Interactive comment on "Determining the infrared radiative effects of Saharan dust: a radiative transfer modelling study based on vertically resolved measurements at Lampedusa" by Daniela Meloni et al.
Anonymous Referee #1
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General comments: This paper lies in the framework of the ChArMEx/ADRIMED experiment, that took place in the Mediterranean in summer 2013. Three vertical profiles of atmospheric and aerosol properties, made at Lampedusa in conjunction with surface, airborne and satellite IR broadband and narrowband radiation as well as radiosonde are analyzed in order to 1) identify the sensitivity of the different radiative measurements to mineral dust microphysical properties (size distribution and refractive index) and 2) analyze their impact in term of radiative forcing. The main result of this study is that if LW irradiance is poorly sensitive to aerosol microphysical properties compared to brightness temperature, the IR dust radiative forcing is non-negligible, and strongly depends on size distribution (SD) and refractive index (RI). This study highlights the importance of a precise knowledge of the dust microphysics to infer correctly their radiative effect. The paper is an interesting sensitivity study of the radiative variables to the aerosol microphysics, leading, in particular, to the conclusion that spectrally resolved measurements of brightness temperature is more fitted to infer dust properties than broadband LW irradiances. However, the part that concludes on the most appropriate refractive indices is less convincing. Such a study would require a more detailed analysis of the differences between refractive indices (at minimum a figure displaying their values in the spectral domain concerned), as well as a more exhaustive variability in the choice of the indices. Here among the three indices used, two indices are quite similar and only one coming from recent measurement campaign of DiBiagio et al., 2017 is really different. Moreover, the study, based principally on RT simulations, lacks of discussions on the uncertainties due to the RT model itself, as well as to the different hypothesis used. In particular, which is the impact of an error in surface temperature or surface emissivity? An error on the water vapor profile? No reference error is calculated under clear sky condition for example, to distinguish error directly due to the model from errors due to the impact of aerosols properties. The resulting biases obtained with the different aerosol properties configurations cannot therefore be really discussed. For example, large biases between simulated and calculated irradiances are not explained (and apparently not due to wrong aerosol properties), implying that something is missing in the RT model, but not enough discussed. The section on IASI data is not enough developed. All the spectra within a box of about 100 kmx100 km are averaged before analysis, causing a standard deviation in the averaged spectrum larger than the effect of the aerosols properties analyzed! Here again, since no reference errors are given, biases obtained from the different aerosol configurations are finally equivalent and it's not possible to state on the best configuration. This part doesn't really bring new information compared to the previous sections or previous studies, or required a more precise development. Finally, some details on the inputs used are missing. A few details are provided on the size parameters used (the reader has to refer to the paper of Denjean et al. 2016 to have the precisions) and the exact refractive index from DiBiagio et al., 2017 use in this study is not given: 3 different indices are coming from Â´nÂ˘athe source regions (Tunisia, Algeria, Morocco) in DiBiagio et al., 2017 whereas only one is used here without any precision!

We agree with the reviewer that a comprehensive analysis including the impact of the uncertainty on the input parameters on the model simulations (of either irradiances and brightness temperature profiles and of radiances at the top of the atmosphere) is useful to better constrain the results. Following the reviewer's suggestion, a sensitivity study addressing the uncertainties of the modelled radiation quantities due to the uncertainty on the input parameters has been carried out, either in aerosol-free conditions or including the aerosol particles. The main model input parameters

affecting infrared radiation in aerosol-free conditions that have been considered are: integrated water vapour, temperature profile, sea surface temperature, surface emissivity. Each quantity has been perturbed one at a time by the amount of its uncertainty, than all the resulting model uncertainties has been combined to provide the overall uncertainty. Similarly, the sensitivity with respect to AOD and dust complex refractive index has been quantified.
The results have been added to the manuscript under the new Section 3.3.
The model LW irradiance uncertainty decreases with increasing altitude for both the downward and upward components. The estimated model uncertainty on the downward and upward LW irradiances at the surface is 2.2 and 2.0 W m^{-2} for simulations without and with aerosols, respectively. At the Falcon 20 altitude (about 10 km) the uncertainties are 0.6 and 1.5 W m^{-2} for the downward and upward component, respectively, for both simulations with and without aerosol. The upward LW irradiance uncertainty is 1.4 W m^{-2} at TOA, for simulations with and without aerosol.. The estimated uncertainty on ARF is obtained by the combination of the above values, and is 4.2 W m^{-2} at the surface and 2.0 W m^{-2} at the TOA. The uncertainty on AHR is largest at about 4.5 km altitude (0.030 K day^{-1} with aerosol and 0.026 K day^{-1} without aerosol), and close to the surface (0.050 K day^{-1} with and without aerosol).
The uncertainty on the downward WINDOW irradiance is 0.9 and 0.6 W m^{-2}, with and without aerosol, respectively. The estimated uncertainty on the modelled zenith BT is 0.7 and 0.3 K, with and without aerosol, respectively.
The aerosol-free CLIMAT BT is much sensitive to SST and surface emission, with slightly larger values at 600 m (0.3 K) than at 5670 m (0.28 K). The overall uncertainty for the case with aerosol is 0.31 K at 600 m and 0.37 K at 5670 m.
The uncertainty on the spectral BT at TOA in the atmospheric window varies between 0.25 and 0.29 K in aerosol-free conditions, and between 0.32 and 0.50 K with aerosol.

The model-measurement differences have been discussed in the text taking into account the uncertainties on the model estimates.

A figure displaying the spectral complex refractive indices used in this study has been added as Supplement Material (Figure S1). With this regard, a summary of the most common complex refractive indices of desert dust is provided in Di Biagio, C., Boucher, H., Caquineau, S., Chevaillier, S., Cuesta, J., and Formenti, P.: Variability of the infrared complex refractive index of African mineral dust: experimental estimation and implications for radiative transfer and satellite remote sensing, Atmos. Chem. Phys., 14, 11093-11116, doi:10.5194/acp-14-11093-2014, 2014. Moreover, the spectral (0-40 µm) normalized extinction coefficients, single scattering albedoes, and asymmetry factors computed using the combination of SDs and RIs described in the text for each layer of the three profiles have been shown in Figure S2, S3, and S4 of the Supplement Material.

The dust refractive indices that we use in the 0-40 µm range have been chosen because they are specific for the source regions found during the ChArMEx campaign (like those from Tunisia, Algeria, Morocco by Di Biagio et al., 2017), or because they are widely used in the retrieval of satellite products or in climate models (like the ones from OPAC by Hess et al., 1998, and by Volz, 1973).
OPAC and Volz (1973) have very similar real and imaginary parts, except for the 9.5-14 µm spectral interval, where we explore the dust impact on the surface irradiance (in the 8-14 µm window) and brightness temperature (9.6-11.5 µm) and in the CLIMAT and IASI brightness temperatures (BTs). The results in Table 3 of the manuscript confirm that the model-measurement differences in the 9.6-11.5 µm BT can be significant (0.7 K) when the OPAC size distribution is used, while are modest (0.4 K) with the *in situ* size distribution.
Other dust refractive indices found in literature were taken into account, although the results are not reported in the manuscript: for example, the Volz (1972) one, which is equivalent to the one

published in Shettle and Fenn (1979). The imaginary part is much lower than that of OPAC and Volz (1973), so lower surface LW and WINDOW irradiances and infrared BT are expected, with consequently modest radiative effect.
The aerosol optical properties obtained with the Longtin et al. (1988) dust refractive index were already examined in a previous paper (Meloni et al., Altitude-resolved shortwave and longwave radiative effects of desert dust in the Mediterranean during the GAMARF campaign: Indications of a net daily cooling in the dust layer, J. Geophys. Res. Atmos., 120, 3386–3407, 2015).

All the three refractive indices by Di Biagio et al., 2017 (Algeria, Tunisia, Morocco) have been used in the study, since the analysis by Denjean et al. (2016) based on back-trajectories and MSG-SEVIRI satellite products shows that dust collected during F35, F38, and F4 flights have different source regions (details are given in Table 1 of Denjean et al., 2016). More specifically, for flight F35 the dust layer above-3.5 km originated from southern Algeria, while the dust layer between 1.5 and 0.5 km was transported from southern Morocco. On 28 June (F38) dust was lifted from Tunisia. Finally, on 3 July (F42) dust originated from Tunisia (above 3 km) and from southern Morocco (below 3 km).
A better description of the choice of the appropriate refractive index on the base of the dust source region was added in Section 3.1.1 (page 9, lines 1-19). We have used different refractive indices from Di Biagio et al. (2017) for each flight and each dust layer based on the source regions found in Denjean et al. (2016). For F35 we used the refractive index for Algerian dust in layer 3 (see Figure 3), that for Moroccan dust in layer 2, and the OPAC water soluble refractive index for layer 1, i.e. below the dust layer. Similarly, the Tunisian dust refractive index is used for F38 flight in layer 2 and the OPAC water soluble one in layer 1. For F42 the Tunisian and the Moroccan dust refractive index are used in layer 2 and 1, respectively.
We clarified the choice of the dust refractive index in Section 3.1.1 and prepared a new Table 2 which includes three tables, one for each day. The tables present the combination of SD and RI used in each layer identified by the lidar and ATR-42 measurements, and the AOD value at 8.6 µm.

Specific comments:
- p2line 21Â˘ a: Â´nÂ˘aMost of these studies have been carried out close to the dust source regions and did not take into account the possible modifications in dust optical properties during long range transport. ": You can also find some studies dealing with the variation of the aerosol properties with transport (e.g. Maring 2003; Ryder et al., 2013; Weinzierl et al., 2017 and so on). Moreover, I don't see the link with the subject of this paper since there is no discussion on the possible change of dust properties with transport. Maring, H.: Vertical distributions of dust and sea-salt aerosols over Puerto Rico during PRIDE measured from a light aircraft, J. Geophys. Res., 108(D19), 1–11, doi:10.1029/2002JD002544, 2003. Ryder, C. L., Highwood, E. J., Lai, T. M., Sodemann, H. and Marsham, J. H.: Impact of atmospheric transport on the evolution of microphysical and optical properties of Saharan dust, Geophys. Res. Lett., 40(10), 2433–2438, doi:10.1002/grl.50482, 2013. Weinzierl, B., ProsPero, J., Chouza, F., FomBa, W., Freudenthaler, V., GasteiGer, J. and Toledano, C.: THE SAHARAN AEROSOL LONG-RANGE TRANSPORT AND AEROSOL–CLOUDINTERACTION EXPERIMENT Overview and Selected Highlights, [online] Available from: http://journals.ametsoc.org/doi/pdf/10.1175/BAMS-D-15-00142.1
We thank the reviewer for suggesting the papers that have been integrated in the Introduction, citing them as example of studies carried out by means of aircraft measurements dealing with the temporal evolution of dust properties occurring during long-range transport.
Our study focuses on the optical properties of transported dust and on its infrared radiative effect in the Mediterranean. The present paper does not aim at assessing how dust optical properties change during transport (Denjean et al., 2016 show indeed that the coarse mode of dust did not change after 5 days of transport possibly due to strong vertical turbulence within the dust layer, preventing the deposition of large particles), but highlights the importance of knowing the dust microphysical and

optical properties to reasonably estimate the IR dust radiative forcing and heating rate at the surface, in the atmosphere, and at the top of the atmosphere.

- P2line 29:
the paper Sellitto et al., 2016 deals with aerosols in the ULTS and not with dust. This reference is not really appropriate here.
The reference has been removed.

- p4line21: why describing AERONET AOD and associated uncertainties if not used? Even not compared in the following to the MFRSR?
We agree with the reviewer. The AERONET AOD is not used because of some missing data, so the sentence in lines 22-23 about AOD uncertainty has been removed.

- P5: For the surface observations, several instruments measuring irradiance are described, but it's not clear if they are all used in this study. Why describing every instrument available if they are not used? Which ones are really used? This section would gain in clarity if simplified.
In Section 2.1 all the ground-based instruments are presented. For sake of clarity, we removed all instruments (like the shortwave radiometers and the pyrheliometer) whose measurements are not used in the analysis.

- P6line13: maybe a summary of the description of the meteorological and dust conditions given in Denjean et al., 2016 would help? It's easier for a reader to get all the relevant information in one paper.
A short description of the synoptic conditions causing dust transport from the Sahara desert to Lampedusa during the campaign has been added in the text.

- P7line15: unity switched from µm to cm-1. Maybe it would be clearer for the reader to stay in µm?
IASI spectral characteristics, like spectral interval, sampling and resolution, are provided in units of cm^{-1}. We have used both µm and cm^{-1} in the text and in figures and table whenever possible to help the reader.

- P8line 18-19: How the AOP (i.e. spectral extinction, single scattering albedo, and phase function at each layer) can be derived from AERONET observation and from Deanjean et al., 2016, in particular for longwave? Observations made by AERONET or Denjean et al. are made in visible wavelength, not in the infrared part of the spectrum. Optical properties cannot be derived in the longwave by these measurements. This sentence is in contradiction with the procedure described later where the size distribution from AERONET and the ATR-42 are used with independent refractive indices to derived these optical properties.
We agree with the reviewer that the sentence in lines 18-19 is misleading. The IR AOPs are not derived from AERONET or airborne observations alone.
The aerosol optical properties in the infrared spectral range are calculated applying the Mie theory using the AERONET and the *in situ* size distributions and the complex refractive indices in the 3-40 µm (OPAC) and in the 2-16 µm (Di Biagio et al., 2017) intervals.
The sentence has been rephrased.

- P9line 14-15: which is the RI used from OPAC? MITR? Must be cleared. Similarly, which RI from DB2017 is used? In Table 2 "Algeria-Tunisia-Morocco dust" is mentioned, but it corresponds to 3 different indices, which one is used?

We used the mineral dust refractive index from OPAC, which is the same for the four dust types (accumulation, coarse, nucleation, transported) of the model. This has been clarified in the text. As for the answer to the reviewer's general comments, we have used different refractive indices from Di Biagio et al. 2017 for each flight and each dust layer based on the source regions found in Denjean et al. 2016. More details are now given in section 3.1.1 and Table 2.

- P9line 19: the sentence "the AOPs are calculated using the AERONET and the in situ SD and the OPAC water soluble RI" have to be rewritten by something like "the AOPs are calculated using either the AERONET or the in situ SD and the OPAC water soluble RI.
We rephrased the sentence according to the reviewer's suggestions.

- P9 line 4: A table given the main parametrization of the SD (radius and width of the distribution size) used would avoid to refer systematically to the paper of Deanjean et al., 2016.
We have produced Table S1 with the median radius, standard deviation, and normalized number concentration for each mode of either the AERONET and the *in situ* log-normal size distributions for the three cases as Supplement material.

- P10 Eq 2: What does the symbol Delta stand for?
The Delta symbol in the heating rate equation represents the variation of net flux and pressure between two contiguous layers.

- P10-11
and Table 3: the uncertainty for the WINDOW irradiance have been changed from 2 to 6 W.m2 from the previous version of the paper. In any cases in the text I read an uncertainty of 3W.m2 (p5, line 19). Which is the good one? In addition, the observed values for the downward irradiance and BT correspond to the average over a 10 minutes interval, what is the standard deviation of the measurement compared to the uncertainty? If the standard deviation is of the order of uncertainty, it means that the signal present small variation within the 10 minutes and maybe it would be better to compare simulations with observation, for every observation within the 10 minutes and average after instead of comparing with the average observation? If the standard deviation is larger, it means that using constant aerosol distribution is not valid.
The measurement uncertainty reported in Table 3 is the expanded (2-sigma) uncertainty, but this was not specified in the table caption, so it seems to disagree with what explained in the text (page 5, lines 19-20), referring to ±3 Wm^{-2} as one sigma uncertainty. This has been better specified in the revised paper.
However, the CGR3 participating to the ChArMEx campaign has been recently tested by PMOD/WRC to assess the possible effect due to the leakage of solar radiation on the WINDOW irradiance. The tests have shown that the effect is negligible, and so the WINDOW irradiance data used in the present analysis have to be reconsidered because they were corrected by subtracting a shortwave stray-light correction of about 4 Wm^{-2} per 1000 Wm^{-2} solar irradiance. So in the revised paper the CGR3 expanded uncertainty returns to be ±2 Wm^{-2} and the WINDOW irradiance data have been corrected, either in Table 3 and in Figure 2.
The standard deviations of the LW and WINDOW irradiance, and of the zenith BT over the 10 minute interval are much lower than the measurement uncertainty. For example on 22 June the standard deviation values are 0.2 Wm^{-2} for the LW irradiance, 0.3 Wm^{-2} for the WINDOW irradiance, and 0.1 K for the BT. We assume that no significant variations occur within the 10 minute interval and that differences can be calculated between the average value and the model simulation. A sentence has been added in the text to state the very low variability within the 10 minute time interval.

- All the section 4.1 need

to be slightly reorganized. In particular, the sentence line 23-24 page 10 is very general for the three days and the three variables, and therefore need to be at the beginning of the paragraph, as well as the sentence line 18-21, which is the associated explanation or put at the end of the section as conclusion. Furthermore, the paragraph need an overall analysis of the results obtained at the end: For LW irradiance and WINDOW irradiance, the impact of the refractive index is below the uncertainty of observation, the impact of the RI for a given SD is close to the uncertainty. For WINDOW, simulations always overestimate the observation, implying that the RT model or the calibration is not correct for this simulation and therefore it is not clear to understand what bring this variable in the study: : : On the contrary, for IR BT, the impact of the SD as well as the RI is significant compared to the uncertainty, this variable seems to be more appropriate to analyze AOP.
We agree with the reviewer. Section 4.1 has been revised, the results commented taking into account the model uncertainties, and a concluding sentence has been added at the end of the section. Although the WINDOW irradiance is overestimated by the model, its simulations with different AOPs have been included in the analysis to show that, even when reducing the spectral interval compared to the broadband, the irradiance is not sensitive to varying AOPs.

- P11 line 27: “The average AOD during the descent is assumed as model input.”: Which AOD is used? The average column integrated value measured by the MFRSR?
Yes, the AOD measured by the MFRSR during the flight and reported in the IR as explained in section3.1.1 has been averaged and used as model input.

- P11line30-33: there is no reason for which the NOAER simulation agree well for all the profile except close to the surface given the aerosol distribution of Figure 3. Something may be missing in the simulation to reproduce the observed downward irradiance in the lower part of the atmosphere that is not due to aerosols.
Figure 6 shows that model without dust (NOAER) underestimates measurements by an amount that is negligible at higher altitudes and increases close to the surface. This effect is due to emission of infrared radiation by the dust above each altitude layer which induces an increase of the downward LW irradiance, and which depends on the dust optical depth and optical properties.

- P12line 1-3: “This confirms the results found for the surface irradiance, i.e. that the broadband irradiance alone cannot help discriminating which SD and RI provide the best representation of the dust optical properties”. This conclusion is not clearly stated in the previous part (see my comment on the section 4.1).
A concluding sentence has been added in Section 4.1 to summarize the results.

- P12line 12-13: “However, while the model-measurement agreement is very good at 600 and 3300 m, where the aerosol impact is small, a systematic overestimation is obtained at 5670 m.”: from Figure 7, there is no evidence of a “systematic overestimation […] at 5670 m”. COL1 and INSU3 seems to fit well observations at 12_m, whereas an overestimation is obtained at 8.7µm. At 10.6µm COL1 induces an overestimation, but INSU3 an underestimation of the observation. I don’t see therefore “a systematic overestimation”.
The sentence was present in a previous version of the manuscript and was erroneously maintained in the submitted version. It has been removed. As the reviewer points out, the overestimate of the model depends on spectral band and on aerosol optical properties.

- P12 line 15-16: “These results show that exploring the BT in the thermal infrared is a useful tool to infer dust optical properties if the SD is provided.”: this sentence should be slightly attenuated: These results show the better sensitivity of BT to dust optical properties than broadband irradiance but for the two other days, where aerosols are lower or with a smaller AOD, the differences between simulations with different AOP are of the order of the observed uncertainty.

The sentence has been modified according to the reviewer's suggestion in "These results show the better sensitivity of BT to dust optical properties than broadband irradiance", since the paragraph refers to flight F35 only.

- P13line 26: "while no BT increase is detected at 1700 m": I don't understand this sentence, on Figure 9, there is an increase of BT at 1700m.
The reviewer's comment is right. At 1700 m, as well as at 900 m, either the pyrgeometer and the CLIMAT capture the infrared increase due to the island emission. The sentence has been changed in "The spikes at 900 m and around 1700 m indicate that also CLIMAT captures the island emission.".

- As for the section 4.1, this section lacks of a conclusion that summarizes the different simulations. Basically, the LW irradiance is not really sensitive to AOP (impact under the uncertainties). In addition, something appears to be missing in the simulations, because simulated upward irradiances are systematically overestimated by simulation in some part of the profile (for the three cases, even it is less important in the first one). An explanation, or at least some hypothesis, of this overestimation is missing in the paper.
A concluding sentence has been added at the end of the section, explaining that irradiance is not sensitive to the AOPs, while the aerosol perturbation to the upward infrared BT can be appreciated only at altitudes above the bulk aerosol emission, like for the flight F35.
Differences between the measured and the model upward LW irradiance profiles for 28 June and 3 July cannot be explained by a wrong representation of the temperature and humidity profiles in the model, that would have affected the CLIMAT profiles also, as described in the text. What is observed is that the CLIMAT BT profiles are well reproduced at different altitudes, also close to the surface for flight F38, suggesting a proper choice of atmospheric profiles and of sea surface temperature and emission.
We formulated an hypothesis of some negative bias affecting the pyrgeometers' measurements due to the fact that the instrument needs some time (the typical response time is 6 s but for airborne measurements the required time may be significantly longer, as shown for example by Albrecht et al., Pyrgeometer measurements from aircraft, Rev. Sci. Instrum., 45, 33–38, 1974) to establish equilibrium with the air temperature. So we expect that when the aircraft is descending rapidly pyrgeometer measurements may be affected. We verified that during flights F38 (from 3500 to 2000 m) and F42 (from 4800 to 1600 m), where model values are larger than measurements, the vertical velocities were -5.5 and -5.3 m/s, respectively. On the contrary, from 5400 to 4000 m during flight F38, where non-significant biases between model and measurements are observed, the vertical velocity is sensibly lower, about 2.6 m/s. Similarly, during flight F35, when model-measurement differences are small, the vertical velocity is 2.8 m/s.
Opposite to CGR4, the CLIMAT measurements are not affected by the ATR-42 descent speed because the instrumental response time is much shorter (160 ms).

- P14 line 14-15 "The resulting standard deviation on the TOA spectral radiance is around 1% for 22 and 28 June and 0.5% for 3 July": this value requires to be in K, in order to be compared with the radiometric noise and more over to be compared with the impact of the different AOP. Given that 1% corresponds to a variation of about 2.9K (_1% of the surface temperature), this standard deviation is larger than the impact of the aerosol properties themselves. It should be better to apply the simulations to each spectrum and then average the differences.
The IASI spectra have been expressed as BTs, and averaged within the chosen area: the standard deviation (in the 8-14 µm interval) is about 0.6 K for 22 and 28 June, and about 0.3 K on 3 July. These values, although larger than the IASI radiometric noise, express the variability of the TOA BT in the domain. The aim of the simulation of the IASI spectra is to show that including the aerosol the TOA-leaving radiance decreases by an amount which is larger than the model uncertainty and the IASI radiometric noise. Moreover, we want to investigate the sensitivity of the

modelled TOA-leaving radiance to different AOPs. The results in Table 7 show that an appreciable aerosol effect is detected on 22 June and on 3 July, leading to an improvement in the model simulations compared to the aerosol-free case.

- Table 7: In the caption is written "Differences (K) between modelled and measured IASI BT spectra" at the beginning and "Differences are expressed as percent RMSD and standard deviation" at the end. The differences are in K or in %? The sentence "In bold the significant differences with respect to the NOAER simulations." Is not clear. What means "significant differences with respect to the NOAER simulations"? What is the criterion to put in bold the difference?
The differences between model and measurements are calculated in the two spectral intervals 780-980 cm^{-1} and 1070-1200 cm^{-1}. Then for each interval the RMSD and the standard deviation are calculated, with the various AOP and also in the aerosol-free case, and expressed in K. The values that have been highlighted in bold are those for which the TOA BT with aerosol and that without aerosol are different taking into account the respective mean and standard deviation (significant difference). The caption of the table has been corrected.

- P14line23 to p15line 6: this paragraph need to be reorganized by day instead of analysing figure 12, and then Table 7 since the conclusions are the same and it would avoid redundant sentences.
The paragraph has been reorganized in order to present the results more concisely and clearly.

- P15 line 4-5: this sentence repeat statement already given in the previous paragraph or has to be rewritten.
The sentence has been removed.

- P15 line 7-24: the paragraph
describing the analysis of Liuzzi et al. (2017) is very long to finally conclude that the impact of INSU3 is of the same order. Either better details of what this study bring compared to the previous one, or why this study use a simplify RT models compared to the previous one is given, or this paragraph has to be shortened. But for now, it's difficult to see where the author is going.
Liuzzi et al. (2017) use an ad-hoc model to reproduce the IASI TOA spectra with the native spectrometer resolution, with the *in situ* size distribution and Di Biagio et al. (2017) refractive indices, tuning some parameters like SST to achieve a good agreement with the measured spectra. We use a model with lower spectral resolution and all the atmospheric and surface parameters derived from observations.
Achieving similar results of those of Liuzzi et al. (2017) at TOA and reproducing also surface and atmospheric irradiances and BT is not obvious and represents an important result of the closure study.
The description of the analysis carried out by Liuzzi et al. has been shortened and the aim of the simulations of the IASI spectra has been better explained.

- P15 line 10: correct "or" by "for" in "The real part is also generally lower or Shettle and Fen "
Done.

- Section 4.4: it would be interesting to see also the results for the two other days and the AOP INSU1 in order to have an idea of the variations of the radiative forcing from very different cases.
The aerosol radiative forcing and heating rate obtained with the INSU1 AOPs have been added and discussed. The ARF and AHR for the other cases have not been presented because the paper is already long. Below we report the tables with the ARF and ARFE for 28 June and 3 July. The values of the ARF is low on both days, either at the surface and at TOA. When taking into account the uncertainties on the modelled ARF, the ARF is different from zero using INSU1 on 28 June and

with INSU1 and INSU3 (only at the surface) on 3 July. It is worth noticing that the ARFE values are similar in the two days.
The ARF values with INSU3 AOPs are much lower on 28 June and 3 July than on 22 June and we expect an analogous behaviour for the aerosol heating rates.

Table 1. LW ARF and ARFE at the surface, TOA, and in the atmosphere (in W m^{-2}) on 28 June calculated with all the AOPs.

	ARF				ARFE			
AOP	COL1	COL3	INSU1	INSU3	COL1	COL3	INSU1	INSU3
Surface	3.0	1.4	5.7	3.6	14.3	6.7	27.1	17.1
TOA	1.3	0.6	2.5	1.8	6.2	2.9	11.9	8.6
Atmosphere	-1.7	-0.8	-3.2	-1.8	-8.1	-3.8	-15.2	-8.5

Table 2. LW ARF and ARFE at the surface, TOA, and in the atmosphere (in W m^{-2}) on 3 July calculated with all the AOPs.

	ARF				ARFE			
AOP	COL1	COL3	INSU1	INSU3	COL1	COL3	INSU1	INSU3
Surface	3.8	2.1	7.1	4.4	14.7	8.1	27.4	17.0
TOA	1.5	0.8	2.6	1.6	5.8	3.1	10.0	6.2
Atmosphere	-2.3	-1.3	-4.5	-2.8	-8.9	-5.0	-17.4	-10.8