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# The last interglacial climate in EC-Earth – comparing the direct and indirect impacts of the insolation changes

Rasmus Anker Pedersen (1,2), Peter Lang Langen (2), and Bo Vinther (1)

(1) Centre for Ice and Climate, Niels Bohr Institute, University of Copenhagen, Copenhagen, Denmark, (2) Climate and Arctic Research, Danish Meteorological Institute, Copenhagen, Denmark

The last interglacial warm climate state was influenced by substantial changes in the annual insolation cycle. The impact of the insolation changes has been investigated using a time-slice simulation with the EC-Earth earth system model. The model climate was forced with the insolation and atmospheric greenhouse gas concentrations from 125,000 years before present, and the resulting quasi-equilibrium state has been analyzed and compared to a pre-industrial climate state. The simulations indicate an annual mean global warming of approximately 1 K. The tropical region exhibits lower temperatures and stronger monsoonal systems, while the Arctic region shows a warming of about 3 K throughout the year.

Arctic sea ice changes appear to be an important driver of warming, especially in relation to a northward shift of the ice edge in the North Atlantic region. Proxy data from ice and ocean sediment cores indicate substantial warming in parts of the North Atlantic region that could be related to similar sea ice changes. The relative importance of the sea ice and sea surface temperature changes and the direct contribution from the insolation is further investigated using a series of experiments in an atmosphere-only version of the model. Based on the results from the coupled model, we assess the relative contributions using hybrid simulations of the atmospheric response to a combination of last interglacial sea surface temperatures and sea ice conditions and pre-industrial insolation, and vice versa.

Special attention is given to the simulated response over the Greenland ice sheet and the potential implications for proxy data from ice cores. Both temperature and precipitation changes could impact the ice core records, and the seasonal and spatial changes over Greenland are analyzed in detail. At the NEEM ice core location, a general warming tendency is accompanied by an increase of summer snowfall that contributes to a further increase of the precipitation-weighted temperature. The atmosphere-only simulations further reveal that both the insolation and the sea ice and sea surface temperature conditions affect the changes over Greenland.