Response to Anonymous Referee #2

We would like to thank the reviewer for the comments and suggestions, which contribute to improving the quality of our work. We have made revisions and have replied to all comments and suggestions. Please, find a detailed point-by-point response to each comment.

Comment:

As well known, Incident shortwave radiation (ISR) at the surface is an essential parameter in the land surface radiation budget and in many land surface process models. This manuscript entitled "Retrieving high-resolution surface solar radiation with cloud parameters derived by combining MODIS and MTSAT data" presented an effective method to retrieve ISR with cloud parameters, including effective particle radius, liquid water path, and ice water path, by combining MODIS and MTSAT data. The retrieved ISR data were also compared with ground measurements and current satellite-derived ISR products. The paper is well written and organized. Overall, I feel the paper presents interesting scientific results as the retrieval algorithm is novel and the comparisons are extensive and valuable for knowing their overall accuracies using direct measurements. However, the manuscript is lacking in detail in a few areas (see comments below for details). Therefore, I would not recommend the paper for potential publication in ACP unless substantial improvements are made to address the following concerns.

Response:

We thank Referee #2 for the encouraging comments. All comments and suggestions have been considered carefully and well addressed.

Comment:

1. As mentioned in the manuscript, the major contributions of the authors are to present an effective method to retrieve high temporal resolution cloud parameters by establishing correlations between MODIS cloud products and MTSAT TOA radiance based on ANN, since the parameterization scheme has been reported in the previous studies presented by the authors. As it is well known, one obvious advantage to use satellite data for the mapping of surface or atmospheric parameters is the fact that it is available at least regionally, potentially even on a global level. Although the authors compared the retrieved high temporal resolution cloud parameters with the MODIS "TRUE values", the mapping of high temporal resolution cloud parameters were not displayed in the context. I would suggest the authors to present some retrieved results of high temporal resolution cloud parameters.

Response:

Cloud covers and cloud parameters change drastically, which significantly affect SSR. In terms of SSR retrieval, it makes little sense to simply average the cloud parameters on the seasonal or annual scale. Thus, an instantaneous image of high resolution cloud parameters at 20:00UTC on July 7th, 2009 was randomly selected and displayed in

Figure 1, which shows the spatial distribution of cloud parameters clearly. The figure will not be added in the manuscript, because displaying an instantaneous image of cloud parameters in the manuscript have no apparent scientific significance. As indicated in the manuscript, the accuracy of our retrieved SSR is comparable or even higher than other two radiation products (GLASS and ISCCP-FD). Therefore, we may expect that the cloud parameters derived in this study is relatively reliable.

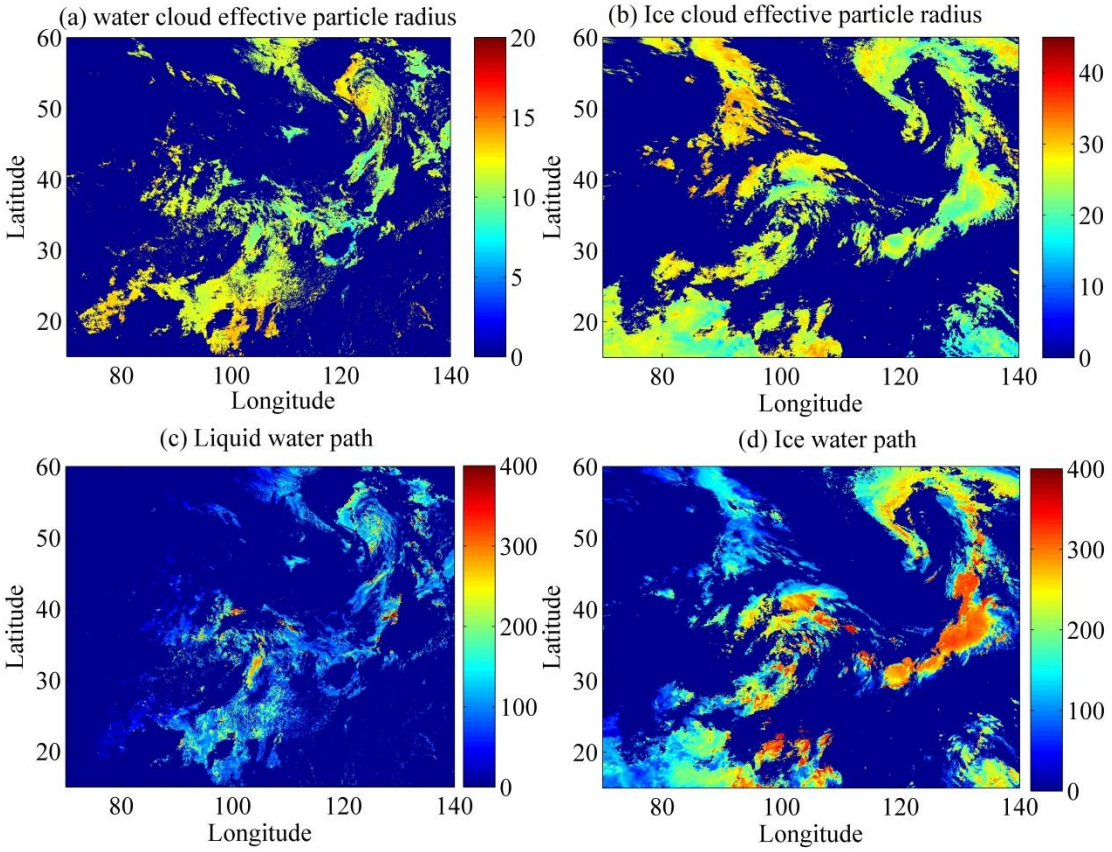

Figure 1 An example of the spatial distribution of cloud parameters at 20:00UTC on July 7th, 2009.

Comment:

2. The authors simply concluded that the overestimation in the proposed scheme might be attributed to the underestimation of the cloud water path. I think extra sensitive analyses are needed in Section 3.2. How the cloud parameters influence the retrieval accuracy?

Response:

Good comment! The sensitivity test of the SSR retrieval algorithm to cloud parameters (effective particle radius and liquid/ice water path) is presented in Figure 2. The condition used for the sensitivity test is specified as a mid-latitude atmosphere with: solar zenith angle=60 deg., surface elevation=0.0 km, precipitable water=0.14 cm, total zone amount=0.25 cm, surface albedo=0.2 and Ångström turbidity coefficient =0.1. We tested the sensitivity of SSR retrieval to estimation errors in both liquid/ice water path and effective particle radius. As shown in Figure 3 and Figure 4

(in the original manuscript), the estimated mean effective particle radius within one standard deviation (1-SD) correspond to the ranges of about 8-12 μm and 22-30 μm for water cloud and ice cloud, which would lead to SSR differences about 25 W m^{-2} and 15 W m^{-2} as seen from Figure 2, respectively. The estimated mean cloud liquid/ice water path within 1-SD correspond to the ranges of about 45-185 g m^{-2}, 80-240 g m^{-2}, which would lead to SSR differences about 154 W m^{-2} and 172 W m^{-2}, respectively. Obviously, errors caused by the cloud liquid/ice water path estimation are much greater than the ones caused by cloud effective particle estimation. Therefore, we believe that the underestimation of cloud liquid/ice water path is the major cause for the overestimation of SSR.

The above information will be added in the revised manuscript.

The MBE and RMSE for cloud parameters estimation will be added on Figure 3 and Figure 4 in the revised manuscript.

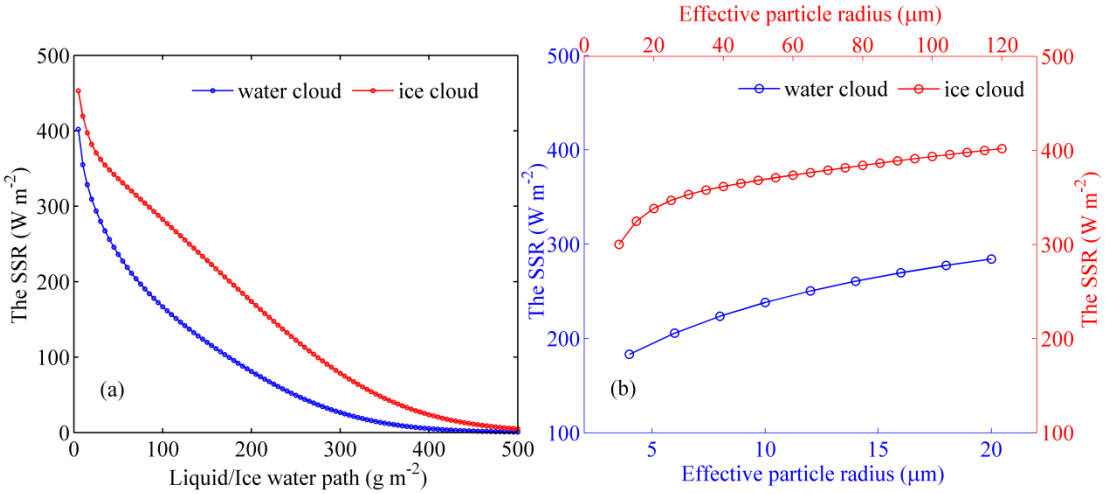

Figure 2 (a) Sensitivity of SSR to cloud liquid/ice water path, given the effective particle radius for water cloud and ice cloud to be 12 μm and 30 μm, respectively; (b) Sensitivity of SSR to cloud effective particle radius for water cloud and ice cloud, given liquid/ice water path to be 80 g m^{-2}.

Comment:

3. The spatial resolution of ISCCP-FD product is about 280 km, while the spatial resolutions the GLASS and the retrieval results based on the proposed method are 5 km. Will different spatial resolutions affect the evaluation results?

Response:

Good comment! It must be admitted that it is very important that both spatial and temporal scales of in-situ SSR measurements are commensurate with those of satellite retrievals. As pointed by Li et al. [2005], it incurs un-negligible errors to use instantaneous SSR measurements to validate coarse-resolution satellite retrievals. However, the spatial sampling uncertainties decrease rapidly as the time-averaging interval increases up to 24 h. Therefore, we compare the evaluation results of our SSR estimates with GLASS and ISCCP-FD product at a daily time scale. The following text will be added in the revised manuscript.

"It may incur large errors to validate ISCCP-FD SSR products by using instantaneous in situ measurements because its spatial resolution is rather coarse (about 280 km). However, at daily time scale, the spatial sampling errors become small (Li et al., 2005). Thus, we compare our SSR estimates with GLASS and ISCCP-FD product at a daily time scale."

Li, Z., M. Cribb, F. L. Chang, A. Trishchenko, and Y. Luo (2005), Natural variability and sampling errors in solar radiation measurements for model validation over the atmospheric radiation measurement Southern Great Plains region, J. Geophys. Res., 110, D15S19, doi:10.1029/2004JD005028.

Minors:

Comment:

1. Page 35203, Line 13: "But their spatial resolutions (> 100 km) are too coarse to meet the requirements of land surface processes studies and practical applications." I think it should be "But their spatial resolutions (> 100 km) are too coarse to meet the requirements of land surface processes studies and practical applications very well."

Response:

Accepted!

Comment:

2. Page 35204, Line 23: "But it is difficult to directly derive cloud properties based on geostationary satellites due to their low spectral resolutions." Quotations are needed for this expression.

Response:

The following reference will be added in the revised manuscript.

King, M. D., Tsay, S. C., Platnick, S. E., Wang, M. H., Liou, K. N.: Cloud retrieval algorithms for MODIS: optical thickness, effective particle radius, and thermodynamic phase, MODIS Algorithm Theoretical Basis Document No. ATBD-MOD-05, 1997.

Comment:

3. Page 35204, Line 23: I think "As well-known, the largest certainties...." should be "As well-known, the larger uncertainties …".

Response:

Compared with other factors such as aerosol, water vapor, ozone and so on, cloud actually is the largest uncertainty factor in satellite retrieval of SSR. Therefore, we think the "largest" is more proper than "larger".

Comment:

4. Page 35205, Line 3: "MODIS and high temporal resolution radiance data of all MTSAT channels" should be "MODIS and high temporal resolution TOA radiance data of all MTSAT channels".

Response:
Accepted!

Comment:
5. Page 35205, Line 3: I think the authors used to MTSAT-1R data. It should be described clearly here.

Response:
Yes, the observed SSR data in 2009 are used to validate the retrieved SSR, which were estimated from MTSAT-1R data. But, both MTSAT-1R and MTSAT-2 data are used in this study to map high spatio-temporal resolution SSR dataset (hourly, 5 km) over China from 2007 to 2014.

Comment:
6. Page 35205, Line 20-25: Specific references should be included in the context.

Response:
The following two references will be added in the revised manuscript.

King, M. D., et al. (2003), Cloud and aerosol properties, perceptible water, and profiles of temperature and humidity from MODIS, IEEE Trans. Geosci. Remote Sens., 41, 442–458, doi:10.1109/TGRS.2002.808226.

Schaaf, C. B., et al. (2002), First operational BRDF, albedo nadir reflectance products from MODIS, Remote Sens. Environ., 83, 135–148, doi:10.1016/S0034-4257(02)00091-3.