Evaluation of the RTTOV in the ECMWF NWP system

Cristina Lupu, Alan Geer and Marco Matricardi
ECMWF, Shinfield Park, Reading, United Kingdom; Contact: Cristina.Lupu@ecmwf.int

1. Changes in the use of RTTOV at ECMWF

<table>
<thead>
<tr>
<th>RTTOV version</th>
<th>IFS cycle usage</th>
<th>Features relevant to IFS</th>
<th>Impact</th>
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<tbody>
<tr>
<td>12.1</td>
<td>Cy46r1 Since 5th June 2018</td>
<td>RTTOV upgrade to version 12.2 included: Updated MW surface emissivity models; Retain sea surface emissivity model ISEM and UWRMmS land emissivity alias; Updated MW coefficients files; IR constraint files unchanged, except formal updates.</td>
<td>Improved first-guess (FG) to fit to many observation types; Neutral forecast scores impact (see Lupu et al., 2017).</td>
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<tr>
<td>12.2</td>
<td>Cy46r1 Since 11th June 2019</td>
<td>RTTOV upgrade to version 12.2 included: a) Full upgrade to v12.2 code for RTTOV-SCATT and RTTOV (technical, but not bit-reproducible); b) New option in RTTOV-SCATT to carry out radiative transfer calculations on radiances instead of brightness temperatures (scientific); c) ATMW optical depth coefficients files now contain band correction coefficients (scientific); d) New optional output structure in RTTOV-SCATT containing information required to perform all sky emissivity retrievals (scientific).</td>
<td>Minor changes in FG fits to microwave instruments; On balance positive, particularly for MHS and SAPHIR. Neutral changes in forecast scores.</td>
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<td>12.3</td>
<td>Ready for future cycle implementation</td>
<td>No scientific changes compared to RTTOV-12.2; although code changes in the RTTOV v12.3 upgrade affect bit reproducibility; It allows experimental use of new scientific features (e.g., option to treat surface as a Lambertian reflector; new CAMEL IR emissivity alias derived from multi-variability) MFRSIS fast visible cloud parameterisation update to account for variable water vapour in affected channels; updated parameterisation of the Baran ice optical property database.</td>
<td>The pertinence model by Rosenkranz (2015) has been chosen to replace Liebe (1989) - see pointer 5p.08 Neutral impact on forecast scores; slight degradation in winter for ATMS channel 6 that is believed to be scientifically insignificant.</td>
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2. RTTOV-12.2 evaluation results

Assimilation experiments were conducted with the Cy46r1 version of the ECMWF’s 4D-Var system at T6399 resolution (approximately 25 km) over 3 months periods from 1st June to 30th August 2017.

- Control: ECMWF data assimilation and forecasting model with all operational observations and using RTTOV-12.1.
- RTTOV version 12.2: Same system configuration, except that RTTOV-12.1 has been upgraded to RTTOV-12.2 through several incremental changes, as listed in section 1:
  - 12.1: no science (Option a);
  - 12.2 (radiance + band cor + emiss): Options a), b), c) and d).

3. RTTOV-12.3 evaluation results

Assimilation experiments based on Cy46r1 of the operational system have been run at the lower spatial model resolution T6399. Experimentation covers a 8-month period over two seasons (1st June 2018 to 15th September 2018 and 1st November 2018 to 15th March 2019).

- Control: ECMWF data assimilation and forecasting model with all operational observations and using RTTOV-12.3.
- RTTOV-12.3: Same system configuration, except that RTTOV-12.2 code has been upgraded to RTTOV-12.3.

4. Updating the infrared spectroscopy and enhancing the representation of CO2 in the RTTOV

The assimilation of long-wave hyperspectral IR radiances currently uses a RTTOV fast model trained on a global mean CO2 profile (e.g., Figure 5) that does not reflect present day CO2 levels. To improve the RTTOV simulations assimilation trials have started where RTTOV uses CO2 fields produced by the Copernicus Atmospheric Monitoring Service (CAMS) thus allowing the simulations to reflect the geo-variability of CO2. Three assimilation experiments based on Cy46r1 of the operational system were conducted, covering the two periods 1 June 2018 to 30 June 2018 and 1 November 2018 to 2 December 2018. As follows:
- Control: ECMWF data assimilation and forecasting model with all operational observations and using RTTOV-12.2.
- RTTOV-12.3: same system configuration, except that RTTOV-12.2 code has been upgraded to RTTOV-12.3.
- RTTOV-12.3: same system configuration, except that RTTOV-12.2 code has been upgraded to RTTOV-12.3.

5. Summary

Latest developments in RTTOV are being exploited in order to improve the assimilation of radiances. RTTOV-12.2 has been operationally used at ECMWF since 11th June 2019, bringing upgrades to the observation operators RTTOV and RTTOV-SCATT. The upgrade allows RTTOV to use the most accurate science possible, it prepares the way for future sensors like Ice Cloud Imager (ICI) and will support future all-sky use of visible and IR satellite data. To ensure use of the most up-to-date and best supported coefficient files, MW gas optical property files have been upgraded including the use of band corrections. RTTOV-12.3 has been also evaluated within a full assimilation system and it is ready to be incorporated in a future IFS operational cycle upgrade. Work has continued to enhance the representation of CO2 in the radiative transfer model used for the radiance assimilation. It remains a priority to use operationally the best IR spectroscopy and a more realistic CO2 profile. Preliminary results show that the use of CAMS CO2 global fields has a positive impact on the analysis.

References


Acknowledgements

EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF CDP-3 program) is acknowledged for funding the work presented in this poster.