Different approaches for crustal and marine contribution estimates: which are the uncertainties?

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The contributions of crustal and marine components to the particulate matter concentration are routinely assessed in many aerosol composition studies by the application of relatively simple methods. However, depending on available chemical species and author's preferences, a variety of approaches are used, with different hypothesis, formulas, corrections and approximations, which may lead to a high variability in obtained results.

As concerns the crustal component, in most of the studies it is calculated by the sum of oxides algorithm (Malm et al., 1994), i.e. by the sum of all the main crustal element oxides (Na_2O, MgO, SiO_2, Al_2O_3, TiO_2, K_2O, CaO, Fe_2O_3). However, as these elements may receive contributions from other sources (like sea-salt for Na and Mg, biomass burning for K, traffic for Fe, etc.), different approaches are used to take it into account. Sea salt contributions to Na and Mg are for example calculated using the Cl concentration (even if it is tricky due to the volatility of this element) or by the Na-Al or Na-Ca system approach (Calzolai et al., 2015); in other cases, the Na-Mg contribution to mineral dust is calculated as an additive 15% to the rest of the crustal matter. Anthropogenic contributions to K and Fe are sometimes corrected using enrichment factors. As a further source of variability, in many studies not all the elements in the formula are measured and their contribution is extrapolated using elemental ratios reported for the upper crust composition.

Moreover, the oxide formula does not take into account the presence of carbonates, which conversely are known to be present in mineral matter. For this reason, in many studies the contribution of Mg and Ca is calculated in the form of carbonates instead of oxides. Of course, both chemical species may be present in crustal material and the choice of which one has to be used is quite arbitrary, and introduces further variability in the results.

In other approaches, only a few soil-related elements are measured and the mineral dust contribution is obtained by some empirical formulas starting from the concentration of just one specific element.

As concerns sea salt, it is often calculated as the sum of Cl plus the sea-salt fractions of just Na, or Na and Mg, or Na, Mg, sulphates and other elements like K, Ca and Br. The Na-Al or Na-Ca system approach is in many cases used to separate sea salt and mineral contributions.

In this presentation, the extended data-base of the AIRUSE project (Amato et al., 2016), which includes all main sea salt and mineral dust elements, is used to calculate these components by the different approaches, both using all the available elements and selected subsets, with the aim of performing a critical review of the variability in the obtained results.

As an example, the crustal component calculated by different methods for the site of Florence, is reported in Figure 1.

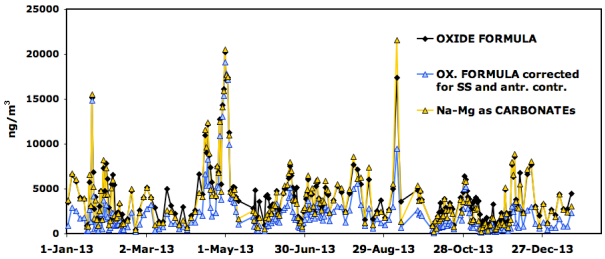

Figure 1. Crustal component calculated by differed methods (Florence, PM10).

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