# Assignment 2 - Sea Level Projections

Due: 15 February 2022

1. The Ice Sheet System Model (ISSM) is one of the most widely-used models of ice sheet flow. Simple numerical experiments with ISSM can be run within your internet browser to explore the role of uncertainty in some physical parameters on the contribution of Antarctic Ice Sheet melt to sea level rise using the VESL website. Select "scientist" to have more control over the simulations and "Let's Go!" in the upper right corner to get started.

   (a) (5 pts) Start by varying only basal melt (i.e. melt from warm ocean temperatures) using the slider in the top right corner. The bottom right corner includes a probability distribution function (PDF) of the ice sheet contribution to sea level in the year 2100 for a range of possible basal melt rates, compared to the current rate of basal melt. By sliding the basal melt rate back and forth, you can see the probability of different sea level contributions given an equal probability of different basal melt rates, and also how the ice thickness in Antarctica changes from now to the year 2100. Speculate about what causes the two peaks in the PDF of sea level rise (i.e., high likelihood of either a little or a lot of sea level rise from Antarctica, but not a moderate amount).

   (b) (10 pts) Now change the parameter to be varied to "all fields". This includes many different parameters which are uncertain and which may attain a wide range of values in the future, including the friction between ice and the solid Earth (basal friction) and the "softness" of the ice (viscosity). By changing the sliders, determine whether a decrease in each parameter causes a rise or a drop in sea level. For each parameter, give a physical explanation for why you think it leads to an increase or decrease in sea level.

   (c) (5 pts) If Antarctica contains more than 50 meters of possible sea level rise, why do you think even large changes in ice sheet parameters will only lead to 2 meters or less of sea level rise over the next 80 years?

2. The VESL website also includes a "gradient fingerprint mapping" interactive tool where you can explore the contribution of different glacier and ice sheets to relative sea level (RSL) rise at certain locations (due to gravitational and glacial isostatic adjustments). You can select different cities with "local relative sea level rise" and "GRACE" time series to investigate how ice melt from different parts of the world might contribution to sea level rise at different locations.

   (a) (5 pts) For a "far-field city" (i.e. one that is far from sources of sea level rise, such as New Orleans, LA), what are the most important sources of RSL rise? Why do you think this is the case?

   (b) (5 pts) How are the RSL contributions different for Boston, compared to a far-field city? Why do you think this is the case?

   (c) (5 pts) What are the most important sources of RSL rise for a near-field Southern Hemisphere city, e.g. Buenos Aires? Why?

3. You can also view comprehensive regional sea level projections on the NASA Sea Level Projection Tool which includes other sources of relative sea level rise under different emissions SSPs.

   (a) (5 pts) How does the comprehensive sea level projection in New Orleans differ from the projection VESL (which only includes ice sheet contributions)? How is it different?

   (b) (5 pts) Using this tool, find the tide gauge you used to complete assignment 1 (or just click a location in the ocean near that tide gauge). How is the rate of sea level rise in 2100 different (or the same) from the rate you calculated on assignment 1 (or the rate in 2020 you can find in this tool)? Use the drop down menus to explain why you think the rate is different (or remains nearly the same).