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Methane emission estimates at northern high latitudes for 2004-2014 from CarbonTracker Europe-CH_4

Aki Tsuruta (1), Tuula Aalto (1), Leif Backman (1), Ingrid T. van der Laan-Luijkx (2), Maarten Krol (2,3), Sander Houweling (3), Renato Spahni (5), Sebastian Lienert (5), Edward Dlugokencky (6), Tuomas Laurila (7), Juha Hatakka (7), Doug Worthy (8), Motoki Sasakawa (9), Olli Peltola (10), Aleksateri Mauranen (10), Martin Heiman (11), Lena Kozlova (12), Andrew Crotwell (13), Wouter Peters (2,13)

(1) Finnish Meteorological Institute, Climate Research, Helsinki, Finland, (2) Wageningen University, Meteorology and Air Quality, Wageningen, the Netherlands, (3) SRON Netherlands Institute for Space Research, Utrecht, the Netherlands, (4) Institute for Marine and Atmospheric Research, Atmospheric Physcis and Chemistry, Utrecht, the Netherlands, (5) University of Bern, Climate and Environmental Physics, Bern, Swizerland, (6) NOAA Earth System Research Laboratory, Global Monitoring Division, Bolder, CO, U.S.A., (7) Finnish Meteorological Institute, Atmospheric Composition Research, Helsinki, Finland, (8) Environment Canada, Climate Research Division, Toronto, Canada, (9) National Institute for Environmental Studies, Center for Global Environmental Research, Tsukuba, Japan, (10) University of Helsinki, Department of Physics, Helsinki, Finland, (11) Max Planck Institute for Biogeochemistry, Department of Biogeochemical Systems, Jena, Germany, (12) University of Exeter, College of Life and Environmental Sciences, Exeter, U.K., (13) Groningen University, Centre for Isotope Research, Groningen, the Netherlands

Northern high latitudes (NHL) are covered by permafrost and peatlands, and store much of global soil carbon. As global warming proceeds, methane (CH_4) emissions from the Arctic and northern boreal regions are assumed to increase due to thawing of permafrost and shortening of soil freeze and snow cover periods. In addition, several large cities and industrial areas including oil and gas fields also contribute significantly to CH_4 emissions from NHL. Together, both biospheric and anthropogenic activities contribute to changes in atmospheric CH_4, but current understanding is still insufficient to quantify their contributions to the NHL and global CH_4 budget. In this study, we present CH_4 emission estimates for NHL for 2004-2014 from the CarbonTracker Europe-CH_4 (CTE-CH_4) data assimilation system. CTE-CH_4 is based on ensemble Kalman filter, and optimises biospheric and anthropogenic emissions simultaneously, constrained by global atmospheric CH_4 observations, which includes newly assimilated sites from NHL. The inversion results show that the contribution from NHL to global CH_4 emissions is higher than previously thought. Posterior total CH_4 emissions from 50°N-90°N are higher than prior estimates mainly from the EDGAR v4.2 FT2010 inventory and LPX-Bern dyptop ecosystem model. Much of the increase from the prior is found in anthropogenic emissions from central Russia, and in biospheric emissions from both North American and Eurasian boreal regions. In addition, the increase in the biospheric emissions resulted in stronger dependency of the CH_4 emissions to temperature than in prior, particularly in autumn. For northern Europe, anthropogenic emissions are estimated to be smaller than the EDGAR inventory, and the inversions suggest that the emission distribution may need to be revised.