GOBIERNO DE ESPAÑA
MINISTERIO DE AGRICULTURA, ALIMENTACIÓN Y MEDIO AMBIENTE
AEMet Agencia Estatal de Meteorología
EUMETSAT
Monitoring weather and climate from space
Surveiller le temps et le climat depuis l'espace

NWC SAF
Support to Nowcasting and Very Short Range Forecasting

NWC SAF/HRW (High Resolution Winds) as "Stand alone AMV calculation software"

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- The Satellite Application Facility on support to Nowcasting (NWC SAF) is a Consortium between Eumetsat and several Nat. Met. Services:
  - Agencia Estatal de Meteorología – AEMET (Spain)
  - Météo France
  - Sveriges Meteorologiska och Hydrologiska Institut – SMHI (Sweden)
  - Zentralamstalt für Meteorologie und Geodynamik – ZAMG (Austria)

- Its main objective is:
  - To provide operational services to enhance the Nowcasting and Very short range Weather forecasting.
  - This is achieved by
    i) Developing/maintaining software packages calculating in real time Meteorological products from Geostationary/Polar satellite data.
    ii) Supporting users on their use.

Inside the Geostationary (MSG) Software Package we have:

+ Three Cloud products:
  - Cloud Mask (CMa)
  - Cloud Type (CT)
  - Cloud Top Temperature & Height (CTTH)

+ An AMV (Atmospheric Motion Vectors) calculation product:
  - High Resolution Winds (HRW),

where the Cloud product outputs (Cloud type & Cloud Top pressure) are authomatically integrated and processed in the AMV algorithm, with "CCC Height Assignment Method".

NWC SAF/High Resolution Winds product

Some important aspects on High Resolution Winds product:

> It can be run locally and in real time by the user.

> The configuration is very easy to define
through the corresponding NWC SAF configuration files.

> Since HRW v2012 (to be released in March 2012):
+ It calculates AMVs using up to seven different MSG/SEVIRI channels:
> HRVIS, VIS06, VIS08, IR108, IR120, WV062, WV073
including Cloudy and WV Clear air AMVs.

> The 2012-2017 Plan includes its extension to
other Geostationary satellites like GOES-R/New Japanese series.

> All additional elements needed for:
- The processing of Cloud information (with RTTOV model) for its use
- The reading/processing of all needed data (NWP, Satellite, Cloud inf.)
- The running of all parts of the algorithm
- The definition of AMV output in several formats

are included in NWC SAF software package or NWC SAF webpage.

The user does not need any additional element to calculate/use the AMVs!

NWC SAF/High Resolution Winds product

As a reminder, these are the main steps of NWC SAF/High Resolution Winds algorithm:

- **Preprocessing: Initialization of SEVIRI & NWP data through libraries included with NWC SAF software.**
- **Tracer calculation with two different methods:**
  - **Gradient**
  - **Tracer characteristics.**
- **Tracer tracking / Wind calculation: With selection of up to 3 correlation centres with Euclidean differences or Cross correlation (default option) methods.**
- **Height assignment with one of two different methods:**
  - **CCC method (default option)**
  - **Brightness temperature interpolation method**
- **Quality control, with Eumetsat Quality Indicator method (used at MPEF).**
- **Orographic flag test, where tracers affected by land influence are rejected.**

More information in the official Documents at NWC SAF Helpdesk:
ATBD (Algorithm Theoretical Basis Document) VR (Validation Report)
http://www.nwcsaf.org/indexScientificDocumentation.html

HRW product input data

Input data to run NWC SAF Software Package:

- **Full Resolution unencrypted HRIT MSG/SEVIRI data**
  > Received from EUMETCAST service.

- **NWP model forecast GRIB data for several variables in the working region**
  > Many options have already been tried with NWC SAF:
  + ECMWF, ARPEGE (France), COSMO (Germany), HIRLAM (Scandinavia), UM (Korea), etc.
  > But other options can also be used.

- **NWC SAF Configuration files:**

  (Text files where the user defines the conditions to be considered in the run; these can be changed at any time):

  - Model configuration files (*.cfm)
  - Region configuration file (*.cfg)
  - Satellite configuration file (sat_conf_file)

The user only has to worry to locate these data in the needed directories

$SAFNWC/import/SEVIRI_data $SAFNWC/import/NWP_data $SAFNWC/config

HRW product output data

Output data for these NWC SAF Products:

- Three HDF5 image files, including the information of Cloud products for the running region:
  - Cloud mask (in $SAFNWC/export/PGE01 dir.)
  - Cloud type (in $SAFNWC/export/PGE02 dir.)
  - Cloud top pressure, temperature, height (in $SAFNWC/export/PGE03 dir.)

- One or two BUFR bulletins (in $SAFNWC/export/PGE09 dir.), including AMV output related to up to two different scales of tracers:
  - "Basic winds": SAFNWC_HRW_***_B.buf.
  - "Detailed winds": SAFNWC_HRW_***_D.buf.

HRW product output data

Output files can be easily visualized/processed through several options:

1. Visualization through applications capable of HDF5 format (like HDFview):
   - > Directly for NWC SAF/Cloud outputs
   - > Also for NWC SAF/HRW AMV output after conversion to HDF5, with tools included in NWC SAF Software package.

2. Visualization and later use under Mcidas environment after conversion of output to Mcidas AREA and MD files.
   - > With tools also freely provided at NWC SAF Helpdesk.

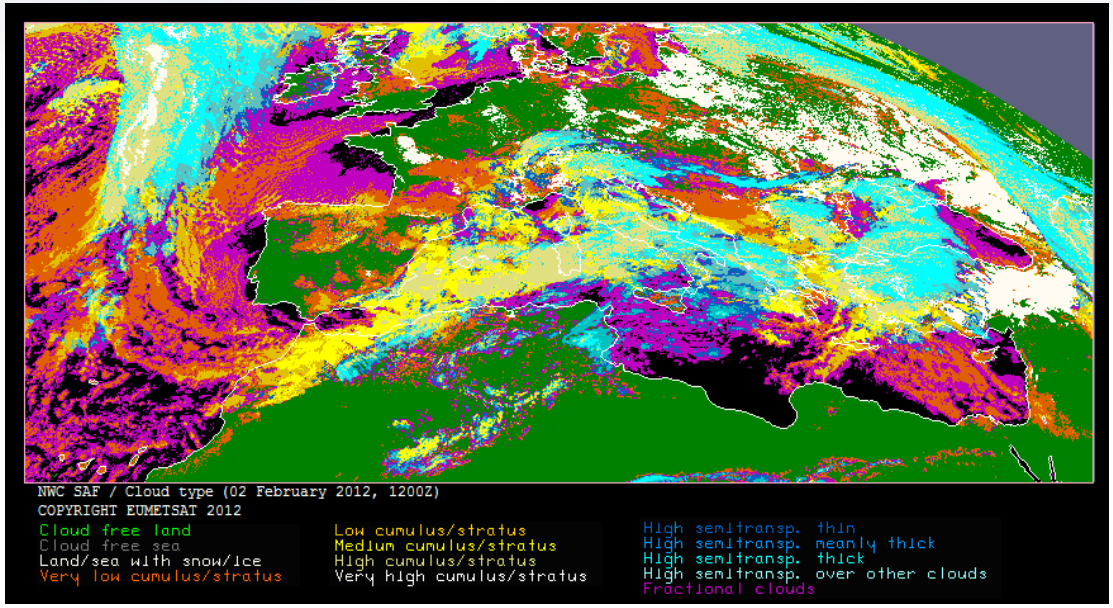
3. NWC SAF AMV BUFR output can directly be processed in NWP assimilation
   - > Already under way in the United Kingdom / Hungary Met. Services.

4. Additional visualization options will be developed during NWC SAF next phase (CDOP2: 2012 – 2017).

HRW product examples

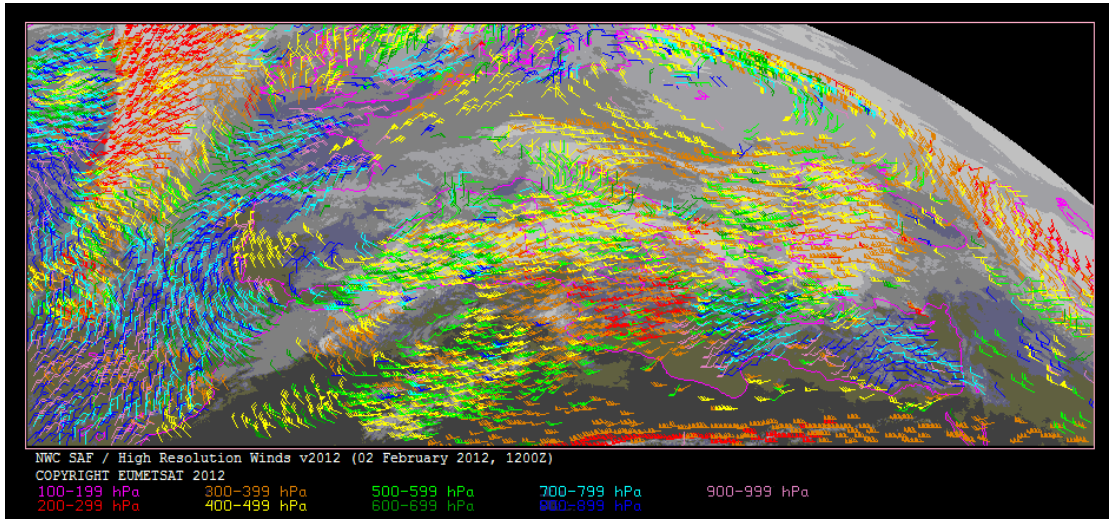
Examples of Visualization of NWC SAF Cloud & AMV products under Mcidas environment:

1. Cloud type



2. High Resolution Winds v2012

(2 February 2012 1200Z, MSG-2 data satellite data, ECMWF NWP model data)



HRW product validation

HRW v2012 Validation against Radiosoundings (Europe & Mediterranean region, Jul 2009-Jun 2010)

HRW v3.2 AMV Validation (Jul 2009-Jun 2010)	cloudy HRVIS	cloudy VIS06	cloudy VIS08	cloudy IR108	cloudy IR120	cloudy WV062	cloudy WV073	clear air WV062	clear air WV073	all AMVs
NC	138633	71213	64022	112833	115171	133011	176648	34023	14155	859709
SPD [m/s]	18.03	11.75	11.71	19.68	19.89	23.63	21.96	17.46	13.58	19.08
NBIAS (ALL LAYERS)	-0.11	-0.16	-0.16	-0.11	-0.10	-0.06	-0.08	-0.05	-0.02	-0.08
NMVD (100-1000 hPa)	0.32	0.44	0.44	0.32	0.32	0.29	0.31	0.34	0.39	0.33
NRMSVD	0.40	0.52	0.52	0.41	0.40	0.36	0.39	0.42	0.46	0.41

HRW v2012 Validation for all layers (100-1000 hPa)

HRW v3.2 AMV Validation (Jul 2009-Jun 2010)	cloudy HRVIS	cloudy VIS06	cloudy VIS08	cloudy IR108	cloudy IR120	cloudy WV062	cloudy WV073	clear air WV062	clear air WV073	all AMVs
NC	74986			69778	73646	126993	141182	34023	1466	522074
SPD [m/s]	23.49			23.12	23.05	23.89	23.35	17.46	14.72	23.02
NBIAS (HIGH LAYER)	-0.10			-0.12	-0.11	-0.06	-0.09	-0.05	+0.04	-0.09
NMVD (100-400 hPa)	0.28			0.30	0.29	0.29	0.30	0.34	0.34	0.30
NRMSVD	0.35			0.37	0.37	0.36	0.37	0.42	0.40	0.37
NC	33356	41595	37728	32724	32364	6018	34416		12689	230890
SPD [m/s]	13.47	13.11	12.97	15.06	15.19	18.18	16.52		13.45	14.37
NBIAS (MEDIUM LAYER)	-0.12	-0.17	-0.17	-0.08	-0.06	+0.00	-0.03		-0.03	-0.10
NMVD (400-700 hPa)	0.38	0.42	0.42	0.39	0.39	0.38	0.39		0.39	0.40
NRMSVD	0.47	0.51	0.51	0.48	0.48	0.48	0.49		0.47	0.49
NC	30291	29618	26294	10331	9161		1050			106745
SPD [m/s]	9.52	9.84	9.89	11.10	11.09		13.13			10.02
NBIAS (LOW LAYER)	-0.09	-0.13	-0.14	-0.09	-0.08		-0.02			-0.11
NMVD (700-1000 hPa)	0.44	0.46	0.46	0.41	0.41		0.40			0.44
NRMSVD	0.52	0.54	0.54	0.49	0.48		0.48			0.52

HRW v2012 Validation for

High (100-400 hPa), Medium (400-700 hPa) and Low (700-1000 hPa) layer

HRW product validation

Comparing with EUMETSAT/MPEF AMVs statistics (kindly provided by A. Smet) in the Northern extratropical region for Jul 09-Jun 10 period:

> **The density of NWC SAF/HRW AMVs is higher (at least x2),**
> **with a mean NRMSVD ~17% higher under the default configuration.**

> **But if the density of AMVs is reduced through a higher QI threshold the NRSMVD is very similar to EUMETSAT/MPEF AMVs with a still higher density of AMVs.**

Validation comparison (NC & NRMSVD) between NWCSAF/HRW and MPEF AMVs (Northern extra tropical area, Jul 2009-Jun 2010)	NWCSAF/HRW (Default configuration)		NWCSAF/HRW (Smaller AMV density)		EUMETSAT/MPEF (Official statistics)	
ALL LEVELS (100-1000 hPa)	859709	0.41	655350	0.35	363943	0.35
HIGH LEVELS (100-400 hPa)	522074	0.37	423849	0.31	242313	0.29
MEDIUM LEVELS (400-700 hPa)	230890	0.49	164201	0.41	39910	0.43
LOW LEVELS (700-1000 hPa)	106745	0.52	67300	0.46	81720	0.46

NWC SAF Software installation and running

- In case of interest on using NWC SAF software (and HRW product):

  + All National Meteorological Services within Eumetsat Member/Cooperating States are automatically considered potential users.

  + All other Organisations may also apply to become user of NWC SAF Software.

- This is done contacting:

  Pilar Fernández, NWC SAF Manager
  (mafernandeza@aemet.es // asanchezp@aemet.es)

- All applicants have become users of NWC SAF software (without restriction up to now!), with:
  - ~ 100 Institutions from all around the world (Europe, Africa, Americas, Asia,…)
  - All types of institutions:
    - National Meteorological Services
    - Universities
    - Research institutions
    - Public service providers
    - Public and private companies

NWC SAF Software installation and running

- Software Delivery is authorized to users through their Licence Agreement, to be signed by EUMETSAT (represented by AEMET) and the applicant User.

- Once the Licence Agreement is signed,
  Access Credentials to the NWC SAF Help Desk Restricted Area are provided,
  where the NWC SAF software package can be downloaded:

  http://www.nwcsaf.org

- The installation takes then only 3 steps, which need less than ONE HOUR to be ready:
  + Download and decompress the software
  + Define a few variables in the ".profile file" and activate them.
  + And run the installation script:

    $SAFNWC/src/safnwc_v2012.sh make install

Nothing else is needed. All software/libraries/products/additional elements to run NWC SAF/MSG software package (and HRW product!) are installed and ready to run with this!

NWC SAF Software installation and running

- **Hardware resources needed to run NWC SAF Software package are small and relatively easy to obtain, under several possible environments:**

	Sun/Solaris	Intel/Linux
O.S	Solaris 8 or later	Fedora Core 6 RedHat Enterprise 3 RedHat 7.3
Memory	1024 MB	256 MB
Disk Space(1)	10 GB	10 GB
Compilers	Sun WorkShop 6 or Forte Developer 7	gcc 4.1.1 Intel ifort v8.1
CPU	UltraSPARC-III (450MHz)	Pentium 4 (2.4GHz)
Shell	Unix KornShell (ksh)	Unix KornShell (ksh)

- **Other environments like Linux/Ubuntu, SUSE and Debian are not officially supported, but some NWC SAF users have also tested them successfully.**

NWC SAF Software installation and running

- A "Task Manager" tool is defined inside the Software package to run the needed products in real time or under a programmed schedule.

- The user simply has to define in the corresponding configuration files:
  - The products and tasks to be run
  - The satellite and region to be considered
  - The configuration of each product

  and provide the Satellite and NWP data in the corresponding directories.

- Then the Task Manager is started with a simple command:

  SAFNWCTM safnwc.cfs

The "Task Manager" then runs each product for each slot after the reception of the corresponding Satellite image files

NWC SAF Software installation and running

- The NWC SAF products can also be run manually with a few scripts.

- To run the "High Resolution Winds" product for a slot, the user only needs:

  1. To locate Satellite & NWP data in the corresponding directories:

     $SAFNWC/import/SEVIRI_data $SAFNWC/import/NWP_data

  2. To prepare NWP data for its use by NWC SAF products with:

     AllMappingNWP safnwc_region.cfs

  3. To run NWC SAF/Cloud products
     (Cloud mask, Cloud type, Cloud top temperature and height) with:

     PGE01 $slot safnwc_region.cfs safnwc_pge01.cfm (for CMa)
     PGE02 $slot safnwc_region.cfs safnwc_pge02.cfm (for CT)
     PGE03 $slot safnwc_region.cfs safnwc_pge03.cfm (for CTTH)

  4. To run NWC SAF/High Resolution winds with:

     PGE09 $slot safnwc_region.cfs safnwc_pge09.cfm

After this, NWC SAF/Cloud HDF5 outputs & NWC SAF/HRW BUFR outputs are available in $SAFNWC/export directory.

NWC SAF Software installation and running

- For any additional doubt/question on
  - NWC SAF software package,
  - How to get it and install it,
  - How to run the "High Resolution Winds" and visualize its outputs,

  do please ask afterwards.

NWC SAF Software installation and running

- Some possible users of NWC SAF/HRW as "Stand alone AMV Calculation Software" could complain on not having easy access to:
  - MSG/SEVIRI data
  - NWP data
  - Radiosounding data for Validation

needed to run/validate HRW AMVs, for any study they might be involved in.

A 3 month dataset (Jan-Mar 2010) including:
- SEVIRI data for the European area for every day between 1115-1200 UTC
- ECMWF NWP model forecast data
- Radiosounding data at 1200 UTC for Validation tasks

is available at NWC SAF (occupying ~35 GB).

It could be distributed for Research & testing, if the corresponding authorization could be granted from EUMETSAT/ECMWF.

With this, any possible user of NWC SAF/HRW would have all needed input data to run/test any possible improvement in AMV algorithms.

- **Additionally,**
  for any improvement in AMV extraction algorithms discovered by the users of NWC SAF/HRW as "Stand alone AMV Calculation Software":

  - **It could be included in the official release of HRW product, if it is considered to be a significant improvement.**

  - **The corresponding user can be economically awarded through a "NWC SAF Visiting Scientist Activity", because of the developments proposed to be integrated in the baseline NWC SAF/HRW algorithm.**

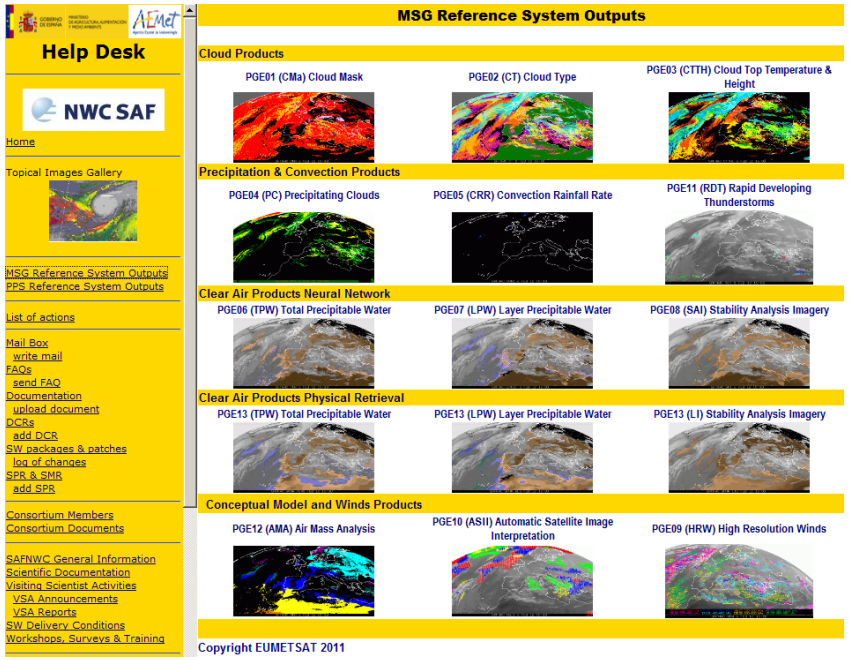
NWC SAF Helpdesk

The NWC SAF consortium keeps a fully dedicated HELPDESK at www.nwcsaf.org, where:

> The Reference System outputs are displayed in real time.

> Users can login and have access to (among other things):

- NWC SAF software package
- NWC SAF test datasets.
- The whole documentation.
- The Catalogue of software changes (SPRs) between versions.
- A Mailbox for interaction with NWC SAF developers.



All questions/doubts by users can be solved through this Mailbox, related to installation/use/problems with NWC SAF software and HRW product!

HRW as "Stand alone AMV Calculation Software"

- **Some conclusions can be extracted to consider NWC SAF/High Resolution Winds inside NWC SAF/MSG Software Package as "Stand alone AMV Calculation software":**

  - It satisfies all basic requirements:

  > It is very easy to get, install and use.

  > It is fairly easy to read (functions written in C language!), and the code is extensively commented to help its understanding.

  > It is fully portable and stand alone (independent from external applications).

  > It extracts AMVs from visible/infrared/water vapour channel data.

  > For the moment it only works with MSG satellite, but adaptations to other geostationary satellites are foreseen in the next years.

  > It has all necessary elements and none has to be provided additionally, including: - Cloud type and height information with RTTOV Transfer model.
  - A good height assignment procedure ("CCC method").
  - Quality control information.

HRW as "Stand alone AMV Calculation Software"

- **Some conclusions can be extracted to consider NWC SAF/High Resolution Winds inside NWC SAF/MSG Software Package as "Stand alone AMV Calculation software":**

  - **There is a fully dedicated Helpdesk where NWC SAF users (around ~100 already!) find support and help on the installation and use of the software.**

  - **There is a periodic release of new official HRW versions, where new developments in the product are implemented.**
    > **The "Visiting Scientist Activities" open the chance of including developments by users in the official release and be economically awarded.**

  - **There is a possibility on offering a "3 month test dataset (Jan-Mar 2010)" (if necessary permissions by EUMETSAT/ECMWF could be granted):**
    > **It would give potential users the possibility of running/validating any new AMV development they would be investigating.**

HRW as "Stand alone AMV Calculation Software"

Considering CGMS-38 (2010) statements on NWC SAF/High Resolution Winds:

> It is modular, well documented and well suited as "Stand alone AMV software".

> Significant changes can be made in it in a reasonable amount of time.

> It provides a very good, ready-to-go, starting point for researchers interested in getting involved in deriving atmospheric winds from satellite measurements.

> It can serve as focal point for sharing/comparing developmental code among among different research groups.

> Specific CGMS Action 38.29: EUMETSAT to conduct an extended validation campaign for AMVs derived with NWC SAF portable AMV software package:

- Was solved through a one year Validation campaign (Jul 2009-Jun 2010), at CGMS-39-EUMETSAT-WP-29 & HRW Validation Reports for v3.1 / v3.2.

In summary, CGMS-38 agreed to consider NWC SAF/HRW software as prototype for a "Stand alone portable AMV calculation software".

HRW as "Stand alone AMV Calculation Software"

Considering CGMS-39 (2011) Recommendations on NWC SAF/HRW software:

Rec. 39.25: CGMS agencies invited to:

> To further test HRW software in NWP data monitoring/assimilation systems:

➔ Already under way with NWP assimilation experiments in Hungary and UK.

> To extend it to clear sky WV AMVs.

➔ Already implemented in HRW v2012.

Rec. 39.26: Satellite AMV providers invited to examine the stand alone NWC SAF AMV software package and report back to CGMS-40:

➔ AMV producers already have access to HRW software for testing (CIMSS, JMA, KMA…)

Rec. 39.27: NWC SAF to consider providing a tested option to allow running of alternative algorithms to support intercomparison studies:

➔ It has been verified that significant changes can be made in it in a reasonable amount of time.

➔ A 3 month Running/Validation dataset for intercomparison of different procedures/methods is available.
It could be distributed to users if necessary permissions are granted.

HRW as "Stand alone AMV Calculation Software"

Finally, coming back to Initial discussions at IWW10 (CGMS-38 and -39):

It became apparent that <u>two different requirements should be considered separately</u>:

➔ **Greater involvement of research groups to help develop and test new approaches for deriving satellite-based AMVs.**

> HRW Software fully satisfies the basic requirements for this purpose

➔ **Increased collaboration between operational AMV producers to speed up improvements to AMV derivation and move towards more consistent approaches.**

> HRW Software can certainly be very helpful doing comparisons and developing collaborations between AMV producers

Thanks

Thoughts / Discussions