Satellite estimate of UV clear-sky erythemal irradiance: Comparison of ground-based and satellite retrieved UV data in Poland

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EGU General Assembly 2019
Vienna | Austria | 7–12 April 2019

EGU POSTER
No. X1.34

Photography encouraged

Clear-sky estimate of erythemal irradiance is frequently used to inform public of risk of UV overexposure. World Health Organization (WHO) issued a guideline to avoid excessive UV radiation in dependence of UV index. i.e., erythemally weighted irradiance in mW/m^2 divided by 25. Moreover the erythemal doses gained during sun-bathing are under interested . To avoid skin redness (erythema), the received dose should be below the thresh-old, the so-called minimum erythema dose (MED). It depends on the personal phototype and for Caucasian skin it is about 250 J/m2. MED is larger for darker skin, e.g. MED~ 1000 J/m2 for black skin.

WHO recommendation of the human behaviour during outdoor activities at sunny places according to UV index value measured at the sunbathing site.

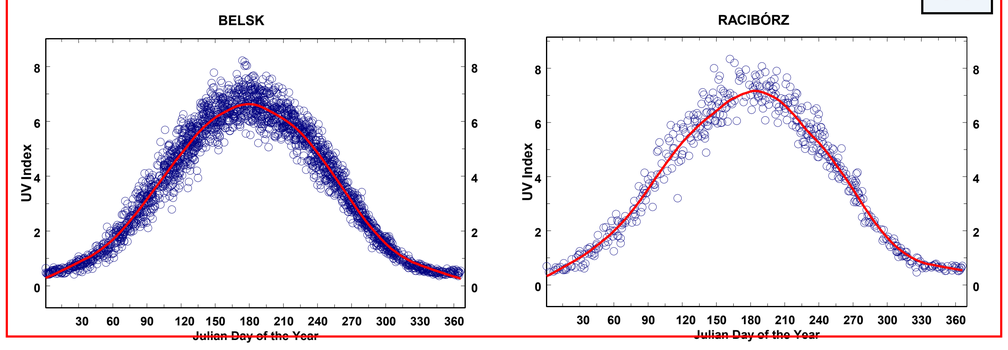
https://www.who.int/uv/intersunprogramme/activities/uv_index/en/index1.html

The objective of the study is to compare UV index and daily erythemal doses for two sites in Poland : Belsk (20.8E, 51.8N; rural station) and Racibórz (18.2E, 50.1N, industrial station) . The radiative transfer model (TUV) is used to calculate daily courses of UV irradiance under clear-sky conditions for various sets of the in-put data. The model input consists of: total ozone by ground-based spectrometer (for Belsk only) and by satellite spectrophotometer (OMI) for both sites, aerosol optical thickness (AOT) at 340 nm by the CIMEL sun-photometers (Belsk, Racibórz) and at 342 nm by the satellite retrieval (OMI data). The third alternative for AOT at 340 nm is provided by the MERRA-2 reanalysis. Comparisons of observed/modeled UVI index and daily doses for various combinations of the aerosols input parameters are examined.

Aerosols and UV observing sites

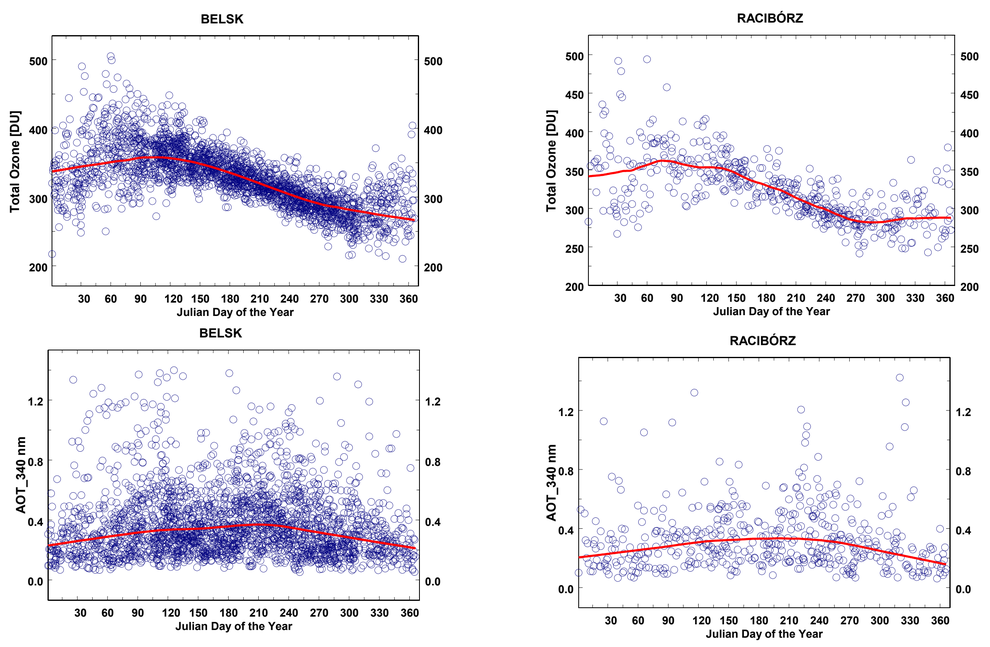
A

UV Index reconstructed for clear-sky conditions at Belsk (2002-2018) and Racibórz (2015-2018) based on measured AOT (CIMEL) and total ozone (Belsk– the Dobson spectrophotometer; Racibórz—Satellite OMI aerosols)



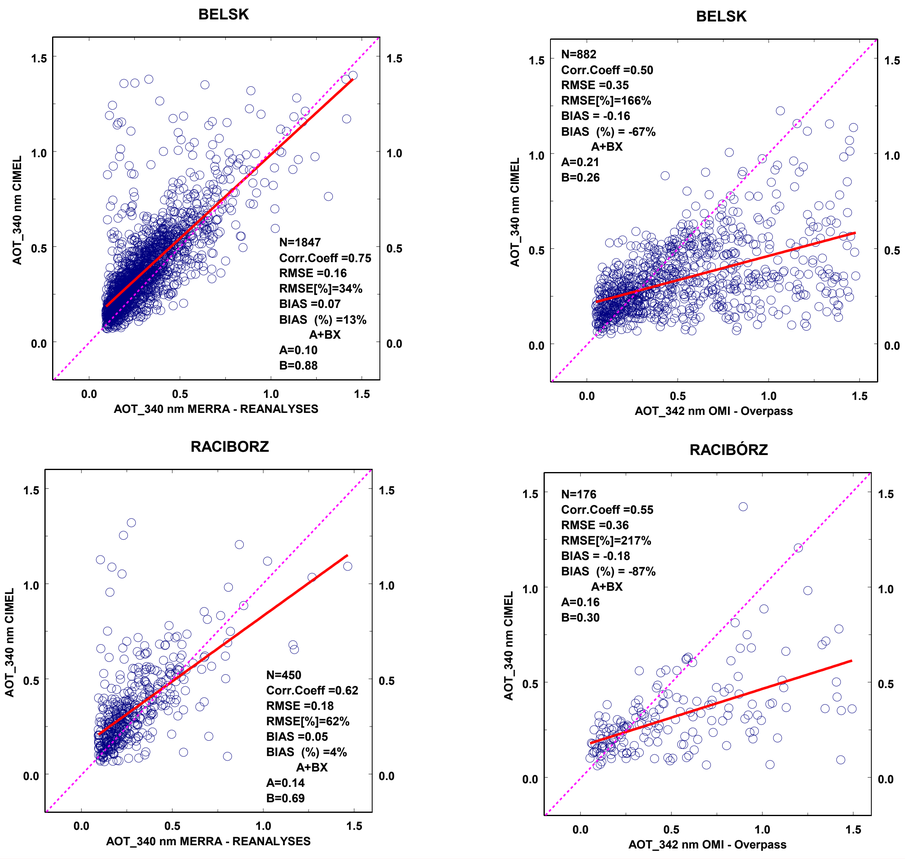
B

Input for the reference UV model : aerosols (CIMEL –AERONET data) total ozone (Belsk—Dobson , Racibórz— OMI)



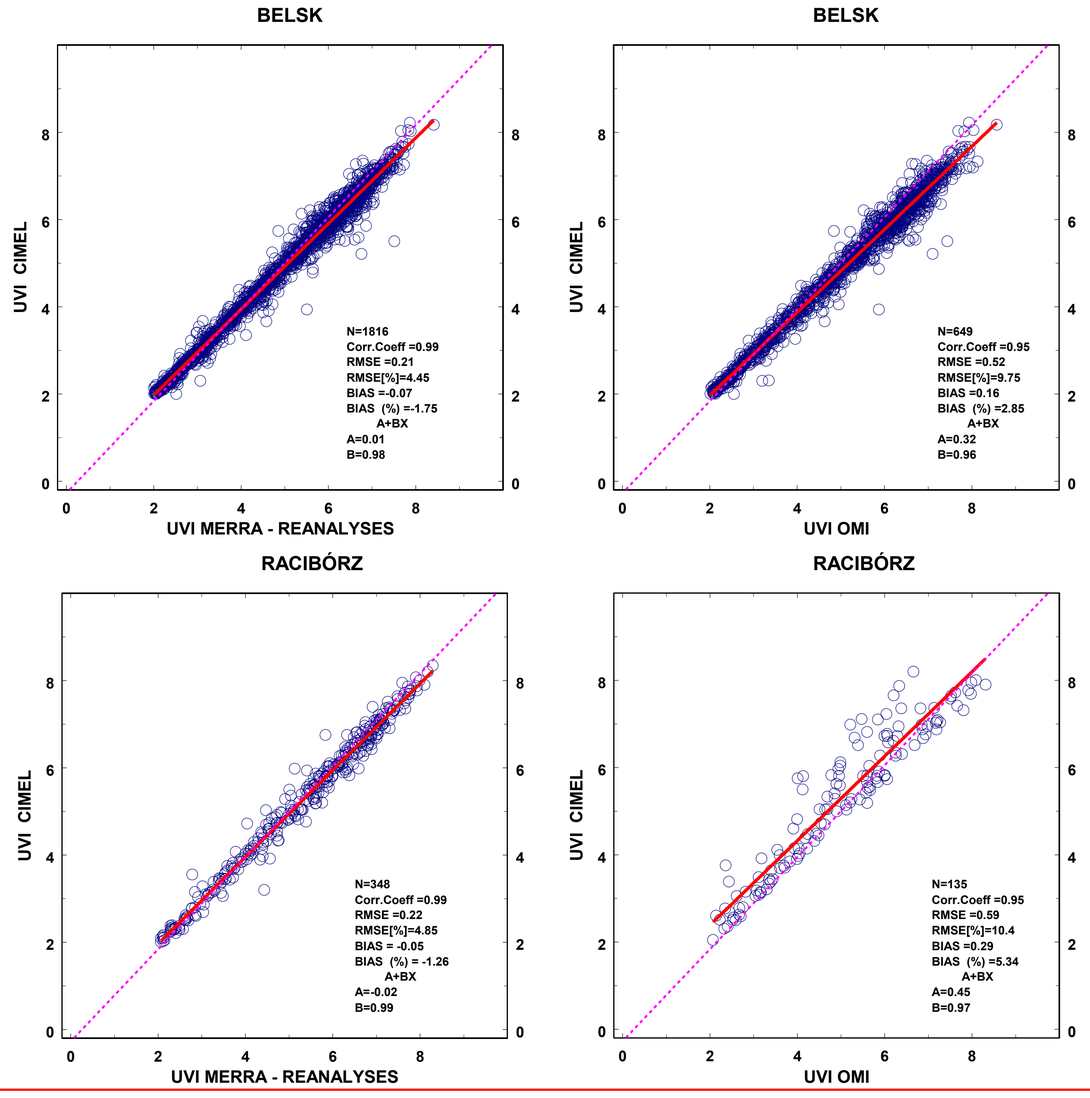
C

Comparison of aerosol optical thickens (AOT) by ground-base CIMEL sunphotometer, OMI (onboard Aura satellite), and MERRA-2 reanalyses (AOT at 550nm converted to AOT at 340 nm with Angstrom coefficient 1.3)



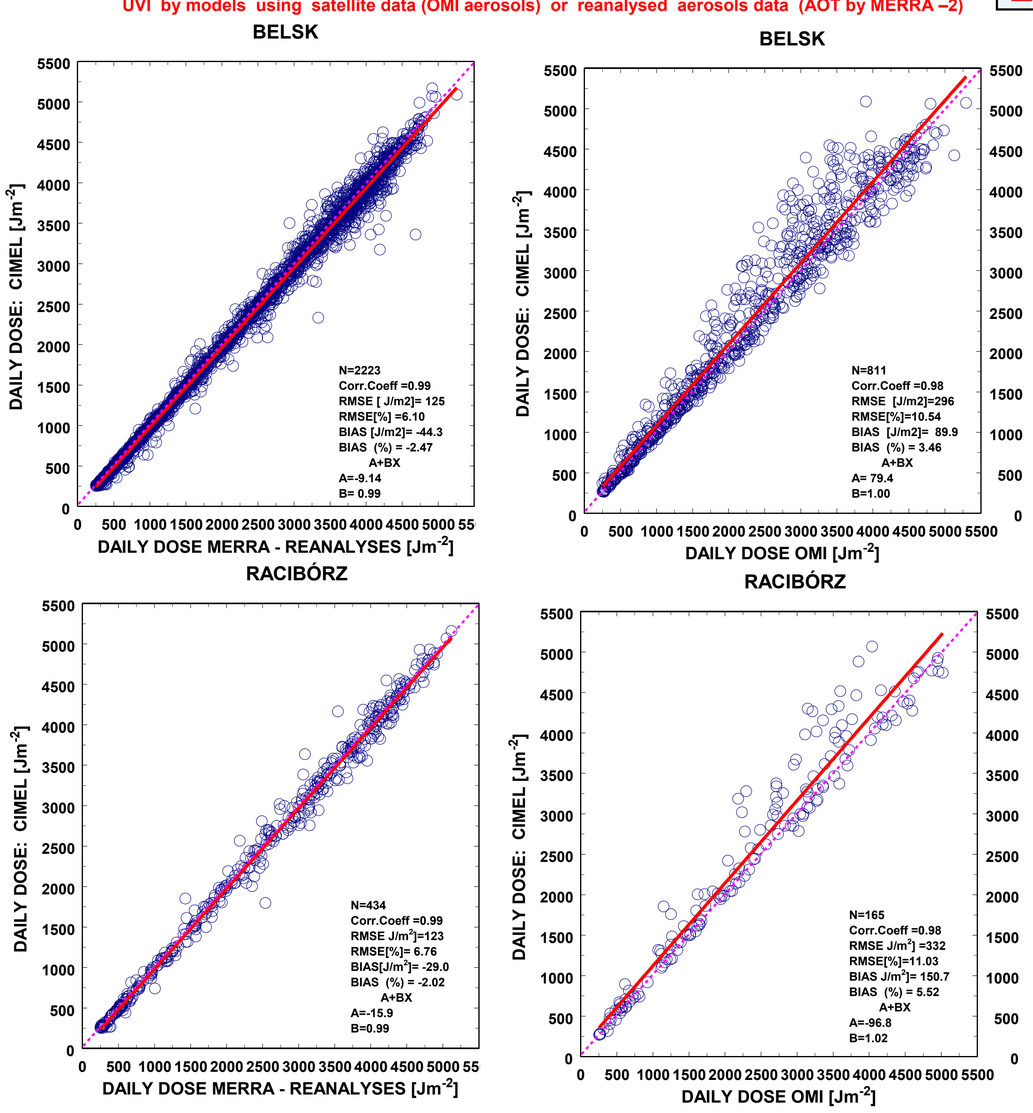
D

Clear-sky UVI by the reference UV model (AOT from ground-based measurements) versus UVI by models using satellite data (OMI aerosols) or reanalysed aerosols data (AOT by MERRA –2)

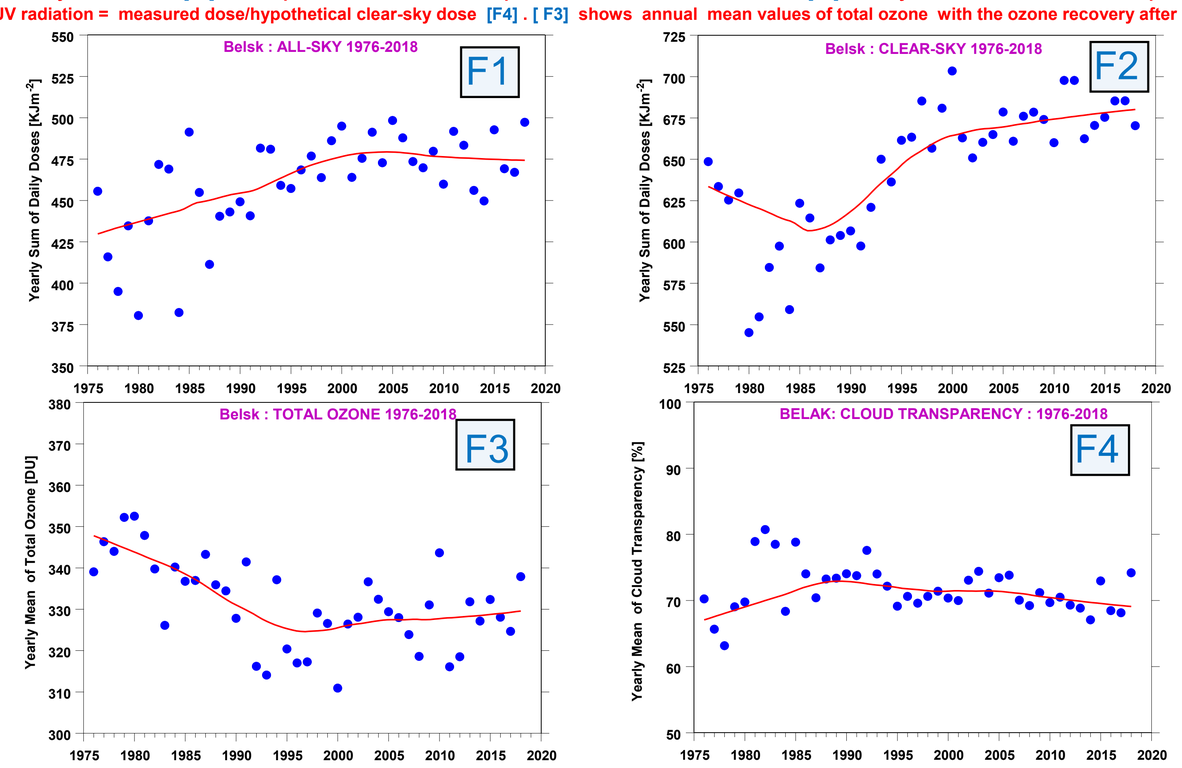


E

Clear-sky daily dose by the reference UV model (AOT from ground-based measurements) versus UVI by models using satellite data (OMI aerosols) or reanalysed aerosols data (AOT by MERRA –2)



Our analysis shows that the Merra-2 aerosols provides good estimate of the Belsk's aerosols, so we could reconstruct annual erythemal doses of clear-sky UV radiation [F2] for the period 1976-2018 and compare them with the measured doses [F1] . Finally we calculate the cloud transparency of UV radiation = measured dose/hypothetical clear-sky dose [F4] . [F3] shows annual mean values of total ozone with the ozone recovery after 1995.



Conclusions:

1) Clear-sky UV Index and daily dose are accurately reproduced using the OMI aerosols observations (onboard of the Aura satellite) and the MERRA-2 reanalyse of AOT at 550 nm
2) MERRA2 reanalysis of AOT provide the better fit to AOT measured at the AERONET stations in Poland (Belsk, Racibórz) with the correlation coefficient of 0.75 and 13% bias (at Belsk)
3) Long-term effects of the aerosols and cloud changes (back to 1980s) on surface UV could be estimat-ed using clear-sky model of UV irradiance with MERRA2 AOT daily values as model's input

Acknowledgments. This work was supported by the National Science Centre (Poland) under grant No.2017/25/B/ST1001650.