Author's response to Referee #1

The thoughtful reading and the time dedicated by the reviewer are highly appreciated. The provided major as well as the minor comments are an important feedback that enabled better focusing of the scientific content and improvement of the manuscript quality. Below please find our point-to-point replies. The responses to the reviewer comments are given in blue text; the original reviewer comments are in black text.

Anonymous Referee #1
Received and published: 3 March 2017

A combination of remote sensing observations, in-situ measurements and chemical analysis at the individual particle scale (especially by scanning electron microscopy with energy-dispersive X-ray spectrometry, SEM/EDX) was used for the chemical, microphysical and optical aerosol characterization at Sede Boker in the Negev Desert, Israel. By making use of the comprehensive data set, estimations were made of the impact of the see breeze on the aerosol radiative effect and of the aerosol core-shell structure and the implication for remote sensing. This is clearly a thorough study. However, the results are mainly based on aerosol samples that were respectively collected before and during the sea breeze on 16 August 2012. One may wonder how representative the situation on that day was for the remainder of the summertime or whether it may also occur for the other seasons. As indicated below, the manuscript has other shortcomings, so that some revision is needed before it can be published in ACP.

Regarding the question "…how representative the situation on that day was for the remainder of the summertime or whether it may also occur for the other seasons."
In general, the information that allows to conclude about the representativeness is provided in the initial version of the manuscript, but it was probably not emphasized and complete. For example, a time series of various observations in Fig. 4 shows occurrence of the sea breeze conditions on eight of nine presented days (including August 16). Note that these observations are repetitive. In addition, it is reported that the sea breeze is clearly observed in meteorological data on 51 days, in the period from June to August 2012, which is almost 60 % of the time. Also, it is reported that similar abrupt increases in the AOT can be observed in the AERONET data during summer time of all preceding and subsequent years.
Regarding the other seasons: the air mass transport from the Mediterranean Sea with high humidity and pollutants is a known characteristic for the summer period in the Negev desert (Andreae et al., 2002; Derimian et al., 2006; Karnieli et al., 2009; Maenhaut et al., 2014). As the effect on aerosol microphysics is mainly associated with the mixed and humid air mass transported from the Mediterranean Sea, it is expected that the summer season is the most affected.
We also would like to mention that the similar aerosol samplings (with and without sea breeze) were conducted on other days during the observation period. The compositional characteristics of particles were quite similar when all other optical and meteorological characteristics are occurring repeatedly. August 16th was selected for more detailed analysis because the sampling conditions, the selected timing for the sampling (i.e., start time, duration) were the most favorable on this day for discussing the variability of physical and chemical characteristics with respect to the variability of optical measurements.

Specific comments:

1. A comprehensive SEM/EDX characterization for aerosol samples from the same Sede Boker site was previously performed by Sobanska et al. (J. Atmos. Chem., 44, 299-322, 2003). In this study coarse (2-10 µm aerodynamic diameter, AD) and fine (<2 µm AD) aerosol samples from summer and winter campaigns were analysed. Although the authors make reference to this paper in the Introduction, they fail to compare their particle classification presented in Figure 3 and their particle type proportions of Figure 8 with results from Sobanska et al. Some comparison with the summer data of Sobanska et al. is necessary.

In line with previous works done on the same sampling site in the summer period, sea salt and mineral dust were reported to be the prevailing particle types (Sobanska et al., 2003; Formenti et al., 2001; Maenhaut et al., 1997). In our particle classification, we define one single "Dust" particle type by grouping same types of mineral dust (aluminosilicate, $CaCO_3$, $CaSO_4$, SiO_2, FeOx, TiO_2, mixed dust and transformed mineral dust) as those obtained by hierarchical cluster analysis (HCA) reported in Sobanska et al. In our study, fresh and aged sea salt particles are grouped in one single "Marine" particle type while in Sobanska et al. fresh and aged sea salt are divided into two types with aged sea salt particles always associated to the coarse fraction (2-10 µm in aerodynamic diameter) and aged sea salt associated to the fine fraction (<2 µm in aerodynamic diameter). Mg-, S-, K-rich particles were grouped in the "Other" type and correspond to the "S-only" and "Industrial mix sulphate and carbonaceous" in Sobanska et al. We did not find any Pb- or Zn-rich particles in our samples compared to Sobanska et al. The main difference in our particle classification lies in the type "Not classified" in Sobanska et al. that corresponds to our "Mixed Dust/Marine" type as we specifically focused our work on the sea breeze effect in a desert setting contrary to the emphasis on local dust events in Sobanska et al.

Furthermore, in Sobanska et al. the authors specified that on a specific day in summer time, a high proportion of sea salt (35% in the coarse size fraction PM2-10 and 12% in the fine fraction PM2) and mixed sea salt/mineral dust (~15% in the fine fraction PM2) were found and were representative for a marine source contribution. On the same day, the authors reported a high proportion of aluminosilicates (~30%) and $CaCO_3$ (~17%) in approx. the same proportion in fine and coarse fractions. Given that the sampling duration was from 08:52-19:30 local time, the chemical analysis of individual particles is representative of the average composition including before/during/after sea breeze. In our case, a short-term particle sampling started on the onset of the daily sea breeze enabled us to investigate specifically the characteristics of particle composition (start and end of daily sea breeze at 16:00 and about 18:00 local time, respectively). In our study, "Dust" and "Mixed Dust/Marine" particles account for 10-56% and 5-27%, respectively, depending on the size fraction and before/during sea breeze. Besides the fact that fine and coarse fractions are not exactly equivalent in the two studies, on overall, our results are consistent with Sobanska et al.
This point has been added in the manuscript by the following sentences inserted in page 12, line 14: "These results are consistent with those obtained by Sobanska et al. (2003) at the same sampling site on a specific day in the summer period (sampling duration includes before/during/after sea breeze): a high proportion of sea salt (35% in the coarse size fraction PM2-10 and 12% in the fine fraction PM2) and mixed sea salt/mineral dust (~15% in the fine

fraction PM2) representative of a marine source contribution. In addition, they reported a high proportion of aluminosilicates (~30%) and $CaCO_3$ (~17%) in approximately the same proportion in fine and coarse fractions."

2. Page 3, lines 18-20: A literature reference would be welcome for the statement in this sentence.
It is (Dayan and Rodnizki, 1999) that is cited in the next sentence. The phrase is modified to make it clear.

3. Page 6, lines 1: It unclear what it meant by "data correspond to the quality level 1.5". Some explanation is needed here.
Corrected. The explanation is "The data correspond to the quality level 1.5, which means that the data have been cloud screened and cleared of any operational problems."

4. Page 19, line 26, and page 31, Figure 8: The use of PM1 and PM2.5, as used here, is very confusing. These terms are normally used to denote particles smaller than 1 and 2.5 µm AD, respectively, whereas they clearly denote other size ranges in the current manuscript. I recommend replacing PM1 by PM2.5-1 and PM2.5 by PM10-2.5.
Absolutely agree. It is corrected in the revised version.

5. Technical and other (mostly minor) corrections: - page 1, line 19: replace "found be" by "found to be". - page 2, line 14: there is something grammatically wrong with "which hygroscopic". - page 2, line 28: replace "site sometimes" by "site is sometimes". - page 3, line 14: replace "program, e.g., (Ichoku" by "program (e.g., Ichoku".
- page 3, line 18: replace "area of" by "areas of".
- page 3, line 22: replace "show generally" by "showed generally".
- page 3, line 24: replace "Although, the" by "Although, the".
- page 3, line 32: I presume that "(4)" should be replaced by an appropriate literature reference.
- page 4, line 8: replace "Although, the" by "Although, the". - page 4, line 25: replace "The Ångström" by "An Ångström".
- page 8, line 9: replace "by (Eilers, 2003; Eilers and Boelens, 2005)" by "by Eilers (2003) and Eilers and Boelens (2005)".
- page 9, line 25: replace "in details the" by "in detail the". - page 10, line 34: replace "2 mm in contrast to 2.5 – 3 mm" by "2 µm in contrast to 2.5 – 3 µm". - page 11, line 2: replace "in visible" by "in the visible". - page 11, line 14: replace "that sensitivity" by "that the sensitivity". - page 12, line 11: replace "fine fractions" by "fine fraction". - page 12, line 27: replace "in (Reid et al., 2003)" by "in Reid et al. (2003)". - page 12, line 27: replace "per particles type" by "per particle type". - page 15, lines 10-11: replace "in (Derimian et al., 2016)" by "in Derimian et al. (2016)". - page 15, line 26: replace "in (Derimian et al., 2016)" by "in Derimian et al. (2016)". - page 16, lines 18 and 23: replace "Dubovik et al., (2000)" by "Dubovik et al. (2000)". - page 16, line 29: replace "in (Dubovik et al., 2000)" by "in Dubovik et al. (2000)".
- page 17, line 1: replace "in (Dubovik et al., 2000)" by "in Dubovik et al. (2000)". - page 17, line 20: there should be space before the "are" in "are 440". - page 17, line 22: replace "it also" by "it is also". - page 18, line 5: replace "14b)," by "14 b,".

- page 18, line 16: replace "Also, notable" by "Also notable".
- page 18, line 34: replace "of (Dubovik et al., 2000)" by "of Dubovik et al. (2000)".
- page 19, line 7: replace "in details" by "in detail".
- page 20, lines 22-23: the quotation marks are unpaired.
- page 21, line 9: replace "J ATMOS OCEAN TECH" by "J. Atmos. Ocean. Tech.".
- page 22, line 18: the journal name should be abbreviated.
- page 24, line 3: the journal name should be abbreviated.
- page 24, lines 5-8: there are several problems with this reference.
- page 25: the heading of Table 1 should be above the table instead of below it; furthermore, replace "Relative humidity" by "relative humidity".
- page 27, line 5: there is something wrong with "arrival occurred on"; rephrasing is needed.
- page 33, within the top right panel of Figure 11: replace "C" by "Ca". - page 34, line 7: I cannot see any colored arrows in the figure. - page 36, line 5: it is unclear what "in this section" is doing here.

Thank you very much for taking time and providing all these technical, but essential correction. All these corrections are considered in the revised version.