Use of Radiances in the CNMCA Operational Ensemble Data Assimilation System

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CNMCA - EnKF DA (*Bonavita, Torrisi and Marcucci, Q.J.R.M.S.,2008,2010*)

- ***OPERATIONAL SINCE 1 JUNE 2011*** to initialize the 7km COSMO-ME model
  (4 june 2013 switch from HRM to COSMO model in the DA cycle)

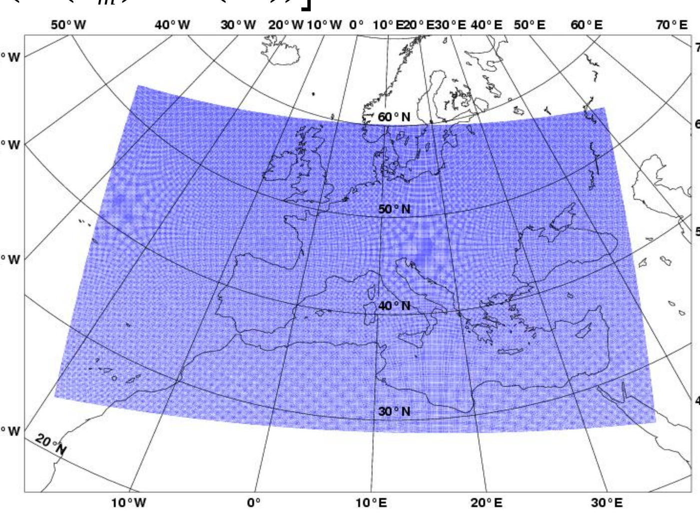
  CNMCA is the first meteorological centre which uses operationally a pure EnKF DA to initialize a deterministic NWP model

- ***LETKF Formulation*** *(Hunt et al,2007)*

Analysis Ensemble Mean $\overline{x}^a = \overline{x}^b + X^b \overline{w}^a \quad \overline{w}^a = \tilde{P}^a Y^{bT} R^{-1}(y - H(x^b)) \quad \tilde{P}^a = \left[(m-1)I + Y^{bT} R^{-1} Y^b\right]^{-1}$

Analysis Ensemble Perturb. $X^a = X^b W^a \quad W^a = \left[(m-1)\tilde{P}^a\right] \quad Y^b = \left[(H(x_1^b) - \overline{H(x^b)}), \ldots, (H(x_m^b) - \overline{H(x^b)})\right]$

- 6-hourly assimilation cycle
- 40 ensemble members + deterministic run with 0.09° (~10Km) grid spacing (COSMO model), 45 hybrid z-sigma vertical levels (top at ~27km)
- (T,u,v,pseudoRH,ps) set of control variables
- Observations: RAOB/TEMP, PILOT, SYNOP, SHIP, BUOY, VAD/Wind Profilers, AMDAR-ACAR-AIREP, MSG3-MET7 AMV, MetopA-B scatt. winds, NOAA/MetopA AMSUA radiances+ LandSAF snowmask,



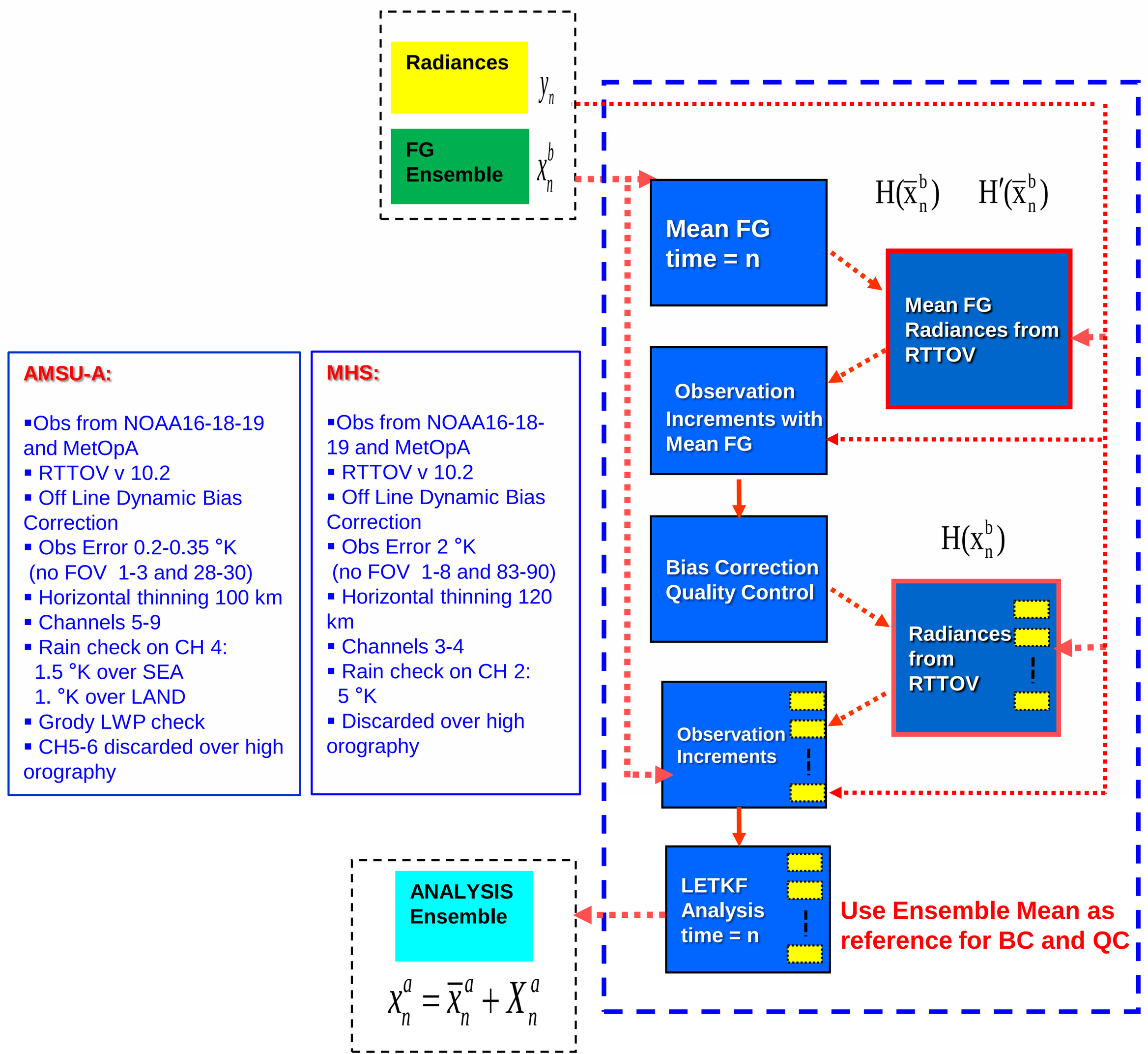
Model and sampling errors are taken into account using:

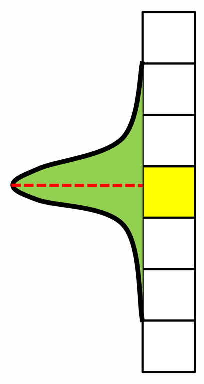
- "Relaxation-to-Prior Spread" Multiplicative Inflaction according to Whitaker et al (2010)

an. pert. $x_a' = x_a' \sqrt{\alpha \frac{\sigma_b^2 - \sigma_a^2}{\sigma_a^2} + 1}$ $\alpha = 0.95$, σ^2 = variance

- Additive noise from EPS
- Lateral Boundary Condition Perturbation using EPS
- Climatological Perturbed SST
- Adaptive selection radius using a fixed number of effective observations (sum of obs weights)

RADIANCES ASSIMILATION

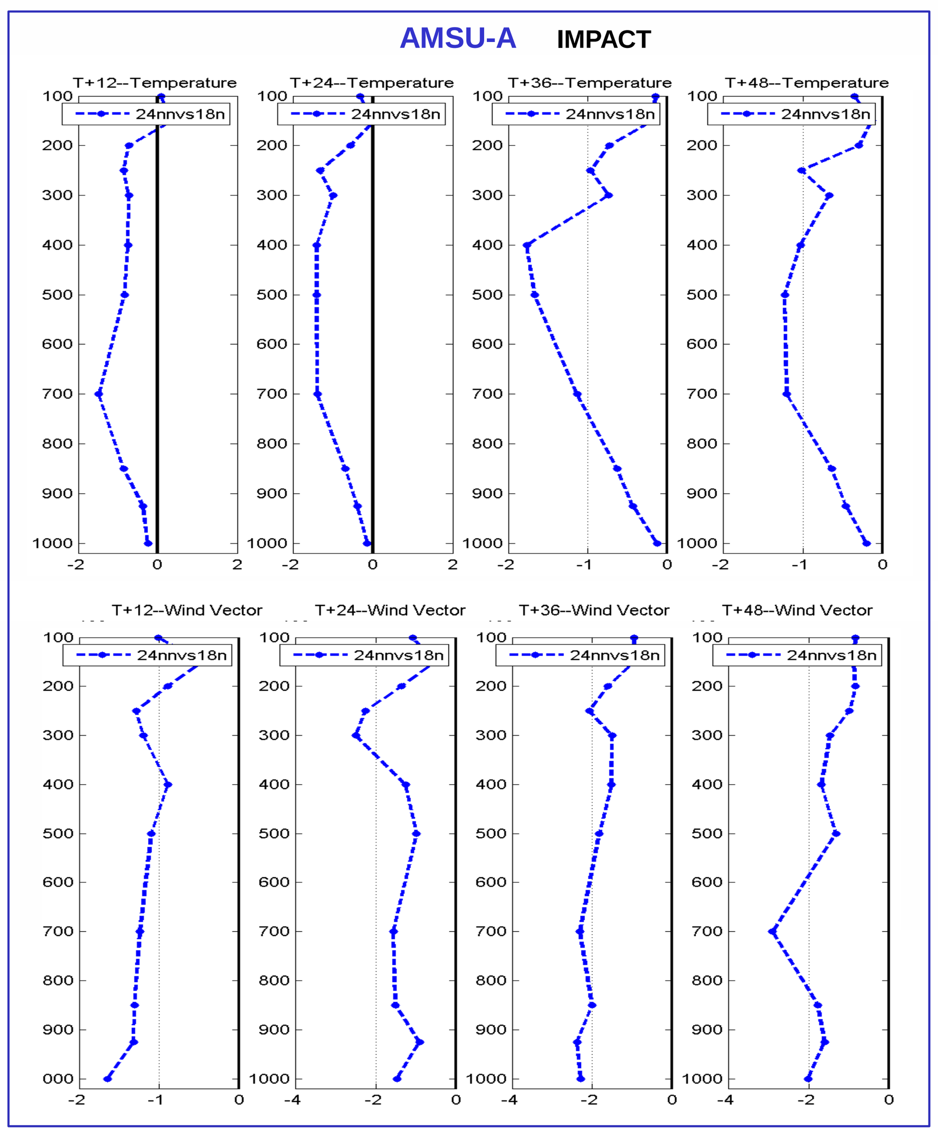




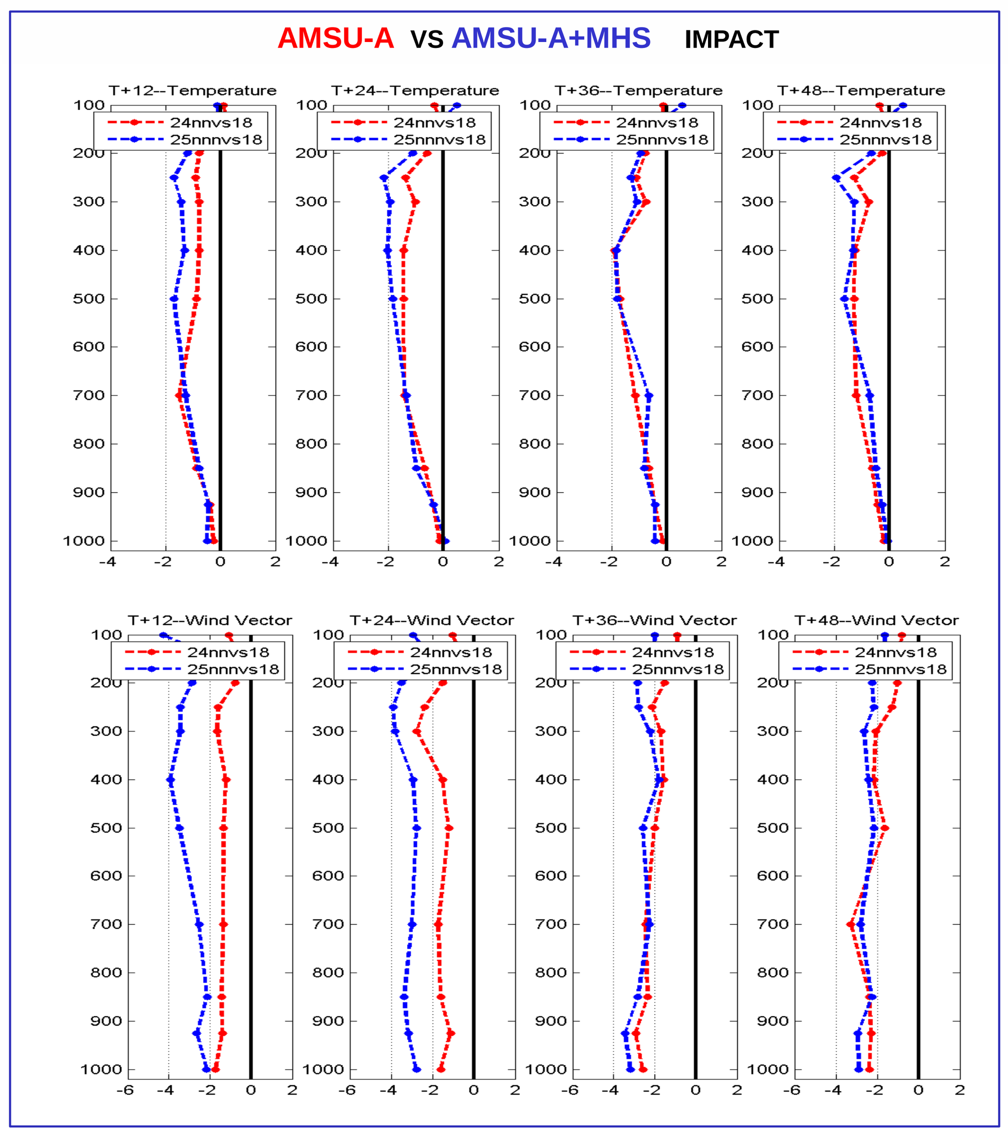
MAXIMUM-BASED METHOD

- At the first attempt, radiances are treated as "single-level" obs, with the standard loc. function (gaussan function)
- Assign radiance to the pressure level obtained by a weighted average using the normalized weighting function (WF) larger than 0.8

AMSU-A IMPACT



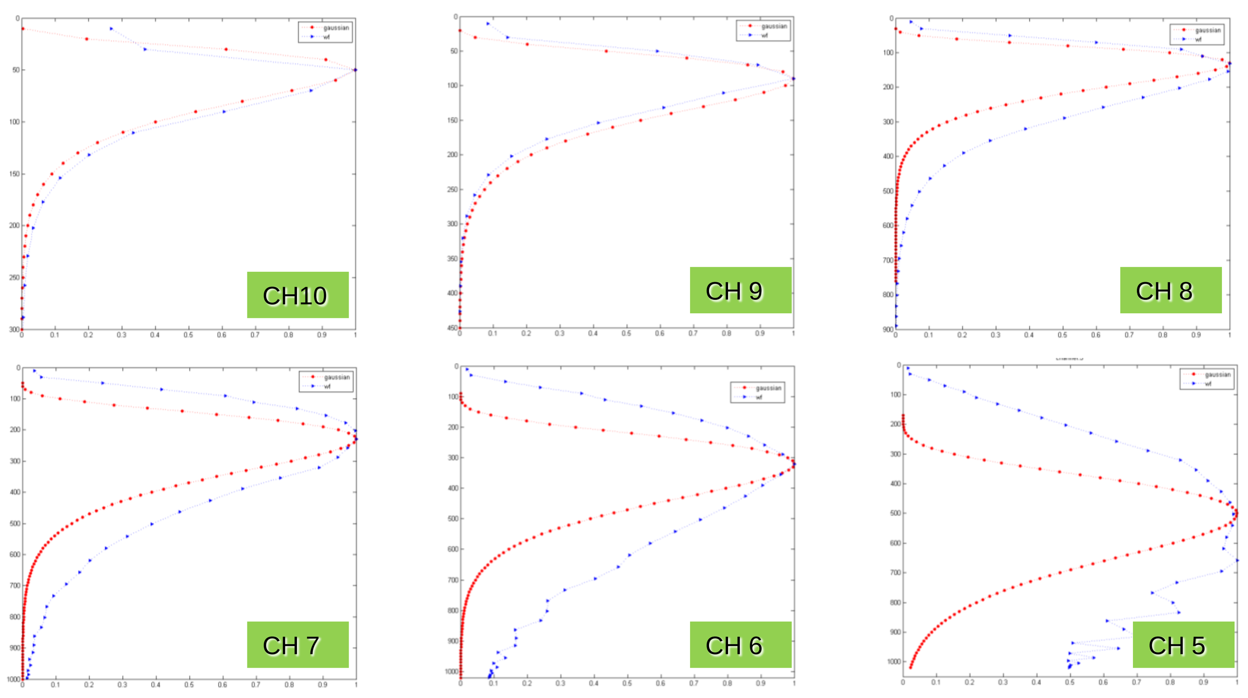
AMSU-A VS AMSU-A+MHS IMPACT



- Radiances assimil. impact is evaluated through the relative difference (%) in RMSE computed against IFS analysis, with respect to "no radiances" configuration, for 00 UTC COSMO runs from 16-09-2012 to 05-10-2012 (*negative value = positive impact*)
- *CLEAR* ***POSITIVE*** *IMPACT OF* ***AMSUA*** *ASSIMILATION ON THE WHOLE COLUMN FOR ALL FORECAST TIMES*
- ***MHS*** *IMPACT IS SMALLER THAN AMSUA ONE IN THIS PRELIMINARY WORK*

AMSU-A LOCALIZATION

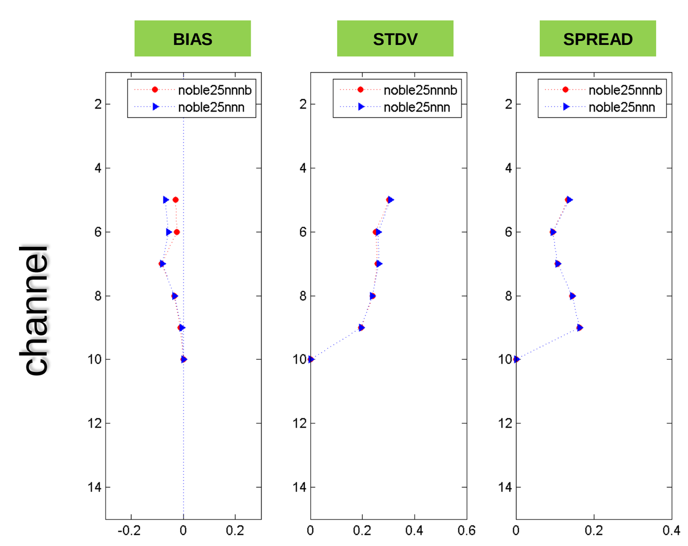
WEIGHTING FUNCTION vs STANDARD LOCALIZATION (gaussian func.)



WF ensemble mean averaged over the period 27 jun -18 jul 2011 and the standard vertical loc. function are shown

DYNAMICAL LAND EMISSIVITY RETRIEVAL

- The method proposed in Karbou et al. (2005) is used to improve the specification of land surface emissivity
- The emissivity is dynamically retrieved from suitable window channels, using background information to estimate the required terms in the radiative transfer equation.
- The retrieved emissivity is then applied for the forward calculations for the sounding channels
- The method is applied to AMSU-A and MHS data: AMSU-A channel 3 and MHS channel 1 are used to estimate the emissivity for the other sounding channels.

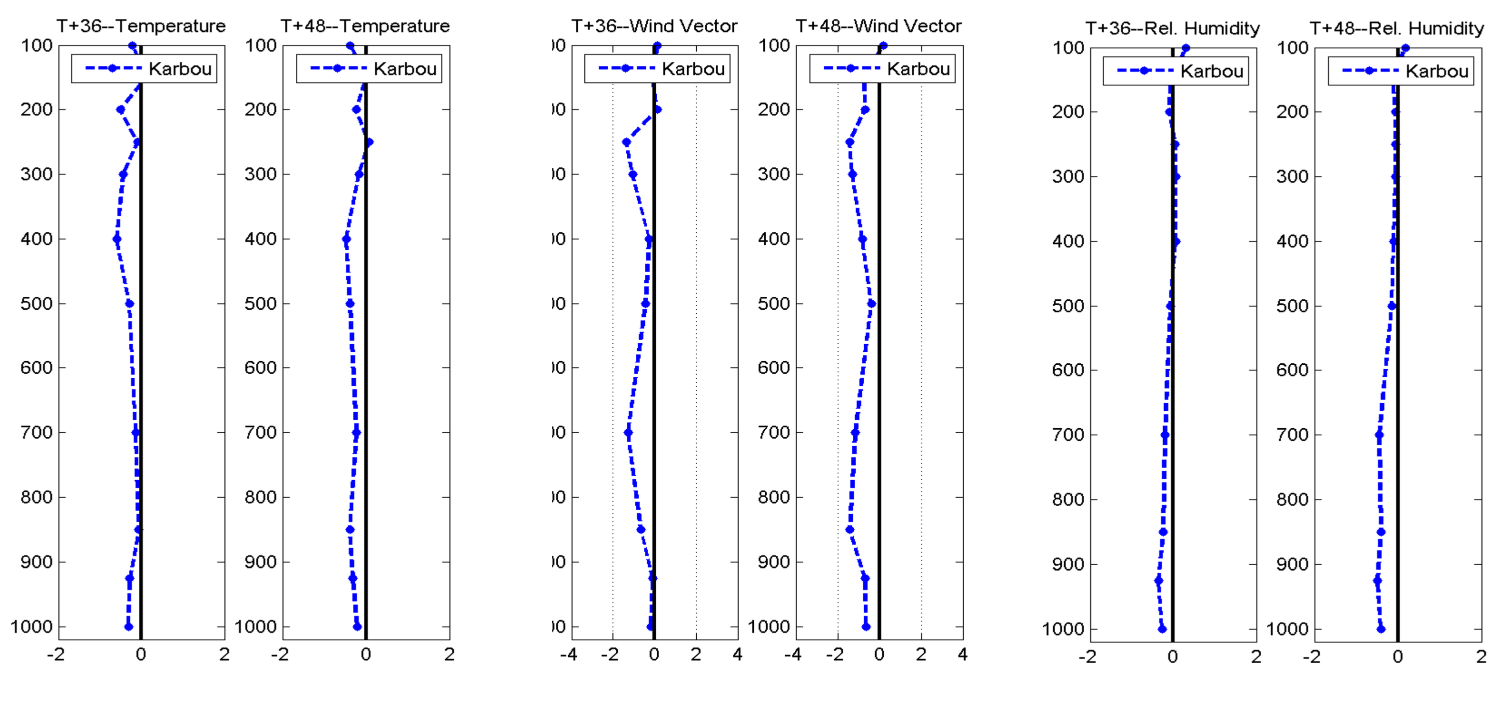


AMSU-A OBSERVATION INCREMENT STATISTICS

(Period:16-09-2012 to 05-10-2012)

- A reduction of AMSU-A temperature bias is observed if the dynamical land emissivity retrieval is applied
- No significant impact on standard deviation

EVALUATION OF THE "DYNAMICAL LAND EMISSIVITY RETRIEVAL" IMPACT

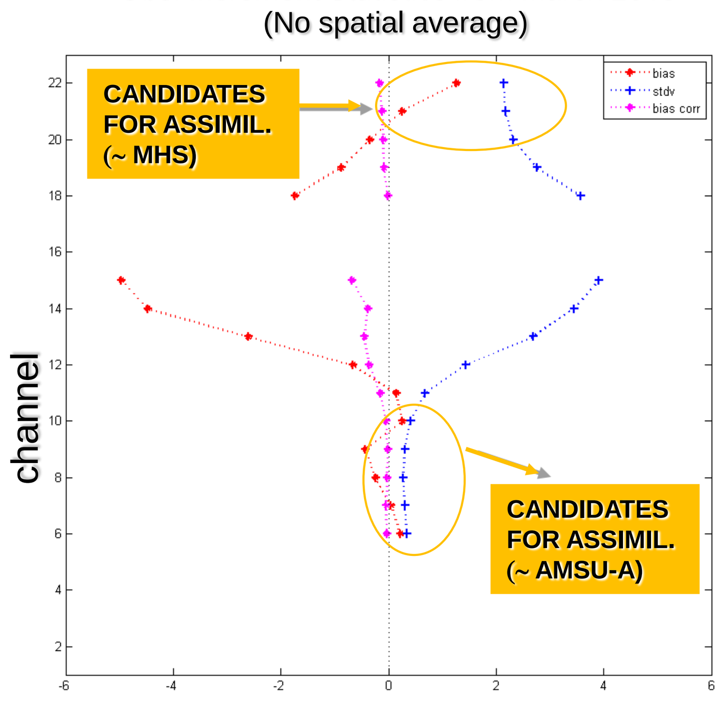


- The impact is evaluated through the relative difference (%) in RMSE computed against IFS analysis with respect to the configuration without dynamical emissivity retr. (MHS+AMSU-A assimilation) for 00 UTC COSMO runs from 16-09-2012 to 05-10-2012
- A clear positive impact is observed at day 2

CURRENT AND FUTURE DEVELOPMENTS

ATMS (OVER SEA)

Obs. Increment Statistics from March 2013
(No spatial average)



- MetopB AMSU-A operational assimilation (very soon)
- Further investigation of MHS assimilation
- Assimilation of spatially averaged ATMS
- Oceanscat2 winds and GPS delays daily monitored
- ASCAT surface soil moisture data assimilation allowing the influence of the near surface atmospheric fields