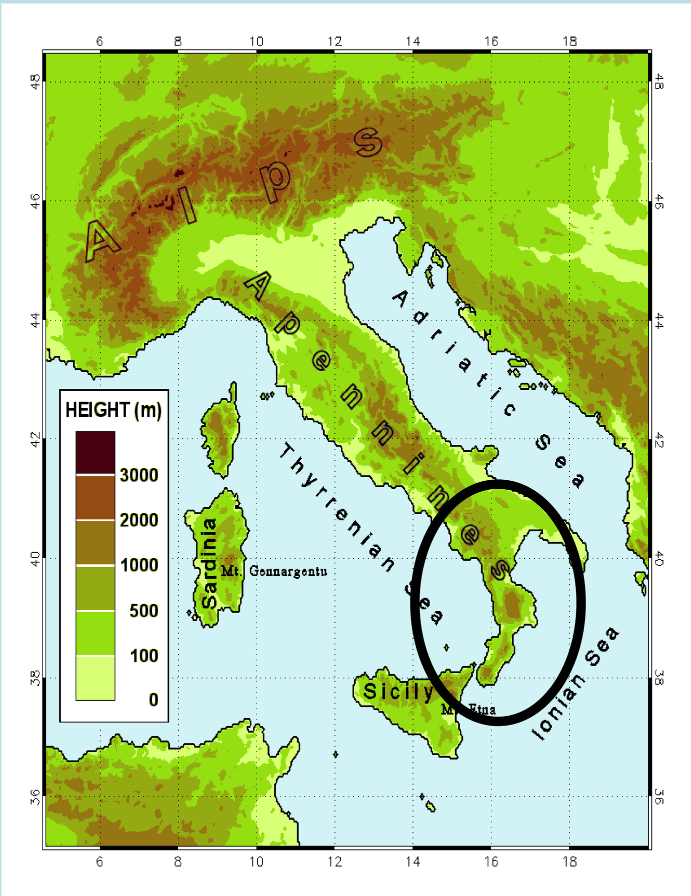
Displacement errors of quantitative precipitation forecasts over the Calabria region

Nazario Tartaglione[1], Stefano Mariani[2,3], Marco Casaioli[2], Christophe Accadia[4], Stefano Federico[5]
[1)] Univ. Camerino [2)] APAT [3)] Univ. Ferrara [4)] EUMETSAT [5)] CRATI

INTRODUCTION

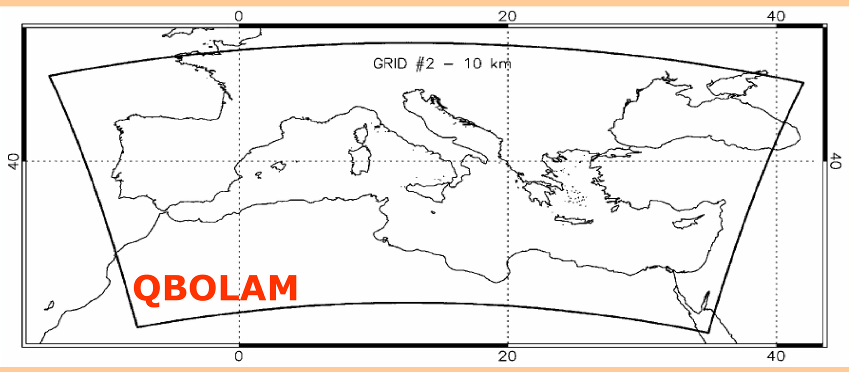
This work was initially started in the frame of a collaboration among APAT–Dept. for Inland and Marine Waters Protection, the CNR–Institute of Atmospheric Science and Climate and the CRATI consortium. The first aim was the QPF verification (Federico et al., *Nuovo Cimento*, 27 C, 2005) of two limited area models (LAMs), namely RAMS and MM5, set–up by CRATI for weather forecasting over Calabria.

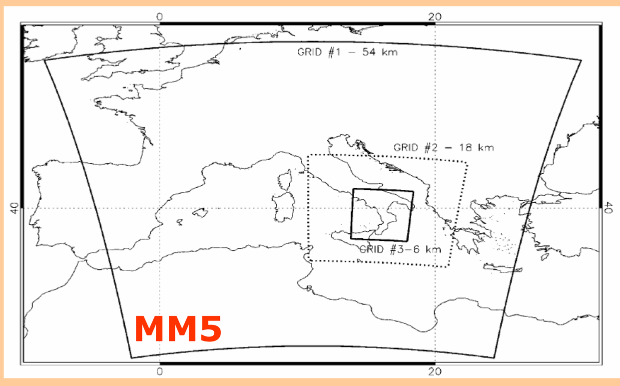
In addition, the precipitation fields modelled by QBOLAM (APAT's forecasting system) were included into the intercomparison as well. This model was previously evaluated over northern Italy – 8 months – and then considering a two-year dataset over Italy.

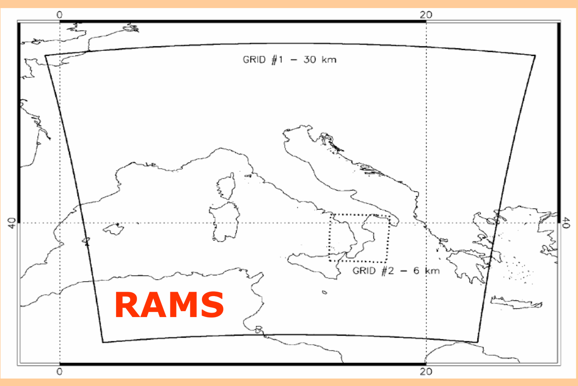


Geomorphological map of Italy and the verification area shown by the ellipse.

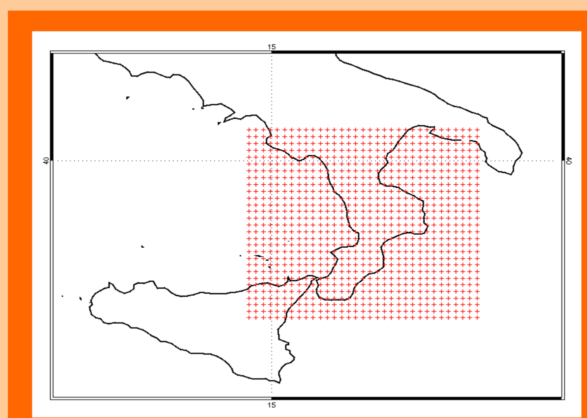
LAMs AND VERIFICATION DOMAINS





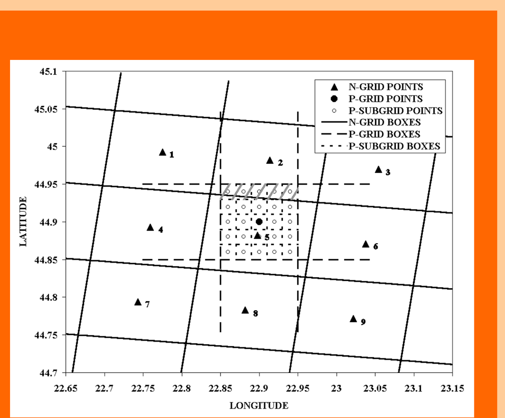


QBOLAM is a 10-km hydrostatic model operational at APAT. MM5 and RAMS are both 6-km non-hydrostatic models operational at the CRATI consortium.



Verification domain, with a 0.1° grid spacing.

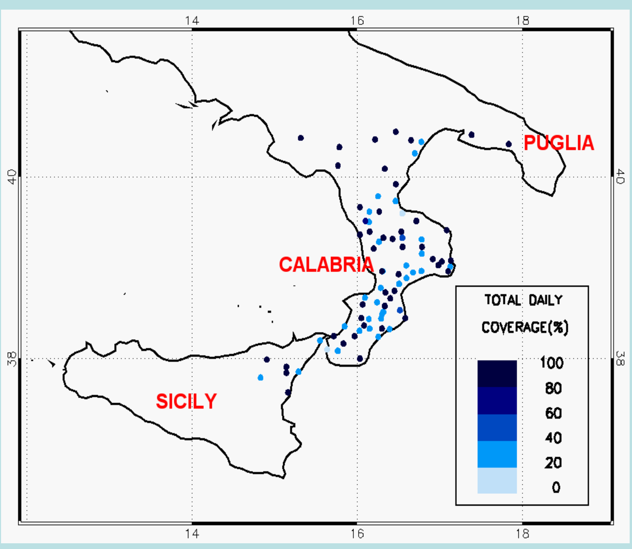
Forecast fields have been interpolated over a 0.1° verification domain (red area in the left panel) using remapping (Accadia et al., *Wea. Forecasting*, 18, 2003, see the right panel).



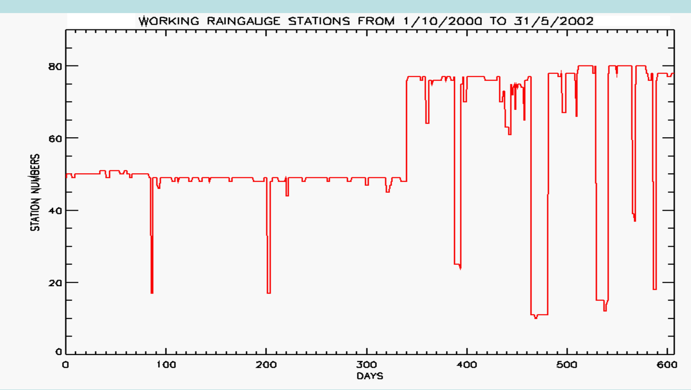
Schematic example of remapping.

OBSERVATION DESCRIPTION

Rain gauges belong to the former Italian National Hydrographic and Marigraphic Service (SIMN; #73), the Regional Service of Sicily (#7) and CRATI (#4).



On the left, geographical distribution of the available rain gauges used to verify LAMs. The blue shading indicates the total daily coverage during the considered 20-month period, from October 2000 to May 2002. The gridded analysis of the precipitation field has been obtained using a two-pass Barnes procedure (Barnes, *J. Appl. Meteor.*, 3, 1964).

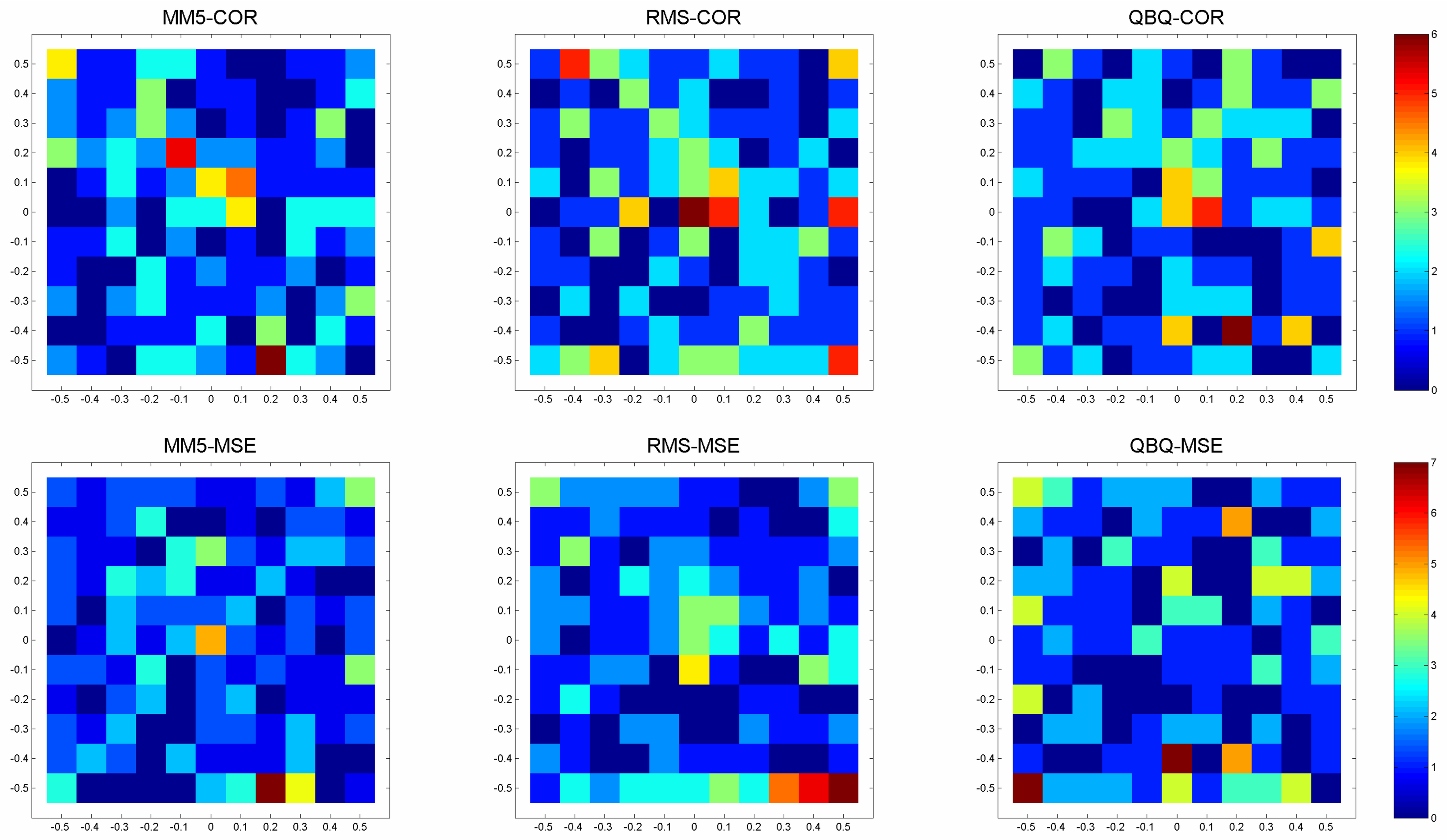


Time series (608 days) of the number of working rain gauges during the considered time period.

Corrisponding author: Nazario Tartaglione
E–mail: nazario.tartaglione@unicam.it

THE CONTIGUOUS RAIN AREA ANALYSIS

The assessment of the agreement between observed and forecast fields is obtained by employing the CRA analysis (Ebert and McBride, *J. Hydrol.*, 239, 2000): an object-oriented technique based on a pattern-matching of two contiguous areas, observed and forecast, delimited by a chosen isohyet (in this case: 0.5 mm day^{-1}). For each day, the forecast pattern has been shifted in lat.–lon. from −5 × 0.1° to 5 × 0.1°.



CRA results using the correlation maximization (top panels) and the MSE minimization (bottom panels), as pattern-matching criteria.

AN OVERALL EVALUATION

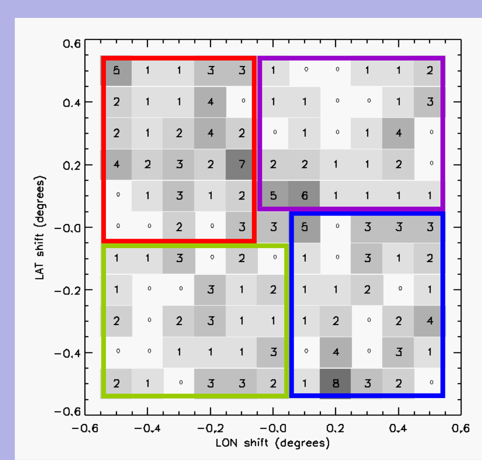
In order to summarize the CRA results and characterize the forecast spatial error over the N-E, S-E, S-W and N-W areas, the CRA Mean Shift (CMS) index is introduced.

$$\text{CMS} = \sum_{i=-N}^{N} \sum_{j=-N}^{N} f_{i,j} \cdot w_{i,j} \in \left[0, N\sqrt{2}\right]$$

where :

- N is the maximum shift value (in this case $N = 5$);
- $f_{i,j}$ is the shift frequency in i, j obtained by dividing the number of shift in i, j with the total number of shift (in this case 202);
- $w_{i,j} = \sqrt{i^2 + j^2}$ measures the distance of the CRA best shift in i, j.

The contribution of each area is obtained by calculating the CMS index only over the *i, j* pairs belonging to the area and then dividing for the total CMS.



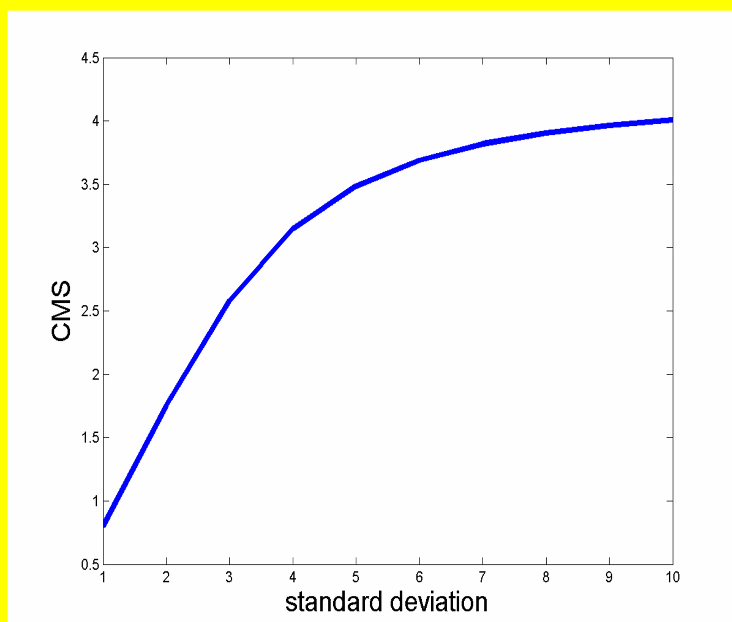
Model	Matching criterion	Total shift number	CRA Mean Shift	N-E shift (%)	S-E shift (%)	S-W shift (%)	N-W shift (%)
MM5	CORR	202	4.030	17.66	30.38	20.44	31.52
MM5	MAE	217	3.987	25.74	28.87	20.36	25.04
MM5	MSE	217	4.101	24.79	29.00	21.63	24.58
QBOLAM	CORR	165	3.995	24.93	27.21	24.08	23.78
QBOLAM	MAE	174	4.437	21.75	24.25	27.25	26.75
QBOLAM	MSE	174	4.486	22.26	23.10	28.11	26.52
RAMS	CORR	182	4.050	21.65	31.23	21.37	25.76
RAMS	MAE	196	4.282	19.92	35.35	18.29	26.44
RAMS	MSE	196	4.340	19.87	33.94	21.29	24.90

Despite the difference of the total shift number (shift frequencies into CMS are indeed normalized with this value!), all models show an average forecast shift of about 40 km (CMS × 0.1°).

However, a slight preference for the S-E area is obtained: precipitation is forecast north-westerly. The minimum average CRA shift is found when using the correlation maximization.

EXPECTED VALUE OF CMS

If we consider an overall evaluation of models, all show a CMS value around 4, which is not particularly good. With the hypothesis of independence of the spatial displacement errors, we expect a Gaussian-like distribution. With a Gaussian distribution having a stand. dev. σ=2Δx (Δx=0.1°), we should have a low value of CMS (less than 2).



CMS as a function of the standard deviation value (σ), supposing that displacements are Gaussian distributed.