Seasonal Characterisation of Tropospheric Ozone and Water Vapour Accumulation Cycles in the Mediterranean Basin

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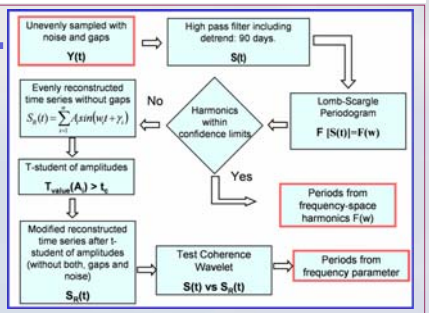
INTRODUCTION

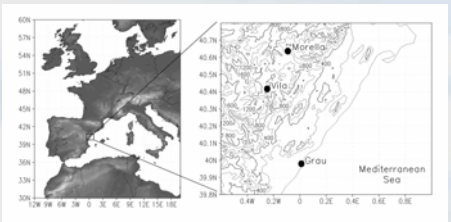
The determination of the main atmospheric accumulation mode in the Western Mediterranean Basin (**WMB**) and its seasonal variability is a relevant issue for integrating some of the feedbacks driving climate change, e.g., precipitation regimes, secondary pollutant production, ventilation conditions, etc. This study is based on a numerical methodology to analyse non-steady principal harmonics in noisy meteorological time series. The study focuses on the **tropospheric ozone** and the total **water vapour accumulation cycles** found on the WMB throughout the years. The data used in this study come from the most recent EOS satellite missions (specifically, time series of water vapour data measured by the **MODIS** instrument on board the **TERRA**, EOS AM-1, satellite) and the **regional air quality surveillance network** of Valencia (Spain)

Methodology

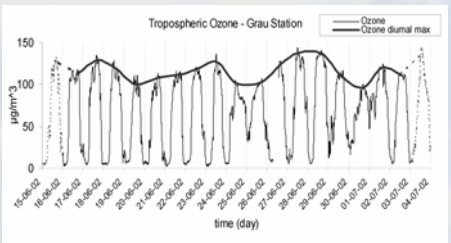
Meteorological measurements often show **non-steady** variability, superimposed on persistent trivial daily, seasonal and annual variability of certain features such as global radiation, air temperature above surface, etc. Some fluctuations in measurements are driven by processes that prevail on some days or months of the year, but disappear on others. The methodology used is based in the application of a parametric model. To ensure the statistical significance of the parametric reconstruction of the original signal, we propose a standard statistical **t-student analysis** of the amplitude in the parametric spectrum for the different wave components (Rovira et al. EMS 2009). To differentiate between seasons, we **split** the data and join it in a new time series with the corresponding data season only.



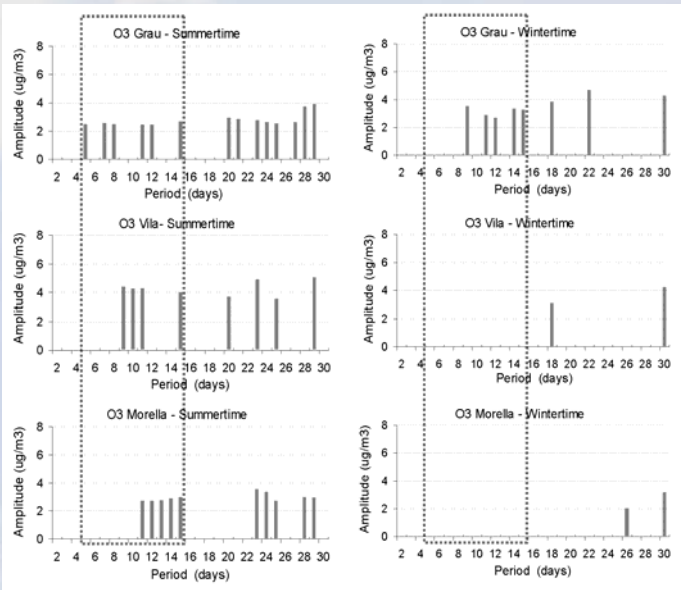
Tropospheric Ozone



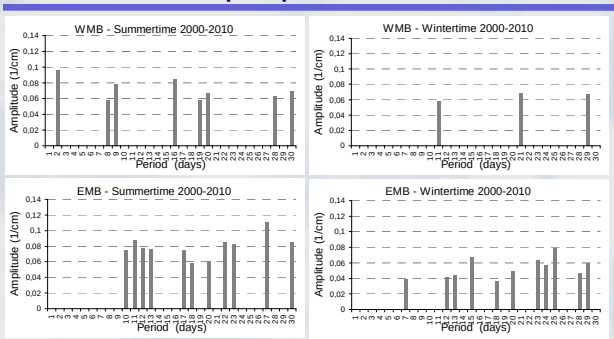
Left: We have used the data from three stations in the Valencia (Spain) surveillance network of corresponding to different geographic situations. The **Grao** station is a suburban-coastal location, **Vila** is a valley-rural station and the **Morella** station is in a mountain area. The whole data set is used in this work: from **1996 to 2010**.



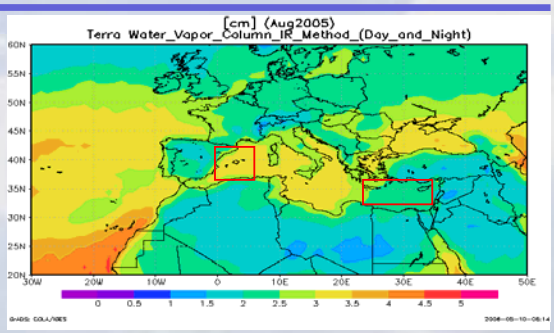
Left: The diurnal **maxima** for each day (as an average of three consecutive hours) is calculated for the whole time series. In this way, we have a collection of daily maxima to analyze the diurnal behavior of the highest daily values of ozone. **Right:** application of the methodology: statistical significant harmonics that explain the variability observed.



Total column water precipitable



The data set used is provided by the **MODIS** instrument on board the Terra Satellite: IR Total column precipitable water [cm] with the time pass over the Mediterranean at 11:00 h. We used a **mean** over ten years **(2000-2010)** in two areas: the **WMB** and the **EMB** (Eastern). **Left:** application of methodology in these areas and seasons. **Right:** water vapor column mean of August 2005 (for example). Rectangles in red are the areas where the spatial means are calculated.



CONCLUSIONS

The parametric reconstruction of four **Ozone time series**, which represent the spatial pattern of the tropospheric ozone time-evolution in the region of Valencia (Spain):

- Depending on the season and the location of the monitoring station from the coast, characteristic times of high-frequency tropospheric ozone variabilities range from **5 to 15 days**. Comparing the results with previous meteorological studies, these variabilities are in good agreement with the characteristic time scales of mesoscale processes driving recharging periods of tropospheric pollutants in the studied are. (Millán et al., 1992)
- During **summertime**, the same high-fequency variabilities (5 to 15 days) are present in the whole studied area, whereas during wintertime there is a **decoupling** between the coastal station and the inland stations. (Gangoiti et al., 2001). **Despite the season**, synoptic characteristic time-scales (> 15 days) are present in the whole studied area.

For the **Total column of water precipitable** in WMB and EMB:

- Annual distribution of total precipitable water vapor in the Mediterranean basin is **different** on both sides (**western** and **eastern**) of the basin. Daily cycles and water vapor accumulation is a seasonal feature present on the whole WMB
- Seasonal analysis of principal harmonics in the time series evidences **marked differences between the WMB and the EMB**.
- Principal harmonics in summer are in good correlation with the **mean atmospheric pollutant accumulation** (recharging period) measured on the Spanish Mediterranean coasts.

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