

Interactive comment on “Assessing the potential for DMS enrichment at the sea-surface and its influence on air–sea flux” by C. F. Walker et al.

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Below we reproduce the comments from reviewer 2 and reply to these:

We thank the reviewer for their support and constructive critique of our manuscript.

1. Bacterioplankton are also an important source of DMS, which they produce from phytoplankton-derived DMSP. This needs to be considered within your proposed paradigm. Did you count bacterioplankton and/or bacterioneuston?

Bacterial abundance was measured at 1 cm and at 1.6m; however, this paper focuses on DMS concentration and flux data, and bacterial utilisation of DMSP in near-surface waters in SOAP is addressed by Lizotte et al. (manuscript to be submitted).

2. DMS as a source of CCN - has this ever been proven? A more contemporary view

C1

of marine CCN sources needs to be acknowledged. What about carbohydrate-based microgels?

As the basis of the CLAW hypothesis, DMS has long been regarded as a potential source of CCN. There is, however, evidence both for and against this (as summarised in Quinn and Bates (2011), including the potential role of organics and microgels. Consequently we have revised this sentence to read:

“It has been hypothesised that DMS-derived aerosols may have a significant impact on the radiation budget (Charlson et al., 1987; Andreae and Crutzen, 1997; Ayers and Gillett, 2000) via direct scattering of sunlight and changes to cloud properties. However, more recent experiments highlight additional biogenic sources and pathways for the production of CCN even in the absence of sulfate aerosol (Quinn & Bates 2011; Bianchi et al., 2016; Kirkby et al., 2016).”

3. Did you quantify phytoneuston? Please explain how dinoflagellates, coccolithophores and other phytoplankton were counted and identified? Given ‘biological conditions’ (Page 10 L24) are a key factor in your conclusions, then I think that some biological data should be included.

Biological data was not included in this manuscript as it focuses on DMS concentrations and flux, and the full biogeochemical description for SOAP will be provided in the overview paper (Law et al., draft to be published) and other papers. We feel there is sufficient biogeochemical distinction of the three blooms to warrant attribution of differences in [DMS] and DMS flux to biological conditions without presentation of this data. Phytoplankton community composition and abundance measurements were made at 1cm depth and also at 1.6m. We have now included the following sentence in the Methods:

“Phytoplankton identification, biomass and abundance data were obtained by optical microscopy of Lugols-preserved samples. These data are presented elsewhere.”

C2

4. Page 1 L25 This statements needs a reference.

The reference McCoy et al. (2015) has now been added to the statement "In remote, relatively pristine marine environments such as the Southern Ocean, the production of aerosols and clouds is predominantly governed by natural sources."

5. Page 2 L 20 Natural degassing or methodological degassing?

We believe the sentence in question is on L28. This has been modified to read:

"To date, studies characterising near-surface [DMS] have shown a decreasing gradient towards the interface, indicative of degassing to the atmosphere (Zemmelink et al., 2005)."

6. Page 3 L1 What is the 'challenge'? Please explain.

This sentence now reads:

"Despite the challenge of maintaining a DMS source in a relatively thin (10-100 μm) layer at the air-water interface that is subject to extreme physicochemical conditions (Zuev et al., 2001), a number of studies have examined and identified enrichment of DMS in the sea-surface microlayer as summarised in Fig. 1 and references therein."

7. Page 12 L27 Dinoflagellates are DMSP producers. OK, but what about DMS?

Enzymatic cleavage of DMSP is currently viewed as the primary process for DMS production. As dinoflagellates are a major source of both DMSP and DMSP lyase, the enzyme which converts it to DMS (Steinke et al, 2002), it is assumed that dinoflagellates are responsible for DMS production. Steinke et al (2002 & references within) identify that dinoflagellates can convert DMSP to DMS, and there are a number of empirical studies that have identified elevated DMS associated with dinoflagellates (e.g. Zhang et al., 2014; Zindler et al., 2012). We have included some of this information in the Discussion.

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