***Answers to the interactive comment on "Characterization of PM10 sources in the central Mediterranean" by Anonymous Referee #1***

*The manuscript presents interesting results on PM10 chemical characterization in a Central Mediterranean coastal site. These data are useful for improving the under-standing of aerosols variability and processes in the Med Basin, and validate modelling outputs in a region with a general lack of data. The work has been carried out correctly, well presented, and data interpretation is in my opinion reasonable within the uncertainty of the methods used.*

We thank the reviewer for the positive evaluation of our work and the productive comments and suggestions. These are addressed point-by-point in the following.

*The main uncertainty is given by the lack of EC and mostly OC data for the source apportionment. Authors claim on the low mass contribution of EC, but in my opinion its signal is still key in tracing primary combustion emissions. OC would also help improving significantly the share of secondary vs primary PM, mostly for the two combustion sources found. In any case authors have presented the (partial) ECOC data available and compared them with PMF source contributions, which show reasonable results.*

We agree with the referee that OC and EC data would add valuable information to this work, as information on the sources and contributions of the carbonaceous aerosol component is also missing in the region of study. Nevertheless, in a recent work (Lucarelli et al., 2015) some of the authors tested the effect of reducing input species in the application of PMF on an experimental data set providing an extended chemical speciation, including elements, EC and OC, and ions. As concerns the test performed removing EC and OC data (and still including elements and ions), PMF results did not significantly vary with respect to the ones obtained including also the carbonaceous species.

This is due to the fact that, although OC is a major aerosol component and EC is an important combustion tracer, OC is a not specific component of PM and EC is not the only combustion tracer. In fact, in this study on Lampedusa, we benefit from other elemental and ionic markers to trace combustion emissions.

Nevertheless, as we agree with the referee about the strength of EC as a marker, lacking a complete EC/OC data-set for the whole campaign, we compared the results for the combustion source as derived by the PMF analysis with the available EC/OC data, although they cover a limited time period. As stated by the referee, the results of this comparison are reasonable. This, together with the evidences from the methodological tests PMF runs with reduced input species, make us confident of the presented results.

We have added some comments on this topic in section 3.3.8.

*Still mineral dust and sea salt contributions are much higher than speciation data (why carbonates are not included?), which authors should also ascribe (even if partially) to the 40% of undetermined mass.*

We agree that differences between PMF and stoichiometric reconstructions based on speciation data are partially to be ascribed to the chemically undetermined mass (carbon components, including carbonates, and water), as discussed in section 3.4.2.

More in detail, the PMF mineral dust factor is about 30% higher than the mineral dust contribution estimated by the oxide formula. The oxide formula assumes that all the crustal elements are in the oxide form, while some of them, for example Ca or Mg may partially be in the carbonatic form ($CaCO_3$ instead of CaO, etc.), and this may produce an underestimation of the crustal component. However, we did not measure carbonates and we do not know how much of Ca or Mg are in the carbonatic form. This point is extensively discussed in section 3.4.2 (we have now modified a sentence to better explain it), and we also added a comment on carbonates at the end of section 3.2.
Possible reasons of the difference between the stoichiometric and the PMF sea salt are also discussed in section 3.4.2.

*The identified factors are indeed realistic but the source contributions could be affected by large errors due to this fact. I strongly advice to carry out Bootstrapping, Displacement and BS-DISP analysis (EPA PMF5) to explore what are the errors in source contributions.*
BS, DISP and BS-DISP are uncertainty methods implemented in the ME-2 and EPA PMF5 tools, but not in the PMF2 model that was used for this work. An explorative analysis performed with EPA PMF5 on the same input data set determined the same sources as presented in this study, although some small differences in the profiles occurred. A comparison of the outputs of different PMF tools is beyond the purposes of this paper, and it was faced in detail in recent papers (Belis 2015a, Belis 2015b and therein cited literature). Nevertheless, we agree with both the referees on the importance of an analysis of the uncertainties: in figure 3 we have now added the uncertainties on the profiles as provided by the PMF2 model. These estimates take into account the uncertainties on the input data and the application of non-negativity criteria, although they do not consider rotational ambiguity (Paatero et al., 2014). However, this aspect was investigated by systematically exploring solutions with FPEAK between -1.0 and 1.0, according to a literature approach (e.g., Vecchi et al., 2008). In the Supplementary Material, profiles of all the identified factors are reported for all the cases with variation in Q value below 5% (all bars are reported with the associated error computed by the PMF2 model). As concerns rotational ambiguity, in any case, it has to be pointed out that the choice of one out of all the rotated solutions is not determined merely by the mathematical outputs of the model: the choice is also driven by physical aspects as the physical sense of the source profiles and temporal evolutions, as well as physical constraints on the reconstruction of the profiles.
Finally, it is useful to recall that in case of large data sets, the importance of both random errors on the input and rotational uncertainty decreases (Paatero et al., 2014), when compared to modelling uncertainty (e.g., constancy of source profiles).

*Before doing that I suggest also to explore the solution with the additional Ca-Sr factor. Soil of Lampedusa is rich in Calcite and Dolomite, and we are probably facing a local resuspension source. Would be interesting to look at the daily contributions of this source (also vs the other crustal source).*
We are aware that the soil of Lampedusa is rich in such minerals, and we had already explored the 8$^{th}$ factor, the "Ca-Sr" one, taking in consideration a local dust resuspension

source. Nevertheless, we excluded this hypothesis due to the following reasons: this factor had a profile without any contribution from other main crustal elements (e.g., Al and Si); the temporal profile of this factor is very similar to the mineral dust one (in particular, it shows the same peaks during Saharan dust advection episodes); the scatter plots for the crustal elements (e.g., Ca, Si, Al...) do not show any cluster-pattern suggesting that some samples have different inter-elemental ratios and therefore a different mineral composition.
This is in agreement with previous preliminary results from this campaign suggesting that the composition of the Lampedusa soil does not relevantly differ from the average Saharan dust one.

*Other minor corrections suggested:*
*-revise some typos (e.g. Mallorcal)*
We are afraid we could not find "Mallorcal" in the text; nevertheless we have gone through the paper to correct as many mistyping as possible.

*- some more details of sampling site in section 2.1 would be welcome, although they are discussed throughout the article*
A couple of details were added in section 2.1.

*-please provide brand of teflon filters*
The information was added in section 2.1.

*- the coomparison of observed values with urban sites from literature might be misleading.*
The idea underneath that comparison was to show that, despite the remoteness of the site, $PM_{10}$ in Lampedusa is characterized by not-negligible aerosol levels, mainly as concerns the secondary ones. This aspect is now explicitly reported in section 3.2.

*- Why there are missing data only for Cu??*
Actually, in the paper we report that we have missing data for other chemical species than Cu, although in a very low number. In particular, at page 20024, lines 23-24, we report the following: "Missing data were less than 1% of the total number of samples for all chemical species, except soluble elements (5%) and Cu (9%)." The percentage of missing data is higher for Cu due to a problem occurred while measuring a batch of samples with PIXE, resulting in a high Cu background signal that prevented the quantification of Cu in those samples.

*- check the Mg oxidation number in page 20028*
We have corrected it.

*- Saharan dust plume may carry also emissions from Refineries*
This information was added in section 3.3.7.

*- I could not visualize Figure 4*

We are sorry for the inconvenience. Figures were checked by the editorial board during the production process, we attach to this document a pdf of Figure 4.

*- The citation Kim et al., 2008 in page 20034 is incorrect. It should be Kim and Hopke, 2008*

We have corrected it.

Additional references not reported in the revised paper:

- Belis, C.A., Pernigotti, D., Karagulian, F., Pirovano, G., Larsen, B.R., Gerboles, M. and Hopke, P.K.: A new methodology to assess the performance and uncertainty of source apportionment models in intercomparison exercises, Atm. Env., 119, 35-44, 2015a.

- Belis, C.A., Karagulian, F., Amato, F., Almeida, M., Argyropoulos, G., Artaxo, P., Beddows, D.C.S., Bernardoni, V., Bove, M.C., Carbone, S., Cesari, D., Contini, D., Cuccia, E., Diapouli, E., Eleftheriadis, K., Favez, O., El Haddad, I., Harrison, R.M., Hellebust, S., Jang, E., Jorquera, H., Kammermeier, T., Karl, M., Lucarelli, F., Mooibroek, D., Nava, S., Nøjgaard, J.K., Pandolfi, M., Perrone, M.G., Petit, J.E., Pietrodangelo, A., Pirovano, G., Pokorná, P., Prati, P., Prevot, A.S.H., Quass, U., Querol, X., Samara, C., Saraga, D., Sciare, J., Sfetsos, A., Valli, G., Vecchi, R., Vestenius, M., Yubero, E., Hopke, P.K.: A New Methodology to Assess the Performance and Uncertainty of Source Apportionment Models II: the Results of Two European Intercomparison Exercises, Atm. Env., accepted for publication, 2015b.


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2008
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a) sea salt
b) mineral dust
c) biogenic emissions
d) secondary nitrate
e) secondary sulphate
f) primary ship emissions
g) combustion emissions
PM10 contribution (µg/m3)

Figure 4.