



Radiative Transfer and Surface Properties Working Group Report

October 29, 2015

ITSC-20
October 28 – November 3, 2015
Lake Geneva, Wisconsin USA

Topics Covered

- Scattering RT intercomparison
- Line-by-line modeling
 - Line shape
 - Datasets for validation
 - 183GHz Workshop
 - Impact of HDO absorption
- Surface properties
- Ongoing RT Intercomparisons
- Other issues
- Spectral response function (SRF) database repository
- Carryover from ITSC-19

SCATTERING RT INTERCOMPARISON

With the increasing use of cloudy radiances in NWP and other applications, an intercomparison and validation of scattering RT fast models was proposed. There was discussion over what form this comparison would take (e.g. validating satellite imagery, using flight campaigns, using case studies, Jacobian comparisons, etc) and what datasets would actually be needed and useful (e.g. profile datasets, optical properties, ground-based measurements, etc).

It was decided a list of needs would be drawn up and disseminated to the group to allow for a more comprehensive survey of requirements.

Action RTSP-1 : Paul van Delst (IMSG@NCEP/EMC), Marco Matricardi (ECMWF), Jerome Vidot (MeteoFrance), and Pascal Brunel (MeteoFrance) to coordinate this task with the RTSP-WG to determine data requirements and define any standard approaches or data formats.

Some specific announcements and requests for data came up in the meeting as part of this effort:

Colocated datasets

Action RTSP-2: Sergio Machado (UMBC) to provide AIRS/ECMWF 7000 profile matched dataset.

Aerosol optical properties

Requests were made regarding the availability of aerosol optical property data, as well as a recognition that current laboratory data for aerosol refractive indices should be reviewed for use in any intercomparisons.

Action RTSP-3 : Paul van Delst to contact Dave Turner (**OSU?**) regarding aerosol refractive index data.

Action RTSP-4 : Marco Matricardi to provide links to aerosol refractive index and optical property datasets, as well as electromagnetic theory code to compute aerosol optical properties.

Recommendation 1_: The RTSP working group recommend that aerosol optical property data be made publicly available, including documentation of the particle size distributions.

Recommendation 2_: The RTSP working group recommends encouraging research into laboratory measurements of aerosol refractive indices.

LINE-BY-LINE MODELLING

Recommendation 3 : The RTSP working group recommends the continued support of LBL model development, both the forward model software and the measurements/calculations to improve the spectroscopy.

Characterising RTM error covariance

The group was asked about ensemble techniques for characterizing RTM error covariances, in particular for line-by-line (LBL) models. The group expressed the view that it is not an intractable problem but is still a very difficult one. It was felt the group should pursue the more classical approach of using colocated datasets for validation at this point.

Absorption line profile characterisation

It was noted that there is recent research about a reformulation of the absorption line shape profile – other than a Voigt lineshape – used in LBL models. This would have an impact on not just the current LBL model implementations but also on the spectroscopic databases.

Implementation of this new line shape formulation is already being tested in 4A/STRANSAC at LMD. There are currently no plans to include this reformulation in the Community Line-by-Line (CLBL) model at NOAA/JCSDA.

Recommendation 4 : Include the potential reformulation of the absorption line shape profile into other LBL model development plans (CLBL mentioned specifically, but applies to any LBL model)

Datasets for validation

Use of GRUAN datasets for validating LBL RT models was discussed. Several datasets of colocated ground-based and IASI measurements are available.

This topic was raised with respect to LBL model validation, but these data would also be useful for cloudy RT model comparisons, but would require specification of the cloud state variables.

Action RTSP-5 : Marco Matricardi (ECMWF) to provide information on how to obtain the GRUAN datasets available on the RTSP-WG website.

LINE-BY-LINE MODELLING

183GHz Workshop

The general feeling regarding the issues at 183GHz was that we don't really know what is going on. Pascal Brunel mentioned tests he is performing to look at the impact of using Planck weighted transmittances to improve RT model results. It was also noted that the measured spectral response of microwave instruments are not generally available.

Recommendation 5 : The RTSP working group recommends that radiative transfer modelers continue investigating the biases observed in the 183GHz channels.

Action RTSP-6 :Marco Matricardi to make the workshop final report available on the RTSP-WG website.

Action RTSP-7 : Paul van Delst to make the measured spectral response functions for ATMS and GMI available via the RTSP-WG website.

Impact of HDO absorption

The treatment of HDO, an isotopologue of water, in line-by-line modeling generally assumes a constant mixture with H₂O in the vertical. However, it is well known the vertical distribution of HDO compared with H₂O can vary significantly both spatially and temporally. Assuming a constant mixture in LBL calculations introduces an error in the radiance spectra that could be as high as 1.5K. When the HDO/H₂O vertical profile mixture differences are accounted for, those errors can decrease to 0.3K.

To mitigate this effect in hyperspectral infrared radiances at the affected frequencies, HDO should be specified as a separate molecule in LBL calculations, to allow for a separate concentration profile to be specified. This is already implemented in 4A/STRANSAC.

Recommendation 6 : The RTSP working group recommends having HDO be specified as a separate molecule in both the LBL models and the spectroscopic data to provide the flexibility to treat it separately in LBL calculations.

Missing molecular species in LBL/fast RT models

Recommendation 7: The RTSP working group recommends that as many as possible molecular species are included in LBL computations used to train fast RT models.

SURFACE PROPERTIES

Measurements for validation

The first item discussed was regarding reference data sets for validation. Thomas August (EUMETSAT) brought to the working groups attention a research team – Dr. Folke Olesen’s group at Karlsruhe Institute of Technology (KIT) – preparing to take FTIR measurements of surface emissivity. Given the benefit of these measurements for RT validation, a recommendation from the RTSP-WG was requested.

Recommendation 8 : The RTSP working group recommends that funding be made available to research groups making measurements of land surface emissivity in the infrared.

A call for similar surface emissivity and reflectivity measurements in the microwave was also made. In addition, to maximize the utility of these measurements, it was recommended that sufficient in situ data for physical model validation (surface and soil temperature, surface and soil moisture, etc) be taken alongside any spectral measurements.

Recommendation 9 : The RTSP working group encourages the measurement of land surface emissivity and reflectivity in the microwave spectral regions of interest to the ITWG members.

Physical models

A recommendation was requested to encourage modeling of bidirectional reflectances for use in fast models. While the discussion focused on the microwave similar efforts were encouraged for infrared and visible sensors.

Recommendation 10 : The RTSP working group recommends development of BRDF models for use in fast RT models.

SURFACE PROPERTIES

Surface emissivity datasets

Eva Borbas (CIMSS/SSEC/University of Wisconsin-Madison) put out a call for beta-testers of the new emissivity dataset (reported here at ITSC-20). Contact information: eva.borbas@ssec.wisc.edu.

Additionally, Eva Borbas asked the RTSP group, and the ITWG in general, for feedback on the emissivity covariance dataset.

Recommendation 11 : The RTSP working group recommends that users of any of the UW IREMIS datasets provide feedback to Eva Borbas to allow for reporting at the next ITSC.

Ben Ruston (NRL Monterey) brought to the RTSP group's attention that he, Eva Borbas, and Glynn Hulley (NASA/JPL) are working on a better definition of snow emissivity spectra in the infrared.

Action RTSP-8 : Ben Ruston to notify the RTSP-WG co-chairs when the improved snow emissivity dataset becomes available.

Louis Garand (Environment Canada) inquired about the availability of broadband emissivities for use with radiation models in the current databases.

Recommendation 12 : The RTSP working group recommends the addition of broadband emissivities to the available databases where appropriate or possible.

ONGOING RT INTERCOMPARISONS

EUMETSAT Retrieval Algorithm Intercomparison

It was noted that EUMETSAT is embarking on an intercomparison of retrieval algorithms and that the first step of that is an RTM intercomparison.

Recommendation 13 : The RTSP working group recommends the results of the RTM intercomparison, including Jacobian comparisons, be reported to the ITWG, via the RTSP-WG, when they are available.

CRTM/RTTOV Intercomparison

Emily Liu (SRG@NCEP/EMC) has been running both CRTM and RTTOV in the NCEP data assimilation system in preparation for the assimilation of all-sky radiances. The RTSP-WG has found the initial comparison of CRTM and RTTOV Jacobians has highlighted some interesting differences between the two models.

Recommendation 14 : The RTSP working recommends that the CRTM/RTTOV intercomparison continue, including Jacobians.

SPECTRAL RESPONSE FUNCTION (SRF) DATABASE REPOSITORY

There was insufficient time to discuss this with the group but one of the co-chairs (Paul van Delst) would like to get the need for the following actions in the record:

- Providing SRF definition software and I/O (netCDF4) modules.

- Include FTS responsivities in the SRF databases.

- Establish a central repository for SRF data. This should be coordinated with similar efforts being undertaken by both GSICS and GEWEX.

Recommendation 15 : The RTSP working group recommends that agencies and/or manufacturers provide future microwave instrument channel characterization data. The GMI Spectral Requirements Verification Report report can be used as a model.

Recommendation 16 : The RTSP working group recommends that agencies provide responsivities for Fourier Transform Spectrometers (FTS) that can be used in modeling those instruments in current RT models.

OTHER ISSUES

Action RTSP-9 : Paul van Delst to contact AER Inc. and find out what portions of the OSS software package are public.

A continuation from the ITSC-19 RTSP-WG report, the group recognized that the use of the scalar form of the radiative transfer equation is not adequate for specific microwave simulations (reported on at ITSC-20). Depending on the application, the full or a reduced number of Stokes vectors is required.

Recommendation 17 : The RTSP-WG encourages RT model developers to generalize the form of the RT equation introducing a vector formalism.

CARRYOVER FROM ITSC-19

Action RTSP-10 : Paul van Delst to followup on ITSC-19 RTSP-WG action items 1, 4, 12-14, 16-19, and 21.

Action RTSP-11 : Stu Newman (MetOffice) to follow up on ITSC-19 RTSP-WG action items 3 and 7