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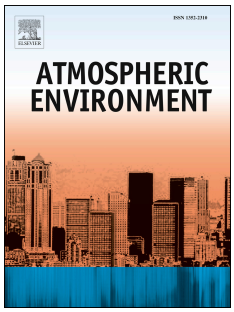

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Aerosols in Northern Morocco: Input pathways and their chemical fingerprint

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Abstract

The Mediterranean basin is one of the most sensitive regions in the world regarding climate change and air quality. Deserts and marine aerosols combine with combustion aerosols from maritime traffic, large urban centers, and at a larger scale from populated industrialized regions in Europe. From Tetouan city located in the North of Morocco, we attempted to better figure out the main aerosol transport pathways and their respective aerosol load and chemical profile by examining air mass back trajectory patterns and aerosol chemical compositions from May 2011 to April 2012. The back trajectory analysis throughout the sampling period led to four clusters, for which meteorological conditions and aerosol chemical characteristics have been investigated. The most frequent cluster (CL3: 39%) corresponds to polluted air masses coming from the Mediterranean Basin, characterized by urban and marine vessels emissions out of Spain and of Northern Africa. Two other polluted clusters were characterized. One is of local origin (CL1: 22%), with a marked contribution from urban aerosols (Rabat, Casablanca) and from biomass burning aerosols. The second (CL2: 32%) defines air masses from the near Atlantic Ocean, affected by pollutants emitted from the Iberian coast. A fourth cluster (CL4: 7%) is characterized by rather clean, fast and rainy oceanic air masses, influenced during their last 24 hours before reaching Tetouan by similar sources with those affecting CL2, but to a lesser extent.
The chemical data show that carbonaceous species are found in the fine aerosols fraction and are generally from local primary sources (low OC/EC) rather than long-range transported. In addition to fresh traffic and maritime vessel aerosols, our results suggest the contribution of local biomass burning.

Keywords: Aerosols; PM2.5; Western Mediterranean Basin; Chemical composition; Back trajectory clustering; Maritime traffic.

1. Introduction

The Mediterranean basin has been described as one of the most sensitive regions of the world regarding climate and air quality (Doche et al., 2014). In the last two decades, international research projects have addressed specific questions about air pollution and transport mechanisms over the basin (e.g. MECAPIP, PYREX, PAUR I and II, MEDUSE, ESCOMPTE, MINOS). In the past five years until now, aerosols have been more particularly studied for their radiative properties (Sicard et al., 2016; Mallet et al., 2016). Ground-based stations are located in the northern part of the basin, but no observations are considered from the Northern African coast.

In Morocco, aerosols or particulate matter (PM) have been investigated for their relation with meteorological parameters (Tahri et al., 2013), their chemical composition (Zghaid et al., 2009; Bounakhla et al., 2009), and their sources (Ait Bouh et al., 2014). The impacts of aerosols on health have been studied using mortality data, occurrence data of asthma attacks (Mohammedia Airpol, 2003) and of respiratory symptoms among asthmatic children (Casa Airpol, 2000). But, to our knowledge, the determination of the respective inputs of local, regional and long-range pollution sources to the aerosol mix in Morocco has never been conducted.

Several methods are commonly used to define the possible sources of atmospheric aerosol that contribute to a receptor site. Statistical methods, like positive matrix factorization and factor analysis, are powerful methods to determine source profiles based on large number of chemical species. However, they