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REPORTS OF THE SUB-COMMITTEES

Comments on the outcome of PPR 1 regarding the impact on the Arctic of emissions of Black Carbon from international shipping

Submitted by Norway

SUMMARY

Executive summary:	This document presents scientific information regarding the effects on the Arctic of emissions of Black Carbon. Furthermore, data regarding the contribution from shipping is presented
Strategic direction:	7.3
High-level action:	7.3.2
Planned output:	7.3.2.2
Action to be taken:	Paragraph 15
Related documents:	MEPC 65/4/22; PPR 1/8/1 and PPR 1/8/6

Introduction

1 This document comments on the outcome of PPR 1 regarding the consideration of Black Carbon emissions.

2 In order to assist the Committee in the consideration of possible actions regarding the impact on the Arctic of emissions of Black Carbon from international shipping, this document present the latest science on this topic.

Background

3 Temperatures in the Artic have been increasing twice as fast as the global average in the past few decades ((AMAP), 2011). Potential increase in activities in the Arctic will most likely increase this trend if mitigation actions are not taken. Short-lived climate forcers – emissions with a lifetime in the atmosphere of a few days to ten years – are relatively important for warming in the Arctic.

4 One emission type with a potentially large impact on warming in the Arctic is Black Carbon (BC). Black Carbon aerosols contribute to global warming by absorbing solar radiation and heat the ambient air. The warming effect of Black Carbon is of particular concern in the Arctic because it absorbs solar radiation and because BC deposits on snow and ice in the Artic reduce the reflectivity – or albedo – of the region, reducing the amount of solar radiation which is reflected back out of the Earth's atmosphere.

Effect of black carbon emissions in the Arctic

5 In climate research, a common means of quantifying the global warming effect of emissions is in terms of radiative forcing, usually expressed in watts per square metre (W/m^2). This refers to the change in radiant energy from the sun received by Earth and radiated back to space. BC is said to contribute to global warming because it exerts positive radiative forcing on the Earth. The presence of BC causes more solar radiation to be absorbed by the atmosphere and the surface than would otherwise be absorbed. Radiative forcing is a good indication of how gases and particles interact with the atmosphere, but it is not necessarily an indication of increase in surface temperature.

6 The warming effects of BC emissions are dependent on several factors: the presence of clouds, surface albedo, and water vapour and background aerosol distributions. Modelling these factors is highly complex, and is performed using climate models. The most advanced climate models are fully coupled, meaning that they model the interactions between the atmosphere, the ocean, land and sea-ice. Studies aiming to quantify the effect of BC on global warming based on radiative forcing report a high degree of uncertainty, with some past studies even reporting that BC in the atmosphere in the Arctic has a cooling effect at the surface (Shindell & Faluvegi, 2009).

7 Some of this uncertainty is due to the difference in the vertical profile of Black Carbon calculated by the models (Samset et al. 2013). The variations in the radiative forcing generated from various climate models are mainly due to the difference in vertical transport of atmospheric BC in the models. BC emissions transported to higher altitudes will result in a small warming effect or even a cooling effect (Sand, Bertnsen, Kay, Lamarque, Seland & Kirkevåg, 2013); however, BC emissions remaining at lower altitudes, as would be the case for emissions from shipping at high latitudes, will result in a warming effect at the surface.

8 One reason that the Artic is particularly sensitive to the altitude of BC is that the low temperatures on the surface of the Arctic create a shield over the region, so that pollutants from higher up in the atmosphere are not easily deposited on the (Earth) surface (Flanner, 2013). Currently, the largest volume of BC in the Arctic is emitted from the mid-latitudes and transported to higher altitudes in the Arctic. Additionally, heat generated by warming of BC in mid-latitudes is transported northwards to the Arctic and causing an increase in surface temperature. However, model simulations indicate that BC emitted within the Arctic region has about five times the surface temperature response per unit BC emitted compared to BC emitted at mid-latitudes (Sand M., Berntsen, Seland & Kristianjánsson, 2013). This is partly due to the effect of BC deposits on snow and ice. Emissions from shipping may have less of a per unit warming effect because there is less snow and ice where and when the ships are travelling. Although more surface warming in the Arctic is due to BC emissions at mid-latitudes because of the heat transported northwards and due to the higher volume of emissions at these latitudes, BC emitted in the Arctic has a higher impact per unit emission. Reducing BC emissions in the Arctic is therefore the more cost-effective means of reducing warming impacts of BC.

Significance of BC emissions from shipping

9 The relative contribution of shipping BC to total BC in the Arctic varies according to the time of year. This is due to the variation in shipping activity and transport and removal processes for BC in the atmosphere. Figure 1 shows the results of a collaborative study performed by the Norwegian Meteorological Institute and DNV GL. It can be seen that the share of total black carbon emissions in the Arctic is significant from June to September, when shipping is most active.

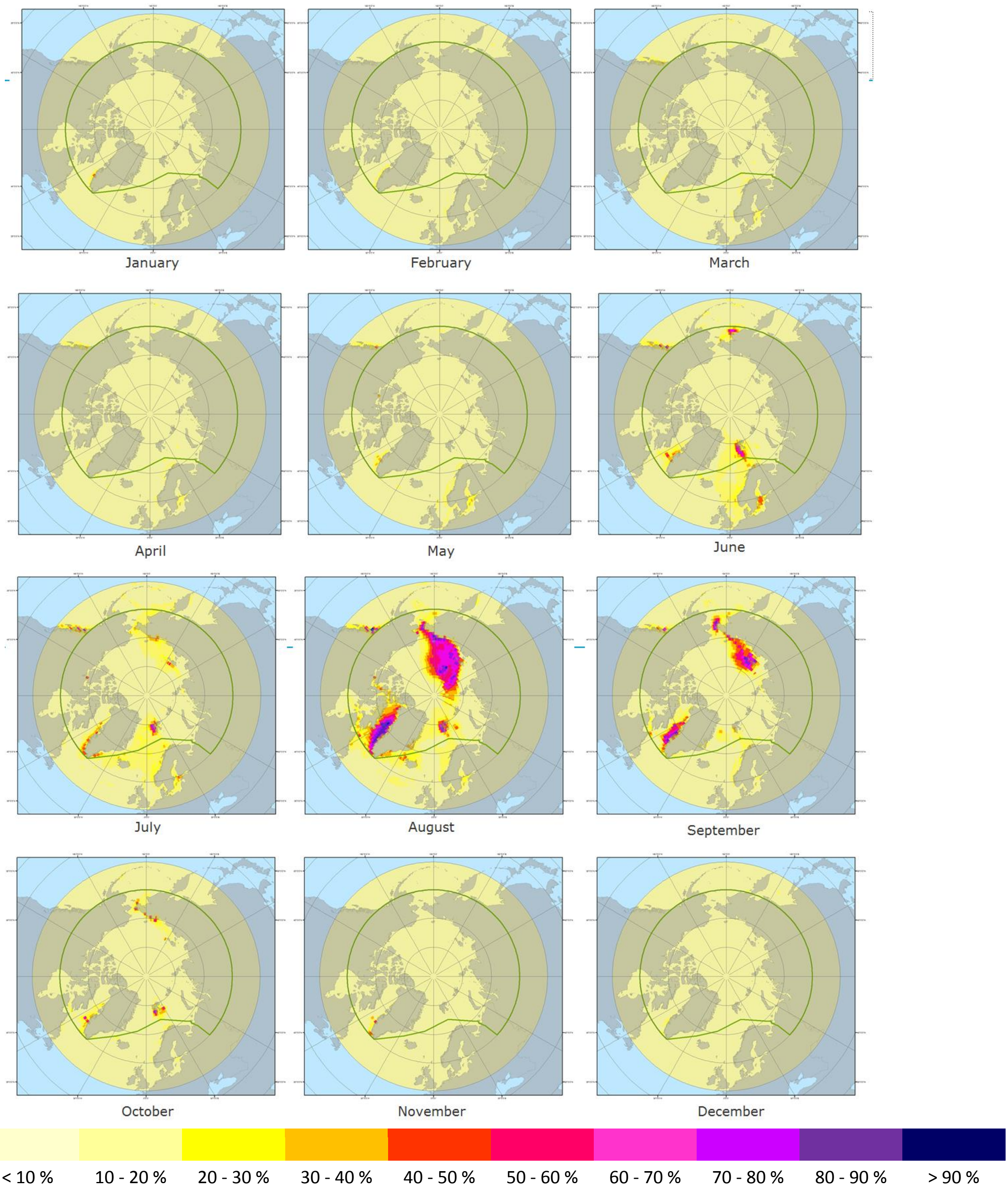

Figure 1: Share of surface black carbon concentration originating from shipping in 2012

10 Figure 1 shows during times and in regions of high transit in August, BC emissions on the surface are dominated by shipping. Note that Figure 1 shows the relative surface concentrations of BC from shipping. The relative share of the total column concentration would be much less. However, on a regional scale other important inventories in the Arctic include oil and gas flaring, and residential fuel burning. One study performed at the Norwegian Institute for Air Research indicates that the role of gas flaring in creating BC emissions is underestimated and can account for as much as 42% of the annual mean BC surface concentration in the Arctic (Stohl, et al. 2013).

11 It is recognized that BC emissions from other sectors, particularly oil and gas, are also significant and would be considered as appropriate in other fora. However, activities from shipping are expected to increase, which will increase their relative contribution to the total BC emissions in the Arctic. One study performed at Centre for International Climate and Environmental Research (CICERO) uses an engineering-based model to forecast the shipping and oil and gas activity in 2030 and 2050, and the corresponding emissions of these sectors. The results indicate that while in 2004 the annual Arctic BC emissions from shipping were only 8% compared to those from oil and gas, by 2030 BC emissions from shipping will be 250% greater than those of the oil and gas sector, and in 2050 they will be 295% greater (Peters et al. 2011).

12 These results indicate that the contribution from the shipping industry is increasing and large enough to warrant action. Much of the increased shipping activity is also due to the expected increase in oil and gas activity in the region.

Conclusions

13 Although much uncertainty remains in quantifying the warming effects of BC in the Arctic, recent studies have shed light on the importance of how different emission sources contribute to BC at different altitudes, with significant impact on its global, and in particular Arctic, warming effect. Most recent science indicates that although the highest volume of BC present in the Arctic comes from the mid-latitudes, BC emitted in the Arctic region as the most significant surface warming effect per unit emission. This is partly due to the fact that BC emitted in the Arctic is emitted near the surface.

14 Currently, a small amount of BC is emitted in the Arctic, but this is expected to increase with increased activity from shipping, as well as from other sectors. This, combined with the importance of emissions of BC released in the Arctic region indicates a need for the mitigation and reduction of Black Carbon emissions from shipping.

Action requested of the Committee

15 The Committee is invited to consider this document and take action as appropriate.

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ANNEX

WORKS CITED

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