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## The influence of transport model resolution on the inverse modelling of synthetic greenhouse gas emissions in Switzerland

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Climate change is one of the biggest challenges of the modern era. Halocarbons contribute already about 14% to current anthropogenic radiative forcing, and their future impact may become significantly larger due to their long atmospheric lifetimes and continued and increasing usage. In addition to their influence on climate change, chlorine and bromine-containing halocarbons are the main drivers of the destruction of the stratospheric ozone layer. Therefore, observing their atmospheric abundance and quantifying their sources is critical for predicting the related future impact on climate change and on the recovery of the stratospheric ozone layer.

Regional scale atmospheric inverse modelling can provide observation-based estimates of greenhouse gas emissions at a country scale and, hence, makes valuable information available to policy makers when reviewing emission mitigation strategies and confirming the countries' pledges for emission reduction. Considering that inverse modelling relies on accurate atmospheric transport modelling any advances to the latter are of key importance. The main objective of this work is to characterize and improve the Lagrangian particle dispersion model (LPDM) FLEXPART-COSMO at kilometer-scale resolution and to provide estimates of Swiss halocarbon emissions by integrating newly available halocarbon observations from the Swiss Plateau at the Beromünster tall tower. The transport model is offline coupled with the regional numerical weather prediction model (NWP) COSMO. Previous inverse modelling results for Swiss greenhouse gases are based on a model resolution of 7 km x 7 km. Here, we utilize higher resolution (1 km x 1 km) operational COSMO analysis fields to drive FLEXPART and compare these to the previous results.

The higher resolution simulations exhibit increased three-dimensional dispersion, leading to a general underestimation of observed tracer concentration at the receptor location and when compared to the coarse model results. The concentration discrepancies due to dispersion between the two model versions cannot be explained by the parameters utilized in FLEXPART's turbulence parameterization, (Obukov length, surface momentum and heat fluxes, atmospheric boundary layer heights, and horizontal and vertical wind speeds), since a direct comparison of these parameters between the different model versions showed no significant differences. The latter suggests that the dispersion differences may originate from a duplication of turbulent transport, on the one hand, covered by the high resolution grid of the Eulerian model and, on the

other hand, diagnosed by FLEXPART's turbulence scheme. In an attempt to reconcile FLEXPART-COSMO's turbulence scheme at high resolution, we introduced additional scaling parameters based on analysis of simulated mole fraction deviations depending on stability regime. In addition, we used FLEXPART-COSMO source sensitivities in a Bayesian inversion to obtain optimized emission estimates. Inversions for both the high and low resolution models were carried out in order to quantify the impact of model resolution on posterior emissions and estimate about the uncertainties of these emissions.