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Aeolus Level 2b Processor Product Specification

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Aeolus Level 2B Processor Product Specification (NWP SAF style).

This documentation was developed within the context of the ESA ADM-Aeolus L2B processor project. It provides documentation in the style used by the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF) to facilitate NWP user application.

The partners in the ESA ADM-Aeolus L2B processor project are the ECMWF, KNMI and Météo-France.

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0.4	20-May-2008	...	adapted to L2BP delivery v1.33	J. de Kloe

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1.Introduction

This document defines the specification of the Aeolus Level 2B Processor (L2BP) software package, in accordance with the requirements of the NWP SAF. The Product Specification describes the deliverable from the point of view of the user.

Note that this ESA project has been documented according to the ECSS guidelines (see [RD-1]), and to minimise the amount of double documentation, the NWP SAF documents will refer to the ECSS style documentation produced for ESA as much as possible.

1.1 Reference documents

- [RD-1] ECSS-E-40B Space System Software Engineering, draft version, 28-June-2000
- [RD-2] AE_SAF_KNMI_L2BP_003_Setup_Guide.v1.1.20080520.pdf
- [RD-3] ESA-ID-ACS-GS-0001_PDS-IPF-Generic-Interface-Guidelines_Iss_2.2_060802.pdf
- [RD-4] AE-IF-ECMWF-L2BP-002_20080116_ExtICD_Iss1.32.pdf
- [RD-5] ADM-IC-52-1666_L1bP-IODD_Iss_3.5.pdf, 18-Feb-2008
- [RD-6] AE-TN-ECMWF-L2P-0072-TEMPLATE_20080229_BufrDefn_Iss1.1.pdf
- [RD-7] AE-IF-ECMWF-L2BP-001_20080116_IODD_Iss1.32.pdf
- [RD-8] AE-TN-MFG-GS-0003_20070615_RBCIODD_Iss1.2.pdf
- [RD-9] AE-IF-DLR-L2A-004_IODD_Iss_1.4_070312.pdf
- [RD-10] AE-TN-MFG-L2B-0130, iss. 1.0, 6 February 2006. This document is available in the software source directory, in the Matlab subdirectory, and is named Howto.doc.
- [RD-11] MFG_readnplot_adm_aeolus_data_with_matlab_v1.2.pdf, 30-Aug-2007
- [RD-12] AE-RN-ECMWF-L2BP-001_20080229_SRN_Iss1.33.pdf
- [RD-13] AE-TN-ECMWF-L2P-0072_20070223_EE2BUFRGuide_Iss_1.1.pdf
- [RD-14] ECMWF_L2_CN1_sow_iss1_051129.pdf
- [RD-15] MFG_L2BP_fortran_structures_20080509.pdf

1.2 Acronyms

ANSI	American National Standards Institute
BRC	Basic Repeat Cycle
BUFR	Binary Universal Form for Representation
E2S	End-to-End Simulator (software package that simulates the satellite hardware)
ECMWF	European Centre for Medium-Range Weather Forecasts
ECSS	European Cooperation for Space Standardization
EE	Earth Explorer (file format)
ESA	European Space Agency
hlos	horizontal line of sight
IFS	Integrated Forecasting System
KNMI	Koninklijk Nederlands Meteorologisch Instituut (Royal Dutch Meteorological institute)
L2BP	ADM-Aeolus Level 2B Processor
PCD	Product Confidence Data

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2.Purpose

The Aeolus Level 2B Processor (L2BP) is a software package intended to process Aeolus Level 1B product files, containing spectrometer data on measurement scale (1-3.5 km), to a Level 2B wind component product representative for the observation scale of typically 50 km.

The processor is developed and maintained by ESA and its subcontractors. It is capable of using L1B data generated by ESA's PDS ground segment from data received from the ADM Aeolus polar satellite¹.

3.Functionality

The L2BP will provide the following functionality:

- ability to screen the input data, perform a classification of the input scene, accumulate from measurement horizontal scale (1-3.5 km) to observation horizontal scale (50 km), and process the input spectrometer counts into a proper wind component projected on the horizontal plane (hlos), with accompanying error quantifiers and product confidence data (pcd).
- ability to either use:
 - as input data and configuration settings files in EE format, and to output the data into a file in EE L2B format (“standalone version”),
 - or use:
 - as input and configuration settings data which are already present in memory (under the form of fortran data-structures) and to output the L2B data into a fortran data-structure (“subroutine version”). This functionality can be helpful for example within an integrated forecast system (IFS).
- ability to convert L1B product files from Earth Explorer (EE) to BUFR file format.
- ability to convert the binary L2B product (file or data-structure) into a text file, which can be visually inspected.
- ability to read the L1B and L2B binary files in EE format into matlab, and to visualize easily the data in that environment with example plotting routines.
- ability to compile the software with a complete set of Makefiles.
- ability to run a series of automated self tests to verify the installation
- Note that currently input or output in BUFR format is not supported by the main processor. This functionality may however be added on user request. (feel free to ask for this if needed **TBC**). Implementation will probably be in the form of additional converters L1B BUFR-to-EE and L2B EE-to-BUFR.

4.Software Organisation

The L2BP software may be used in several different ways. It is delivered as a portable standalone tool with test data, providing a basis for integration within a larger processing system like the IFS used at ECMWF. Detailed guidance on how to choose between the different options, and how to implement them, is given in [RD2].

It is also possible to only compile and use the EE2BUFR conversion tool, although this tool is mainly intended to be used at ESA's ground processing site.

1 Note that this satellite is to be launched no sooner than end 2009. Therefore no actual data is available at the moment, and all software development and testing is performed with data generated by ESA's satellite simulation tool E2S.

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Future versions of the software may have other EE2BUFR or BUFR2EE tools included, if this is needed by the users.

5. Inputs/Outputs

5.1 Main L2B processor

As mentioned in the functionalities, the main L2B processor may be called either directly (as a standalone tool, reading/writing EE files), or within a larger system (as a subroutine call, using in input/output fortran data-structures).

5.1.1 Standalone version

The standalone main L2B processor needs the following inputs:

- a JobOrder file specifying the names and locations of all other inputs. The structure of this file is described in [RD3], section 4.2. Specific values for fields used by the L2BP are described in [RD4], section 4.2.1;
- a L1B product file containing the satellite data. The structure for the EE version of this file is described in [RD5], chapter 6. The structure for the BUFR version of this file is described in [RD6], chapter 3;
- a L2B auxiliary parameter file containing all additional processor settings. The structure of this file is described in [RD7], section 5.4;
- an auxiliary meteo file containing a set of temperature and pressure profiles. The structure of this file is described in [RD7], section 5.1;
- an auxiliary Rayleigh-Brillouin Response Calibration file needed to process the Rayleigh channel. The structure of this file is described in [RD8], chapter 4;
- an auxiliary climatology file containing backscatter-to-extinction estimates. The structure of this file is described in [RD7], section 5.3;
- an auxiliary calibration file containing the satellite instrument properties. The structure of this file is described in [RD9], section 4.3;

Note that examples of all these file types are part of the software package.

The L1B product file will be made available by ESA in EE and BUFR format as soon as possible after sensing and L1B processing. The user should provide its own auxiliary meteo file needed for processing the data. The other L2B auxiliary files will probably be stable, and may only be updated when a new processor version is released. Calibration files will change more often, but are only input to the L1B stage, so they are not needed for the L2BP, except for the Aux RBC file, which is expected to be stable.

The standalone main L2B processor produces the following outputs:

- a L2B product file. The structure of this file is described in [RD7]
- optional: outputs to stdout and/or stderr. These are adjustable, and maybe suppressed completely if needed. Currently a lot of temporary debugging information is also issued on this channel. In the current version this cannot yet be suppressed.
- an optional log file, containing the same information that would have been written to the stdout channel.

Note that the logging output of the processor, both to stdout/stderr and to file, are structured as described in [RD3]. This is an ESA requirement and enables converting the logging output into an xml formatted ProductReport file in a post-processing step. For external users this is probably not relevant. However, the logging output itself may be very important for the user, because it will contain errors, warnings, progress messages and informational and debug messages issued by the software. The software contains a large number of tests providing verification of the outputs. The portable standalone

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processor outputs may be compared to outputs generated within an IFS. This will be of great help when installation problems or bugs have to be resolved.

The level of logging output used by the processor is controlled by 2 switches in the JobOrder file. See [RD3] for details on their meaning and how to set them. The temporary debugging output that is issued by the current code is not in the prescribed form, and cannot be controlled in this way. A filtering script named run_L2BP.sc is provided to delete this output if needed.

5.1.2 Subroutine version

The subroutine version of the main L2B processor needs the following inputs:

- information on which files are to be read. The standalone version uses the JobOrder mechanism for this input, but in the subroutine version obviously the user has to take care of this. Still if desired the JobOrder data-structure as defined in [RD15], section 4.5, may be used for this.
- a data-structure containing the L1B satellite data. The structure of this data is described in [RD15], sections 4.1 and 4.9;
- a data-structure containing the L2B auxiliary data with processor settings. The structure of this data is described in [RD15], section 4.4;
- a data-structure with auxiliary meteo data containing a set of temperature and pressure profiles. The structure of this data is described in [RD15], sections 4.7 and 4.8;
- a data-structure with auxiliary Rayleigh-Brillouin Response Calibration data needed to process the Rayleigh channel. The structure of this data is described in [RD15], section 4.6;
- a data-structure with auxiliary climatology data containing backscatter-to-extinction estimates. The structure of this data is described in [RD15], section 4.2;
- a data-structure with auxiliary calibration data containing the satellite instrument properties. The structure of this data is described in [RD15] (still to be implemented);

The subroutine version of the main L2B processor produces the following outputs:

- a data-structure containing the L2B product data. The structure of this data is described in [RD15], sections 4.3 and 4.10.
- optional: outputs to stdout and/or stderr. These are adjustable, and maybe suppressed completely if needed. The format of the logging is described in [RD3], section 4.5.
- an optional log file, containing the same information that would have been written to the stdout channel. The format of the logging is described in [RD3], section 4.5.

Note that the logging output itself may be very important for the user, because it will contain errors, warnings, progress messages and informational and debug messages issued by the software. These outputs may be compared to outputs generated by the standalone main L2B processor, for verification purposes. This will be of great help when installation problems or bugs have to be resolved and to verify that the subroutine version is correctly implemented as compared to the standalone version.

5.2 EE2BUFR conversion tool

The EE2BUFR tool has the following input:

- a L1B product file in EE format. The structure for the EE version of this file is described in [RD5], chapter 6.

It produces a single output:

- a L1B product file in BUFR format. The structure for the BUFR version of this file is described in [RD6], chapter 3.

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5.3 Matlab Tools

The ReadBinaryData.m Matlab tool may be used to read a number of different EE formatted files into memory. Amongst others it reads the L1B, L2B, AUX_RBC and AUX_CLM files in EE format. A plotting tool ReadL2Bloop.m is also provided to make some example plots of this data. This tool maybe adapted by the user to suit his own needs. Inputs needed and instructions to use this tool are detailed in [RD-11].

6. System Requirements

6.1 Languages

The main L2BP, the EE2BUFR conversion tool and all accompanying interfaces are written in ANSI Fortran90. By using the ANSI standard for this programming language the program should be portable to all systems supporting this standard.

A limited set of extensions is used. These are collected in a single place (a module called CompilerFeatures) to allow easier porting of the software to alternative platforms. A few support routines written in the ANSI c-language are used to provide functionality normally not available in Fortran90.

The L2BP software uses python for several consistency checks, and for the ReportGenerator, but these are not essential for correct functioning of the software. The main L2BP program should run without problems on a system without python installed, but a number of fails should be expected in the provided automatic set of install tests (i.e. all tests related to testing the provided pythons cripts will fail).

The L2BP make system uses portable Makefiles combined with several scripts in the csh scripting language.

The Matlab read and plot software are written in the Matlab language, compatible with matlab version 7.0 or upwards. Compatibility with any of the free Matlab clones has not been tested and cannot be guaranteed.

6.2 External libraries

The L2BP software uses the EE_CFI set of libraries provided by ESA for xml handling and geodetic calculations. Precompiled versions of these libraries may be downloaded from <http://eop-cfi.esa.int/> after registration. This software is available for the following platforms:

- SUN Solaris
- Mac OSX
- Windows
- Linux, 32 and 64 bit Intel compatible platforms

To allow portability to platforms not supported by the precompiled EE_CFI set of libraries, the L2BP software has implemented alternative versions of the needed modules. A choice to use these may be made at the start of the software installation.

The EE2BUFR conversion tool uses the BUFR library made available by ECMWF. It may be downloaded from <http://www.ecmwf.int/products/data/software/>. Currently the main L2BP software has no dependency on this BUFR library.

The needed library versions are described in [RD-12], section 2.5.

6.3 Installation

All steps needed for installation of the standalone version of the L2BP and the EE2BUFR tool are described in [RD-12], chapter 3, and [RD-13], section 3.3.

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6.4 Supported platforms

The L2BP software (including EE2BUFR conversion tool) has been installed and tested on the following platforms:

- Linux 32 bit Intel processor (kernel 2.6.x), with Fortran compilers: pgf90 (Portland), ifort (Intel), g95 (GNU), gfortran (GNU)
- Linux 64 bit Intel and AMD processors (kernel 2.6.x), with Fortran compilers: ifort (Intel), g95 (GNU), gfortran (GNU)
- IBM AIX unix, with the xlf90 (ibm) Fortran90 compiler
- ...

If you have successfully installed and run the software on any other platform-compiler combination, please let us know, so we can add it to this list.

6.5 Performance

Examples of run times for the main L2B processor are given in (nowhere yet).

The L2BP software is required to process a full orbit of L1B data (consisting of about 200 BRC's) within 30 minutes on the target platform described below in section 6.6.

6.6 Operational and resource requirements

Some rudimentary parallelisation support is included in the L2BP software to allow use of the subroutine version within an IFS environment. The different BRC's may be processed in parallel, since their processing is independent, but currently each processor will have to read all input files again. Future software versions will be able to use the MPI library to communicate such data from one processor to all others, eliminating the need for reading the same file many times.

The target platform envisaged by ESA for use of the L2BP software is (see [RD-14]):

- pentium PC, with a minimum of 256MB ram and 20GB of usable disk space;
- OS: Redhat Linux Enterprise Server, kernel 2.4.21;
- gnu compiler collection (gcc), version 3.3.2.

Note however that such a machine is currently not available within the L2B team, so all actual testing has been done on newer machines and OS versions. The main difference is that we used the newer gcc v4.x version and a 2.6.x kernel. However, since we try to follow the language standards strictly no problems are expected for use on the target platform.

7. Documentation

All applicable documentation needed to install, and run the L2BP software is listed in section 1.1.

These documents are made available along with the L2BP software via the ESA website or ftp site dedicated to this.

8. Queries and feedback

Please direct any queries and feedback to the ESA Aeolus Project Team or to the ECMWF.

These can be contacted through their respective websites

<http://www.esa.int/esaLP/LPadmaeolus.html> and <http://www.ecmwf.int/> or directly by email to: ... (to be decided)