NWP SAF

MWIPP Product Specification

Version 1.0

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MWIPP Version 1 Product Specification

This documentation was developed within the context of the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF), under the Cooperation Agreement dated 7 December 2016, between EUMETSAT and the Met Office, UK, by one or more partners within the NWP SAF. The partners in the NWP SAF are the Met Office, ECMWF, DWD and Météo France.

Change record			
Version	Date	Author / changed by	Remarks
1.0	07/02/2018	Nigel Atkinson	

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1. INTRODUCTION

This document defines the specification for Version 1 of the Microwave Imager Processing Package (MWIPP), 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 Proposal for the Third Continuous Development and Operations Phase (CDOP-3) March 2017-February 2022,
[RD-2] NWPSAF-MO-UD-014, A Preprocessor for SSMIS Radiances Scientific Description
[RD-3] NWPSAF-MO-UD-014, SSMIS UPP Averaging Module Technical Description
[RD-4] NWPSAF-MO-SW-002, Development Procedures for Software Deliverables, version 3.11, 26.05.2016.

2. USER REQUIREMENT REVIEW

2.1 General considerations

User requirements for NWPSAF software deliverables are defined in consultation with the NWPSAF Steering Group, taking into account (i) the tasks agreed in the relevant proposal for the phase of the SAF being undertaken (e.g. CDOP-3), (ii) any new requirements that have been identified by the methods described below, and (iii) the resources available.

User requirements are typically gathered by several methods:

- Discussions at meetings and conferences, such as the International TOVS Study Conferences
- Feedback from users via the NWP SAF Helpdesk
- Feedback from users in connection with NWP collaboration projects
- Surveys

Additionally, requirements can arise due to external constraints, e.g.

- Satellite launches, launch delays or termination of satellite missions
- Support for new software compilers, or cessation of support for old compilers
- Changes in external packages on which the NWPSAF deliverable relies
- Availability of ancillary data

2.2 Input from RD-1 (CDOP-3 proposal)

RD-1 makes the following statements about MWIPP:

- The MWIPP will be a generic pre-processor for MW imagers based on the existing capability of the SSMIS-PP package, developed during CDOP-1 and 2. Initially this package is intended for use with SSMIS, AMSR-2 and FY-3 MWRI, as well as MWI and ICI on EPS-SG.

- MWIPP will be based on those elements of the existing SSMIS-PP that have not already been assimilated into the SSMIS Unified Pre-processor maintained by NRL. Thus MWIPP will include averaging and re-mapping functions that are not available elsewhere. Additional and unique new functionality, for example the ability to correct for striping artifacts (evident in SSMIS data), will be added if supported by evolving NWP user requirements.

- MWIPP will make use of the re-mapping and smoothing functions currently available within the "UPP Averaging Module" of the SSMIS_PP, developed under CDOP-1 and CDOP-2. The new development will be to generalize the software so that it can be used with instruments other than SSMIS.

- MWIPP will include functionality currently in SSMIS_PP. This is used at several NWP centres to reduce the noise in the brightness temperatures from NRL Unified Pre-Processor (UPP) data. The data are assimilated into NWP models.

- Two major releases of MWIPP are foreseen. The first, schedule for late 2018, will support (as a minimum) all SSMIS sensors, but will also include (subject to NWP user requirements) the ability to process data from AMSR-2 and the FY-3 MWRI instruments. The second, near the end of CDOP-3, will support the use of MWI and ICI data, subject to availability of information on the instrument characteristics.

This document addresses the 2018 release of the package, referred to above.

2.3 Input from ITSC-21, Darmstadt, 2017

The proposed MWIPP was presented at ITSC-21[1] in a talk (1.06) and discussed in working groups. The following questions were posed:

Which of the following would you like to see implemented in MWIPP?

- *Continued support for the SSMIS Averaging Module (works with UPP BUFR files)*
- *Averaging facilities for other imagers (as currently done for SSMIS)?*
- *Format conversion, e.g. hdf5/NetCDF4 to BUFR? If so, for which instruments? AMSR-2, GMI, MWRI, MWI, ICI ?*
- *Mapping between MWI and ICI? (Different instruments on the same satellite)*
- *Any other generic pre-processing?*

Feedback received

The NWP Working Group reviewed the above list of questions, and the following specific suggestion was made:

- For all-sky assimilation, superobbing is generally onto a fixed (NWP) grid rather than across the scan line. The pre-processor should support averaging onto this kind of grid as well as on the native instrument grid

[1] http://cimss.ssec.wisc.edu/itwg/itsc/itsc21/index.html

The Working Group also took an action to provide further review, by 1st March 2018. If that review yields further requirements, this Product Specification will be updated.

2.4 Input from NWP centres

Several NWP centres, who do not have access to EUMETCast, have asked about software to convert AMSR-2 hdf5 data to BUFR. The Met Office has provided prototype software (wrappers to ecCodes[2]) that replicates EUMETSAT's operational BUFR product, and this should be considered for further development and inclusion in MWIPP.

GMI is also used operationally at several NWP centres. It should be noted that GMI data are currently distributed (by EUMETSAT) as 2 separate sub-instruments – low frequency and high frequency channels have different viewing geometries and swath widths. Although no firm requirement is currently identified, the capability to map from one to the other, e.g. as preparation for Metop-SG, may be considered for a future release in response to identified user need.

2.5 Review of the SSMIS-PP

The functions of the SSMIS-PP and the UPP averaging module are reviewed in Table 1.

Table 1: Main functions of the SSMIS-PP package

Function	Required in MWIPP?	Comment
Ingest of NRL BUFR files	Yes	
Re-mapping	Not for SSMIS	Already done for SSMIS in NRL's UPP: all channels are mapped to LAS. Will be required for MWI/ICI. Could be useful for GMI.
Spatial averaging	Yes	This is the main function of the UPP averaging module
Solar intrusion and gain anomaly correction	No	This function is part of NRL's UPP
Reflector emission and spillover corrections	No	This function is part of NRL's UPP
BUFR output	Yes	

Note that much of the functionality of SSMIS-PP was transferred to NRL's Unified Pre-processor (UPP) in 2009. In SSMIS-PP, the solar intrusion and reflector corrections were only ever implemented in for the F16 instrument – which no longer provides a sounding capability. The only part of SSMIS-PP that is still relevant to users is the averaging module (which takes BUFR input and generates BUFR output).

The SSMIS-PP uses the Met Office BUFR library for I/O. For long-term maintainability it is strongly recommended to migrate these functions to ecCodes.

2.6 Relevant functionality in AAPP

The Chinese Feng-Yun-3 (FY-3) satellite platforms carry the MicroWave Radiation Imager. The data are available to the global NWP community in the following forms:

[2] https://software.ecmwf.int/wiki/display/ECC/ecCodes+Home

- Global data in hdf5 and/or BUFR
- Direct readout data from local stations, in hdf5
- Inclusion in DBNet is foreseen (BUFR format)

In terms of format, there are strong similarities between MWRI and the other microwave instruments on FY-3 platforms, namely MWHS, MWHS-2 and MWTS-2. The AAPP package already has the capability of processing these data – i.e.

- Ingest of CMA's hdf5 or BUFR
- Output in BUFR, or in AAPP-style hdf5.

No requirement has been identified for a channel re-mapping capability for MWRI. Therefore at the present time there is a case for retaining the MWRI capability within AAPP, and not moving it to MWIPP. This is easier for DBNet stations, since they only have to install AAPP.

3. CONSOLIDATED REQUIREMENTS FOR MWIPP

3.1 High level requirements

MWIPP version 1 should have the following high-level capabilities:

1. Ingest of native-format (hdf) data from AMSR-2
2. Ingest of BUFR data from SSMIS (UPP) and AMSR-2
3. Mapping to reference footprints or a user-supplied grid (generic)
4. Spatial filtering to a user-supplied reference beam width (generic)
5. Creation of BUFR and hdf5 (or NetCDF4) output files

MWIPP version 2 will, in addition, support MWI/ICI on Metop-SG.

The algorithm to be used for mapping/filtering will be specified more fully in the Top Level Design, but it is envisaged that it will be similar to that used in SSMIS_PP. For mapping to a user-defined grid, a nearest-neighbour approach can be used. (More sophisticated re-mapping could be considered later).

Code should be modular where possible, to allow for possible integration of parts of the package in the user's own application.

3.2 Software provision

The package will normally be distributed via the NWPSAF web site as source code, with separate data files as required.

3.3 Language

Fortran 90 is the language of choice for the main modules, following the standards described in [RD-4].

Additionally, C, Python, Perl, bash or ksh may be used where appropriate.

A suitable configure/build system should be included in the package.

3.4 Operating system and hardware

The software is required to run on a 64-bit Linux PC, running a current operating system such as CentOS7 or RHEL7.

3.5 Performance

When processing SSMIS UPP data, the goal is to achieve run-times comparable with the existing SSMIS_PP Averaging Module.

Run-time examples should be included in the user documentation.

3.6 Interface requirements

Where external libraries are required, MWIPP may rely only on free software libraries. These libraries will either be packaged together with the relevant sections of MWIPP or the user will be given instructions on how to download them from a third party. Use of ecCodes (from ECMWF) is foreseen.

3.7 Test cases

Suitable test cases shall be prepared and made available to users.

4. DOCUMENTATION

Scientific and technical documentation shall be written and supplied to users via the NWPSAF web pages. The documents should address:

- Product specification
- Top level design
- Test plan
- Science description
- Installation guide
- Operation guide

Two or more of the above may be combined into a single document, if it makes things easier for the user.

5. REQUIREMENTS SUMMARY

The Test Plan should address the verification of the following requirements:

Identifier	Requirement	How to verify
MWIPP1	Documentation is clear, understandable and complete	Beta testing
MWIPP2	Code conforms to the requirements of [RD-4]: commented, understandable and modular	Inspection
MWIPP3	Any necessary external libraries are freely available	Inspection (e.g. examine the corresponding web sites for the external libraries)
MWIPP4	Code builds with no errors on a 64-bit Linux PC, running a current operating system such as CentOS7 or RHEL7. More than one Fortran compiler shall be tested.	Test
MWIPP5	Ingest BUFR files for SSMIS and AMSR-2	Test
MWIPP6	Ingest native-format files for AMSR-2	Test
MWIPP7	Spatial averaging capability (replicates SSMIS_PP)	Test
MWIPP8	Map to user-defined grid	Test
MWIPP9	Creation of BUFR output files for SSMIS and AMSR-2 (optionally GMI and MWRI)	Test
MWIPP10	Creation of hdf5 or NetCDF4 output files	Test
MWIPP11	Run times are documented in the test log, and are comparable with SSMIS_PP when processing SSMIS.	Test and inspection
MWIPP12	Test cases for the users exist, have clear instructions and run correctly	Beta testing