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Impact of the feedback between Antarctic ice sheet freshwater and subsurface ocean temperature on 21st century sea level rise

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Many coupled climate models (atmosphere/ocean/sea ice) show that as the Antarctic ice sheet looses mass, the freshwater input into the ocean increases stratification and subsurface temperature in contact with the ice shelves (Bronselaer et al. 2018). This could be a powerful positive feedback yet it is not included in sea level projections. One reason is that it has not been tested in climate models that include an ice sheet model. In fact, many different models are necessary to constrain the uncertainty associated with this feedback arising from (i) the magnitude of the subsurface ocean temperature rise for a given freshwater flux and (ii) the sensitivity of the ice sheet mass loss to temperature change.

In this presentation I propose a simple method to quantify the impact of this feedback on 21st century sea level rise. I assess the relation between freshwater input and subsurface temperature from 5 climate models (EC-EARTH, GFDL, CESM, CSIRO Mk3L, GISS modelE-R). I then use a relation between subsurface temperature and Antarctic mass loss diagnosed from the SeaRise ice sheet models using Linear Response Functions (Levermann et al. 2014).

This quantification of the freshwater positive feedback is then included in a probabilistic sea level rise projection model that includes other sea level contributors and their dependencies (Le Bars 2018). Initial results suggest that this feedback has small impact on sea level for a low emission scenario but for a large emission scenario it increases the skewness of the sea level probability distribution. In other words, low probability high end sea level projections become larger.

Bronselaer, B., et al. (2018). Change in future climate due to Antarctic meltwater. Nature. http://doi.org/10.1038/s41586-018-0712-z

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Levermann, A., et al. (2014). Projecting Antarctic ice discharge using response functions from SeaRISE ice-sheet models. Earth System Dynamics, 5(2), 271–293. http://doi.org/10.5194/esd-5-271-2014