

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

Xylar S. Asay-Davis

Christopher Y. S. Bull, Stephen Cornford, Eva Cougnon, Jan De Rydt,
Benjamin K. Galton-Fenzi, Rupert Gladstone, Daniel Goldberg, David Gwyther,
James Jordan, Nicolas Jourdain, Gunter Leguy, William Lipscomb,
Gustavo Marques, Daniel F. Martin, Pierre Mathiot, Yoshihiro Nakayama,
Kaitlin A. Naughten, Robin S. Smith, H el ene Seroussi, Chen Zhao

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



Climate and Cryosphere

Understanding the changing cryosphere and its climate connections

Marine Ice Sheet-Ocean Model Intercomparison Project (MISOMIP)

Global sea-level rise is one of the most discussed potential consequences of global warming. The most uncertain aspect of such future sea-level change has to do with the marine based ice sheets, and particularly that of the West Antarctic Ice Sheet (WAIS). Despite its potential importance, current generation global climate models are unable to simulate sea-level change arising from ice sheet-ocean interaction.

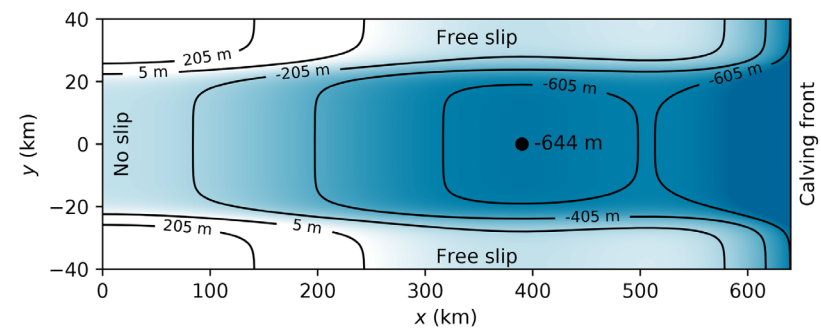
As a step towards remediating this situation, we are bringing together, through annual workshops, the international modeling community with expertise in this area so to advance the state-of-the-art in regional-scale simulations. The outcome of these workshops will be physically-based estimates of sea-level change coming from WAIS over the present century and beyond. Such regional-modeling research will lay the groundwork for including ice sheet-ocean interaction in global scale, IPCC class models.

This targeted activity is led by [David Holland](#). For more information, contact [Denise Holland](#). The design and implementation of coupled experiments have been led to date by the co-chairs, Xylar Asay-Davis (LANL, USA) and Helene Seroussi (JPL, USA). Starting in 2019, the co-chair positions will next be taken up by Jan de Rydt (U. Northumbria, UK) and Nicolaus Jourdain. (U. Grenoble, France).

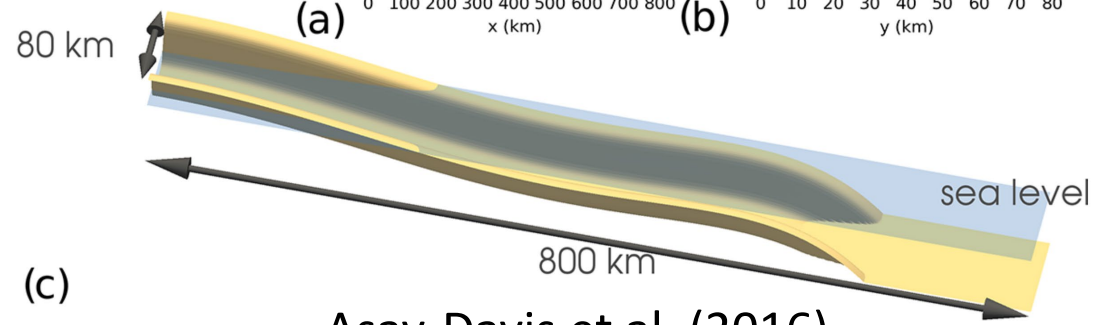
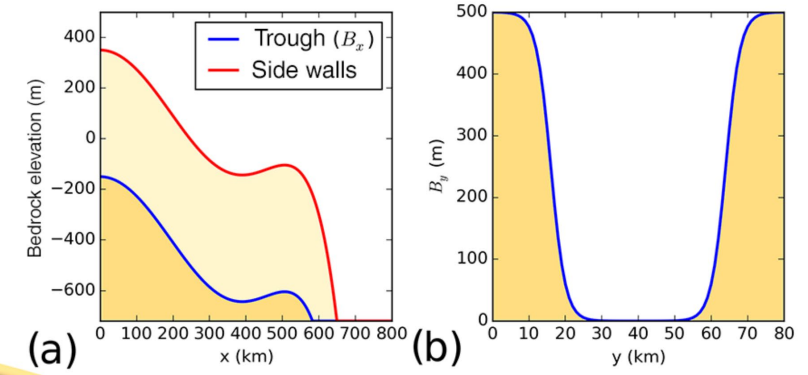


Idealized Community Experiments

- **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)

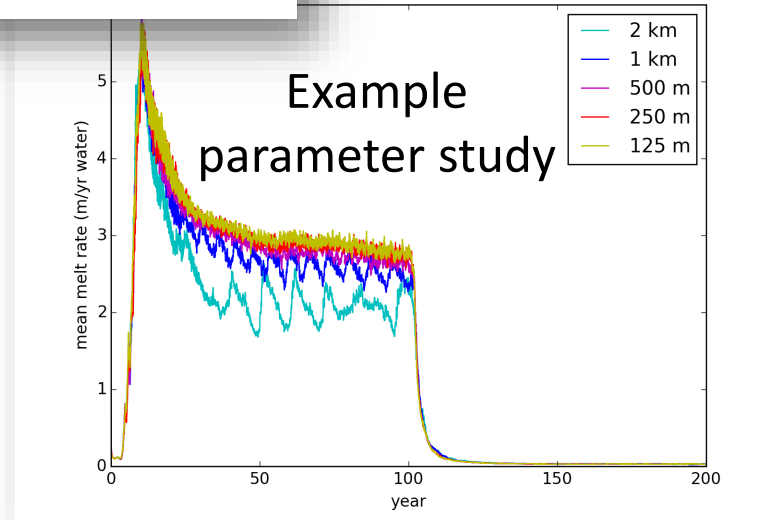
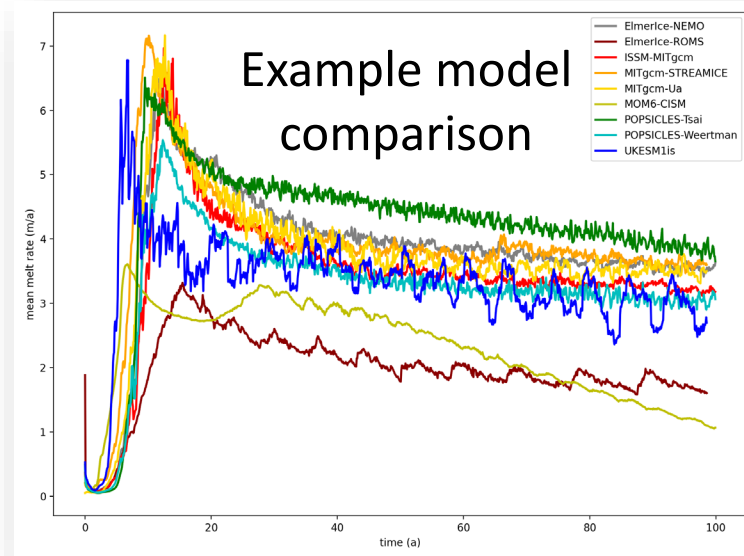


Asay-Davis et al. (2016)



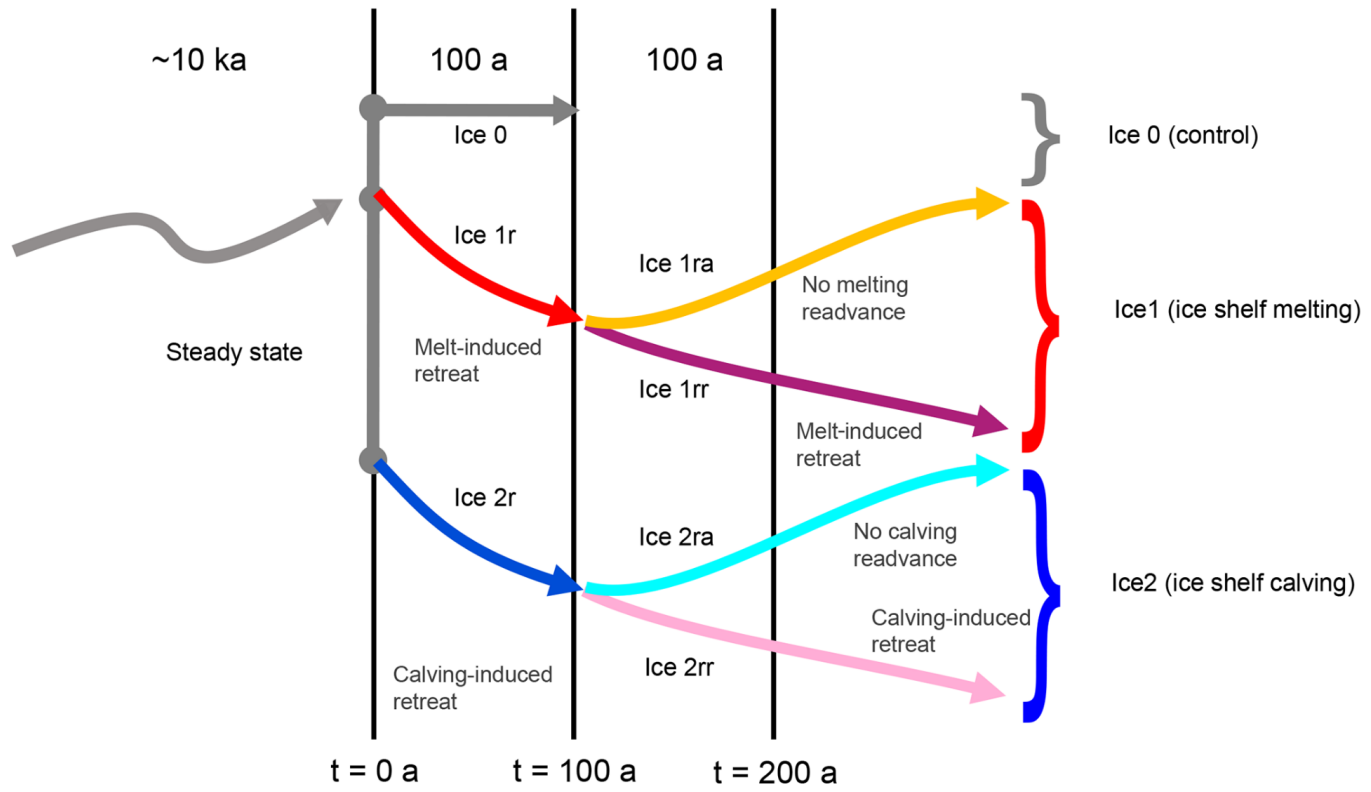
Purpose of MISMIP+, ISOMIP+, MISOMIP1

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





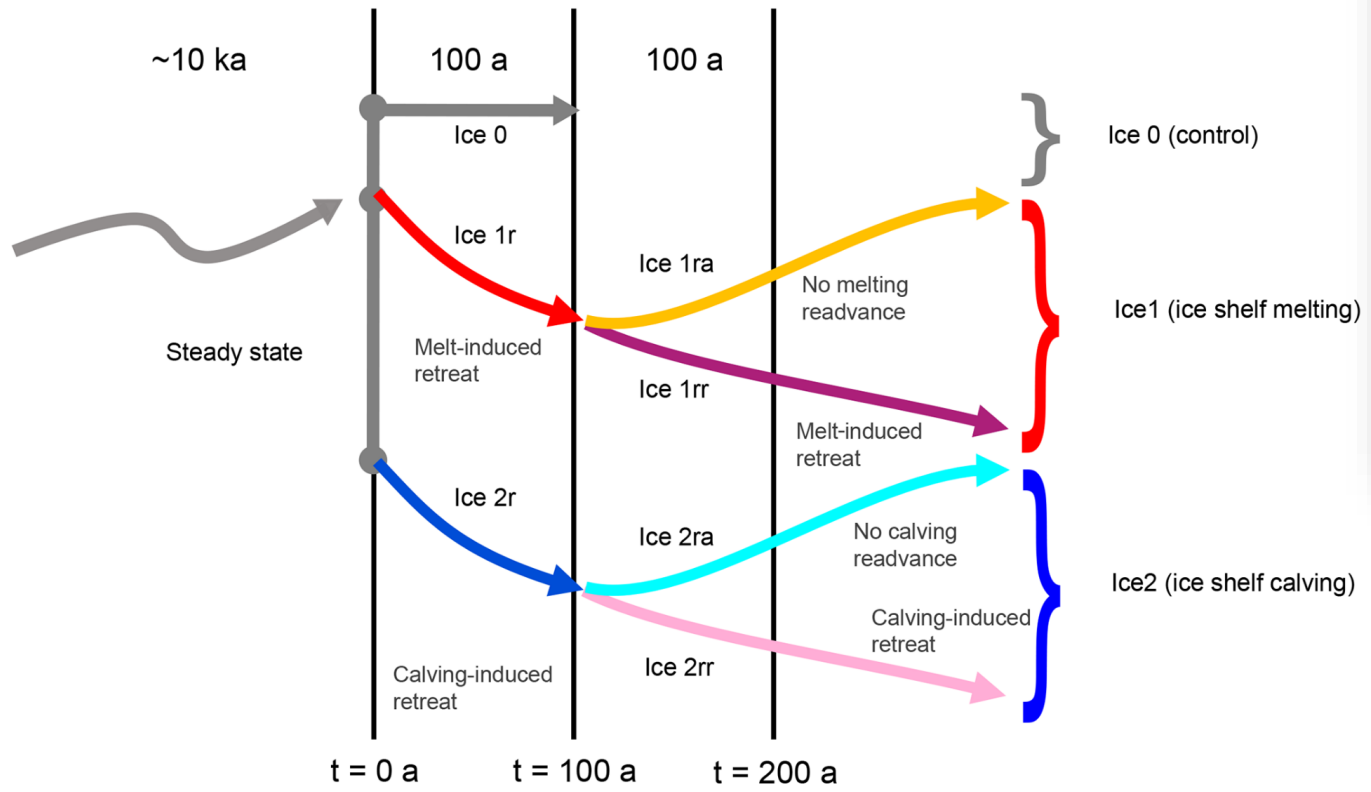
MISMIP+



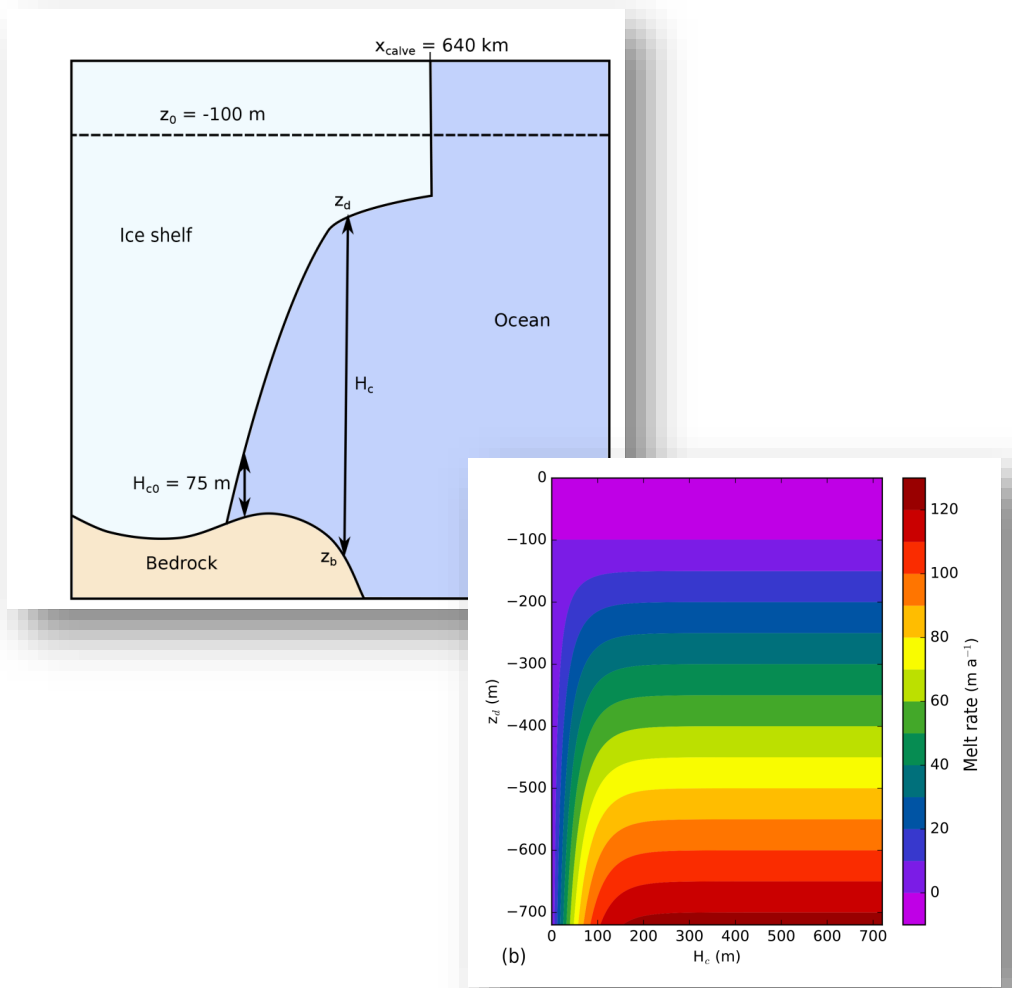
Cornford et al. (2020)



MISMIP+



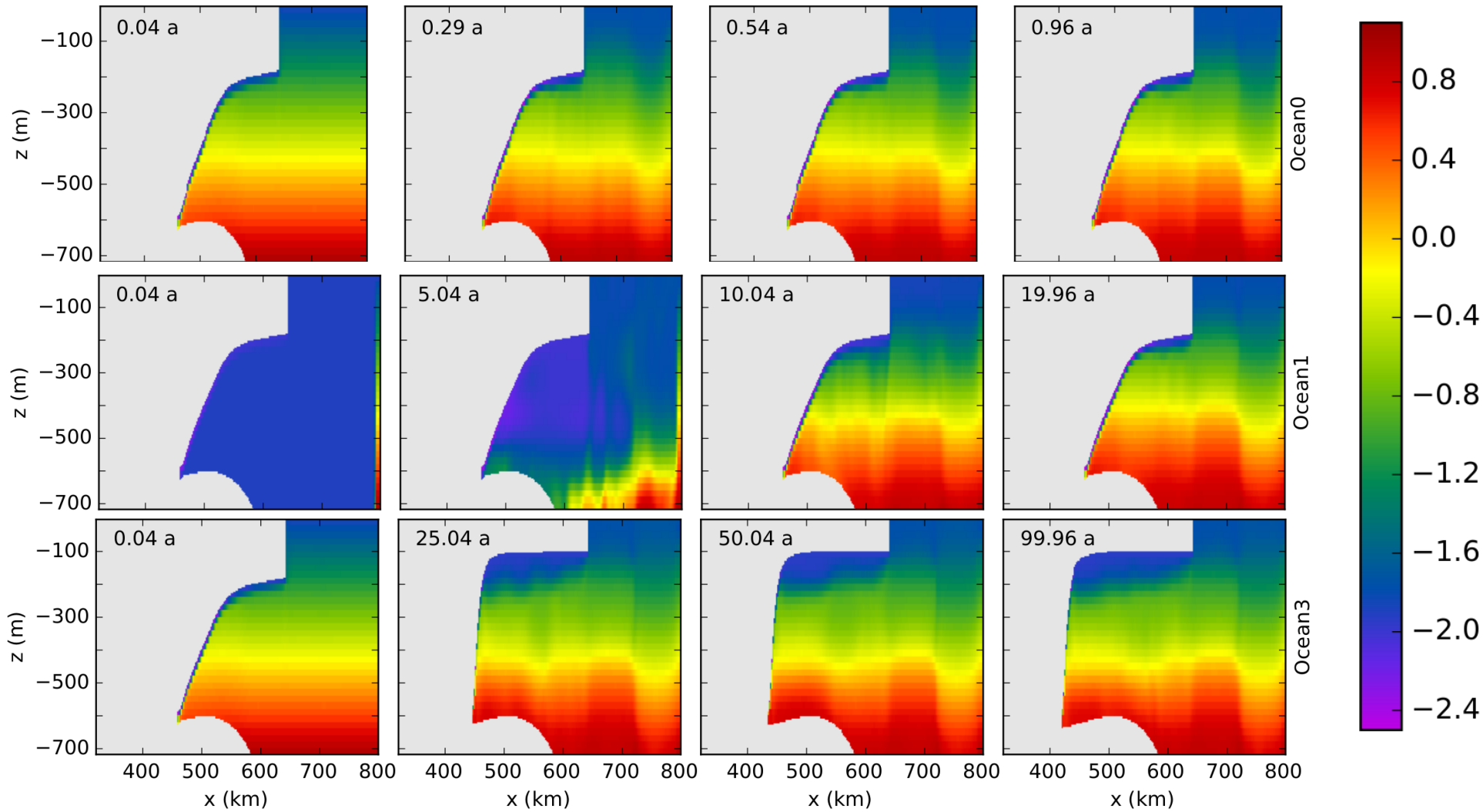
Cornford et al. (2020)



Asay-Davis et al. (2016)



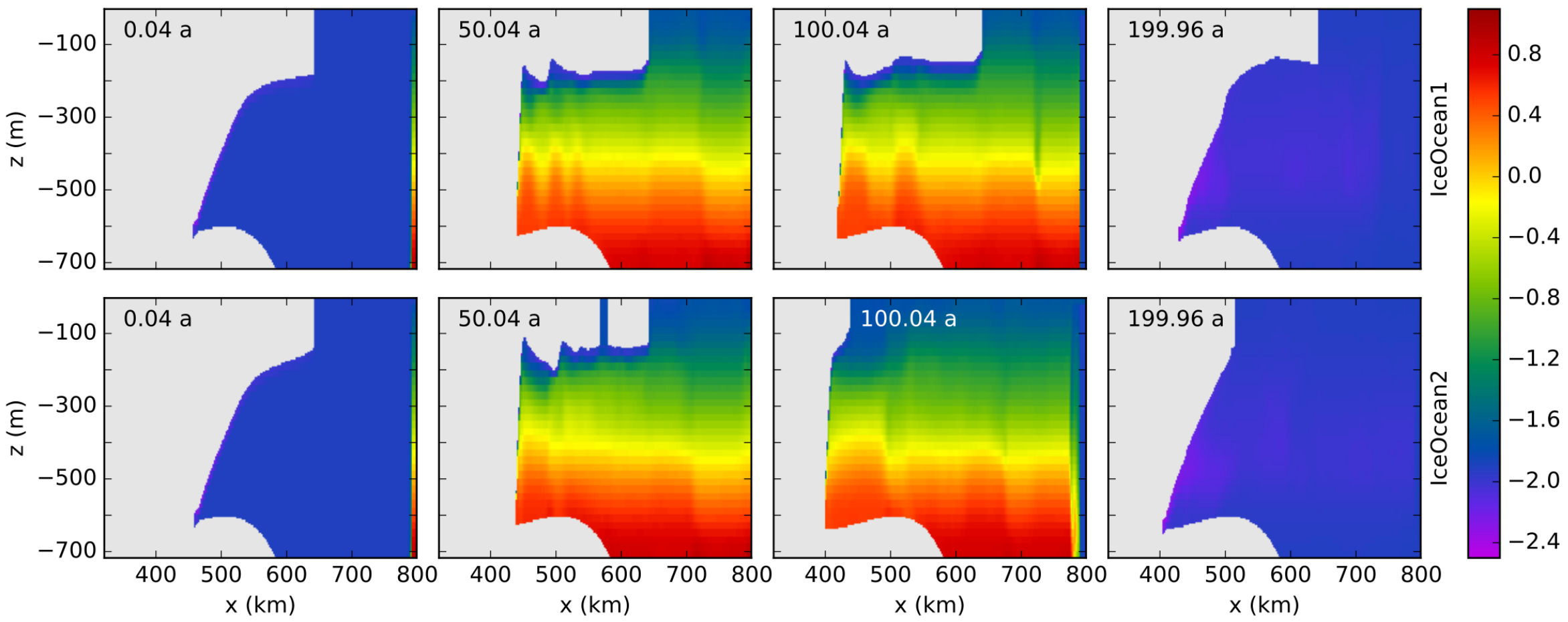
ISOMIP+ temperature sections vs. time



Asay-Davis et al. (2016)



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, H�el�ene Seroussi, Mathieu Morlighem
MITgcm-STREAMICE	James Jordan, Dan Goldberg, Paul Holland
MITgcm-�a	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

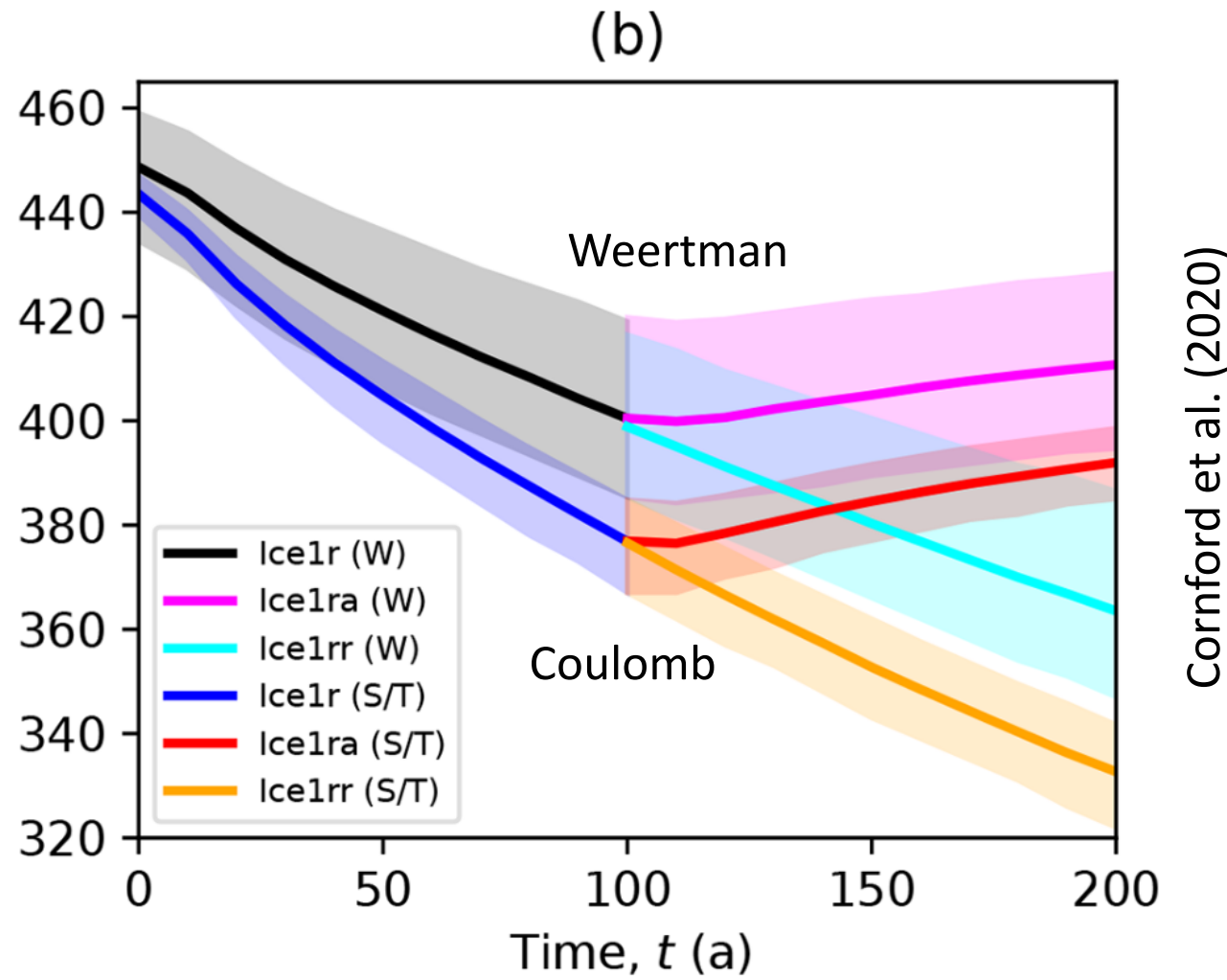


MISOMIP1: Participating Models

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.



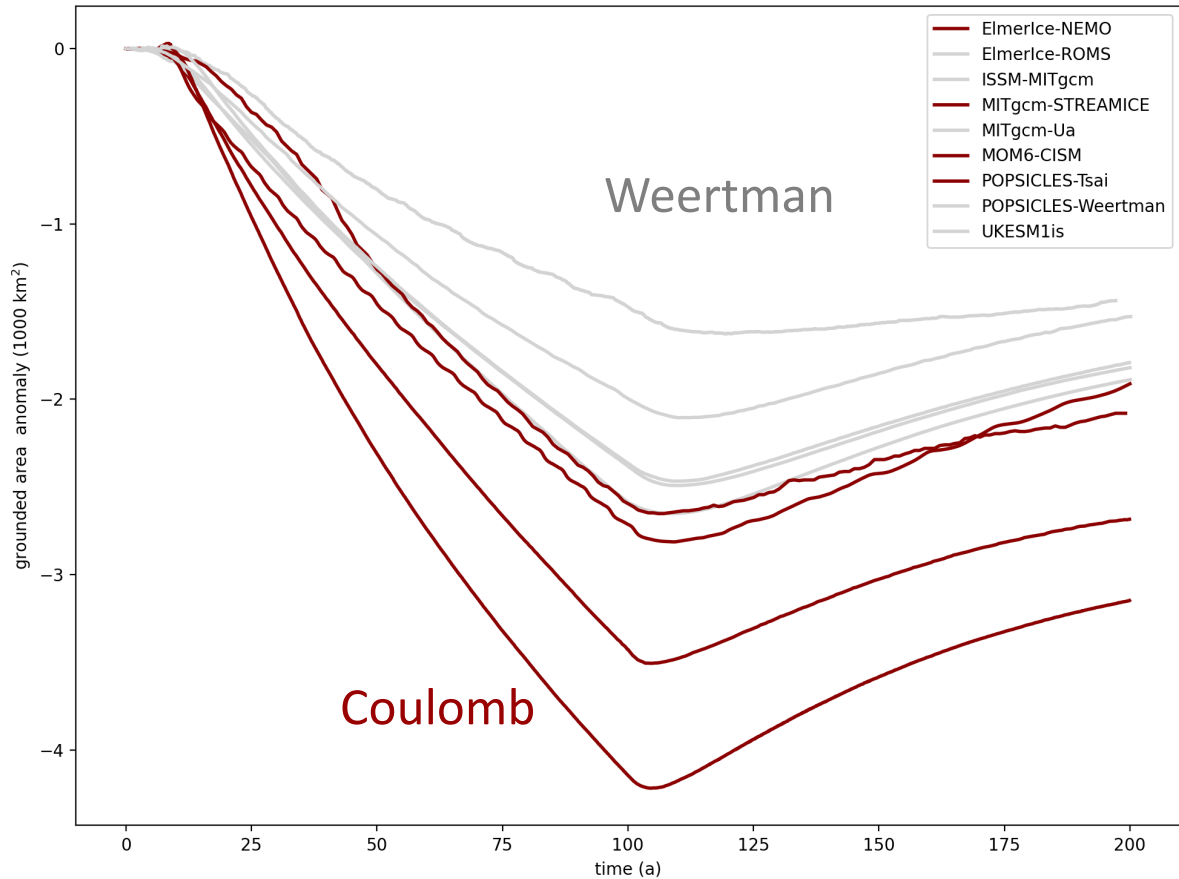
Ice-sheet basal friction: MISMIP+





Ice-sheet basal friction

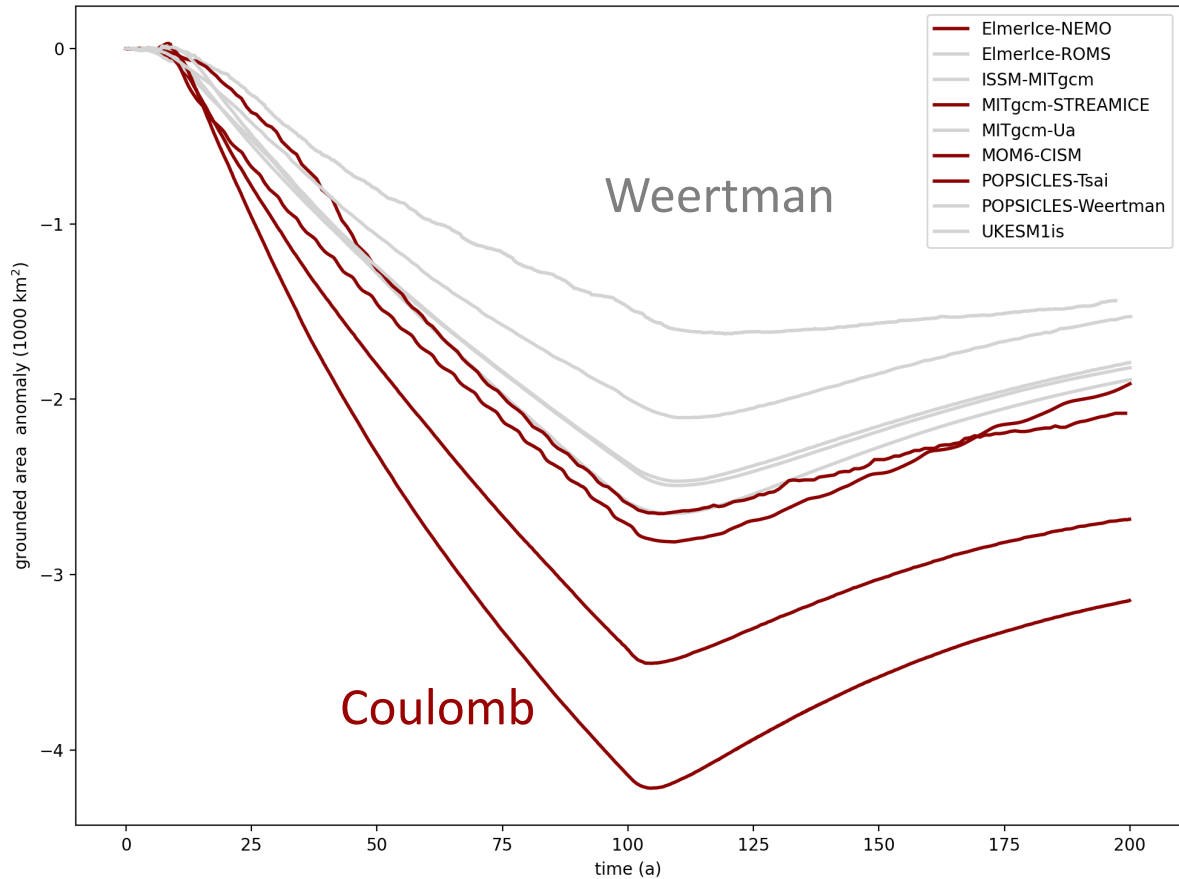
Grounded Area



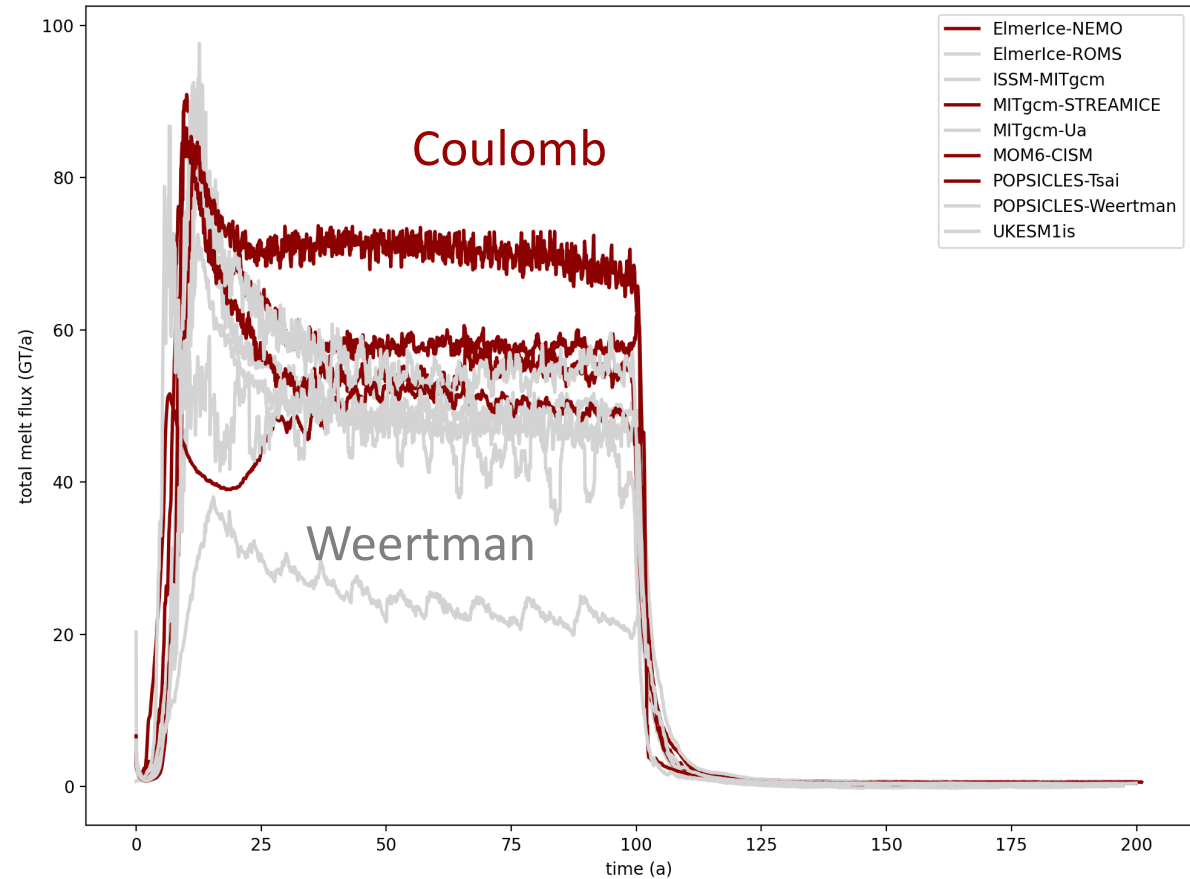


Ice-sheet basal friction

Grounded Area

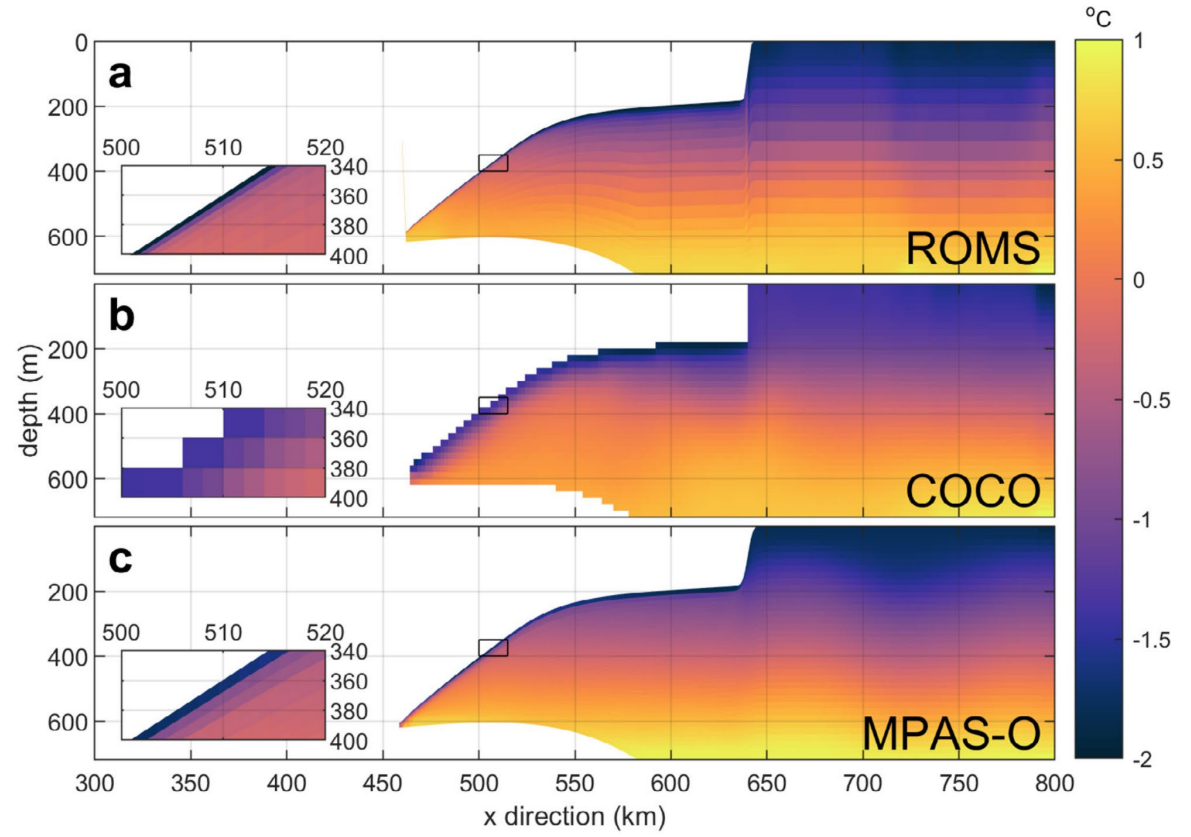
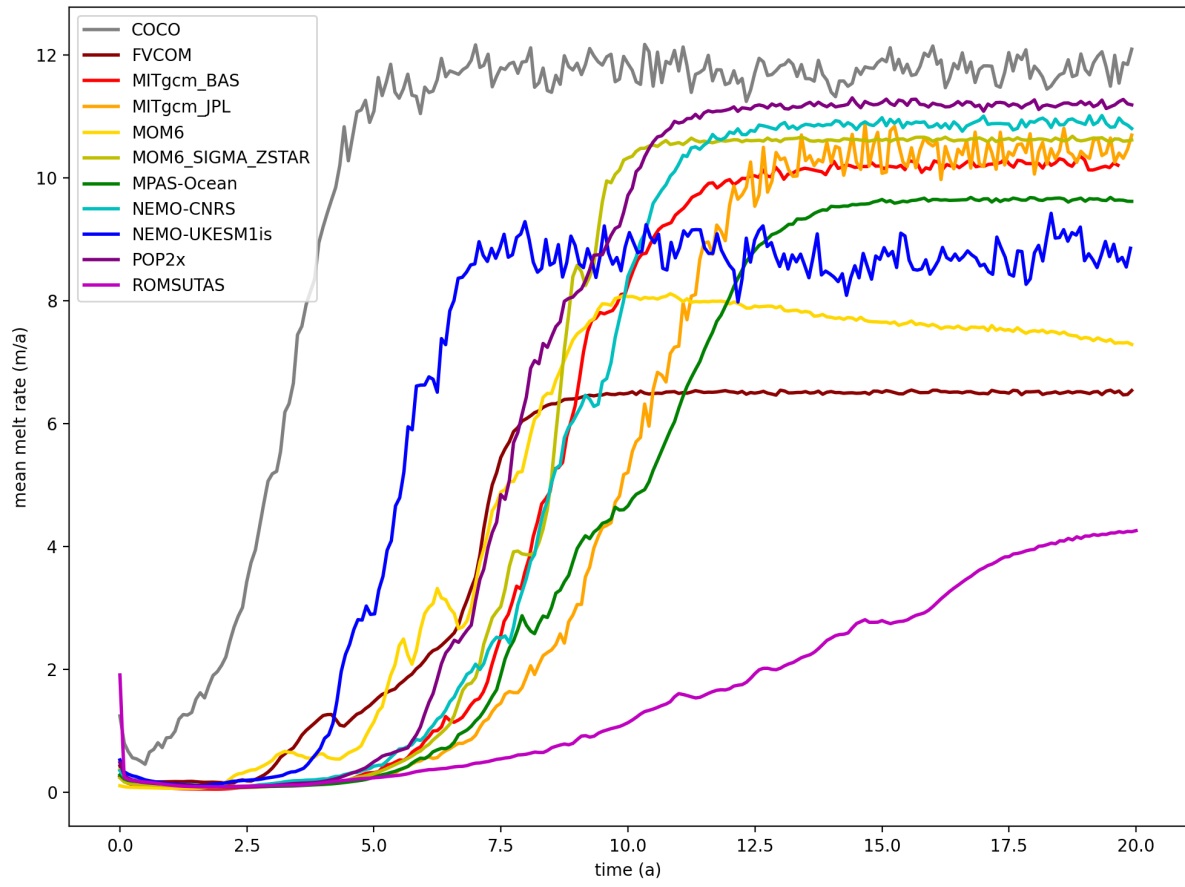


Total Melt Flux





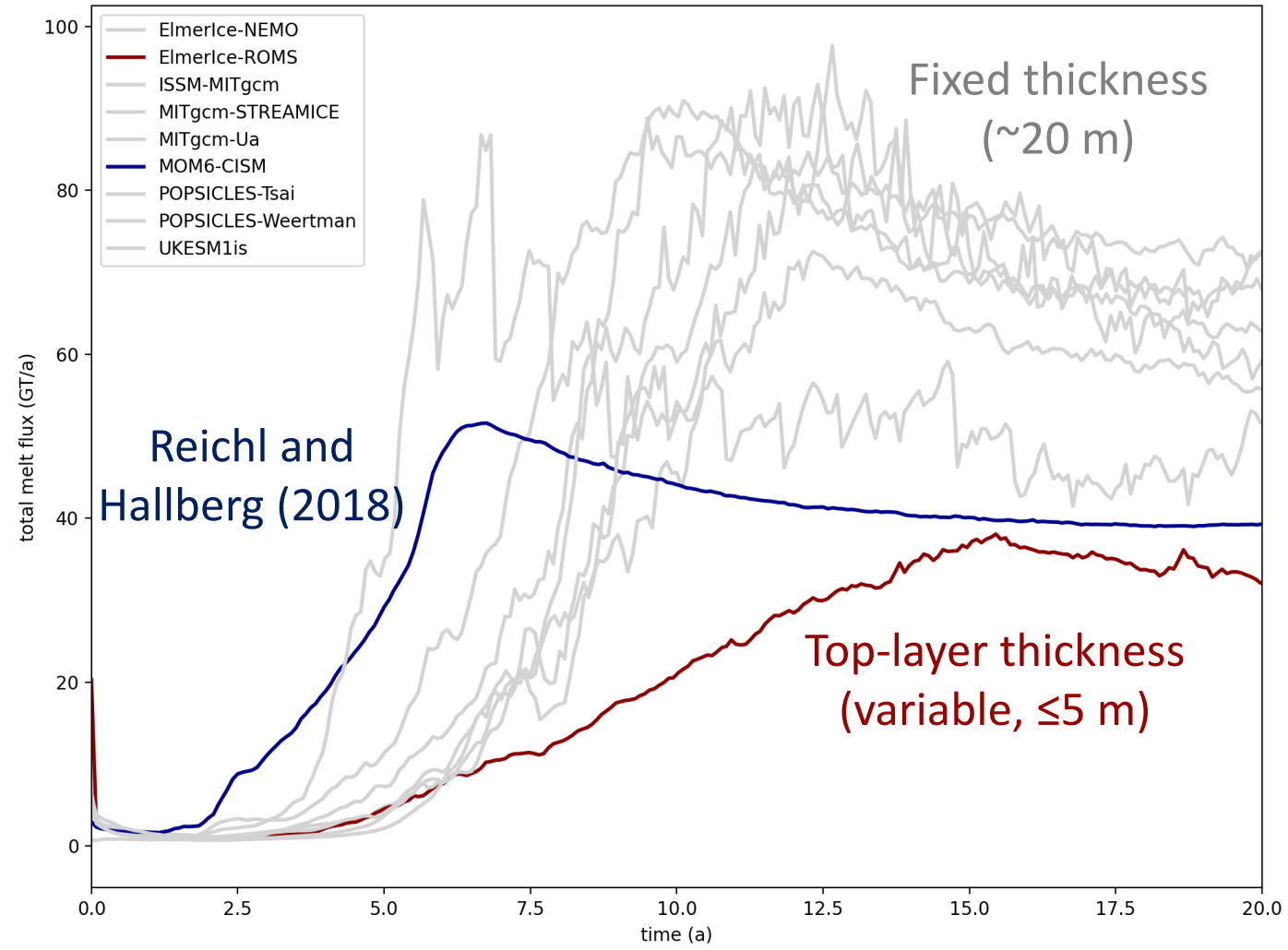
Ocean boundary layer: ISOMIP+



Gwyther et al. (2020)

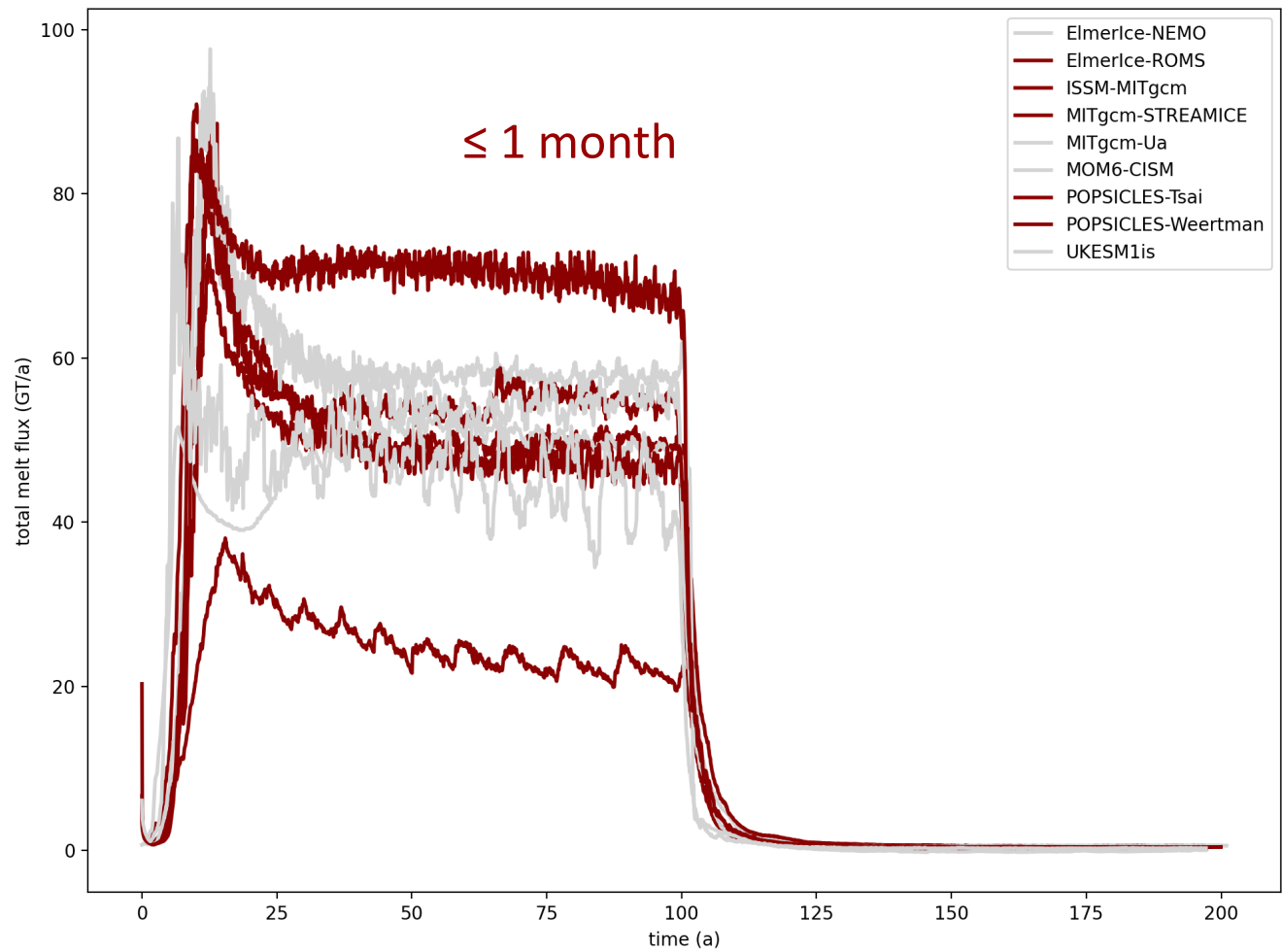


Ocean boundary layer



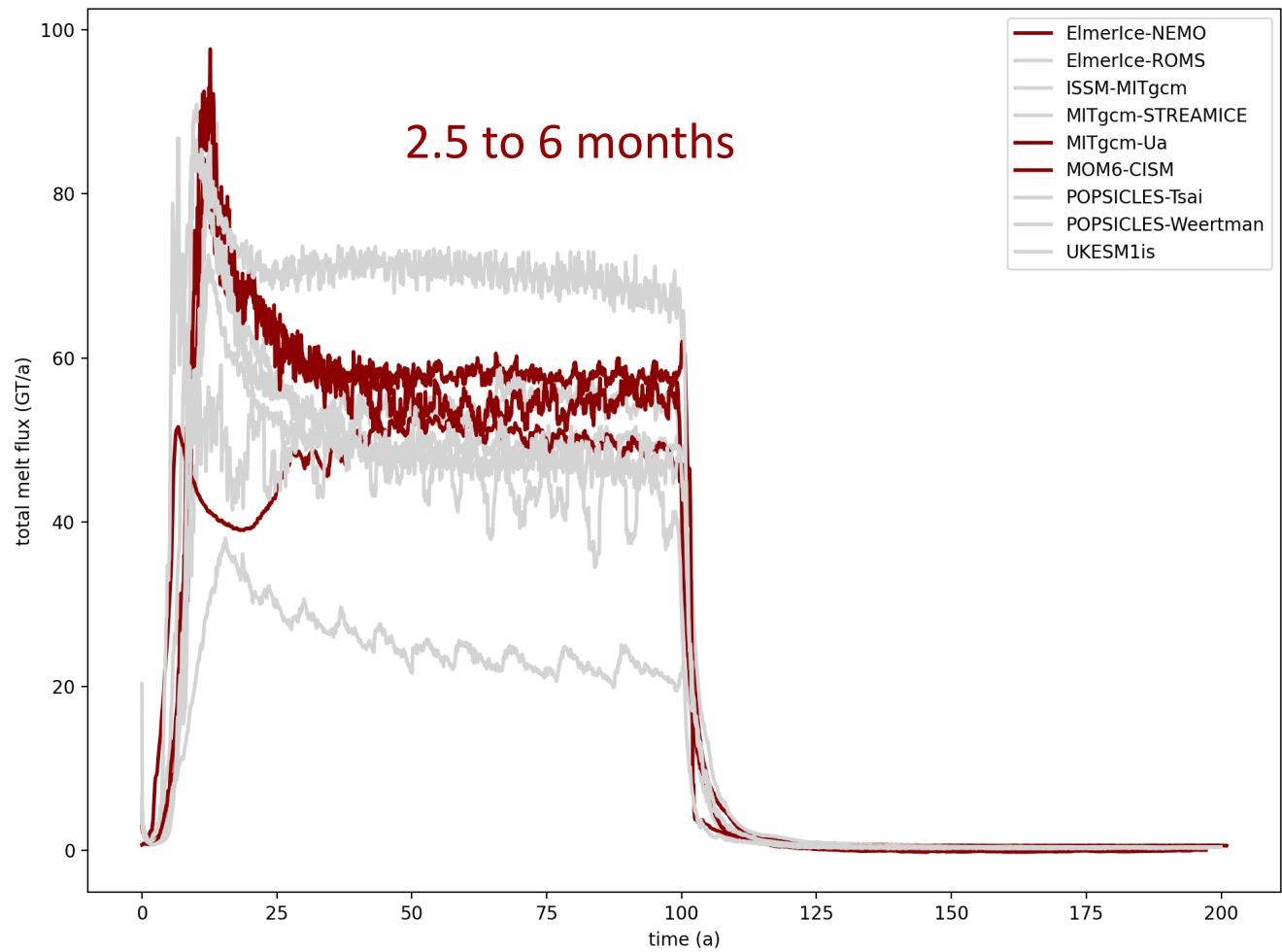


Coupling frequency: ≤ 1 month



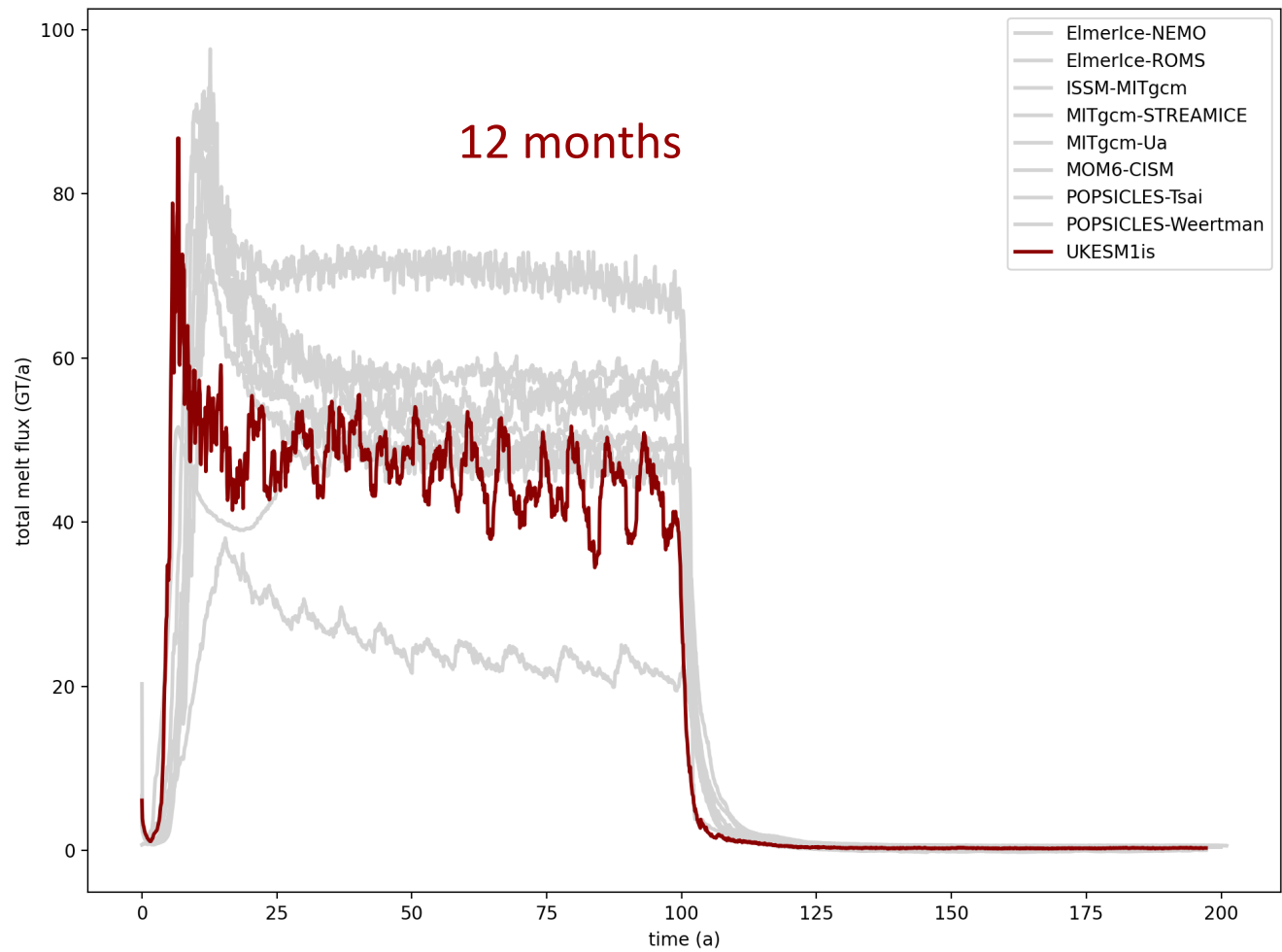


Coupling frequency: 2.5 to 6 months





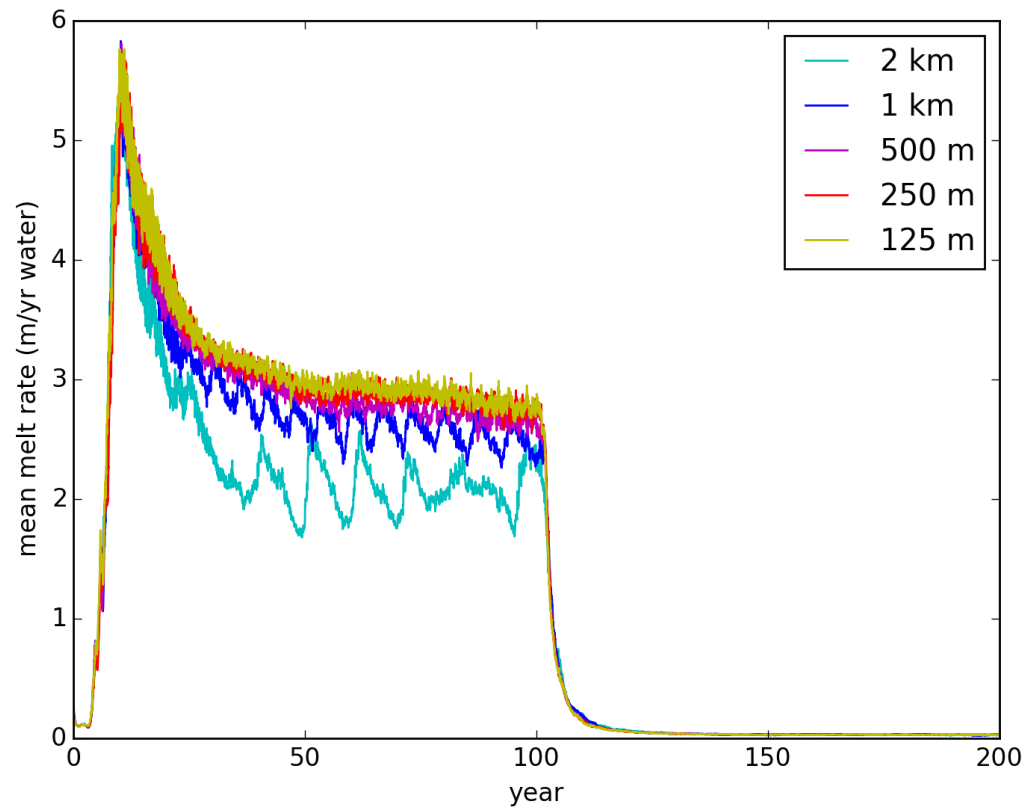
Coupling frequency: 12 months



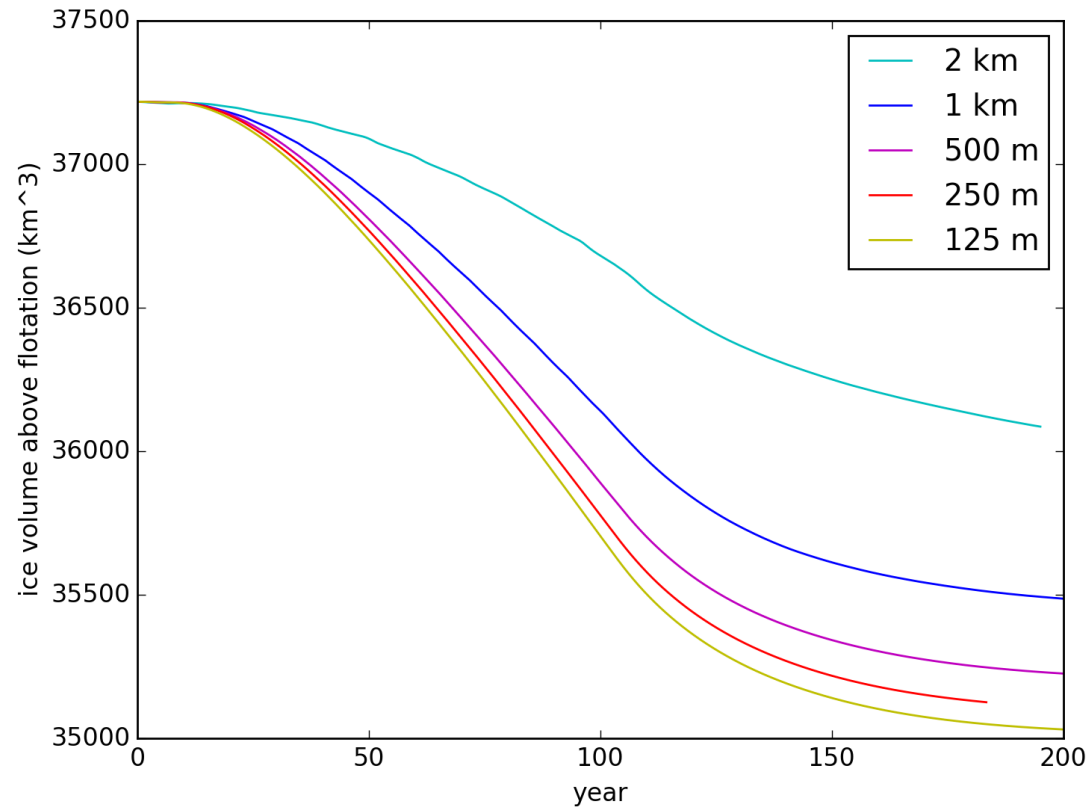


POPSICLES study: ice sheet max. res.

Mean melt rate

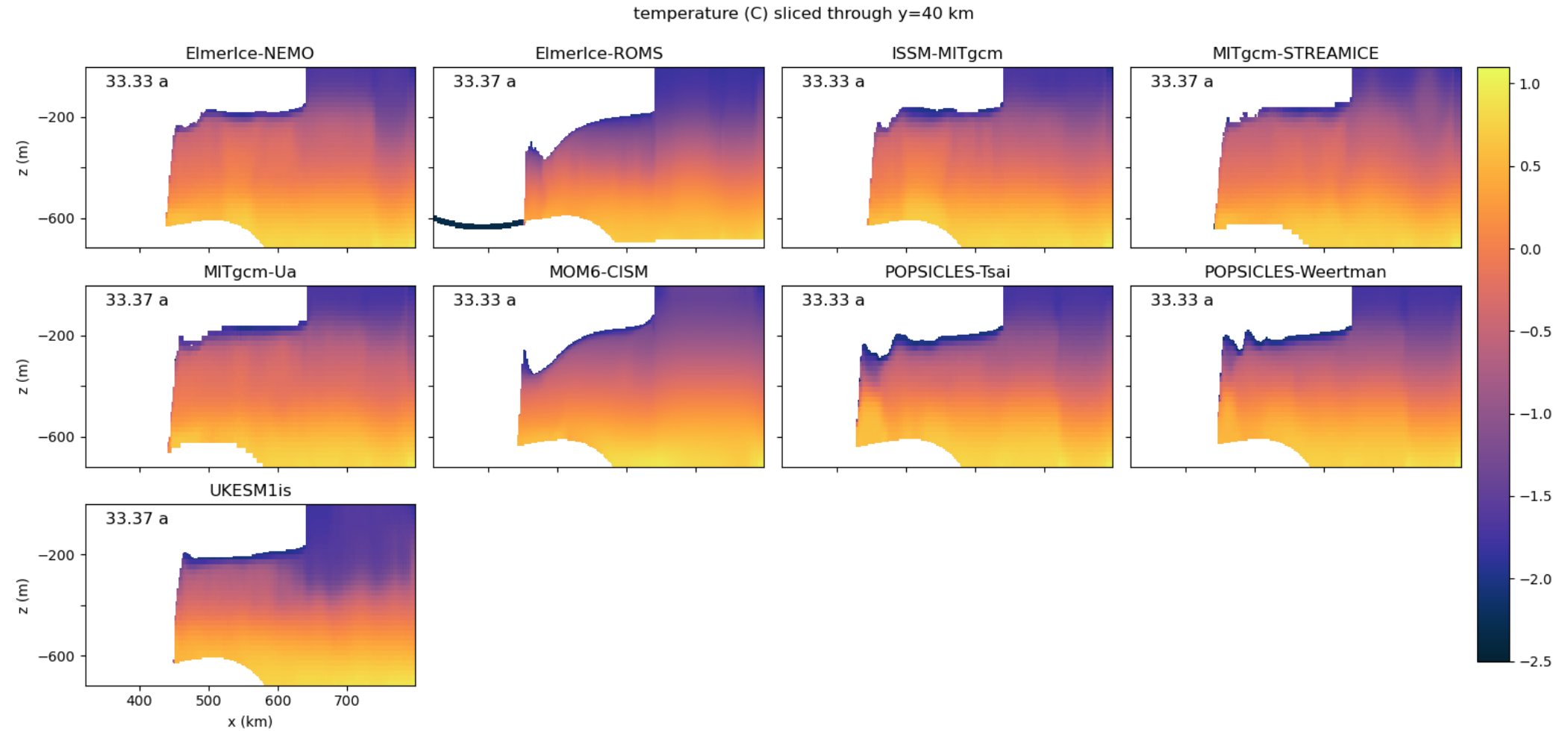


Volume above flotation





Topographic features from coupling





Future work

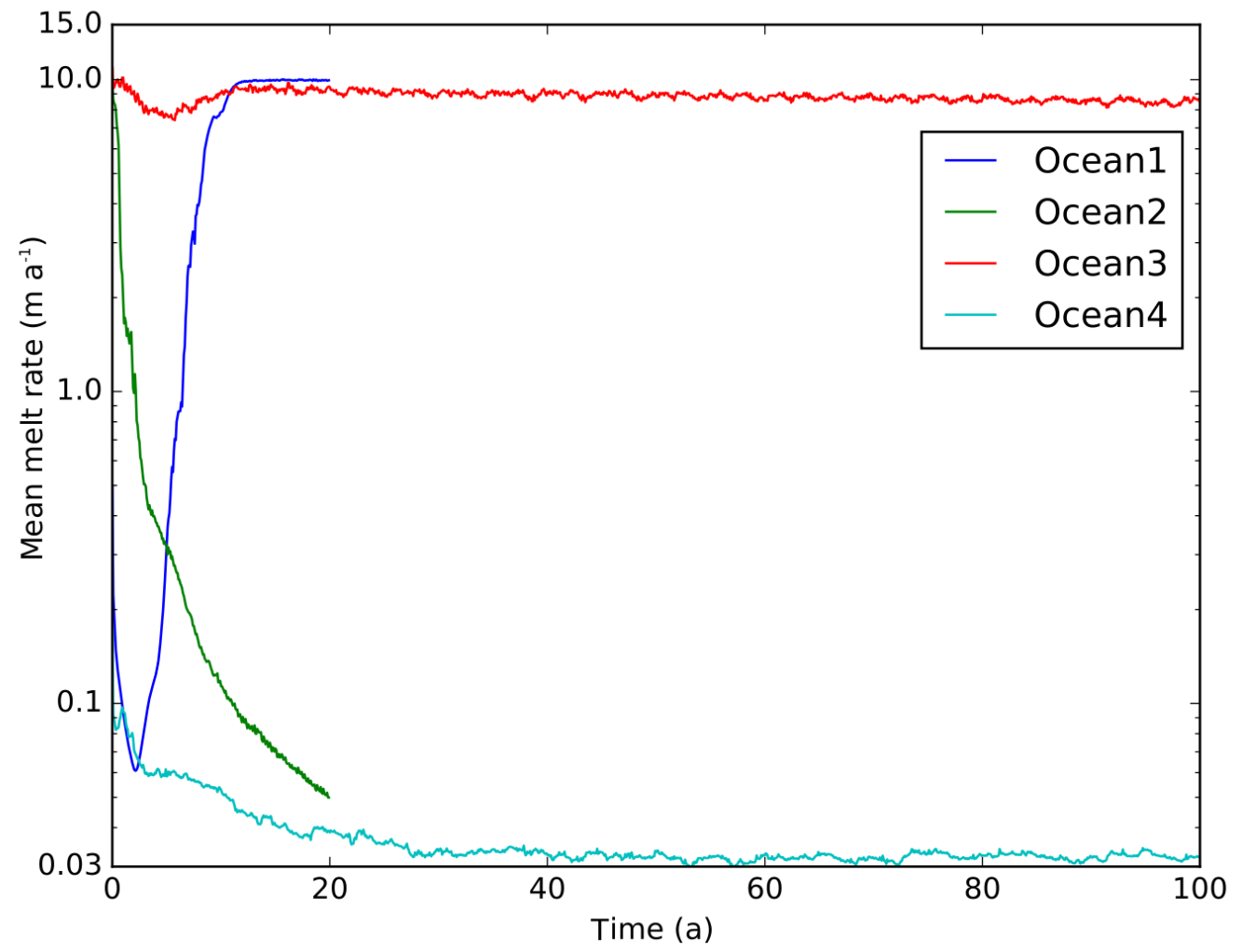
- What does coupling add? Quantitative comparisons:
 - MISMIP+ vs. MISOMIP1 w/ same ice-sheet model
 - ISOMIP+ vs. MISOMIP1 w/ same ocean model
- Explore impacts of ocean and ice-sheet resolution
- Parameter studies varying:
 - Ocean and ice-sheet resolution
 - Coupling interval
 - Ocean boundary layer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

Thank You!





ISOMIP+ mean melt rates

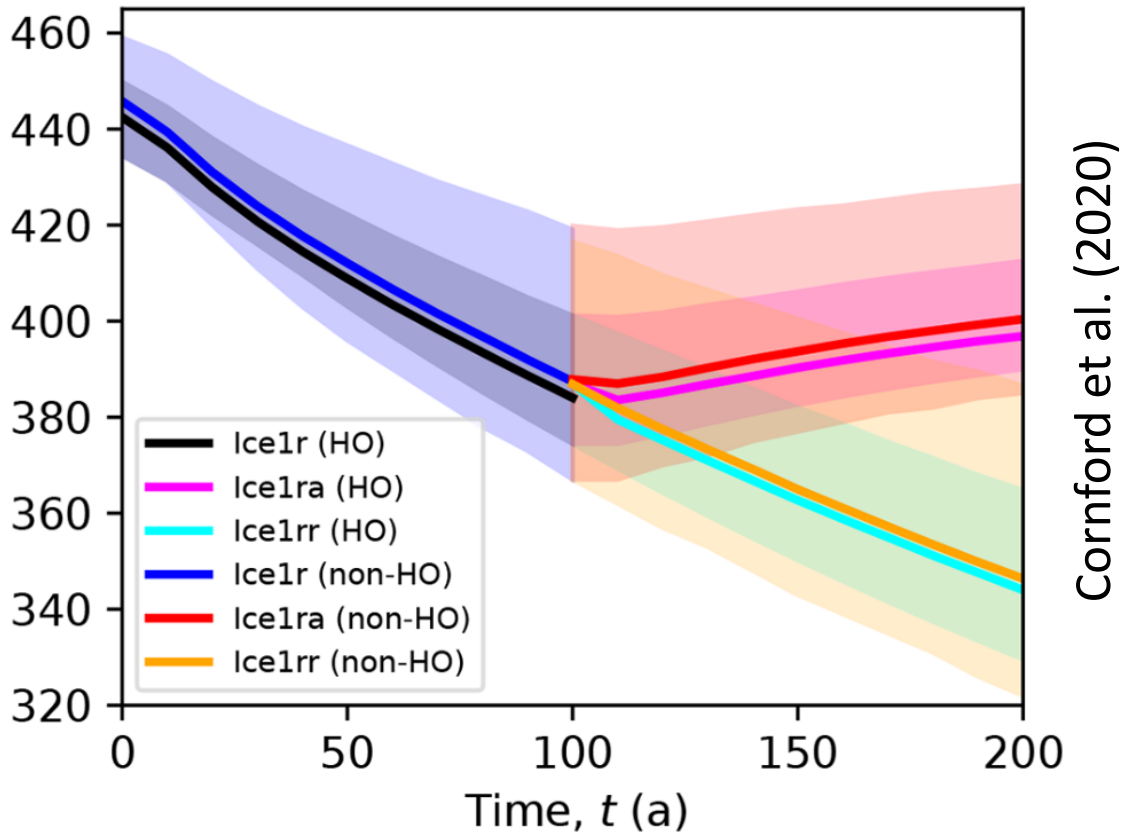


Asay-Davis et al. (2016)



Ice-sheet stress approximation

(b)

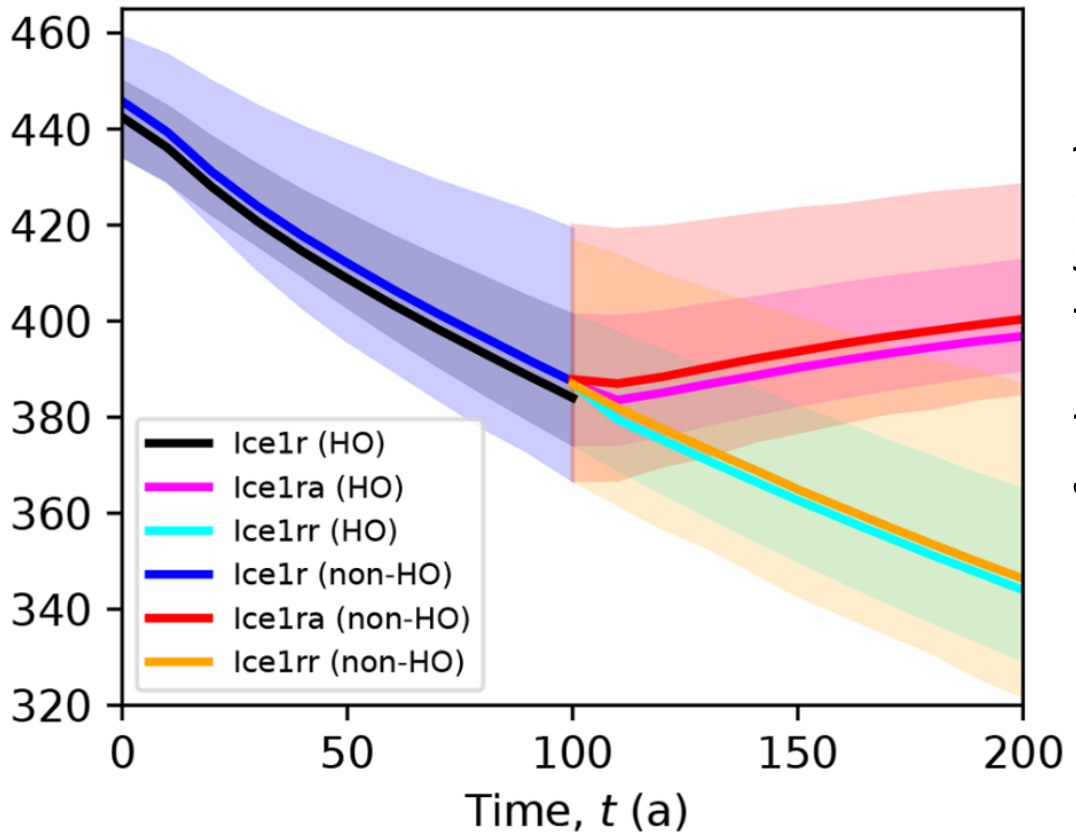


Cornford et al. (2020)



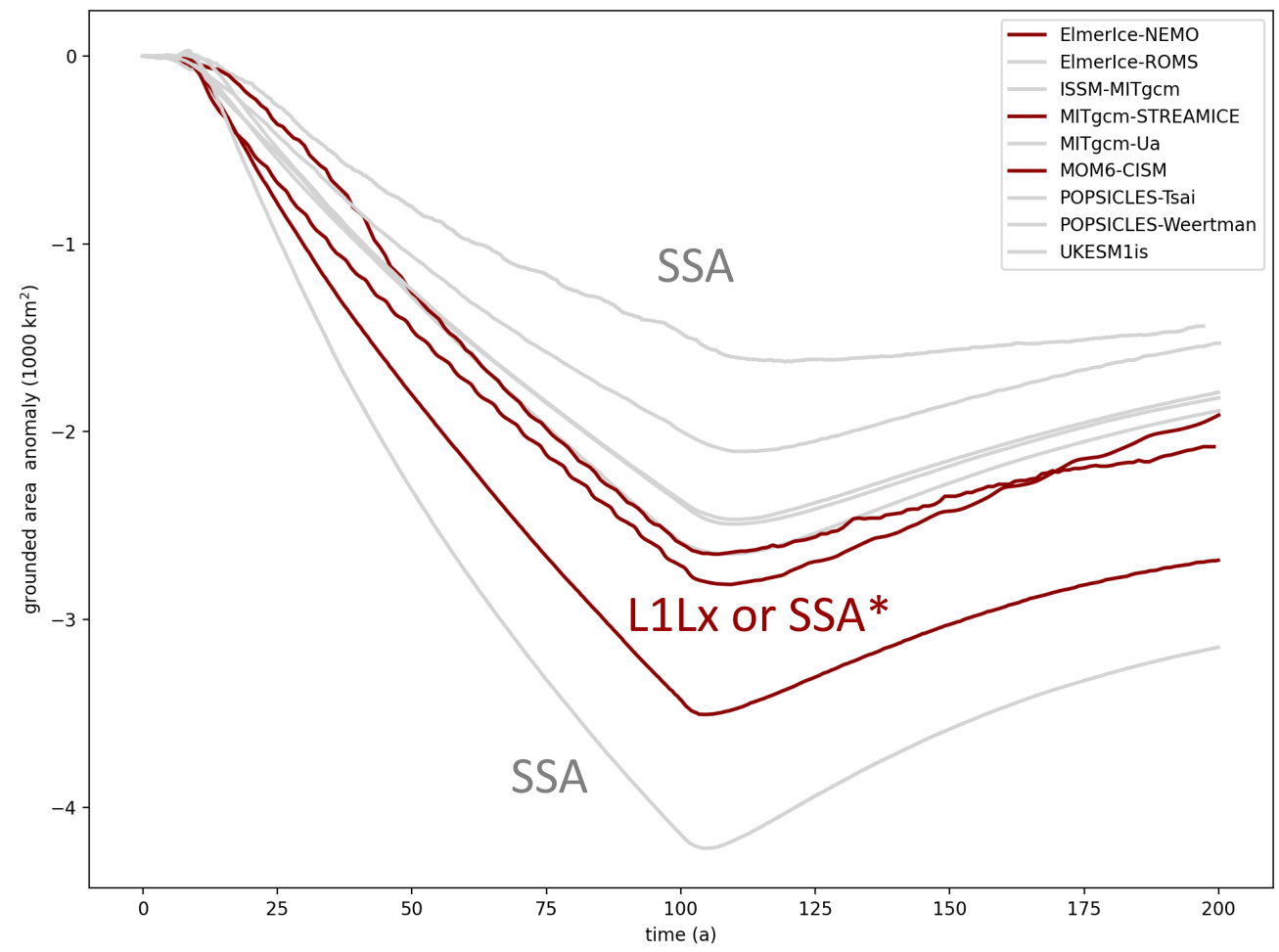
Ice-sheet stress approximation

(b)



Cornford et al. (2020)

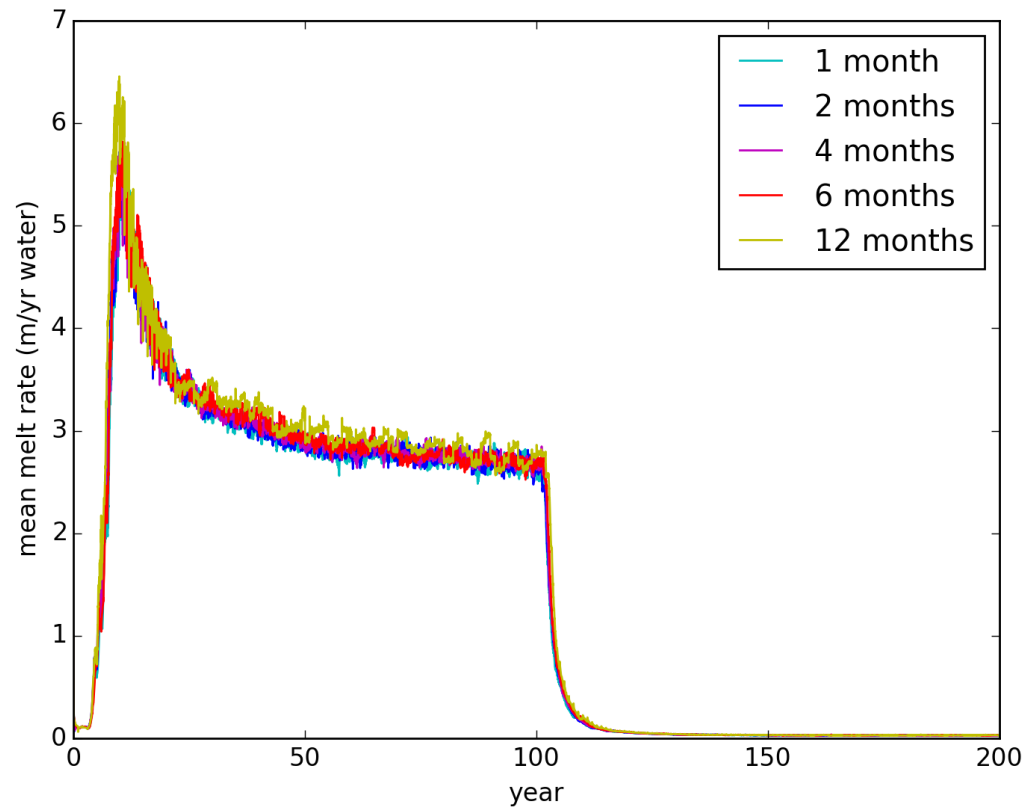
Grounded Area



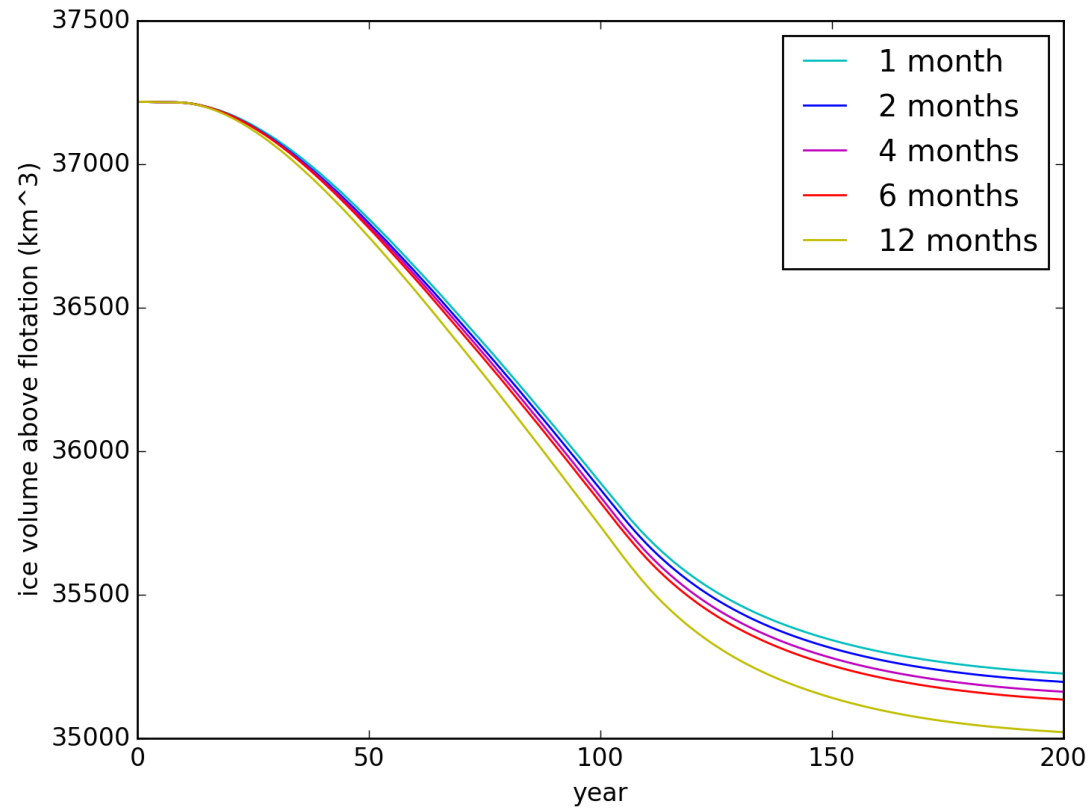


POPSICLES Parameter study: coupling interval

Mean melt rate



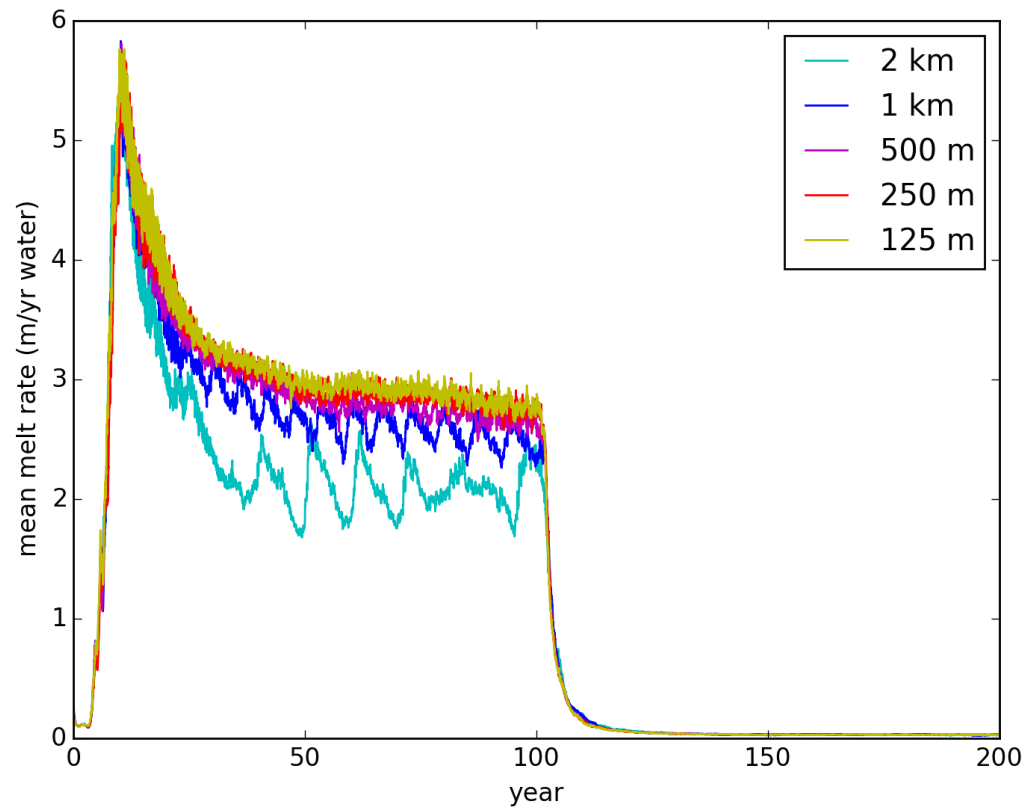
Volume above flotation



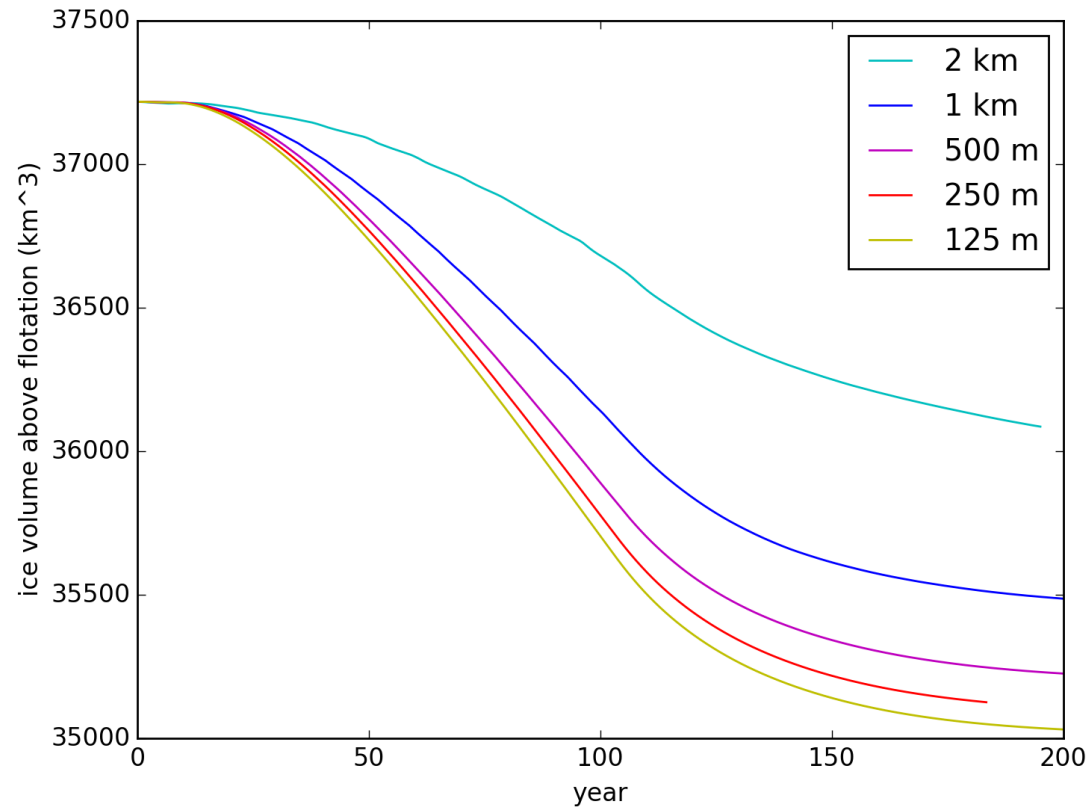


POPSICLES study: ice sheet max. res.

Mean melt rate



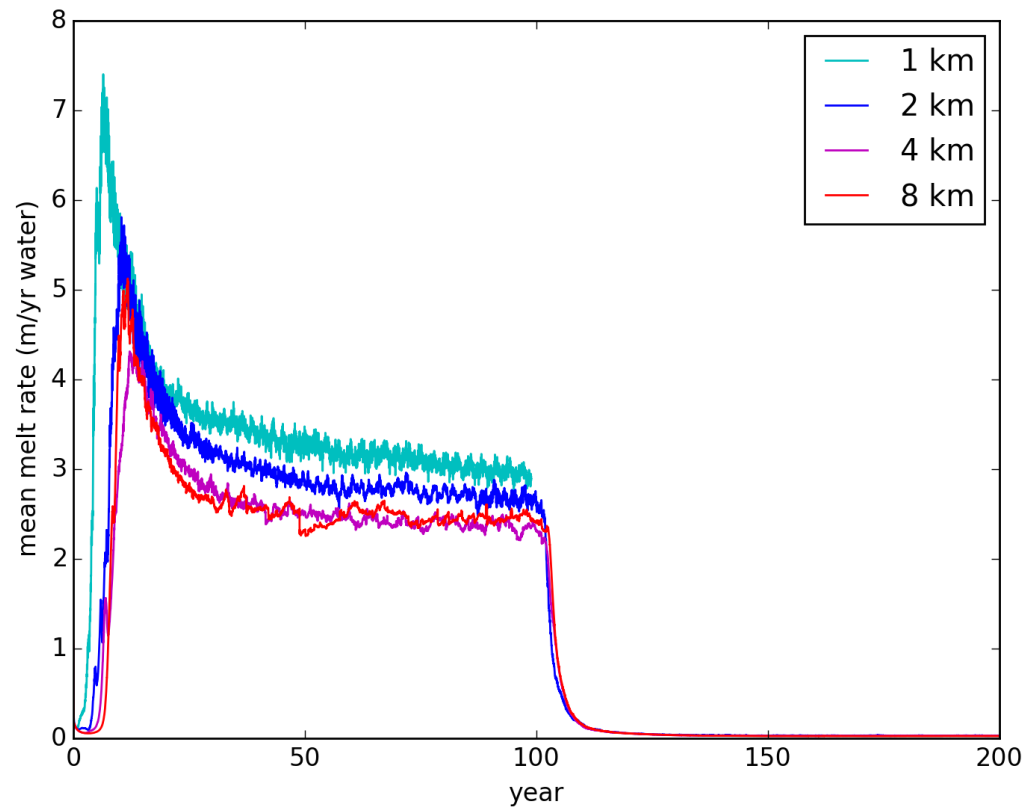
Volume above flotation



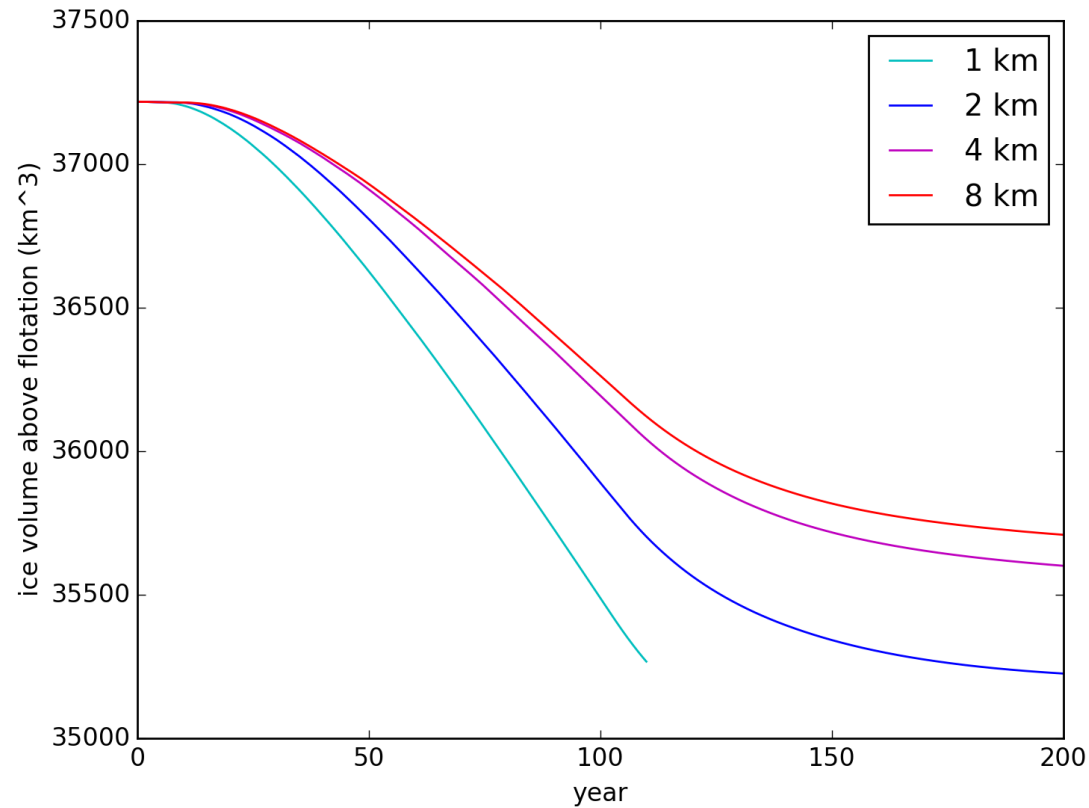


POPSICLES study: ocean horizontal resolution

Mean melt rate



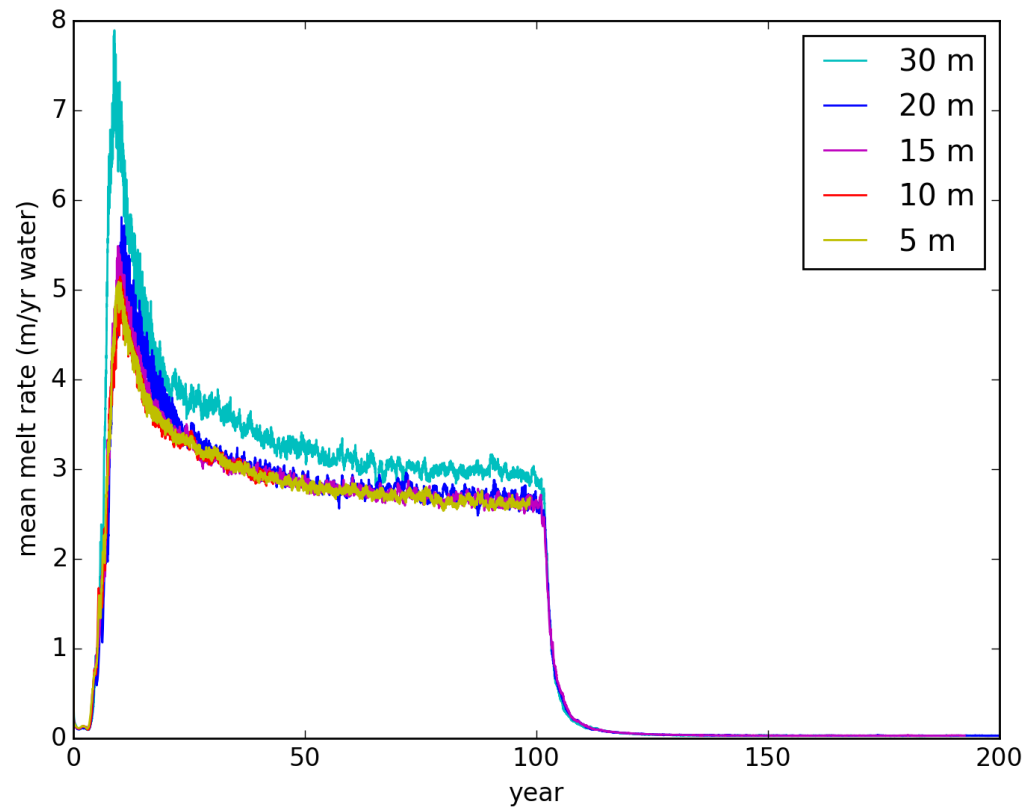
Volume above flotation





POPSICLES study: ocean vertical resolution

Mean melt rate



Volume above flotation

