IMPACT OF RADAR DATA ASSIMILATION ON WRF SIMULATIONS OF THE ANIENE FLOOD

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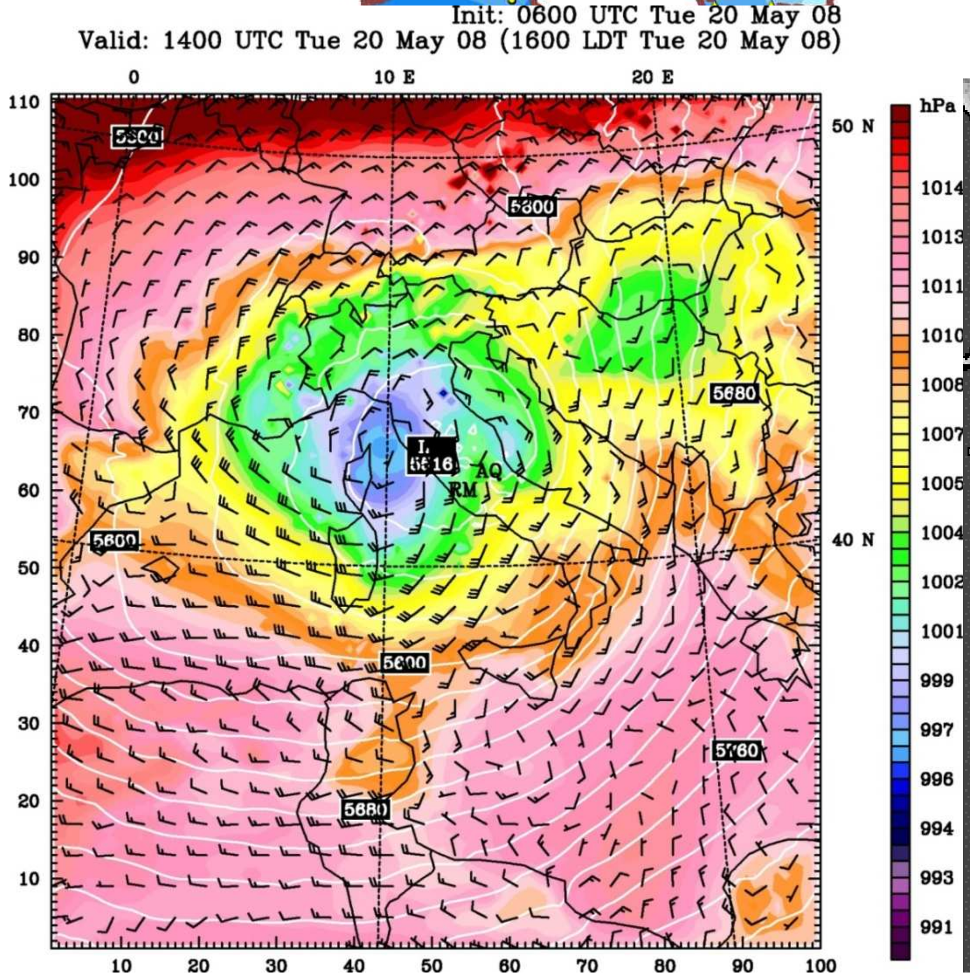
INTRODUCTION

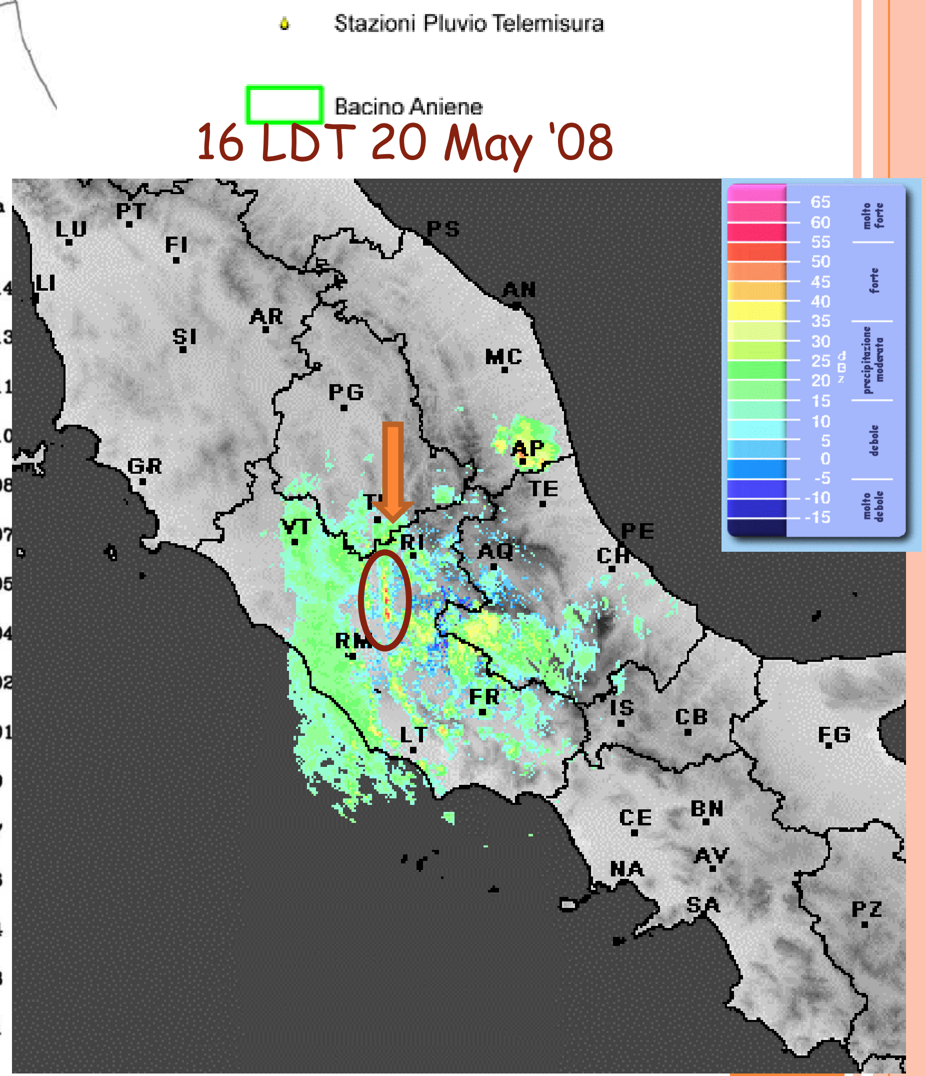
- Assimilation of Doppler radar data may improve the small-scale structures in the initial conditions, reduce the model spin-up time, and enhance the short-time NWP skills.

- The objective of this study is to investigate **the impact of the 3DVAR data assimilation of Dual-Doppler radar data (radial velocity and reflectivity) for a heavy rainfall case: the Aniene event, occurred during May 19-22, 2008 in the urban area of Rome.**

- Sensitivity to scale lengths and coefficients relative to the calculation of the reflectivity has been done. Model results are presented in term of both reflectivity and accumulated rainfall, and statistical estimators.

A HEAVY RAINFALL CASE: THE ANIENE EVENT





RADAR DATA

PYLON OF 50 METERS IN MONTE MIDIA

MAIN TECHNICAL CHARACTERISTICS:

SITE: height 1660 m, 42.38° lat, 13.32° lon

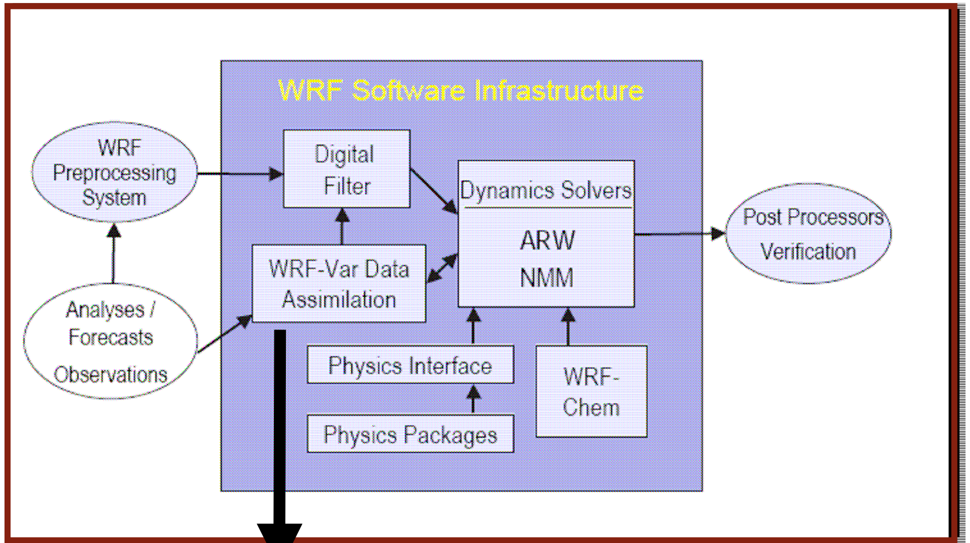
ANTENNA: parabolic reflector with a radome, 2.44 m diameter, horizontal linear polarization

TRANSMITTER AND RECEIVER:
magnetron, with a power of maximum 250 kw at 5.64 ghz with a PRF of 250 hz and 787 (intensity mode), 885 and 1180 (velocity mode)

RANGE AND MAXIMUM VELOCITY:
480/120 km intensity/velocity mode

MEASURED PARAMETERS:
Z (reflectivity), Vr (radial velocity), σVr (spectrum broadness)

MODEL DESCRIPTION



WEATHER RESEARCH & FORECASTING 3rd VERSION

NON- HYDROSTATIC MODEL WITH PRIMITIVE EQUATIONS, WHICH USES A VERTICAL MASS COORDINATE THAT FOLLOWS THE GROUND

Input Data	*Format*	*Created By*
First Guess	NETCDF	WRF Preprocessing System (WPS) and real.exe or WRF
Observations	ASCII (PREPBUFR also possible)	Observation Preprocessor (OBSPROC)
Background Error Statistics	Binary	WRF-Var gen_be utility

⇨ WRF PREVIOUS FORECAST OUTPUT (WARM-START)

⇨ GTS OBSERVATIONS and RADAR DATA

⇨ BACKGROUND ERROR MATRIX GENERATED BY THE NMC METHOD

3D-VAR IN RADAR DATA ASSIMILATION

Error source for heavy precipitation

- **RICHARDSON'S LINEARIZED EQUATION**

  this is a balanded eq. Based on continuity, hydrostatic and adiabatic assumption, including vertical velocity increments in the Analysis

- **OBSERVATION OPERATOR FOR DOPPLER RADIAL VELOCITY**

  mixing cartesian velocity u, v, w terminal velocity and radial velocity

- **OBSERVATION OPERATOR FOR DOPPLER REFLECTIVITY**

  to estimate precipitation intensity

- **DUDHIA'S WARM RAIN PROCESS**

  to include the four major processes of the hydrometeors cycle

$Z = aR^b$ in dBZ

default values are : $a=2.04\ 10^4$, $b=1.75$

New coefficients estimated for Monte Midia Radar (Montopoli et al.,2009) :

$a=5.34$; $b=3.38$

MODEL CONFIGURATION AND EXPERIMENTS CARRIED-OUT

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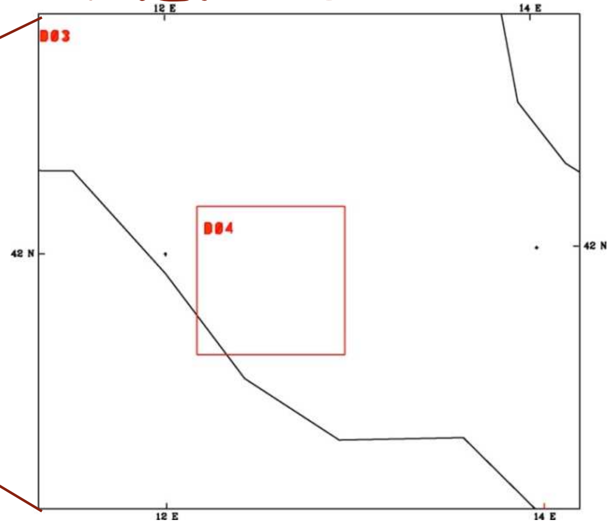


DOM. 1 = 21.2 KM

DOM. 2 = 7.06 KM

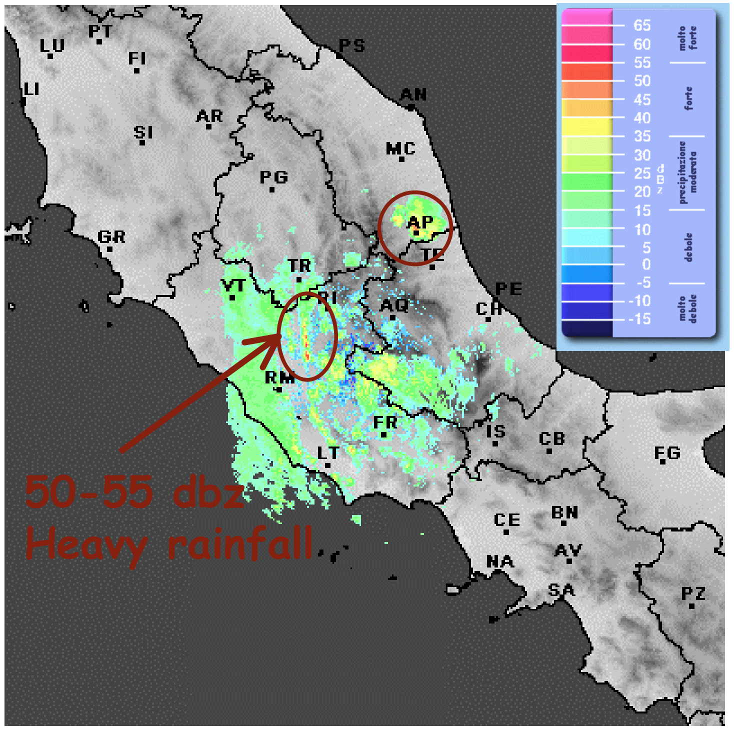
DOM. 3 = 2.35 KM

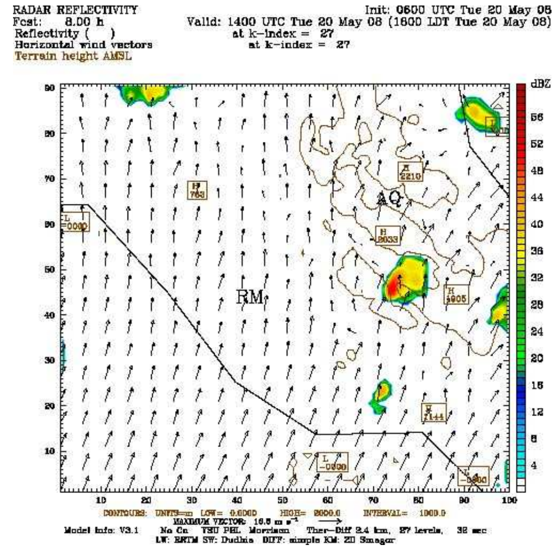
DOM. 4 = 785 M

old_GTS+RADAR (exp1)	A 24h warm-start simulation with 26 vertical levels, Morrison's scheme as microphysics and length scale value 1.0
new_GTS+RADAR_1.0 (exp2)	A 24h warm-start simulation obtained from a 3h-DA CYCLE, with 37 vertical levels, WSM6 scheme as microphysics and length scale value 1.0
new_GTS+RADAR_0.1 (exp3)	A 24h warm-start simulation obtained from a 3h-DA CYCLE, with 37 vertical levels, WSM6 scheme as microphysics and length scale value 0.1
new_GTS+RADAR_0.3 (exp4)	A 24h warm-start simulation obtained from a 3h-DA CYCLE, with 37 vertical levels, WSM6 scheme as microphysics and length scale value 0.3

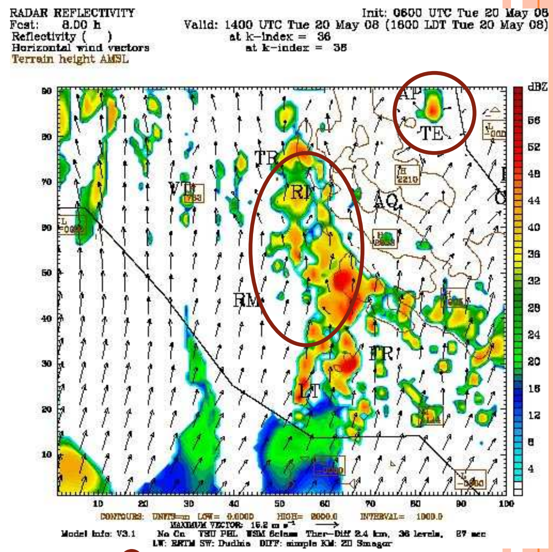
RESULTS:
OBSERVED AND SIMULATED REFLECTIVITY

Convective cells
16 LDT 20 May '08

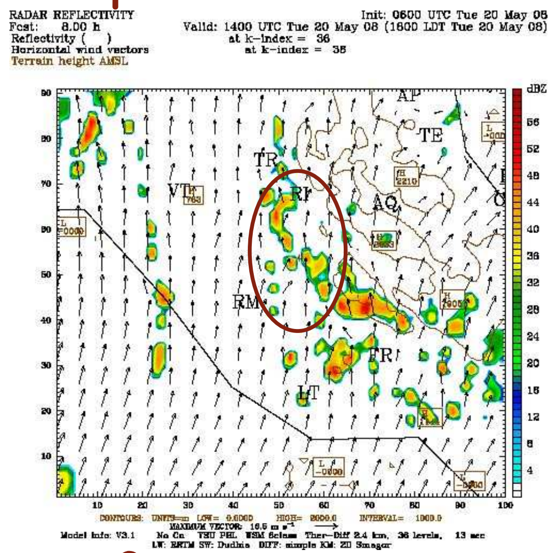




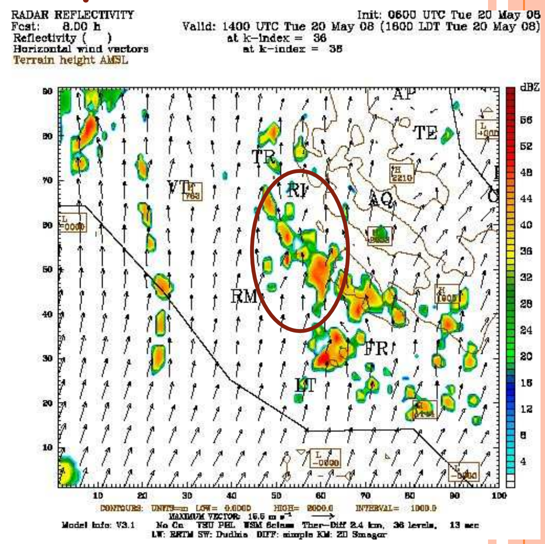
exp1



exp2



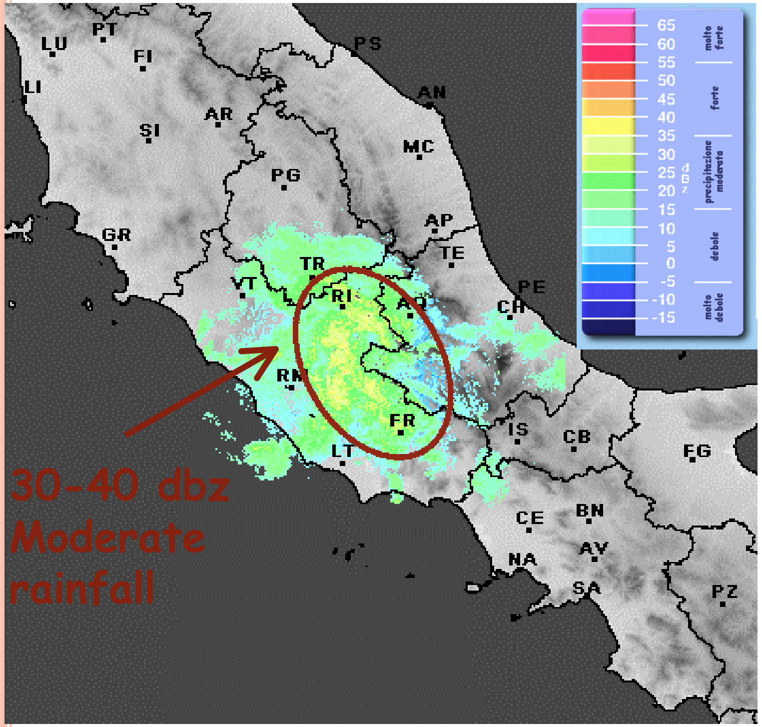
exp3

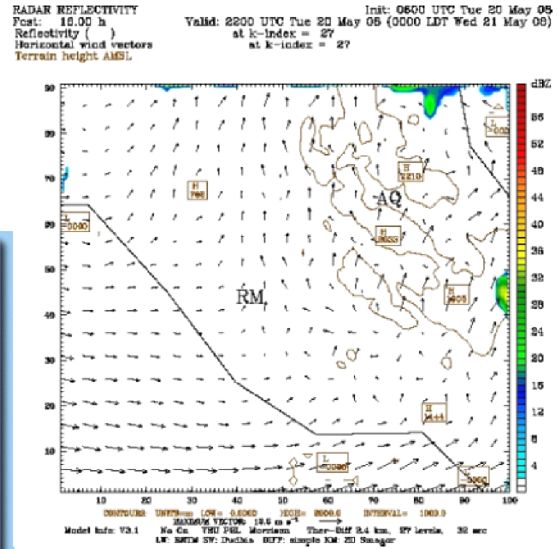


exp4

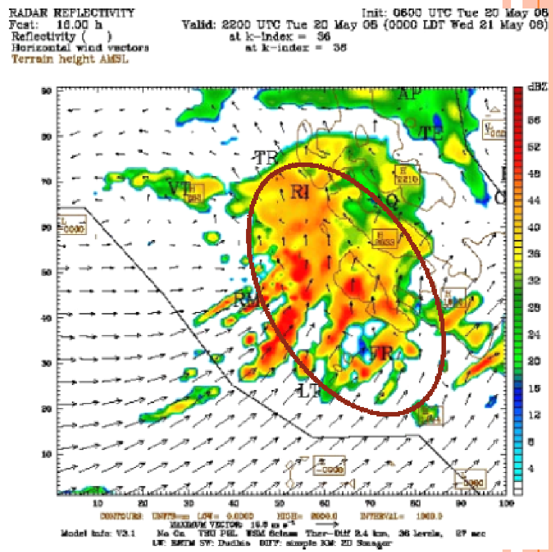
RESULTS:
OBSERVED AND SIMULATED REFLECTIVITY

Stratiform rainfall
00 LDT 21 May '08

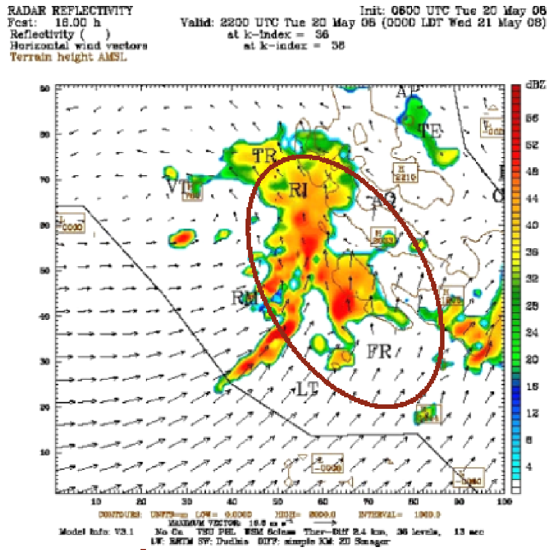




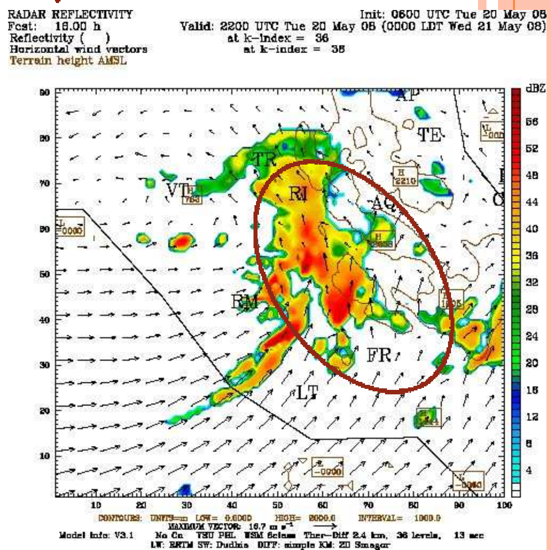
exp1



exp2

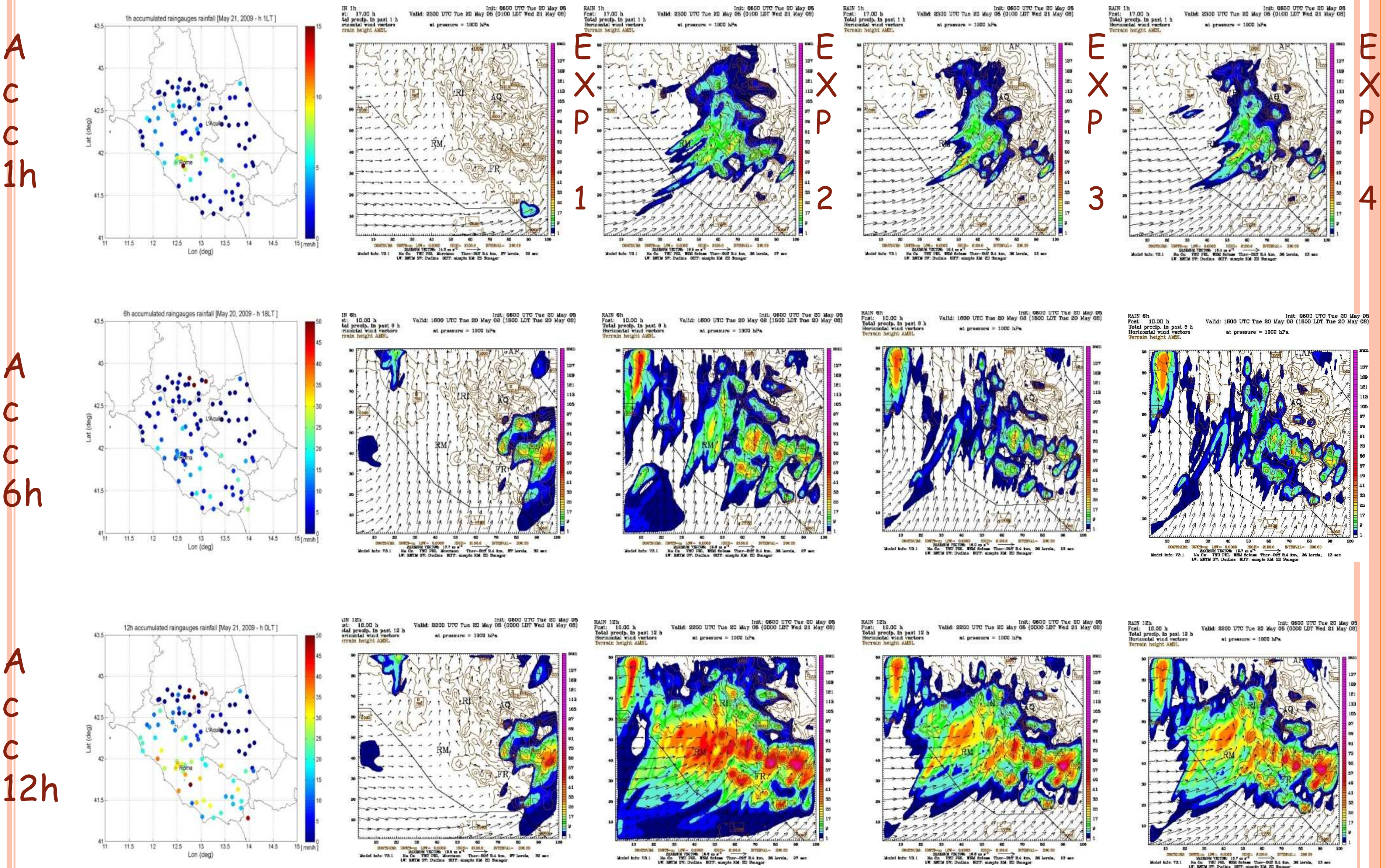


exp3



exp4

RESULTS:
ACCUMULATED AND RETRIEVED RADAR RAINFALL



STATISTICAL INDICATORS

$$ACC = \frac{d+a}{a+b+c+d} \qquad FAR = \frac{b}{a+b}$$

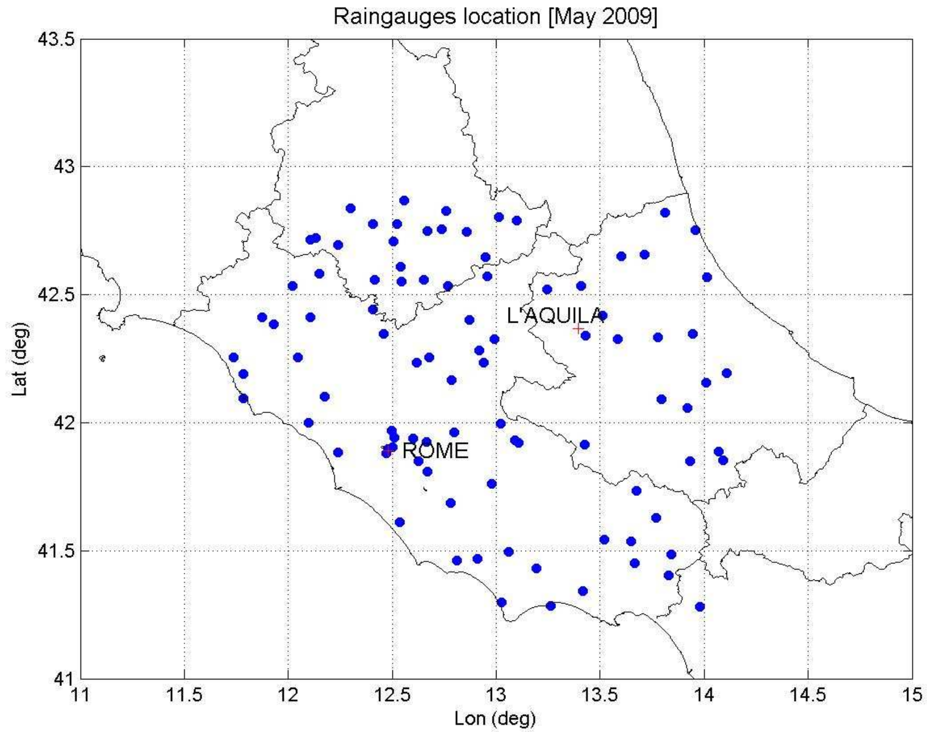
$$FBIAS = \frac{b+a}{c+a} \qquad EQTS = \frac{a-R}{a+b+c-R}$$

$$RMS = \sqrt{\frac{\sum_{i}^{N} (obs_i - \text{mod}_i)^2}{N}}$$

	$\text{mod} \geq \tau$	$\text{mod} < \tau$
$\text{obs} \geq \tau$	a	c
$\text{obs} < \tau$	b	d

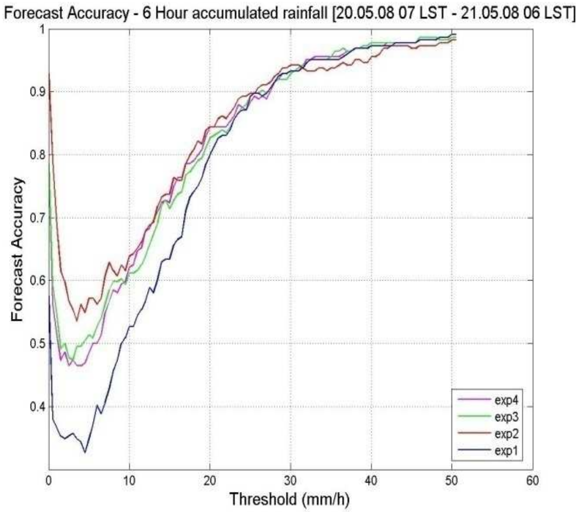
CONTINGENCY TABLE

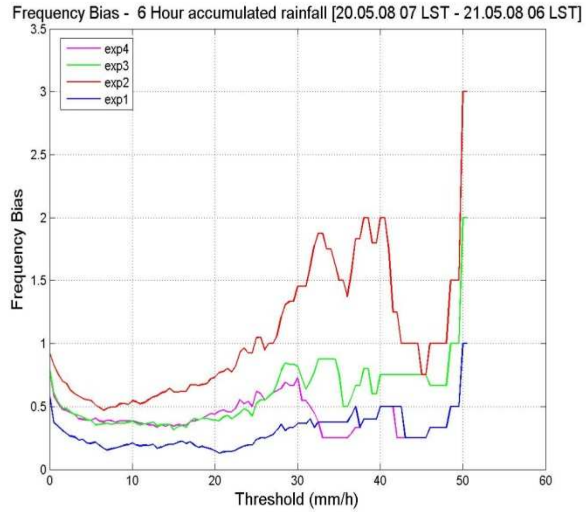
INDICE	ACC	FAR	FBIAS	EQTS	RMS
BEST VALUE	1	0	1	1	SMALL

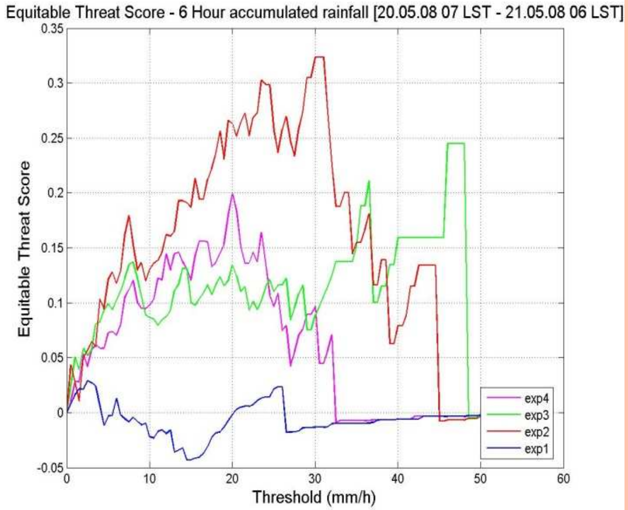


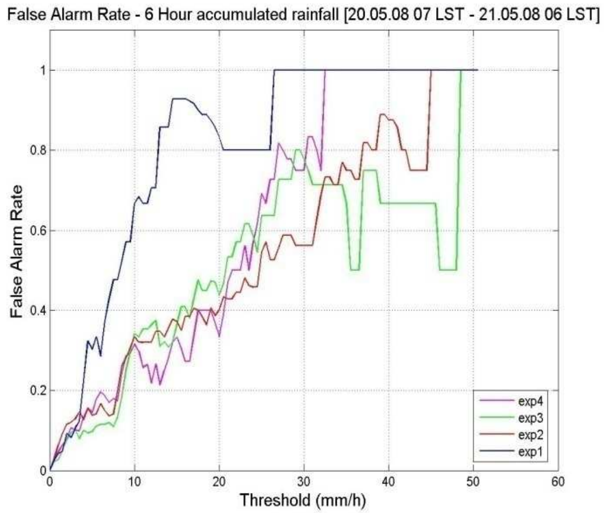
POSITION OF THE 93 RAIN GAUGING STATIONS FROM WHICH THE DATA DERIVES

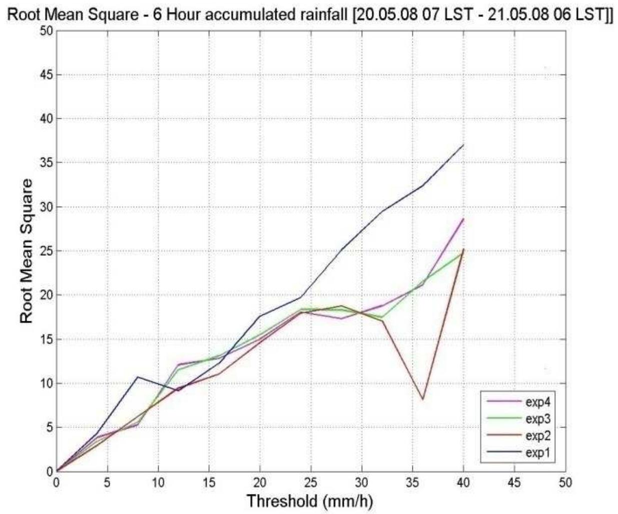
STATISTICAL RESULTS:
6-h accumulated rainfall



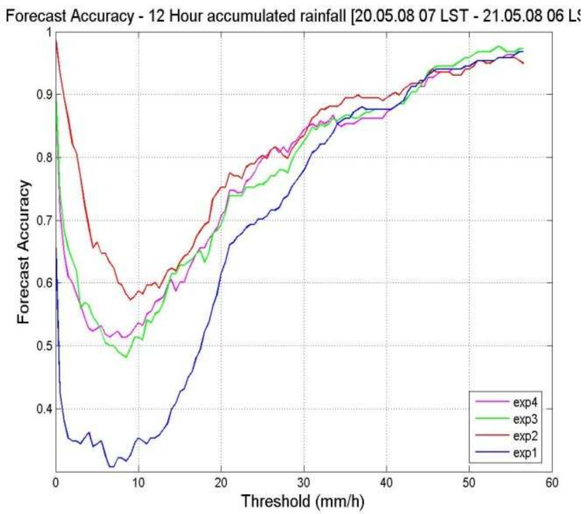


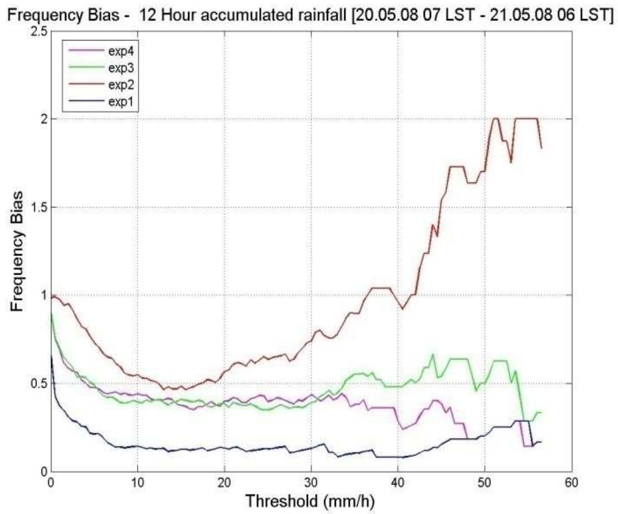


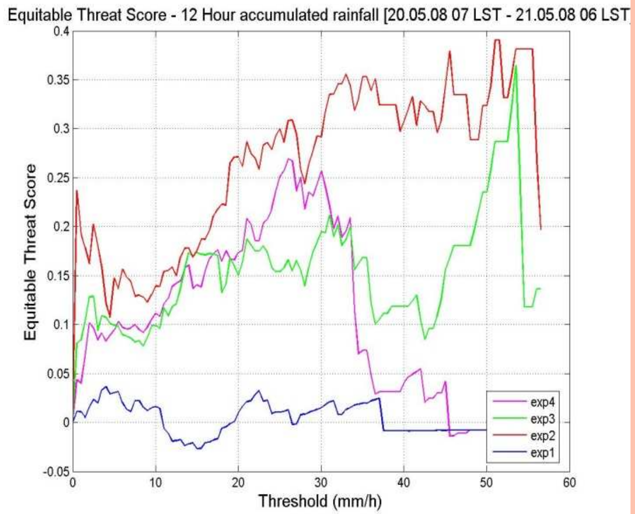


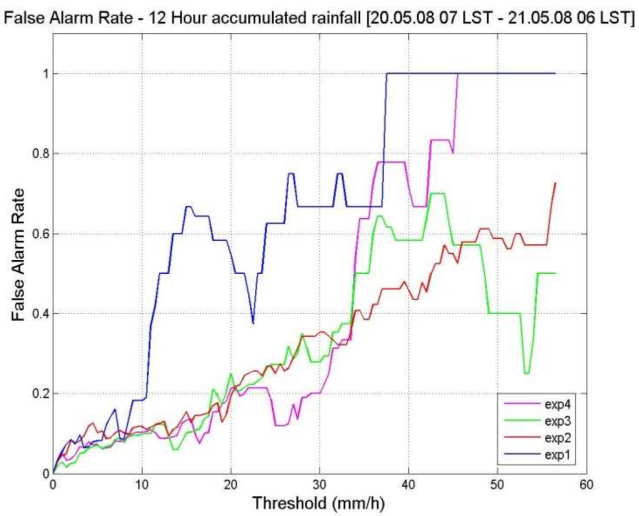


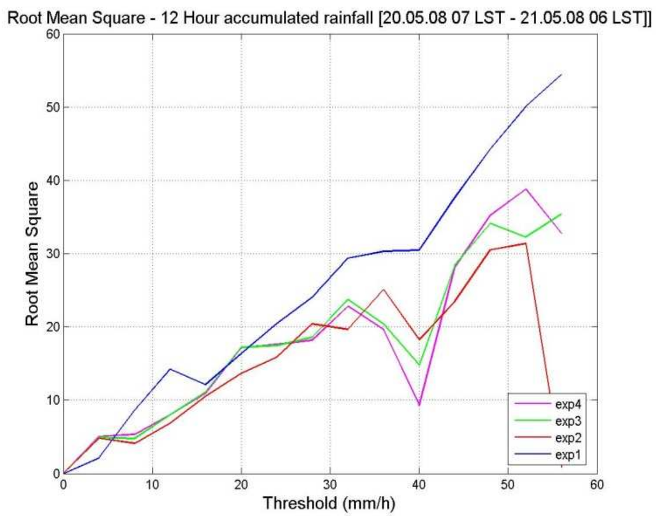
STATISTICAL RESULTS:
12-h accumulated rainfall











CONCLUSIONS

- Good ability of the model to reproduce both local convection and large scale precipitation using "cycling run mode", in particular for the experiments obtained from 3h-DA CYCLE.

- Among all experiments, 4th one seems to be that better reproduce the event, both concerning reflectivity and accumulated rainfall.

- The statistical estimators clearly show a better performance of the experiments using a scale-length factor smaller than 1.0 , that is the 3rd and 4th experiments.

FUTURE DEVELOPMENTS

- Improvement of the DA cycle strategy.
- Further tuning of length-scale factors.
- BE matrix for all domains.

THANK YOU