

2. WORKING GROUP REPORTS

2.1 RADIATIVE TRANSFER AND SURFACE PROPERTY MODELLING

Web site: <http://cimss.ssec.wisc.edu/itwg/groups/rtwg/rtwg.html>

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2.1.1 Introduction

Two areas of discussion dominated the RTSP-WG meeting at ITSC-16: issues related to computing and validating cloudy radiances, and instrument characterization.

Regarding the former, it was felt that a comparison of cloudy radiance model results would be of limited use until common datasets – such as cloud optical property and cloud profile data – were available for participants. In addition, several members expressed the opinion that comparisons between models is not of as great a value as comparisons to observations, with the caveat that this is a more difficult problem since issues such as spatial inhomogeneity must be taken into account. Many of the action items from this meeting address the issue of assembling the relevant datasets.

With the expected launches of many new satellites over the next two years, the issue of obtaining the relevant sensor characteristics (spectral response functions for infrared instruments, and frequency information for microwave instruments) was discussed. Obtaining this information in a timely manner is very important for the development of the fast RT models such that various groups can evaluate the information content of the sensor data (both real and synthetic).

It was noted that much progress was accomplished in the area of surface emissivity modeling/mapping over land with global and regional datasets, notably hyperspectral IR, becoming available from various sources.

The new action items listed below are to be completed by May 2009.

2.1.2 Profile datasets

Marco Matricardi reported on two profile datasets: a dataset derived from model output consisting of 15000 profiles including latitude, longitude, surface (pressure, temperature, relative humidity at 2m; surface type) and cloud information (LWC, IWC, and cloud fraction) from which the new ECMWF 82-profile training set was extracted, and a several thousand profile dataset containing trace gas profiles.

Action RTSP-1

Marco Matricardi to announce to the RTSP-WG when the latter several thousand profile data set, including the trace gases, is available.

Xu Liu reported on the option to have the MOZART¹ data directly available on the RTSP-WG website. The data is a monthly average at 1.5° latitude resolution.

Regarding cloud profile datasets, the issue was raised on how to convert typical cloud parameters in NWP (such as CLW or IWP) into quantities such as effective radius that are required for some RT models – such as the CRTM. It was noted that some methodologies for doing this may not represent full natural variability.

Action RTSP-2

Tom Kleespies to document the various cloud droplet size distributions used for determining effective radius values.

CloudSat/Calypso retrieved cloud property datasets and ARM site measurements were identified as potential sources of additional cloud profile datasets.

Action RTSP-3

Paul van Delst to document available cloud profile datasets.

2.1.3 Instrument characteristics

It was noted that various instrument responses (SRFs for IR and frequencies for μ W) were difficult to find and in different formats.

Action RTSP-4

Paul van Delst to add the information on IR SRF and μ W frequencies for as many instruments as possible (current and historical) on the RTSP-WG website.

The CrIS instrument response is required by NWP centres to allow generation of fast RT model coefficients for use in data assimilation. Prior to the RTSP-WG meeting, fruitful discussions were had with IPO representatives to determine how to obtain the required CrIS information. Sample CrIS datasets and data formats were also brought up, although those subjects are somewhat outside the purview of the RTSP-WG and are already being addressed through other channels.

Action RTSP-5

Paul van Delst to continue working with IPO to obtain CrIS instrument response information for US NWP centres, and determine the path/timeline for dissemination by IPO of the information to non-US NWP centres.

Action RTSP-6

Paul van Delst to link the 2001 CrIS ATBD to the RTSP-WG website once it is determined if it is in the public domain.

Action RTSP-7

Paul van Delst to check with Walter Wolf (NOAA/NESDIS) on the status of CrIS sample datasets and data formats.

¹ Model of Ozone And Related species in the Troposphere. See: Hauglustaine, D. A., et al, *J. Geophys. Res.*, **103**(D21), 28291–28335 (1998).

The availability of other new instrument responses was discussed:

Action RTSP-8

Gang Ma to notify the RTSP-WG how to obtain the FengYun-3 instrument SRFs (IR) and frequencies (microwave) when they become publicly available after launch (likely August 2008).

Action RTSP-9

Roger Saunders to contact the Korean Aerospace Research Institute (KARI) to obtain the instrument spectral response information for the COMS imager (scheduled launch late 2009) when it becomes available.

Action RTSP-10

Alexander Uspensky to notify the RTSP-WG how to obtain the Electro-L (scheduled launch 2008) MSU-GS SRFs and the Meteor-M MTZVA frequencies when they become publicly available. Electro-L is scheduled to launch 2008; Meteor-M1 is scheduled to launch 2008, Meteor-M2 in 2010.

Action RTSP-11

Tom Kleespies to notify the RTSP-WG how to obtain the MetOp-B and NOAA-N' HIRS/4 and AVHRR/3 SRFs when they become publicly available.

The SSMIS F-17 and F-18 bandpasses are available, but it is not entirely clear how to use them. With respect to the CRTM, this issue also involves F-16 SSMIS where boxcar responses were used with the LBL transmittances. This was addressed at a CRTM Working Group meeting prior to ITSC-16.

Action RTSP-12

As per CWG Action item, Paul van Delst to make available results/discussions with NRL SSMIS investigators on how to best use the provided SSMIS bandpass information.

The availability of historical instrument responses was also discussed with respect to their use in reanalyses. Recent work by S. Kobayashi (JMA/ECMWF) and Q. Liu (NESDIS) regarding SSU, and L. Shi regarding VTPR was noted. Action RTSP-4 addresses making these instruments' SRFs available.

Action RTSP-13

Paul van Delst to make available on the RTSP-WG webpage references and/or links to the SSU and VTPR work described above.

2.1.4 Line by Line (LBL) modeling

Initial discussion focused on the current status of LBL models used for RT model training, kCARTA and LBLRTM (GENLN2 is no longer actively maintained).

kCARTA: (Note: this information is based on what RTSP-WG attendees knew – no kCARTA developer was present at ITSC-16) Observation minus kCARTA calculation residuals for IASI are being performed by Larrabee Strow's UMBC group and they appear

consistent with similar comparisons for AIRS. The modifications to the CO₂ line mixing made in SARTA based on AIRS is in the process of being transferred to kCARTA.

LBLRTM: AER, Inc continues to develop and support LBLRTM.

Action RTSP-14

Raymond Armante to make available to the RTSP-WG the results of the LMD line mixing study when completed.

Investigations into the H₂O continuum via CAVIAR², a consortium of researchers in the UK, are underway. Some initial laboratory measurements in the 3400-4000cm⁻¹ spectral region show that the H₂O continuum fits a dimer model better than the MT-CKD model.

Action RTSP-15

Roger Saunders to provide a link to the CAVIAR results to be posted on the RTSP-WG website.

The ARM program is funding the RHUBC-II³ field campaign (Co-PI's Dave Turner and Eli Mlawer) scheduled for Aug-Oct 2009 to characterize and improve the accuracy of RT and ice scattering models in the far infrared (>15μm).

The need to validate spectroscopic data was discussed. Modeling of hyperspectral instruments could potentially be sensitive to existing differences in spectroscopic databases⁴. The ability to select the best data from different spectroscopic databases (e.g., HITRAN and GEISA) for use in LBL model computations was highlighted. Diversification of the source of spectroscopic data is currently difficult because, for example, line mixing coefficients derived from one database may not be able to be used with potential superior spectroscopic data from another. In addition, the ability to "mix-and-match" the best data between spectroscopic databases can help identify where extra research is needed to improve the data.

Recommendation RTSP-1 to fast RT modelers

To assess the impact of the use of different public spectroscopic databases in their fast models.

Action RTSP-16

Nicole Jacquinet to provide links to GEISA and HITRAN (and other databases if necessary) websites and other updated information of interest, as well.

2.1.5 Fast RT modeling

It was noted that a standalone version of the Vertical Interpolator code developed by Yves Rochon⁵, and currently used in RTTOV-9, will be made available via the RTSP-WG website after ITSC-16.

The topic of relative comparisons between models for cloudy calculations was discussed (Recommendation RTSP-1 from ITSC-15). It was noted that these comparisons would be

² Continuum Absorption at Visible and Infrared wavelengths and its Atmospheric Relevance.

³ Radiative Heating in Underexplored Bands Campaign. See <http://acrf-campaign.arm.gov/rhubc>.

⁴ See Jacquinet-Husson et al, *JQSRT*, **109**, 1043-1059 (2008); Matricardi, M. ECMWF Tech.Memo. 525, May 2007.

⁵ See Rochon et al., *QJRM*, **133**, 1547-1558 (2007)

difficult to do in a way that any differences could be easily interpreted. It was stated that comparisons of cloudy model calculations with cloudy observations, while also quite difficult, would be a more useful task. Some issues with model/observation comparisons are the optical properties⁶ used by different models and spatial inhomogeneity (FOV effect) in the observations. Regarding the latter, Yong Chen (NESDIS/CIRA) has done work on this area making use of Cloudsat retrievals in collocation with AMSUA/MHS data (paper submitted to JGR).

Action RTSP-17

Paul van Delst to investigate a common format for optical properties data that will be made available on the RTSP-WG website.

Action RTSP-18

Yong Han to provide information and reference about the results from Yong Chen's study regarding the effect of spatial inhomogeneity when comparing cloudy calculations and observations. To be posted on the RTSP-WG website.

The first thing that would be required before embarking on these cloudy observation/calculation comparisons is an observation dataset that also includes cloud property information such as effective radius and water content profiles.

Action RTSP-19

Fuzhong Weng to provide a dataset for AMSU-A(Aqua) observations and cloud profile information retrieved from collocated CloudSat observations. This dataset will be made available via the RTSP-WG website.

Recommendation RTSP-2 from ITSC-15 was to incorporate non-LTE effects in fast RT models. This recommendation is carried over.

Recommendation RTSP-2 to fast RT developers

Non-LTE effects should be included/parameterised in fast RT models. Progress on this issue (from the SARTA, RTTOV, and CRTM teams) should be reported before the next ITSC.

Recommendation RTSP-3 from ITSC-15 was for NWP centres to document the methodologies used to speed up the hyperspectral radiance assimilation, specifically with regards to parallelisation and load balancing.

Action RTSP-20

Roger Saunders (MetOffice), Ben Ruston (NRL), Marco Matricardi (ECMWF), Louis Garand (Environment Canada), Gang Ma (for NMC) and Paul van Delst (NCEP/EMC) to provide documentation of methodologies used in NWP centres to speed up the assimilation of radiances and quality control (for example parallel processing strategy, OpenMP, number of profiles per call, geographical separation of the data etc.). Specify any machine-dependent characteristics.

Recommendation RTSP-4 from ITSC-15 was for fast RT modelers to consider upwelling oceanic radiation (water leaving radiance) when designing the next generation of RT models

⁶ Extinction coefficient, single scatter albedo, asymmetry parameter, and phase function parameterisation.

that include the visible part of the spectrum. Work on visible components of RT models is just beginning in most cases so the recommendation is carried over.

Recommendation RTSP-3 to fast RT modelers

Consider upwelling oceanic radiation (water leaving radiance) when designing the next generation of RT models that include the visible part of the spectrum.

Whether or not to use levels or layers as input to RT models was discussed. The choice depends on the application: CRTM was designed specifically for NWP so atmospheric state variable inputs are by layer; The RTTOV community extends much beyond NWP applications and thus level input was chosen. However, forecast models produce layer quantities so using an inputs-by-level RT in that application requires the layer inputs to be converted to levels – and the methodology used may be dependent on the layering scheme.

Action RTSP-21

Roger Saunders (MetOffice), Ben Ruston (NRL), Marco Matricardi (ECMWF), Louis Garand (Environment Canada), Gang Ma (for NMC), and Paul van Delst (NCEP/EMC) to provide documentation of methodologies used in NWP centres to convert layer atmospheric state variables to level values.

Addition of the Zeeman line splitting to RT models was discussed. Yong Han is working on adding the Doppler effect to his current SSMIS Zeeman model. It was noted that users will want to know what extra inputs are required in the Zeeman RT models. This should be addressed by the model documentation.

RT modeling for precipitating clouds was discussed. The speed of multiple-stream radiative transfer and access to optical property data for non-spherical particles were raised as concerns.

Action RTSP-22

Following Action RTSP-17, Paul van Delst will make available on the RTSP-WG website, optical property data for non-spherical particles used at the JCSDA, as well as any supplied by other attendee's organisations.

Action RTSP-23

Ben Ruston to contact colleagues at CSU to obtain additional cloud optical property data for non-spherical particles.

CNES organised at URY (France) in April 2008 a workshop TRATTORIA 2008 dedicated to radiative transfer in a terrestrial atmosphere for remote sensing. It gathered about 70 French scientists and a few experts from UK, Spain and Belgium. It permitted to establish the state of art in the various spectral domains and identify the priorities for future work in 3D models, parameterization and fast RTM.

Action RTSP-24

Pascal Brunel to provide the TRATTORIA-2008 workshop summary when it becomes available for inclusion on the RTSP-WG website.

2.1.6 Surface property modeling

Work on a generic interface to the emissivity climatology on the MetOffice NWP-SAF site is beginning as an NWP-SAF Visiting Scientist project. Ben Ruston, Eva Borbas, Filipe Aires, Fuzhong Weng, and Catherine Prigent are the principal investigators. Infrared intercomparisons should be completed around August 2008, and the interface (for infrared and microwave) should be available near May 2009. Eric Pequignot will also participate in the IR emissivity database design.

Action RTSP-25

Ben Ruston and Filipe Aires to notify the RTSP-WG when the emissivity climatology intercomparisons and interface are completed.

Work on comparisons between the NESDIS ocean microwave emissivity model, FASTEM-3, and the JPL two-scale surface model is scheduled, subject to funding availability, to resolve regional differences between them.

Recommendation RTSP-5 from ITSC-15 was to plan a second workshop on Remote Sensing and Modeling Surface Properties prior to ITSC-16. This recommendation is brought over.

Recommendation RTSP-4 to Co-Chairs of the second meeting on surface property modeling.

Plan the Second Workshop on Remote Sensing and Modeling of Surface Properties prior to ITSC-17 tentatively in June of 2009. The meeting will deal with retrievals and parameterizations of emissivity, bi-directional reflectance and land surface temperature.

Action RTSP-26

Co-Chairs of this workshop will make official announcement to ITWG and other NWP and satellite centers about the workshop information as soon as the date is firmed up.

2.1.7 Model intercomparisons

It was noted that the AIRS Intercomparison is continuing with investigators submitting results to the intercomparison webpage. Results for MODTRAN (Gail Anderson) and the MetOffice Principal Components RTM (Stephan Havemann) have been submitted.

2.1.8 Validation datasets

The JAIVEx dataset was discussed. Stuart Newman of the MetOffice is the point of contact to obtain the data, which is distributed via DVD. The data contains clear sky radiances, profile and surface data over both land and ocean. The ARIES measured ISRFs are included on the DVD.

Action RTSP-27

Paul van Delst to add JAIVEx link/POC to the RTSP-WG webpage.