

Interactive comment on “Aerosols over Continental Portugal (1978–1993): their sources and an impact on the regional climate” by A. L. Morozova and I. A. Mironova

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We are very thankful to Anonymous Referee N1 for being so supportive of our work presented in this paper. Here we provide some replies to his/her comments and suggestions (please note that the revised text is in italic and specific differences to the original text are in bold):

1. Page 31010, line 17. Abstract: The most significant finding is the decrease of the daily temperature (and diurnal temperature range) related to the decrease of sunshine duration

C11950

observed during the summer periods of increased content of the absorbing aerosols in the atmosphere. Is this a new finding or has been observed by other authors elsewhere? Indicate the main implications of this finding.

Yes, similar relations were found in previous studies. As is mentioned in the 2nd paragraph of the Sec. 4.1 “This cooling trend coincides with epochs of frequent SDE events (high <Alpos> values) and is in an agreement both with most recent/precise measurement (Santos et al., 2008) and with modeling studies (Santos et al., 2013).” Also, this effect is discussed in del Rio et al. (2012). We inserted the following paragraph in the Sec. 4.1 (after 2nd paragraph there):

The relations between the temperatures over Iberian Peninsula and SshD during the second half of the 20th c. were earlier reported (see del Rio et al., 2012 and references therein). They were attributed, mainly, to the variations of the circulation patterns over the North Atlantic and consequent changes in the cloudiness. However, accordingly to the data of our analysis, the variations of the SshD can result also from the strong dust intrusions.

New reference is added to the Reference list:

del Río, S., Cano-Ortiz, A., Herrero, L., Penas, A.:Recent trends in mean maximum and minimum air temperatures over Spain (1961–2006), Theor. Appl. Climatol., 109, 605–626, DOI 10.1007/s00704-012-0593-2, 2012.

2. Page 31011, Line 26: “The detailed analysis of the properties and time variations of the Portuguese aerosols can be found in Pereira et al. (2005, 2008, 2011, 2012), Santos et al. (2008, 2013), Catry et al. (2009), Calvo et al. (2010), Obregón et al. (2012).” The study carried out by Calvo et al. (2010) is developed in Spain and not in Portugal.

C11951

The sentence is changed to:

The detailed analysis of the properties and time variations of the Portuguese aerosols can be found in Pereira et al. (2005, 2008, 2011, 2012), Santos et al. (2008, 2013), Catry et al. (2009), Obregón et al. (2012), Vicente et al. (2012, 2013), Evtugina et al. (2013); the analysis of the radiative effect of the aerosols originated from wildfires for the close region in the north-western Spain is presented in Calvo et al. (2010).

3. Page 31012, Line 5: "The present paper is dedicated to understanding of the local aerosol sources and the role of the local aerosol content played in variations of the climate of the Continental Portugal region for the 1978-1993 period". Do authors considerer volcanic emissions as a local source? Furthermore, this sentence should be rewritten; it is not clear.

The sentence is changed to:

*The present paper is dedicated to understanding of the **local and global aerosol sources and the effect of the local aerosol content in climate variations** of the Continental Portugal region for the 1978-1993 period.*

4. Page 31012- 31013: from page 31013, line 5 to page 31013, line 16: this section should be shortened. Too much information is given here. For example, it is not necessary to mention all the data sources used, they have already been described in section 2.

These lines present "Introduction" into our paper. Here we put the main tasks and need to explain what we will investigate. We can't delete this information and shorten text. However the list of the aerosol sources is removed from the 1st paragraph of the Sec. 3 because they are already described in the previous section.

C11952

5. Acronyms should be described the first time they appeared. For example TOMS is mention by the first time in page 31012, line 11 and their significance in reported in page 31013, line 19.

Corrected. Now the TOMS acronym significance is explained in the Introduction (4th paragraph there) and the FFT acronym is explained in the new Sec. 2.3 "Atmospheric parameters".

6. Authors describe the study zones in section 2.1. "Aerosol parameters". However, I would recommend including a new section entitled "Study zones" with this information.

Now the Sec. 2 includes sub-section 2.1 "Studied locations" containing the information on the sites of the measurements of the aerosol index and atmospheric parameters:

We use the aerosol data over two locations in the Continental Portugal (see Fig. 1a) – the only available TOMS aerosol data for this region. The first one is the site ID 082 over Lisbon (38 46 N, 9 8 W, 105 m a.s.l.), the second one is the site ID 288 over Penhas Douradas (40 25 N, 7 33 W, 1380 m a.s.l.). In the first case the region around the site is one of the most urbanized and industrial sites in Portugal where the anthropogenic effects expected to be strong. The second site corresponds to a less populated mountain region affected by the anthropogenic pollution in a lower degree but frequently exposed to forest fire smokes and dust events (Pereira et al., 2005; Pereira et al., 2008; Obregón et al., 2012). Hereafter we use a term "urban" for the site ID 082 and a term "rural" for the site ID 288.

Consequently, we used climatic data measured by two meteorological observatories that are close to the AI sites. The first data set belongs the Geophysical Institute of University of Coimbra (hereafter, "IGUC series"). The second set belongs to the Geophysical Institute of Instituto Dom Luiz of University of Lisbon (hereafter, "IGIDL series"). Both locations are shown on the map in Fig. 1a (marked as "Coimbra" and

C11953

"Lisbon", respectively).

7. Page 31014, line 13: Replace "For each of two sites and for each of the months: : :." by "For each site and for each month: : :"

Corrected.

8. Page 31015, line 15: Replace "Not only spatial and temporal distributions of aerosols are very variable but also their origin as well" by "Not only spatial and temporal distributions of aerosols are very variable but also their origin".

Corrected.

9. Page 31016, line 13: Bourassa and Robock (2012) should be Bourassa et al., (2012).

Corrected.

10. For SO₂ concentration estimation, authors calculate a mean value from five EMEP stations. Since EMEP stations are mainly background stations, how can this fact influence the conclusions obtained?

In the Supplementary Material to the presented manuscript (now this part is inserted in the main text) it is shown that the smoothed monthly variations of SO₂ (obtained from background stations of Continental Portugal) well confirm the behaviour of smoothed aerosol indices <Alneg> (obtained by satellites data). The correlation coefficients are high enough – see Figure S1.7 (now Fig. 2g). This result allows us to conclude that SO₂ can be one of the important pollutants that influence the whole aerosol content over the Continental Portugal. Regrettably, the measured data for other pollutants (like NO₂) that are available from the same data base for the studied period are very fragmented, and can't be used to create a reliable composite series. This situation is

C11954

discussed in the end of the Sec. 3.1.4. (p. 31020, l. 19-26).

11. Figure captions included in the manuscript and in the supplementary information should be checked. Sometimes the information in the figure caption is already indicated in the figure. For example Fig. 2: Figure caption should be shortened. The information: ": : :gray bars show data related to the site ID 082; red-white crossed bars show data related to the site ID 288." is already indicated in the figures.

Figures captions are corrected and repetitions are removed.

12. Page 31020, line 2: "The annual values of the SO₂ content are shown in Fig. 2f. As one can see, there is a strong dependence between the variations of the <Alneg> (shown in Fig. 2b) and the SO₂ content". Please, indicate the correlation coefficient in the text.

Now the correlation coefficient is mentioned in the text: *The annual values of the SO₂ content are shown in Fig. 2f. As one can see, there is a strong dependence between the variations of the <Alneg> (shown in Fig. 2b) and the SO₂ content. The anti-correlation (**correlation coefficient $r = -0.53$, p value = 0.06**) between the curves reflects the increase of the scattering particles in the atmosphere (lower <Alneg> values) coinciding with the growth of the measured SO₂ concentration.*

13. Page 31022, line 20: write a comma between "SDEs" and "the wildfires"

Corrected

14. Page 31023, line 3: "To our mind, this is a result of the different pollution and circulation conditions over the sites."

C11955

Please, rewrite this sentence trying to clarify what authors want to say.

The whole paragraph is rewritten now:

Here we present the analysis of the relations between the aerosol content and the atmospheric parameters described in Section 2. The analysis was done separately for two locations. The analysis of the climatic conditions between the Lisbon and Coimbra (see the Supplementary Material, Part 1.2) showed their strong similarity. This similarity results from the relatively short distance between these locations and their proximity to the ocean. On the other hand, the measured AI monthly means, as was discussed in Sect. 3, are different for these two sites. To our mind, there are two main reasons for these differences: First reason is that the Lisbon area is much more polluted than the region around the rural site (ID 288); second reason is that the more north-eastern position of the site ID 288 provides this location is affected by the dust intrusions more frequently.

15. Page 31011, line 8 and page 31024, line 3: IPCC 2013, is not in the reference list

New reference is added in the Reference List and corresponding sentences are corrected accordingly:

Climate Change 2013: The Physical Science Basis: Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, IPCC (Ed.), Cambridge University Press, 2014.

16. Page 31027, lines 6- 19: Conclusions. The first paragraph is an abstract of the study carried out, it is not a conclusion. Authors can include an introduction sentence, but not 15 lines.

The conclusion is shortened, the 1st paragraph is removed and consequent changes

C11956

are made in other paragraphs.

17. Supplementary material should be shortened, and repetition with the main manuscript should be avoided. Thus, for example, the description of both studied zones or the description of the parameters analyzed is included in the main manuscript

Supplementary Material is shortened, repetitions are removed, two figures are moved to the main text (Fig. S1.1 is now Fig. 1e-f and Fig. S1.7 is now Fig. 2g), and the following paragraph from the previous version of the Supplementary Material is inserted in the preface of Sec. 3:

The AI series for both sites show annual cycle, mainly, due to the well established seasonal changes of the <Alneg> (see Fig. 1e) – more scattering aerosols are seen from October to March, due to the seasonal cycles of nitrate aerosols (see e.g. Calvo et al., 2013) and/or other anthropogenic pollutants. During the autumn-winter cold period there is an additional input of soot from the domestic heating and, probably, an increase of the local traffic due to the rainy weather conditions (Pereira et al., 2012, Querol et al., 1998). The <Alpos> shows a tendency to bimodal seasonal variations having higher values in July-August with a second (lower) maximum in February-March (Fig. 1f). This bimodality is in an agreement with the in-situ measurements made in Évora, Portugal (38.5 N, 7.9 W, 300 m a.s.l.) during the 2002-2008 time period (Pereira et al., 2008, 2011). The summer peak is related to the wildfire smokes and intensive SDE events, and the winter maximum is mostly due to the combined effect of local traffic and increased emission from heating sources.

18. Reference list: Sato et al., 1993. Write a point at the end of the reference

Corrected

19. You can realize that the most important studies regarding

C11957

emissions from wildfires have been carried out by the research team of the University of Aveiro. So, you can also include some references from this team: Evtugina et al., (2013), Vicente et al. (2012, 2013) Alves et al. (2011).

The references are inserted (see our reply to the comment N2). Thank you very much for pointing out these references.

List of other corrections:

1. In the revised manuscript we use additional terms “urban” for the site ID 082 and “rural” for the site ID 288

2. The following sentences are added now to the conclusion: *Our results confirm the data from previous studies showing the important role of the anthropogenic pollution, wildfires and SDEs as drivers of the aerosol variation over the Continental Portugal.*

3. In the revised version we inserted additional references to the Table 2 for reader's comfort

4. Following text is added to the Section 2.3 Atmospheric parameters (previously Sec. 2.2):

The comparison of the IGUC and IGIDL series shows that the climatic conditions in Lisbon and Coimbra are quite similar (correlation coefficients in the range from 0.5 to 0.998 with low p-values and meta p-values) but not totally identical. Most important differences were found for the April and August series of precipitation and DTR (correlation coefficients are lower than 0.5). A whole set of correlation coefficients between the IGUC and IGIDL series can be found in the Supplemented Material, Part 1.2.

5. Abstract: The first sentence “Understanding of aerosol sources **which** affect climate is an important problem open in front of scientists as well as policymakers.”

C11958

Changed to:

*Understanding of aerosol sources **that** affect climate is an important problem open in front of scientists as well as policymakers.*

6. Introduction, 2nd paragraph: The sentence “One of the important **outcomes** of aerosols is their effect on the Earth's radiation budget. Aerosols affect it in two ways: as a direct and an indirect forcing.”

Changed to:

*One of the important **impacts** of aerosols is their effect on the Earth's radiation budget. Aerosols affect it in two ways: as a direct and an indirect forcing.*

7. Introduction, 4th paragraph: “**This approach allows us to minimize the effect of the well known spatial heterogeneity of the aerosol content.** Here we take into account a number of different types of aerosols, their local and global sources and their relations with variations of some local climatic parameters: sunshine duration, precipitation, pressure and temperature. The satellite-based TOMS (Total Ozone Mapping Spectrometer) atmospheric aerosol index helps us to obtain information about the aerosol content in the studied region.”

Changed to:

*Here we take into account a number of different types of aerosols, their local and global sources and their relations with variations of some local climatic parameters: sunshine duration, precipitation, pressure and temperature. The satellite-based TOMS (Total Ozone Mapping Spectrometer) atmospheric aerosol index helps us to obtain information about the aerosol content in the studied region. **This approach allows us to minimize the effect of the well known spatial heterogeneity of the aerosol content.***

8. Last sentence of the Section 2: “Since the data series contain significant gaps (14% of the whole data set length), and measurement time intervals are different for different

C11959

stations **we used these data with the linearly interpolation of the gaps to calculate a single mean series.**"

Changed to:

*Since the data series contain significant gaps (14% of the whole data set length), and measurement time intervals are different for different stations **we applied linear interpolation to estimate the missing data and calculated a single mean series.***

9. Section 4.1, 2nd paragraph, grammatical correction:

*In September the correlation coefficients have an opposite sign and **are** statistically insignificant.*

10. Section 4.2, 2nd paragraph, grammatical correction:

*First of all, the biggest correlation coefficients are obtained for the <Alneg> but not for the <Alpos> as for another **the other** location."*

11. New references are added:

Alves C., Vicente A., Nunes T., Gonçalves C., Fernandes A.P., Mirante F., Tarelho L., Sanchez de la Campa A., Querol X., Caseiro A., Monteiro C., Evtugina M., Pio C. (2011) Summer 2009 wildfires in Portugal: emission of trace gases and aerosol composition. *Atmospheric Environment*. 45, 641-649, 2012.

Bližňák, V., Valente, M. A., Bethke, J. Homogenization of time series from Portugal and its former colonies for the period from the late 19th to the early 21st century. *Int. J. Climatol*, doi: 10.1002/joc.4151, 2014.

Evtugina M., Calvo A., Nunes T., Alves C., Fernandes P., Tarelho L., Vicente A., Pio C. VOC emissions of smouldering combustion from Mediterranean wildfires in central Portugal. *Atmospheric Environment*. 64, 339-348, 2013.

Morozova, A. L., and M.A. Valente. Homogenization of Portuguese long-term temper-

C11960

ature data series: Lisbon, Coimbra and Porto. *Earth Syst. Sci. Data*, 4, 187-213, 2012.

Querol, X., Alastuey, A., Puigercus, J.A., Mantilla, E., Miro, J.V., Lopez-Soler, A., Plana, F., Artiñano, B.: Seasonal evolution of suspended particles around a large coal-fired power station. particulate levels and sources, *Atmospheric Environment*, 32, 11, 1963-1978, 1998.

Stickler, A., Brönnimann, S., Valente, M. A., Bethke, J., Sterin, A., Jourdain, S., Roucaute, E., Vasquez, M.V., Reyes, D.A., R. Allan, R., Dee, D. ERA-CLIM: historical surface and upper-air data for future reanalyses. *Bull. Amer. Meteorol. Soc.*, 95(9), 1419-1430, doi: <http://dx.doi.org/10.1175/BAMS-D-13-00147.1>, 2014.

Vicente A., Alves C., Calvo A.I., Fernandes A.P., Nunes T., Monteiro C., Almeida S.M., Pio C. Emission factors and detailed chemical composition of smoke particles from the 2010 wildfire season. *Atmospheric Environment*. 71, 295-303, 2013.

Vicente A., Alves C., Monteiro C., Nunes T., Mirante F., Cerqueira M., Calvo A., Pio C. Organic speciation of aerosols from wildfires in central Portugal during summer 2009. *Atmospheric Environment*, 57, 186-196, 2012.

12. A number of stylistic and grammatical corrections unrelated to the Referees' comments were applied.

Please also note the supplement to this comment:

<http://www.atmos-chem-phys-discuss.net/14/C11950/2015/acpd-14-C11950-2015-supplement.pdf>

Interactive comment on *Atmos. Chem. Phys. Discuss.*, 14, 31009, 2014.

C11961