Changes of aerosol radiative effect on clear sky solar radiation over Europe

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INTRODUCTION

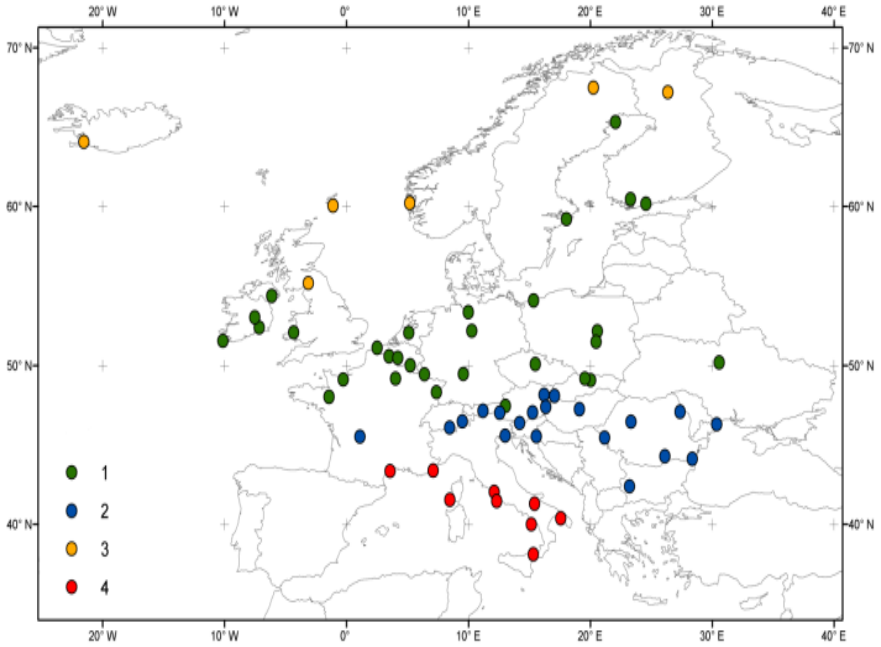
Aerosols modify the radiation flux of Earth`s atmosphere through direct, indirect and semi-direct effects.
All long-term changes in aerosol content in the atmosphere will trigger changes in solar radiation flux

Objectives of the study

1. Qquantification the radiative effect of aerosols on clear sky radiation
2. Determination of the **trends in aerosol radiative effect** controlled by the aerosol content changes

Data

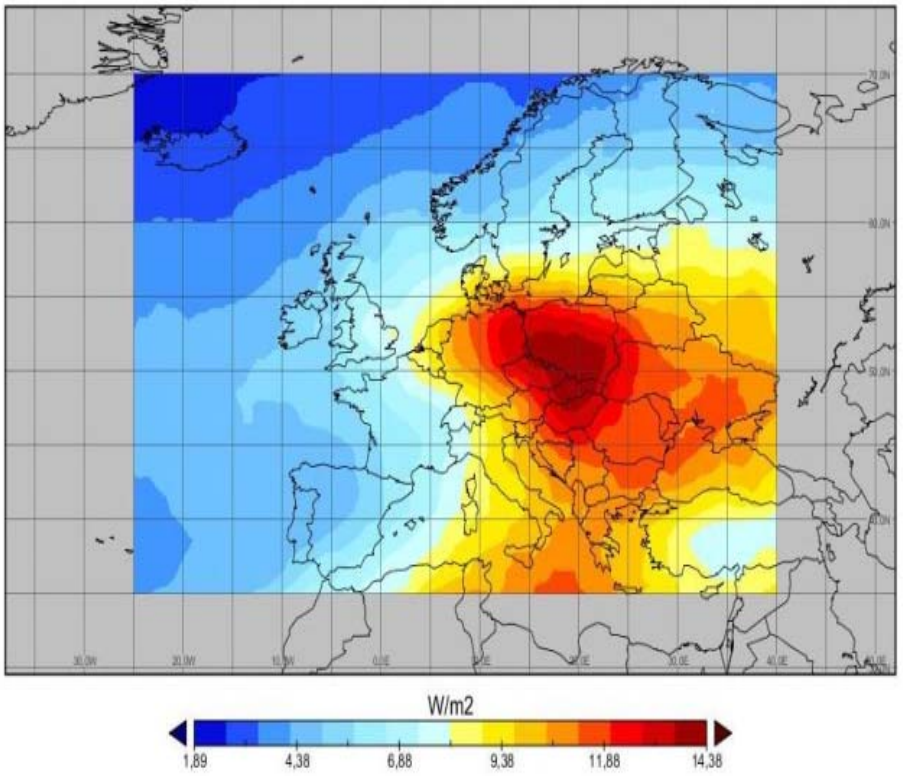
1. aerosols measurements coming from the NASA EOS-AURA OMI (Ozone Monitoring Instrument) project and include aerosol optical thickness data at 500 nm (AOT_{500}), spatial resolution of 1x1 degrees, for the period of 1980-2001 (except 1993-1996)
2. surface solar radiation data from the World Radiation Data Centre (WRDC), 66 stations in Europe, for the period of 1975-2006
3. ERA-INTERIM water vapour monthly means for the period of 1983-2005

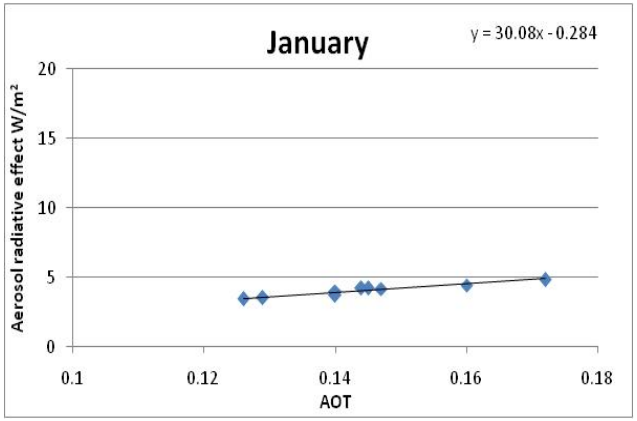


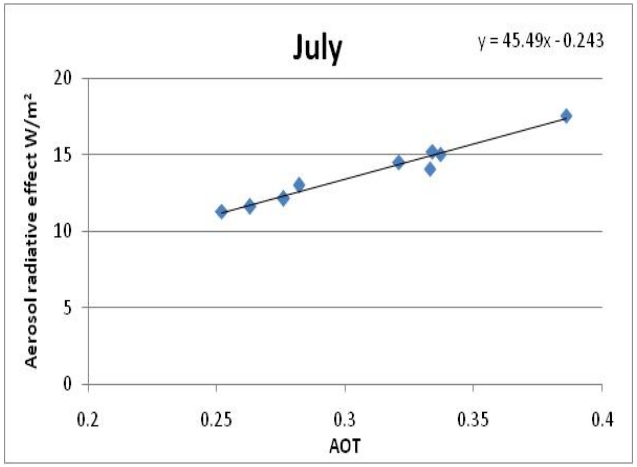
Aerosol radiative effect on clear sky solar radiaton

Direct approach

-the values of aerosol radiation effect are determined by the MAGIC radiation code (libRadtran radiative transfer model)



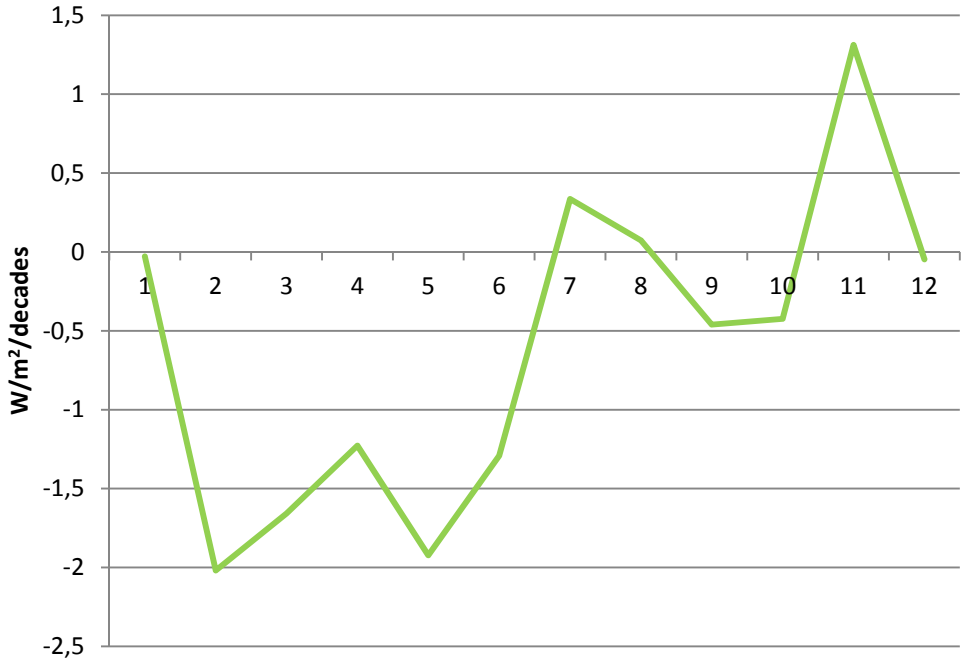




Trend analyze of aerosol radiative effect

Based on the linear function a radiative effect values can be assigned to each monthly AOT_{500} values available from the OMI satellite measurements.

The multiannual change of aerosol radiative effect over Europe is -0.61 W/m^2/decades

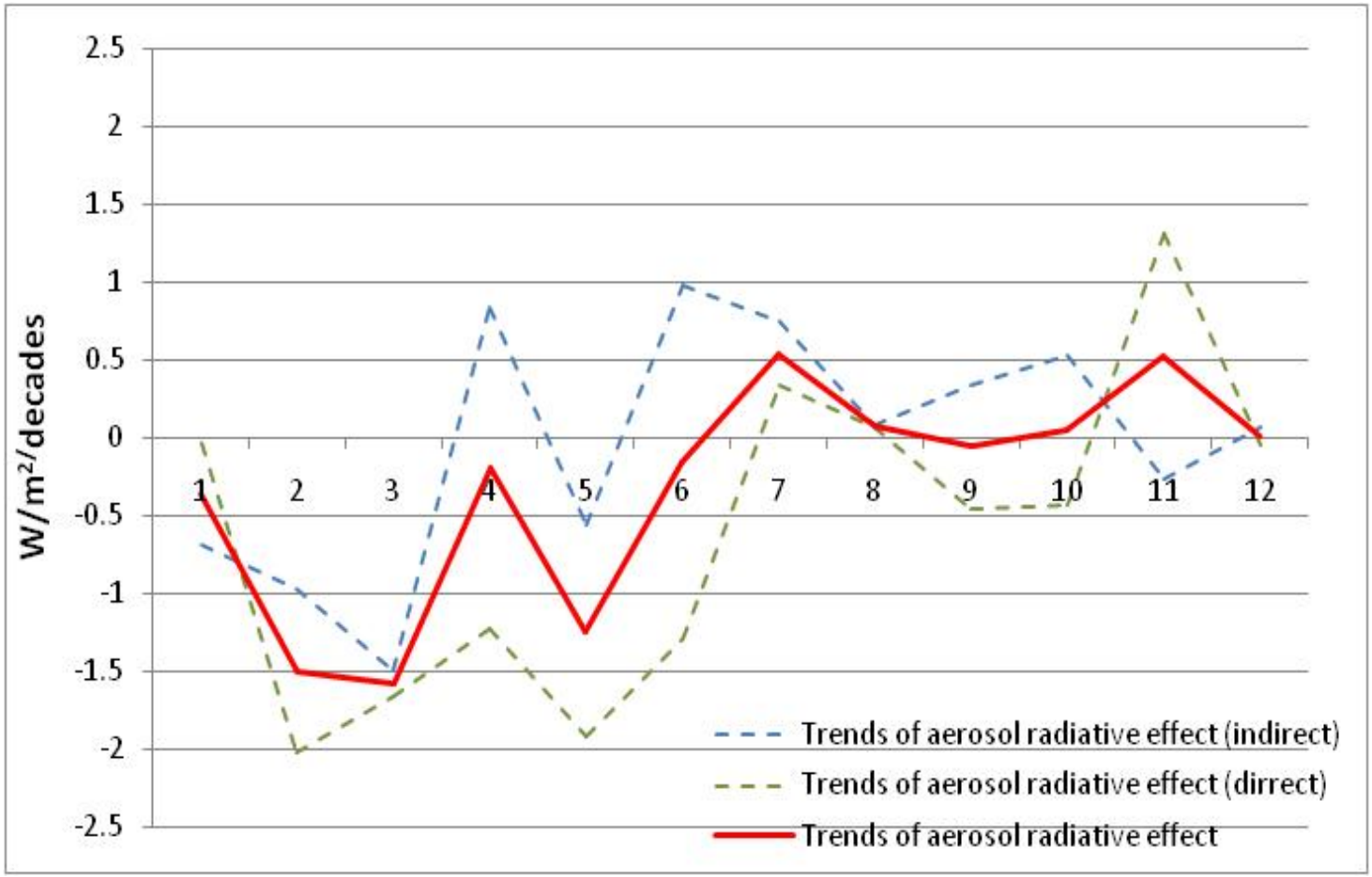


Aerosol radiative effect on clear sky solar radiation

Indirect approach

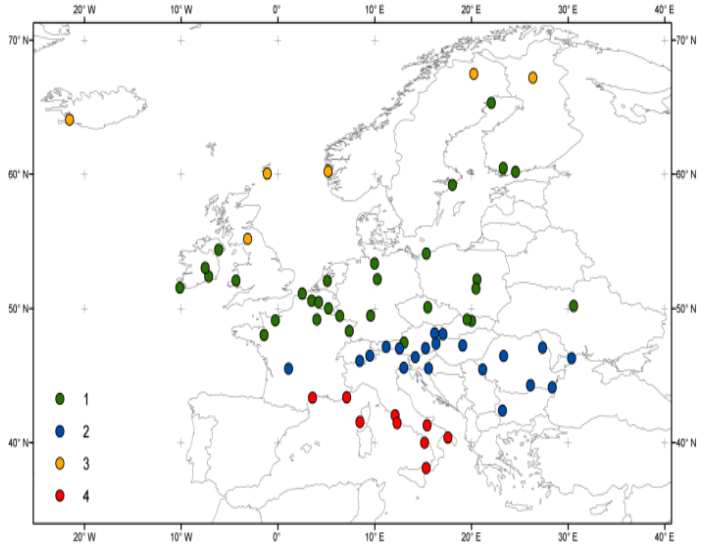
- separation of cloudy and cloud-free situations from the surface solar radiation: all empirical values greater than 90% of the modelled (MAGIC code) **clear sky value** are denoted as radiation in cloud free situation

	Jan.	Febr.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Year
Trends of clear sky solar radiation (WRDC) W/m^2/decades	0,73	0,97	1,67	-0,88	0,71	-1,11	-0,79	-0,30	-0,39	-0,57	0,12	-0,01	0,01
Trends in water vapor radiative effect on clear sky radiation W/m^2/decades	-0,04	0,01	-0,17	0,03	-0,16	0,13	0,04	0,21	0,04	0,05	0,14	-0,06	0,02
Trends in aerosol radiative effect on clear sky radiation W/m^2/decades	-0,69	-0,97	-1,50	0,85	-0,55	0,98	0,75	0,09	0,35	0,53	-0,27	0,07	-0,03



- annual trend of aerosol radiative effect on clear sky radiation over Europe is -0.32 W/m^2/decades

Regional patterns of changes in aerosol radiative effect



Regions	Jan-Febr	March-Apr	May-Jun	Jul-Aug	Sept-Okt	Nov-Dec	Year
Central and North-East Europe (1)	-0,99	-1,78	-0,10	0,38	-0,58	-0,42	-0,58
South-East Europe (2)	-0,55	-0,28	-0,89	-0,54	-0,07	-0,10	-0,41
Northern Europe (3)	-1,55	0,32	1,29	1,73	1,24	0,15	0,53
Southern Europe (Mediterranean) (4)	0,31	1,80	1,63	1,18	1,57	0,43	1,15

Changes in solar radiation in different radiative regions of Europe based on WRDC ground-base surface solar radiation data (1975-2006), the significance level of trends p=0,05

Regions	Stations (number)	The magnitude of the significant linear trend (W/m^2/decade)	Relative trend (%)
Central and North-East Europe	**30**	**1,98 (±0,27)**	**1,64**
South-East Europe	**21**	**4,35 (±0,31)**	**3,00**
Northern Europe	**6**	**-2,37(±0,22)**	**-2,73**
Southern Europe (Mediterranean)	**9**	**-3,61 (±0,37)**	**-2,05**

Results and discussion

- trends in aerosol radiative effect over Europe is quantified using direct and indirect approaches and the results are found to be similar;

- radiative effect of water vapour on clear sky solar radiation exhibits +0.02 W/m^2/decades being smaller by an order of magnitude from the changes detected in aerosol radiative effect (-0.32 W/m^2/decades);

-the monthly trends in radiative effects induced by aerosols in the case of clear sky radiation are varying between +0.5 and -1.5 W/m^2/decades over Europe; in average -0.32 W/m^2/decades;

Results and discussion

- aerosol radiative effect trends are negative in Central, North-Eastern and South-Eastern Europe and showing an increase in the southern and northern part of the continent;

- in Southern Europe the aerosol radiative effect trends (1.15 W/m^2/decades) have the same order of magnitude than the trends of surface solar radiation (-2.05 W/m^2/decades). In the same time the decrease in cloudiness is also detected in this region, thus the variation of solar radiation is caused mainly by the changes of aerosol content;

- in the northern part of the continent the decrease in solar radiation is explained mainly by the changes of cloudiness with opposite sign.

Thank you for your attention!