CGMS-39 EUM-WP-29
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Prepared by EUMETSAT
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EUM REPORT ON VALIDATION CAMPAIGN FOR AMVS DERIVED WITH THE NWCSAF PORTABLE AMV SOFTWARE PACKAGE

In response to CGMS action/recommendation 38.29

The purpose of this paper is to provide to CGMS members the information which will close the following CGMS action 38.29 on EUMETSAT.

Action 38.29: EUMETSAT to conduct an extended validation campaign for AMVs derived with the NWCSAF portable AMV software package.

The portable SAFNWC/MSG software package from the EUMETSAT Satellite Application Facility (SAF) on support to Nowcasting and Very short range forecasting is a stand-alone software package which can derive AMVs (Atmospheric Motion Vectors) using the MSG/SEVIRI HRVIS (High Resolution Visible) and IR108 (Infrared 10.8 μm) channels, 24 hours a day and locally by the user, through its "High Resolution Winds (HRW)" product. HRW output (BUFR bulletins) is similar to other AMV products available at the WMO Global Telecommunications System.

This paper briefly describes the SAFNWC HRW software, and gives general outcomes and appropriate references on the complete scientific validation of the last version HRW v3.1 of the SAFNWC HRW software, which has been done considering MSG-2 Satellite Nominal scan AMVs at 12:00 UTC, in an area covering Europe and North Africa (772x1856 low resolution pixels centred at 40.5ºN/11.1ºE), during the whole year July 2009 – June 2010.

Action/Recommendation proposed:
CGMS 39 is invited to finally close Action 38.29 and to recommend the matter as discussion item at the next International Winds Workshop

EUM report on validation campaign for AMVs derived with the NWCSAF portable AMV software package

1 INTRODUCTION

The purpose of this paper is to provide to CGMS members the information which will close the following CGMS action 38.29 on EUMETSAT.
Action 38.29: EUMETSAT to conduct an extended validation campaign for AMVs derived with the NWCSAF portable AMV software package.

2 NWCSAF PORTABLE AMV SOFTWARE

2.1 Description

The portable SAFNWC/MSG software package from the EUMETSAT Satellite Application Facility (SAF) on support to Nowcasting and Very short range forecasting (hereafter NWC SAF) is a stand-alone software package which can derive AMVs (Atmospheric Motion Vectors) using the MSG/SEVIRI HRVIS (High Resolution Visible) and IR108 (Infrared 10.8 µm) channels, 24 hours a day and locally by the user, through its "High Resolution Winds (hereafter HRW)" product. HRW output (BUFR bulletins) is similar to other AMV products available at the WMO Global Telecommunications System.

Both "Nominal scan mode" conditions and "Rapid scan mode" conditions can be considered by HRW product. The MSG region to be processed, the specific MSG satellite, the tracer dimension, and the separation between the initial tracer image and the later tracking image among many other processing parameters can also be easily configured by the user.

A new version of this product was released during 2011 (HRW v3.1), including the "CCC height assignment method" (Borde & Oyama 2008, Büche 2006) which couples tracking and height assignment closer together. The HRW algorithm includes the following seven steps:

1) Initialization of data:
Latitude/longitude/solar zenith angle matrices, NWP data, MSG/IR108 brightness temperatures, MSG/HRVIS reflectances, SAFNWC/MSG Cloud type and Cloud top temperature and height outputs for the running region, using functions also included in SAFNWC/MSG software package.

2) Tracer determination at an initial image:
Two methods are used consecutively:
Gradient (fast and efficient search of well defined cloud edges).

Tracer characteristics (coverage holes are filled with a longer but still reasonable computing time; three different tests are run based on a brightness threshold separating the cloudiness in front from the background, a well defined shape of the target bright pixels to avoid too linear elements, and a small infrared temperature dispersion in the HRVIS case to avoid multilevel clouds).

3) Tracking and Wind calculation at a later image:

One of two well known methods is used for this process: Euclidean distance or Cross correlation (default option).

The tracking area can be defined through the extrapolation of the linearly interpolated NWP wind guess for a quicker algorithm (default option). The best three tracking centres are kept, to perform a final selection step after the Quality Control.

4) Height assignment:

Two different methods can be used:

CCC method: defines the AMV height considering only the height of the pixels contribution most to the image correlation (new and default method for HRW v3.1, available for Cross correlation tracking if SAFNWC/MSG Cloud type and Cloud top temperature and height products outputs have also been calculated).

IR108 brightness temperature profile interpolation method: calculates the cloud top and cloud base interpolating IR108 brightness temperature to NWP or Climatological profiles, and defines the AMV height from one of these two values considering the cloud type related to the tracer.

5) Quality Control:

The Quality Indicator Method, developed at EUMETSAT for AMV calculation at MPEF (Holmlund 1998), has been adapted for HRW product. Several consistency tests are computed, considering:

Vector/direction/speed consistency with AMVs in the previous slot (Temporal test).

Vector consistency with neighbour AMVs (Spatial test).

Vector consistency with NWP forecast winds (Forecast test).

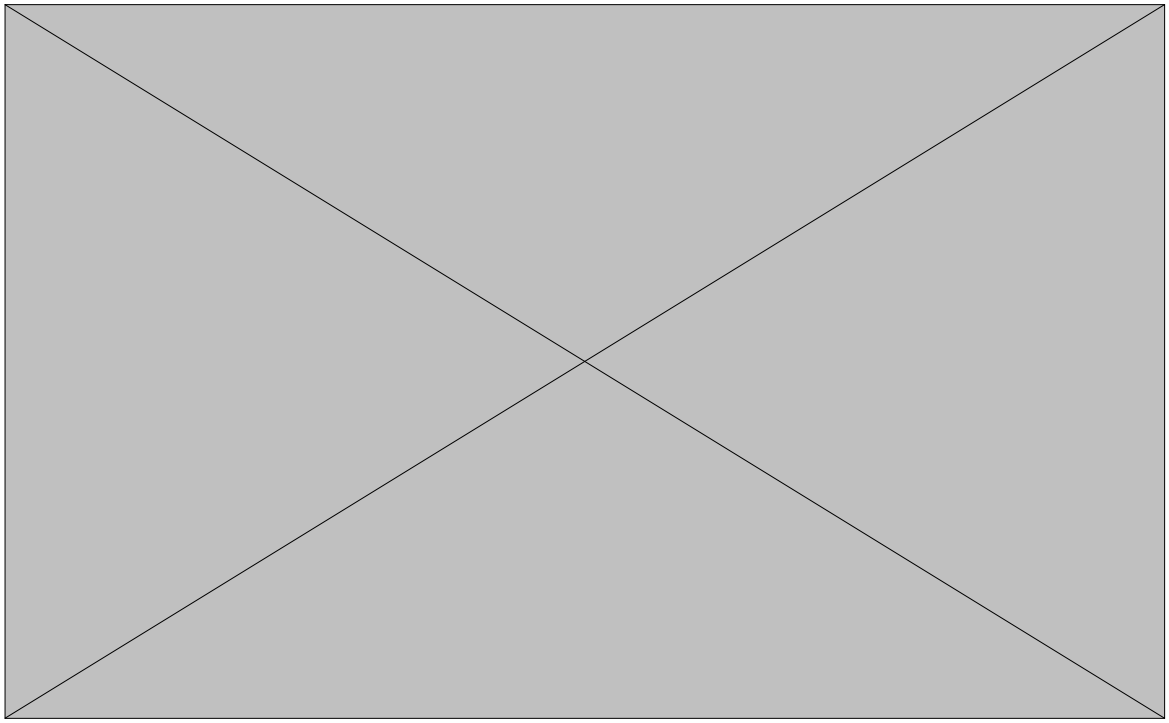
An individual Quality Index (QI) is calculated for each consistency test, with the normalized statistical fitting functions described by the method. An overall Quality Index is calculated as the weighted sum of partial QIs, with a larger contribution from the spatial test.

6) Orographic flag:

An Orographic flag related to the detection of land tracers, tracers blocked by orography and orographic waves can also be calculated by the software. A complete description of this process can be found in the Algorithm Theoretical Basis Document for “High Resolution Winds” (HRW-PGE09 v3.1) document referenced below.

7) Final AMV selection:

When more than one AMV has been extracted per tracer the final wind selection is done using comparison flag that is assigned to each AMV. Five different flags are calculated, considering a comparison between the up to three AMVs per tracer related to their correlation, temporal quality test, spatial quality test, forecast quality test and orographic flag. The final AMV selection is based on the AMV with the best comparison flags.



Example of “SAFNWC/MSG High Resolution Winds v3.1”
for the European and Mediterranean area (5 January 2011, 12:00 UTC).

A complete description of HRW algorithm can be found in the “Algorithm Theoretical Basis Document for High Resolution Winds (HRW - PGE09 v3.1)” document referenced below.

2.2 Validation

A complete scientific validation of HRW v3.1 has been done considering MSG-2 Satellite Nominal scan AMVs at 12:00 UTC, in an area covering Europe and North Africa (772x1856 low resolution pixels centered at 40.5ºN/11.1ºE), during the whole year July 2009 – June 2010.

The validation is based on the comparison of HRW AMVs with winds obtained from radiosoundings available from the GTS, following the criteria defined at the Third International Winds Workshop (Ascona, Switzerland, 1996). Collocation criteria are based on a maximum distance of 150 km and a maximum pressure difference of 25 hPa between AMV and collocated radiosonde observation.

Results of the HRW v3.1 validation HRW v3.1 are summarized in table 1, showing respectively the total amount of AMVs (NC), the mean radiosounding wind in m/s (SPD), the normalized bias (NBIAS), the normalized mean vector difference (NMVD), and the normalized root mean square vector difference (NRMSVD) estimated for AMVs extracted using the HRVIS and IR108 channels. The results are also given considering three vertical layers: high (100-400 hPa), medium (400-700 hPa) and low

(700-1000 hPa). The HRW v3.1 default configuration has been considered to get these results: use of "Cross correlation tracking" and "CCC height assignment method", and following AMV output filtering (QI ≥83 for high and medium layers and QI ≥84 for low layer; Orographic flag = 0,4,5; Pressure between 100 and 1000 hPa for HRVIS AMVs and between 100 and 900 hPa for IR108 AMVs).

HRW v3.1	HRVIS All layers	HRVIS High layer	HRVIS Medium layer	HRVIS Low layer	IR108 All layers	IR108 High layer	IR108 Medium layer	IR108 Low layer
NC	82408	49252	18338	14818	140029	97861	34071	8097
SPD [m/s]	19,18	24,04	13,55	9,98	20,55	23,32	14,97	10,61
NBIAS	-0,11	-0,11	-0,12	-0,1	-0,19	-0,19	-0,21	-0,17
NMVD	0,31	0,28	0,39	0,43	0,36	0,34	0,42	0,45
NRMSVD	0,39	0,35	0,48	0,51	0,45	0,43	0,53	0,53

Table 1: Validation parameters for HRW v3.1 with the default configuration ("Cross correlation tracking" and "CCC method height assignment")

The changes included in the HRW v3.1 increased significantly (more than twice) the amount of available winds compared to the previous version HRW v3.0 of the algorithm, with a mean NRMSVD around a 20% smaller for the HRVIS winds and around a 10% smaller for the IR108 winds. This improvement is mainly due to a better performance of the algorithm at mid levels and low levels and a larger proportion of AMVs in the layer that have lowest errors (the high levels).

A complete description of this Validation of HRW algorithm can be found in the "Validation Report for "High Resolution Winds" (HRW-PGE09 v3.1)" document referenced below. Specific studies related to the impact of tracking method, the height assignment method, the quality index threshold, the orographic flag, the cloud type, the pressure level, and the CCC method pressure error are included in that document.

Several important outcomes can be noted from this validation study:

- The use of SAFNWC/MSG CTTH Cloud top pressure output in the "CCC method height assignment" creates a direct correspondence between the altitude set to HRW winds and the cloud top heights estimated by SAFNWC/MSG PGE03 product at the same location. This eliminates possible inconsistencies between both products.
- Previous HRW v3.0 version of HRW product did not treat AMVs related to some semi-transparent cloud types because the software did not include any semi-transparency correction methods. The HRW v3.1 can now process AMVs related to all cloud types, including semi-transparent clouds, because semi-

transparency correction methods are included in SAFNWC/MSG CTTH product used by the "CCC method".

HRW v3.1 extracts a new quality parameter called "pressure error" (in hPa), which estimates variability of the pixels selected by CCC method to set the AMV height. The impact of this parameter has been tested showing that smaller the pressure error smaller the NRMSVD.

2.3 NWC SAF software distribution policy

All National Meteorological Services within the EUMETSAT Member and Cooperating States are automatically considered potential users of NWC SAF software packages. Any other organization may also apply to become user of it through its Leading entity (Pilar Fernández, NWC SAF Manager, mafernandeza@aemet.es).

Software delivery is authorized through a Licence Agreement, signed by EUMETSAT (represented by the Leading entity) and the applicant user. After this, access credentials to the NWC SAF Helpdesk User Area are given, where the software can be downloaded free of charge. More information about the usage licence is available at SAFNWC website: http://www.nwcsaf.org.

3 CONCLUSIONS

A complete validation of NWC SAF "High Resolution Winds v3.1" algorithm has been done considering a full year of HRW AMVs and Radiosounding wind data. Results of HRW v3.1 with the inclusion of "CCC height assignment method" show a significant increase in the amount of AMVs with a better mean NRMSVD than previous versions of the algorithm. The complete validation report can be downloaded from the NWC SAF website.
The validation confirms that the portable AMV software package provides wind vectors of state-of-the-art quality.

4 REFERENCE DOCUMENTS

J. García Pereda, 2011: Algorithm Theoretical Basis Document for "High Resolution Winds" (HRW-PGE09 v3.1). Available at NWC SAF website: www.nwcsaf.org/scidocs/Documentation/SAF-NWC-CDOP-INM-SCI-ATBD-09_v3.1.pdf

J. García Pereda, 2011: Validation Report for "High Resolution Winds" (HRW-PGE09 v3.1). Available at NWC SAF website: www.nwcsaf.org/scidocs/Documentation/SAF-NWC-CDOP-INM-SCI-VR-09_v1.0.pdf

R. Borde & R. Oyama, 2008: A direct link between feature tracking and height assignment of operational Atmospheric Motion Vectors (Proceedings 9th International Wind Workshop, EUMETSAT Pub.51).

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Holmlund, K, 1998: The Utilization of Statistical Properties of Satellite-Derived Atmospheric Motion Vectors to Derive Quality Indicators. *Wea. Forecasting*, 13, 1093-1104.