O 19. THE EFFECT OF PARTICULATE MATTER POLLUTION OF SAHARAN DUST OVER EUROPE IN MAY-2020: A CASE STUDY OF KARAMAN CITY CENTER, TURKEY

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ABSTRACT: Desert dust rising from the African region and covered very long distances with meteorological events can be an important source of pollution for many countries from time to time. Although dust and sand masses that remain in the atmosphere for a long time are known to be inert and stable, but studies show that they affect vegetative production by changes in precipitation and radiation regimes. It is important for natural phenomena and has also revealed their effects in regions over which the atmospheric transport occurs. The Sahara dust storm of mid-May 2020 has strongly, affected many European countries. The Sahara dust and hot air transport is reported over the Mediterranean region to the Balkans and further to Turkey. Depending on the climatic conditions, the Sahara dust may remain in some regions for longer period. Rainy and humid weather conditions slow down the flow of dust and increase the settling rate in that region. In such cases it creates mud-like precipitation accompanying with rain. In this study, Sahara dust pollution effect is investigated for a particulate event pollution with the use of measurements from the network system in all cities in Turkey. For this purpose, the values of PM pollution are analysed before the desert dust reached Turkey, during the event and when it left the country. PM measurement values in Karaman province were examined and it was shown that the Sahara dust increased significantly in the period when it reached this region. Then, PM values were seen to come down to normal levels.

Keywords: *Africa, Dust, Sahara, Karaman, Particulate matter, Air pollution.*

1. INTRODUCTION

Particulate matter (PM) including dust is a combination of solid and liquid particles with different sizes, which result both from natural phenomenon and anthropogenic activities and it is one of the main contributors to the global aerosol load (Kamani et al., 2014; Zender et al.,2004; Textor et al., 2006). Dust storms usually occur depending meteorological synoptic system when strong winds lift large amounts of sand and dust from bare, dry soils into the atmosphere. Dust cover often includes a small solid particle which may remain suspended for some time, with an aerodynamic diameter between 10 and 2.5 μm (PM10, PM2.5). Dust decrease air quality downwind and plays a vital role in climate and biophysical feedbacks in the Earth system like it is essential in atmosphere for cloud formation, raindrops, snowflakes and air temperatures changes through the absorption and scattering of solar and terrestrial radiation (Washington et al., 2009; Middleton and Goudie, 2001; Perez et al., 2012; Balkanski et al., 2007; De Mott et al., 2003; Levin et al., 2005; Koren et al., 2010). Billions of tons of soil erode due to strong wind move thousands kilo meter through the atmosphere each year from not plant areas (Griffin, 2007). The World's most important dust sources are located in the Sahara in north Africa, followed by Arabia and southwest and central Asia and it has been estimated that 55% of the global dust emissions originate from the North African desert (Parsons and Abrahams, 2009; Huneuus et al., 2011).

Dust deposits are a source of micro-nutrients for both continental and maritime ecosystems, but serious risks for human health. Particles also carry large amounts of biogenic factors providing biologic plausibility for triggering health effects (Griffin, 2007). Dust particle size is a key determinant of potential hazard to human health, usually finer particles, smaller than about 10μm, may penetrate the lower respiratory tract and may pass through the lungs and enter the bloodstream, affect other organs, with possible cardiovascular consequence health problems (Brook et al., 2010; Martinelli et al., 2013; Goudie, 2014).

Dust transport from Northern Africa towards higher latitudes, focusing on wind and cyclonic activity inside and around the Mediterranean basin (Alpert et al., 1990; Moulin et al., 1998). The transport of Saharan dust into the Mediterranean countries has a clear seasonality permanently loaded with significant amounts of dust in spring and autumn depending meteorological synoptic system (Escudero et al., 2005; Karanasiou et al., 2012).

An air pollution event of elevated surface concentrations of PM10 occurred in the Karaman city during 10-22 May 2020. The aim of this work is to characterize changes of urban area air quality affected by Saharan dust. Air quality in small cities like Karaman is sensitive to long range transportation of pollution and meteorological conditions. Air pollution time series show changes from day to day not only due to emission of cities. Thus, the analysis of local air pollution data as well as meteorological and topographical conditions is very important. Daily air pollution values are generally below the legislative limits in Karaman. However, from the air pollution data time series one can see that the limit values are exceeded for certain days. In particularly, the 10-22 May 2020 period, when PM10 values increase the allowable values, should be specially evaluated. In terms of health, sustainability and safety, reports on long-term pollution transport and clean air action plans on the air quality of the city require special evaluation of pollutants from outside the city. We expect this study to contribute to the evaluation of episode states in other cities and days as in this example.

2. DATA AND METHOD

Karaman, inhabited from the beginning of BC 8000, is located to the south of the Central Anatolian Region with a major commerce, culture and art center. Karaman province and its vicinity is known as the region charms and fascinates the visitors with the touristic beauties as underground cities, caves, religious centers and also with natural beauties as plateaus and other natural flora and fauna. According to the data of the General Directorate of Meteorology between 1951 and 2019, Karaman has dry periods in July, August and September, less than 10 mm. In the province with an annual total rainfall of 341 mm, the minimum precipitation falls in July with 5.3 mm and in December with a maximum of 47 mm. There is an average of 78 days of precipitation per year. The rainiest days are 10 days in December. The warmest months are July and August with an average maximum temperature of 31°C. The coldest month is January with an average minimum temperature of -3.7°C (Table 1).

Table 1. Karaman climate data, measurement period (1951 - 2019)

Parameters	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Avg. Temperature (°C)	0.5	1.9	6.3	12	16	20	23	23	19	13	6.9	2.5	12
Avg. Max. Temperature (°C)	5.4	7.3	13	18	23	28	31	31	27	21	14	7.5	18.7
Avg. Min. Temperature (°C)	-3.7	-3	0.5	4.9	8.8	12	15	15	10	5.7	1.1	-1.7	5.4
Avg. Sunshine duration (hour)	3.5	4.5	6.3	7.8	9.7	12	13	12	10	7.5	5.4	3.3	94.4
Avg. Rainy Days	10	9.4	9.1	8.1	8.6	5.3	1.5	1.1	1.9	5.9	6.6	10	77.9
Avg. Monthly Precipitation (mm)	42	35	36	37	35	24	5.3	6.7	9	29	34	47	341

In this study, hourly PM_{10} from air quality measurement stations of the Ministry of Environment and Urbanization between 01.01.2018 and 31.05.2020 were used. The period is chosen to assess how important the corona virus outbreak and the Sahara dust are for the local and regional atmospheric dust charges and how we can implement these sources for better understanding the dust emission. Sahara dust pollution effect and its consequences were investigated on particulate matter pollution measured from the network system of Karaman cities in Turkey. For this purpose, analysis of the of PM pollution value has been carried out before reaching the desert dust over Turkey land, when it comes to Turkey and left it. The results revealed that the Sahara dust concentration increased significantly in the period when it reached this region. Then, PM values returned to normal levels.

This study investigates the change in atmospheric particulate matter values of curfews taken due to the corona virus outbreak and Saharan dust period at Karaman city Centre. PM10 pollutant data was used in Karaman city Centre data of the Ministry of Environment and Urbanization. The measures gathered during this event were compared with the values of period from 1 January to 15 march before the covid-19 and after the epidemic period 16 March to 30 April 2020 and May 2020 before and after. In addition, seasonal conditions, 2020 data and normal period 2018 and 2019 data were also compared. Period 1, before the Covid-19 measures (between January 1 and March 15). Period-2, after the Covid-

19 struggle started (between March 16 and April 15). Period 3 is still Covid-19 struggle continue. Period 4, Saharan dust period 10-22 May. Daily air pollutant data of the period of last three years were compared.

3. RESULTS AND DISCUSSION

Data were analysed for 3 different periods in order to examine the effects of Covid-19 measures taken from the frame of the intervention studies on dust PM10 values in Karaman. The first semester is between 1 January and 15 March, which was before covid-19. The second term is between March 16 and April 30, when effective combat with covid-19 was held. Period 3 includes the month of the fight against covid-19. Period 4, on the other hand, is the 10-22 may date when long-distance transport and dust transport from Africa are effective. The daily average PM10 values are below the limit value of 50 µg / m3 in all periods except 10-22 May 2020 , when dust transportation is significant (Table 2). Prior to Covid-19, in 2020 year, PM_{10} values were 12 percent less than in previous years. In the context of the fight against Cocid-19, in the 2nd period when human activities decreased, the value of 2020 decreased significantly by 27% compared to previous years.

Table 2. PM_{10} values in 4 different periods in the last three years and percentages of change in the same period compared to previous years in 2020

Periods	2018	2019	2020	2020/(2018;2019)
Jan 1, 15 March	36	28	28	**-12**
March 16, April 30	37	29	24	**-27**
May	30	32	30	**-2**
12-20 May	23	30	52	97

PM_{10} as the air quality parameter in Karaman city sampling station shows that PM10 values decreased significantly during pandemic outbreak and increased during Sahara dust event. In particularly, the effect of desert dust reflected in increasing PM10 values by 97 percent in Karaman city comparing to the average values of 2018 and 2019 years (Figure 1).

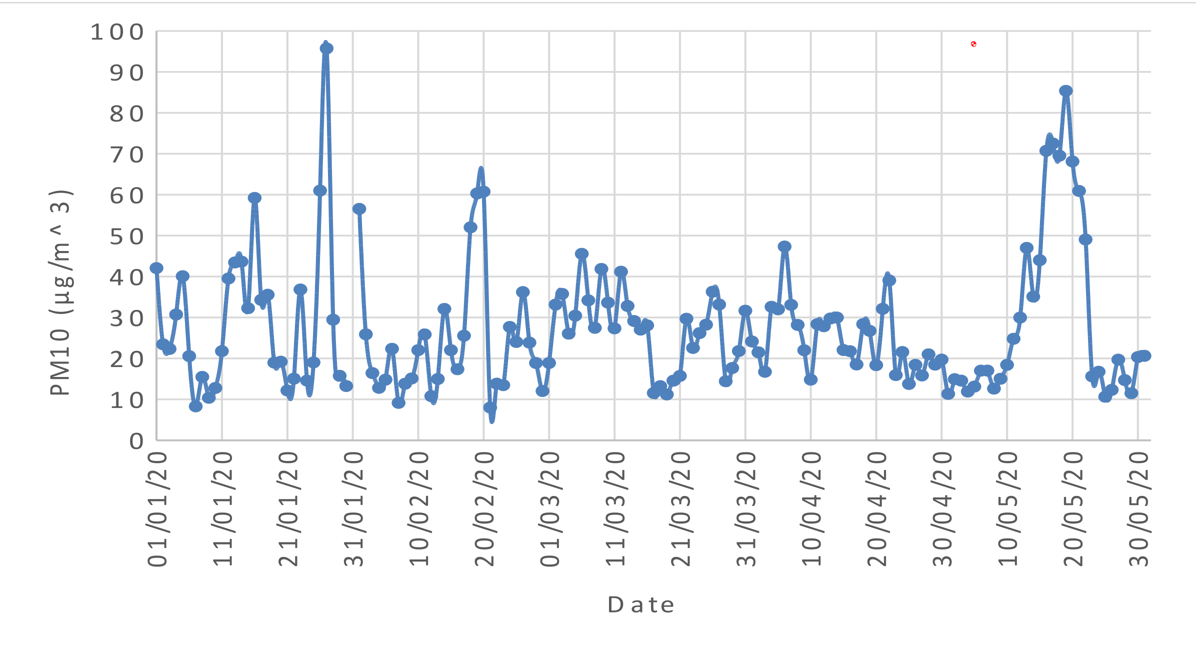

Figure 3. PM10 values time series from January 1 to May 31, 2020

Usually, due to spring hot days dry desert air masses move to northern latitude. This also occurred during, 10-22 May 2020, when the plume of air pollution by dust from the Sahara Desert was transported over the Europe including Turkey and reached Karaman. (Figure 2 and Figure 3)

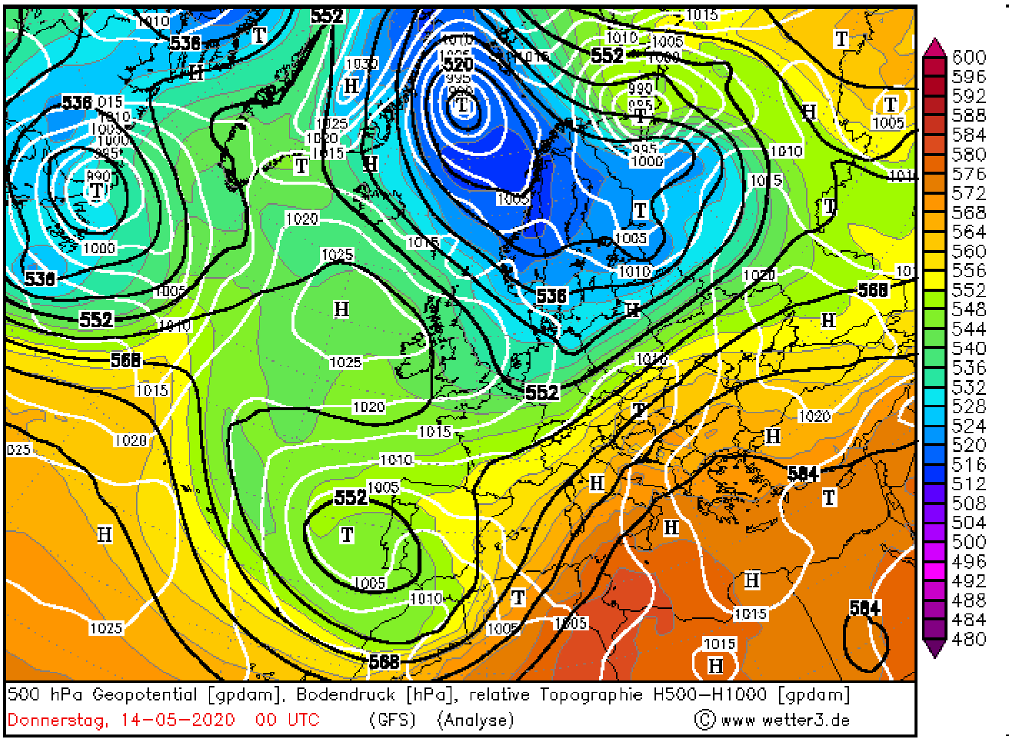

Figure 4. Strong advection of Saharan dust from North Africa into Europe during 14 May 2020

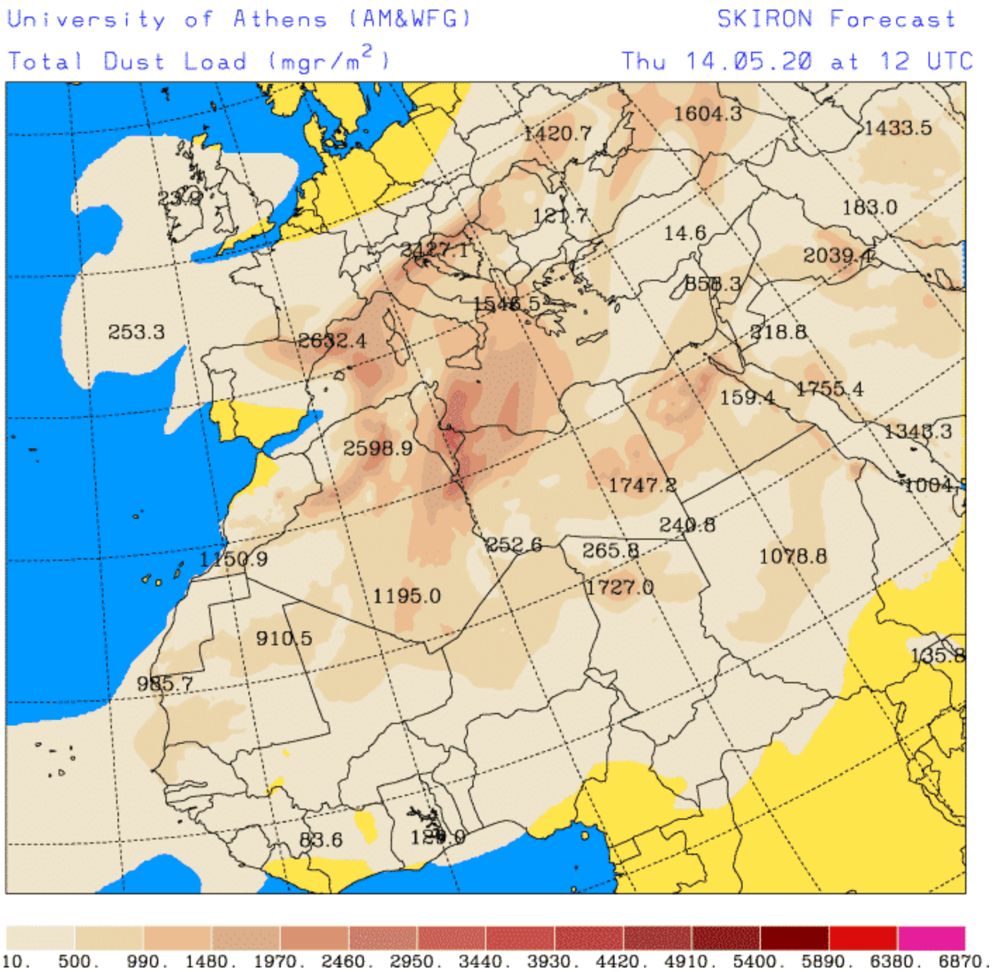

Figure 5. North African dust advection over Turkey

4. CONCLUSION

Industrial restrictions applied during the Covid-19 pandemic quarantine shows great positive influence on air quality. Air quality monitoring studies are of great importance in terms of determining the causes and sources of pollution. The distribution and transport of pollution compounds allow us to better develop appropriate control strategies and evaluate the effectiveness of these strategies. It was revealed that the measurements gathering during the period of virus outbreak, limited traffic and reduction of industrial activities have shown remarkable improvement in air quality. The other important aspect is that air pollution and physical atmosphere affect each other through complex interactions. This means that network measurement systems should satisfy to air quality control, but also to monitor atmospheric processes. In order to improve the sustainable environment and keep air quality control at a required level, the measurement networks should be maintained at a proper state.

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