EMS Annual Meeting Abstracts
Vol. 16, EMS2019-585, 2019

A climatological analysis of CAPs over the southern Spanish Meseta

Domingo Rasilla (1), Alberto Martilli (2), Fernando Allende (3), and Felipe Fernandez (3)

(1) Departamento de Geografía, Urbanismo y OT, Universidad de Cantabria, (2) División de Contaminación Atmosférica, Centro Investigaciones Energéticas, Medioambientales y Tecnológicas, (3) Departamento de Geografía, Universidad Autónoma de Madrid

Persistent CAP ("Cold air pools") are a frequent phenomenon in the southern Spanish Meseta, resulting in poor air quality in the Metropolitan Area of Madrid, or hazardous conditions for ground and air transportation due to fog episodes. Thus, knowledge of the main characteristics, dynamics and forcing mechanisms are an initial but necessary step to their accurate forecasting. Consequently, the aims of this research is to identify the most representative meteorological conditions inducing the formation of CAPs and their influence on temperature inversion intensity, to describe the spatial configuration and temporal structure of CAPs, to verify the connections between extreme low temperatures induced by CAPs over the past decades and synoptic (weather types) and large-scale pressure indices (NAO), and finally to analyze the impact of those CAP on air quality conditions.
In order to fulfill such objectives, we have used data for different sources. The Spanish Meteorological Agency provided us with daily and hourly air temperature records, while LST were obtained from MODIS V6 MYD11A2 database. Moreover, upper air data from the WMO 08221 (Madrid-Adolfo Suárez Airport) station were used to analyze the vertical structure of the atmosphere. Air quality data were analyzed from records supplied by Madrid's Municipality and Madrid′s Regional Government air quality surveillance networks.
The results of our analysis show that two classes of inversions are typical of the region, a ground-based inversion and an upper level inversion (approximately between 800 and 900 hPa pressure levels). Surface inversions are more frequent at night and winter, while subsidence inversions form all over the year, although with seasonal differences in altitude, depth and strength. The strongest CAP events are the result of the merging both types of inversion, closely related to large-scale circulation features, such as high pressure systems. CAP tend to cluster into multi-day episodes, driven by synoptic-scale weather and other lower-frequency climate patterns, such as the North Atlantic Oscillation, which also led their inter-annual and decadal variability.
Also, CAP frequency and strength is closely related to winter low nocturnal temperatures and pollution episodes, recording significantly increases in particulate matter levels (especially those of smaller diameter, such as PM2.5) and NO_2, due to poor ventilation conditions. The absence of air mass renewal also leads to frequent episodes of nocturnal urban heat island, and radiation fog episodes, with a remarkable impact on both road and flight communications.