GOBIERNO DE ESPAÑA
MINISTERIO DE 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

Latest developments in NWC SAF High Resolution Winds (HRW) product

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Javier García-Pereda (jgarciap@aemet.es)

Régis Borde (regis.borde@eumetsat.int)

Roger Randriamampianina (roger@met.hu)

Index

High Resolution Winds New version v3.2

- High Resolution Winds (HRW) is the AMV product inside EUMETSAT Satellite application facility on support to Nowcasting software

- It provides high density sets of AMVs from MSG images for near real time applications.

- Two important changes between 2010 and 2012 up to version HRW v3.2 (released to users in March 2012):

  + Extension of AMV calculation to seven SEVIRI channels:
    HRVIS VIS06 VIS08 IR108 IR120 WV062 WV073

  + A new Height assignment procedure using "CCC method"
    (Borde & Oyama, 2008)

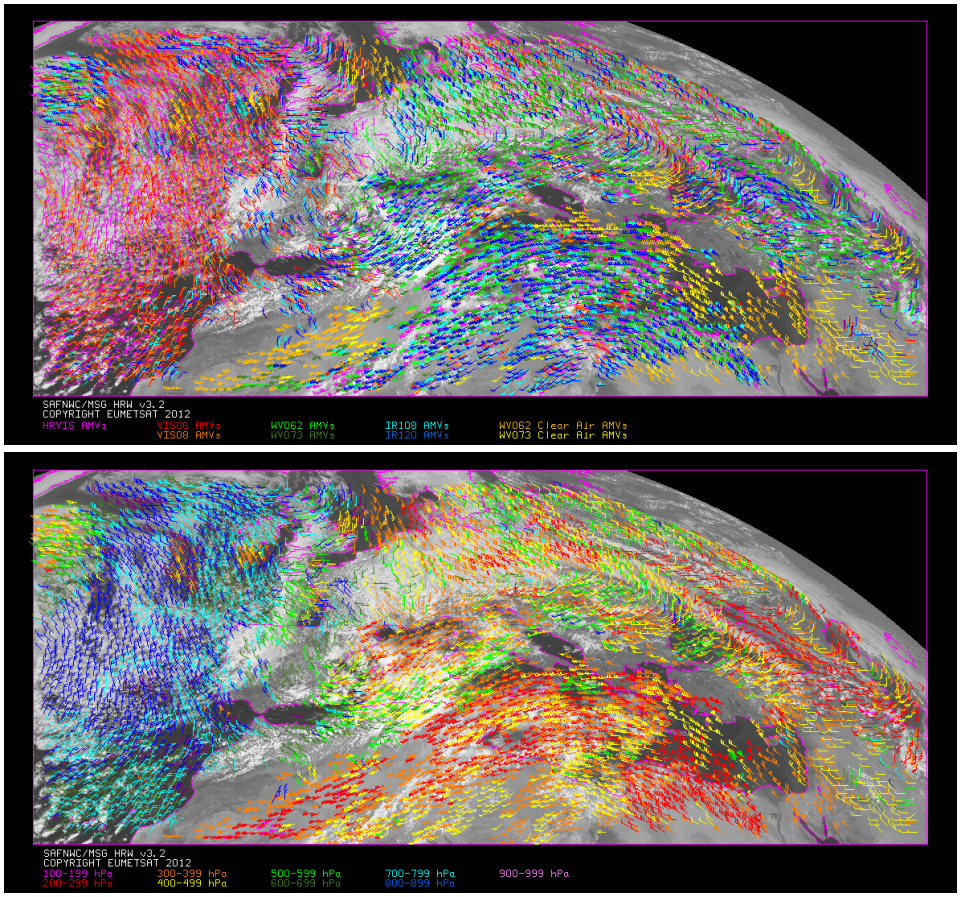
High Resolution Winds New version v3.2

With these changes:

- The density of AMV data increases significantly.
- Holes in coverage reduce significantly.
- Clear air AMVs calculated for the first time (with WV062 / WV073 channels).

Example of HRW v3.2 output for 14 May 2010 at 1200Z

Colours considering SEVIRI channel used (up) and AMV pressure level (down)



High Resolution Winds New version v3.2

Using "CCC method" for the Height assignment:

+ AMV pressure is defined considering only the pressure of pixels contributing most to the image correlation.

+ "NWC SAF Cloud products" (Cloud mask, Cloud type, Cloud top temperature & height) are processed together with HRW as cloud information input, including their techniques to set "Cloud height":

  > Opaque cloud top pressure retrieval from IR108/IR120 BTs, including:
  - RTTOV simulation of radiances.
  - Thermal inversion processing.

  > Semitransparent cloud top pressure retrieval with:
  - Radiance ratioing method (Menzel et al. 1983)
  - H_20/IRW intercept method (Schmetz et al. 1993) (using WV062, WV073 and IR134 as sounder channels).

High Resolution Winds New version v3.2

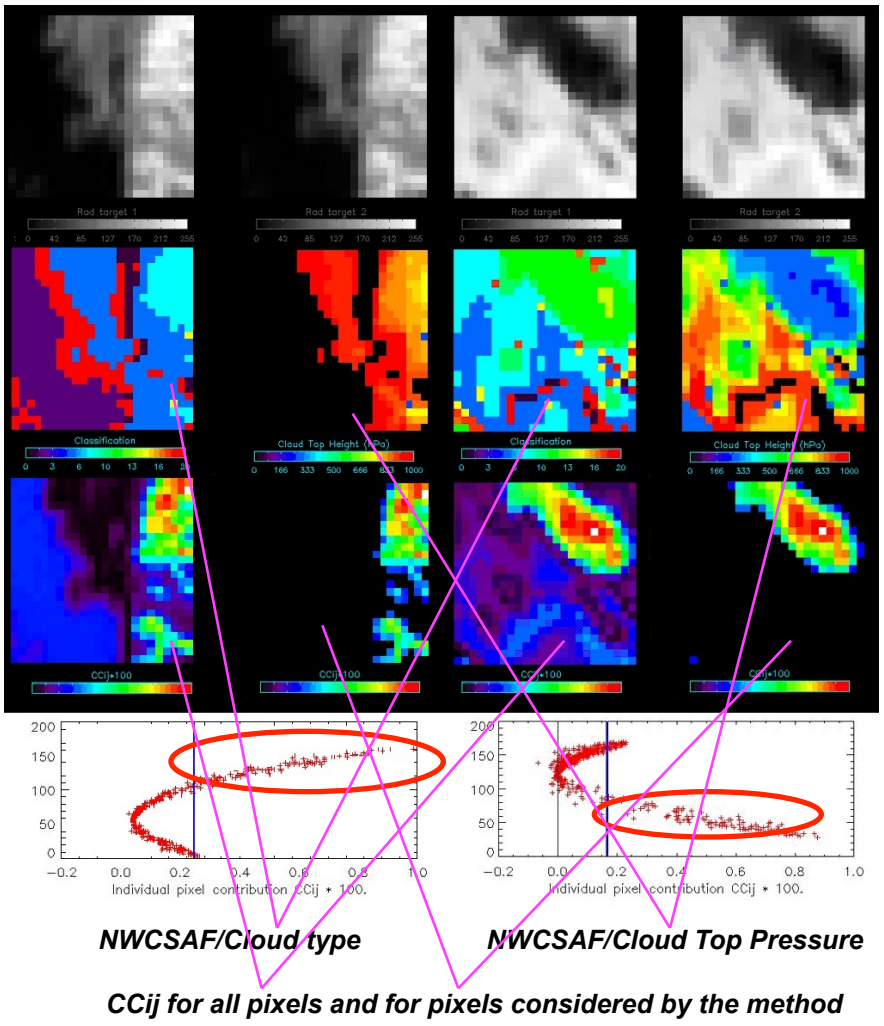
Additional conditions for Cloudy AMVs:

- NWC SAF/Cloud Top pressure used for calculation of "AMV pressure" and "AMV pressure error".

- Only cloudy pixels considered, as defined by NWC SAF/Cloud type.

- Bright branch of Refl(CC_{ij}) graph used in VIS cases.

- Largest branch of BT(CC_{ij}) graph used in WV/IR cases.



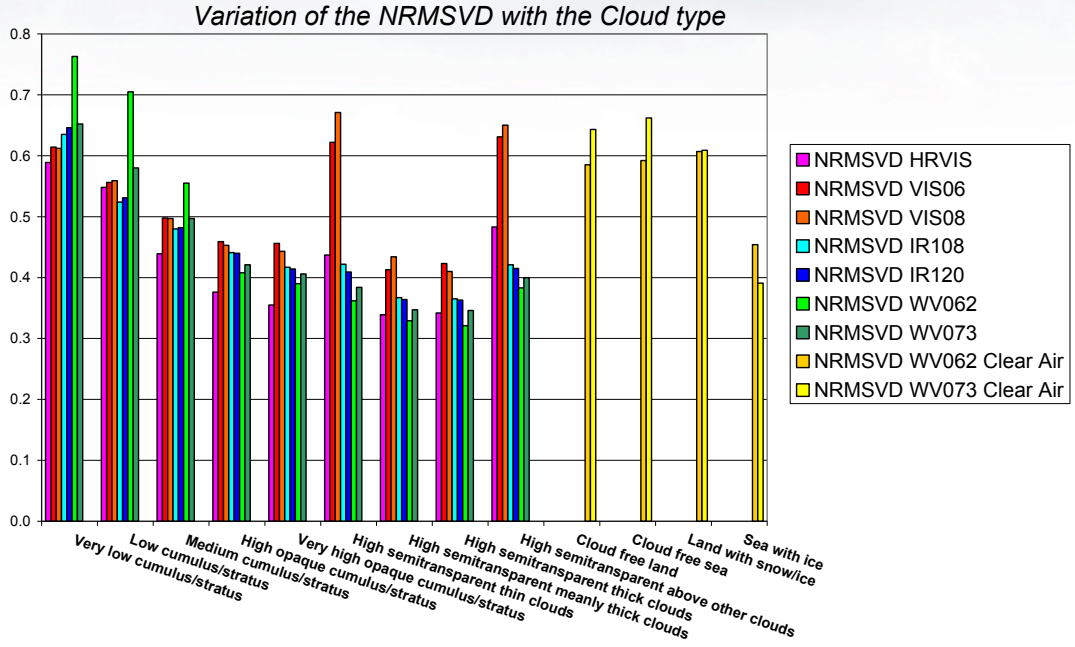
High Resolution Winds New version v3.2

Modifications for WV062 and WV073 Clear Air AMVs:

- "AMV temperature" and "AMV temperature error" calculated instead considering: - the "WV Brightness Temperature".
  - the "Cold branch of the BT(CCij) graph".

- "AMV pressure" calculated interpolating the "AMV temperature" to the NWP temperature forecast profile.

Validation of High Resolution Winds v3.2



	HRVIS	VIS06	VIS08	WV062	WV073	IR108	IR120
1 Cloud free land	■	■	■			■	■
2 Cloud free sea	■	■	■			■	■
3 Land contaminated by snow/ice	■	■	■			■	■
4 Sea contaminated by ice	■	■	■			■	■
6 Very low cumulus/stratus				■			
8 Low cumulus/stratus				■			
10 Medium cumulus/stratus				■			
12 High opaque cumulus/stratus		■	■			■	■
14 Very high opaque cumulus/stratus		■	■			■	■
15 High semitransp. thin clouds	■	■	■				
16 High semitransp. meanly thick clouds		■	■				
17 High semitransp. thick clouds		■	■				
18 High semitransp. above other clouds	■	■	■				

Some filterings are defined, with the variation of NRMSVD with the Cloud type and the MSG channel:

HRVIS AMVs valid for all cloudy types except "High semitransparent thin and above other clouds".

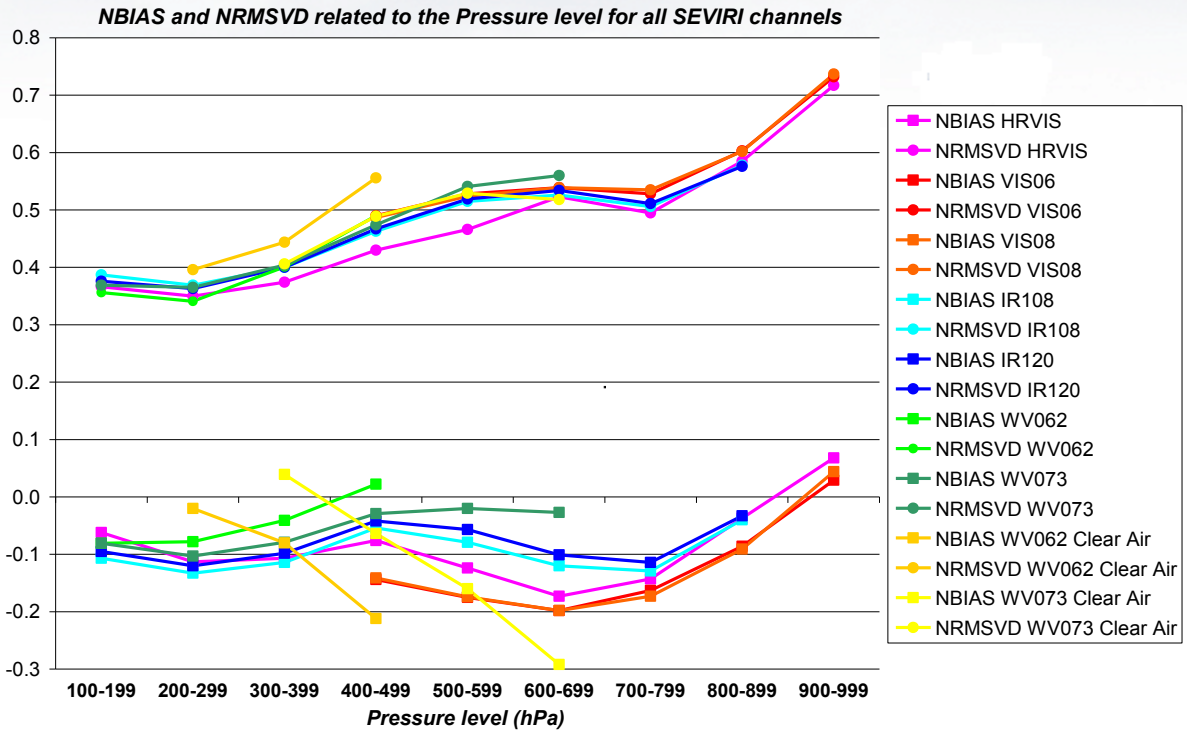
VIS06 and VIS08 AMVs only valid for "Very low to medium clouds".

IR108 and IR120 AMVs valid for all cloudy types except "High & very high opaque clouds".

WV062 AMVs valid for all types except "Very low to medium clouds".

WV073 AMVs valid for all types.

Validation of High Resolution Winds v3.2



Verifying the NBIAS/NRMSVD with the Pressure level and the SEVIRI channel:

> Small differences in the NRMSVD for AMVs related to different channels:
  - Only HRVIS AMVs lower values // WV062 Clear air AMVs higher values.

> Cloudy NBIAS progressively more negative in WV, IR, HRVIS, LRVIS AMVs.

> Clear air NBIAS more negative at lower levels and larger in the WV062 AMVs.

Validation of High Resolution Winds v3.2

- **Comparing Validation statistics against Radiosoundings for versions HRW v2010 and v2012 (July 2009-June 2010, in the 'Europe & Mediterranean region'):**

HRW v3.0 AMV Validation (Jul 2009-Jun 2010)	cloudy HRVIS			cloudy IR108						all AMVs
NC	53915			47941						101856
SPD [m/s]	15.03			17.01						15.96
NBIAS (ALL LAYERS)	-0.04			-0.03						-0.04
NMVD (100-1000 hPa)	0.38			0.40						0.39
NRMSVD	0.48			0.49						0.48

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

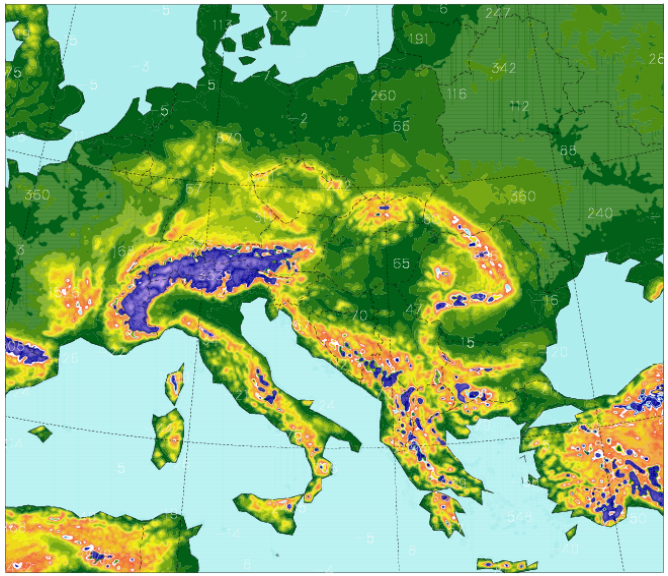
> There is an important increase in the amount of AMV data.

> There is a very important reduction of the NMVD/NRMSVD (~20%).

> But also an increase in the NBIAS.

NWP Assimilation studies of HRW AMVs

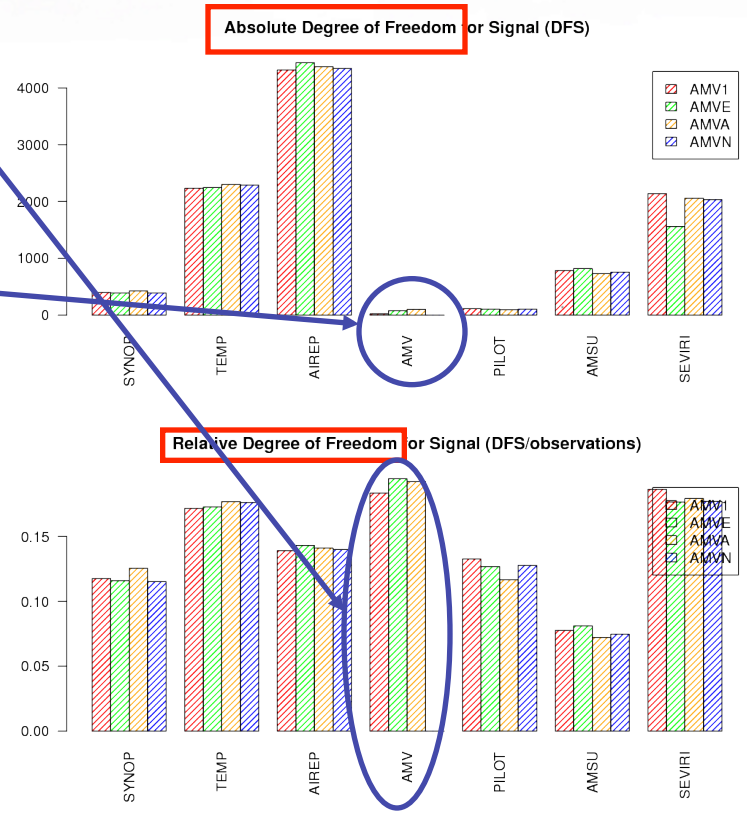
- An HRW AMVs Assimilation study (comparing with MPEF AMVs) has been done by Roger Randriamampianina (Hungarian Met. Service) during one summer month in 2011, using its:
  - Hydrostatic ALADIN CY36T1 Limited area NWP model.
  - 3DVAR Upper air assimilation analysis
  - Optimum interpolation surface analysis
  - Digital filter initialization technique



- HRW v2011 used, with Assimilation of:
  - > HRVIS AMVs by day.
  - > IR108 AMVs by night.
  - > Number of active AMV observations per satellite channel in the tens (similarly to MPEF AMVs).

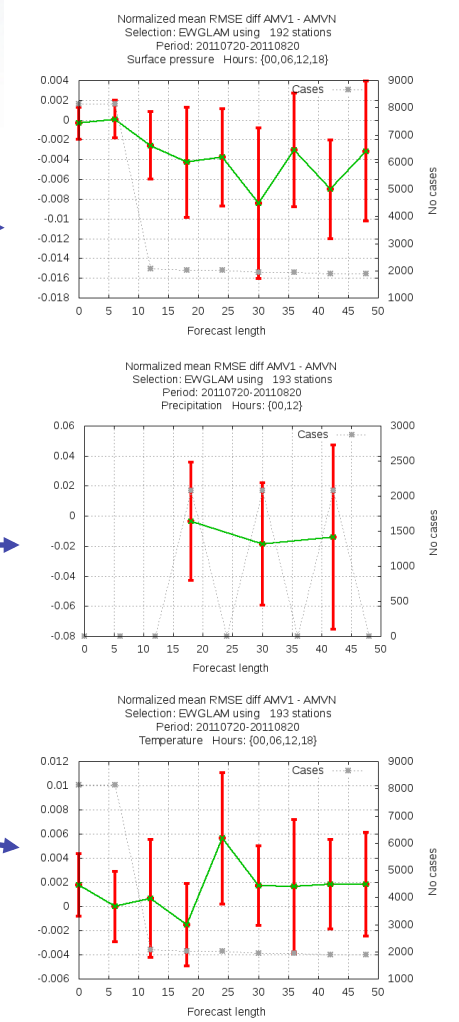
NWP Assimilation studies of HRW AMVs

- The relative impact in the Analysis of AMV data (MPEF & HRW) is very important, although the absolute impact is small because of the small amount of active AMVs.
  - > Red dataset: with HRW AMVs.
  - > Green dataset: with MPEF AMVs.
  - > Yellow dataset: with both AMVs.



NWP Assimilation studies of HRW AMVs

- **Considering the NWP forecast, the inclusion of HRW AMVs causes:**
  - > **Small reductions in the mean RMSE of the surface pressure (specially in the second day; sometimes significant).**
  - > **Reductions in the mean RMSE of the precipitation.**
  - > **But also very slight increases in the mean RMSE of the 2 meter temperature.**



* A report on this is now being prepared!
* Additional assimilation studies are now under way at the UK Met.Office (➔ G.Kelly)

Study on "Temporal and spatial scaling issues in AMV extraction"

- HRW v3.2 version has been used for an AMV Validation study with EUMETSAT comparing AMVs with:
  - Different target sizes (8x8, 16x16, 24x24, 32x32, 40x40 pixels).
  - Different temporal gaps between images (5, 10, 15, 20, 25, 30, 45, 60, 75, 90 min.)
  - Two different image scales (1 km SEVIRI/HRVIS, 3 km SEVIRI/VIS08).
  - Two different NWP model scales (0.5º and 0.125º ECMWF model data).
  - The use or not of "NWP wind guess" in the definition of the tracking area.

- The "European & Mediterranean region" during the period Jan-Jun 2010 is considered for the validation, comparing 1200Z AMVs against:
  - Radiosoundings.
  - NWP wind analysis.
  - NWP wind analysis at the best fit level.

Study on "Temporal and spatial scaling issues in AMV extraction"

Main conclusions of the study:

+ Good AMVs can be calculated with all configurations
  > Mean NRMSVD between 0.25 and 0.60.

+ The use in AMV algorithm of NWP data with different resolutions has basically no impact in AMV output.

+ Validation statistics better not using the wind guess:
  > General small reduction of NBIAS / NRMSVD.
  > There is also a reduction in the amount of AMV data but in cases operatively interesting not too significant.

AMV Validation (Jan-Jun 2010) with Radiosoundings 24x24 pixels / 15 min. time gap	HRVIS With wind guess 0.5° NWP	HRVIS With wind guess 0.125° NWP	HRVIS Without wind guess 0.125° NWP	VIS08 With wind guess 0.5° NWP	VIS08 With wind guess 0.125° NWP	VIS08 Without wind guess 0.125° NWP
NC	19874	19800	16254	15604	15520	14880
NBIAS (100-1000 hPa)	-0.105	-0.104	-0.098	-0.187	-0.186	-0.185
NRMSVD	0.381	0.380	0.374	0.475	0.473	0.466

Comparing Validation statistics against the different types of data:

+ Against NWP data:
  - NRMSVD better than against Radiosoundings (up to a 30% smaller)

+ Against NWP best fit level:
  - NRMSVD reduces up to 0.08 (HRVIS case) and 0.11 (VIS08 case).
  - NBIAS reduces up to -0.02 (HRVIS case) and -0.03 (VIS08 case).

➔This verifies that HRW (AMV) errors can improve very significantly only through changes in the Height assignment process!

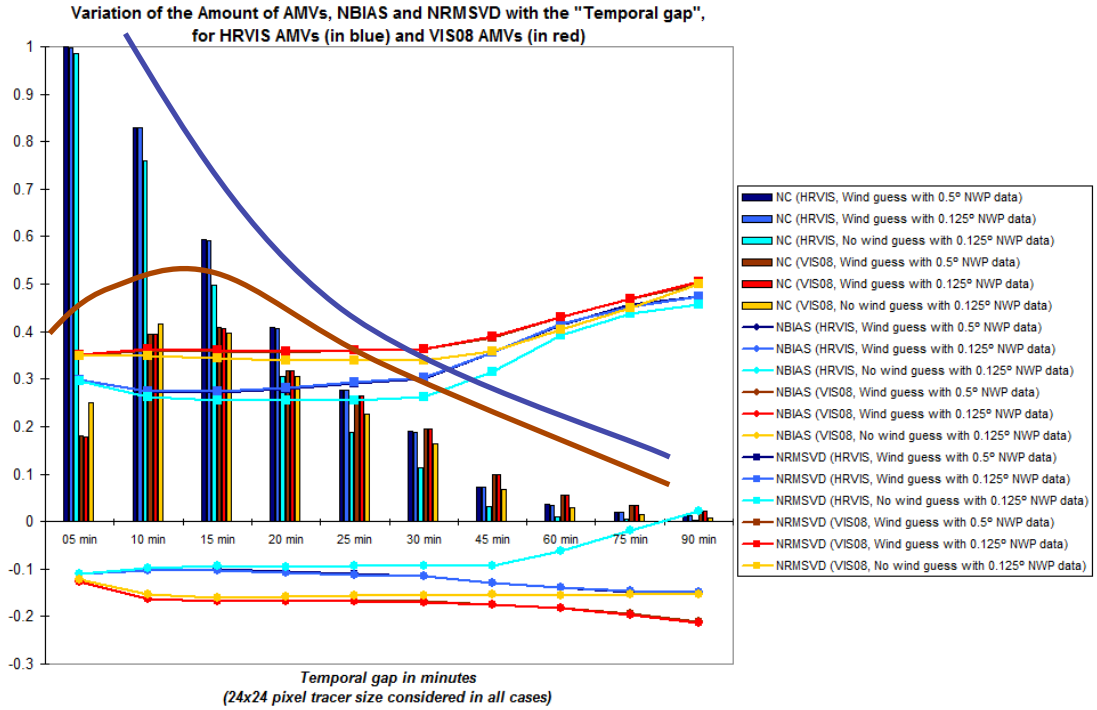
AMV Validation (Jan-Jun 2010) Running without wind guess and 0.125 NWP model data 24x24 pixels / 15 min. time gap	HRVIS against Radiosound.	HRVIS against NWP at AMV level	HRVIS against NWP at best fit level	VIS08 against Radiosound.	VIS08 against NWP at AMV level	VIS08 against NWP at best fit level
NBIAS (100-1000 hPa)	-0.098	-0.093	-0.021	-0.185	-0.160	-0.029
NRMSVD	0.374	0.254	0.091	0.466	0.345	0.120

Study on "Temporal and spatial scaling issues in AMV extraction"

Considering the "Temporal gap", the "Maximum amount of AMVs" is:

+ For a temporal gap of 5 min. for HRVIS 1 km pixel scale.
  For a temporal gap of 10-15 min. for VIS08 3 km pixel scale.

+ Up to 30 min.: Impact in NBIAS/NRMSVD small
+ For larger temp. gaps: larger NRMSVD (keeping always below 0.60).
  NBIAS more negative (if wind guess used).



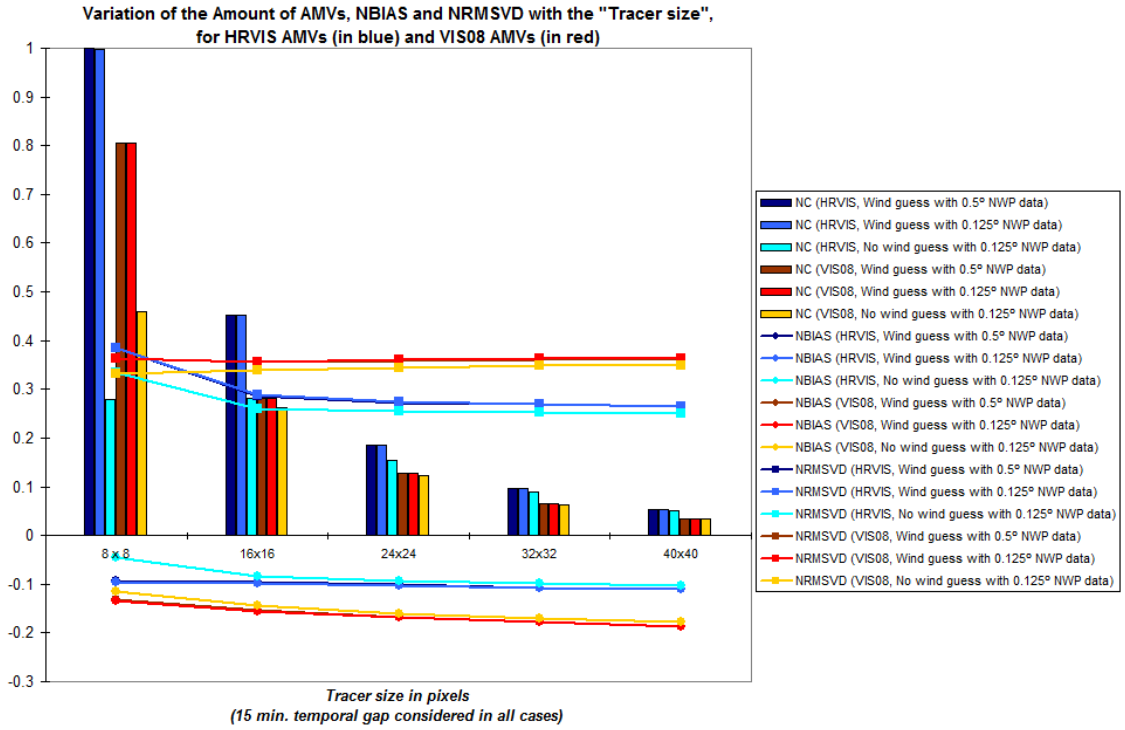
If both pixel scales are run together, a 10 min. Temp. gap maximizes amount of AMVs with very good NBIAS/NRMSVD values.

(Known since two years ago for "HRW default Rapid scan config.").

Study on "Temporal and spatial scaling issues in AMV extraction"

Considering the "Tracer size":

+ More negative NBIAS with larger tracer sizes.
+ No impact in the NRMSVD with tracer sizes of 16x16 km or larger



A Tracer size of at least 16x16 km seems to optimize the Validation statistics and the Amount of AMV data

Some additional ideas:

+ Preference for smaller tracer sizes when comparing with Radiosounding/NWP winds at AMV level as reference data.
  > A better Height assignment seems to occur with smaller tracers (with a smaller dispersion of heights inside the tracer).

+ Statistics against NWP at best fit level prefer INSTEAD larger tracer sizes
  > Once the Height assignment is solved, AMV error related to Tracking (better solved with larger tracers, better avoiding false correspondences of unrelated patterns between images).

Study on "Temporal and spatial scaling issues in AMV extraction"

AEMet Agencia Estatal de Meteorología

NWC SAF Support to Nowcasting and Very Short Range Forecasting

Final results of this study:

+ A Report on this study is being prepared for April 2012.
  (A "Intermediate Report" with all statistics is already finished).

+ The study is going to be extended later on
  to AMVs from IR108 / WV062 channels.

+ Because the "Statistics against the NWP best fit level"
  show that at least ~70% of error is related to the height assignment,
  a study is going to be done on "AMV level – NWP best fit level",
  to find a possible relationship between both.

  > If this is possible,
  NBIAS could reduce to a value near the optimum -0.02/-0.03
  and NRMSVD could reduce to a value near the optimum 0.08/0.11,
  improving extraordinarily HRW AMV statistics.

Future evolution of NWCSAF/HRW product

- NWC SAF starts now a new phase (CDOP-2) until 2017.

- New developments during this phase for HRW algorithm:
  - > Extension to additional SEVIRI channels (suggestions?).
  - > "Use without wind guess" as default option through further optimizations (nevertheless, it is already available).
  - > Changes in Quality Control, including:
    - Dependence of QI threshold with density of AMV data.
    - Inclusion of QI without forecast.
  - > Adaptation of HRW algorithm to other Geostationary satellites (after adaptation of NWC SAF Cloud products).
  - > Use of HRW output in other NWC SAF applications (like "Calculation of trajectories" or "Satellite and NWC SAF images extrapolation").

- And any other one suggested by HRW users, among them those related to its possible use as "Stand alone AMV calculation software"

➔ A session on this has been programmed for Thursday.