Climatology of air mass origin for Princess Elisabeth Antarctica station: clustering and analysis for atmospheric particle properties and Volatile Organic Compounds

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Antarctica is considered the best preserved region on Earth from anthropogenic emissions. However, the impact of anthropogenic airborne particles and pollutants could be significantly larger than expected. Furthermore, a detailed understanding of present-day atmospheric transport pathways of particles and of volatile organic compounds (VOC) from source to deposition in Antarctica remains essential to document not only biogeochemical cycles, but also the transport to and deposition of organic micro-pollutants in Antarctica.

Since 2010, the aerosol total number and size distribution, aerosol absorption coefficient and mass concentration of light-absorbing aerosols and the aerosol total scattering coefficient have been monitored at the Belgian research station Princess Elisabeth Antarctic (PEA). The station is situated in Dronning Maud Land, East Antarctica (71.95° S, 23.35° E, 1390 m asl). Besides these instruments, a cloud condensation nuclei counter (CCNc) has been operated during three austral summers (Herenz et al., 2019). Meteorological data come from an automatic weather station.

Atmospheric particles have been collected during the last four austral summers for chemical analysis by high-volume sampling on pre-baked quartz-fibre filters (organics), polyurethan foam filters (VOCs) and on Teflon filters (inorganics). In addition, passive samplers have been installed at seven locations along a 250 km N-S transect from the coast to the Antarctic plateau, and the collected samples have been analysed on organics, VOCs and rare-earth elements, respectively.

The FLEXTRA trajectory model and the FLEXPART dispersion model are applied in order to investigate possible source regions and transport pathways into Antarctica of atmospheric particles and VOCs. The models are driven with ECMWF meteorological fields. 10-days backward trajectories, starting from PEA, were calculated for the period 01/01/2010 to 31/12/2019, in 3-hour-intervals. A k-means cluster analysis has been done, revealing (based on latitude, longitude and altitude) four clusters of air mass origin.

Results will be presented for the seasonal air mass origin clusters and also the distribution of several parameters like, e.g., total precipitation, specific humidity, potential vorticity, mixing layer height, along the cluster trajectories.

We will also show results of the distribution of the measured atmospheric particle properties between and within the air mass origin clusters. In addition, FLEXTRA and FLEXPART results will also be shown for the air mass origin of specific events, e.g., when the aerosol total number and concentration increased distinctly over short time, indicating new particle formation events. This will also be applied to results of the VOC analyses, e.g., first analyses show distinct differences in the ratio between oxidised and non-oxidised polycyclic aromatic hydrocarbons for samples of different time periods.

Figure 1 shows the four air mass origin clusters for the austral summer season (December-January-February).

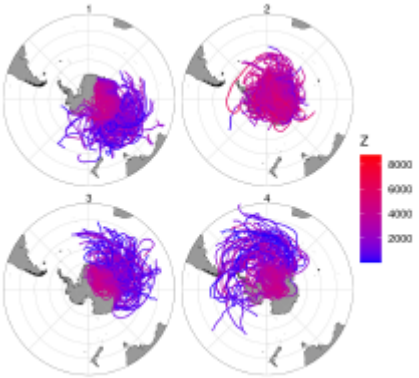

Figure 1: clusters of air mass origin for austral summer, for 10 years of back trajectories starting at PEA station; Z is height in m asl

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