Geophysical Research Abstracts
Vol. 13, EGU2011-11633, 2011
EGU General Assembly 2011

Quantifying the predictive uncertainty of numerical mass balance models

Cameron Rye (1), Ian Willis (1), Neil Arnold (1), and Jack Kohler (2)

(1) Scott Polar Research Institute, University of Cambridge, Cambridge, UK., (2) Norwegian Polar Institute, Polar Environmental Centre, Tromsø, Norway.

Spatially distributed, physically based mass balance models are valuable tools for exploring the detailed spatial and temporal responses of glaciers and ice sheets to climate forcing. Indeed, the last two decades have seen their application become increasingly widespread, partly due to the increased availability of computational resources, and partly because scientists have a natural tendency to adopt realistic descriptions of real-world processes. However, while considerable progress has been made in the development of sophisticated numerical models, very little attention has been given to their predictive uncertainty. In particular, mass balance models have traditionally been calibrated (or "tuned") in order to identify a single set of model parameters (e.g. snow density, surface albedo, temperature lapse rate) such that the model's behaviour closely matches that of the real system it represents. But, as will be demonstrated for a case study in Svalbard, it is often difficult (if not impossible) to find a single "best" set of parameter values that reproduce all the characteristics of real-world observations. Instead, multiple equally plausible parameter sets will usually exist, which undoubtedly introduces a degree of uncertainty into model forecasts. Despite knowledge of this problem within the environmental science community, there has yet to be a rigorous attempt to quantify the predictive uncertainty of glacier mass balance models. The present work will address this limitation through the novel application of a calibration technique previously not employed in glacial modelling – multi-objective optimisation – designed to identify multiple optimal parameter sets that fit different characteristics of the real-world observations, thereby enabling an assessment of the uncertainty associated with predictions. This is a generic methodology that can be applied to any type of mass balance model and to both glaciers and ice sheets. Overall it is argued that a new calibration paradigm is urgently required to provide more useful information on the uncertainty associated with ongoing and future projections of ice volume and sea level rise.