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Relevance of last interglacial changes for climate projections with a focus on Greenland

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The sensitivity of interglacial Greenland temperature to orbital and CO2 forcing is investigated using (i) Greenland ice core data and (ii) coupled ocean-atmosphere model simulations, under different interglacial orbital configurations, and also in response to increased CO2 concentrations. These different forcings cause very distinct simulated seasonal and latitudinal temperature and water cycle changes, limiting the analogies between the last interglacial and future climate. However, the IPSL_CM4 model shows similar magnitudes of Arctic summer warming and climate feedbacks in response to 2xCO2 and orbital forcing of the last interglacial period (126 000 years ago). The IPSL model results depict a remarkably linear relationship between top of atmosphere incoming summer solar radiation and simulated changes in summer and annual mean central Greenland temperature. This contrasts with the stable isotope record from the Greenland ice cores, showing a multi-millennial lagged response to summer insolation. Cryosphere-ocean feedbacks during early interglacials could explain the observed lags because of changes in ice sheet elevation and ice sheet meltwater, as investigated with sensitivity studies. A quantitative comparison between ice core data and climate simulations requires to explore the stability of the stable isotope - temperature relationship. Atmospheric simulations including water stable isotopes have been conducted with the LMDZiso model under different boundary conditions. This set of simulations allow to calculate a temporal Greenland isotope-temperature slope (0.3-0.4? per ^{o}C) during warmer than present Arctic climates, in response to increased CO2, increased ocean temperature and orbital forcing. This temporal slope appears twice smaller than the modern spatial gradient and is consistent with other ice core estimates. Similar findings are obtained using the ECHAM4iso model forced by the IPSL_CM4 last interglacial SST. Larger slopes (0.5-0.7? per ^{o}C) were however obtained with the HadAM3iso (for projections), suggesting that that the results may be model-dependent and calling for more systematic intercomparisons. Comparisons with Greenland ice core stable isotope data reveals that IPSL/LMDZiso simulations strongly underestimate the amplitude of the ice core signal during the last interglacial, which could reach 8-10^{o}C fixed-elevation warming. While the model-data mismatch may result from missing positive feedbacks (e.g. vegetation), it could also be explained by a reduced elevation of the central Greenland ice sheet surface by 300-400 m.