Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

ACG38-10 Room:101A Time:May 21 11:45-12:00

Crustal rebound in Greenland inferred form ice sheet history derived from three-dimensional ice sheet modelling

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It is very important to determine the temporal variation of meltwater volume and the spatial extent of ice sheets in late Quaternary for studying past and future climate changes and for constraining mantle rheology. Most of the melting histories of ice sheets from Last Glacial Maximum have been inferred on the basis of geophysical and geological constraints (e.g., Peltier, 2004) using the glacial isostatic adjustment (GIA) modelling. However, such reconstructions have ice thickness that is unconstrained in regions from which the required geophysical data are unavailable and furthermore insufficient constraint that might support them to be glaciologically self-consistent. And also there are some difficulties in the geophysical reconstructions that are the ambiguity between ice load magnitude and the timing of ice load removal.

On the other hand, three-dimensional ice-sheet modelling (e.g., Abe-Ouchi et al. 2007) produces physically self-consistent ice sheet which further constrains the history and spatial variations of the load, but have difficulties due to their high sensitivity to the various climate forcing as well as from uncertainties associated with basal processes. However, it is clear that the combination of these two approaches would be expected to lead to a much more highly constrained reconstruction of ice sheet history.

In this study, we try to combine the two methodologies based on the three-dimensional thermo-mechanically coupled ice-sheet model and the bedrock deformation derived from GIA model. As a first step, we evaluate the crustal deformation in Greenland based on the ice models deduced by IcIES (Ice sheet model for Integrated Earth system Studies: Abe-Ouchi et al., 2007). Crustal deformation includes vertical uplift and subsidence, geoid height variations, and regional sea level variations along the coasts of Greenland. We compare the sensitivity of the adoption of ice sheet histories. In particular, we clarify the effect of Laurentide ice sheet on crustal deformation in Greenland.

Keywords: Greenland Ice Sheet, ice sheet modelling, isostasy, crustal deformation, sea level change