A Comparison of Nowcasting Methods on the Italian Radar Mosaic

Postgraduate Master (second level) in Meteorology and Oceanography

Valentina Gregori[1], Ferdinando De Tomasi[1], Gianluca Ferrari[2], Andrea Chini[2]

[1] Università del Salento, Piazza Tancredi 7, 73100, Lecce (LE)

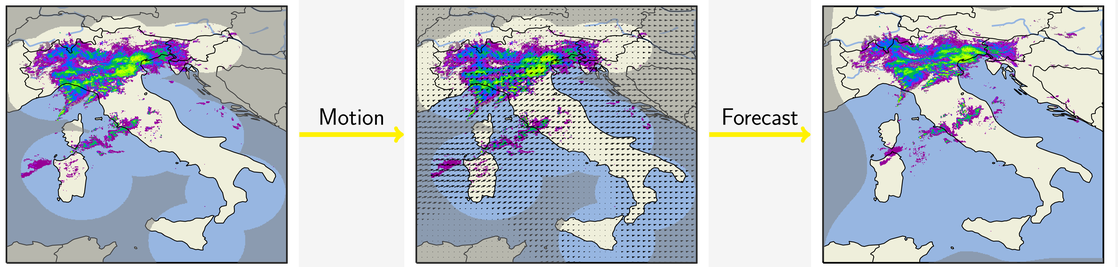
[2] Radarmeteo Srl, Via IV Novembre 119, 35020, Due Carrare (PD)

valentina.gregori@studenti.unisalento.it, Ferdinando.DeTomasi@le.infn.it, gianlucaferrari@radarmeteo.com, andreachini@radarmeteo.com

Objectives

Nowcasting refers to high-resolution meteorological forecasting on a short period, with the aim to identify imminent critical weather situations. These forecasts are highly relevant for a variety of industrial, agricultural, and leisure activities. Radarmeteo, a company providing meteorological services, uses nowcasting from radar images to assist the work of their forecasters and to provide customized solutions to business customers. To increase the value of their products, Radarmeteo was interested in:

- augmenting the forecasts usability by shortening the computation times;
- adopting more recent methods to improve the quality of the nowcasts.



Nowcasting Algorithms

- Eulerian (baseline): the forecast is identical to the current observation
- Extrapolation: the reflectivity field remains constant in the Lagrangian coordinate frame
- S-PROG [1]: the rain field is a multifractal framework and small scale systems are not tracked beyond their expected lifetime
- ANVIL [2]: solves a simplified equation that models source and dissipation processes also considering the lifetime of the structure
- STEPS [3]: ensemble method that adds noise to S-PROG to represent the uncertainty of development of precipitation systems
- proprietary: advection-based method that moves the echoes along the GFS estimated wind path

Motion Field Estimators

The velocity is estimated from a sequence of two or more recent radar images:

- LK [4]: evaluation of spatio-temporal intensity changes via the least squares criterion
- Proesmans [5]: evaluation of spatio-temporal intensity changes with a smoothness constraint
- DARTS [6]: calculation of the flux of the precipitations via the continuity equation
- VET [7]: minimization of a cost function with two constraints: reflectivity conservation and a smoothing function

Experimental Setup

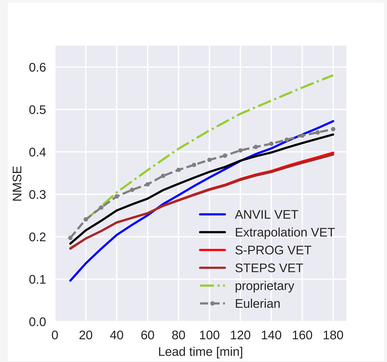
Data:

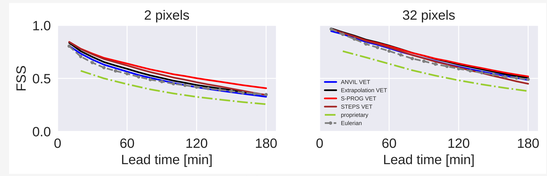
- 193 events from radar mosaic
- 3 h of forecasts from
  1. Eulerian baseline
  2. proprietary method
  3. 16 combinations nowcasting - motion field estimators

Verification metrics:

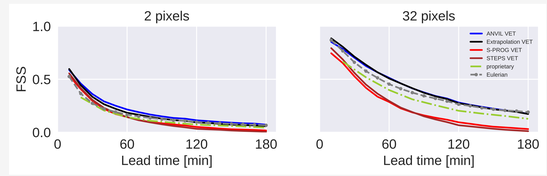
- normalized mean squared error (NMSE) of the reflectivity field
- probability of detection (POD): fraction of the "rainy" events that are correctly forecast
- false alarm rate (FA): fraction of observed "non-rainy" events that are false alarms
- fractions skill score (FSS): comparison of the fraction of pixels that exceeds a reflectivity threshold inside a reference area

Results

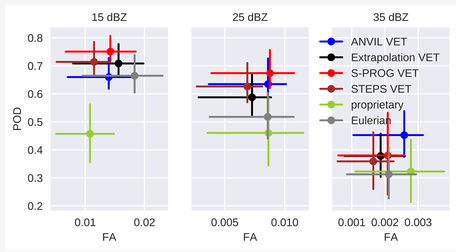




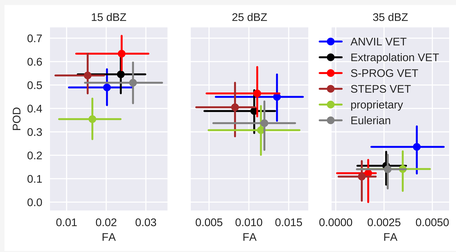
(a) 15 dBZ



(b) 35 dBZ



(c) 20 min



(d) 60 min

Conclusions

Improvements with respect to the proprietary method:

- Computation time reduced of one/two orders of magnitude
- Reduction of missed events and false alarms
- Increase of spatial accuracy and representativeness of the field

About the tested methods:

- No differences between motion field estimators
- ANVIL: good performance at high reflectivity thresholds, at cost of false alarms. Useful for protection agencies to emit alerts
- STEPS and S-PROG: good recognition of events at low reflectivity. Useful for solar energy or alert of mist
- Extrapolation: good spatial accuracy at big scales. Useful for forecasters in stratiform situations

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