1. **Incorrect assumption of isotropic radiation** Based on radiation transfer equation, it can be easily shown that in general case the upward radiance field at the TOA is not isotropic. Thus spectral flux cannot be computed accurately by simply multiplying a factor of pi. The author supported the usage of this incorrect assumption by stating the globally average difference between CERES-IASI OLR is small. But this heavily averaged difference over the entire LW spectrum cannot justify the usage of this assumption at all, for so many compensating error sources can contribute to this broadband flux difference (I will discuss in detail about this in Comments #2 and #3). In atmospheric radiation, there is a widely used and well established approximation, the diffusivity approximation, which can be found in nearly all the atmospheric radiation textbook. It states that the flux can be approximated by the radiance at 53 degree (diffusivity factor 1.66) multiplying pi. This diffusive approximation has been first introduced by Elsasser in 1941 by examining the radiation chart and has been widely used ever since, in both observation and modeling. Li (2000) gave theoretical explanation of this approximation. Virtually all the GCM radiation schemes employ this approximation to compute the LW flux since they cannot afford to compute radiance at multiple zenith angles and then integrate them to obtain flux. If what the authors used in this study were true, it would be equivalently saying that this well established diffusive approximation were wrong and every scheme could simply compute radiance at nadir view. Such direct contradiction to the well established and well verified approximation to compute LW flux is not even mentioned, let alone justified or proved. Furthermore, in one reference cited by the authors, Huang et al. (2008) clearly shows how each spectral channel can deviate from the isotropic radiation assumption for the clear-sky situation. Figure 2 in Huang et al. (2008) shows that, in some spectral channels, the anisotropic factor is as large as 1.2, which means that a 20% error would be introduced if the spectral flux of such channel were estimated as in this study. Note the same Figure 2 in Huang et al. (2008) also corroborates that the anisotropic factor for the diffusivity angle suggested by Elsasser is indeed much closer to one than that of nadir view angle for all the LW spectral channels. In another reference cited by the authors, Huang et al. (2006), such nadir view radiance from old dataset IRIS was used to multiply with pi in the second part of the study. But Huang et al. (2006) carefully defined it as "nadir flux" and used this term in all figure captions and relevant discussions to distinguish from OLR or flux as commonly defined. The"nadir flux" was never used to compare with actual OLR observation or OLR simulation in the entire text of Huang et al. (2006). In a nutshell, it is

fundamentally wrong to compute OLR in the way done in this study. It contradicts well-established and well verified diffusivity approximation and the equation of LW radiative transfer. The author failed to show any proof why they can do so. The "flux" derived in this way has a dimension of flux, but physically is not the same quantity as the OLR obtained by CERES or simulated by any GCMs. Thus, all the consequent comparisons with CERES OLR and analysis of such results in the context of OLR (or spectral OLR) are groundless. The author can define this as a flux quantity, but by no means it is OLR. The author shows a seemingly good agreement between heavily averaged CERES OLR and derived OLR (at SNO or global mean), but this seemingly good agreement can be due to many compensating errors (as I will discuss this in more detail in following comments). This is not something we can argue "end justified the means", because the "means" here is fundamentally wrong according to the physics, unless the author can approve the otherwise. Note the SNO approach is powerful for comparing radiometric quantities directly measured by the instrument, as shown in many recent calibration studies. But OLR here is not a derive quantity and compensating errors must be identified if the authors want to employ this approach.

We agree that the isotropic assumption is inaccurate to use in this context and we did not make this assumption. We performed the comparison with radiance quantities only, from both IASI and CERES, to avoid adding the uncertainties involved in the flux-to-radiance conversion. We agree that this mistake was easy to make however, as we used the term OLR to stand for Outgoing Longwave Radiance when this acronym is almost always synonymous with the flux quantity. We have rewritten the paper to remove this confusion by using the terms INLR (Integrated Nadir Longwave Radiance) to refer to the broadband radiance product and CINLR (Cloud Integrated Nadir Longwave Radiance) to replace the radiance CRF (Cloud Radiative Forcing) quantity. We have also added a paragraph to the introduction that extensively states this (page 8, line 20 to page 9, line 9). Further we have also removed the sentence in the conclusions which made a crude estimation of the outgoing flux equivalent.

2. **Limitation of A "one-fit-all" regression model for all scene types over the globe** The study employs a regression model to estimate farIR spectral flux after carefully selecting the predictor midIR channels, as shown in Eq. (1). My understanding is Eq. (1) is applied to the entire globe and there is no separate set of parameter derived for different scene types (e.g., ocean vs. land vs. snow surfaces, overcast

vs. partial cloud etc.). It is well known that the regression model works best for the mean state and can behave badly for individual state that is largely deviated from the mean state. This is, in my opinion, why in observations like ERBE or GERB, more physics based angular distribution model approach has been adopted instead of such statistical regression. Physically, different scene types (surface type and cloud properties) can have very different spectral dependence, especially for midIR channels that are sensitive to the surface emission. Therefore, a regression model working best for ocean surface might not work for the land surface, and vice versa. Taking cloud fraction and cloud optical depth into account will further compound this issue exponentially. Even a set of regression coefficients is derived using thousands of observed profiles, there is virtually no discussion how the regression model behaves for different scene types and how the spectral emissivity of difference surface types has been obtained and incorporated into the simulation/training. As long as the predictor channels used in the regress include channels sensitive to surface emissions, and as long as the authors want to discuss any spatial features beyond global average fluxes, the authors are obligated to discuss the regression errors for different scene types, especially the dependence on the surface type and on the cloud fraction and cloud optical depth (or equivalently cloud emissivity).

In fact, though the globally averaged CERES-IASI OLR difference is small, Figure 8 does show that, even after heave average over one month, a large portion of globe still has OLR difference more than ±10 Wm-2. Such big difference is likely attributed to more than one error sources, but oversimplified regression model is definitely a reason and its error contribution needs quantification. The comparisons with CERES OLR beyond the SNO cases are ill defined due to the different stages of diurnal cycle covered by the Terra/Aqua CERES and IASI. However, this cannot be simply attributed as the dominant error sources for Figure 8 when other sources of errors are not quantified at all.

The model is constructed using 3200 soundings which have been shown by past studies to fully capture the wide variability of atmospheric scenes and conditions (text added on page 10, lines 25-28). The stratification of scenes, simulations with built in instrument errors, and expanded regression model form are all refinements that would further improve the performance of technique, however the purpose of this study is to demonstrate the feasibility of this technique, not argue it has reached the optimal stage, which could be

done in future studies. This has been added to the conclusion, page 20, lines 5-13. Furthermore the benefits of more complicated and sophisticated algorithms usually come with the trade-off of limitation, dependencies and possibly additional uncertainties in the auxiliary inputs, while not necessarily guaranteeing better overall accuracy or precision. At this stage we prefer to keep this algorithm self-contained with the IASI radiance observations alone.

We agree that the global composite comparison between IASI and CERES incorporates errors due to sampling differences in time and space which are difficult to separate from errors in the regression algorithm. As advised we have removed section 3.2 and figure 8 entirely.

3. **Title vs. content** The title leaves an impression that this study is to use IASI to estimate spectral flux over the entire LW spectrum (i.e. "the total spectrum of OLR" as in the title). However, the only validation done in this study is comparison with CERES OLR. A good agreement with OLR is necessary condition for a good estimate of the total spectrum of OLR, but not a sufficient condition at all, let alone the quantity derived in this study is not OLR at all (see my comment #1). There are so many possible compensations among different spectral bands that makes the total OLR correct but for utterly wrong reasons. In another word, the question posed in the title has not been convincingly answered by this study at all.

   This study employs a simple and physically incorrect conversion from radiance to flux, as I discussed in comment #1. This conversion alone leads to errors in all spectral channels, midIR and farIR. Then when the summation of spectral flux is computed, it is not clearly at all how much of the agreement with CERES broadband OLR is due to compensations of errors among different channels (or different bands). Even there is no spectrally resolved observations in the farIR that are suitable for direct validation of the algorithm, it seems the study can at least use LBLRTM to simulate farIR spectral flux and IASI radiance simultaneously, then compare the spectral flux regressed from such simulated IASI radiance against the spectral flux computed by LBLRTM directly. Such comparison should be done for clear-sky scenes as well as cloudy-sky scenes with a variety of cloud fractions. Relevant to this issue, the text especially the long introduction reads more like the farIR being the focus of this paper instead of spectral OLR of the LW spectrum. The farIR, as a band, has been discussed more than any spectral details of the flux as computed in this study (which is not the OLR per se)

With the lack of any space borne instruments that isolate the far infrared we cannot evaluate each simulated spectral lines individually. We emphasise the limitations of the model in the conclusions, page 19, line 26 to page 20, line 4. However the broadband comparison is the most independent observational test available, because the algorithm is not constructed with broadband targets but spectral ones, i.e. no broadband observations are involved in the training of the INLR product so there is no reason that compensation would exist to bring the overall values closer together. The fact that the two products are so close in value provides us with confidence in the applicability of this algorithm. We have retitled the paper to *Using IASI to simulate the total spectrum of Outgoing Nadir Longwave Radiance* to emphasise that this is a pilot project that explores the feasibility of this approach, rather than having reached the final stage.

The kind of analysis the reviewer suggests doesn't give new information beyond the limitations of the model, only that the model was constructed correctly. We have added an error analysis to this effect in the methodology, page 11, line 28 to page 12, line 9, and show 2 new figures (Figures 5 and 6), which show the rms errors and the relative rms errors both of which are small. Our study further strengthens the case for a space borne far infrared instrument with which to further validate and develop this model.

The reviewer is right to feel that the far infrared is the focus of this study as, apart from the NIR which contributes very little, this is the only region that was constructed, given that IASI provides direct continuous measurements over the mid infrared region. The spectral resolution of the simulated far infrared region is the main benefit, however the total product constructed is the total outgoing longwave spectrum, which is what allows it to be evaluated against other broadband products. We have clarified the main aim of the paper being to construct the spectrum, and the INLR is used as a tool for its evaluation.