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Total atmospheric deposition of dissolved organic matter (DOM) at the island of Lampedusa (Central Mediterranean Sea)

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Deposition of atmospheric aerosol and particles can influence the marine biogeochemical cycles providing inputs of nutrients, metals and organic matter, including some pollutants. Aerosol inputs of nitrogen (N), phosphorus (P), and iron (Fe) to the open ocean can stimulate phytoplankton growth in nutrient-limited and iron-limited areas and therefore modulate the ocean biogeochemical processes. The Mediterranean Sea is the largest semi-enclosed basin and one of the most oligotrophic areas in the world. It continuously receives anthropogenic aerosols from Europe and Saharan dust from the south. Although the aerosol organic fraction may play a crucial role in the C, N, and P biogeochemical cycles, very limited information is available on the atmospheric contribution to the Mediterranean Sea.

The main goals of this study are: (i) to quantify atmospheric fluxes of DOC, DON and DOP at the island of Lampedusa, and the C:N:P molar ratio in the atmospheric DOM delivered to the surface waters; (ii) to investigate the optical properties (absorption and fluorescence) of the chromophoric DOM (CDOM) in the atmospheric deposition; (iii) to quantify atmospheric soluble metals and nutrients (such as iron, phosphorus, lead, vanadium) and to compare their temporal evolution with that of DOC, DON, and DOP.

Atmospheric deposition was collected bi-monthly between March 19^{th}, 2015 and October 6^{th}, 2017 at the ENEA Station for Climate Observations (35.52˚N, 12.6˚E, Lampedusa Island, Italy). Lampedusa is far from continental areas and from relevant pollutant sources and is located in an ideal position for the study of atmospheric DOM fluxes.

DOC fluxes ranged between 0.06 and 1.78 mmol C m^{-2} day^{-1}, DON ranged between 0.015 and 0.25 mmol m^{-2} d^{-1}, while DOP fluxes ranged between 0 and 0.027 mmol m^{-2} d^{-1}, with a marked variability. The highest atmospheric DOC fluxes were found in correspondence with high values of both soluble metals and nutrients. DON and DOP are important fraction of N and P in total deposition, representing more than one-third of the total dissolved nitrogen and phosphorus. C:N:P molar ratios in atmospheric DOM showed a marked variability, with average values of 1909:292:1. The atmospheric fluxes and elemental ratios of DOM were in good agreement with depositions measured in the north-western Mediterranean Sea, although in different time periods. The Parallel Factorial Analysis (PARAFAC) was applied to 121 excitation emission matrixes (EEMs), and validated a seven-component model. The excitation and emission spectra of these components were similar to those observed in the open waters of the Mediterranean Sea and in the oceans, in dust samples collected in alpine lakes as well as in aerosol particles collected in the polar region. The seven groups of fluorophores were identified by comparison with the literature, and included humic-like and protein-like materials and a mixture of Polycyclic Aromatic Hydrocarbons (PAHs) and proteins. Our results support that atmospheric input may be the principal, and up to now overlooked, external source of DOM to the Mediterranean Sea.