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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Can IASI be used to simulate the total spectrum of outgoing longwave radiation?" *by* E. C. Turner et al.

Anonymous Referee #1

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General comments

The paper is clearly laid out, well-structured and written in excellent English. It demonstrates that empirical regressions between highly correlated observed and unobserved wavenumbers can be used to provide a broadband longwave radiance estimate from IASI data which agrees well with broadband observations from CERES. However it fails to put this method for deriving broadband longwave radiance from spectrally limited infrared observations, in the context of the extensive body of work that exists on this subject. Furthermore its primary stated aim, that of demonstrating a method to use IASI data to directly infer spectral detail in unobserved spectral regions without performing an explicit retrieval is poorly addressed. This aspect of the paper suffers from some misleading or confusing descriptions of its aim and lacks several vital com-

ponents in its description and evaluation. These deficiencies leave the question in the title unanswered, the statement in the conclusions, “This study serves as a proof of concept of the usefulness of IASI for estimating the total LW radiance and the terrestrial far infrared at an unprecedented level of spectral resolution.”, unsupported and the results discussed in section 4 without context.

For these reasons I feel that in its current form the paper is not suitable for publication. The work described may become publication worthy if it: clarifies its aim; improves the evaluation of the broadband estimation and puts these results in the context of similar methods; makes efforts to properly evaluate the ability of the method to reconstruct the simulated spectra; provides details of the model inputs and assumptions and demonstrates the suitability of the simulations for their purpose.

Specific Comments

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.

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

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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.

Clarity of the aim and model details: In parts of the paper the authors seem to lose sight

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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.

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?

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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.

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