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Study of surface mass balance at three ice rises in Dronning Maud Land (East Antarctica): contrasting spatial and temporal variabilities

Content

The surface mass balance (SMB) is one of the largest sources of uncertainty when determining the Antarctic ice sheet total mass balance and thus Antarctica's contribution to sea level rise. Here we present a reconstruction of surface mass balance at two ice rises located in Princess Ragnhild Coast (Dronning Maud Land). To reconstruct the SMB history, we first date our ice cores using a suite of seasonal parameters (water stable isotopes, major ions and ice conductivity). Annual layer thickness is then converted into meter water equivalent using the measured density profile and by accounting for ice deformation at depth using strain rates. The latter are obtained from ice dynamical modelling at the ice divide.

The resulting SMB reconstructions exhibit a large interannual variability and no significant trend over the last 60 years for both ice rises. This is in sharp contrast with the SMB reconstruction from the Derwael Ice Rise (located at 90 km from our easternmost ice rise) that showed a significant SMB increase since the 1950's, consistent with expected snowfall increase as a result of higher temperatures (Philippe et al., 2016).

SMB reconstructions are further scrutinized through spectral analysis to look for multi-annual and/or multi-decadal variability in the signals. Results are compared for the three ice rises to look for synergies or the absence of it.
Different factors may contribute to these contrasting results over a relatively short distance, such as variability in precipitation regime (e.g. atmospheric rivers) and/or post-depositional processes (e.g. wind erosion), although local dynamic conditions at the drilling location have recently been shown to potentially affect the absolute value of SMB but not its temporal variability (Cavitte et al., 2022). Such large discrepancies over short distances of the order of spatial resolution of global atmospheric models have major implications for understanding precipitation changes across the Antarctic ice sheet.

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