



Precipitation over the Southern Ocean: comparison of several ship-based measurement techniques during the Antarctic Circumnavigation Expedition

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Changes in precipitation over the Southern Ocean have significant effects on projections of Southern Ocean salinity, sea ice life-cycle and Antarctic surface mass balance. Atmospheric models used for simulating weather and climate have shown significant differences in precipitation. The problem lies not only in the need to improve model parameterisations but also in the lack of cloud and precipitation measurements in these regions, leading to large uncertainties in model estimates of variability and trends in Southern Ocean precipitation. Unique precipitation measurements using a multi-sensor approach were performed during the Swiss Polar Institute's Antarctic Circumnavigation Expedition (December 2016-March 2017). We conducted ship-based measurements of precipitation properties using photoelectric sensors, including a Snow Particle Counter (SPC) providing particle size distribution and two simple particle counters (manufactured by Wenglor) providing total particle counts. A 24GHz micro-rain radar (MRR) was used for measurements of vertical precipitation profiles. Radar effective reflectivity derived from MRR measurements allows to quantify snowfall intensities starting from several hundred meters above ground up to 3km height. However, these estimates strongly depend on snowfall particle size and shapes. In order to constrain snowfall estimates from MRR and particle counters, we use particle size distribution from the SPC and also information about particle shapes and sizes from formvar snowflake replicas that we collected continuously during snowfalls. The slides with formvar replicas have been scanned using a slide scanner microscope (Axio Scan Z1) providing high-resolution 3D images of snowflakes. Meteorological conditions in the boundary layer were recorded at high temporal resolution by Vaisala's Marine Automatic Weather Station. Additionally, we obtained regular atmospheric profiles by launching radiosondes, some with supplemental cloud liquid water content sensors.

In this poster, we will show a comparison of precipitation estimates from various sensors. First, we present sensitivity studies of estimating particle and mass flux using SPC and Wenglor particle counters. While the SPC sensor sees particles as small as 0.03 mm, the particle size lower limit of the Wenglor counters is 0.1-0.2 mm. Both sensors show comparable total particle counts when SPC measurements are integrated for >0.2 mm. Horizontal mass flux is highly sensitive to the particle size range and the applied assumptions. The assumptions used to estimate snowfall rates from snow particle counters (i.e. particle fall speed, particle density) will be discussed in the context of our snow particle shapes and size measurements. Further, we show comparison of the snowfall rates derived from photoelectric sensors and from the MRR. Preliminary analysis for one of snowfall events in February 2017 showed different timing in the precipitation peak, while the SPC-derived snowfall rate is highly dependent on the particle fall speed. For specific case studies, the differences in the snowfall rates derived from different sensors will be analyzed together with snowflake microphysical information collected at the ship level and radiosonde profiling to understand the snowflake atmospheric path.