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Mass balance studies employing numerical ice sheet modelling and satellite remote sensing data

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The Antarctic ice sheet, its dynamics and mass balance, play a decisive role in the global climate system and for possible changes in global sea level. This is due to possible shifts in albedo and its role for the global radiation budget as a result of changes in snow and ice extent on the one hand and to the insertion or withdrawal of water from the ocean as a result of melting or freezing processes at the ice surface and/or the ice/ocean interface on the other. Conversely, alterations in climatic conditions and/or rising or falling mean sea levels exert significant influences on the dynamics of ice sheet/ice shelf systems. The present and future mass flux across the grounding line separating an ice sheet from an ice shelf represents a particularly useful diagnostic or prognostic variable, respectively.

Ice sheet and ice shelf flow are described by a set of non-linear differential equations (conservation of mass, energy and momentum) which are usually solved through numerical model calculations. However, in order to carry out model simulations, a host of initial and boundary conditions are required for, e.g., describing the geometry of the ice body under consideration, accumulation and ablation rates and ice flow velocities at the margins of the study region. Such data are difficult to come by for a remote region such as Antarctica and remote sensing data are increasingly employed to fill the gaps that sparse in-situ measurements leave open.

We will present results of a recently completed numerical modelling study of the Riiser Larsen ice shelf and its drainage area in the Eastern Weddell Sea region of Antarctica. The model represents a so-called higher order model at a spatial resolution of 2.5 km and 10 vertical sigma-layers. The model geometry (total model domain:

130×10^3 km^2) is largely derived from published data sets but also from satellite-based laser altimetry (GLAS). Ice flow velocities, utilized both as boundary conditions and for verification of model results have been derived from ERS-SAR scenes and a few in-situ measurements. The resulting mass flux for an optimal set of boundary conditions amounts to app. 2×10^{13} kg yr^{-1} and indicates a stable mass balance for present accumulation rates in the study region. However, increasing accumulation rates and surface temperatures in accordance with possible future climate change scenarios leads to negative mass balances for the Riiser Larsen ice shelf and its drainage area.