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On the effect of damage on the recent changes in the Amundsen Sea Sector

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Ice mass loss from Antarctic Ice Sheet is increasing, accelerating its contribution to global sea level rise. In the Amundsen Sea sector, recent observations of rapid ice-shelf thinning and grounding line retreat have been attributed to increased basal melting driven by inflows of warm Circumpolar Deep Water. However, recent studies have shown that basal melting alone might not be sufficient to explain the recent acceleration, retreat and thinning of the outlet glaciers in the sector.

As part of the European Horizon 2020 research project PROTECT — that assesses and projects changes in the land-based cryosphere to produce robust projections of SLR — we conduct numerical simulations to determine the role of damage on changes observed over the last two decades in the Amundsen Sea Sector. More particularly, we use a Stokes flow formulation combined with a Continuum Damage Mechanics model of the open-source ice flow model Elmer/Ice to simulate the ice flow evolution. We initialize our ice sheet model with data assimilation methods using 1996 observations of surface velocities as well as a corrected geometry based on the current ice-sheet geometry and the ice thickness rates of change observed over the past 20 years. From this initial state, we run forward simulations over 20 years with and without damage mechanics, and compare the model evolution to observed surface velocities and ice thickness rates of change, as well as observations of grounding line positions. Our results shed light on the importance of damage in the evolution of the region, in particular an acceleration of several hundred meters per year due to the decreasing buttressing effect of the ice shelves triggered by the increasing damage.