Development of a Rapid Update Cycle system using radar and conventional data for short-term forecasting. Preliminary results on a severe weather event

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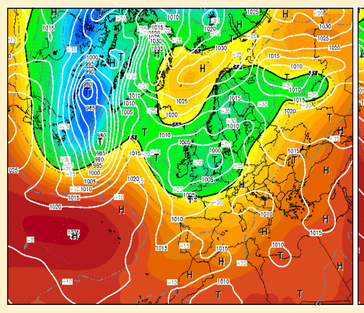
Abstract

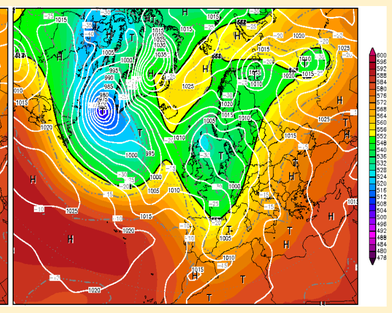
The Italian territory have numerous areas particularly exposed to hydrogeological and hydraulic risk, a problem of great social impact, both for the number of victims and for the huge damages produced. The complex orography and the presence of small river basins, which quickly respond to the precipitations, make the territory particularly vulnerable to intense and persistent phenomena. In the last decade the reliability of short-term forecasts has greatly improved and a further step has been made in estimating the initial conditions using data assimilation techniques that allow both the use of conventional and non-conventional observations, such as radar and satellite data. In order to improve the estimation of short-term quantitative precipitation forecasting (SQPF) an iterative assimilation system called *Rapid Update Cycle* (RUC) is implemented using the *3D-Var* variational technique. The algorithm uses a very high frequency assimilation cycle of *in-situ* surface and radiosonde observations in combination with radar reflectivity data on a high resolution domain (3km). The analyzed event is characterized by the intrusion of colder air into the Mediterranean basin that produced a minimum depression over the Ligurian Sea. The associated cold front generates intense rainfall and high instability over Liguria and Tuscany regions in the first part of October 14, 2012. Then, it moves towards central and north-eastern Italy during the afternoon and evening, causing precipitation peaks higher than 160 mm/24h. The event is analyzed using the *Weather Research and Forecastin*g (WRF) numerical model. Three different experiments (NODA, SYN and CNTRL) have been performed in order to evaluate the impact of RUC on different types of observed data. In addition, a statistical analysis has been carried out using different verification techniques from the *Model Evaluation Tools* (MET).

IOP13 SYNOPTIC OVERVIEW: OCTOBER, 14-15th 2012

VALID: 14 OCT 00 UTC

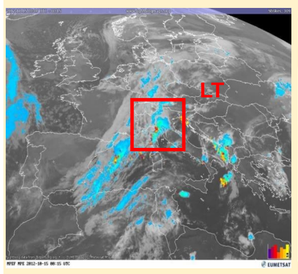


VALID: 15 OCT 00 UTC



A wide upper level trough over France with a cold front moving and advecting low level moist air towards Corsica and Italy

15 OCT 00:15 UTC



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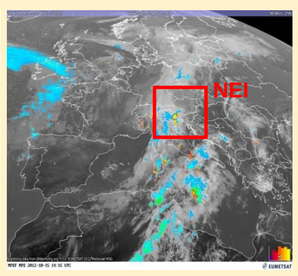

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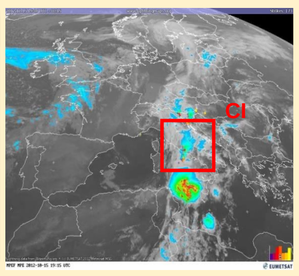
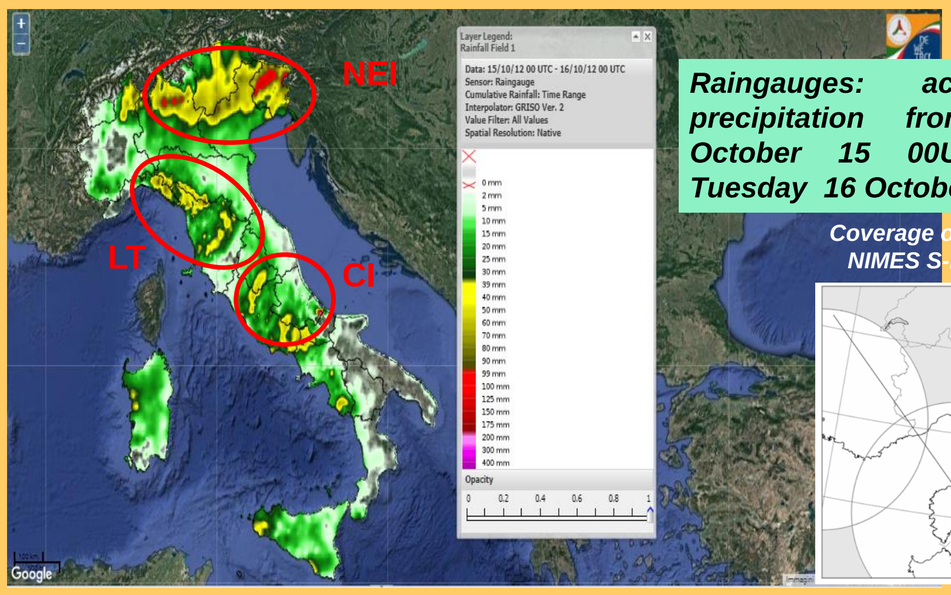


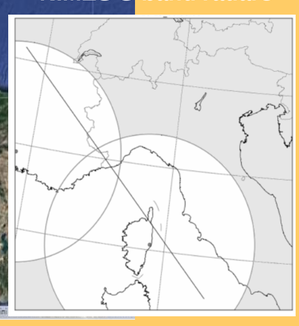
Evolution of satellite images (Meteosat MSG from EUMETSAT) and lightnings data (from Blitzorthung) over three target areas: Liguria-Tuscany, North East Italy and Central Italy

IOP13 OBSERVATIONS: DEWETRA RAIN GAUGES & RADAR DATA COVERAGE



Raingauges: accumulated precipitation from Monday October 15 00UTC to Tuesday 16 October 00UTC

Coverage of ALERIA and NIMES S-band radars

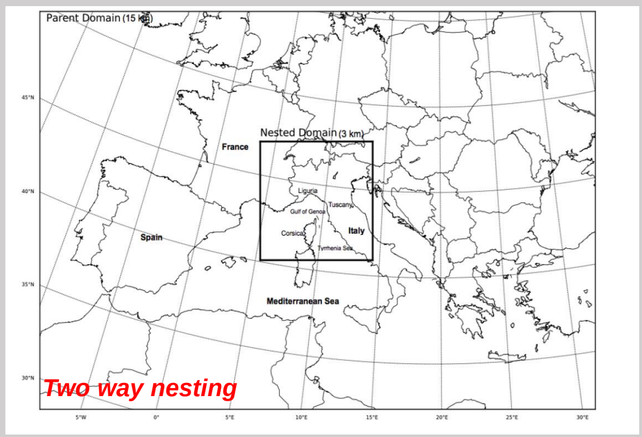


The rainfall maxima reached 160 mm/24h in NEI, 120 mm/24h in LT and 60 mm/24h in CI

WRF-DA MODEL SETUP

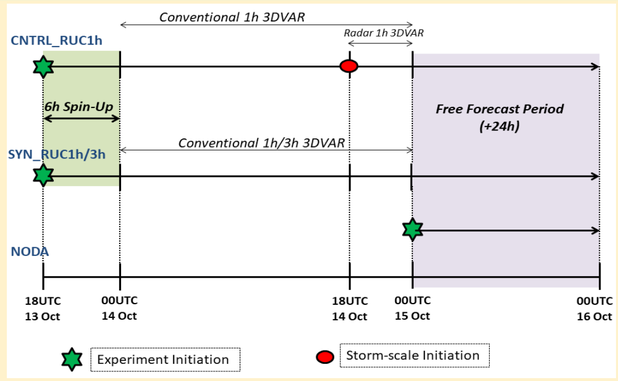
PARENT DOMAIN:
- 248 X 169 horizontal grid dimensions
- 15km horizontal grid spacing
- 50 vertical levels

NESTED DOMAIN:
- 251 X 251 horizontal grid dimensions
- 3km horizontal grid spacing
- 50 vertical levels



Physics options	D01	D02
Microphysics	New Thompson	New Thompson
Cumulus	Kain-Fritsch	Resolved
Planetary boundary layer	YSU	YSU
Short-wave radiation	Dudhia	Dudhia
Long-wave radiation	RRTM	RRTM

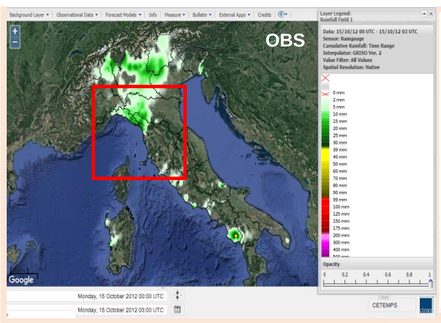
EXPERIMENTAL DESIGN

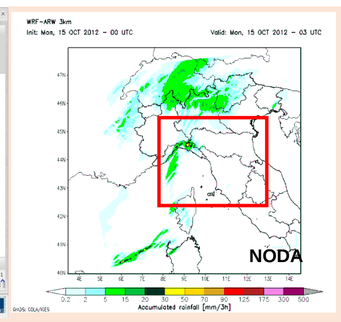


Both in the scheme on the left and in the table below, the experiments conducted and the assimilation procedure are summarized

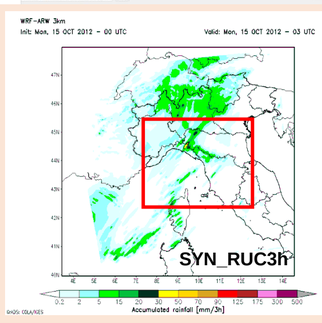
Experiment	Assimilation	Kind of data	RUC
NODA	no	/	/
SYN_RUC3h	yes	conventional	3h
SYN_RUC1h	yes	conventional	1h
CNTRL_RUC1h	yes	conventional+radar	1h+1h

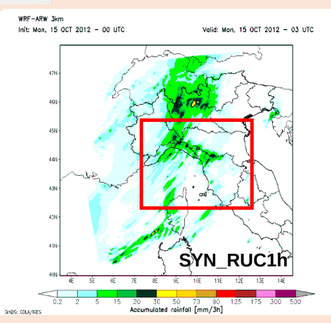
RESULTS: ACC3h 00-03 UTC 15 OCTOBER, 2012

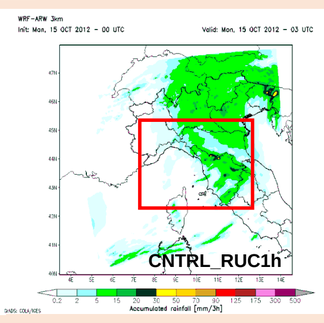




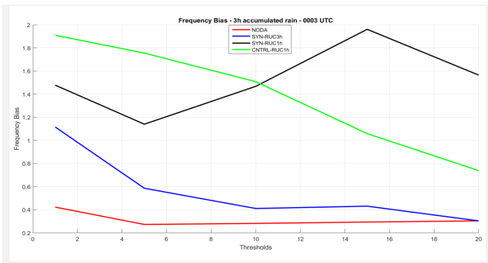
Qualitative comparison over LT of 3h accumulated rainfall (00-03UTC of Oct 15) among observations and the 4 experiments (NODA, SYN_RUC3h, SYN_RUC_1h and CNTRL_RUC1h)





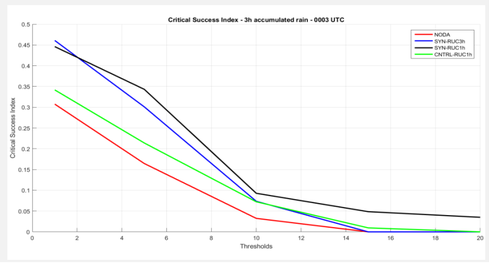


VERIFICATION ANALYSIS



A "good" value of Frequency Bias is close to 1: SYN_RUC1h (black curve) has quite good values for thresholds until 10mm/3h; CNTRL_RUC1h (green curve) has values too much greater than 1 until 10mm/3h that indicates the event is forecasted too frequently.

Critical Success Index is strongly related to FBIAS and the best value is 1: SYN_RUC1h (black curve) is the experiment that gives the best response for all thresholds; NODA (red curve) is the worst.



CONCLUSIONS & FUTURE DEVELOPMENTS

- *Concerning the qualitative analysis, SYN_RUC1h seems to be the best over LT, both concerning rainfall localization and intensity*
- *The two statistical indeces confirm the good response of SYN_RUC1h*
- *Test of a 15min RUC with radar data will be performed*
- *Comparison between RUC 3DVAR and EnKF will be conducted*
- *A spatial verification between the predicted and observed rainfall fields will be done*

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