Geophysical Research Abstracts
Vol. 20, EGU2018-10635, 2018
EGU General Assembly 2018

Estimating climate sensitivity using Last Glacial Maximum model-data constraints that include parametric, feedback, and proxy uncertainties

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The Last Glacial Maximum (LGM) provides potentially useful constraints on equilibrium climate sensitivity (ECS) because it is the most recent period of large greenhouse gas and temperature change. In addition, the wealth of proxy data from ice cores, ocean cores, and terrestrial records during this time period helps to test the relationship between greenhouse gas concentrations and temperature. A previous study (Schmittner et al., 2011) has estimated probability distributions of ECS using a small ensemble of model simulations that varies model sensitivity to atmospheric CO_2 concentrations. However, this estimate neglected cloud feedbacks, one of the largest sources of uncertainty among coupled climate models. Here, we provide a new estimate of ECS using a much larger ensemble of simulations (>2000) that includes an assessment of uncertainty due to cloud feedbacks. We apply a new method to diagnose both shortwave and longwave cloud feedbacks from coupled models in the CMIP/PMIP archive, and we apply this spread in cloud feedbacks to the University of Victoria Earth System Climate Model (UVic-ESCM). In addition, we also explore parametric uncertainties in dust forcing, snow albedo, and atmospheric diffusivities, which all influence important feedbacks in UVic-ECSM. Finally, we use Bayesian statistics to compare LGM proxy data with this new model ensemble to provide a new probabilistic estimate of ECS that better includes dominant sources of model and data uncertainty. We will compare model results with a compilation of individual proxy records, global air temperature reconstructions, and recent estimates of global mean ocean temperature from noble gas measurements in ice cores.