2. WORKING GROUP REPORTS

1. RADIATIVE TRANSFER AND SURFACE PROPERTY MODELS
Web site: www.cimss.wisc.edu/itwg/rtwg.html

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This working group focuses on the issues related to atmospheric radiative transfer (RT) and surface property (SP) models which are relevant for radiance assimilation and atmospheric and surface retrievals from past, current and planned infrared and microwave sounder data. From now on we refer to this working group as **RTSP-WG** (previously RTWG).

Unless noted otherwise, action items are to be completed by 15 September 2005.

2.1.1 Atmospheric profile datasets for radiative transfer

Radiative transfer models require a dataset of diverse profiles for training and independent validation.

a) Training datasets
The group is actively using various profiles datasets whose characteristics are summarised in Table 2.1. This table was reviewed and a revised version of the table will be placed on the RTSP-WG web pages.

Actions: Co-chairs to add revised version of Table 2.1 to RTSP-WG web site. Revisions listed below to be accomplished by 31 August 2005.
1. Roger Saunders to provide the web link for the trace gas profile set to add to Table 2.1
2. Hal Woolf to put CIMSS data sets on the web and provide updated information for Table 2.1
3. Eva Borbas to provide details of her profile dataset. Co-chairs to add entry in Table 2.1
4. Co-chairs to add a column in table 2.1 indicating data sets the RTSP-WG considers to be standard and only include URLs of datasets we endorse.

Diverse Profile dataset	Number of profiles	Number of levels	Contact point/web page
TIGR v3 radiosonde set	2311	40L	http://ara.lmd.polytechnique.fr
Sub set from v2	43	43L	Marco Matricardi, ECMWF
ECMWF 60L model set	13495	60L	http://www.metoffice.com/research/interproj/nwpsaf/rtm/
Sub set	52	101L	
ECMWF 50L model set	13766	50L	
Sub set	117	43L	
UMBC set	49	101L	Scott Hannon, UMBC
	49	42L	Hal Woolf, CIMMS
NOAA-88	8005	40L	Larry McMillin, NESDIS
Sub set	32	40L	
CIMSS	32	40/42/101 L	Hal Woolf, CIMSS
CIMSS Ozone	380	40L	Hal Woolf, CIMSS
Sub set	34	40L/43L	M. Matricardi for 43L
Trace gases CH_4, CO, N_2O, CO_2	43	90L	Marco Matricardi, ECMWF http://cimss.ssec.wisc.edu/itwg/groups/rtwg/trace_gases.tar.gz

Table 2.1 Summary of diverse profile datasets used to train RT models

b) Validation datasets

The group indicated willingness to document observational data sets which are available for model validation. If modelers become aware of auxiliary data streams which are missing or documentation which is lacking which limits the exploitation of a given data set, they are requested to raise the problem with the RTSP-WG co-chairs.

Action
> **Fuzhong Weng to inform RTSP-WG when A-train matchup data set is available for RT model validation.**

Action
> **Xu Liu to contact MOZART model group for combined (co-located) temperature, humidity and trace gas profile data sets for independent RT validation and provide RTSP-WG co-chairs with details of data set availability (actual and planned).**

Following a review of ITSC-13 RTSP-WG recommendation 2.1.3,
Action
> **Nicole Jaquinet-Husson to document observational datasets available for line-by-line (and fast model) validation and details on how to access these data sets if publically available.**

Action (carried forward)
> **All members of the group to send information on validation datasets to RTSP-WG co-chairs who will post this information on the RTSP-WG web site.**

c) Profile utilities

The RTSP-WG recognizes the importance of standard methods for profile interpolation and integration for RT modeling, and has previously distributed profile interpolation codes. However, associated adjoint (and TL) operators (essential for correct mapping of Jacobians) were not distributed.

Action

   Louis Garand to provide his profile interpolation and associated adjoint/TL code to the group.

Action

   Louis Garand to survey NWP centres to establish the profile interpolation and adjoint techniques they use. Seek for the best code to map Jacobians from RTM levels to NWP model levels (this implies an appropriate design of the forward interpolation routine).

2.1.2 Instrument characteristics required for RT modeling

The group reviewed where there were new requirements or gaps in the instrument data required for RT modelling. The following is a list of the new or existing sensors where the group recognized information is still required for accurate RT simulations:

AVHRR Spectral Response Functions (SRFs). Pascal Brunel indicated he would provide AVHRR SRF's from TIROS-N to NOAA-18 to anyone who requested that information from him.

Action

   Tom Kleespsies to co-ordinate with Pascal Brunel and post links to all AVHRR SRFs.

IASI SRF : Claude Camy-Peyret will provide updated SRF to the ISSWG by July 2005.

Action

   Nicole Jacquinet-Husson to provide the updated IASI SRF dataset to the ITSC RTSP-WG as soon as it is available.

SRFs for other METOP instruments (HIRS-4, AVHRR …)

Action

   Peter Schluessel will be the point of contact for SRFs for ATOVS on METOP.

AIRS SRFs and a list of blacklisted channels are maintained on the UMBC ftp site.

Action

   Co-chairs to update RTSP-WG web page infomation on AIRS SRF and channel blacklist referred to above

2.1.3 Line by Line (LbL) model status

Due to time constraints a comprehensive review of the status of LbL models was not undertaken during the meeting. Rolando Rizzi undertook to contact LbL modellers to invite them to provide a summary of their model developments to the RTSP-WG co-chairs who will co-ordinate this material for the RTSP-WG web pages.

Infrared LbL models to be surveyed include GENLN2, RFM, kCARTA, LBLRTM, 4A, σ-IASI, Hartcode, FLBL. Microwave LbL models to be included in the survey include MONORTM, MPM 89/92, Rosenkranz, ATM, STRANSAC and ARTS.

Action
Rolando Rizzi to contact LBL modelers and invite them to provide a summary of LbL model development status to RTSP-WG co-chairs by September 15, 2005. This summary should include model name, version, code access and licensing details, important technical features (including adjoint or analytical Jacobian capability, treatment of scattering) and literature references.

Action
RTSP-WG co-chairs to add a summary of LbL model information on RTSP-WG web page by 15 December, 2005.

IR LbL model developments presented at ITSC-14 are summarized below:

FLBL from Shawn Turner (MSC) now has analytical Jacobian capability (ITSC-14 poster B42).

Work at Bremen University and at the UK Met Office has recently demonstrated that ozone absorption affects the AMSU 183 GHz channels (brightness temperature changes of the order of 0.5 K).

Recommendation
The RTSP-WG recommends this ozone absorption is included in radiative transfer models.

2.1.4 Assessment of spectroscopic databases

The 23 GHz water vapor line absorption half widths were recently revised according to the results from the ARM site and models should be revised accordingly.

Action
Stephen English will provide results of a study quantifying the impact for AMSU and SSMI radiances to the group.

It was noted that in some instances there were some discrepencies between the spectroscopic parameters documented in peer-reviewed literature and those actually integrated within official releases of spectroscopic databases. Nicole Jacquinet-Husson

highlighted significant differences in water vapour and methane spectroscopic parameters in some specific spectral regions.

Furthermore, the group noted that accurate referencing of subsets of line parameters, and revisions thereof, is also critical in model development and validation.

Recommendation
> **The RTSP-WG urges spectroscopic database developers to adopt a standard and rigorous version control system for spectroscopic databases.**

2.1.5 Fast RT models

The working group was pleased to note significant advances in super-channel modeling for hyperspectral instruments (e.g. the Principal Component Radiative Transfer Model, PCRTM).

The working group commended the Community Radiative Transfer Model (CRTM) framework initiative. A prototype CRTM is undergoing testing and the first official release is planned for June 2005.

OPTRAN: Operational version in CRTM uses polynomial fits to compute transmittances to reduce memory requirements for hyperspectral instruments. Code under development: 1) transmittance correction term and individual transmittances instead of effective transmittances; 2) revised internal vertical coordinate; 3) constraints to assure smooth adjoints; 4) additional gases. CRTM uses interfaces to facilitate swapping of RTM components (transmittance, scattering, surface properties, cloud absorption, etc. Point of contact: Yong Han (Yong.Han@noaa.gov).

RTTOV: RTTOV-8 was released in November 2004. This release includes some of the RTIASI capability and supports carbon dioxide as a variable gas. There have been major changes to code structure with the use of derived data types. More details can be found in the RTTOV ITWG Technical Report, poster B40 and the associated paper. The RTTOV-9 release is planned for February 2007 (will include more variable gases). Point of contact: Roger Saunders.

GASTROPOD: Version v0.3.0 has been released and an includes an interface with Met Office 1DVar. Code and coefficients online at gastro.sf.net. Point of contact: Vanessa Sherlock.

OSS: Version 1 released and implemented in CRTM. Validation in scattering atmospheres is on-going. Development/testing of first accelerated version with multi-channel training should be completed for the fall of 2005. Point of contact: Jean-Luc Moncet.

MSCFAST: No new development. Used for assimilation of GOES-10 and 12 water vapor channel radiances at MSC and for retrievals of surface skin temperature. Point of contact: Louis Garand.

LMD fast models: Point of contact: Alain Chedin/Noelle Scott.

SARTA: Version 1.05 of the Stand-alone AIRS Radiative Transfer Algorithm, SARTA, was released in December 2004 and uses the January 2004 coefficient database. It is a clear air fast forward model with variable H2O, O3, CO, CH4, and CO2 (no Jacobian capability), and is based on HITRAN 2000 spectroscopic database and MTCKD v1.0 water continuum, with some tuning to match validation observations. This implementation of the AIRS-RTA is used in the DAAC version 4 processing and is available online: http://asl.umbc.edu/pub/packages/. Work continues on development of the AIRS-RTA algorithm. Several new features and improvements will be implemented for the next official release (December 2005). Point of contact: Scott Hannon.

PLOD/PFAAST: No change to code. Line-by-line data used to train the scheme were updated to LBLRTM-8.4, HITRAN-2000, AER 1.1 updates and UMBC-49. The training set includes an "ultra-cold" atmosphere. Point of contact: Hal Woolf.

RTIASI: The current release of RTIASI is RTIASI-5. In RTIASI-5 the integration of the RT equation is done on 90 levels using the linear in tau approximation to parameterise the Planck function. H2O, O3, CO2, N2O, CH4 and CO and treated as profile variables. Solar radiation is included in the interval 2000-2760 cm-1 assuming Lambertian reflectance for land surfaces, and explicit calculation of bidirectional reflectance over sea. RTIASI-5 includes a parameterization of multiple scattering and absorption for water clouds (5 classes), cirrus clouds (9 classes) and aerosols (10 classes). Work is ongoing to develop an emissivity model for a land/sea-ice/snow surface. Point of contact: Marco Matricardi (marco.matricardi@ecmwf.int).

PCRTM: Principal Component based Radiative Transfer Model. Version 1.0 completed in Fortran 90. Supports: NAST-1, IASI, AIRS. Features include Principal Component (PC) scores and analytical Jacobians of PC scores with respect to state vectors. Scattering not included. Variable gases are currently H_2O and O_3. Trained with LBLRTM using HITRAN-2000 spectroscopy. The vertical pressure grid has 101 levels. Point of contact: Dr Xu Liu (Xu.Liu-1@nasa.gov).

The group agreed that information on the various fast model developments should be co-ordinated on the RTSP-WG web site.

Action
     Modellers to provide fast RT model summary including name, version, code access and licensing details, supported instruments, technical features (including FM/TL/AD or analytical Jacobians, scattering properties, variable gases, spectroscopy, training set, generating lbl, vertical discretisation), literature references to co-chairs.

Action

Co-chairs to add a summary of fast models to RTSP-WG web page by 15 December, 2005.

One action, for the RTSP-WG to provide guidance on developing and testing tangent linear and adjoint code, was carried over from ITSC-13.

Action
Tom Kleespies and Roger Saunders to collect notes on this topic and post a summary on the ITWG RTSP-WG web site.

2.1.6 AIRS RT model comparison

The goals of the intercomparison were:
- To compare the forward model calculations for all the AIRS channels from all the models for 52 diverse profiles and one tropical Pacific profile coincident with AIRS data
- Assess the Jacobians from each model using the Garand measure of fit for a limited selection of channels.
- To estimate model error covariances
- Document the time taken to run each model

- Results have been completed, and were presented at ITSC-14 in poster B41 by Saunders et al. These results will form the basis of a journal publication.

- The group noted that additional work is needed before publication, namely
- identify where differences are likely to result from spectroscopic differences or from fast model errors which are not linked to spectroscopy,
- present Jacobian error characteristics (for the selected subset of channels) using box and whisker plots (median, quartiles, minimum and maximum values of the Garand measure of fit).

The issue of the accuracy of Jacobians for weak absorption features should also be addressed or noted in the publication (this is probably not characterized with the current intercomparison channel subset).

In poster B06 Vanessa Sherlock assessed how these RT model differences could impact on retrieval accuracy using a 1D-Var code. This study had been proposed as part of a second phase of the AIRS RT intercomparison during ITSC-13. A journal publication is planned.

Action
All AIRS RT modellers should facilitate the publication of the intercomparison results without delay.

Recommendation
The RTSP-WG recommends that future RT model validation studies be undertaken when collocated A-train sensor data sets become available.

2.1.7 Surface Property Models

Ben Ruston proposed the formation of a task group representing more specifically the Land Surface Property (LSP) activities of RTSP-WG to co-ordinate research efforts in land surface emissivity modelling.

The RTSP-WG supported this initiative, and in subsequent discussions it was agreed the task group would address surface property modelling for all surface types. The group will focus on co-ordinating research efforts in land surface emissivity atlas and model development in the first instance.

The RTSP-WG noted the SP task group needs to co-ordinate with the ITSC Sounding Working Group (Lydie Lavanant) to provide a summary of existing atlases and surface type classification.

Action
      A surface property task group of the RTSP-WG to be set up and co-ordinated by Ben Ruston.

Post Meeting note: Catherine Prigent and Fuzhong Weng have accepted to co-chair the SP task group and Ben Ruston and Sid Boukabara will report to RTSP-WG on the SP task group activities.

The SP task group met at ITSC-14. At that meeting several working points on land surface emissivity were identified. The SP task group will:

- Document the land emissivity implementation techniques and their impacts on forecasts from different NWP centers
- Inter-compare retrieval methodologies
- Standardize the spatial and temporal averaging methodology leading to infrared and microwave emissivity atlases
- Review the output fields available from land surface modeling systems, and target those fields useful or necessary for forward modeling of emissivity.
- Recommend an aggregation strategy for global soil and vegetation databases for the use of emissivity modeling, and gathering of emissivity statistics.

The RTSP-WG group meeting discussed the current issues and limitations in emissivity modelling. A summary of this discussion follows:

2.1.7.1 Microwave emissivity

Ocean surface
The group agreed efforts should focus on model-model and model-observation discrepancy at low frequencies (below 20 GHz) and polarimetic capability.

Land/sea ice surfaces
The group recommended the SP task group should explore how to specify spectral emissivity at all observed microwave frequencies in absence of adequate emissivity data (extrapolation, modeling, retrieval, climatology).

2.1.7.2 Infrared emissivity

Ocean surface
The group noted modellers need to account for the temperature dependence of the infrared sea surface emissivity, particularly at temperatures less than 10 degrees C. The current consensus is that the effect of ocean salinity is small and is not worth including in the modeling.

Land surface
The RTSP-WG recommends the use of the CERES land classification (including water fraction) and requests the SP task group identify and recommend other relevant databases.

Recommendation
    The RTSP-WG recommends standardization of emissivity model interfaces, e.g. within CRTM framework.

Recommendation
    The RTSP-WG recommends studies into relationship between retrieved IR and MW skin temperatures (and retrieved/modelled emissivities).

Guy Rochard argued for the need for clear scientific justification for radio frequency protection and requested the RTSP-WG work to identify ITSC-endorsed microwave surface emissivity data and atlases. The RTSP-WG noted the SP task group should consider this request.

2.1.8 Radiative transfer modeling for cloudy scenes

The group noted significant advances in radiative transfer modelling in the presence of cloud over the past two years.

George Ohring presented the findings of a workshop on the assimilation of satellite cloud and precipitation observations in NWP models at the ITSC-14 conference. A report on this workshop is available.

Action
    F. Weng and R. Bennartz to summarize recent progress on modeling of radiation in cloudy/precipitating atmospheres (including discussion of the effects of FOV and 3D cloud structure).

Claudia Stubenrauch presented the results of CIRAMOSA, a European Union study to assess the accuracy of different parameterizations of ice crystal single scattering properties for radiative transfer in cirrus clouds (see poster A05, Eddounia et al.).
The CIRAMOSA final report will be available online:
http://ww.lmd.polytechnique.fr/CIRAMOSA/Welcome.html, under the results link.

2.1.9 Review of group web page

In light of the formation of the new Surface Property task group, the co-chairs will review and revise the structure of the RTSP-WG web site if necessary. The co-chairs will update the content of the web pages to include the new information provided during ITSC-14 and identified in this report. The RTSP-WG members are invited to propose additions and improvements at any time.

Action
   Co-chairs to review and update RTSP-WG web pages by December 15, 2005.