2. WORKING GROUP REPORTS

2.1 RADIATIVE TRANSFER AND SURFACE PROPERTY MODELLING

Web site: https://groups.ssec.wisc.edu/groups/itwg/rtsp

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2.1.1 Fast RT Model Intercomparison

The Radiative Transfer and Surface Properties working group (RTSP-WG) agreed to continue RT model intercomparisons and expand it slightly to cover both clear-sky and cloudy RT comparisons, particularly focused between RTTOV and CRTM. One outcome of this intercomparison is to make the input and output datasets publicly available to other RT modelers. In addition to forward modeled radiances, these intercomparisons would also specifically focus on comparing Jacobians.

The initial comparisons would start with a limited set of test cases (profiles) that already exist within the RTTOV testing suite.

For cloudy radiance comparisons, different cloud overlap and cloud physical treatments should be explored, with the goal of identifying deficiencies or areas for future improvements in either modeling approach.

In order to assess the accuracy of RT models, we recommend the use of validation campaign data that has high quality observations of physical and radiometric parameters needed to validate (or partially validate) the forward RT model radiances.

Action RTSP-1 on Benjamin Johnson

To identify specific field campaigns in support of validating fast RT models (specifically RTTOV and CRTM at first).

Action RTSP-2 on Raymond Armante

To give feedback to the RTSP-WG Co-Chairs on the COMET campaign.

Action RTSP-3 on Jerome Vidot

To provide feedback on cloud scattering validation datasets.

Recommendation RTSP-1 to the aerosol research community

The RTSP working group recommends encouraging research into laboratory measurements of aerosol refractive indices.

2.1.2 Fast Model Coefficient Generation

Fast models are crucially important for near real time simulation and assimilation of satellite observations. In this set of recommendations, we seek to improve the availability and quality of spectral responses functions needed to generate accurate coefficients required by fast RT models.

Recommendation RTSP-2 to the RT Community

Explore alternative options for the support vibrational temperatures for non-LTE computations.

Recommendation RTSP-3 to RT Model Developers

Fast non-LTE models should include a representation of ozone variability in the upper atmosphere.

Recommendation RTSP-4 to RT Model Developers

We continue to support the previous ITSC-20 recommendation of creating a spectral response function (SRF) repository, to be shared publicly with the RT community. Challenges include export controlled and proprietary information. RTTOV maintains an up-to-date collection of the SRF/passband data used for RTTOV coefficients which may be of interest:
https://www.nwpsaf.eu/site/software/rttov/download/coefficients/spectral-response-functions/

Action RTSP-4 on Benjamin Johnson

To create SRF repository and coordinate inputs from RTWG and other contributors. Will coordinate with Emma Turner (Met Office) to receive updates to SRFs for RTTOV.

Recommendation RTSP-5 to CGMS

Encourage sensor manufacturers and instrument engineering and science teams to provide SRFs with higher quality, consistent format, and with rapid availability.

2.1.3 LBL Models

Line-by-line (LBL) models are essential to the continued development of fast, accurate radiative transfer models used in NWP and other applications. The current application of LBL models in fast RT models can be further improved through several of the recommendations that we have provided below. In general, we seek to improve the quality of LBL models (including underlying spectroscopic databases), and support diversity and continued development and funding for LBL modelling efforts.

Recommendation RTSP-6 to Line-by-Line model developers and funding agencies

The RTSP-WG strongly supports continuous line-by-line model development as a fundamental basis for accurate radiative transfer calculations in fast RT models. The RT community also encourages and supports the development of competing line-by-line codes.

Recommendation RTSP-7 to Line-by-Line model developers and spectroscopic database developers

Look at the current continuum absorption models at higher MW frequencies (< 1000 GHz) and promote the use of the MT_CKD model in line-by-line microwave codes. Explore the possibility of using other approaches (e.g., Korshelev 2011) for frequencies below 200 GHz.

Recommendation RTSP-8 to Line-by-Line model developers and spectroscopic database developers

The characterization of LBL model biases should be aimed at identifying spectral regions that can serve as anchor observations. Attempt to map uncertainties in spectroscopy into radiance uncertainties, starting from major lines of a given region.

Action RTSP-5 on Marco Matricardi

To contact RFM group regarding approaches to encourage/enable recommendation RTSP-8.

Action RTSP-6 on Vivienne Payne

To establish and communicate approaches to encourage/enable recommendation RTSP-8.

Recommendation RTSP-9 to Line-by-Line model developers

To include new formulations of the Doppler line broadening line shape (e.g., include velocity dependence in Voigt line shape). This work depends on the availability of relevant data.

Action RTSP-7 on Claude Camy-Peyret

To provide comprehensive communication to the conference co-chairs and to the RTSP-WG regarding a unified model for describing the shape of the relevant atmospheric water vapour lines from the MW to the visible including the very important TIR and SWIR regions.

2.1.4 Spectroscopic Parameters

Similar to our support for line-by-line modeling improvements, we also seek to encourage the development of new and improved spectroscopic databases, particularly with respect to those databases that support LBL models. We address a specific need for extending research into higher microwave frequencies that will be used on future sensors.

Recommendation RTSP-10 to spectroscopy researchers

A strong emphasis should be put on the continuous support of theoretical and laboratory spectroscopic studies. Continuous efforts should be maintained in the generation and improvement of basic line parameters.

Recommendation RTSP-11 to spectroscopy researchers

The RTSP-WG recommends promoting research into spectroscopy of higher frequency microwave channels up to 1000 GHz.

2.1.5 Surface Properties

The RTSP-WG encourages continued development and improvements in both physical surface modeling and radiative transfer interfaces to these models with the explicit goal of increasing the overall accuracy and physical representativeness of emissivity computations. This is applicable to all surface types and includes current and future sensor capabilities. The following recommendations are aimed at strengthening the research aspects and encourages communication and collaboration between and within the physical modeling and RT modeling communities.

Recommendation RTSP-12 to the surface emissivity modeling community
Develop accurate physical models to support surface emissivity modeling requirements in RT models.

Recommendation RTSP-13 to the surface emissivity modeling community
The RTSP-WG strongly recommends support of developing reference-quality ocean-surface emissivity modeling, specifically infrared, microwave, for both active and passive simulations.

Action RTSP-8 on the RTSP-WG Co-Chairs (Marco Matricardi and Ben Johnson)
Share recommendation with other relevant working groups (e.g., IPWG, Land Surface subgroup, other relevant surface research communities).

Recommendation RTSP-14 to surface-specific spectral library developers
Include broader and more diverse vegetation sampling (e.g., new types), and include the effects of senescence. Also include the impact of the diurnal cycle in spectral emission/reflection databases.

Recommendation RTSP-15 to Atmospheric RT and surface model developers
Improve the interface between land surface model parameters and RT models, and specifically incorporate angular dependence impact on polarized emissivity and reflectivity over all surface types.

2.1.6 Optical Properties for Scattering Models

In a similar vein to the surface modeling, the optical properties of scattering particles (e.g., aerosols, clouds, precipitation) also require continued support to improve physical and radiometric accuracy. The accuracy of scattering computations can be significantly affected by errors and uncertainties of the parameterization of optical properties of the scattering particles. Although several methods exist to compute the optical properties of spherical and non-spherical particles, the representation of the optical properties of an ensemble of scattering particles of different sizes and habits is still an outstanding issue. More research is needed into the characterization of these size distributions. This is especially true for ice particles for which a variety of different habits has been observed. In addition, the size distribution of small ice particles is still poorly known.

The following recommendations and action items identify and seek to bring awareness to these deficiencies.

Recommendation RTSP-16 to aerosol/cloud/precip microphysical and scattering model developers
For all scatterers, extend the frequency range to cover the ranges of current and upcoming sensors, from visible to microwave (i.e., ICI channels). Extend the range of particulate sizes to be consistent with observed parameters for each particle type.

Recommendation RTSP-17 to aerosol microphysical and scattering model developers
Explore the necessity of using non-spherical aerosol particle scattering properties in fast RT models.

Action RTSP-9 on Ben Johnson

To report on current developments of physical and scattering properties of aerosols, clouds, and precipitation to the RTSP working group.

2.1.7 Scattering Model Solvers

Scattering approximations used in fast RT models is essential for operational use within simulations involving scattering atmospheres. In that respect, it is crucial that the RT community compares the results from scattering model solvers to both each other, and to external models that may be more robust / accurate. External validation is also an essential component to understanding the systematic errors that may be present in any given model. These comparisons aid in identifying key deficiencies in the models.

Ideally this approach includes aerosols, clouds, and precipitation comparisons, under a wide range of situations. This feeds back into the fast RT Model intercomparison efforts described previously, where the RTSP-WG plans to develop (in the future) additional test cases for fast RT model intercomparisons under scattering conditions.

We also specifically recognize a need for improved accuracy in RT modeling in 3D cloud structures.

Recommendation RTSP-18 to RT developers

Extend the comparison of parameterized RT schemes used in fast models. This includes both clouds and aerosols.

Recommendation RTSP-19 to RT developers

We encourage the comparison / validation of full scattering and full polarization solvers. This should include the computational efficiency, specifically including the adjoint model. Analytic adjoint models should be considered.

Recommendation RTSP-20 to aerosol scattering modelers and RT model developers

For aerosol scattering computations, more research is needed to characterize the regimes where fast approximations are effective.

2.1.8 Future RT Outlook

Part of the challenge of developing fast RT models is to be prepared and responsive to upcoming requirements that will be imposed on RT developers by the NWP or other communities. These recommendations specifically identify areas of potential or upcoming importance that need to have some early attention and discussion. It is expected that these items will move up into other areas as requirements and research progresses.

Recommendation RTSP-21 for RT model developers

Look at the importance of simulating radiances in presence of small-scale variability within the FOV. To be done in coordination with model developers.

Recommendation RTSP-22 to RT model developers

Promote the extension of RT models to the simulation of active/passive data (e.g., Radar/LIDAR/Scatterometers), and to UV, visible, and far-infrared portions of the spectrum. A robust treatment of atmospheric, spectroscopic, and surface polarization (linear and circular) should also be considered.