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CCN and aerosol properties at Princess Elisabeth station, East Antarctica, combined with cloud and precipitation observations and air mass origin

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Since 2010, several complementary ground-based instruments for measuring the aerosol composition of the Antarctic atmosphere have been operated at the Belgian Antarctic research station Princess Elisabeth, in Dronning Maud Land, East Antarctica (71.95° S, 23.35° E, 1390 m asl.). In addition, several ground-based remote sensing instruments for cloud and precipitation observations have been installed for continuous operation, including a ceilometer (cloud base height, type, vertical extent) and a 24 Ghz micro-rain radar (vertical profiles of radar effective reflectivity and Doppler velocity). The station is inhabited from November through end of February and is operated under remote control during the other months.

Knowledge on atmospheric aerosols is essential because they affect not only the Earth's radiation budget, but also cloud properties by acting as cloud condensation or ice nuclei. Via cloud formation, aerosols are therefore important also for precipitation, which is the only source of mass gain to the Antarctic ice sheet. In this contribution, results of aerosol and cloud condensation nuclei (CCN) measurements will be shown with a focus on their properties around events with precipitation, drifting snow and changing cloud conditions. Also, the influence of air mass origin will be analysed.

The aerosol total number concentration N-total showed a clear seasonal cycle with some hundreds of particles/cm3 during austral summer and some tens of particles/cm3 during winter. Mostly in summer, N-total increased to some thousands of particles/cm3 during short periods (hours to one day). Simultaneous measurements of N-total, size distribution (measured in 99 log- channels between 90 and 7000 nm) and CCN number (N-ccn) revealed that then mostly the number of particles smaller than 90 nm increased, indicating new particle formation events. New particle formation events indicated that aerosols were not only transported to Antarctica but could also be produced there. These events were often connected to distinct changing cloud and wind conditions. Strong precipitation events led to distinct decreases of N-ccn. The analysis of the hygroscopicity parameter derived from size distribution and N-ccn measurements showed a range between 0.5 and 1.2 at supersaturations of 0.1 %, with slight inter-annual variations. Mean values were 0.8 for summer 2013/14 and 0.9 for summer 2015/16. Such values are typical for marine aerosol of the Southern Ocean.