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Methane fluxes in the high northern latitudes estimated using a Bayesian atmospheric inversion

Rona Thompson (1), Andreas Stohl (1), Cathrine Lund Myhre (1), Motoki Sasakawa (2), Toshinobu Machida (2), Tuula Aalto (3), Edward Dlugokencky (4), Douglas Worthy (5), and Andrey Skorokhod (6)

(1) NILU, Kjeller, Norway (rona.thompson@nilu.no), (2) National Institute for Environmental Studies, Tsukuba, Japan, (3) Finnish Meteorological Institute (FMI), Helsinki, Finland, (4) National Oceanic and Atmospheric Administration, Global Monitoring Division (NOAA-GMD), Boulder, Colorado, USA, (5) Environment Canada, Toronto, Canada, (6) A.M. Obukhov Institute of Atmospheric Physics RAS, Moscow, Russia

Methane (CH_4) is the second most important anthropogenic greenhouse gas after CO_2. Atmospheric CH_4 increased from pre-industrial concentrations of around 850 ppb (parts-per-billion) to 1773 ppb in the late 1990s and then remained approximately stable until the mid 2000s. However, since 2006 atmospheric CH_4 has begun to increase again. The reasons for the stabilization and subsequent increase are likely to be a combination of changes in anthropogenic emissions such as from fossil fuels, as well as natural wetland sources. While global atmospheric inversions indicate that natural wetland sources in the tropics and subtropics have contributed to the recent increase, land surface and ecosystem models generally indicate no increase in these sources. Another potential source for the change in CH_4 concentration could be wetlands in the high northern latitudes, which comprise about 44% of global wetland area. These latitudes are also undergoing rapid warming, which will impact wetland emissions of CH_4.

We present CH_4 fluxes for the high northern latitudes (>50°N) from 2005 to 2012 estimated from a Bayesian atmospheric inversion. The inversion incorporates observations from 17 in-situ and 6 discrete-sample sites across North America and Northern Eurasia. Atmospheric transport is based on the Lagrangian particle dispersion model, FLEXPART, run with ECMWF meteorological analyses. Emissions were optimized monthly and on a spatial grid of variable resolution (from $1° \times 1°$ to $4° \times 4°$). Background concentrations were estimated by coupling FLEXPART to monthly global 2-D fields of CH_4 concentration from a bivariate interpolation of smoothed data from the NOAA ESRL network. We estimate the total mean North American flux (>50°N) to be 18 – 27 Tg y^{-1}, and the total mean Northern Eurasian flux (>50°N) to be 55 – 66 Tg y^{-1}, both substantially higher than the prior (based on LPX-Bern for wetland and EDGAR-4.2FT2010 for anthropogenic fluxes). We also find a small trend in the wintertime fluxes in North America and North Eurasia, which may indicate an increase in anthropogenic emissions in both regions.