Community Radiative Transfer Model Working Group (CWG)
Meeting Summary

World Weather Building – Room 707
April 28, 2008

Attendees:

CWG Technical and Management Oversight:
Fuzhong Weng, NESDIS/STAR

CWG Co-chairs:
Yong Han, NESDIS/STAR
Paul van Delst, SAIC

CWG Core Members:
Ben Ruston, NRL
Zhiquan Liu, NCAR/AFWA
Emily Liu, NASA/GMAO (not present)
Dan Birkenheuer, OAR
Ye Hong, Aerospace (for NPOESS)

CWG Collaborating Members:
Ping Yang, Texas A&M
Ralf Bennartz, Univ. Wisconsin
Alan Lipton, AER
Vivienne Payne, AER
Andy Jones, CSU (not present)
Quanhua (Mark) Liu, Perot Systems
Yong Chen, CIRA
Banghua Yan, Perot Systems
Ron Vogel, IMSG
Min-Jeong Kim, CIRA
Michiko Masutani, RSIS (for NCEP/EMC)

I. Review of Action Items from CWG Meeting 2008-Jan-30 (Paul van Delst)

- Code Review & Acceptance Guidelines: no feedback received, but feedback can still be sent to Paul van Delst.
- FTP upload capability (for new deliveries of code to CRTM): now available.
- CRTM web page: framework is complete. Content will be added starting in May.
- CRTM code repository: EMC has begun process of setting up accessible repository. Servers will be in NCEP "DMZ", accessible via User ID.

II. CRTM Software Status (Paul van Delst)

- CRTM v1.1 released February 29, 2008. Available on JCSDA ftp site.
- Features:
    - Extra-layering methodology using climatology for "missing" layers beneath model top.
    - NESDIS MHS Snow & Sea Ice emissivity models
    - Coefficient updates
        - MW TauCoeff: no longer includes Liebe Zeeman adjustment in favor of Yong Han's Zeeman correction method.
        - IR TauCoeff: ordinary (ORD), Plank-weighted (PW), and mixed (ORD-PW) coefficients are available.
        - MW SpcCoeff: No antenna correction (No_AC), AAPP antenna correction (AAPP_AC) from Eumetsat, and NESDIS antenna correction (NESDIS_AC) are all available.
            - Discussion:
                - BY: User must determine if file contains instrument antenna temperature or brightness temperature and which correction to use.
                - FW: Providers of BUFR data should take care of antenna temperature, but if they don't, then CRTM will need to provide conversion.

III. Radiance Assimilation Status in WRF-Var (Zhiquan Liu)

- Ingests AMSU-A/B, MHS, HIRS, AIRS, SSMIS
    - Discussion
        - BY/BR: NOAA-16 AMSU-A channel 4 is bad after January 2007
- Uses both CRTM v1.1 & RTTOVS v8.7
- Bias correction: scan bias correction, variational bias correction
- Radiance assimilation in 3D-Var and 4D-Var
- CRTM Jacobian profile shows improvement with CRTM v1.1
- CRTM is faster when using latest CRTM (pre-release) vs. CRTM v1.1
- Cloudy radiance assimilation
    - FW/TL/AD interface implemented (inputs needed: profile & particle radius)
    - WSM3 microphysics
    - Particle size from cloud water content. Total water as control variable, partition into cloud water & rain.
        - Discussion:
            - FW: What else beside liquid water is used to determine particle size?
            - ZL: Using Marshall-Palmer distribution for particle size.

            - FW: Impact of rain will offset cloudy assimilation negatively in microwave.
    - Comparison of CloudSat with NOAA-17 AMSU-B simulation shows large quantitative differences. Work is still needed to improve this.
- In future, will add more instruments (IASI, GOES), tune for various testbeds, continue with cloudy radiance assimilation & 4DVAR , ensemble-based radiance assimilation
    - Discussion:
        - MJK: Is bias correction included in cloudy radiance assimilation?
        - ZL: There is no bias correction because the physics is still not well understood. Statistics not good enough to develop a bias correction.

IV. Core Member Reports

- Quanhua Liu: Improving Computational Efficiency
    - Cloudy radiance assimilation is difficult due to discontinuous nature of clouds. Generating multi-dimensional error co-variance is difficult. Large uncertainties in cloud microphysics (particle size, shape); need to gather this info from cloud water content, temperature, water vapor. Computational needs are expensive due to multiple scattering.
    - IBM intrinsic matrix multiplication is slow. Adding faster matrix functions.
    - Moving RTSolution forward results (for adjoint) from CRTM_RTSolution.f90 to CRTM_RTSolution_Define.f90
    - Saves 30% CPU time, but not enough for cloudy radiance assimilation requirement.
    - Developed fast 2 and 4-stream + observation angle. 4-stream + observation angle is accurate for MW and IR radiances (but needs better treatment of cloud and aerosol phase function). Uses ADA computation with faster calculation in each layer.
        - Discussion
            - FW: What is the computational requirement?
            - QL: GSI must finish analysis in 20 minutes. 4-stream solution may meet cloudy requirement.

            - Y. Hong: If optimizing for IBM, how will speed on other platforms be affected?
            - PVD: Linux platforms do not have the problems with matrix math that IMB does. Also, the new computation algorithms are not IBM-specific, so can be used on other platforms. Other groups should help test the speed on different platforms.

            - FW: Large graupel size may result in large errors for low-number streams.
            - QL: In general, error from SOI paper is 0.3K using 4-stream solution.

- PY: Ice and water clouds need 8 streams for visible channels. What is increase in CPU time?
- QL: This will need investigation.
- RB: With SOI in Vis-NIR, doubling the stream increases computation time fourfold.
- **ACTION**: CRTM team work with U. Wisconsin on SOI speed and accuracy.

- Yong Han/Yong Chen: Transmittance Algorithm Improvement
  - Current CompactOPTRAN has good memory efficiency and smooth Jacobian profiles, but can yield poor accuracy for some channels. Also has relatively poor computational efficiency (solves 10^{th}-order polynomial). Needs more trace gases (CO_2).
  - Effort to include multiple transmittance algorithms in CRTM: OPTRAN, RTTOV, SARTA. All are band-based: channel transmittance is estimated directly with averaged SRF. Will keep CompactOPTRAN as an option.
  - Training package is 50% complete. Includes transmittance algorithm, coefficient generation.
  - Still to be worked on: CRTM module for multi-algorithm transmittance, test & evaluation (LBL tests, comparison with current, comparison with observation, data assimilation experiments).
- Paul van Delst: Interpolation Module Update
  - Interpolation code used in scattering (cloud & aerosol) calculation: optical properties in LUTs are interpolated to inputs (frequency, effective radius, and temperature).
  - Known problems with polynomial and spline interpolation. Derivatives of interpolates not continuous across LUT hingepoints. Cloud and aerosol LUTs have data density and quality issues. Need improvements for cloudy radiance assimilation and same interpolation for emissivity models.
  - Averaged quadratic interpolation was integrated into CRTM.
  - Discussion:
    - PY: How is phase function interpolated?
    - QL: The phase function coefficients are interpolated.
- Ben Ruston
  - Comparison of CRTM and RTTOV in Navy 3D-Var NAVDAS
  - Statistics show CRTM v1.1 very similar to RTTOV v8.7. CRTM is doing much better than before when comparing with RTTOV v6 and RTTOV v8.
  - CRTM still undergoing spin-up, so quality control (bias correction) still being established. Some statistics are worse because of this, but will improve.
  - Discussion:
    - **ACTION**: Steve Swadley or Gene Poe can provide additional information on SSMIS channel frequency response.
    - Y. Hong: How different is the QC threshold for CRTM vs. RTTOV.
    - BR: QC checks are for 3 standard deviations.
- Ye Hong
  - It would be good to encourage broader use of CRTM, more users, but need a CRTM User Guide.

    - CRTM is good for cal/val activities. Will put CRTM on cal/val linux machines at IPO.
    - **ACTION**: CRTM team update and improve the User Guide for broader users.
- Dan Birkenheuer
    - Is using CRTM in conjunction with GSI. Need a CRTM User Guide.
    - Will CRTM releases be coordinated with GSI releases?
    - PVD: One can use GSI with the packaged CRTM or can upgrade to a new CRTM by simply switching to the new CRTM library.

V. Collaborating Member Reports

- Ping Yang
    - Will deliver single scattering properties for aerosols to be included in CRTM aerosol LUT.
- Ralf Bennartz
    - Running WRF with SOI via CRTM
    - Multiple ongoing investigations involving WRF/SOI/CRTM. Will present results at the June 10-11 meeting.
- Alan Lipton and Vivienne Payne
    - Training OSS for 13 gas species.
    - Investigating microwave continuum.
    - Validation of various models against AIRS and IASI using data from ARM, Pacific (Nauru), Gulf of Mexico
        - LBL RTM, SARTA, MonoRTM
    - Discussion:
        - PVD: Has OSS been trained for use with cloudy atmospheres?
        - AL: It can be.
- Andy Jones
    - Microwave Land Surface Emissivity Model (MWLSM) code delivered to JCSDA (both forward and adjoint) and is under review.

VI. Open Discussion

- BR: Will there be principal component (PC) support in CRTM?
- FW: Keeping an open mind but needs more testing. Possibility exists for collaboration in testing PC method.
- QL: When just using PC scores, can quality control and bias correction still be accomplished?
- BR: Quality control is still possible but determining observational error covariance will be tricky.
- PVD: How much data is not assimilated when using PC scores?
- BR: Twice as much is thrown out because one can't select high or low-peaking channels when a cloud is present.

- PY: What is the time frame for implementing cloudy radiance assimilation?
- PVD: Will not be in GSI 4th-quarter release (September). Will have to be later.
- FW: The real work in cloudy radiance assimilation will be in the next fiscal year. Efforts up to now have been preliminary.

- FW: Community needs version planning for future CRTM releases.
- Y. Han: We will discuss future versions and timing plans at the next CWG meeting.
- **ACTION**: CRTM team provide the CRTM version plan, i.e. each version associated with new improved physics.

VII. Adjourn

Action Item Summary:

1. CRTM team work with U. Wisconsin on SOI speed and accuracy.
2. CRTM team contact Steve Swadley or Gene Poe to get information on SSMIS channel frequency response.
3. CRTM team update and improve the User Guide for broader users.
4. CRTM team provide the CRTM version plan, i.e. each version associated with new improved physics.