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Abstract title:

Improving the representation of the spatio-temporal variability of methane emissions in Europe

Abstract text:

Methane (CH_4) is a potent greenhouse gas. In addition, methane plays a crucial role in tropospheric ozone formation, contributing to air pollution and posing harmful effects on human health. Although modelling CH_4 and the exploitation of modern observation systems for GHGs requires temporal explicit information, a comprehensive representation of the spatial and temporal variability in a-priori estimates of anthropogenic CH_4 emissions remains largely absent.

We have developed a framework to derive explicit spatio-temporal emission information of anthropogenic CH_4 by extending the dynamic emission modeling system ARTEMIS which was originally developed for air pollutants to account for CH_4. The spatial allocation of emissions follows the gridding methodology of the European $CoCO_2$ or CAMS inventory, while national-level spatial allocation data were employed for Germany. To improve the spatial allocation of methane emissions from biogas production we have re-distributed the emissions to the exact location of the facilities and weighted the amount using their annual generation output.

CH_4 emissions from enteric fermentation from cattle have been disentangled from ammonia driven agricultural subsectors by implementing a dedicated diurnal emission profile connected to feed allocation. The temporal variability of CH_4 emissions from landfills has been parametrized as function of (changing) surface atmospheric pressure as derived from flux measurements at landfill locations. This causes the emissions to vary a factor 4 around the mean over the year, with a large

spatial correlation length. Furthermore, for the spatio-temporal variability of emissions from residential combustion a temperature dependent approach was implemented while activity data was used to improve the timing of emissions from the public power sector. The updated emission fields were incorporated into the LOTOS-EUROS chemical transport model, to assess the added value of the new emission data. Evaluation against ICOS tall tower observations demonstrated improved correlations between modeled and measured methane concentrations underscoring the need of such refinements.

Finally, we have expanded our emission data set with information on isotopic composition enabling -in a next step- the modelling of isotopic rations using dynamic emission fields of $\delta^{13}C\text{-}CH_4$ and $\delta^{14}C\text{-}CH_4$.