Very preliminary analysis of the Marine Ice Sheet-Ocean Model Intercomparison Project first phase (MISOMIP1)

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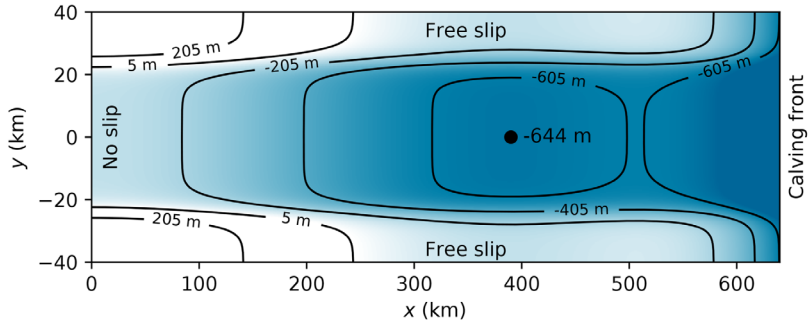
Land Ice Working Group 2021

MISOMIP

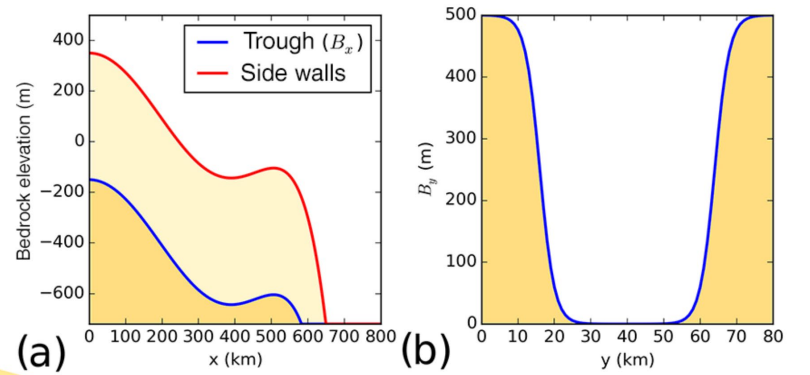
- Marine Ice Sheet-Ocean Model Intercomparison Project (MISOMIP)
- Sponsored by the Climate and Cryosphere (CliC) project
- Design, coordinate MIPs:
  - Idealized
  - Realistic
- Aims:
  - Model evaluation
  - Verification with observations
  - Future projections
- Focus: Amundsen and Weddell Sea sectors

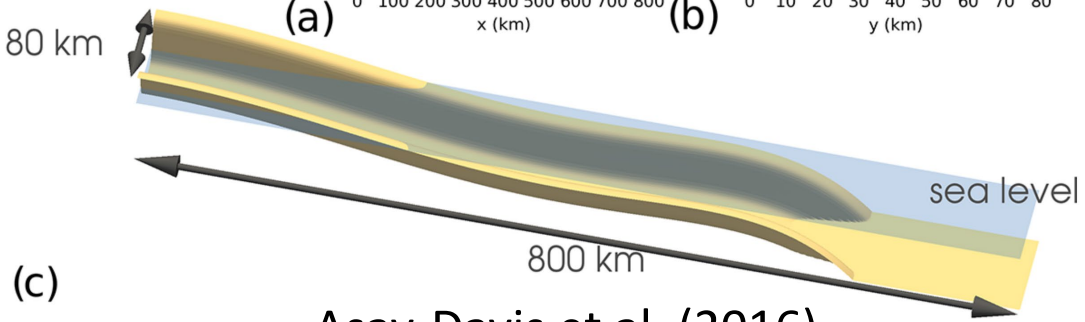
Idealized Community Experiments

- **MISMIP+** (Marine Ice-Sheet Model Intercomparison Project, 3rd phase)
  - Ice-sheet only
  - Parameterized basal melting
- **ISOMIP+** (Ice shelf-Ocean Model Intercomparison Project, 2nd phase)
  - Ocean only
  - Ice topography from a MISMIP+ result
- **MISOMIP1** (Marine Ice Sheet-Ocean Model Intercomparison Project, 1st phase)
  - coupling of MISMIP+ and ISOMIP+



Cornford et al. (2020)

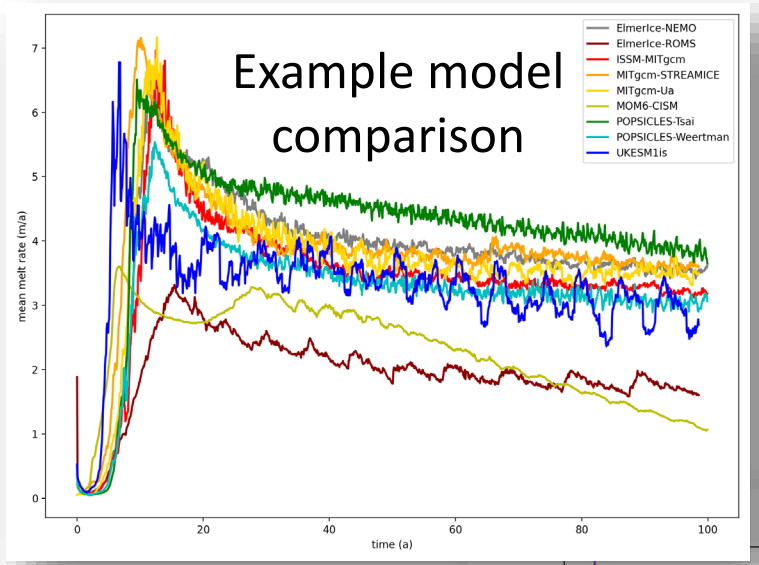


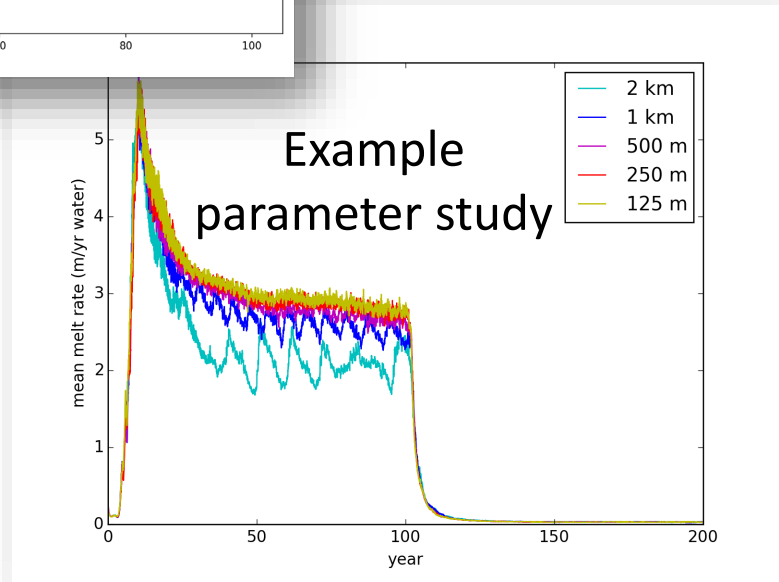


Asay-Davis et al. (2016)

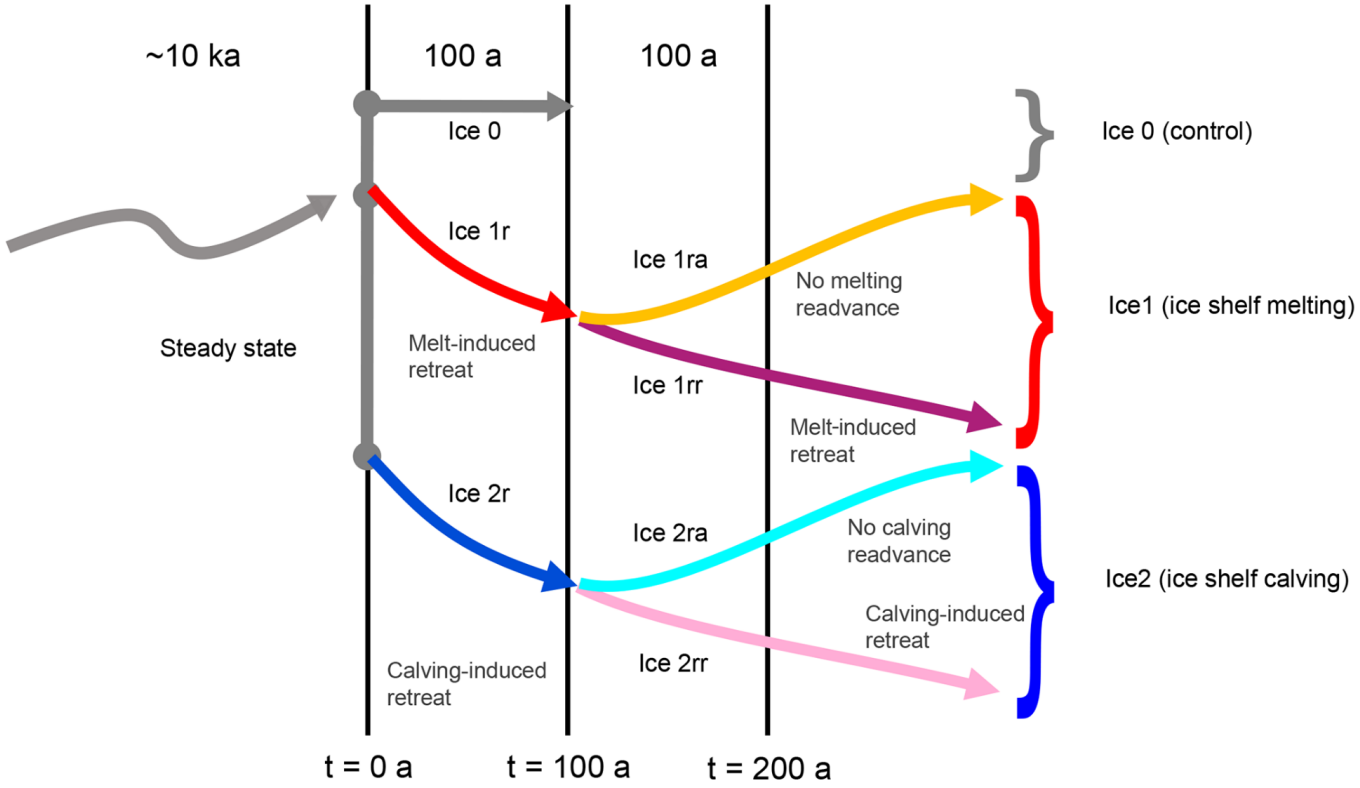
Purpose of MISMIP+, ISOMIP+, MISOMIP1

1. Provide simplified experiments for comparing models
2. Path for testing components during development of a coupled ice sheet-ocean model
3. Enable/inspire a parameter and process studies branched from the basic experiments



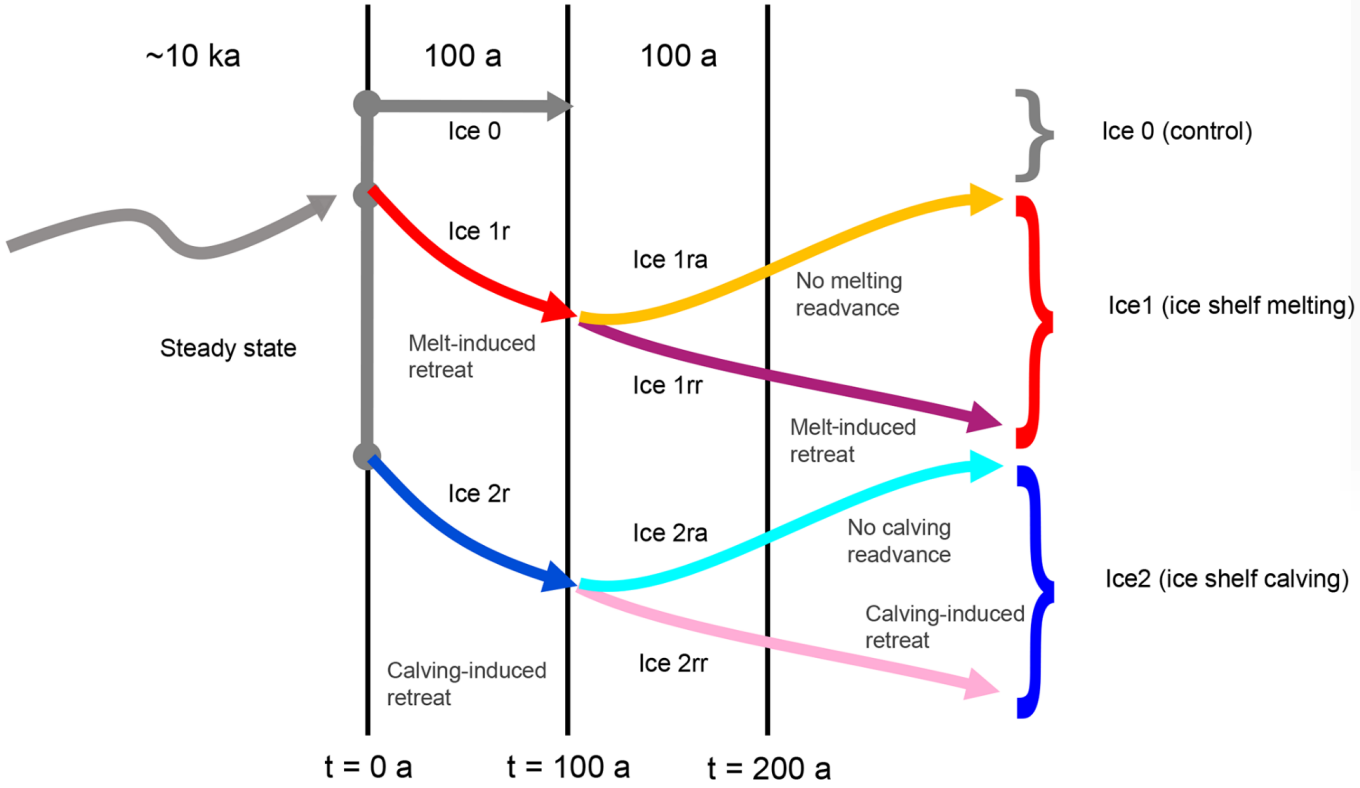


MISMIP+

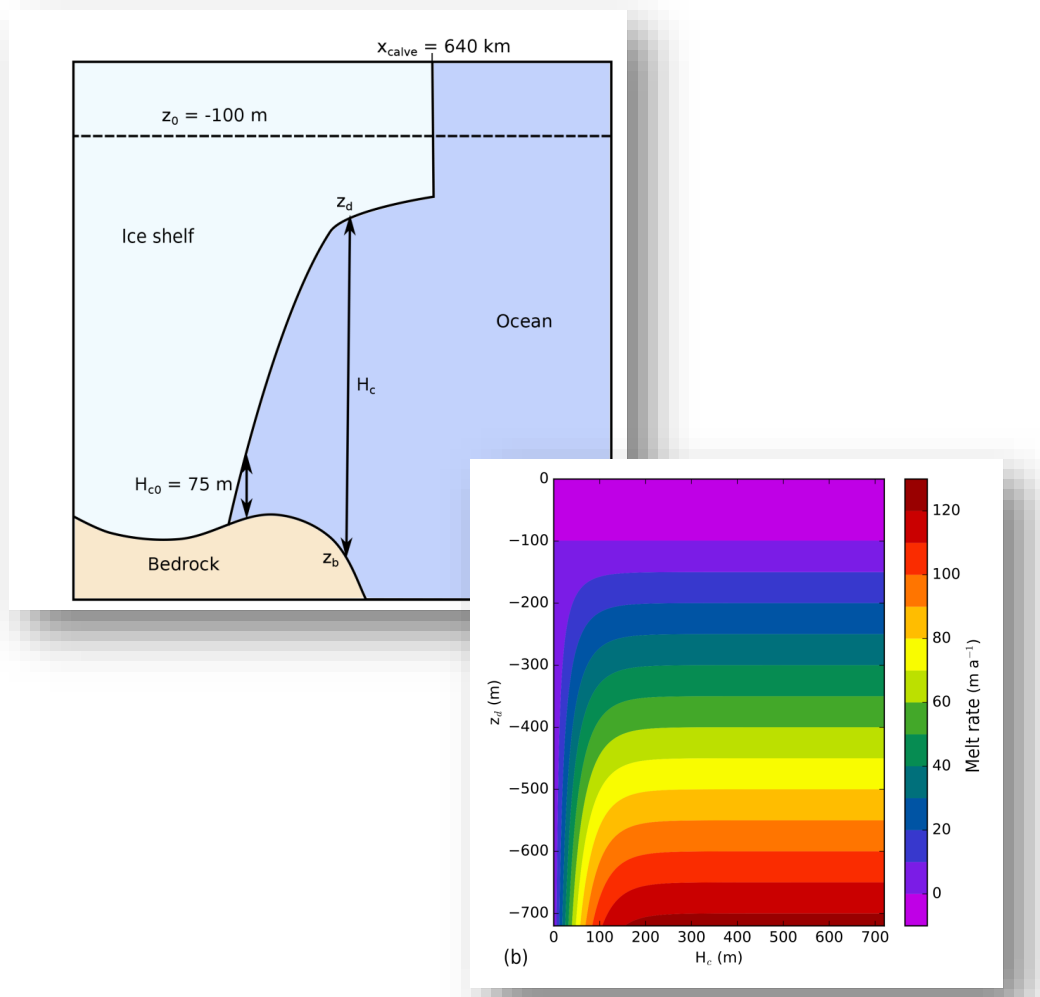


Cornford et al. (2020)

MISMIP+

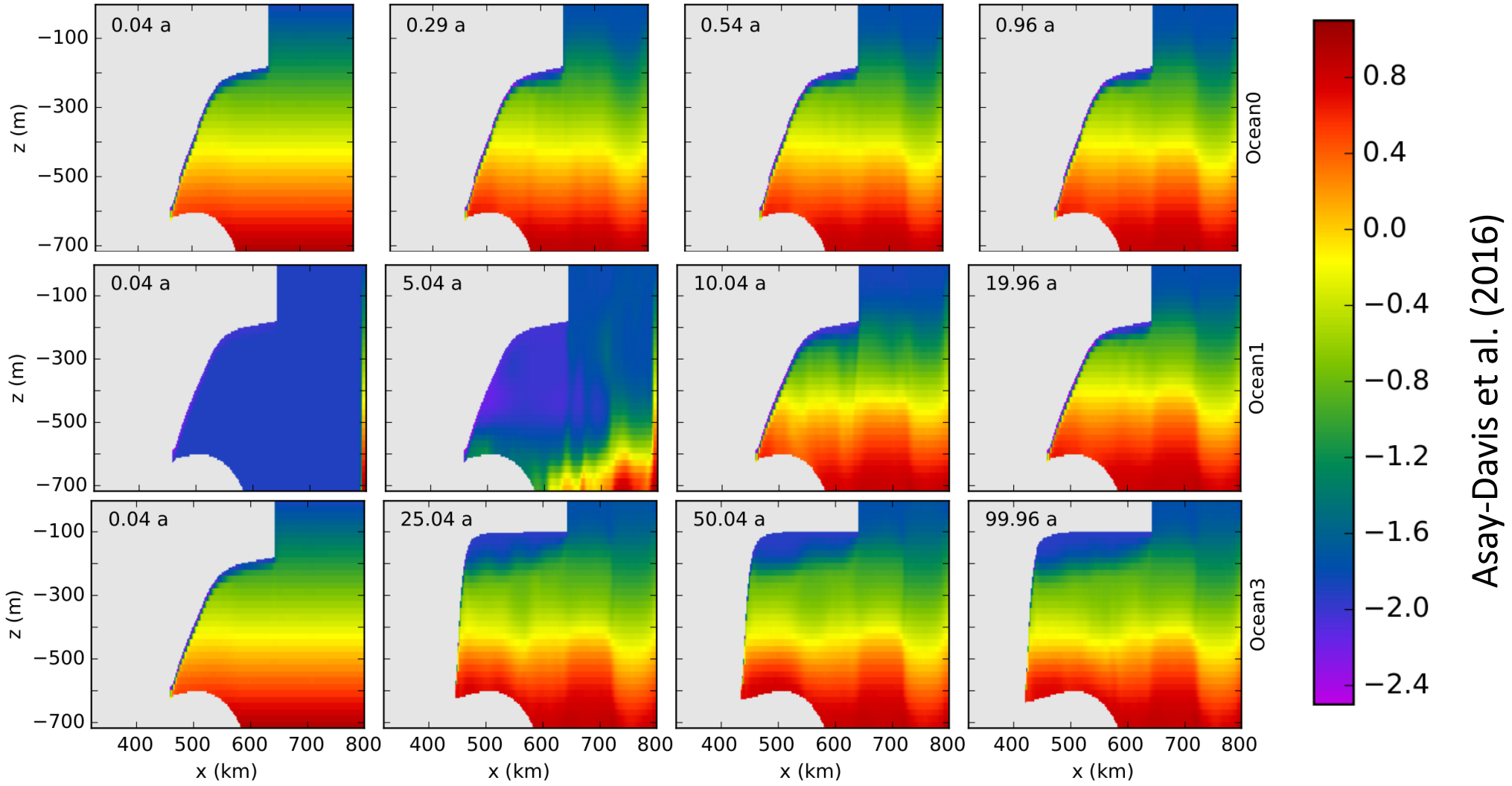


Cornford et al. (2020)

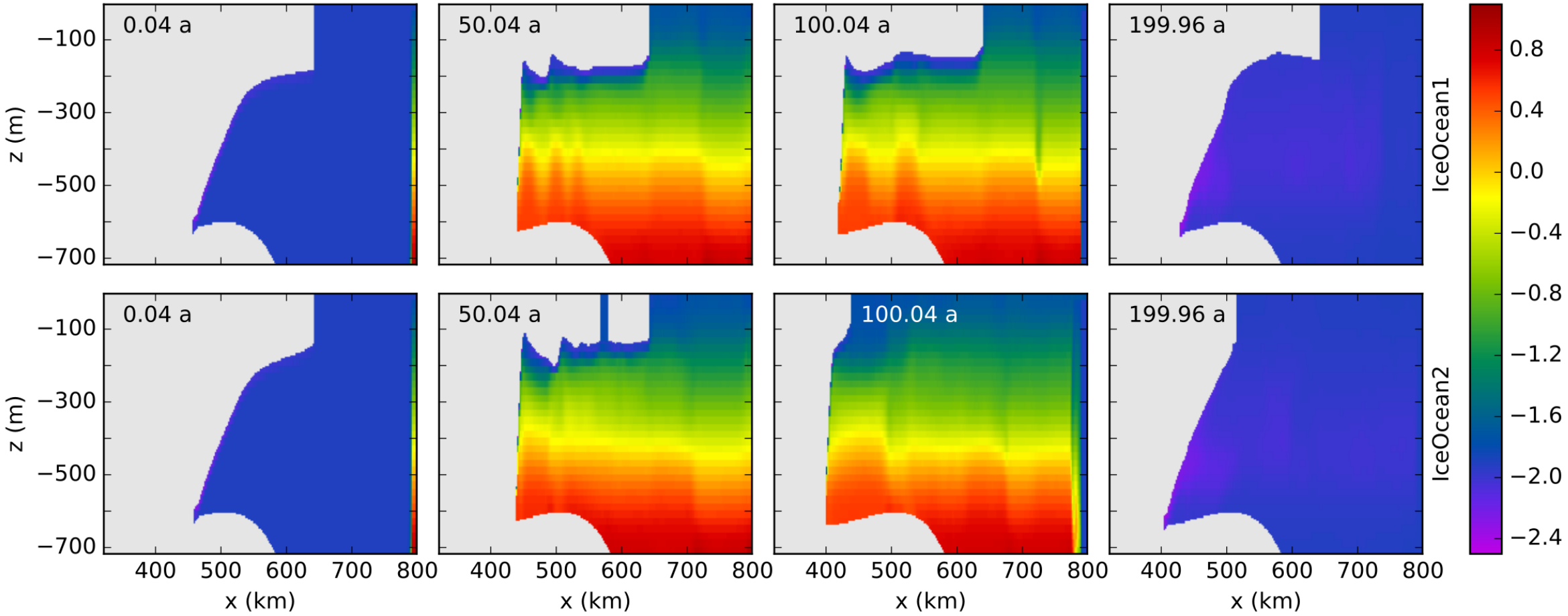


Asay-Davis et al. (2016)

ISOMIP+ temperature sections vs. time



MISOMIP1 temperature sections vs. time



Asay-Davis et al. (2016)

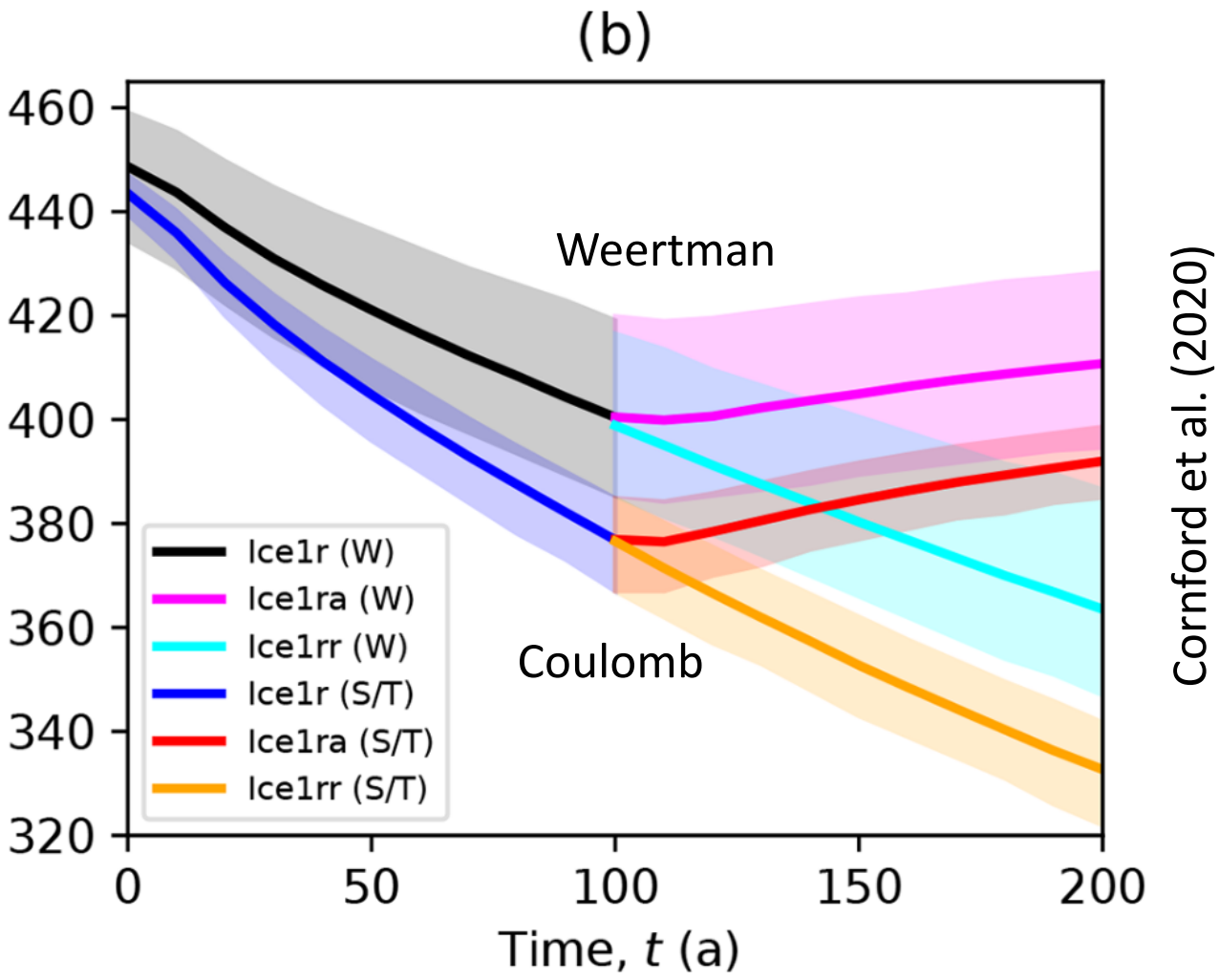
MISOMIP1: Participating Models

Model	Participants
Elmer/Ice-NEMO	Nicolas Jourdain, Pierre Mathiot
Elmer/Ice-ROMS	Rupert Gladstone, Ben Galton-Fenzi, David Gwyther, Chen Zhao
MITgcm-ISSM	Yoshihiro Nakayama, Hélène Seroussi, Mathieu Morlighem
MITgcm-STREAMICE	James Jordan, Dan Goldberg, Paul Holland
MITgcm-Úa	Kaitlin Naughten, Jan De Rydt, Hilmar Gudmundsson
MOM6-CISM	Gustavo Marques, Gunter Leguy, Bill Lipscomb
POPSICLES	Xylar Asay-Davis, Dan Martin
UKESM1is	Robin Smith, Chris Bull, Pierre Mathiot, Steph Cornford

MISOMIP1: Participating Models

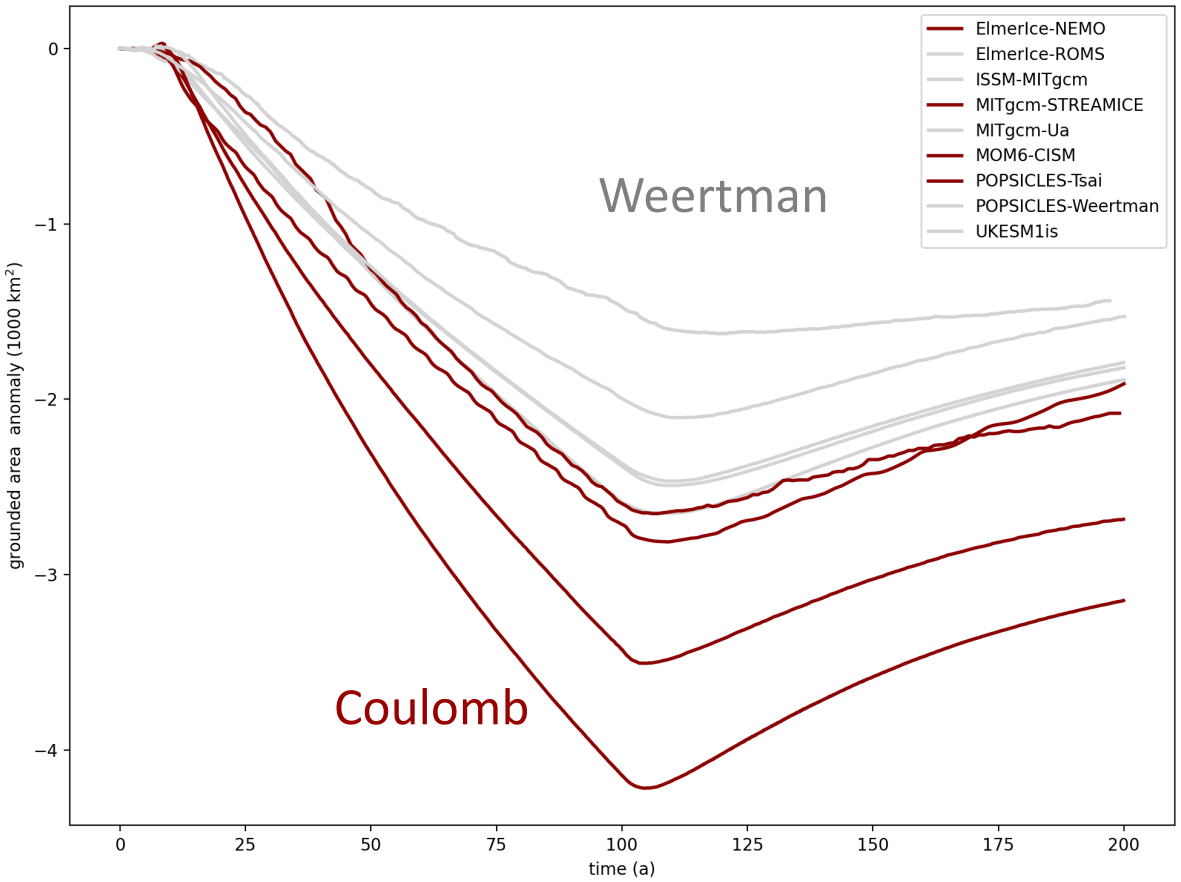
Model	Basal friction	Stress approx.	Ocean vert. coord.	Coupling freq.
Elmer/Ice-NEMO	Coulomb	SSA*	z*	6 mo.
Elmer/Ice-ROMS	Weertman	SSA	Terrain-following	~0.5 mo.
MITgcm-ISSM	Weertman	SSA	z	≤1 mo.
MITgcm-STREAMICE	Coulomb	L1Lx	z	≤1 mo.
MITgcm-Úa	Weertman	SSA	z	6 mo.
MOM6-CISM	Coulomb	L1Lx	Hybrid terrain-following z*	~2.5 mo.
POPSICLES	Both	SSA	z	1 mo.
UKESM1is	Weertman	SSA	z*	12 mo.

Ice-sheet basal friction: MISMIP+



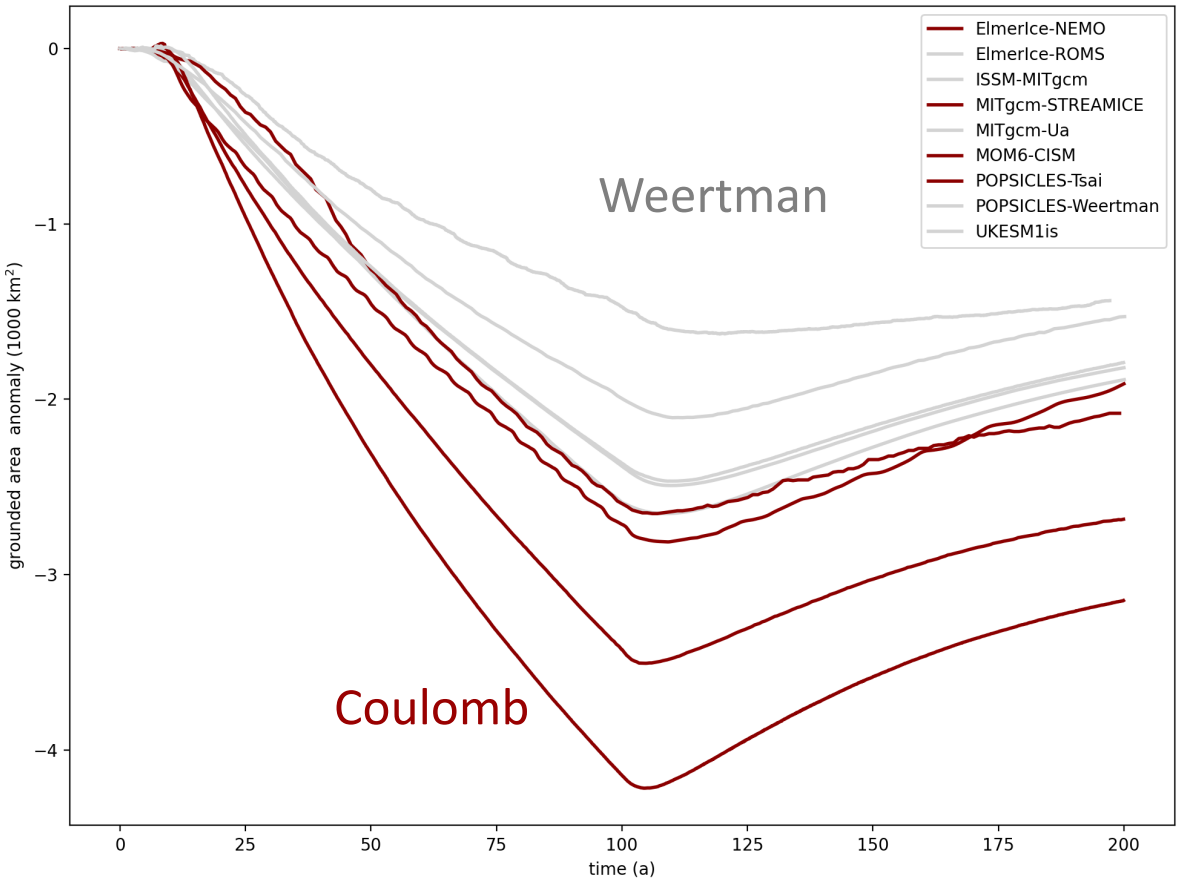
Ice-sheet basal friction

Grounded Area

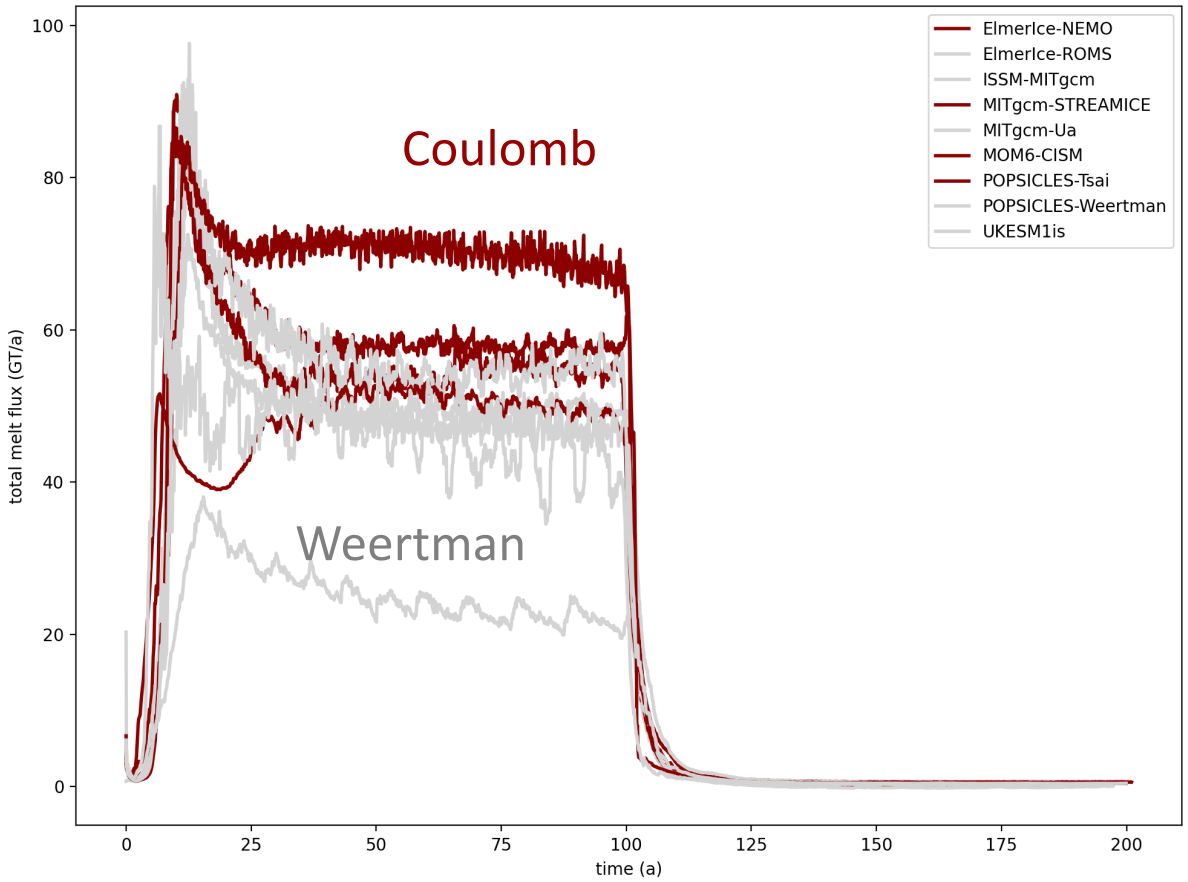


Ice-sheet basal friction

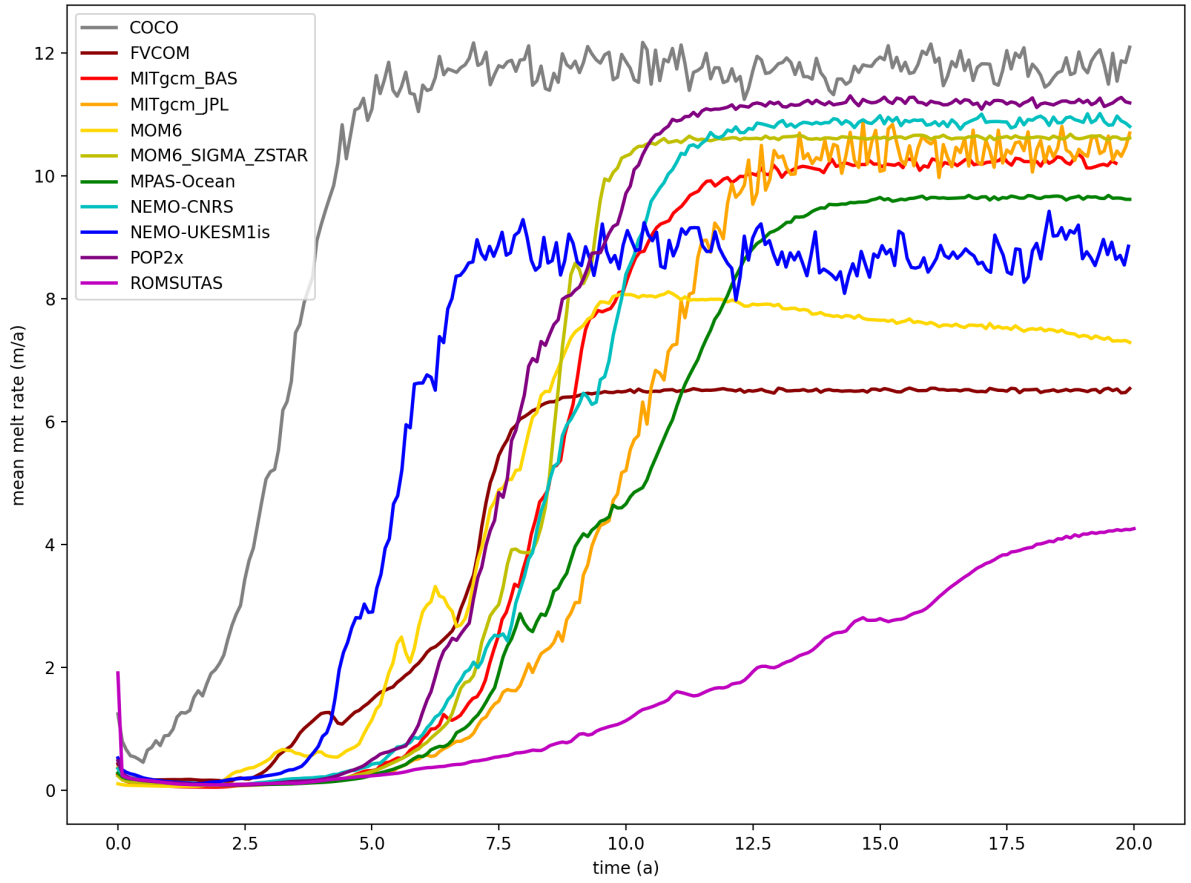
Grounded Area

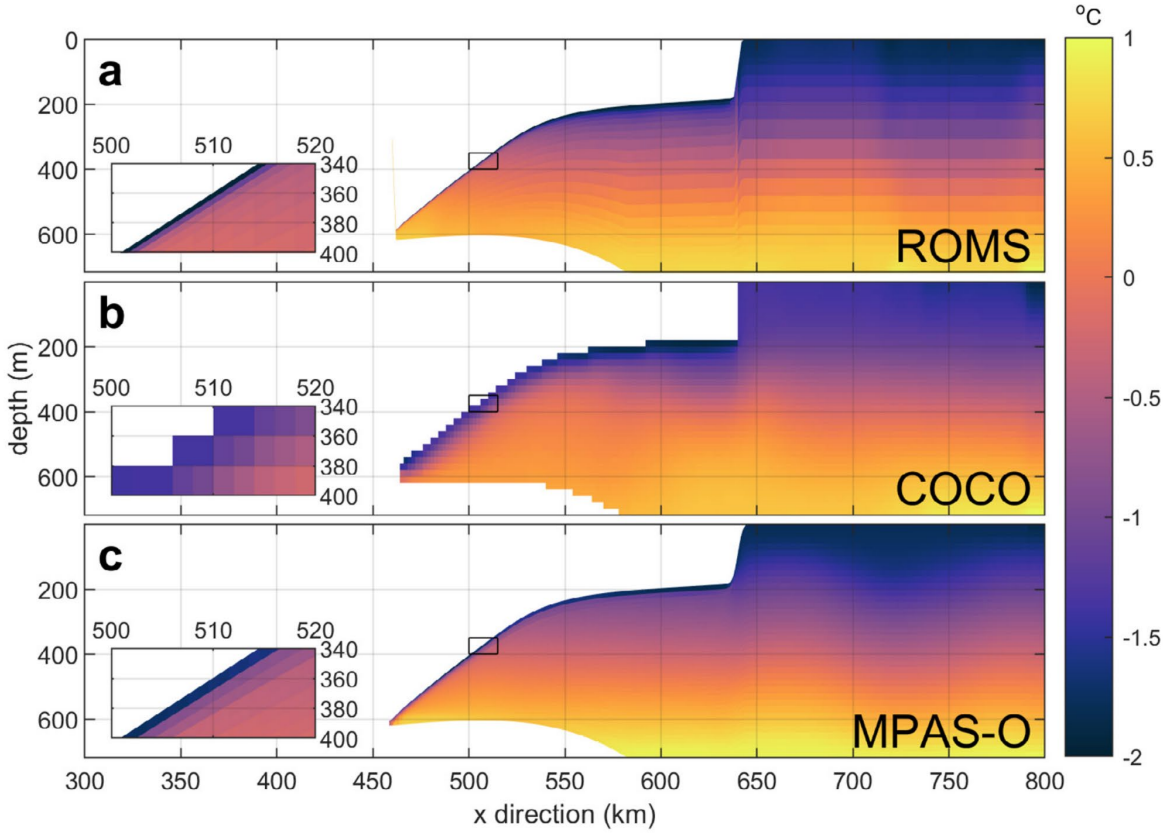


Total Melt Flux



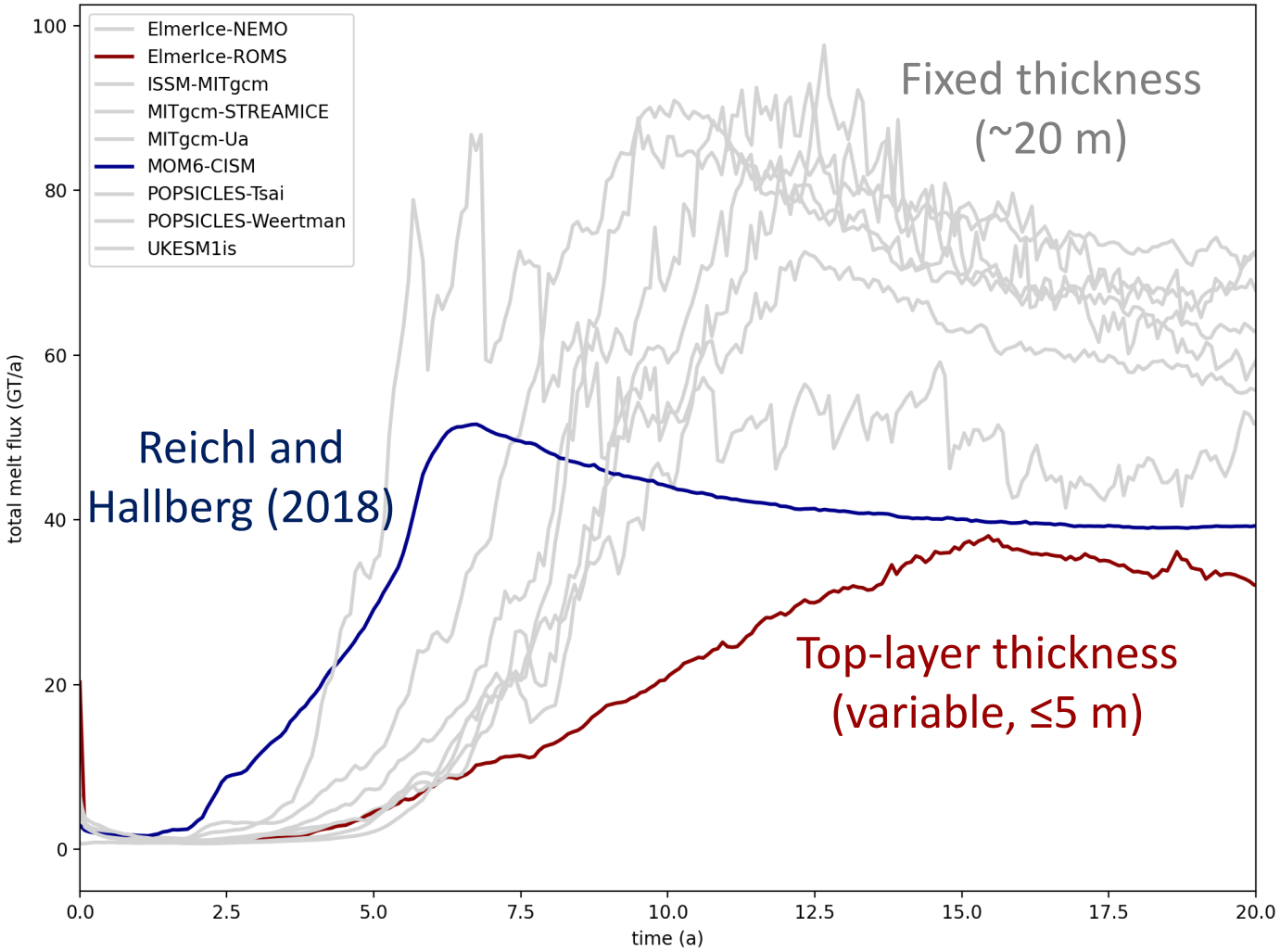
Ocean boundary layer: ISOMIP+



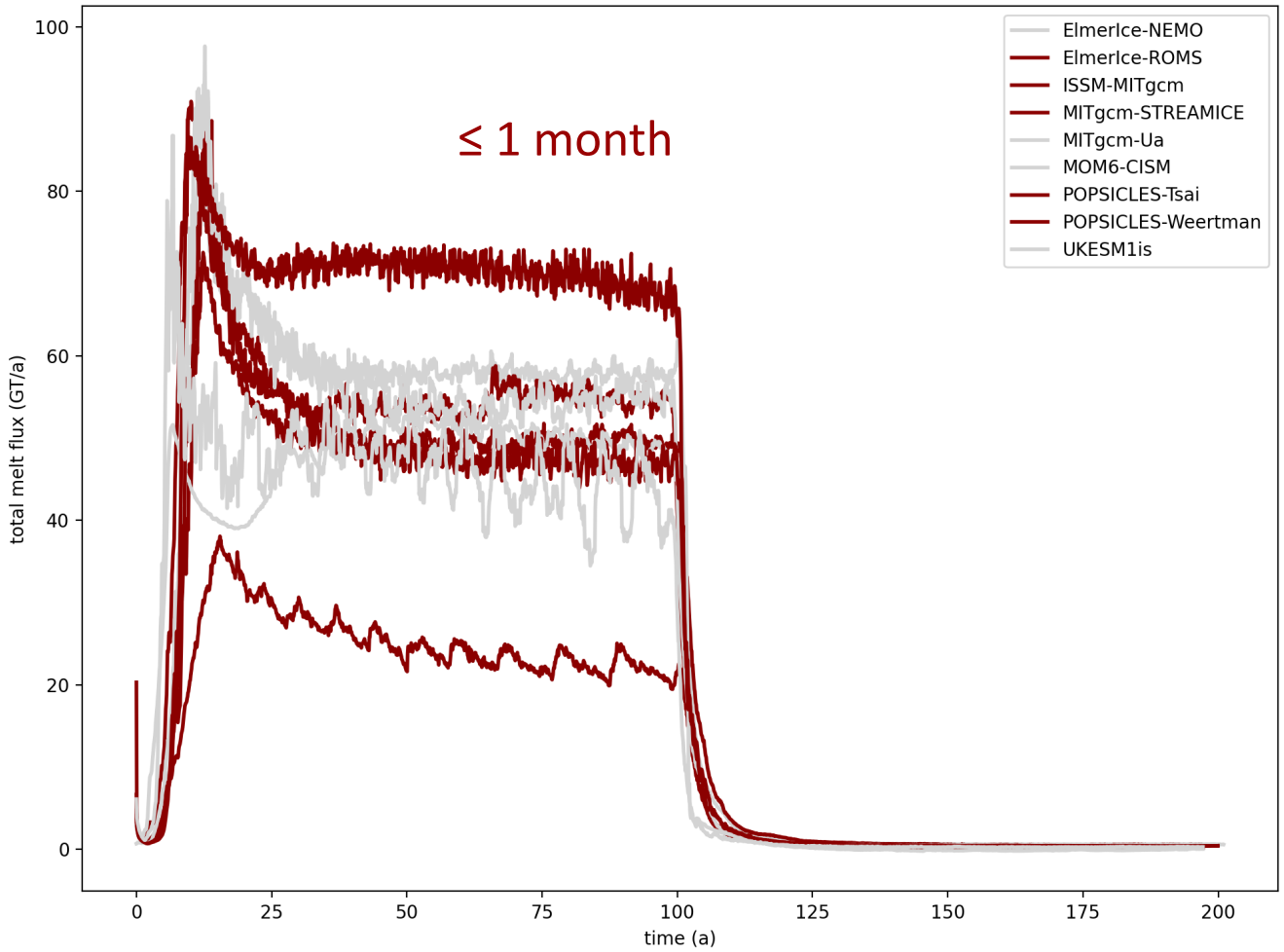


Gwyther et al. (2020)

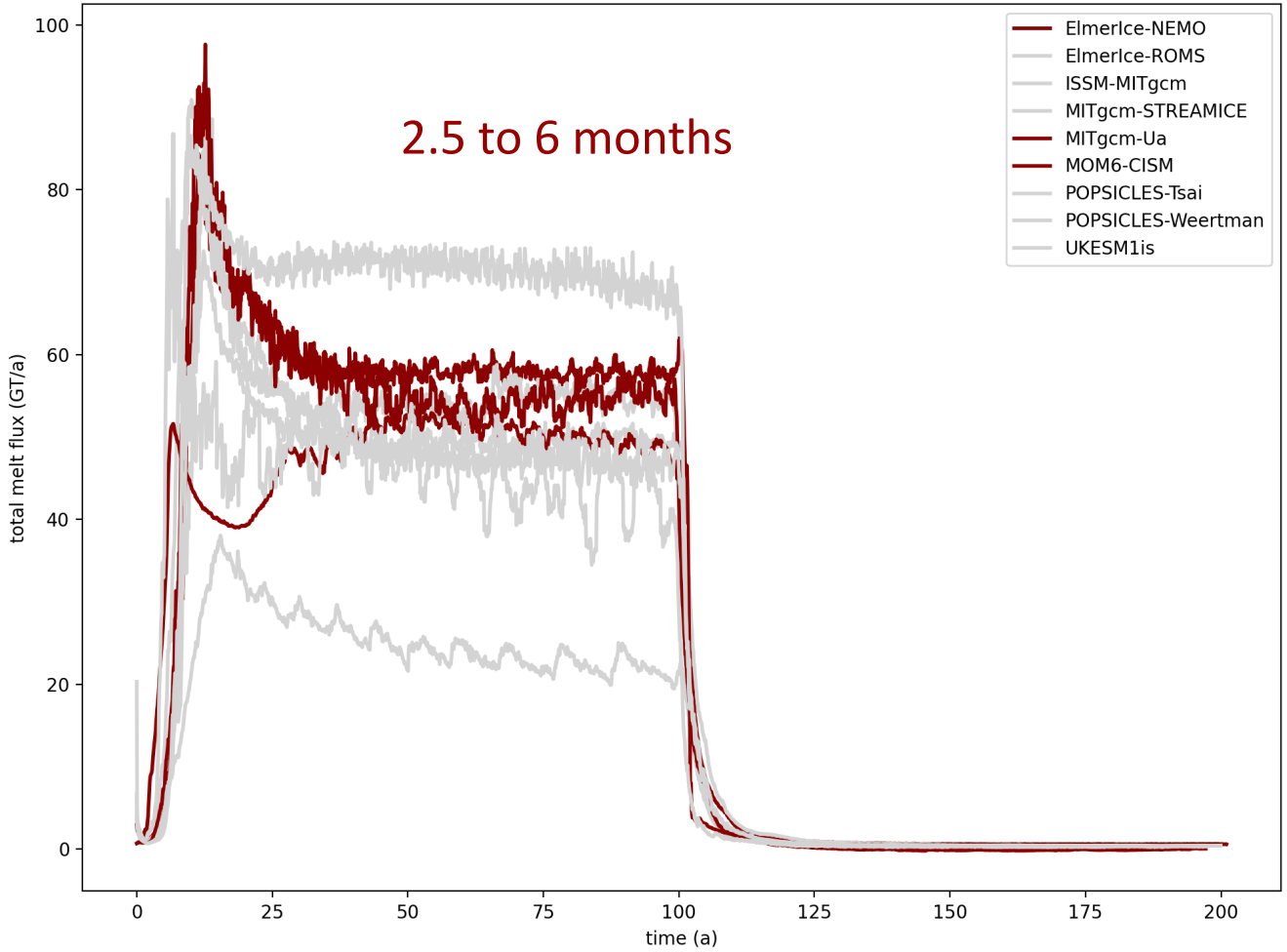
Ocean boundary layer



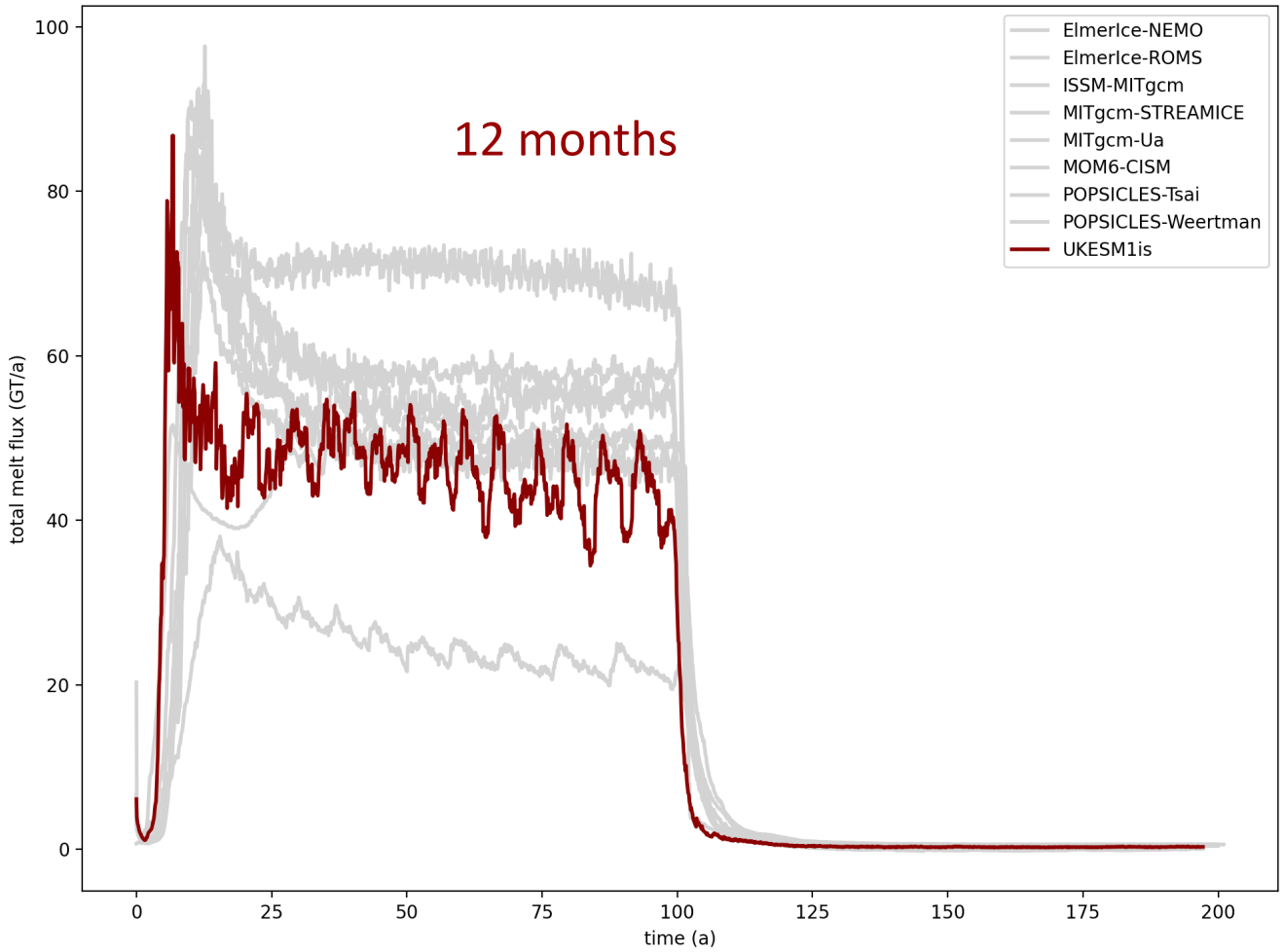
Coupling frequency: ≤ 1 month



Coupling frequency: 2.5 to 6 months

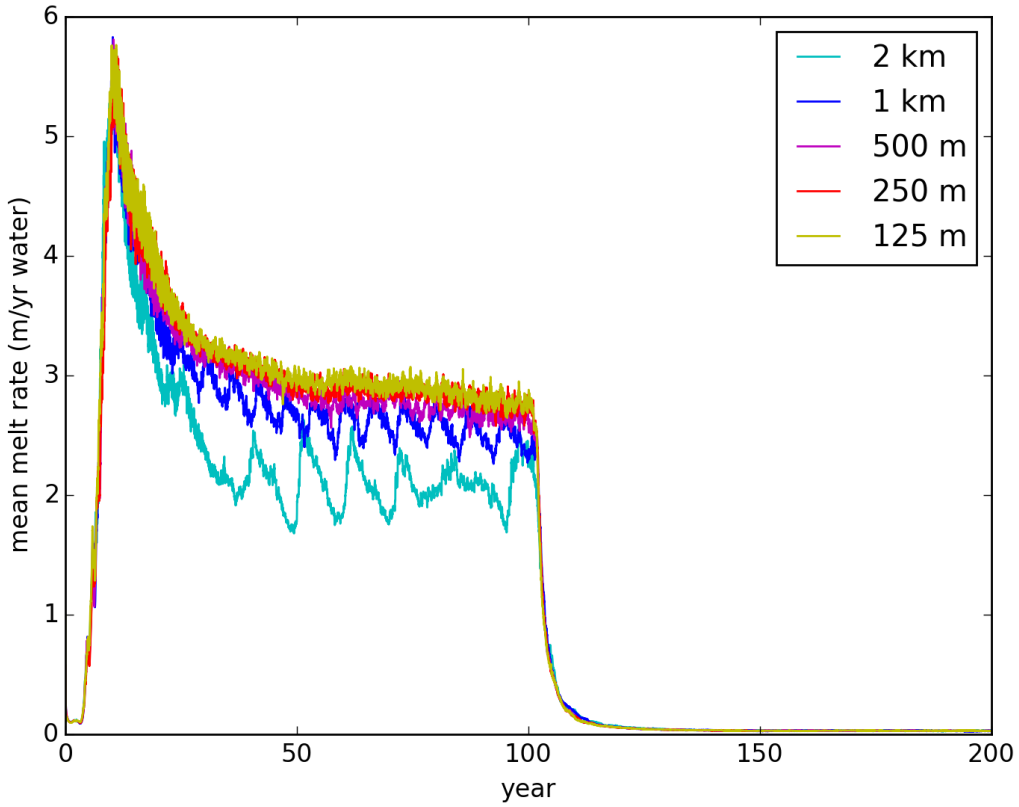


Coupling frequency: 12 months

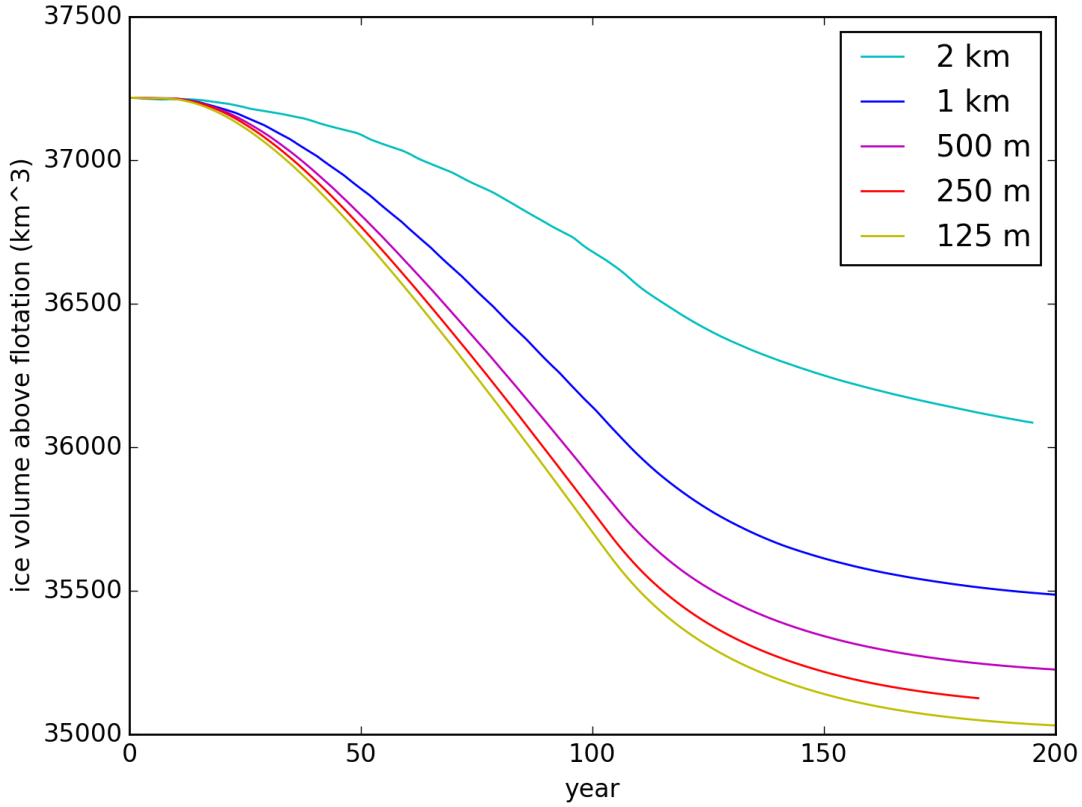


POPSICLES study: ice sheet max. res.

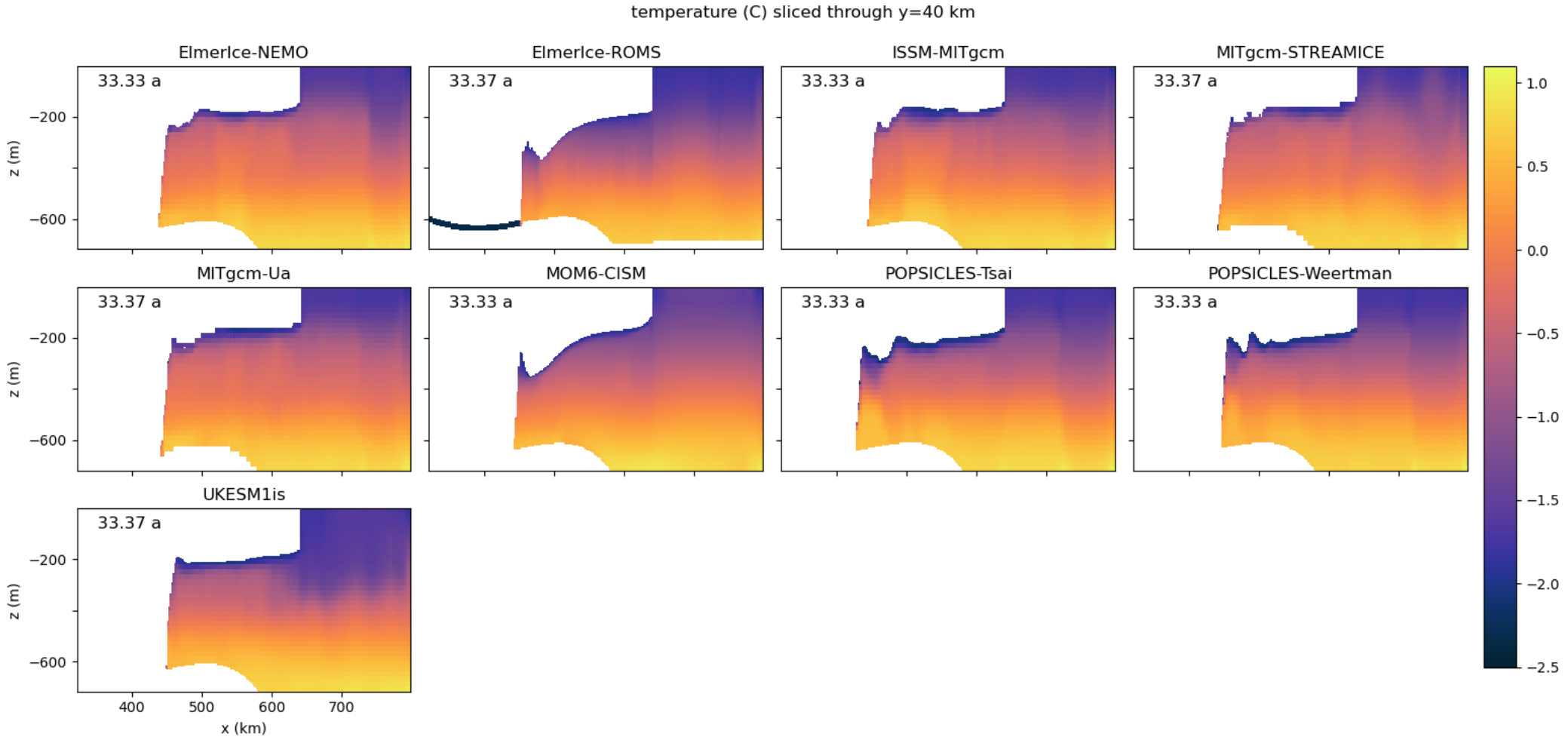
Mean melt rate



Volume above flotation



Topographic features from coupling

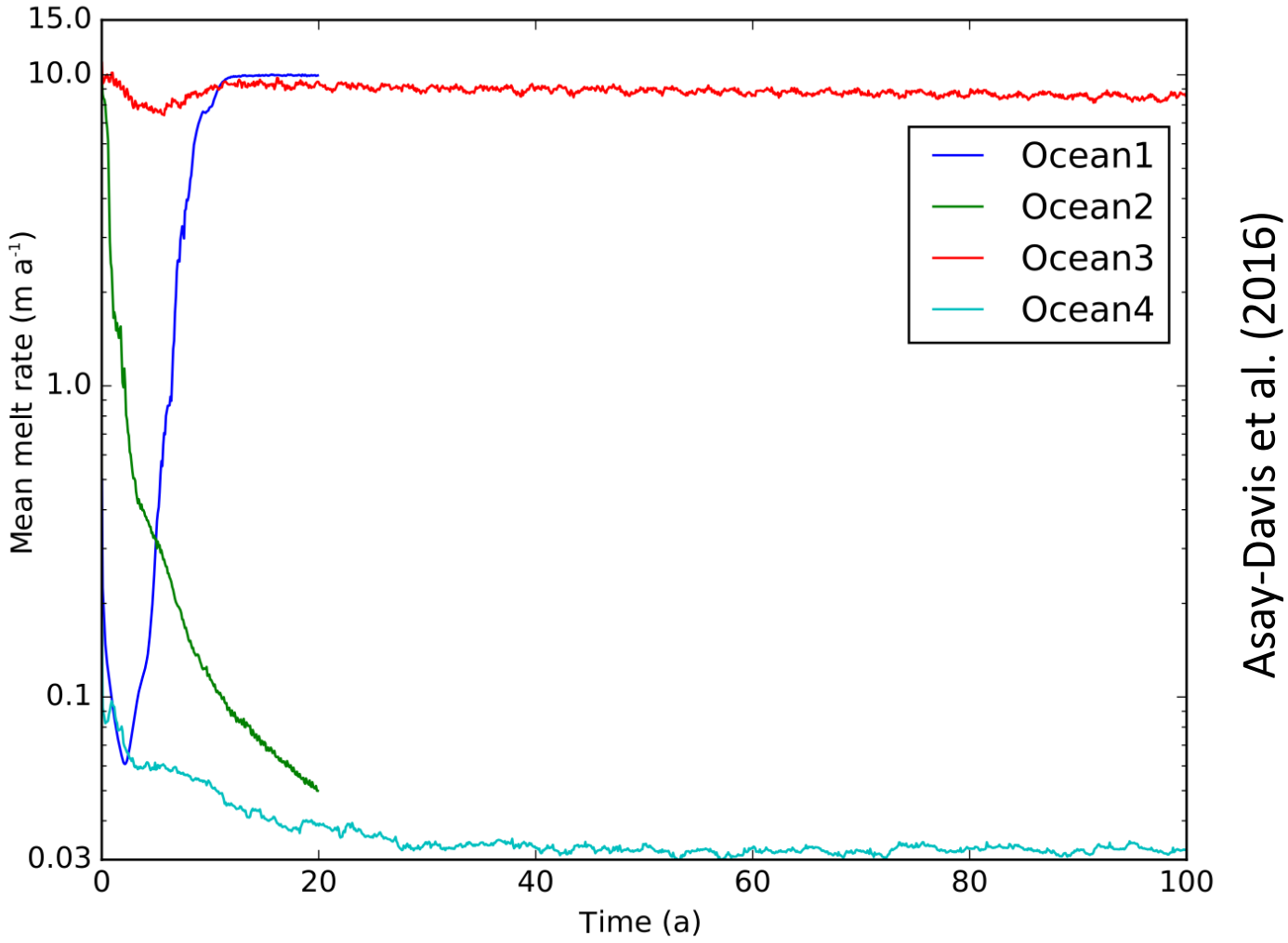


Future work

- What does coupling add? Quantitative comparisons:
  - MISMIP+ vs. MISOMIP1 w/ same ice-sheet model
  - ISOMIP+ vs. MISOMIP1 w/ same ocean model
- Explore impacts of ocean and ice-sheet resolution
- Parameter studies varying:
  - Ocean and ice-sheet resolution
  - Coupling interval
  - Ocean boundary layer treatment

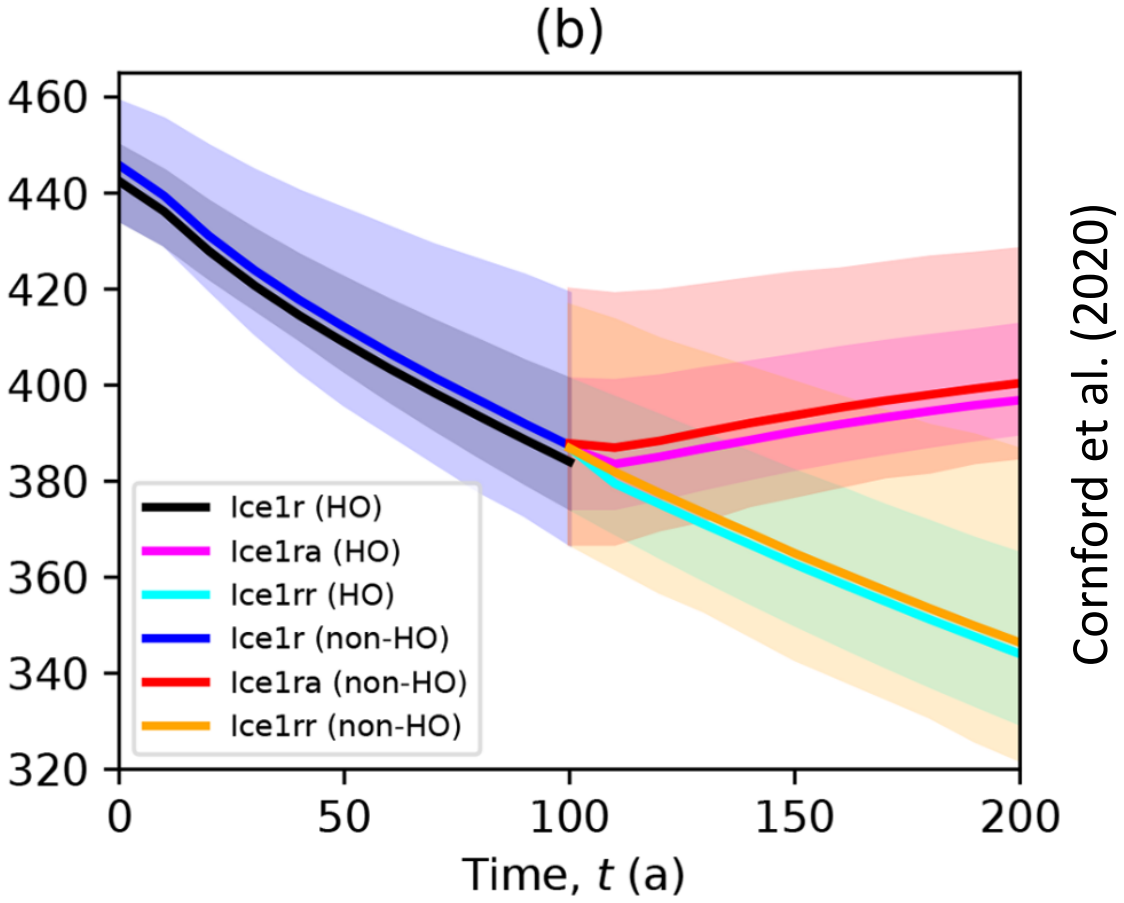
Thank You!

ISOMIP+ mean melt rates



Asay-Davis et al. (2016)

Ice-sheet stress approximation



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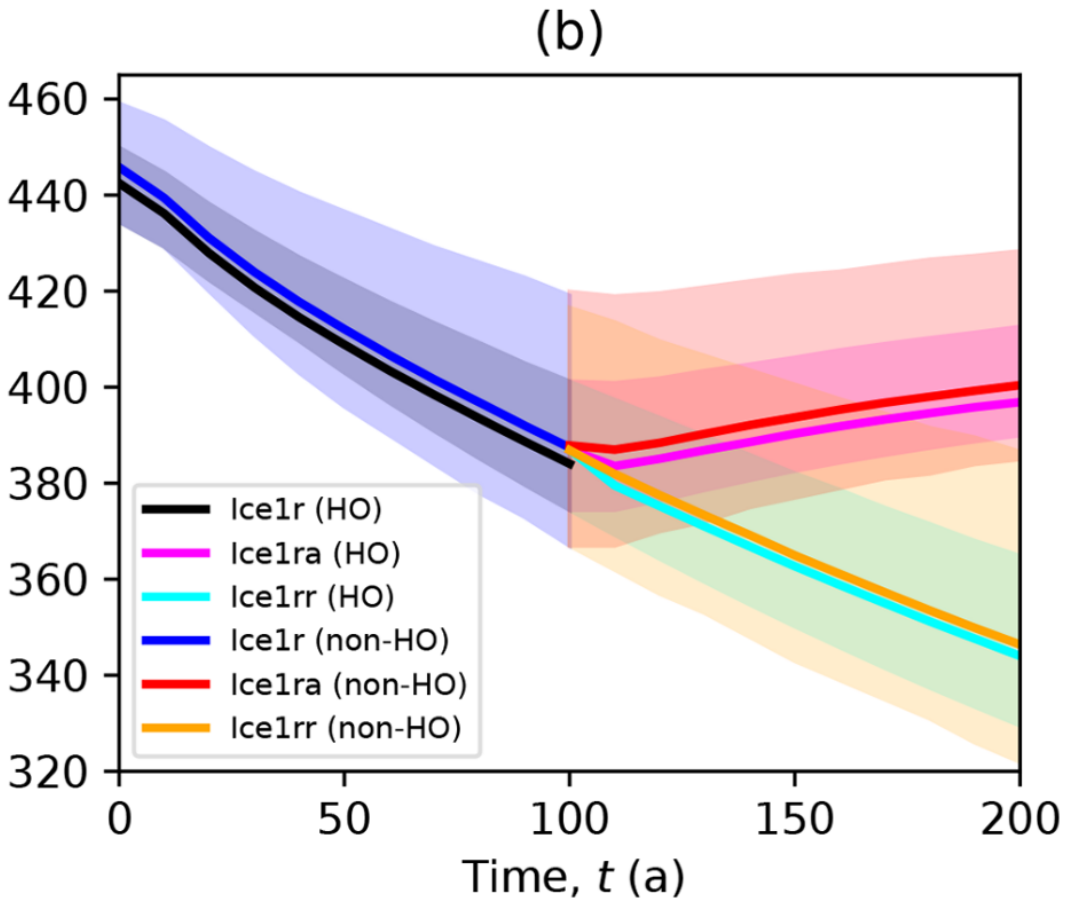
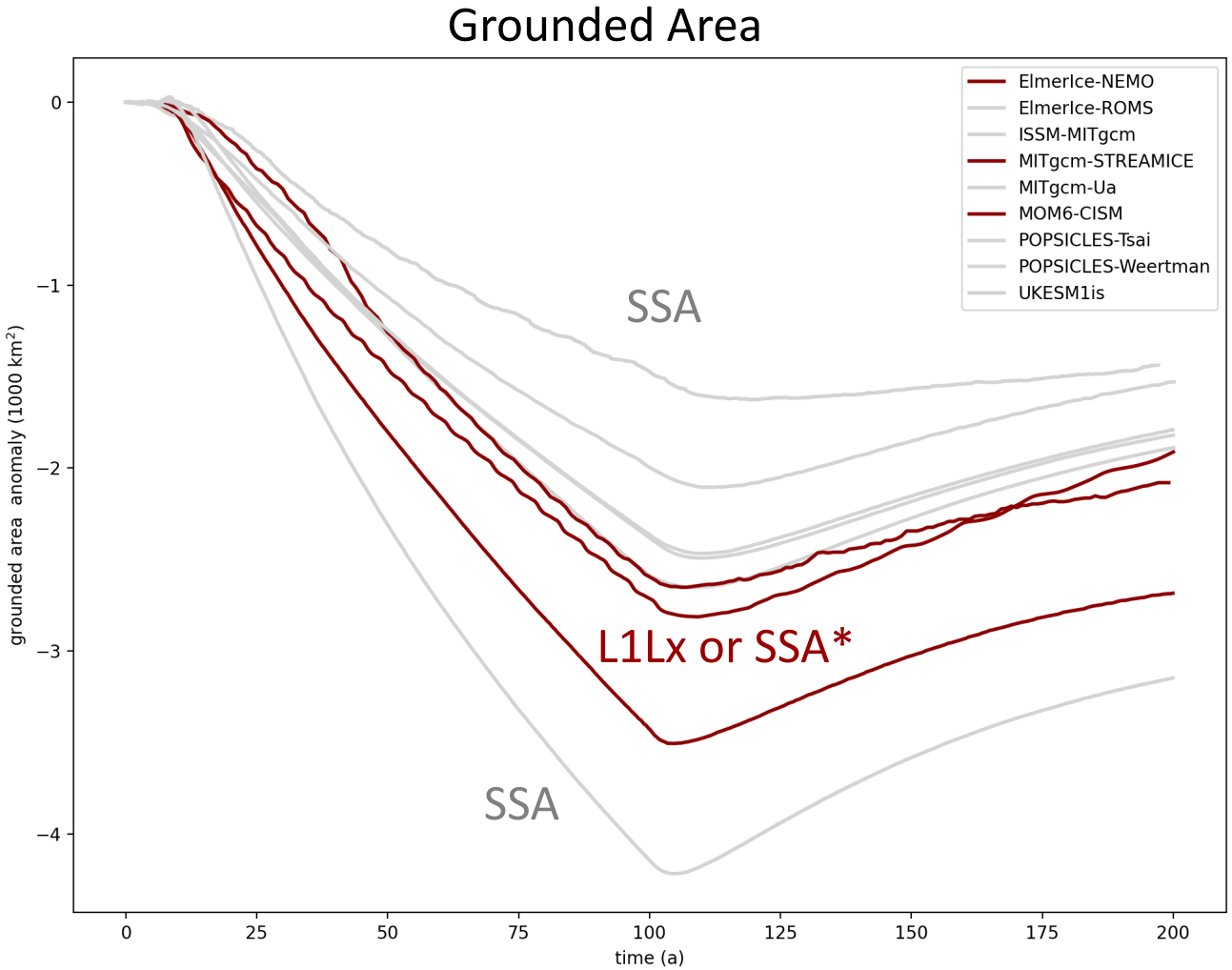
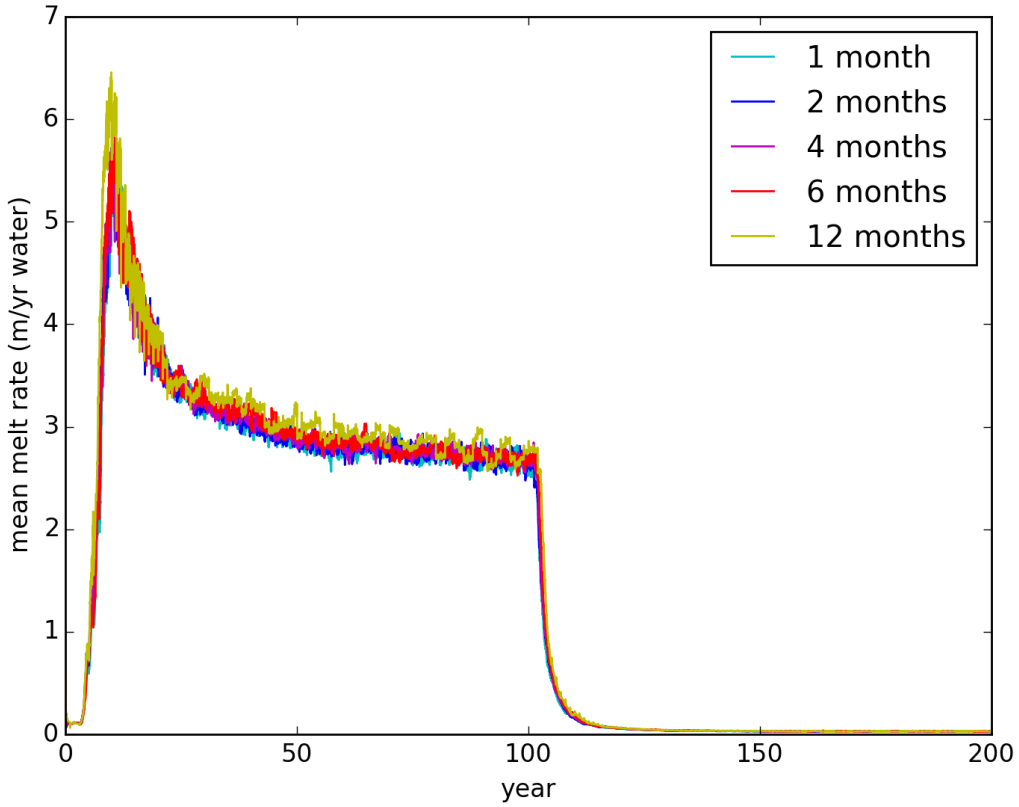


Cornford et al. (2020)

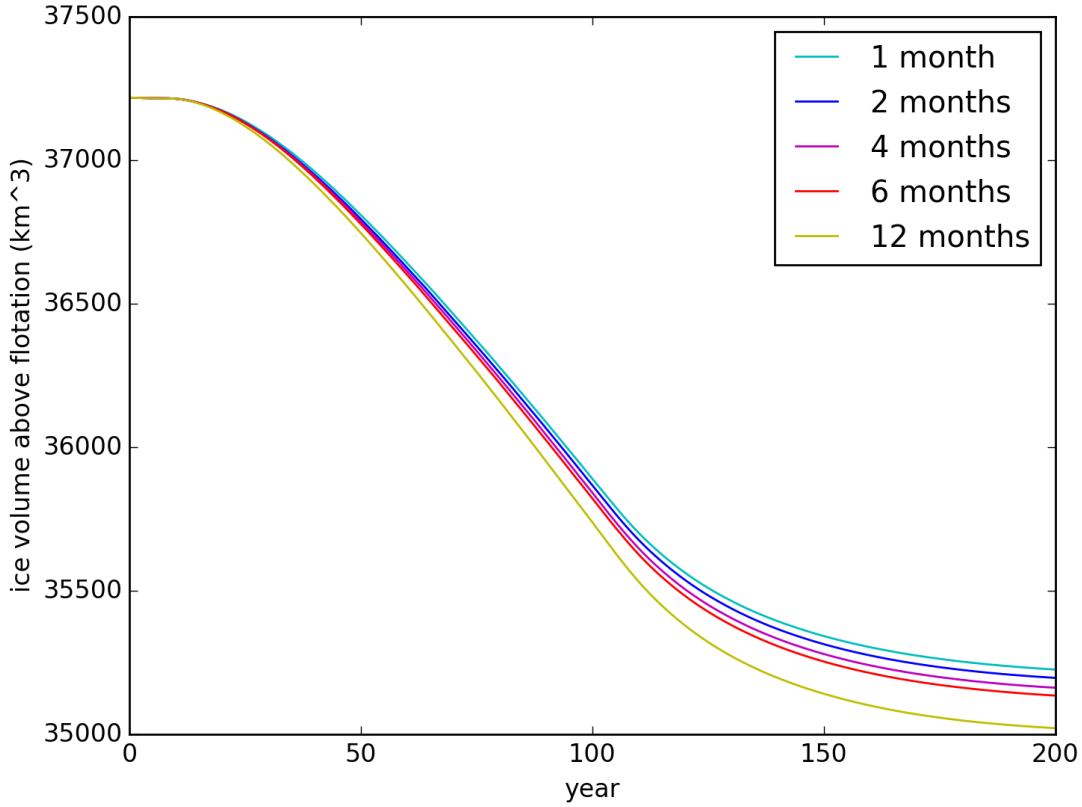


POPSICLES Parameter study: coupling interval

Mean melt rate

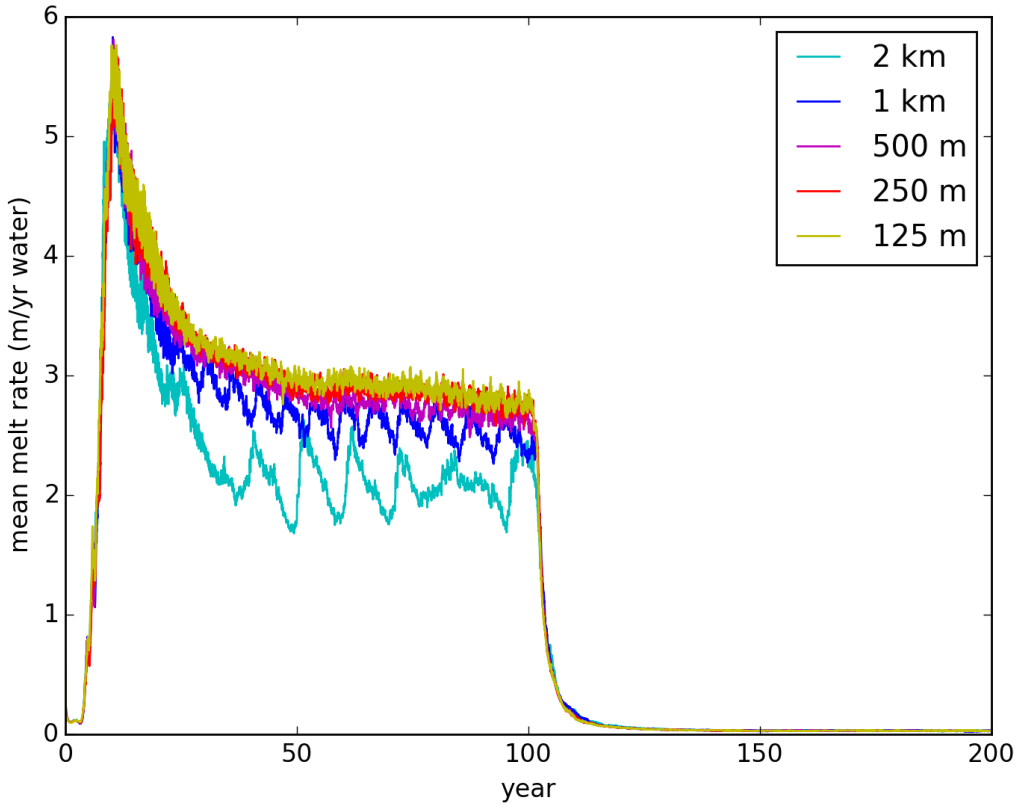


Volume above flotation

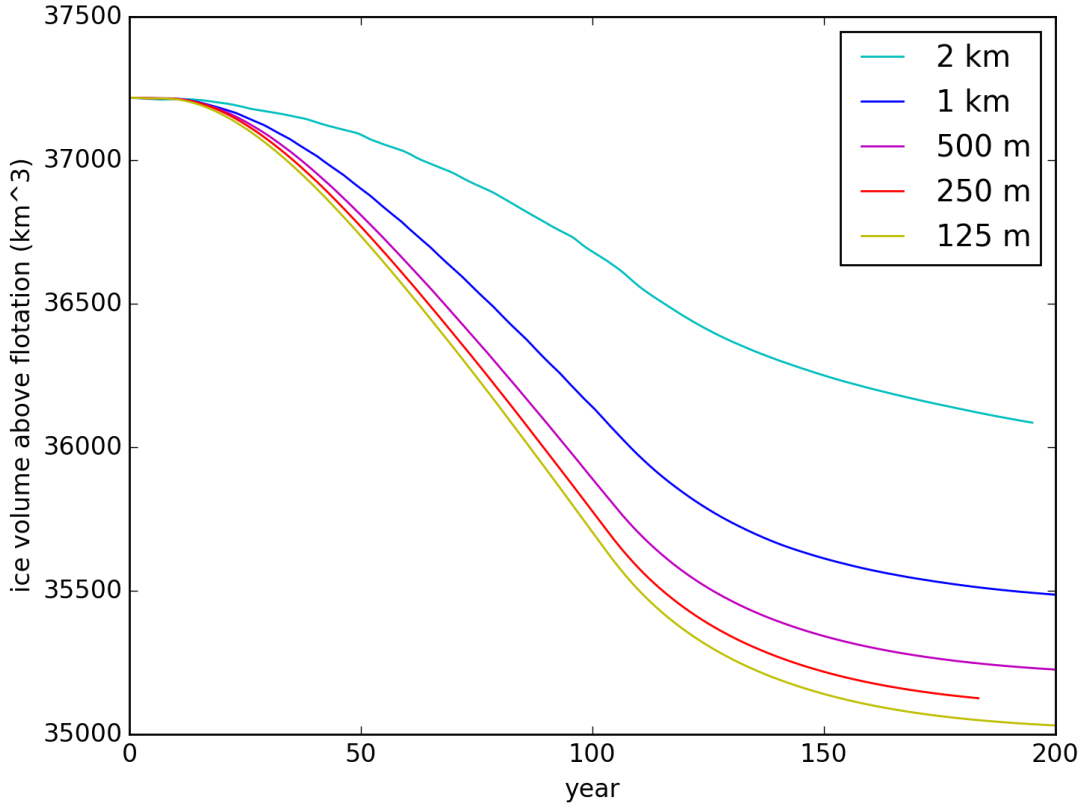


POPSICLES study: ice sheet max. res.

Mean melt rate

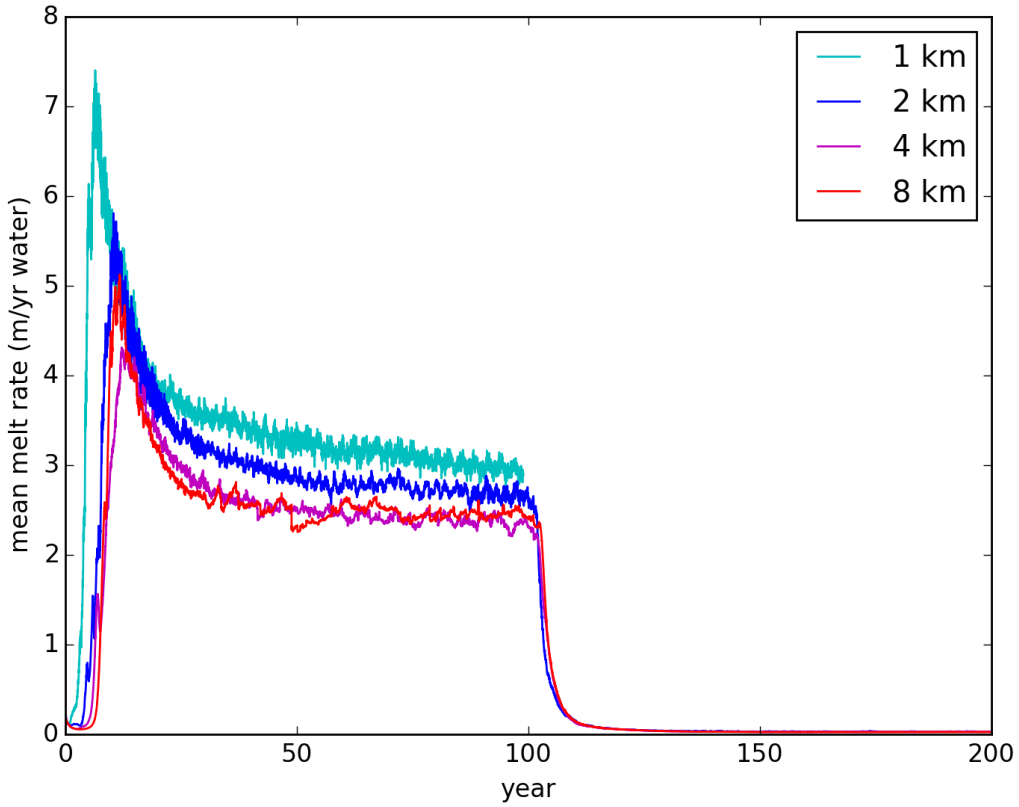


Volume above flotation

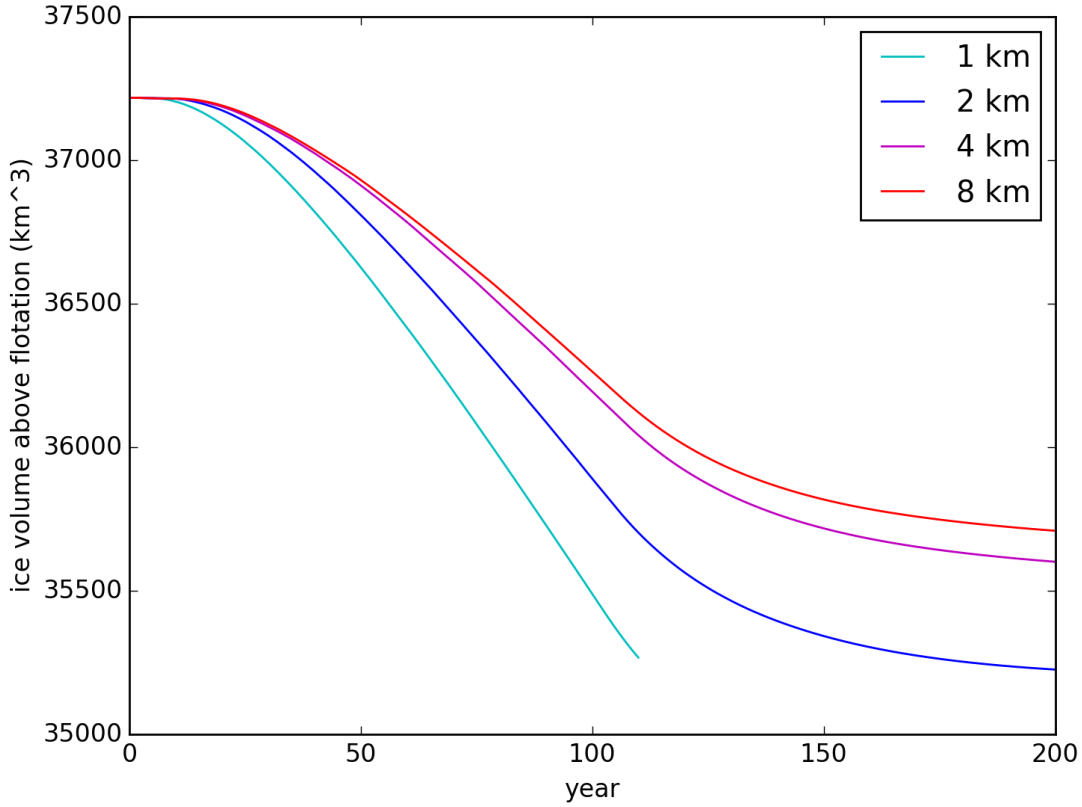


POPSICLES study: ocean horizontal resolution

Mean melt rate

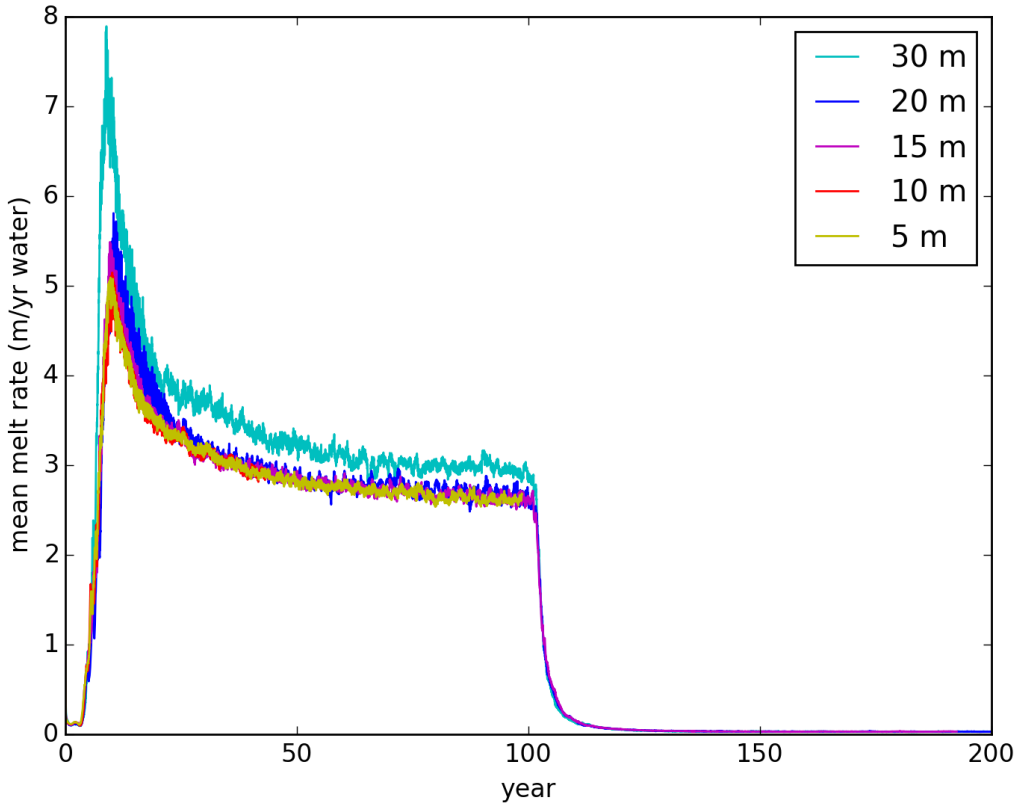


Volume above flotation



POPSICLES study: ocean vertical resolution

Mean melt rate



Volume above flotation