Geophysical Research Abstracts
Vol. 15, EGU2013-6856, 2013
EGU General Assembly 2013

Projecting West Greenland's future tidewater glacier discharge with Monte Carlo

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Due to non-linear feed backs arising from the acceleration of outlet glaciers, it is difficult to forecast the future ice dynamic contribution of Greenland's tidewater glaciers to sea level rise. We perform Monte Carlo simulations of the form and flow of West Greenland over a wide parameter space using a 2-D (depth-integrated) thermo-mechanical ice flow model. Climate forcing is prescribed as a perturbation from the past and future surface mass balance rate predicted by MAR (Modèle Atmosphérique Régional). While more sophisticated ice sheet models exist (e.g. 3-D Navier-Stokes), employing a more computationally efficient model allows us to perform a large number of fully-transient simulations in order to quantify the cumulative uncertainty in projected tidewater glacier discharge stemming from poorly constrained or understood processes, such as the rheology of Wisconsin ice, ice temperature and basal sliding. Following a forward model selection approach, an ensemble filter is imposed following transient spin-up to ensure that only simulations that accurately reproduce contemporary observed glacier geometry and velocity are forced into the future; all other simulations are discarded. This approach therefore provides the opportunity to assimilate spatially and temporally diverse field observations into a predictive modeling framework. We present bounded estimates of the dynamic discharge of several well-observed West Greenland tidewater glaciers to the year 2100.