Method for producing the COST 726 maps and illustration of the result

Jean Verdebout
European Commission – Joint Research Centre

COST Action 726 Seminar

Warsaw, May 13-14, 2009

GENERAL

The maps are obtained by direct fully coupled radiative transfer modelling of the cloudless surface UV, on which the cloud modification factor is then applied.

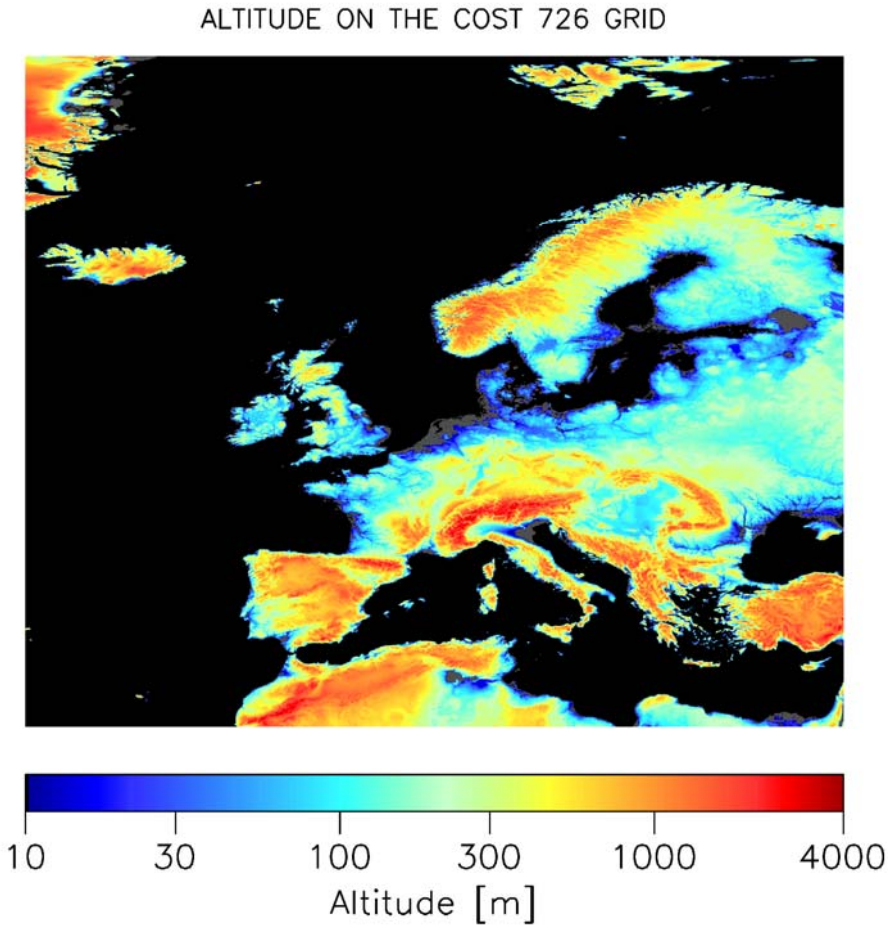
The resulting maps have a spatial resolution of 0.05 x 0.05 deg. , even if most of the input data are at a 1 x 1 deg. resolution.
The covered area extends from 25.5 W to 35.5 E and from 30.5 N to 80.5 N.

The higher spatial resolution allows better taking into account the effects of altitude.

The first step is therefore to transport input data to the finer spatial grid.

ALTITUDE

The digital elevation model is the GTOPO30 of USGS. The altitude, originally on a 30” grid, is averaged in each 0.05 deg. cell

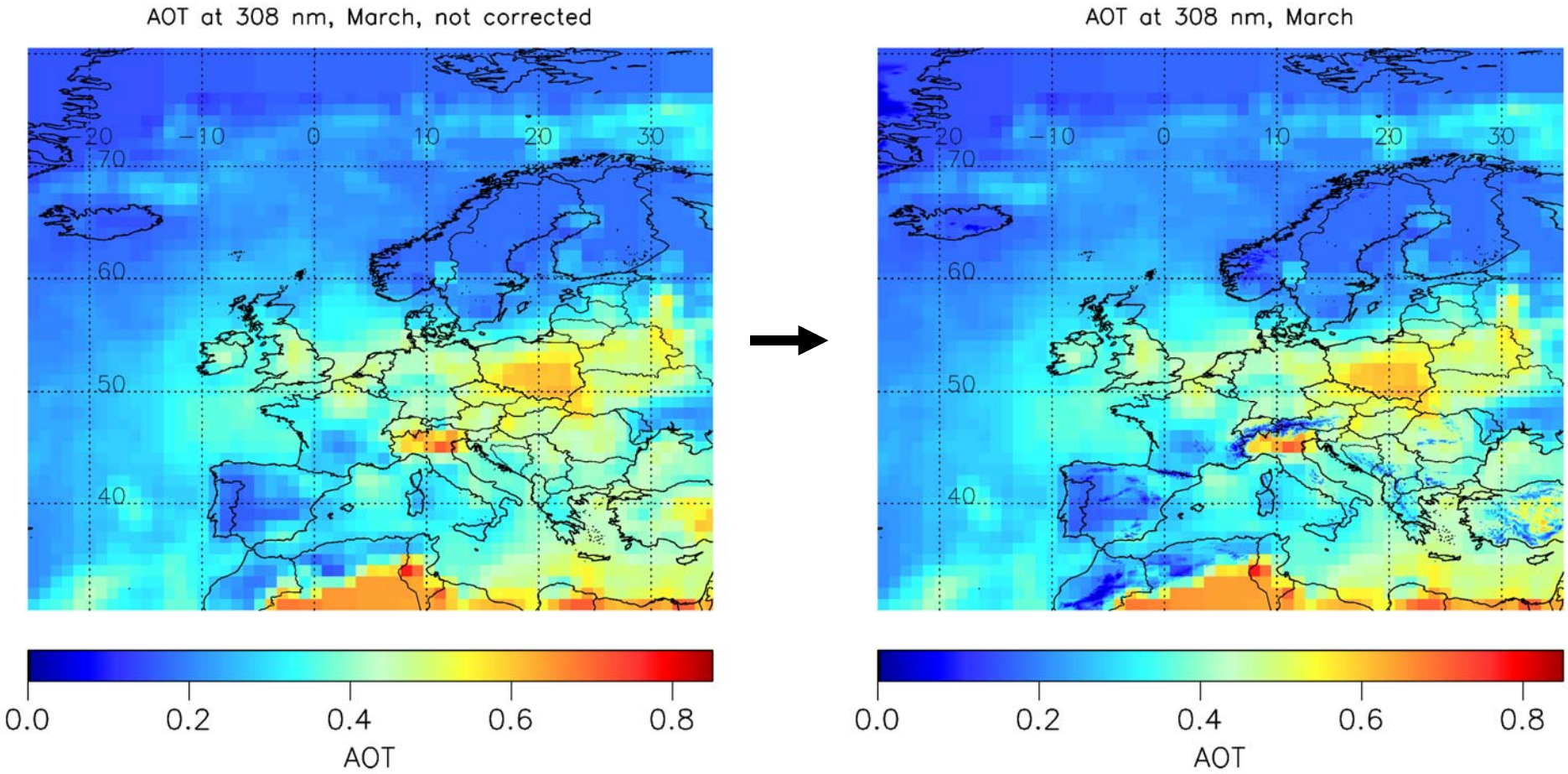


http://edc.usgs.gov/products/elevation/gtopo30/gtopo30.html

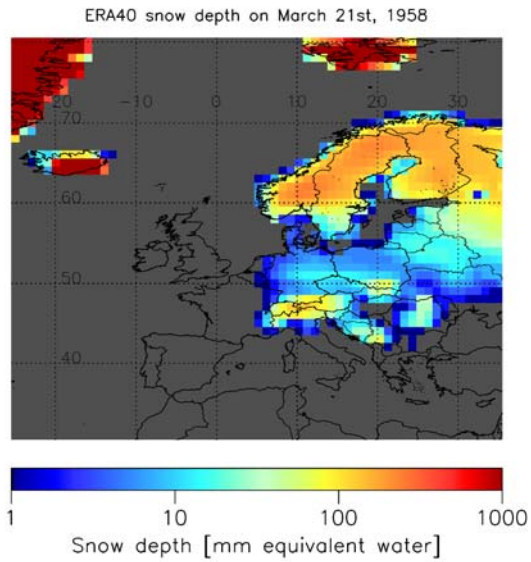
AEROSOL OPTICAL THICKNESS

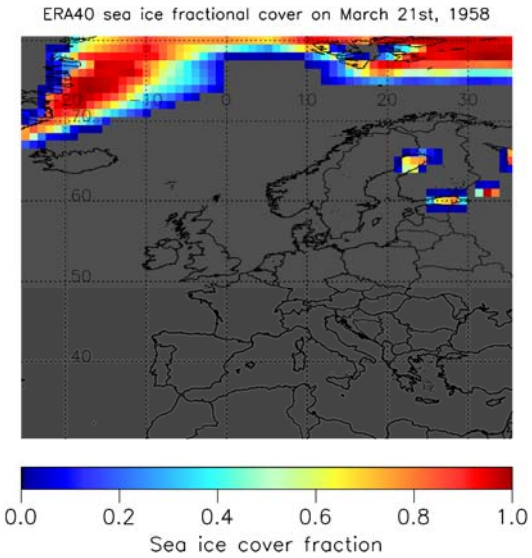
The 1x1 deg. MODIS/AERONET AOT map is corrected for altitude:

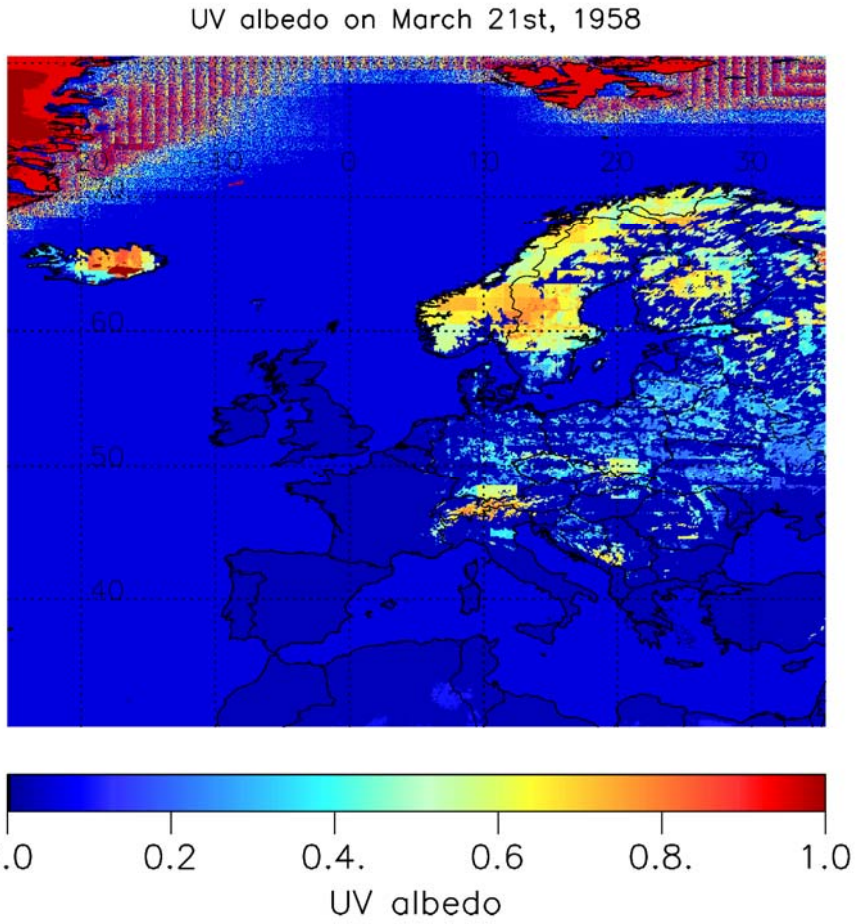
$$AOT = AOT_{nc} / (altitude[km])^{1.65} \quad \text{if altitude} > 1\ km$$



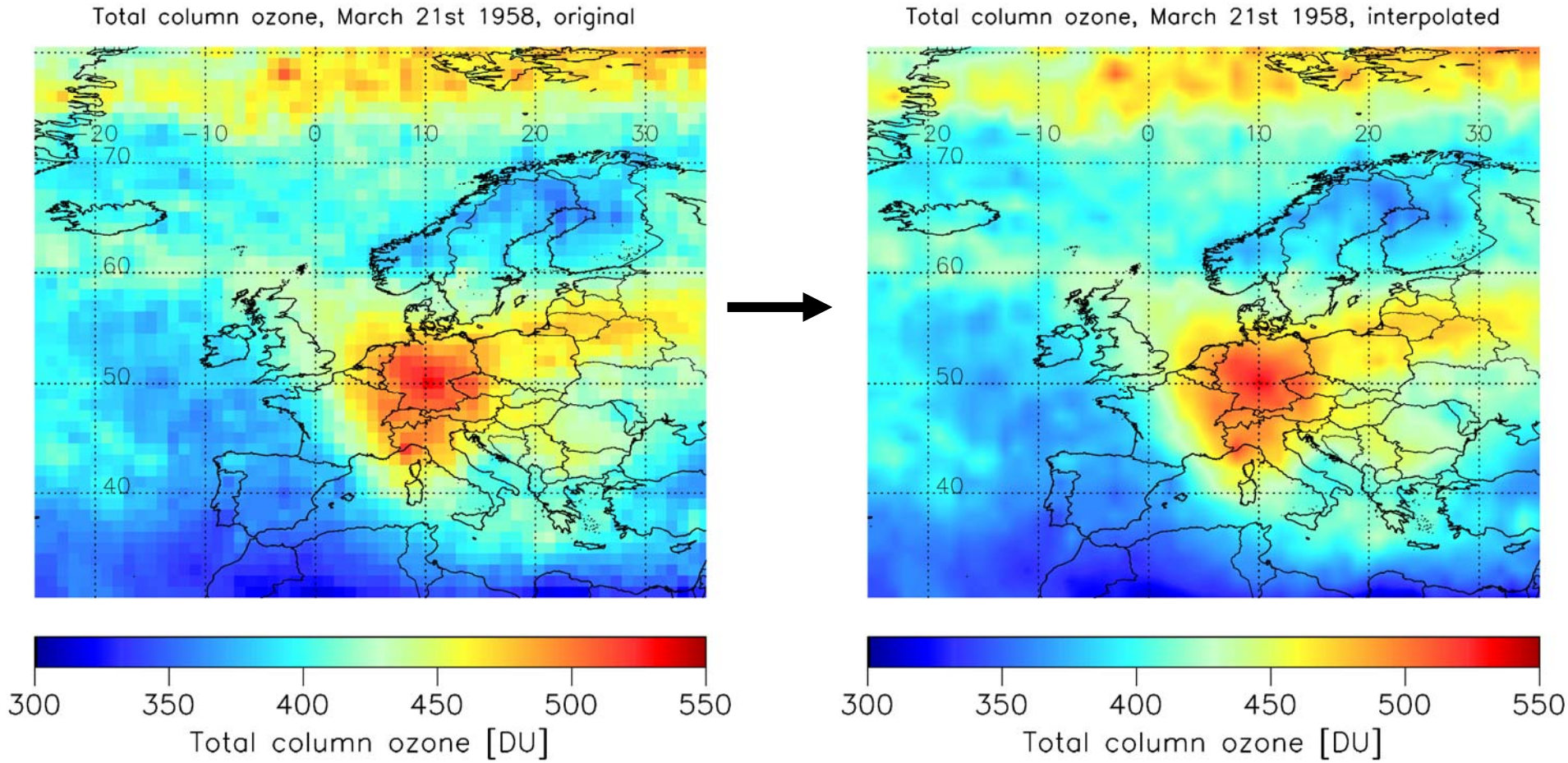
The UV surface albedo at 0.05 deg. resolution is empirically inferred from ERA40 snow depth and sea ice cover data at 1deg. resolution.







The COST ozone map at 1deg. resolution is interpolated on the 0.05 deg. grid



GENERATING THE CLOUD FREE MAPS

Because of the large number of calculations to be performed, the surface downwelling irradiance is obtained by multiple interpolation in a Look Up Table (LUT); running the RT code is not practicable.

LUT (sza, ozone, AOT, UV albedo, altitude, spectral weighting function)

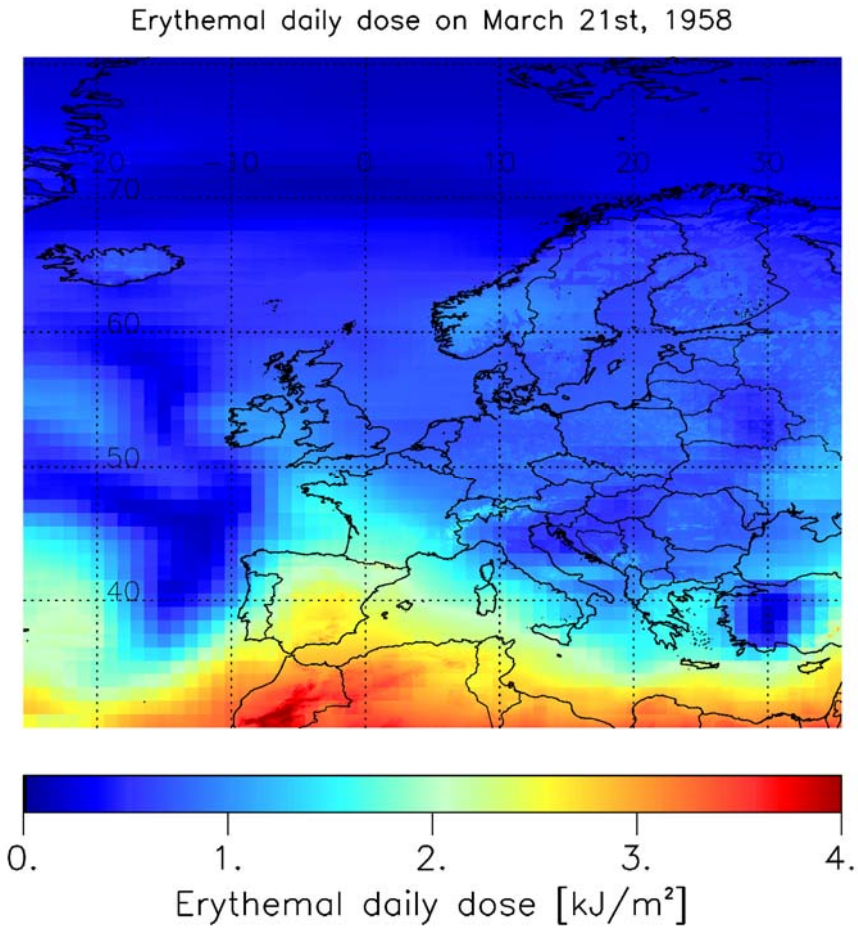
The LUT was pre-computed with the LibRadtran/UVspec code* for sets of discrete values of the input parameters.

The LUT contains the downwelling surface irradiance weighed for the erythemal effect (CIE87) and at 7 wavelengths with a 5 nm FWHM triangular slit function (295, 300, 305, 310, 315, 330 and 360 nm). This allows to compute the doses corresponding to an arbitrary action spectrum.

The downwelling surface irradiance is computed every half hour and the daily doses are then obtained by integration (on time).

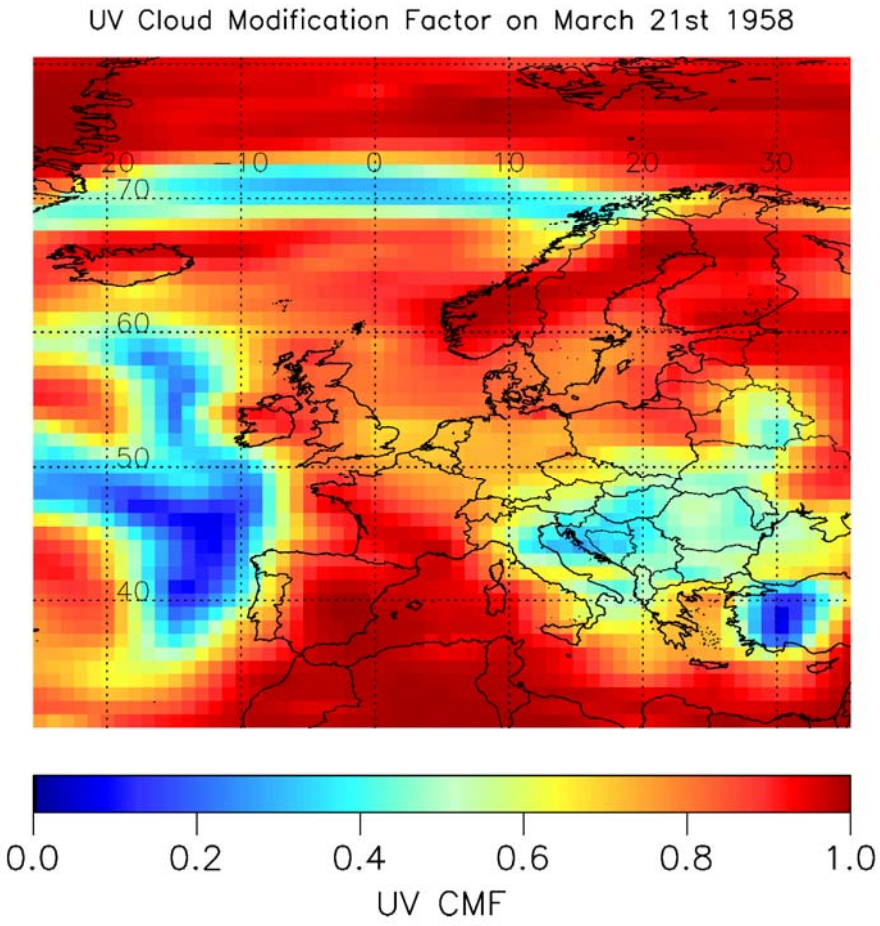
***Mayer, B. and Kylling, A.: Technical note: The libRadtran software package for radiative transfer calculations - description and examples of use, Atmos. Chem. Phys., 5, 1855-1877, 2005 ; (http://www.libradtran.org/doku.php).**

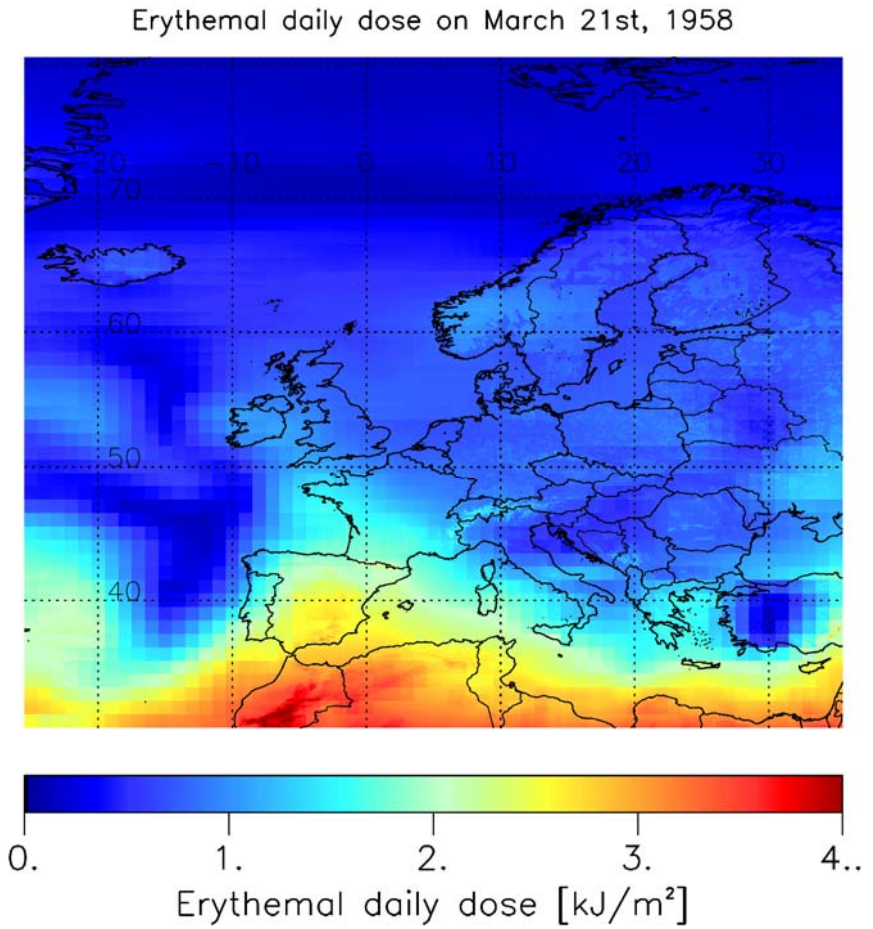
Cloud free erythemal daily dose on March 21st 1958



FINAL STEP: CLOUD MODIFICATION FACTOR

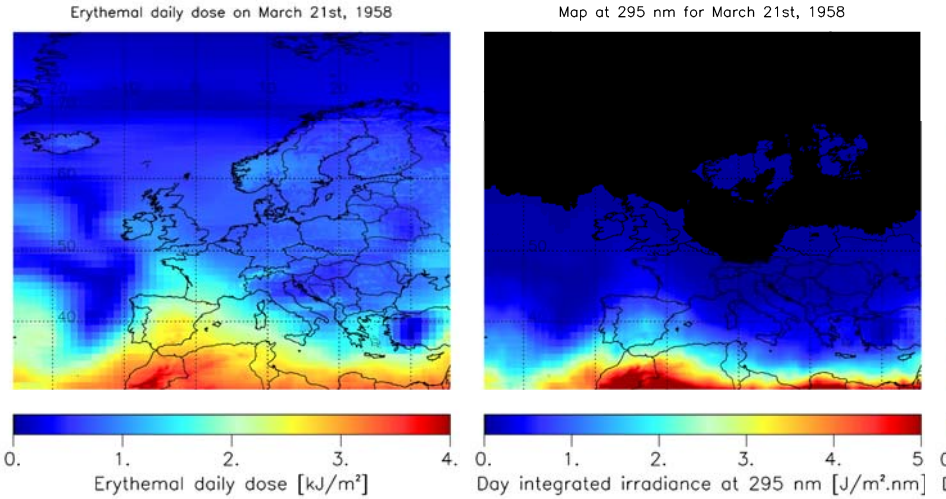
The UV cloud modification factor is applied on the cloud free map





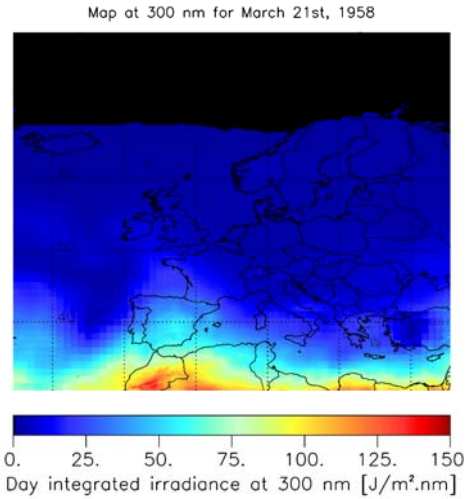
March 21st 1958: Erythemal + 7 wavelengths

CIE87

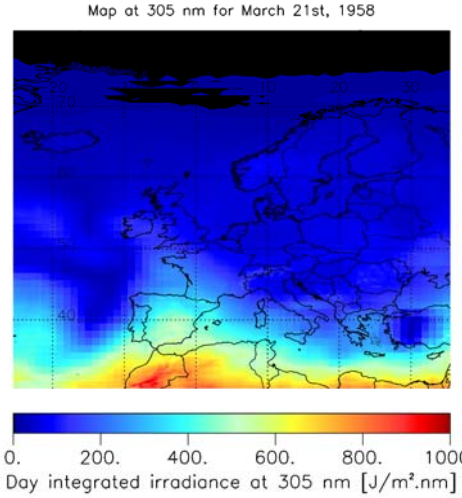


295 nm

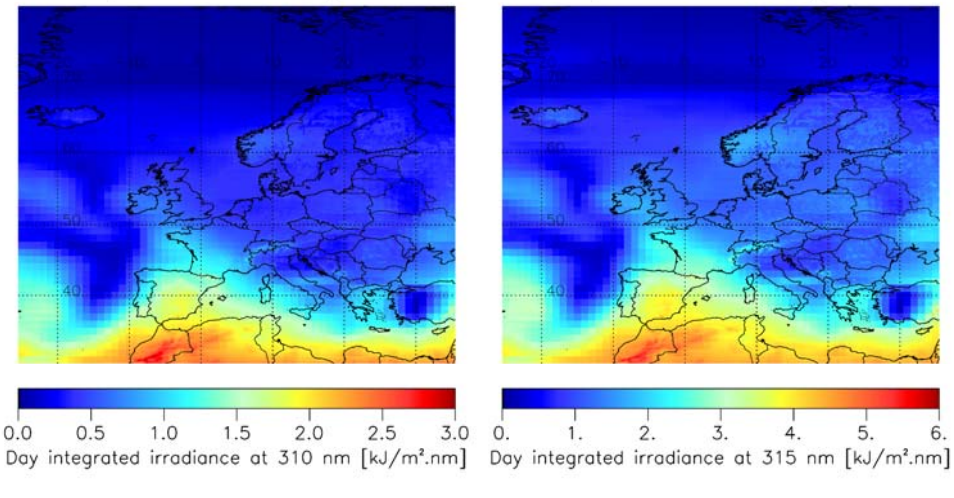
300 nm



305 nm

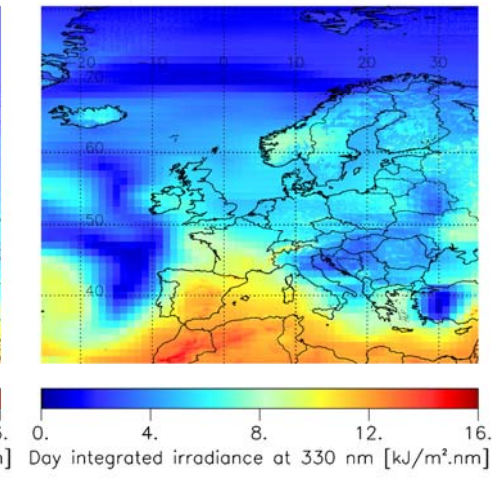


310 nm

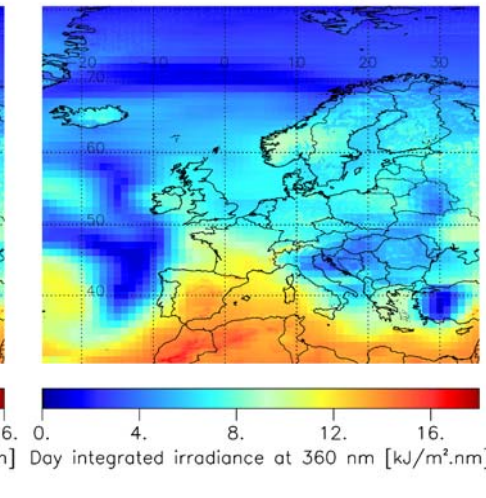


315 nm

330 nm



360 nm



A FEW NUMBERS ABOUT THE DATA SET

The maps have been produced for each day from January 1st 1958 to August 31st 2002; there isn't any missing day.

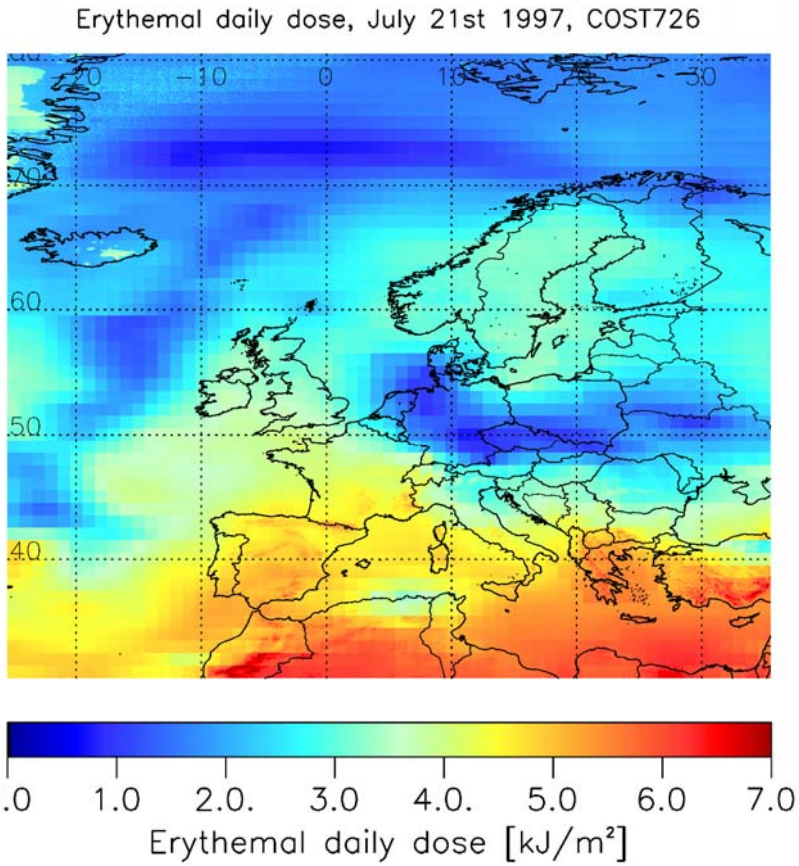
16,314 days x 8 = 130,512 maps.

Each map is 1220 columns (W-E) by 1000 lines (S-N).

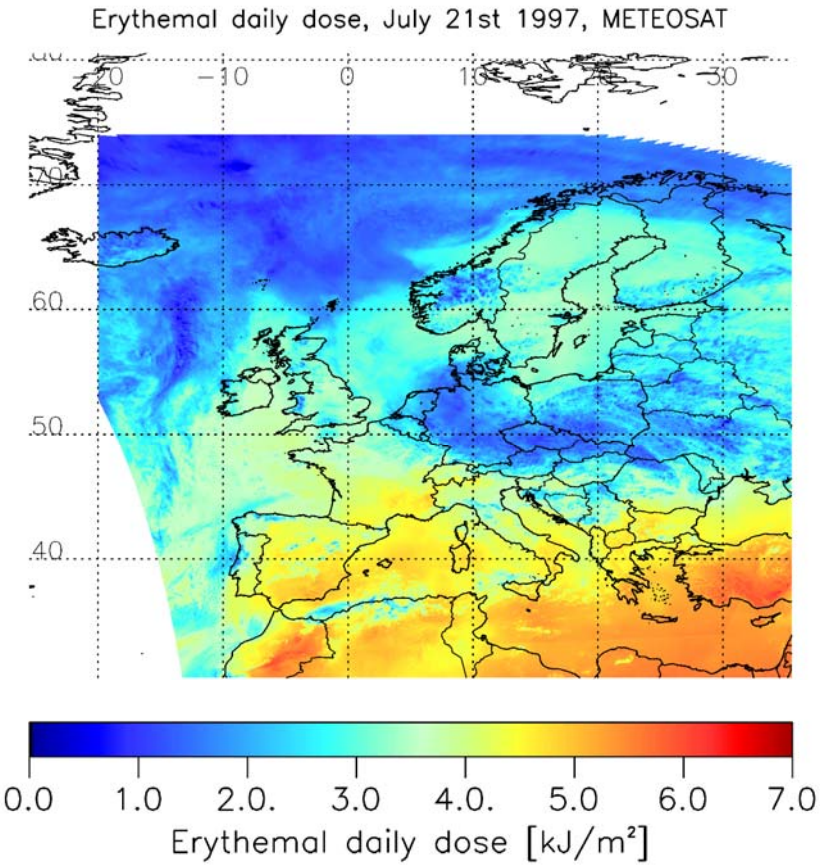
If kept in a 4 bytes floating point format, each map is a 4,880 kB file, the total data set amounts to 635,898,560 kB (~640GB).

The COST daily dose maps do capture the correct spatial pattern at the European scale. Below is a comparison with a map produced from METEOSAT data (July 1st 1997).

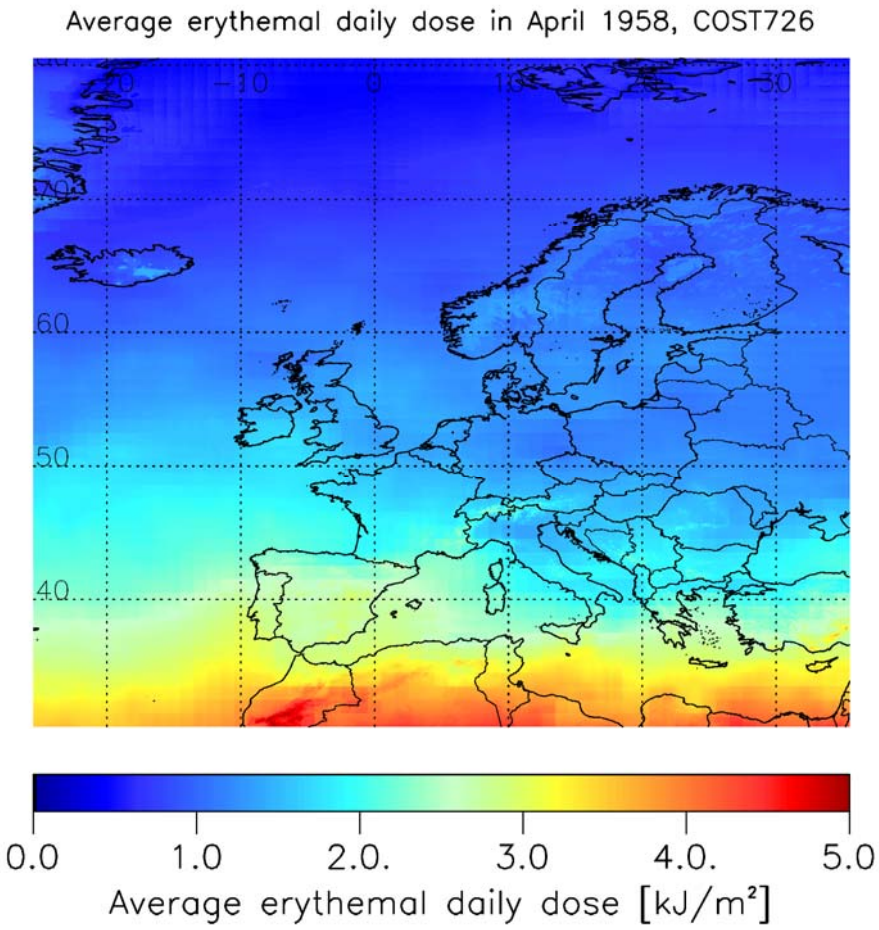
COST 726



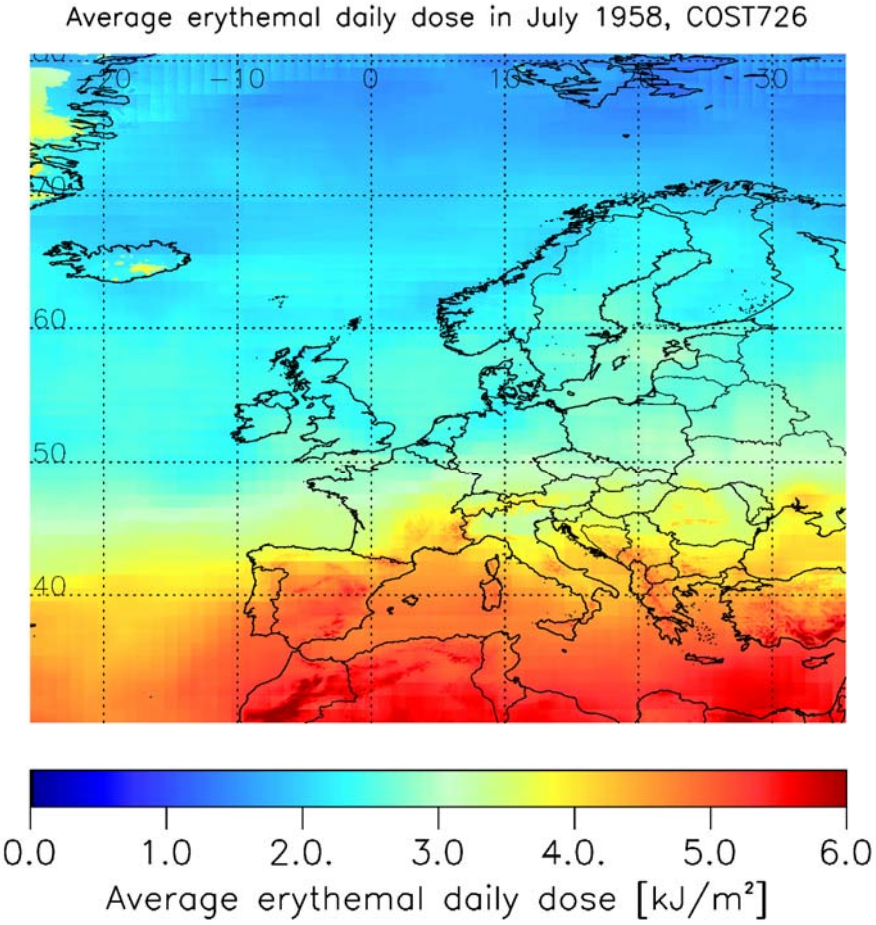
METEOSAT



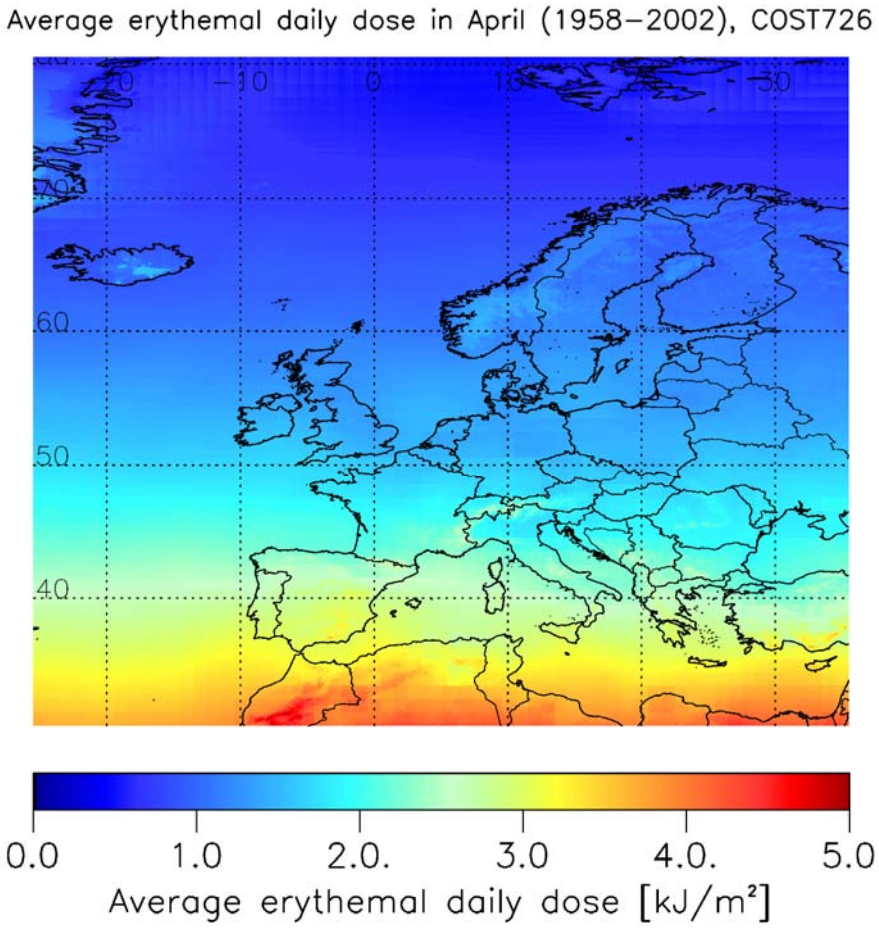
April 1958

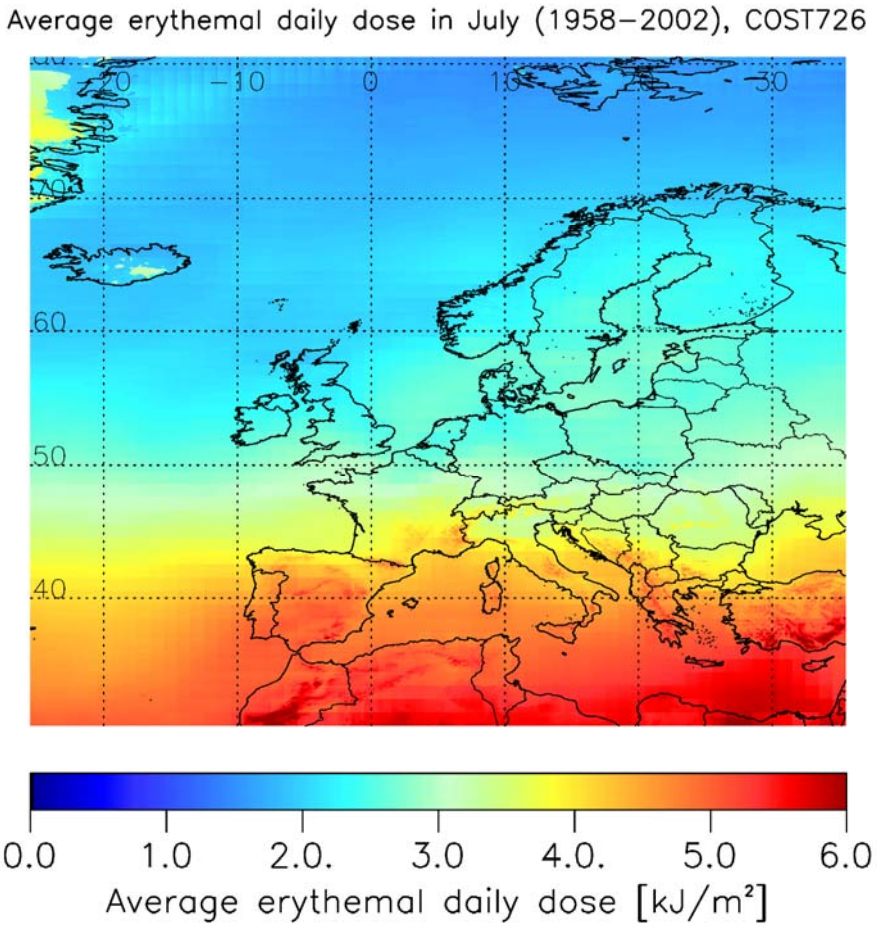


July 1958



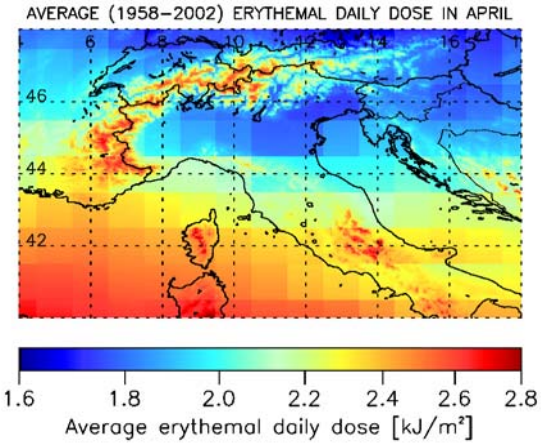
Monthly average maps themselves averaged over the 45 years of the data set. Useful as a reference and to document the systematic geographical patterns.



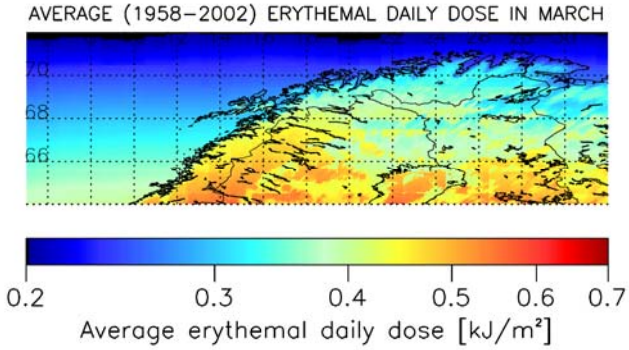


SYSTEMATIC GEOGRAPHICAL PATTERNS

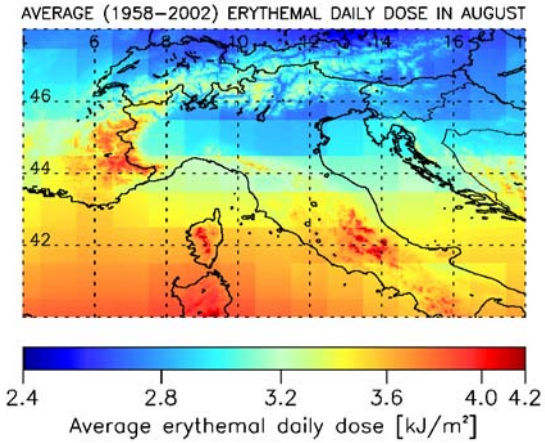
April



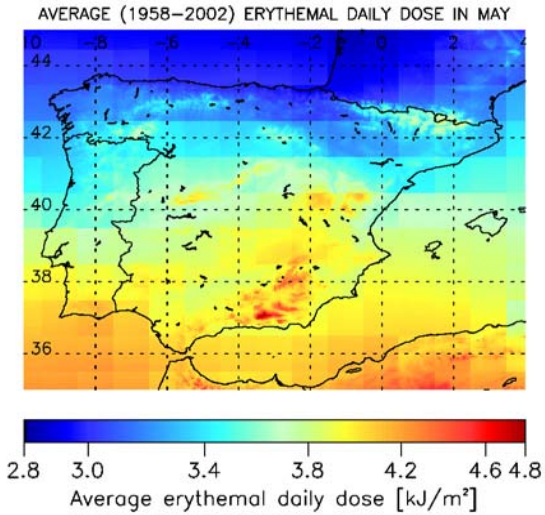
March

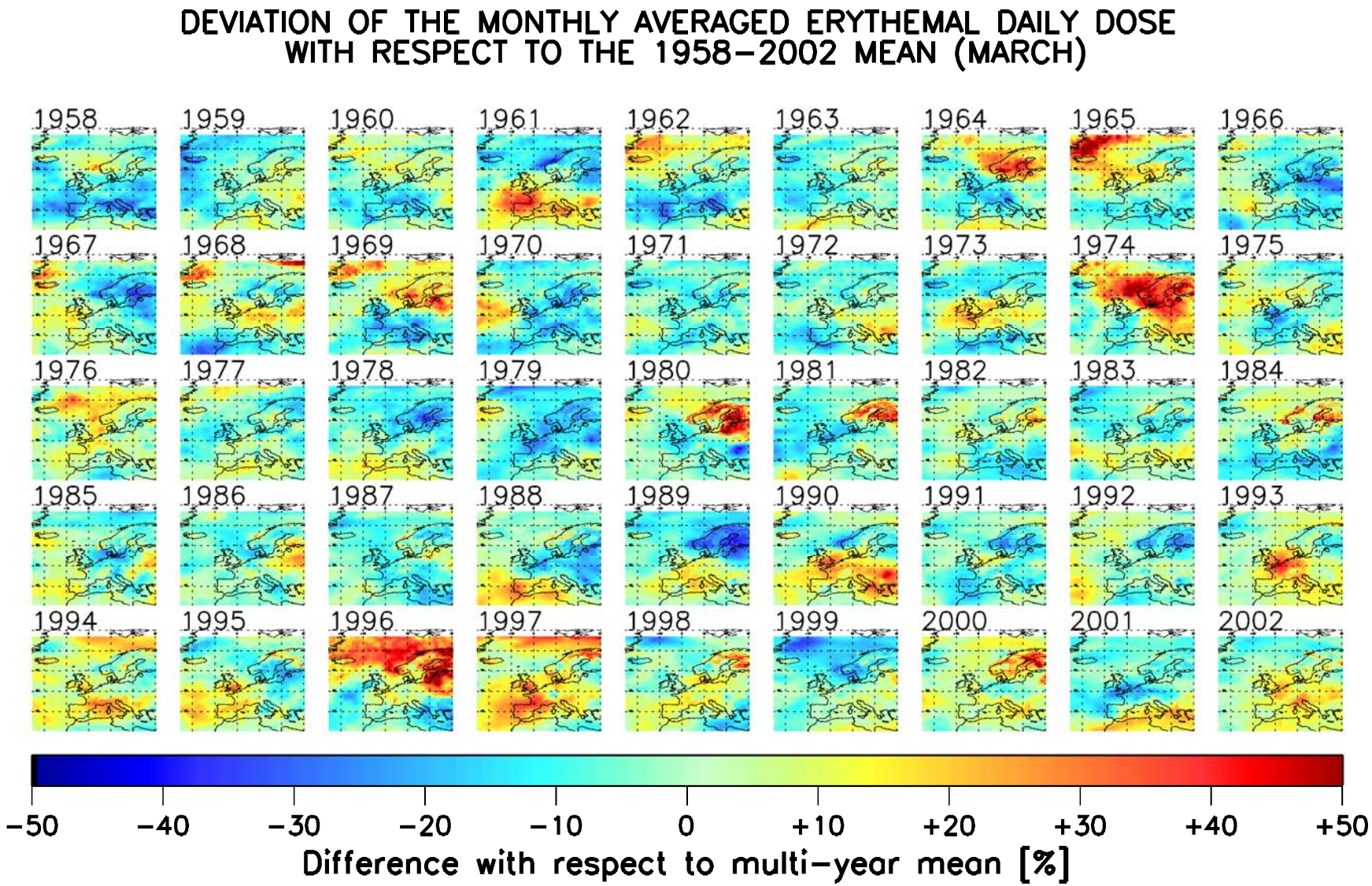


August

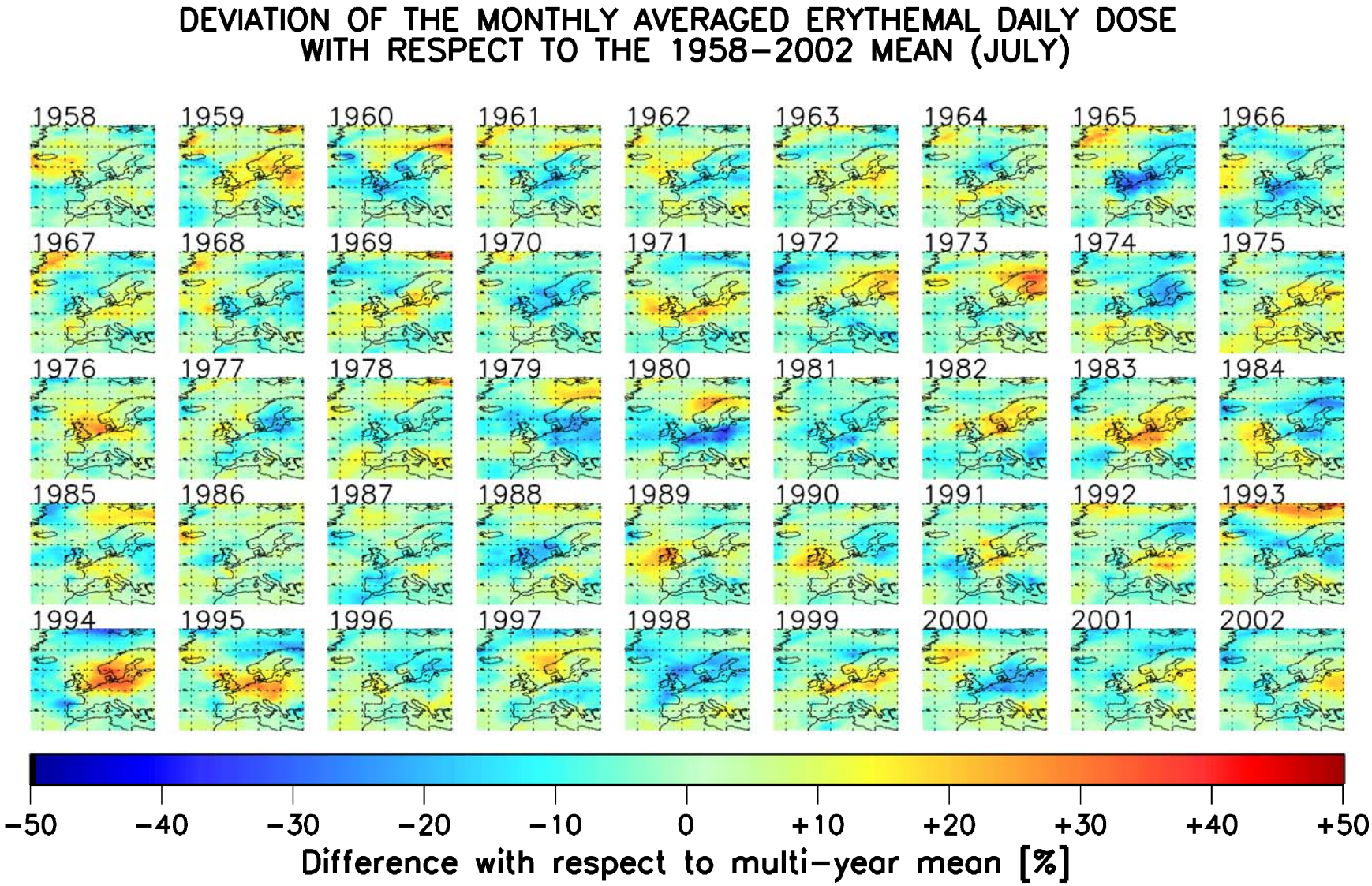


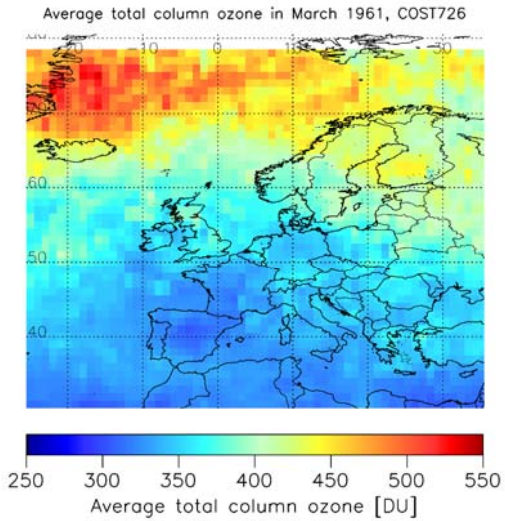
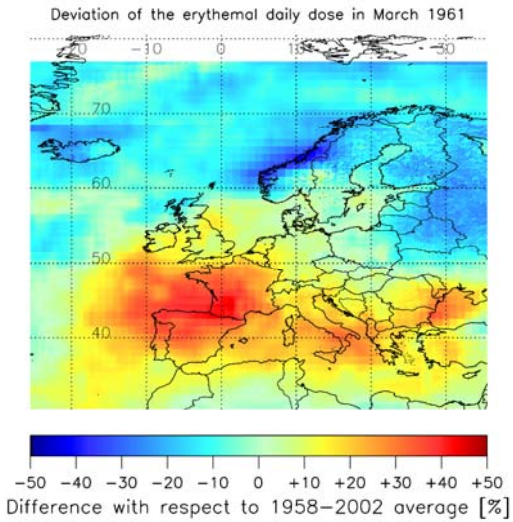
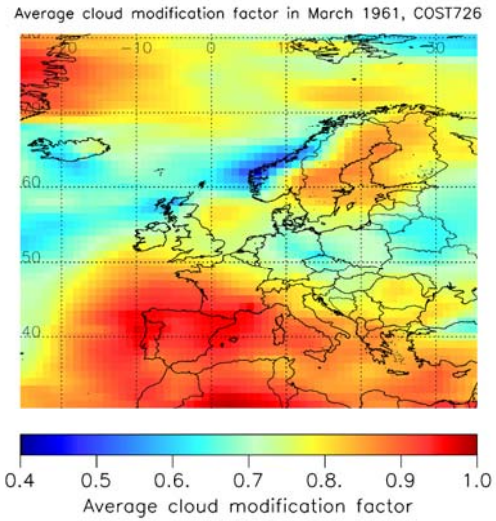
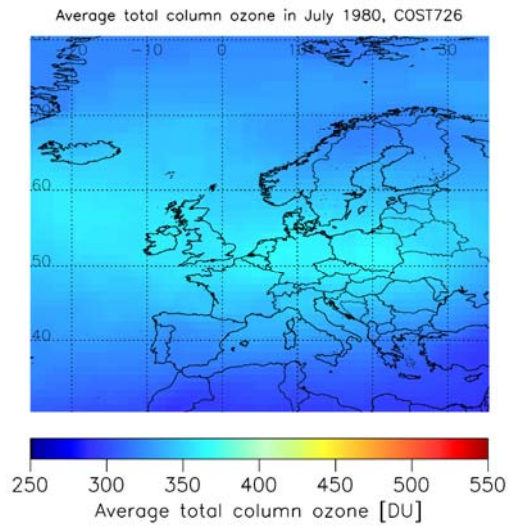
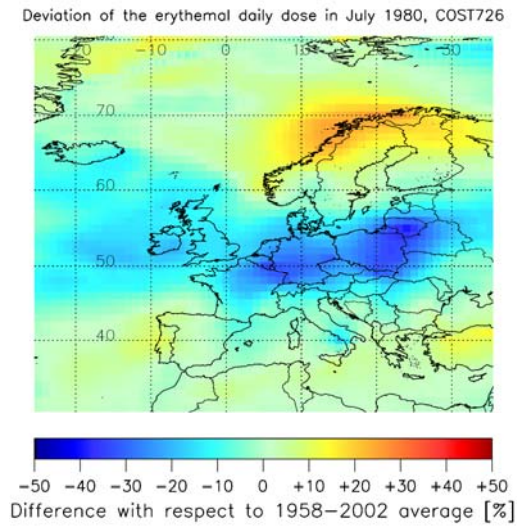
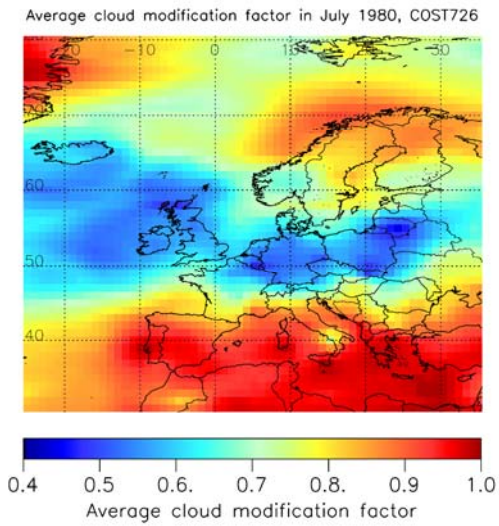
May



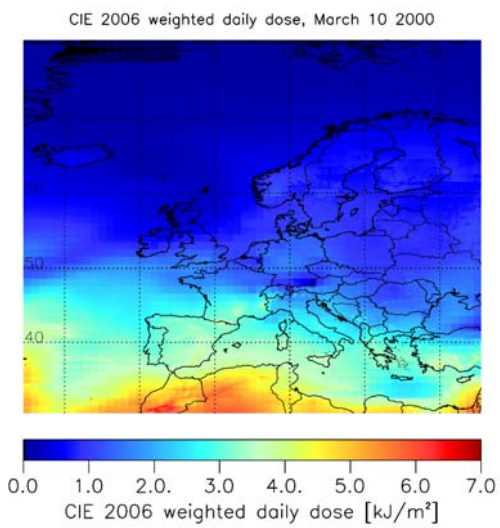
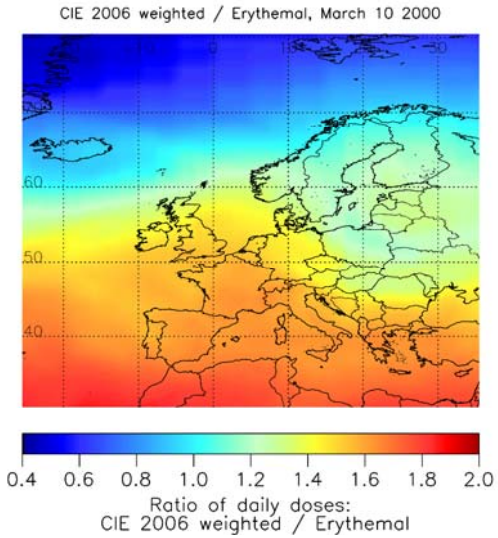
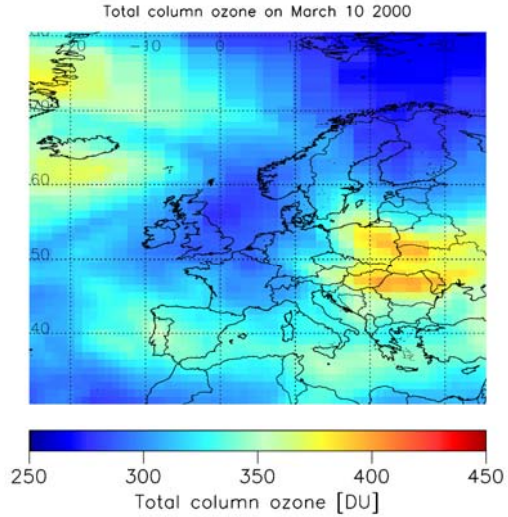
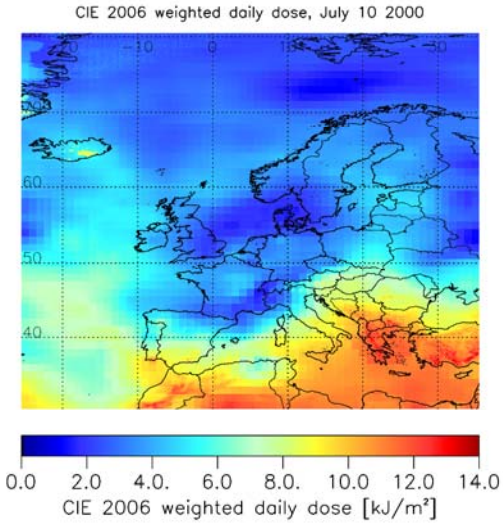
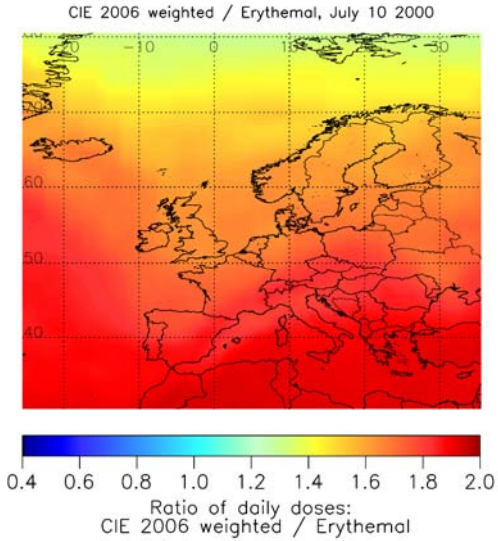
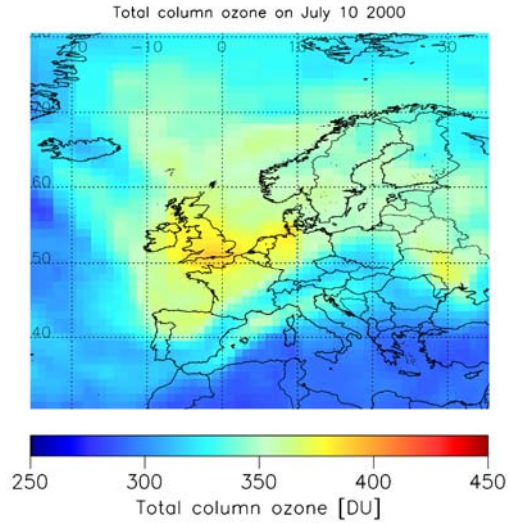

DEVIATION OF THE MONTHLY AVERAGED ERYTHEMAL DAILY DOSE
WITH RESPECT TO THE 1958–2002 MEAN (MARCH)
1958
1959
1960
1961
1962
1963
1964
1965
1966
1967
1968
1969
1970
1971
1972
1973
1974
1975
1976
1977
1978
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
−50
−40
−30
−20
−10
0
+10
+20
+30
+40
+50
Difference with respect to multi−year mean [%]

YEAR TO YEAR VARIABILITY

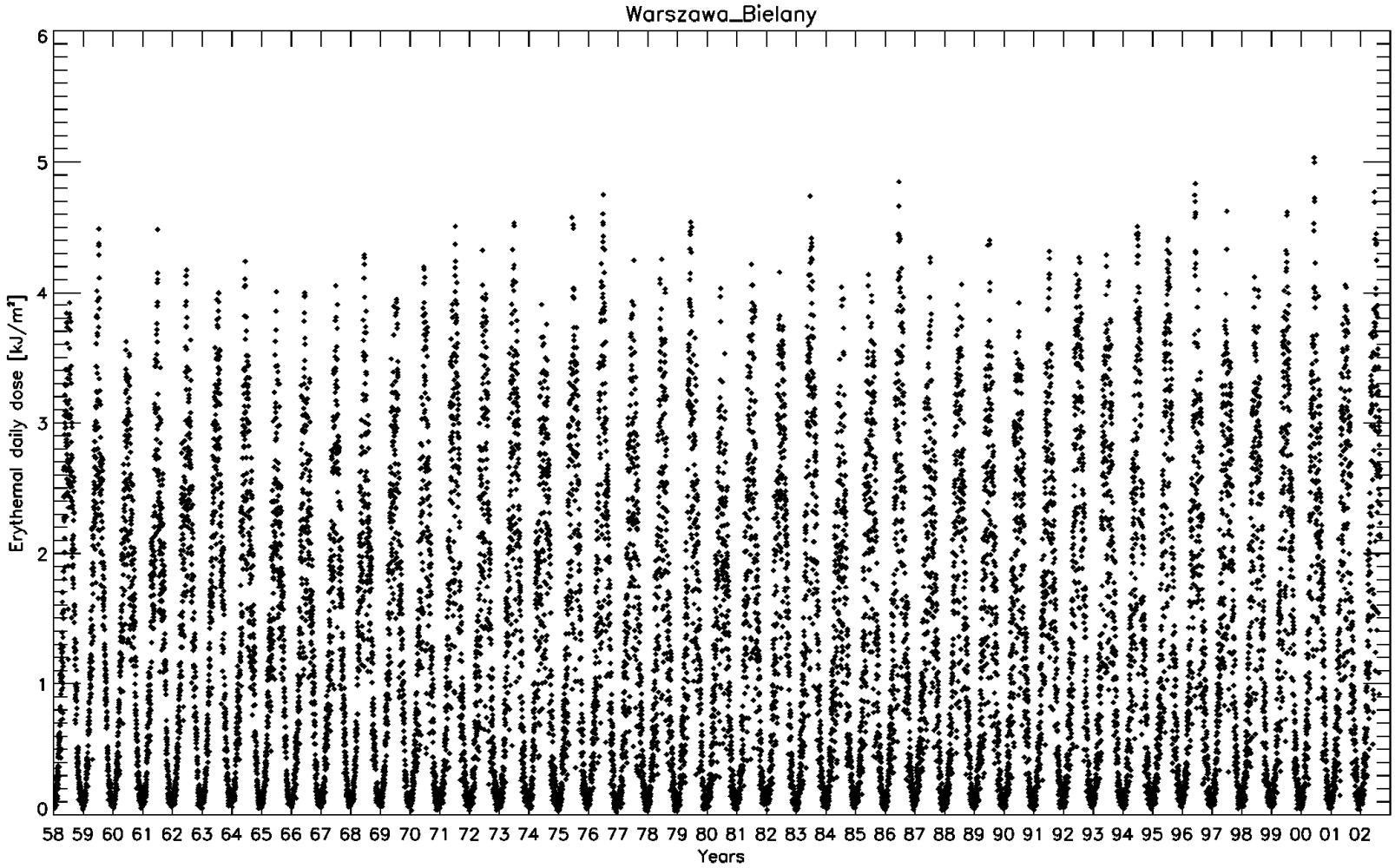


	Total Column Ozone	Excess/deficit in erythemal dose	CMF
March 1961			
July 1980			

ERYTHEMAL vs. "VITAMIN D"

	"Vitamin D" weigthed	Ratio "Vitamin D" / Erythemal	Total Column Ozone
March 10 2000			
July 10 2000			

Time series of the erythemal daily dose in Warsaw



Thank you Dziękuję Danke Merci Dank u Dêkuji

Ευχαριστώ Tak Tänan Kiitos Köszönöm Grazie

Takk Obrigado Multumesc Grazcha Dakujem Gracias

Tack Спасибо Tapadh leat Diolch yn fawr Eskerrik asko

Trugarez Gràcies Durdaladawhy Grazia Dankon Tanke

Mèrczi Kali' sso'rta-ssu Ei De gra Dilan Dank Gura mie ayd

Ek dank auk schoin Koutai Dankscheen Mercé Gestena Nais

Giitit itt Takkâ Spässep Grassias Thenk ye Thenks Aiteh

Djeelsha grawsta Grazzii Engraziel Dankeschee Ganta A dank aych