

Reviewer #2

General comments: In this study, the authors present observations of particle composition and size distributions from the Barrow Environmental Observatory. The authors compare and contrast observations of aerosol from air masses that originated over the Arctic Ocean with aerosol from air masses that originated from the direction of the Prudhoe Bay oil fields. I recommend the manuscript for publication, provided that my following points, and those of the first reviewer, are addressed. In order to reduce redundancy for the authors' response, I will restrict my points to those not covered by the first reviewer.

Specific comments:

P3 Lines 14-16: Stohl et al. (2013) makes no attribution of PM or OC from Prudhoe Bay.

We clarified this statement to now read: “The majority of PM emitted by US Arctic oil and gas extraction sources (turbine gas combustion, diesel emissions from generators and vehicles, and flaring (Stohl et al., 2013)) in 2004 corresponded to BC (1.9 kt) and OC (2.0 kt) (Peters et al., 2011)”.

P9 Lines 18-25: I think perhaps that the authors intend to exclude regional-scale nucleation events here, but not nucleation within emissions plumes from the Prudhoe Bay oil fields. The authors even suggest that the emissions from such drilling operations can contribute to new-particle formation on page 3, lines 19-21. Observations of particle growth would be expected for a regional-scale nucleation event, but not for continuous nucleation within an emitted plume of condensable gases, such as those observed by Brock et al. (2002) and Brock et al. (2003). If there was continuous new-particle formation occurring within a plume from the Prudhoe Bay oil field, under steady-state conditions (including constant wind speed and direction), no change in the size of observed aerosol would be observed unless the distance from the source changed. The age of the aerosol between nucleation in the plume and detection at the observation site would be constant with time, and therefore so would the size of the aerosol.

We clarified this on P10 L9-10: “However, regional new particle formation would typically be followed by particle growth (Kulmala et al., 2004), which was not observed (Figure S2).”

Technical Corrections:

P11 Line 16: “(Sierau et al. (2014))” should be “(Sierau et al., 2014)”

We corrected this.

References

- Kulmala, M., Vehkamäki, H., Petäjä, T., Dal Maso, M., Lauri, A., Kerminen, V.-M., Birmili, W., and McMurry, P. H.: Formation and growth rates of ultrafine atmospheric particles: a review of observations, *J. Aerosol. Sci.*, 35, 143-176, 2004.
- Peters, G., Nilssen, T., Lindholt, L., Eide, M., Glomsrød, S., Eide, L., and Fuglestad, J.: Future emissions from shipping and petroleum activities in the Arctic, *Atmos. Chem. Phys.*, 11, 5305-5320, 2011.
- Stohl, A., Klimont, Z., Eckhardt, S., Kupiainen, K., Shevchenko, V., Kopeikin, V., and Novigatsky, A.: Black carbon in the Arctic: the underestimated role of gas flaring and residential combustion emissions, *Atmos. Chem. Phys.*, 13, 8833-8855, 2013.