# EXPERIMENTS WITH CANARI FOR AROME

Final report based on the work done in METEO-FRANCE during the period

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by

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## INTRODUCTION

Currently the analysis of the screen level fields ($T_{2m}$, $H_{2m}$, $U_{10m}$, $V_{10m}$) within the CANARI/ARPEGE/ALADIN environment is performed on one hand for diagnostic purposes (diagpack over a FRANCE domain) and on the other hand for initialization of the surface fields (temperature and soil water content) from ($T_{2m}$, $H_{2m}$) analysis fields for both ARPEGE and ALADIN.

The purpose of this work has been to tune an analysis of 2m temperature and humidity ($T_{2m}$, $H_{2m}$) fields over the AROME domain (588x500, mesh distance 2.5 km) on the base of 3-hour AROME first guess.
The tests have been done for 2 cases (2007121512 and 2007121506) with 7 different sets of parameters controlling the input observation data as well as some of the characteristics of the statistical model of the CANARI OI analyses.
The evaluation of the quality of the analyses has been done by comparison of the analyses increments and observation departures for each set of parameters. The experiments have been performed with the executable /mf/dp/marp/marp001/tampon/bin/ald/al33/al33t0_odb-op1B.04.SX8RV20.x.exe (operational library at the date of the stage).

The reference analysis (An) has been defined as the analysis with the set of parameters used in the operational ARPEGE screen level fields analysis. The other 6 sets of parameters define the 6 modifications of the analysis we have tested, described in the report as (An_mod, mod2, .., mod6).

The report consists of Introduction, 4 sections and 3 Appendices

Section I Description of the different sets of parameters defining the different modifications of the analysis scheme.

Section II Comparison of the results obtained by the different analyses modifications against the analysis increments.

Section III Comparison of the results obtained by the different modifications of the analyses against the observation departures.

Section IV. Remarks, conclusions and plans for the future work.

Appendix1

Table 1
Summarized statistics from the CANARI output for the experiments performed with different values of  the parameters in the namelist, defining the different modifications of the analyses.

Appendix2

Plots of the increments of the experiments an, an_mod,an_mod2,an_mod3,an_mod4,an_mod5 and an_mod6 for 2007121512

Plots of the increments for T2m
Plots of the increments for Hu2m

Appendix3

Plots of the observation departures for the guess, an, an_mod, an_mod2, am_mod3, an_mod4, an_mod_5 and an_mod_6 for 2007121512 :

Plots of the observation departures for T2m
Plots of the observation departures for Hu2m

**Section I** . Description of the different sets of parameters defining the different modifications of analysis scheme.

From the tunable by namelist CANARI parameters, we have chosen to study the impact of the parameters LCORRF, ORODIF, OROLIM, REF_A_H2., REF_A_T2 on the quality of the CANARI analysis. Those parameters define the statistical structure and the input observation data for the OI analysis, namely:

1. LCORRF

This parameter defines the horizontal correlation function of the analysed variable and is expressed by

$$\rho_{12} = \exp\left(-\frac{1}{2}\frac{r^2}{a^2}\right)$$, if LCORRF=.FALSE.

or

$$\rho_{12} = \exp\left(-\frac{1}{2}\frac{r}{a}\right)$$, if LCORRF=.TRUE.

The first formula is used in ALADIN/diagpack software, while the second one is used in ARPEGE for initialization of the surface fields (Ivatek-Sahdan, St., 2001)

2. REF_A_H2, REF_A_T2

These parameters define the characteristic length a in the expression of the horizontal correlation function for 2 meters humidity and temperaturerespectively.

3. OROLIM, ORODIF

OROLIM : maximum altitude for surface obs use;
ORODIF : maximum altitude difference between obs and model.
These parameters define the max altitude of the observation point, above which the observation is rejected, and the max difference between the model orography at the observation point and the altitude of the observation point, above which the observation is rejected.

To perform the reference CANARI analyses (hereafter referred as An) we have used the following set of parameters:

| | | |
|---|---|---|
| &NALORI | LCORRF=.TRUE., | |
| &NACOBS | OROLIM=10000., | ORODIF=10000., |
| &NAM_CANAPE | REF_A_H2=85000., | REF_A_T2=80000., |

Those values correspond to the values of the parameters used in the operational ARPEGE/CANARI analysis scheme.

To perform analyses which will describe in more details the 2m temperature and humidity fields we have defined the following 6 different sets of the above described parameters :

| | LCORRF | OROLIM | ORODIF | REF_A_T2 | REF_A_H2 |
|---|---|---|---|---|---|
| An | True | 10000 | 10000 | 80000 | 85000 |
| An_mod | False | 10000 | 10000 | 80000 | 85000 |
| An_mod2 | False | 1500 | 800 | 80000 | 85000 |
| An_mod3 | False | 1500 | 800 | 40000 | 40000 |
| An_mod4 | False | 1500 | 800 | 60000 | 60000 |
| An_mod5 | False | 10000 | 800 | 60000 | 60000 |
| An_mod6 | True | 1000 | 300 | 40000 | 40000 |

With the modification An_mod we could have an idea of the impact only of the parameter LCORRF on the results of the analyses.

In case of the modification An_mod2, the stations situated above 1500 m or at which the difference between altitude and the model orography exceeds 800 m are rejected - thus we could study the impact of those limits on the analysis quality.

The set of parameters in An_mod3 corresponds to those in the ALADIN/diagpack software. With the modifications An_mod3 and An_mod4 we studied the impact of decreasing the characteristic length of the horizontal correlation function, while the purpose of the modification An_mod5 is to show the importance of the OROLIM parameter on the analysis quality.

With the last set An_mod6 we wanted to perform analysis with:

- small characteristic length (40000 m), but smooth horizontal correlation function (LCORRF = .T.) to benefit from the dense observation net over France, but not to have spotted analysis over the areas with less observation density;
- use of observations points at altitude not higher than1000 m, at which the difference between the model orography and  altitude do not exceed 300m . That will allow to avoid the observation points at high altitudes which are not described well by the isotropic correlation functions used in the CANARI software.

Such a set is supposed to fit best the area and the data coverage over the AROME domain – with very high SYNOP data density over France and not so high over Spain and other neighbouring countries.

**Section II**    Comparison of the results obtained by the different analyses modifications against the analysis increments

The comparison between the results obtained from the different analyses modifications against analysis increments (A-G) for 2m temperature and humidity are presented in Appendix1.

It is seen that for all sets of parameters described above, the value of the relation siga/sigp, which underlines the reduction factor between the rms errors of the analysis and the guess, is comparable with that for diagpack.  The mean value of the increments (T2m-G), (Hu2m-G), averaged over all the points, is smaller for the An_mod6 set (in average the analysis is closer to the guess, which is detected also by the value of mean siga/sigp), but the standard deviation is also smaller in comparison with the other modifications. That means that for the other modifications  in average the analysis is not so close to the first guess field, but there are areas with bigger value of the standard deviations, included no change of the guess field.

In Appendix 2 we have presented the  plots of the increment fields for all modifications of the analyses.

From the plots for T2m  is seen that :

- there are significant negative values of the increments over the mountainous regions, especially over the Pyrenees and high positive values over Spain;
- with modifications mod2 and mod3 we have areas with bigger values and spotted structure of the increments over Spain;
- with the last set mod_6 we manage to describe smaller features in the fields, avoiding the spotted features over Spain.

From the plots for Hu2m is seen that there are negative increments almost all over the analyses domain with exception of southern part of France. The modification mod_6 leads to smoother field of the increments.

**Section  III**  Comparison of the results obtained by the different modifications of the analyses against the observation departures

With the comparison  of the results obtained by the different modifications of the analyses presented in Appendix2 we have shown  some advantages of modification mod_6, but we also wanted to study the observation departures (for guess and for each of the modifications of the reference analyses) as a measure of the analyses quality.

In Appendix3 we have presented the plots of the observation departures. It is obvious that first guess observation departures are higher than those for any of the analyses modifications, but it is very difficult from those plots to draw any conclusion on the advantages or drawbacks of any of the modifications. To make use of observation departures as a measure of the analysis quality, better options of the plotting software should be used.

**Section IV**.  Remarks, conclusions and plans for the future work

In this report it is worth mentioning two problems met in the CANARI output statistics:

- the model orography (modoro) in the observation points is missing in the final ODB file;
- the statistics in CANCER about the observation departures for the analysis are not updated and as a result in the CANARI output the values of  OBS-MOD before and after the analysis are the same (those of observation departures for the guess)
- that fact led to the necessity of using the analysis file as a first guess file to obtain the observation departures plots in Section III of the report.

Despite that problems we could consider that the purpose of the work has been completed successfully and it has been shown that CANARI could run with AROME guess giving reasonable results. From the plots has been drawn the conclusion that the density of the points with SYNOP observations is good enough to present the meso-scale processes. To evaluate more precisely the impact of the different parameters on the quality of the analyses and  to define the proper set for CANARI for AROME, it is necessary to find  additional measure  for that quality. Such a measure could be an evaluation of  their impact on the derived surface fields.

REFERENCES

Ivatek-Sahdan,  St., 2001 – Improvement of surface analysis (for assimilation purpose) Internal CNRM/GMAP Report (Toulouse, 15.10-14.14.2001)

Appendix1

Table 1

Summarized statistics from the CANARI output for the experiments performed with different values of the parameters in the namelist, defining the different modifications of the analyses.

| Name of the exp | Parameters | | | | |
|---|---|---|---|---|---|
| | LCORRF | OROLIM | ORODIF | REF_A_T2 | REF_A_H2 |
| An | True | 10000 | 10000 | 80000 | 85000 |
| An_mod | False | 10000 | 10000 | 80000 | 85000 |
| An_mod2 | False | 1500 | 800 | 80000 | 85000 |
| An_mod3 | False | 1500 | 800 | 40000 | 40000 |
| An_mod4 | False | 1500 | 800 | 60000 | 60000 |
| An_mod5 | False | 10000 | 800 | 60000 | 60000 |
| An_mod6 | True | 1000 | 300 | 40000 | 40000 |

| | (T2m-G), (H2m-G) for An/mod/mod2/mod3/ mod4/mod5/mod6 | | | | |
|---|---|---|---|---|---|
| | LCORRF | OROLIM | ORODIF | REF_A_T2 | REF_A_H2 |
| An | True | 10000 | 10000 | 80000 | |
| An_mod | False | 10000 | 10000 | 80000 | 85000 |
| An_mod2 | False | 1500 | 800 | 80000 | 85000 |
| An_mod3 | False | 1500 | 800 | 40000 | 40000 |
| An_mod4 | False | 1500 | 800 | 60000 | 60000 |
| An_mod5 | False | 10000 | 800 | 60000 | 60000 |
| An_mod6 | True | 1000 | 300 | 40000 | 40000 |

| | **Temperature** (T2m – G) moyenne | ecart-type | Min | Max | T2m siga/sigP |
|---|---|---|---|---|---|
| An 06 | 0.4905E+00 | 0.1171E+01 | -.3403E+01 | 0.3469E+01 | 0.6021E+00 |
| An 12 | -.2452E+00 | 0.8127E+00 | -.3713E+01 | 0.2904E+01 | 0.5989E+00 |
| An_mod 06 | 0.4591E+00 | 0.1264E+01 | -.3906E+01 | 0.3636E+01 | 0.5219E+00 |
| An_mod 12 | -.2119E+00 | 0.8637E+00 | -.3685E+01 | 0.3019E+01 | 0.5178E+00 |
| An_mod2 06 | 0.4646E+00 | 0.1288E+01 | -.3906E+01 | 0.3636E+01 | 0.5268E+00 |
| An_mod2 12 | -.2185E+00 | 0.8853E+00 | -.3980E+01 | 0.3143E+01 | 0.5229E+00 |
| An_mod3 06 | 0.4529E+00 | 0.1153E+01 | -.3805E+01 | 0.3914E+01 | 0.6844E+00 |
| An_mod3 12 | -.1805E+00 | 0.8552E+00 | -.5572E+01 | 0.3864E+01 | 0.6816E+00 |
| An_mod4 06 | 0.4599E+00 | 0.1251E+01 | -.3933E+01 | 0.3700E+01 | 0.5914E+00 |
| An_mod4 12 | -.2054E+00 | 0.8884E+00 | -.4572E+01 | 0.3469E+01 | 0.5880E+00 |
| An_mod5 06 | 0.4605E+00 | 0.1227E+01 | -.3933E+01 | 0.3700E+01 | 0.5859E+00 |
| An_mod5 12 | -.1937E+00 | 0.8661E+00 | -.3785E+01 | 0.3292E+01 | 0.5824E+00 |
| An_mod6_12 | -.1792E+00 | 0.7197E+00 | -.3793E+01 | 0.2057E+01 | 0.7305E+00 |

| | **Humidity** (H2m-G) moyenne | ecart-type | Min | Max | H2m siga/sigp |
|---|---|---|---|---|---|
| An 06 | -.1053E+00 | 0.9506E-01 | -.3060E+00 | 0.4432E+00 | 0.5507E+00 |
| An 12 | -.1068E+00 | 0.8909E-01 | -.3363E+00 | 0.2723E+00 | 0.5463E+00 |
| An_mod 06 | -.9872E-01 | 0.1084E+00 | -.3119E+00 | 0.4540E+00 | 0.4373E+00 |
| An_mod 12 | -.1017E+00 | 0.9613E-01 | -.3519E+00 | 0.2353E+00 | 0.4318E+00 |
| An_mod2 06 | -.1015E+00 | 0.1052E+00 | -.3119E+00 | 0.4679E+00 | 0.4408E+00 |
| An_mod2 12 | -.1001E+00 | 0.9806E-01 | -.3519E+00 | 0.3515E+00 | 0.4359E+00 |
| An_mod3 06 | -.7886E-01 | 0.1051E+00 | -.3433E+00 | 0.4681E+00 | 0.6276E+00 |
| An_mod3 12 | -.7245E-01 | 0.9870E-01 | -.3990E+00 | 0.3892E+00 | 0.6227E+00 |
| An_mod4 06 | -.9164E-01 | 0.1091E+00 | -.3230E+00 | 0.4812E+00 | 0.5256E+00 |
| An_mod4 12 | -.8970E-01 | 0.1004E+00 | -.3776E+00 | 0.3741E+00 | 0.5207E+00 |
| An_mod5 06 | -.8952E-01 | 0.1120E+00 | -.3159E+00 | 0.4809E+00 | 0.5219E+00 |
| An_mod5 12 | -.9158E-01 | 0.9943E-01 | -.3776E+00 | 0.3106E+00 | 0.5161E+00 |
| An_mod6_12 | -.9251E-01 | 0.8797E-01 | -.3644E+00 | 0.2741E+00 | 0.6966E+00 |

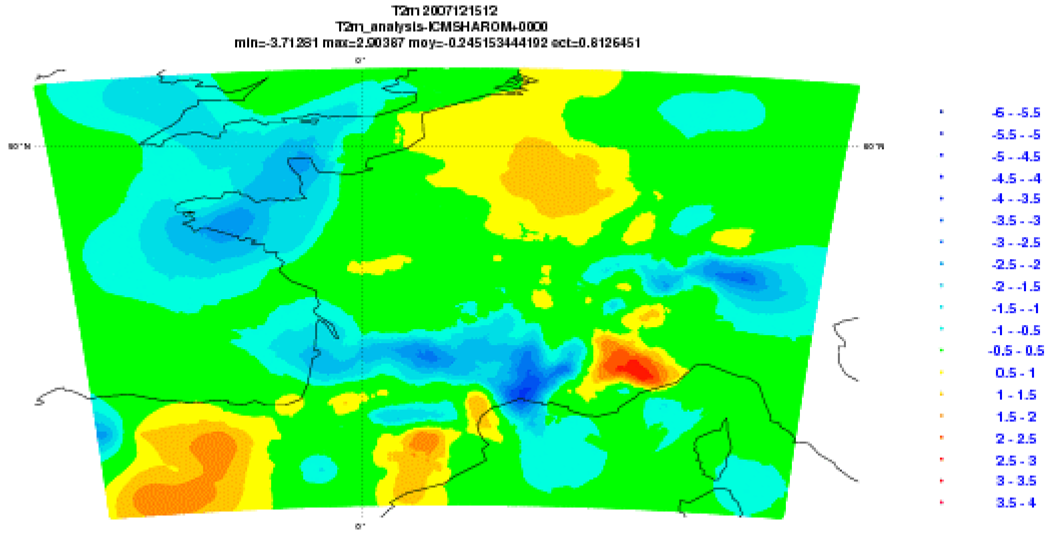
Comparison with diagpack for 2008070114

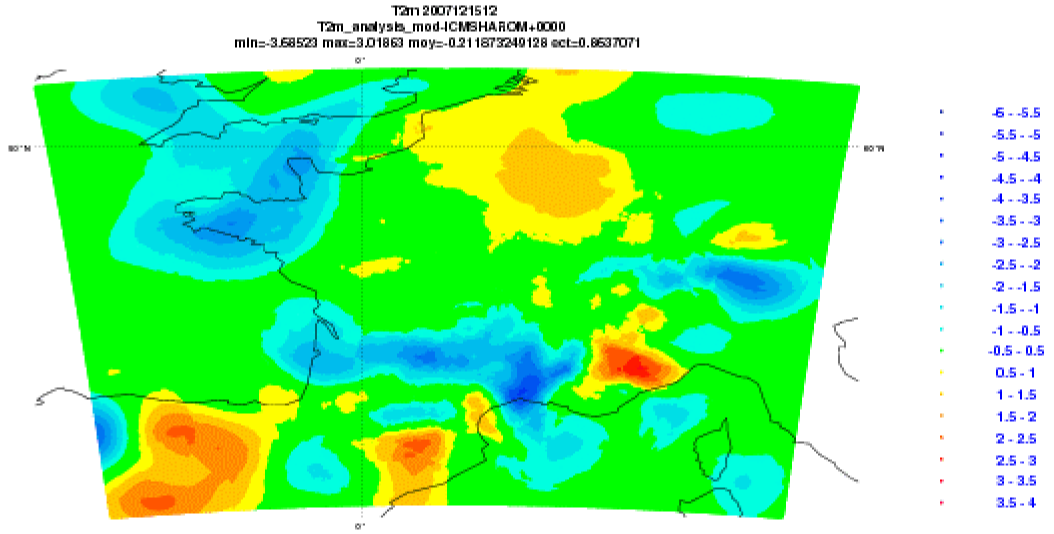
| Temperature | Humidity |
|---|---|
| Siga/sigp | siga/sigp |
| 0.6151 | 0.6330 |

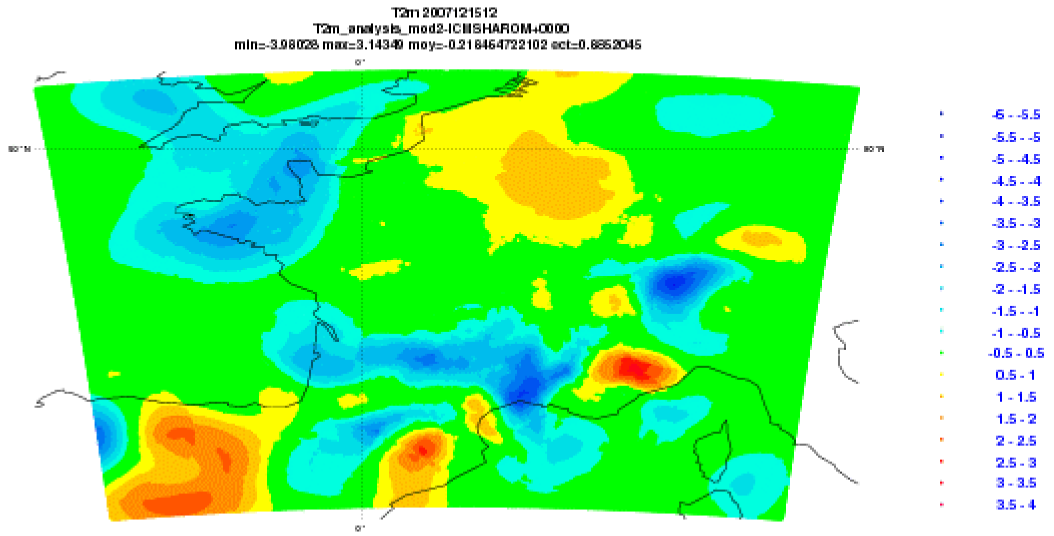
## Appendix2

Plots of the increments of the experiments an, an_mod,an_mod2,an_mod3,an_mod4,an_mod5 and an_mod6 for 2007121512

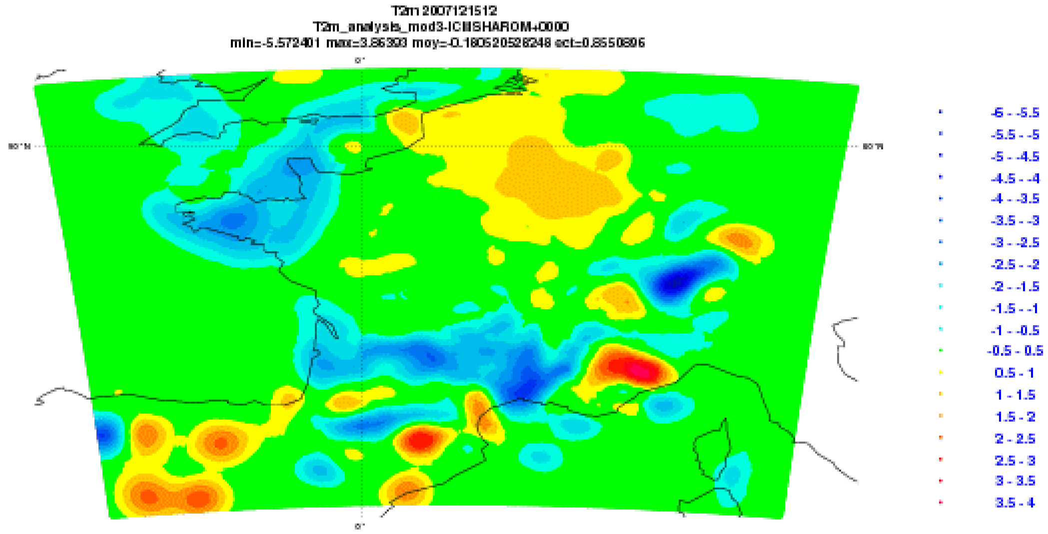
Plots of the increments for T2m
Plots of the increments for Hu2m

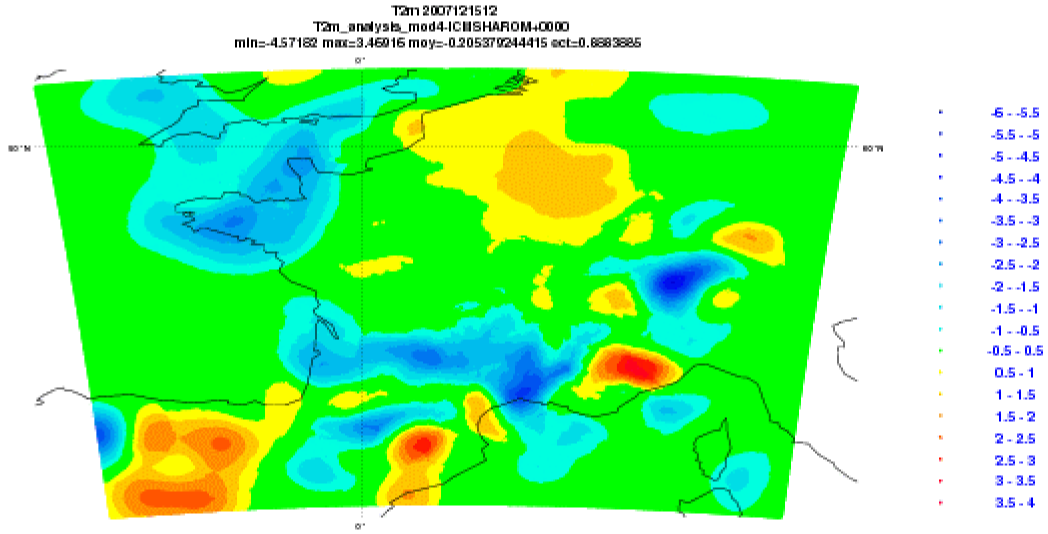


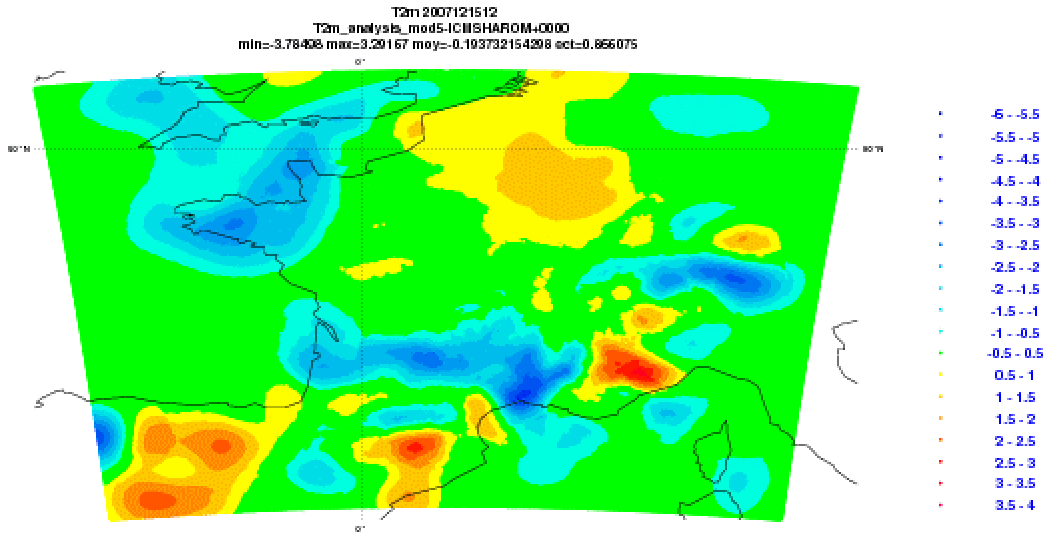



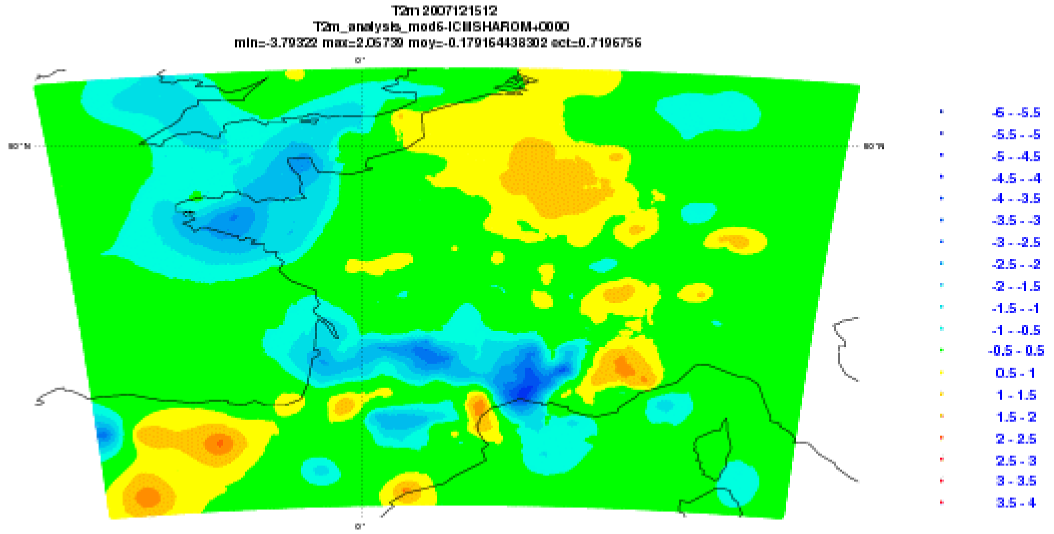

Plots of the increments for T2m



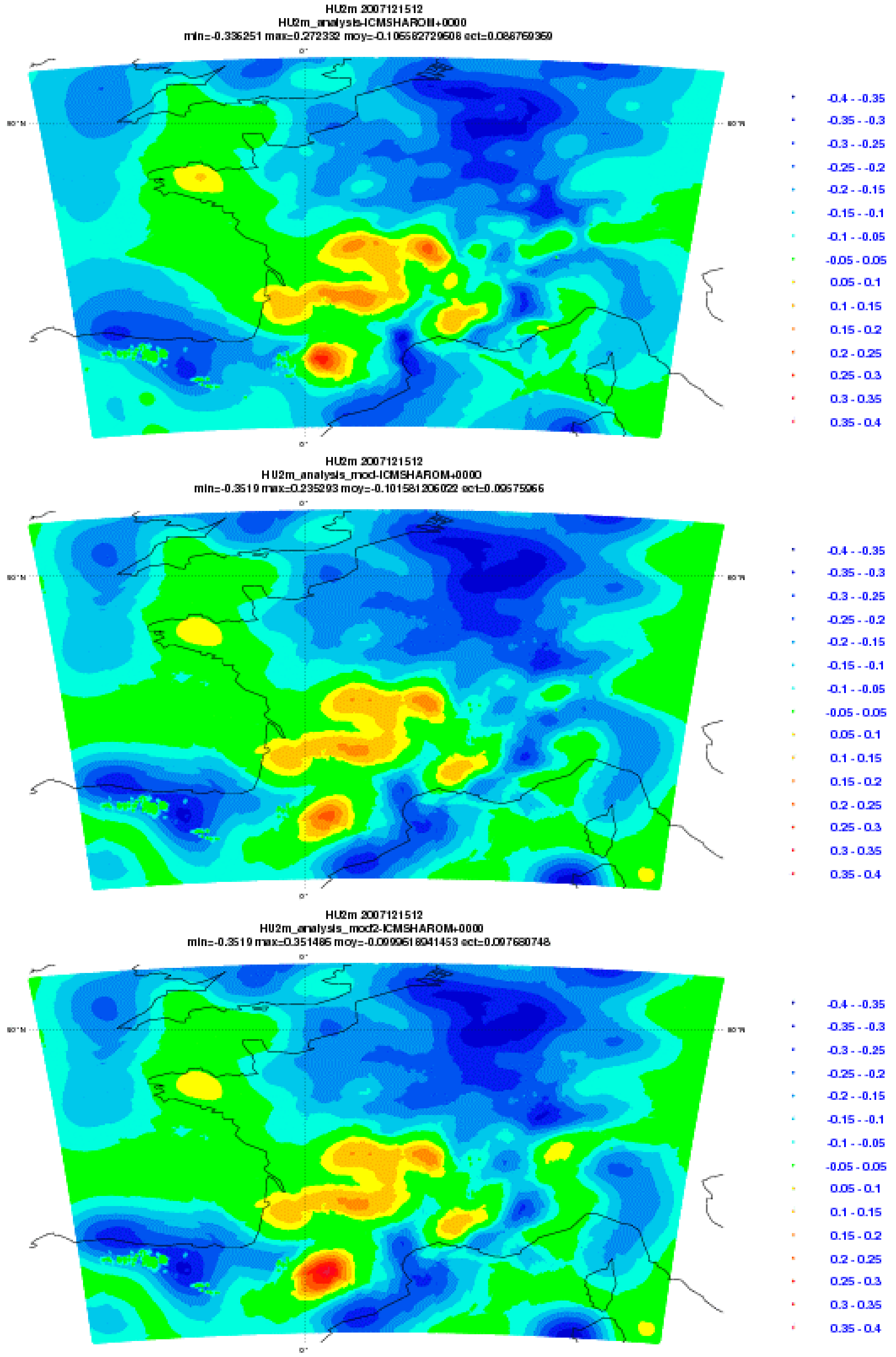



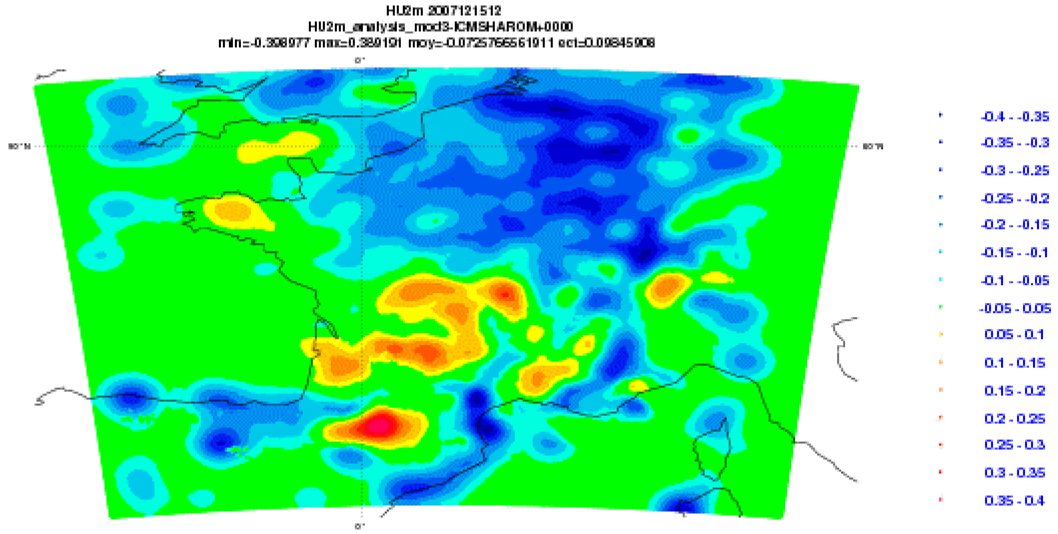

Plots of the increments for T2m - continue

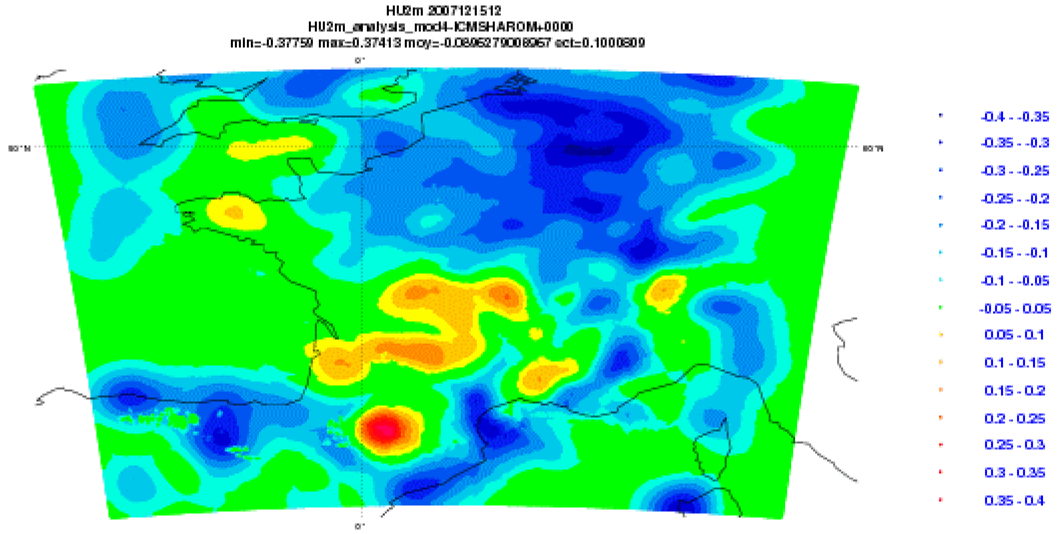


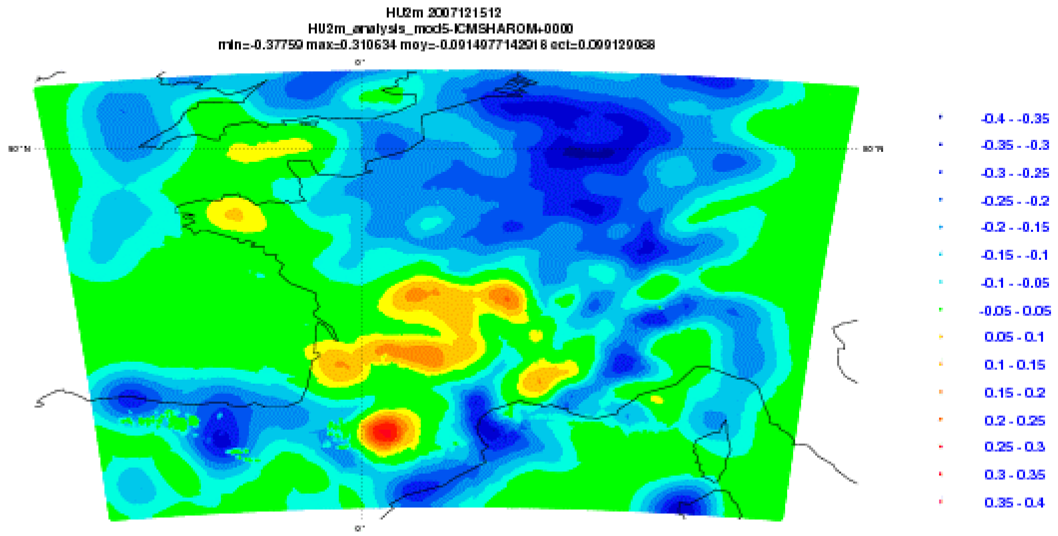

Plots of the increments for T2m - continue



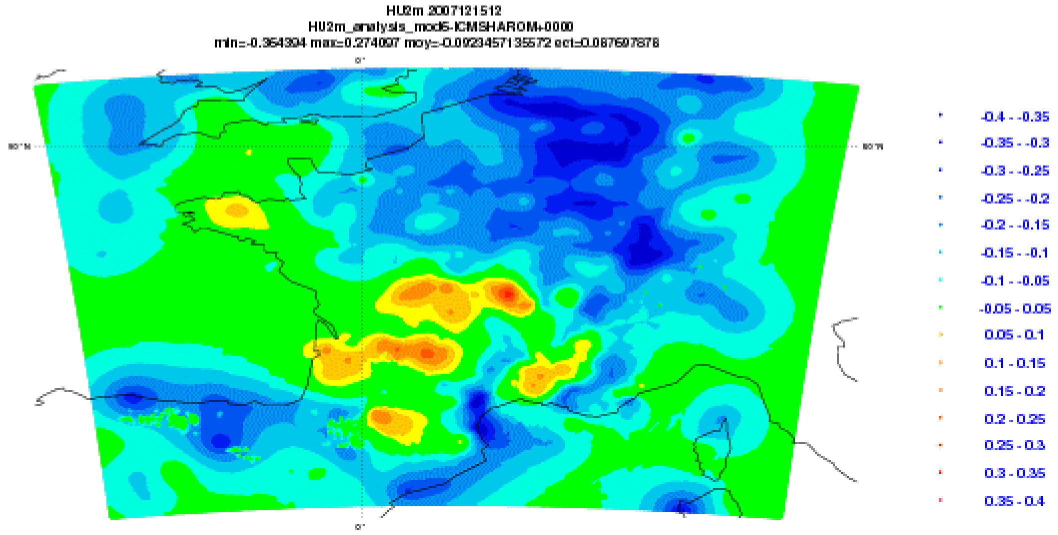

Plots of the increments for Hu2m




Plots of the increments for Hu2m - continue

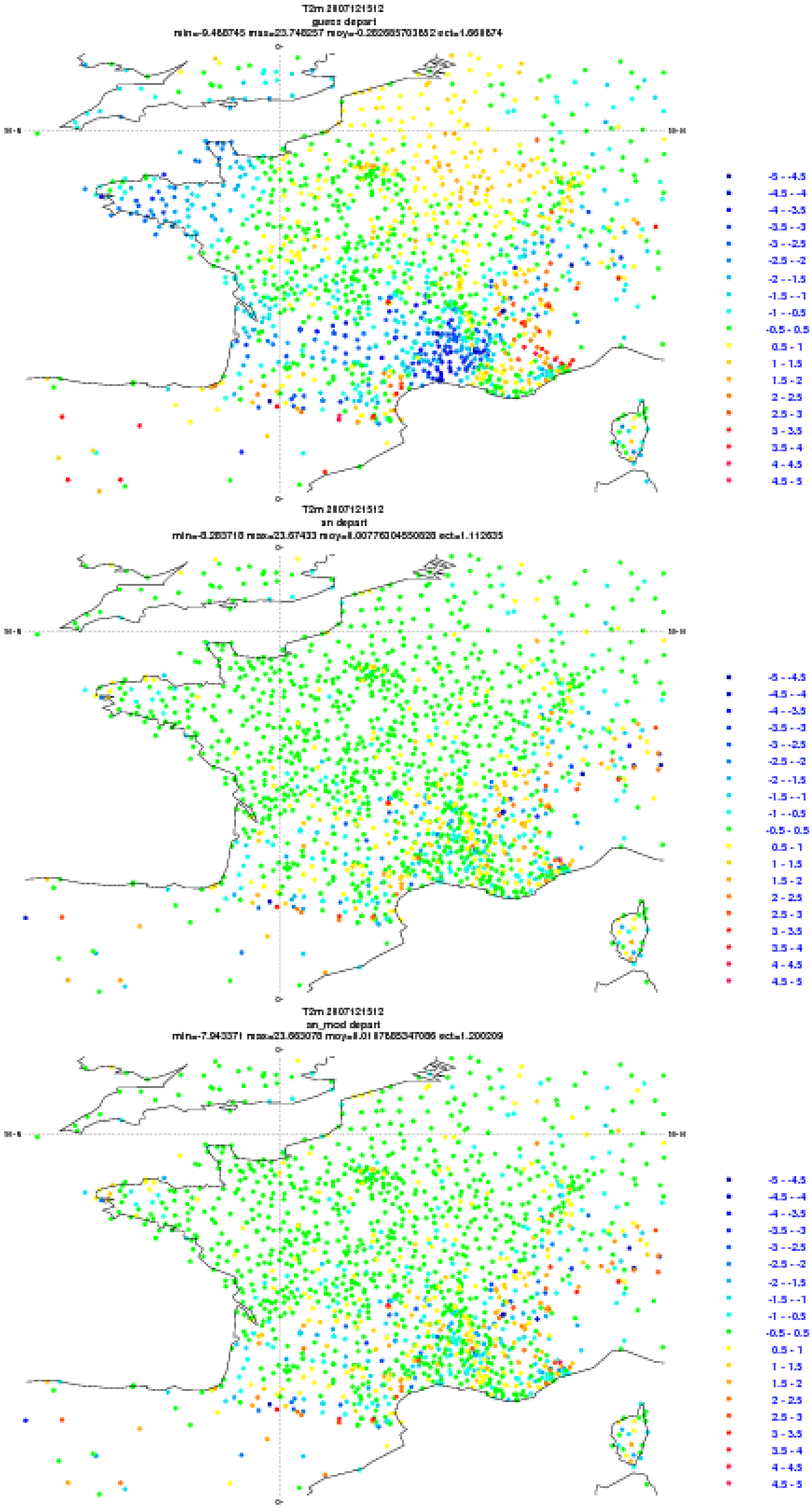



Plots of the increments for Hu2m - continue

Appendix3

Plots of the observation departures for the guess, an, an_mod, an_mod2, am_mod3, an_mod4, an_mod_5 and an_mod_6 for  2007121512 :

Plots of the observation departures for T2m
Plots of the observation departures for Hu2m

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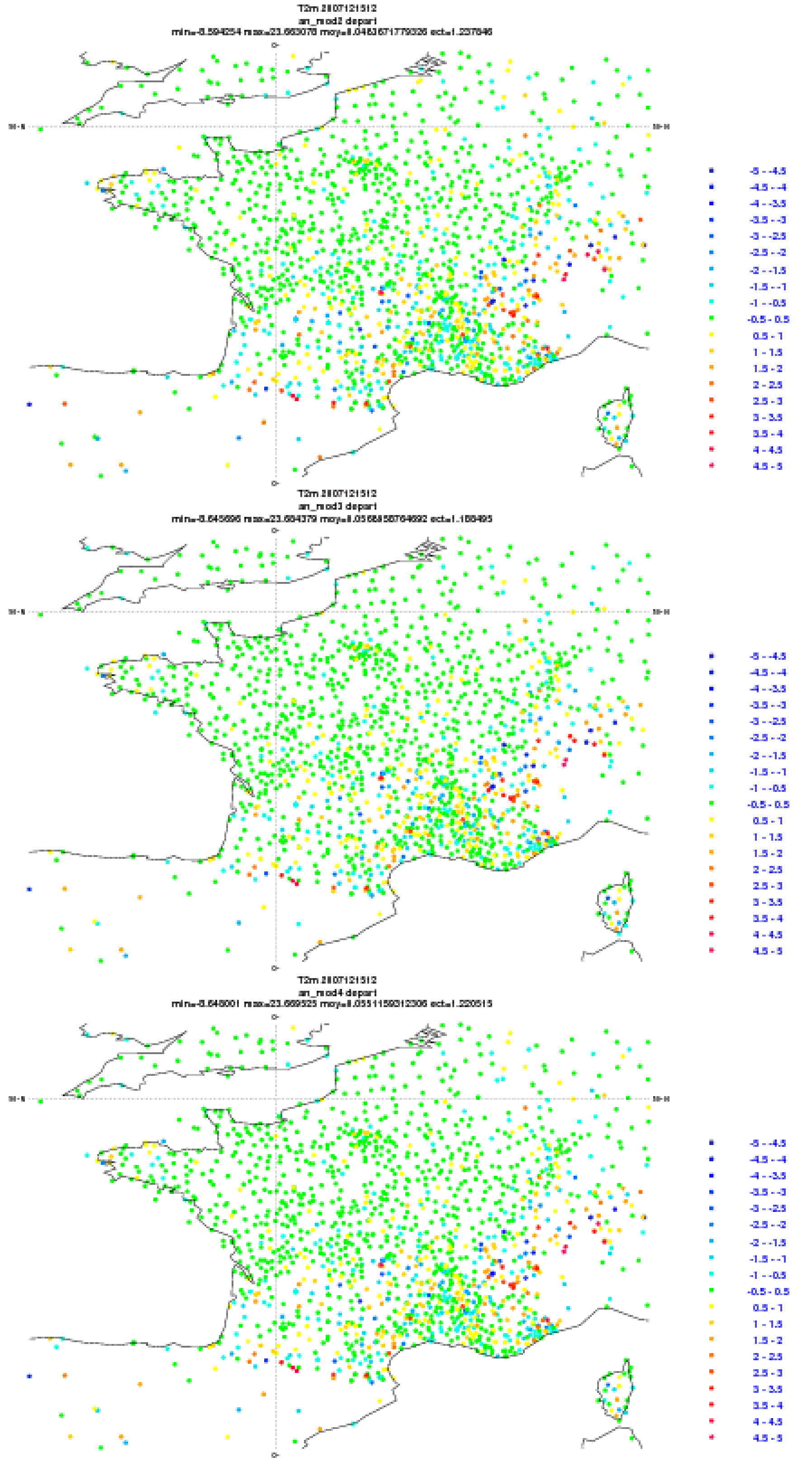


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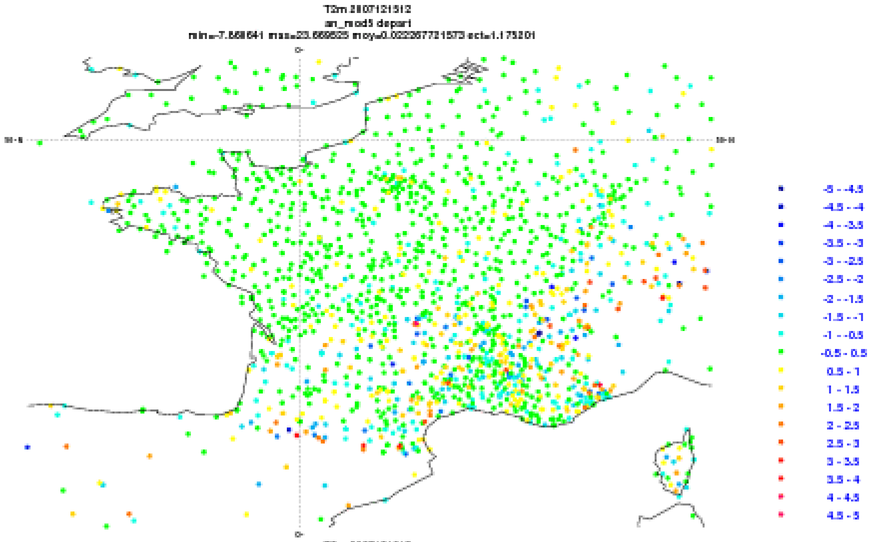
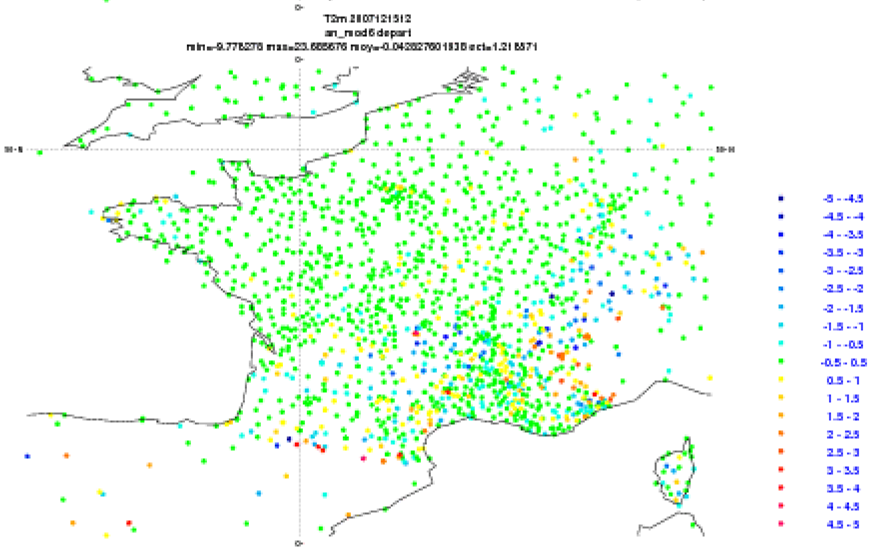
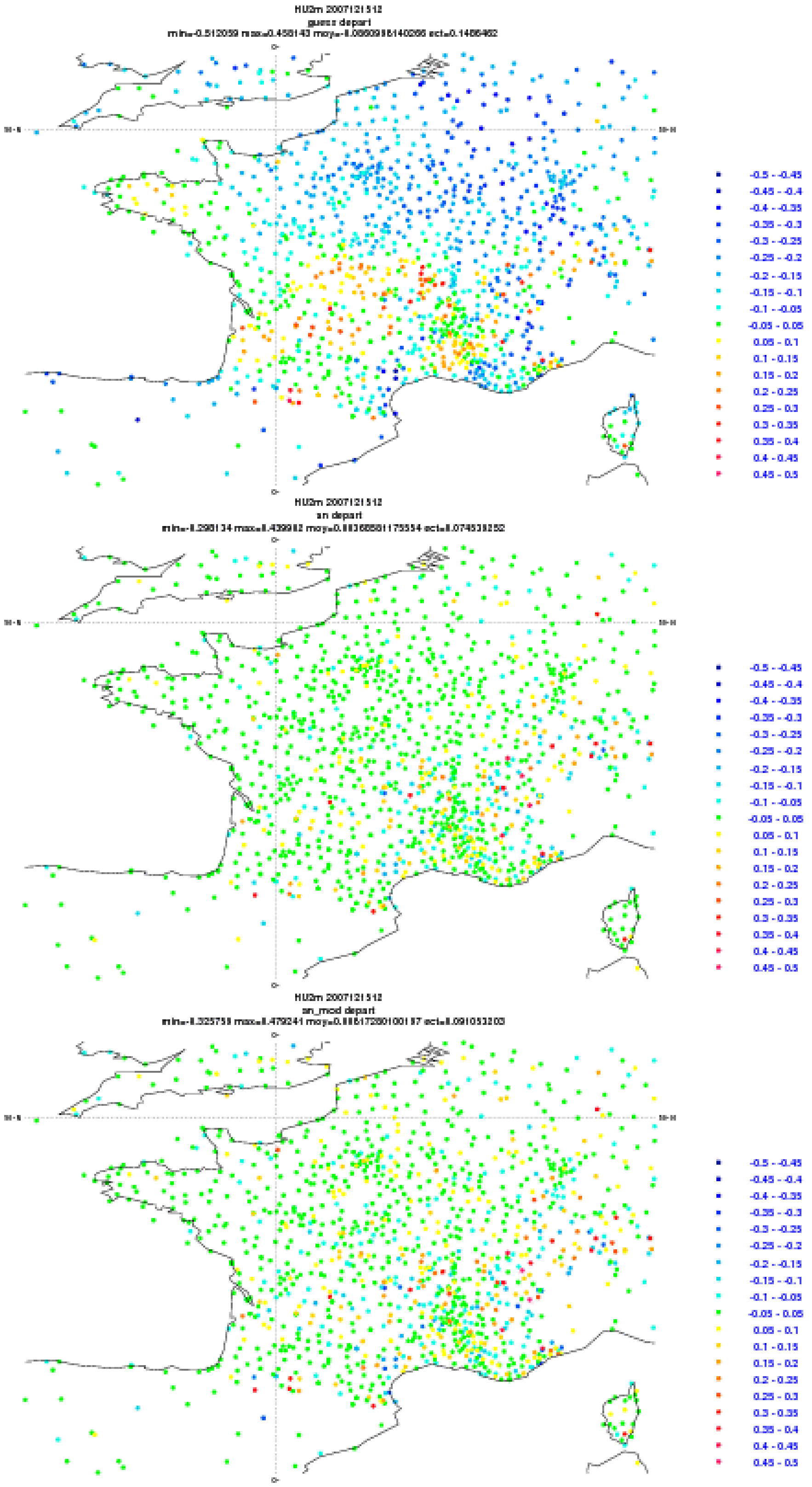
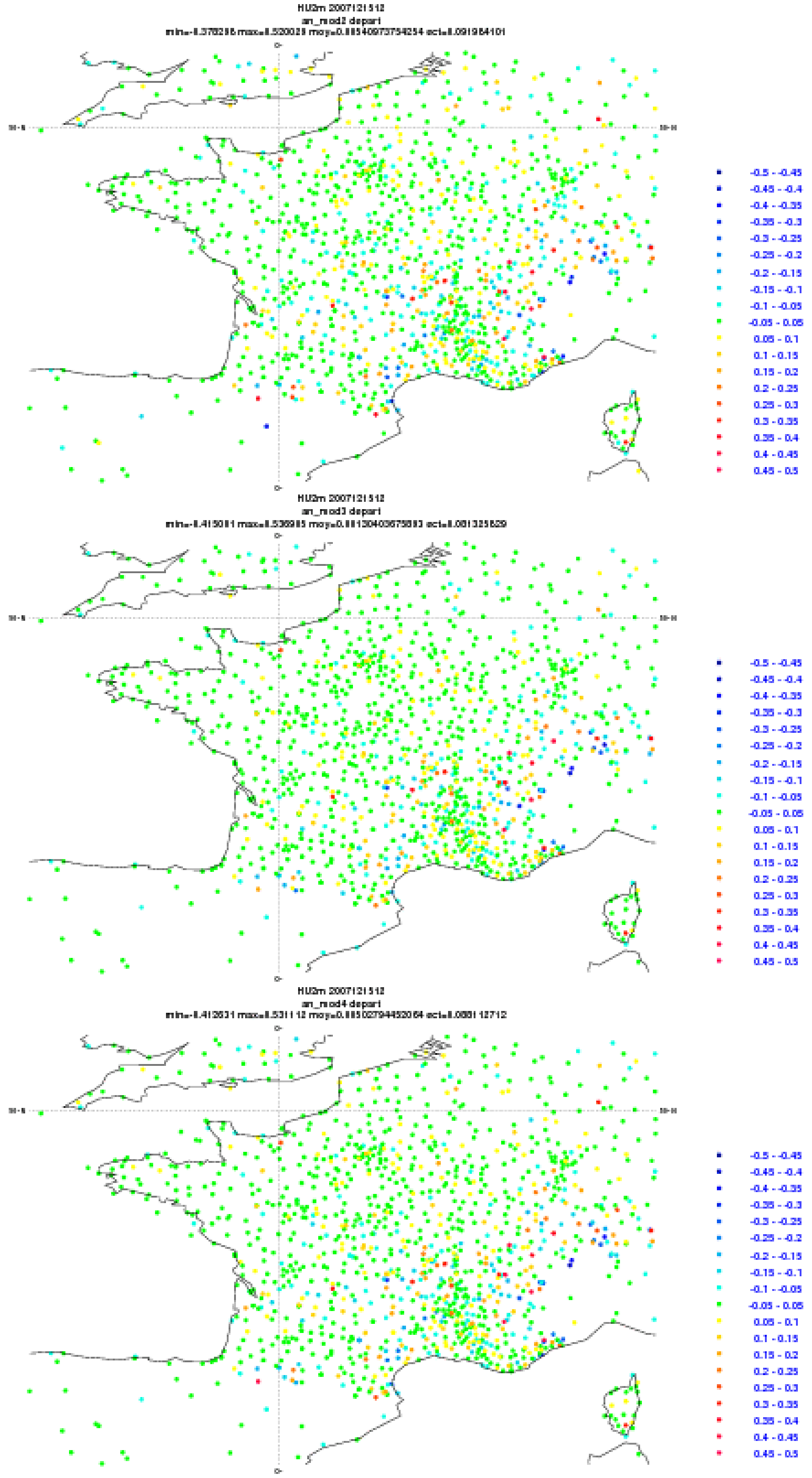



Plots of the observation departures for T2m - continue




Plots of the observation departures for Hu2m

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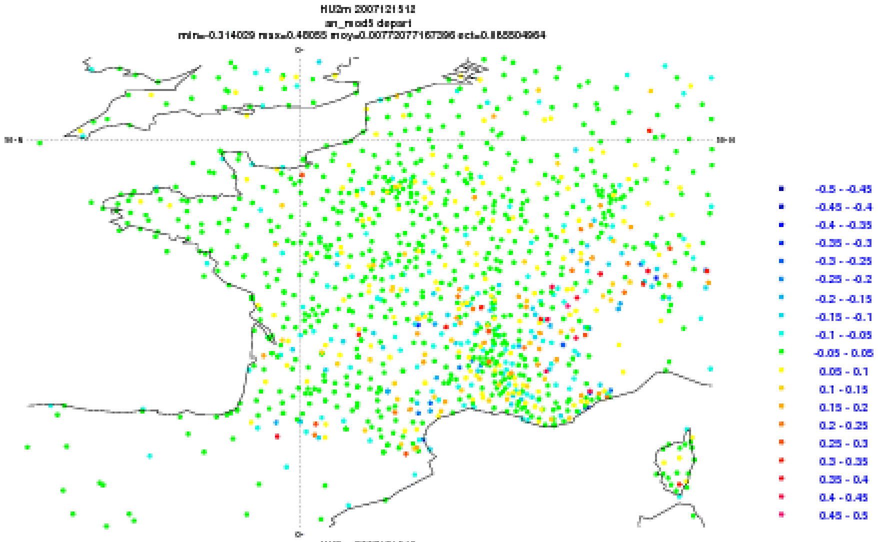


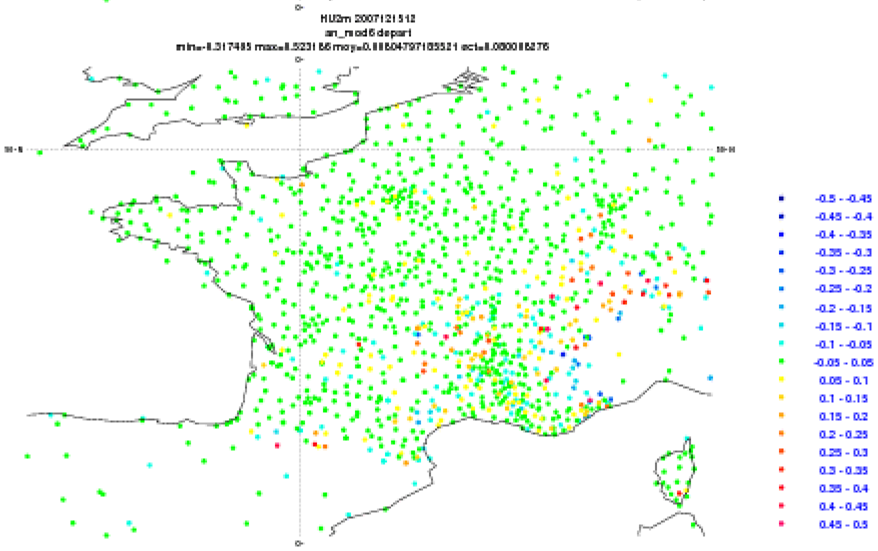


Plots of the observation departures for Hu2m - continue