Generating a Polar Wind Vector Data Set from METOP-AVHRR Observations

Roger Huckle[1,2], Jörg Schulz[1]
[1] EUMETSAT, Eumetsat-Allee 1, 64295 Darmstadt, Germany
[2] VEGA Space GmbH, Europaplatz 5, 64293 Darmstadt, Germany

The ERA-CLIM Project

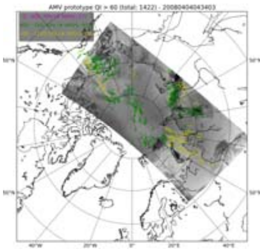
- Aim: Prepare the observations for a 20th century reanalysis
- Project Lead by ECMWF [2]
- EUMETSATs Contribution:
  - AVHRR Atmospheric Motion Vectors
  - Radio Occultation bending angles
  - ASCAT Level 1 data products
  - Combined GOME-2 & IASI ozone columns
  - METEOSAT Atmospheric Motion Vectors as well as Clear and All Sky Radiance.

The Opportunity

- Two algorithms for AMV retrieval from METOP-A AVHRR are implemented:
  - Operational as in EUMETSAT ground segment [3]
  - EUMETSAT prototype based on CIMSS algorithm [4]
- Creation of extensive data set (2007-2012) using both algorithms for the Metop-A mission.
- Comparison against radiosondes and NWP data.
- Unique opportunity to **directly compare** the two different algorithms **over more than 5 years**.

Atmospheric Motion Vector (AMV) Algorithm

- EUMETSAT algorithm uses full spatial resolution Local Area Coverage (LAC) data
- Displacement of objects from one satellite image to the next
- Objects are identified in the base image and searched for in the next image(s)
- Objects can be clouds, water vapor or other trace gases
- Needs a minimum of two images; three or four images likely to increase the quality
- NWP wind field can be used to define a search area and to reduce computation time
- AMVs are filtered applying several quality checks
- For AVHRR only the IR-Window images from channel 4 (11µm) are used
- For geostationary satellites images every 15-30 minutes are used
- Overpasses in Polar Regions are 102 minutes apart, but still usable [1]

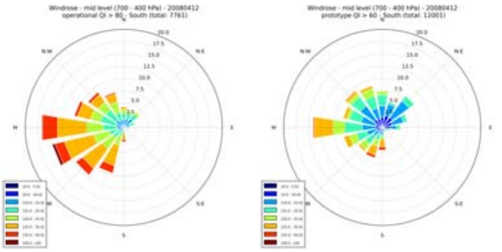


	EUMETSAT (Operational)	CIMSS[1] (Prototype)
Number of images	2 (duplet orbits)	3 (triplet orbits)
Area covered	From 55° pole wards	From 65° pole wards
Input data	3 minute PDUs	AREA files

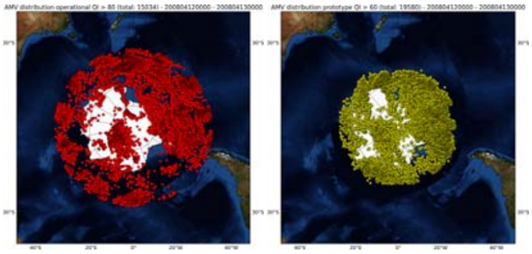
In the EUMETSAT ground segment 3 minute pieces from an orbit (PDU) are used. AREA files are in McIDAS file format and contain channel 4 data in a polar stereographic projection (one for each pole).

[1]CIMMS = Cooperative Institute for Meteorological Satellite Studies

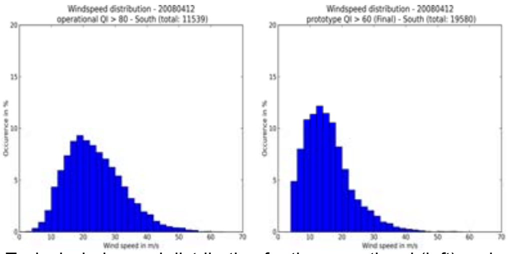
Comparisons and Statistics



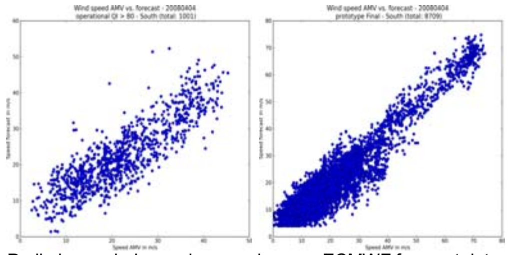
Direction and speed distribution of mid level (700-400 hPa) winds over Antarctica for the operational (left) and CIMSS (right) algorithm.



Location of AMVs for the operational (left) and CIMSS (right) algorithm. More winds away from the pole in the operational algorithm due to duplet mode.



Typical wind speed distribution for the operational (left) and CIMSS (right) algorithm for one day.



Preliminary wind speed comparison vs. ECMWF forecast data (operational (left) and CIMSS (right)), for one day at 12 UTC.

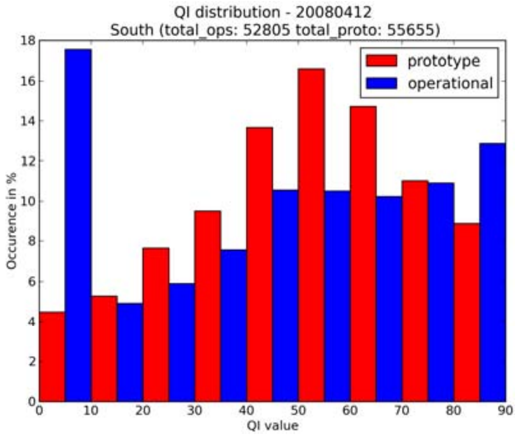
	Operational			Prototype		
	Speed	U-comp	V-comp	Speed	U-comp	V-comp
Bias	0.34	0.78	1.31	0.76	0.62	0.20
RMS	5.13	5.62	5.94	4.07	4.17	4.35

AMV speed, u and v component compared vs. ECMWF forecast data (within 1 hour). All values in ms^{-1}.

Quality Indicators

Quality Indicators	EUM	CIMSS
Forecast Consistency	1.0	0.0
Spatial vector consistency (Buddy)	2.0	2.0
Spatial height consistency	0.0	N/A
Temporal height consistency	0.0	N/A
Tracking vector consistency	2.0	1.0
Tracking speed consistency	0.0	1.0
Tracking direction consistency	0.0	1.0
U-component	N/A	0.0
V-component	N/A	0.0

Quality Indicators for every AMV [5]. With current weighting for the overall QI. Overall QI also available excluding forecast QI.



Overall QI distribution for the two algorithms. The higher the value the "better" the AMV.

Conclusions & Discussion

- Comparison of two algorithms for more than 5 years after completing reprocessing campaign provides high potential for quality analysis and algorithm improvement;
- Preliminary results on selected test cases:
  - More winds detected by the prototype;
  - Operational alg. winds also further away from pole;
  - Distribution of wind directions similar, but higher wind speeds in EUMETSAT operational winds;
  - QI distribution in CIMSS data Gaussian, with peak at 50%;
  - QI maximum for ops near 0% and second maximum for QI > 80%;
  - Comparison statistics vs. ECMWF forecast data for one day show slightly better results for CIMSS winds.
- Possible reasons for algorithm quality differences:
  - Use of duplets instead of triplets may lead to less good temporal consistency of derived winds;
  - Height adjustment of CIMSS winds tuned with objective analysis towards a better fit with forecast data leads to better match with validation data.

Outlook

- Consistently processed Metop-A polar AMVs will become available from EUMETSAT towards the end of 2012;
- Plan to compare geostationary with polar winds in overlapping area to further assess need for duplet orbit approach;
- Plan to generate AMVs with EUM operational algorithm using AVHRR GAC data back to 1982.

The Authors

Jörg Schulz

Roger Huckle

References

[1] J. Turner, D.E. Warren, 1989: Cloud track winds in the polar regions from sequences of AVHRR images, *International Journal of Remote Sensing*, Vol. 10, Iss. 4-5, pp. 695-703.
[2] D.Dee, 2011: ERA-CLIM: European Reanalysis of Global Climate Observations, GMES Climate Change Conference, Helsinki.
[3] EUMETSAT, 2010: *AVHRR Level 2 Polar Winds Product Format Specification*, EUMETSAT, Darmstadt, [available at www.eumetsat.int].
[4] S.J. Nieman, W.P. Menzel, C.M. Hayden, D. Gray, S.T. Wanzong, C.S. Velden and J. Daniels, 1997: Fully Automated Cloud-Drift Winds in NESDIS Operations, *Bull. Amer. Meteor. Soc.*, 78, pp. 1121-1133.
[5] K. Holmlund, 1988: The Utilization of Statistical Properties of Satellite-Derived Atmospheric Motion Vectors to Derive Quality Indicators, *Weather Forecasting*, American Meteorological Society, 13, pp. 1093-1104.

EUMETSAT
Roger.Huckle@eumetsat.int