updated title

# Towards coupling within a peri-Antarctic setup: Sensitivity of the ice-sheet model for the temporal resolution of sub-shelf melt rates provided by the ocean model

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# PARAMOUR

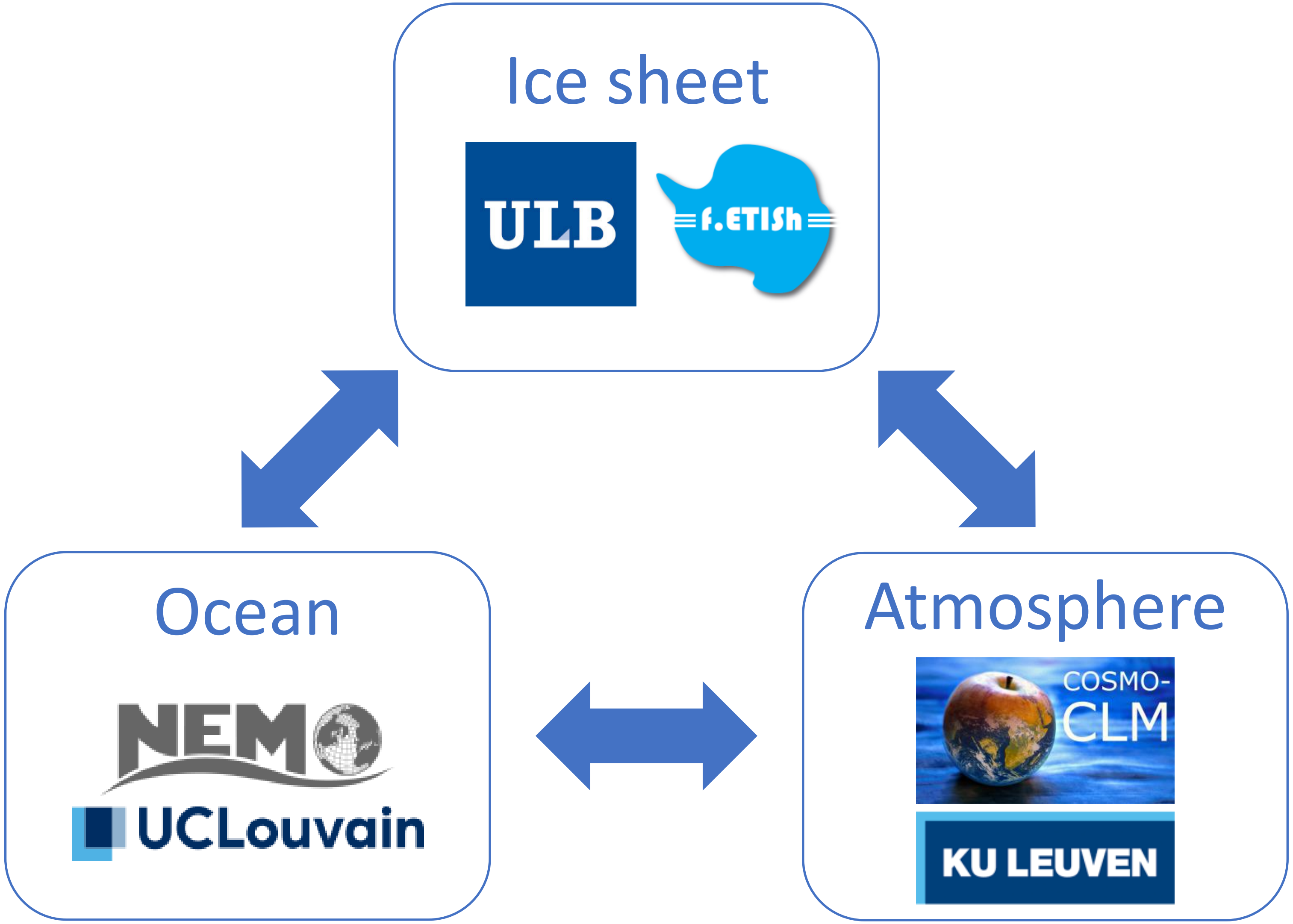
Decadal Predictability and vAriability of polar climate: the Role of AtMosphere-Ocean-cryosphere mUltiscale inteRactions

Coupling of ocean, atmosphere and ice sheet model for:

1) **Antarctica and the Southern Ocean**
2) The Totten glacier region
3) Greenland, the Arctic and the North Atlantic sector

Retrospective (1980-2015) and prospective (2015-2045) climate simulations

## Coupled model system for Antarctica and the Southern Ocean:



# PREPARATION FOR ICE-OCEAN COUPLING

Peri-Antarctic setup for ice-ocean coupling (ice perspective):

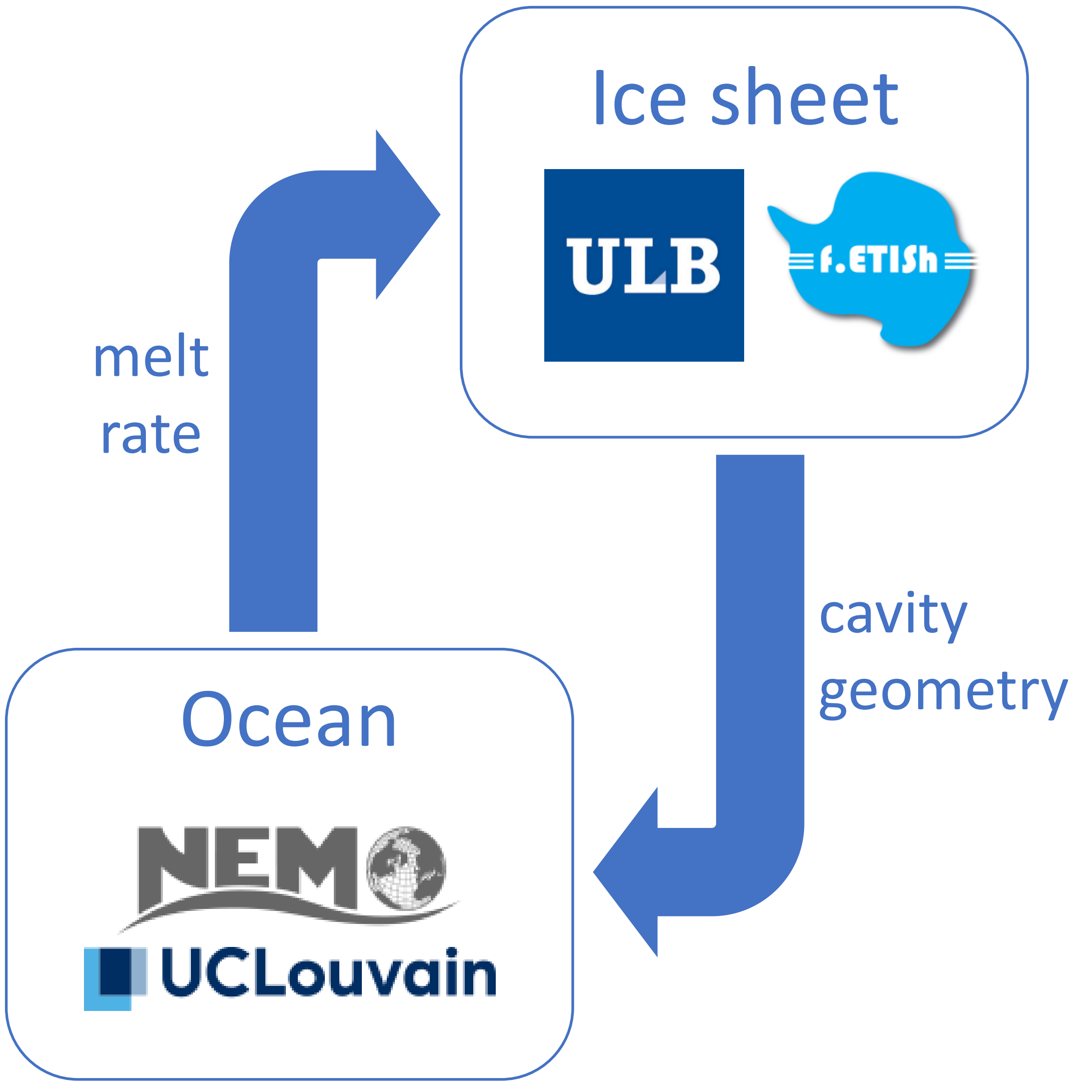
- Ice sheet model f.ETISh *(Pattyn, 2017)*, 8km resolution
- Sub-shelf melt rates from ocean model NEMO (see: EGU2020-5647 by Pelletier et al.)
- Ice shelf cavity geometry delivered to ocean model

  → Coupling frequency and temporal resolution of sub-shelf melt rates needs to be determined

**This study:**
**Sensitivity of the ice sheet model for the temporal resolution of melt rates**

**→ no coupling within this study**

## Data exchange between ice sheet and ocean model at each coupling step



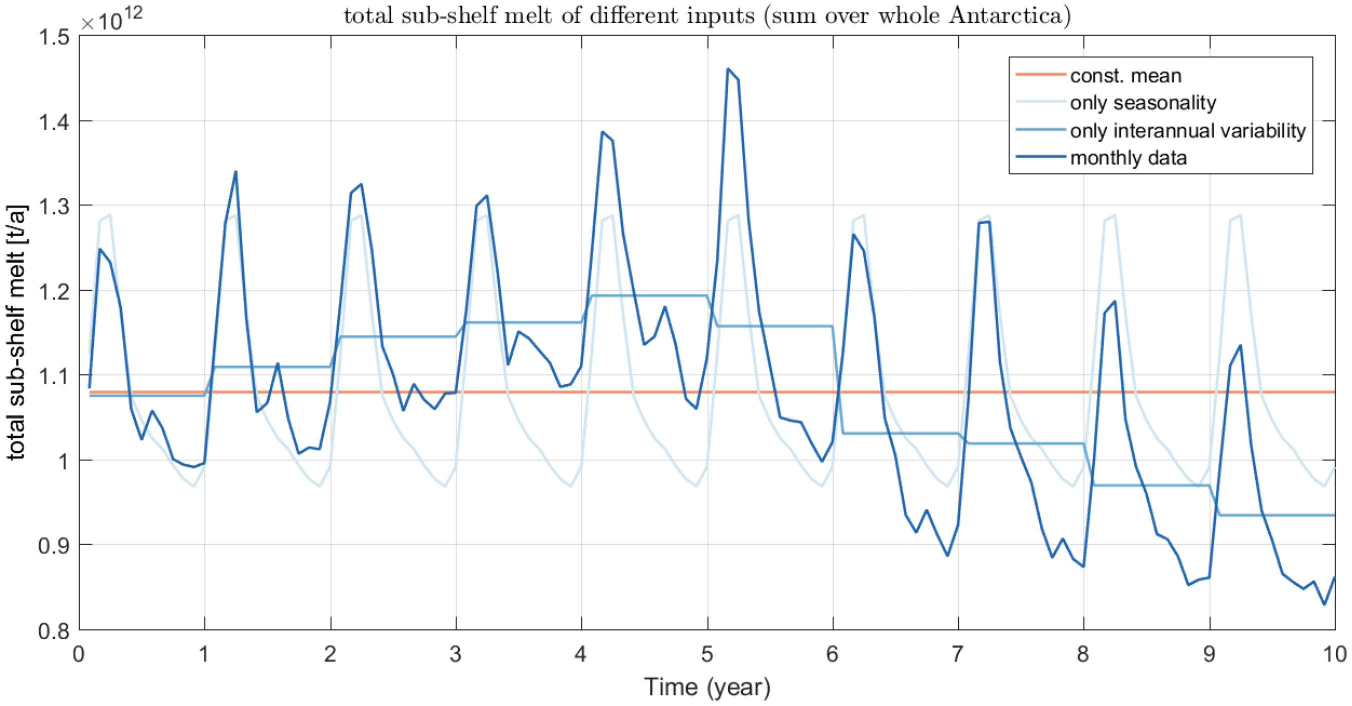
# STUDY SETUP

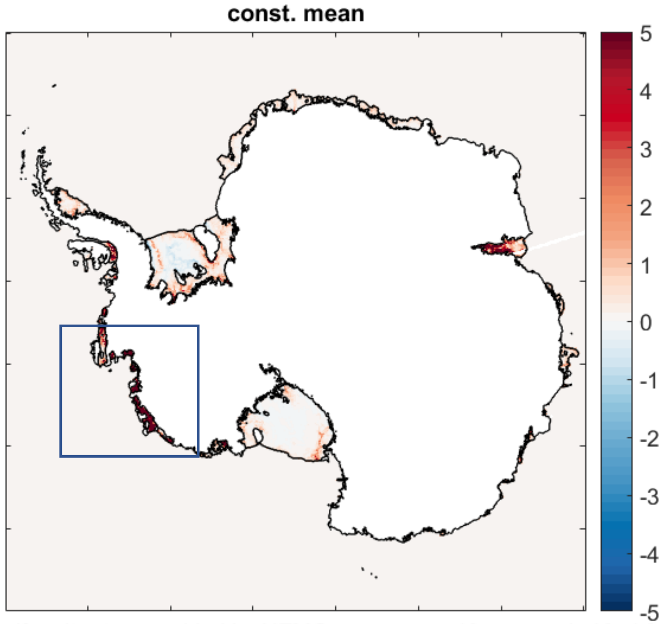
Standalone f.ETISh runs over 100 years

Sub-shelf melt rate from stand-alone NEMO run (10 years, 1984-1993, monthly melt rates)

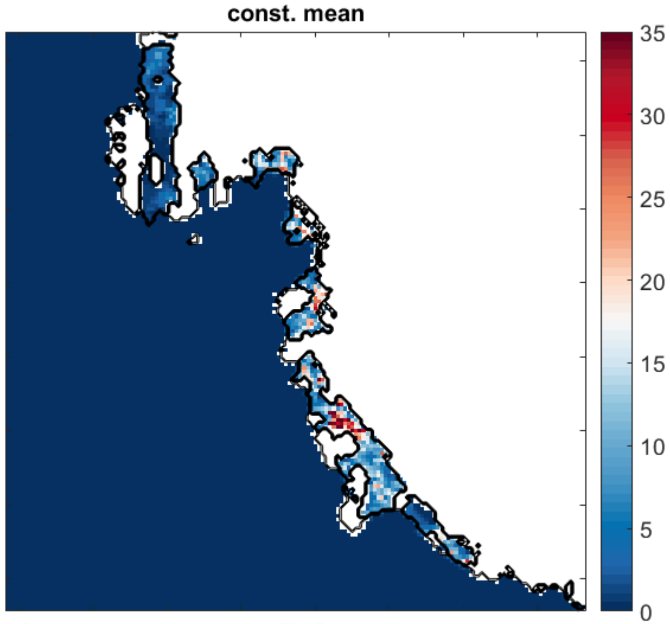
→ basis for 4 melt rate data-sets:

- **“monthly data”**
  - Original 10 years run by NEMO with monthly melt rates
  - Used in a loop (10 times in a row)
- **“only seasonality”**
  - Monthly 10 year mean melt rates
  - Identical years
- **“only interannual variability”**
  - Yearly mean melt rates
  - Used in a loop (10 times in a row)
- **“const. mean”**
  - Mean melt rates over whole NEMO run
  - Constant for whole run




sub-shelf melt rates provided by NEMO: mean over 10 year period [m/a]




sub-shelf melt rates provided by NEMO: mean over 10 year period [m/a]

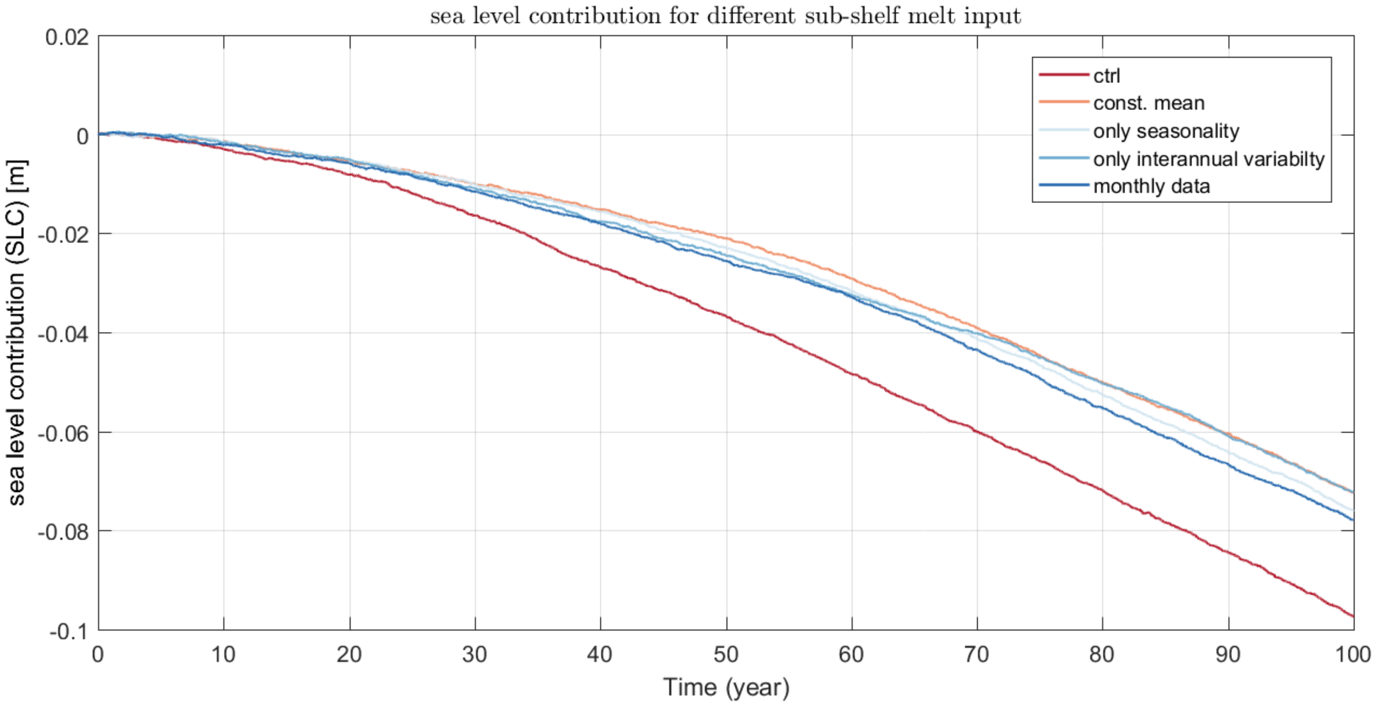
# RESULTS

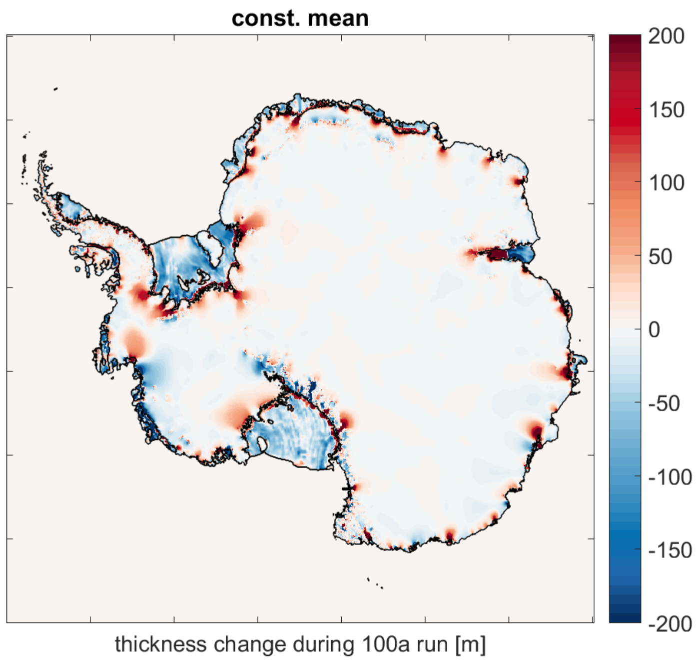
Negative drift for all experiments, but mass loss compared to control run (“ctrl”)

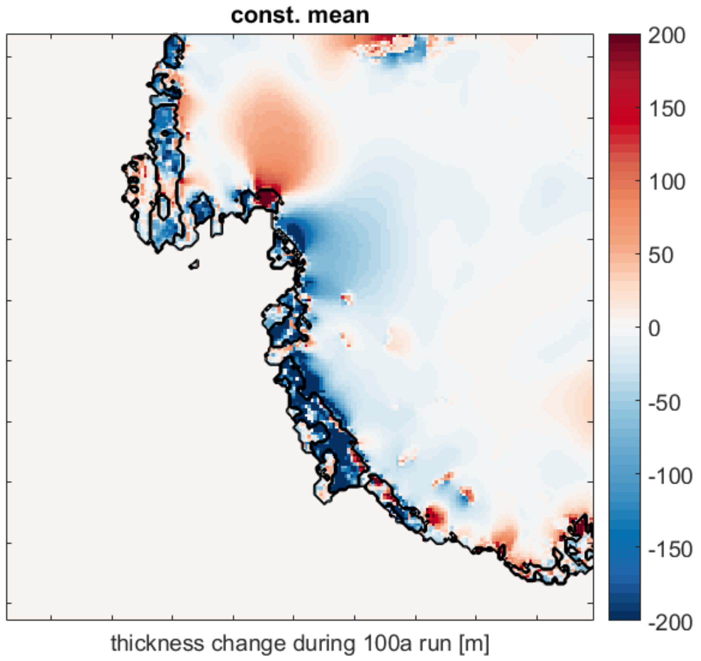
Thickness changes dominated by:

- strong thickening of narrow ice streams with high bed variability that cannot be well resolved
- Mass loss for Amundsen Sea area (exception Pine Island Glacier)
- Thinning for almost all ice shelves

Smaller SLC (mm scale) for monthly resolution of melt data (“only seasonality” + “monthly data”) compared to yearly or const. melt data



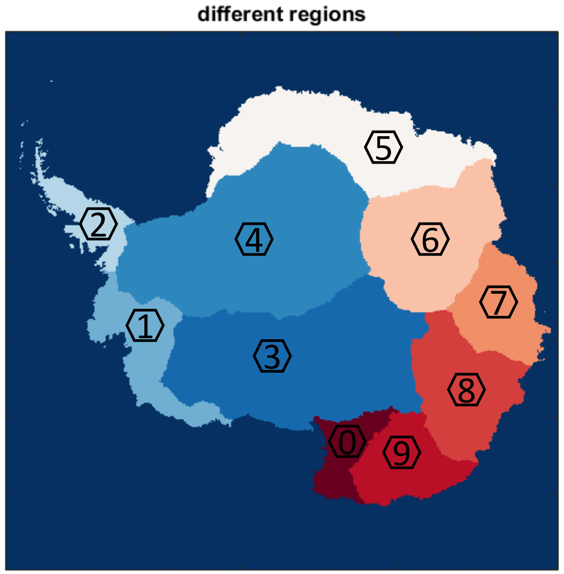
# RESULTS

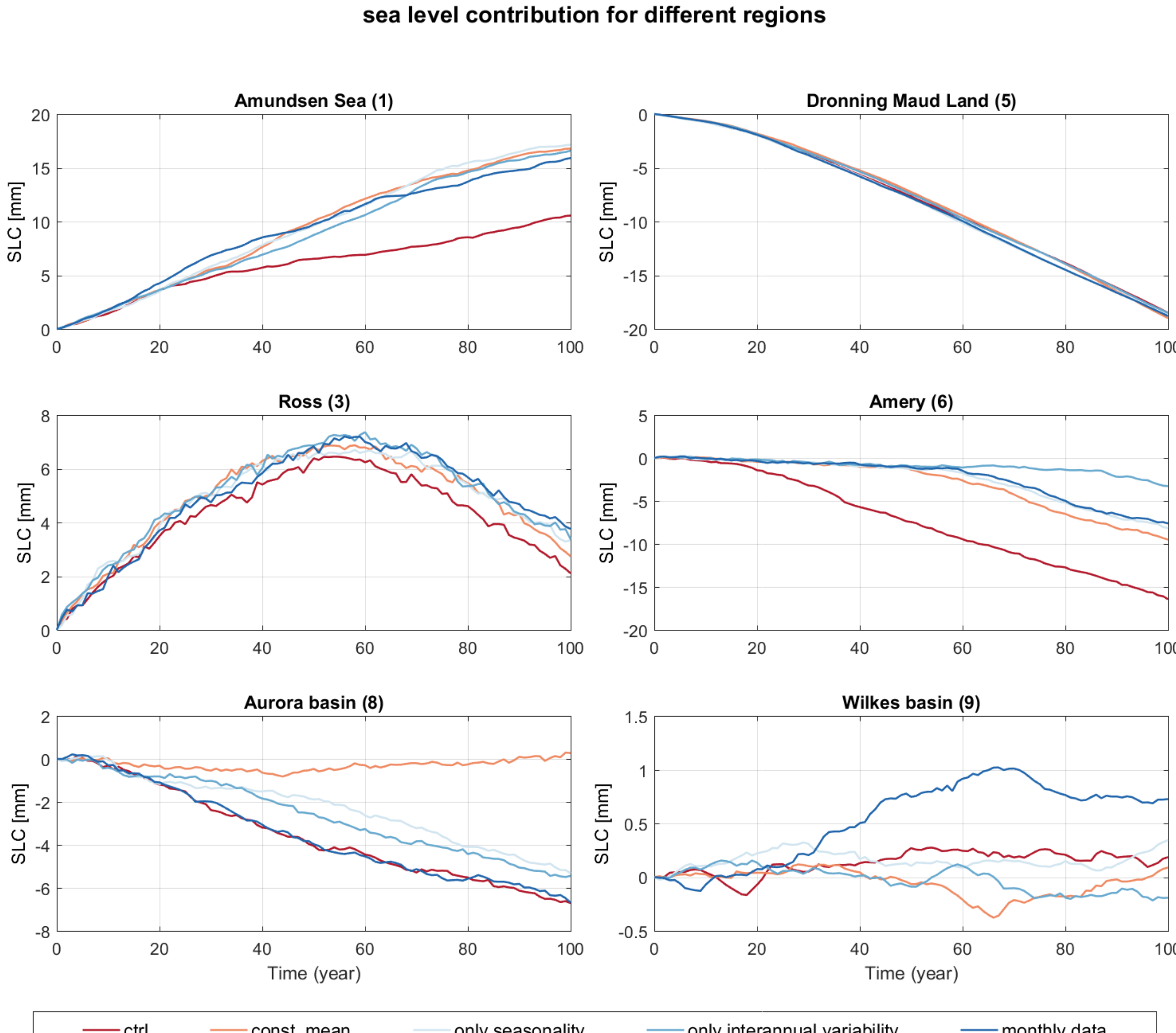
## DIFFERENT REGIONS

Many regions (2, 4, 7) show comparable behavior to Dronning Maud Land (5): negative drift, limited influence of different melt data sets

Particularly East Antarctica seems to be sensitive:

Amery (6), Aurora basin/Totten (8) and Wilkes basin (9) show strong spread for different temporal resolution of melt rates



# RESULTS
## SPATIAL PATTERN

All experiments show comparable thickness evolution

Neglectable influence on ice shelf thickness changes

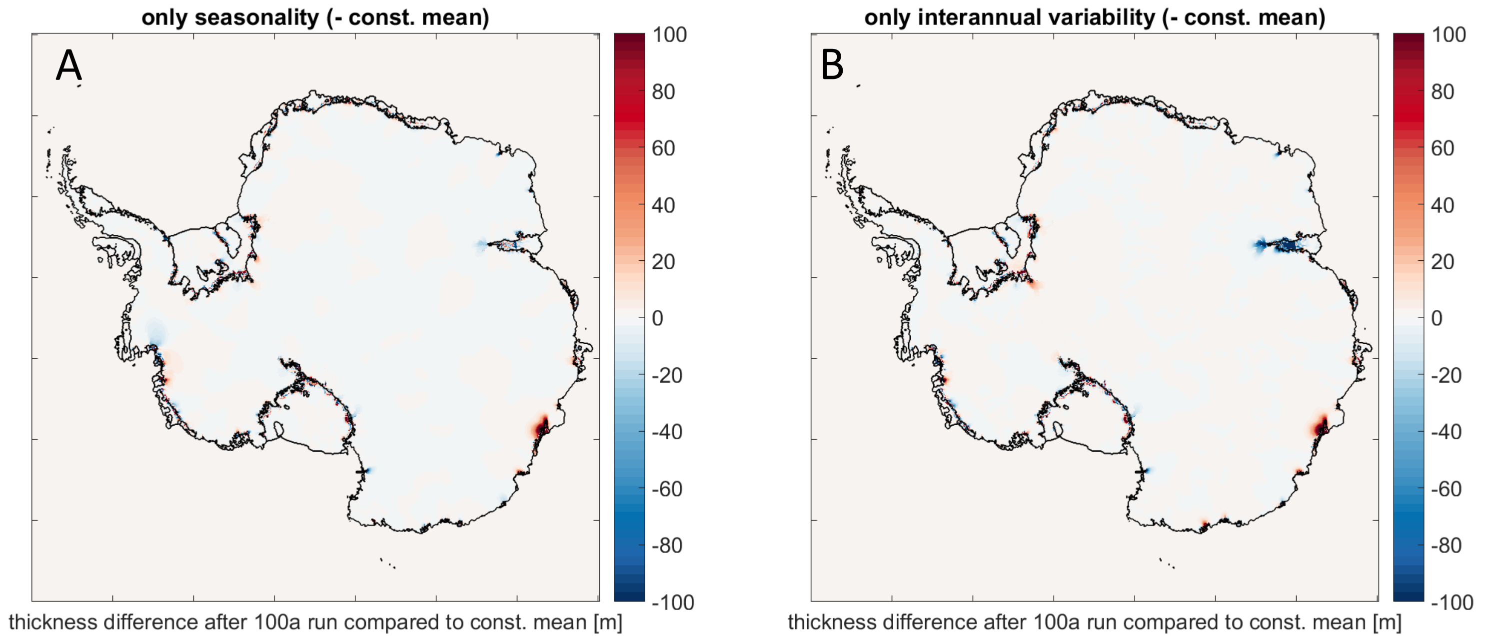
For higher temporal resolution of melt data:

- Stronger thickening for Totten (8)
- Less mass loss for Thwaites (1)
- Less thickening for Amery (6)

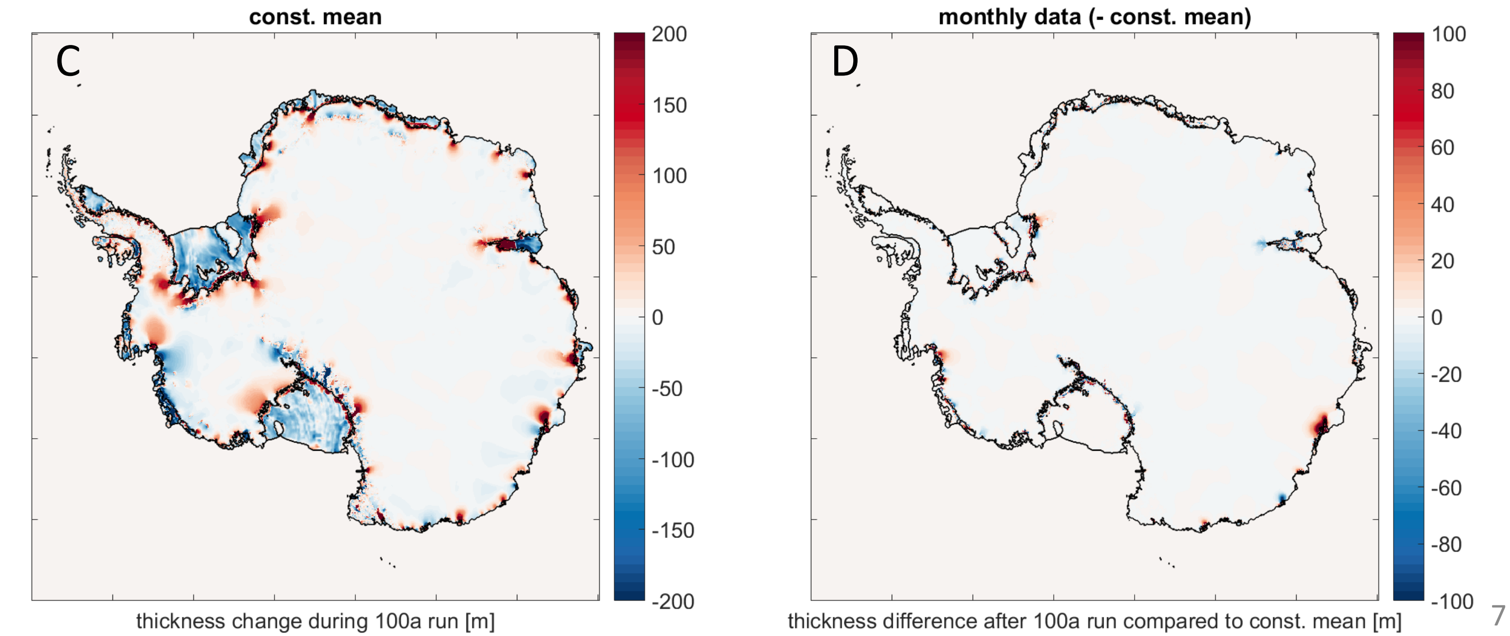
Possible reasons for experiment differences:

- Temporal resolution of the melt data
- Model uncertainty for narrow ice streams

→ More experiments needed




**Thickness change during 100 years run with const. mean melt (C) and thickness change anomalies (compared to fig. C) for seasonality (A), interannual variability (B) and the monthly data (D)**

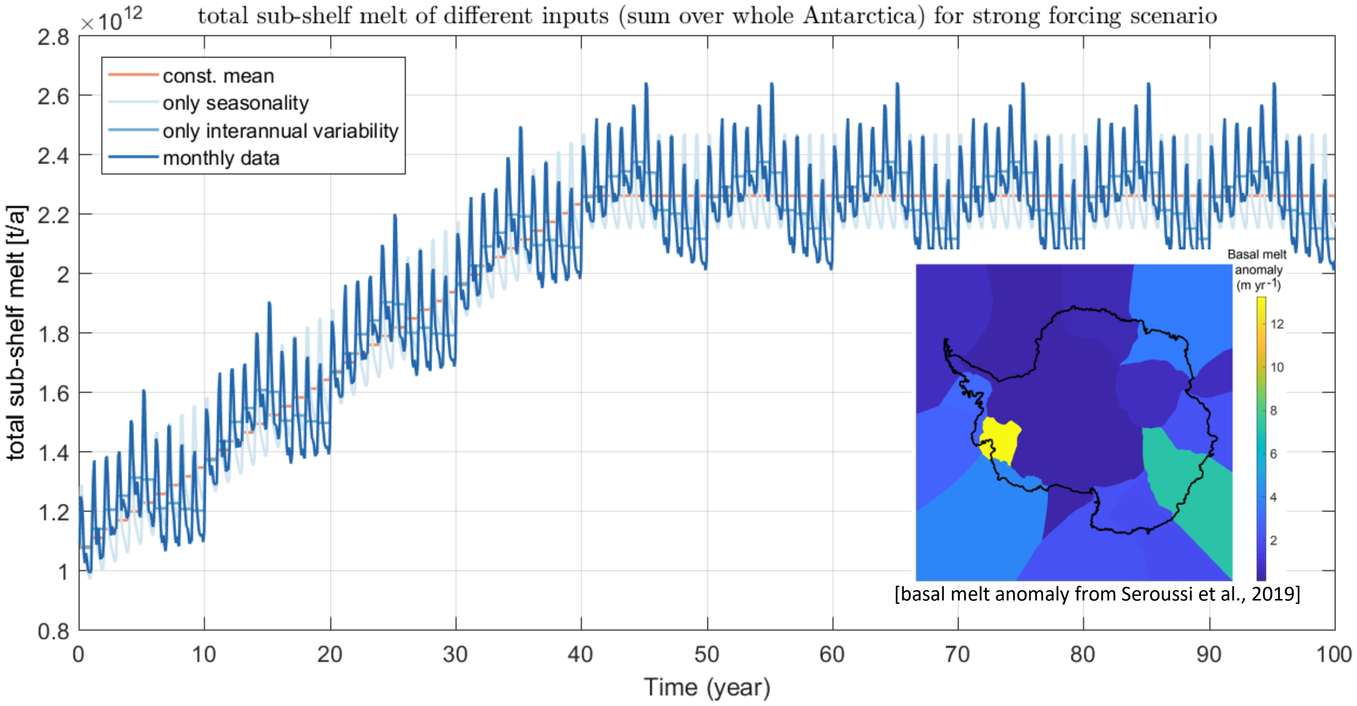


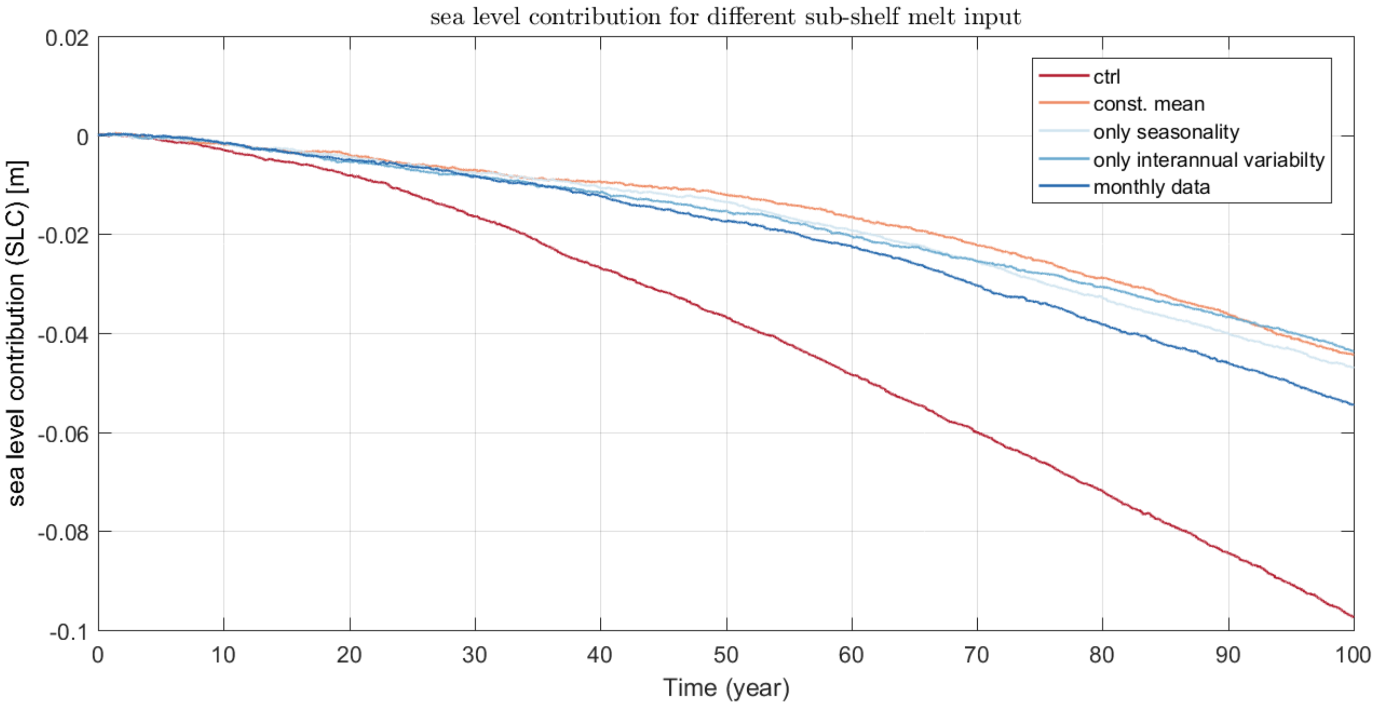
# RESULTS
## INCREASED MELT

Melt anomaly added to melt rate data sets (based on experiments before)
- Based on initMIP-Antarctica *(Seroussi et al., 2019)*
- Different melt anomaly for different regions
- Added anomaly increases stepwise (yearly) over first 40 years, then kept constant

Larger mass loss than for experiments without melt anomaly (less negative SLC)

Smaller SLC (mm scale) for monthly resolution of melt data ("only seasonality" + "monthly data")
→ In accordance with experiments without melt anomaly



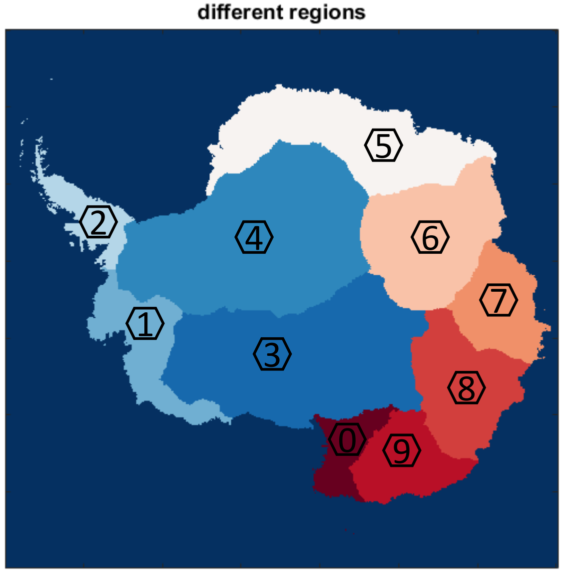



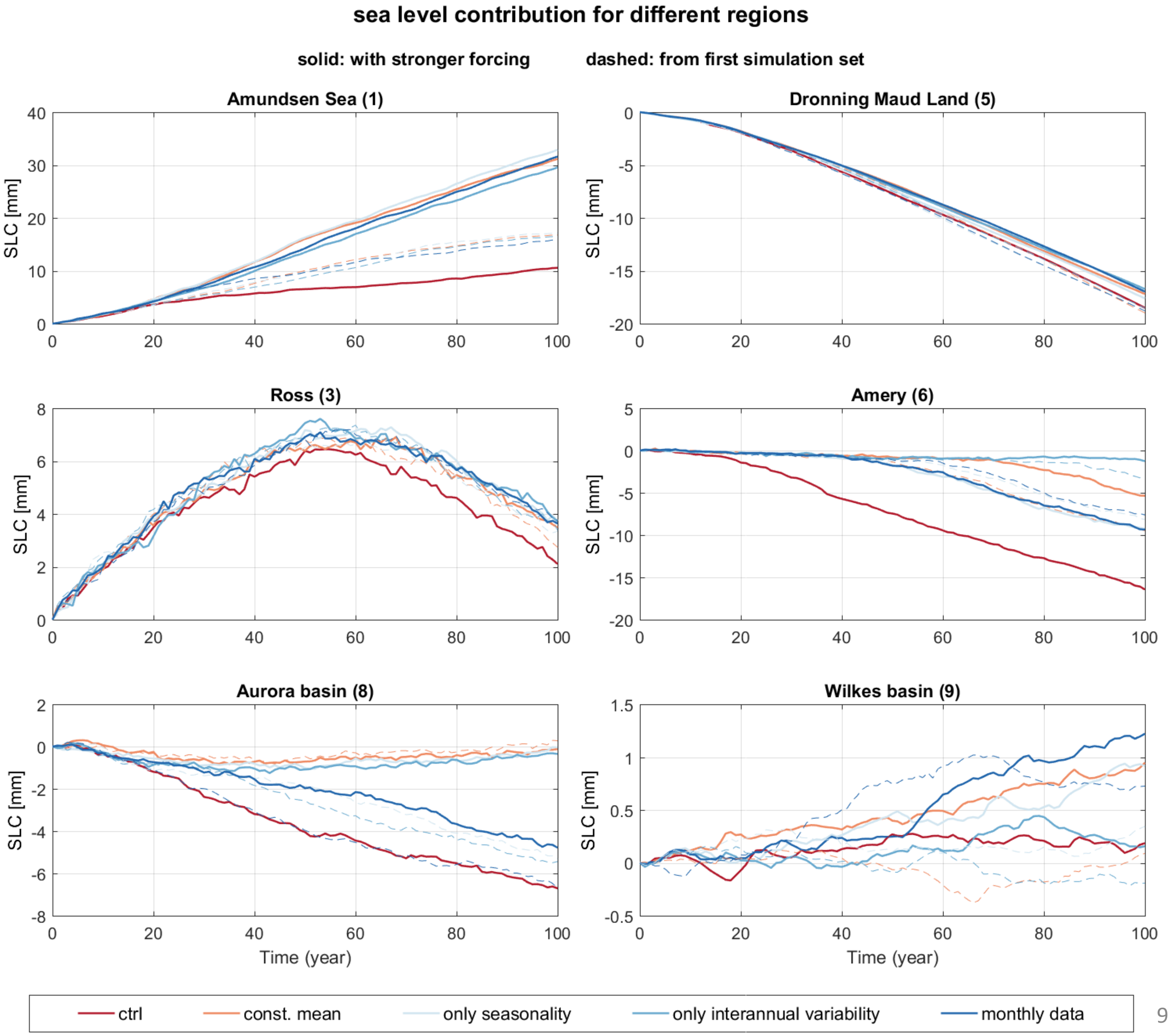
# RESULTS
## INCREASED MELT

SLC for Amundsen Sea area (1) doubles

For East Antarctica (6, 8, 9):

- Strong spread for different temporal resolution of melt rates (similar to first simulation set)
- No consistent dependency on the melt rate data set

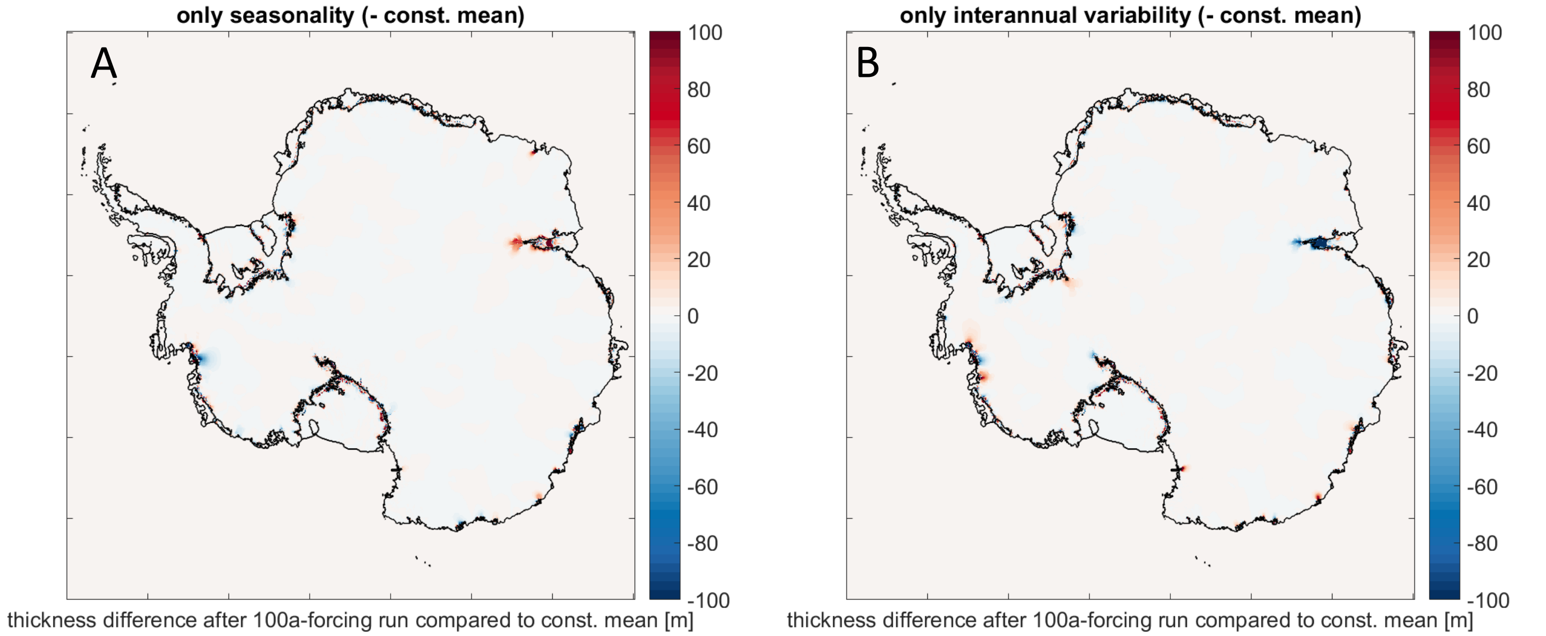


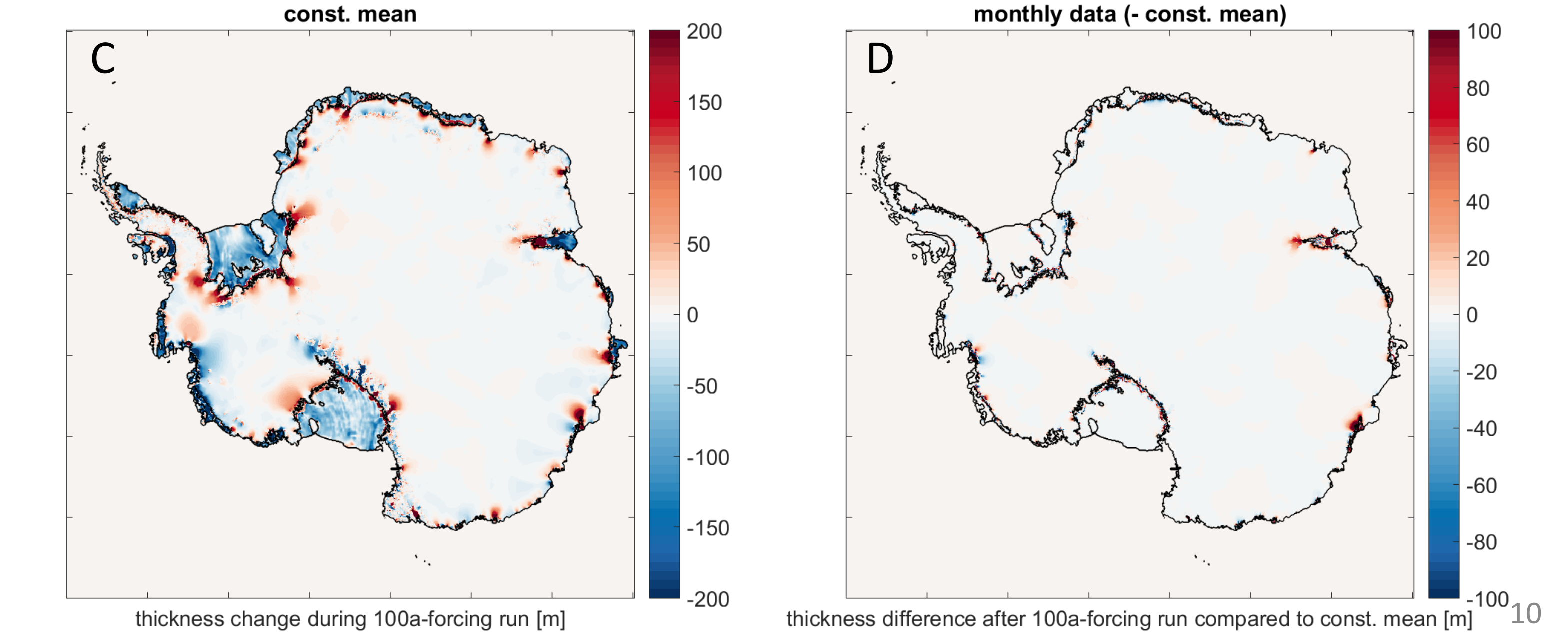
# RESULTS
## INCREASED MELT

Compared to experiments without melt anomalies:

- Comparable spatial pattern of thickness changes
- Stronger thinning of ice shelves
- Same regions with thickness change anomalies, but different behavior
    - Stronger mass loss for Thwaites (1)
    - Increased thickening for Amery (6)
- Comparable behavior for Totten glacier (8)




Increased melt: Thickness change during 100 years run with const. mean melt (C) and thickness change anomalies (compared to fig. C) for seasonality (A), interannual variability (B) and the monthly data (D)



# SUMMARY

## Sensitivity for temporal resolution of melt rates

Limited influence on ice shelf thickness changes

Minor impact of temporal resolution on sea level contribution for most regions

Totten glacier, Thwaites glacier and Amery show largest variability within experiments

Preliminary results, experiments still ongoing

## Outlook

- Runs for further temporal resolutions for melt data (weekly, 3-monthly)
- Repeat study with different melt data sets to better determine between changes due to temporal resolution of melt rates and model uncertainty
- Sensitivity of sub-shelf melt rates for coupling frequency (cavity geometry update within ocean model)
- Introducing sub-shelf melt feedback on changing cavity geometry by coupling with ocean model

## References


- Pattyn, 2017, https://doi.org/10.5194/tc-11-1851-2017
- Seroussi et al., 2019, https://doi.org/10.5194/tc-13-1441-2019

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