1. **Broadband radiance determination:** It is interesting to consider the possibly of using IASI data to this end and the method employed differs somewhat in detail from exiting narrow-band to broadband techniques. However, the authors make little mention of existing progress in this area and the method falls short of delivering the expected level of accuracy of multichannel techniques covering this spectral region (e.g. Ellingson et al. 1989) and seems only to achieve similar results to exiting methods based on much more limited spectral observations from two narrow-band channels in the window and water vapour bands of AVHRR or METEOSAT (see for example Gube 1982; Schmetz and Liu 1988; Cheruy et al.1991; Minnis et al. 1991; Gruber et al., 1994;). It is difficult then to see what the proposed method offers over these established techniques, which in many cases included the additional determination of the flux. The authors need to do more to highlight the advance of their approach and properly put it in the context of this body of work.

Page 5, line 28 – page 7, line 14 reviews the existing body of work on narrowband to broadband techniques. This originally concentrated on polar orbiting satellite instruments, however we have extended this to include lines 15-18 on page 6, and added a new paragraph on the geostationary instrument studies that the reviewer mentions (page 6, line 26 to page 7, line 17). We have added a paragraph and two figures to the methodology section that quantify the accuracy of the regression model (page 11, line 28 to page 12, line 8) and produces a total relative error of 0.15%, which we believe exceeds the accuracy of existing similar methods. However producing a surrogate broadband instrument is not the focus of the study, which is detailed further in answer to the reviewers 3rd point. The proposed method is unique among others in that it resolves the far infrared (and near infrared) at high resolution, utilising the full breadth of the spectrally continuous IASI range, and the paper is refocused with this aim in mind, see particularly the abstract.

2. **Retrieval of simulated spectra:** As far as deriving spectral detail is concerned, it is obvious the method cannot add any additional information to the IASI observations beyond model assumptions. However, the technique described could plausibly provide a valuable shortcut to reconstructing simulated spectra and offer an alternative to for example simulations based on retrieved information from IASI. The authors need to clarify this aim and evaluate the ability of the method in achieving it, considering its strengths and weaknesses over the alternatives such as performing an explicit retrieval to provide

input to a simulation. As it stands the authors fail to demonstrate, even **theoretically**, how well the proposed method performs in this regard.

The validation of the technique's ability to provide a reasonable estimate of broadband radiance does little to validate its spectral fidelity: there is a difference between spectrally important features and their radiative impact and compensating errors in different spectral regions, which have been seen in previous model comparisons (see Huang et al., 2006), cannot be diagnosed by such broadband validation.

Furthermore a discussion of correlations does not enable the distribution of residuals to be inferred for each wavelength, nor inform on the ability of the model to capture the variability of the true atmosphere. It is clear that the empirical relations derived from the simulated spectra will provide an imperfect reconstruction, whilst the variability in the correlation coefficient shown in figure 4 leads to the expectation that the errors will have spectral structure (note: although this figure is described in the text as containing the regression coefficients it actually appears to contain the correlation coefficients). In addition, noise on the IASI observations and any deficiencies in the simulations ability to model the IASI region will also impact how well the simulated spectra can be reconstructed. These factors are not considered, either in selecting the optimum channel predictors or in evaluating the fidelity of the reconstruction. These effects should be quantified; the theoretical fidelity and robustness of the reconstruction demonstrated and its performance evaluated under different conditions and for different scenes. Its sensitivity to the expected noise in the IASI observations also needs to be determined. It would make sense that these studies also consider the optimum spectral resolution of the reconstructed spectra, taking into account the ability of the method.

With the lack of any space borne far infrared measurements in existence with which to calculate empirical relationships, we are limited to theoretical methods in constructing the regression model. We have added text that states these limitations within the bounds of the line-by-line code, LBLRTM, which we believe is the most accurate tool available for our purposes (page 8, lines 12-18). This is re-iterated in the conclusion, page 20, lines 5-10. The quantification of theoretical model errors described in answer to the reviewers 1st point demonstrates how well it performs. The unfiltered CERES total longwave radiance provides constraints on the total radiant energy, which effectively is a comparison of the FIR and NIR regions,

assuming the radiant energy from the overlapping observable range are in agreement between CERES and IASI. Naturally this assumption involves the accuracy of both instruments, calibration differences and unfiltering processes. The biases found in Section 3 are partly attributed to these factors, and are all well within the expected errors (page 15, lines 22-24).

While not evaluating the individual spectral lines individually the broadband comparison is the most independent observational test, 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. The fact that the two products are so close in values provides us with confidence in the applicability of this algorithm. It is unlikely that the broadband fidelity is due to compensating biases along the spectrum given this lack of 'tuning'. Theoretical errors arising from the log-log regression model are small (see fig 5 in revised paper), Thus, biases arising from deficiencies in LBLRTM, and cloud properties, in the FIR would need to sum to close to zero given the agreement between our IASI product and CERES data. This suggests that over the FIR as a whole our reconstruction is accurate. That does not preclude errors within the FIR which would need direct observations of the FIR to evaluate, a development we would be pleased to see.

The Huang et al. 2006 paper that the reviewer mentions, *Quantification of the source of errors in the AM2 simulated tropical clear-sky outgoing longwave radiation,* is a global climate model evaluation study where compensating errors arise due to fundamental problems with the simulation of climate model atmospheric fields and their wideband radiation schemes, which is a different problem to the spectral radiance reconstruction model addressed here, using radiosonde observations and a line-by-line model which are far more accurate.

The spectral structure of the models rms errors are shown in Figure 5, right hand panel, and the relative errors are shown in Figure 6. In terms of relative error there is little dependency on wavenumber. 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 to 28. The stratification of scenes, simulations with built in instrument errors, and expanded regression model form are all refinements that could further improve the performance of the 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 is presented in the conclusion, page 20, lines 5-13.

3. **Clarity of the aim and model details:** In parts of the paper the authors seem to lose sight of the fact that the method they propose is a shortcut to derive a model based simulation from the information contained in the IASI observations. The authors discuss in the introduction (page 18423 line 12 to line 6 on page 18424) the importance and uniqueness of the far infrared, the additional information in can potentially provide on upper tropospheric water vapour compared to the mid-infrared, the poor understanding of the water vapour continuum at these wavelengths and observational and modelling discrepancies in this spectral region and conclude that greater understanding and long term observations in this spectral region are needed. These are excellent points and are well illustrated by the references given. I would add to this that the models ability to correctly reproduce the far infrared spectral signature of cirrus which as the authors note is of particularly significance for this spectral region, will also be limited, given both the difficulties in simulating these properties and the potential for unique information about these clouds to be contained in the far infrared (Di Giuseppe and Rizzi,1999; Yang et al., 2003, Baum et al., 2014). The method presented in the paper to reconstruct simulations of the spectral regions not observed by IASI will of course include all the deficiencies and uncertainties of the original model of the type discussed above and will not add any additional information to that contained in the IASI spectral range except those of the model assumptions. Thus, although it is not explicitly stated, this discussion is of the limitations of their technique and it would seem to be in need of a counter augment from the authors on why the technique is nevertheless of use.

We agree with the reviewer that it is unlikely the model will be able to capture the spectral signature of cirrus clouds, given the limitations of the LBLRTM model in its treatment of clouds. Validation of this aspect of the LBLRTM model is something that is lacking in the literature, in contrast to extensive validations of clear-sky parameters such as the water vapour continuum, and this is certainly something that this product could benefit from in the future. We have added text on page 19, line 26 to page 20, line 4 to caution applications that might be sensitive in this regard. The text states how this study strengthens the case for a spaceborne far infrared instrument, in order to develop the model to allow more detailed analyses.

4. Consideration that the resulting spectra retrieved are limited by the model used and all the results discussed in section 4 are specific to this model and its assumptions (plus subject to additional errors introduced by the method employed to reconstruct the spectra) is also lacking in the presentation of section 2.2 and section 4. Hardly any information about the modelling input and assumptions are provided, all that is stated is that LBLRTM is used along with radiosonde data from 1600 soundings with a second set of cloudy simulations performed by random insertion of a cloud layer. Where are the radiosondes from and do they cover the full variability in the atmosphere? What cloud properties are used, are the cloudy atmospheric profiles different from the clearsky? How are the cloud properties determined? How are ice particles modelled? What particle size, shape and water content are used in the simulations? Is scattering included? What surface properties are used? How well do the simulations match IASI observed spectra? Maybe such questions are of less importance for a proof of concept only, but the results in section 4 are entirely dependent on these issues, they are a demonstration of what this model says is going on in the far infrared given information on the atmosphere from IASI. It is not appropriate to include and discuss these results without this context.

Full details of the input radiosonde data have been added to the methodology on page 10, line 25 to page 11, line 14. High level clouds are assumed to have the spectral properties of cirrus given by Haurwitz and Kuhn (1974). As said in answer to the reviewers second point 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 is presented in the conclusion, page 20, lines 5-13.