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# Use of fuzzy methods in verification and comparison of high resolution forecasts

## (first tests)

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## Fuzzy verification methods applied for comparison of high resolution precipitation

### Data used in experiment:

ALADIN Numerical Weather Prediction (13.5 km spatial resolution) output

AROME Numerical Weather Prediction (2.7 km spatial resolution) output

### Verified field

precipitation (6h, 12h, 24h cumulation)

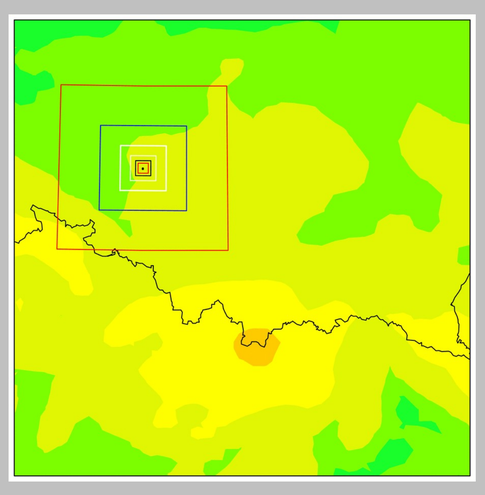
### Thresholds:

0.0, 0.1, 0.2, 0.5, 1.0, 2.0, 5.0, 10.0, 20.0, 50.0 [mm/24h]

### Precipitation intervals:

0.0 – 0.1, 0.1 – 0.2, 0.2 – 0.5, 0.5 – 1.0, 1.0 – 2.0, 2.0 – 5.0, 5.0 – 10.0, 10.0 – 20.0, 20.0 – 50.0, above 50.0 [mm/24h]

### Scales and domain characteristics:



Example of the different scales of the neighborhood surrounding the grid box of interest:

1km, 10km, 15km, 25km, 45km, 85km, 165km

## Fuzzy verification methods adopted for experiment

- Upscaling — useful forecast resembles the observations when averaged to coarser scales. Matching strategy — neighborhood observation vs neighborhood forecast.
- Minimum coverage — useful forecast predicts the event over a minimum fraction of the region of interest. Matching strategy — neighborhood observation vs neighborhood forecast
- Multi-event contingency table — useful forecast predicts at least one event close to an observed event. Matching strategy — single observation vs neighborhood forecast.
- Area-related RMSE — useful forecast has similar distribution of intensities as the observations. Matching strategy — neighborhood observation vs neighborhood forecast.
- Conditional square root of RPS — useful forecast has a high probability of matching the observed value. Matching strategy — single observation vs neighborhood forecast.
- Practically perfect hindcast — useful forecast resembles one that would have been issued by a forecaster given perfect knowledge of the observations beforehand. Matching strategy — single observation vs neighborhood forecast.
- Pragmatic — useful forecast has a high probability of detecting events and non-events. Matching strategy — single of observation vs neighborhood forecast.
- Fractions skill score — useful forecast has similar frequency of forecast events and observed events. Matching strategy — neighborhood observation vs neighborhood forecast.
- Fuzzy logic — useful forecast is more correct than incorrect. Matching strategy — neighborhood observation vs neighborhood forecast.

## Standard metrics employed in verification and used for comparison of high resolution forecasts

False alarm rate

$$F = \frac{false\ \ alarms}{correct\ \ rejections + false\ \ alarms}$$

False Alarm Ratio

$$FAR = \frac{false\ \ alarms}{hits + false\ \ alarms}$$

Proportion Correct hit rate

$$PC = \frac{hits + correct\ \ rejections}{N}$$

Probability Of Detection

$$POD = \frac{hits}{hits + misses}$$

Threat Score

$$TS = \frac{hits}{hits + misses + false\ \ alarms}$$

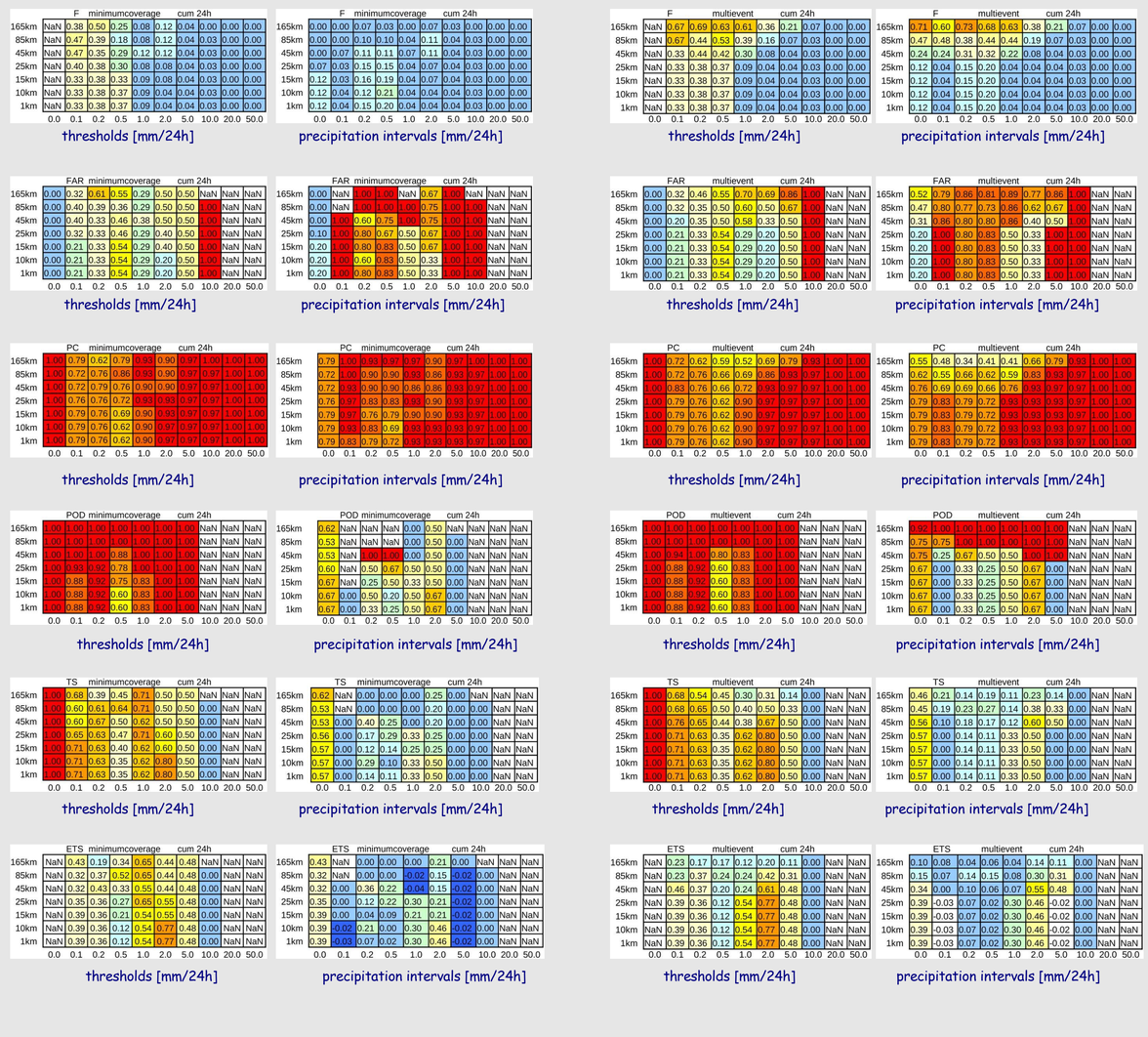
Equitable Threat Score

$$ETS = \frac{hits - hits_{random}}{hits + misses + false\ \ alarms - hits_{random}} \quad \text{where}$$

$$hits_{random} = \frac{1}{N}((hits + misses) \times (hits + false\ \ alarms))$$

## Results

### (examples)




The presence of the extremal values of indicators in tables (obtained in tests) imply strong consistency for precipitation forecasts given by both models. In other words, output of the lower resolution model ALADIN and model AROME which covers more subtle features (because of the denser grid) are not the same but very similar. These were preliminary tests thus further study is needed.

Ebert E. E., 2008, Fuzzy verification of high-resolution gridded forecasts: a review and proposed framework, *Meteorol. Appl.*, **15**, 51–64;

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