Arctic aerosol physical and optical characterization during the POLARCAT summer campaign in Greenland

B.Quennehen[a], A. Schwarzenboeck[a], O.Jourdan[a], A.Stohl[b], J.Schmale[c], S.Crumeyrolle[a] and K.S.Law[d]

[a] *Laboratoire de Météorologie Physique, Université Blaise Pascal/OPGC/CNRS, Aubière, France*
[b] *Norwegian Institute for Air Research, Kjeller, Norway*
[c] *Max Plank Institut for Chemistry, Particle chemistry departement, Mainz, Germany*
[d] *Laboratoire Atmosphère, Milieux, Observations Spatiales, Université Pierre et Marie Curie/IPSL, Paris, France*

contact: b.quennehen@opgc.univ-bpclermont.fr

Abstract number 1406

1. INTRODUCTION

This study present in-situ measurements of physical and optical aerosol properties for the POLARCAT summer campaign. In particular, complete aerosol size distributions ($20 < D_p < 3000$ nm) and light scattering have been measured. In addition, complementary measurements of aerosol chemical in-situ properties and aerosol remote sensing have been performed on board the same aircraft.

In order to classify origin and composition of the sampled air masses (at least for anthropogenic pollution and biomass burning plumes), simulations from the Lagrangian dispersion model FLEXPART (Stohl et al, 1998) are used in addition to measured aerosol chemical and optical properties. Moreover, the FLEXPART analysis allows a better understanding of the correlation between aerosol composition, Co and O_3 measurements.

The POLARCAT project is part of the **International Polar Year**. It aims to quantify the contribution and impact of trace gases and aerosols transported to the Arctic region by a characterization of anthropogenic pollution plumes. Within the frame of this project, the **French ATR-42 research aircraft**, equipped particularly with in-situ and remote sensing instrumentation, was deployed during 2 measurement campaigns in 2008. While during the spring campaign the ATR-42 has been flying out of **Kiruna, Sweden**, the summer campaign was operated out of **Kangerlussuaq, Greenland.**

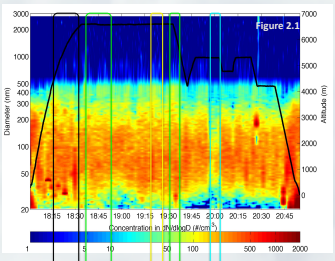
2. AEROSOL PHYSICAL PROPERTIES

A. SIZE DISTRIBUTION

Aerosol size distributions are measured with both a Scanning Mobility Particle Sizer (SMPS) for particle diameters in the range between $20 < D_p < 450$ nm and a Passive Cavity Aerosol Spectrometer Probe (PCASP 100-X, DMT) measuring between $100 < D_p < 3000$ nm.

The figure 2.1 present the aerosol size distribution along the flight 80 (July 13th), color scale is for concentrations, the flight altitude is represented as the black line.

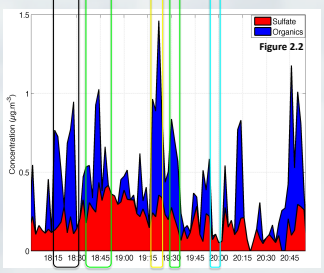
Surprisingly, it appear that larger concentrations in particle with diameter > 300 nm are measured higher than 5km.



B. CLASSIFICATION: Chemical data

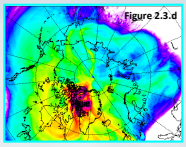
Chemical concentration measurements have been performed for organics and sulfates using an Aerosol Mass Spectrometer (AMS) in order to identify corresponding biomass burning and/or anthropogenic pollution plumes. Corresponding CO and O_3 are also available but not shown in this presentation.

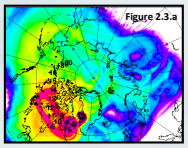
During the first leg at 6500 m height, 4 major pollution peaks of organics well correlate with larger number and mass concentrations in the accumulation mode (PCASP), whereas the respective sulfate concentration tend to decrease (see figure 2.2). These pollution peaks will be compared to the very clean air masse observed at 8 PM.

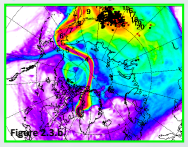


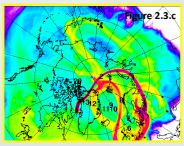
C. CLASSIFICATION: The FLEXPART lagrangian dispersion model

Using FLEXPART products, the air mass origins can be quantified. The color scale is in ns.m/kg. For this particular flight, we observe 3 principal origins for polluted air masses: North America (fig 2.3.a), Siberia/China (fig 2.3.b), and Europe (fig 2.3.c). Size spectra of the 3 polluted air masses are compared with local clean air masses (fig 2.3.d) (see fig 2.4).

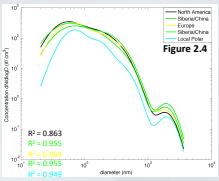








D. FITTED MEAN SIZE DISTRIBUTION



Aïtken mode			
Origins	Conc. (#/cm³)	Sigma	Diam. (nm)
NA	189	1.68	56
SC	147	1.76	66
EU	170	1.65	62
SC	194	1.79	57
LP	80	1.49	70

Figure 2.4 (above) presents mean fitted aerosol size distributions classified according to air mass origins. The Aïtken mode characteristics (table above) suggest that even after long range transport, pollution plumes (compared to non polluted air) can be recognized because of still higher particle concentrations (with broader sigma).

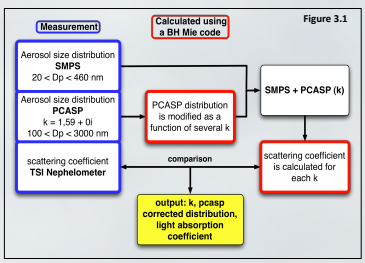
3. AEROSOL OPTICAL PROPERTIES

A. LIGHT SCATTERING MEASUREMENT – OPTICAL CLOSURE

The light scattering coefficient has been measured by a TSI nephelometer at 3 different wavelengths (450, 550 ,700 nm).

Simultaneously, we calculate the scattering coefficient for more than 400 complex refractive indices (from 1.33 to 1.59 for the real part and 0 to 0.05 for the imaginary part) from the aerosol size distribution measurements using the Mie code proposed by Bohren & Huffman (1983).

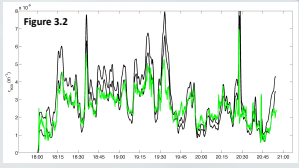
The scheme of our algorithm, to match measured with calculated scattering coefficients, while varying the refractive index, is presented on figure 3.1 and inspired by the work of Guyon et al. (2003).

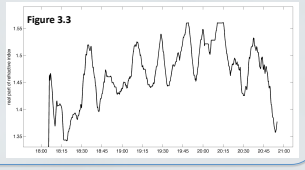


B. PRELIMINARY RESULTS OF THE INVERSION

Results from the inversion algorithm are presented both on figure 3.2 and 3.3. The black lines in fig. 3.2 represents the calculated minimum and maximum values of the scattering coefficient whereas the green line represent the nephelometer measurements.

Fig. 3.3 show the evolution of the real part of the refractive index calculated through the inversion. It may be a third way (in addition to chemistry and back-trajectory studies) to fine-tune the classification of air masses.





4. CONCLUSIONS & PERSPECTIVES

This study deals with physico-chemical and optical properties of summer arctic aerosol particles. These properties are mainly influenced by the origin of air masses and remain, even after long range transport, identifiable with larger concentrations for every diameter and especially in the coarse mode. Polluted Aïtken particle mode seem to broader than the Aitken mode of non polluted Arctic air masses. The implemented optical closure will lead to a better understanding of the aerosol optical properties from different source regions.

References:

Bohren C. F. and Huffman D. R., *Absorption and scattering of light by small particles.* Wiley-Interscience, New York, 1983.

Guyon, P., Boucher, O., Graham ,B., Beck, J., Mayol-Bracero, O.L., Roberts, G.C. et al (2003).Refractive index of aerosol particles over the Amazon tropical forest during the LBA-EUSTACH 1999. *Journal of Aerosol Science*, *34*, 883–907.

Stohl, A., M. Hittenberger, and G. Wotawa (1998): Validation of the Lagrangian particle dispersion model FLEXPART against large scale tracer experiments. Atmos. Environ. 32, 4245-4264.

Acknowledgments: The authors would like to thanks the French research agencies ANR, CNES, CNRS-INSU, and IPEV as well as Univ. Of Mainz and EUFAR. We also thanks SAFIRE for their support during the planning and execution of the French ATR-42 campaigns and, together with DT-INSU, for help with instrument integration.

Special thanks goes to APECS, IASC and the Research Council of Norway for funding my participation at the OSLO IPY Science conference.