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Interactive comment on "An online emission module for atmospheric chemistry transport models: Implementation in COSMO-GHG v5.6a and COSMO-ART v5.1-3.1" *by* Michael Jähn et al.

Anonymous Referee #1

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This manuscript presents a description of an online anthropogenic emission module and its implementation in two different atmospheric transport models, COSMO-GHG and COSMO-ART. The strength of the tool is (when compared to other existing emission processing tools) in its ability to perform online operations, which allow reducing the number and size of input files and the corresponding I/O. This is demonstrated by comparing the performance of the online emission module to an off-line and stand-alone Python package tool also developed by the authors. The paper is well written although it is sometimes lacking details. Therefore, it should be revised according to the following comments before its publication.

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Discussion paper

*Figure 1 and section 2:

Please indicate the file format of the data listed in the parallelograms.

If I understood it correctly, the python tool is responsible for generating the emission and temporal and vertical profiles NetCDF files that are later read by the online emission module. Nevertheless, in Figure 1 it is not clear which information/files are used to generate this NetCDF files (e.g. in which format are the emission and temporal/vertical profiles originally provided by the user to the Python tool). Similarly, the description and process for generating these NetCDF files (e.g. gridded_emissions_nc, hour_of_day_nc, day_of_week_nc, ...) should be included in section 2 and corresponding subsections (right now the description of the files is included in section 3.1).

*Section 2.1 – gridded emission inventories:

Perhaps this section should be accompanied with a table that list the different inventories that are currently available for processing and their main characteristics (e.g. name of inventory, pollutants considered, sector classification, year(s) of reference, spatial resolution-coverage, reference).

In its current version, the presented tool is capable of processing three different families of anthropogenic inventories (TNO, EDGAR and Swiss national inventory). I understand that other types of emissions such as biogenic or ocean are estimated/incorporated into COSMO using other specific models/tools (e.g. MEGAN for BNMVOCs), but what about biomass burning emissions (e.g GFAS or GFED)? Are they being estimated using an online approach inside COSMO?

*Section 2.2 and 2.3:

Temporal, vertical and speciation profiles are being applied to gridded emissions. Therefore, all the equations of these sections should represent emission of a tracer X at time t and grid cell c (instead of only tracer X at time t).

*Section 2.4:

Why the grid cell areas are calculated in degree? There are tools like CDO (Cdo{rbpy} for Python) that allow calculating grid cell areas in m2. It is currently not clear with which tools/libraries is the emission conservative mapping being performed (e.g using ESMF? Specific python libraries that allow creating geometric objects, such as shapefiles, and subsequently performing spatial interpolations?)

Following with the previous sections (2.2 and 2.3), an equation illustrating how the emissions are being mapped from the source grid cells onto destination grid cells should be included.

*Section 3.3.1:

How are separated the emissions when there are several countries into a cell (i.e. country border cells)? Or it is assumed that all emissions belong to the country that contains the largest fraction of the cell? Some inventories like TNO provide the information of emissions per grid cell and emitting country. Is this information used when given?

*Conclusion and Table 4 results:

According to the results presented in Table 4, the main advantage of using the online emission module instead of the offline tool is the significant reduction of the disk storage. Both in the COSMO-ART and COSMO-GHG test cases, authors suggest that increasing the length of the simulation period would imply a proportional growth of the benefit in disk usage. This very much would depend on how the workflow of the modelling system is set up. For instance, when running a 1-year simulation with an offline emission tool, modelers tend to generate an emission file of 24 hours for day “d”, then run the atmospheric chemistry model for day “d”, erase the emission file for day “d”, generate an emission file of 24 hours for day “d+1”, run the atmospheric chemistry model for day “d+1” and so on. In this situation, the benefit in disk usage would remain the same regardless of the simulation period (i.e. you will always be storing only one emission file of 24 hours). Having said that, I think the authors should include the time

required for data pre-processing when comparing the off-line and online approach. Otherwise the comparison remains unfair: the online computation of hourly emissions is considered but the offline computation of hourly emissions is not, which is also part of the modelling chain. Finally, the values reported for the simulation times should be split between time required to compute hourly emissions (online/offline), time spent on I/O and "others". This would allow to justify the suggested compensation between I/O decrease and computation increase reported by the authors.

*Meteorological parametrizations:

Besides the improvement shown by the authors in terms of disk storage, one would say that the main advantage of building an online emission module is the capability of computing on-line meteorological parametrizations such as heating degree day (for temporally distributing residential heating emissions) or plume rise calculation (for vertically distributing point source emissions). Scientifically (and even technically) speaking, the gains of performing such an implementation in comparison to an off-line approach may be much more significant. I understand that such an implementation may be more complex/time consuming than the one presented in this work, but perhaps it would be good to highlight it as a current limitation of the current tool and the need to work on it in the near future.

*Portability to other atmospheric transport models:

Authors suggest that the offline python package is of potential use for any atmospheric transport model system. I think this statement may be too strong in its current formulation, especially considering that each model requires the emissions to be provided following specific file formats (e.g. specific attributes in the NetCDF files) and conventions (e.g. units), and that certain models (e.g. WRF-CHEM, CMAQ) work with map projections that are currently not supported by the python package (e.g. lambert conformal conic, Mercator). Moreover, the current offline approach includes a COSMO pre-processor tool to perform a vertical interpolation to the model levels. How this

vertical interpolation would be performed in other models?

*Supplementary material:

Table S-1 to S-5: please specify from which works/references are the profiles derived.

COSMO-GHG example namelist includes some namelist members that are not defined in Table 3 of the manuscript or in the text (e.g. itype_lbc). Please provide a description of them (or remove them if they are not relevant to the publication).

In order to illustrate how "contribl" is used for chemical speciation, can you also provide a COSMO-ART example namelist?

*Other specific comments:

Please specify the units of Ex(t), Ex,s and fx,s

Table 3: Why itype_emiss and itype_tscale are only needed for COSMO-GHG?

Figure 2 caption, please include the meaning of each polygon shape/colour (following the example of Figure 1's caption).

Please, add the following reference to the CAMS-REG-APV2_2 inventory: Granier, C., Darras, S., Denier van der Gon, H.A.C., Doubalova, J., Elguindi, N., Galle, B., Gauss, M., Guevara, M., Jalkanen, J.-P., Kuenen, J., Liousse, C., Quack, B., Simpson, D., and Sindelarova, K.: The Copernicus Atmosphere Monitoring Service global and regional emissions (April 2019 version), Copernicus Atmosphere Monitoring Service (CAMS) report, 2019, doi:10.24380/d0bn-kx16, 2019

In the introduction, when listing currently available emission processing systems, I would suggest to also mention the HEMCO system: Keller, C. A., Long, M. S., Yantosca, R. M., Da Silva, A. M., Pawson, S., and Jacob, D. J.: HEMCO v1.0: a versatile, ESMF-compliant component for calculating emissions in atmospheric models, Geosci. Model Dev., 7, 1409–1417, https://doi.org/10.5194/gmd-7-1409-2014, 2014

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