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Reconciling bottom-up and top-down N2O emission inventories for Germany, Switzerland and the UK

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Nitrous oxide (N_2O) is a major GHG and ozone-depleting substance which is produced by microbial processes in soils, with mineral nitrogen availability, carbon availability, soil moisture, soil temperature, oxygen availability and pH being important controlling factors. Emissions of N_2O are notorious for being short-lived with the magnitude of emissions being difficult to predict due to the interplay of the aforementioned controlling factors. In Europe, the major share of anthropogenic N_2O emissions result from fertilizer application to agricultural land. National reporting typically relies on so-called Tier 1 or 2 approaches which relate activity data (N inputs) to an emission factor to estimate a national total. However, this method does not consider the full set of spatially and temporally varying controlling factors, so that the latter approaches may be biased. For this reason, reconciliation with an independent, top-down method has large potential to improve national GHG budgets and to review mitigation strategies.

Here we present results from the Horizon Europe project Process Attribution of Regional emISsions (PARIS), where we calculate bottom-up and top-down N_2O emission inventories for Germany, the UK and Switzerland at monthly time resolution for the timeframe 2018 – 2024. Bottom-up estimates are obtained using the biogeochemical model LandscapeDNDC and state-of-the-art European datasets. Top-down estimates are averaged results from three different inverse modeling systems: InTEM (UK MetOffice), RHIME (University of Bristol), ELRIS (EMPA) and two different atmospheric transport models: NAME-UM and FLEXPART-ECMWF.

We find the emission estimates from both top-down and bottom-up methods to be consistently higher than the corresponding national inventories, but bottom-up approaches are within the uncertainty of the top-down estimate. In terms of seasonality, bottom-up and top-down methods indicate a seasonal cycle, although its magnitude is country dependent. Across all countries, the

discrepancy between bottom-up and top-down estimates is greatest in autumn, where LandscapeDNDC predicts an emission peak following planting of winter crops. Discrepancies regarding magnitude and seasonality of top-down and bottom-up approaches will be discussed considering controlling factors for N_2O emissions simulated using LandscapeDNDC.