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### ★ Abstract title:

Aircraft Measurements of SO<sub>2</sub> in Pollution Plumes of Major Population Centers in Europe and East-Asia during EMeRGe

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We present in-situ measurements of SO<sub>2</sub> in pollution plumes of Major Population Centers (MPCs) 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 operated out of Oberpfaffenhofen, Germany and Tainan, Taiwan, respectively. The SO<sub>2</sub> measurement techniques used include a Chemical Ionization Mass Spectrometer (CI-ITMS) with an in-flight on-line calibration and a Pulsed Fluorescence Detector. We discuss the SO<sub>2</sub> observations together with additional trace gases and aerosol parameters measured from HALO (e.g. CO, NO, NO<sub>y</sub>, O<sub>3</sub>, PAN, CO<sub>2</sub>, CH<sub>4</sub>, ultrafine and fine aerosol). We relate the sampled MPC pollution plumes to emission sources using air mass back-trajectory analysis. In Europe, the highest SO<sub>2</sub> 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<sub>2</sub> mixing ratios were measured downwind of MPCs of China, Taiwan, and the Philippines with mixing ratios of up to 10 ppb. Whereas the majority of the European MPCs were probed within a distance of ~10 km, the emissions of East-Asian MPCs (especially China) were measured at a much larger distance from the sources (>100 km downwind). We determine the age of the various sampled SO<sub>2</sub> pollution plumes using simulations with a dispersion model and estimate the chemical loss of SO<sub>2</sub> during transport.