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SUPPORT TO NOWCASTING AND VERY SHORT RANGE FORECASTING

NWCSAF/High Resolution Winds AMV Software for Geostationary and Polar satellites Status in 2023

8-12 May 2023

Sixteenth International Winds Workshop, Montréal, Canada

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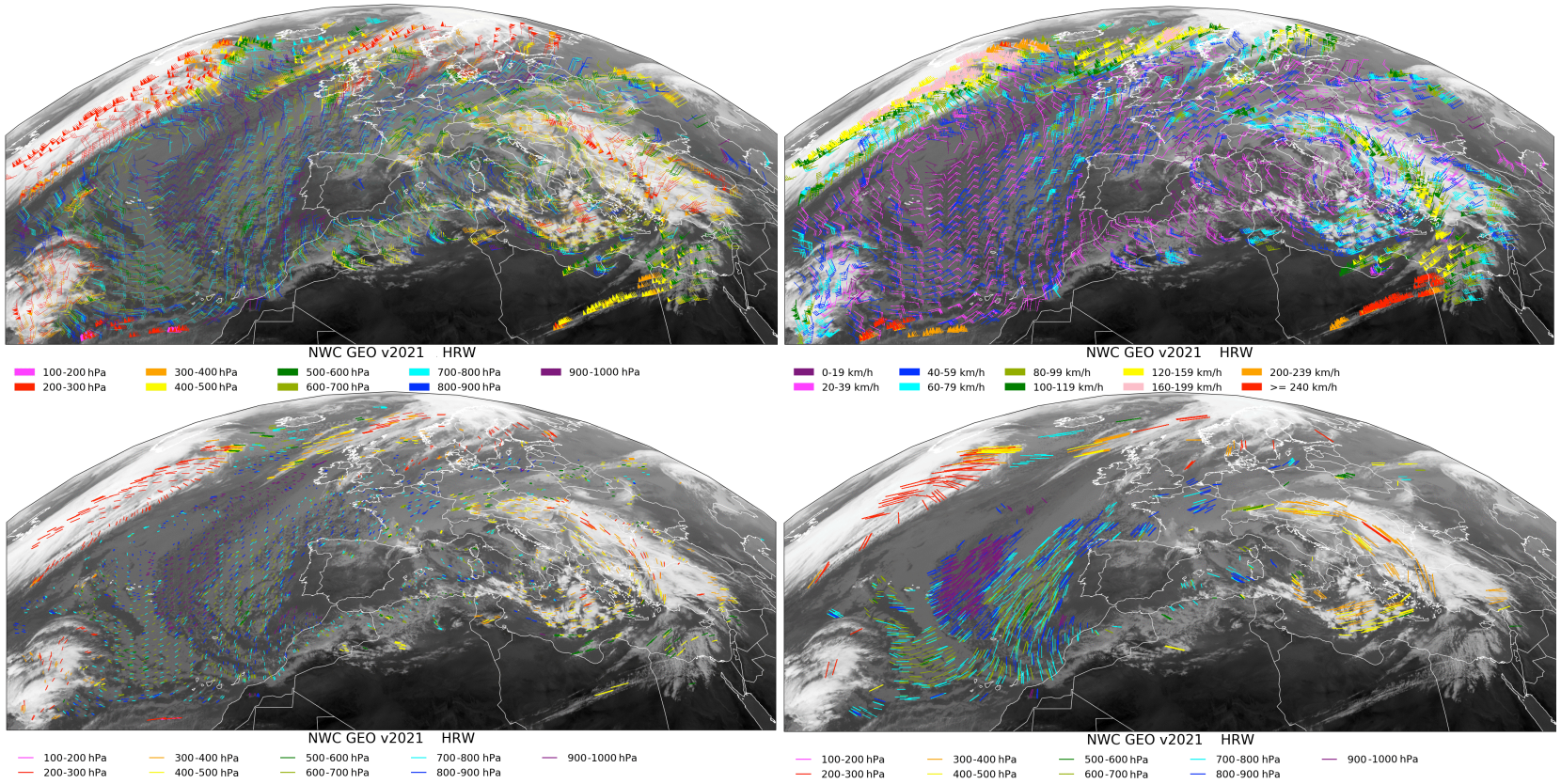
NWC/GEO-High Resolution Winds (Geostationary)

High Resolution Winds software provides a detailed calculation of "Atmospheric Motion Vectors (AMVs)" and "Trajectories", inside the NWCSAF software packages for geostationary and polar satellites.

Latest geostationary version released in April 2022 (NWC/GEO-HRW v6.2, inside NWC/GEO v2021 software package).



High Resolution Winds for NWC/GEO v2021, 27 Jan 2023 12:00Z

AMVs considering level & speed (up); Trajectories for last 1 & 3 hours (down)

NWC/GEO-High Resolution Winds (Geostationary)

Updates in NWC/GEO-HRW latest version:

1. Use and validation with the whole ring of geostationary satellites around the world:

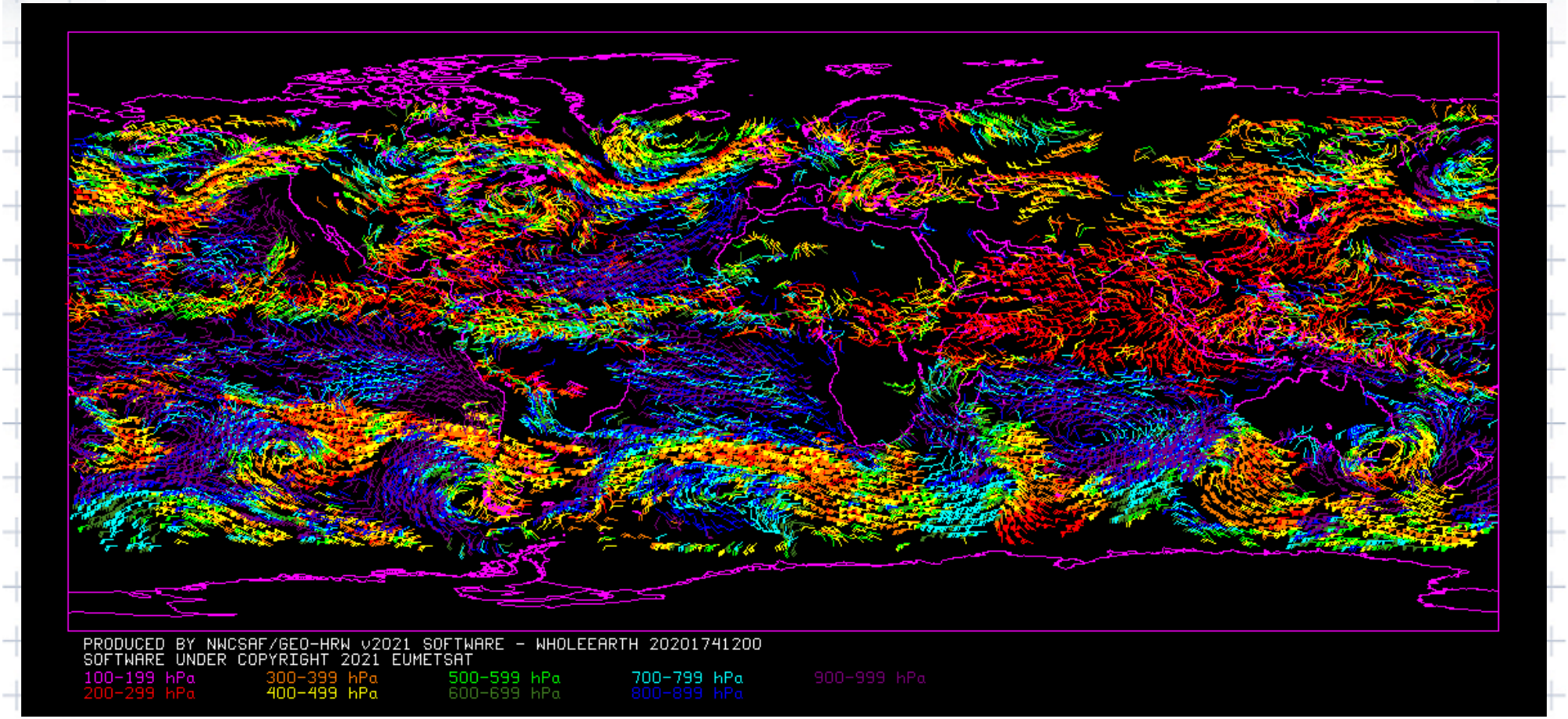
MSG & MSG/IODC (AMVs every 15 or 5 min.) **Himawari-8/9** (AMVs every 10 min.)
GOES-13/14/15 (AMVs every 30 or 15 min.) **GOES-16/17/18** (AMVs every 10 min.)

Note: adaptation to **GOES-18** available
with extension **NWC/GEO v2021.1** since **October 2022**.
It permits **full operability of NWC/GEO-HRW in the Eastern Pacific**,
without all the filtering of noisy data implemented for GOES-17,
caused by the problems in the cooling system of GOES-17/ABI radiometer.

Similar validation against radiosonde winds for all satellites,
with smaller values for Himawari-8/9 and GOES-R series with respect to MSG
(a good perspective for the use with MTG-I in the coming months).

NWC/GEO-HRW v6.2 (v2021) AMVs		MSG-2 Jul'09-Jun'10 Europe	GOES-13 Jul'10-Jun'11 CONUS	Himawari-8 Mar'18-Aug'18 China-Korea-Japan	GOES-16 May'19-Jul'19 CONUS
NC		1164357	633574	1364409	1351066
SPD [m/s]		15.54	20.48	20.32	20.41
NBIAS		-0.07	-0.03	+0.06	+0.05
NMVD	(ALL LAYERS)	0.33	0.29	0.29	0.28
NRMSVD	(100-1000 hPa)	0.40	0.37	0.36	0.36

NWC/GEO-High Resolution Winds (Geostationary)



With this, "NWC/GEO-High Resolution Winds" calculates AMVs and Trajectories in all regions of the world.

Updates in NWC/GEO-HRW latest version:

2. Better distribution of AMVs in high/medium/low levels

- ➔ For a better characterization of all levels of the troposphere in which AMVs are calculated (approx. between 140 and 1000 hPa).
- ➔ For all satellites the proportion of medium+low level AMVs has increased at least a 9%, and for MSG satellites, an optimal distribution of high/medium/low level AMVs of 35%/32%33% has been reached.
- ➔ To do this, the distance between tracers is dependent on the cloud type
  - 4 times shorter for AMVs related to: medium level clouds
    low level clouds
    clear air.

Updates in NWC/GEO-HRW latest version:

3. Optimisation of the running time of NWC/GEO-HRW

Up to 30% reduction:

- Use of less repetitive and more effective operations and functions.
- Optimization of the more time consuming parts of the algorithm:

Examples:

a) The "tracking" now considers "tracking areas" with sizes based on km:
   - They are calculated for each tracer considering the real size in km of corresponding pixels (with smaller "tracking areas" when nearer to the Earth disk edge).

b) In the "quality control":
   - Reference AMVs which can be used for the temporal/spatial quality tests have been better delimited for a quicker processing.

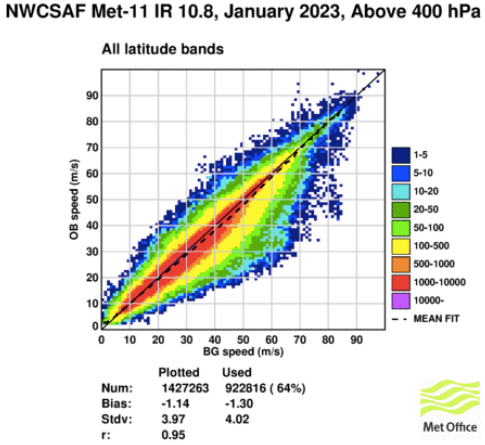
NWC/GEO-High Resolution Winds (Geostationary)

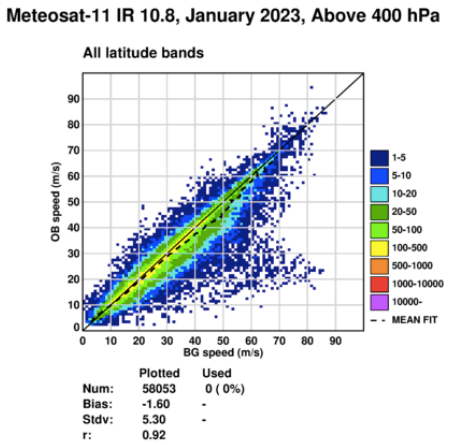
External validation of NWC/GEO-HRW AMVs in the "NWPSAF AMV Monitoring":

http://nwpsaf.eu/monitoring/amv/23_01/density_ukv.html

http://nwpsaf.eu/monitoring/amv/23_01/map_ukv.html

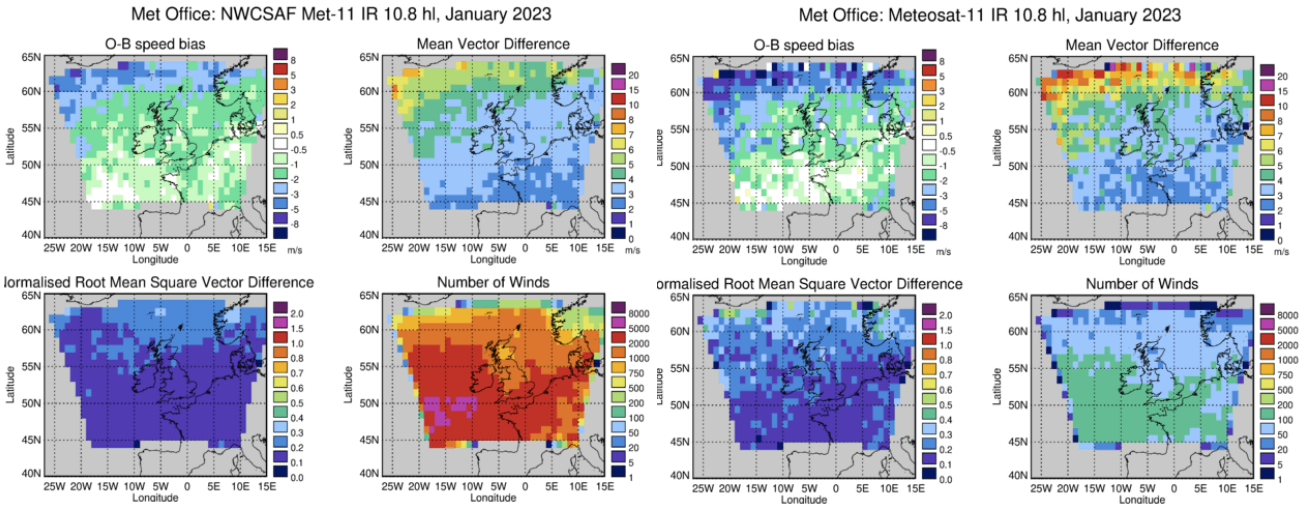
Monthly verification
around the British Isles,
of NWCSAF/HRW AMVs (left)
in comparison with
Eumetsat/MPEF AMVs (right)





NWCSAF/HRW AMVs
show in general:

- **Better AMV density** (1-2 orders of magnitude larger).
- **Better OB-BG statistics** (except for a few cases of BIAS).



NWC/GEO-High Resolution Winds (Geostationary)

In 2022, the NWCSAF financed the "Fourth AMV intercomparison study",
in which the same 6 institutions involved in the previous occasion took part.

- **> AMV algorithms are becoming more similar when compared to results from previous Intercomparison studies.**
- **> The comparisons to Aeolus and aircraft winds also result in consistent results.**
- **> However, there are still differences and elements to further investigate.**

**** More info in the later presentation by Dave Santek in this workshop.**

Table 8-16: Experiment 2b: All AMVs (CQI >= 50) comparison to rawinsondes within 150 km. N= number of matches; P bias = pressure bias; P RMS = pressure RMS; SpdBias = speed bias; SpdRMS= speed RMS; DirBias = wind direction bias; VecRMS = vector RMS.

Site	N	P bias	P RMS	Spd bias	Spd RMS	Dir bias	Vec RMS
BRZ	3996	0.09	13.99	0.08	4.82	-0.35	6.95
EUM	4033	0.54	14.64	-0.73	6.74	3.09	8.73
JMA	5647	0.25	13.91	-0.03	3.96	0.73	5.59
KMA	3370	0.33	12.80	-2.12	7.23	0.11	8.85
NOA	2328	0.77	13.52	-0.09	4.49	-1.62	6.13
NWC	5041	0.55	14.40	0.40	5.37	3.70	6.89

Table 8-23: Experiment 2b: All AMVs (CQI >= 80) compared to background grid: NWP analysis wind. N = total number of AMVs; BFN = number of AMVs with best fit level; VO = mean vector difference; RMSE = root mean square error; VOAF = mean vector difference after best fit; RMSEAF = root mean square error after best fit.

EXP	N	BFN	VO	RMSE	VOAF	RMSEAF
BRZ	25843	5357	3.22	4.11	2.79	3.71
EUM	45173	13432	4.26	6.31	3.57	5.81
JMA	94720	35004	2.34	3.00	1.94	2.60
KMA	40954	13816	4.11	5.93	3.30	5.32
NOA	28056	9281	3.13	3.98	2.48	3.37
NWC	91483	26317	2.96	3.91	2.39	3.31

Verification of AMVs against radiosonde winds (up) and NWP wind analysis (down).
- **BRZ: CPTEC/INPE (Brazil)**
- **EUM: Eumetsat**
- **JMA: JMA**
- **KMA: KMA**
- **NOA: NOAA**
- **NWC: NWCSAF/HRW**

NWC/PPS-High Resolution Winds (Polar)

A requirement from NWCSAF users was raised in March 2018 to extend NWCSAF/High Resolution Winds to polar satellites. Reasons for this:

➔ European Nordic weather services
(related to the regional MetCoOp HARMONIE model)
wish more wind data for NWP assimilation at high latitudes,
with a stringent timeliness requirement of 15 minutes.
(No other polar AMV dataset seems to satisfy this timeliness requirement).

➔ With both options (NWC/GEO-HRW and NWC/PPS-HRW)
the user can obtain AMVs with a very homogeneous algorithm
in all corners of the world with a high update frequency:
➔ 4-6 times per hour throughout all the geostationary ring.
➔ Several times per hour (depending on latitude) with polar satellites.

This can be very useful in global NWP models or climatic studies!

NWC/PPS-High Resolution Winds (Polar)

NWCSAF has already delivered to users
two versions of its NWC/PPS-HRW software for polar AMVs:

- ➔ **NWC/PPS-HRW v7.P (inside NWC/PPS v2021 software in November 2021).**
- ➔ **NWC/PPS-HRW v7.Q (inside NWC/PPS v2021.3 software in March 2023).**

AMVs are calculated from
reprojected polar images in static regions of different sizes,
in a similar way to what is done by NWC/GEO-HRW for geostationary satellites.

- ➔ **90% of the code is exactly equivalent for both implementations.**
- ➔ **HRW outputs equivalent for both geostationary and polar AMVs.**

Someone already using NWC/GEO-HRW can use NWC/PPS-HRW very quickly.

NWC/PPS-HRW prepared by: Javier García-Pereda (AEMET),
Nina Håkansson, Sara Hörnquist (SMHI).

NWC/PPS-High Resolution Winds (Polar)

Updates in NWC/PPS-HRW latest version:

➔ Processing extended to 16 polar satellites
with AVHRR-3, VIIRS, MODIS, MERSI-2 (new) and SLSTR (new) radiometers.
(AMVs with any combination of images from all these satellites).

➔ AMV calculation extended to MODIS/WV067 cloudy and clear air AMVs,
and MERSI-2 & MODIS/WV073 cloudy and clear air AMVs.

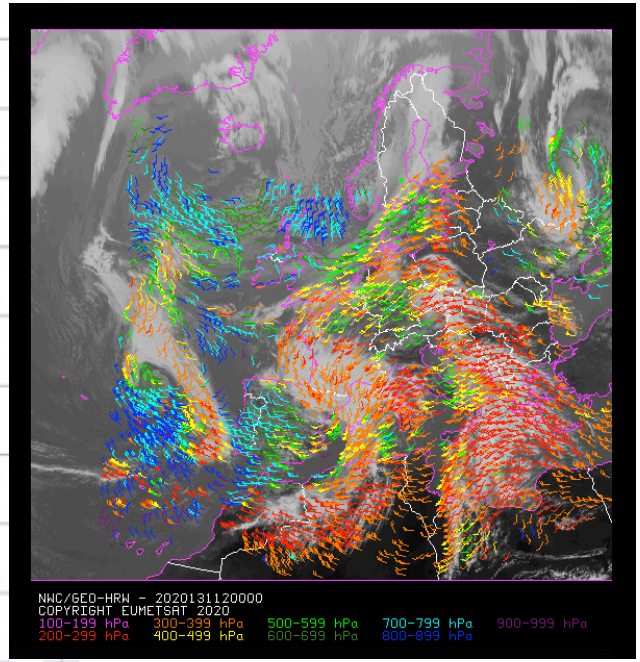
➔ Many running parameters of NWC/PPS-HRW retuned in the second version:
better AMV densities (4 times more AMVs!) and fewer holes in the coverage.

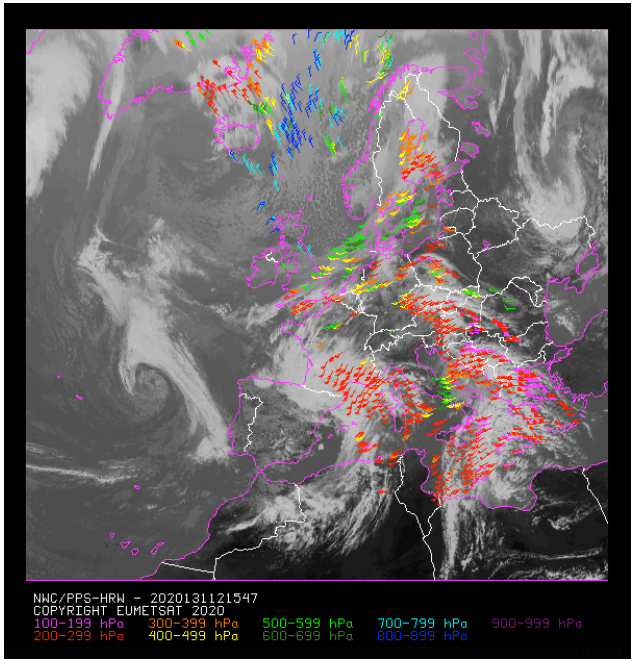
➔ NWC/PPS-HRW v7.Q is related to NWC/GEO-HRW v6.2,
sharing the optimization in the running time,
and a better distribution of AMVs in high/medium/low levels.

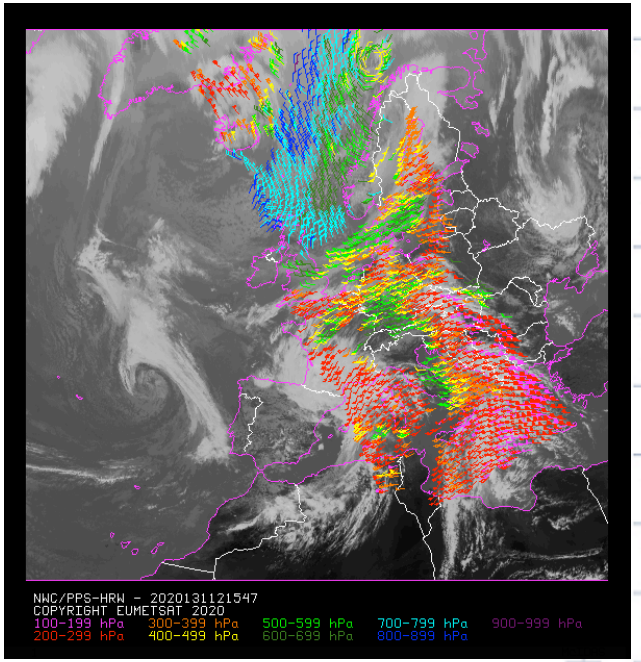
NWC/PPS-High Resolution Winds (Polar)

Comparing (for 10 May 2020, 12UTC):

NWC/GEO-HRW v2021 | **NWC/PPS-HRW v2021** | **NWC/PPS-HRW v2021.3**







➔ **NWC/PPS-HRW provides AMVs beyond the ≈ 65º latitude limit defined in NWC/GEO-HRW.**

➔ **The AMV temporal/spatial density in the first polar HRW version was smaller, but it is very similar in the second polar HRW version and the geostationary HRW version due to the retuning of its running parameters.**

- **Users of the first polar HRW version are requested to update the software to the second polar HRW version for a much better use of the product!**

NWC/PPS-High Resolution Winds (Polar)

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Comparing the AMV validation between the GEO and the two polar HRW versions:

Validation in the European region against Radiosounding winds	NWC/GEO-HRW v2021 (v6.2) Jul'09-Jun'10, 12:00Z	NWC/PPS-HRW v2021 (v7.P) Apr'20-Jun'20, 11:00Z-13:00Z	NWC/PPS-HRW v2021.3 (v7.Q) Apr'20-Jun'20, 11:00Z-13:00Z
NC	1164357	109905	413478
SPD [m/s]	15.54	19.08	17.64
NBIAS (ALL LAYERS)	-0.07	-0.05	-0.02
NMVD (100-1000 hPa)	0.33	0.36	0.34
NRMSVD	0.40	0.44	0.41
NC	407408	66059	191243
SPD [m/s]	22.28	24.29	23.28
NBIAS (HIGH LAYER)	-0.04	-0.06	-0.03
NMVD (100-400 hPa)	0.26	0.34	0.33
NRMSVD	0.32	0.40	0.38
NC	377043	25985	124906
SPD [m/s]	13.99	12.90	13.94
NBIAS (MEDIUM LAYER)	-0.07	-0.03	-0.02
NMVD (400-700 hPa)	0.36	0.40	0.36
NRMSVD	0.44	0.48	0.43
NC	379906	17861	97329
SPD [m/s]	9.86	8.79	11.33
NBIAS (LOW LAYER)	-0.10	-0.02	-0.02
NMVD (700-1000 hPa)	0.42	0.48	0.34
NRMSVD	0.49	0.55	0.40

➔ **The improvement between the first and the second polar version is clear:**

- Many more AMVs with better validation parameters.

➔ **Comparing the GEO version and the second polar version:**

- Statistics for the whole dataset of AMVs are similar (with GEO AMVs better at the high layer; Polar AMVs better at the low layer).
- Polar AMVs are more frequent in the high layer.

Preparation for MTG-I satellites

Considering HRW v7.0 inside NWC/GEO-I version MTG-I day 1,
for release when MTG-I becomes operational:

A) Main task: HRW to be defined operational for MTG-I

➔ Working in a similar way to what it is currently doing with Himawari-8/9 and GOES-R satellites.

B) Definition of HRW NetCDF optional outputs as fully "CF compliant".

➔ For a better use by external applications (using the "CF conventions" as guidance).

C) Some improvements suggested by NWCSAF users:

➔ F.ex.: Inclusion of "Aeronautical units (flight level)" in the HRW NetCDF outputs for use by aviation.

Plans for NWCSAF CDOP4 phase (up to 2027)

Plans for the following years

inside "NWCSAF/CDOP4 phase (2022-2027)"

agreed with EUMETSAT from Comments/Recommendations defined at:

- ➔ 2016 and 2018 International Winds Workshops
- ➔ 2019 NWCSAF Users Survey
- ➔ 2020 NWCSAF Users Workshop

From the 2019 NWCSAF Users Survey:

➔ **HRW well considered among NWCSAF products:**

- **Used by 55% of answers (second only to NWC/GEO-Cloud products).**
- **With a 7.8/10 rate (after only NWC/GEO-Cloud and Convective products).**

Plans for NWCSAF CDOP4 phase (up to 2027)

Main planned changes for NWCSAF/HRW:

A) Improvements due to updates in NWCSAF/Cloud products:

- ➔ Stratiform/cumuliform cloud separation
- ➔ Cloud base calculation
- ➔ Improvements in “CTTH/Cloud top”, “CMIC/Cloud microphysics” products (including extension of CMIC to night conditions).
- ➔ Better assessment of multilayer clouds and semitransparent clouds.

B) Improvements suggested by NWCSAF users:

- ➔ Inclusion of “Error in the AMV displacement” as defined by Graeme Kelly/MetOffice.

Plans for NWCSAF CDOP4 phase (up to 2027)

Main planned changes for NWCSAF/HRW:

C) Refinements in:

➔ AMV calculation with High resolution channels
(for better AMV densities).

➔ AMV validation statistics in medium/low levels
(there is still room for improvement here).

D) Possible distribution of NWC/HRW outputs through Eumetcast

➔ Due to the big configurability of HRW product
it is difficult to define a HRW option valid for everybody.

➔ However, if different users define what they need,
and this is relatively similar, it can be considered.

… and more (please contact me for any more details).

Plans for NWCSAF CDOP4 phase (up to 2027)

"Visiting Scientist Activities" with external institutions
have also been defined in the CDOP4 phase with following objectives:

A) New Intercomparisons every 4 years of AMV algorithms worldwide.

➔ As already done in previous AMV Intercomparison studies.

B) Evaluation of the "AMV stereo height assignment"

➔ Considering the parallax displacement of an AMV
observed by two geostationary satellites in two different locations.

We keep the interest of having collaboration
of experts in this task (James Carr, Dong Wu,…) for the implementation.

NWC/HRW as "Stand alone AMV software"

Due to its characteristics and its ease to be obtained/run locally,

NWCSAF/HRW was proposed at previous "International Winds Workshops"

as "Stand alone AMV calculation software"

available for all AMV researchers and users.

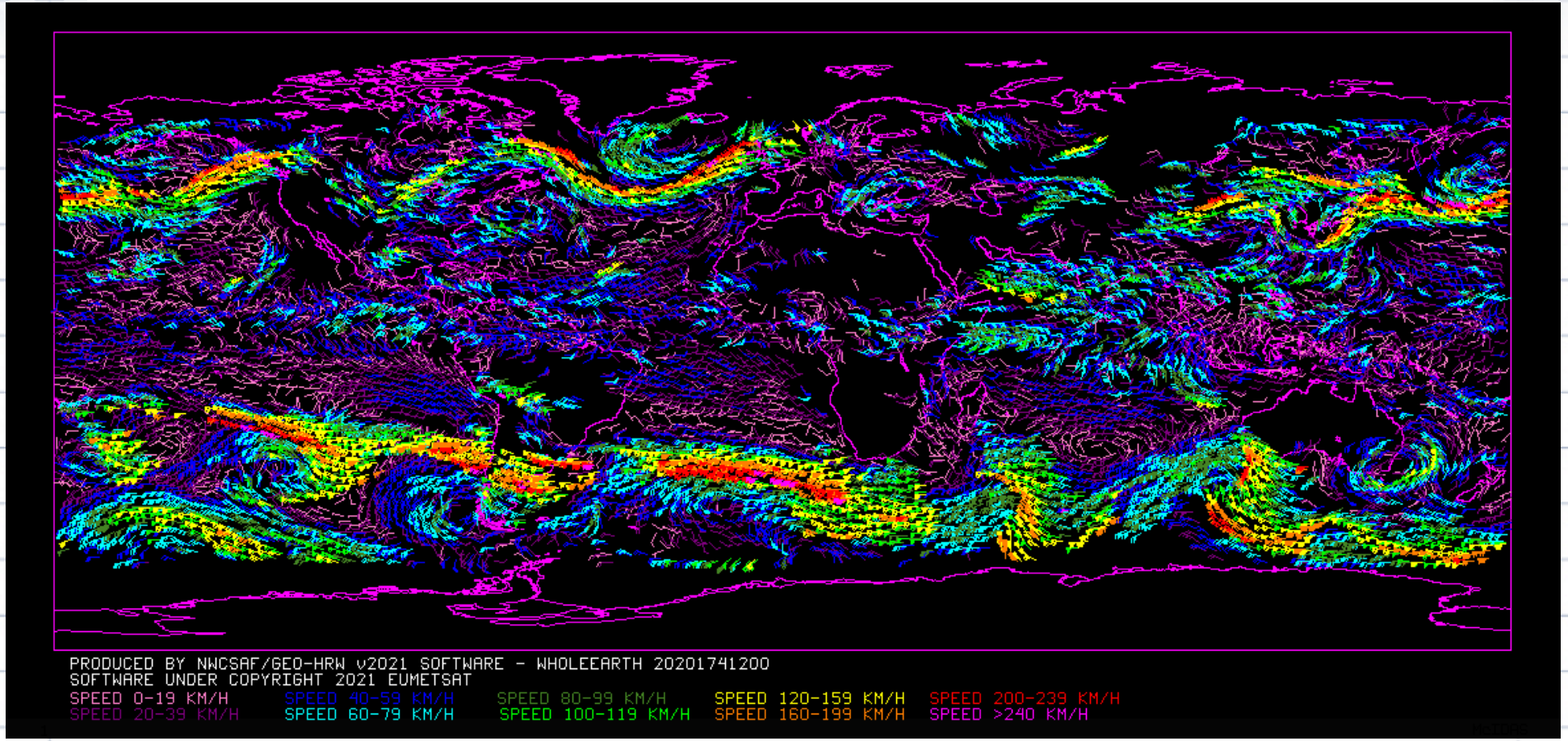
Its good validation results by independent studies

(2014/2018/2022 AMV Intercomparisons with MSG/Himawari/GOES-R)

and its usability with many satellites in all areas of the world

should be an incentive for

more researchers all around the world to use NWCSAF/HRW AMVs.



Thank you very much for listening! Any questions?

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