EGYPTIAN METEOROLOGICAL AUTHORITY
SCIENTIFIC RESEARCH DEPARTMENT
AIR POLLUTION DEPARTMENT



Air Pollution Report Over Stations of Cairo and Marsa Matruh during January 2017

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0.1 Introduction

Egyptian Meteorological Authority (EMA) has 5 stations to measure the background pollution around Egypt. The stations are Cairo, South Valley, Marsa Matruh, Hurghada, and Farafra, and their locations are shown in the following map (figure. 1).

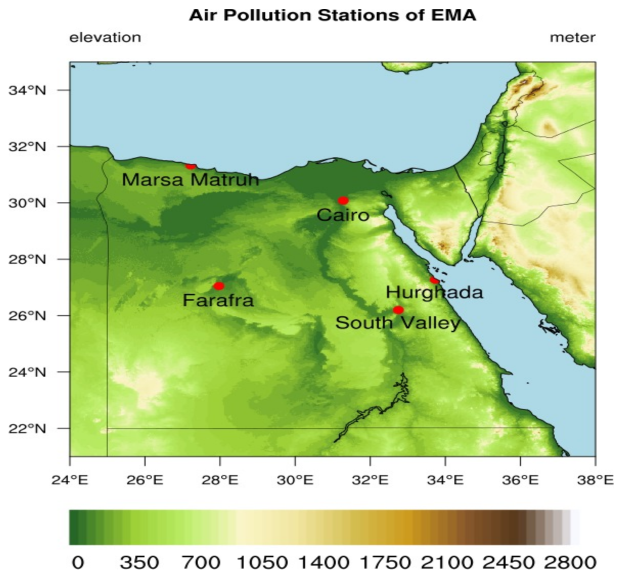

Figure 1: *Air pollution stations*

0.1.1 Brief Notes on the Air Pollutants

An air pollutant is a substance in the air that can affect humans and the ecosystem. It can be solid particles, liquid droplets, or gases. A pollutant can be produced naturally or as a result of the anthropogenic activities. Pollutants can be classified as primary or secondary. Primary pollutants are that pollutants emitted directly into the air, such as ash from a volcanic eruption, carbon monoxide gas from motor vehicle exhaust, or the sulfur dioxide released from factories. Secondary pollutants are not emitted directly into the air, but they are created in the air when primary pollutants react or interact, such as surface ozone which is formed indirectly by the action of sunlight on nitrogen dioxide. Some pollutants may be both emitted directly and formed from other primary pollutants. Here we show some known impacts of the some air pollutants on the health, the environment, and the climate in the table 1, according to European Environment Agency (EEA, 2013 [1]).

Table 1: *Effects of some of air pollutants on the health, the environment, and the climate. Source: EEA, 2013 [1].*

Pollutant	Health effects	Environmental effects	Climate effects
Particulate matter (PM)	Cancause or aggravate cardiovascular and lung diseases, heart attacks and arrhythmias, affect the central nervous system, the reproductive system and cause cancer. The outcome can be premature death.	Can affect animals in the same way as humans. Affects plant growth and ecosystem processes. Can cause damage and soiling of buildings. Reduced visibility.	Climate effect varies depending on particle size and composition: some lead to net cooling, while others lead to warming. Can lead to changed rainfall patterns. Deposition can lead to changes in surface albedo (the ability of the earth to reflect radiation from sunlight).
Ozone (O_3)	Can decrease lung function; aggravate asthma and other lung diseases. Can lead to premature mortality.	Damages vegetation, impairing plant reproduction and growth, and decreasing crop yields. Can alter ecosystem structure, reduce biodiversity and decrease plant uptake of CO_2.	Ozone is a greenhouse gas contributing to warming of the atmosphere.
Nitrogen oxides (NO_x)	NO_2can affect the liver, lung, spleen and blood. Can aggravate lung diseases leading to respiratory symptoms and increased susceptibility to respiratory infection.	Contributes to the acidification and eutrophication of soil and water, leading to changes in species diversity. Acts as a precursor of ozone and particulate matter, with associated environmental effects. Can lead to damage to buildings.	Contributes to the formation of ozone andparticulate matter, with associated climate effects.
Sulphur oxides (SO_x)	Aggravates asthma and can reduce lung function and inflame the respiratory tract. Can cause headache, general discomfort and anxiety.	Contributes to the acidification of soil and surface water. Causes injury to vegetation and local species losses in aquatic and terrestrial systems. Contributes to the formation of particulate matter with associated environmental effects. Damages buildings.	Contributes to the formation of sulphate particles, cooling the atmosphere.

Table 2 shows a some of health-based ambient pollutant in the Egyptian standards listed in the Executive Regulations of Law 4/1994 in Annex 5, and the updated air quality guidelines of World Health Organization (WHO) (WHO, 2006 [3].).

Table 2: *Comparison of health-based ambient air quality standards*

Pollutant	Averaging Time	Maximum Limit Value	
		Egypt	WHO
Surface Ozone (O3)	8-hour	120 μgm^{-3} ($\approx$ 61 ppb)**	100 μgm^{-3} ($\approx$ 51 ppb)
	1-hour	180 μgm^{-3}($\approx$ 91 ppb)	—
Nitrogen Dioxide (NO2)	Annual	60 μgm^{-3} ($\approx$ 32 ppb)	40 μgm^{-3} ($\approx$ 21 ppb)
	24-hour	150 μgm^{-3} ($\approx$ 80 ppb)	—
	1-hour	300 μgm^{-3} ($\approx$ 160 ppb)	200 μgm^{-3}($\approx$ 106 ppb)
Sulfur Dioxide (SO2)	Annual	60 μgm^{-3} ($\approx$ 23 ppb)	—
	24-hour	150 μgm^{-3}($\approx$ 54 ppb)	20 μgm^{-3} ($\approx$ 8 ppb)
	1-hour	350 μgm^{-3} ($\approx$ 134 ppb)	—
	10-minute	—	500 μgm^{-3} ($\approx$ 191 ppb)
Particulate Matter (PM10)	Annual	—	20 μgm^{-3}
	24-hour	70 μgm^{-3}	50 μgm^{-3}

** The conversion from μgm^{-3} to ppb assumed the standard pressure is 1013 hPa, and the mean temperature is 298 K.

0.1.2 Measuring Instruments Information

Here some information about the instruments used in EMA stations to monitor, as shown in fig. 2.

CO2: The Thermo Scientific Carbon Dioxide Analyzer, Model 410i utilizes advanced NDIR optical filter technology to measure the concentration of Carbon Dioxide in stack gas levels.

Surface O3: The Thermo Scientific Model 49i Ozone Analyzer utilizes UV Photometric technology to measure the amount of ozone in the air from ppb levels up to 200 ppm. The Model 49i analyzer is a dual cell photometer, the concept adopted by the NIST for the national ozone standard.

SO2: The Thermo Scientific Model 43i-TLE Enhanced Trace Level SO2 Analyzer utilizes pulsed fluorescence technology to measure the amount of sulfur dioxide in the air down to 50 ppt .

NOx: The Thermo Scientific Model 42i NO-NO2-NOx Analyzer utilizes Chemiluminescence principle.

PM10: There are two kinds of instruments of PM10:
1- The Thermo Scientific SHARP Monitor, Model 5030 is a synchronized hybrid ambient "real-time" particulate monitor. The SHARP Monitor combines light scattering photometry and beta radiation attenuation for continuous PM10/PM2.5 measurement.
2- The PM10 High Volume Air Sampler(HVPM10) Graseby Andersen/GMW Model 1200.
In addition to the Sunphotometer of AERONET (http://aeronet.gsfc.nasa.gov/) (in Cairo station), to measure the aerosol optical and radiative properties as shown in the Figure 3.

Figure 2: *All instruments in the South Valley station*

Figure 3: *Sunphotometer on Cairo station*

0.2 Cairo Station

0.2.1 Station Information

The instruments of monitoring are located on the roof of a building at EMA in Cairo. The station location is : latitude: 30.08° N, longitude: 31.29° E, and elevation: 70.0 meter amsl.

0.2.2 Analyses of the Measurements

2) Aerosol optical properties: In this part we will show some aerosol optical and radiative properties from AERONET site of Cairo_EMA_2, level 1.5. Real Time Cloud Screened data. These properties include the daily average of aerosol optical depth (AOD; i.e. the quantity of light removed from a beam by aerosol scattering or absorption during its path through the air.) for 8 wavelengths (1640,1020, 870, 675, 500, 440, 380, 340 nm) as shown in figure 4a, the aerosol size distribution during January 2017 (fig. 4b), and the aerosol radiative forcing (RF; i.e. is the net change in the energy balance of the Earth system due to adding of aerosols), which expressed in watts per square meter averaged over a particular period of time, IPCC, 2007 ([2].) at the surface (RF_SRF) and TOA (RF_TOA) as shown in figure 4c.

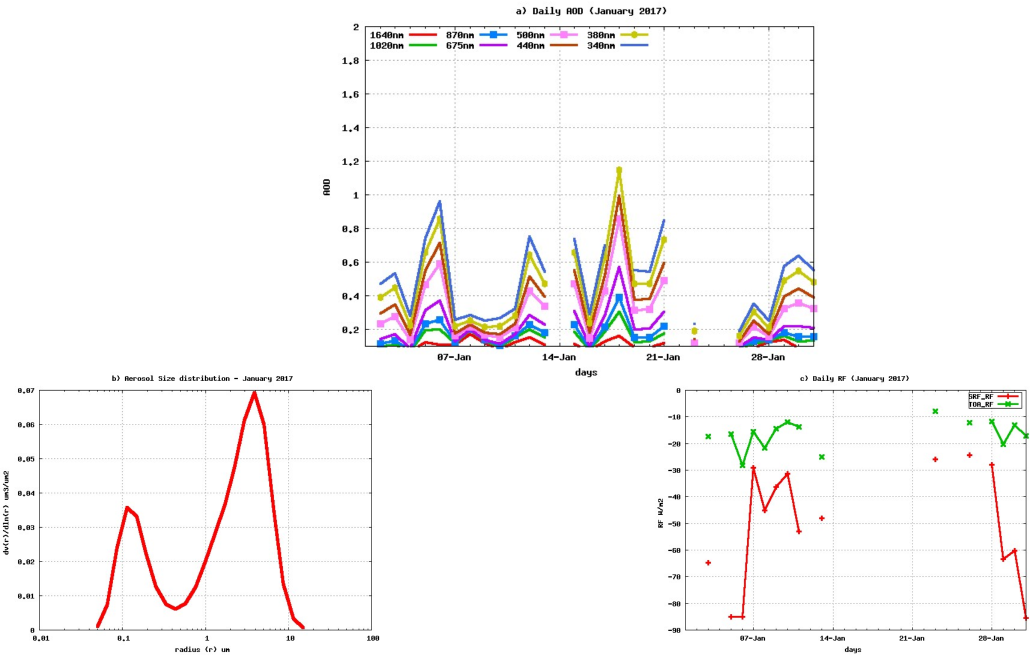

Figure 4: *a)Aerosol optical depth for 8 wavelengths, b)Aerosol size distribution, and c)Radiative Forcing(W/m^2), at SRF(red line) and TOA (green line)*

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0.3 Marsa Matruh Station

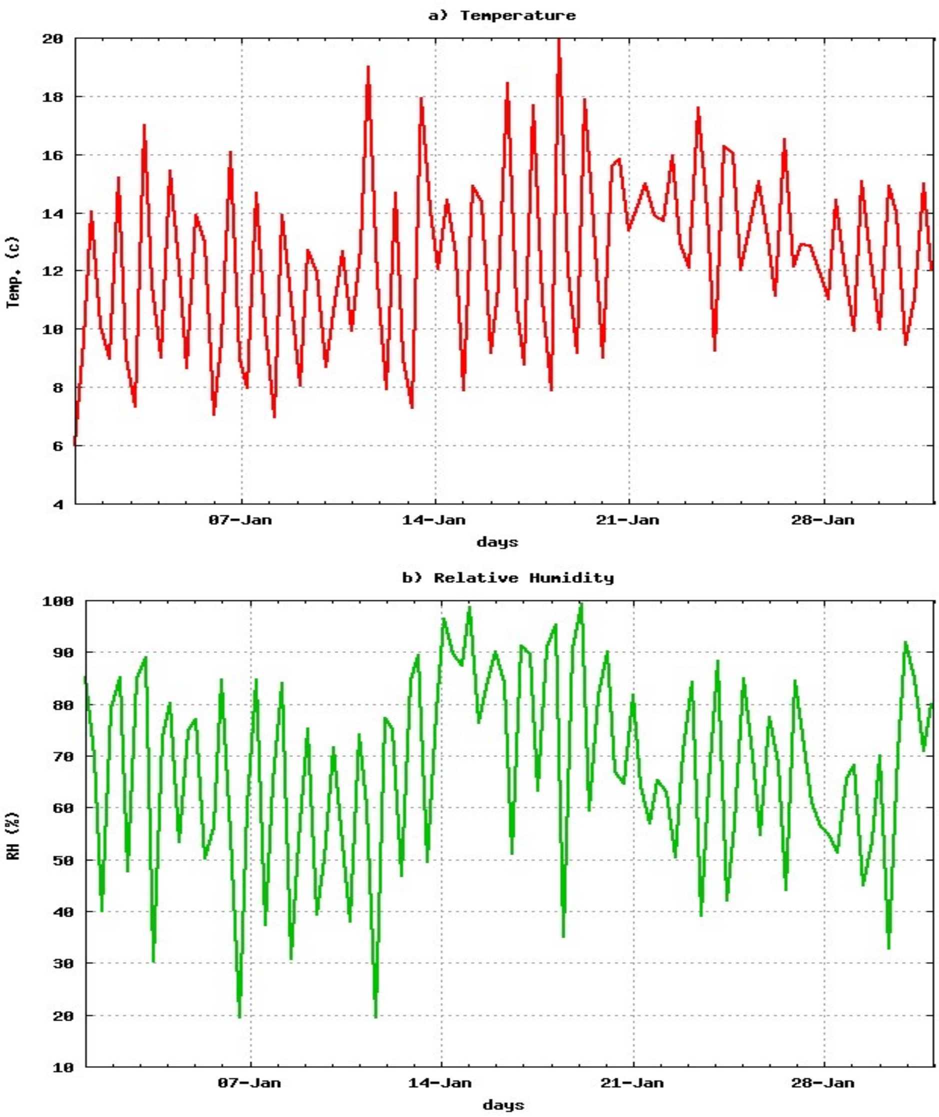
0.3.1 Station Information

The instrument of monitoring is located near the coast of The Mediterranean Sea at the north of Egypt. The station location is : latitude: 31.33° N, longitude: 27.22° E, and elevation: 35 meter amsl.

0.3.2 Analyses of the Measurements

Meteorological parameters

The hourly measurements of temperature and relative humidity are shown in figure 5a, and the figure 5c shows the wind rose during January 2017, with the percentage of each speed (in Knots) in each direction. The total number of records was 719, and the calm wind represented ≈ 2% from the whole records.



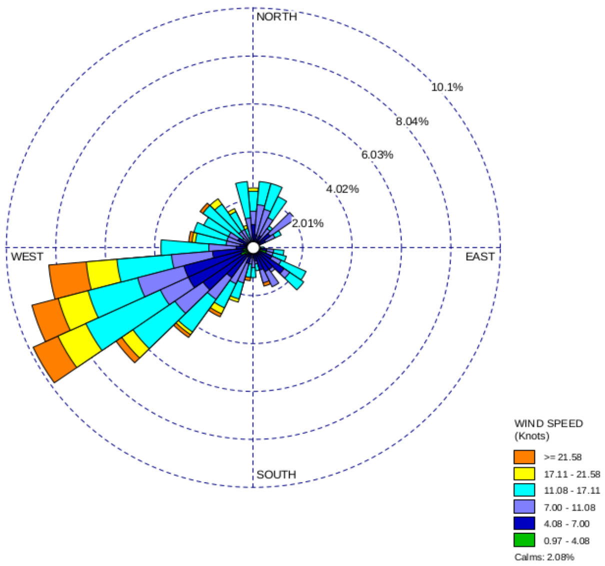


Figure 5: *Hourly measurements of a)temperature (C), b)relative humidity (%), and c) wind rose*

Aerosol Measurements

The PM10 concentrations collected approximately every 2 days during the hours from 11 to 13, measured by PM10 High Volume Air Sampler(HVPM10), over Marsa Matruh station during January 2017 are reported in figures 6.

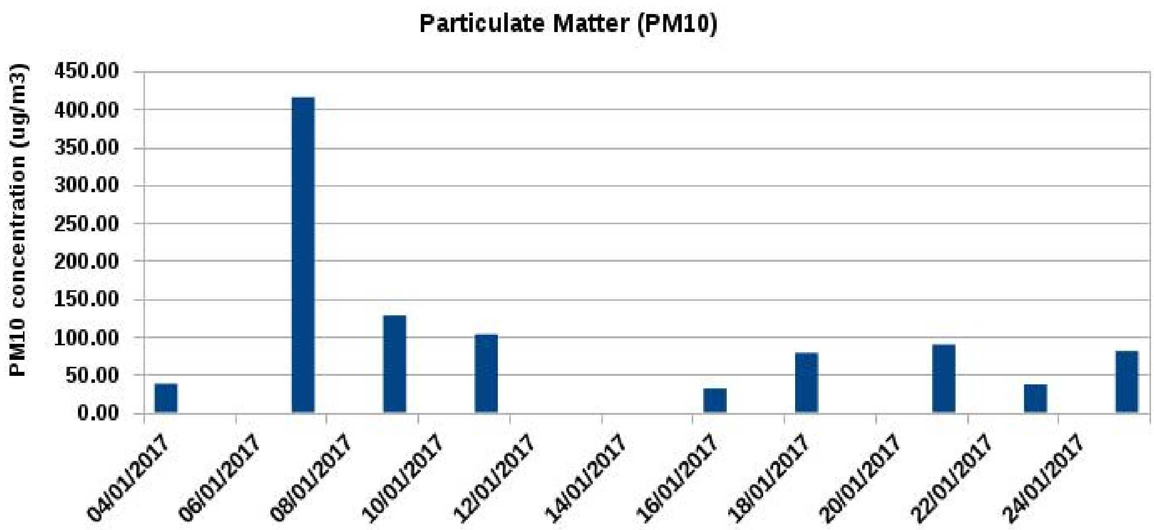


Figure 6: *Concentrations of pm10* (μgm^{-3})

Bibliography

[1] EEA *Air quality in Europe - 2013 report. EEA Report No 9/2013. European Environment Agency.* 2013.

[2] IPCC *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.* 2007.

[3] WHO *Air quality guidelines.Global update 2005. Particulate matter, ozone, nitrogen dioxide and sulfur dioxide. World Health Organization.* 2006.