Response to Reviews 12/10/2021

**Color Coding:**

Black: Reviewer

Red: Authors

We thank this Reviewer for very helpful comments.

**Comment:** There is some displacement in the line numbering of the Reviewers and the submitted version of the manuscript. We have also downloaded the ATM version, but there is still a shift. This made it sometimes difficult to identify the location of the Reviewers comments.

## Reviewer # 2

**Suggestions for technical corrections or reasons for rejection**

I believe it is important to document satellite retrieval products so that the user can cite the product as well as understand it. This paper documents the NOAA STAR GOES ABI TOA SW flux product. The methodology section reads more like an ATBD, there are many tables on how the LUT parameters were binned. There is no science reasoning on why the algorithm was built the way it was. It simply jumps straight into the atmospheric profiles, aerosol inputs, etc., used in the radiative transfer model. For an algorithm paper, I expect that the validation to be based on the product data and I am unsure if the product exists. In this case, ABI channel data is utilized and processed through the algorithm. The authors should be using the official CERES SSF L2 product not the CERES FLASHFlux L2 product for validation. The FLASHFlux product was designed for real-time processing, where many inputs were replaced with real-time datasets, such as FPIT rather than GEOS.5.4.1 atmospheric profile data. Also, the FLASHFlux fluxes are not properly calibrated. Lastly the validation is based on a single swath of Terra and Aqua CERES fluxes. At least 4 seasonal months should be compared. I am also taken back, that by changing the surface type classification over Mexico the TOA SW flux can differ by 250 Wm-2, which is very large. CERES would help resolve these issues, but this case was not compared with CERES data. Unless I did not properly perceive the objectives of the paper, the paper is insufficient and incomplete to properly document the NOAA STAR GOES ABI TOA SW flux product and should be resubmitted.

## Response to Reviewer # 2

### Reviewer # 2

The methodology section reads more like an ATBD, there are many tables on how the LUT parameters were binned.

### Response

The paper describes a methodology how to derive the TOA fluxes. Due to its nature, detailed tables are appropriate and similarity to an ATBD is unavoidable.

## Reviewer # 2

There is no science reasoning on why the algorithm was built the way it was. It simply jumps straight into the atmospheric profiles, aerosol inputs, etc., used in the radiative transfer model.

## Response

No new theory has been developed to deal with this problem. The procedures are straightforward as followed by other investigators that deal with this problem. The new aspect of the work is the implementation for a new satellite. The readers should be informed as how this step was implemented in the relevant inference schemes.

## Reviewer # 2

For an algorithm paper, I expect that the validation to be based on the product data and I am unsure if the product exists. In this case, ABI channel data is utilized and processed through the algorithm.

## Response

A product of shortwave fluxes does exist at NOAA/STAR. Our paper describes one part of the algorithm and as such, the validation is focused on this part. The evaluation of the entire algorithm that leads to the final product is out of the scope of this paper. There are many other issues involved in the implementation that can cause discrepancies at the surface. Evaluation against the SW at the surface would not tell the whole story about the quality of the TOA part.

## Reviewer # 2

The authors should be using the official CERES SSF L2 product not the CERES FLASHFlux L2 product for validation. The FLASHFlux product was designed for real-time processing, where many inputs were replaced with real-time datasets, such as FPIT rather than GEOS.5.4.1 atmospheric profile data. Also, the FLASHFlux fluxes are not properly calibrated.

## Response

We agree with this Reviewer on the need to use the final CERES product. Indeed, that is what was done in all the cases described in the paper. We apologize for the mistake we made in labeling the product. We have been involved in using the FLASHFlux data in preliminary evaluation for such a long time (due to the latency in data availability) that FLASHFlux was engrained in our memory. We have now prepared a data base of what was used so the reader can check this point out. Information will be provided how to access this database.

## Reviewer # 2

Lastly the validation is based on a single swath of Terra and Aqua CERES fluxes. At least 4 seasonal months should be compared.

## Response

We have added a case for summer so all the seasons are represented.
Factors that affect the NTB and ADM conversion include geometry angles, surface type and cloud optical depth for cloudy case. The surface type may be season dependent. We did compared cases in both summer and winter seasons. There are no significant differences in the statistics as seen in the new augmented Table 7.

Reviewer # 2

I am also taken back, that by changing the surface type classification over Mexico the TOA SW flux can differ by 250 Wm-2, which is very large. CERES would help resolve these issues, but this case was not compared with CERES data.

## Response

Seems that this comparison is raising some questions. Since it is based only on one case, we have decided to eliminate this section.

## Reviewer # 2

Unless I did not properly perceive the objectives of the paper, the paper is insufficient and incomplete to properly document the NOAA STAR GOES ABI TOA SW flux product and should be resubmitted.

## Response

We thank you for this recommendation. We have done additional documentation of the work that was done, added more cases and we plan to resubmit the manuscript if our responses are found to be satisfactory.

## Supplementary Comments of Reviewer # 2

## Reviewer # 2

**General comments.**

The authors should be using the official CERES SSF L2 product not the CERES FLASHFlux L2 product for validation. The FLASHFlux product was designed for real-time processing, where many SSF inputs were replaced with real-time datasets, for example the GEOS 5.4.1 reanalysis rdataset was replace by the realtime FPIT dataset. The more realtime dataset algorithm datasets are often revised due to changing input quality. The CERES input datasets were designed for consistency across the record by limiting algorithm changes to avoid discontinuities in the parameter values. Also, the FLASHFlux fluxes do not employ the most up to date CERES instrument calibration coefficients.

## Response

We have responded to this comment earlier. Indeed, that is what was done (mistake in labeling).

## Reviewer # 2

I am assuming that the NOAA STAR GOES ABI TOA SW flux product is not available to the public.

## Response

The comment of this Reviewer made us realize that perhaps, it should be made available to the public. Under consideration.

## Reviewer # 2

I am having a hard time understanding why there is very little validation being performed. Table 7 simply is not sufficient, not even a full year of data is analyzed. It seems that exact time matching is necessary for validation. The ABI scans are every 15/10 minutes providing closely matched ABI and CERES fluxes.

## Response

The ABI is at 5 min intervals. However, we want to compare four products simultaneously. It is hard to find cases when all of the GOES-16, GOES-17, CERES/Terra and CERES/Aqua have overlap in time and that the overlap is large enough to compare all of them.

## Reviewer # 2

There is no high-resolution TOA SW flux dataset ground truth dataset, agreed, that is the motivation for this product. The CERES dataset provides observed instantaneous SW fluxes at the 20-km nominal resolution. Linear interpolating the CERES footprint center fluxes across the ABI pixels does not represent a valid 2-km flux field. Cloud edges are not distinct.
This implies that the ABI high-resolution TOA SW fluxes should be mapped into the CERES footprint for validation. Or into lower resolution latitude and longitude grid such as performed by Akkermans, T.; Clerbaux, N. Narrowband-to-Broadband Conversions for Top-of-Atmosphere Reflectance from the Advanced Very High Resolution Radiometer (AVHRR). Remote Sens. 2020, 12, 305. https://doi.org/10.3390/rs12020305
Note they also stratify the validation results by IGBP type. The important part of the validation is determining whether the algorithm is not adding an overall bias to the TOA SW fluxes, while trying to reduce the RMS error. The instantaneous RMS error is a function of spatial scale. They also validate a several year's worth of TOA fluxes

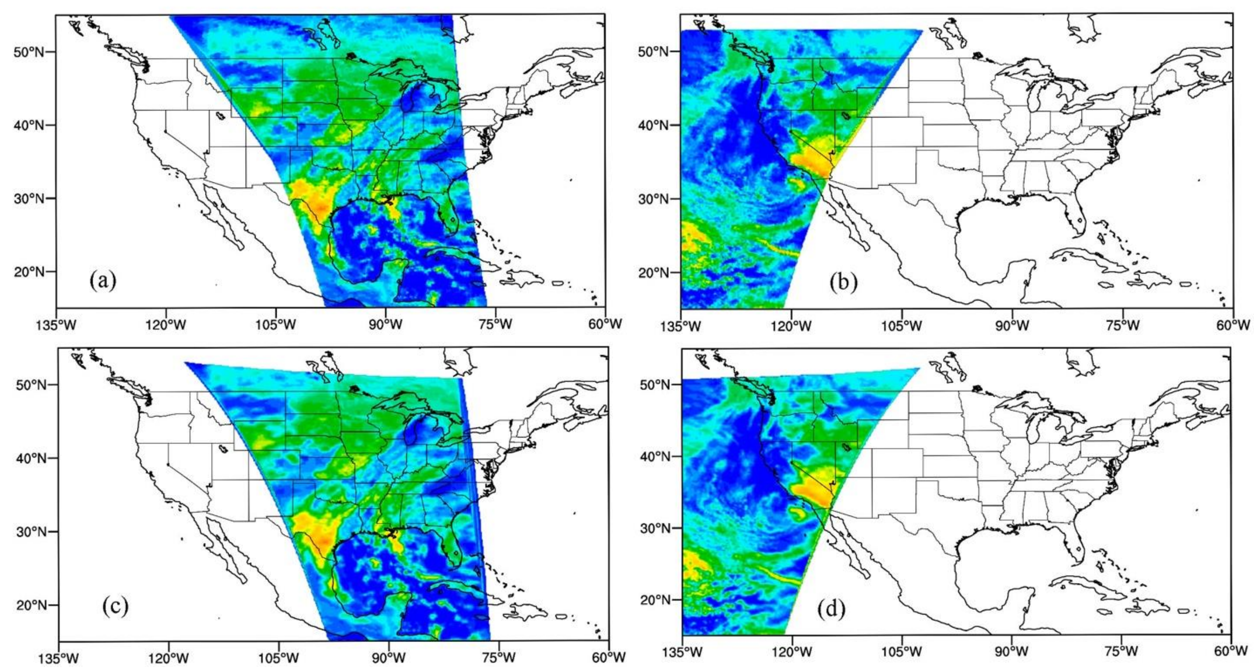
## Response

For the re-mapping, we adopted the ESMF re-gridding package. The detailed information can be found at:

http://earthsystemmodeling.org/regrid/

For an ideal situation, the ABI high-resolution TOA SW fluxes should be mapped into the CERES footprint for validation as suggested by the Reviewer. However, there are reasons that make it difficult to do so. For example, the case 12/26/2019 UTC 19. There could be more than 18000 pixels in a single swath of the SSF if constrained to the region of U.S. Different pixels have different times. Neglecting the seconds, there are still more than 30 mins differences (this changes case by case) between the first pixel and the one at the end and this brings up a time matching issue. But if remapping the SSF to ABI, we can set up a unique time for ABI (ABI is at 5 min intervals) and then constrain the region and the time range of SSF.

Both remapping the ABI to SSF and re-mapping SSF to the ABI bring up spatial matching errors as recognized by the scientific community. In Figure 10, we show the SSF before re-gridding (Figs 10 (a) & (b)) and after re-gridding (Figs. 10 (c) and (d)). As seen, the fluxes after re-mapping CERES SSF to the ABI resolution resemble well the original CERES. A case of reverse mapping is shown in the Supplement Section and indeed as the Reviewer suggested, it reduces the edge effects. Another consideration is the computational efficiency of re-mapping the curvilinear tripolar grid to unconstructed grid. For large arrays, it is more efficient to remap the unconstructed grid to the curvilinear tripolar grid.




Part of Figure 10. (a) All sky TOA SW from CERES SSF/Aqua, (b) CERES SSF/Terra, (c) re-gridded CERES SSF/Aqua, (d) re-gridded CERES SSF/Terra.

We have done one case of remapping the ABI to CERES_SSF as suggested, and the edges do improve. There are additional consideration in selecting the direction of re-mapping. This Figure will be put in the Supplements.

## Remapping 2-km ABI flux to CERES_SSF scale (20 km)

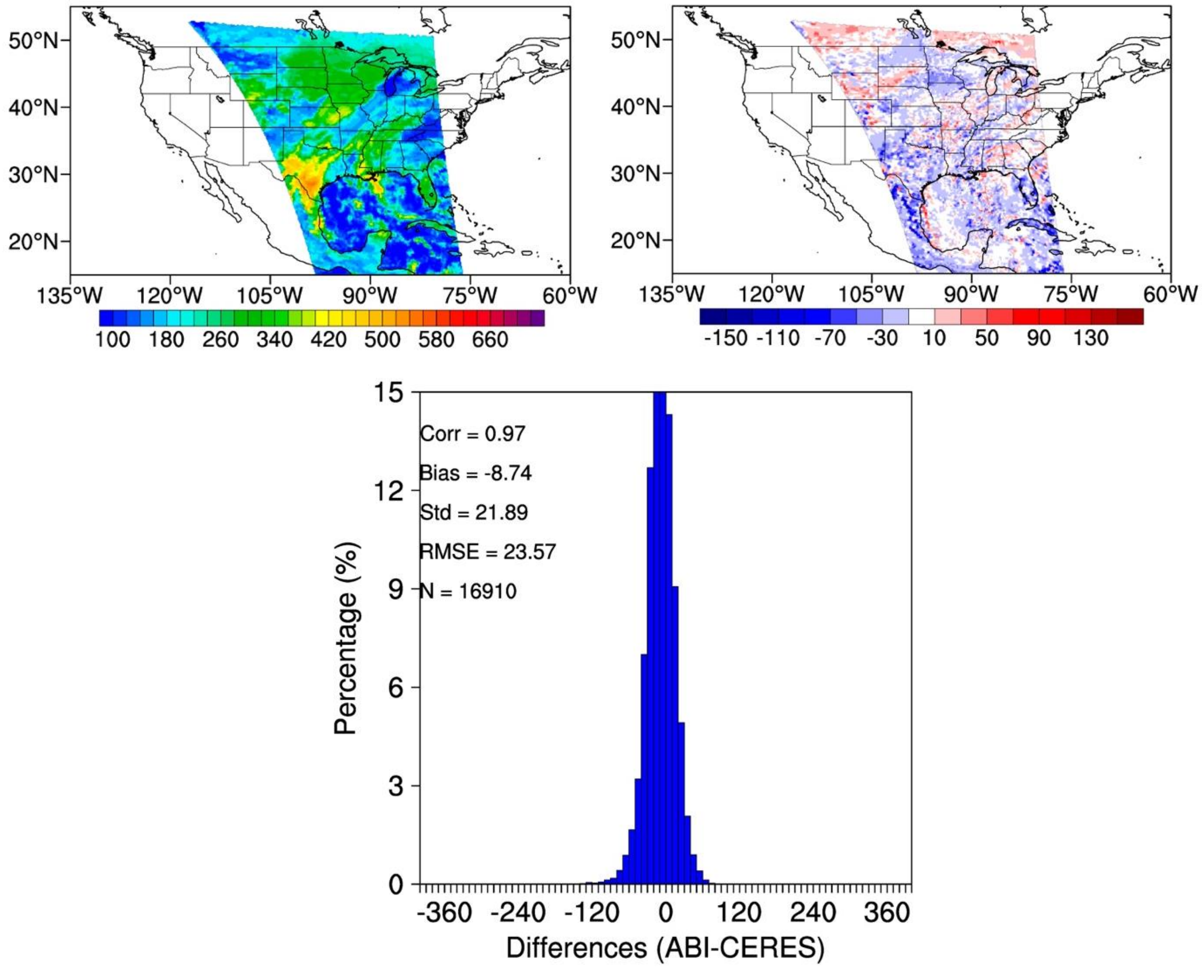
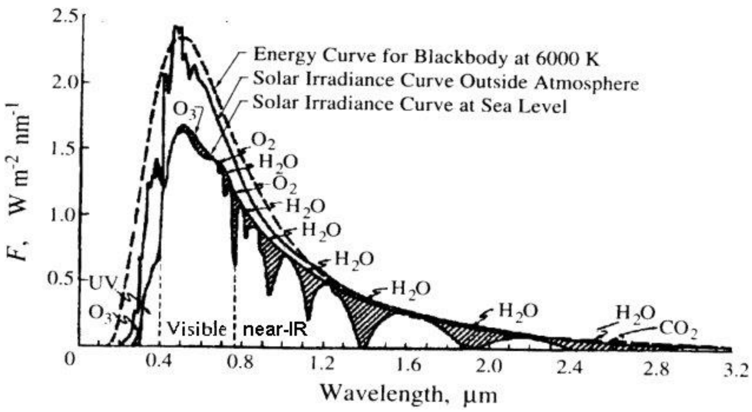



Figure S1. Top Left: Mean ABI Flux on 12/26/2019 UTC 19:00 from GOES-16 re-gridded to CERES SSF (20km)/Aqua domain; Top Right: Difference between re-gridded ABI Flux and CERES SSF/Aqua; Bottom: frequency distribution of the differences (bottom).

## Reviewer # 2

The bin/channel regression rely on RTM results that have varying PW and ozone concentration. The PW water above the cloud or clear-sky surface is necessary to predict the NIR water vapor absorption, since none of the ABI band used are located inside absorption bands. It is not clear to me how current algorithm accounts for NIR water vapor absorption? This was unclear in section 2.

## Response




ABI channel 4 (1.37um) is in the $H_2O$ absorption band, although not at the center.

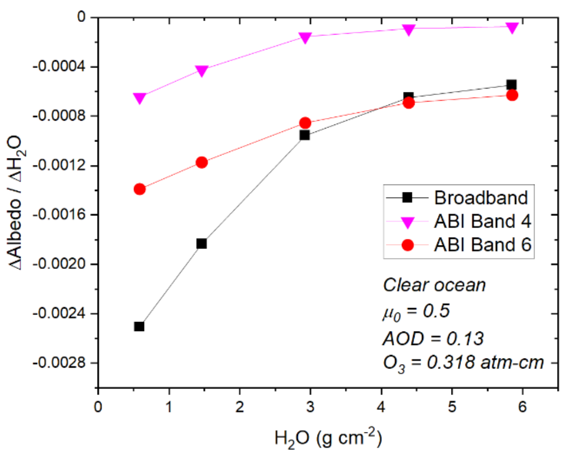



Figure. Sensitivity of channel 4 and 6 narrowband albedos and the broadband albedo to changes in column water vapor amount for a clear-sky ocean scene with fixed values of aerosol optical depth (AOD=0.13), ozone amount (O3=0.318 atm-cm) and cosine of solar zenith angle of 0.5. The ratio [A(i+1)-A(i)]/[H2O(i+1)-H2O(i)] is shown as a function of total column H2O. Here i runs from 1 to 5 and represents the five different H2O amounts (H2O) and the corresponding albedos (A).

## Reviewer # 2

Could the MODIS 2-week surface band BRDF be used in MODTRAN to update the predefined MODTRAN BRDFs? The MODIS BRDF product could be used to account for regional and seasonal variability.

Response

Yes, in principle it can be done but we have worked with the MODTRAN built-in BRDFs.

**Specific Comments:**

Reviewer # 2

Line 38 this paragraph seems out of place. Unless this study was used to for ABI channel selection it does not seem relevant.

Response

We believe that this paragraph gives an idea of the difficulties faced performing the study described in our paper. We would like to keep it.

Reviewer # 2

Line 45. It would be beneficial for the reader to briefly outline the whole algorithm. To discuss both the indirect path and I am assuming a direct path. Perhaps to provide how this algorithm was developed and if it is used in any historical products.

Response

The manuscript describes estimation of the broadband TOA reflected flux from ABI observations. In this respect, the entire algorithm developed for this is fully described in the manuscript. While the work discussed here was performed in support of the development of the NOAA STAR Shortwave Radiation Budget (SRB) algorithm for estimating reflected shortwave fluxes at TOA (RSR) and downward shortwave fluxes at the surface (DSR) from ABI observations, the entire discussion could be entirely detached from the STAR algorithm.

Depending on the type of information available, there are two approaches to estimate RSR. When a full description of the atmosphere (gas amounts, spectral optical depth of aerosols and clouds, cloud phase, etc.) and the surface (spectral surface reflectance) are available one could input these into a radiative transfer model and calculate RSR. This is referred to as the "direct path" approach. An alternative to the direct path is to estimate a broadband reflectance from the narrowband ABI reflectance applying a narrowband to broadband conversion, and then an angular distribution model (ADM) to estimate a broadband albedo, from which RSR is calculated. Here this is referred to as the "indirect path" approach.

The NOAA STAR SRB algorithm implements both approaches. Details of the implementation are given in the Algorithm Theoretical Basis Document (ATBD) for Downward Shortwave Radiation (Surface), and Reflected Shortwave Radiation (TOA) (https://www.star.nesdis.noaa.gov/goesr/documents/ATBDs/Baseline/ATBD_GOES-R_Shortwave%20Radiation_3.1_Nov2018.pdf) and Laszlo et al (2008, 2020). The direct path is based on the NASA Clouds and the Earth's Radiant Energy System (CERES)/Surface and Atmospheric Radiation Budget (SARB) algorithm (Charlock and Alberta, 1996) algorithm, while the indirect path has its heritage in the in the GOES surface and insolation product (GSIP, Pinker et al., 2002) and build on the method described in Pinker and Laszlo (1992). The indirect path algorithm was also used to generate a product in the National Aeronautics and Space Administration (NASA)/Global Energy and Water Exchange (GEWEX) Surface Radiation Budget project (Whitlock et al., 1995; Stackhouse et al., 2011). Even though it is implemented, the NOAA STAR SRB algorithm does not currently use the direct path since the ABI surface albedo product needed to run it is not yet available operationally.

Reviewer # 2

Line 64 Does ground refer to truth dataset or to actual ground observations, since in the summary mentions "ground truth"

Response

"ground truth" refers to the CERES TOA reflected flux. It is used as a reference data in the evaluation of the ABI TOA reflected flux.

Reviewer # 2

Line 95 Are the Kato and Loeb snow ADMs used as part of the CERES Ed2 ADMs?
Kato, S., and N. G. Loeb (2005), Top-of-atmosphere shortwave broadband observed radiance and estimated irradiance over polar regions from Clouds and the Earth's Radiant Energy System (CERES) instruments on Terra, J. Geophys. Res., 110, D07202, doi:10.1029/2004JD005308

Response

Yes, as mentioned in Table 2. The above reference is in the latest version of the paper.

Reviewer # 2

Line 97 The Niu and Pinker are theoretical simulations, how do they translate to observation numbers in Eq. 3?

Response

The comments of this Reviewer are well taken. We were also concerned about the issues he/she has raised. We have done numerous experiments to understand the sources of differences between the theoretical and CERES ADMs to convince ourselves that the synthesis of the two is sound, even if the two approaches are not identical. In **Figure 1** the patterns of bi-directional correction differences for desert under clear-sky from MODTRAN simulations and CERES observations are illustrated. Largest difference occurs for higher VZAs. While inaccuracies in the specific surface spectral reflectance used in the simulations may contribute to the differences, our experiments show that they are most likely due to differences in sampling frequency of observations at high VZAs. A hybrid approach is applied that hopefully is compensating for the uneven-sampling in the two methods.

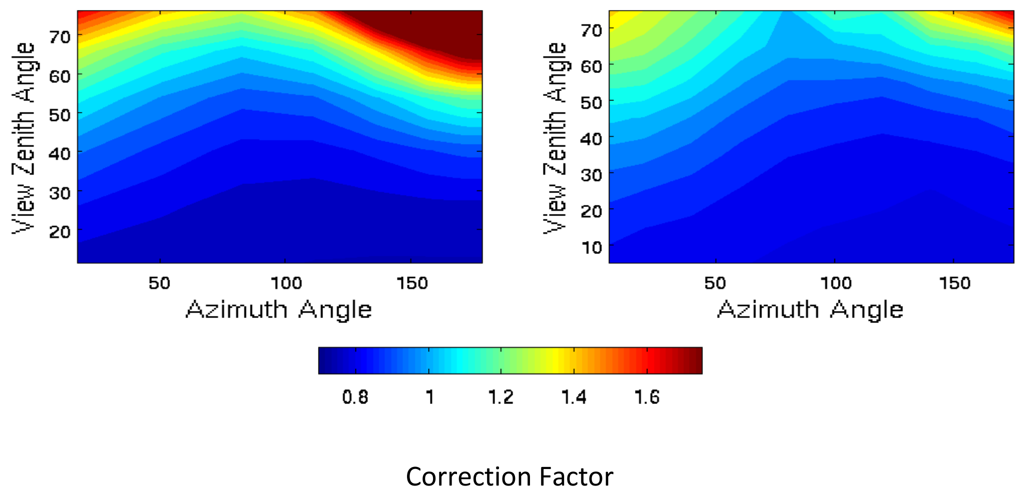



*Figure 1. Bi-directional correction factors at SZA 63.2° over desert for clear-sky Left: Simulations; Right: CERES observations (Bright Desert)*

Before undertaking the simulations, we had to develop a method to reconcile different scene types and angular binning of the CERES and simulated ADMs and a weighting function to combine the two data sources. CERES-TRMM clear-sky ADM classification by surface types does not fully match the IGBP surface classification. In the simulations, the 12 IGBP surface classifications are used. For clear sky, there are 8 surface types in CERES ADMs. An effort was made to combine the corresponding CERES ADMs and simulated ADMs based on IGBP scene classifications to generate new synthesized ADMs for 12 IGBP surface types. The cloud classification in CERES ADMs is based on Cloud Optical Depth (COD) and cloud phase (water cloud, ice cloud) over ocean, low-mod tree/shrub, mod-high tree/shrub, desert, and snow/ice.

For clear sky, the synthesized ADMs are generated from a combination of simulated and CERES bi-directional correction factors based on IGBP surface classifications for each angular bin by weighting as presented in the manuscript. For example, CERES Low-Mod Tree/Shrub ADMs are grouped from observations of the following three IGBP surface scenes: Savannas, Grassland, and Crops/Mosaic (Loeb et al., 2003). The difference in the bi-directional correction factors between the combined and CERES ADMs for Savannas is shown in **Figure 2.** At lower viewing zenith angles the percentage of differences is mostly within +/- 10% but the differences are much larger at higher viewing zenith angles.

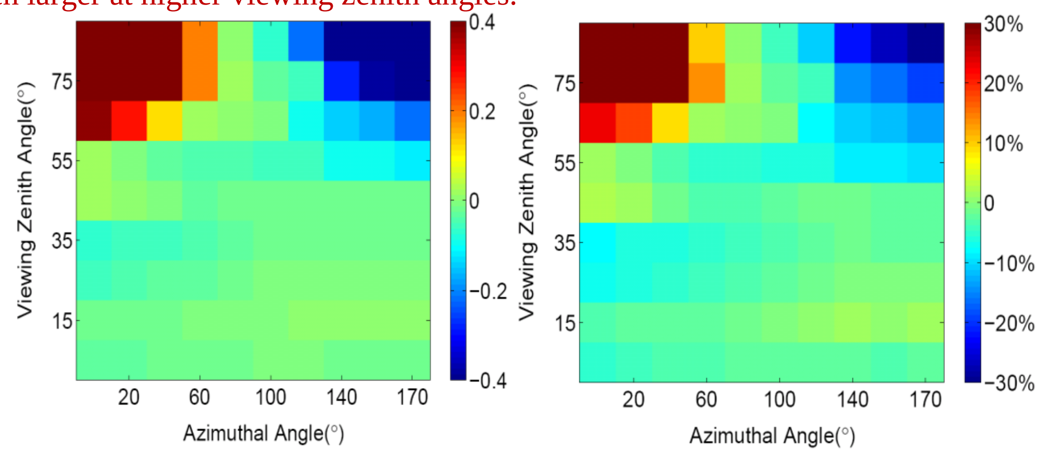


*Figure 2.* *Distribution patterns of the difference of the bi-directional correction factor between combined ADMs and CERES ADMs for Savannas over clear sky at Solar Zenith Angle of 70-80°:*
*Left: Difference (Combined ADMs – CERES ADMs)*
*Right: Percentage of Difference (Difference/CERES ADMs)*

At an early stage of this work when ABI observations were not yet available, we have tested the approach with SEVIRI observations. The following Table (Niu and Pinker, 2011) illustrates that using the hybrid approach results in better agreement with CERES compared to what was achievable with CERS ADMs alone.

Table 7. Evaluations of July 2004 monthly mean TOA upward SW flux estimates as driven with SEVIRI observations when using CERES ADMs or synthesized ADMs, against CERES observations (SRBAVG product).

| | BIAS (W m$^{-2}$) | | RMSE (W m$^{-2}$) | |
|---|---|---|---|---|
| Statistical results | CERES ADMs | Synthesized ADMs | CERES ADMs | Synthesized ADMs |
| Clear sky (7801 samples) | 8.7 | 4.6 | 7.1 | 6.5 |
| All sky (8128 samples) | −3.1 | −2.7 | 8.2 | 6.3 |

As mentioned in our manuscript, we have originally prepared two papers. The first one summarized the early results with proxy observations like SEVIRI, GERB, MODIS etc. where some of these issues are explained in detail. Due to concern that the early material may not be any more of interest to the readers, we have focused in the second paper on ABI using the latest versions of GOES-16 and 17 data.

## Reviewer # 2

Line 131. I do not see how the Fig. 4 comparison adds value to the paper. The profiles were selected to get a sampling of the diversity of atmospheric profiles found on Earth.

## Response

From past experience, we are aware that some Reviewers like to see how the sampling was done so we would like to keep Figure 4.

### Reviewer # 2

Line 237 Is the Matlab stepwise fit used in the algorithm? If not this should sentence should be left out because it adds confusion.

## Response

We have derived coefficients of regression using a constrained least-square curve fitting method of Matlab, “lsqnonneg”, which can solve a linear or nonlinear least-squares (data-fitting) problem and produce non-negative coefficients. Non-negative coefficients avoid generating negative TOA flux, which is not physically valid.

To ensure that information from all channels is used and avoid the complex cross-correlation problem, it was opted to generate Narrow to Broad (NTB) coefficients for each ABI channel separately. These channel specific NTB coefficients are applied to each channel to convert ABI narrow-band reflectance to extended band. The final broad-band TOA reflectance is taken as the weighted sum of all 6-channel specific broad-band reflectance. The logic behind this approach is the assumption that the narrow-band reflectance from each channel is a good representative for a limited spectral region centered around the channel and the total spectral reflectance is dominated by the spectral regions that contains the most solar energy

Reviewer # 2

Fig. 8 Could the spectral boundaries or band edges for each ABI band also be shown in Fig. 8. This way the reader can see the spectral range radiance that is predicted based on a single ABI band.

Response

The band edge values are listed in the text.

Reviewer # 2

Line 260 could the band edges be given in µm in the text also.

Response

The band edge values are listed now also in µm. They are:

0.2001 0.5341 0.7584 1.0845 1.4680 1.8896 4.0000 µm

Reviewer # 2

Section 2.6 Which channel takes into account the bulk of the NIR water vapor absorption?

Response

Channel 6 (2.25 µm) and to some extent channel 4 (1.37 µm).

Reviewer # 2

Line 264 Figure 9 is spelled out, whereas Fig. 8 is not on line 261

Response

Corrected. Thank you.

Reviewer # 2

Line 266. I would agree that along the cloud edges there would be large differences between ABI and CERES TOA fluxes. These large differences would occur even if there were a perfect algorithm. However, over large spatial domains the ABI and CERES fluxes should be similar.

Response

Indeed, it is so.

Reviewer # 2

Table 6 and 7 are not referenced in the text.

Response

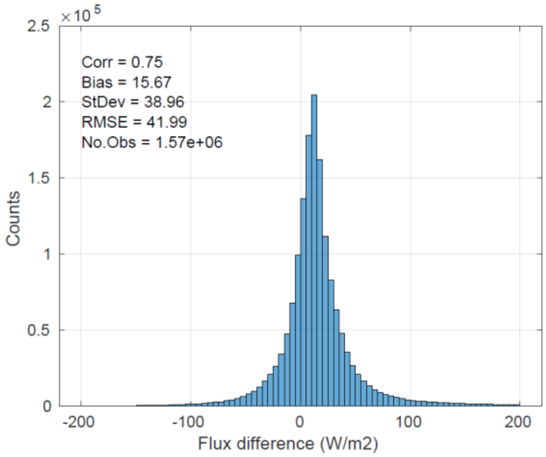
Inserted now.

Reviewer # 2

Line 267 It would be nice to have statistics for Figure 9 similar to what is in Table 7. I do not see 2017/11/25, 17:57Z Fig 9 statistics with the 2019 statistics in Table 7.

Response

We have added it now to Figure 9.




Reviewer # 2

Line 276. This is where Table 6 should be referenced to identify the CODC product

Response

We have now referenced it in the text.

Reviewer # 2

Line 283. The authors should use the CERES SSF Level 2 data, rather than CERES FlashFLUX footprint fluxes. As mentioned in the text, that FlashFLUX does not use the most up to date CERES instrument calibration coefficients. The CERES SSF product is available within 3-

months of real-time.

## Response

Indeed, this was done as explained before.

## Reviewer # 2

What is limiting the number of validation match ups? Is the issue that your computing resources have limited computer storage that downloading all of the required datasets for ABI pixel level fluxes and comparisons with CERES is not possible after real-time when these products are no longer available at CLASS?

## Response

The 2-km Pixel-level ABI fluxes are not yet available at CLASS, so these had to be generated and stored locally. The other one is the matching.

## Reviewer # 2

Line 304. The CERES footprint data has a resolution of 20-km at nadir, while the ABI pixel has 2-km resolution. By linear interpolating spatially the CERES fluxes across the ABI pixel does not properly distribute spatially the CERES flux observation (by not preserving cloud edges) and I would not consider that a truth dataset, since it does not represent the observed 2-km fluxes, It would be better to map the ABI pixels into the CERES footprint to validate the NTB algorithm. A CERES footprint at 60° view angle (near the scan edge) has a 40-km extent encompassing over 400 ABI pixels at nadir. Even better would be to evaluate the ABI product regionally, say for 1°

## Response

For the re-mapping, we adopted the ESMF re-gridding package. The detailed information can be found at:
http://earthsystemmodeling.org/regrid/
For an ideal situation, the ABI high-resolution TOA SW fluxes should be mapped into the CERES footprint for validation as suggested by the Reviewer. However, there are reasons that make it difficult to do so. For example, the case 12/26/2019 UTC 19. There could be more than 18000 pixels in a single swath of the SSF if constrained to the region of U.S. Different pixels have different times. Neglecting the seconds, there are still more than 30 mins differences (this changes case by case) between the first pixel and the one at the end and this brings up a time matching time issue. But if remapping the SSF to ABI, we can set up a unique time for ABI (ABI is at 5min intervals) and then constrain the region and the time range of SSF.

Both remapping the ABI to SSF and remapping SSF to the ABI bring up spatial matching errors as recognized by the scientific community. In Figure 10, we show the SSF before re-gridding (Figs 10 (a) & (b)) and after re-gridding (Figs. 10 (c) and (d)). As seen, the fluxes after re-mapping CERES SSF to the ABI resolution resemble well the reverse re-mapping. Another consideration is the computational efficiency of re-mapping the curvilinear tripolar grid to unconstructed grid. For large arrays, it is more efficient to remap the unconstructed grid to the curvilinear tripolar grid.

We have done remapping to 1° s suggested. Here is the result. Will add it to Supplement.

## Remapping ABI flux to 1°

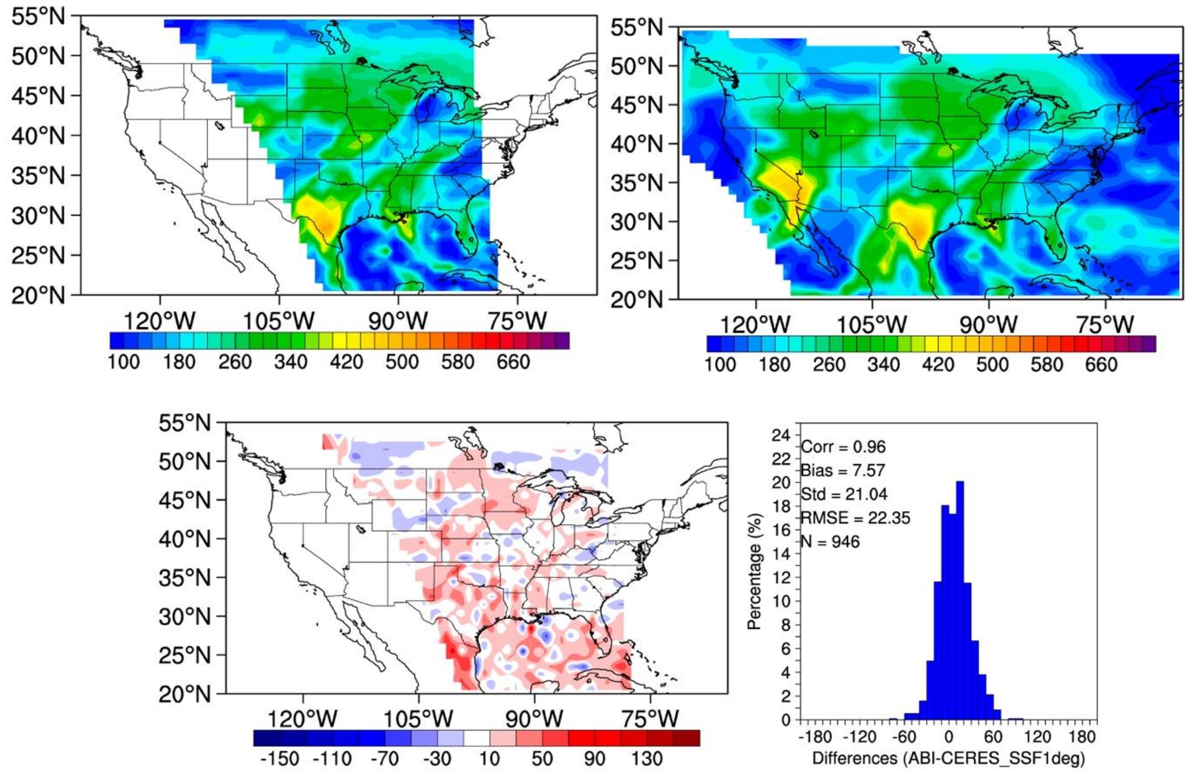



Figure S2. CERES_SSF1deg/Aqua (top left), ABI Flux from GOES16 re-gridded to 1°, the difference between re-gridded ABI Flux and CERES_SSF1deg/Aqua (bottom left) and the frequency distribution of the differences (bottom right).

## Reviewer # 2

Fig 10 caption missing (e)

## Response

We have re-drafted Figures 10-13 using CERES SSF (20 km) to compare with ABI. Legends have been adjusted accordingly.

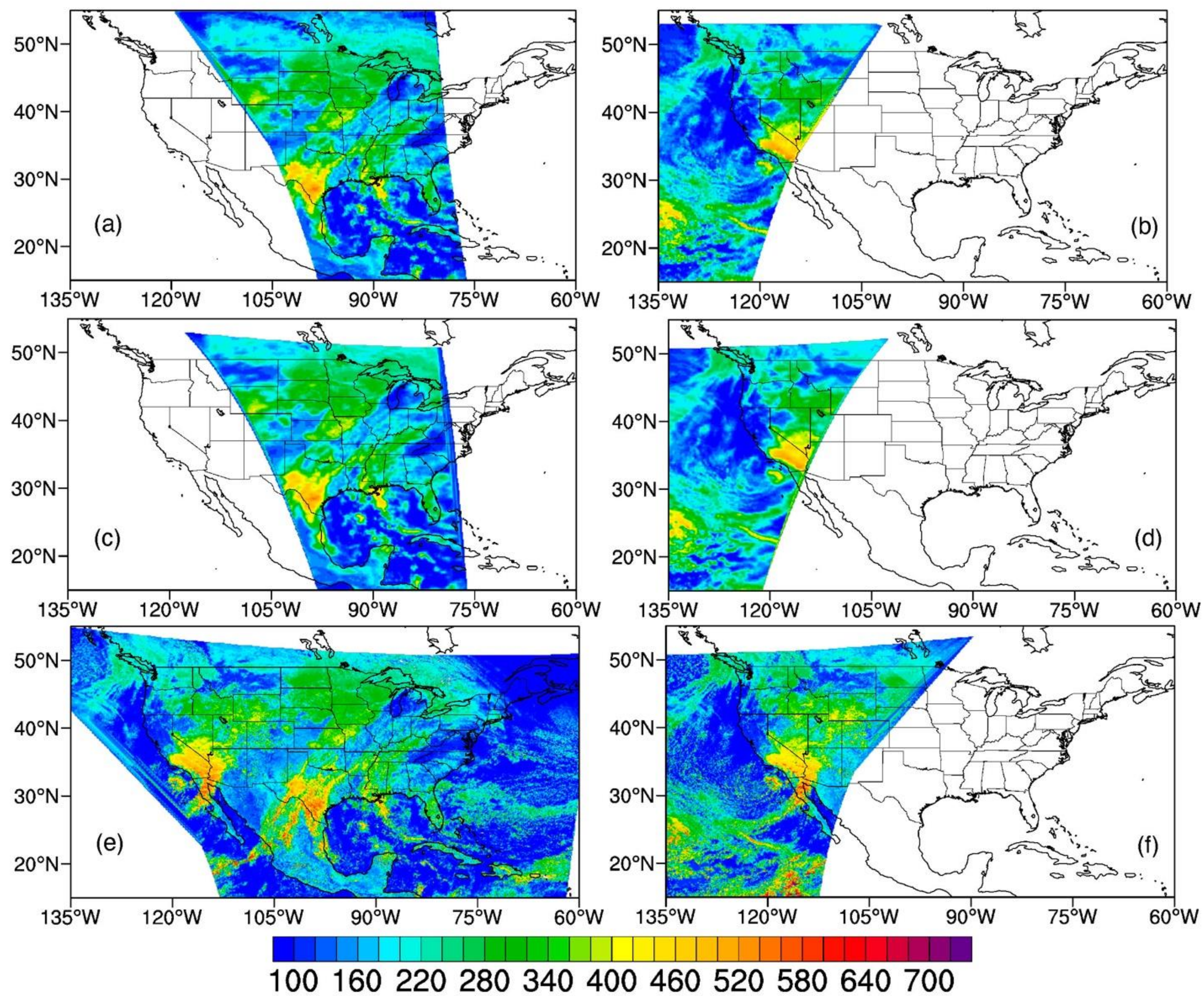



Figure 10. (a) All sky TOA SW from CERES_SSF/Aqua, (b) CERES_SSF/Terra, (c) re-gridded CERES_SSF/Aqua, (d) re-gridded CERES_SSF/Terra, (e) GOES-16 and (f) GOES-17 on 12/26/2019 at UTC 19:36.

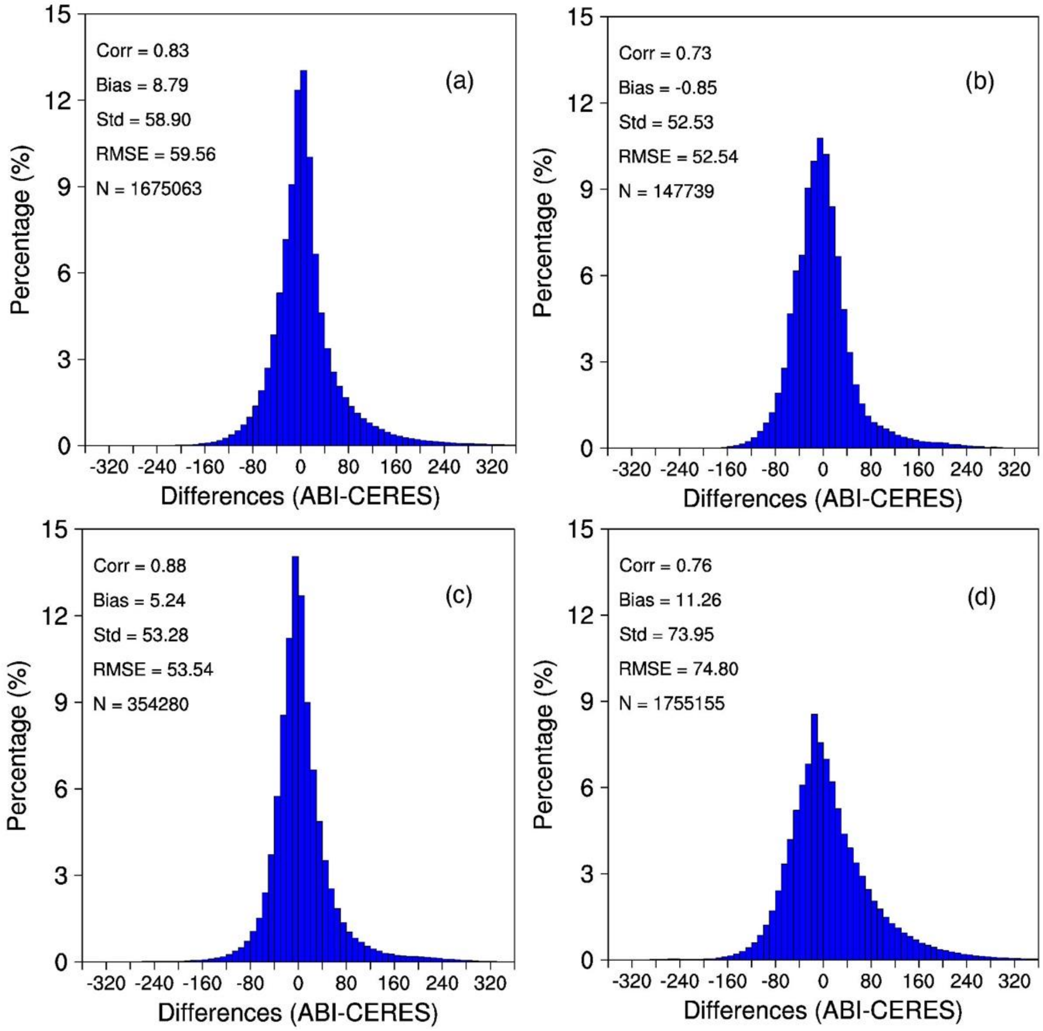



Figure 11. (a) Frequency distribution of all-sky TOA SW differences between ABI on GOES-16 and CERES and (b) ABI on GOES-17 and CERES_SSF using Aqua (c) and (d) as above for Terra. All observations were used (clear and cloudy) on 12/26/2019 at UTC 19:36.

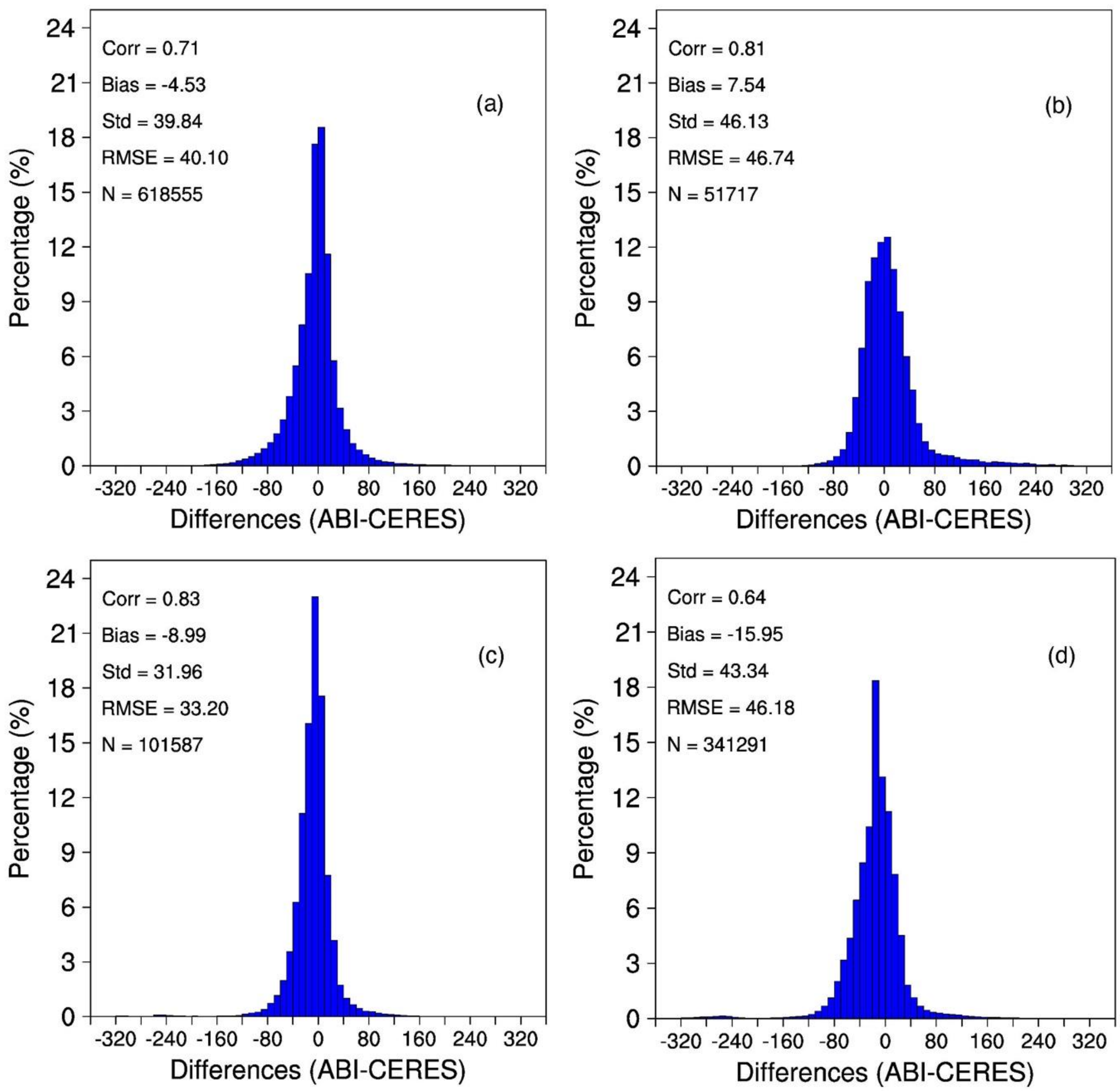



Figure 12. Same as Figure 11 for clear sky TOA SW differences.

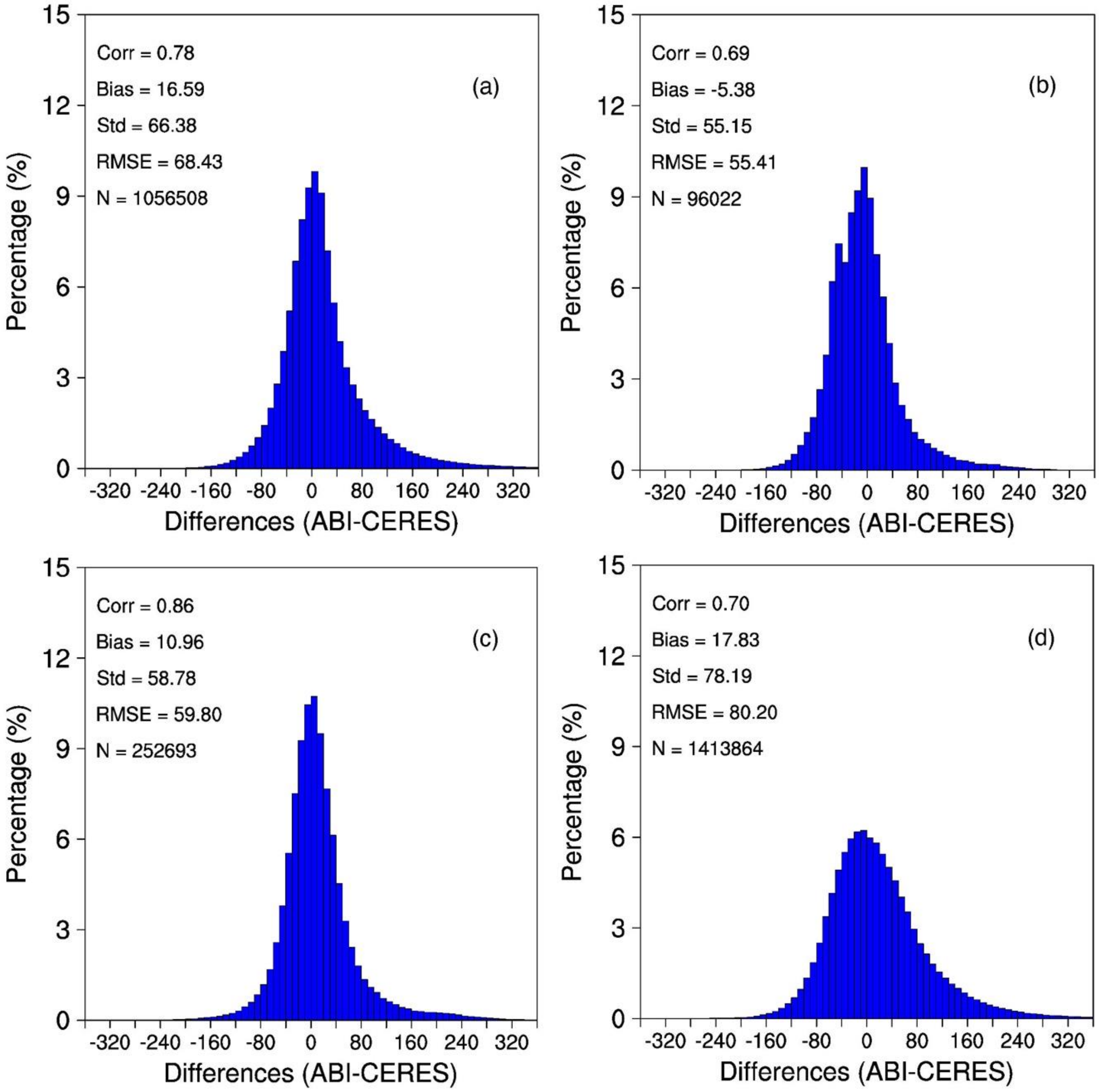



Figure 13. Same as Figure 11 but for cloudy TOA SW differences.

## Reviewer # 2

Line 326 Based on Table 6, the ABI radiances, aerosols, cloud mask, phase and optical depth are used as inputs. For clear-sky the surface spectral reflectance is based on 12 IGBP types, and 4 types for cloudy types. How is the pixel level above surface or cloud top amount to account for NIR atmospheric water vapor absorption. A lot of effort was used to define atmospheric profiles, I would assume this would be based on the ABI channel radiances. My other concern is that the

0.86 vegetation reflection is a function of season and region, in winter the leaves have fallen off the trees, where as in summer the trees have leaves. By simply relying on IGBP type does not account for the seasonal vegetation reflection.

## Response

We have noted the problem of seasonality. It is not trivial to incorporate it.

## Reviewer # 2

Line 346 and line 33. Given that the ABI sampling is less than 15 minutes. The 7.5 minute difference is very small. Once the SW fluxes are compared at the footprint or regional scales the time difference will not make much of a difference in the bias. All Terra and Aqua overpasses should be matched for well sampled validation results. The following paper Fig. 2 shows that the time difference does not dramatically increase the matching noise
B. A. Wielicki, D. R. Doelling, D. F. Young, N. G. Loeb, D. P. Garber and D. G. MacDonnell, "Climate Quality Broadband and Narrowband Solar Reflected Radiance Calibration Between Sensors in Orbit," IGARSS 2008 - 2008 IEEE

## Response

Thank you for pointing this out to us. We have now referenced this finding of Wielicki et al. Indeed, for large scale the 15 min difference does not show up at cloud edge/.

## Reviewer # 2

Line 348 I agree that seasonal/regional variation of the NIR vegetation reflection must be taken into account.

## Response

Thank you.

## Reviewer # 2

Line 358 The CERES edition 4 ADMs also rely on NDVI, which accounts for changes in the vegetation NIR reflectance. The CERES edition 2 relies on surface types only.
Su, W., Corbett, J., Eitzen, Z., and Liang, L.: Next-generation angular distribution models for top-of-atmosphere radiative flux calculation from CERES instruments: methodology, Atmos. Meas. Tech., 8, 611–632, https://doi.org/10.5194/amt-8-611-2015, 2015

## Response

We have used CERES edition 2 which relies on surface types only.

## Reviewer # 2

Line 38- what is the source of the open shrub, desert, woody savanna and grassland spectral albedos? Are these TOA albedos?

## Response

They are from the MODTRAN model and are spectral surface albedos.

## Reviewer # 2

Line 397. I agree there is no truth dataset for 2km resolution BB fluxes. That is the reason why this dataset is being produced. In order to perform a fair comparison, the high-resolution ABI pixels fluxes must be mapped into the CERES footprint, or both reduced to a 100-km region in order to track the ABI and CERES over the record.

## Response

We have responded to this comment in response to Reviewer # 2 comment to line 304.

Line 405. "transformation of narrowband quantities into broadband ones" This sentence is ambiguous.

## Response

Not clear to us what is wrong here

## Reviewer # 2

Line 414. What is this sentence trying to say? "The process of preparing for the usefulness of a new satellite sensor needs to be done in advance, the final configuration of the instrument becomes known at a much later stage." This was not addressed in the paper

## Response

Has been removed.

## Reviewer # 2

Line 416 What is this sentence trying to say? "As such, the evaluation of the new algorithms is in a fluid stage for a long time." Usually there is an initial release and as the algorithms improve incrementally while the version number is updated over time. For example MODIS L1b C6.1 dataset is currently available and C7 is being developed and tested.

## Response

We believe that the decision when to release preliminary results depends on the situation at hand. As long as it is not possible to have some evaluation of the product, it may be counter-productive to release the data.

## Reviewer # 2

Line 417 This sentence is confusing. “Agreement or disagreement with know “ground truth” is not fully informative on the performance of the new algorithms to estimate desired geophysical parameters.” Are you talking about compensating errors?

## Response

The sentence is not clear. Is now reworded.

## Reviewer # 2

Line 420 reliable cloud screening and cloud properties. What about non-retrieved cloud properties from cloud mask identified pixels? What about optically very thin clouds where the surface contributes to the TOA reflectance.

## Response

For such cases, no retrievals were done.

## Reviewer # 2

Line 421 The CERES SSF L2 Edition 4 product SW fluxes has been available prior to ABI and have not gone through any major revisions. The SSF1deg fluxes have been used to monitor global and regional SW flux variability over time. On the other hand the FlashFLUX has undergone revisions.

## Response

Indeed, that is so.

## Reviewer # 2

What is the application of high-resolution ABI TOA SW fluxes, that the low resolution CERES fluxes cannot fulfill? For the application, what is the required SW TOA accuracy?

## Response

That resolution is needed for implementing the SW algorithm at NOAA/STAR. If other users are interested in the product, it is up to them to determine if the accuracy as established against CERES (the only game in town) is sufficient.

Line 429 If the ABI aerosol algorithm does not ever reach stability in the future, will the TOA SW product ever be released?

## Response

Not clear how these two issues are related. The TOA SW fluxes at this stage do not depend on the aerosol algorithm. To incorporate the real time aerosol product into the TOA algorithms is a future project.