CONSORTIUM FOR SMALL SCALE MODELING

COSMO

Convection resolving COSMO implementations

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31st EWGLAM Meeting, 30.9.2009

Outline

Operational models

- Germany: COSMO-DE at 2.8 km since April 2007
- Italy: COSMO-I2 at 2.8 km since April 2007
- Italy: COSMO-IT at 2.8 km since October 2007
- Switzerland: COSMO-2 at 2.2 km since February 2008
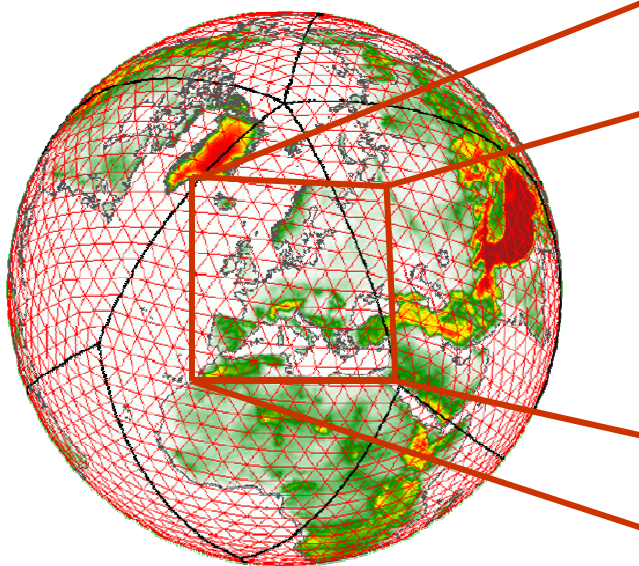- Romania: COSMO-Ro2 at 2.8 km since June 2009

Experimental models
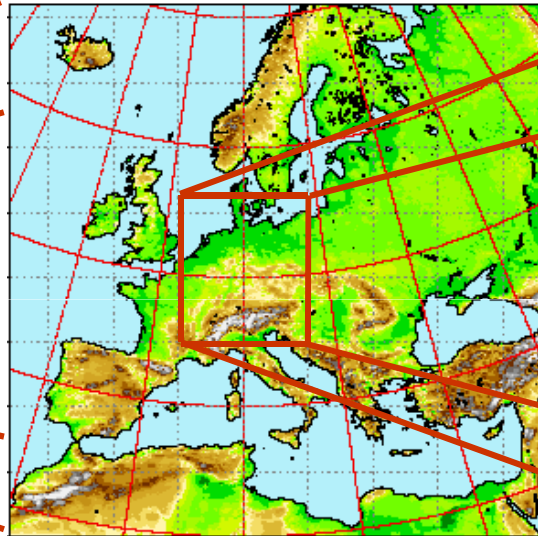
- Greece: COSMO-GR
- Italy: COSMO-RC

Operational Model Chain of DWD: GME, COSMO-EU and -DE
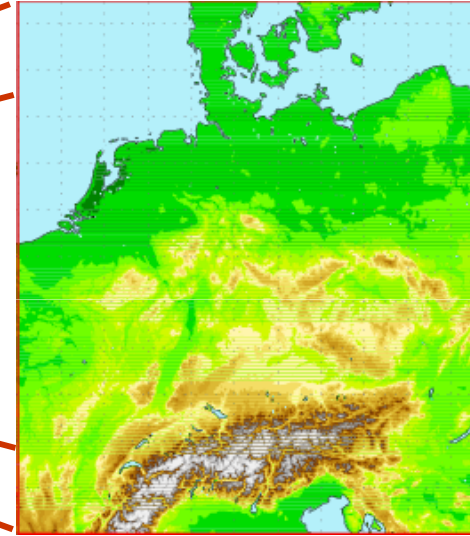## (since 16. April 2007)

GME

COSMO-EU

COSMO-DE

hydrostatic
parameterised convection
$\Delta x \approx 40$ km
368642 * 40 GP
$\Delta t = 133$ sec., T = 7 days

non-hydrostatic
parameterised convection
$\Delta x = 7$ km
665 * 657 * 40 GP
$\Delta t = 40$ sec., T= 78 h

non-hydrostatic
resolved convection
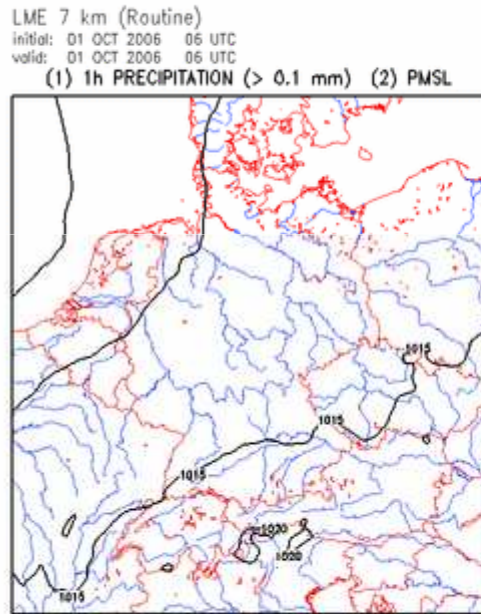$\Delta x = 2.8$ km
421 * 461 * 50 GP
$\Delta t = 25$ sec., T = 21 h

Convection in COSMO-EU and –DE

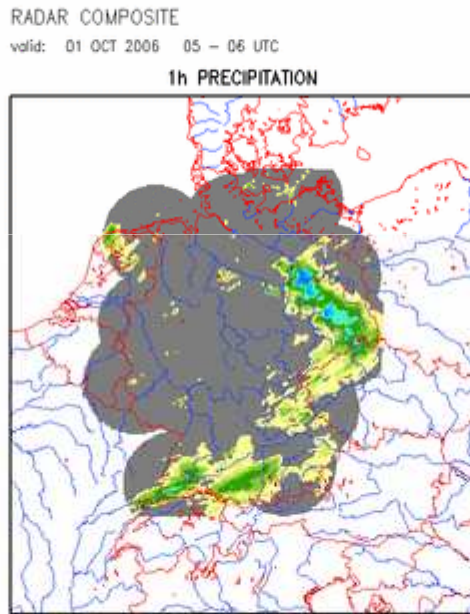## Convectively enhanced frontal precipitation, 1.10.2006, 6 UTC run

Obs.: up to 20 mm/12 h

COSMO-EU (Δx=7 km)   Radar observation   COSMO-DE (Δx=2.8 km)

1hour precipitation sum (mm)

Convection in COSMO-EU and –DE

Convectively enhanced frontal precipitation, 1.10.2006, 6 UTC run

Obs.: up to 20 mm/12 h

Operational time table at the DWD
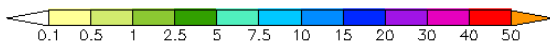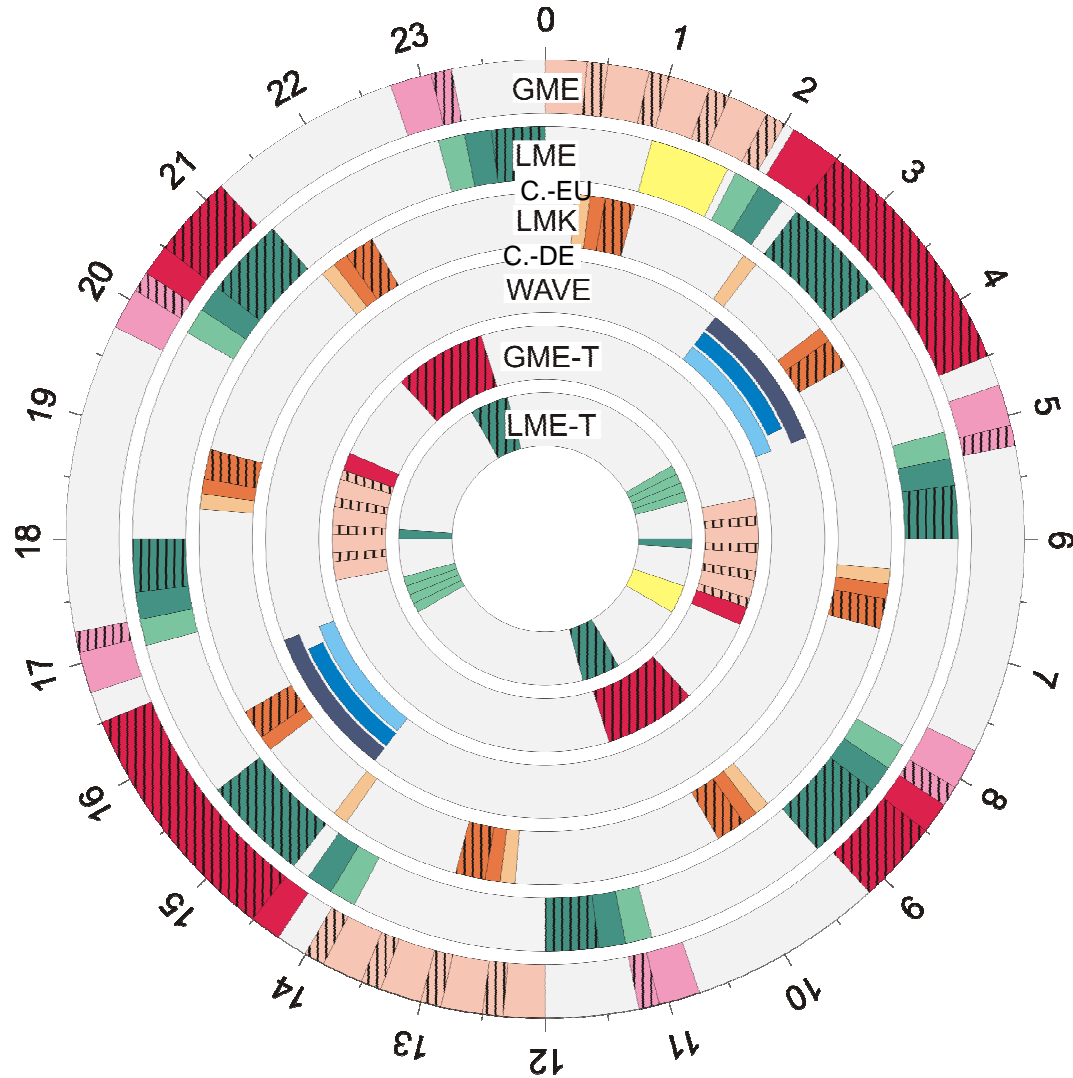

Models:
GME, WAVE,
COSMO-EU, -DE

~1 TB data / day!

on NEC SX-8R, runs on 36 proc.

⊔	GME, LME, LMK:	Analysis / Nudging
⦀	GME, LME, LMK:	Forecast
▮▮▮	WAVE (GSM, LSM, MSM)	
▮	LME: Surface moisture analysis	
▮▮▮	Main run	
▮	Pre-Assimilation	
▮▮▮	Assimilation	
T	Testsuite	

Upscaling for GME, COSMO-EU and COSMO-DE
August 2009 12h sums from +6 to +18h, reference German radar
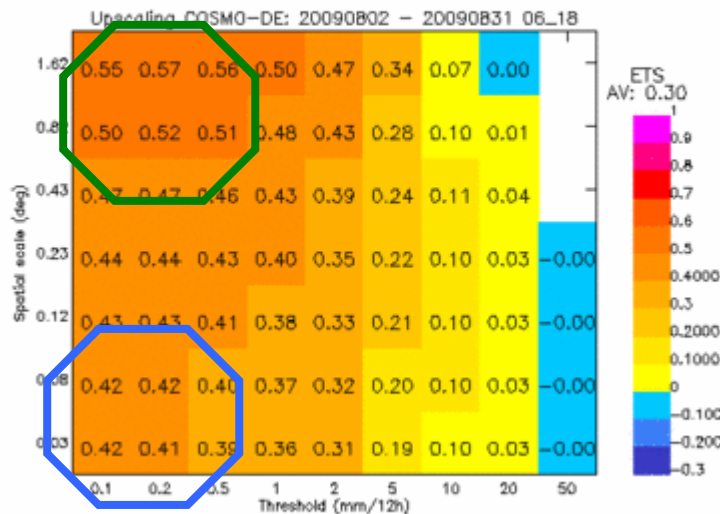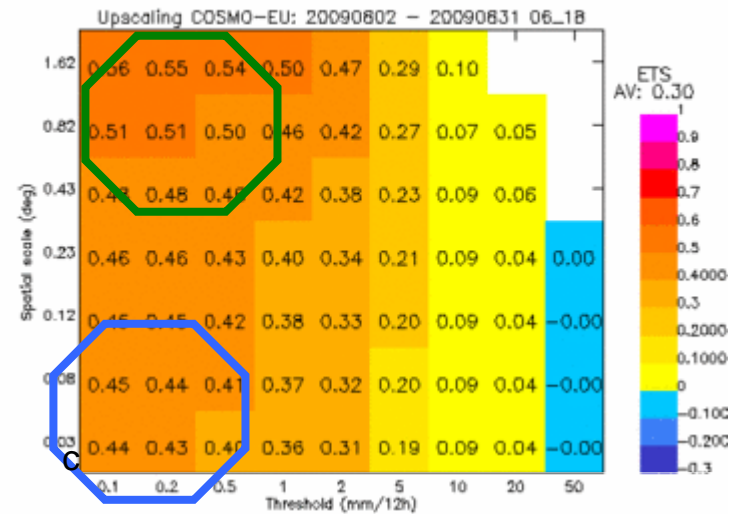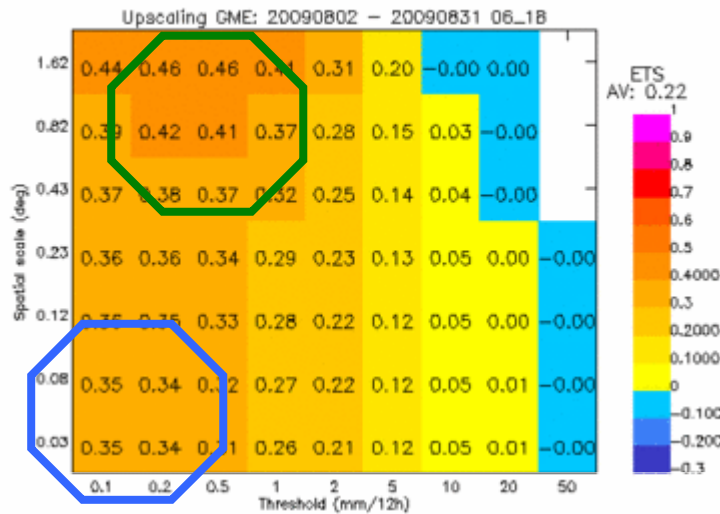
Convection resolving model of ARPA-SIMC COSMO-I2 (Operational since April 2007)

- Horizontal grid spacing 2.8km

- 45 vertical levels

- Runge-Kutta numerical scheme

- 48h Forecasts at 00 and 12 UTC

- BC's from COSMO-I7
  (in turn BC's from ECMWF-IFS)

- Own assimilation cycle
  nudging of conventional obs

- Production system at
  CINECA computing centre:
  IBM P6-575 Infiniband Cluster
  using 512 of 5376 cores,
  Total capacity 101 TFlop/s

- Fall-back on Linux Opteron cluster
  using 480 cores of 5120 cores,
  Total capacity 26.6 TFlop/s

CONSORTIUM FOR SMALL SCALE MODELING
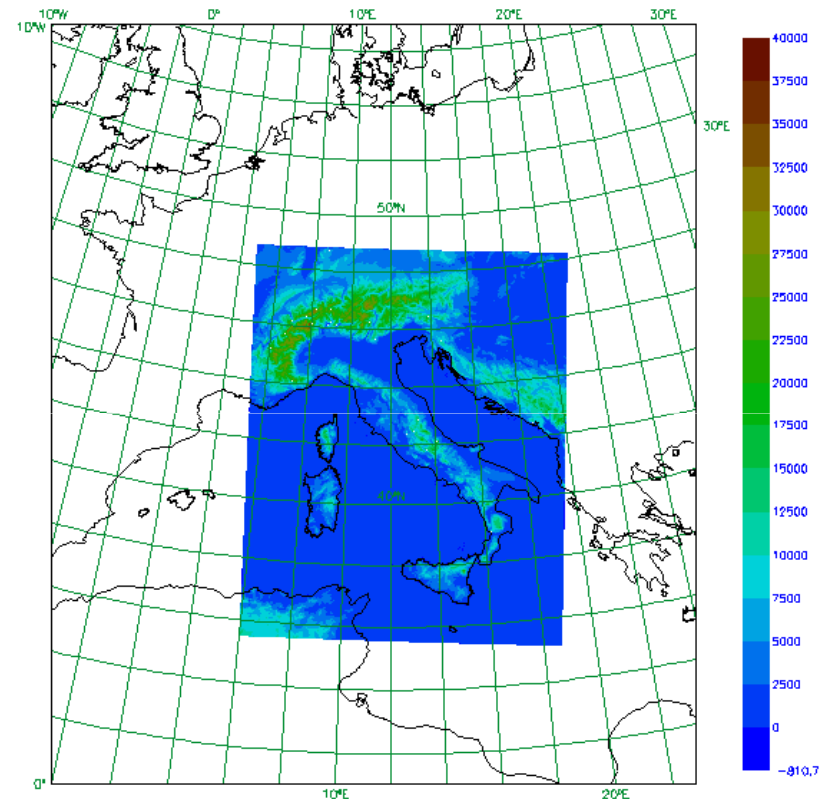
Comparison precipitation ECMWF/ COSMO-I7/ COSMO-I2 One year over Italy

- COSMO-I7 → slightly overestimation; COSMO-I2 → underestimation
- I7 equivalent or slightly better then I2, but less missings for I2
- COSMO-model much better than ECMWF

0.2   2   10   20   35   THRES.
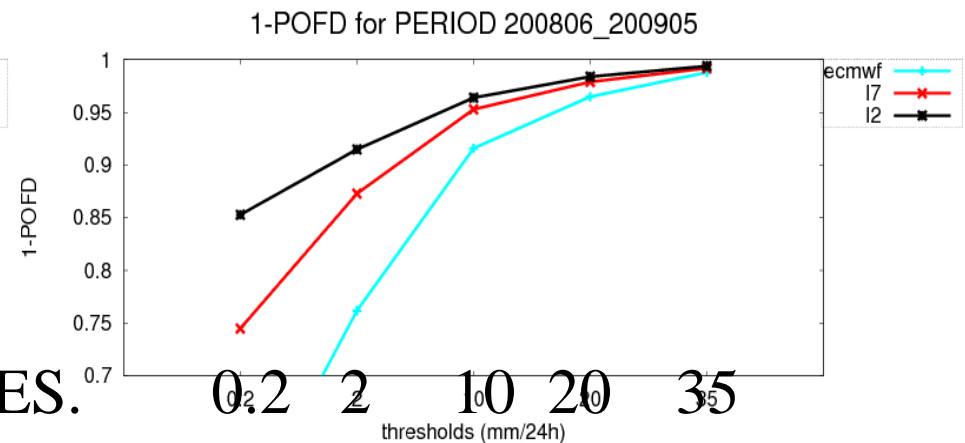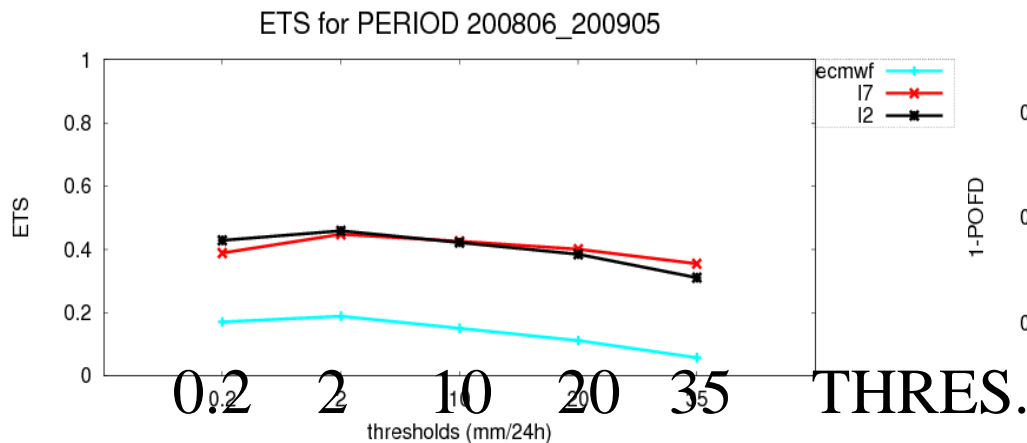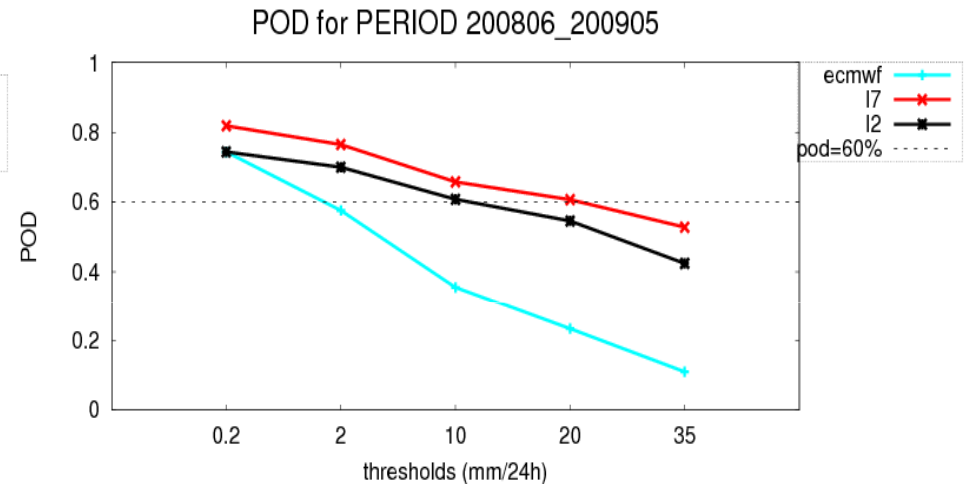
Operational Model Chain of Italian Met. Center (CNMCA)

ONLY FOR DATA ASSIMILATION SYSTEM

EURO-HRM (14Km) ITALIAN MET SERVICE

COSMO-ME (7Km) ITALIAN MET SERVICE

COSMO-IT (2.8Km) ITALIAN MET SERVICE

14 km
- hydrostatic equations
- parameterized convection

7 km
- compressible equations
- parameterized convection

2.8 km
- compressible equations
- explicit convection

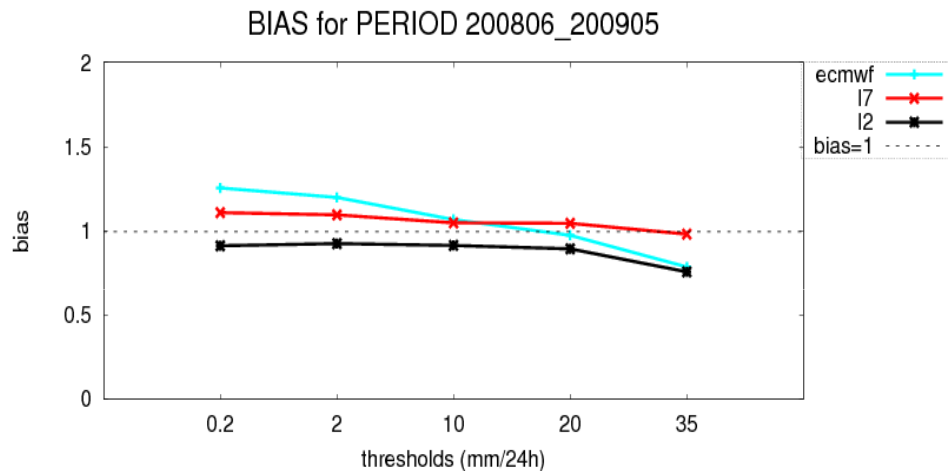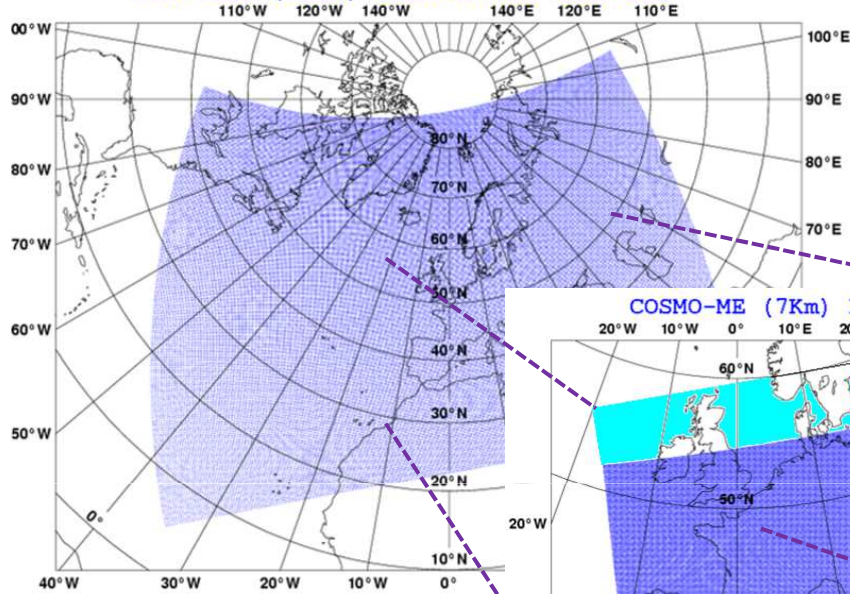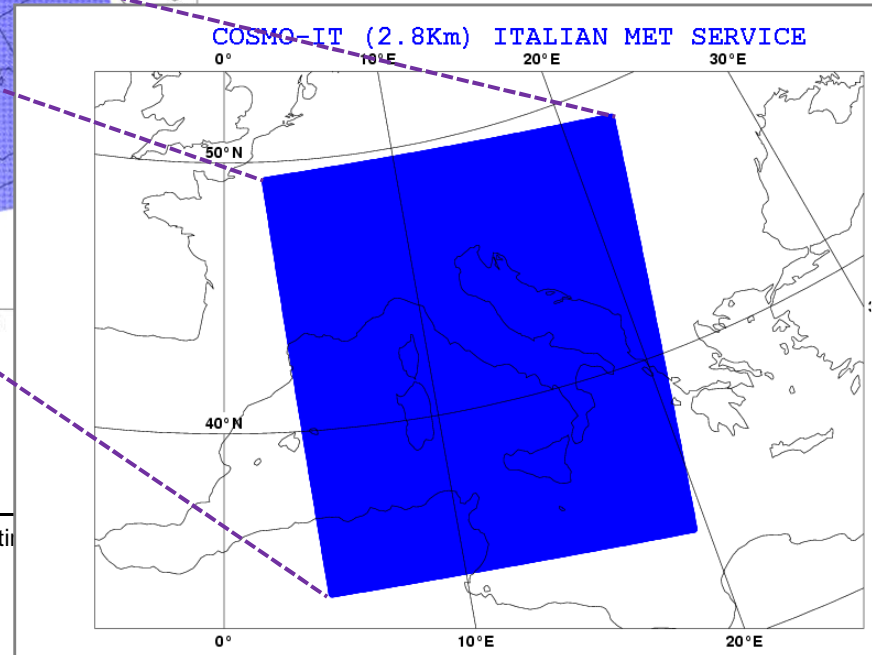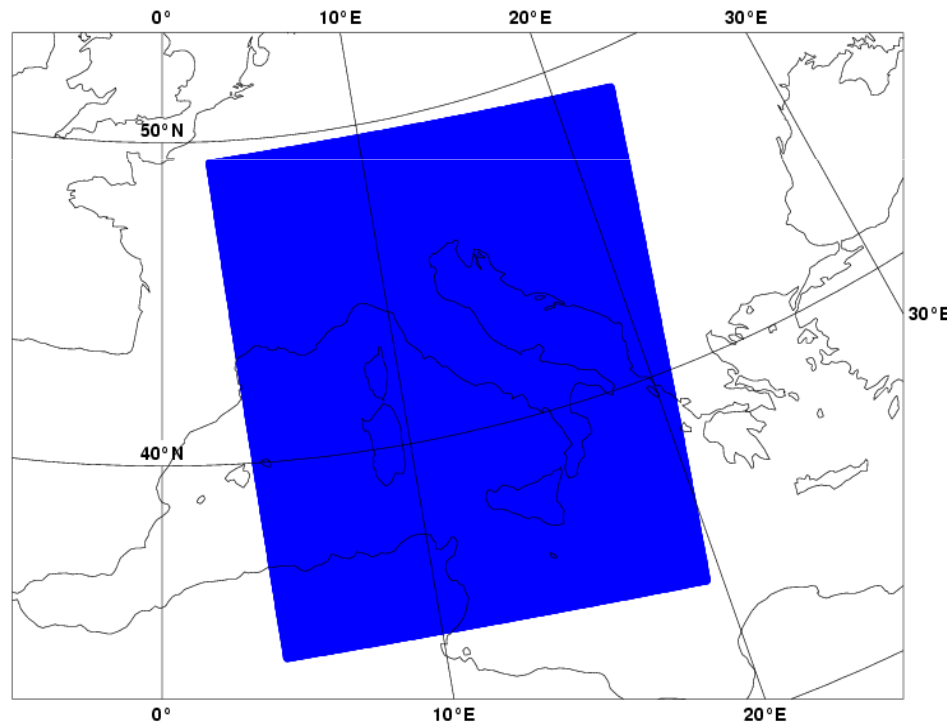# Convection resolving model of CNMCA COSMO-IT (Operational since April 2007)

- Run at the Italian Met Service since October 2006 for (intensive) tuning
- Runge-Kutta dynamical core is used
- Deep convection scheme is switched off
- Only shallow convection is parameterized

Domain size	542 x 604
Grid spacing	0.025 (2.8 km)
Number of layers / top	50 / ~22 km
Time step and scheme	25 s
Forecast range	24 hrs
Initial time of model run	00/12 UTC
Lateral bound. condit.	COSMO-ME
L.B.C. update frequency	1 hr
Initial state	6h Nudging from 3D-VAR
Initialization	None
External analysis	None
Special features	Filtered topography
Status	Operational
Hardware	IBM (ECMWF)
N° of processors	352

Convection resolving COSMO implementations | 31st EWGLAM meeti
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L. Torrisi, CNMCA

Comparison precipitation ECMWF/ COSMO-ME/ COSMO-IT One year over Italy

- COSMO-ME and COSMO-IT similar / difficult to decide the winner
- COSMO-IT with tendency to overestimation
- COSMO-model much better than ECMWF
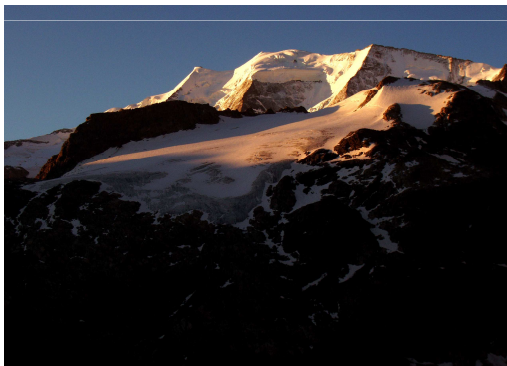
E.Oberto, ARPA-Piemonte
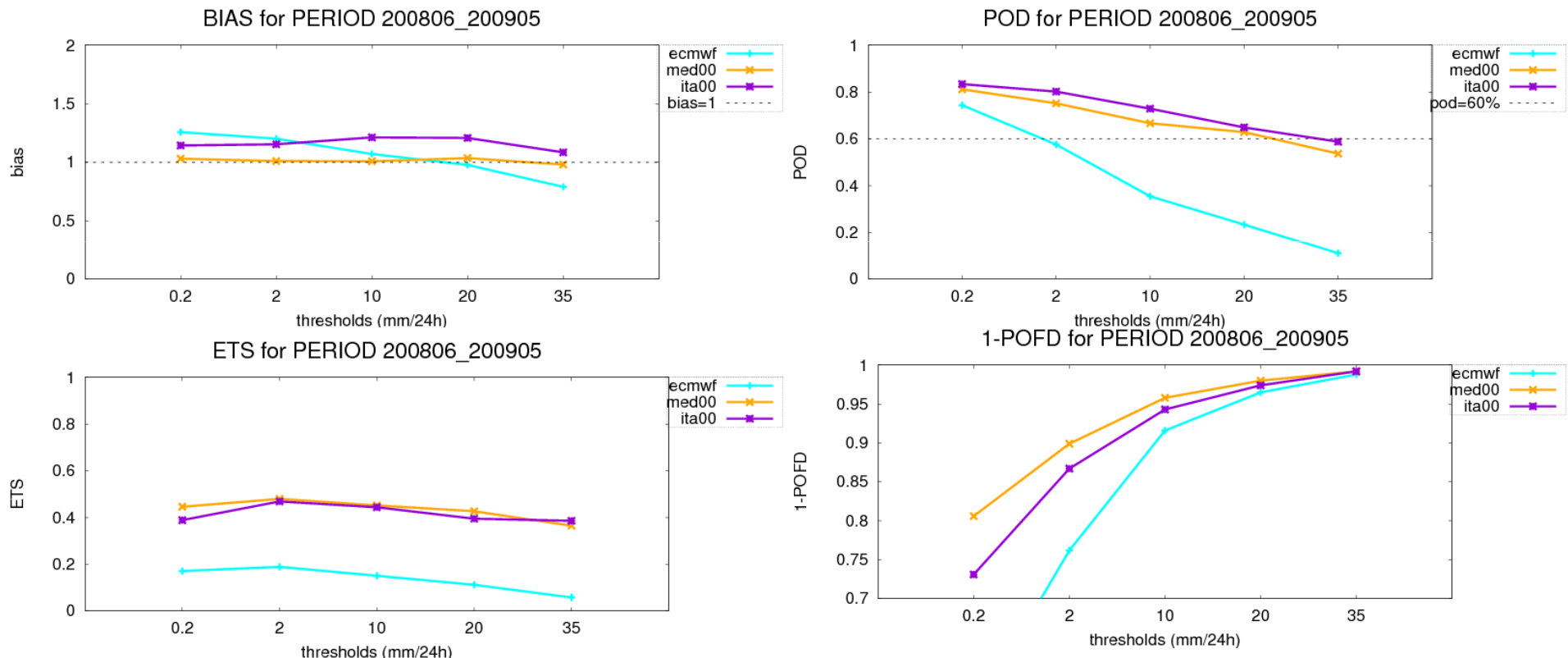
HPC Platforms at CSCS

Production system: Cray XT4 'buin'

- 448 compute nodes
  - AMD Opteron dual core, 2.6 GHz, 2 GB RAM
- 16 service nodes (used as Front-end)
  - AMD Opteron dual core, 2.6 GHz, 4 GB RAM
- 28 TB Lustre parallel File system
- Reserved usage for MeteoSwiss

Failover system: Cray XT3 'palu'

- 548 compute nodes
  - AMD Opteron dual core, 2.6 GHz, 3 GB RAM
- 12 service nodes (used as Front-end)
  - AMD Opteron dual core, 2.6 GHz, 4 GB RAM
- 90 TB Lustre parallel File system
- Shared machine, also used for development

- UNICOS/lc operating system:
  Linux on service nodes, Catamount on compute nodes

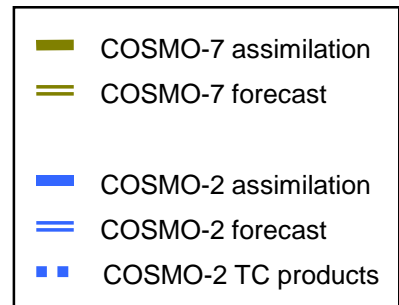# COSMO-2: Production Scheme
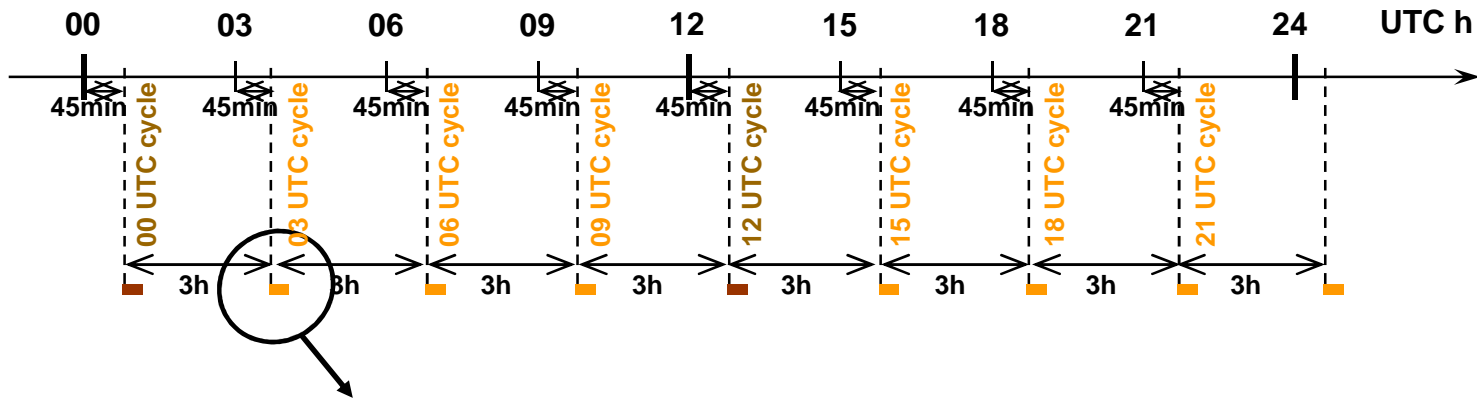
Short production cycle (+24h COSMO-2):

Legend:
- COSMO-7 assimilation
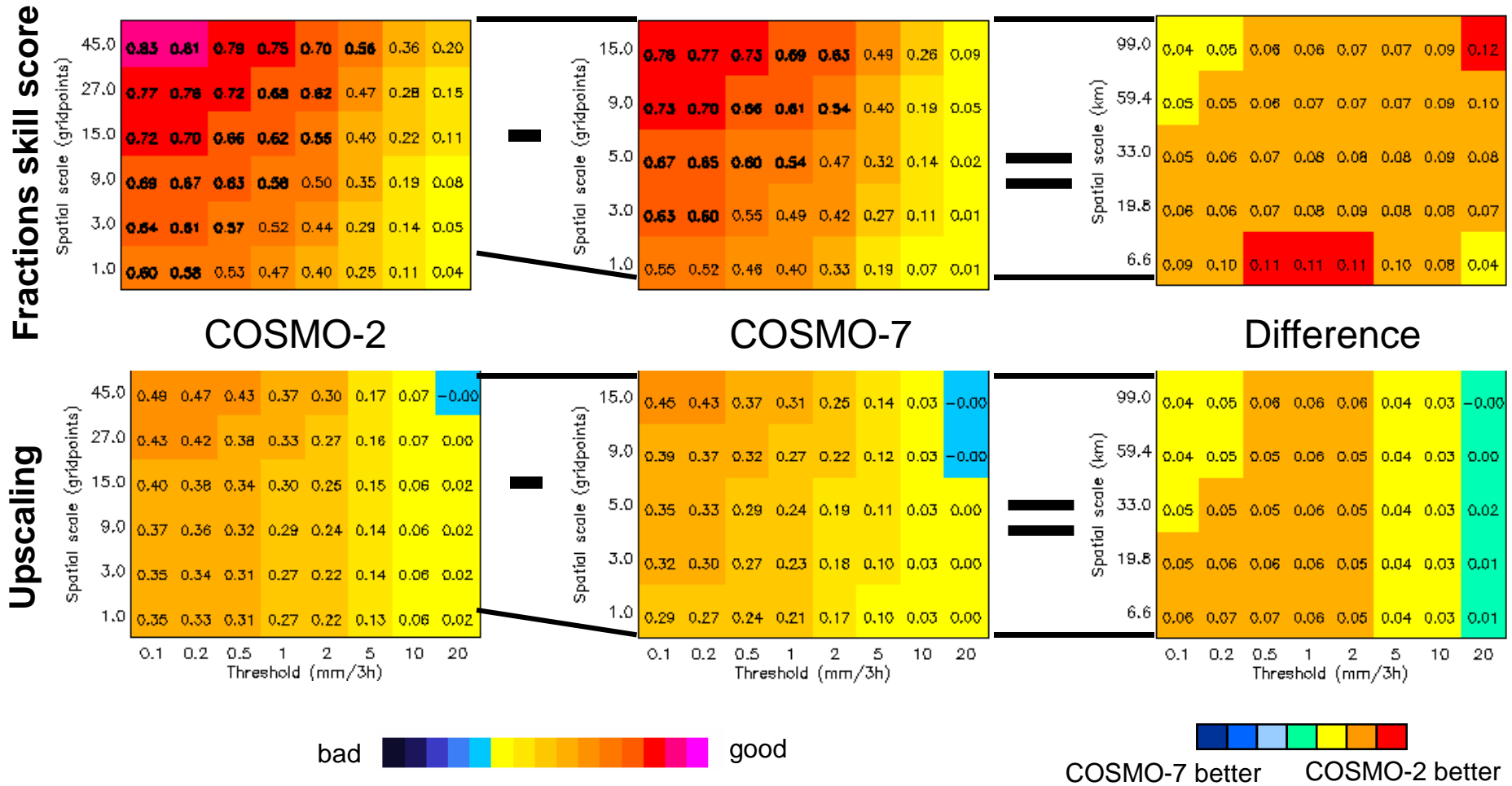- COSMO-7 forecast
- COSMO-2 assimilation
- COSMO-2 forecast
- COSMO-2 TC products

Fuzzy verification of COSMO-7 and COSMO-2
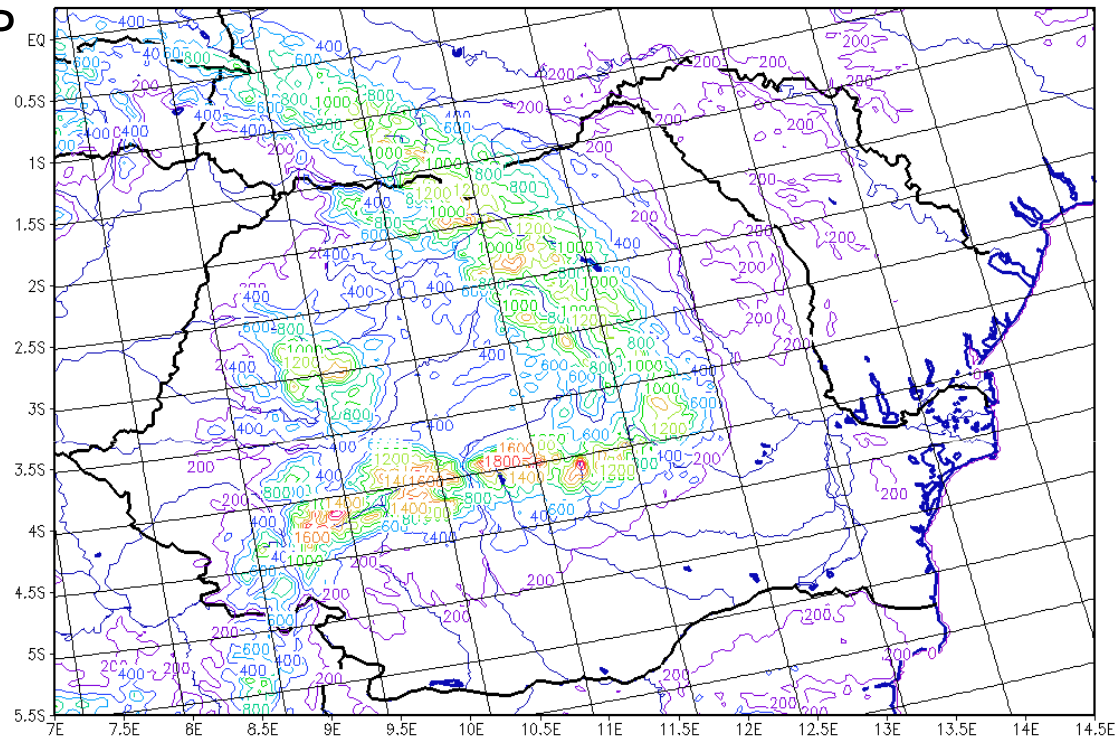## 3h precipitation sum (Jun-Nov 2007), ref. calibrated Swiss radar

Operational Suite of COSMO-Ro2 at NMA Since June 2009

- Domain size: 301 x 231 GP

- Horizontal grid 2.8km

- 50 vertical levels

- Runge-Kutta scheme

- 30h forecasts at 00 and 12 UTC

- BC's interpolated from COSMO-Ro7 (in turn BC's from GME)

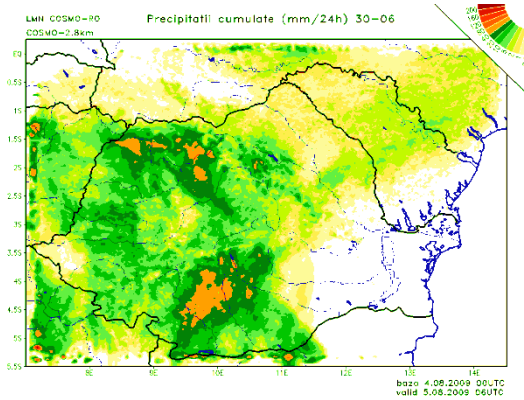- No data assimilation (Synop assimilated in COSMO-Ro7)
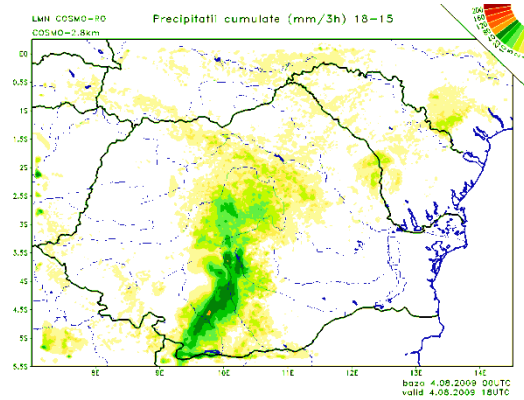

COSMO-Ro 2.8km (ie=301, je=231, ke=50)

- **IBM Linux Cluster, 14 Server Blades**
  - **each blade with 2 processors Intel Xeon Quad Core 3.00 GHz, 8 GB RAM**
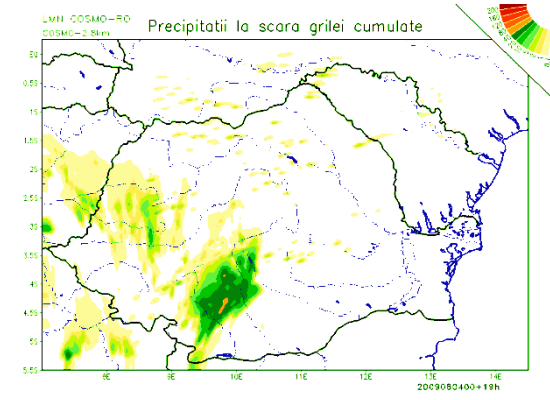- **Storage unit: 4.2 TB**
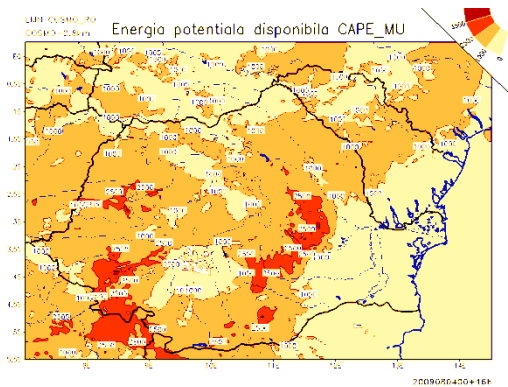- **Timing using 7 nodes: 125 min**

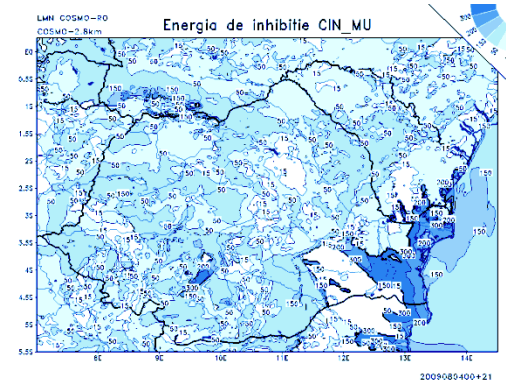# Sample of COSMO-Ro2 products

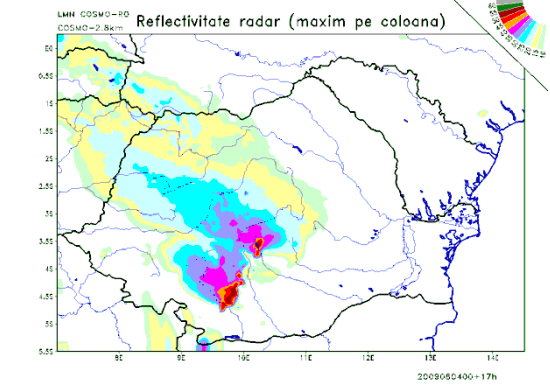**24h acc. preciptation**

3h acc. preciptation
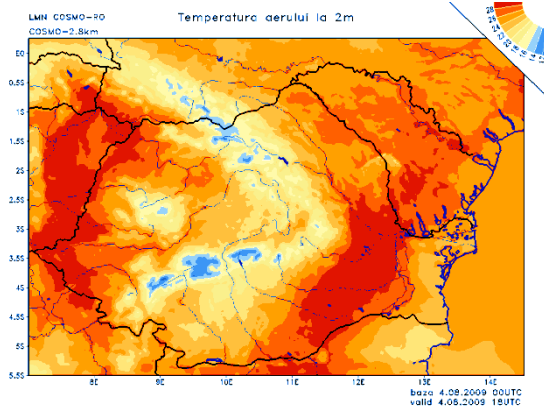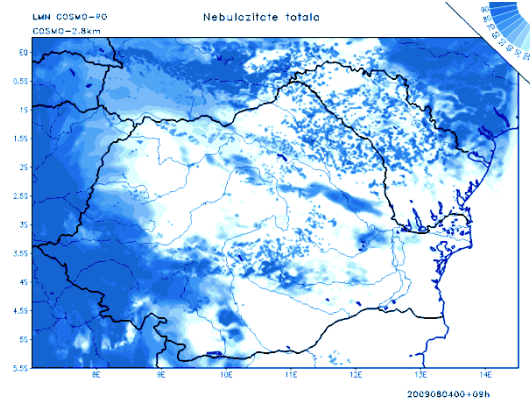

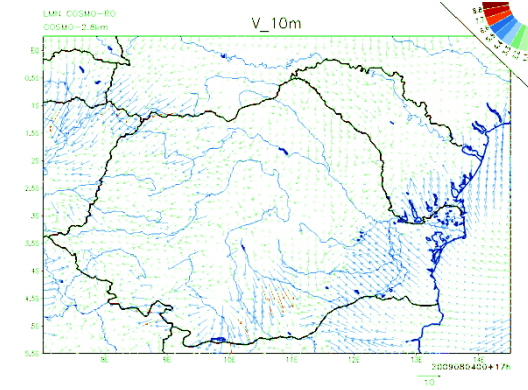**Grid scale rain**
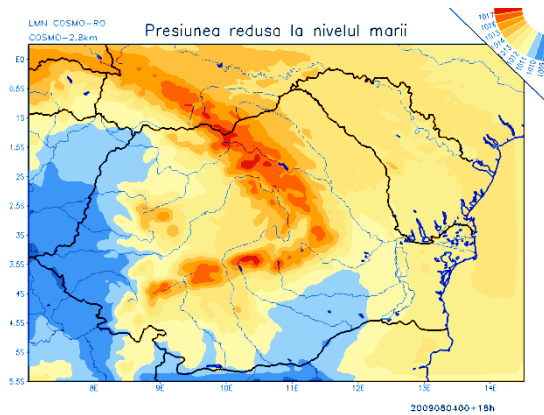

CAPE

CIN

Radar reflectivity

Sample of COSMO-Ro2 products

Temperature at 2m

Total cloud cover

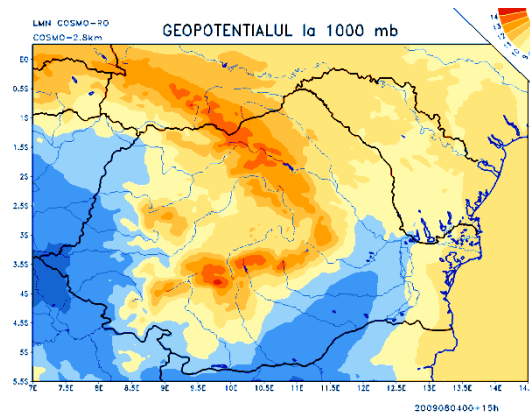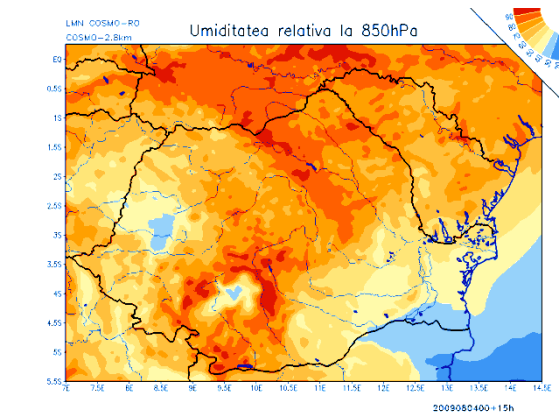**Wind velocity at 10m**
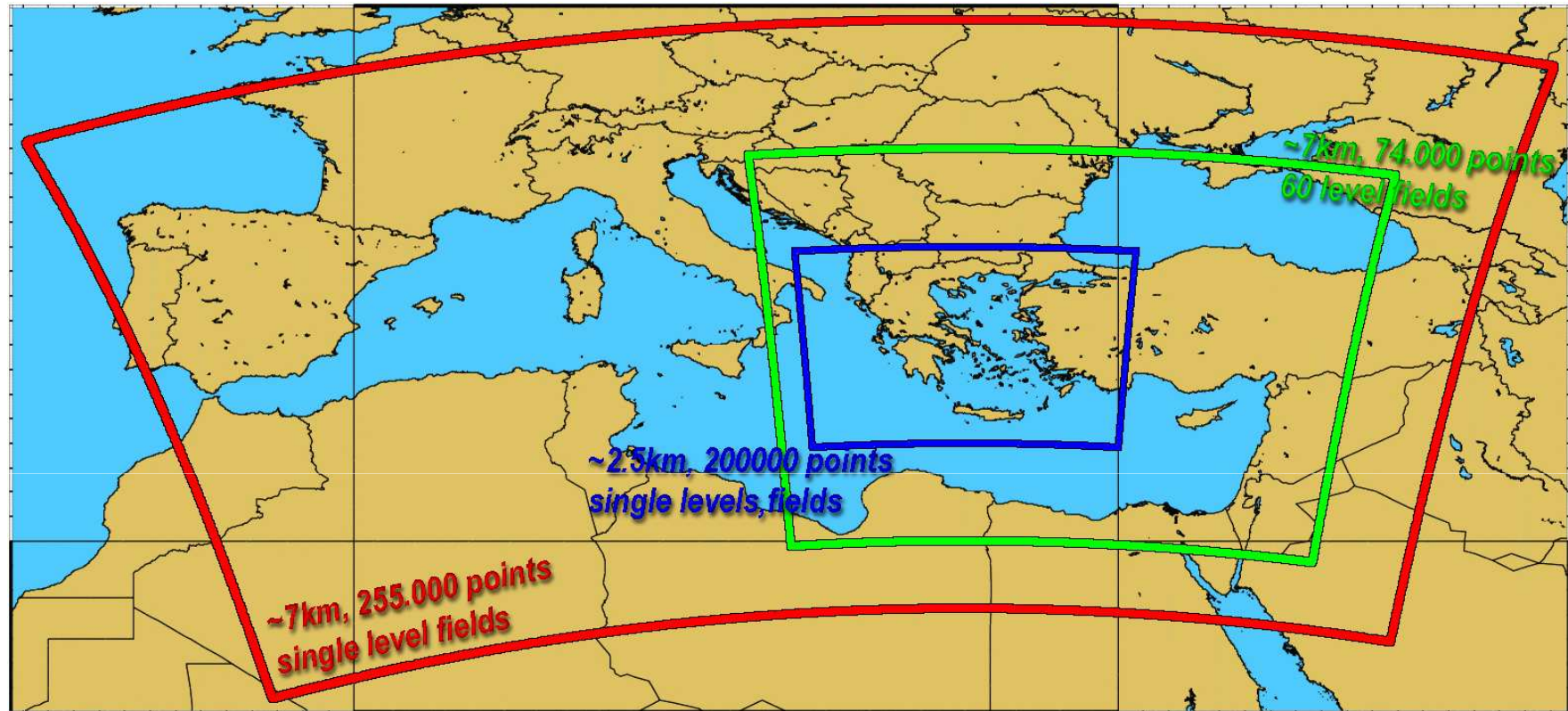

Mean see level preasure

Geopotential

Relative umidity

High-resolution COSMO-GR model in HNMS: first impressions
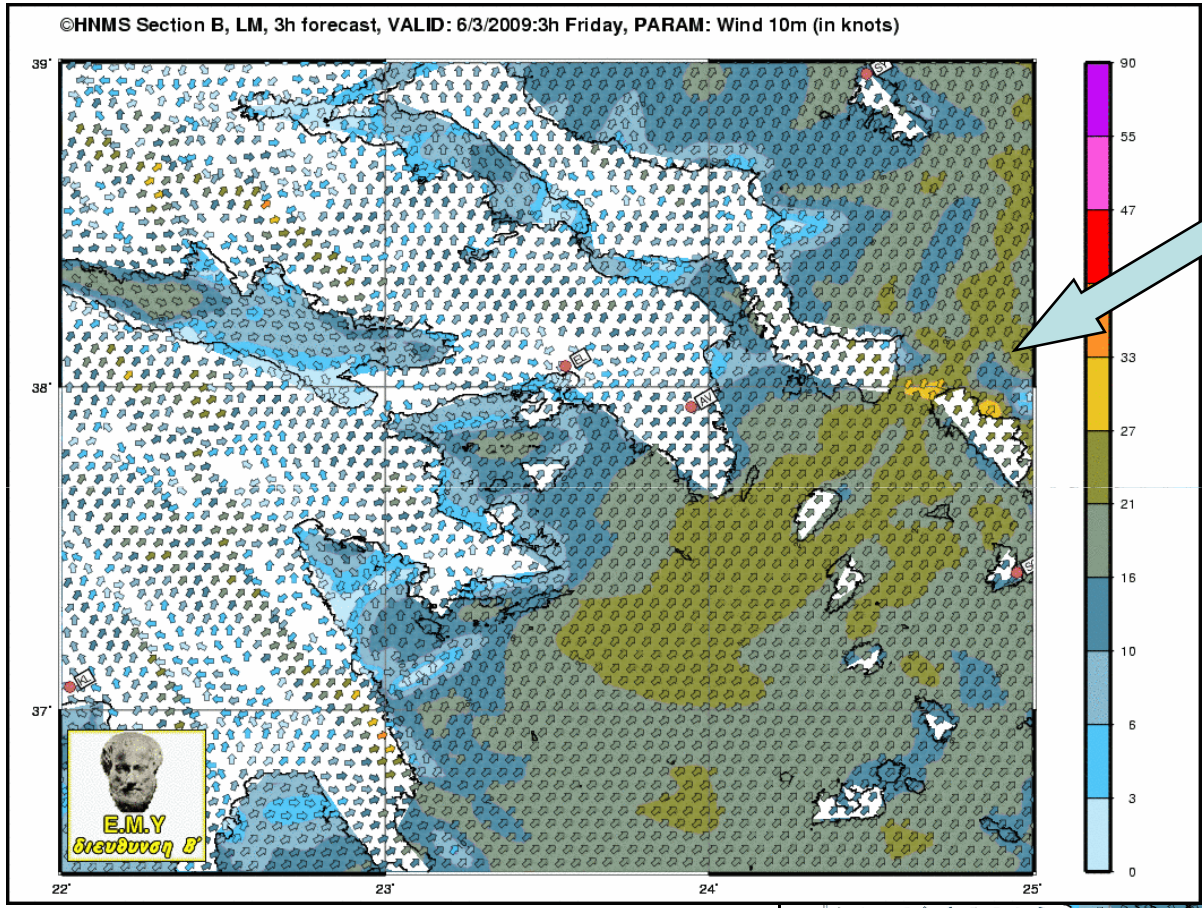

- **COSMO run at 7km over Mediterranean and Black sea since 2006**

- **Used to initialize the high-resolution ~2,5km model over Greece**
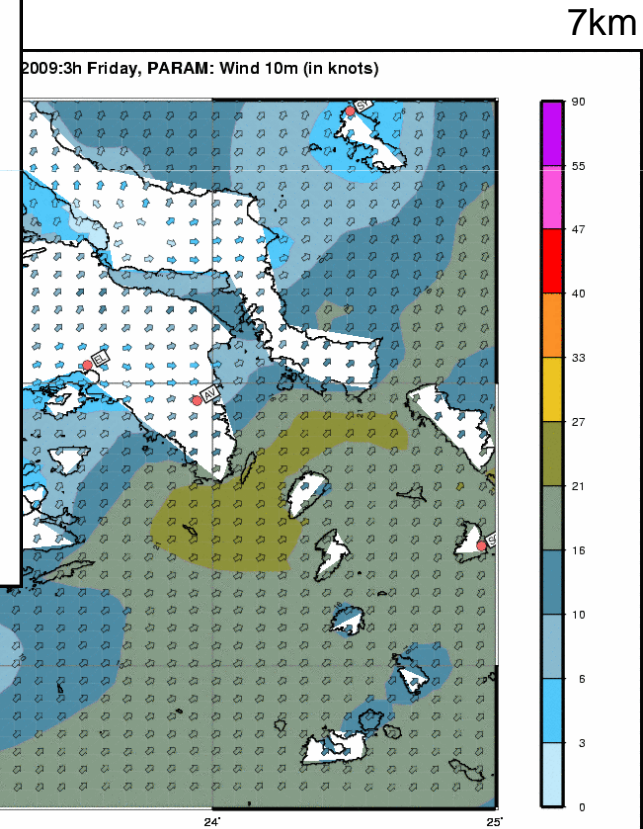
High-resolution COSMO-GR model in HNMS: first impressions
10m Wind

©HNMS Section B, LM, 3h forecast, VALID: 6/3/2009:3h Friday, PARAM: Wind 10m (in knots)

2.5km

7km

Local wind force increase not observed in the 7km run

High-resolution COSMO-GR model in HNMS: first impressions
Precipitation

7km

2.5km
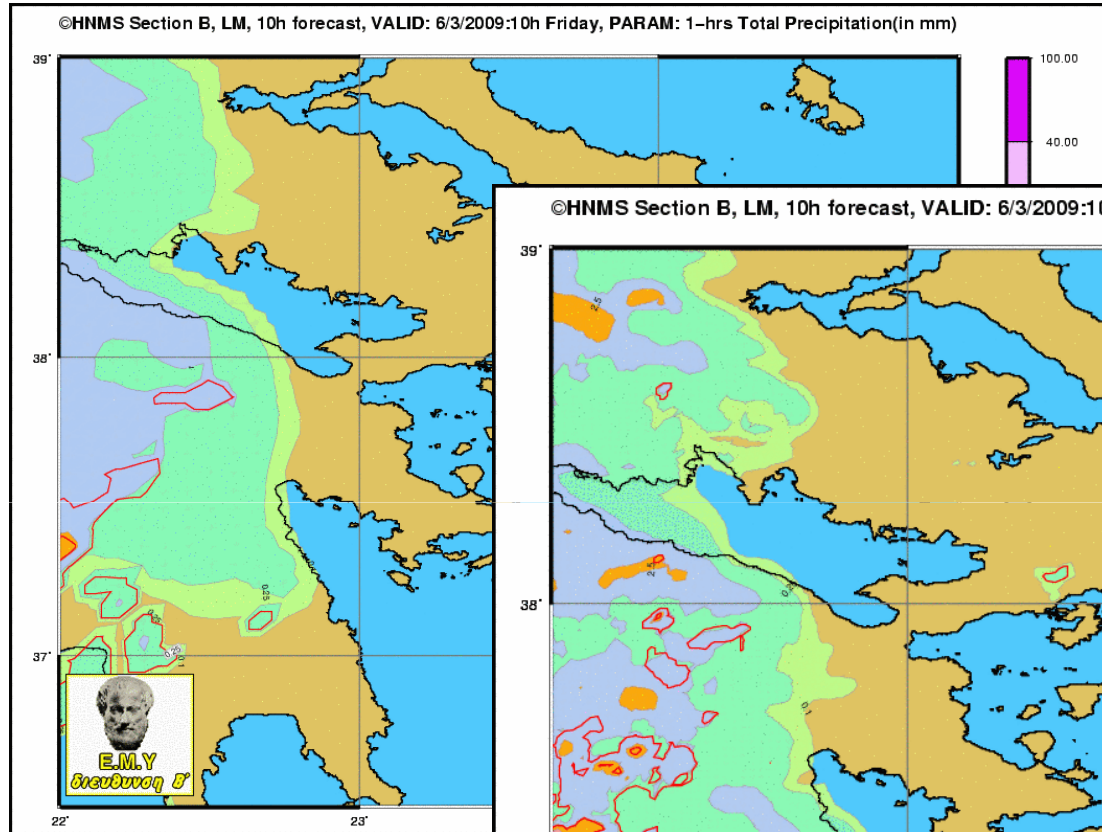
More detailed distribution of precipitation

Convection resolving COS
philippe.steiner@meteoswis
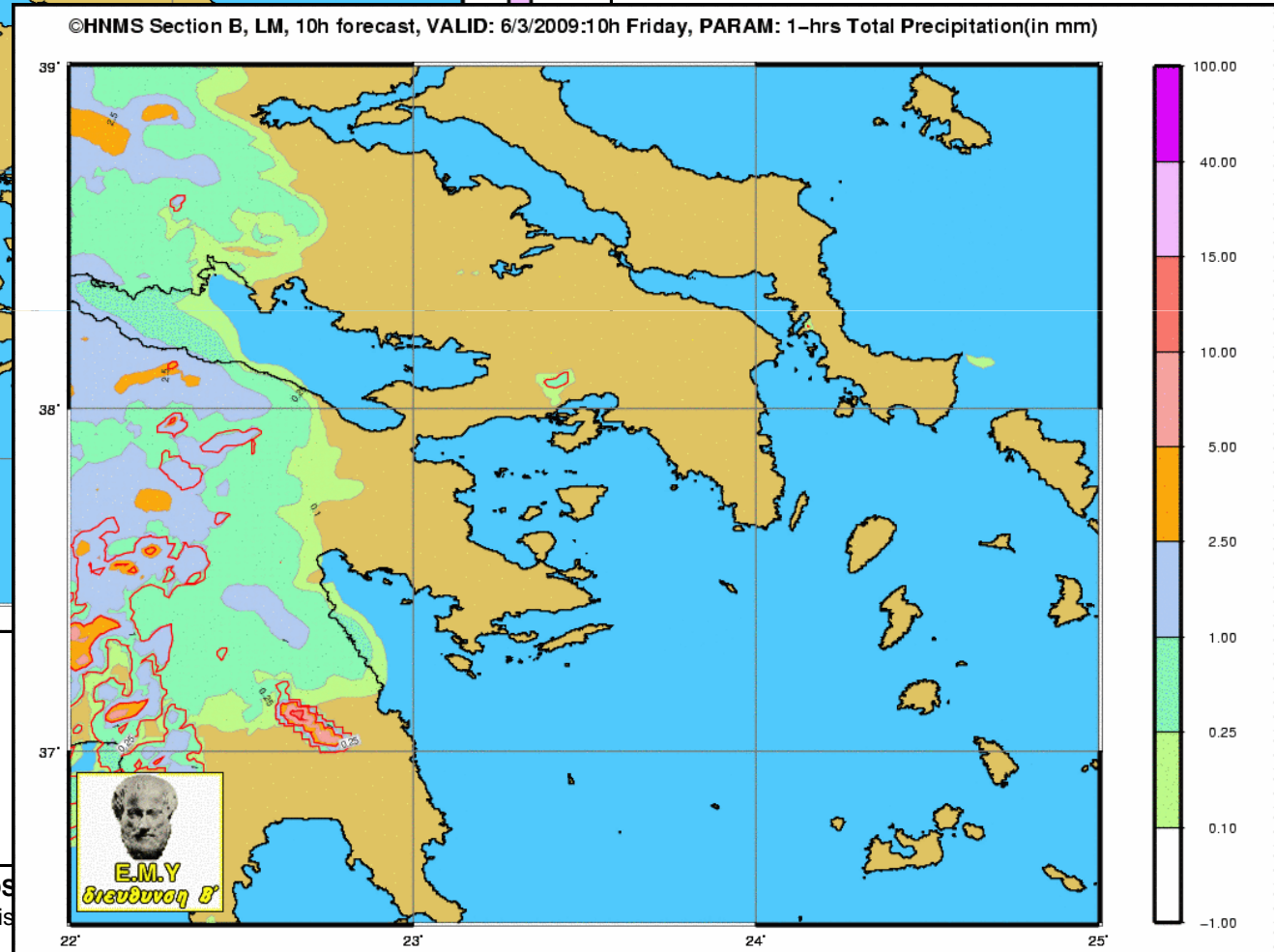
Experimental model at ARPA-SIMC
COSMO-RC (Rapid updating Cycle)

- Hor. Grid spacing 2.8km

- 45 vertical levels

- Runge-Kutta numerical scheme

- Small integration area over Northern Italy

- 4 x18h forecasts (6h assimilation cycles)

- Runs on Linux cluster at ARPA-SIMC

- Own assimilation cycle (nudging) of:

    - clear sky MSG data through 1d-var

    - radar rain rates through 1d-var

    - conventional observations (including local networks) through nudging

- Plans to enlarge the integration area and increase the forecast frequency in 2010