The PASPARTOUT project: Pathways of particles, VOCs and moisture into East Antarctica in a changing climate

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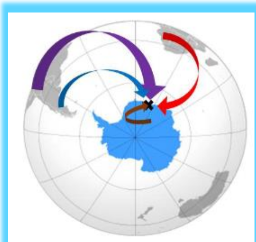
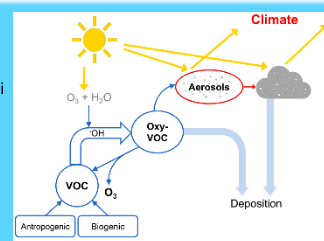
WHAT – WHY – TOOLS



The atmospheric circulation, water cycle and cloud-aerosol-interactions are key elements of the Antarctic climate system. Clouds play significant role for radiative energy budget and are linking water vapour transport into Antarctica with precipitation; Aerosols have impact on cloud microphysics, being cloud condensation and ice nuclei
Measurements at the Belgian Antarctic research station Princess Elisabeth (PEA; 71°57'S, 23°20'E, 1390 m asl):
Cloud and precipitation measurements and in-situ measurements of atmospheric particles, cloud condensation and ice nuclei; active and passive sampling for volatile organic compounds (VOCs) and organic micro-pollutants; inorganic trace elements and isotopes

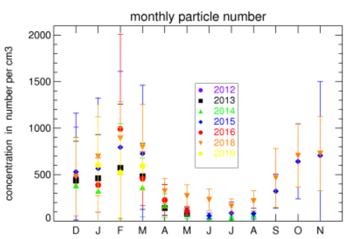


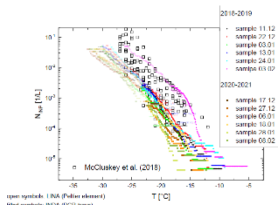
Analysing ECMWF ERA-5 multi-decadal data → investigation of current atmospheric circulation patterns and weather regimes
→ defining a climatology for East-Antarctica.
Backward trajectory and dispersion modelling (FLEXTRA, FLEXPART)
→ climatology of transport pathways and potential source regions

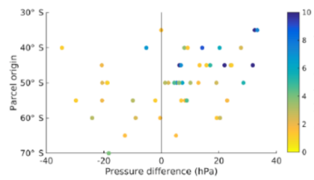
Model data and measurements → applying regional climate model COSMO-CLM2
→ implications on cloud-aerosol-precipitation interaction

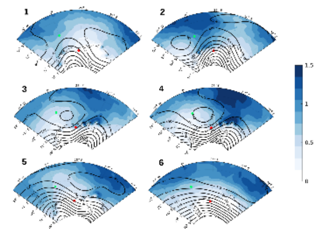
Using CMIP-6 archive of climate model data
→ how might cloud-aerosol-precipitation interactions change in a future climate

AEROSOL, ICE NUCLEI, PRECIPITATION, WEATHER



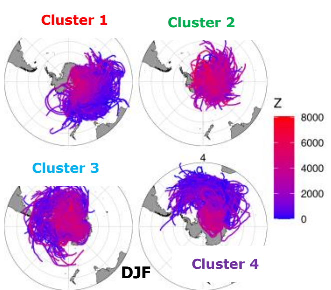


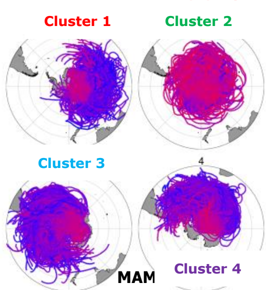




First figure: yearly cycle of monthly means of the total atmospheric particle number; Second figure: measured ice nuclei particle concentrations at PEA; Third graph: relation between pressure gradient (PEA and 0° E, 62° S; green dot on the fourth graph; details see Souverijns et al., 2018), snowfall events at PEA (2010-2016), air mass origin and total amount of snowfall;
Fourth graph: Circulation climatology over Dronning Maud Land; thick lines 500hPa geopotential fields; blue colours average precipitation linked to this circulation pattern; red dot PEA;

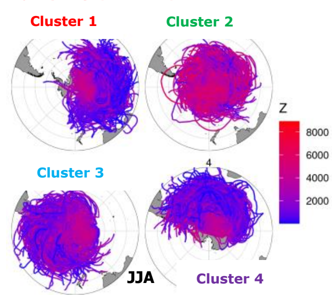
AIR MASS CLIMATOLOGY and CLUSTERS

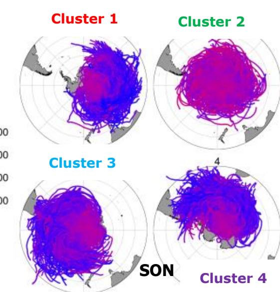




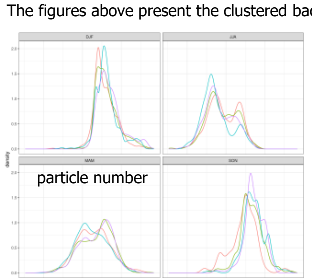
We use the FLEXTRA model to calculate 10-day backward trajectories for 11 years (2010-2020), 6-hourly. ECMWF ERA-5 data was used for meteorology (0.5°x0.5° grid).

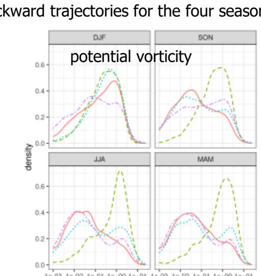
By applying k-means clustering, 4 clusters were found, based on latitude, longitude and altitude.

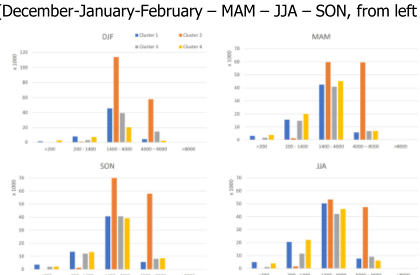




The figures above present the clustered backward trajectories for the four seasons (December-January-February – MAM – JJA – SON, from left to right). Z is the altitude above sea level.



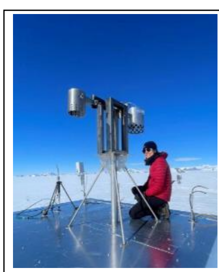




The two figures on the far left show density plots of particle number and potential vorticity, for the clusters and seasons (colour code see plots above. above). Figure left: repartition of back trajectories for the seasons, the four clusters and for distinct altitude sections.

Overall percentages of backward trajectory occurrence in clusters (%, colour code above)

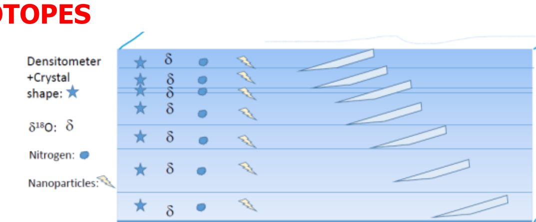
DJF	18	54	18	10
MAM	20	37	20	23
JJA	25	31	20	24
SON	19	42	19	20



ORGANICS, INORGANICS, ISOTOPES

automated sampling – at PEA and at coast
→ year-round sampling with temporal resolution
→ particle, isotope analyses
→ better constraints on potential source areas
→ connecting to back trajectories, weather patterns

see also Van Overmeiren et al., 2023, 2024
in addition, snow pits for samples of deposited snow
→ particles, isotopes deposited over last one, two years;
left: auto-sampler for VOCs and auto-sampler for inorganics



'take home':
PASPARTOUT: better understanding the links between atmospheric circulation patterns, weather regimes, particles, VOCs, moisture and implications on current climate / the implications within a changing global climate are investigated by using CMIP6 scenarios

REFERENCES: Souverijns et al., https://doi.org/10.5194/tc-12-1987-2018 / Van Overmeiren et al., 2023, https://doi.org/10.1016/j.atmosenv.2023.120074 / Van Overmeiren et al., 2024, https://doi.org/10.1021/acs.est.3c06425

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