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Inverse modeling of European CH_4 emissions: sensitivity to the observational network

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Abstract. Inverse modeling is widely employed to provide "top-down" emission estimates using atmospheric measurements. Here, we analyze the dependence of derived CH_4 emissions on the sampling frequency and density of the observational surface network, using the TM5-4DVAR inverse modeling system and synthetic observations. This sensitivity study focuses on Europe.

The synthetic observations are created by TM5 forward model simulations. The inversions of these synthetic observations are performed using virtually no knowledge on the a priori spatial and temporal distribution of emissions, i.e. the emissions are derived mainly from the atmospheric signal detected by the measurement network.

Using the European network of stations for which continuous or weekly flask measurements are available for 2001, the synthetic experiments can retrieve the "true" annual total emissions for single countries such as France within 20%, and for all North West European countries together within ~5%. However, larger deviations are obtained for South and East European countries due to the scarcity of stations in the measurement network. Upgrading flask sites to stations with continuous measurements leads to an improvement for central Europe in emission estimates. For realistic emission estimates over the whole European domain, however, a major extension of the number of stations in the existing network is required. We demonstrate the potential of an extended network of a total of ~60 European stations to provide realistic emission estimates over the whole European domain.

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