NWP SAF
OSI SAF

PenWP Version 2.2
Release Note

Version 2.2.00

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This documentation was developed within the context of the EUMETSAT Satellite Application Facility on Numerical Weather Prediction (NWP SAF), under the Cooperation Agreement dated 29 June 2011, 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, KNMI and Météo France.

Change record				
Version	**Date**	**Author**	**Approved**	**Remarks**
1.9.01	08-12-2014	Anton Verhoef		First version for PenWP version 1.9.01 (internal)
1.9.02	19-01-2015	Anton Verhoef		Modified for PenWP version 1.9.02 (internal)
1.9.03	19-03-2015	Anton Verhoef		Modified for PenWP version 1.9.03 (internal)
1.9.04	04-05-2015	Anton Verhoef		Modified for PenWP version 1.9.04 (preparation for NWP SAF beta release)
1.9.05	26-05-2015	Anton Verhoef		Modified for PenWP version 1.9.05 (NWP SAF beta release)
2.0.00	28-10-2015	Anton Verhoef		Version for PenWP 2.0 DRI
2.0.01	11-12-2015	Anton Verhoef		Modified according to DRI comments
2.1.00	21-02-2017	Jur Vogelzang		Version for PenWP 2.1
2.2.00	29-05-2018	Anton Verhoef		Version for PenWP 2.2

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1. INTRODUCTION

The Pencil Beam Wind Processor (PenWP) is a software package written mainly in Fortran 90 with some parts written in C for handling data from the SeaWinds (on QuikSCAT or ADEOS-II), OSCAT (on Oceansat-2 and ScatSat-1), HSCAT (on HY-2A) and RapidScat (on the International Space Station) scatterometer instruments. PenWP is intended to be a generic wind processor for Ku-band pencil beam scatterometer data.

PenWP generates surface winds based on pencil beam radar backscatter data. It allows performing the ambiguity removal with the Two-dimensional Variational Ambiguity Removal (2DVAR) method and it supports the Multiple Solution Scheme (MSS). The output of PenWP consists of wind vectors which represent surface winds within the ground swath of the scatterometer.

Input of PenWP is Normalized Radar Cross Section (NRCS) data. The input files of PenWP are in BUFR. Conversion programs are included in the package to convert Hierarchical Data Format (HDF5) data from various instruments to BUFR. Output is written using the SeaWinds BUFR template or the KNMI BUFR template with generic wind section.

Apart from the scatterometer input data, PenWP needs Numerical Weather Prediction (NWP) model winds as a first guess for the Ambiguity Removal step. These data need to be provided in GRIB edition 1 or 2.

If you have any questions concerning PenWP, please contact the NWP SAF help desk on http://nwpsaf.eu/.

2. PACKAGE CONTENTS

The tar file contains everything necessary to install PenWP in a UNIX/Linux environment, except for some ECMWF software libraries that need to be downloaded separately (see below).

Contents of the penwp directory:
```
doc       Documentation, including this document
execs     Link to penwp executable, shell script for running PenWP
hscat     Program to convert HSCAT HDF data to BUFR format
oscat     Program to convert OSCAT HDF data to BUFR format
seawinds  Program to convert SeaWinds and RapidScat HDF data to BUFR format
src       Source code for PENWP program and supporting routines
test      Example HDF5 and GRIB input files for testing purposes
```

Contents of the genscat directory:
```
ambrem                     Ambiguity removal routines
ambrem/twodvar             KNMI 2DVAR ambiguity removal routines
icemodel                   Ice screening routines
inversion                  Inversion and quality control routines
support                    General purpose routines sorted in subdirectories
support/BFGS               Minimization routines needed in 2DVAR
support/bufr               BUFR tables (in subdirectory) and file handling
                           routines
support/Compiler_Features  Compiler specific routines, mainly command line
                           handling
support/convert            Conversion between wind speed/direction and u and v
support/datetime           Date and time conversion routines
support/ErrorHandler       Error handling routines
support/file               File handling routines
```

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support/grib          GRIB file handling routines
support/hdf5          HDF5 handling routines
support/netcdf        NetCDF file handling routines
support/num           Numerical definitions and number handling routines
support/singletonfft  FFT routines needed in minimization
support/sort          Sorting routines
tools/bufr2asc        tool to convert BUFR format files to ASCII
tools/bufr2nc         tool to convert BUFR format files to NetCDF
tools/bufr_l2_reader  Support routines for conversion tools
```

3. APPLICABLE DOCUMENTS

In directory penwp/doc:
- PenWP Release Note (NWPSAF-KN-UD-010_PenWP_Release_Note.pdf), this document.
- PenWP User Manual and Reference Guide (NWPSAF-KN-UD-009_PenWP_User_Guide.pdf), a document that includes information on how to install and run the package.
- PenWP Product Specification (NWPSAF-KN-DS-002_PenWP_Prod_Spec.pdf), a document that contains information on the functionality of PenWP and on the input and output specifcations.

Delivered separately / to be obtained from the NWP SAF web site (http://nwpsaf.eu/):
- PenWP Top Level Design (NWPSAF-KN-DS-001), a document containing information on the design of PenWP and its module design.
- PenWP Test Plan and Test Report (NWPSAF-KN-TV-008), a document that contains all undertaken tests and their results.

4. MAIN CHANGES

PenWP version 2.2 can process OSCAT data from ScatSat-1(improved ISRO data version 1.1.3). The interface and handling of the 2DVAR Ambiguity Removal module was improved to streamline and simplify the processing. See the list of changes in section 7 for more details.

5. INSTALLATION

The system requirements for compiling and running PenWP are described in section 2.4 of the Product Specification. In short, PenWP should run on most Unix/Linux based platforms with e.g. the Portland, g95, gfortran, Sun, Intel or SGI compilers.

Detailed instructions for installation can also be found in the User Manual and Reference Guide, section 2. A shortened version is given here.

To install PenWP, the following steps must be taken:

1. Copy the PenWP package (file PenWP<version>.tar.gz) to the directory from which PenWP will be applied, and unzip and untar it. This will create subdirectories penwp and genscat that contain all code needed, and a script called compile_penwp for easy compilation.
2. Download the ECMWF BUFR library file bufr_000405.tar.gz (or another version not earlier than 000240) from https://software.ecmwf.int/wiki/display/BUFR/BUFRDC+Home and copy it to directory genscat/support/bufr. Note that library versions 000388 and 000389 are not supported.
   3. Download the ECMWF GRIB API library file grib_api-1.20.0-Source.tar.gz (or another version not earlier than 1.9.0) from https://software.ecmwf.int/wiki/display/GRIB/Home and copy it to directory genscat/support/grib.
4. Run the script ./compile_penwp which is in the top directory where the PenWP package (tar file) was copied to and follow its directions.

5. PenWP is now ready for use, provided that the environment variables have the proper settings. PenWP can be invoked by the the script penwp/execs/penwp_run, which sets all necessary environment variables.
6. The penwp/tests directory contains some sample OSCAT and NWP files that can be used to test the software. See the readme.txt in this directory for more details.

6. KNOWN PROBLEMS

During compilation, the g95 and gfortran compilers issue warning messages. These can be safely neglected.

Some users have reported problems at runtime with older versions of the gfortran compiler. When you have a version older than 4.6.3, it may be advisable to upgrade.

7. DETAILED LIST OF CHANGES

Changes in PenWP v2.2.00 21 March 2018
- Several fixes and improvements implemented for Oceansat-2 reprocessing in OSI SAF.
- Several changes to properly handle ScatSat-1 data.
- Fixed a small bug in GRIB collocation module leading to a model data displacement of up to one grid point in East-West direction. This was only an issue for reduced Gaussian grids, not for regular grids.
- Refined ice probability thresholds, use 0.50 for OSCAT and 0.55 for other Ku-band instruments.
- Apply non-linear s0 corrections for ScatSat-1.
- Changed interface and handling of 2DVAR Ambiguity Removal to streamline and simplify the processing.
- Enlarged number of grib files to be handled to 35, to enable handling of hourly NWP forecasts.
- Reject observations that are too far out of the swath edge in the L1B to L2A processing.
- Implemented an improved method to determine if a real has missing value, to reduce the number of compiler warnings with gfortran.
- In oscat_l1b_l2a, the number of slices per footprint is dynamically determined.

Changes in PenWP v2.1.00 21 February 2017
- Implemented new HDF5 library, source code is compiled now rather than using binary library files.
- Changes to support MacOSX Darwin platform.
- Added functionality to read either slices (default) or eggs from L1b file in oscat_l1b_l2a.
- Conversion tools Bufr2Asc and Bufr2Nc are now included in the PenWP package.
- Correction of 0.2 m/s in monitoring for real NWP winds is skipped when neutral NWP winds are read from GRIB.
- Corrected small bug in the averaging of L1B azimuth angles to L2A azimuth angles in oscat_l1b_l2a.
- Added -wo option to use or write data from only one orbit in the input file. Used to split OSCAT files at the south pole.
- Do not stop processing when ice map cannot be read successfully but continue with empty ice map.
- Added functionality for ScatSat-1.
- Apply extra constant correction of -0.47 dB HH and -0.56 dB VV for Oceansat-2 data before 20 Aug 2010.

- Corrected bug in computation of Oceansat-2 orbit numbers, orbit numbers have to be computed before sorting and merging of rows.
- Assign row numbers to Oceansat-2 data even when the file starts after the descending equator crossing.
- Empirical background error correlations in 2DVAR invoked by the -nbec command line option. This leads to a better analysis and, hence, to better ambiguity removal in 2DVAR.

Changes in PenWP v2.0.00 28 October 2015
- Introduced WVC dependent backscatter corrections for Oceansat-2/OSCAT.
- Lowered the QC rejection rate between 6 and 18 m/s by looking at RapidScat - ASCAT collocations. Created new QC threshold tables for RapidScat, QuikSCAT, OSCAT and HSCAT.
- In seawinds_hdf2bufr, allow negative sigma0s until -29 dB rather than -33 dB to get some more low winds after the RapidScat noise increase due to the anomaly in Aug. 2015. Moreover, improved setting of s0_quality flags.
- Implemented version 000405 of the BUFR software and version 1.14.0 of the GRIB API software.

Changes in PenWP v1.9.05 26 May 2015
- For RapidScat, skip inner swath when redistributing the eggs of beam 1 over beam 1 and 3 in seawinds_hdf2bufr.F90.
- For RapidScat, allow extra margin for KNMI flag in nadir swath when setting monitoring bit.
- Make changes in file names, variables etc. to consistently use HSCAT rather than HYSCAT for the scatterometer on HY-2A.
- Changed the GRIB module such that it can handle reduced Gaussian grids as well as regular grids.
- Set qual_sigma0 flag in WVC quality always when one of the beam data is incomplete (bug fix).

Changes in PenWP v1.9.04 4 May 2015
- Removed the compiler directives for NCEP in the GRIB module. Code will now automatically detect if model data is from ECMWF or other models, and handle this appropriately.
- InstrumentShortName of RapidScat HDF input data files was changed from SeaWinds into RapidScat, allow this name as well when converting to BUFR.

Changes in PenWP v1.9.03 19 March 2015
- Implemented monitoring bit setting for ISS/RapidScat.
- Changed common code tables C-5 and C-8 entries for HY-2A/scat and ISS/RapidScat into proposed values:
- C-5: HY-2A: 502 (was 990), ISS: 801 (was 991)
- C-8: HY-2A/scat: 686 (was 990), RapidScat 314 (was 991)
- Changed the backscatter calibration coefficients for QuikSCAT to the values used in SDP for reprocessing. Re-computed MLE normalisation and QC threshold tables.

Changes in PenWP v1.9.02 19 January 2015
- Recomputed MLE normalisation tables and QC threshold tables. Removed very high values in the right part of the swath which are associated with missing or corrupted data.
- For ISS, redistribute beam 1 data (HH) over beam 1 and 3 in case of missing beam 3 (seawinds_hdf2bufr.F90). This should help to reduce the number of missing winds in the right part of the swath where data is sometimes missing due to blockage by solar panels.
- Bug fix in seawinds_hdf2bufr to ensure that all output files are always written with -wpo option.

- For ISS, reduced the backscatter calibration coefficients from 0.75 dB to 0.45 dB for 25km and from 0.70 dB to 0.38 dB for 50 km. Re-computed MLE normalisation and QC threshold tables.
- In the monitoring, changed computation of number of WVCs containing sufficient backscatter info. Exclude WVCs with four_beam flag set from this number.

Changes in PenWP v1.9.01 8 December 2014
- First internal version for near-real time processing of ISS/RapidScat.