Review of paper:

A 4-D climatology (1979-2009) of the monthly aerosol optical depth distribution over the Mediterranean region from a comparative evaluation and blending of remote sensing and model products.

by P.Nabat et al.

Positives

- comprehensive comparison of available AOD retrieval data from satellite remote sensing
- separate assessment of spatial and temporal AOD correlations (to AERONET reference data)
- use (MODIS aqua) satellite data to describe local monthly AOD variability for 2003-2009 period

Concerns

- focus only on AOD data at a solar single wavelength
- composition data rely on interpretations (by two different) models
- indirect path to optical properties (assumed SSA and g for components - rather than AERONET)
- less useful (completely model based) for the 1979-2003 period

General comments

The paper explains multi-data source monthly average composites for the mid-visible aerosol optical depth (AOD) for the Mediterranean region (in the troposphere). A comprehensive inter-comparison among different satellite retrieval products and among model output of different simulations and assimilations is conducted. AOD data are assessed in comparisons to ground-based remote sensing statistics sampled at AERONET sites, to justify selected AOD data choices. Vertical stratification is scaled by active remote sensing from space, component sub-divisions are scaled by preferences in modeling and the temporal extension for the last 30 years is mainly tied to simulated sulfate AOD multi-annual trends by a single model according to prescribed changes in sulfur emission input to that model.

The AOD data-sets comparisons are the major part of the paper while the description of the different aspects of the climatology is relatively brief. There is a strong reliance on MODIS AOD data, also maintaining their regional variations of monthly AOD. Thus, if MODIS retrievals as correct (and there are larger uncertainties over land and there are sampling biases), then this climatology is well suited to address the reduction of the visible solar radiative energy that reaches the surface (for the 2003-2009 period in the Mediterranean). Still, to perform flux calculations, spectral variations must be addressed, not only for AOD but also for the properties describing the aerosol composition (single scattering albedo and asymmetry-factor) – especially in the context of climate assessments (at TOA).

The aerosol composition approach takes a rather indirect path, hereby introducing additional uncertainties. Rather than linking directly to AERONET optical properties, model simulations are applied to split the MODIS AOD data into components of SU, SS, DU, OC and BC. Now, these models usually include model size schemes, so there is an automatic split between AOD by coarse mode sizes (DU, SS) and by fine-mode sizes (mainly SU, OC, BC). Thus, the quality of the assumed split could be demonstrated with respect to the fine mode AOD an coarse mode AOD and in conjunction with assumed component SSA of Table 5 (which seem to be high in terms of absorption for OC and high on absorption or size for DU) via AAOD data to monthly statistics at AERONET sites.

It should also be demonstrated that this climatology is superior to data by any single model (e.g. LMD-INCA) without the use of data from satellite remote sensing. In that sense, why not including the final climatology as additional ‘participant’ in AOD assessments of Figures 5 to 7?

Personally, I am biased that the detail and accuracy of AERONET should not be wasted only on evaluations, but should be an integral part of an aerosol climatology at least for the 1996-2012 period. While I am less enthusiastic about the climatology, the comparison of all these different satellite AOD retrievals alone warrants a publication, but here is would also help to be more clear, which particular versions are used or have been downloaded.

minor comments

when introducing SeaWiFS data you may mention that there is now a better product available, as described in Hsu et al. 2012 (the assessed version is very discouraging)

when introducing CALIPSO data make sure to mention, which version is used (I assume version 2 and for difference between version 2 and 3 it could be referred to the Koffi et al 2012 paper)

replace at several places (e.g. 556, 594) 'inferior' with 'lower' of 'smaller', since inferior gives the impression of lower in quality

It should not surprise that GEMS and MACC 'reproduce the AOD seasonality' of MODIS (and MISR) since MODIS data are used in these assimilations.

The pick of Aqua over Terra, may also be related to recently discovered issues with Terra (since 2005 increasingly lower AOD), it is not clear if these problematic data or updated data are here assessed - so from that perspective in the Aqua (/deep blue) data are certainly the safer choice

The pick for the best models in order to extract info on composition seems tied to the best scores with respect to total AOD to AERONET but not with respect to AOD components. Another aspect is that the regional choices are picked based on MODIS data (which are not really a reference). Note, that for the fine/coarse mode split, AERONET are available as reference.

The RegCM4 is chosen to represent dust, but there is some concern about the rather poor correlations of these data to AERONET is the Taylor plots. Good scores for coarse mode AOD with respect to AERONET would be more convincing.

Sulfate aerosol seems to dominate among the fine-mode (not necessarily 'anthropogenic' [line 812 … 'anthropogenic dominated' as in line 834 sounds better]) sizes, but organics are not completely zero and larger not just in TEG97 [line 831] but also in GEMS.

At the stage in the middle of the paper, it is unclear, how the MODIS Aqua defined total AOD is split into subcomponents, because the sum of DU and SS of RegCM4 and SU, BC and OC of MACC will locally differ from the Aqua total AOD. It would help to show the assumed AOD maps for all five components in an extra figure since the compositional separation is also used to define the AOD vertical distribution, based on the CALIPSO type identifiers. Please refer already here to the later description and definition.

The relative vertical distributions of CALIPSO are determined for each of the 16 regions. Are there now sharp altitude gradients at the layer boundaries? Some explanations are needed.

For the pre-2000 data, the LMD simulations seem quite agreeable to the NOAA Patmos data. I would hesitate even to show (broadband sensor data related) MVIRI data, which are not only biased low and have apparent discontinuities with sensor changes, but also seem to drift to lower values with space deployment time (these data are certainly less mature than Patmos, as also AVHRR had to deal and correct for sensor changes and overpass-time drifts).

Since stratospheric AOD enhancements in the years after the ElChichon and Mt.Pinatubo volcanic eruptions were removed, maybe the title and text should refer to a 'tropospheric' AOD data.

Aha, now the component normalization is explained. Apparently, multi-annual (7 year) monthly averages are used to the effect that the AOD of the climatology for a month of particular year (e.g. 2006) will not be the same as that for MODIS Aqua (… only similar over the 2003-2009 period).

I wonder if a 60m vertical resolution is actually necessary or overkill (there are significant uncertainties with the CALIPSO data). I rather would focus on a finer spatial resolution than just the 16 areas.

The MACC resolution is 1.125 degree. I assumed the 0.5deg resolution is based on (linear?) interpolations?

Is it correct that the coarse mode monthly AOD varies from year to year between 2003 and 2009 based on the RegCM-4 model? What happen with the coarse mode AOD for the years before the year 2000 - just the 2003-2009 multi-annual monthly data? Please clarify.

The temporal trend validation is largely a LMD INCA model evaluation, indicating that the (sulfate) emission changes are relatively well represented in that model… which begs the question, why this climatology is needed (a demonstration of a better performance over the model would go a long way).

In the conclusion it is claimed that there 'is no means to evaluate properly the separation of components'. The argument that dust (or sea-salt) may also contribute to the fine-mode is rather weak, since most of the the DU AOD and SS AOD will contribute to the coarse mode.

The exclusion of the volcanic data should have been mentioned right from the start and day-to-day can certainly not be addressed with monthly averages.

The attempt to address the optical properties by components with averages for components in Table 5 is rather simple as they ignore assume fixed size, shape and refractive indices and ignore their variations. This is disappointing, since (via AERONET) monthly reference data for these properties actually exist and could be tested: ftp://ftp-projects.zmaw.de/aerocom/aeronet/STATISTICS/grd_1203 'osunal' (direct attenuation data AOD and ANG) and 'oskyal' (inversion data: AOD, ANG, AAOD, fineAODfraction)

I do not always agree with SSA and g values for the component data, listed in Table 5. In the table below I attach values I would use (based on single scattering simulations). I am concerned about the relatively low SSA values for DU and OC. The low SSA values for DU seem plausible only for very large dust sizes (radii of ca 4um!) and I wonder if these are realistic for transported dust over the Med. Regions. Also the properties for BC, as demonstrated, are strongly size-dependent.

type	Reff (um)	SSA .55um	SSA 1um	g .55um	G 1um
Sea-salt	2.5	.99	.99	.76	.72
Soil dust	2.0	.94	.96	.78	.73
Organic carbon	0.15	.98	.92	.62	.43
Black carbon	0.08	.28	.13	.33	.16
Black carbon	0.13	.36	.26	.53	.38
Sulfate	0.2	.99	.99	.70	.60

Table 1 the spatial resolutions are confusing as the higher resolutions are not actually applied in the (coarse) 1 degree assessments. In addition, also MODIS (10km) and MISR (17.6km) official aerosol products are available at higher resolutions than indicated in the Table. I would the original resolution and the resolution used.

Figure 5 from the seasonal difference in Figure 4 I would expect larger deviations in Figure 5. The box wisker Figure 5 needs definitions as the boundary PDF values (20%/80% for the box?, 95%/5% for the dashed line?, central line for the median (50%)?, what is the meaning of the individual small circles?)

Figure 6 and 7 both figures apparently indicate that at some sites there are even ANTI-correlations at least spatially … so that even the 'better' retrievals of MODIS and MISR are far from perfect.

Figure 8 the label in the figure display 'OR' while 'OC' is mentioned in the caption. Similarly, in the text both OR and OC are both mentioned although I think the same is meant (is confusing)

Figure 14 this is a sorry figure. Since the data are so poor, why even show them, especially since they are irrelevant for the climatology.

Figure 15 I am struggling with the figure and I strongly suggest to remove it unless it is strongly improved. The text is quite clear about the normalization and the temporal extension - but not this figure. Some diamonds indicate a component, so I assume the lower right refers to dust. I have no idea what should be in the pink box and using a black background for a box with black letters is not too smart.