



Radiative Transfer and Surface Properties Working Group Report

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ITSC-21

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Topics Covered in ITSC-21 RTSP-WG

Fast RT Model Intercomparison

Fast RT Model Coefficient Generation

Line-By-Line Models

Spectroscopic Parameters

Surface Properties

Optical Properties for Scattering Models

Scattering Model Solvers

Future RT Outlook

Carryover from ITSC-20

Fast RT Model Intercomparison

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Fast RT Model Coefficient Generation

Line-By-Line Models

Spectroscopic Parameters

Surface Properties

Optical Properties for Scattering Models

Scattering Model Solvers

Future RT Outlook

Carryover from ITSC-20

Fast RT Model Intercomparison

Summary: Continue CRTM/RTTOV model intercomparisons and expand it slightly to cover both clear-sky and cloudy RT comparisons.

Recommendations and Action Items

- **Action RTSP-1:** Benjamin Johnson to identify specific field campaigns in support of validating fast RT models (specifically RTTOV and CRTM at first).
- **Action RTSP-2:** Raymond Armante to give feedback to the RTSP-WG co-chairs on the COMET campaign.
- **Action RTSP-3:** Jerome Vidot to provide feedback on cloud scattering validation datasets.
- **Recommendation RTSP-1:** The RTSP working group recommends encouraging research into laboratory measurements of aerosol refractive indices.

Fast RT Model Coefficient Generation

Fast RT Model Intercomparison

Fast RT Model Coefficient Generation

Line-By-Line Models

Spectroscopic Parameters

Surface Properties

Optical Properties for Scattering Models

Scattering Model Solvers

Future RT Outlook

Carryover from ITSC-20

Fast RT Model Coefficient Generation [1/2]

Summary: The RTSP-WG seeks to improve the availability and quality of spectral response functions needed to generate accurate coefficients required by fast RT models.

Recommendations and Action Items

- **Recommendation RTSP-2** : RT Community to explore alternative options for the support vibrational temperatures for non-LTE computations.
- **Recommendation RTSP-3**: Fast non-LTE models should include a representation of Ozone variability in the upper atmosphere.
- **Recommendation RTSP-4**: Continue to support previous ITSC-20 recommendation of creating a spectral response function (SRF) repository, to be shared publicly with the RT community.

Fast RT Model Coefficient Generation [2/2]

Summary: The RTSP-WG seeks to improve the availability and quality of spectral response functions needed to generate accurate coefficients required by fast RT models.

Recommendations and Action Items

- **Action RTSP-4:** Benjamin Johnson to create SRF repository and coordinate inputs from RTWG and other contributors.
- **Recommendation RTSP-5:** CGMS to encourage sensor manufacturers and instrument engineering and science teams to provide SRFs with higher quality, consistent format, and with rapid availability.

Line-By-Line Models

Fast RT Model Intercomparison

Fast RT Model Coefficient Generation

Line-By-Line Models

Spectroscopic Parameters

Surface Properties

Optical Properties for Scattering Models

Scattering Model Solvers

Future RT Outlook

Carryover from ITSC-20

Line-By-Line Models [1/2]

Summary: RTSP-WG seeks to improve the quality of LBL models (including underlying spectroscopic databases), and support diversity and continued development and funding for LBL modelling efforts.

Recommendations and Action Items

- **Recommendation RTSP-6:** 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:** Look at the current continuum absorption models at higher MW frequencies (< 1000 GHz) and investigate the use of MTK_CKD model in line-by-line microwave codes.
- **Recommendation RTSP-8:** Characterization of LBL model biases, especially in well characterized regions of the spectrum. Attempt to map uncertainties in spectroscopy into radiance uncertainties, starting from major lines of a given region.

Line-By-Line Models [2/2]

Summary: RTSP-WG seeks to improve the quality of LBL models (including underlying spectroscopic databases), and support diversity and continued development and funding for LBL modelling efforts.

Recommendations and Action Items

- **Action RTSP-5:** Marco Matricardi to contact RFM group regarding approaches to the above recommendation
- **Action RTSP-6:** Vivienne Payne to establish and communicate approaches on above recommendation.
- **Recommendation RTSP-9:** For 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)
- **Action RTSP-7:** 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.

Spectroscopic Parameters

Fast RT Model Intercomparison

Fast RT Model Coefficient Generation

Line-By-Line Models

Spectroscopic Parameters

Surface Properties

Optical Properties for Scattering Models

Scattering Model Solvers

Future RT Outlook

Carryover from ITSC-20

Spectroscopic Parameters

[1/1]

- **Summary:** 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.

Recommendations and Action Items

- **Recommendation RTSP-10:** 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:** The RTSP-WG recommends promoting research into spectroscopy of higher frequency microwave channels up to 1000 GHz.

Surface Parameters

Fast RT Model Intercomparison

Fast RT Model Coefficient Generation

Line-By-Line Models

Spectroscopic Parameters

Surface Properties

Optical Properties for Scattering Models

Scattering Model Solvers

Future RT Outlook

Carryover from ITSC-20

Surface Parameters [1/2]

- **Summary:** The following recommendations are aimed at strengthening the research aspects of surface modeling and associated RT simulations, and encourages communication and collaboration between and within the physical modeling and RT modeling communities.

Recommendations and Action Items

- **Recommendation RTSP-12:** recommendation to the modeling community to develop accurate physical models to support emissivity modeling requirements in RT models.
- **Recommendation RTSP-13:** 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:** RTSP-WG Co-Chairs : share recommendation with other relevant working groups (e.g., IPWG, Land Surface subgroup, other relevant surface research communities).

Surface Parameters [2/2]

- **Summary:** The following recommendations are aimed at strengthening the research aspects of surface modeling and associated RT simulations, and encourages communication and collaboration between and within the physical modeling and RT modeling communities.

Recommendations and Action Items

- **Recommendation RTSP-14:** recommendation to spectral library developers to 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.
- **Recommendation RTSP-15:** 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.

Optical Properties for Scattering Models

Fast RT Model Intercomparison

Fast RT Model Coefficient Generation

Line-By-Line Models

Spectroscopic Parameters

Surface Properties

Optical Properties for Scattering Models

Scattering Model Solvers

Future RT Outlook

Carryover from ITSC-20

Optical Properties for Scattering Models [1/1]

Summary: The optical properties of scattering particles (e.g., aerosols, clouds, precipitation) 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.

Recommendations and Action Items

- **Recommendation RTSP-16:** 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:** explore the necessity of using non-spherical aerosol particle scattering properties in fast RT models.
- **Action RTSP-9:** Ben Johnson to report on current developments of physical and scattering properties of aerosols, clouds, and precipitation to the RTSP working group.

Scattering Model Solvers

Fast RT Model Intercomparison

Fast RT Model Coefficient Generation

Line-By-Line Models

Spectroscopic Parameters

Surface Properties

Optical Properties for Scattering Models

Scattering Model Solvers

Future RT Outlook

Carryover from ITSC-20

Scattering Model Solvers

[1/1]

- **Summary:** Scattering approximations used in fast RT models are essential for operational use within simulations involving scattering atmospheres. The RT community should compare results from scattering model solvers to both each other, and to external models.

Recommendations and Action Items

- **Recommendation RTSP-18:** to RT developers, extend the comparison of parameterized schemes, including both clouds and aerosols.
- **Recommendation RTSP-19:** to RT developers, encourage the comparison / validation of full scattering solvers. This should include the computational efficiency, specifically including the adjoint model. Analytic adjoint models should be considered.
- **Recommendation RTSP-20:** to RT developers, for aerosol scattering computations, more research is needed to characterize the regimes where fast approximations are effective.

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Fast RT Model Intercomparison

Fast RT Model Coefficient Generation

Line-By-Line Models

Spectroscopic Parameters

Surface Properties

Optical Properties for Scattering Models

Scattering Model Solvers

Future RT Outlook

Carryover from ITSC-20

Future RT Outlook [1/1]

Summary: Fast RT models should be responsive to upcoming requirements arising from NWP or other communities. We specifically identify areas 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.

Recommendations and Action Items

- **Recommendation RTSP-21:** for RT developers to look at the importance of simulating radiances in turbulent layers in coordination with model developers.
- **Recommendation RTSP-22:** 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.