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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Technical note: The MESSy-submodel AIRSEA calculating the air-sea exchange of chemical species" *by* A. Pozzer et al.

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General remarks

We thank both the anonymous referees for constructive support.

Reviewer 1 is concerned that the submodel is not documented in sufficient detail, in particular with regard to which chemical compounds can be investigated besides CO2 and acetone. We have clarified the model further as described below.

The use of the submodel requires input from the user ("molar volume at boiling point, Henry's law coefficient and molar mass"), as is summarized in the text as "implementation in the MESSy submodel". All the implemented equations and a complete description of the submodel have been presented in this work. Although no specific values

have been given (with the exception of carbon dioxide), however, all the citations necessary to obtain them are present in the text. Nevertheless, to make the description more comprehensive, in the new version we have introduced a table with some suggested values (and references) for the tested species. Moreover an example of the AIRSEA namelist, with explanation of the switches, has been added as electronic supplement.

It should be noted that this submodel is modifying the mixing ratios according to on-line calculations. Before it can be applied in a global model it is always required to test the implementation, so as not to involuntarily destroy the chemistry.

Regarding the different piston velocity parametrisations, we agree that it is essential to have more parametrisations available. These parametrisations of K_w will be implemented (selectable by the user) within the next version of MESSy. In addition we have added some text and a new table summarising the implemented equations in the revised version of the manuscript.

Specific comments

Introduction

As it is stated in the manuscript AIRSEA has been developed mainly for organic compounds. Nevertheless it can be extended to many other tracers. However, it is true that no clear statements of the restrictions are present, and this has been amended in the new version

AIRSEA cannot be applied readily for tracers which have a very high reactivity in the salty water. This high reactivity can greatly enhance the transfer velocity. A typical example is ozone (O_3), which reacts (and dissociates) in the ocean so quickly that

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the deposition velocity is 40 times the calculated with this submodel. However, the submodel could be adapted (through the α parameter in Eq.(4) of the paper) to also account for these gases.

Submodel description

- The value of the Setschenow constant has to be defined by the user in the namelist file as input. It is to the responsibility of the submodel user to introduce the (hypothetically) correct value, although some suggested values are already provided for some tested tracers. The calculation of the theoretical value has been implemented only for cases where no direct measurements are available. Different parametrisations of K_s are available, but the one implemented in the AIRSEA submodel does not require additional data and is one of the more realistic parametrisations present in the literature (Ni,2000). However, we have expanded this topic in the new version with a description of the relative error of this theoretical calculation.

- We are grateful for the reviewers profound knowledge of the MESSy system and helpful comments. Specifically, we completely agree that there should be consistency between the submodels. Several recent code developments have made this submodel (in its default configuration) to be coherent and consistent with all the parametrisations present in DRYDEP, OFFLEM and ONLEM. This topic has also now been better addressed and clarified in the new text

Implementation

The submodel namelist already includes values for tested tracers (CO_2, isoprene, DMS, acetone, methanol and other simple organic carbon compounds), although not

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all of them have been activated to avoid interference/double counting with other MESSy submodels. A table with the tested tracer has been added (see “General remarks”).

Evaluation

Transfer velocity and satellite measurements

- The two parametrisations have different dependencies on the solubility of the tracer. While Eq.(7) is independent, Eq.(8) contains the dimensionless Ostwald number. Hence, the tracer solubility contributes to the determination of the transfer velocity. For CO_2 and a sea surface temperature of 280 K, Eq.(8) predicts higher values than Eq.(7) only for U_{10} lower than 7 m/s. The parametrisation described by Asher(1998) (Eq.(8)) is therefore giving different “enhancements” for different tracers.

- Yes. We have reformulated the sentence as suggested.

- We agree that the sentence is not clearly formulated. After a model (or instrument) development, it is required to test it for well known cases. The objective in this section is to show that from the dynamical model (giving the wind speed and surface temperature) the submodel recreates the transfer velocity as calculated with the same approach based on observations. This corroborates the results obtained in a different way (satellite measurements), confirming that the implementation of the equations is correct. We have rephrased this part.

  Our calculations are based on instantaneous wind fields using a single year simulation, and we contend that a detailed comparison with a climatology (Boutin and Etcheto,1997) will not give any additional informations. The main focus is to show that globally the two datasets are comparable. However, some text has

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been added including general remarks about the global average of the CO_2 transfer velocity.

METEOR55 ship cruise

- We agree with reviewer 1 and extend the description of the METEOR campaign, although we note that a comprehensive details of these measurements are published by Williams et al.(2004).
- Jöckel et al.(2006) is published online on ACP. The simulation, as explained in detail in Jöckel et al.(2006), has been weakly nudged.
- The concentration of 14 nmol/L has been calculated from the average of the measurements made during the METEOR 55 field campaign, corrected with salinity and temperature dependency of the Henry's law coefficient. This information is included in the revised manuscript.
- Figs.(6) and (7) have been clarified
- The caption of Fig(8) has been changed as suggested
- We evaluate the submodel with data from a field campaign, less than one month long (end October to mid November 2002). The focus is to show that the model is performing better (Figs.(6) and (7)) with the AIRSEA submodel than without. It is therefore reasonable to present a picture which illustrates the change in the mixing ratios for the analysed region and time, and we have chosen a day in the middle of the campaign as a sensible example. We have reformulated this part to clarify that the focus of our analysis was the impact of the submodel application on the short term.

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An extrapolation of the global effect based on the use of a single value for the water concentration of acetone is clearly not feasible. As shown by Williams et al. (2004), even in the relatively small region of the cruise, a North-South gradient in the sea surface acetone concentration is present, corresponding to the inter-hemispheric gradient Studies of the AIRSEA submodel effect for CH_3COCH_3 on global scale and on longer time-scale are beyond the scope of this technical note and will be addressed in future studies.

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