Atmospheric rivers impact on the East Antarctic surface mass balance during recent years

Irina V. Gorodetskaya, *Centre for Environmental and Marine Studies, University of Aveiro, Portugal, and Katholieke Universiteit Leuven, Earth and Environmental Sciences, Leuven, Belgium;* Irina.Gorodetskaya@kuleuven.be

Maximilian Maahn, *National Oceanic and Atmospheric Administration, Earth System Research Laboratory, Boulder, Colorado, USA*
Hubert Gallée, *Laboratoire de Glaciologie et Géophysique de l'Environnement, Grenoble, France*
Jan T.M. Lenaerts, **Michiel R. van den Broeke**, *Utrecht University, Institute for Marine and Atmospheric research Utrecht, Utrecht, Netherlands*
Stef Lhermitte, Niels Souverijns, Alexandra Gossart, Nicole P.M. Van Lipzig, *Katholieke Universiteit Leuven, Earth and Environmental Sciences, Heverlee, Belgium*
Stefan Kneifel, Susanne Crewell, *University of Cologne, Institute for Geophysics and Meteorology, Cologne, Germany*

Several strong snowfall events over Dronning Maud Land (DML) in 2009 and 2011 produced a positive mass anomaly over the East Antarctic ice sheet, counterbalancing the increasing ice discharge from West Antarctica in these years. Using in situ accumulation measurements and radar-derived snowfall rates from Princess Elisabeth station (PE), located in the DML escarpment zone, along with the European Centre for Medium-range Weather Forecasts (ERA) Interim reanalysis, it was shown that the most intense precipitation events at PE (up to 30 mm water equivalent per day) were associated with atmospheric rivers (ARs) (*Gorodetskaya et al, 2014, Geophys. Res. Lett.*, *41*, doi:*10.1002/2014GL060881*). ARs were represented by enhanced tropospheric integrated water vapor amounts and strong poleward moisture transports concentrated in narrow long bands stretching from subtropical latitudes to the East Antarctic coast. Several ARs reaching the coastal DML contributed 74–80% of the outstanding SMB during 2009 and 2011 at PE. These AR events linked DML snowfall and accumulation to the subtropical moisture sources, namely, the southern Indian and Atlantic Oceans. Moreover, large contribution (46%) to climatologically 'normal' annual snow accumulation amount during 2012 comes from only one intense snowfall associated with an AR. The important role of ARs in the Antarctic ice sheet surface mass balance suggests that climate models require adequate representation of ARs. Two coupled land-atmosphere regional climate models - MAR (Modèle Atmosphérique Régional) and RACMO-ANT - are used to simulate DML climate and surface mass balance. The models are run at ~5 km horizontal resolution using initial and boundary conditions from the ERA-Interim re-analysis atmospheric and oceanic fields. We analyze representation of the AR events in the two models, including their extent, intensity, as well as time and location of where the AR moisture bands are reaching the Antarctic coast. Model-simulated snowfall events associated with ARs are evaluated using the Passive and Active Microwave TRAnsfer model (PAMTRA), which allows direct comparison of the radar-measured snowfall at PE and model-based vertical profiles of the radar reflectivity and Doppler velocity.