Kurzfassungen der Meteorologentagung DACH
Garmisch-Partenkirchen, Deutschland, 18.–22. März 2019
DACH2019-225

Model simulations of the atmospheric methane distribution 1997-2016: Evaluation against observations with conclusions on emission sources.

Peter Zimmermann
Max-Planck-Institut für Chemie, Atmospheric Chemistry, Mainz, Germany (p.zimmermann@mpic.de)

The global budget of atmospheric methane has been simulated with the EMAC-model for the period 1997-2016, distinguishing eleven CH_4 source categories and applying atmospheric chemical and soil microbial sinks. Simulated CH_4 has been compared to observations from nine NOAA surface stations and 327 intercontinental CARIBIC flights.

Source segregated simulation (tagging) results have been processed with a non-linear optimization procedure to fit the station records wrt minimum RMS. The linear dependency of the atmospheric CH_4abundance on the source strengths allows an a posteriori rescaling of the individual emission amounts considered. So, e.g. Amazon wetlands, rice paddies, and bogs emissions are enhanced by about 8.8 along with a compensating reduction of anthropogenic fossil CH_4 emissions of 10.8 Tg/y. Furthermore the tagged simulation enables to analyze the composition of global CH_4 observations.

Simulating inter-annually constant sources and sinks reproduces the observations during the no-methane-trend period 1997-2006 in magnitude as well as seasonal and synoptic variability. Monthly averages fit the station measurements within a RMS of 1.35 %. The optimization post-processing improves the approximation to 0.35 %.

The 95 intercontinental CARIBIC flight data for the no-trend period up to 2007 are accurately reproduced by the model. The 740 air samples were mostly taken during northern hemispheric flights at $\sim$10km altitude near the tropopause. The average CH_4-volume mixing-ratio of 1785.36 nmole/mole is reproduced by the model within a 1.1% RMS deviation range.

To explain the renewed growth of CH_4 since 2007, a 28.3 Tg/yr larger global CH_4 emission was assumed in a first guess. Two additional tagged sources, one representing natural emissions from wetlands in the Amazon and the other anthropogenic shale gas production emissions in North America, have been invoked to investigate their role in the CH_4 trend. A comparable contribution by both sources explains the observed trend from 2007 to 2016. Based on non-linear optimization an additional contribution of 14.25 Tg/y from Amazon wetlands and an emission of 8.95 Tg/y from northern American shale gas sources explains the fits the all stations RMS deviation over the trend period considered within 0.5 %.

The 4287 samples collected at 232 CARIBIC flights after 2007 provide a comprehensive statistical data base, and the simulation average with an RMS = 1.3 % and R^2= 0.8 indicate that the model accurately reproduces observed CH_4 near the tropopause.