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A dynamical process study of intense precipitation events over the East Antarctic ice sheet and Southern Ocean

Annick Terpstra and Irina Gorodetskaya
University of Aveiro, Aveiro, Portugal (annick.terpstra@ua.pt)

Extreme precipitation events over the Antarctic coastal and escarpment zones strongly influences regional accumulation patterns and thereby the Antarctic ice-sheet mass balance. Several recent intense precipitation events in Dronning Maud Land (leading to anomalous regional snow accumulation in 2009 and 2011) were preceded by episodes of intense poleward moisture transport organised in narrow, elongated bands. These so-called atmospheric rivers, linking moisture uptake in tropical regions and the deposition at high-latitudes, provide favourable conditions for intense precipitation events over the ice sheet. However, the poleward extent of such moisture plumes is not always sufficient for precipitation formation over the continent, resulting in precipitation over the ocean thus failing to contribute to the surface mass balance of the Antarctic ice sheet.

In this study we compare and contrast moisture transport events resulting in either precipitation over the Southern Ocean at the sea-ice/ice-shelf margin or over the Antarctic continent. Identification of the ocean precipitation cases is based on atmospheric river events during the Antarctic Circumnavigation Expedition (ACE, austral summer 2016-2017). We combine ECMWF products analysis with high-resolution regional numerical simulations using Polar-WRF, to gain insight in factors influencing the ability for moisture to reach the Antarctic ice sheet. In particular we focus on (1) moisture sources for precipitation, separating between the transport of moisture originating from lower-latitudes and local moisture recycling, (2) underlying dynamical mechanism for moisture transport, and (3) the production of precipitation.