Review

This manuscript describes the theoretical foundations of the Japanese radiative flux and heating rates product for EarthCARE. The algorithm derives vertical profiles of longwave (LW) and shortwave (SW) radiative fluxes and heating rates at 34 atmospheric levels by applying a radiative transfer model to aerosol and cloud profiles retrieved from the EarthCARE cloud profiling radar, lidar, and multi-spectral imager. The primary focus of this study is to document the anticipated accuracy of the product by applying the algorithm to existing observations collected by the A-Train. The subject is appropriate for *Atmospheric Measurement Techniques* and the uncertainty analysis is quite thorough considering the algorithm has yet to be implemented for EarthCARE. My primary concerns center on the organization of the findings. In particular, the abrupt transition from the algorithm description to validation could be softened by including the preliminary results prior to discussing the comparisons. In addition, there are several opportunities to reference related literature that should be considered. Since I do not anticipate those modifications requiring substantial rewriting, I recommend the paper be published in AMT after the following minor revisions to address these concerns.

Specific Comments:

1. The most significant issue with the paper in its current form is the organization of results. This transition from algorithm description immediately into comparisons with CERES is quite abrupt. It would be interesting to see some examples of the algorithm before discussing its evaluation. I think the example in Figure 1 could be used to simply illustrate the methods described in Section 2 (omitting the CERES comparisons in panel (e) which are hard to see anyway). That could be followed the spatial distributions of aerosol and cloud radiative effects in Figures 6 and 7 to provide context for what the algorithm does before assessing the accuracy of these results.
2. Line 43: The acronym for CERES is missing some words "Clouds and the Earth's Radiant Energy System"
3. Line 49: Since this is not the first paper to estimate fluxes using radiative transfer modeling with atmospheric inputs, I suggest referencing some of the pioneering papers on this topic (e.g. Rossow and Lacis, 1990; Rossow and Zhang, 1995; Zhang et al, 1995; Whitlock et al, 1995).
4. Line 69: It may also be worth adding that these measurements will provide important continuity for the data record that began with the A-Train in 2006 (L'Ecuyer and Jiang, 2010).
5. Line 90: While it is likely beyond the scope of this particular study, there could be value in digging deeper into comparisons with FLXHR-lidar and CCCM to trace the source of discrepancies in all three algorithms. Since the algorithm has already been applied to CloudSat/CALIPSO/MODIS observations, it could immediately be compared to FLXHR-lidar and CCCM in a manner like that of Ham et al. (2014). The results would be very interesting for understanding all three algorithms.
6. Line 113: I think 'were utilized' should be 'will be utilized' since EarthCARE data were not actually used in this paper.
7. Line 157: Do you mean 'daytime' instead of 'diurnal'?
8. Line 180 (and again on Line 311): The spatial resolution of CloudSat is 1.4 km (across track) by 1.8 km (along track).

9. Line 229 - 231: There is precedence for separating results according to cloud phase in this way. Perhaps cite Matus et al. (2017) here.
10. Line 297: The preceding discussion does not provide adequate context for the value of these estimates. The ability of spaceborne active sensors to constrain surface fluxes and atmospheric flux divergence represents one of the most important contributions they have made to climate science. This is discussed in detail in papers like Haynes et al. (2010), L'Ecuyer et al. (2019), and Hang et al. (2019), for example. If this is better articulated in the introduction, the point here could be that without quantifying the uncertainties, it is hard to know how trustworthy this information is.
11. Line 328: It would also be good to compare against other recent studies that produce similar estimates (Matus et al, 2019 is one example but there are others, including some by Winker et al.)
12. Line 337: Similarly, some qualitative comparisons against prior work are warranted here as well (there are lots of options but Matus et al, 2017; L'Ecuyer et al, 2019 and Hang et al, 2019 all utilize similar observations to extract the effects clouds at TOA, SFC, and in the ATM).
13. Line 363: This isn't an accurate statement. The analysis quantifies how the accuracy of radiative flux calculations varies with spatial and temporal averaging scale.
14. Figure 1: The transition from yellow to light blue in the upper atmosphere in Figure (d) is likely an artifact of the color bar. It might be good to have a small band of white from -0.05 to 0.05 to represent areas of 0 heating.
15. Figure 3 caption: Technically this figure is only the same as Figure 2 panels (a) and (d).
16. Figure 5 caption: Again, this figure is only the same as Figure 4 panels (a) and (d).
17. There are also several minor grammatical errors throughout the paper. A few representative examples follow, but I suggest taking a careful read through the paper for other similar issues:
    a. Line 38: ‘circulation’ should be ‘circulations’
    b. Line 44: ‘radiometer’ should be ‘radiometers’
    c. Line 199: ‘value’ should be ‘values’
    d. Line 200: ‘of the aerosols’ should be ‘of aerosols’

References

1. Ham, S.-H., S. Kato, F. G. Rose, D. Winker, T. L’Ecuyer, G. G. Mace, D. Painemal, S. Sun-Mack, Y. Chen, and W. F. Miller, 2017: Cloud occurrences and cloud radiative effects (CREs) from CCCM and CloudSat radar-lidar products, *J. Geophys. Res.* **122**, 8852-8884.
2. Hang, Y., T. S. L’Ecuyer, D. Henderson, A. V. Matus^{s}, and Z. Wang, 2019: Reassessing the role of cloud type in Earth’s radiation budget after a decade of active spaceborne observations. Part II: Atmospheric heating, *J. Climate* **32**, 6219-6236.
3. Haynes, J. M., T. H. Vonder Haar, T. L'Ecuyer, and D. Henderson, 2013. Radiative heating characteristics of Earth's cloudy atmosphere from vertically resolved active sensors, *Geophys. Res. Letters* **40**, doi:10.1002/grl.50145.
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type in Earth's radiation budget after a decade of active spaceborne observations. Part I: Top of atmosphere and surface, *J. Climate* **32**, 6197-6217.

6. Matus, A. and T. S. L'Ecuyer, 2017: The role of cloud phase in Earth's radiation budget, *J. Geophys. Res.* **122**, doi:10.1002/2016JD025951.
7. Matus, A. V., T. S. L'Ecuyer, D. S. Henderson, and T. Takemura, 2019: New global estimates of aerosol direct radiative effects, kernels, and forcing, from active satellite observations, *Geophys. Res. Letters* **46**, 8338-8346.
8. Rossow, W. B., and A. A. Lacis, 1990: Global, seasonal cloud variations from satellite radiance measurements. Part II: Cloud properties and radiative effects, *J. Clim.*, **3**, 1204–1253.
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11. Zhang, Y.-C., W. B. Rossow, and A. A. Lacis, 1995: Calculation of surface and top of the atmosphere radiative fluxes from physical quantities based on ISCCP data sets: 1. Method and sensitivity to input data uncertainties, *J. Geophys. Res.*, **100**, 1149–1165.