The assimilation of SEVIRI radiances into the COSMO Model

F. Di Giuseppe[1] B. Krzeminski[3] R. Hess[2] C. Schraff[2]

[1]Servizio Idrometeorologico -Bologna,IT

[2]Deutscher Wetterdienst, Offenbach, Germany

[3]Instytut Meteorologii i Gospodarki Wodnej, Warsaw, Poland

SRNWP, Dobrovnik 2007

INPACT OF SATELLITE DATA IN NWP

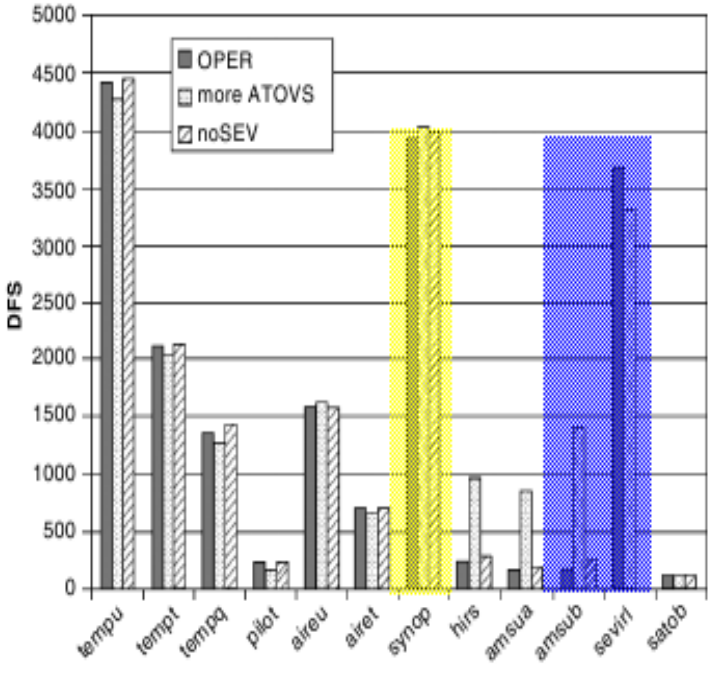
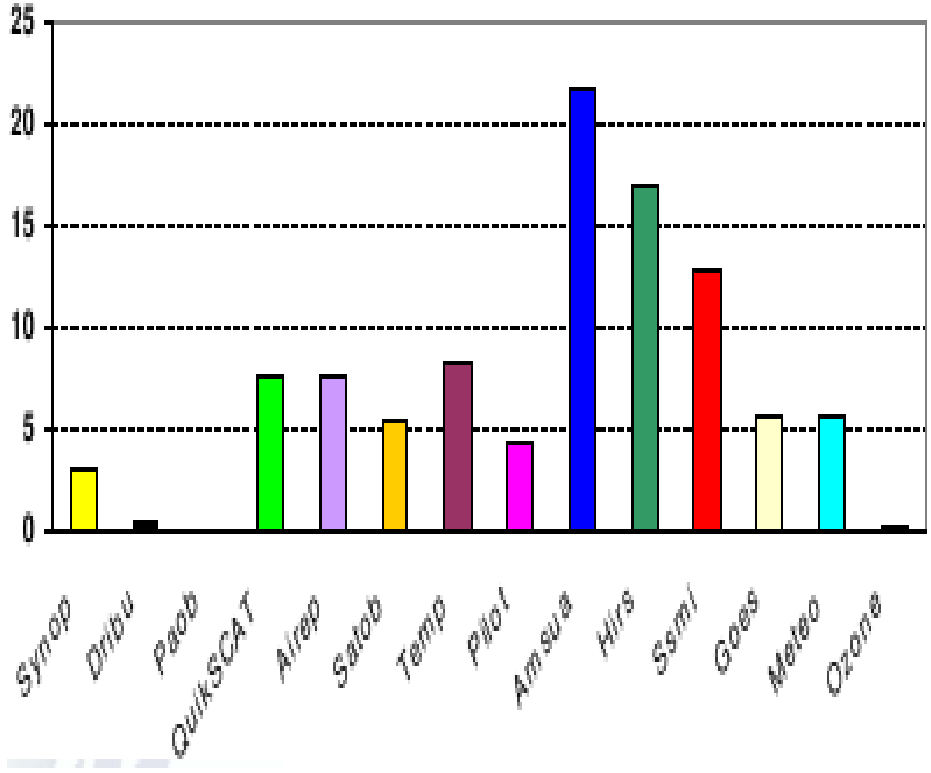


Figure 6. DFS values per observation type for *OPER*, *moreATOVS* and *noSEV*.

Montmerle et al., QJRMS, 2007

- SEVIRI has the same impect as synop
- SEVIRI has more inpact than Amsu-a,b



Global influence (%) of satellite and in situ observations on background analysis when assimilated by the ECMWF 4-D Var system. Synop: surface obs; Dribu: drifting buoys; Paob: Southern Hemispheric bogus obs.; QuikSCAT: scatterometer sea-surface winds; Airep: com. aircraft reports; Satob: satellite Geo./MODIS winds; Temp: radiosondes, land/sea; Pilot: pilot balloons; Amsua: AMSU temp./r.h. soundings; Hirs: hyper-spectral satellite soundings; Ssmi: microwave soundings/surface.wind; Goes and Meteo: IR soundings; Ozone: radiative characteristics

courtesyofCarlaCardinali, ECMWF

Outline

System Set-up

Ingredients for SEVIRI assimilation

- Channel Selection
- Bias Correction
- Cloud Detection
- Error specification

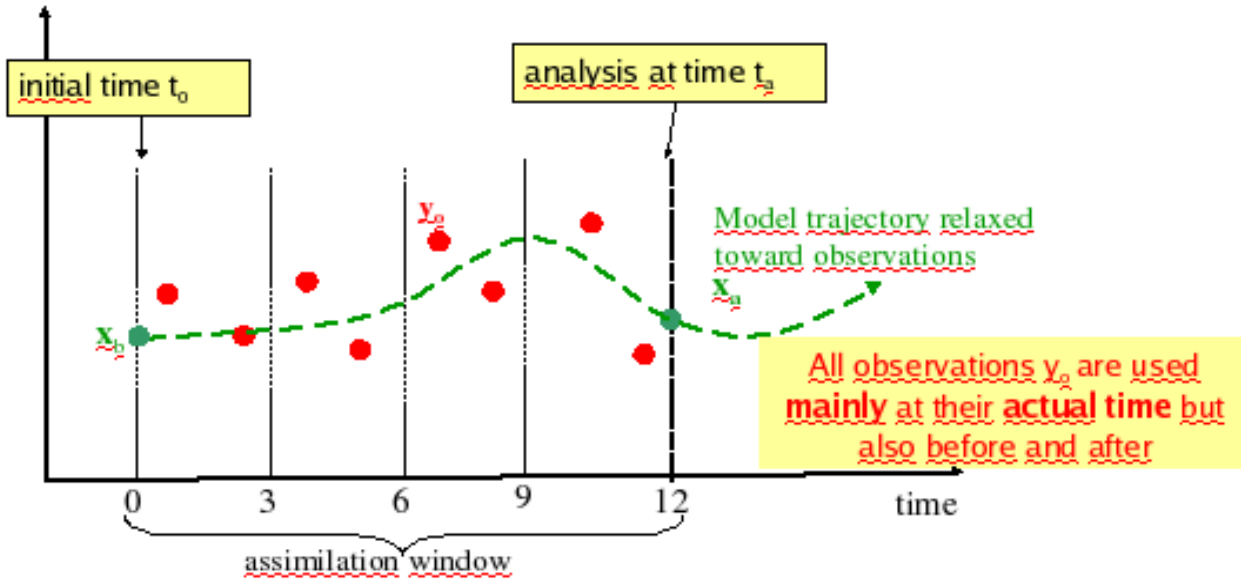
Some experiments

- 1DVAR performance
- Two case studies

Conclusions

Nudging

Nudging approach (Newtonian Relaxation Scheme): The model trajectory is nudged in every time step towards the observations with special terms additional to the model dynamics (nudging towards observations during forecast). The sizes of the terms depend on the distance to the observations and on the time difference between observation and current model time.



Nudging + 1DVAR

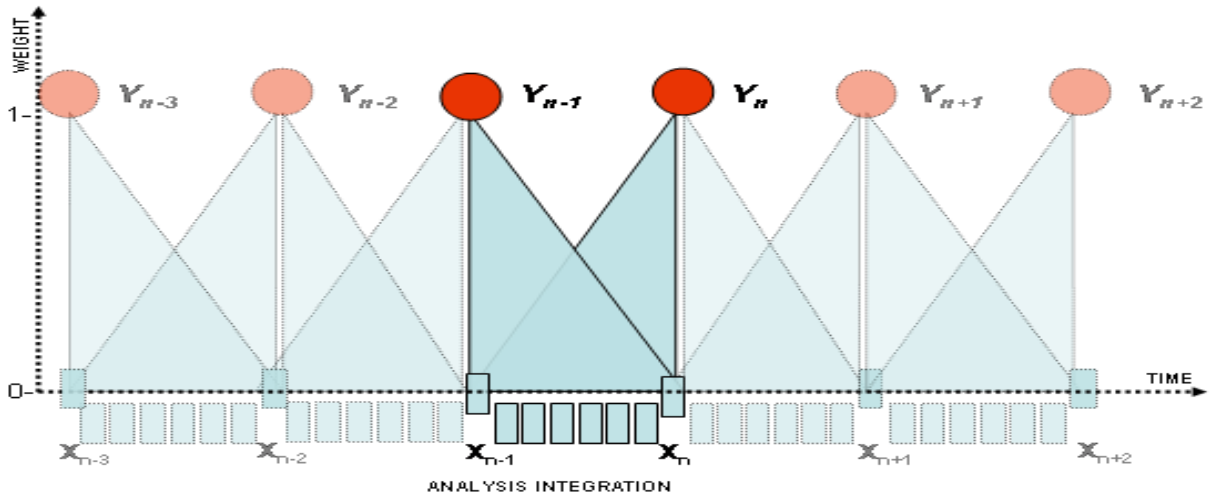
Conventional observations:

Direct nudging of model variable toward observation

Non-Conventional observations:

1D-Var preliminary retrievals of temperature and humidity have to be computed. For MSG observations use first guess available 15' before observation time. Repeat retrieval at nominal obs time.

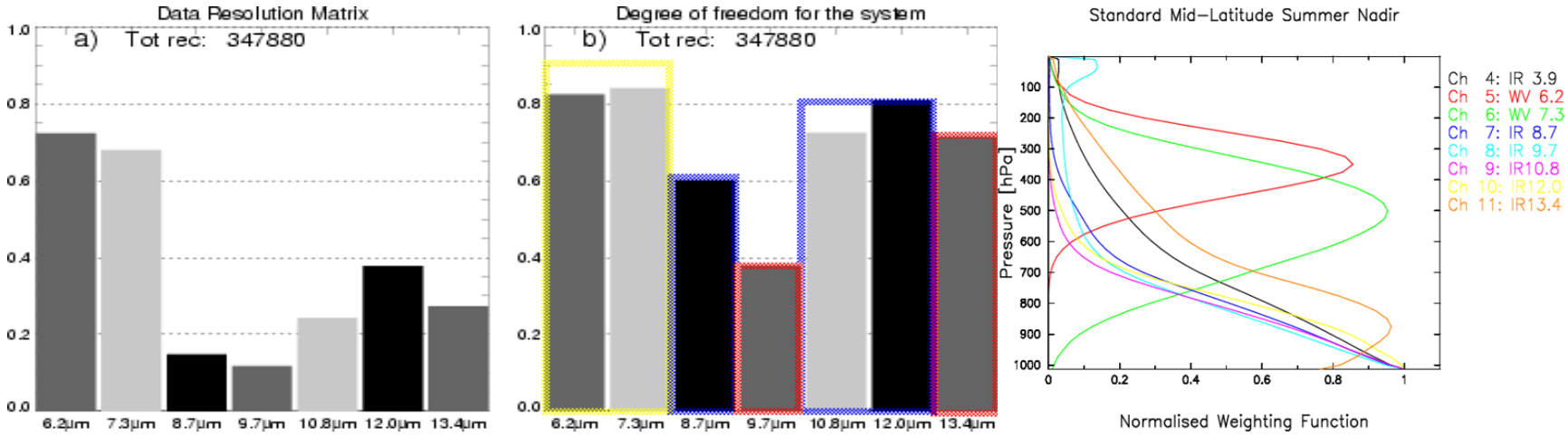
Attention: first guess and observation become correlated!



Degree of freedom for signals (DFS)

DFS: measures how much a channel in *isolation* is able to reduce the model error defined by **B** in the observational space $DFS = \frac{\mathbf{h}^T\mathbf{B}\mathbf{h}}{1+\mathbf{h}^T\mathbf{B}\mathbf{h}}$

DRM: The DRM uses **A** to estimate which is the most useful channel in the analysis between *all* the ones used.

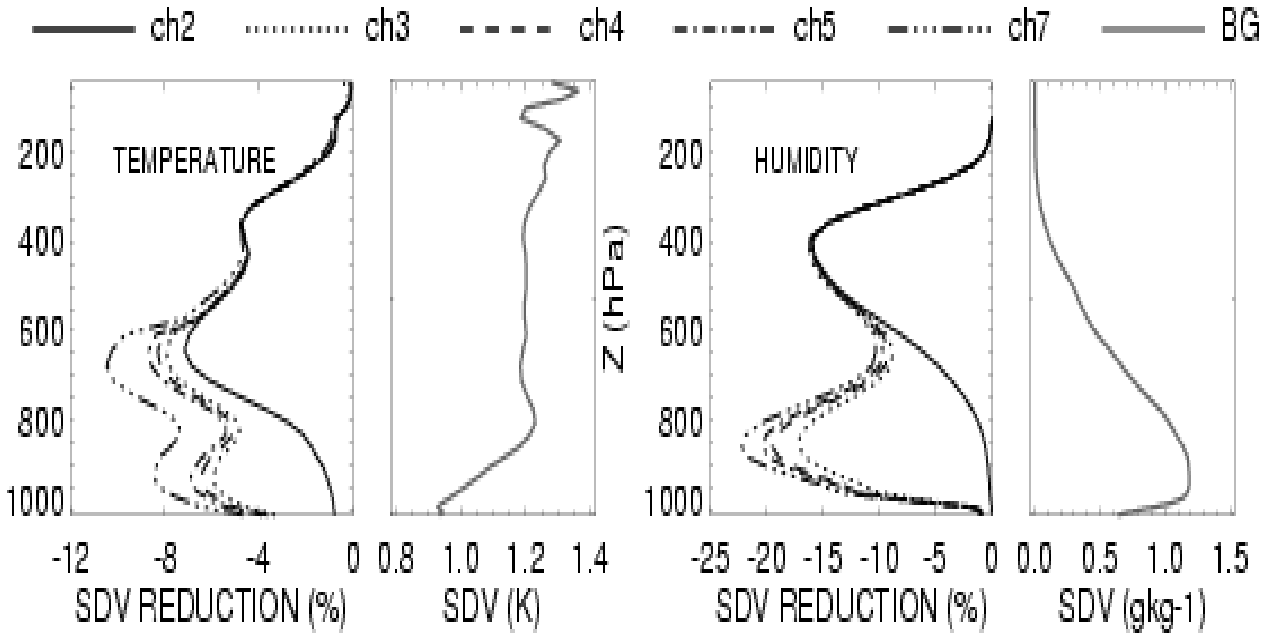


- The O_3 gas monitoring channels at $9.7\mu m$ blacklisted because large inaccuracies in the radiative transfer simulation are expected
- The $13.4\mu m$ blacklisted for persistent bias correction problems.

Analysis Errors

Sets of channels under test to define the best channel combination to be used in the 1DVAR retrieval.

Set Id	*Channel Frequency* (μm)						
ch2	6.2	7.3					
ch3	6.2	7.3			10.8		
ch4	6.2	7.3			10.8	12.0	
ch5	6.2	7.3	8.7		10.8	12.0	
ch7	6.2	7.3	8.7	9.7	10.8	12.0	13.4



Expected error reduction in background errors (temperature and humidity profiles). Analysis error is the square root of the diagonal elements of $\mathbf{A} = (\mathbf{B}^{-1} + \mathbf{H}^T\mathbf{R}^{-1}\mathbf{H})^{-1}$.

Analysis data period

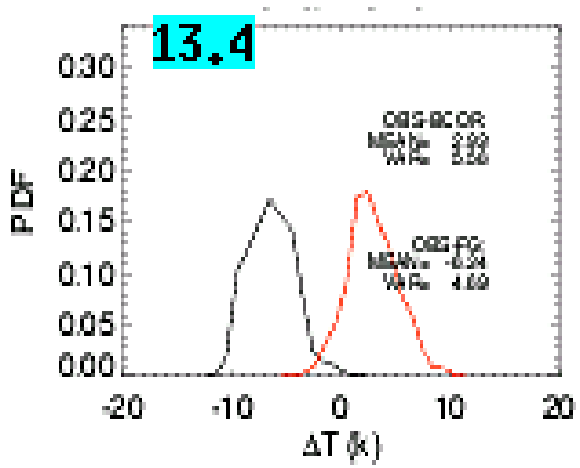
1-20 September 2006

Bias Correction

Air-Mass dependent bias:

Multi-linear regression coefficients based on 4 predictors:

1. 900hPa-700hPa thickeness
2. 200hPa-50hPa thickeness
3. integrated total water mixing ratio
4. T_{2m}



Coefficients dependent on weather regimes - updated Seasonally

Scan-Angle dependent bias:

Negligible for geostationary satellite

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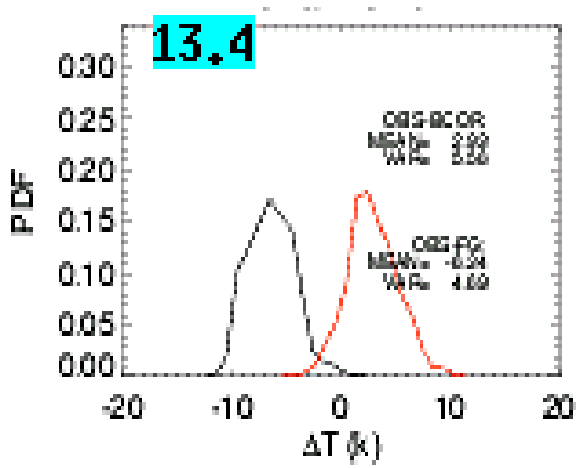

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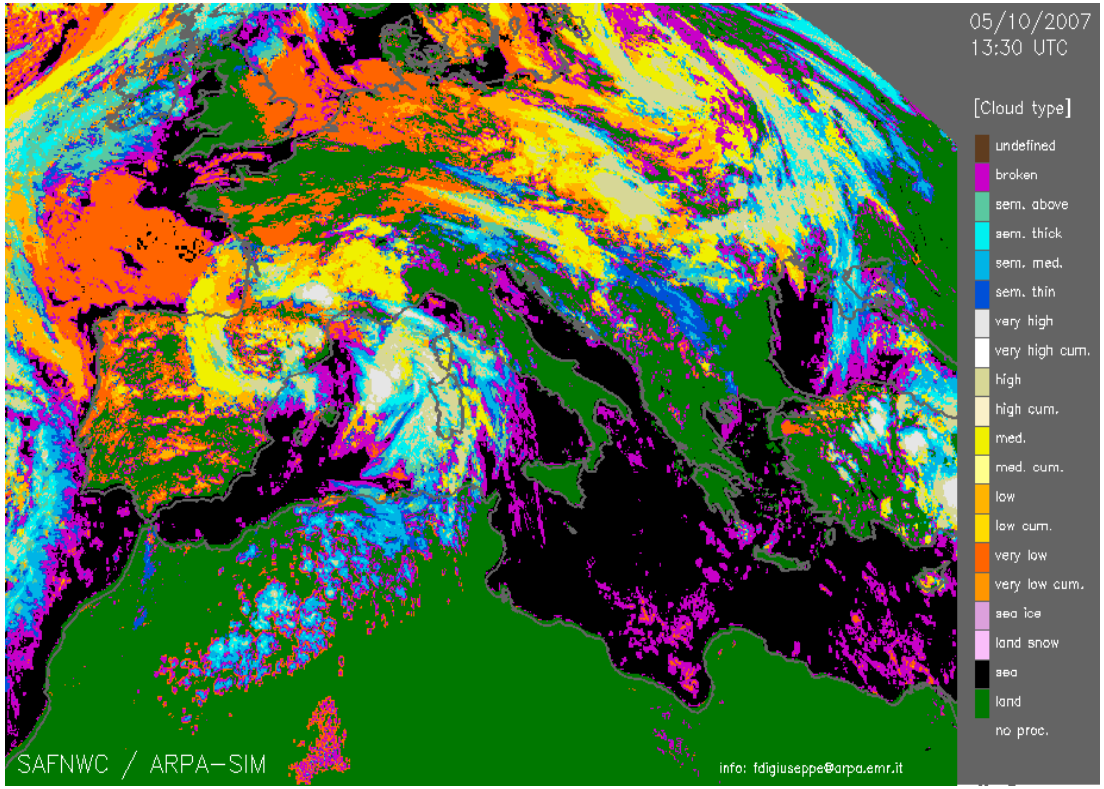
Cloud detection

Only cloud-free observations over sea points are used.



Cloud detection scheme based on a multi-spectral threshold technique
SW from SAFNWC (Satellite Application Facility to support NoWCasting and very short range forecast)

Extra quality checks: Pixels discarded:

- Pixels whose background profiles possess saturated mixing ratio values
- $BT^{obs}_{10.8\mu m} - BT^{bg}_{10.8\mu m} < 3K$

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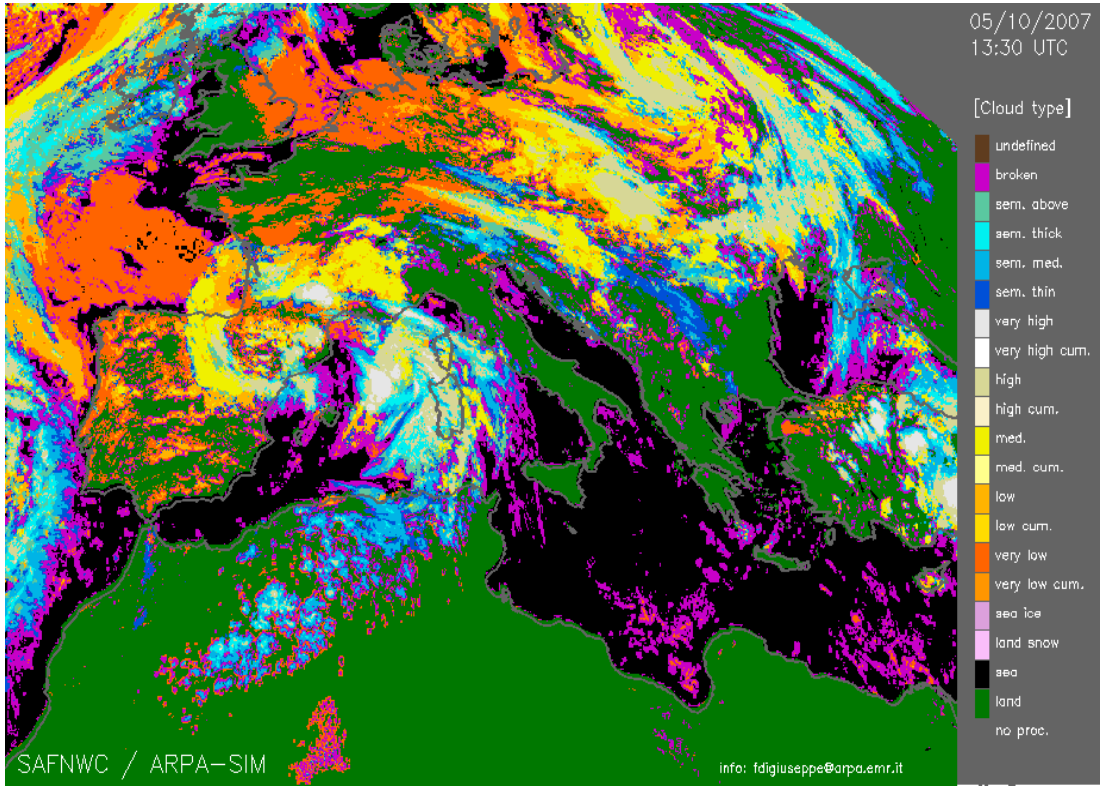

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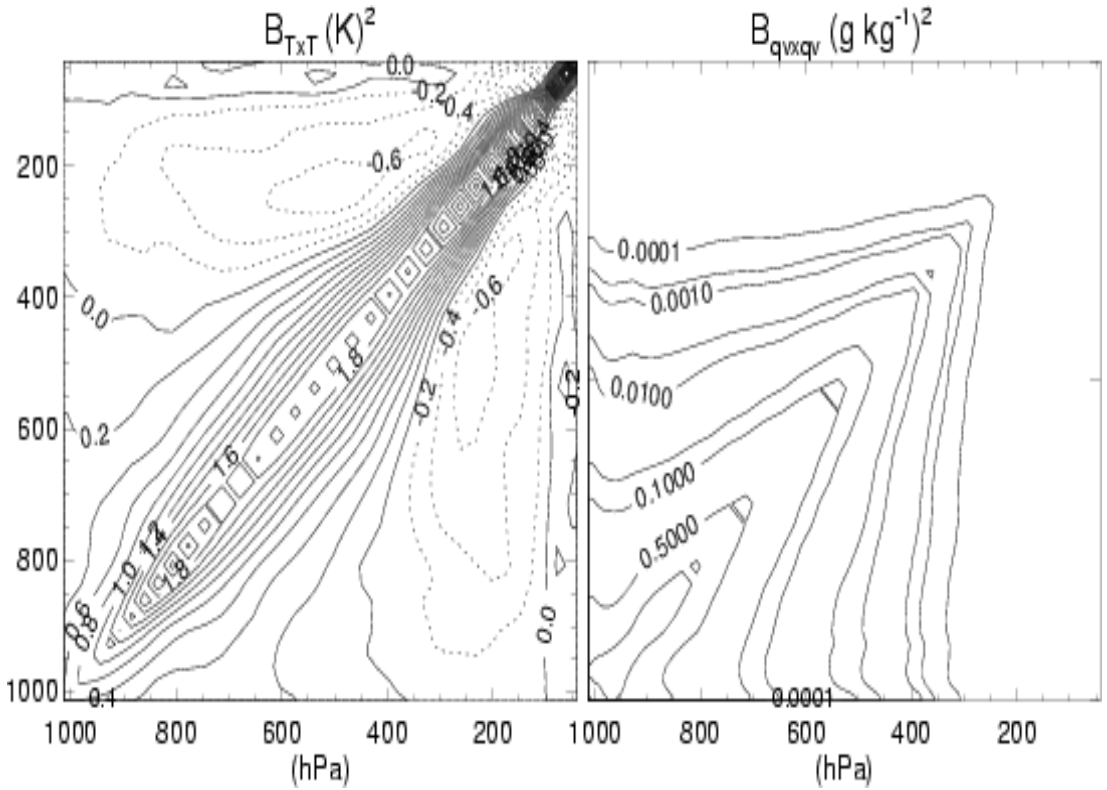
B calculation

B: NMC method forecast comparisons at +12h and +36h averaged over four months worth of data

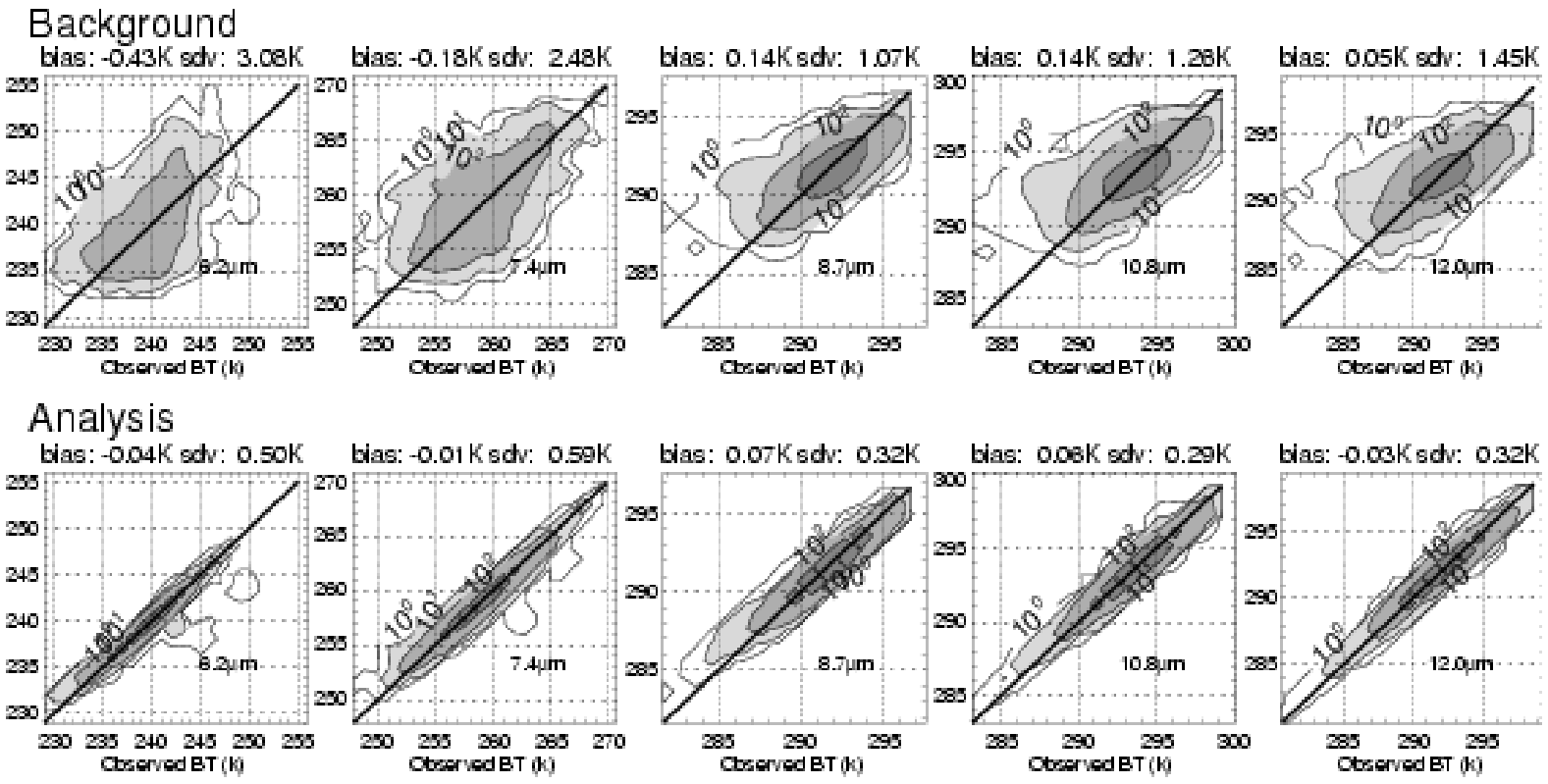
Analysis data period

(1 June -30 September 2006)



B dependent on weather regimes - Now it is updated seasonally but ideally should be Flow-dependednt

Departure Statistics

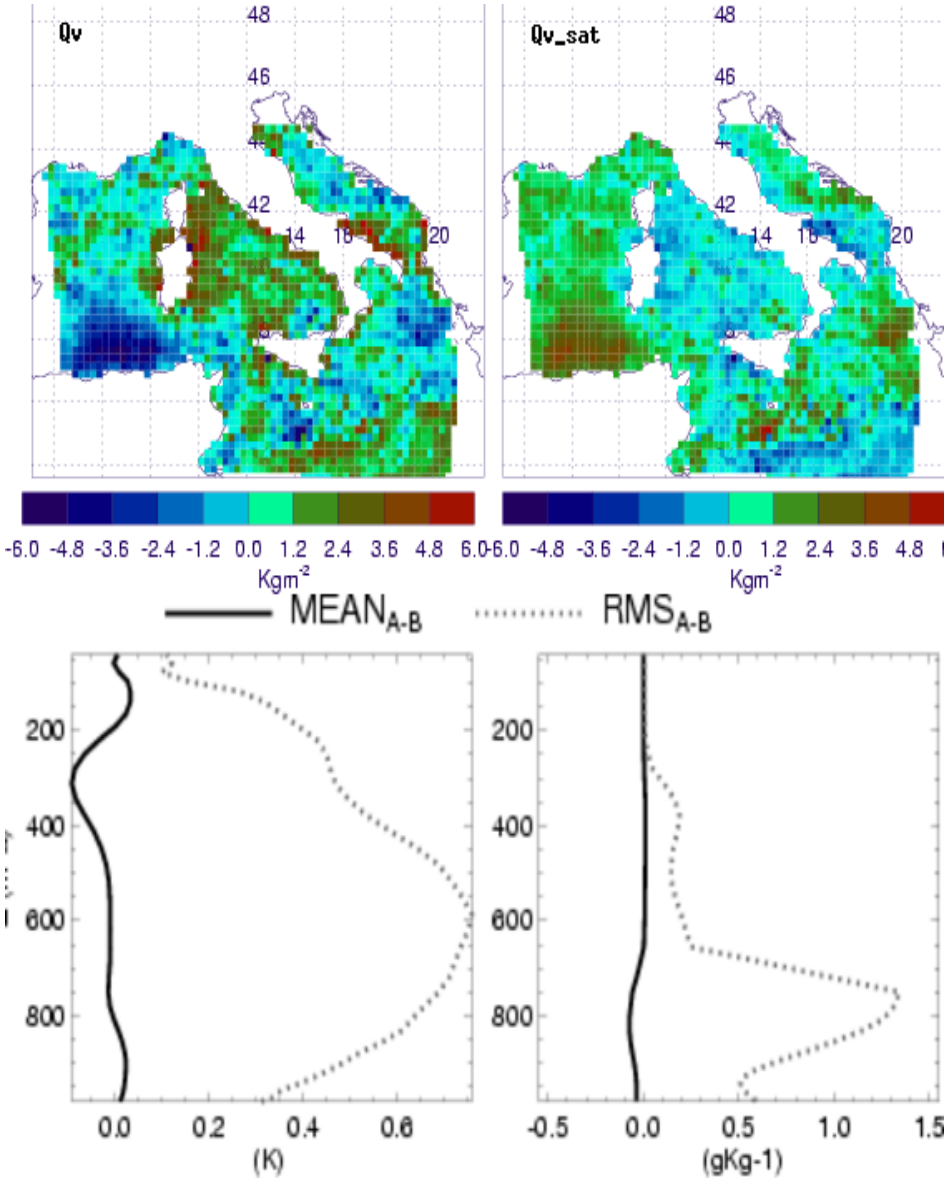


Two dimensional Probability Density Function (PDF) of background departures (upper panels) and analysis departures (lower panels) for an example data set for the 5 channels selected for the 1DVAR.

Analysis data period

(18 of September 2006)

Analysis Increments

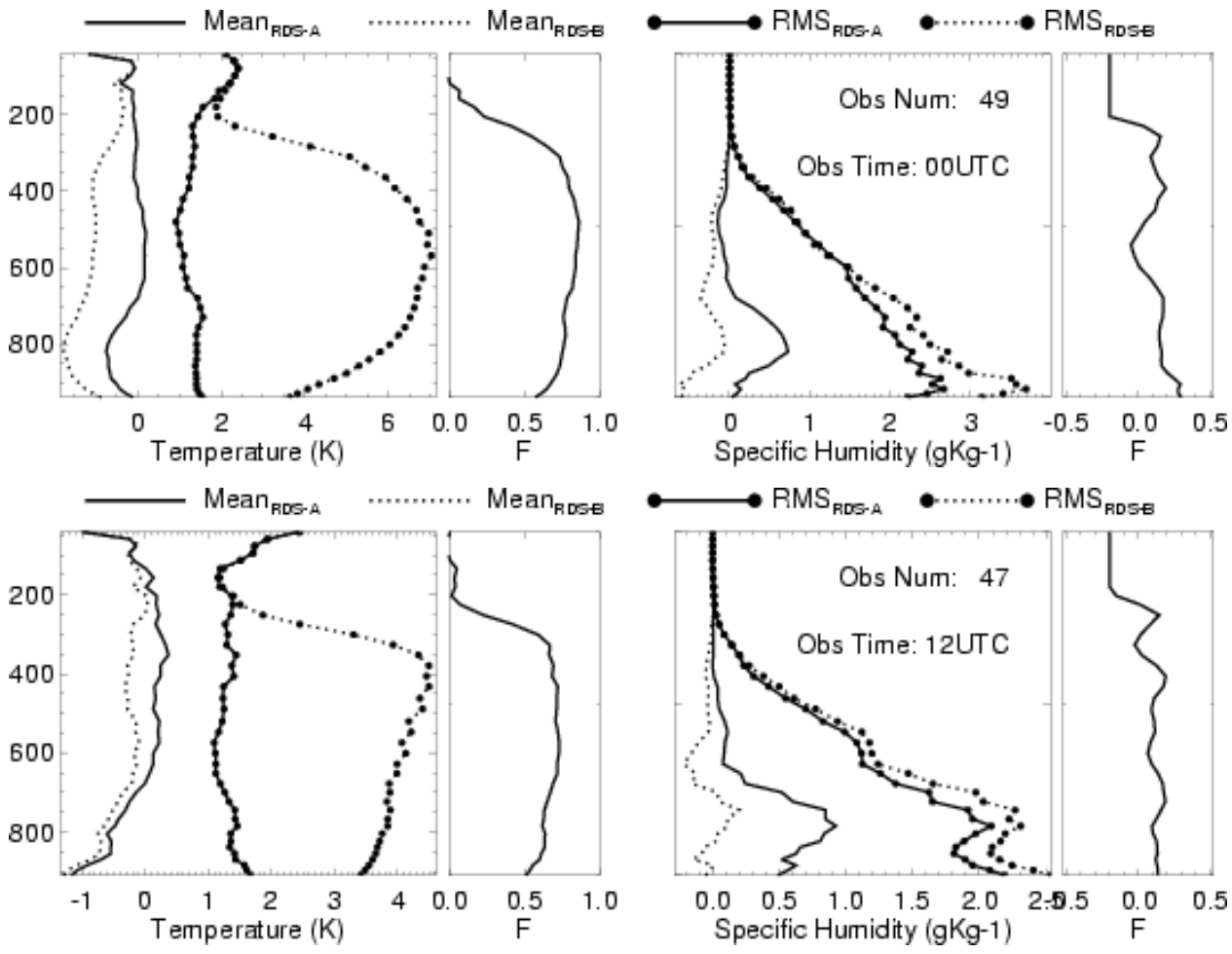


Positive (Negative) differences between observed and background BTs are transformed in increases (decreases) of temperature profiles and decreases (increases) of water vapour. Mean increments are correctely close to zero the final analysis will be in balance minimising problems of model spin-up.

Analysis data period

(18 of September 2006)

Radiosound Comparison



$$F=(RMS_{RDS-B} - RMS_{RDS-A})/RMS_{RDS-B}$$

Analysis data period

(1- 20 September 2006)

Case Study

1. *False allarm case:* 8th of July 2004
   False alarm occurred in North North-Eastern Italy, Trentino Alto Adige and Friuli-Venezia-Giulia. A risk scenario was diagnosed by LM outputs. In particular a large atmpspheric instability and convection events were forecasted. In reality the event was of minor intensity and drier winds with associated scattered thunderstorms were recorded only on the early morning of the 9th July.
2. *Heavy precipitation case:* 9th April 2005
   Missed forecast of heavy precipitation in the liguria region. Typically produced by south-westerly up-stream flow due to orographic forcing

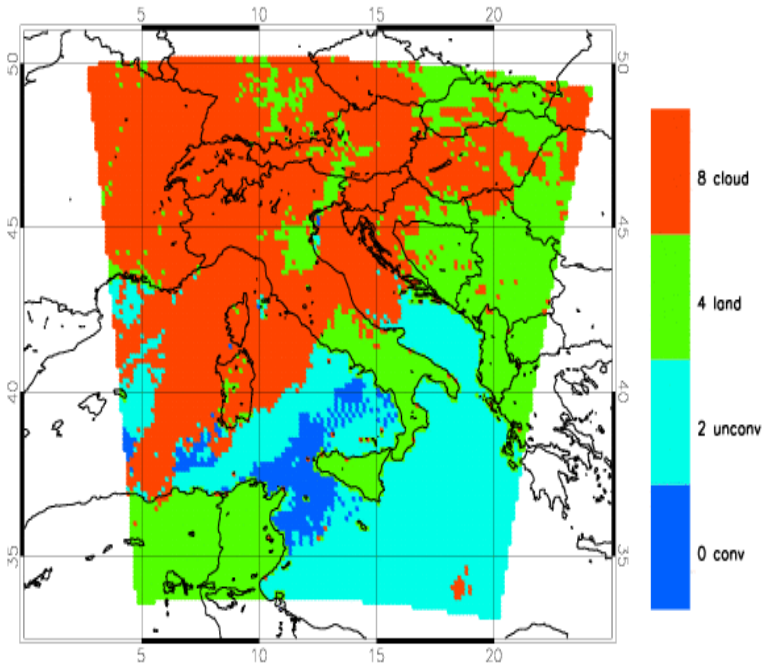
Flag Processing

MSG1 field : flg_prc

number of points : 13380

number of good points (i.e. where flg_prc has value 0): 466

date : 20040708 11:30 UTC



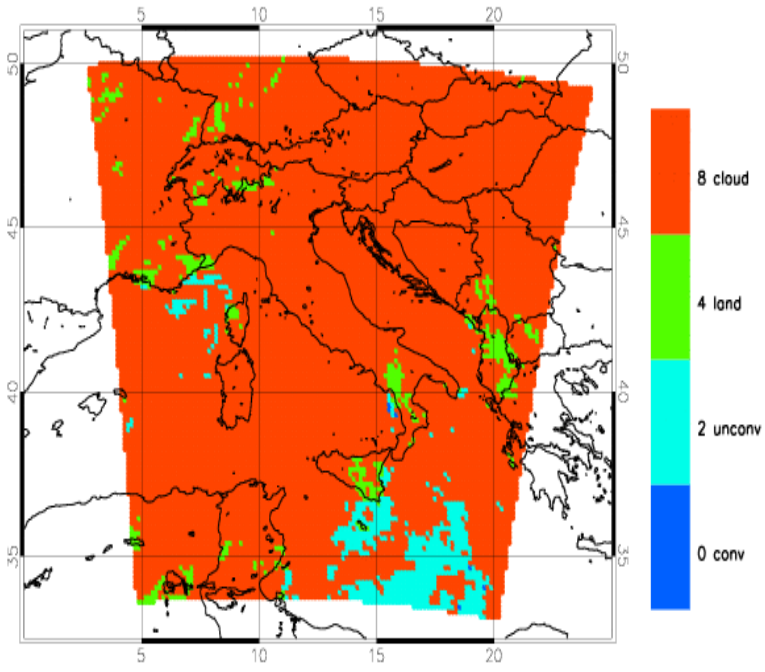
ASSIMILATION CYCLE : +11 hrs and 30 mins

MSG1 field : flg_prc

number of points : 13380

number of good points (i.e. where flg_prc has value 0): 6

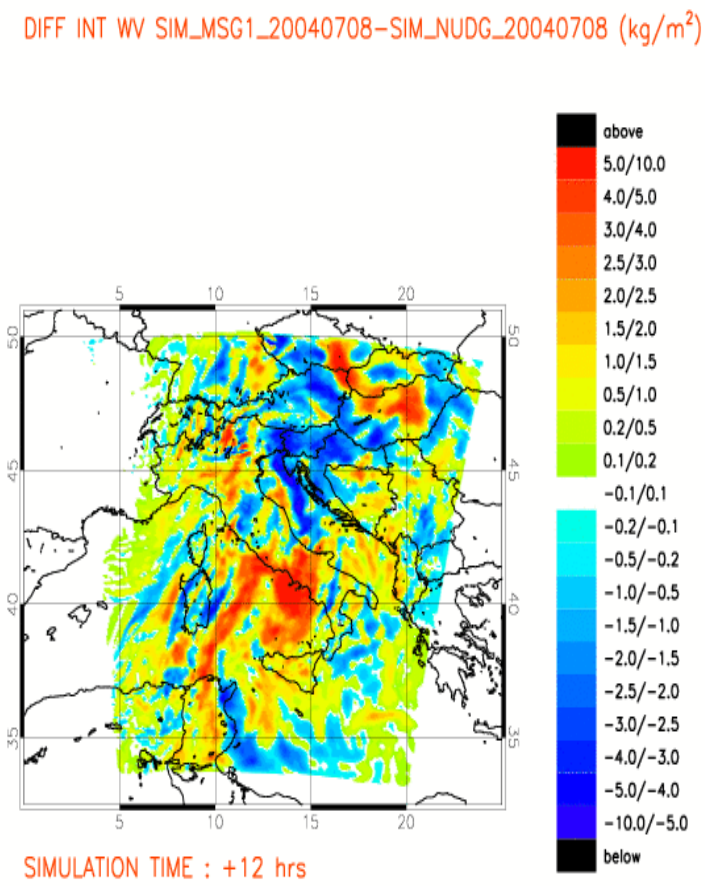
date : 20050409 20:45 UTC

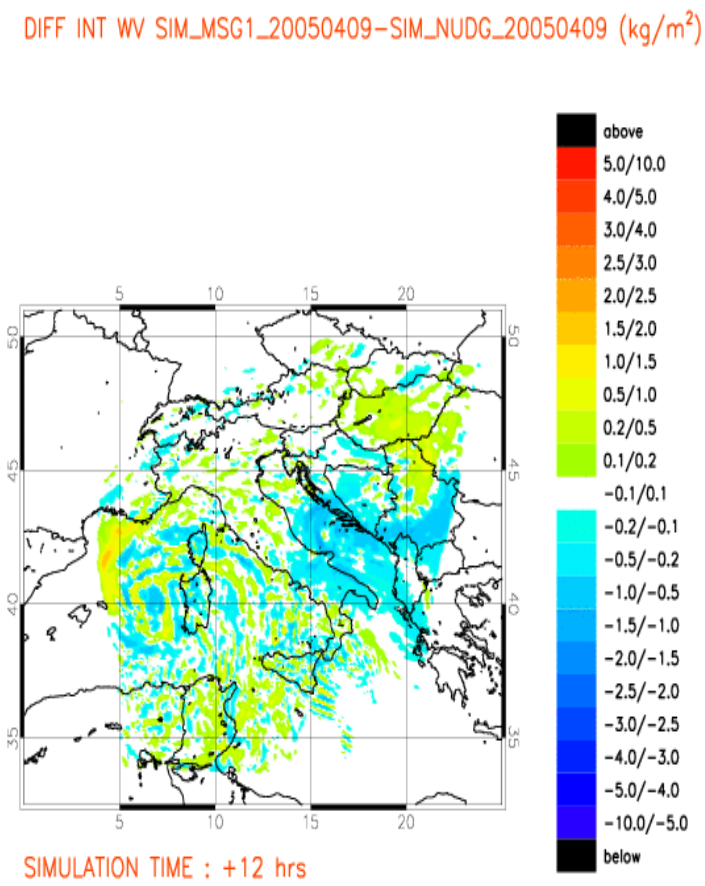


ASSIMILATION CYCLE : +8 hrs and 45 mins

Forecast increments

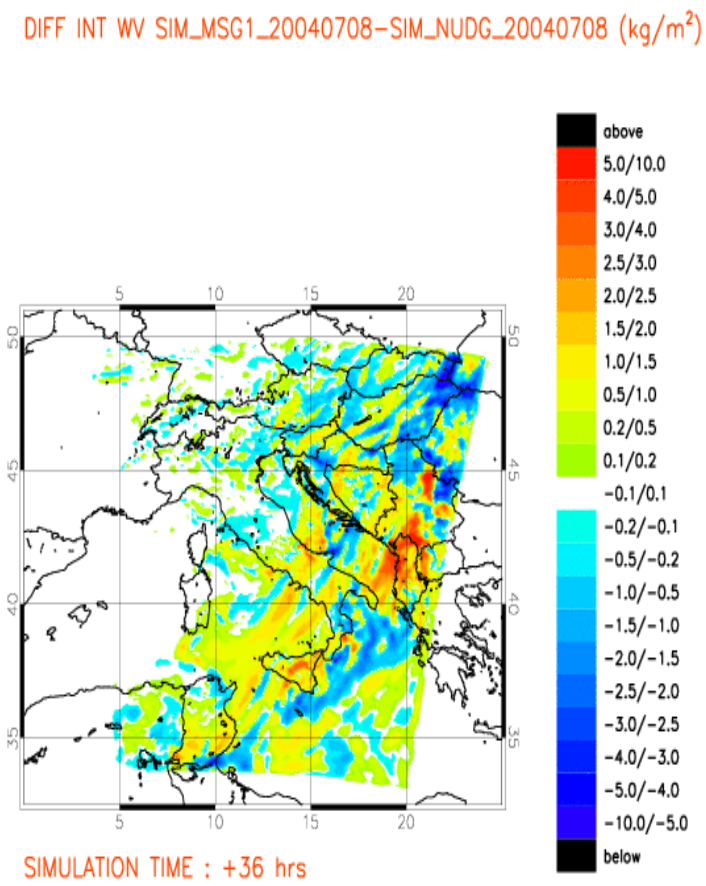
EXP-CTRL in column integrated water vapour at +12 hr FORECAST

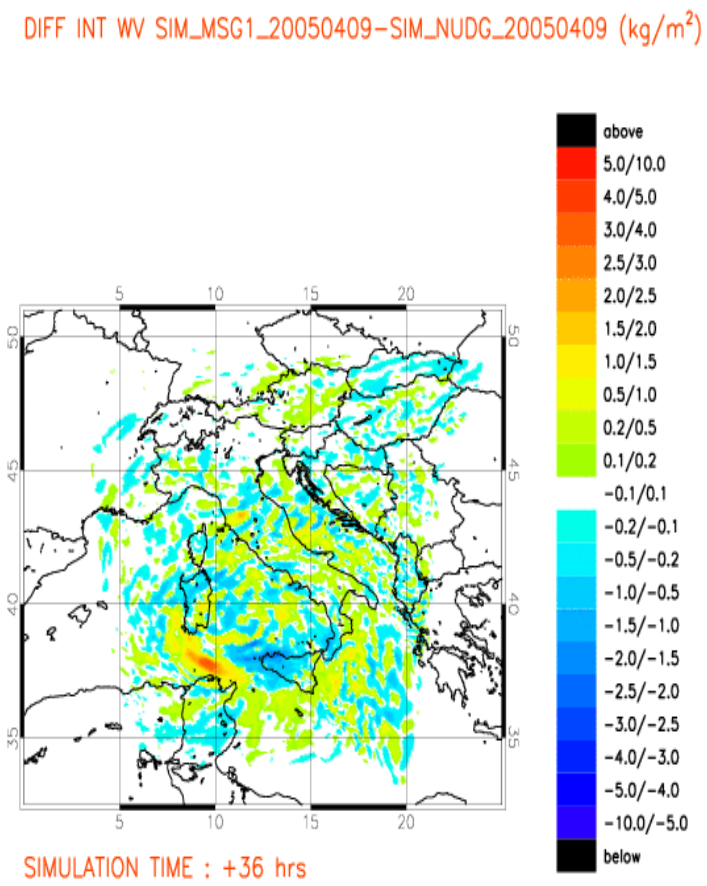




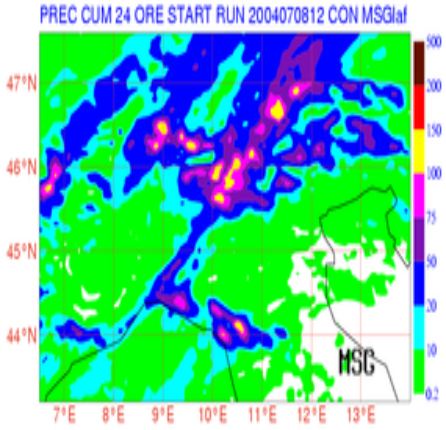
Forecast increments

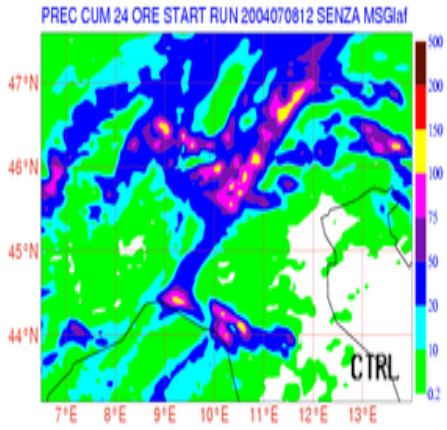
EXP-CTRL in column integrated water vapour at +36 hr FORECAST

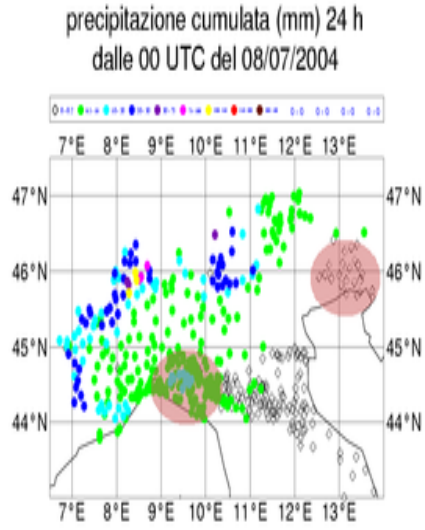


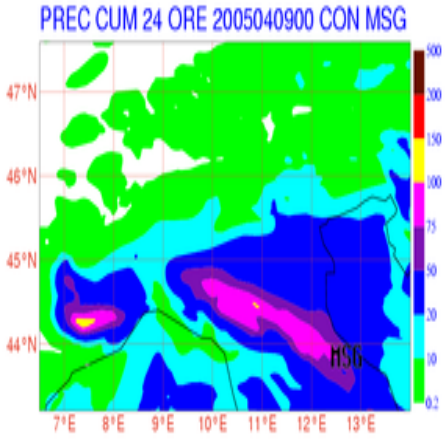


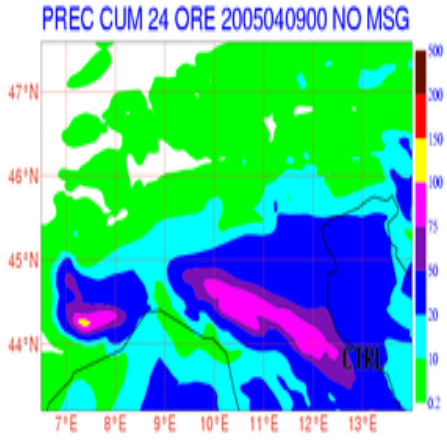
Precipitation forecast

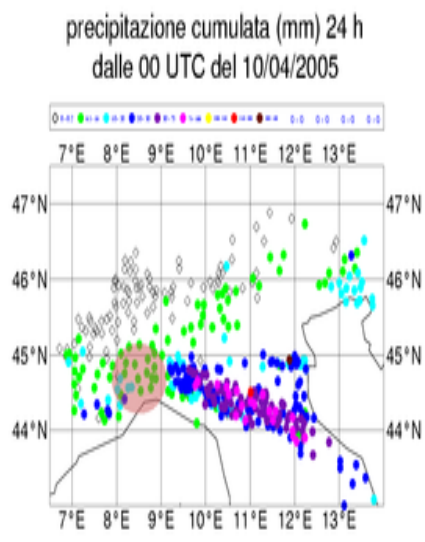












Conclusion

- *On the system set-up :*
  1. Large inpact provided by the WV channels
  2. IR window channels can be used (all of them for robusteness of the system) if good knowledge of ground temperarure.
  3. Preliminary test have shown positive inpact in precipitation forecast
- *In general...* Expecially in regional model needs for assimilation over LAND and in CLOUDY conditions