Analysis of a Saharan dust event in the Campania region by a combination of satellite observation, ground monitored data and CHIMERE modeling simulations

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1. Introduction

The Sahara is the world largest source of aeolian soil dust (Schůtz et al., 1981; D'Almeida, 1987; Swap et al., 1996). The Saharan dust is composed by mineral dust with dimension smaller than 10μm (called PM10). It generally comes from Africa, but exact locations of source areas are not well known. Saharan dust events have been studied all around the world to analyze their effects on climate change, air quality and human health.

2. Objective and methods

The objective of this work is the evaluation of a severe Saharan dust event occurred on April 14th to 17th 2018. The attention is focused on the Campania region (Italy, Fig. 1). The final aim is to evaluate the contribution of such Saharan dust event to the total level and spatial distribution of PM10 concentrations by:

- **Satellite observations** using Aqua-MODIS images
- **Monitoring stations** of ARPAC to analyze in situ data of PM10 mean daily concentrations
- **Modeling simulations** by CHIMERE model to compare predicted with observed data and validate the model

Fig. 1 Campania region (Italy)

3. Sinoptic situation

- On April 13th 2018 Italy and north Africa were interested by an high pressure, with a cold front that leaved Italy
- The high pressure moved eastward leaving a low pressure center in north Africa on April 14th and cloud coverage increased
- The low pressure interested southern Italy on April 15th reaching Sicily, southern Sardinia and Campania, increasing the cloud coverage. The presence of the Jet Stream (150/170km/h) from Africa to Italy is evident on Jet Stream 300hPa map (Fig. 2) and height wind at 6000m reached 35m/s (126km/h) as shown in Fig. 3. Temperature increased till 24°C (Fig.4)
- On April 16th the Campania region was interested by a partial cloud coverage and a maximum wind speed of 24km/h
- on April 17th the low pressure center moved eastward with intense precipitations

(www.ancecampania.it; www.wetterzentrale.de; www.meteociel.fr)

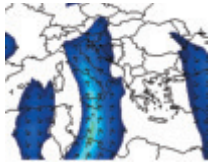

Fig. 2 Jet Stream 300hPa map of April 15th 2018 at 02:00 p.m

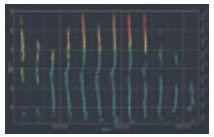

Fig. 3 Height wind map of April 15th 2018 by ARPAC windprofiler

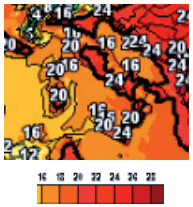

Fig. 4 Temp.2m map of April 15th 2018

4. Results

4.1 Satellite observations

Images by MODIS of the study area have been selected. The arrival of Saharan dust in Sicily (April 13th 2018) is showed in Fig. 5a (red circle). The evolution of the event is showed in Fig. 5b, 5c, 5d.

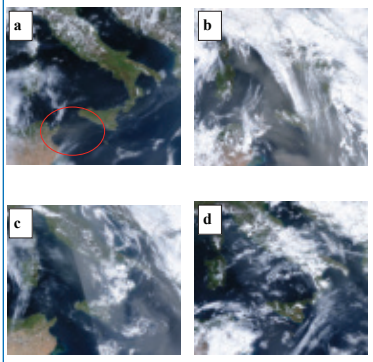

Fig. 5 MODIS dust image with corrected reflectance (true color) by Aqua as base layers. (a) April 13th 2018 at 01:30 p.m., (b) April 15th 2018 at 01:30 p.m., (c) April 16th 2018 at 01:30 p.m., (d) April 17th 2018 at 01:30 p.m.

4.2 Monitored data

.Fig. 6a, 6b and 6c show high PM10 daily mean concentration values in all stations, background stations and urban stations from April 14th to 17th.

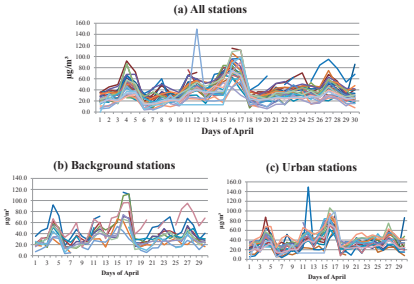

Fig. 6 PM10 daily mean concentrations in (a) all stations, (b) background stations and (c) urban stations

Fig. 7 shows the comparision between PM10 daily mean concentration values and PM2.5 in every district.

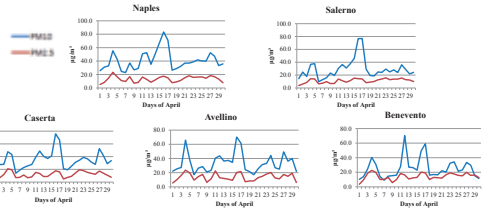

Fig.7 PM10 daily mean concentrations compared with PM2.5 in every district

Finally, the amount of PM10 in respect of PM2.5 was calculated using the formula $[1 - (\overline{PM2.5}/\overline{PM10})]$ as shown in Fig. 8.

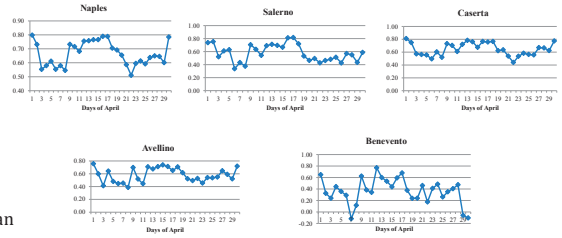

Fig. 8 Amount of PM10 in respect of PM2.5 in every district

4.3 CHIMERE simulations

Some statistical parameters were employed to validate the model (Hanna et al., 1991, 1993): the fractional bias (FB), the geometric mean bias (MG), the normalized mean square error (NMSE), the geometric variance (VG), the correlation coefficient (R) and the fraction of predictions within a factor of two of observations (FAC2). The following results have been obtained: $FB = -0.44$; $MG = 0.69$; $NMSE = 0.44$; $VG = 1.53$; $R = 0.56$; $FAC2 = 0.68$

A perfect model would have MG, VG, R, and FAC2=1.0 and FB and NMSE=0.0, but the previous results show acceptable values of most of the parameters.

Fig. 9 shows four CHIMERE daily maps of PM10 daily mean concentration from April 14th to 17th 2018 in the Campania region.

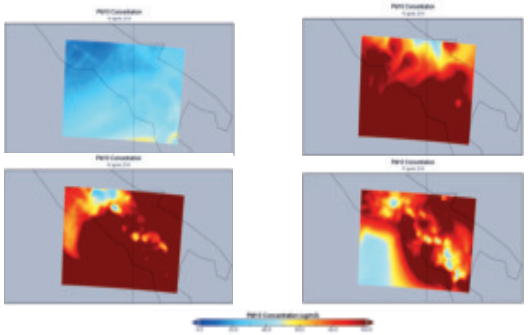

Fig. 9 CHIMERE maps of PM10 daily mean concentrations of April (a) 14th, (b) 15th, (c) 16th and (d) 17th 2018 of the Campania region

5. Conclusions

Main conclusions achieved from this study are:

- on April 13th to 17th 2018 Saharan dust event occurred in the Campania region (southern Italy) as shown by Aqua-MODIS images;
- PM10 daily mean concentration values, which were measured by monitoring stations located in the region, started to greatly increase on April 15th 2018 with 71.3μg/m^3 reaching the greater value of 114.9μg/m^3 on April 16th and decreasing on April 17th;
- CHIMERE model simulations showed the spatial distribution of the Saharan dust that interested all the Campania region with very high PM10 daily mean concentration values. Such simulations were validated using statistical parameters which showed an acceptable quality, even though with a slight overestimation.

Thanks to the combination of different approaches it was possible to evaluate both qualitatively (through the spatial distribution) and quantitatively (through the absolute values) the Saharan dust event and its main aspects which characterized the Campania.

References

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