

A Model-Data Comparison of the Last Glacial Maximum Surface Temperature Changes



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Context and Motivation

- Over the Last Glacial Maximum (LGM), the presence of vast Northern Hemisphere ice sheets caused abrupt changes in surface topography and background climatic state.
- However, there is a large uncertainty of the LGM ice sheet reconstructions, especially the Laurentide Ice Sheet (LIS).
- Here to assess the role of LIS uncertainty on the LGM climate, we have performed simulations with 6 different LIS reconstructions in an Earth System Model (COSMOS).
- Model-data comparisons can help to understand the origin of their mismatches in both reconstruction of past climate change and model simulations, and thus give a test for climate projections as derived from climate models.

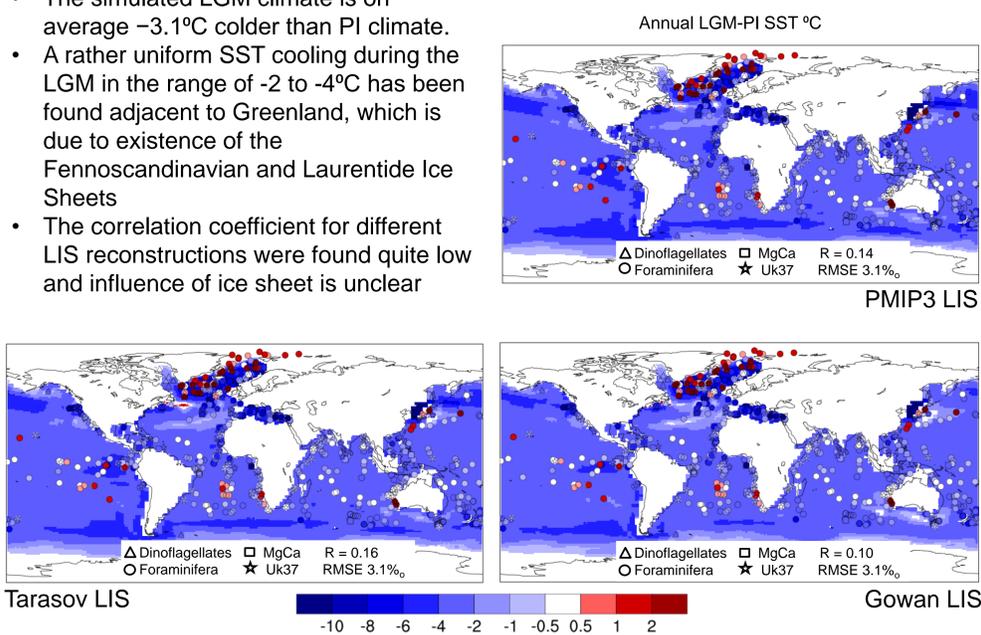
Model & Methods

- Coupled Earth System Model, COSMOS has been used which includes the ECHAM5 atmosphere model at T31-resolution with 19 vertical layers
- Ocean model MPI-OM in GR30 resolution with 40 uneven vertical layers.
- Last glacial maximum (LGM) greenhouse gases, ice sheets, sea level and orbital parameters are set in accordance with the Zhang et al., (2013).
- Six ice sheet reconstructions (GLAC-1D (Tarasov 2012 EPSL); ICE-6g (Peltier, 2004); Lambeck (2014); Liccardi (1998); Gowan (2016); PMIP3) has been compared with sea surface temperature reconstruction data by MARGO project members, (2009) which based on microfossil-based (planktonic foraminifera, diatom, dinoflagellate and radiolarian) and geochemical (alkenones and planktonic foraminifera Mg/Ca) palaeothermometers.

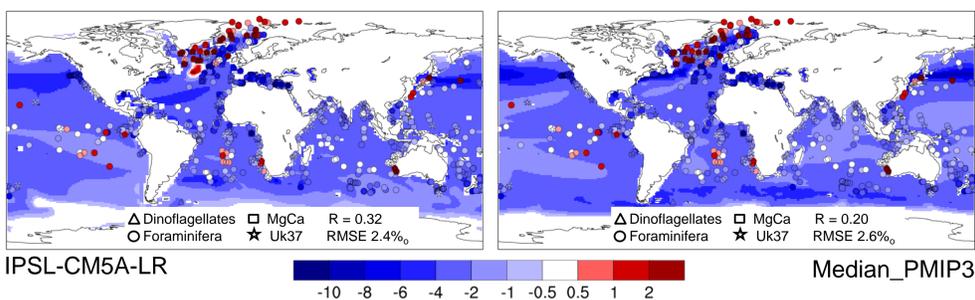
Model-Data Comparison

Influence of ice sheets

- The simulated LGM climate is on average -3.1°C colder than PI climate.
- A rather uniform SST cooling during the LGM in the range of -2 to -4°C has been found adjacent to Greenland, which is due to existence of the Fennoscandinavian and Laurentide Ice Sheets
- The correlation coefficient for different LIS reconstructions were found quite low and influence of ice sheet is unclear



Proxies SST annual mean: PMIP3 Models

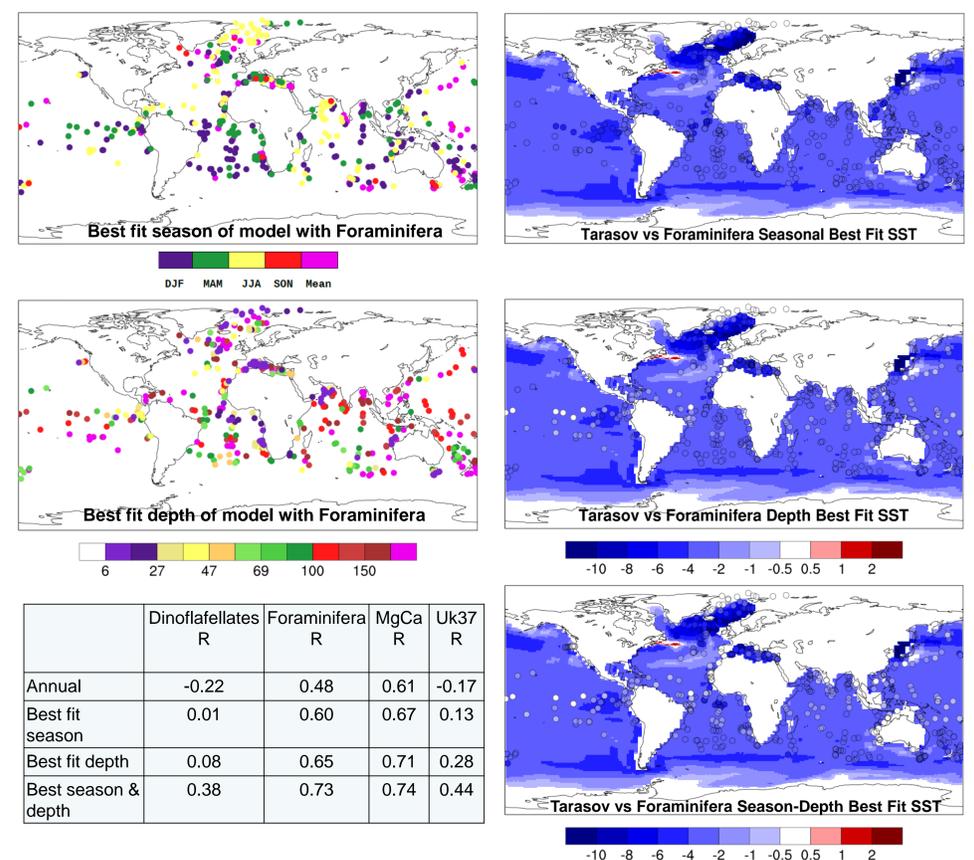


	MARGO R	Dinoflagellates R	Foraminifera R	MgCa R	Uk37 R
IPSL-CM5A-LR	0.32	0.66	0.34	0.25	0.33
MRI-CGCM3	0.08	0.21	0.10	0.26	0.19
MIROC-ESM	0.27	-0.08	0.54	0.62	0.09
MPI-ESM-P2	0.001	-0.29	0.25	0.44	-0.11
GISS-E2-R	0.25	0.51	0.44	0.51	0.08
CCSM4	0.20	0.23	0.48	0.54	-0.06
FOGOALS-E2	0.13	-0.22	0.31	0.41	-0.32
CNRM-CM5	0.04	-0.12	-0.01	0.18	-0.07

- Among the eight PMIP3 model, IPSL-CM5A-LR show highest correlation coefficient with MARGO data.
- The correlation coefficient of different model with MARGO data were found low, but for individual proxies it is increased.

Seasonality and Habitat Depth of the Recorder system

Comparing different season like DJF, MAM, JJA, and SON mean SST with a proxy record and different water layer (Planktonic organisms are able to move in the different water column), to see which season and depth shows the best agreement with proxy reconstruction.



Conclusions

- SST reconstruction of models show some mismatches with MARGO data sets
- This mismatch exists for all considered models, even if we take into account seasonality and different water depths at which the recording organisms may have lived.
- Our results show that Mg/Ca show winter biased and foraminifera, dinoflagellates and alkenones are summer biased.
- Mg/Ca records fit best with surface layer. The rest represents subsurface layer.
- Considering habitat depths can reduce the discrepancy between models and proxies.
- Observed mismatch between modelled and reconstructed climate is related to seasonal and depth bias.

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