Atmos. Chem. Phys. Discuss.,
https://doi.org/10.5194/acp-2018-700-RC3, 2018

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impact of mineral dust on shortwave and longwave radiation: evaluation of different vertically-resolved parameterizations in 1-D radiative transfer computations" *by* Maria José Granados-Muñoz et al

Anonymous Referee #3

Received and published: 14 September 2018

The paper examines a case of a moderate dust intrusion in Granada with the aim of calculating the dust radiative effect either in the SW and in the LW regions at the surface, at the top of the atmosphere, and within the dust layer by means of the GAME radiative transfer model. The focus of the study is the sensitivity of the SW and LW radiative fluxes and effects on the dust microphysical and optical properties derived in three different ways, using a combination of remote sensing (AERONET and lidar) measurements and the GRASP inversion code, and in situ airborne measurements from the SAFIRE ATR42 aircraft. This study is carried out in the framework of the

ChArMEx/ADRIMED campaign and takes advantage of the large observation efforts placed during the project, using either ground-based, airborne and satellite observations. The results of the model calculations are those expected (SW cooling and LW heating by dust, with a not negligible LW/SW ratio), and the case study is not that of an extraordinary dust transport (AOD moderately low). However, the most important conclusion provided by the authors is that optical properties derived from different measurements and with different techniques may provide non-negligible differences in the radiative effects, and should be of concern when estimating dust forcing. I recommend publication, but after some major issues are resolved by the authors.

Major issues The main issue on the presented results concerns the simulation of the SW irradiances using the three different aerosol optical properties DS1, DS2, and DS3, and the evaluation of the ARE. The authors found that very close SW irradiances at surface are obtained with the three datasets (the values seem coincident in Figure 7, but no quantitative information is provided in the text), while differences in the vertical profiles of the downward SW irradiances simulated with GAME are visible in Figure 6 close to the surface when using DS1 or DS2 (which seems to provide identical irradiances than DS3). So there seems to be an inconsistency between the simulations of the vertical profiles and of the surface SW irradiance. As a second point, the LW ARE is very low, due to the values of the AOD, and they might be comparable to the model uncertainties. So a careful evaluation of the uncertainties on the model output should be performed. The fact that the net LW irradiance on 17 June is overestimated by the model is likely not a problem of the CO2 and O3 profiles (the water vapor one should have been taken into account in the simulation, as it measured during the flights) used in the model (to my knowledge the impact of this minor gas is negligible) , but comes from the fact that NET=FâĘŞ-FâĘŚ, and FâĘŞ is overestimated, while FâĘŚ is comparable to measurements. The model overestimation of the LW irradiance at the surface on 17 June (which, however, is as large as the measurement uncertainty) cannot be due to clouds affecting the measurements and not accounted in the model, because clouds increase the LW irradiance, and this should cause a model underestimation. I suggest to perform a sensitivity study to assess the uncertainty on the modelled SW and LW irradiances due to the uncertainty of the input parameters. As the authors state, the CERES observations are too far in space (600 km) and in time (2 hours) to the surface observations, and a quantitative comparison with the RT model simulations is not possible. I think that the approximate results on the TOA fluxes using CERES data should be removed.

Minor issues Introduction: a quantitative description of the SW and LW dust radiative effect in the Mediterranean from previous studies is missing. Page 6, line 9: remove “diffuse” before downward radiative fluxes for the LW. Page 7, line 10: the authors should better explain how measurements corresponding to large pitch and roll aircraft angles are filtered. Moreover, this should be applied not only to downward pyrgeometer measurements, but to either pyranometers and pyrgeometers, both downward and upward-looking. The description of the correction of the ATR42 radiation measurements for the variation in the solar position and in the aircraft attitude during flight applies to pyranometers and not the pyrgeometer measurements, as stated in line 10. The final uncertainty in the airborne SW irradiance profiles is not reported. Page 8, lines 23-24: a figure showing the airmass back trajectories may be useful. Page 8, line 26: change “profile” with “flight”. Do the same at Page 9, line 5. Page 9, lines 26-27: the authors mean that, due to the lack in MODIS data of LST the air temperature 2 m a.g.l. have been used as surrogate of the LST? This may lead to a relevant underestimation of the upward LW irradiance. Did the authors verify the differences in air and surface temperature in other cases and the impact of using one or the other in the simulation of the upward LW irradiances? Page 13 lines 11-12: maybe the authors mean “extrapolation” instead of “interpolation” and “longer” instead of “shorter”. Page 14 line 11: use “solar” and not “visible”. Page 15 line 2: the sentence “Even though the discrepancies in the AOD are within the uncertainty. . .” is misleading. DS1 and DS2 use AERONET AOD measurements as input, so both should agree within the measurement uncertainty ($\pm$0.01) at 550 nm. But a difference of 0.05 is reported in Table 4. This difference should be addressed and explained. Page 15 lines 5-7:

the spectral variation of the SSA is provided only for the wavelengths at which it has been derived (Figure 4). For example DS3 from aircraft measurements is provided only for one wavelength. This not helps in understanding how optical properties may influence the SW radiation in the whole interval. Page 15 lines 8-9: this sentence is rather obvious, since the comparison with aircraft radiation fluxes can be done only for the altitudes covered by the ATR42. Page 15 line 13: maybe the authors mean “below” instead of “above”. Page 15 lines 25-28: the authors should present and discuss absolute and relative differences between measurements, AERONET calculations and GAME simulations. I don’t understand the sentence stating that on 16 June the radiation presents large values (than 17 June?), please explain. An overestimation by 6% by GAME is much larger than the irradiance uncertainty. The estimation of the simulated irradiances is necessary in order to understand if such a difference is within the model and measurement respective uncertainties, otherwise it should be commented and possible causes addressed. Page 17 lines 8-15: the SZA at which the RTM simulations are performed should be cleared. Are they those corresponding to the middle of the F30 and F31 flights (31.49° for 16 June and 61.93° for 17 June?). The SW ARE depends on the SZA, so when the authors presents the ARE from previous studies are they sure that such values can be direct compared with theirs? I don’t think so, since results from Papadimas et al. (2012) are regional summer means. The same goes for the comparison with the other references (Sicard et al, 2014a,b; Barragan et al., 2017). Moreover, ARE depends on AOD. Thus, when comparing cases with different AOD, the radiative forcing efficiency (ARE per unit AOD) may be the most appropriate quantity. Page 18, line 7: change “diffuse” with “longwave”. Page 18, line 13: the upward and not the downward component of the LW irradiance depends on LST. Page 30, Table 3: albedo in not defined in the LW region! Do authors refer to emissivity? Is it spectrally integrated or for a single wavelength? Page 34, Figure 5: a shift is visible in the volume concentration profile of 17 June form GRASP code and aircraft measurements. Can the authors comment on it? Page 35, Figure 6: The uncertainty range of the radiative fluxes from airborne instrumentation should be added in the plot to help understanding how much model calculations agree with measurements. The same for Figure 9.

Interactive comment on Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-700, 2018.