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Methane emissions in the Arctic and sub-Arctic from a Bayesian atmospheric inversion

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Methane (CH4) is the second most important anthropogenic greenhouse gas after CO_2. Globally, atmospheric CH4 concentrations have increased since direct measurements began, in the early 1980s, but then stabilized from the mid 1990s to the mid 2000s. Since 2006, the atmospheric CH4 growth rate has become positive again causing concern that it may be the response to climate feedbacks, especially in the Arctic, where there is a potential for a large release of CH4 to the atmosphere under warmer conditions. Such feedbacks include high latitude wetlands, permafrost and methane hydrates. Conversely, recent studies, suggest that this change is the result of a rise in wetland emissions of CH4 in the tropics and subtropics combined with a rise in fossil fuel emissions.

We present CH4 emission estimates for the Arctic and sub-Arctic from 2007 to 2011 using atmospheric mole fraction observations in a Bayesian inversion framework. This framework 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 $1^\circ \times 1^\circ$ to $4^\circ \times 4^\circ$). Background mixing ratios were found by coupling FLEXPART to output from the Eulerian chemistry transport model, TM5. We found evidence of a widespread release of CH4 corresponding to the onset of soil freezing. Furthermore, we find higher emissions in Northern Eurasia compared to the prior in both summer and winter.