Radiance Simulator v1 Product Specification

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0.1	20/08/2014	A. Smith	Final draft
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Table of Contents

1. INTRODUCTION

This document defines the specification for Version 1 of the NWP SAF Radiance Simulator, in accordance with the requirements of the NWP SAF. The Product Specification describes the deliverable from the point of view of the user.

1.1 Reference documents

[RD-1] NWPSAF-MO-DS-033, Radiance Simulator User Guide

2. PURPOSE

The NWP SAF radiance simulator was initially proposed to support pre-launch scientific studies and pre-operational development work in support of the MTG-IRS instrument. The user requirement for the radiance simulator is, however, more general. Studies into future instruments on-board EUMETSAT's MetOp-SG for example, such as the Microwave Sounder (MWS), the Microwave Imager (MWI) and the Ice Cloud Imager (ICI) will also soon require test datasets, based on simulations from NWP models.

The capability to model radiances from new satellite instruments, from other agencies, is normally integrated into the NWP SAF fast radiative transfer model (RTTOV) many months or years prior to launch. The purpose of the radiance simulator is to supplement this capability with a flexible interface to NWP model fields in order to enable the generation of simulated observations for all instruments supported by RTTOV in a straightforward way.

The Radiance Simulator is designed to work specifically with datasets from NWP models, either analysis fields or short-range forecasts. Any potential use for climate applications is outside the scope of this release.

3. FUNCTIONALITY

The radiance simulator will perform the following functions

- *Ingest of NWP model fields*, provided in common data formats. In the initial implementation this will include support for the following formats:

  - GRIB
  - Met Office fieldsfiles / PP files
  - NWP SAF 60L profile dataset from ECMWF analyses
  - NWP SAF 91L profile dataset from ECMWF analyses

  Model fields will consist of

  - Level pressure
  - Temperature

  - Humidity
  - Cloud liquid water
  - Cloud ice water
  - Cloud fraction
  - Surface wind
  - Surface skin temperature
  - Surface air temperature
  - Surface humidity

- *Ingest of observation files (optional)*. The user may provide observation metadata including observation locations and viewing geometry and other fields to allow simulations to be performed at those locations.

- *Interpolation of model fields to observation locations*. This is optional, dependent on the above. If no observation data are provided, simulations are performed at model profile locations.

- *Prepare input to, and run, radiative transfer model*. This will be RTTOV version 11 in the first instance. Depending on the availability of the required model fields, both infrared and microwave scattering simulations will be feasible.

- *Output* top-of-atmosphere brightness temperatures or radiances, emissivity values and input observation data. Options for the initial implementation will include:

  - Output of Jacobians
  - Output of layer transmittances
  - Output of model profiles

4. INPUTS / OUTPUTS

The main inputs to the radiance simulator will be:

- A control file; containing all information required to set up and run the simulator. This will include paths to observation and model data files, RT coefficient files and run-time options including output control.

- An observation file (optional); containing observation-specific information required for the simulation. This will include latitude, longitude, surface type, surface height and satellite zenith angles.

- An NWP model file; containing the fields required for the radiance calculation (listed in section 3).

The output of the radiance simulator is:

- A netCDF file containing simulated radiances or brightness temperatures, emissivity values, input observation data (if applicable), and optionally model profiles, and other calculated variables specified in the input control file.

5. SYSTEM REQUIREMENTS

5.1 Language

The radiance simulator is written in Fortran-90 with the addition of a small number of Fortran 2003 features. Testing has been carried out with several different compilers – see the User Guide [RD-1] for further details.

The following external libraries are required

- GRIB-API (version 1.10 or later)
- netCDF (version 4.0 or later)
- RTTOV (version 11)

5.2 Supported platforms

Unix/Linux platform, including AIX. Parallel processing is not supported, all simulations use a single processor or thread.

5.3 Performance

Speed of execution is not a primary consideration in the Radiance Simulator specification. Lengthy execution times are dominated by the time required to run the radiative transfer model (RTTOV) which is an external package. Examples of execution times will be provided in the Results section of the Test Plan.

6. DOCUMENTATION

A User Guide [RD-1], incorporating technical and scientific descriptions of the code is provided.

7. LIMITATIONS

Simulations can only be performed for an instrument if the appropriate RTTOV coefficients are available.

There are a number of other limitations that users should be aware of. Some of these will be addressed in a future release if there is sufficient demand.

- Met Office UM data files:
  - The use of packed files will not be supported. The UM *ieee* routine may be used to unpack the data.
- GRIB files:
  - Only those originating from ECMWF are supported. This is due to variations in the way fields can be stored, particularly with regard to pressure levels. Support for other sources may be added in future releases.
- The following processing options are not included but may be in a future release:
  - Interpolation of stretched grids. Simulations will take place on the original grid.
  - The effects of reflected solar radiation in the IR.
  - Use of variable trace gas (CO2, N2O, CO, CH4) profiles.
  - Use of aerosol profiles.

8. LIST OF REQUIREMENTS

This section details specific requirements to be addressed in the Radiance Simulator Test Plan.

8.1 The Radiance Simulator shall perform all the functions listed in Section 3 of this document.

8.2 The Release Note accompanying the package shall list the contents of the package and how to unpack the software.

8.3 The software should be successfully built, following the instructions in the User Guide.

8.4 The software should compile and run on a range of Linux platforms, including Linux PC, AIX.

8.5 The test cases shall run to completion, and shall have no unexpected differences relative to the reference results provided in terms of the accuracy of the output products.