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Fast emission estimates in China and South Africa constrained by satellite observations

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Emission inventories of air pollutants are crucial information for policy makers and form important input data for air quality models. Unfortunately, bottom-up emission inventories, compiled from large quantities of statistical data, are easily outdated for emerging economies such as China and South Africa, where rapid economic growth change emissions accordingly. Alternatively, top-down emission estimates from satellite observations of air constituents have important advantages of being spatial consistent, having high temporal resolution, and enabling emission updates shortly after the satellite data become available. However, constraining emissions from observations of concentrations is computationally challenging.

Within the GlobEmission project (part of the Data User Element programme of ESA) a new algorithm has been developed, specifically designed for fast daily emission estimates of short-lived atmospheric species on a mesoscopic scale (0.25×0.25 degree) from satellite observations of column concentrations. The algorithm needs only one forward model run from a chemical transport model to calculate the sensitivity of concentration to emission, using trajectory analysis to account for transport away from the source. By using a Kalman filter in the inverse step, optimal use of the a priori knowledge and the newly observed data is made.

We apply the algorithm for NO_x emission estimates in East China and South Africa, using the CHIMERE chemical transport model together with tropospheric NO_2 column retrievals of the OMI and GOME-2 satellite instruments. The observations are used to construct a monthly emission time series, which reveal important emission trends such as the emission reduction measures during the Beijing Olympic Games, and the impact and recovery from the global economic crisis. The algorithm is also able to detect emerging sources (e.g. new power plants) and improve emission information for areas where proxy data are not or badly known (e.g. shipping emissions). The new emission inventories result in a better agreement between observations and simulations of air pollutant concentrations, facilitating improved air quality forecasts.