Changes on Totten glacier dependent on oceanic forcing based on ISMIP6

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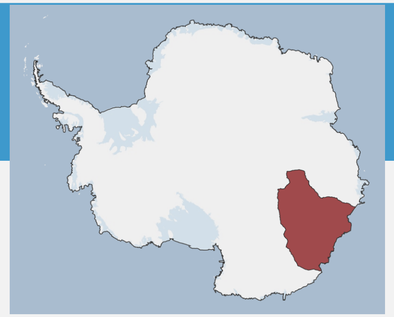
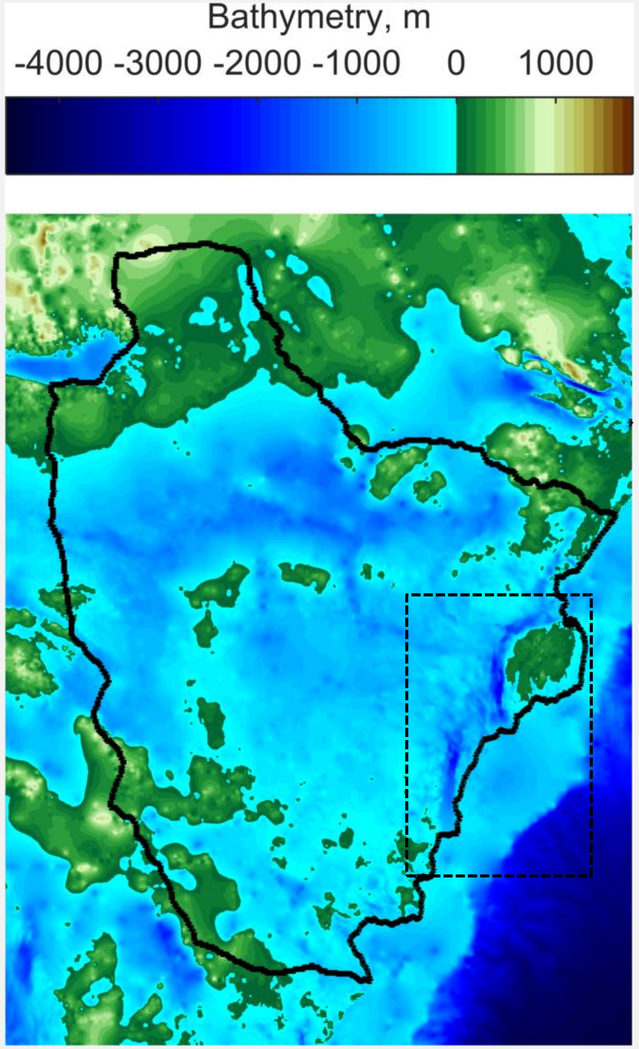
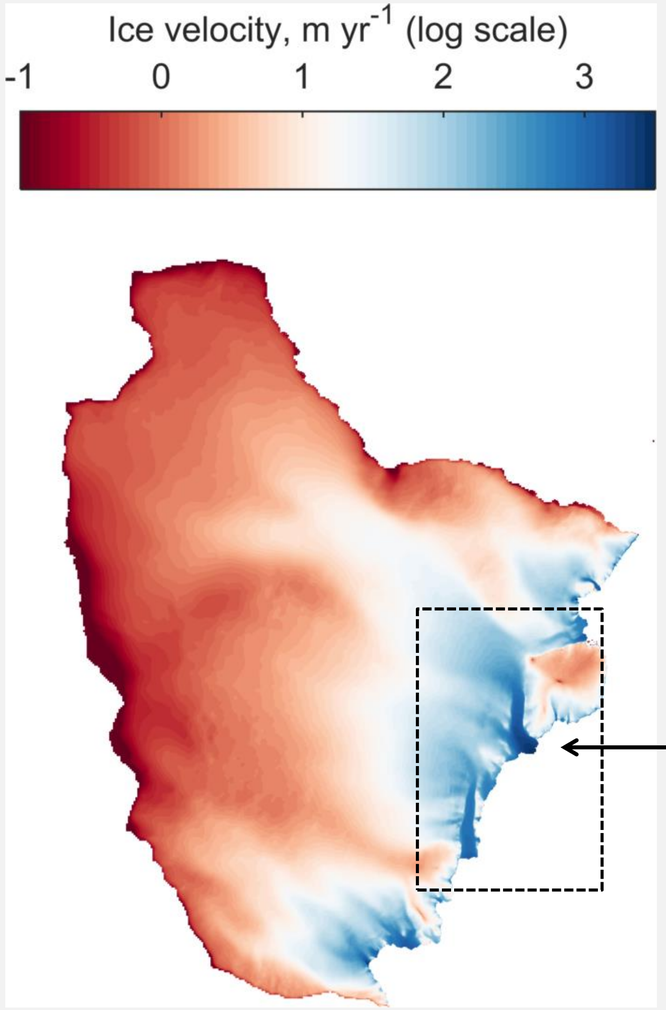
Aurora Basin







Left: Bathymetry from Morlighem et al., 2019

- Potential for sea level contribution: ~5.5 m with main area of bedrock below sea level
- Major outlet: Totten glacier
  - Observed periodic thinning and speed-up on decadal time scales with overall steady mass balance over 1994-2012 (Paolo et al., 2015)
- This study investigates effects of ISMIP6 scenarios locally on a single East Antarctic basin
  - Employing different AOGCMs and RCP

Simulation set-up

- Ice sheet model BISICLES (Cornford et al., 2013): adaptive mesh (500m-4km), L1L2, Coulomb-limited sliding law
- Simulations forcing based on ISMIP6 Antarctic scenarios (Seroussi et al., 2020)
  - Simulation time: 2015 - 2100
  - Atmosphere-Ocean General Circulation Models (AOGCMs) from

CMIP5

CCSM4	CSIRO-MK3	HadGEM2-RS
IPSL-CM5A-MR	MIROC-ESM-CHEM	NorESM1-M

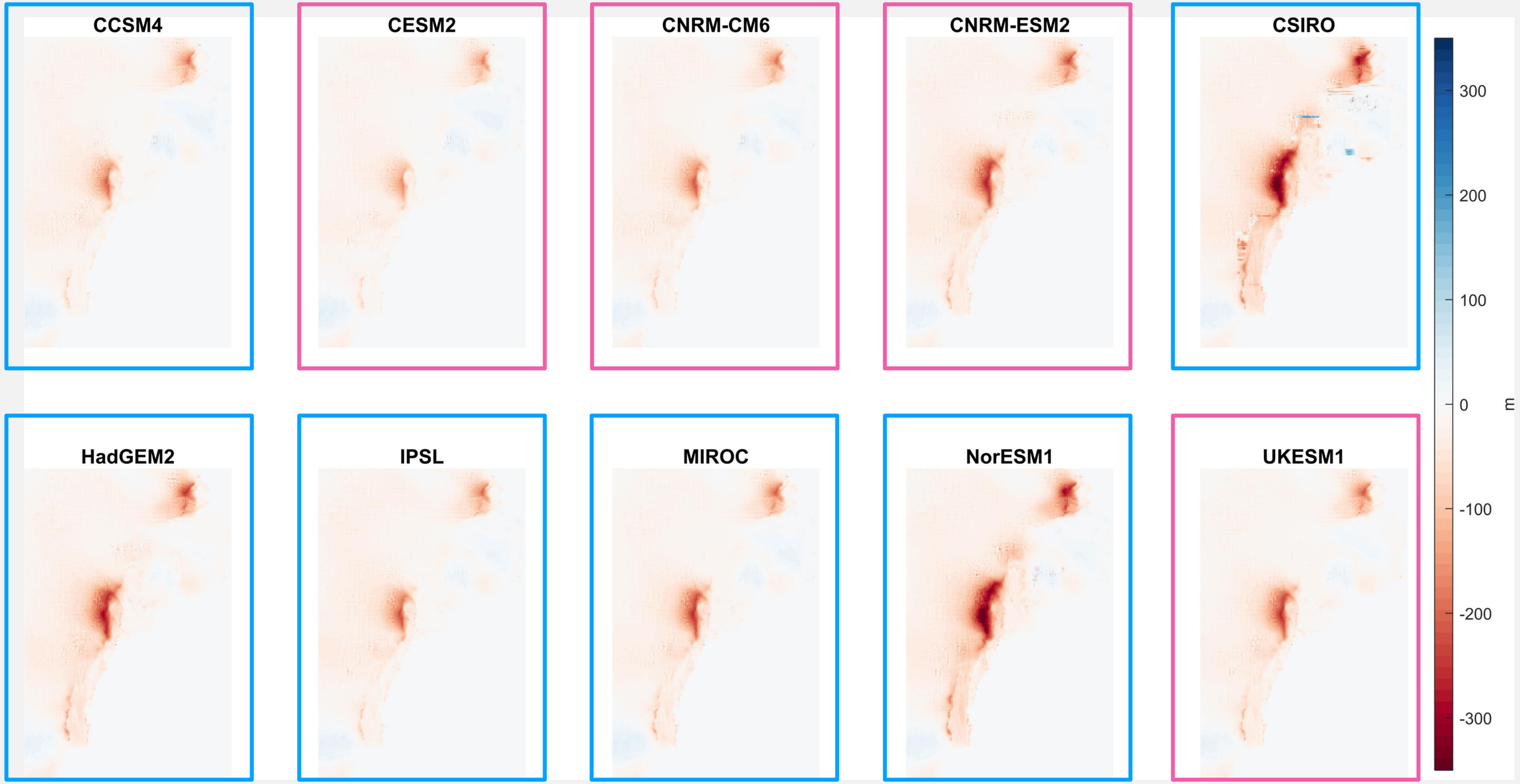
CMIP6

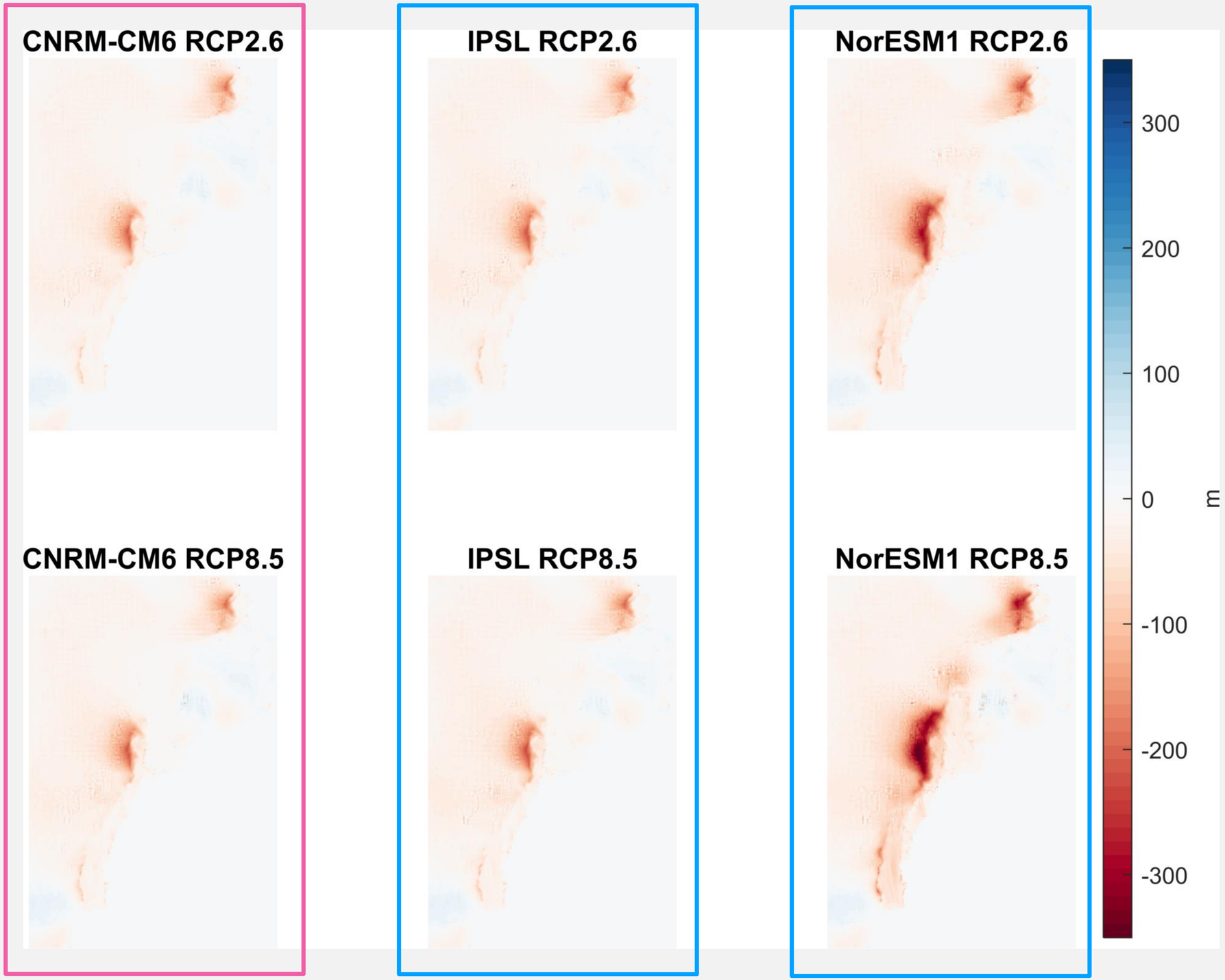
CNRM-CM6-1	CNRM-ESM2-1
CESM2	UKESM1-0-LL

  - Forcing provided by ISMIP6 (based on CMIP):
    - Surface mass balance anomaly (Atmosphere)
    - Thermal forcing (Ocean, non-local parameterization (Favier et al., 2019))

Surface elevation change 2015 – 2100 (RCP 8.5)

Same change of pattern with highest thinning by CSIRO, HadGEM2 and NorESM





2 out of 3 models don’t results in major differences in surface elevation changes (2015 – 2100) comparing RCP 2.6 vs. 8.5

Cumulative sea level contribution

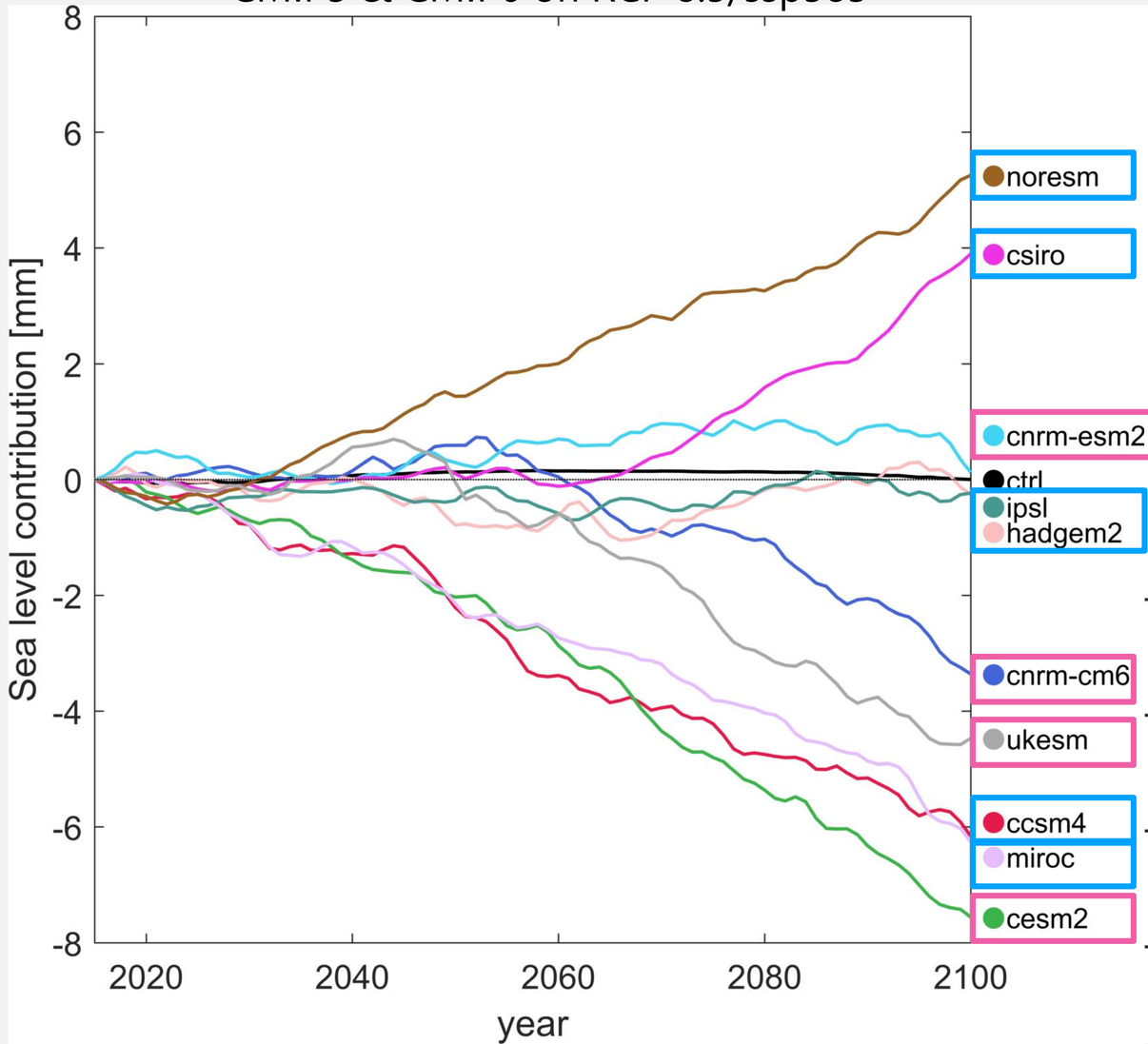
3 trends: mass gain, mass loss, fluctuating around 0

The trend is influenced by the choice of AOGCM and not by warming scenario (RCP)

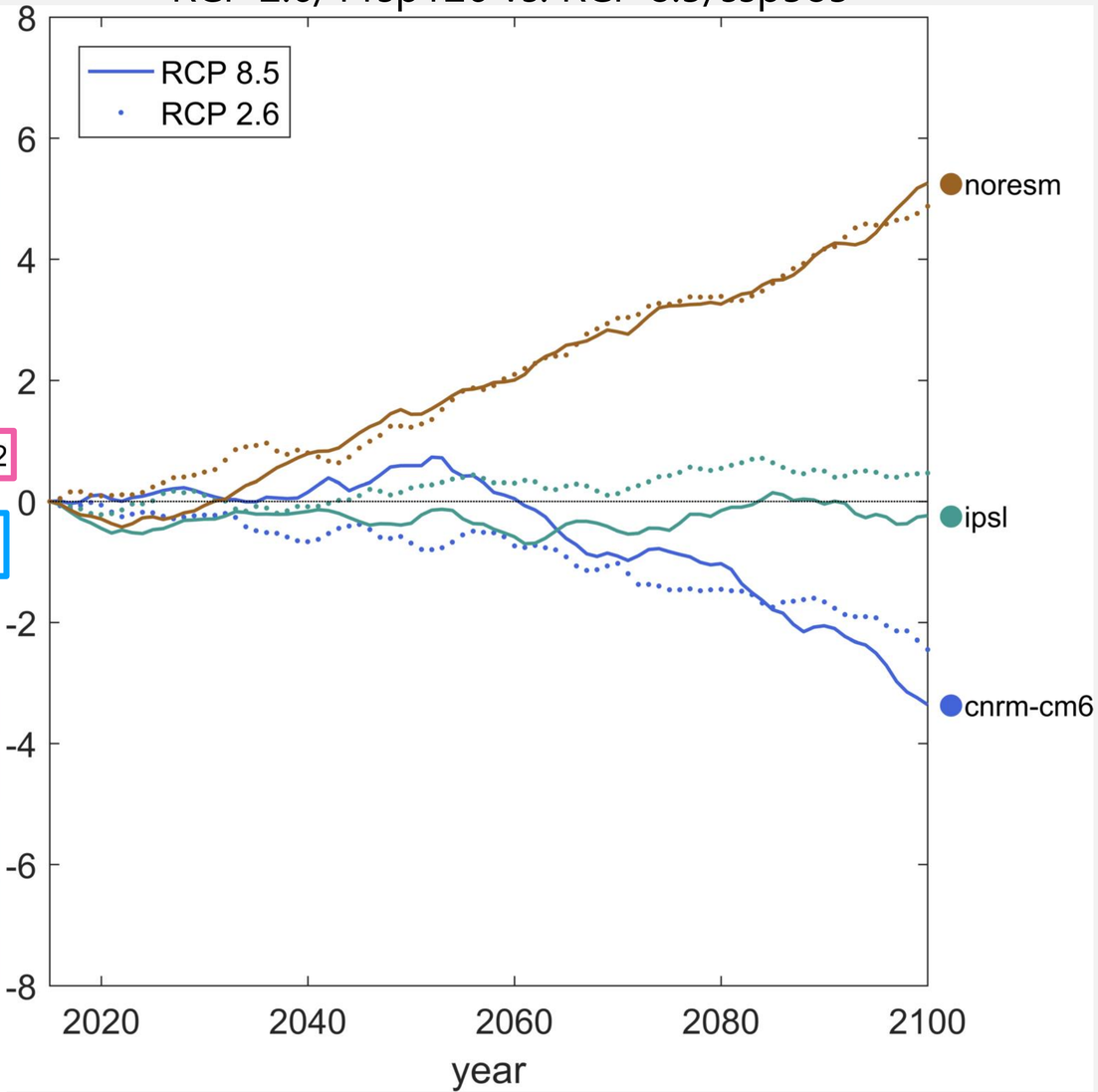
Mass loss

Mass gain

CMIP5 & CMIP6 on RCP 8.5/ssp585



RCP 2.6/11sp126 vs. RCP 8.5/ssp585



What's going on

- Forcing varies between:
  - SMB anomalies: [-8; 12] Gt/yr
  - Basal ocean melt rates: [0; 33] m/yr
    - Capturing only melt, no refreezing
- Grounding line retreat and advance both possible

The choice of CMIP model is crucial for Totten's mass balance!

- SMB anomalies between models vary within same order of magnitude, but ocean thermal forcing differs by orders of 2, especially towards to end of the century

➡ Ocean induced basal melt - determining if basin loses or gains mass - is based on:

- extrapolated thermal forcing from CMIP model
- choice of parameterization

➡ Ocean circulation below ice shelves and melt parameterizations have to be better understood to improve future sea level contribution estimates from ice sheets

References

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- Favier et al., 2019, https://doi.org/10.5194/gmd-12-2255-2019
- Morlighem et al., 2019, https://doi.org/10.1038/s41561-019-0510-8
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