VALIDATION OF ONE-YEAR LAMI MODEL RE-ANALYSIS ON THE PO-VALLEY, NORTHERN ITALY. COMPARISON TO CALMET MODEL OUTPUT ON THE SUB-AREA OF VENETO REGION

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INTRODUCTION

This work began as part of the CTN–ACE, year 2004, Task 09.01.04: models observatory with two application on Mediterranean Area (Italy) held by dr. Marco Deserti of ARPA-Meteorological Service of Emilia Romagna (SIM). The Task had the aim to prepare input data (emissions inventory, boundary conditions and meteorology) for an inter-comparison exercise between Quality Air Models and to test a possible operative chain in order to run daily an air quality model for the two areas of Italy: Padan-Adriatic (BPA) and Mediterranean (MED). In this framework SIM made a 1 year LAMI reanalysis, from March 2003 to April 2004. The aim of this work is to verify the quality of the surface wind field output of this reanalysis and to compare it with the one of the CALMET meteorological diagnostic model, currently in use in the ARPA-Veneto Meteorological Centre (CMT).

SHORT DESCRIPTION OF THE LAMI 3.9 REANALYSIS AT SIM

Lokal Modell (LM) is a state-of-the-art non-hydrostatic meteorological model; its development started at DWD and it is now carried on by the Weather Services of Germany (DWD), Switzerland, Italy and Greece through the COSMO consortium.

The LAMI (Limited Area Model Italy) project is based on an agreement among UGM and ARPA-SIM to produce a numerical forecast based on Lokal Model on Italy; it runs twice a day at 7 km horizontal resolution and 35 vertical levels.

For the CTN a year-reanalysis was run and the model output was split in the two areas of interest (see Fig. 2). This application has the following characteristics:

<u>Initial conditions</u>: the run is a composite of 732 runs, each 12hours long. For each run the upper initial conditions are given by the previous LAMI run whilst the surface condition are given by interpolation of the ECMWF analysis; <u>boundary condition</u>: one way nesting by Davies relaxation scheme; every 6 hours ECMWF analysis on 60 vertical levels and horizontal resolution 0.5°; <u>data assimilation</u>: nudging of observation (GTS data coming from UCEA for horizontal wind vector, potential temperature, relative humidity, 'near-surface' pressure) in a continuous cycle, with identical analysis increments used during 6 advection time steps. Data are analysed vertically first, and then spread along horizontal surfaces. The balance is achieved between hydrostatic temperature and geostrophic wind increments and 'near-surface' pressure analysis increments; <u>platform</u>: cluster Linux with 12 processors. Total run-time 40 CPU days; <u>resolution</u>: 7km in horizontal, 16 vertical levels up to 5000m.

SHORT DESCRIPTION OF CALMET APPLICATION AT CMT

CALMET is a diagnostic meteorological model, used to create the input for dispersion modelling. The surface wind field is calculated by interpolating the data, plus taking into account some features due to orography like slope flows. It is run on Veneto region by CMT with a resolution of 4 km and 10 vertical levels up to 3000m (see Fig. 2 for domain details). For this application the same surface data of the LAMI re-analysis have been used.

DATA SET FOR VERIFICATION

The CTN group collect data from different Italian Regional Meteorological Services in order to build a surface wind data-set for verification. Some of these meteorological stations have been rejected because they had too many missing data or because they were representative of a very local wind-regime. In Fig. 3 most of the selected stations are shown (in Veneto region they are too many): the wind rose display allows to reject station with strange behaviour.

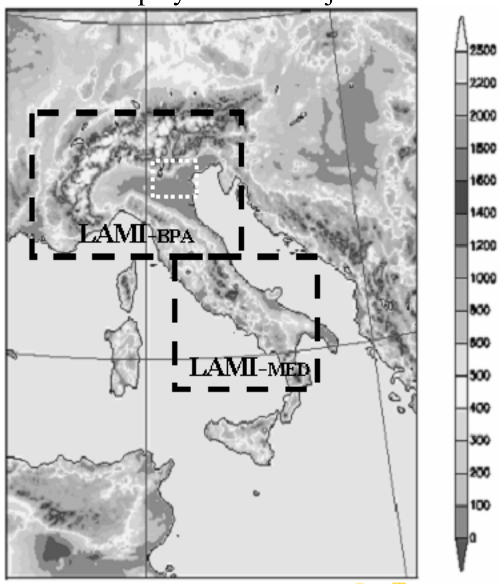


Fig. 2:LAMI domain, subareas for CTN (black) and CALMET domain (white)

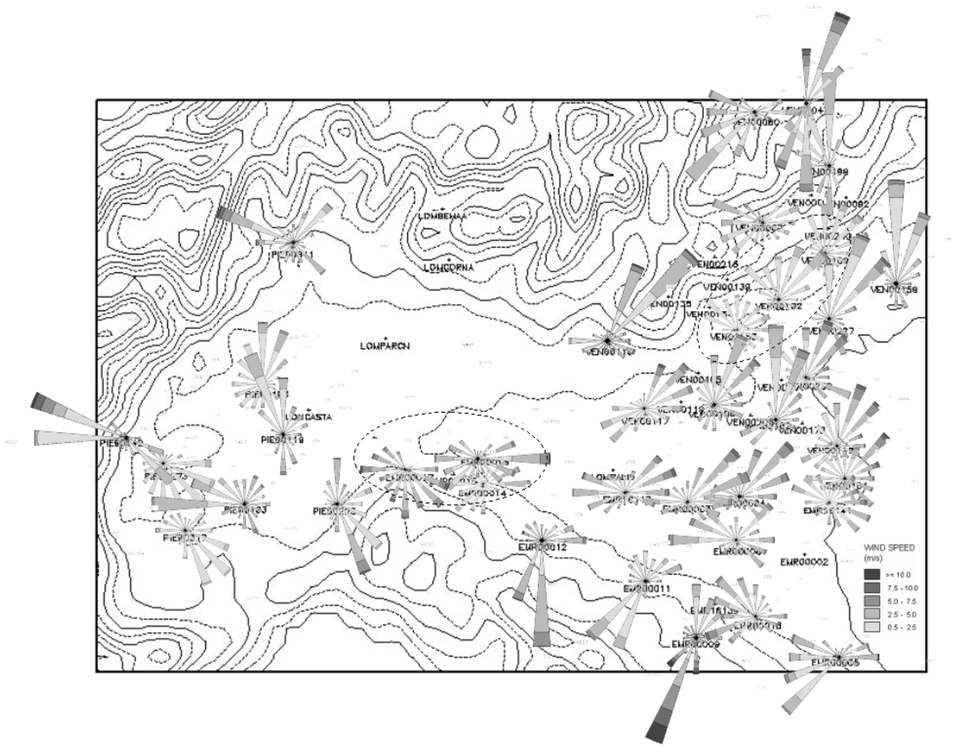


Fig. 3: wind roses for most of the selected surface stations

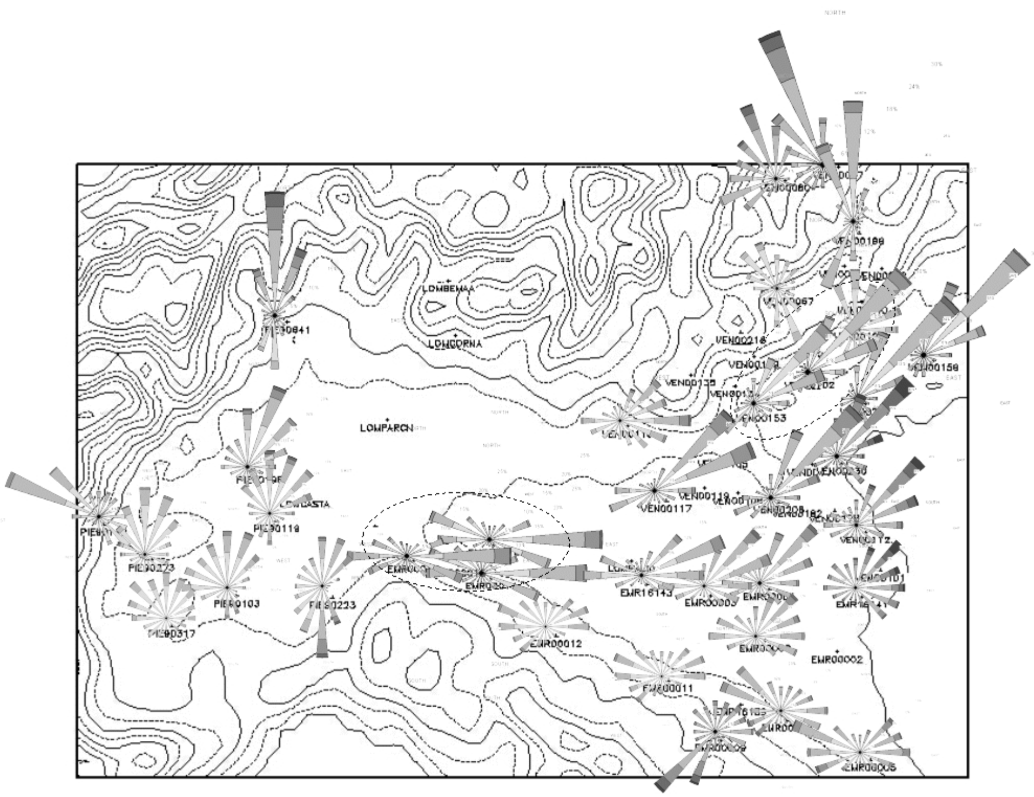
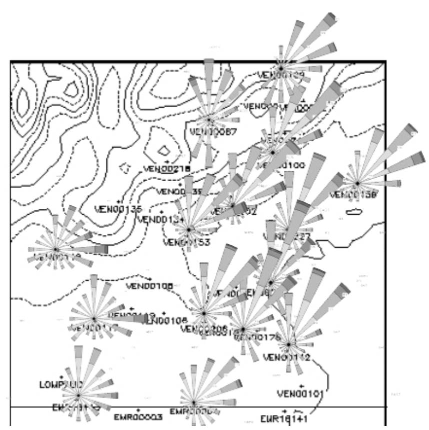


Fig. 4: wind roses for LAMI (up) and CALMET (right)



The Piemonte (PIE) stations are in the WEST, Emilia-Romagna (EMR) in the CENTER and SOUTH, Veneto (VEN) in the NORTH-EAST and are at 10 and 5m (the last are in mountainous regions). From this figures is possible to recognise that the LAMI model overestimates the strength of the north-estern wind (Bora) on the EAST-side of the PO-valley, in particular south of the Alps (marked with eastern oval). The LAMI model is also are overestimating the strength of the estern wind northern part of the Appennins (marked with the central oval). As expected the wind field of the CALMET model is much more uniform.

LAMI AND CALMET STATISTICALVERIFICATION

To evaluate the performance of the LAMI and CALMET wind field we calculated the statistical parameters reported below, where $wv_c(s,t)$ is the wind velocity calculated on the station *s* at the time *t* (one instantaneous value every hour), $wv_o(s,t)$ is the relative observed wind velocity (one hour-average on scalars value), ntot(*s*) is the total number of observations on station *s*, $\sigma_c(s)$, $\sigma_o(s)$ are the standard deviations.

$$BIAS(s) = \frac{\sum_t (\mathrm{wv_c(s,t) - wv_o(s,t)})}{\mathrm{ntot(s)}} \quad (3); \quad \mathrm{RMSE(s)} = \frac{\sqrt{\sum_t (\mathrm{wv_c(s,t) - wv_o(s,t)})^2}}{\sqrt{\mathrm{(ntot(s) - 1)}}} \quad (4)$$

$$\mathrm{SKILL - VAR(s)} = \frac{\sigma_c(s)}{\sigma_o(s)} \quad (5)$$

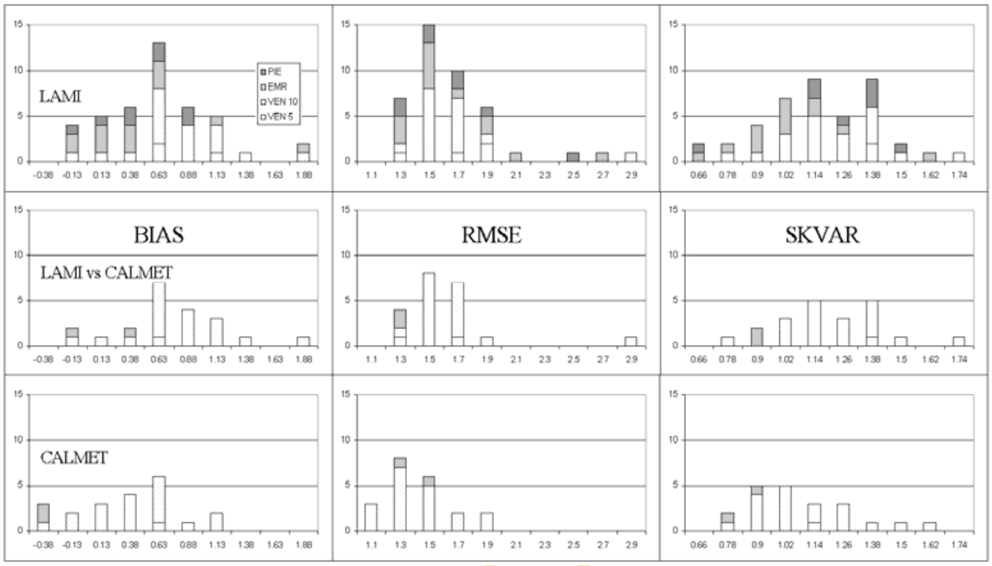


Fig. 5: distributions of statistical parameters on verification stations (wind velocity)

For the statistical evaluation for wind direction we consider the following indices: %30° and %60° (% cases with wind direction in agreement within 30° and 60°, respectively), also coupled with wind intensity range success (within 0.5 or 1 m/s) as in Table 8, last two rows.

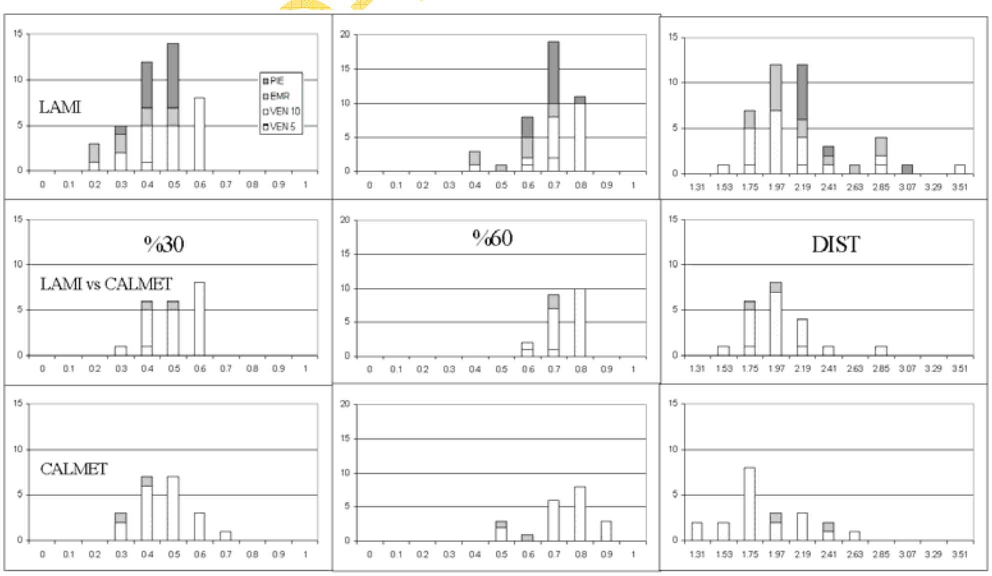


Fig. 6: distribution of statistical parameters on verification stations (wind direction)

DIST takes into account both wind intensity and direction (u(t,s) and v(t,s) being the wind vector components).

$$DIST(s) = \frac{\sum_t \sqrt{((u_c(t,s) - u_o(t,s))^2 + (v_c(t,s) - v_o(t,s))^2)}}{\text{ntot(s)}} \quad (6)$$

In Fig. 5 and Fig. 6 the histograms of the statistical parameter on verification stations are reported: the first rows of figures refer to LAMI model, BPA domain as in Fig. 4 (42 stations); the second rows refer to LAMI evaluated just on the surface stations inside the CALMET domain to be compared to the third, which refer to CALMET model (21 stations).

Table 8: MEDIANS for the distributions of some statistical values

MEDIAN value	LAMI				CALMET
	PIE	EMR	VEN	CALMET domain	
# DATA	8687	8358.5	8746.5	8758	8747.5
MODEL_MEAN	2.15	2.49	2.69	2.61	2.18
STATIONS MEAN	1.71	2.17	1.92	1.92	1.92
MODEL DEV	1.48	1.56	1.70	1.68	1.46
STATIONS DEV	1.21	1.56	1.37	1.44	1.44
BIAS (m/s)	0.52	0.31	0.74	0.69	0.31
RMSE (m/s)	1.60	1.44	1.63	1.58	1.40
SKVAR	1.32	1.02	1.24	1.17	1.03
R (correlation)	0.39	0.62	0.65	0.65	0.66
% SUCC 30°	0.31	0.43	0.42	0.44	0.42
% SUCC 60°	0.52	0.66	0.70	0.70	0.70
DIST (m/s)	2.13	2.07	2.04	2.00	1.79
% 0.5m/s & 30°	0.16	0.21	0.19	0.20	0.23
%1m/s & 60°	0.36	0.44	0.41	0.43	0.51

CONCLUSIONS

LAMI model overestimates systematically the wind intensity, especially in the Veneto and Piemonte regions; CALMET performs slightly better on the Veneto region but is still overestimating the wind. This could mean that the surface data set used in both models are not enough representative of the area wind regime, for example they do not describe properly the decay of Bora-wind in the hinterland. The fact that LAMI overestimate the wind more than CALMET, as can be seen by looking at the areas marked with ovals in Fig. 3 and Fig. 4, could mean that there is something to be adjusted in the dynamic interaction between wind and sea or orography, or in the boundary conditions. It has to be noted that on Piemonte the correlation (R) and the rates of success (%30 and %60) are particularly poor, in particular LAMI doesn't seem to model correctly the north-western component.

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