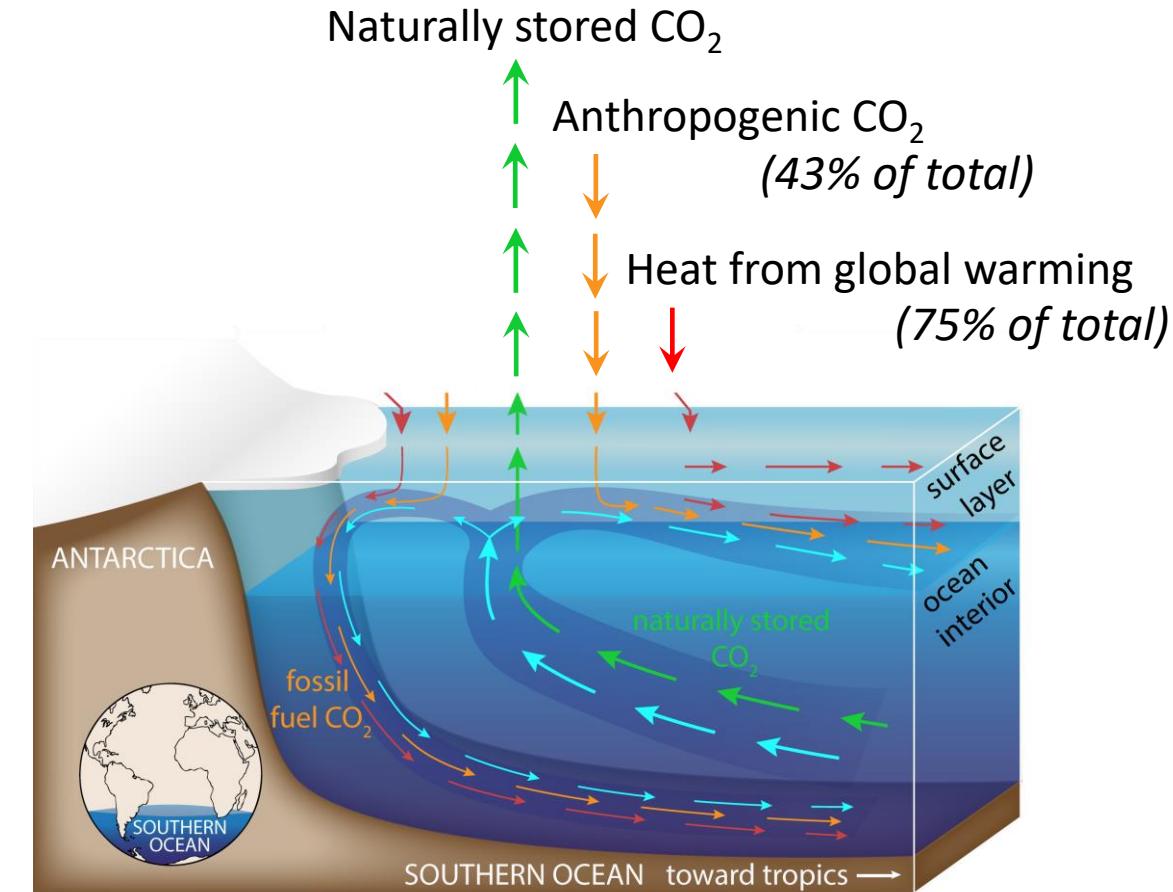
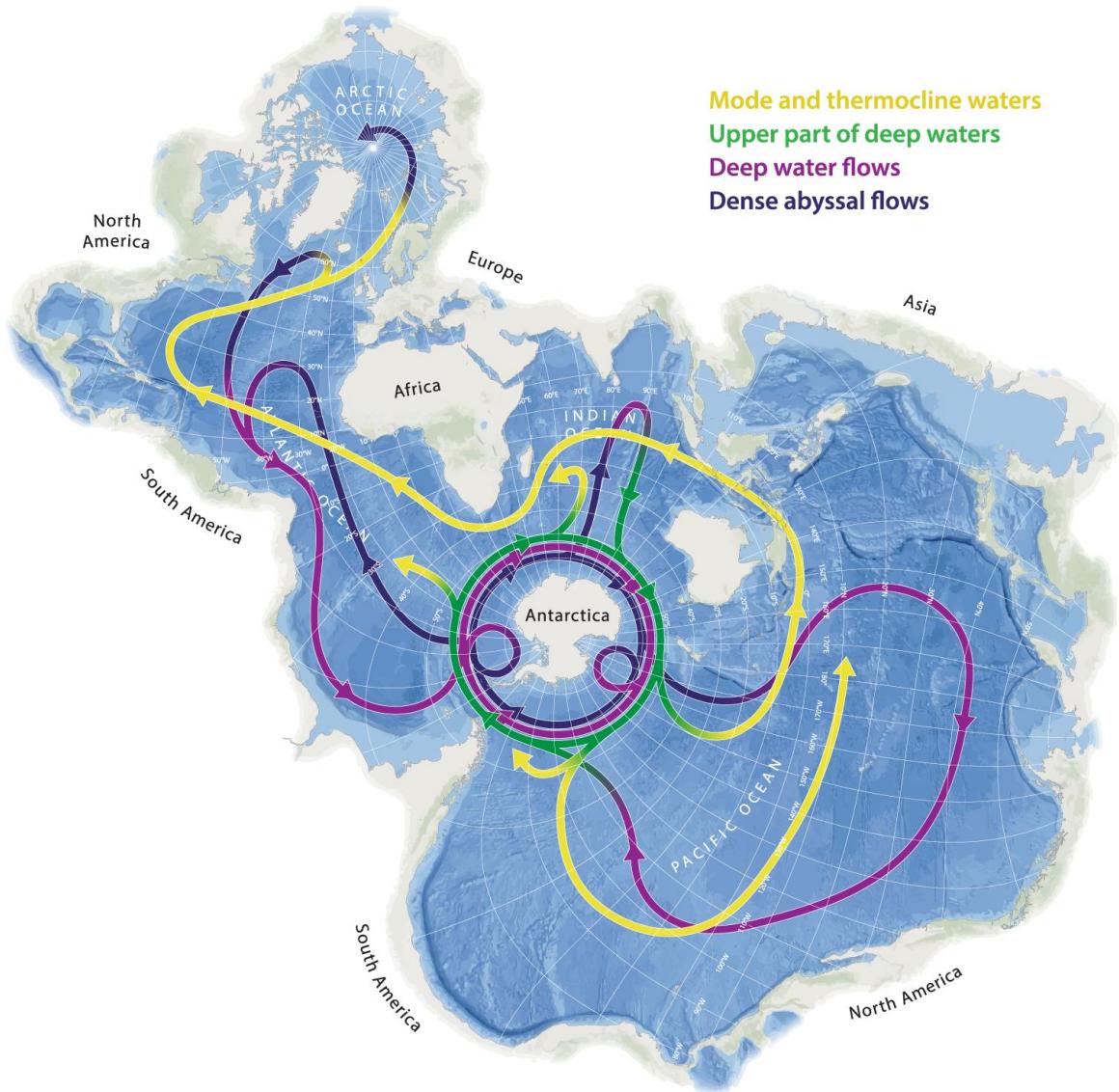


**Oceans  $\text{CO}_2$  uptake accounts for  
20-30% of the Anthropogenic emissions**

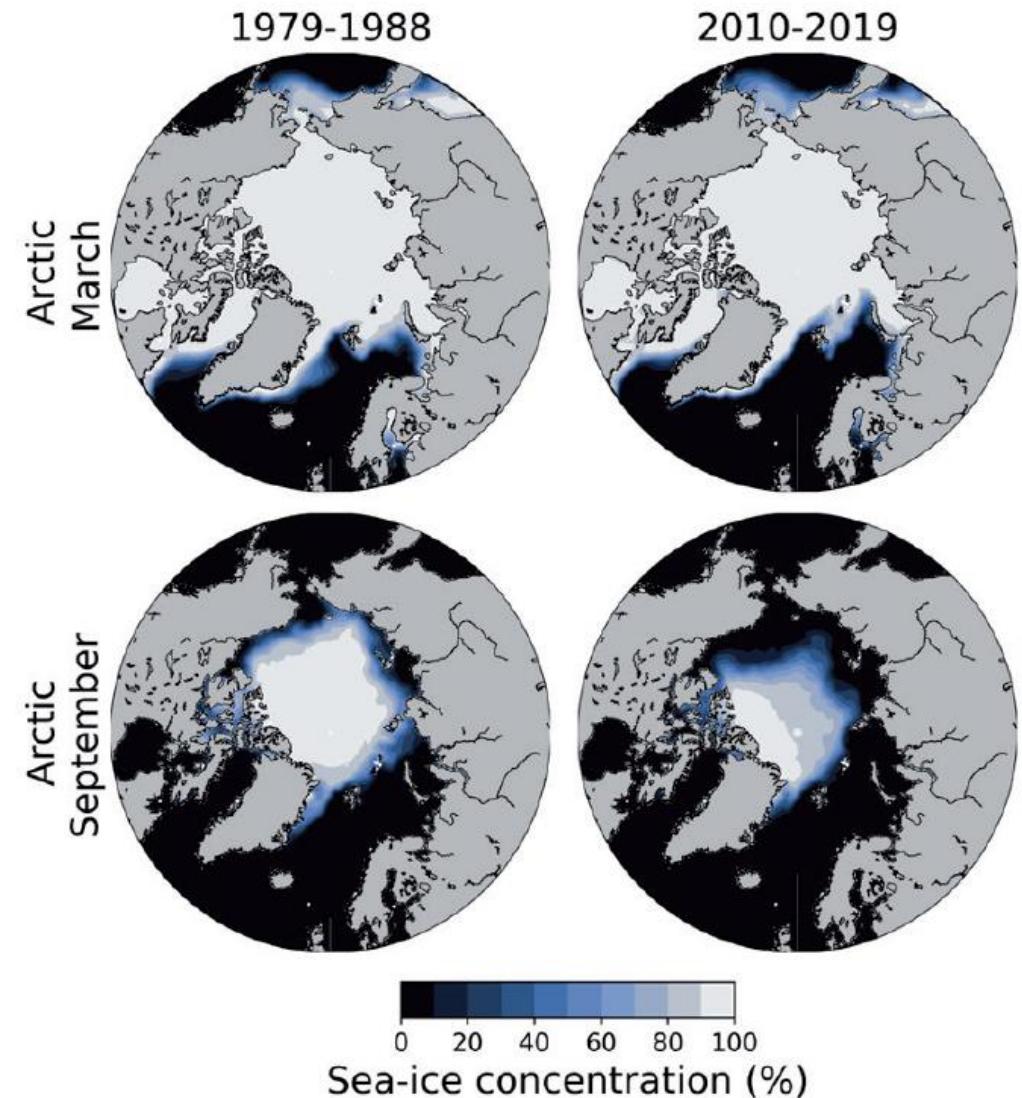
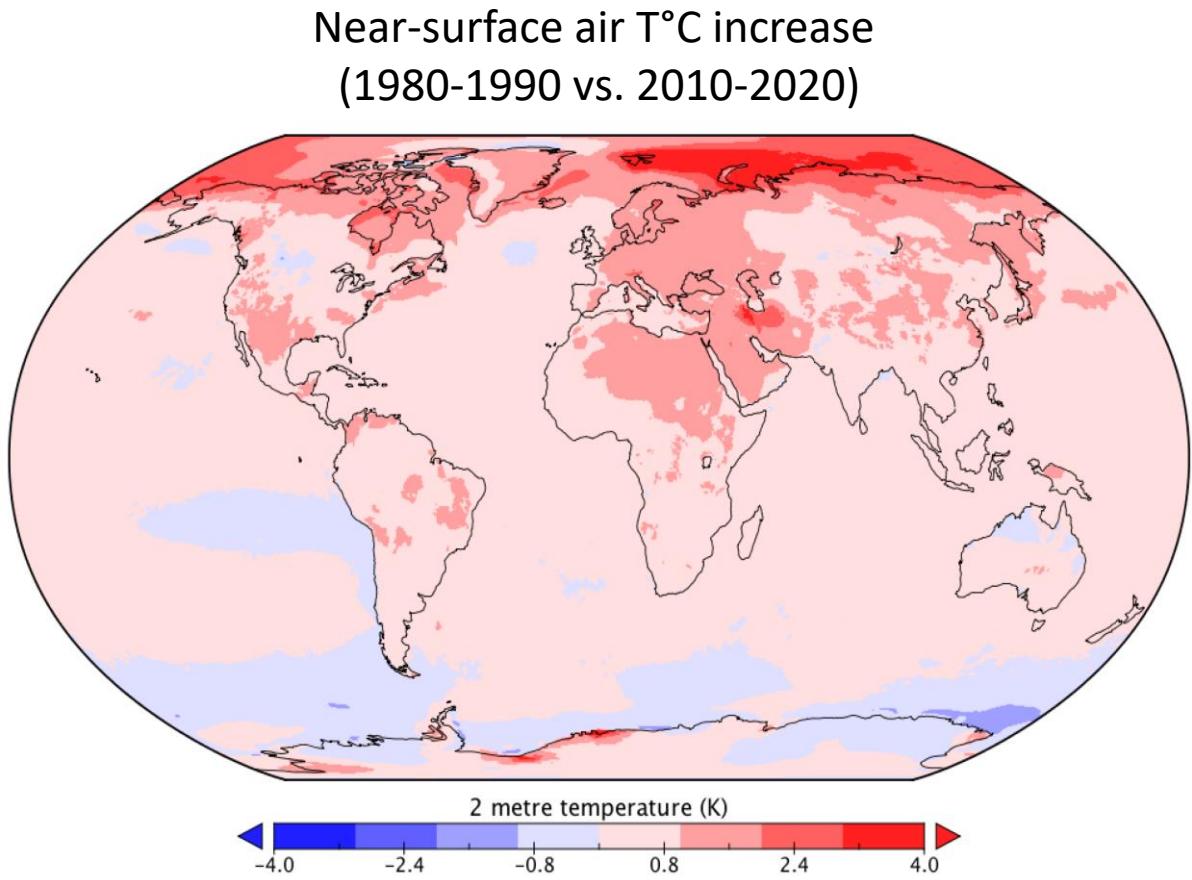
# Polar Oceans – Same interfaces but different geographical contexts



# Southern Ocean – The engine of the ocean conveyor belt



# Arctic Ocean – A sentinel of climate change



# Polar Oceanography in Belgium



8 Research groups



Strong research outputs  
(145 publications since 2017)  
(Deeply involved in international networks)

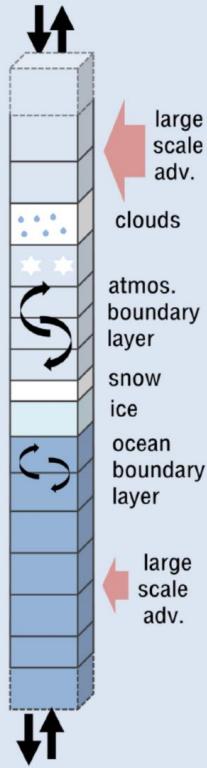


19 research cruises  
(since 2017)  
1543 days in polar region

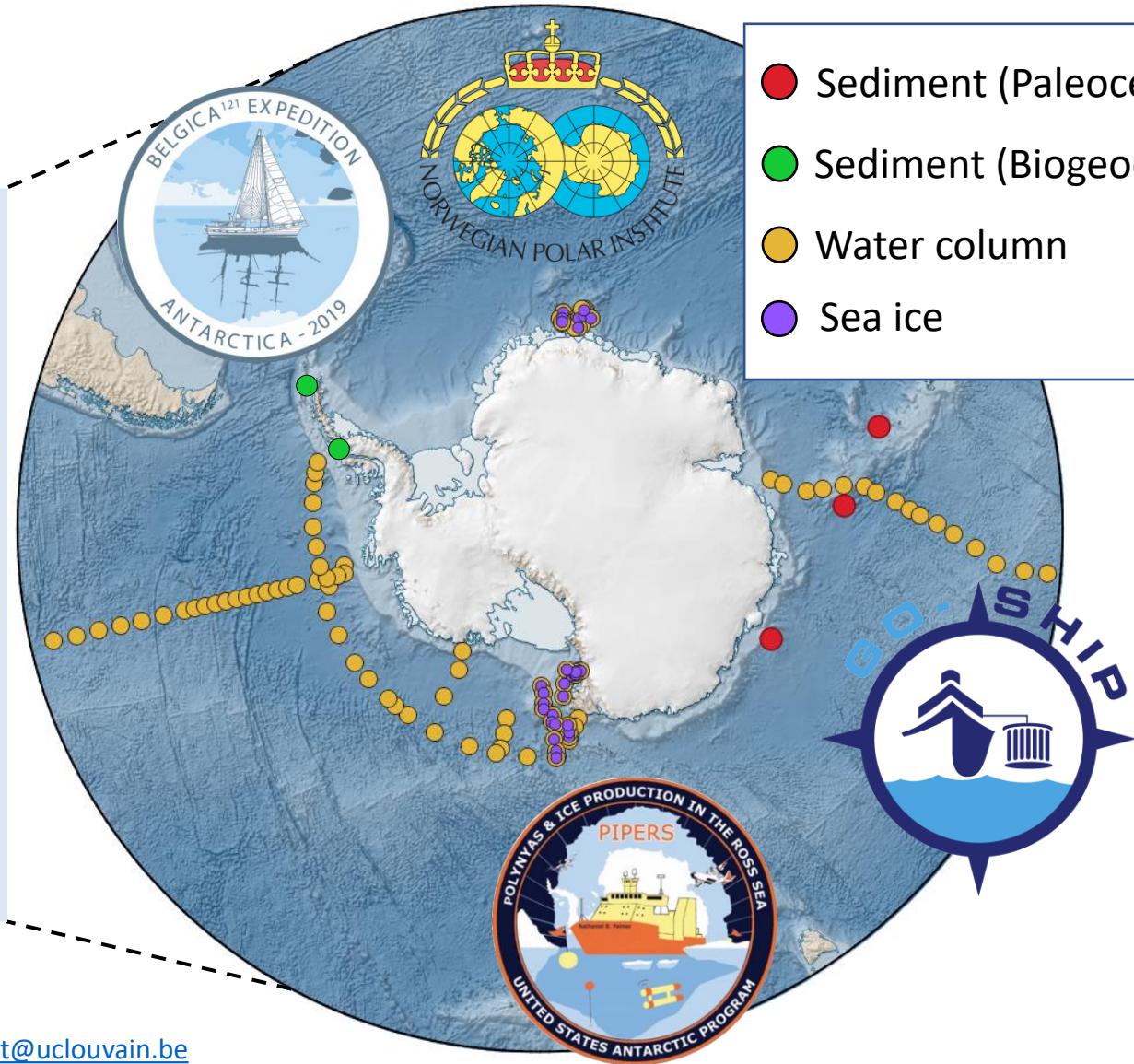


# Southern Ocean – Where we are and what we are doing?

NEMO-LIM model



UCLouvain



- Sediment (Paleoceanography)
- Sediment (Biogeochemistry)
- Water column
- Sea ice



## Research questions?

- Ocean dynamics
- Ocean biogeochemistry
- Sea-ice physics
- Sea-ice biogeochemistry
- Paleoceanography
- Benthic biogeochemistry

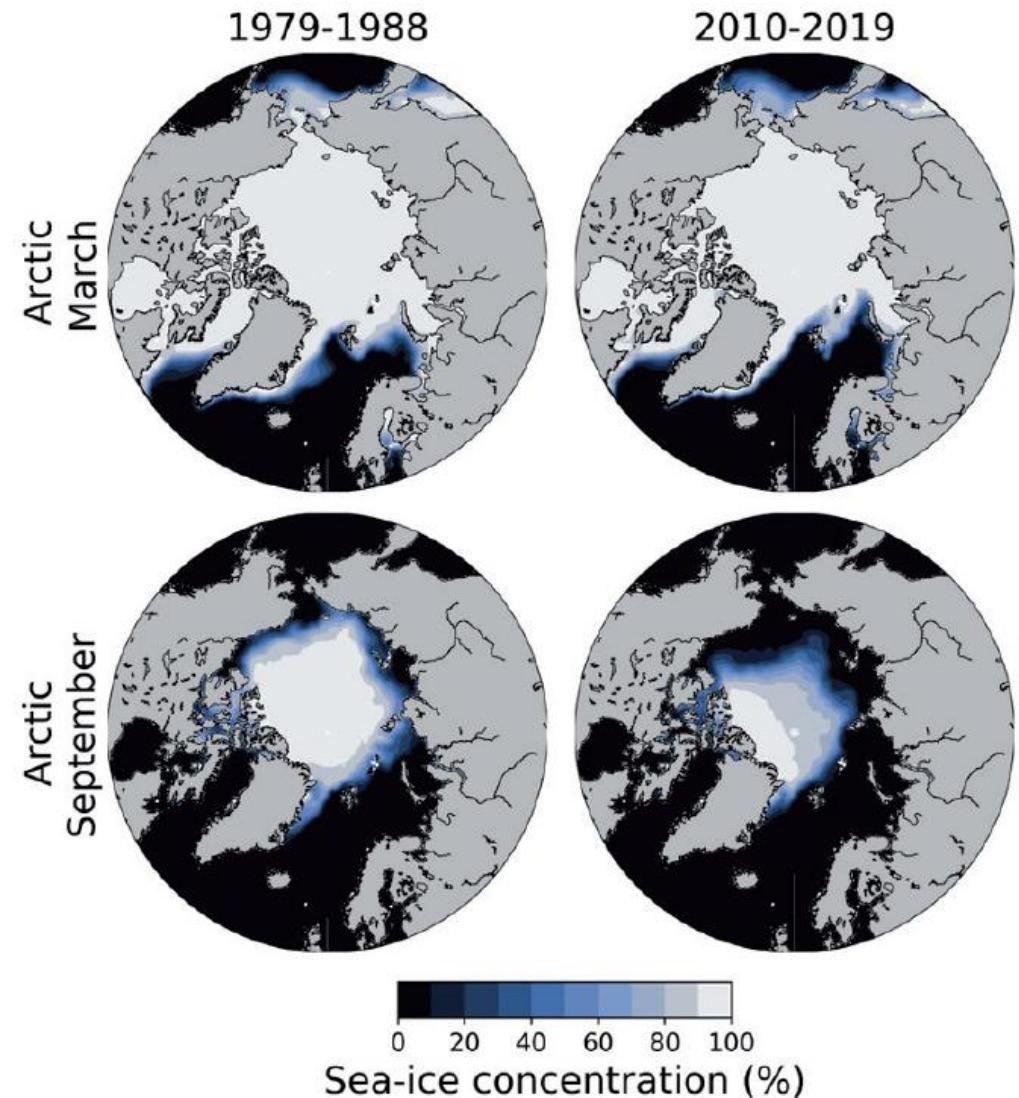
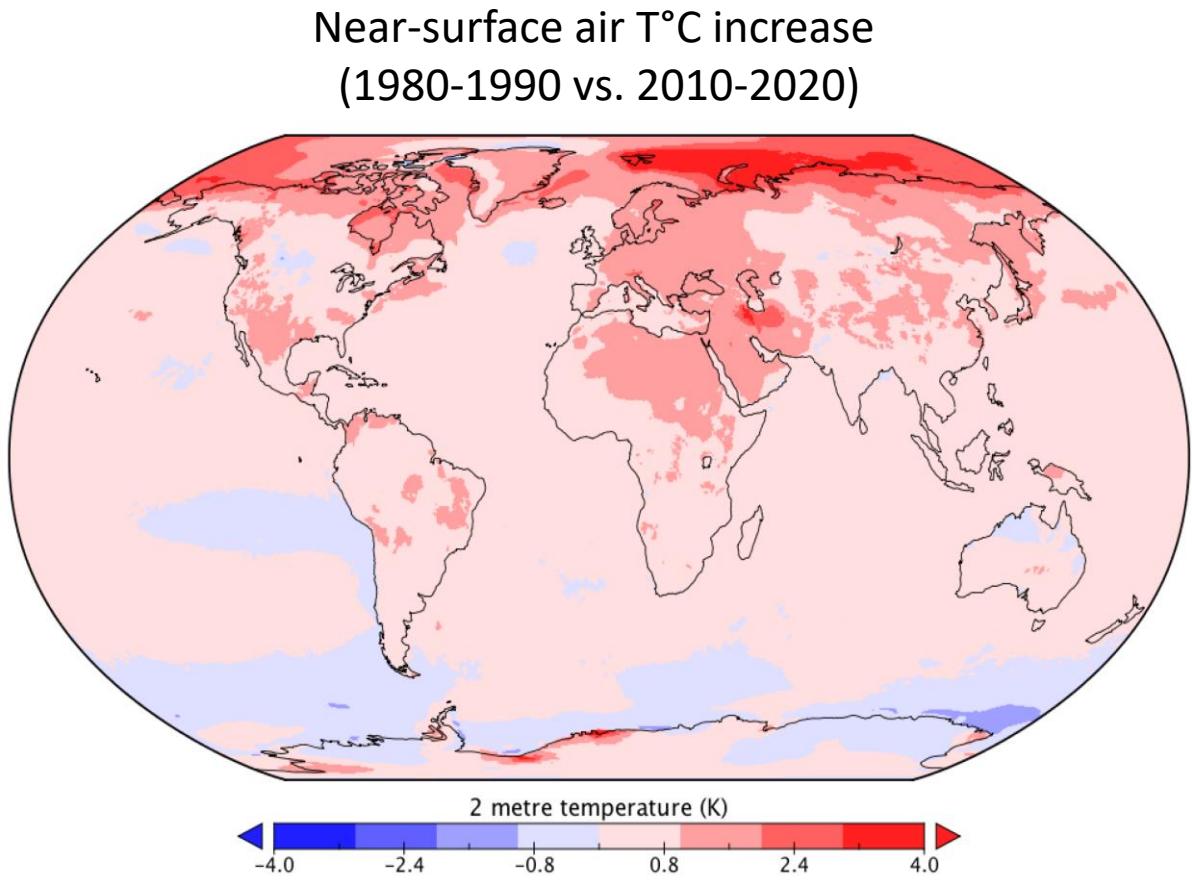


Thierry Fichefet: [thierry.fichefet@uclouvain.be](mailto:thierry.fichefet@uclouvain.be)



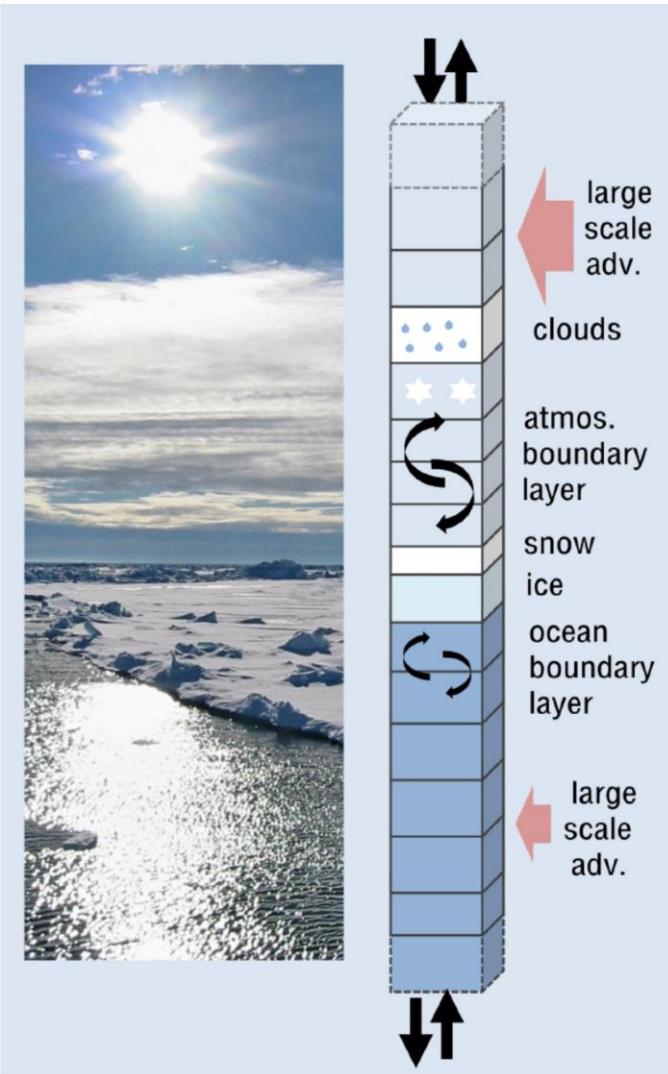
François Fripiat: [francois.fripiat@ulb.be](mailto:francois.fripiat@ulb.be)

# Arctic Ocean – A sentinel of climate change



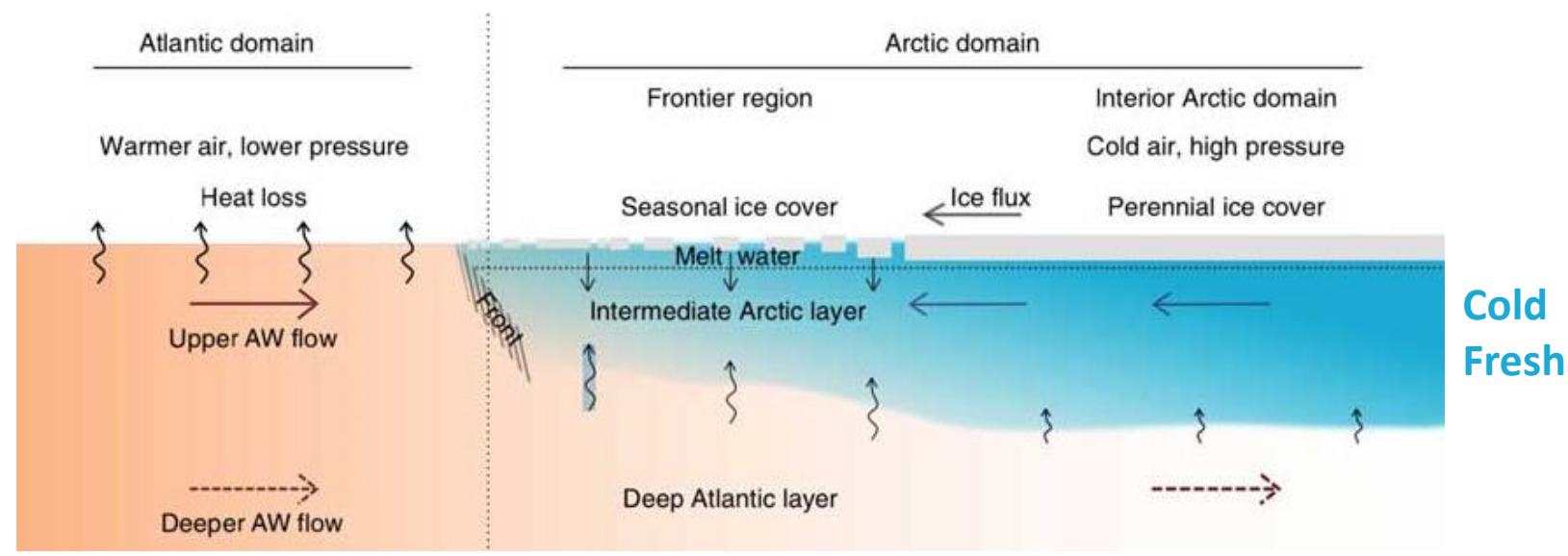
# Atlantification of the Arctic Ocean and upper-ocean dynamics?

Nucleus for European Modeling of the Ocean (NEMO)



Louvain-La-Neuve Sea Ice Model (LIM)

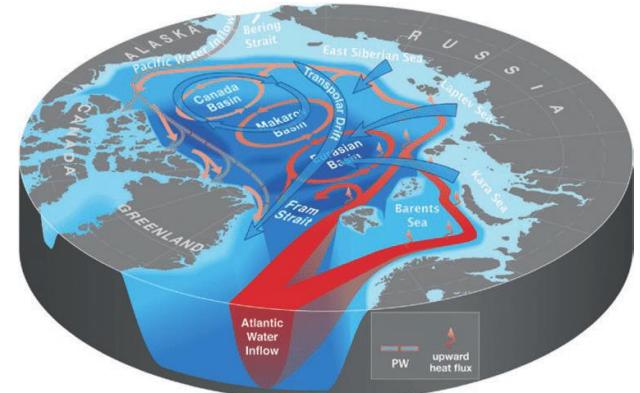
**UCLouvain**



Lind et al., *Nat. Climate Change*

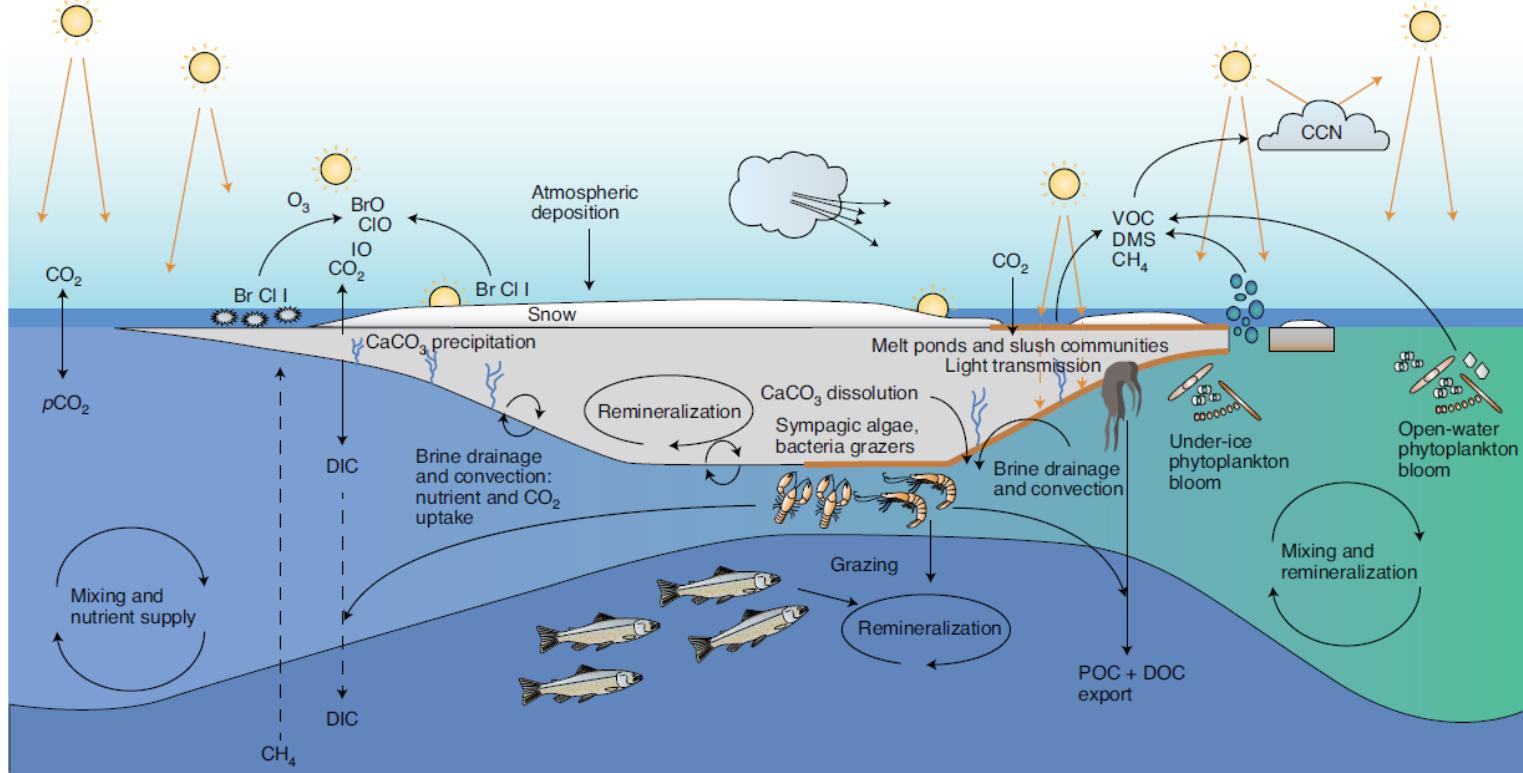
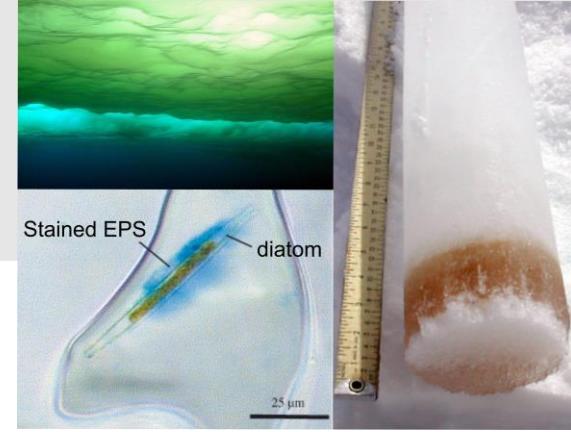


Thierry Fichefet: [thierry.fichefet@uclouvain.be](mailto:thierry.fichefet@uclouvain.be)



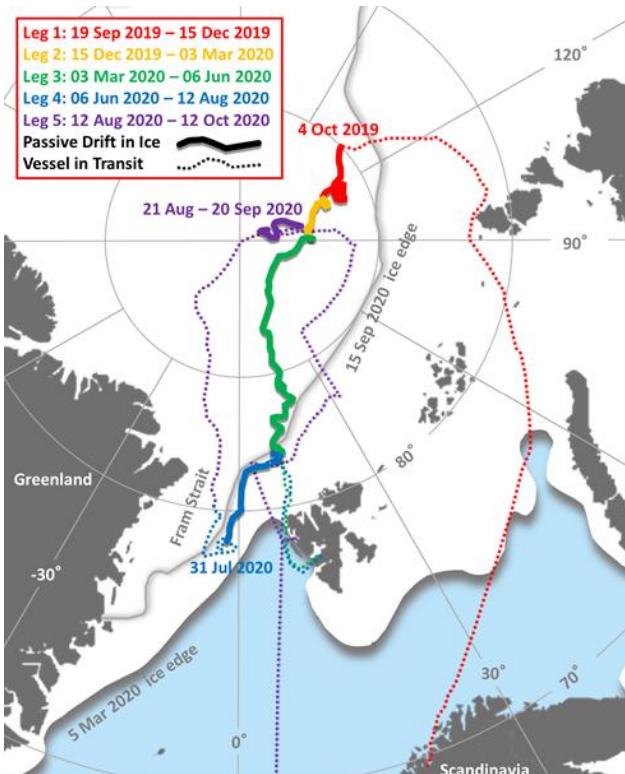
# Sea ice – A key biogeochemical interface?

In-situ production and consumption of **Greenhouse Gases**?  
**Gas exchange** with the ocean and the atmosphere?



# Sea ice – A key biogeochemical interface?

**MOSAiC expedition (2019-2020)**  
A year drifting in Arctic Sea Ice



**TARA Polar Station (2025-2045)**  
A drifting polar science station



Fondation  
**tara océan**  
explorer et partager



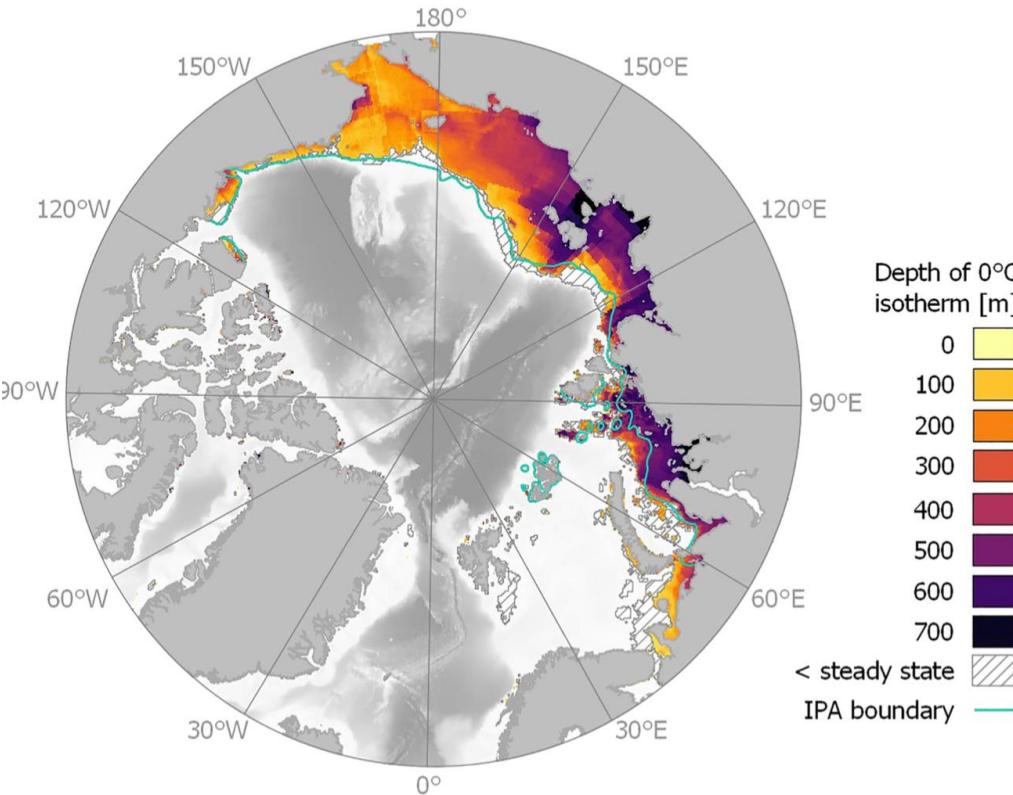
*agnès b.*



# Sea ice – A key biogeochemical interface?



# Subsea permafrost – A groggy climate giant?

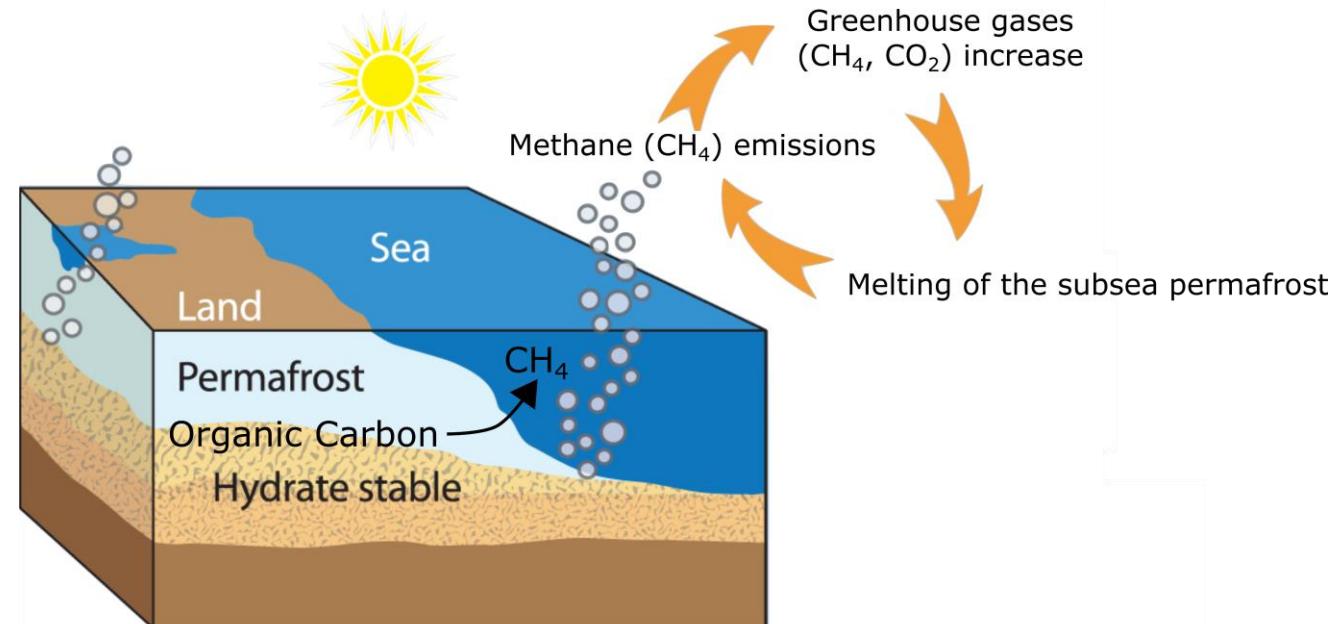


Overduin et al., 2019, JGR ocean

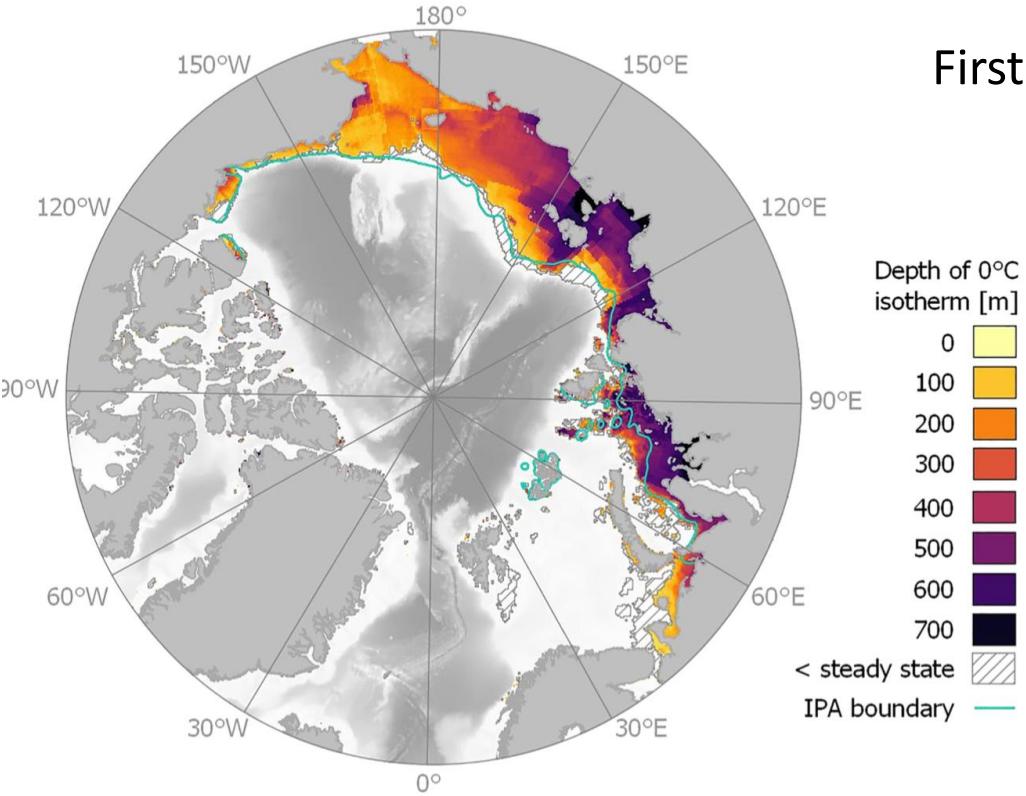
**Methane ( $\text{CH}_4$ ) emission from melting permafrost**

**Positive feedback on climate?**

**Not yet included in integrated assessment models**



# Subsea permafrost – A groggy climate giant?



First model-estimates of pan-Arctic  $\text{CH}_4$  emissions  
from subsea permafrost

Preliminary data (not to be shared)  
To contact Sandra Arndt for further Information



$\text{CH}_4\text{gas}$  (Tg C / year)

Time (year)

Ridolfi et al., *in prep*



Sandra Arndt: [sandra.arndt@ulb.be](mailto:sandra.arndt@ulb.be)

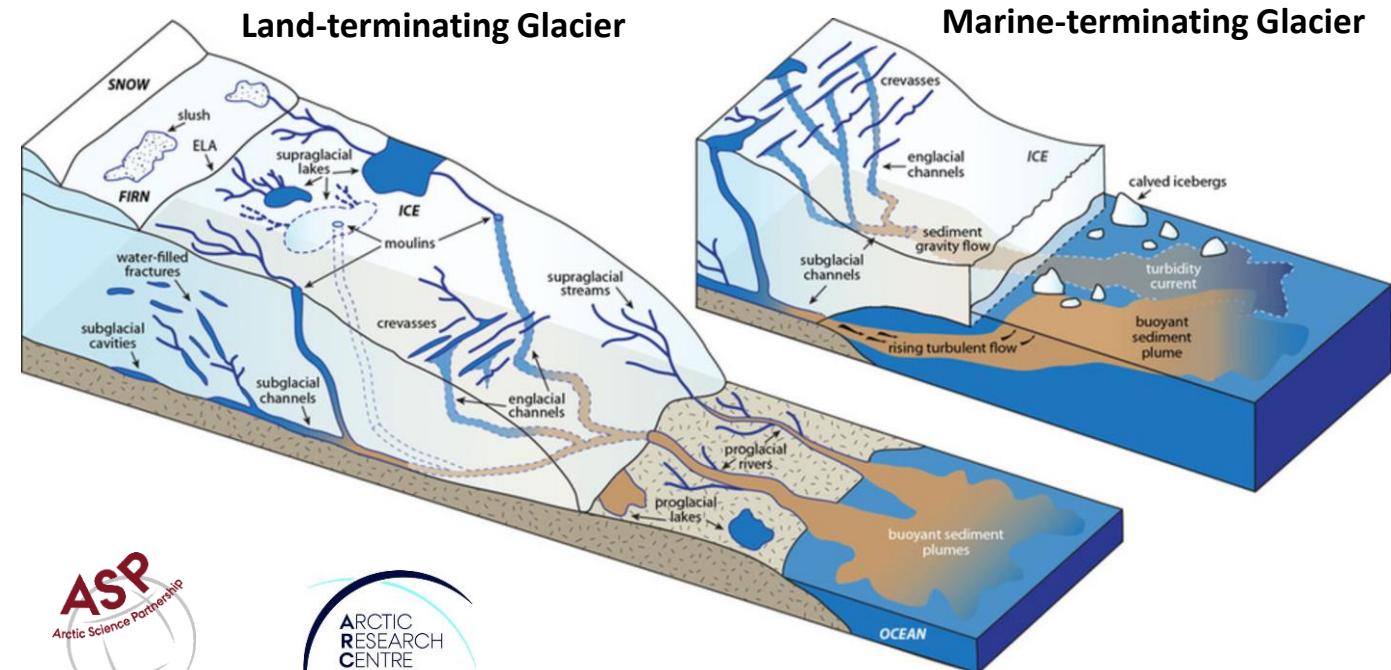
# Link between Greenland Ice-sheet and Ocean?

Eurofleets IOPD Campaign (2022)



Accelerated **freshwater** and **nutrient** supply to the Ocean

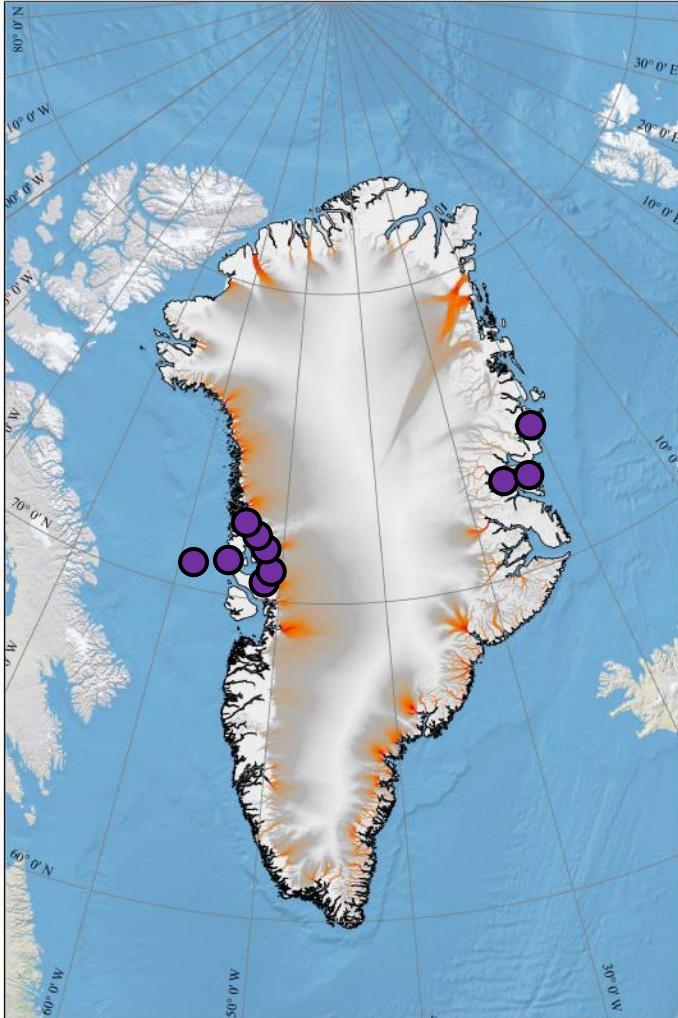
Impacts on **Ocean physics** and **biogeochemistry**?



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Leandro Ponsoni: [leandro.ponsoni@vliz.be](mailto:leandro.ponsoni@vliz.be)

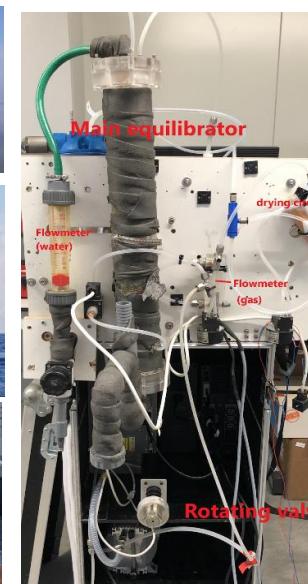
# Greenland Ice-Sheet's impact on Oceanography?



**Ocean observation system and technology**  
for physical and biogeochemical properties



Marine Robotics



Underway Systems



Real Time observatory



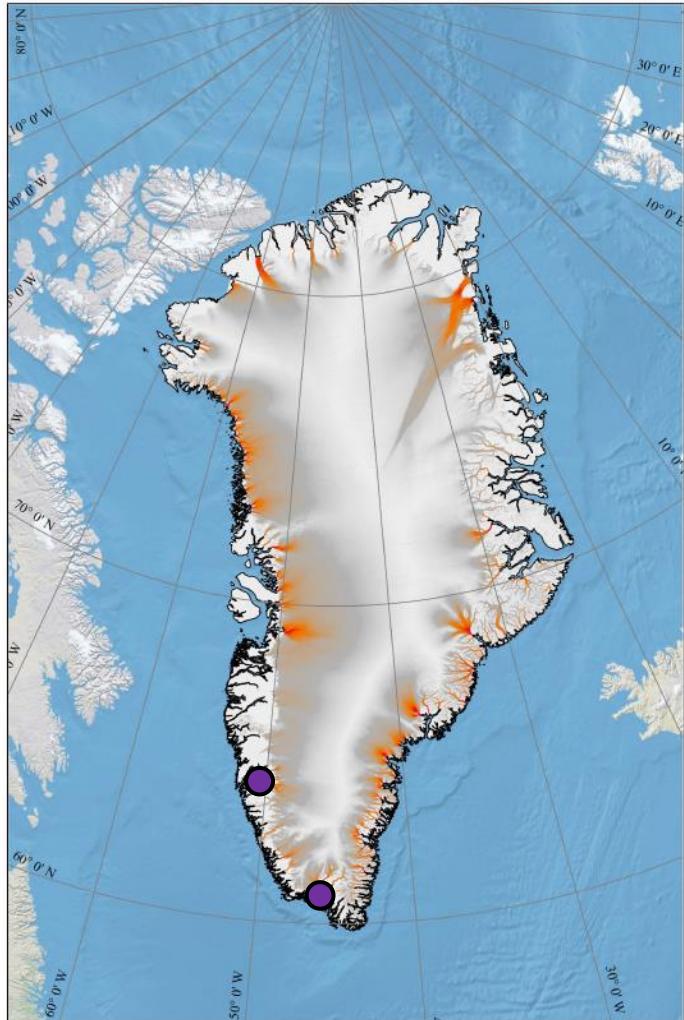
Wieter Boone: [wieter.boone@vliz.be](mailto:wieter.boone@vliz.be)

Thanos Gkritzalis: [thanos.gkritzalis@vliz.be](mailto:thanos.gkritzalis@vliz.be)

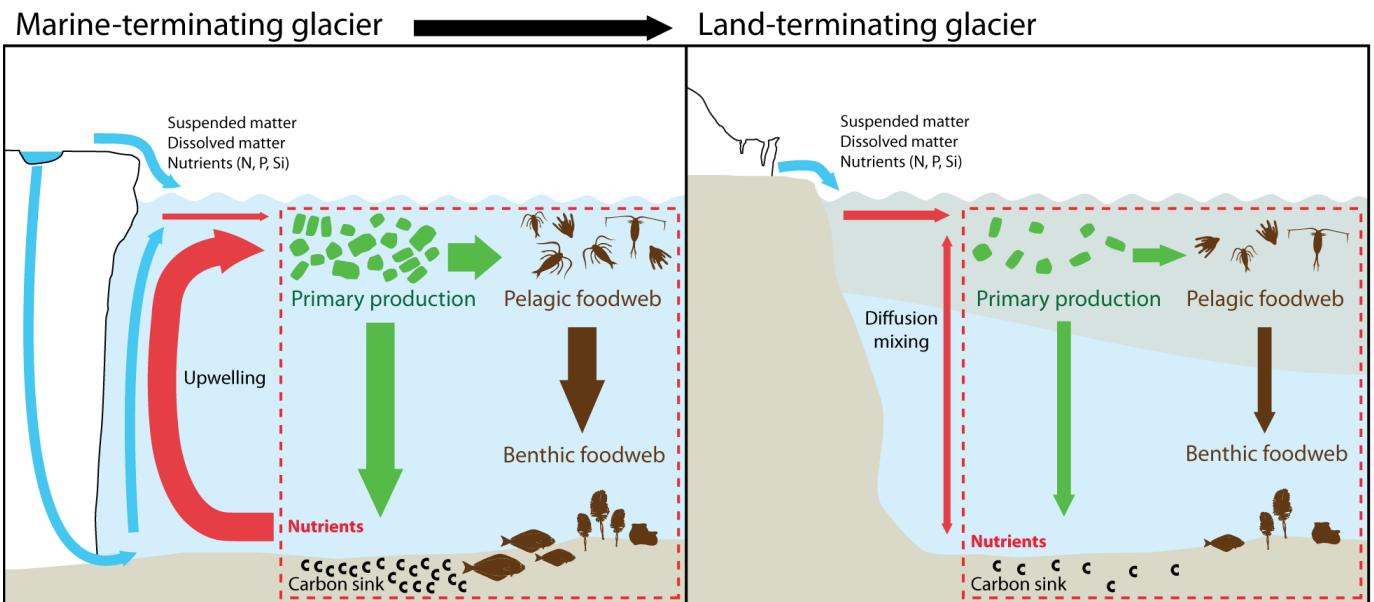
# Greenland Ice-Sheet's impact on Oceanography?



# Greenland Ice-Sheet's impact on Oceanography?



## Impact on benthic biogeochemistry?



Meire et al., 2017, *Global Change Biology*



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# R.V. Belgica – New opportunity to expand Belgian Research in Arctic regions

