REPORT

Improvement of surface analysis (for assimilation purpose)

Toulouse, 15th October – 14th December 2001.

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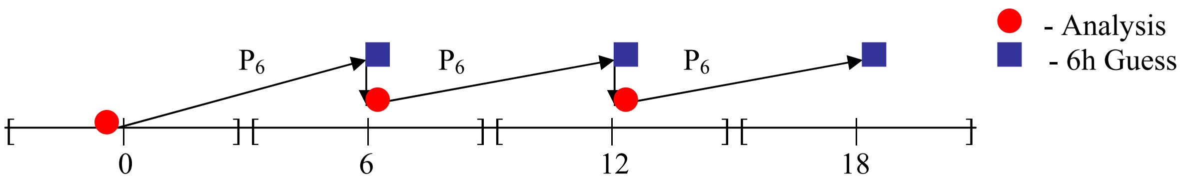
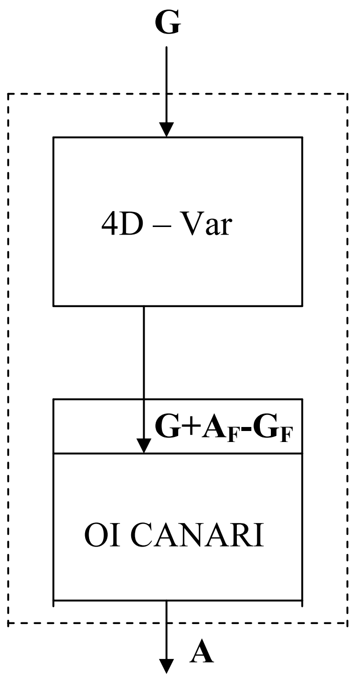
Toulouse, 14th December 2001.

1. Why 2m analyses of T_{2m} and H_{2m}?

Data Assimilation cycle in ARPEGE is defined as shown bellow.



Next diagram presents Upper-air Analysis and Surface Analysis in Assimilation cycle



Upper-air Analysis

A_F and G_F are filtered

Surface Analysis is performed with Upper-air Analysis. Analysis is performed on next Surface parameters (T_S, T_P, W_S, W_P, SNS)

Surface Analysis is performed in 4 steps:

a) computation of Obs – Guess,
b) control of observation to the Guess,
c) 2m analyses T_{2m}, H_{2m},
d) analyses of T_S, T_P, W_S, W_P and relaxation for SNS.

$$(T_S)^A - (T_S)^G = (T_{2m})^A - (T_{2m})^G = \Delta T_{2m}$$

$$(T_P)^A - (T_P)^G = 1/\tau \, \Delta T_{2m}$$

$$(W_S)^A - (W_S)^G = \alpha_T \, \Delta T_{2m} + \alpha_H \, \Delta H_{2m}$$

$$(W_P)^A - (W_P)^G = \beta_T \, \Delta T_{2m} + \beta_H \, \Delta H_{2m}$$

where α_T, α_H, β_T and β_H are functions of soil texture, vegetation, local solar time, LAI/R_{smin} (leaf area index/min. surface resistance) cloudiness and other met. fields (wind, rain, snow, …)

2. Description of T_{2m} and H_{2m} Analysis

Univariates **O**ptimal **I**nterpolation Analysis is performed in operational ARPEGE. Variables are T_{2m} and H_{2m} because they are input for Analysis of other surface fields.

For Surface Analysis Observation data from SYNOP, BUOY and SHIP are used.

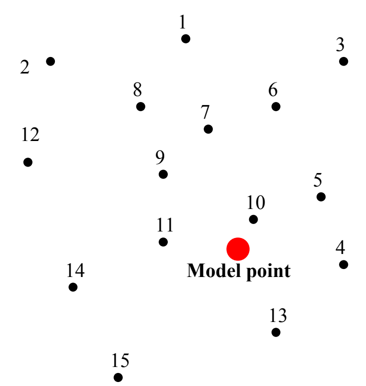
For T_{2m} Analysis just T_{2m} data are used $$\mathbf{T^A_{2m}=T^G_{2m}+\sum_{i=1}^{15}\alpha_i\left(\left(T^O_{2m}\right)_i-\left(T^G_{2m}\right)_i\right)}$$

For H_{2m} Analysis just H_{2m} data are used $$\mathbf{H^A_{2m}=H^G_{2m}+\sum_{i=1}^{15}\alpha_i\left(\left(H^O_{2m}\right)_i-\left(H^G_{2m}\right)_i\right)}$$

Control of Observations in operational suite is performed just with Control to the Guess like it is shown below.

Control to the Guess if $\mathbf{\frac{|O-G|}{\sqrt{\sigma_O^2+\sigma_G^2}}>k}$ then observation is rejected.

No Quality Control $\mathbf{\frac{|O-A|}{\sqrt{\sigma_O^2+\sigma_A^2}}>k'}$. In case of local storm data are rejected with control of the Guess, but with Quality Control that information about storm will be in the Analysis.



Correlation function is supposed to be isotropic and homogenous. No vertical correlation for the Surface fields. Correlation function is defined with next function:

$\rho_{12}=\mathbf{exp(-\frac{1}{2}\frac{r^2}{a^2})}$, where r is the distance between two points.

Closest 15 points are used to compute Analysis in model point with next equation:

$$\mathbf{T^A_{2m}=T^G_{2m}+\sum_{i=1}^{15}\alpha_i\left(\left(T^O_{2m}\right)_i-\left(T^G_{2m}\right)_i\right)}$$

αi are optimal known background and observation point statistics and is computed from next matrix equation.

$$\left(\overline{\overline{\mathbf{B}}}+\overline{\overline{\mathbf{O}}}\right)\overline{\alpha}_i=\overline{\mathbf{C}}_i$$

$\overline{\overline{\mathbf{B}}}=\left[\rho^G_{ij}\right]$ - background covariance matrix $1\le i\le 15$, $1\le j\le 15$

$\overline{\overline{\mathbf{O}}}=\left[\rho^O_{ij}\right]$ - Obs covariance matrix $1\le i\le 15$, $1\le j\le 15$

$\overline{\mathbf{C}}_i=\left[\rho^G_j\right]$ - background error covariance between grid points and observation points $1\le j\le 15$

3. Statistical model

Canari is OI Analysis, and it changes the Guess value of the variable in model grid points. How much it will change the value depends on the standard deviation of the Observations and the standard deviation of the Guess and of course on correlation coefficient.

Operational values in ARPEGE namelist are:

$\sigma^{G}_{T2m} = 2.3$ °C $\sigma^{G}_{H2m} = 0.17 = 17$ % $\boldsymbol{\sigma^{G} = \sigma^{G}_{namelist} * \exp[-\alpha\,(m - \frac{1}{m})]^{2}}$

$a_{T2m} = 350$ km $a_{H2m} = 300$ km $\boldsymbol{a^{G} = a^{G}_{namelist} * \exp[-\alpha\,(m - \frac{1}{m})]}$

$\alpha = 0.02$ is coefficient that defines how much namelist values will be changed dependency of stretching factor m, $1/3.5<m<3.5$.

Extreme values for operational run are in the table bellow.

	France (m=3.5)	Antipode (m= 1/3.5)
σ^{G}_{T2m}	2.02 °C	2.61 °C
σ^{G}_{H2m}	14.9 %	19.3 %
a_{T2m}	328 km	376 km
a_{H2m}	281 km	320 km

These values were similar to the values when CANARI was used operationally in Assimilation cycles and for Upper-air Analyses and for Surface Analyses, because at that time it was possible to have common statistical model. That is the reason why the new statistics are calculated.

4. Calculation of correlation and stand. deviations of Obs and Guess errors

Using a comparison between Obs and 6 hours forecast it is possible to calculate coefficient of correlation and standard deviation of Obs and Guess.

Mean difference between Obs and Guess is defined with the following formula:

$$\overline{(O-G)^2} = \overline{(O-T+T-G)^2} = \overline{(O-T)^2} + 2\overline{(O-T)(T-G)} + \overline{(T-G)^2} = \sigma_O^2 + \sigma_G^2$$

where O is value of Observation, G is value of the Guess and T is True value which is not known. It is supposed that correlation between error of Guess and error of Obs is = 0.

Mean difference between Obs and Guess at two points is:

$$\overline{(O_1-G_1)(O_2-G_2)} = \overline{[(O_1-T_1)+(T_1-G_1)][(O_2-T_2)+(T_2-G_2)]} = \text{ | all Guess Obs correlation = 0 | =}$$

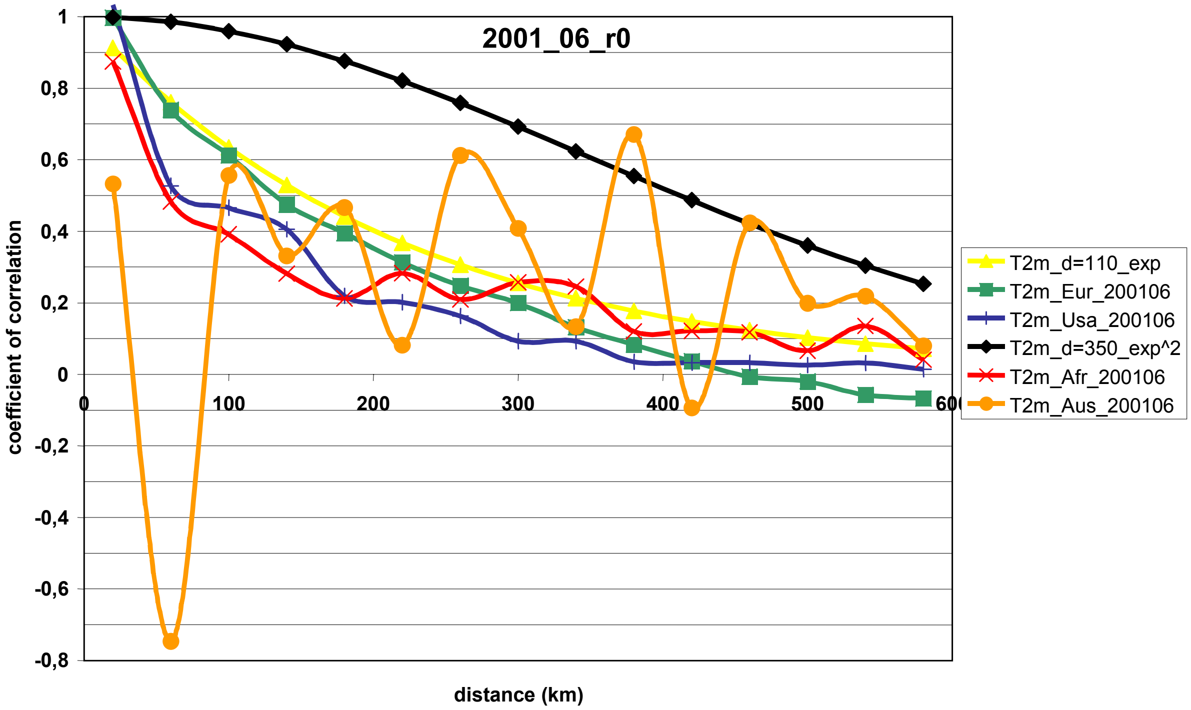
$$= \overline{(O_1-T_1)(O_2-T_2)} + \overline{(T_1-G_1)(T_2-G_2)} = \overline{(T_1-G_1)(T_2-G_2)} = \rho^G_{12}\sigma_{G1}\sigma_{G2} = \rho^G_{12}\sigma^2_G$$

It is supposed that correlation between Observation errors in two points is = 0.

Because correlation coefficient is a function of the distance between two points, mean difference between Obs and Guess ($\overline{(O_1-G_1)(O_2-G_2)}$) is divided in 14 equidistance classes (40 km) in calculations.

5. Results of statistical calculations

Correlation coefficients are calculated separately for different domains. Calculations are made for every 3rd day in December 2000 and June 2001 for 00 run for 4 domains. For Europe domain calculations are made for December 2000 January, February, Jun, July and August 2001.



Picture 1. Coefficient of correlation dependency to distance between points for different domains, black line represents operational coefficient of correlation, and yellow the new definition

Because the correlation function $\rho_{12}=\exp(-\frac{1}{2}\frac{r^2}{a^2})$ does not fit the empirical correlation coefficient, the new function $\rho_{12}=\exp(-\frac{1}{2}\frac{r}{a})$ is tested.

Namelist values for tested function are:

$\sigma^G_{T2m} = 1.7$ °C $\sigma^G_{H2m} = 0.13 = 13$ %

$a_{T2m} = 105$ km $a_{H2m} = 101$ km

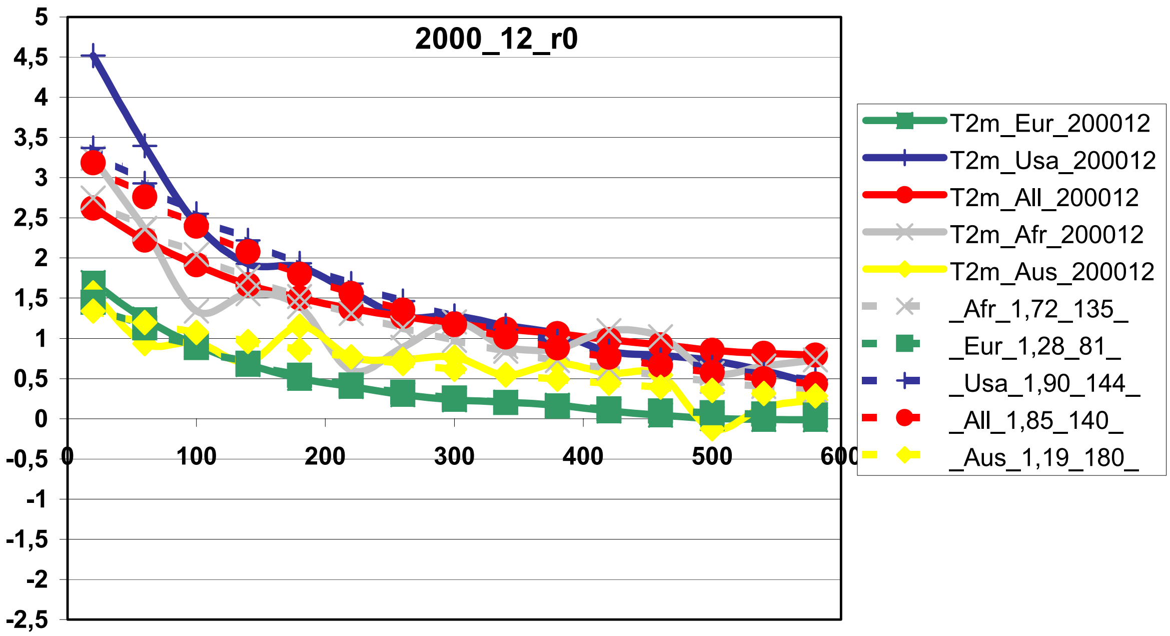
$\alpha = 0.05$.

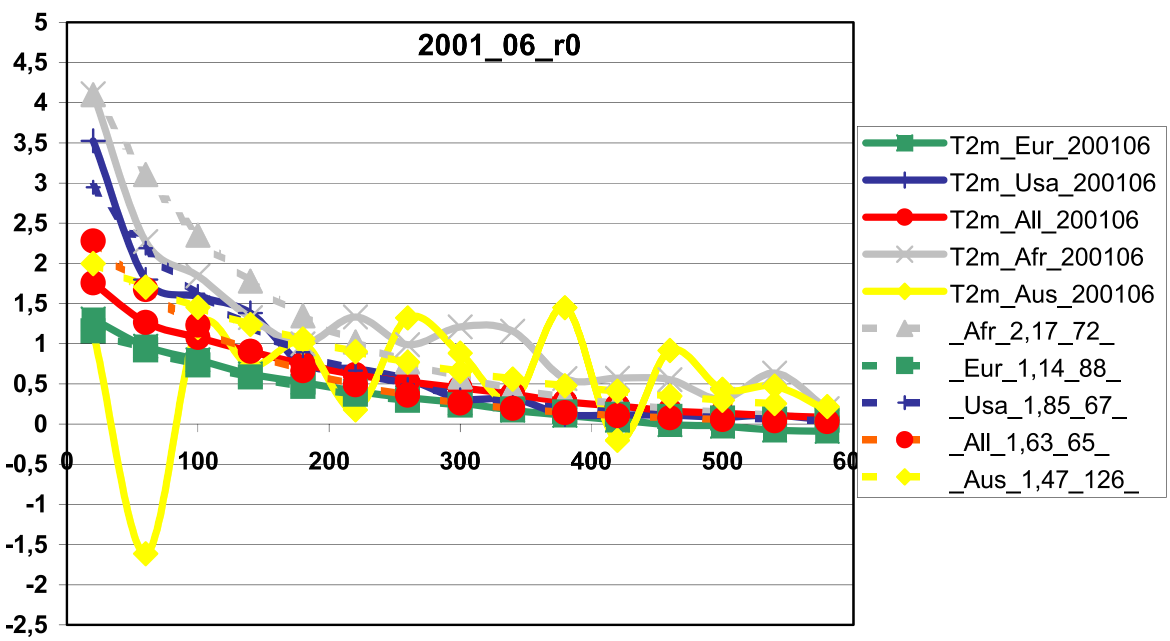
Extreme values for the test run are in the table bellow.

	France (m=3.5)	Antipode (m= 1/3.5)
σ^G_{T2m}	1.23 °C	2.34 °C
σ^G_{H2m}	9.4 %	17.9 %
a_{T2m}	89 km	123 km
a_{H2m}	86 km	119 km

Dependency on the domain

Correlation coefficient multiplied with square of standard deviation of Guess dependency to distance between points for different domains for December 2000 and June 2001, and with dashed line results with the first assumption for standard deviation of Guess and radius for new function are shown on the following picture. On the next two pictures it is obvious that there is not enough data in Australian and African domain, curves from those are not smooth like it is case for Europe.

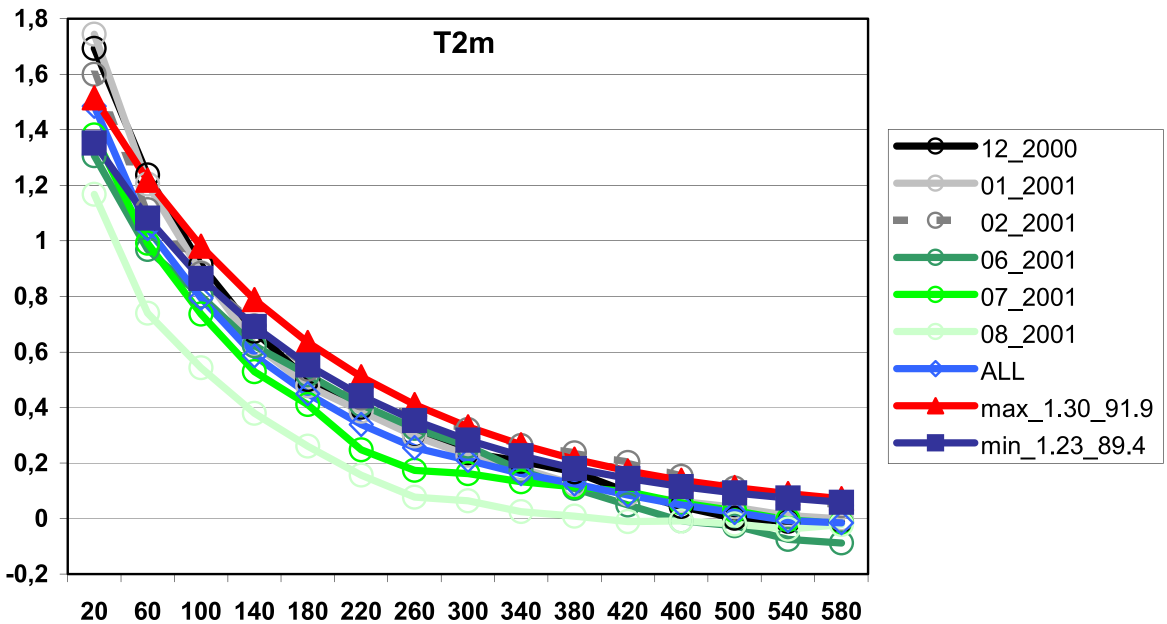


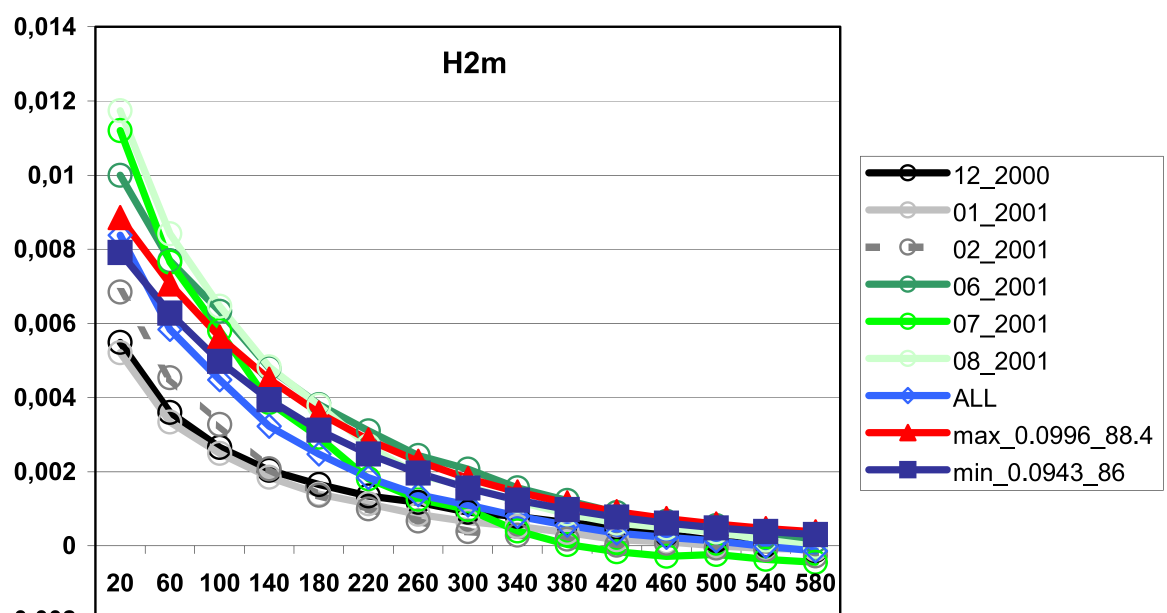


Picture 2. Correlation coefficient multiplied with square of standard deviation of Guess dependency to distance between points for different domains for December 2000 and June 2001, with dashed line results with the first assumption for standard deviation of Guess and radius for new function

Dependency to time of the year

For Europe statistical calculations are made for 6 months, variation is not that big like it is for the other domains. Red and dark blue line are minimum and maximum of multiplied coefficient of correlation and squared standard deviation of Guess. If the value for temperature is higher then the value for humidity is lower when we compare them with mean values for all 6 months.

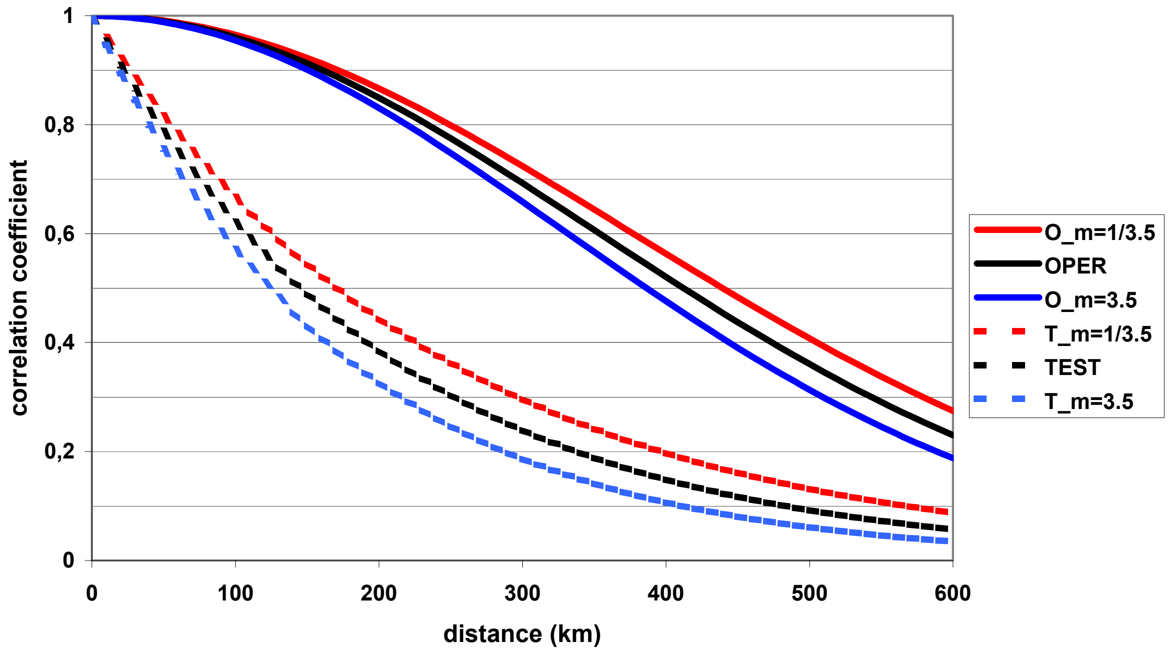




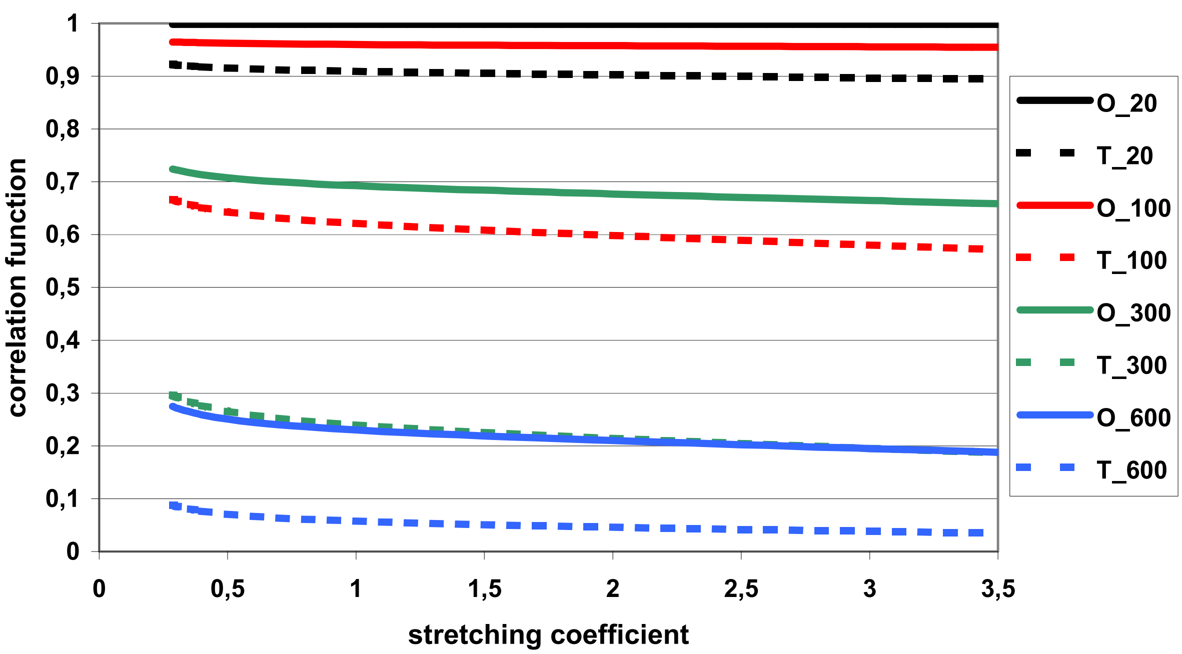
Picture 3. Coefficient of correlation multiplied with square of standard deviation of Guess dependency to distance between points for Europe for 6 months

6. Definition of new and old function and namelists parameters

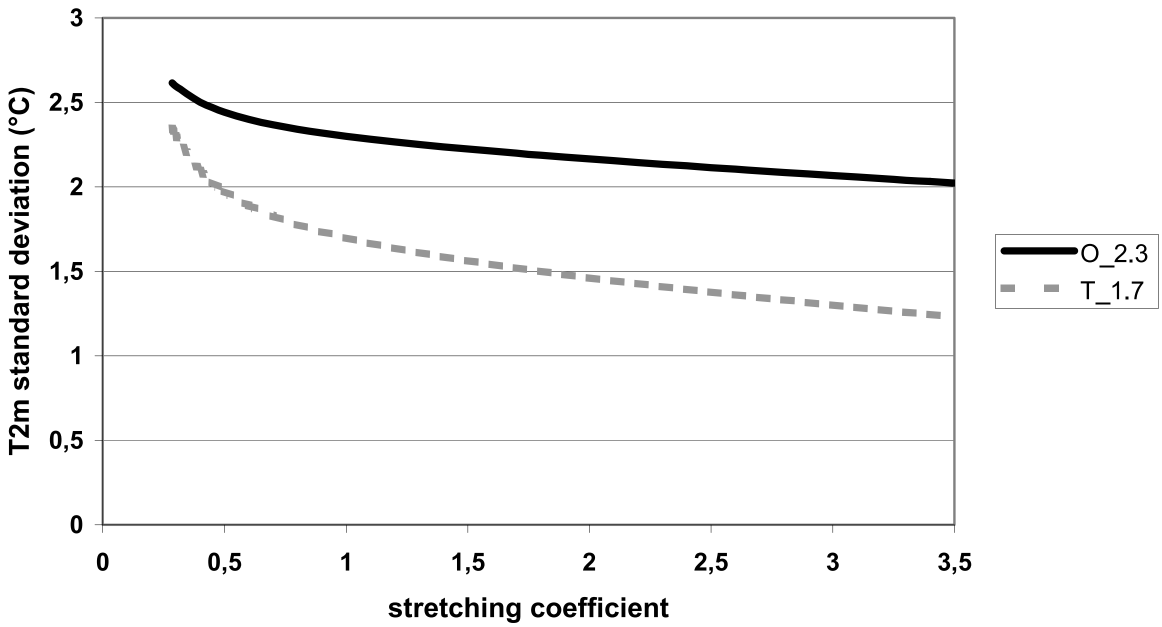
Next pictures will present the difference between new and old definition of parameters. Operational definition is presented with full lines and in legends with letter O, new definition is presented with dashed lines and with letter T.



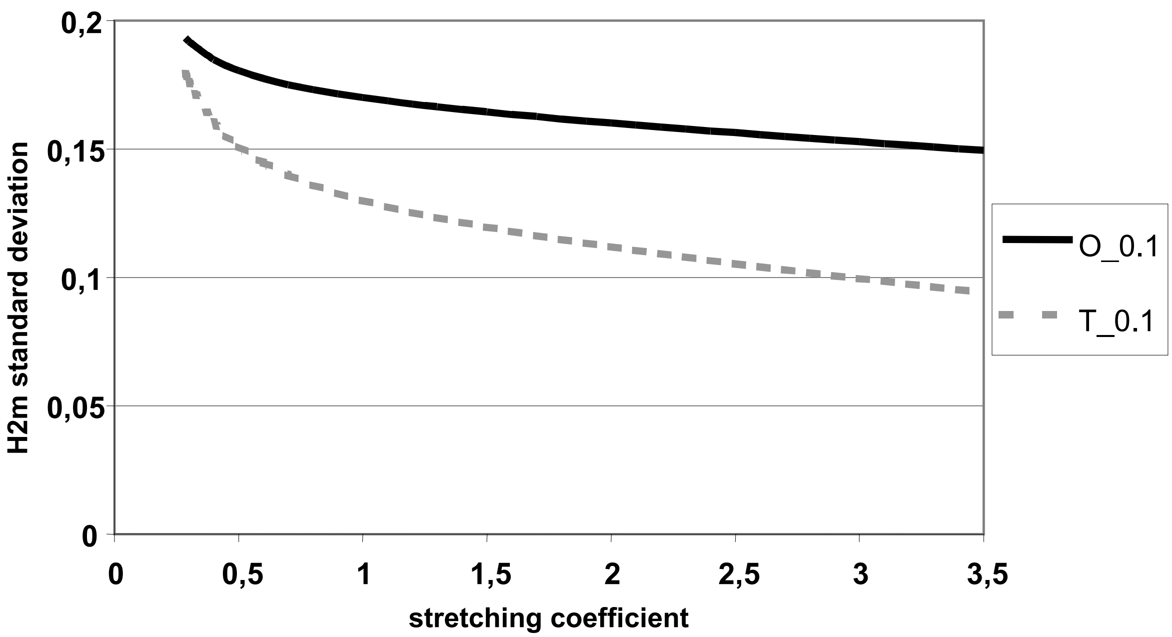
Picture 4. Coefficient of correlation dependency to distance between points for old (O-operational) and new (T-test) for stretching coefficient (1/3.5, 1 & 3.5)



Picture 5. Coefficient of correlation dependency to stretching coefficient for different distance between points for old (O-operational) and new (T-test) function



Picture 6. Standard deviation of 2 m Temperature dependency to stretching coefficient for old (O-operational) and new (T-test) function

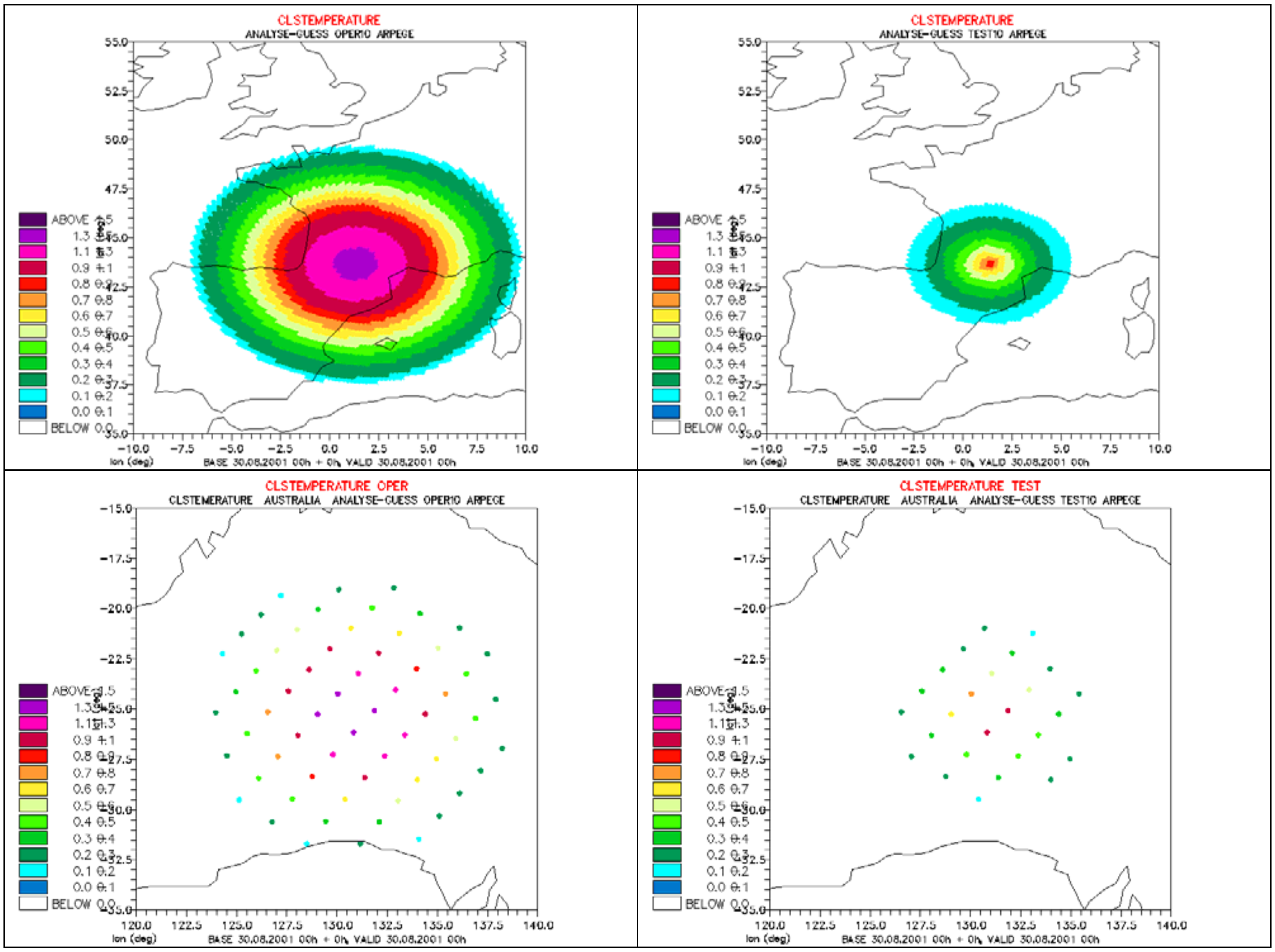


Picture 7. Standard deviation of Relative Humidity on 2 m dependency to stretching coefficient for old (O-operational) and new (T-test) function

7. One point tests

Impact on 2 m Temperature

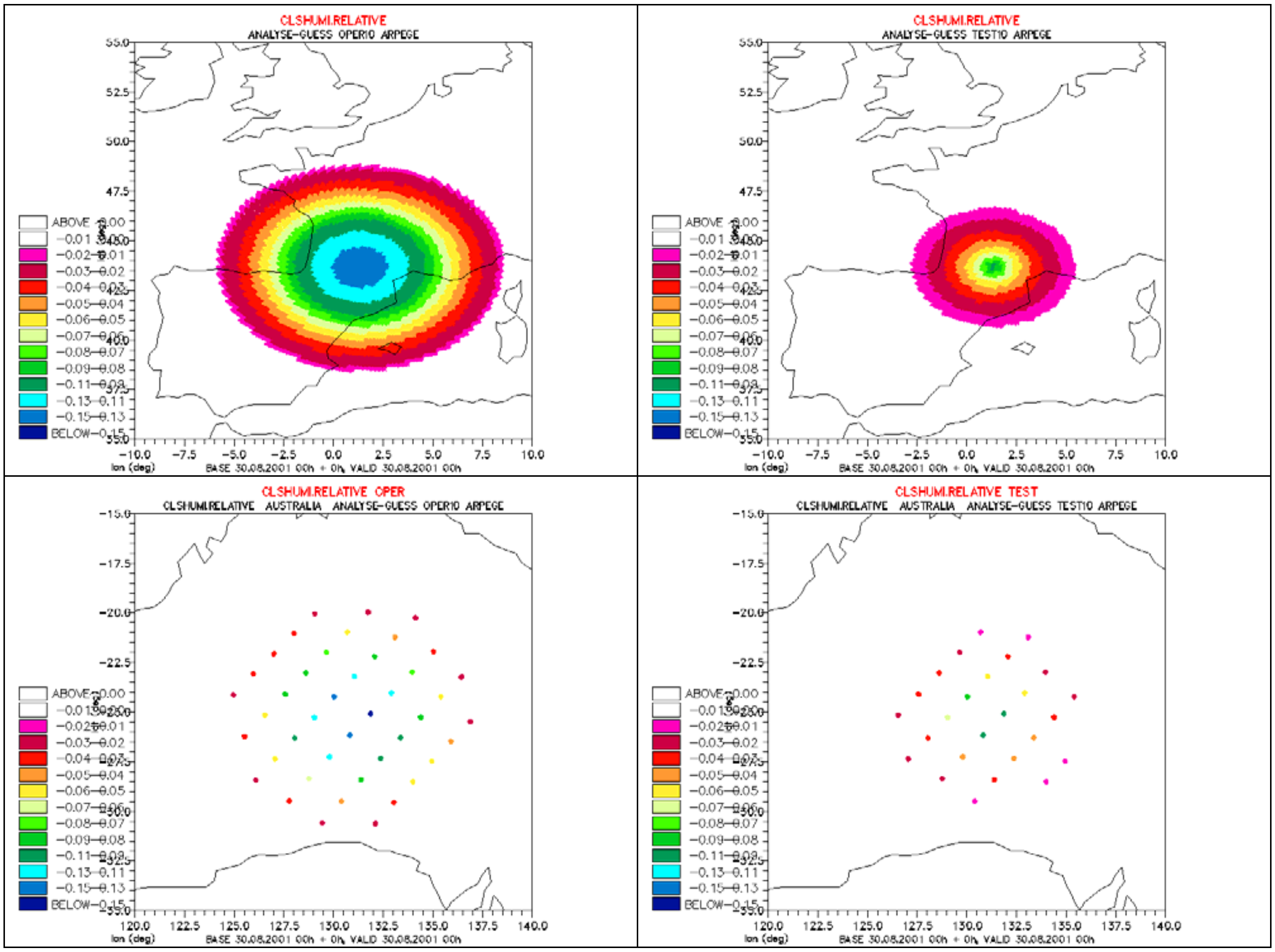
In one grid point 2 m Temperature Obs value is different from the Guess value for +2 °C. Impacts over Europe and Australia are shown on the following pictures. Amplitude and radius for one point impact is smaller with the new function and the new standard deviation of Guess.



Picture 8. Impact of 2 °C difference between Guess and Observation in a single point over Europe and Australia for 2 m Temperature for old (OPER-operational) and new (TEST-test) function

Impact on 2 m Relative Humidity

In one grid point 2 m Relative Humidity Obs value is different from the Guess value for –0.2. Impacts over Europe and Australia are shown on the following pictures. Like it is for 2 m Temperature, amplitude and radius for one point impact is smaller with the new function and the new standard deviation of Guess.



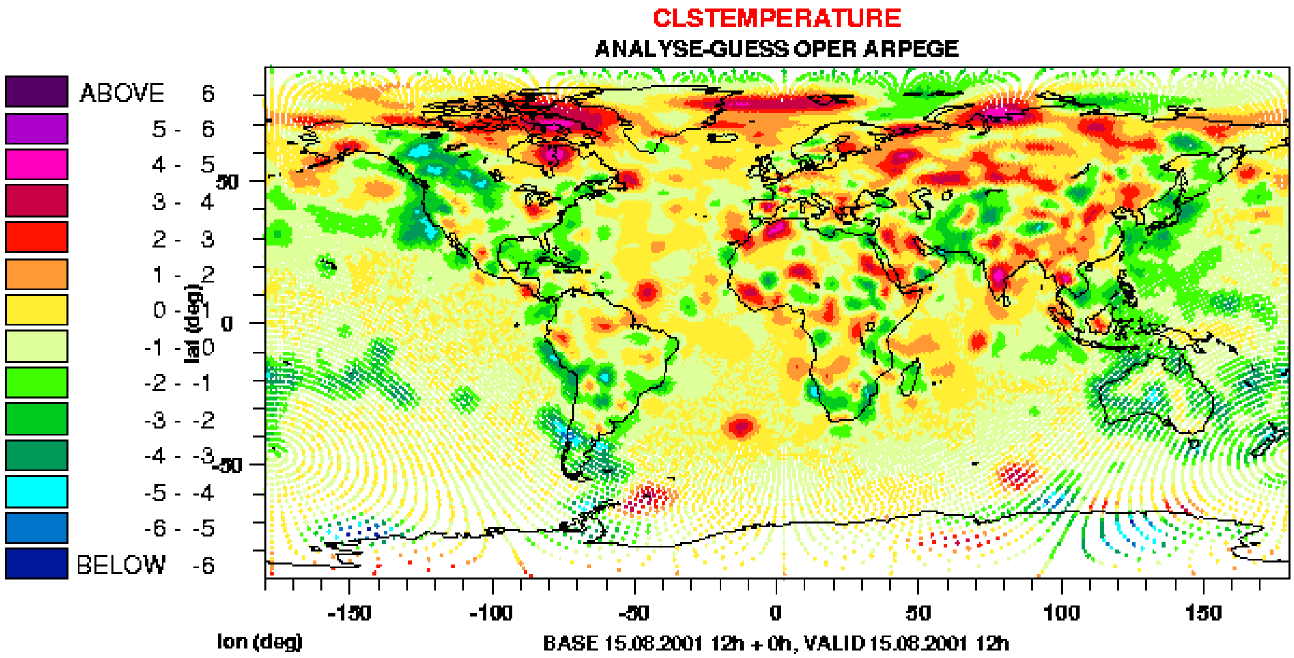
Picture 8. Impact of 0.2 difference between Guess and Observation in a single point over Europe and Australia for 2 m Relative Humidity for old (OPER-operational) and new (TEST-test) function

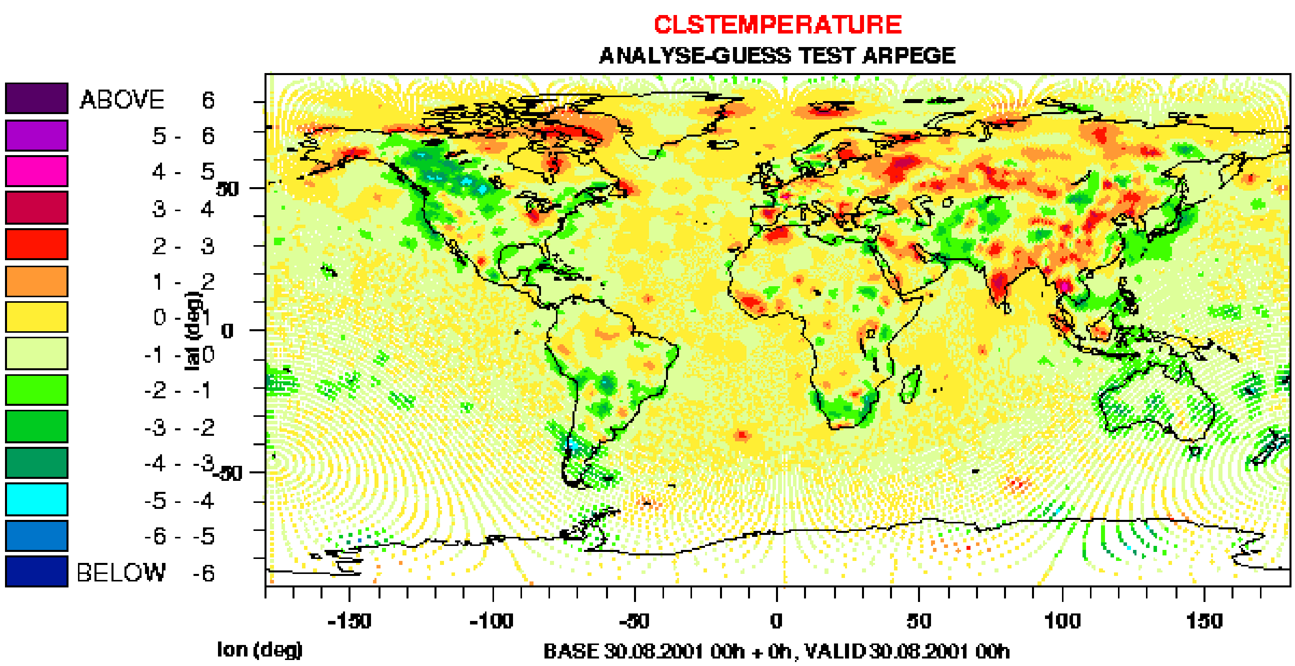
8. Difference between Operational and Test experiment

Analysis in Observation points is calculated as mean value of Analysis values in 4 nearest model points. That mean values were compared with Observation values.

2 m Temperature

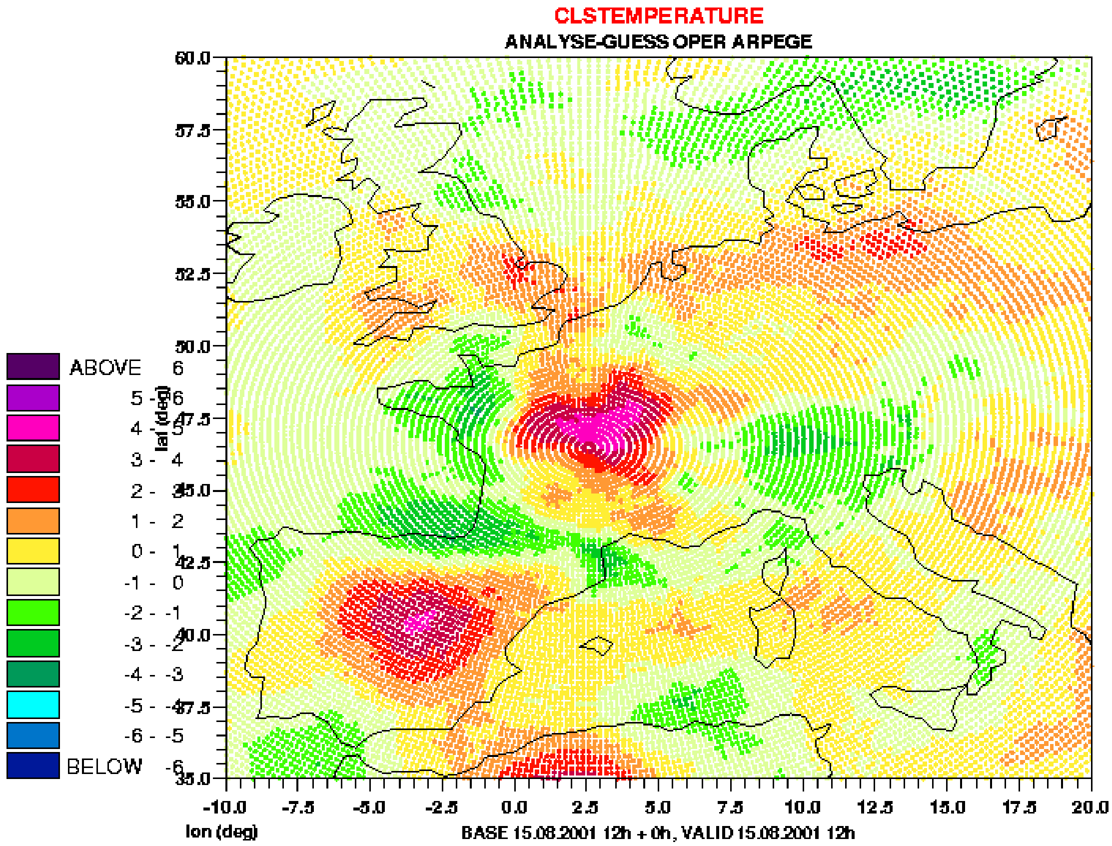
Experiment was performed for 15th August 2001 for 12 UTC.

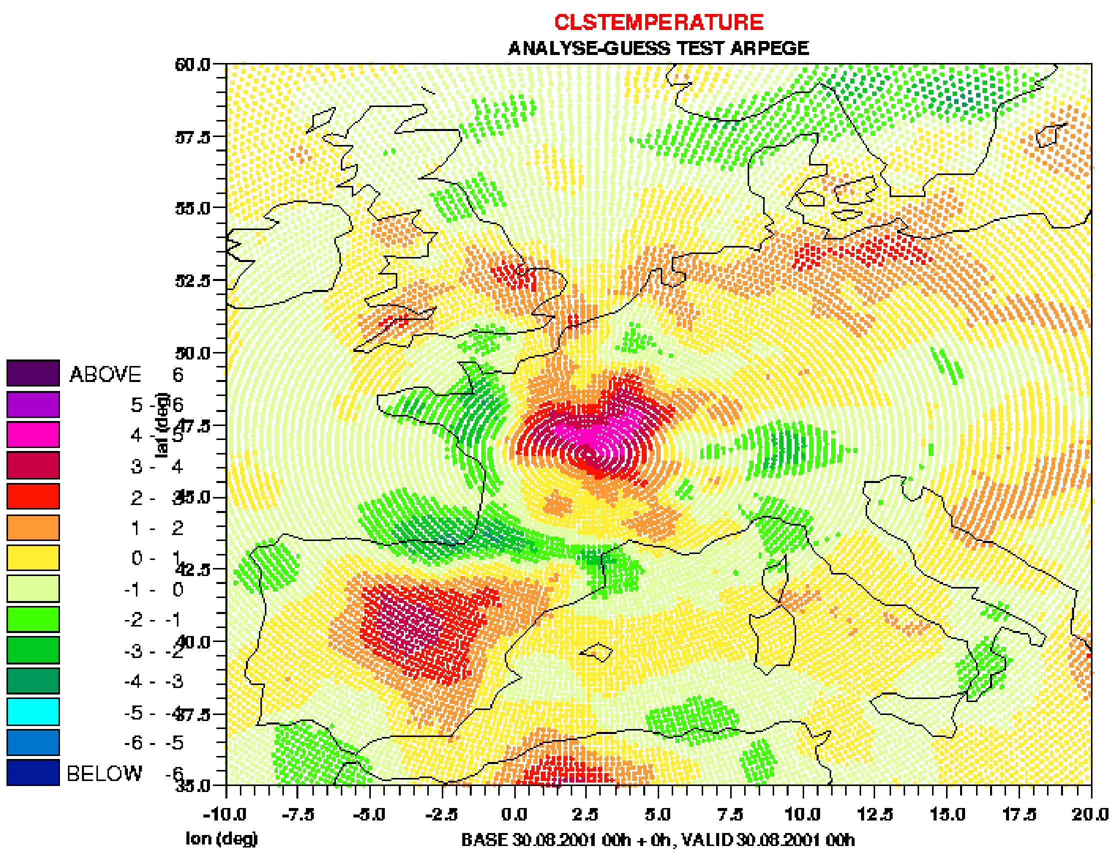




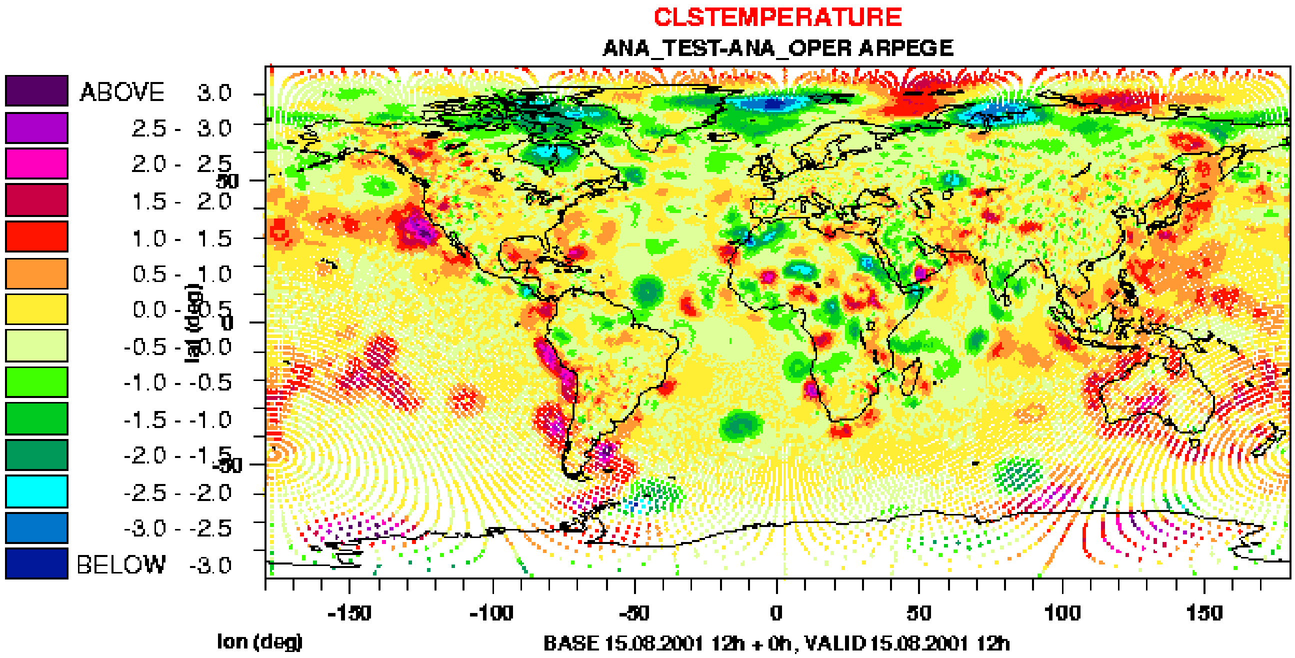
Picture 9. Difference between Analysis and Guess with operational (OPER) and test (TEST) function and namelist for 2 m Temperature

Amplitude and radius of changes are smaller with the new function and new values in namelist.

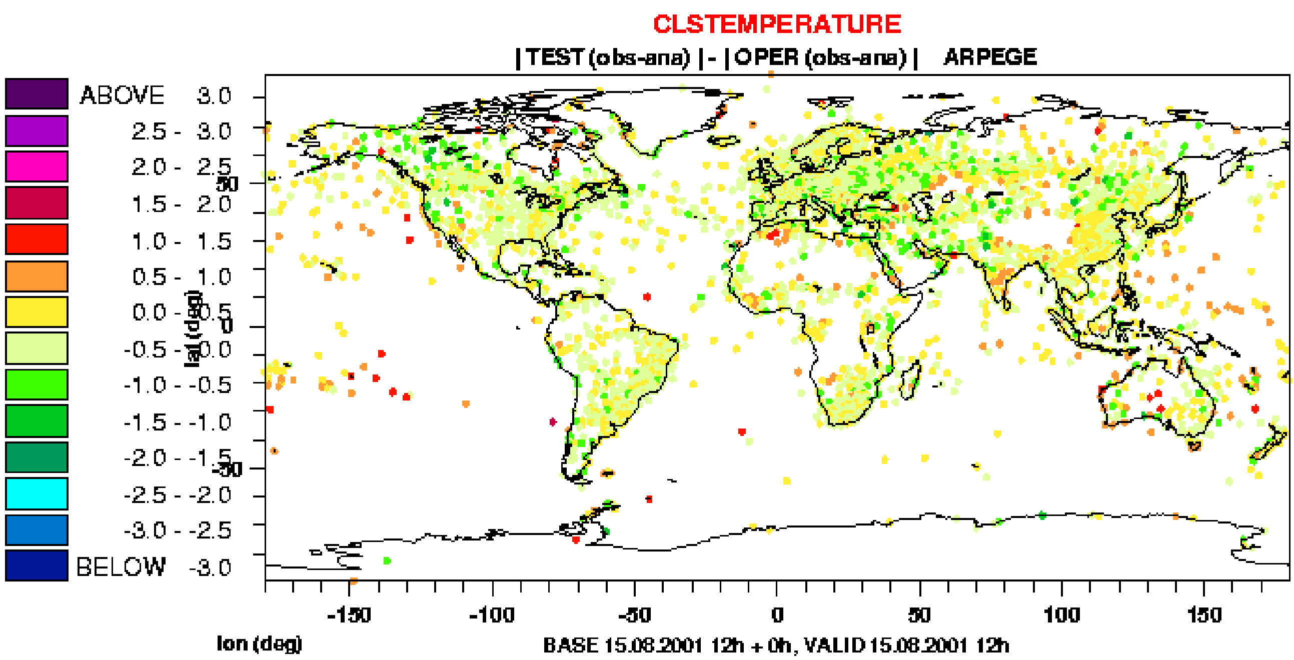




Picture 10. Difference between Analysis and Guess with operational (OPER) and test (TEST) function and namelist for 2 m Temperature over Europe



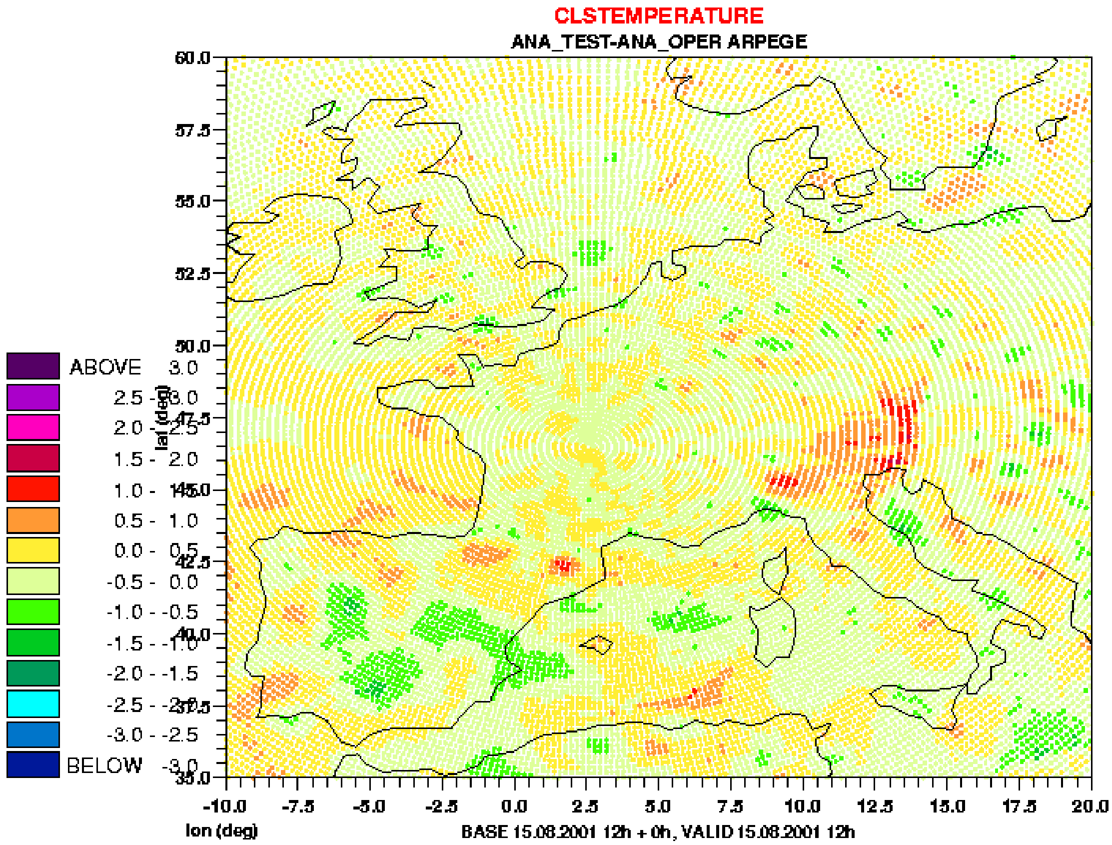
Picture 11. Difference between two Analyses, test (TEST) and operational (OPER) for 2 m Temperature



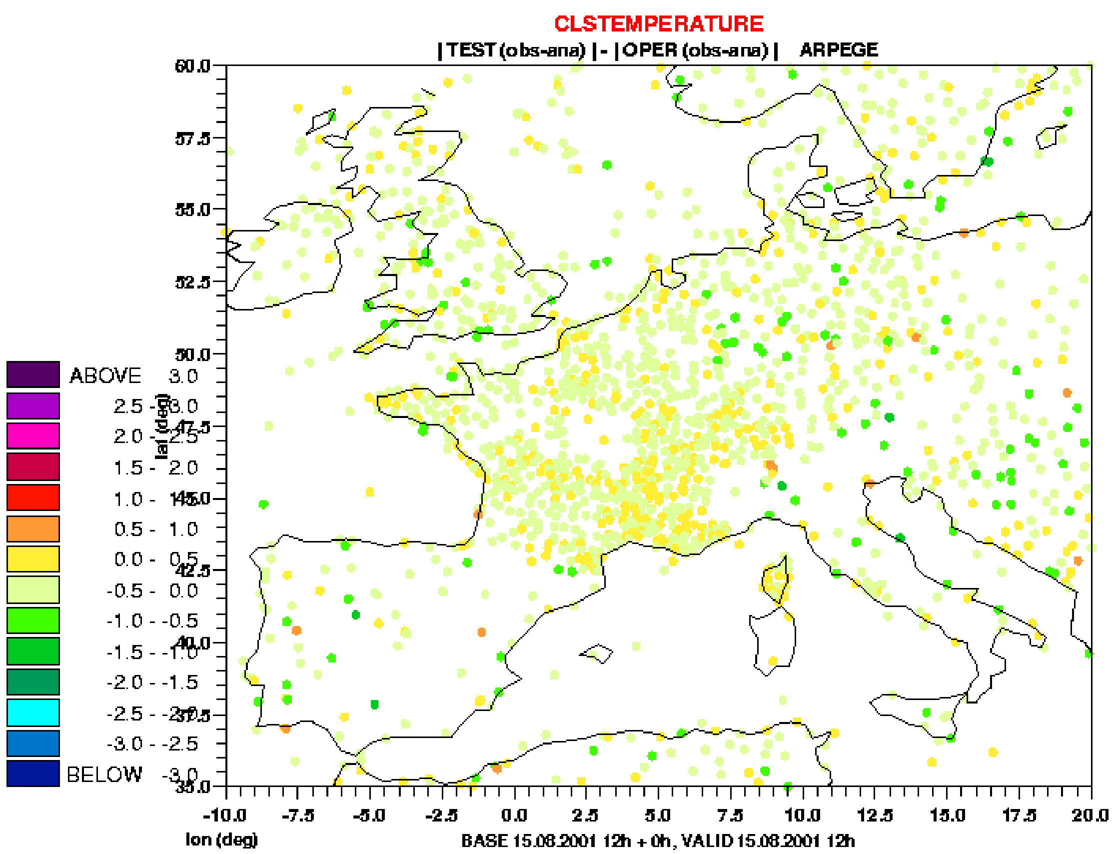
Picture 12. Absolute value of Observation and Analysis differences of 2 m Temperature difference between new (TEST) and operational (OPER) analysis

Highest changes between two analyses are over the sea, especially on the western coasts of Americas, Africa and Australia, high mountains and in Polar Regions. In Europe the largest impact is in Alps and Pyrenees region.

It looks like that better scores are over land for Test analysis and over sea, especially Pacific Ocean. Over Europe it is very hard to distinguish which analysis is better.



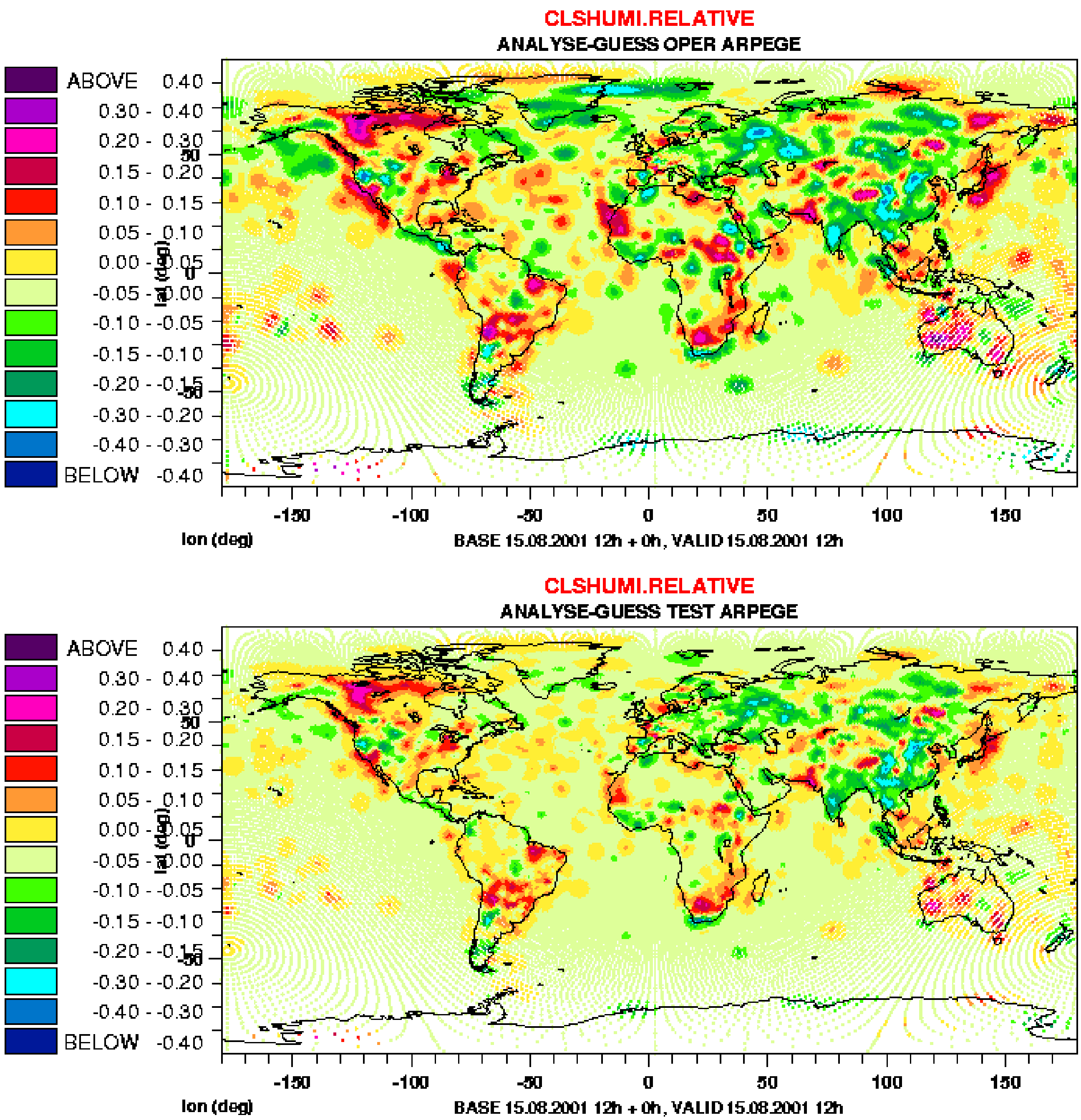
Picture 13. Difference between two Analyses, test (TEST) and operational (OPER) for 2 m Temperature over Europe



Picture 14. Absolute value of Observation and Analysis differences of 2 m Temperature difference between new (TEST) and operational (OPER) analysis over Europe

2 m Relative Humidity

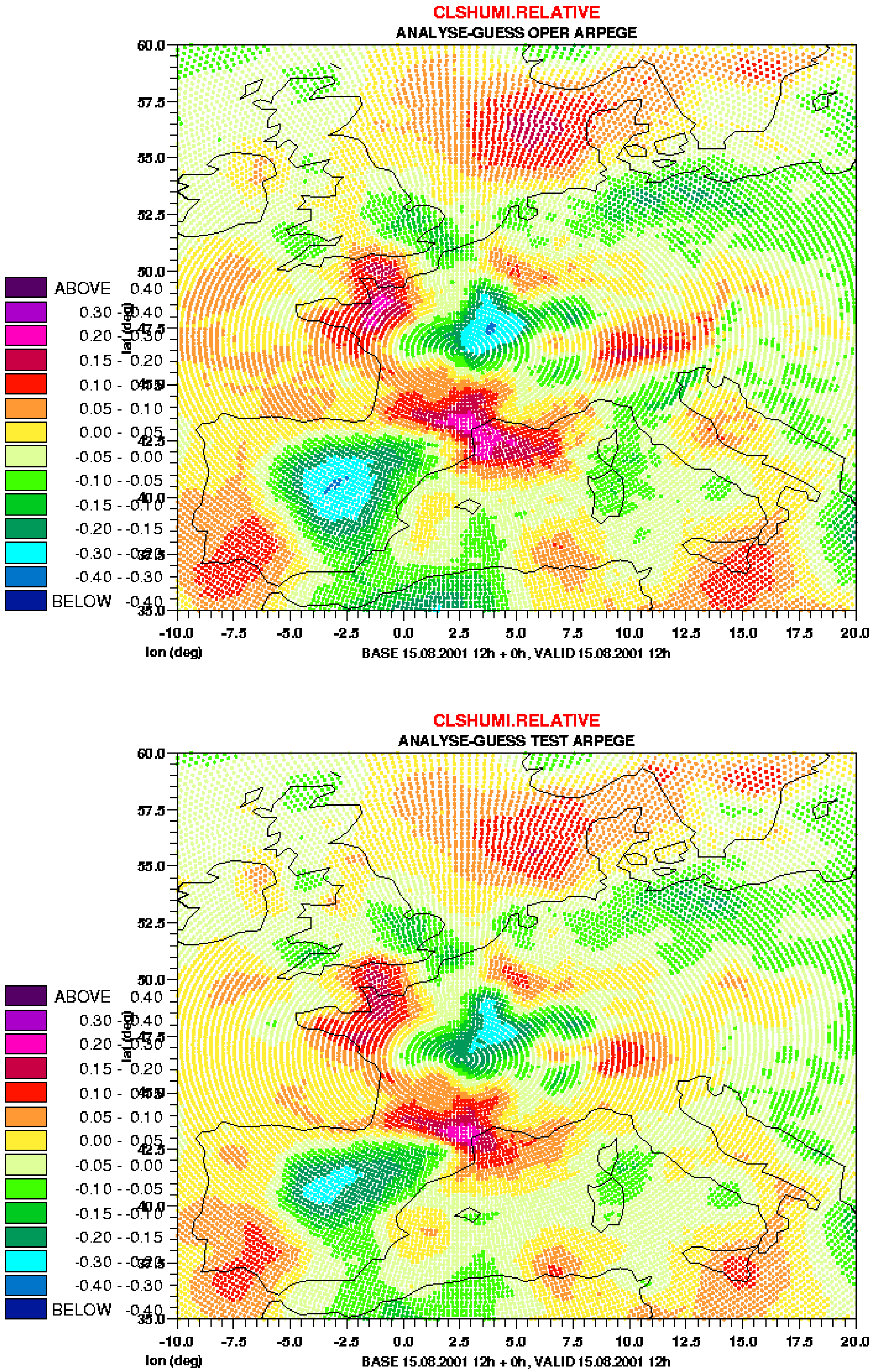
Experiment was performed for 15th August 2001 for 12 UTC.



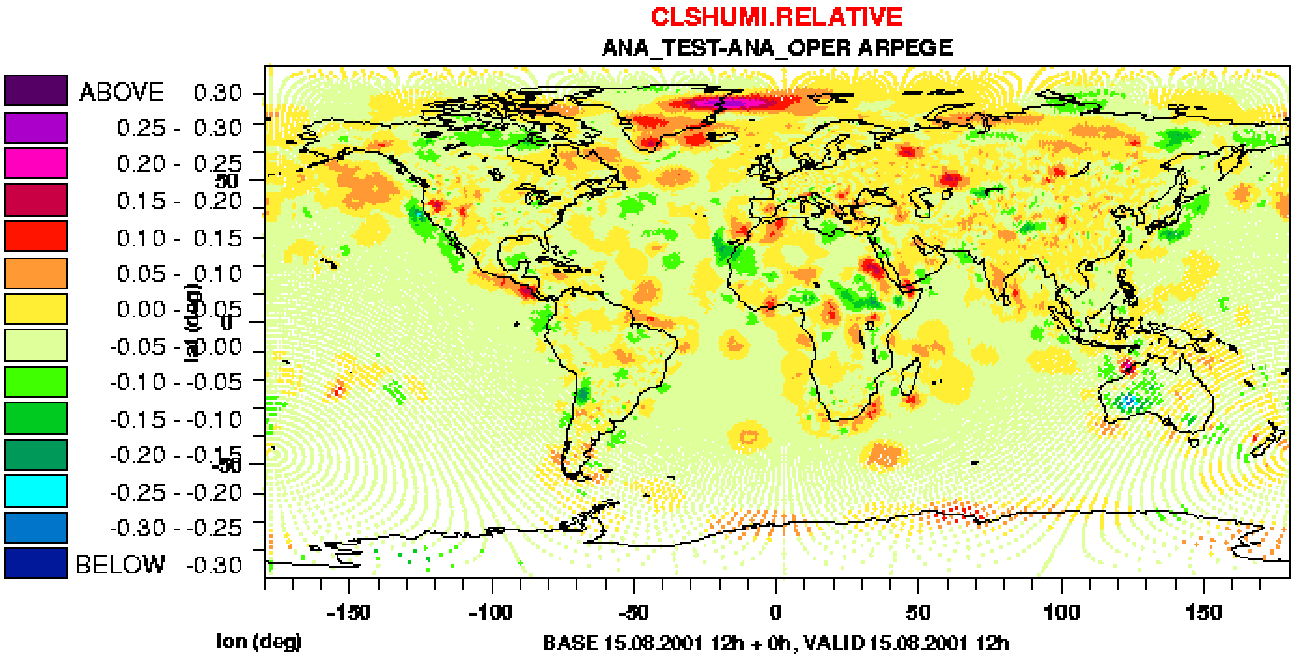
Picture 15. Difference between Analysis and Guess with operational (OPER) and test (TEST) function and namelist for 2 m Relative Humidity

Amplitude and radius of changes are smaller with the new function and new values in namelist, same like for 2 m Temperature.

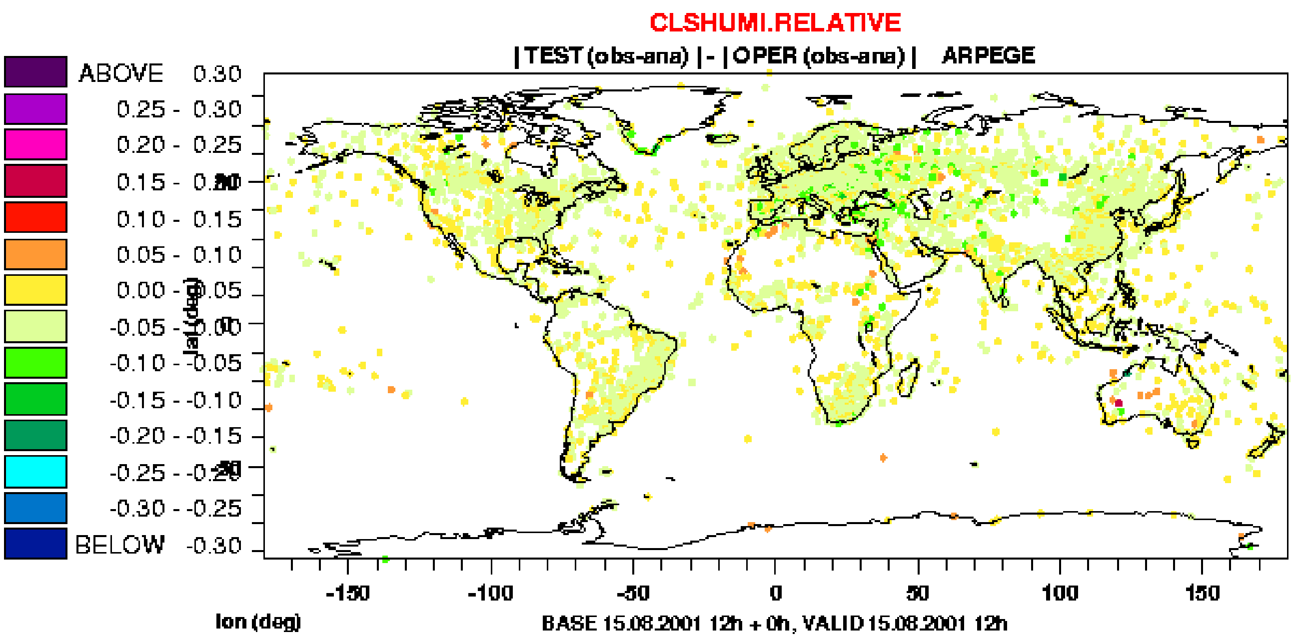
On next page zoom area over Europe is shown.



Picture 16. Difference between Analysis and Guess with operational (OPER) and test (TEST) function and namelist for 2 m Relative Humidity over Europe



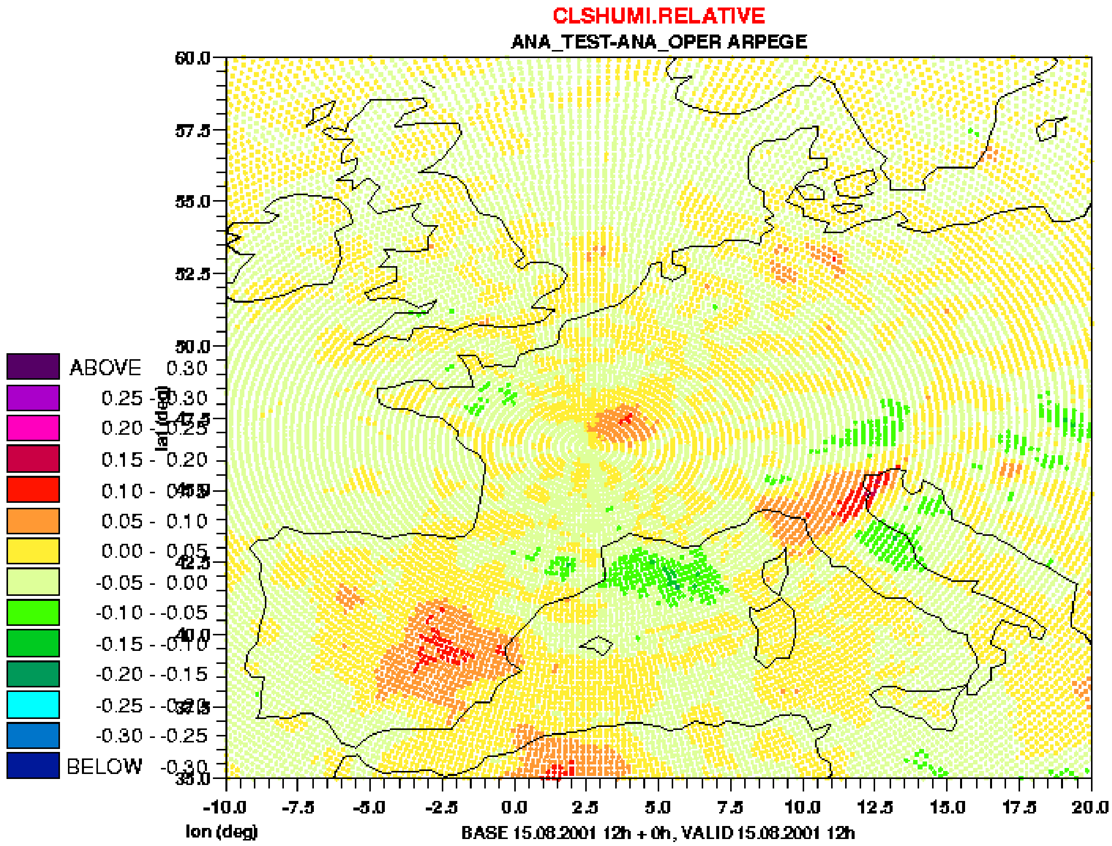
Picture 17. Difference between two Analyses, test (TEST) and operational (OPER) for 2 m Relative Humidity



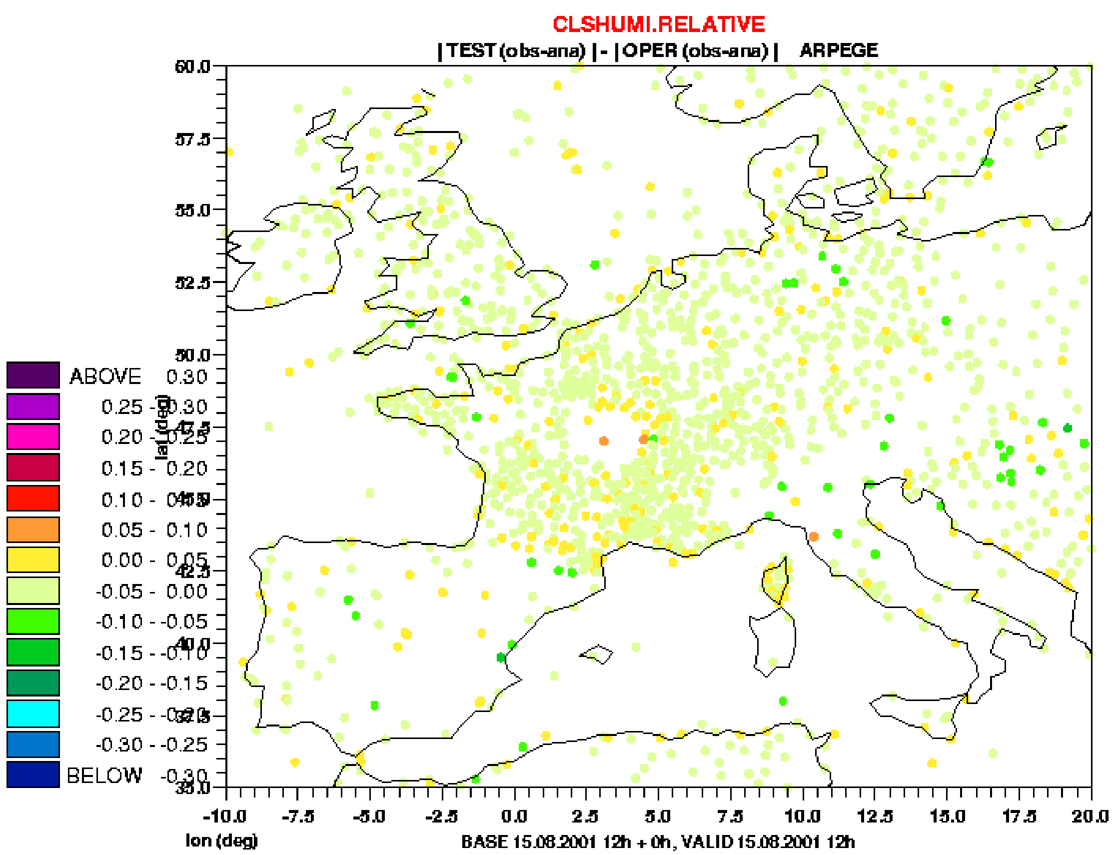
Picture 18. Absolute value of Observation and Analysis differences of 2 m Relative Humidity difference between new (TEST) and operational (OPER) analysis

For difference between two Analyses largest impact is near the western coasts of Americas, Africa and Australia. Over the Europe the largest impact is in France (may bee storm), north Italy and eastern Spain.

From the picture it looks like that the scores are better over sea for Operational, and over land for Test analysis. Over the Europe it looks like that the tested analysis is better.



Picture 19. Difference between two Analyses, test (TEST) and operational (OPER) for 2 m Relative Humidity over Europe



Picture 20. Absolute value of Observation and Analysis differences of 2 m Relative Humidity difference between new (TEST) and operational (OPER) analysis over Europe

9. Bias and RMS statistics for different Domain

In next tables, results of statistics for different Domains for 2 runs on 15th August 2000 12 and 18 UTC for 2m Temperature and 2m Relative Humidity are shown. Operational is with **O** and the new with **T**.

Table 1. Domains for statistics computation

DOMAIN	LAT_NORTH	LAT_SOUTH	LON_EAST	LON_WEST
FRANCE	51.00	43.00	8.00	-5.00
EUROPE	60.00	35.00	20.00	-10.00
ALA_FR	57.00	33.00	25.00	-12.00
N_AM_N	70.00	40.00	-60.00	-130.00
N_AM_S	40.00	10.00	-70.00	-120.00
S_AM_N	10.00	-20.00	-30.00	-80.00
S_AM_S	-20.00	-50.00	-40.00	-80.00
N_ATLA	70.00	10.00	-20.00	-60.00
AUSTRA	-10.00	-40.00	160.00	110.00
AFRI_N	35.00	0.00	50.00	-20.00
AFRI_S	0.00	-35.00	50.00	10.00
EUAS_E	70.00	40.00	80.00	25.00
EUAS_W	70.00	20.00	150.00	80.00
PACI_N	50.00	10.00	-120.00	-180.00
PACI_S	10.00	-60.00	-85.00	-180.00
NOR_PO	90.00	70.00	180.00	-180.00
SOU_PO	-60.00	-90.00	180.00	-180.00
S_ATLA	0.00	-60.00	10.00	-40.00
PACI_W	50.00	0.00	180.00	140.00
IND_OC	10.00	-60.00	100.00	50.00

Table 2. Bias and RMS for 2 m Temperature on different Domains for 12 UTC and 18 UTC runs

20010815r**12**	20010815r**18**
obs_ana_T2M_**T**.dta obs_ana_T2M_**O**.dta	obs_ana_T2M_**T**.dta obs_ana_T2M_**O**.dta
WORLD Nb. Points= 6000 6000	WORLD Nb. Points= 5698 5698
bias= 0.915642 bias= 0.939620	bias= 0.860416 bias= 0.859919
rms= 2.406641 rms= 2.499656	rms= 2.350288 rms= 2.426732
FRANCE Nb. Points= 691 697	FRANCE Nb. Points= 637 643
bias= 0.834399 bias= 0.803027	bias= 0.731397 bias= 0.694977
rms= 2.488198 rms= 2.558691	rms= 2.275484 rms= 2.330768
EUROPE Nb. Points= 1691 1694	EUROPE Nb. Points= 1619 1622
bias= 0.753542 bias= 0.744191	bias= 0.628851 bias= 0.597916
rms= 2.393936 rms= 2.520186	rms= 2.332144 rms= 2.442965
ALA_FR Nb. Points= 1685 1690	ALA_FR Nb. Points= 1627 1632
bias= 0.806030 bias= 0.787077	bias= 0.689047 bias= 0.641912
rms= 2.431005 rms= 2.553799	rms= 2.398921 rms= 2.509262
N_AM_N Nb. Points= 562 565	N_AM_N Nb. Points= 556 559
bias= 1.014057 bias= 1.088708	bias= 0.980396 bias= 0.998050
rms= 2.581394 rms= 2.756255	rms= 2.450257 rms= 2.592718
N_AM_S Nb. Points= 210 211	N_AM_S Nb. Points= 213 214
bias= 0.689762 bias= 0.831185	bias= 1.013803 bias= 0.904019
rms= 2.122716 rms= 2.217592	rms= 2.205433 rms= 2.254005

Table 2. Bias and RMS for 2 m Temperature on different Domains for 12 UTC and 18 UTC runs

20010815r**12**	20010815r**18**
obs_ana_T2M_**T**.dta obs_ana_T2M_**O**.dta	obs_ana_T2M_**T**.dta obs_ana_T2M_**O**.dta
S_AM_N Nb. Points= 207 207	S_AM_N Nb. Points= 196 196
bias= 1.322609 bias= 1.384734	bias= 1.424082 bias= 1.292857
rms= 2.784971 rms= 2.871212	rms= 2.978522 rms= 3.001424
S_AM_S Nb. Points= 155 155	S_AM_S Nb. Points= 150 150
bias= 1.145097 bias= 1.330000	bias= 1.316467 bias= 1.499933
rms= 2.845135 rms= 2.951599	rms= 2.725204 rms= 2.893139
N_ATLA Nb. Points= 122 123	N_ATLA Nb. Points= 101 101
bias= 0.344016 bias= 0.252764	bias= 0.507327 bias= 0.390990
rms= 1.415267 rms= 1.554745	rms= 1.735584 rms= 1.900904
AUSTRA Nb. Points= 116 116	AUSTRA Nb. Points= 104 105
bias= 0.034052 bias= 0.415690	bias= 0.063173 bias= 0.439810
rms= 1.631572 rms= 1.608896	rms= 1.524370 rms= 1.521788
AFRI_N Nb. Points= 271 272	AFRI_N Nb. Points= 255 256
bias= 0.754059 bias= 0.691765	bias= 0.803529 bias= 0.604023
rms= 1.930482 rms= 2.002089	rms= 1.928646 rms= 1.948217
AFRI_S Nb. Points= 218 219	AFRI_S Nb. Points= 188 188
bias= 0.894908 bias= 0.979726	bias= 0.848989 bias= 0.997234
rms= 1.825575 rms= 1.954475	rms= 2.226227 rms= 2.340483
EUAS_E Nb. Points= 401 402	EUAS_E Nb. Points= 406 407
bias= 0.689027 bias= 0.568756	bias= 0.601281 bias= 0.543268
rms= 1.990310 rms= 2.165387	rms= 1.838019 rms= 1.952996
EUAS_W Nb. Points= 721 721	EUAS_W Nb. Points= 694 694
bias= 1.685049 bias= 1.672816	bias= 1.576282 bias= 1.647968
rms= 2.926200 rms= 2.951560	rms= 2.789037 rms= 2.866281
PACI_N Nb. Points= 102 103	PACI_N Nb. Points= 100 101
bias= 0.857941 bias= 1.064466	bias= 0.129600 bias= 0.330396
rms= 2.873302 rms= 2.850308	rms= 2.501865 rms= 2.478937
PACI_S Nb. Points= 34 34	PACI_S Nb. Points= 42 42
bias= -1.164118 bias= -0.492059	bias= -0.768810 bias= -0.311429
rms= 1.518548 rms= 0.924521	rms= 1.090198 rms= 0.607795
NOR_PO Nb. Points= 64 64	NOR_PO Nb. Points= 59 59
bias= 1.017656 bias= 0.681875	bias= 0.961186 bias= 0.705254
rms= 1.773726 rms= 1.541312	rms= 1.741093 rms= 1.626532
SOU_PO Nb. Points= 39 39	SOU_PO Nb. Points= 38 38
bias= 1.882821 bias= 2.083846	bias= 1.503158 bias= 1.666316
rms= 4.431586 rms= 4.397125	rms= 3.798894 rms= 3.889876
S_ATLA Nb. Points= 47 47	S_ATLA Nb. Points= 45 45
bias= 0.464043 bias= 0.470426	bias= 0.276444 bias= 0.366889
rms= 1.238827 rms= 1.316781	rms= 1.175432 rms= 1.349844
PACI_W Nb. Points= 52 52	PACI_W Nb. Points= 52 52
bias= -0.443654 bias= -0.091923	bias= -0.456538 bias= -0.101538
rms= 1.068449 rms= 0.962934	rms= 1.160797 rms= 1.051031
IND_OC Nb. Points= 63 63	IND_OC Nb. Points= 50 50
bias= 0.053968 bias= -0.021905	bias= -0.401000 bias= -0.124400
rms= 0.967986 rms= 0.949045	rms= 1.104039 rms= 0.919780

Table 3. Bias and RMS for 2 m Relative Humidity on different Domains for 12 UTC and 18 UTC runs

20010815r**12**	20010815r**18**
obs_ana_H2M_**T**.dta obs_ana_H2M_**O**.dta	obs_ana_H2M_**T**.dta obs_ana_H2M_**O**.dta
WORLD Nb. Points= 5602 5602	WORLD Nb. Points= 5359 5359
bias= 0.013183 bias= 0.014468	bias= 0.011493 bias= 0.014462
rms= 0.082589 rms= 0.090244	rms= 0.089975 rms= 0.095807
FRANCE Nb. Points= 626 631	FRANCE Nb. Points= 589 595
bias= 0.005128 bias= 0.003883	bias= -0.003005 bias= 0.004420
rms= 0.076243 rms= 0.084762	rms= 0.093106 rms= 0.099433
EUROPE Nb. Points= 1594 1597	EUROPE Nb. Points= 1549 1552
bias= 0.008908 bias= 0.008817	bias= 0.007063 bias= 0.012545
rms= 0.086769 rms= 0.098813	rms= 0.107332 rms= 0.116684
ALA_FR Nb. Points= 1587 1591	ALA_FR Nb. Points= 1554 1559
bias= 0.007139 bias= 0.007813	bias= 0.003166 bias= 0.010616
rms= 0.087003 rms= 0.099363	rms= 0.108494 rms= 0.117694
N_AM_N Nb. Points= 475 477	N_AM_N Nb. Points= 473 475
bias= 0.020063 bias= 0.015849	bias= 0.015645 bias= 0.020274
rms= 0.082581 rms= 0.087638	rms= 0.084601 rms= 0.092090
N_AM_S Nb. Points= 201 202	N_AM_S Nb. Points= 204 205
bias= 0.025821 bias= 0.020891	bias= 0.013529 bias= 0.021366
rms= 0.077937 rms= 0.075982	rms= 0.082462 rms= 0.087156
S_AM_N Nb. Points= 205 205	S_AM_N Nb. Points= 194 194
bias= 0.009805 bias= 0.006585	bias= 0.006443 bias= 0.011907
rms= 0.064328 rms= 0.069229	rms= 0.085461 rms= 0.088600
S_AM_S Nb. Points= 152 152	S_AM_S Nb. Points= 147 147
bias= 0.023750 bias= 0.018618	bias= 0.012925 bias= 0.015918
rms= 0.102216 rms= 0.100003	rms= 0.097861 rms= 0.095789
N_ATLA Nb. Points= 107 108	N_ATLA Nb. Points= 88 88
bias= 0.012056 bias= 0.017778	bias= 0.012955 bias= 0.019659
rms= 0.069679 rms= 0.075314	rms= 0.068788 rms= 0.077158
AUSTRA Nb. Points= 96 96	AUSTRA Nb. Points= 90 91
bias= 0.049062 bias= 0.040937	bias= 0.040667 bias= 0.030000
rms= 0.119491 rms= 0.111966	rms= 0.107176 rms= 0.092801
AFRI_N Nb. Points= 265 266	AFRI_N Nb. Points= 247 248
bias= 0.012340 bias= 0.010977	bias= 0.019595 bias= 0.019476
rms= 0.077657 rms= 0.077736	rms= 0.093661 rms= 0.095379
AFRI_S Nb. Points= 190 191	AFRI_S Nb. Points= 155 155
bias= 0.035474 bias= 0.034503	bias= 0.045290 bias= 0.029355
rms= 0.090309 rms= 0.096556	rms= 0.109474 rms= 0.102784
EUAS_E Nb. Points= 393 393	EUAS_E Nb. Points= 402 403
bias= 0.000178 bias= 0.012290	bias= 0.006667 bias= 0.006352
rms= 0.079689 rms= 0.097906	rms= 0.076050 rms= 0.088922
EUAS_W Nb. Points= 713 713	EUAS_W Nb. Points= 687 687
bias= 0.010884 bias= 0.015316	bias= 0.010102 bias= 0.010393
rms= 0.076918 rms= 0.085592	rms= 0.058960 rms= 0.066615
PACI_N Nb. Points= 74 75	PACI_N Nb. Points= 77 78
bias= 0.039459 bias= 0.038267	bias= 0.047143 bias= 0.044872
rms= 0.120113 rms= 0.115349	rms= 0.114750 rms= 0.107429

Table 3. Bias and RMS for 2 m Relative Humidity on different Domains for 12 UTC and 18 UTC runs

20010815r**12**	20010815r**18**
obs_ana_H2M_**T**.dta obs_ana_H2M_**O**.dta	obs_ana_H2M_**T**.dta obs_ana_H2M_**O**.dta
PACI_S Nb. Points= 33 33	PACI_S Nb. Points= 41 41
bias= 0.017273 bias= 0.006970	bias= 0.006098 bias= 0.001463
rms= 0.062740 rms= 0.048461	rms= 0.047447 rms= 0.029878
NOR_PO Nb. Points= 52 52	NOR_PO Nb. Points= 54 54
bias= -0.004231 bias= 0.002692	bias= -0.008148 bias= 0.004815
rms= 0.055331 rms= 0.054772	rms= 0.077913 rms= 0.064950
SOU_PO Nb. Points= 27 27	SOU_PO Nb. Points= 25 25
bias= -0.027407 bias= -0.012963	bias= -0.027200 bias= -0.011200
rms= 0.080554 rms= 0.062450	rms= 0.096623 rms= 0.081240
S_ATLA Nb. Points= 44 44	S_ATLA Nb. Points= 43 43
bias= 0.005000 bias= 0.005682	bias= 0.022093 bias= 0.021628
rms= 0.063030 rms= 0.067907	rms= 0.078311 rms= 0.088146
PACI_W Nb. Points= 50 50	PACI_W Nb. Points= 49 49
bias= 0.041000 bias= 0.028800	bias= 0.041837 bias= 0.025918
rms= 0.075273 rms= 0.065452	rms= 0.061793 rms= 0.050810
IND_OC Nb. Points= 59 59	IND_OC Nb. Points= 47 47
bias= 0.028475 bias= 0.030847	bias= 0.034894 bias= 0.025106
rms= 0.068123 rms= 0.068766	rms= 0.062807 rms= 0.051818

The bias of 2 m Temperature for European Domains are better for the operational then for the test run. On other Domains sometimes is better for the test run.
The RMS of 2 m Temperature is better for test run for most of the domains for.

For 2 m Relative Humidity bias is better for the operational run for more then 60 % of the domains.
The RMS of 2 m Relative Humidity is same for operational and the test run, but is better for all domains in Europe.

10. Conclusion

Because the calculated values of the correlation coefficients were not similar to the operational Gauss correlation function $\rho_{12}=\exp(-\frac{1}{2}\frac{r^2}{a^2})$ it was proposed that new function is tested $\rho_{12}=\exp(-\frac{1}{2}\frac{r}{a})$.

Namelist values for tested function are: σ^G_{T2m}= 1.7 °C, σ^G_{H2m}= 0.13 = 13 %, a_{T2m}= 105 km, a_{H2m}= 101 km and α= 0.05.

It is not possible to conclude are the results of new analyses better or worst, and more experiments are needed.