Concentrations and sources of climatically important particles and gases in the Antarctic Peninsula, Argentine station Marambio

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The current rapid climate change is mainly due to the increased anthropogenic emissions of greenhouse gases, while in contrast, the main "break" in this advancing process has so far been aerosol particles. Aerosol particles, coming from various natural and anthropogenic sources interact with the solar radiation, change the amount of cloudiness and rain, and the cloud microphysical properties, and such in general lead to climate cooling. However, understanding the sources, sinks and processing of these major atmospheric climate forcers is still incomplete, and more so near the poles. 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 (Mauritsen et al., 2011; Asmi et al., 2012).

Here we present results of our analysis of more than 5-years of continuous data of greenhouse gases and aerosol particles measured at the Antarctic Peninsula station Marambio. The major open questions we wish to answer include: 1) How are the typical seasonal cycles of aerosols and 2) greenhouse gases and what are the factors that cause these cycles, and 3) Based on the observed quantities and properties of aerosols, what are their proposed climate impacts?

1) Recently we have shown that the primary marine and terrestrial sources are mainly controlling the aerosol mass and optical parameters throughout the year (Asmi et al., 2018). Maximum mass concentrations are observed in winter due to strong winds leading to a resuspension of soil and to marine sea-spray emissions. Our recent analysis of aerosol number, however, shows an opposing pattern related to the intensive secondary particle formation during summers. Detailed results of the characteristics and seasonality, and motives behind these, will be discussed in the presentation.
2) Greenhouse gases in Marambio are measured with a cavity ring-down spectroscopy instrument (Picarro), with a system of auto-calibration. Similar measurements were recently started in the Global Atmospheric Watch (GAW) station, Ushuaia, in the southern tip of Argentina. These measurements together are used to better understand the role of southern ocean as a sink (or source) of carbon dioxide and methane. The vicinity of the southern ocean is seen for example as decreasing concentration of CO2 during summer and oceanic winds. Currently, we are working towards a quantitative analysis of the source and sink terms.
3) The climate impacts of the aerosols are manifested via their radiative properties, impacts on surface albedo and participation in cloud formation and microphysical processes. Aerosol single-scattering albedo, a parameter related with aerosol "brightness", was high (around 0.96 ± 0.10) in Marambio throughout the year. The absorbing fraction could be both long-range transported or regional soil (or anthropogenic) aerosol. Wavelength dependence of absorption was analyzed to define the relative roles of different sources. An absorption exponents in the range 1.2—1.7 were observed, thus suggesting biomass burning, dust and/or mixed sources. The further analysis of indirect climate impacts of the observed aerosols are on-going. The chemical composition of aerosols suggests rather soluble and hygroscopic mixture, thus making the aerosols good cloud condensation nuclei (CCN). Preliminary analysis showed that e.g. the persistence of commonly observed fog episodes in the Peninsula could be connected with an elevated initial aerosol concentrations.

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.