10.3. Monitoring the atmospheric deposition of aerosols in Sierra Nevada

Morales-Baquero, R.
University of Granada

Abstract

The deposition of atmospheric aerosols (dust) is a climatic variable that has not been taken into account until very recently. Therefore, the role that atmospheric depositions play in the biogeochemistry of Mediterranean ecosystems has not been sufficiently studied, although the data that are being reported indicate that the atmospheric particulated material, and especially Sahara Desert dust, represents one of the main inputs of nutrients and trace elements, among other components, to Mediterranean ecosystems. Concretelly, this study monitors the aerosols deposition in Sierra Nevada within a western Mediterranean context in relation to global climate change.

Aims and methodology

The quantification and variability of rainfall has been studied for some time with reliable time series that span decades and a relatively fine spatial resolution. However the genesis, mobilization, and deposition of suspended particles in the atmosphere are barely known. Arid areas are the main sources of aerosols and the Sahara Desert, the greatest of the entire planet, is responsible for the exportation of vast amounts of dust that are transported by the atmosphere towards the Atlantic Ocean and Europe.

The Mediterranean area receives, by particulate deposition, significant quantities of Ca, Fe, P, organic matter, and other elements without gaseous phases. The biogeochemical cycles of these elements have traditionally been considered closed within the ecosystems. Therefore, there is growing interest in quantifying these atmospheric fluxes and their impact on Mediterranean ecosystems. The aim of the present study is to establish a continuous data series on atmospheric aerosol deposition in Sierra Nevada and to study it in relation to climate change in order to predict its impact on those mountain systems.

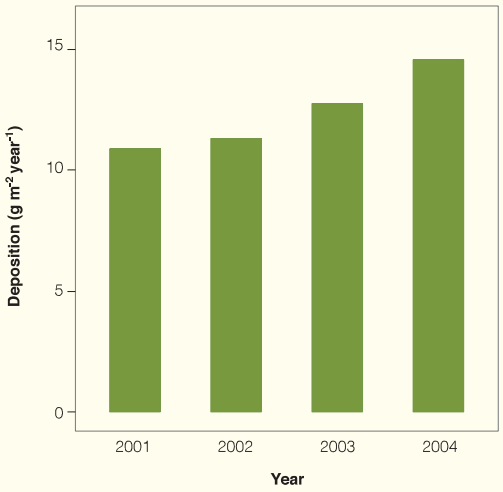
Since 2001 weekly samples of aerosol deposition have been collected in Sierra Nevada in two biennial series that lasted until 2005, with the exception of 2003. The samples were taken by passive automatic collectors that differentiate the dry deposition of aerosols from wet deposition (particles carried by the rain).

Currently, the weekly collection of particulate matter continues using a new automatic instrument installed in the weather station of Cañar, of the Regional Organization of National Parks, in coordination with the *CHARMEX* network, which is described below.

Results

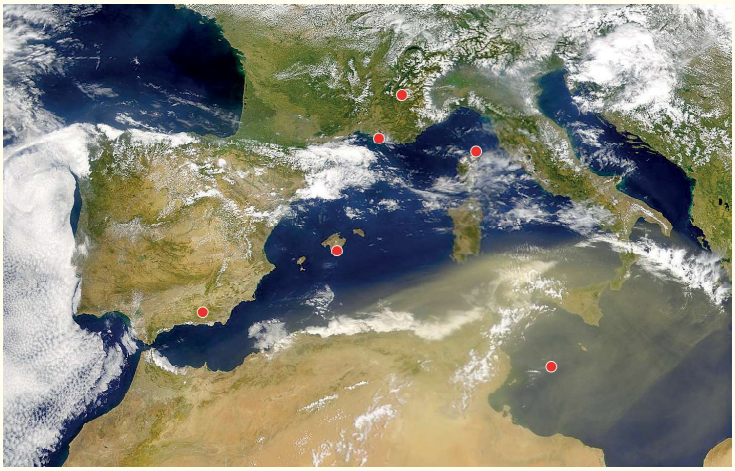
The data compiled show that more than 70% of the particulate matter is deposited in dry form, the rest carried by the rain. This reflects the singularity of the southern Mediterranean area in relation to more northern parts of the Northern Hemisphere, where the wet precipitation of aerosols is predominant. The evolution within the study period shows a progressive increase in the quantity of deposited material, ranging from 10.9 g m^{-2} $year^{-1}$ in 2001 to 14.6 g m^{-2} $year^{-1}$ in 2005 (Figure 1). Furthermore, the determinant influence of the deposition of organic carbon, phosphorus, nitrogen and calcium in the biogeochemistry of aquatic systems in Sierra Nevada has been demonstrated [11-14], as well as the determinant role of Saharan calcium inputs on Mediterranean forest [10].

Figure 1



Annual deposition of atmospheric particulate matter over Sierra Nevada

Figure 2



Deployment in the Western Mediterranean of the network of CARAGA collectors within the project *CHARMEX*.

Discussion and conclusions

The observed trend is consistent with the increase of Saharan dust emissions towards the Mediterranean region according to changes detected in global climate patterns. However, the data available are too scarce. Longer time series are needed to relate the dynamics of aerosols and their variability with other climatic variables.

Given the scarcity of data on aerosols their study has stirred interest in the scientific community and thus, French researchers coordinated by Professor François Dulac (Centre D'études Civils, Saclay) has promoted an initiative called: *CHARMEX* (The Chemistry-Aerosol Mediterranean Experiment). This project involves an ambitious long-term work plan that has the following objectives:

1. To establish the current state of the Mediterranean atmosphere.

2. To quantify the impact of reactive aerosols and gases.

3. To predict the future trends of these balances and impacts.

The specific aims cover a broad spectrum, including knowledge of radiative forcing, transport mechanisms, atmospheric chemistry, deposition, effects on ecosystems, and anthropogenic influence. Reaching these objectives implies the collaboration of a several groups of international researchers from different branches of science. This network currently consists of 7 nodes, 2 of which are in Spain: one in Majorca and the other in Sierra Nevada. In each node, an instrument that collects aerosols autonomously, called CARAGA, and developed specifically for this network, has been installed (Figure 2).

The network began to be deployed in 2010. In May of 2012, the autonomous collector was installed in the weather station of Cañar. During the first year, the functioning of this apparatus, which is a prototype, required various adjustments and sampling was irregular. From May 2013, weekly data were taken regularly and continue to be taken in a coordinated way with the rest of the stations of the *CHARMEX* network. With the collected data, critical information is expected to be compiled in order to validate the cycles and models of atmospheric depositions at the synoptic scale, as well as to know the past, present, and future role of these depositions on the functioning of Mediterranean ecosystems.