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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Linking marine phytoplankton emissions, meteorological processes and downwind particle properties with FLEXPART" *by* Kevin J. Sanchez et al.

Anonymous Referee #1

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General Comments

This manuscript presents the linking of marine aerosols to oceanic biological and meteorological parameters that were estimated by residence-time-weighted air mass transport history. The paper appears to be original and to provide a valuable dataset obtained during four field campaigns. However, there are a few scientific issues to be addressed before the paper can be accepted for publication.

Specific Comments

As the authors highlighted, the biological activities of the surface ocean have an important influence on the physiochemical properties of marine aerosols. Further clear

explanation of the biological characteristics of the study area would greatly benefit the paper. These biological characteristics may include the following: 'the main phytoplankton species, because the emission of biogenic VOCs is highly species-specific', 'differences in mean chlorophyll-a concentration and net primary production (NPP) for four field campaigns', and 'major biological pathway in oceanic VOCs production'.

Air mass transport history, combined with biological and meteorological parameters, was used to estimate environmental factors controlling marine aerosols and VOC in this study. Similar analyses have been conducted previously (Arnold et al., 2010; Park et al., 2018); hence, the authors should definitely explicitly explain what aspects of their work are novel and of significance.

The authors need to provide time series measurement results for key observation parameters (including atmospheric concentration of organics, sulfate and DMS).

Biogenic VOCs in the ocean can be produced via several pathways, including photosynthetic byproducts, bacterial degradation of dissolved organic matter, and zooplankton grazing on marine phytoplankton. The authors need to verify relevant explanations (e.g., lines 32-33).

Provide relevant references for lines 46-48 and lines 54-55.

Line 56: dissolved organic matter also acts as an important contributor to marine aerosols.

Line 66: In general, the abundance of marine phytoplankton reaches its maximum during the spring period, and the mixed layer depth is much shallower during summer than during spring.

Line 93: Chlorophyll-a could be used as an indicator for the biomass of marine phytoplankton, but not for biogenic VOC emissions. The production of biogenic VOCs is highly species-specific and is controlled by a complex food-web mechanism.

Lines 213-214: NPP is not the only process that is linked with biogenic VOC emissions;

oceanic VOC production is also related to multiple biological processes. Please modify this sentence.

Line 273: “because the phytoplankton cycle is fairly slow (1 year)”. I agree that the use of 8-day averaged values for sea surface chlorophyll-a and NPP is sufficient to evaluate the relation between aerosol parameters and oceanic biological activities. However, this explanation is inadequate because the life cycle of individual phytoplankton is not that slow (typically a few days). I believe that it might be better to demonstrate the variation in daily (or 8-day) chlorophyll-a concentration at a given domain for each cruise period to support the idea that the use of 8-day chlorophyll-a values is appropriate.

Lines 284-286: Comparing in-line chlorophyll-a with trajectory-weighted chlorophyll-a does not make sense. This is because the FLEXPART backward trajectories reflect the travel history of air parcels rather than ocean currents.

As shown in Fig. 4, several key aerosol parameters are weakly and moderately correlated with FLEXPART-residence-time-weighted explanatory variables when all datasets obtained from the four separate field campaigns that were conducted in different seasons are gathered. However, to clearly support the author’s explanation, a statistically valid relation between these parameters should be observed for each cruise. This is because Environmental factors affecting the formation and growth of marine aerosols may vary from season to season.

It would be better to provide figures for 5-day FLEXPART residence-time-weighted values, since the authors insist that many of the correlation strength increased at longer trajectory lengths.

Line 436: The use of ‘satellite measured ocean surface biomass’ is not correct. This is because colored detrital organic materials and euphotic zone depth do not reflect biomass at the sea surface.

Line 440: replace ‘abundance’ with ‘biomass’

Line 447: What does ‘surface biomass’ indicate? ‘Net primary production’? NPP does not mean biomass.

Provide a clear explanation for ‘refractory’ and ‘non-refractory’ particles.

Lines 31-35 (abstract), 445-453 (conclusion), and relevant explanation in the Results and Discussion section: The explanation in these parts is confusing and hard to follow. As the authors noted, the lifetime of DMS in the atmosphere (1-2 days) is longer than that of other trace gases such as isoprene and monoterpene (less than a few hours). Considering the typical growth rate of SOA particles in the marine atmosphere, the difference in the lifetime of these VOCs (DMS, isoprene, etc.) may not significantly affect their temporal contribution to the organic aerosol mass over the study period. Moreover, the North Atlantic Ocean is well-known for high sea water DMS concentrations (a few nM, and occasionally increasing up to hundreds of nM during the phytoplankton bloom period due to the high abundance of DMS-producing phytoplankton groups such as haptophytes). The seawater concentration of isoprene (a few pM) in the North Atlantic Ocean is much lower than that of DMS (e.g., Dani and Loreto, 2017).

Technical corrections

Line 68: replace SO4 with SO42-

Line 168: provide full name for SEMS

References

Arnold, S.R., Spracklen, D.V., Gebhardt, S., Custer, T., Williams, J., Peeken, I., Alvain, S., 2010. Relationships between atmospheric organic compounds and air-mass exposure to marine biology. Environ. Chem. 7 (3), 232–241. https://doi.org/10.1071/EN09144.

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