

Interactive comment on “Dimethylsulfide (DMS) production in polar oceans may be resilient to ocean acidification” by Frances E. Hopkins et al.

Anonymous Referee #1

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General comments The paper describes experimental results examining the response of DMS and DMSP concentration, synthesis & production rates to acidification in Southern Ocean & Arctic waters and compares them with previously published results from the NW European shelves. The authors report regional trends in responses, which they attribute to the variability in the carbonate system and its influence on the plasticity of the phytoplankton community and DMS/DMSP response. The analysis is somewhat limited to the carbonate system & phytoplankton size class without consideration of other factors. The paper is clear and well-written, and makes important points including regional variation in response to acidification, and also that different processes occurring at different scales are responsible for the variable responses reported over different timescales (as exemplified by comparison of microcosm versus

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mesocosm responses). The paper is of publication standard if the points below relating to interpretation & analysis can be addressed.

Specific comments

Title The comparison with the NW European Shelf results is an important part of this paper and merits mention in the title

Introduction Line 122 – these microcosm experiments are not long enough to test adaptation. Results from experiments on timescales of < 1 week may give insight into plasticity and acclimation, but not “adaptive capacity”

Results Fig. 3 Error bars are relatively large at 96 hours in Arctic waters – this should be noted and discussed

Line 304-305; Fig 4c Error - “DMSP concentrations were found to DEcrease significantly in response to elevated CO₂ AT 48 h for Barents Sea (Fig. 4 C)”. Also note that DMSP was not significantly different at 96 hours.

Discussion 4.1 Regional differences in the response of DMS(P) to OA The interpretation of the treatment effects would benefit from statistical analysis to support the interpretation in:

Line 375-376 “De novo DMSP synthesis and DMSP production rates show a similar relationship with DIC/Alk (Fig. 7 A and B)” - is the difference between 0.91 > and < 0.91 significant? With the exclusion of one station (DIC/Alk ~0.901) there looks to be no difference in Figure 7. Statistical confirmation required.

Line 379-380. “At T1, Chl a showed little response to elevated CO₂ at polar stations, whereas a strong negative response was seen in temperate waters (Fig. 8A)” – again this description does not really match the data in the figure. The polar stations show a smaller range of treatment effect than temperate stations which show both larger positive and negative effects. Statistical confirmation required

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Line 380-382. “A slight positive response in Chl a was seen at most temperate stations by T2, with generally little response at polar stations (Fig. 8 B).” Aren’t the highest treatment effects at the polar stations? Statistical confirmation required

The analysis is limited to considering the carbonate system & phytoplankton size class as the factors determining regional response. Other factors will have differed between the polar waters and NW European shelf and may have influenced DMS/DMSP response to ocean acidification such as temperature, light, nutrients and phytoplankton community composition. For example, the authors mention “slower microbial metabolism at low water temperatures”, so could this explain the observed difference in regional response? Datasets for these variables are most likely available, and a more comprehensive analysis that considers these would benefit the paper and interpretation. This may have already been carried out by the authors, in which case it should be noted that there are no relationships between response and these other variables.

A minor point here is that methodological differences should also be considering when assessing response. For example, different light cycles were used on different voyages.

They should also consider the degree to which the experimental manipulations alter the carbonate system relative to the ambient mean. The magnitude of change upon acid/base addition from the mean state of the carbonate system may be a more important factor than the regional range. For example, a proportionally larger shift in pH or carbonate upon acid/base addition may initiate a greater stress response and so DMS/DMSP production.

Lines 431-434: “In the following section, we explore the causes of this apparent resilience in terms of the environmental conditions to which the communities have presumably adapted.” It should be noted that the variation in DIC/Alk reflects regional scale variation in single point measurements at each station (Line 362 “. . . the sampled waters”), and not the DIC/Alk variation at a particular site. Phytoplankton may experience greater or less variation at a single location on a temporal basis, which may

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be a more important factor determining response. The role of temporal variation in determining response should be discussed.

Lines 451-457. The examples cited to support the authors contention that variability induces plasticity are from coastal waters and under ice, where greater variability would be expected. Would the variability be equally as large at the open ocean stations in this study?

Line 462-463 The authors mention the mean state here. Although the inclusion of the Tynan et al (2016) data is useful, this regional variation gives no indication of the local spatial & temporal variation that phytoplankton would experience at each station. The argument would be stronger if the responses were compared with mean local values for the carbonate system (from Tynan et al) for each station, which will to some extent, integrate temporal & spatial variability, rather than using just the values for the water sampled for the experiment (which I assume is what was done).

Technical corrections Line 55 chlorophyll-a maxima IN SURFACE WATERS Line 87 Sentence is a bit clunky Line 130-133 Shorten sentence Line 145 – Clarify that the Hopkins & Archer (2014) is from the NW European Shelf Line 256 – What does E1-E4/E5 refer to? Line 315 “Initial DMSP concentrations were higher AT THE SOUTHERN OCEAN STATIONS than for Arctic stations. . .” Line 317 “Net increases in DMSP occurred throughout, EXCEPT AT SOUTH GEORGIA. . .” Line 320 “the final time point at South Georgia (144 h) when a significantly LOWER DMSP with increasing CO2 was observed” Line 350. As the results from the 4 unpublished NW European microcosm experiments are not presented in this paper, they should be identified as unpublished in Table 1 Line 365; Table 1 legend should identify that the polar stations are the two JR voyages excluding Station NS & IB.

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