2005 Emission Inventory

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Temporal modulation of emissions

While emission inventories have shown noticeable improvements during the last years, also from a methodological point of view, little attention was paid to the definition of temporal profiles of emission variation.

Actually emissions show substantial temporal variations, both at monthly, daily and hourly level: e.g. emissions from domestic heating are released only during the cold months; suspension of industrial emissions occurs chiefly during week-ends; road transport emissions depends on working cycles.

The global emission referred to the whole year can be unable to represent adequately the situation of a zone in which, due to some reason, a great activity of a source is concentrated in very short periods, with possible dangerous acute effects of some pollutants, even if the global annual emission datum is moderate.

On the other hand, the elaboration of healing strategies and interventions requires to take into account how pollutant load is distributed during different periods of the year and during different hour of the day, because photochemical pollution (formation of photo-oxidant compounds) depends in a special way on critical atmospheric "short-term" conditions, which can be influenced by hourly or daily variations of emissions.

The elaboration of simulation models of growing complexity requires, for the aims of modeling, the use of input data more and more detailed from a temporal point of view. Up to this moment, temporal variations taken into account have not considered national, regional and provincial differences, basing on medium values deriving from very approximate data bases. The use of a better temporal and spatial resolution in the definition of emission variation could heavily influence the dynamics of photochemical compounds in atmosphere. It is important to notice that there is still no demonstration of the effects of a better level of temporal detail on results of modeling simulations. Further attention and resources are required for these topics, due to their relevance.

Range of uncertainty naturally increase as temporal and spatial resolution of emission data increase. Estimates of hourly, daily and monthly emissions cannot nowadays be considered precise descriptions of actual emissions, but estimates anyway that contribute to a better definition of the problem.

In order to consider temporal variation of emissions, the simpler approach uses temporal emission profiles that consist in a series of coefficients (24 for hourly emission, 7 for daily variation in a week, 12 for monthly modulation) which, properly multiplied for the total annual emission, allow to achieve the hourly, daily or monthly one.

A substantially analogous approach is used for the detailed description of the temporal activity of a source, of yearly duration factors (d/y) or daily working factors (h/d).

Coefficients that constitute the temporal profile are often presented as normalized, on the medium value or on the emission maximum value.

If temporal modulation coefficients are normalized on the medium value, the relative emission at a given hour "h", day "d" and month "m" can be obtained from annual emission basing on the following formula:

$$\mathbf{Emission_t = Q / (24 * 7 * 12) * p_h * p_d * p_m} \quad (3)$$

where:

Emission $_t$ = emission at the time t (hour: o; day: g; month: m);

Q= annual emission;

p $_h$ = hourly coefficient at the time t;

p $_d$ = daily coefficient at the time t;

p $_m$ = monthly coefficient at the time t.

Temporal modulation coefficients seldom derive from statistical elaborations carried out using experimental data; monitoring systems for the main pollutants are installed only for a very limited number of major plants such as waste incinerators or power plants, allowing to define an experimental trend of the emissions.

For all other not controlled sources, a statistical simulation approach is needed, and requires the use of weight variables, also named indicators, basing on which it is possible define coefficients used for the disaggregation. Examples of indicators are working hours or traffic flows, and they are specific indicators of the source class (civil, industry, traffic).

Example An example in order to clarify the application of this methodology is the calculation of nitrogen oxides hourly emission from the public power plant of Ostiglia (MN), SNAP activity 1.1.1 Combustion plants > 300 MW (boilers), annual emission and temporal profile being known:

NO_x annual emission = 10,130 t/y;
p_h = hourly coefficient (13-14) = 1.1 (4.7 %) ;
p_d = daily coefficient (Wednesday) = 1.12 (16 %);
p_m = monthly coefficient (January) = 0.85 (7.1 %).
NO_x emissions from 13 to 14 of a Wednesday of January are achieved applying the formula (3):

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Ejan,wed,13-14 = 10130 / (24*7*12)*1.1*1.12*0.85 = 5.3 t/hour
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while emissions from 3 to 4 of a Sunday of July (ph = 0.8, pd = 0.62, pm = 0.92) is equal to:

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Ejul,sun,3-4 = 10131/(24*7*12)*0.8*0.62*0.92 = 2.2 t/hour
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