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Estimation of European CH_4 and N_2O emissions using a regional-scale atmospheric inversion system

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Methane (CH_4) and nitrous oxide (N_2O) play a significant role in the European greenhouse gas budget. Anthropogenic emissions of these gases are reported to the United Nations Framework Convention on Climate Change (UNFCCC) by almost all European countries. However, considerable uncertainties still exist in the bottom-up emission inventories for CH_4 and in particular for N_2O. Inverse modelling can provide complementary top-down emission estimates based on atmospheric concentration measurements and can - in the ideal case - serve as a verification tool for the emission inventories.

The regional-scale inversion system TM3-STILT is applied to estimate European CH_4 and N_2O emissions for 2006-2007 with a nominal spatial resolution of up to 0.25° x 0.25°. In this inversion system, the high-resolution regional Stochastic Time-Inverted Lagrangian Transport model STILT is coupled to the global 3-dimensional transport model TM3 in order to account for small-scale variability as well as large-scale patterns in fluxes and transport. Based on the same modular nesting technique, STILT inversions are also combined with the global 3-dimensional transport model TM5. The inversions are based on hourly atmospheric concentration measurements at 8-10 European continental sites and flask/hourly measurements at a large number of global sites in combination with a-priori flux estimates obtained from global emission inventories.

A series of sensitivity studies covering a range of inversion set-up parameters is performed to investigate the robustness of the emission estimates and to assess their uncertainties. They confirm that the available observational data mainly constrain the emission estimates for the western and central part of Europe. The overall patterns of the emission estimates for this region are relatively robust, even without the use of detailed a-priori emission information.