Clear Air Products

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NWC SAF Physical retrieval Product

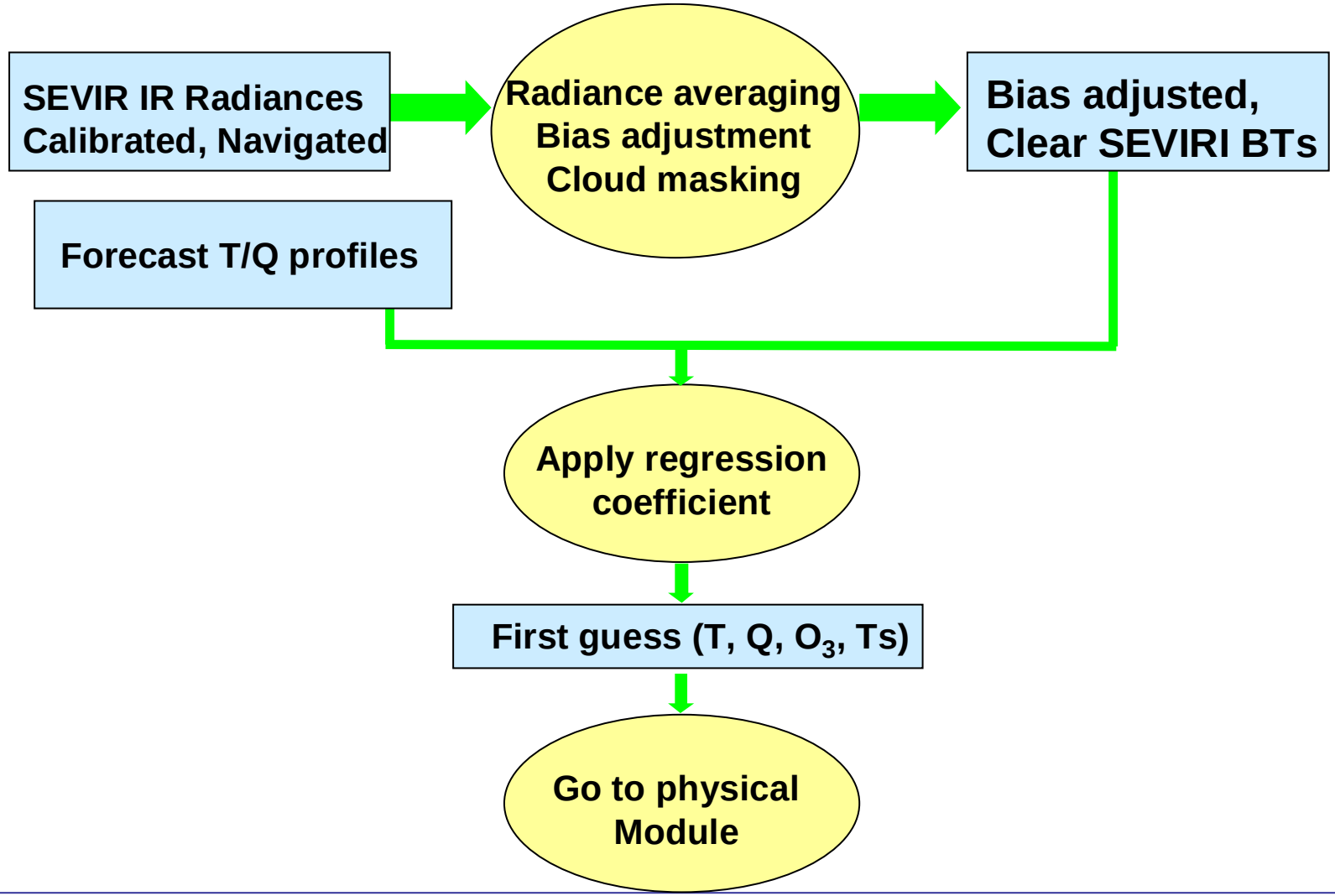
- The main objective of NWC SAF is to produce Software packages for MSG and Polar satellite. In the case of NCWSAF/MSG package the purpose of the NWC SAF algorithms is to derive each parameter at pixel by pixel scale every 15 minutes over a region selected by user.
- During the 11th Meeting (February 2007), the NWC SAF Steering Group proposed to the AEMET Project Team to focus the work during the SAF CDOP on implementing a physical retrieval approach.
- Through two NWC SAF Visiting Scientist Activities (VSA), Dr. Jun Li from CIMSS of University of Wisconsin-Madison provided the physical retrieval code (physical iterative approach with regression as first guess).
- In March 2009 took place in Darmstadt the Product Consolidation Review (PCR) of the PGE13 SEVIRI Physical Retrieval (SPhR) product. It was authorized the distribution of PGE13 SPhR to beta users as a patch to 2009 NWCSAF/MSG version. In July was distributed to ZAMG and CM-SAF.
- The SEVIRI Physical retrieval (SPhR) is included as PGE13 from version 2010.

Summary
of
NWC SAF physical retrieval product

NWC SAF Physical retrieval (PGE13 SPhR)

- The PGE13 SPhR algorithm is an optimal estimation algorithm with some improvements over the classical approach:
  - Use of non linear regression to built First Guess.
  - Use of a regularization parameter (also called smoothing factor) introduced for convergence and solution stability.
  - Use of EOFs to reduce the dimension of matrix and reduce the computation time.

Non linear regression



Minimization of cost function

$$J(X) = [Y^m - F(X)]^T E^{-1} [Y^m - F(X)] + [X - X^b]^T \gamma B^{-1} [X - X^b]$$

Measurements

Forward Model

Measurement Error

Background

Background Error

Regularization parameter is introduced to balance the contributions from background and satellite observations in solution. It is adjusted dynamically in the iterations (Li and Huang 1999; Li et al. 2000)

With Quasi-Newton Iteration

$$\delta X_{n+1} = (F_n'^T \cdot E^{-1} \cdot F_n' + \gamma B^{-1})^{-1} \cdot F_n'^T \cdot E^{-1} \cdot (\delta Y_n + F_n' \cdot \delta X_n)$$

RTTOV-9.3 used for forward model (F) and Jacobian calculations (F')

EOFs representation

- Since there are correlations among atmospheric variables, only a limited number of variables are needed to explain the vertical structure variation of an atmospheric profile (Smith, 1976).

Using profile eigenvectors (2 for T, 3 for q, and 1 for Ts)

$$X - X^{b} = \Phi A \quad \text{where} \quad A = (\alpha_1, \alpha_2, ..., \alpha_M) \quad \text{and} \quad \Phi = \begin{bmatrix} \Phi_T & 0 & 0 \\ 0 & \Phi_q & 0 \\ 0 & 0 & \Phi_{T_s} \end{bmatrix}$$

Iteration form:

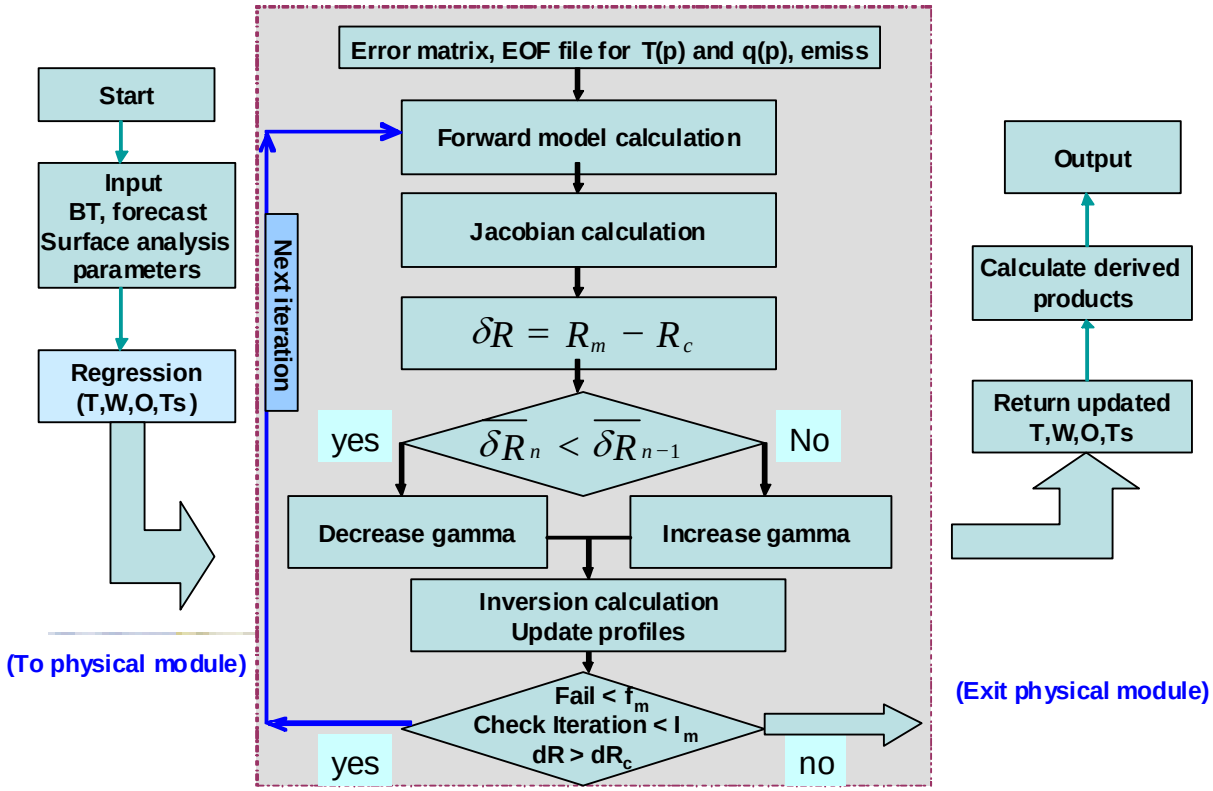
$$A_{n+1} = (\tilde{F}_n^{'T} \cdot E^{-1} \cdot \tilde{F}_n^{'} + \gamma B^{-1})^{-1} \cdot \tilde{F}_n^{'T} \cdot E^{-1} \cdot (\delta Y_n + \tilde{F}_n^{'} \cdot A_n)$$

$$A_0 = 0 \qquad \tilde{F}' = F' \cdot \Phi$$

- This allow reduce CPU time and speed up the process due to reduce dimension on matrix.

Flowchart of algorithm

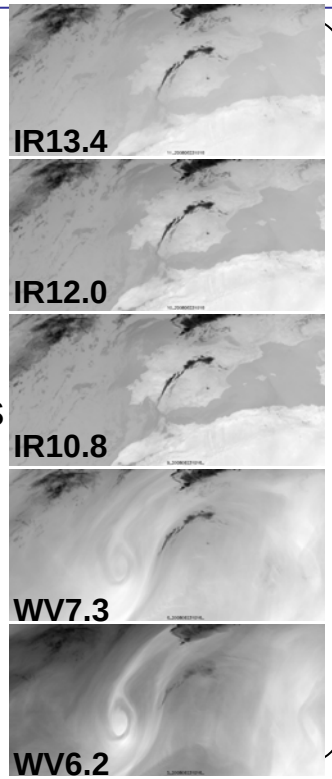
Use of PGE01 CMa to determine if pixel is clear. Only over clear pixel.

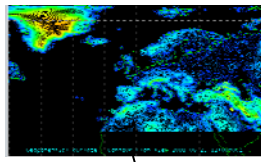


RTTOV-9.3 used for forward model and Jacobian calculations.

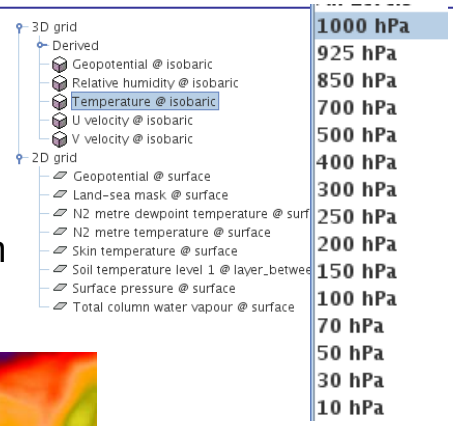
PGE13 SPhR inputs and outputs scheme

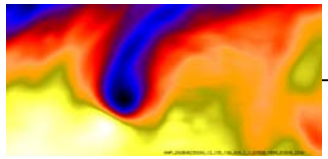
HRIT images





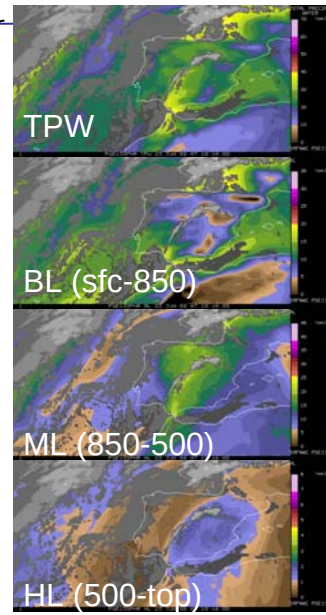
Spatial interpolation

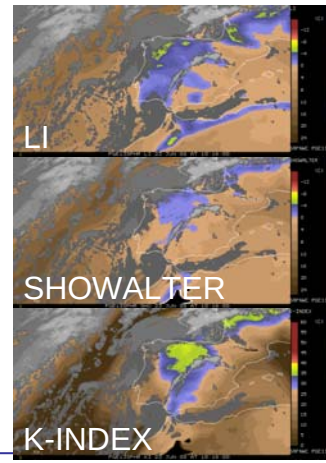




PGE13
YYYYMMDDhhmm region config_file

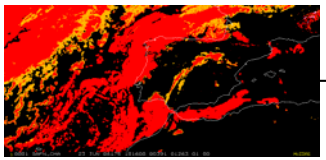
H5





Ancillary & coefficients
Lon, lat, zenith
Bias correction, regression, EOF, etc

PGE01 Cloud Mask



SAFNWC/MSG Task Manager synchronises the execution of the products and the first product that is generated upon the arrival of a new image is the cloud mask (NWC SAF PGE01).

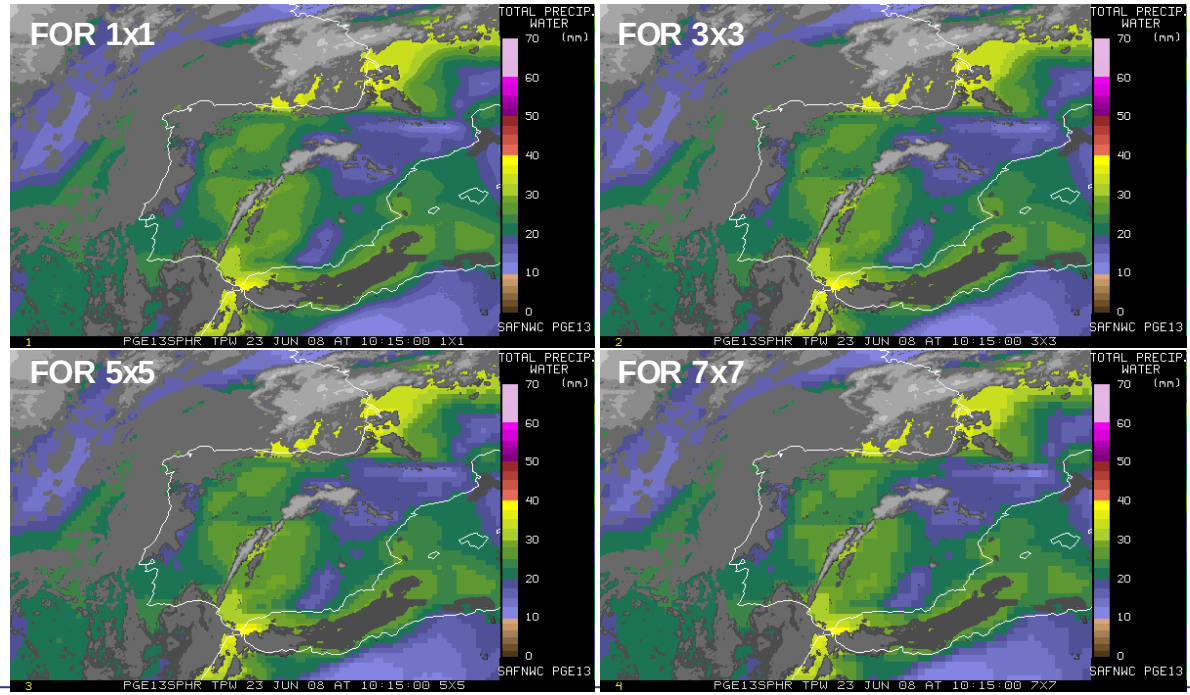
+ differences (phy. Ret –NWP)

INPUT description: Background NWP data

- NWP GRIB file +0 to +24 hours forecast are needed.
- **Background NWP are spatial, temporal and vertically interpolated to get NWP data collocated with SEVIRI data at 43 RTTOV levels.**
- **In real time operational mode, NWC SAF package has predefined tools (coordinated by Task Manager daemon) to make automatically the spatial remapping to the predetermined regions once the NWP GRIB files are receipted. Temporal and vertical interpolation is made inside PGE13 only at clear air FOR.**
- The same NWP GRIB files that are actually used for PGE01-03 can be used; hence, any user that is running SAFNWC/MSG package could be able to run PGE13. Users can use their own model and choice for the NWP supply.

FOR (Field of Regards)

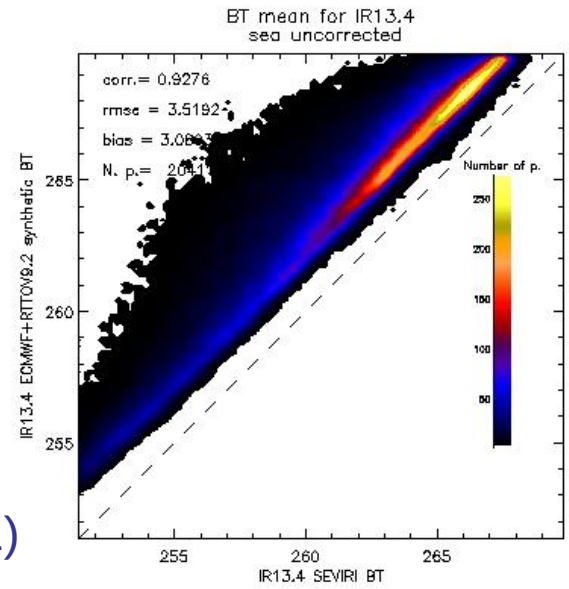
- A window of 3x3 have been considered as default.
- **The size of FOR (MxM) is one parameter in the configuration file**
  - The users can select the size of FOR (MxM size of the window) depending on the size of the region to process and the machine characteristics.



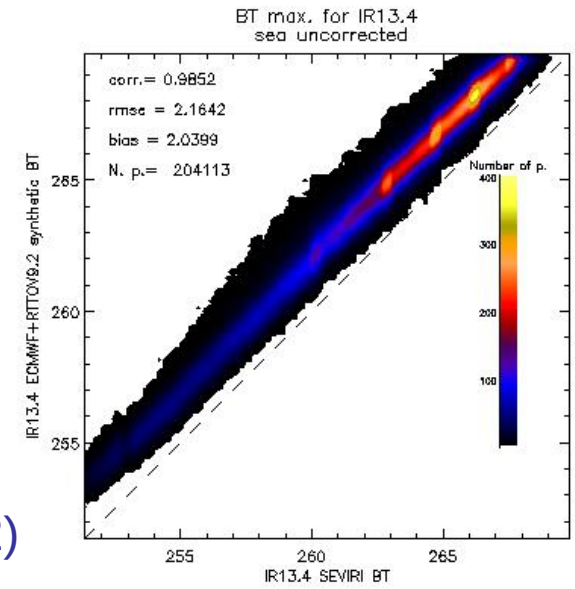
FOR methods: MEAN or warmest@IR10.8

- Two methods to calculate the FOR brightness temperatures have been implemented:
  - (1) Mean of all clear pixels inside the FOR
  - (2) The IR10.8 warmest clear pixel inside the FOR

(1)



(2)



PGE13 SPhR OUTPUTS: HDF-5 main outputs (1/2)

- The following fields are calculated for clear pixels:

1. SPhR_TPW: Total precipitable water from the retrieved profiles of temperature and humidity in mm.
2. Precipitable water in three layers LPW from the retrieved profiles of temperature and humidity in mm:
    1. SPhR_BL: Surface Pressure - 850 hPa,
    2. SPhR_ML: 850 – 500 hPa,
    3. SPhR_HL: 500 - TOP
3. SPhR_LI: Lifted Index from the retrieved profiles of temperature and humidity in ºC
4. SPhR_SHOWALTER: Showalter Index from the retrieved profiles of temperature and humidity in ºC
5. SPhR_KI: K-Index from the retrieved profiles of temperature and humidity in ºC

PGE13 SPhR OUTPUTS: HDF-5 main outputs (2/2)

- The following fields are calculated for clear pixels:

6. SPhR_DIFFTPW: Difference between TPW from retrieved profile and TPW from NWP profiles in mm
7. SPhR_DIFFBL, SPhR_DIFFML, SPhR_DIFFHL: Difference between LPWs from retrieved profile and LPWs from NWP profiles in mm
8. SPhR_DIFFLI, SPhR_DIFFKI, SPhR_DIFFSHW: Difference between instability indexes from retrieved profile and instability indexes from NWP profiles
9. Quality Flags: SPhR_QUALITY, SPhR_SFLAG fields.
10. Configurable IR channel BT degraded to 7 bits only in cloudy pixels

Together with the parameters calculated directly from the retrieved profile, it was considered adequate at Madrid Workshop to provide as other outputs the differences between the parameter obtained with the retrieved profile and the same parameter obtained with the NWP model profile as additional outputs

PGE13 SPhR optional OUTPUTS: binary files with the profiles at the different steps of physical retrieval algorithm

- As an **optional output**, the intermediate retrieved profiles of temperature and humidity resulting from the physical retrieval module and the profiles from the NWP model interpolated at 43 RTTOV levels may be written as another output on binary format.

- The users can activate it in the ASCII configuration file one option so that a binary files will be written in the $SAFNWC/tmp directory. This allows users to debug their local implementation, to get access to the retrieved temperature and humidity profiles and to compare them with the background NWP profiles.

PGE13 outputs: optional binary files description

Binary files for the example of 20080623 at 1200 on Region 2200x1019

Float [2200,1019,15] T (K) and humidity (Relative humidity) background NWP in AEMET @15 pressure levels

`$SAFNWC/tmp/PGE13_nwp_t_____200806231200_C0509_1856_S1019_2200`

`$SAFNWC/tmp/PGE13_nwp_q_____200806231200_C0509_1856_S1019_2200`

Float [2200,1019] fields with Surface Pressure and Skin temperature from background NWP (ECMWF in AEMET)

`$SAFNWC/tmp/PGE13_nwp_sp_____200806231200_C0509_1856_S1019_2200`

`$SAFNWC/tmp/PGE13_nwp_sk_____200806231200_C0509_1856_S1019_2200`

Float [43+43+43+4, 2200,1019] T (K), q (ppmv), Ozono, T_{2m}, q_{2m}, P_{sfc} and SKT spatial, temporal and vertically interpolated @43 RTTOV levels at clear air FOR positions from ECMWF background NWP

`$SAFNWC/tmp/PGE13_background__200806231200_C0509_1856_S1019_2200`

Float [43, 2200,1019] T (K) and q (ppmv) spatial, temporal and vertically interpolated after regression (FG) step

`$SAFNWC/tmp/PGE13_fg_____200806231200_C0509_1856_S1019_2200`

Float [43+43+1 , 2200,1019] Temperature (K), q (ppmv) and SKT from the iterations

`$SAFNWC/tmp/PGE13_retr_iter_1_200806231200_C0509_1856_S1019_2200`

`$SAFNWC/tmp/PGE13_retr_iter_2_200806231200_C0509_1856_S1019_2200`

`$SAFNWC/tmp/PGE13_retr_iter_3_200806231200_C0509_1856_S1019_2200`

Float [43, 2200,1019] T (K) and q (ppmv) spatial, temporal and vertically interpolated @43 RTTOV levels used for TPW, LPW and instalility indexes calcultations to write H5 outputs

`$SAFNWC/tmp/PGE13_end_prof____200806231200_C0509_1856_S1019_2200`

Float [5, 2200,1019] with the Retrieved BT

`$SAFNWC/tmp/PGE13_retr_bt____200806231200_C0509_1856_S1019_2200`

PGE13 validation and training dataset

Writing of binary files has been used for BT bias correction at the version 2010, for training of the 2010 FG regression generation and for validation of the PGE13 version 2010.

PGE13 SPhR training and validation dataset

- To build a training and validation dataset with the MSG data, ECMWF NWP model and RAOB profiles is an important task.
- This task is based in reprocessing two years at 0 UTC and 12 UTC with PGE13 only over a list of points (RAOB positions and a grid of 1ºx1º). Binary files allows to create a dataset of (T, q) profiles collocated with SEVIRI radiances, etc. Collocated data from 2008/01 to 2009/12:
    1. SEVIRI
    2. ECMWF
        1. analysis and T+12 forecast
        2. 00 and 12 UTC
        3. 15 fixed pressure levels or 91 hybrid levels interpolated to the 43 RTTOV pressure levels
    3. RAOB observation from Wyoming University

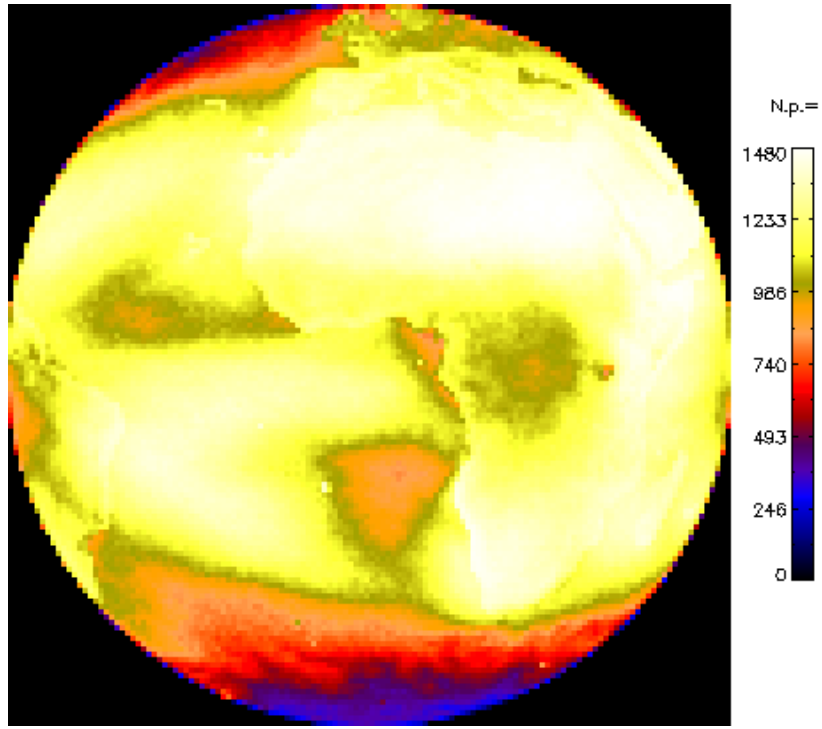
PGE13 validation and training dataset

Bias BT correction

Bias BT correction: Generation of dataset period using period November 2007 to December 2009

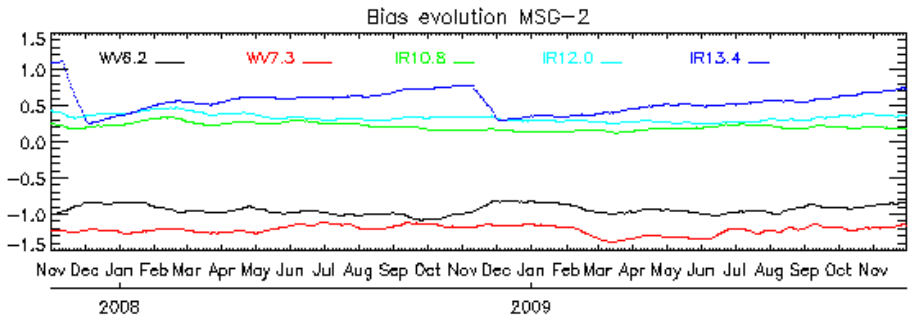
PGE13 executed with options:

- FOR of 25x25
- BTs from warmest@IR10.8
- 00 and 12 UTC for period November 2007 to December 2009
- Background NWP from the ECMWF analysis



Spatial distribution of the number of observations

Bias correction coefficients for MSG/2



Evolution of the bias correction between BT_SEVIRI and synthetic BT_RTTOV.

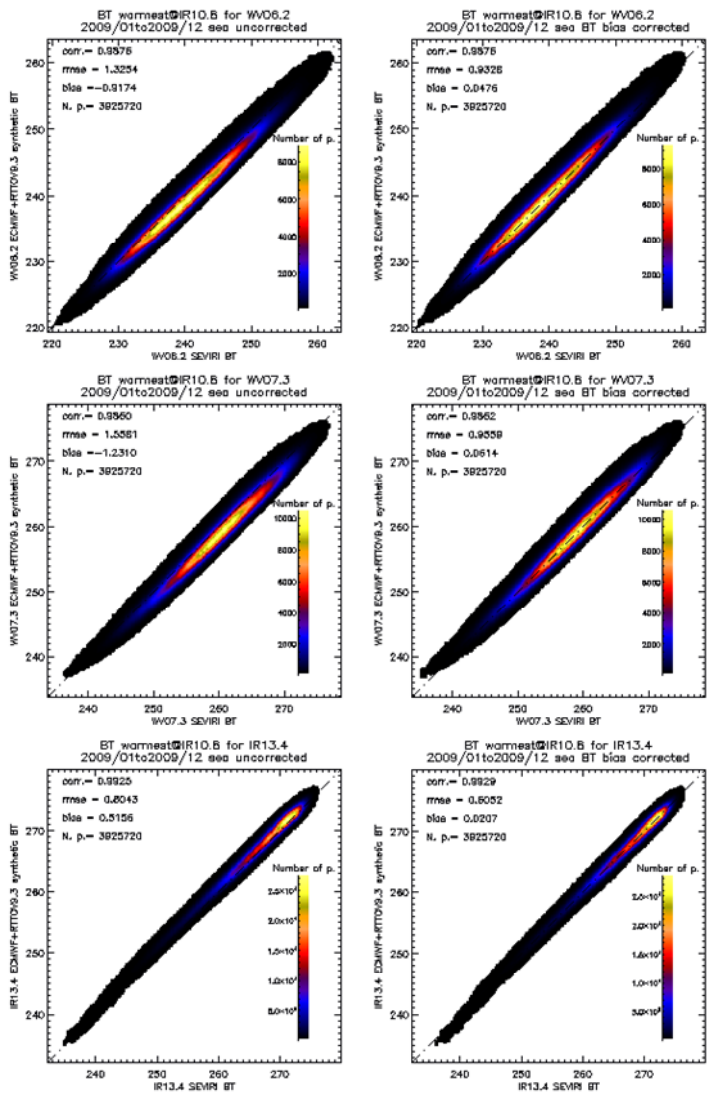
Differences between a mean value before and after the bias correction calculated for a “moving” window of one month for five SEVIRI channels.

After inspection of the evolution of the bias and after the analysis of the spatial distribution of the error only pixels over sea for period 2009/01 to 2009/12 has been used to calculate

It will be the default values in *“safnwc_pge13_msg2.cfm“*.

Before correction

After correction



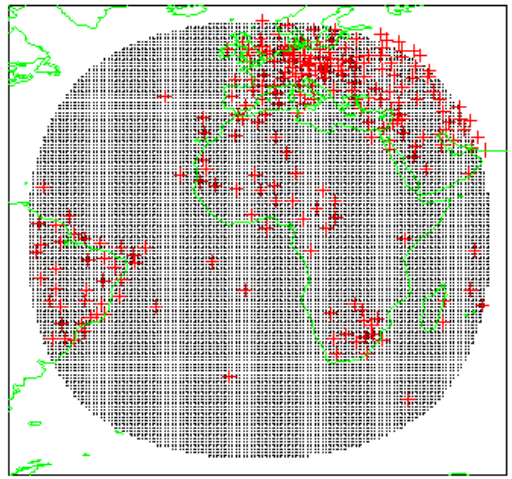
FG training dataset

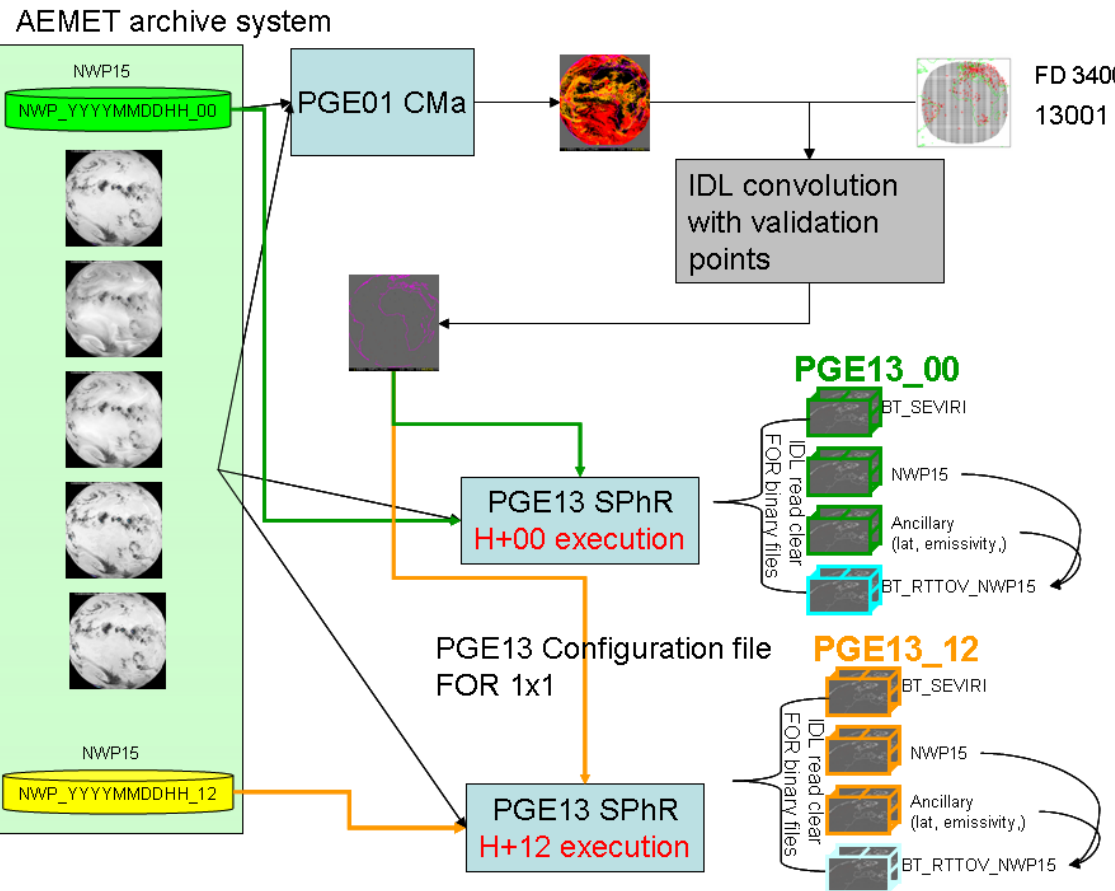
FG regression coefficient file for 2010 generation

Creation of FG regression dataset for one image

Points of the FG regression and validation dataset. Grid network of 1º x 1º plus Radiosonde Stations (red crosses).

FD 3400x3400 region





For every clear pixels one structure with collocated SEVIRI, NWP data and ancillary data are written.

Later collocated 91 hybrid profiles has been added

Then are joined by month; they can be joined easily for wider period

2010 FG regression generation

- Due to the PC memory constraints only 1 out 6 observation for period 2009/01 to 2009/12 has been used to train the FG regressions.

$$Z = \sum_{j=1}^{N} A_j \cdot Tb_j + \sum_{j=1}^{N} B_j \cdot Tb_j^2 / 250 + C \cdot p_s + D \cdot latitude + E \cdot p_{land} + \sum_{l=1}^{ntemp} F_{tl} \cdot T_l + \sum_{l=1}^{nq} G_{wl} \cdot \log(q_l) + H_0$$

Where:

- *Z* is: T or q at the 43 RTTOV pressure levels or Skin temperature
- **Tb** is the SEVIRI bias corrected brightness temperature

  In training is RTTOV BT from NWP(T+0) for each zenith angle (every degree)
- ***T*** and ***q*** are background NWP forecast temperature and specific humidity profile at the 43 RTTOV pressure levels respectively
- **Ps** is the surface pressure

1000 hPa
925 hPa
850 hPa
700 hPa
500 hPa
400 hPa
300 hPa
250 hPa
200 hPa
150 hPa
100 hPa
70 hPa
50 hPa
30 hPa
10 hPa

- Due to some levels when are interpolated to the 43 pressure levels are linear combination when interpolated for low number of fixed pressure levels problem:

NWP(T+12)=NWP(T+00)+(hybrid(T+12)-hybrid(T+00))

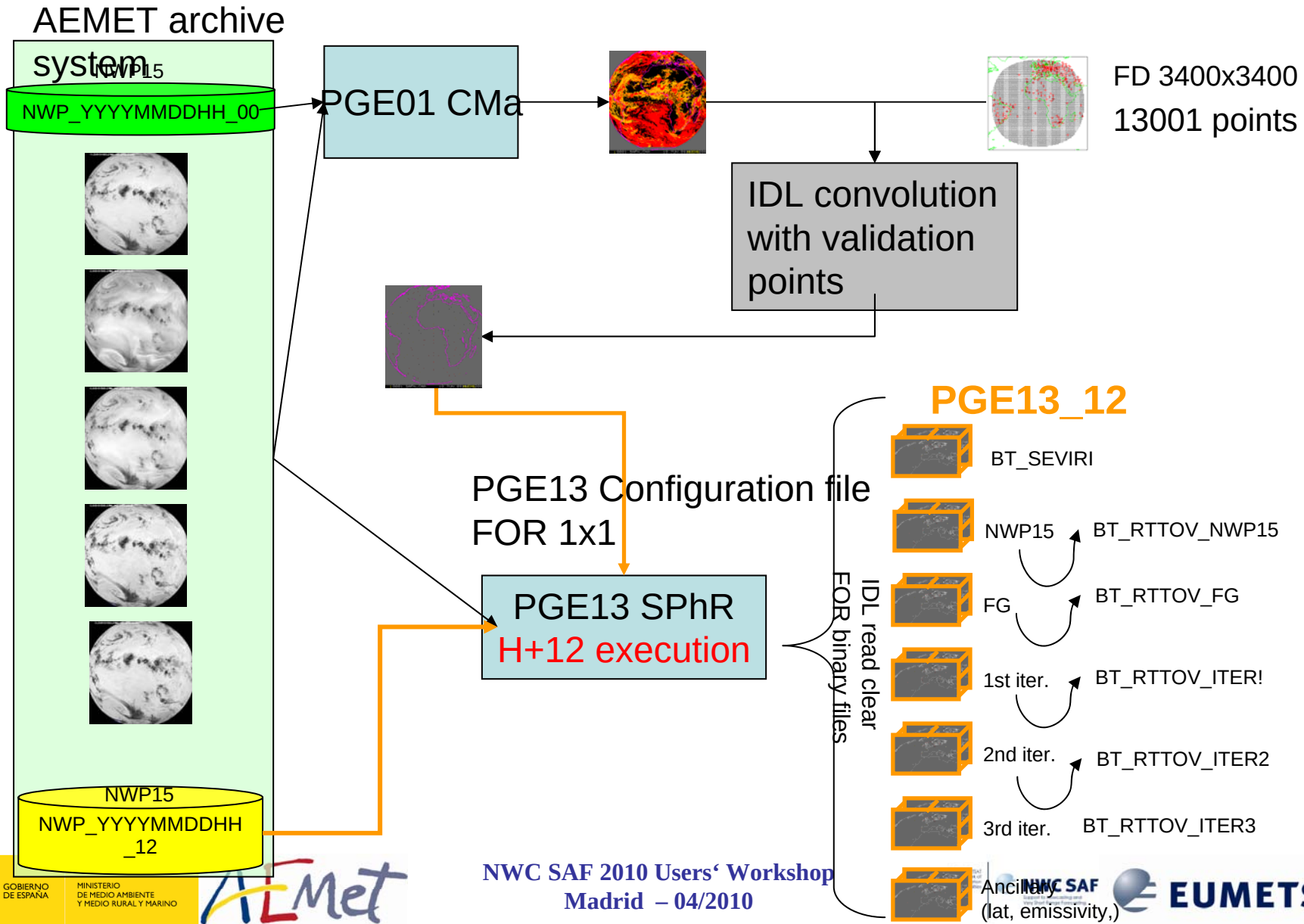
The coefficient file contains 76 regression coefficients for every parameter. Each regression corresponds to one local zenith angle ranging from 0 to 75 degrees

PGE13 validation dataset

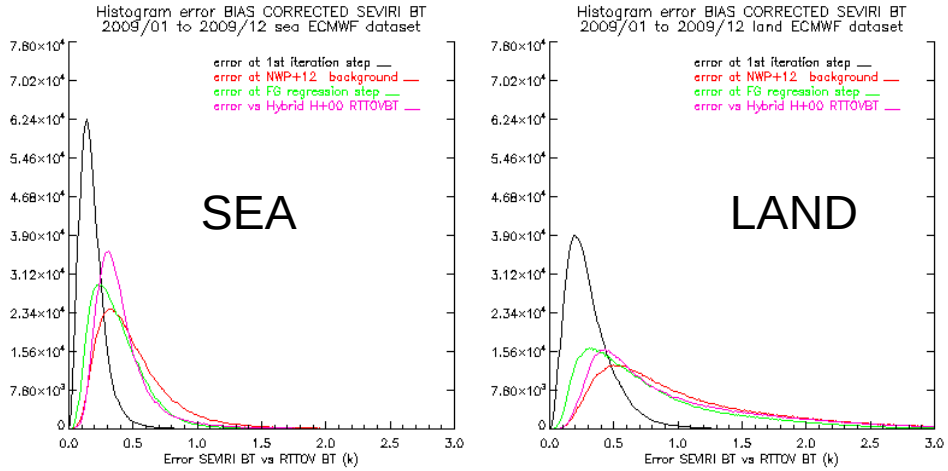
The 5 out of 6 observations of 2009 not used to build the training dataset has been used.

Separated validations for sea, land and with RAOB observations.

Reprocessing with the new FG regression and bias correction as 2010 version

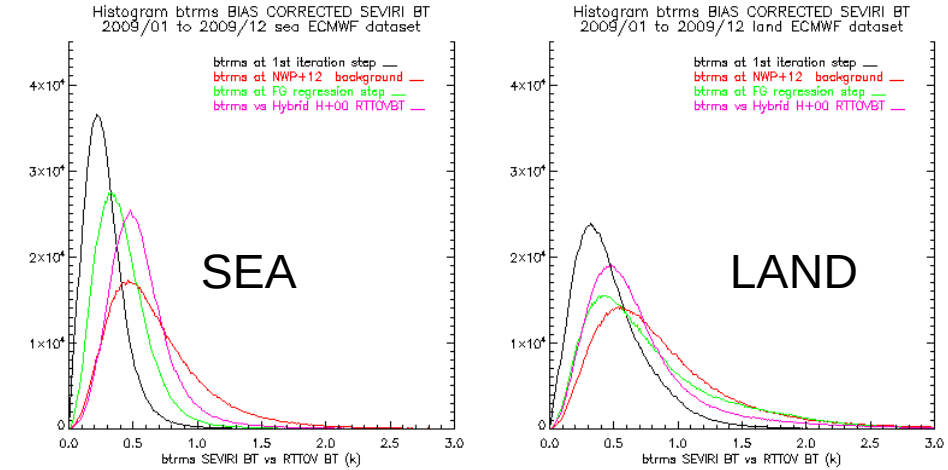


Analysis of the distance between SEVIRI BTs and RTTOV BTs at different steps of the algorithm



Error BT distance between SEVIRI_BTs and RTTOV_BTs withWV6.2, WV7.3, IR10.8, IR12.0 and IR13.4

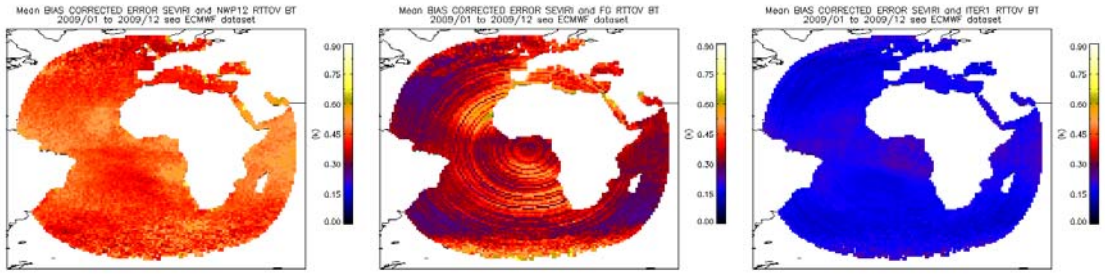
$$\sqrt{\sum_{L=1}^{3}(BT_{RTTOV_l} - BT_{SEVIRI_l})^2}$$

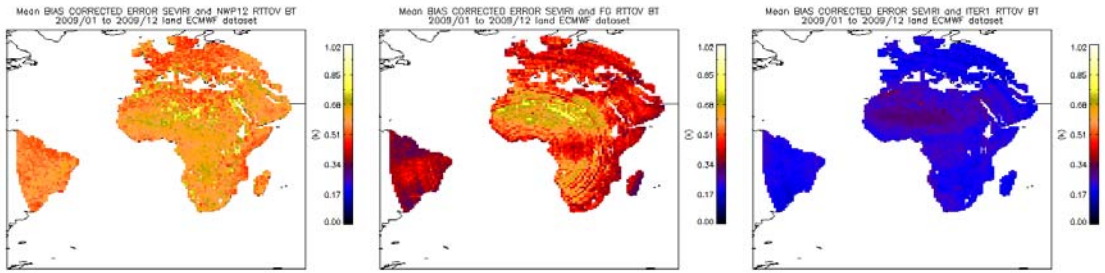


BT_RMS distance between SEVIRI_BTs and RTTOV_BTs only with absorption channels WV6.2, WV7.3 and IR13.4

PGE13 validation dataset over all 5 out of 6 pixels in period 2009/01 to 2009/12.

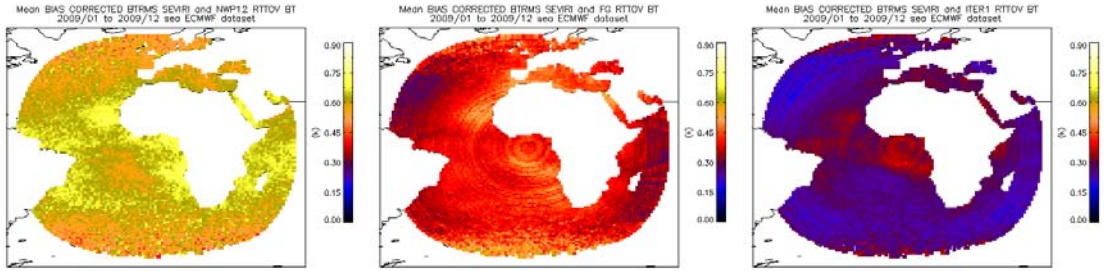
Analysis of the distance between SEVIRI BTs and RTTOV BTs at different steps of the algorithm

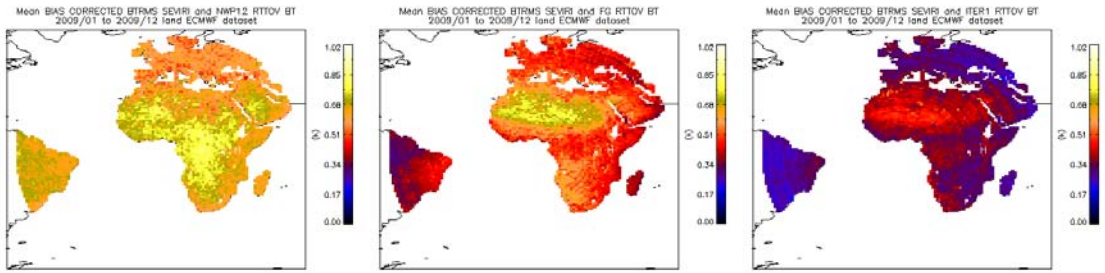




Error BT distance between SEVIRI_BTs and RTTOV_BTs calculated with WV6.2, WV7.3, IR10.8, IR12.0 and IR13.4

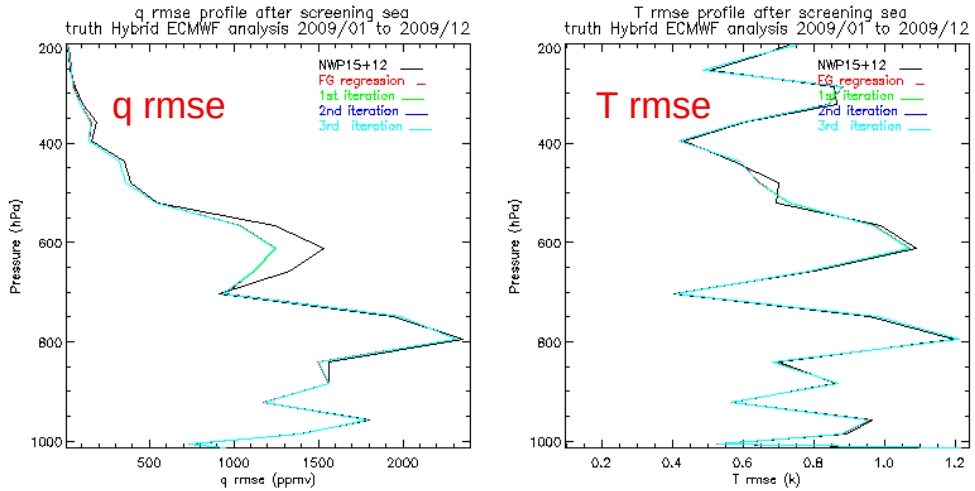
$$\sqrt{\sum_{L=1}^{3}(BT_{RTTOV_l} - BT_{SEVIRI_l})^2}$$





BT_RMS distance between SEVIRI_BTs and RTTOV_BTs only calculated with absorption channels WV6.2, WV7.3 and IR13.4

SEA: Vertical profile of rmse and bias analysis



⇦ RMSE of q and T profiles at different steps compared with ECMWF analysis hybrid profiles over sea pixels in the Full Disk region after screening

⇦ BIAS of q and T profiles at different steps compared with ECMWF analysis hybrid profiles

Background NWP model ECMWF at 15 fixed pressure levels

1000 hPa
925 hPa
850 hPa
700 hPa
500 hPa
400 hPa
300 hPa
250 hPa
200 hPa
150 hPa
100 hPa
70 hPa
50 hPa
30 hPa
10 hPa

SEA

Statistical summary after screening

BL sea after screening	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	0.905354	0.901597	0.900310	0.901019	0.901660
BIAS	0.0247280	0.00914995	0.0296746	0.0294641	0.0333900
correlation	0.986676	0.986804	0.986848	0.986832	0.986803

LI sea after screening	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	0.964472	0.949411	0.951603	0.951917	0.952654
BIAS	-0.0866577	-0.120672	-0.138958	-0.138855	-0.142475
correlation	0.982987	0.983570	0.983574	0.983571	0.983560

ML sea after screening	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	1.97091	1.65863	1.64896	1.64723	1.64636
BIAS	0.952874	0.717595	0.733197	0.733079	0.735719
correlation	0.961386	0.969552	0.970292	0.970366	0.970462

SHOWALTER sea after screening	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	1.39813	1.35960	1.36235	1.36223	1.36262
BIAS	-0.472928	-0.438872	-0.455726	-0.455923	-0.458460
correlation	0.964991	0.966440	0.966603	0.966616	0.966635

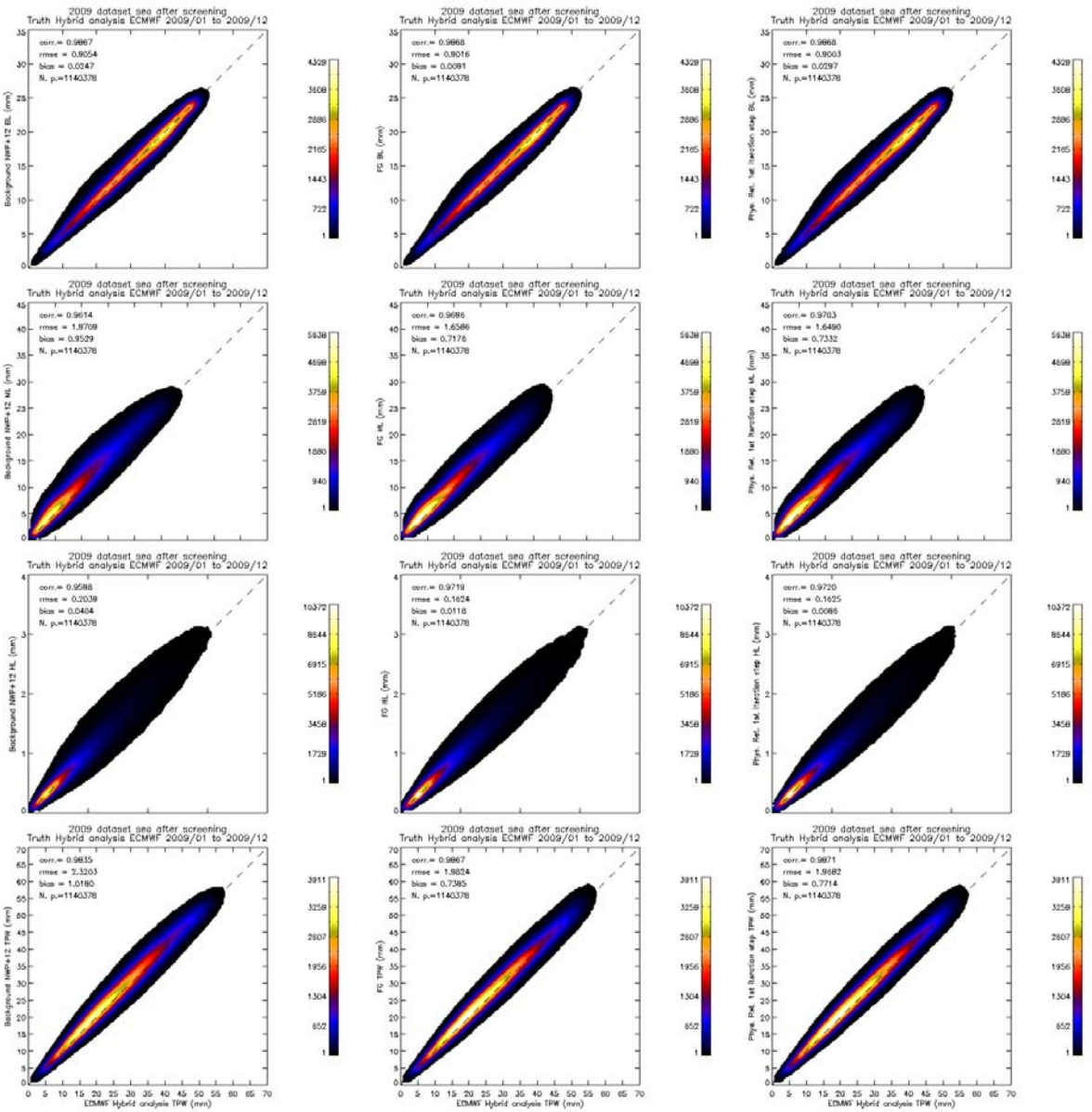
HL sea after screening	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	0.203906	0.162411	0.162463	0.162338	0.162283
BIAS	0.0404229	0.0118043	0.00856599	0.00829746	0.00843952
correlation	0.959780	0.971931	0.971968	0.971998	0.972024

KI sea after screening	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	4.01535	4.01561	4.01774	4.01750	4.01716
BIAS	0.845849	0.911897	0.961828	0.963396	0.970284
correlation	0.974562	0.975788	0.975943	0.975963	0.975987

TPW sea after screening	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	2.32029	1.98237	1.96823	1.96537	1.96457
BIAS	1.01802	0.738544	0.771436	0.770849	0.777537
correlation	0.983500	0.986707	0.987121	0.987163	0.987224

1,140,378 pixels

SEA pixels: LPW and TPW 2D histograms for period January 2009 to December 2009 (5 out 6 pixels)



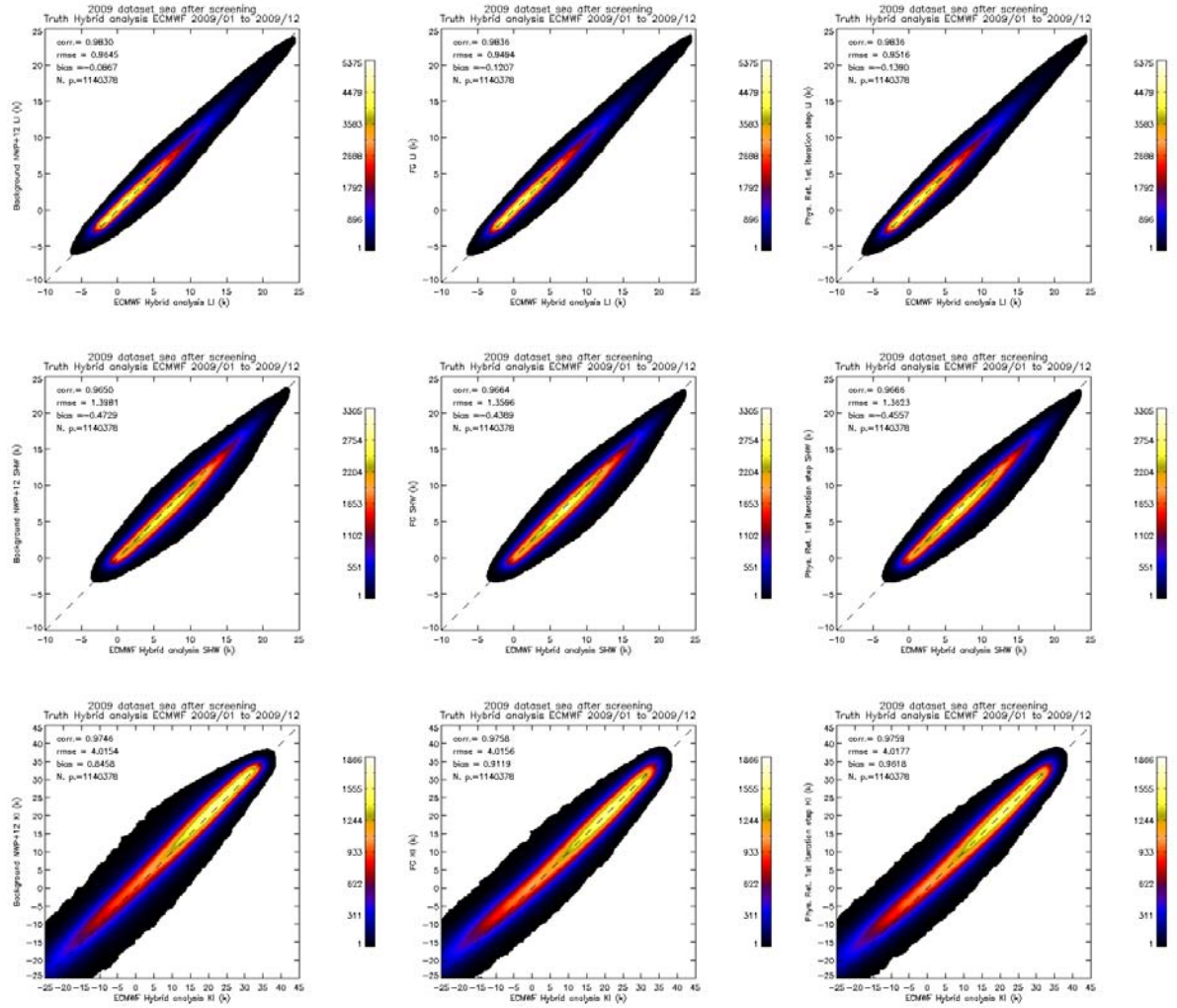
BL 2D histograms over sea validation points

ML 2D histograms over sea validation points

HL 2D histograms over sea validation points

TPW 2D histograms over sea validation points

SEA pixels: Instability indices 2D histograms for period January 2009 to December 2009 (5 out 6 pixels)

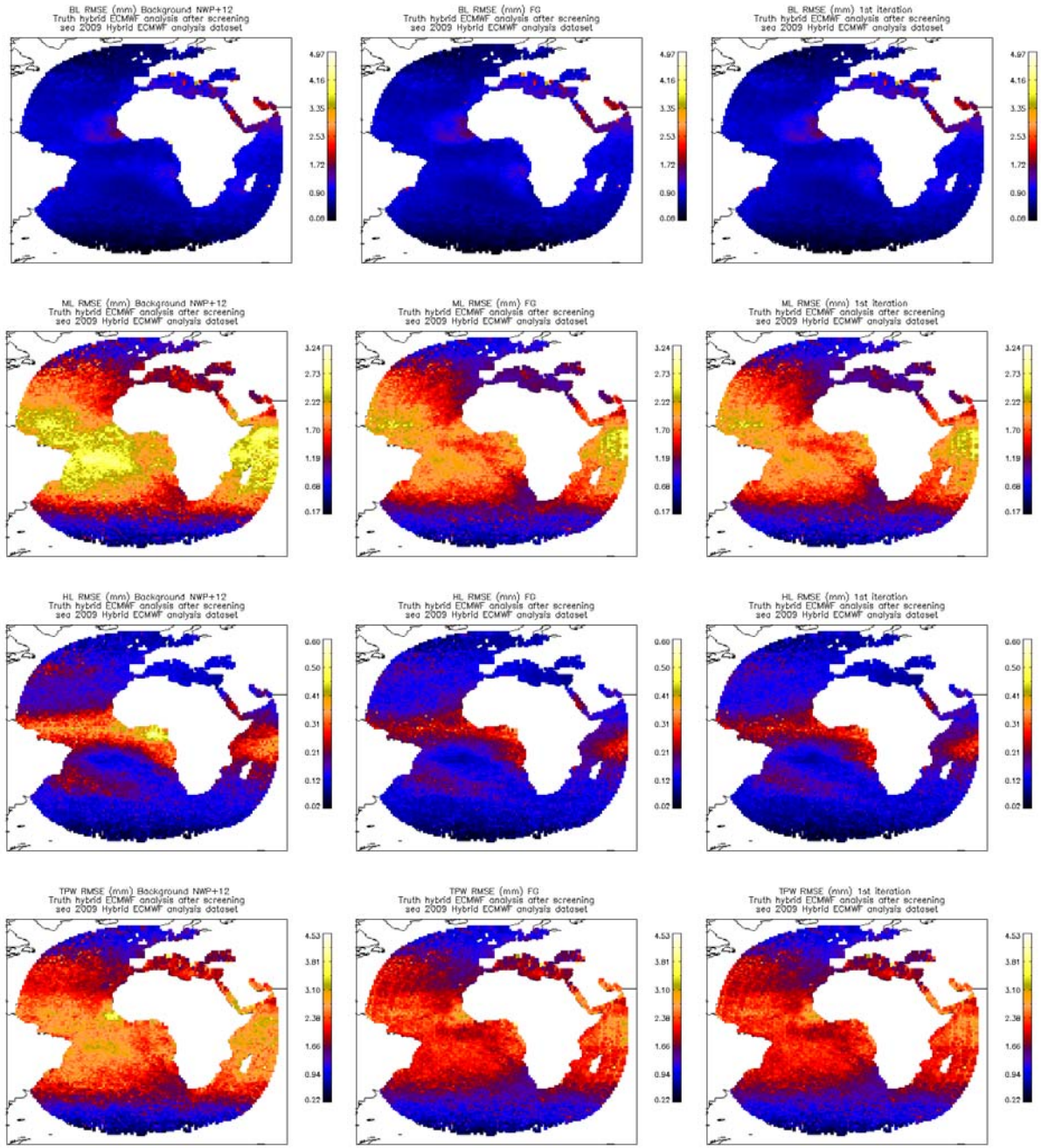


Lifted Index (LI) 2D histograms over sea validation points

Showalter Index 2D histograms over sea validation points

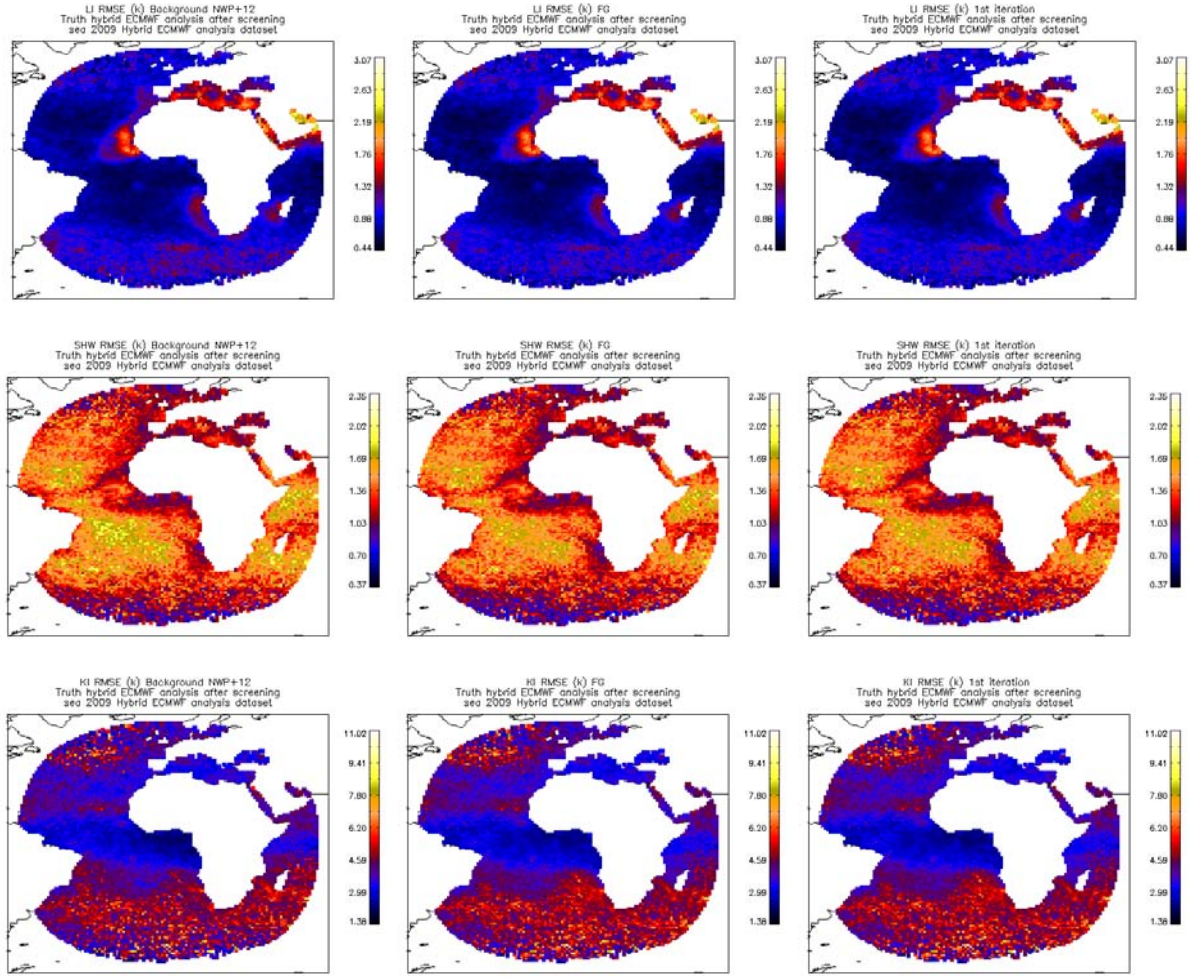
K Index (KI) 2D histograms over sea validation points

RMSE SEA
LPW and TPW



Spatial distribution of the BL, ML, HL and TPW rmse over sea validation points in period January 2009 to December 2009 for 5 out 6 pixels dataset.

RMSE SEA
Instability indexes



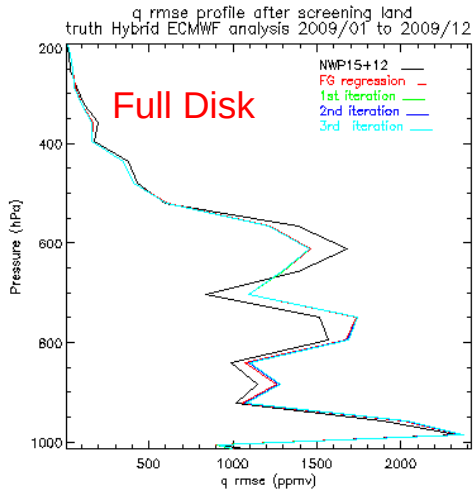
Spatial distribution of the instability parameters rmse over sea validation points in period January 2009 to December 2009 for 5 out 6 pixels dataset.

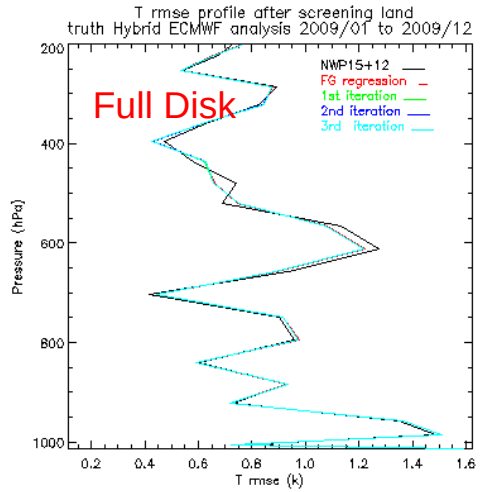
PGE13 validation land

It has been made over the Full Disk and only over Europe (land with latitude > 40º)

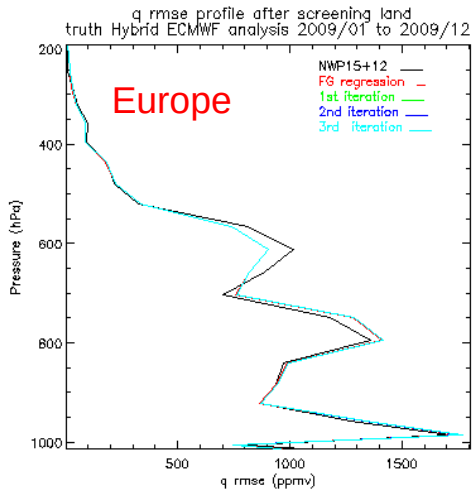
One screening to reject pixels with differences with large error between SEVIRI BT and RTTOV BT has been made before. The statistical tables without screening are available in the Validation Report

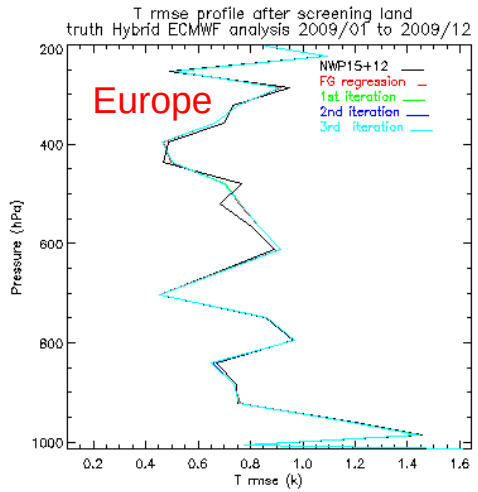
LAND: Vertical profile of rmse and bias analysis





⇦ RMSE of q and T profiles at different steps compared with ECMWF analysis hybrid profiles over Full Disk after screening





⇦ RMSE of q and T profiles at different steps compared with ECMWF analysis hybrid profiles over Europe (latitude > 40º) after screening

Period January 2009 to December 2009 for 1 out 6 pixels (offset +1) after screening

LAND statistical summary after screening for the Full Disk region

BL land	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	0.834421	0.887161	0.900003	0.900172	0.902694
BIAS	0.214078	0.317031	0.336535	0.335959	0.339049
correlation	0.989502	0.989035	0.988903	0.988881	0.988846

LI land	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	1.03359	1.14162	1.15725	1.15760	1.16038
BIAS	-0.252843	-0.532538	-0.558198	-0.558288	-0.562444
correlation	0.984450	0.984180	0.984063	0.984045	0.984019

ML land	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	1.58691	1.62211	1.62933	1.62829	1.63026
BIAS	0.534978	0.646458	0.685083	0.684766	0.689180
correlation	0.978155	0.979563	0.979966	0.979973	0.979989

SHOWALTER land	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	0.933196	1.01760	1.03448	1.03510	1.03757
BIAS	-0.195298	-0.399024	-0.428529	-0.428772	-0.432439
correlation	0.984354	0.983668	0.983527	0.983503	0.983471

HL land	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	0.233906	0.195551	0.193422	0.193233	0.193104
BIAS	0.0610868	0.0291593	0.0162655	0.0158393	0.0159748
correlation	0.967399	0.974676	0.974480	0.974508	0.974543

KI land	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	3.01096	3.33018	3.36462	3.36710	3.37155
BIAS	0.254233	0.843766	0.929980	0.932938	0.943593
correlation	0.985430	0.983113	0.982974	0.982957	0.982941

TPW land	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	1.94755	2.07006	2.08424	2.08260	2.08778
BIAS	0.810140	0.992644	1.03788	1.03656	1.04420
correlation	0.989378	0.989465	0.989633	0.989622	0.989612

644171 pixels

LAND statistical summary after screening for the Europe region (land latitude > +40º)

BL land after screening (lat > 40º)	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	0.848630	0.859634	0.862507	0.861912	0.862677
BIAS	0.127633	0.207843	0.216942	0.216907	0.219253
correlation	0.973670	0.974379	0.974378	0.974396	0.974375

LI land after screening (lat > 40º)	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	1.099010	1.169170	1.175670	1.175290	1.176790
BIAS	-0.199776	-0.435095	-0.448072	-0.448272	-0.451487
correlation	0.981741	0.981729	0.981692	0.981705	0.981697

ML land after screening (lat > 40º)	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	1.202900	1.169890	1.174890	1.174270	1.174970
BIAS	0.475428	0.443104	0.451672	0.451531	0.453685
correlation	0.969552	0.970447	0.970540	0.970545	0.970557

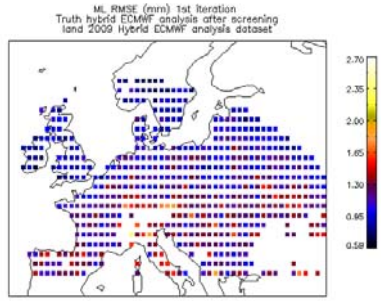
SHOWALTER land after screening (lat > 40º)	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	1.046550	1.103520	1.108970	1.108950	1.110160
BIAS	-0.311694	-0.424968	-0.431204	-0.431373	-0.433844
correlation	0.977400	0.976529	0.976408	0.976405	0.976401

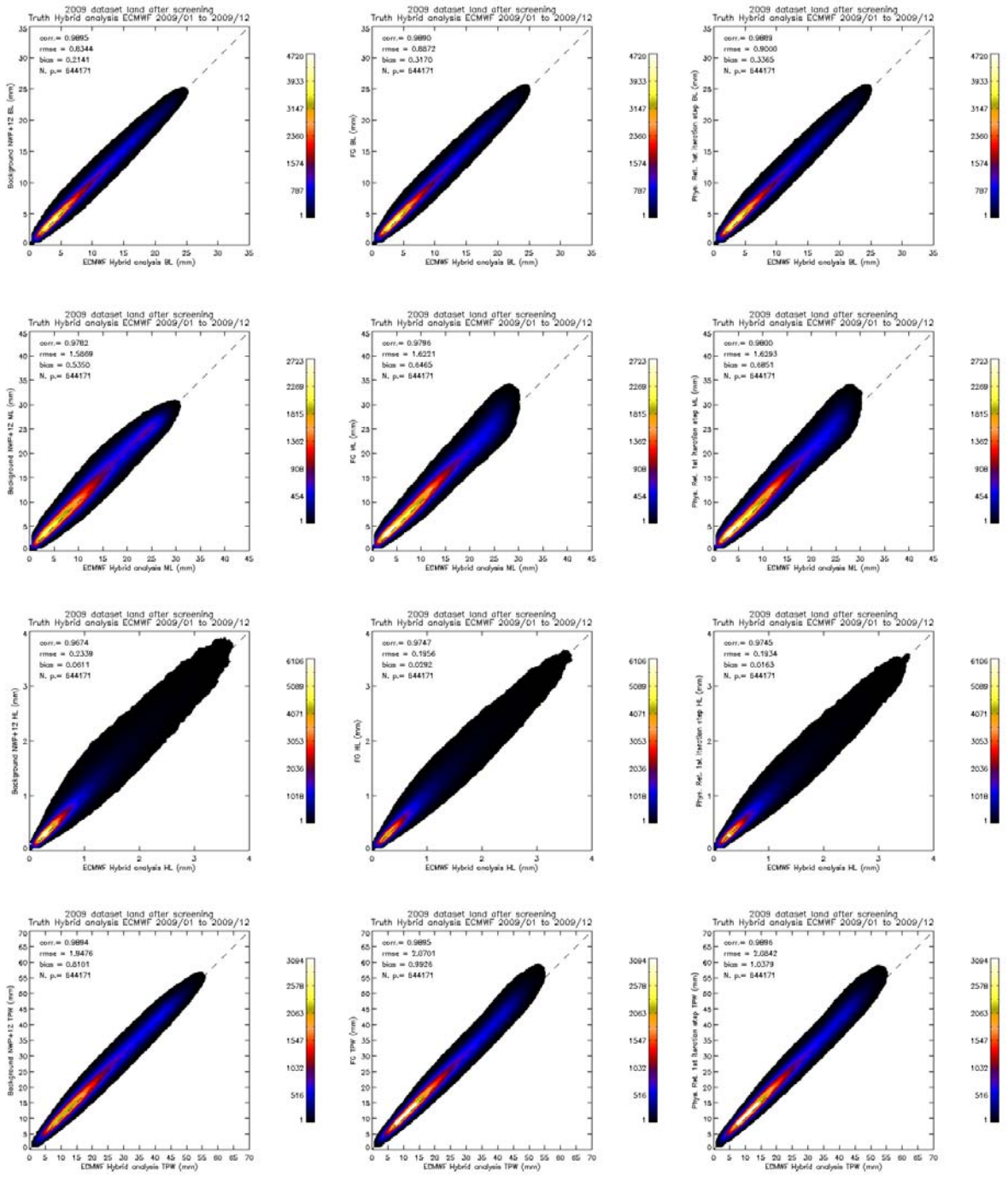
HL land after screening (lat > 40º)	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	0.120204	0.112925	0.113145	0.113257	0.113367
BIAS	0.036408	0.010286	0.015227	0.015212	0.015405
correlation	0.964118	0.964184	0.963681	0.963604	0.963544

KI land after screening (lat > 40º)	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	3.429650	3.579540	3.608040	3.609840	3.611220
BIAS	-0.035617	0.449097	0.464876	0.468041	0.477684
correlation	0.976142	0.974043	0.973599	0.973579	0.973585

TPW land after screening (lat > 40º)	NWP15(T+12)	FG	1st iteration	2nd iteration	3rd iteration
RMSE	1.579180	1.570590	1.579960	1.578290	1.580220
BIAS	0.639468	0.661234	0.683839	0.683654	0.688340
correlation	0.983267	0.983857	0.983919	0.983931	0.983935

75427 pixels

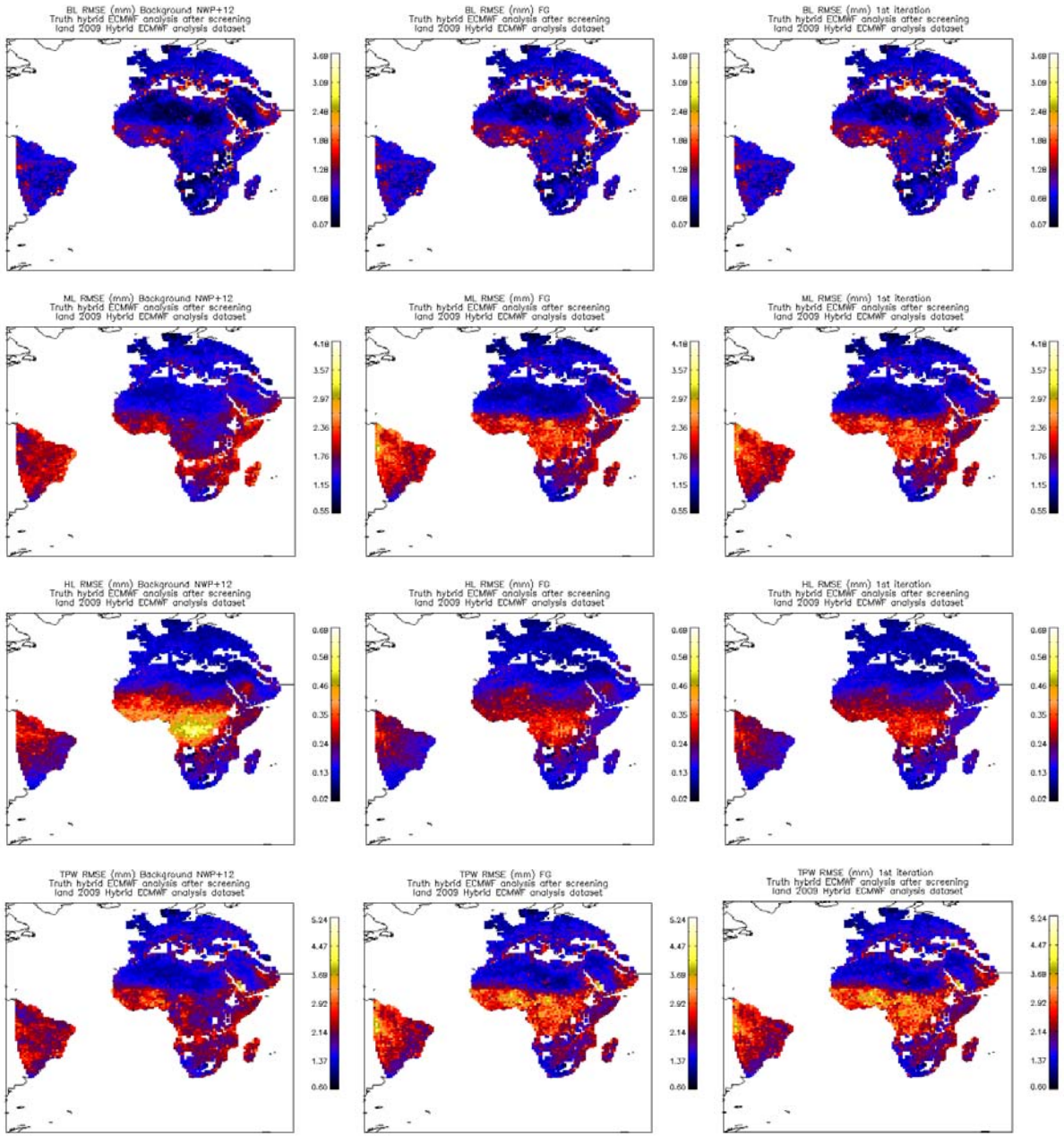




LAND
Full Disk

2D histograms over Full Disk region after screening

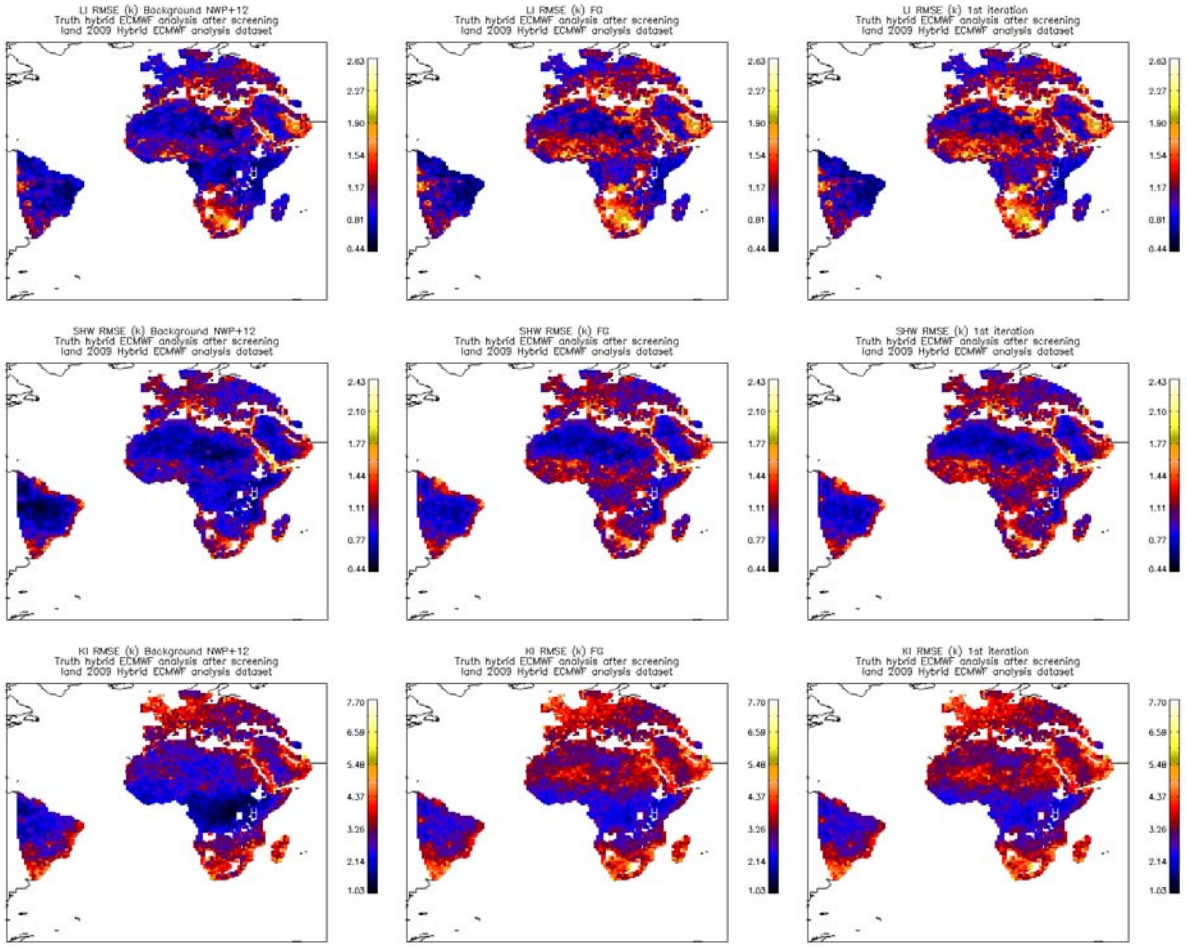
The PGE13 LPWs don't show need to correct them in the post processing period January 2009 to December 2009 for 5 out 6 pixels dataset.



LAND
Full Disk

Spatial distribution of the BL, ML, HL and TPW rmse over land validation points in period January 2009 to December 2009 for 5 out 6 pixels dataset.

LAND
Full Disk



Spatial distribution of the instability parameters rmse over land validation points in period January 2009 to December 2009 for 5 out 6 pixels dataset

Validation against Radiosondes provided by Wyoming University

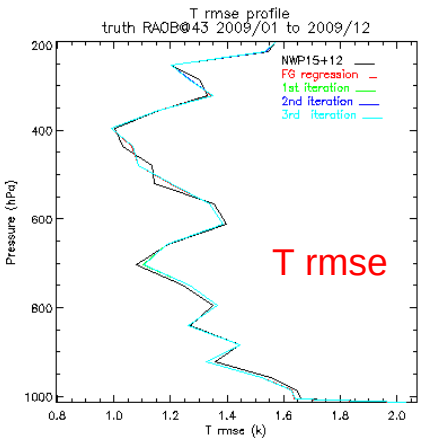
Radiosounding profiles on ASCII files (hereafter RAOB data) for 2008 and 2009 years have been kindly provided by **Larry D. Oolman from Wyoming University** and the software to decode and convert them to same format, vertical levels and units than ECMWF and SPhR records has been developed. Validation results obtained for 2009 year are presented here.

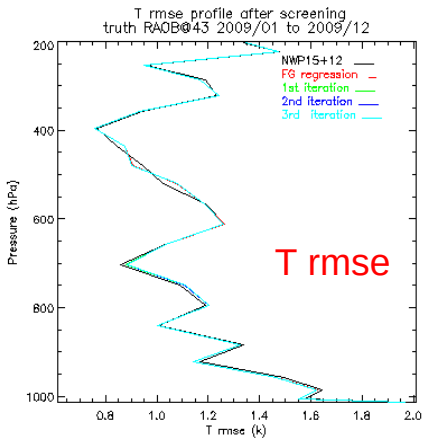
RAOB: rmse of T and q profiles

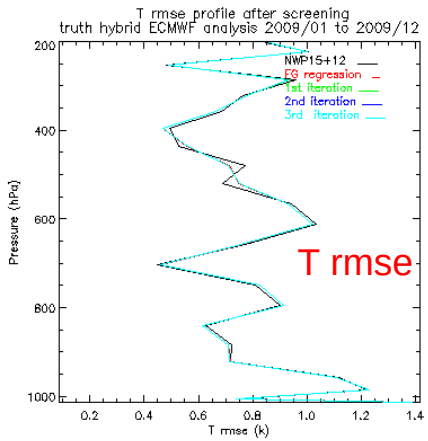
All truth RAOB

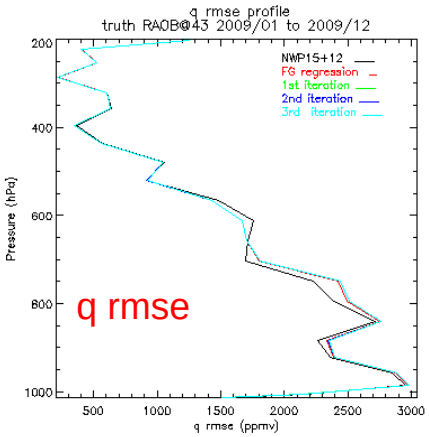
After screening truth RAOB

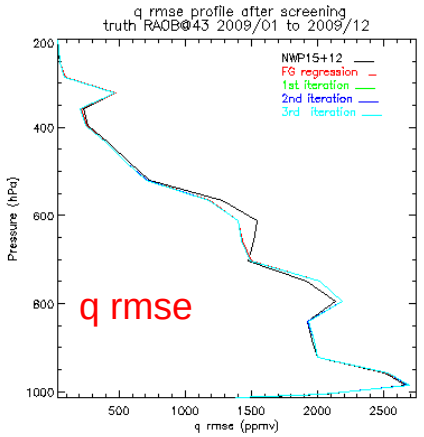
After screening truth hybrid ECMWF

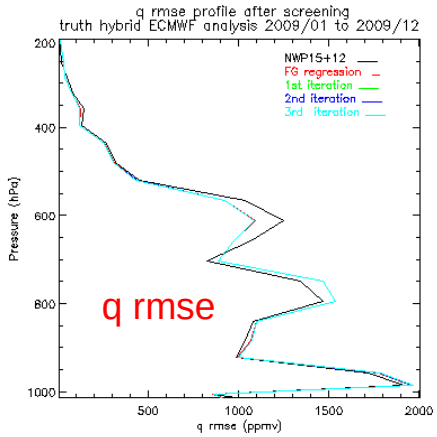








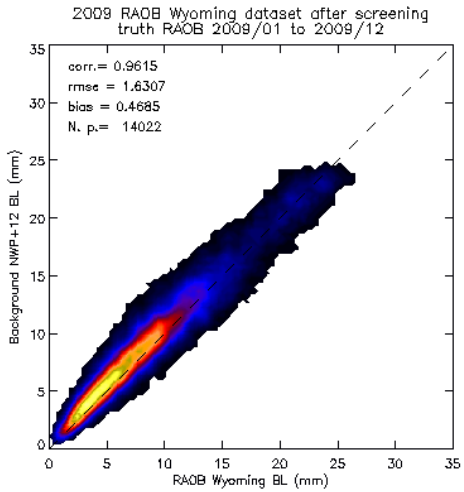


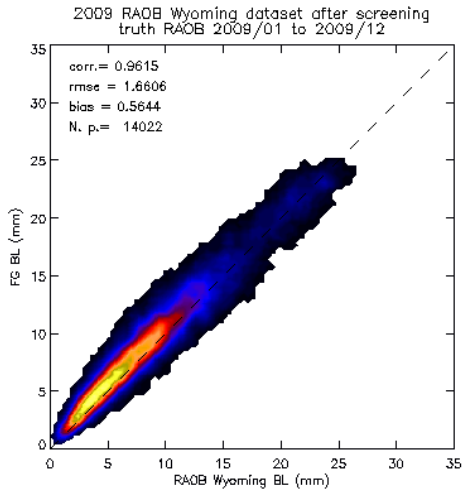


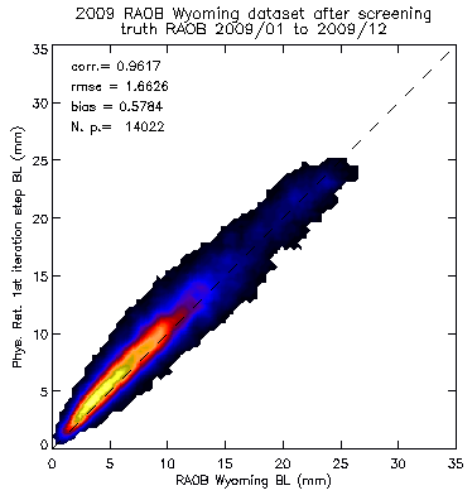
RMSE at different steps compared with RAOB profiles (left and middle) and with ECMWF analysis (right) hybrid profiles in period January 2009 to December 2009 for RAOB dataset.

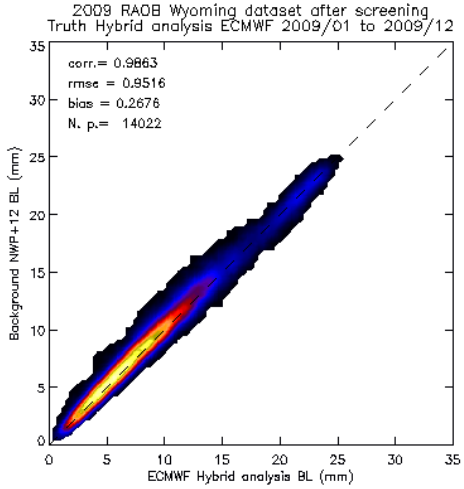
RAOB validation: BL

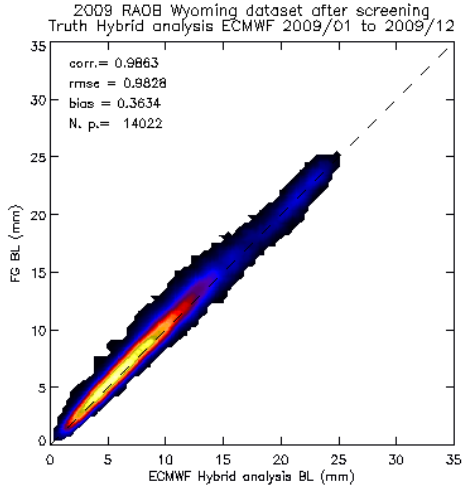
January 2009 to December 2009 at different steps

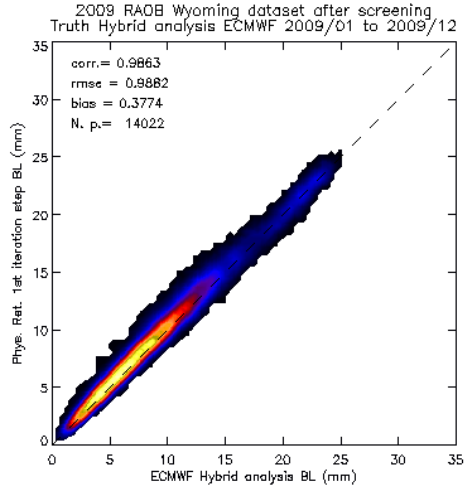






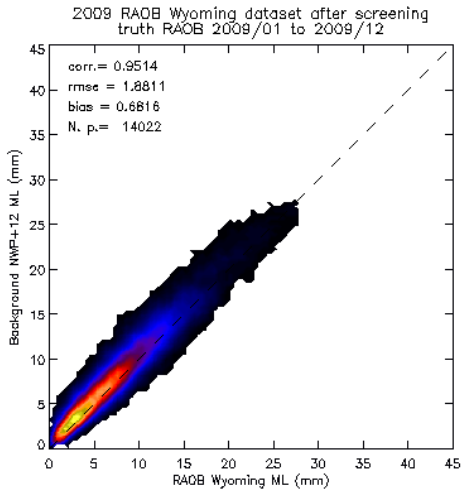


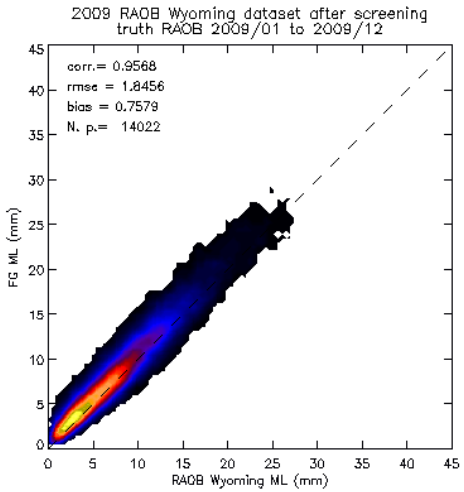


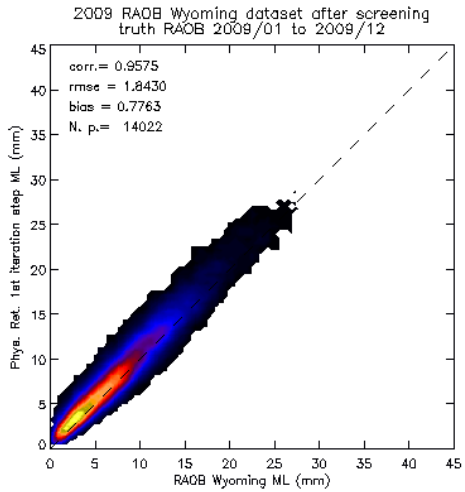


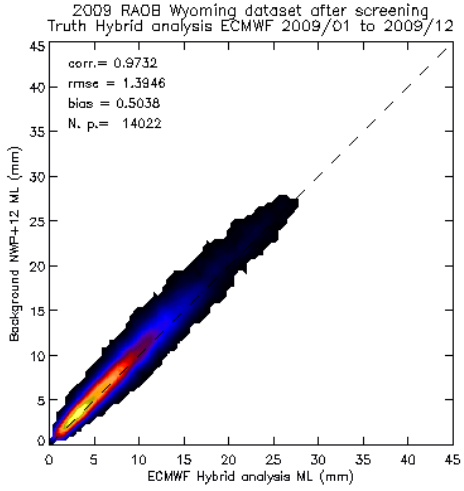
RAOB validation: ML

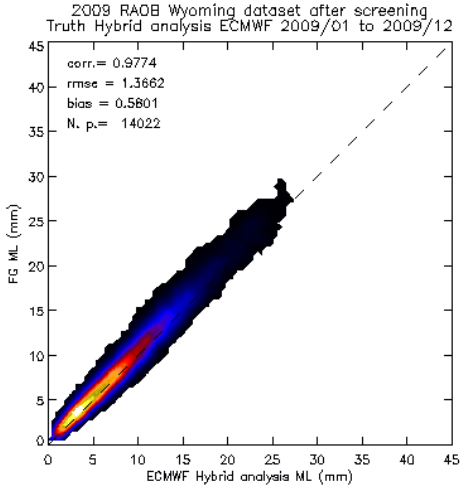
January 2009 to December 2009 at different steps

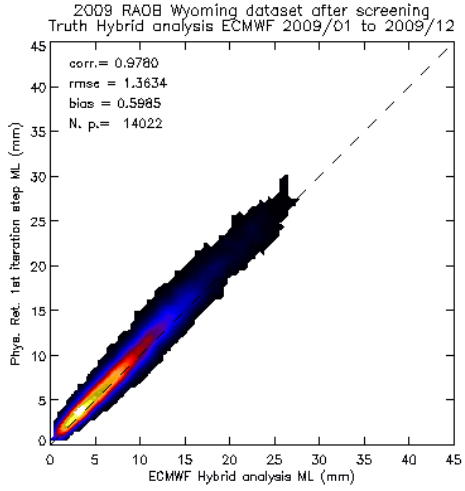






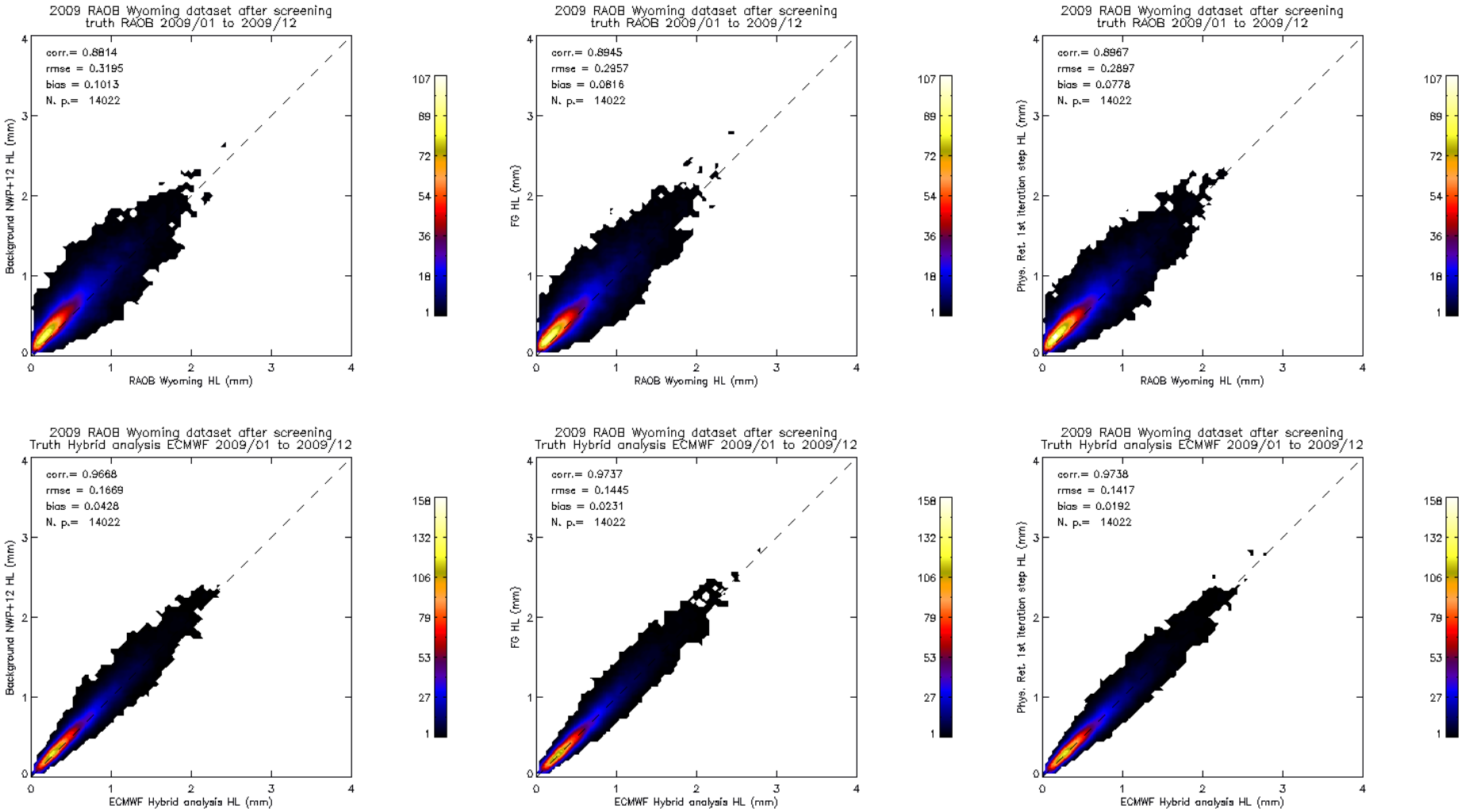






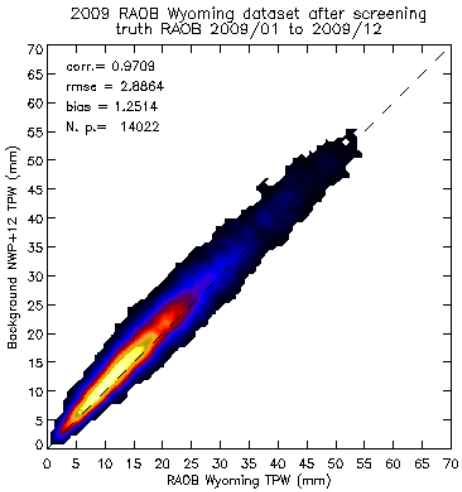
RAOB validation: HL

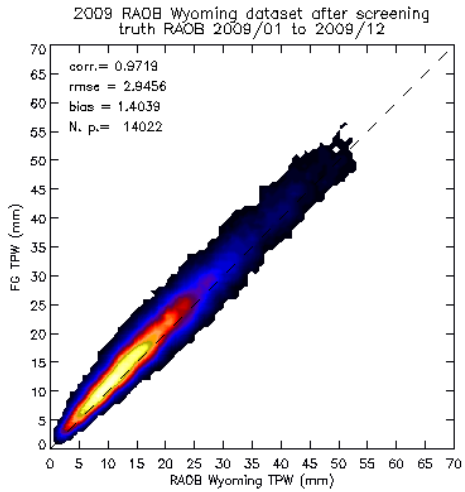
January 2009 to December 2009 at different steps

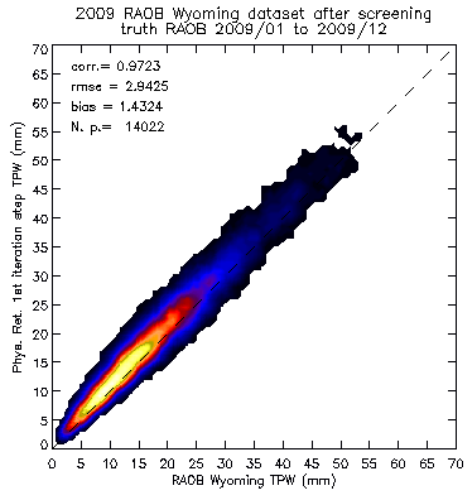


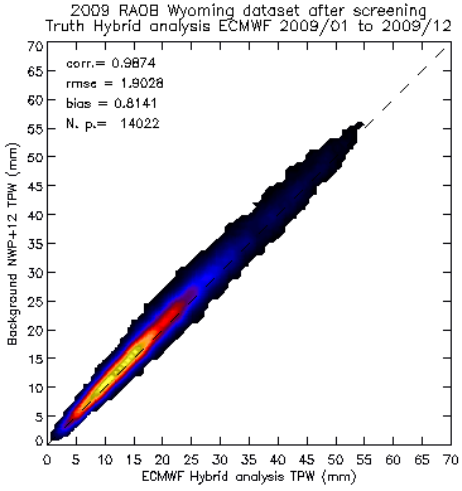
RAOB validation: TPW

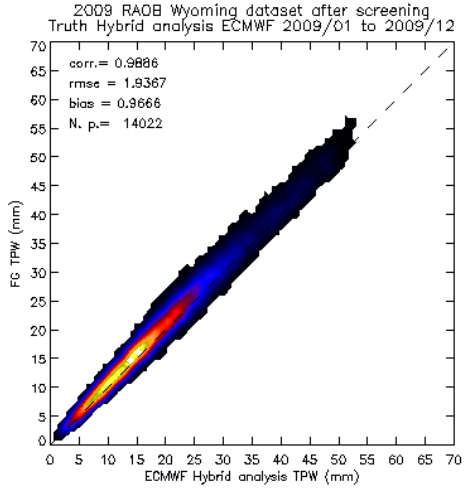
January 2009 to December 2009 at different steps

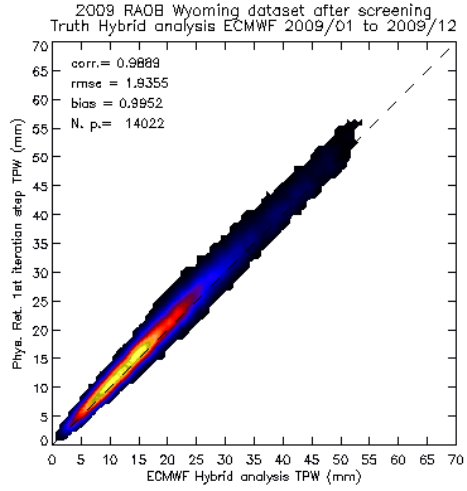






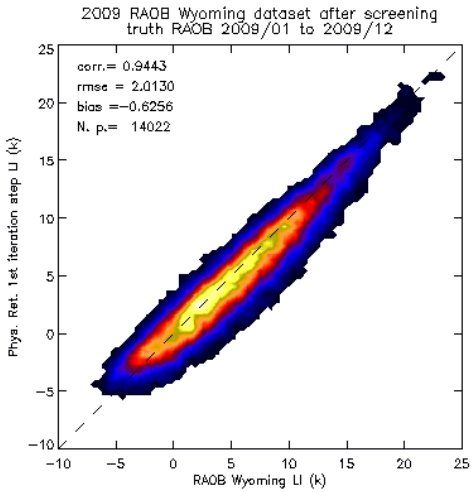


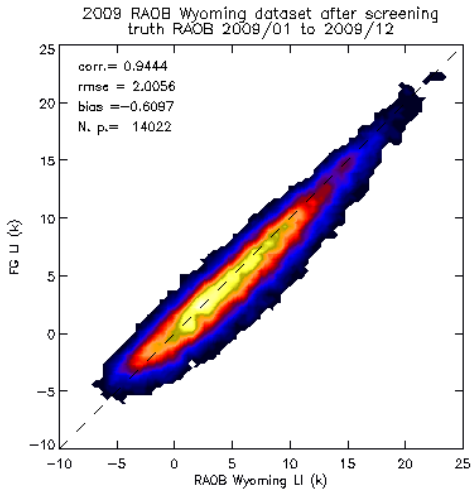


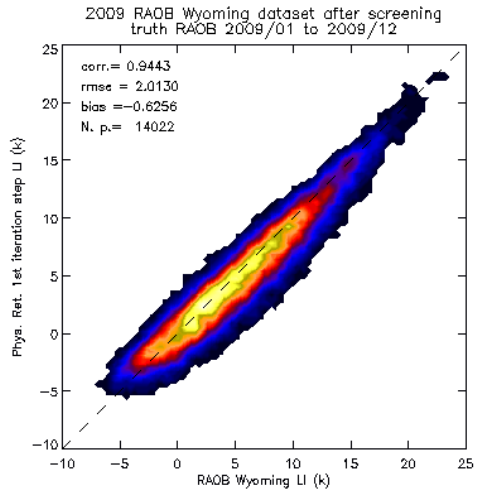


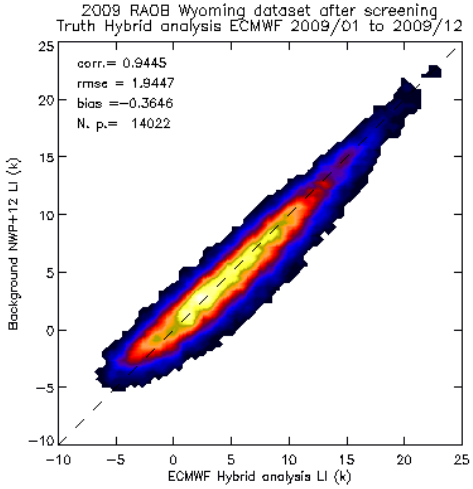
RAOB validation: Lifted Index (LI)

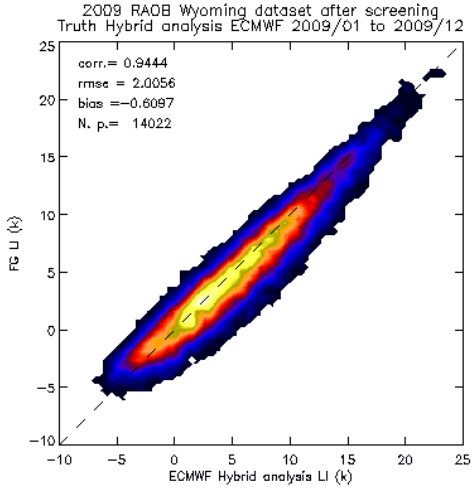
January 2009 to December 2009 at different steps

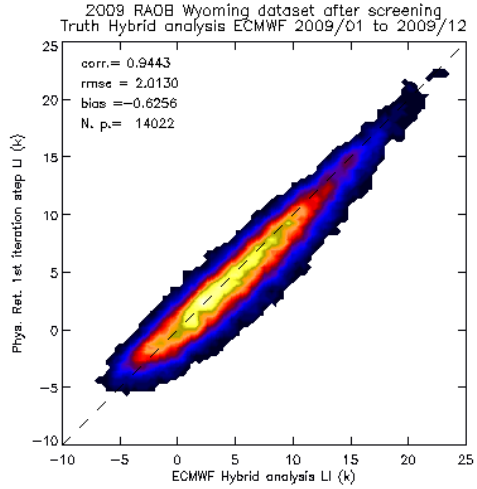






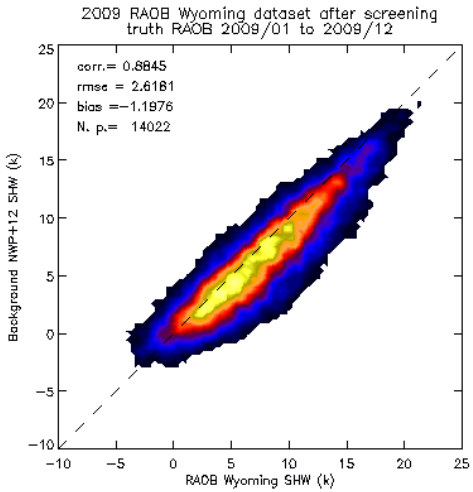


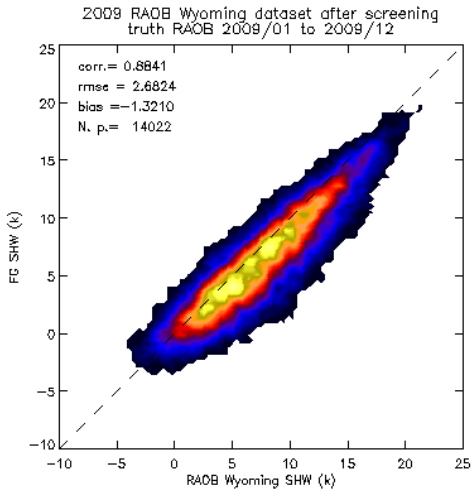


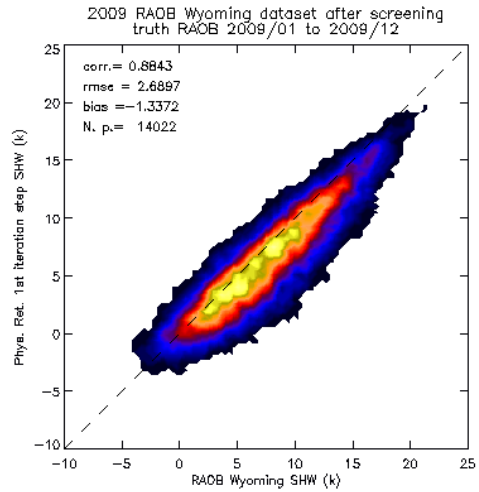


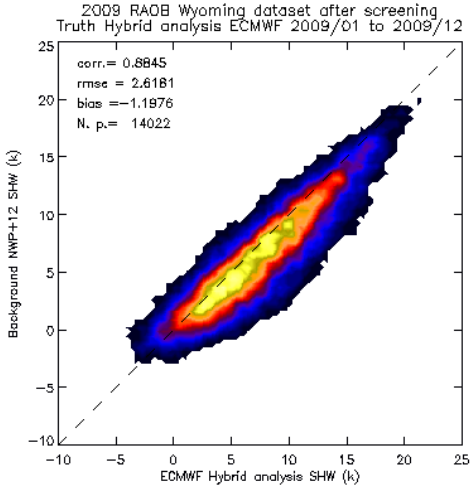
RAOB validation: Showalter Index

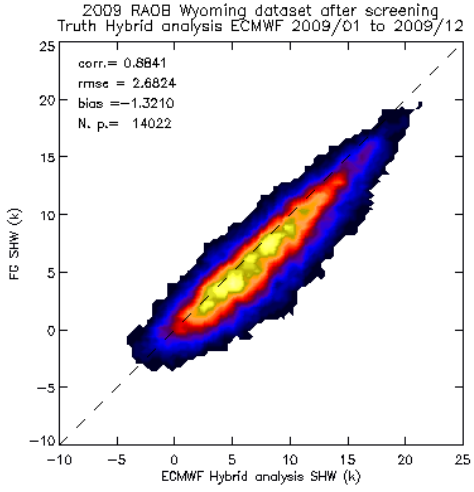
January 2009 to December 2009 at different steps

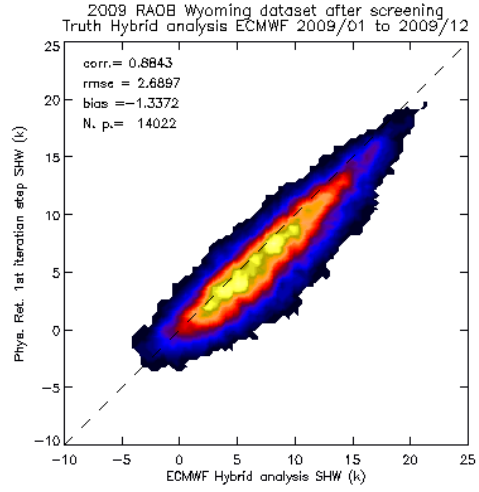






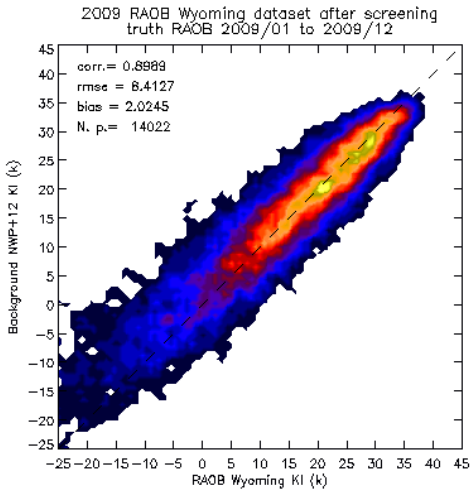


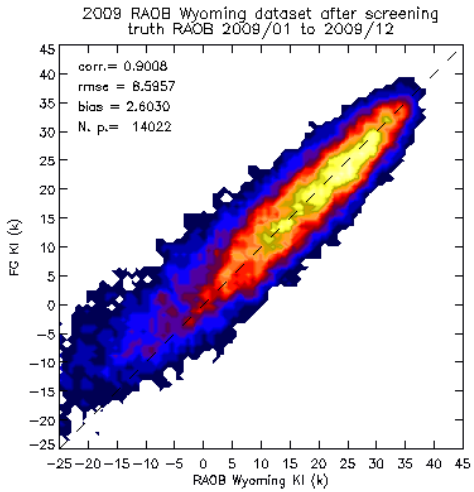


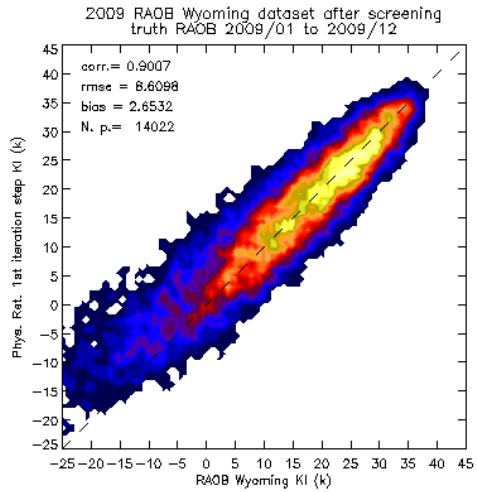


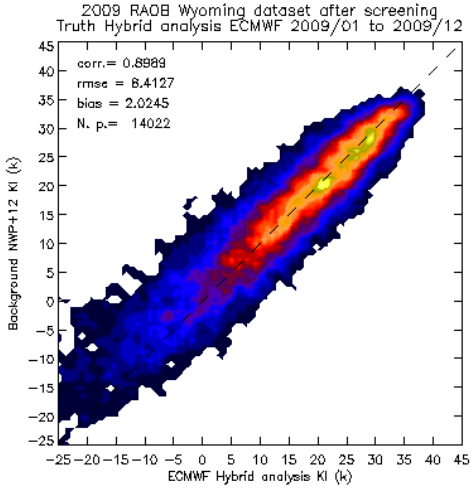
RAOB validation: K-Index (KI)

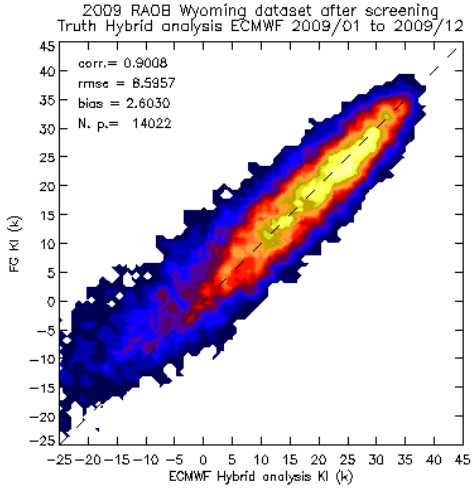
January 2009 to December 2009 at different steps

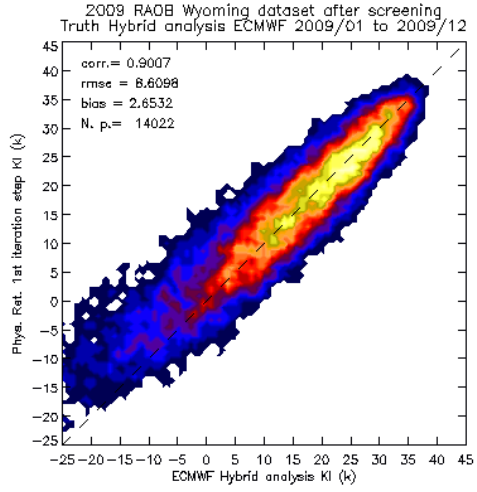


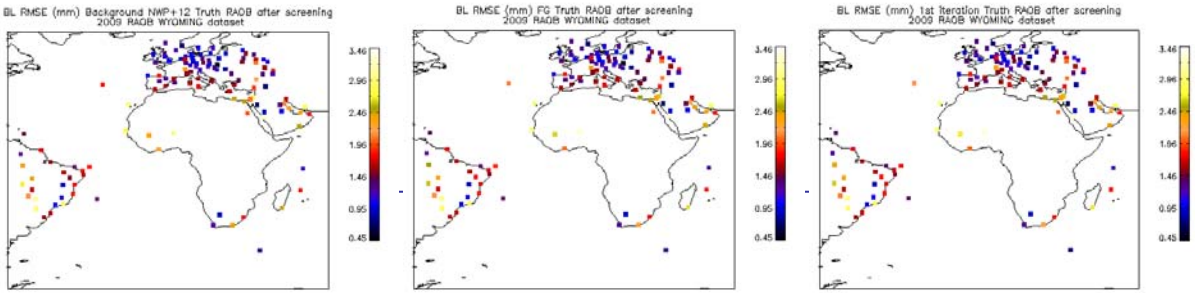




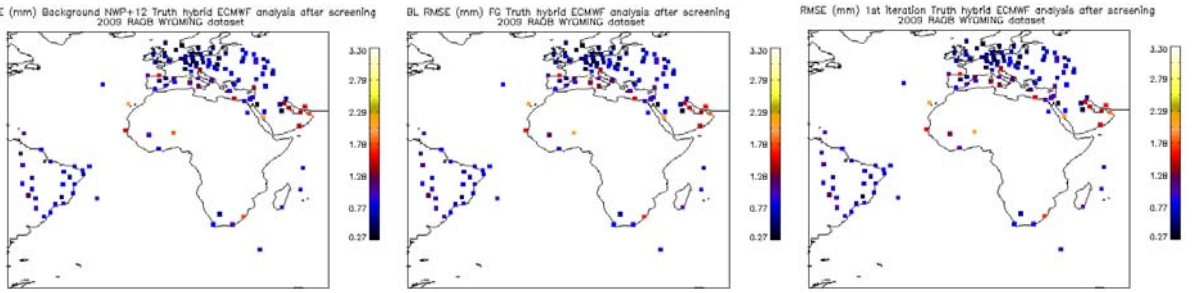








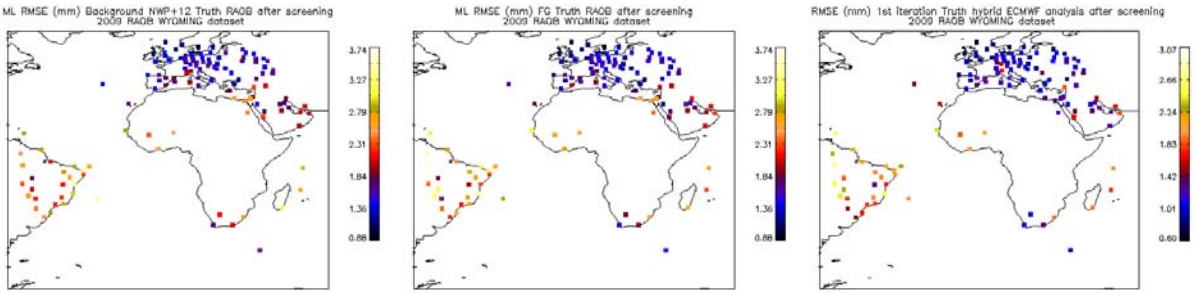
BL rmse truth RAOB



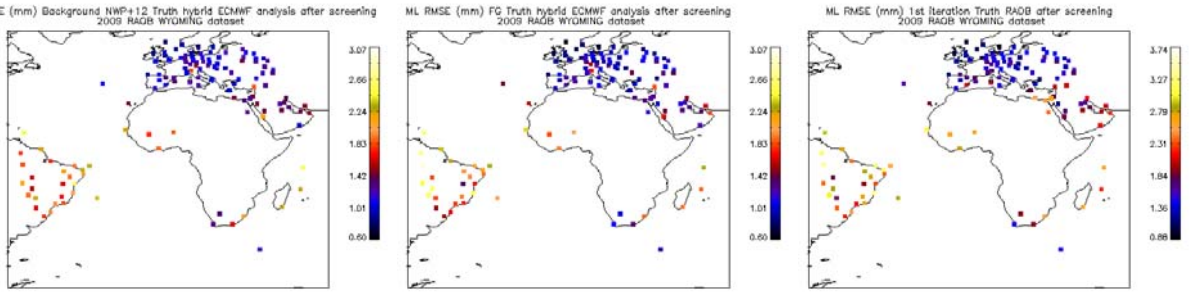
BL truth 91 hybrid levels ECMWF analysis.

Spatial distribution of rmse at different steps over RAOB validation points in period January 2009 to December 2009.

NWP15 (T+12) FG step 1st iteration step



ML rmse truth RAOB



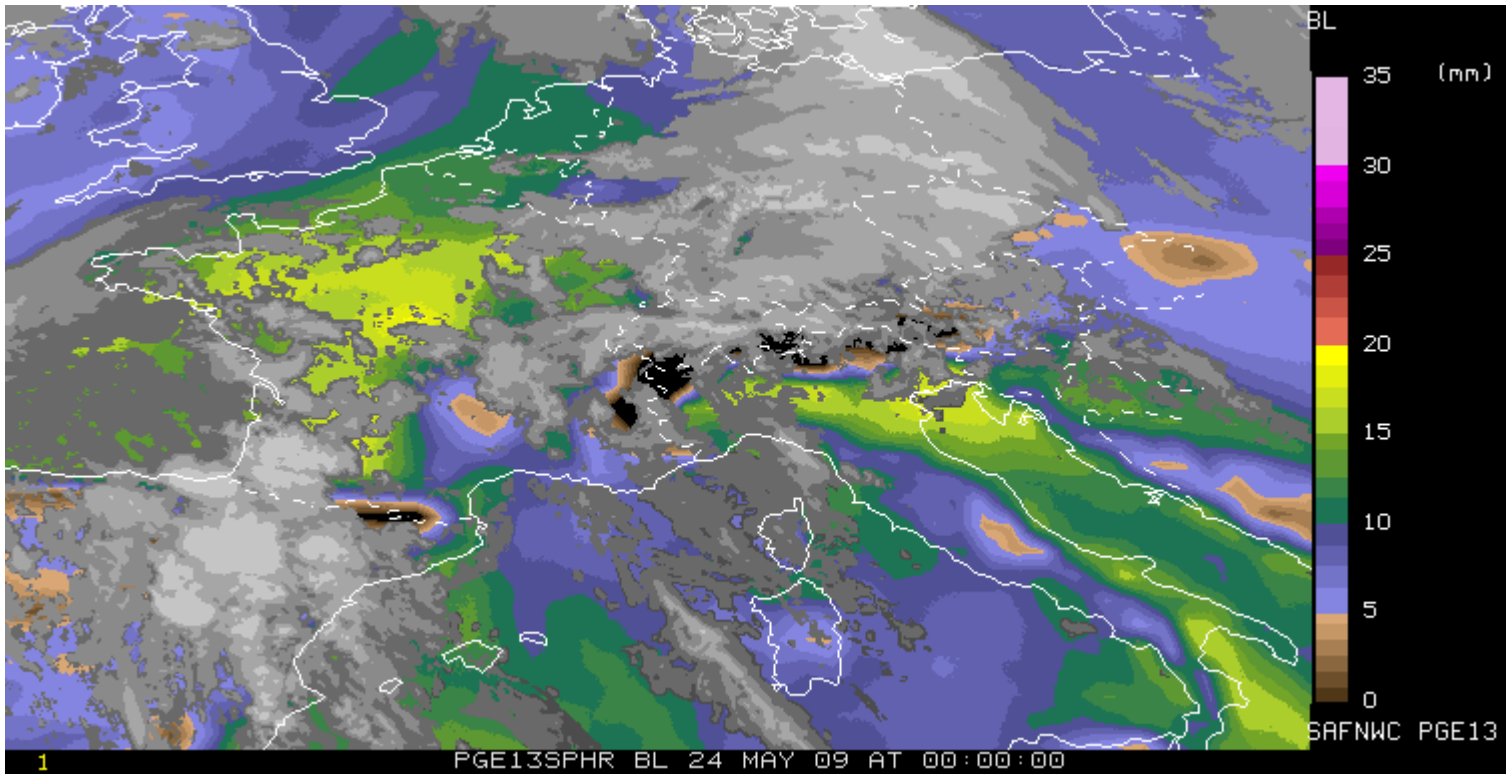
ML truth 91 hybrid levels ECMWF analysis.

1st Case study

24th to 25th 2009/05

Convection Working Group Case Study

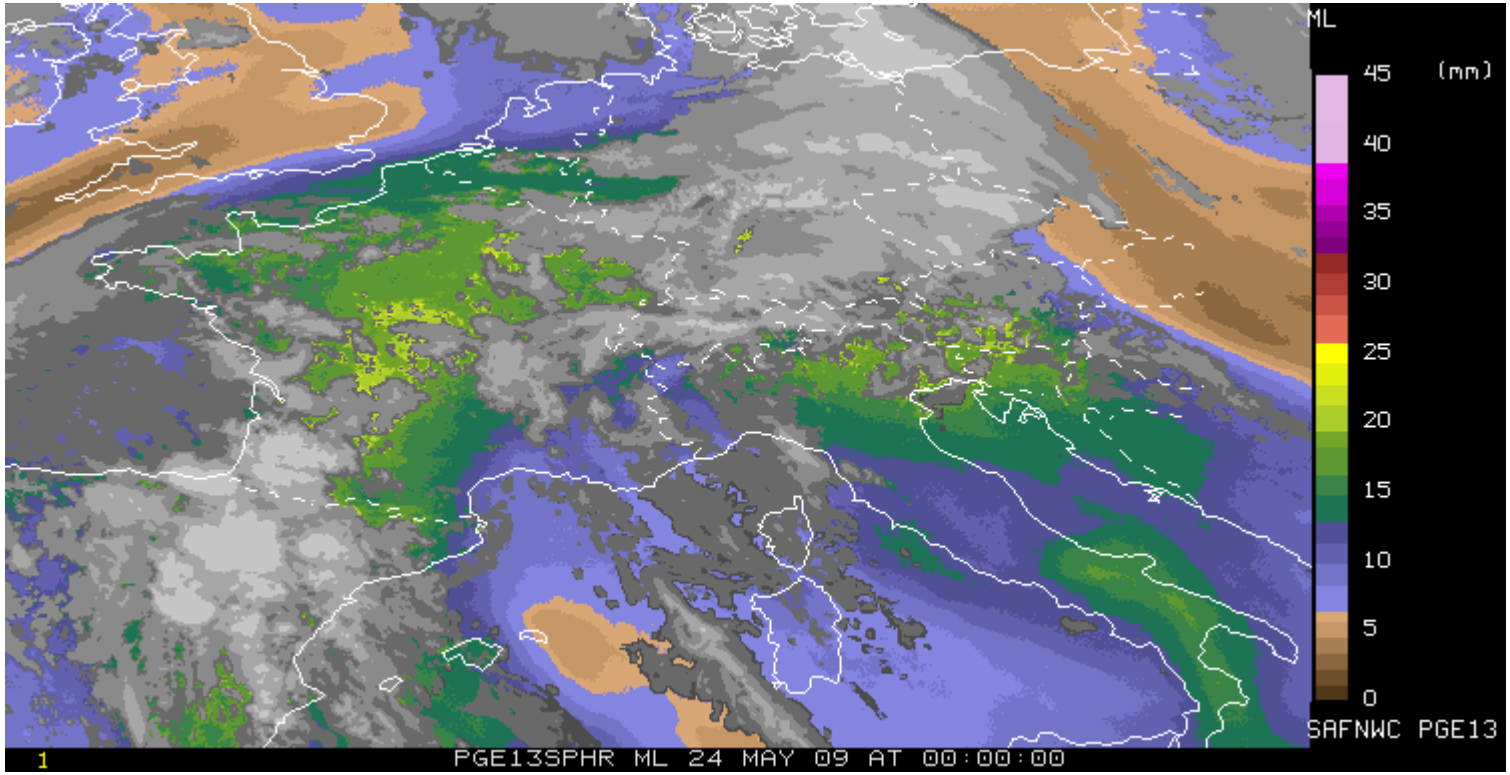
NWCSAF/MSG SPhR_BL



Precipitable Water in Boundary Layer BL(Psfc-850 hPa)

Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

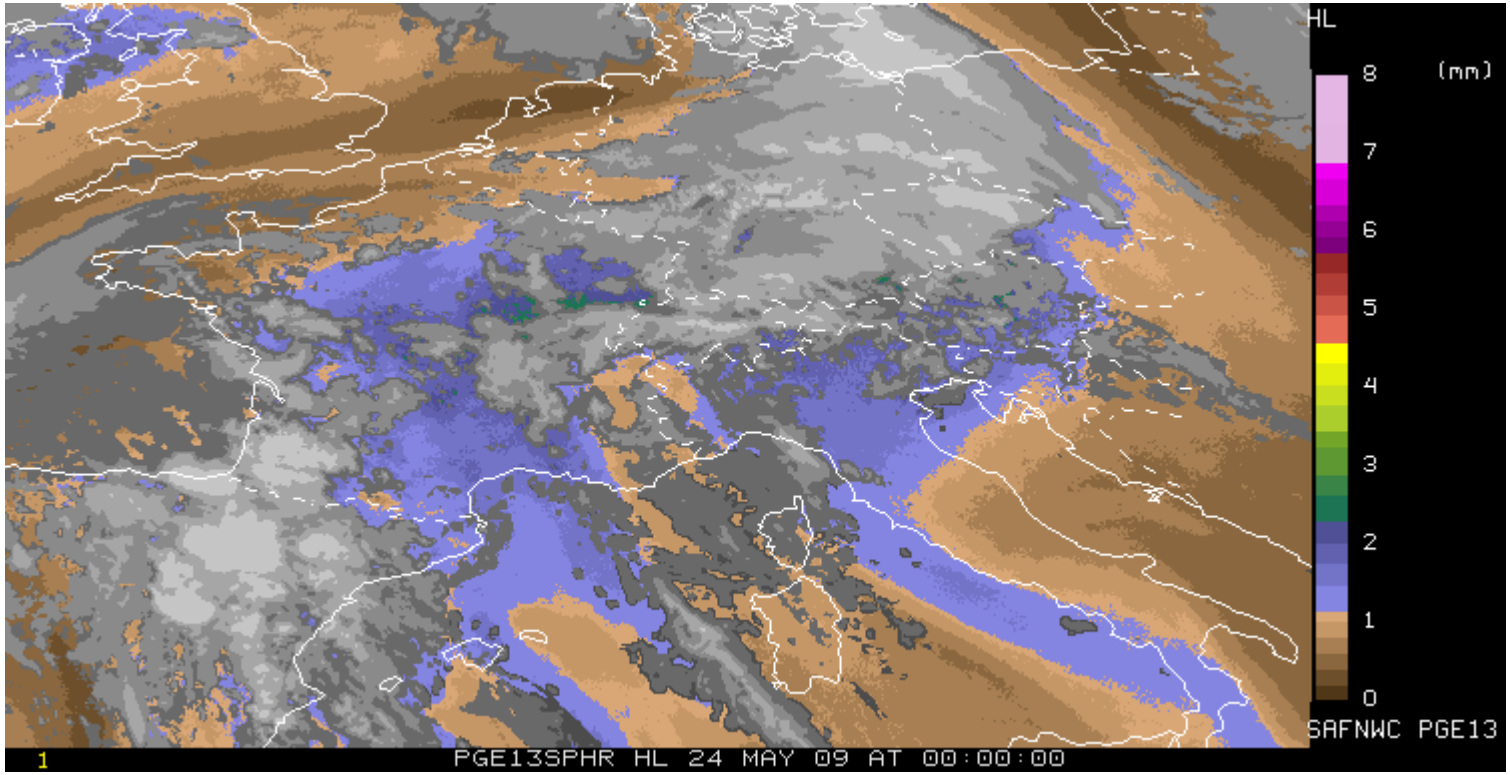
NWCSAF/MSG SPhR_ML



Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

Precipitable Water in Middle Layer ML(850-500 hPa)

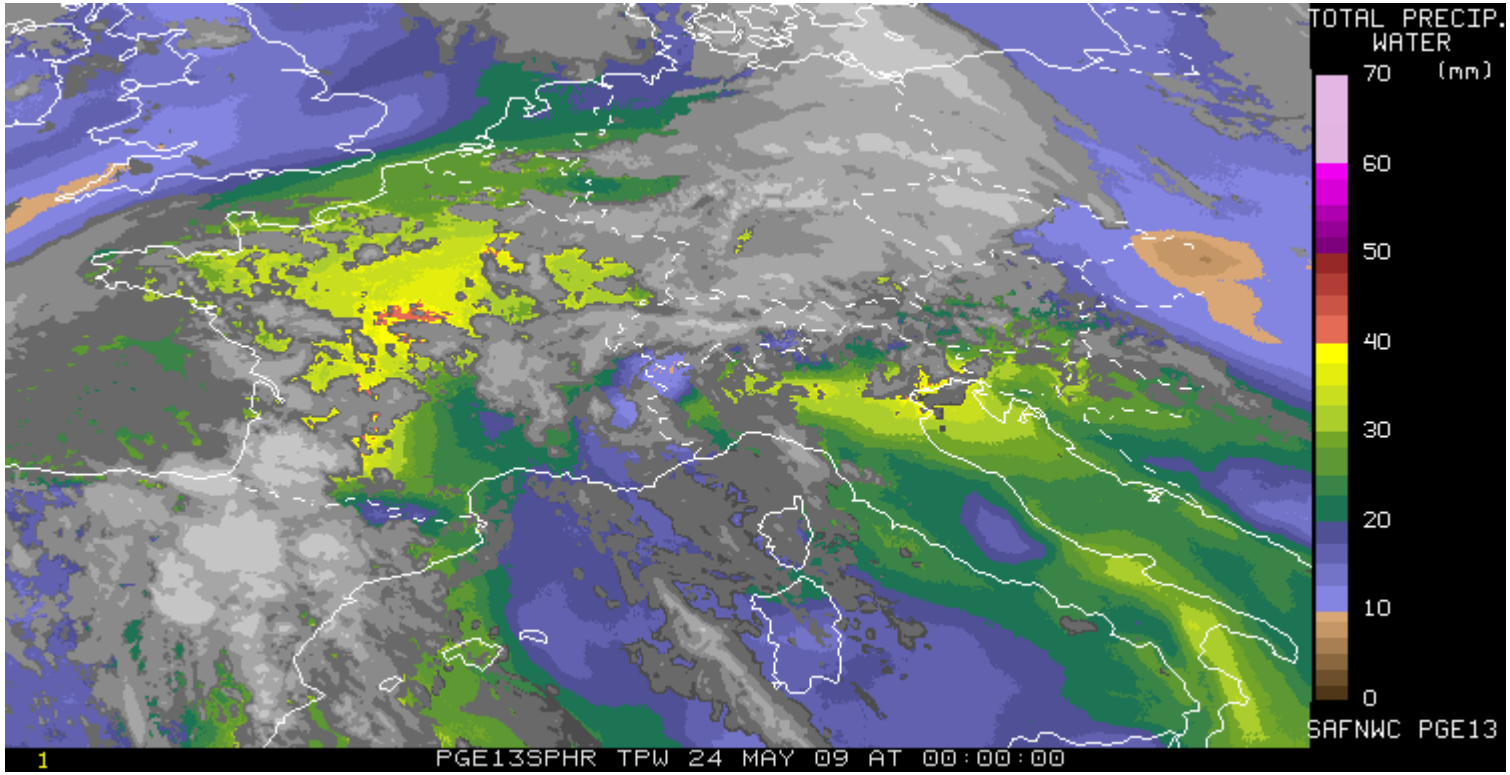
NWCSAF/MSG SPhR_HL



Precipitable Water in High Layer HL(P< 500 hPa)

Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

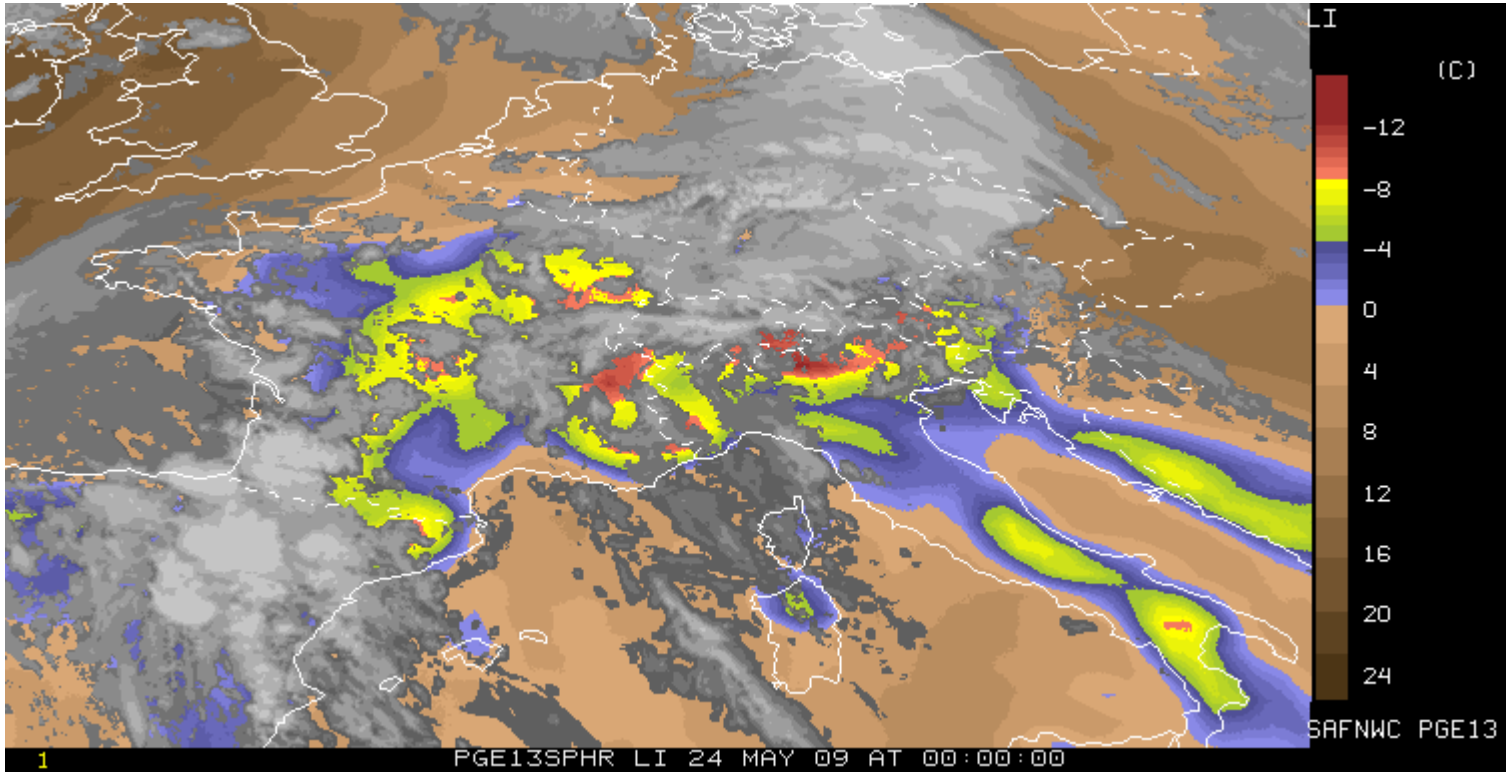
NWCSAF/MSG SPhR_TPW



Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

Total Precipitable Water TPW (Psfc-top)

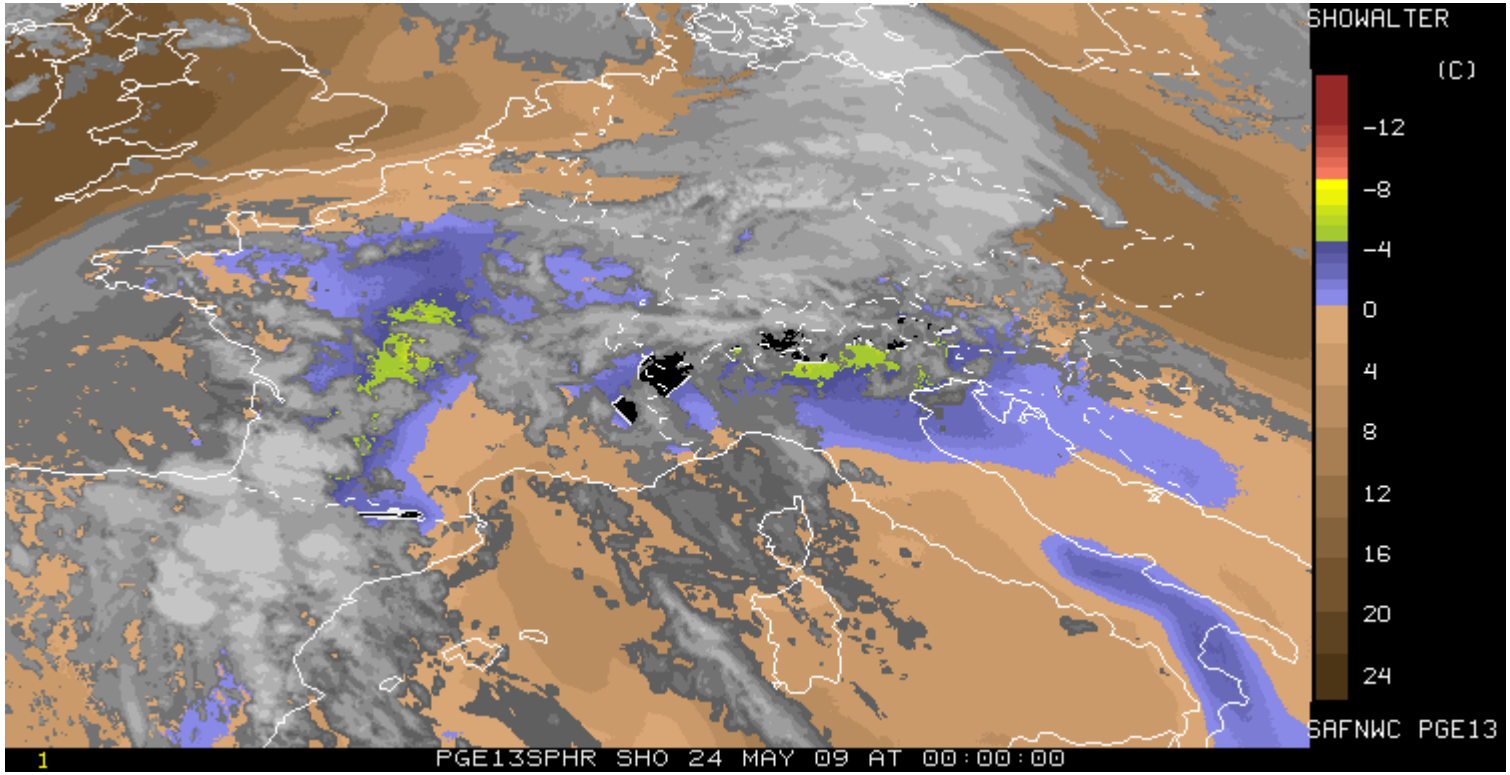
NWCSAF/MSG SPhR_LI



$LI = T_{500} - T_{500\ parcel}$ (in °C)

Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

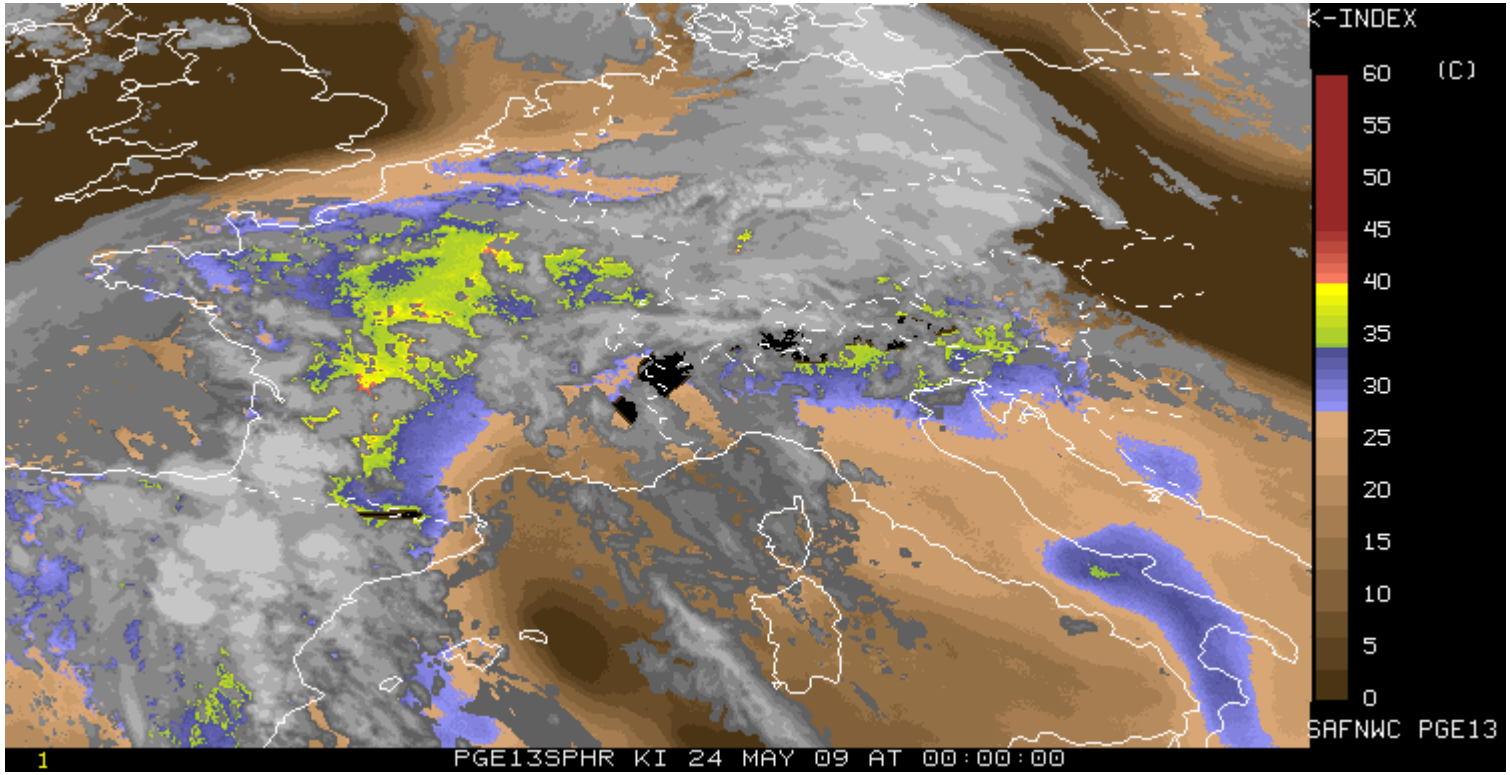
NWCSAF/MSG SPhR_SHOWALTER



Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

SHOWALTER=T_{500} - $T_{500\ \text{parcel raised from 850}}$
(in °C)

NWCSAF/MSG SPhR_K-INDEX

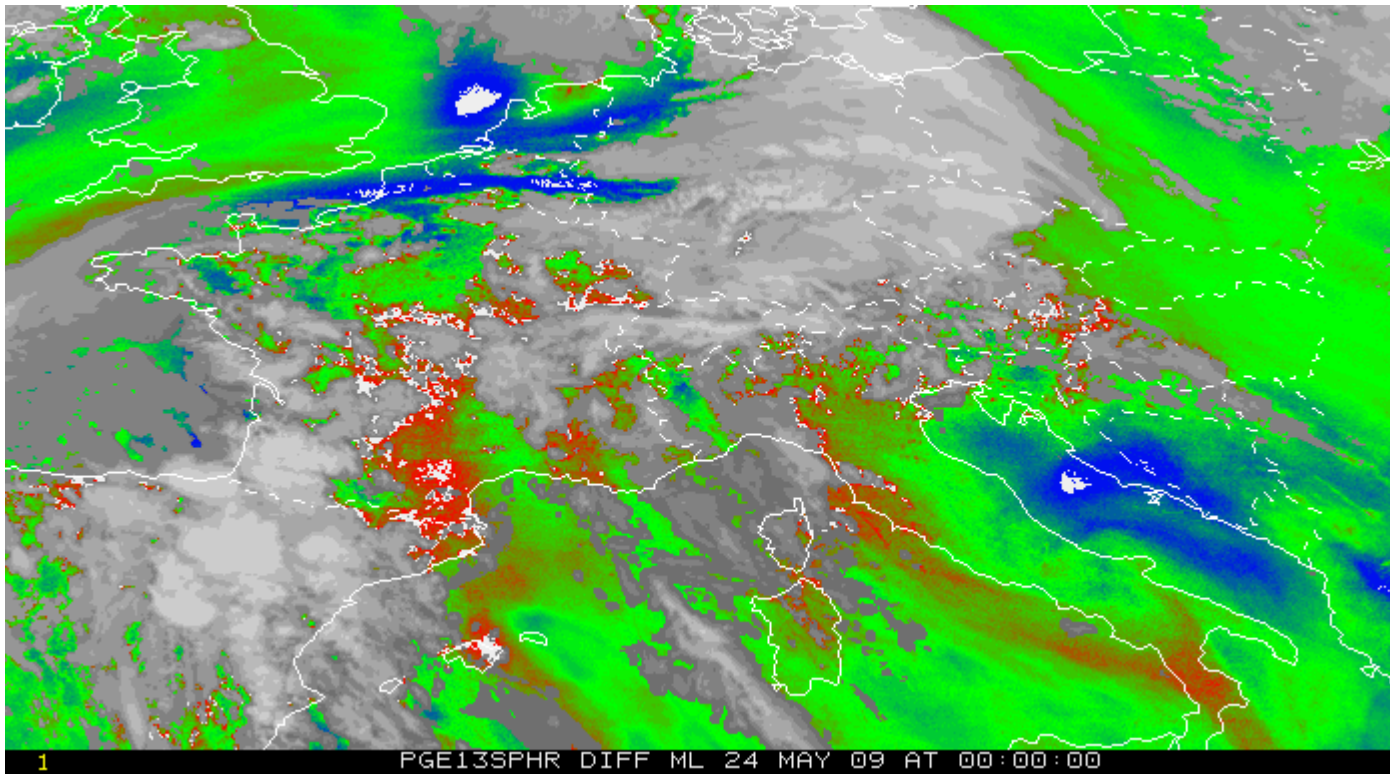


$$KI = (T_{850} - T_{500}) + Td_{850} - (T_{700} - Td_{700})$$

Reprocessed with 2010 version and 1x1 FOR

Special configuration file to force three iterations in all pixels.

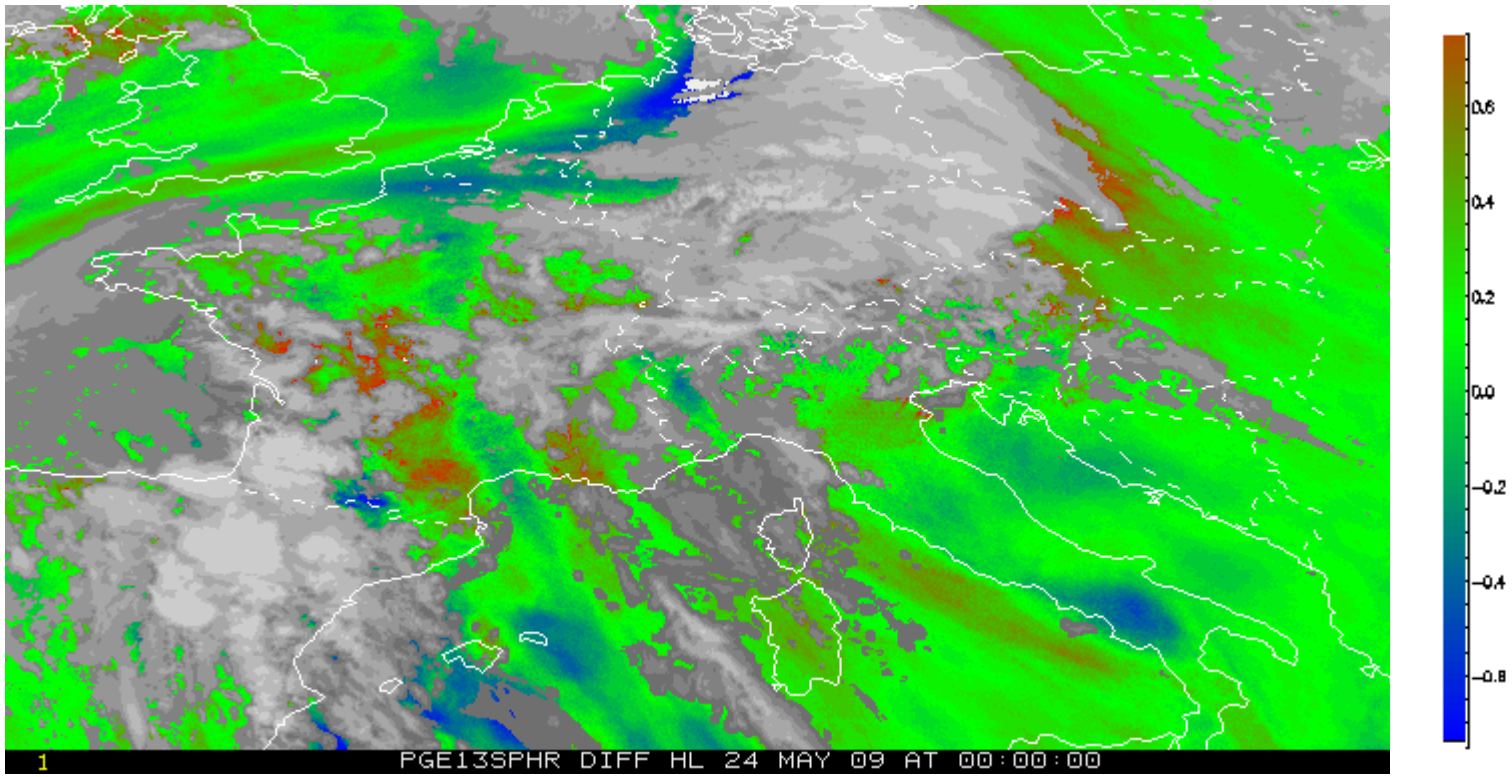
NWCSAF/MSG SPhR_DIFFML ($ML_{retrieval}$-ML_{NWP})



Differences in ML(850-500 hPa)

Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

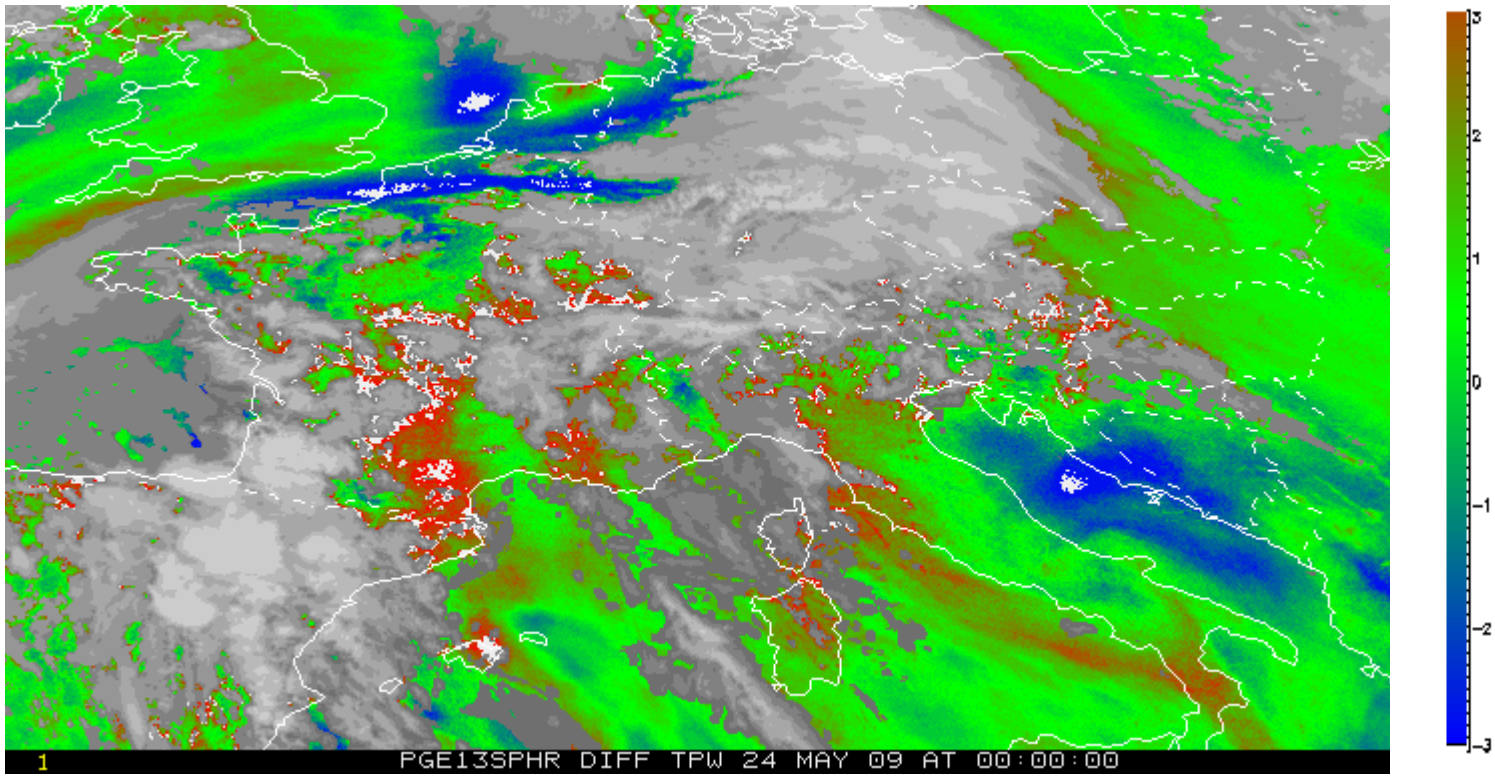
NWCSAF/MSG SPhR_DIFFHL ($HL_{retrieval}$-HL_{NWP})



Differences in HL(P< 500 hPa)

Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

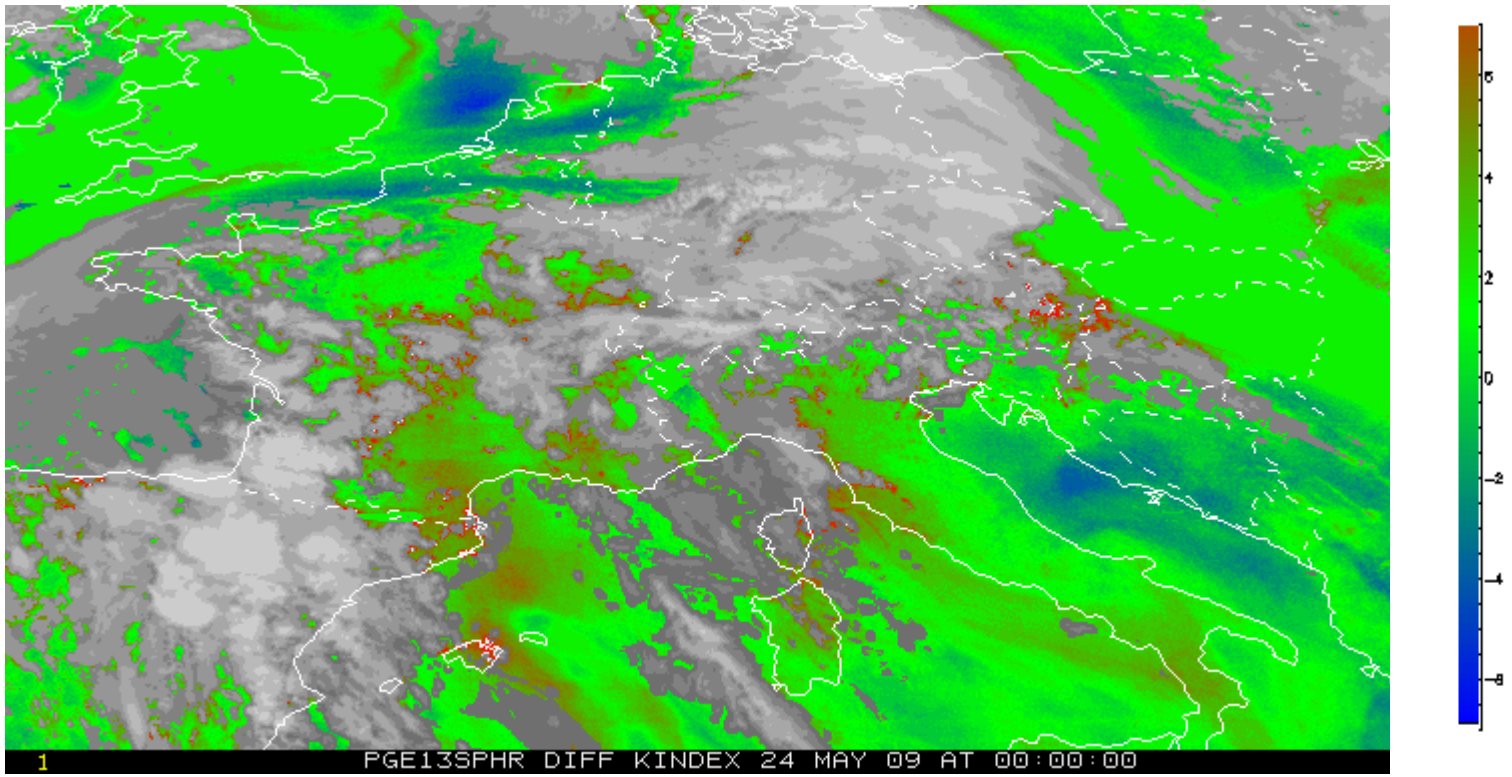
NWCSAF/MSG SPhR_DIFFTPW ($TPW_{retrieval}$-TPW_{NWP})



Differences in TPW ($P_{surface}$-top)

Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

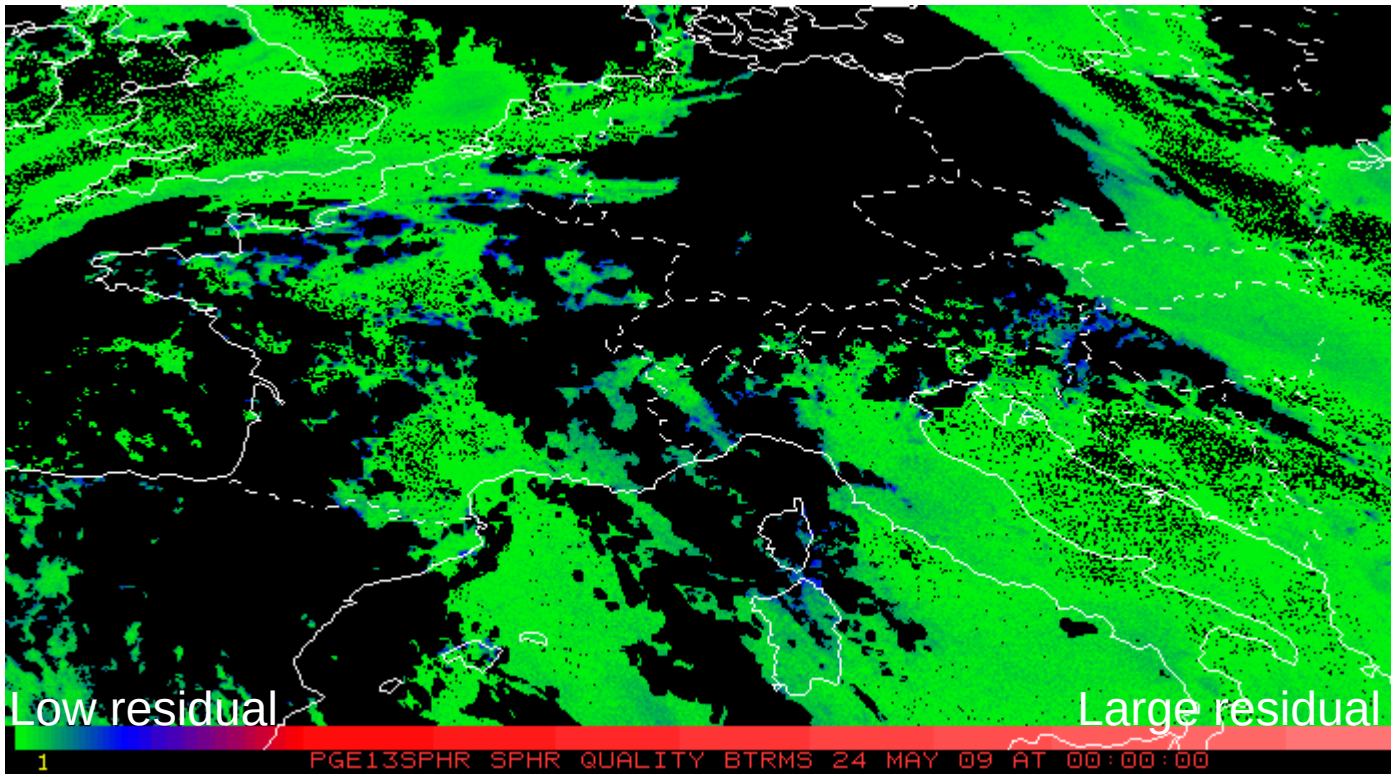
NWCSAF/MSG SPhR_DIFFKI ($KI_{retrieval}$-KI_{NWP})



Differences in K-Index

Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

NWCSAF/MSG SPhR_QUALITY
Residual analysis

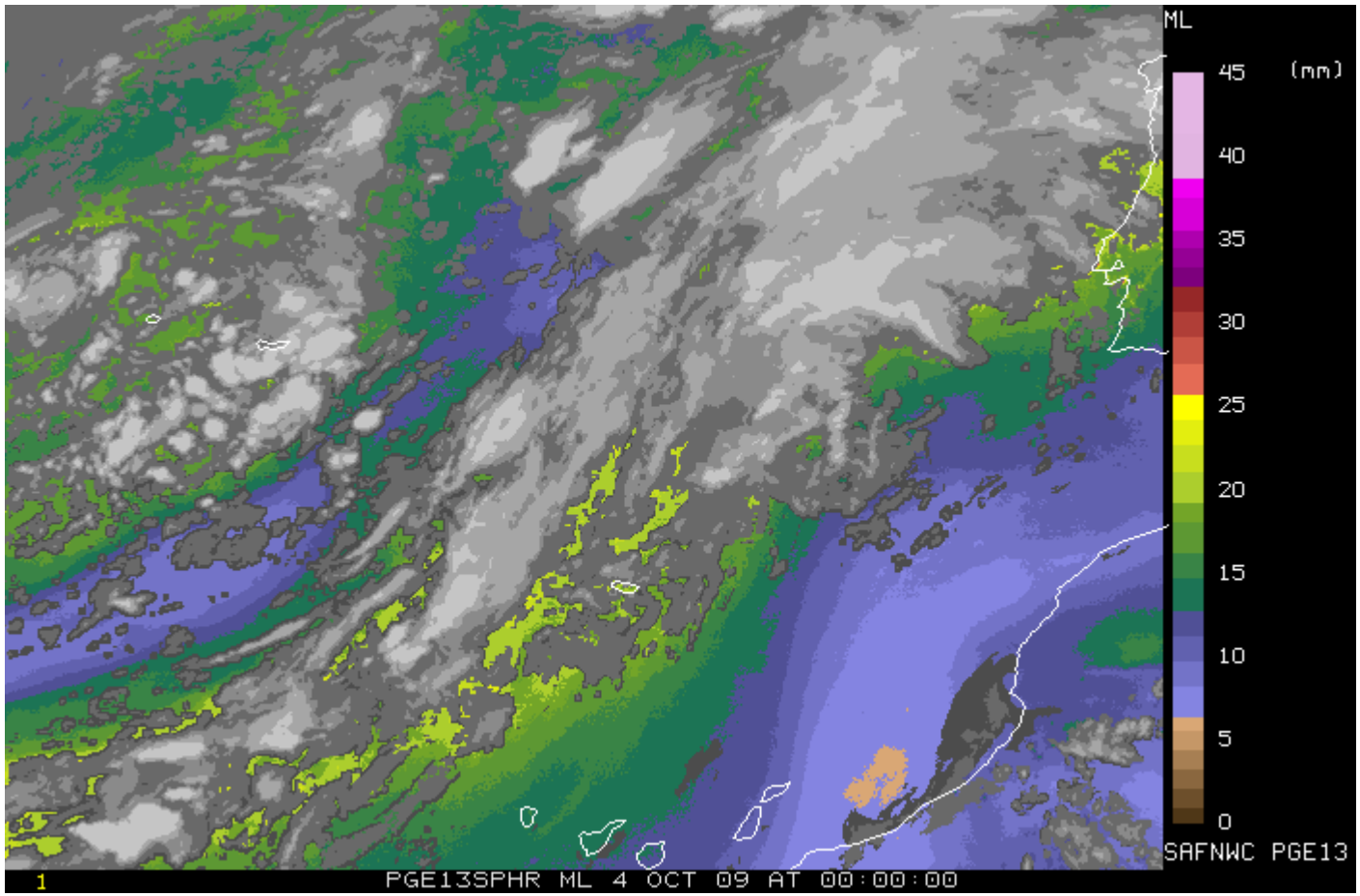


Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force three iterations in all pixels.

Based on differences between SEVIRI BT and RTTOV BT for the retrieved profiles

Case Study: Tropical Storm Grace
NWCSAF/MSG SPhR_ML

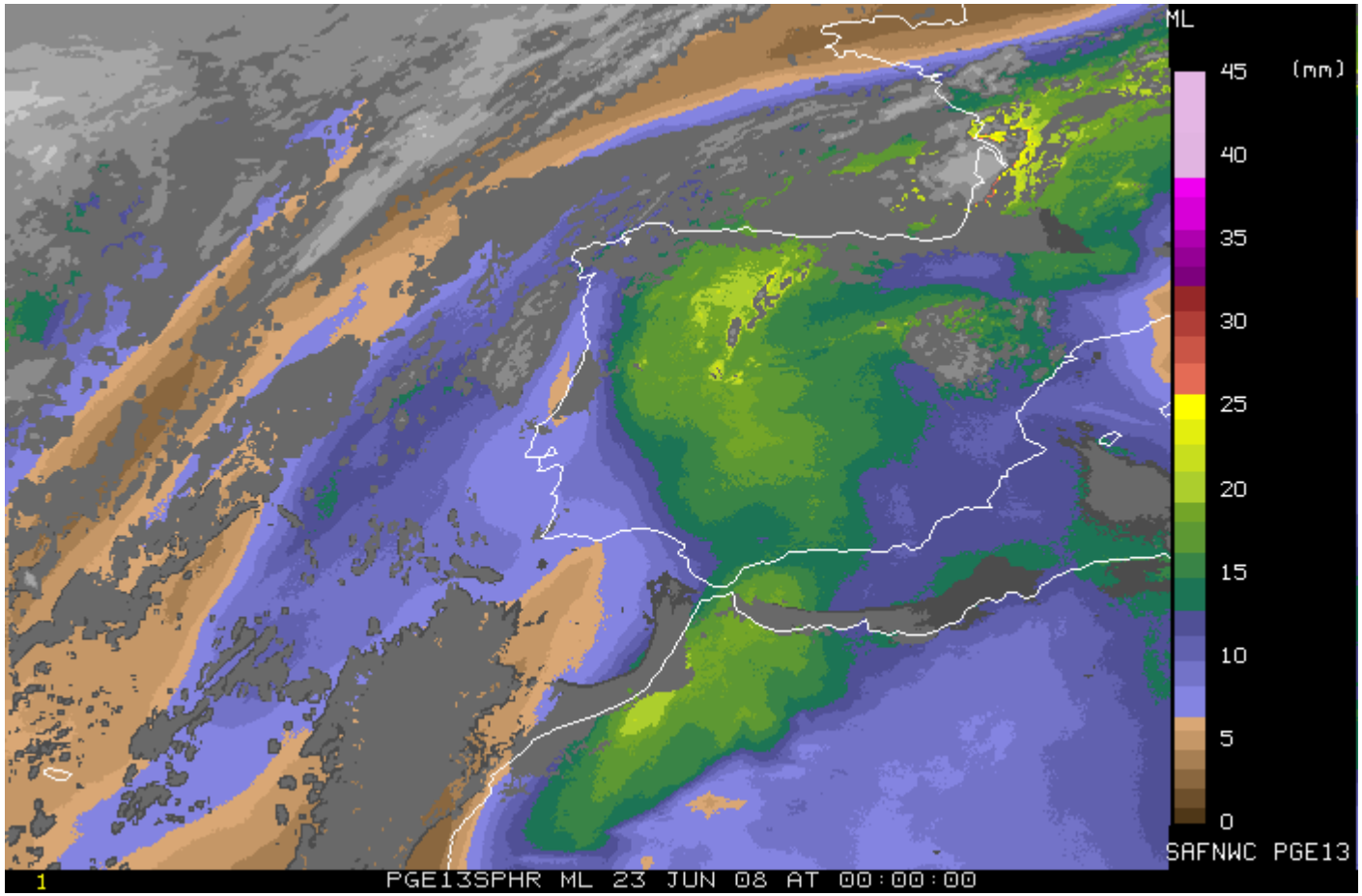
4th and 5th October 2009



Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force only one iteration in all pixels.

Precipitable Water in Middle Layer ML(850-500 hPa)

Case Study: 23 June 2008
NWCSAF/MSG SPhR_ML



Reprocessed with 2010 version and 1x1 FOR
Special configuration file to force only one iteration in all pixels.

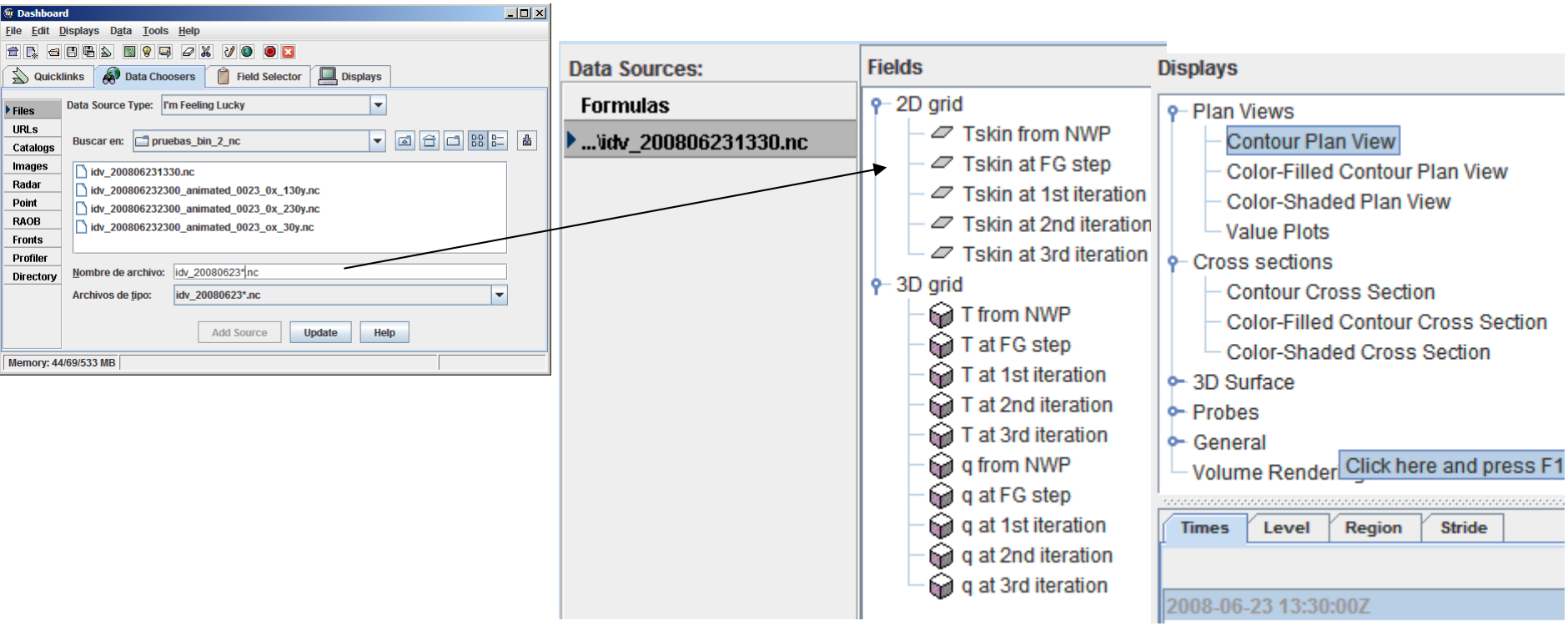
Precipitable Water in Middle Layer ML(850-500 hPa)

Conversion of PGE13 binary files to netCDF format

netCDF format can be managed by several standard tools.

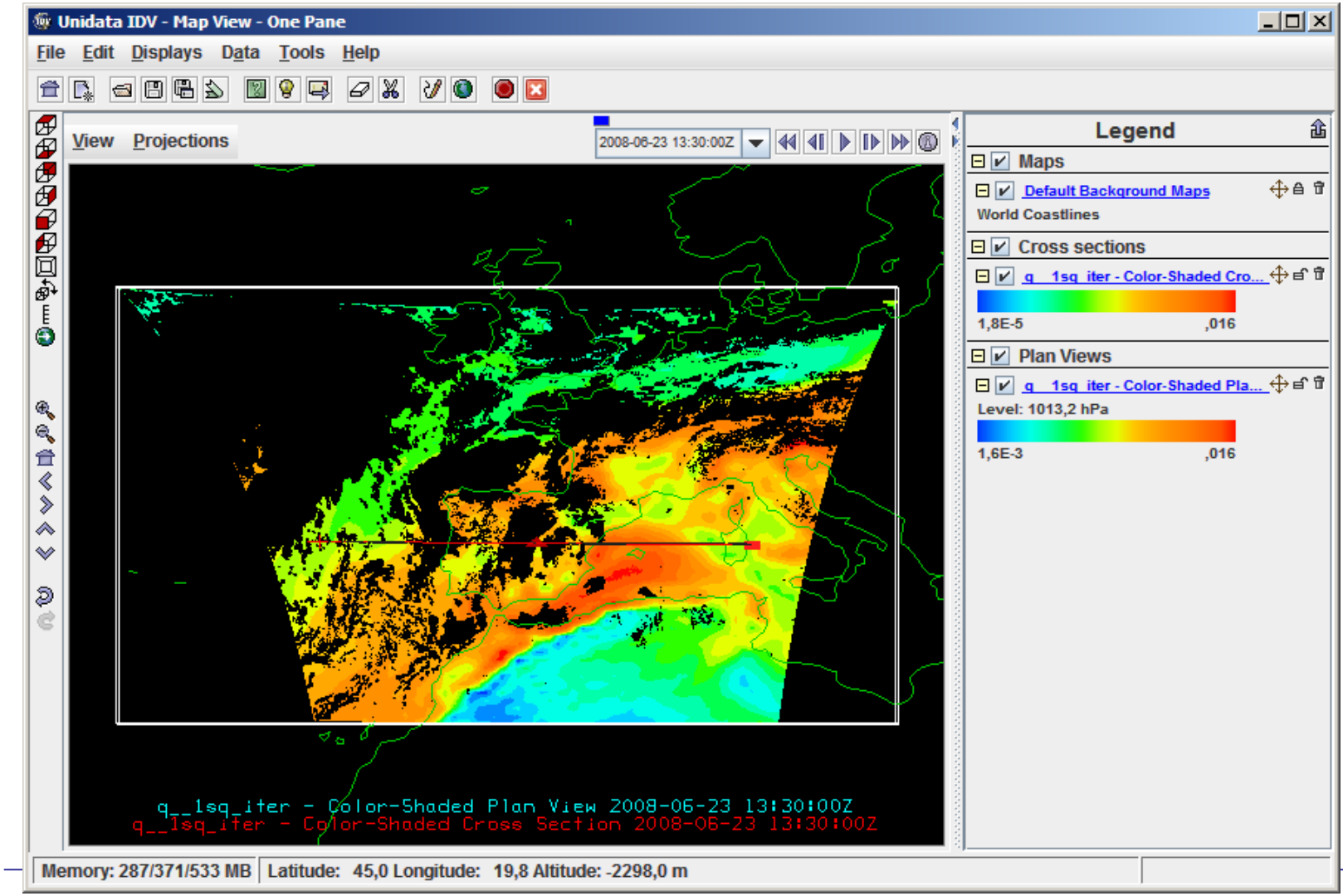
As example are presented here interactive sessions with freely available IDV and McIDAS-V

Binary to netCDF conversion. Use with IDV

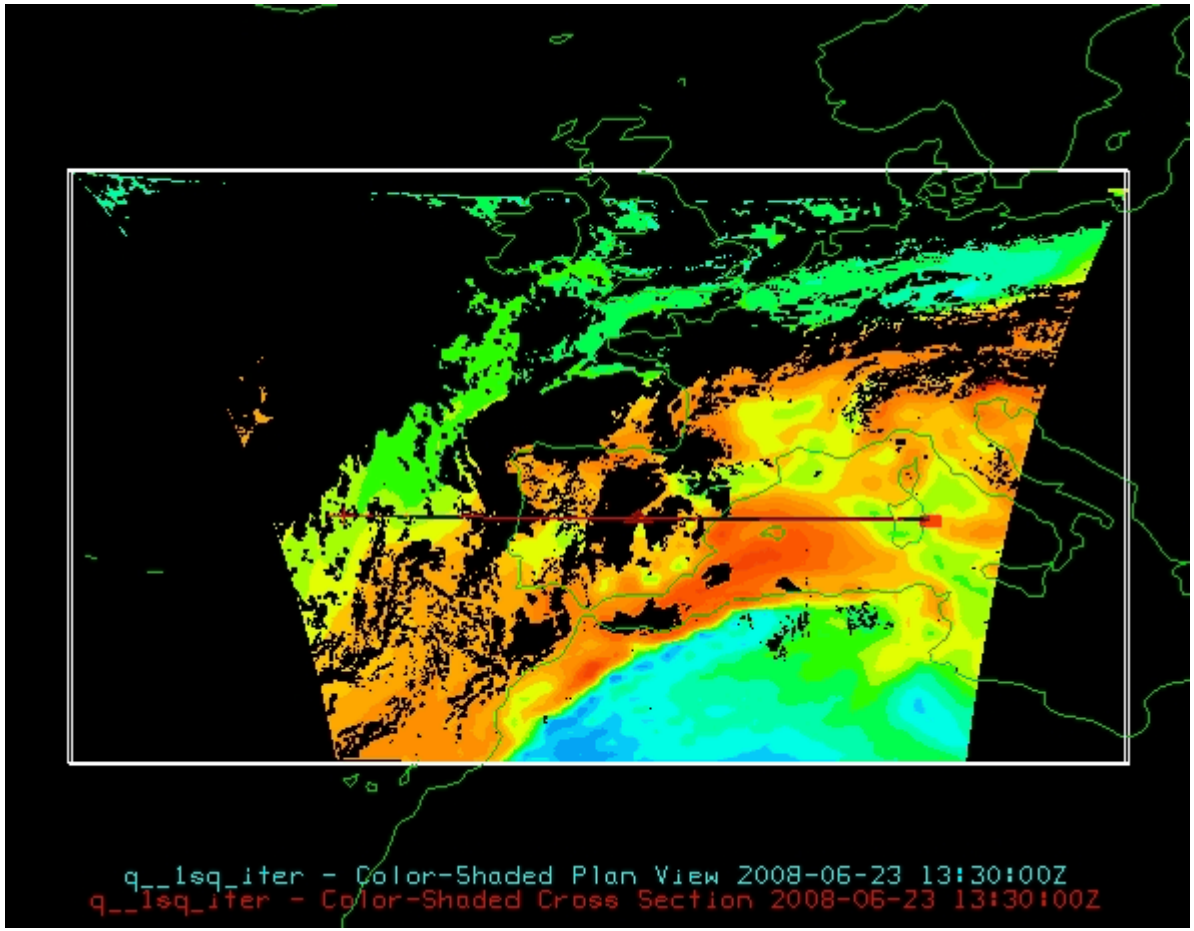


Now the prototype on IDL has been developed
It will be migrated to C or Fortran.
The longitude and latitude are added from the $SAFNWC/tmp directory
It will supported as best effort basis.

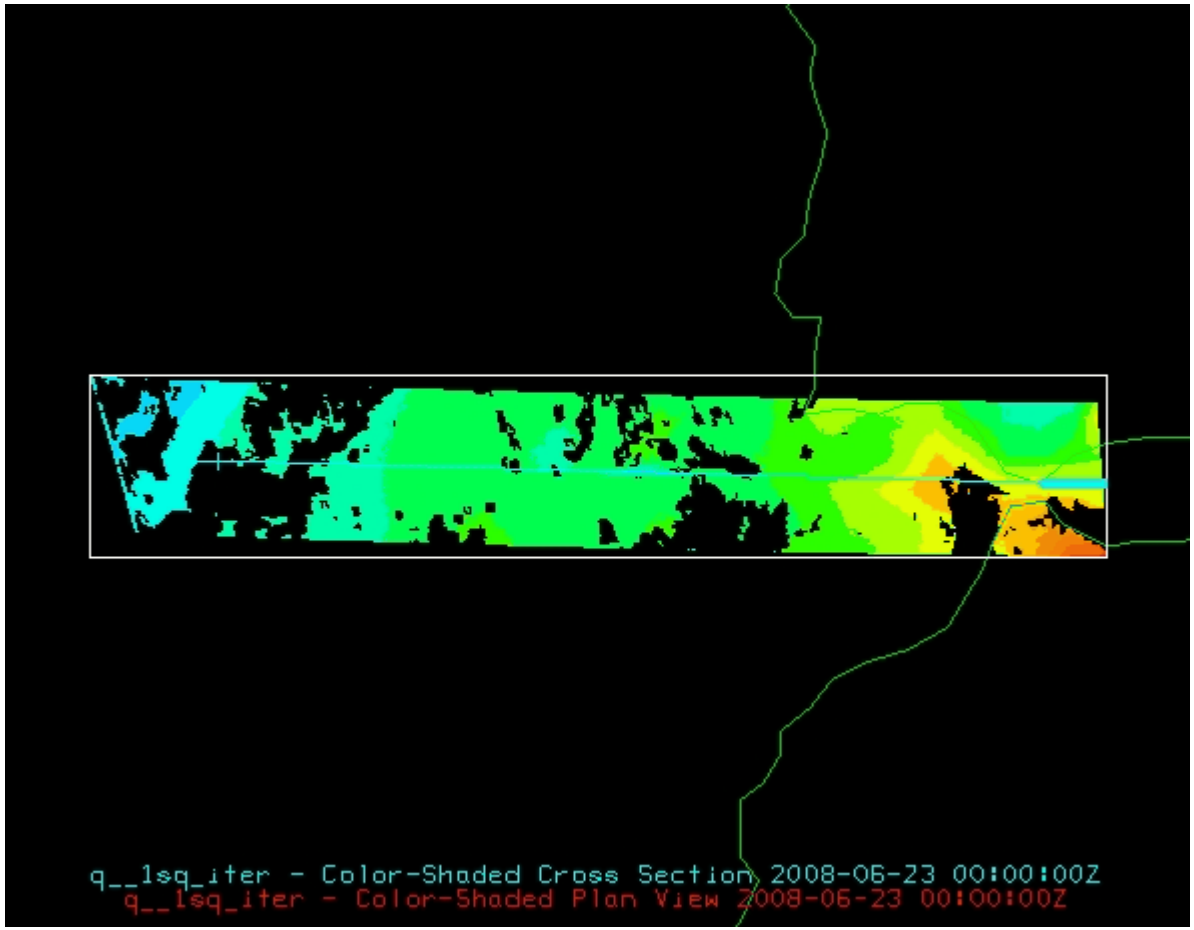
Binary to netCDF conversion. Use with IDV



Binary to netCDF conversion. Use with IDV



PGE13 binary to netcdf: Example of the Binary files outputs animations of vertical cross-sections



Several images are written in the same file.

Temporal evolution

23 JUNE 2008

Relations with other SAFs (1/2)

Clima SAF has been beta tester of the PGE13. CM SAF plans to use for its developments.

One module to calculate the error estimation has been developed for the CM SAF as a patch to the PGE13.

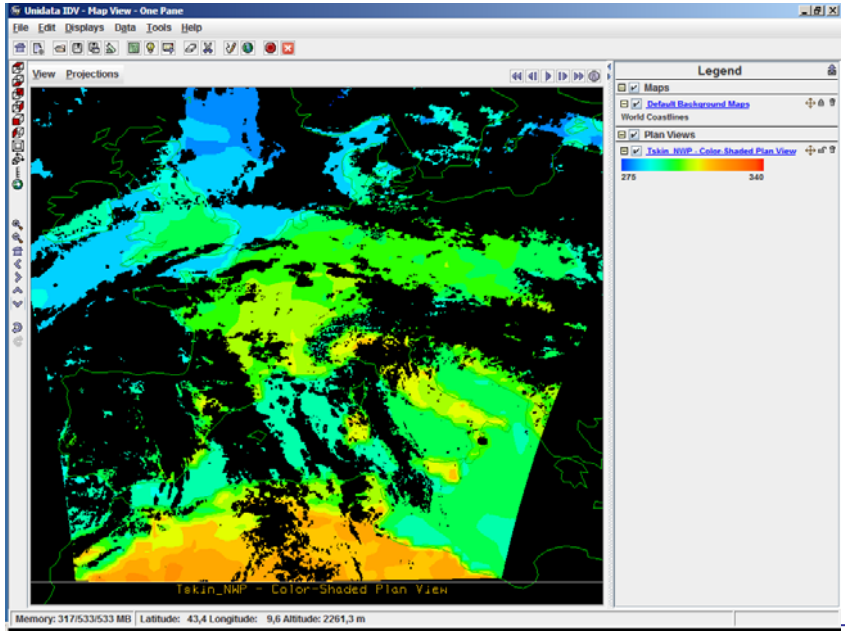
- Sources kindly provide by Jun Li (CIMSS – Wisconsin)
- Integrated in the code by Miguel A. Martinez (AEMET)
- Tested and adapted for CM-SAF by Katja Hungershöfer (DWD –CM SAF)

Relations with other SAFs (2/2)
Synergies with OSI SAF and Land SAF

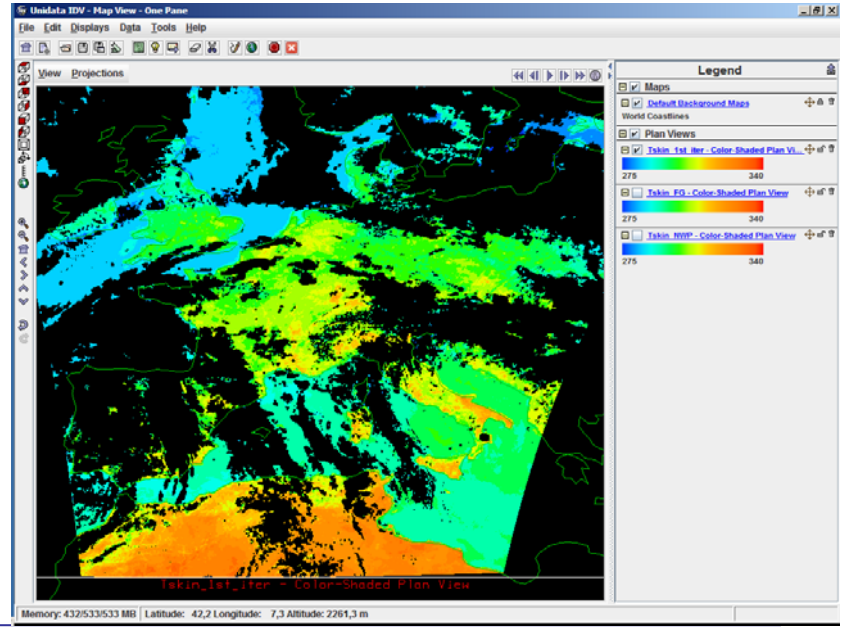
T_{skin} should be compared with SST and LST

SST from OSI SAF and LST from Land SAF could be used to train the T_{skin}

T_{skin} from NWP(T+12 hours)



T_{skin} from physical retrieval

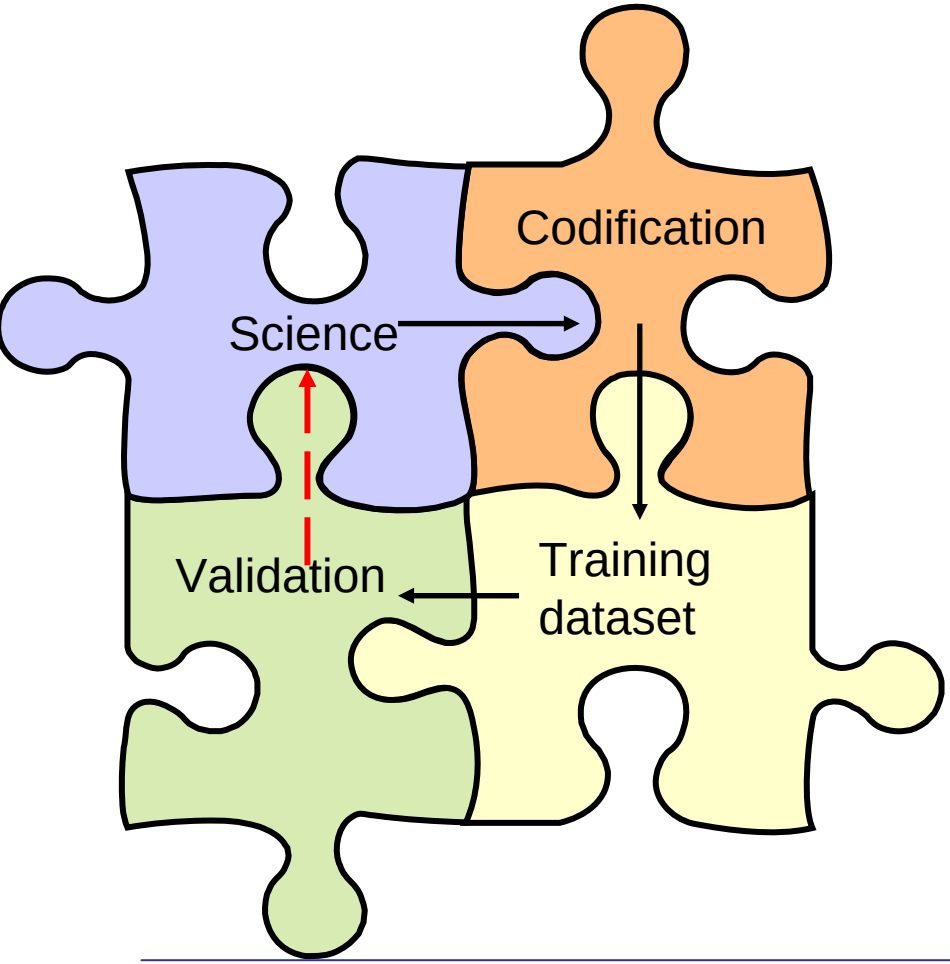


Conclusions

- A new PGE, PGE13 SPhR (SEVIRI Physical Retrieval), has been developed in NWCSAF/MSG package.
- The full operational and validated version is available from **2010 NWCSAF/MSG package**.

- After this extensive validation exercise, next conclusions are obtained:
  - Validation has been performed for an extended period of a complete year 2009.
  - Validation has been performed for the complete SEVIRI disk.
  - Best results are obtained for humidity in medium layers due to the contribution of the two water vapor channel.
  - SEVIRI has limited information to improve the vertical information beyond the forecast, but does provide useful spatial information. This limitation is clearer for the vertical information of temperature.
  - Performance results present important variations along the complete MSG disk. Better results for all the parameters are obtained for European interest regions.

State of project



- Availability of the PGE13 SPhR code and the training dataset generation allows to improve the science for next versions and for MTG era.

Future versions of PGE13 SPhR

Future works

- To increase the vertical information in the background NWP: To check the performance of physical retrieval using as background NWP hybrid profiles instead of the fixed pressure levels (it will need some modifications code, one local PGE14 clone of the PGE13 could be use in order to check it).

- To test new ideas on FG regression: as example management of the surface pressure

- To calculate and validate new EOFs and covariance matrices.

- The training and validation dataset will be used to made a validation of the neural network products (PGE06, PGE07 and PGE08). After this validation one attempt to improve the performance (use of a bigger a best training dataset, the possibility to train the neural network directly using BT SEVIRI with TPW, LPW and LI index calculated from the physical retrieval, to include the emissivity atlas not used before, …)

Thanks for your attention !