

## Ice loss in small glacier systems of the Arctic Islands (Iceland, Svalbard, the East Arctic Islands) revealed by GRACE

MATSUO, Koji<sup>1\*</sup>, HEKI, Kosuke<sup>1</sup>

<sup>1</sup>Dept. Natural His. Sci., Hokkaido Univ.

The islands in Arctic region (Arctic Islands) are covered by water ice (i.e. ice sheet, glacier, and ice cap) over 80 % of their land area and form the largest store of water ice in Northern Hemisphere. Arctic Islands consist of Greenland, the Canadian Arctic Archipelago, Iceland, the West Arctic Islands (Svalbard) and the East Arctic Islands (Novaya Zemlya, Severnaya Zemlya, and Franz Joseph Land). The total of ice covered area in Arctic region is about ~2,000,000 km<sup>2</sup>, and most of them are composed of ice sheet in Greenland (~ 1,750,000 km<sup>2</sup>). As for glaciers and ice caps, about half (~ 150,000 km<sup>2</sup>) is located on the Canadian Arctic Archipelago, another quarter is found around the Greenland region (~ 76,000 km<sup>2</sup>), and the other quarter is on Iceland, and the West, East Arctic Islands (~ 100,000 km<sup>2</sup>).

In recent years, rapid shrinking of continental ice sheets and mountain glaciers due to global warming has been reported in many parts of the world. A system of twin satellites Gravity Recovery and Climate Experiment (GRACE), launched in 2002 to measure time-variable gravity field, detected such large-scale mass changes as slight changes in the satellite-to-satellite range, and enabled direct and quantitative measurements of them. GRACE observation in the last decade revealed ice loss rates of 190 +/- 77 Gt/yr in Antarctica (e.g. Chen et al., 2009), 115 +/- 20 Gt/yr in Alaska (e.g. Tamisiea et al., 2005), 47 +/- 13 Gt/yr in Asian High Mountain Ranges (Matsuo and Heki, 2010), and 28 +/- 11 Gt/yr in Patagonia (Chen et al., 2007). As for the Arctic Islands, ice loss rates of 252 +/- 28 Gt/yr in Greenland (e.g. Schrama and Wouters, 2011), 62 +/- 10 Gt/yr in the Canadian Arctic Archipelago (Gardner et al., 2011), and 9 +/- 4 Gt/yr in Svalbard (Memin et al., 2011) have been reported until now. However, those in the other islands, such as Iceland and the East Arctic Islands, still remain uninvestigated.

In this study, we focus on the Arctic glaciers where their ice loss rates have not been reported yet, i.e. Iceland and the East Arctic Islands, and try to estimate current ice loss rates there using GRACE time-variable gravity data during 2003-2011. Here, we followed the method proposed by Matsuo and Heki (2010) as the estimation method of mass loss rate from GRACE data. And we used the Glacial Isostatic Adjustment (GIA) model presented by Paulson et al. (2007) in order to remove their contribution. Finally, we got 10.9 +/- 0.7 Gt/yr for Iceland and 10.6 +/- 3.1 Gt/yr for the East Arctic Islands (6.9 +/- 1.5 Gt/yr for Novaya Zemlya, 2.6 +/- 0.9 Gt/yr for Severnaya Zemlya, 1.1 +/- 0.7 Gt/yr for Franz Joseph Land) as current ice loss rates, which are substantially faster rates in comparison to those estimated by field observations during 1961-2001 of 2.5 +/- 8.7 Gt/yr for Iceland and 0.8 +/- 4.1 Gt/yr for the East Arctic Islands (Dyurgerov and Meier, 2005). This suggests that the global tendency of accelerating ice loss also can be seen for these Arctic glaciers.

### [Reference]

- Chen et al. (2007), *Geophys. Res. Lett.*, L22501, doi:10.1029/2007GL031871.  
Chen et al. (2009), *Nature Geosci.*, 859-862, doi:10.1038/NGEO694.  
Dyurgerov and Meier (2005), *Occasional Paper 58*, University of Colorado, Boulder, p. 118.  
Gardner et al. (2011), *Nature*, 357-360, doi:10.1038/nature10089.  
Matsuo and Heki (2010), *Earth Plan. Sci. Lett.*, 30-36, doi:10.1016/j.epsl.2009.11.053.  
Memin et al. (2011), *Geophys. J. Int.*, doi: 10.1111/j.1365-246X.2010.04922.x.  
Paulson et al. (2011), *Geophys. J. Int.*, doi: 10.1111/j.1365-246X.2007.03556.x.  
Schrama and Wouters (2011), *J. Geophys. Res.*, B02407, doi:10.1029/2009JB006847.  
Tamisiea et al. (2005), *Geophys. Res. Lett.*, L20501, doi:10.1029/2005GL023961.

Keywords: Glacial melting, Space geodesy, GRACE, The Arctic, Global warming, Sea level rise