Is Greenland gaining mass?

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Objective

Over the last 20 years, Greenland has been losing ice at a growing rate, and this is a trend that is likely to continue. **However**, in the timespan 2016-2017, Greenland has had a small net-ice gain, a phenomenon not documented for decades. Does this mean that the tides are turning, or is it a one-time event? With the aid of the gravitational data from the GRACE satellites, I aim to examine that in this project.

A surprising turn of events

Greenland's accumulated surface-mass balance in Gigatons

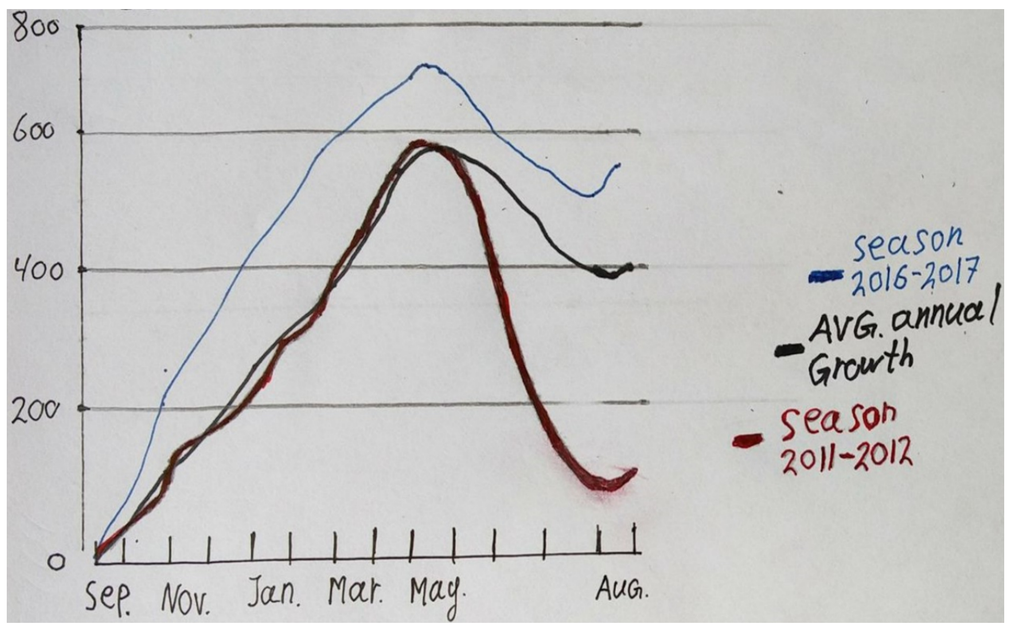


Figure 1: An expression for how much snow falls in Greenland. (dmi.dk)

Data analysis

The data are collected in 10-day periods since 2002, by the GRACE (Gravity Recovery and Climate Experiment) twin-satellites. The GRACE satellites are designed to map the variations in Earth's gravity field. The satellites create a map that tracks the changes of water over time, based on the change of gravity in the region.
During 2016-2017 however, the Danish Meteorological Institute reported a small net gain of ice in Greenland.(https://www.dmi.dk/groenland/maalinger/indlandsisens-massebalance/)
Subtracting the amount of ice and snow gain with the amount of ice and water lost, we gain a **small**, unprecedented mass gain of ice in 2016-2017.
However, this is due to 2 factors: A large amount of snowfall, especially due to the tropical hurricane Nicole in 2016, which dumped large amounts of snow onto Greenland. And a relatively short and cold Greenlandic summer, resulting in a smaller melt-off of ice.

Velocity and Acceleration

It is interesting to observe the rate of change of mass in different areas of the world. Which regions are gaining or losing mass, and how fast? And is this tendency of mass change accelerating or decelerating?

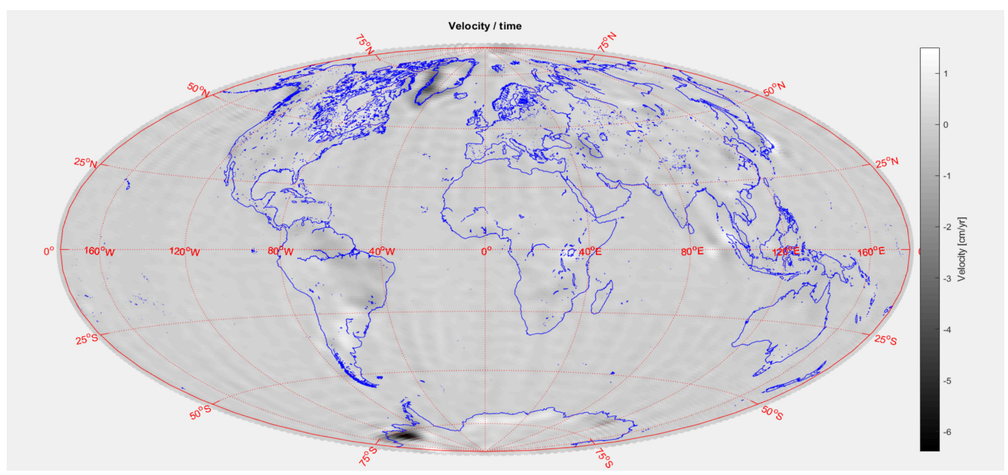


Figure 2: Velocity as of 15-Jun-2016

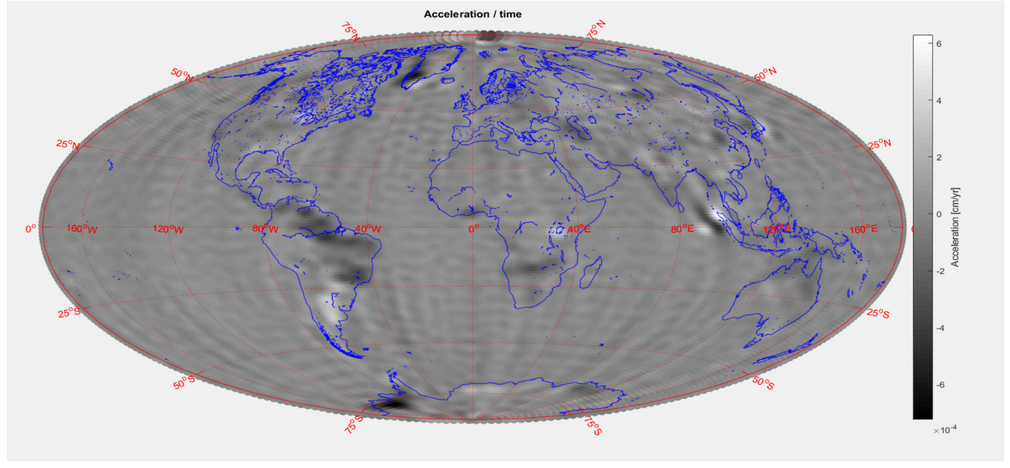
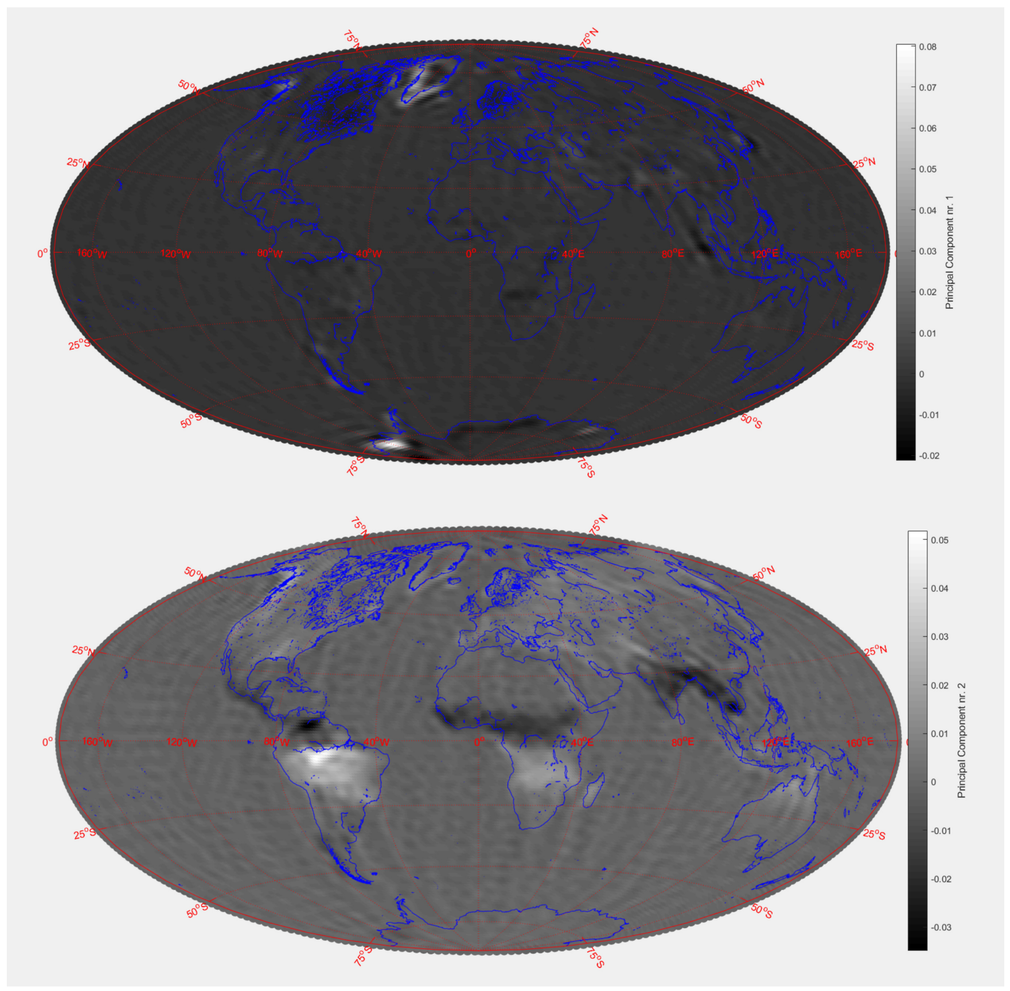


Figure 3: Acceleration

Principal components

Illustrated below are the 2 principal components of the EWH analysis:



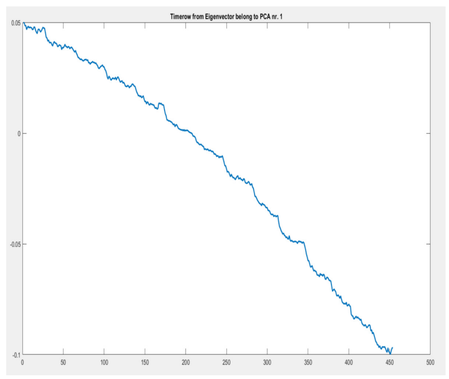


Figure 4: Eigenvector for PCA1

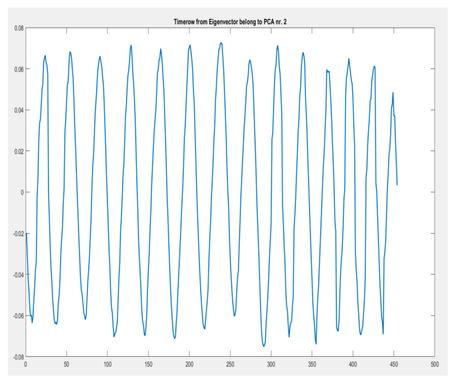


Figure 5: Eigenvector for PCA2

Global annual oscillation

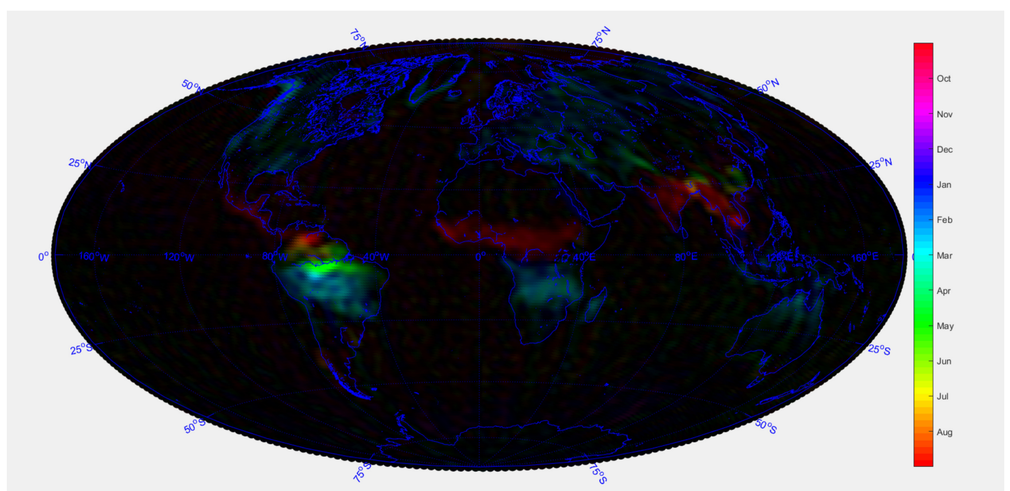


Figure 6: Phases of annual oscillation with significantly large amplitude