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Identification and characterisation of regional ozone episodes in the southwest of the Iberian Peninsula

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HIGHLIGHTS

- We characterise for the first time regional ozone episodes in SW Iberia.
- Episodes have been identified by using a statistical criterion.
- Episodes are developed under two different synoptic conditions.
- Both conditions originate a similar surface wind regimen in the study area.
- Episodes are generated coinciding with breeze periods and high temperatures.

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ABSTRACT

Tropospheric ozone is considered one of the most significant air pollutants due to its negative effects on human health, agricultural crops, ecosystems and climate. The features of the southwest of the Iberian Peninsula (high temperatures and high solar radiation, the presence of the Guadalquivir basin and sources of precursors) favour the occurrence of episodes of high concentrations that cause exceedances of legal thresholds with relative frequency. Despite this, no study examining regional ozone episodes has been carried out in this region until now. In the present work a surface hourly ozone dataset (2003–2006) measured at 11 representative stations located in the southwest of the Iberian Peninsula (western Andalusia) was analysed in order to identify and characterise, for the first time, the regional ozone episodes that occur in this area. Using a statistical criterion, eight regional episodes were identified and analysed. The analysis of synoptic weather patterns revealed that these episodes occur in conjunction with two different synoptic conditions (high surface pressure either close to the British Isles or over the Atlantic Ocean). Both conditions generate weak isobaric surface pressure over the Iberian Peninsula, favouring the establishment of easterly winds at 500 m and the development of winds with two main prevailing directions (southwest-northwest, following the Guadalquivir basin) in the study area. During episodic days ozone follows a similar daily cycle to that observed on non-episode summer days, although the levels reached during the former are higher. In both cases, a direct relationship between the daily ozone cycle and the local wind regimen was not observed. This therefore seems to indicate that the daily cycle followed by ozone is mainly regulated by the precursor emissions produced in the environment, by the temperature changes taking place during the day and by the influence of the lower troposphere during anticyclonic weather conditions.

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1. Introduction

Surface ozone is one of the most important photochemical pollutants in the Troposphere due to its negative effects on human health (Kassomenos et al., 2013), wild vegetation (Paolleti, 2006), crops (Carrasco-Rodríguez et al., 2005) and climate (Khoder, 2009). It is formed through a set of photochemical reactions involving NO_X

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and volatile organic compounds in the presence of solar radiation (e.g. Finlayson-Pitts and Pitts, 2000). Likewise, ozone is considered a regional pollutant since the transport of primary pollutants from urban and industrialised zones may lead to changes in the photochemical activity of other areas far from the emission sources (e.g. Cristofanelli and Bonasoni, 2009). Therefore, regional studies investigating ozone behaviour (such as the present work) are more useful than those which focus on smaller-scale areas (i.e. local studies), especially if their aim is to characterise ozone dynamics across a wide zone.

The weather (high temperatures and high levels of solar radiation), orography (the Guadalquivir basin) and the presence of precursor emission sources (large cities and important industrial complexes) in the southwest of the Iberian Peninsula favour the

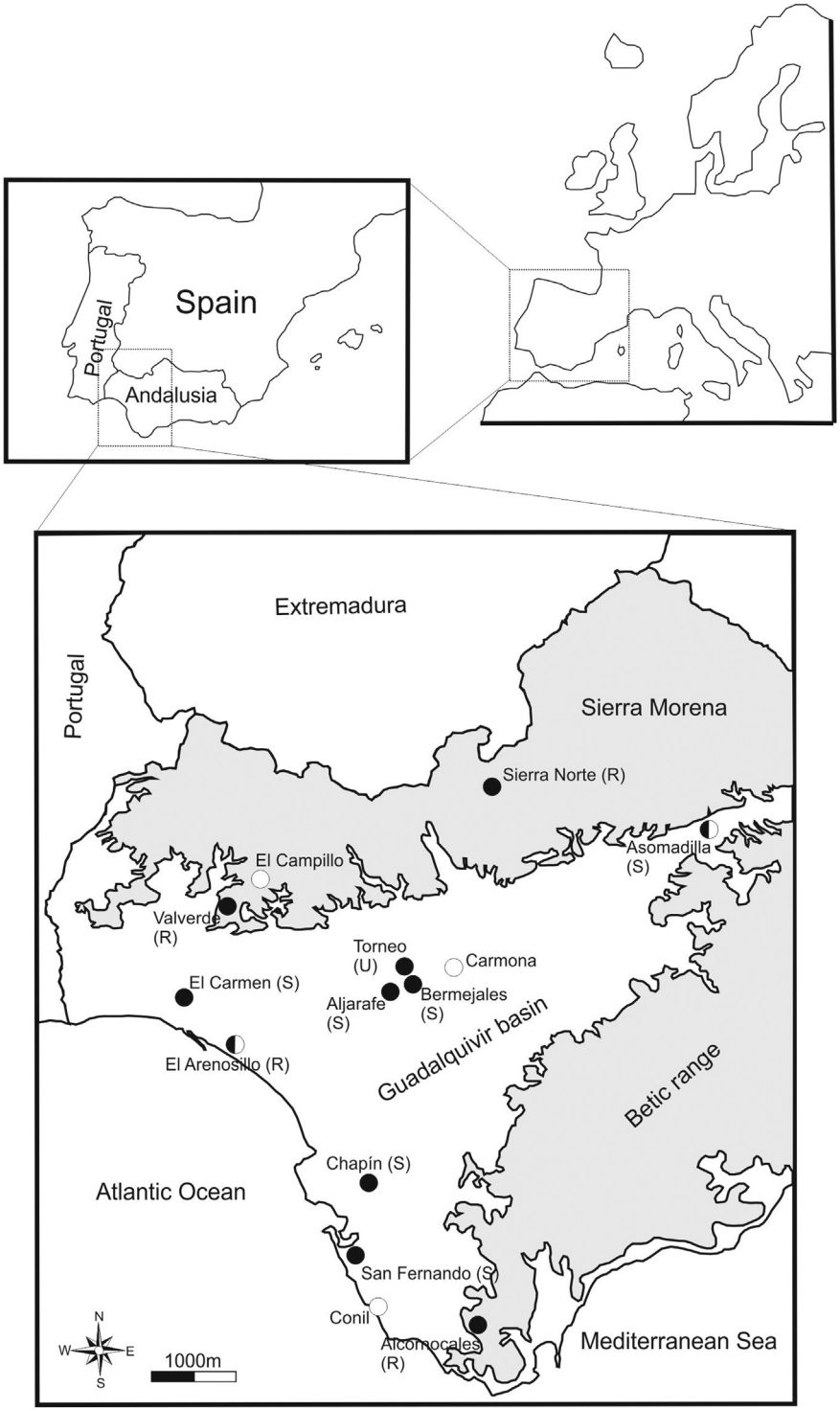

Fig. 1. Map of the study area showing its regional setting in Europe and Spain, together with the locations of the monitoring stations. Black circle: ozone station; white circle: meteorological station; black and white circle: ozone and meteorological station. U: urban station; S: suburban station; R: rural station.

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