Differences and similarities between surface and columnar aerosol climatology in the Iberian Peninsula

D. Mateos, V.E. Cachorro, C. Toledano, M.A. Burgos, Y. Bennouna, B. Torres, D. Fuertes, R. González, C. Velasco-Merino, R. Román, A. Calle and A.M. de Frutos

Grupo de Óptica Atmosférica, Departamento de Física Teórica, Atómica, y Óptica, Universidad de Valladolid, Paseo Belén 7, CP 47011, Valladolid, Spain. E-mail: mateos@goa.uva.es @goa-uva

OBJECTIVE

Analysis of the aerosol load over the Iberian Peninsula (IP), considering both particulate matter (PM) and aerosol optical depth (AOD) data from a climatological perspective.

DATABASE

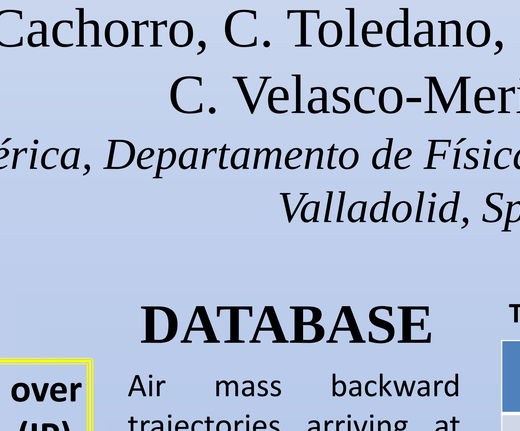
Air mass backward trajectories arriving at five sectors of the IP between 2001 and 2013 are evaluated using the HYSPLIT model.

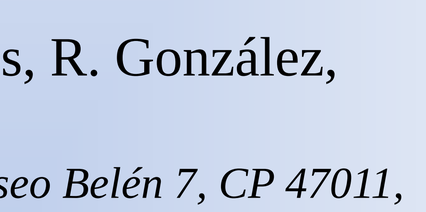
Table 1. PM_{10} and AOD_{440nm} time series used in this study (in brackets the total number of daily data).

Variable	Meaning	Network	N sector	NE sector	C sector	SE sector	SW sector
PM_{10}	PM < 10 µm (surface)	EMEP	2001-2013 (4640)	2001-2013 (4649)	2001-2013 (4685)	2001-2013 (4345)	2008-2013 (1771)
AOD_{440nm}	AOD at 440nm (columnar)	AERONET	2012-2013 (384)	2004-2013 (2367)	2003-2012 (3385)	2004-2013 (2428)	2000-2013 (3613)

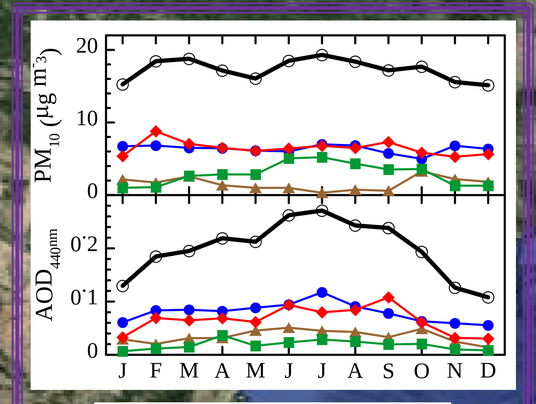
Position of each air mass between the −24 h and the −120 h of the considered date is used to evaluate the aerosol load contribution, weighting the number of hours overflight in each world region (Artic -A-, Polar Maritime -MP-, Tropical Maritime -MT-, Tropical Continental -CT-, Mediterranean -Me-, Continental -C-, and Local -C- origins). Air masses at 500 m are assumed to produce all the concentration in PM data, while those at 1500 m represent the AOD.

AOD_{440nm} – PM_{10} ANALYSIS

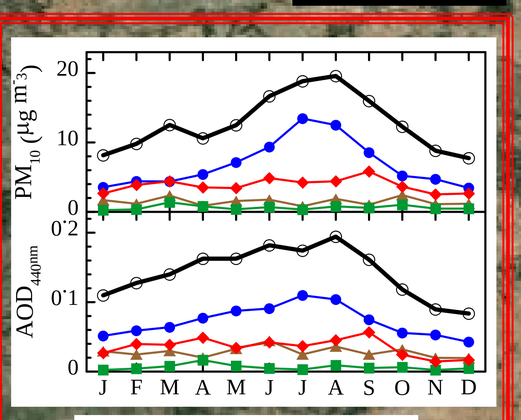




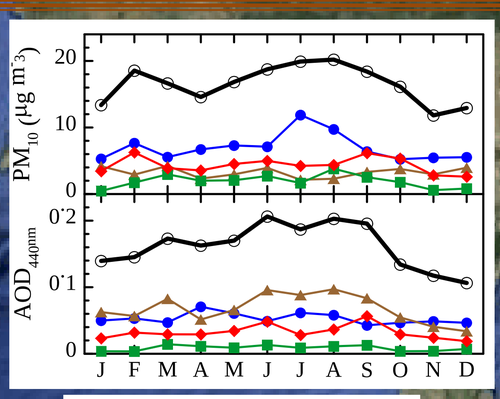
- Aerosol climatology is influenced by North-Atlantic and Arctic areas, being also important the continental origin.
- PM_{10} shows a weak change through the year. Tropical area also shows impact in winter, early spring (annual maximum in March), and autumn.
- Low number of AOD data. Continental origin peaks in March and July causing large AOD values. Tropical area also is relevant in October.
- Good PM-AOD relationship.



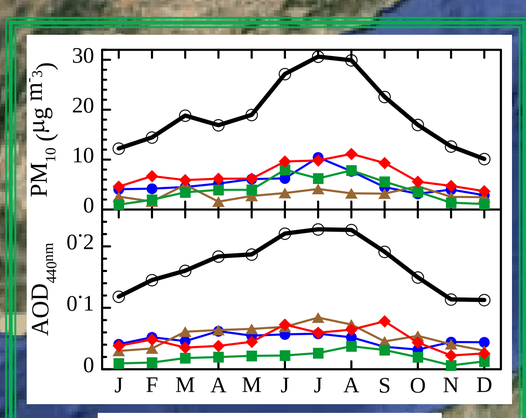
- Atlantic, continental and Mediterranean origins dominate the aerosol climatology.
- PM_{10} cycle shows weak variations through the year.
- AOD_{440nm} notably increase during summer (bell shape).
- PM_{10} presents a larger tropical contribution between October and March, while the AOD exhibits the maximum values in spring and summer.
- Bad relationship between PM_{10} and AOD_{440nm} values.



- Arctic, polar maritime, and local origins govern the aerosol climatology.
- PM10 cycle shows a decline in April due to a larger contribution of polar air masses and the reduction of desert dust events. Large summer values controlled by Atlantic-Arctic and continental-local origins.
- A summer local minimum in July is observed in the AOD_{440nm} cycle (reduction of desert dust), which is not visible in the PM_{10} cycle.
- Good agreement between PM_{10} and AOD_{440nm}.



- Largest impact of the desert dust events in the IP.
- Atlantic area is governing the PM_{10} annual cycle.
- The AOD_{440nm} cycle is modulated by the tropical area (e.g., March, June,, August, September).
- The smaller tropical air mass occurrence in April and July also affect AOD_{440nm}.
- The incidence of the Mediterranean air masses is only notable at the surface.
- Bad PM-AOD relationship.



- There is no a particular origin governing the aerosol climatology.
- PM_{10} minimum in April is linked to the decrease of tropical influence, which also presents a local maximum in October. Large summer values due to local and Mediterranean air masses.
- Large AOD_{440nm} values in summer are due to tropical and local influences.
- Best agreement in the correlation between PM_{10} and AOD_{440nm}.

CONCLUSIONS

Data (2001-2013) from available sites of the EMEP and AERONET networks are classified in five Iberian sectors.

- PM_{10} annual cycle presents a first maximum in March (early spring) and a second one in summer (July or August) separated by a local minimum in April. With respect to AOD, the southern sectors (SW and SE) exhibit the same annual pattern as PM_{10}. In the remaining sectors the AOD presents a more defined bell shape with maxima in summer.

- The polar maritime and Arctic air masses are proved as the main responsible of the aerosol climatology, but the eastern Iberian coast presents a dominant role of the Mediterranean Sea. Finally, the southwestern area is clearly governed by desert dust intrusions from North Africa.

- A linear relationship between PMx and AOD is proved, although this relationship is clearly affected by the meteorological and synoptic conditions. Overall, both variables are correlated by a simplified factors ranging between 20 and 90 for the different sectors of the Iberian Peninsula.

ACKNOWLEDGEMENTS

- AERONET (NASA/GSFC, PHOTONS/LOA and RIMA/GOA staff) and EMEP networks.
- Funding from: the European Union Seventh Framework Programme (FP7/2007-2013) under grant agreement Nr. 262254 [ACTRIS]; Spanish MINECO (projects of ref. CGL2011-23413, CGL2012-33576); Environmental Council of the CyL Regional Government (Consejería de Medio Ambiente, Junta de Castilla y León), AERQUA project.

Further details

Mateos, D., et al. (2015). Columnar and surface aerosol load over the Iberian Peninsula establishing annual cycles, trends, and relationships in five geographical sectors. Science of the Total Environment 518–519, 378–392.

VIII Workshop Lidar Measurements in Latin America (WLMLA)
6th to 10th April, 2015
Cayo Coco, Cuba