Characterization of ozone and particulate matter levels in a coastal site with the application of a trajectory clustering correlation methodology

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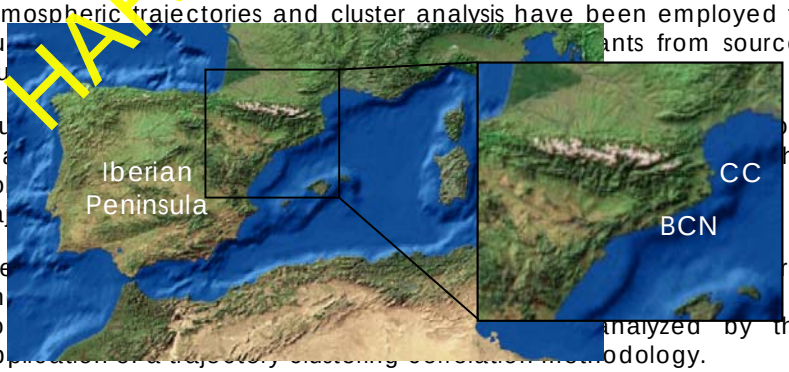
INTRODUCTION

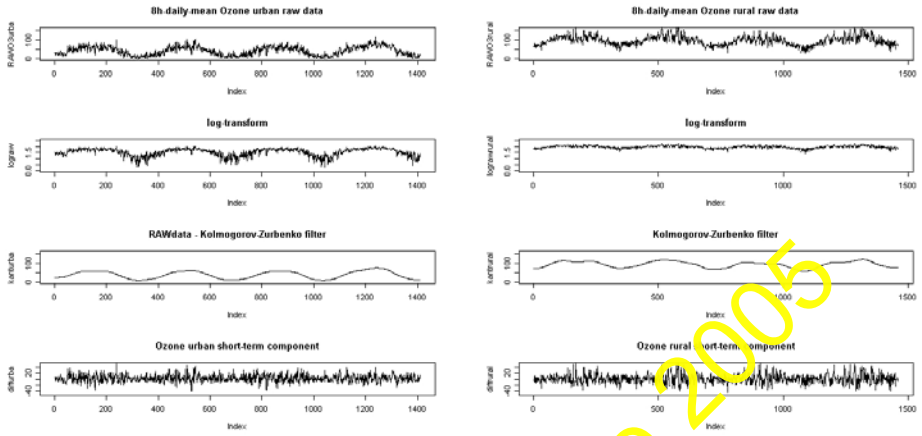
- Atmospheric trajectories and cluster analysis have been employed to stu… …ants from sources situ…
- Clu… …out rela… …he po… …of tra…
- The… …rns an… …a co… …analyzed by the appl… …odology.
  - City of Barcelona (BCN; 41.4N, 2.11E)
  - Rural site in Cap de Creus (CC; 42'31N, 3'31E)



METHODOLOGY

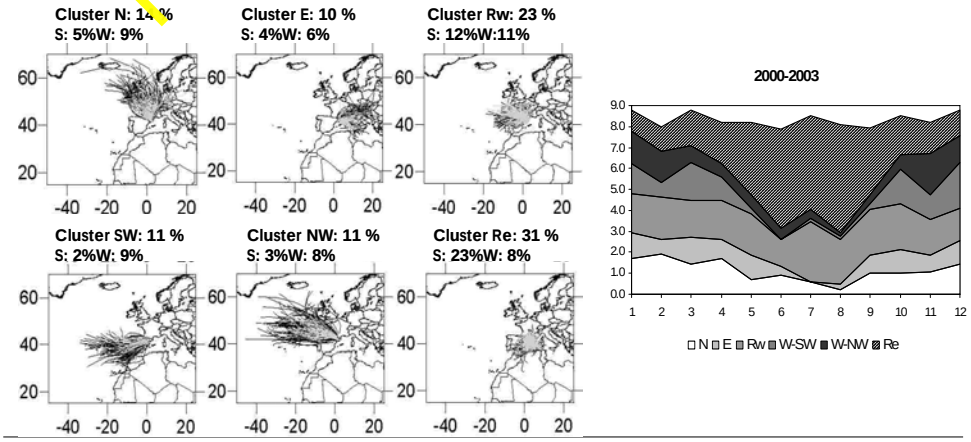
✓ Data base:

2000 – 2003 8-hour-daily-mean time-series of O_3 on BCN and CC.
2000 – 2003 daily-mean time-series of PM_{10} on BCN.
2000 – 2003 2-day kinematic HYSPLIT backtrajectories computed with FNLdata.



BACKTRAJECTORY CLUSTER ANALYSIS

✓ Cluster algorithm: four years (2000-2003) of 2-day 500m-kinematic back trajectories, computed with the HYbrid Single-Particle Lagrangian Integrated Trajectory model version 4 (HYSPLIT) (Draxler and Hess, 1998) with FNL meteorological data, were clustered and classified in groups of similar length and curvature.

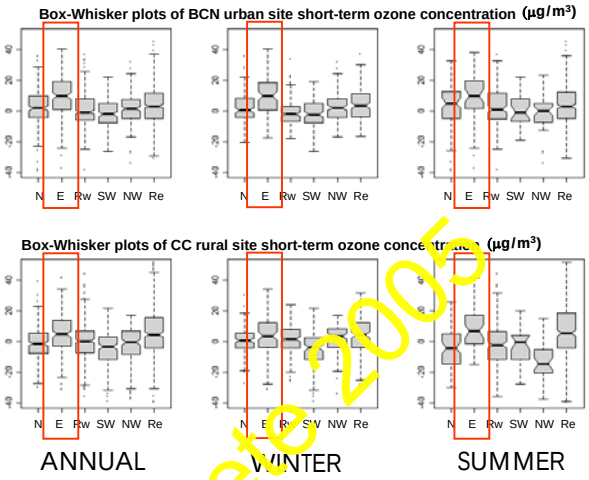


INFLUENCE OF SYNOPTIC METEOROLOGY ON SURFACE POLLUTANTS CONENTRATION: OZONE

✓ The short-term component of O_3 concentration has been related to cluster analysis results. Box-whisker plots show this relation for the urban (top panels) and the rural site (bottom panels).

✓ Situations embedded in **cluster E** present the highest increase in O_3 levels especially during summer in both sites.

✓ Attending to the direction of air masses (eastern advections) and the simultaneous high levels in both sites, one could relate these O_3 concentrations to a regional transport of air masses with higher O_3 concentrations or primary pollutants from the WMB and the European continent to the eastern coast of the IP.



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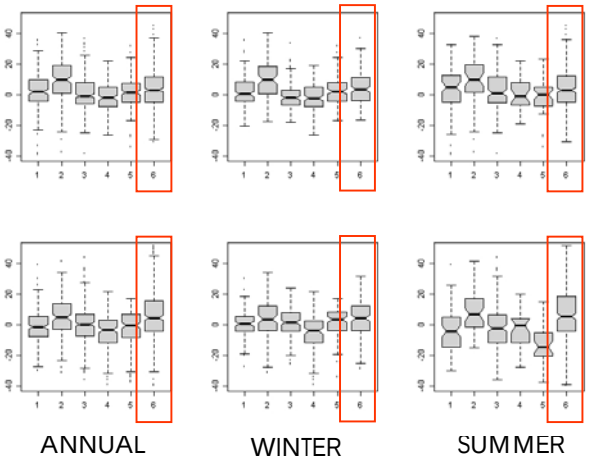
✓ The short-term component of O_3 concentration has been related to cluster analysis results. Box-whisker plots show this relation for the urban and the rural site.

✓**Cluster E** groups situations characterized by recirculation of air masses for several days over the region, presenting high O_3 levels, with a higher increase in the concentrations for CC (rural site) than in BCN (urban site).

✓ Following Jiménez and Baldasano (2004), the stagnant meteorological conditions during summertime and the local transport of polluted air masses mainly from the emitter urban area of BCN provokes the accumulation of O_3 in the NO_x-limited rural site of CC.



INFLUENCE OF SYNOPTIC METEOROLOGY ON SURFACE POLLUTANTS CONENTRATION: OZONE

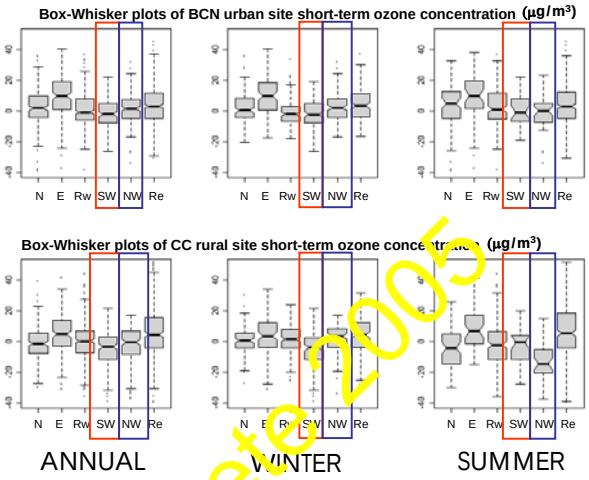
✓ The short-term component of O_3 concentration has been related to cluster analysis results. Box-whisker plots show this relation for the urban and the rural site.

✓ Westerly situations (**cluster SW and NW**) are characterized by a decrease of pollutants in both regions.

✓Important decrease in **cluster SW** during wintertime for both sites.

✓Northwestern situations (**cluster NW**) just present an important decrease in O_3 levels in the rural stations during summertime.

✓The development of the local wind Tramuntana (northern wind) near CC may contribute to the decrease in O_3 concentrations. Usually, the BCN urban site is not directly affected by the Tramuntana wind.

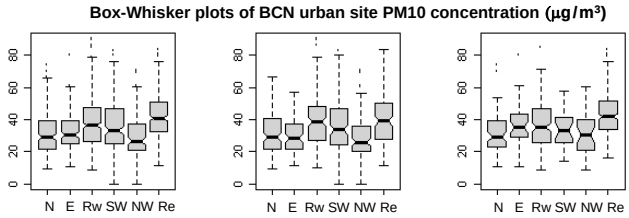


INFLUENCE OF SYNOPTIC METEOROLOGY ON SURFACE POLLUTANTS CONENTRATION: PARTICULATE MATTER

✓ **Northern, eastern and western flows** are characterized by lower PM10 mean concentrations.

✓It is important to remark that **eastern situations** are characterized by low winter levels of PM10. This behavior is opposed to the observed with O_3, which presents a clear increase on concentration compared with the climatic compound. Eastern flows are maritime air masses that present low concentration of PM10.

✓ **Cluster Rw** presents more scenarios with higher concentrations related to re-suspension of aerosols due to the recirculation of air masses over the region of study.



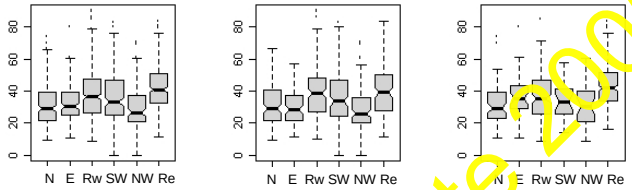
INFLUENCE OF SYNOPTIC METEOROLOGY ON SURFACE POLLUTANTS CONENTRATION: PARTICULATE MATTER

✓This behavior is observed also in **cluster Re**, which presents the higher mean values of PM10. This cluster includes marked episodes of re-suspension of aerosols with high concentrations of PM10 related to the accumulation of aerosols within the region for several days due to the low baric gradient situation with slow motions.

✓The significance of the Saharan dust outbreaks over the IP is also observed in **cluster SW**, with higher levels of PM10. This cluster groups the back trajectories with a marked southwestern component, which may be related with advective situations of warm air masses from the north Africa to the IP with high concentrations of aerosols.

✓On the other hand, **cluster NW** presents the lower levels of PM10. The advective characteristics of this cluster and the association with the front pass situations with development of rain contribute to the decrease of PM10 concentrations.

Box-Whisker plots of BCN urban site PM10 concentration (µg/m³)



CONCLUSIONS

✓ Although the results show a clear decrease in O_3 levels during wintertime, it is remarkably the **higher concentrations of O_3 associated to eastern regional transport** from western Mediterranean basin.

✓ During summertime, **O_3 levels increase**, especially in meteorological situations characterized by **low-pressure gradient** with recirculations of air masses within the WMB, and under dominated **anticyclonic situations**.

✓PM10 concentrations present a smooth behavior between clusters, with **higher levels associated to anticyclonic and low-pressure gradient situations** characterized by important atmospheric subsidence over the zone and slow flows with important resuspension of aerosols.

✓**Saharan dust outbreaks over the IP are also identified in cluster SW**, with higher levels of PM10 exceeding the 75 percentile.

✓The trajectory clustering correlation methodology appears as a useful tool for the study of air quality scenarios related to meteorological situations.

Thanks for your attention