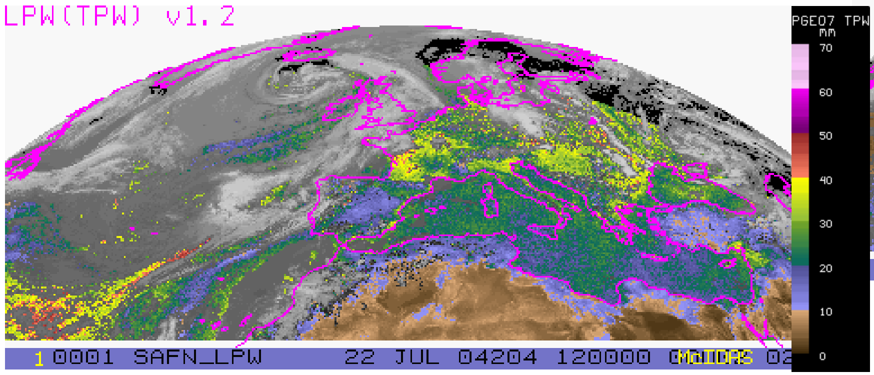
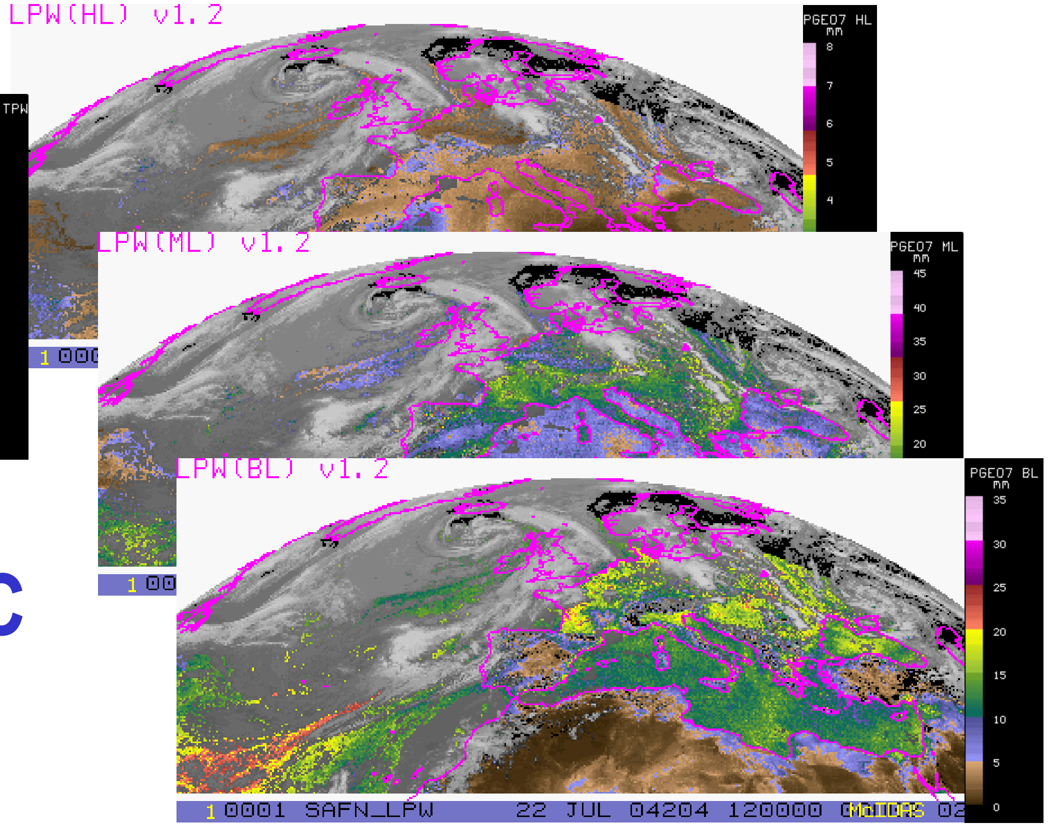
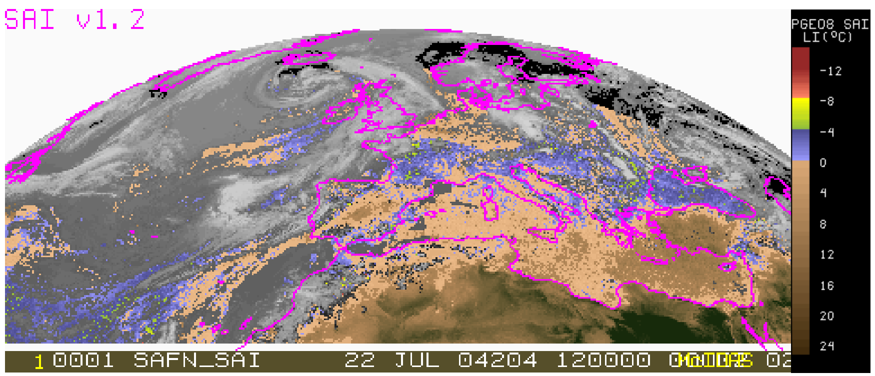




VALIDATION OF SAFNWC PGE07(LPW) and PGE08(SAI)



M.A. Martínez & M. Velázquez

INM(SPAIN)

Product Assessment Review (PAR) Workshop
(Madrid, 17-18-19 October 2005)

INDEX

- FRAMEWORK

- VALIDATION:
  - ECMWF (LPW_BL,LPW_ML,LPW_HL,LPW_TPW & SAI_LI)
  - RADIOSONDE (LPW_BL,LPW_ML,LPW_HL,LPW_TPW & SAI_LI)
  - GPS (LPW_TPW)

- FINAL CONCLUSIONS

GOALS

- Compare the precipitable water and Lifted Index obtained applying the LPW and SAI SAFNWC algorithm with independent measurements/estimations.

- Detect problems in the SAFNWC LPW and SAI algorithms in order to improve the algorithms.

Advantages of SEVIRI for retrieving the precipitable water and lifted index

✓ **The spatial resolution** ⇒ 3 km at nadir
versus
GOES sounder ⇒ 10-km
HIRS ⇒ 19-km
AIRS ⇒ 15-km

✓ **The temporal resolution** ⇒ it takes one full resolution image every 15 minutes (continuous monitoring).

➢ The spectral range, the spatial resolution (3 km in the IR bands in nadir), and a cycle of 15 minutes enable it to observe the earth's atmosphere and continuously monitor changes.

Disadvantage of SEVIRI for retrieving the precipitable water and lifted index

- The spectral resolution

  ✓ The sounder radiances have higher spectral resolution and therefore contain more information about the atmospheric vertical distribution of moisture.

  ✓ Because of the limited spectral resolution of SEVIRI, the Layer Precipitable Water is constituted by integrated vertical layers (as opposed to vertical profiles obtained with sounders).

Main SAFNWC requirements

EUMETSAT Satellite Application Facilities for Nowcasting and Very Short Range Forecasting (SAFNWC)

- Near Real Time (NRT)
- Full resolution (3km x 3km at Nadir)
- Frequency to be selected by the user (default every repeat cycle, 15 minutes)
- Region to be selected by the user
- Based in observations

SAFNWC/MSG Products

No.	Product Name (Acronym)	Characteristics	Institute	
1	**Cloud Mask and Cloud Amount** (CMa)	ICloud products	MF	
2	Cloud Type (CT)	Cloud products	MF	
3	Cloud Top Temperature/ Height (CTTH)	Cloud product	MF	
4	Precipitating Clouds (PC)	Precipitation product	SMHI	
5	Convective Rainfall Rate (CRR)	Precipitation product	INM	
6	Total Precipitable Water (TPW)	Air mass product	INM	
7	**Layer Precipitable Water** (LPW)	Air mass product	INM	PGE07
8	**Stability Analysis Imagery (SAI)**	Air mass product	INM	PGE08
9	High resolution Wind from HRVIS (HRW)	Wind product	INM	
10	Automatic Satellite Image Interpretation (ASII)	Thunderstorm product	ZAMG	
11	Rapidly Developing Thunderstorm (RDT)	Conceptual Models product	MF	
12	**Air Mass Analysis** (AMA)	Air mass products	ZAMG	

Air Mass Products: TPW, LPW, SAI and AMA.

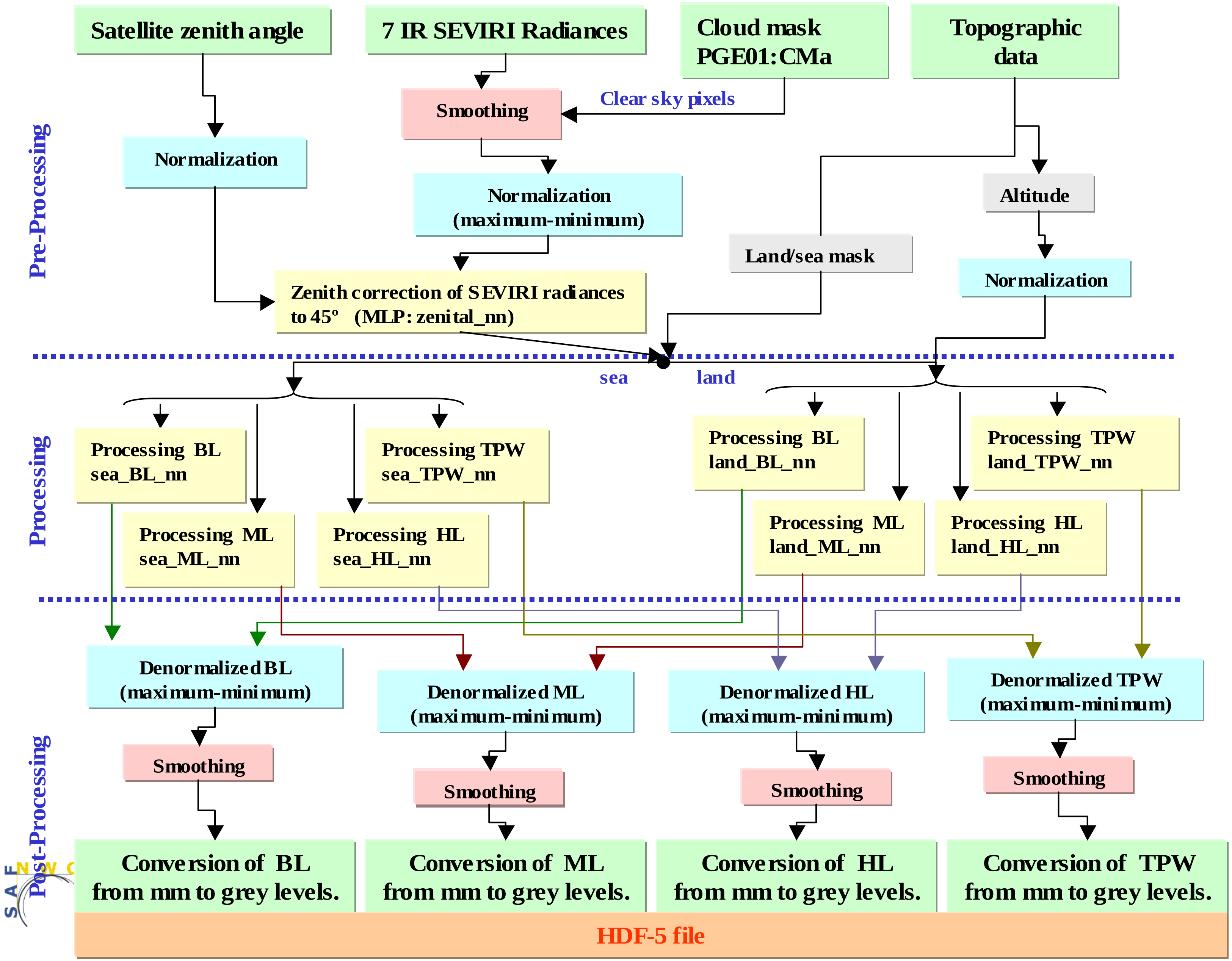
Main PGE07_LPW outputs

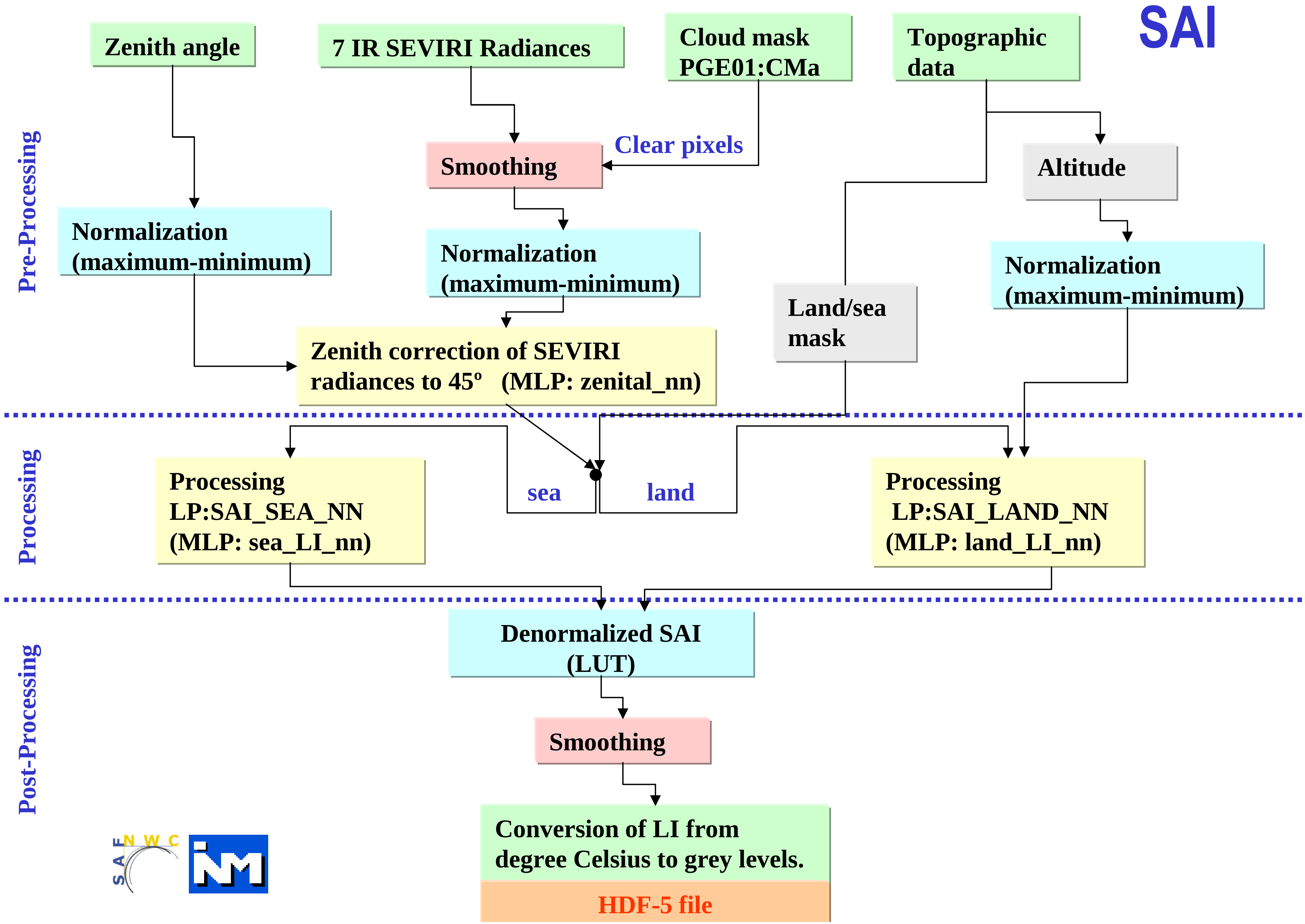
✓ **Water Vapour contained in a vertical column of unit cross-section in 3 layers in the troposphere and in the total.**

LPW Parameter	Bottom level	Top level
LPW(BL)	P_{SFC}	840 hPa
LPW(ML)	840 hPa	437 hPa
LPW(HL)	437 hPa	0 hPa
LPW(TPW)	P_{SFC}	0 hPa

NOTE: SEVIRI retrievals of atmospheric water vapor are intended to help in the analysis of preconvective scenes since numerical weather prediction models and conventional meteorological observations are sparse.

LPW algorithm




SAI
Pre-Processing
Processing
Post-Processing
Zenith angle
7 IR SEVIRI Radiances
Cloud mask PGE01:CMa
Topographic data
Clear pixels
Smoothing
Altitude
Normalization (maximum-minimum)
Normalization (maximum-minimum)
Normalization (maximum-minimum)
Land/sea mask
Zenith correction of SEVIRI radiances to 45° (MLP: zenital_nn)
Processing LP:SAI_SEA_NN (MLP: sea_LI_nn)
sea
land
Processing LP:SAI_LAND_NN (MLP: land_LI_nn)
Denormalized SAI (LUT)
Smoothing
Conversion of LI from degree Celsius to grey levels.
HDF-5 file

Improvements in version 1.1 (October 2004)

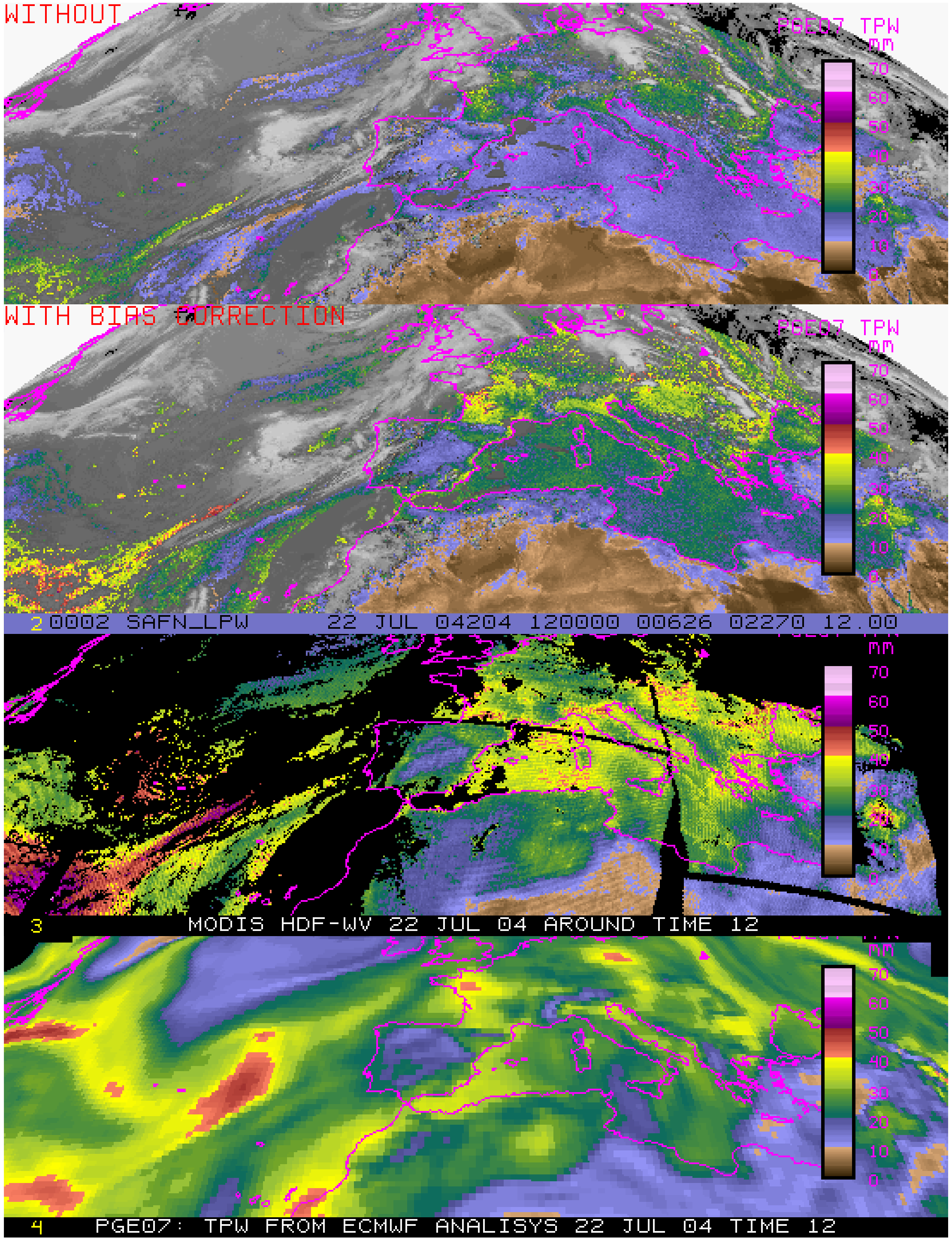
- ✓ Due to the high dispersion of the simulated radiances versus observed radiances a direct adjustment is not adequate.

- ✓ So it was designed a radiances bias estimation method. (Presented in SPIE EUROPE 2004)

- ✓ There are different ways to introduce the bias estimation in the SAFNWC LPW and SAI algorithms. The more simple of them is to use the bias to modify the maxima and minima included in the configuration file. The old maxima and minima (included in the v1.0 configuration files) were obtained from simulated radiances. In v1.1 and v1.2 they were changed by new maxima and minima: these are calculated so that the bias radiances correction and the RTTOV normalization are performed in the same step.

IMPACT OF THE BIAS RADIANCES CORRECTION

(22-07-2004 at 1200 GMT)



LPW(TPW) MSG SAFNWC before radiances bias correction v1.0

Included in version 1.1 since October 2004

LPW(TPW) MSG SAFNWC after bias radiances correction v1.1/v1.2

TPW from MODIS/TERRA (MOD07_L2)

TPW from ECMWF analysis

Improvements in SAI version 1.2 (May 2005)

- SAI v1.0 presented a narrow dynamic range.
- SAI v1.1, after bias radiances correction, remains a narrow dynamic range.
- In SAI v1.2, the dynamic range is wider, due to the training of the SAI neural networks with the new T_{500} perturbed dataset. (The training dataset was built adding +0.25ºC , 0ºC and -0.25 ºC to the temperature of the 29th(478.5hPa) and 30th(521.6hPa) RTTOV-7 levels for all profiles contained in SSDB+60L-SD dataset).

LPW and SAI subjective validation

- ✓ The SEVIRI LPW and SAI parameters are regularly computed in near real time, using SAFNWC software package installed in the INM NWCSAF/MSG Reference System.
- ✓ The products are displayed routinely and a subjective evaluation is done, allowing to identify existing deficiencies and to find the potential causes (equivalent parameters coming from ECMWF analysis and radio-sounding observations are analyzed and compared with SAFNWC LPW and SAI parameters using INM McIDAS environment).

Sources used in the LPW and SAI objective validation

⇒The validated SEVIRI area is denoted as MSGN and it is formed by 2200x1019 pixels.

✓For all LPW and SAI parameters:

- ECMWF analyses (00 and 12 UTC) from July 2004 to June 2005.
- Radiosonde (RS) from July 2004 to June 2005.

✓For LPW_TPW:

- GPS estimations of Integrated Water Vapor (IWV) from 17 May to 23 July 2005. (Presented in SPIE EUROPE 2005)

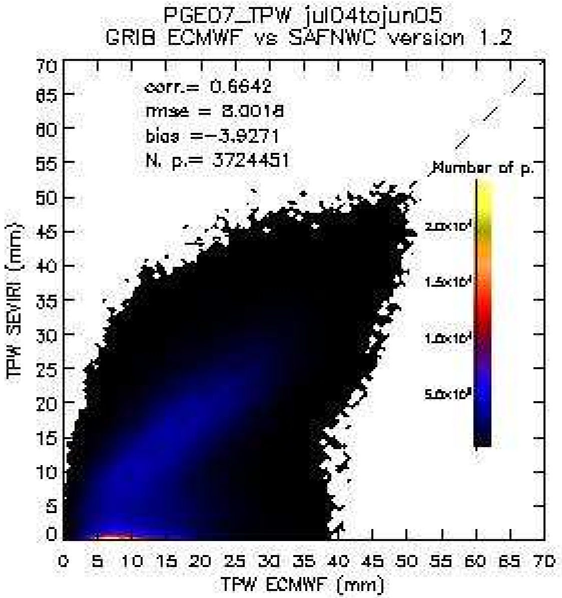
COMPARISON WITH ECMWF ANALYSIS

LPW and SAI validation with ECMWF analysis profiles

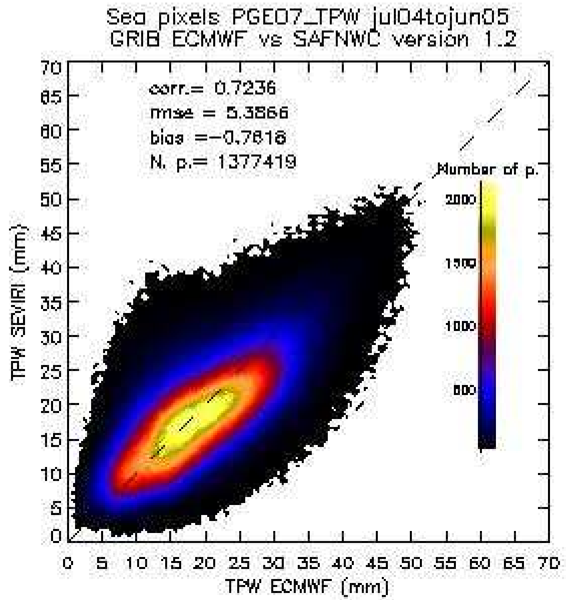
- ECMWF analyses (00 and 12 UTC) from July 2004 to June 2005. The region downloaded from MARS/ECMWF is defined by the corners (70ºN, 40ºW) and (28ºN, 40ºE), with a grid step of 0.5º.
- The ECMWF parameters are remapped to SEVIRI projection (2200 elements, 1019 lines). One every ten is extracted to build the validation dataset (220 elements, 101 lines).
- Only zenith angles lower than 70º are considered.
- LPW version 1.2 (equal to v1.1) has been reprocessed from July 2004 to June 2005 at 00 and 12 GMT.
- SAI version 1.2 has been reprocessed from July 2004 to June 2005 at 00 and 12 GMT.
- To separate clear and cloudy pixels, the CMa SAFNWC has been used.
- All pixels classify as clear are included in the validation dataset. (None additional constrains have been used to remove data).

2D-histogram (LPW_TPW)

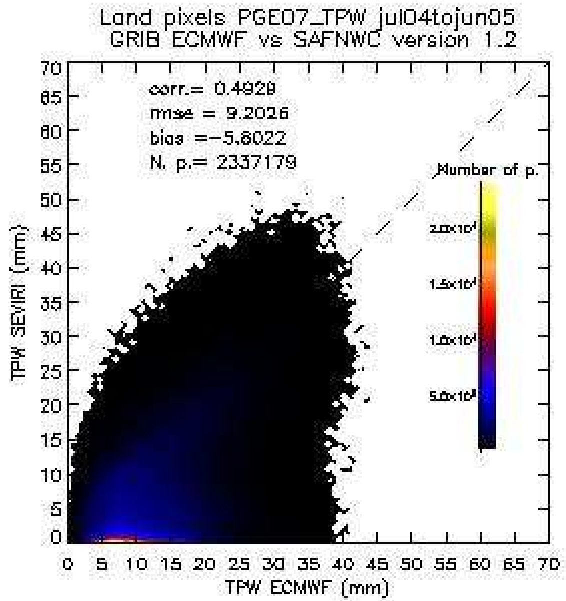
ALL PIXELS



Sea pixels

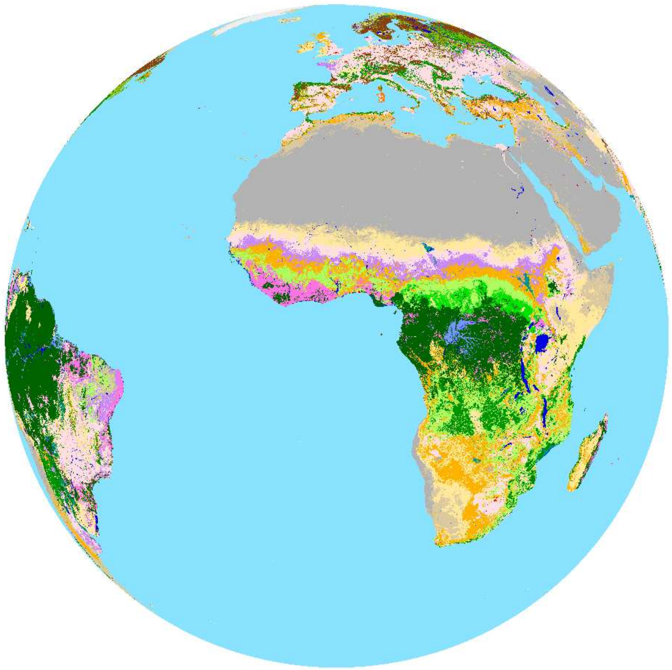


Land pixels



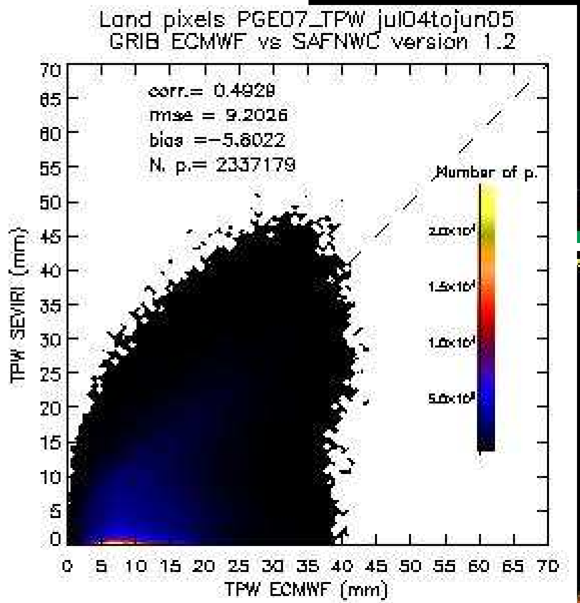
The bad behaviour in the 2D-histogram is due to land pixels.

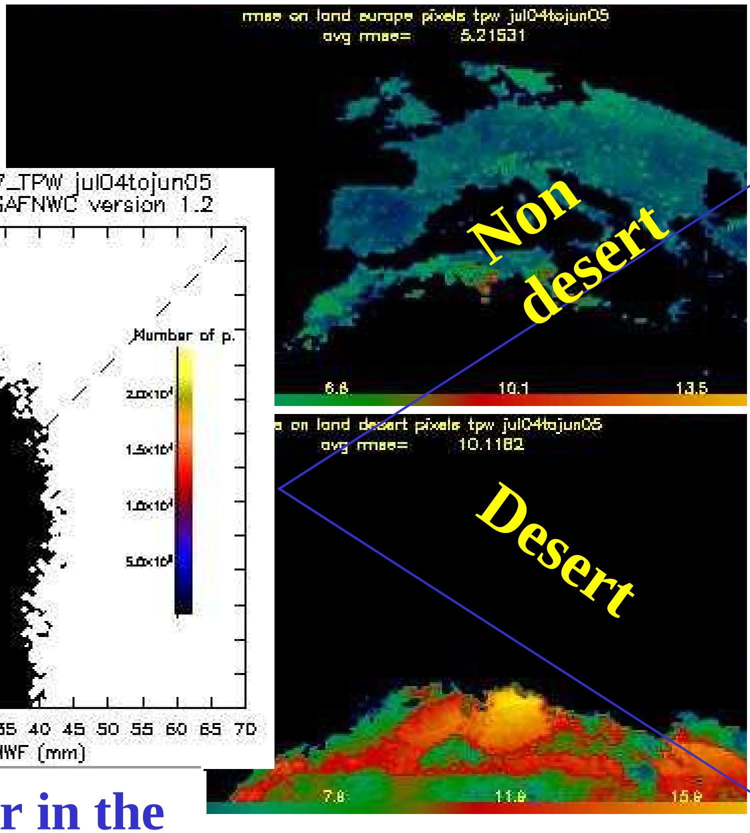
The Global Land Cover was supplied by the LANDSAF/MSG group of the Valencia University in a JPEG file. The file contains 25 classes of land cover, among them “bare areas” that includes dessert areas.

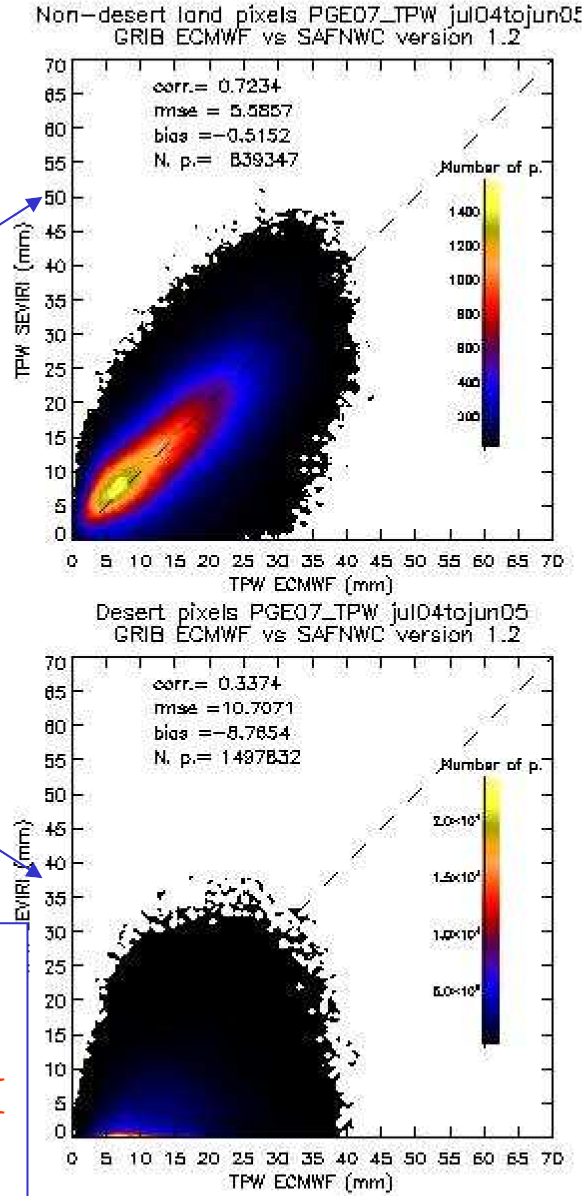


VALUE	CLASSNAMES
0	Ocean
1	Tree Cover, broadleaved, evergreen
2	Tree Cover, broadleaved, deciduous, closed
3	Tree Cover, broadleaved, deciduous, open
4	Tree Cover, needle-leaved, evergreen
5	Tree Cover, needle-leaved, deciduous
6	Tree Cover, mixed leaf type
7	Tree Cover, regularly flooded, fresh water
8	Tree Cover, regularly flooded, saline water
9	Mosaic: Tree Cover / Other natural vegetation
10	Tree Cover, burnt
11	Shrub Cover, closed-open, evergreen
12	Shrub Cover, closed-open, deciduous
13	Herbaceous Cover, closed-open
14	Sparse herbaceous or sparse shrub cover
15	Regularly flooded shrub and/or herbaceous cover
16	Cultivated and managed areas
17	Mosaic: Cropland / Tree Cover / Other natural vege
18	Mosaic: Cropland / Shrub and/or grass cover
19	Bare Areas
20	Continental Water Bodies
21	Snow and Ice
22	Artificial surfaces and associated areas
23	No data
24	"Coastal Water"
255	Space (outside of MSG disk)

Land pixels (LPW_TPW)







And the bad behaviour in the land 2D-histogram is due to desert pixels.

Desert areas presents non realistic results. Therefore, LPW and SAI v1.2 are not adequate for desert pixels.

Two different LPW and SAI SAFNWC dataset have been built depending of the CMa

- **Denoted as system reference:** the CMa that runs in the reference system is used, therefore ECMWF forecast fields were used to obtain CMa (since 17May 2005 CMa v1.2).

- **Denoted as v1.2:** the CMa has been reprocessed using the CMa software v1.2. The CMa v1.2, has been reprocessed from July 2004 to June 2005 at 00 and 12GMT, using ECMWF analysis fields.

LPW and SAI statistical parameters (Jul/04-Jun/05) depending of the CMa

✓ For all parameters (BL,ML,HL, TPW and LI) :

- The correlation coefficient increases weakly when the CMa version 1.2 using analysis is used.
- The rms decreases weakly when the CMa version 1.2 is used.
- The 2D-histograms present better behaviour when the CMa version 1.2 is used.

LPW_BL statistical parameters with different CMas

Reference system	V1.2

Correlation

Reference system	V1.2
0.6914	0.7013

rms (mm)

Reference system	V1.2
3.1564	3.1343

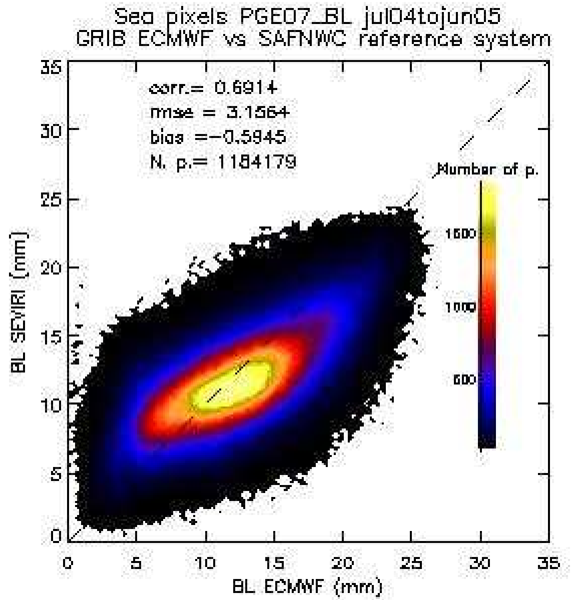
Correlation

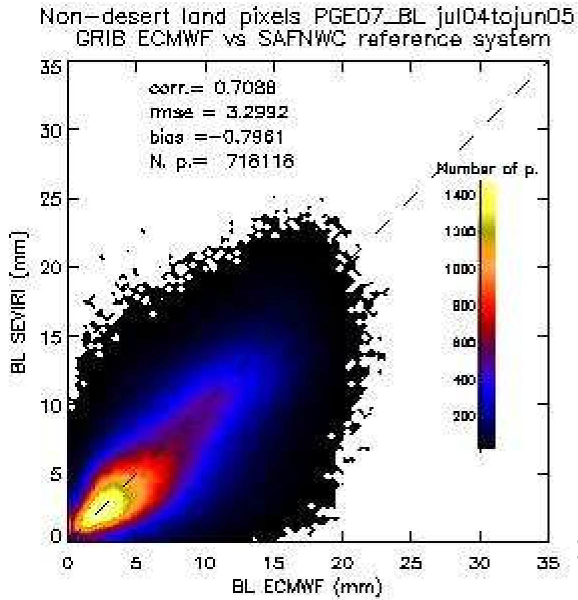
Reference system	V1.2
0.7088	0.7058

rms (mm)

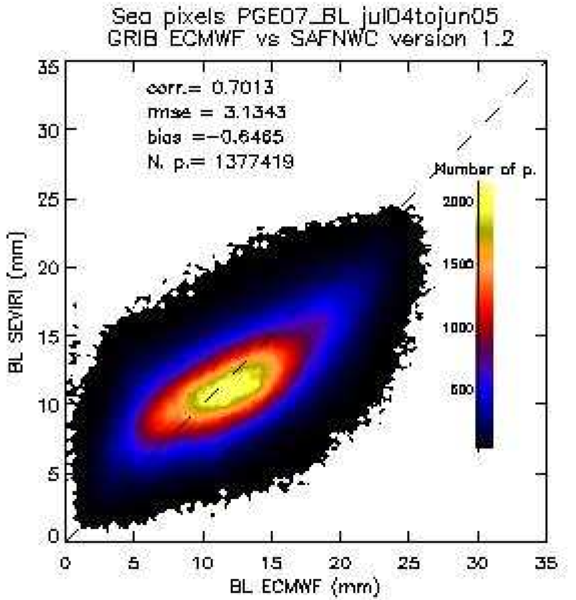
Reference system	V1.2
3.2992	3.2756

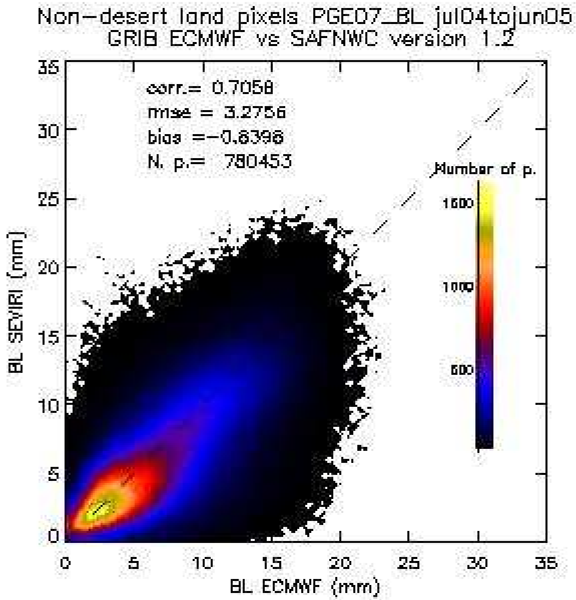
Reference system





V1.2



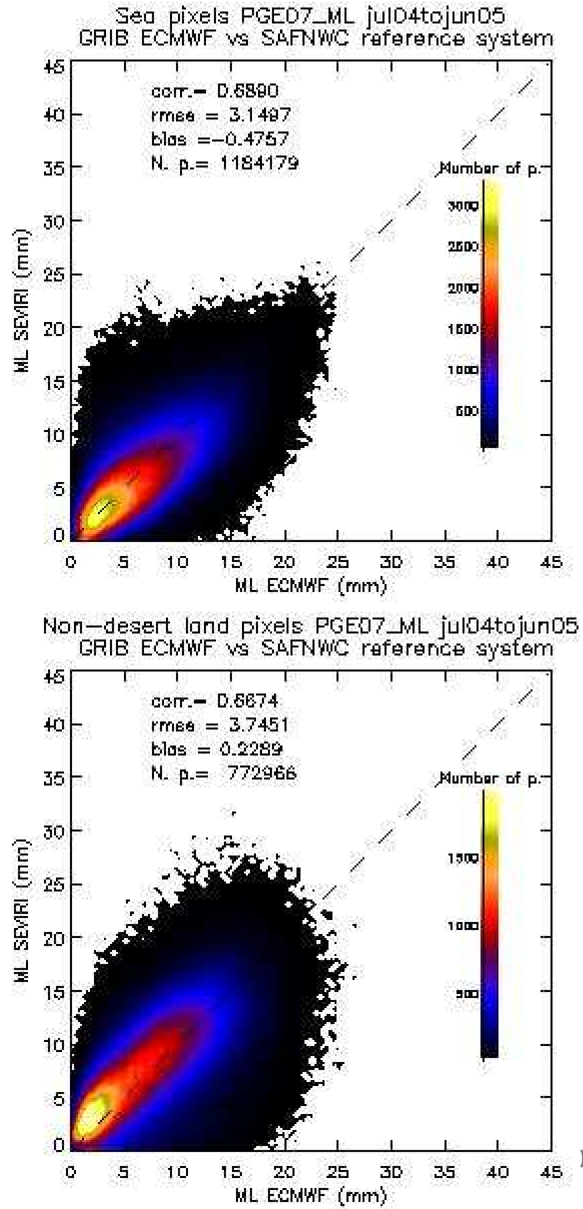


Produ

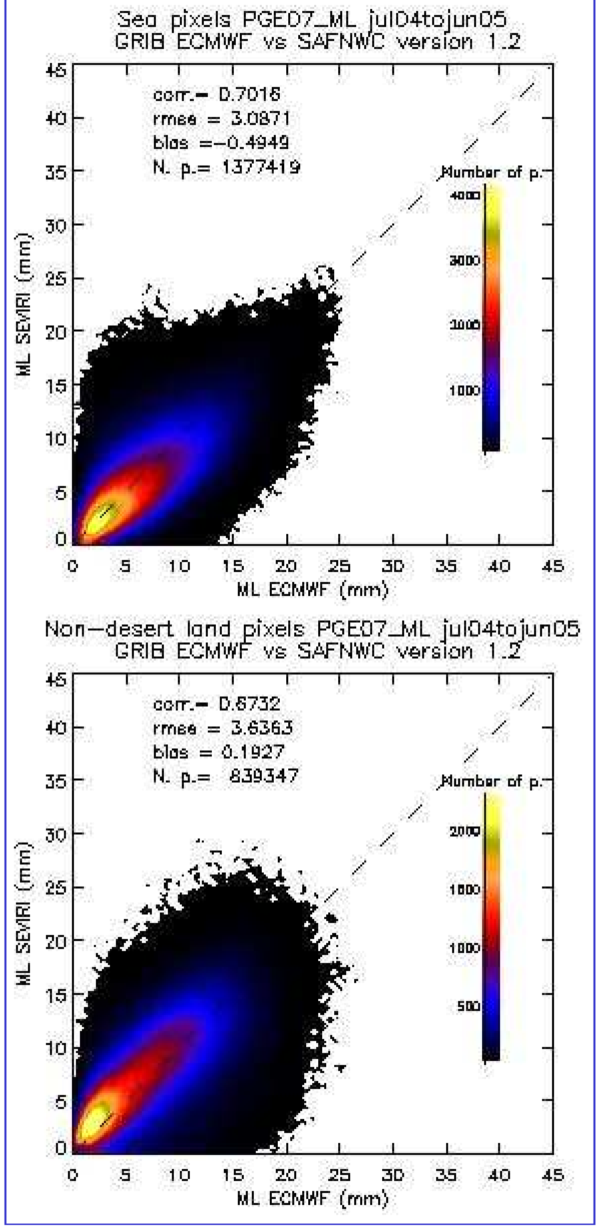
LPW_ML statistical parameters with different CMas

Reference system	V1.2
Correlation	
0.6890	0.7016
rms (mm)	
3.1497	3.0871
Correlation	
0.6674	0.6732
rms (mm)	
3.7451	3.6363

Reference system



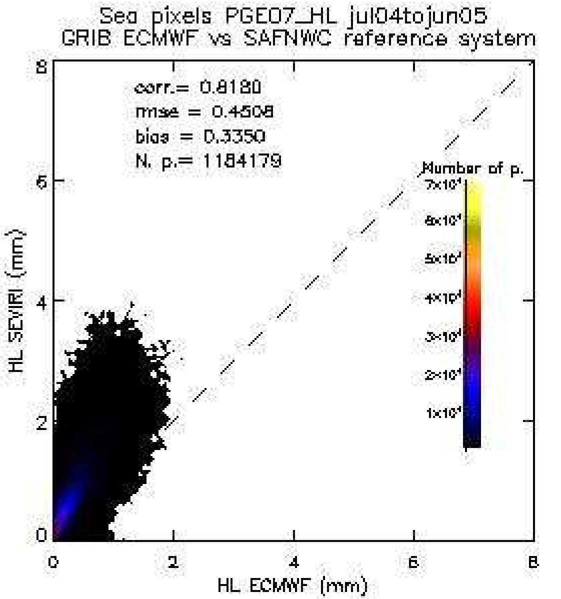
V1.2

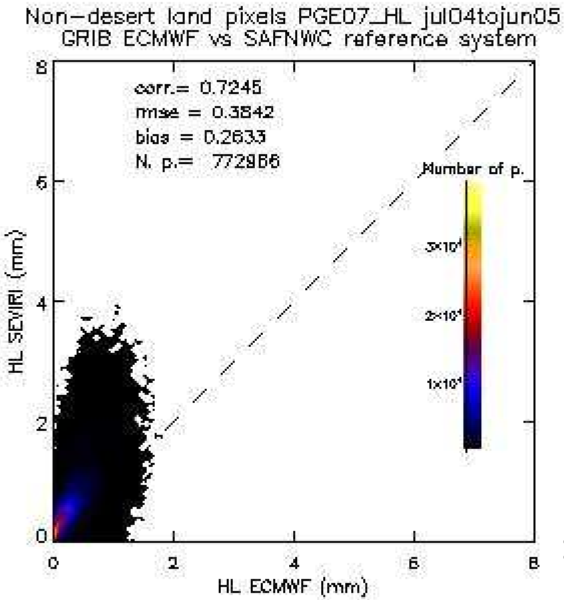


LPW_HL statistical parameters with different CMas

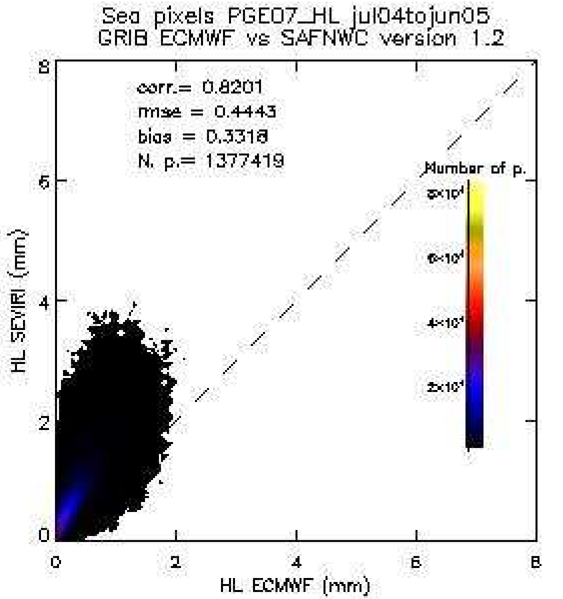
Reference system	V1.2
Correlation	
0.8180	0.8201
rms(mm)	
0.4508	0.4443
Correlation	
0.7245	0.7340
rms(mm)	
0.3842	0.3658

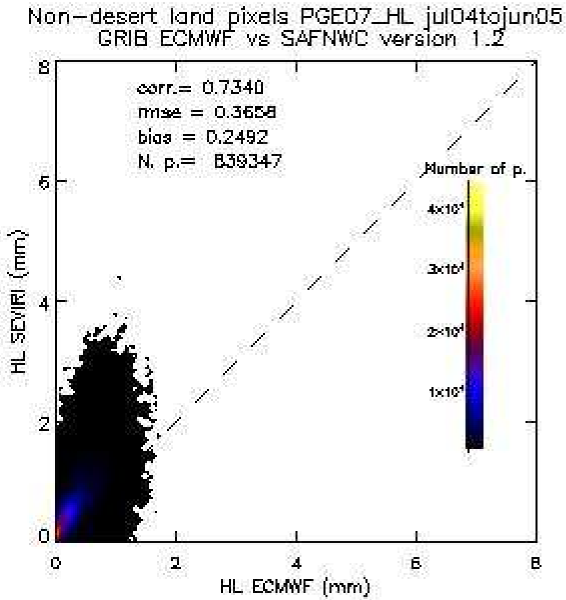
Reference system





V1.2

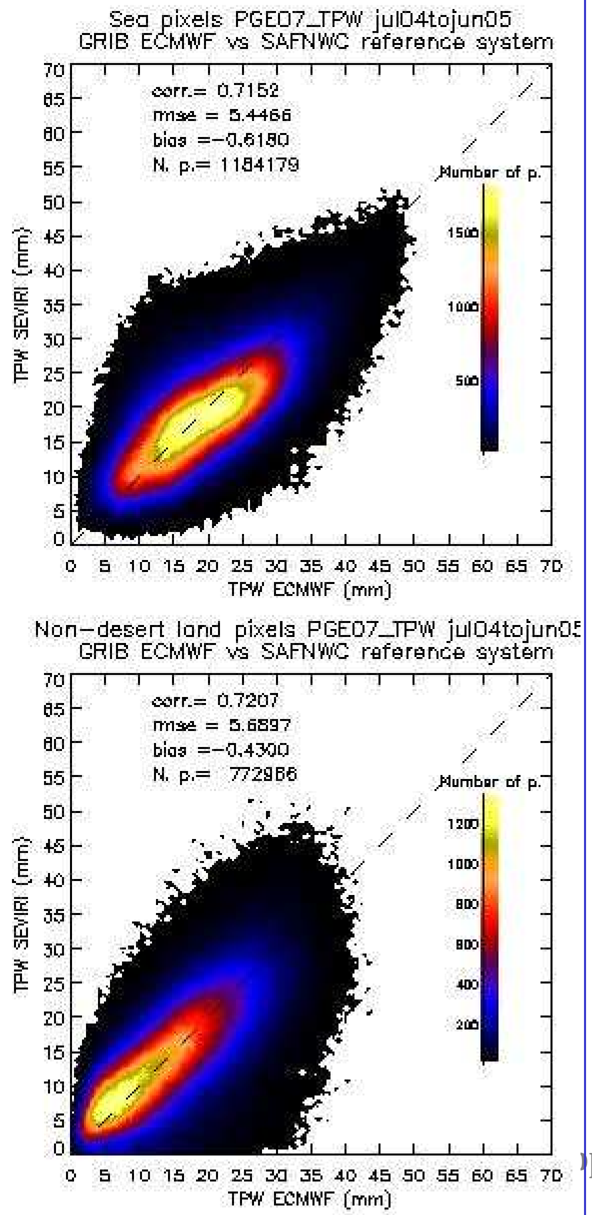




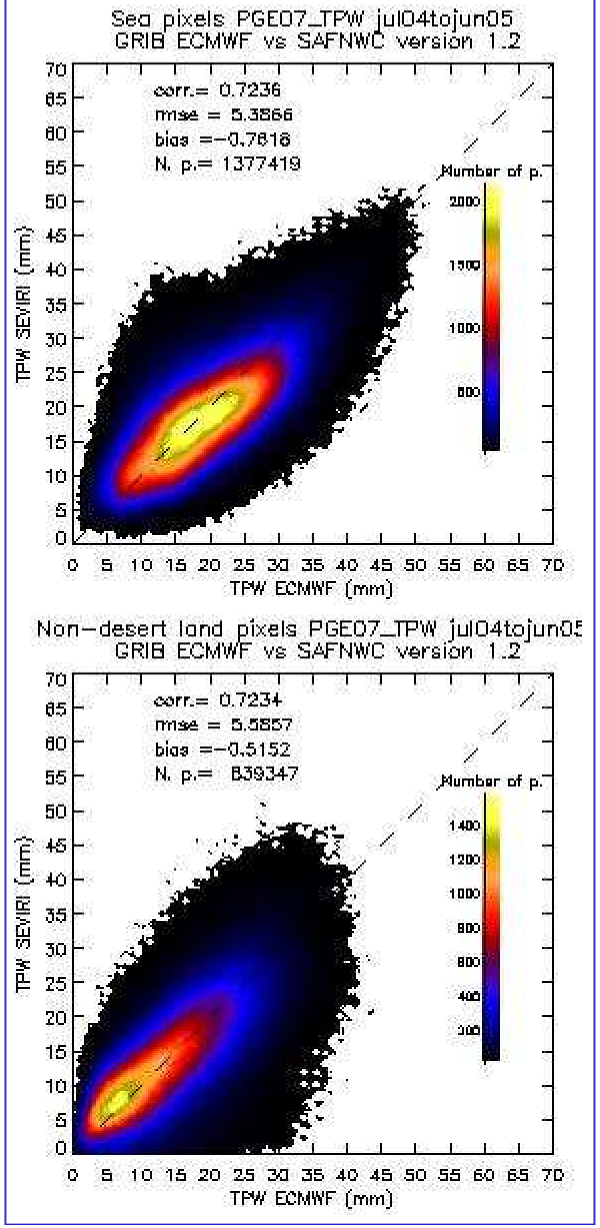
LPW_TPW statistical parameters with different CMas

Reference system	V1.2
Correlation	
0.7152	0.7236
rms(mm)	
5.4466	5.3866
Correlation	
0.7207	0.7234
rms(mm)	
5.6897	5.5857

Reference system



V1.2



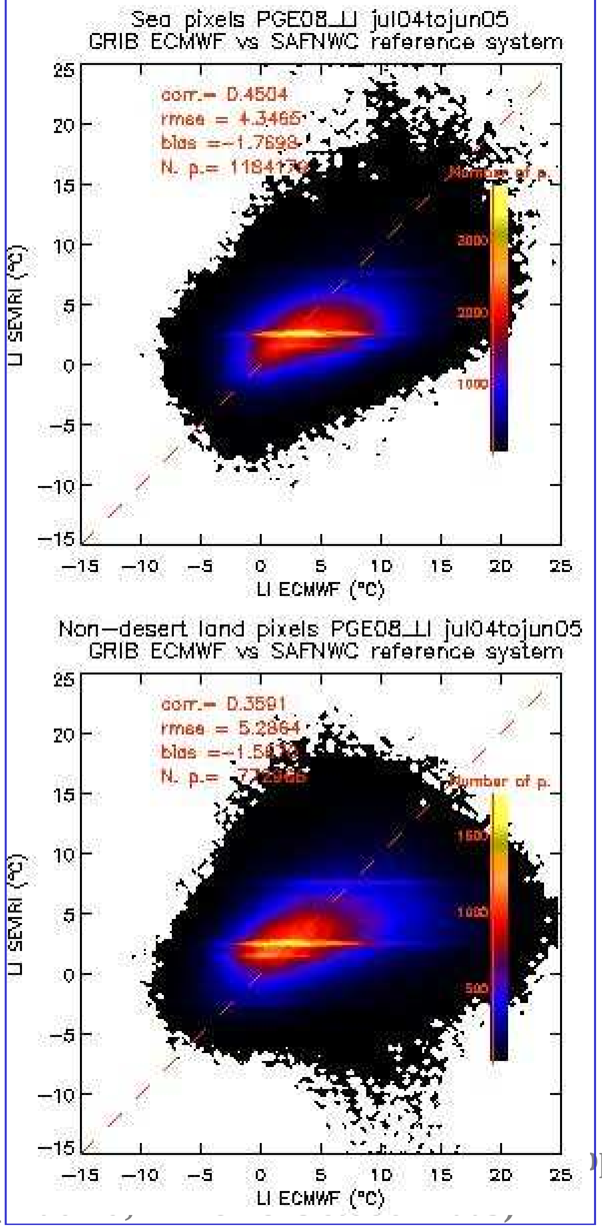
Produ

SAI_LI statistical parameters with different CMas

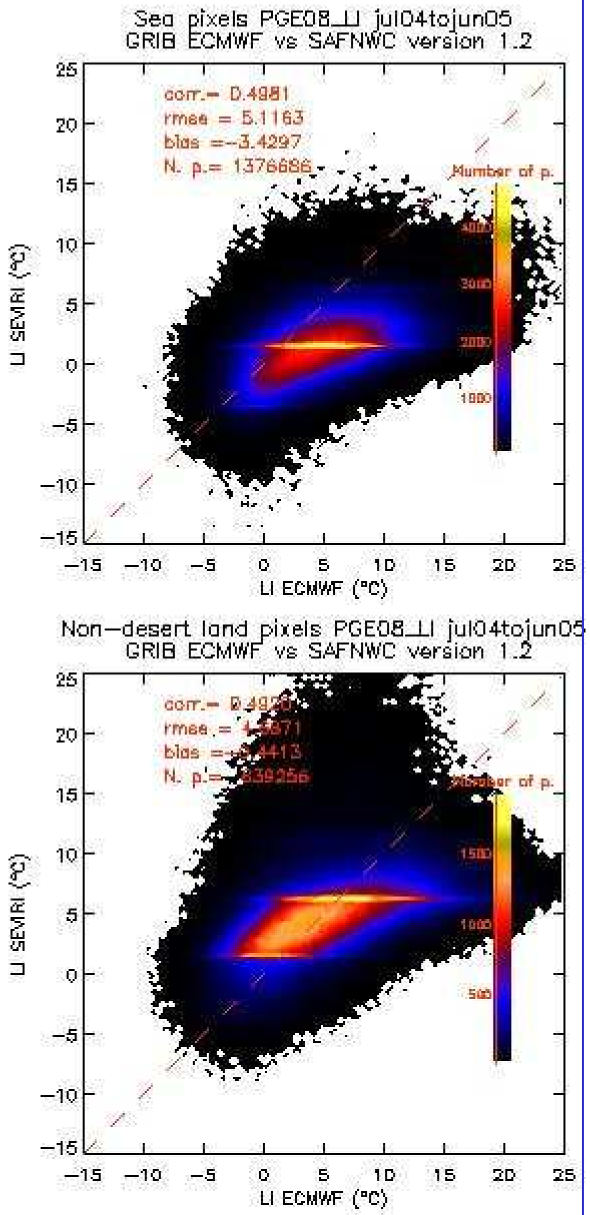
Reference system	V1.2
Correlation	
0.4504	0.4981
rms(ºC)	
4.3465	5.1163
Correlation	
0.3591	0.4920
rms(ºC)	
5.2864	4.6871

Produ

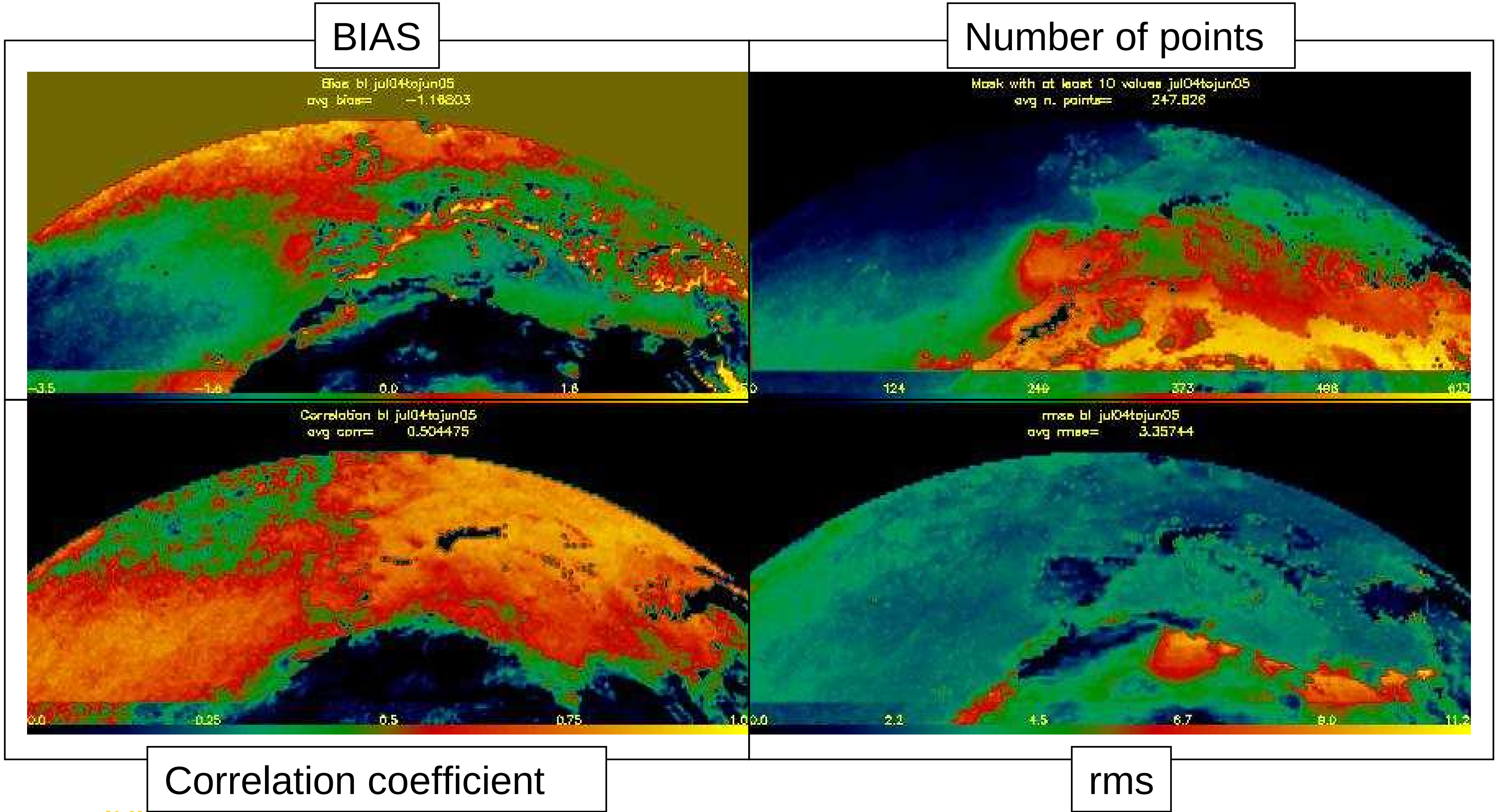
Reference system



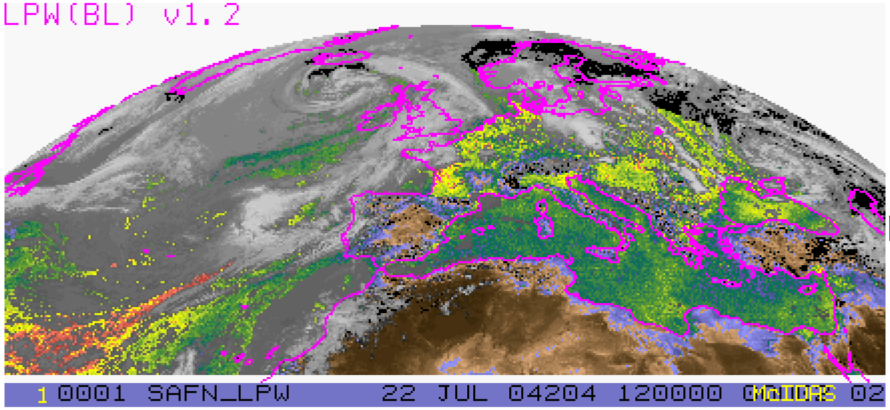
V1.2



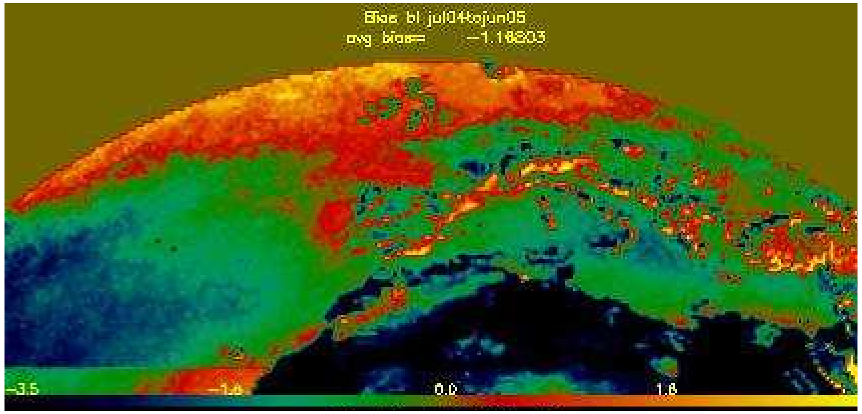
Spatial behaviour of the LPW_BL statistical parameters (Jul/04-Jun/05)



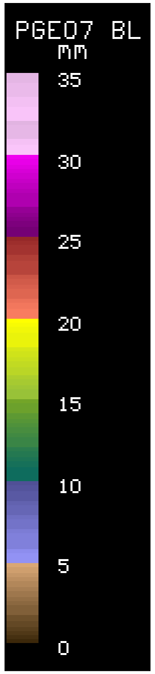
LPW_BL after bias removal

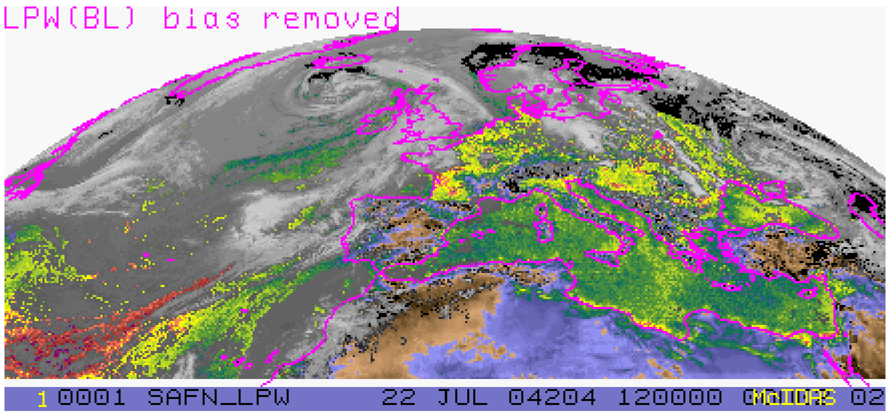


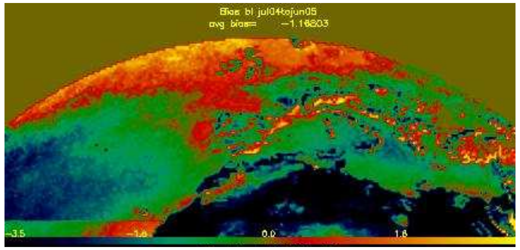
minus



equal







LPW_BL 2D-histograms without and with bias removed

With bias removed:

✓ **Correlation increase**

Sea:

0.7013 → **0.7572**

Land (non-desert):

0.7058 → **0.8420**

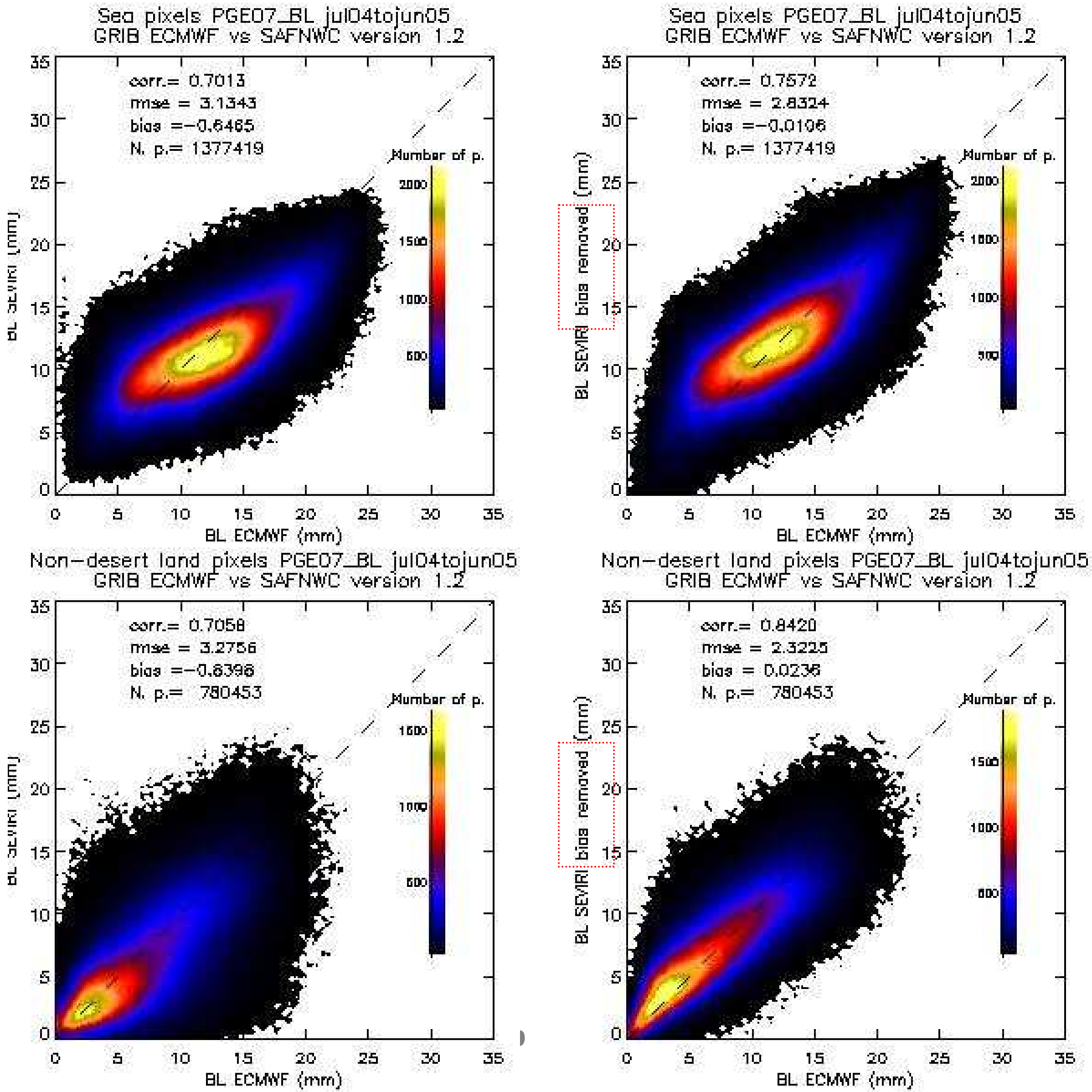
✓ **rms(mm) decrease**

Sea:

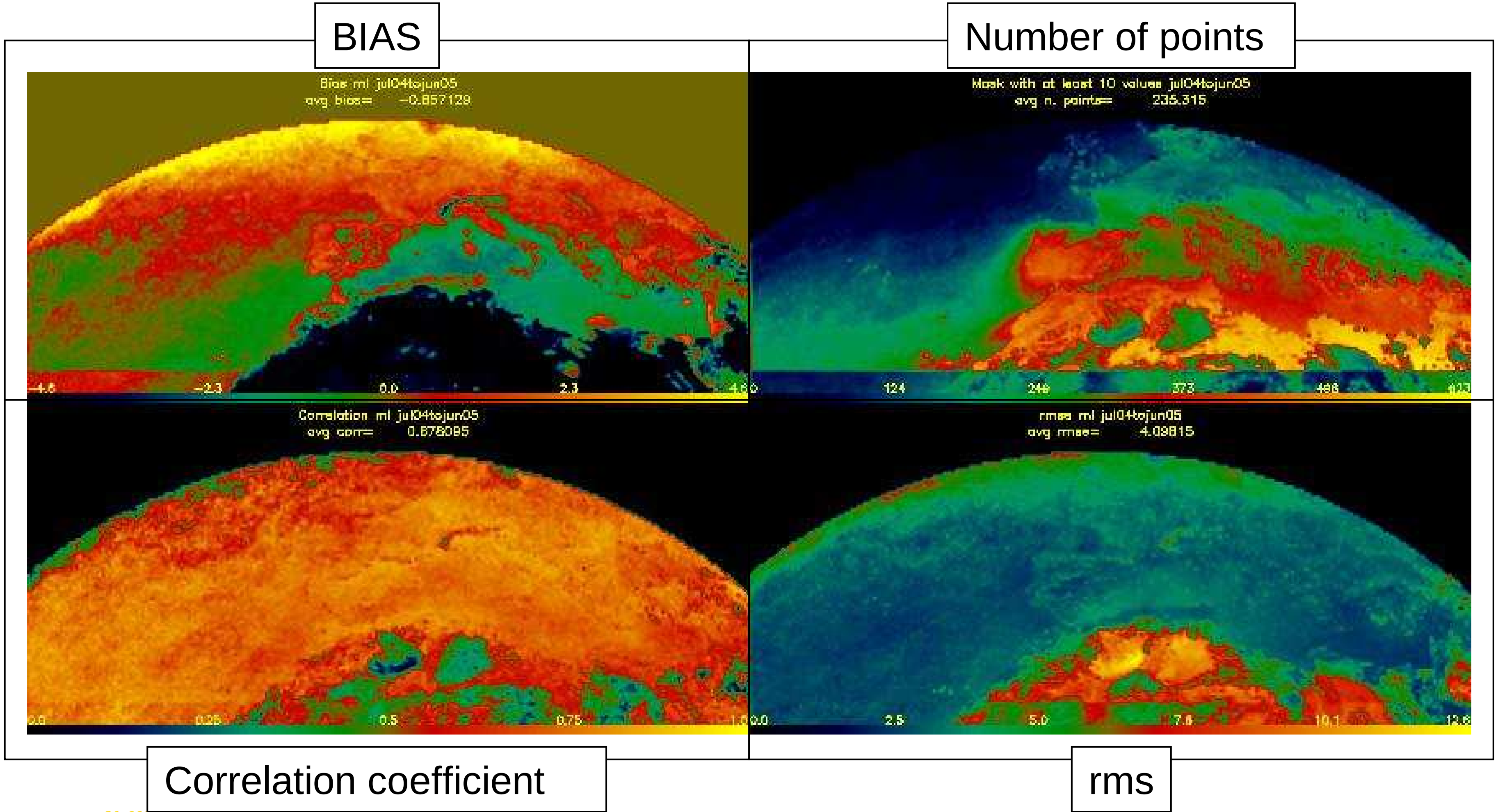
3.1343 → **2.8324**

Land (non-desert):

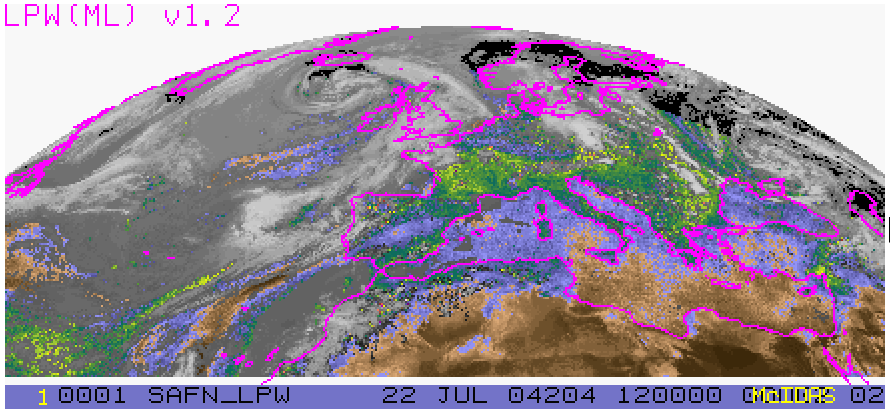
3.2756 → **2.3225**



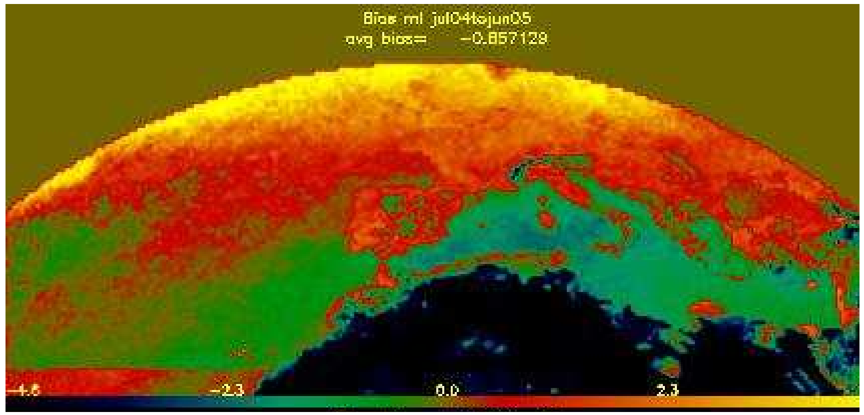
Spatial behaviour of the LPW_ML statistical parameters (Jul/04-Jun/05)



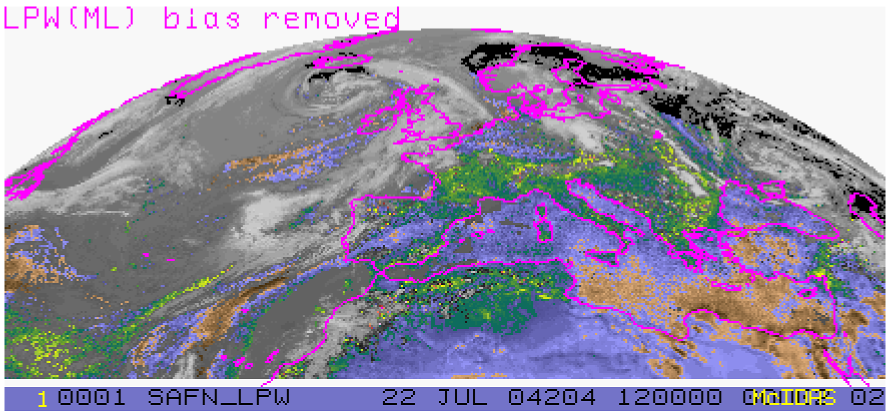
LPW_ML after bias removal

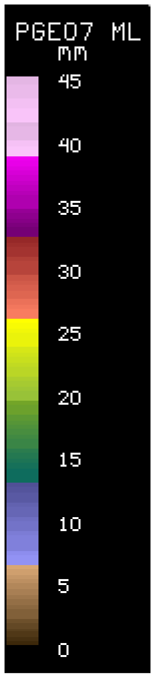


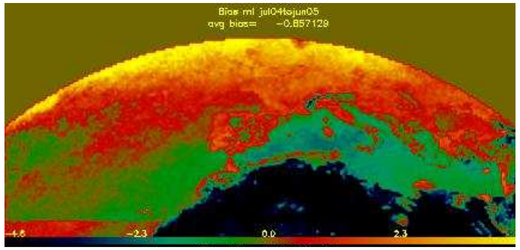
minus



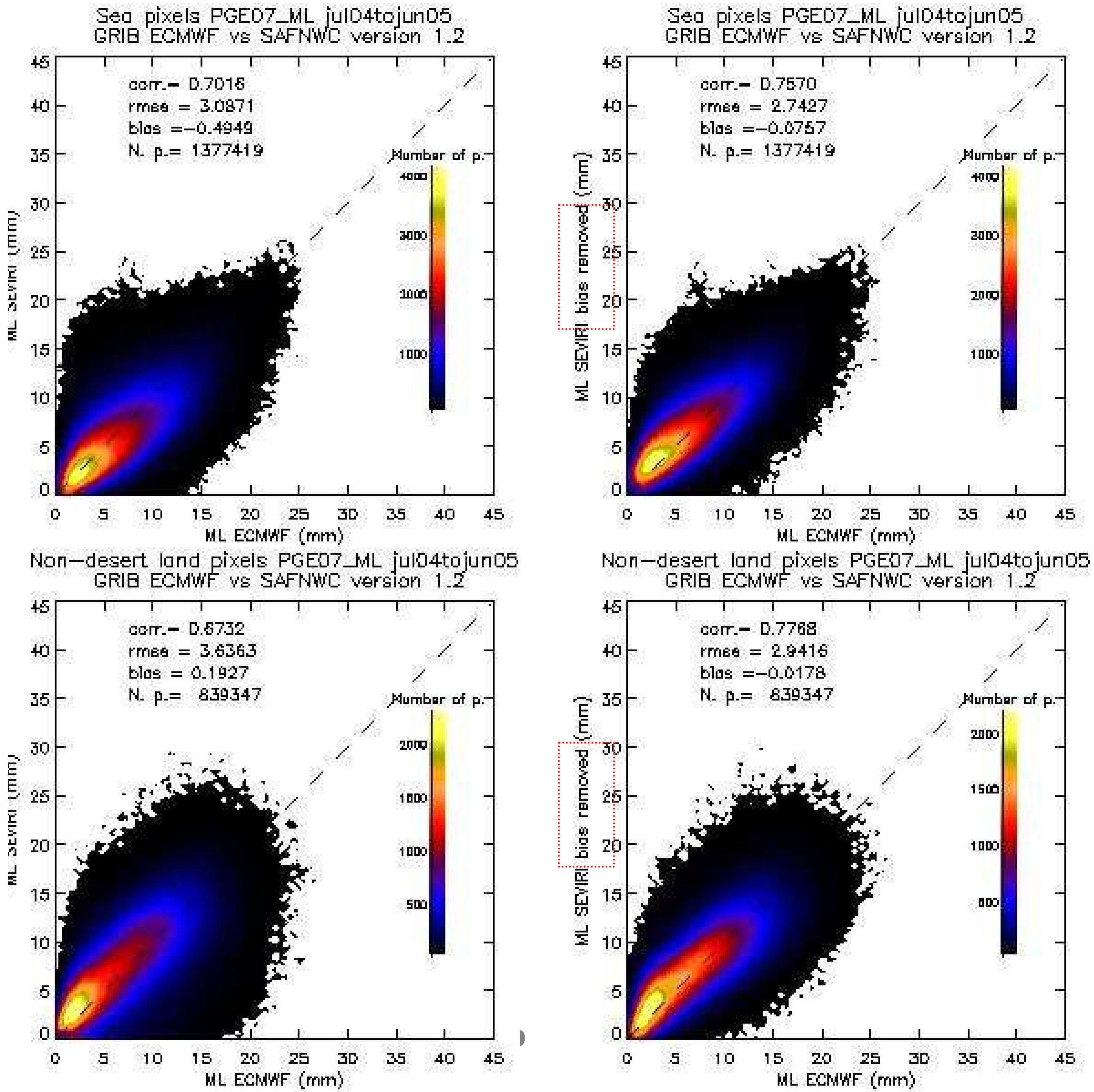
equal







LPW_ML 2D-histograms without and with bias removed



With bias removed:

✓ **Correlation increase**

Sea:

0.7016 → 0.7570

Land (non-desert):

0.6732 → 0.7768

✓ **rms(mm) decrease**

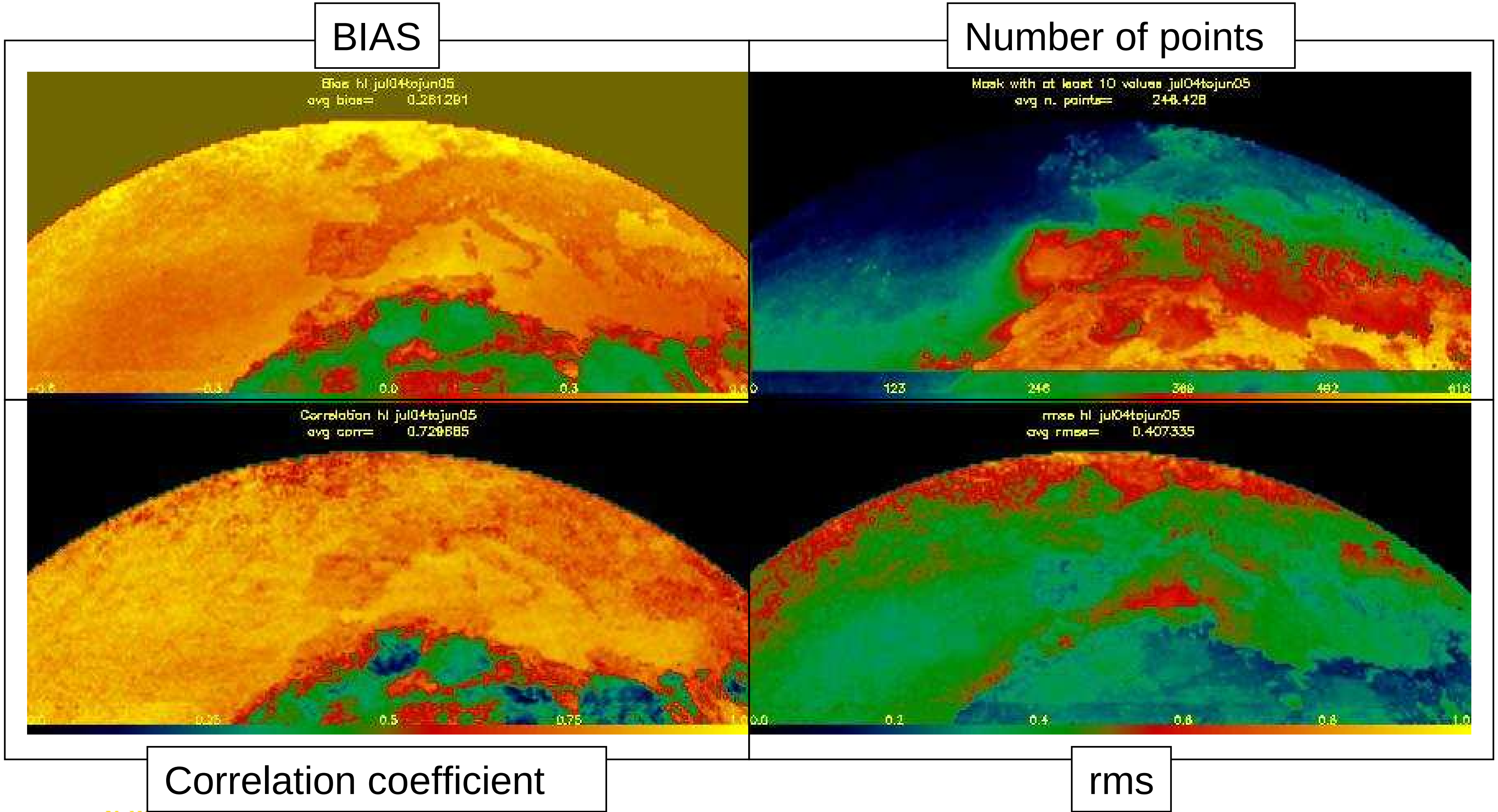
Sea:

3.0871 → 2.7427

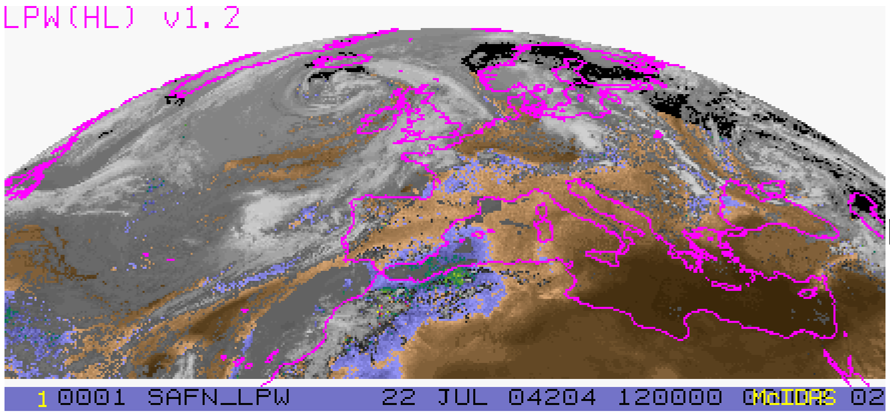
Land (non-desert):

3.6363 → 2.9416

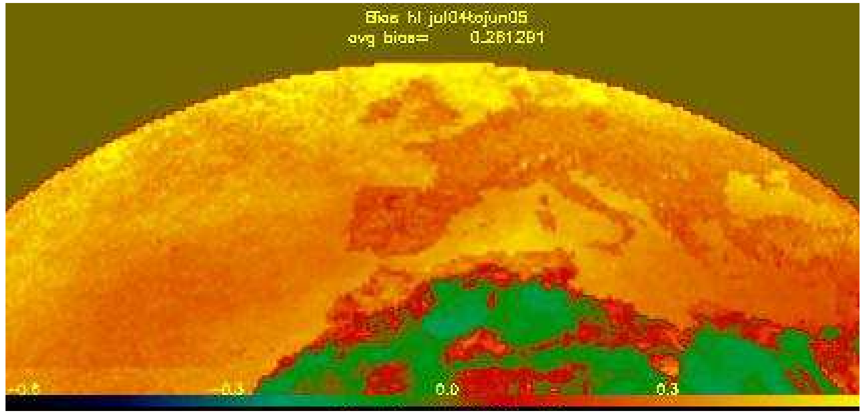
Spatial behaviour of the LPW_HL statistical parameters (Jul/04-Jun/05)



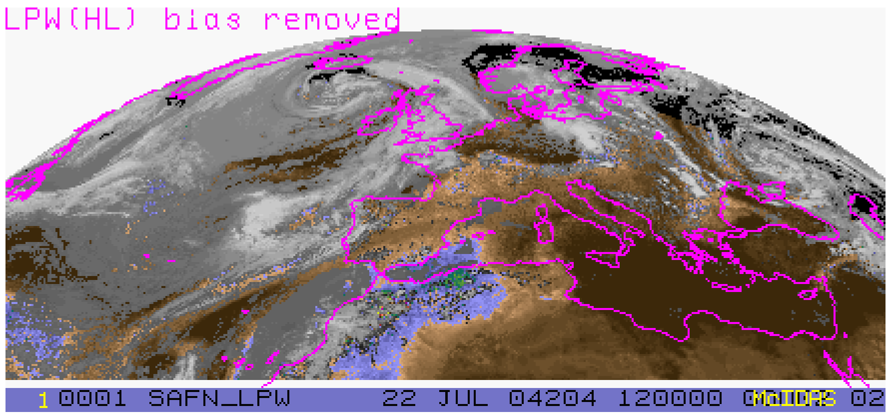
LPW_HL after bias removal



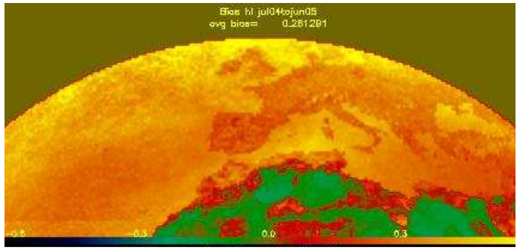
minus



equal



LPW_HL 2D-histograms without and with bias removed



With bias removed:

✓ **Correlation increase**

Sea:

0.8201 ➡ **0.8311**

Land (non-desert):

0.7340 ➡ **0.7587**

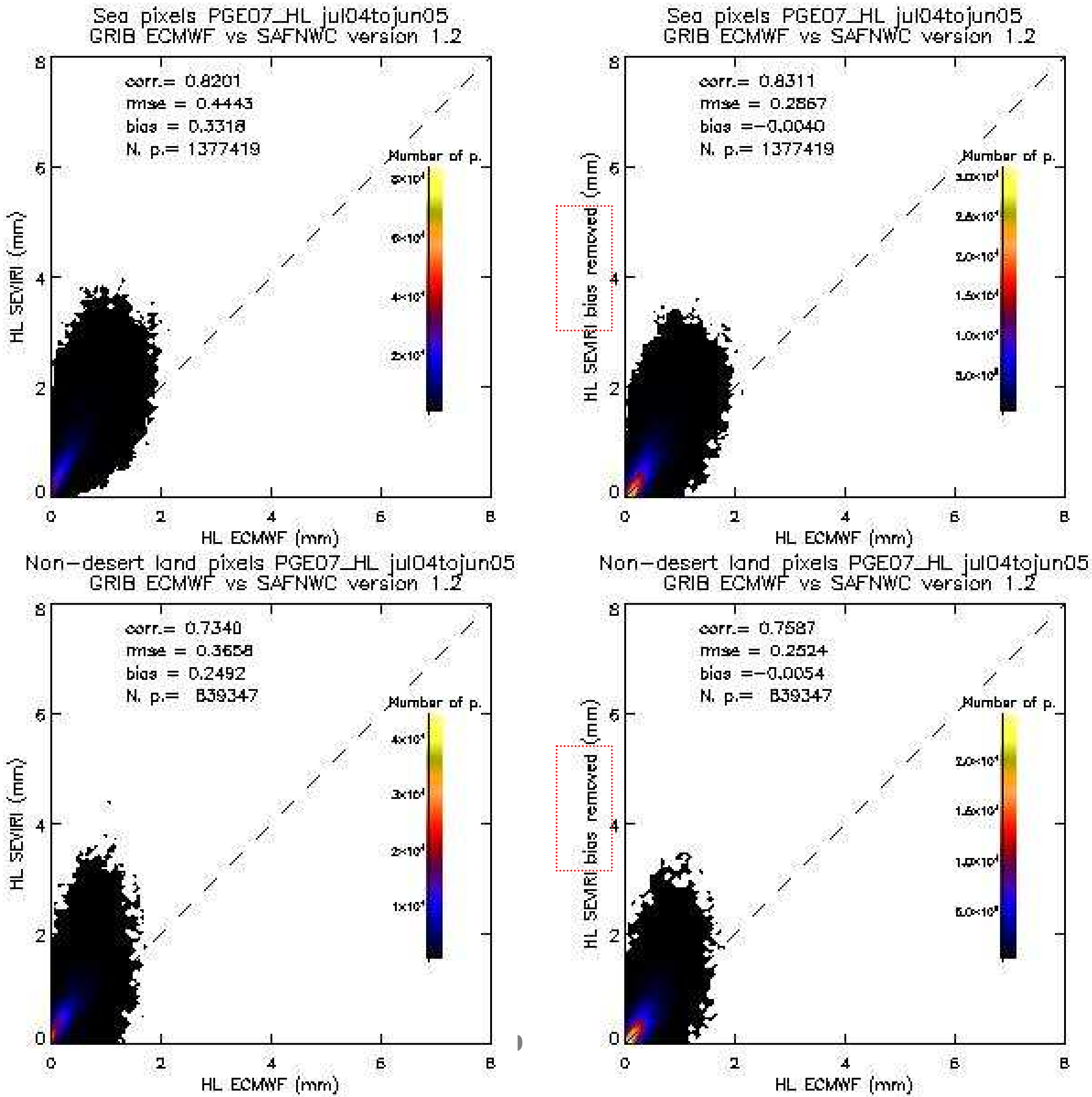
✓ **rms(mm) decrease**

Sea:

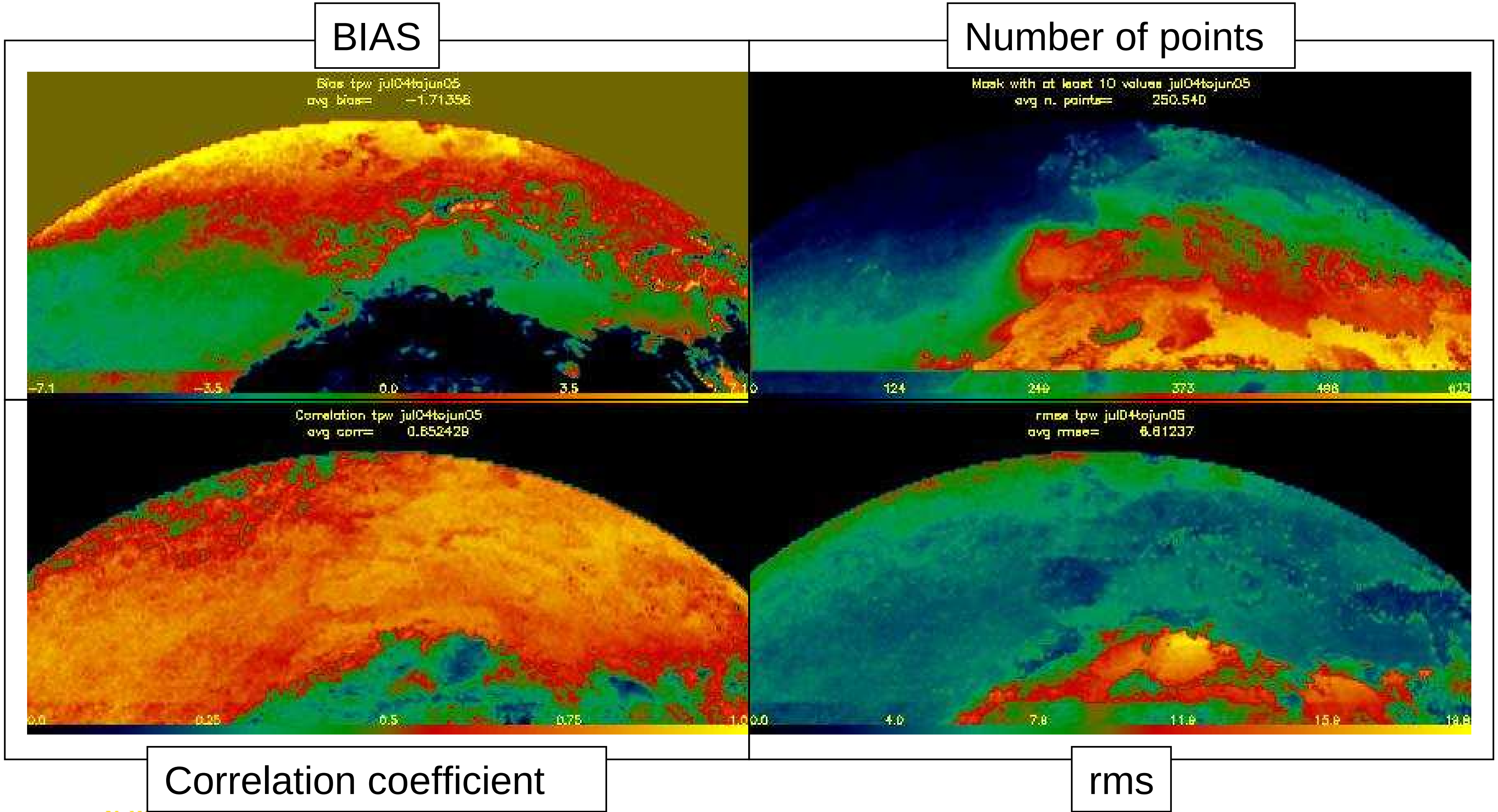
0.4443 ➡ **0.2867**

Land (non-desert):

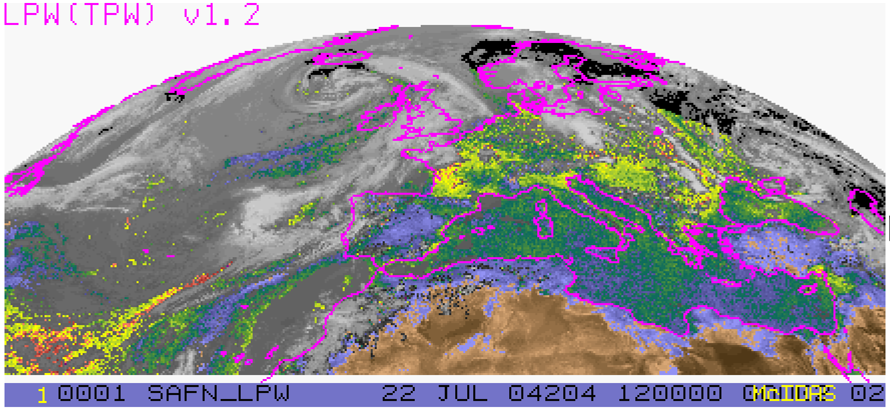
0.3658 ➡ **0.2524**



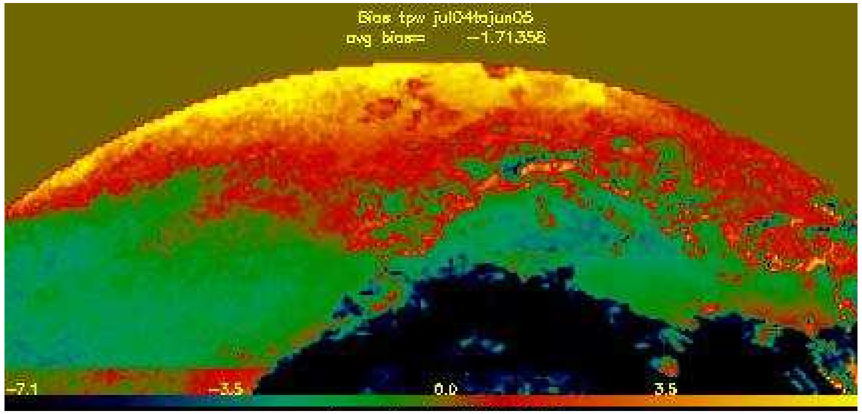
Spatial behaviour of the LPW_TPW statistical parameters (Jul/04-Jun/05)



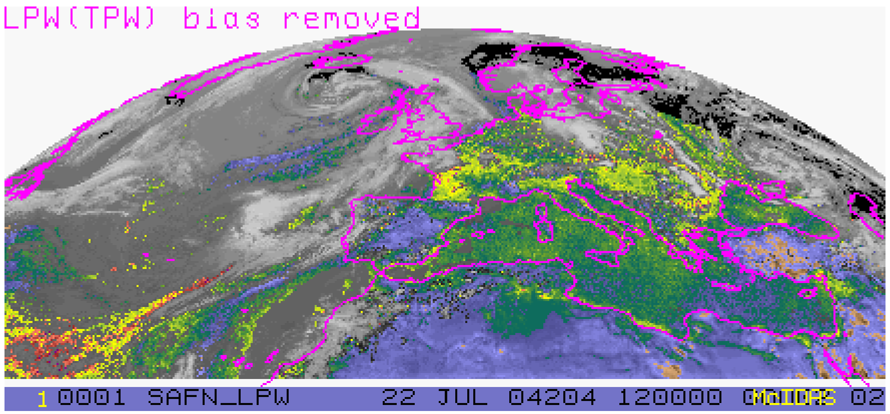
LPW_TPW after bias removal

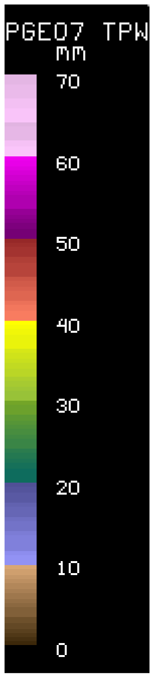


minus

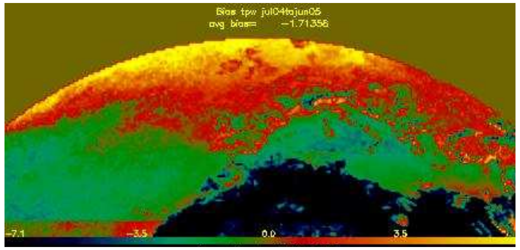


equal





Product Assessment Review (PAR) Workshop
(Madrid, 17-18-19 October 2005)



LPW_TPW 2D-histograms without and with bias removed

With bias removed:

✓ **Correlation increase**

Sea:

0.7236 ➡ **0.7752**

Land (non-desert):

0.7234 ➡ **0.8148**

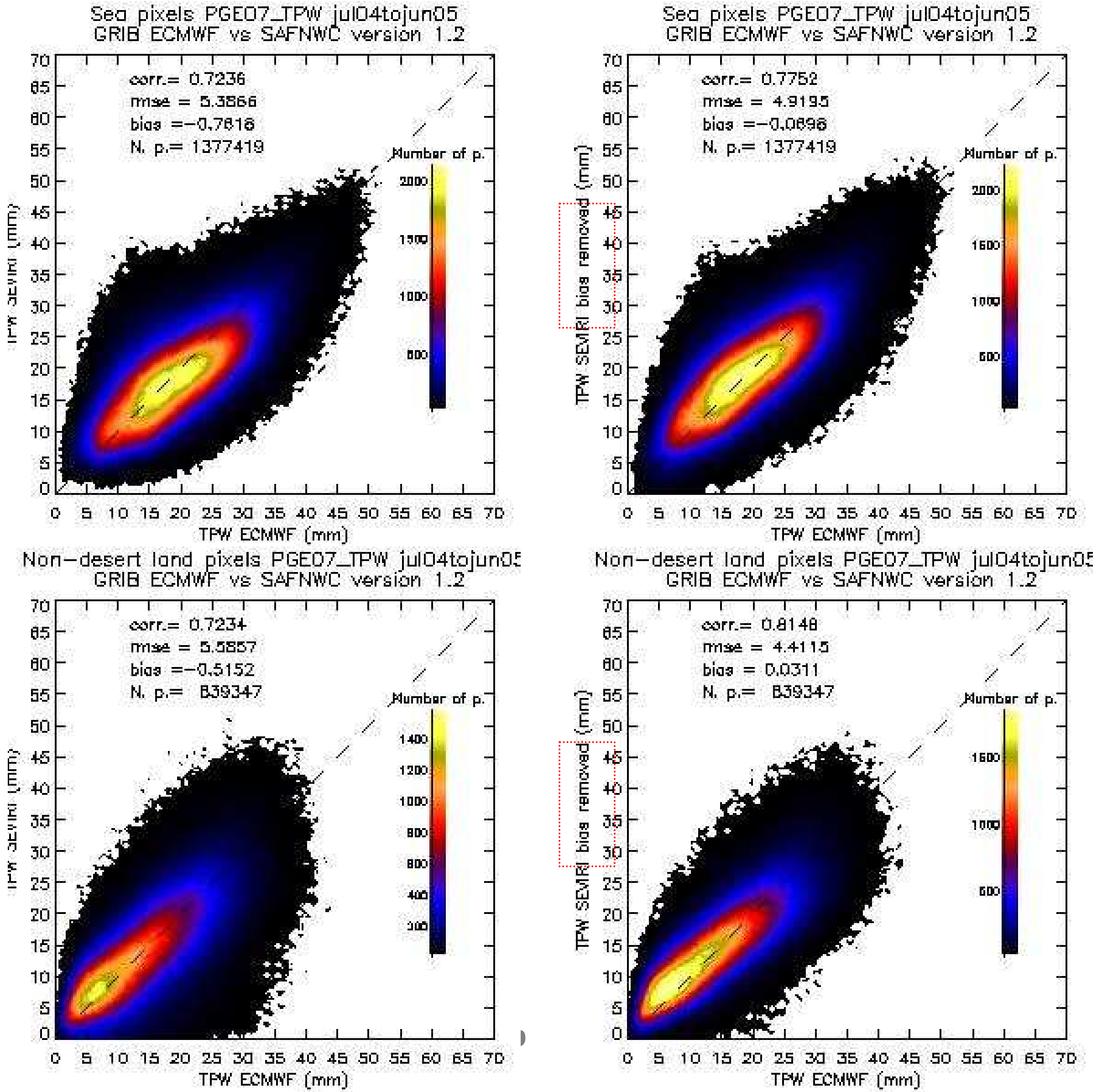
✓ **rms(mm) decrease**

Sea:

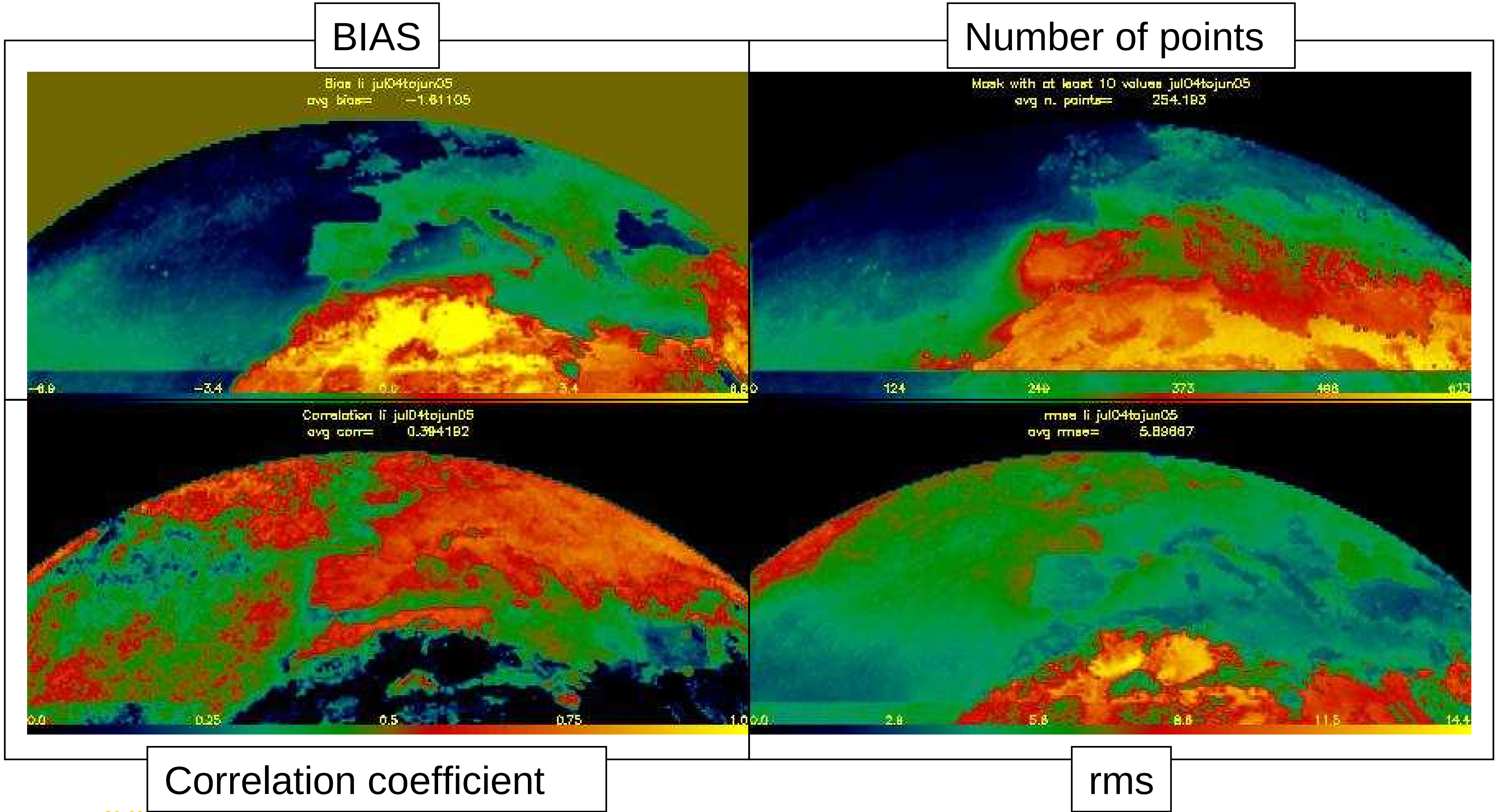
5.3866 ➡ **4.9195**

Land (non-desert):

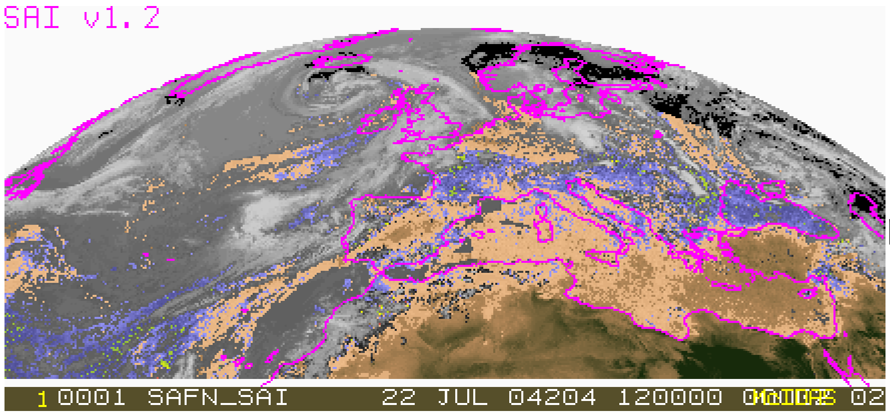
5.5857 ➡ **4.4115**



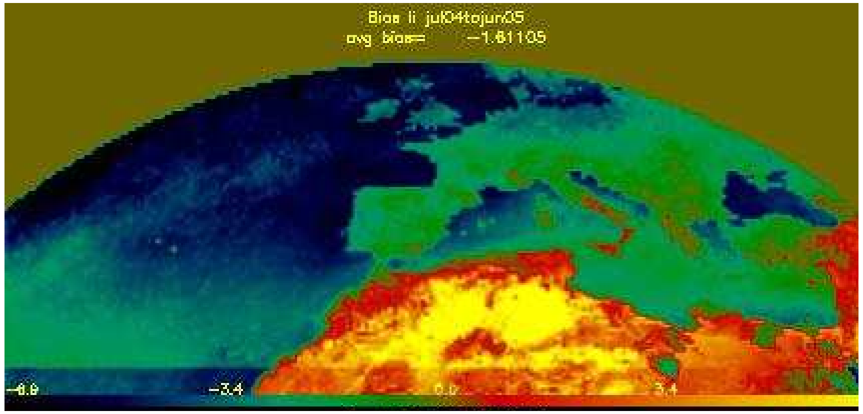
Spatial behaviour of the SAI_LI statistical parameters
(Jul/04-Jun/05)



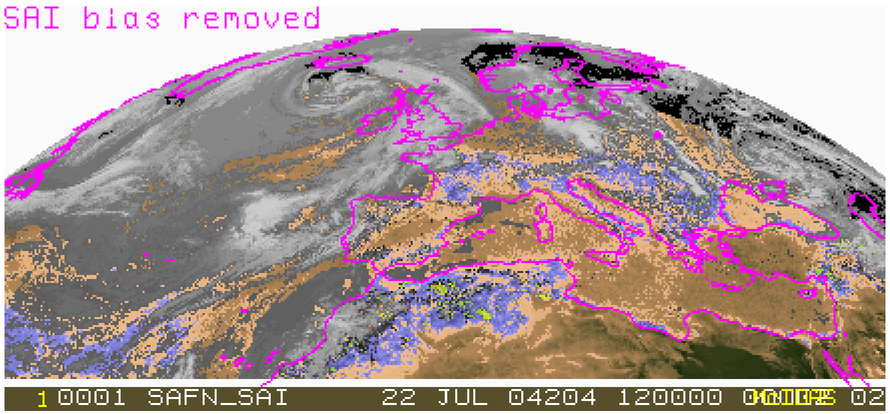
SAI_LI after bias removal

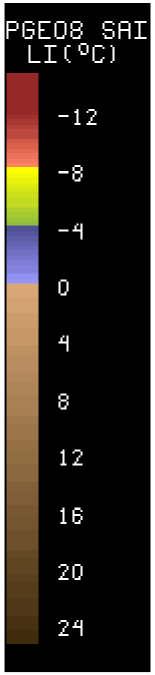


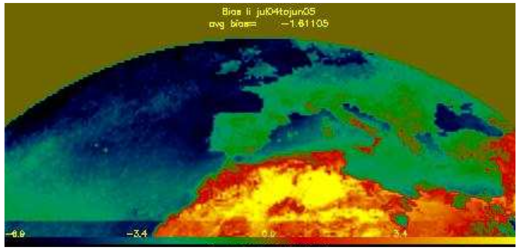
minus



equal







SAI_LI 2D-histograms without and with bias removed

With bias removed:

✓ **Correlation increase**

Sea:

0.4981 ➡ **0.5874**

Land (non-desert):

0.4920 ➡ **0.6111**

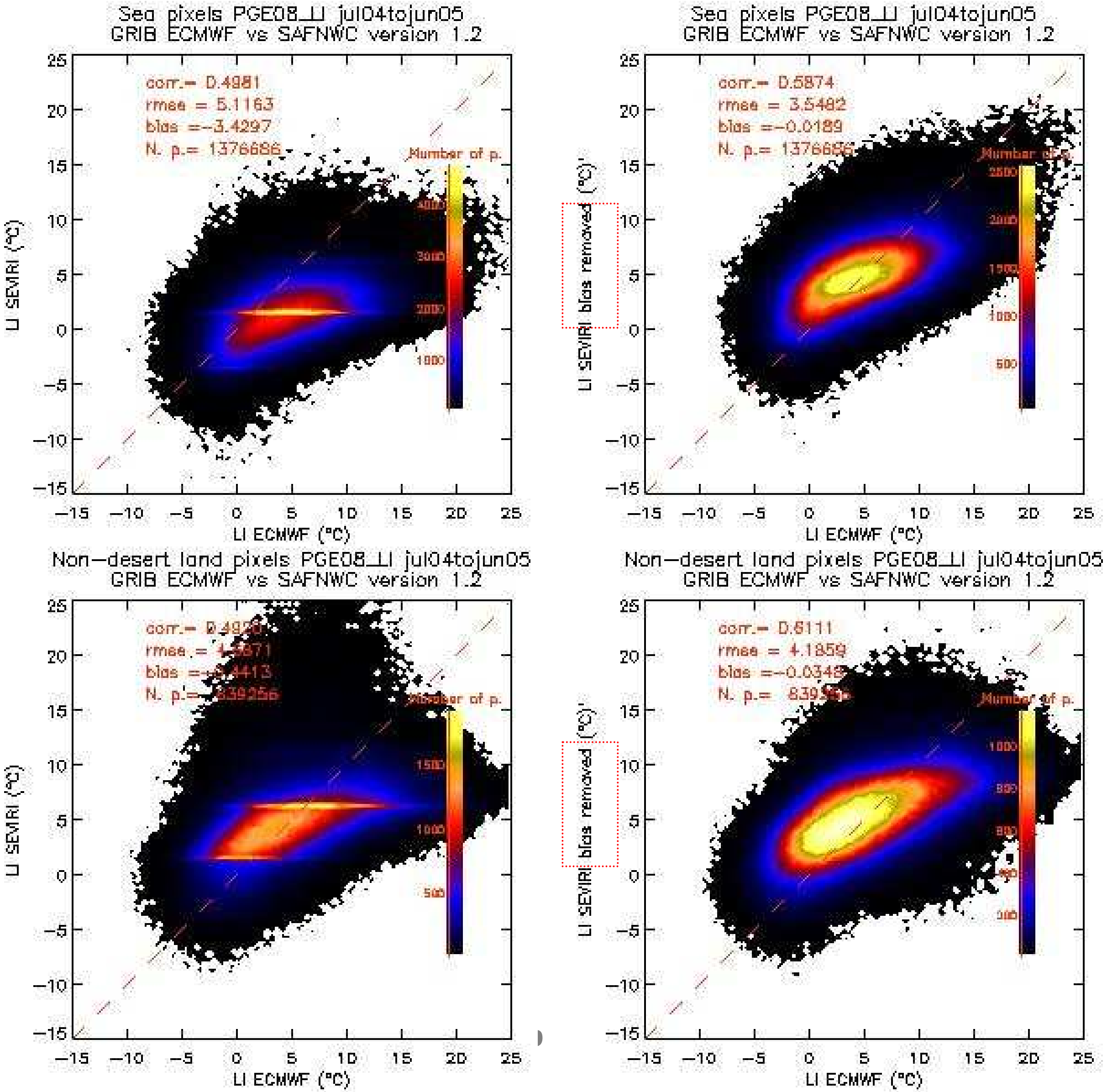
✓ **rms (ºC) decrease**

Sea:

5.1163 ➡ **3.5482**

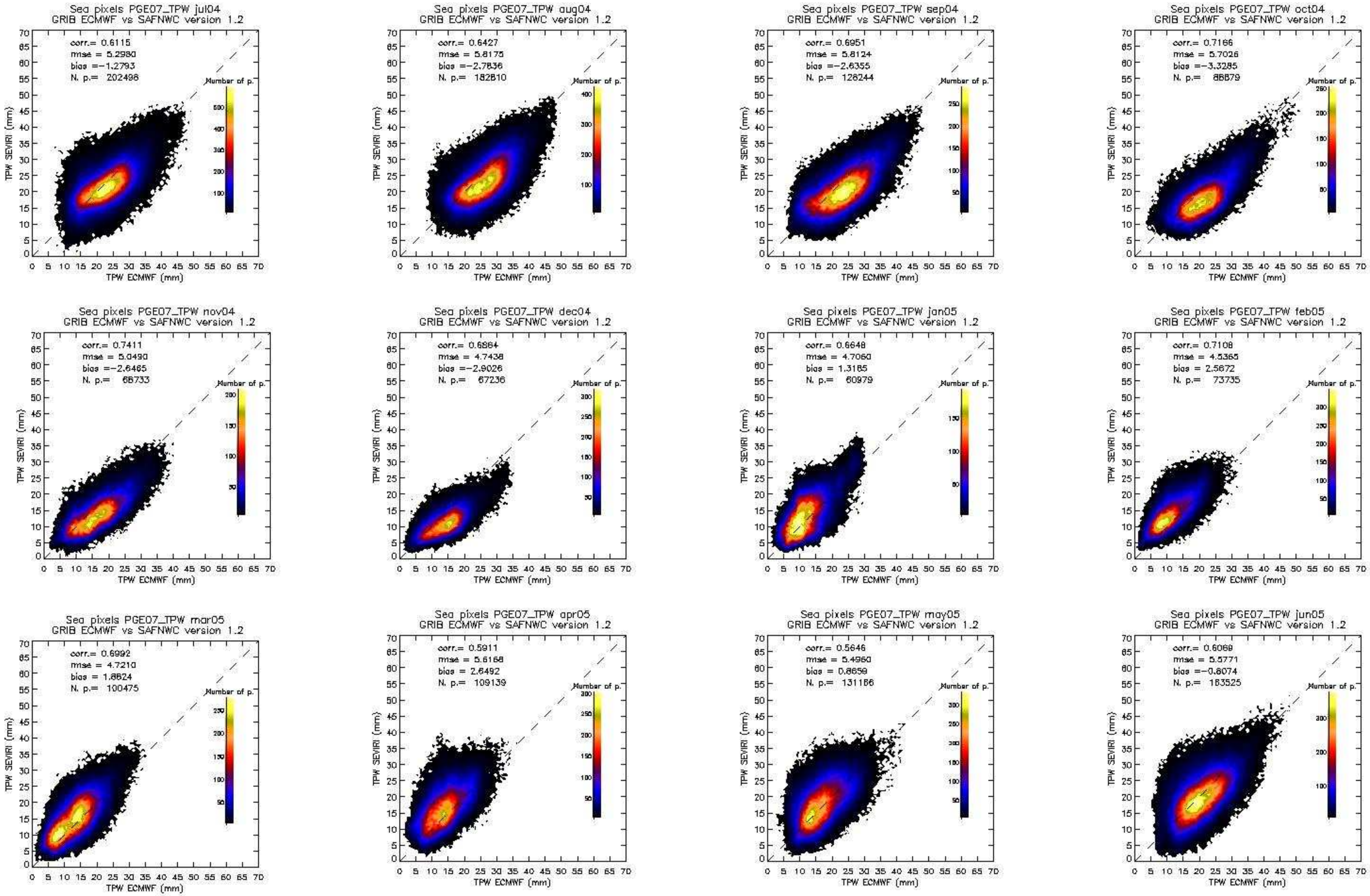
Land (non-desert):

4.6871 ➡ **4.1859**

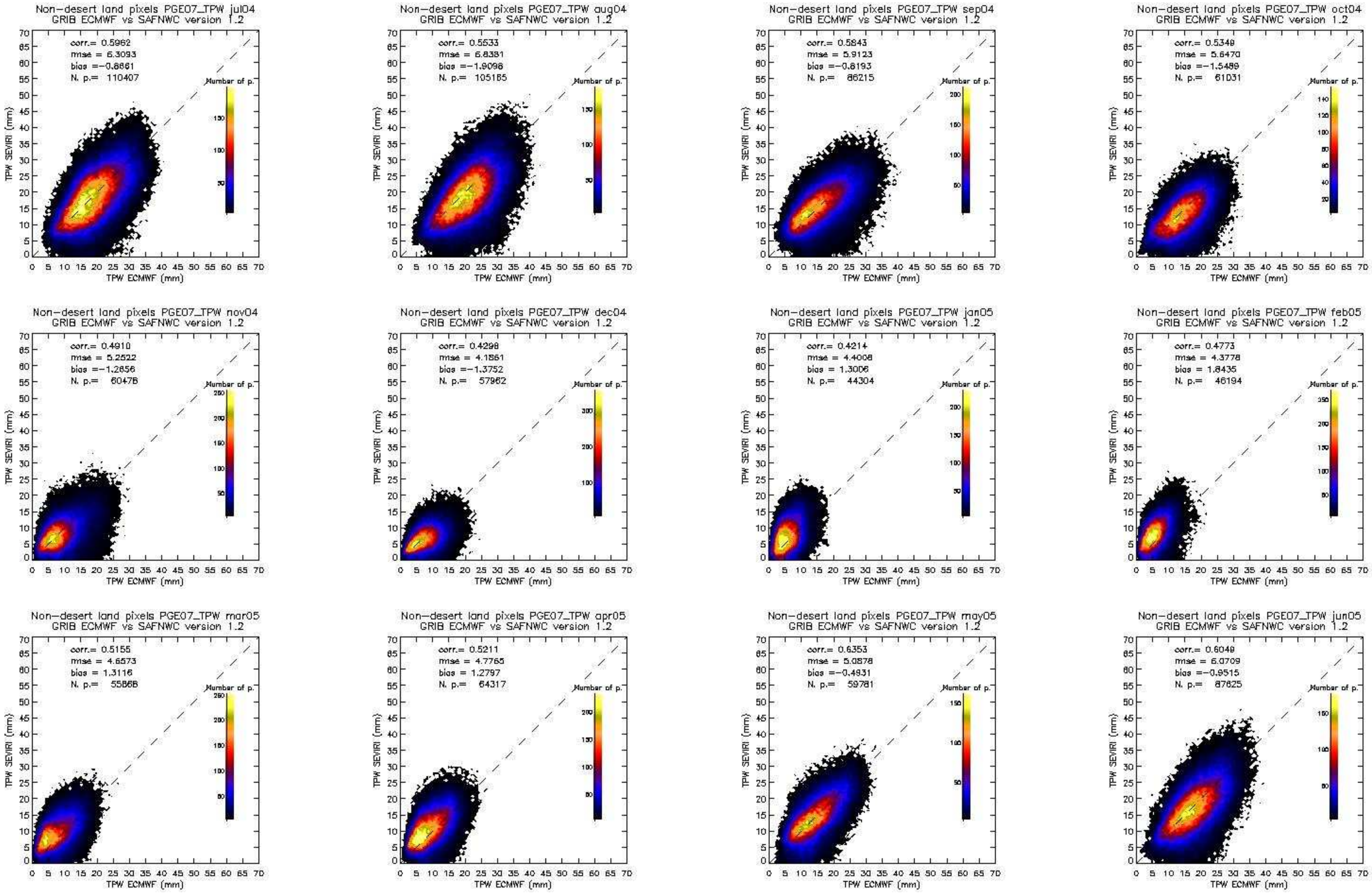


Sea LPW_TPW 2D-histograms month by month

(from July 2004 to June 2005)



Land non desert LPW_TPW 2D-histograms month by month (from July 2004 to June 2005)



Conclusions of ECMWF validation

✓ Annual cycle variation is not detected.

✓ Diurnal cycle is not detected, except in SAI_LI on land pixels. The behaviour of the trends between 00 and 12 GMT are good (continuous). With the operational version (1.2) is possible to use the trend of the parameters.

✓ The removal of the ECMWF' local bias improves significantly the statistical parameters.

✓ Future work:

⇨ The radiances bias correction should be revised. After the validation, we think that if the local bias between simulated and observed radiances is removed in the algorithms pre-processed step, all the parameters will increase their quality.

COMPARISON WITH RADIOSONDE

LPW and SAI validation with radiosonde

- Radiosonde (00 and 12 UTC) from July 2004 to June 2005 downloaded from ECMWF/MARS.
- LPW version 1.2 (equal 1.1) has been reprocessed from July 2004 to June 2005 at 00 and 12GMT.
- SAI version 1.2 has been reprocessed from July 2004 to June 2005 at 00 and 12GMT.
- To separate clear and cloudy scenes the CMa SAFNWC v1.2 is used.
- All pixels classify as clear are included in the validation dataset. (None additional constrains have been used to remove data).

LPW_BL versus BL obtained from radiosonde

✓Better correlation with radiosonde than with ECMWF analysis

▪ECMWF : 0.7058

(Land non-desert without bias correct

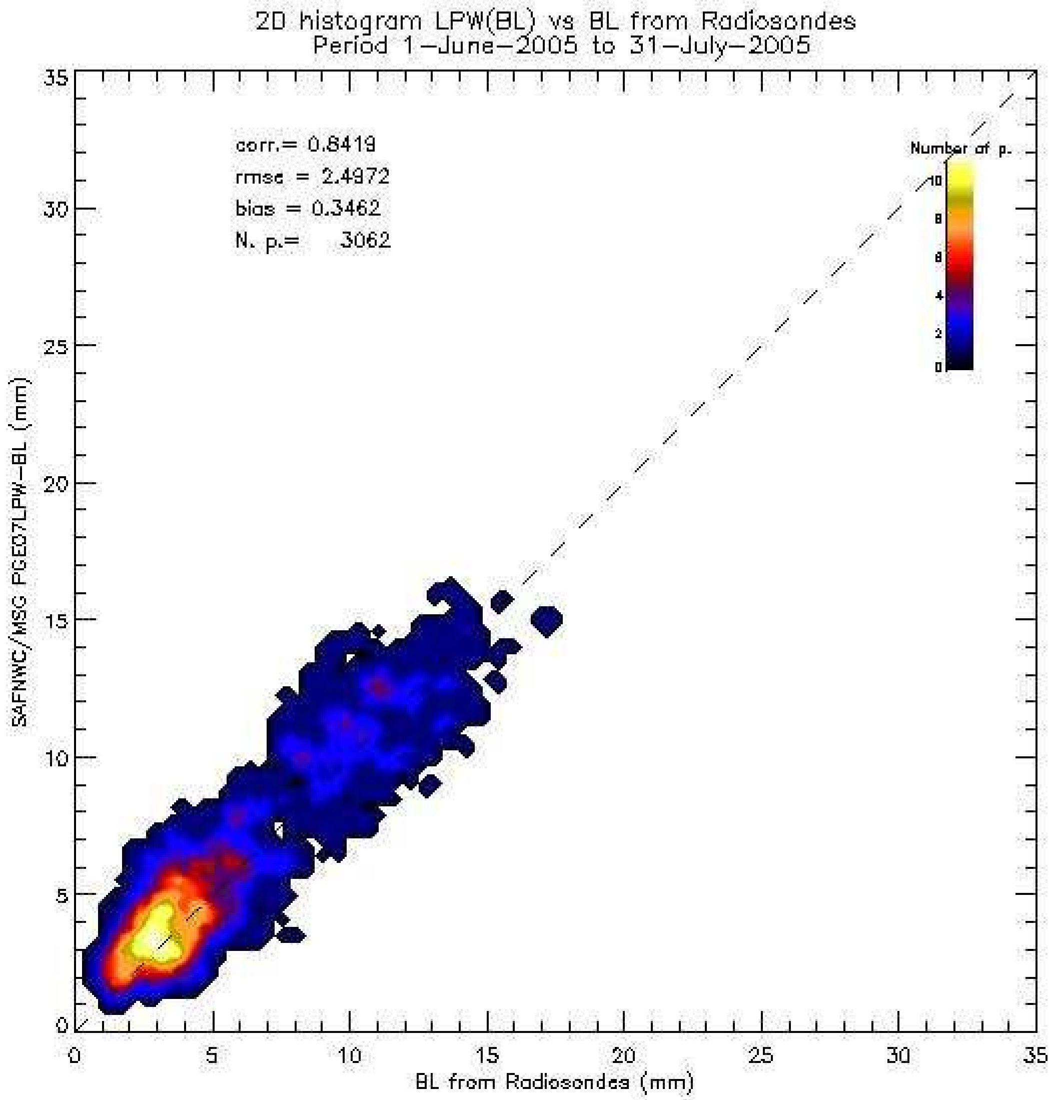
▪Radiosonde: 0.8419

✓Rms lower with radiosonde than with ECMWF analysis.

ECMWF: 3.2756mn

(Land non-desert without bias correct

Radiosonde: 2.4972mn



LPW_ML versus ML obtained from radiosonde

✓**Similar correlation**

▪**ECMWF : 0.6732**

(Land non-desert without bias correct

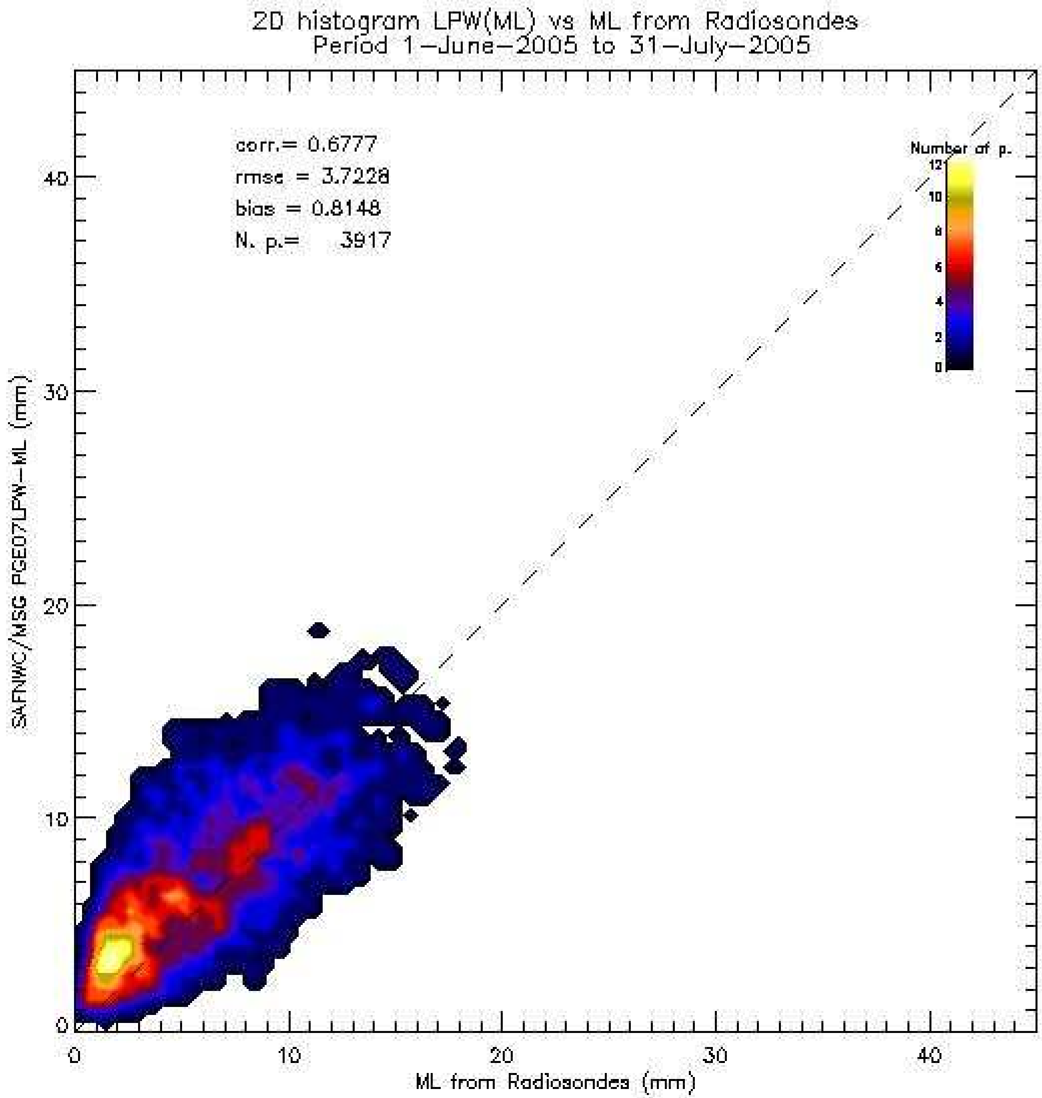
▪**Radiosonde: 0.6777**

✓**Similar rms**

▪**ECMWF: 3.6363mn**

(Land non-desert without bias correct

Radiosonde: 3.7228mn



LPW_HL versus HL obtained from radiosonde

✓Better correlation with radiosonde than with ECMWF analysis

▪ECMWF : 0.7340

(Land non-desert without bias correct

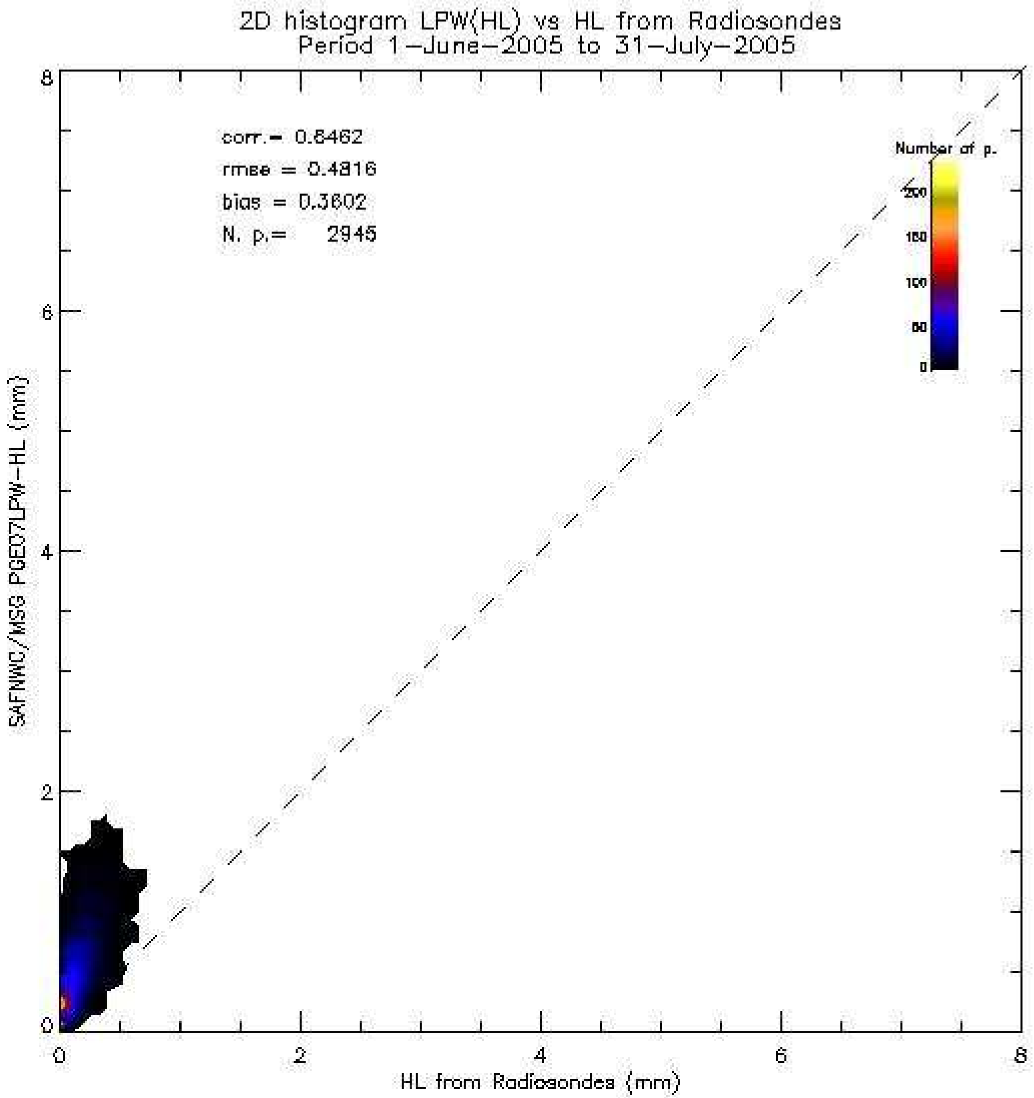
▪Radiosonde: 0.8462

✓Rms higher with radiosonde than with ECMWF analysis

ECMWF: 0.3658mn

(Land non-desert without bias correct

Radiosonde: 0.4811mn



LPW_TPW versus TPW obtained from radiosonde

✓**Similar correlation**

▪**ECMWF : 0.7234**

(Land non-desert without bias correction)

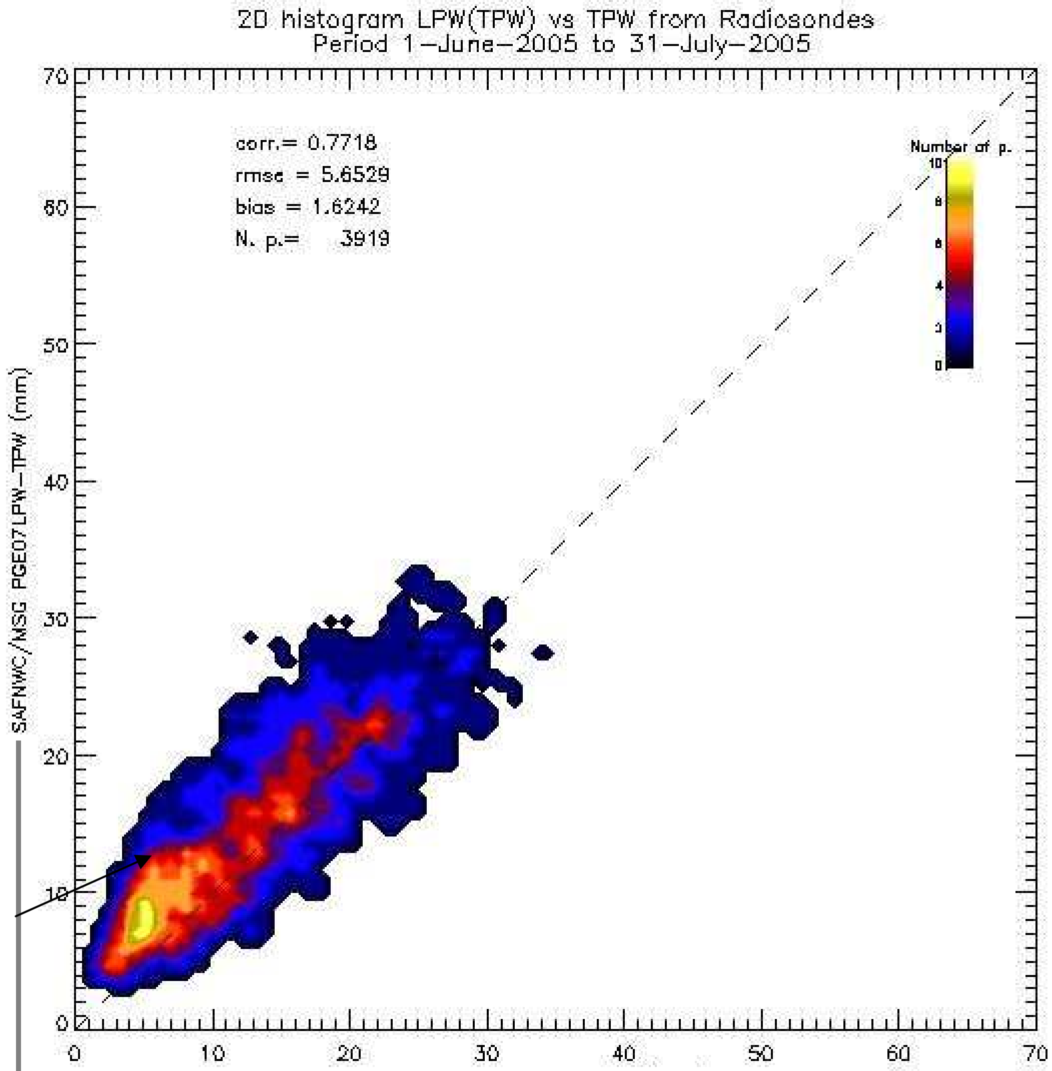
▪**Radiosonde: 0.7718**

✓**Similar rms:**

ECMWF: 5.5857mm

(Land non-desert without bias correction)

Radiosonde: 5.6529mm



Probably, this strange behaviour is due to that in the North of Europe with high satellite zenith angles LPW_TPW is systematically wetter (It was analyzed with more detail in the IWV GPS and LPW_TPW intercomparison, SPIE EUROPE 2005).

SAI_LI versus LI obtained from radiosonde

✓Similar correlation

▪ECMWF : 0.4920

(Land non-desert without bias correction)

▪Radiosonde: 0.5188

✓Similar rms:

ECMWF: 4.6871 ºC

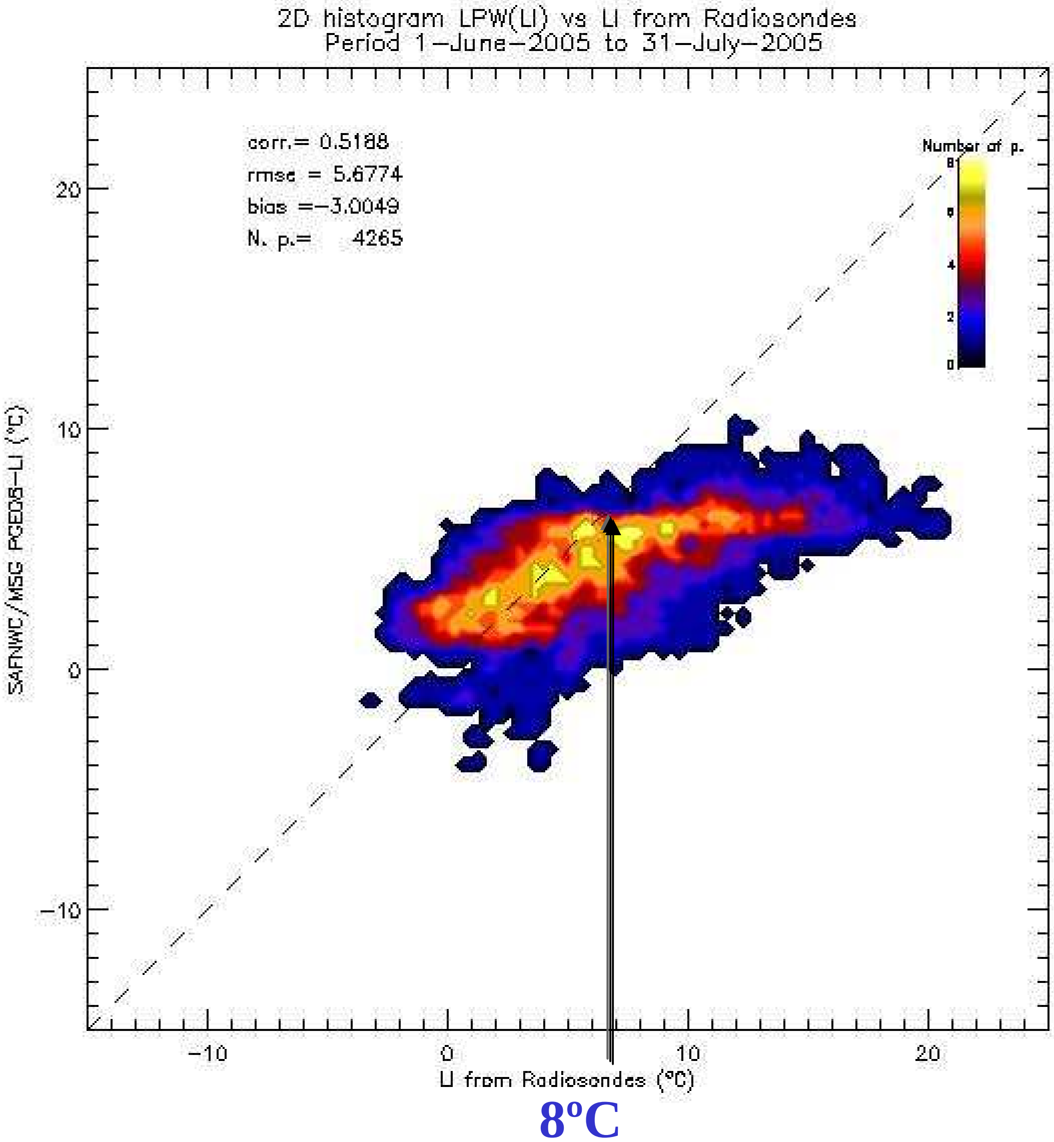
(Land non-desert without bias correction)

Radiosonde: 5.6774 ºC

Considering only LI radiosonde < 8ºC (2067 points)

Rms decrease (ºC)

from 5.6774 to 3.8095



Conclusions of radiosonde validation

- ✓ The statistical parameters obtained with radiosonde and ECMWF on non desert pixels are similar for LPW_ML, LPW_HL, LPW_TPW and SAI_LI.
- ✓ LPW_BL presents good agreement (correlation coefficient of 0.8418 and rms 2.492 mm) taking into account that all pixels classify as clear are included in the validation dataset (no external constrains have been used to remove data).
- ✓ LPW_BL presents better statistical parameters with radiosonde comparison than with ECMWF. Probably, due to the ECMWF analysis represents worse the precipitable water in low levels. Therefore, it isn't recommendable to used ECMWF data to remove the bias in each point for this parameter.

COMPARISON OF SAFNWC LPW_TPW VERSUS IWV GPS

Framework: IWV GPS

- ✓ The Global positioning system (GPS) ground-based receivers can work as meteorological sensors.

- ✓ GPS estimations of Integrated Water Vapor (IWV) are available with a high temporal resolution (few minutes), and they are not adversely affected by the presence of clouds.

- ✓ European network of global positioning system (GPS) receivers are now routinely used to provide near-real-time estimations of precipitable water vapor.

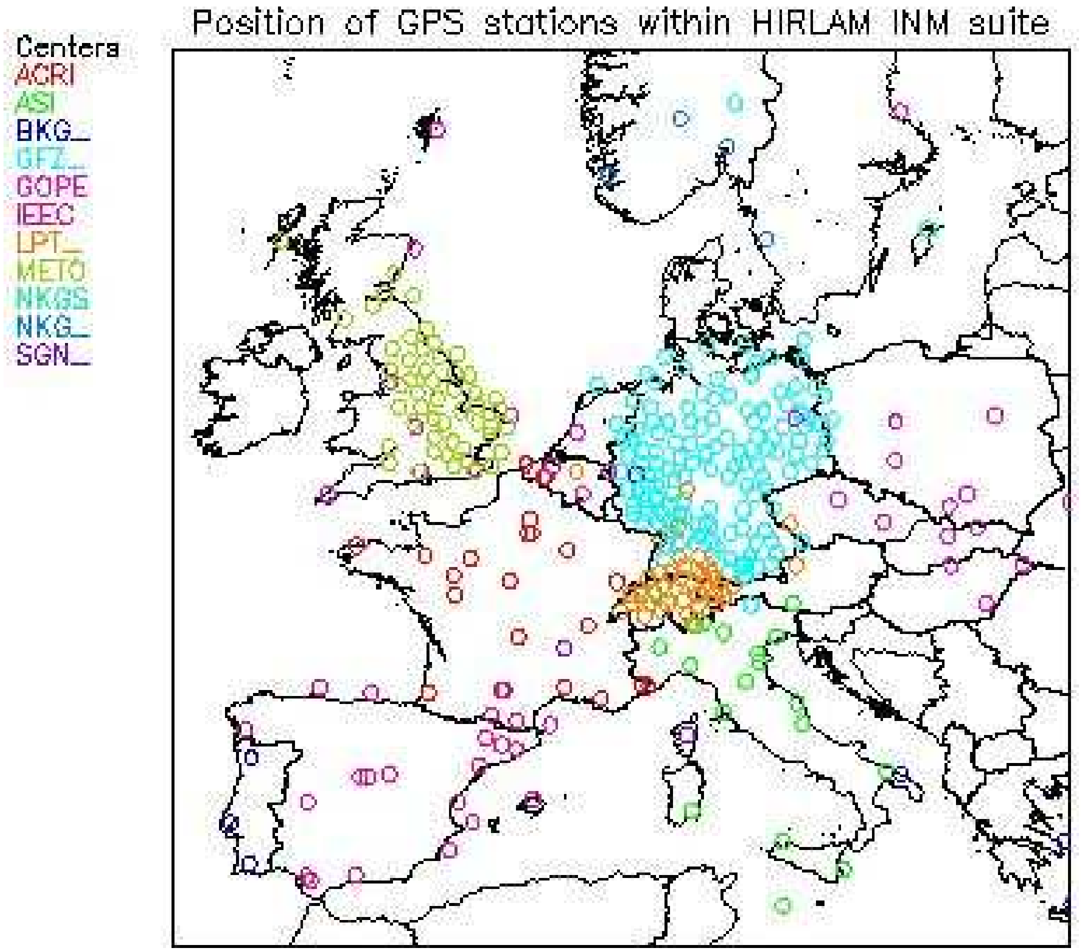
TOUGH Project

from February 2003 to February 2006

✓Interdisciplinary project

✓15 institutes with expertise in the GPS system and meteorological institutes

✓ Coordinated by DMI (Danish Meteorological Institute)



GPS sites gathered by processing centres

The operational NWP suite at INM

HIRLAM (High Resolution Limited Area Modelling)

- ✓ It is a complete NWP system including Data Assimilation with analysis of conventional and non-conventional observations to provide initial conditions to both upper air and surface variables, and a limited area forecasting model with a comprehensive set of physical parameterisations.

- ✓ The INM NWP operational suite runs the HIRLAM model over a wide rotated domain covering from eastern North America to Russia and from the tropics to the North Pole at a 17km horizontal resolution and with 40 levels in the vertical.

HIRLAM 3DVAR assimilation system

- ✓ The observations may be:
  - Active data.
  - Passive data, that are passed trough the 3DVAR system but do not enter to the minimization process, but are compared to the first guess and checked in the screening step.

- ✓ Passive data (among others):
  - The ground based GPS data from European stations collected in the framework of the E.U. funded project TOUGH.
  - The LPW(TPW) product developed by the INM team for the Nowcasting SAF in some selected geographical locations.

DATASET USED IN THE INTERCOMPARISON

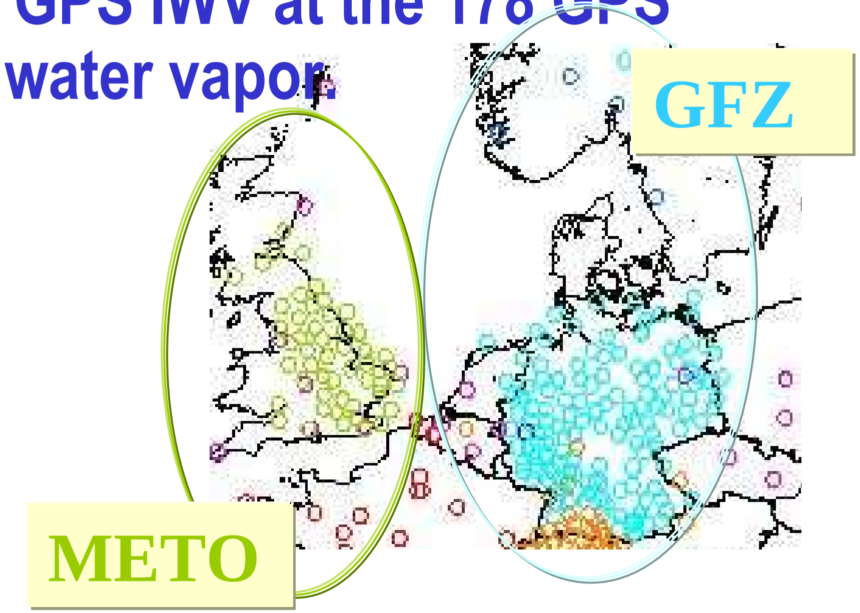
- GPS zenith total delays (ZTD), covering the West of Europe, are being introduced in the INM NWP HIRLAM operational suite.

- The GPS precipitable water vapor and the collocated LPW(TPW) parameter are introduced in the INM HIRLAM analysis, the total precipitable water is then calculated from the model first guess (HIRLAM six hours forecast) at the GPS sites

- Therefore, three independent water vapor measurement sources are available at the GPS sites: LPW(TPW), GPS IWV and HIRLAM PWV.

GPS sites used in the intercomparison

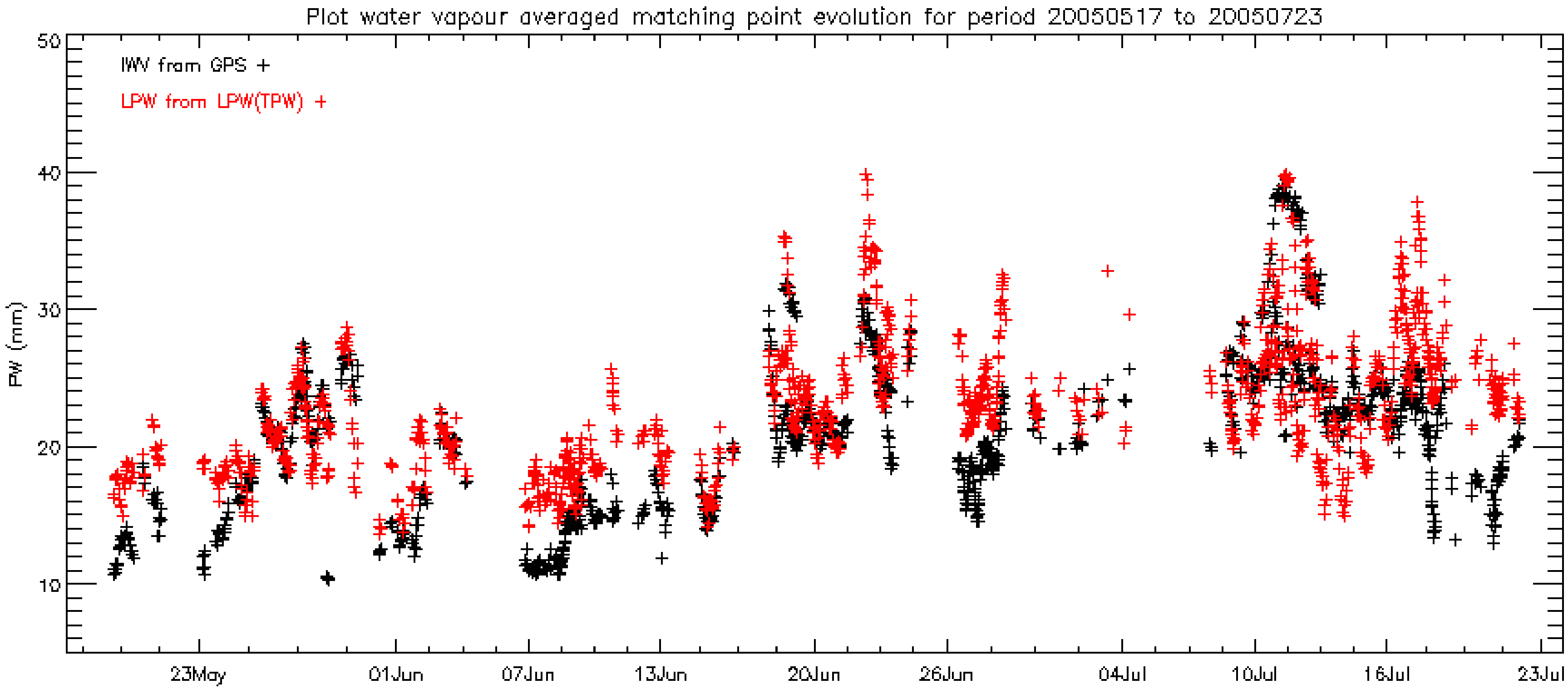
- LPW(TPW) is compared with GPS IWV at the 178 GPS sites that provide integrated water vapor.



- All the stations are tested:
  - together
  - separately centre by centre
  - separately one by one

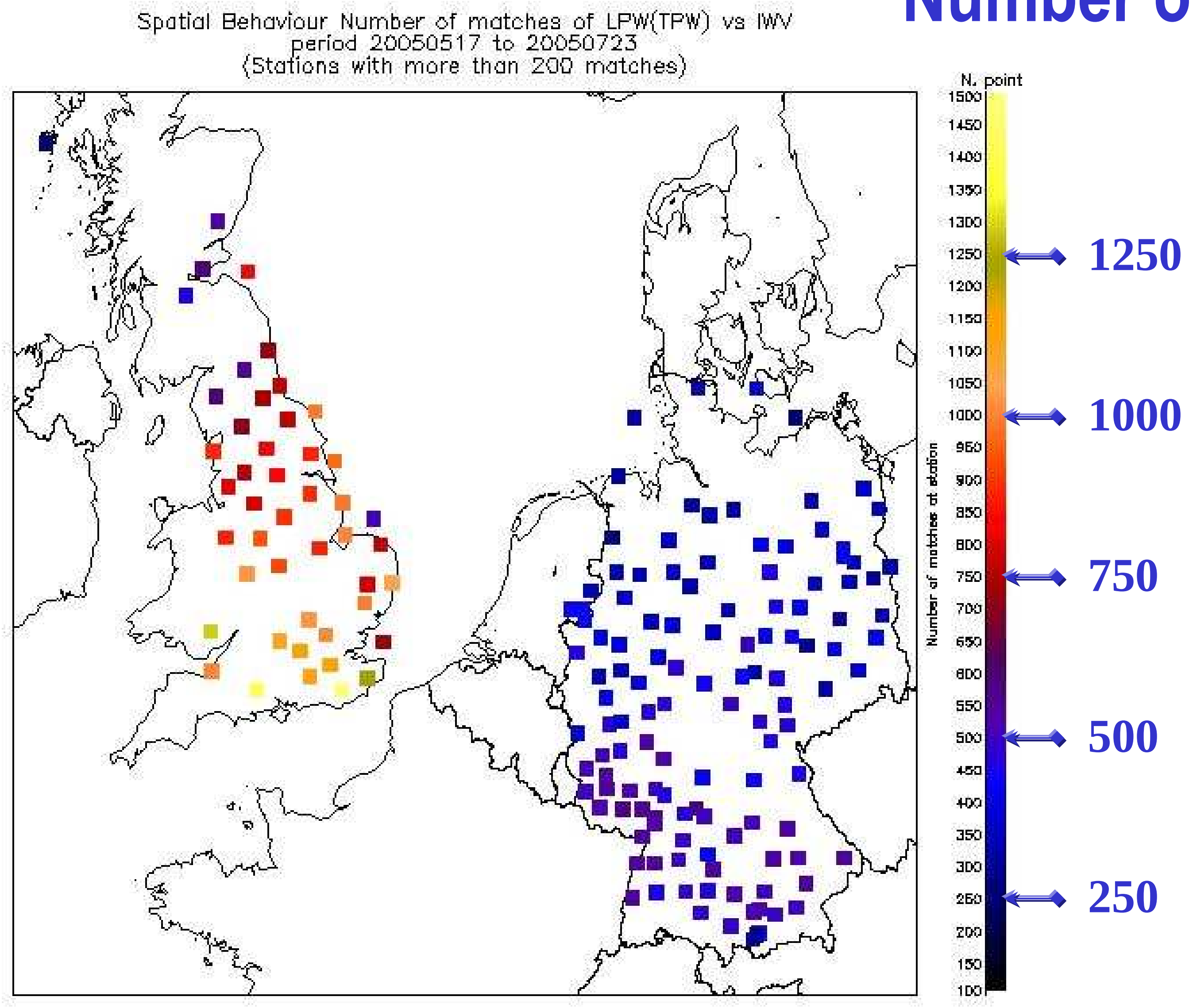
- The purpose is to check the accuracy of LPW(TPW) and to identify the potential causes of the discrepancies in order to identify ways to improve the algorithm.

Evolution of LPW(TPW) and GPS IWV time series

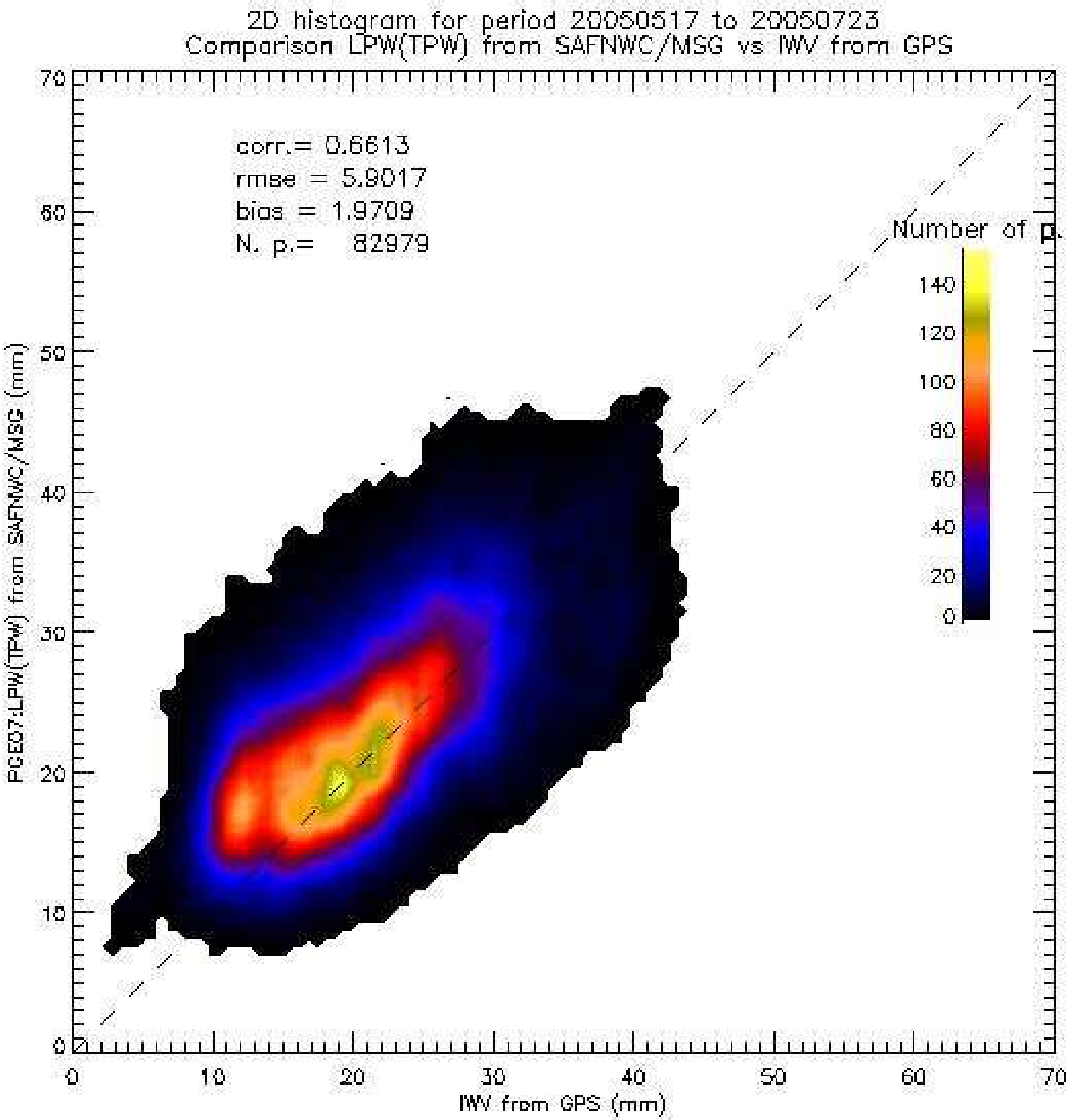


✓The mean of LPW(TPW) and GPS IWV is calculated in the slots in which more than 20 GPS sites are cloud free.

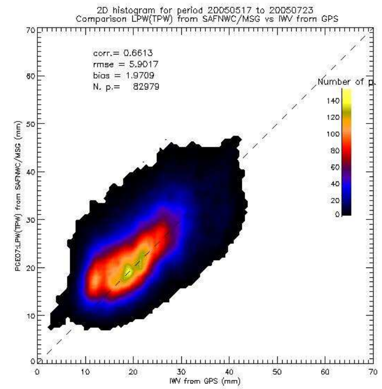
Number of points

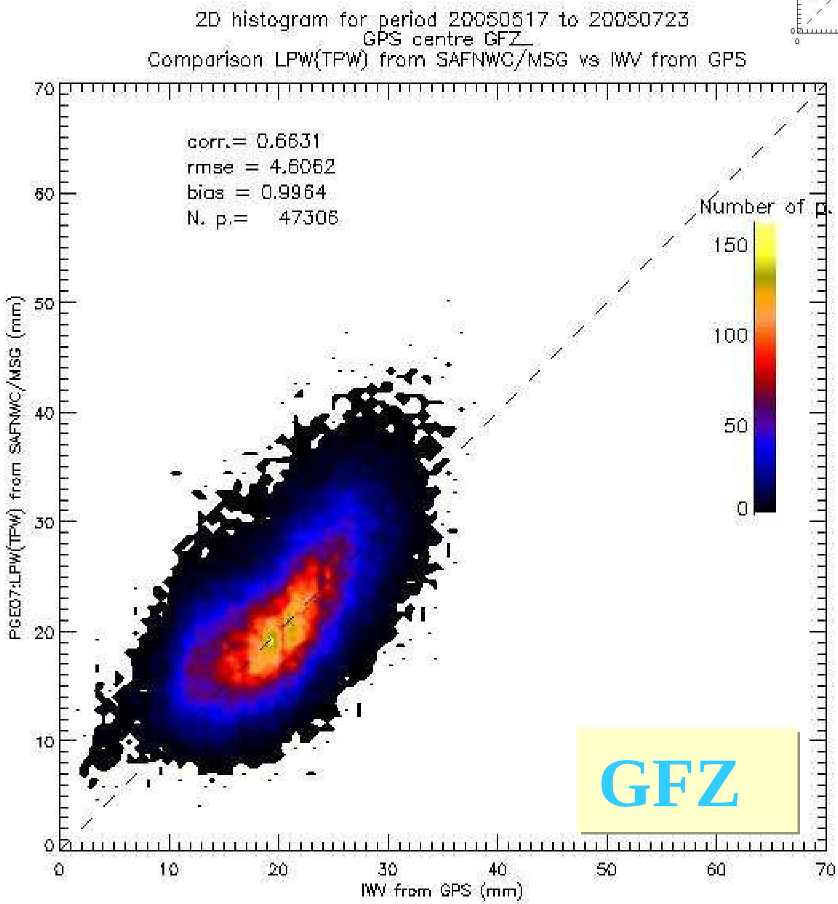


Smoothed 2D histograms of LPW(TPW) and GPS IWV



Smoothed 2D histograms by Processing Centre





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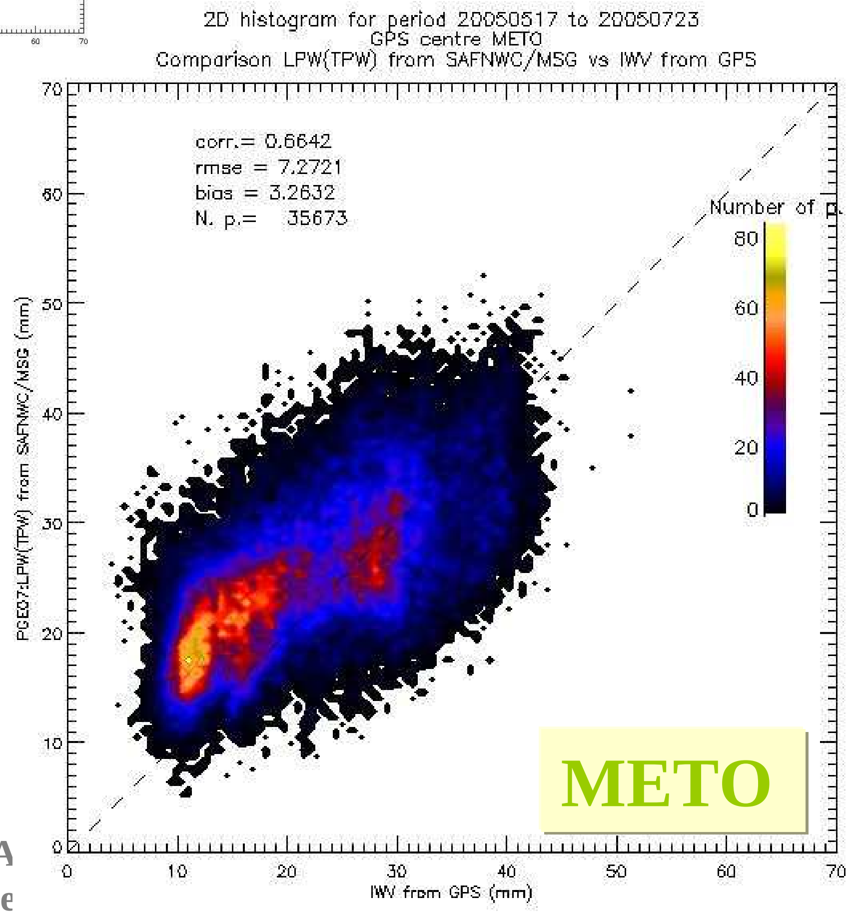
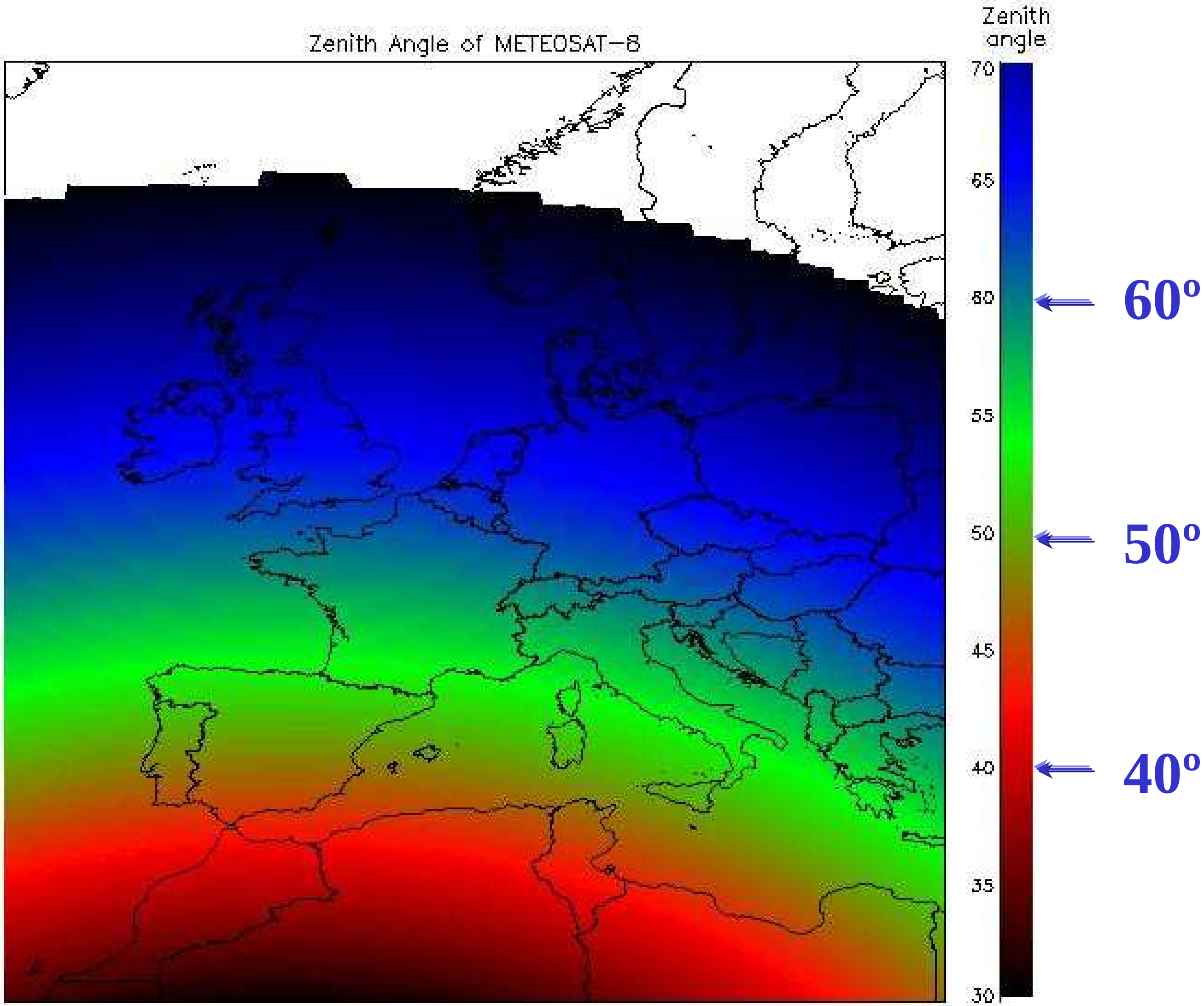
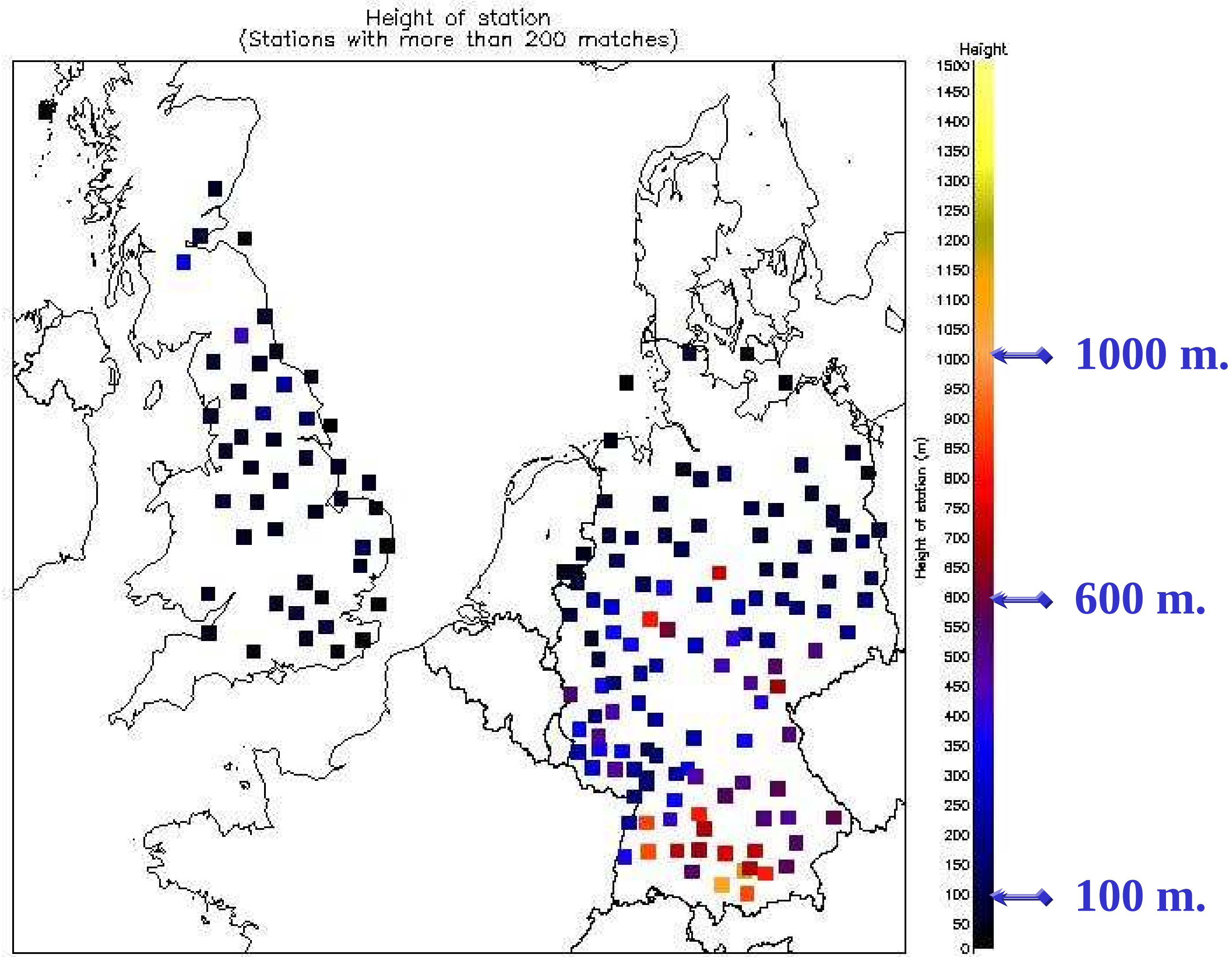


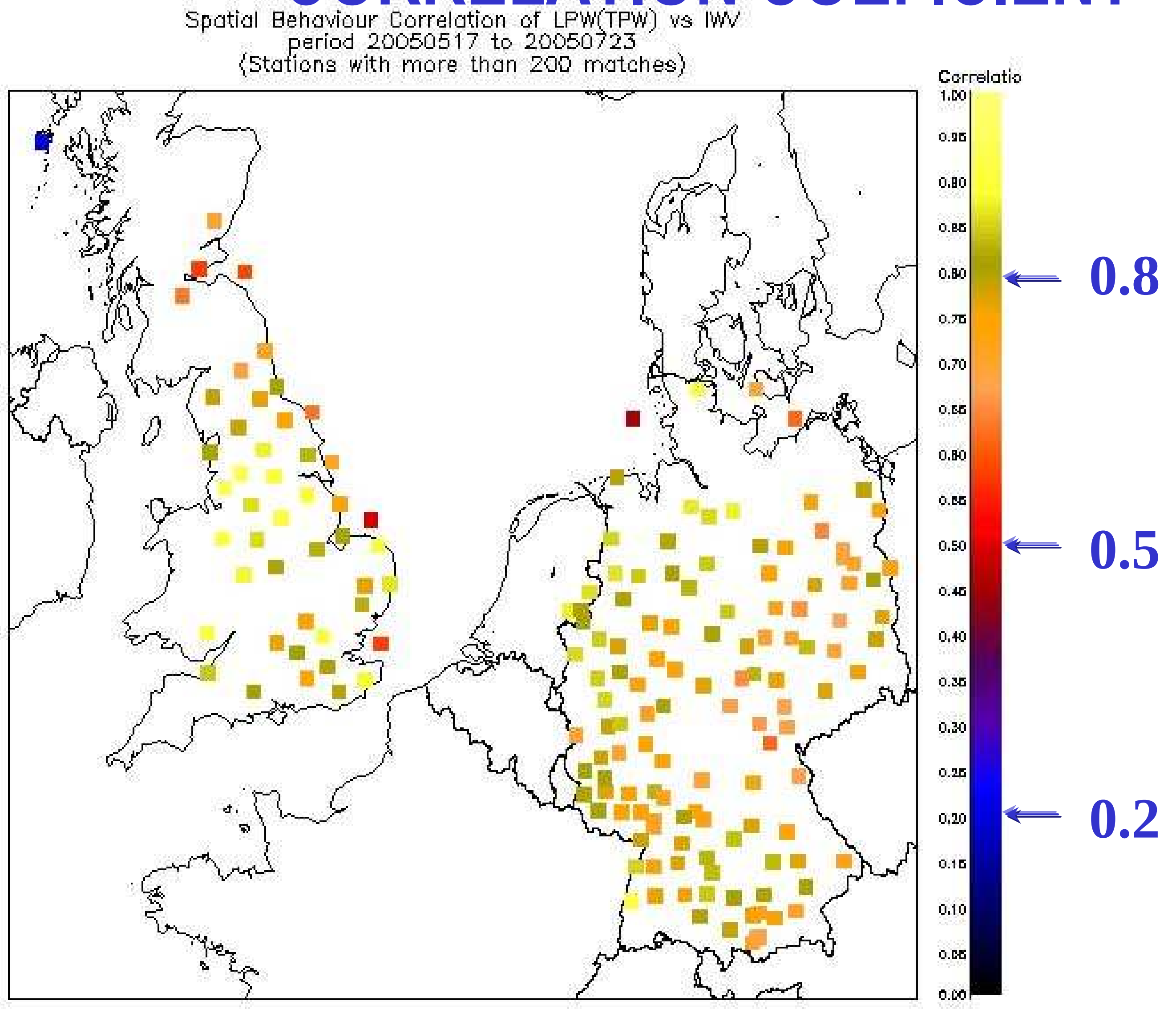
MSG zenith angle



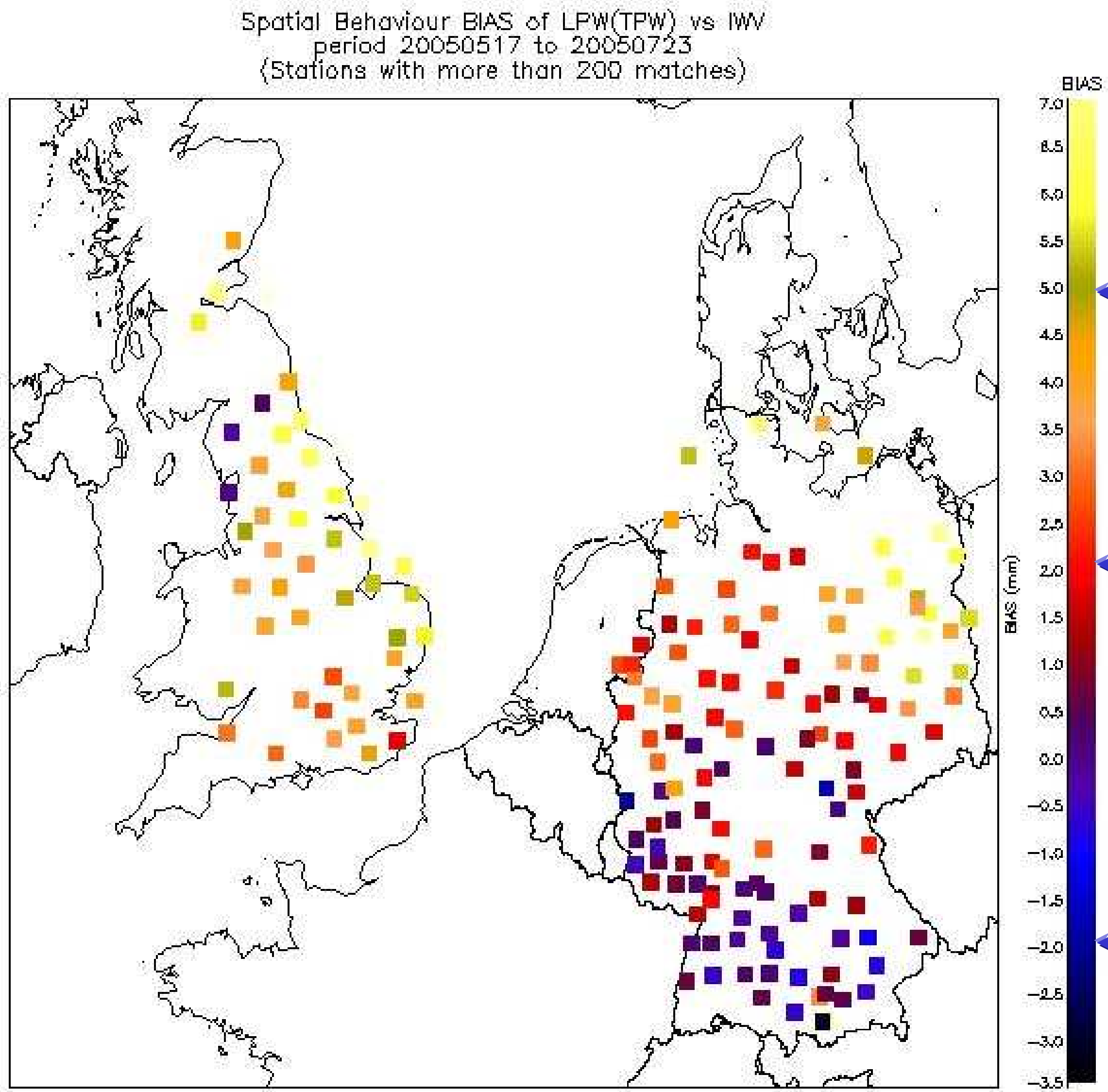
Station height



CORRELATION COEFICIENT



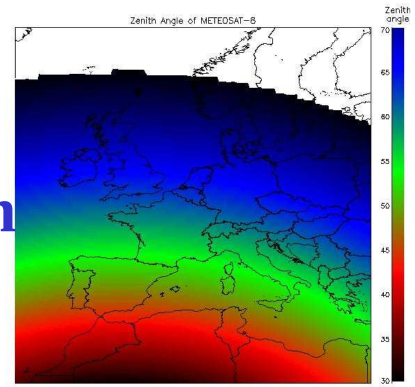
BIAS

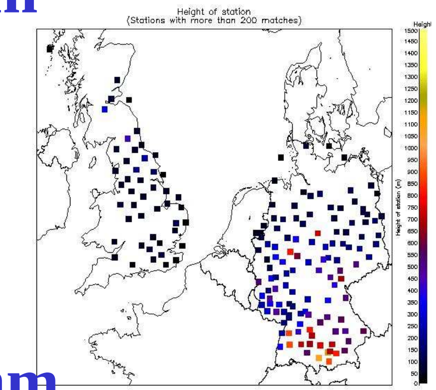


5mm

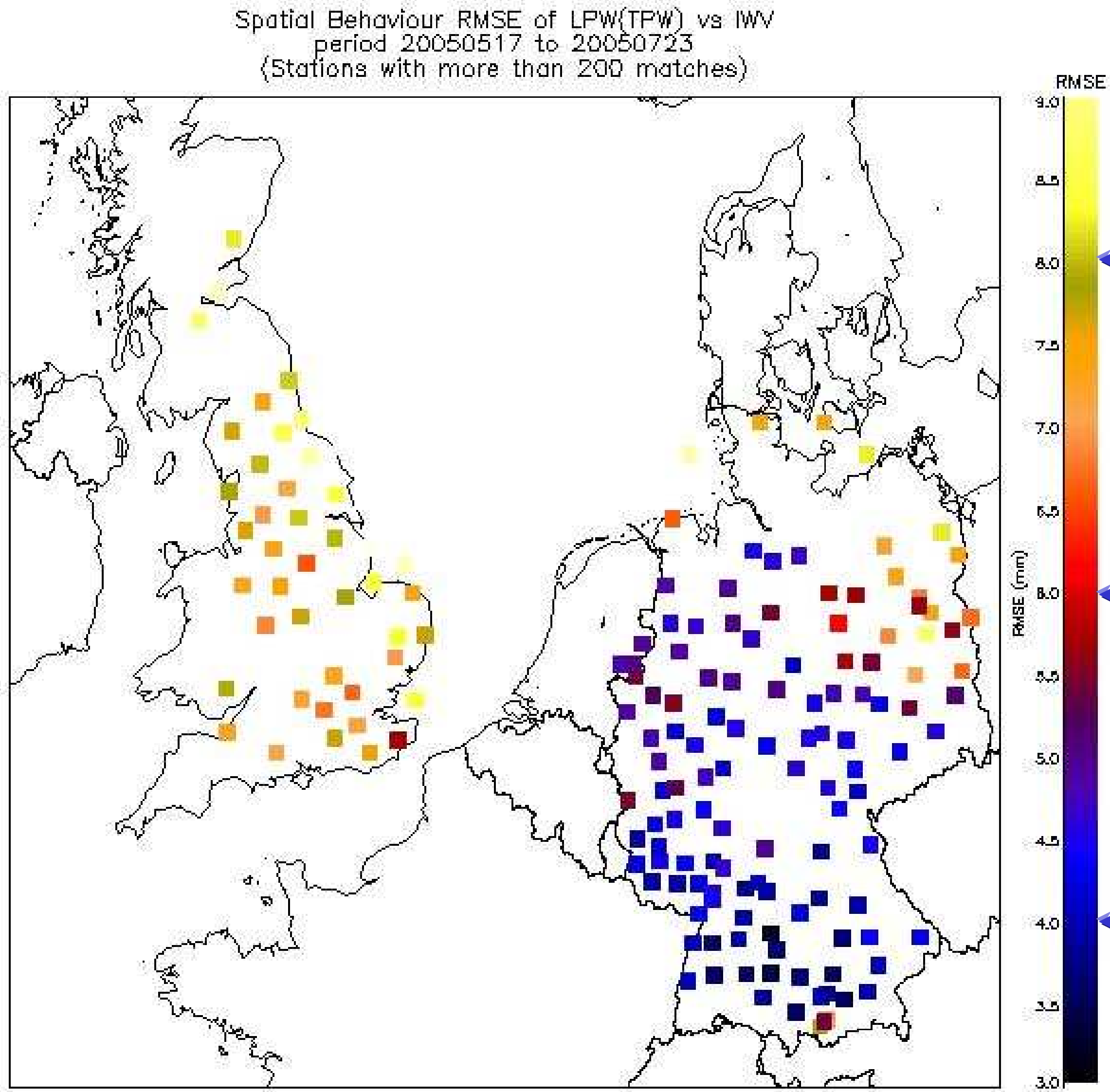
2mm

-2mm





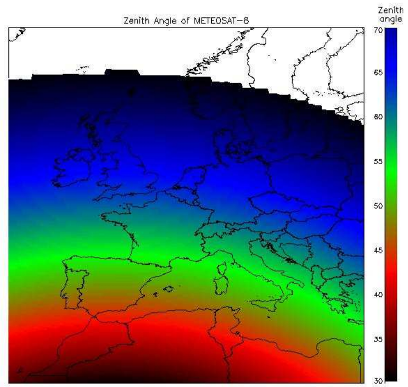
rms

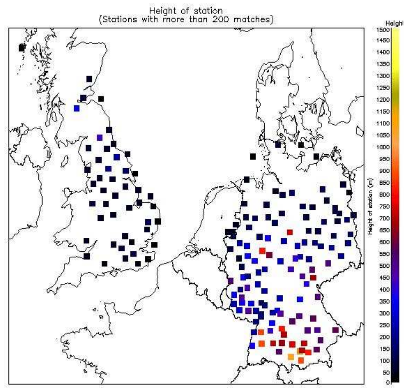


8mn

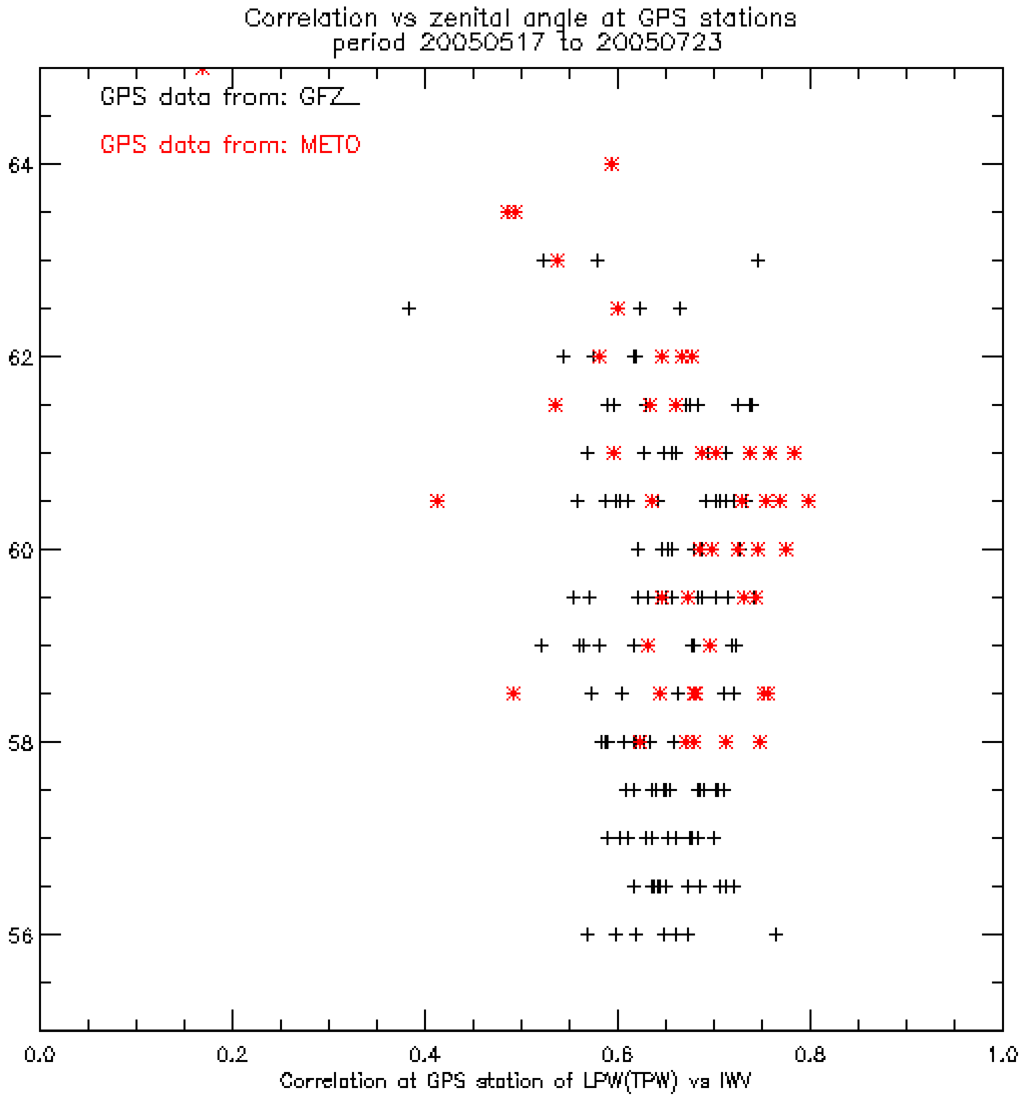
5mn

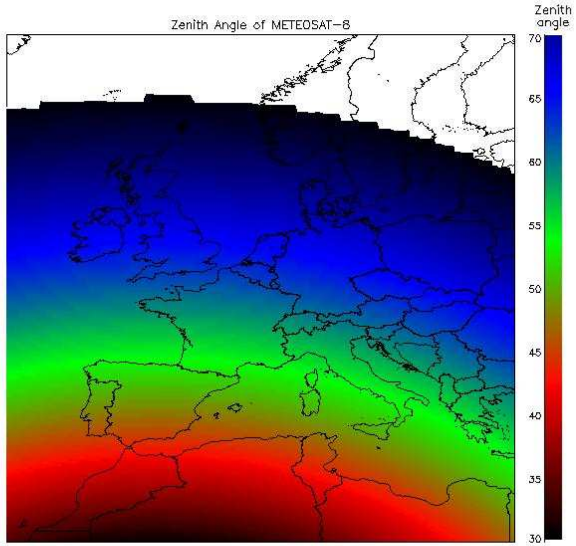
4mn





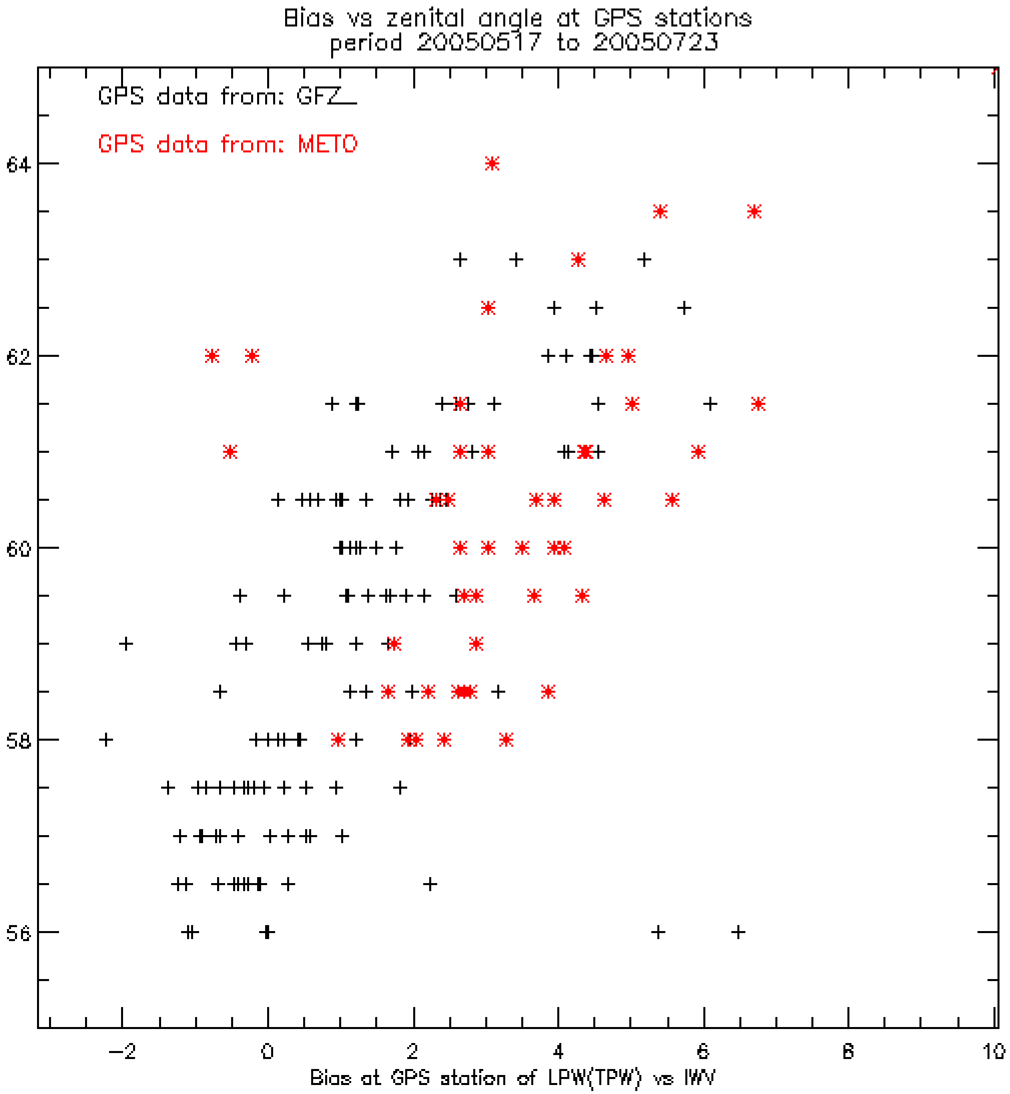
CORRELATION COEFICIENT vs ZENITAL ANGLE

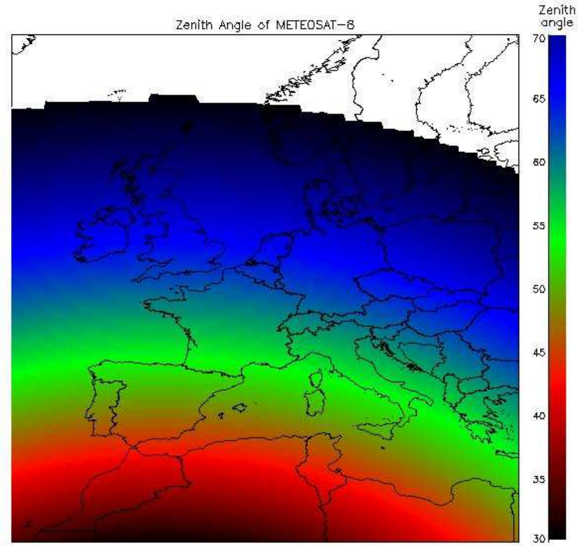




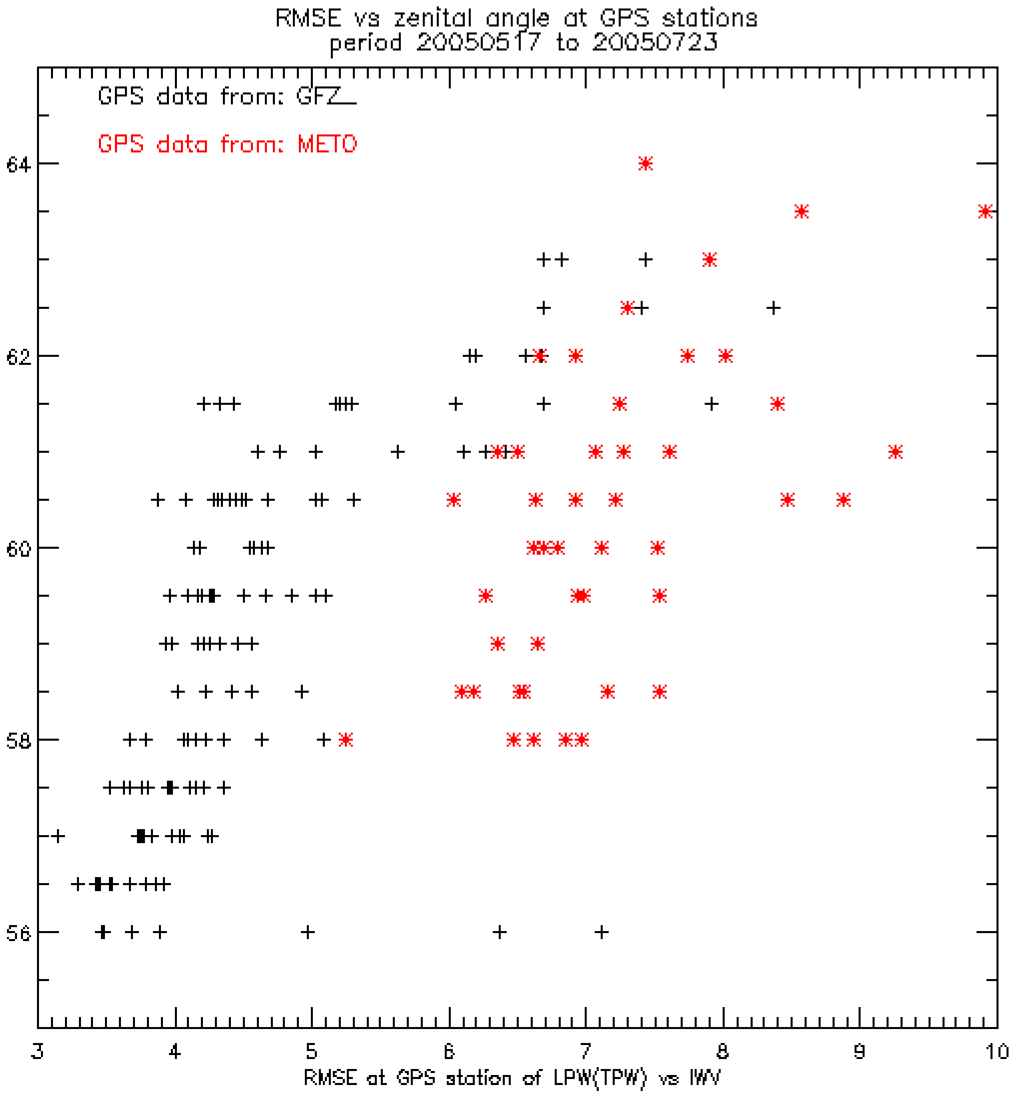
Product Assessment Review (PAR) Workshop
(Madrid, 17-18-19 October 2005)

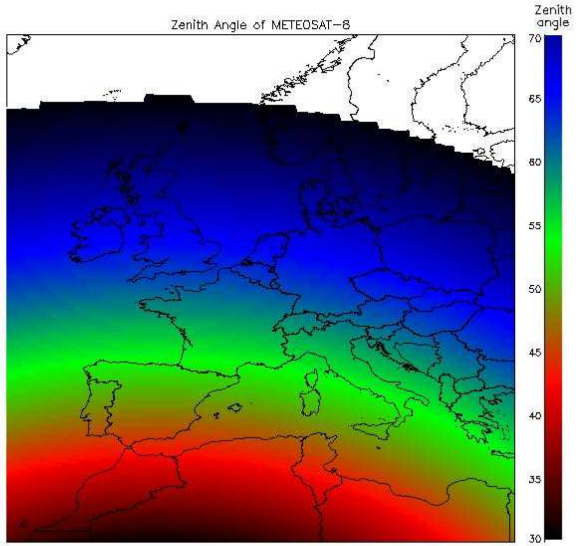
BIAS vs ZENITAL ANGLE



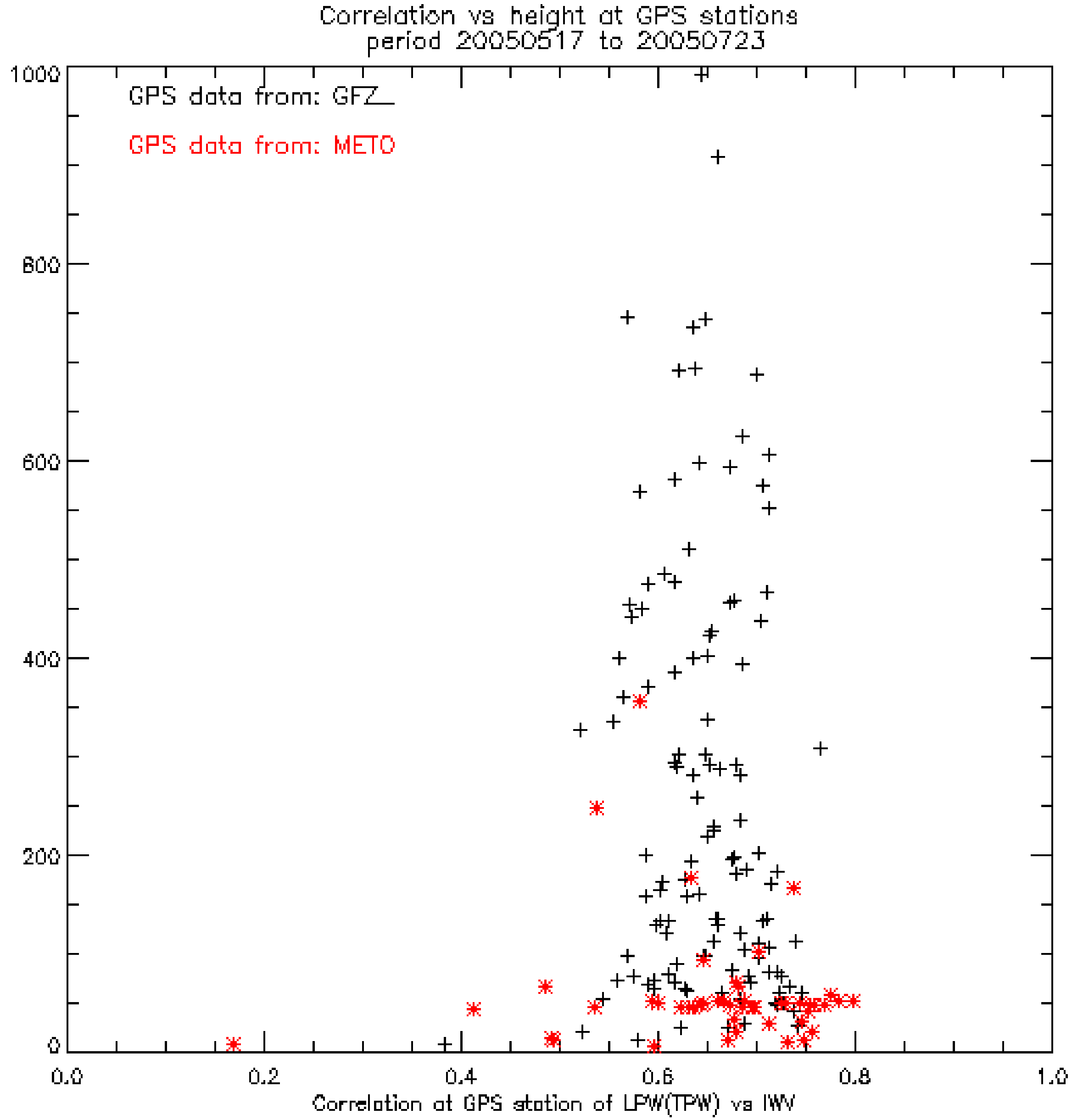


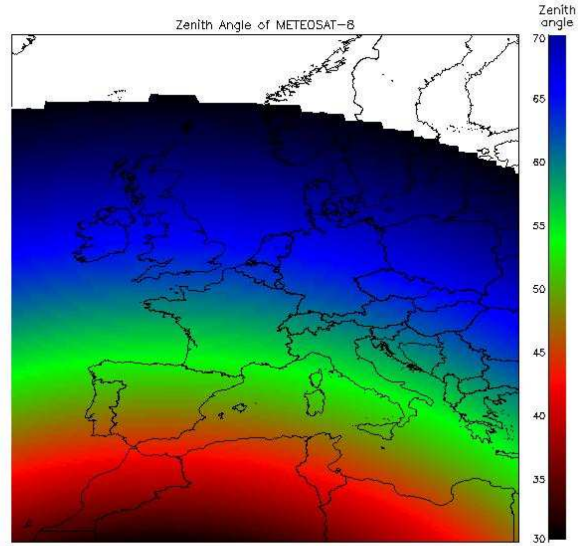
rms vs ZENITAL ANGLE

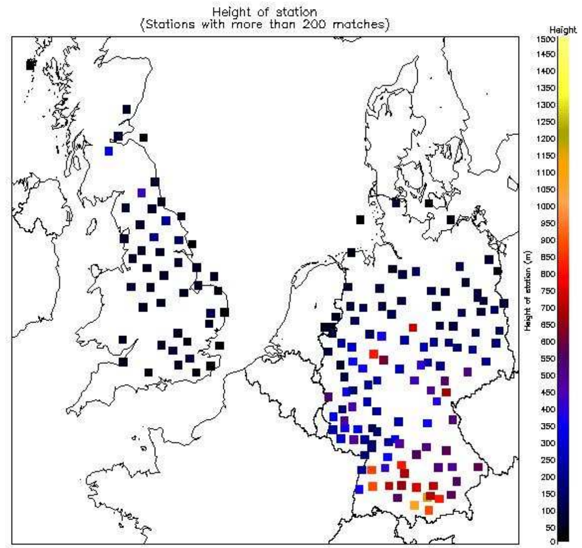




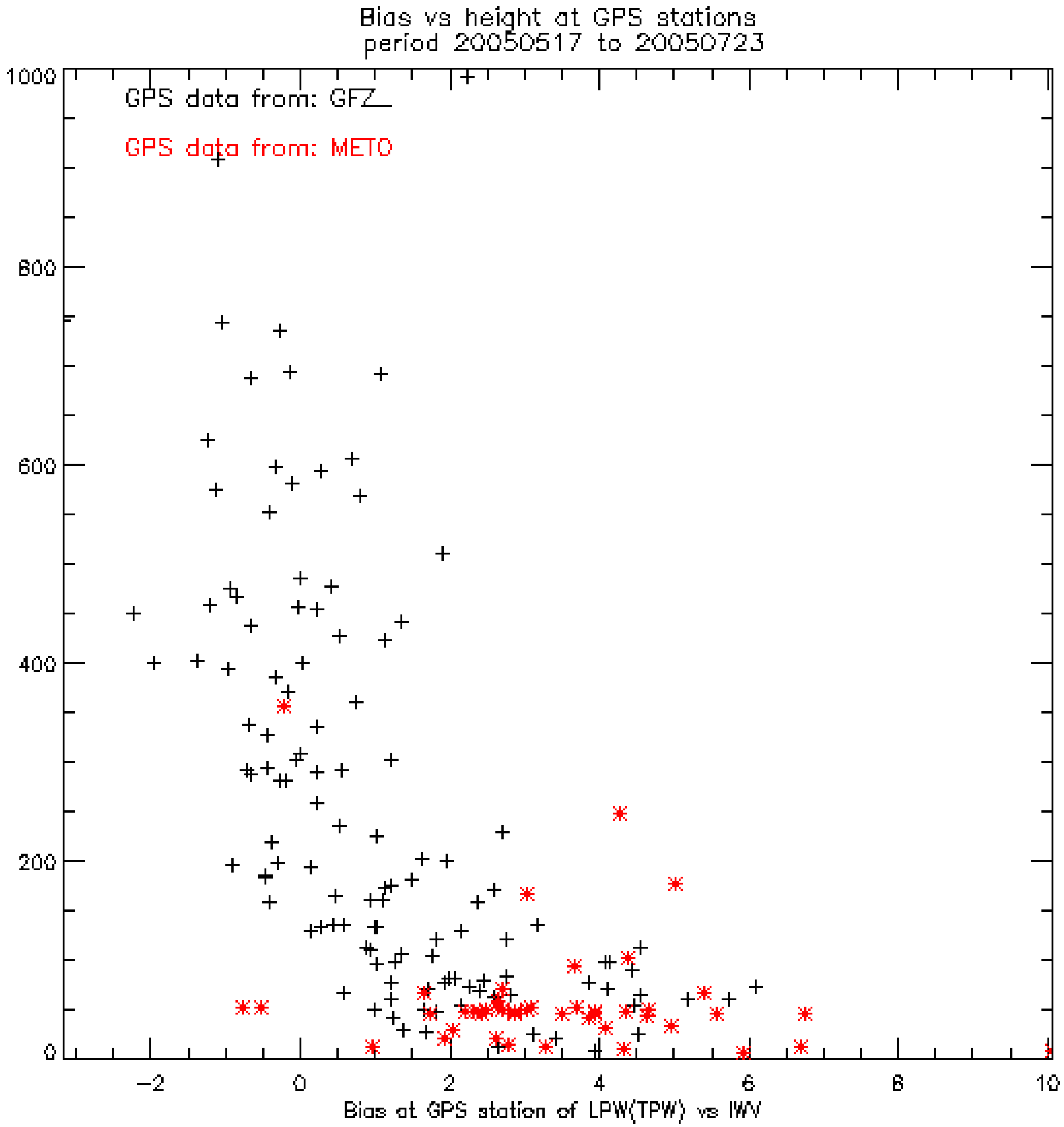
CORRELATION COEFICIENT vs HEIGHT

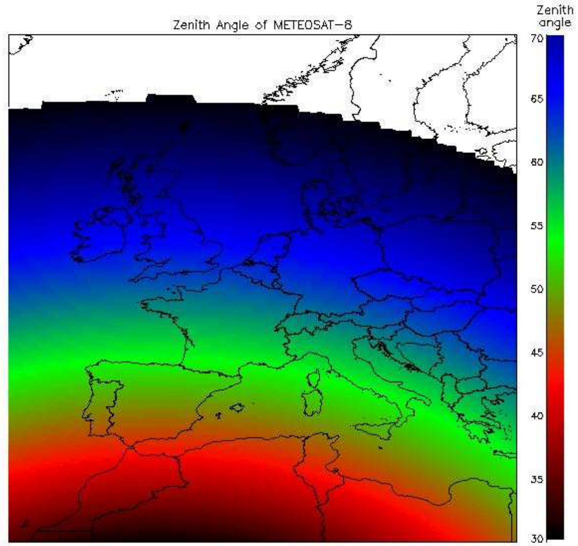


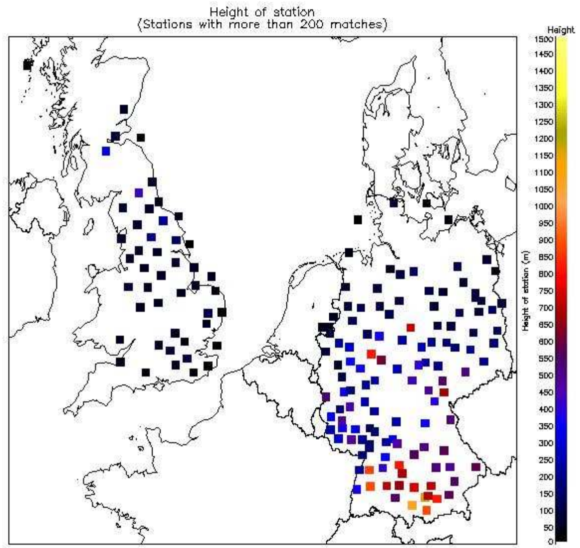




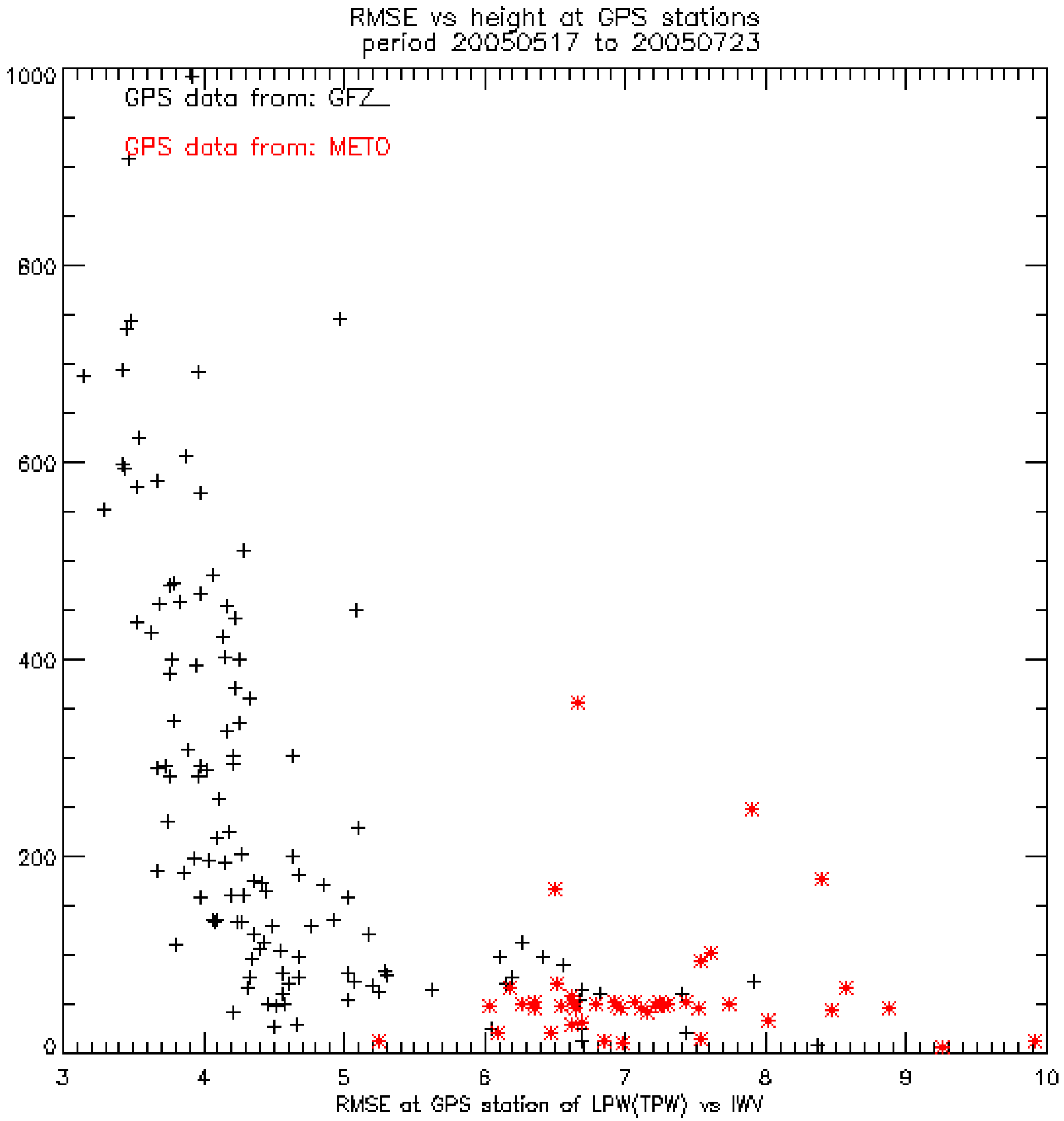
BIAS vs HEIGHT

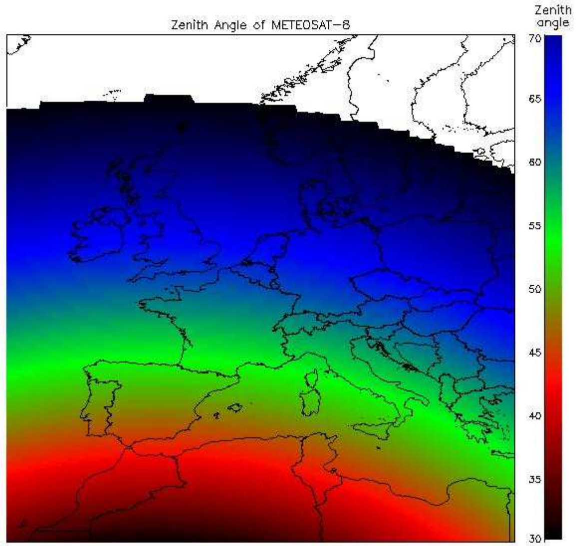


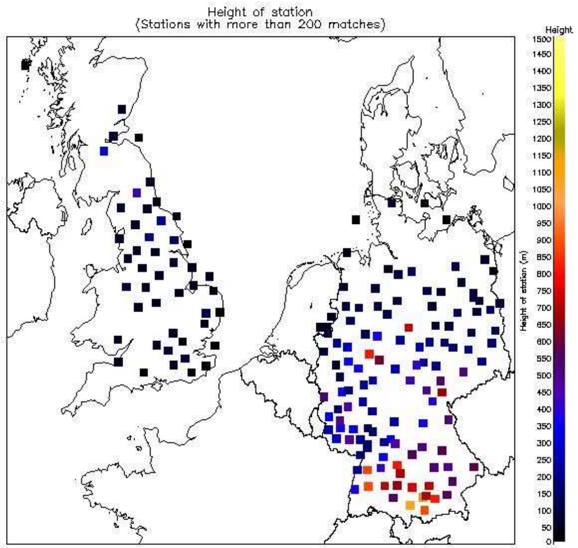




rms vs HEIGHT







CONCLUSIONS OF GPS VALIDATION (1/2)

- ✓ LPW(TPW) is systematically wetter than the GPS IWV, specially over England.
- ✓ It is most likely that the discrepancies reflect the impact of the satellite zenith angle in the LPW(TPW) algorithm.
- ✓ These results are similar to previous results obtained in the zenith angle correction study using simulated radiances. All the methods tested in that study gave good performances in LPW(TPW) after the zenith satellite correction for zenith angles lower than 60º, and for all cases the bias and rms increase significantly for zenith angle greater than 60º.
- ✓ On the other hand, the station height dependence with the rms and bias is not clear with these first datasets.

CONCLUSIONS OF GPS VALIDATION (2/2)

✓ **Future works:**

⇨ The GPS IWV and LPW(TPW) could be used together. The PWV spatial structure could be derived from LPW(TPW) at MSG resolution and the GPS interpolated values could be used to remove the data contaminated by clouds and not filtered by the SAFNWC Cloud Mask.

⇨ When the LPW(TPW) behaviour will be well established and the improvements will be designed, the knowledge acquired could be used to improve the performances in the other three LPW layers (low, middle and high levels). Due to all LPW layers have the same processing scheme.

LPW FINAL CONCLUSIONS

- ✓ LPW parameters present a good dynamic range.
- ✓ LPW statistical parameters are similar from low values to high values.
- ✓ Diurnal cycle is not detected. Therefore, the trends of the parameters can be used by the forecasters.
- ✓ LPW provides estimation independent of the NWP fields.
- ✓ Although LPW can be improved (desert pixels,…), the v1.2 is enough stable to begin to be used.

SAI FINAL CONCLUSIONS

- ✓ SAI_LI v1.2 presents a wide dynamic range.
- ✓ SAI provides estimation independent of the NWP fields.
- ✓ The trends of the LI can be used by the forecasters with best quality than LI values.
- ✓ The differences between sea and land SAI_LI in night time with ECMWF LI are also presented in MODIS LI, therefore: What's the truth?

LI discrepancies

- Discrepancies have been found in the spatial patterns of LI SAFNWC and LI ECMWF. In another hand, LPW(TPW) SAFNWC and TPW ECMWF spatial pattern present a good concordance.

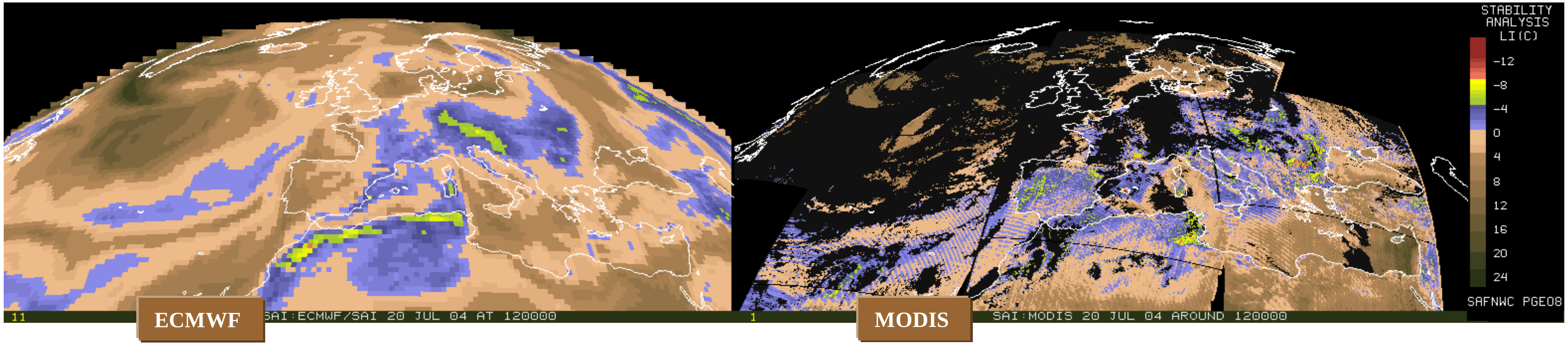
- LI and TPW supplied by GSFC have been remapped to MSG projection in order to compare with the other two sources. The comparison of the three sources give good concordance for TPW patterns and this supports the previous hypothesis of using ECMWF analysis to validate LPW(TPW) SAFNWC. The comparison of the three sources for LI patterns presents strong discrepancies especially in the Atlantic Ocean on the west of Portugal. This doesn't allow to use ECMWF analysis directly in SAI(LI) SAFNWC validation purposes.

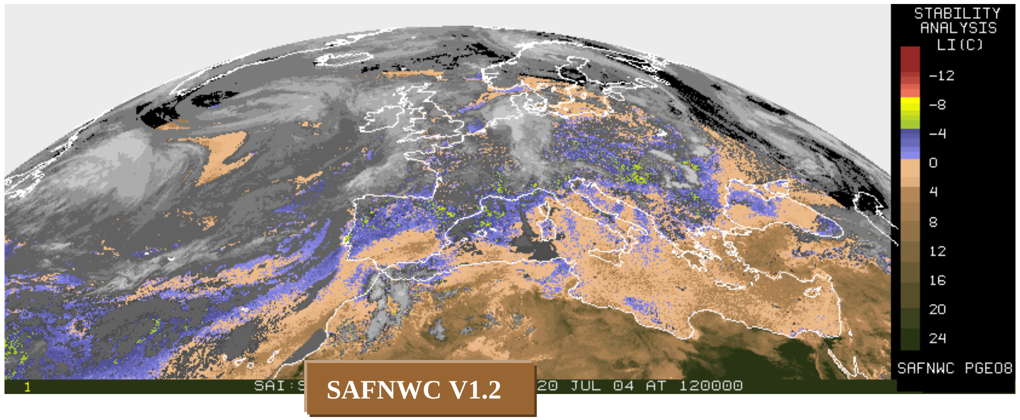
The following dates were compared

YEAR	DAY	TIME		YEAR	DAY	TIME
2004	202	12		2004	242	00
2004	203	00		2004	242	12
2004	203	12		2004	243	00
2004	204	00		2004	243	12
2004	204	12		2004	244	00
2004	205	00		2004	244	12
2004	205	12		2004	245	00
2004	206	00		2004	245	12
2004	235	00		2004	246	00
2004	235	12		2004	246	12
2004	240	00		2004	247	00
2004	241	00		2004	247	12
2004	241	12		2004	248	00

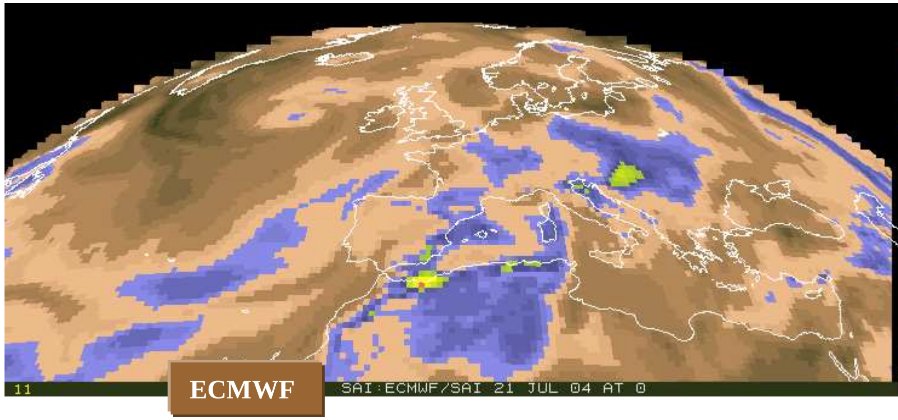
Highlighted in green the most discrepant cases

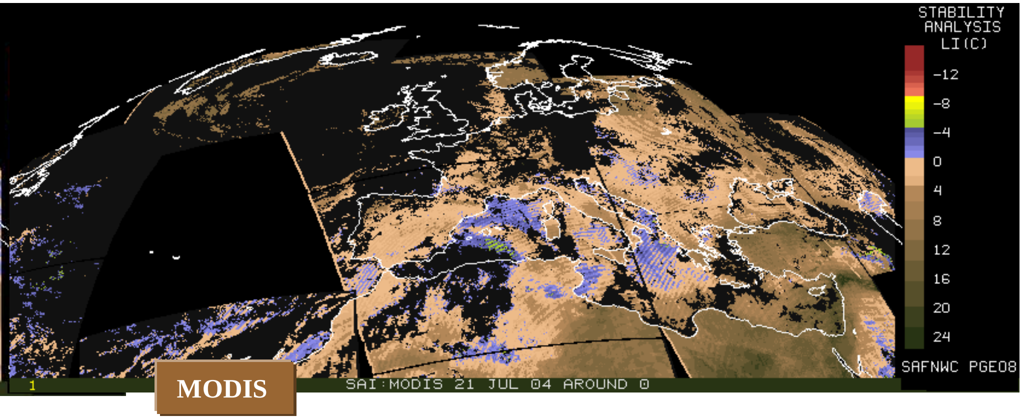
What's the truth?
(20 –july-2004 at 12 GMT)

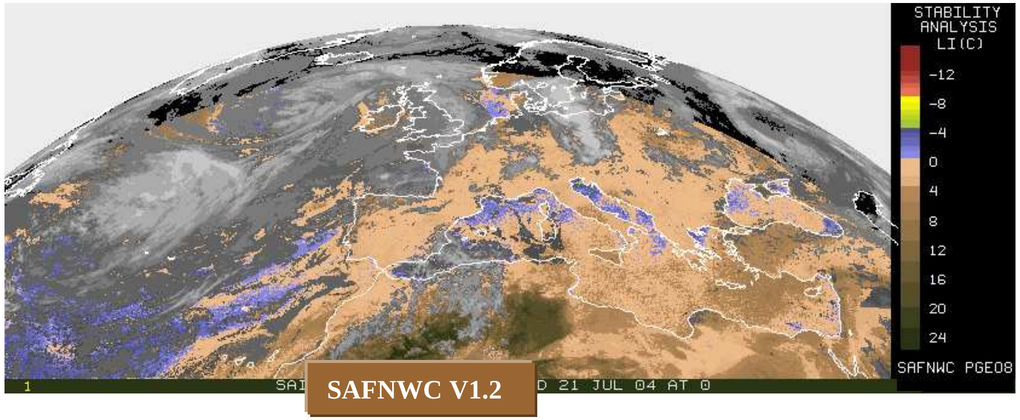




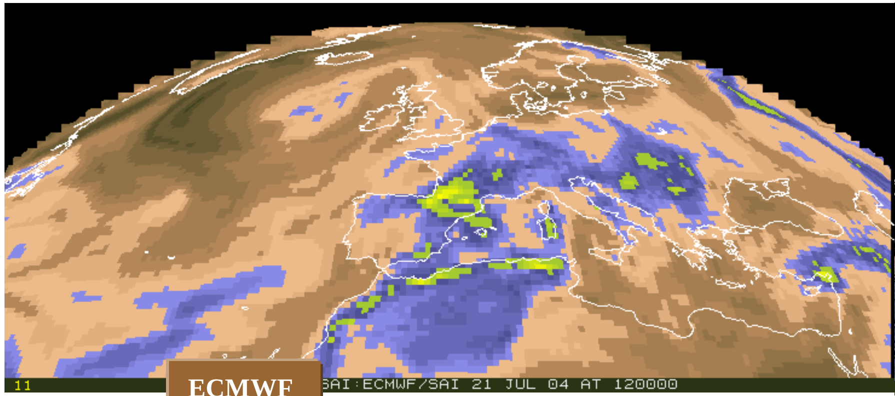
What's the truth?
(21 –july-2004 at 00 GMT)



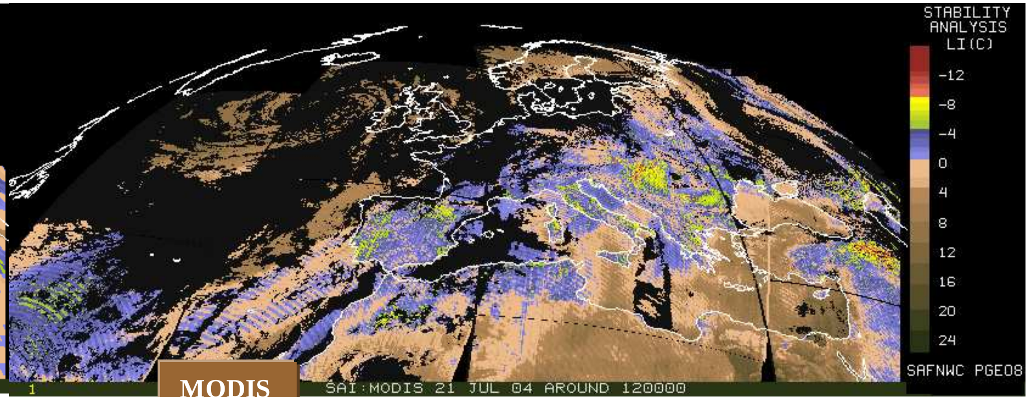




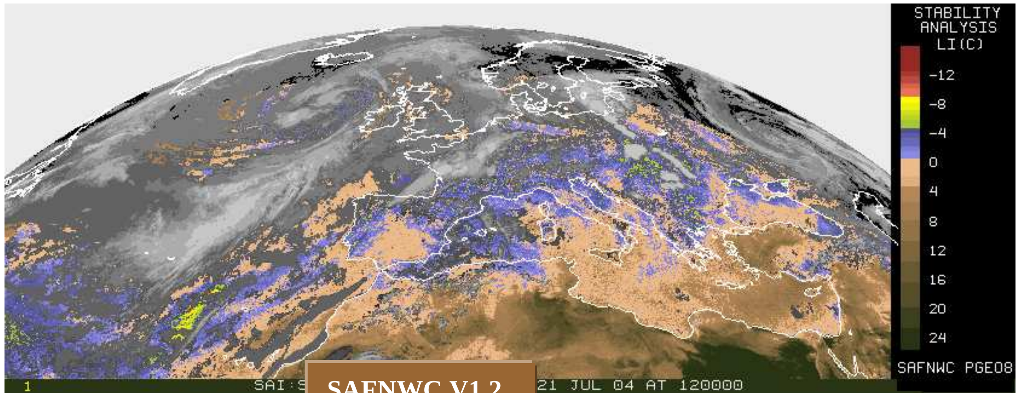
What's the truth?
(21 –july-2004 at 12 GMT)



ECMWF



MODIS



SAFNWC V1.2

MAIN FUTURE WORKS

⇨ The radiances bias correction should be improved.

⇨ To investigate possible solution to obtain algorithms for desert areas.

⇨ The GPS IWV and LPW(TPW) could be used together.

⇨ To use this reference period to check the future improvements.

⇨ To perform an objective comparison between MODIS LI and SAI LI, in order to detect potential improvements.