Events of biomass burning affecting mainland Spain from 2005 to 2020

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INTRODUCTION

According to The Global Burden of Disease study, in 2019, air pollution caused 6.7 million deaths globally, being the 4th leading risk factor for mortality worldwide. Its total impact is exceeded only by high blood pressure, dietary risks, and tobacco use [1]. In urban areas, there are several main pollution sources such as traffic, industries and biomass combustion. Biomass burning is regarded as an important source of pollutants, particularly particulate matter (PM), which has been classified by the International Agency for Research on Cancer as carcinogenic for humans [2]. Biomass burning can result from natural events, such as wildfires [3], as well as from anthropogenic sources such as biomass combustion for residential heating [4] and open burning of pruning residues for waste disposal [5]. It has been reported that in rural areas, wildfires might increase PM levels up to four times compared to periods without this source of pollution, largely exceeding the air quality guidelines [6].

The present work focuses on analyzing the influence of biomass burning in different sectors of the Iberian Peninsula from 2005 to 2020. In addition, the weather types under which these situations take place have been analyzed and a more detailed study in the city of León is presented.

METHODOLOGY

Study zone

Fig. 1. Sectors defined by the Ministry for the Ecological Transition and the Demographic Challenge and location of León.

Database

Biomass burning: Ministry for the Ecological Transition and the Demographic Challenge (MITECO).

PM_{10} concentration in LE01 traffic air quality station (León): Air Quality Network of Junta of Castilla y León.

Pressure for weather types: National Center for Atmospheric Research.

Aditional tools

Models: HYSPLIT and NAAPs

Weather types

LAMB TYPES					
ANTICYCLONIC TYPES		PURE DIRECTIONAL		CYCLONIC TYPES	
A	Anticyclonic	NE	Northeast	C	Cyclonic
ANE	Northeast-anticyclonic	E	East	CNE	Northeast-cyclonic
AE	East-anticyclonic	SE	Southeast	CE	East-cyclonic
ASE	Southeast-anticyclonic	S	South	CSE	Southeast-cyclonic
AS	South-anticyclonic	SW	Southwest	CS	South-cyclonic
ASW	Southwest-anticyclonic	W	West	CSW	Southwest-cyclonic
AW	West-anticyclonic	NW	Northwest	CW	West-cyclonic
ANW	Northwest-anticyclonic	N	North	CNW	Northwest-cyclonic
AN	North-anticyclonic			CN	North-cyclonic

RESULTS

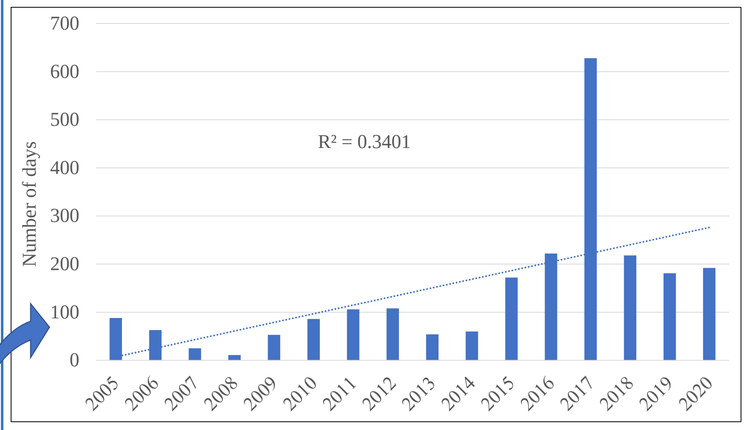


Fig. 2. Annual evolution of the total number of days with biomass burning events in the Iberian Peninsula between 2005 and 2020

Statistically significant increasing trend in all sectors except NW

In the Northwest area, the number of events was greater (723 days). This sector includes Galicia, León and Asturias. These areas have the highest incidence of wildfires.

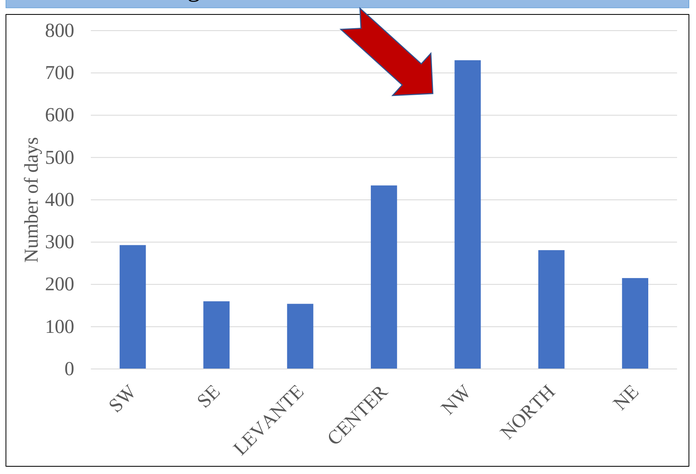


Fig. 3. Total number of days with biomass burning events in the different sectors between 2005 and 2020

- Summer: highest mean number of cases
- Spring and winter: lowest mean number of cases

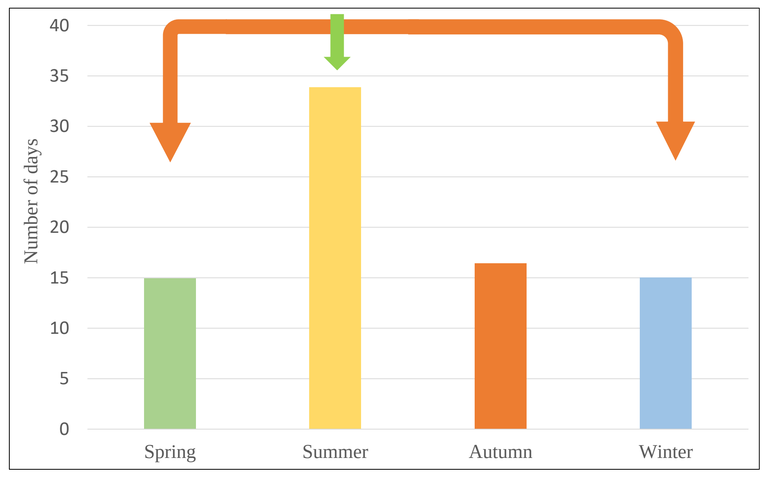


Fig. 4. Average number of days affected by biomass burning events in each season between 2005 and 2020

Seasonal distribution of biomass burning events among the different sectors were similar. The sector that differs most was the Northwest, displaying the highest number of events in winter.

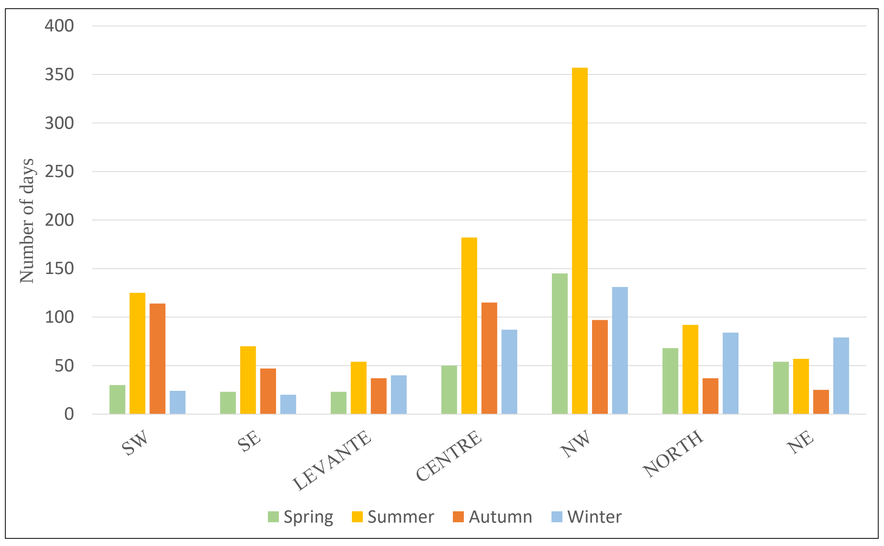
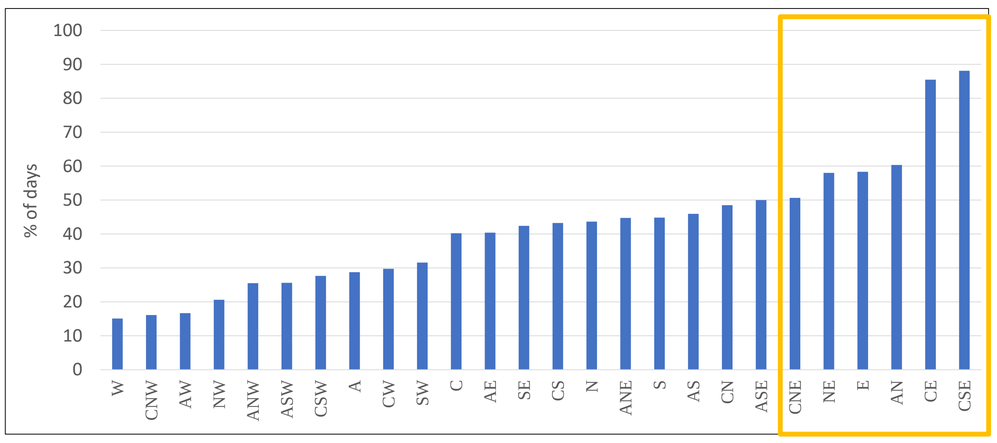


Fig. 5: Mean number of days with biomass burning events in the different sectors for each season within the study period



It is observed that all these weather types (except AN) have an eastern component.

Fig. 6. Ratio between the number of days with biomass burning events for each weather type and the total number of days that this weather type has occurred during the study period

The weather types whose percentage is greater than 50%, when occur, it is most likely that a biomass burning episode will be recorded.

Analysis of the impact of a forest fire in León

The forest fire selected for the analysis took place in the French Basque Country, between March 10 and 14, 2014 (located about 325 km from the city of León).

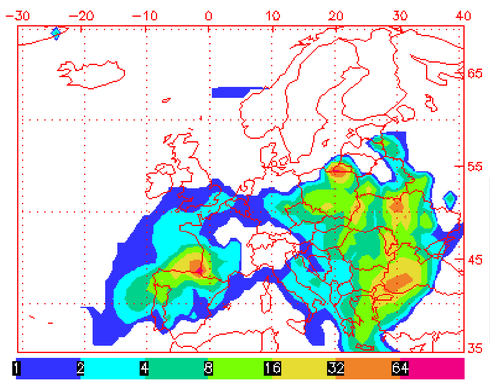


Fig. 7. Concentration (µg/m³) of smoke on 12 of March 2014, obtained from the NAAPs model

The wildfire affected the northern part of the Iberian Peninsula, including the city of León

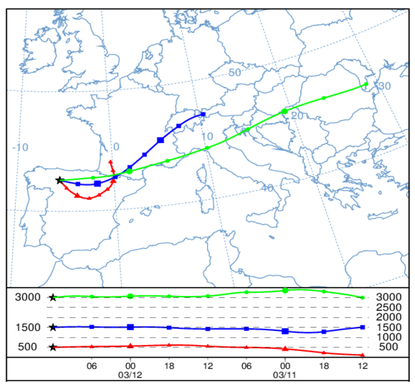


Fig. 8. 48h Back trajectories obtained with the HYSPLIT model at three different heights (500, 1500 and 3000 m), for the city of León on 12 of March 2014 at 1200 UTC

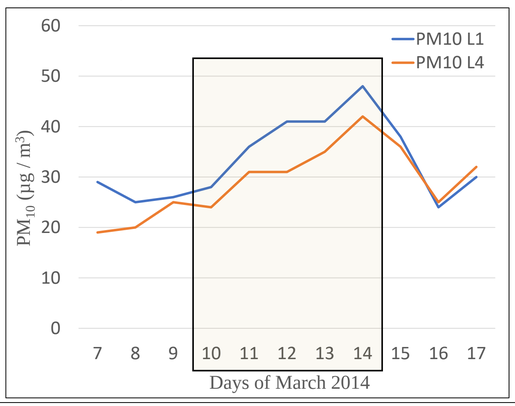


Fig. 9. Evolution of the concentration of PM_{10} before, during and after the fire at the León1 (L1) and León 4 (L4) stations. The period of occurrence of the fire has been indicated with a colored rectangle

PM_{10} levels increased during the wildfire between March 10 and 14, 2014

CONCLUSIONS

- In the study period (2005-2020), a significant positive trend was observed in the number of days with biomass burning events in the Iberian Peninsula.
- In all sectors, except the Northwest, there was a significant increasing trend in the number of days with biomass burning events, reaching its maximum in 2017.
- The weather type in which more biomass burning events were recorded was the Northeast, followed by the Anticyclone.
- The weather types most likely to be accompanied by biomass burning events are: ASE, CNE, NE, E, AN, CE, CSE. It is observed that all these weather types (except AN) have an eastern component..
- In the city of León, 338 days were recorded in which the daily limit value established for PM_{10} concentrations (50 µg/m³) was exceeded. Of these exceedances, about 20% were probably influenced by biomass burning events.
- Between March 10 and 14, 2014, the city of León was affected by a wildfire that occurred in the area of the French Basque Country. Statistical analysis showed that PM_{10} concentrations in the city of León increased significantly during fire days.

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