Geophysical Research Abstracts
Vol. 14, EGU2012-9022-1, 2012
EGU General Assembly 2012

Characterizing extreme air pollution events over the Iberian Peninsula by establishing the Circulation Types

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A wide number of studies show that the Iberian Peninsula (IP) exceeds some of the thresholds of air quality established in the legislation. The use of chemistry transport models (CTMs) plays a key role in order to forecast the threshold exceedances for human health and ecosystems, and to understand the causes of these extreme air pollution events. However, the short-term forecasts available today (generally less than 48 hours) may hamper the decision-making and the design of abatement strategies to comply with air quality standards in the Iberian Peninsula. In this sense, a characterization of the Circulation Types (CTs) related to such extreme air pollution events could help to characterize and understand future exceedances. Moreover, the projected increase of the frequency of extreme events related to air pollution over southwestern Europe and the Iberian Peninsula could be related to an increase of the frequency of some specific CTs.

Bearing this in mind, this work presents a characterization study of the CTs associated with the summertime and wintertime extreme air pollution events in the Iberian Peninsula. We propose a definition of extreme air pollution events based on a regionalization process applied to a model climatology of air pollution over the Iberian Peninsula. Data from the regional modelling system MM5-CHIMERE-EMEP for the period 1970-2000 (driven by ERA40) is used in this study. The domain of study covers the Iberian Peninsula with a horizontal resolution of 25 km and a vertical resolution of 23 layers in the troposphere.

The values over the legislation thresholds (both for hourly and daily values) are defined as extremes. The meteorological situations of the selected days are classified by a previous objective classification, developed seasonally using a K-means cluster analysis that employs Z500 and SLP variables. A seasonal description of the main features of each cluster related to pollutant concentration is presented and discussed. The results indicate the complexity of the summer atmospheric scenarios due to the topography and climatic particularities of the Iberian Peninsula, with marked Atlantic-Mediterranean differences.

The summer months are characterised by higher temperatures and solar radiation, leading to the formation of ozone and secondary aerosols that dominate the contribution to the particulate matter levels, especially in meteorological situations characterized by a low-pressure gradient with re-circulations of air masses within the Iberian Peninsula. The results also show a clear decrease in ozone levels during wintertime, with higher concentrations associated to short-range transport. PM10 concentrations present a smooth behavior between clusters, with higher levels associated to anticyclonic situations characterized by important atmospheric subsidence over the zone. The winter episodes are fundamentally dominated by stable anticyclonic situations, favouring the high levels of particulate matter, nitrogen oxides and elemental carbon.