Bottom-up and top-down approaches at the landscape scale, over a mixed landscape

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Nitrous oxide (N_2O) is a greenhouse gas mainly originating from fertilised agricultural soils. However, emissions, which are driven by microbial activity, leads large indirect emissions from water systems loaded with nitrogen transferred by leaching or atmospheric deposition. Moreover, N_2O emissions are highly variable in time and space, leading to large uncertainties when integrating N_2O at larger scale. This study tries to tackle this issue by coupling a top-down approach based on eddy covariance (EC) on a tall tower and footprint analysis and a bottom-up modelling approach validated with local scale measurements.

A Quantum Cascade Laser absorption spectrometry analyser is used to measure the N_2O fluxes at 96 m high. A footprint approach is used to allocate the flux a 5-km radius area around the tower including more than thousands of hectares of crop fields and the Roskilde fjord, Denmark. Ecosystem models (CERES-EGC for crops and PaSIM for grasslans), are used to aggregate the N_2O emission from the land, while fluxes from the Roskilde fjord are derived from N_2O concentration measurements in the sea water.

Bottom-up and top-down agree in evaluating emissions from crops of roughly 0.2 mg N_2O-N m^{-2} day^{-1} from July to December 2014, with a range including large depositions and emissions. The N_2O concentrations in the Fjord were around 0.1 µg N L^{-1} despite variations of nitrate and ammonium concentrations, leading to N_2O fluxes in the range -7 to 6 mg N_2O-N m^{-2} day^{-1}, consistent with the range of EC measurements. 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 N_2O at the regional scale.