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Reactive Species in the upper troposphere and lower stratosphere: aircraft measurements and EMAC/MECO(n) modelling

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Reactive species play an important role in the upper troposphere and lower stratosphere, as a changing chemical composition results in a changing radiative balance in the global atmosphere. Understanding key atmospheric processes in that region allows, e.g. identifying relative importance of individual processes, as well as quantifying the impact of aircraft emissions on composition and climate.
In this study we combine atmospheric measurements performed on-board of aircraft with regional and global scale comprehensive atmospheric modelling. Observations from a research aircraft, HALO (High Altitude Long Range Research Aircraft), are used together with IAGOS/CARIBIC routine measurements on scheduled aircraft. We use the atmospheric model MECO(n), which combines global modelling with regional nesting. MECO(n) is a MESSy-fied ECHAM and COSMO models n-times nested, including comprehensive chemistry and additional diagnostics.
We perform a hindcast of the ML-CIRRUS campaign period (March-April 2014) by nudging model meteorology to ECMWF reanalysis data, in order to investigate atmospheric processes and aircraft contribution. During the measurement campaign, target regions were Europe and the North Atlantic flight corridor (NAFC), where a high density of air traffic occurs. In this study we focus on measurement of reactive chemical species, in particular NO_y and ozone. The paper will first present atmospheric mixing ratios from both, MECO(n) model hindcast and aircraft observations, together with additional diagnostics enabled by the EMAC modular approach. Our study will present case studies for distinct measurement days. As part of the analysis, we present the impact of aviation emission as perturbation pattern to atmospheric mixing ratio of reactive species derived by comparing two distinct MECO(n) simulations, one including and one excluding aircraft emissions, along individual aircraft measurement paths. Aviation contribution to key atmospheric components demonstrates a strong geographic and temporal variation, hence identifying regions which are strongly influenced by aviation emissions, which would be promising candidates for measuring aircraft impacts.
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