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Comparing bottom-up and top-down approaches at the landscape scale, including agricultural activities and water systems, at the Roskilde Fjord, Denmark

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The greenhouse gas nitrous oxide (N2O) mainly originates in direct emissions from agricultural soils due to microbial reactions stimulated by the use of nitrogen fertilisers. Indirect N2O emissions from water systems due to nitrogen leaching and deposition from crop fields range between 26 and 37% of direct agricultural emissions, indicating their potential importance and uncertainty (Reay et al. 2012). The study presented here couples a top-down approach with eddy covariance (EC) and a bottom-up approach using different models and measurements. A QCL sensor at 96-m height on a tall tower measures the emissions of N2O from 1100 ha of crop fields and from the south part of the Roskilde fjord, in a 5-km radius area around the tall tower at Roskilde, Denmark. The bottom-up approach includes ecosystem modelling with CERES-EGC for the crops and PaSIM for the grasslands, and the N2O fluxes from the Roskilde fjord are derived from N2O sea water concentration measurements.

EC measurements are now available from July to December 2014, and indicate a magnitude of the emissions from the crop fields around 0.2 mg N2O-N m-2 day-1 (range -9 to 5) which is consistent with the CERES-EGC simulations and calculations using IPCC emission factors. N2O fluxes from the Roskilde fjord in May and July indicated quite constant N2O concentrations around 0.1 μg N L-1 despite variations of nitrate and ammonium in the fjord. The calculated fluxes from these concentrations and the tall tower measurements consistently ranged between -7 and 6 mg N2O-N m-2 day-1. The study site also contains a waste water treatment plant, whose direct emissions will be measured in early 2015 using a dynamic plume tracer dispersion method (Mønster et al. 2014). A refined source attribution methodology together with more measurements and simulations of the N2O fluxes from the different land uses in this study site will provide a clearer view of the dynamics and budgets of N2O at the regional scale. The complementarity between these bottom-up and top-down approaches and their usefulness to disentangle direct and indirect N2O fluxes will also be discussed.

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