Transport of Saharan Dust Over Mediterranean Basin - Ecological and Health Risks

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ABSTRACT

The Mediterranean area is recognized as one of the main climate change hotspots and one of the most susceptible world regions. This region is characterized by complex mixing of anthropogenic pollutants from industries and large urban areas with aerosols from various natural sources (dust from the Sahara, sea salt and forest fires). Saharan dust (SD) is one of the major component of atmospheric aerosols over the Mediterranean Basin and is an active component of the climate system. Generally, atmospheric particulate matter (PM) constitutes one of the most challenging problems both for air quality and for climate change policies. Aerosols influence heat balance of the Earth, directly by reflecting and absorbing solar radiation and indirectly through altering the cloud microphysics. On the other hand, they influence human health by inducing adverse respiratory effects. In the Mediterranean countries, SD outbreaks contribute to high concentrations of PM_{10} fraction (particles with aerodynamic diameter > 10 μm) that often exceed the limit set by the EU Air Quality Directive. This PM can be a serious irritant and pose a major health hazard. Additionally, the extreme dust transport events may modify the radiative budget of Mediterranean basin and the basin biogeochemical cycle as well.

Saharan dust storms may also transmit large amounts of bioaerosols (e.g., biological agents in the dust/aerosols such as pollen, plant fragments, spores, viruses, algae, fungi, and bacteria) over the Mediterranean. The majority of these bioparticles are known to be potential respiratory allergens. Dust-borne microorganisms also may play a significant role in the ecosystem health. It has been shown that bacteria are metabolically active after the transport with SD to the European Alps. Therefore, the long-range transport of viable bacteria with SD may represent a way for bacteria to colonize new environments.

Our studies on the aerosols and rainwater chemistry in Croatia have shown that the rainwater composition are highly affected by the transport of the eolian dust from North Africa (very often in spring and summer). The significantly higher values of particulated organic carbon (POC) were measured in rain sample during the Saharan dust event. It was also observed that alkaline compounds from Saharan material increase the pH of precipitation, thus reduce the frequency of acid rains. In the framework of the Croatian science foundation MARRES project, the unique, highly eutrophic, and euxinic marine lake, Rogoznica Lake (RL) in the central Dalmatia (Middle Adriatic, 43°32'N 15°58'E), and the North Adriatic as a semi closed, shallow and potentially eutrophic basin were selected for tracking environmental changes. These marine ecosystems are characterited by a lack of trace metals and nutrients in surface water limiting phytoplankton production. Because of that, the atmospheric deposition via precipitation of these components (specially of iron, Fe) is vital for primary production. For example, in the rainwater associated with Saharan dust intrusions (Fig. 1), sampled in May 2019 at RL area (middle Adriatic), increased concentration of iron (10 ug L^{-1}) in particulate form was detected. It was assumed that afterwards the intensive phytoplankton bloom (oxygen saturation up to 250%) in the surface water layer of RL (0 -7 m depth), might be related to this SD event. This support the fact that the SD particles rich in Fe have large impact on iron-limited marine ecosystems.

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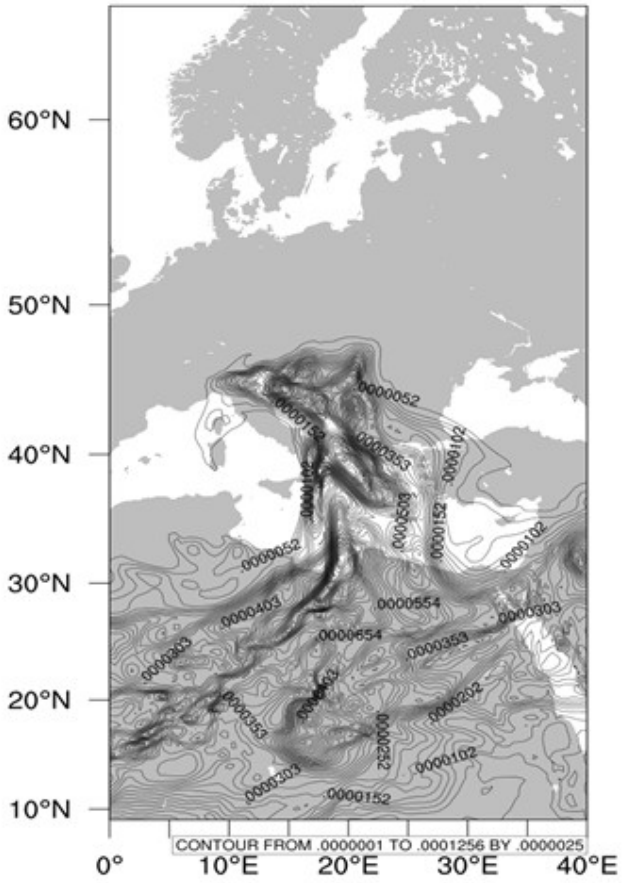

Figure 1. Strong Saharan dust over Mediterranean towards Croatia at 27 May 2019 at 12:00

In the northern Adriatic (NA), long-term investigations of organic matter (OM) content have shown changes in concentrations and properties of OM as direct consequence of biological, mainly phytoplankton activities, and changes in its abundance and community compositions.

Partially, these changes may be associated with effect of mineral particles and bioaerosols from the northern Africa. Predictions for increased dust emissions may intensify the transport and potential impact of SD emissions on oligotrophic marine regions.

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