Summary report on the Ny-Ålesund Atmosphere Flagship Black Carbon (BC) workshop (7-8 November, 2019, Oslo, Norway)

Conveners: Rob Modini, Marco Zanatta, Stefania Gilardoni, Bjørn Samset

1. Introduction and workshop goals

Black carbon (BC) aerosols have been measured in Svalbard, and more broadly across the Arctic, for at least 30 years. In tandem with these observational efforts, increasingly complex computer models have been developed to simulate Arctic BC. The primary goal of these activities, at least in recent years, has been to quantify the climate impact of Arctic BC. This goal is motivated by the fact that the Arctic region is warming more quickly than the globe on average – a phenomenon known as Arctic amplification – and the role of BC is still far from being clearly understood.

Within the framework of the Ny-Ålesund Atmosphere Flagship a group of researchers who are studying Arctic BC met in Oslo, Norway on November 7 and 8, 2019 to discuss the following topics:

- Existing and planned long term and short term BC observations (including eBC, rBC and EC) in Ny-Ålesund and across the Arctic;
- Modelling approaches to describe atmospheric ageing, transport, and radiative forcing of Arctic BC;
- Optimization of integrated modelling and observational approaches to improve understanding of BC climate and air quality impacts.

The initial focus of the workshop discussions was centred on research activities in or around the settlement of Ny-Ålesund on the Svalbard archipelago. However, given the timing of the workshop – at the beginning of the year-long MOSAiC expedition (https://www.mosaic-expedition.org/) – the workshop discussions were expanded to cover a pan-Arctic scope. In particular, we discussed and planned how the new MOSAiC period observations could be combined with existing BC research activities in Ny-Ålesund and at other sites across the Arctic.

Given the crucial interplay between observations and models, in order to understand the climate impacts of Artic BC, we aimed to have roughly equal participation from both the BC observational and modelling communities. The mantra of the meeting was: “Try to show off all the things that you don’t know…rather than just the things that you do know”. Like this we hoped to increase understanding across the observational and modelling communities in order to identify new areas where we could work together.

2. Workshop program

The workshop included both presentation and discussion sessions. The four presentation sessions are listed below including presentation titles and authors. The discussion sessions occurred around these presentation sessions and at the conclusion of the workshop.

Presentation session 1: Atmospheric BC observations in the Arctic

1. BC metrics and measured properties: everything you always wanted to know about BC data but were afraid to ask (Konstantinos Eleftheriadis - NCSR).
2. Measuring absorption – direct & indirect measurements (Griša Močnik - J. Stefan Institute).

3. Past and current BC observations in the Arctic (Kjetl Tørseth - NILU).
4. SESS report 2019: BC observations on Svalbard (Stefania Gilardoni - CNR).
5. Long term EC and radiocarbon observations from Canada (Lin Huang -Environment Canada, presented by Stefania Gilardoni – CNR).
6. Measuring and modelling activities at Villum Research Station (VRS) in North Greenland (Andreas Massling - AU).
7. R/Y Oceania as a platform for aerosol studies in the Arctic (Anna Rozwadowska - IOPAN).
8. Observations during the MOSAiC year (Marco Zanatta - AWI).

Presentation session 2: From the atmosphere to the snow

9. Novel Assessment of Black Carbon in the Euroasian Arctic during NABCEA (Aki Virkkula - FMI).
10. Vertical aerosol and BC measurements on the ice flow during MOSAiC (Birgit Wehner - TROPOS).
11. BC-cloud interaction from airborne observations above Svalbard (Marco Zanatta - AWI).
12. BC-cloud interactions from Zeppelin Observatory, Svalbard (Robin Modini - PSI, Radovan Krejci - SU).
13. New evidence of soot particles affecting past and future clouds and climate (Zamin Kanji - ETH).
14. Snow observations around Ny-Ålesund, Svalbard over the last 10 years (Jean-Charles Gallet - NPI).
15. BC snow and air observations from Hornsund, Svalbard (David Capelletti - UNIPG).

Presentation session 3: Modelling approaches in the Arctic

16. Modelling BC in the Arctic: ongoing discussion and open issues (Bjørn Samset - CICERO).
17. Review of reporting systems for BC emissions inventories (Brad Matthews, Environment agency Austria).
18. Visualisations of model-measurement comparisons (Jacob Schacht - TROPOS).
19. Source apportionment of BC at Zeppelin (Stephen Platt - NILU).
20. AMAP modelling overarching goals (Marianne Tronstad Lund, CICERO).
21. Modelling activity and data policy during MOSAiC (Marco Zanatta - AWI , Bernd Heinold - TROPOS).

Presentation session 4: Parameterization in models

22. Regional modeling of Arctic BC with the WRF-Chem model (Louis Marelle - LATMOS).
23. Atmospheric transport modeling and top-down emissions estimates (Nikos Evangeliou - NILU).
24. Global modeling of BC ice nucleation (Zachary McGraw - UIO).
25. Parametrization of atmospheric ageing of BC (Marco Zanatta - AWI).
26. Parametrization of size distribution of BC (Hitoshi Matsui – Nagoya University, presented by Robin Modini – PSI).

3. List of participants (28 total)

Roxana Cremer (Stockholm University), Birgit Wehner (TROPOS), Andreas Massling (Aarhus University), Griša Močnik (J. Stefan Institute), Mauro Mazzola (CNR Italy), Louis Marelle (LATMOS France), David Cappelletti (Universita degli Studi di Perugia), Zamin Kanji (ETH Zurich), Bernd Heinold (TROPOS), Jacob Schacht (TROPOS), Alf Kirkevåg (Norwegian Meteorological Institute), Kjetil Tørseth (NILU), Stephen Platt (NILU), Marianne Tronstad Lund (CICERO), Robin Modini (PSI), Stefania Gilardoni (CNR Italy), Marco Zanatta (AWI), Anna Rozwadowska (IOPAN), Radovan Krejci (Stockholm University,

remote), Nikos Evangeliou (NILU), Bjørn Samset (CICERO), Konstantinos Eleftheriadis (NCSR), Jean-Charles Gallet (NPI), Zachary Mcgraw (University of Oslo), Bradley Matthews (Environment Agency Austria, remote), Aki Virkkula (FMI), Lin Huang (Environment Canada, remote) and Hitoshi Matsui (Nagoya University, remote).

4. Scientific outcomes of the workshop

The workshop was successful in bringing together a broad range of different researchers with expertise in both BC observations and modelling. This provided an excellent opportunity to start making plans for collaborations that will take advantage of the wealth of new BC observations that are being collected in and around the MOSAiC expedition. In addition, it also provided a unique opportunity to summarize the current status of major Arctic BC research efforts and to discuss areas where observations and models are or could be working together (making "handshakes"). This mostly included emission, lifetime, ageing and climatic impacts such as interaction with clouds and solar radiation. These insights are currently being prepared in a meeting report, which we intend to submit to a peer-reviewed publication.

5. Workshop recommendations

A major issue in quantifying the climatic impacts of BC in the Arctic is that models are optimized to match specific in-situ observations (e.g. BC vertical profiles). This in turn typically produces unintended consequences in other areas of the model (e.g. sulphate vertical profiles). This model 'equifinality' might lead to similar outcomes by different representations of model processes. It indicates that we are not truly validating model radiative forcing estimates with observations. A second crucial question was risen "Will a perfect model agree with perfect observations?". How could the different spatial sampling of the models (200 km) and the observations (10 km) represents be possibly compared? Despite advances in computing power, there is still a big gap between the complexity of processes that we are able to directly validate with observations and what can be included in a model.

Ways forward to remedy the current issues:

- BC in models and measurements should be compared with other aerosol species This means co-located measurements of many aerosol species are very important.
- Inverse modelling can improve the emission inventory of BC in and around the Arctic, reducing one of the reasons for model/measurement discrepancies, and thus supporting a better understanding of BC transport and removal mechanisms.
- Understanding atmosphere-cryosphere interaction is essential to develop reliable parameterizations of BC wet and dry deposition, BC impacts on snow and ice albedo, and to support the use of historical BC records in snow and ice to reconstruct atmospheric BC trends.
- The 'perturbed parameter ensemble' approach that has been developed and used with good success in the Southern Ocean around Antarctica allows using observations from the cruise to reduce uncertainty in (global) radiative forcing estimates. Slow mobile measurements such as cruises produce many observations across a given model grid-box, so the grid-box average is much more representative.

- Due to the complex meteorological impact on aerosol phenomenology, the interaction with non-aerosol modellers and observers in the field of meteorology and atmospheric dynamic is highly needed.

Overall, technology is mature enough that substantial improvement of current understanding of BC climatic impact requires active interaction across multiple disciplines and common intents of the modelling and observational communities.