Sensitivity of atmospheric CH$_4$ concentrations to emission data sets and other forcings

A. Stenke, A. Coulon, E. Rozanov, and T. Peter

Introduction

Surface-based measurements reveal a continuous increase of atmospheric CH$_4$ levels in the 1980s, followed by a slowdown of the CH$_4$ growth rates in the 1990s, and a period of zero-growth between 1999 and 2006. Since 2007 atmospheric CH$_4$ concentrations are on the rise again. Although the main CH$_4$ sources and sinks have been identified, their absolute strengths and interannual variability are highly uncertain, and the reasons for the observed stabilization and the reinforced increase remain unclear. We performed simulations with the CCM SOCOL using different flux boundary conditions for CH$_4$. Furthermore, we did several sensitivity simulations with respect to other forcing parameters and their impact on atmospheric CH$_4$.

CH$_4$ growth rates. 'ACCMIP' compares very well with observations until the beginning of the 1990s, afterwards it shows a constant decrease. 'EDGAR4.1' growth rates are generally smaller than observed, but after 1992 the interannual variability is close to observations.

Annual cycle. SOCOL captures the observed annual cycle with high (low) CH$_4$ values in winter (summer). 'ACCMIP' overestimates amplitude of annual cycle, 'EDGAR4.1' is in good agreement.

SOCOLvs3/MIM1

- Model tool: CCM SOCOL vs3 incl. condensed isoprene chemistry (MIM1)
- Operational model version: prescribed CH$_4$ mixing ratios in the PBL
- Now: explicit treatment of CH$_4$ emission fluxes at the surface

CH$_4$ sensitivity to emission data sets

A. Post-Pinatubo
Negative growth rates in 1992 after the Pinatubo eruption related to enhanced tropospheric oxidation capacity and/or decreased CH$_4$ wetland emissions.

B. ENSO 1997/98
Enhanced CH$_4$ growth rates in tropics and northern mid- to high-latts due to enhanced CH$_4$ wetland and CO biomass burning emissions (see scenario 'CO' below). Not visible in run 'ACCMIP'.

C. 2000/2001
Model results suggest strong impact of NOx emission trends (see scenario 'NOx' below). Decrease in CH$_4$ wetland emissions is another potential reason.

CH$_4$ sensitivity to other forcing parameters

Model set-up: CH$_4$ emissions and one more forcing annually varying, other boundary conditions fixed to year 1988.

Exp Forcing parameter
CTRL88 all forcings, except CH$_4$, fixed to 1988
SST sea surface temperatures
SA stratospheric aerosol burden
CO$_2$ CO$_2$ concentration
N$_2$O N$_2$O concentration
Phot photolysis rates
CO CO emissions
NOx NOx emissions
SSI spectral solar irradiance
ODS ozone depleting substances

email: andrea.stenke@env.ethz.ch