



## **Transient variations in glacial mass near Upernavik Isstrøm (Greenland) detected by the combined use of GPS and GRACE data**

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The continuously operating Global Positioning System (GPS) stations mounted on bedrock around the coast of Greenland provide important geodetic datasets to quantify the solid Earth's response to historical and present-day ice mass variations. Here we apply the Multichannel Singular Spectral Analysis (M-SSA) to the combination of GPS data and Gravity Recovery and Climate Experiment (GRACE) data so that we can identify and fully utilize the spatial correlations from these two independent datasets. Using the GPS and GRACE data near Upernavik Isstrøm in western Greenland as an example, we demonstrate that this method successfully detects two transient events in ice mass variations in 2010 and 2012–2014, respectively. Our quantitative analysis of the surface mass balance and glacial dynamics suggests that the transient change in 2010 was due to dynamically-induced mass loss, as the glaciers decelerated in early 2009 and then accelerated in late 2010. The transient change in 2012–2014 was mainly due to surface melting. Specifically, the surface melt was more pronounced in 2012 and less in 2013, whereas there was little contribution from anomalies in accumulation.