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Constraining the overall future projection of Upernavik Isstrøm by observations

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The uncertainty of the future contribution to sea level rise of the Antarctic and Greenland polar ice sheet remains important, as shown by the latest multi-model intercomparison (ISMIP6). We can summarise three main sources of uncertainties that are related to the ice flow model, the atmospheric and oceanic forcing and final to the Shared Socioeconomic Pathways (SSP). Results for the Greenland Ice Sheet (Goelzer and al., 2020) show that the model uncertainty explains a similar part of the ensemble spread (40 mm of sea-level rise by 2100) compared to the atmospheric forcing uncertainty (36 mm) or the SSP uncertainty (48 mm) and two times more than the ensemble spread due to the oceanic forcing uncertainty (19 mm).

Uncertainties in ice flow models are mainly due to different assumptions in numerical models and parameterisation, as well as model initialisation (spin-up, data assimilation). Here, we investigate the sensitivity of a single ice flow model (Elmer/Ice) to different sources of uncertainties for Upernavik Isstrøm, a tidewater glacier in the North-West sector of Greenland. To achieve this goal, we have identified potential sources of uncertainties: parameters related to the initialization of the model by inverse method (ice stiffness, friction law, regularization, input observations), those related to the dynamics (ice flow law, friction law) and finally those related to the forcing (sensitivity to the ocean, global climate model, regional climate model, SSP). To evaluate their influence we run a 200-member ensemble that samples these different sources of uncertainty. Each member is initialised to a state close to 1985 and evaluated during a historical simulation from 1985 to 2015 where the front positions are forced using observations (Wood et al., 2021). We then use the ISMIP6 protocol where the front position is parametrized as a function of ocean temperature and runoff to perform projections to 2100.

We then evaluate the sensitivity of this ensemble to our different sources of uncertainty using Sobol indices. Based on this novel approach, we define several metrics that allow us to score individual ensemble members using a comprehensive record of ice velocity, surface elevation and mass loss over the period 1985-2015. We then evaluate the possibility of reducing the uncertainty in Upernavik Isstrøm's contribution to sea level rise using these scores.