We sincerely thank you for providing very insightful evaluations and suggestions for the manuscript. Our responses to the comments are listed below.

Color Code: Referee's comments, Authors response, Proposed changes in manuscript

Line numbers before and inside the bracket refer to those in revised manuscript with and without track of changes, respectively.

The article of Zhou and colleagues presents a novel global gridded dataset of sea-surface DMS concentration and emission based on the ANN technique. Given that DMS is the main biogenic source of atmospheric sulfur globally, the development of approaches that enable the production of detailed DMS emission maps is crucial for atmospheric chemistry and climate studies. The advantage of the new dataset over previous ones is to be found in its daily temporal resolution and multiyear coverage, which (unfortunately) is not matched by increased spatial resolution.

The article is generally well written and gives compelling arguments (e.g. in a strong Introduction) for the wide use of this novel dataset. Beyond the time-resolved fields, other welcome innovations with respect to previous machine learning approaches are the exclusion of time and coordinates as predictor variables (which should enhance model generality and decrease the risk of overfitting) and the validation against fully independent datasets. Below I make some suggestions. I also propose some non-exhaustive corrections to the writing, and encourage the authors to undertake a general check of English grammar.

Specific comments:

L65: please consider citing:

Galí, M., & Simó, R. (2015). A meta-analysis of oceanic DMS and DMSP cycling processes: Disentangling the summer paradox. *Global Biogeochemical Cycles*, *29*(4), 496-515.

Hopkins, F. E., Archer, S. D., Bell, T. G., Suntharalingam, P., & Todd, J. D. (2023). The biogeochemistry of marine dimethylsulfid. *Nature Reviews Earth & Environment*, *4*(6), 361-376.

Thank you for your suggestion. We have added these two references.

L89: the reference to Galí 2021 is incorrect (no machine learning used in that study). The following references to machine learning studies should be included:

McNabb, B. J., & Tortell, P. D. (2022). Improved prediction of dimethyl sulfide (DMS) distributions in the northeast subarctic Pacific using machine-learning algorithms. *Biogeosciences*, *19*(6), 1705-1721.

McNabb, B. J., & Tortell, P. D. (2023). Oceanographic controls on Southern Ocean dimethyl sulfide distributions revealed by machine learning algorithms. *Limnology and Oceanography*, *68*(3), 616-630.

Thank you for pointing out this mistake arising when organizing the reference list. The references to Arctic Ocean should be as following and we have corrected it. The citations you recommended have also been added.

> *Humphries, G. R. W., Deal, C. J., Elliott, S. & Huettmann, F. Spatial predictions of sea surface dimethylsulfide concentrations in the high arctic. Biogeochemistry 110, 287-301 (2012)*

Qu, B., Gabric, A. J., Zeng, M. & Lu, Z. Dimethylsulfide model calibration in the Barents Sea using a genetic algorithm and neural network. Environ. Chem. 13, 413-424 (2016)

Lines 91-99 (87-90): The machine learning techniques have also been used to simulate the distribution of DMS in the Arctic (Humphries et al., 2012; Qu et al., 2016), North Atlantic Ocean (Bell et al., 2021; Mansour et al., 2023), Northeast Pacific Ocean (McNabb and Tortell, 2022), Southern Ocean (McNabb and Tortell, 2023), and East Asia (Zhao et al., 2022).

L91, entire paragraph: note that higher temporal resolution would be even more valuable if accompanied by higher spatial resolution. Daily resolution (e.g. satellite data) typically shows (sub)mesoscale patterns that are blurred at 1 degree or after monthly averaging.

Thank you for your insightful comment. We agree that high temporal resolution would be more valuable if accompanied by higher spatial resolution. For this study, the spatial resolution is constrained by the ECCO dataset, in which the largest spatial grid size is 110 km, thus we are not able to achieve higher spatial resolution without interpolation. We believe that improving spatial resolution is a direction that needs to be advanced in the future. A short discussion on this issue has been included in Section 4 (**Uncertainties and limitations**).

Lines 693-697 (564-569): In terms of the temporal resolution, our product significantly surpasses previous monthly climatologies. However, the higher temporal resolution would be even more valuable if accompanied by higher spatial resolution. In this work, the spatial resolution is limited by the ECCO dataset, where the largest spatial grid size is 110 km. Therefore, we are not able to achieve higher spatial resolution without interpolation. Enhancing the spatial resolution of DMS fields using high-quality input datasets with finer spatial resolution represents a prospective direction for future research.

L124: Is the information on Lat-Lon-Cap 90 really needed here?

Thanks for pointing this out. We agree this information is unnecessary and have removed it. However, to let the reader get a general idea of how large the grid is, we added the grid size range of LLC-90 in Table 1.

L126: using climatological data (nutrients, O2) to produce daily multiyear datasets is a bit paradoxical (as discussed later)

Yes, we agree that using climatological data to produce daily multiyear datasets is not a perfect approach, which may introduce additional uncertainties. We have updated the data sources of those variables. Specifically, we utilized Copernicus-GlobColour Level-4 dataset for Chl *a* and CMEMS global biogeochemical multi-year hindcast for nutrients and DO. Consequently, all input features now originate from multiyear datasets with daily resolution.

Table 1. The data sources and related information of variables used for model development, DMS simulation, and flux calculation

Variable	Data source	URL	Temporal resolution	Temporal coverage	Spatial grid
DMS	GSSD database	https://saga.pmel.noaa.gov/dms/	In-situ	Mar. 1972 – Aug. 2017	-
	Other campaigns integrated in Hulswar et al. (2022)	https://data.mendeley.com/datasets/hyn62spny2/1	In-situ	Feb. 2000 – Jun. 2016	-
Chl *a*	GSSD database	https://saga.pmel.noaa.gov/dms/	In-situ	Oct. 1980 – Aug. 2017	-
	Copernicus-GlobColour Level-4	https://data.marine.copernicus.eu/product/OCEANCOLOUR_GLO_BGC_L4_MY_009_104/description	Daily	Sep. 1997 – present	0.042°×0.0
	CMEMS global biogeochemical multi-year hindcast (only used for the simulation of DMS concentration in polar regions when satellite Chl *a* is unavailable)	https://data.marine.copernicus.eu/product/GLOBAL_MULTIYEAR_BGC_001_029/description	Daily	Jan. 1993 – present	0.25°×0.25
SST	NOAA OI SST V2	https://psl.noaa.gov/data/gridded/data.noaa.oisst.v2.highres.html	Daily	Sep. 1981 – present	0.25°×0.25
MLD	NASA ECCO V4r4	https://data.nas.nasa.gov/ecco/data.php?dir=/eccodata/llc_90/ECCOv4/Release4	Daily	Jan. 1992 – Dec. 2017	LLC90 (22 110 km)
DSWF					
SSS					
Nitrate	CMEMS global biogeochemical multi-year hindcast	https://data.marine.copernicus.eu/product/GLOBAL_MULTIYEAR_BGC_001_029/description	Daily	Jan. 1993 – present	0.25°×0.25
Phosphate					
Silicate					
DO					
WS	NASA ECCO V4r4	https://data.nas.nasa.gov/ecco/data.php?dir=/eccodata/llc_90/ECCOv4/Release4	Daily	Jan. 1992 – Dec. 2017	LLC90 (22 110 km)
SI	NOAA OI SST V2	https://psl.noaa.gov/data/gridded/data.noaa.oisst.v2.highres.html	Daily	Sep. 1981 – present	0.25°×0.25

Figure 4: Line P stills shows large interannual variability in late summer (Aug) that is not captured by the ANN. This would be clearer if a linear (not log) y-scale was used, and may deserve some discussion.

Thank you for your comment. The y-axis here has been changed to linear scale. Since each data point of Line P program just represents a single measurement taken at a specific time point within the month, rather than the monthly mean, it is difficult to tell the interannual variability based on these measurements. However, we acknowledge that our model falls short in accurately reproducing the extremely high DMS concentrations. This limitation stems from the sparse availability of samples with extreme DMS concentrations for training. We pointed out this issue in the revised manuscript.

Lines 375-383 (319-326): Notably, the model generally underestimates high DMS concentrations during summer, particularly those exceeding 10 nM, consistent with earlier discussions. Aggregating data from all campaigns across three regions, the $\log_{10}$ space RMSE of simulated DMS concentrations against observations is 0.294, marginally higher than the training set. Most simulated values (87.8%) are within the range of 1/3 to 3 times of observations. The results further evidence that there is no significant overfitting in our model. When data from each campaign are binned, simulations demonstrate high consistency with observations, as depicted in Fig. 6c (RMSE = 0.278, R^2 = 0.651). In summary, although our ANN ensemble model may not precisely reproduce small-scale variations and extreme values in specific regions and periods, it reasonably captures overall large-scale variations.

L284: this is also consistent with the phytoplankton spring-summer bloom patterns…

Thank you for your valuable information. We have added it into the discussion.

Lines 406-410 (341-344): The other is the subarctic North Atlantic (45°–80° N). A notable increase of DMS concentration starts around 45°–50° N in May and gradually shifts northward beyond 50° N by July (Fig. 7-8). This spatiotemporal evolution pattern corresponds to the evolution of solar radiation intensity and the spring-summer bloom patterns of phytoplankton (Friedland et al., 2018;Yang et al., 2020).

Fig. 6 caption: "for each grid point"

Revised as suggested.

Fig. 8: inclusion of Kt is welcome

L354: are these mean concentrations weighted by pixel (grid cell) area?

Yes, they are also corresponding to area-weighted mean concentrations. We have added this information.

Lines 495-497 (413-415): The global area-weighted annual mean DMS concentrations in L11 and H22 are 2.43 nM and 2.26 nM, respectively, which are approximately 41.3% and 31.4% higher than Z23.

L362: this feature of G18 may be due to overestimation of Chl by satellites in coastal regions because of the interference of CDOM and non-algal detrital particles.

Thank you for point this out. We have added it into the discussion.

Lines 505-508 (421-423): This characteristic is not fully replicated by other DMS fields, possibly due to the overestimation of Chl *a* by satellites in coastal regions caused by the interference of colored dissolved organic matters and non-algal detrital particles (Aurin and Dierssen, 2012).

Fig. 8, 10, 11: I recommend reporting Kt in m d-1 rather than m s-1

This is a good suggestion. The unit of Kt in these figures and main text have been changed to m d^{-1}.

L455: but note that G18 and W20 can be used to produce daily multiyear DMS fields as Z23. This is not possible for interpolated climatologies L11 and H22.

Thank you for your comment. We have added a discussion on it.

Lines 649-651 (533-535): It is worth noting that the satellite-based algorithms of G18 and ANN model of W20 can also be utilized to produce daily multiyear DMS fields as Z23. Future investigations could include comparisons with these fields, facilitating a more comprehensive assessment of the performance of each algorithm/model.

Fig. 12a: please use the same colours as in Fig. 9e to distinguish the different algorithms

Revised as suggested.

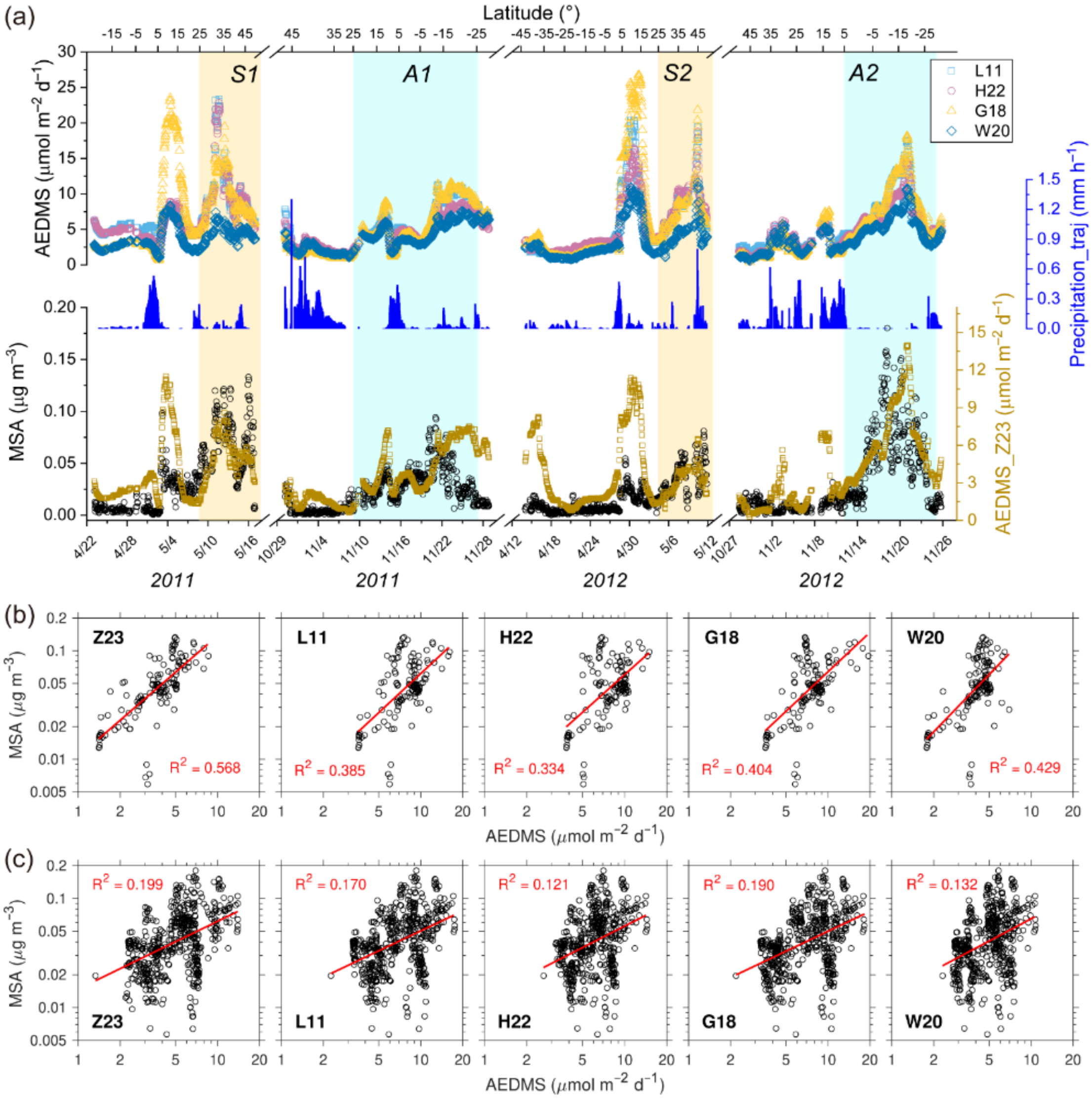

Figure 14. (a) Time series of observed MSA concentration, AEDMS calculated based on different DMS concentration datasets, and average precipitation along the backward trajectory (Precipitation_traj) during four Atlantic cruises in 2011–2012. (b–c) Correlations between hourly MSA concentration and AEDMS based on different DMS concentration datasets (b) during periods S1 + S2 and (c) during periods A1 + A2. Data points during the periods with air mass time fraction within the boundary layer less than 90% or Precipitation_traj larger than 0.05 mm h^{-1} were removed.

Suggested rewording:

L103: “demonstrated” >> “shown, depicted”

L171 “Root(ed) mean square error”

L176 “is larger” >> “exceeds”

L259: “off-line” >> “discrete sampling (Niskin bottle)”

Revised as suggested.

L505: revise grammar

Thank you for pointing this out. We have revised the grammar.

Line 698 (570): When using our newly developed DMS dataset, there are two issues that need to be noted.