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What are the drivers of atmospheric methane fluctuations during the last three decades?

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Atmospheric methane (CH4) concentrations have more than doubled since pre-industrial times, making CH4 the second most important greenhouse gas after CO_2 in terms of radiative forcing. Continous observations starting from the early 1980s indicate an increase of about 0.5 %/year until 2000, including a slowdown after 1990. After a period of about 8 years with growth rates close to zero, methane concentrations have been rising since 2007. The reasons for the observed variability are still unclear. The decrease of fossil fuel emissions resulting from the collapse of the Soviet Union in 1990 is found to be a possible reason for the slowdown of the methane growth rate during this period. The relative contribution of changes in natural and anthropogenic emissions on methane growth after the year 2000 remains unclear, as does the impact of the hydroxyl radical, the main atmospheric methane sink.

The SOCOL chemistry-climate model (CCM) has been used to perform simulations for the period 1980-2010, forced with prescribed meteorological fields. CCMs provide an ideal tool to investigate the relative importance of different methane emission source categories such as natural wetlands, rice paddies, ruminants, industry, etc., as well as methane sink processes. Additional methane tracers have been included into SOCOL, used with flux boundary conditions for CH4, which allow the tracking of methane emissions from different source categories and geographical regions. These new simulations provide an innovative way to better understand methane variability, both in terms of emission changes and changes in the chemical sink.

Main results based on the implemented tracers will be presented, showing the effects of both changing emissions and loss processes. Different time periods are distinguished, based on global methane concentrations. From 1980 to 1990, increasing anthropogenic emissions over Europe lead to a positive global methane growth rate. A decrease of these emissions after 1990 is consistent with the slow down in the global methane growth rate for 1990-2000. It appears that this trend is maintained after 2000 because of reduced natural emissions (mainly from wetlands). After 2005, the model shows a too pronounced increase in methane levels, which might be explained by overestimated anthropogenic emissions from China. The strong El-Nino event in 1997-98 is put in evidence by the model results to be responsible of the global increase of methane concentration via biomass burning over Tropical Asia.