10th International SRNWP-Workshop on Nonhydrostatic Modelling

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Testing of COSMO-1 over Italy

Maria Paola Manzi[1], P. Mercogliano[1,2], M. Milelli[3]

[1] Impact on soil and Coast Division, EuroMediterranean Centre for Climate Change (CMCC),I-81043 Capua (CE), Italy

[2] Meteo System & Instrumentation Laboratory, Italian Aerospace Research Center (CIRA), I- 81043 Capua (CE), Italy

[3] ARPA Piemonte, I-10135 Torino, Italy

Outlook

- Aim of the work
- Description of the test cases
- Features of the simulations
- Performances evaluation using :
  - satellite data
  - radiosounding data
- Conclusions

Aim of the work

In the framework of the MeteoSwiss project COSMO-NExT, a development of the COSMO configuration at 1.1 km, deterministic, is under development (named COSMO-1).

COSMO-1 is a new set-up of the COSMO model developed in order to:

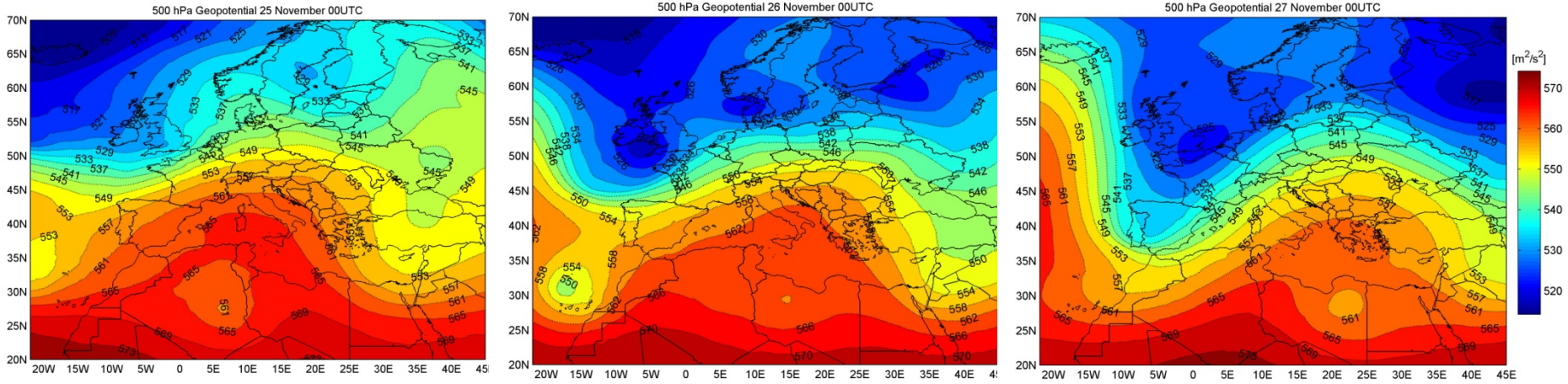
- increase the resolution in space and time
- update the present frequency of the operative COSMO configurations

COSMO-1 is also in testing phase at CIRA, in collaboration with MeteoSwiss and Arpa Piemonte.

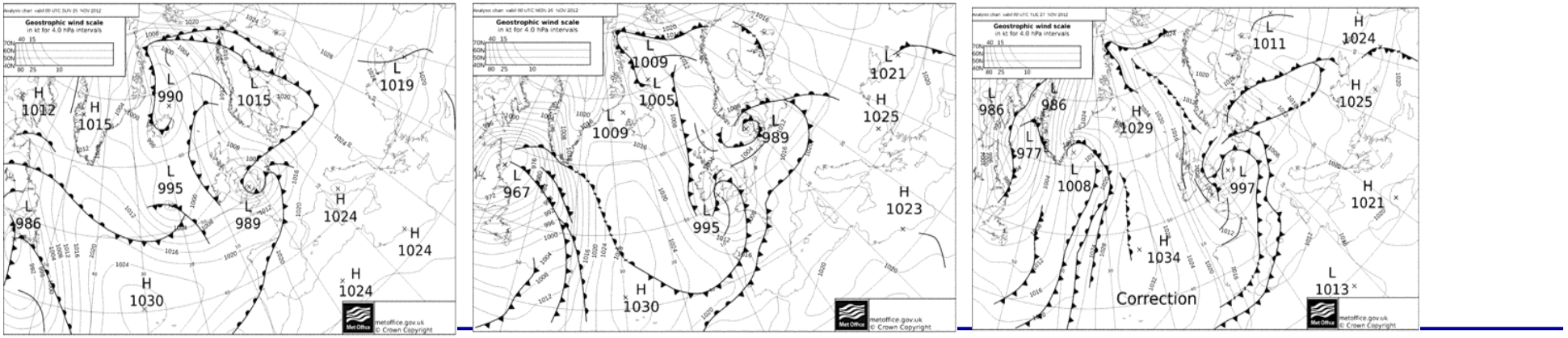
The first step of this testing phase concerned the installation and running of the code (COSMO version 4.26) on the CMCC supercomputer (NEC SX 8R) installed at CIRA.

The second step concerned the running of simulation of the COSMO-1 over the Italian domain for a 5 days period and the evaluation of the performances with different type of observations.

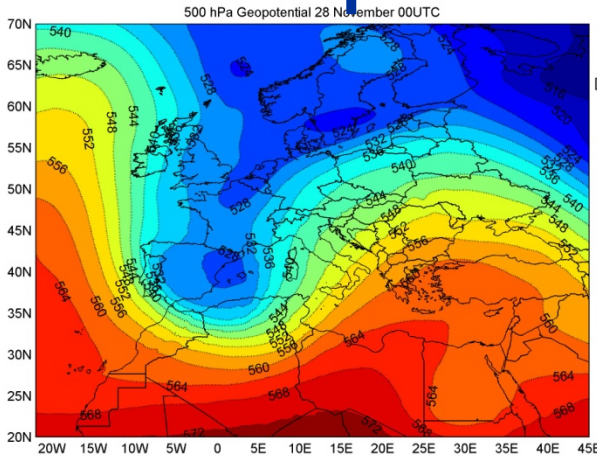
Description of the test cases (1)

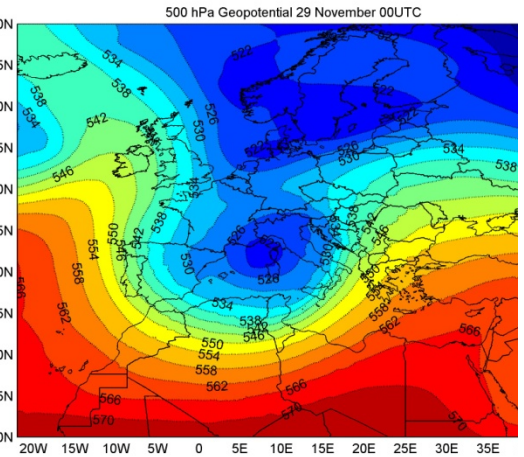


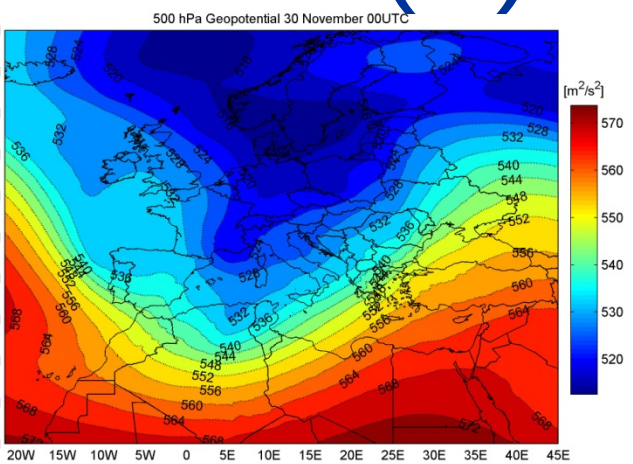
From the 25th to the 27th of November 2012, the Mediterranean area was interested by a high pressure ridge. During the 26th of November there was a gradual collapse of the Mediterranean anticyclonic area pushed towards Eastern Europe by an Atlantic perturbation. The precipitation over the southern Italy started the 27th of November



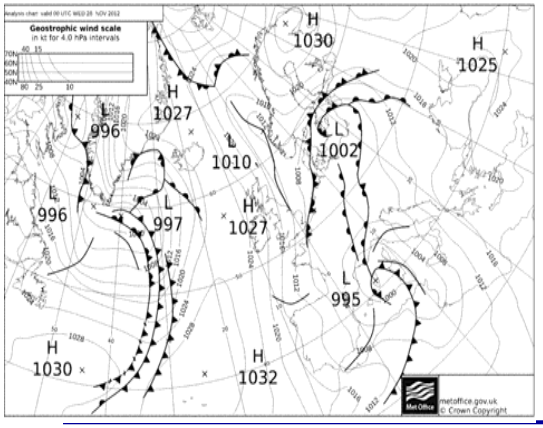
Description of the test cases (2)

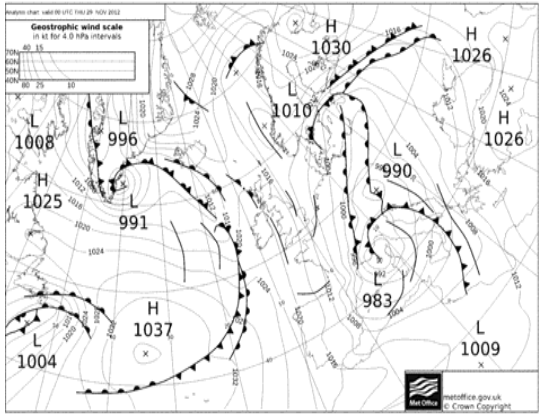


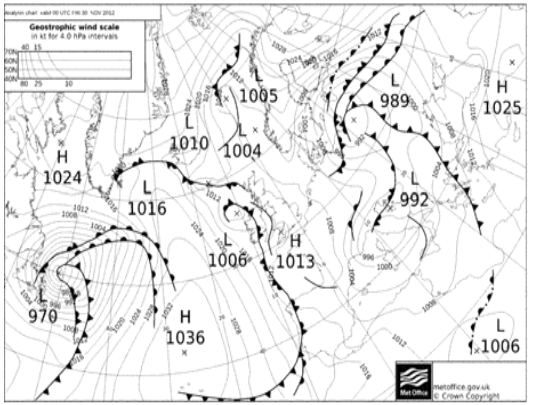




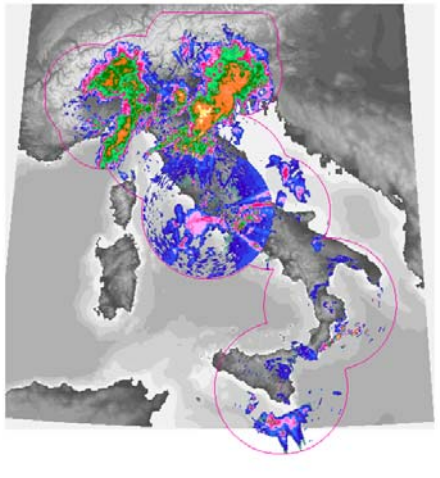
From the afternoon of the 27th to the 30th of November 2012 Italy was interested by an intense southern moist flow due to a low pressure system centred over the western Mediterranean Sea. This synoptic pattern caused an intense thunderstorm activity with widespread precipitations over the peninsula.

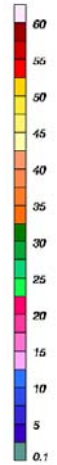




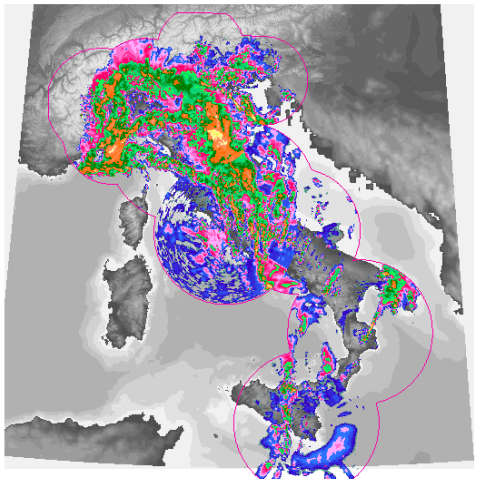


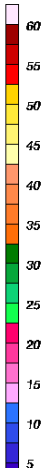
Description of the test cases (3)





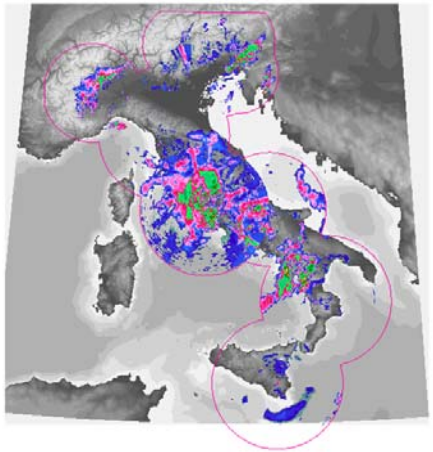
27/11/2012
19 UTC

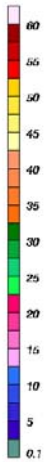




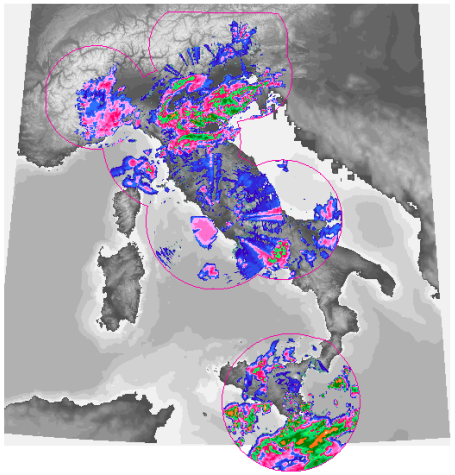
28/11/2012
12 UTC

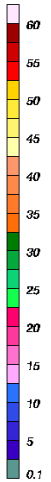
Maps of reflectivity @ 2000 m of altitude (CAPPI) from national radar mosaic (provided by Italian Civil Protection).





29/11/2012
09:30 UTC

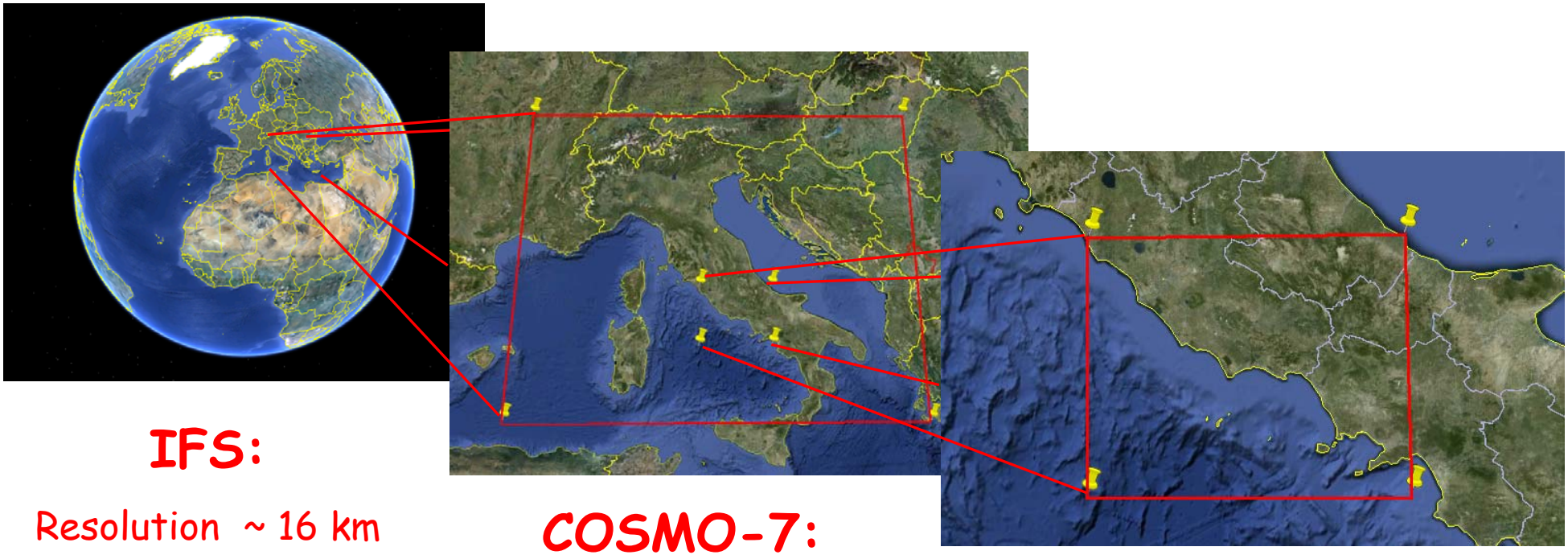




30/11/2012
10:00 UTC

Pictures from : http://www.arpa.emr.it/cms3/documenti/_cerca_doc/meteo/radar/rapporti/rapporto_meteo_20121127-1202.pdf

Features of simulations



IFS:

Resolution ~ 16 km

COSMO-7:

Resolution ~ 7 km

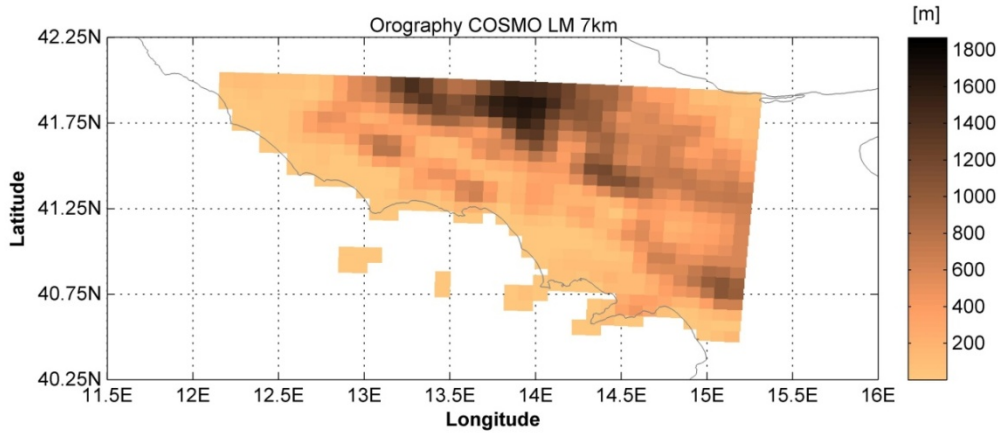
COSMO-1:

Resolution ~ 1 km

Features of simulations: COSMO 7 km

Initial and boundary condition from ECMWF (about 16 km)

Grid characteristic	ie_tot=240, je_tot=160, ke_tot=40
Time step	dt = 40.0
Interval between two consecutive boundary data	hincbound=3.0
Soil processes	lsoil=.true., lmulti_layer=.true.,
Subgrid-scale convection	lconv=.true. , itype conv=0, (Tiedtke scheme)
Switch for nudging	lnudge =.TRUE.,
Format of output files	yform_write='ncdf',



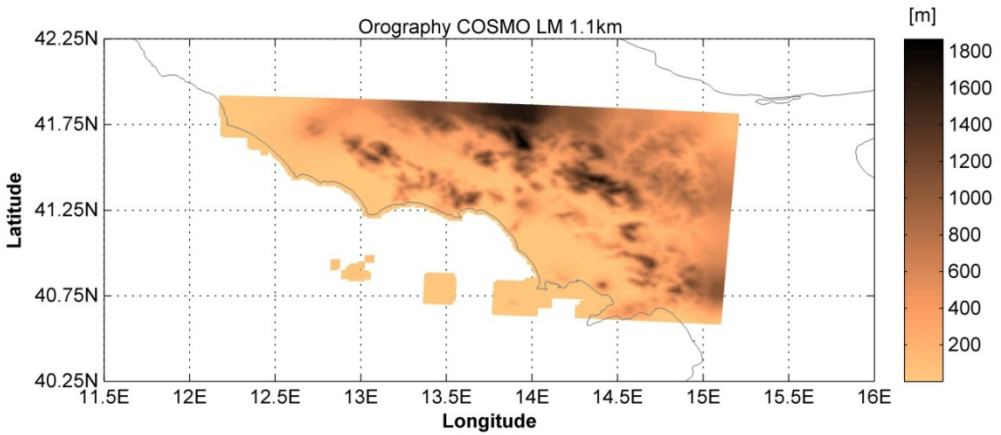
Parameters for the satellite images

```
&SATCTL
 itype_rttov=9,
 num_sensors=1,
 sat_input_01='MSG',    2,'SEVIRI',8, .TRUE., .TRUE., .TRUE., .TRUE.,
 nchan_input_01=1,2,3,4,5,6,7,8,
 lcon_clw=.TRUE,
```

Features of simulations: COSMO 1.1 km

Initial and boundary condition from COSMO-7 (about 7 km)

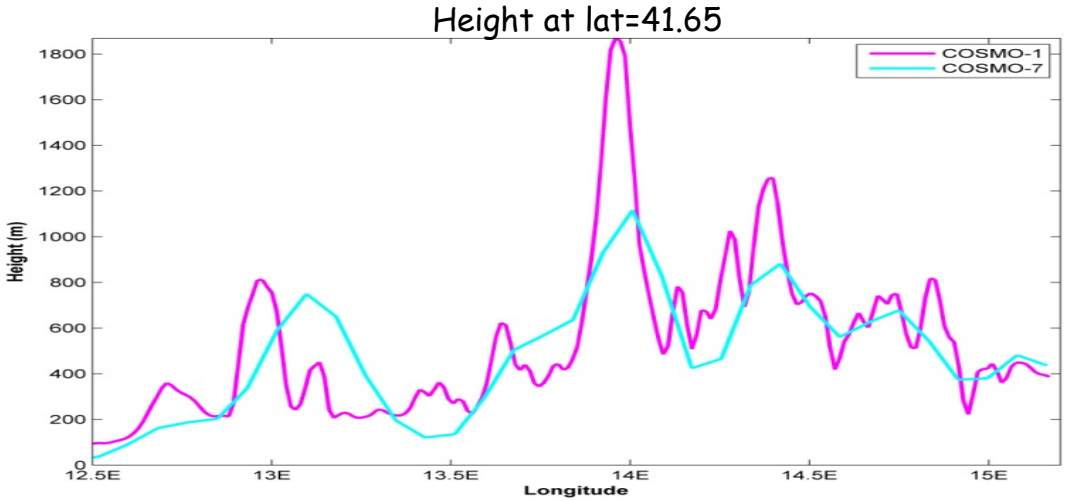
Grid characteristic	ie_tot=225, je_tot=120, ke_tot=60
Time step	dt = 5.0
Interval between two consecutive boundary data	hincbound=1.0
Soil processes	lsoil=.true., lmulti_layer=.true.,
Subgrid-scale convection	lconv=.true. , itype conv=3, (Shallow convection based on Tiedtke scheme)
Switch for nudging	lnudge =.false.,
Format of output files	yform_write='ncdf',

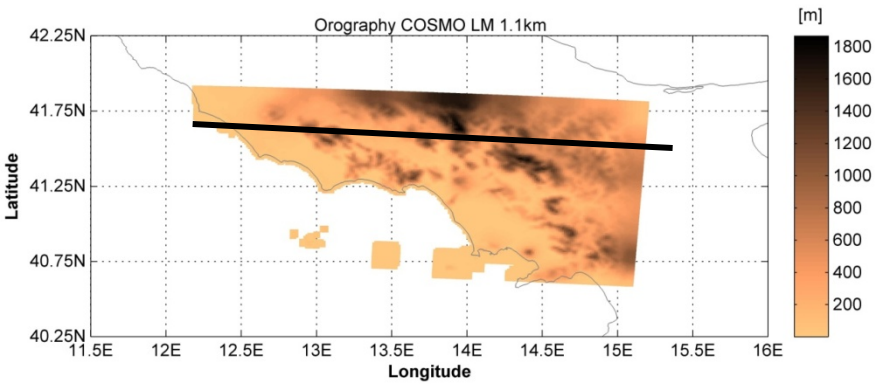


Parameters for the satellite images

```
&SATCTL
 itype_rttov=9,
 num_sensors=1,
 sat_input_01='MSG',     2,'SEVIRI',8, .TRUE., .TRUE., .TRUE., .TRUE.,
 nchan_input_01=1,2,3,4,5,6,7,8,
 lcon_clw=.TRUE,
```

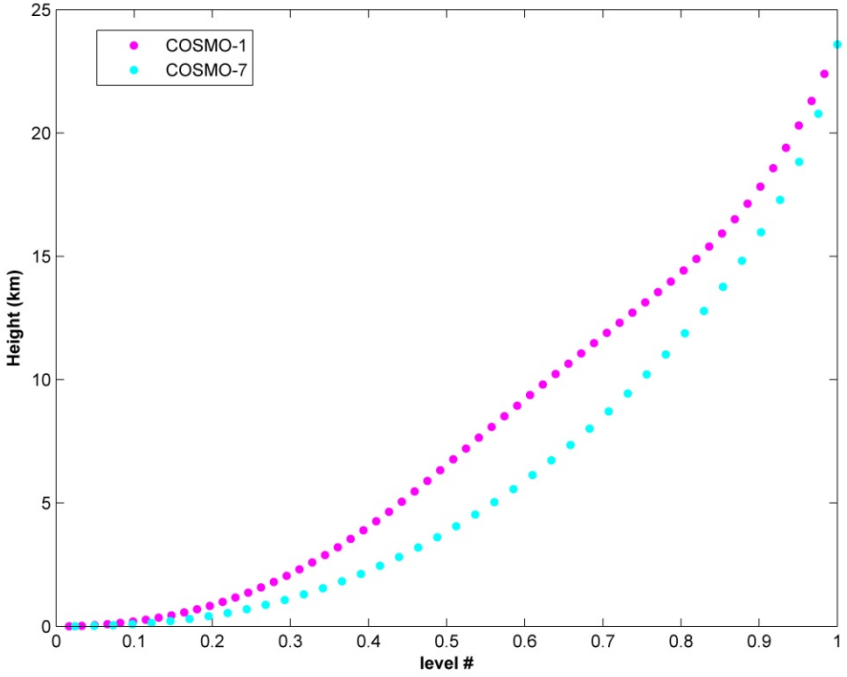
Features of simulations: Orography





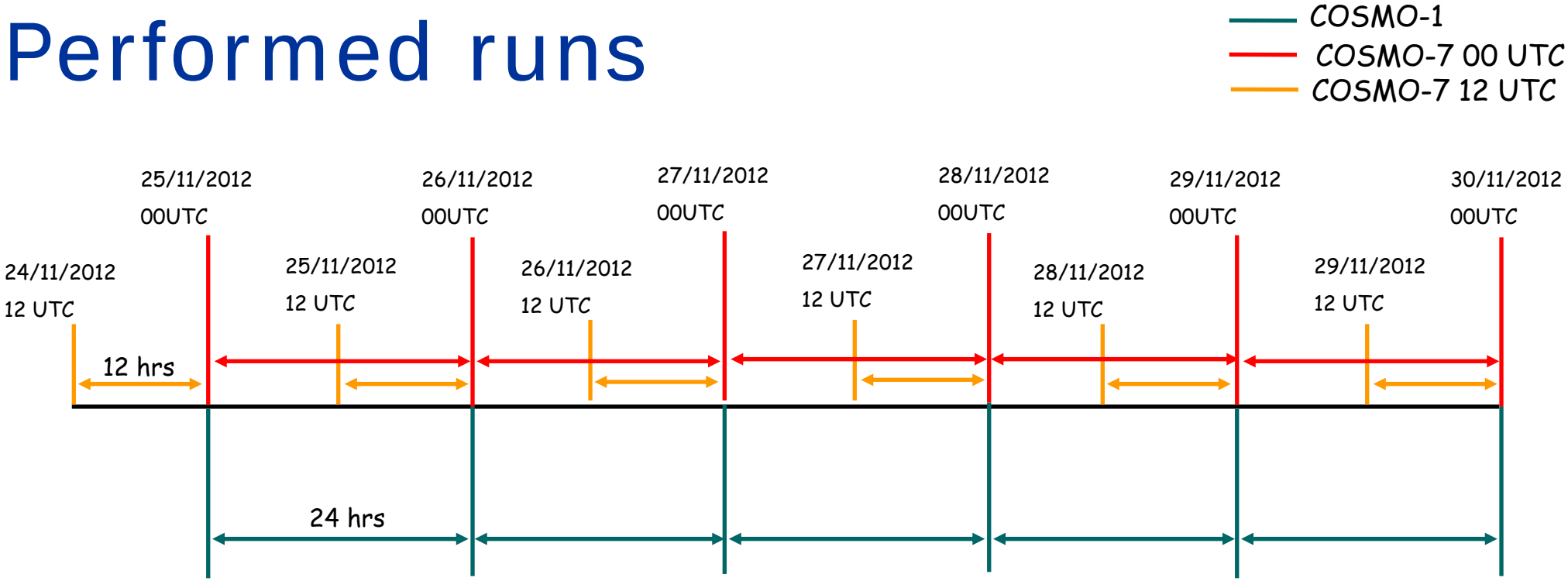
Treatment of orography and filtering (int2lm 7km – 1km)	
Type of low pass filter and number of sequential applications of filter	lfilter_oro=.true., ilow_pass_oro=4, numfilt_oro=1,
Parameter for filtering and order of the orography filtering	eps_filter=0.1, norder_filter=5,
Extra smoothing of steep orography	ilow_pass_xso=6, (type of low pass filter) lxso_first=.FALSE., (extra smoothing of orography first) numfilt_xso=6, (number of sequential applications of filter) rxso_mask=300.0, (mask for xso)

Features of simulations: Vertical grid



No further investigation has been carried out in this work about the number of the vertical levels to be used in COSMO-1, since previous studies (done by Milelli) show that the model behavior substantially doesn't change, changing the number of vertical levels (60 vs. 100).

Performed runs

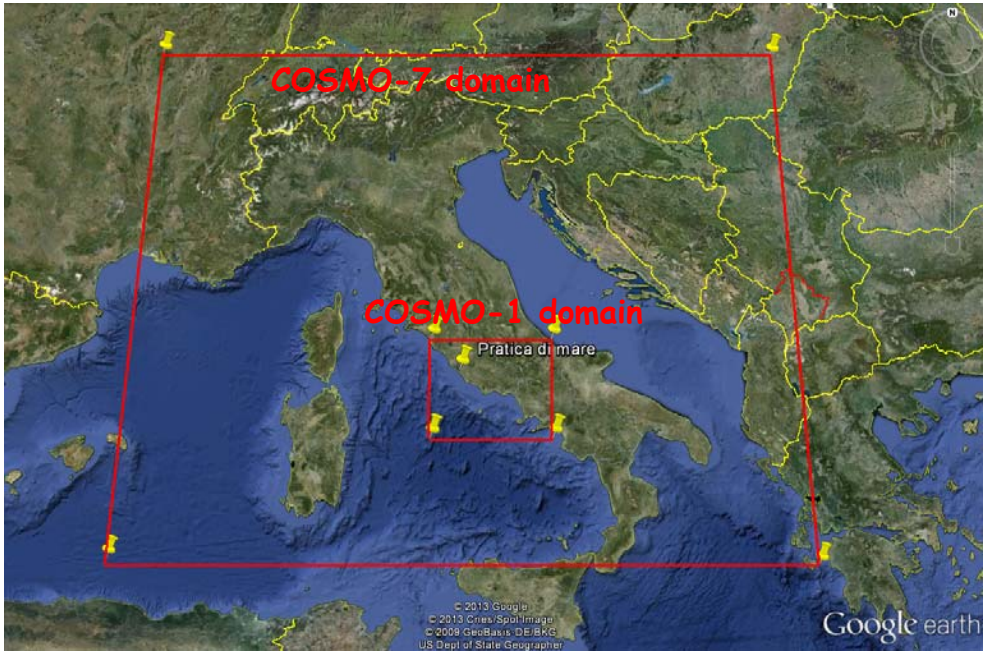


- COSMO 7 12 UTC: COSMO 7km – initial time 12 UTC_ Forecast range 12 hours. Nudging is performed for each hour.
- COSMO 7 00 UTC: COSMO 7km – initial time 00 UTC_ Forecast range 24 hours. Nudging is performed for each hour.
- COSMO 1 is initialized by COSMO-7 00UTC with a forecast range of 24 hours. No nundging. Upgrade of b.c. each 1 hour.

Computational costs:

Resolution	ie x je	dt	Processors	Elapsed Time
7 km	240 x 160	40	2	50 min
1.1 km	225 x 120	5	1	530 min

- Elapsed Time refers to 10 hours forecast
- Even if the domain of COSMO-1 simulations is reduced, so that to have almost the same number of grid points, the elapsed time is ten times that of COSMO-7. It is due to the lower number of processors but especially it's due to the lower dt needed for COSMO-1 runs.

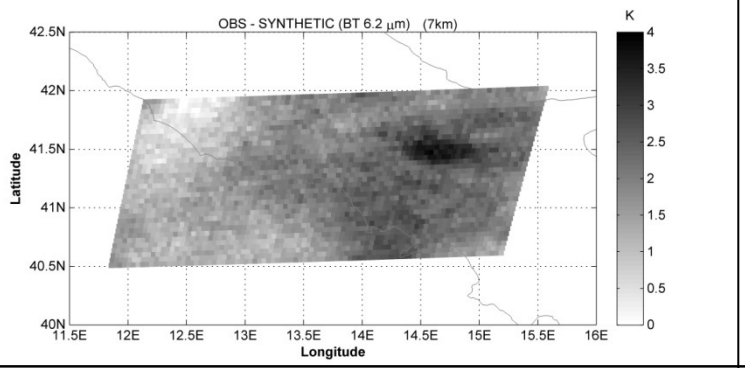


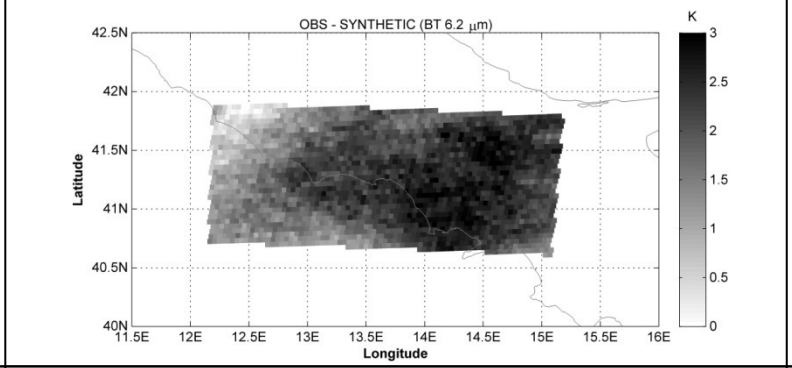
Performances evaluation with satellite (1)

Simulation of 26/11/2012 forecast hour 04UTC

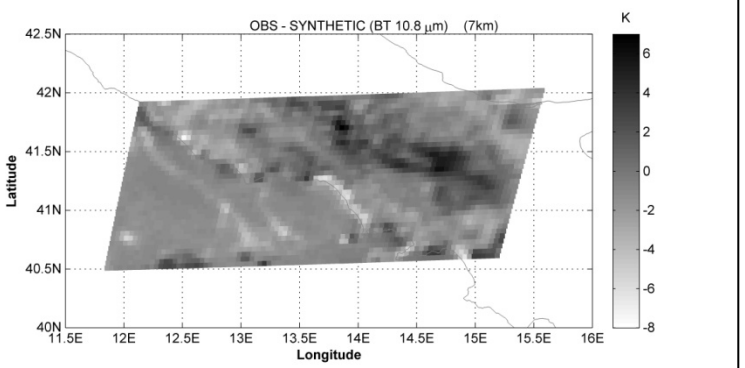
COSMO-7 | **COSMO-1**

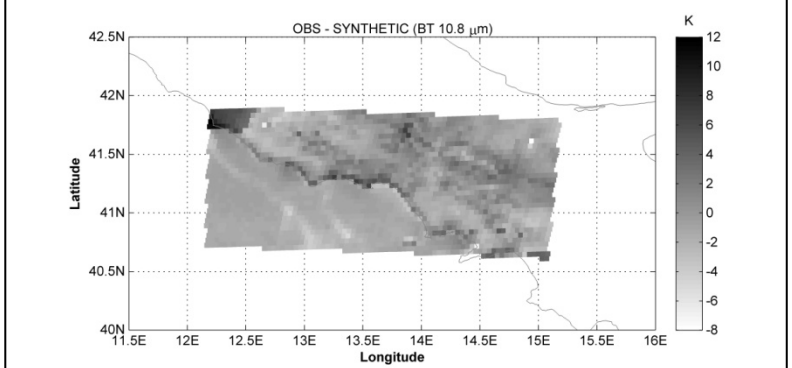
WV 6.2 µm





IR 10.8 µm





WV 6.2 µm ⟷ Water Vapour

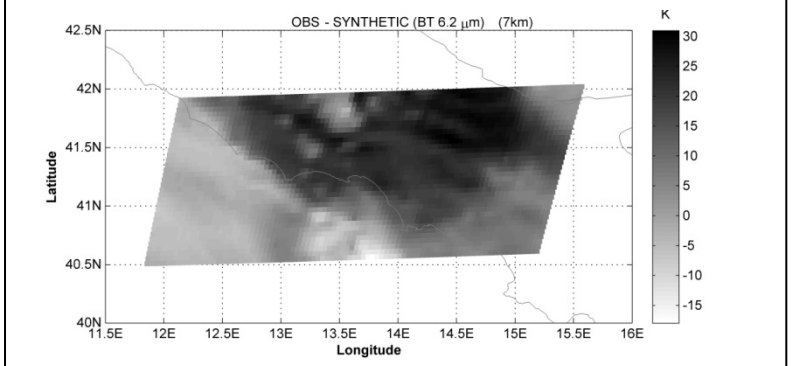
IR 10.8 µm ⟷ Cloud Temperature

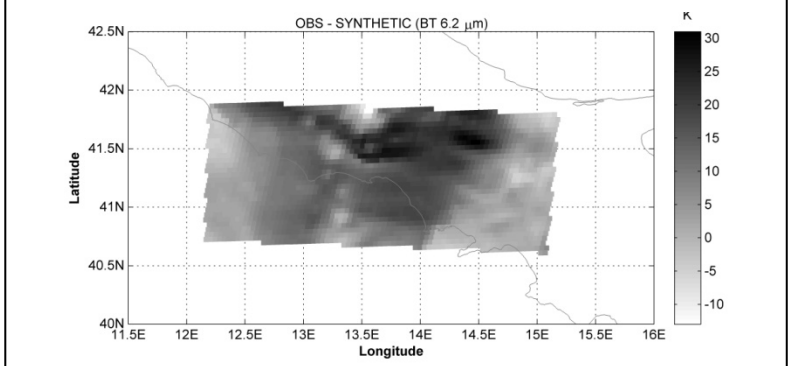
Performances evaluation with satellite (2)

Simulation of 28/11/2012 forecast hour 11UTC

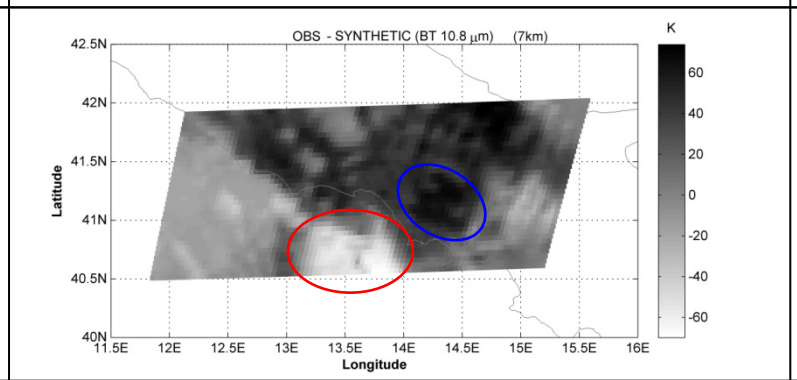
COSMO-7 | **COSMO-1**

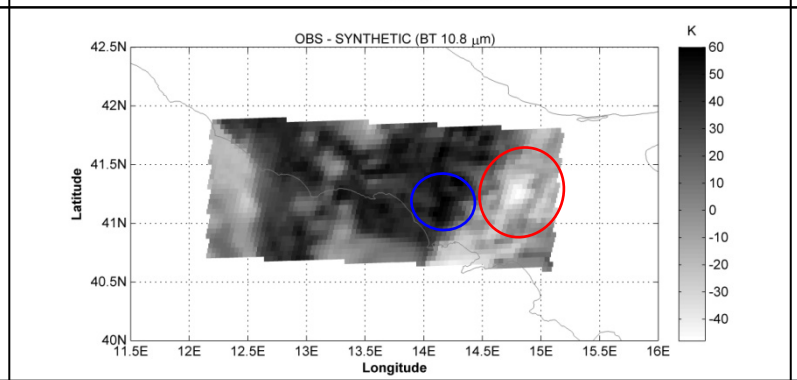
WV 6.2 µm





IR 10.8 µm



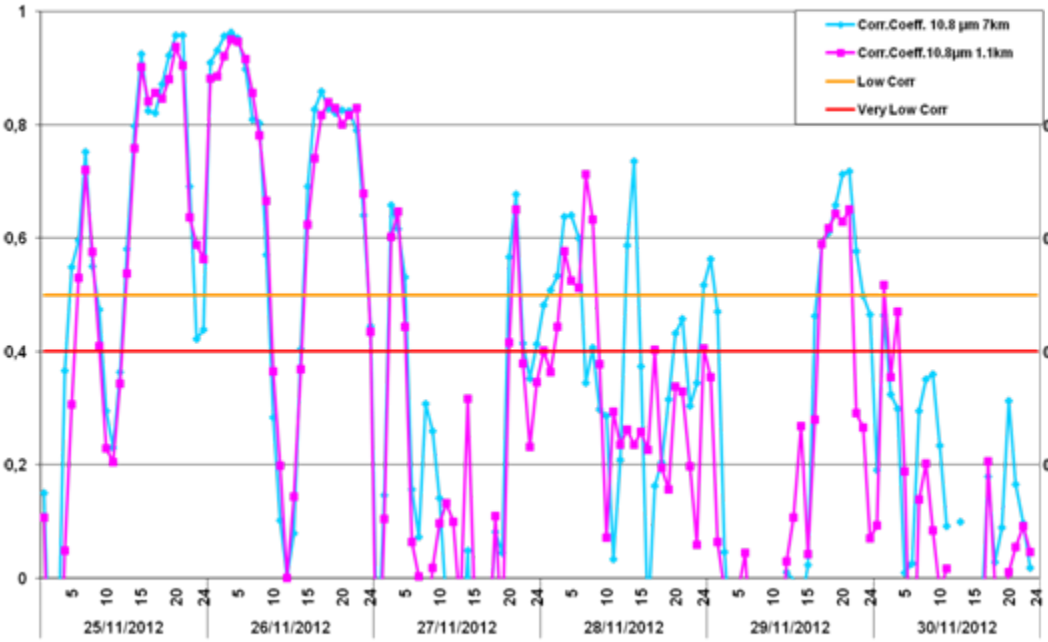


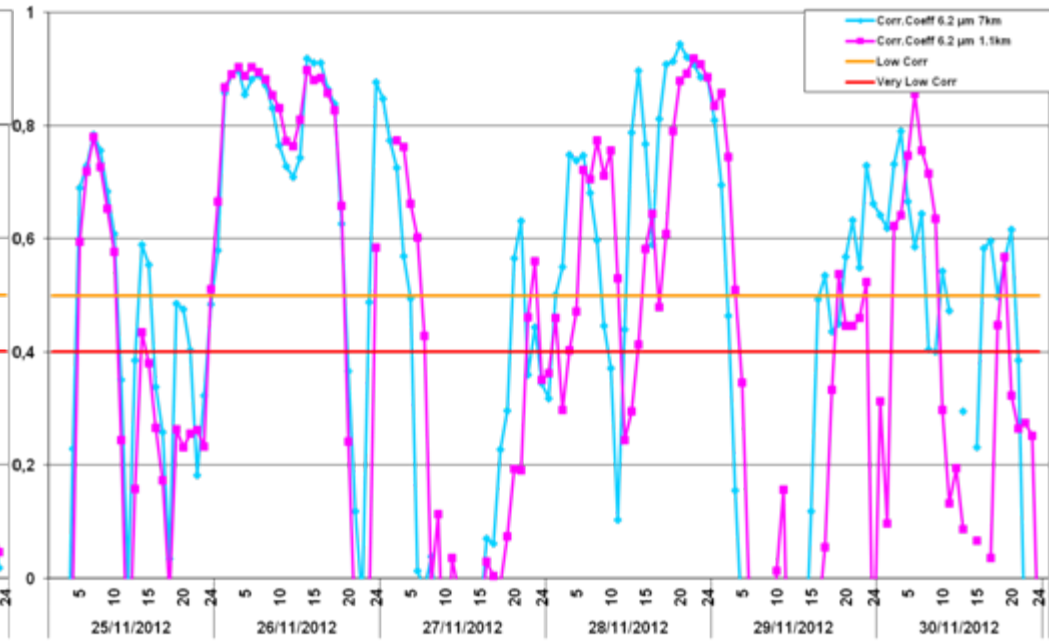
WV 6.2 µm ⟷ Water Vapour

IR 10.8 µm ⟷ Cloud Temperature

Performances evaluation with satellite (3)

Correlation coefficients (B.K.Reichert, C.Träger-Chatterjee, J.Asmus 2005)

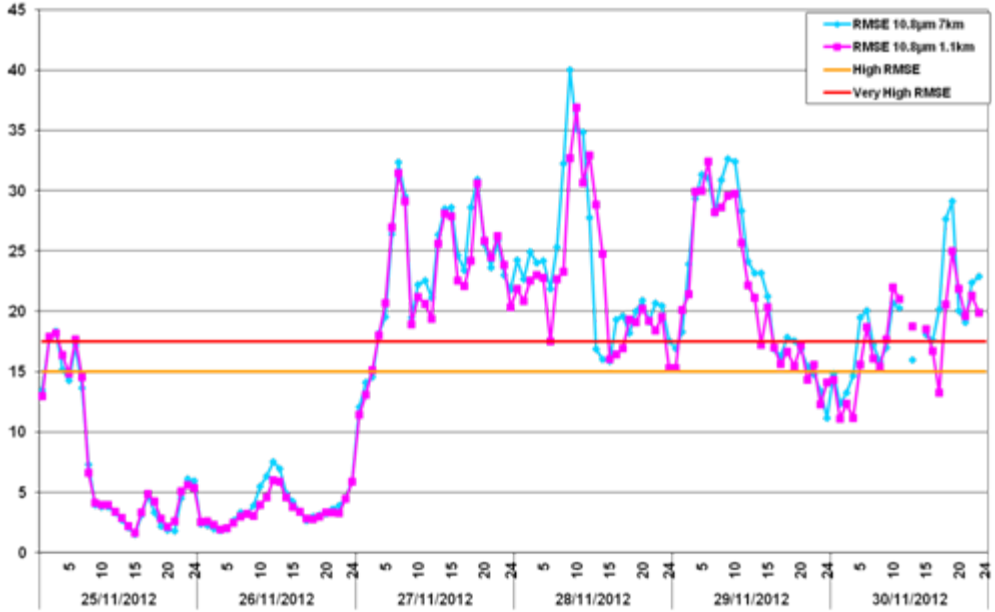


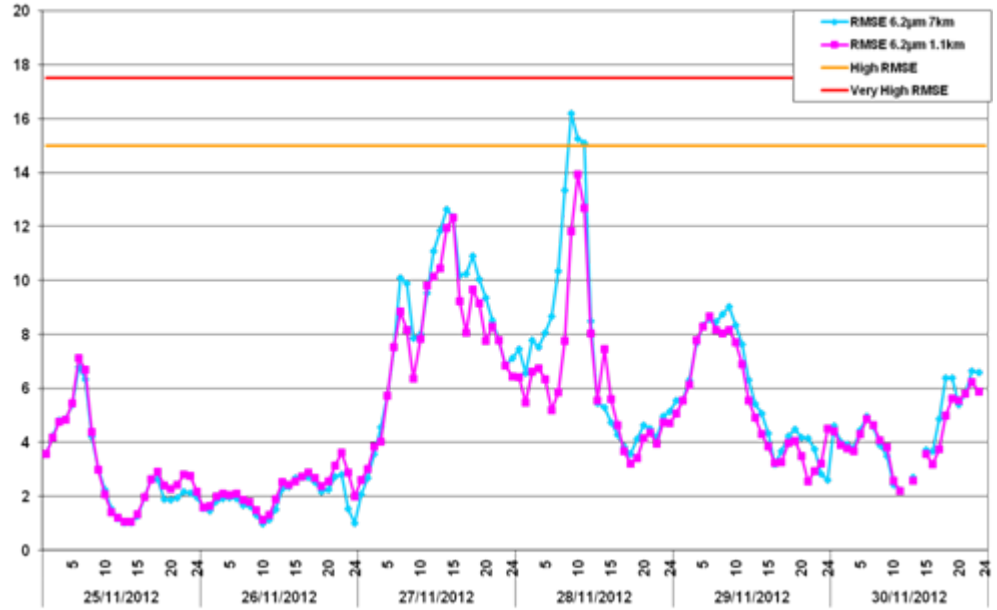


- COSMO-7 and COSMO-1 show almost the same pattern except for simulations of 28th
- General good agreement with observations for periods without clouds for both channels
- Lower agreement for cloudy periods, especially for IR 10.8 µm channel

Performances evaluation with satellite (4)

RMSE (B.K.Reichert, C.Träger-Chatterjee, J.Asmus 2005)

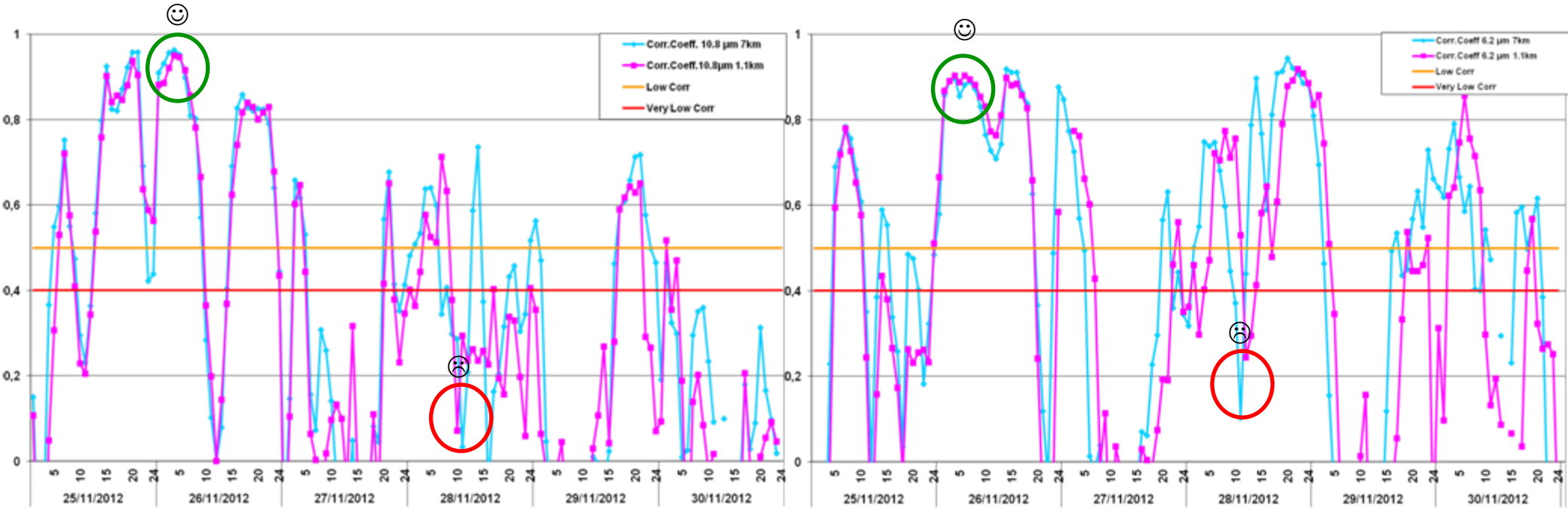




- COSMO-7 and COSMO-1 show almost the same pattern
- General low error for periods without clouds for both channels
- Higher error for cloudy periods for IR 10.8 µm channel
- Almost no error for WV 6.2 µm channel for the entire period

Performances evaluation with satellite (3)

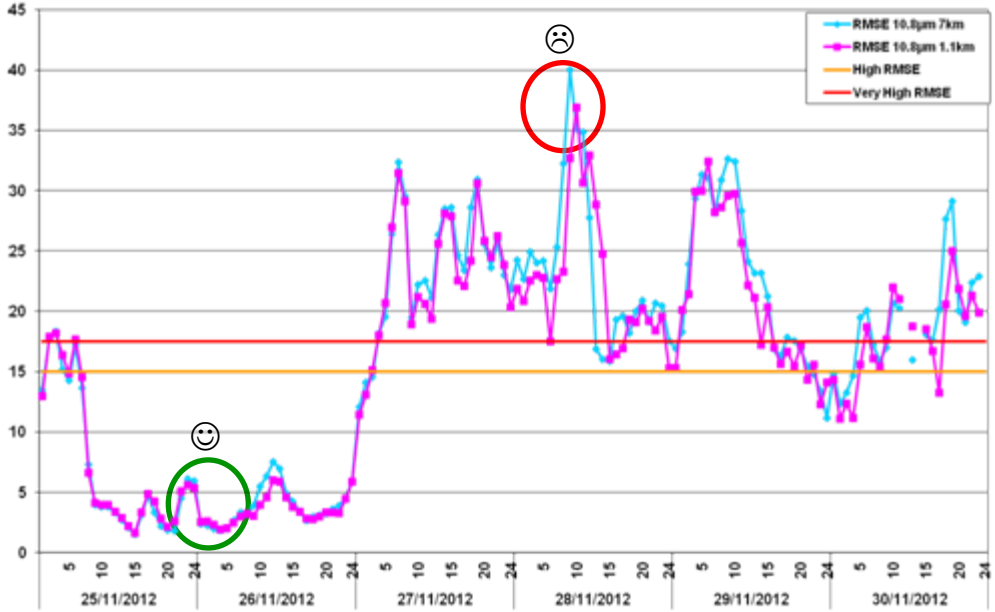
Correlation coefficients

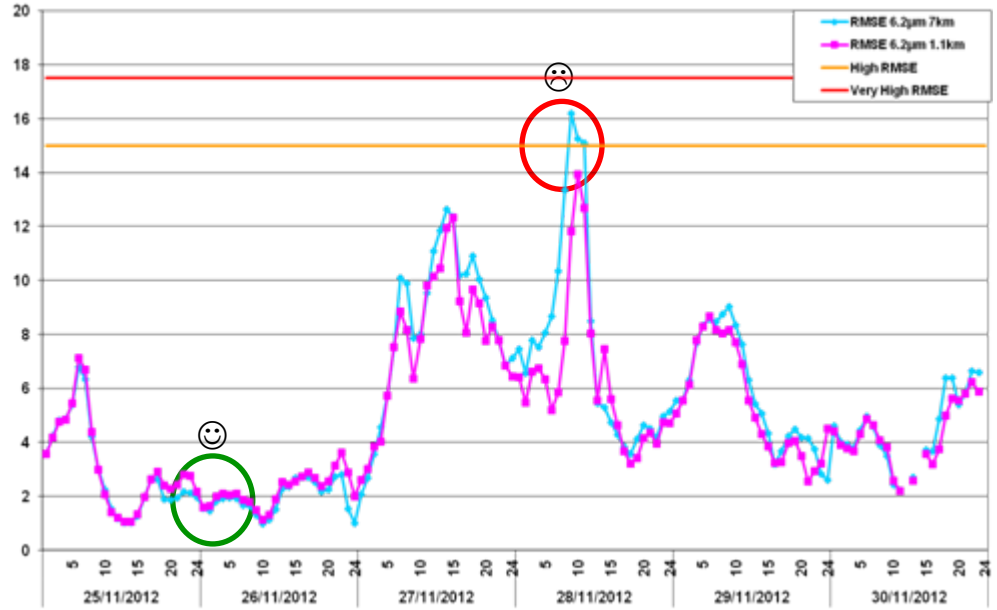


- COSMO-7 and COSMO-1 show almost the same pattern except for simulations of 28th
- General good agreement with observations for periods without clouds for both channels
- Lower agreement for cloudy periods, especially for IR 10.8 µm channel

Performances evaluation with satellite (4)

RMSE



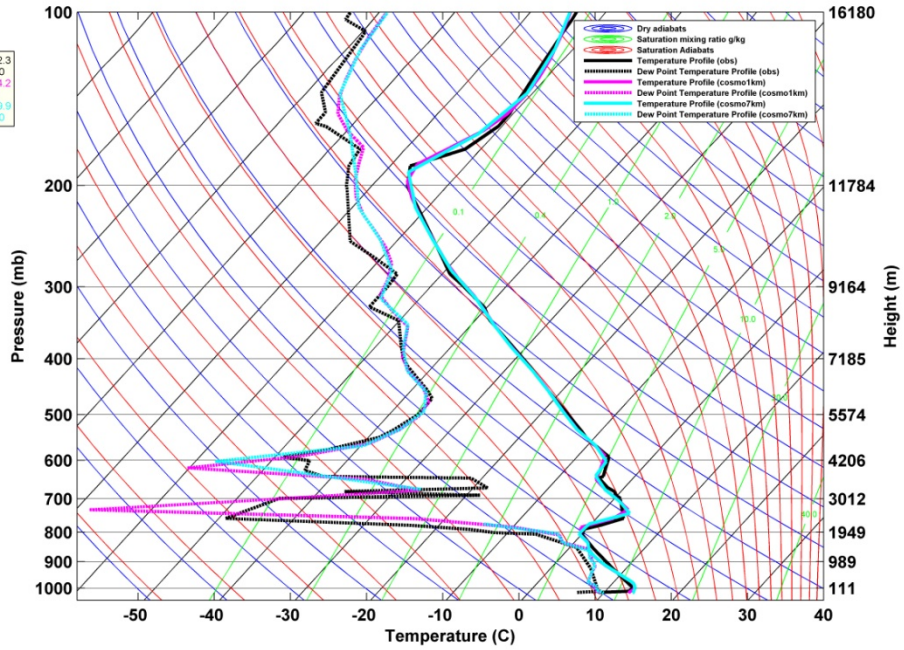


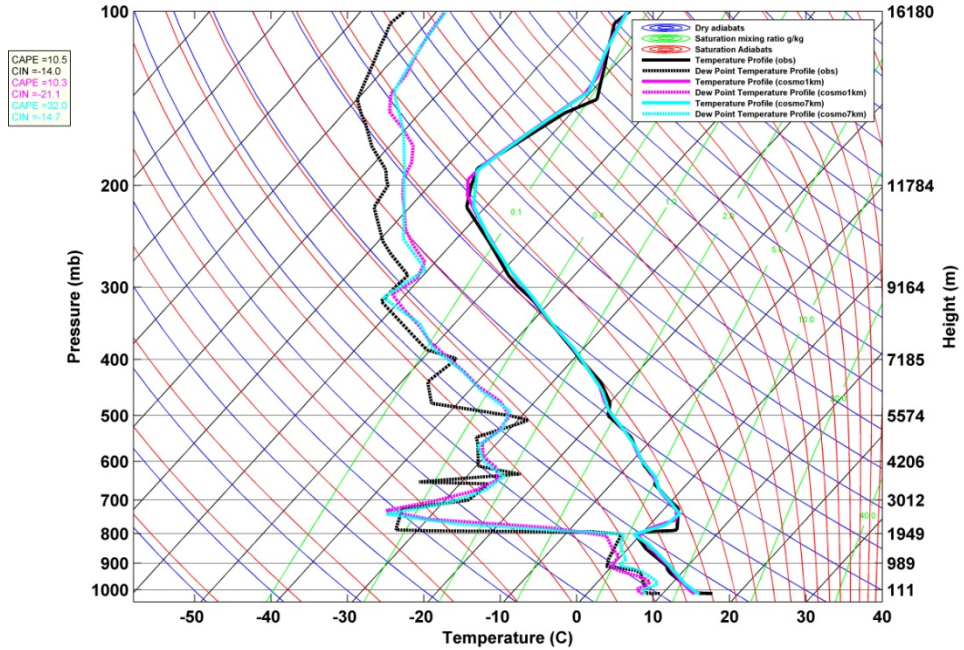
- *COSMO-7 and COSMO-1 show almost the same pattern*
- *General low error for periods without clouds for both channels*
- *Higher error for cloudy periods for IR 10.8 µm channel*
- *Almost no error for WV 6.2 µm channel for the entire period*

Performances evaluation with radiosounding (1)

- Soundings taken from Pratica di mare every 00 UTC and 12 UTC
- Station latitude: 41.65
- Station longitude: 12.43
- Station elevation: 32.0
- COSMO Soundings realized for the nearest grid point

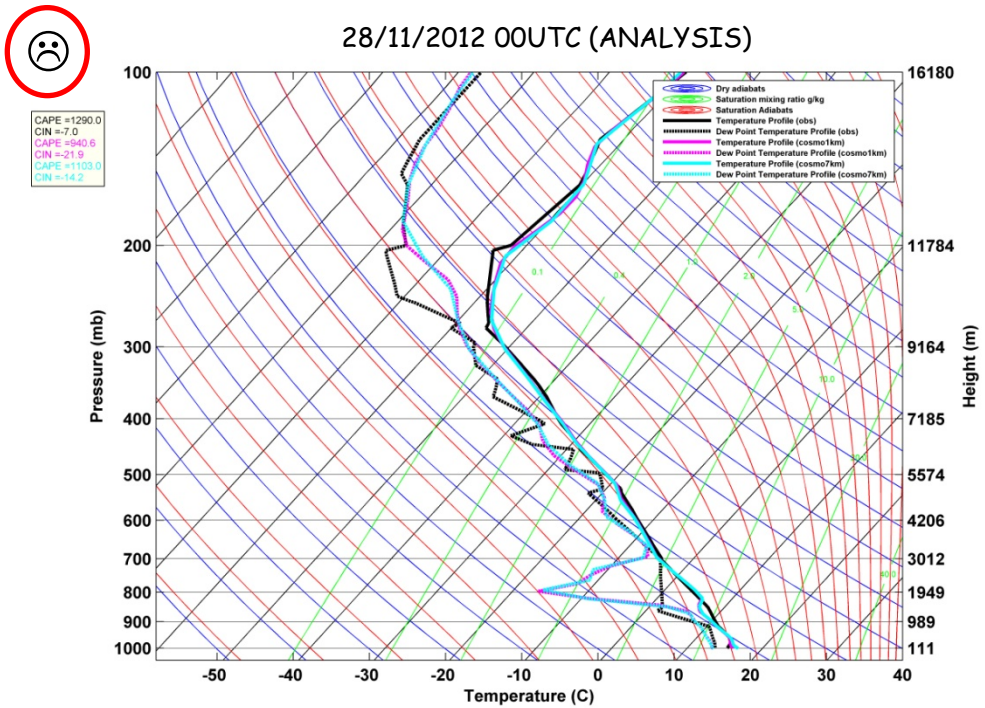
Performances evaluation with radiosounding (2)

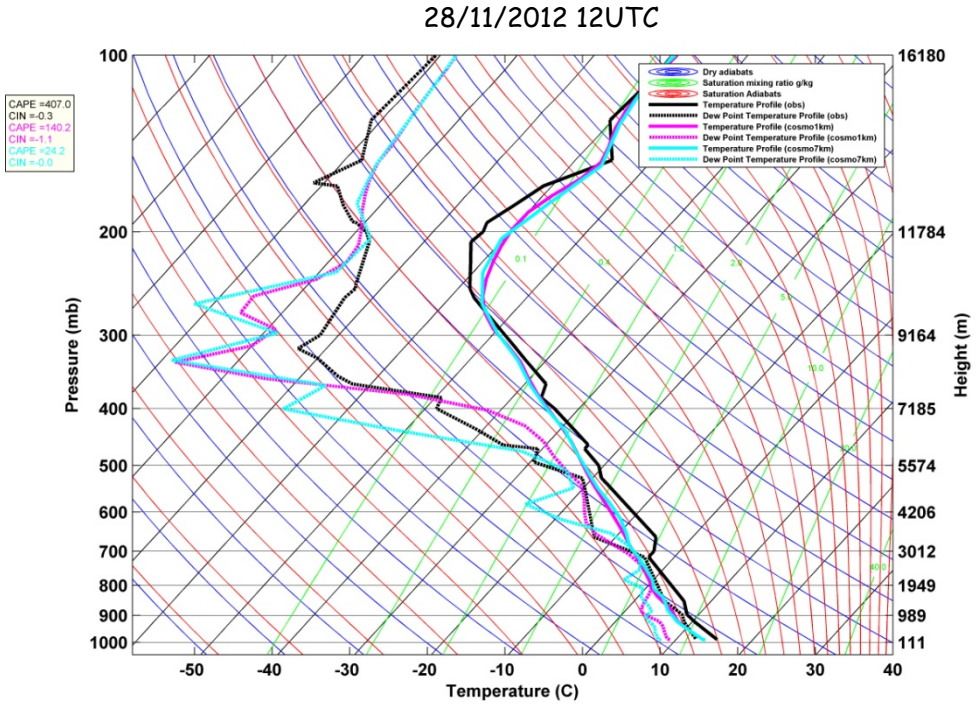




- COSMO-7 and COSMO-1 show almost the same pattern
- General good agreement with the pattern of the observation sounding

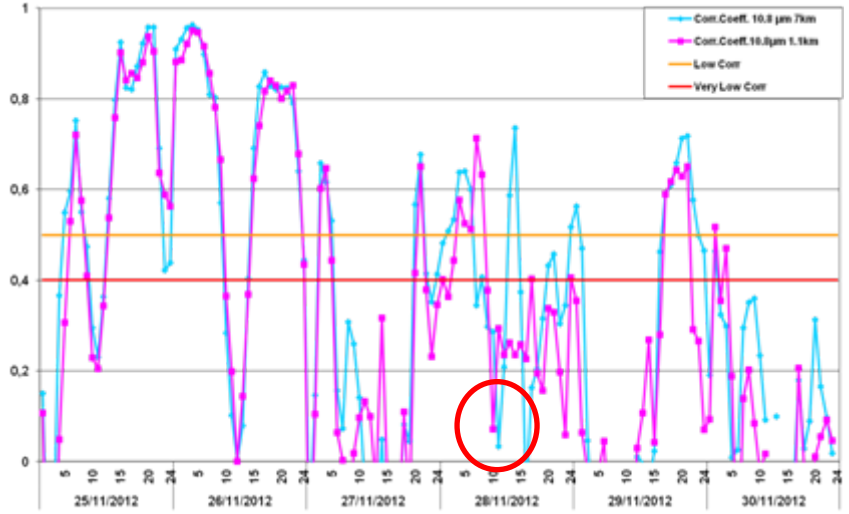
Performances evaluation with radiosounding (3)

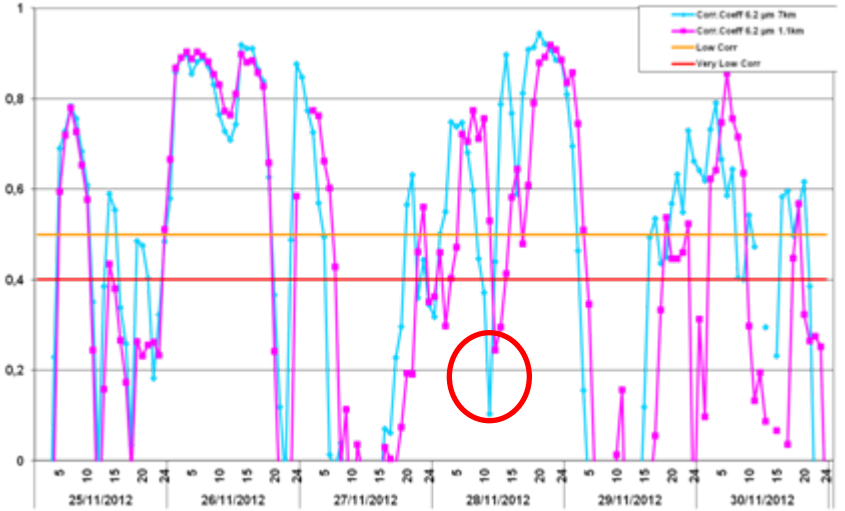


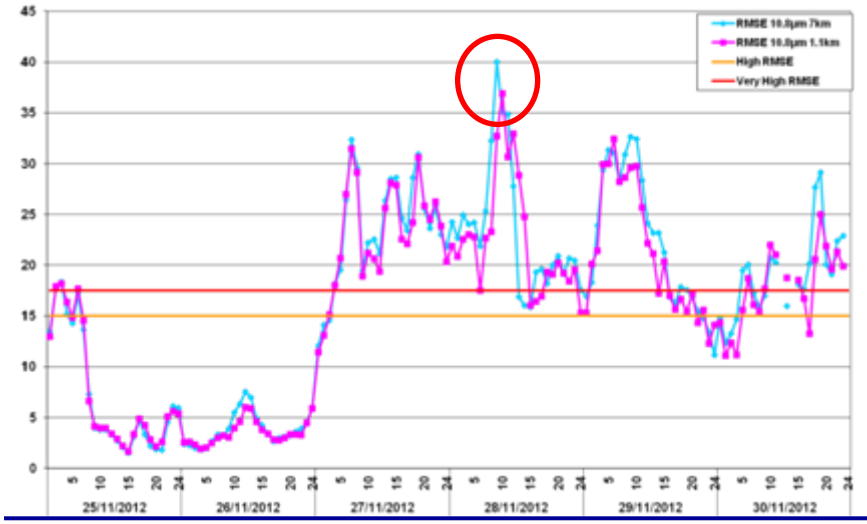


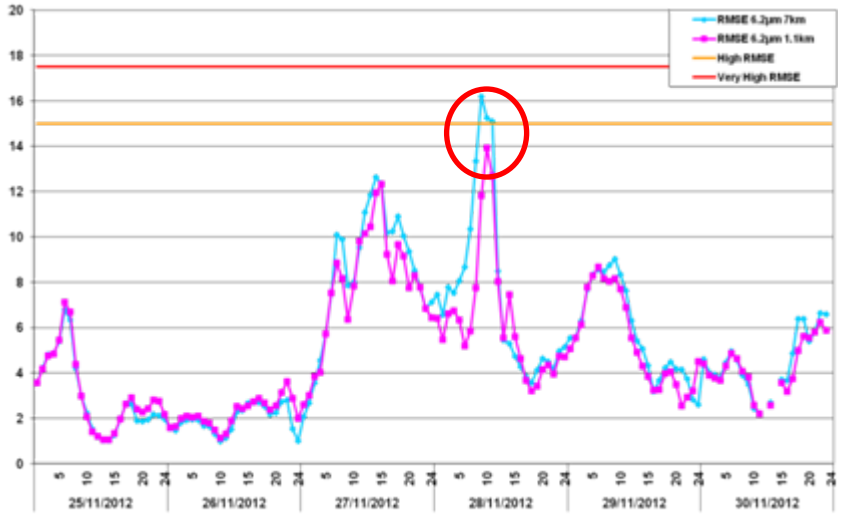
- COSMO-7 and COSMO-1 show almost the same pattern
- There's a lower agreement with the pattern of the observed sounding:
  - the analysis differs for lower levels (900-700 hPa) and for upper levels (250-200 hPa)
  - the 12UTC simulations show a lower surface temperature and a different pattern on high levels (worse for 7km)

Performances evaluation with radiosounding (4)





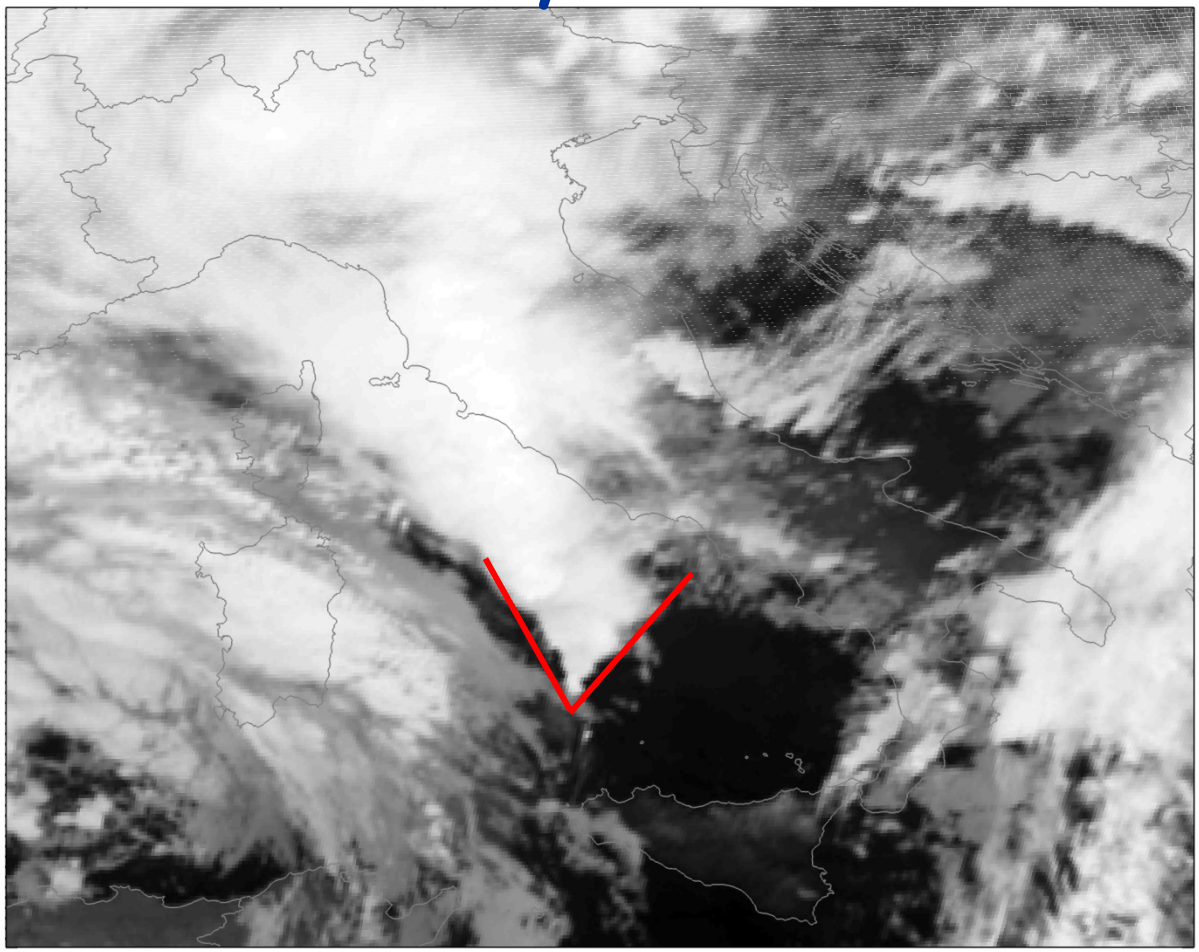




Conclusions

- The aim of the work was the evaluation of the performances of COSMO-1 model with different types of observations, suitable for the high resolution of the model
- The behaviour of COSMO-7 and COSMO-1 is quite the same for almost every variable analyzed in the validation, even if, for the cloudy days analyzed, COSMO-1 has better performances. Further investigations will be done.
- Next steps include tuning of physical parameters to optimize this configuration, the study of energy spectra and performing of other test cases (in order to include the study of other meteorological situations).

Thanks for your attention!



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