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Simulation of current and future tropospheric chemistry with the Earth System Model EMAC

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The increasing future methane (CH_4) leads to changes in the lifetime of CH_4 and in the Hydroxyl radical (OH) and (O_3) mixing ratios and distribution in the lower atmosphere. With increasing CH_4 the lifetime of CH_4 and the O_3 mixing ratios in the troposphere will increase, the tropospheric OH mixing ratios will decrease (Winterstein et al., 2019; Zhao et al., 2019). The CH_4 changes, together with the future Nitrous oxide (N_2O) and temperature increase, will lead to a different tropospheric chemistry. For example, substances as acetone (CH_3COCH_3), ethane (C_2H_6), formic acid (HCOOH) or peroxy acetyl nitrate (PAN) will change their distribution and mixing ratios.

In different studies we could show that EMAC (ECHAM/MESSy Atmospheric Chemistry, Jöckel et al., 2010) has the ability to simulate some of the mentioned tropospheric substances in comparison to results of the GLORIA (Gimballed Limb Observer for Radiance Imaging of the Atmosphere) instrument, used on board of the research aircrafts Geophysica and HALO during the STRATOCLIM (July/August 2017) and WISE (August to October 2017) campaigns (Johansson et al., 2020; Wetzel et al., 2020).

In this study, we will additional show the first results of the simulated future changes of tropospheric chemistry (especially with focus on CH_3COCH_3, C_2H_6, HCOOH and PAN and the upper troposphere) related to the future increase of CH_4, N_2O and temperature change as a result of climate change. For these we use different EMAC simulations from the project ESCiMo (Earth System Chemistry Integrated Modelling, Jöckel et al., 2016).

We will present some results of the comparison of EMAC to GLORIA and results with regard to the future development of the (upper) tropospheric chemistry in EMAC.