ITSC-19 Radiative Transfer and Surface Properties Working Group

Name	Email
Yong Han	Yong.han@noaa.gov
Marco Matricardi	Marco.matricardi@ecmwf.int
Xu Liu	Xu.liu@nasa.gov
Jean-Claude Thelen	Jean-Claude.thelen@metoffice.co.uk
Pascal Brunel	Pascal.brunel@meteo.fr
Stephan Havemann	Stephan.havemann@metoffice.co.uk
Su Jin Ha	Sj.hakiaps.org
Yong Chen	Yong.chen@noaa.gov
Heather Lawrence	Heather.lawrence@ecmwf.int
Sung-Rae Chung	Csr@korea.kr
Fuzhong Weng	Fuzhong.weng@nooa.gov
Quanhua Liu	Quanhua.liu@nooa.gov
Nicole Jacquinet-Husson	Jacquinet@lmd.polytechnique.fr
David Tobin	davet@ssec.wisc.edu
Louis Garand	Louis.garand@ec.gc.ca
James Hocking	James.hocking@metoffice.gov.uk
Raymond Armante	Raymond.armante@lmd.polytechnique.fr

Table 1: ITSC-19 RTSP working group attendees

Clouds and aerosols

Profile and observation data

Collect existing profile and observation (in-situ and radiance) datasets for use in comparison, validation and training of cloudy/scattering RT models.

Action RTSP-1: Yong Chen to provide the CLOUDSAT profile dataset or information about it to be hosted, or linked to, on the RTSP-WG web page.

Action RTSP-2: Marco Matricardi to provide the ECMWF profile dataset or information about it to be hosted, or linked to, on the RTSP-WG web page.

Action RTSP-3: Jean-Claude Thelen to check the availability of aircraft data observations and in-situ datasets from the UK Met Office and communicate the relevant information to RTSP working group co-chairs.

Optical properties (IR and MW, spherical and non).

Collect information on existing cloud and aerosol optical properties to be used in RT models simulations.

Action RTSP-4: Mark Liu to provide RTSP working group co-chairs information on the availability of cloud optical properties data from P. Yang (infrared) and Gang Hong (microwave).

Action RTSP-5: James Hocking to provide recent aerosol optical properties data for volcanic ash and Asian dust or information about it to be hosted, or linked to, on the RTSP-WG web page.

Reference RT model for scattering

List available models for generating cloud- and/or aerosol- affected radiances for use as a reference.

Action RTSP-6: RTSP working group co-Chairs to continue the compilation of a list of available models and publish on RTSP-WG website (with associated links as appropriate).

Action RTSP-7: Jean-Claude Thelen to make available the reference LBL model for scattering developed at the Met Office or information about it to be hosted, or linked to, on the RTSP-WG web page.

Recommendation 1: the RTSP working group recommends that reference models for scattering are properly validated although the group recognise that this is not easy to accomplish.

Cloudy radiance model intercomprison and validation

The RTSP working group agreed that the intercomparison and validation of cloudy radiative transfer models is difficult to outline without first defining the input data sets, the particle optical properties, and a reference calculation. No action or recommendation has been envisaged at this stage.

Fast model new features

Non-LTE

The group noted the good progress has been made in the implementation of non-LTE in fast forward models. Two items regarding the implementation of non-LTE in fast models were discussed, specifically:

- Where to get the vibration temperature profiles? (Manuel Lopez-Puertas, IAA)
- What are the accuracies of the current fast model parameterisations?

The following action was introduced:

Action RTSP-8: Marco Matricardi to communicate to the group information on the global dataset of vibrational temperatures developed at IAA and check whether it is possible for this dataset to be distributed to the wider community via a link to the RTSP-WG web page.

Recommendation 2: the RTSP-WG encourages RT developers to assess the accuracy of current non-LTE fast model parameterisations.

Unapodised radiance models for FTS sensors.

Radiative transfer models to compute unapodised radiances are not currently used operationally, but their development anticipates a possible future need.

It was noted that for Principal Component based fast RT model the simulation of unapodised radiances is already available as a standard feature. This is not the case for the more conventional optical depth based fast RT models.

Alternative methodologies were also discussed, e.g. deapodisation – all channels only.

Clarification is needed regarding the convolution of the monochromatic spectra.

Recommendation 3: The RTSP-WG encourages the development of fast unapodised RT models.

Doppler shift

The neglect of Doppler (or Doppler-Fizeau) shift effects due to he Earth's rotation can be a not negligible source of error in fast RT model simulations.

Recommendation 4: The RTSP-WG encourages the introduction of Doppler shift effects in fast RT models.

Polarisation

The RTSP-WG recognized that the use of the scalar form of the radiative transfer equation is not adequate for specific microwave simulations. Depending on the application, the full or a reduced number of Stokes vectors is required.

Recommendation 5: The RTSP-WG encourages fast RT model developers to generalize the form of the RT equation introducing a vector formalism.

Principal Component based fast models

PC_RTTOV, PCRTM, HT-FRTM

The RTSP-WG noted that despite the significant advantages offered in terms of computational efficiency and accuracy, the utilisation of PC based models is seldom explored by fast RT model users.

Recommendation 6: The RTSP-WG encourages members of the TOVS community to exploit the capabilities offered by PC based fast models.

Recommendation 7: The RTSP-WG encourages the development of PC based fast models.

Instruments

Sensors

Sensors for which instrument characteristics are required are shown in Table 2.

New Sensors		Old Sensors	
Meteor-M	FY-3B	SSU	SCAMS (Nimbus-6)
EPS-NG	IASI-NG	PMR (Nimbus-6)	SSMR (Seasat)
MTG-IRS	GIFTS/STORM	HIRS (Nimbus-6)	SSM/T (DMSP)
GEOCOM-2A	FY-3C	VTPR (NOAA 2-5)	SSM/T-2 (DMSP)
GOES-R	Himawari-8	IRIS-4	
ABI	AMI		

Table 2: List of sensors for which instrument characteristics are required.

Action RTSP-9: ITSC group members to contact RTSP-WG co-chairs regarding information on available sensor data.

Action RTSP-10: Paul van Delst to create a sensor acronym glossary on RTSP-WG web site.

Recommendation 8: Create a repository of sensor characteristics data for RT modeling community accessible via the RTSP-WP page.

Sensor characteristics

Generation of fast model coefficients for sensors requires timely delivery of sensor characteristics data to RT model developers. Satellite radiance data cannot be effectively used in either NWP or retrieval schemes if the RT model does not accurately reflect the sensor response.

The data typically required are:

- Spectral Response Functions (SRFs)
- Channel polarisations,
- Antenna temperature corrections
- FTS line shape or analytical model. Information on spectral sampling, and how to best handle the band edges should also be supplied.

Action RTSP-11: David Tobin to communicate to RTSP working group co-chairs the most recent specification of the AIRS spectral response function. **COMPLETED**

Action RTSP-12: Mark Liu to check the specification of the ATMS spectral response function and communicate the relevant information to RTSP working group co-chairs.

Action RTSP-13: Mark Liu to made available to RTSP working group co-chairs all information regarding the spectral response function of instruments on FY-3C.

Action RTSP-14: Sung-Rae Chung to give feedback to RTSP working group co-chairs on the AMI spectral response function specification.

Recommendation 9: Sensor vendors supply digitised channel system responses for both microwave, infrared, and visible instruments.

Recommendation 10: Delivery of instrument characteristics as early as possible (even if not the final version – or especially so) to allow analysis of data in an RT modeling context.

Surface Properties

At visible wavelengths, surface reflected and underwater scattered radiation over oceans can be highly polarized.

Recommendation 11: RT modelers are encouraged to develop surface emissivity models in the visible that include polarization.

Action RTSP-15: RTSP working group co-chairs to compile a list of available surface emissivity models in the visible.

BRDF implementations for fast RT models are required for all land surface types. The working group noted the availability of the MODIS BRDF product.

Recommendation 12: Develop BRDF models for snow and ice.

The RTSP working group discussed the development of the CEMS emissivity model.

Reccomendation 13: The RTSP working group is encouraged to give feedback on the use of the CEMS community model.

Action RTSP-16: M. Liu to inform the RTSP working group co-chairs on CSEM related developments.

Surface property physical reference models should be identified for use in validating fast RT surface property modelling. The reference models should have the following characteristics:

- Be themselves validated.
- Include angular dependence.
- Be valid on both micro- and macroscopic scales.
- Be usable with dedicated surface property missions (e.g. SMOS, SMAP)

Recommendation 14: Encourage the development of physical based emissivity models.

Recommendation 15: Physical models should cover as wide a range of surface types as possible.

Action RTSP-17: Xu Liu to give feedback on physical BDRF models.

Action RTSP-18: Mark Liu to provide information on infrared physical models development.

Action RTSP-19: Fuzhon Weng to provide information on MW physical models development.

The RTSP working group noted that RTTOV RT model developers are introducing an angular dependence to the surface emissivities stored in the atlas used for RTTOV calculations.

Recommendation 16: Encourage RT developers to introduce an angular dependence to data stored in surface emissivity atlases.

The RTSP working group discussed the water refractive index dependence on temperature.

Recommendation 17: Encourage RT developers to account for the infrared emissivity dependence on temperature.

Action RTSP-20: James Hocking to provide empirical corrections to water refractive indices derived from aircraft data measurements.

Spectroscopy and line-by-line forward models

LBLRTM, 4A (STRANSAC), RFM, kCARTA

The RTSP-WG welcomes the launch of the CLBL project (i.e. the update of LBLRTM to current FORTRAN standards and its expansion to a more modular form).

Action RTSP-21: Mark Liu to check whether details of the project requirements can be made available to the RTSP-WG.

The RTSP-WG discussed a number of issues related to water vapour continuum absorption. Although in principle it welcomes the adoption of a more physically based approach to the problem of the continuum absorption, it is not clear whether the science is mature enough.

- MT-CKD-type of format for continuum coefficients allows for easy insertion into LBLRTM – which is the forward model employed by RTTOV and CRTM to generate the transmittance data used to train the regression models.
- There is a dependence of continua parameterisation on line spectroscopy so the MT-CKD-type of continua updates are not necessarily transferable to other LBL models.

Recommendation 18: LBL model developers to study the possibility of a more physically based approach to the problem of water vapour absorption.

Action RTSP-22: Carmine Serio to provide measured continua coefficients for the far-IR and associated documentation (see Serio, C. et al 2012, JQSRT).

LBL models should be designed to allow their users the utilisation of alternative molecular databases. The RTSP working group notes that some effort in that direction has already been undertaken within the context of the 4A model.

Recommendation 19: LBL model developers should pursue the adoption of a code design that allows a more flexible approach to the use of molecular data.

Recommendation 20: Encourage validation and intercomparison of LBL models/spectroscopy to assess the impact of spectroscopic uncertainties and the differences between line-by-line and fast RT models. The members of the RTSP working group recognise this is a project that will require a large effort.

Recommendation 21: Encourage the use of satellite data global datasets to validate LBL models.

Action RTSP-23: Mark Liu to provide feedback on the coordination of a clear sky LBL/fast RT model intercomparison exercise.

The launch of the next generation of high resolution infrared sounders offers the possibility of the exploitation of minor molecular species.

Recommendation 22: Ensure that adequate funding is assigned to the study of the spectroscopy of minor species.

Recommendation 23: Support for line-by-line (LBL) reference model development is of paramount importance and should be continued to ensure that operational centres have access to the latest updates in LBL forward modelling.

Recomendation 24: include full Zeeman effect in MW LBL models.

Visualisation Packages

Visualisation packages for sounder data are a very valuable tool for research and training.

Recommendation 25: The group encourage their development and maintenance.

Action RTSP-24: James Hocking to communicate information about how to obtain the RTTOV GUI visualisation package and link it to, on the RTSP-WG website