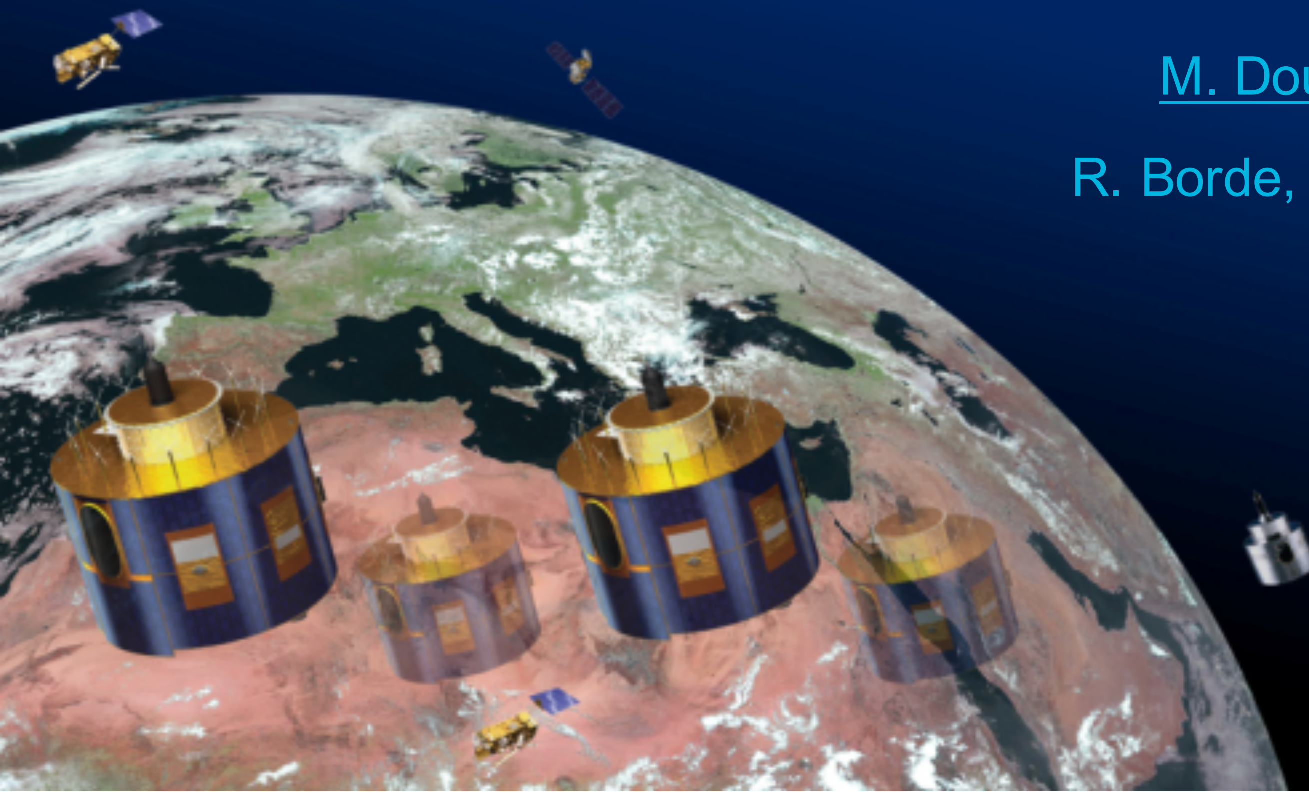
REPROCESSING OF ATMOPHERIC MOTION VECTORS AT EUMETSAT

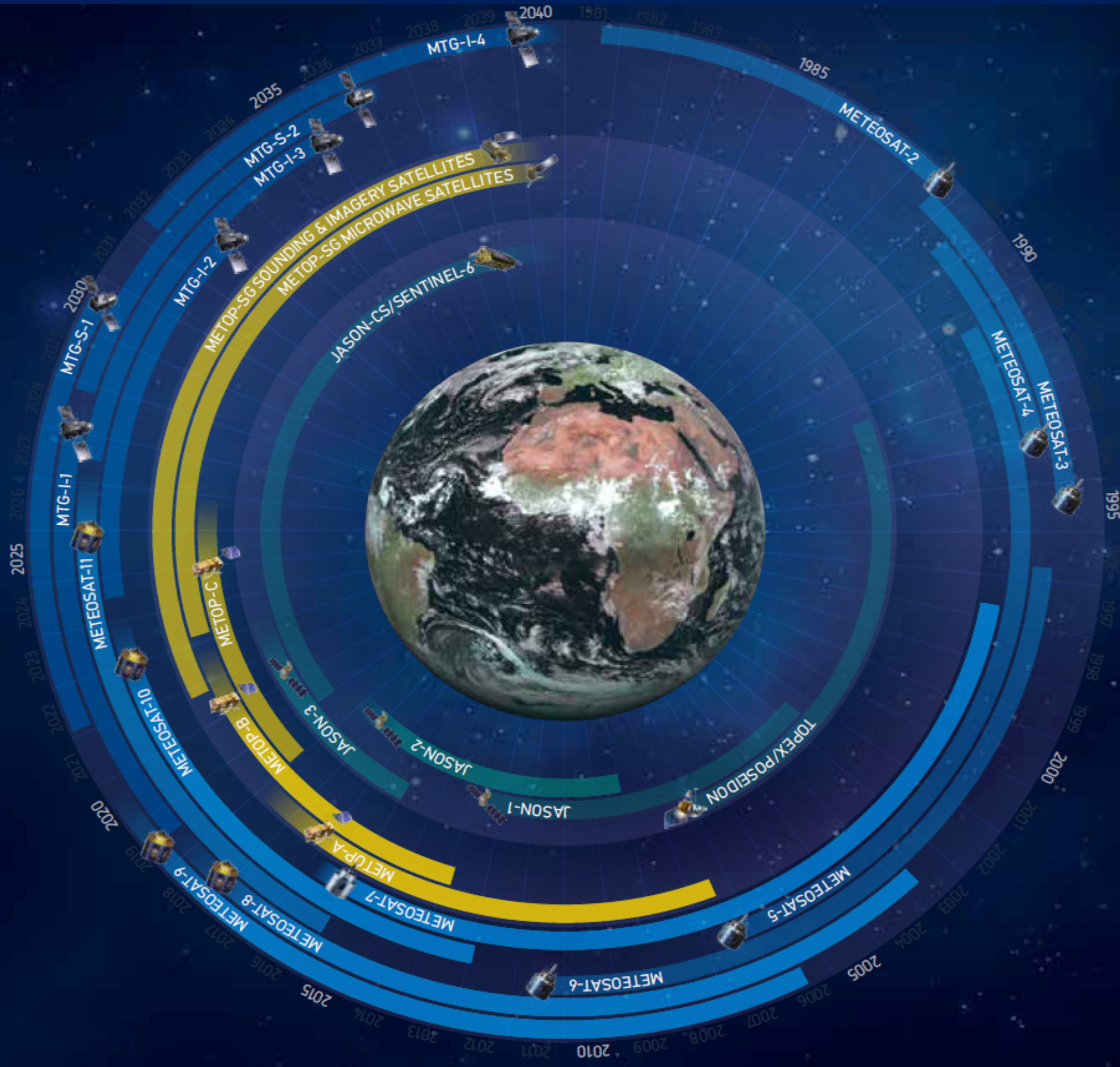
M. Doutriaux-Boucher, A. Lattanzio,

R. Borde, O. Hautecoeur, and J. Schulz

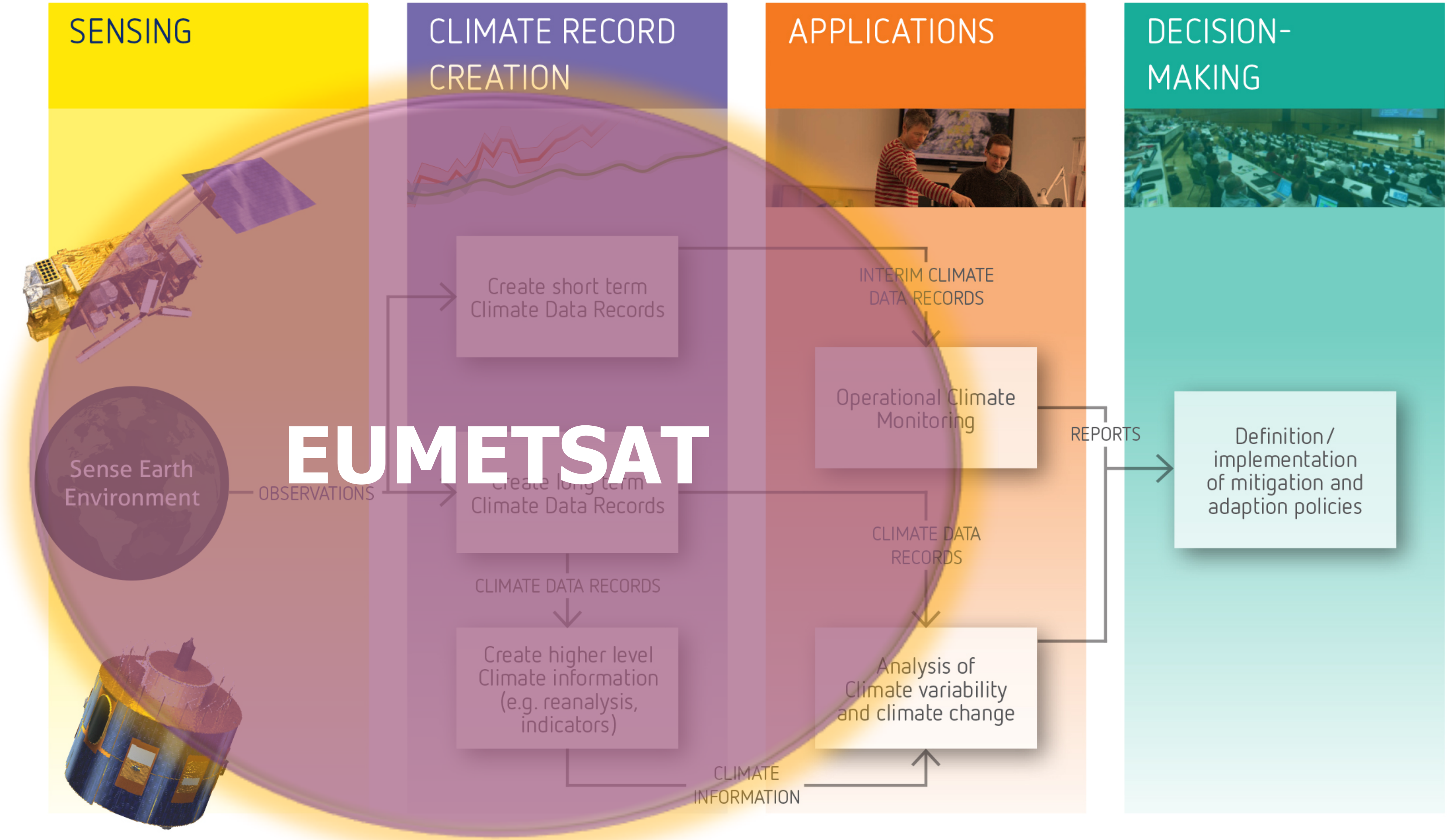


EUMETSAT Satellites – Past, Present and Future

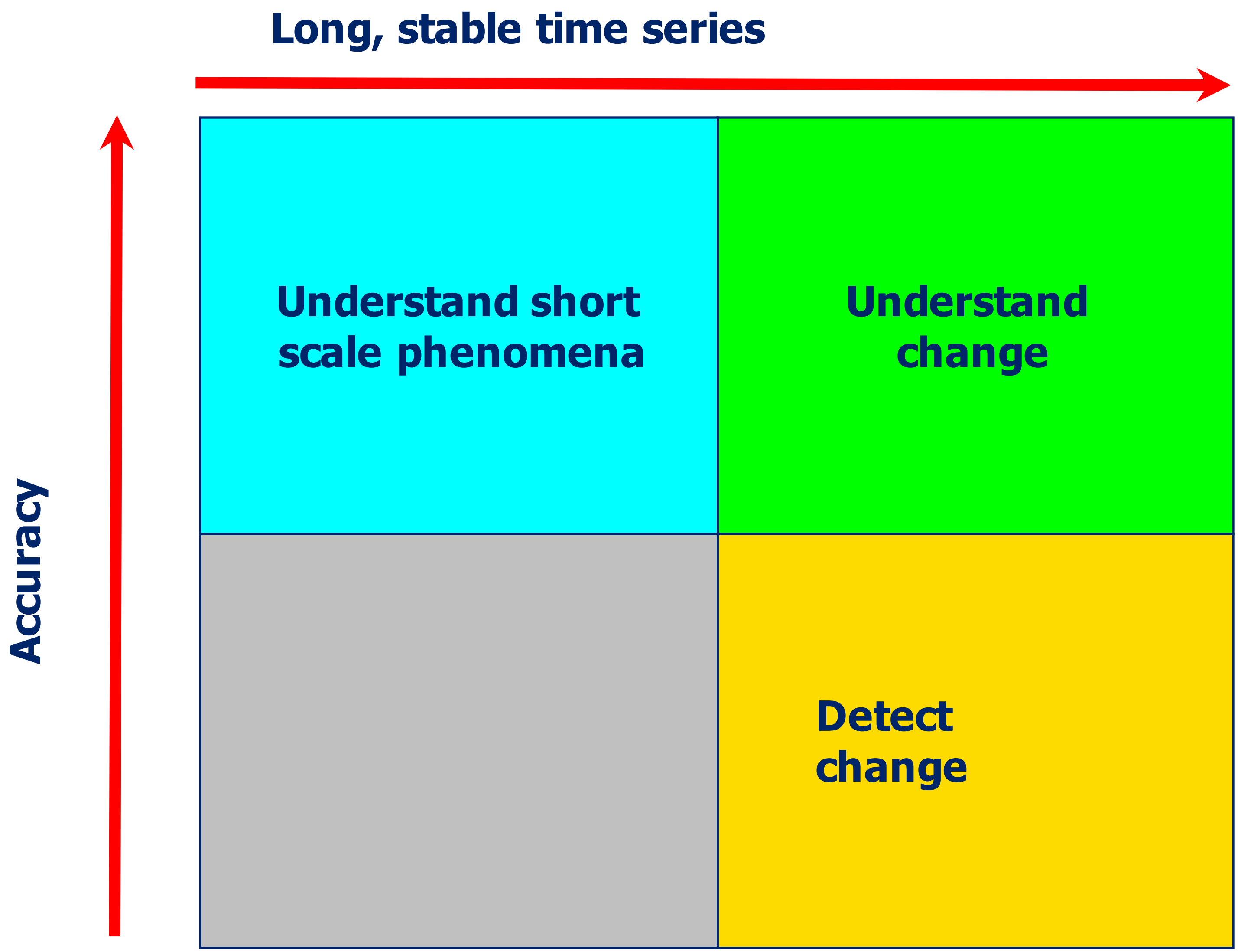
30 YEARS 1986-2016



Introduction to Climate Monitoring



EUMETSAT's Role in Climate Monitoring

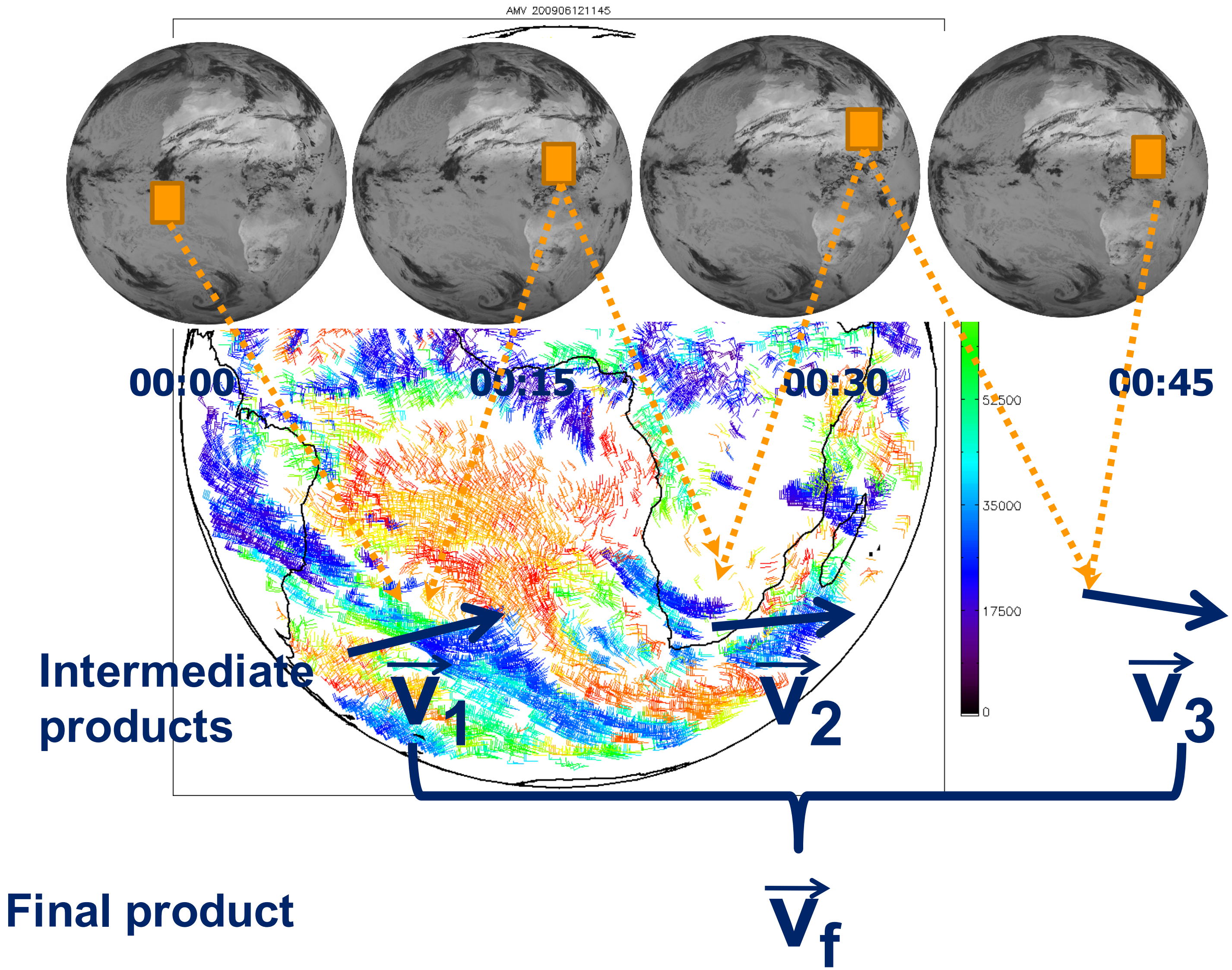


The structure of the presentation

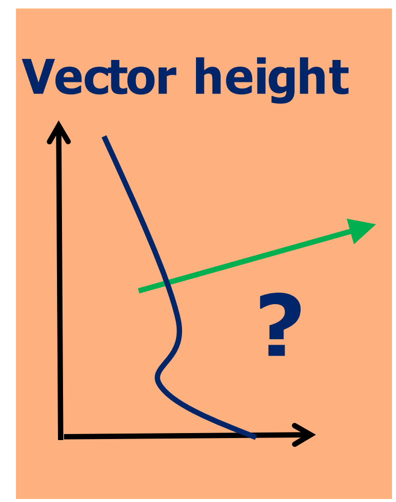
AMV reprocessing activities at EUMETSAT

- Past activities
- Current activities
- Future activities

AMV from imager onboard geostationary satellite



About 10000 winds are detected.



EUMETSAT

AMV CDR: what is already done ?

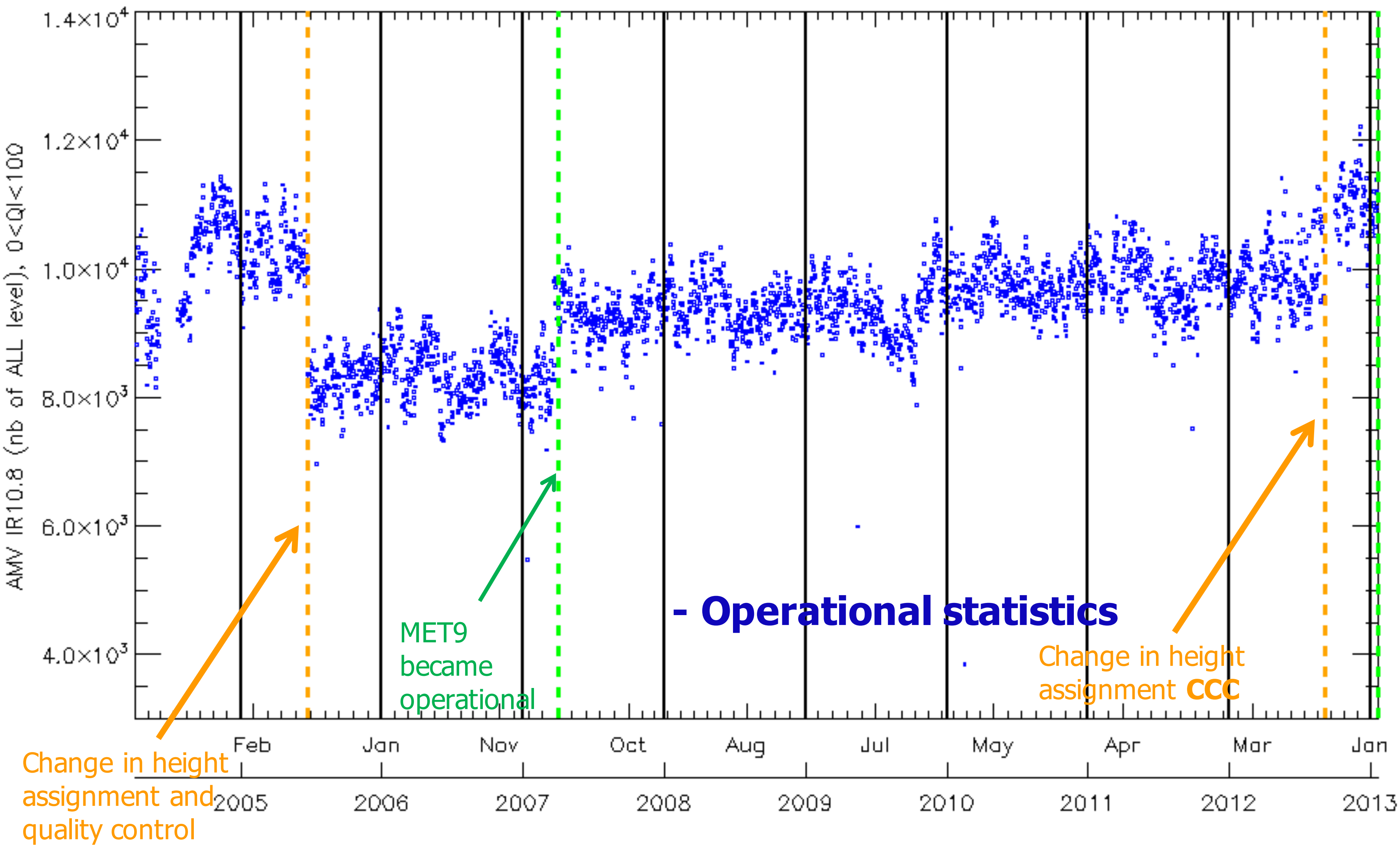
Examples using geostationary AMVs:

1- stable and homogeneous dataset to be used for generation of reanalyses

2- understanding of climate/atmosphere phenomena

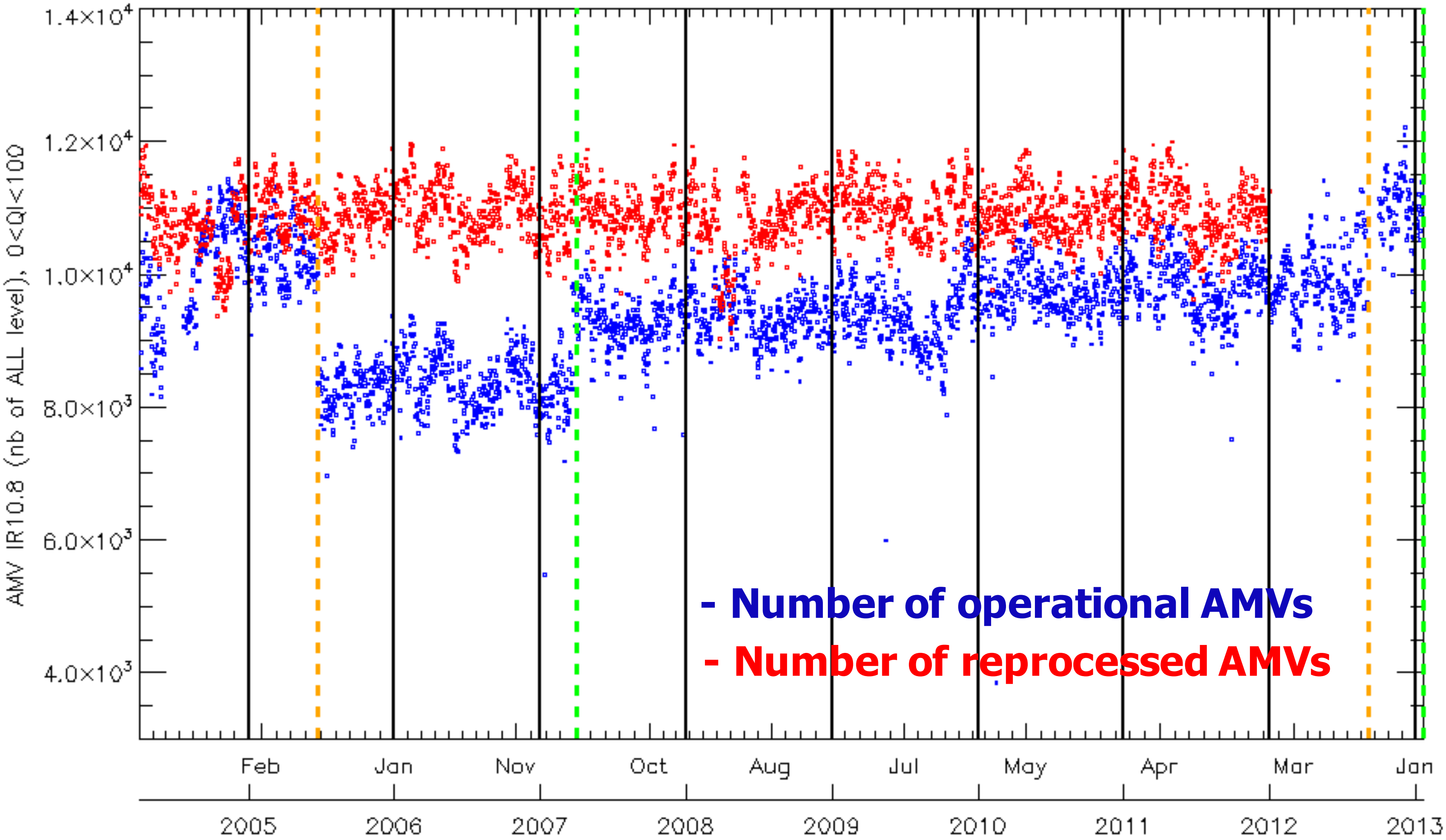
EUMETSAT

Time series of the number of derived AMVs



EUMETSAT

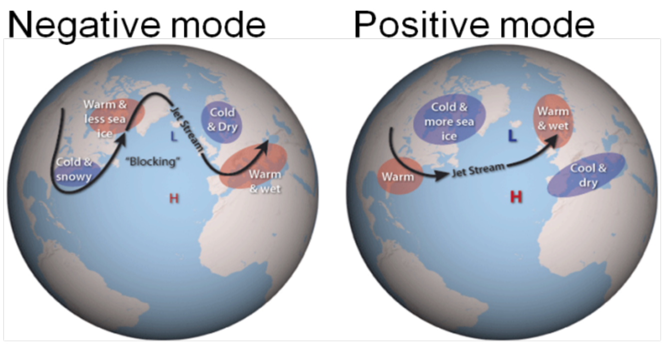
Time series of the number of derived AMVs

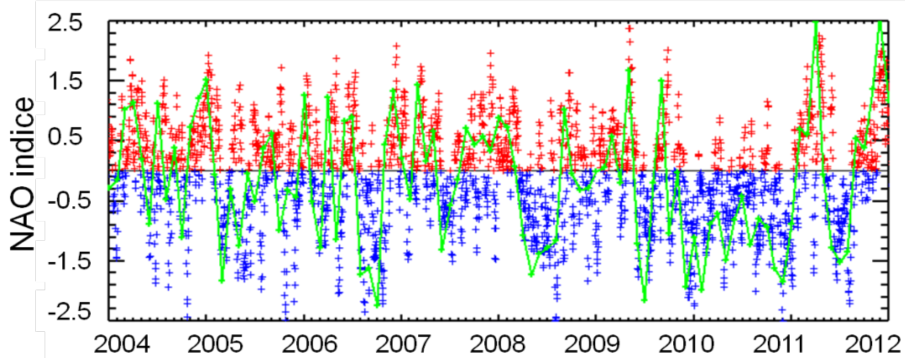


EUMETSAT

Verification of the validity: North Atlantic Oscillation

The NAO is a climatic phenomenon in the North Atlantic ocean of fluctuations in the difference of atmospheric pressure at sea level between the Icelandic and the Azores. It controls the strength and direction of westerly winds and storm tracks across the North Atlantic.





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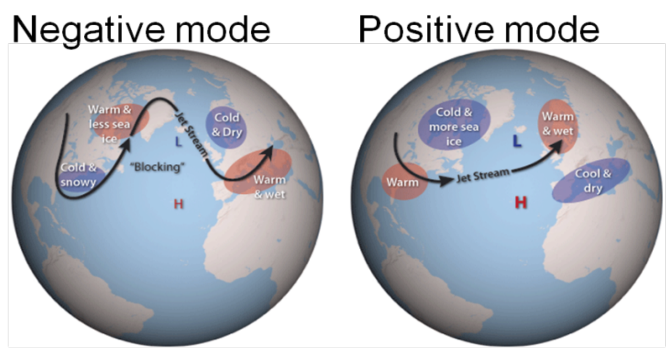
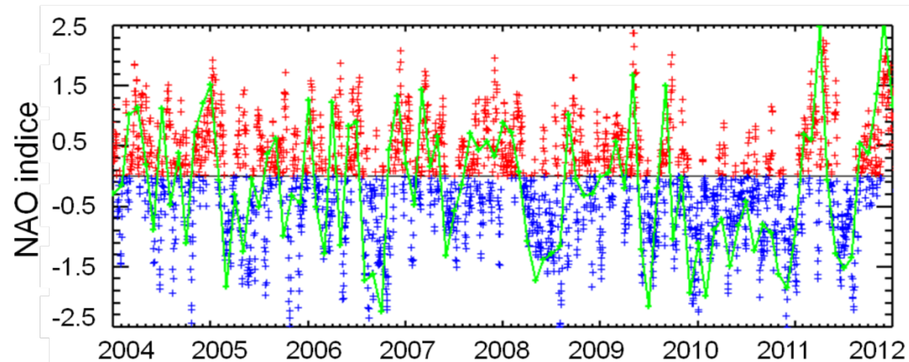
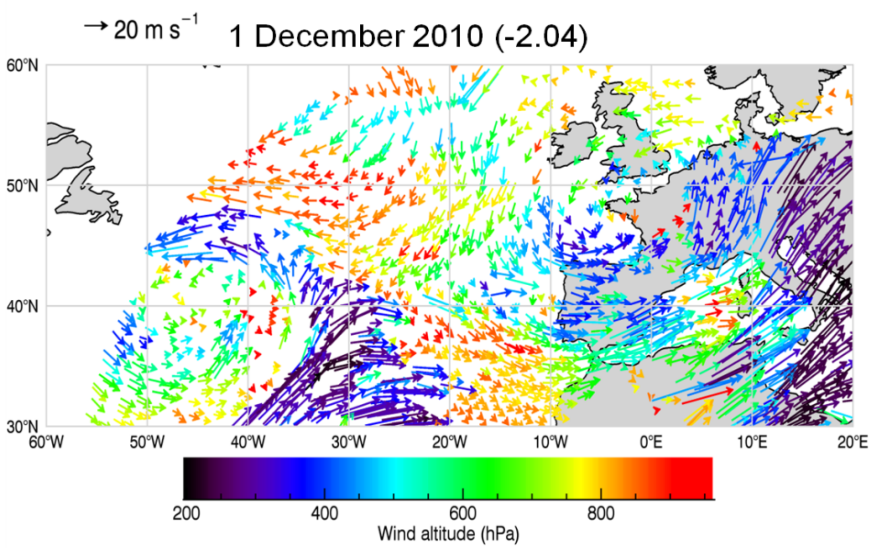
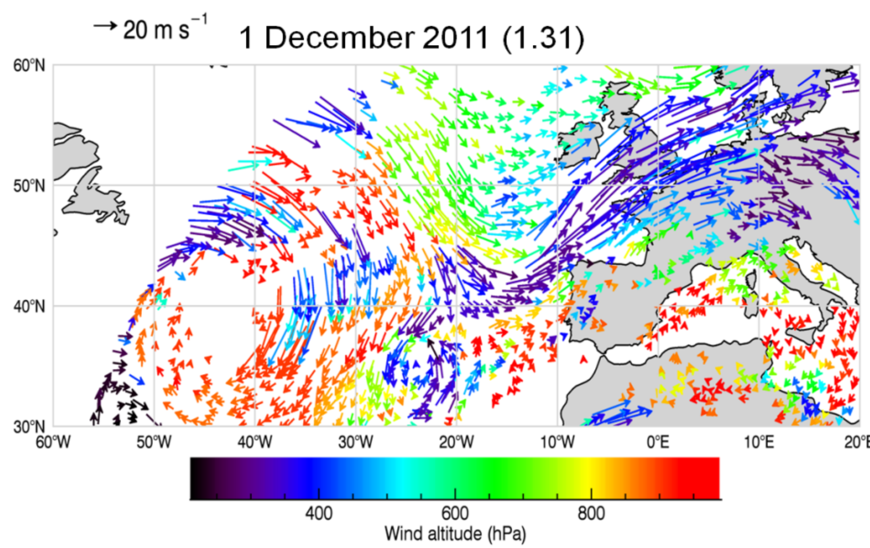
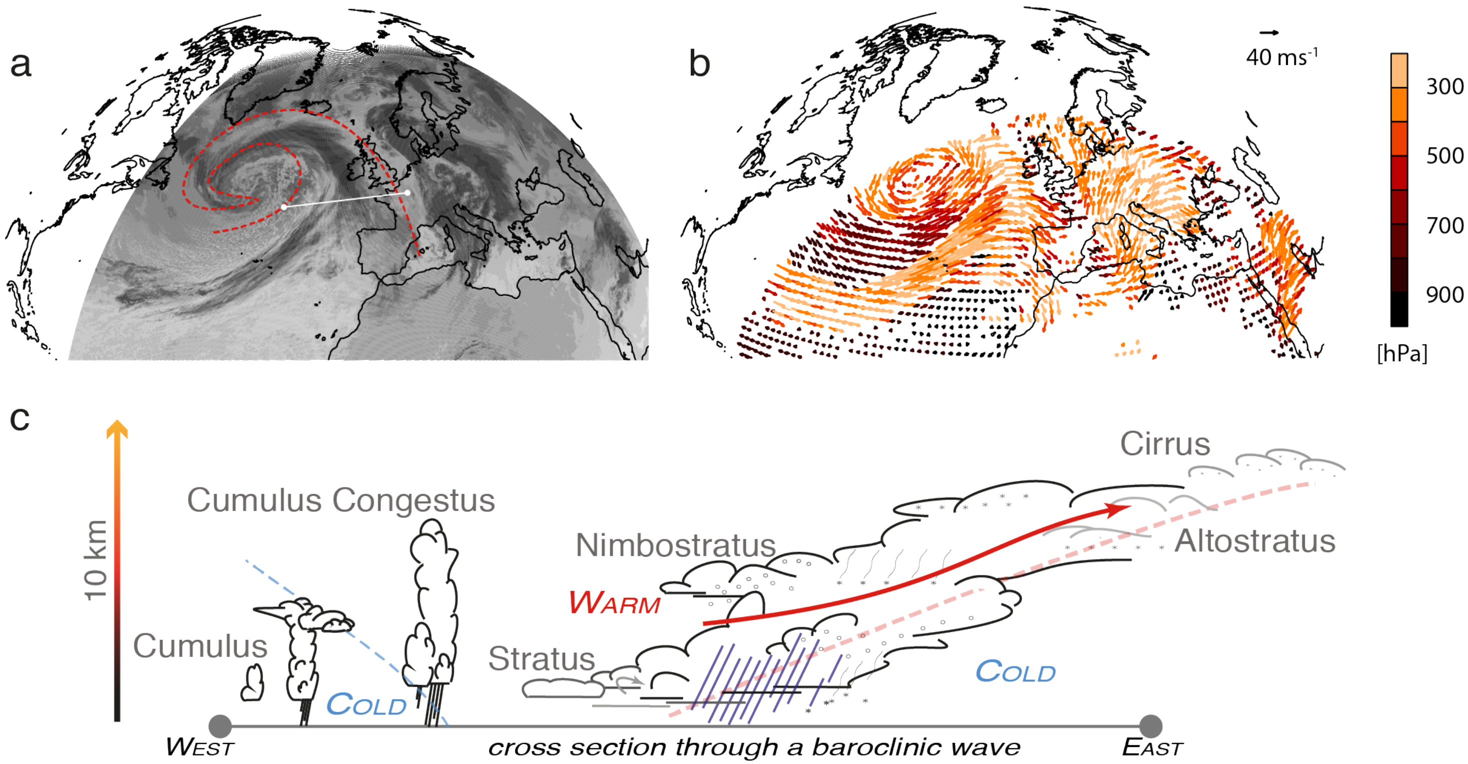








AMV CDR to study variability of atmospheric circulation

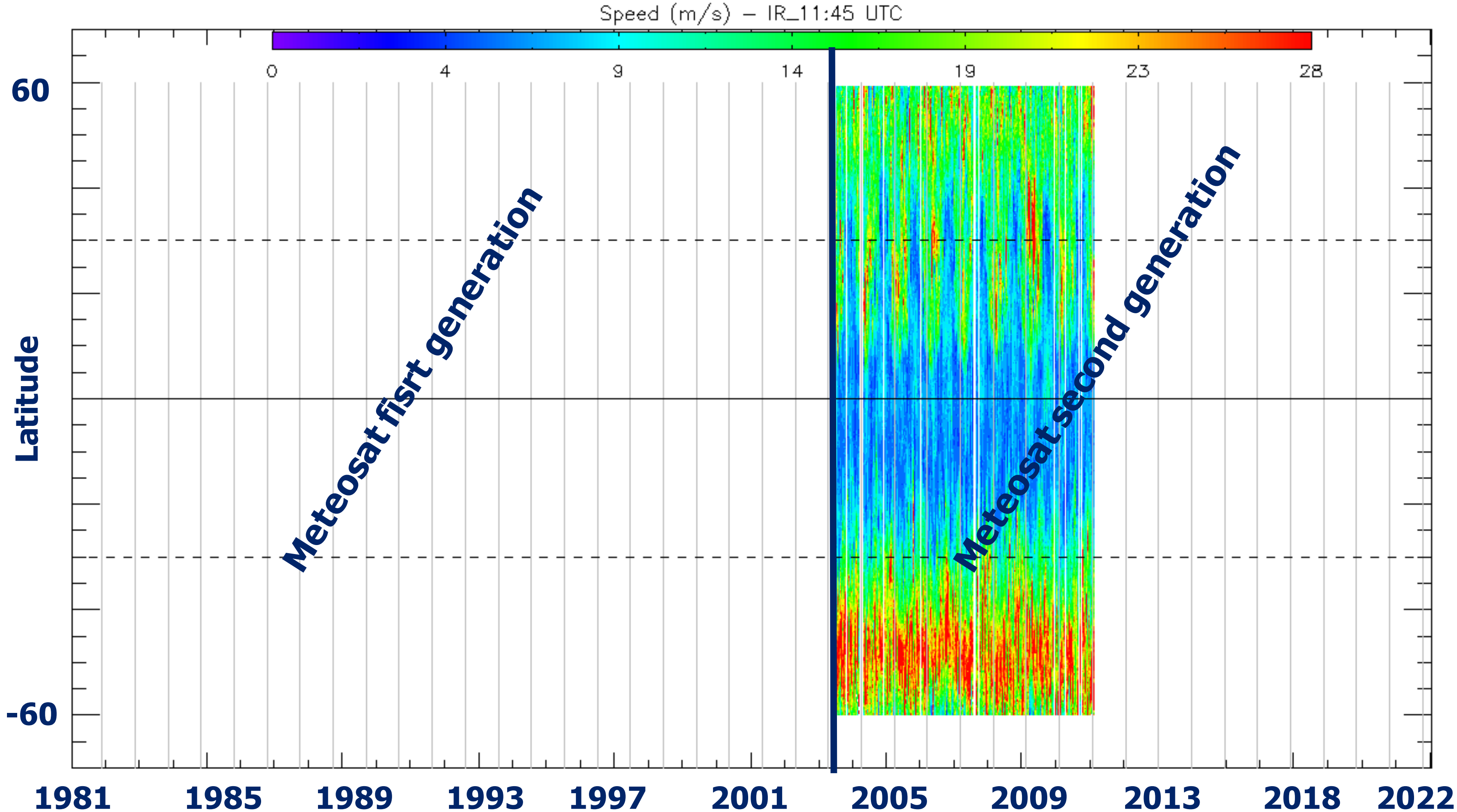


What controls the position, strength and variability of storm tracks? a, Infrared radiances visualize patterns of clouds in a developing storm whose wavelike structure is outlined by red contours delineating air-mass boundaries in upper troposhere. **b,** Cloud motion vectors, coloured by cloud-top pressure, derived from radiances. **c,** Conceptual cartoon illustrating major cloud types along a cross-section through te storm system. In a and b the data are from 5 January 2014 and limited by the field of view of the Meteosat satellite. Panel **a, b** © 2015, EUMETSAT.

Bony et al., Nature Geosc., doi:10.1038/ngeo2398, 2015. AMV presented in the Figure processed by EUMETSAT, 2014.

...and in a few years from now, the complete series...

Using SEVIRI type AMV algorithm for MFG and MSG processing



Summary of the 1st EUMETSAT MSG-SEVIRI wind CDR

- 8 years of MSG level 2 products have been reprocessed at EUMETSAT with the latest available algorithm (2004-2012).

- MSG reprocessing leads to a stable and homogeneous dataset. The dataset is useful and can be used for climate studies, reanalyses, ...

- The reprocessing is planned to be extended backward for Meteosat first generation (as soon as the algorithm to process the first generation satellite with a CCC-like algorithm exists at EUMETSAT).

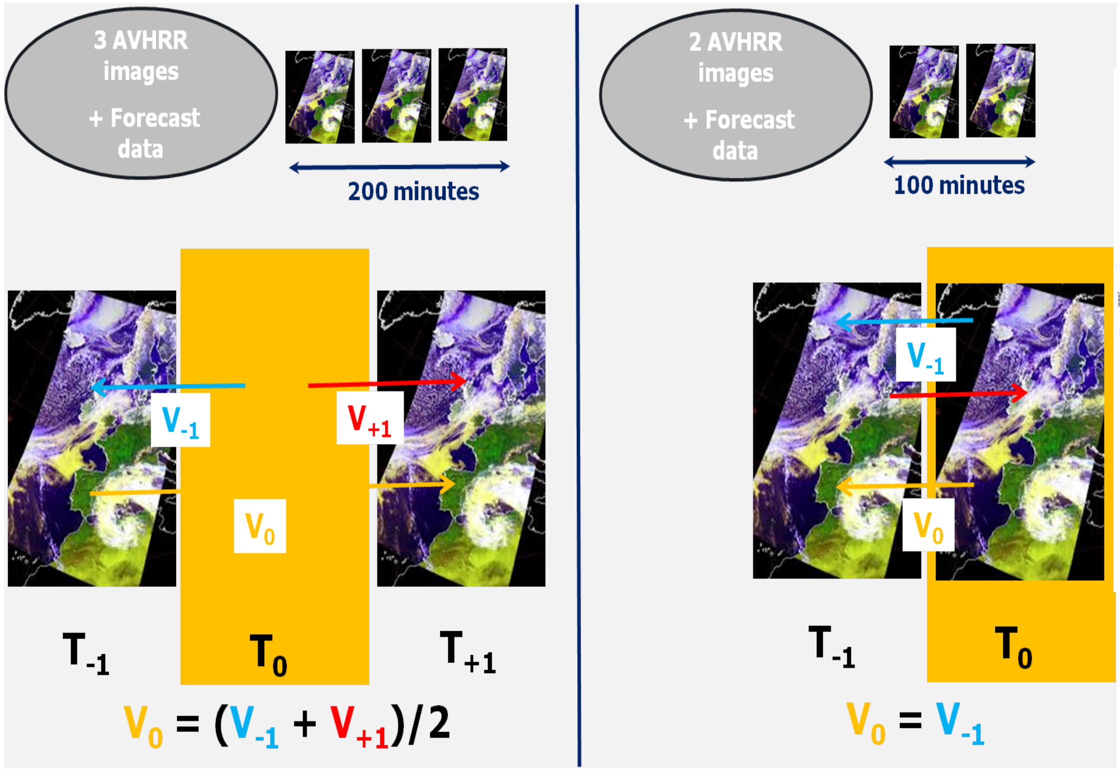
- The reprocessing will be repeated in the future.

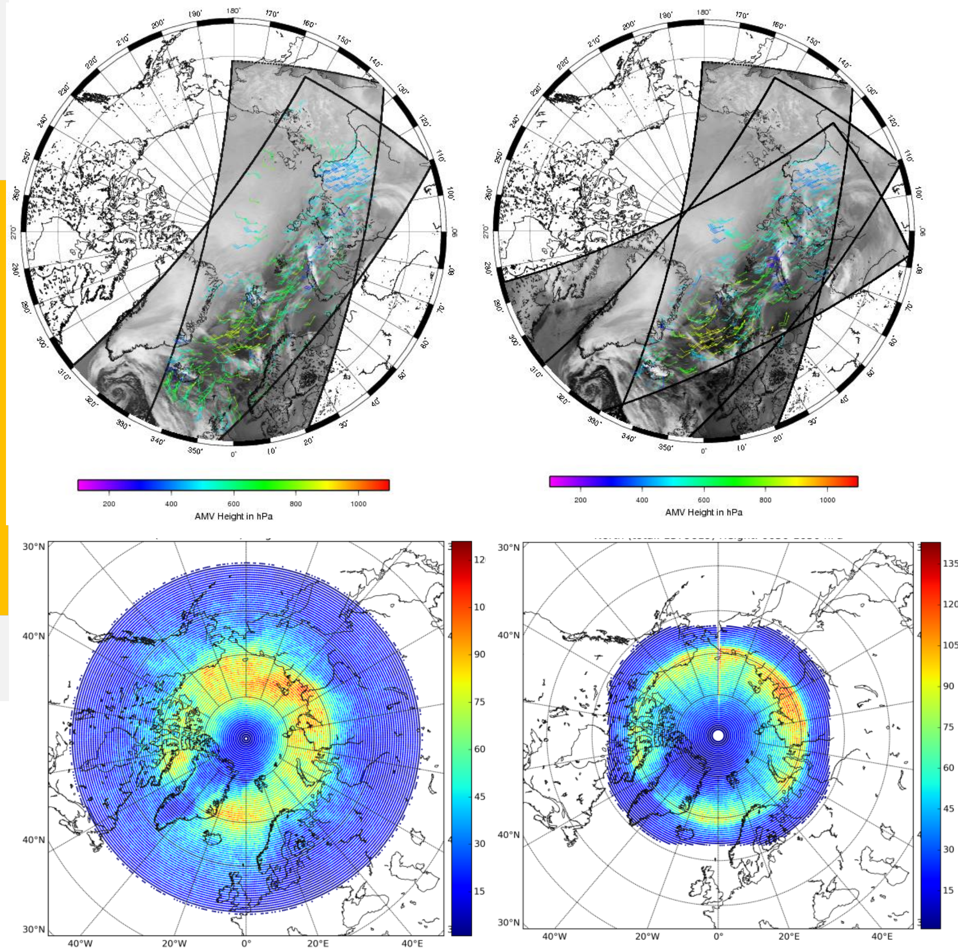
AMV CDR from imager onboard low earth orbit satellite

In the framework of the ERA-CLIM project, Metop-A AMV data have been reprocessed for the entire period 2007 – 2012:

- using CIMSS algorithm (v1.0)
- using EUMETSAT algorithm (v2.4)

LEO AMVs: CIMSS versus EUMETSAT algorithms

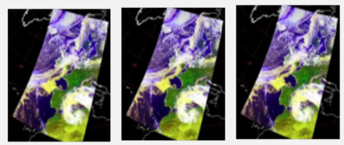




EUMETSAT

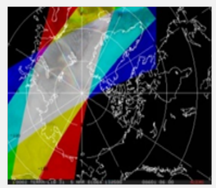
CIMSS versus EUMETSAT algorithms

3 AVHRR images
+ Forecast data



200 minutes

Remapping of entire image polar stereographic projection on a constant 2x2km grid (pre-processing)



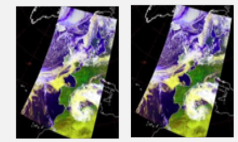
Targeting 13x13 target box (2x2 km)

Tracking search box 48x48 ← Forecast (first guess)

Initial height assignment Done once on mid image (in targeting step) ← Forecast (IR EBBT)

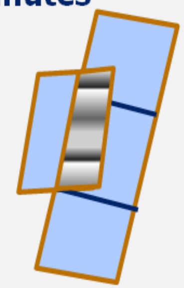
Final height Adjusted to best fit NWP data ← Forecast (Best fit)

2 AVHRR images
+ Forecast data



100 minutes

Remapping of each PDU on the reference image to a non constant grid (online)



Targeting 28x28 target box (1x1 to 4x2 km)

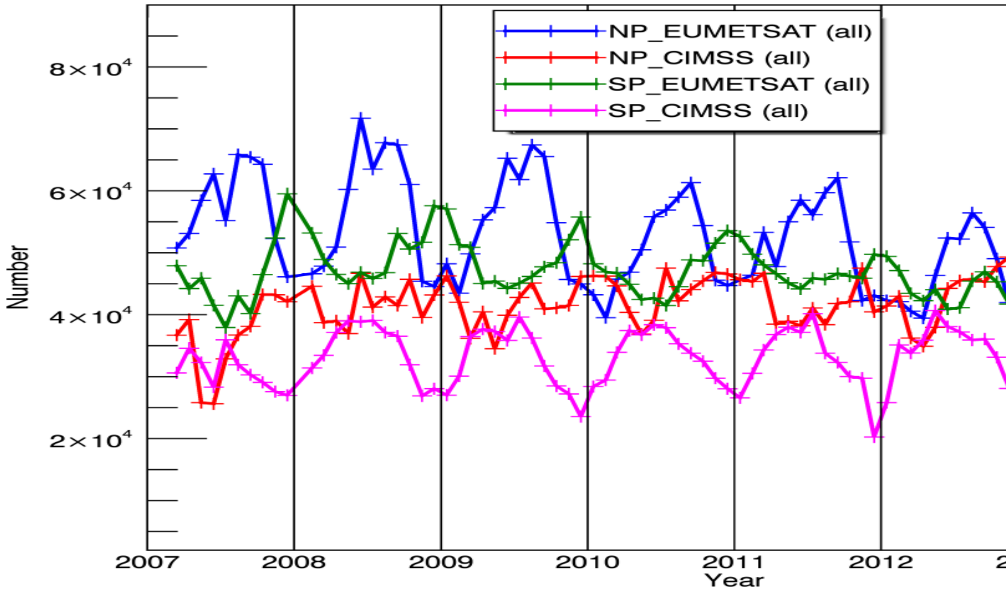
Tracking search box 100x100 ← Forecast (first guess)

Initial height assignment Done twice, forward and backward image ← Forecast (IR EBBT)

Final height CCC Method

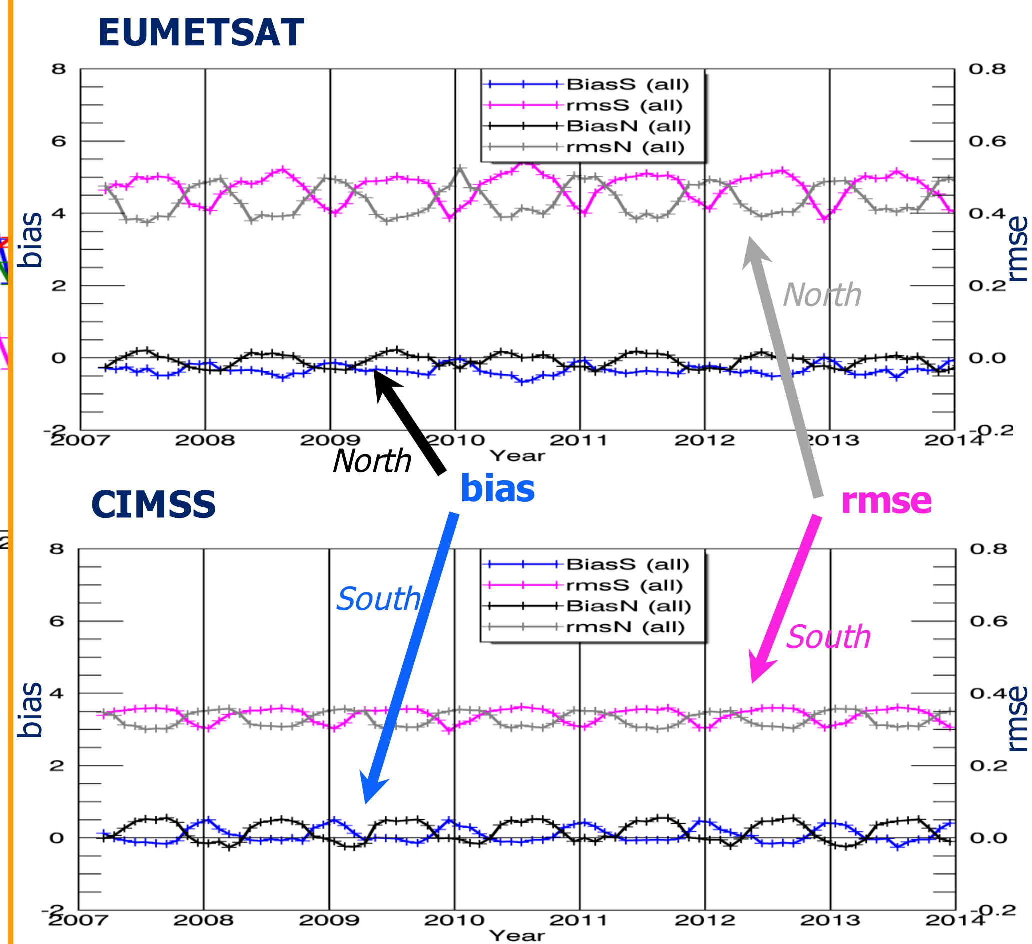
EUMETSAT

Time series 2007 - 2014



Monthly averaged time series of the number of **Metop-A** winds retrieved using EUMETSAT (blue and green) and CIMSS (red and magenta) algorithms over the North (blue and red) and South Poles (green and magenta). Only AMV with a QI greater than 50 are considered.

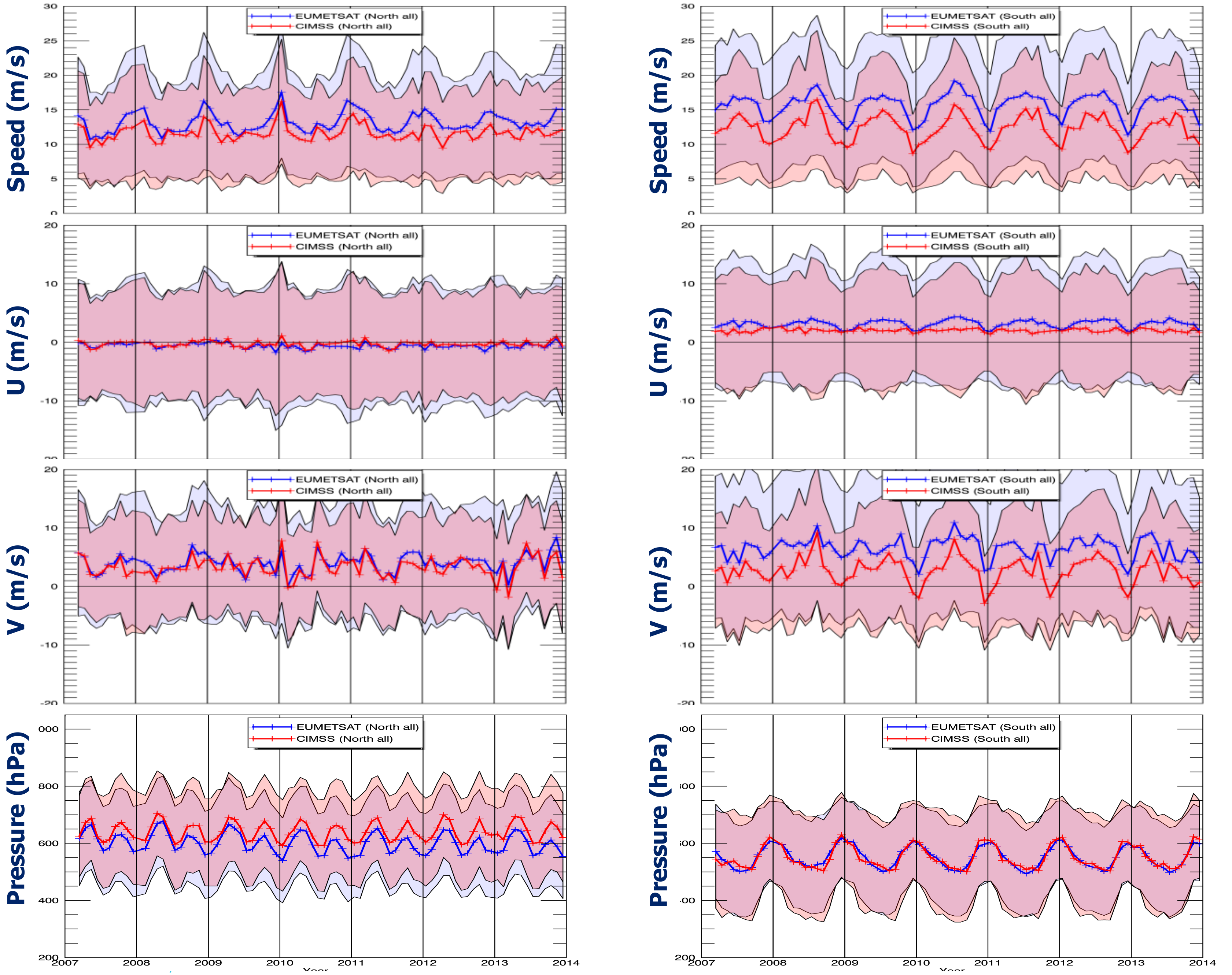
Bias and rmse against forecast



EUMETSAT

North pole

South pole



CIMSS

EUMETSAT

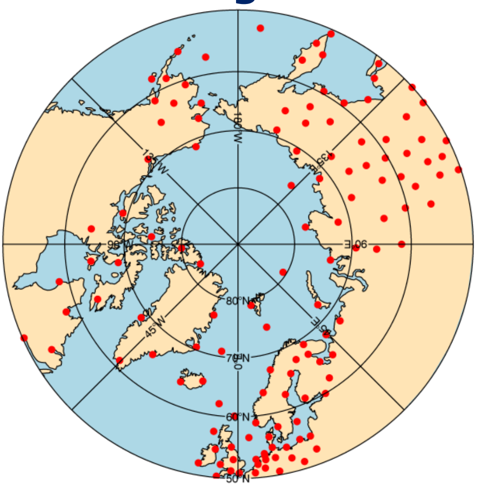
30 YEARS 1986-2016

EUMETSAT

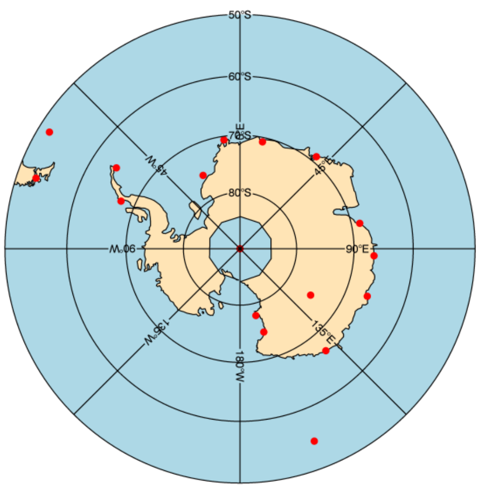
Comparison against RAOBS radiosonde [100km, 100 minutes, QI>50]

	EUMETSAT all AMVs					CIMSS all AMVs			
	DJF	MAM	JJA	SON		DJF	MAM	JJA	SON
Speed	14.15	12.80	12.25	13.31	**speed**	14.85	12.56	11.71	12.40
bias	-0.70	-0.47	-0.42	-0.53	**bias**	-1.24	-1.07	-0.96	-0.96
mvd	5.57	5.10	4.75	5.09	**mvd**	5.56	4.98	4.64	4.92
rmse	9.55	8.65	8.07	8.67	**rmse**	9.83	8.82	8.16	8.59
cc	0.86	0.85	0.85	0.88	**cc**	0.80	0.80	0.81	0.81

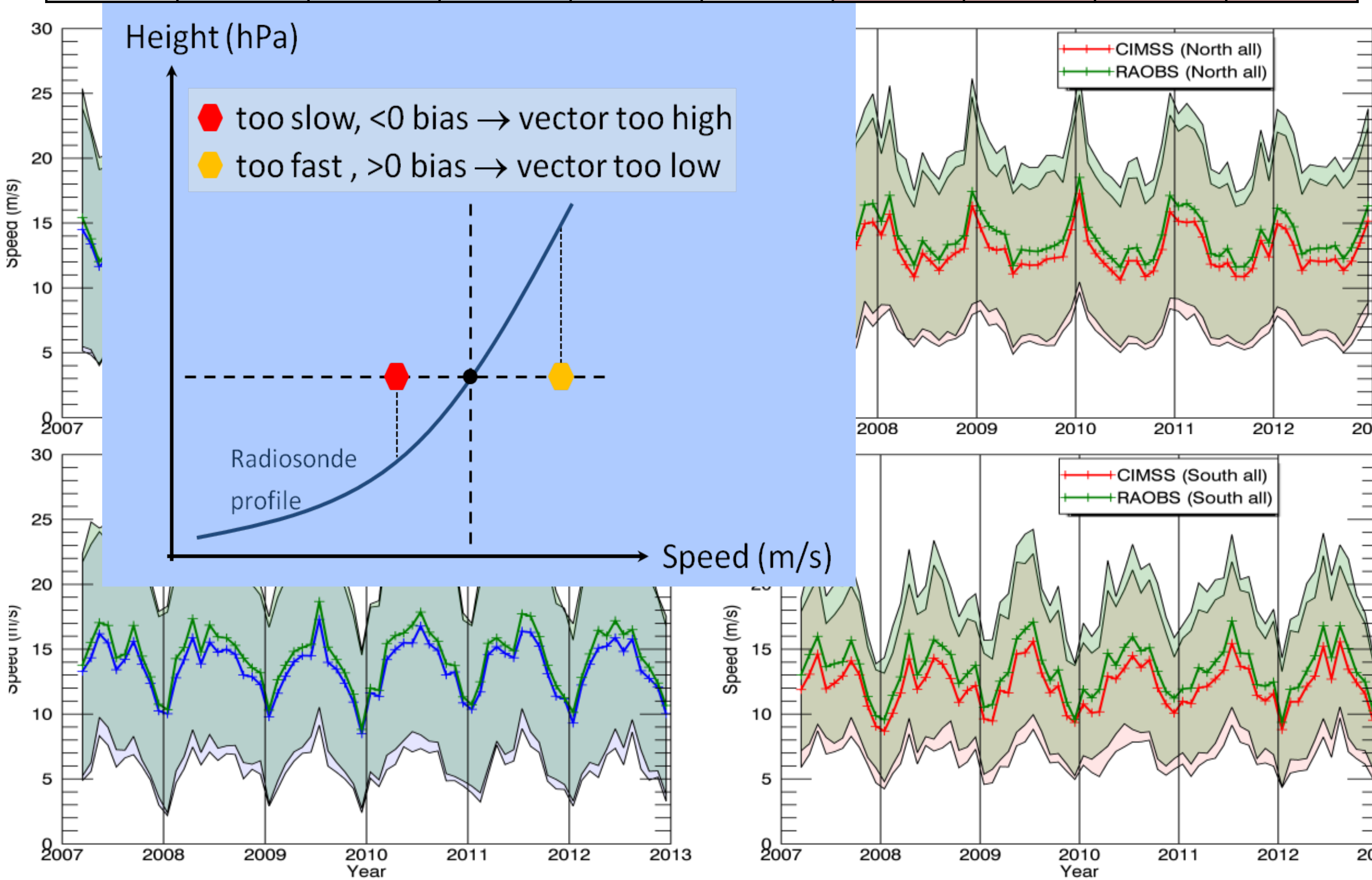
Location of radiosonde co-locating with AMVs



129 RAOBS used in 2011



18 RAOBS used in 2011



First release of Metop-A AMVs, a summary

- Used EUMETSAT and CIMSS algorithms with differences being:
  - Number of orbits used for tracking;
  - Target selection differs (search box sizes);
  - Height assignment methods.
- Geographical Coverage:
  - EUM covers the jet stream region;
  - EUM overlaps with geostationary satellites;
  - CIMSS has smaller regional coverage.
- Comparison results indicated:
  - Differences between algorithms do not depend on location;
  - Both data records show the same temporal variability with no obvious flaws or trends
  - Increase of the wind speed with altitude, a clear seasonal cycle being more pronounced over the South Pole (amplitude for North Pole 3-4 ms^{-1}, and South Pole 5-6 ms^{-1}).
  - The average height (or pressure) of the AMVs over the South Pole has a seasonal cycle with winds derived at higher altitude during winter seasons. is a double seasonal cycle with winds being put higher in the atmosphere in summer and winter and lower in spring an autumn.
- EUMETSAT less tight with the forecast data, better for usage in reanalysis.

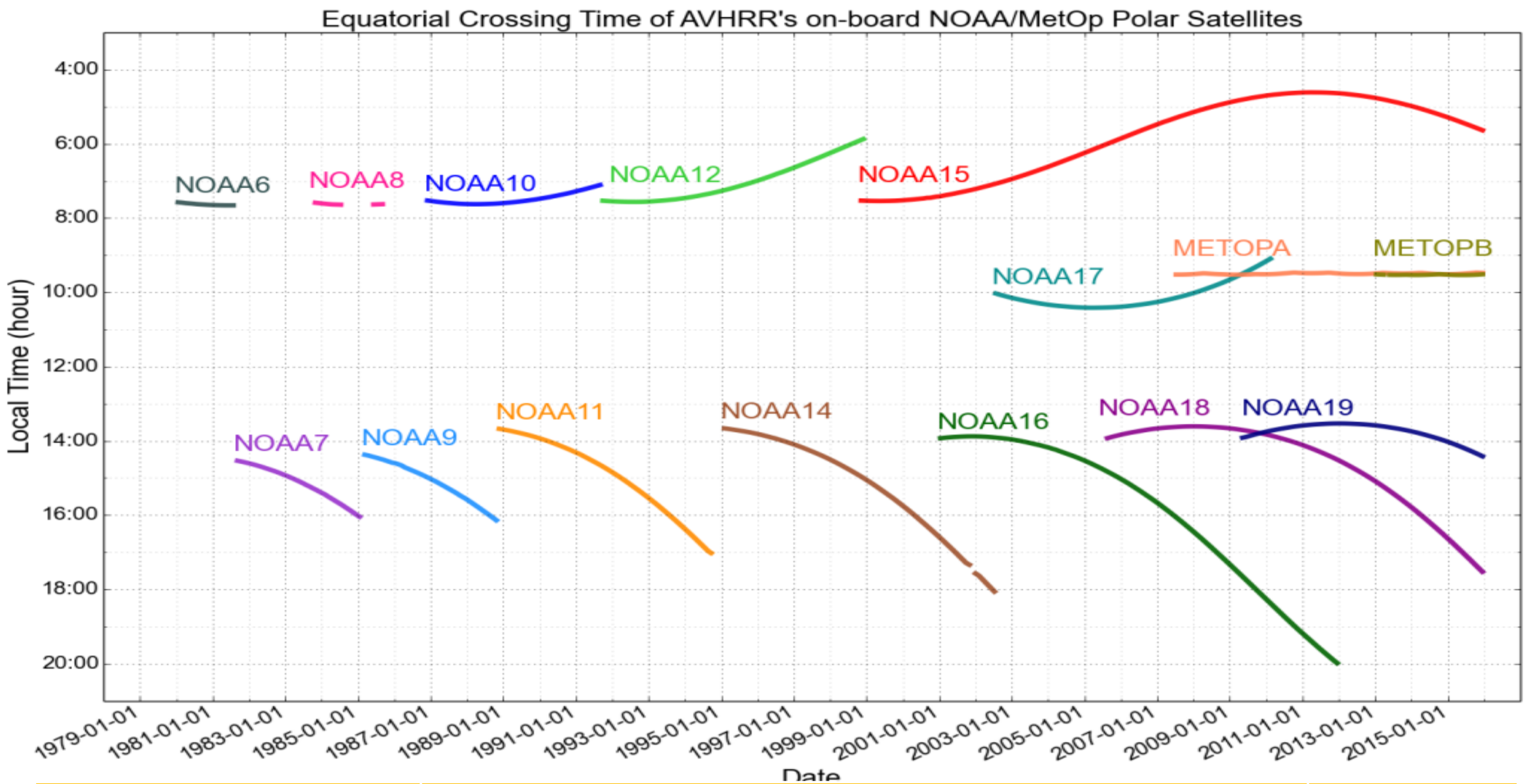
- Reprocessing activity led to algorithm improvement used in a second reprocessing.

AVHRR instrument was/is also on board NOAA satellites

AVHRR FCDR PyGAC dataset [1978-2015] is used as an input data

Developed jointly by CM SAF & Cloud_cci

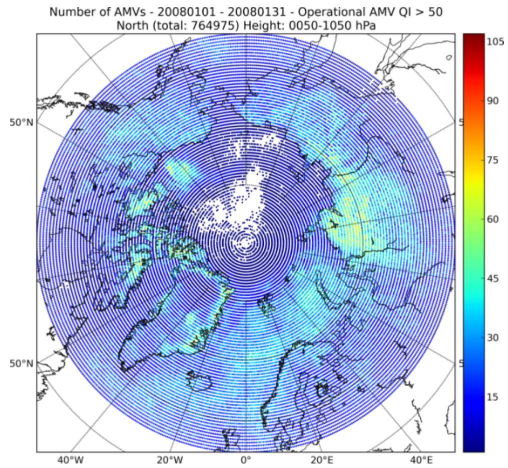
Reading and calibrating GAC L1b data



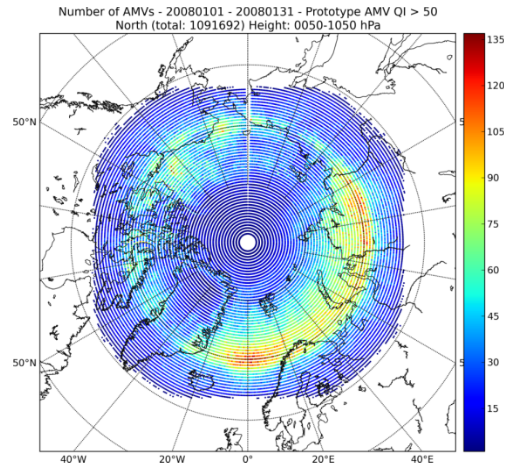
AVHRR GAC Data	ECFS path	Total Size
L1b dataset	ec:/sf3/data/GAC_avhrr_archive	15.07 TB
L1c dataset	ec:/sf7/data/AVHRR_GAC_L1c_archive_v2	22.06 TB
Latest SQLite database	ec:/sf7/data/AVHRR_GAC_L1c_sqls/v2_201603/ AVHRR_GAC_archive_v2_201603_post_overlap.sqlite3	291 MB

Polar AMVs from AVHRR: GAC versus LAC format

Done
Metop-A
[2007-2015]

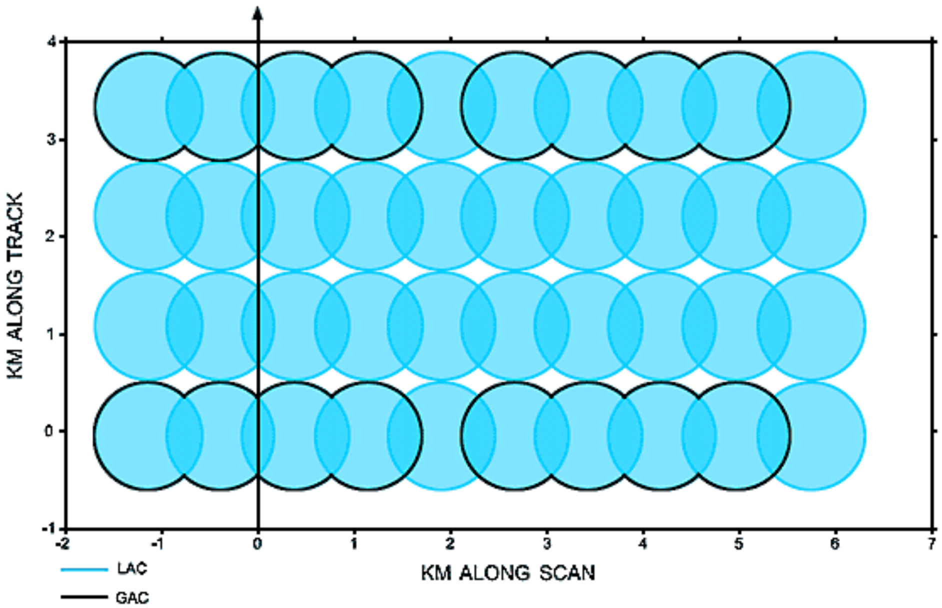


EUMETSAT AVHRR



CIMSS AVHRR

Entire AVHRR series (1982-present) GAC format



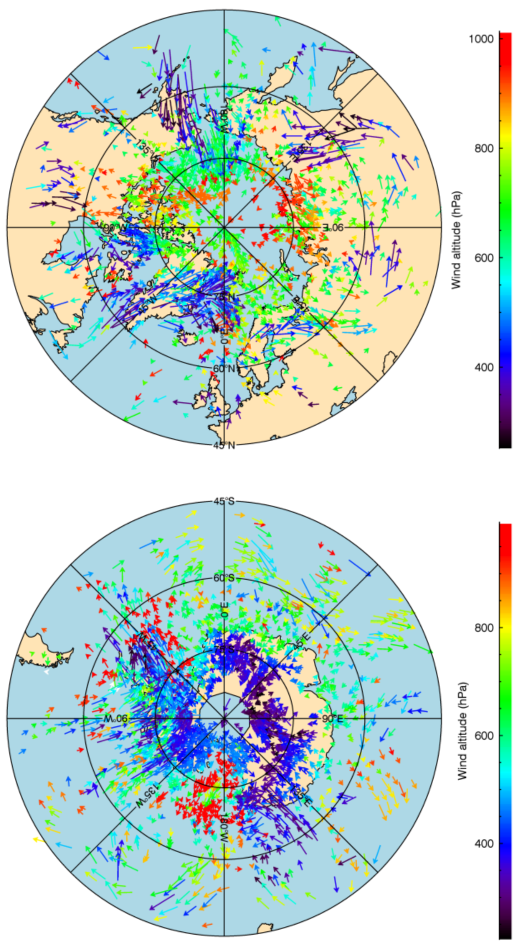
EUMETSAT

polar AMVs using EUMETSAT algorithm using GAC and LAC AVHRR data

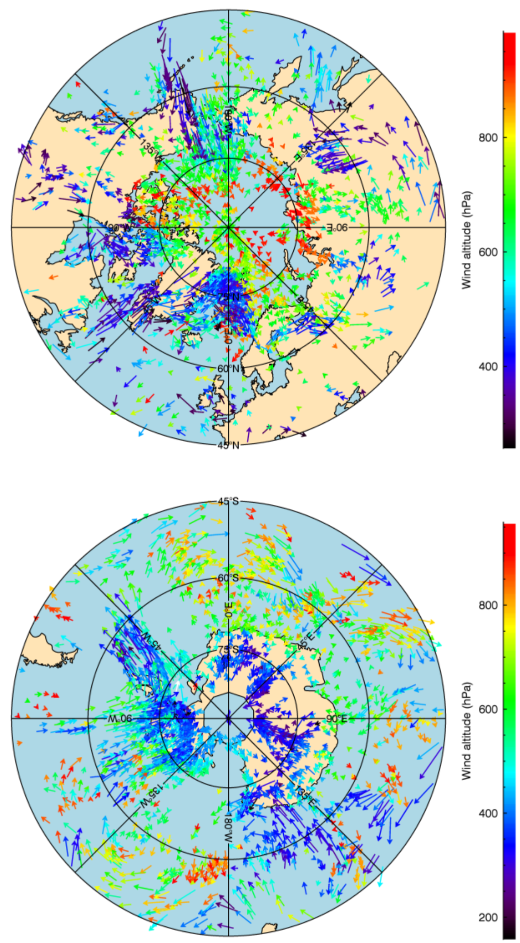
10th May 2016
AMVs with QI > 60 and speed ≥2.5 m/s

	NOAA 19	METOP A	MetopB
North pole	18440	42518	44975
South pole	25283	45440	43146

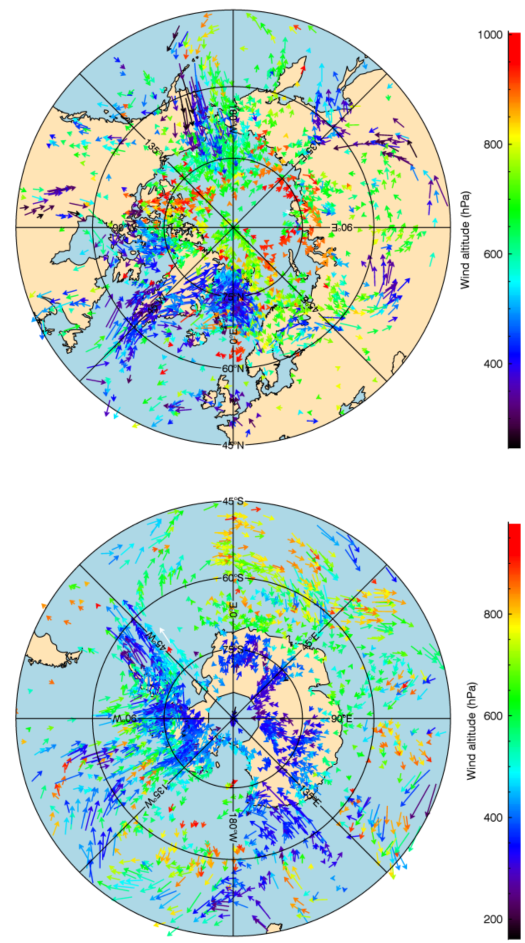
NOAA 19 - AVHRR/3

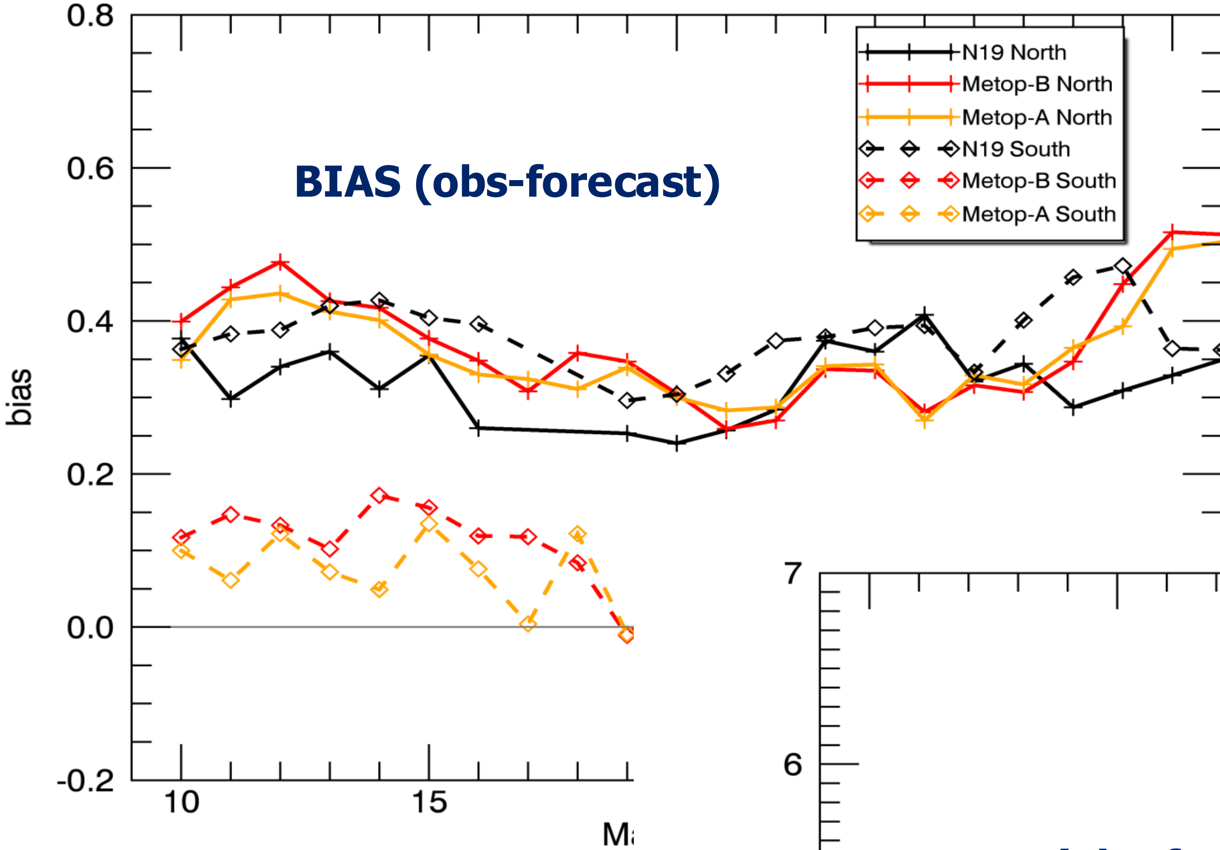


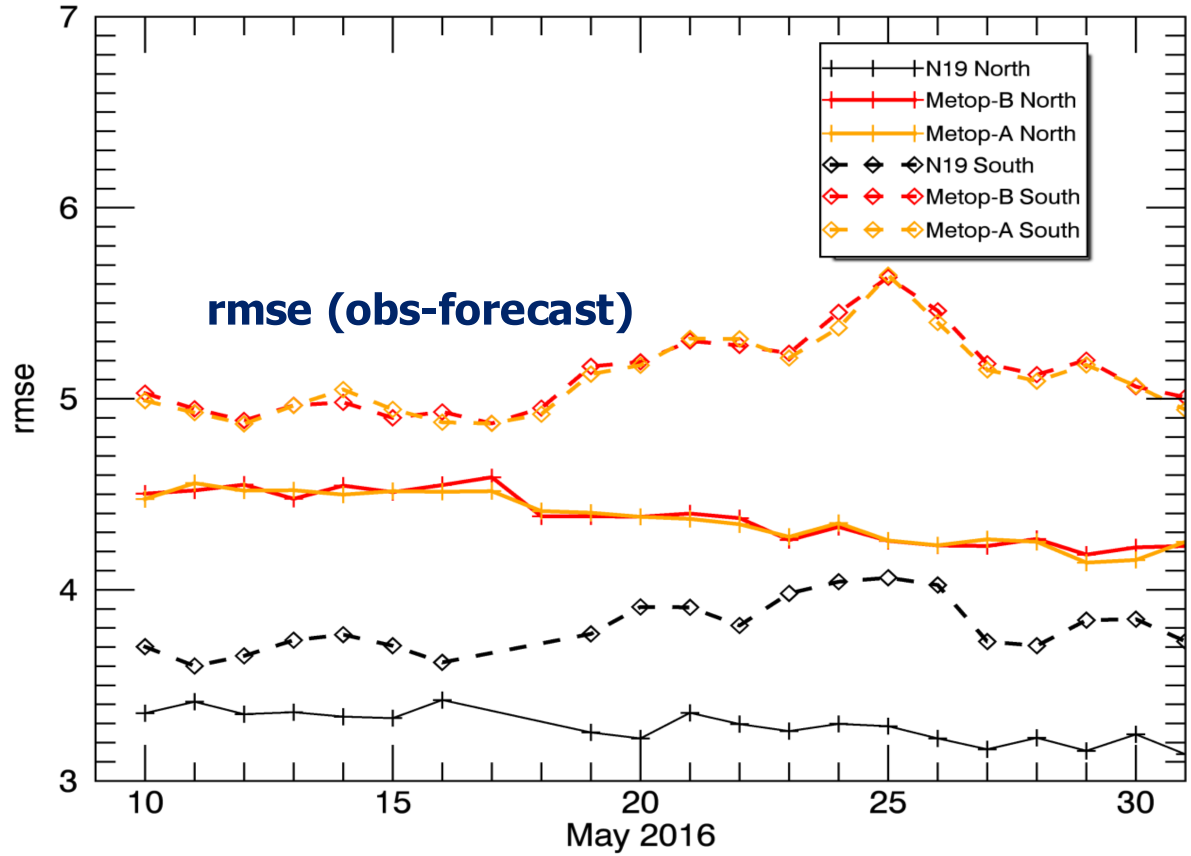
Metop A - AVHRR/3



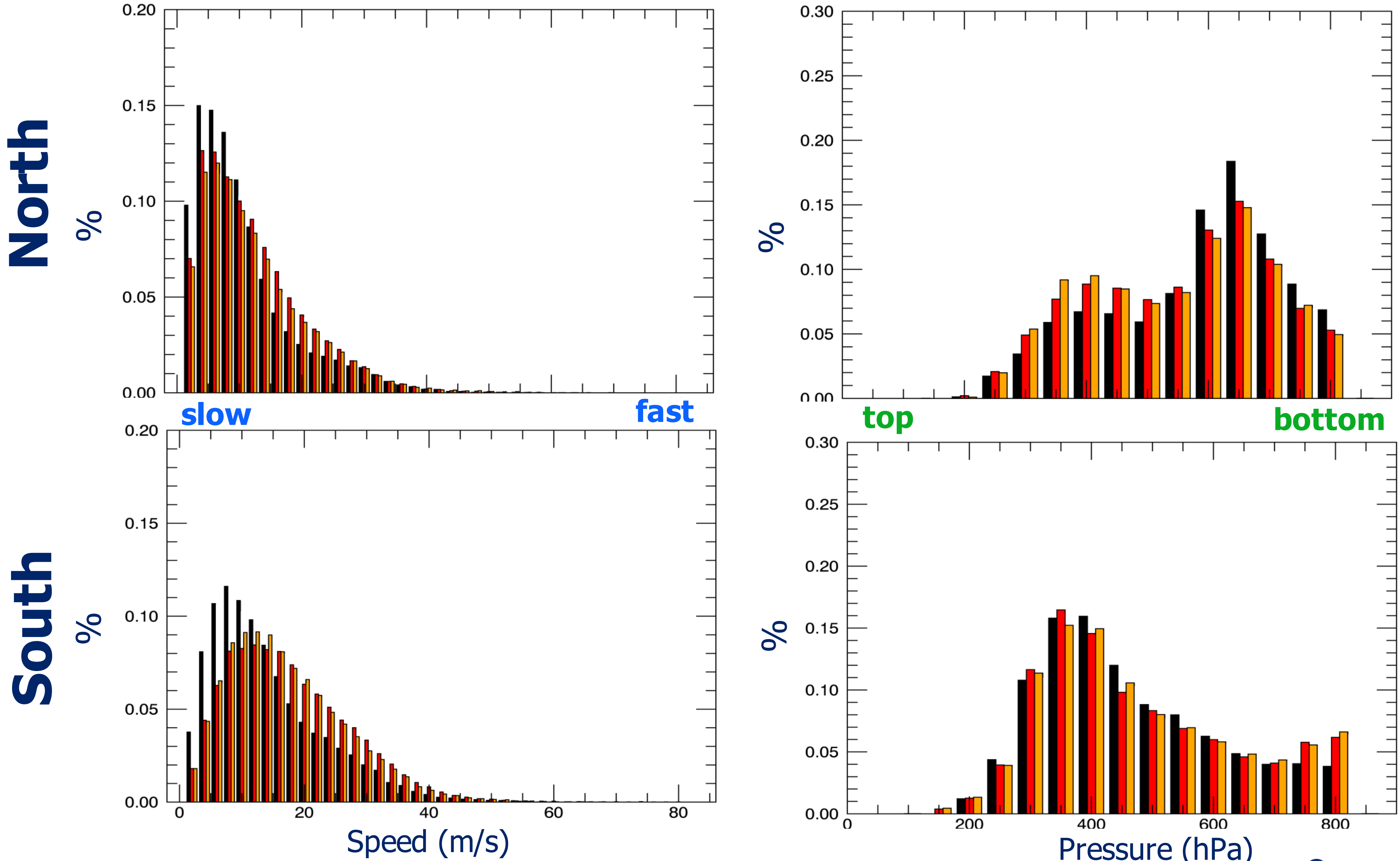
Metop B - AVHRR/3



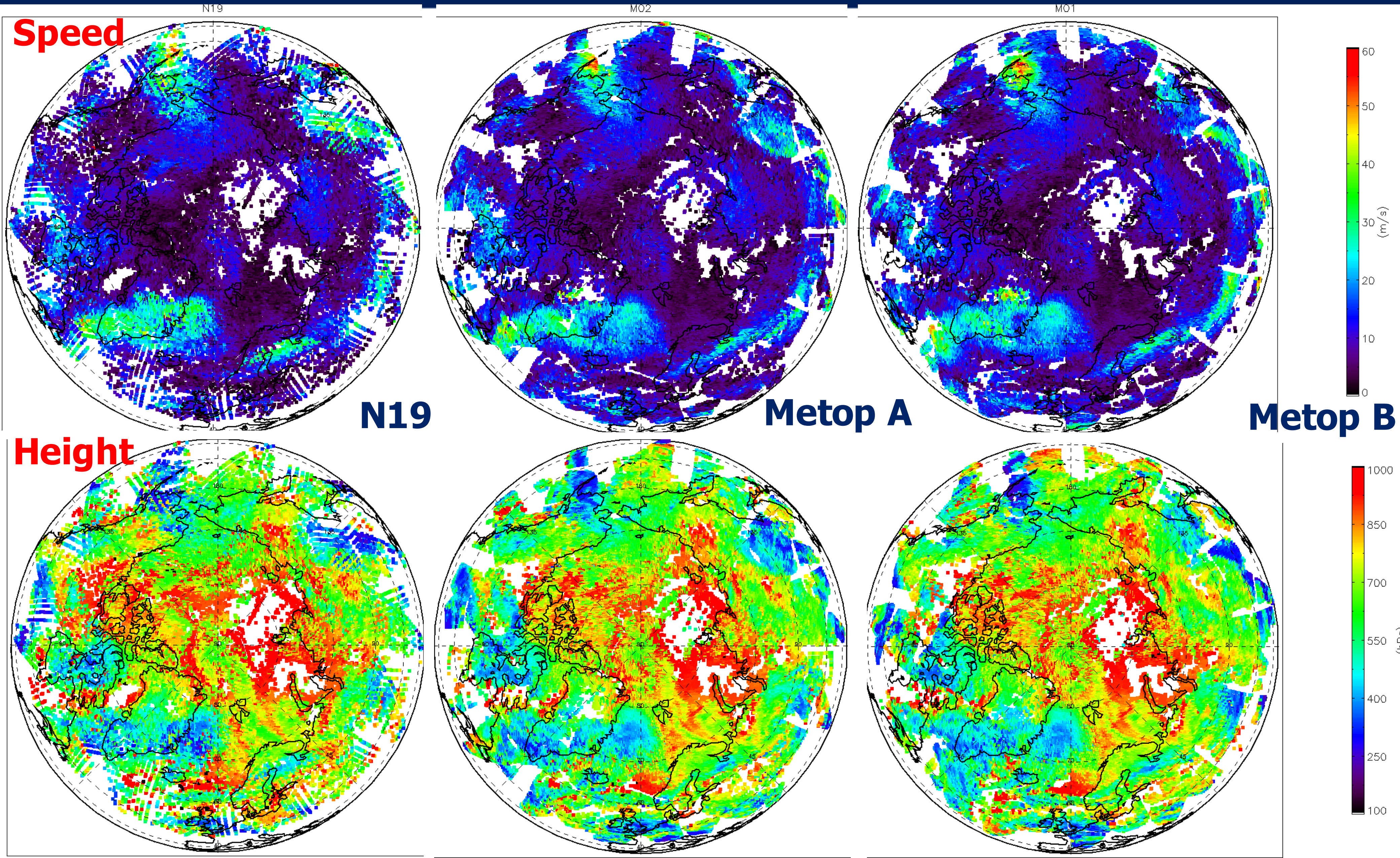

BIAS (obs-forecast)
bias
0.8
0.6
0.4
0.2
0.0
-0.2
10
15
N19 North
Metop-B North
Metop-A North
N19 South
Metop-B South
Metop-A South


rmse (obs-forecast)
rmse
7
6
5
4
3
10
15
20
25
30
May 2016
N19 North
Metop-B North
Metop-A North
N19 South
Metop-B South
Metop-A South

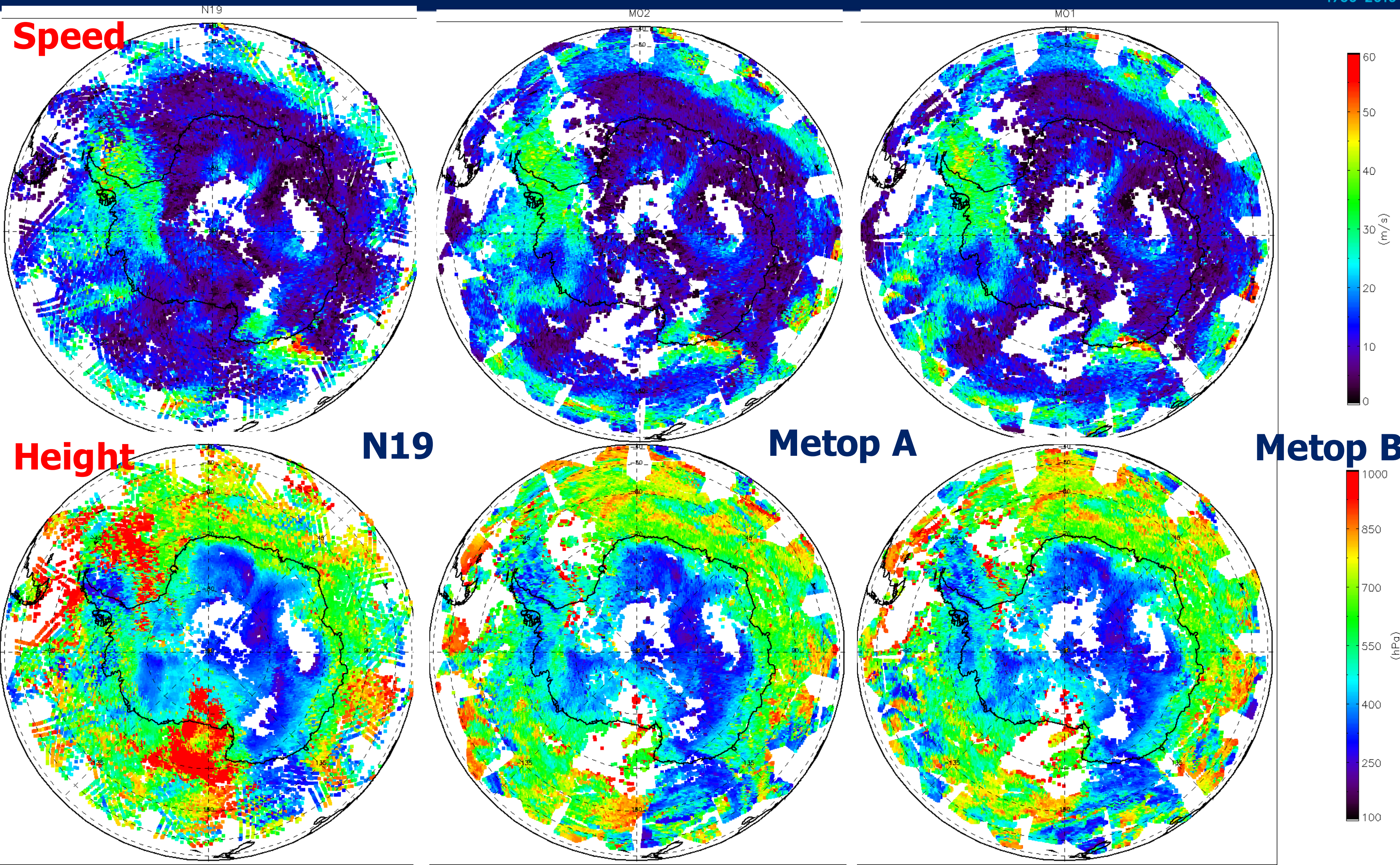
10 May 2016, distribution of AMVs speed and height



10 May 2016 AMV speed and height (0.5x0.5 deg)



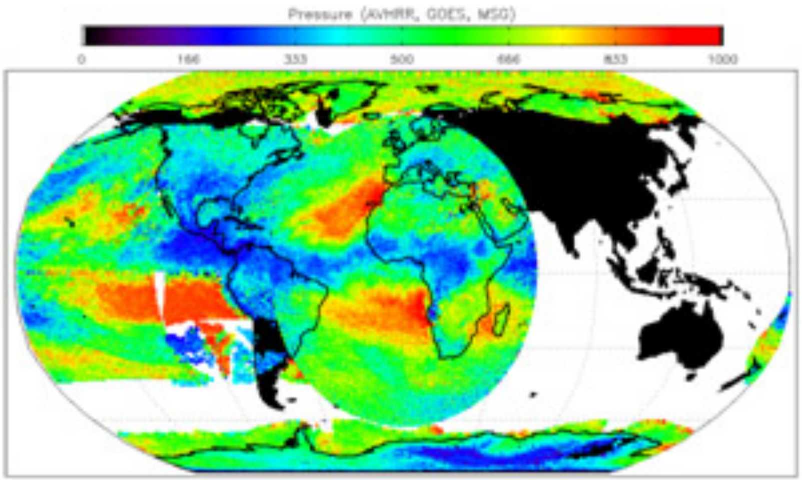
10th May 2016, South pole



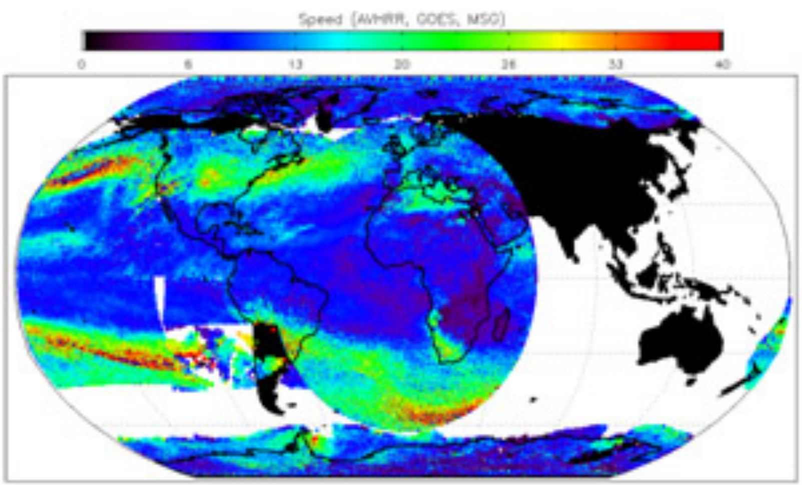
Future reprocessing plans

	Time coverage	Geographical coverage	Description	Date
GEO AMV reprocessing				
Meteosat 2-10	1983 – 2016	Europe/Africa	Release 2	2017
Meteosat 2-10	1983 – 2018	Europe/Africa	Release 2 extension	2018
LEO AMV reprocessing				
NOAA 7-19, Metop A/B		Polar region (up to 65º)	Release 1	2016
Metop A/B AVHRR AMV LAC	2007 - present	Polar region (up to 50º)	Release 2	2019
Metop AVHRR		Global	Release 1	2019
NOAA GAC AMVs		Polar region (up to 50º)	R1 polar extension	2020
NOAA GAC AMVs		Polar region (up to 50º)	R2	2020

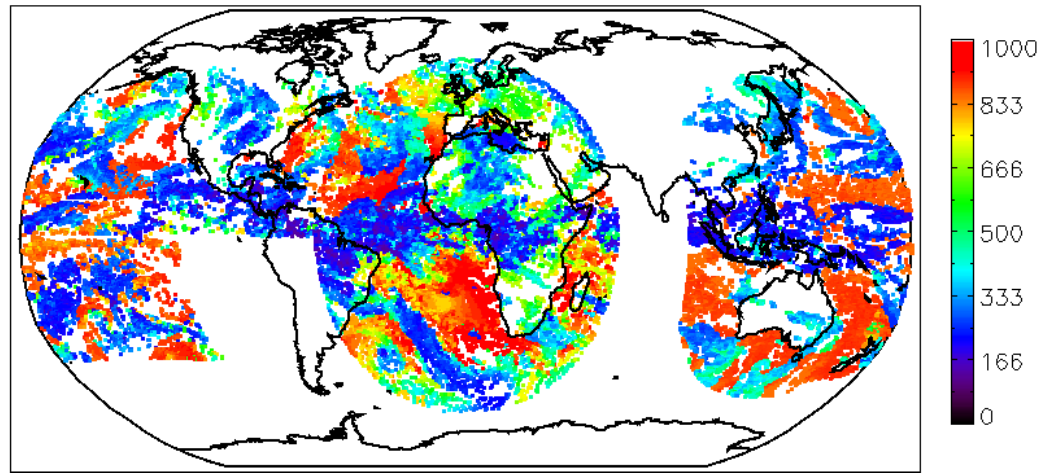
SCOPE-CM: possible global AMV reprocessing mainly for reanalysis use

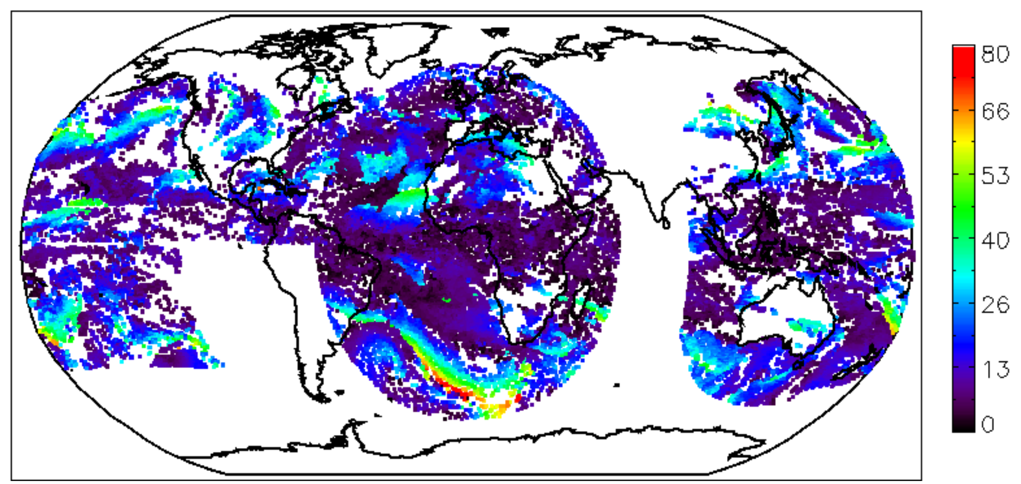


METOP, MSG, GOES – June 2008

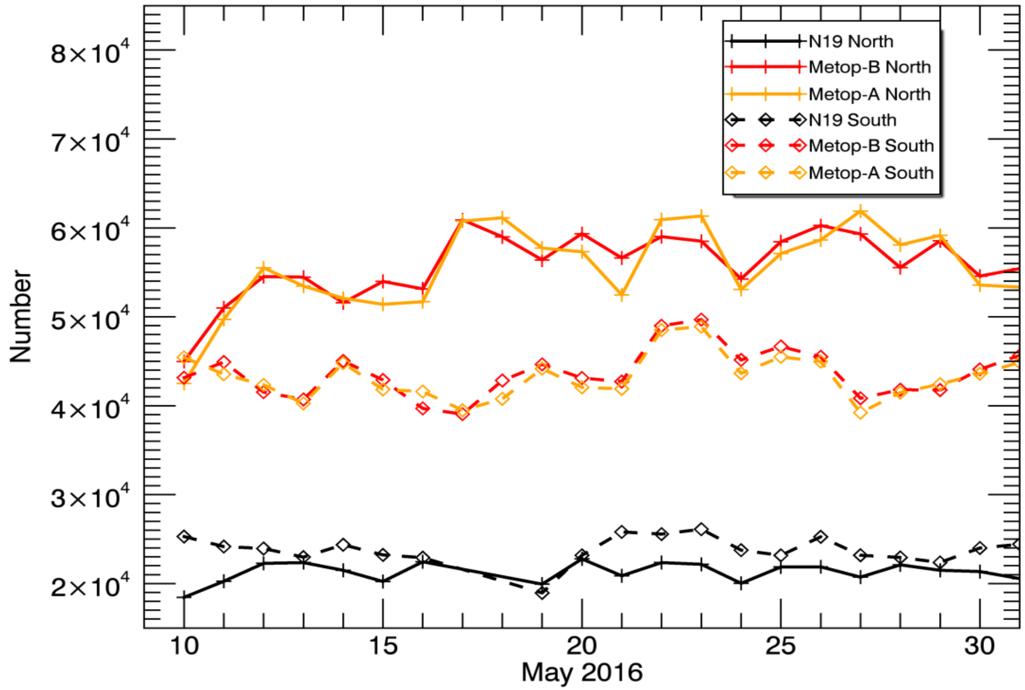


MSG, GOES, MTSAT – 1st May 2008, ~01:00

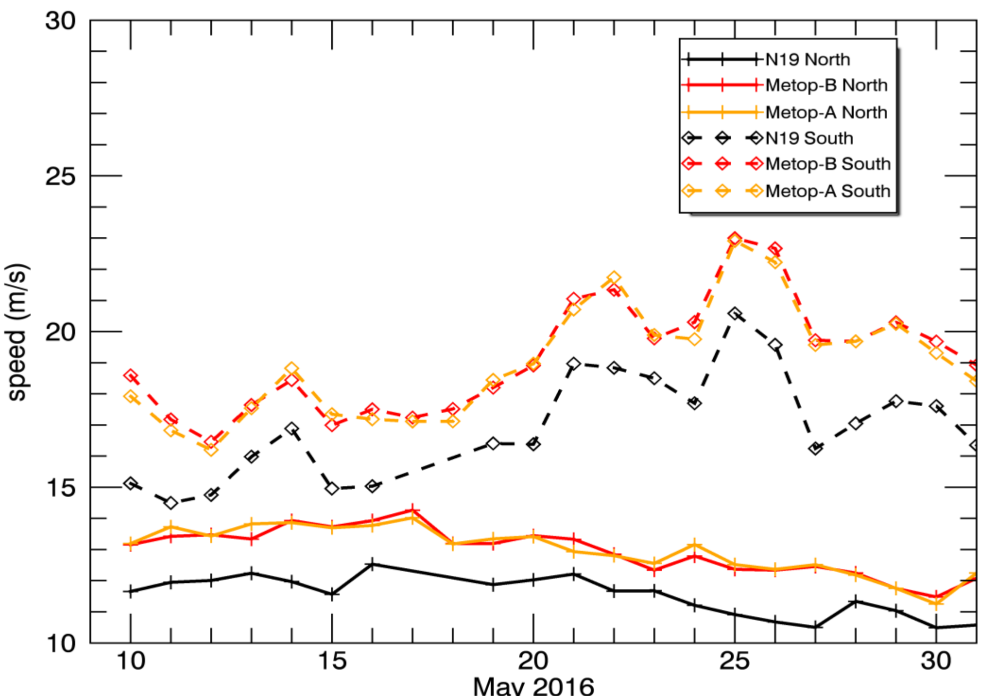




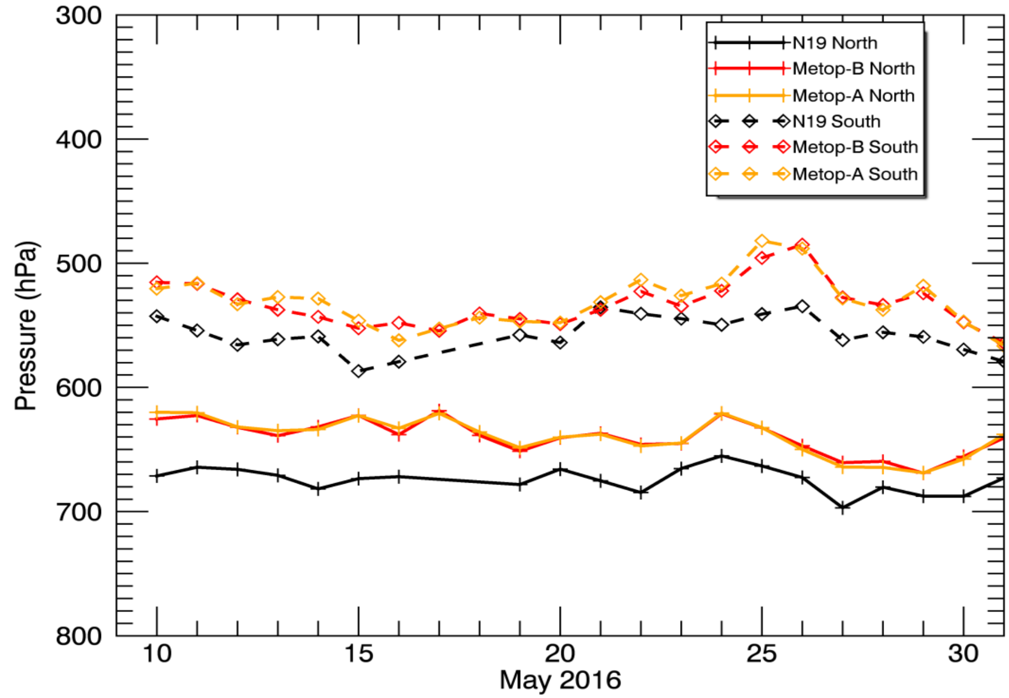

Thank You



N19 North
Metop-B North
Metop-A North
N19 South
Metop-B South
Metop-A South
Number
May 2016



N19 North
Metop-B North
Metop-A North
N19 South
Metop-B South
Metop-A South
speed (m/s)
May 2016



N19 North
Metop-B North
Metop-A North
N19 South
Metop-B South
Metop-A South
Pressure (hPa)
May 2016