**Lab and Homework 6: GRACE observations of ice sheet mass balance**

***Provide all answers in a text document or PDF (using e.g. Word, LateX, Jupyter NB), and send everything to me via a personal message on Slack (preferably) or email before April 15, 1.30 pm. Any file you submit should be named FirstName\_LastName\_HW6 (e.g. Jan\_Lenaerts\_HW6).***

**Please work on this together with your Lab Group (using Slack/Zoom), but, as usual, the homework plots, descriptions, and explanations should be your own individual work. For any questions regarding this Lab/HW, or anything else, please contact me on Slack. I am available on Zoom as well; let me know if you’d like to chat about anything, and I will send you a Zoom link. This is a stressful time for everyone, and I hope we can support each other throughout the remainder of the semester.**

*Guide to the data*

*The Excel data file GRACE\_timeseries.xlsx (in this Dropbox folder) contains two tabs. The first tab (Ice\_Sheet\_Mass\_Monthly\_records) contains the monthly records of ice sheet mass for both Greenland and Antarctica.*

*The second tab (Mass\_Balance\_Components) contains the two components (annual resolution) of the overall Greenland Ice Sheet mass balance, which are (1) ice discharge (D) and (2) the surface mass balance (SMB).*

1. Reflect on what the time series in first tab (*Ice\_Sheet\_Mass\_Monthly\_records)* shows. What do positive/negative values imply for the ice sheet? And what does that mean for sea level?
2. Calculate the best linear trend of the GRACE time series for both ice sheets. What are the units of this best linear trend? Can you come up with at least 3 reasons why these numbers are uncertain? Reflect on the differences/similarities between the two ice sheets. Convert the numbers to global sea level rise trend, and provide units of that trend as well.
3. When you have detrended the time series (in 2 above), can you reflect on what the remaining signal is showing? Speculate on what processes might be driving this signal, separately for Greenland and Antarctica.
4. Some papers suggest an accelerating mass loss from Greenland and Antarctica (e.g., Rignot et al., 2011 – paper in Dropbox folder). Can you quantify the acceleration term from this time series? What are the units? Do you think this acceleration trend explains the data better than simply using a linear trend (as in 2 above)?
5. Compare the MB of this method (what we call the input-output method, i.e. MB = SMB - D) with the MB from GRACE - they should look very similar! For a resource of these data and methods, refer to Van den Broeke et al., 2016 (in Dropbox folder).
6. Examine at the different components and show that about 60% of the signal of Greenland MB decrease (as observed by GRACE) is explained by SMB decrease, and about 40% by increase in ice discharge (D).