

# *The Barents-Kara Ice Sheet response to the CMIP6-PMIP4 simulations for the LGM climate*

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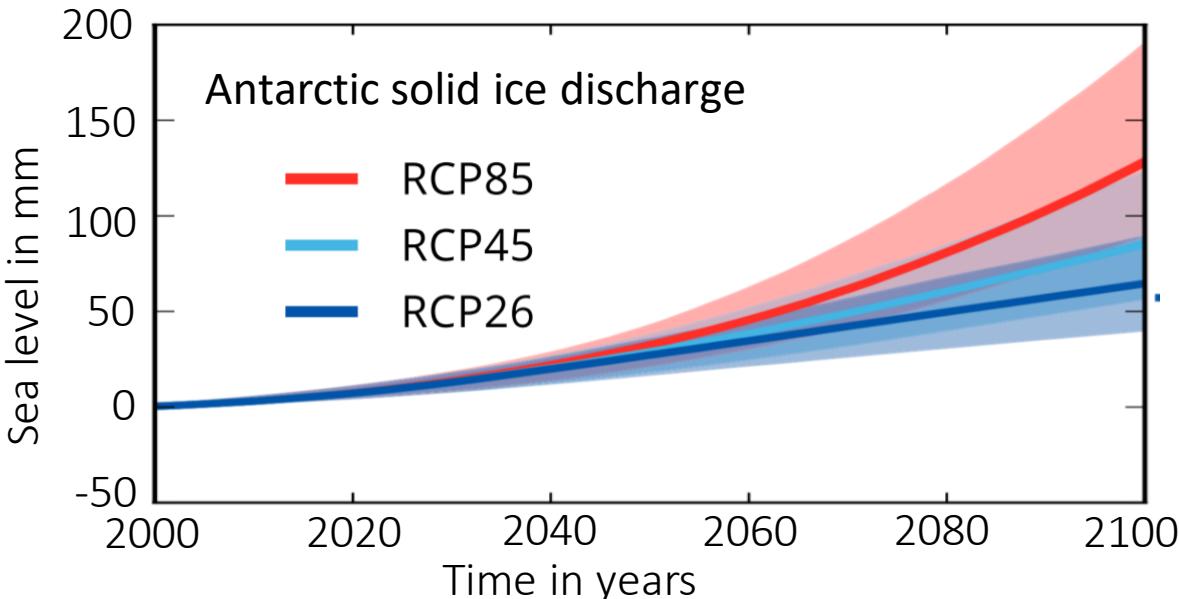
*Funded by ANR EIS*

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## 2. Objectives



Mengel, M. et al, (2016). Future sea level rise constrained by observations and long-term commitment

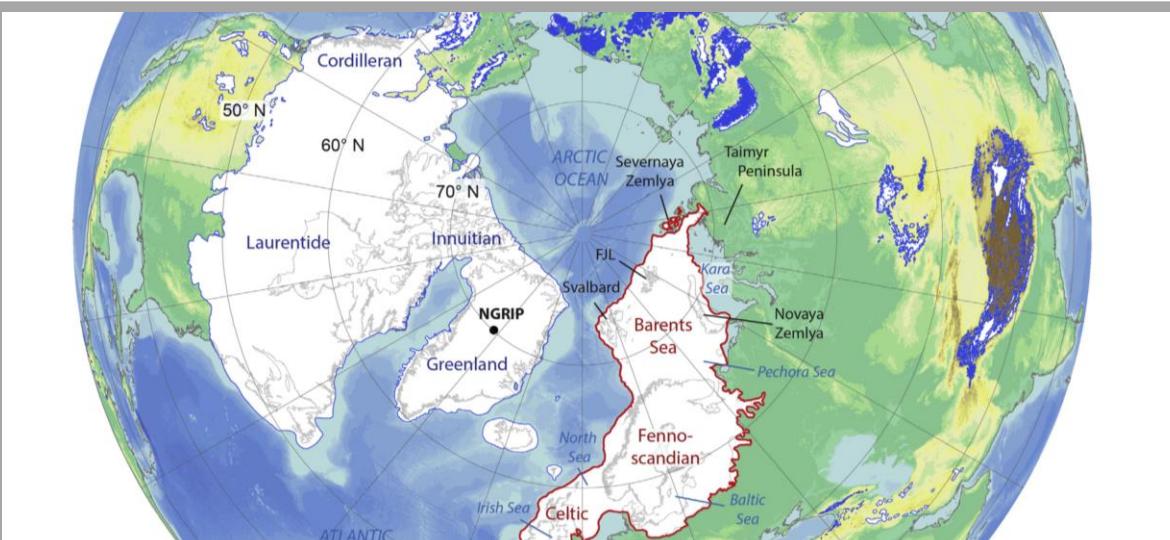
- Since 1990
  - Acceleration of Glacier Outflow
  - Increase in Calving Events
- WAIS Mass Loss increase x6 between 2009 – 2017
- Sea level Rise → Potential impact on human society
- Future evolution WAIS → Large uncertainties
  - Misunderstanding marine ice sheet evolution

Reducing uncertainties → investigate past marine ice sheets

Barents Kara ice sheet (BKIS) at the LGM :

- Marine ice sheet
- Potential analogue to WAIS

*Study the processes responsible for the collapse of the BKIS during the last deglaciation*



Patton, H. et al, (2016). The build-up, configuration, and dynamical sensitivity of the Eurasian ice-sheet complex to Late Weichselian climatic and oceanic forcing

### 3. Approach

#### Simulating BKIS Evolution :

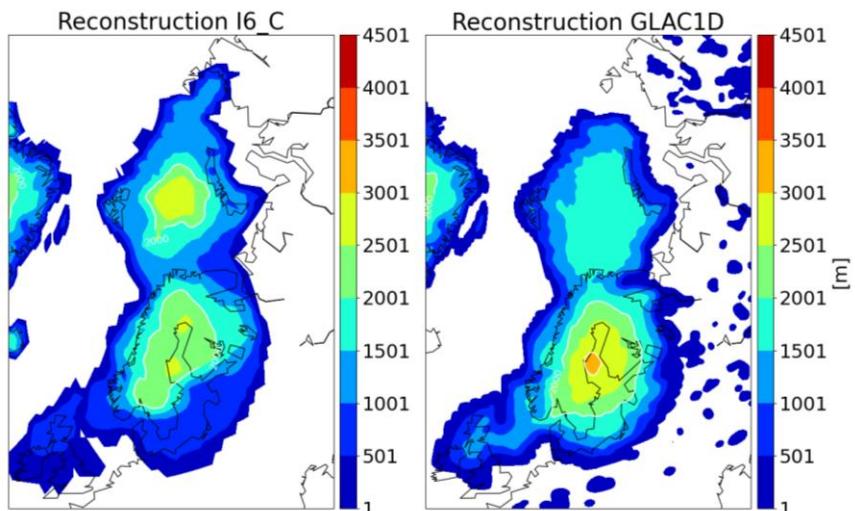
- ❑ GRISLI 2.0 ice-sheet model (20kmx20km) [7]
- ❑ Forced by 5 PMIP4/PMIP3 models

#### New parameterization Basal Melting (BS) :

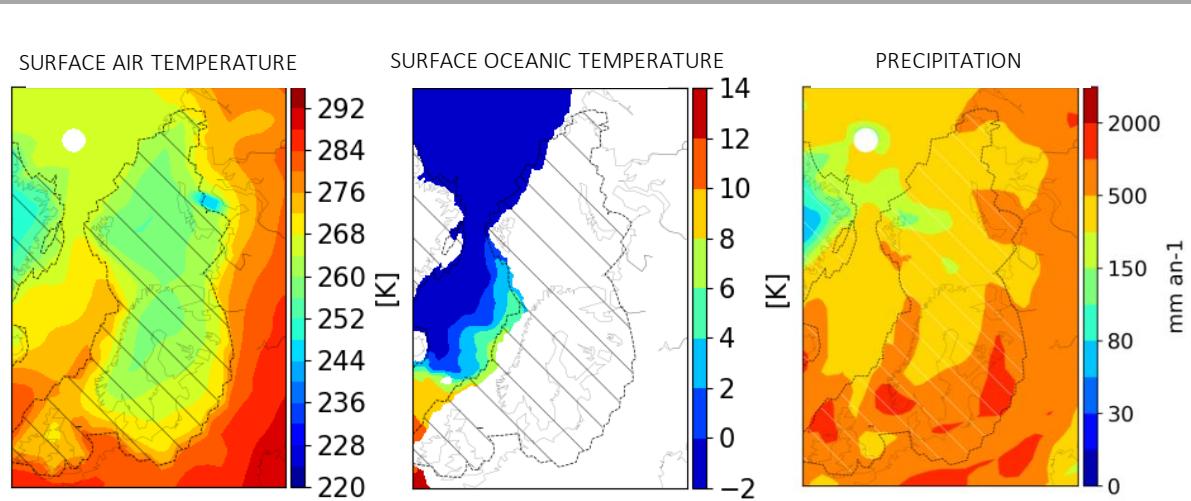
- ❑ DeConto and Pollard, 2016 [8]
- ❑  $BS = K_t * Cte * |T_0 - T_f|(T_0 - T_f)$

*Cte : physical constant,  $T_0$  : ocean temperature,  $T_f$  : freezing temperature (salinity dependence) and  $K_t$  : transfer factor*

Peltier (left) and Tarasov (right) BKIS reconstruction at the LGM



JJA mean Surface air temperature, Surface oceanic temperature and precip for MPI-ESM-P PMIP3

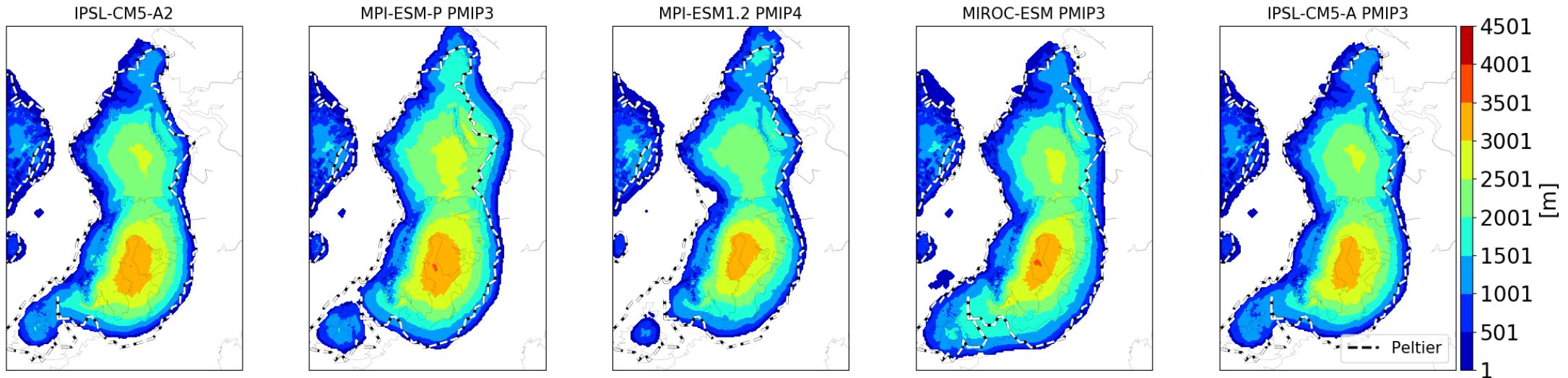


Building BKIS for each GCM (5) with GRISLI model until equilibrium.

Sensitivity studies : anomalies of surface air temperature (TAS) and basal melting ( $K_t$ )

- ❑ Adding Anomalies :
  - TAS  $\rightarrow [+1^\circ\text{C}, +2^\circ\text{C}, +3^\circ\text{C}, +4^\circ\text{C}, +5^\circ\text{C}]$
  - $K_t$  (i.e BS)  $\rightarrow [5, 7, 9, 11, 13, 15]$  (m/yr/C)
  - TAS +  $K_t \rightarrow [+2^\circ\text{C } K_t =[5,9,13]], [+4^\circ\text{C } K_t =[5,9,13]]$

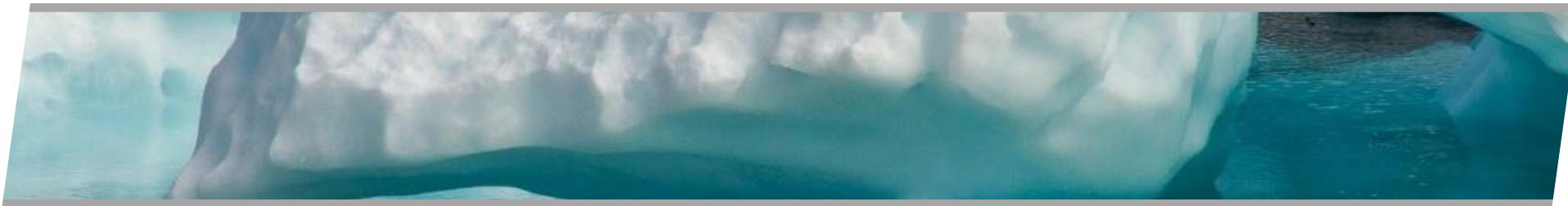
## 4. Simulated LGM ice sheets



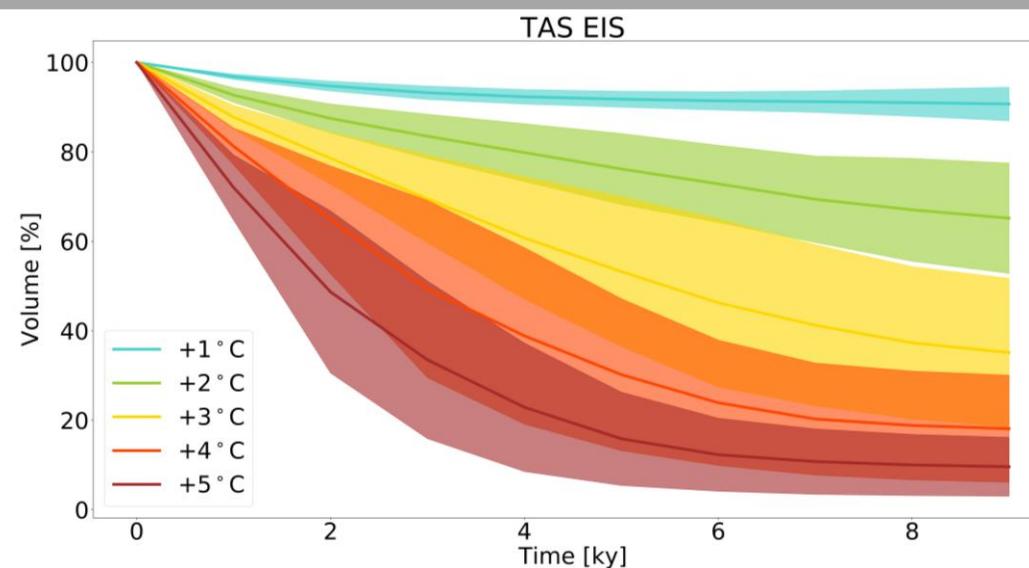
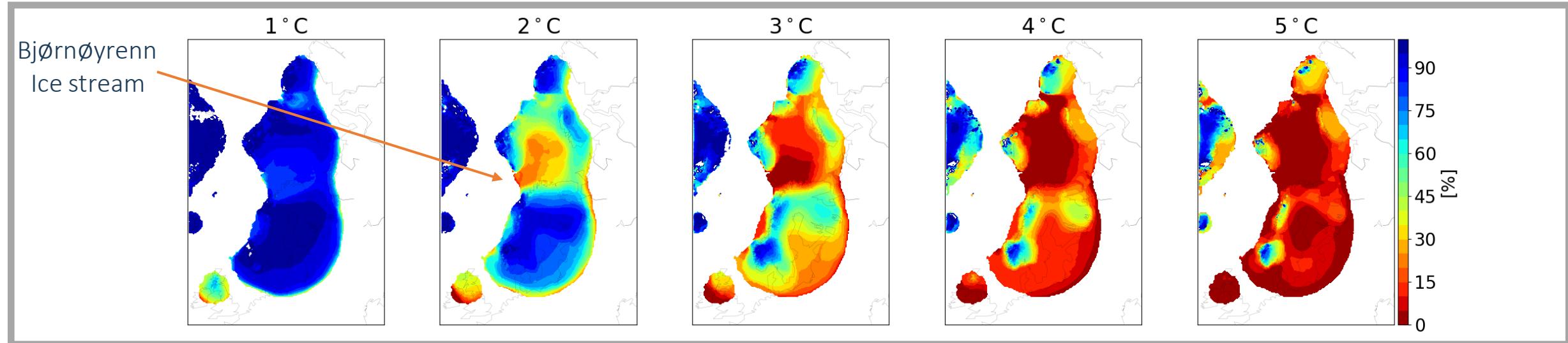
- Initial state : no ice sheet
- 60000 years to reach equilibrium
- GRISLI was forced by absolute climate of PMIP3 and PMIP4 models
- [UP] : Shows the final state for each simulation forced by different climates. Dashed line is the ice sheet extend in the Peltier's reconstruction

Models	Version	IS Boundary Conditions
IPSL-CM5A	PMIP3	Peltier/Tarasov/Lambeck
MPI-ESM-P	PMIP3	Peltier/Tarasov/Lambeck
MPI-ESM1.2	PMIP4	Peltier
MIROC-ESM	PMIP3	Peltier/Tarasov/Lambeck
IPSL-CM5A2	PMIP3	Peltier/Tarasov/Lambeck

## Sensitivity to surface air temperature



## 5. Sensitivity to surface air temperature



[UP] : Multi-model mean of the remaining ice sheet volume compared to the initial ice sheet. (Blue : 100% remains, Red : 0% remains)

- BKIS more sensitive than FIS
- Weak point : Bjørnøyrenn

[LEFT] : Multi-model mean of the Eurasian Ice Sheet volume evolution. Shaded areas show the standard deviation

- Large spread between models

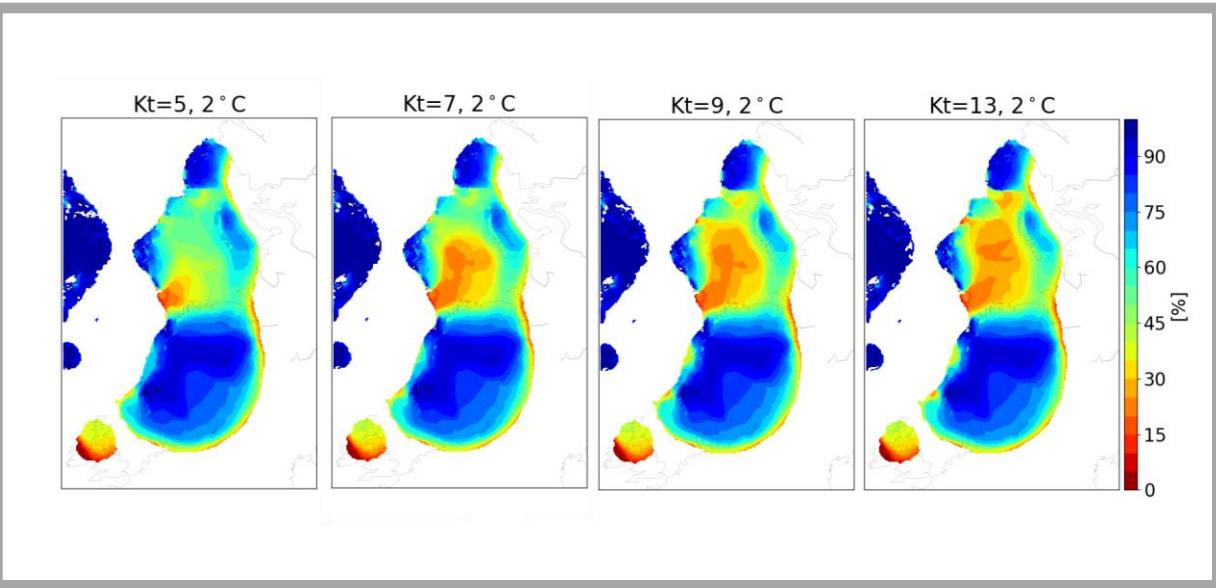
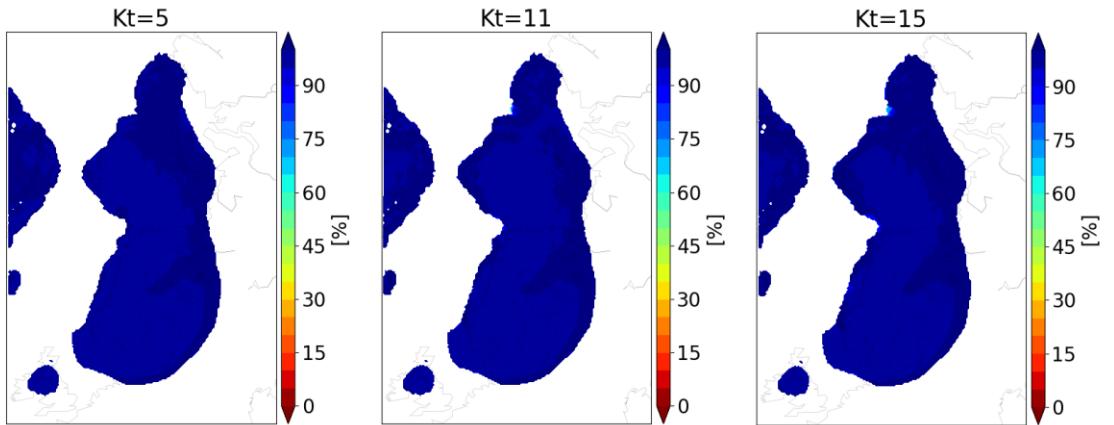
## Sensitivity to basal melting



## 6. Sensitivity to basal melting

[DOWN] : Multi-model mean of the Ice Sheet volume evolution with a basal melting anomaly. (Blue : 100% remains, Red : 0% remains)

- Anomalies [Kt =(5,11,15)] :
  - No change is observed
- Basal melting → strong effect on ice shelf
  - Initial ice sheet → More than 95% of the ice sheet is grounded ice → No ice shelf



[UP] : Multi-model mean of the remaining ice sheet volume compared to the initial Ice Sheet for basal melting + TAS anomalies (Blue : 100% remains, Red : 0% remains)

- Anomalies [+2°C + Kt =(5,7,9,13)] : More Kt increases greater the BKIS mass loss is important. FIS is not impacted
- TAS anomalies disturb the equilibrium and create ice shelf  
→ Kt has an effect

## 7. Conclusion

- ❑ GRISLI ice model forced by 5 different climates to observe BKIS sensitivity
- ❑ BKIS sensitivity to atmospheric surface temperature has shown
- ❑ Because of the initial state (> 90% grounded ice), BKIS is not sensitive to a basal melting anomaly
  - Basal melting anomaly coupled with a constant surface air temperature anomaly shows BKIS sensitivity

Perspective :

- ❑ Sea level sensitivity
- ❑ Precipitation sensitivity
- ❑ BKIS last deglaciation

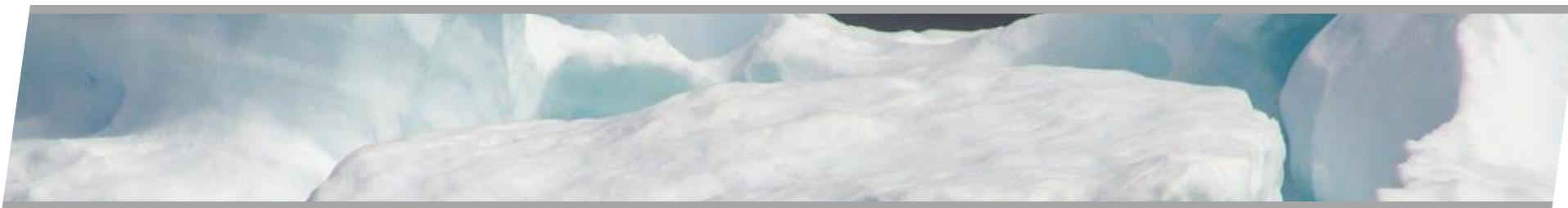


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Thank you for reading

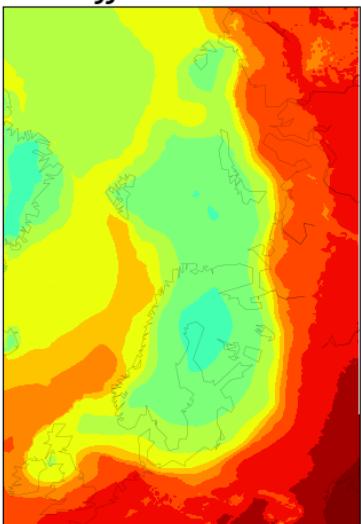


## SUPPLEMENTARY

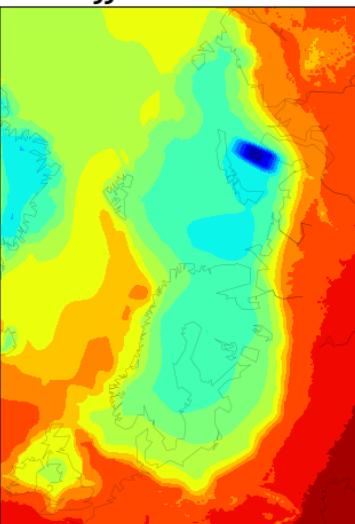


## JJA surface air temperature

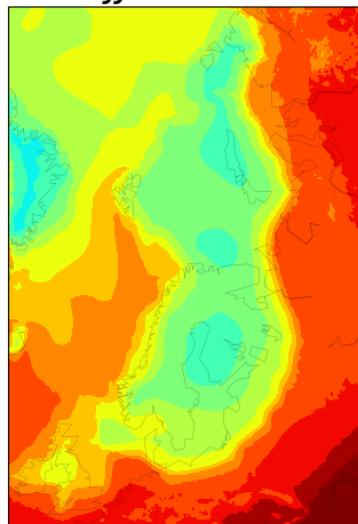
TJJA IPSLA2



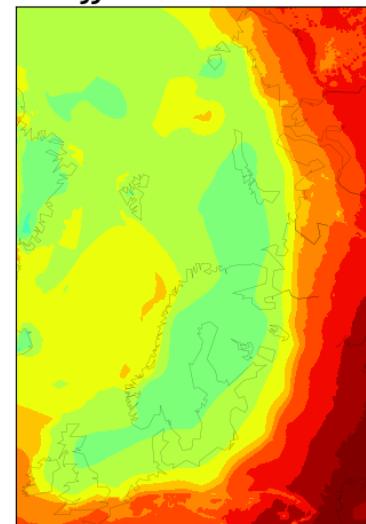
TJJA MPI P3



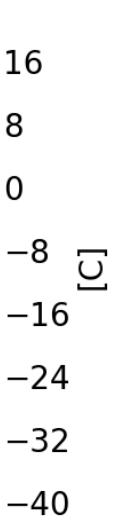
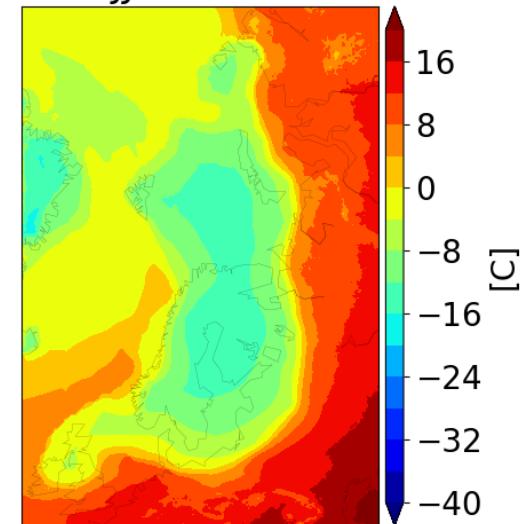
TJJA MPI P4



TJJA MIROC P3

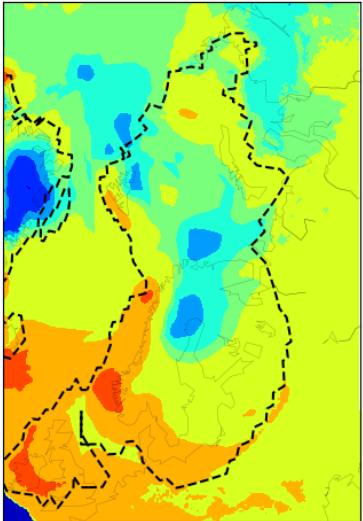


TJJA IPSL P3

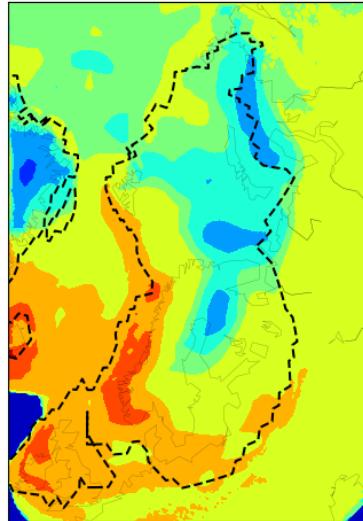


## Accumulation

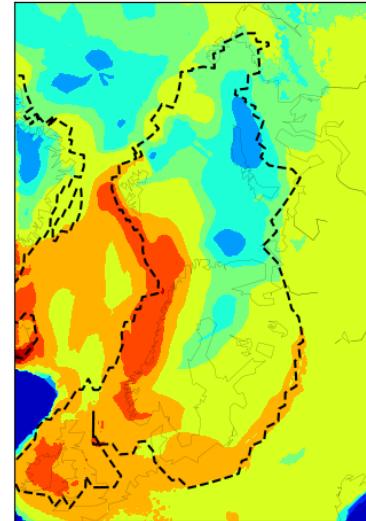
Acc IPSLA2



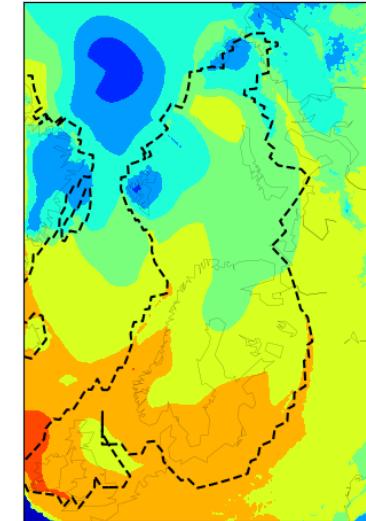
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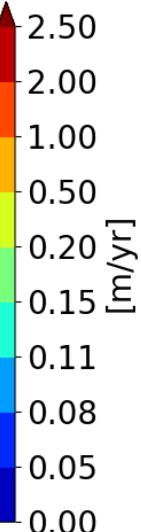
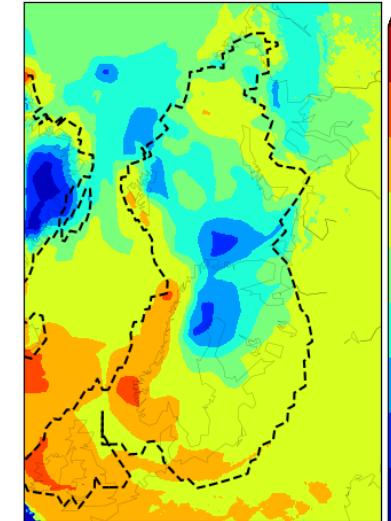
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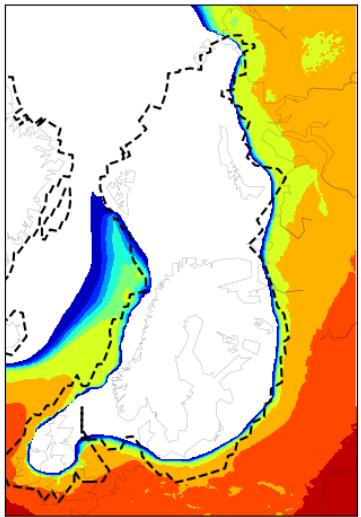


Acc IPSL P3

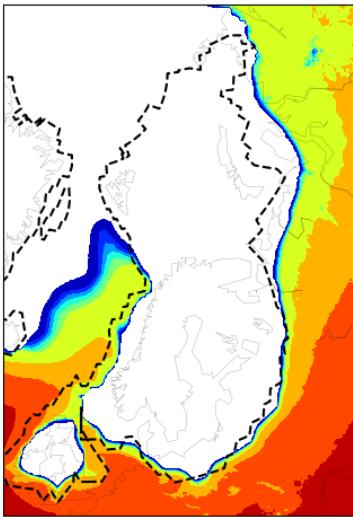


## Ablation

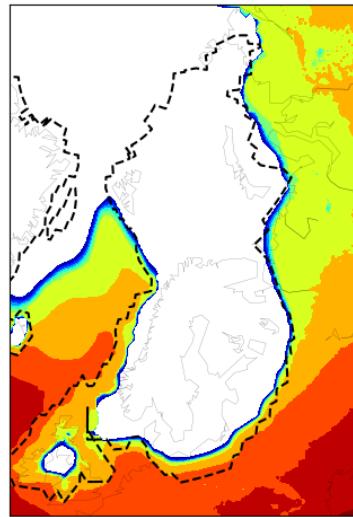
Abl IPSLA2



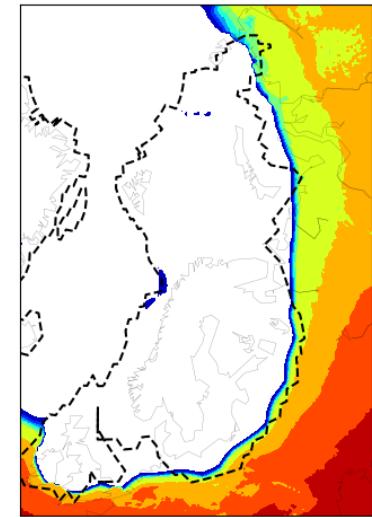
Abl MPI P3



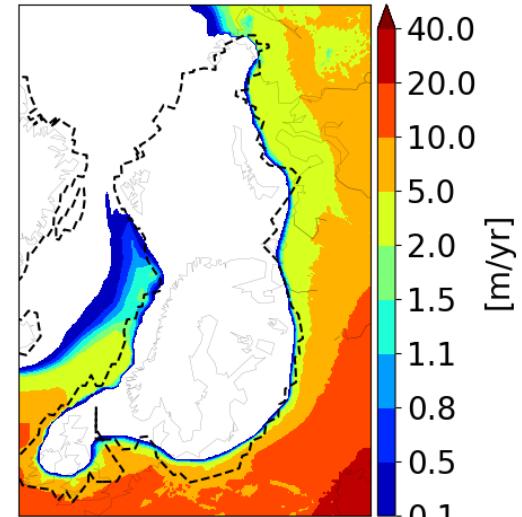
Abl MPI P4



Abl MIROC P3



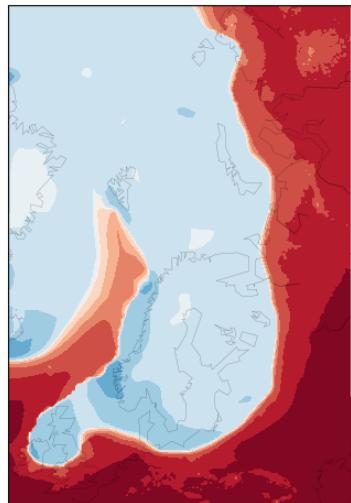
Abl IPSL P3



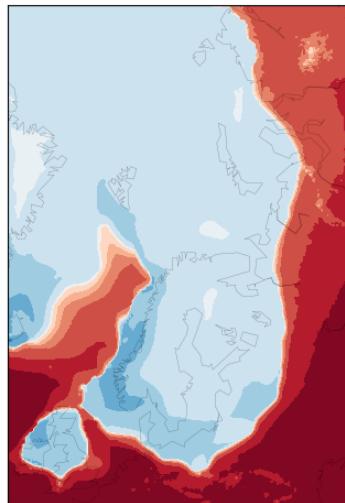
[m/yr]

## Surface mass balance

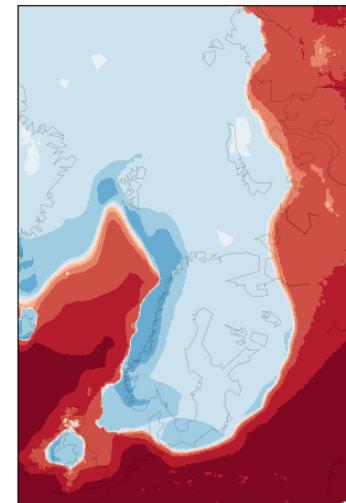
SMB IPSLA2



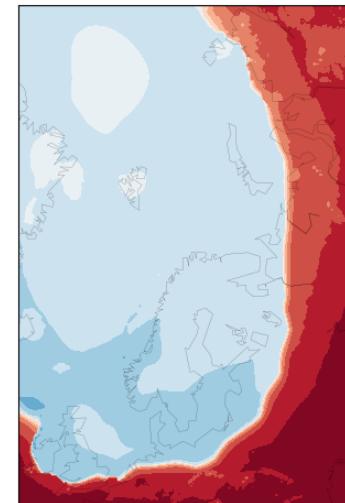
SMB MPI P3



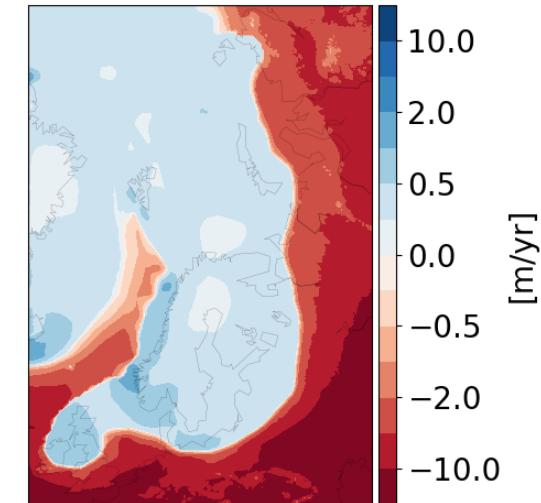
SMB MPI P4



SMB MIROC P3



SMB IPSL P3



[m/yr]