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Improving estimates of N_2O emissions for western and central Europe using a Bayesian inversion approach

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The nitrous oxide (N_2O) mixing ratio has been increasing in the atmosphere since the industrial revolution, from 270 ppb in 1750 to 320 ppb in 2007 with a steady growth rate of around 0.26% since the early 1980's. The increase in N_2O is worrisome for two main reasons. First, it is a greenhouse gas; this means that its atmospheric increase translates to an enhancement in radiative forcing of 0.16 ± 0.02 Wm^{-2} making it currently the fourth most important long-lived greenhouse gas and is predicted to soon overtake CFC's to become the third most important. Second, it plays an important role in stratospheric ozone chemistry. Human activities are the primary cause of the atmospheric N_2O increase. The largest anthropogenic source of N_2O is from the use of N-fertilizers in agriculture but fossil fuel combustion and industrial processes, such as adipic and nitric acid production, are also important.

We present a Bayesian inversion approach for estimating N_2O fluxes over central and western Europe using high frequency in-situ concentration data from the Ochsenkopf tall tower (50°01′N, 11°48′, 1022 masl). For the inversion, we employ a Lagrangian-type transport model, STILT, which provides source-receptor relationships at 10 km using ECMWF meteorological data. The a priori flux estimates used were from IER, for anthropogenic, and GEIA, for natural fluxes. N_2O fluxes were retrieved monthly at 2 x 2 degree spatial resolution for 2007. The retrieved N_2O fluxes showed significantly more spatial heterogeneity than in the a priori field and considerable seasonal variability. The timing of peak emissions was different for different regions but in general the months with the strongest emissions were May and August. Overall, the retrieved flux (anthropogenic and natural) was lower than in the a priori field.