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Airborne in-situ observations of SO_2 in Europe and Asia during the EMeRGe field campaigns

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We report on high-resolution SO_2 in-situ measurements performed during the EMeRGe (*Effect of Megacities on the Transport and Transformation of Pollutants on the Regional to Global Scales)* campaigns in Europe (July 2017) and Asia (March/April 2018) using the German research aircraft HALO based in Oberpfaffenhofen, Germany, and Tainan, Taiwan, respectively. Seven measurement flights in Europe and 14 flights in Asia were performed for sampling of pollution plumes down-stream of selected Major Population Centers (MPCs) at altitudes mainly below 3km.

For the SO_2 measurements two instruments were used, a Chemical Ionization Ion Trap Mass Spectrometer (CI-ITMS) with an in-flight on-line calibration and a Pulsed Fluorescence Analyzer. In addition further trace gases were measured (e.g. CO, NO, NO_y, O_3, PAN, CO_2, CH_4) for the characterization of the pollution plumes and potential emission sources. In Europe, the highest SO_2 mixing ratios were observed in the boundary layer downwind of the Po Valley, Greater London and the Benelux-MPC with peak values of 6 ppb. In East-Asia, enhanced SO_2 mixing ratios were measured downwind of the coasts of China, Taiwan, and the Philippines, in particular Manila, with values up to 10 ppb. Whereas the majority of the European MPCs were probed within a distance of $\sim$10km, the emissions of East-Asian MPCs (especially China) were measured at much larger distance from the sources ($>$100km downwind).

We use HYSPLIT dispersion simulations from the emission centers and air mass back-trajectory analysis from the flight sections with enhanced SO_2 concentrations to infer the emission sources. We also determine the age of the various sampled SO_2 pollution plumes and estimate the chemical loss of SO_2 during transport.