The satellite wind activities at Météo-France

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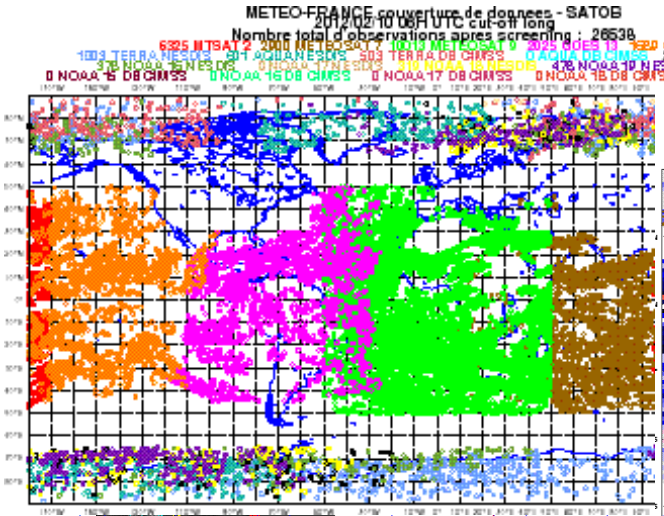
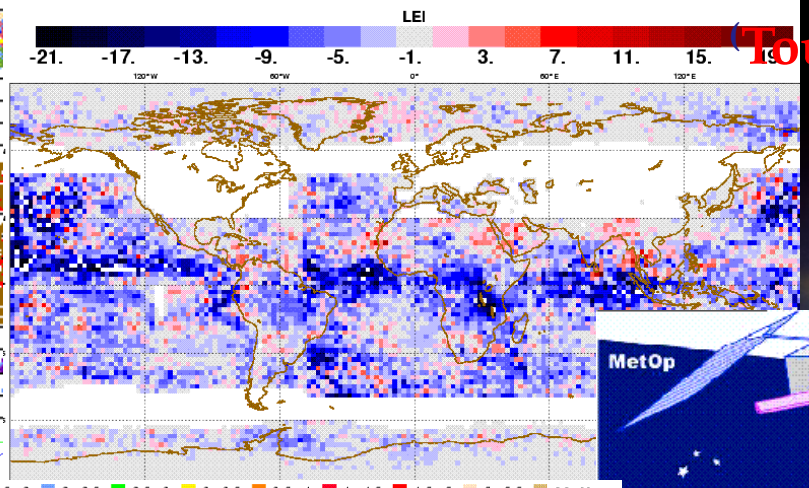
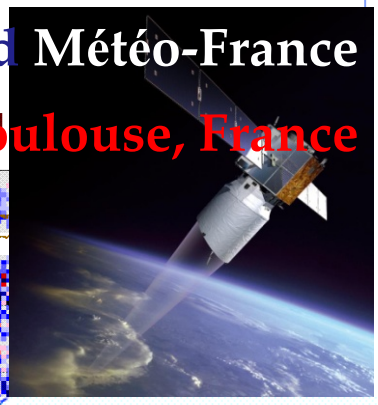
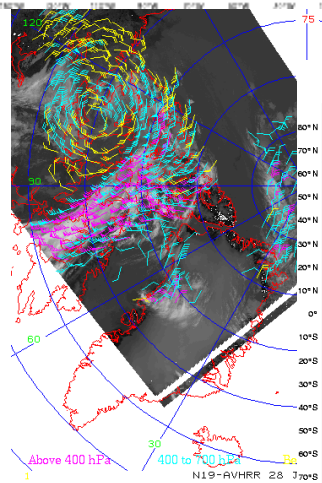
CNRM-GAME, CNRS and Météo-France

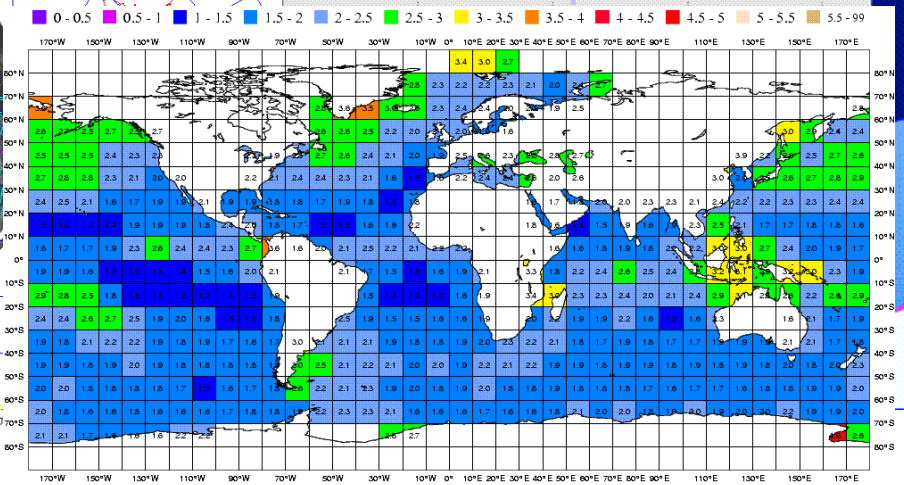
Toulouse, France

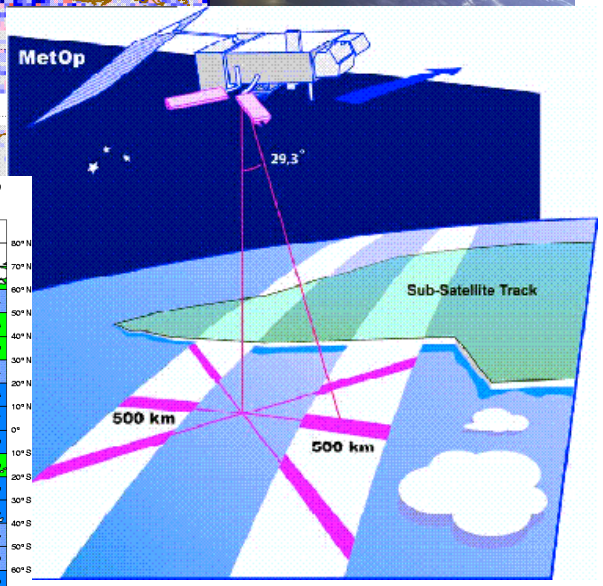












What are the satellite wind activities in a NWP centre?

- Introduce new observations when they are avalaible (polar winds, OSCAT, soon a new ASCAT, new streams as EARS ASCAT, soon HY2A)

- Improve the use of the observations already assimilated (ASCAT, AMVs) by a better quality control, a better selection, better observation operators, a better tuning of errors,… What else? Global, regional, mesoscale models?

- Manage the changes of satellites (MTSAT-1R to MTSAT-2, GOES-11 to GOES-15)

- Estimate the quality of what we do, by denial experiments, the Forecast Sensitivity to Observations (FSO),… That will be the topic of the group discussion at the end of the day

- Prepare the future missions (Aeolus planned end of 2013, CFOSat in 2015)

… without to forget some plumbing tasks

Morning's menu of French cooking

- Introduction in the operational assimilation system over the past 2 years of
  - the clear-sky WV winds from MODIS
  - the AVHRR NOAA winds (NESDIS product)
  - additional Direct Broadcast polar winds (CIMSS-Eumetcast link)

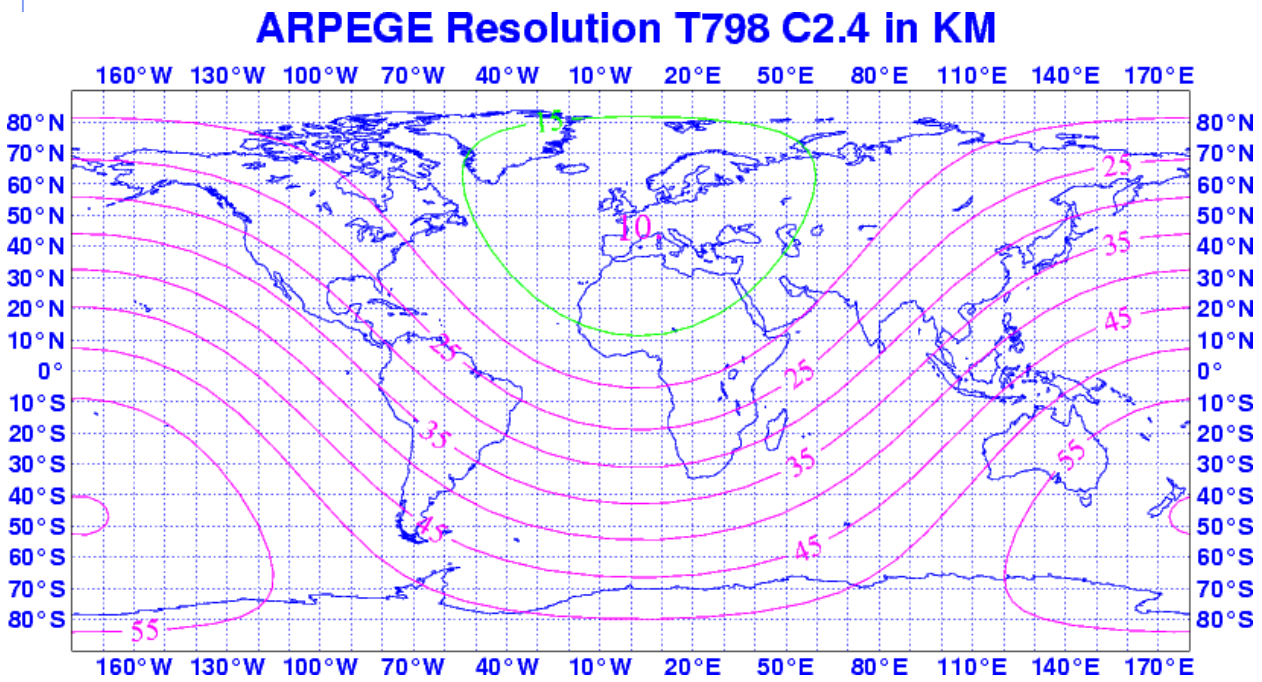
- Evaluation of a first OSCAT wind dataset (processed by KNMI in the frame of the Eumetsat OSI-SAF)

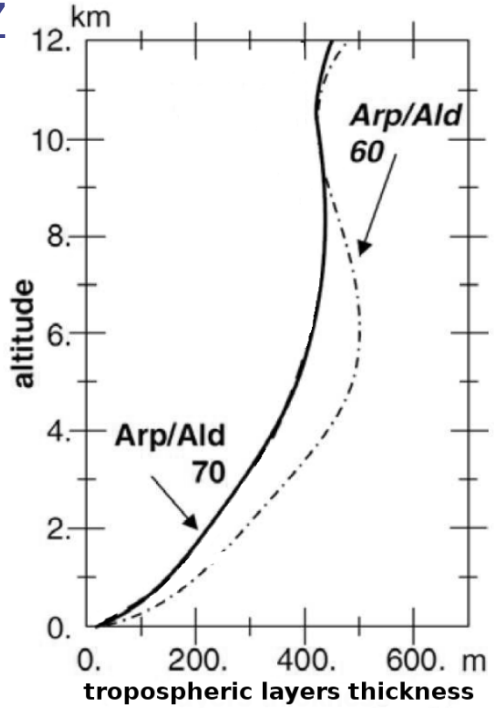
- Improvements in the use of ASCAT winds (KNMI processing) with a better quality control, a better selection and a better tuning of errors,...

Data assimilation/NWP system: global model ARPEGE

Main characteristics:

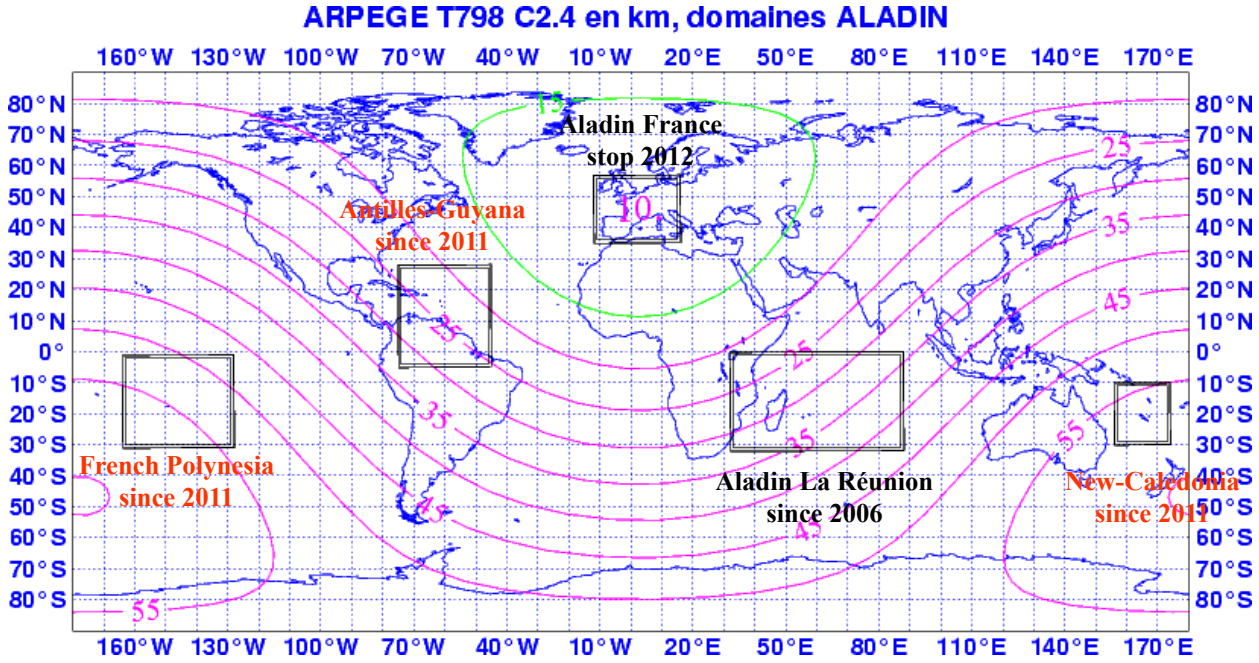
- Spectral global model, streched grid, semi-implicit semi-Lagrangien temporal scheme, incr. its resol. to T738C2.4L70, time step:600s (in April 2010)
- 4DVAR Assimilation: 6 hr time window, T107/T323 (63 km Gaussian grid), Time window: T ± 3hr, Analysis times (T):00,06,12,18Z





Data assimilation/NWP system: regional model ALADIN

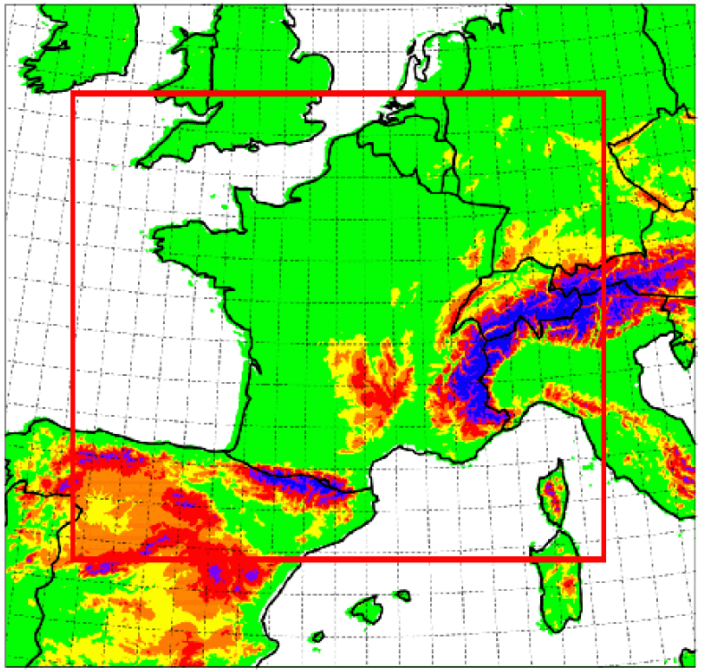
- Main characteristics:
  - regional model over Europe and La Réunion, spectral, semi-implicit semi-Lagrangien temporal scheme, resol. 7.5km, 70levels, timestep: 450s
  - 3DVAR Assimilation: 6 hr time window, T199 (100 km Gaussian grid), Time window: T ± 3hr, Analysis times (T):00,06,12,18 Z, coupling every 3 hours with ARPEGE
- Overseas extensions (since 2011, IFS coupling):



Data assimilation/NWP system: meso-scale model AROME

- Main characteristics:
  - meso-scale model (non-hydrostatic), spectral, semi-implicit semi-Lagrangien temporal scheme, 2.5km of resolution, 60 levels, time step: 60s
  - 3DVAR Assimilation: 3 hr time window, T359 (55 km Gaussian grid), Time window: T ± 1.5hr, Analysis times (T):00,03,06,09,12,15,18,21 Z, coupling each hour with ARPEGE

Operational domain Arome
(red square defines the first operational model until 11/2010)



Clear-sky WV MODIS winds: context

- History:
  - ✓ IR and cloudy WV MODIS winds, NESDIS product, used operationally since 2006;
  - ✓ Started to use Direct Broadcast MODIS winds (Tromsø, Mc-Murdo) through CIMSS/Eumetcast link in February 2009;
  - ✓ No (still) other polar winds (NOAAs, Metop).

- Test the adding of the clear sky WV MODIS winds in the frame of ARPEGE, 1 month experiment, operational run as reference with IR/ cloudy WV MODIS winds.

- Selection clear-sky as cloudy WV MODIS: no wind below 700hPa, thinning every 2°5 & by 1 hour timeslot (with other MODIS winds).

Clear-sky WV MODIS winds: use and model fit (assimilation run)

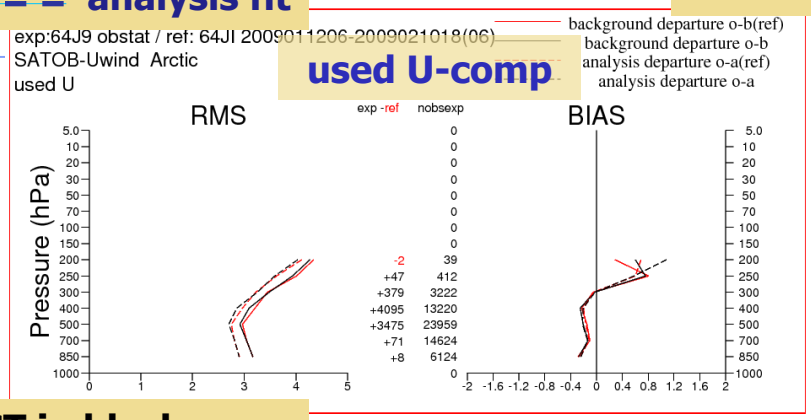
—— background fit

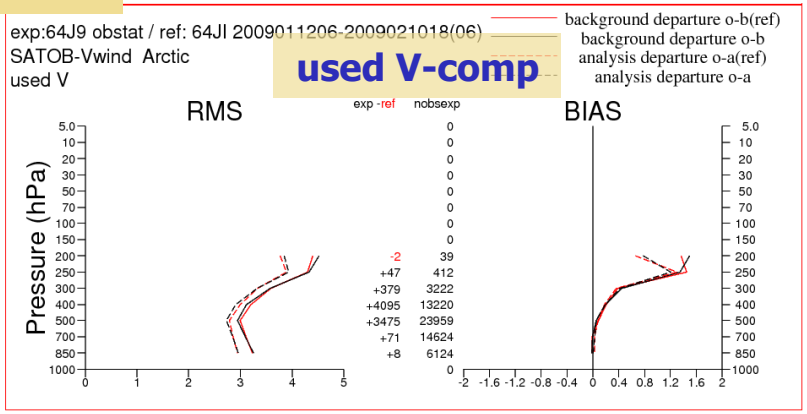
– – – – analysis fit

TEST in black

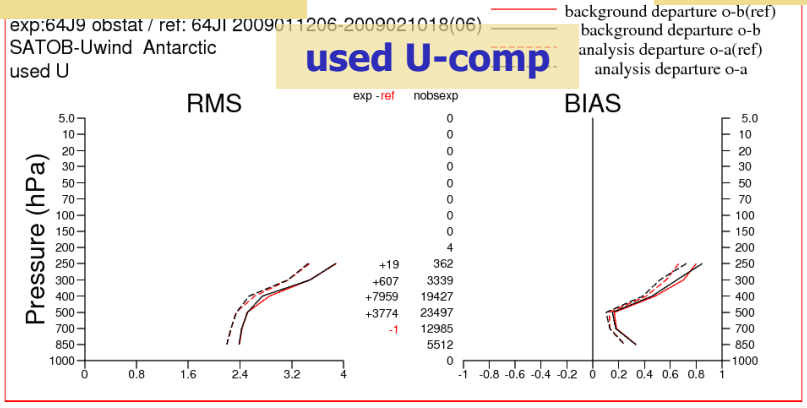
REFERENCE in red

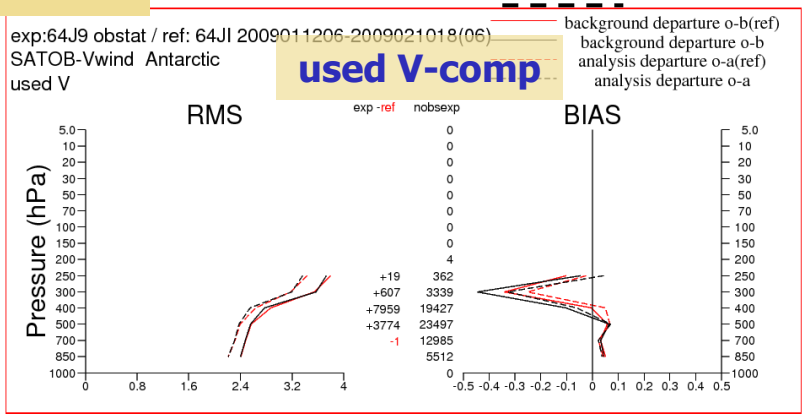
ARCTIC





ANTARCTIC





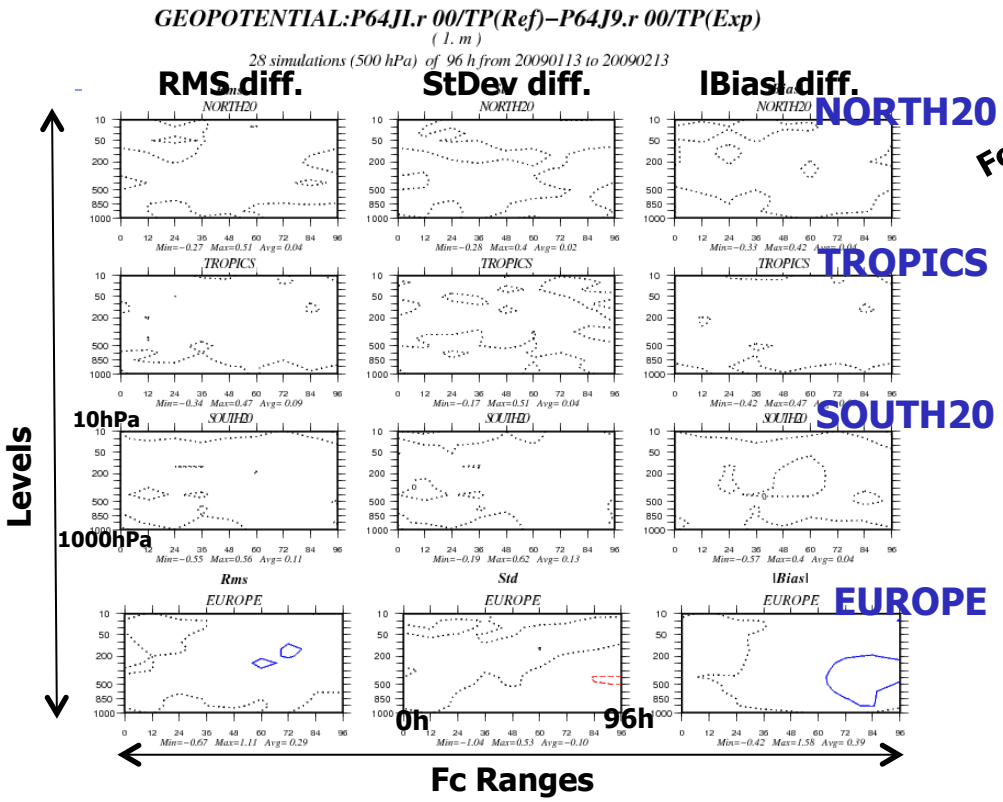
- **+15% (+280 winds per day) used over Arctic**
- **+23%(+430 per day) used over Antarctic**

mainly between 300 / 500 hPa

- **a better fit in TEST with additional clear-sky WV winds**

Clear-sky WV MODIS winds: forecast scores

Geopotential forecast scores, Ctrl radiosondes



blue (red) line => positive (negative) fc scores for clear-sky WV Modis TEST, 1m per isoline, dotted is neutral score

BOOTSTRAP Test, 28 cases

Fc Ranges

	SOUTH20								TROPICS								NORTH20							
Domain	SUD20								TROPIQ								NORD20							
Range	0h 12	24	36	48	60	72	84	96h	12	24	36	48	60	72	84	96	0	12	24	36	48	60	72	84	96
10hPa		-																							
30												+													
50	+											++		+											
100						+																	+		
150																									
200																									
250																									
300									+																
400						+			+																
500						+								++											
700		+																							
850																									
925																									
1000hPa																									

EUROPE

Domain	EUROPE								
Range	0	12	24	36	48	60	72	84	96
10			+						
30									
50						++			
100						+	++		
150						+	++		
200					+	++	++		
250					+	+			
300									
400									
500									
700									
850									
925									
1000									

+/- : confidence of 99%

++/-- : confidence of 99.9%

...that the TEST is better/worse

- **Scores neutral or slightly positive, same thing with T, Hu and Wind**
- **Neutral with the other CONTROLs (own analysis, IFS analysis)**

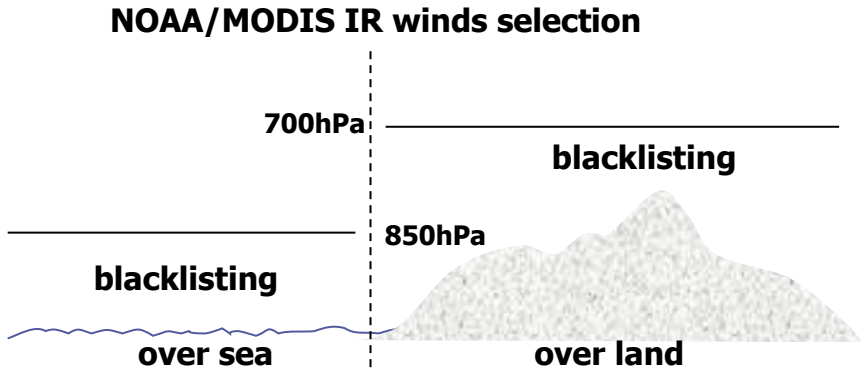
➡ **Clear-sky WV MODIS winds operational in April 2010**

AVHRR (IR) NOAA winds (NESDIS product): context

- Assimilation was able to start once these have been routed by GTS to Toulouse, thanks to the support of Jeff Keys of CIMSS , Mary Forsythe of MetOffice and the IT teams between Exeter and Toulouse.

- Testing in ARPEGE, 3 weeks experiment, pre-operational run as reference.

- Selection as IR MODIS winds: thinning every 2°5 & by 1 hour timeslot (with other MODIS winds), blacklisting over sea/over land:

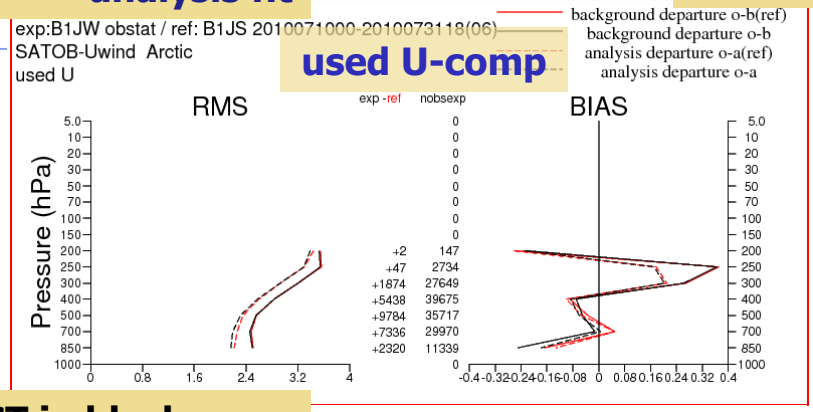


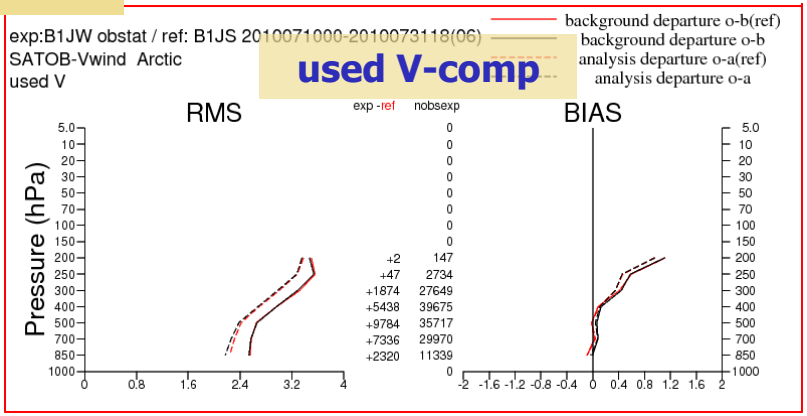
AVHRR (IR) NOAA winds: use and model fit (assimilation run)

—— background fit
– – – – analysis fit

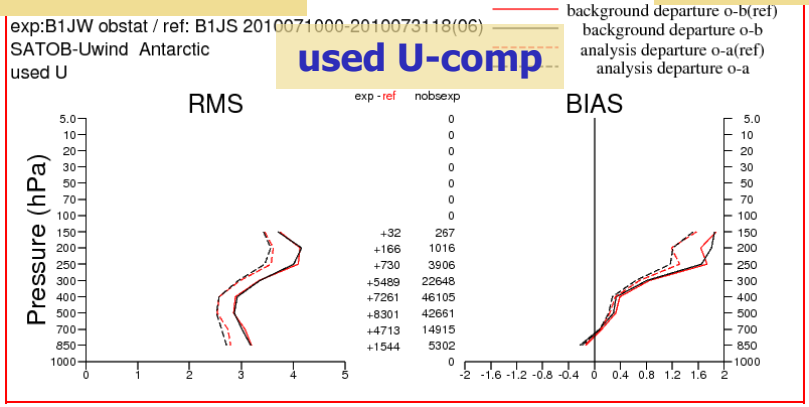
TEST in black
REFERENCE in red

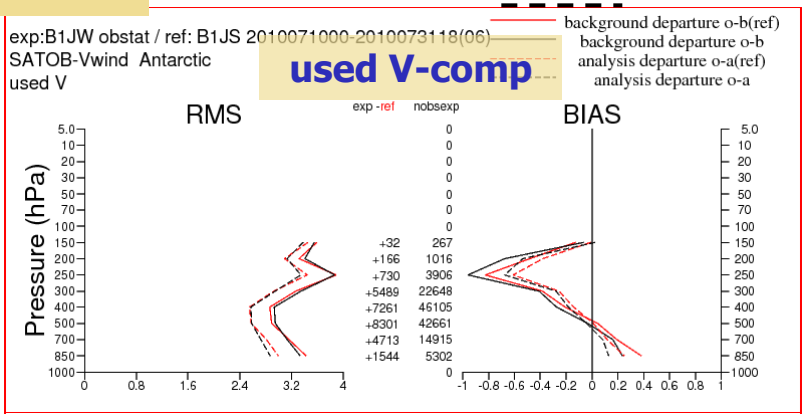
ARCTIC





ANTARCTIC





- **+22% (+1200 winds per day) used over Arctic**
- **+26%(+1300 per day) used over Antarctic**

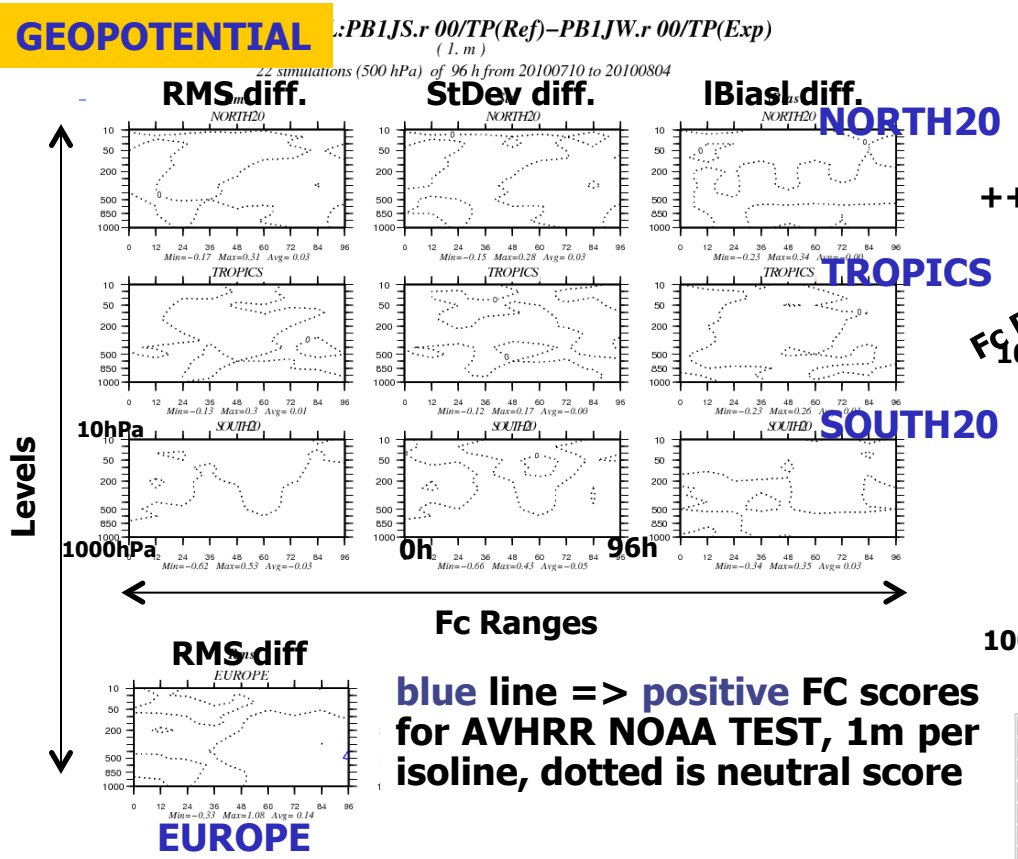
rather below 500 hPa

- **TEST fit slightly better for U, more mixed for V**
- **NOTE: no data in forecast run (arrival too late)**

AVHRR (IR) NOAA winds: forecast scores

Forecast scores, Ctrl radiosondes

GEOPOTENTIAL



EUROPE

blue line => positive FC scores for AVHRR NOAA TEST, 1m per isoline, dotted is neutral score

SIGNE Tests, 22 cases

+/- : confidence of 90%

++/-- : confidence of 95%

...that the TEST is better/worse

TEMPERATURE

Domain	SUD20									TROPIQ									NORD20								
Range	0	12	24	36	48	60	72	84	96	0	12	24	36	48	60	72	84	96	0	12	24	36	48	60	72	84	96
10					+			+		++		+		--	+			--	++			++			++		
30	++	++	++	++	++		++		++	+				++		+			+		++	++	+		++	++	++
50	+		+	+	+					+	++								++	+	++	++	++	++			
100	++		++		++	++	++												++	++	++	++	++		+		
150	++			+		+		++				+		+		+			++	++	+	++	++	++			
200	++	++		++		++	--	++				++							++	++	++						
250	++	++				++			++	++			++						++	++	+		+		+		
300	++	++		+						++		+					+		++	++				+			
400	++	++								++	+	++							++		++	++		++			
500	++		++	+		+					++	++							++	++	++		++				+
700	+					+						+		+					++	++			+				
850	++	+	++		++					++		++		--					++	+		++	+		+		
925		++			+							++											++				
1000	+	++		++	++	+													+								

WIND

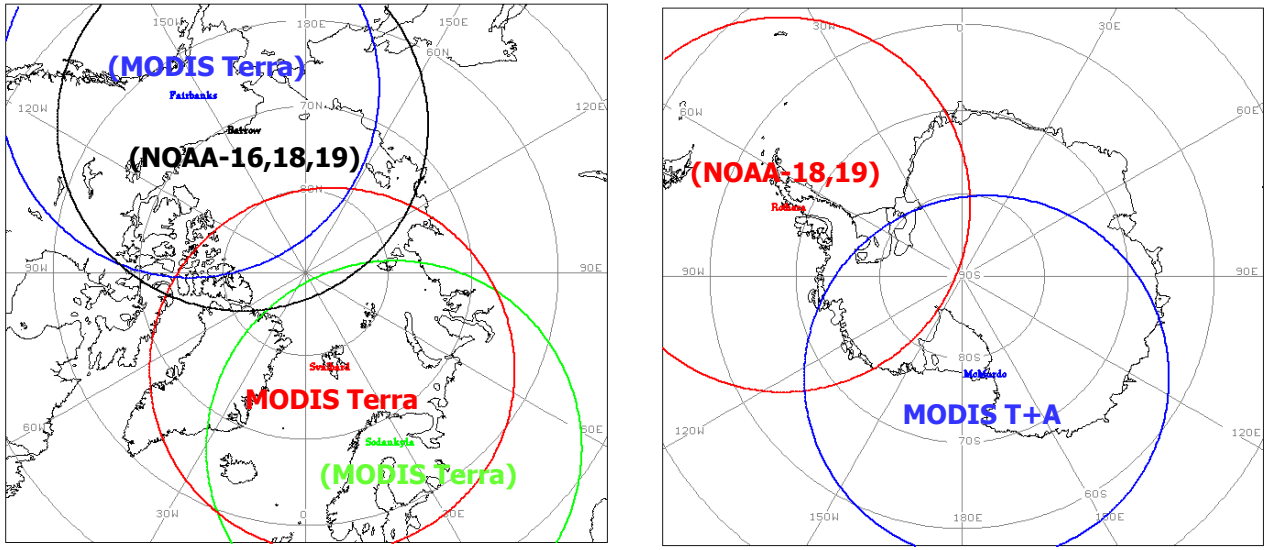
Domain	SUD20									TROPIQ									NORD20								
Range	0	12	24	36	48	60	72	84	96	0	12	24	36	48	60	72	84	96	0	12	24	36	48	60	72	84	96
10	++		++	++															++			+	++	++			
30						+				++		++								++	++		++				
50				+			-	-					++	++	+				++		++	++		+			
100		+											+	+									+				
150		+																	++				+			-	
200				+						++				-			-		++				+				
250							--			++												--					
300																										--	
400										+	+		++	+						+							
500	-			++	--							-			++			+		+							
700									+	+									++						+		
850					++			++											++								+
925				++	+				-																		
1000					++			++											+							+	

- **Global scores neutral on geopotential (positive over Europe)**
- **Similar scores on other parameters (T, Hu, Wind) and with other controls**

AVHRR (IR) NOAA winds operational in November 2010

Direct-Broadcast NOAA/MODIS winds: context

- NOAA/MODIS winds from additional Direct Broadcast stations received at Météo-France from December 2010, again thanks the support of Jeff Keys of CIMSS and Eumetsat for the Eumetcast link.
- DB winds network is described on the CIMSS website:



Direct Broadcast MODIS/NOAA winds network, source: http://stratus.ssec.wisc.edu/products/db/

- Winds from additional DB stations (Fairbanks, Barrow, Sodankylä, Rothera) are on the maps between brackets.
- Tromsø and Mac-Murdo already used since February 2009.
- Evaluation again led with ARPEGE, in the first half of December.

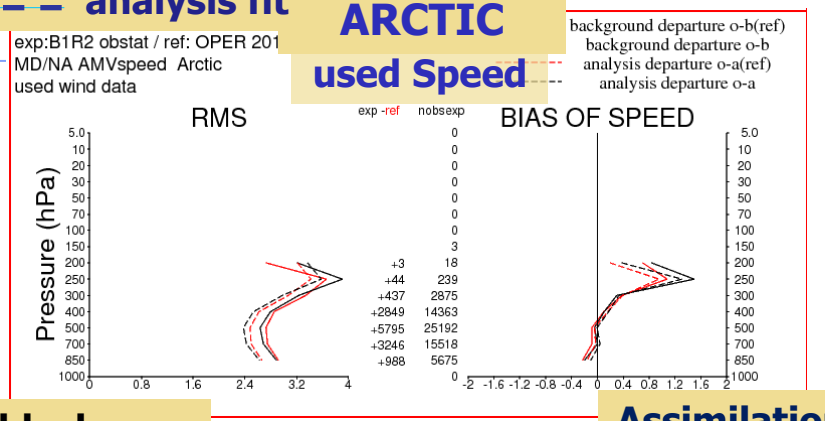
Direct-Broadcast NOAA/MODIS winds: use and model fit

—— background fit

– – – – analysis fit

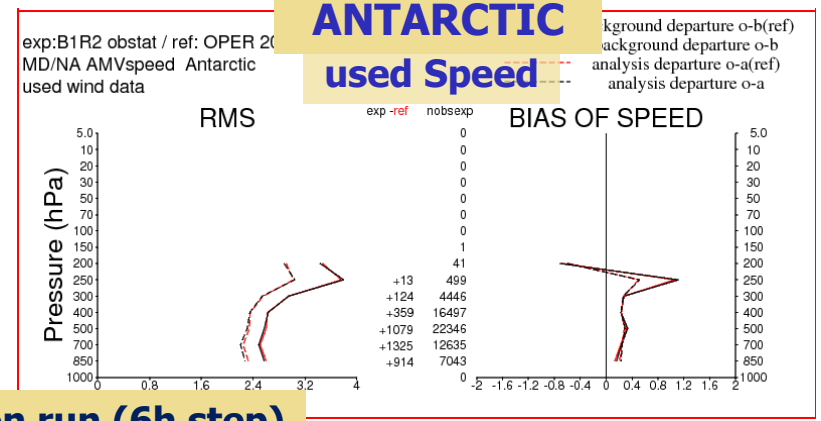
ARCTIC

used Speed



ANTARCTIC

used Speed



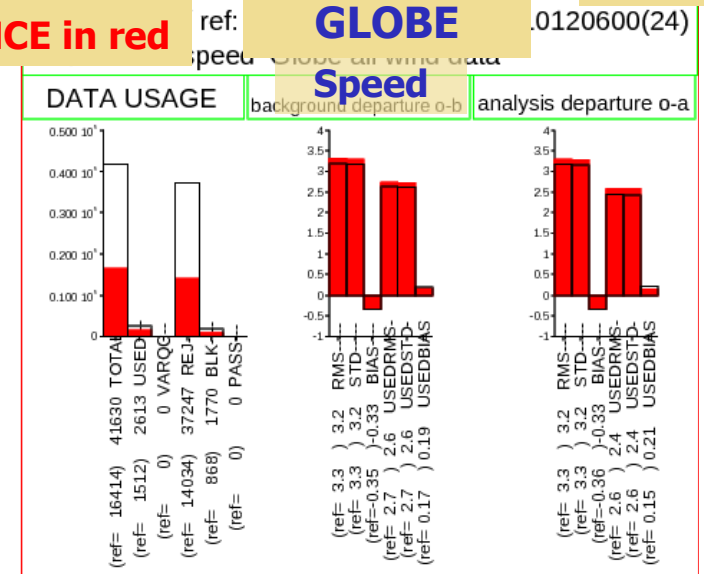
TEST in black

REFERENCE in red

Assimilation run (6h step)

GLOBE

Speed



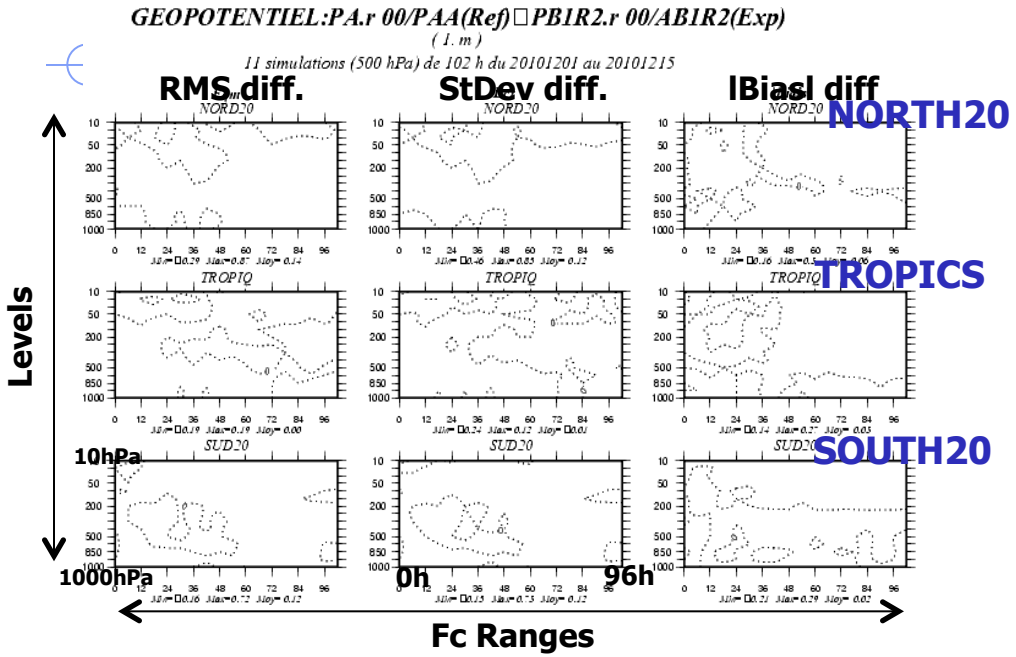
DATA use l BKGRD stat. l ANA. stat.

Forecast run (24h step)

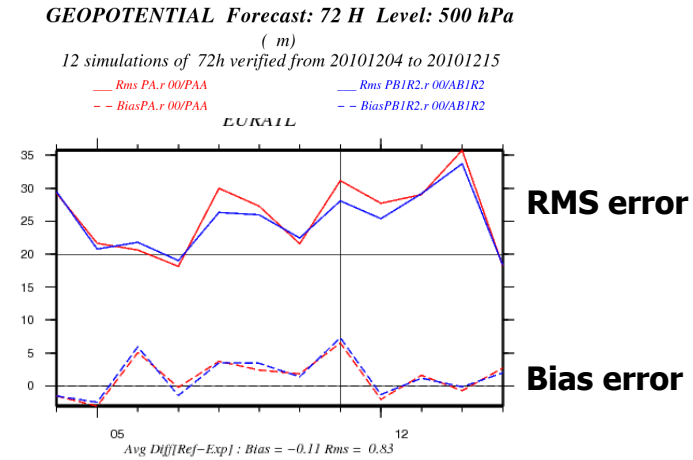
- **Assimilation run**
  - **+16% used (+1600 obs per day)**
  - **TEST fit better in mid-levels, worse around 200hPa but sample is lower**
- **Forecast run**
  - **+184% available, +66% used (+200 obs per day), including now NOAA winds**

Direct-Broadcast NOAA/MODIS winds: forecast scores

Geopotential forecast scores, Ctrl own analysis



FC scores for add. DB Modis/NOAA TEST, 1m per isoline, dotted is neutral score



Temporal evolution of Z500+72h scores over North-Atlantic/Europe

- **Neutral scores on the large domains**
- **Good impact over Europe (RMS reduction)**

additional DB MODIS/NOAA winds operational in December 2010

Scatterometer winds: context

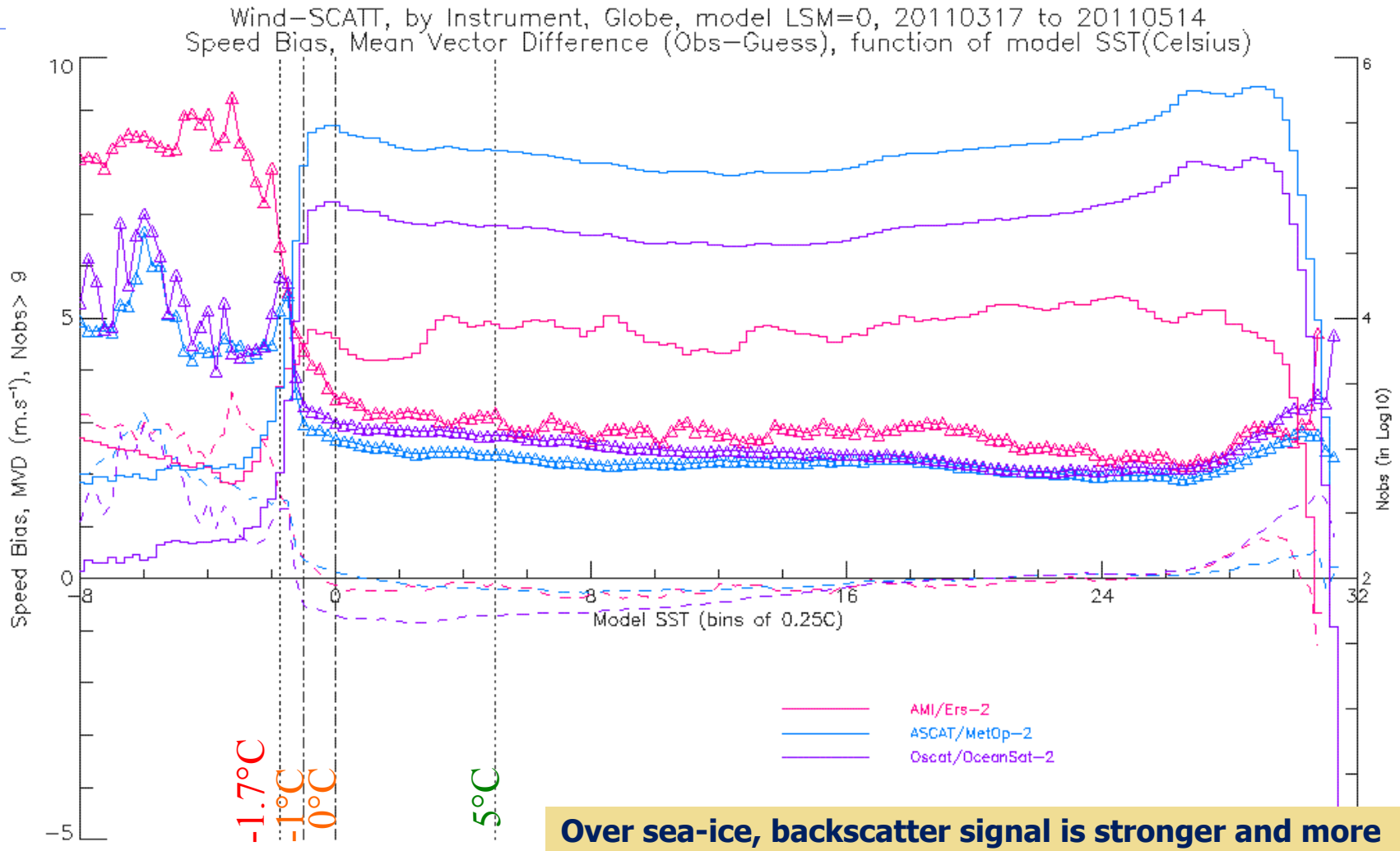
- Improvements in the use of scat winds (switch to 4 solutions instead of 2 for Quikscat (2008), neutral wind operator (2009))

- Scat winds QC are being revisited in the frame of our assimilation processing:
  - ✓ Relaxation of the sea ice mask (0°C or less, instead of 5°C currently)
  - ✓ Checking the impact of the KNMI flags in the selection of scat winds

- This QC study was made in the framework of the evaluation of the new OSCAT data distributed through ftp by KNMI

- Scat winds (ERS-2, ASCAT and OSCAT) were compared to the operational Background of the global model, from 17/03/2011 to 14/05/2011.

RMSVD and Wind speed bias of (O-B) function of SST@model with LSM@model=0



Over sea-ice, backscatter signal is stronger and more isotropic => positive speed bias + higher errors

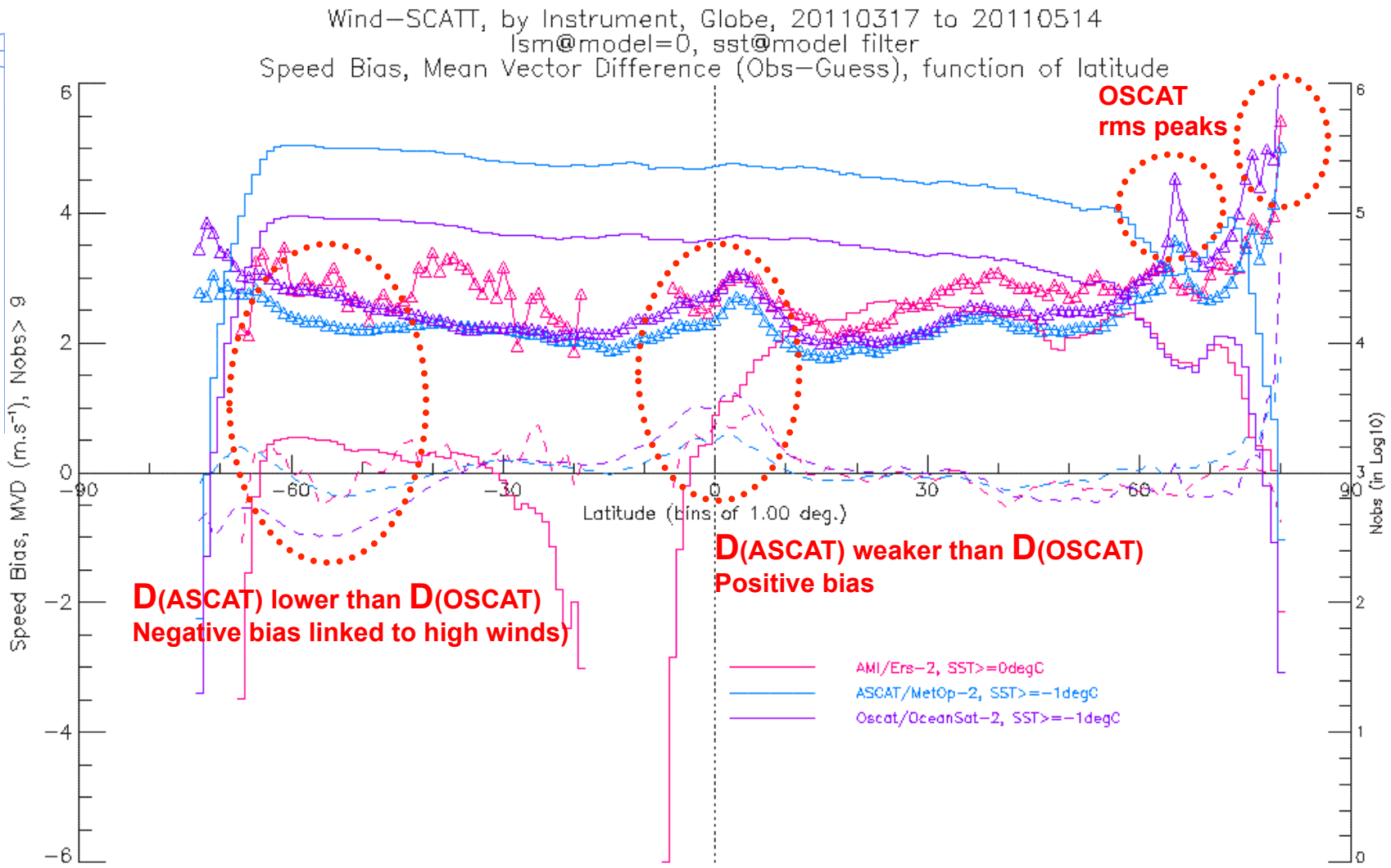
(O-B) versus KNMI flags, LSM@mod=0, SST@mod>-1°C

- KNMI product flags: land-sea mask, distance to cone, monitoring and the variational quality control

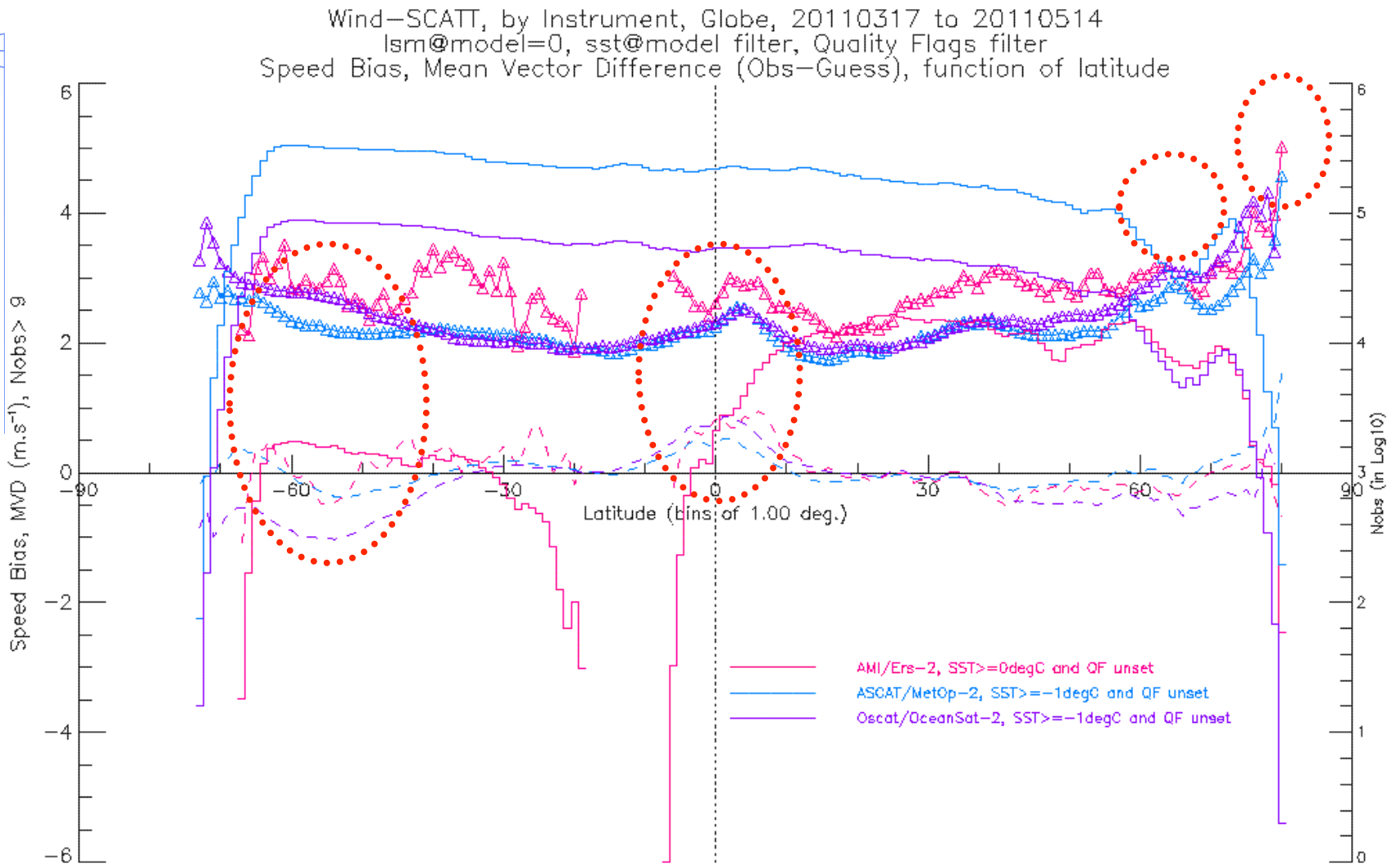
- Contribution to (O-B) by flag (Ascat, Oscat):

		LSM Flag	Distance to cone	VarQC	Monitoring	Not flagged
Ascat	**S[D(u,v)^2]**	2.5e+06	7.6+07	4.2e+06	2.0e+05	1.4e+08
	RMSVD	2.6	6.8	8.0	2.5	2.1
	%(nobs/total)	1.2	0.6	0.2	0.1	97.9/2.1
Oscat	**S[D(u,v)^2]**	2.9e+06	7.7e+06	2.5e+06	0	3.9+e07
	RMSVD	2.9	4.4	4.1	N.A	2.3
	%(nobs/total)	4.3	4.8	1.8	0	89.6/10.9

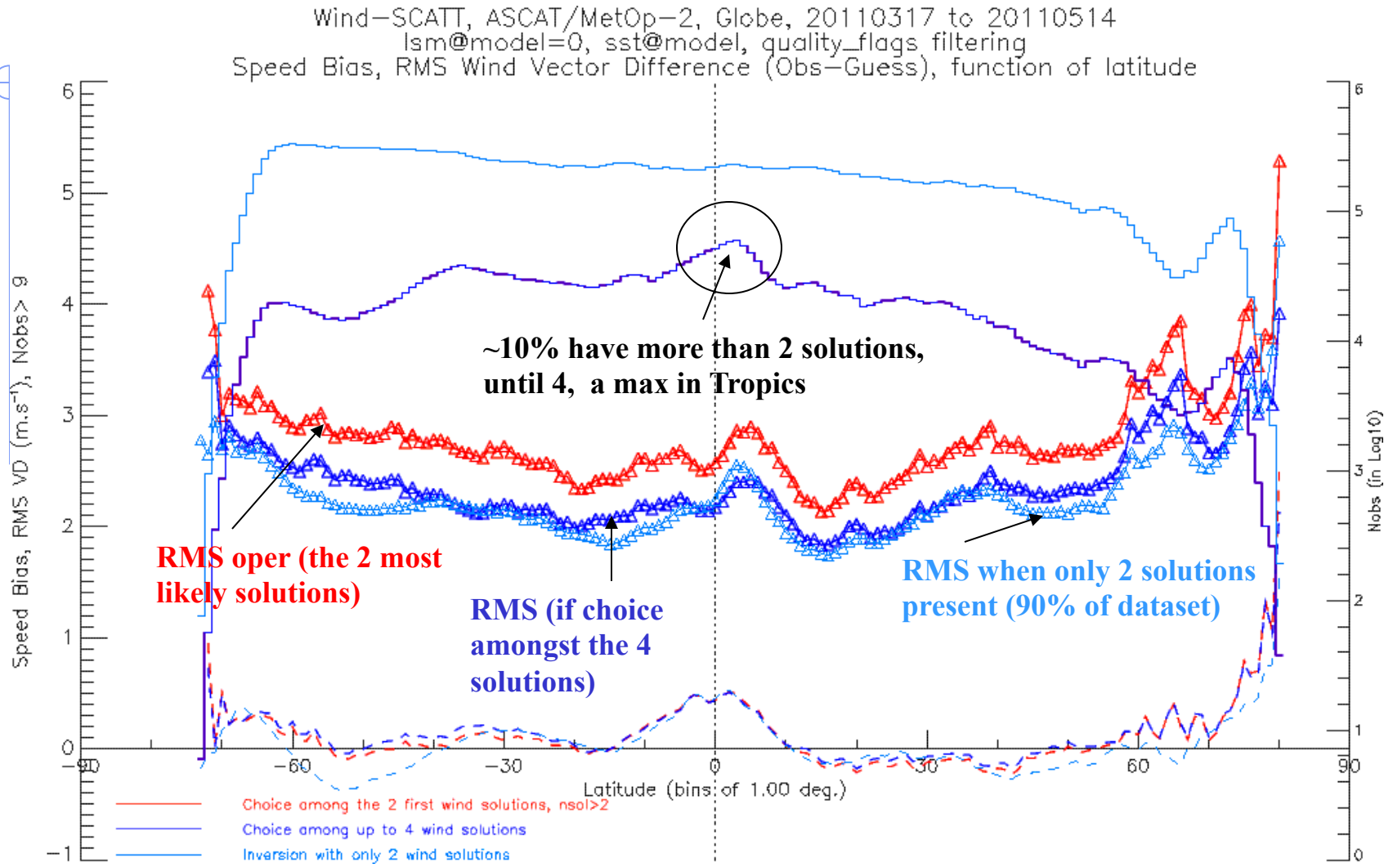
RMSVD and speed bias of OBS-GUESS function of latitude (no KNMI flag, SST@mod>−1°C, LSM@mod=0)



Using KNMI flags



Until 4 solutions for ASCAT since 2010?



Proposed changes in the current e-suite:

- Oscat not (still) operational, so changes tested only with ASCAT winds

- Changes are:
  - ✓ SST threshold for ice is now <-1°C (valid for all scat winds), +15% ASCAT winds (towards the poles)
  - ✓ ASCAT: choice amongst the 4 solutions, when present, is now permitted, instead of the 2 most likely before
  - ✓ ASCAT errors is now 1.4m/s for U-comp., 1.6m/s for V-comp., based on (O-B) statistics, instead of 1.8m/s before

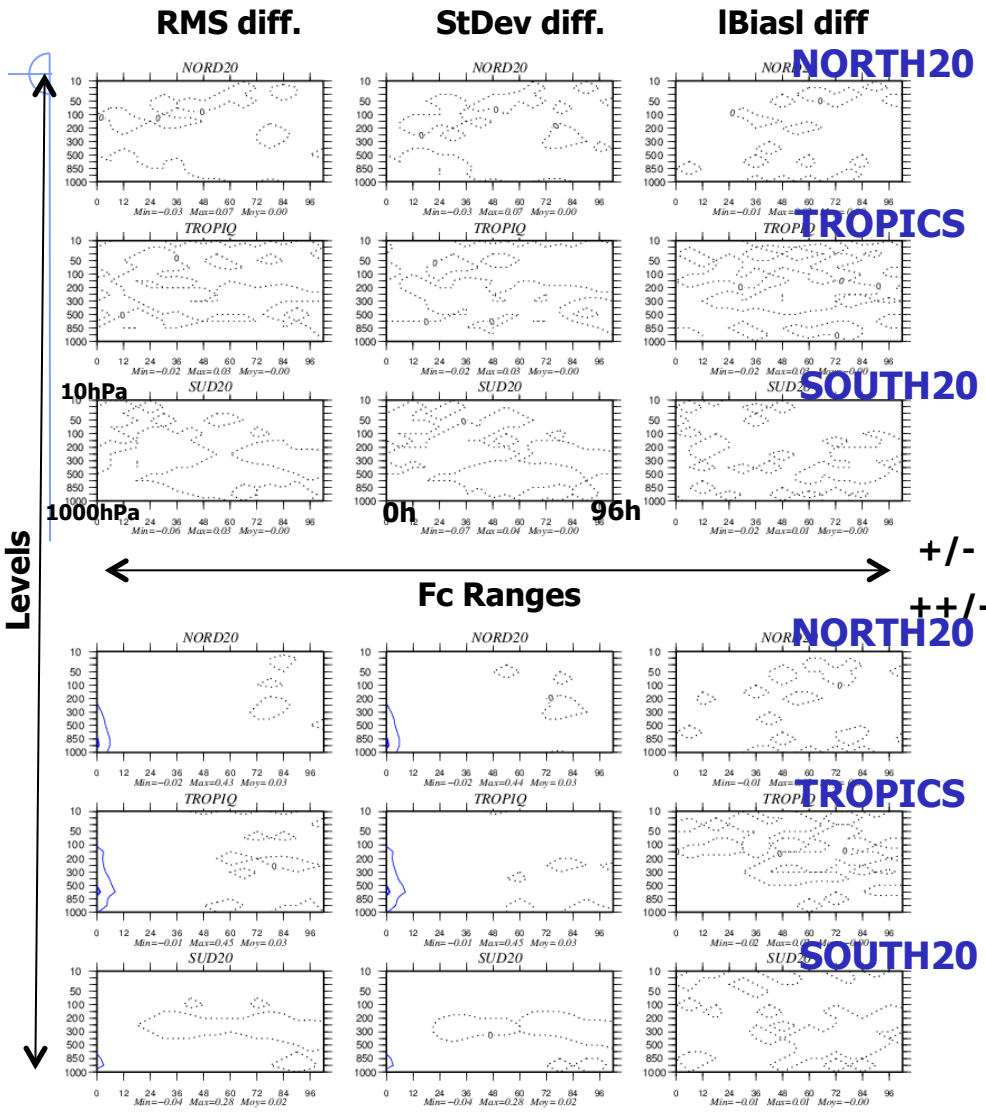
- Testing in ARPEGE, 1 month between 20/08/2011 and 19/09/2011, operational run configuration as reference (new code version, and lower resolution)

ASCAT winds changes: forecast scores

WIND forecast scores

Ctrl: own analysis

Ctrl: Test analysis



BOOTSTRAP Tests, 31 cases

Fc Ranges

Domain	SUD20									TROPIQ									NORD20								
Range	0h 12	24	36	48	60	72	84	96h		12	24	36	48	60	72	84	96		0	12	24	36	48	60	72	84	96
10hPa																-											
30	-																										
50			-																								
100	-																										
150																											
200																											
250		--								-																	
300																											
400																											
500																											
700	--	-																									
850	--	--	-							--	--								--								
925	--	--	--							--	--		--		--				--	-							
1000hPa	--	--	--							--	--	-			--				--	--	-						

+/- : confidence of 99.9% ...that the TEST is better/worse

++/-- : confidence of 99%

Fc Ranges

Domain	SUD20									TROPIQ									NORD20								
Range	0h 12	24	36	48	60	72	84	96h		12	24	36	48	60	72	84	96		0	12	24	36	48	60	72	84	96
10hPa	++	+		++						++	++	++							++	++	++	++					
30	++	++	+							++	++	++							++	++	++	++	++				
50	++	++								++	++	++	+						++	++	++						
100	++	++	+							++	++	++	+	+					++	++	+						
150	++	++								++	++	++							++	++							
200	++	++								++	++								++	++							
250	++	++								++	++								++	++	++						
300	++	++								++	++	++							++	++	++						
400	++	++								++	++	++	++						++	++	++						
500	++	++								++	++	++	++						++	++	++	++					
700	++	++	++	++	+					++	++	++	++	+					++	++	++						
850	++	++	++	++	+					++	++	++	++						++	++	++						
925	++	++	++	++						++	++	++							++	++	++						
1000hPa	++	++								++	++	++							++	++	++						

Conclusion:

- A quantitative work was led for using more AMVs over Poles, with rather weak but positive impacts on the forecast scores

- A qualitative work led on scatterometer winds gives first results really encouraging on ASCAT (QC, errors revisions)… and this effort will have to continue and to be extended to AMVs

- Without to leave the other tasks, as reminded in the introduction, and mainly the preparation in the use of the next data from ESA mission Aeolus.