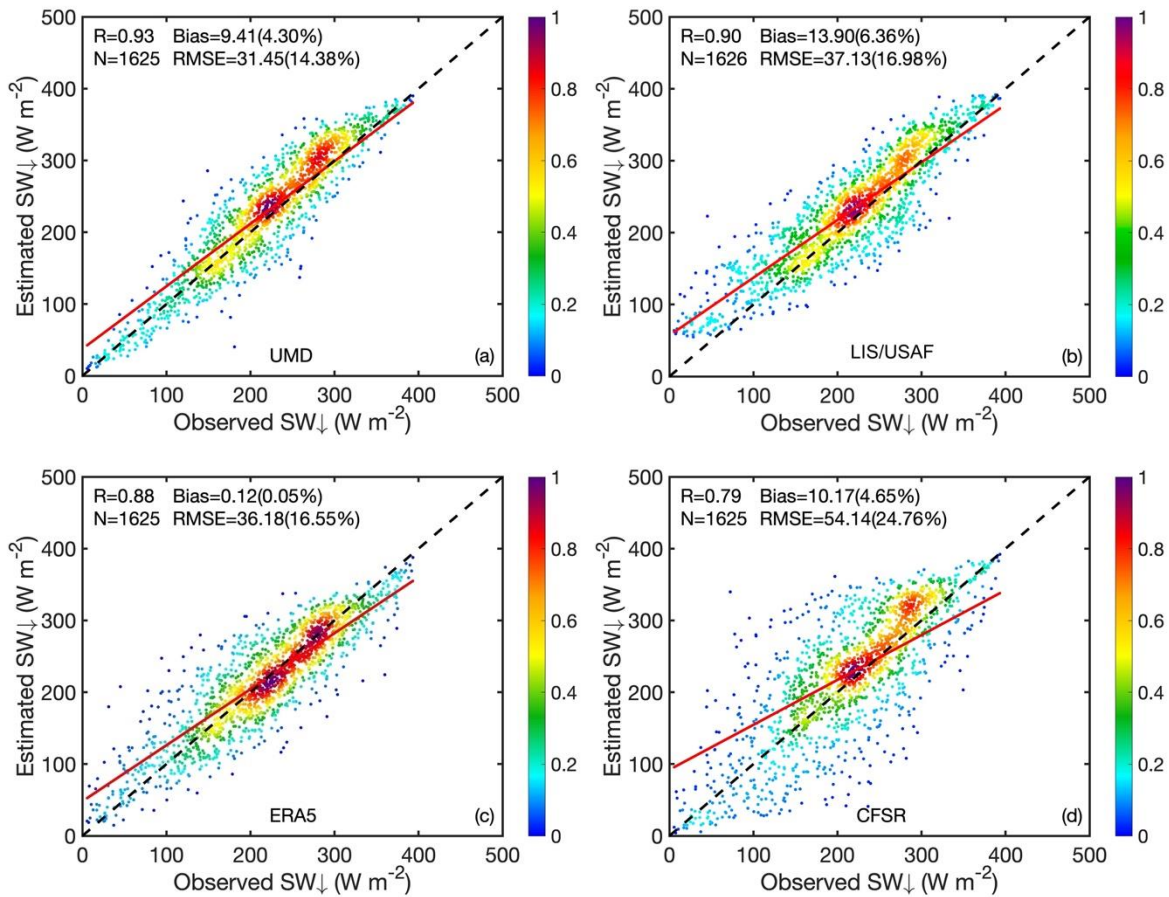


## Supplement

Several large-scale regions are of specific interest for researchers. Unfortunately, high quality observations of SW $\downarrow$  fluxes at these locations are very meager. We have done evaluation of the various SW $\downarrow$  products over Brazil, Australia, Africa and China, using all available observations.

### 1) EVALUATION OVER BRAZIL

The Baseline Surface Radiation Network (BSRN) (Ohmura et al. 1998; Driemel et al. 2018) sites Petrolina (PTR) and São Martinho da Serra (SMS) are in Brazil and represents a large and important portion of South America. **Figure S1** presents the evaluation of daily SW $\downarrow$  from UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA-2 against observations at these two BSRN sites during 10/01/2013-08/31/2015. Statistics can be found in **Table 1**. The satellite estimates and the ERA5 reanalysis products performed best with a  $R$  ( $\geq 0.88$ ) and smaller  $RMSE$  ( $\leq 36.18$  W m $^{-2}$ ). Provided is also information on the % change from the mean for *Bias and RMSE*.



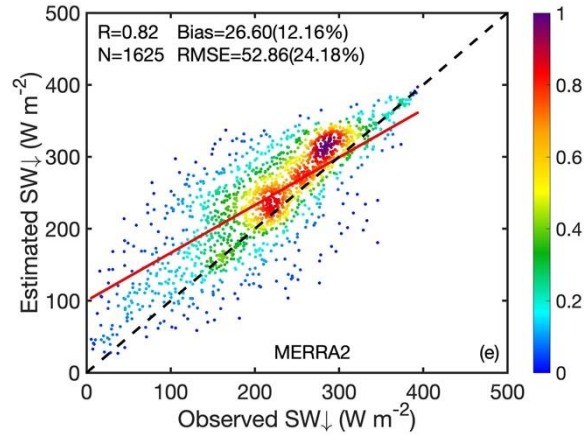


Fig. S1. Evaluation of daily SW $\downarrow$  from UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA2 against observations at two BSRN sites in Brazil (PTR and SMS) during the period of 10/01/2013 – 08/31/2015.

Table S1. Statistics of evaluation of daily SW $\downarrow$  from UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA2 against ground observations over Brazil during the period of 10/01/2013 – 08/31/2015.

	<i>R</i>	<i>Bias</i>	(%)	<i>RMSE</i>	(%)	<i>N</i>
<b>UMD</b>	0.93	9.41	4.30	31.45	14.38	1625
<b>LIS/USAF</b>	0.90	13.90	6.36	37.13	16.98	1625
<b>ERA5</b>	0.88	0.12	0.05	36.18	16.55	1625
<b>CFSR</b>	0.79	10.17	4.65	54.14	24.76	1625
<b>MERRA2</b>	0.82	26.60	12.16	52.86	24.18	1625

## 2) EVALUATION OVER AUSTRALIA

There are three BSRN sites in Australia used for the evaluation of daily SW $\downarrow$  from UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA-2. They are: Alice Springs (ASP), Cocos Island (COC) and Darwin Met Office (DWN). The best agreements are achieved by UMD/MODIS and LIS/USAF with respective *Rs* of 0.96 and 0.93, *Bias* of -0.11 W m $^{-2}$  and 0.33 W m $^{-2}$  and *RMSE* of 21.80 and 28.23, respectively. Provided is also information on the % change from the mean for *Bias* and *RMSE*.

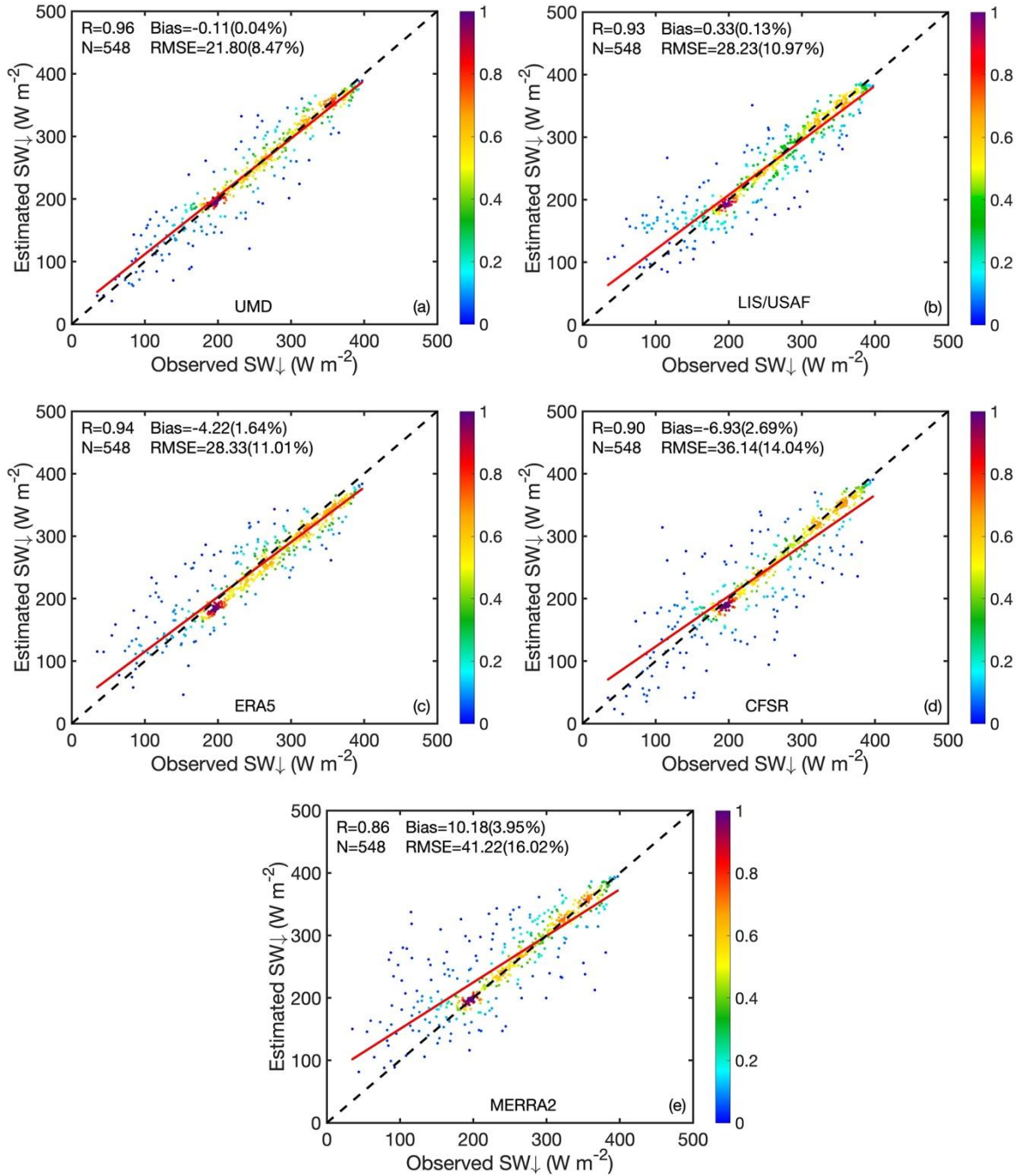


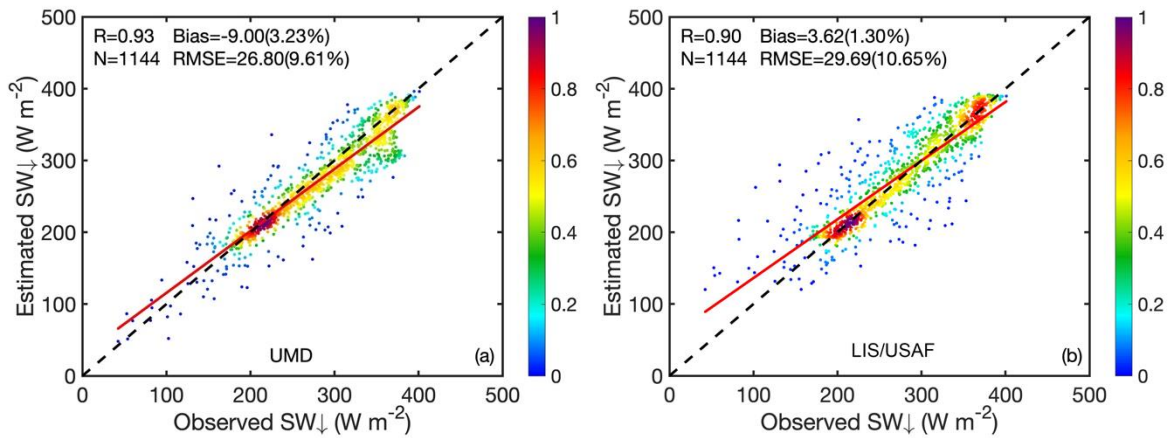
Fig. S2. Evaluation of daily SW<sub>↓</sub> from UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA-2 against ground observation over Australia during the period of 10/01/2013 – 08/31/2015.

Table S2. Statistics of evaluation of daily SW $\downarrow$  from UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA2 against ground observations over Australia during the period of 10/01/2013 – 08/31/2015.

	<i>R</i>	<i>Bias</i>	(%)	<i>RMSE</i>	(%)	<i>N</i>
<b>UMD</b>	0.96	-0.11	0.04	21.80	8.47	548
<b>LIS3</b>	0.93	0.33	0.13	28.23	10.97	548
<b>ERA5</b>	0.84	-4.22	1.64	28.33	11.01	548
<b>CFSR</b>	0.90	-6.93	2.69	36.14	14.04	548
<b>MERRA2</b>	0.86	10.18	3.95	41.22	16.02	548

### 3) EVALUATION OVER AFRICA

The two BSRN sites in Africa used in this study are Tamanrasset (TAM) and Gobabeb (GOB). The LIS/USAF (*Bias*=3.62 W m<sup>-2</sup>) and MERRA-2 (*Bias*=1.82 W m<sup>-2</sup>) overestimate the daily SW $\downarrow$  while the lowest RMSE are for UMD of 26.80 and LIS/USAF 29.69. Provided is also information on the % change from the mean for *Bias* and *RMSE*.



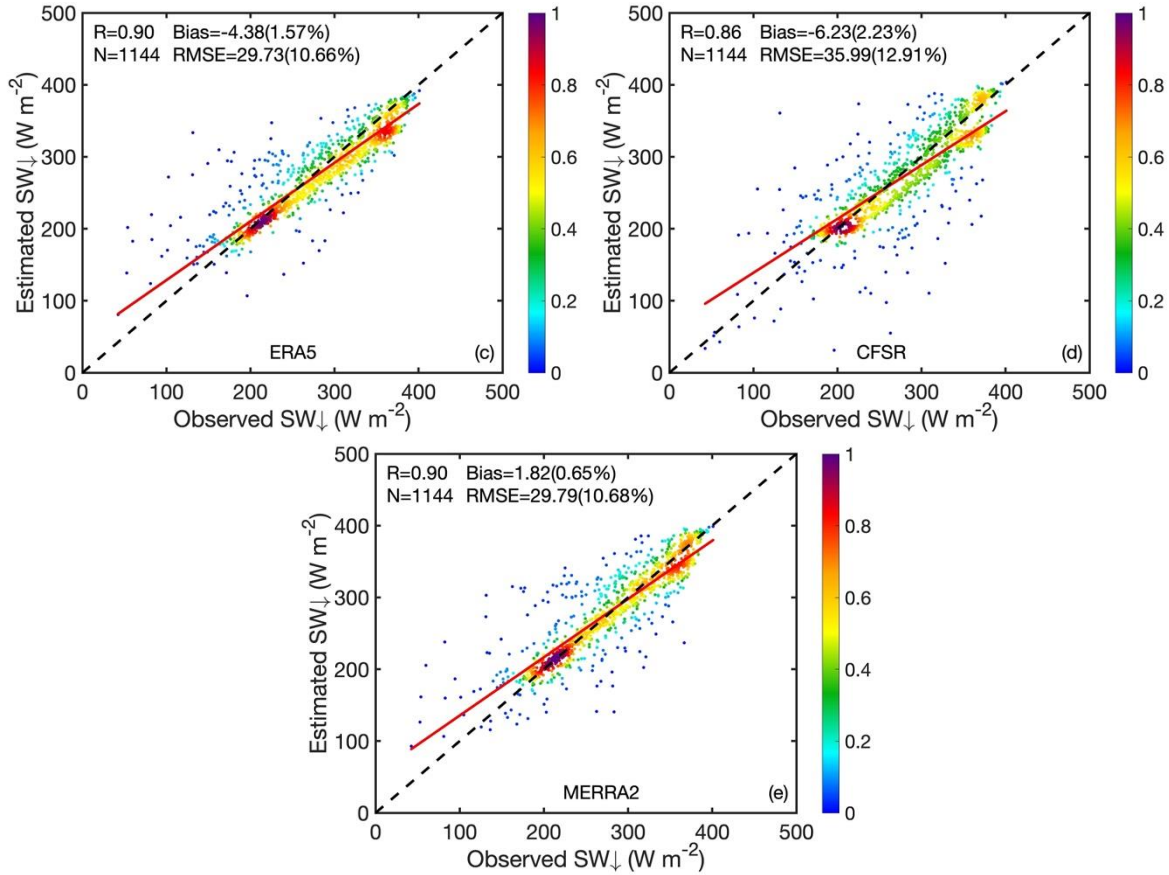


Fig. S3. Evaluation on daily SW $\downarrow$  from UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA2 against ground truth over Africa during the period 10/01/2013 – 08/31/2015.

Table S3. Statistics of evaluation of daily SW $\downarrow$  from UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA2 against ground observations over Africa during 10/01/2013 – 08/31/2015.

	<i>R</i>	<i>Bias</i>	(%)	<i>RMSE</i>	(%)	<i>N</i>
<b>UMD</b>	0.93	-9.00	3.23	26.80	9.61	1144
<b>LIS/USAF</b>	0.90	3.62	1.30	29.69	10.65	1144
<b>ERA5</b>	0.84	-4.38	1.57	29.73	10.66	1144
<b>CFSR</b>	0.86	-6.23	2.23	35.99	12.91	1144

<b>MERRA2</b>	0.90	1.82	0.65	29.79	10.68	1144
---------------	------	------	------	-------	-------	------

#### 4) EVALUATION OVER CHINA

Only one station in China Xianghe (XIA), belongs to the BSRN. There are about 100 stations in China but they do not meet the criteria of BSRN. **Figure 4** shows the daily SW $\downarrow$  from XIA, UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA-2 during 10/01/2013-08/31/2015. Statistics of the evaluations are shown in **Table 4**. The best results are for UMD and ERA5 with R values of 0.93 and 0.92, *Bias* of -1.98 and 13.20 and RMSE of 29.53 and 35.05 respectively. Provided is also information on the % change from the mean for *Bias and RMSE*.

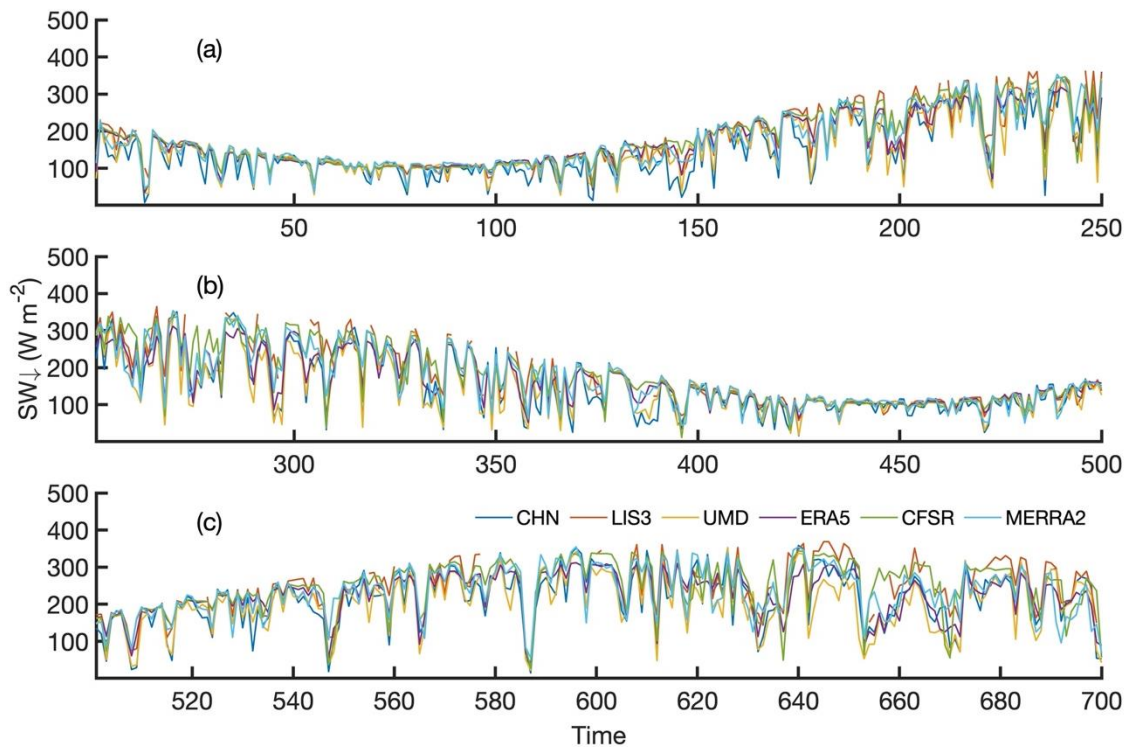


Fig. S4. Daily SW $\downarrow$  from UMD/MODIS, LIS/USAF, ERA5, CFSR and MERRA-2 against ground observed SW $\downarrow$  at BSRN site of Xianghe (XIA), China during 10/01/2013 – 08/31/2015.

Table S4. Statistics of evaluation of daily SW $\downarrow$  from UMD/MODIS, LIS3, ERA5, CFSR and MERRA2 against BSRN/XIA during 10/01/2013 – 08/31/2015.

	<i>R</i>	<i>Bias</i>	(%)	<i>RMSE</i>	(%)	<i>N</i>
<b>UMD</b>	0.93	-1.98	1.18	29.53	17.60	579
<b>LIS/USAF</b>	0.90	27.64	16.47	46.41	27.66	579
<b>ERA5</b>	0.92	13.20	7.87	35.05	20.89	579
<b>CFSR</b>	0.88	27.0	16.10	47.95	28.58	579
<b>MERRA2</b>	0.90	17.13	10.21	40.06	23.88	579

The sample sizes differed for each region with 1626 for Brazil, 548 for Australia, 1144 for Africa and 579 for China.