

Capability of ICA Method for separating GIA and Ice Mass Signals in Antarctica

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The Gravity Recovery and Climate Experiment (GRACE) mission provided global gravity change data with a spatial resolution of a few hundred kilometers and a temporal resolution of 30 days. The GRACE data revealed the total mass changes in Antarctica and contributed to Antarctic Ice Sheet (AIS) mass balance researches. However, there are large uncertainties in Glacial Isostatic Adjustment (GIA) effects, which should be removed from the GRACE data, for estimating the AIS mass balance. While many studies have been conducted for estimating or removing the GIA effects thus far, we try to use a statistical analysis method called Independent Component Analysis (ICA) and investigated its capability of separating GIA and AIS mass signals.

We primarily employed GRACE RL05 mascon data provided by NASA Jet Propulsion Laboratory (JPL) of all the GRACE available period from January 2002 to June 2017 with the spatial coverage of all Antarctica. And we used three ICA methods, namely, spatial ICA (sICA), temporal ICA (tICA), and spatio-temporal ICA (stICA), for testing the characteristics and/or the capabilities of the methods.

The results showed that the GIA like signal can be recovered successfully with sICA which separated GIA signals and AIS mass change signals into two statistical independent components. On the other hand, tICA decomposed the GIA signal into two independent components. This suggested that tICA could not solve the signals mixing problem completely. Nevertheless, tICA detected an extra anomaly snow-fall signal around 2010. This shows that tICA may have the potential to separate long-term trend signals with different time scales. The results of stICA suggested that its characteristics could be seen as a combination of the above two methods. Thus, an appropriate combination of the methods should be examined.

We also tested other datasets and revealed the different datasets and/or pre-processing of the datasets largely affected the obtained results. It is impossible to assess the validity of the results only using the GRACE data. Therefore, additional information should be necessary to validate and interpret the results.

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