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On the fine vertical structure of the low troposphere over the coastal margins of East Antarctica

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Eight years of high-resolution radiosonde data at nine Antarctic stations are analysed to provide the first large scale characterization of the fine scale vertical structure of the low troposphere up to 3 km of altitude over the coastal margins of East Antarctica.
Radiosonde data show a large spatial variability of wind, temperature and humidity profiles, with different features between stations in katabatic regions (e.g., Dumont d'Urville and Mawson stations), stations over two ice shelves (Neumayer and Halley stations) and regions with complex orography (e.g., Mc Murdo). At Dumont d'Urville, Mawson and Davis stations, the yearly median wind speed profiles exhibit a clear low-level katabatic jet. During precipitation events, the low-level flow generally remains of continental origin and its speed is even reinforced due to the increase in the continent-ocean pressure gradient. Meanwhile, the relative humidity profiles show a dry low troposphere, suggesting the occurence of low-level sublimation of precipitation in katabatic regions but such a phenomenon does not appreciably occur over the ice-shelves near Halley and Neumayer. Although ERA-Interim and ERA5 reanalyses assimilate radiosoundings at most stations considered here, substantial - and sometimes large - low level wind and humidity biases are revealed but ERA5 shows overall better performances.
A free simulation with the regional model Polar WRF (at a 35-km resolution) over the entire continent shows too strong and too shallow near-surface jets in katabatic regions especially in winter. This may be a consequence of an underestimated coastal cold air bump and associated sea-continent pressure gradient force due to the coarse 35-km resolution of the Polar WRF simulation.
Beyond documenting the vertical structure of the low troposphere over coastal East-Antarctica, this study gives insights into the reliability and accuracy of two major reanalysis products in this region on the Earth and it raises the difficulty of modeling the low-level flow over the margins of the ice sheet with a state-of-the-art climate model. The study also discusses the temporal and spatial representativity of the (bi-)daily radiosonde profilings at nine stations for providing a realistic picture of the full - i.e. including the sub-daily variability - statistics over the whole coastal rim of the East-Antarctic ice sheet.