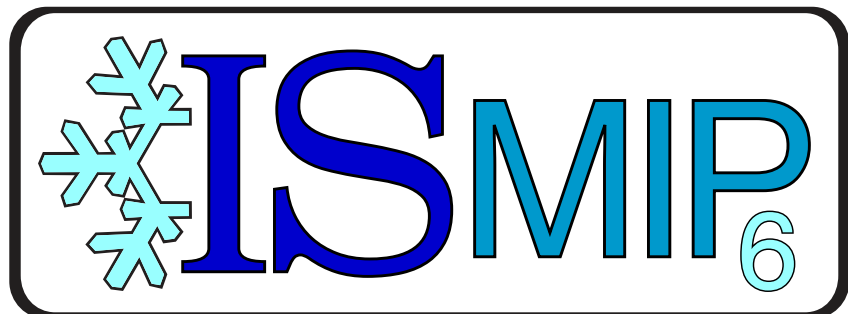


# ISMIP6 Antarctica 2300 Preliminary results

## Land Ice Winter Working Group Meeting

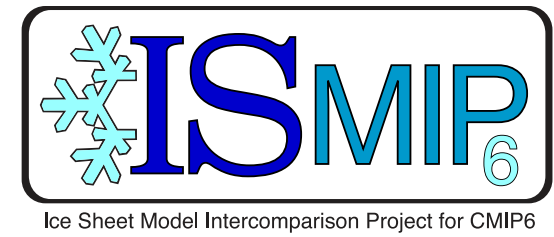
**Disclaimer:** Results are preliminary and are subject to change as submissions are finalized



Ice Sheet Model Intercomparison Project for CMIP6

*With participation from  
ISMIP6 Steering Committee, ISMIP6 ocean,  
atmosphere, and climate focus groups, and ISMIP6  
participants*

# ISMIP6 Antarctica 2100

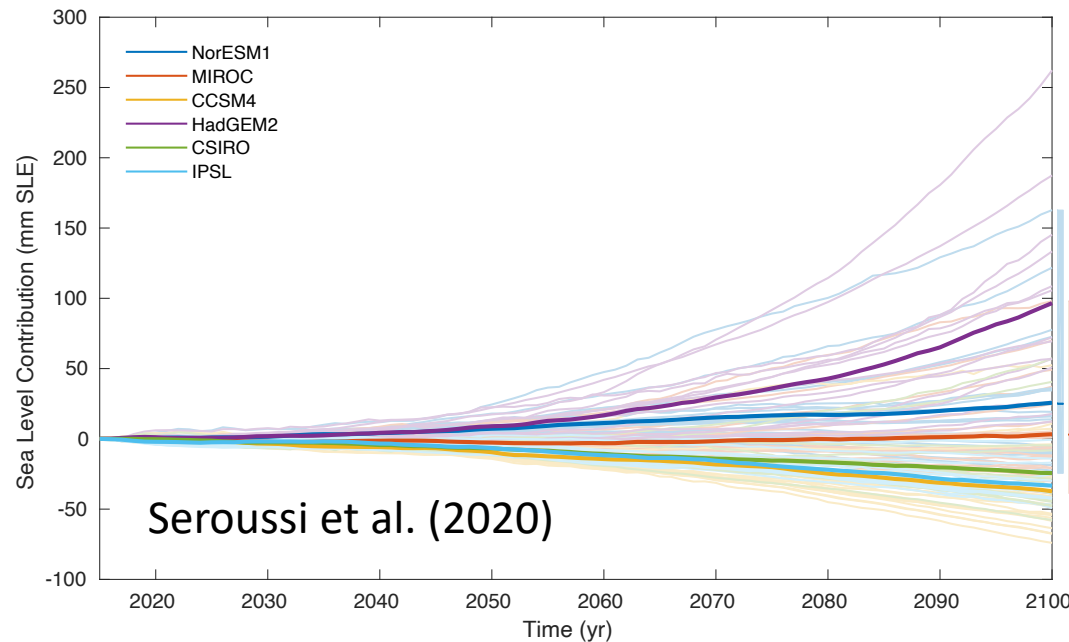


## Main results:

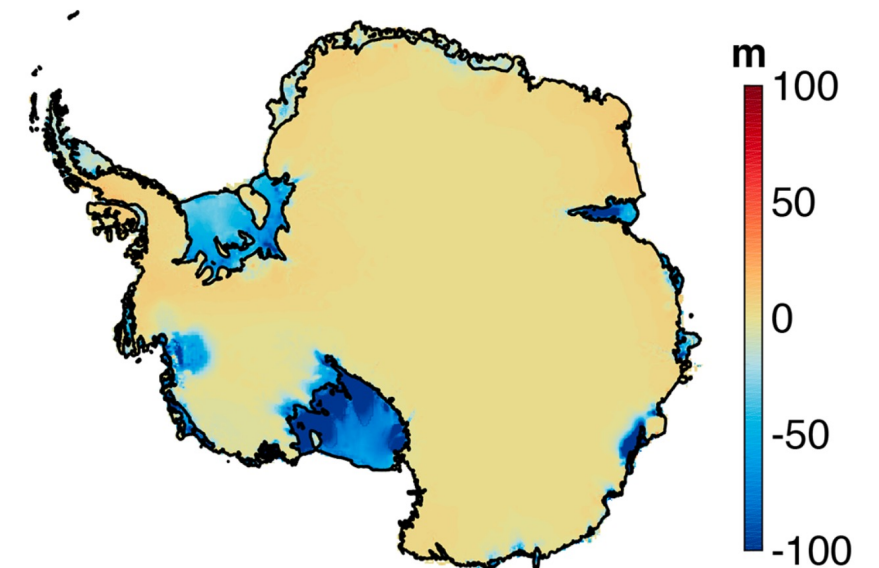
- Balance of additional snowfall and dynamic ice mass loss
- Contrast between East and West Antarctica
- Dynamic changes in a few glaciers by 2100

## Remaining questions:

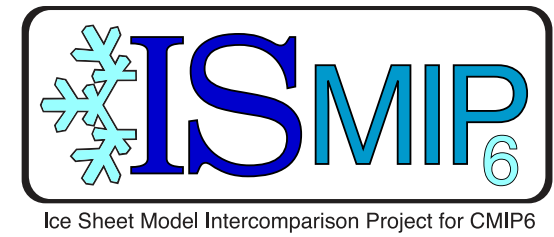
- Warming of oceans late in the century
- Relatively limited time for ice streams to respond to thinning ice shelves by 2100



Average thickness change with NorESM RCP8.5 between 2015 and 2100



# ISMIP6 Antarctica 2300



## Goals:

- Response of Antarctic Ice Sheet (AIS) through 2300
- Assess long-term stability of different regions (Amundsen, Filchner-Ronne, Ross, ...)
- Assess uncertainty from climate forcing and ice sheet models

## Other context:

- Garbe et al. (Nature, 2020):
  - Long-term stability analysis of AIS under various amounts of global warming
  - Many temperature thresholds beyond which ice loss is irreversible
- Lowry et al. (Commun. Earth Environ. 2021):
  - Forcing from multiple climate models, constant forcing after 2100, without ice-shelf collapse
  - Total global warming before 2100 controls the long-term AIS sea-level commitment
  - High-emissions signature of AIS sea-level contribution does not clearly emerge before 2150

# List of experiments

## Experiments

- **Extended:** Forcings from climate models run until 2300 (RCP8.5 and ssp5-85)
- **Repeat:** 2080-2100 forcings randomly selected until 2300
- **With/without ice shelf collapse**

## Climate models

- **NorESM** RCP 2.6 & 8.5: baseline model (but no 2300 extension)
- **CCSM4** RCP 8.5

- **CESM2-WACCM** ssp 585 (high-top atmosphere model)
- **HadGEM2** RCP 8.5
- **UKESM** ssp 585

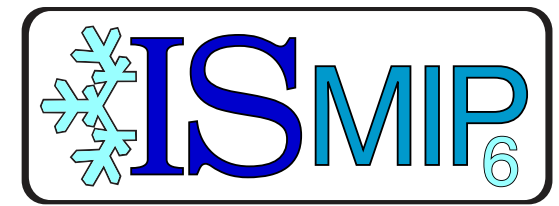
**Table 1: Tier 1 Experiments**

Exp	Model	Scenario	Forcing	Collapse
AE01	NorESM1-M	RCP2.6	Repeat	No
AE02	CCSM4	RCP8.5	To 2300	No
AE03	HadGEM2	RCP8.5	To 2300	No
AE04	CESM2	ssp5-85	To 2300	No
AE05	UKESM	ssp5-85	To 2300	No
AE06	UKESM	ssp5-85	Repeat	No

**Table 2: Tier 2 Experiments**

Exp	Model	Scenario	Forcing	Collapse
AE07	NorESM1-M	RCP8.5	Repeat	No
AE08	HadGEM2	RCP8.5	Repeat	No
AE09	CESM2	ssp5-85	Repeat	No
AE10	UKESM	ssp1-26	To 2300	No
AE11	CCSM4	RCP8.5	To 2300	Yes
AE12	HadGEM	RCP8.5	To 2300	Yes
AE13	CESM2	ssp5-85	To 2300	Yes
AE14	UKESM	ssp5-85	To 2300	Yes

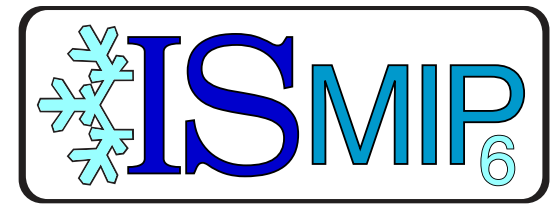
# Participating models



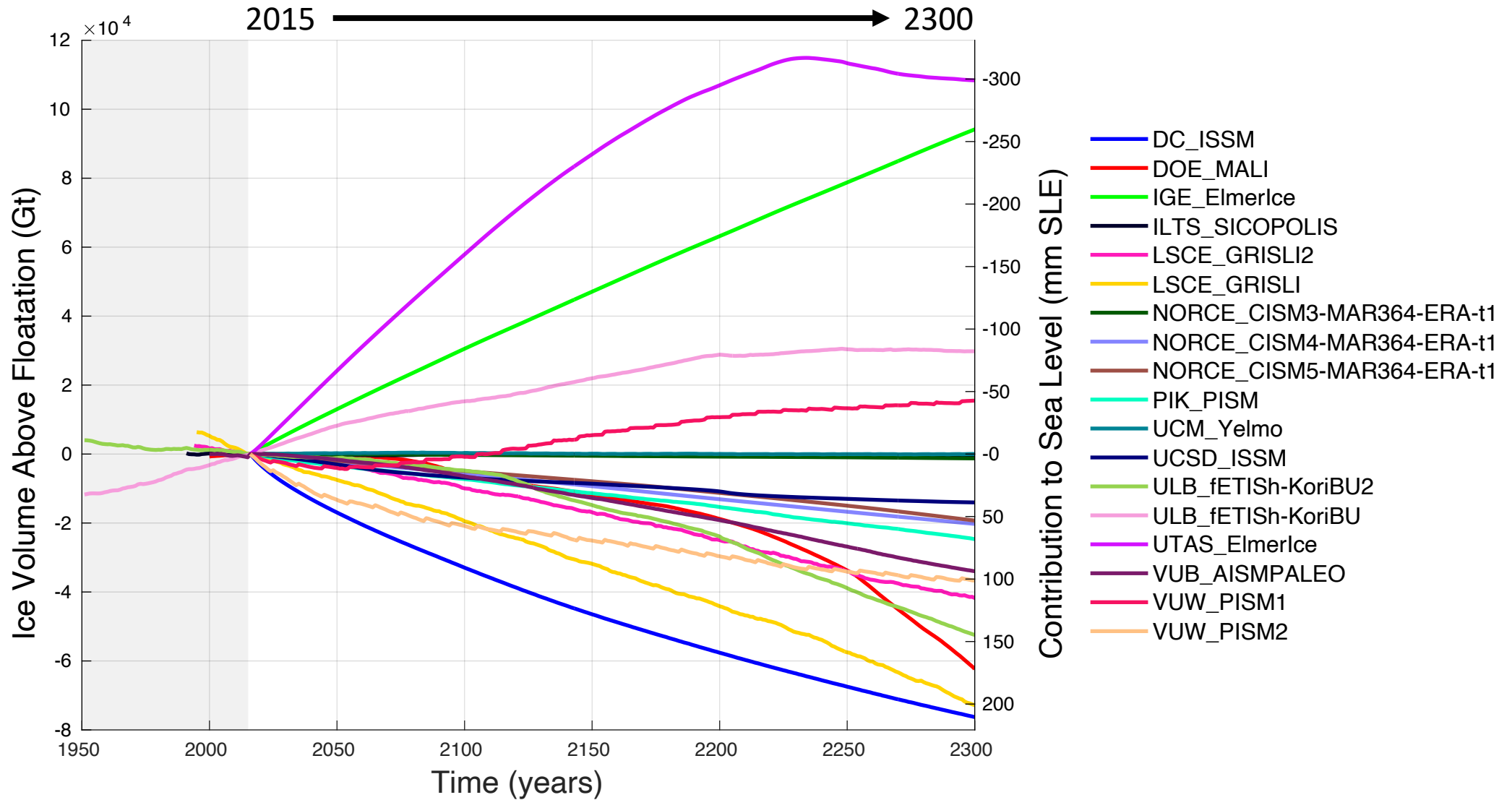
Ice Sheet Model Intercomparison Project for CMIP6

Model name	Numerics	Stress balance	Resolution (km)	Init. Method	Initial Year	Melt in partially floating cells	Ice Front	Ice shelf melt parameterization	Bedrock adjustment
DC_ISSM	FE	SSA	2-50	DA	2007	Sub-Grid	Fix	Quad. Non-local	No
DOE_MALI	FE/FV	HO	2-20	DA+	2000	Floating condition	Fix	Quad. Non-local	No
IGE_ElmerIce	FE	SSA	1-50	DA	1995	No	Fix	PICO	No
ILTS_SICOPOLIS	FD	Hybrid	8	SP+	1990	Floating condition	MH	Quad. Non-local	ELRA
LSCE_GRISLI	FD	Hybrid	16	SP+	1995	Floating Conditions	MH	Quad. Non-local	No
LSCE_GRISLI2	FD	Hybrid	16	SP+	1995	No	MH	Quad. Non-local	No
NCAR_CISM	FE/FV	L1L2	4	SP+	1995	Sub-Grid	RO	Quad. Non-local	No
NORCE_CISM3	FE/FV	L1L2	8	SP+	1995	Sub-Grid	RO	Quad. Non-local	No
NORCE_CISM4	FE/FV	L1L2	16	SP+	1995	Sub-Grid	RO	Quad. Non-local	No
NORCE_CISM5	FE/FV	L1L2	32	SP+	1995	Sub-Grid	RO	Quad. Non-local	No
PIK_PISM	FD	Hybrid	8	SP	1850	Sub-Grid	StR	PICO	No
UCM_Yelmo	FD	SSA*	16	SP+	1990	Sub-Grid	VM	Quad. Non-local	ELRA
UCSD_ISSM	FE	HO	3-50	DA	2007	Sub-Grid	Fix	PICOP	No
ULB_FETISH_median	FD	Hybrid	16	DA*	2005	N/A	Div	Plume	No
ULB_FETISH_pico	FD	Hybrid	32	DA*	2005	N/A	Div	Plume	No
UTAS_ElmerIce	FE	SSA	0.5-23	DA	2015	Sub-Grid	Fix	Quad. Local	No
VUB_AISMPALEO	FD	SIA+SSA	20	SP	2000	N/A	MH	Quad. Non-local	No
VUW_PISM1	FD	Hybrid	16	SP	2015	No	StR	Lin	VE
VUW_PISM2	FD	Hybrid	16	SP	2015	Yes	StR	Lin	VE

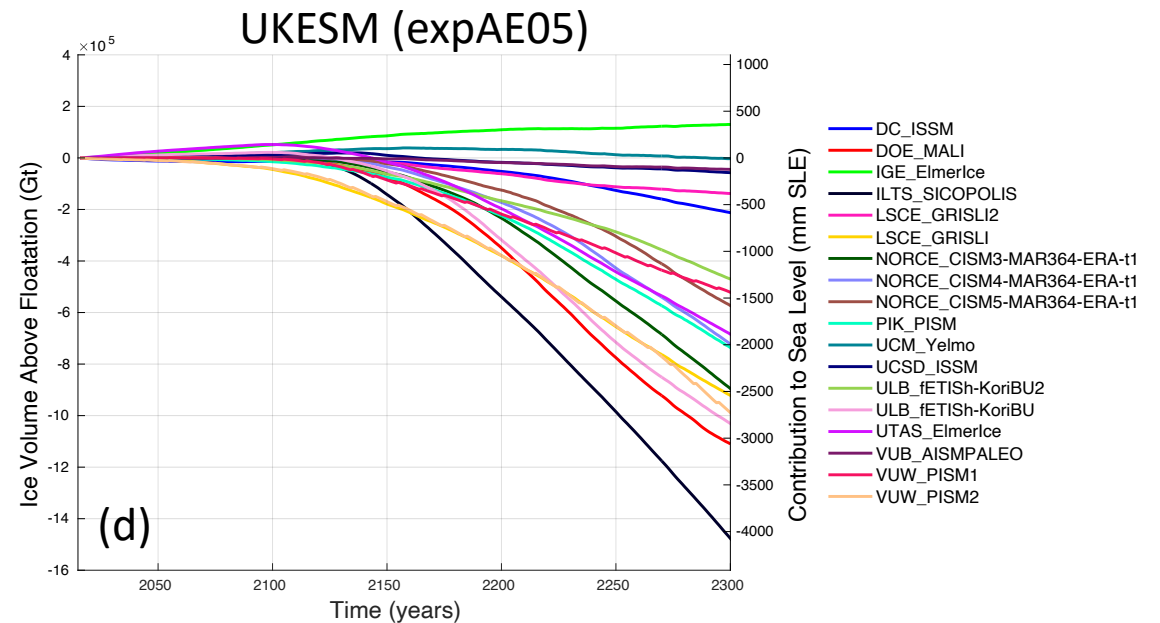
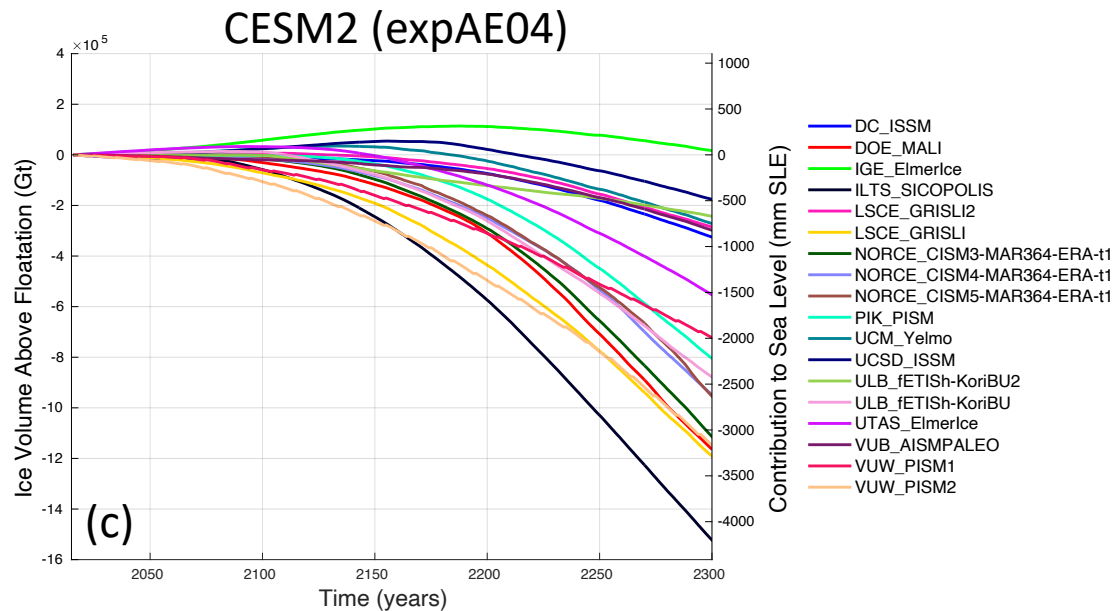
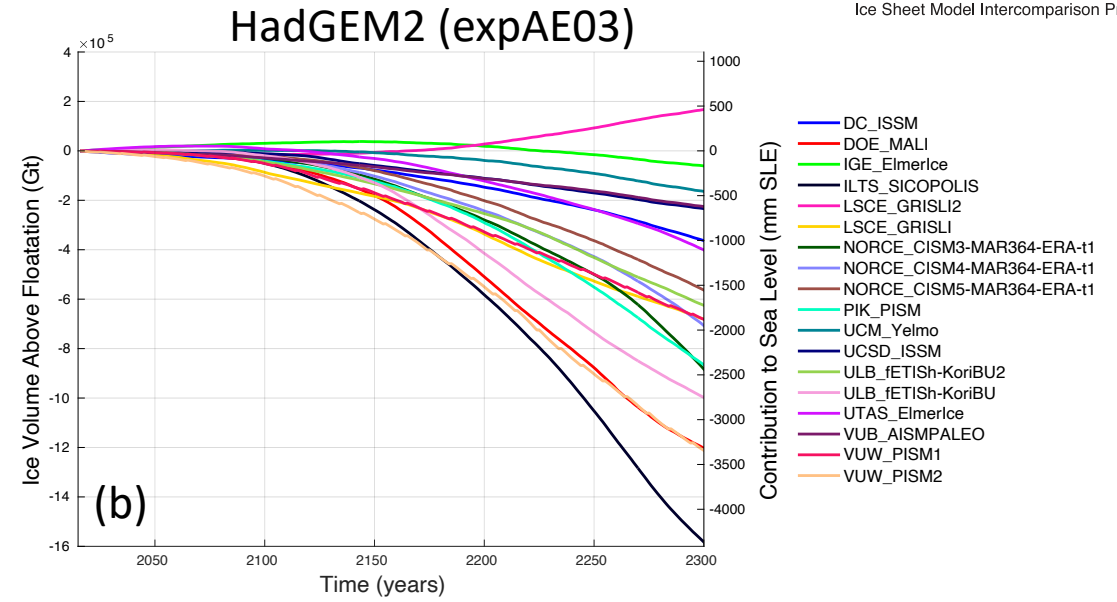
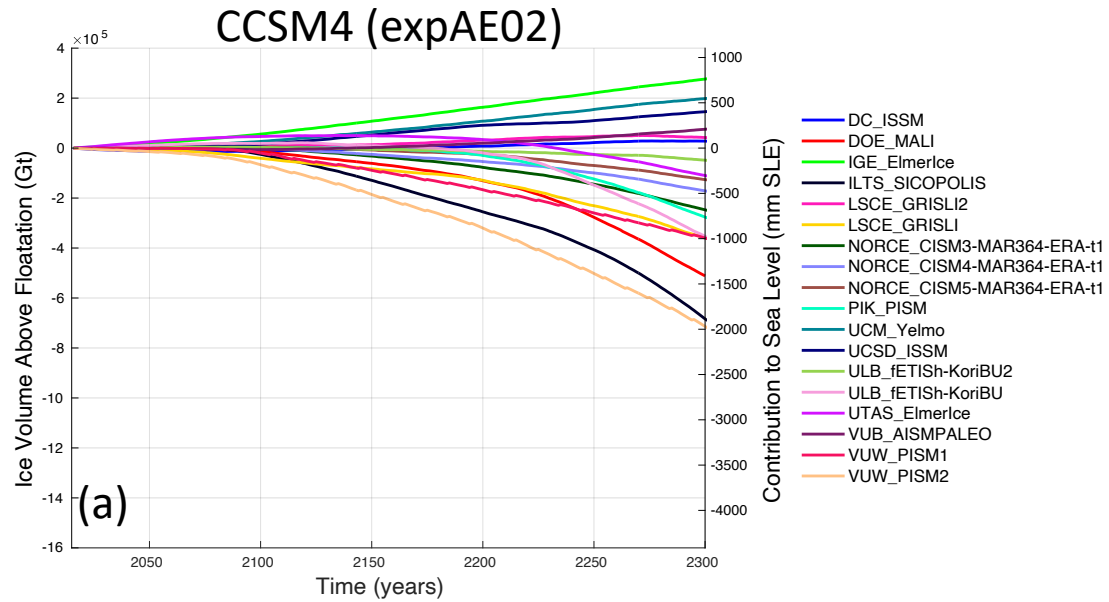
# Historical and control experiment



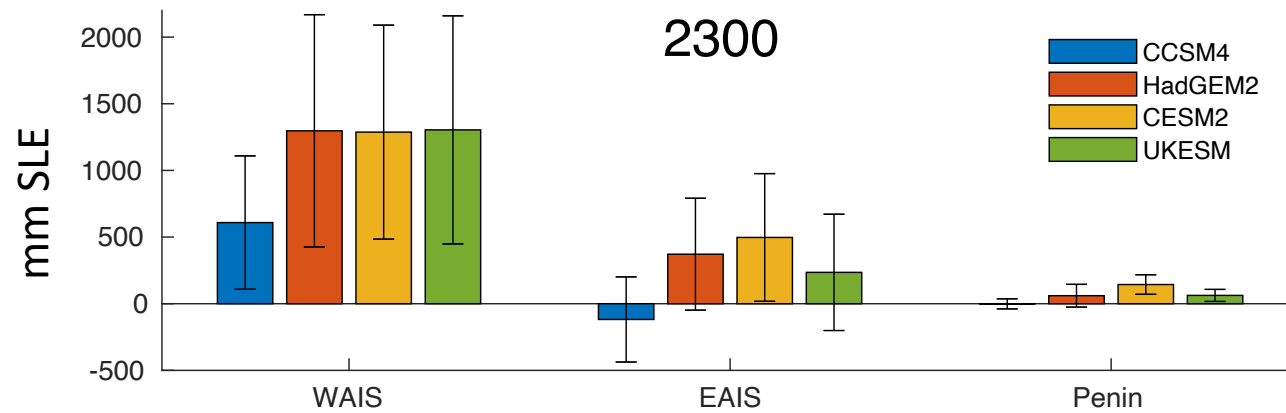
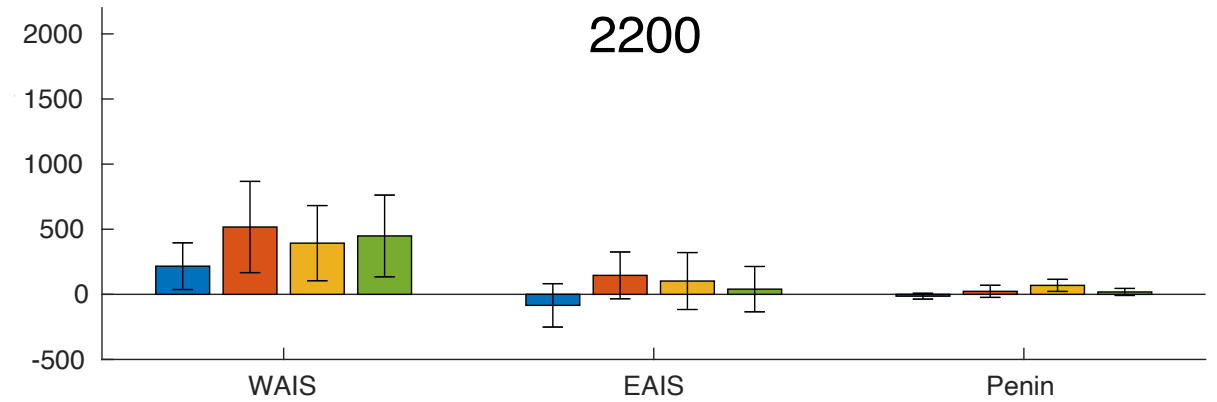
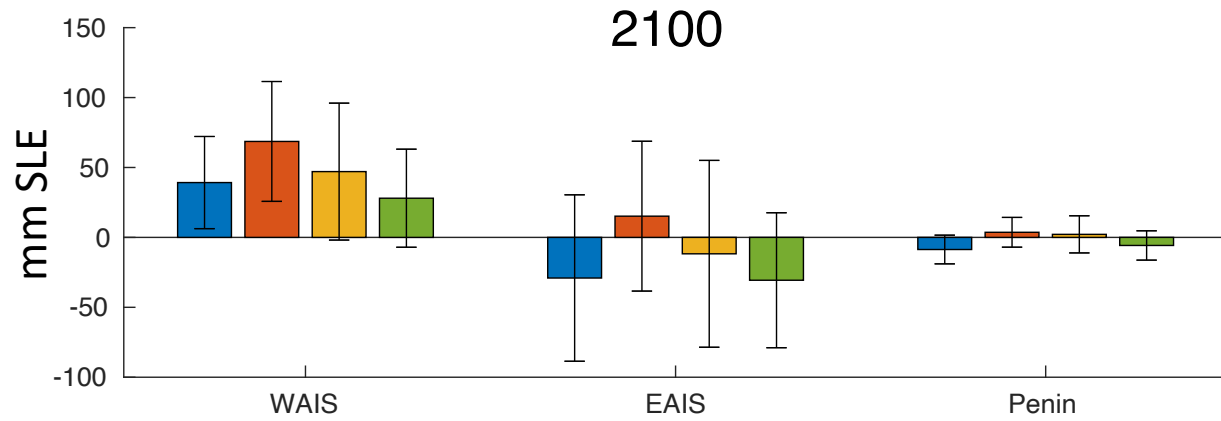
Ice Sheet Model Intercomparison Project for CMIP6



# Experiments with Extended 2300 forcing

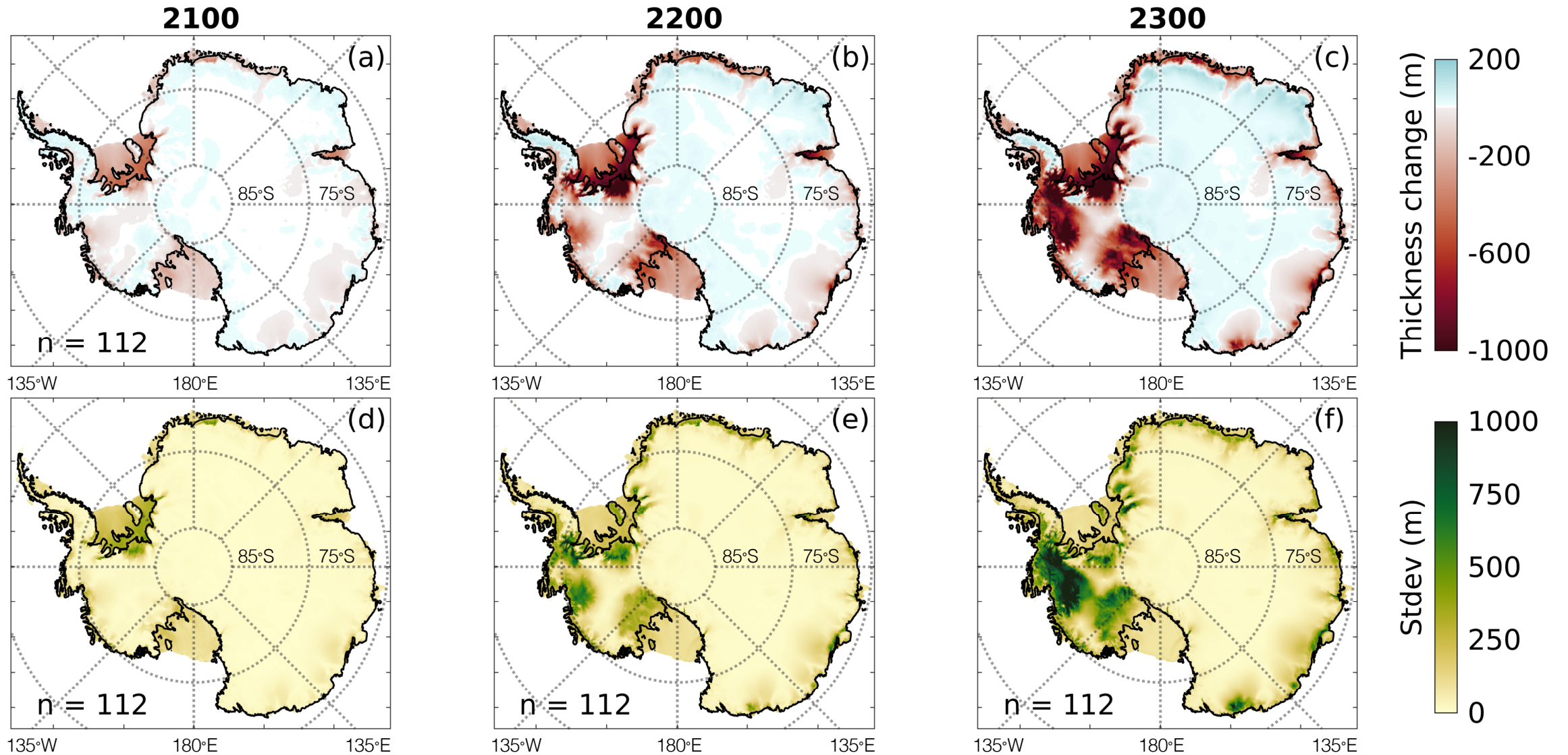


# Evolution by region with 2300 forcing





# Local changes with 2300 forcing

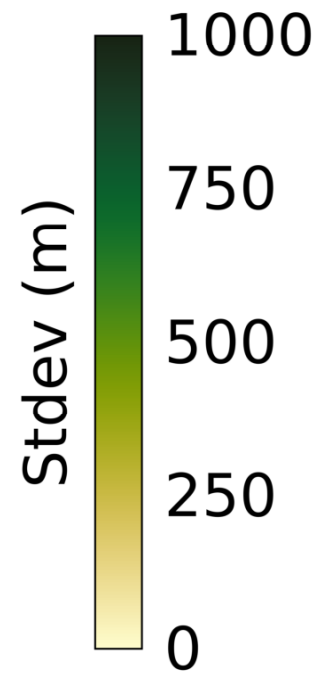
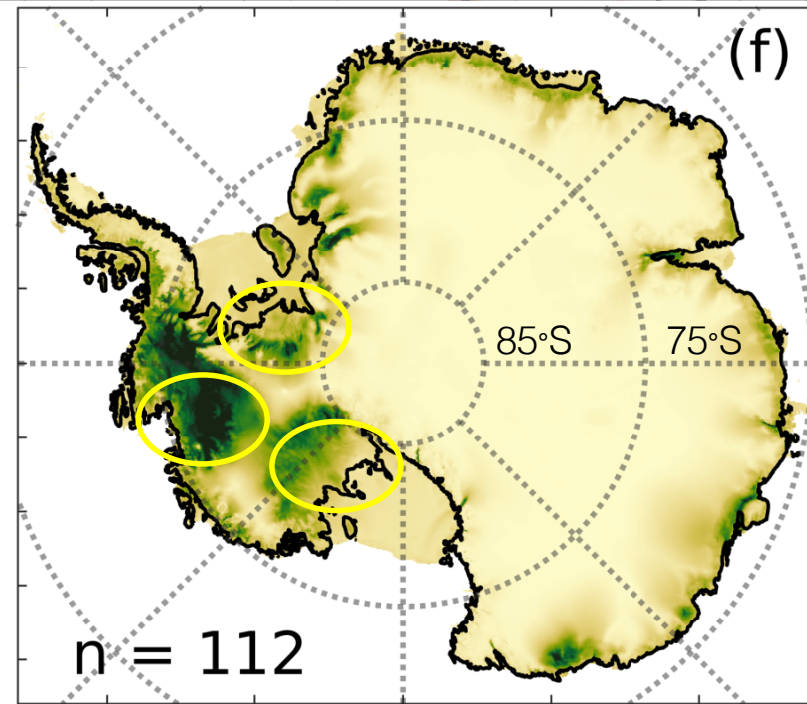
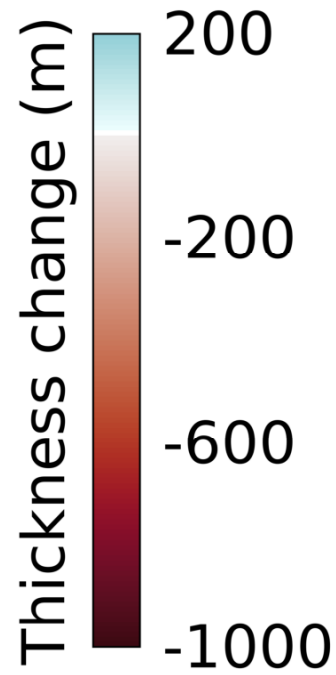
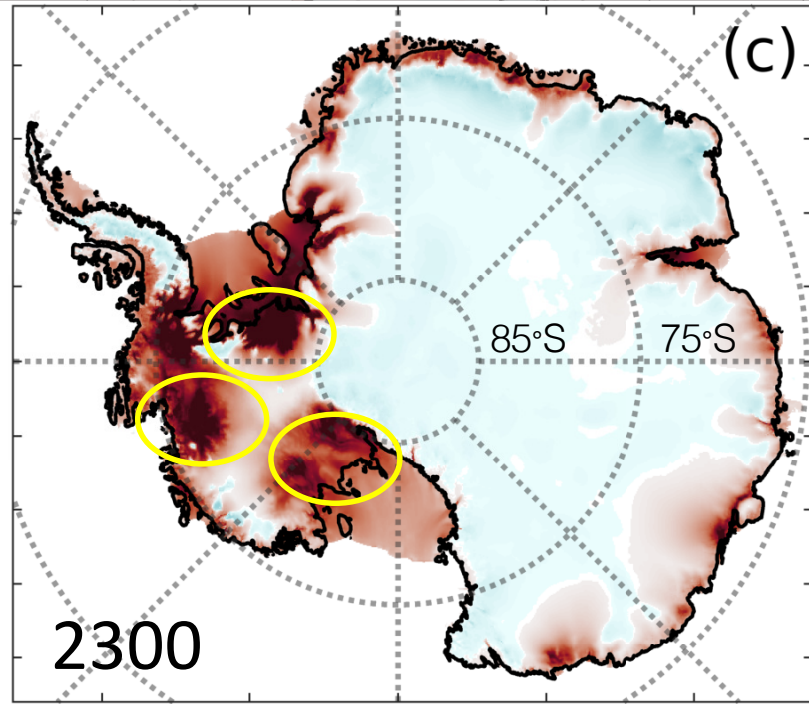


# Local changes with 2300 forcing

2100

2200

2300



135°W 180°E 135°E

135°W 180°E 135°E

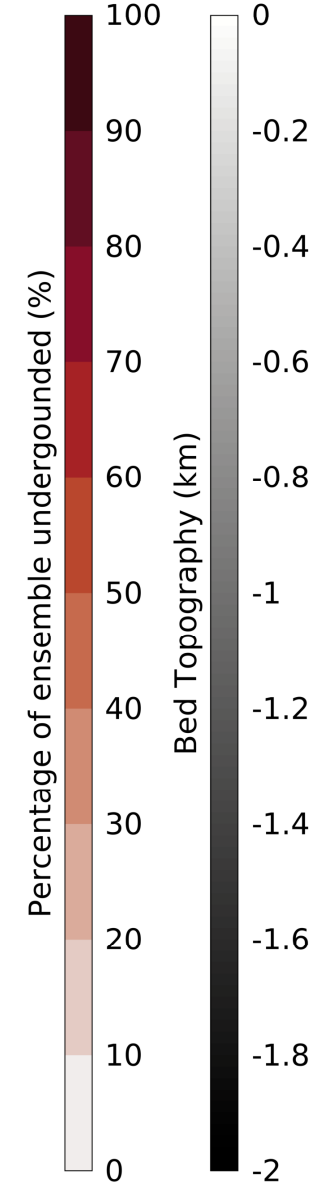
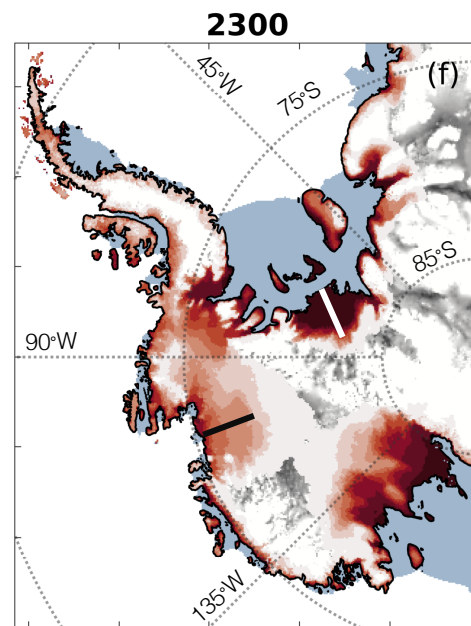
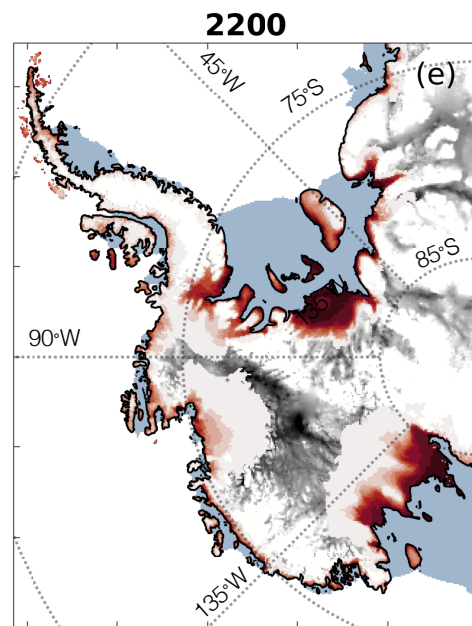
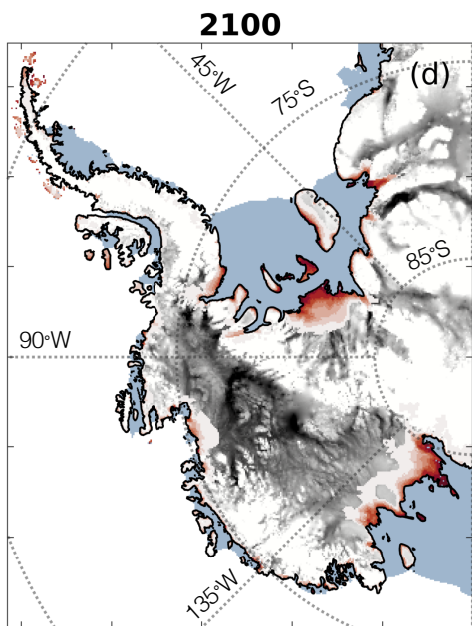
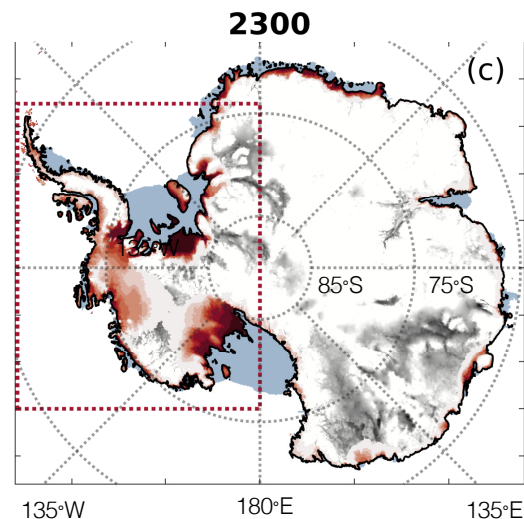
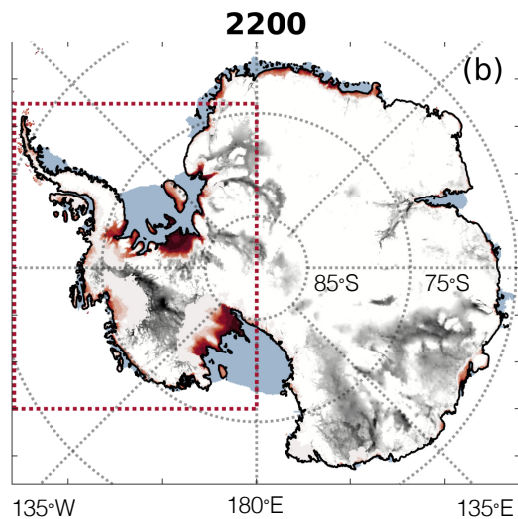
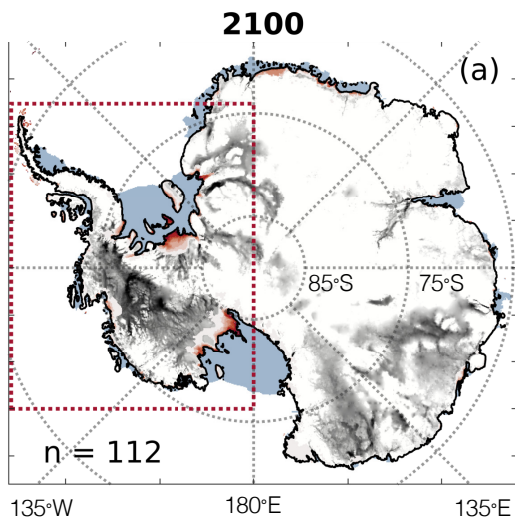


135°W 180°E 135°E

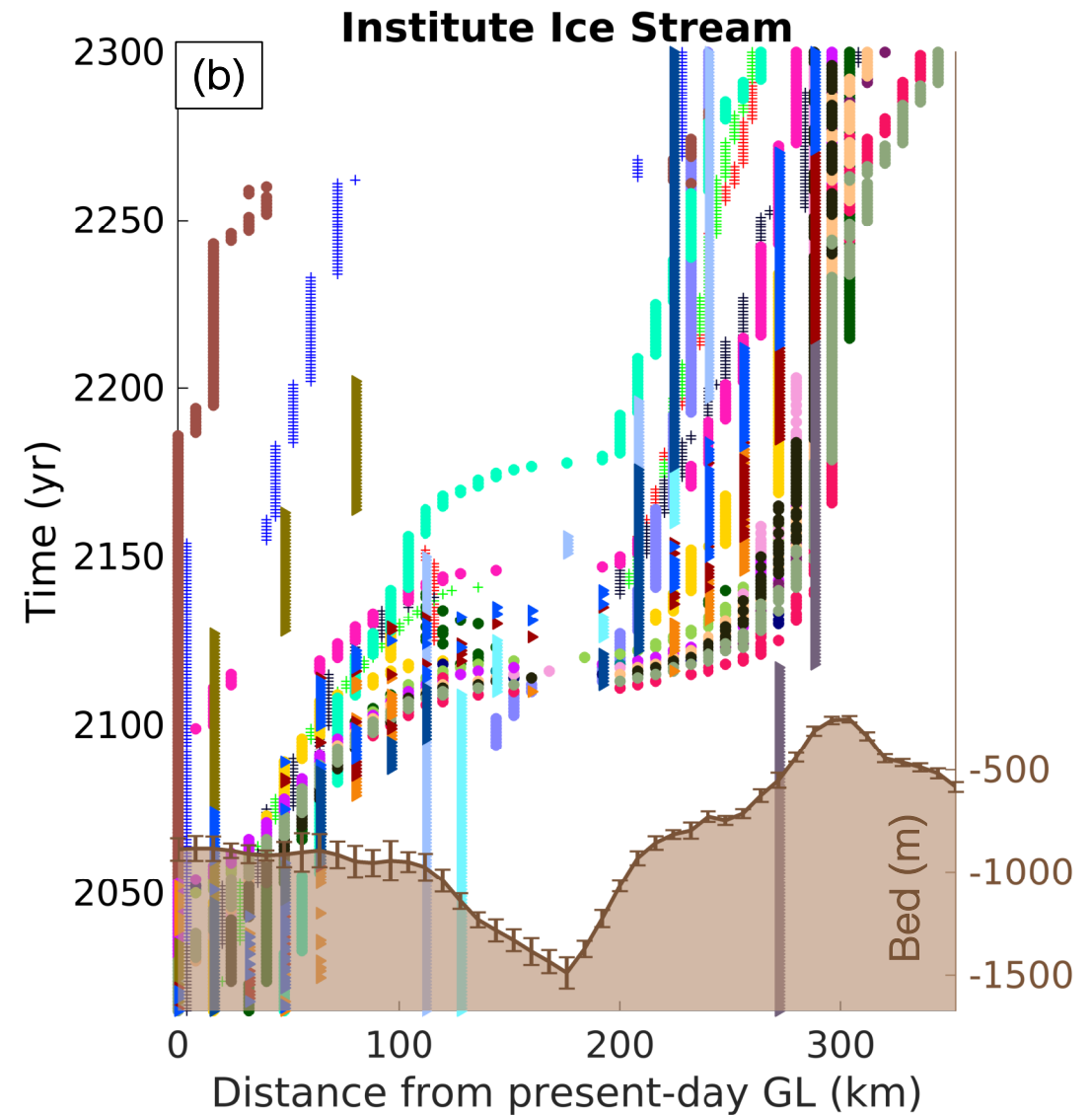
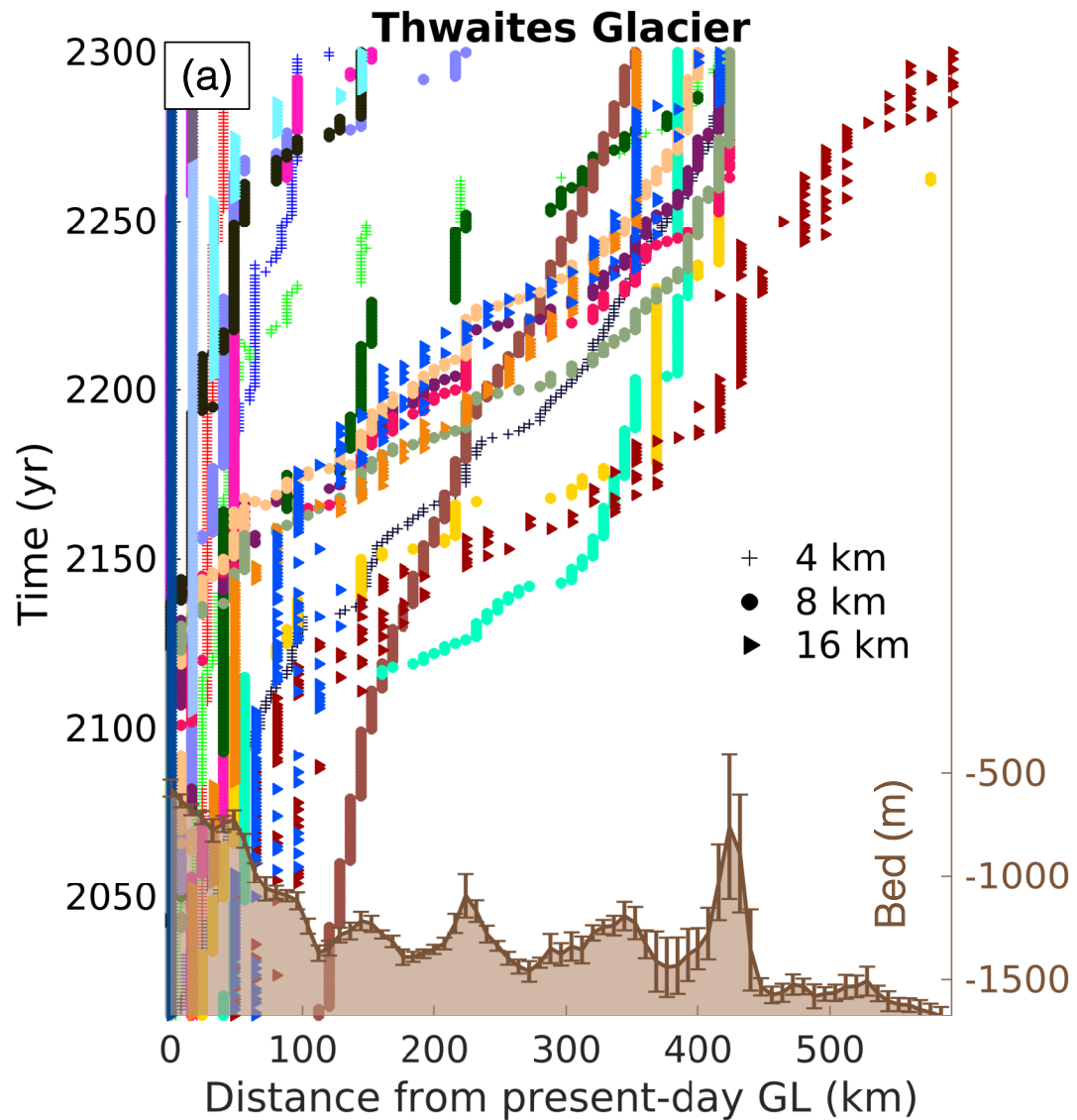
135°W 180°E 135°E

135°W 180°E 135°E

# Grounding line retreat with 2300 forcing



# Retreat profiles with HadGEM2 (expAE03)



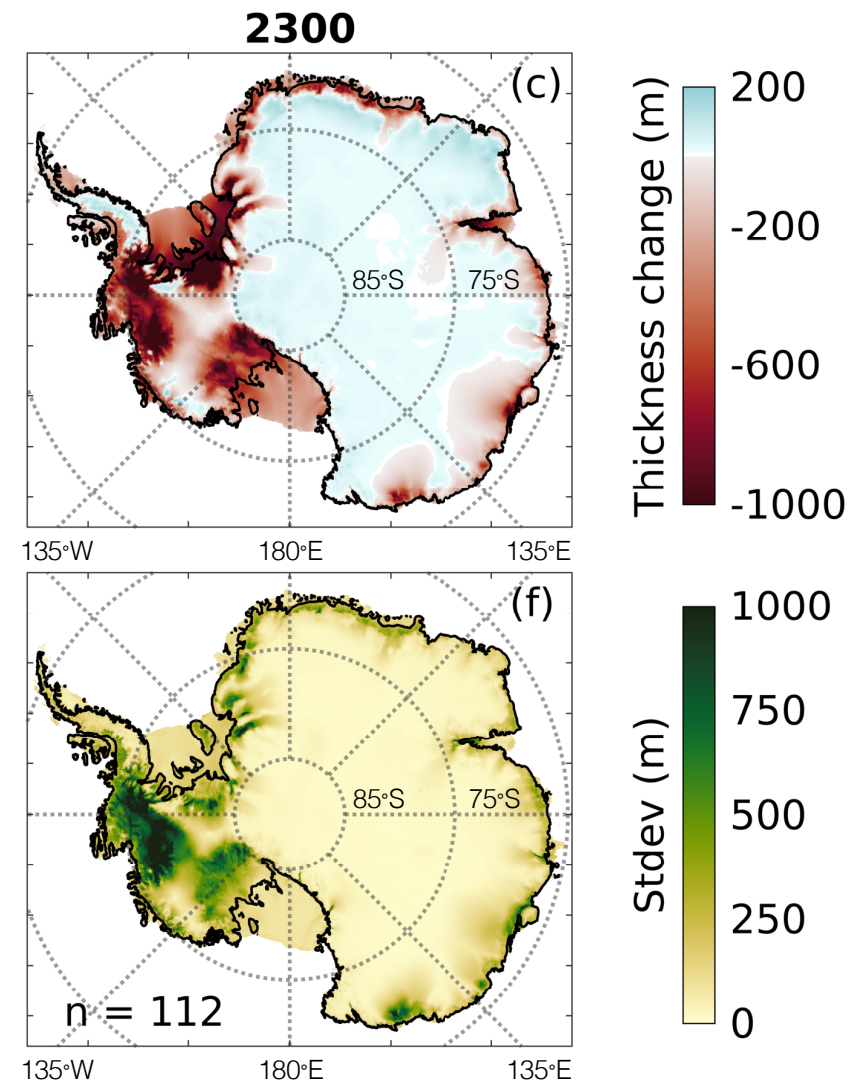
## Sea level rise contribution of AIS

- Up to 4 m by 2300 in high end simulations
- Ice response after ~2150
- Dynamic coastal thinning outpaces inland snow precipitation
- Large uncertainty from ice sheet model and applied forcing

## Regional retreat

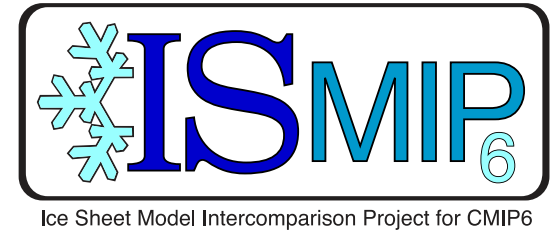
- Amundsen Sea Sector
- Glaciers feeding Ross and Ronne Ice Shelves

**Disclaimer:** Results are preliminary and are subject to change as submissions are finalized





## More information



### Wiki:

- Page dedicated to AIS 2300: <https://www.climate-cryosphere.org/wiki/index.php?title=ISMIP6-Projections2300-Antarctica>

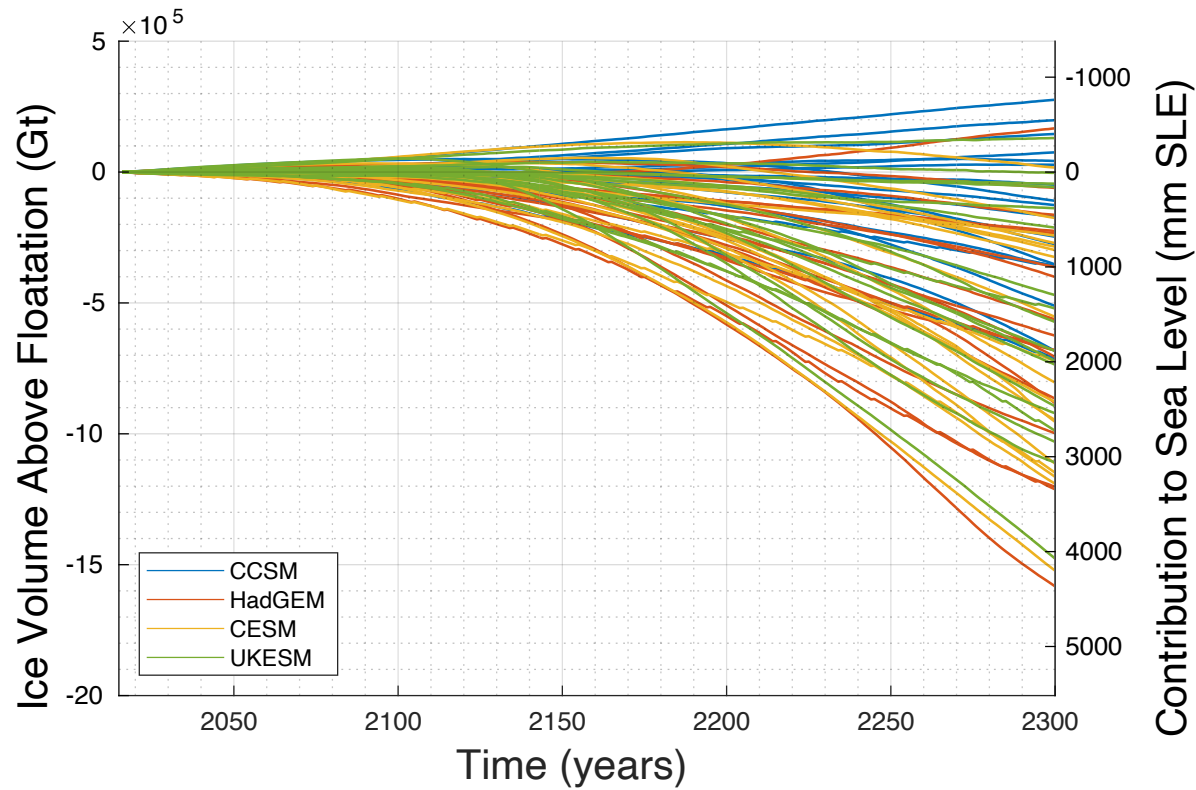
### Questions:

- Email: [ismip6@gmail.com](mailto:ismip6@gmail.com)

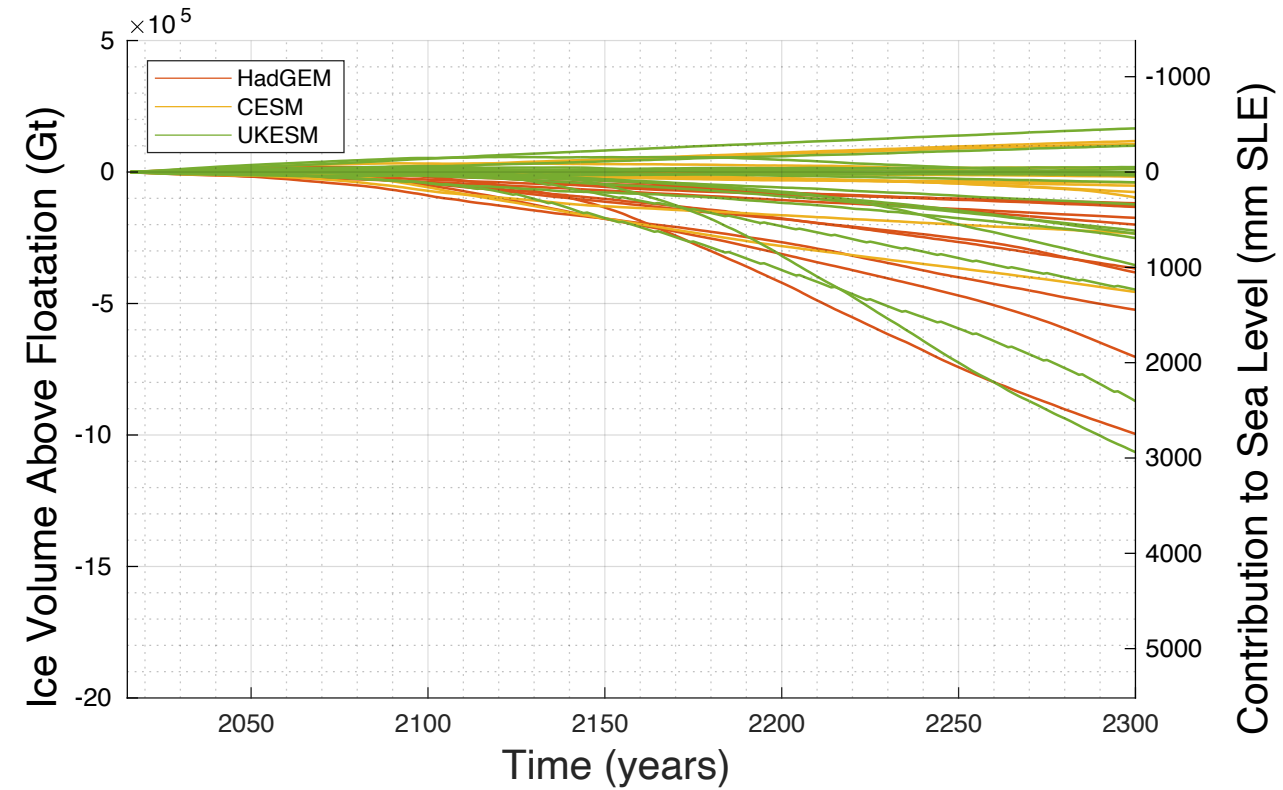
*Acknowledgements.* We thank the Climate and Cryosphere (CliC) effort, which provided support for ISMIP6 through sponsoring of workshops, hosting the ISMIP6 website and wiki, and promoting ISMIP6. We acknowledge the World Climate Research Programme, which, through its Working Group on Coupled Modelling, coordinated and promoted CMIP5 and CMIP6.

# 2300 forcing vs repeat forcing

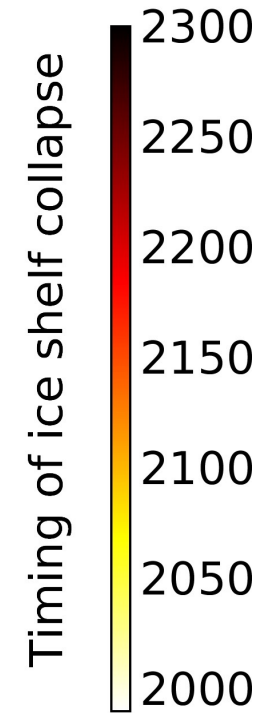
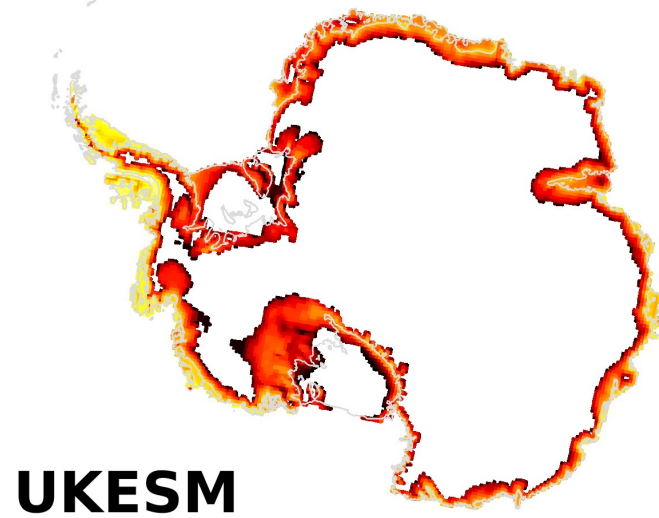
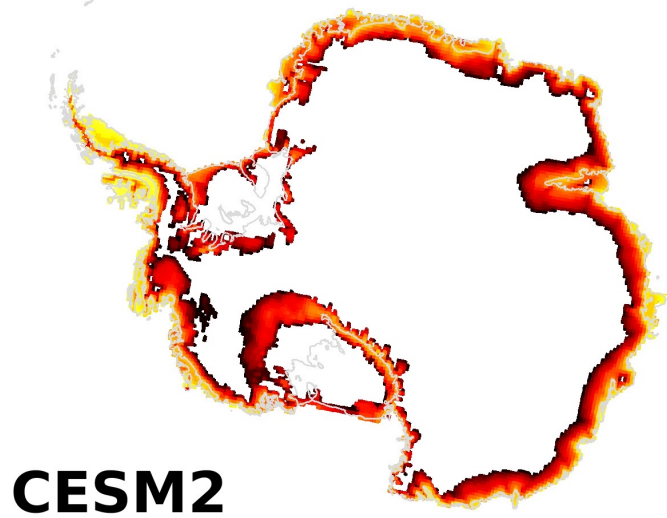
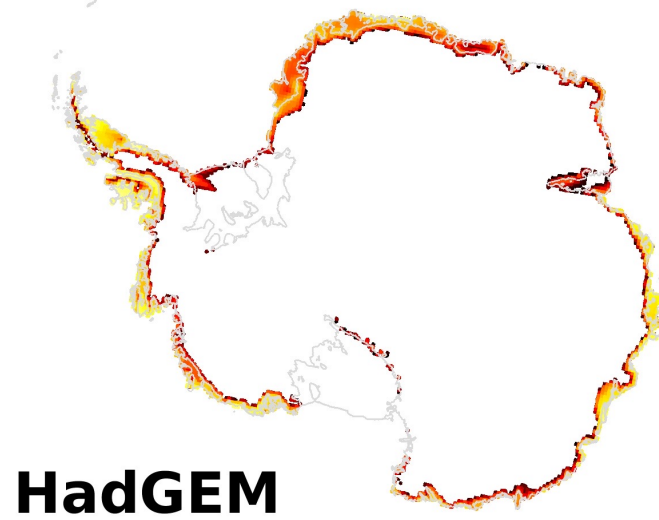
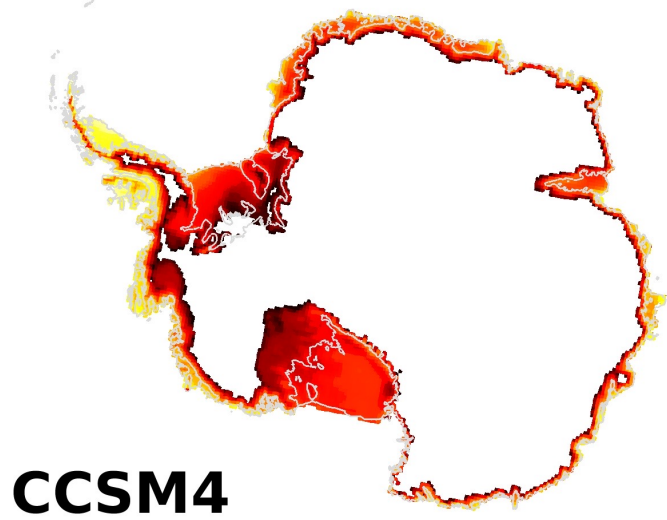
## 2300 forcing



## Repeated forcing (2080-2100)

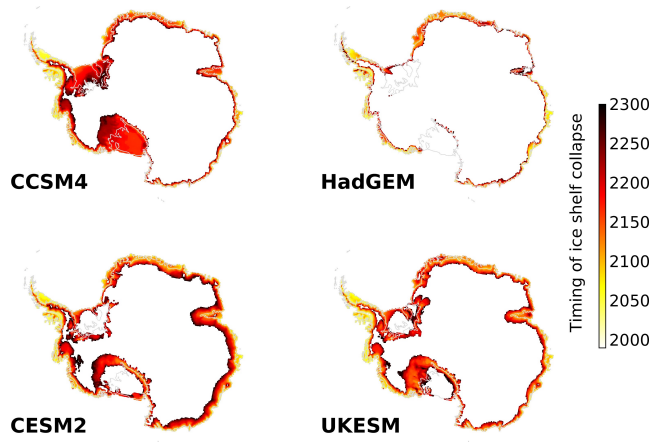


# Impact of ice shelf collapse

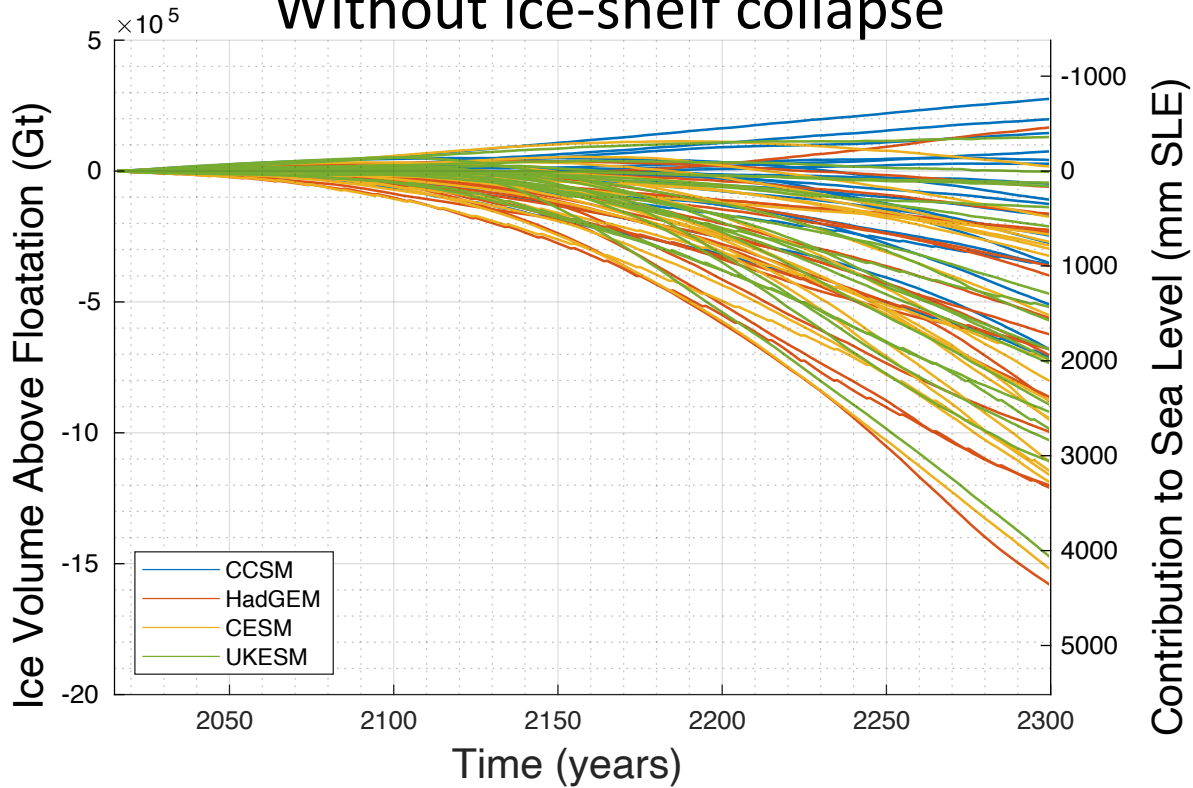




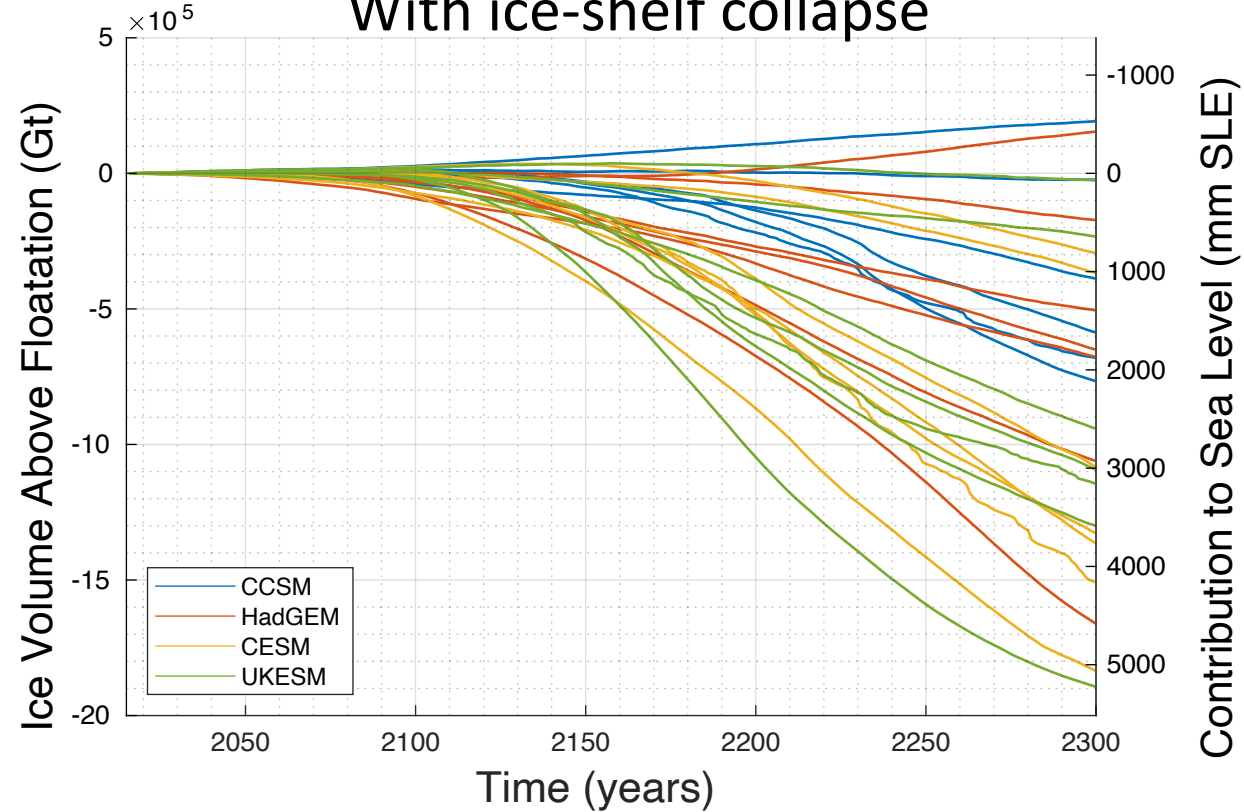
# Impact of ice shelf collapse



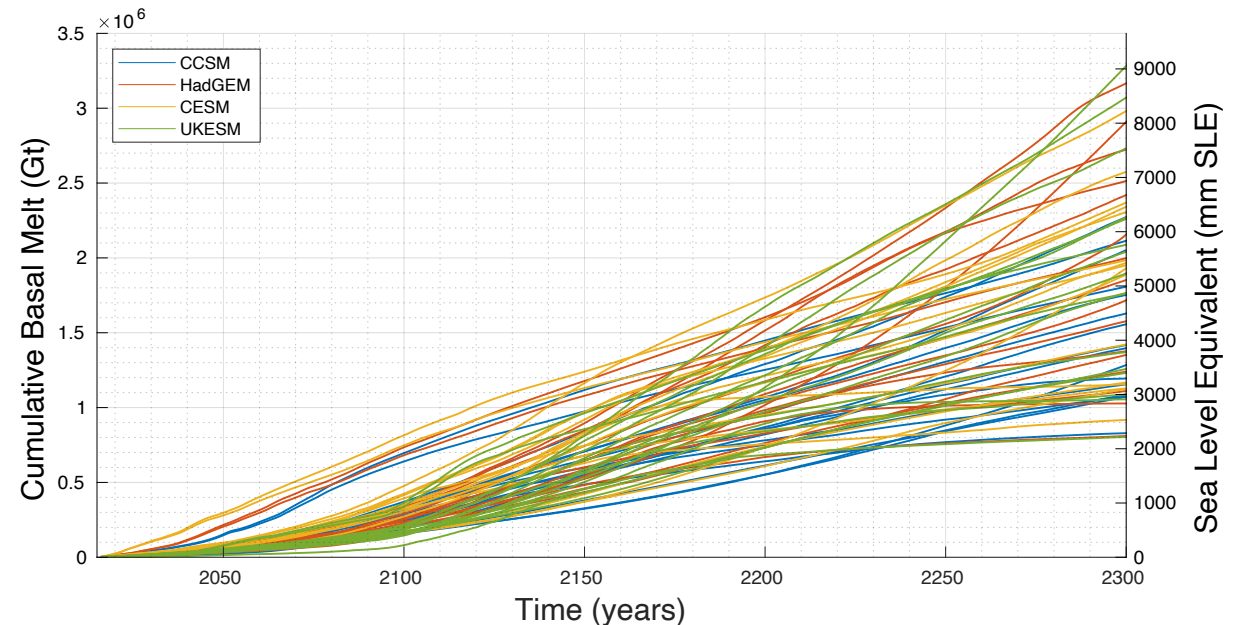
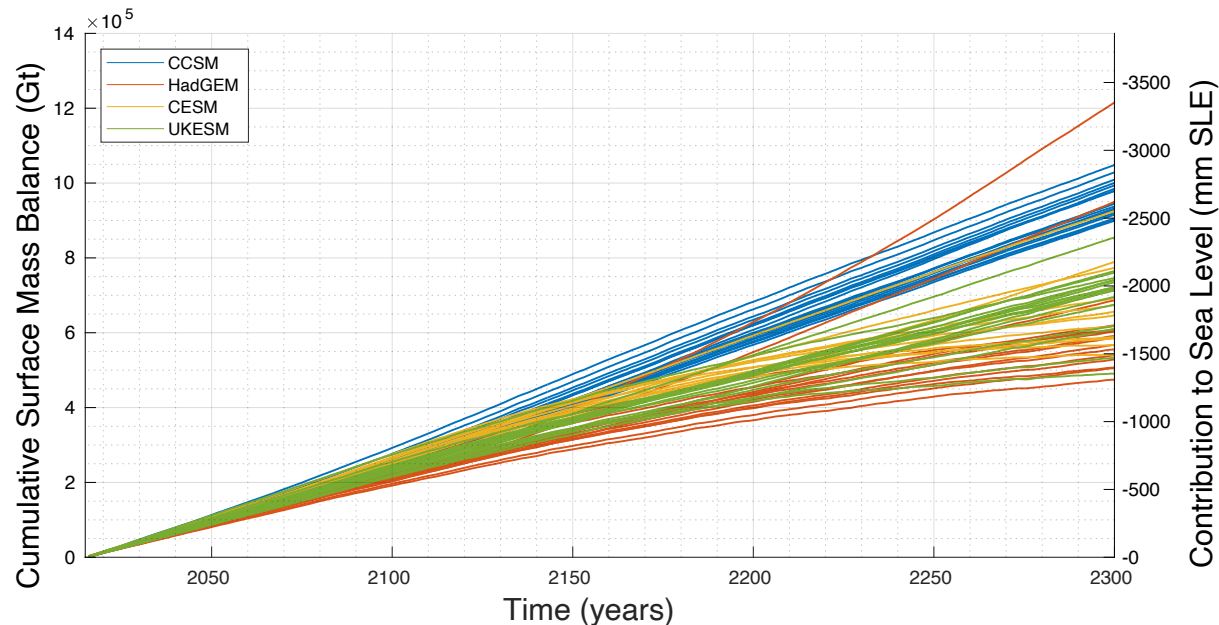
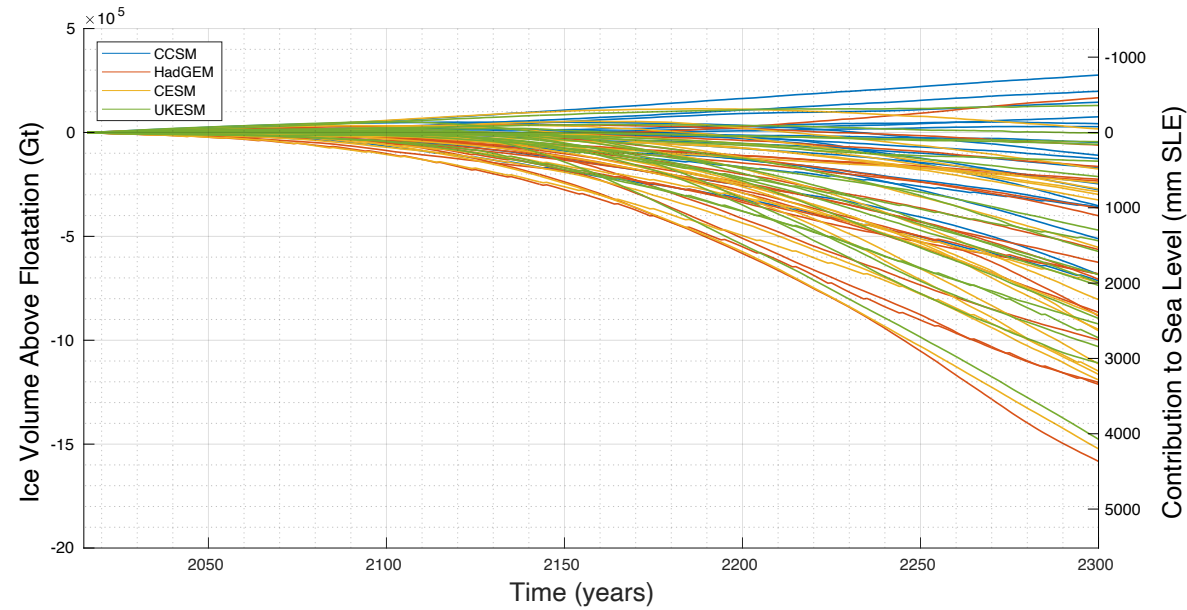
## Without ice-shelf collapse



## With ice-shelf collapse



# Experiments with Extended 2300 forcing



# Impact of GIA correction

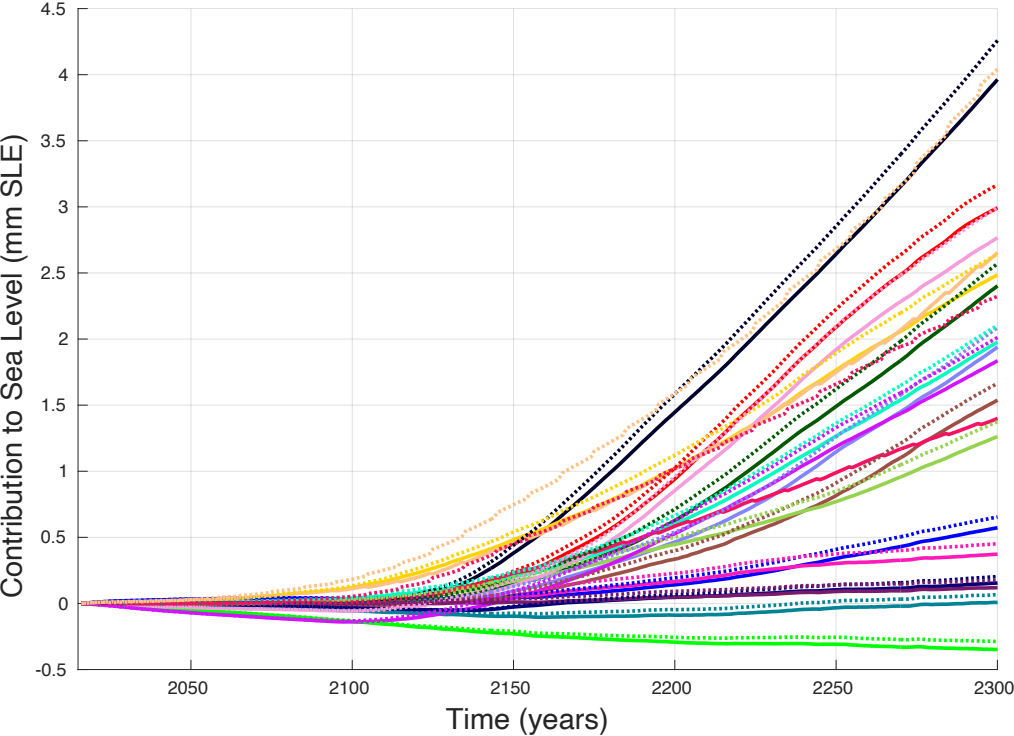


Ice Sheet Model Intercomparison Project for CMIP6

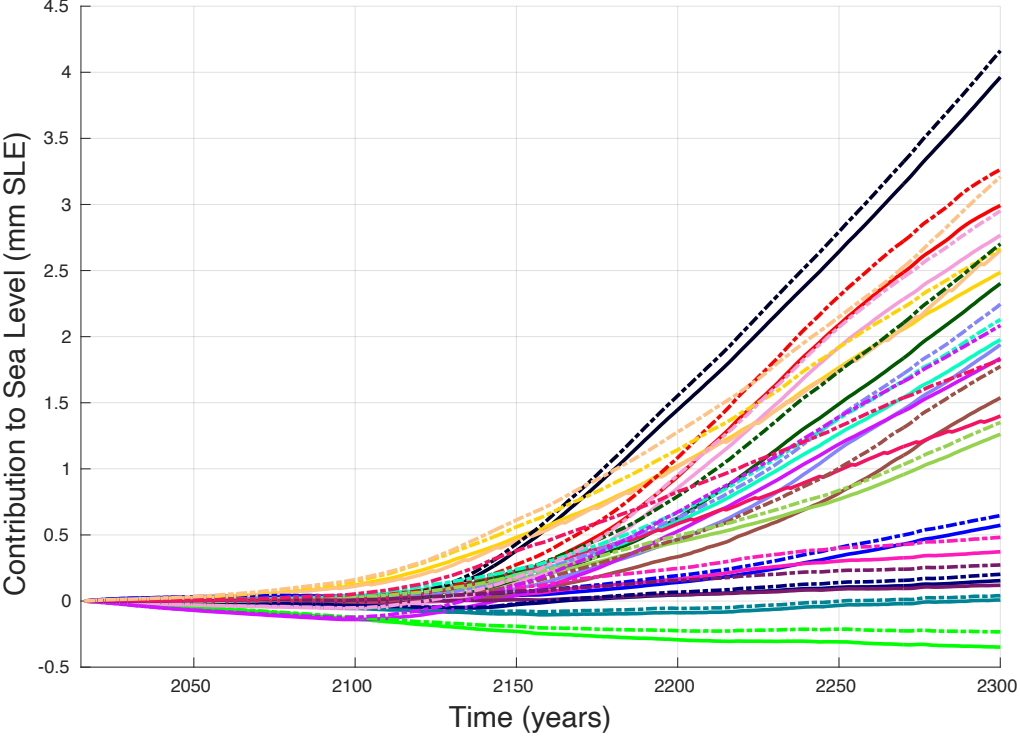
GIA correction based on:

Goelzer et al. (2020)

Adhikari et al. (2020)

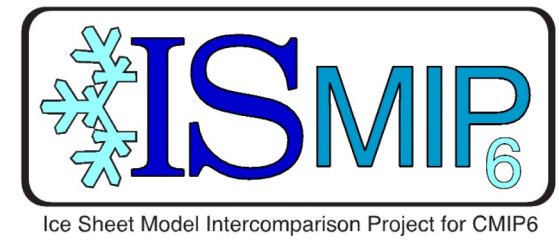


- DC\_ISSM
- DOE\_MALI
- IGE\_ElmerIce
- ILTS\_SICOPOLIS
- LSCE\_GRISLI2
- LSCE\_GRISLI
- NORCE\_CISM3-MAR364-ERA-t1
- NORCE\_CISM4-MAR364-ERA-t1
- NORCE\_CISM5-MAR364-ERA-t1
- PIK\_PISM
- UCM\_Yelmo
- UCSD\_ISSM
- ULB\_fETISh-KoriBU2
- ULB\_fETISh-KoriBU
- UTAS\_ElmerIce
- VUB\_AISMPALEO
- VUW\_PISM1
- VUW\_PISM2



Solid lines: no correction  
Dashed/dotted lines: correction

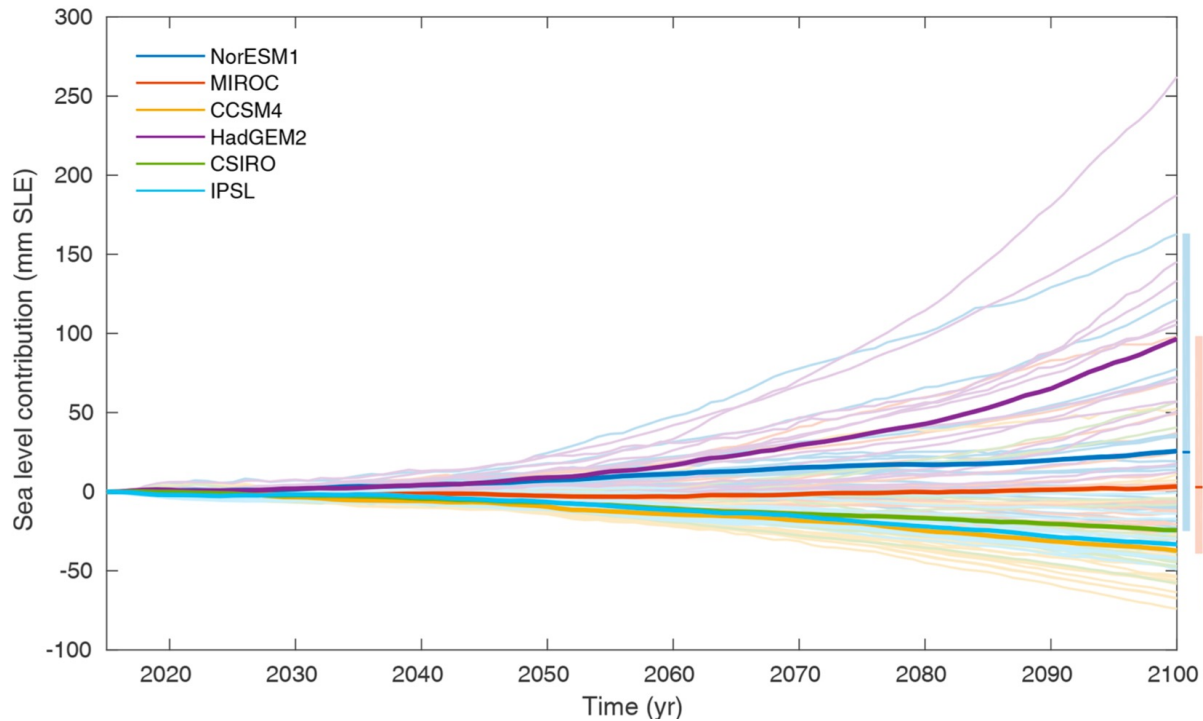
# Comparison with previous ensemble



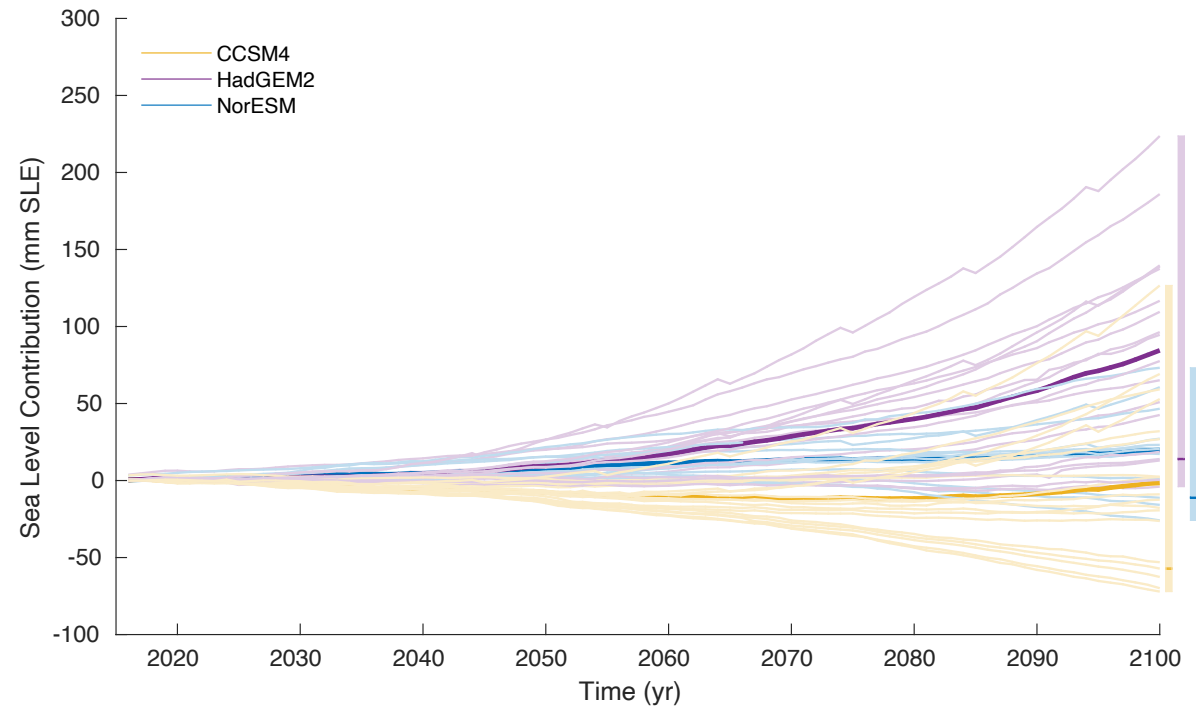
Evolution until 2100 for 3 common climate forcings:

- NorESM
- CCSM
- HadGEM

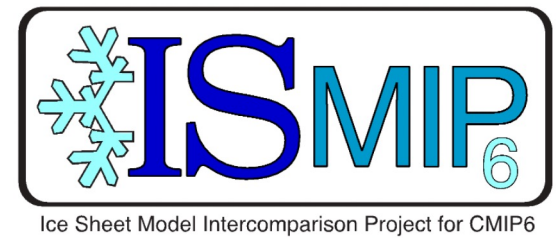
## Previous ensemble



## New ensemble

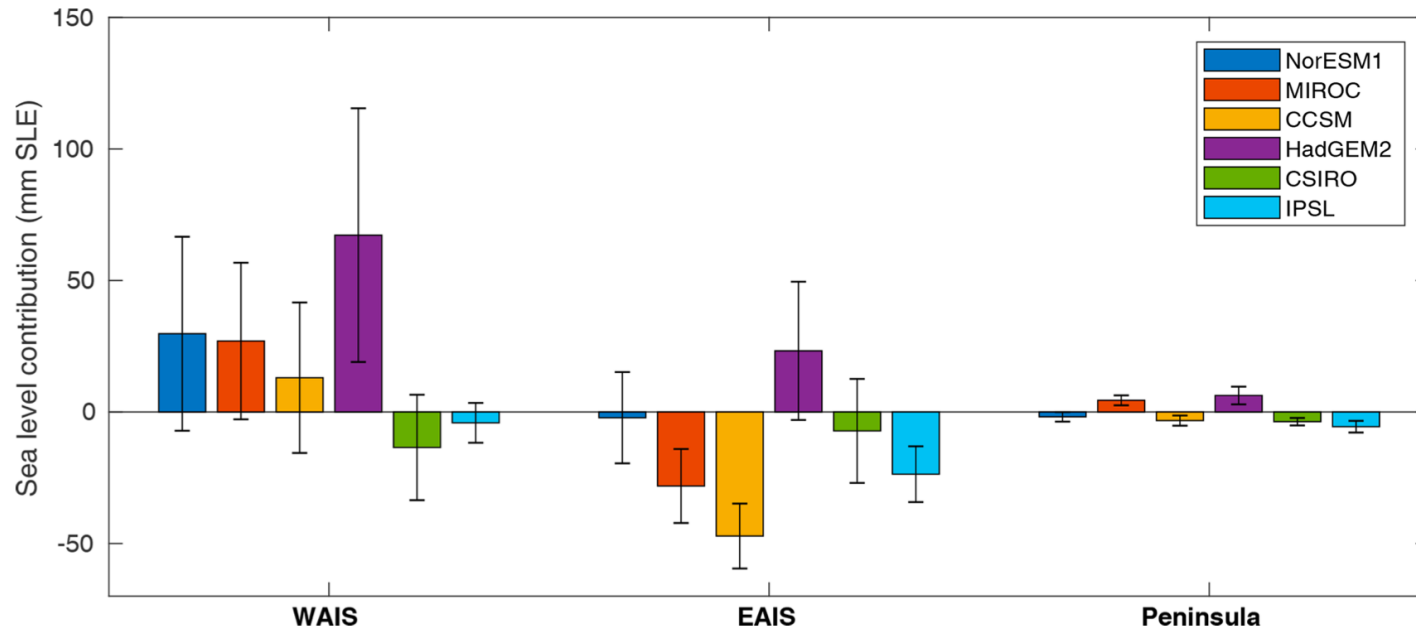


# Comparison with previous ensemble

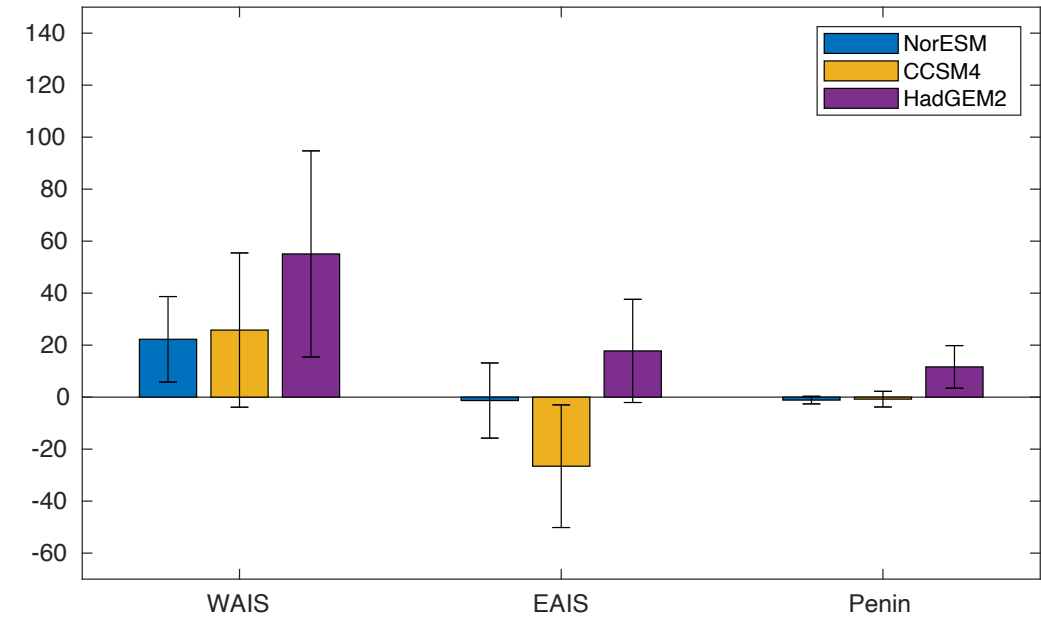


Evolution until 2100 per region (minus control)

## Previous ensemble



## New ensemble



# Preliminary results (anomalies)

