PRELIMINAR CHARACTERIZATION OF COLUMNAR AEROSOLS PROPERTIES (AOD-AE) AT THE SAHARAN TAMANRASSET (ALGERIA) STATION

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AEROSOL OPTICAL DEPTH & ÅNGSTRÖM EXPONENT AT TAMANRASSET

Since September 2006 a Cimel sunphotometer is running at Tamanrasset (Algeria) set up by the Izaña Atmospheric Research Center (AEMET) in collaboration with l'Office Nationale de la Météorologie (Algeria). More than two years of aerosol measurements have been analyzed from October 2006 to January 2009.

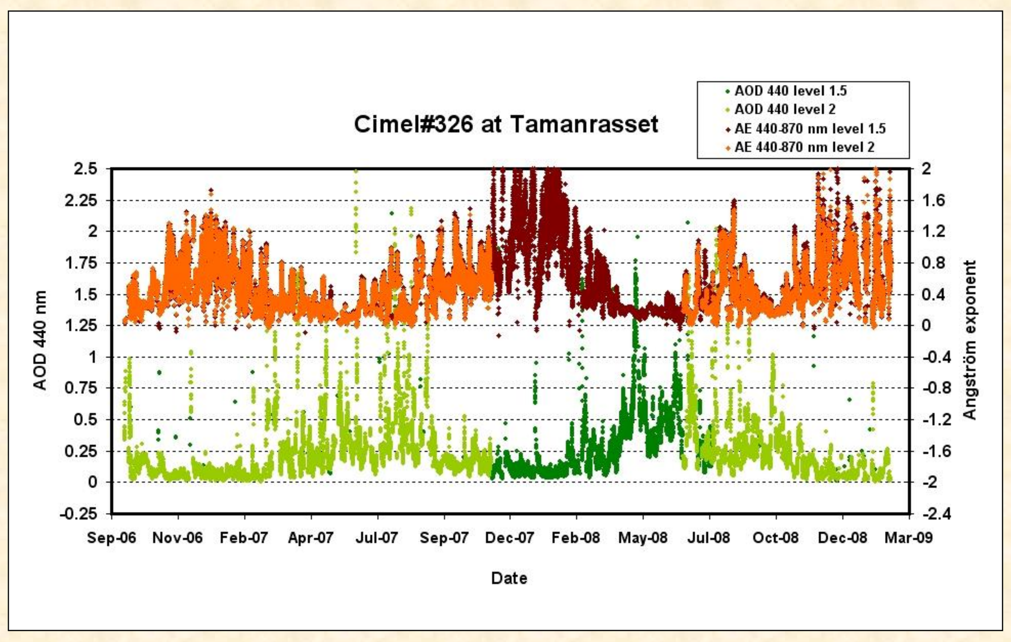


Figure 1. Temporal evolution for Aerosol Optical Depth (AOD) at 440 nm and for 440-870 nm Ångström Exponent (AE) all points values

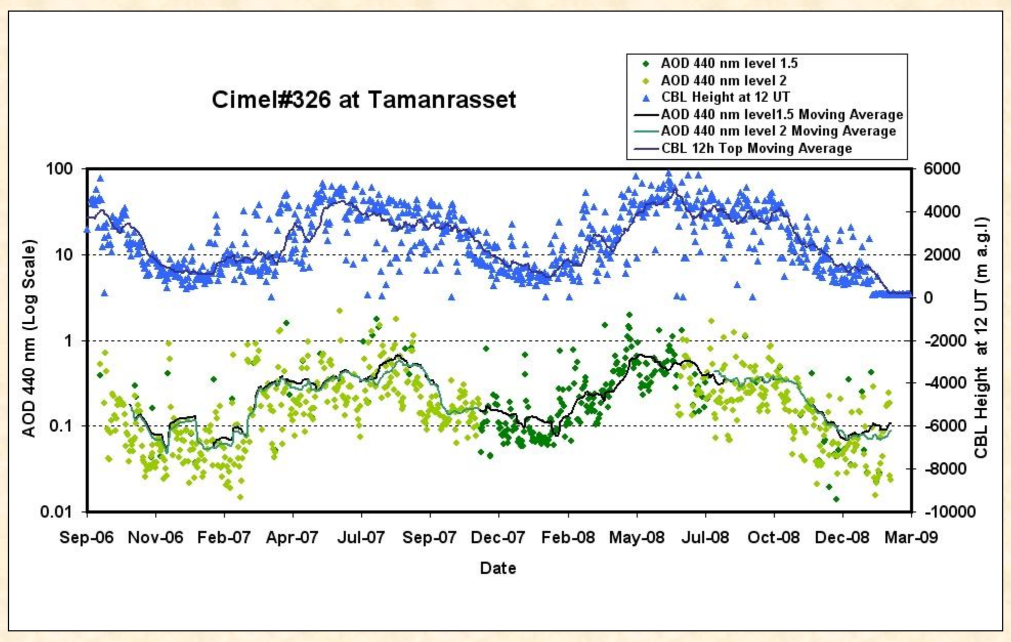


Figure 2. Temporal evolution for AOD at 440 nm (daily mean values) and for the Convective Boundary Layer height (CBL) determined from the 12 UTC soundings in Tamanrasset.

The mean aerosol optical depth (AOD) at 440 nm is 0.25 ± 0.15 and the mean 440-870 nm Ångström Exponent (AE) is 0.44 ± 0.21, evaluated from AERONET level 2 daily and monthly mean values. Both time series data show a clear seasonal cycle (figure 1 and 4). A dry-cool season (fall and winter time) is characterized by low AOD and high AE values, and a wet-hot season (in spring-summer), with strong and frequent mineral dust storms, giving high AOD and low AE values, are observed at this station. The spring-summer season is driven by a strong and thick convective boundary layer over Tamanrasset which has been analysed using the rawinsonde dataset (figure 2). Both, AOD and AE values shows the behaviour of a station where desert mineral dust is the prevailing aerosol defining the characteristic of the site.

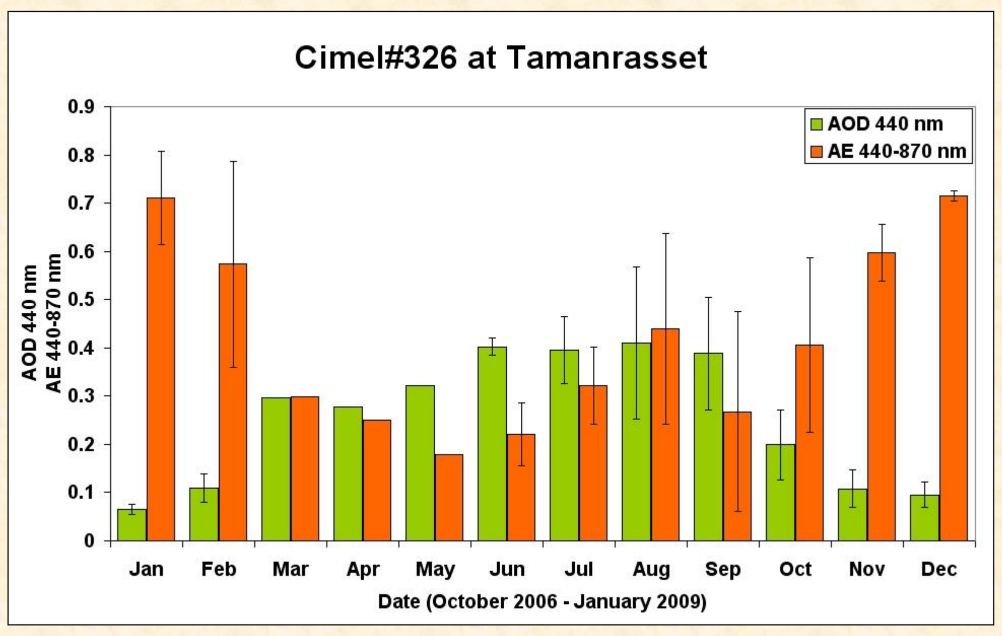
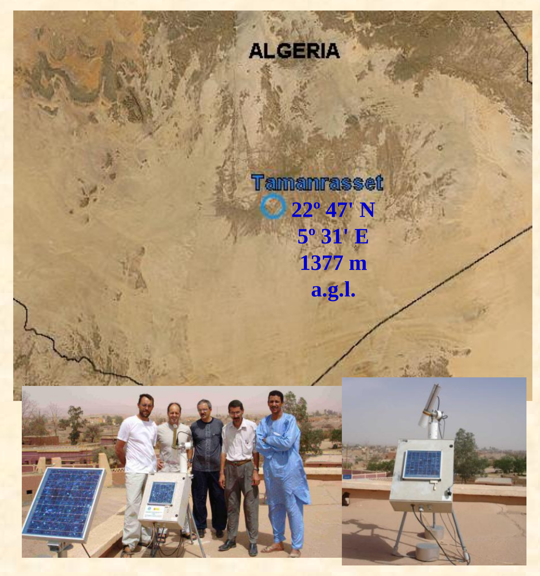


Figure 3. Monthly means of AOD at 440 nm and Ångström exponent at Tamanrasset, calculated using the AERONET level 2 monthly mean values . Error bars indicate standard deviation

TAMANRASSET STATION

The Cimel sunphotometer is placed at this station located at the headquarters of the Office National de la Méteorologie (ONM) which was integrated in the AERONET network as a strategic site within the Global Atmospheric Watch (GAW) programme for its situation in the Ahaggar Mountains surrounded by the Sahara Desert, as, a priori, representative of pure desert dust, free of industrial activities.



PARAMETER (nm)	AOD (1020)	AOD (870)	AOD (675)	AOD (440)	AOD (380)	AE (440-870)
MEAN	0.198	0.210	0.226	0.247	0.260	0.438
STD. DEV.	0.138	0.141	0.146	0.148	0.150	0.210
MAXIMUM	2.111	2.160	2.205	2.176	2.159	1.537
MINIMUM	0.003	0.006	0.010	0.015	0.018	-0.012
MEDIAN	0.220	0.235	0.258	0.280	0.289	0.400

Table 1. Five AOD channels and AE statistics evaluated from AERONET level 2 daily and monthly mean values for this dataset at Tamanrasset

The frequency histograms show that a 60% of AOD measurements are below 0.15 (cumulative frequency at figure 4), which is more than expected, because usually about a 85% of the AOD values are above 0.15 at the stations located southward of Saharan sources (Basart et al, 2009).

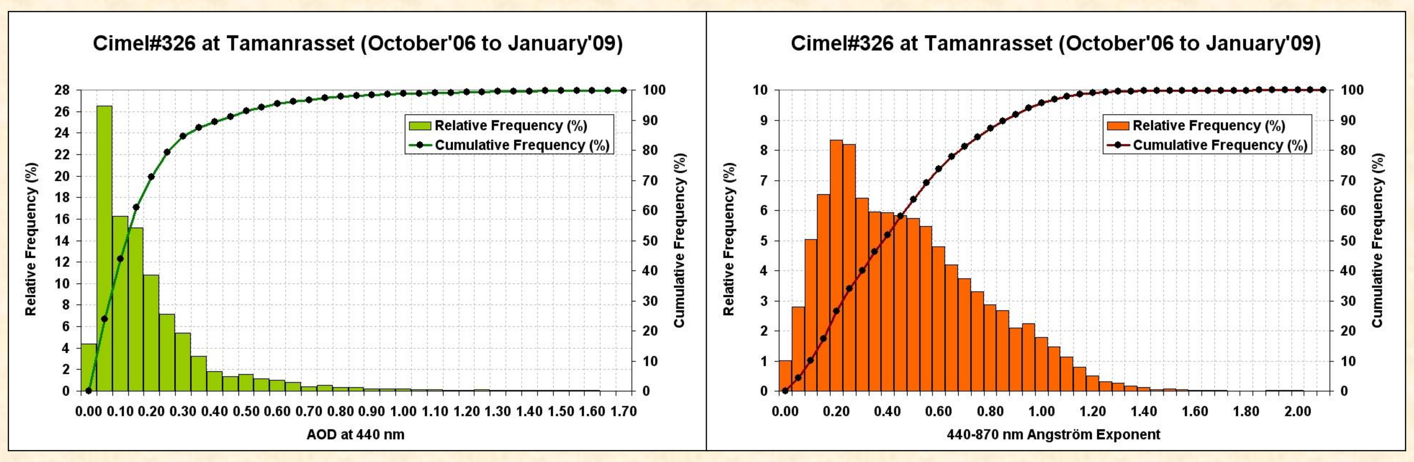


Figure 4. Frequency histograms of the AOD at 440 nm and Ångström exponent in Tamanrasset

POLLUTION DERIVED AEROSOLS & NO DUST LOADED AIR MASSES

There are two kind of scenarios we want to analyse in depth: high turbidity events not related to desert mineral dust but linked to pollution derived aerosols, and clear air masses events during fall and winter time. The graphical method of Gobbi to discriminate different aerosol types is used in this task.

The presence of pollution derived aerosols is suggested for a significant number of episodes with Ångström exponent values around 1 together with AOD greater than 0.2 (figure 3 & green box in figure 5). One of this episodes was observed in August'07 and the corresponding HYSPLIT back-trajectories (figure 7) show air masses coming from the north-east of Africa where several refineries does exist.

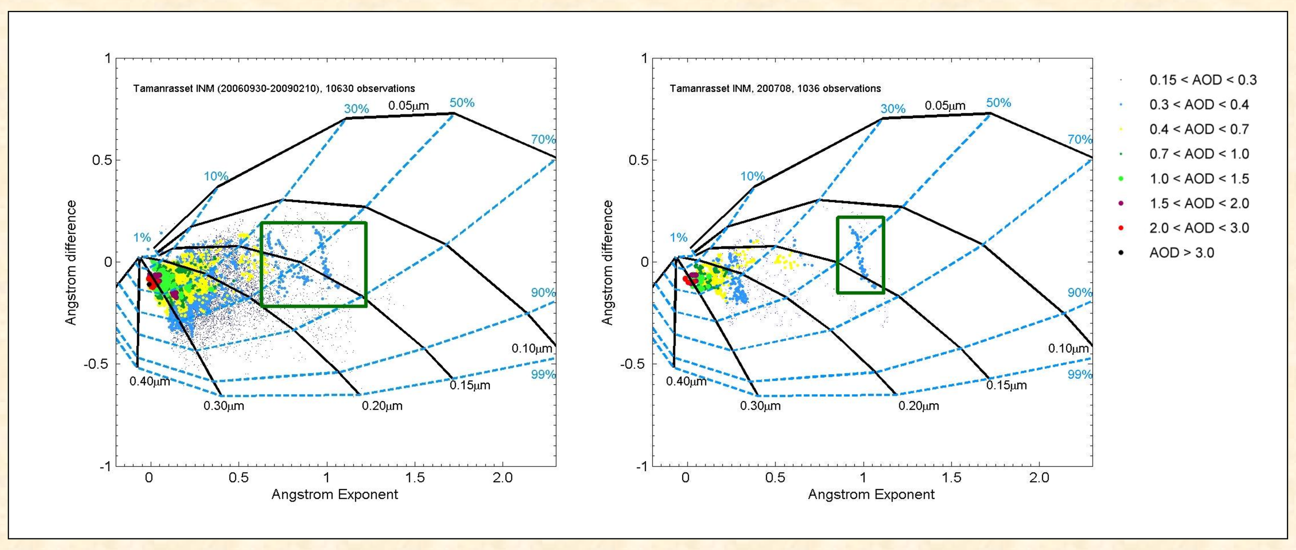


Figure 5. Ångström exponent difference, $\delta\alpha = \alpha(440,675) - \alpha(675,870)$, as a function of the 440–870 nm Ångström exponent and AOD at 440 nm (color code) evaluated using the AERONET level 2 all points values. The first graph is for the whole dataset values. The second graph is only for measurements from August'07

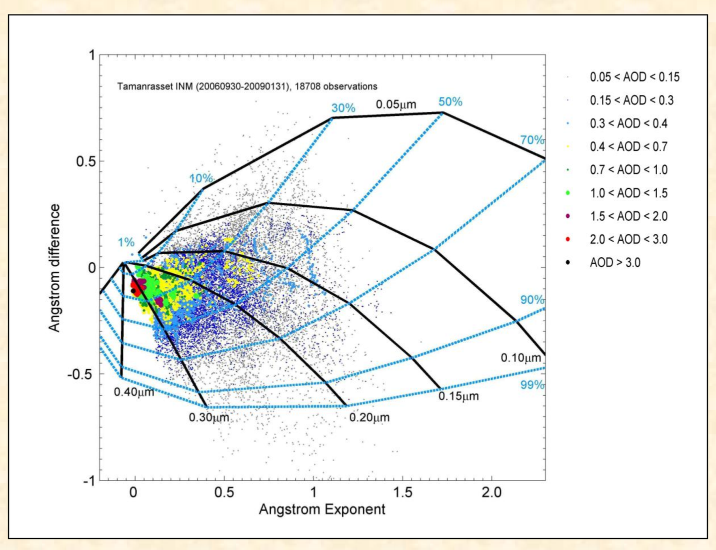


Figure 6. Gobbi's graphical-framework evaluated using the AERONET level 2 all points values adding the 0.05<AOD<0.15 measurements

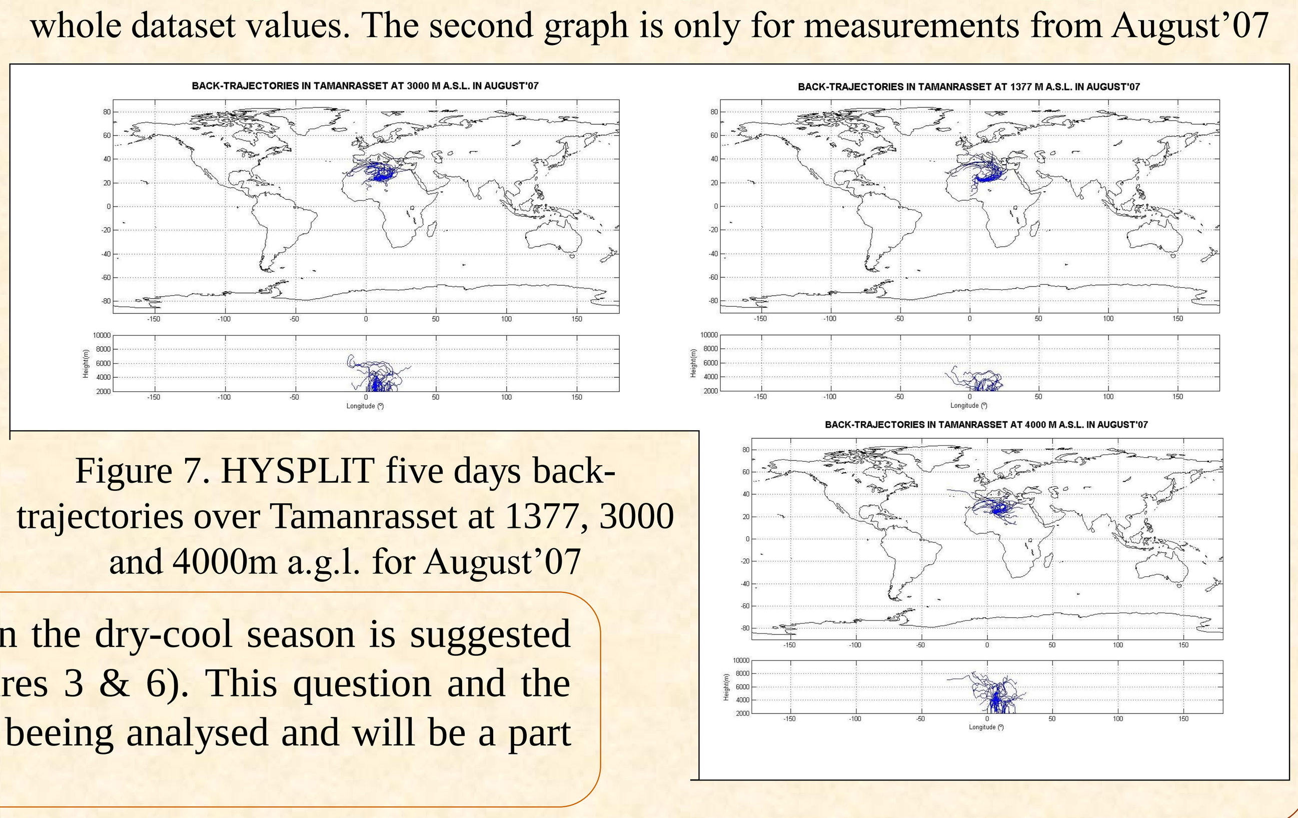


Figure 7. HYSPLIT five days back-trajectories over Tamanrasset at 1377, 3000 and 4000m a.g.l. for August'07

The presence of no dust loaded air masses in the dry-cool season is suggested for the frequency of AOD below 0.15 (figures 3 & 6). This question and the possible sources of polluted air masses have beeing analysed and will be a part of future tasks.

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HEAVY DUST PLUMES, CIRRUS CLOUDS & FICTITIOUS DIURNAL CYCLE

Several problems have been found during this two year record of continuous measurements. The cloud screening became an extremely difficult task because the presence of heavy dust plumes, preferentially during the summertime (figures 1 & 4), which were confused many times with clouds (resulting in underestimation of the AOD), and by the quasi permanent presence of cirrus clouds, associated to the subtropical jet stream, in wintertime, resulting in an overestimation of the AOD. The measurements taken the 10th of July of 2008 help us to illustrate this underestimation of AOD (figures 8 & 9).

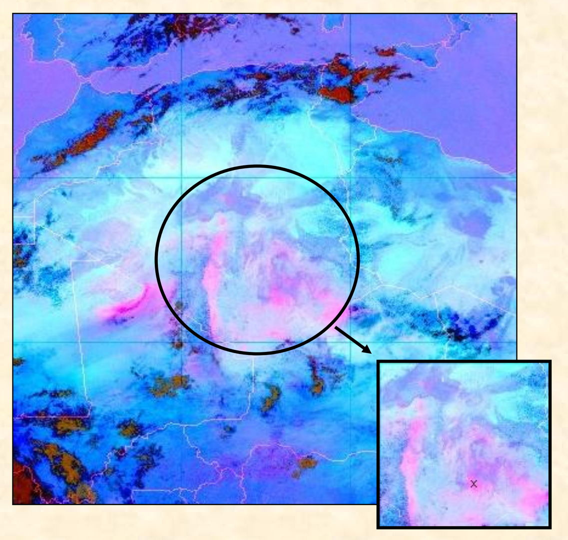

Figure 8. Meteosat Second Generation (MSG) RGB composition images over Tamanrasset (cross marked in the small picture) on the 10th of July of 2008 at 14:45 UT. Pink color corresponds to dust storm and brown and green to clouds.

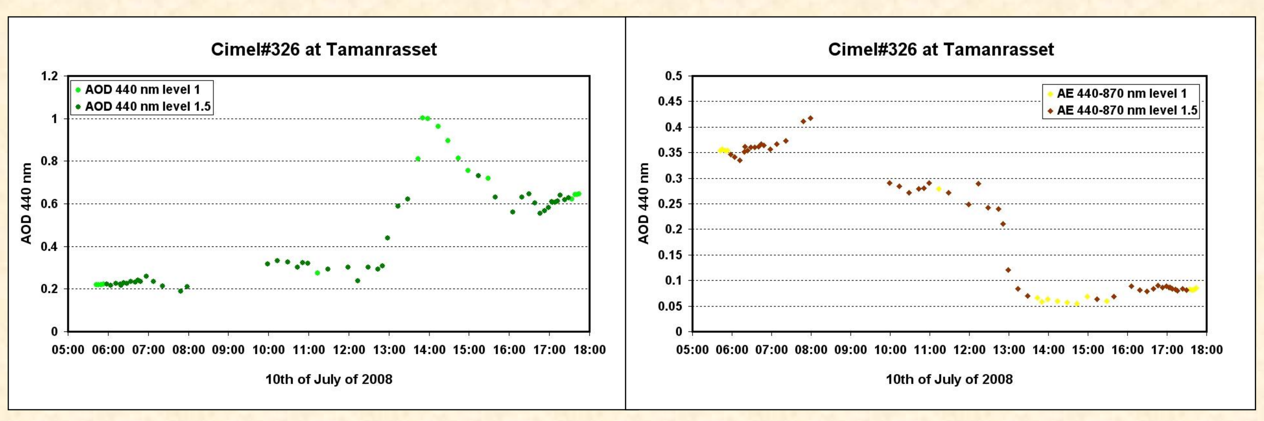

Figure 9. Aerosol Optical Depth (AOD) at 440 nm and 440-870 nm Ångström Exponent (AE) level 1.0 & 1.5 from the 10th of July of 2008. The AERONET cloud-screening remove the higher AOD values and there are no data for level 2.0

Around six months of data in 2008 show a strong fictitious diurnal cycle (example in figure 10) and they did not achieve the level 2.0 in the AERONET database. The KCICLO method appears as a tool to be used to correct the calibration factor and recover this dataset.

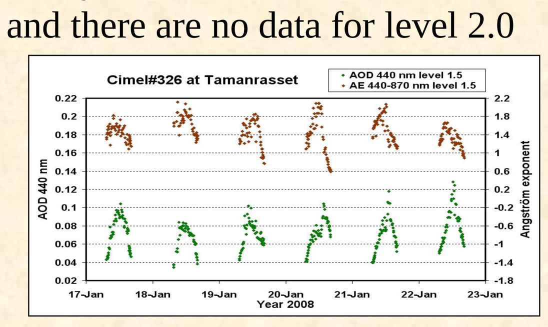

Figure 10. Diurnal cycle of AOD at 440 nm and AE level 1.5 from January'08

References:
S. Basart, C. Pérez, E. Cuevas, J. M. Baldasano, G. P. Gobbi.: Aerosol characterization in Northern Africa, Northeastern Atlantic, Mediterranean Basin and Middle East from direct-sun AERONET observations. Atmos.. Chem. Phys., 9, 8265–8282, 2009

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