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

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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.

AOD_{440nm} – PM\textsubscript{10} ANALYSIS

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

- 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\textsubscript{10} cycle.
- Good agreement between PM\textsubscript{10} and AOD_{440nm} at 1500 m.

TABLE 1. PM\textsubscript{10} and AOD_{440nm}, time series used in this study (in brackets the total number of daily data).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Meaning</th>
<th>Network</th>
<th>N sector</th>
<th>NE sector</th>
<th>C sector</th>
<th>SE sector</th>
<th>SW sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>AOD\textsubscript{440}</td>
<td>AOD at 440nm (columnar)</td>
<td>AERONET</td>
<td>2012-2013 (384)</td>
<td>2004-2013 (2367)</td>
<td>2003-2012 (3385)</td>
<td>2004-2013 (2428)</td>
<td>2000-2013 (3613)</td>
</tr>
<tr>
<td>PM\textsubscript{10}</td>
<td>PM &lt; 10 µm (surface)</td>
<td>EMEP</td>
<td>2001-2013 (4640)</td>
<td>2001-2013 (4648)</td>
<td>2001-2013 (4685)</td>
<td>2001-2013 (4345)</td>
<td>2008-2013 (1771)</td>
</tr>
</tbody>
</table>

- There is no a particular origin governing the aerosol climatology.
- PM\textsubscript{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\textsubscript{440} values in summer are due to tropical and local influences.
- Best agreement in the correlation between PM\textsubscript{10} and AOD\textsubscript{440}.

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

- PM\textsubscript{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\textsubscript{10}. In the remaining sectors the AOD presents a more defined bell shape with maxi 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 PM\textsubscript{10} and AOD\textsubscript{440} 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.

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Further details