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Intrusion of Northern African desert dust in Romania. Detection and data analysis

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Abstract

This paper presents several pollution episodes with desert dust, over Timisoara city, originated from Africa during 2011 and 2012. Desert dust intrusions were observed over Romania by using ground-based measurements and air mass trajectory calculations. The study is relying on detailed physical, chemical and optical aerosol properties, data collected from the sun photometer located in Timisoara, Romania. These instruments have the advantage that they are able to monitored continuous aerosol optical depth (AOD), with high accuracy, fact that is essential for the measuring procedure. The type of aerosol particles was determined by means of AOD, Ångström parameter (α), single scattering albedo (SSA), volume size distribution and real part of refractive index. Dust desert dispersion was investigated by using HYSPLIT model.

Keywords: Desert dust; aerosol optical depth; Ångström parameter; size distribution.

1. Introduction

Desert dust aerosols are tiny soil particles suspended in the atmosphere which are carried by air masses. Desert dust aerosol have a significant impact on local and global climate, regional air quality, visibility, cloud processes, human health (Mahowalda et al., 2013). Also, desert or mineral dusts have a key role in the atmospheric radiation budget thought scattering of the solar radiation (Alizadeh Choobari et al., 2014) (Calinoiu et al., 2013).

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Consequently it is absolutely necessary to monitor aerosols, by diverse possibilities and techniques, and at different levels, not only at soil. The mentioned global effects strongly depend on the physical and optical properties of aerosol particles. Several studies about accuracy of aerosol optical properties from sun and sky radiance measurements were conducted by Dubovik and colleagues (Dubovik et al., 2000a; 2000b; 2002; 2006).

The aim of this paper is to investigate the optical and physical properties of the dust aerosol based on the AERONET sun photometer data/observations in the Timisoara city from Romania. The city is located in the Western part of Romania and it is situated on the southeastern edge of the Pannonia plain, Timisoara (45°46' N, 21°26' E) lies at an altitude of 85 m. Timisoara is characterized by a warm temperate climate, fully humid (Köppen climate classification *Dfb* - based on the digital Köppen-Geiger world map on climate classification) with warm summer, typical for the Pannonia Basin (Kottek et al., 2006). The dominating temperate air masses during spring and summer are of oceanic origin and come with precipitations.

A sun photometer is an optical instrument for the measurement of the spectral solar radiation. The range of wavelength for instrument is between 0.34 – 1.65 μm. The sun photometer accomplishes two basic measurements, either direct sun (nine spectral bands: 340, 380, 440, 500, 670, 870, 940, 1020 and 1640 nm) or sky (440, 670, 870 and 1020 nm) both within several programmed sequences.

2. Results and discussion – dust event

The type of aerosol particles was determined by means of aerosol optical depth, Angstrom coefficient, single scattering albedo volume size distribution and real part of refractive index. We specified the dust event by considerable daily increase in AOD and decrease in Angstrom coefficient.

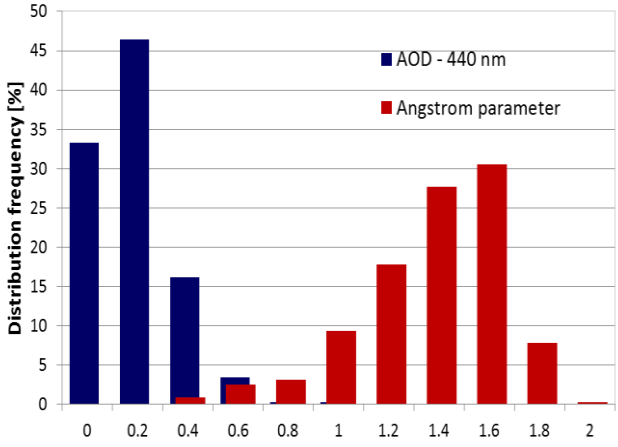

Fig. 1. Frequency distribution of daily AOD and Ångström parameter for 2011 and 2012 in Timisoara.

Fig. 1 illustrates the frequency distribution of AOD at 440 nm and α between 440 and 870 nm during the period of observation. Frequency of AOD shows an obvious peak, with values between 0.2 and 0.4, accounting 45 % of total distribution. For Ångström parameter, the frequency histogram shows two peaks, with values between 1.2 - 1.4 and 1.4 - 1.6

representing around 30 %. For desert dust we take into account only the values of the Ångström parameter which are below 0.4 and the values of AOD that are greater than 0.4.

Dust event was analyzed for 5th September 2011, when the average AOD was 0.45 at wavelength 440 nm (Fig. 2) and α is low (α < 0.75). The single scattering albedo value increase with wavelength (SSA_{440} = 0.91 to SSA_{1020} = 0.96) and the imaginary part of the refractive index was found in the range 0.003±0.001, meaning that the coarse mode is predominant.

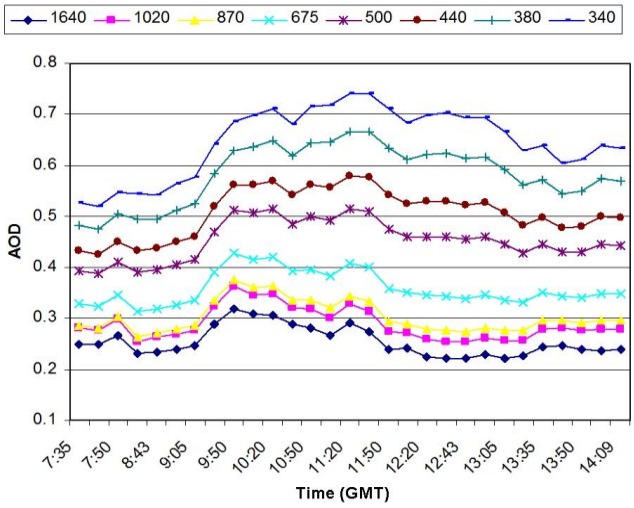

Fig. 2. Aerosol optical depth for 05.09.2011 in Timisoara.

From size distribution (Fig. 3) it can be observed that on 5th September 2011 coarse particle mode is prevailing.

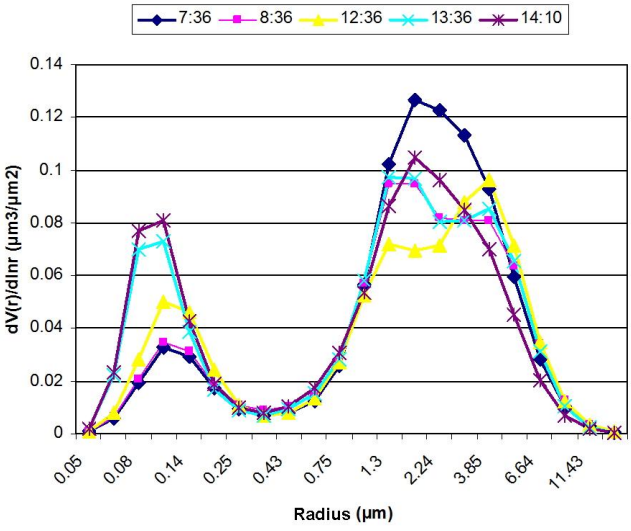

Fig. 3. Variation of size distribution for 5th September 2011 in Timisoara.

The back trajectories for this episode have been extracted from the HYSPLIT model (Hybrid Single-Particle Lagrangian Integrated Trajectory) (Draxler et al., 2013). The model has been run for trajectories between 2500 and 3500 m above ground level (AGL) in Timisoara at 10 UTC. Air masses trajectories were found to be oriented from northern Africa towards the South of Europe (Fig.4).

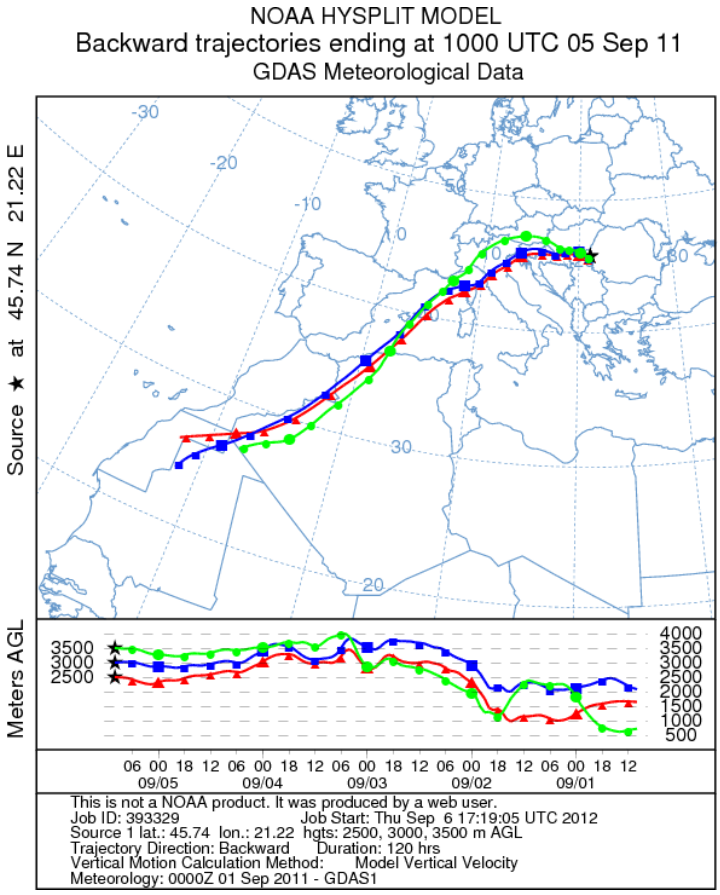

Fig. 4. HYSPLIT model for 5 September 2011 in Timisoara.

Two pollution episodes in Timisoara during 2011 and three during 2012 were analyzed. April 26 and September 5, 2011 produced high values of AOD_{440} (0.58 on April 26 and 0.55 on September 5). They were considered to be desert dust due to the low values of the Ångström parameter (α= 0.43 respectively 0.75), to the predominance of the coarse mode and to the single scattering albedo increasing with wavelength (SSA_{440} = 0.92 to SSA_{1020} = 0.96 respectively SSA_{440} = 0.91 to SSA_{1020} = 0.97). The imaginary part of the refractive index was found in the range 0.003 ± 0.001. Similar optical properties of aerosols in June 3 and 10, and November 19 in 2012 indicate their desert origin as well. In order to explain the data, backward trajectories were analyzed using HYSPLIT model. Air masses trajectories were found to be oriented from Northern Africa towards the South of Europe.

3. Conclusions

The aerosol properties including aerosol optical depth, Ångström coefficient, single scattering albedo, volume size distribution and real part of refractive index were analyzed for Timisoara station by using the sun photometer measurements during 2011 and 2012. In this period several pollution episodes occurred, five of them being analyzed in this work. The results of HYSPLIT model show that dust particles have been transferred over Timisoara, from North Africa.

4. Acknowledgements

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References

Alizadeh Choobari O., Zawar-Reza P., Sturman A. (2014). The global distribution of mineral dust and its impacts on the climate system: A review. Atmospheric Research, 138, 152 -165.

Calinoiu D., Paulescu M., Ionel I., Stefu N., Pop N., Boata R., Pacurar A., Gravila P., Paulescu E., Trif-Tordai G. (2013). Influence of aerosols pollution on the amount of collectable solar energy. Energy Conversion and Management 70, 76–82.

Draxler R.R., Rolph G.D. (2013). HYSPLIT (HYbrid Single-Particle Lagrangian Integrated Trajectory) Model access via NOAA ARL READY Website: www.arl.noaa.gov/HYSPLIT.php.

Dubovik O., Smirnov A., Holben B., King M.D., Kaufman Y.J., Eck T.F., Slutsker I. (2000a). Accuracy assessments of aerosol optical properties retrieved from AERONET sun and sky-radiometric measurements. Journal of Geophysical Research, 105, 9791 – 9806.

Dubovik O., King M.D. (2000b). A flexible inversion algorithm for retrieval of aerosol optical properties from Sun and sky radiance measurements. Journal of Geophysical Research, 105, 673 – 696.

Dubovik O., Holben B., Thomas F., Smirnov A., Kaufman Y.J., King M.D., Tanre D., Slutsker I. (2002). Variability of absorption and optical properties of key aerosol types observed in worldwide locations. Journal of the Atmospheric Sciences, 59, 590 – 608.

Dubovik O., Sinyuk A., Lapyonok T., Holben B.N., Mishchenko M, Yang P., Eck T.F., Volten H., Munoz O., Veihelmann B., W.J. van der Zande, Leon J.F., Sorokin M., Slutsker I. (2006). Application of spheroid models to account for aerosol particle nonsphericity in remote sensing of desert dust. Journal of Geophysical Research, 111, p. 34.

Kottek M., Grieser J., Beck C., Rudolf B., Rubel F. (2006). World Map of the Köppen-Geiger climate classification updated. Meteorologische Zeitschrift 15, 259–263.

Mahowalda N., Albania S., Koka J.F., Engelstaederc S., Scanzaa R., Warda S., Flanner G.M. (2013). The size distribution of desert dust aerosols and its impact on the Earth system, Aeolian Research, In Press, Elsevier.