# Evolution of the global methane concentration, sources and sinks during 1911-2010

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Methane in the atmosphere is second only to carbon dioxide ($CO_2$) as the contributor to the human induced radiative forcing over the past two centuries. Once broken down mainly by the reaction with hydroxyl (OH) radicals, CH4 actively participates in air pollution chemistry in the troposphere and is the predominant source of water vapour in the stratosphere. The global abundance of atmospheric methane has increased from ~900 ppb during the 1900s to ~1800 ppb during the 2000s. During the same period, the anthropogenic $CH_4$ emission has increased from 92 Tg/yr to about 321 Tg/yr (EDGAR-HYDE). However, much less is known about the cause of $CH_4$ concentrations increase over the $20^{th}$ centuries.

The CCSR/NIES/FRCGC Atmospheric General Circulation Model (AGCM)-based Chemistry Transport Model (ACTM) [Patra et al., 2009] is used to simulate $CH_4$ concentrations for the period 1900 to 2010. The AGCM transport is simulated online using the interannually varying monthly-mean sea-surface temperature distributions from the Hadley Centre. We combined emissions from bottom-up inventories of annual-mean anthropogenic emissions from EDGAR-HYDE 1.4 [van Aardenne et al., 2001] and EDGAR 3.2 [Olivier and Berdowski, 2001], simulated monthly-mean sources from wetland and rice paddies using a terrestrial biogeochemical model (i.e., VISIT [Ito and Inatomi, 2011]), and monthly varying biomass burning emissions from the GISS climatology [Fung et al., 1991].

The model simulations are compared with the constructed $CH_4$ concentrations time series from polar ice core data from Arctic and Antarctic, and direct measurements since 1980s at multiple sites around the globe. Our results suggest that the bottom-up global total sources were underestimated during the period of 1940-1980, because the simulated rate of $CH_4$ concentration increase are smaller than that observed. On the contrary, the global total emissions are overestimated for the 1980s. We have employed simple mass balance formulation to derive corrections to the emissions for better simulation of the $CH_4$ concentrations for the whole period of our simulation. Both the slow/normal (~5 ppb/yr) and rapid (~14 ppb/yr) growth rates for the periods 1900-1950 and 1950-1990, respectively, the dramatic drop in growth rate (~3.9 ppb/yr) during 1990s, and renewed growth rate (~5 ppb/yr) in 2007 are simulated well within ~2 ppb by ACTM while using the modified $CH_4$ sources.

**References**

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