ISMIP6 Antarctica Projections: a multi-model ensemble of the Antarctic ice sheet evolution over the 21st century

H. Seroussi[1], S. Nowicki[2], A. Abe Ouchi[3], C. Agosta[4], X. Asay-Davis[6], A. Barthel[6], R. Calov[5], R. Cullather[2], C. Dumas[4], R. Gladstone[7], H. Goelzer[8,9], N. Golledge[10], J. Gregory[11], R. Greve[12], M. Hoffman[6], A. Humbert[15], P. Huybrechts[16], N. Jourdain[17], T. Kleiner[15], E. Larour[1], G. Leguy[18], W. Lipscomb[18], D. Lowry[10], C Little[19], M. Morlighem[20], F. Pattyn[9], A. Payne[21], T. Pelle[20], S. Price[6], A. Quiquet[4], R. Reese[5], N. Schlegel[1], A. Shepherd[22], E. Simon[2], R. Smith[11], F. Straneo[23], S. Sun[9], J. Sutter[15], L. Trusel[24], J. Van Breedam[16], R. van de Wal[8], R. Winkelmann[5], C. Zhao[26], T. Zhang[6], and T. Zwinger[27].

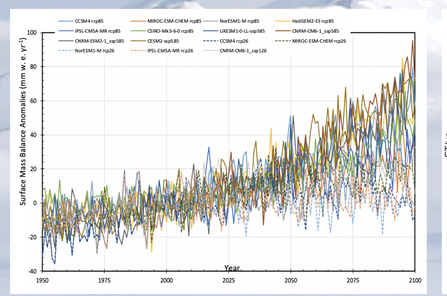
[1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA, [2]NASA Goddard Space Flight Center,Greenbelt, MD, USA, [3]University of Tokyo, Japan, [4]Laboratoire des sciences du climat et de l'environnement, France, [5]Potsdam Institute for Climate Impact Research, Germany, [6]Los Alamos National Laboratory, NM, USA, [7]University of Lapland, Finland, [8]Institute for Marine and Atmospheric research Utrecht, Utrecht University, The Netherlands, [9]Université Libre de Bruxelles, Belgium, [10]Antarctic Research Centre, Victoria University of Wellington, New-Zealand, [11]University of Reading, UK, [12]Institute of Low Temperature Science, Hokkaido University, Sapporo, Japan, [13]Norwegian Polar Institute, Tromsø, Norway, [14]Energy and Climate Group, Department of Physics and Technology, The Arctic University – University of Tromsø, Norway, [15]Alfred Wegener Institute for Polar and Marine Research, Bremerhaven, Germany, [16]Vrije Universiteit Brussel, Belgium, [17]Institut des Géosciences de l'Environnement, France, [18]National Center for Atmospheric Research, Boulder, CO, USA, [19]Atmospheric and Environmental Research, Inc., Lexington, Massachusetts, USA, [20]Department of Earth System Science, University of California Irvine, CA, USA, [21]University of Bristol, UK, [22]University of Leeds, Leeds, UK, [23]Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA, USA, [24]Department of Geography, Pennsylvania State University, University Park, PA, USA, [25]Geosciences, Physical Geography, Utrecht University, Utrecht, the Netherlands, [26]University of Tasmania, Hobart, Australia, [27]CSC IT Center for Science, Finland.

Ice Sheet Model Intercomparison Project for CMIP6

Participating models

Model name	Numerics	Stress balance	Resolution (km)	Init. Method	Initial Year	Melt in partially floating cells	Ice Front	Open melt parameterization	Standard melt parameterization
AWI_PISM	FD	Hybrid	8	Eq	2005	Sub-Grid	StR	Quad	Non-Local
DOE_MALI	FE/FV	HO	2-20	DA+	2015	Floating condition	Fix	N/A	Non-Local anom.
ILTS_PIK_SICOPOLIS1	FD	Hybrid	8	SP+	1990	Floating condition	MH	N/A	Non-Local
IMAU_IMAUICE1	FD	Hybrid	32	Eq	1978	No	Fix	N/A	Local anom.
IMAU_IMAUICE2	FD	Hybrid	32	SP	1978	No	Fix	N/A	Local anom.
JPL1_ISSM	FE	SSA	2-50	DA	2007	Sub-Grid	Fix	N/A	Non-Local
LSCE_GRISLI	FD	Hybrid	16	SP+	1995	N/A	MH	N/A	Non-Local
NCAR_CISM	FE/FV	L1L2	4	SP+	1995	Sub-Grid	RO	Non-Local + Slope	Non-Local
PIK_PISM1	FD	Hybrid	8	SP	1850	Sub-Grid	StR	PICO	N/A
PIK_PISM2	FD	Hybrid	8	SP	2015	Sub-Grid	StR	PICO	N/A
UCIJPL_ISSM	FE	HO	3-50	DA	2007	Sub-Grid	Fix	PICOP	Non-Local
ULB_FETISH_16km	FD	Hybrid	16	DA*	2005	N/A	Div	Plume	Non-Local
ULB_FETISH_32km	FD	Hybrid	32	DA*	2005	N/A	Div	Plume	Non-Local
UTAS_ElmerIce	FE	Stokes	4-40	DA	2015	Sub-Grid	Fix	N/A	Local
VUB_AISMPALEO	FD	SIA+SSA	20	SP	2000	N/A	MH	N/A	Non-Local anom.
VUW_PISM	FD	Hybrid	16	SP	2015	No	StR	Lin	N/A

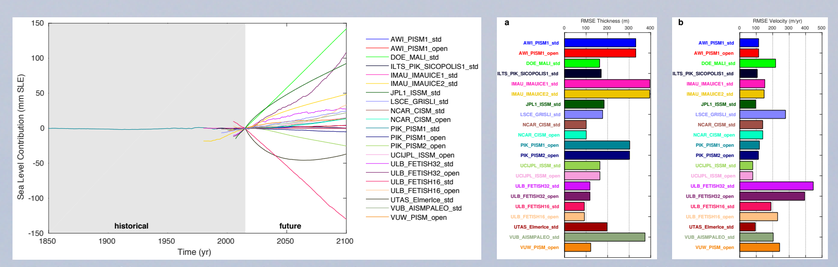
Forward experiments



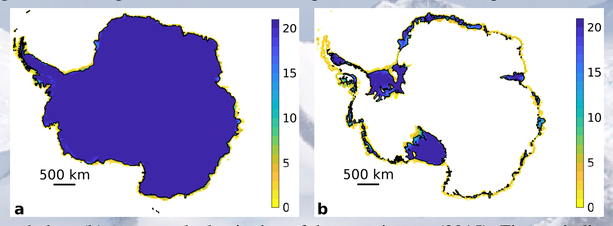
Surface mass balance anomalies (left, in mm w.e/yr) and basal melt (right, in Gt/yr) forcings from CMIP5 AOGCMs. Forcings assume fixed ice sheet and ice shelves geometry

Experiment	AOGCM	Scenario	Ocean Forcing	Ocean coefficient	Ice Shelf Fracture	Tier
historical	None	None	Free	Medium	No	Tier 1 (Core)
ctrl_proj	None	None	Free	Medium	No	Tier 1 (Core)
exp01	NorESM1-M	RCP8.5	Open	Medium	No	Tier 1 (Core)
exp02	MIROC-ESM-CHEM	RCP8.5	Open	Medium	No	Tier 1 (Core)
exp03	NorESM1-M	RCP2.6	Open	Medium	No	Tier 1 (Core)
exp04	CCSM4	RCP8.5	Open	Medium	No	Tier 1 (Core)
exp05	NorESM1-M	RCP8.5	Standard	Medium	No	Tier 1 (Core)
exp06	MIROC-ESM-CHEM	RCP8.5	Standard	Medium	No	Tier 1 (Core)
exp07	NorESM1-M	RCP2.6	Standard	Medium	No	Tier 1 (Core)
exp08	CCSM4	RCP8.5	Standard	Medium	No	Tier 1 (Core)
exp09	NorESM1-M	RCP8.5	Standard	High	No	Tier 1 (Core)
exp10	NorESM1-M	RCP8.5	Standard	Low	No	Tier 1 (Core)
exp11	CCSM4	RCP8.5	Open	Medium	Yes	Tier 1 (Core)
exp12	CCSM4	RCP8.5	Standard	Medium	Yes	Tier 1 (Core)
exp13	NorESM1-M	RCP8.5	Standard	PIGL	No	Tier 1 (Core)
expA1	HadGEM2-RS	RCP8.5	Open	Medium	No	Tier 2
expA2	CSIRO-MK3	RCP8.5	Open	Medium	No	Tier 2
expA3	IPSL-CM5A-MR	RCP8.5	Open	Medium	No	Tier 2
expA4	IPSL-CM5A-MR	RCP2.6	Open	Medium	No	Tier 2
expA5	HadGEM2-RS	RCP8.5	Standard	Medium	No	Tier 2
expA6	CSIRO-MK3	RCP8.5	Standard	Medium	No	Tier 2
expA7	IPSL-CM5A-MR	RCP8.5	Standard	Medium	No	Tier 2
expA8	IPSL-CM5A-MR	RCP2.6	Standard	Medium	No	Tier 2

Initial state

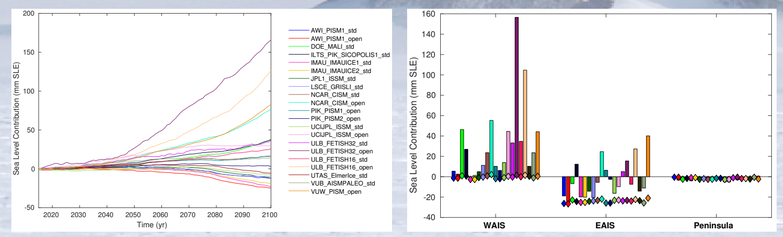


Evolution of ice mass change during the *historical* and *ctrl_proj* experiments (left, in mm SLE). Error estimates in ice thickness (middle, in m) and in ice surface velocity (right, in m/yr) at the beginning of experiments compared to observations (Rignot et al., 2011; Morlighem et al., 2019)



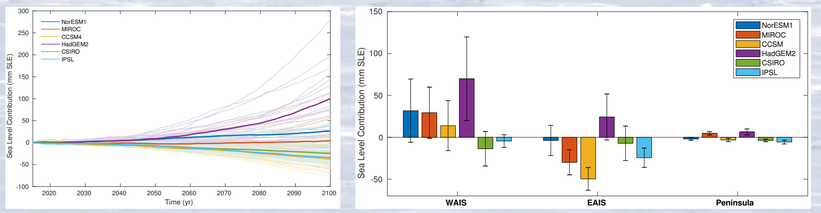
Ice (a) and ice shelves (b) extent at the beginning of the experiments (2015). Figures indicate number of models simulating ice (a) and ice shelves (b) at every point of the grid. Black lines are observations of the ice and ice shelves extent, respectively (Morlighem et al., 2019)

NorESM1-M RCP 8.5



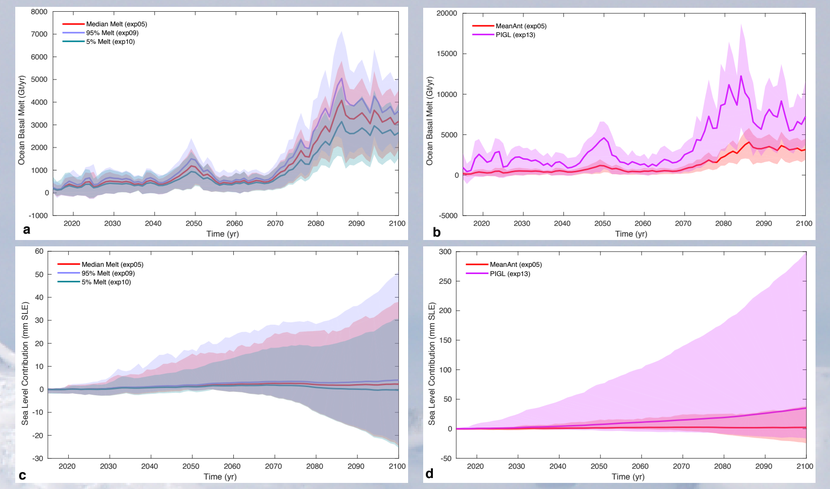
Projected sea level contribution (left, mm SLE) with NorESM1-M RCP 8.5 scenario relative to *ctrl_proj*. Regional sea level contribution over the 2015-2100 period (right, mm SLE) relative to *ctrl_proj*. Diamonds represent the additional surface mass balance applied during the 2015-2100 period relative to *ctrl_proj*.

Comparison of RCP 8.5 scenarios



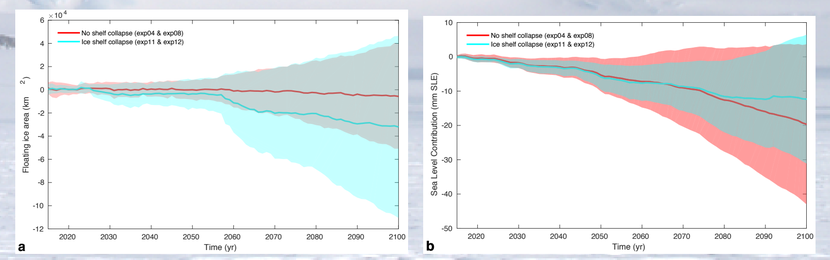
Projected sea level contribution (mm SLE) under RCP 8.5 scenario. Evolution of total ice mass between 2015 and 2100 (left) and regional sea level contributions (right). All contributions are relative to *ctrl_proj*.

Impact of ocean melt



Total basal melt (a and b, in Gt/yr) under Antarctic ice shelves and contribution to sea level (c and d, in mm SLE) for the sensitivity experiments to melt parameterization (a and c) and melt calibration (b and d) over the 2015-2100 period. All results are based on the NorESM1-M RCP 8.5 scenario and relative to *ctrl_proj*.

Impact of ice shelf collapse



Total Antarctic ice shelf area simulated (a, in km^2) and sea level contribution (right, in mm SLE) with (b) and without (red) ice shelf collapse over the 2015-2100 period. All results are based on the CCSM4 RCP 8.5 scenario and relative to *ctrl_proj*.

References and aknowlegments

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Helene.Seroussi@jpl.nasa.gov

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