Atmos. Meas. Tech. Discuss., 5, C2685–C2692, 2012
www.atmos-meas-tech-discuss.net/5/C2685/2012/

Atmospheric
Measurement
Techniques
Discussions

Interactive comment on "A fast method for the retrieval of integrated longwave and shortwave top-of-atmosphere irradiances from MSG/SEVIRI (RRUMS)" *by* M. Vázquez-Navarro et al.

M. Vázquez-Navarro et al.

margarita.vazquez@dlr.de

Received and published: 29 October 2012

We thank reviewer #1 for their comments.

1. Thank you. We added "upwelling" to the title.

2. The reviewer is certainly correct in the sense that the irradiance measured from any point in space is averaged over hundreds of kilometers. But that does not really affect our interpretation. And if it did, it would also affect any radiation budget instrument in space - ERBE, CERES, GERB - because they all have resolutions much higher than the averaging length. If we followed the argumentation of the reviewer, a retrieval

from GERB should not be possible at all because the irradiance seen from GERB is averaged over the full Earth disk. The aim of all these instruments and retrievals (in addition to determining the radiation budget as accurately as possible) is to determine the radiative effect of various atmospheric components (e.g. clouds) on the outgoing longwave and reflected shortwave radiation. And in that sense it is perfectly legal to do that on a pixel-by-pixel basis, irrespective of the pixel size. That is, instead of looking top-down, we are looking bottom-up and determine the radiative effect of an object by quantifying the reflected irradiance by integrating the observed radiance over the upper hemisphere. In order to calculate the complete reflected irradiance one has to calculate the average of all pixels.

The CERES algorithm does exactly the same as we do - by first classifying each individual pixel as water cloud or ice cloud or whatsoever, and then applying the corresponding ADM to convert the radiance to irradiance. If we need to quantify the contribution of a small object (e.g. an aircraft contrail) to the radiation budget, then we need a high-resolution sensor. Of course the reviewer is correct that 3D effects become more and more important when the resolution is increased. At the resolution of MSG SEVIRI, however, the uncertainty due to cloud imhomogeneity effects should be close to its possible minimum which typically occurs at resolutions of a few kilometer, as several studies have shown: If the pixel size is larger (CERES, GERB) then the unresolved inhomogeneities cause increased uncertainties (plane-parallel bias) while ICA errors become more important when the pixel size is smaller.

3. Retrieval of OLR:

The EUMETSAT document uses the same narrowband radiances that we use to derive the temperature. In OLR, the fact that a cloud has a certain temperature causes it to emit a certain amount of energy to the atmosphere. Thus, an approach using temperatures is a fair one. It has also the advantage that it does not need the form of the spectral response function nor the width of the spectral interval for each channel. Additionally, the EUMETSAT approach requires a three-level cloud classification:

semi-transparent clouds, opaque-clouds and clear sky, whereas the RRUMS method requires only a cirrus mask. We have used the EUMETSAT document to derive the OLR for a scene (MSG slot 201209301500), please, see the attached Figures.

Of course, the coefficients are attached as supplementary material. Thank you.

4. Retrieval of RSR:

The description of the training procedure has been included in the paper. The training has been carried out as follows: The data has been split into a training and a validation data set. We trained a network with 200 nodes resulting in 2002 weights using 9172000 data vectors obtained from model calculations and used the same amount of data for validation. By the way, the error statistics do not differ substantially between traing and validation data set, which is explained by the huge amount of training data. The difference from 7790000 model calculations as mentioned in 2.2 is explained by the fact, that each model vector containes radiances with and without a cirrus cloud. In order to force the network to reach a value of zero at night we had to add both in training and validation 1382000 data vectors linearly interpolated between 0 and the model results for high solar zenith distances, as the model calculations stopped at 78° (cosine of zenith angle 0.2). We detected also an error in the paper: Bias and standard deviation determined by the validation data set are 9.1 and 33.4 Wm^{-2} (9.3 and 32.8 Wm^{-2} for the training set).

We are aware, that with a more sophisticated network both bias and standard deviation could be reduced. This paper describes the state of the network, which has been used already in several studies.

We have eliminated the linear model description from the paper. However, we think it is important to point out that a linear model, which is a more simple approach, has been attempted, although with less satisfactory results.

5. Validation CERES/GERB:

Figure 7, 11, 12 and 13 show the performance of the RRUMS method vs. CERES and GERB. The reader can clearly see the differences among those retrievals, as suggested. We have added bias and stddev to the tables.

The data set used for training results from pure model calculations, thus it assumes a perfect calibration and the nominal spectral response functions for each channel. Any error in the calibration should have an impact on the derived fluxes. The comparison to the well calibrated direct measurements by GERB and CERES demonstrates the performance of our method with SEVIRI data as they are provided by METEOSAT.

The change in the definition of infrared radiance used for the processing in May 2008 is not considered here. In Libradtran always spectral radiances have been used, which is equivalent to the new METEOSAT processing. The differences in outgoing longwave radiation are small, as the main differences between the old and the new processing scheme show up only at low temperatures.

SPECIFIC REMARKS:

- p4971 L2: We have replaced the Kiehl and Trenberth 1997 estimates by Loeb et al. 2008.

- p4971 L13: "resolution possible nowadays" replaced by "currently available"

- p4972 L19: "Eumetsat" replaced by "EUMETSAT"

- p4974 L13: "HRVIS" replaced by "HRV"

- p4981 L22: "a linear fit similar to the thermal irradiance" replaced by "a linear fit based on solar radiances similar to that used for the OLR"

- p4983 L21: "the neural network sometimes fails detecting thin clouds" replaced by "it has been observed that this neural network sometimes fails detecting thin clouds"

- p4985 L10: "poorer resolution" replaced by "lower resolution"

- p4993 / Table 2: 13th of august. The CERES swath for that date and time was located at an extreme angle for SEVIRI's viewing capabilities. It should not have been included in the table.

- p4993,4994 / Tables 2,3: stddev and bias added

- Figures have been re-processed as density plots following the suggestions of the reviewer. Also acquisition times have been included in all plots depicting satellite scenes (although they all correspond to the same scene).

We thank reviewer #2 for their comments.

1. Whereas the method is perhaps not novel, it is original. So far, neither a neural-network based method to derive RSR or a multilinear fit based on the Stefan-Boltzmann equation to derive OLR that allow the retrieval of both magnitudes on the SEVIRI grid using only SEVIRI measurements have been published. The GERB team has certainly a 9km x 9km product, we have included a mention to it in the introduction. However, as the ROLSS (RMIB On Line Short-term Service) website points out, and I quote (italics are not mine): "these data are unvalidated and should *not* be used for quantitative scientific studies". Moreover, these "high resolution" data do not appear on the GGSPS site (GERB Ground Segment Processing System) under "Authorised data products".

2. The paper is not exclusively intended for the quantification of the effect of contrails on climate, although it was the necessity of the latter that led us to develop the methods. However, the actual scope of the methods is wider. It is definitely not a follow-up of a previous paper. While the global net effect of contrails on climate might be, as the reviewer points out, in the order of mW, a measurement in principle out of the reach of the sensitivity of not only our method, the local effect is much larger. As a matter of fact, the LW and SW signals from single contrails are in the order of the tens of Watt (positive and negative), and RRUMS is perfectly capable of quantifying it. In any

case, in this paper we do not focus on this ability, instead we describe and discuss two methods that allow the observation of small scale features on the radiative balance of the Earth. The speed of the method was not a key factor in the development, but a very fortunate outcome indeed.

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 4969, 2012.

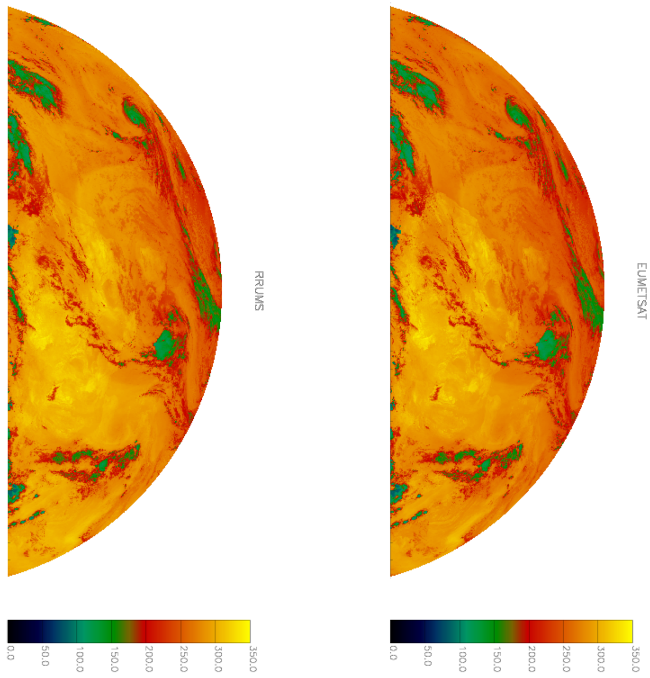

Fig. 1. Top: EUMETSAT OLR, Bottom: RRUMS OLR. Both, in W/m^2.

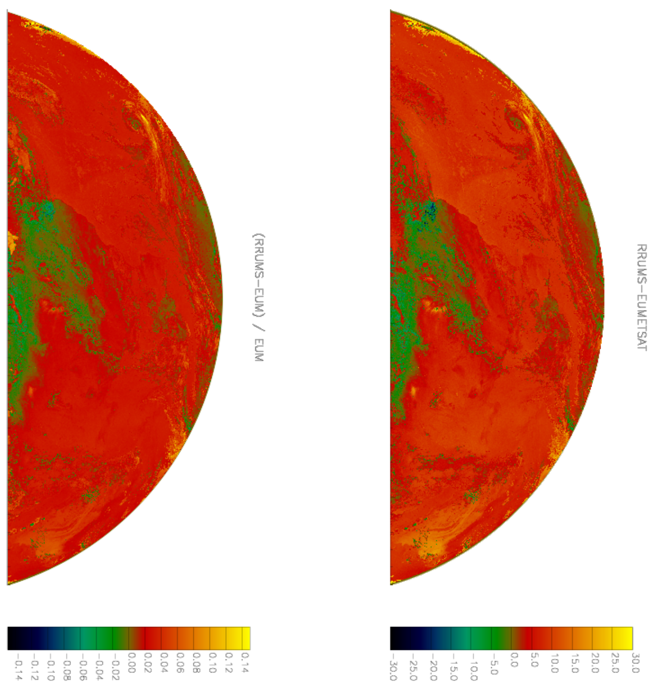

Fig. 2. Difference between RRUMS OLR and EUMETSAT OLR. Top: absolute difference in W/m^2, Bottom: relative difference.