Atmos. Meas. Tech. Discuss., 8, C1018–C1023, 2015
www.atmos-meas-tech-discuss.net/8/C1018/2015/

Atmospheric Measurement Techniques Discussions

Interactive comment on "A methodology for investigating dust model performance using synergistic EARLINET/AERONET dust concentration retrievals" *by* I. Binietoglou et al.

Anonymous Referee #1

Received and published: 5 May 2015

The manuscript describes a method to use vertical dust concentrations derived from combined retrievals (LIRIC) using routine lidar measurements from the EARLINET network and sunphotometer measurements from AERONET to evaluate dust model results. The manuscript is well written, the figures are well readable.. I do however have some concerns that should be addressed by the authors before I can recommend the manuscript for publication at AMT.

General remark:

Obtaining dust/aerosol concentration data information from (ground-based) remote

sensing observations is certainly desirable, e.g. for determining aviation safety after volcanic eruptions. It can of course also be used for dust model evaluation, as suggested here. A positive aspect here is the synergetic use routine measurements from the lidar and sunphotometer networks, as the production of such data could possibly be automated at some point. The authors argue that to compare such retrieved concentrations with model concentrations that are directly simulated by the model without assuming particle site distribution (which in fact in the 8-size-bin models are also simulated directly) An alternative approach for direct comparisons of models and observations would be to have all assumptions on the model side – i.e. by simulating the actual measured instrument signals by model forward operators. However even synergetic retrievals such as the LIRIC algorithm need additional assumptions. Here the e.g. assumption of constant microphysical properties is mentioned, also to convert volume concentration to mass concentration requires additional information on particle densities. As dust modeler I would be hesitant to use such concentration retrievals until such a product is thoroughly evaluated itself, and possible errors und uncertainties are quantified as actually proposed as an outlook in the 'Conclusions' section of this manuscript.

Further comments:

Page 3608, line 20: Why would 'giving a bird's eye view' be useful? Satellite instruments can do that. I would rather point that models are a useful tool to study the processes and sensitivities controlling the dust distribution, and in particular are used to compute regional and global budgets of dust.

Page 3608, line 27: 'monitored' – not a good expression here, better: 'tested'

Page 3607, line: 10: Dust models are not only validated with optical thickness data but often measurements of surface concentration and deposition fluxes are used for model evaluation as well.

Page 3607, line: 15: 'A better vertical distribution' – this implies that models do not

perform well in this aspect, which is in fact contradicted in this manuscript (the vertical structure appears to be quite well represented by the models, even if the total dust concentration is underestimated)

Page 3610, line 9: 'information about the actual size distribution' – this statement is misleading, at least for some of the retrieval methods. To my understanding LIRIC algorithm retrieves the size distribution from sunphotometer inversions, which I would not label 'actual size distribution ' but 'retrieved size distribution'.

Page 3611, line 20: 'is' -> 'in'

Page 3613, Table 1: The table is difficult to understand without additional information. I suggest to provide more detailed information on which products are retrieved/available at the different levels described on Page 3613.

Page 3614, line 7 'assumed aerosol intensive properties' –Remark: Before such products can really be useful for model evaluation it must be clearly stated and transparent (1) what these assumptions are (e.g., assumption of constant microphysical properties is mentioned on page 3016) and if these are applicable/representative for the studied problem; and (2) to which extent the retrieved data product is sensitive to deviations from these assumptions.

Page 3015-3016: LIRIC description: Unfortunately the authors refer for the detains of the LIRIC algorithm to a paper by Chaikovsky et al. (2015), which has the status 'in preparation' according to the references section. The other reference to the algorithm provided here is Chaikovsky et al (2012) which refers to a conference proceeding. Neither are peer reviewed or easily available to the reader. Please use other references here.

Page 3016, line 25: Regarding the retrieval errors of 20% - can this number be generalized for all dust cases? Granados-Munoz investigate the volume concentration derived by LIRIC, here mass concentrations are compared – what are the assumptions for

particle densities?

Page 3619, Table 2: Table 2 needs improvement. Model domain size is not shown in Table 2, please include the relevant information. Also, how frequently are the boundary data updated? What is meant by ''data assimilation' in this context – presumably 'dust assimilation? Overall the table is not clearly arranged, please improve the formatting.

Page 3019, line 20: Why is the NRT evaluation mentioned here while this is not a focus of the evaluation presented here? In fact it would be interesting to get some insights into possibilities of NRT evaluation of dust forecasts using the LIRIC data, mabe in the Outlook section.

Page 3620, line 16 – Can you find a more recent reference than d'Almeida 1987?

Page 3620, line 20: 'this effect is expected to be small' – please explain why this would be the case.

Page 3624, line 11: It is not surprising that RSME is strongly affected by outliers. To characterize dust events they could be characterized by the 95th percentiles which would also be a basis for a statistical comparison.

Methodology section: Overall remark – thickness of dust layer would be an interesting additional test parameter – appear to have the tendency to be too diffusive in the vertical, as appears to be the case for DREAM-NMME-MACC in Figure 8. This could have important consequences for estimating CCN/IN supply at high altitudes from dust model results.

Page 3625, line 16 'forecasting' -> 'simulating'

Page 3625, Line 22: Here cases are indicated where some of the models do not predict dust events which are detected by the observations. Of course such misrepresentation would lead to a low bias for the models, since only cases are compared where dust is observed by EARLINET/Aeronet, while other cases where models would simulate dust events at a different time (possibly due to deviations in the transport athway) would not

be compared. For comparing individual cases, model results not only at the location but also in neighboring model gridcells should be taken into account.

For a statistical comparison it would be a fairer approach to compare the LIRIC profiles with maximum dust cases (e.g. 95th percentile values, clear sky conditions) from the models , to compare actual dust events. Of course the number of available profiles may be too low to allow for statistical significance.

Page 3626, line 3: Not volume concentration, but mass loads are shown in Figure 5.

Page 3626, line 20: Can the model low bias be due to a misinterpretation of other aerosol types as dust in the LIRIC algorithm? Since the models only provide dust this would automatically lead to too low model dust. Also, in addition to the concentration values it would be educational and straightforward to also compare modeled optical thickness values with the Aeronet data. The models will likely match the AOD values much better, which may hint to misrepresentations of particle size distributions in the models. Also, where available comparison with extinction profiles would be useful additional information.

Page 3628, line 27: I do not understand 'averaged at 1km altitude ranges', please explain.

Page 3629, line 23: The slightly worse performance of the 'Western' cluster may also be due to the dust production mechanism, which may be related to wet convective events near the Atlas mountain. Regional models have notorious problems to reproduce such dust cases. However, the discrepancies in the performance between the western and eastern clusters appear to be quite small.

Page 3230, line 4-5 – Reference?

Page 3230, line 9: '.. clear indication that the dust vertical structure by dust models needs to be further explored ' – this is not really shown by this paper. Instead the comprisons can be interpreted that the vertical structure is actually quite well represented

in the model, while the concentrations are all lower than the LIRIC retrievals. So it appears to be more a problem of the concentration than the vertical structure?

Page 3230, line 12: Studying the reasons for differences between the models would to first order be a task for model intercomparisons, observation data can only be of limited use here. Comparison of model results and observations could help to pick out the 'best' model. It will not explain the reasons for differences – which may well lie in the simulated dust emissions, which should always be intercompared first.

Page 3230, line 17: I agree with the usefulness of the ensemble model approach – however, in the presented cases an ensemble approach would not have helped the fact that all models have lower concentrations than the LIRIC retrieval.

In fact, well tested models would have been evaluated not only with optical thickness measurements but also with surface concentration measurements and if possible particle size distribution. That all models (which are at least in part well established) have lower concentrations that the LRIC retrievals is rather curious. Can you explain this? Please note that in most dust models the emission flux is 'tuned', i.e. scaled for best match with a set of observations. A useful dust model evaluation should therefore not be limited to one set of observations (but should at include e.g. both concentration and optical thickness observations)

Page 3230, line 21: 'automated retrieval algorithms' – that would indeed be useful in particular for NRT retrievals or even dust assimilation.

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 3605, 2015.