IMPACTS OF THE METEOROLOGY ON AEROSOLS, CLOUDS AND THE RADIATIVE BALANCE OVER THE ANTARCTIC PENINSULA

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RESUMEN

Las regiones polares son sensibles a los impactos de los aerosoles. En este estudio, demostramos con observaciones directas las características de los aerosoles en la Península Antártica, su variabilidad y las conexiones con la meteorología, y más adelante, proponemos algunos mecanismos que impactan al clima y al balance radiativo por medio de los nubes. Nuestros resultados apuntan la importancia de los aerosoles para los procesos atmosféricos en la región Antártica.

ABSTRACT

The polar regions are sensitive to the aerosol climate impacts and feedbacks. In this study, we will shed light in the observed aerosol characteristics in the Antarctic Peninsula, their variability and interlinkages with local weather, as well as we propose some mechanisms of aerosol possible impacts on climate and radiative balance via clouds. Our results suggest that aerosols should be considered as an important variable in atmospheric processes, especially in the region of Antarctica.

Palabras clave: Antarctic aerosols, Aerosol-cloud interactions, Long-term measurements.

1) INTRODUCTION

Atmospheric aerosols are an integral part of the climate, having effects on water-, carbon-, and nutrient cycles and the amount of solar radiation entering the surface, changing the amount of cloudiness and rain, and the microphysical properties of the clouds. Thus, they induce both global climate impacts as well as they affect the local weather (e.g. Mulcahy et al., 2014). The polar regions are especially sensitive to the aerosol climate impacts and feedbacks, due to the presence of bright reflective surfaces with a naturally high albedo and the low background concentrations (Maurizen et al., 2011; Asmi et al., 2012). Too little is known about the inter-annual cycles and processes of aerosols and their role in cloud formation in the Antarctica. Here, we will shed light in the observed aerosol characteristics in the Antarctic Peninsula, their variability and interlinkages with local weather, and propose some mechanisms of aerosol impacts on climate and radiative balance via clouds.

2) METHODS

This study is based on 5-years of continuous aerosol and meteorological observations in the station Marambio (64º15`S; 56º38`W), which we recently upgraded to cover cloud observations using a Vaisala ceilometer model CL51. The meteorological parameters (T, RH, press, winds, radiation) are measured with Vaisala sensors, Thies ultrasonic anemometer and Kipp&Zonen pyranometers. Aerosol size distribution and optical properties are measured with a Differential Mobility Particle Sizer, an Ecotech nephelometer and a Thermo Multi-Angle Absorption Photometer (details in Asmi et al., 2018).

3) RESULTS AND CONCLUSIONS

Recently, we have demonstrated the importance of the meteorological parameters, such as the wind as a driver for the primary emissions of marine and soil aerosols, and the solar radiation induced photochemical oxidation of marine emissions as significant in affecting the secondary aerosol formation during high-radiation season, i.e. summer (Asmi et al., 2018). We also demonstrated that the radiative properties of the aerosols over the Antarctic Peninsula remain rather constant throughout the year, and with the changing sources, with a majority of aerosols being highly light reflecting.

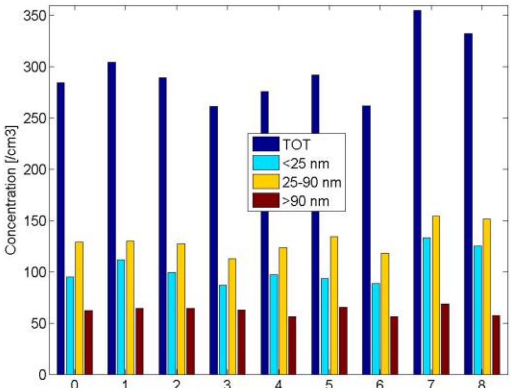

Fig 1. Aerosol concentration with changing cloud coverage (0/8 to 8/8)

Clouds have been proposed to decrease the number of the smallest (< 25 nm) particles via reduced photo-oxidation potential (Sogacheva et al., 2008). We determined the cloudiness in Marambio during year 2017 from the ceilometer data and analysed the impact of clouds on aerosols (Fig. 1). However, aerosol concentration showed no systematic changes with changing cloud cover.

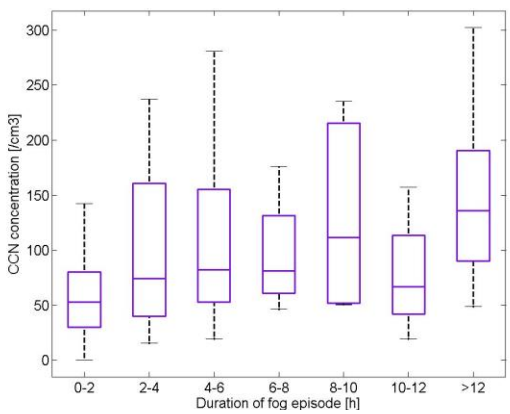

Fig 2. Time of fog-events with changing CCN concentrations.

Finally, the question remains on aerosol impacts on clouds: their formation, radiative properties and lifetime. We studied the aerosol impact on surface fog formation, analyzing the duration of fog episodes based on ceilometer data, and the >100 nm aerosol (i.e. cloud condensation nuclei, CCN) concentration before every fog-event. Our preliminary results suggest that indeed, fog-events show a tendency towards a longer lifetime with more CCN present (Fig 2).

Currently, we are analyzing aerosol-cloud interactions at various meteorological conditions to better understand the importance of different factors for cloud formation, and any possible aerosol impacts on clouds.

REFERENCES

Asmi, E. et al. 2012: Aerosol cloud activation in summer and winter at puy-de-Dôme high altitude site in France, Atmos. Chem. Phys., 12, 11589-11607, https://doi.org/10.5194/acp-12-11589-2012.

Asmi, E. et al., 2018: Primary sources control the variability of aerosol optical properties in the AntarcticPeninsula,TellusB, Chem. Phys. Meteorol., 70:1, doi:10.1080/16000889.2017.1414571.

Mauritsen, T. et al. 2011: An Arctic CCN-limited cloud-aerosol regime, Atmos. Chem. Phys., 11, 165-173, https://doi.org/10.5194/acp-11-165-2011.

Mulcahy, J. P. et al. 2014: Impacts of increasing the aerosol complexity in the Met Office global numerical weather prediction model, Atmos. Chem. Phys., 14, doi:10.5194/acp-14-4749-2014.

Sogacheva, L. et al. 2008: New aerosol particle formation in different synoptic situations at Hyytiälä Southern Finland, Tellus, 60B, 485–494, https://doi.org/10.1111/j.1600-0889.2008.00364.x.