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EUMETSAT

Monitoring weather and climate from space
Surveiller le temps et le climat depuis l'espace

The impact of the Wind guess, the Tracer size and the Temporal gap between images in the extraction of AMVs

18th June 2014

Twelfth International Winds Workshop
Copenhagen, Denmark

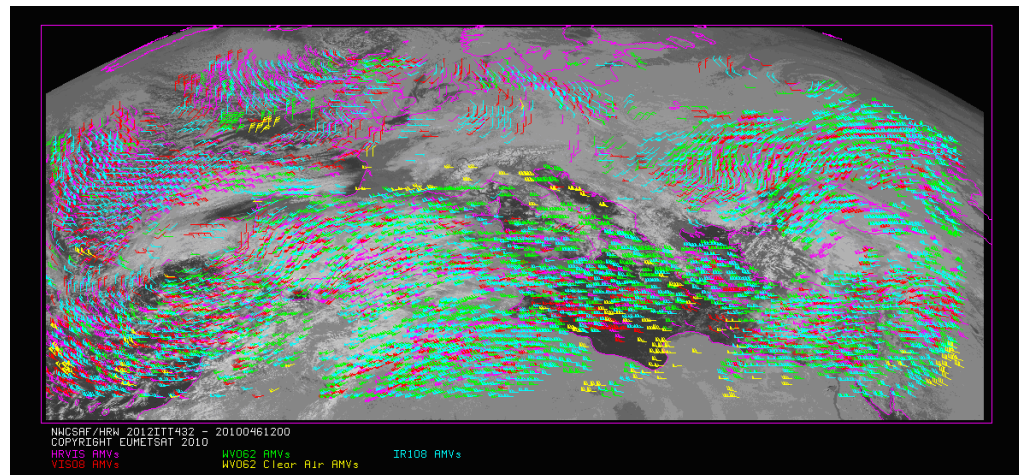
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- I. Aim of this study**
- II. Impact of the Wind guess in the extraction of AMVs**
- III. Impact of the Tracer size and the Temporal gap in the extraction of AMVs**
- IV. Conclusions**

- **AMVs are assimilated in NWP global models for a long time**
- **The evolution to smaller scale regional models needs assimilation of smaller scale observations**
 - For example, by using **AMVs with Rapid scan imagery**
AMVs with smaller tracer sizes
AMVs from high resolution channels
- **There is obviously a link between the spatial scale of the tracked feature and its lifetime**
→ Better understanding this link is the objective of this study.

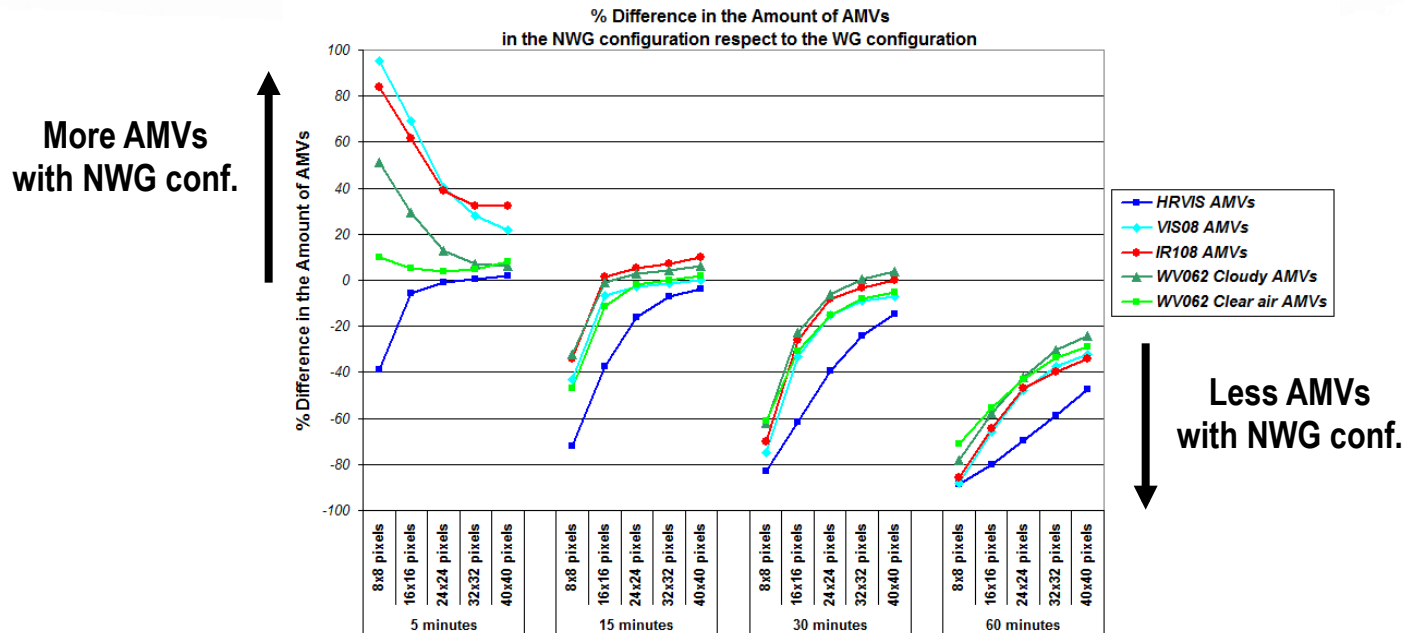
- **NWCSAF/High Resolution Winds software** has been used for a **Validation study** comparing AMVs:
 - Based on **4 different MSG/SEVIRI channels** (HRVIS, VIS08, IR108, WV062).
 - **Using/not using NWP wind guess** in the definition of the tracking area.
 - With **5 different target sizes** (8x8, 16x16, 24x24, 32x32, 40x40 pixels).
 - With **10 different temporal gaps between images** (5, 10, 15, 20, 25, 30, 45, 60, 75, 90 min).
- **1200Z AMVs** for 132 days in the period **Jan-Jun 2010** in the **European & Mediterranean region** have been calculated, validating against:
 - **Radiosoundings.**
 - **NWP wind analysis.**



Other similar studies exist, but with a much smaller validation period!!

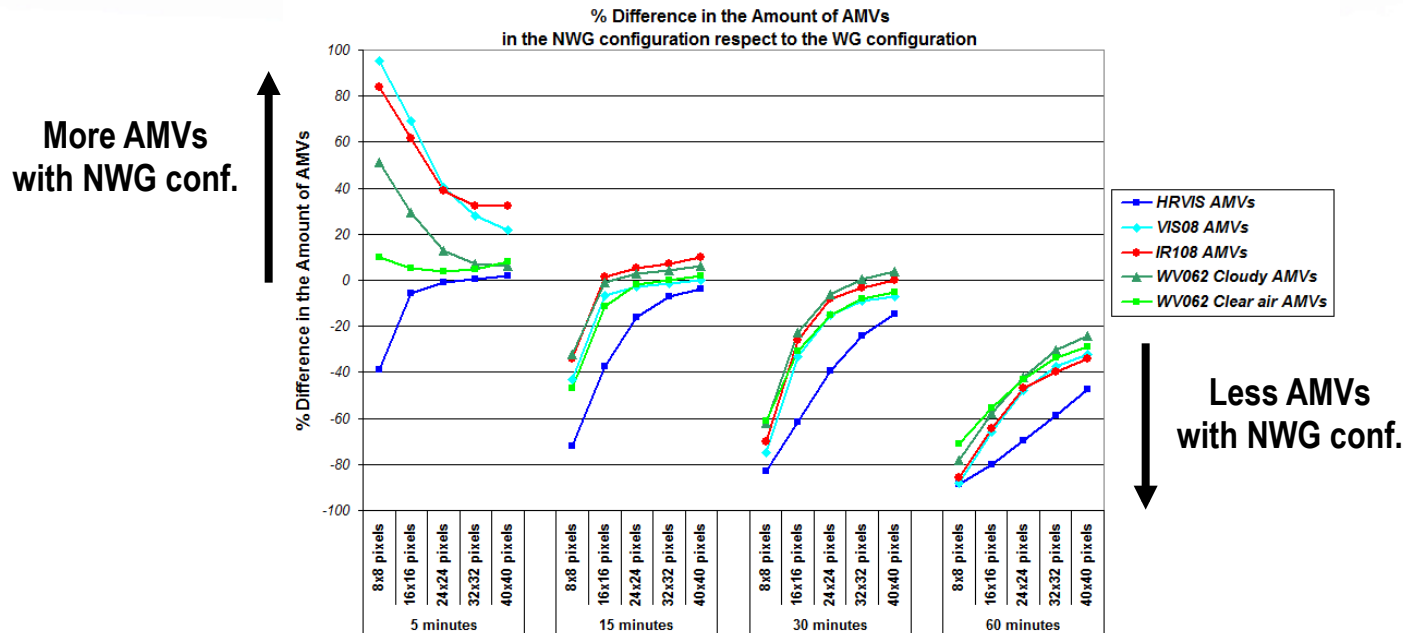
Impact of the wind guess

Considering the amount of AMVs:



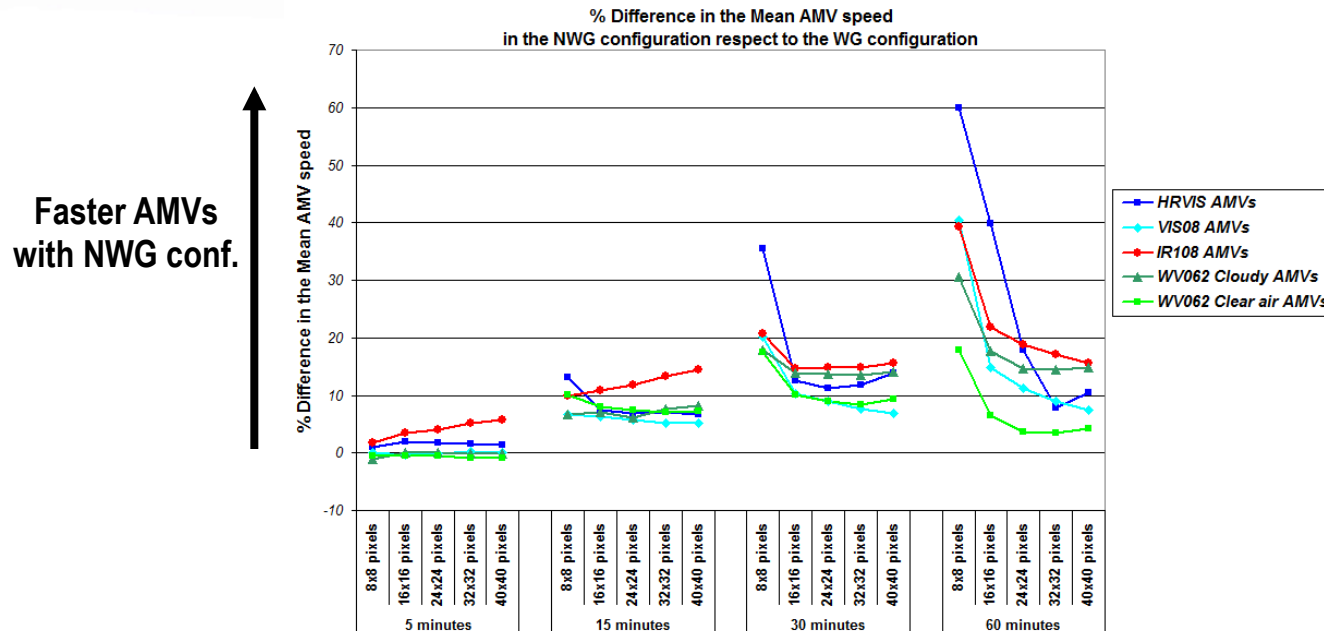
- + Smaller amount of AMVs in NWG conf.
with long temporal gaps or small tracer sizes (up to 89% ▼)
- + This result is in contradiction with theoretical expectations:
 - Shouldn't NWG find all solutions in WG conf. + additional ones not found by WG because of its constraints?

Considering the amount of AMVs:



- + Explanation might be related to the QI and its spatial quality test
 - ➔ WG conf. AMVs less noisy and more in agreement with each other
 - ➔ Having a higher QI, but maybe:
 - > Inferring a 'wrong tracking' (long gaps and small tracers used!) ?
 - > Inferring an 'artificial replication' of the wind guess?

Considering the mean AMV speed:



- + **Faster AMVs in NWG conf., specially for long temporal gaps with small tracer sizes (up to 60% ▲).**
 - > Faster AMVs more possibly outside of the tracking area in WG conf.
- + **Small difference between NWG and WG confs. for short temporal gaps.**

Considering the NBIAS (against NWP analysis):

NBIAS for WG configuration

	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels
	HRVIS			VIS08			IR108			WV062 Cloudy			WV062 Clear air		
5 min.	-0.09	-0.11	-0.12	-0.08	-0.13	-0.15	-0.04	-0.09	-0.11	+0.01	-0.01	-0.04	-0.00	-0.05	-0.06
15 min.	-0.10	-0.10	-0.11	-0.13	-0.17	-0.19	-0.07	-0.10	-0.12	-0.02	-0.04	-0.06	-0.03	-0.08	-0.11
30 min.	-0.11	-0.12	-0.13	-0.13	-0.17	-0.19	-0.08	-0.10	-0.12	-0.04	-0.05	-0.07	-0.07	-0.09	-0.12
60 min.	-0.13	-0.14	-0.15	-0.15	-0.18	-0.20	-0.12	-0.13	-0.14	-0.09	-0.08	-0.09	-0.11	-0.12	-0.14

Difference in the NBIAS
in the NWG configuration respect to the WG configuration

	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels
	HRVIS			VIS08			IR108			WV062 Cloudy			WV062 Clear air		
5 min.	+0.01	+0.00	+0.00	+0.01	+0.01	+0.00	+0.01	+0.01	+0.01	-0.00	-0.01	-0.00	+0.00	-0.01	-0.02
15 min.	+0.05	+0.01	+0.01	+0.02	+0.01	+0.01	+0.02	+0.01	+0.02	+0.01	+0.01	+0.01	+0.04	+0.02	+0.02
30 min.	+0.14	+0.02	+0.02	+0.04	+0.01	+0.01	+0.05	+0.02	+0.02	+0.04	+0.02	+0.02	+0.07	+0.03	+0.03
60 min.	+0.25	+0.08	+0.03	+0.13	+0.02	+0.02	+0.12	+0.05	+0.02	+0.10	+0.03	+0.02	+0.08	+0.02	+0.01

+ Less negative NBIAS in NWG conf.,
specially for **long temporal gaps & small tracer sizes.**

+ Sometimes even becoming positive for the smallest tracer size.

Considering the NRMSVD (against NWP analysis):

NRMSVD for WG configuration

	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels
	HRVIS			VIS08			IR108			WV062 Cloudy			WV062 Clear air		
5 min.	0.34	0.30	0.28	0.37	0.35	0.35	0.34	0.32	0.31	0.29	0.27	0.25	0.31	0.30	0.29
15 min.	0.39	0.27	0.27	0.36	0.36	0.36	0.29	0.27	0.27	0.23	0.22	0.21	0.28	0.28	0.28
30 min.	0.49	0.30	0.30	0.38	0.36	0.37	0.31	0.26	0.27	0.28	0.23	0.24	0.33	0.29	0.29
60 min.	0.53	0.42	0.39	0.49	0.43	0.43	0.43	0.33	0.33	0.40	0.30	0.31	0.38	0.32	0.32

% Difference in the NRMSVD
in the NWG configuration respect to the WG configuration

	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels
	HRVIS			VIS08			IR108			WV062 Cloudy			WV062 Clear air		
5 min.	-8%	-1%	-1%	-2%	-0%	-0%	-5%	-5%	-6%	-1%	+1%	+2%	-5%	+2%	+3%
15 min.	-13%	-7%	-6%	-9%	-4%	-4%	-12%	-9%	-11%	-7%	-5%	-6%	-7%	-4%	-4%
30 min.	-10%	-13%	-11%	-8%	-7%	-5%	-13%	-13%	-12%	-12%	-12%	-12%	-9%	-7%	-7%
60 min.	-8%	-6%	-7%	-3%	-6%	-6%	-8%	-12%	-11%	-8%	-13%	-14%	-6%	-5%	-4%

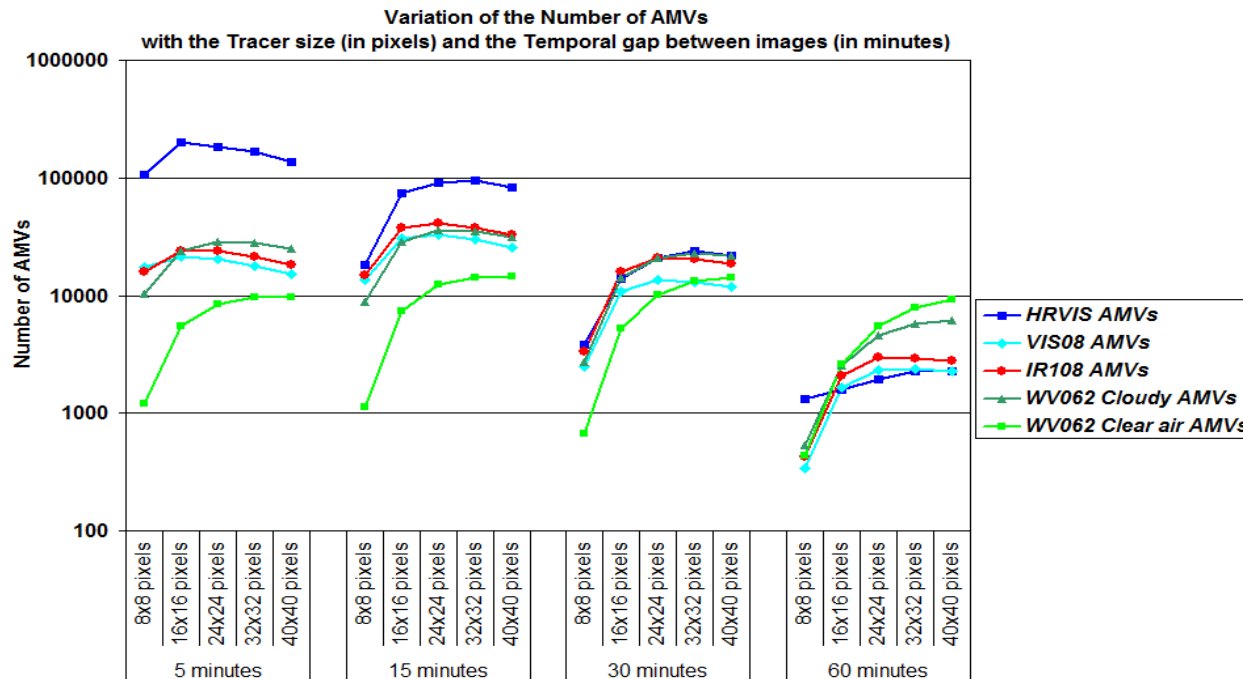
- + Smaller NRMSVD in the NWG conf.,
except in a few cases using the shortest temporal gap.
- + Maximum reduction of the NRMSVD in the NWG conf. up to 15% ▼ .
- + Similar trends for both NBIAS and NRMSVD against Radiosoundings.

Impact of the wind guess in the definition of the tracking area:

- + **AMV statistics better in the NWG conf.**
(NBIAS/NRMSVD against Radiosoundings/NWP analysis)
- + **Worse performance of WG conf. expectedly related to a wrong estimation of the AMV altitude before the tracking**
 - ➔ **Causing a bad definition of the tracking area;**
the correct matching solution cannot be found.
- + **Larger amount of AMVs in WG conf.**
for long gaps, small tracer sizes may imply:
 - ➔ **Calculated AMVs are mainly (only?)**
containing information coming from the NWP model.

Impact of the Tracer size and the Temporal gap between images

Considering the number of AMVs:



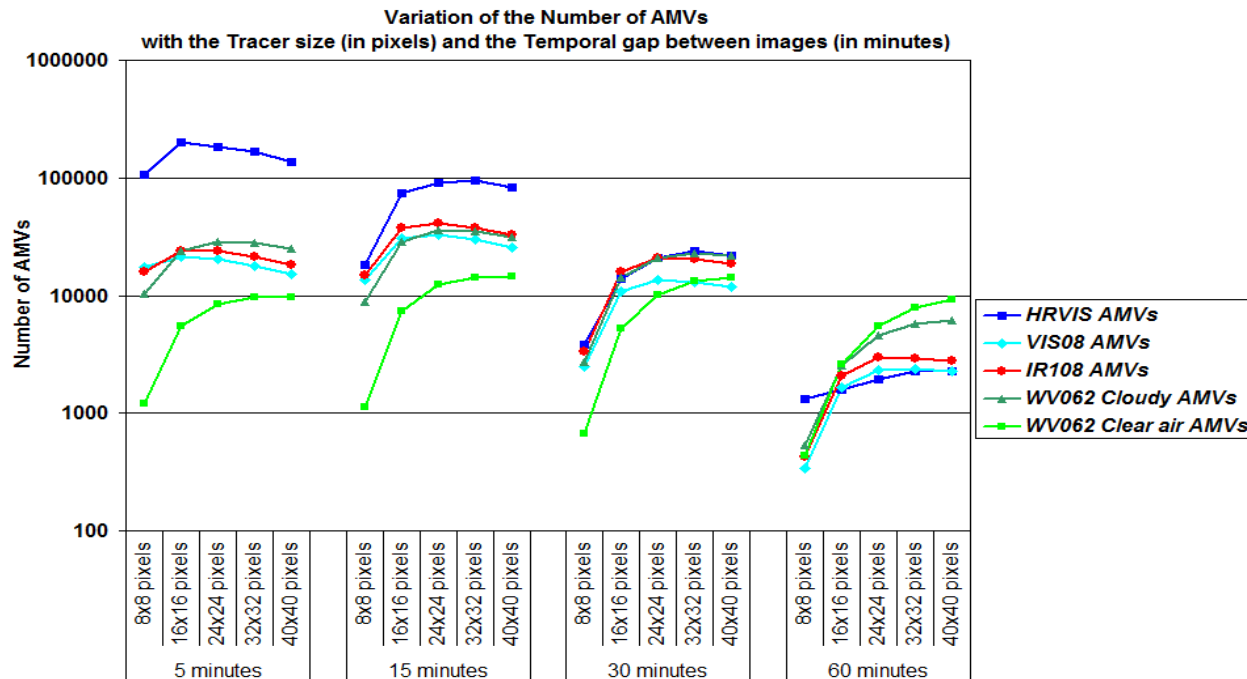
+ Maximum number of AMVs:

> 5 min. gap in 1 km pixel scale; 10 min. gap in 3 km pixel scale.

> 16x16 to 24x24 pixel tracer size in 3 km pixel scale VIS/IR AMVs;
Up to 40x40 pixel tracer size in WV AMVs, specially Clear air AMVs.

Impact of the Tracer size and the Temporal gap between images

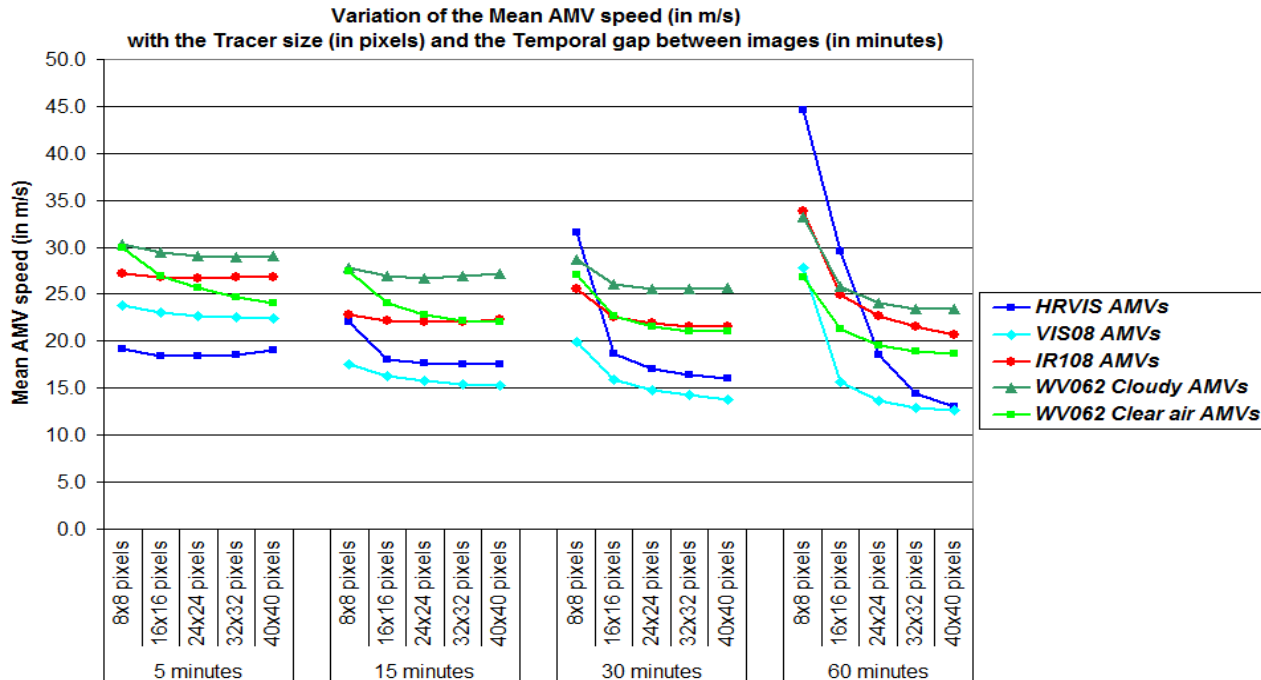
Considering the number of AMVs:



- + Number of AMVs related to the lifetime of the features to be tracked.
 - > Longer persistence of Brightness Temperature (IR/WV) features respect to Reflectance (VIS) features.
 - > Longer persistence of WV humidity features respect to WV cloud features. (Clear air AMVs 3% of total for 5 min. gap; 49% of total for 90 min. gap).

Impact of the Tracer size and the Temporal gap between images

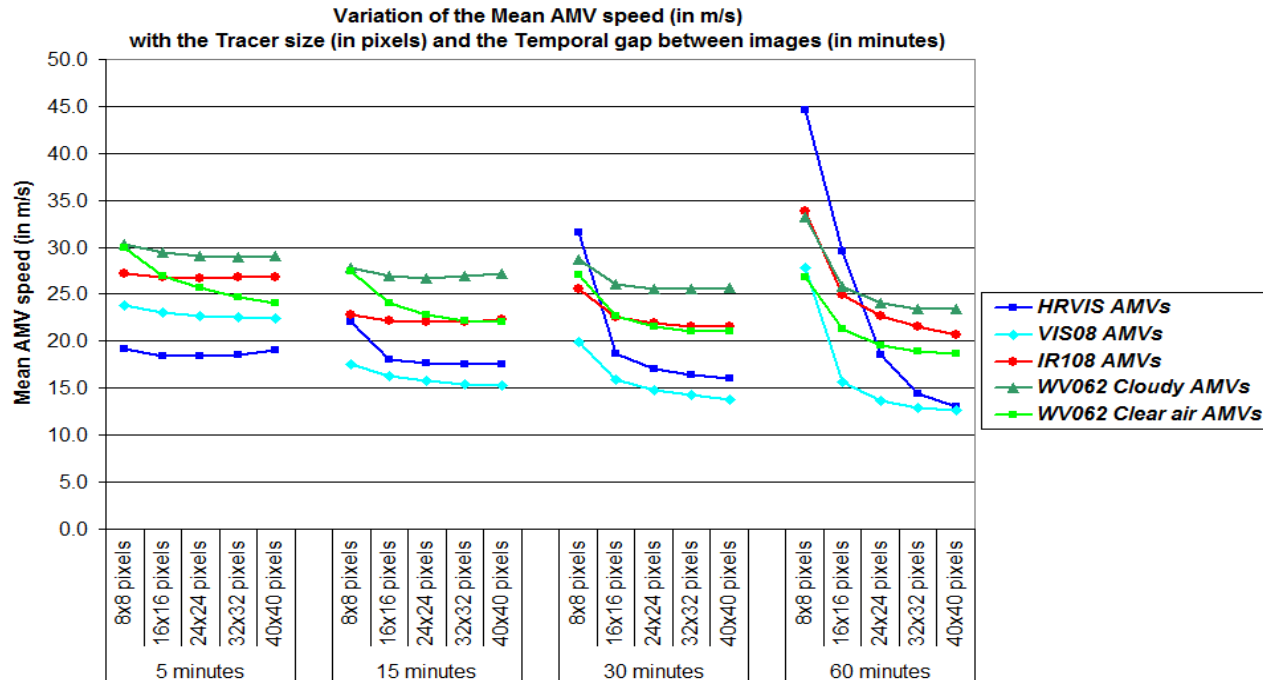
Considering the mean AMV speed:



- + Smaller mean AMV speed for larger tracer sizes.
- + Smaller mean AMV speed for long gaps when large tracer sizes used.
- + Very large mean AMV speeds for long gaps when small tracer sizes used.

Impact of the Tracer size and the Temporal gap between images

Considering the mean AMV speed:



> Better persistence of small tracers when related to strong winds?
of large tracers when related to weak winds?

➔ Very specific AMV types located at different levels of the atmosphere
calculated for **long temporal gaps and small/large tracers!!**

Impact of the Tracer size and the Temporal gap between images

Considering the NBIAS:

	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels
	HRVIS NWP Analysis			VIS08 NWP Analysis			IR108 NWP Analysis			WV062 Cloudy NWP			WV062 Clear air NWP		
5 min.	-0.08	-0.11	-0.11	-0.07	-0.12	-0.15	-0.03	-0.08	-0.10	+0.01	-0.02	-0.04	+0.00	-0.06	-0.08
15 min.	-0.04	-0.09	-0.10	-0.11	-0.16	-0.18	-0.05	-0.09	-0.10	-0.01	-0.03	-0.05	+0.01	-0.06	-0.09
30 min.	+0.03	-0.09	-0.11	-0.09	-0.15	-0.18	-0.03	-0.08	-0.10	-0.00	-0.03	-0.05	+0.01	-0.06	-0.09
60 min.	+0.11	-0.06	-0.12	-0.02	-0.16	-0.18	-0.00	-0.08	-0.12	+0.01	-0.04	-0.07	-0.03	-0.09	-0.12

- + **NBIAS** more clearly negative for long temporal gaps with large tracer sizes.
- + **Positive NBIAS** in some cases with small tracer sizes.
- + **Similar trends** against both Radiosounding (not shown) and NWP analysis winds.

Impact of the Tracer size and the Temporal gap between images

Considering the NRMSVD:

	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels	8x8 pixels	24x24 pixels	40x40 pixels
	HRVIS NWP Analysis			VIS08 NWP Analysis			IR108 NWP Analysis			WV062 Cloudy NWP			WV062 Clear air NWP		
5 min.	0.31	0.29	0.28	0.36	0.35	0.34	0.32	0.30	0.29	0.29	0.27	0.26	0.29	0.30	0.30
15 min.	0.33	0.25	0.25	0.33	0.34	0.35	0.25	0.24	0.24	0.21	0.21	0.20	0.26	0.27	0.27
30 min.	0.44	0.26	0.26	0.35	0.34	0.35	0.27	0.23	0.23	0.24	0.20	0.21	0.30	0.27	0.27
60 min.	0.49	0.39	0.37	0.47	0.40	0.40	0.39	0.29	0.29	0.36	0.26	0.27	0.35	0.30	0.30

- + **Minimum NRMSVD** values for **temporal gaps between 15 & 30 min.**
> Increment for longer gaps less noticeable in WV AMVs.
- + **Smaller NRMSVD** values for **larger tracer sizes.**
- + **Similar trends** against both
Radiosounding (not shown) and NWP analysis winds.

A separate study was done, considering AMVs at exactly the same latitude/longitude localizations.

Similar results obtained:

- + **Small impact of the tracer size in the number of AMVs** (more significant for Clear air AMVs)
- + **Important reduction of the number of AMVs** with long temporal gaps.
- + **Smaller mean AMV speed** for large tracer sizes.
- + **Smaller mean AMV speed** for long gaps with large tracer sizes.
- + **More negative NBIAS** for large tracer sizes with long temporal gaps.
- + **Minimum NRMSVD** for large tracer size with intermediate temporal gaps.

Results inherent to AMV characteristics, not dependent on the data used !!

General agreement with similar studies in the past with less extensive validation datasets:

- Shimoji & Hayashi (2012),
- Bresky et al. (2012),
- Sohn & Borde (2008).

With all, a balance is needed to be found for an optimum calculation of AMVs:

5 to 10 minute temporal gaps provide the largest amount of AMVs.

But **15 to 30 minute temporal gaps** provide the best NRMSVD values.

Smaller NBIAS values for smaller tracer sizes.

But **smaller NRMSVD values** for larger tracer sizes.

All parameters cannot be optimized at the same time !!

Defining a working configuration with 3 km pixel resolution images:

- * Reduce the temporal gap up to 10 minutes or the nearest larger value.
 - > Large amount of AMVs.
 - > NBIAS & NRMSVD difference respect to best values smaller than 15%.
 - Nominal gap for most current/future geo satellites.
 - 5 min. temporal gap implies a more noticeable increase of NRMSVD.
- * Calculation of Cloudy AMVs optimized with 16x16 to 24x24 pixel tracer size.
 - Largest amount of cloudy AMVs with good statistics.
- * Calculation of WV Clear air AMVs optimized with 40x40 pixel tracer size.
 - Better tracking of its smoother and larger humidity features.

- * **AMV statistics (NBIAS/NRMSVD) better when the wind guess has not been used to define the tracking area.**
- * **It is not possible to optimize all validation parameters (Number of AMVs/NBIAS/NRMSVD) with the same configuration of tracer size and temporal gap between images.**
- * **The use of better image resolutions implies the use of shorter temporal gaps for an optimum AMV calculation:**
 - 3 km image resolution → 10 min.**
 - 1 km image resolution → 5 min.**

Results of this study published in two papers:

*** Borde, R. and J. García-Pereda, 2014:**

***The impact of the wind guess on the tracking of Atmospheric Motion Vectors.
J. Atmos. Oceanic Technol, 31, 458-467***

*** J. García-Pereda and Borde, R., 2014:**

***The impact of the tracer size and the temporal gap between images
on the extraction of Atmospheric Motion Vectors.
J. Atmos. Oceanic Technol. (still in press).***

**Javier García Pereda & AEMET want to acknowledge
EUMETSAT for the financial funding provided for their contribution to this study.**