Emission modelling

Air pollutants released into the atmosphere as a result of anthropogenic and natural activities. The development of high-quality and high-resolution emission models of primary gases and aerosols represents a key step in providing information to modelling systems for air quality, climate change and policy.

Summary

Emission models are representations of the real systems that produce emissions. They describe quantities, location and temporal variation of emissions from multiple sources in a coherent framework.

One of the basic aspects of emission models is representativeness, which implies that emission results match the requirements of the air quality modelling system in terms of spatial resolution, temporal resolution and chemical disaggregation. For achieving these targets, the model has to be capable of obtaining results as realistic as possible to minimize the uncertainty. Hence, it is essential to accurately characterize the variety of emission sources (point, line and area source), as well as to use up-to-date information and emission estimation methodologies compiling the state-of-the-art.

Apart from direct measurement of specific emissions, which usually are scarce and only available for large point sources, bottom-up and top-down approaches are the two major methods available for modelling emissions. Both methods require information concerning activity factors (AF) and emission factors per activity (EF). In the case of top-down approaches, AF is first collected at national or regional level and then distributed over the grids of the working modelling domain based on information or surrogate data that is representative of the activity (e.g. population density). In the case of bottom-up approaches, AF is collected on a fine spatial scale (e.g. traffic data and speed circulation per road stretch) and EF are source-specific. Exclusive use of bottom-up approaches fails due to lack of available input data, while exclusive use of top-down methods will lead to an undesirable level of accuracy. Hence, a combination of both approaches is presented as the best option in order to estimate high-resolution emissions.

The group works in the development and improvement of the High-Elective Resolution Modelling Emission System (HERMES), an open source, parallel and stand-alone multiscale atmospheric emission model that processes and estimates gas and aerosol emissions for use in chemistry transport models (CTMs). HERMES consists on two independent modules that can be combined or executed separately: (i) the *global_regional* module (HERMES_GR) and (ii) the *bottom_up* module (HERMES_BU). HERMES_GR is a processing system used to calculate emissions through an automatic combination of existing inventories and user defined vertical, temporal and speciation profiles. HERMES_BU is an emission model that estimates emissions at the source level (e.g. road link) combining state-of-the-art bottom-up methods with local activity and emission factors. HERMES is currently implemented in three different forecasting system, namely the air quality forecast system for Spain (CALIOPE) (http://www.bsc.es/caliope/), the International Cooperative for Aerosol Prediction (ICAP) multi-model ensemble (www.nrlmry.navy.mil/aerosol/icap.1135.php) and the AIRE-CDMX air quality forecasting system for Mexico City (http://www.aire.cdmx.gob.mx/pronostico-aire/). HERMES is also used for regulatory modelling applications, such as air quality management studies aimed to analyse the impacts of different policies and strategies on air quality.

The group also co-chairs the Emission Working Group of the Forum for AIR quality MODelling in Europe (http://fairmode.jrc.ec.europa.eu) and coordinates the Service Evolution work package of the Copernicus CAMS_81 – Global and Regional emissions service (https://atmosphere.copernicus.eu).

Objectives

- Study of anthropogenic and biogenic emissions released into the atmosphere by using high resolution numerical modelling;
- Improvement of the capabilities of such models to simulate complex emission sources with a minimum level of uncertainty;
- Analysis of the performance of emission models when coupled with air quality modelling systems.

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