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# Assessing errors and uncertainties in subnational fossil fuel $CO_2$ emission estimates: A case for ODIAC

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Global greenhouse gases (GHG) gridded products have been and will remain an important tool to allow us to combine emissions estimates compiled as inventories with atmospheric modeling in order to objectively assess the impact of our emissions. However, the weakness of those emission products is the fact that subnational emissions are largely based on emission downscaling, and the emission changes seen in the gridded products are not necessarily accurately reflecting the impact of subnational emission drivers (e.g. local emission reduction action). Assessing the subnational downscaling errors is critical in order to provide a science-based emission monitoring support, especially at fine spatial scales of atmospheric modeling and satellite observations.
With this in mind, we attempted to characterize and quantify the subnational disaggregation errors in a global downscaled emission dataset in hopes of formulating an error reduction/mitigation approach. This study focusses on the high-resolution, global fossil fuel carbon dioxide emission ($FFCO_2$) gridded data product ODIAC. The ODIAC employs geospatial information such as point source emission estimates and geolocation as well as satellite-observed nightlights to achieve the global 1km emission distribution. Given the errors matter differently depending on applications of the gridded products, we took several different approaches to study the subnational disaggregation errors at different spatial scales. First, we compared ODIAC to the national scale multi-resolution emission dataset GESAPU over the domain of Poland in order to characterize spatial patterns of the disaggregation errors across different scales from urban to rural areas. Taking advantage of a high-resolution WRF simulation with Hestia urban emission estimates in Los Angeles, we attempted to quantify the disaggregation errors in ODIAC in the units of parts per millions (ppm), rather than emission units that are not directly measurable. We also examined the impacts of different $FFCO_2$ configurations by including international bunker emissions, three dimensional aircraft emissions, and emissions in the form of reduced carbon species in a global flux inversion framework.