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Understanding mechanisms behind intense precipitation events in East Antarctica: merging modeling and remote sensing techniques

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Large interannual variability has been found in surface mass balance (SMB) over the East Antarctic ice sheet coastal and escarpment zones, with the total yearly SMB strongly depending on occasional intense precipitation events. Thus for correct prediction of the ice sheet climate and SMB, climate models should be capable to represent such events. Not less importantly, models should also correctly represent the relevant mechanisms behind. The coupled land-atmosphere non-hydrostatic regional climate model MAR (Modèle Atmosphérique Régional) is used to simulate climate and SMB of Dronning Maud Land (DML), East Antarctica. DML has shown a significant increase in SMB during the last years attributed to only few occasional very intense snowfall events. MAR is run at 5km horizontal resolution using initial and boundary conditions from the European Centre for Medium-range Weather Forecasts (ECMWF) Interim re-analysis atmospheric and oceanic fields. The MAR microphysical scheme predicts the evolution of the mixing ratios of five water species: specific humidity, cloud droplets and ice crystals, raindrops and snow particles. Additional prognostic equation describes the number concentration of cloud ice crystals. The mass and terminal velocity of snow particles are defined as for the graupel-like snowflakes of hexagonal type. These definitions are important to determine single scattering properties for snow hydrometeors used as input (along with cloud particle properties and atmospheric parameters) into the Passive and Active Microwave radiative TRAnsfer model (PAMTRA). PAMTRA allows direct comparison of the radar-measured and climate model-based vertical profiles of the radar reflectivity and Doppler velocity for particular precipitation events. The comparison is based on the measurements from the vertically profiling 24-GHz MRR radar operating as part of the cloud-precipitation-meteorological observatory at Princess Elisabeth (PE) base in DML escarpment zone, from 2010 through now. Preliminary results show that MAR simulates well the timing of major synoptic-scale precipitation events, while a bias exists towards higher radar reflectivities using MAR snowfall properties compared to PE MRR measurements. This bias can be related to the differences both in the amount and type of snowflakes reaching the surface. The spatial extent of precipitation also matters as PE provides only vertical profiling. PAMTRA is used to evaluate specific intense snowfall events at PE-centered grid, while MAR-simulated atmospheric fields are further analyzed for understanding the large- and meso-scale atmospheric circulation and moisture transport patterns, together with cloud properties responsible for these events. PE measurements showed that the most intense precipitation events at PE (up to 30 mm water equivalent per day) have been associated with atmospheric rivers, where enhanced tropospheric integrated water vapor amounts are concentrated in narrow long bands stretching from subtropical latitudes to the East Antarctic coast. We analyze representation of such events in MAR, including their extent, intensity, as well as time and location of where such moisture bands are reaching the Antarctic coast.