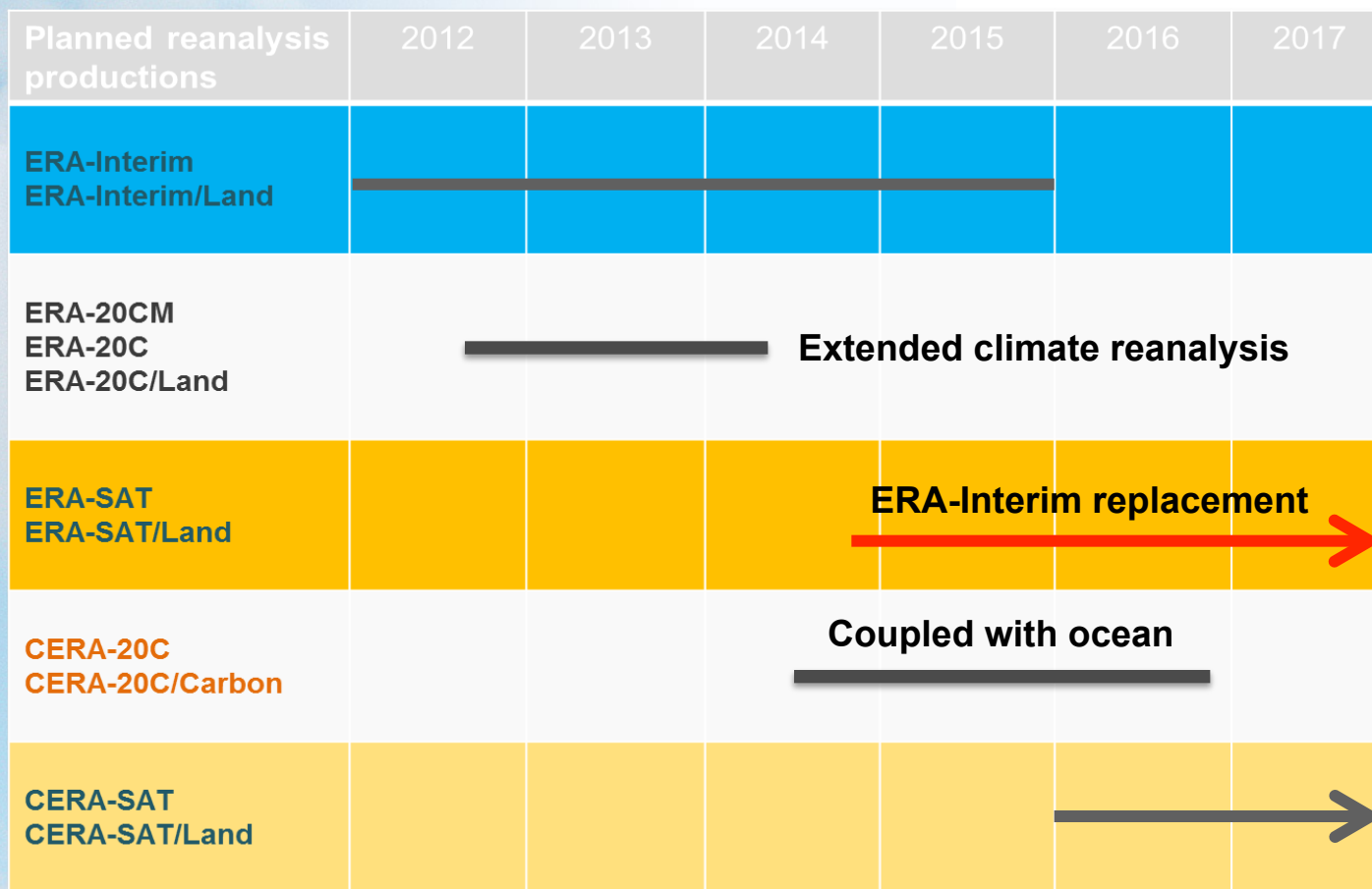


# REPROCESSED AMVs FOR THE NEXT ECMWF GLOBAL REANALYSES

C.Peubey, N. Bormann, P. Poli and K. Salonen (ECMWF)



**Huge acknowledgement to all reprocessing efforts at many centres!**

# OUTLINE

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- 1. Reanalysis overview**
- 2. Reprocessed datasets**
- 3. Evaluation of monitoring statistics**
- 4. Initial forecast impact assessment**
- 5. Conclusions**

# REANALYSES: MAIN PRINCIPLES

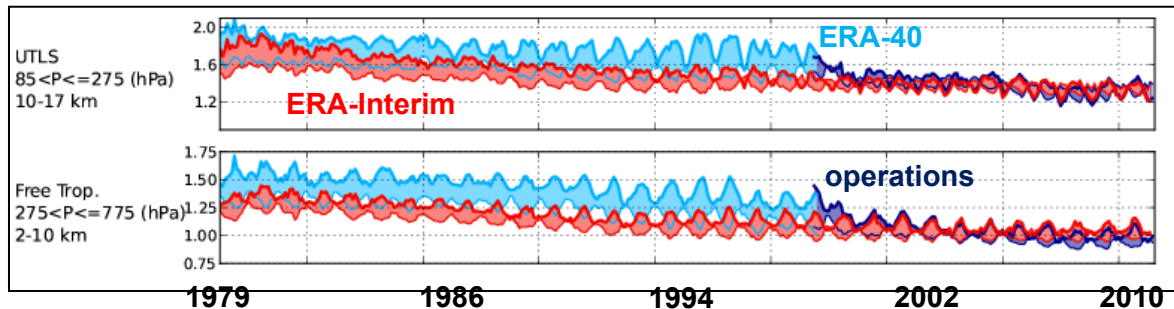
Reanalyses aim to provide the best estimate of the state of the atmosphere over several decades by:

→ using the same NWP system for all the period, achieving consistency in time and smoothness of the analysis

→ using the most advanced version of the NWP system (hence getting all the improvements made to the ECMWF model since ERA-Interim started 8 years ago, see graph)

→ using improved versions of the available observational datasets

**RMS of differences between observations from radiosondes and short-termforecast (background)**



Thin line: Northern Hemisphere extratropics  
Thick line: Southern Hemisphere (less well observed)

- Applications:
- verification and diagnosis of other NWP models
  - Input to other models (e.g. tracer models)
  - Providing climatologies
  - Assessment of inter-consistency between observing systems
  - Study for climate trends

# ERASAT CONFIGURATION

## NWP configuration:

- Deterministic run at T511 (~40km)
- 91 levels
- 12h assimilation window
- Use Ensemble of Data Assimilation (EDA=use of an ensemble to get error covariances)
- Use of cycle 40R3 as opposed to 31R2 for era-Interim (among the main improvements: EDA system, revised convection and cloud schemes, use of CMIP5 climate fields for the external forcings)

## Archive and Feedback of observations in ODB-2:

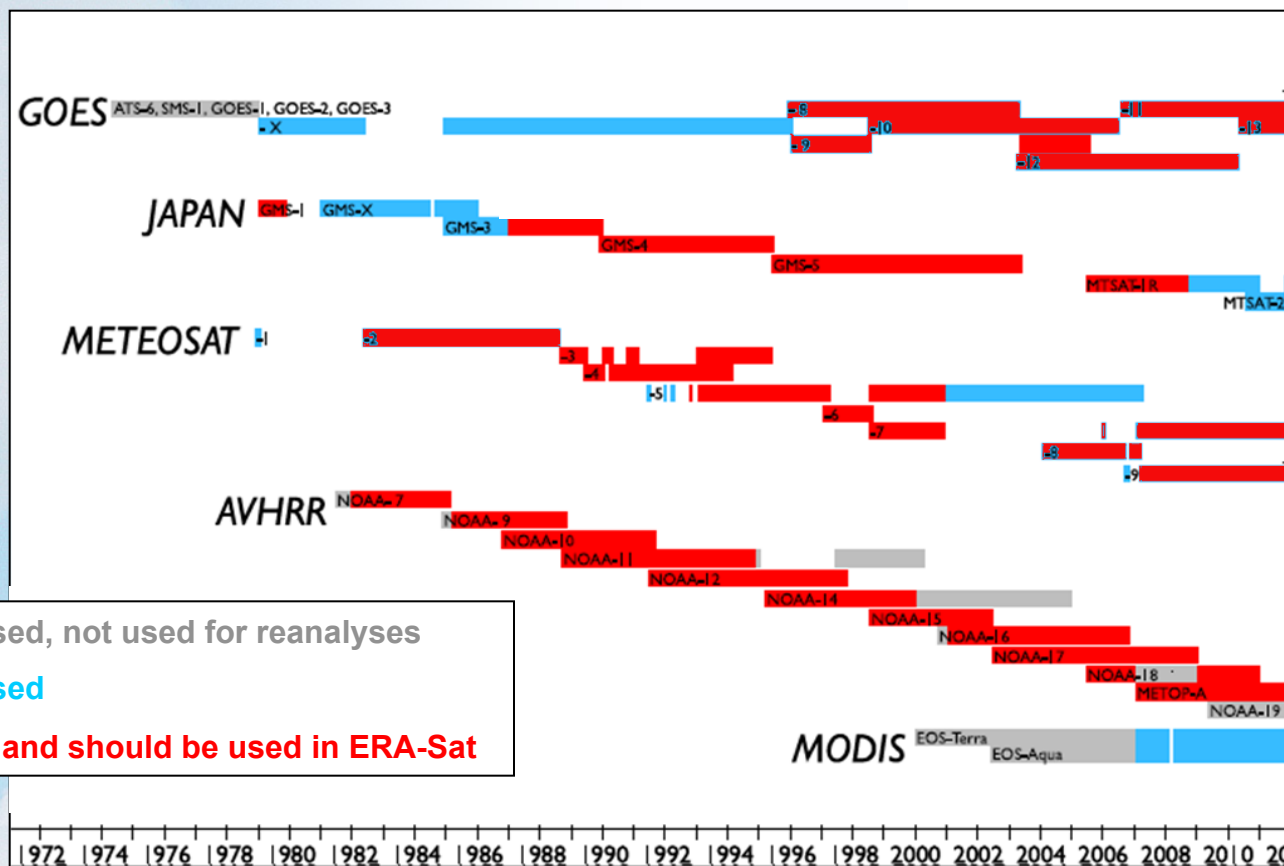
- BUFR input files use the features in place in the operational ECMWF NWP system
- For files with other formats (rep. GOES), the data are collocated with era-interim to get departures. Both observations and departures are then saved in ODB-2 format on MARS (ECMWF archiving system)
- After each assimilation cycle and for all observations, departures from the new experiment and screening information are added to the ODB-2 archive

The ODB-2 archive will soon be available for external users on a data server (various formats available for retrievals)

Meanwhile, users having access to MARS can retrieve the ODB-2 files with a bit of our help, but this would be far less user-friendly

# HISTORICAL AMV DATASETS

A very large fraction of the available datasets have now been reprocessed, thanks to the reprocessing efforts at many centres (EUMETSAT, JMA, CIMSS)!



Not reprocessed, not used for reanalyses  
 Not reprocessed  
 Reprocessed and should be used in ERA-Sat

# ASSIMILATION EXPERIMENTS

Aim: For each new reprocessed AMV dataset, investigate the benefit over the configuration we had in ERA-Interim. Comparison either to the “old” dataset or no data at all (*all the other observations in the test-experiment are the same as in the control*).

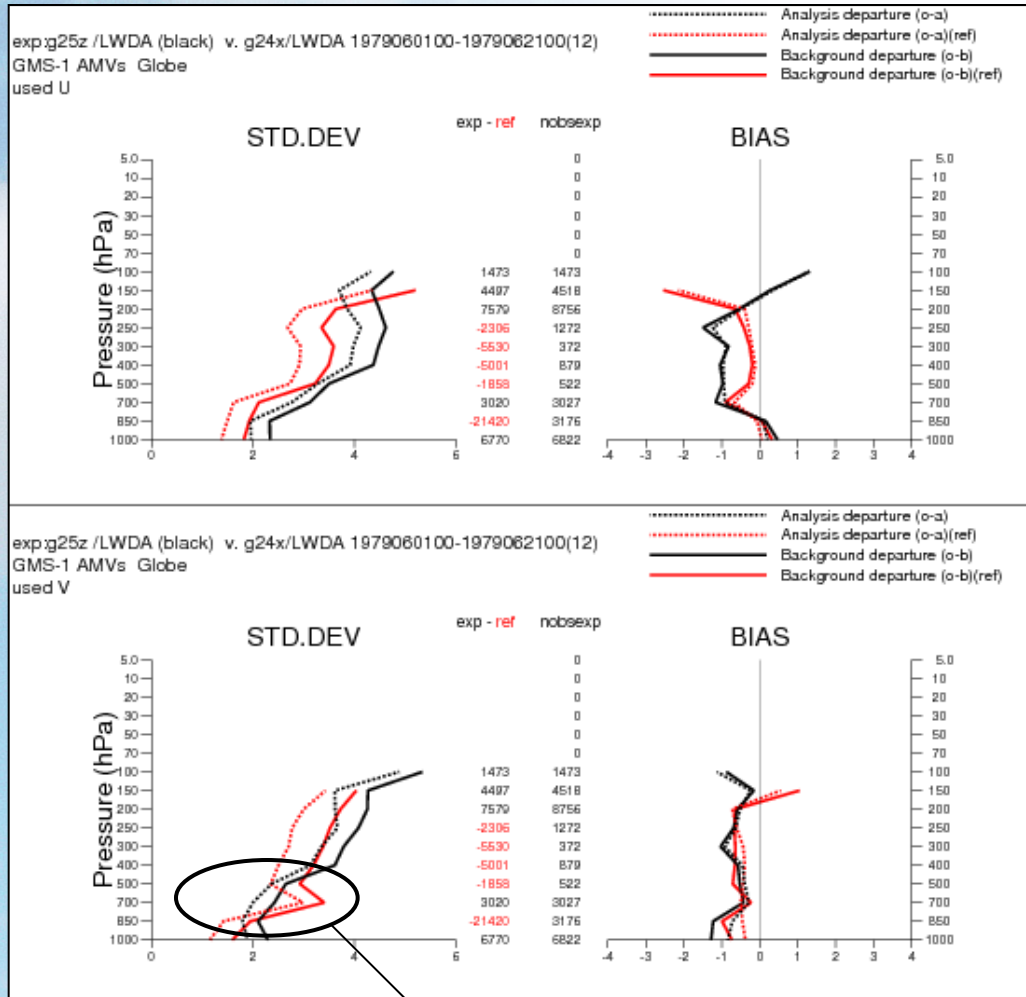
Satellite	Period	Control exps.
GMS-1 (JMA)	Sept. 1979	Old GMS-1
GMS-4 (JMA)	June 1994	Old GMS-4
GOES-11/GOES-12 (+ test adding short IR), (CIMSS)	Oct. 2009	Old GOES-11/12
NOAA-7 (CIMSS)	Sep. 1983	No NOAA-7
NOAA-11/NOAA-12 (CIMSS)	June 1994	No NOAA-11/12
NOAA-18 (CIMSS)	Sep. 2009	Old NOAA-18
METOP (EUMETSAT with CIMSS and EUMETSAT algorithm)	Mar. 2012	Old METOP

MET-9 and MTSAT to come next ...

Blacklisting and quality control similar to operations, with modifications as necessary.

# STATISTICS FOR USED AMVs: GMS-1 (1979)

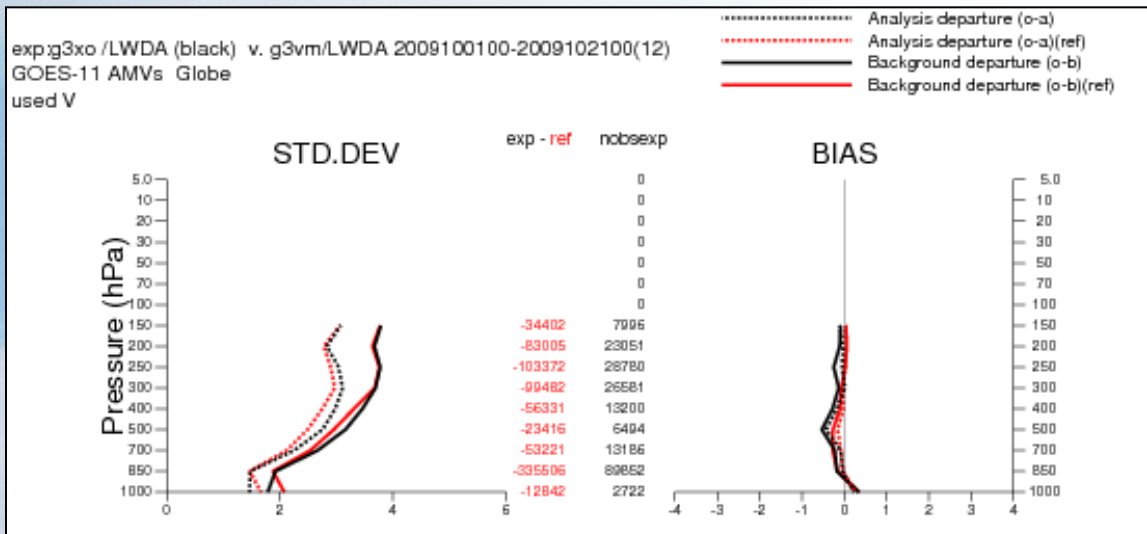
After quality-control and blacklisting, the reprocessed data show a clear improvement.



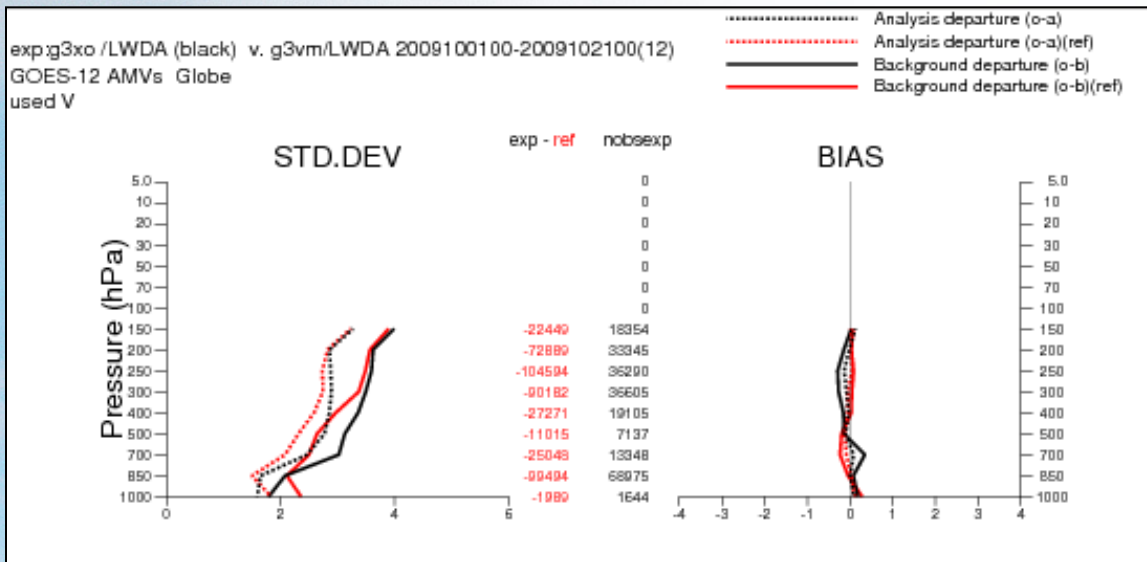
- ..... O-A Old
- ..... O-A Reprocessed
- O-B Old
- O-B Reprocessed

Gap in the reprocessed data

# STATISTICS FOR USED AMVs: GOES-11/12 (2009)



- ..... O-A Old
- ..... O-A Reprocessed
- O-B Old
- O-B Reprocessed



- Similar results for u-wind
- Adding IR2 did have an obvious impact on those particular statistics



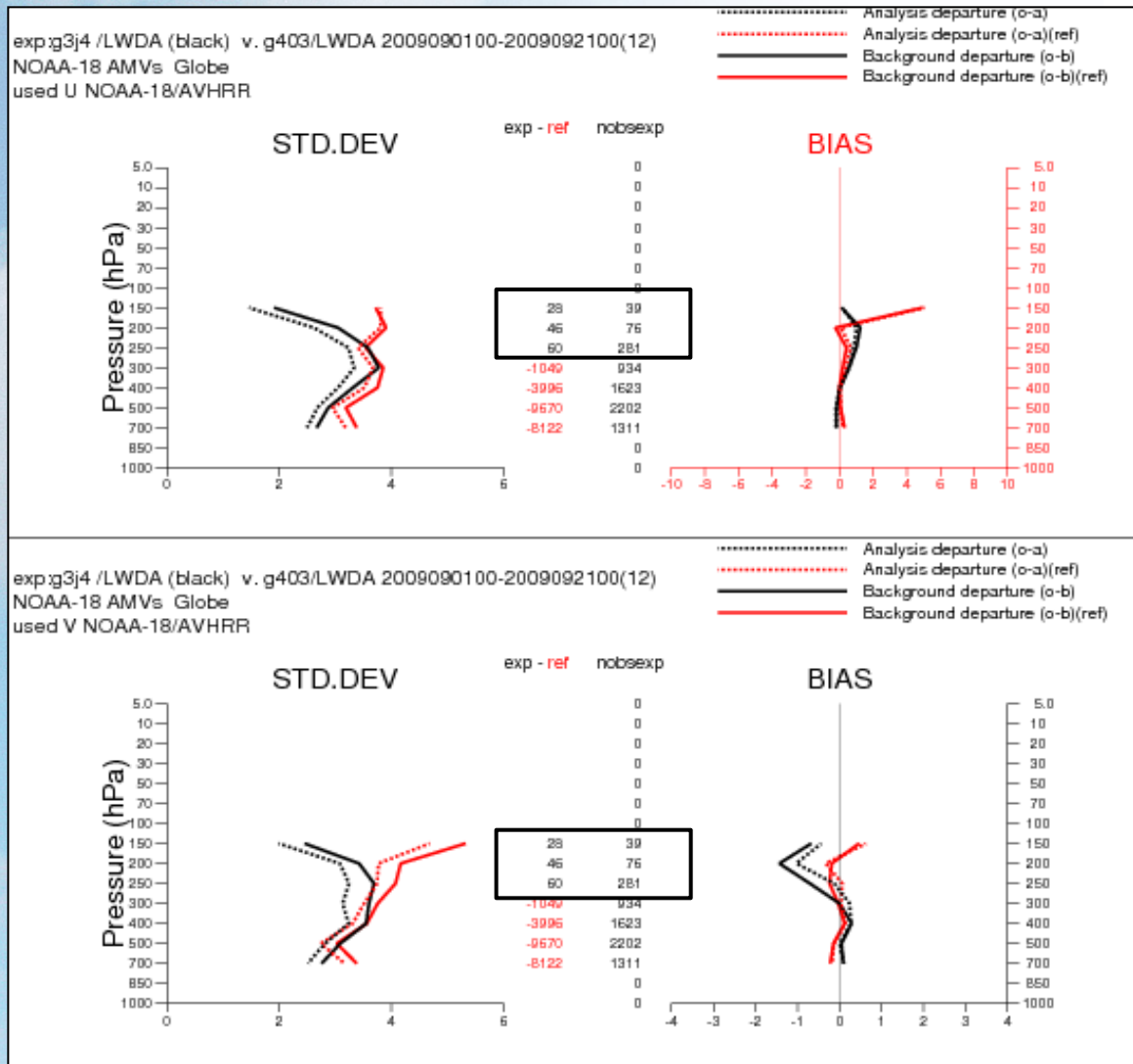
# FIRST-GUESS DEPARTURES: AVHRR AMVs

Rep:qi ≥ 50	≥ 400 hPa	< 400hPa
<b>NOAA-7</b>		
Number ( per day)	6 750	829
Mean	-0.08	-1.57
Std	5.21	7.62
<b>NOAA-11</b>		
Number ( per day)	8 000	1700
Mean	0.05	-0.31
Std	5.48	7.39
<b>NOAA-12</b>		
Number ( per day)	7200	1700
Mean	0.22	-0.47
Std	5.26	7.54
<b>NOAA-18</b>		
Number ( per day)	9400 (1000)	1400 (350)
Mean	-0.12 (-0.56)	-1.38 (0.05)
Std	5.06 (3.44)	7.84 (4.57)

Rep:qi ≥ 85	≥ 400 hPa	< 400hPa
<b>NOAA-7</b>		
Number (per day)	1 720	311
Mean	-0.02	-1.44
Std	5.31	7.86
<b>NOAA-11</b>		
Number (per day)	2 400	600
Mean	0.01	-0.92
Std	5.68	7.86
<b>NOAA-12</b>		
Number (per day)	2200	560
Mean	0.27	-0.93
Std	5.34	8.03
<b>NOAA-18</b>		
Number (per day)	2700 (250)	530 (120)
Mean	-0.4 (-0.53)	-0.77 (0.39 )
Std	5.17 (3.55 )	8.61 (5.02)

# STATISTICS FOR USED AMVs: NOAA-18 AVHRR (2009)

## Old NOAA-18 vs reprocessed NOAA-18



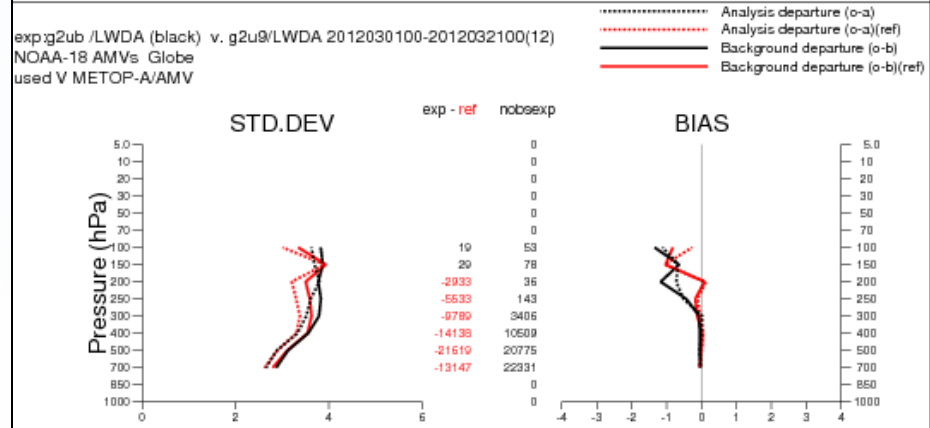
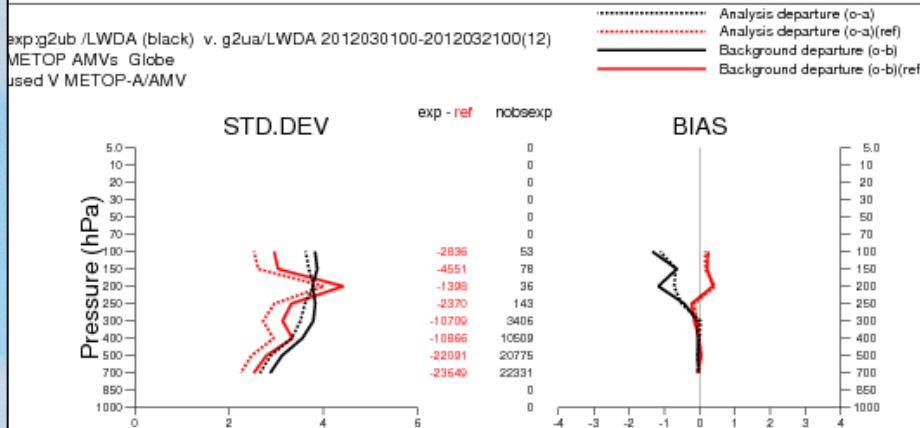
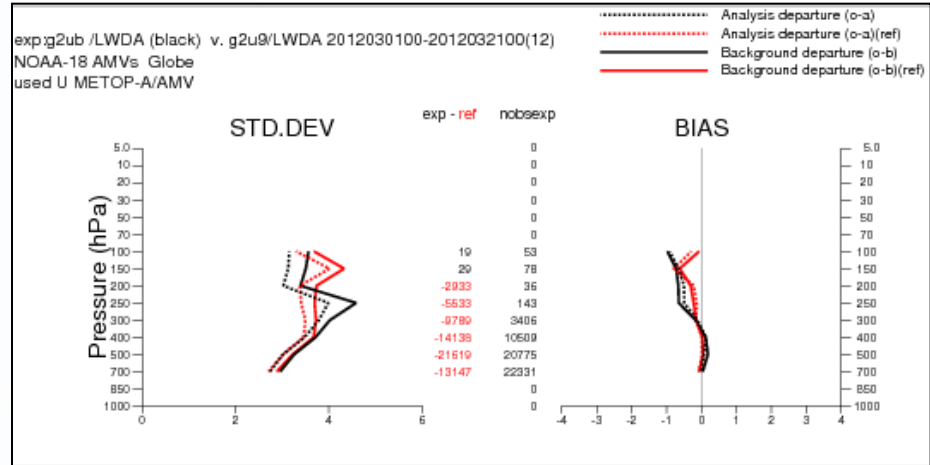
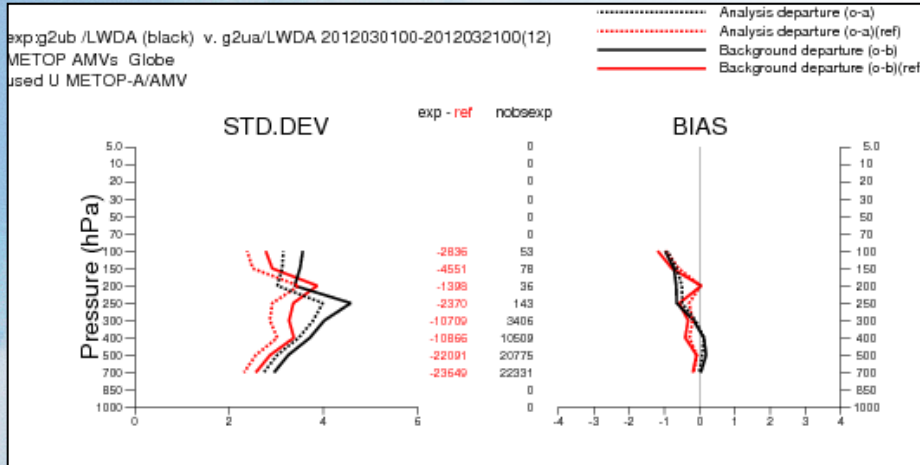
- .... O-A Old
- .... O-A Reprocessed
- O-B Old
- O-B Reprocessed

# STATISTICS FOR USED AMVs: METOP AVHRR (2012)

(reprocessed by EUMETSAT)

Old vs reprocessed with CIMSS algorithm

Old vs reprocessed with EUMETSAT algorithm



..... O-A Old

———— O-B Old

..... O-A Reprocessed

———— O-B Reprocessed

# IMPACT ON ANALYSIS AND FORECAST

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- **Impact on the analysis and first-guess fit to conventional data** (over 21 days, in u/v-wind)
- **Forecast scores** (as difference of forecast RMSE calculated over 1 month)

*Statistics averaged over the geographical area covered by the data*

# IMPACT ON ANALYSIS AND FORECAST: GMS-1 and GMS-4 (1979)

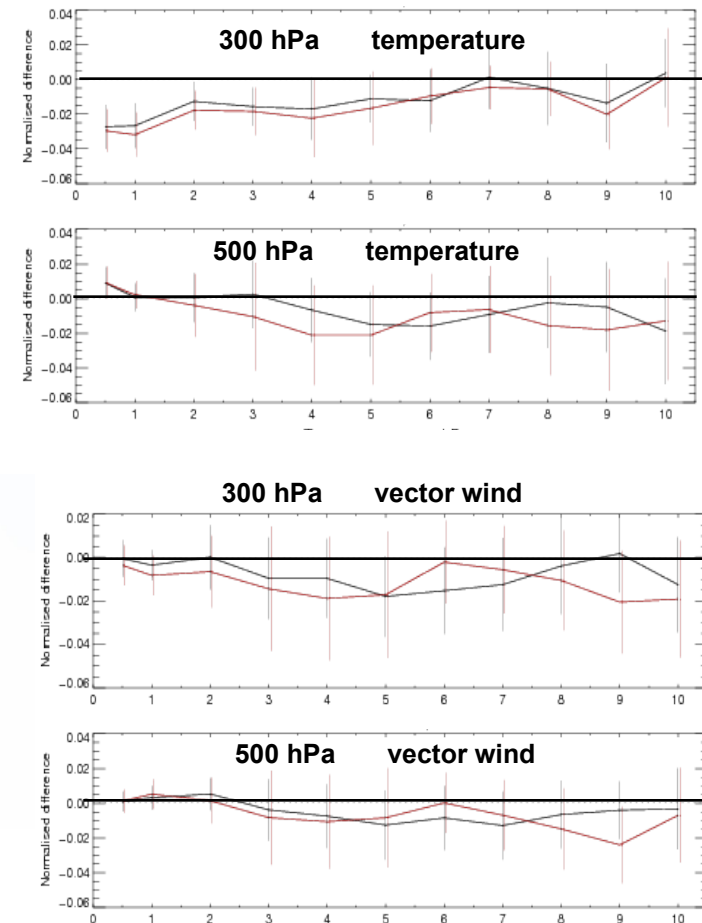
Satellites	Impact on fits to conventional data	Forecast scores	Number active data (~per day)
<b>GMS-1</b>	neutral	neutral	2300
<b>GMS-4</b>	neutral to mixed impact	neutral	5500
<b>GOES-11/12</b>	neutral (with or without IR2)	Positive impact on temperature (neutral on VW) Lower forecast error with IR2 (but not stat. significant)	50700 35000
<b>NOAA-7</b>	mixed/positive	Positive Impact on VW at 500hPa in SH	1500
<b>NOAA-18</b>	neutral to negative (vs no data or old data)	Neutral to slightly positive	1500
<b>METOP</b>	CIMSS: neutral vs old, slightly negative vs no data. EUMETSAT: slightly negative	CIMSS: neutral EUMETSAT: slightly negative	6700(CIMSS) 7000(EUM.)

Reason for lack of impact not clear.

# IMPACT ON ANALYSIS AND FORECAST: GOES (2009)

Satellites	Impact on fits to conventional data	Forecast scores	Number active data (~per day)
GMS-1	neutral	neutral	2300
GMS-4	neutral to mixed impact	neutral	5500
<b>GOES-11/12</b>	neutral (with or without IR2)	Positive impact on temperature (neutral on VW) Lower forecast error with IR2 (but not stat. significant)	50700 35000
NOAA-7	mixed/positive	Positive Impact on VW at 500hPa in SH	1500
NOAA-18	neutral to negative (vs no data or old data)	Neutral to slightly positive	1500
METOP	CIMSS: neutral vs old, slightly negative vs no data. EUMETSAT: slightly negative	CIMSS: neutral EUMETSAT: slightly negative	6700(CIMSS) 7000(EUM.)

**Difference in forecast RMSE (reprocessed minus old, without and **with** 3.9 mic)**  
(Statistics over the GOES-11 /12 disks)

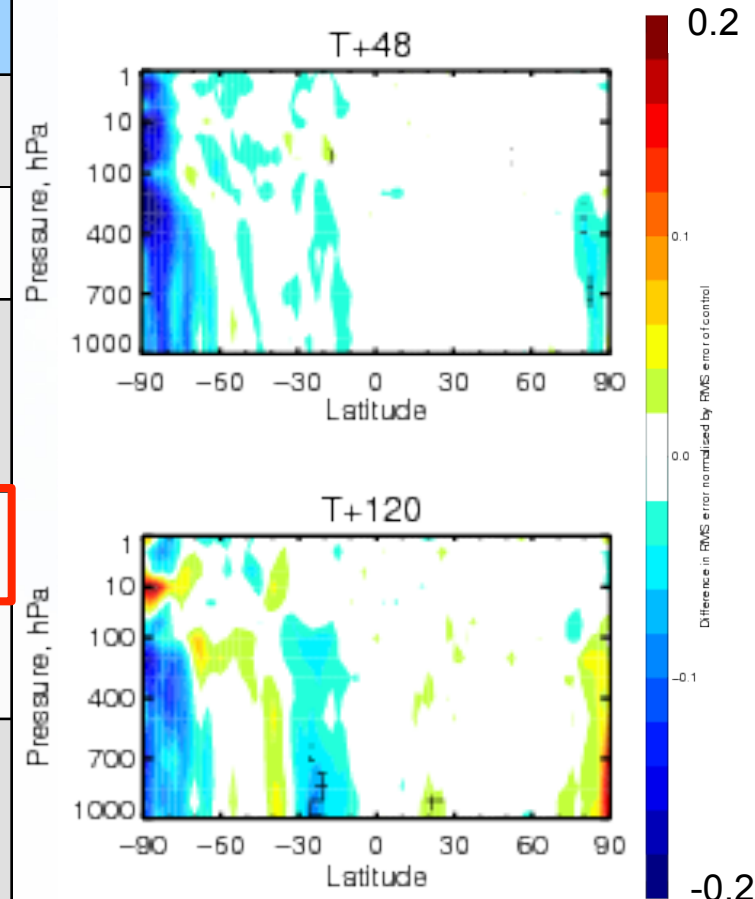


**NEGATIVE = POSITIVE IMPACT OF THE REPROCESSED DATA**

# IMPACT ON ANALYSIS AND FORECAST: NOAA-7 AVHRR (1983)

Satellites	Impact on fits to conventional data	Forecast scores	Number active data (~per day)
GMS-1	neutral	neutral	2300
GMS-4	neutral to mixed impact	neutral	5500
GOES-11/12	neutral (with or without IR2)	Positive impact on temperature (neutral on VW) Lower forecast error with IR2 (but not stat. significant)	50700 35000
<b>NOAA-7</b>	mixed/positive	Positive Impact on VW at 500hPa in SH	1500
NOAA-18	neutral to negative (vs no data or old data)	Neutral to slightly positive	1500
METOP	CIMSS: neutral vs old, slightly negative vs no data. EUMETSAT: slightly negative	CIMSS: neutral EUMETSAT: slightly negative	6700(CIMSS) 7000(EUM.)

Difference in forecast RMSE (with minus without NOAA-7)

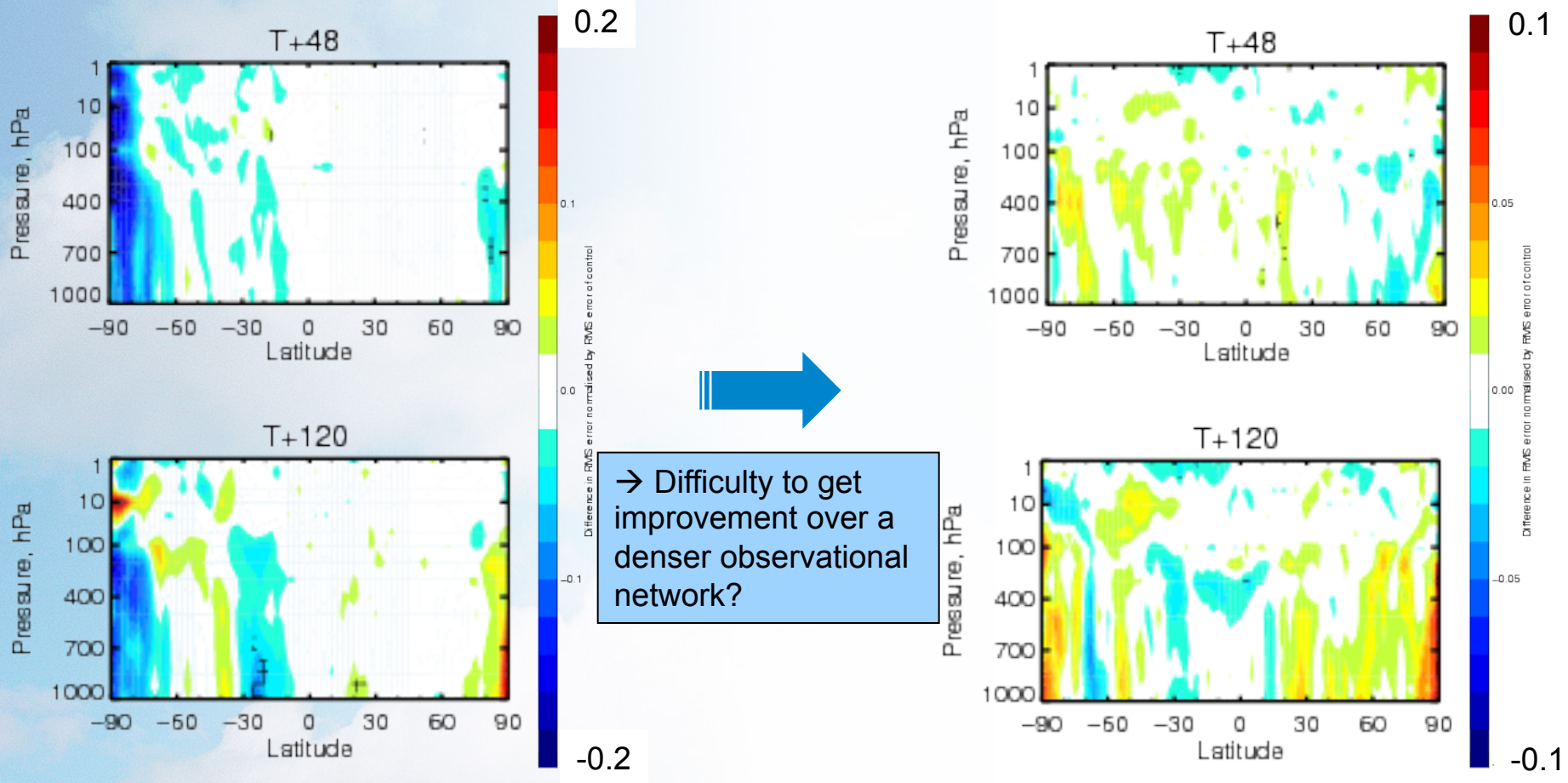


# IMPACT ON ANALYSIS AND FORECAST: AVHRR AMVs

Difference in normalised forecast RMSE (VW)

1983: "NOAA7" minus "no NOAA7"

2009: "NOAA18" minus "no NOAA18"

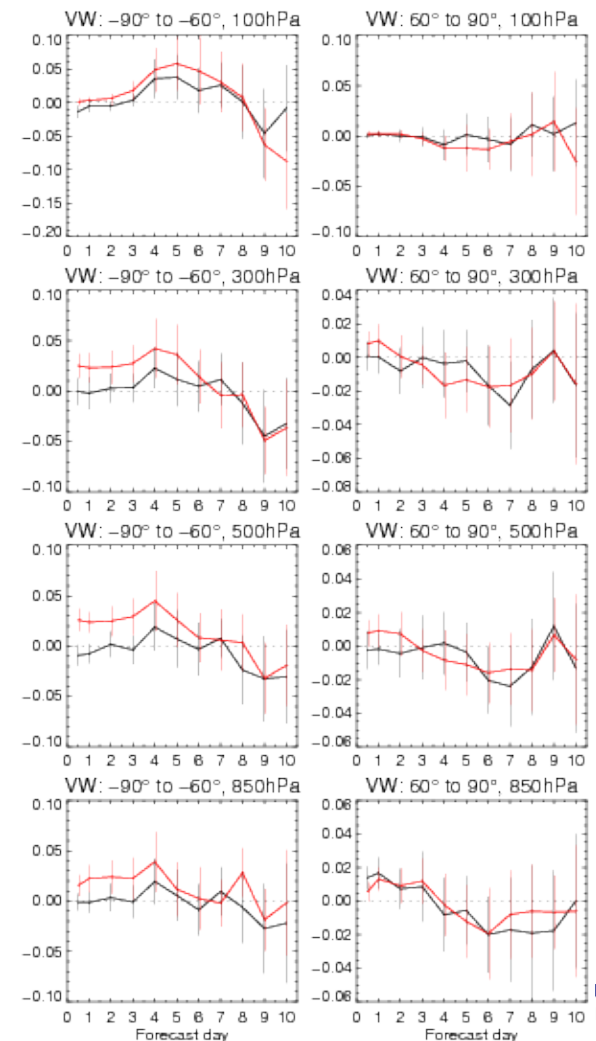




# IMPACT ON ANALYSIS AND FORECAST: METOP AVHRR (2012)

Satellites	Impact on fits to conventional data	Forecast scores	Number active data (~per day)
GMS-1	neutral	neutral	2300
GMS-4	neutral to mixed impact	neutral	5500
GOES-11/12	neutral (with or without IR2)	Positive impact on temperature (neutral on VW) Lower forecast error with IR2 (but not stat. significant)	50700 35000
NOAA-7	mixed/positive	Positive Impact on VW at 500hPa in SH	1500
NOAA-18	neutral to negative (vs no data or old data)	Neutral to slightly positive	1500
<b>METOP</b>	CIMSS: neutral vs old, slightly negative vs no data. EUMETSAT: slightly negative	CIMSS: neutral EUMETSAT: slightly negative	6700(CIMSS) 7000(EUM.)

**Difference in forecast RMSE (VW) with CIMSS and EUMETSAT algorithms**



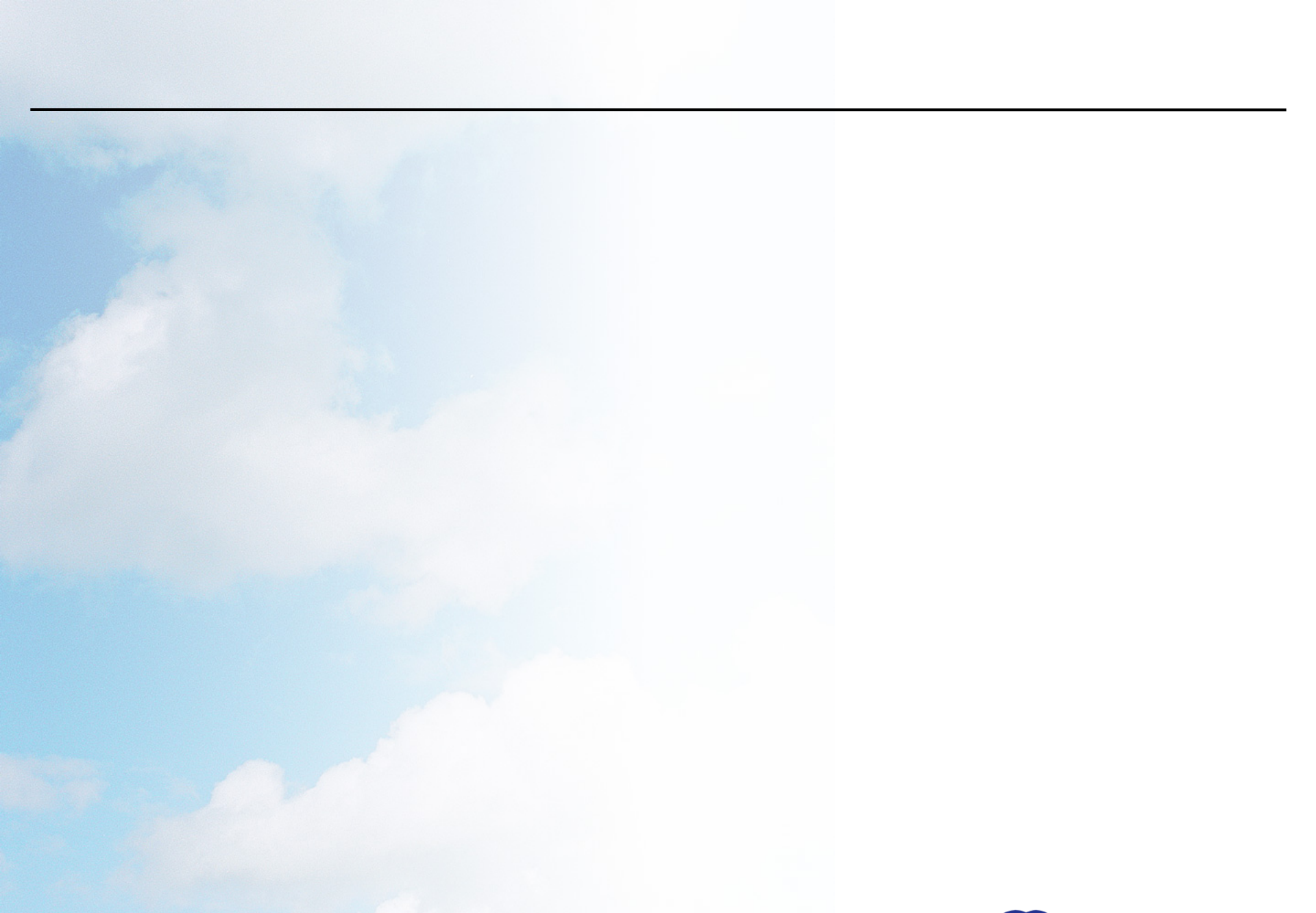
# CONCLUSIONS

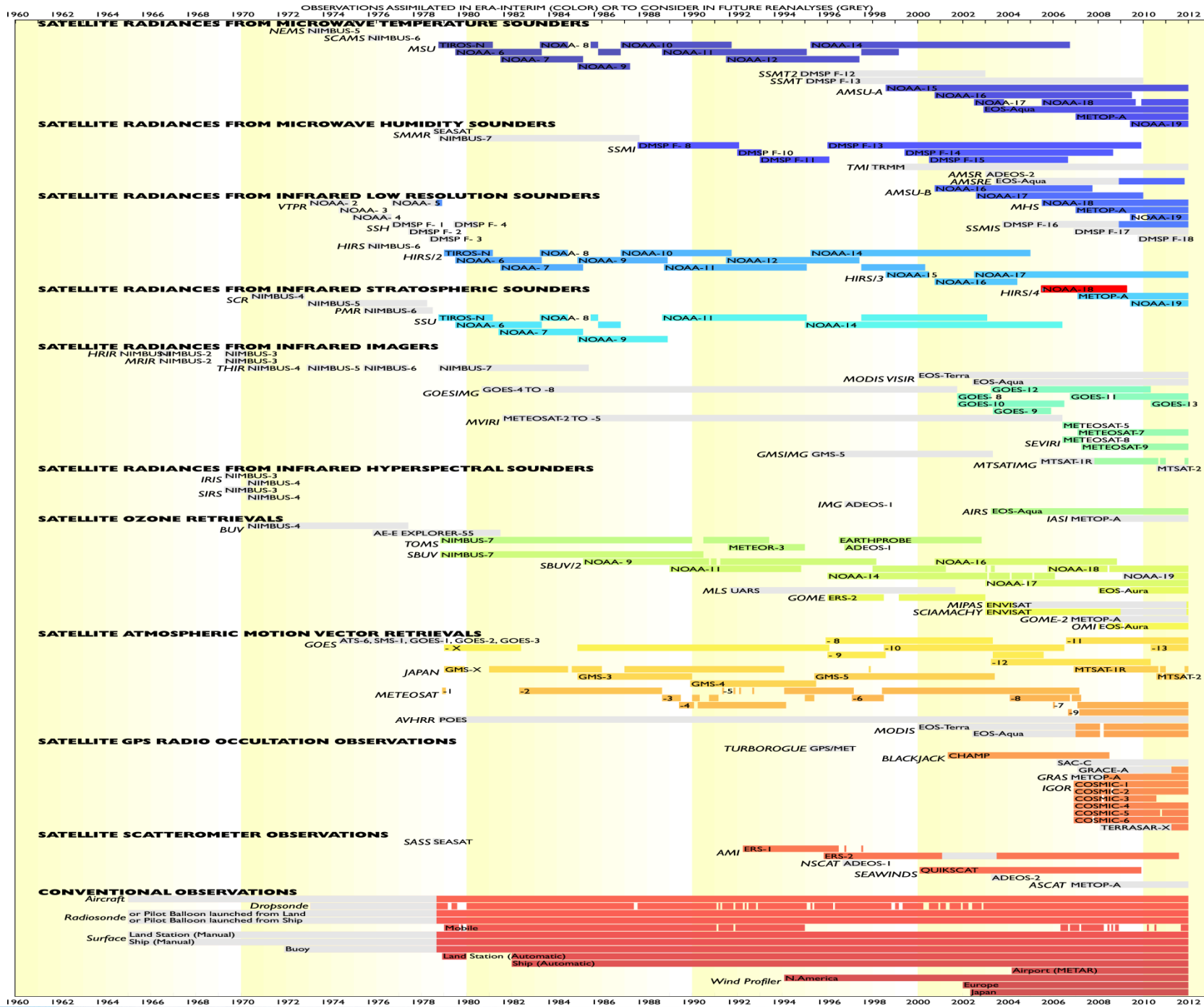
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- Thanks to reprocessing efforts in the AMV community, a large amount of reprocessed AMV data are now available for future reanalyses.
- The quality of the reprocessed data is much improved (exception: NOAA-18 AVHRR):
  - Clearest for earliest data.
  - Particularly clear for the “used data”: Benefit of QI; robustness of our screening in the blacklist.
- Preliminary assimilation experiments suggest positive impact on analyses and forecast:
  - Especially for NOAA-7 (1983), but also GOES-11/12 (2009).
  - More neutral for GMS and METOP, but longer experimentation required.
- MTSAT-1R and MET-9 reprocessed datasets to be tested soon.
- Based on current results, reprocessing of the pre-1995 GOES dataset should be very beneficial to future reanalyses.

---

THE END





# REPROCESSED SATELLITE OBSERVATIONS FOR ERASAT

AMVs	period	reprocessing agency (release date estimate)
METEOSAT 3-7	1989-1998	EUMETSAT
METEOSAT 8-9 (MSG)	1982-2009	EUMETSAT (2012)
MTSAT+GMS+GOES9	1979-2009	JMA
AVHRR / METOP	2006-2012	EUMETSAT (2012)
GOES-8-12	1995-1914	CIMMS
<b>RADIANCES</b>		
MHS / NOAA		
AMSUB / NOAA	2005-2012	Met-Office (2012)
SSMIS	2001-2010	Met-Office (2012)
TMI / TRMM	1987-present	CM-SAF
AMS-R / AQUA	1997-2012	NASA-JAXA
METEOSAT 3-7	2002-2011	JAXA
METEOSAT 8-9 (MSG)	1989-1998 (fill in gaps)	EUMETSAT
MTSAT+GMS+GOES9	1982-2009	EUMETSAT (2012)
	1979-2009	JMA
<b>GPS-RO</b>		
METOP-COSMIC		
CHAMP-GRACE-A	2006-TBD	EUMETSAT (2012)
	2006-TBD	EUMETSAT (2013)
<b>SURFACE WINDS</b>		
ASCAT / METOP-A		
	2007-2010	EUMETSAT (2013)
<b>WAVE HEIGHT</b>		
ERS-1.2-ENVISAT-JASON-TOPEX		
	1991-2010	ESA?
<b>OZONE</b>		
TOMS v8.6		
SBUV	1978-2005	NASA

**ERA-CLIM:** *EU collaborative research project, 2011-2013, 9 global partners aiming to prepare input observations, model data, and data assimilation systems for a global atmospheric reanalysis of the 20<sup>th</sup> century.*

It includes:

**+ pre-1979 datasets:**

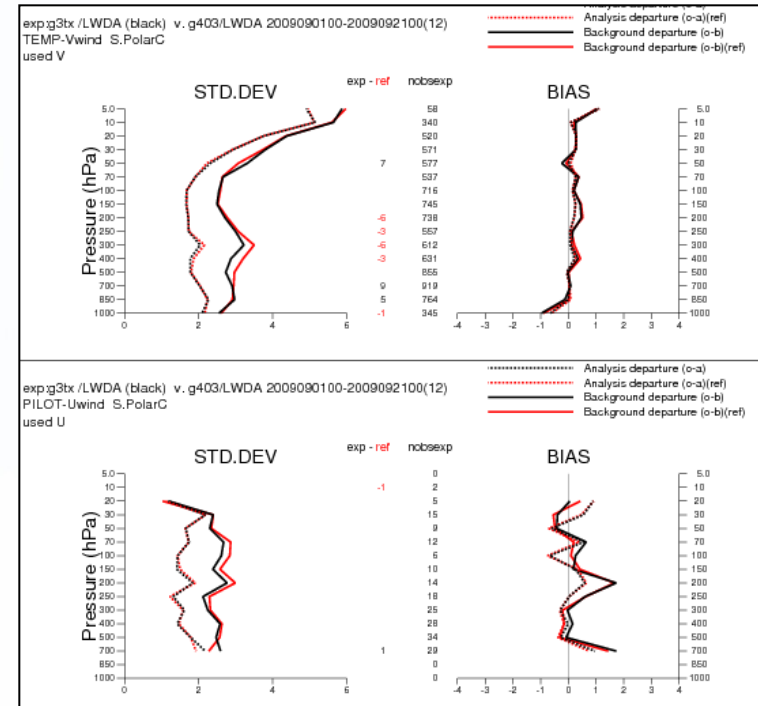
- PMR/*NIMBUS-6* (1975-1978)
- SCR/*NIMBUS4-/5* (1970-1978)

# VALIDATION OF REPROCESSED AMV DATASETS

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# IMPACT ON ANALYSIS AND FORECAST

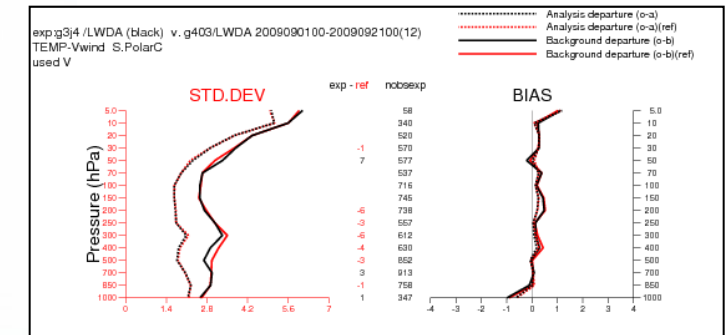
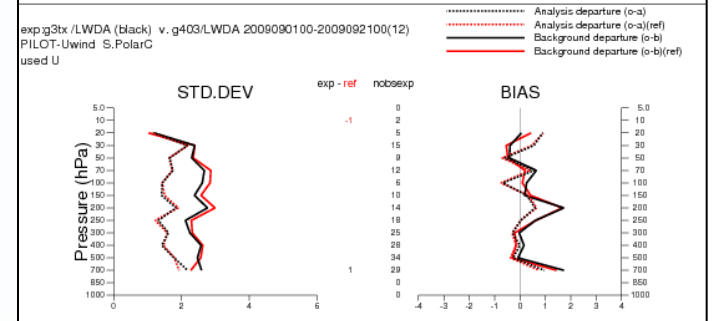
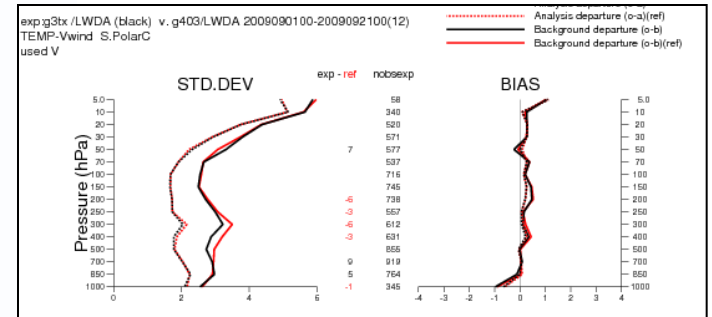
Instruments	Impact on fits to conventional data	Forecast scores	Numbers
GMS-1	neutral	neutral	
GMS-4	neutral to mixt impact	neutral	
GOES-11/12	neutral (with or without IR2)	Positive impact on temperature (neutral on vw)  Lower forecast error with IR2 (but not stat. significant)	
NOAA-7	mixte/positive	Lower vw error (only significant at 500hPa SH)	
NOAA-11/12	Neutral to negative	Neutral on T, slightly negative on VW	
NOAA-18	Neutral to negative (vs no data or old data)	Neutral, but errors are smaller than for old data.	
METOP	CIMMS neutral vs old, slightly negative vs no data. EUMETSAT slightly negative	Neutral for CIMMS, negative for EUMETSAT	





# IMPACT ON ANALYSIS AND FORECAST

Instruments	Impact on fits to conventional data	Forecast scores	Numbers
GMS-1	neutral	neutral	
GMS-4	neutral to mixt impact	neutral	
GOES-11/12	neutral (with or without IR2)	Positive impact on temperature (neutral on vw) Lower forecast error with IR2 (but not stat. significant)	
NOAA-7	mixte/positive	Lower vw error (only significant at 500hPa SH)	
NOAA-11/12	Neutral to negative	Neutral on T, slightly negative on VW	
NOAA-18	Neutral to negative (vs no data or old data)	Neutral, but errors are smaller than for old data.	
METOP	CIMMS neutral vs old, slightly negative vs no data. EUMETSAT slightly negative	Neutral for CIMMS, negative for EUMETSAT	



# EARLY ASSIMILATION EXPERIMENT: BLACKLISTING

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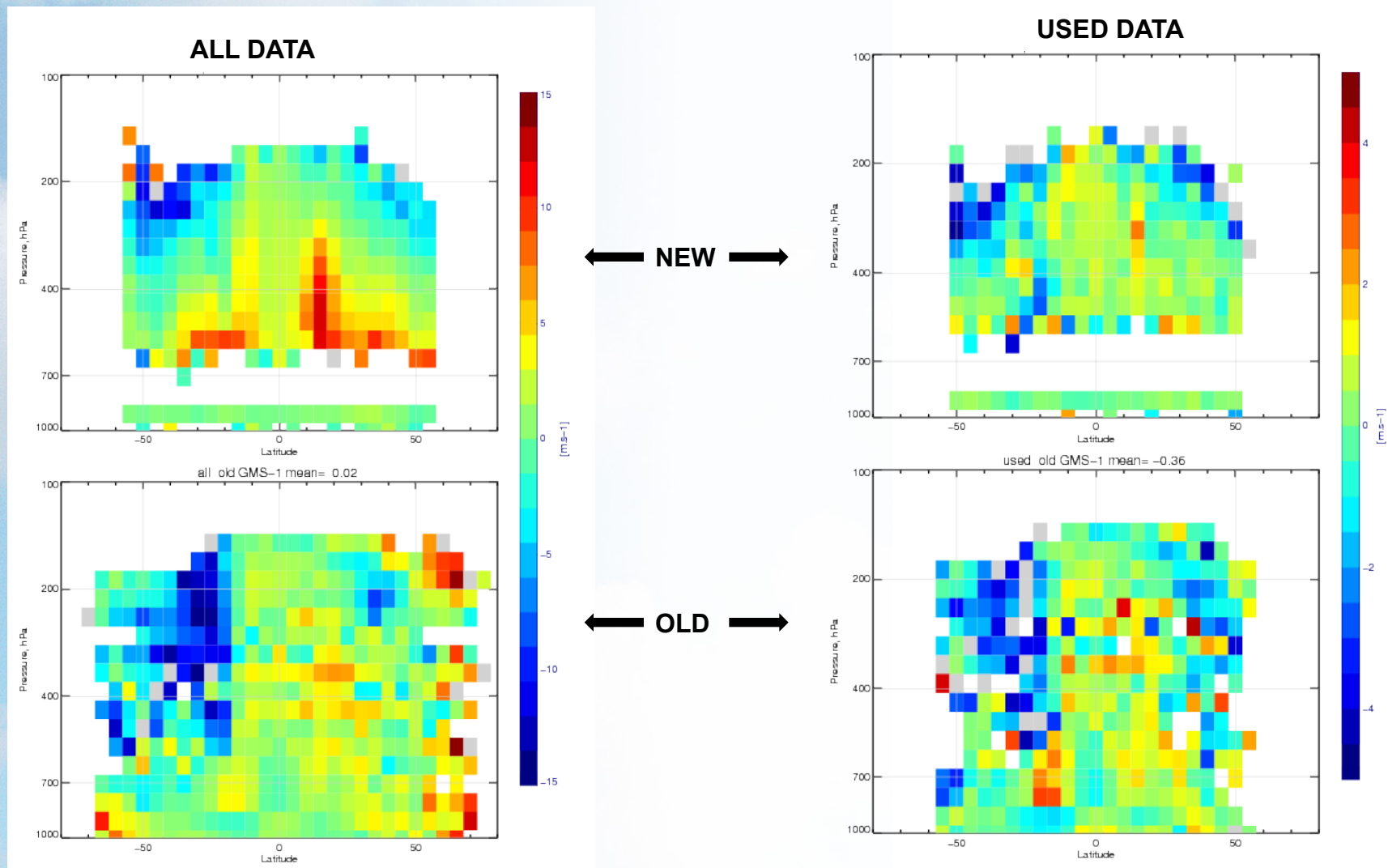
The blacklisting depends on instrument, region, height, satellite zenith angle, QI and date.

It is too complex to go in details, generally the following are blacklisted:

- regional blacklisting over land for geostationary satellites
- $-60 < \text{LAT} < 60$  for polar satellites
- Satellite zenith angles  $> 60$  (when available) for geostationary satellites
- VIS above 700hPa
- IR below 700hPa for the polar satellites
- $\text{QI\_FC} < 60$  to 90 (if no  $\text{QI\_NOFC}$  available)
- $\text{QI\_NOFC} < 85$  (except GOES where  $\text{QI\_NOFC} < 60/65$ )

# FIRST-GUESS DEPARTURES: GMS-1

## Mean first-guess departure in wind speed



# FIRST-GUESS DEPARTURES: GMS

Rep:qinofc $\geq 50$ <i>Old: (No qi)</i>	$\geq 400$ hPa	$< 400$ hPa
GMS-1		
Number (~ per day)	7700 (5300)	3700(8000)
Mean	0.93 (0.46)	1.04 (-1.47)
Std	4.88 (4.66)	5.94 (8.90)
GMS-4		
Number (~ per day)	18300 (1500)	8970 (550)
Mean	0.81 (0.1)	0.70 (-0.35)
Std	4.8 (2.43)	6.55 (6.01)

Rep:qinofc $\geq 85$ <i>Old: (No qi)</i>	$\geq 400$ hPa	$< 400$ hPa
GMS-1		
Number (~ per day)	6426 (5300)	~3000(8000)
Mean	1.15 (0.46)	1.44(-1.47)
Std	5.09 (4.66)	6.13 (8.90)
GMS-4		
Number (~ per day)	16500 (1500)	7820 (550)
Mean	0.97 (0.1)	0.98 (-0.35)
Std	4.89 (2.43)	6.68 (6.01)

# FIRST-GUESS DEPARTURES: GMS

not improved

improved

Rep:qinofc $\geq 50$ <i>Old: (No qi)</i>	$\geq 400$ hPa	$< 400$ hPa
GMS-1		
Number (~ per day)	7700 (5300)	3700(1400)
Mean	0.93 (0.46)	1.04 (-1.47)
Std	4.88 (4.66)	5.94 (8.90)
GMS-4		
Number (~ per day)	18300 (1500)	8970 (550)
Mean	0.81 (0.1)	0.70 (-0.35)
Std	4.8 (2.43)	6.55 (6.01)

Rep:qinofc $\geq 85$ <i>Old: (No qi)</i>	$\geq 400$ hPa	$< 400$ hPa
GMS-1		
Number (~ per day)	6426 (5300)	~3000(8000)
Mean	1.15 (0.46)	1.44(-1.47)
Std	5.09 (4.66)	6.13 (8.90)
GMS-4		
Number (~ per day)	16500 (1500)	7820 (550)
Mean	0.97 (0.1)	0.98 (-0.35)
Std	4.89 (2.43)	6.68 (6.01)

# FIRST-GUESS DEPARTURES: GOES

Rep:qi_nofc ≥ 50	≥ 400 hPa	< 400hPa
<b>GOES-11</b>		
Number (~ per day)	360.000 (73000)	148.000(27.500)
Mean	0.57 (0.50)	0.66 (0.12)
Standard deviation	2.03 (2.28)	4.08 (4.33)
<b>GOES-12</b>		
Number (~ per day)	130.000 (54 000)	155.000 (48 000)
Mean	0.09 (0.17)	0.93 (0.50)
Standard deviation	2.40 (2.86)	3.99 (2.73)

Rep:qi_nofc ≥ 85	≥ 400 hPa	< 400hPa
<b>GOES-11</b>		
Number (~ per day)	217.000(54.000)	93.000(16.500)
Mean	0.48 (0.58)	0.84(0.33)
Std	1.88 (2.13)	3.95 (4.23)
<b>GOES-12</b>		
Number (~ per day)	66300. (38 000)	98.650 (31000)
Mean	0.01 (0.37)	1.20 (0.77)
Std	2.30 (4.12)	3.92 (4.08)

# FIRST-GUESS DEPARTURES: GOES

not better

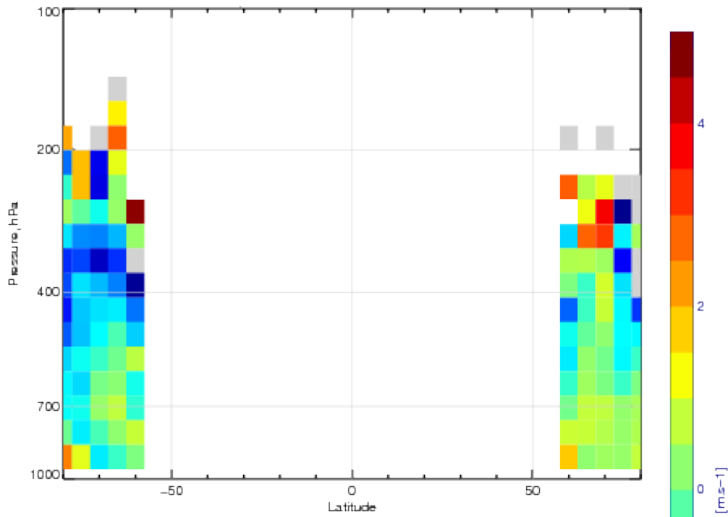
improved

Rep:qinofc $\geq 50$	$\geq 400$ hPa	$< 400$ hPa
GOES-11		
Number (~ per day)	360.000 <i>(73000)</i>	148.000 <i>(27.500)</i>
Mean	0.57 <i>(0.50)</i>	0.66 <i>(0.12)</i>
Standard deviation	2.03 <i>(2.28)</i>	4.08 <i>(4.33)</i>
GOES-12		
Number (~ per day)	130.000 <i>(54 000)</i>	155.000 <i>(48 000)</i>
Mean	0.09 <i>(0.17)</i>	0.93 <i>(0.50)</i>
Standard deviation	2.40 <i>(2.86)</i>	3.99 <i>(4.12)</i>

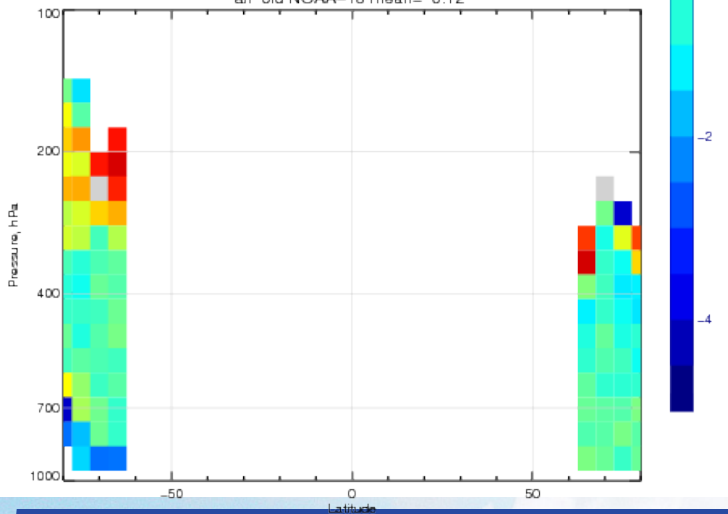
Rep:qinofc $\geq 85$	$\geq 400$ hPa	$< 400$ hPa
GOES-11		
Number (~ per day)	217.000 <i>(54.000)</i>	93.000 <i>(16.500)</i>
Mean	0.48 <i>(0.58)</i>	0.84 <i>(0.33)</i>
Std	1.88 <i>(2.13)</i>	3.95 <i>(4.23)</i>
GOES-12		
Number (~ per day)	66300. <i>(38 000)</i>	98.650 <i>(31000)</i>
Mean	0.01 <i>(0.37)</i>	1.20 <i>(0.77)</i>
Std	2.30 <i>(2.72)</i>	3.92 <i>(4.08)</i>

# FIRST-GUESS DEPARTURES: NOAA-18

## ALL DATA



all old NOAA-18 mean = 0.12

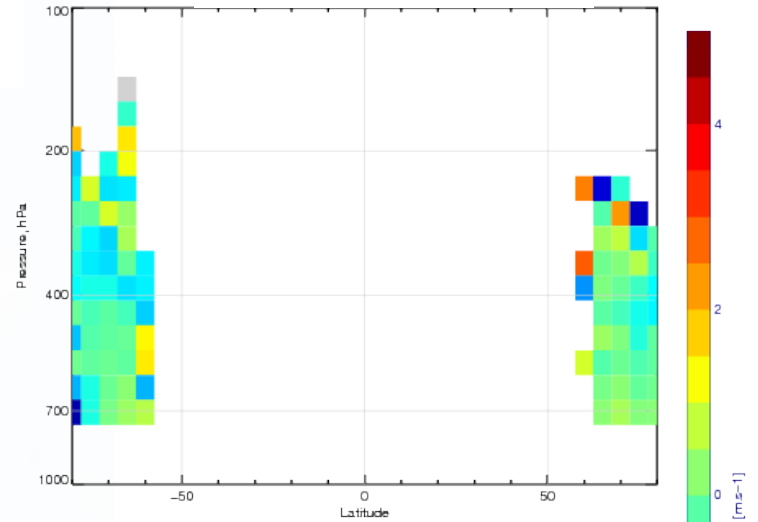


## Mean first-guess departure in windspeed

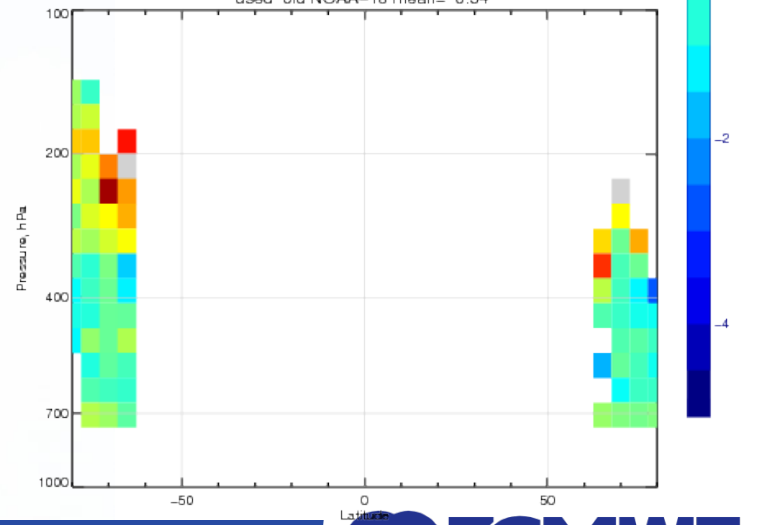
← NEW →

← OLD →

## USED DATA



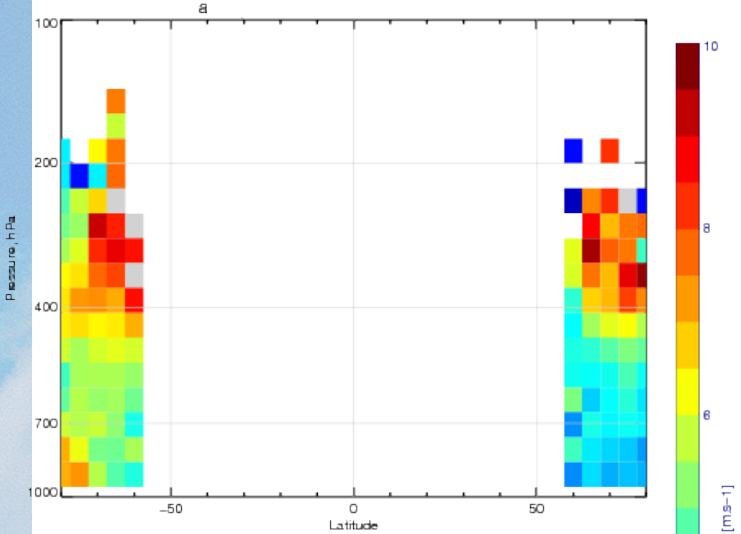
used old NOAA-18 mean = 0.34



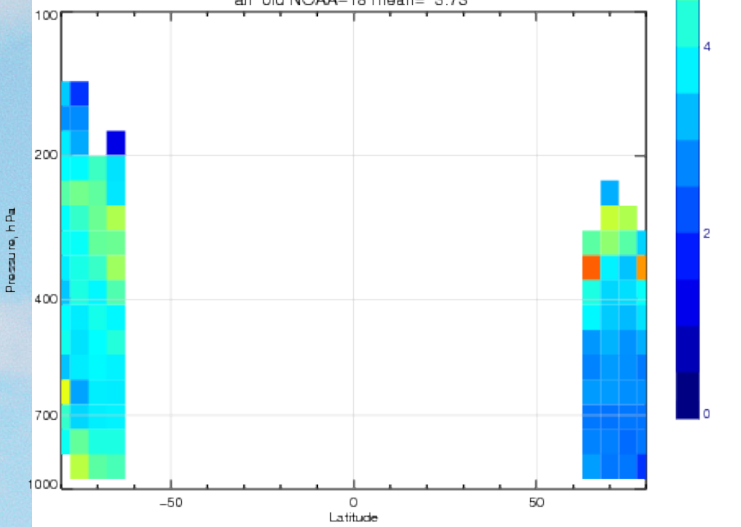


# FIRST-GUESS DEPARTURES: NOAA-18

## ALL DATA



all old NOAA-18 mean= 3.73

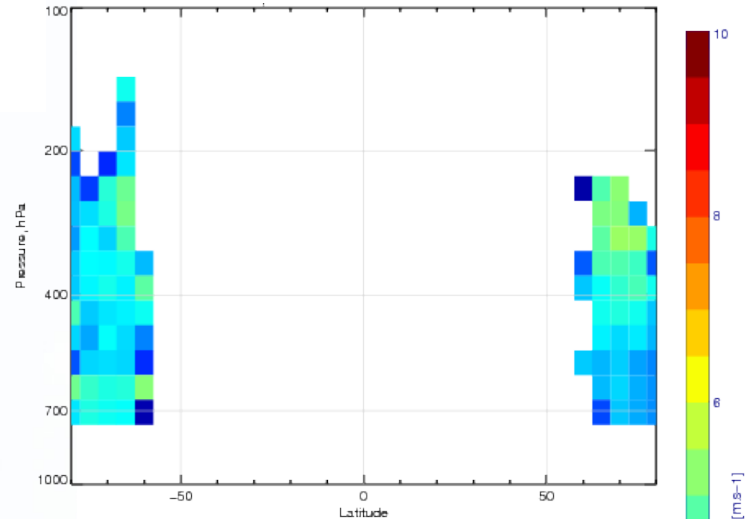


Standard deviation of the first-guess departure in windspeed

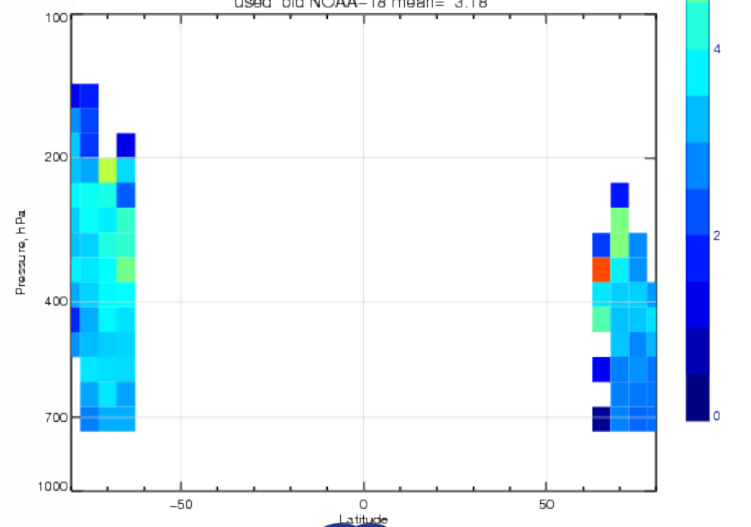
← NEW →

← OLD →

## USED DATA



used old NOAA-18 mean= 3.18



# FIRST-GUESS DEPARTURES: METOP AVHRR (2012)

(reprocessed by EUMETSAT)

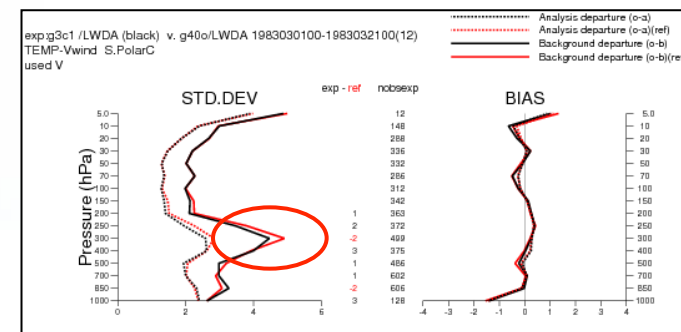
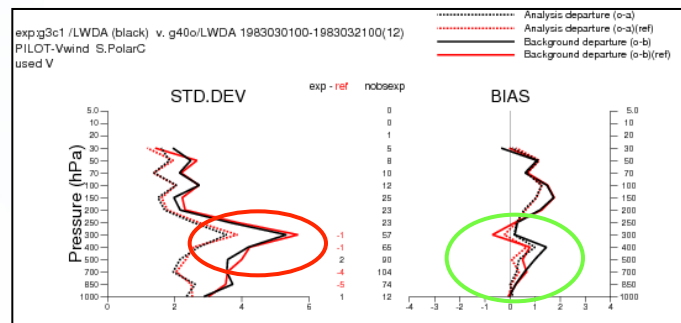
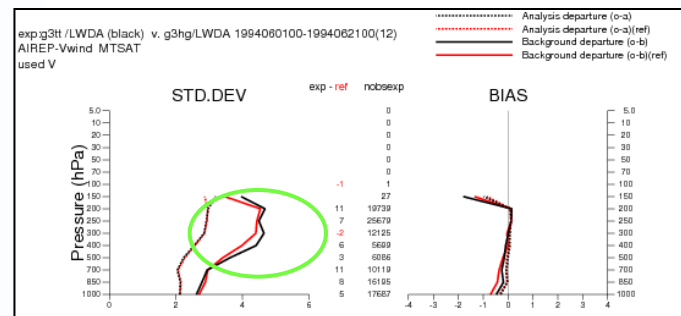
Rep:qi_nofc ≥ 50	≥ 400 hPa	< 400hPa
METOP (CIMMS vs EUMETSAT vs OLD)		
Number (~ per day)	60.000 / 48.000 / 36.500	6700 / 7600 / 3500
Mean	-1.16 / 0.36 / 0.9	-1.82 / -0.42 / -0.11
Std	3.95 / 4.72 / 4.79	4.64 / 5.78 / 5.76

Rep:qi_nofc ≥ 85	≥ 400 hPa	< 400hPa
METOP (CIMMS vs EUMETSAT vs OLD)		
Number (~ per day)	13.200 / 13.500 / 12.700	1900 / 3160 / 2050
Mean	-0.98 / 0.12 / 1.15	-1.56 / -0.15 / 0.25
Std	4.50 / 4.63 / 4.64	5.17 / 5.63 / 5.43

# IMPACT ON ANALYSIS AND FORECAST: NOAA-7

Instruments	Impact on fits to conventional data	Forecast scores	Number active data (~per day)
GMS-1	neutral	neutral	2300
GMS-4	neutral to mixt impact	neutral	5500
GOES-11/12	neutral (with or without IR2)	Positive impact on temperature (neutral on vw) Lower forecast error with IR2 (but not stat. significant)	50700 35000
<b>NOAA-7</b>	<b>mixed/positive</b>	Positive Impact on VW at 500hPa in SH	1500
NOAA-11/12	Neutral to negative	Neutral on T, slightly negative on VW	1500
NOAA-18	Neutral to negative (vs no data or old data)	Neutral to slightly positive	1500
METOP	CIMMS neutral vs old, slightly negative vs no data. EUMETSAT slightly negative	Neutral for CIMMS, negative for EUMETSAT	6700(CIMM S) 7000(EUM.)

“no NOAA-7” vs “reprocessed NOAA-7”

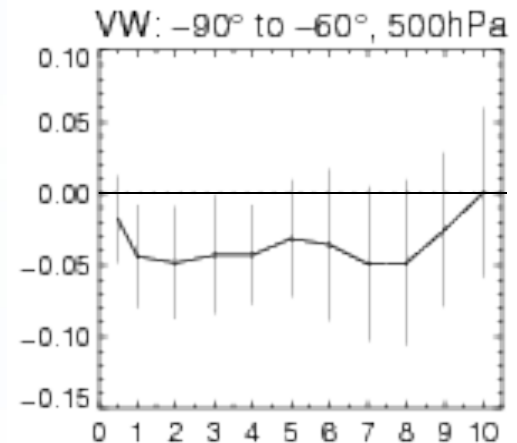


# IMPACT ON ANALYSIS AND FORECAST

Instruments	Impact on fits to conventional data	Forecast scores	Number active data (~per day)
GMS-1	neutral	neutral	2300
GMS-4	neutral to mixt impact	neutral	5500
GOES-11/12	neutral (with or without IR2)	Positive impact on temperature (neutral on vw) Lower forecast error with IR2 (but not stat. significant)	50700 35000
<b>NOAA-7</b>	mixte/positive	<b>Positive Impact on VW at 500hPa in SH</b>	1500
NOAA-11/12	Neutral to negative	Neutral on T, slightly negative on VW	1500
NOAA-18	Neutral to negative (vs no data or old data)	Neutral to slightly positive	1500
METOP	CIMMS neutral vs old, slightly negative vs no data. EUMETSAT slightly negative	Neutral for CIMMS, negative for EUMETSAT	6700(CIMMS) 7000(EUM.)

**Difference in forecast RMSE  
“NOAA-7” minus “no NOAA-7”**

*(Statistics over the Poles)*



**NEGATIVE = POSITIVE IMPACT OF THE REPROCESSED DATA**

# IMPACT ON ANALYSIS AND FORECAST: NOAA-18 AVHRR (2009)

Satellites	Impact on fits to conventional data	Forecast scores	Number active data (~per day)
GMS-1	neutral	neutral	2300
GMS-4	neutral to mixed impact	neutral	5500
GOES-11/12	neutral (with or without IR2)	Positive impact on temperature (neutral on VW) Lower forecast error with IR2 (but not stat. significant)	50700 35000
NOAA-7	mixed/positive	Positive Impact on VW at 500hPa in SH	1500
<b>NOAA-18</b>	neutral to negative (vs no data or old data)	Neutral to slightly positive	1500
METOP	CIMSS: neutral vs old, slightly negative vs no data. EUMETSAT: slightly negative	CIMSS: neutral EUMETSAT: slightly negative	6700(CIMSS) 7000(EUM.)

## Difference in forecast RMSE (VW)

“NOAA-18” minus “old NOAA-18”

