

# **Uncertainties in solar CMF interpolated from the COST-726 grid**

H. Staiger

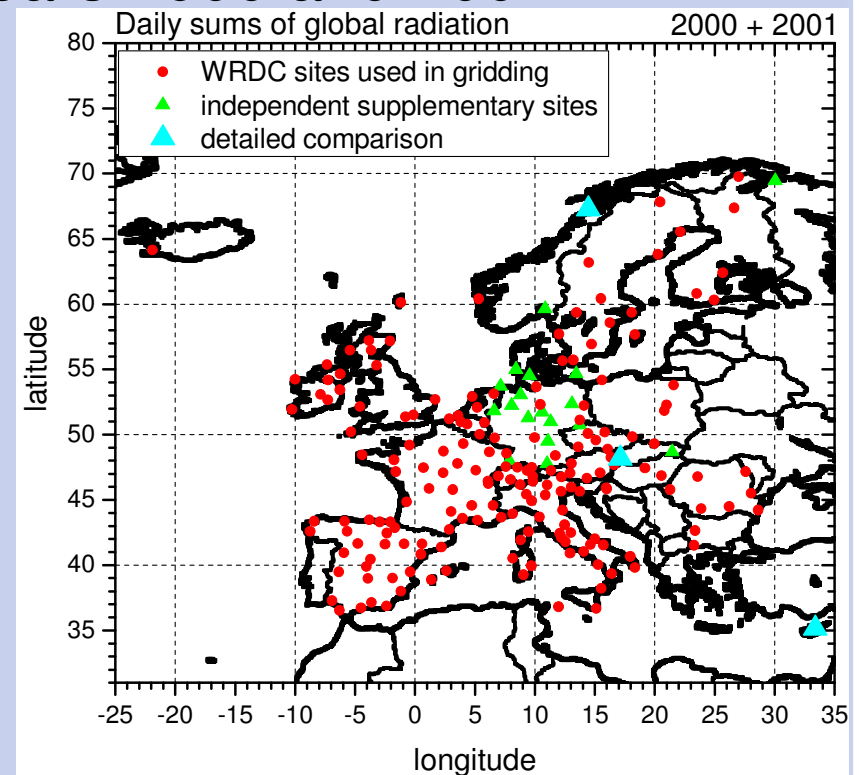
German Meteorological Service (DWD), emeritus

## Measured total global irradiation, years 2000 and 2001:

No. provided by

applied in gridding

183	WRDC	Russia	A. Tsvetkov
		<u>independent</u>	
3	NIAER	Norway	T.H. Sivertsen
15	DWD	Germany	U. Feister
2	SHMU	Slovakia	M. Chmelik
1	MS	Cyprus	St. Pashiardis



## Solar Cloud Modification Factors (SOL-CMF):

ERA40 ECMWF via:FMI J. Kaurola

## Method:

Calculation of “measured” daily SOL-CMF:

Clear-sky daily sums of global irradiation:

- ESRA algorithm (Greif and Scharmer, ed., 2000)
- Monthly means of Linke turbidity factor (Remund et al. 2003)

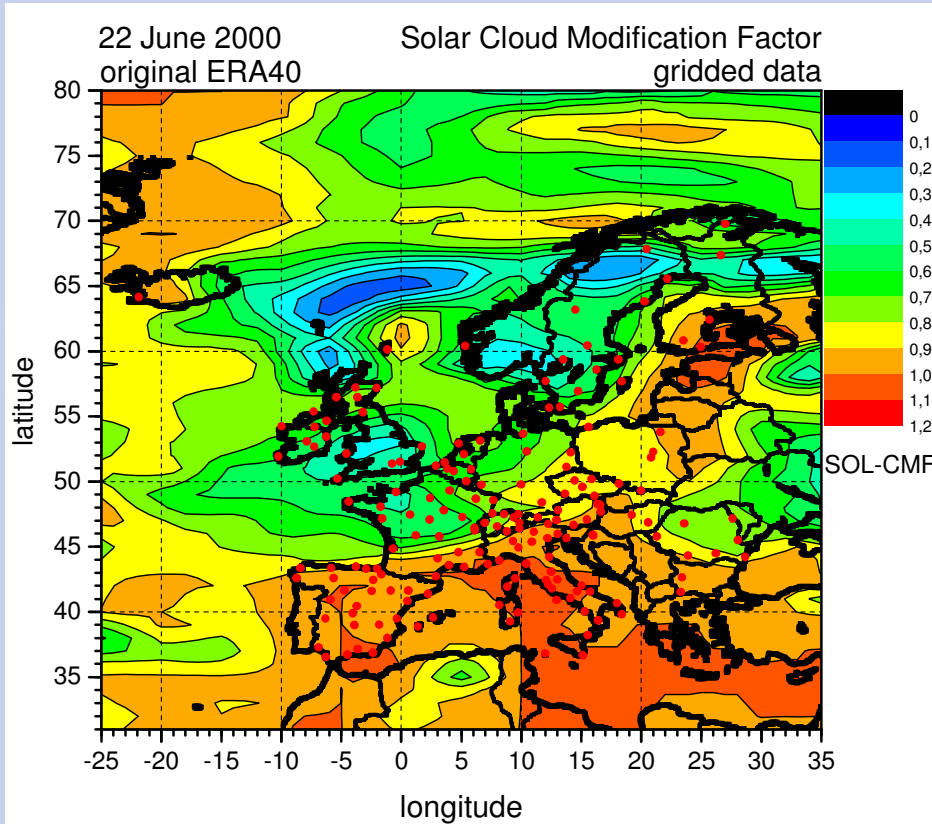
SOL-CMF = measured daily sum of irradiation / clear-sky sum

## Gridding / interpolation:

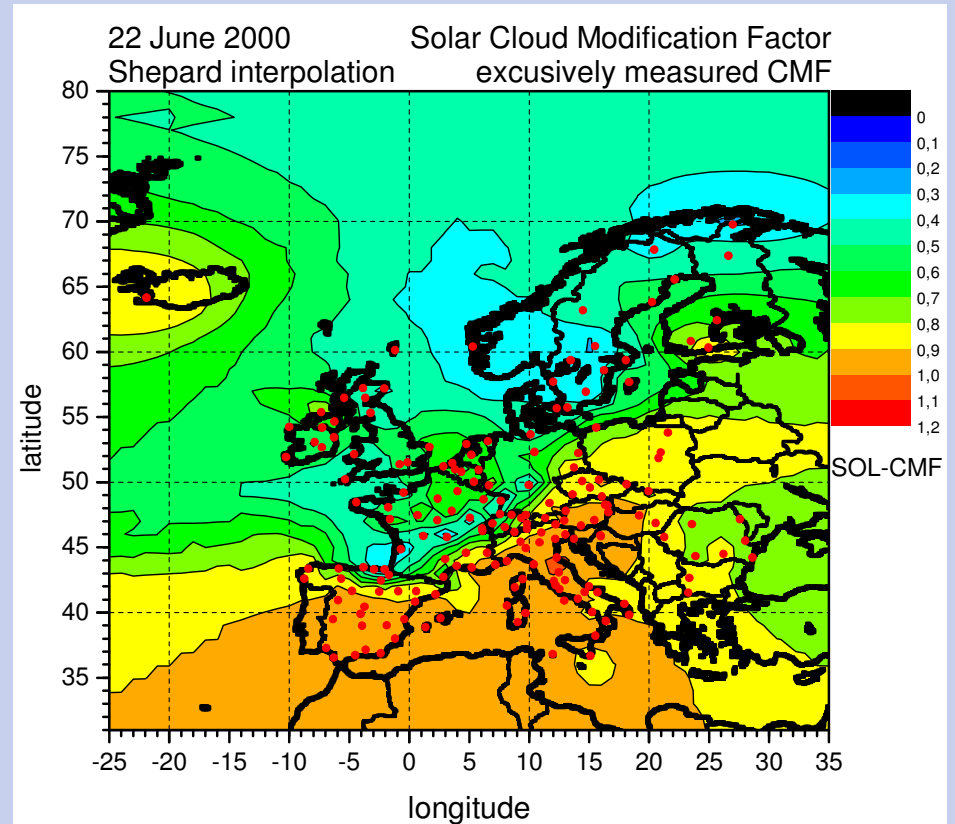
horizontal distance: great circle       $\Delta h \cdot f$ : altitude equivalence (Zelenka 1986)

$$d_i = \sqrt{d_{\text{hor}}^2 + (\Delta h \cdot f)^2}, \quad f = 0.1 \frac{\text{km}}{\text{m}}$$

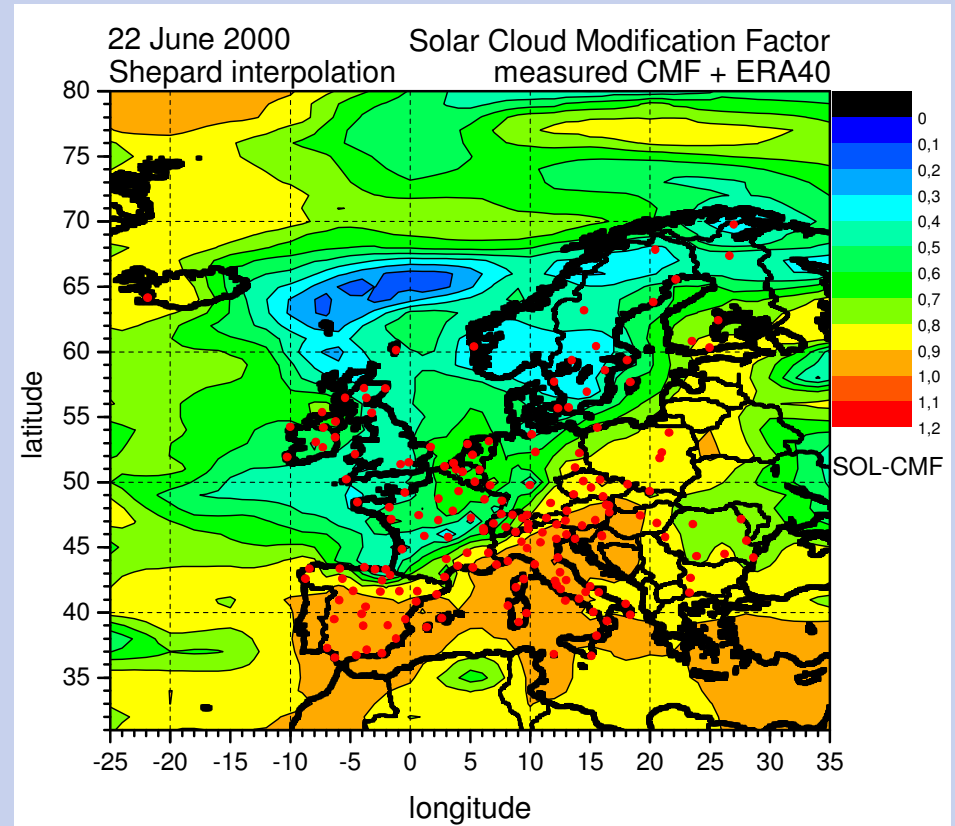
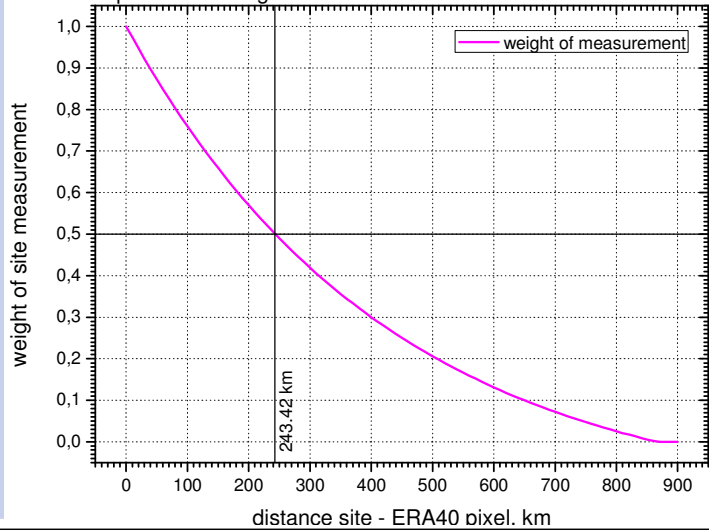
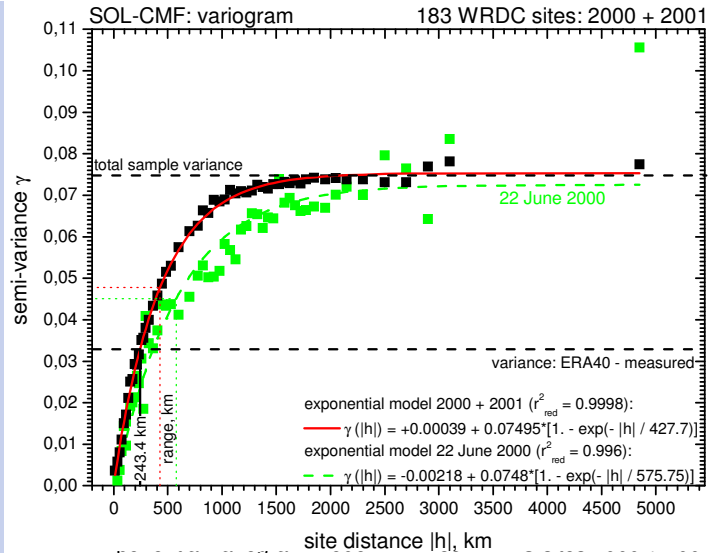
Shepard gravity interpolation:  $w_i = \left[ \frac{r_{\text{search}}}{d_i} - 1 \right]^2, \quad \sum w_i = 1, \quad r_{\text{search}} = 6371 \text{ km}$



original ERA40 SOL-CMF



gridded measured SOL-CMF

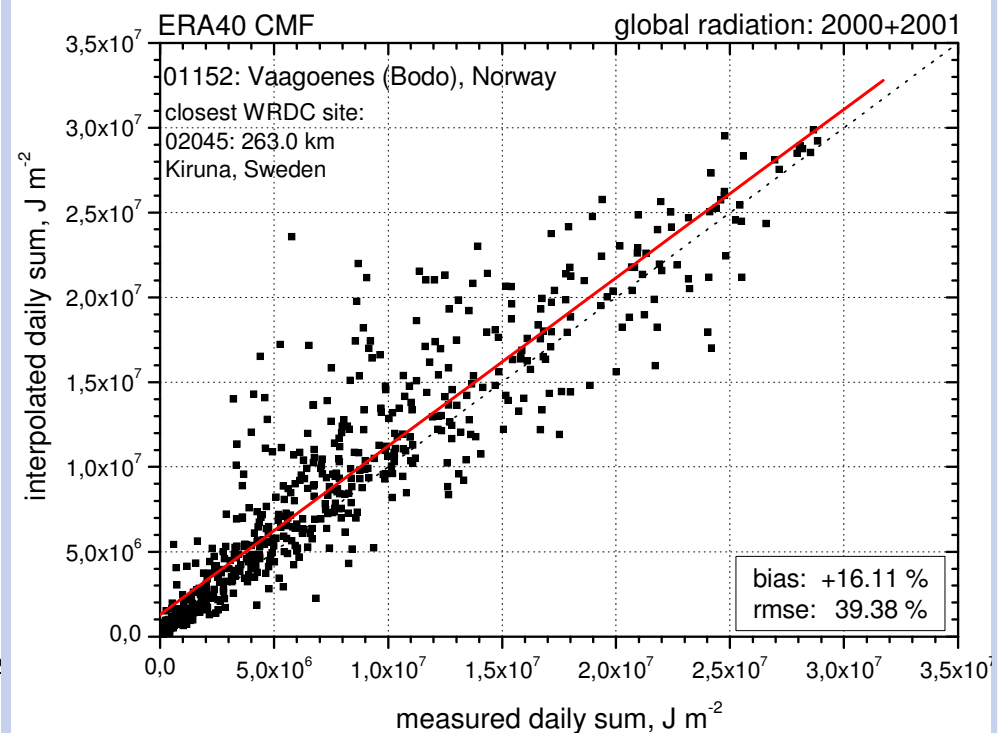
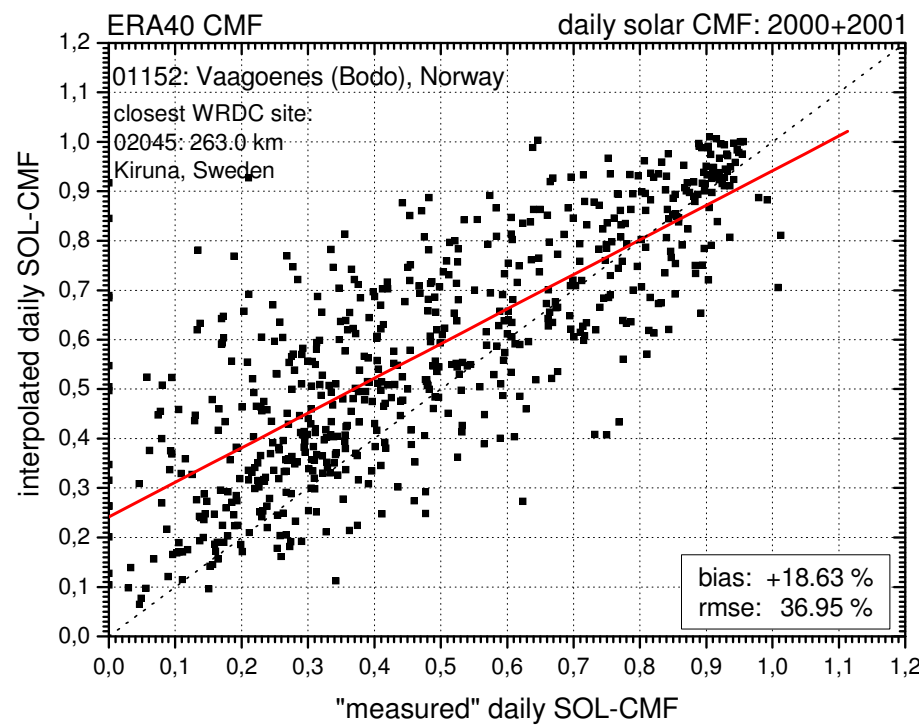


mixed "measured" and ERA40 bias cor.

Vaagoenes (Bodø), Norway:

+67.283 N +14.467 E

40 m



SOL-CMF

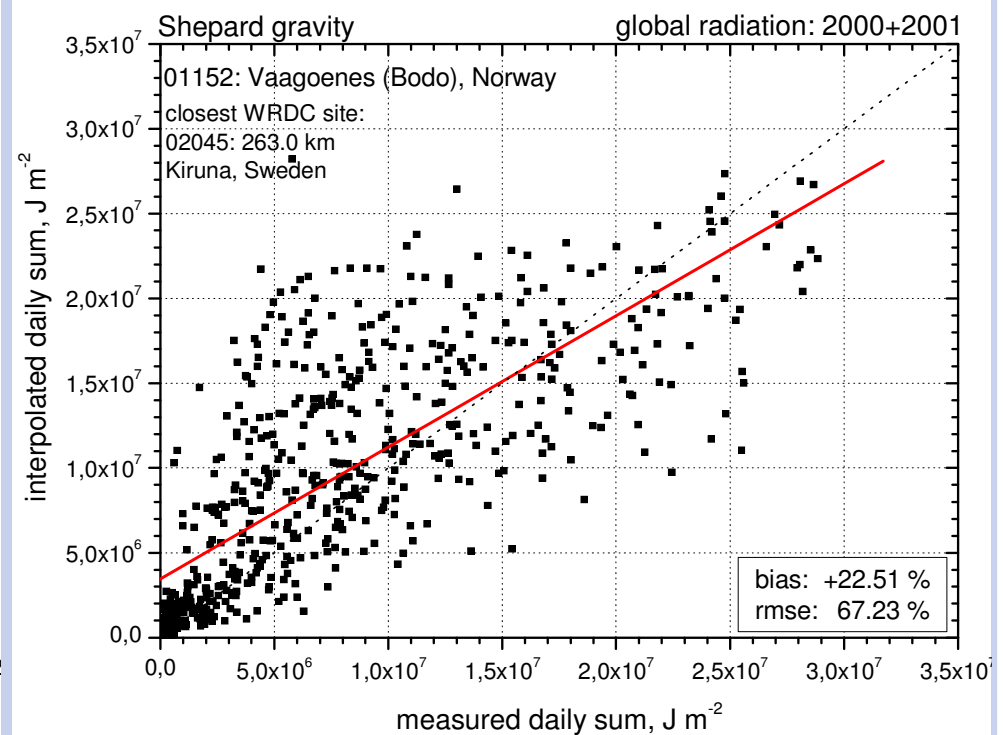
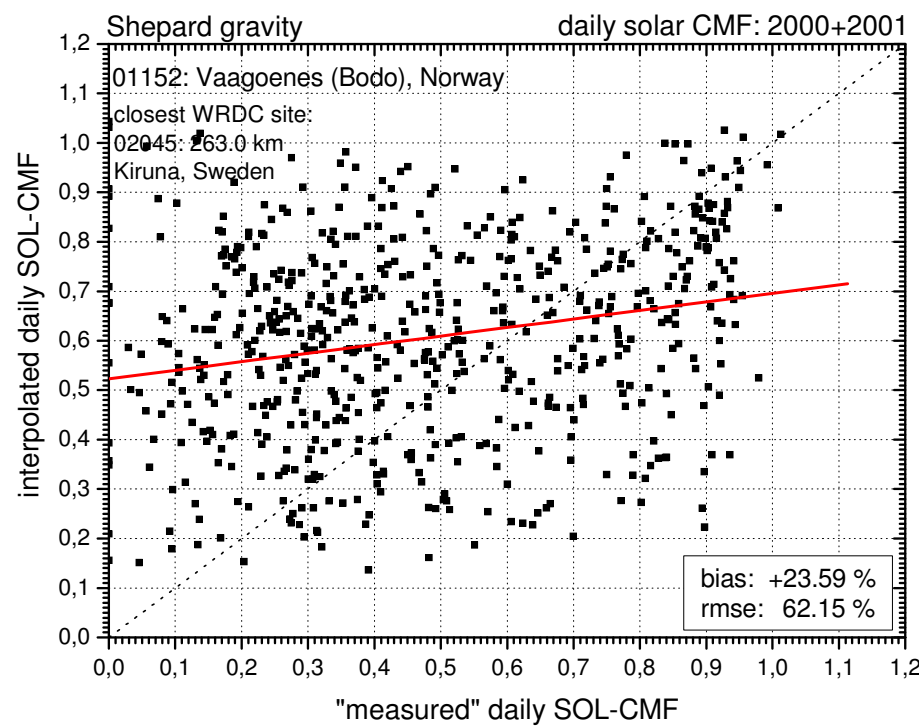
ERA40 original

global irradiation

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SOL-CMF

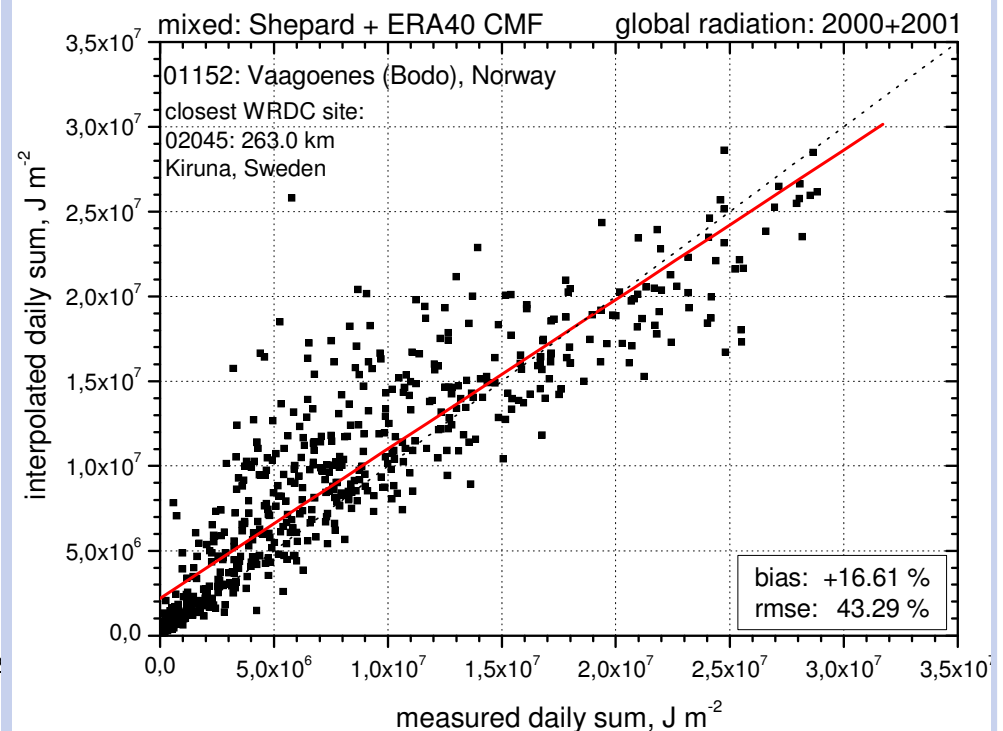
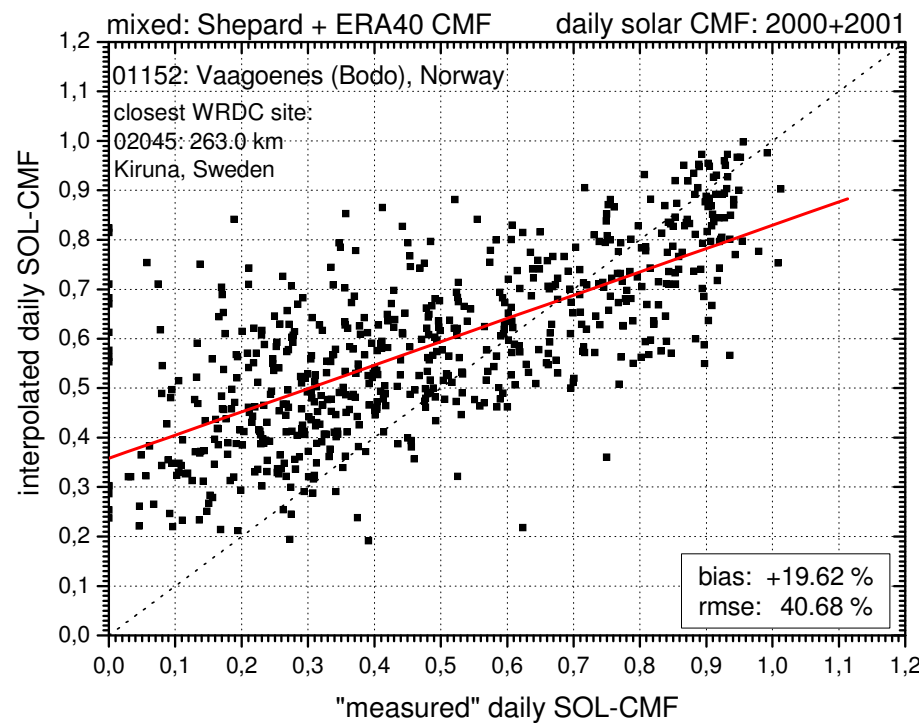
gridded measurements

global irradiation

Vaagoenes (Bodø), Norway:

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40 m



SOL-CMF

mixed mode

global irradiation

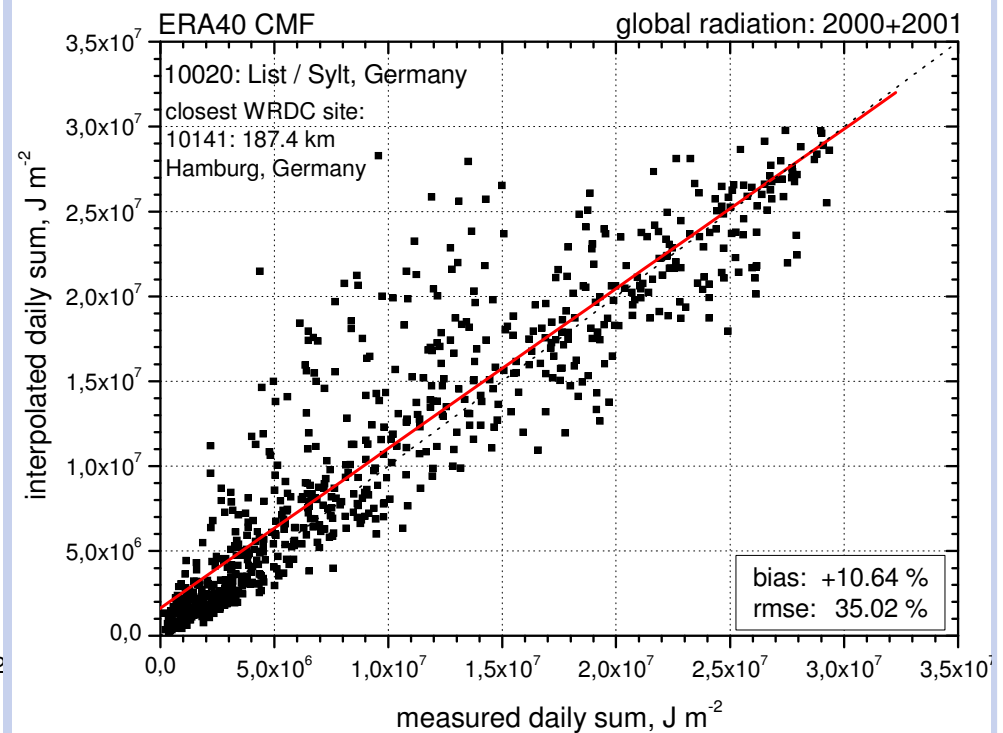
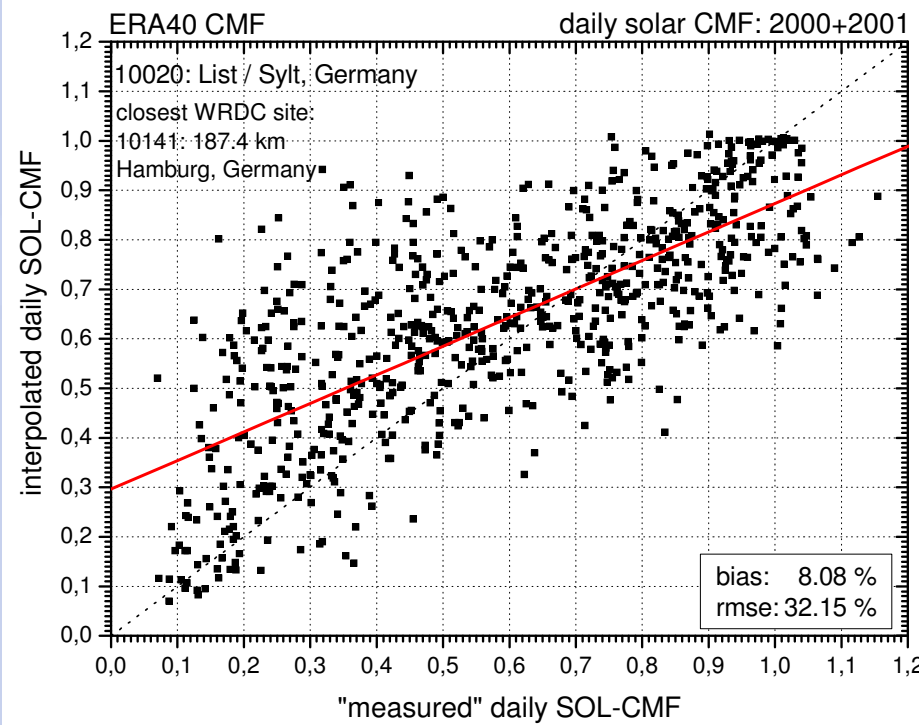


List / Sylt, Germany

+55.010 N

+8.410 E

33 m



SOL-CMF

ERA40 original

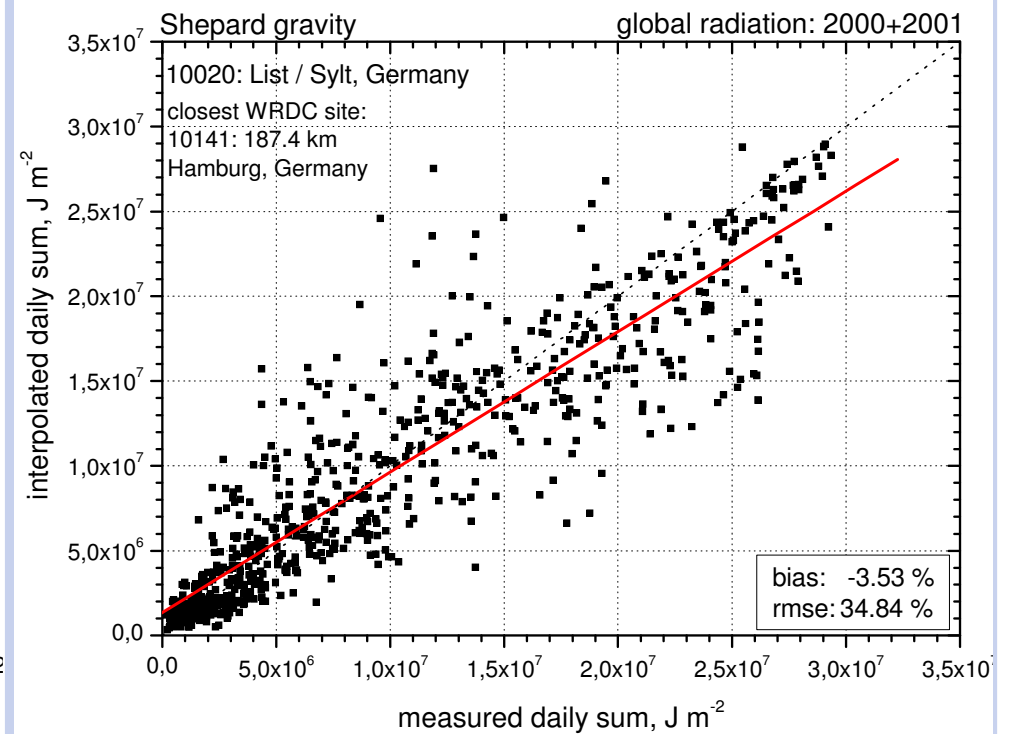
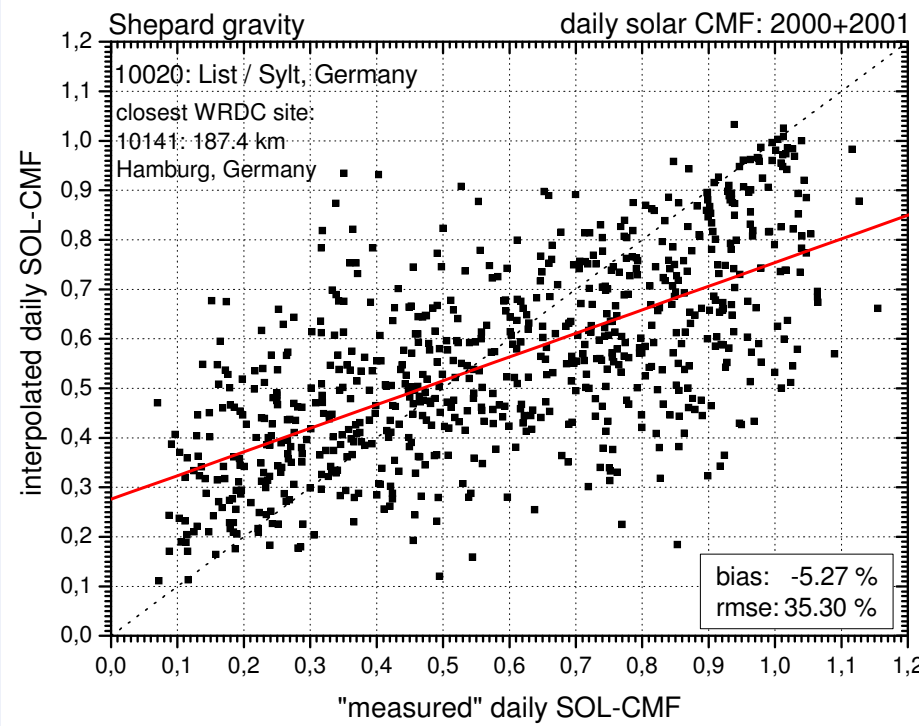
global irradiation

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SOL-CMF

gridded measurements

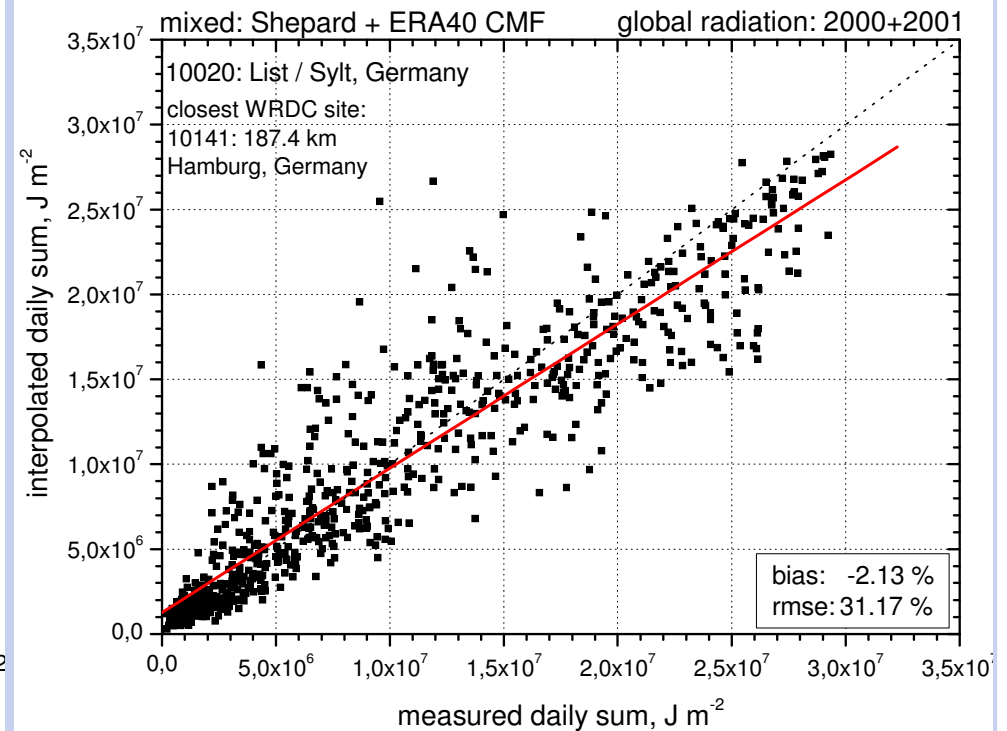
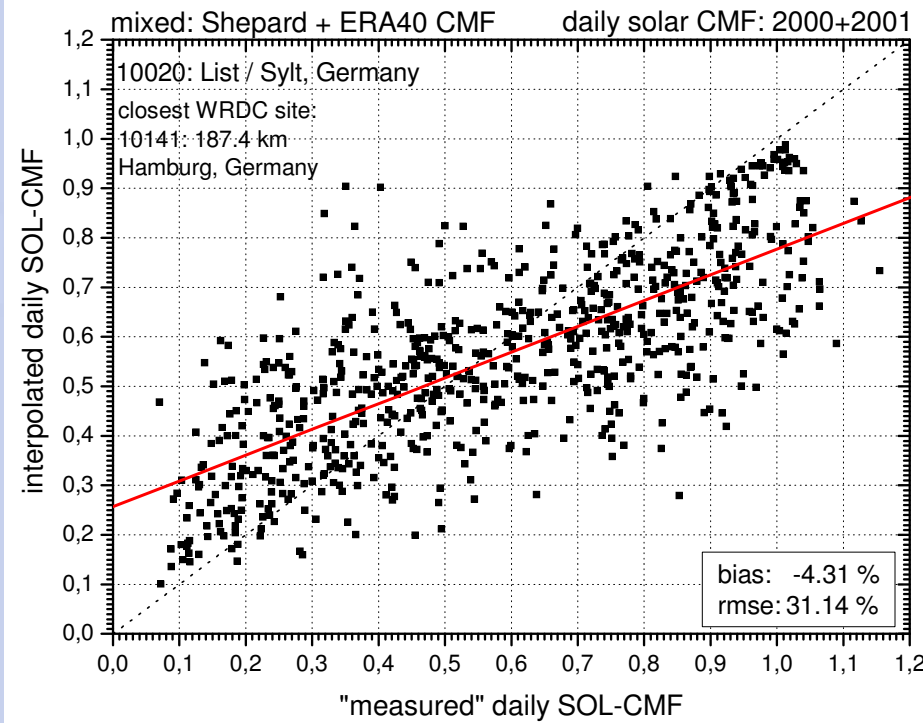
global irradiation

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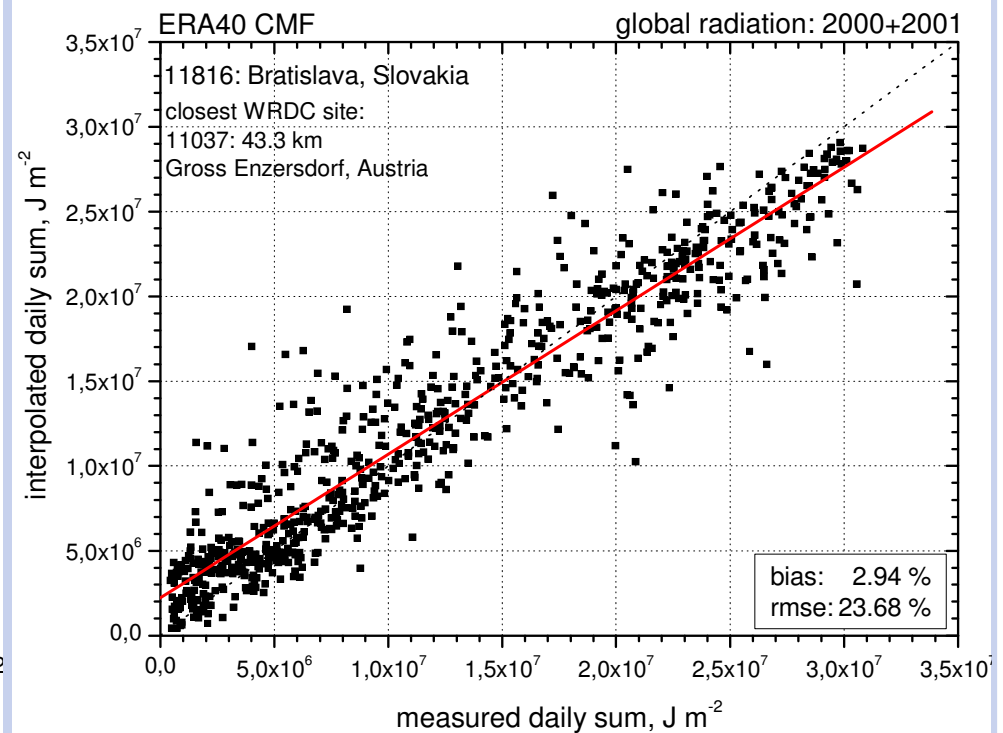
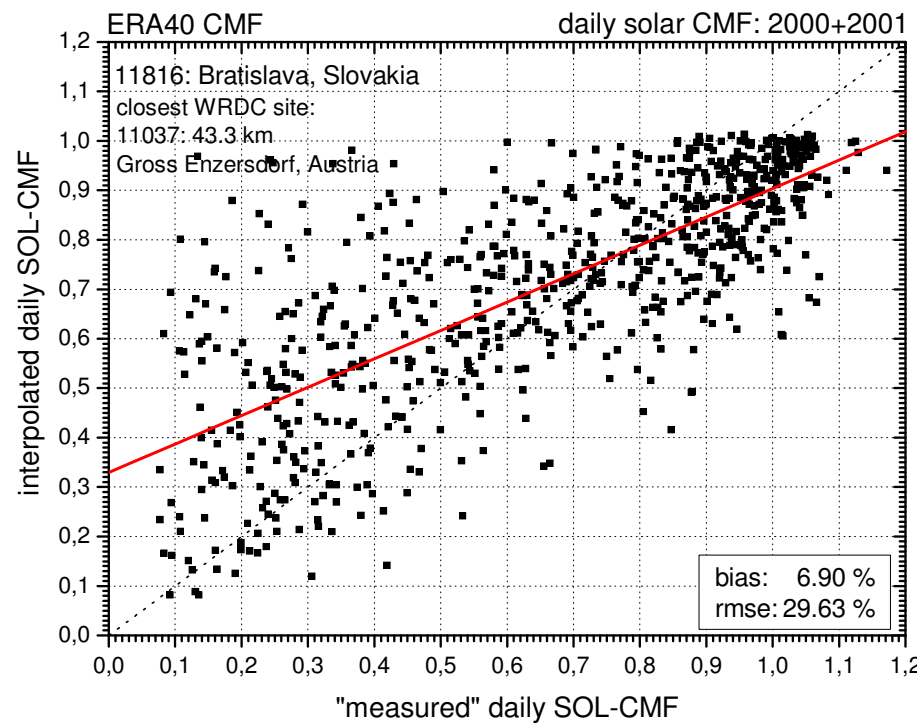
SOL-CMF

mixed mode

global irradiation

Bratislava, Slovakia

+48.170 N +17.120 E 292 m



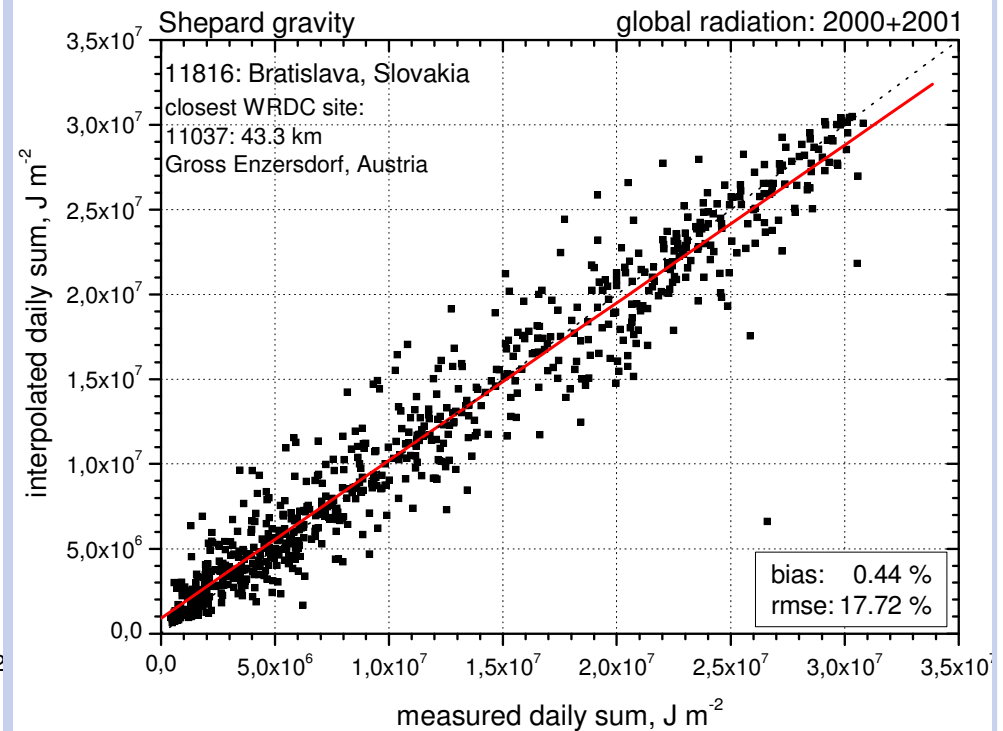
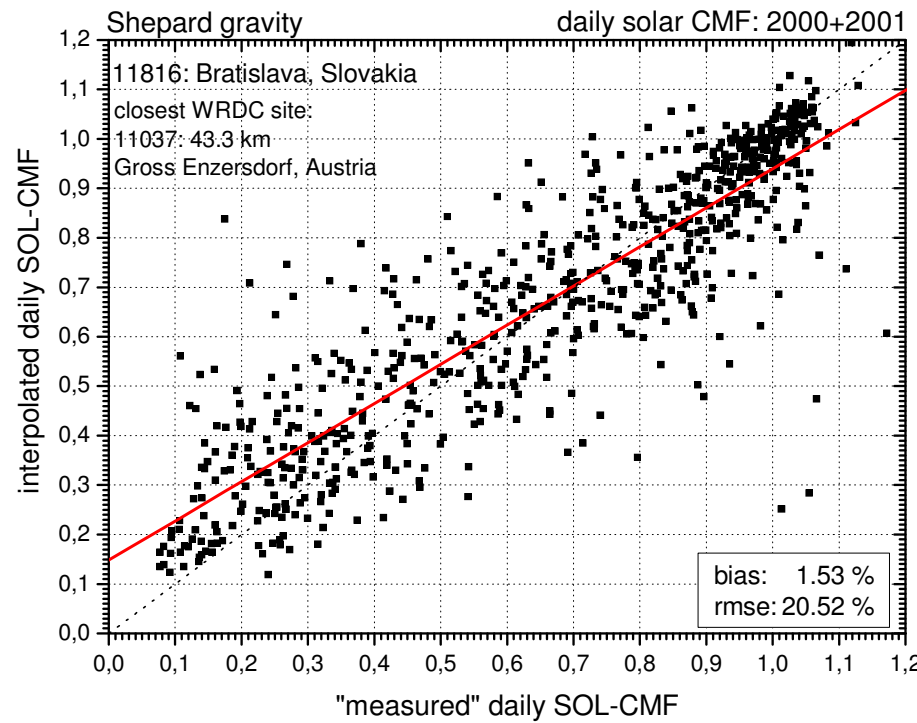
SOL-CMF

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global irradiation

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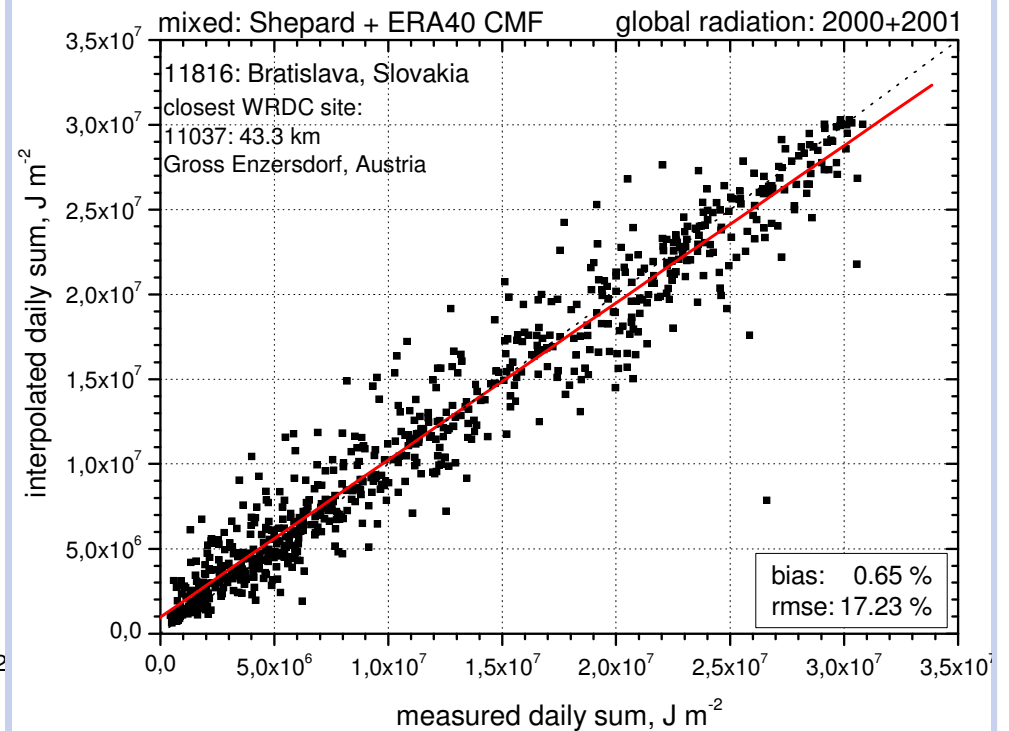
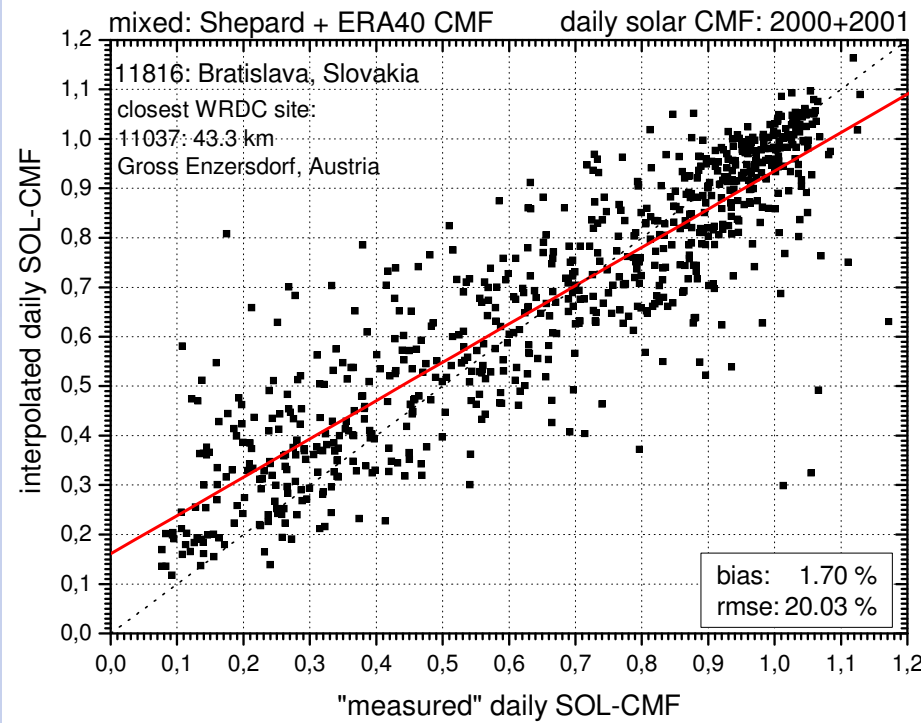
SOL-CMF

gridded measurements

global irradiation

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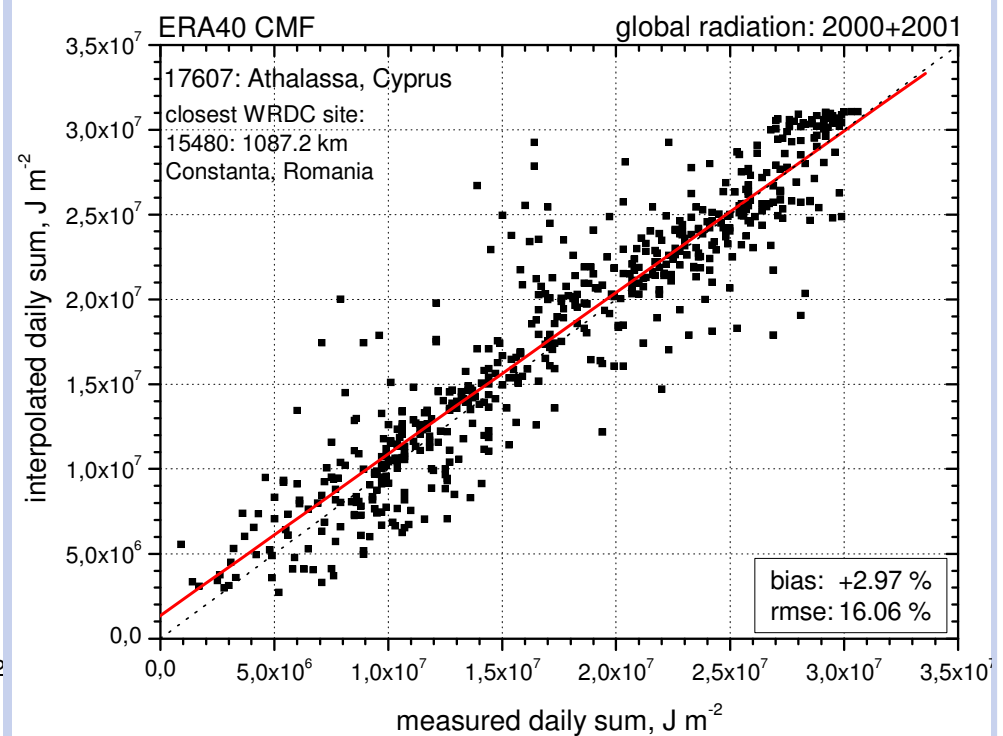
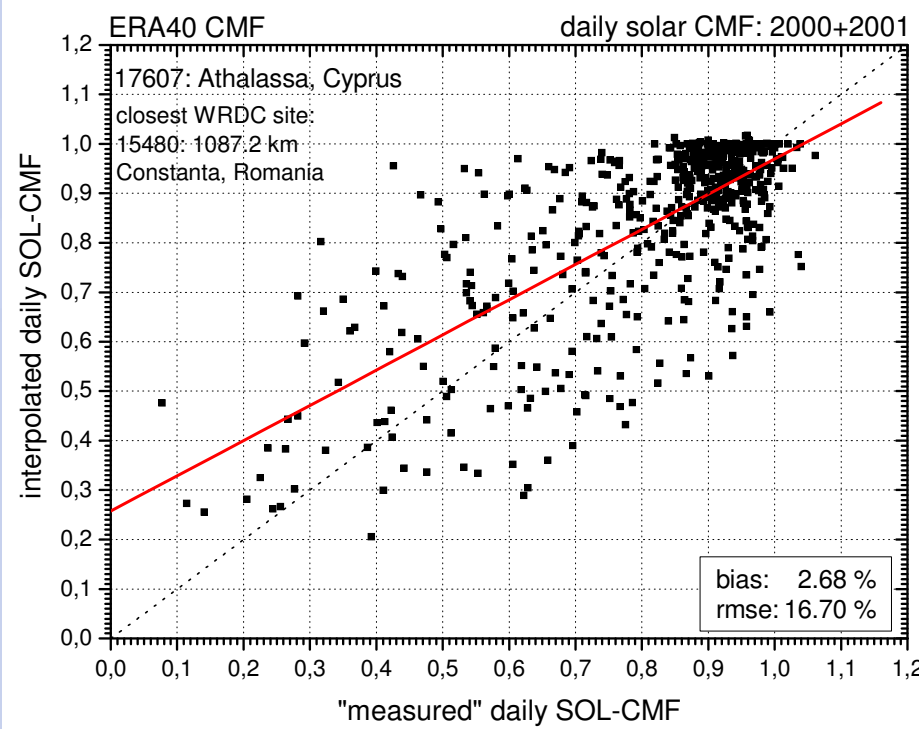
SOL-CMF

mixed mode

global irradiation

Athalassa, Cyprus

+35.150 N 33.400 E 162 m



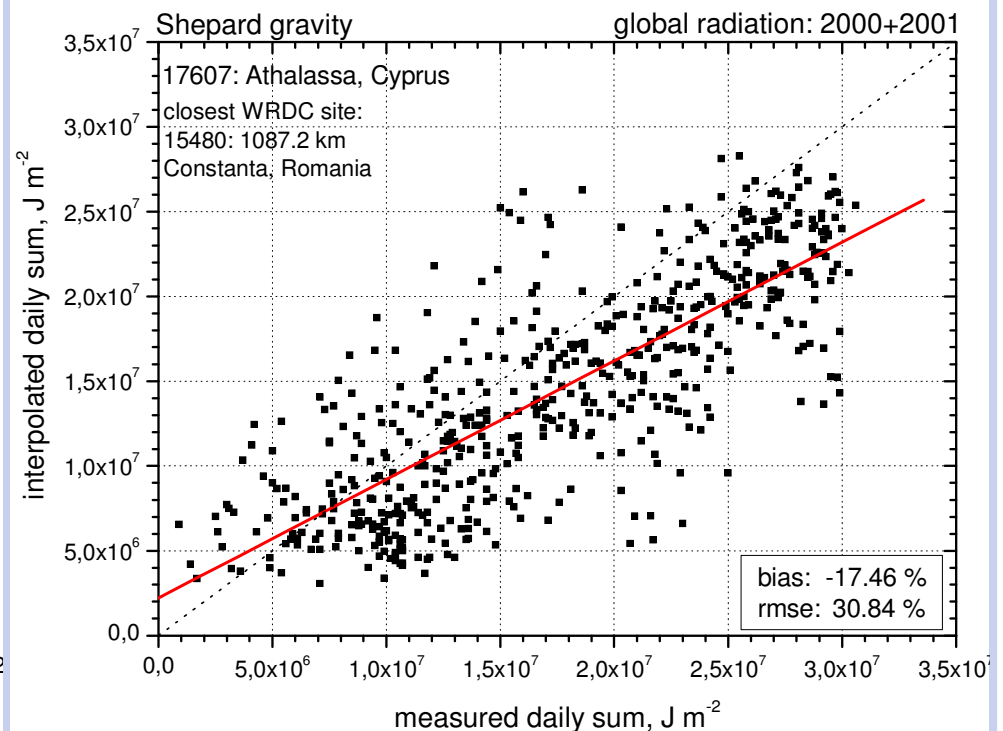
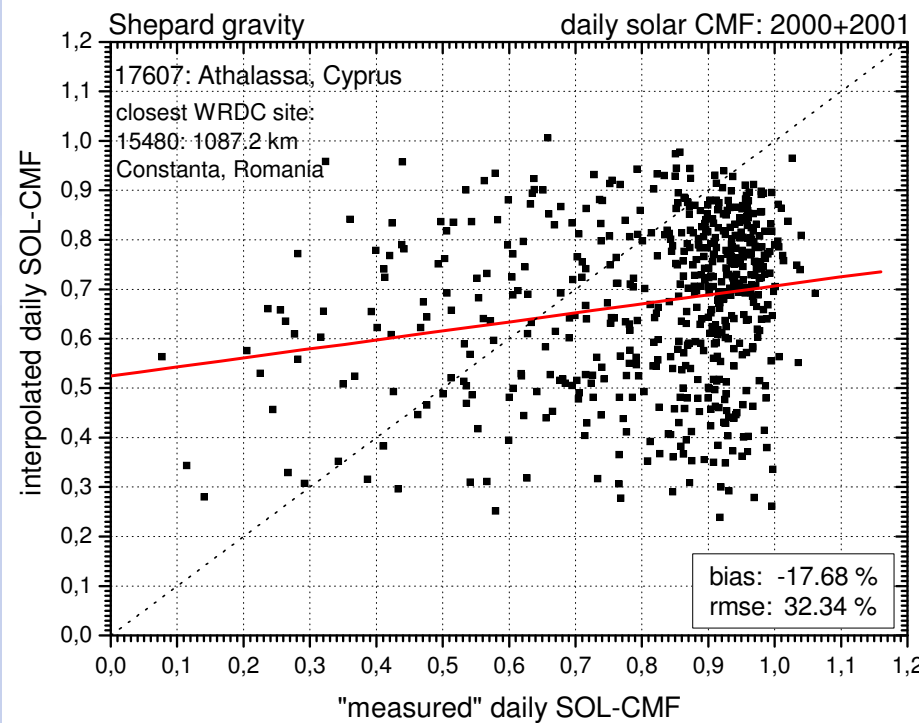
SOL-CMF

ERA40 original

global irradiation

Athalassa, Cyprus

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SOL-CMF

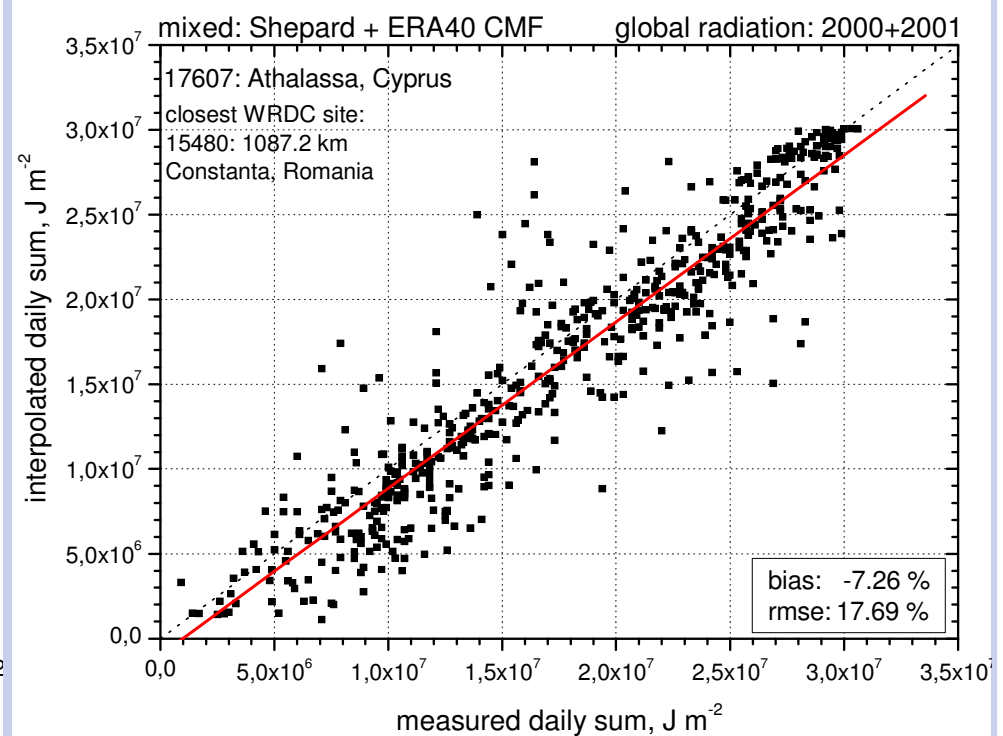
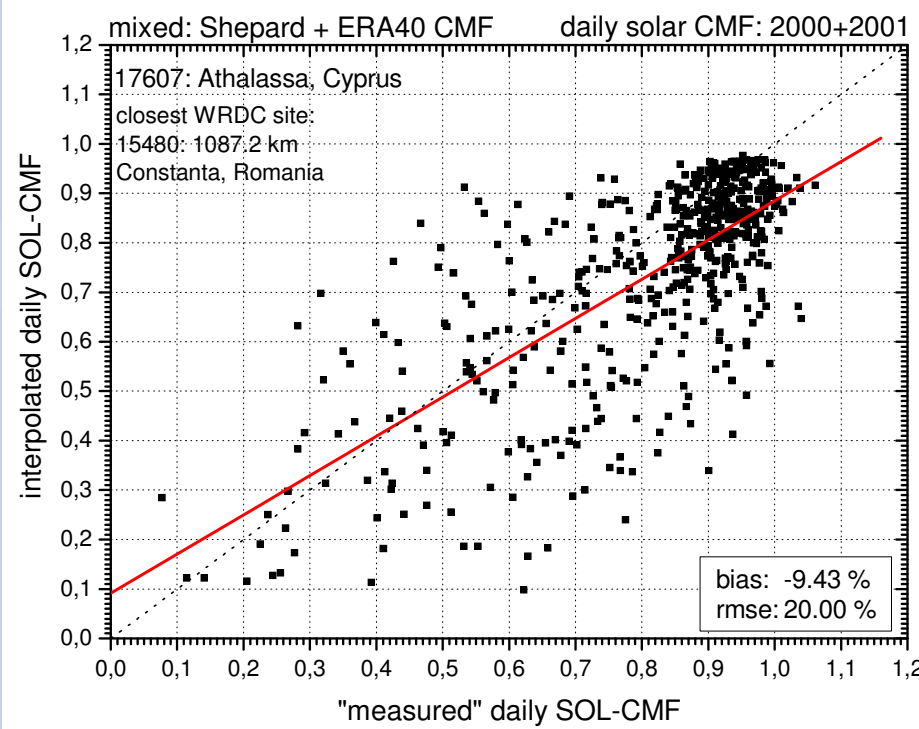
gridded measurements

global irradiation



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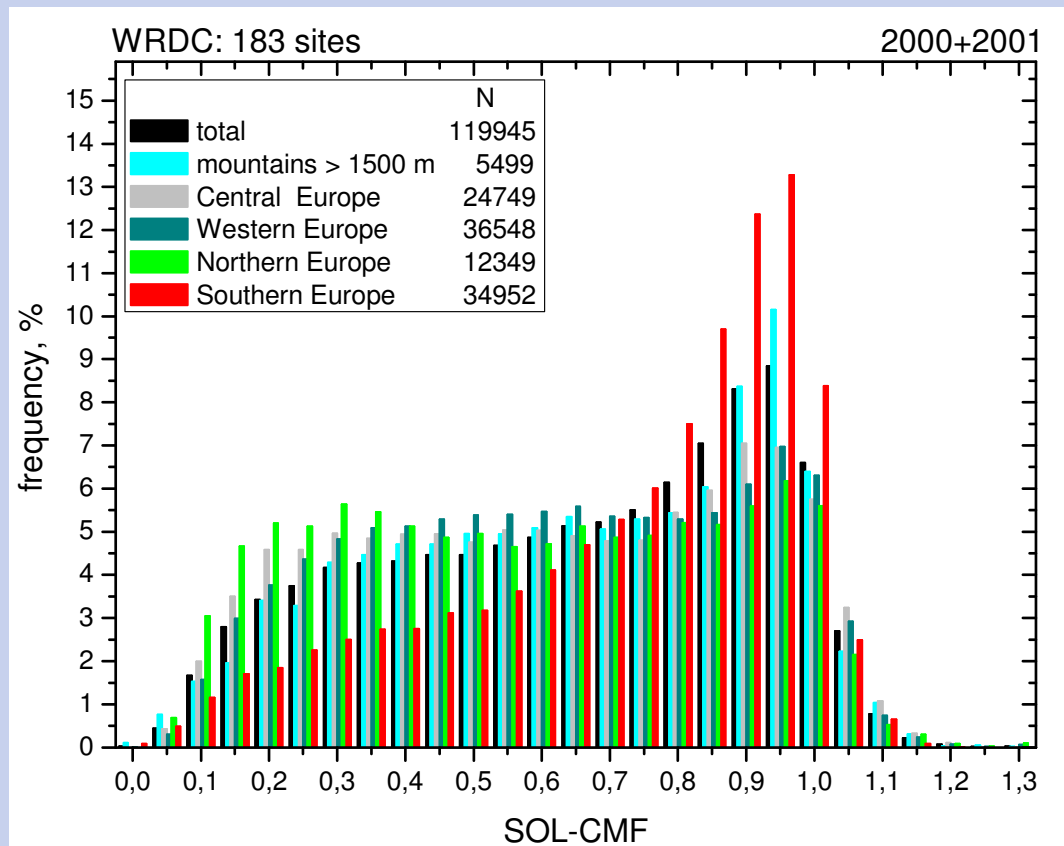


SOL-CMF

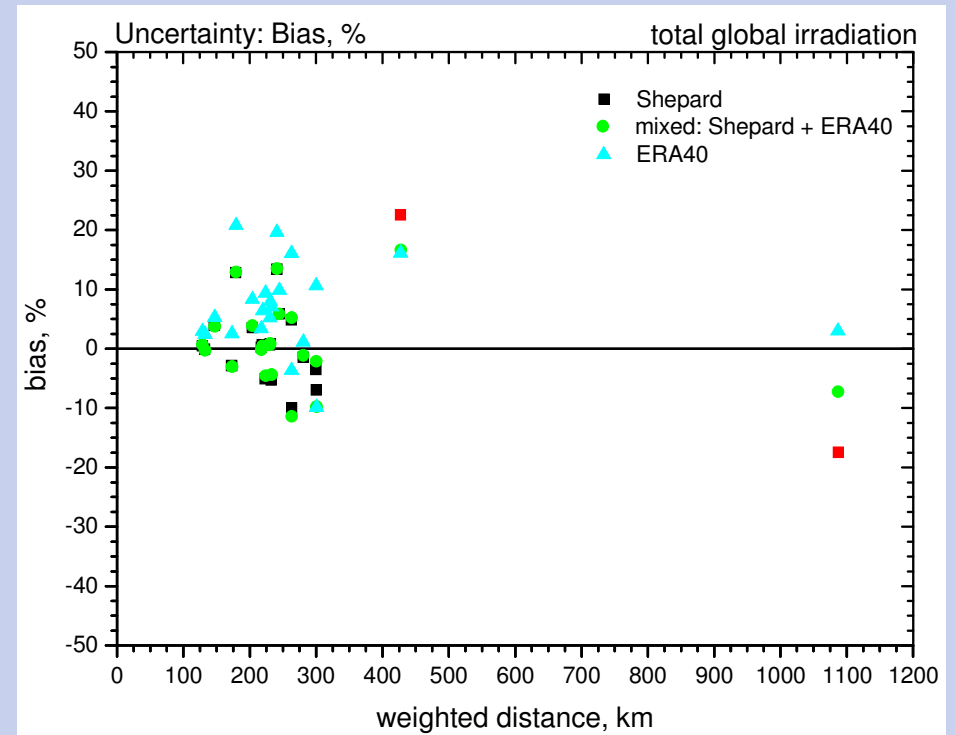
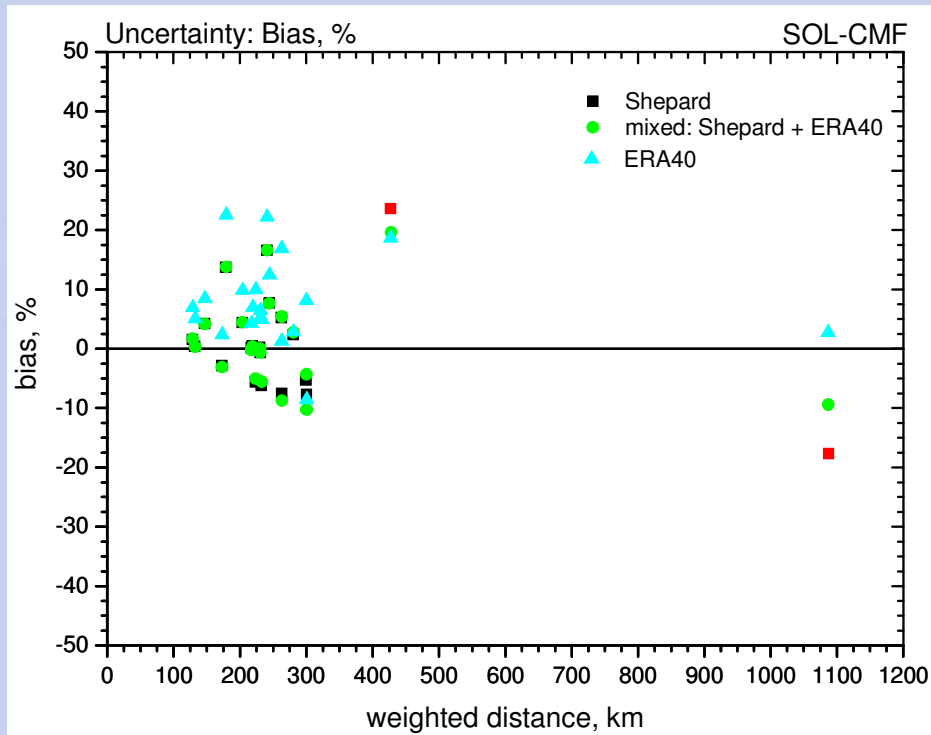
mixed mode

global irradiation

## Frequency distribution of SOL-CMF throughout Europe



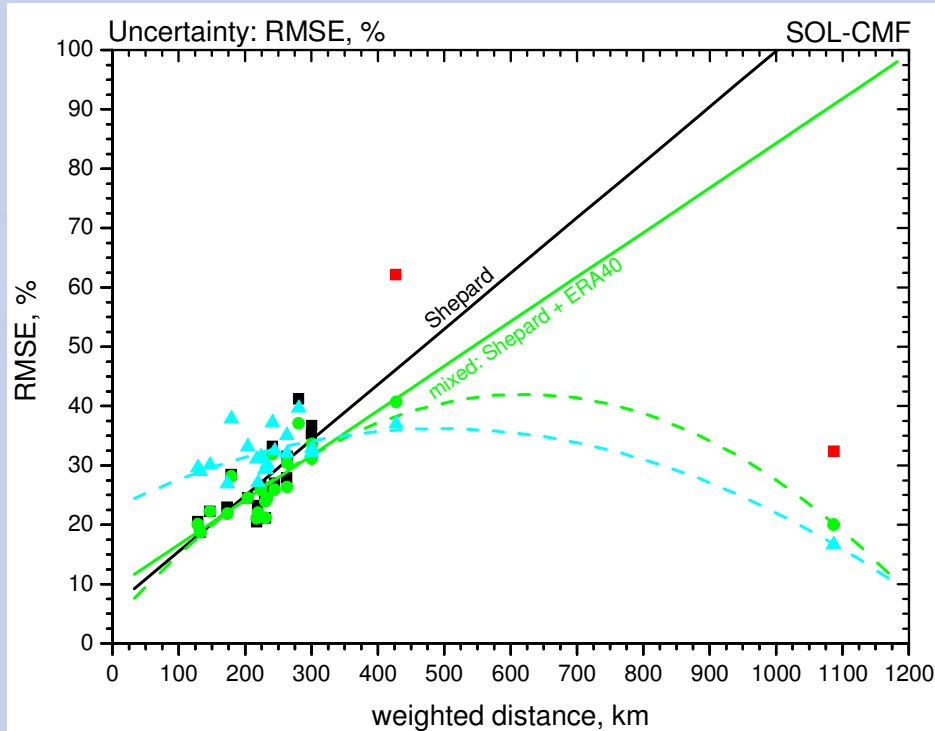
## Uncertainties: Bias



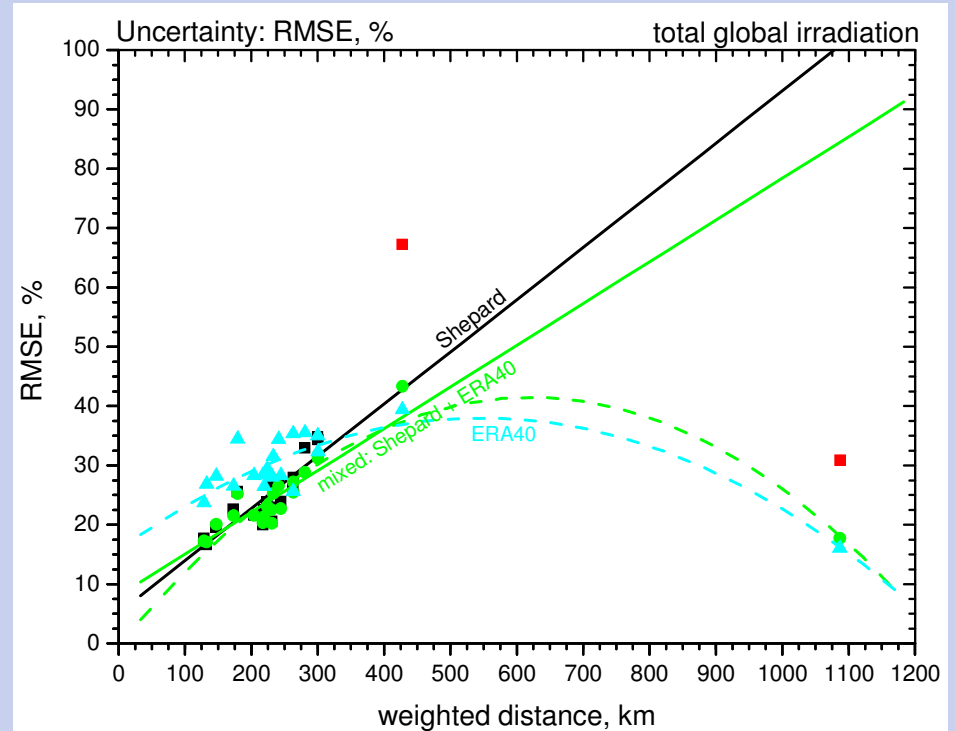
SOL-CMF

global irradiation

## Uncertainties: Root Mean Square Error



SOL-CMF



global irradiation

## Summary

**Uncertainties** in SOL-CMF and total global irradiation interpolated from the  $1^\circ \cdot 1^\circ$  COST-726 grid (21 independent sites):

	SOL-CMF			total global irradiation		
	bias	$\pm 95\%$ cf	RMSE	bias	$\pm 95\%$ cf	RMSE
ERA40:	+7.1 %	$\pm 13.7\%$	31.1 %	+6.1 %	$\pm 13.1\%$	28.9 %
Mixed :	+0.2 %	$\pm 12.2\%$	26.1 %	-0.0 %	$\pm 11.1\%$	23.9 %

Mixed: RMSE linear dependent on network density of measuring sites:

- $\sim 8\%$  for distances  $< 15$  km  $\rightarrow 31\%$  (ERA40) for distances  $> 250$  km

Bias and RMSE are influenced whether a network represents the meteorological conditions or not.

## Conclusions:

Overall uncertainties depend on

- network density (number of sites providing measured irradiation) and on
- sites, selected to represent areas of “homogeneous” climatology.

There is an antagonism between the requests to rely on

- a dense network, aiming to reduce bias and RMSE of gridded values, and
- high quality of measurements, aiming to minimise impacts of uncertainties in measurements on gridding results.



Thank you for your attention







