

Modelling of the Long-Term Variability of the Erythemaly Weighted UV Radiation over Europe within Framework of the COST-726 Action:

*Digest of Chapter 6.3 of Final Cost726 Report
Temporal development, trend analysis–erythemaly weighted UV*

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1) Trend model:

flexible curve fit to the relative deviations

2) Stations' Reconstructions :

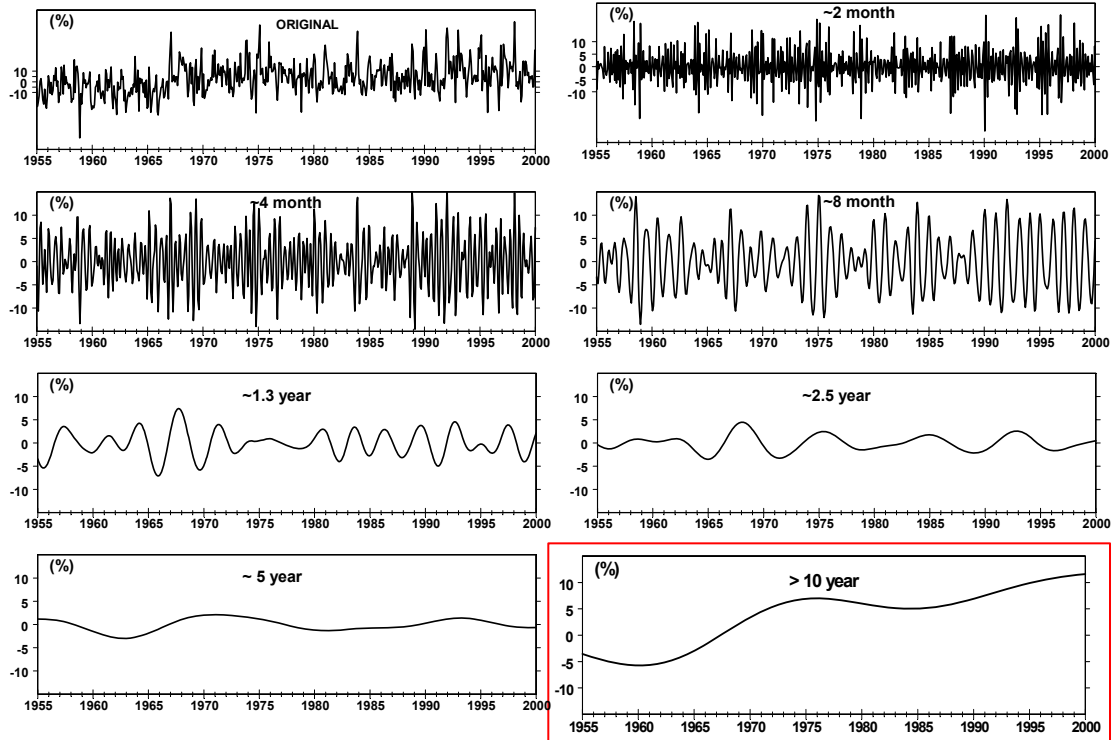
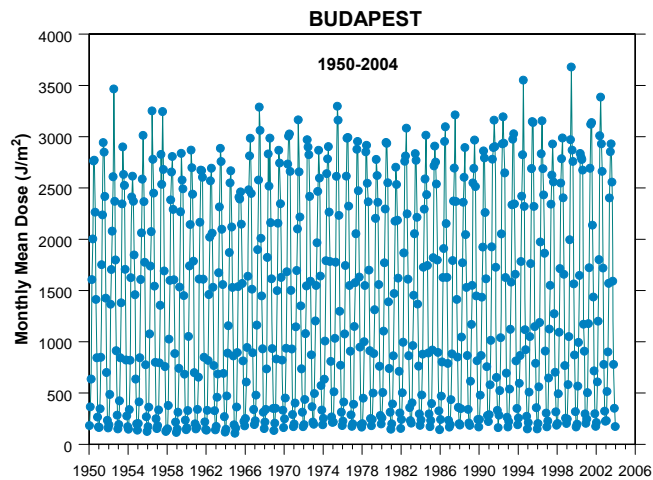
**Budapest, Hamburg, Hohenpeissenberg,
Potsdam, Uccle, Tartu, Uccle, Warsaw,
Zakopane**

UV_{eryt}, Total Ozone ← reconstructed data,

CMF_{uv} ← observed global solar radiation

3) COST-726 Maps :

(UV_{eryt}, Total Ozone, CMF_{uv})



Reconstructed UV time series for Budapest

Wavelet decomposition of the monthly fractional variations taken from reconstructed (GSAS model, Slovakia) erythemally weighted doses for the period 1950-2004 in Budapest

Trend Model

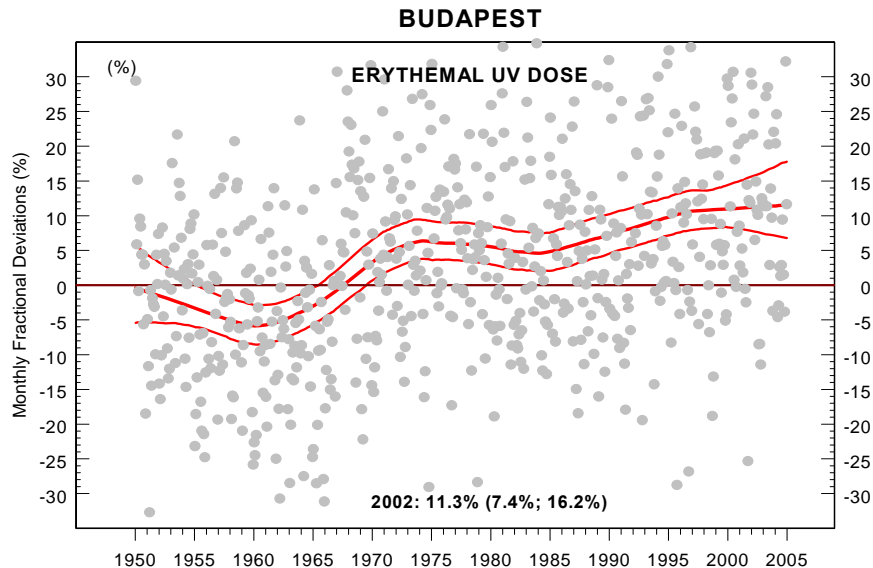
Possible way of presenting trend:

IO₃C announcement:

„ ... the midlatitude column ozone values for period 2002-2007 were approximately 3% below pre-1980 values in NH... ”

We follow IO₃C style of presenting long-term variability:

- **SMOOTH CURVE FIT TO THE RELATIVE DEVIATIONS**
(in % of pre-1979 level)
- **CALCULATION OF THE MEAN RELATIVE LEVEL AND 95% CONFIDENCE LIMITS FROM THE PATTERN OF SMOOTH CURVE in 2002**

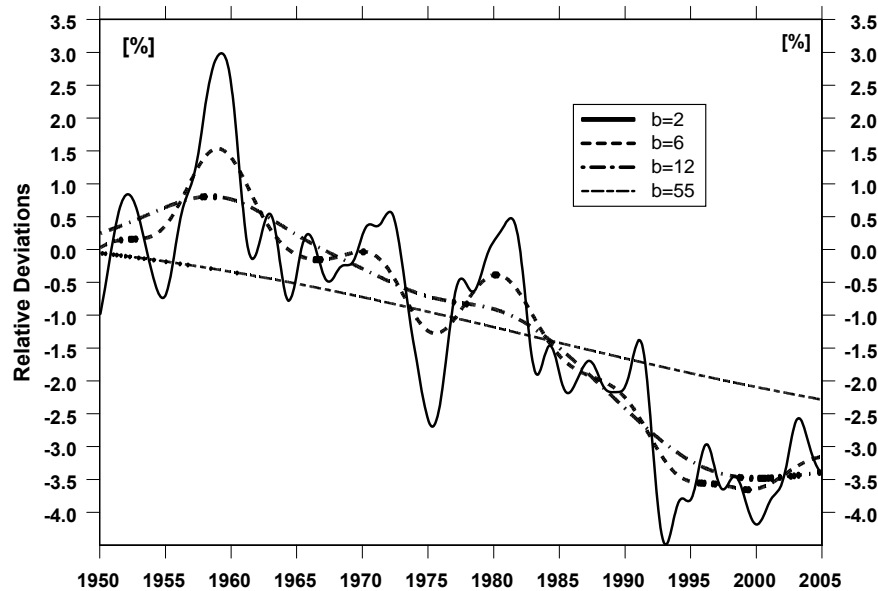


$$\Delta UV(t) = (UV(t) - UV_{NORM}) / UV_{NORM} \cdot 100\%$$

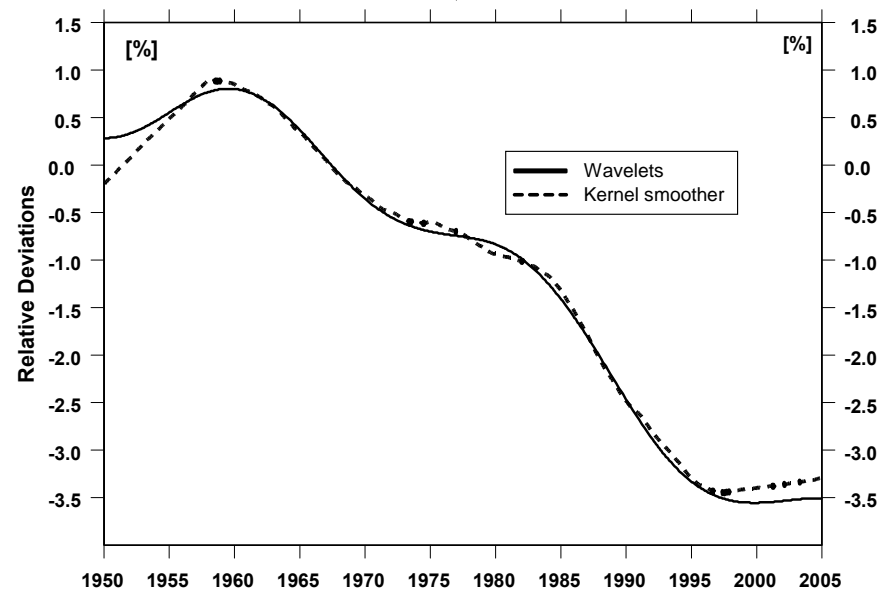
$$\Delta UV(t) = \text{Smooth_Term}(t) + \text{Noise}(t)$$

HOW TO SELECT THE LONG-TERM PATTERN? SMOOTH CURVE FIT TO THE DATA?

Smooth pattern of the O₃ monthly means averaged over the 40°-45°N band: the kernel smoother with different temporal bandwidth b (in years)



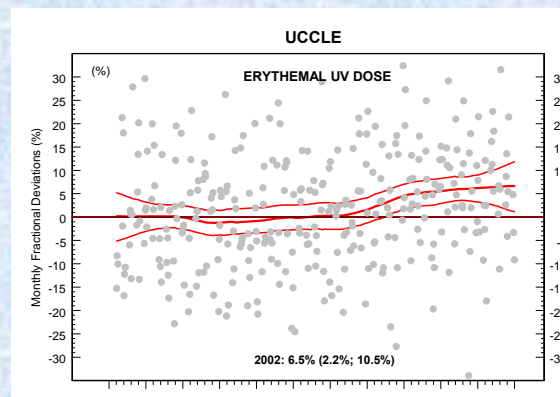
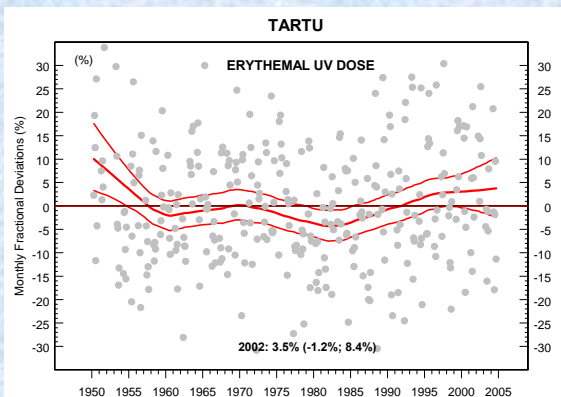
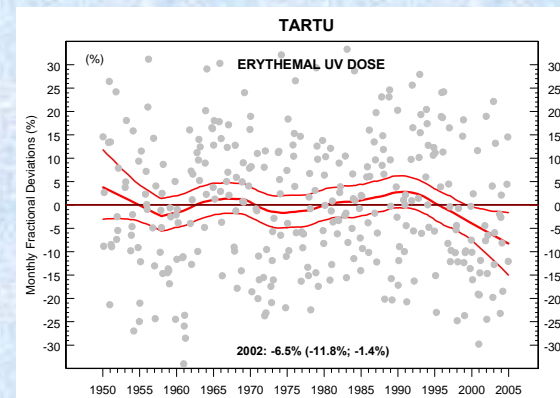
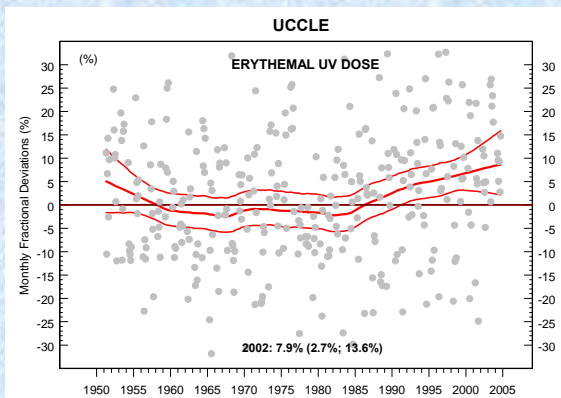
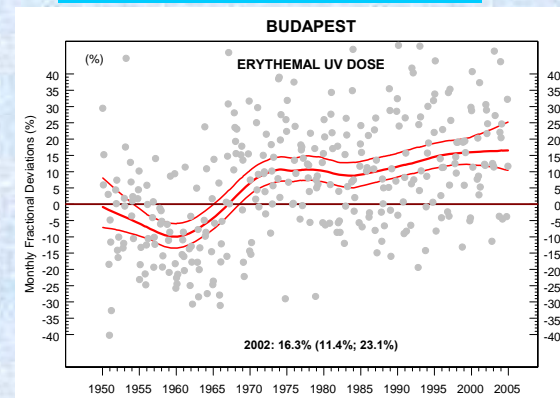
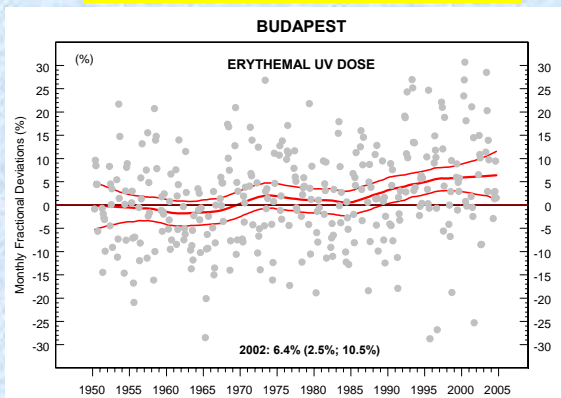
A smooth component of the wavelet multiresolution decomposition, and the kernel smoother with $b=8$ -year



Results

APRIL-SEPTEMBER

OCTOBER-MARCH



RESULTS OF TREND ANALYSES

STATIONS: Tables: Models [GSAS, IMWM, RIVM]

COST726 MAPS: Table (zonal means) + Figures

Deviation of Mean level (UV, TOTAL O3, CMFuv) in 2002 relative to the base line level (before 1979) in percent of the base line level for warm periods (April-September), cold periods (October-March), and the whole year (January-December).

$$\Delta UV^*_{2002-1979} = (UV^*(t=2002) - UV^*(t<1979)) / UV^*(t<1979) * 100\%$$

**95% confidence ranges of the estimates are in the parentheses.
Statistically Significant Results - Green BOXES **

RIVM model			
Site	UV	CMF_{UV}	Ozone
April-September (warm period)			
Budapest	5.7*(1.9, 9.7)	2.4 (-0.7, 5.5)	-2.5*(-4.1, -0.9)
Hamburg	5.0*(0.6, 10.9)	0.8 (-2.5, 4.8)	-3.2*(-4.7, -1.7)
Hohenpeissenberg	8.0*(2.4, 13.7)	3.1 (-1.1, 7.5)	-4.3*(-6.1, -2.2)
Potsdam	6.2*(2.4, 13.7)	3.1 (-1.3, 7.6)	-2.8*(-4.7, -1.0)
Uccle	8.1*(2.7, 14.7)	3.3 (-0.6, 8.0)	-3.4*(-5.3, -1.7)
Warsaw	11.2*(6.9, 15.2)	7.1*(3.9, 10.1)	-2.9*(-4.6, -1.4)
Zakopane	-0.7 (-4.7, 4.0)	-4.0*(-8.0,-0.8)	-2.7*(-4.2, -1.3)
October-March (cold period)			
Budapest	10.8*(6.4, 16.3)	7.0*(2.5,11.3)	-4.2*(-6.5, -2.2)
Hamburg	5.3*(1.5, 9.3)	-0.2 (-2.5, 4.8)	-4.7*(-6.9, -2.5)
Hohenpeissenberg	0.4 (-4.7, 5.9)	-5.8*(-9.8,-1.7)	-5.5*(-8.7, -2.7)
Potsdam	11.7*(6.7, 16.1)	6.4*(2.4,10.2)	-4.7*(-7.5, -2.3)
Uccle	9.0*(5.0, 12.7)	3.4 (-0.3, 7.1)	-4.6*(-6.7, -2.7)
Warsaw	10.3*(5.5, 14.1)	8.3*(3.8,11.8)	-2.9*(-4.8, -1.5)
Zakopane	-3.6*(-7.6, -0.5)	-5.6*(-8.6,-1.7)	-3.1*(-4.6, -1.9)

MAP RESULTS

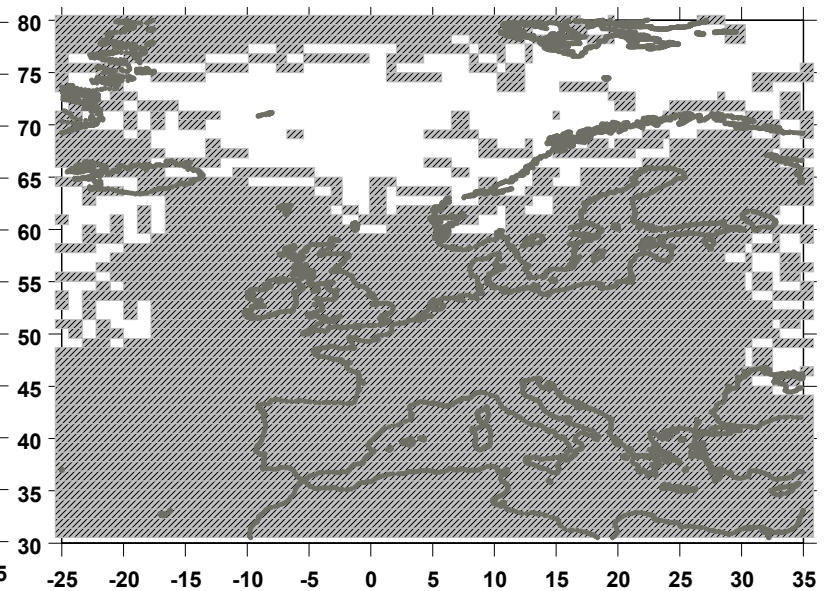
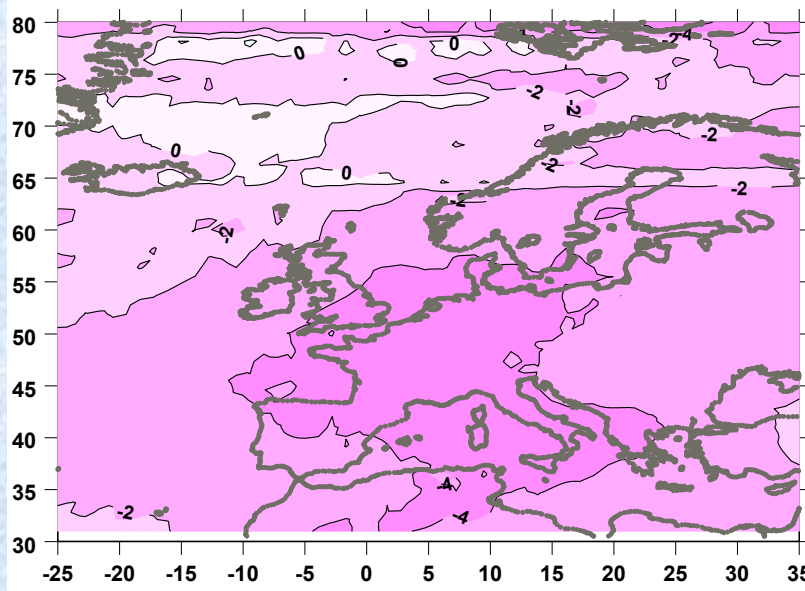
Latitude bands

$$\Delta UV^* = (UV^*(t=2002) - UV^*(t < 1979)) / UV^*(t < 1979) * 100\%$$

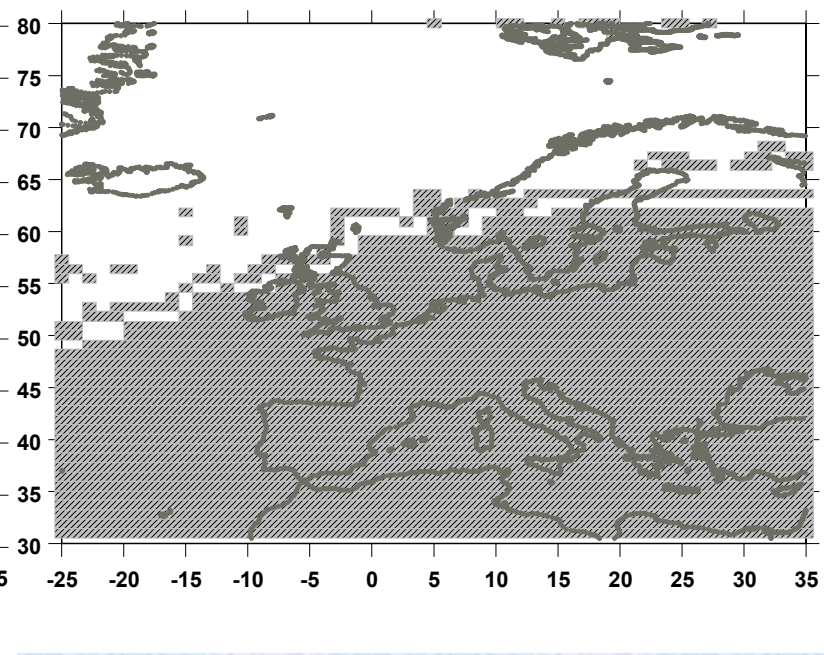
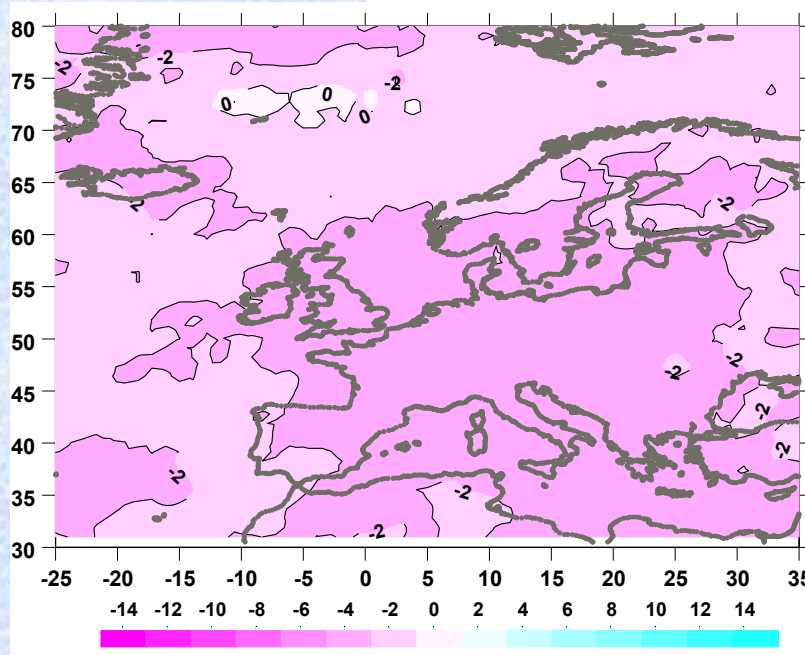
Band	Warm	Cold	Year
35° - 40°N	2.1 (-0.3, 4.9)	6.3 (2.8, 9.5)	4.7 (2.2, 7.5)
45° - 50°N	0.8 (-2.3, 3.8)	6.5 (3.5, 9.6)	4.5 (1.5, 7.1)
55° - 60°N	1.8 (-1.7, 6.1)	1.3 (-2.0, 4.6)	1.2 (-1.2, 4.3)
65° - 70°N	-1.2 (-4.0, 1.6)	-0.7 (-4.6, 4.6)	-1.4 (-4.4, 2.2)
75° - 80°N	-4.8 (-7.8, -1.3)	1.9 (-4.1, 9.2)	-2.4 (-6.2, 2.0)

O₃

COLD PERIODS (OCTOBER-MARCH)

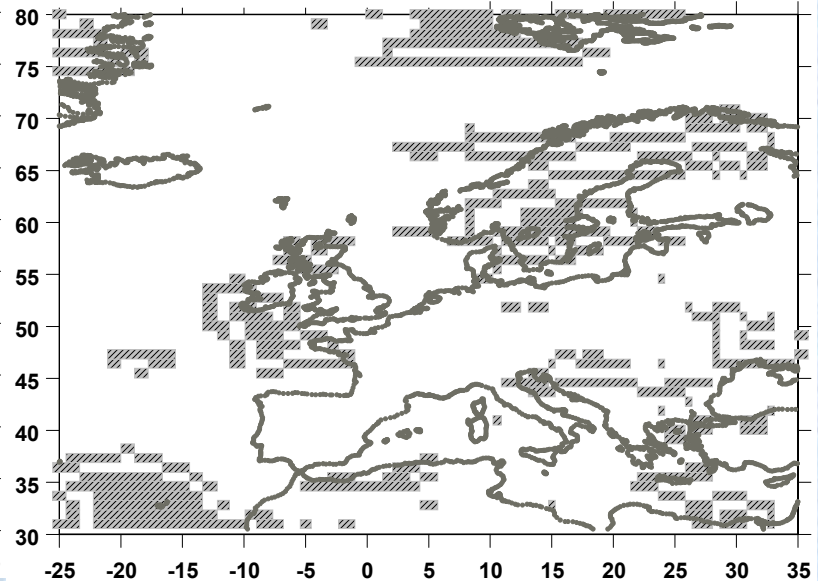
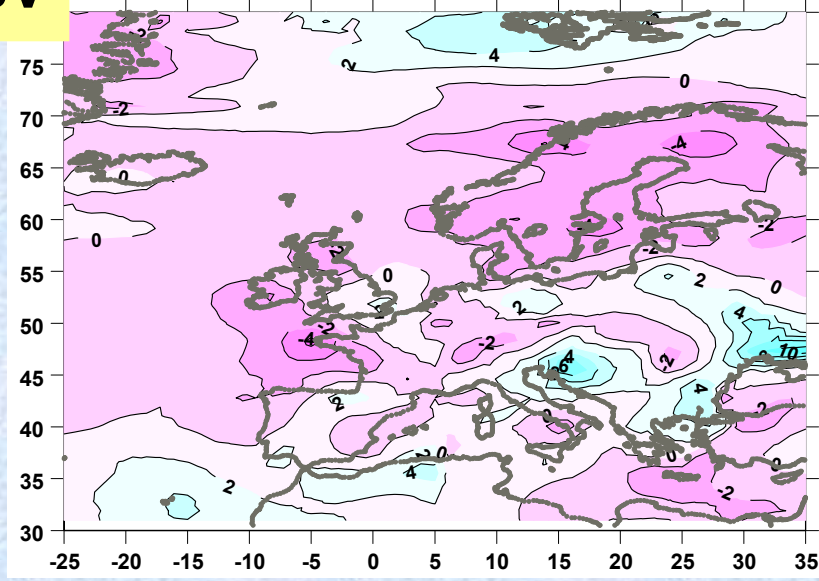


WARM PERIODS (APRIL-SEPTEMBER)

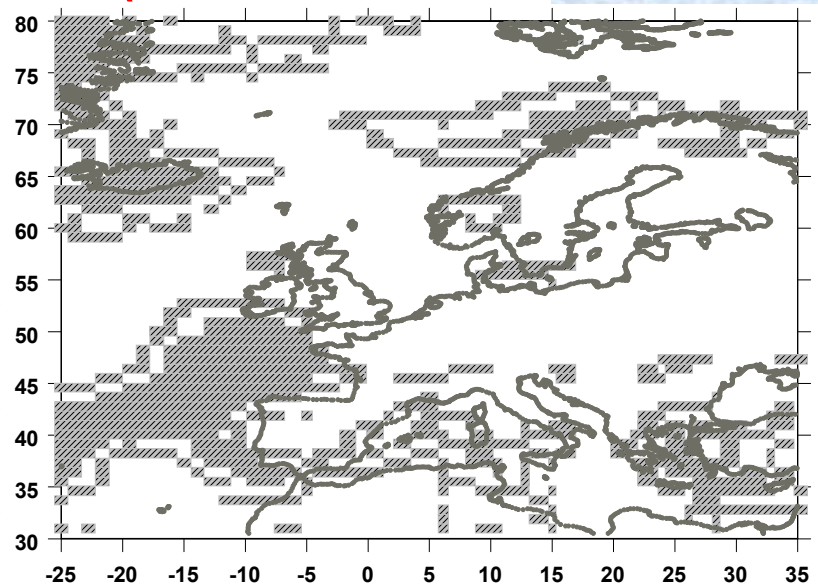
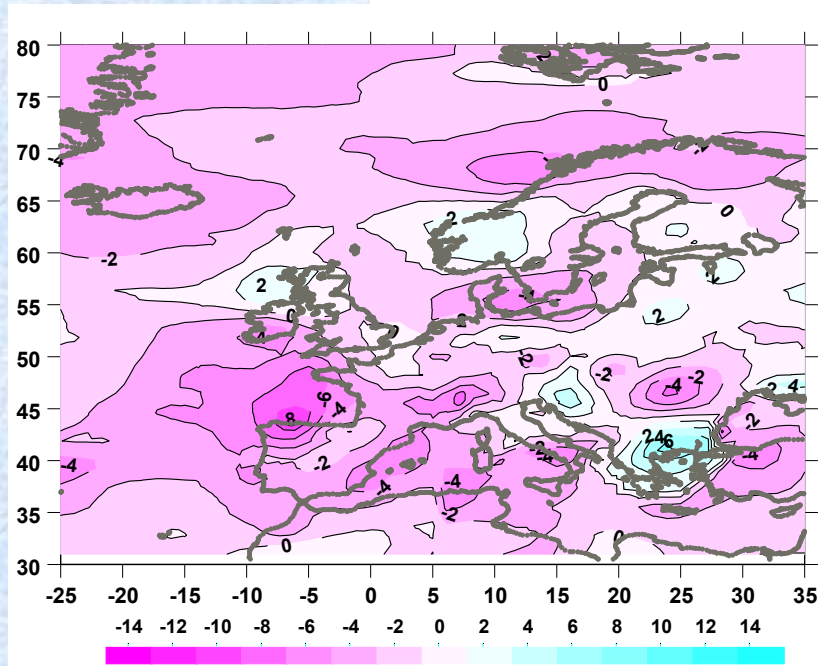


CMF_{UV}

COLD PERIODS (OCTOBER-MARCH)

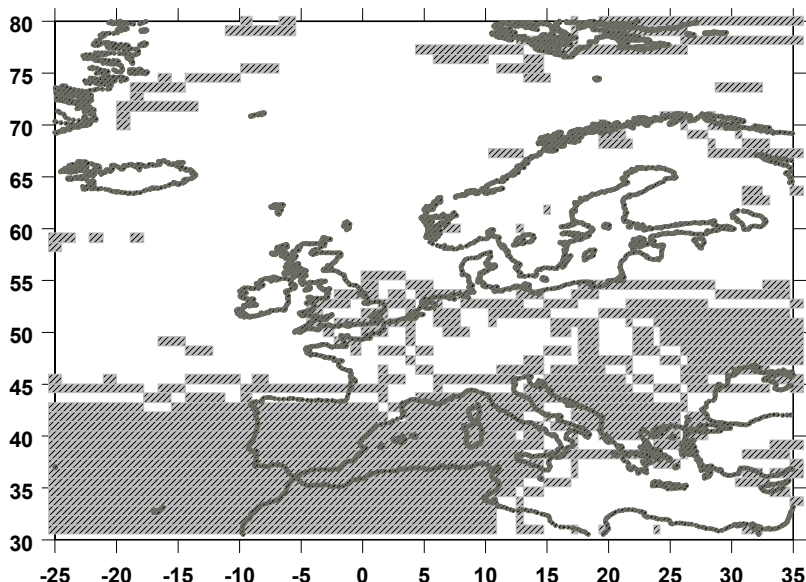
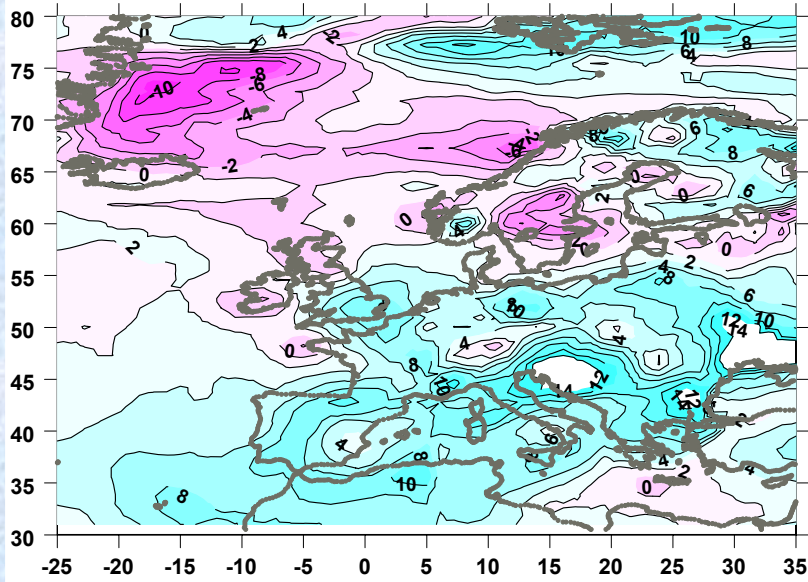


WARM PERIODS (APRIL-SEPTEMBER)

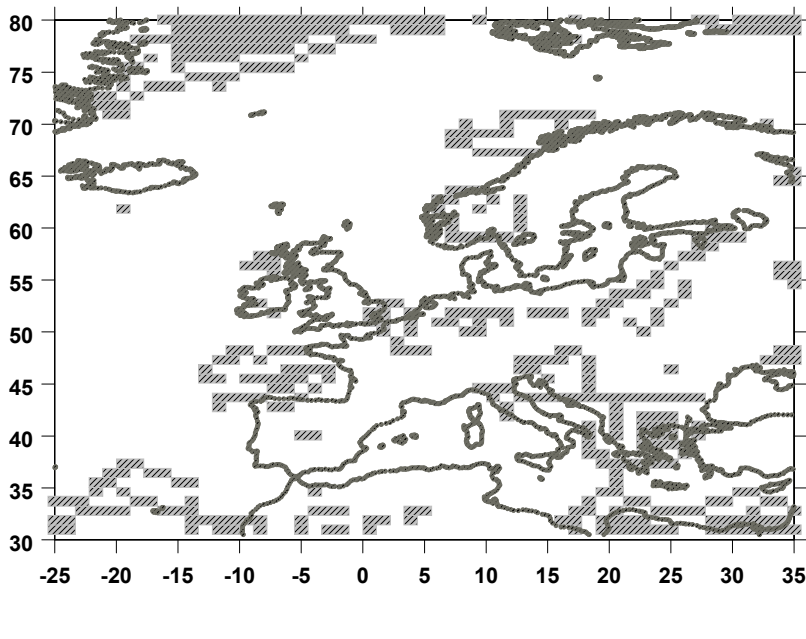
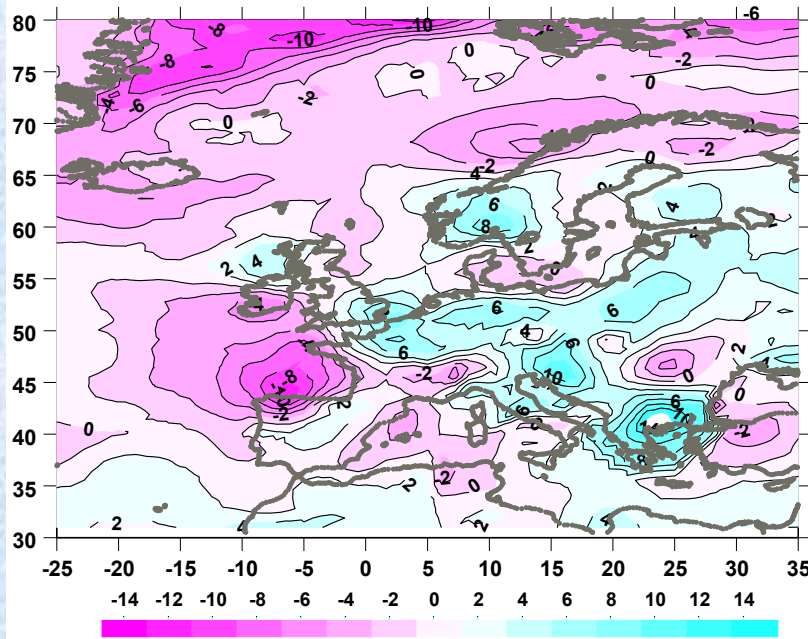


UV

COLD PERIODS (OCTOBER-MARCH)



WARM PERIODS (APRIL-SEPTEMBER)



Conclusions

1. Adopt International Ozone Commission (IO₃C) style for presenting trend, deviation in the end of time series from the benchmark (mean values over initial period,)
2. Discussed Long-term UV variability over Europe -driven by the modelled ozone and atmospheric transparency changes inferred from global radiation data (mostly cloud effects, aerosols?)

ozone effects on UV - smooth over the whole analysed area, range~1-5%

cloud effects on UV – local brightening or dimming, range $\pm 10\%$
3. The present (2002) mean UV level within $\pm 10\%$ range relative the baseline (before 1979) UV level,
4. UV increases over the continent, UV decreases over seas
5. Large uncertainty of the estimated UV level, i.e. for large European areas we could not find a statistically significant values