

Supplementary Material

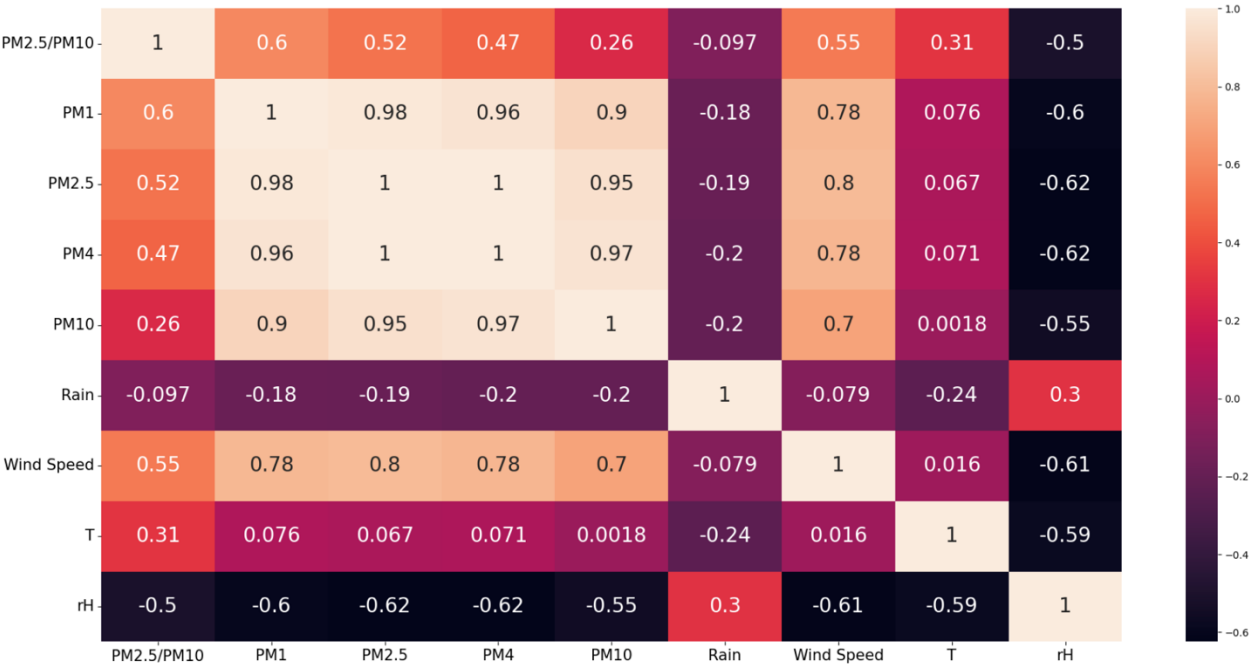
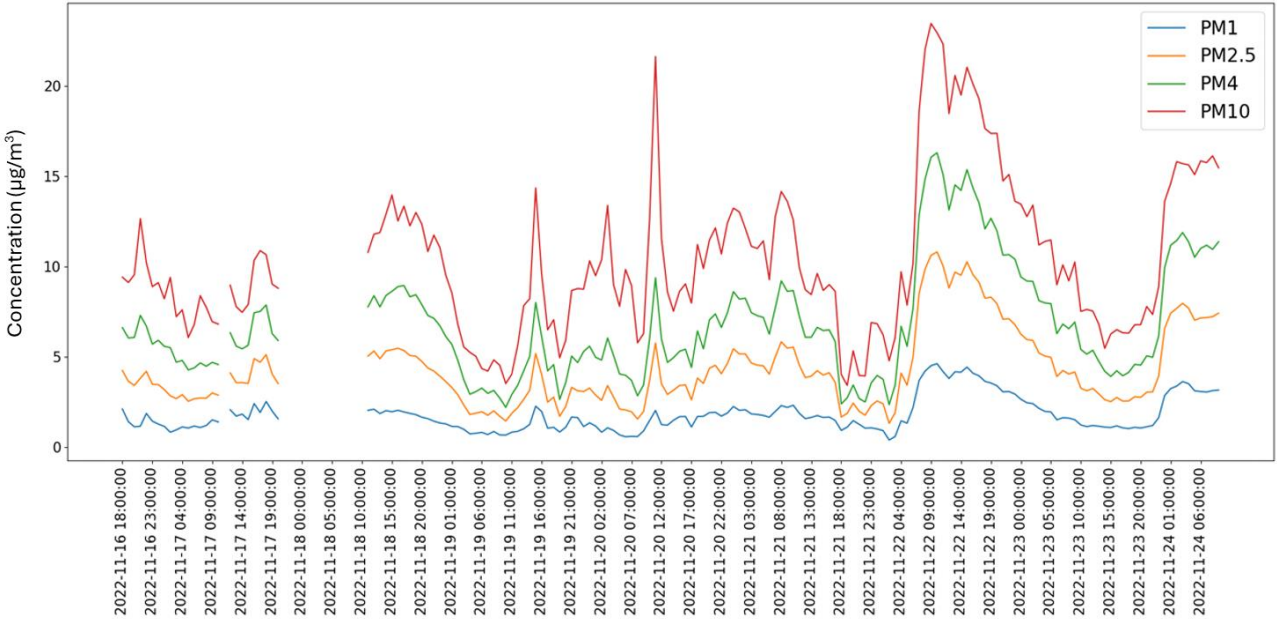


Figure S1. Pearson’s correlation index for all variables measured during the first measurement campaign (preliminary campaign) held in Culuccia island from November 16, 2022 to November 24, 2022.



Graph S1. Trends of different PM concentrations during the preliminary campaign on Culuccia Island from November 16, 2022 to November 24, 2022.

Table S1. Mean values of all PM fractions measured, and mean values of relative humidity and temperature recorded in all three campaigns (March, June, and October).

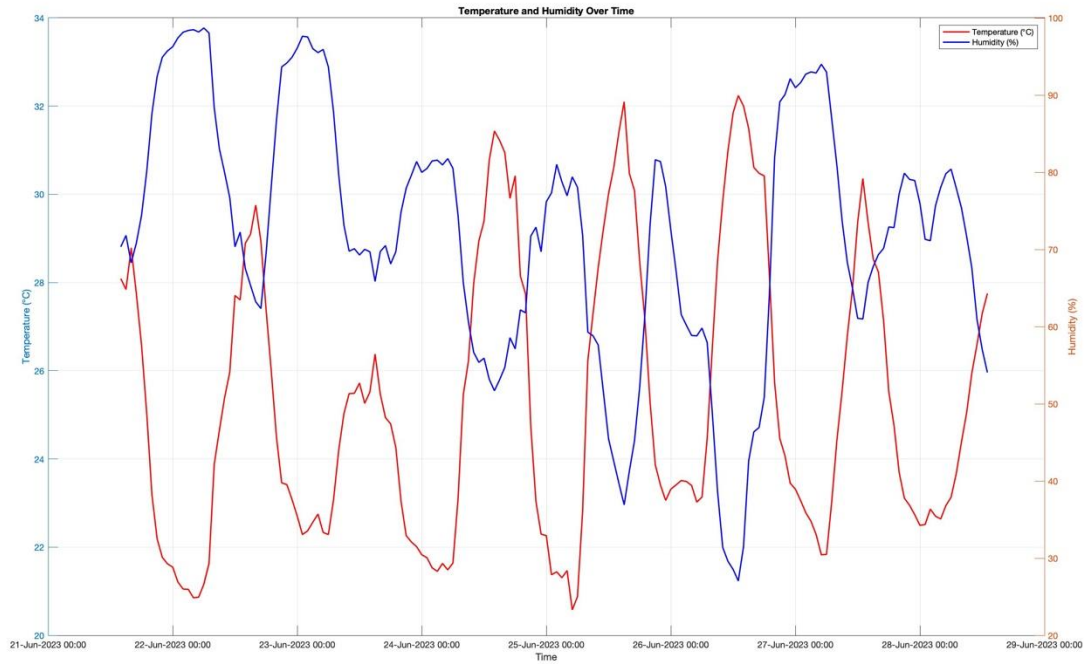
Average Value	PM1 ($\mu\text{g}/\text{m}^3$)	PM2.5 ($\mu\text{g}/\text{m}^3$)	PM4 ($\mu\text{g}/\text{m}^3$)	PM10 ($\mu\text{g}/\text{m}^3$)	Temp ($^{\circ}\text{C}$)	rH (%)
March 2023	3,34	6,55	9,30	11,90	13,34	72,65
June 2023	6,47	10,40	14,06	22,76	25,27	72,00
October 2023	5,71	7,25	8,92	12,02	22,34	77,06

Meteorological Conditions of Culuccia Island

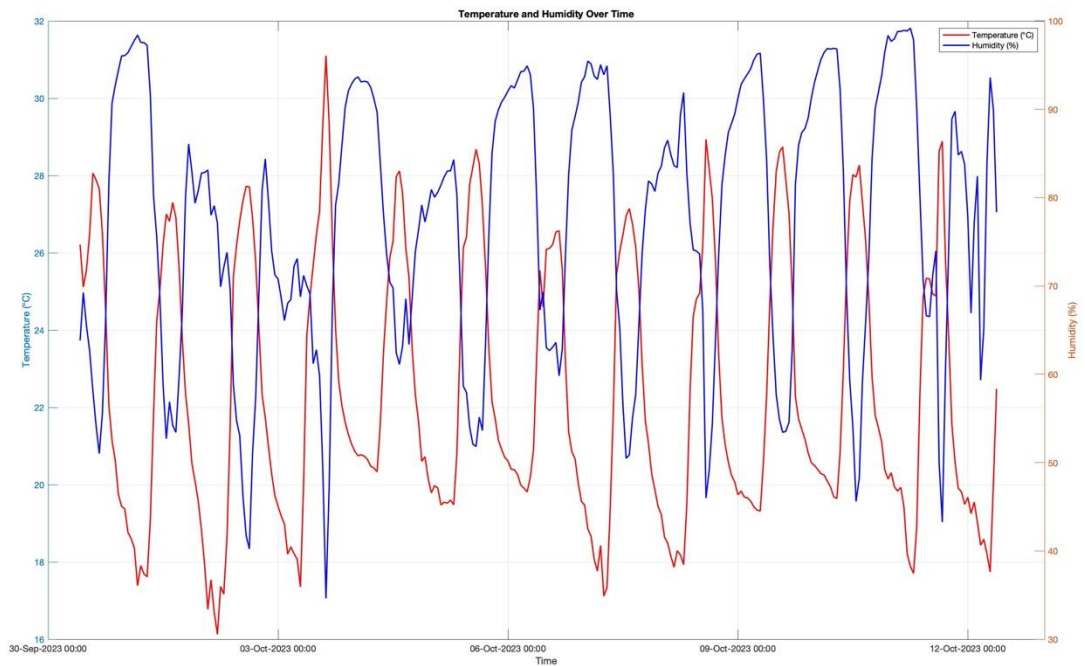
To better characterize the area from a meteorological and climatic perspective, the article includes the average temperatures for each campaign and the trends in relative humidity; below, the temperature and relative humidity trends for each campaign are presented.



Graph S2. Temperature ($^{\circ}\text{C}$) and relative humidity (rH %) trends for the March campaign.



Graph S3. Temperature (C°) and relative humidity (rH %) trends for the June campaign.



Graph S4. Temperature (C°) and relative humidity (rH %) trends for the October campaign.

To provide further details on the specific meteorological conditions, we recommend the website Windy App, with particular reference to the Porto Pollo area <https://windy.app/forecast2/spot/302769/Port+Pollo+Italy+Porto+Pollo/statistics> (which provides historical wind forecasts, including wind speed and direction). It is a reliable and professional source, as it contains historical records and comprehensive meteorological data for our area of study.

It is important to note that wind values tend to vary significantly in direction, intensity, and duration throughout the day. For this reason, we preferred to refer to the Windy App, which provides a statistical average over time. This allows for an overview of wind patterns throughout the entire year of 2023, offering a broader context. This variability of the wind data is confirmed by the fact that calm conditions were recorded for the October 23 campaign, whereas a strong wind storm was recorded during the November 22 preliminary campaign.

In the 2023 measurement campaigns (March, June, and October), the wind speed values ranged from 2.5 to 5.5 m/s.

Formation and Significance of Secondary Inorganic Salts in Coastal Environments

The formation of secondary inorganic salts in the marine environment is a complex process influenced by various chemical and physical factors. Sulfate, nitrate, and sodium chloride salts are among the most common and play significant roles in both marine ecology and atmospheric chemistry.

Sulfate salts primarily form through chemical reactions involving sulfate ions (SO_4^{2-}) present in seawater. The main source of sulfate ions in the marine environment is the oxidation of sulfur-containing compounds, such as hydrogen sulfide (H_2S), which can arise from the decomposition of organic matter. During the evaporation of seawater, the concentration of ions increases, leading to the crystallization of sulfate salts. These salts can influence the chemical and physical properties of seawater, contributing to the formation of sea spray.

Nitrate salts, such as sodium nitrate (NaNO_3) and ammonium nitrate (NH_4NO_3), form in marine environments through biological processes and chemical reactions. Nitrification, a biological process in which bacteria convert ammonia into nitrites and then into nitrates, is an important source of nitrate ions. Additionally, nitrates can form through reactions between acids and bases, where nitric acid reacts with bases present in seawater.

Sodium chloride (NaCl) is the most abundant inorganic salt in seawater. Its formation is primarily the result of the dissolution of minerals and the natural salinity of ocean waters. When seawater evaporates, NaCl becomes concentrated and crystallizes. This process is particularly evident in coastal areas. Furthermore, sodium chloride is a fundamental component of sea spray.

Environmental conditions, such as temperature and relative humidity, significantly affect the formation and stability of these salts. For instance, under high humidity conditions, sodium salts like sodium nitrate can undergo deliquescence, transitioning from a solid to a liquid state. This phenomenon is important for the formation of atmospheric aerosols and can have implications for health and the environment. In summary, the formation of secondary inorganic salts is a dynamic process influenced by chemical interactions, biological reactions, and environmental conditions. Sulfate, nitrate, and sodium chloride salts not only play crucial roles in the marine biogeochemical cycle but also influence climate and air quality, highlighting the importance of understanding these processes in ecological and climatic contexts.