Recent impact studies of satellite-derived wind products at the DWD

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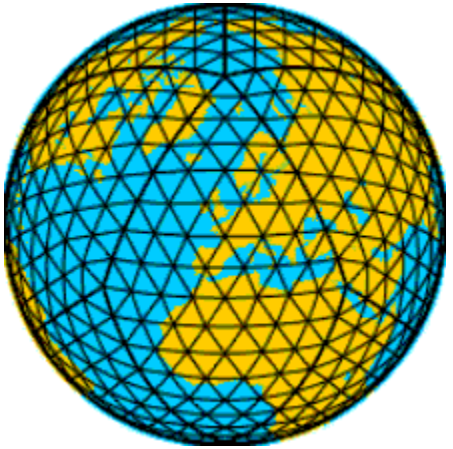
- **Introduction**
- **General analysis and forecast impact of AMV wind vectors**
- **Monitoring and impact results of Meteosat-8/9 Meteosat5/7 GOES 10/11**
- **Quality and Impact of MTSAT-1R**
- **Quality estimations of the MODIS winds from NOAA/NESDIS**
- **Use of ASCAT scatterometer winds**
- **Summary**

Global Model GME



- Operational NWP Model of DWD
- gridpoint model, hexagonal triangular grid
- 40 km mesh size, 36870 grid points/layer
- 40 layers (hyprid, sigma/pressure)
- prognostic variables: p_s, u, v, T, q_v, q_c, q_i, o_3
- intermitient data assimilation (OI, 3-hourly) -> 3DVAR (PSAS) system
- incremental digital filter initialization (P.Lynch)
- At 00 UTC and 12 UTC: forecasts for 174 hours
- At 18 UTC: forecasts for 48 hours

Usage of AMV winds at DWD

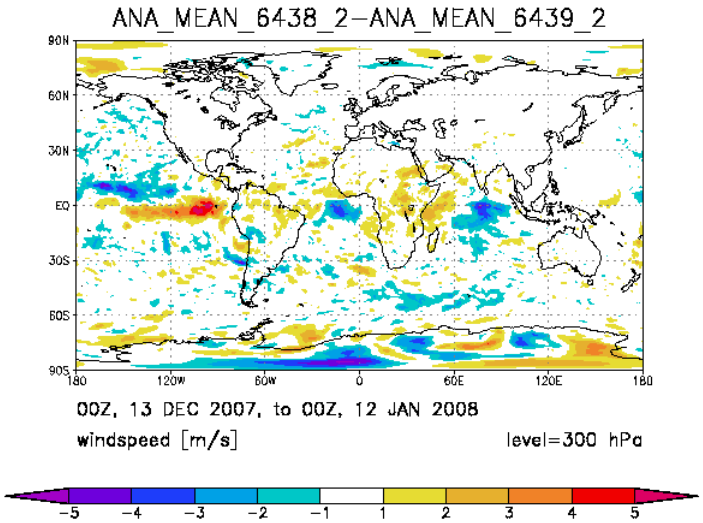
- **Geostationary satellites (GOES 11/12; Eumetsat 7/9; MTSAT-1R)**
  - **extratropics over oceans; tropics over oceans and land**
  - **IR above 1000 hPa**
  - **WVcloudy above 400 hPa; WVclear is not used**
  - **VIS below 700 hPa**
  - **QI threshold blacklisting**
  - **FG check: asymmetric to remove negative OBS-FG bias**
  - **Thinning: 1 wind per pre-defined thinning box (200 km;15 vertical layers). data selection by highest noFirst Guess QI in a box**

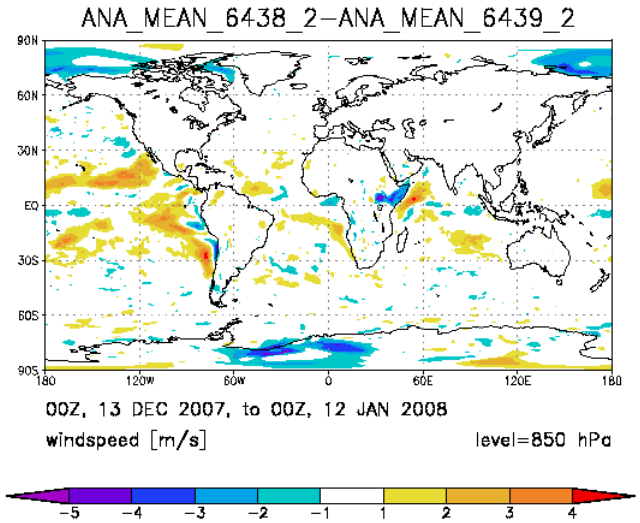
- **Polar orbiting satellites (MODIS)**
  - **over land and oceans**
  - **IR above 1000 hPa, over Antartica over 600 hPa**
  - **WVcloudy above 600 hPa**
  - **QI threshold blacklisting**
  - **FG check: asymmetric to remove negative OBS-FG bias**
  - **Thinnig: 1 wind per thinning box (~60 km; 15 vertical layers)**

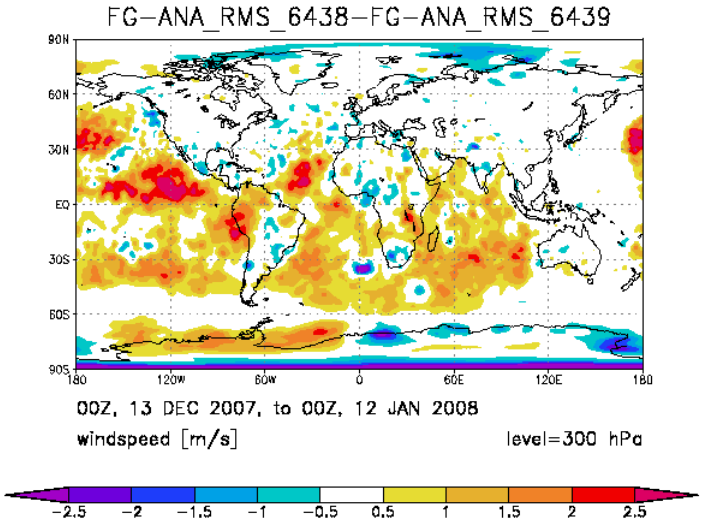
AMV Impact Experiment

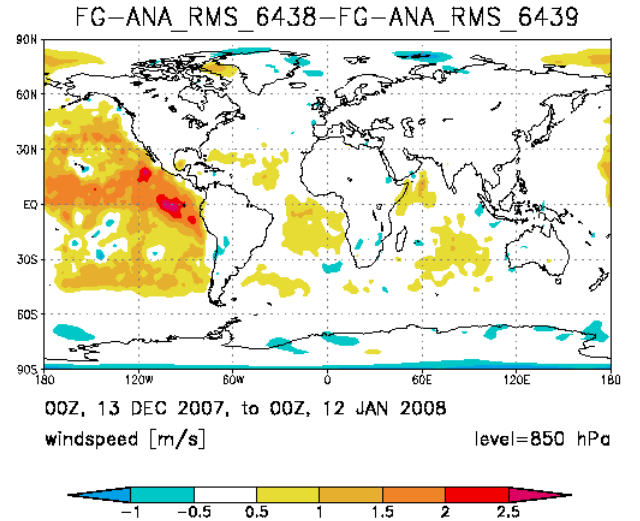
- Following an initiative by Mary Forsythe and Lars Peter Riishojgaard
- Data denial experiment with 3DVAR
- No use of geostationary and polar AMV wind vectors
- Winter period (12th Dez. 2007 – 12th January 2008)
- 00 UTC and 12 UTC forecasts

Difference of mean wind speed analysis and mean RMS of increments

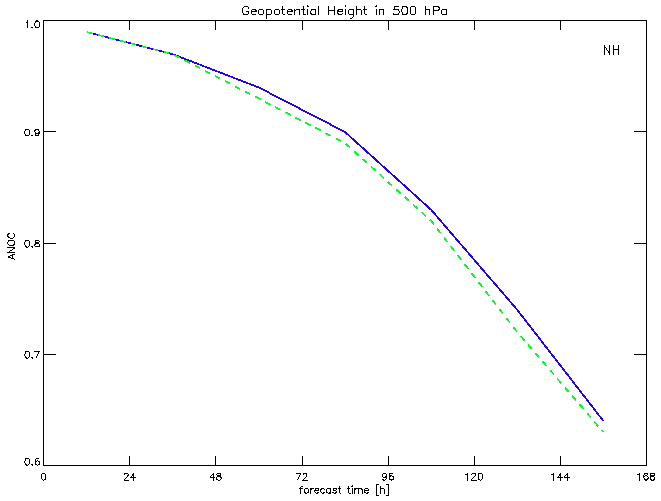




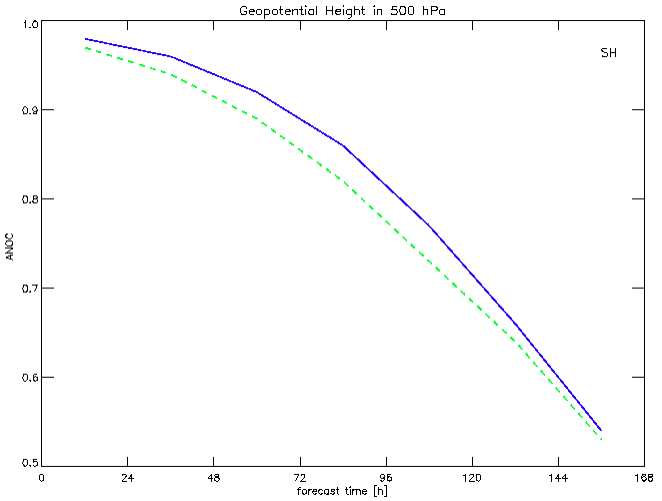




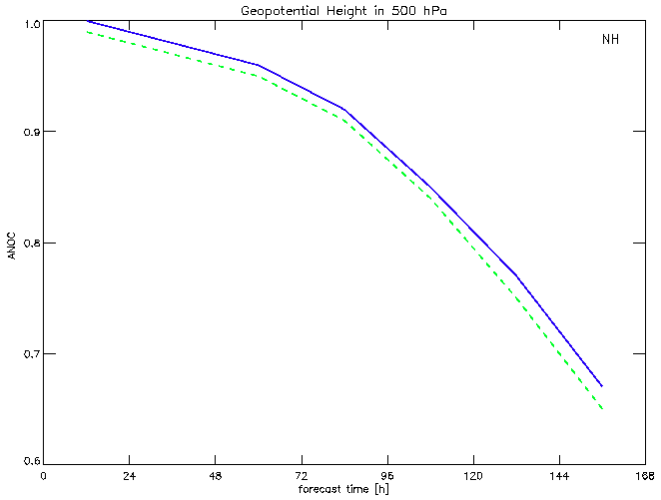
Anomaly correlation coefficient for the Geopotential Height in 500 hPa
20071212 - 20080112



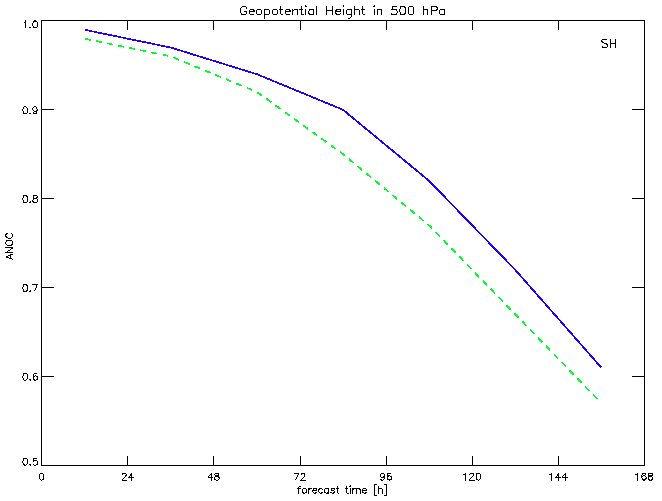
00 UTC



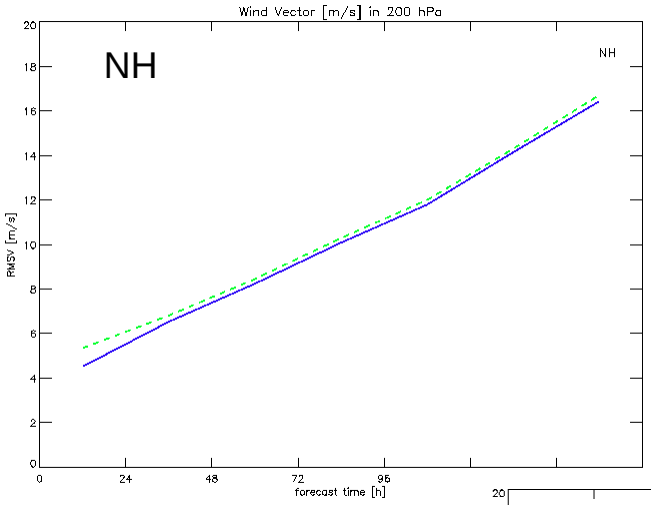
Crtl
Crtll without AMVs

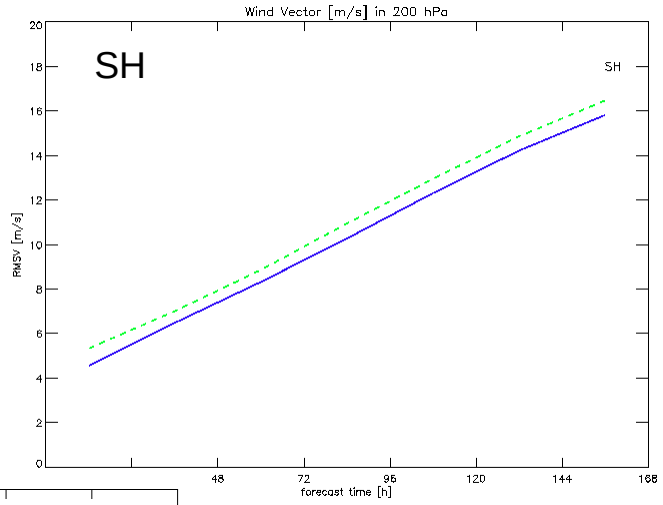


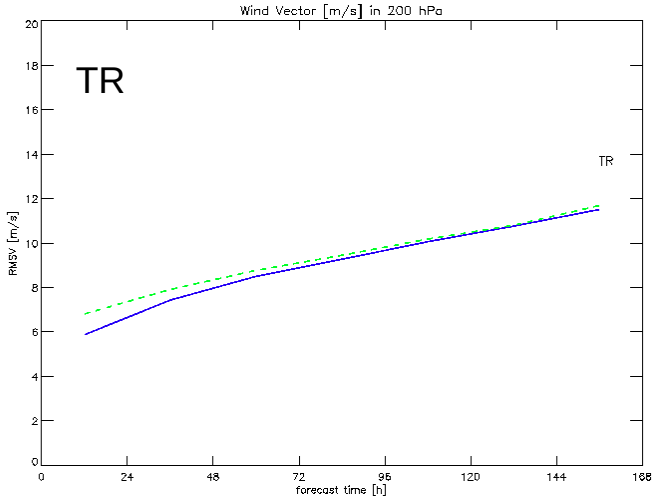
12 UTC



RMSV Wind Vector in 200 hPa
2007121212 - 2008011212





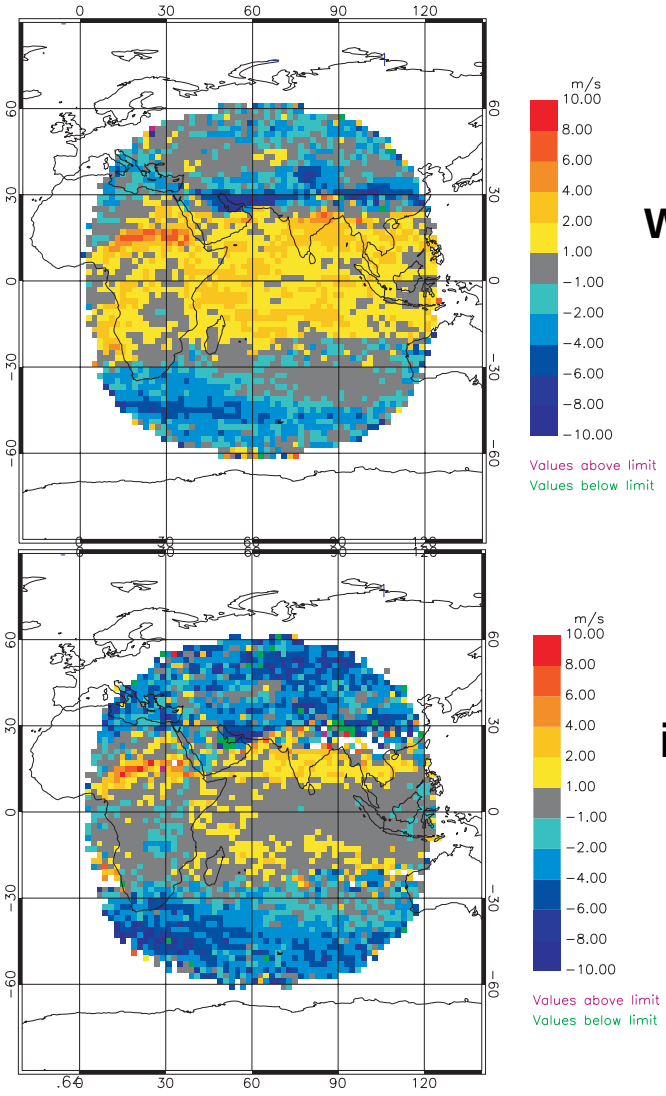


Routine
Routine without AMVs

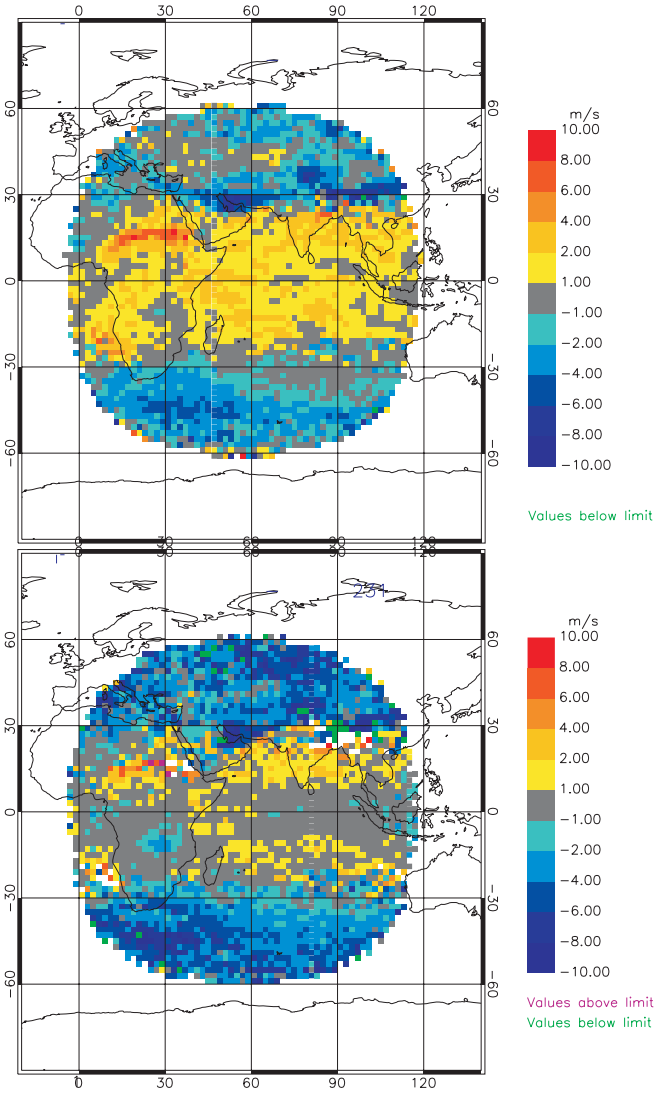
OBS – FG Statistics for Meteosat-5 and Meteosat-7 wind speed

01 Dec. 2006 – 31 Dec. 2006 > 400 hPa

METEOSAT 5



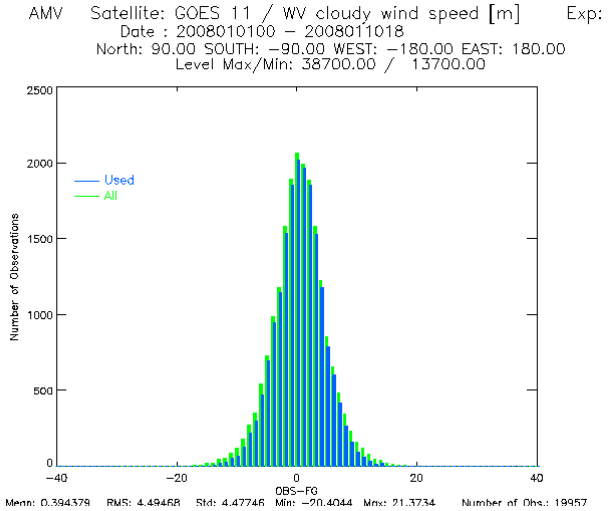
WVcloudy

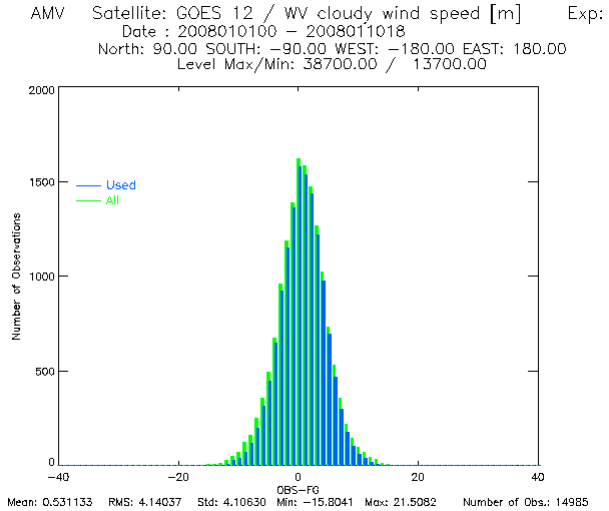


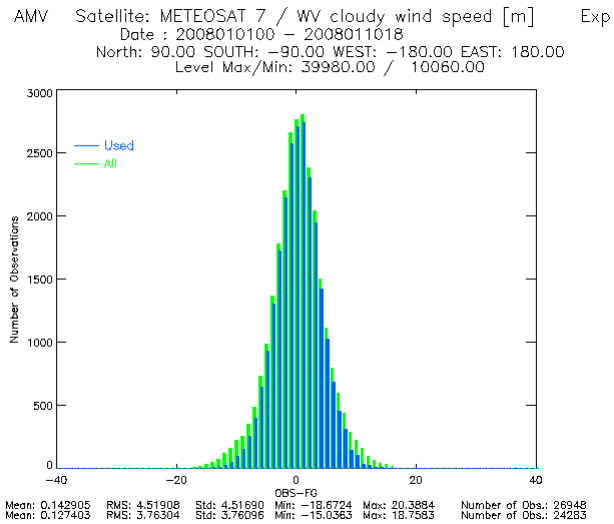
infrared

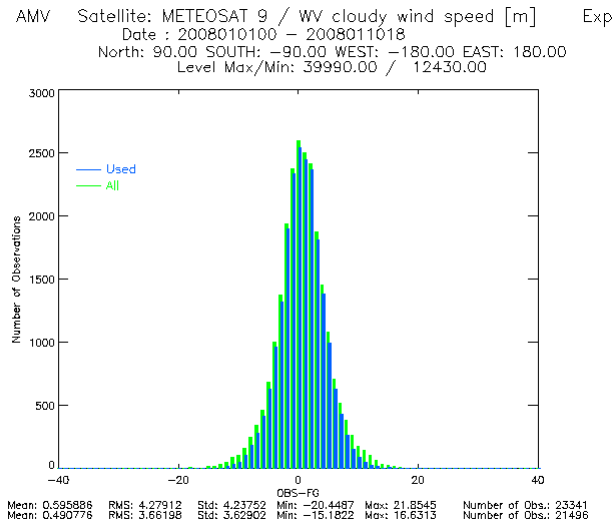
METEOSAT 7

Frequency distribution of obs – fg wind speed statitstics



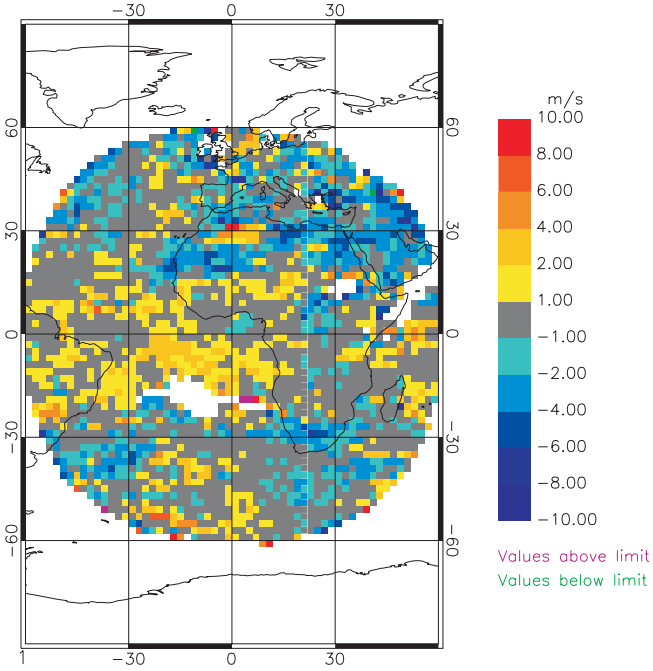




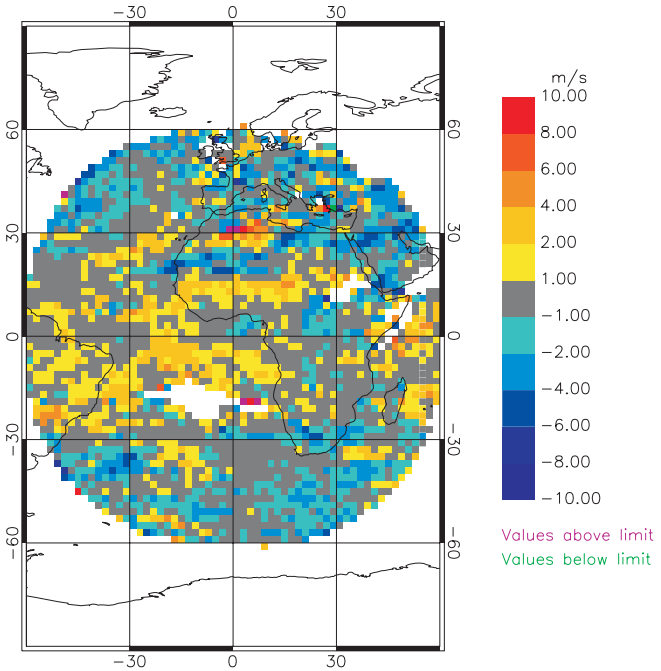


OBS minus FG statistics for AMV infrared wind speed
10 days in March 2007 > 400 hPA

Meteosat-8



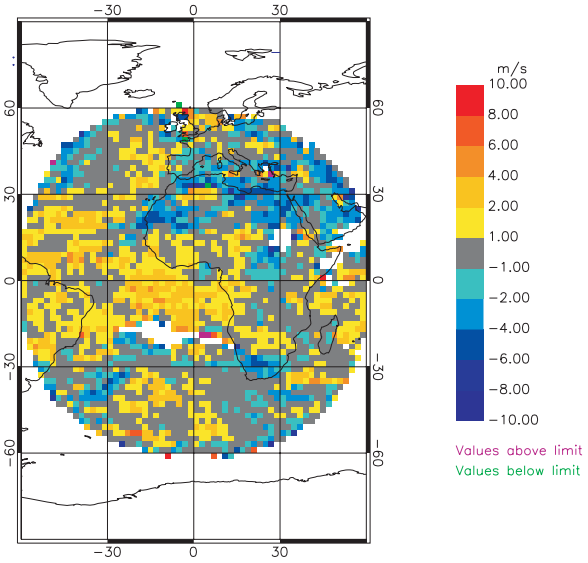
Meteosat-9

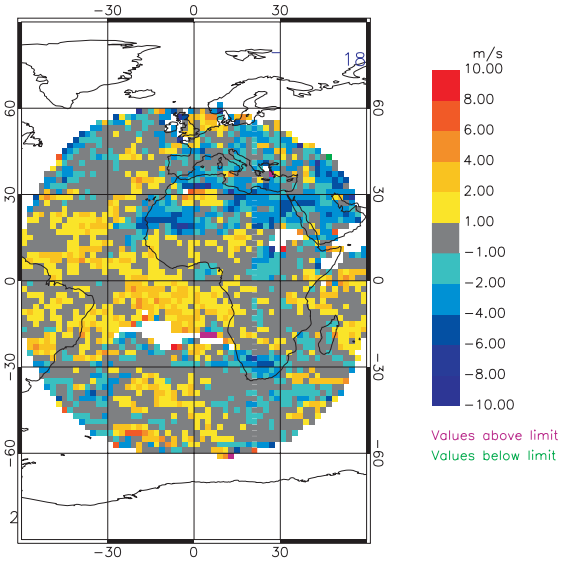


OBS minus FG statistics for AMV WVcloudy wind speed
10 days in March 2007

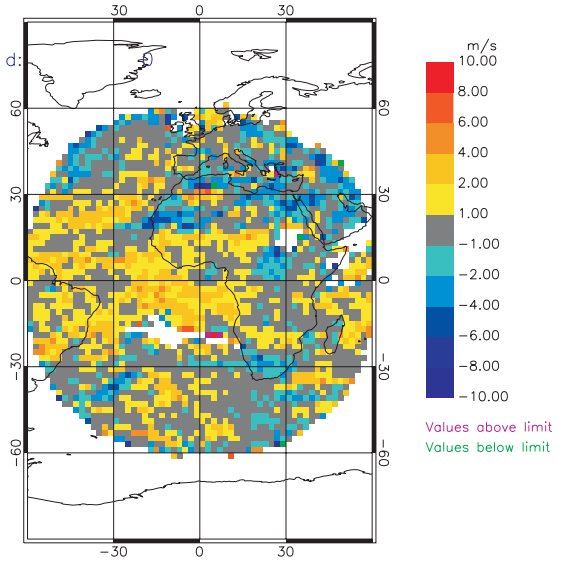
> 400 hPa

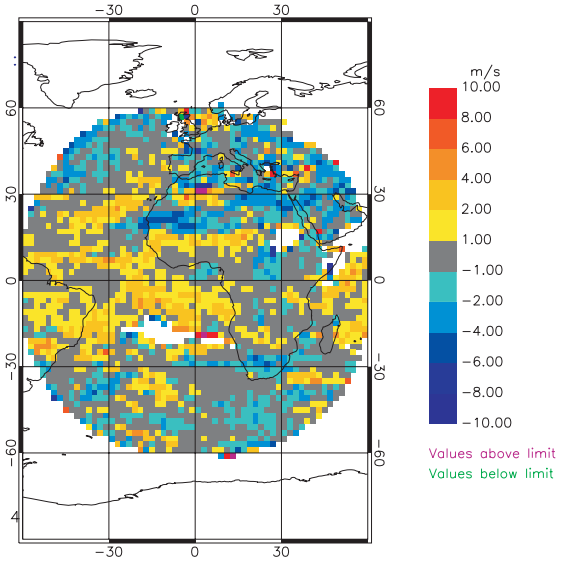
METEOSAT8



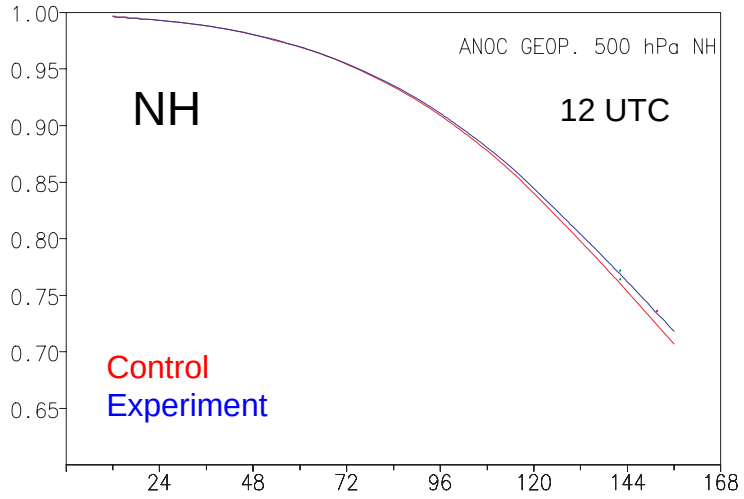


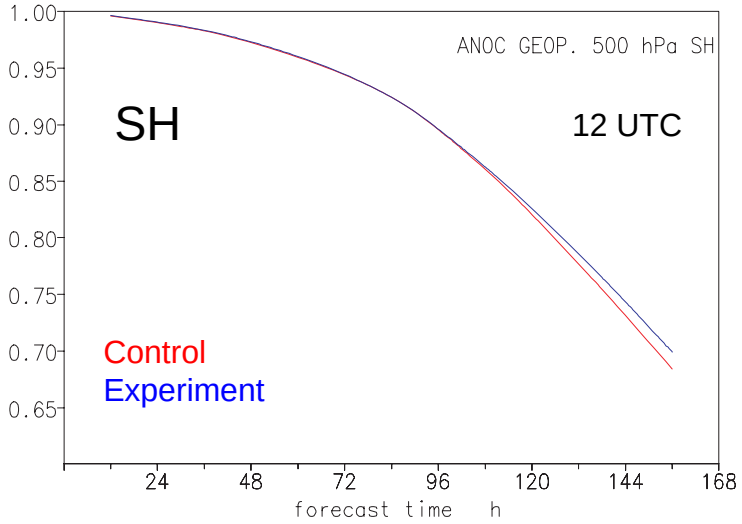
METEOSAT9





Anomaly correlation coefficient of the 500 hPA geopotential height
2007032412 – 2007042412 31 forecasts
Control (Routine with Meteosat-8) Exp (Routine with Meteosat-9)





Analysis and forecast impact of MTSAT-1R

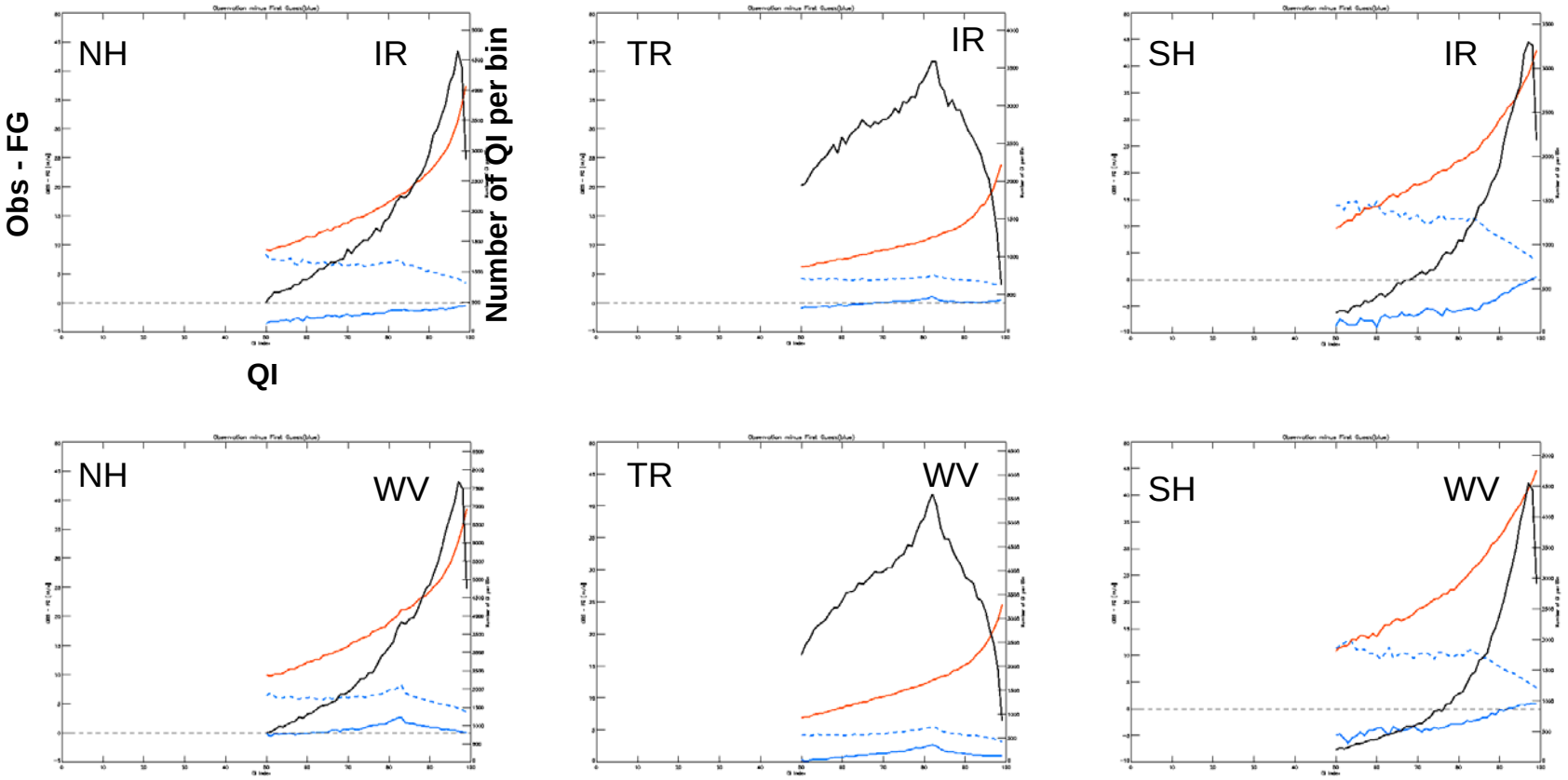
- **Usage**
  - **extratropics over oceans; tropics over oceans and land**
  - **IR between 1000 and 700 hPa and above 400 hPa**
    - **QI > 85**
  - **WVcloudy above 400 hPa**
    - **QI > 85**
  - **WVclear is not used**
  - **VIS below 700 hPa**
    - **QI > 85**
  - **FG check: asymmetric to remove negative OBS-FG bias**
  - **Thinning: 1 wind per pre-defined thinning box (200 km;15 vertical layers). data selection by highest noFirst Guess QI in a box**
  - **One month analysis and forecast experiment (June/July 2007)**

First Guess Departure against QI Index for MTSAT-1R

Date: 2007061500 – 2007070500

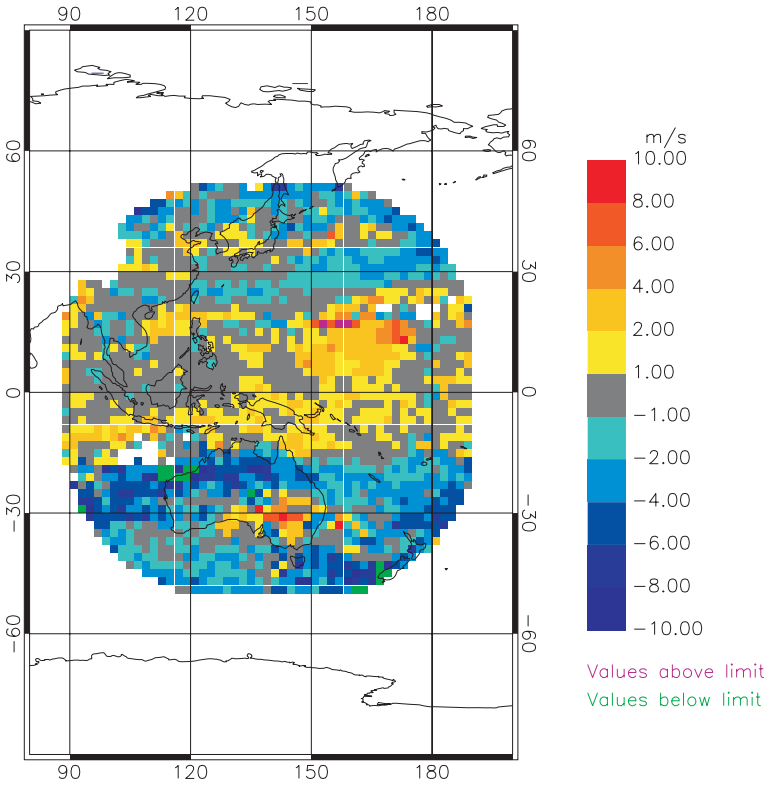
Wind Speed [m/s] >400 hPa

Obs wind speed
Obs – fg bias
Obs – fg rms

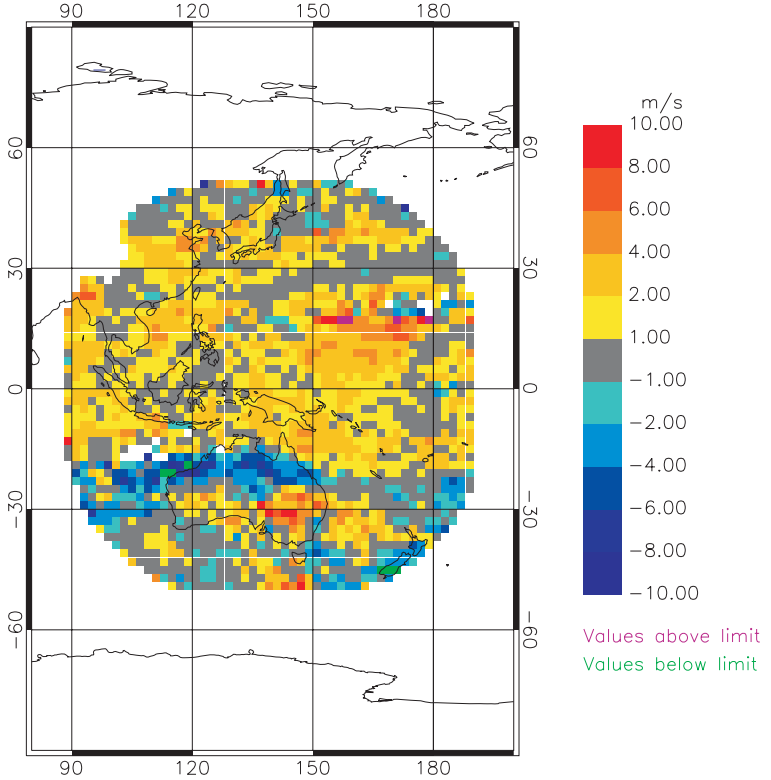


OBS – FG Statistics for MTSAT-1R for July 2007
> 400 hPa QI > 80

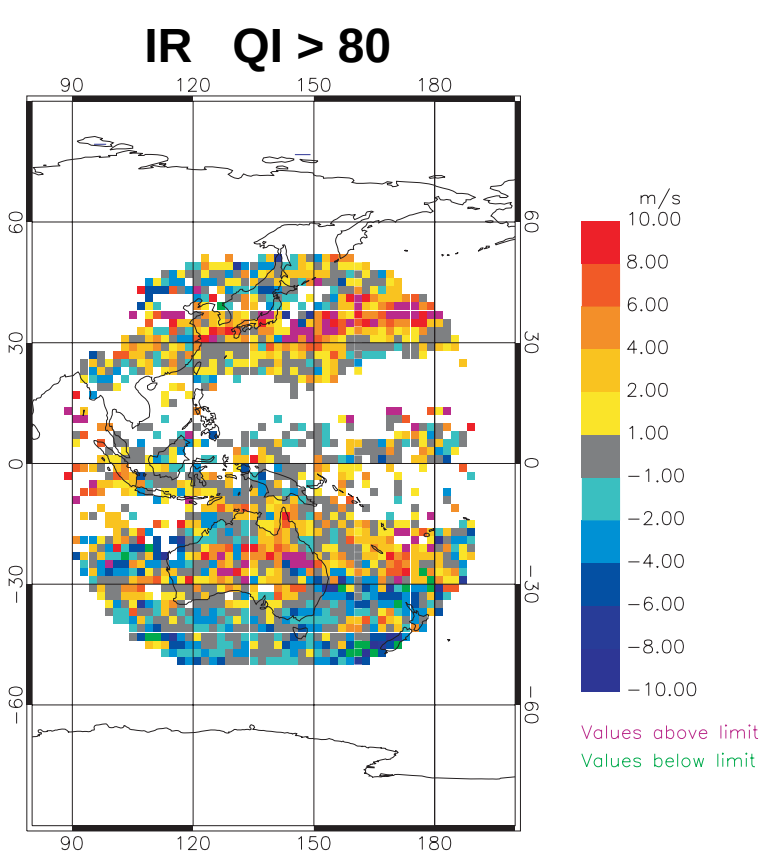
IR

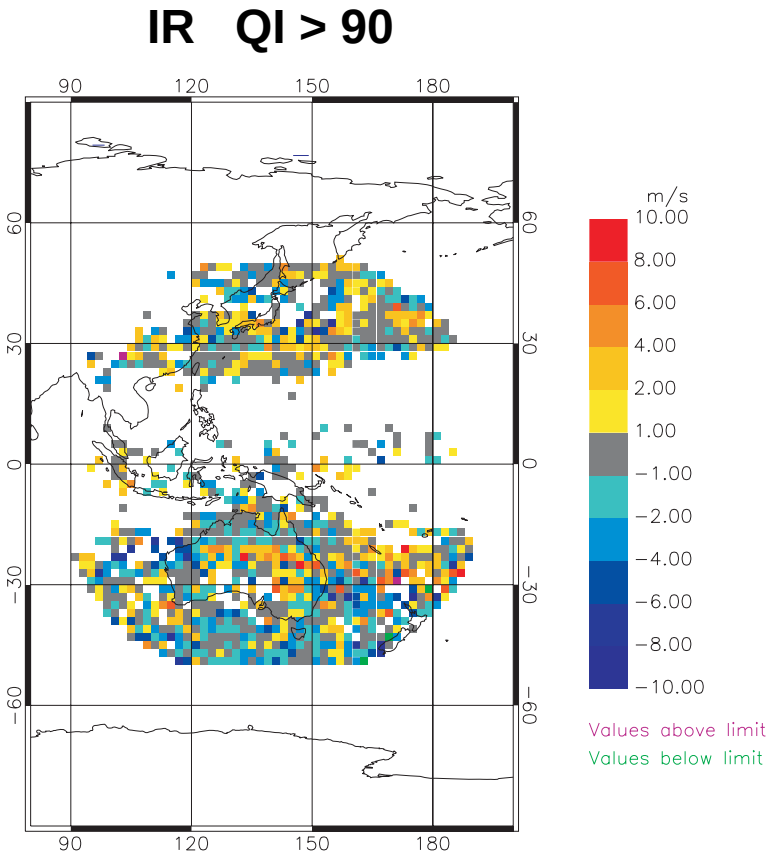


WVcloudy

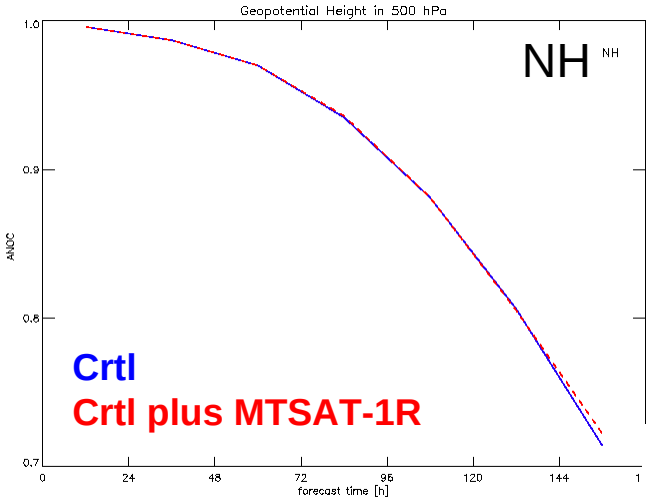


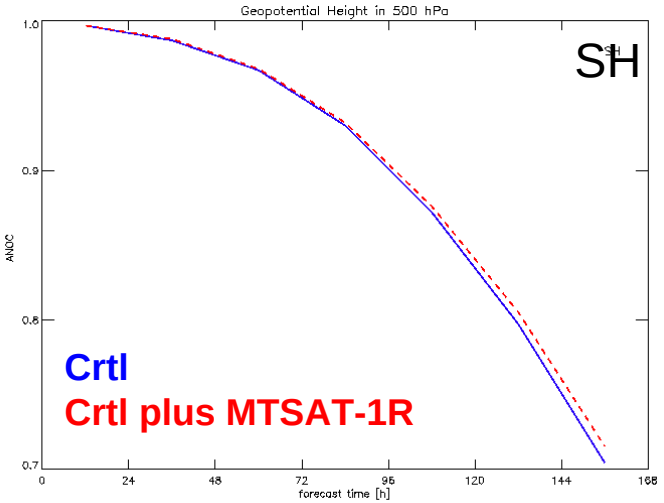
OBS – FG Statistics for MTSAT-1R for July 2007
700 hPa - 400 hPa

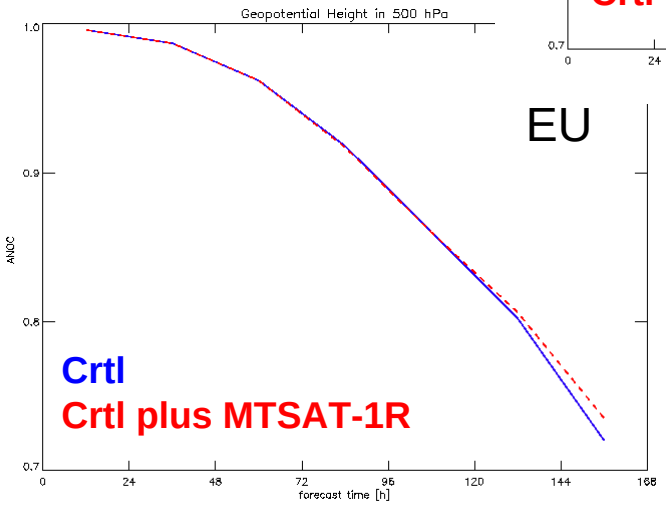




Anomaly correlation coefficent
Date: 2007060912 - 2007070912



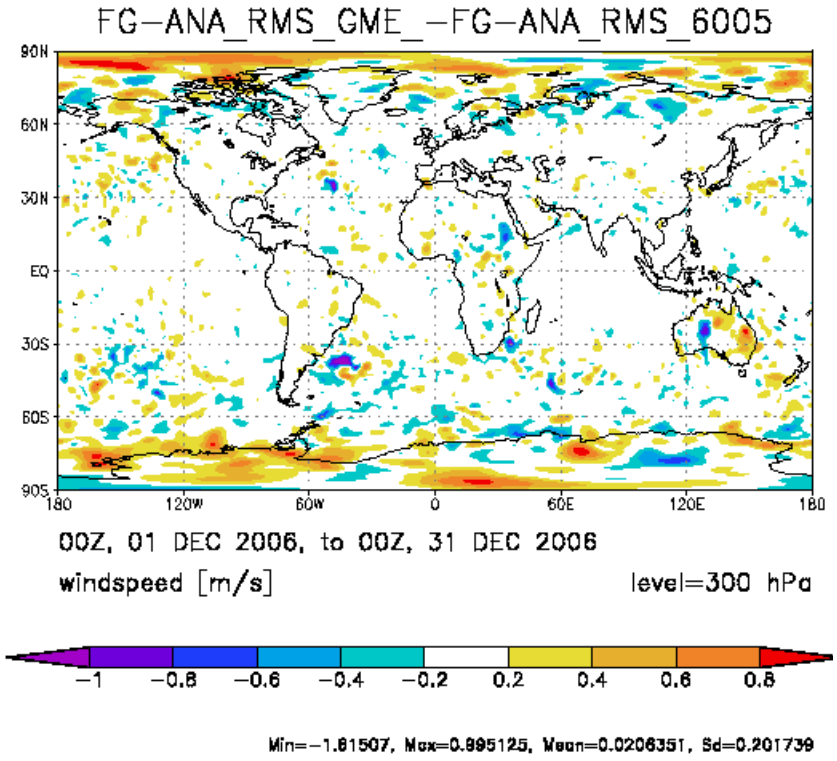


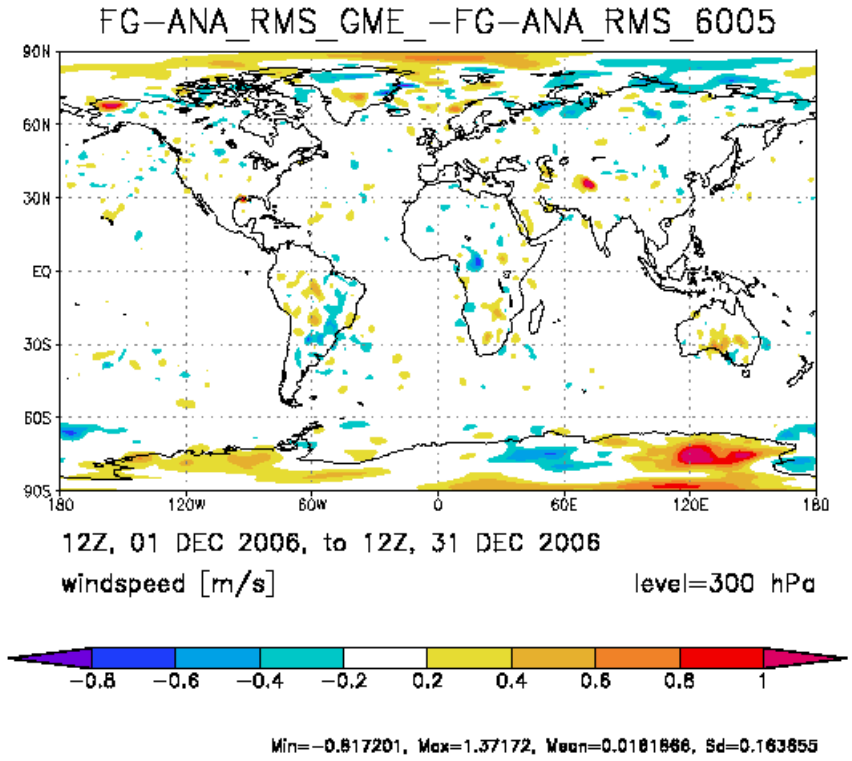


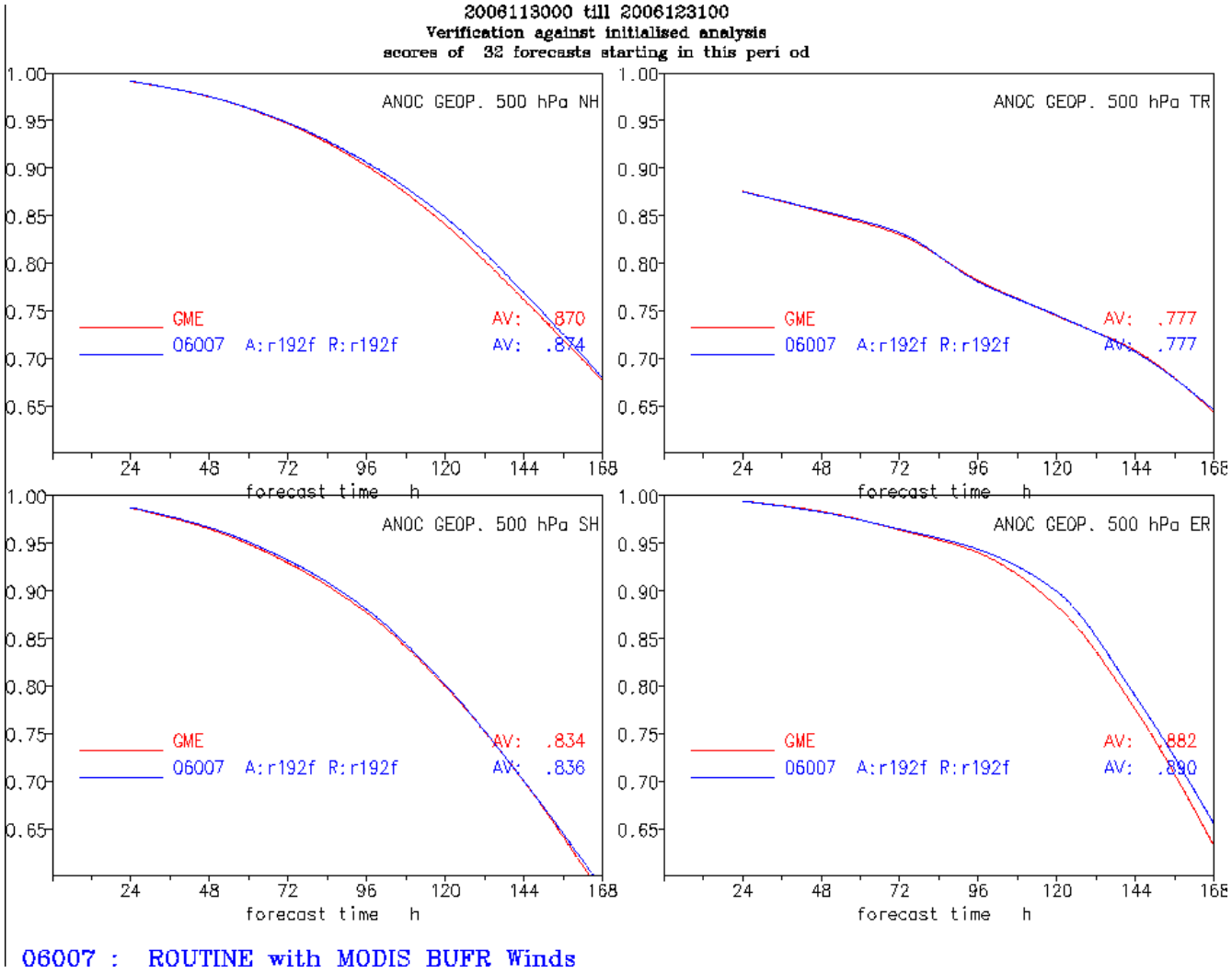
Use of MODIS winds from NOAA/NESDIS with QI Index

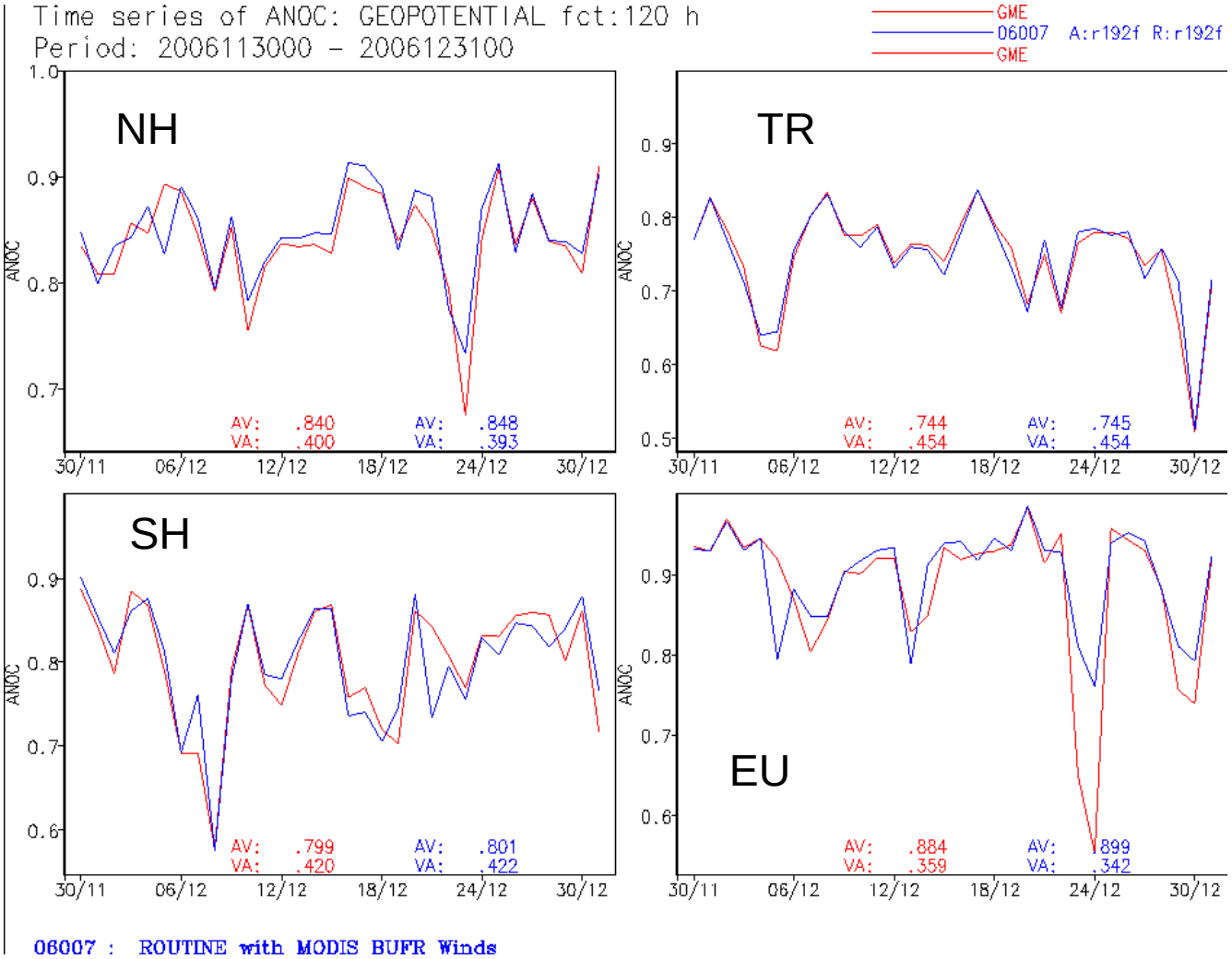
- **Usage**

  - **Since Nov. 2005 DWD receives MODIS winds over GTS processed by NOAA/NESDIS**
  - **Use of MODIS winds over both, land and sea**
  - **IR above 1000 hPa, over Antartica only over 600 hPa**
  - **WVcloudy above 600 hPA**
  - **QI Index for IR and WVcloudy > 65**
  - **FG check: asymmetric to remove negative OBS-FG bias**
  - **Thinning: 1 wind per pre-defined thinning box (60 km;15 vertical layers). data selection by highest noFirst Guess QI in a box**
  - **One month analysis and forecast experiment (NOV/Dez. 2006)**


FG−ANA_RMS_GME_−FG−ANA_RMS_6005
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
00Z, 01 DEC 2006, to 00Z, 31 DEC 2006
windspeed [m/s]
level=300 hPa
−1
−0.8
−0.6
−0.4
−0.2
0.2
0.4
0.6
0.8
Min=−1.81507, Max=0.995125, Mean=0.0206351, Sd=0.201739


FG−ANA_RMS_GME_−FG−ANA_RMS_6005
90N
60N
30N
EQ
30S
60S
90S
180
120W
60W
0
60E
120E
180
12Z, 01 DEC 2006, to 12Z, 31 DEC 2006
windspeed [m/s]
level=300 hPa
−0.8
−0.6
−0.4
−0.2
0.2
0.4
0.6
0.8
1
Min=−0.817201, Max=1.37172, Mean=0.0181666, Sd=0.163855


2006113000 till 2006123100
Verification against initialised analysis
scores of 32 forecasts starting in this peri od
ANOC GEOP. 500 hPa NH
GME AV: .870
06007 A:r192f R:r192f AV: .874
ANOC GEOP. 500 hPa TR
GME AV: .777
06007 A:r192f R:r192f AV: .777
ANOC GEOP. 500 hPa SH
GME AV: .834
06007 A:r192f R:r192f AV: .836
ANOC GEOP. 500 hPa ER
GME AV: .882
06007 A:r192f R:r192f AV: .890
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
24 48 72 96 120 144 168
forecast time h
06007 : ROUTINE with MODIS BUFR Winds


Time series of ANOC: GEOPOTENTIAL fct:120 h
Period: 2006113000 - 2006123100
GME
06007 A:r192f R:r192f
GME
NH
TR
SH
EU
ANOC
AV: .840 VA: .400
AV: .848 VA: .393
AV: .744 VA: .454
AV: .745 VA: .454
AV: .799 VA: .420
AV: .801 VA: .422
AV: .884 VA: .359
AV: .899 VA: .342
30/11
06/12
12/12
18/12
24/12
30/12
06007 : ROUTINE with MODIS BUFR Winds

Direct Broadcast MODIS Winds

- **Motivation and Usage**

MODIS polar winds are not available in time to be used in operational (main) run. Only available in update run

Direct broadcasting winds from Tromso, McMurdo ~ 100 minutes earlier

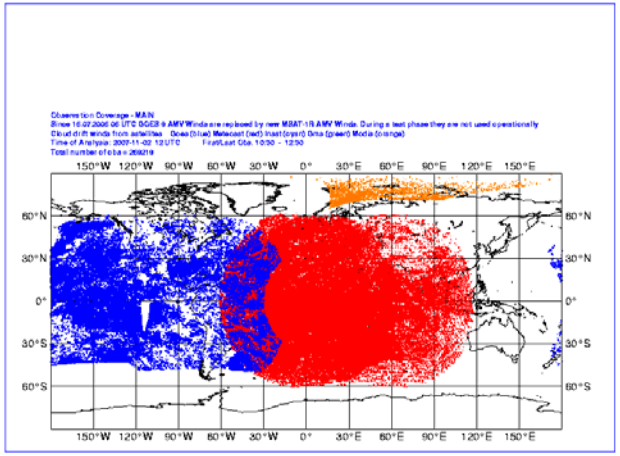
Provide only partial coverage and only Terra can be received in the NH

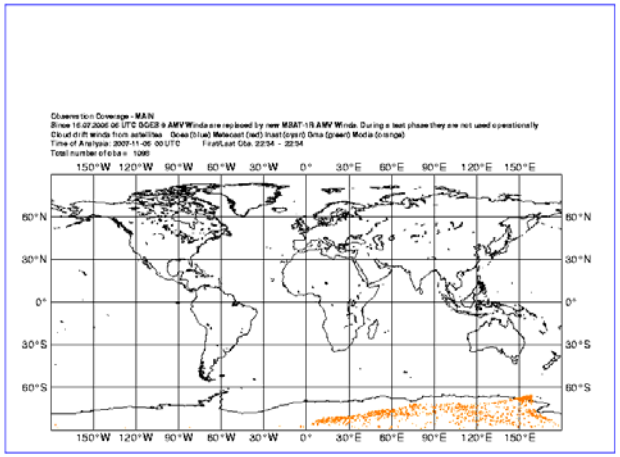
At DWD, no MODIS winds could be used in the main runs.
Using DB winds, some polar winds can be used also in the main run.
Additionally, more polar winds can be used in the update cycle runs

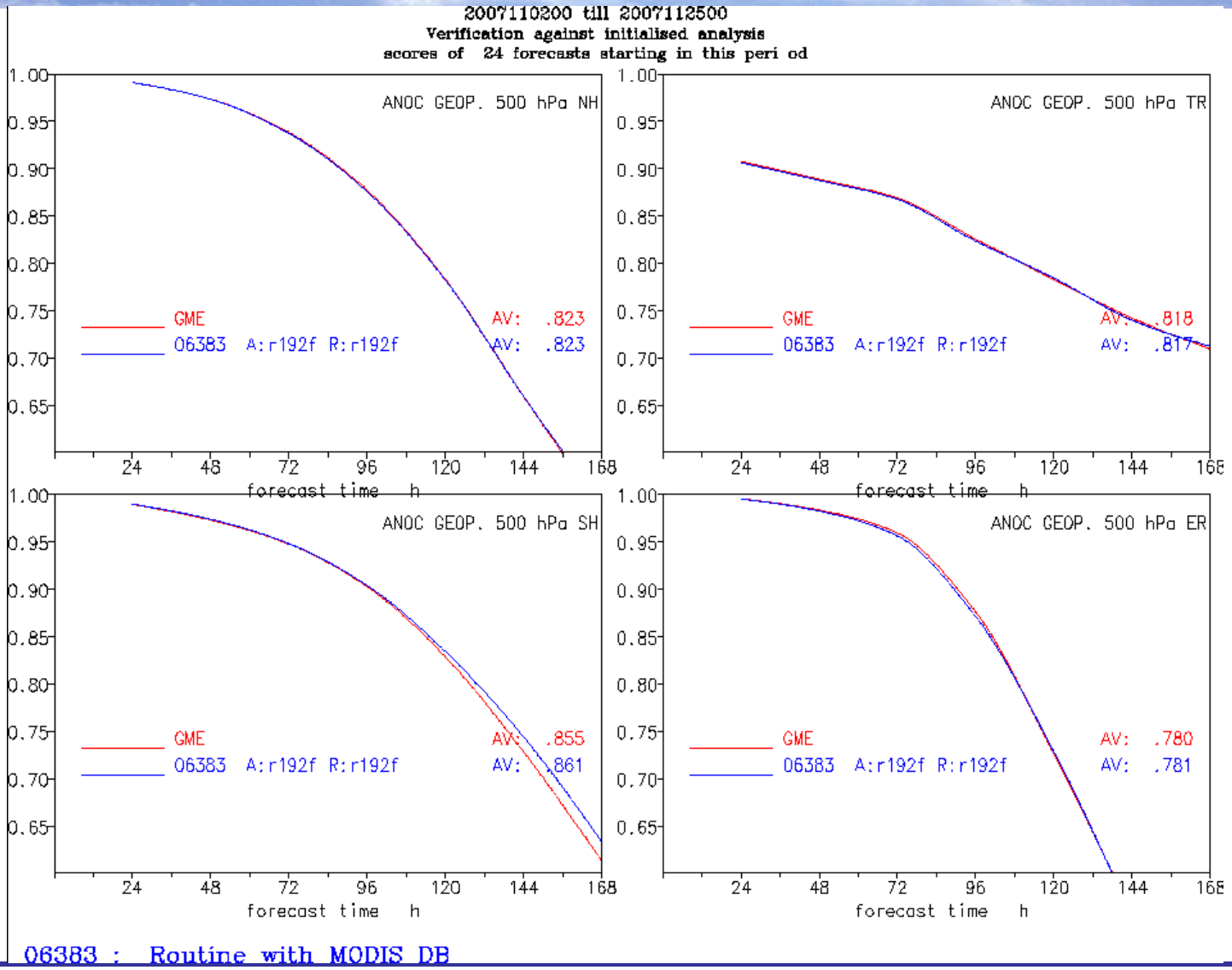
Monitoring results show same quality as conventional MODIS winds

Experimental use of DB polar winds in the same way as conventional MODIS winds

Experiment: 23 days in November 2007

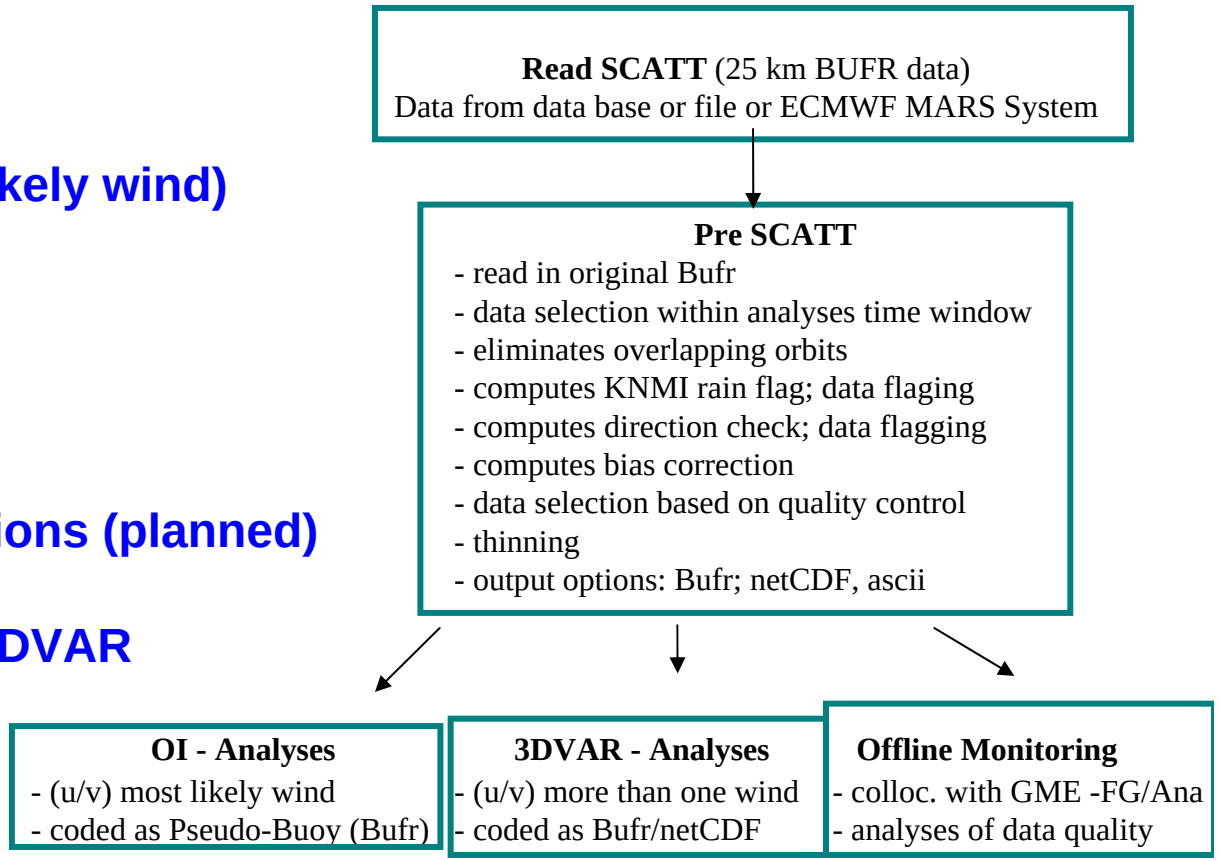




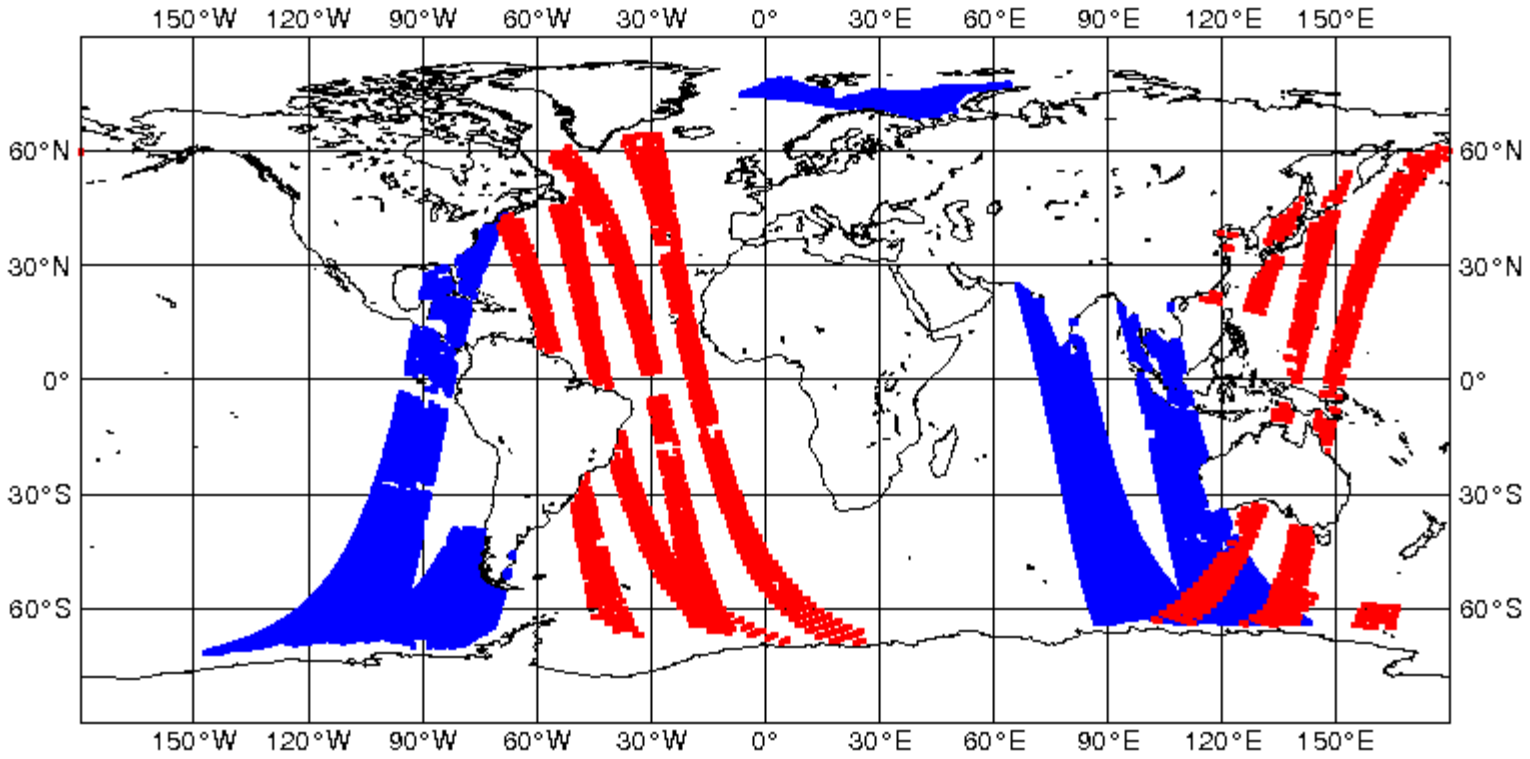

2007110200 till 2007112500
Verification against initialised analysis
scores of 24 forecasts starting in this peri od
ANOC GEOP. 500 hPa NH
GME AV: .823
06383 A:r192f R:r192f AV: .823
ANOC GEOP. 500 hPa TR
GME AV: .818
06383 A:r192f R:r192f AV: .817
ANOC GEOP. 500 hPa SH
GME AV: .855
06383 A:r192f R:r192f AV: .861
ANOC GEOP. 500 hPa ER
GME AV: .780
06383 A:r192f R:r192f AV: .781
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
24 48 72 96 120 144 168
forecast time h
06383 : Routine with MODIS DB

Use of scatterometer data at DWD

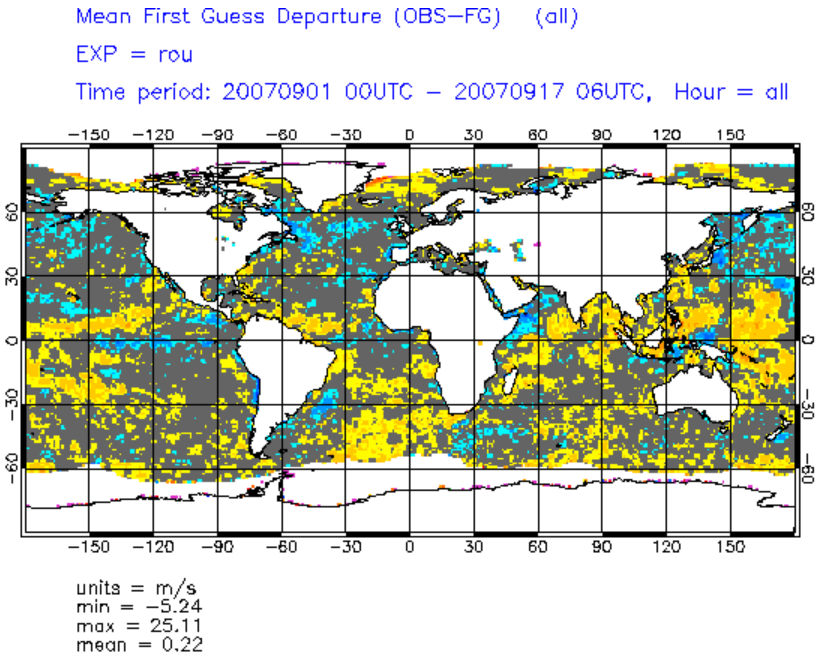
- 10 m wind vectors (most likely wind)
- QuikScat and ASCAT
- Global and regional
- Use of multiple wind solutions (planned)
- Experiments with OI and 3DVAR

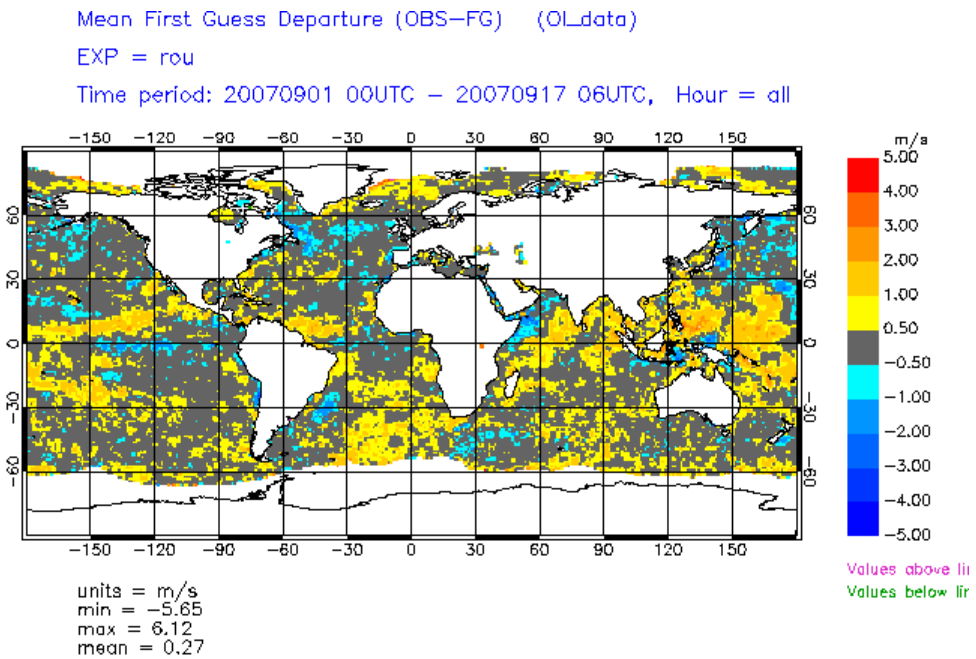


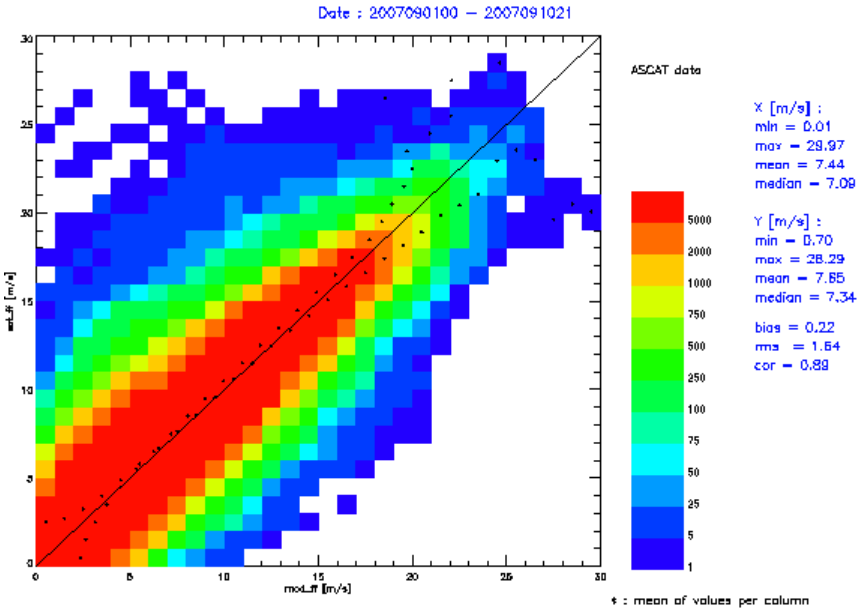
Scatterometer Data Coverage
2008022500 +/- 1.5 H
ASCAT (red) QuikScat (blue)

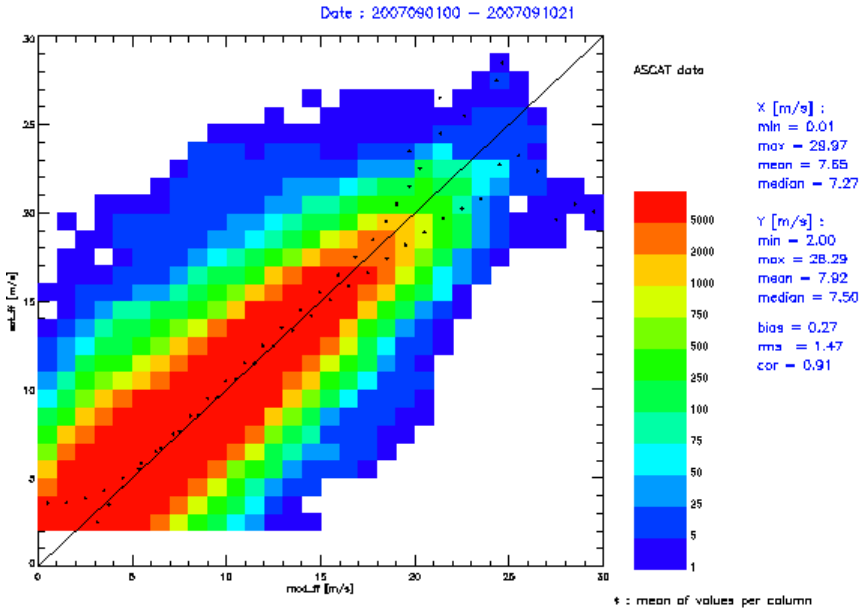


ASCAT Scatterometer Statistics
10 m Windspeed [m/s]

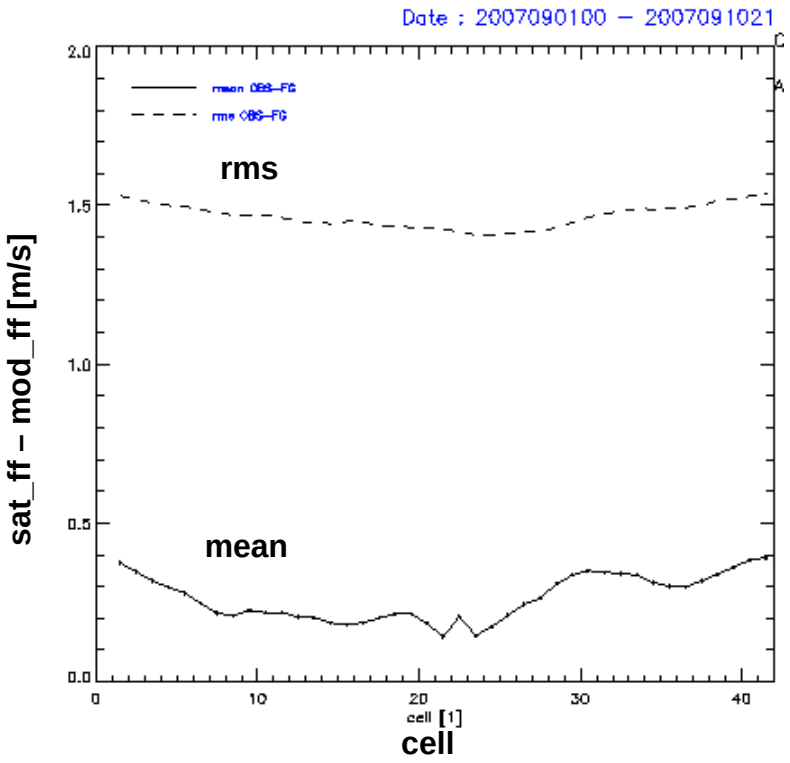


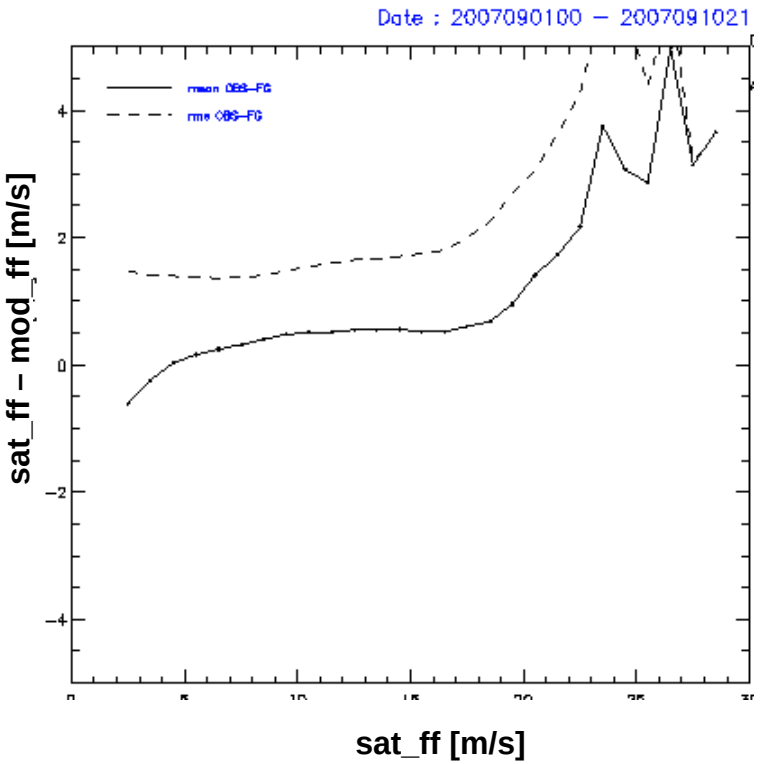



Date : 2007090100 – 2007091021
ASCAT data
X [m/s] :
min = 0.01
max = 28.97
mean = 7.44
median = 7.09
Y [m/s] :
min = 0.70
max = 28.29
mean = 7.85
median = 7.34
bias = 0.22
rms = 1.64
cor = 0.89
mxl_ff [m/s]
ecl_ff [m/s]
: mean of values per column


Date : 2007090100 – 2007091021
ASCAT data
X [m/s] :
min = 0.01
max = 28.97
mean = 7.65
median = 7.27
Y [m/s] :
min = 2.00
max = 28.29
mean = 7.92
median = 7.50
bias = 0.27
rms = 1.47
cor = 0.91
mxl_ff [m/s]
ecl_ff [m/s]
: mean of values per column

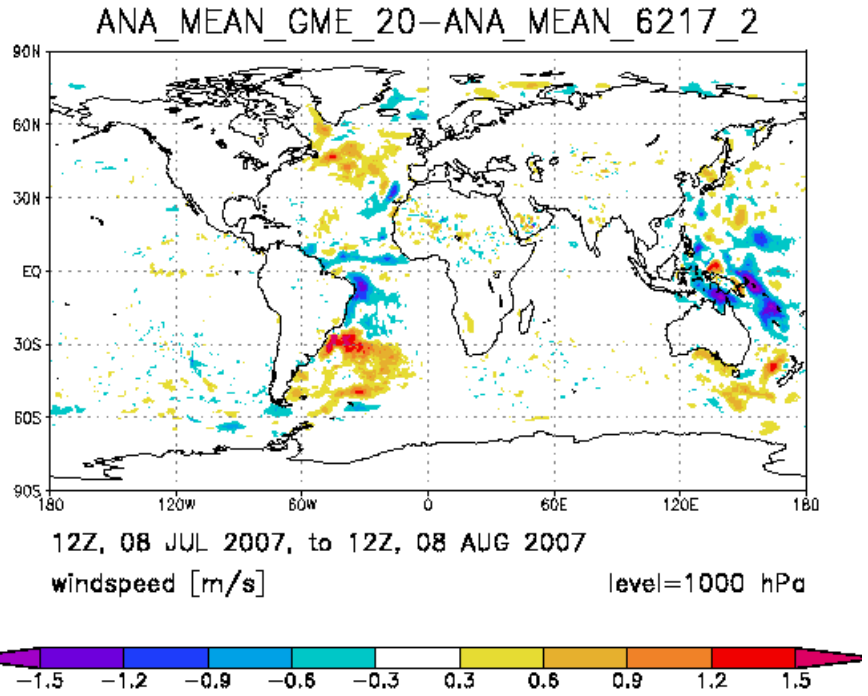
ASCAT wind vector cell quality



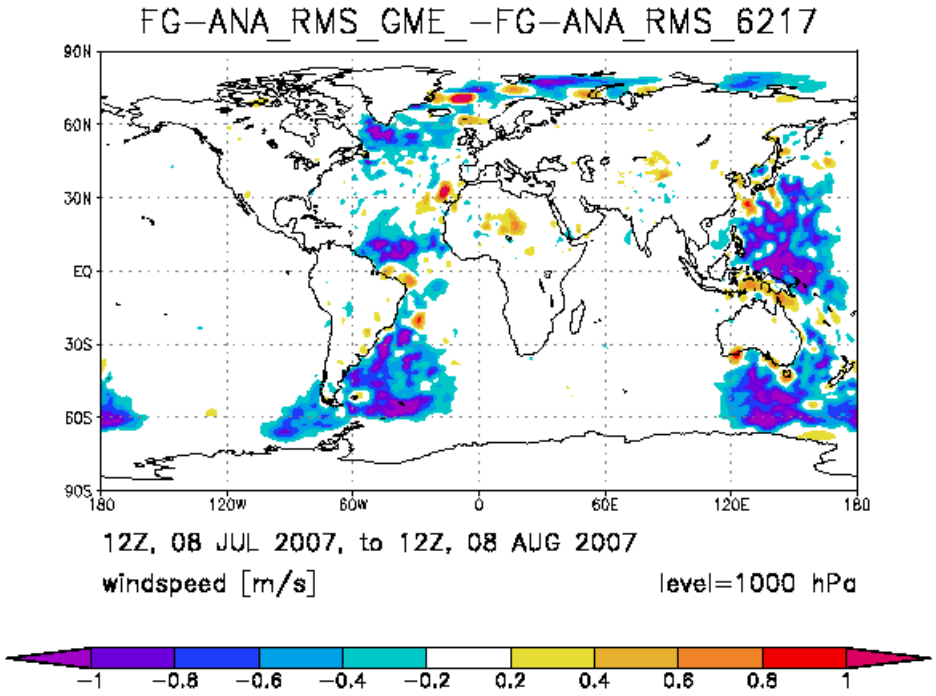


Monthly Mean Difference between Control (Routine) and Control + Ascat data
Date: 2007070812 - 2007080812

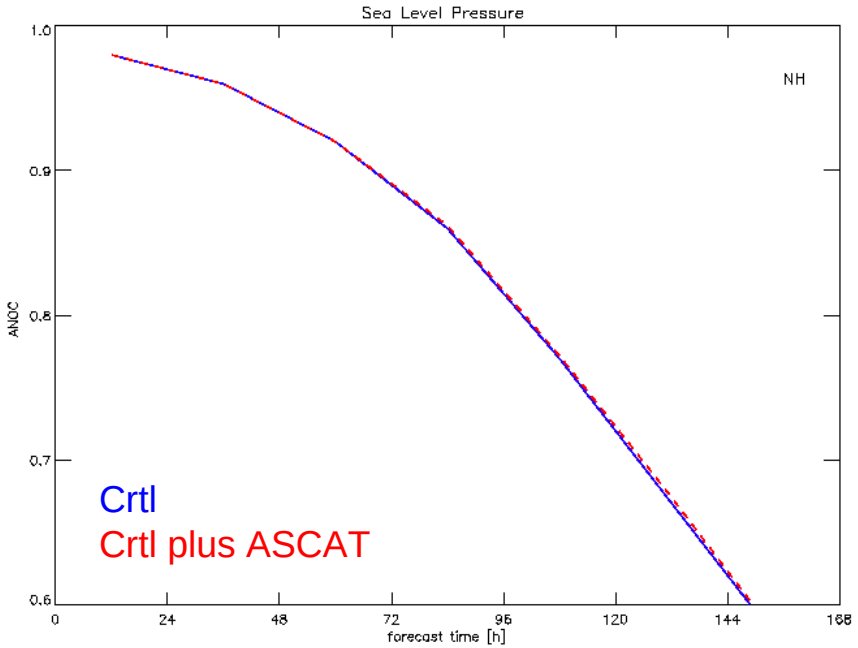
Difference of Analyses



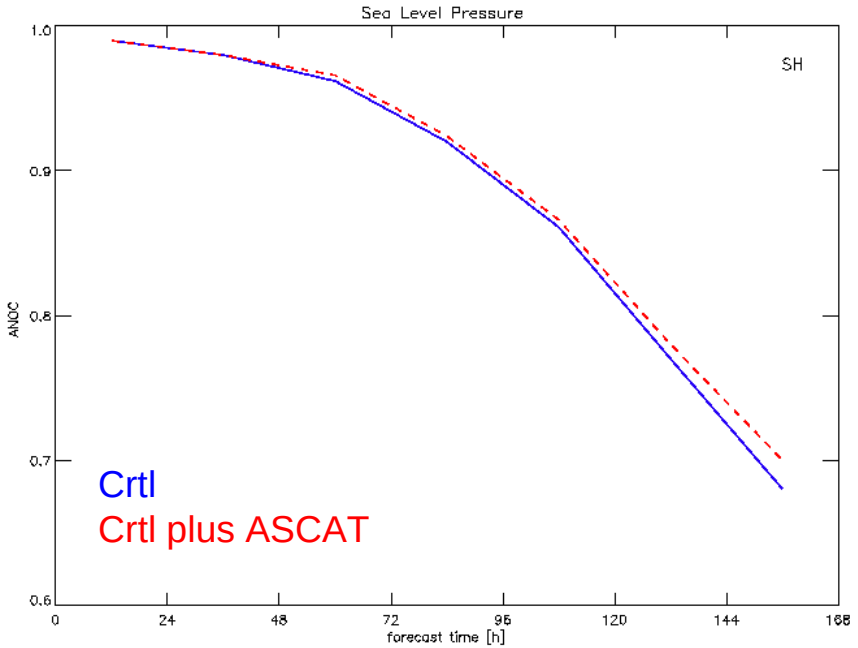
Difference of FG-ANA RMS



Anomaly correlation coefficient for sea level pressure
Period: 2007070812 – 2007080812

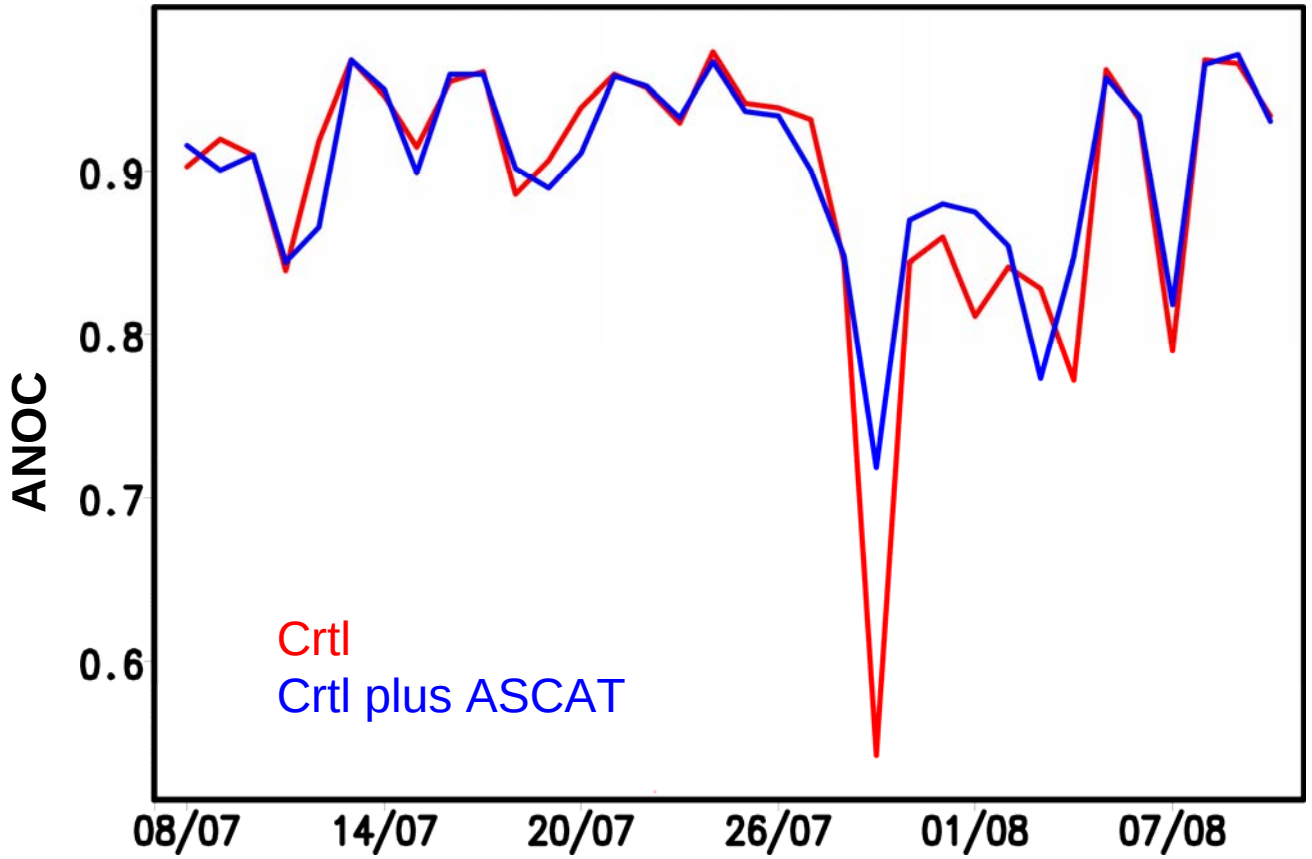


Northern Hemisphere

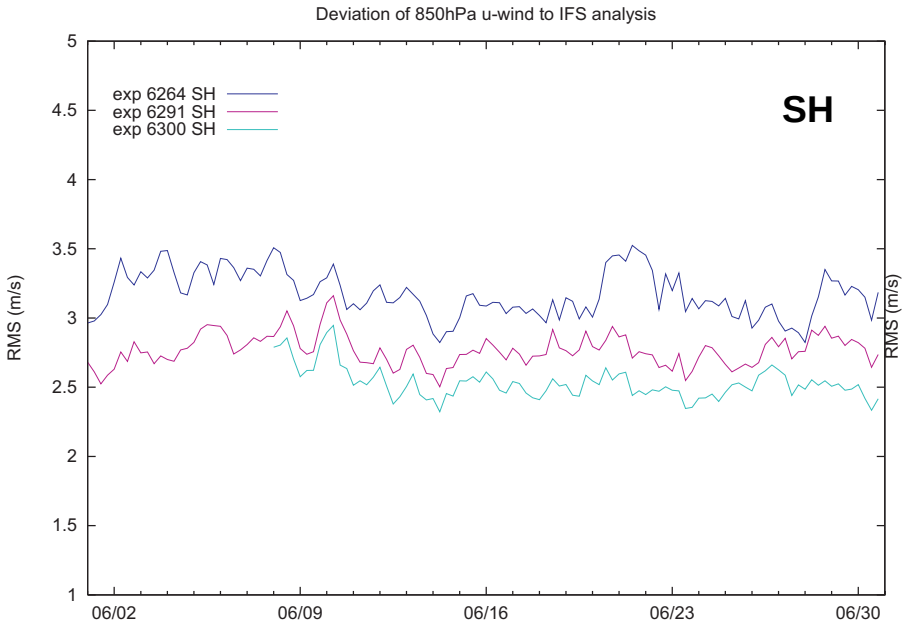


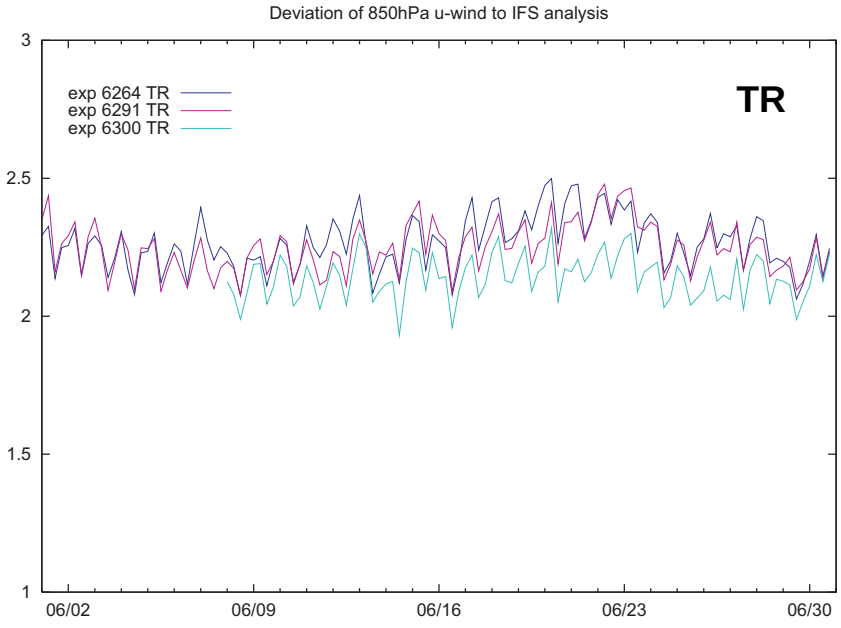
Southern Hemisphere

Time series of anomaly correlation coefficient for Europe
Mean sea level pressure VV=72h
Start of the forecasts 00 UTC



Deviation of u-wind component at 850 hPa of 3DVAR analysis to IFS analysis
Juni 2007
3DVAR with and without scatterometer data (QSCAT plus ASCAT)





Summary I

- Despite extensive use of satellite radiances AMV wind vectors still a valuable observing system for the global data assimilation system at DWD
- AMVs change the model background significantly over large parts of the tropical and subtropical ocean areas
- The eastward zonal flow is decelerated over the tropical pacific
- Decreased wind speed analyses in the stratocumulus inversion regions over the Pacific and Atlantic oceans
- Negative impact of not using AMV wind vectors is most predominant on the southern hemisphere and in the Tropics
- Slightly positive benefit on both hemispheres using MET-8/9 winds in place of Met-7 AMVs

Summary II

- No negative impact was found by replacing GEOS10 and MET-5 winds by wind vectors from GOES11 or MET-5
- A positive impact of MTSAT-1R was assessed after a change in height assignment took place in 2007
- QI Index very helpful to filter out bad data
- MODIS winds have a positive impact on the analysis over the Artic and Antarctic area
- Positive forecast impact of MODIS winds on both Hemispheres
- Direct broadcast winds very helpful to get polar winds earlier due to early cut-off time of the main forecast run

Summary III

- 10 Meter wind vectors of ASCAT can be used in all weather conditions.
- Rain flag algorithm of KNMI successful to eliminate rain contaminated QuikScat data
- ASCAT data smaller bias than QuikScat data. Therefore no bias correction
- Scatterometer data have positive impact on single analyses/forecasts
- General small positive impact on forecast quality for both Hemispheres, predominantly on the Southern Hemisphere
- Use of ASCAT data improved the forecast of a deep low pressure system off the Irish coast substantially
- Small structures are difficult to analyses due to broad scale error correlation functions