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COMPILATION OF INVENTORIES OF INDUSTRIAL EMISSIONS

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Abstract

The mathematical modeling of the transport and transformation of trace species in the atmosphere is one of the scientific tools currently used to assess atmospheric chemistry, air quality, and climatic conditions. From the scientific but also from the management perspectives accurate inventories of emissions of the trace species at the appropriate spatial, temporal, and species resolution are required. There are two general methodologies used to estimate emissions: bottom-up and top-down (also known as inverse modeling). Bottom-up methodologies used to estimate industrial emissions are based on activity data, emission factors (amount of emissions per unit activity), and for some inventories additional parameters (such as sulfur content of fuels). To compile regional and global inventories researchers can either bring together estimates made at the national or sub-national level by national experts or directly estimate emissions based on activity rates from reports compiled by multi-national organizations such as the United Nations and the International Energy agency and on emission factors and other information available in the literature. In all cases the data used must be checked for completeness, transparency, consistency, comparability, and accuracy. These emissions estimates must now be given finer spatial (usually gridded), temporal, and for some inventories species resolution. The location of major stationary sources (power plants, industrial complexes) is usually known, so the emissions can be directly assigned to the appropriate grid cell. For emissions from other activities, such as transportation, spatial resolution is obtained via the use of surrogate information, such as population, land use, traffic counts, etc. which already exists in or can directly be converted to gridded form. To obtain finer temporal resolution (seasonal, daily, weekday/weekend, etc.) auxiliary information such as plant schedules, traffic counts, etc. is used. Speciation factors have been and are being developed to speciate inventories of of NO_x (NO, NO_2), particulate matter (PM2.5, PM10, by species), and hydrocarbons (individual species or groups of species). Top-down (inverse modeling) methodologies directly invert air quality measurements in terms of poorly known but critical parameters to constrain the emissions needed to explain these measurements; values of these parameters are usually computed using atmospheric transport models. Several statistical tools are being used to address the inversion problem, including empirical Bayes framework, synthesis inversion techniques based on Green=s function, single value decomposition, and tangent linear and adjoint models. Currently there are several strong limitations of inverse modeling. It is harder to address emissions by sector using inverse modeling; for the long-lived trace gases the signature in the measurements induced by various sources is small, so high precision measurements are needed; emissions are highly variable so their representation needs many degrees of freedom making the inverse problem highly underdetermined; additional a priori information based on model results, secondary observations or simplifications of the requirements for the inverse solution are needed, which introduces additional errors in the calculations; the high diffusivity of atmospheric transport and mixing quickly erases the small-scale emissions structure so that measurements at remote monitoring stations only capture the large-scale variability of the emissions.

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