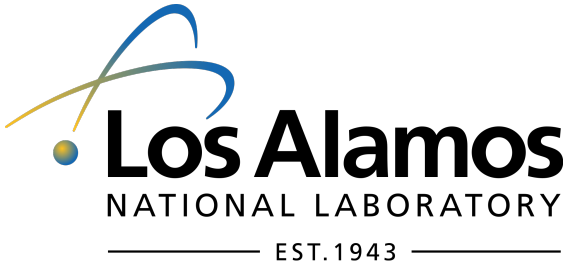


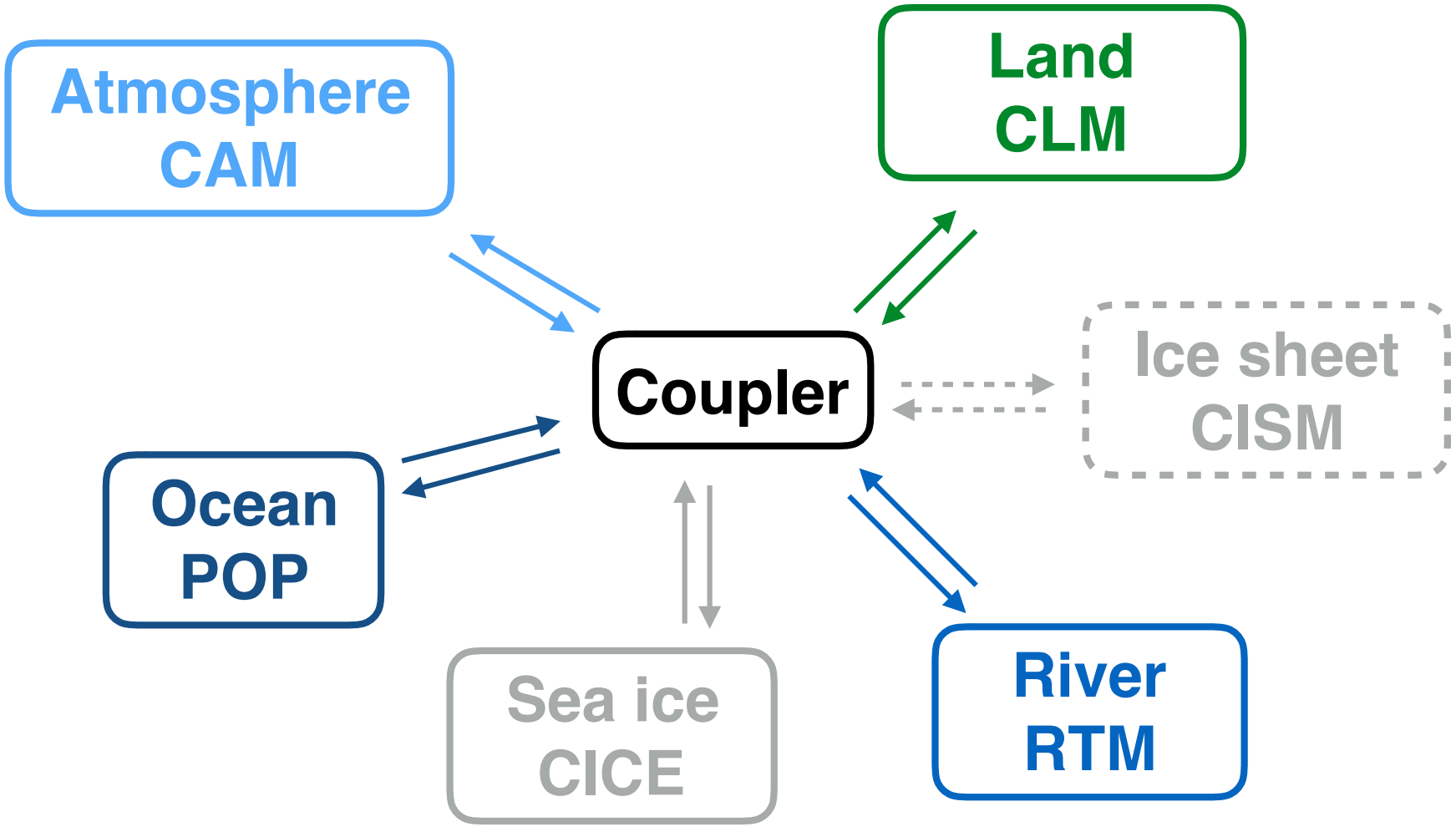
A paleo perspective on some current issues and challenges in coupled CESM-CISM simulations

Marcus Löfverström
NCAR

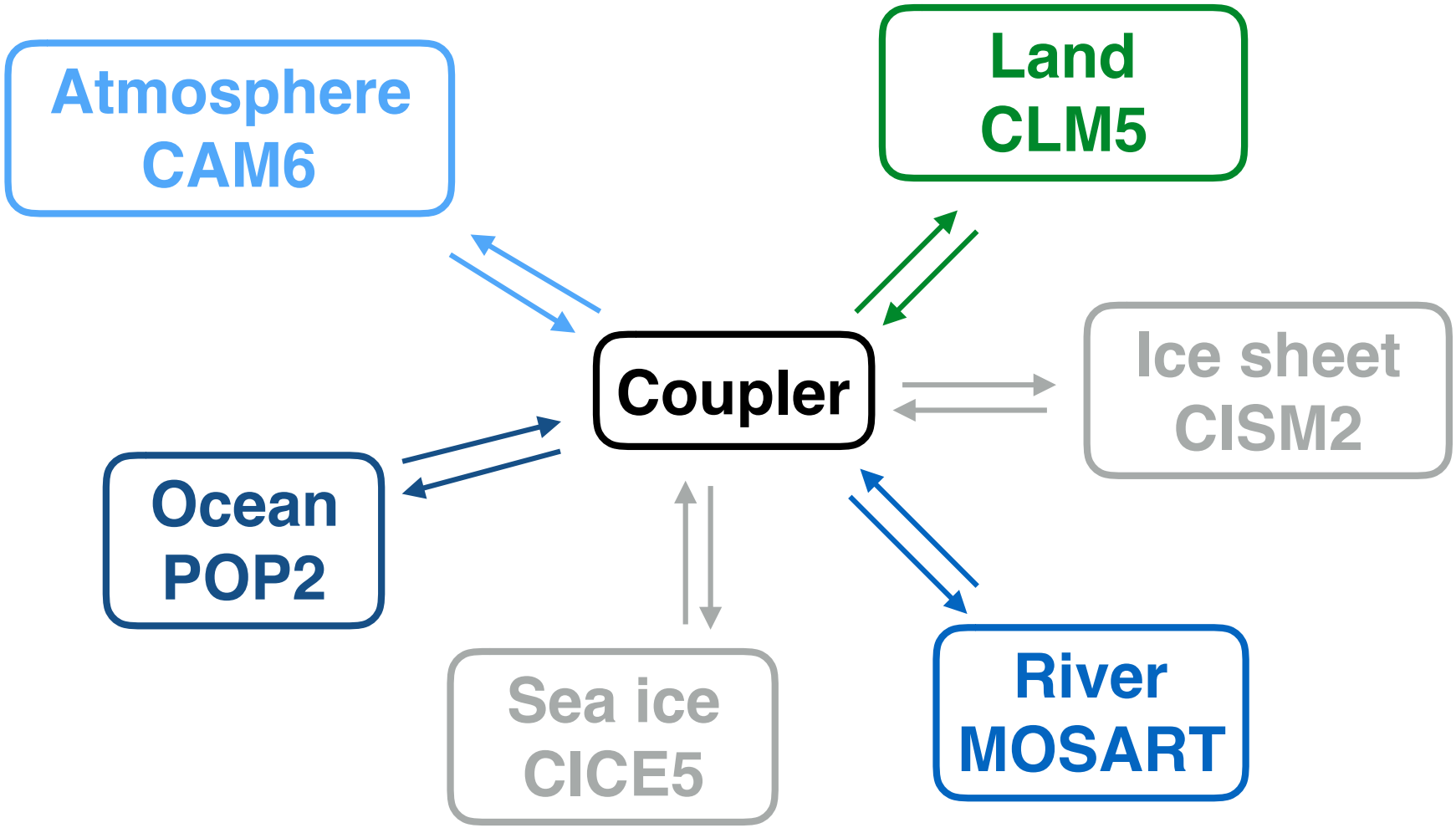
CESM workshop, Breckenridge, CO, 2016

Bette Otto-Bliesner
Bill Sacks
Jeremy Fyke
Bill Lipscomb
Shawn Marshall
Jan Lenearts
Leo van Kampenhout

Community Climate System Model (CCSM 1,2,3,4)
Community Earth System Model (CESM1)

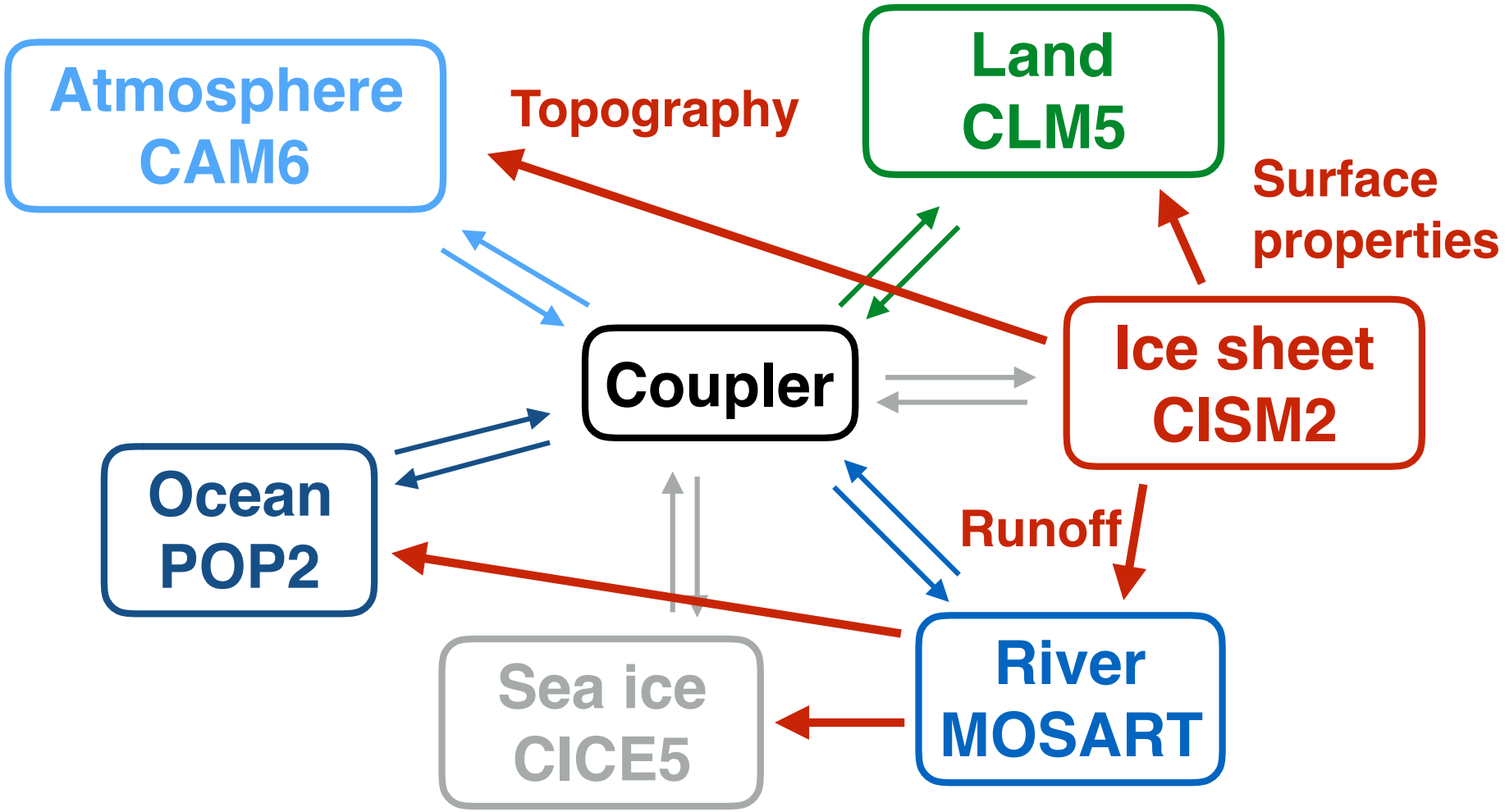


Community Earth System Model 2 (CESM2)



Community Earth System Model 2 (CESM2)

Information about the evolving ice-sheet topography has to be passed to the other model components at runtime



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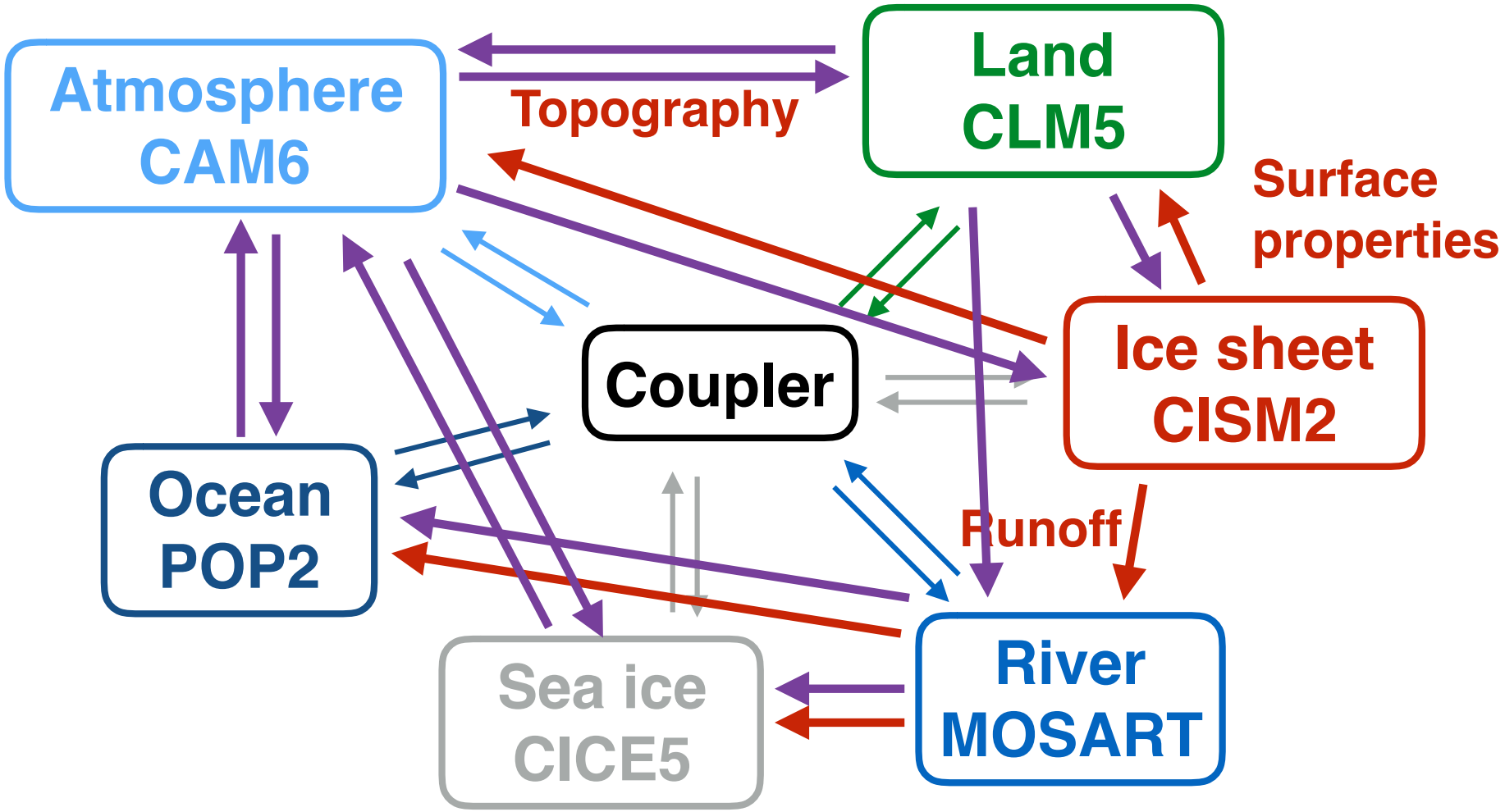
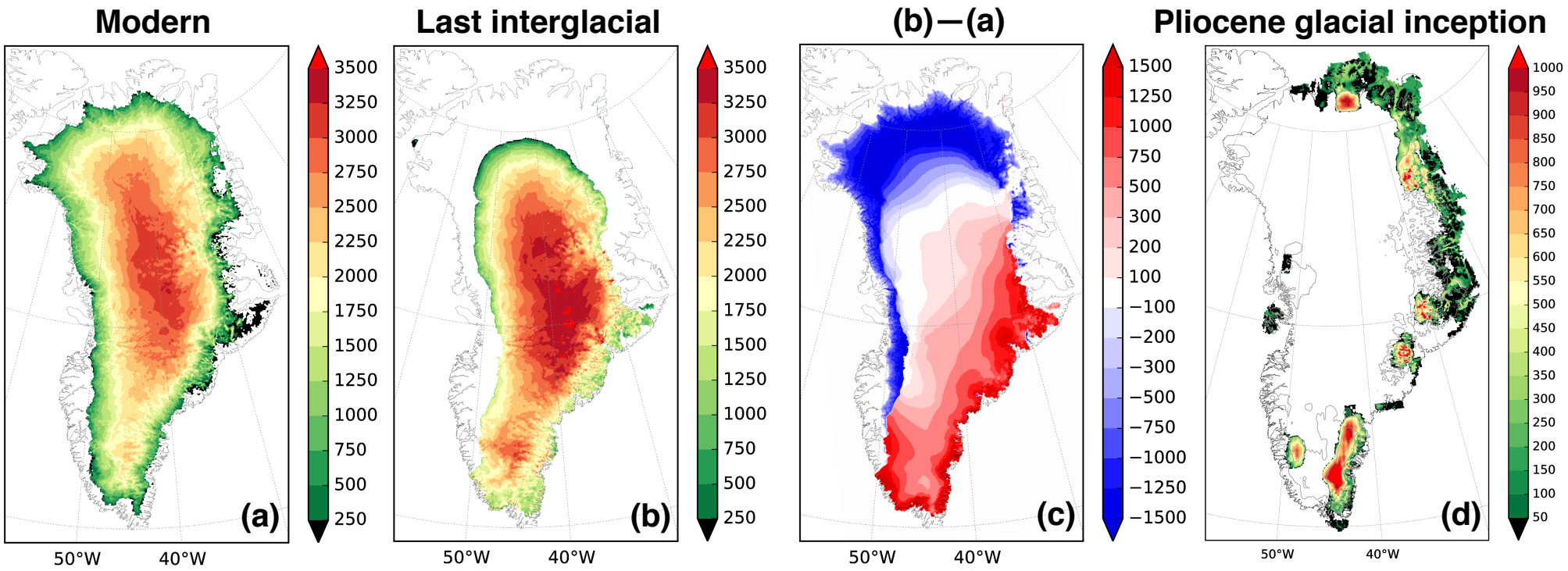


Dynamic ice-sheet topography

Information about the evolving ice-sheet topography has to be passed to the other model components at runtime

When is this important?



Problem with a dynamic ice-sheet topography

(kudos to Jeremy Fyke and Peter Lauritzen)

Information about the evolving ice-sheet topography has to be passed to the other model components at runtime*

runtime update is impossible but an annual update can be done

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runtime update is impossible but an annual update can be done

*annual in a “CESM sense”, CISM can run multiple years per CESM year

Problem with a dynamic ice-sheet topography

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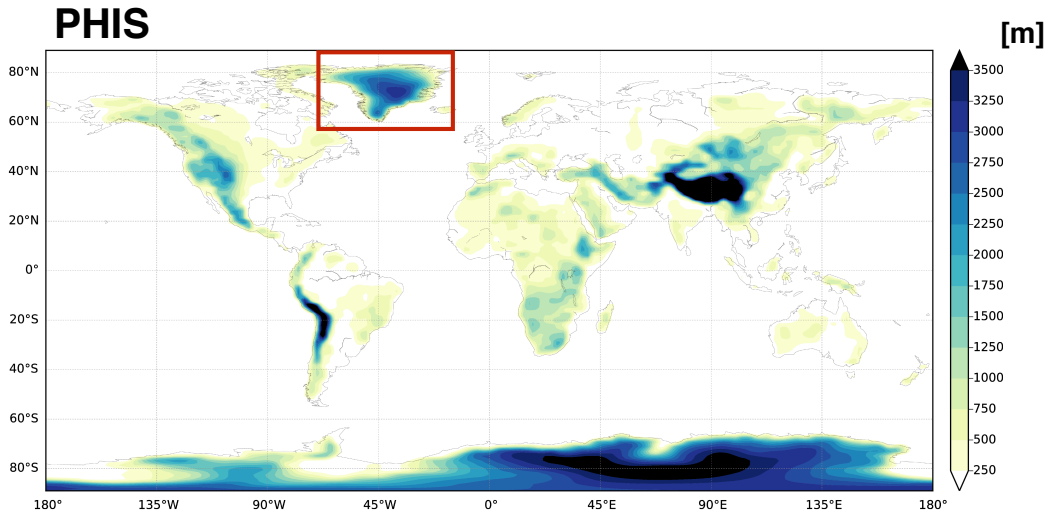
Which fields are computed?



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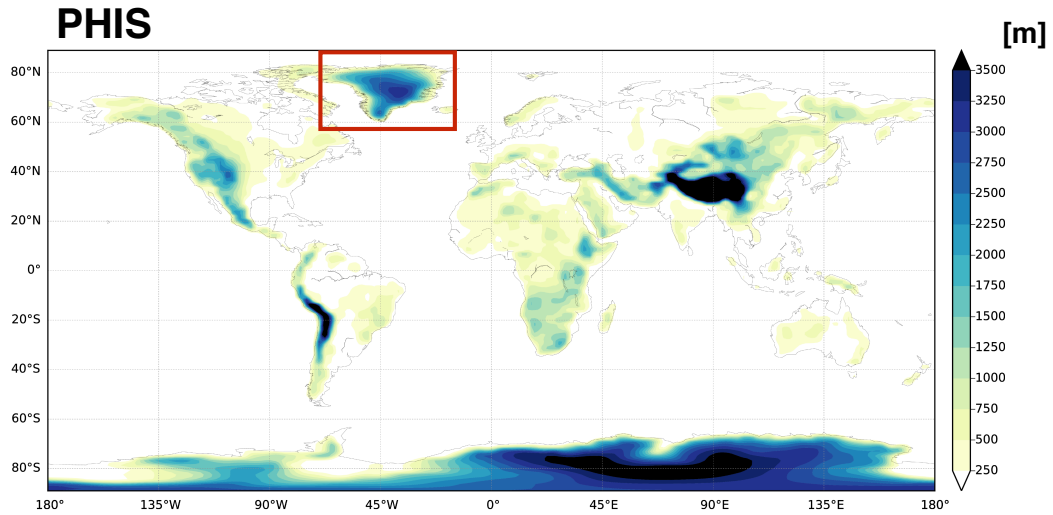

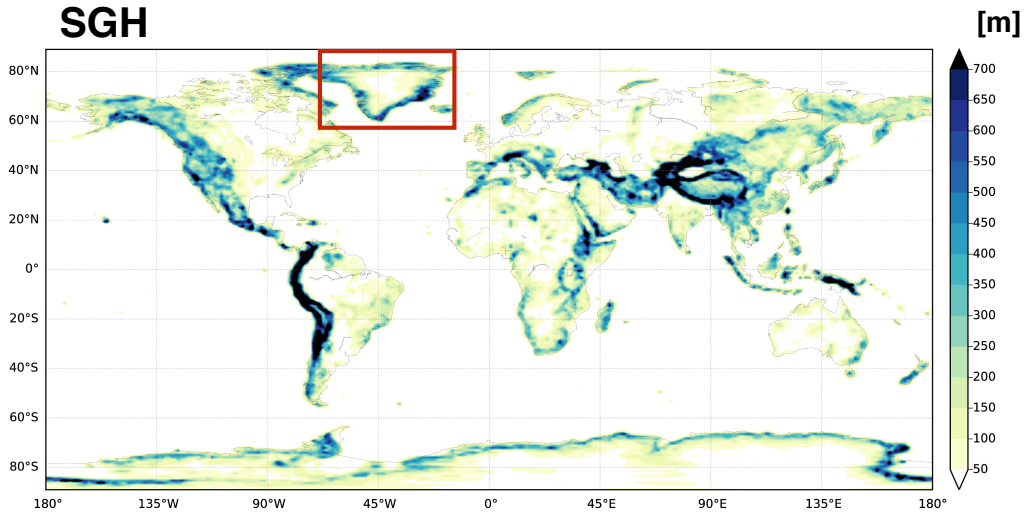

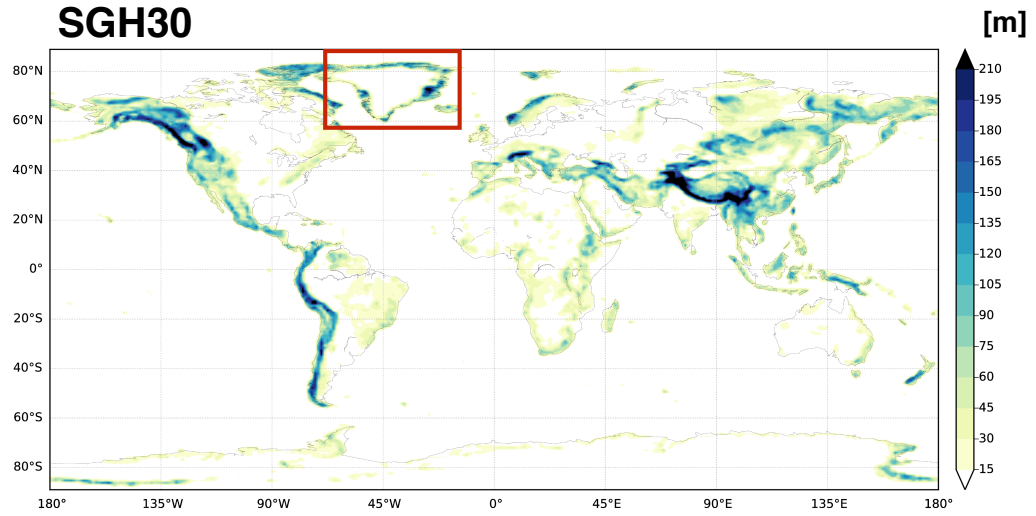

Problem with a dynamic ice-sheet topography

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How does the topography updating work?

CESM restart step:

1: Automatic submission of *topography updating routine* (independent submission that runs parallel to CESM)

Problem with a dynamic ice-sheet topography

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1: CISM topography remapped and inserted into 30'' global topography file

2: Compute new topography, sub-grid topography variations (SGH and SGH30) and update landmask if necessary

3: Write fields to a temporary file (used in step 2 above)

Problem with a dynamic ice-sheet topography

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How does the topography updating work?

CESM restart step:

1: Automatic submission of *topography updating routine* (independent submission that runs parallel to CESM)

2: If updated topography from previous year exists, insert into CAM restart file

3: Data archiver

4: CESM resubmission

Topography updating routine:

1: CISM topography remapped and inserted into 30'' global topography file

2: Compute new topography, sub-grid topography variations (SGH and SGH30) and update landmask if necessary

3: Write fields to a temporary file (used in step 2 above)

Problem with a dynamic ice-sheet topography

(kudos to Jeremy Fyke and Peter Lauritzen)

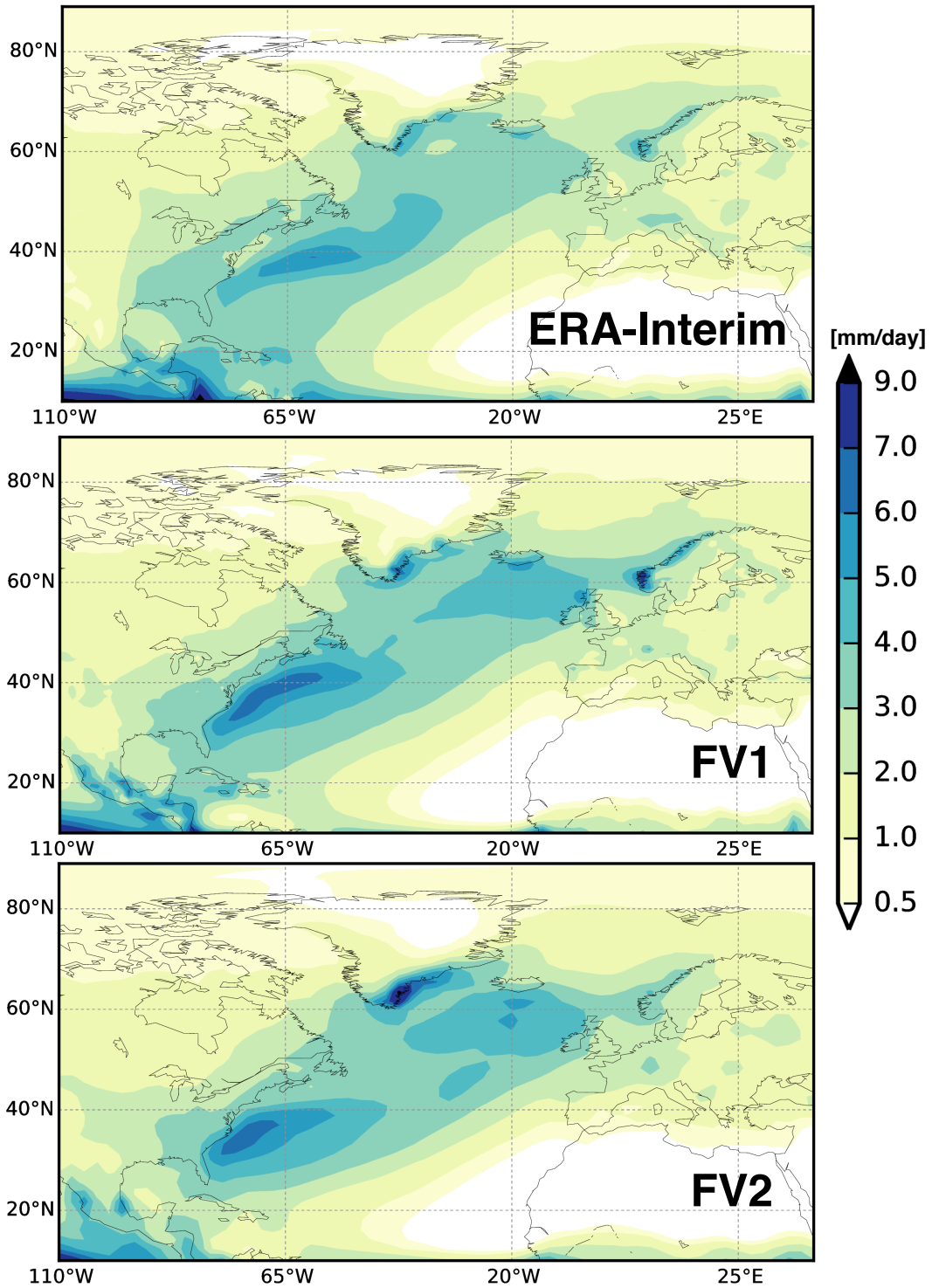
What is new?

- Support for CAM FV1 & FV2 resolutions and CISM 4 & 5km grids
- Using latest version of Fortran library to compute *SGH* and *SGH30*
- Accelerated by Python interface to write large datasets
- Takes advantage of “data assimilation call” in CIME

New routine is 30-40% faster (15 mins instead of 25 mins) and more versatile than predecessor

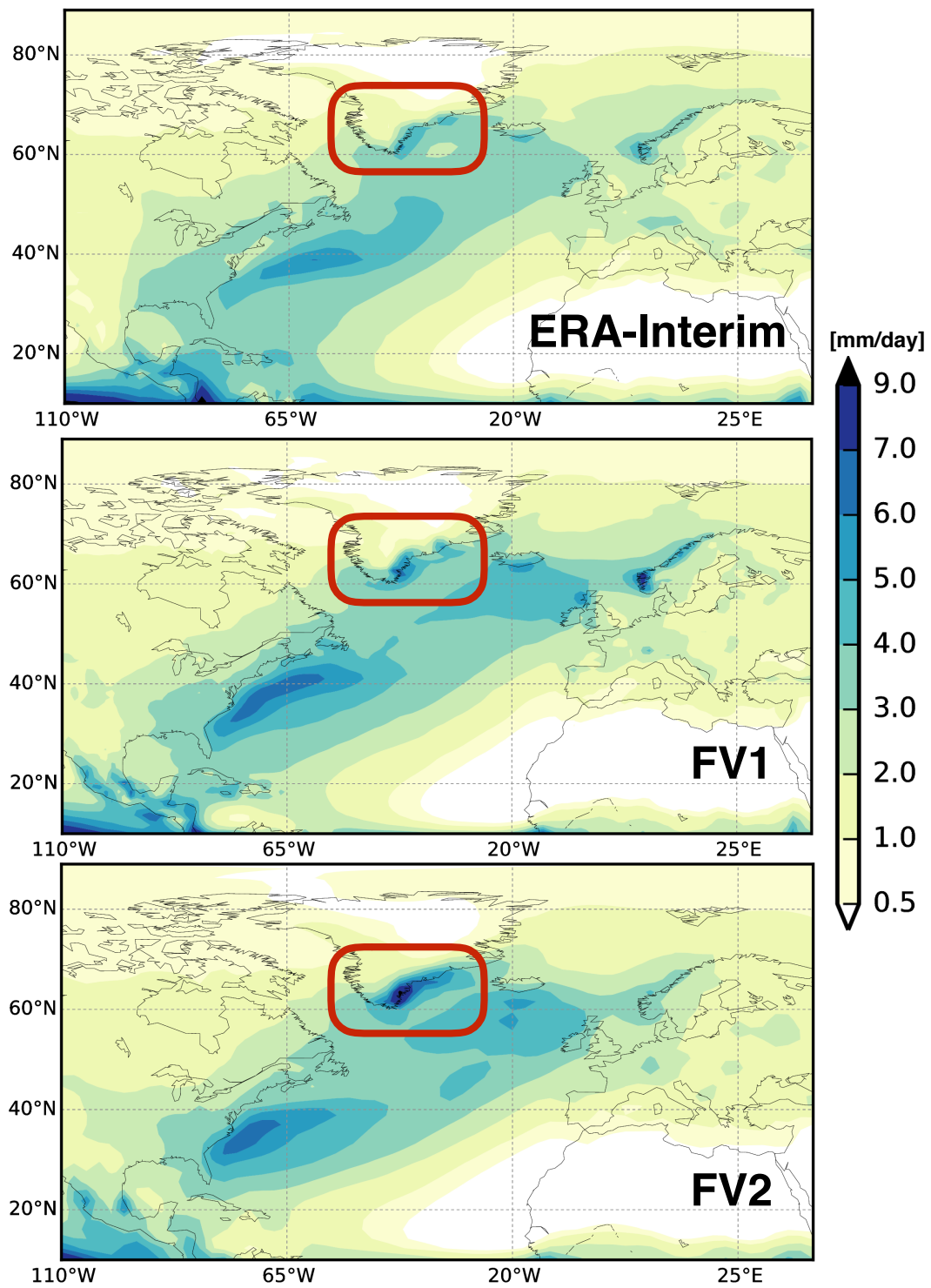
https://svn-ccsm-models.cgd.ucar.edu/tools/dynamic_cam_topography/trunk

Problem with present day climate in CESM2 Annual precip



Problem with present day climate in CESM2

Too much precipitation
in southern Greenland



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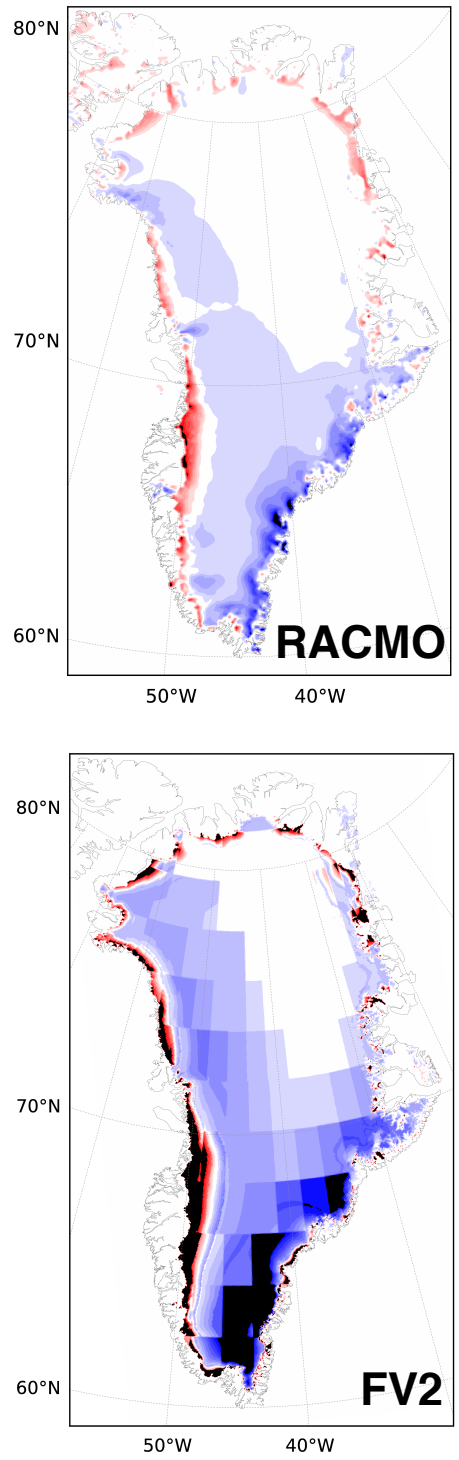

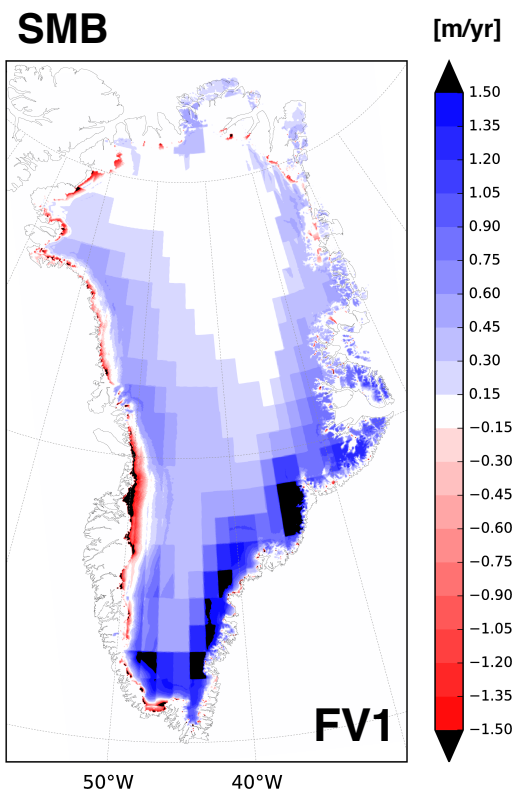

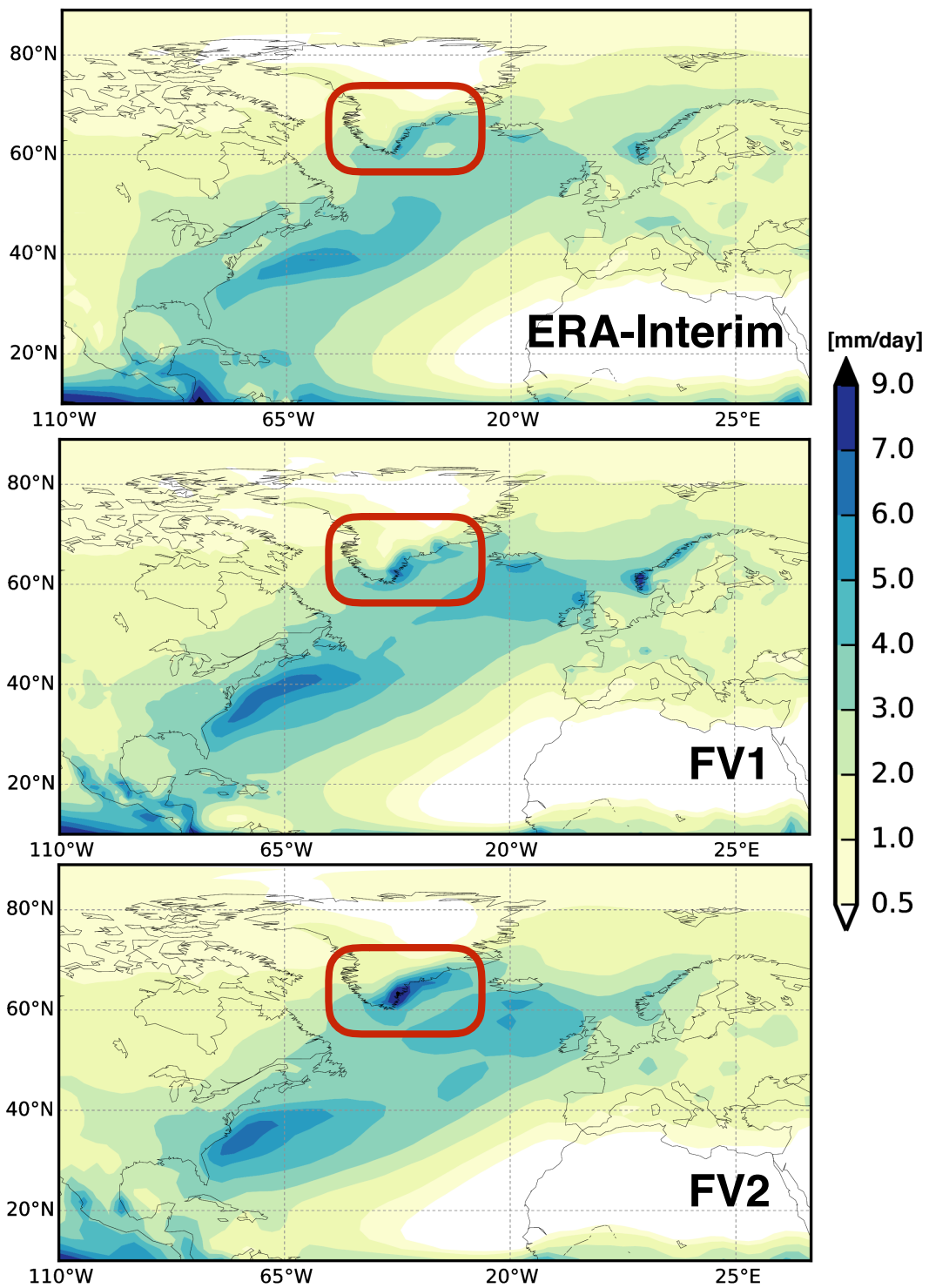

Last interglacial simulations of the Greenland ice sheet

	PI (1850)	LIG (127 ka)
CO_2	285×10^{-6}	287×10^{-6}
CH_4	792×10^{-9}	724×10^{-9}
N_2O	276×10^{-9}	262×10^{-9}
CFC_1	125×10^{-13}	0
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CMIP6

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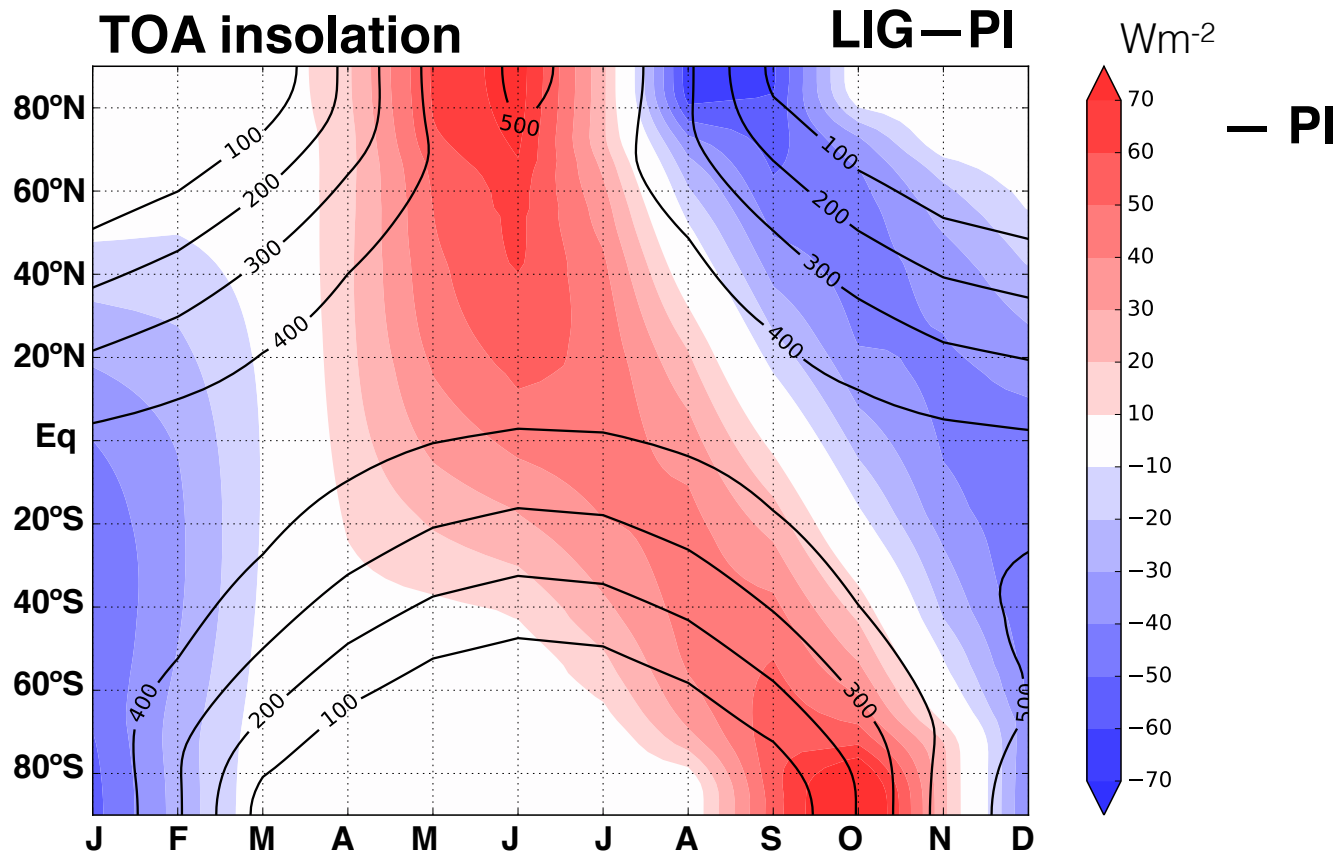
CMIP6



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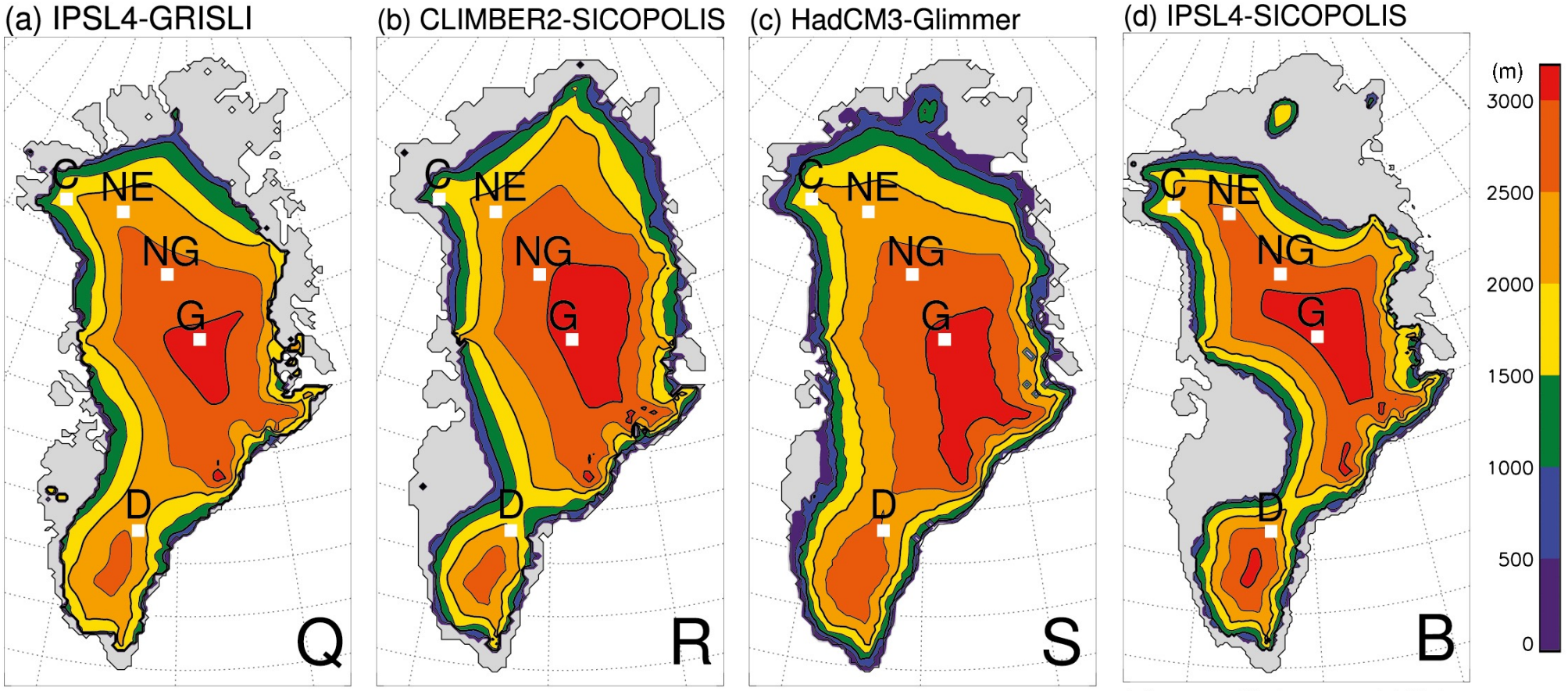

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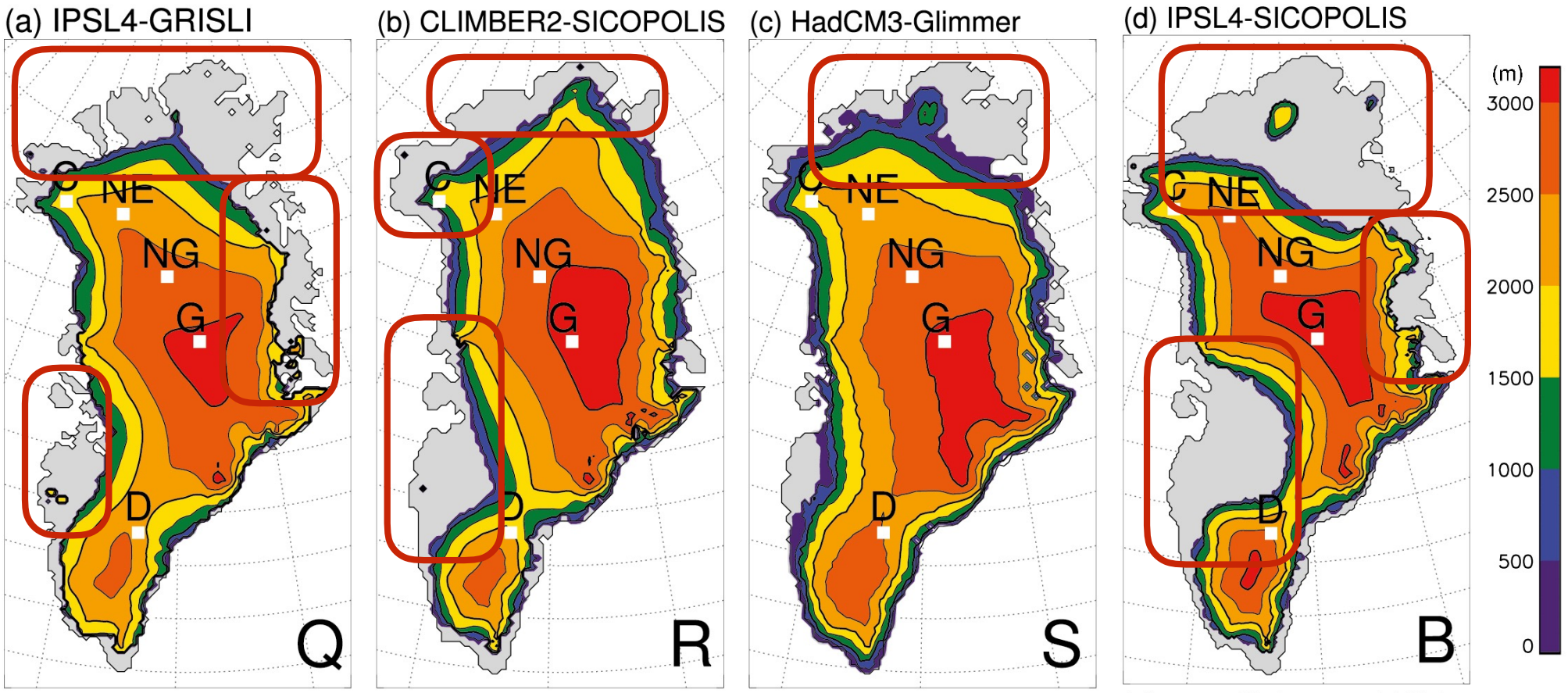

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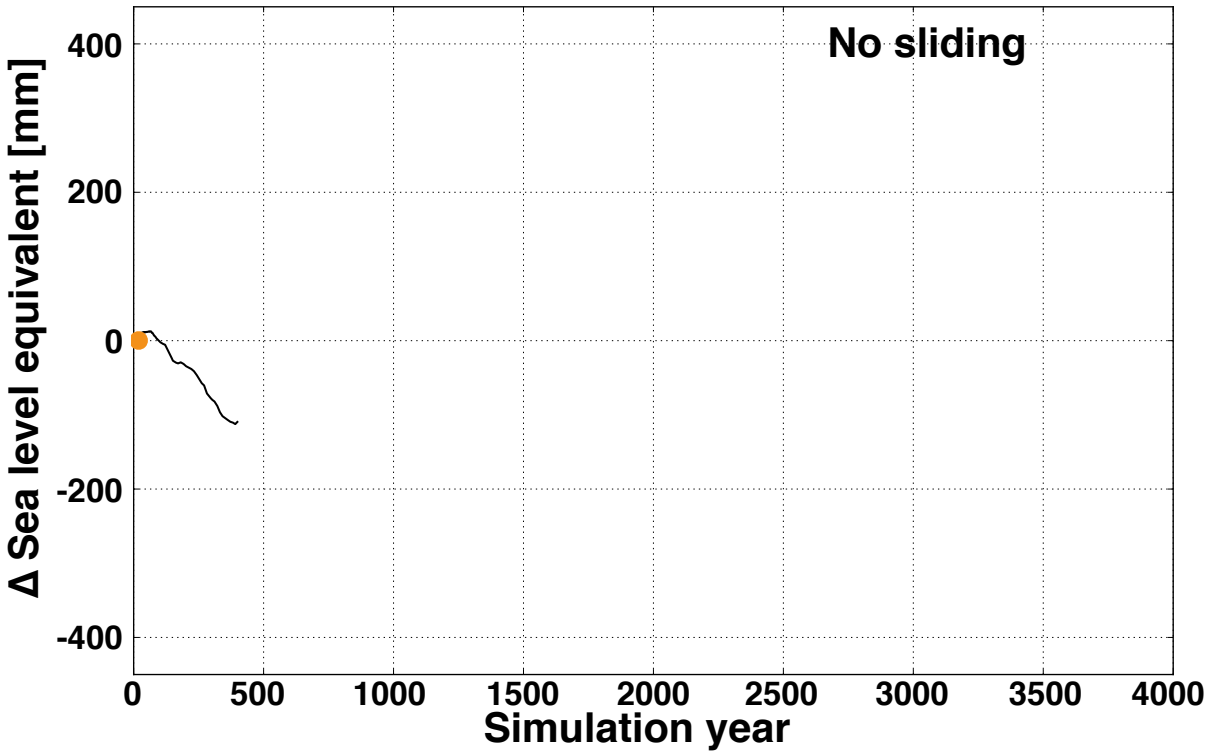
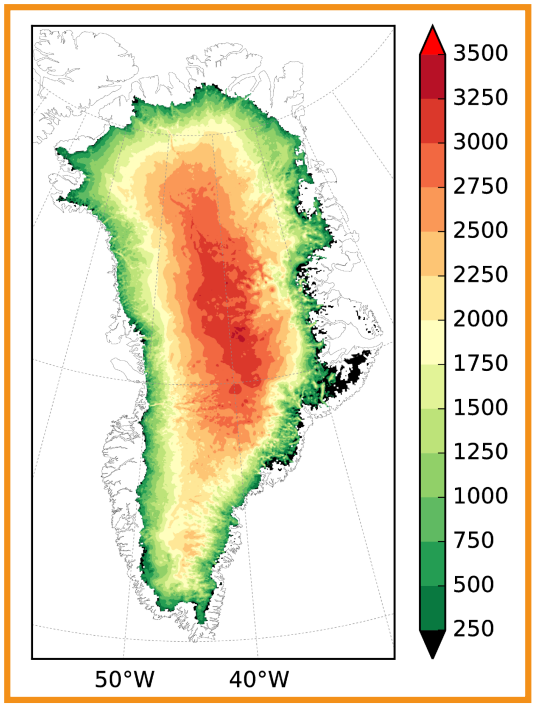
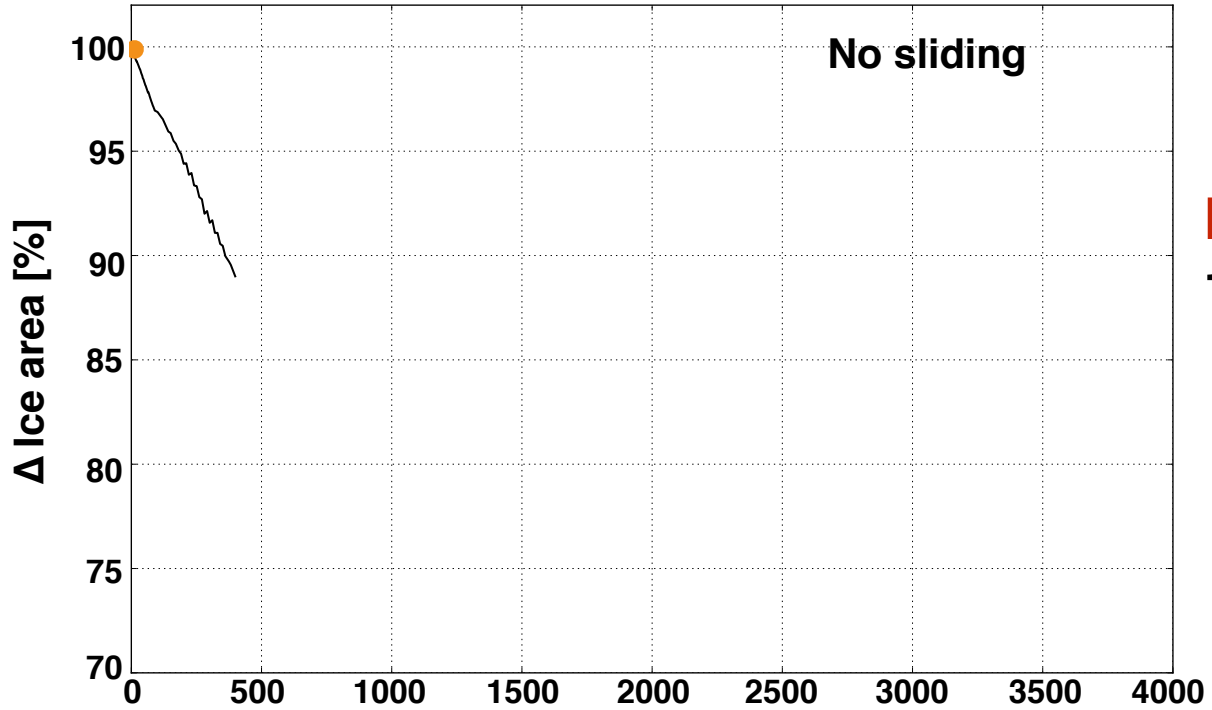


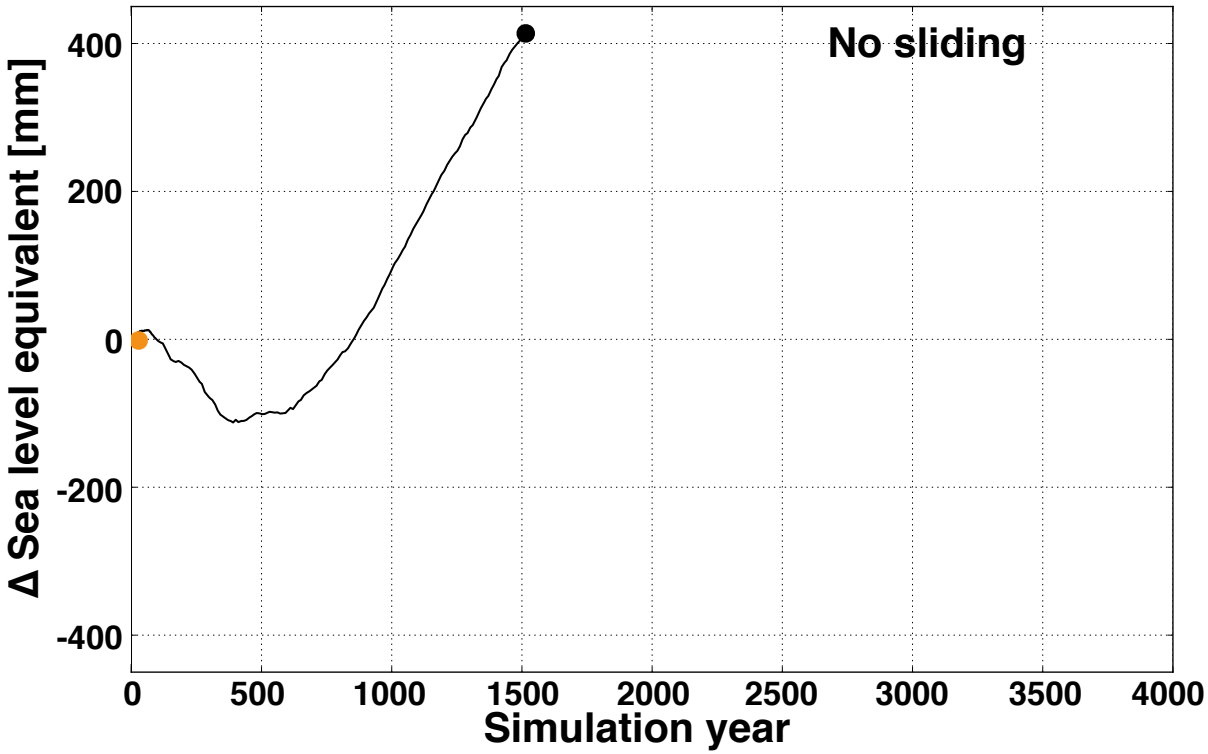


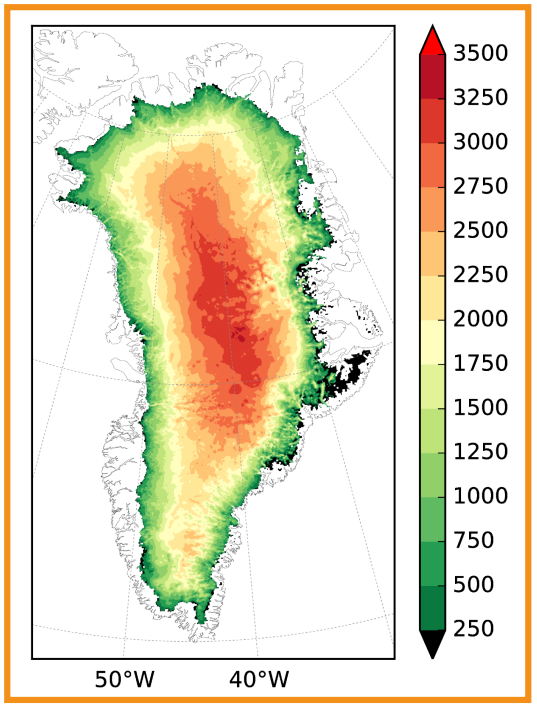


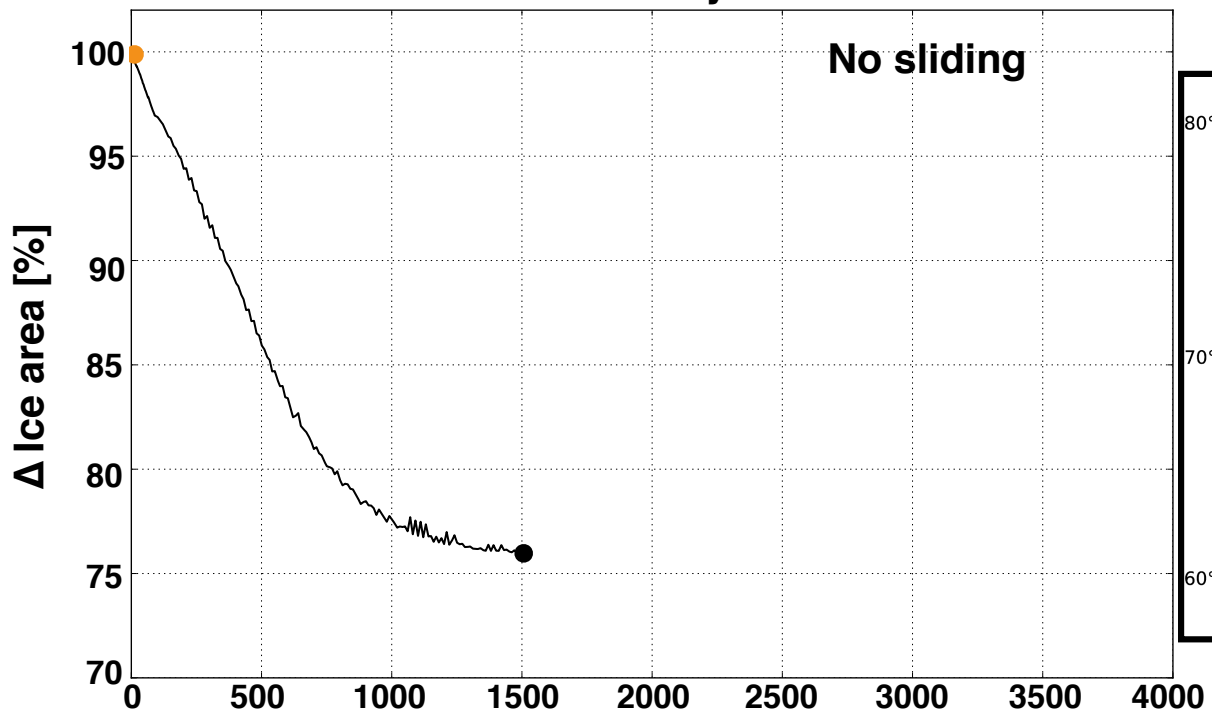
FV2 fully coupled CESM-CISM

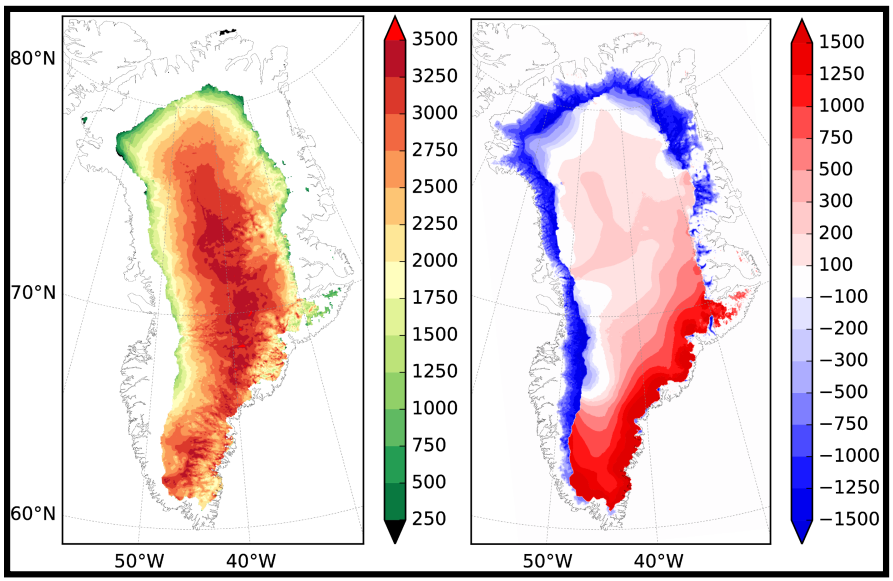
10x acceleration of CISM

Last interglacial simulations of the Greenland ice sheet









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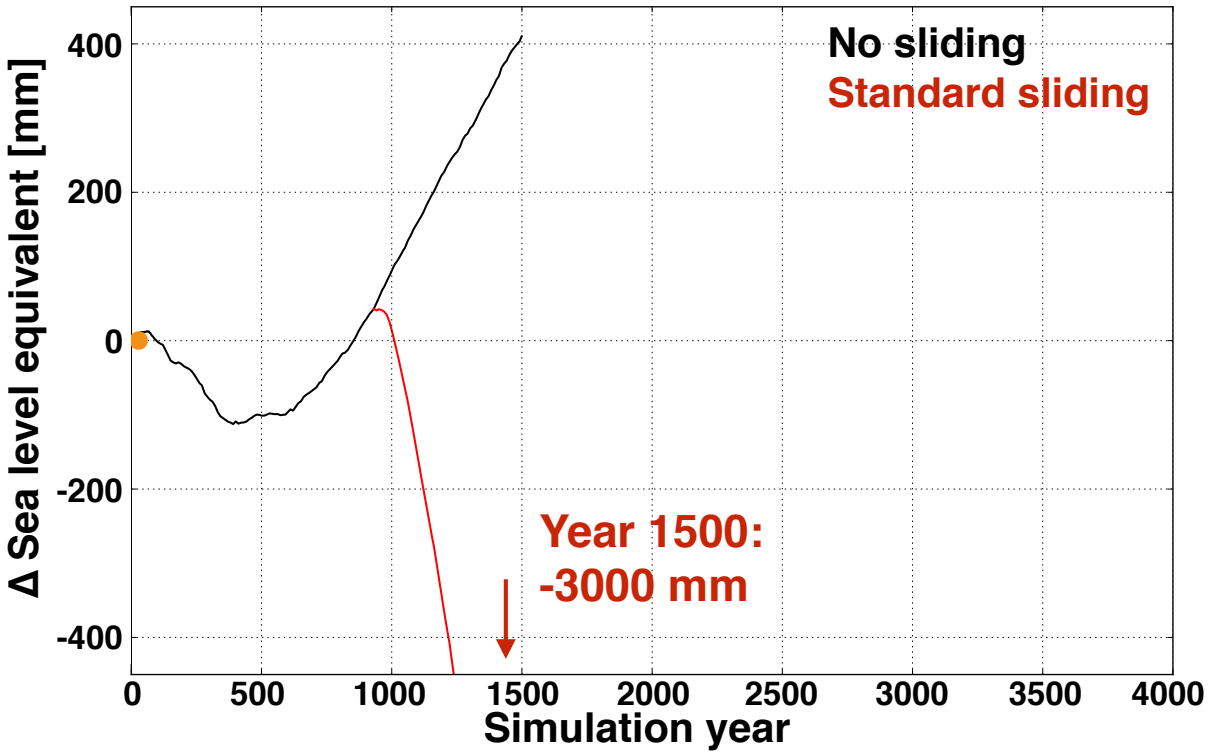

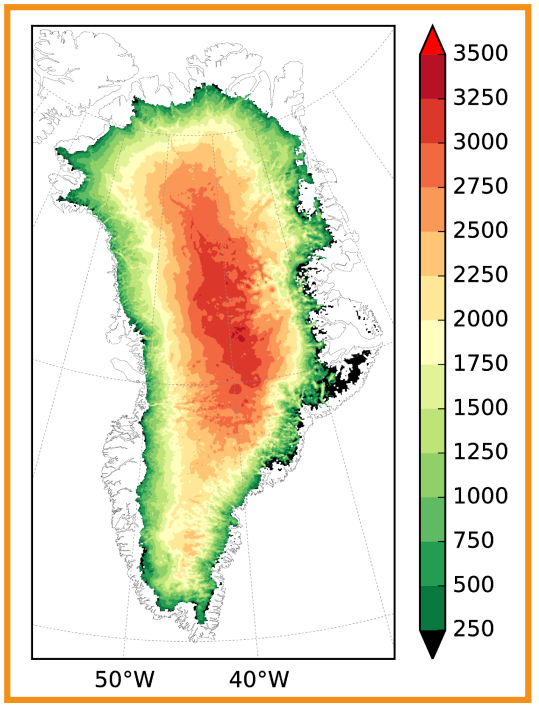

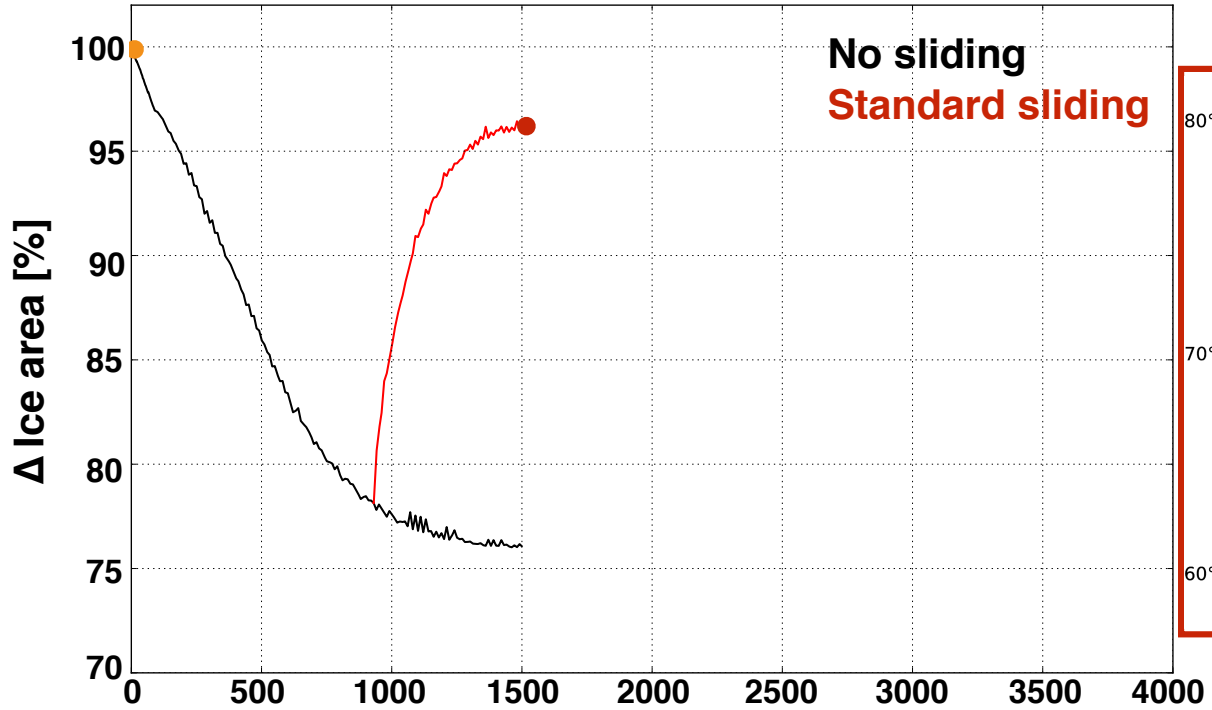

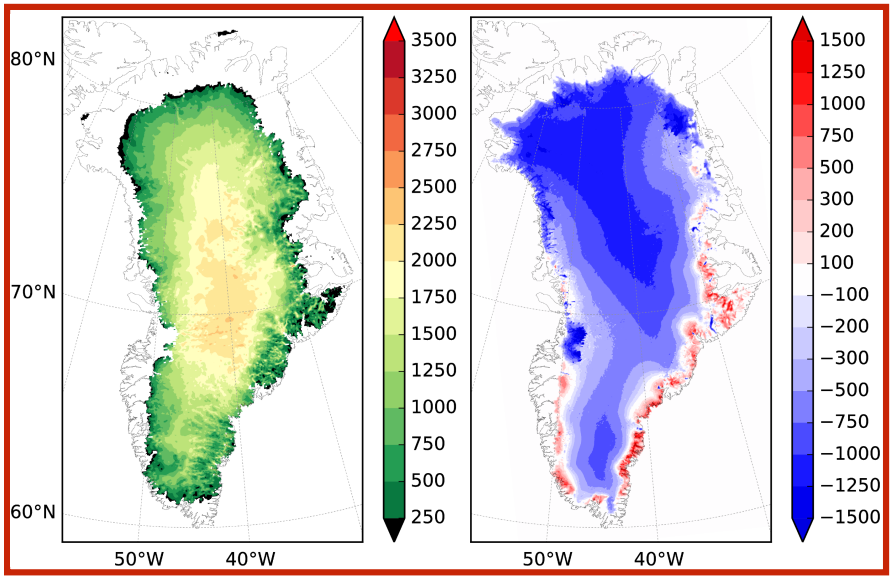

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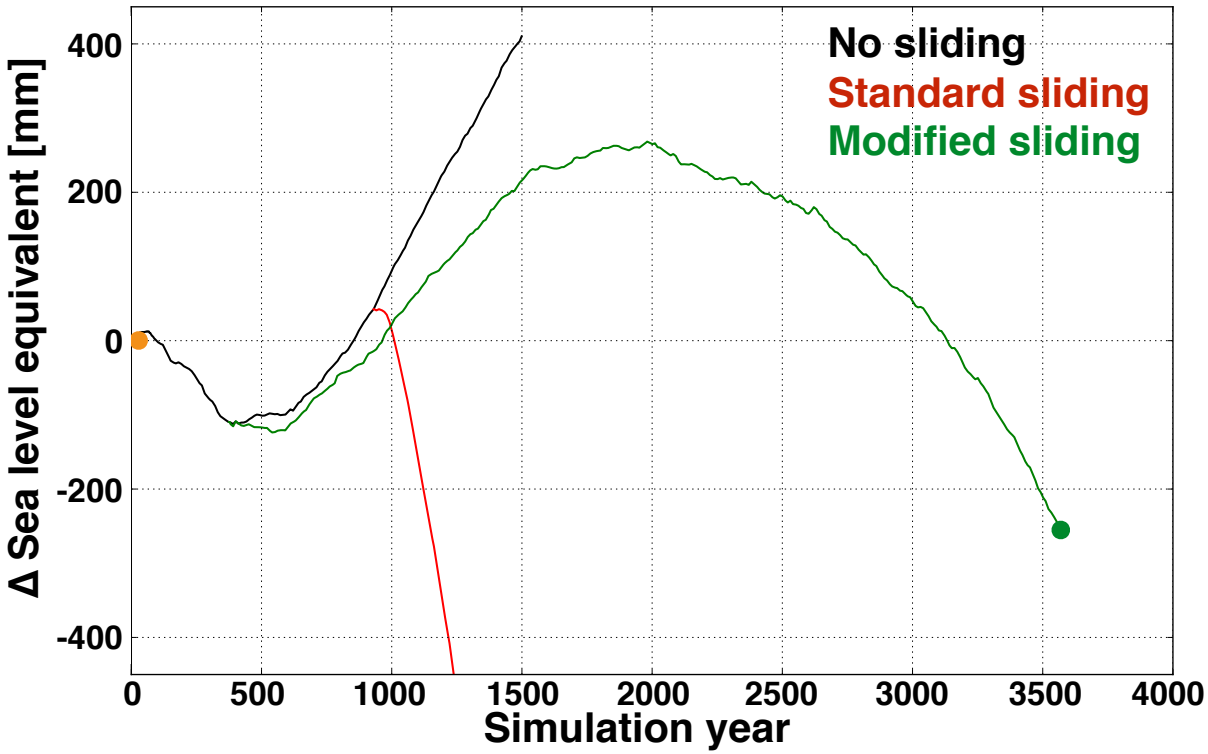

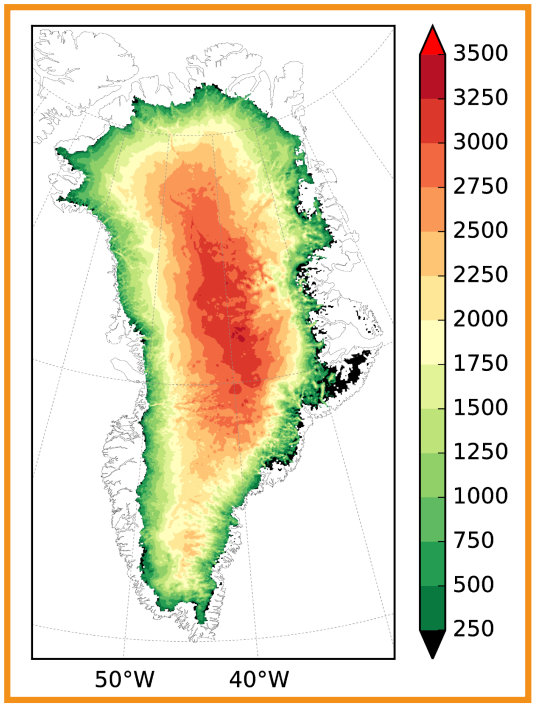

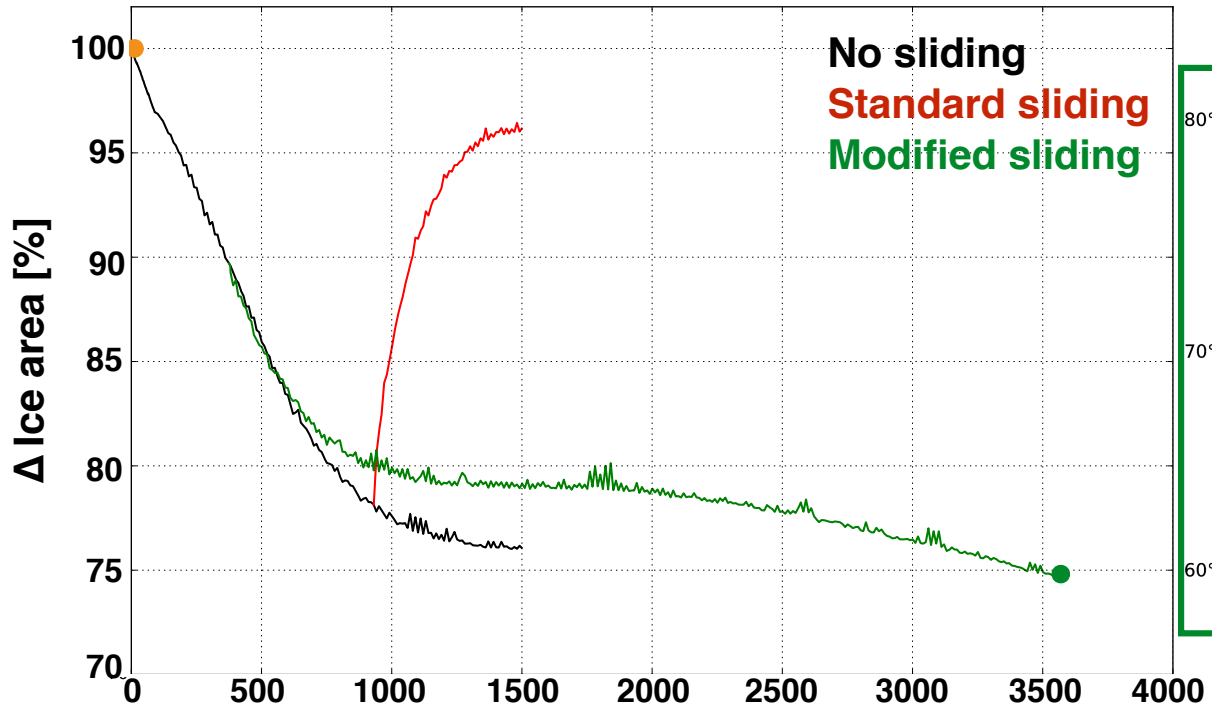

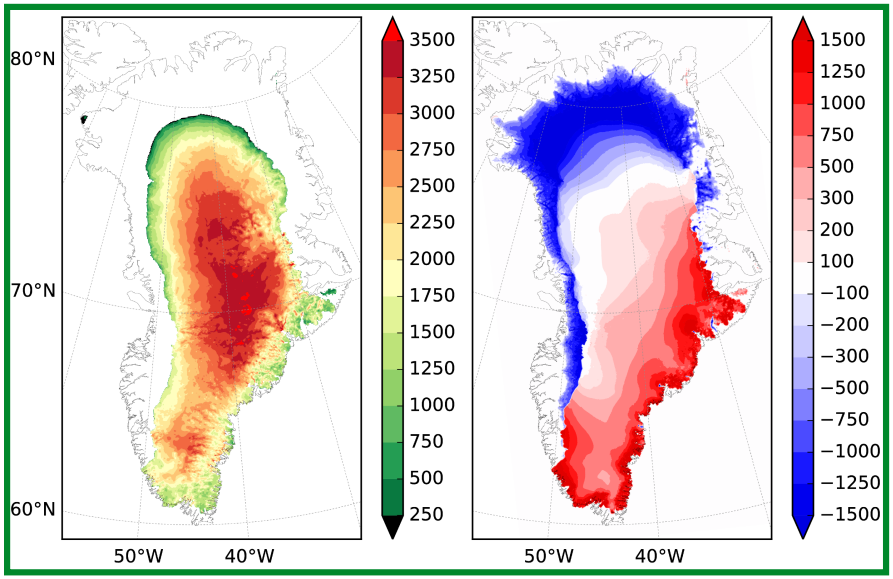

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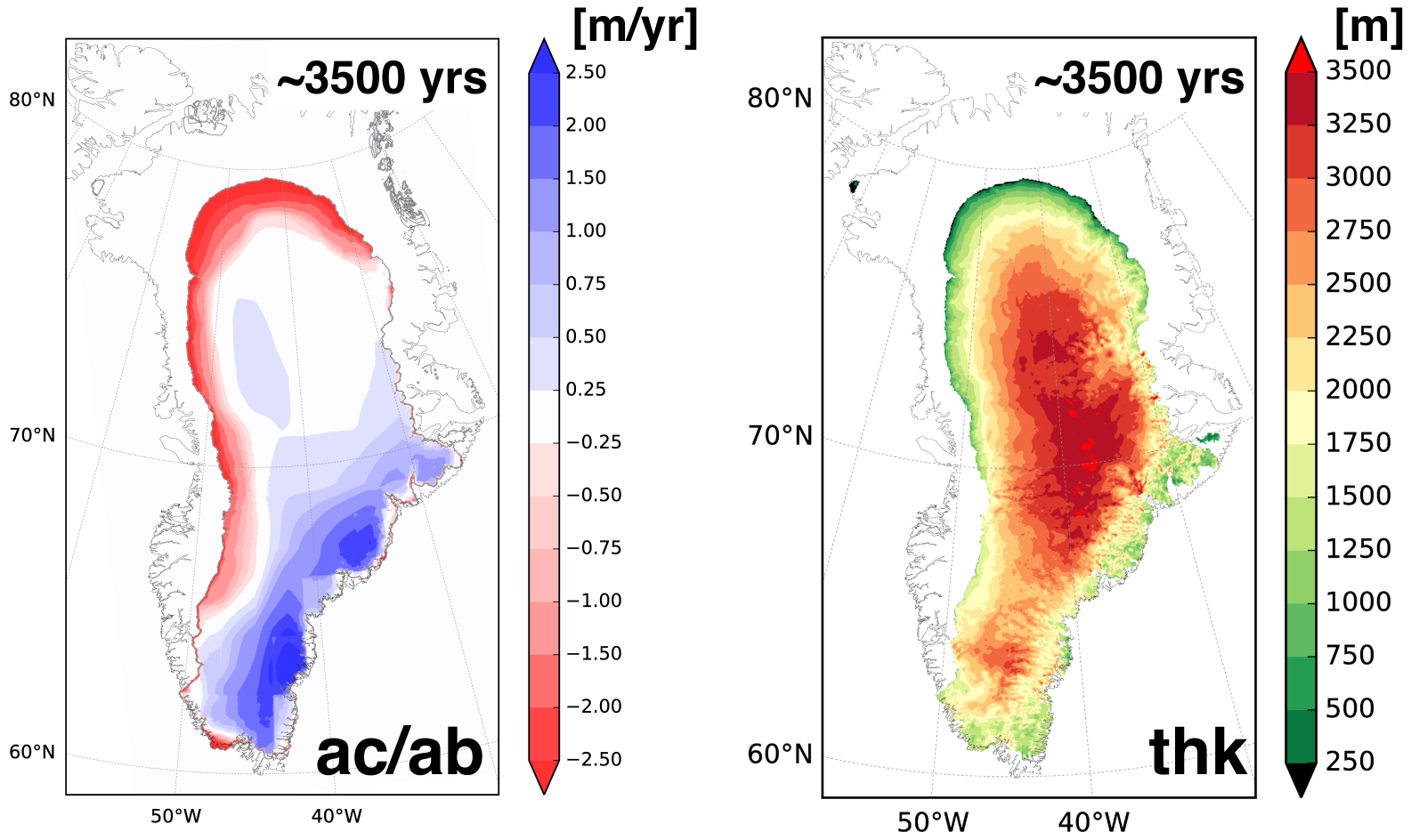
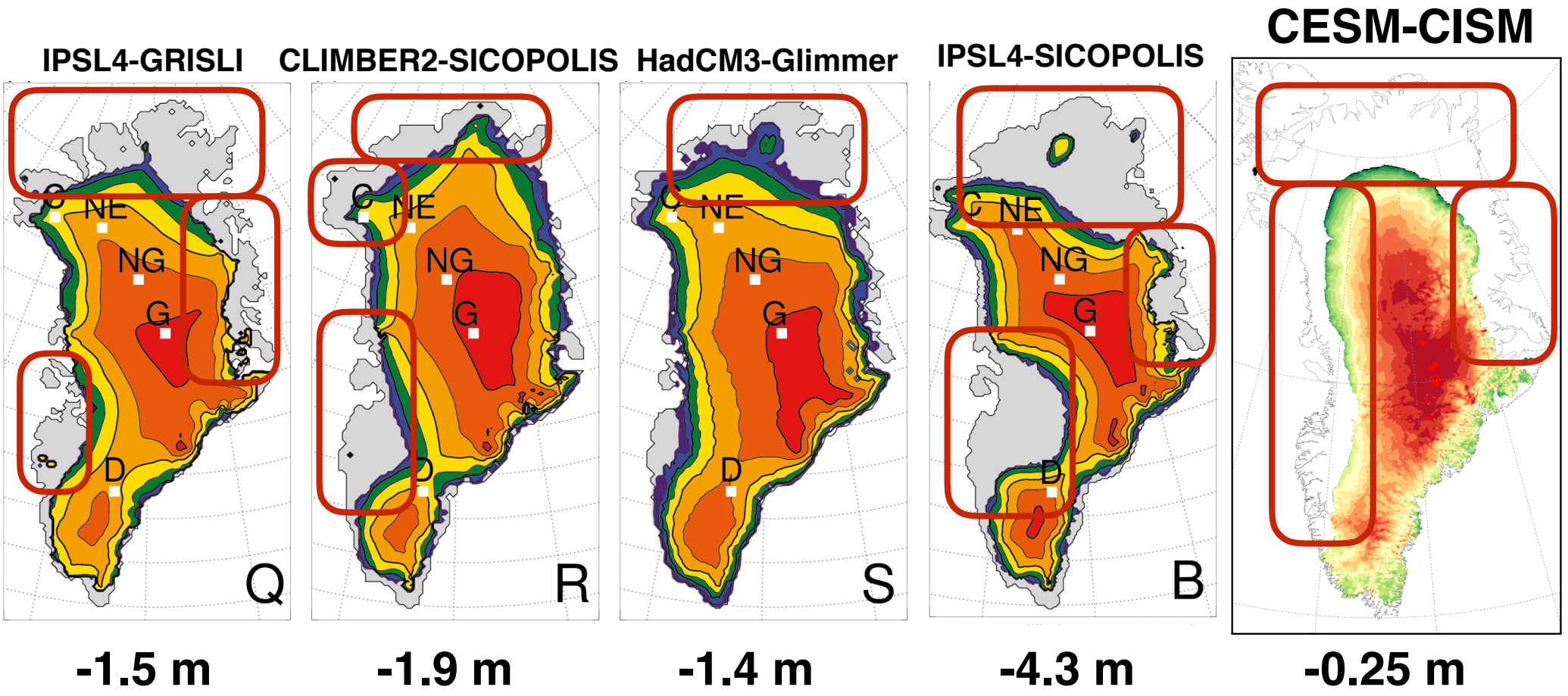


Last interglacial simulations of the Greenland ice sheet

Comparison with IPCC simulations



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Summary and conclusions

CESM status:

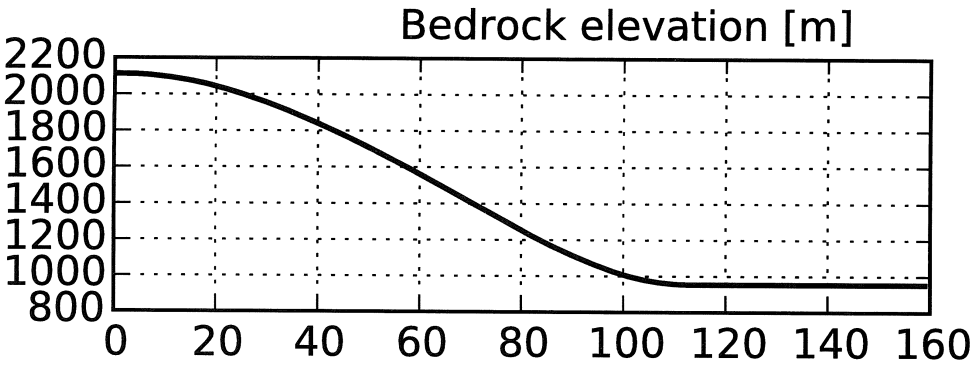
- Support for dynamic topography in CESM-CISM
- Too much precipitation in southern Greenland

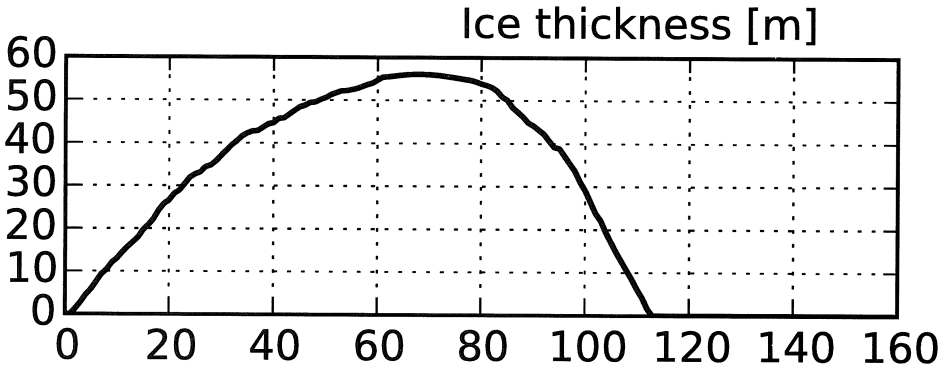
Last interglacial simulations:

- Basal sliding is important (default parameterization slides too much)
- Ice loss in northern and western Greenland (w.r.t. PI)
- Substantial growth in southern Greenland

Problem with isostasy (?)

Synchronous coupling (glacial inception problem)





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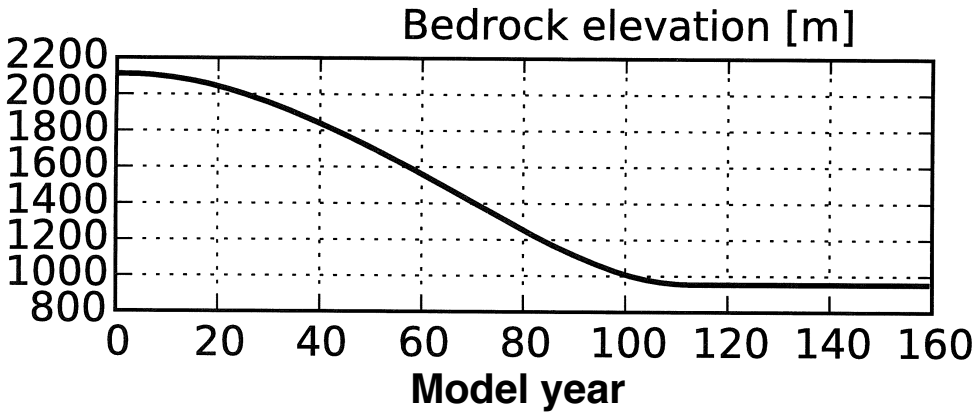

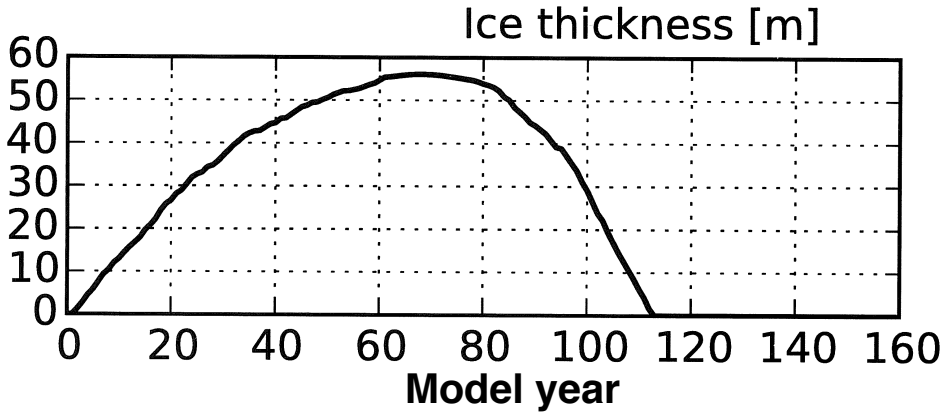

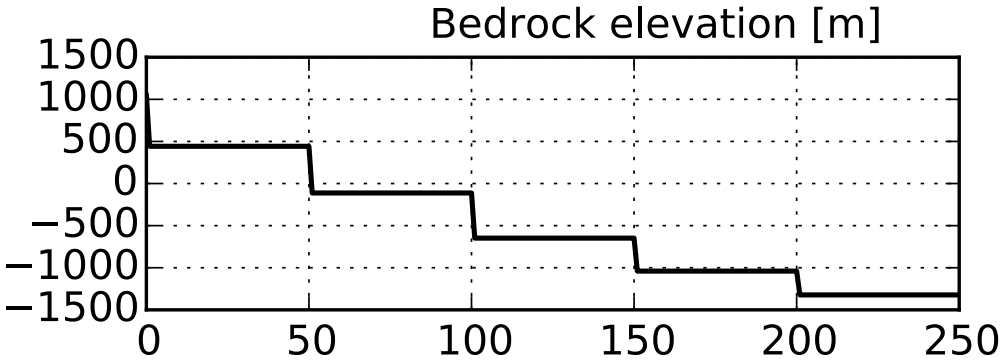

50 yr asynchronous coupling (default parameterization)

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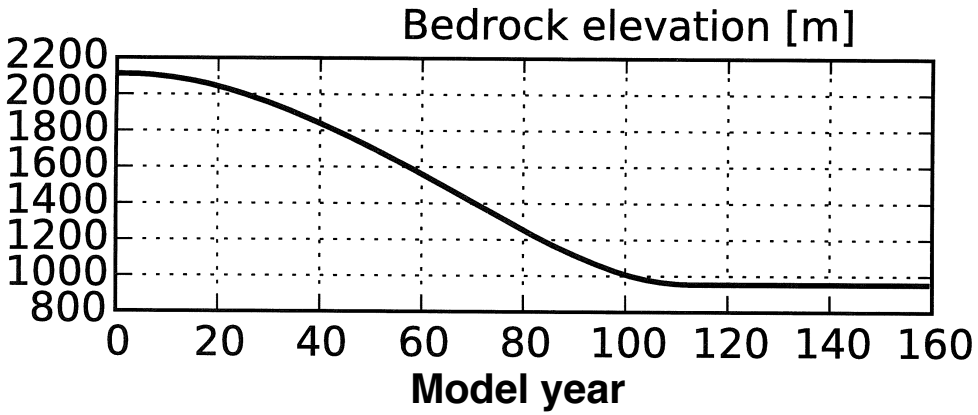

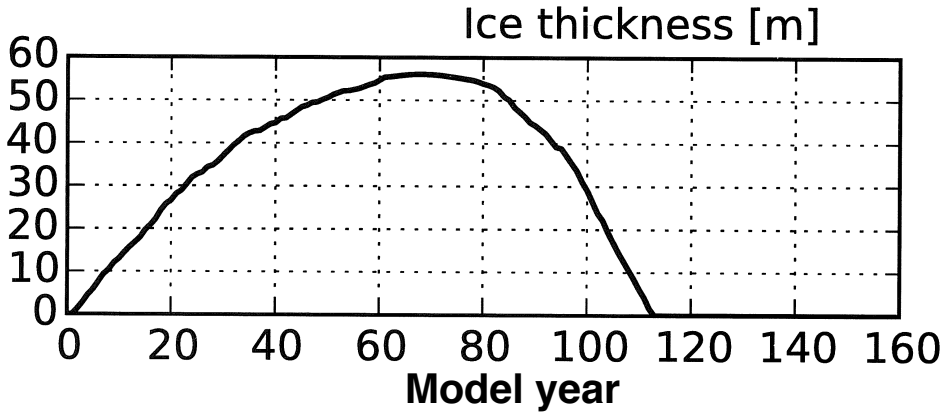

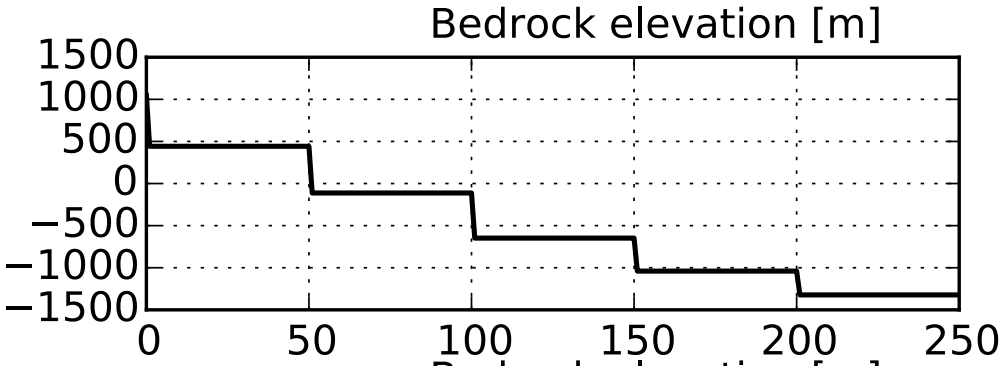

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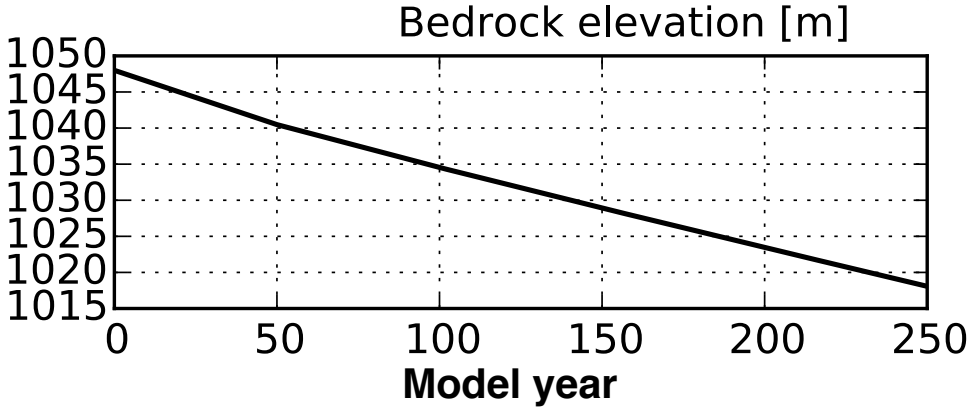
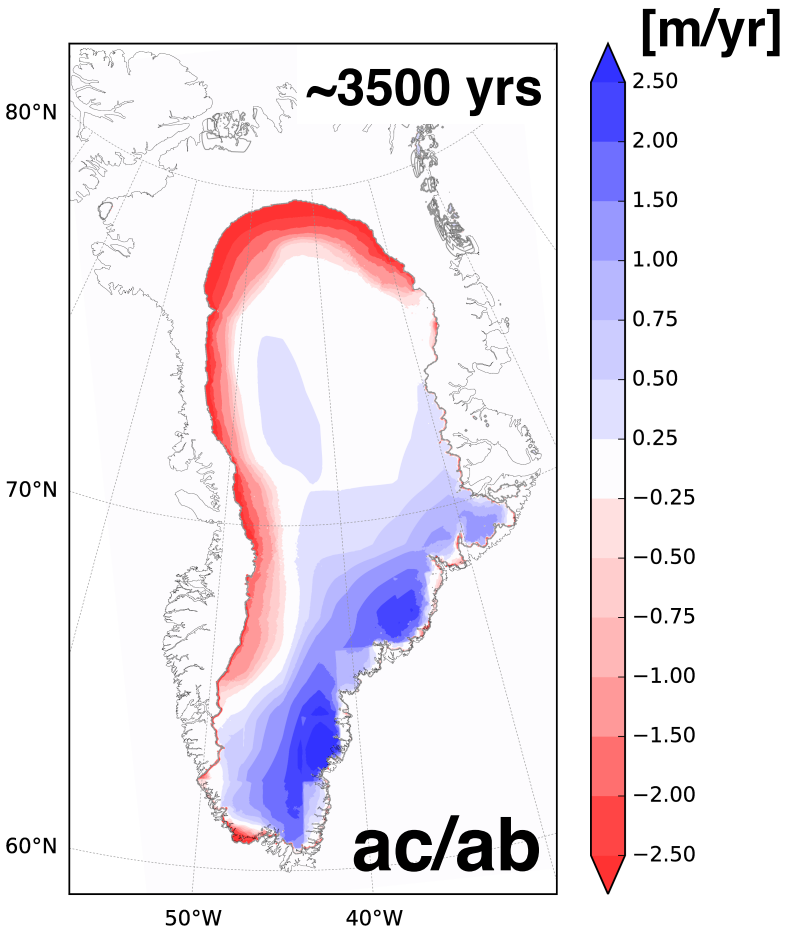
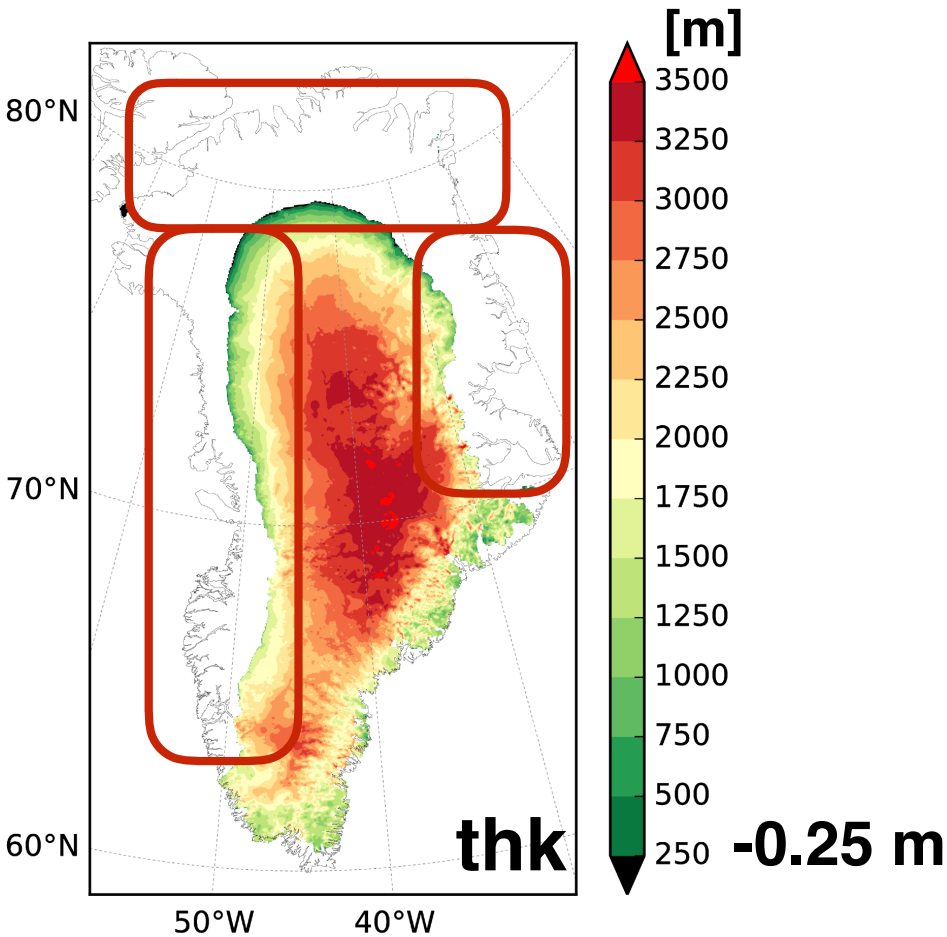
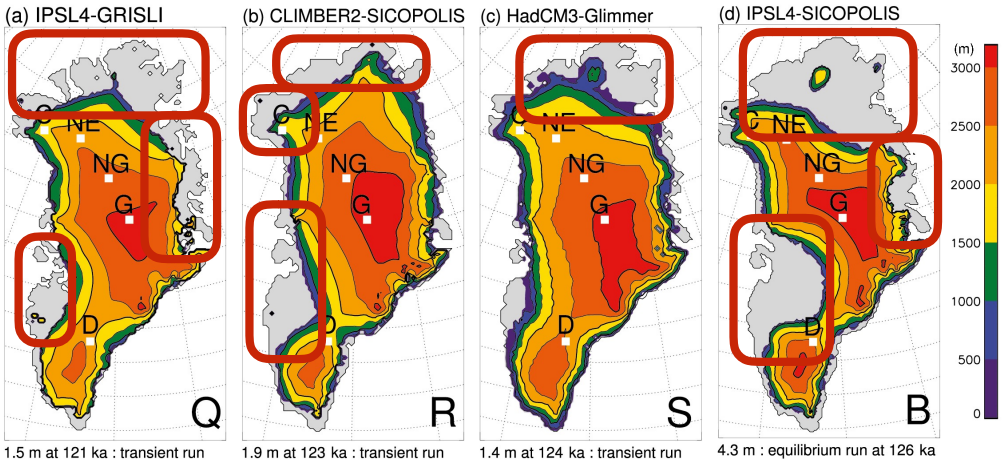


50 yr asynchronous coupling (more realistic?)

Last interglacial simulation







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