1DVAR assimilation of ATOVS radiances at CNMCA

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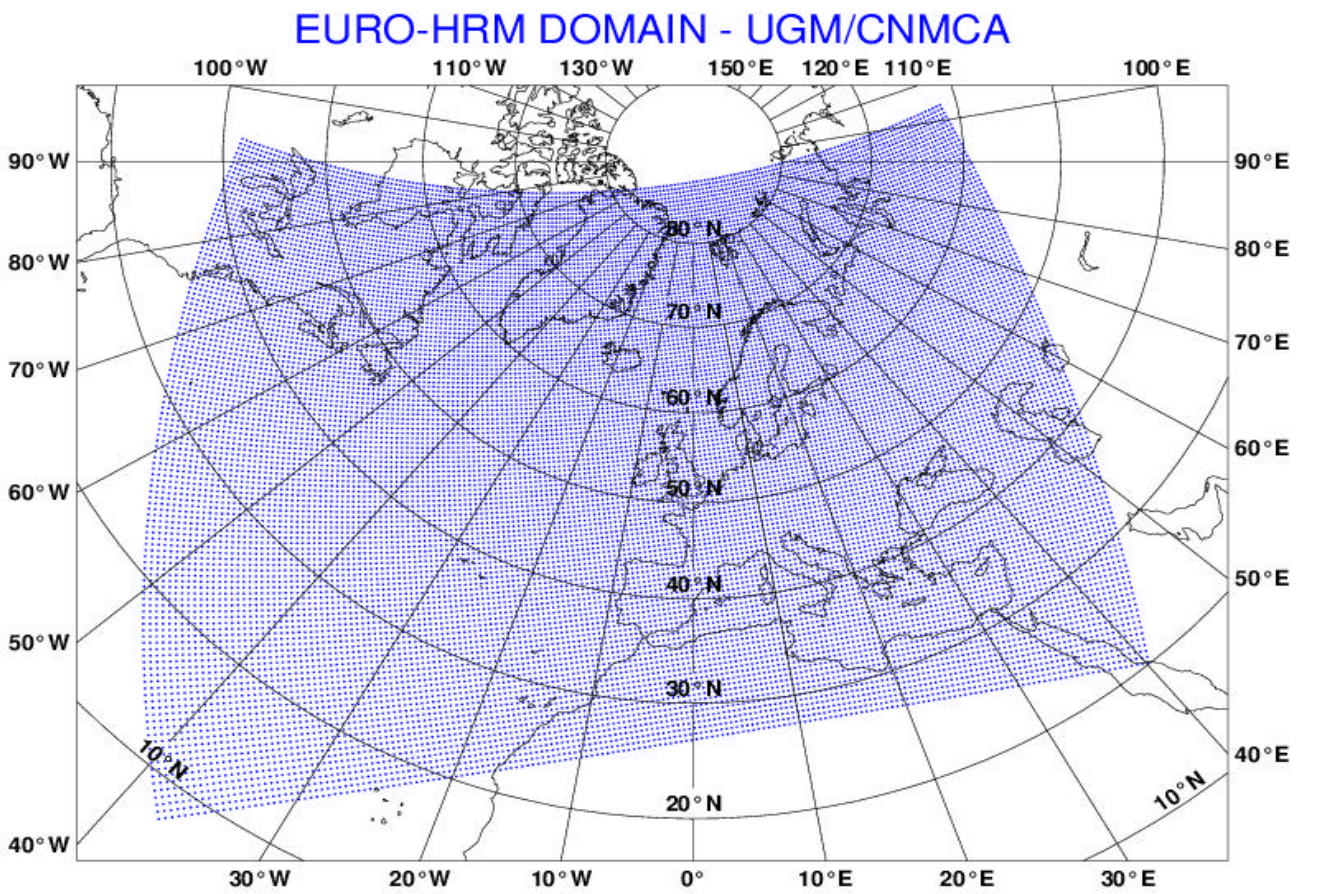
COSMO General Meeting – Langen 23-26 October 2003

Outline

- Current status of data assimilation at CNMCA
- Motivation for the ATOVS assimilation project
- Current status of the project
- Scientific and technical issues
- Future plans


EURO-HRM DOMAIN - UGM/CNMCA
100°W
110°W
130°W
150°E
120°E
110°E
100°E
90°W
80°W
70°W
60°W
50°W
40°W
90°E
80°E
70°E
60°E
50°E
40°E
80°N
70°N
60°N
50°N
40°N
30°N
20°N
10°N
10°N
30°W
20°W
10°W
0°
10°E
20°E
30°E

- Regional hydrostatic HRM grid point model in rotated coordinates
- 31 model levels
- 0.5° gridpoint spacing over Euro-atlantic domain, 0.25° over nested meditarranean domain
- Intermittent (6-h) data assimilation cycle with ECMWF boundaries
- Objective analysis: OI scheme in (Z,u,v,RH,P_s) on 20 vertical levels

• New objective analysis scheme under test: **3D-PSAS** algorithm on 30 vertical levels, (T,u,v,q,P_s) analyzed variables.

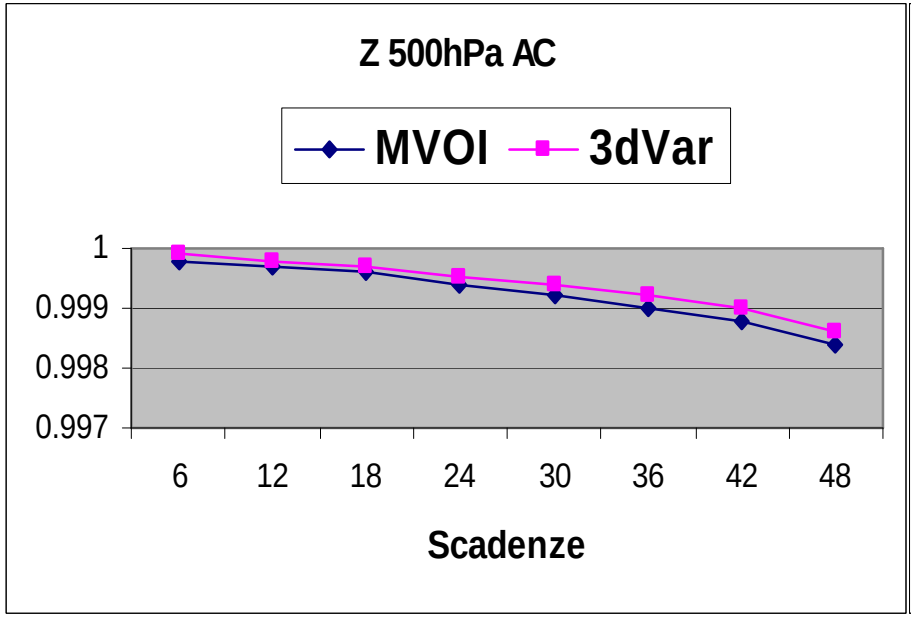
$$J = \tfrac{1}{2}[\mathbf{y} - H(\mathbf{x}_a)]^T \mathbf{R}^{-1}[\mathbf{y} - H(\mathbf{x}_a)] + \tfrac{1}{2}[\mathbf{x}_b - \mathbf{x}_a]^T \mathbf{P}_b^{-1}\,[\mathbf{x}_b - \mathbf{x}_a]$$

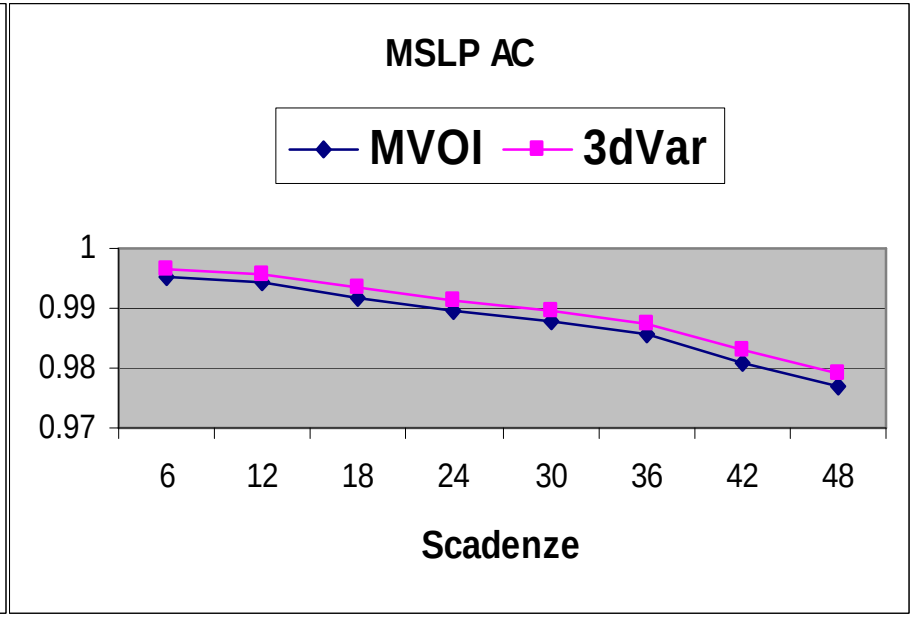
After linearization of Observation operator H around the background state $H \rightarrow \mathbf{H}(x_b)$:

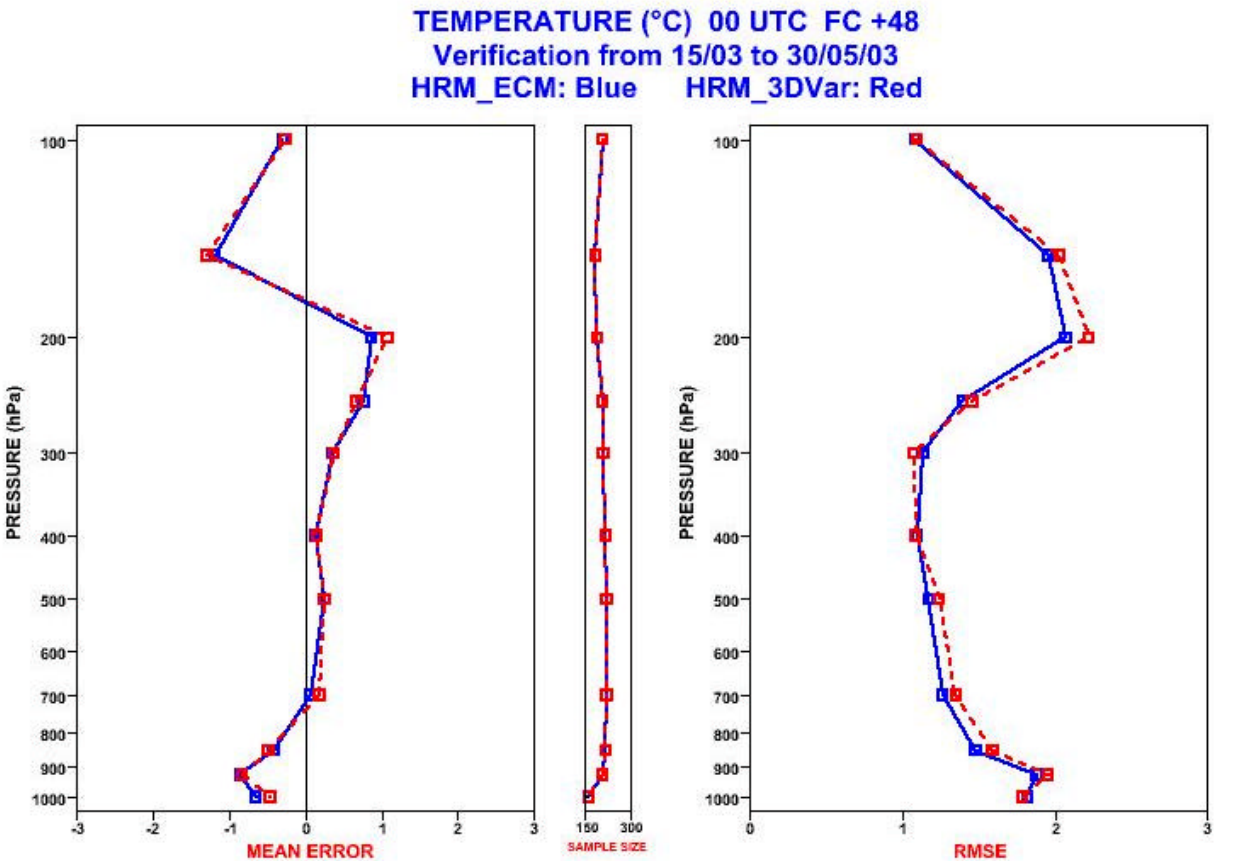
$$\boldsymbol{x}_a - \boldsymbol{x}_b = \boldsymbol{P}_b\, \boldsymbol{H}^T\, (\boldsymbol{H}\, \boldsymbol{P}_b\, \boldsymbol{H}^T + \boldsymbol{R})^{-1} [\boldsymbol{y} - H(\boldsymbol{x}_b)]$$

Which is solved through a preconditioned, parallel, conjugate gradient descent algorithm

$$AC = \frac{\sum_{n=1}^{N} (f_n - C_n)(a_n - C_n)}{\left[\sum_{n=1}^{N} (f_n - C_n)^2 \sum_{n=1}^{N} (a_n - C_n)\right]^{1/2}}$$

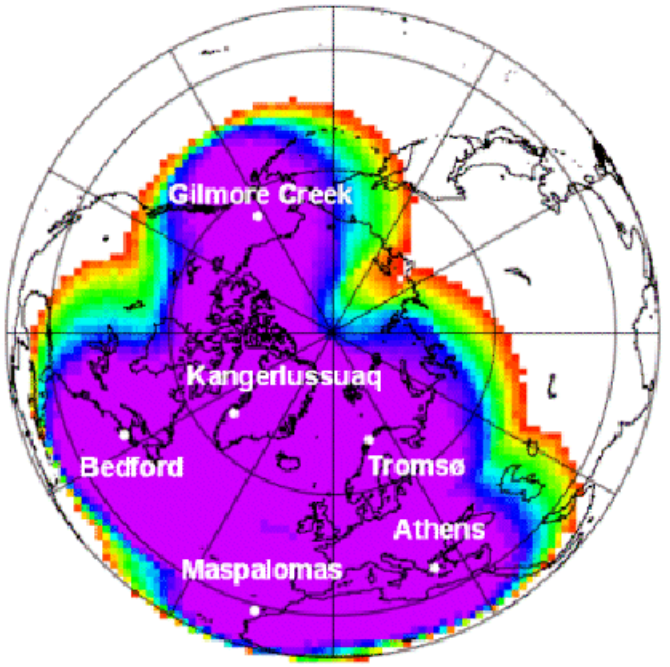


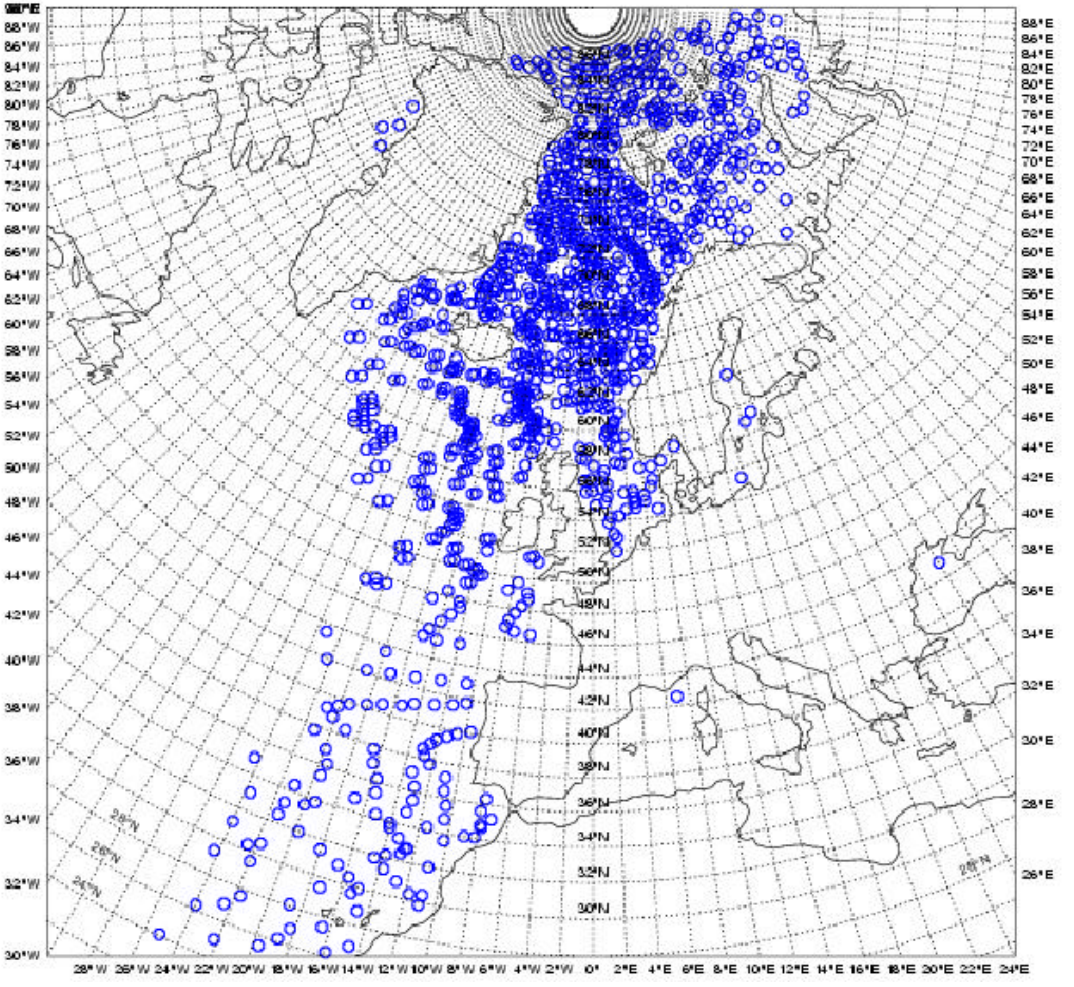



TEMPERATURE (°C) 00 UTC FC +48
Verification from 15/03 to 30/05/03
HRM_ECM: Blue HRM_3DVar: Red
PRESSURE (hPa)
100
200
300
400
500
600
700
800
900
1000
-3
-2
-1
0
1
2
3
MEAN ERROR
150
300
SAMPLE SIZE
PRESSURE (hPa)
0
1
2
3
RMSE

- So far only Obs linearly related to analysis variables have been assimilated
- ATOVS and (more so) next generation of hyperspectral sounders provide wealth of info on data sparse areas now available in near real time (Eumetsat ARS)
- 3D-PSAS algorithm can be extended to weakly nonlinear problems, but at high computational cost.
- Numerical cost of 3D-PSAS ~ proportional to (Num of Obs)^2

NOAA16-17 ATOVS 20030713 12Z





• 1DVar interactive retrieval of Temperature and Humidity profiles

• 1DVAR package of the NWP SAF: standalone 1DVar retrieval system for nadir-sounding passive instruments

• Solution of the same equation of the linear 3D-PSAS algorithm, plus outer loop (Newtonian iteration) to account for weak nonlinearities:

$$\boldsymbol{x}_{n+1} - \boldsymbol{x}_b = \boldsymbol{P}_b \boldsymbol{H}_n^T (\boldsymbol{H}_n \boldsymbol{P}_b \boldsymbol{H}_n^T + \boldsymbol{R})^{-1} [\boldsymbol{y} - H(x_n) - \boldsymbol{H}_n(\boldsymbol{x}_b - \boldsymbol{x}_n)]$$

•Observation operator *H* and its jacobian from RTTOV version 7

- Implementation of the 1DVAR package on HP alpha and PC32 linux platforms
- Interface to EARS program level1c ATOVS observations and HRM model fields
- Extrapolation of Temperatures above 10hPa (HRM model top) and ozone columns from climatological dataset
- Dinamically adjusted, air mass dependent (AMSUA ch 6-9 as air mass predictors) bias correction model based on Eyre (1992)
- Only clear fovs (based on simple check on HIRS 8 observed vs computed radiances) over the sea

Current status…

Tuning of bias correction software and collecting statistics of retrieved profiles vs colocated (≤200Km) radiosondes

To do list…

- Evaluation of impact on forecast fields
- Use of AVHRR imager information to improve cloud detection and for skin surface temperature ⇒ retrievals over land?
- Filtering of apriori information from the retrieved profiles through averaging kernel techniques (Rodgers, 2000)
- Interface to LM model fields

Thank you for your attention

Questions?