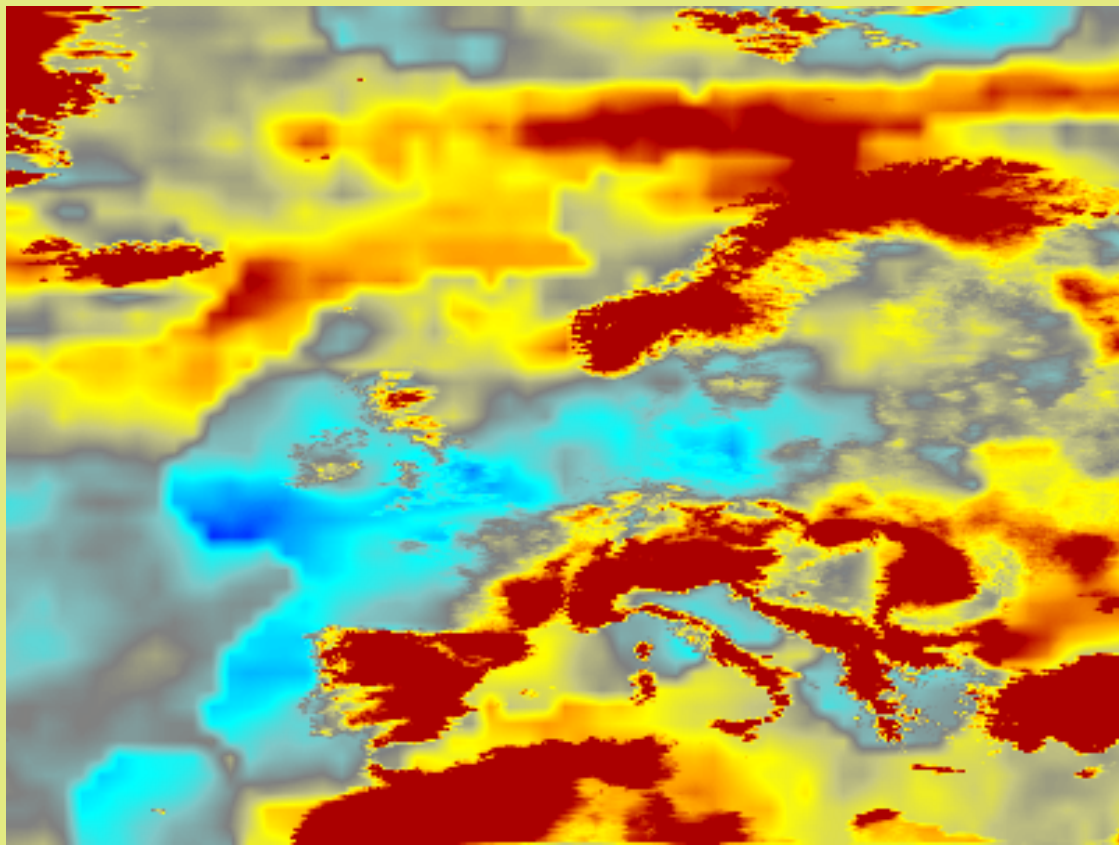


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## **Comparison of measured and modeled UV-radiation to validate ground and satellite based approaches for COST UV- reconstruction methods**

H. Slaper, P.N. den Outer

COST-726 final seminar, Warsaw May 2009

# Comparing ground based modelling and satellite based data in reconstruction

- Data-sources:

- COST-726 UV-mapping: Satellite derived station extracted data (Verdebout)

- COST-726 ozone (Krzyscin)

- ERA-40 CMF (Kaurola, FMI) modified to obtain CMF-Global (Staiger, DWD); modified to CMF-UV (den Outer, RIVM)

- Ground based UV-modelling (den Outer, Slaper, RIVM)

- ozone and pyranometer in combination with CMF-UV-algorithm (den Outer) and local information on aerosol (SCOUT-O3)

- UV-measurements

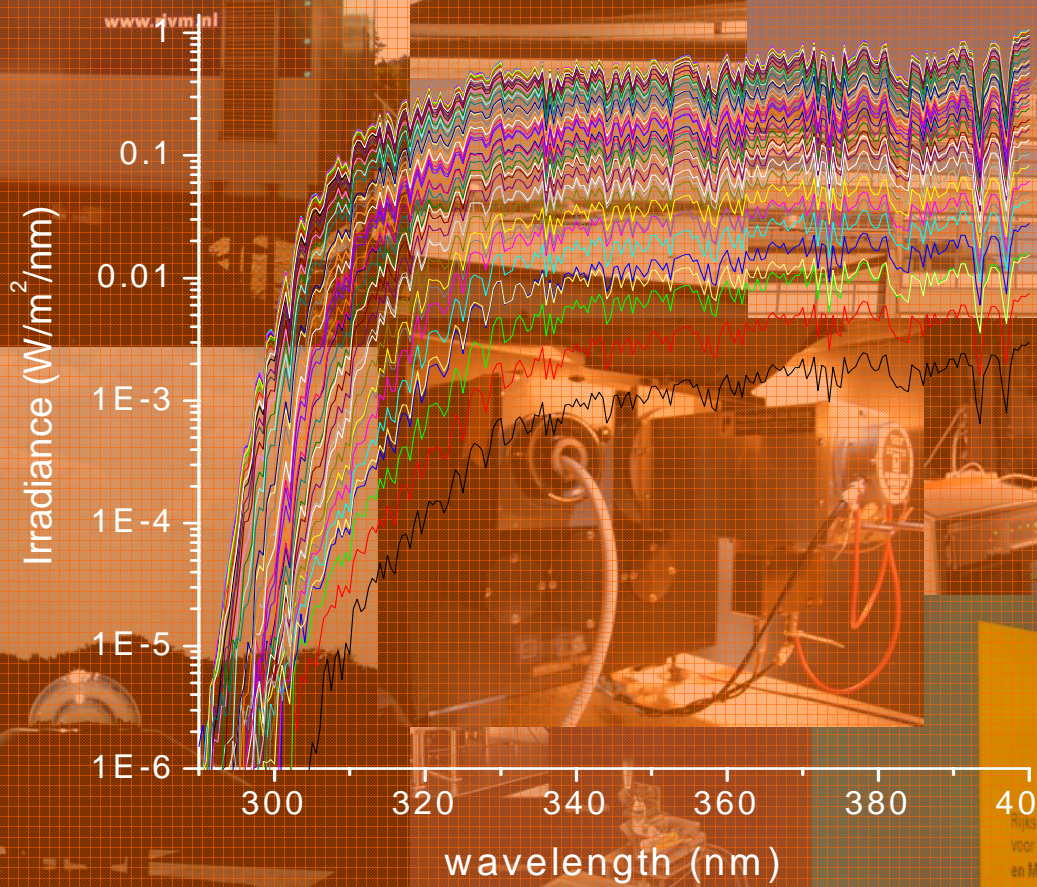
- 8 sites from SCOUT-O3 data set

- 4 additional sites from COST-726



Bilthoven, Lat.: 52.12° Long.:5.20°

### Analysed spectra

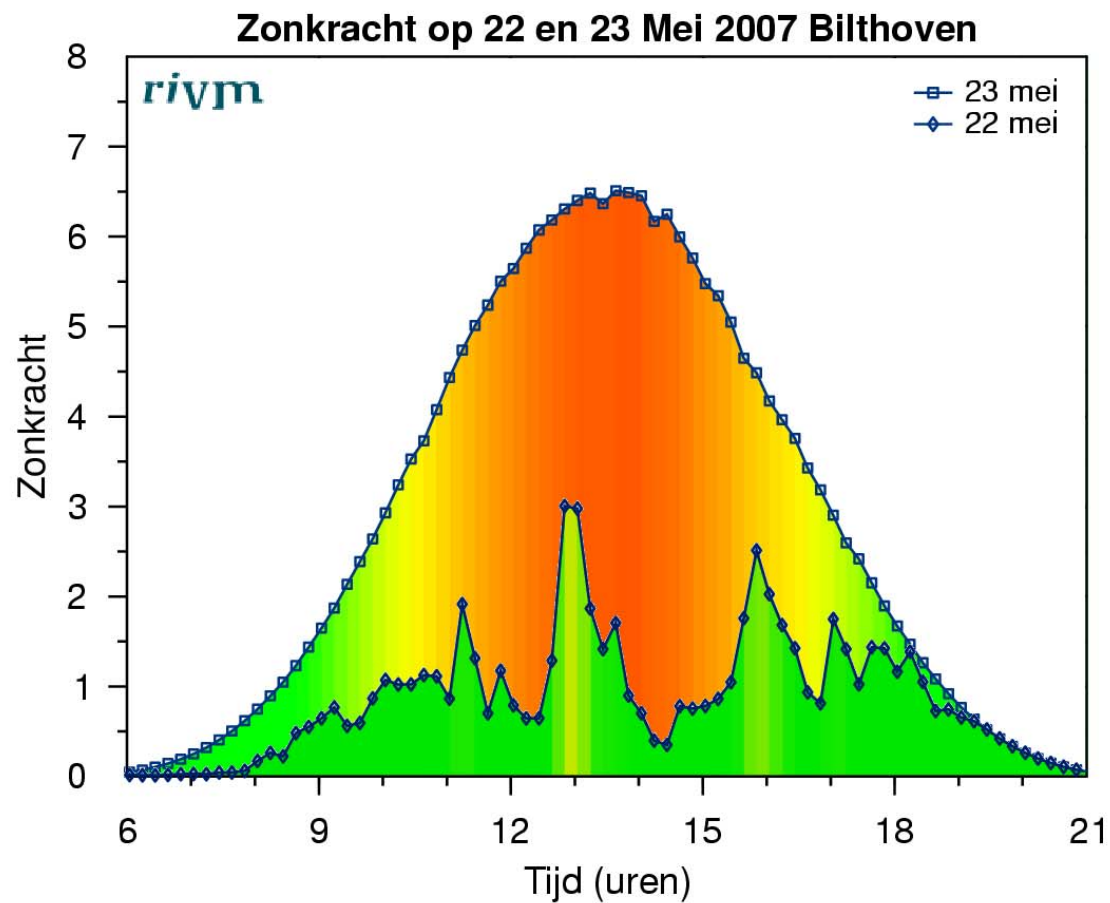


Solar UV measuring station

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# UV-index measurements in Bilthoven (daily pattern)

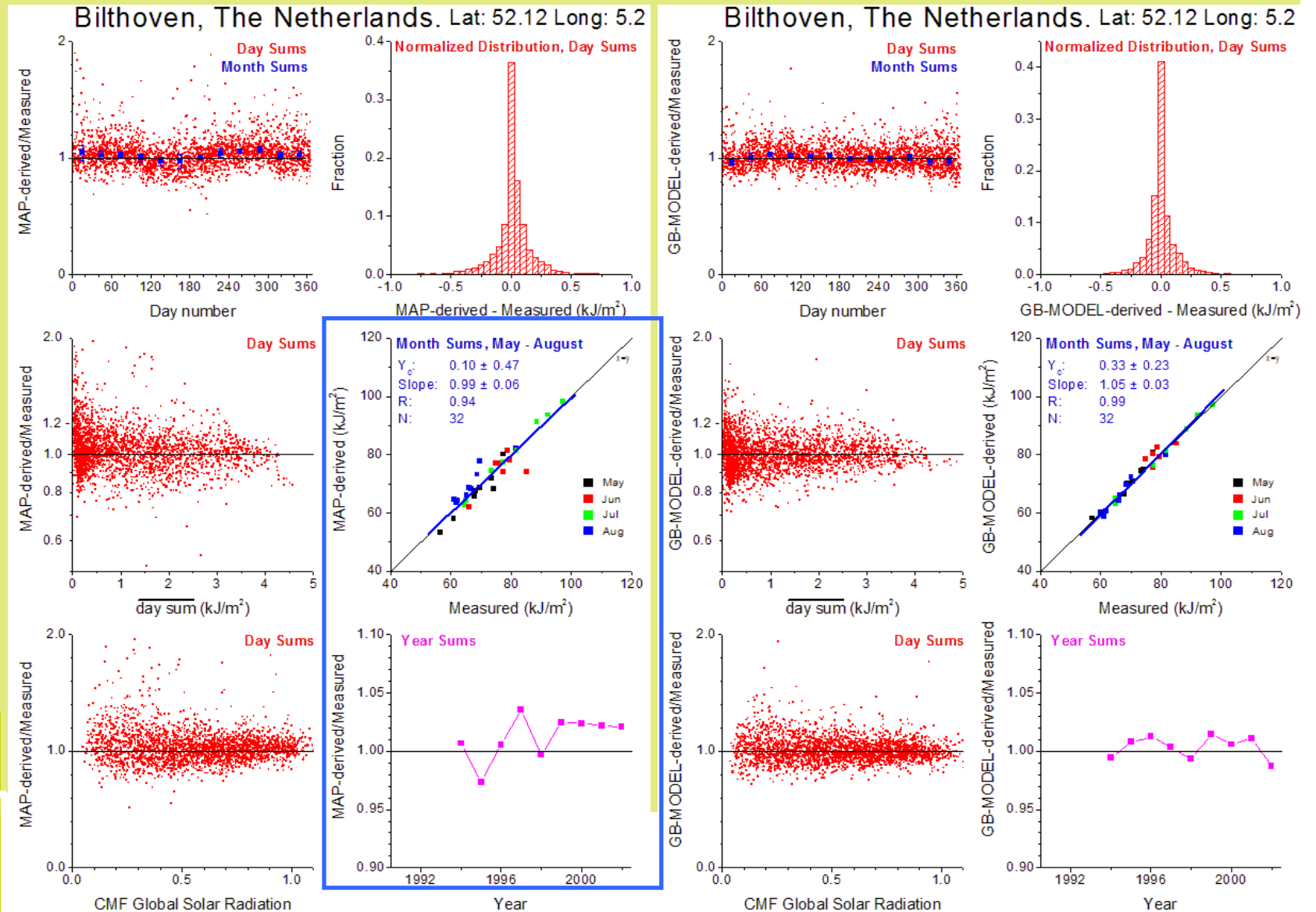


# Comparisons

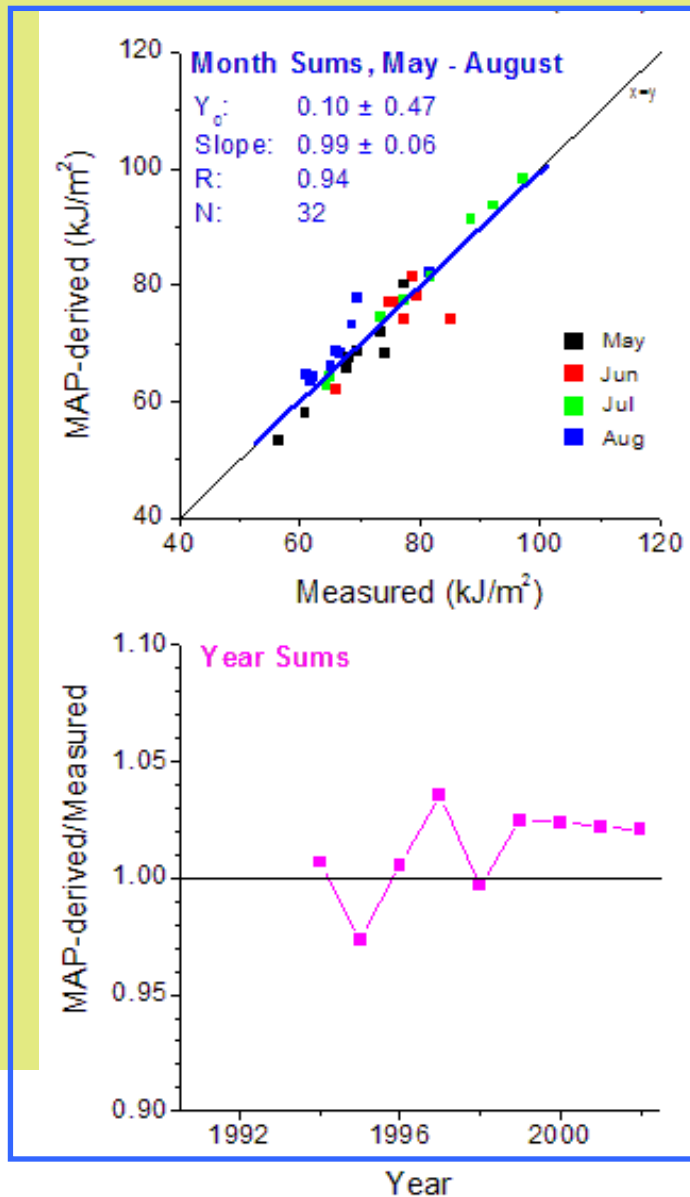
- Daily values (as provided by data-deliverers):
  - ratio Model / Measured
    - COST-map extracted (8+4 sites)
    - ground based modelling (8 sites)
  - all days and (statistics on May-August days only) (plot 1,2,3)
  - absolute difference = (Model - Measured) (plot 4)
- Monthly sums
  - > 14 days + supplementation
    - $\{(Me(\text{measured})/Mo) * (Mo(\text{full}))\}$
  - ratio's (plot 1)
  - correlation plot: Model versus measured (plot 5)
- Yearly sum + supplementation
  - > 220 days covered from measurements + supplementation
  - variability of yearly ratios (plot 6)



# Comparing Mapping and Ground based model with measured UV



# Inclusion criteria for monitoring stations

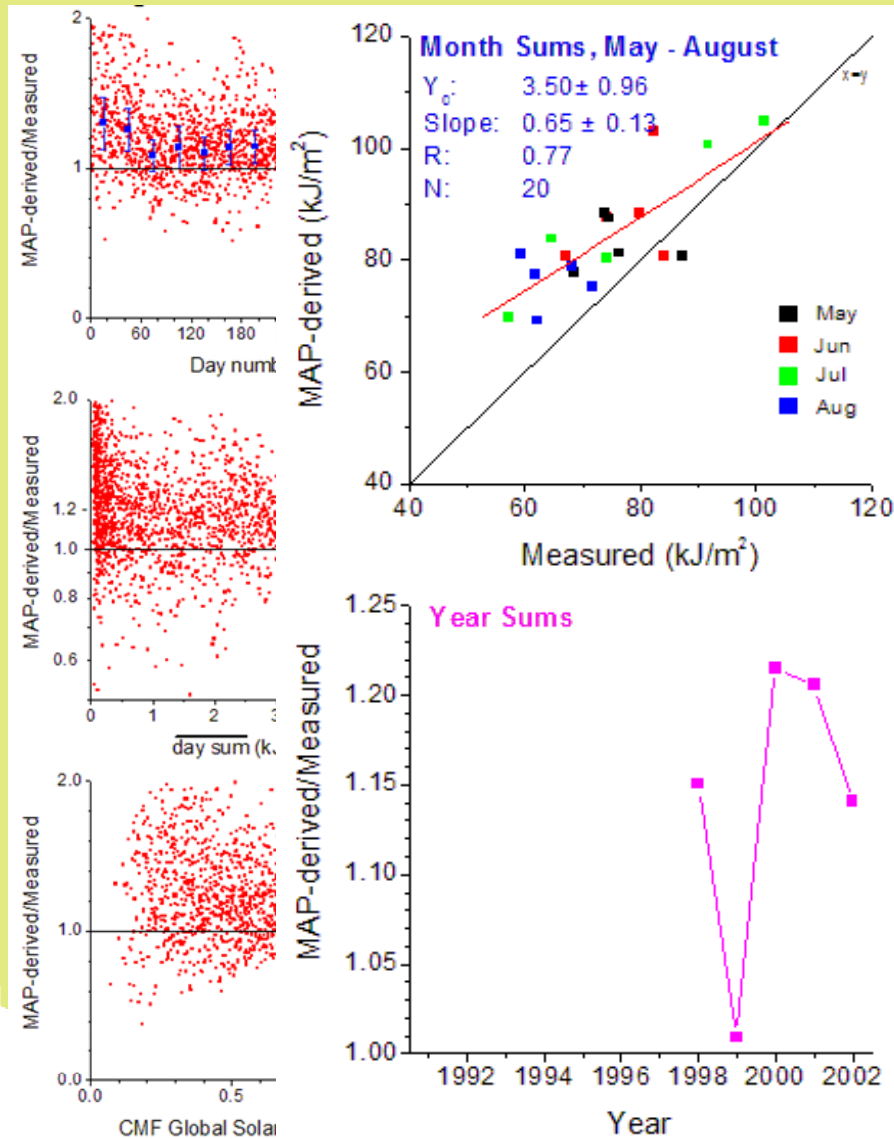


- at least 18 summer months (>14 days)

- one of three criteria should be met:

- slope Modelled versus Me  $>0.75$
- correlation Modelled versus Me  $>0.8$  for summer months (May-August)
- Year to year standard deviation in modelled to measured ratio  $< 0.05$

# Station not meeting criteria



Slope = 0.65 < 0.75 X

R = 0.77 < 0.80 X

stand.dev. = 0.082 > 0.05 X



# Stations included in overall validation COST-726

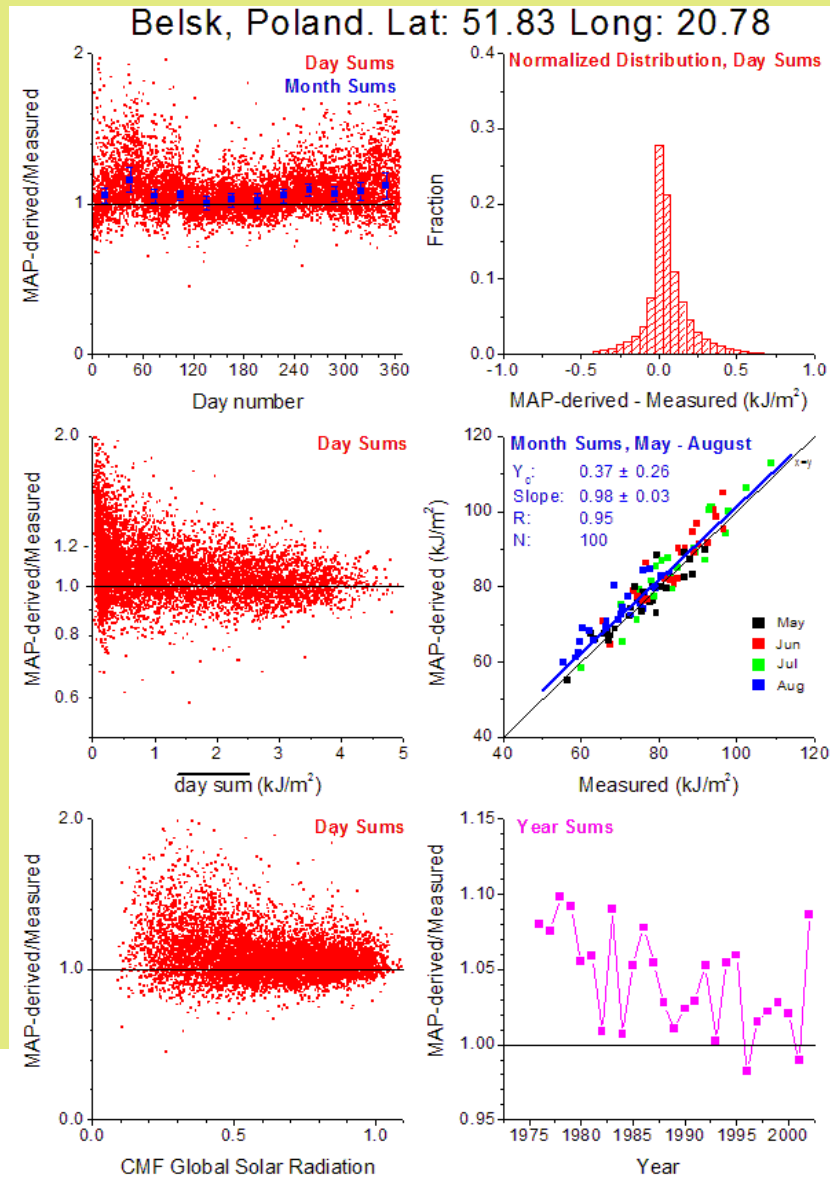
Location	Institute	Latitude N - Longitude E (deg.dec)	Instrument	Measured days, months, years	Groundbased ancillary modelling/ dependent cloud retrieval
Bergen, Norway	NRPA	60.38- 5.33	Multiband	2156, 72, 7	No / Yes
Belsk, Poland	IGFPAS	51.83 - 20.78	Broadband Brewer	8577, 307, 27	No / Yes
Davos, Switzerland	PMOD/WR C	46.81 - 9.84	Broad band	2384, 80, 7	No / Yes
Ispra, Italy	JRC/ISPRA	45.80 - 8.63	Brewer	2795, 100, 8	No / No

# Stations included in overall validation (SCOUT-O3)

Location	Institute	Latitude N - Longitude E (deg.dec)	Instrument	Measured days, months, years	Groundbased ancillary modelling/ dependent cloud retrieval
Sodankylä, Finland	FMI	67.36 - 26.63	Brewer MKII	2382, 88, 10	Yes / Yes
Jokioinen, Finland	FMI	60.81 - 23.49	Brewer MKIII	2295, 84, 8	Yes / Yes
Norrköping, Sweden	SMHI	58.58 - 16.15	Broadband	7111, 234, 20	Yes / No
Potsdam, Germany	DWD	52.36 - 13.08	Brewer MKII, MKIII	2177, 76, 7	Yes / Yes
Lindenberg, Germany	DWD	52.21 - 14.12	Brewer MKIV, SPECTRO 320D	1895, 71, 8	Yes / Yes
Bilthoven, The Netherlands	RIVM	52.12- 5.19	Broad band Dilor 2XY.50	2811, 97, 9	Yes / Yes
Hradec Kralove, Czech Republic	CHMI	50.18 - 15.83	Brewer MKIV	2396, 80, 7	Yes / Yes
Thessaloniki, Greece	LAP	40.63 - 22.95	Broad band	3728, 133, 11	Yes /Yes

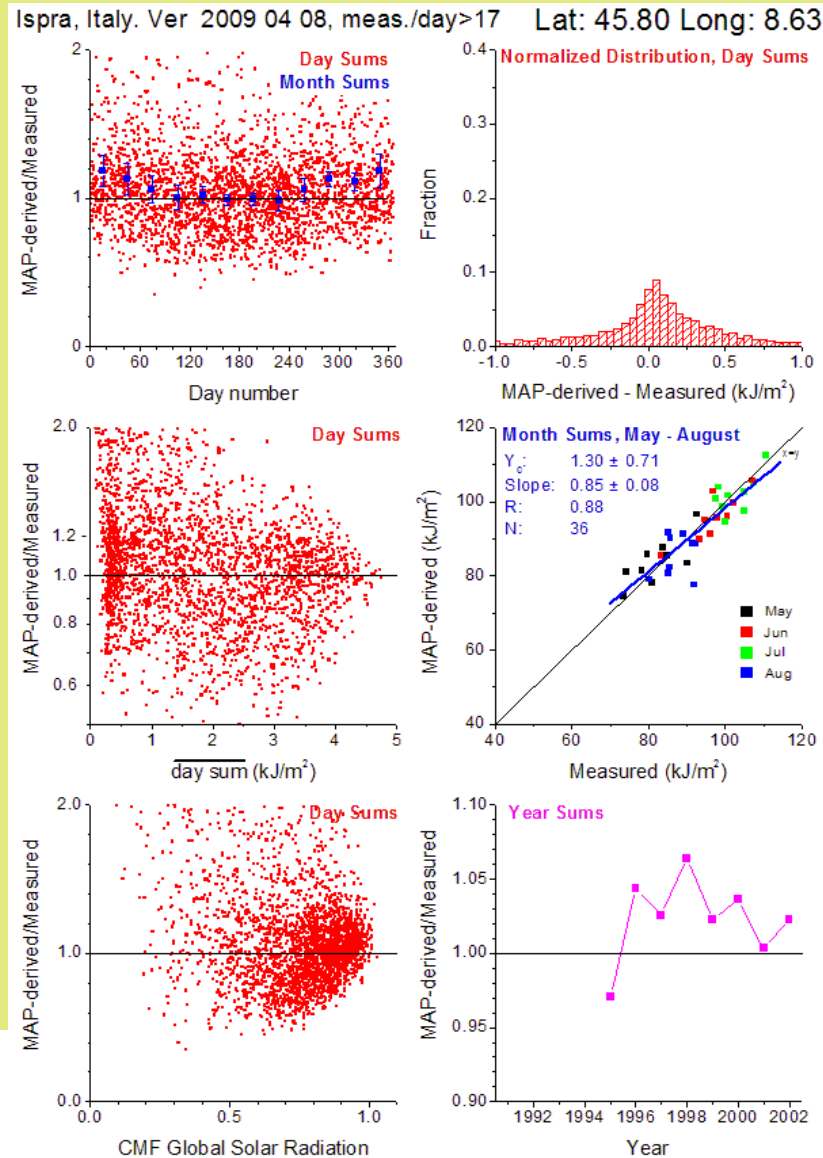
# Comparing COST UV-mapping with Belsk (PL) COST 726 measurements

Cloud retrieval dependent



# Comparing COST UV Mapping with Ispra (It) measured data

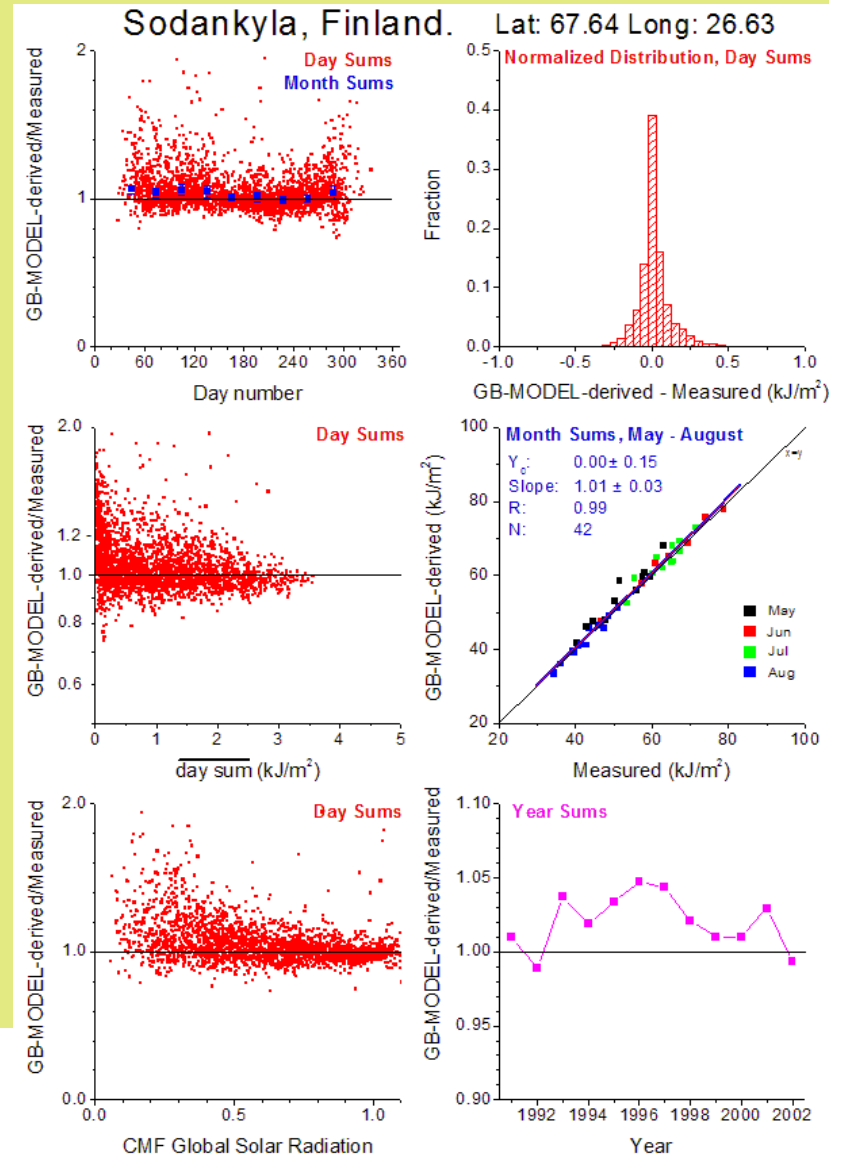
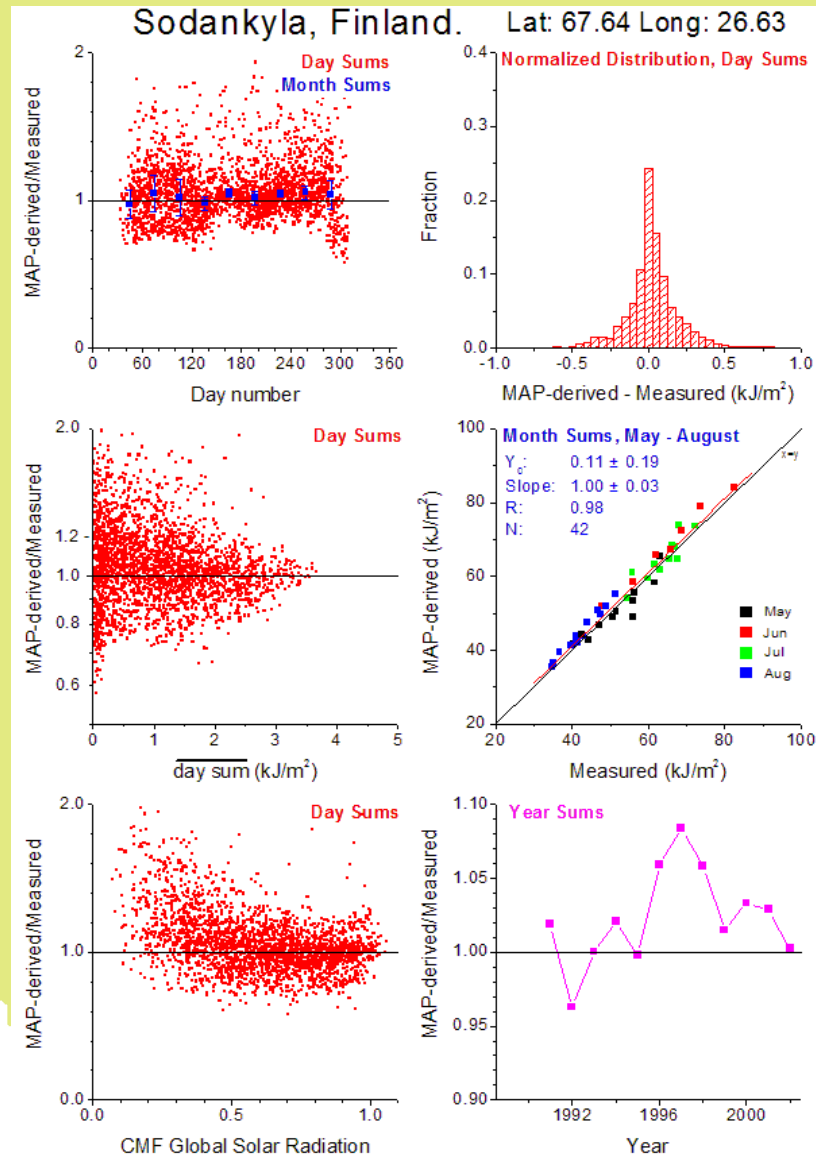
Cloud retrieval independent



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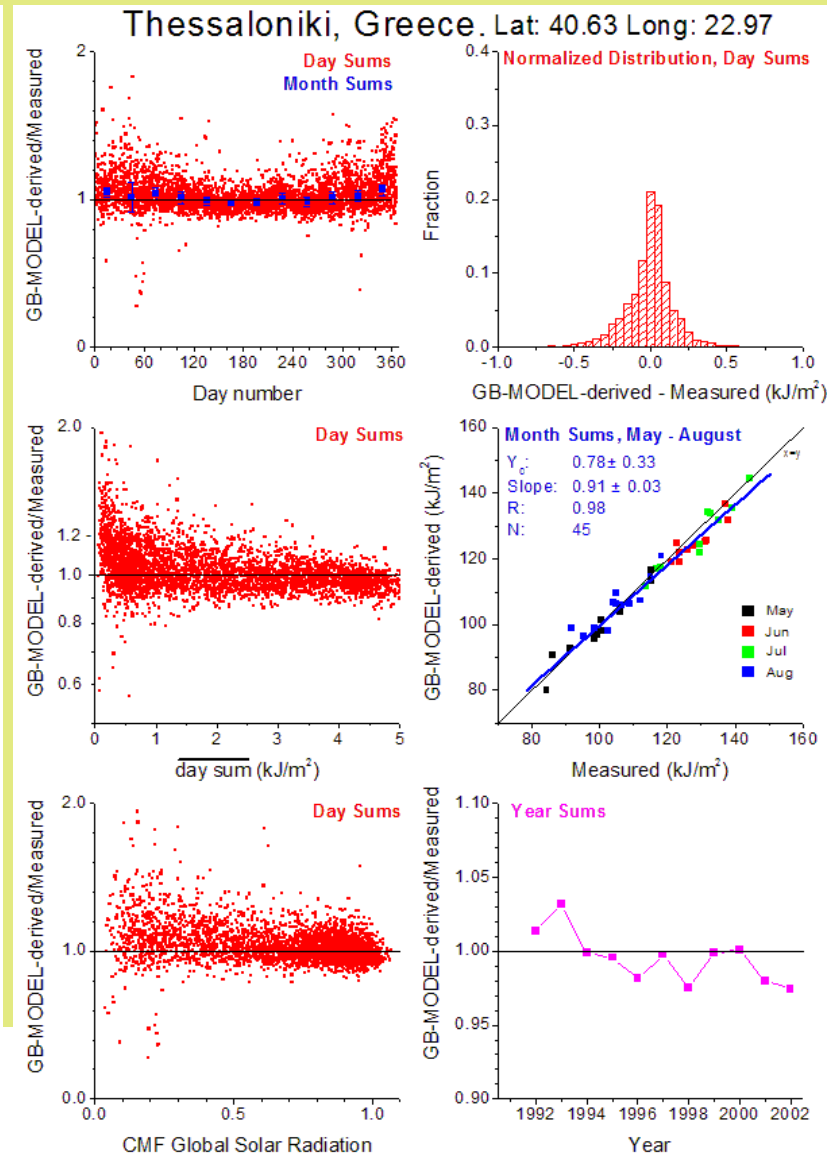
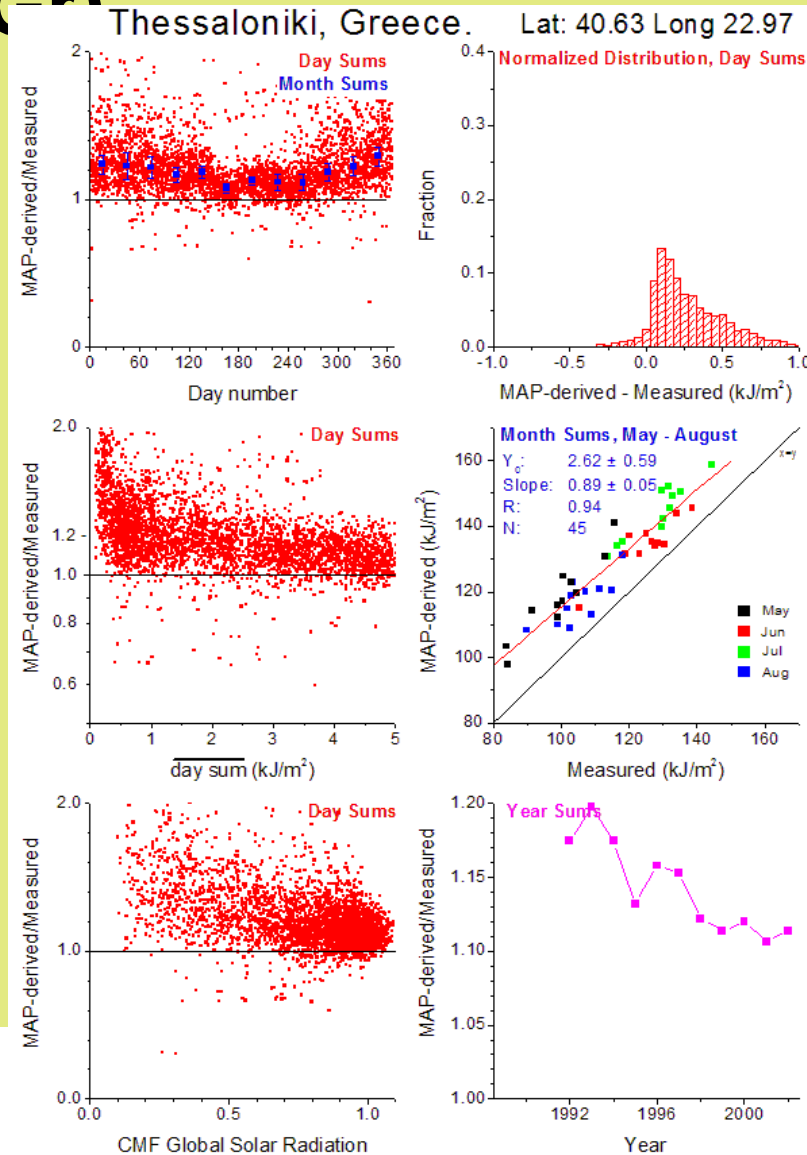
# Comparing Mapping and Ground based model with measured UV Sodankyla (Fi)





# Comparing Mapping and Ground based model with measured UV, Thessaloniki

(C)

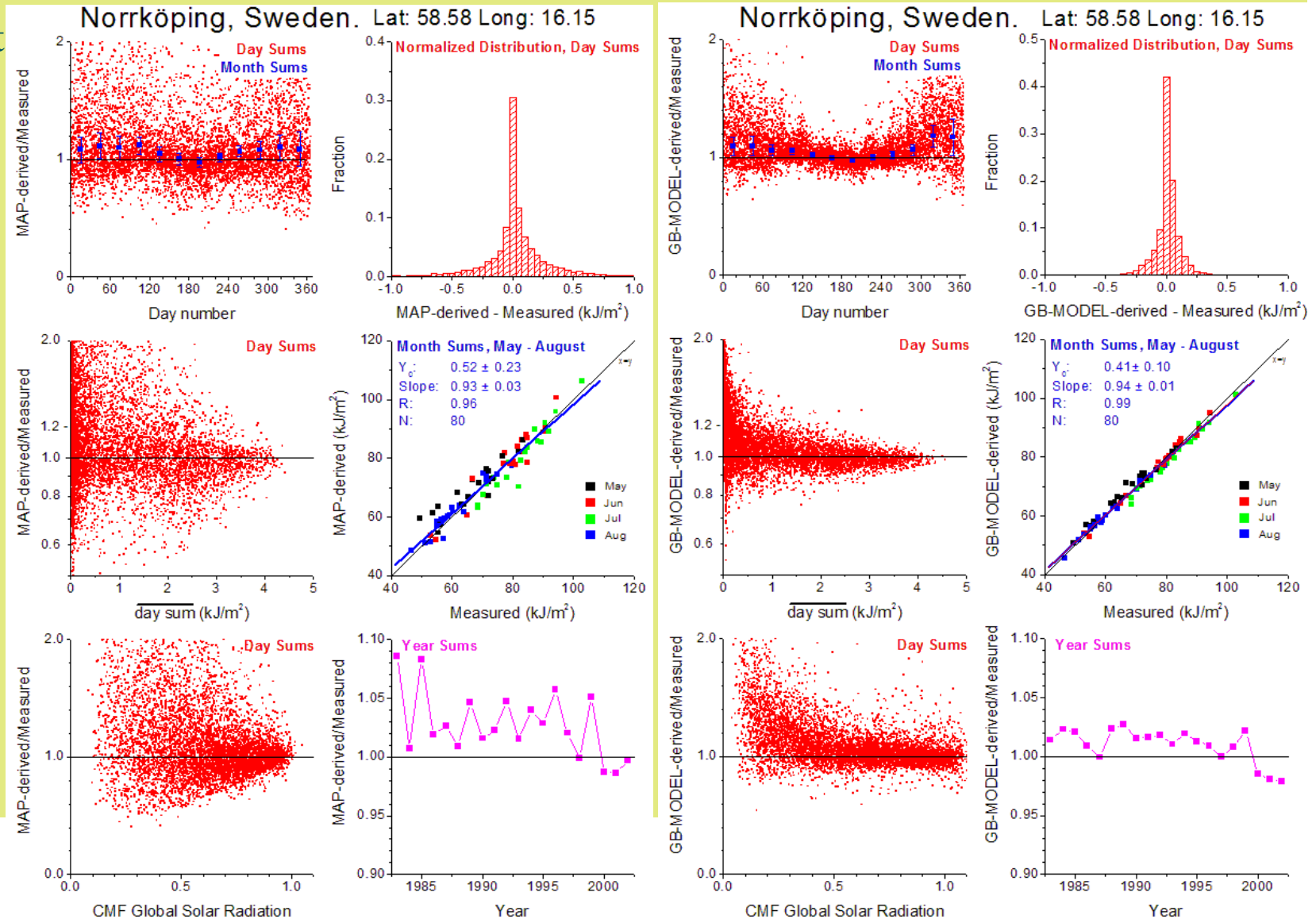


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# Comparing Mapping and Ground based model with measured UV, Norrköping

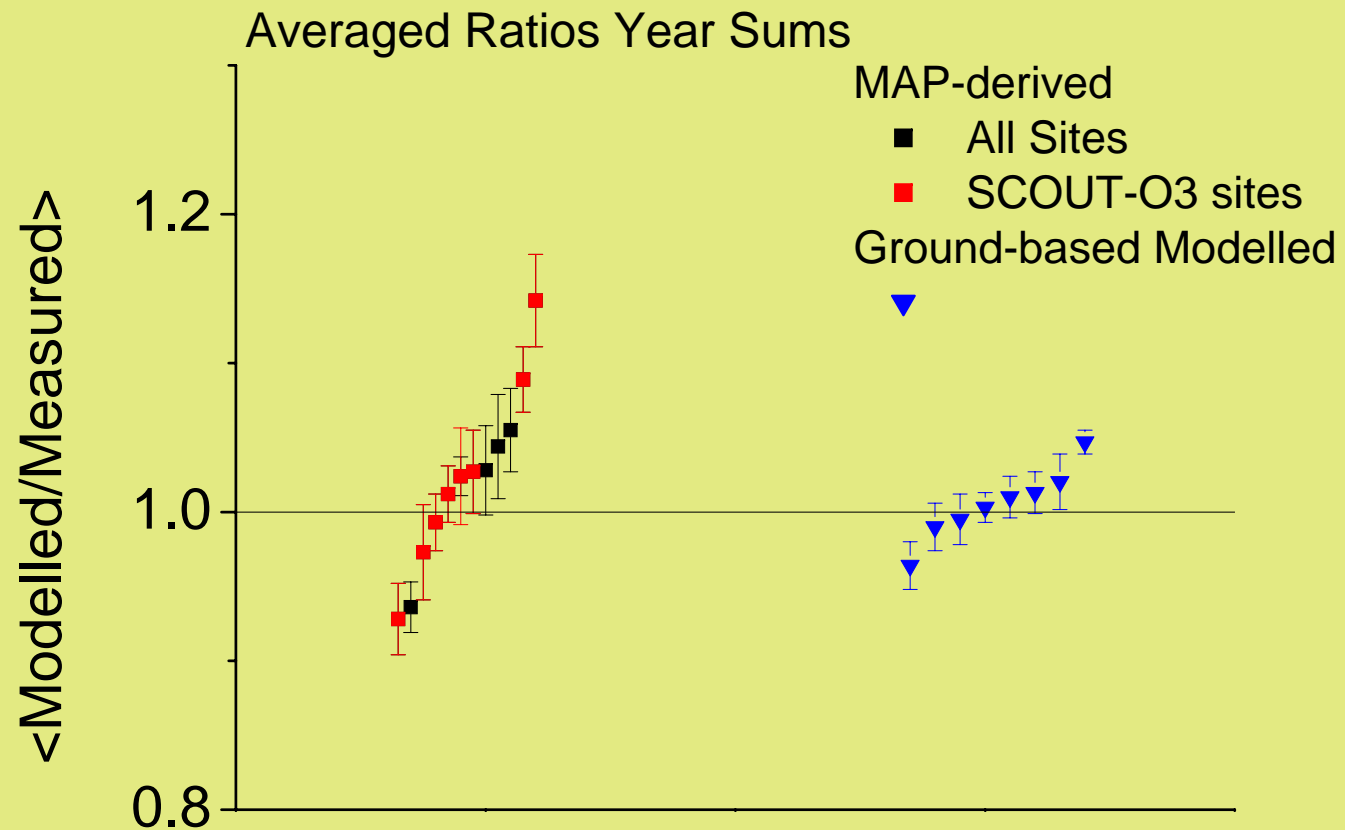
independent



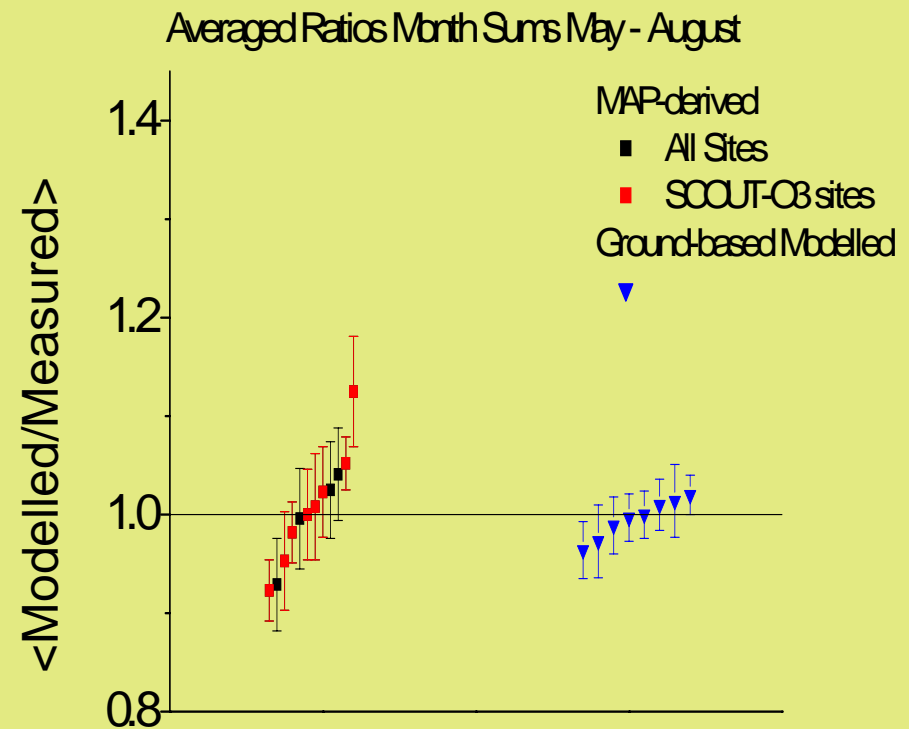
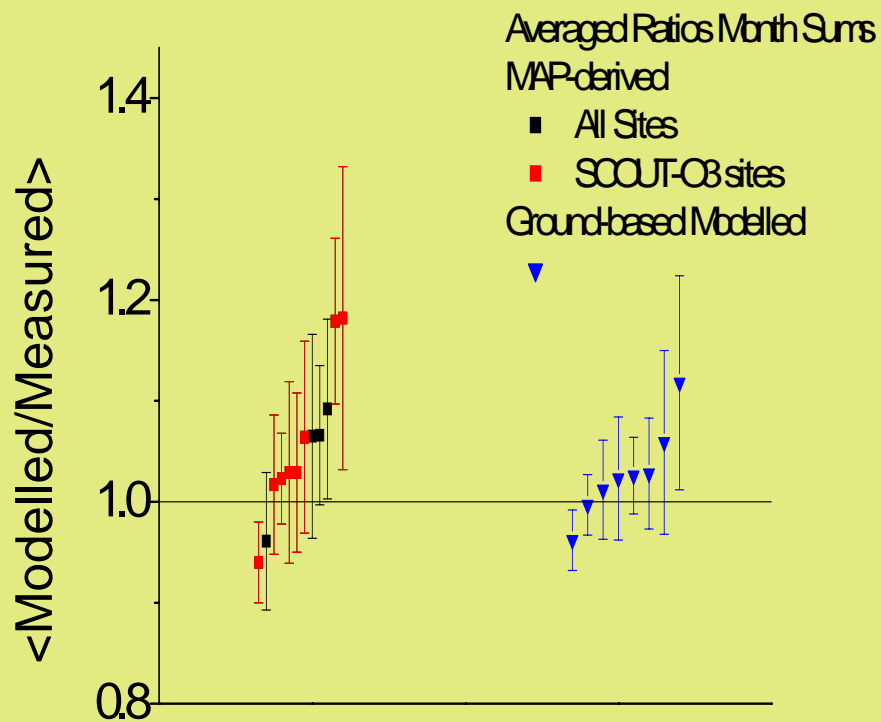
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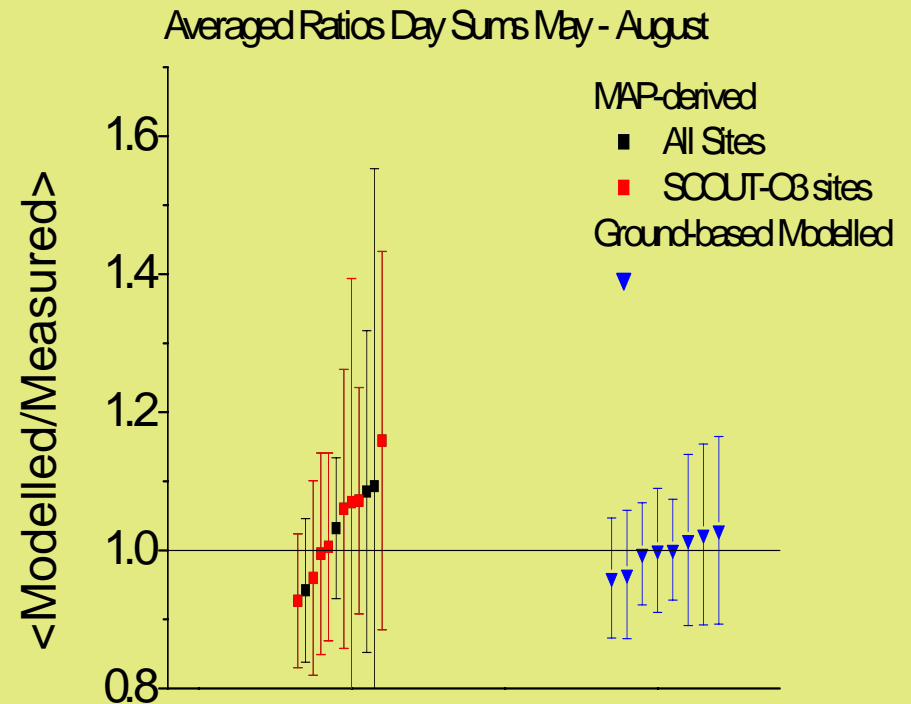
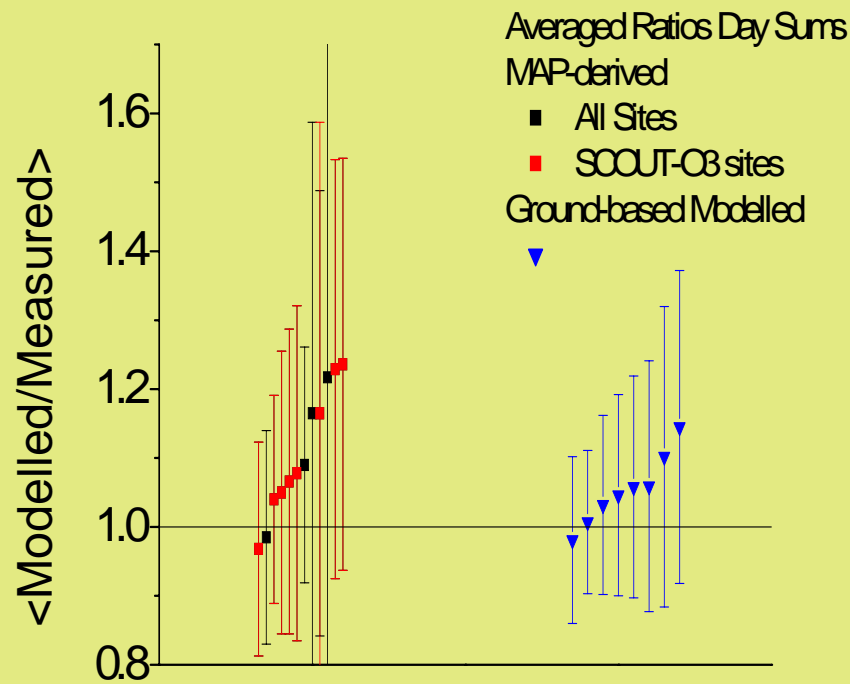
# Mapping (le) and ground based (ri) modelling versus measured



# Monthly comparison: Year round (left) versus summer months (right)



# Daily ratios: Year round (left) and summer months (right)





# Summary statistics for all included sites, all sites, all summer periods

		Cost-726 mapping 8 SCOUT-stations	Cost-726 mapping 4 additional	Ground based modeling (RIVM) 8 SCOUT-stations
Summer period (May-August)				
Monthly	Average ratio	1.008	0.998	0.996
	SD Site to site	0.062	0.049	0.020
	SD month to month	0.043	0.049	0.028
Daily	Average ratio	1.031	1.038	0.999
	SD Site to site	0.074	0.069	0.025
	SDday to day	0.186	0.225	0.101

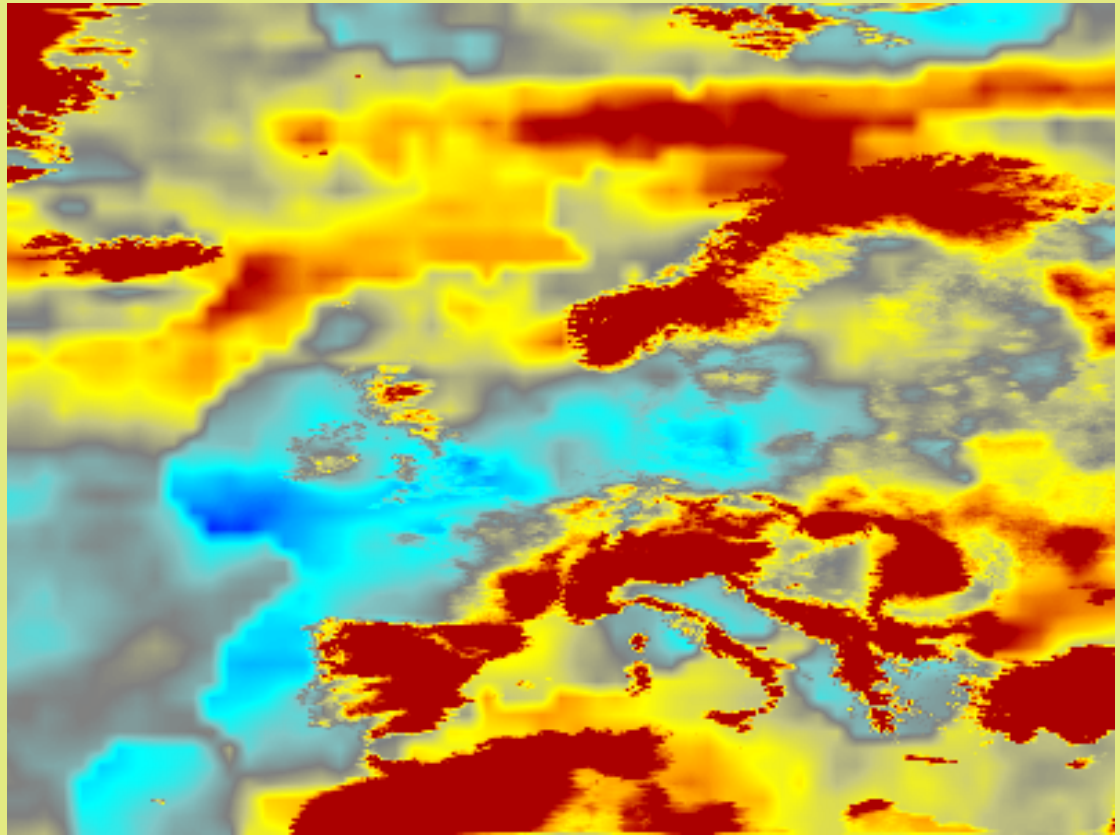
# Summary statistics for all included sites

Summary statistics for ratios of modeled versus measured daily, monthly and yearly UV-doses for all sites and data-years

		Cost-726 mapping 8 SCOUT-stations	Cost-726 mapping 4 additional	Ground based modeling (RIVM) 8 SCOUT-stations
Year	Average ratio	1.024	1.016	1.005
	SD Site to site	0.067	0.054	0.024
	SD year to year	0.024	0.028	0.014
Monthly	Average ratio	1.058	1.046	1.028
	SD Site to site	0.083	0.058	0.046
	SD month to month	0.081	0.082	0.058
Daily	Average ratio	1.104	1.114	1.054
	SD Site to site	0.096	0.101	0.052
	SD day to day	0.25	0.31	0.16

# Conclusions

- UV-doses from ground based modelling provides best estimates for long term change analysis, and day to day analysis
- UV-maps are very adequate on monthly and yearly basis
  - daily location specific estimates are uncertain (20-30%)
- Station based reconstruction is available at 8 sites in Europe (den Outer presentation tomorrow)
- Relative deviations up to nearly 15%; main uncertainty probably relates to aerosols (and clouds)
- uncertainty with respect to trends: 5 -10% (?) and location dependent (and stability of input data)



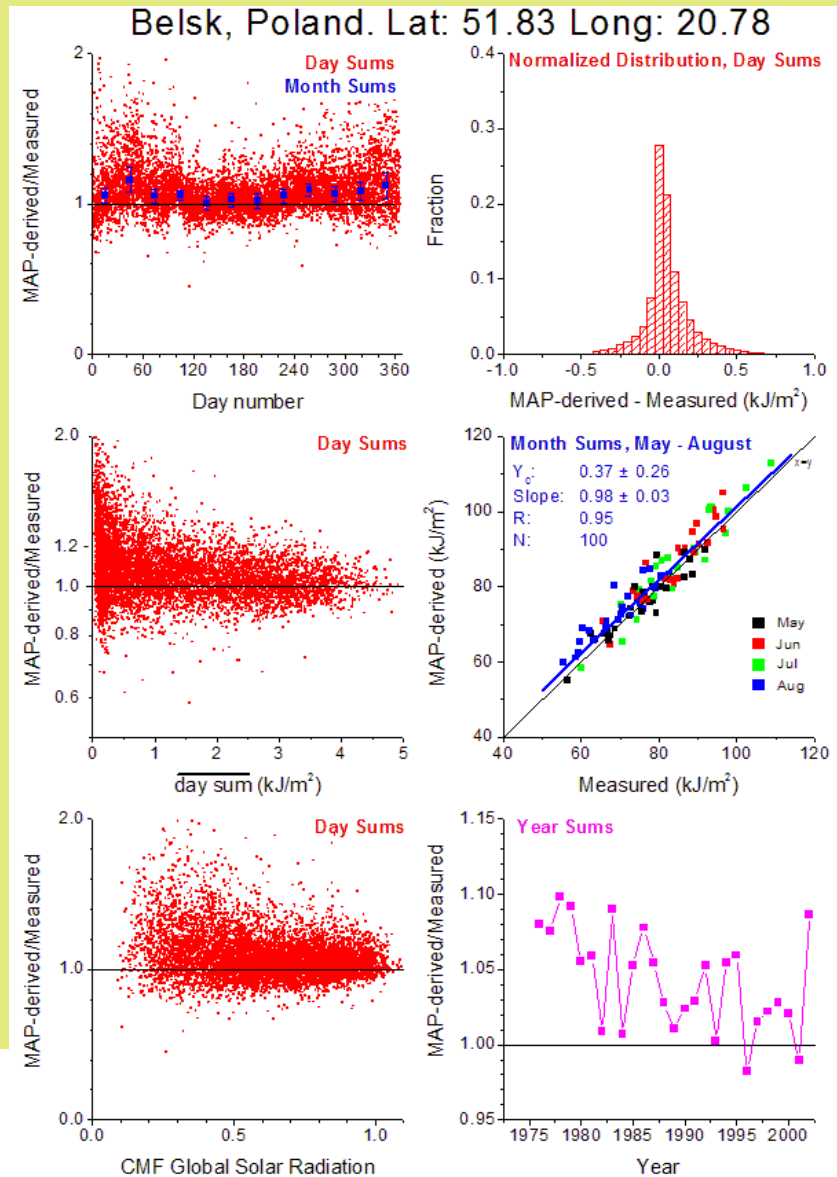
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**Thanks for the attention**

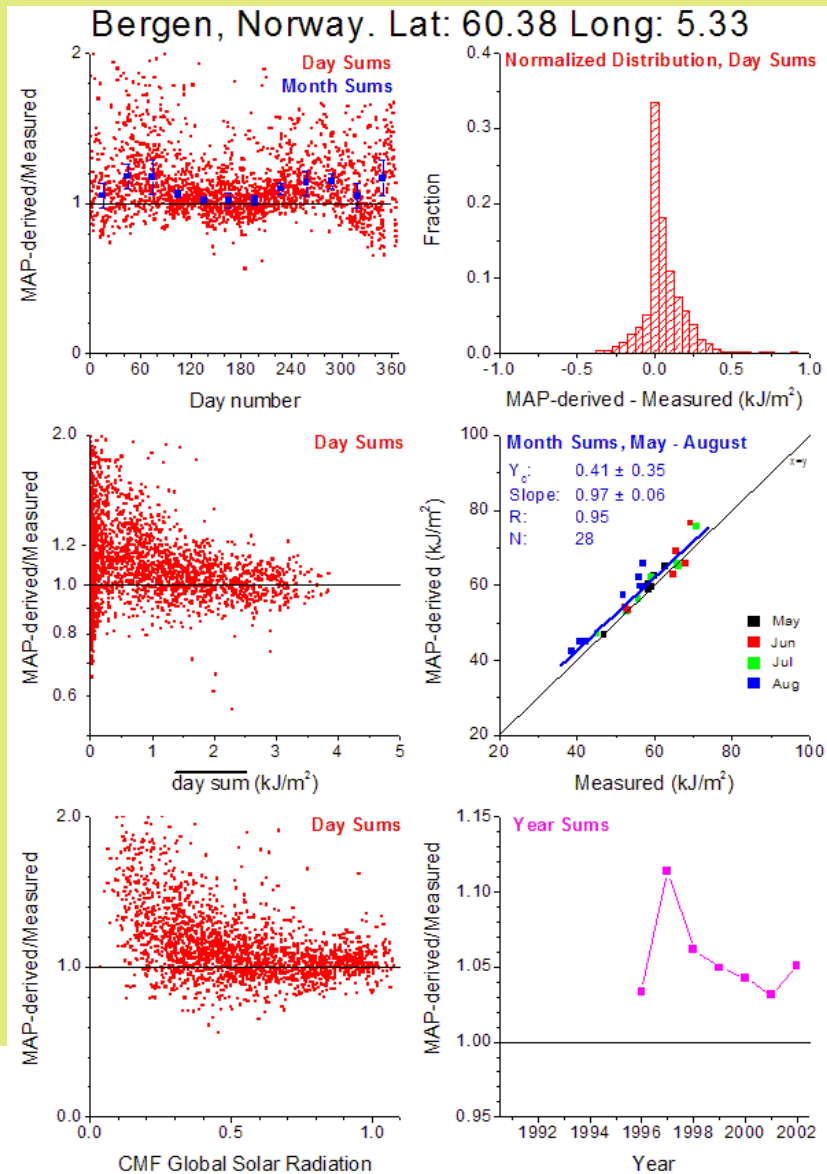
Harry Slaper, Peter den Outer, Arjan van Dijk

# Comparing mapping with UV-measurements

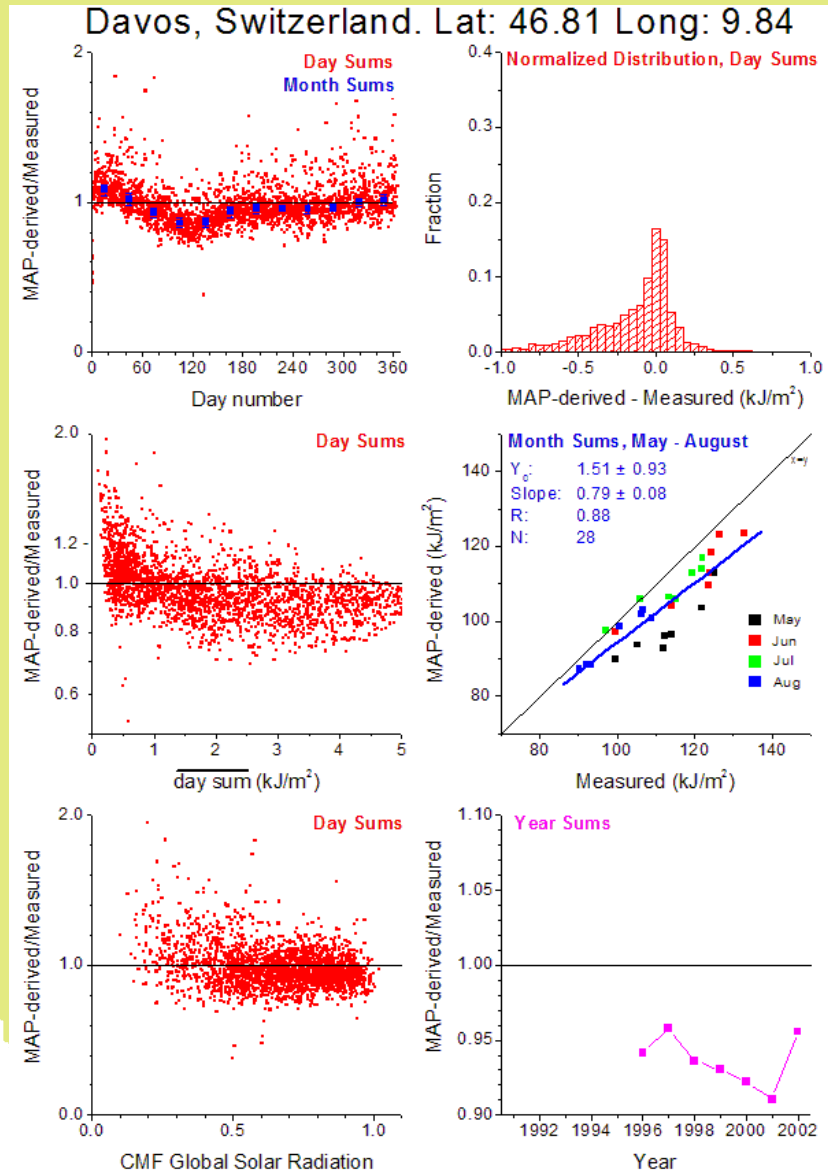




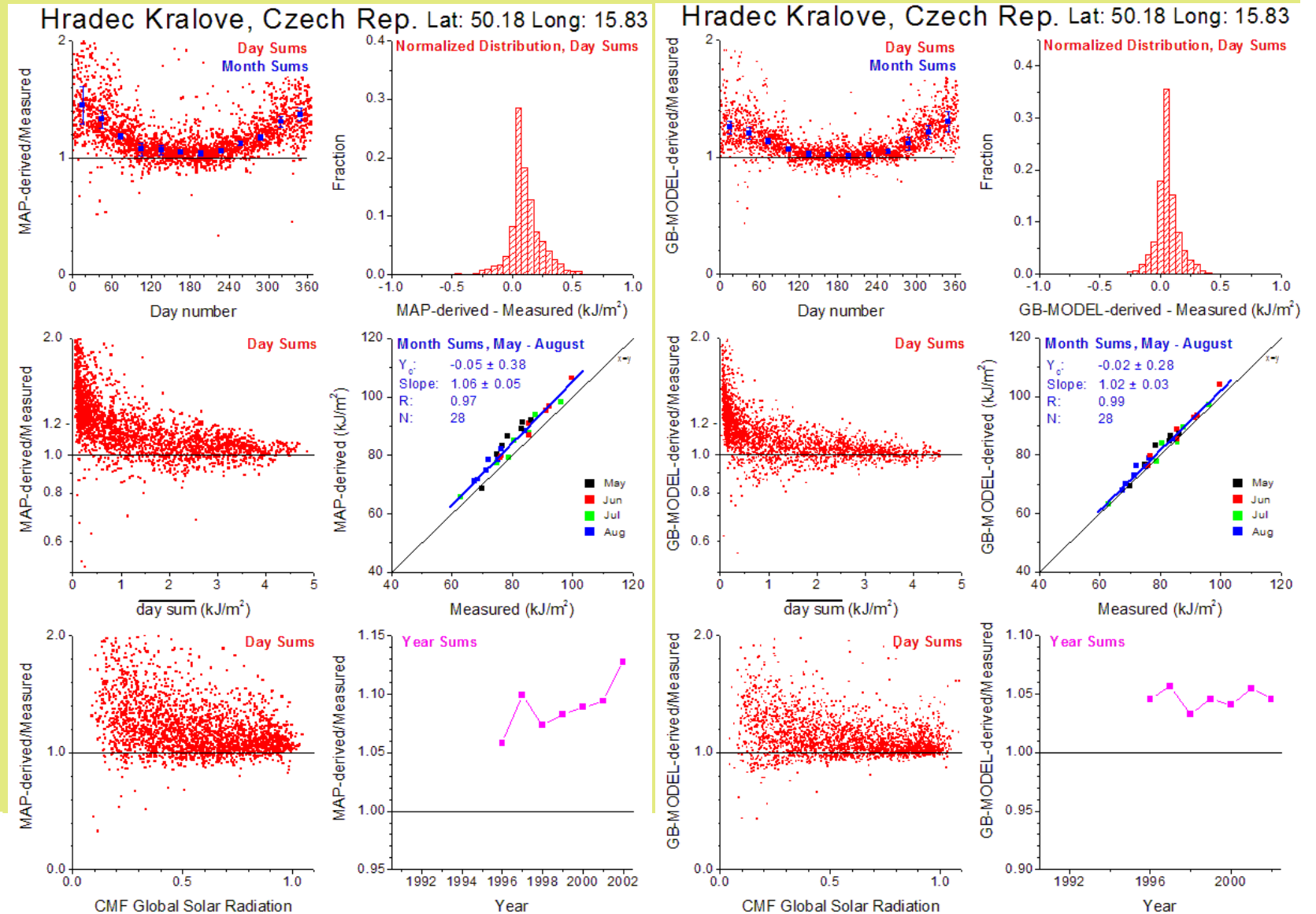
# Comparing mapping with UV-measurements



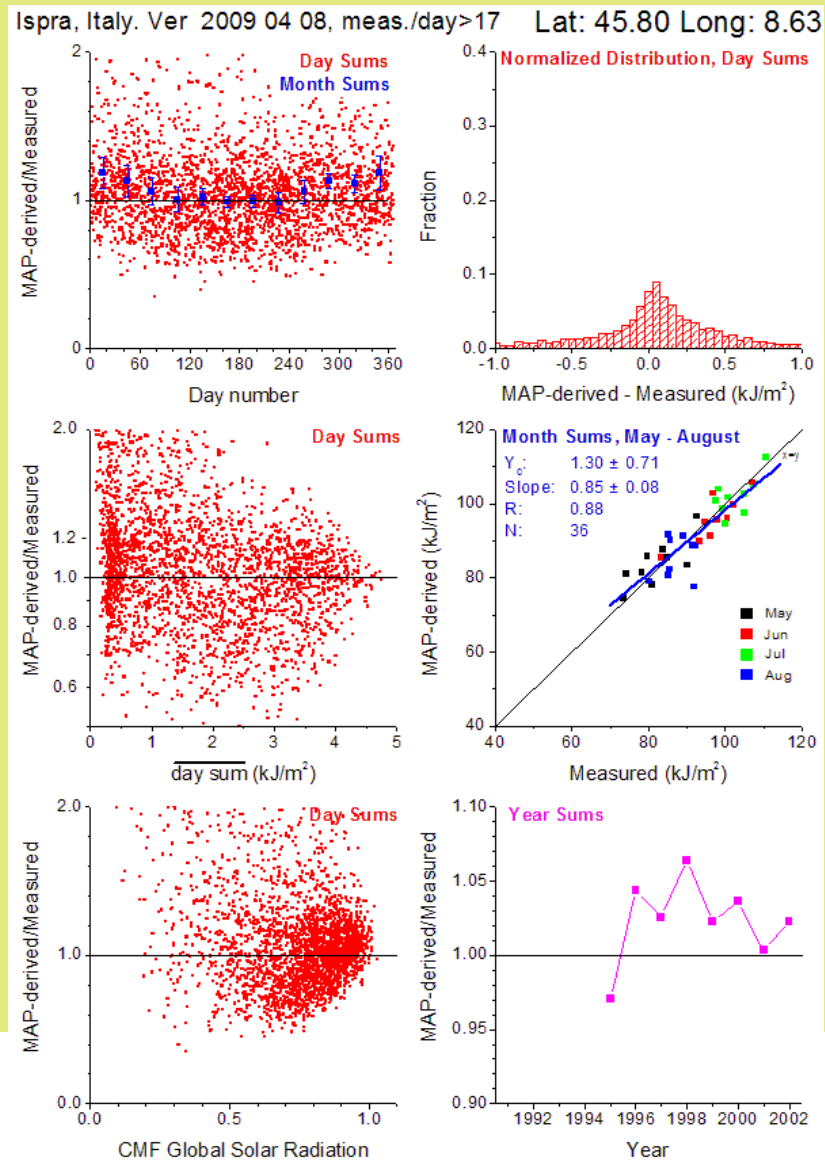
# Comparing mapping with UV-measurements



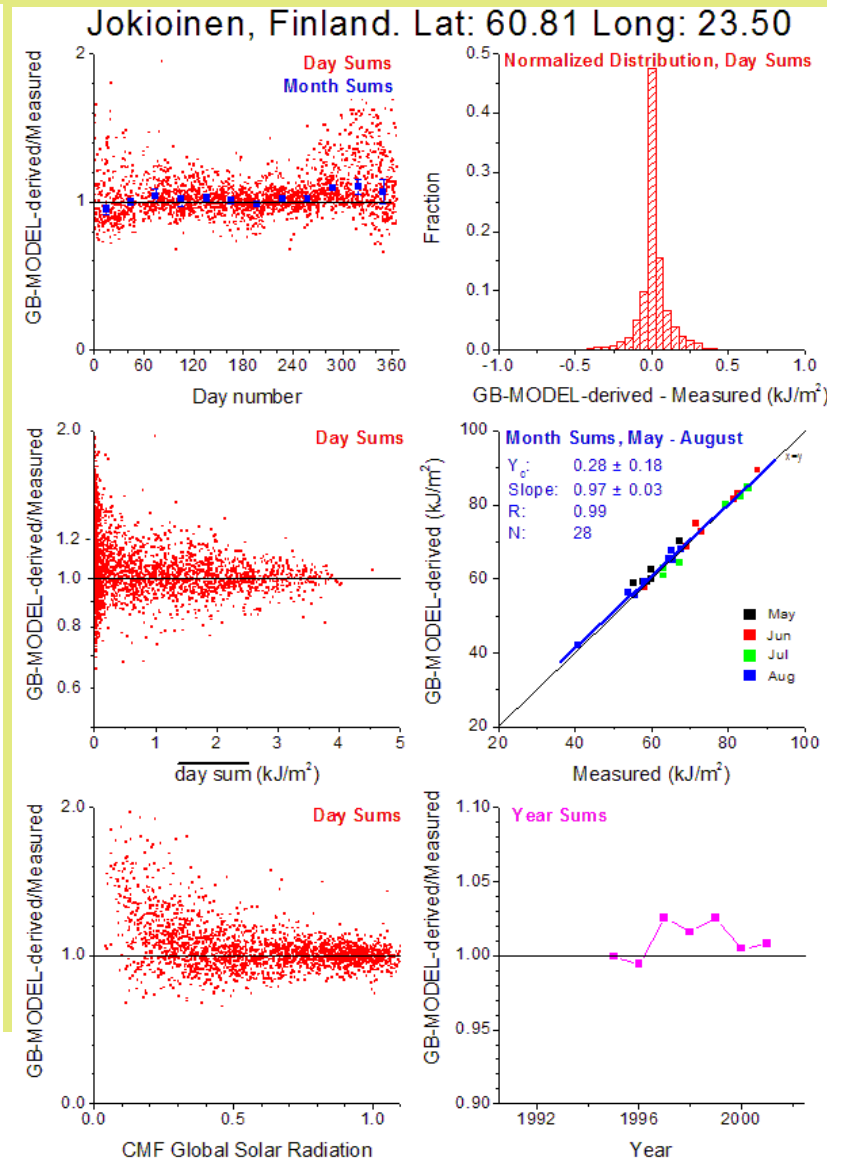
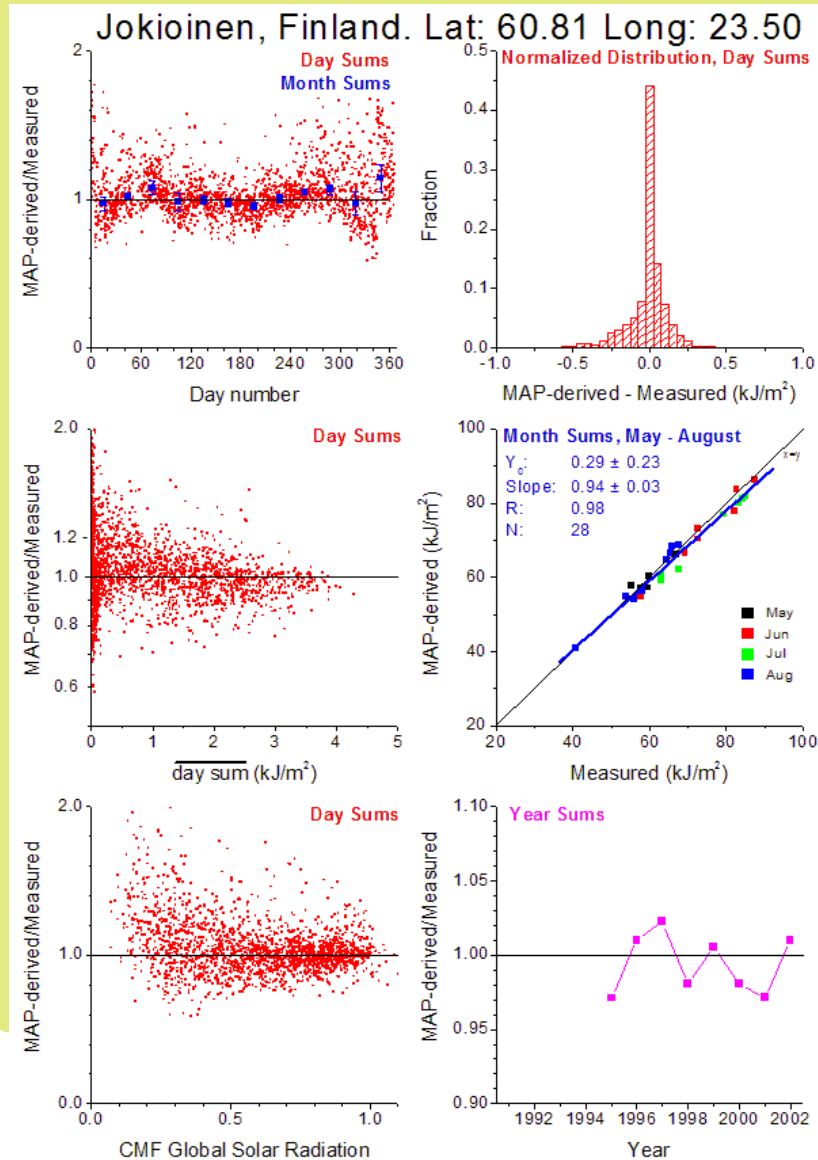
# Comparing Mapping and Ground based model with measured UV



# Comparing Mapping and Ground based model with measured UV



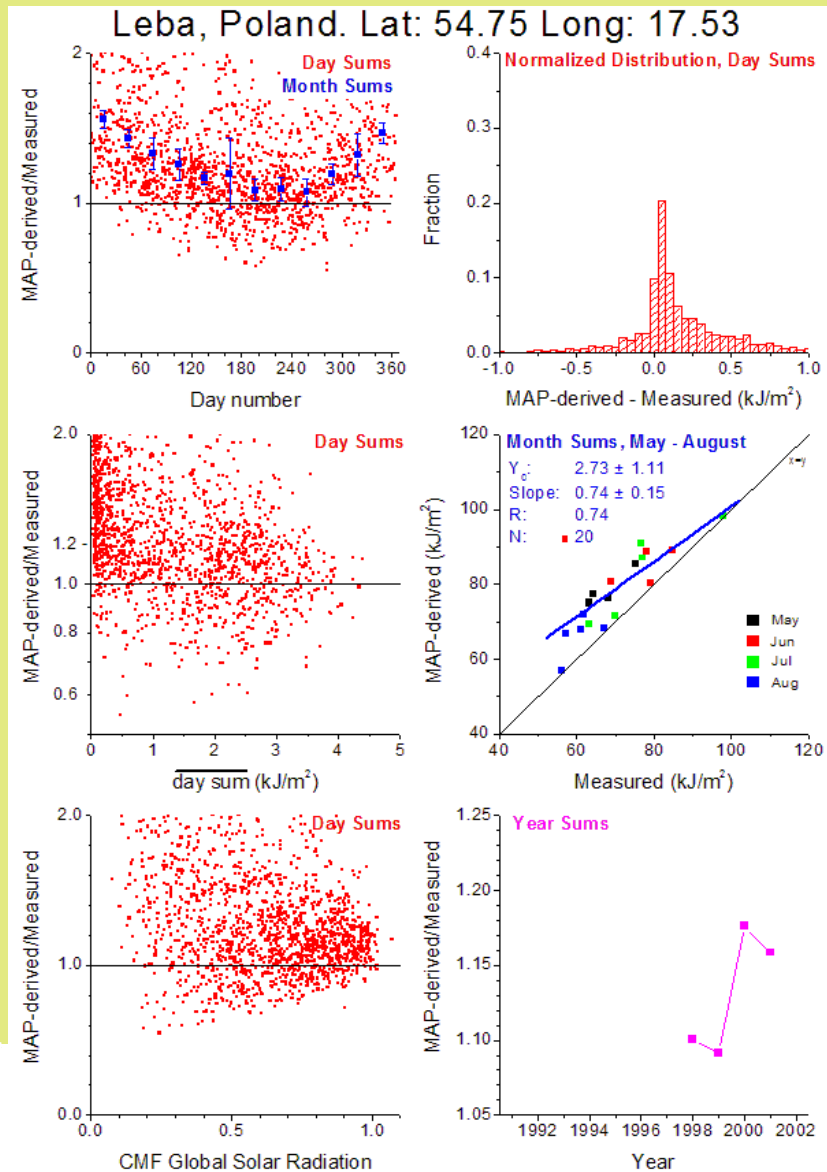
# Comparing Mapping and Ground based model with measured UV



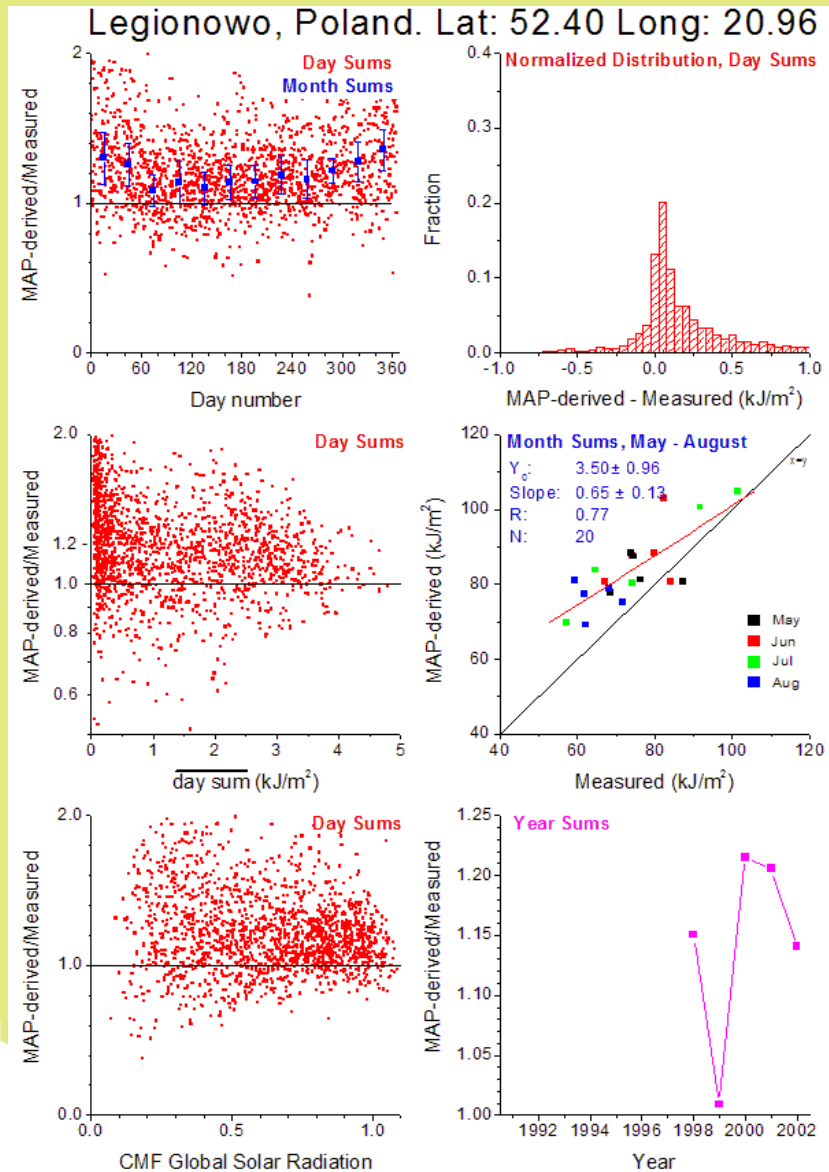
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# Comparing mapping with UV-measurements

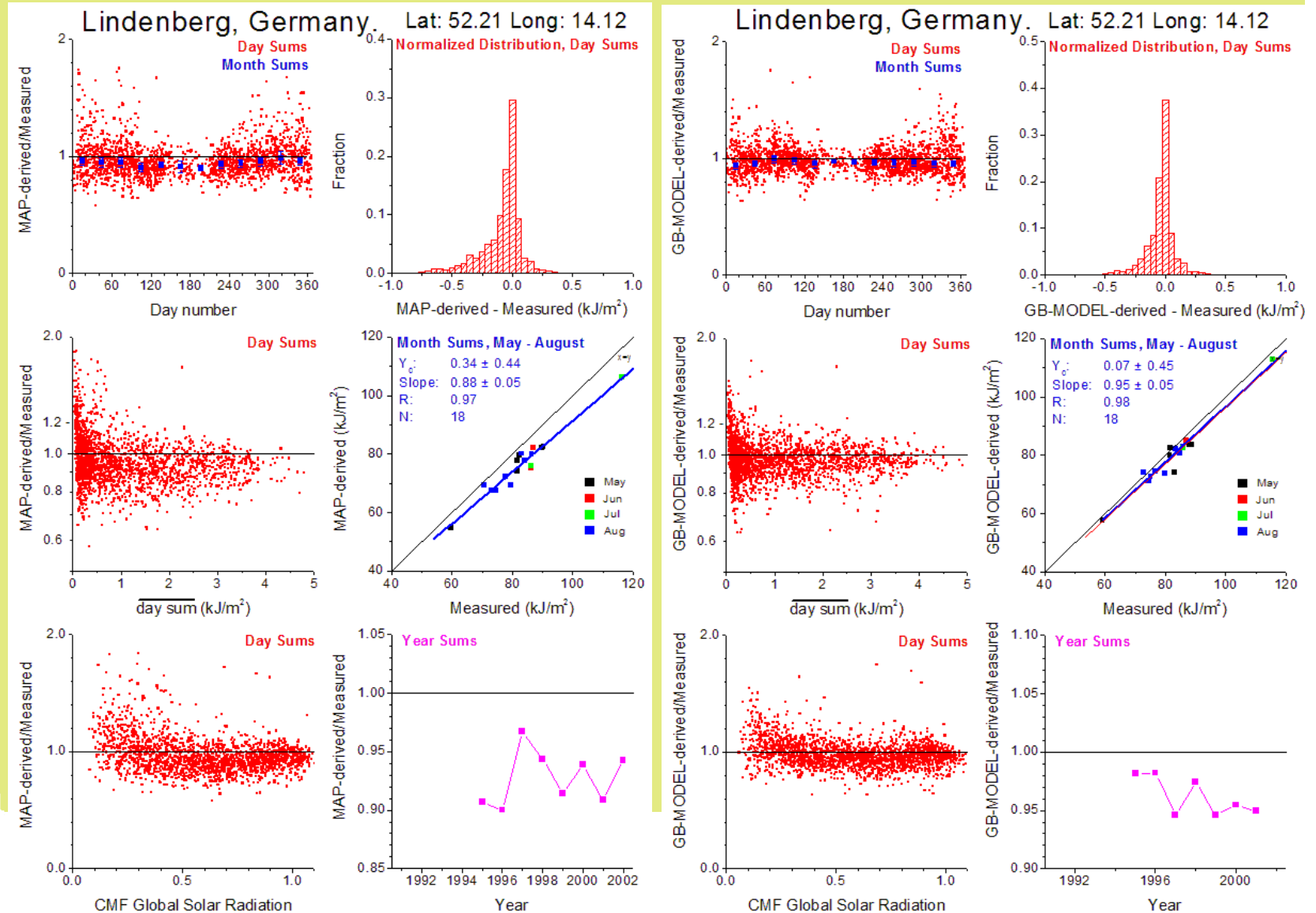


# Comparing mapping with UV-measurements





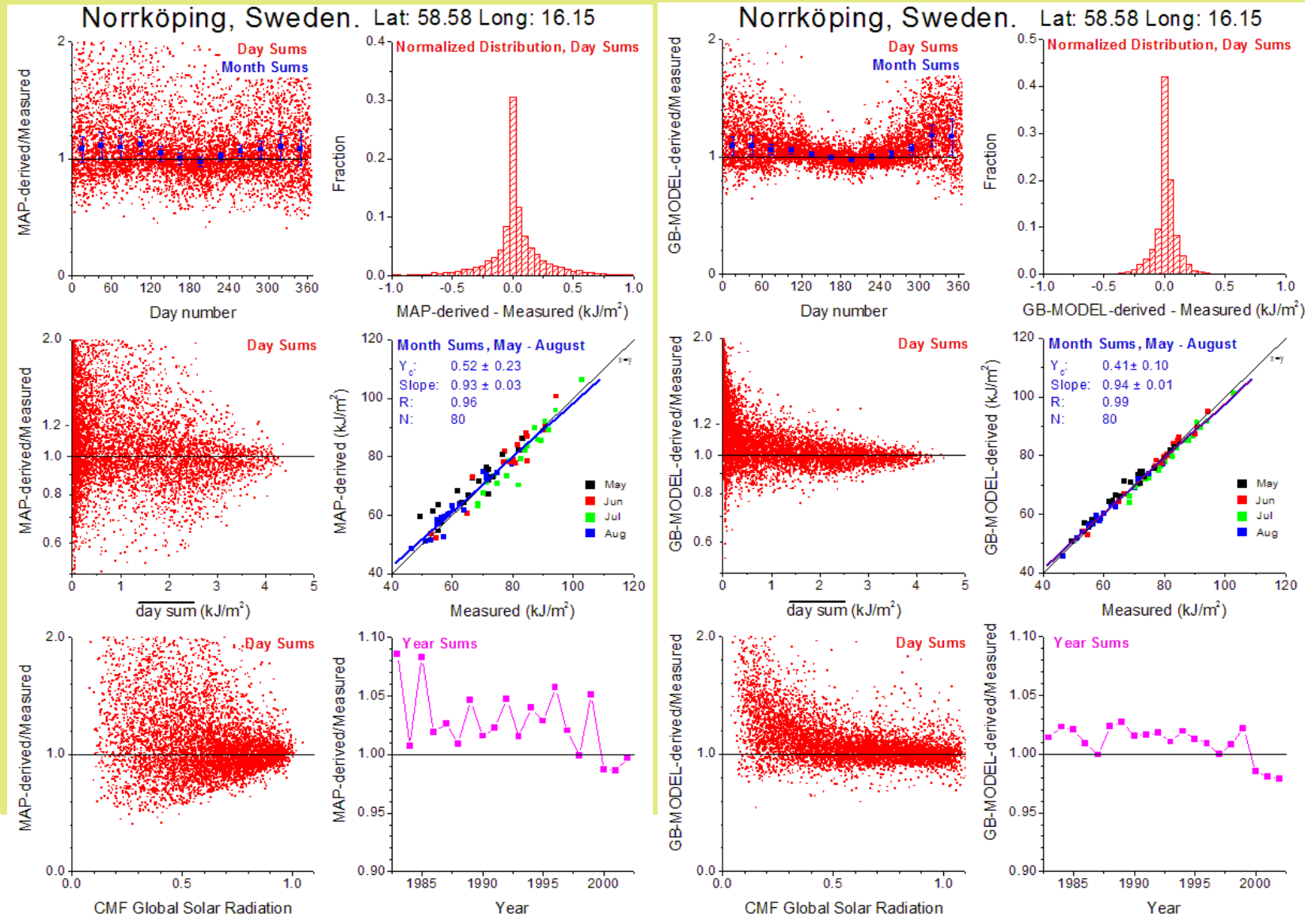
# Comparing Mapping and Ground based model with measured UV



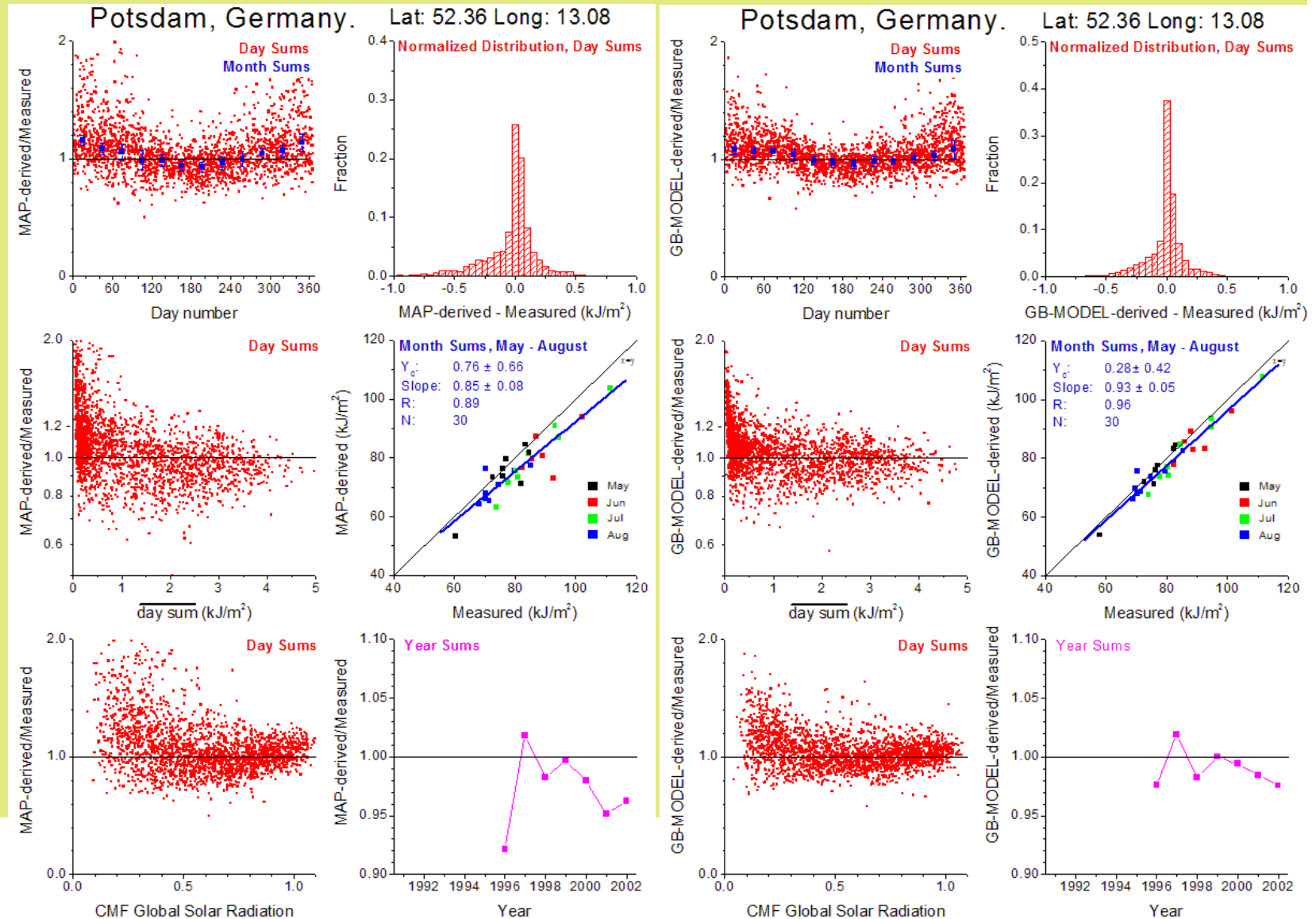
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# Comparing Mapping and Ground based model with measured UV



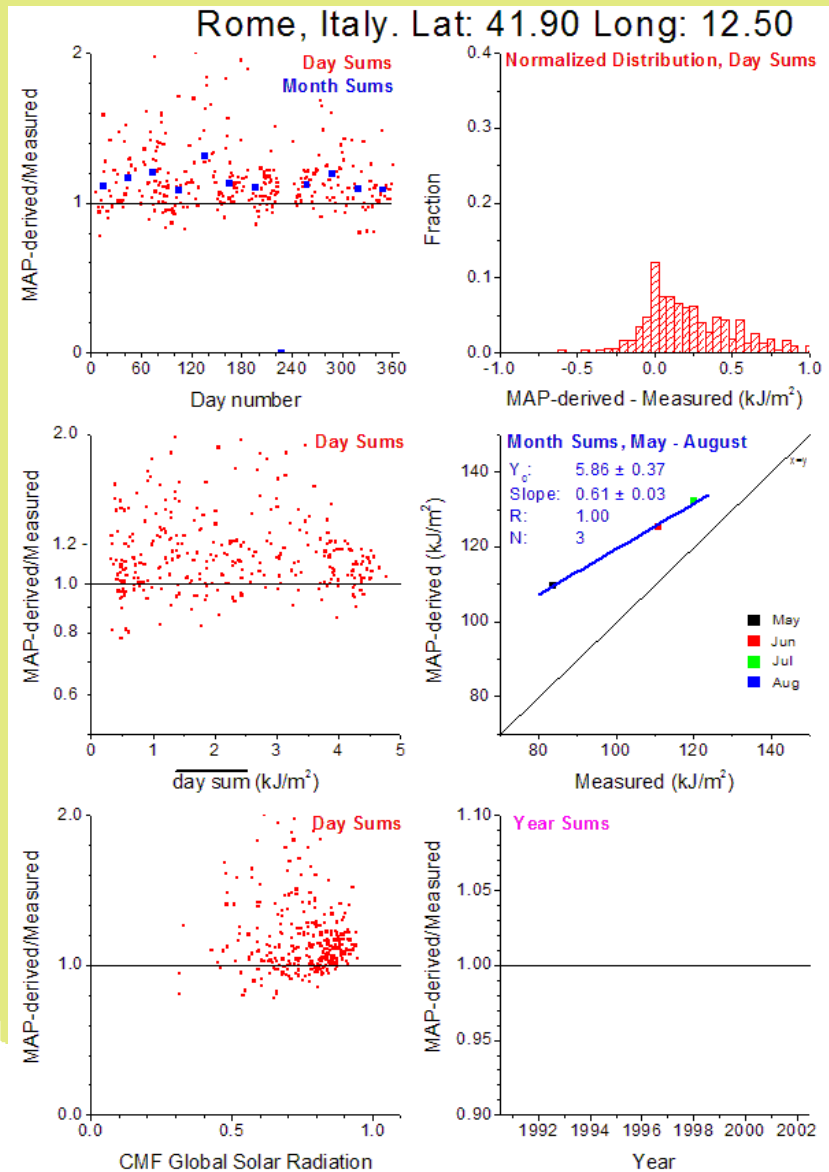
# Comparing Mapping and Ground based model with measured UV



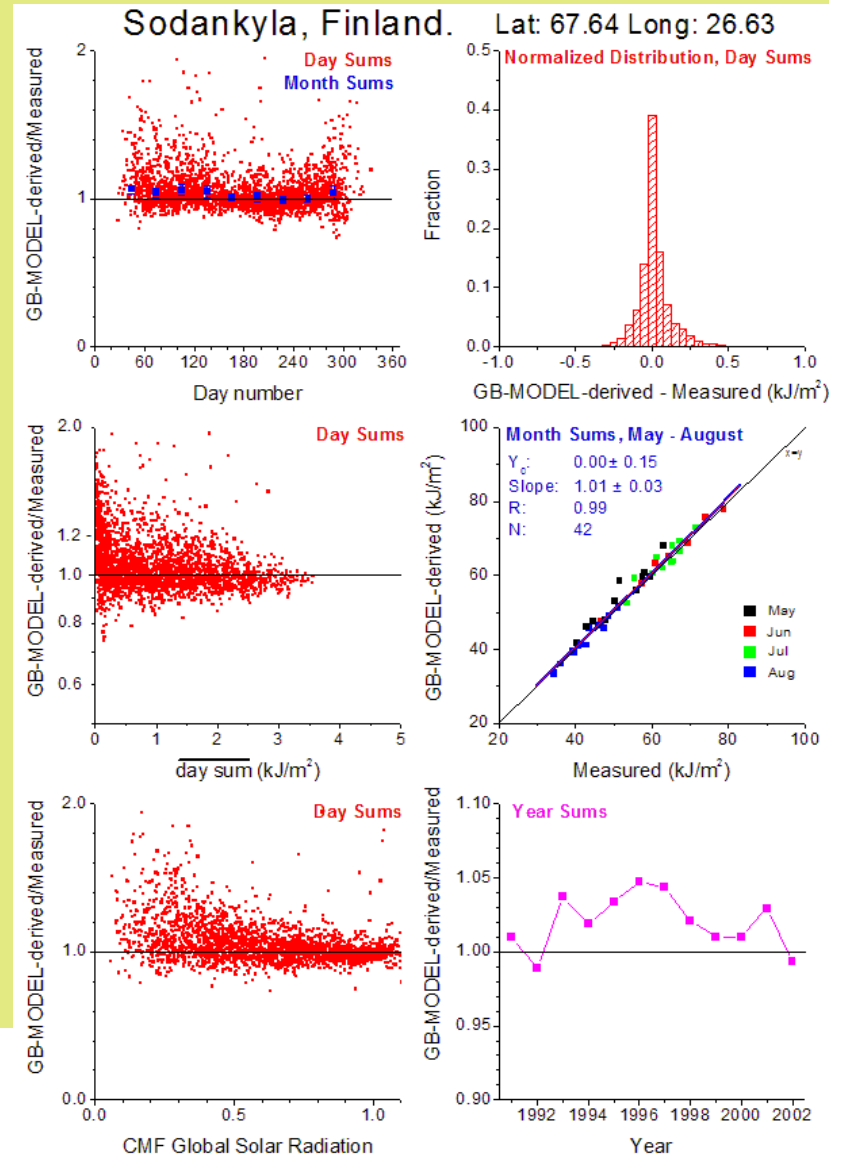
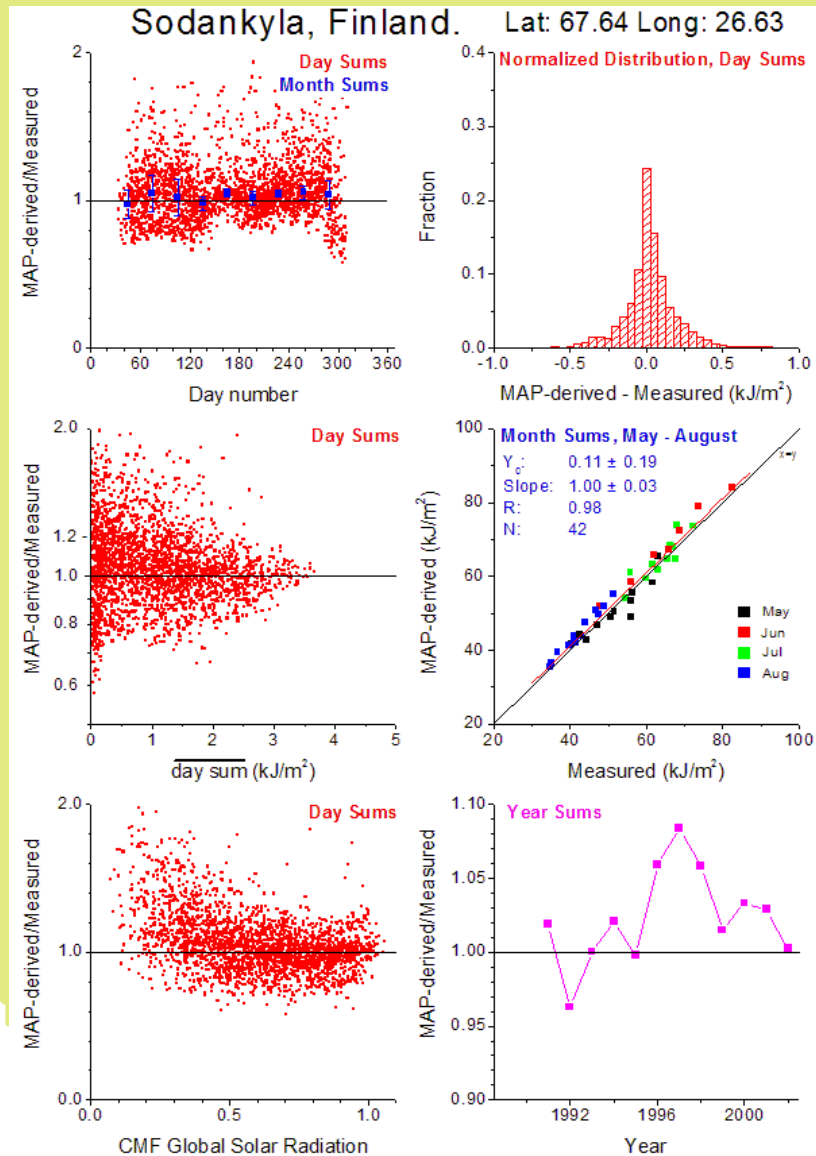
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# Comparing mapping with UV-measurements



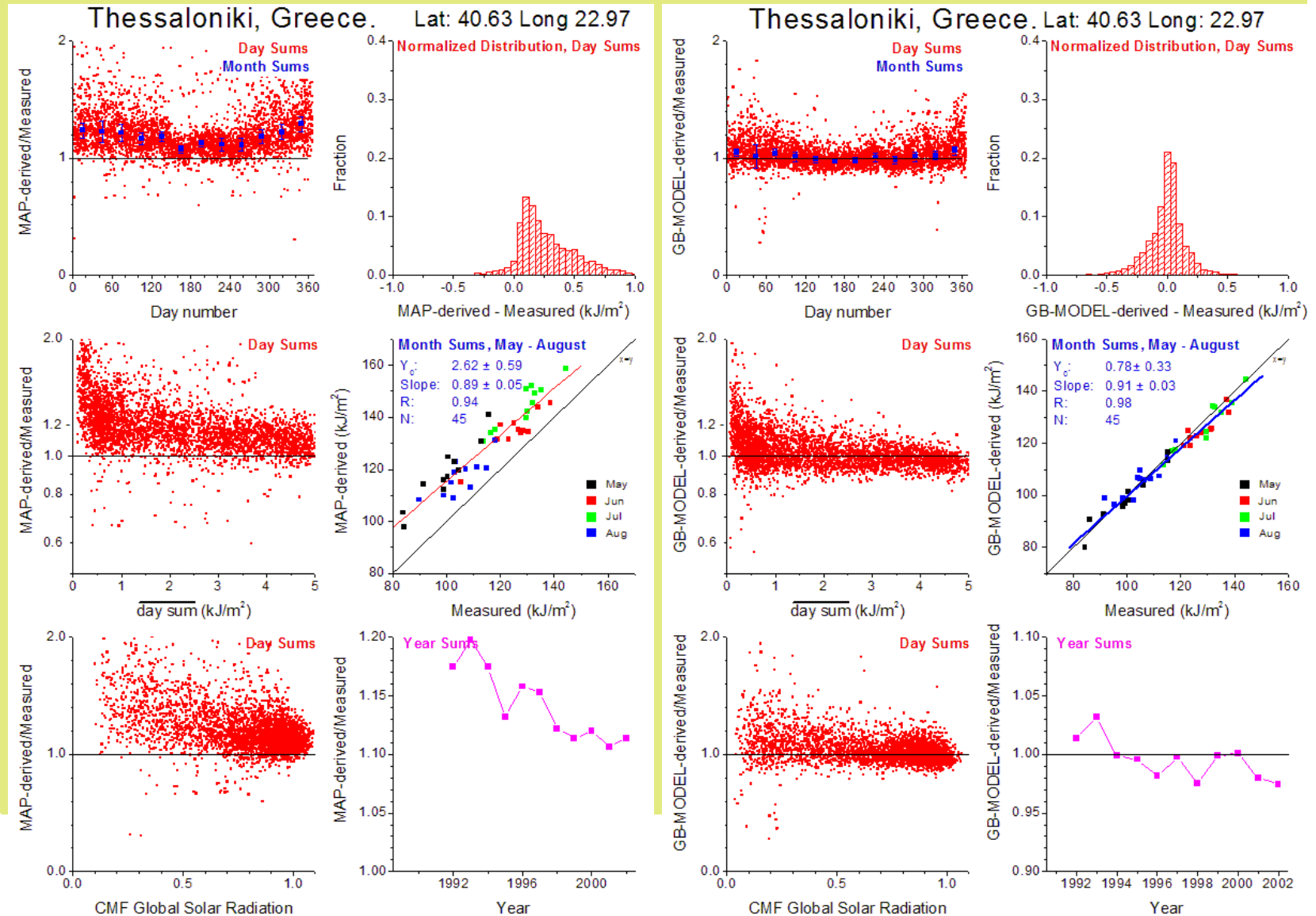
# Comparing Mapping and Ground based model with measured UV



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# Comparing Mapping and Ground based model with measured UV



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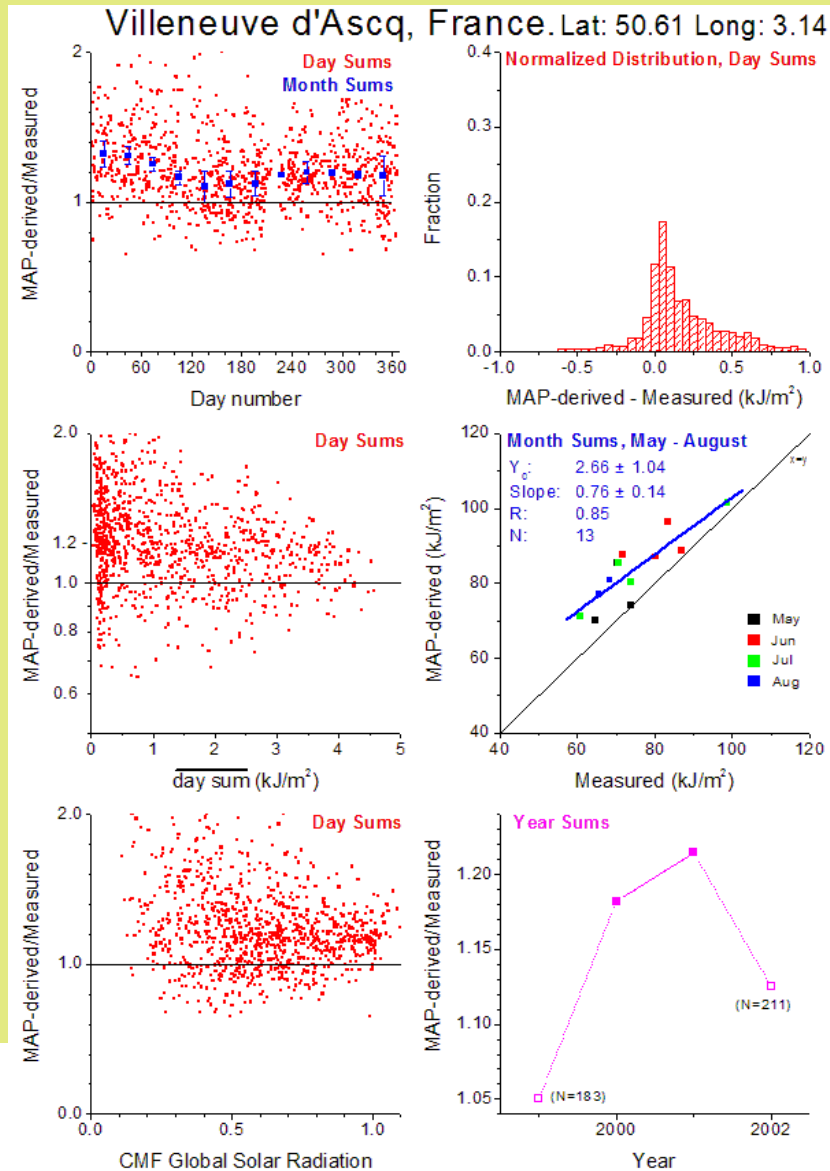
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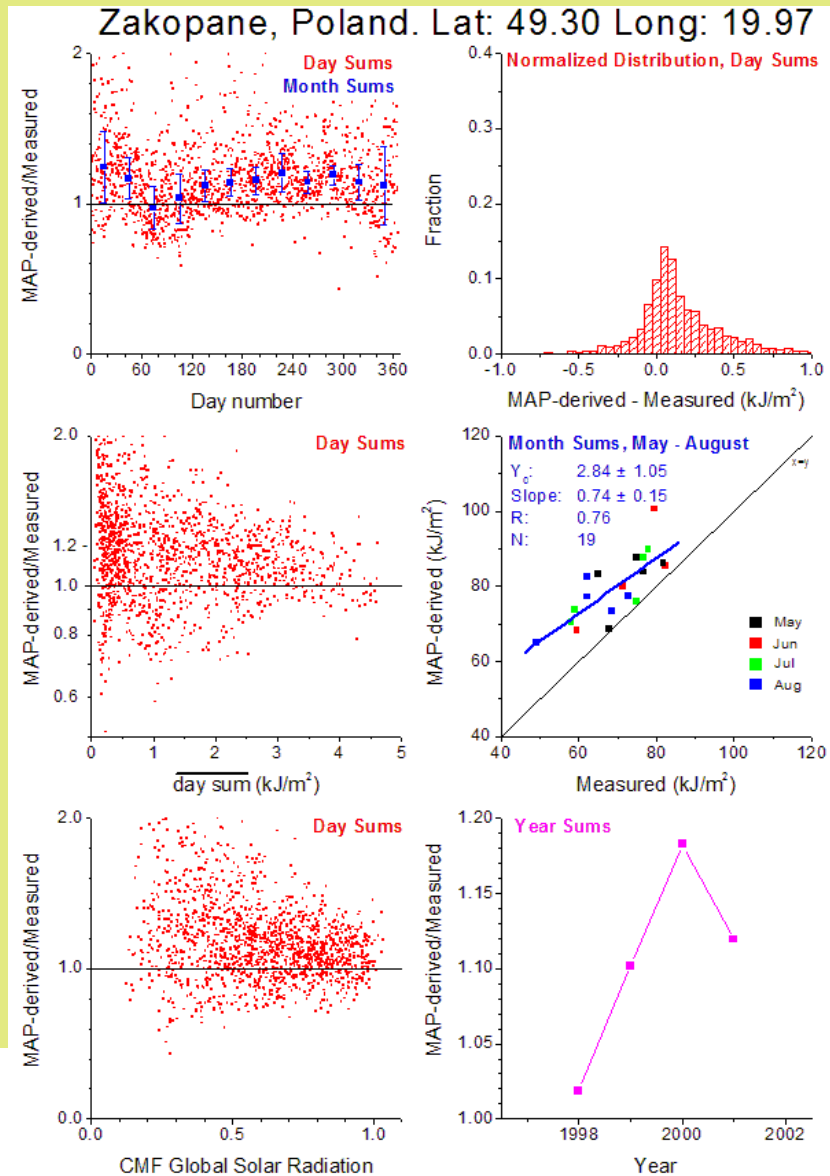




# Comparing mapping with UV-measurements



# Comparing mapping with UV-measurements



# Comparing mapping with UV-measurements

Days:

1.104 sd 0.096 (SC)

1.191 sd 0.119

Months:

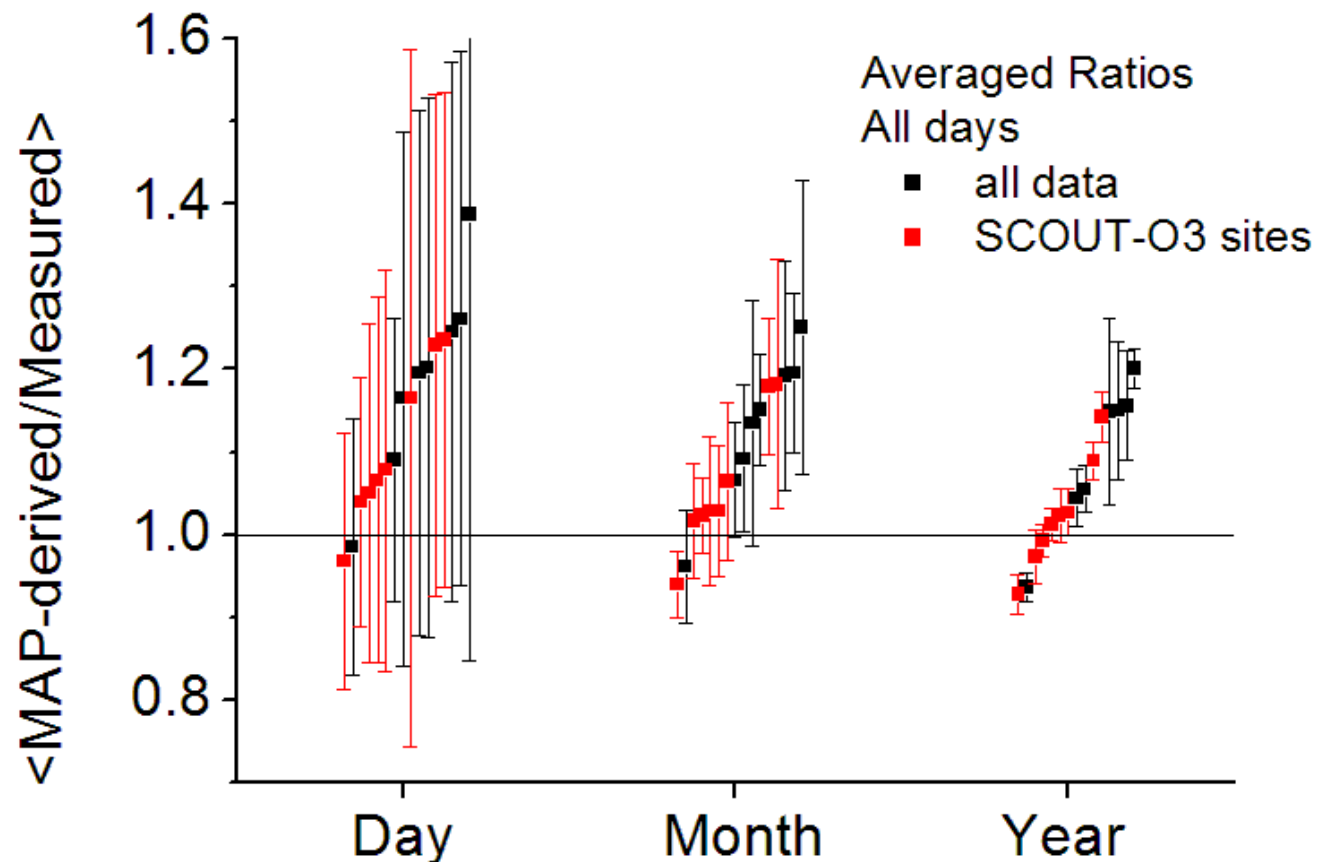
1.058 sd 0.083 (SC)

1.130 sd 0.105

Years:

1.024 sd 0.066 (SC)

1.0996 sd 0.092



# Comparing ground based modelling with UV-measurements

Days:

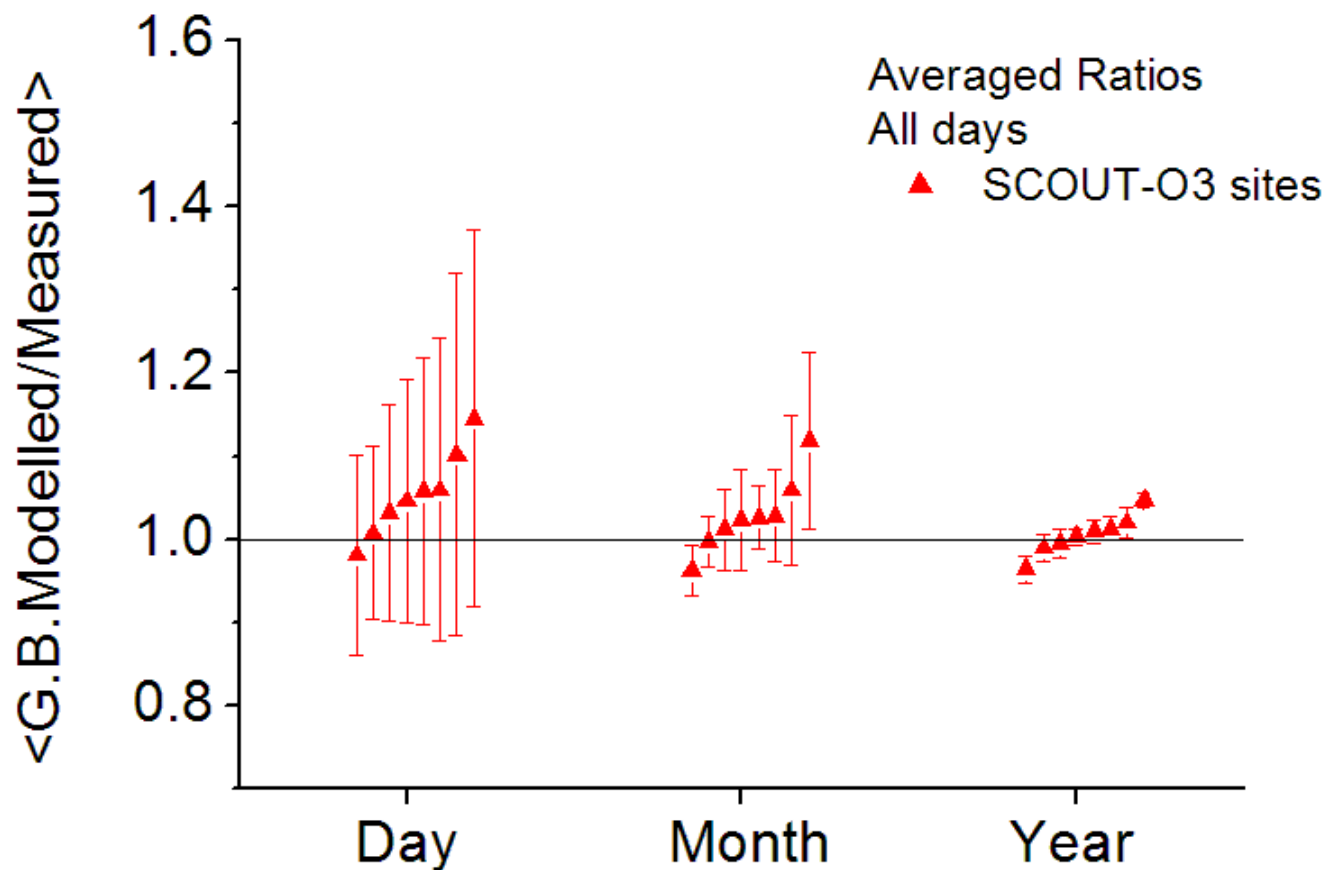
1.054 sd 0.054 (SC)

Months:

1.028 sd 0.047 (SC)

Years:

1.004 sd 0.024 (SC)



# Comparing mapping with UV-measurements

Days:

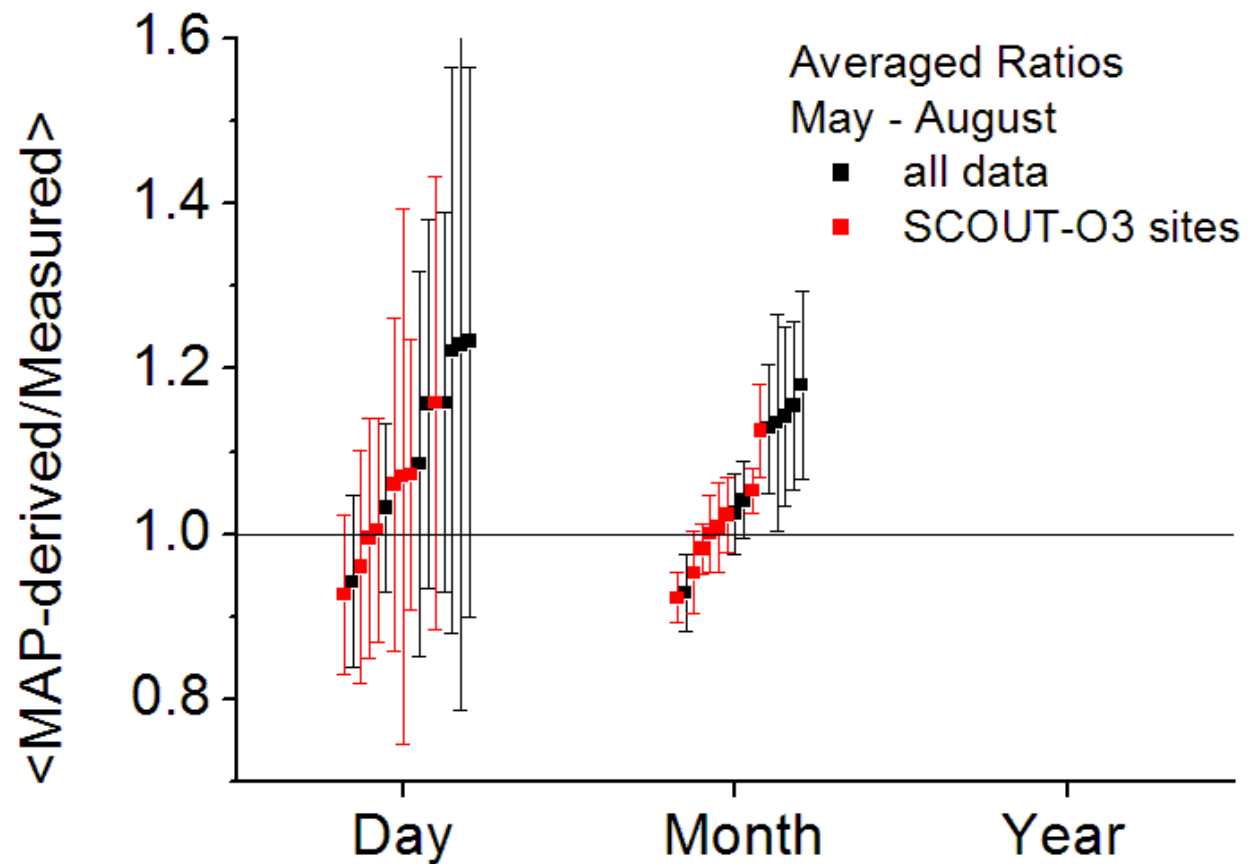
1.031 sd 0.074 (SC)

1.133 sd 0.105

Months:

1.008 sd 0.062 (SC)

1.092 sd 0.085



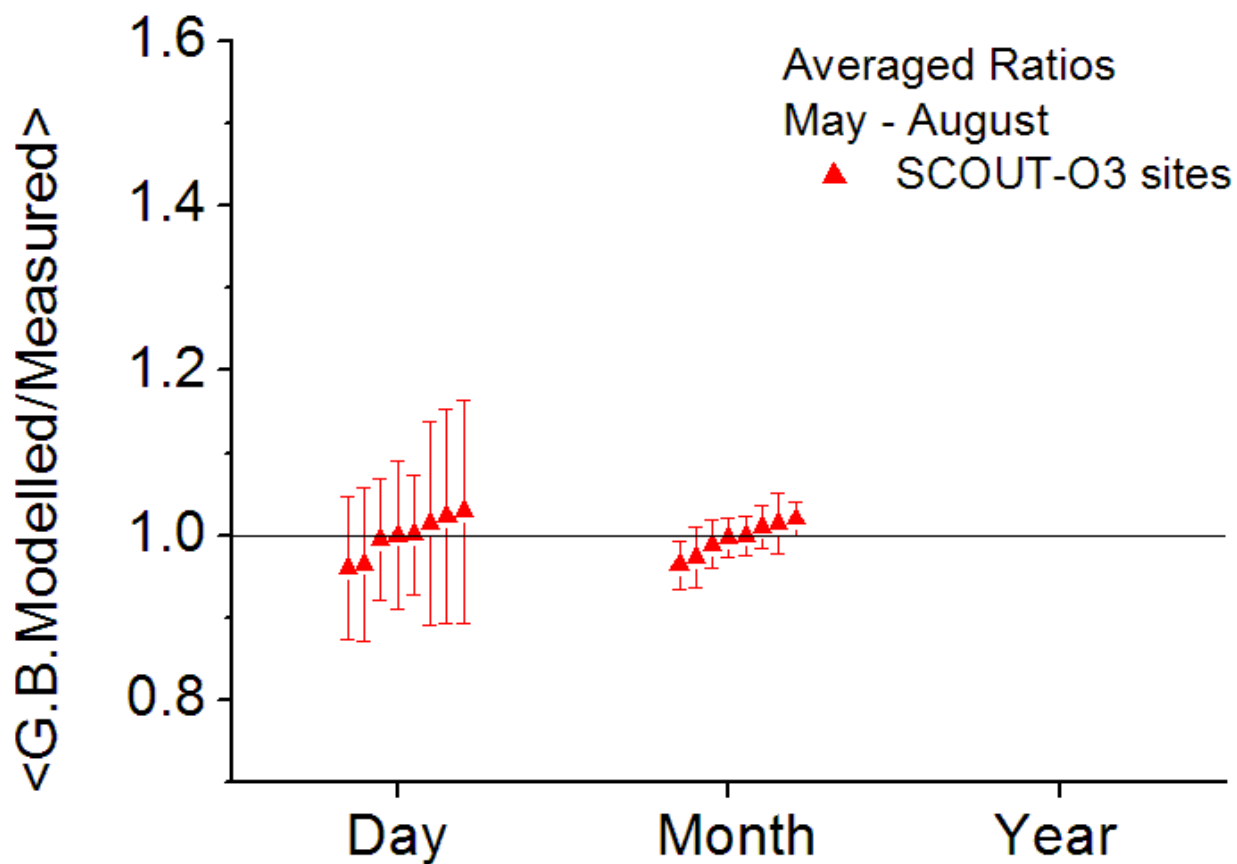
# Comparing ground based modelling with UV-measurements

Days:

1.000 sd 0.027 (SC)

Months:

0.995 sd 0.021 (SC)



# Summary from validation analysis using UV-measurements

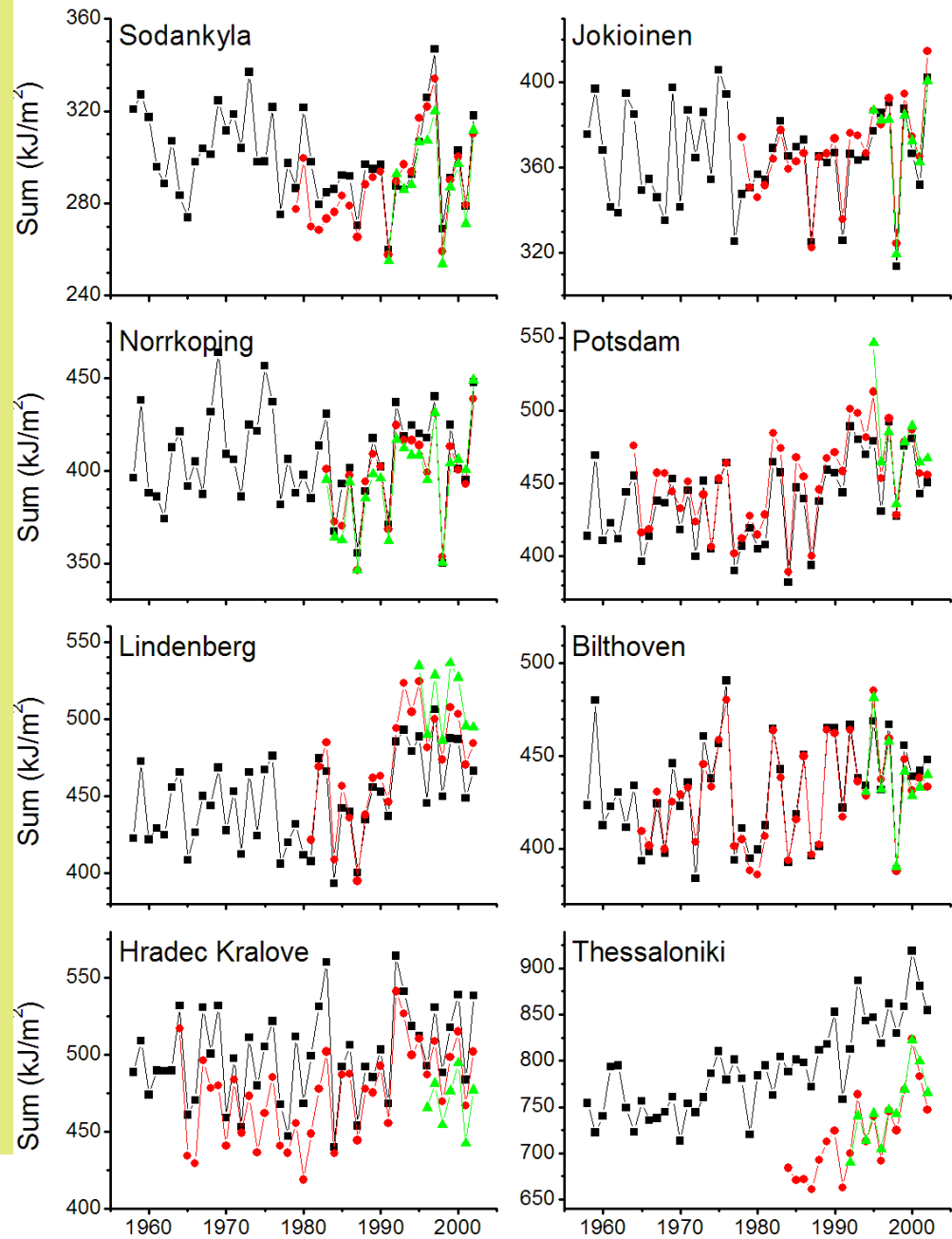
- Average ratio over all sites for yearly doses:
  - Mapping: 1.024 sd 0.066 for SCOUT sites  
1.100 sd 0.092 for other sites
  - ground based modelling: 1.004 sd 0.024 (SCOUT sites)
- Months:
  - Mapping: 1.058 sd 0.083 for SCOUT sites  
1.130 sd 0.098 for other sites
  - ground based modelling: 1.028 sd 0.047 (SCOUT sites)
- Days:
  - Mapping 1.104 sd 0.096 for SCOUT sites  
1.191 sd 0.119 for other sites
  - ground based modelling: 1.054 sd 0.054



# Reconstruction results

## Year Sums of Erythemal UV

- COST726-MAP Extracted
- Ground-based Modelled
- ▲ Measured

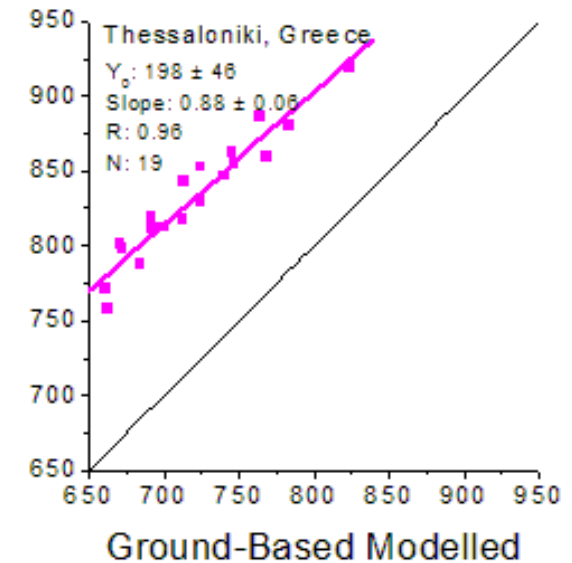
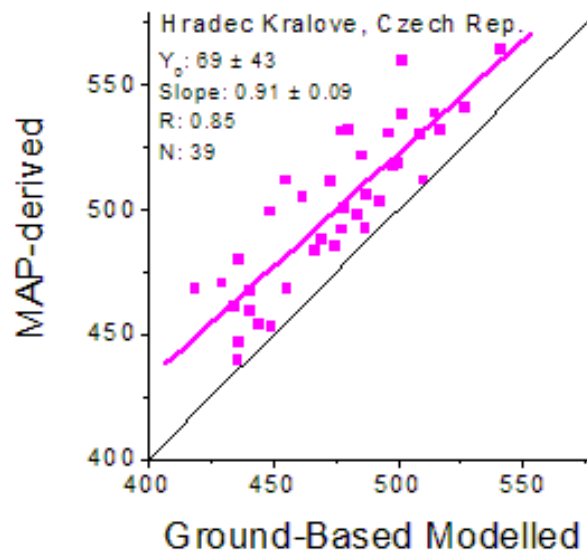
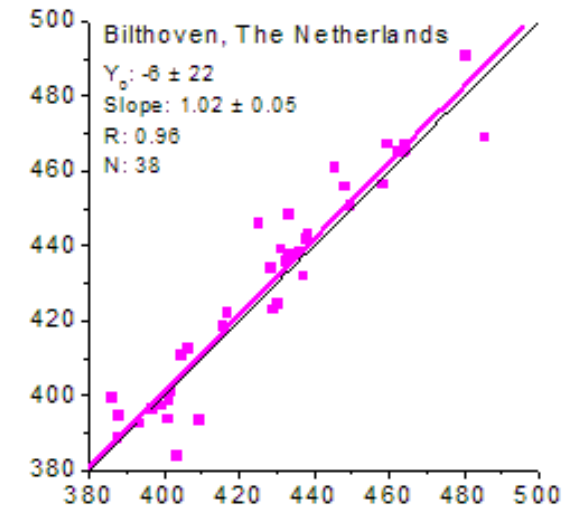
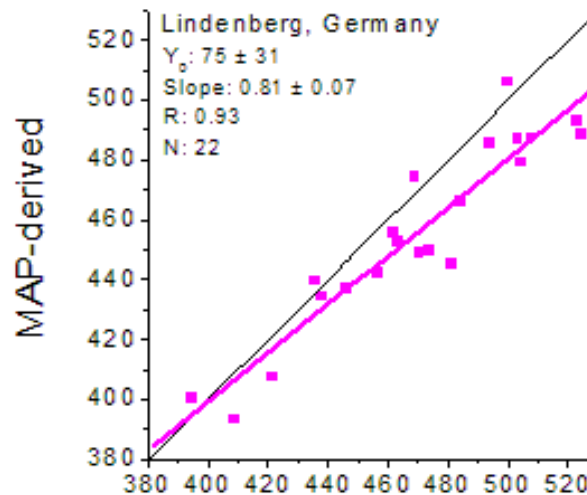


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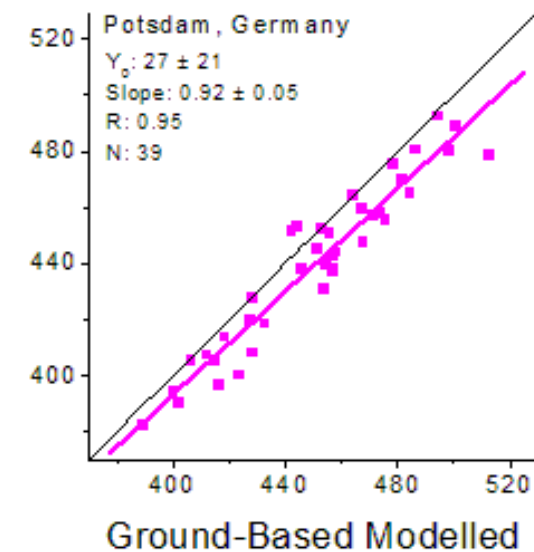
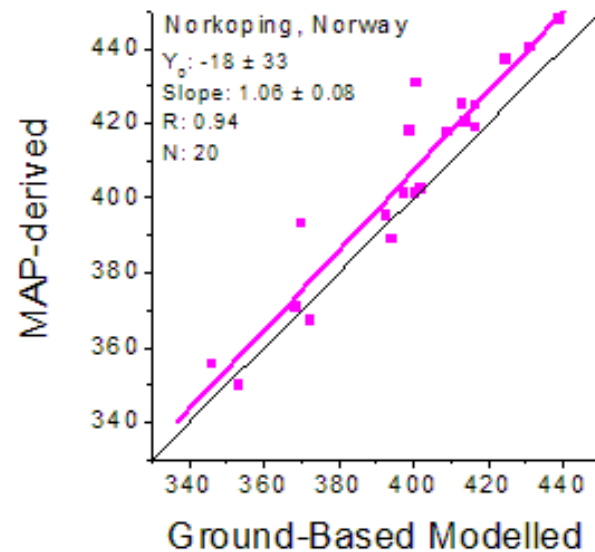
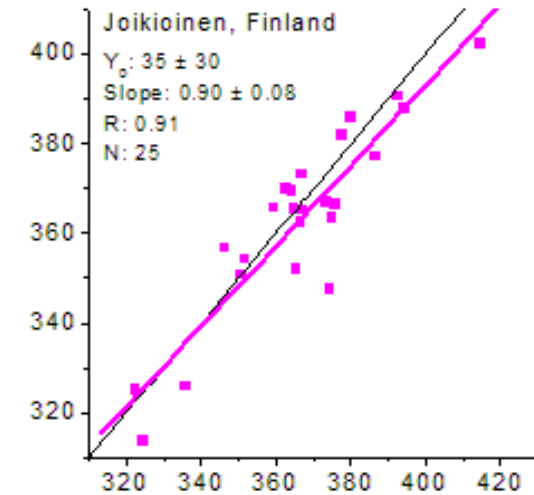
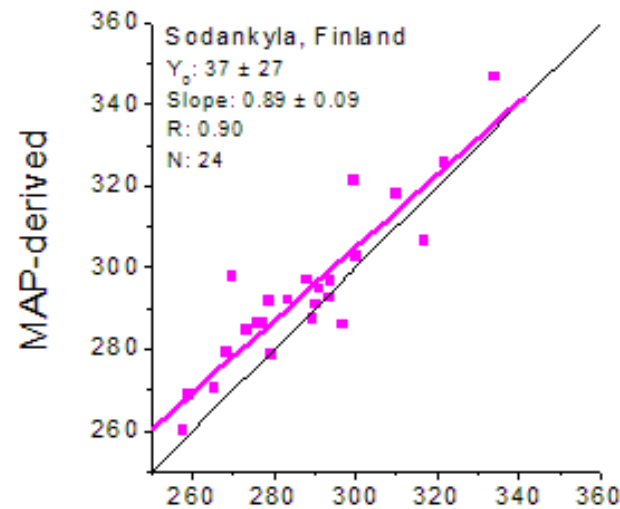
# Comparing reconstructions: ground based and mapping

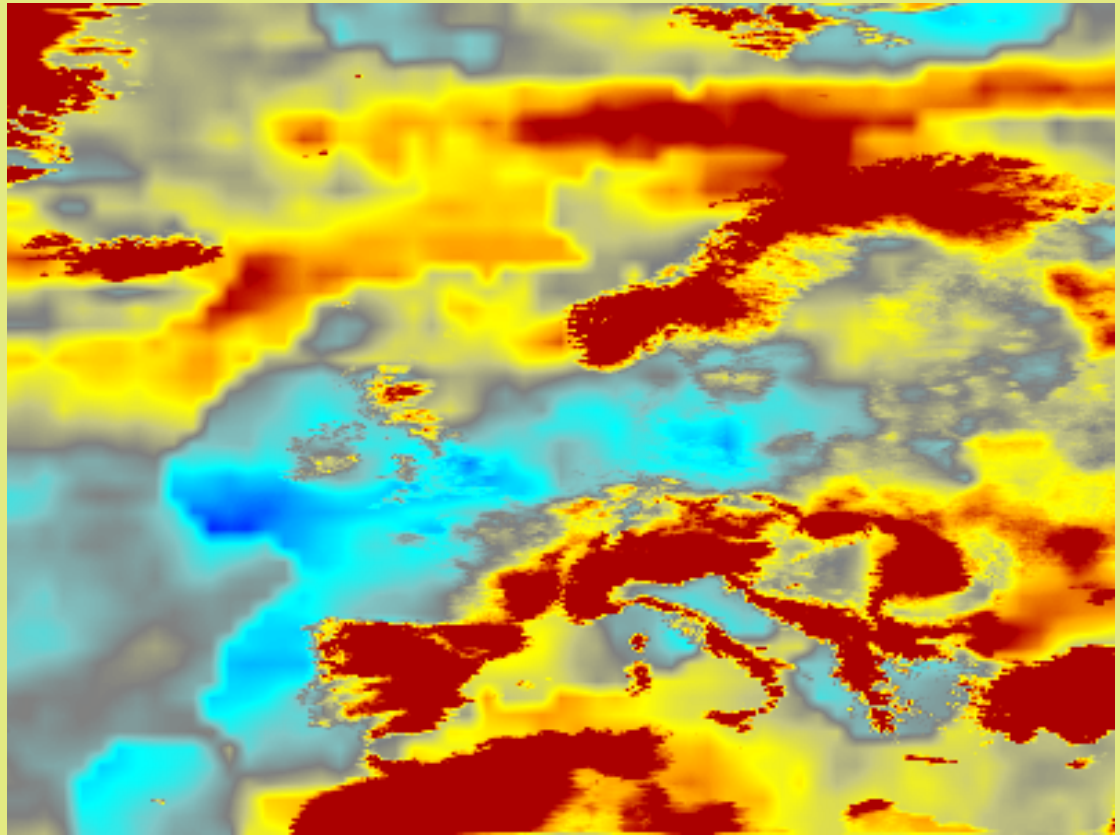
## Correlation Year Sums ( $\text{kJ/m}^2$ )



# Comparing reconstructions: ground based and mapping

## Correlation Year Sums ( $\text{kJ/m}^2$ )





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**Thanks for the attention**

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