

Simulation of North American ice sheet at the LGM with FAMOUS-BISICLES and its sensitivity to global mean temperature and albedo

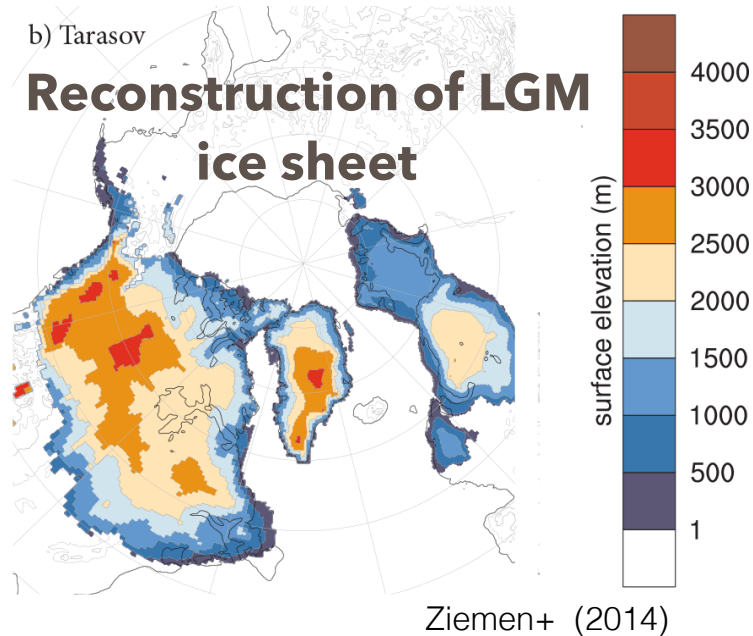
Sam Sherriff-Tadano, Niall Gandy, Ruza Ivanovic, Lauren Gregoire

University of Leeds

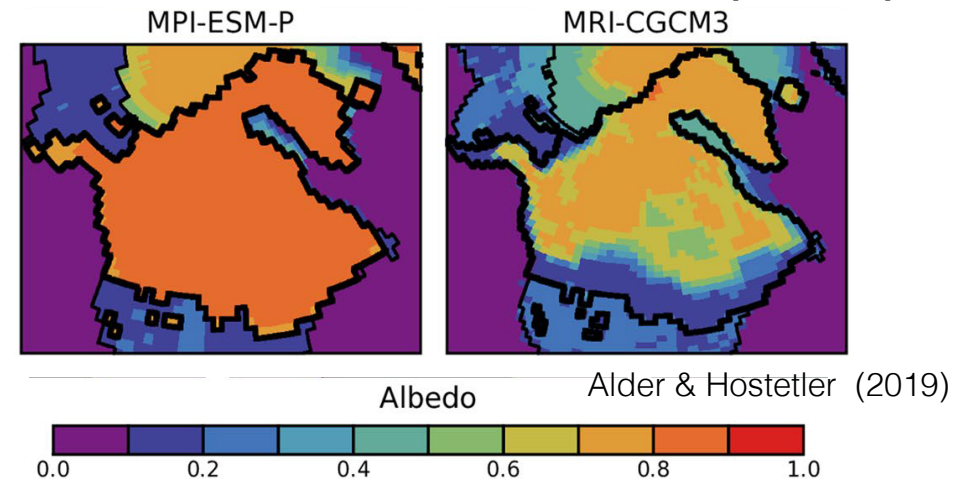
Charlotte Lang, Jonathan Gregory, Robin Smith

University of Reading

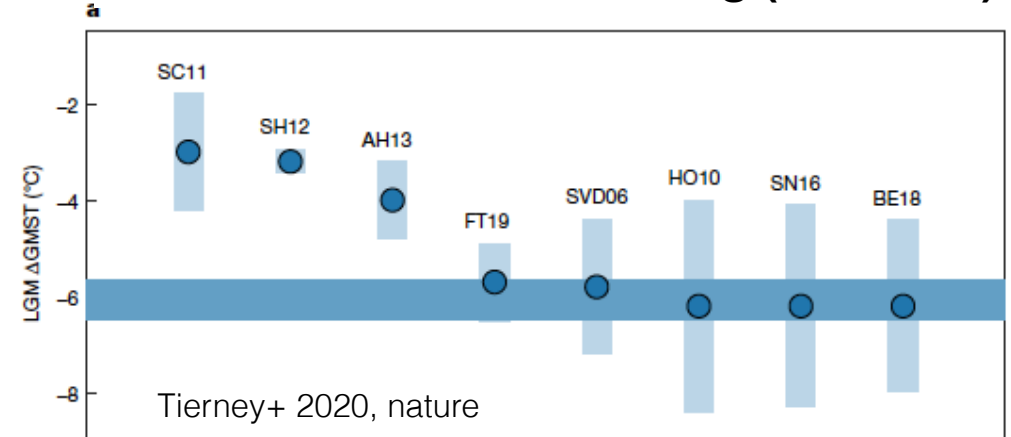
Last Glacial Maximum: Huge ice sheets covering Northern Hemisphere



Uncertainties in bare ice albedo (0.2-0.7)

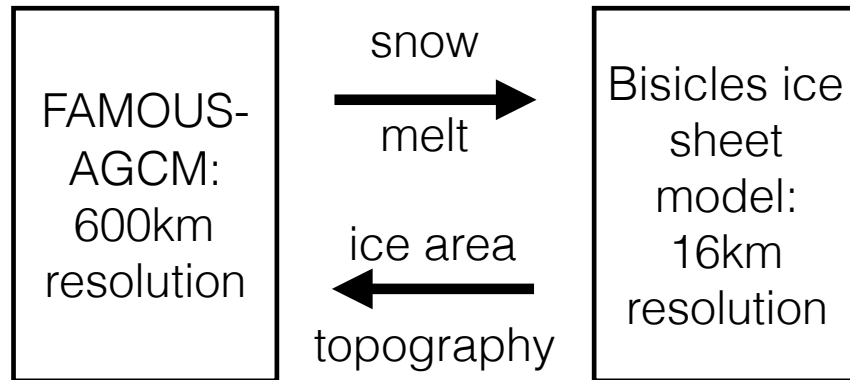


Uncertainties in LGM cooling (-6K ~ -3K)



- Can a recently developed climate-ice sheet model reproduce North American ice sheet at LGM?
- What are effects of uncertainties in albedo and LGM cooling on the ice sheet?

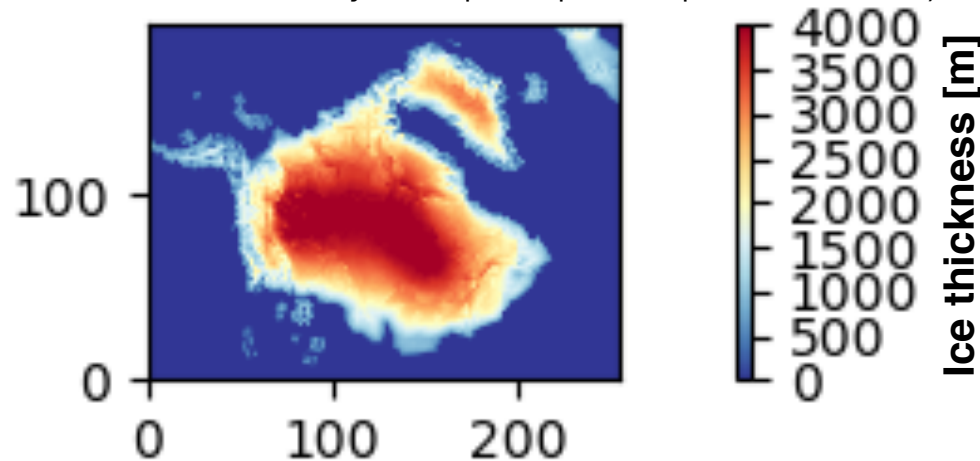
Ice sheet-AGCM coupled Model:Famous-Ice (Smith+ 2021, Gregory+ 2020)



- Used for simulations of climates and Greenland ice sheet of modern & future (Lang+ 2021 EGU)
- Surface energy budget & SMB downscaled by addition of 10 tiles (Smith+ 2021)
- Basal drag scheme: combination of Columb and Weertmen laws (Gandy+ 2019)
- Climate Forcing: PMIP4 LGM (Kageyama+ 2021)

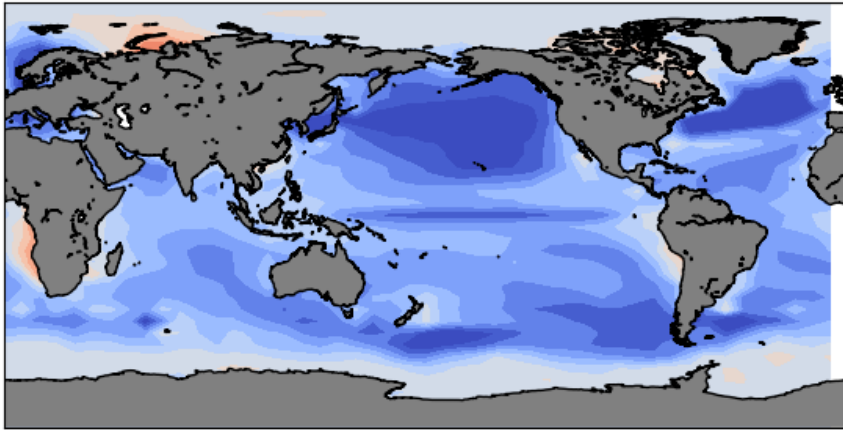
Initial Ice thickness

(Tarasov 26ka+ 5000 year spin up with positive SMB)

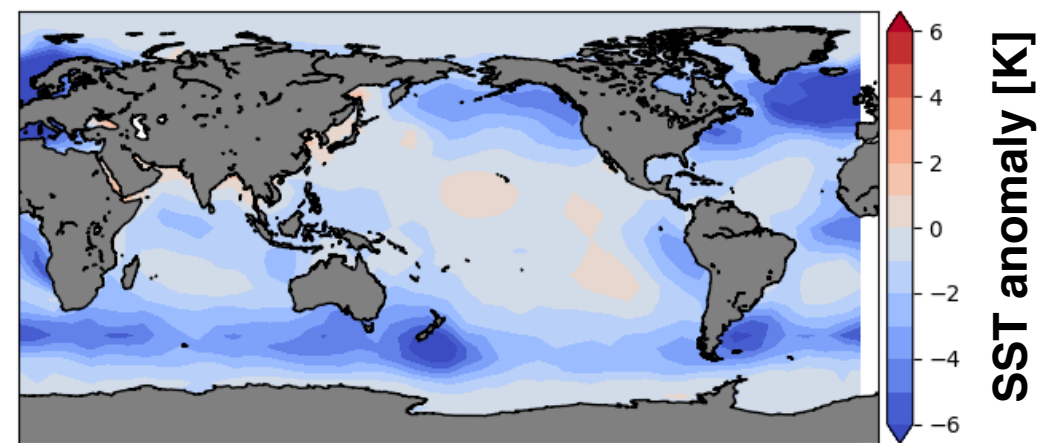


How to specify global temperature? - Fixed SST experiments

HadCM3 LGM — WOA98(obs);
global cooling 6.5K

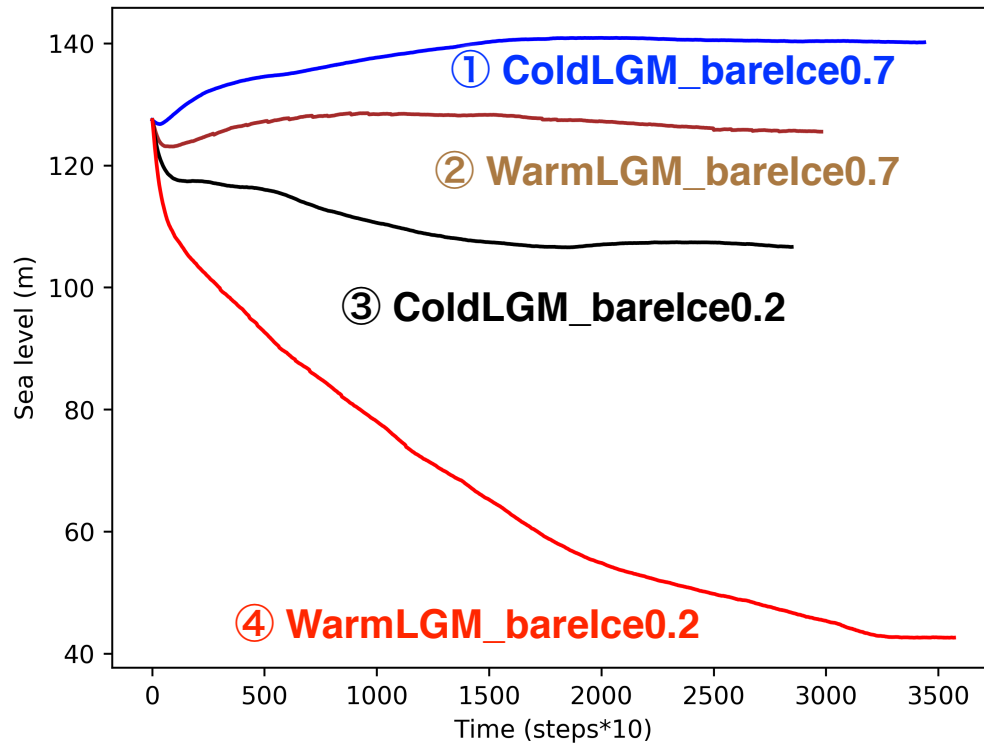


GLOMAP2021 LGM — WOA98(obs);
global cooling 3K

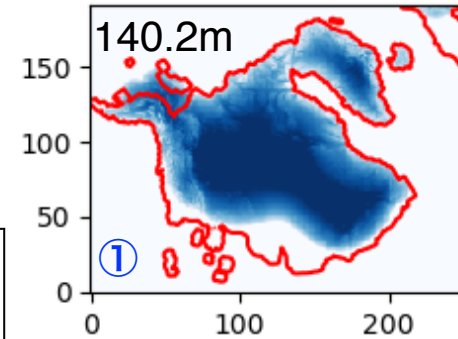


Exp	SST	Bare ice albedo
ColdLGM_bareIce0.7	HadCM3	0.2
WarmLGM_bareIce0.7	HadCM3	0.7
ColdLGM_bareIce0.2	GLOMAP	0.2
WarmLGM_bareIce0.2	GLOMAP	0.7

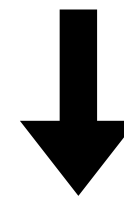
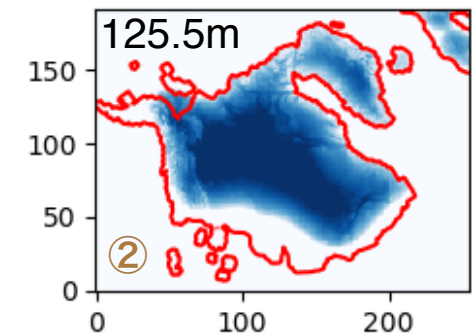
Roles of climate & albedo



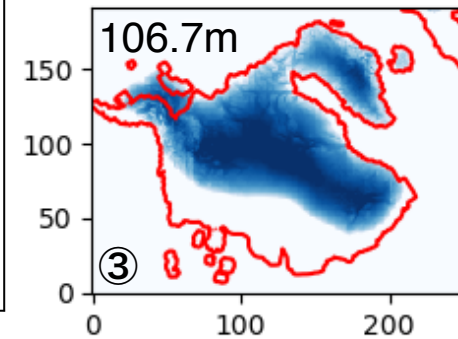
- Both uncertainties exert an important effect on quasi-equilibrium ice sheet volume



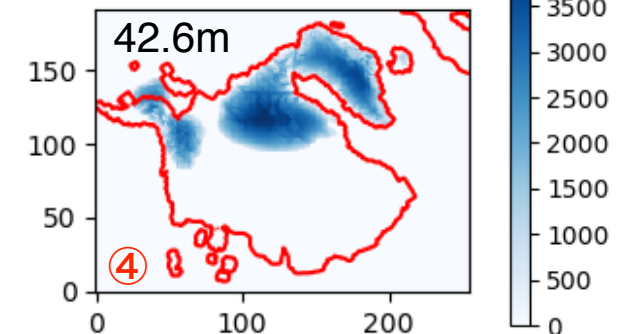
Climate (SST)
effect: -15m



Albedo effect:
-34m



Red contour: Tarasov 26ka
Blue: Ice thickness [m]



Conclusions & Future plan

- Ice area was reasonably reproduced under cold LGM and high bare ice albedo with Famous-Bisicles. However this could be related to biases caused by low resolution of the model (e.g. Abe-Ouchi+ 2007) and clouds (Gregory+ 2012)
- Uncertainties in albedo and LGM cooling exert an important effect on North American ice sheet (Quantitative effects of albedo & climate also depends on initial condition)
- High sensitivity of LGM ice to albedo is related to less cloudy condition at southern ablation area (Gandy+ in prep, Gregoire+ 2022 EGU, Ivanovic+ 2022 EGU)
- Ensemble simulations (cloud, ice albedo, ice basal drag) of LGM are ongoing