Review of “Determining the Daytime Earth Radiative Flux from National Institute of Standards and Technology Advanced Radiometer (NISTAR) Measurements” by Su et al. 2018

General comments:

This manuscript derives sunlit side of the Earth’s radiation budget (SW and LW) from a single pixel measurement of NISTAR instrument on board the DSCOVR mission and compares with the radiation fluxes derived from the CERES measurements. This is a very interesting and important work as the Earth’s radiation budget has been so far solely measured by the ERBE/CERES project and there are very little independent and direct measurements of these important quantities. This work builds upon many previous works the team has been working on for many years including narrowband broadband conversion, ADM, GEO/LEO composite cloud products etc. The paper is well written and structured. I do have some questions and suggestions regarding the derivation of global ADM and evaluation of each components of the fluxes.

Specific comments:

Line 98: What is the uncertainty level of NISTAR L1B radiance? What kind of calibration procedures have been used to produce the L1B radiance? You have discussed some of the issues later in the paper but it’s worthwhile to have a paragraph to discuss the NISTAR at the beginning of the paper. NISTAR provides a completely different methodology of estimating the earth’s radiation budget and independent check of Earth’s radiation budget created from CERES measurements, the difference found in this article is very serious and should be adequately explained. NISTAR’s absolute calibration and uncertainty is of fundamental importance, otherwise the readers would question the well-established CERES products.

*The NISTAR instrument team (who produce the L1 data) is responsible for the instrument calibration and the team has presented their calibration at the DSCOVR science team meetings (https://avdc.gsfc.nasa.gov/pub/DSCOVR/Science_Team_Meeting_Sept_2019/L1/NISTAR_Goddard%20Science%20Team%2020190917.pdf). So far their analysis are mainly focused on the SW channel. NISTAR has three broadband electrical substitution radiometers (ESRs). All ESRs have a large background noise as they measure the change in incident optical power. Two steps are utilized to remove the background noise: first using a shutter to modulate the source which removes most of the background noise then using dark space view to remove the residual shutter-modulated background. The shutter modulated background is largest for the total channel and is smaller for the SW channel. As the LW is derived from the difference between total and SW channels, both total channel and SW channel background noises contribute to the LW uncertainty. The NISTAR total channel uncertainty is 1.5% and the SW channel uncertainty is 2.1%. More details on NISTAR calibration is added on page 4-6.*

Line 147. The conversion from filtered to unfiltered radiances used the ratio derived from model simulation data using eq 5 and 6. Why not using the regression (3) and (4)? The regression indicates the ratio could not be constant because it’s a quadratic function and has an offset. It’s justified to use a constant ratio between the two if the ratio varies little as for the SW band, but a constant ratio for NIR would introduce an unnecessary source of error (1_2%) for the NIR and I don’t see why you should abandon the regression.

*The Equations 3 and 4 are the original method we planned to use for the NISTAR unfiltering. But unlike other LEO instruments that have scene-type information and Sun-viewing geometry for each footprint, and the regression can be applied based upon the scene type and Sun-viewing geometry of each footprint. NISTAR views the entire Earth as a single pixel, and the cloud fraction, cloud type, and land/ocean portions differ from time to time. Luckily, the NISTAR SW spectral response function is such that the ratio between filtered and unfiltered radiances exhibit very little sensitivity to the scene types and Sun-viewing geometry. As we don't have the scene-type information, the regression method can't be applied to NIR either. We rewrote the sections on pages  7 and 8 to correct this.*

Line 152: Did you use NIR in this work? If not, could you explain why NISTAR takes the NIR measurement?

*We did not use the NIR channel in our work. When NISTAR was design in the 1990s, the primary utility for the NIR channel is to study the enhanced absorption of SW radiation by clouds (Collins 1998) and more recently by Carlson et al. (2019) to look at the spectral ratio of the sunlit side of the Earth and the potential of using the ratio for model evaluation (see introduction on page 3).*

Line 187: EPIC images have 8x8 km2 resolution at nadir and are 1/cos(vza) larger at larger view zenith angles. The EPIC cloud products are retrieved at its native resolution with (2014x2014) pixels in a granule. Some channels have degraded into 1024x1024 for downlink but reversed to 2014x2014 afterwards.
Equation (9) and (11), Ij and Fj seem to refer to radiance and flux in each EPIC composite pixel. Do you actually use those in the mean ADM calculations? If yes, did you use the EPIC measured narrowband radiances to compute the broadband radiance and flux for each pixel?

*In Equations (9) to (11) (now Equations 7-9), the ^I and ^F refer to the radiances and fluxes from the CERES ADMs (same symbols are used in Equation 6). To clarify the confusion, we added a sentence on page 12 (lines 291-292). They are not from EPIC.*

Why did you grid the fluxes into 1x1 grid boxes and not the radiances? The global mean flux is computed from Eq. 11 to take care of different sizes of grids in each latitude. If you grid the radiance, then you would compute the mean radiance the same fashion as the flux. Otherwise, if you average the radiance from each pixel directly, then you would also have to consider the pixel size differences and the radiance average has to be a pixel-size weighted average.

*Radiance and flux are fundamentally different physical quantities. Radiance is the total amount of energy confined to a given direction per unit surface area (in Wm-2sr-1). One essential property of radiance is that it is additive, meaning if several sources contribute to the radiance at a particular point and in a particular direction, the total radiance is the sum of the radiances from each source as if it were acting alone (Bohren and Clothiaux, 2006). On the other hand,* *flux is the energy per unit surface area (Wm-2) and need to be area-weighted when compute global means.*

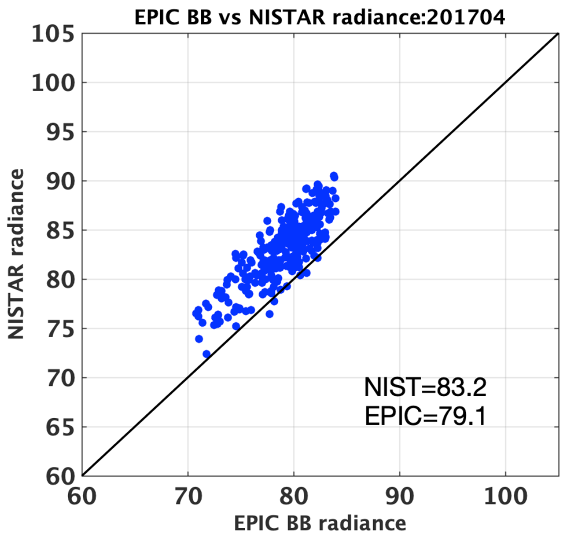
If my understanding is correct, then the global ADM not only rely on composite product's scene identification, CERES ADM for each pixel, but also on EPIC's radiances measurements (which rely on CERES-MODIS collocation and narrowband to broadband conversion) to derive the global mean ADM. The EPIC-based sunlit global SW flux (Su et al. 2018) has used EPIC radiances and CERES ADMs and does not really need global ADM and thus global ADM is essentially untested. From EPIC radiance to flux, it relies on CERES derived narrowband-broadband conversion and CERES ADM, therefore the EPIC global flux provides some consistent check but not absolute validation in my opinion.

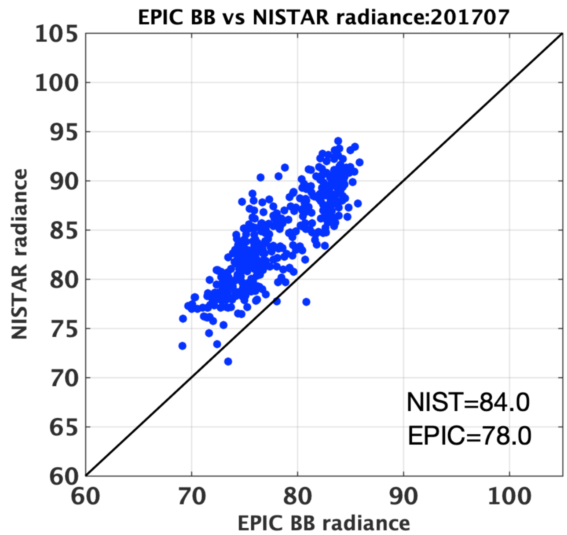
*The global ADM is derived using the scene identifications (surface type, cloud fraction, cloud optical depth, etc. ) from EPIC composite to select the anisotropic factors from the CERES ADMs. EPIC radiances are not used.*

*In Su et al. (2018), we used the same methodology to derive the global SW anisotropy factors (same as Equations 7-10 in the revised version). They are then applied to the EPIC global daytime mean "broadband" SW radiances, which were derived by using narrowband-to-broadband regressions. The EPIC global daytime mean "broadband" SW radiances are analogous to the NISTAR SW measurements, and the same SW anisotropy factors were applied to both NISTAR and EPIC SW radiances to derive SW fluxes. As demonstrated in Su et al. (2018), the SW flux from EPIC agree with CERES SYN to within 2%, which means that the method that we developed to derived the global mean anisotropic factors are robust.*

Eq. 13 and 14. From these equations, we know that the NISTAR flux depends on unfiltered radiances from NISTAR and the global ADM derived from EPIC (which itself depend on many other instruments and procedures). I would strongly suggest the authors examine the global ADM and NISTAR's radiance measurements separately to understand the variability and trends from each of these components. The computation of global ADM can be refined as mean radiance could be computed with pixel-size weighted average. The NISTAR total radiance and NIR radiance are also worth looking at especially when LW is derived from total subtract the SW.

*Again, EPIC composite provides the cloud properties that needed to select the anisotropy factors. We don't use any EPIC measurements in this study. The global mean anisotropy factors are calculated by deriving the anisotropic factors for each EPIC pixel. We did examine the NISTAR radiance against the "global daytime mean SW radiances from EPIC", derived by using narrowband-to-broadband regressions (Su et al. 2018). The NISTAR radiances are consistently greater than the EPIC "broadband SW" radiances. Below are the comparison between NISTAR and EPIC radiances for April and July 2017. The mean differences are between 4 to 6 Wm-2sr-1. We chose not to include these results in this paper to avoid any confusions and the EPIC and CERES comparisons were provided in Su et al. (2018).*




*As noted by the reviewer, the LW radiance is derived by subtracting SW from the total. Thus the LW contains information of the total channel. As the focus of this paper is to derive SW and LW fluxes from NISTAR and validate the product with CERES product, and there aren't any global daytime total and NIR measurements that can be used to compare with the NISTAR measurements, simply looking at the NISTAR total and NIR channel measurement won't add value to the paper.*