TM5-MP - Feature #4961

Updated ocean DMS source

10/23/2017 03:56 PM - Twan van Noije

Status:	Closed	**Start date:**	10/23/2017
Priority:	Normal	**Due date:**	
Assignee:	Twan van Noije	**% Done:**	0%
Category:		**Estimated time:**	0.00 hour
Target version:		**Spent time:**	0.00 hour

Description

We have since long calculated the DMS emissions over the ocean based on a monthly climatology of surface ocean DMS concentrations from Kettle et al. (GBC, 1999), an expression of the transfer velocity as a function of wind speed and Schmidt number from Liss and Merlivat (1986), and a temperature dependence of the Schmidt number described by a (third-order) polynomial for which I do not have a reference.

I have now included a new parameterization based on the climatology of ocean concentrations from Lana et al. (GBC, 2011), which is an update of the climatology from Kettle et al., in combination with recent expressions for the transfer velocity and Schmidt number from Wanninkhof (Limnol. Oceanogr.: Methods, 2014). The (fourth-order polynomial) fit used for the Schmidt number is based on data presented by Saltzman et al. (JGR, 1993), but applies to a broader range of temperatures as the (third-order polynomial) fit presented there. The polynomial applied in the original TM5 code gives a quite different (and less reliable) dependence. I have also replaced the temperature criterion applied in the earlier implementation, to decide whether emissions are suppressed by the presence of sea ice. In the new scheme, the fractional sea ice cover is used directly.

For more information, see my comments in the code.

I will make some sensitivity simulations using ERA-Interim for the year 2010 to test the impact on the DMS source.

History

#1 - 11/02/2017 11:03 AM - Twan van Noije

- Description updated

#2 - 11/02/2017 11:03 AM - Twan van Noije

- Description updated

#3 - 11/02/2017 03:24 PM - Twan van Noije

- File DMS_figure1.pdf added

- File DMS_figure2.pdf added

- File DMS_figure3.pdf added

- File DMS_figure4.pdf added

I have carried out a number of test simulations to evaluate the new scheme to calculate the ocean DMS source, as described above. Three simulations were done, with different implementations of the ocean DMS source:

- Original TM5 code
- Updated scheme using actual sea surface temperatures (SSTs)
- Updated scheme with SST approximated by the local 2-m air temperature (t2m).

The reason for including the third simulation, is that the SST field is not available in TM5 in the current setup of EC-Earth. It would be straightforward to add it to the set of fields transferred from IFS to TM5. However, the easiest solution would be to use t2m instead of SST, as is done in the old implementation. Note that the transfer coefficient depends on the sea water temperature through the Schmidt number.

All simulations were done for the year 2010, driven by ERA-Interim. Results are presented in the attached figures. In all figures, the numbers at the top right are the global means of the displayed fields.

Figure 1 shows the annual mean DMS flux for the three simulations. Note that I haven't removed the land DMS sources in these plots. The total land source is 0.87 Tg S/yr. The figure shows that approximating SST by t2m only has a small impact on the simulated pattern and strength of the source. The global annual total ocean DMS source (Tg S/yr) increases from 19.2 with the old code to 26.1 and 25.5 with the new scheme using SST and t2m, respectively. Thus, the impact of replacing SST by t2m is to reduce the global ocean source by only 2.4%. This is much smaller than both the

uncertainty in the source and the resolution dependence of the source calculation (in particular due to sub-grid variability in the 10-m wind), which is currently not accounted for. Therefore, the default setting in the new scheme is still to use t2m instead of SST. The results presented in Figures 2 to 4 have also been obtained using t2m.

Figure 2 compares the monthly DMS fluxes for January and July with the results from Lana et al. Their best estimate of the annual total ocean source is 28.1 Tg S/yr. Clearly, the new scheme produces patterns and amounts that are in much better agreement with Lana et al. The remaining differences can be explained by differences in both resolution, formulation of the transfer coefficient, and interannual variability.

Figures 3 and 4 compare the sulphate loads and aerosol optical depths simulated with the new and old schemes. The global annual mean sulphate burden increases from 0.855 to 0.923 Tg S. Strongest increases are found over the Indian Ocean and tropical Pacific. Over large parts of these regions, the (annual mean) sulphate load increases by 10 to 75%, while the optical depth increases by 5 to 50%. Since the model tends to underestimate the optical depth over most of the tropical oceans, it is expected that the use of the new DMS scheme will lead to reduced AOD biases in these regions.

The new scheme has been committed in revision r668. It requires a new input file of sea water concentrations. The new input file ("DMS_ocean_conc.nc") is available from ec:/nks/EMISSIONS/DMS/ and should be put in the same directory as the old input file ("DMSconc.hdf"), which it replaces.

I propose we merge this update into the trunk.

#4 - 11/10/2017 11:33 AM - Twan van Noije

- Status changed from In Progress to Resolved

The new scheme has been merged into the trunk. I close the issue.

#5 - 11/10/2017 11:35 AM - Twan van Noije

- Status changed from Resolved to Closed

Files

DMS_figure1.pdf	478 KB	11/02/2017	Twan van Noije
DMS_figure2.pdf	689 KB	11/02/2017	Twan van Noije
DMS_figure3.pdf	520 KB	11/02/2017	Twan van Noije
DMS_figure4.pdf	576 KB	11/02/2017	Twan van Noije