European Geosciences Union General Assembly
May 4 – May 8 2020 •online

Validation of Clear-Sky Global LAnd Surface Satellite (GLASS) Longwave Radiation Product

*Qi Zeng, Jie Cheng *, Feng Yang*
State Key Laboratory of Remote Sensing Science, Faculty of Geographical Science, Beijing Normal University, Beijing 100875, China.
* Corresponding author: Jie_Cheng@bnu.edu.cn

1. Background

Surface longwave (LW) radiation plays an important role in global climatic change, which is consist of surface longwave upward radiation (LWUP), surface longwave downward radiation (LWDN) and surface longwave net radiation (LWNR). Numerous studies have been carried out to estimate LWUP or LWDN from remote sensing data, and several satellite LW radiation products have been released, such as the International Satellite Cloud Climatology Project - Flux Data (ISCCP - FD), the Global Energy and Water cycle Experiment-Surface Radiation Budget (GEWEX-SRB) and the Clouds and the Earth's Radiant Energy System - Gridded Radiative Fluxes and Clouds (CERES-FSW). But these products share the common features of coarse spatial resolutions (100-280 km) and lower validation accuracy.

Under such circumstance, we developed the methods of estimating long-term high spatial resolution all sky instantaneous LW radiation, and produced the corresponding products from MODIS data from 2000 through 2018 (Terra and Aqua), named as Global LAnd Surface Satellite (GLASS) Longwave Radiation product, which can be free freely downloaded from the website (http://glass.umd.edu/Download.html).

2. METHODOLOGY

Clear-sky LW radiation estimation algorithms

- **LWUP. We adopted the algorithm put forward by Cheng et al.(2016) to calculate the clear-sky LWUP:**

$$LWUP_{clear} = a_0 + a_1 L_{29} + a_2 L_{31} + a_3 L_{32}$$

where L_{29}, L_{29} and L_{32} are the TOA radiances for MODIS channels 29, 31 and 32, respectively, and a_0, a_1, a_2 and a_3 represent the regression coefficients.

- **LWDN. The hybrid algorithm also come from Cheng et al.(2017) was used to calculated the clear-sky LWDN:**

$$LWDN_{clear} = a_0 + a_1 LWUP_{clear} + a_2 \log(1+cwv) + a_3 \log(1+cwv)^2 + a_4 L_{29}$$

where CWV is the column water vapor. $LWUP_{clear}$ is LWUP computed via equation (1). We use a backup method to calculate clear-sky LWDN over a high-elevation area with extremely low CWV, which is expressed as:

$$LWDN_{clear} = a * cwv^b$$

where a and b are the coefficients.

Cloud-sky LW radiation estimation algorithms

- **LWUP.** The cloudy-sky LWUP is calculated from the surface temperature and the broadband emissivity as follows:

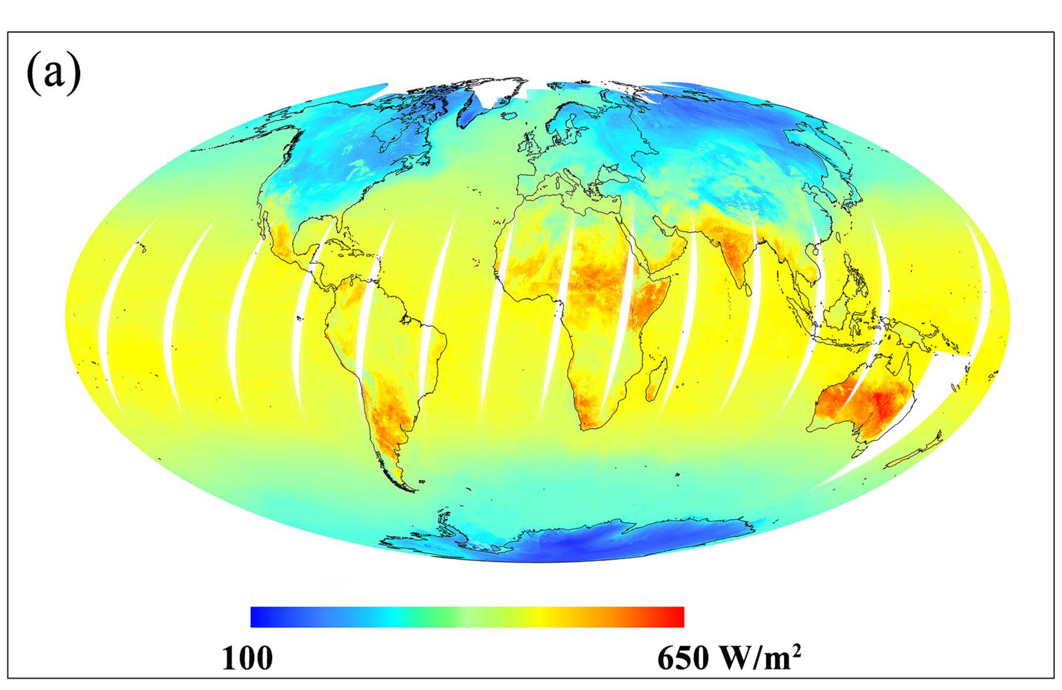
$$LWUP_{cloud} = \sigma \varepsilon_s T_s^4$$

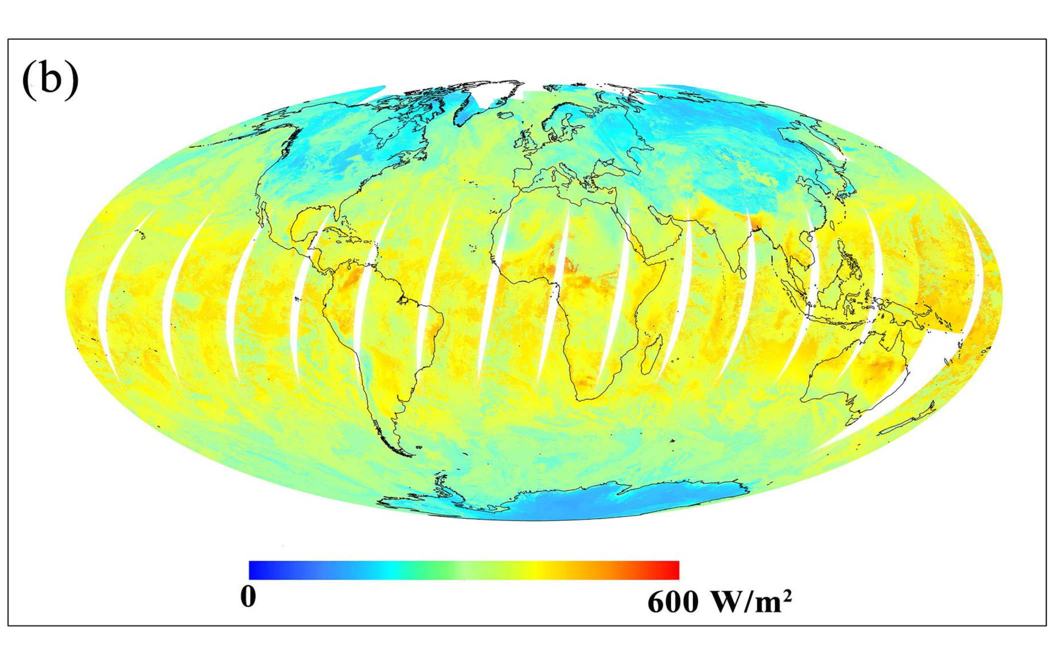
where σ is the Stefan-Boltzmann constant; is the surface temperature, which is extracted from MOD06/MYD06; T_s represents the surface broadband emissivity, which is obtained from the GLASS broadband emissivity product.

- **LWDN.** The cloud-sky LWDN is estimated from MODIS cloud parameters using the single-layer cloud model of Forman and Margulis(2007).

$$LWDN_{cloud} = \sigma \varepsilon_a T_a^4 + \sigma(1-\varepsilon_a)\varepsilon_c T_c^4$$

where ε_a is the air emissivity; ε_c represents the cloud emissivity; T_a and T_c are the air temperature at the screen level and the cloud-top temperature, respectively.





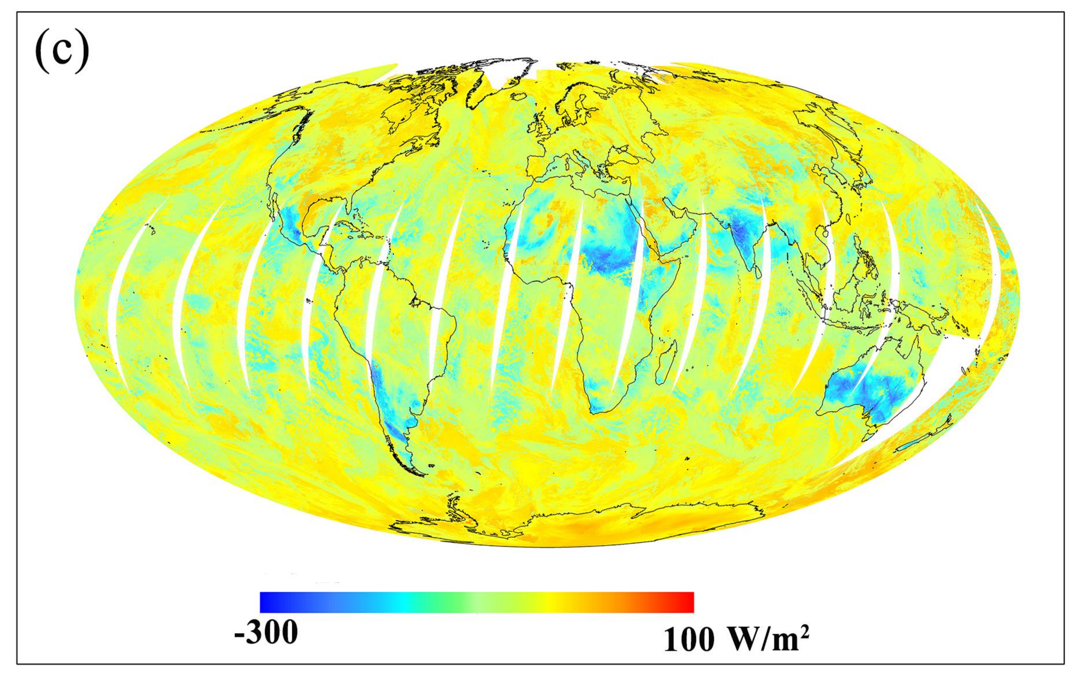


Fig 1. Examples of global daytime LW radiation maps that were derived from the MODIS/Terra data from DOY 49, 2006. (a) LWUP; (b) LWDN; and (c) LWNR.

3. RESULTS AND ANALYSIS

LW validation

- **Global accuracy.** The ground measurements of 141 commonly used sites from six independent flux networks that are AsiaFlux, AmeriFlux, BSRN CEOP, HiWATER-MUSOEXE and TIPEX-III.

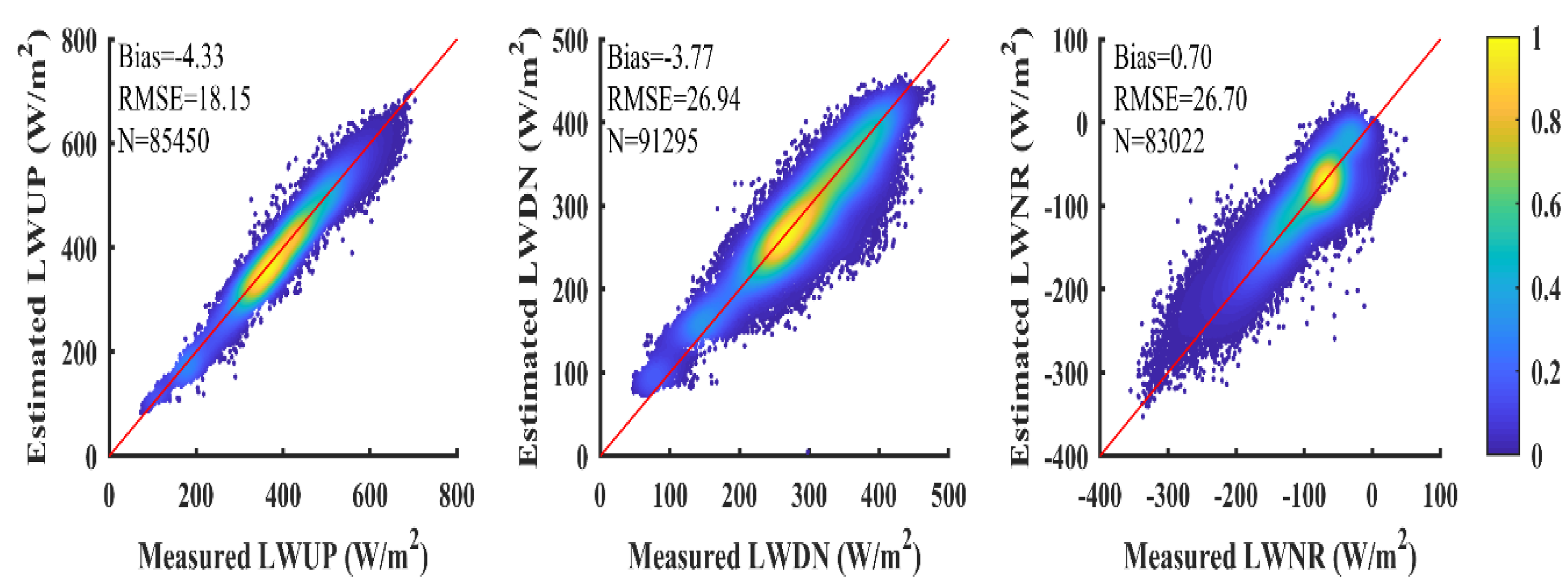


Fig. 2. Overall validation results of GLASS LWUP, LWDN and LWNR.

- **Day and night accuracy.** Figure 3 shows the difference during the day and the night.

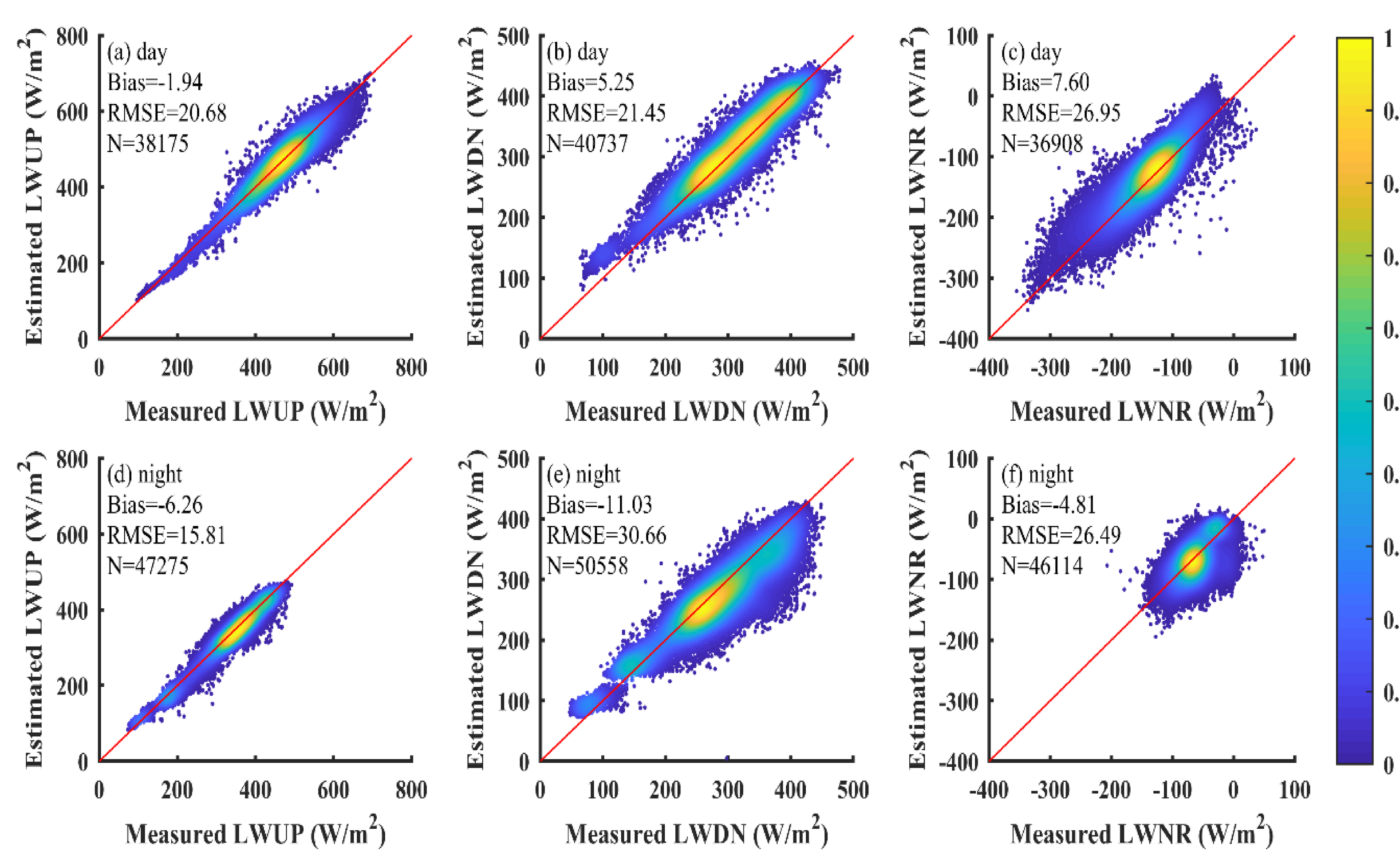


Fig. 3 Validation results of GLASS LWUP, LWDN and LWNR during daytime and nighttime, respectively.

- **Terra and Aqua accuracy.** Figure 4 shows the obvious difference of the GLASS LW between the Terra and Auqa.

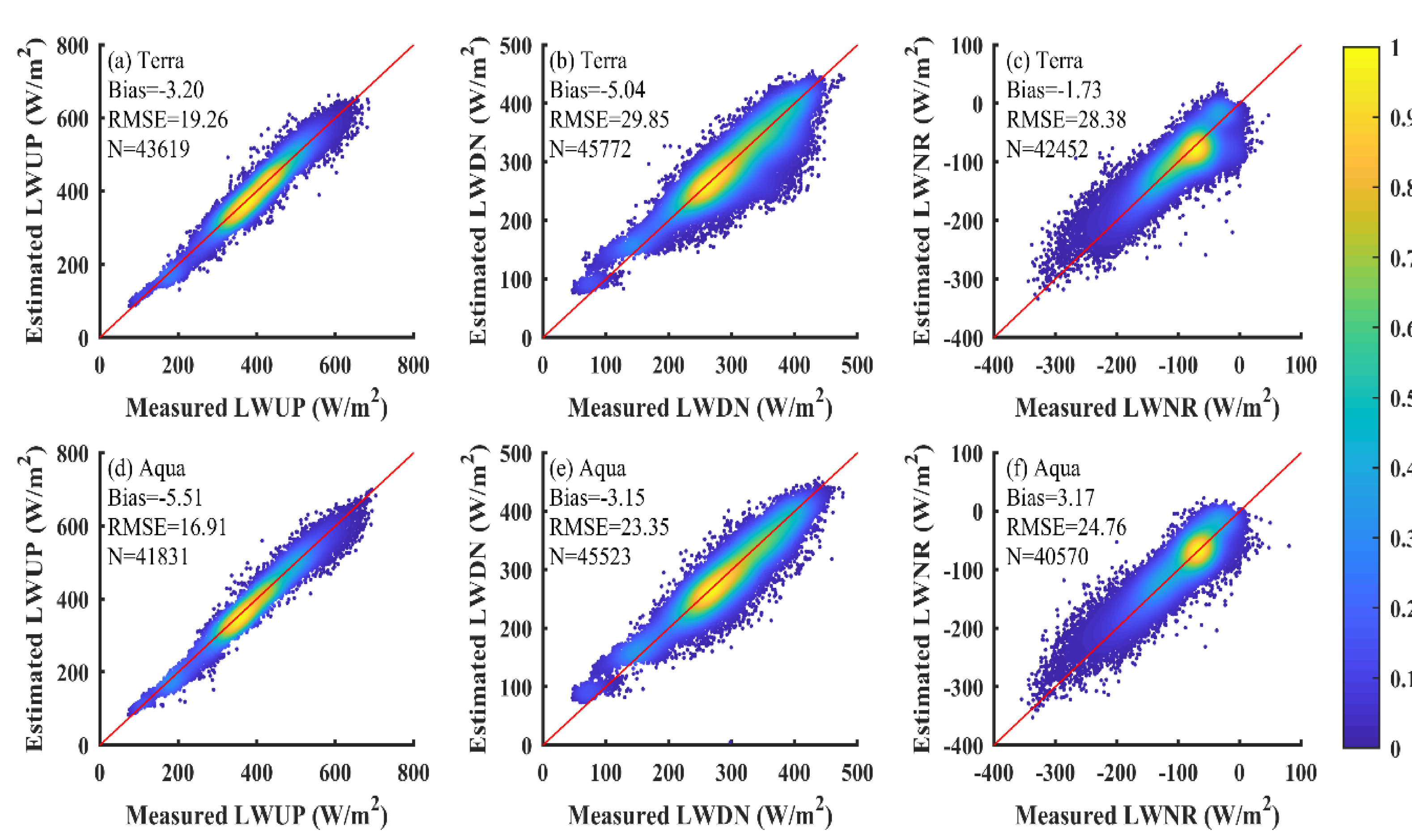


Fig. 4 Accuracies of GLASS LWUP, LWDN and LWNR derived from Terra and Aqua, respectively.

4. Conclusion

In this article, ground measurements collected from 141 sites in six independent networks (AmerciFlux, AsiaFlux, BSRN, CEOP, HiWATER-MUSOEXE and TIPEX-III) are used to evaluate the clear-sky GLASS LW radiation products at global scale. The bias and RMSE is -4.33 W/m² and 18.15 W/m² for LWUP, -3.77 W/m² and 26.94 W/m² for LWDN, and 0.70 W/m² and 26.70 W/m² for LWNR, respectively. Compared with validation results of the above mentioned three LW radiation products, the overall accuracy of GLASS LW radiation product is much better. We will continue to improve the retrieval algorithms and update the products accordingly.