RTSP Working Group

ITSC-25 • Goa, India • May 2025

Presented by: RTSP Co-Chairs
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Ben Johnson (UCAR/JCSDA)

Session Overview

- Open-format session encouraging discussion and informal updates
- Reviewed ITSC-24 outcomes and intersessional progress
- Focused on spectroscopy, cloud/aerosol optics, emissivity, NLTE, validation
- Collected updated recommendations and actionable priorities

Major Topics Discussed

- LBLRTM vs CLBLM and spectroscopy data continuity
- Study on atmospheric absorption models using ISMAR data (updates from Vinia Mattioli)
- Cloud/aerosol scattering data
- Land surface snow/ice emissivity modeling (across all spectra), dynamic surface emissivity vs. static emissivity
- NLTE effects in high-altitude IR channels
  - Zhenglong Li (U. Wisc.) has updated NLTE low sun angle improvements
  - There was a NLTE bugfix in RTTOV and update to LBLRTM 12.8 for v14
  - Sigma-IASI NLTE next release in 2026 k-karta style (UMBC)
  - CMA found bug in early morning discontinuity (low sun angle) fixed in ARMS
- Microwave spectral response functions, apodization artifacts
- Field campaigns and RT model validation needs

Updated Recommendations (1/3)

- **RTSP-1: Develop full-spectrum aerosol/cloud datasets (To: IPWG & CGMS DA community)**
  - Support the creation of optical property datasets that cover visible, IR, microwave, and sub-mm regions to enable assimilation of radiances across spectral domains.
  - Temperature dependent optical properties, keep water content and effective radius separate (don't over-constrain)
- **RTSP-2: Create a catalog of ML/AI methods for RT (To: RTSP WG & RT community)**
  - Document machine learning tools used for fast radiative transfer, surface emissivity estimation, and Jacobian acceleration, to promote shared practices.
  - Strong recommendation to retain physical models for validation / training of AI/ML and science
- **RTSP-3: Release real MW/IR spectral response functions (To: Sensor agencies & RT developers)**
  - Encourage space agencies to provide actual SRFs for microwave and IR instruments to phase out the use of boxcar approximations in forward models.

Updated Recommendations (2/3)

- **RTSP-4: Promote JQSRT special issue honoring Mikhail Tretyakov (To: Spectroscopy & RT community)**
  - Invite contributions to the 2025 special issue recognizing Mikhail Tretyakov's contributions to gas spectroscopy and radiative transfer modeling, by end of 2025
- **RTSP-5: Identify PC-RTTOV users for planning support (To: RTTOV user community)**
  - Call for users of Principal Component RTTOV to inform the developers about usage needs and help prioritize future development support.
- **RTSP-6: Continue support for refractive index temperature dependence studies (To: RT optics community)**
  - Advance efforts to expand temperature-resolved refractive index datasets, especially for ice and aerosols in far-IR and sub-mm bands (e.g. Di Biagio et al., 2017), ACP)

Updated Recommendations (3/3)

- **RTSP-7: Study sub-grid cloud variability impacts (To: Cloud RT modeling teams)**
  - Evaluate how unresolved spatial variability affects radiative transfer simulations, particularly for partially cloudy or convective scenes.
- **RTSP-8: Integrate CAMELv3 snow/land emissivity in RTMs (To: CRTM, RTTOV, ARMS developers), extend to far-IR**
  - Finalize incorporation of CAMELv3 emissivity atlas across major fast RT models to standardize land emissivity treatment in simulations.
  - Request to extend surface emissivity DBs to better support far-IR
- **RTSP-9: Investigate AI for dynamic surface emissivity (To: ML/RT community)**
  - Explore use of AI/ML to adjust land emissivity dynamically based on observed conditions like flooding, soil moisture, or vegetation changes.

Updated Recommendations (4/3)

- **RTSP-10** (To: Spectroscopy Community): A strong emphasis should be put on the continuous support of theoretical and laboratory spectroscopic studies. It is crucial that a compilation of basic line parameters is maintained.
  - Additional support for TOA Far-IR spectroscopy in support of current and future missions
- **RTSP-11** (To: surface emissivity model developers): We strongly encourage the continued support, development, and collaborative testing of fully polarized surface BRDF models for use in (a) fast RT models that are developing polarization capabilities, and (b) training AI/ML models

Updated Action Items (1/3)

- **Action 1: Compare ARAHMIS vs LBLRTM models (Lead: Jerome Vidot)**
  - Evaluate ARAHMIS as a potential alternative line-by-line model. Document performance and compatibility for RT modeling use.
- **Action 2: Test LBLRTM with different line datasets (Lead: Emma Turner)**
  - Assess LBLRTM's performance using alternate spectroscopic line databases and analyze radiance sensitivity to source variability.
- **Action 3: Coordinate RTTOV/CRTM/ARMS intercomparison (Leads: Emma Turner)**
  - Conduct forward model comparisons using common inputs and conditions, to evaluate consistency and identify biases.

Updated Action Items (2/3)

- **Action 4: Update RTSP website and resource pages (Lead: Vito Galligani)**
  - Modernize the RTSP webpage with recent recommendations, meetings, field data links, references and technical reports for the working group.
- **Action 5: Share field validation datasets (Lead: WG volunteers)**
  - Curate and share campaign data (e.g. AEROSE, FIRAR, WHIMSY) for radiance validation across clear/cloudy and dry/humid scenarios.
- **Action 6: Add publications/intercomparison section to WG site (Everyone)**
  - Create a section for shared publications and model intercomparison outputs to support cross-institutional transparency and reuse.
  - https://itwg.ssec.wisc.edu/rtsp/

Updated Action Items (3/3)

- **Action 7: Support refractive index DB development (Lead: RTSP WG coordination)**
  - Collaborate with optics experts (e.g., Ping Yang) to expand access to temperature-resolved refractive indices across full spectral ranges.
- **Action 8: Follow up on KCARTA updates (Lead: Ben Johnson)**
  - Re-engage Sergio Machado or alternative contacts to determine KCARTA's status and future development path for k-distribution RT.
- **Action 9: Create validation framework for RTMs (Lead: RTSP WG)**
  - Draft community guidelines for validating LBL and fast RTM outputs using standard profiles and measured radiance benchmarks.
- **Action 10: Bring IPWG cloud property results into WG discussion.**
  - Find liaison to IPWG/ICWG who can report on relevant topics

Future Topics & Contacts

- Spectroscopy: Eli Mlawer, Iouli Gordon
- Cloud/aerosol optics: Ping Yang, aerosol experts
- NLTE modeling: Manuel López-Puertas
- MW/IR calibration: Vivienne Payne
- Line data continuity: Raymond Armante (LMD)
- Zeeman updates for new sensors (??)
- Visible Reflectance simulations (surface, gases, clouds, aerosols)

- Gallucci, et al. (2024) – Uncertainty in simulated brightness temperature due to sensitivity to atmospheric gas spectroscopic parameters from the centimeter- to submillimeter-wave range. Atmos. Chem. Phys. doi.org/10.5194/acp-24-7283-2024.

- Fox, et al. (2024) – An evaluation of atmospheric absorption models at millimetre and sub-millimetre wavelengths using airborne observations. Atmos. Meas. Tech., https://doi.org/10.5194/amt-17-4957-2024.