

Interactive comment on “Future emissions from oil, gas, and shipping activities in the Arctic” by G. P. Peters et al.

G. P. Peters et al.

glen.peters@cicero.uio.no

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Whilst the reviewer made several useful comments, we feel that the review had some factual errors which we would like to indicate before a decision is made on the manuscript. We are happy to make necessary changes based on the review to improve our paper and the reviewer does point to a few areas where we can improve the article. First, however, we feel that several issues need clarification and/or correction. This is not a complete response to the review. We are only indicating key issues for further discussion.

The following numbers refer to the reviewer's numbering. We only raise the relevant points which refer to factual errors or comments we find misleading.

C1835

1 Is the article in ACP scope?: The reviewer says “maybe”, while referencing the article by Corbett et al in ACP which covers the same issue (and is one reason we submitted to ACP).

2 Novel concepts: Our paper models oil and gas production and shipping, and transit shipping in the Arctic. The reviewer claims our work is not novel; however, we disagree with this assessment. A global model of oil and gas production (FRISBEE, peer reviewed and well described, see Aune et al) is used to estimate the oil and gas production and in this paper we focus on the Arctic results in addition to distributing them over a 1x1 grid. We are only aware of one other study of Arctic oil and gas production (referenced, Wood MacKenzie and Robertson). A separate model of shipping is used to describe the oil and gas shipping and the transit shipping. For the transit shipping, “The voyage cost calculations includes fuel costs, explicitly modelling the effect of transiting ice, and additional construction costs for ice-strengthening. For each port pair, cargo volumes are then assigned to the most profitable route, which in turn gives the number of transits in 2030 and 2050.” We are not aware of such a detailed model elsewhere in the literature. For the oil and gas component, “The fuel consumed by tanker vessels is modelled by assuming shipping routes and transshipment ports based on the [output of the FRISBEE model], and by combining this with the same model for fuel consumption as for transpolar shipping”. In total, we are not aware of such a detailed modelling attempt of Arctic oil and gas and shipping emissions, and invite the reviewer to provide evidence of similar or more detailed attempts.

4 Is FRISBEE a “black box”?: Sections 3.2.1-3 describes the FRISBEE model (about 3 pages) plus 4-5 pages in the Supplement plus three references, including two in peer reviewed journals. It is not uncommon, in our opinion, to use an economic model to generate scenarios or projections. Referring to the Corbett et al paper cited in the review, it also makes assumptions (explicitly and implicitly, such as a percentage of trade diversion through the Arctic) and we believe our paper does a more thorough analysis to model future activities in the Arctic (shipping and otherwise).

C1836

6 Data not made available: We have no issue posting our data as supporting information.

7 We intentionally leave out work: This seems to be explicitly referring to the Corbett paper, which we have cited, but perhaps not enough. We also cite other Arctic shipping studies (Khon et al and Paxian et al). We have performed comparisons, but these could be more detailed. We also perform comparisons of the oil and gas production. We are currently involved in a project comparing Arctic inventories and atmospheric/climate responses. In a revised version, we can include more detailed comparisons between studies.

8 The study is Norwegian focused: Norway is not mentioned in the title, abstract, or introduction. The figures clearly show this is not a Norwegian focused study. That the authors are Norwegian is the only Norwegian bias we can think of.

Reviewer's detailed comments:

1. We separate the comment into the oil and gas modelling and the shipping modelling.

FRISBEE (oil and gas): The comments on the FRISBEE model are misleading and incorrect. The FRISBEE model is used to estimate the oil and gas production. The FRISBEE model has been described elsewhere, applied elsewhere, and has been peer reviewed in addition to several working papers (which is more common in economics). The assumptions of the model are well described in the paper, supporting information, and the various cited references. We have performed various sensitivity studies, such as the dependence on the oil price, see Figure 2. FRISBEE is a global model, but in this paper we focus on the Arctic results. We also distribute the results spatially on a 1x1 grid. We are aware of one other Arctic study and we compare our results (as we cite, Wood MacKenzie). The comments on the FRISBEE model are not very specific other than referring to it as a "black box".

Shipping: Another model (also described in the paper) is used to estimate the transit

C1837

shipping and this is based on engineering and economics, and is well described in the paper and supporting information. The transit shipping model is not explicitly coupled to FRISBEE, but the oil and gas shipping depends on the output of FRISBEE: "The fuel consumed by tanker vessels is modelled by assuming shipping routes and transshipment ports based on the production figures, and by combining this with the same model for fuel consumption as for transpolar shipping."

Many of the modelling comments raised by the reviewer are discussed in various parts of the paper and supporting material; perhaps we can do this better, but we do not believe the reviewer's comment is a fair representation of our work. If it is necessary, we are happy to improve our explanations, but in many cases the reviewer's comments are not very specific.

2. As far as we are aware, our paper for the first time produces estimates of oil and gas production at the gridded level in the Arctic; the Wood MacKenzie study allocates output to petroleum provinces. In addition, our paper for the first time considers shipping specifically due to oil and gas production in the Arctic. We invite the reviewer to provide a list of references of studies that we have missed covering oil and gas production and oil and gas shipping in the Arctic. The reviewer is correct that other papers have considered transit shipping, and to quote "Other studies have assumed a percentage diversion of traffic (Corbett et al., 2010), a prolonged sailing season (Khon et al., 2010), or treated sea-ice as an impassable barrier (Paxian et al., 2010)". Paxian et al. (2010) give a range of 0.73 – 1.28 Mt for fuel consumption in the North-East Passage in 2050, which is less than our estimate of 1.78 Mt, though system boundaries differ which makes comparison difficult. Corbett et al. (2010) has higher estimates, by a factor 1.3-2, but again care is also needed to ensure consistent system boundaries. The reason for the difference seems to be that Corbett et al. (2010) assume that as much as 2% and 5% of global seaborne trade will be shifted to the Arctic in 2030 and 2050, respectively. We do acknowledge, however, that we can discuss the differences between the different modelling approaches and corresponding results in more detail

C1838

in a revised version.

3. If ACP would like the data set provided, this can be done.

Glen Peters, on behalf of the authors.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 4913, 2011.