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First airborne in situ SO2 observations of two coal-fired power plants in Serbia and Bosnia-Herzegovina: Potential for top-down emission estimate and satellite validation

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Sulfur dioxide (SO_2) is known as a major air pollutant harmful to human health. Furthermore, it is a precursor gas of sulfate aerosol, which exerts a direct negative radiative forcing and thus leads to climate cooling. Anthropogenic SO_2 sources are primarily associated with the combustion of sulfur-rich fossil fuels. While the operation of flue gas desulfurization devices has led to large SO_2 reductions in western Europe, a hotspot of anthropogenic SO_2 sources remains in the Balkan region as recently observed from space by the TROPOMI instrument on the Sentinel-5P satellite. Large coal-fired power plants with no or only incomplete SO_2 removal cause these high emissions.

Targeting these strong emitters, the DLR Falcon 20 aircraft was equipped with an isotopically on-line calibrated Chemical Ionization Ion Trap Mass Spectrometer (CI-ITMS) to obtain detailed in situ SO_2 observations during the METHANE-To-Go-Europe aircraft campaign in autumn 2020. These SO_2 measurements were complemented by in situ observations of greenhouse gases (CO_2, CH_4), aerosol number concentrations, and other short-lived pollutants (CO, NO, NO_y). Two flights, on November 2nd and 7th 2020, focused on characterizing the pollution plumes downwind of two coal-fired power plants located in Bosnia-Herzegovina (Tuzla) and Serbia (Nikola Tesla), respectively. These power plants belong to the ten strongest SO_2 emitters in Europe, and according to the World Health Organization, both countries are among the most polluted ones in Europe.

We present a detailed analysis of the two DLR Falcon flights with strongly enhanced SO_2 mixing ratios (exceeding 50 ppb), which were observed at low flight altitude (<1 km). Respective flight patterns were designed to allow for the evaluation of the TROPOMI vertical SO_2 column densities, and both flights were performed during cloud-free conditions. The airborne measurements and satellite data will also be complemented by hourly ground-based SO_2 measurements near both power plants. In addition, measurements are combined with state-of-the art model simulations from (i) the regional atmospheric chemistry climate model MECO(n); (ii) the atmospheric transport

and dispersion model HYSPLIT; and (iii) the chemistry coupled Weather Research and Forecasting model WRF-Chem to improve the emission quantification of these power plants.