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On the possibility of constraining the Charney climate sensitivity: View from multimodel LGM simulations

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Charney climate sensitivity (CCS) is defined as the equilibrium surface temperature change under the doubling of atmospheric CO_2 concentration specifically without vegetation, ice sheet, and carbon cycle feedbacks. CCS is one of the most important metrics for climate projections of coming centuries, and past climate changes have been used to constrain its uncertainty. The use of paleoclimate as a guide for the future needs to be demonstrated based not only on statistical relation between the past and future climate changes but also on sound physical understanding of mechanisms behind the changes. Much attention has been paid to the last glacial maximum of about 21 thousand years ago, and this presentation overviews previous and current effort on estimating CCS based on LGM climate. The emphasis is placed on the activity with general circulation models (GCMs) and the analysis of the latest PMIP3/CMIP3 multimodels. While perturbed physics ensembles of single models (sensitivity to model parametric uncertainty) suggest a relatively high correlation between LGM and $2xCO_2$ global climate feedbacks, the multimodel analysis (sensitivity to model structural uncertainty) suggests little correlation between the two. This implies that globally averaged LGM climate change does not likely provide a strong constraint on the CCS spread in current GCMs. The radiative feedback analysis indicates that the reason lies in the cloud feedback induced by the ice sheet forcing unique to LGM. On the other hand, it was and is proposed that regional change, particularly in the tropics, may be of more use than global mean change. In order to more effectively impose the regional constraint and to increase our confidence, however, uncertainties in proxy data and the forcing estimate need to be reduced and the number of models needs to be increased.