Humidity treatment at CNMCA Operational Ensemble Data Assimilation System

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Outline

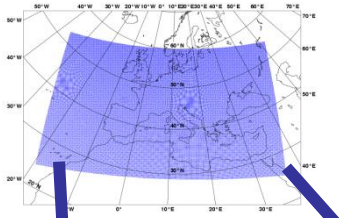
- Overview of the operational CNMCA-LETKF system

- Impact of last changes in humidity treatment:
  - Pseudo-RH variable (J. Liu,2007)
  - MHS observations assimilation
  - Dynamical land emissivity retrieval
  - Localization tests

CNMCA NWP SYSTEM since 1 June 11

Ensemble Data Assimilation:

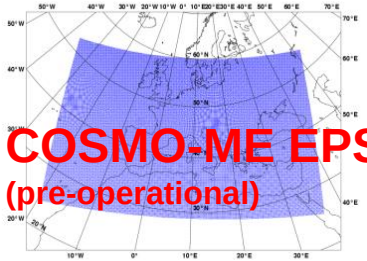
LETKF analysis ensemble (40+1 members) every 6h using RAOB (also 4D), PILOT, SYNOP, SHIP, BUOY, Wind Profilers, AMDAR-ACAR-AIREP, MSG3-MET7 AMV, MetopA-B/Oceansat2 scatt. winds, NOAA/MetopA-B AMSUA radiances
+ Land SAF snow mask,
IFS SST analysis once a day



10 km
45 v.l.

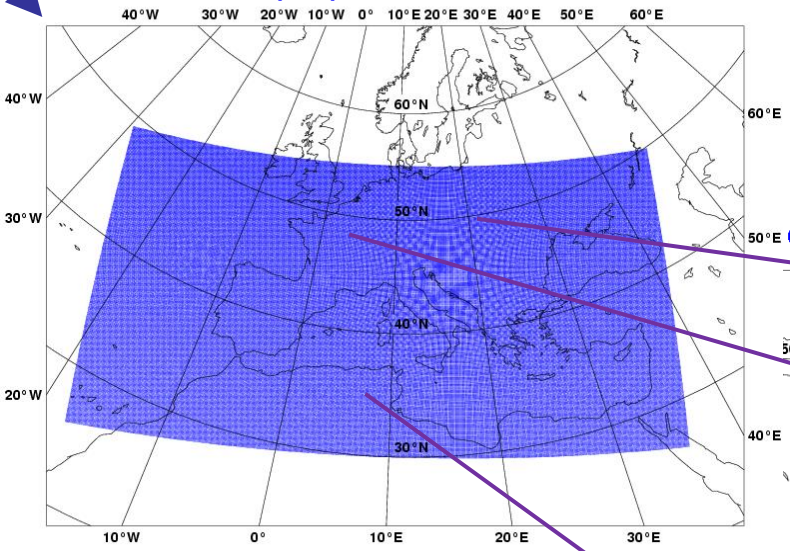
Control State Analysis

LETKF Analysis



COSMO-ME EPS
(pre-operational)

COSMO-ME (7km) ITALIAN MET SERVICE



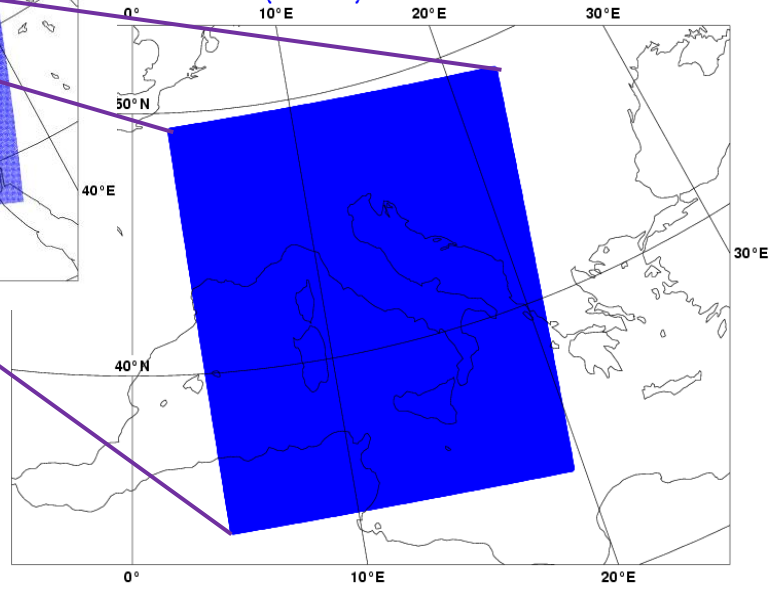
7 km
40 v.l.

- compressible equations
- parameterized convection

2.8 km
65 v.l.

- compressible equations
- explicit convection

COSMO-IT (2.8Km) ITALIAN MET SERVICE



Local Area Modelling: COSMO

Changes in CNMCA LETKF system

Recent changes in the operational suite are:

- COSMO model (tuning and adaptation)
- Space and time displacement in radiosoundings (only BUFR messages)
- Humidity bias correction for Vaisala RS
- AMSU-A radiances over sea and land
- Additive noise from IFS forecasts instead from model climatology
- Humidity bound check
- Pseudo-RH variable
- Reduced horizontal length for humidity obs
- Dynamical land emissivity retrieval and MHS assimilation

Pseudo-RH Variable

"Among the other choices of humidity variable types, the best result is from pseudo-RH assimilation. The error distribution of pseudo-RH is more Gaussian than specific humidity observations. It has similar error distribution as the relative humidity observations, but unlike relative humidity observations, it has no error correlation with the other observation variables" *(J. Liu, 2007, PhD thesis)*

Two options were evaluated:

1- LIU pseudo-RH normalization Dqv_i / $\overline{qv\_sat}^{bg}$

obs increments of specific humidity normalized by the mean bg saturation specific humidity

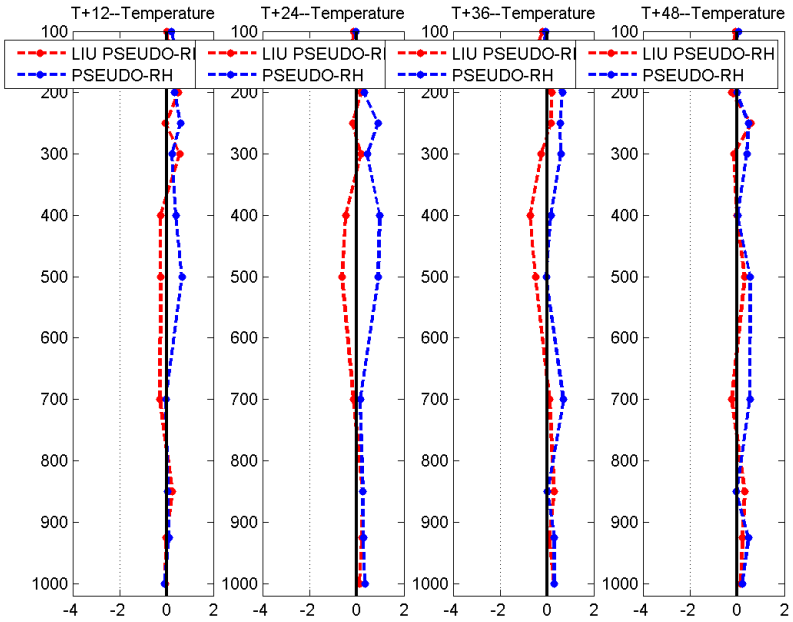
2- pseudo-RH variable qv_i / $qv\_sat^{bg}{}_i$

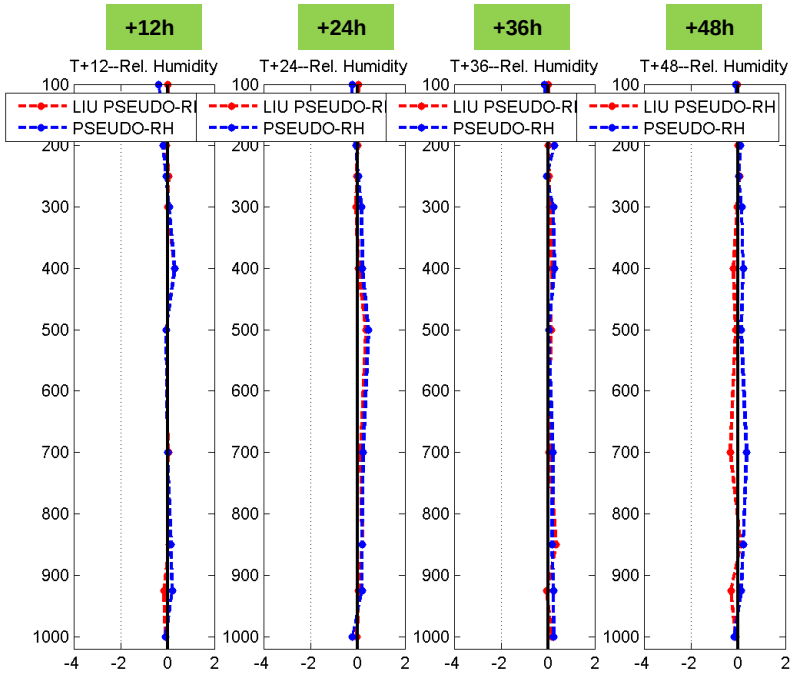
change of variable (from specific humidity to pseudo-RH) using the bg saturation specific humidity for each i-member

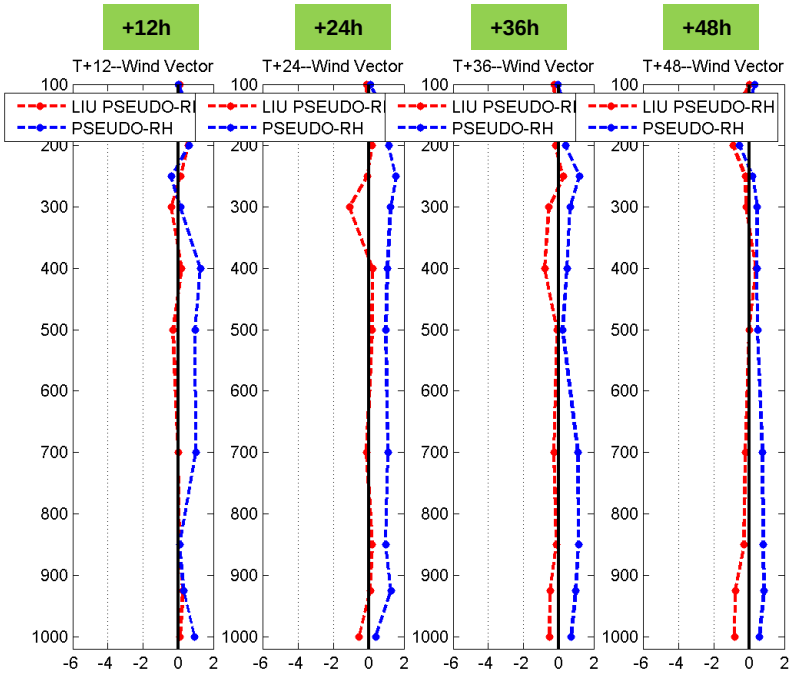
PSEUDO-RH VARIABLE

Relative difference (%) in RMSE computed against IFS analysis for 00 UTC COSMO runs from 16-09-2012 to 05-10-2012

negative value = positive impact





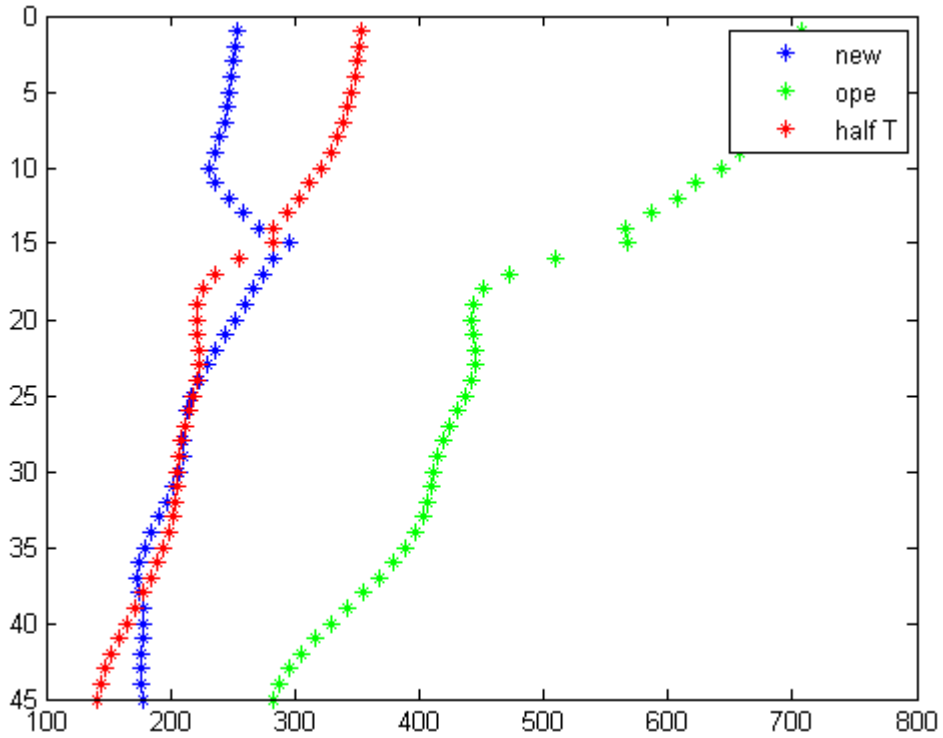


Horizontal localization lengths of humidity observations

The use of different localization lengths for humidity obervations have been evaluated:

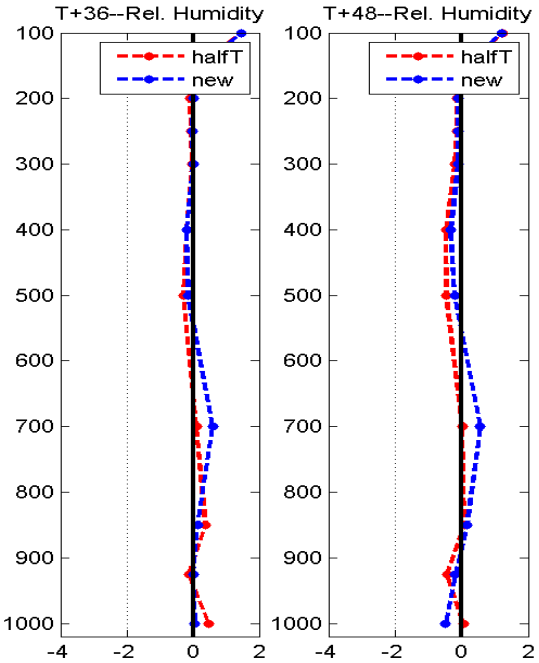
1- HUM loc. Length = 0.5 TUV loc. length

2-adapted from humidity correlation length

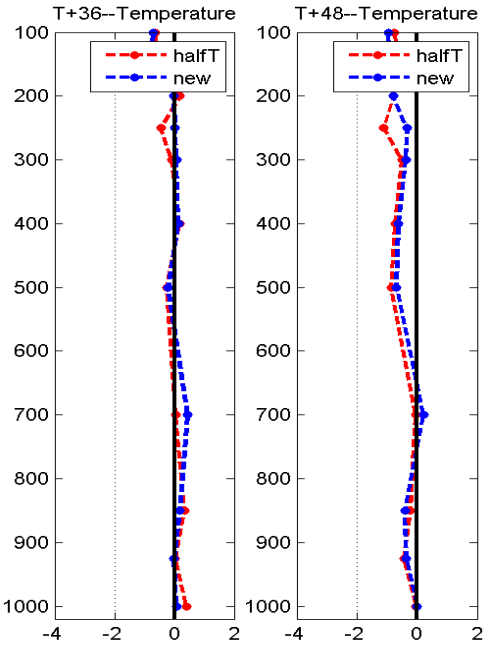


HUM obs horizontal localization lenghts

+36h +48h



+36h +48h



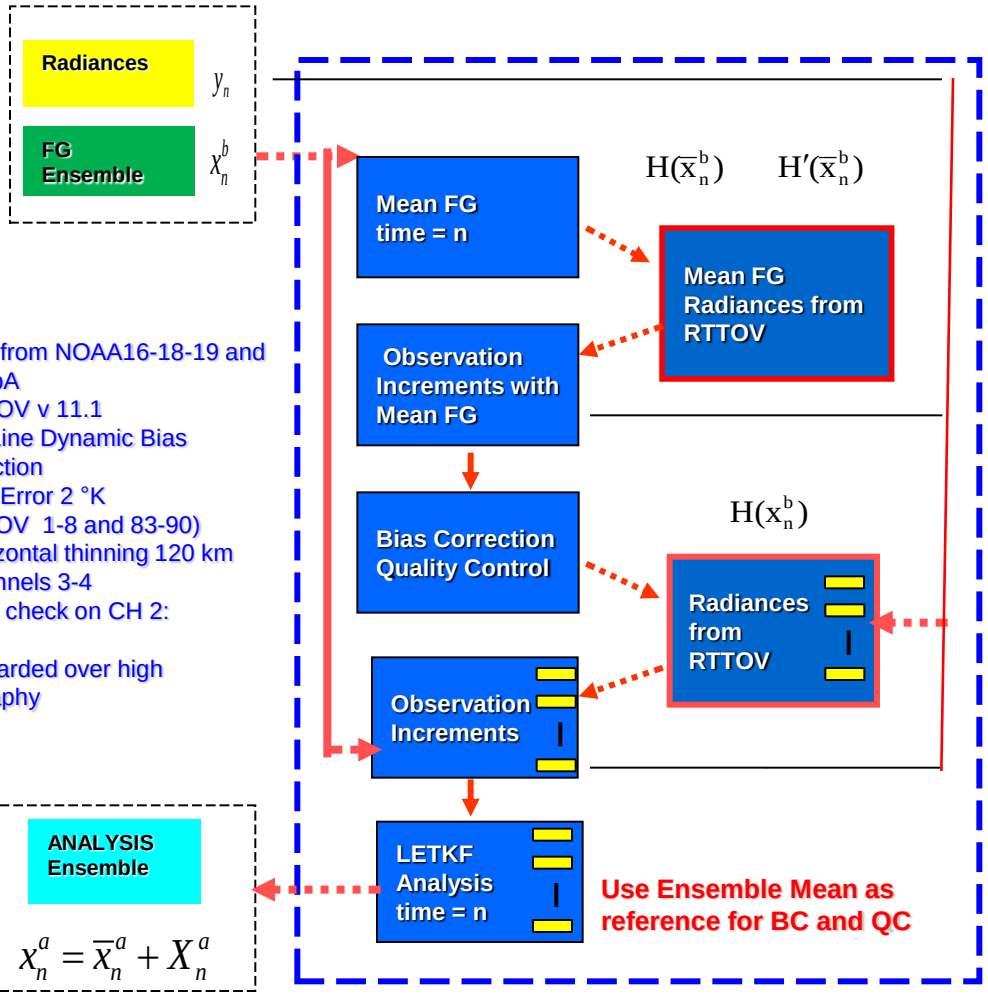
1- HUM loc. length = 0.5 TUV loc. length

2- NEW

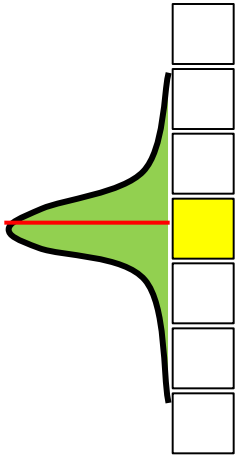
Relative difference (%) in RMSE computed against IFS analysis for 00 UTC COSMO runs from 16-09-2012 to 05-10-2012 *negative value = positive impact*

A positive impact is observed at day 2 changing the humidity-obs localization

MHS rad. assimilation



- Obs from NOAA16-18-19 and MetOpA
- RTTOV v 11.1
- Off Line Dynamic Bias Correction
- Obs Error 2 °K (no FOV 1-8 and 83-90)
- Horizontal thinning 120 km
- Channels 3-4
- Rain check on CH 2: 5 °K
- Discarded over high orography



Weighting function (transmittance vert. derivative)

$$w_k = (\tau_{v,k-1} - \tau_{v,k}) / (\ln(p_k) - \ln(p_{k-1}))$$

MAXIMUM-BASED METHOD

- MHS are treated as "single-level" obs
- Assign radiance to the pressure level obtained by a weighted average using the normalized weighting function (WF) larger than 0.8

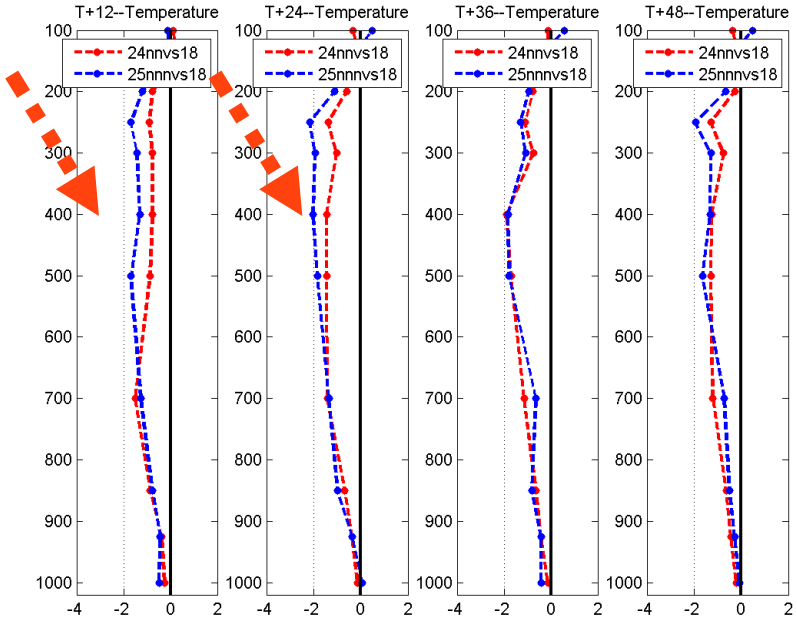
MHS rad. assimilation

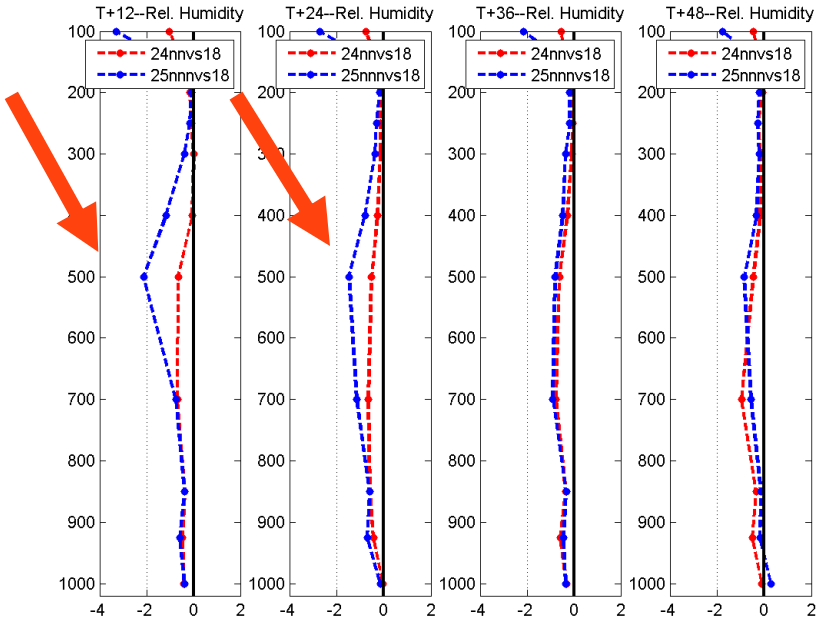
Relative difference (%) in RMSE computed against IFS analysis for 00 UTC COSMO runs from 16-09-2012 to 05-10-2012

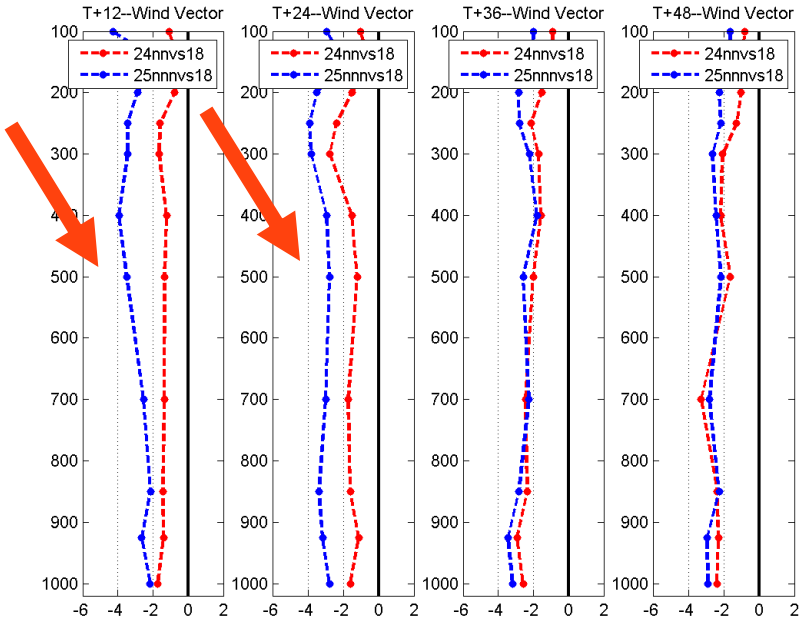
negative value = positive impact

MHS+AMSU

AMSU





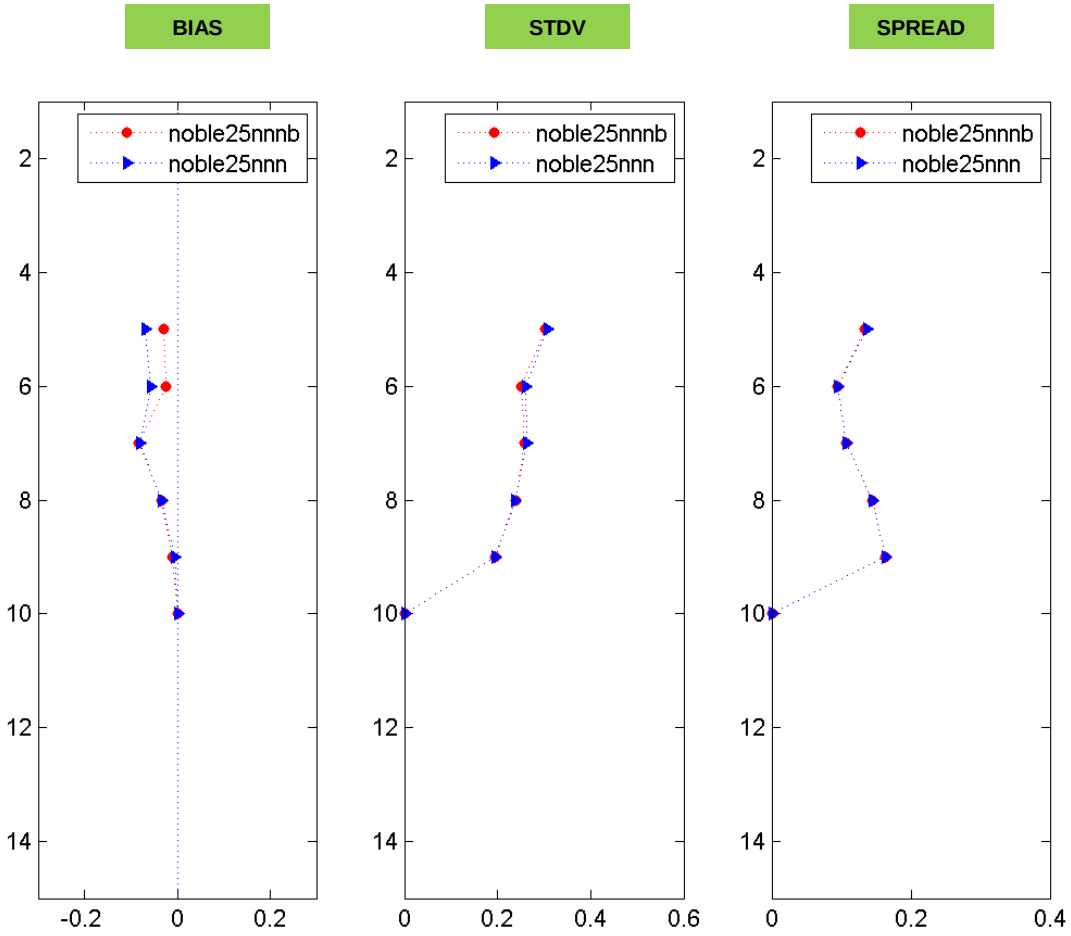


Dynamical land emissivity retrieval

- 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

Dynamical land emissivity retrieval

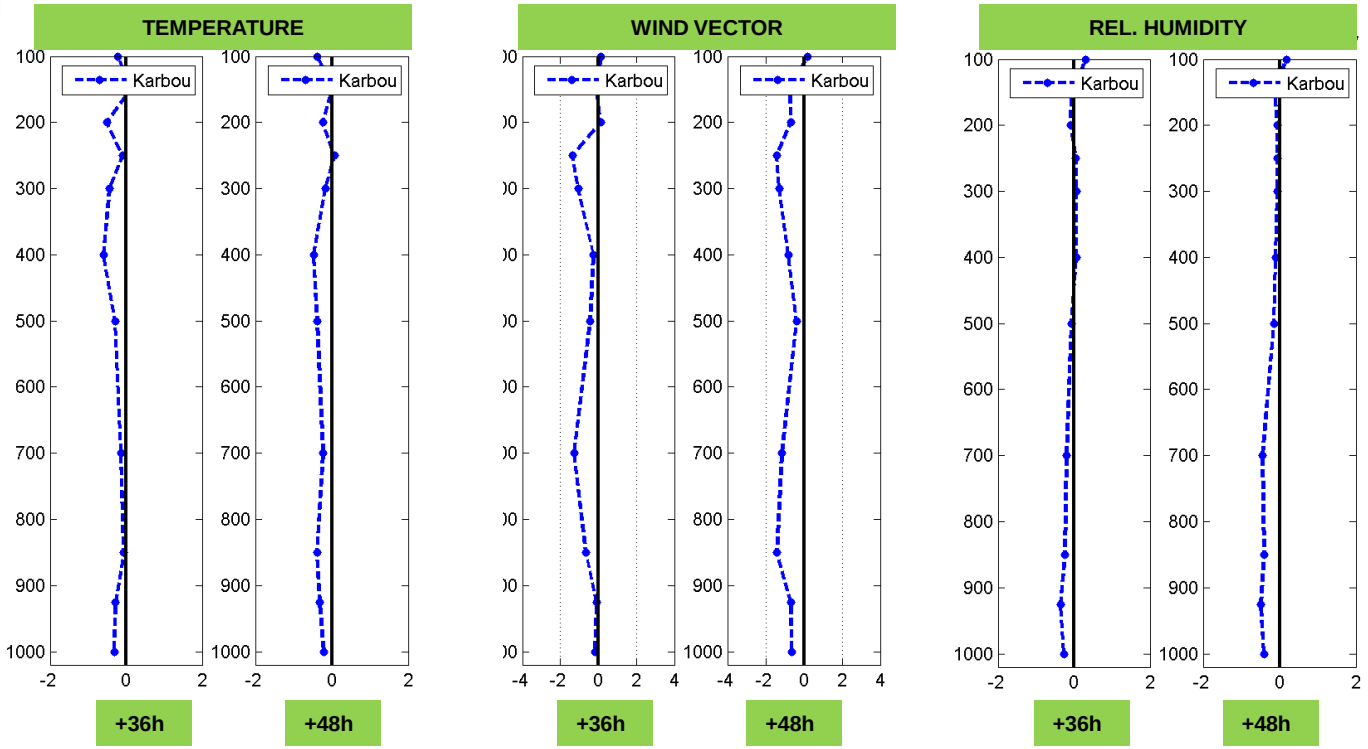
AMSU-A OBSERVATION INCREMENT STATISTICS



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

Dynamical land emissivity retrieval



•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

- Self-evolving additive inflaction / Stochastics physics
- ATMS radiances and GPS zenith total delays assimilation tests
- Improved drifting radiosounding thinning
- Use of KENDA
- Shorter assimilation window
- COSMO-ME Short-Range EPS based on LETKF is experimentally running

Thanks for your attention!