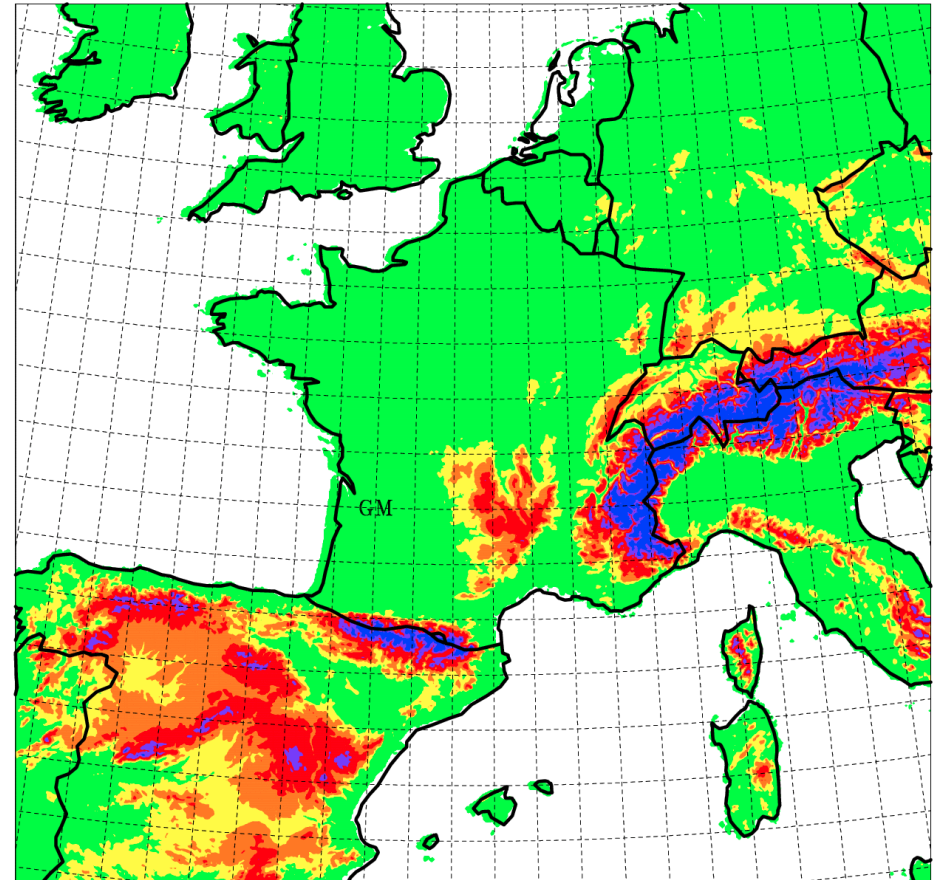


Neighbourhood processing for precipitation in Arome ensemble prediction system

Aladin/Hirlam Workshop Helsingor 15 April
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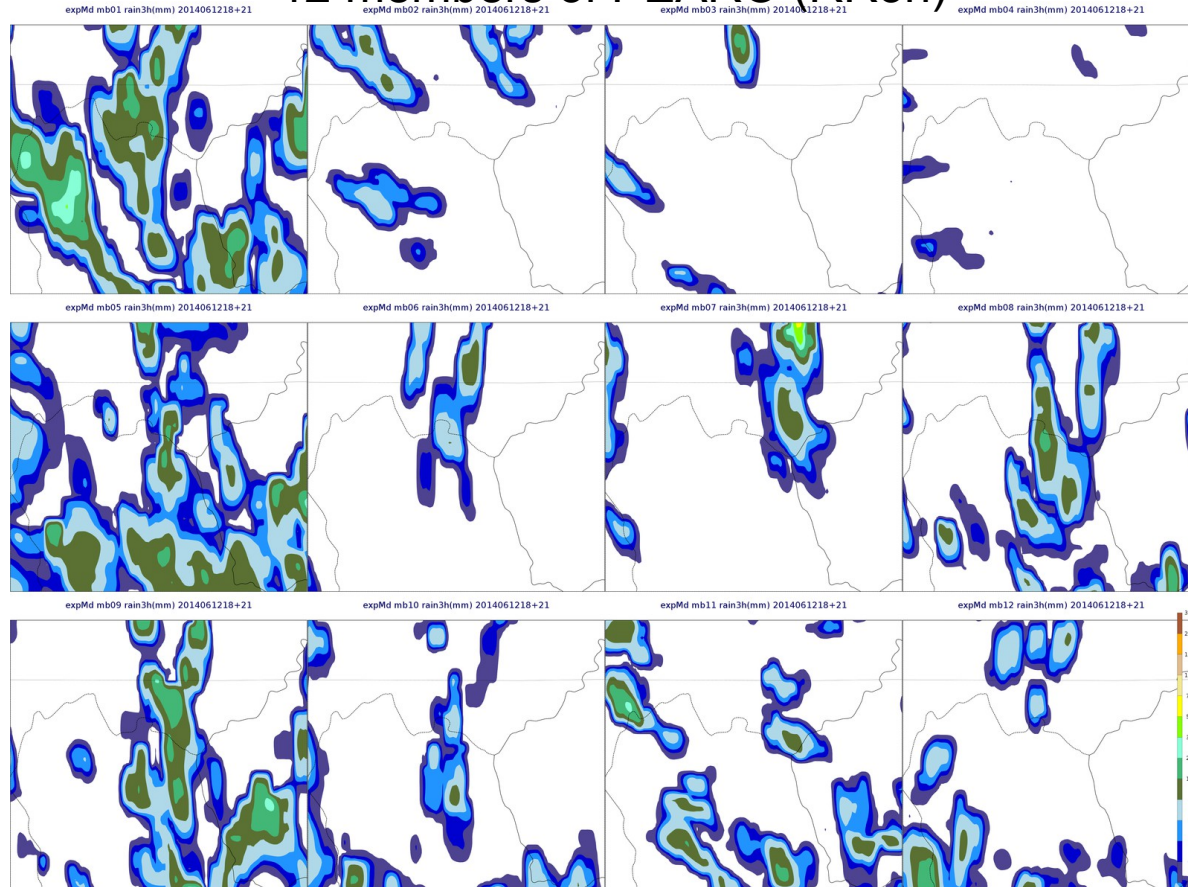
Arome ensemble prediction system (PEARO)

- Pre-operational system
- 12 members
- Based on deterministic Arome 2,5km
- Lateral boundaries and initial upper air perturbations from ARPEGE-EPS (PEARP)
- Initial surface : correlated random perturbations of SST, soil moisture,...
- Stochastic perturbation of physical tendencies (SPPT)

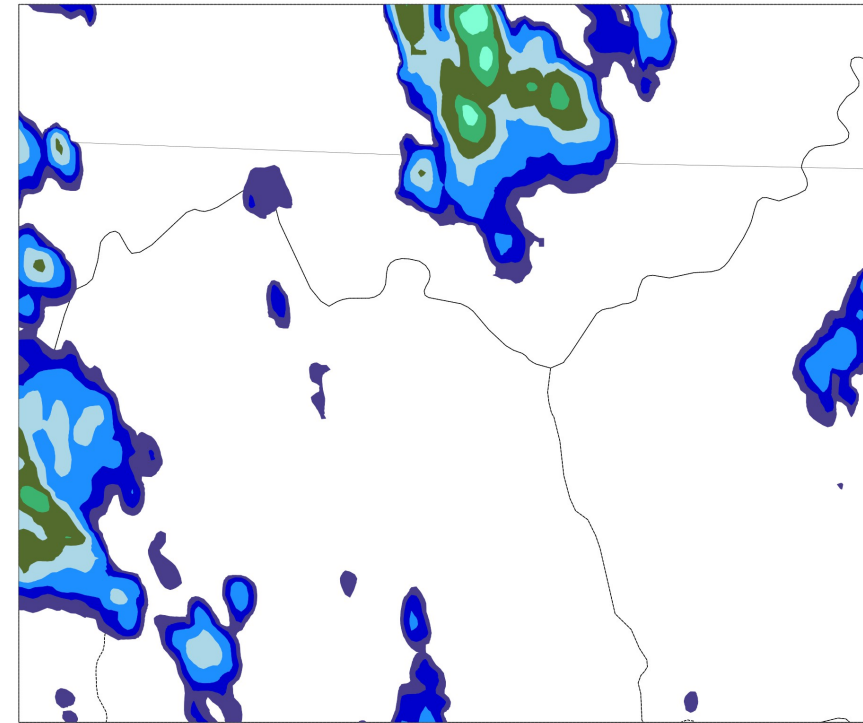


Problems in precipitation forecasting

12 members of PEARO (RR3h)



Reality (RR3h)



- Localization and temporal errors especially at convective scale (in time and space)
- Limited number of members in the PEARO
=> Neighbourhood processing

Outline

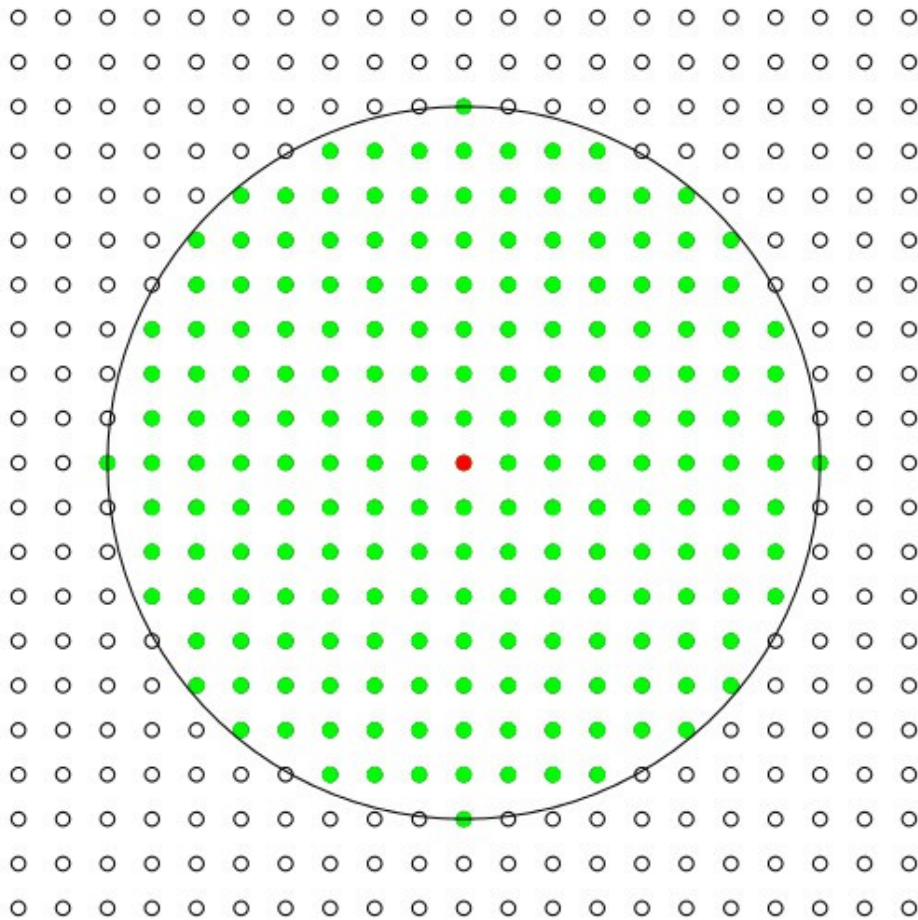
- Spatial neighbourhood processing
 - Regular sampling
 - Random sampling
 - Uniform
 - Centered
- Temporal neighbourhood processing

Data used for scores

- Accumulated rainfall on 3 hours
- More than 1000 rain gauges, especially in France, for each date
- Several periods between June and December 2014



Spatial neighbourhood processing



Red point : Forecast point

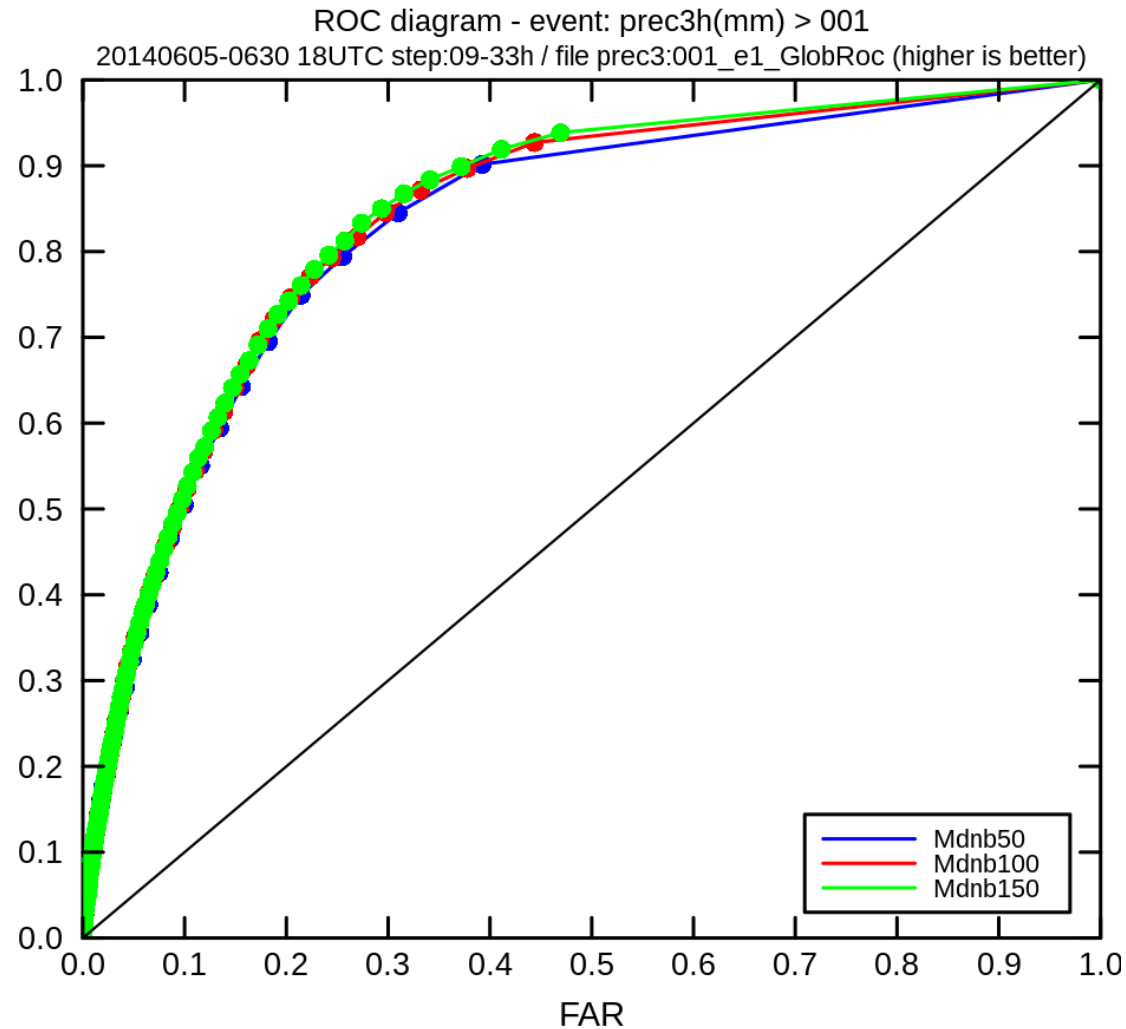
Green points : Additional points used
in neighbourhood processing

- Green points are assumed to sample the red point forecast PDF
- Goals : Get a more realistic distribution, increase the number of members, take into account the uncertainty on localization
- But, we need to sample this huge amount of data
- Two groups of sampling methods : randomly or regularly

Sampling method :

Size of the sample

- A sampling theory result gives a value of 100 for 10% error
- Few changes in scores for a sample size greater than 100
- Limiting the sample size to 100, reduces the cost and the memory used



Blue : sample size=50

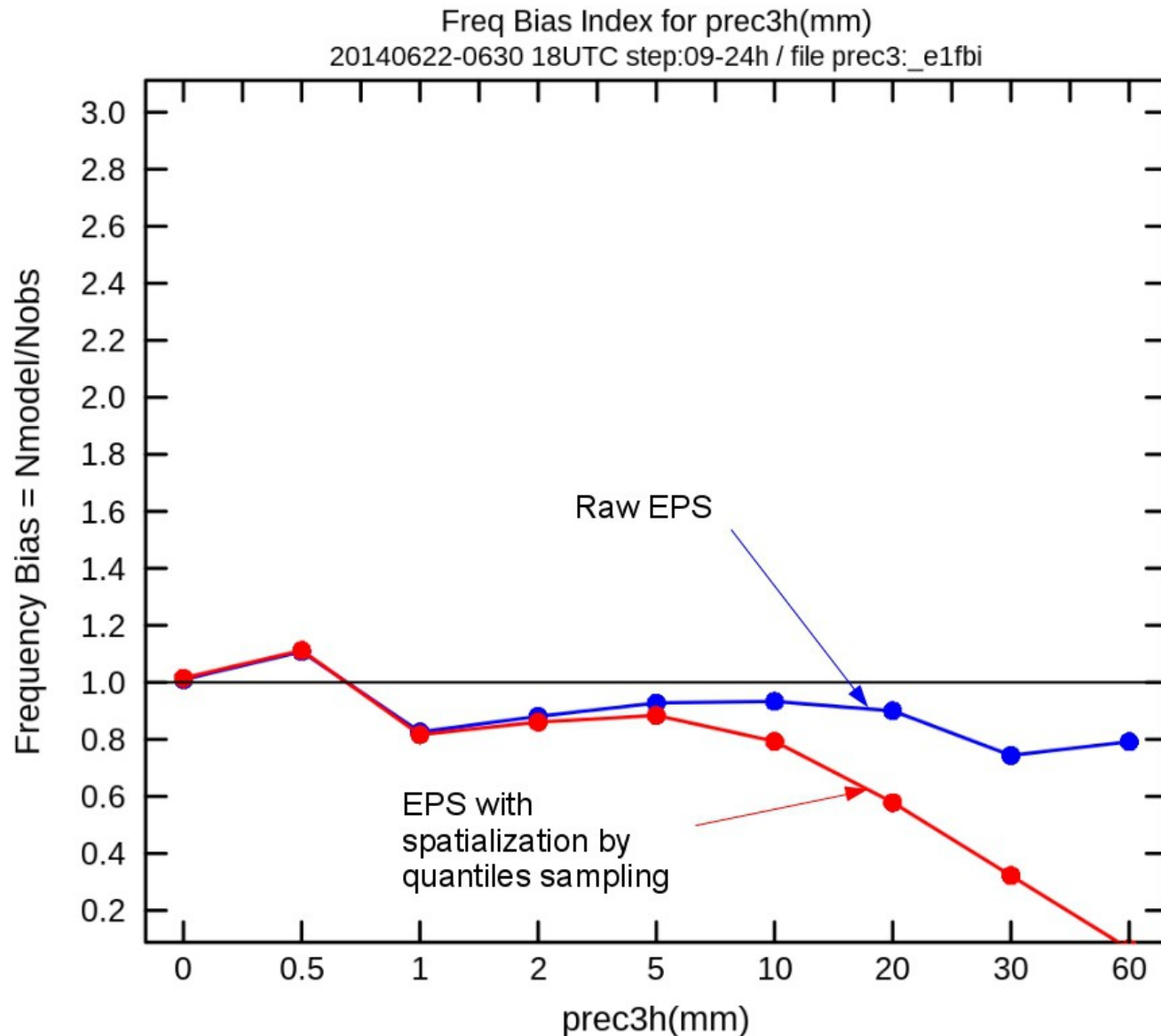
Red : sample size=100

Green : sample size=150



Sampling by quantiles :

Impact on FBI (Frequency Bias Index)

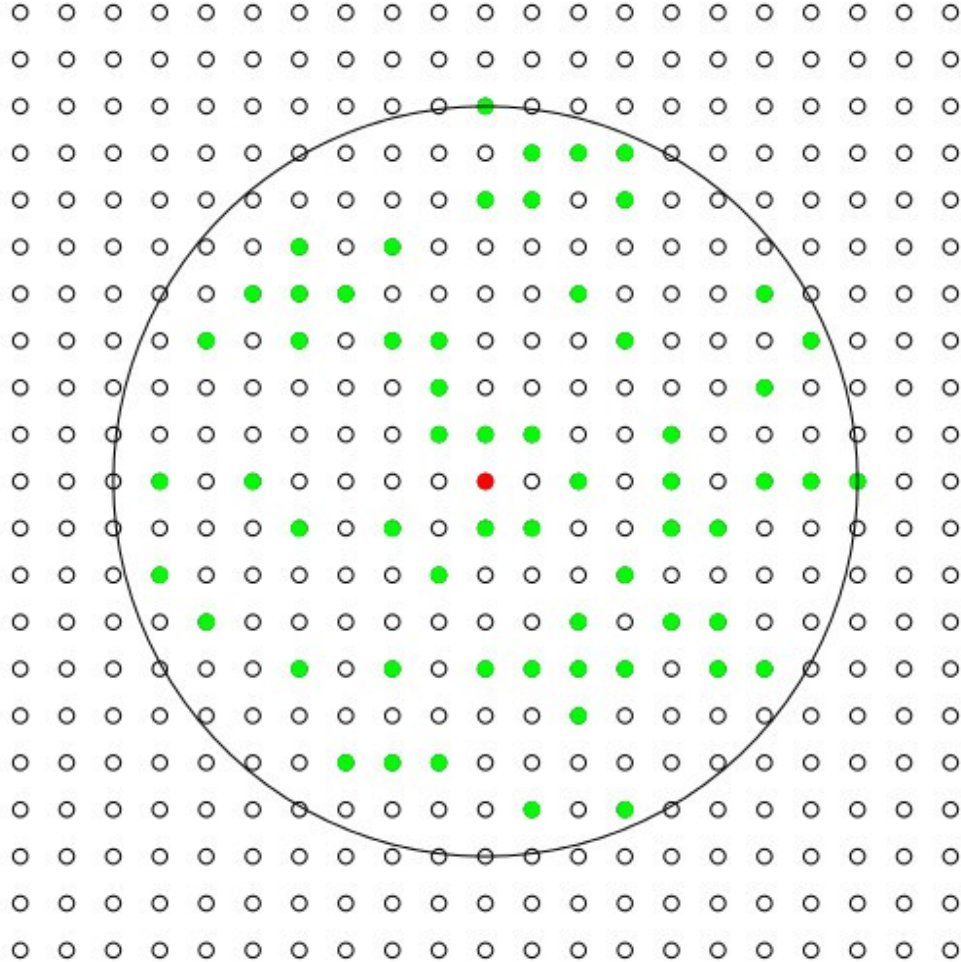


- We sample the PDF using the quantiles of all member values in the neighbourhood
- But a bias appears. Quantiles miss the extreme values

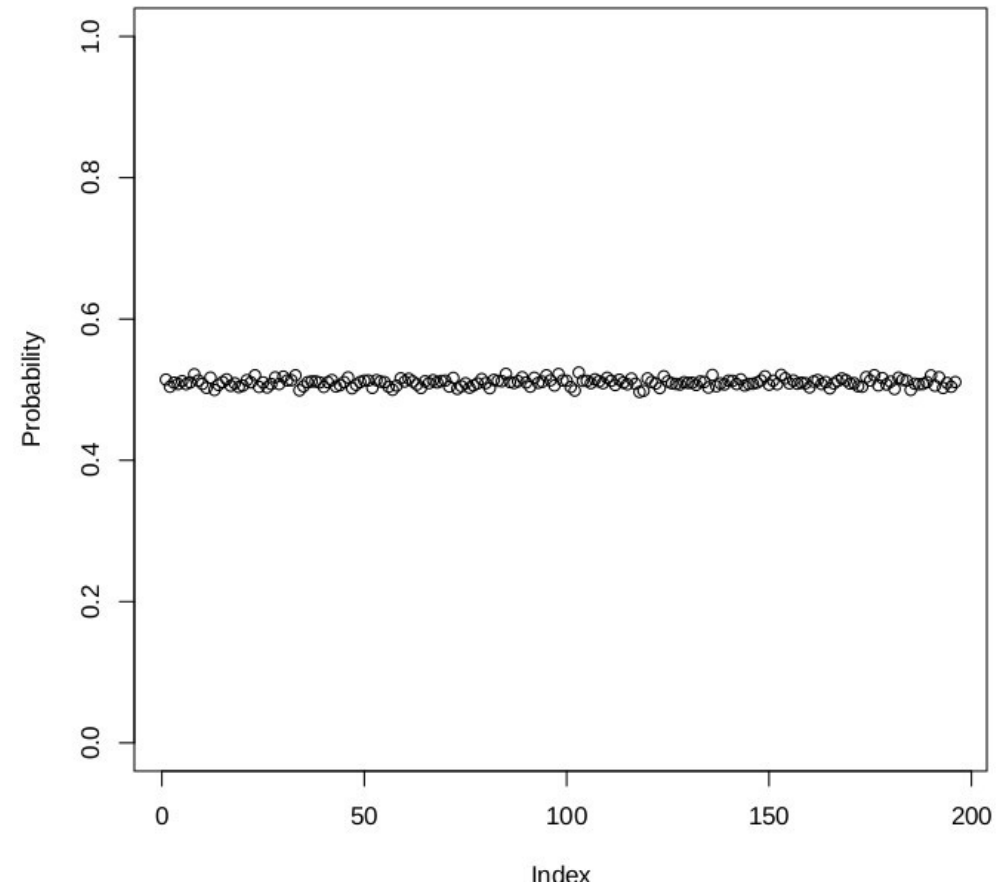
Uniform random sampling method

We sample the PDF by drawing random values in the neighbourhood.

We assume that forecast values near the centre are **as realistic** as forecast values near the border



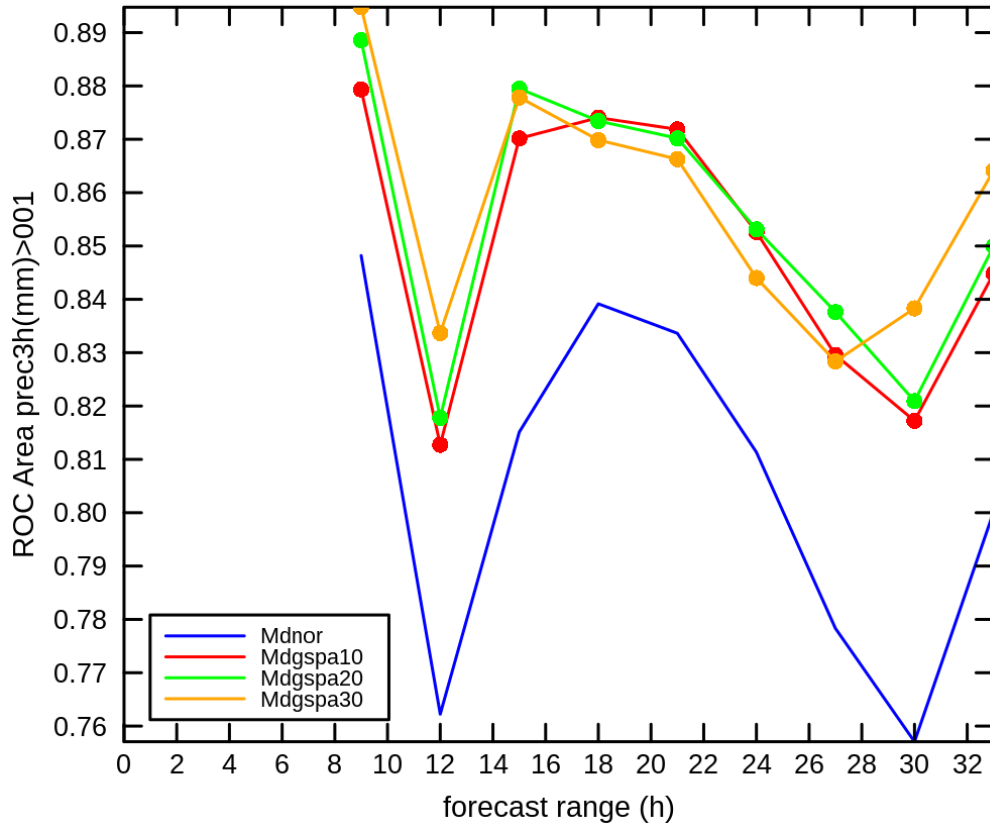
Green points :
Selected points in the
random sampling



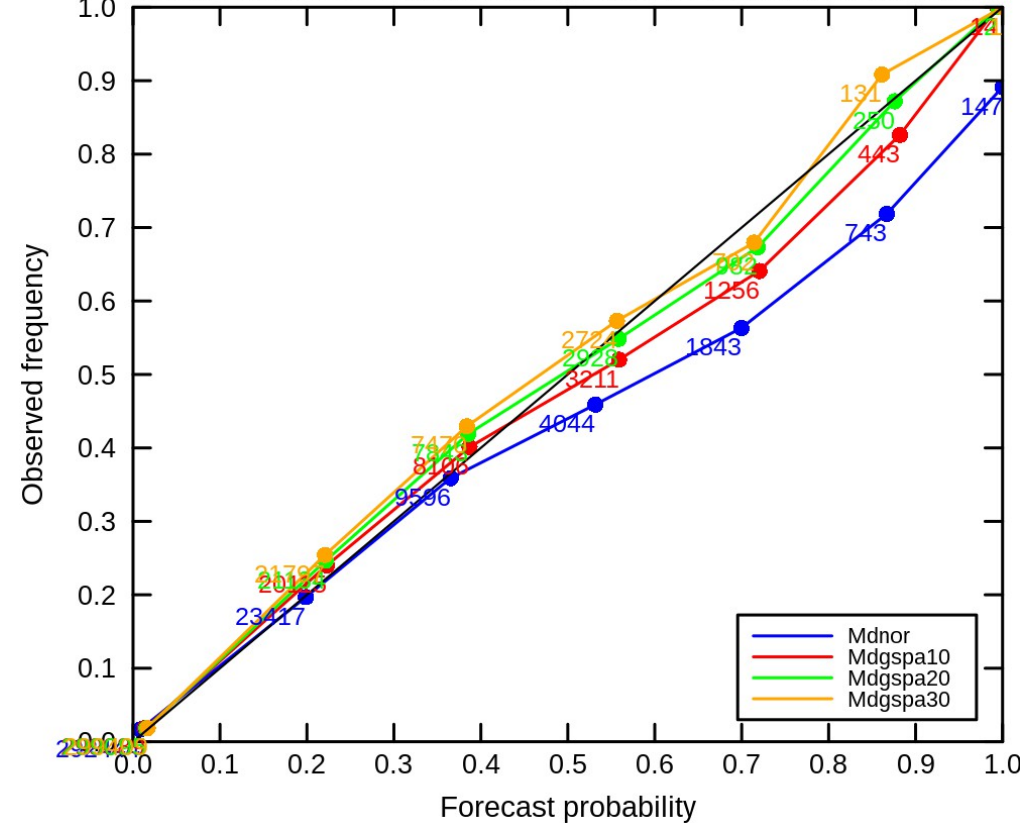
Probability of a point to be chosen
following its rank in the vector (related
to the distance to the center)

Uniform random sampling : Variation with spatialization radius

ROC Area prec3h(mm)>001 for exp: Mdnor Mdgspa10 Mdgspa20 Mdgspa30
20140605-0630 18UTC / file prec3:001_e1_RangeRoca(higher is better)



Reliability diagram - event: prec3h(mm) > 001
20140605-0630 18UTC step:09-33h / file prec3:001_e1_GlobReliab (ideal on diagonal)

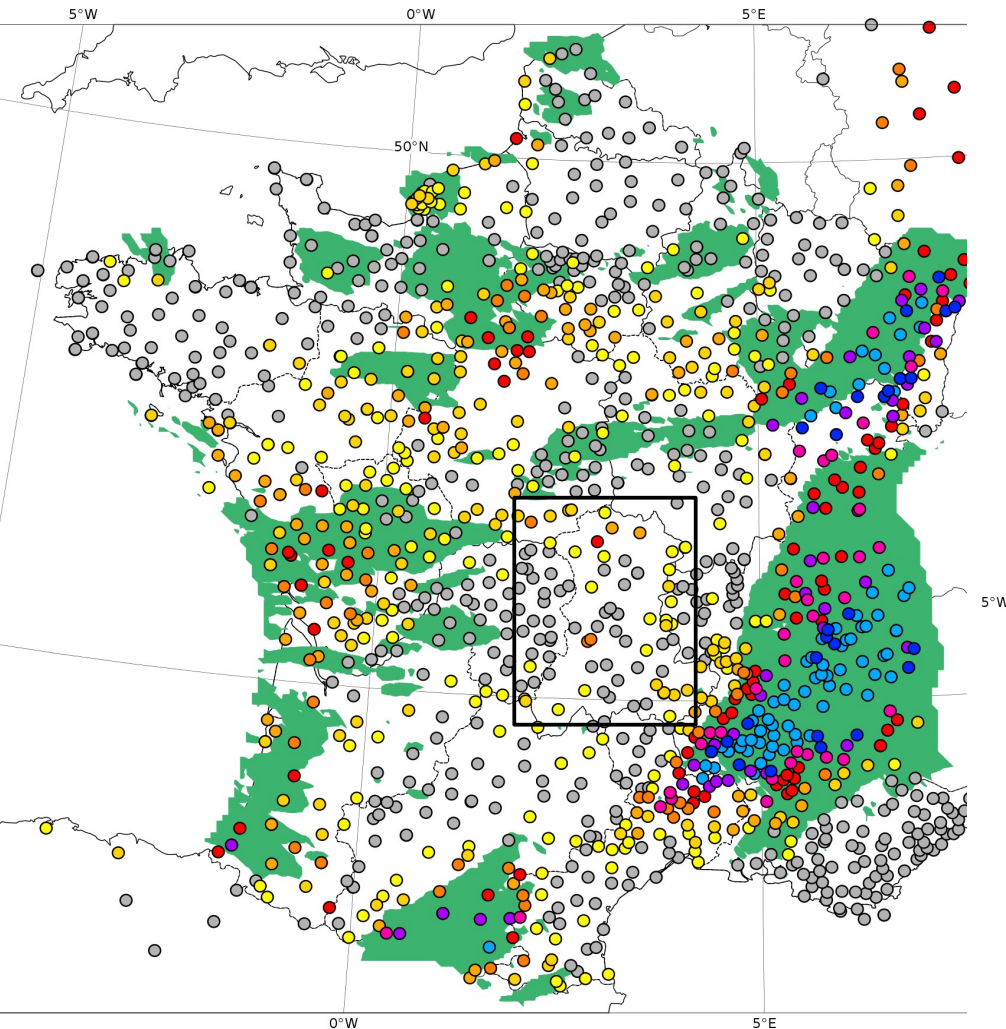


Blue : Raw ensemble **Red, green and orange** : Spatialized ensemble **10, 20 and 30** gridpoints radius

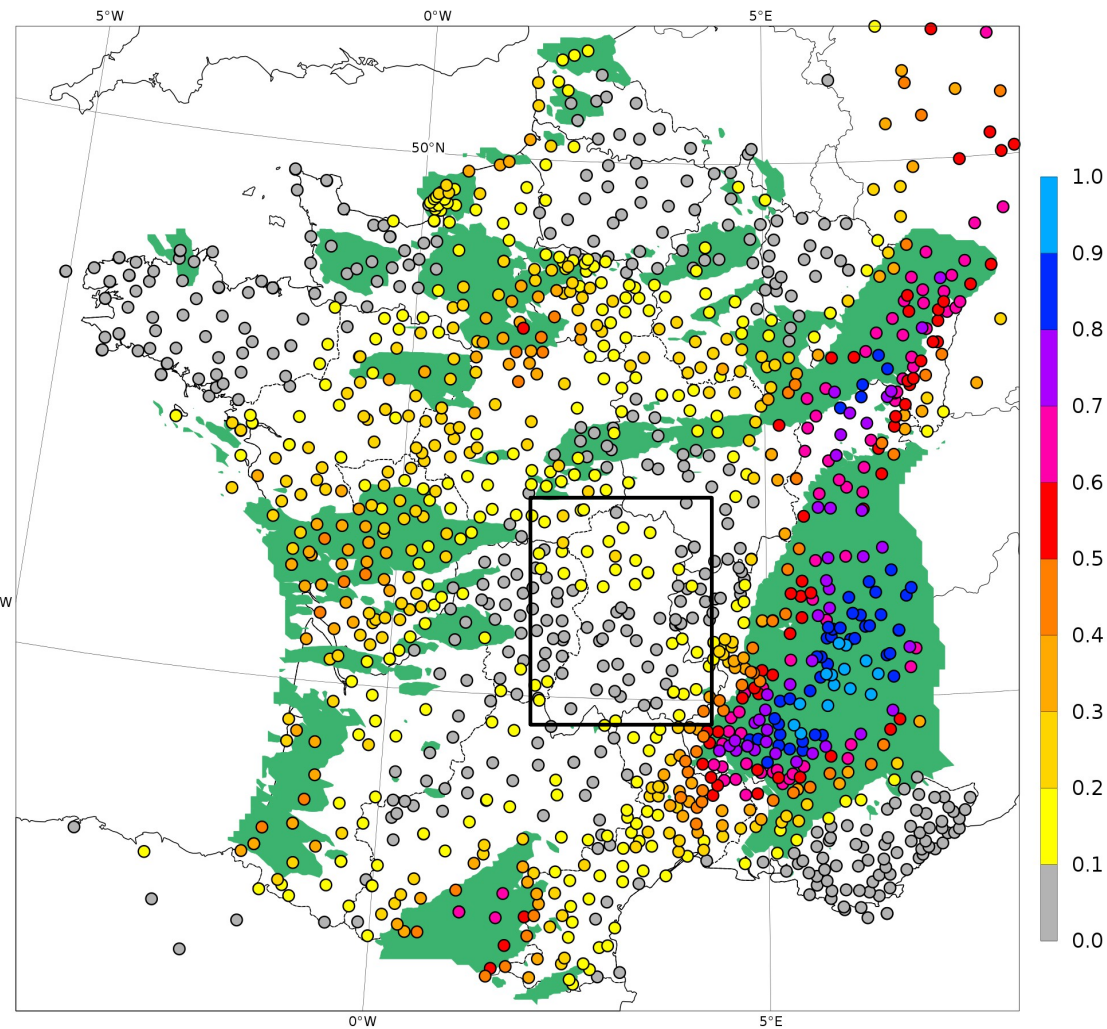
- Improvement of ROC Area score and reliability up to 15-20 gridpoints radius
- No change on bias scores up to 20 gridpoints radius

Uniform random sampling : Impact on probabilités

Probability $RR > 1\text{mm}$ before
spatialization



Probability $RR > 1\text{mm}$ after
spatialization (20 gridpoints radius)



Area where $RR > 1\text{mm}$ was observed (radar + rain gauges)

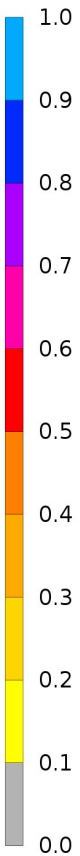
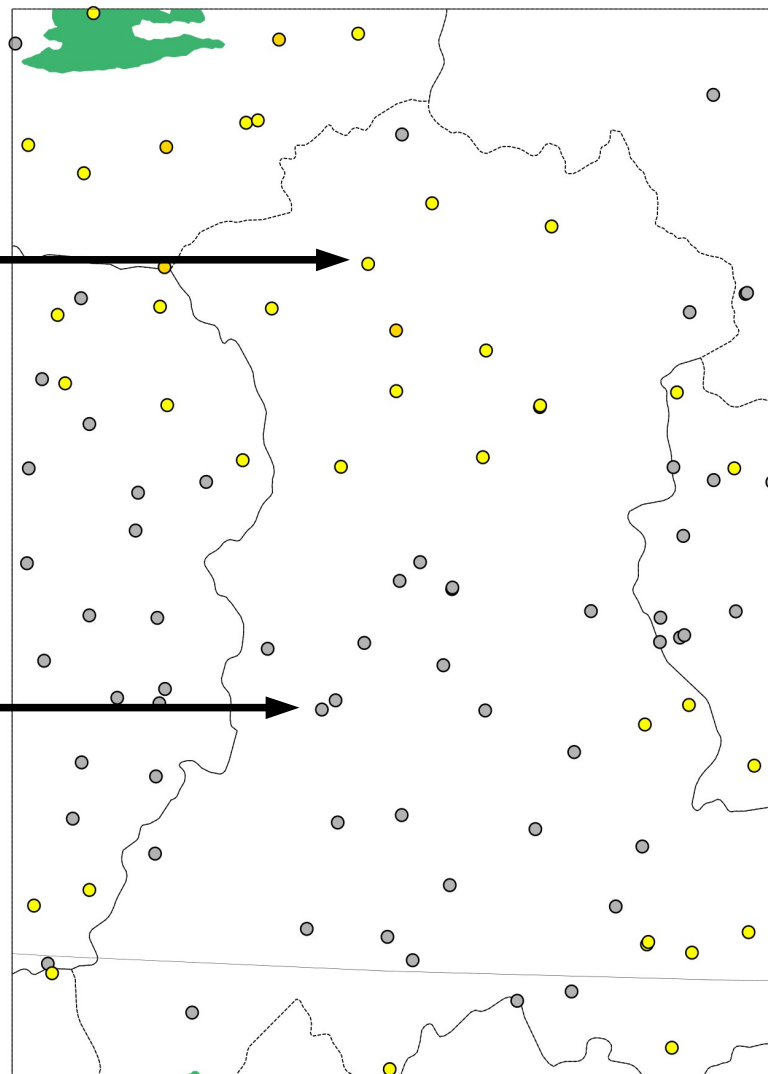
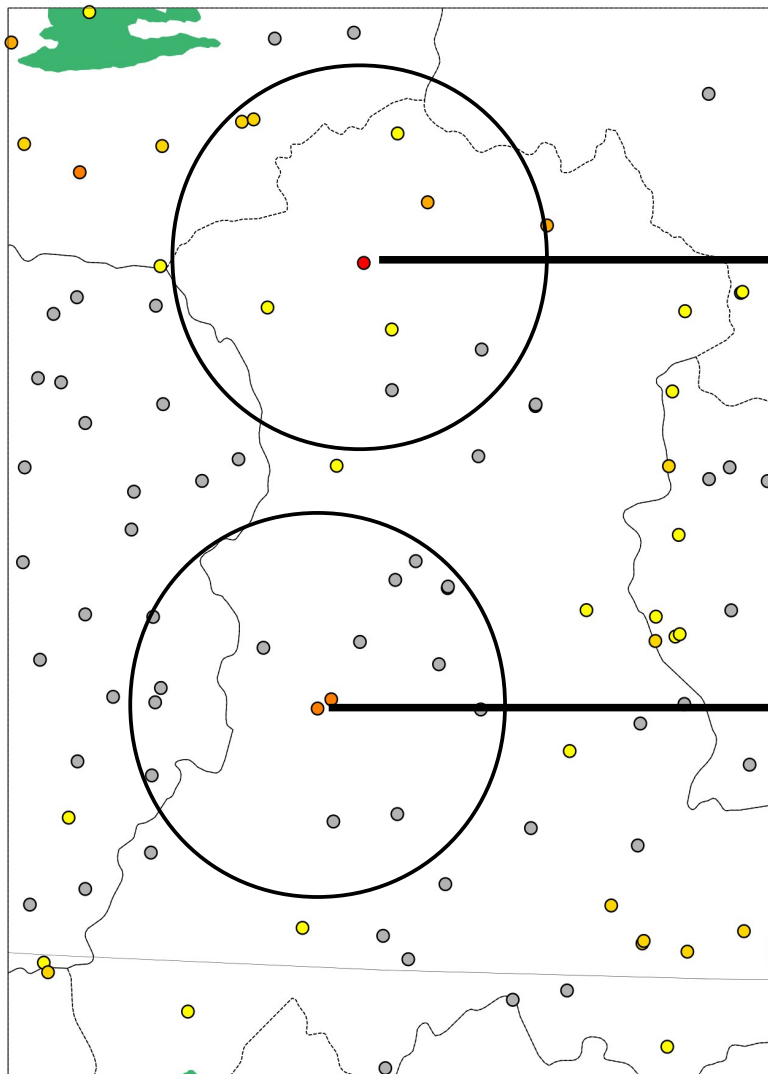


— 50 km
METEO FRANCE

Uniform random sampling : Impact on probabilités

Probability RR>1mm before
spatialization

Probability RR>1mm after
spatialization (20 gridpoints radius)



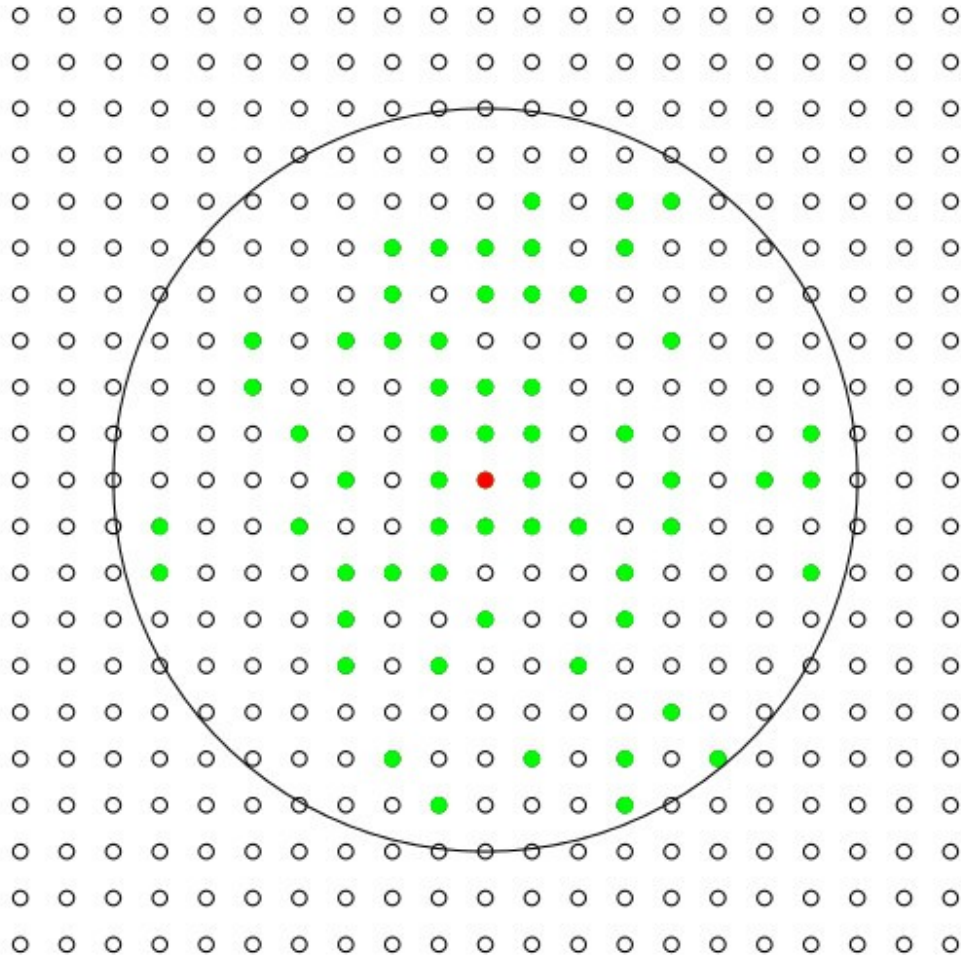
50 km

Area where RR>1mm was observed (radar + rain gauges)

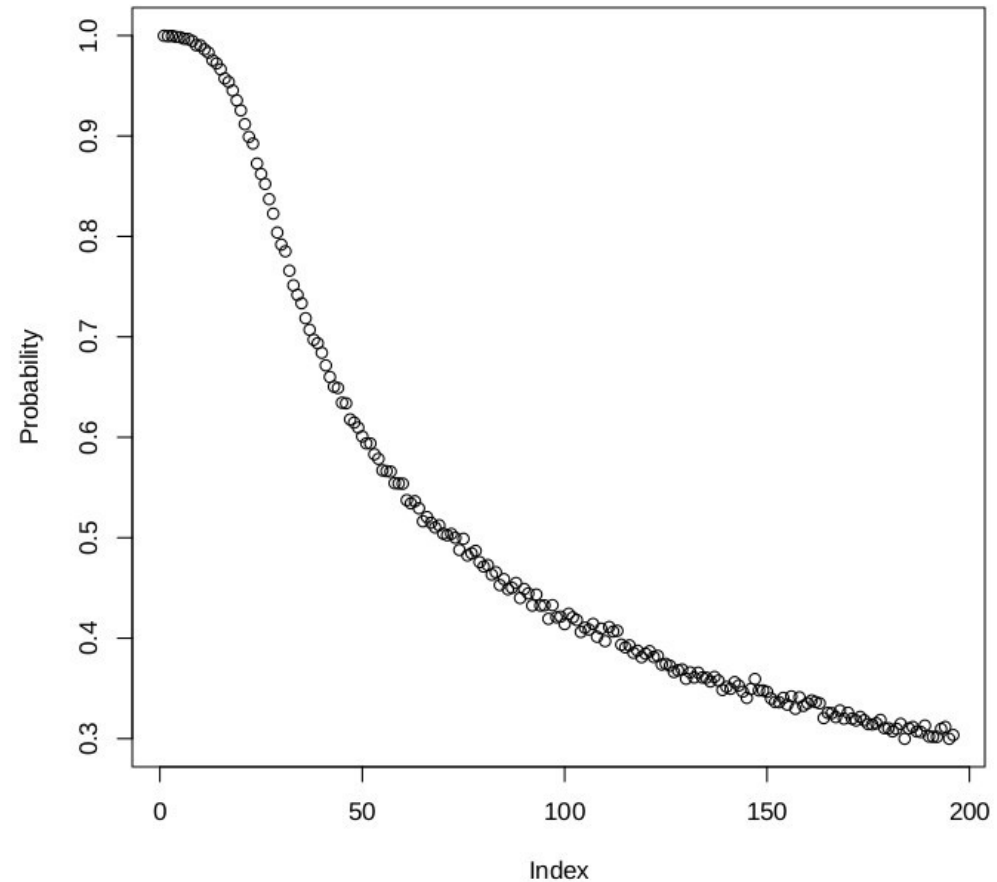
Centred random sampling method

We sample the PDF by drawing random values in the neighbourhood.

We assume that forecast values near the centre are **more realistic** than forecast values near the border

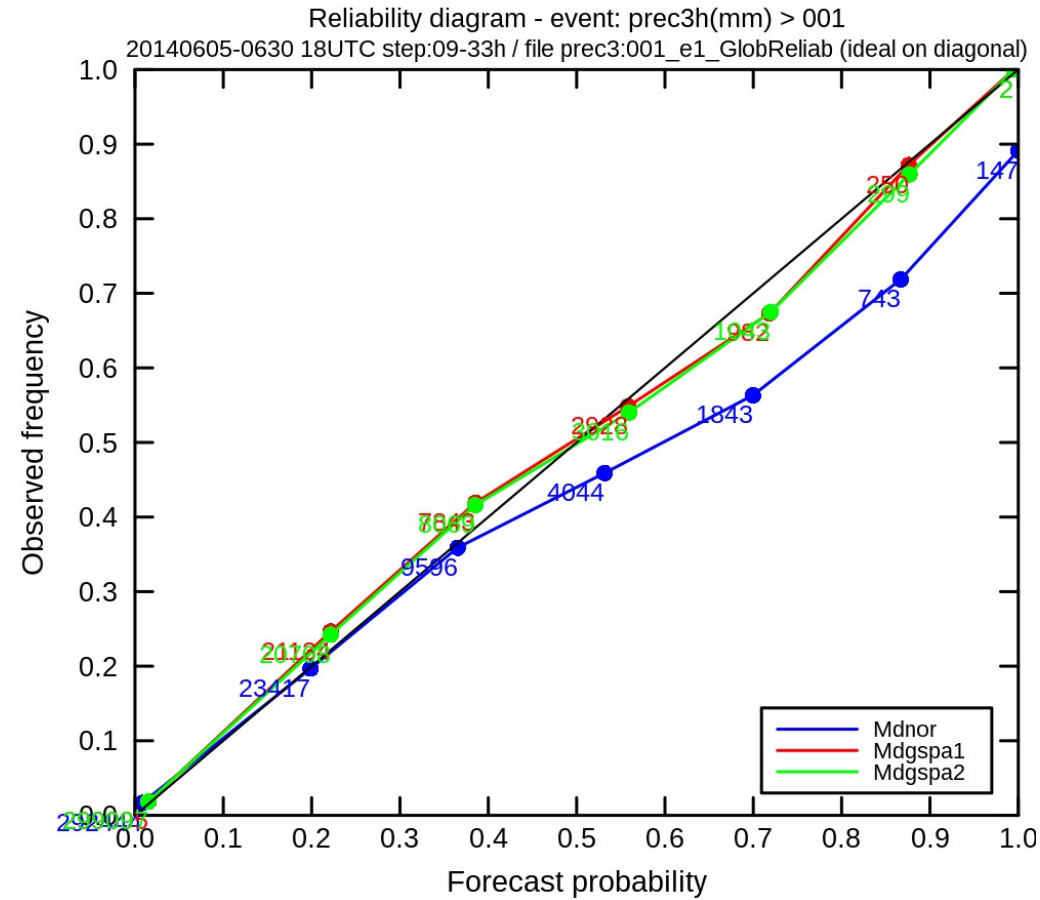
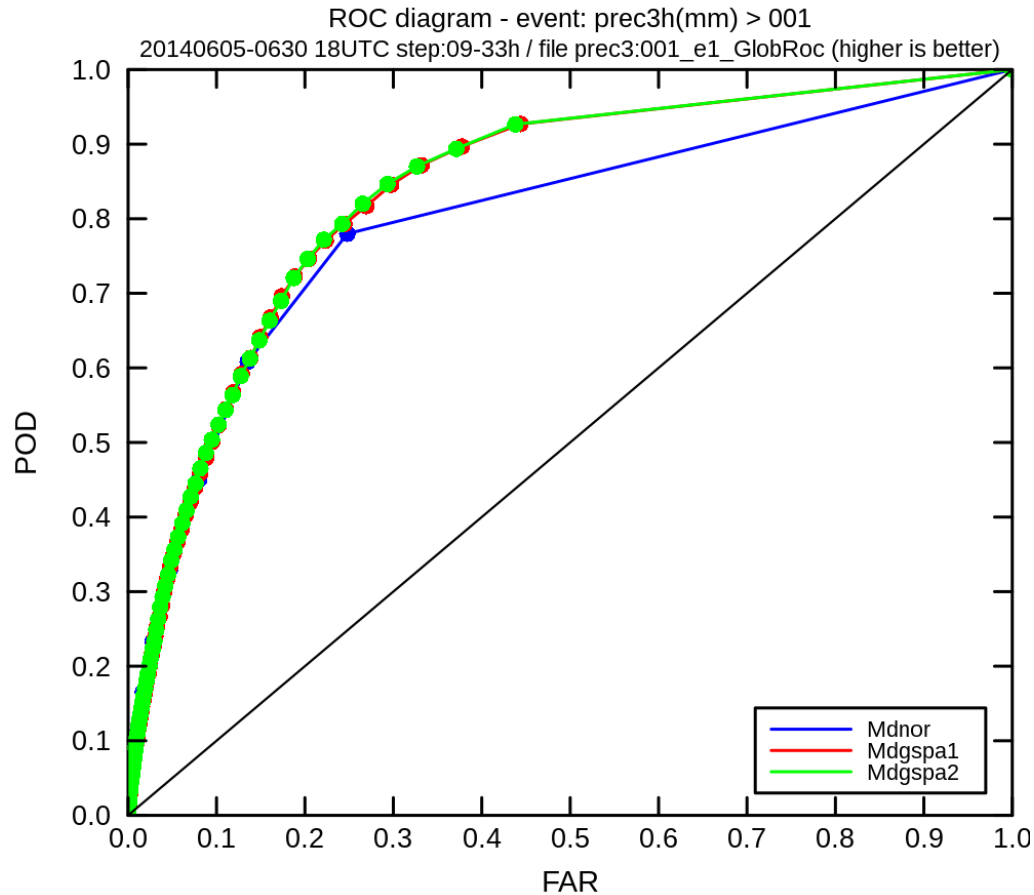


Green points :
Selected points in the
random sampling



Probability of a point to be chosen following its rank in the vector (related to the distance to the center)

Centered random sampling : Comparison with the uniform random sampling



Blue : Raw ensemble Red, and green : Spatialized ensemble uniform and centered sampling
Spazialisation radius = 20 gridpoints

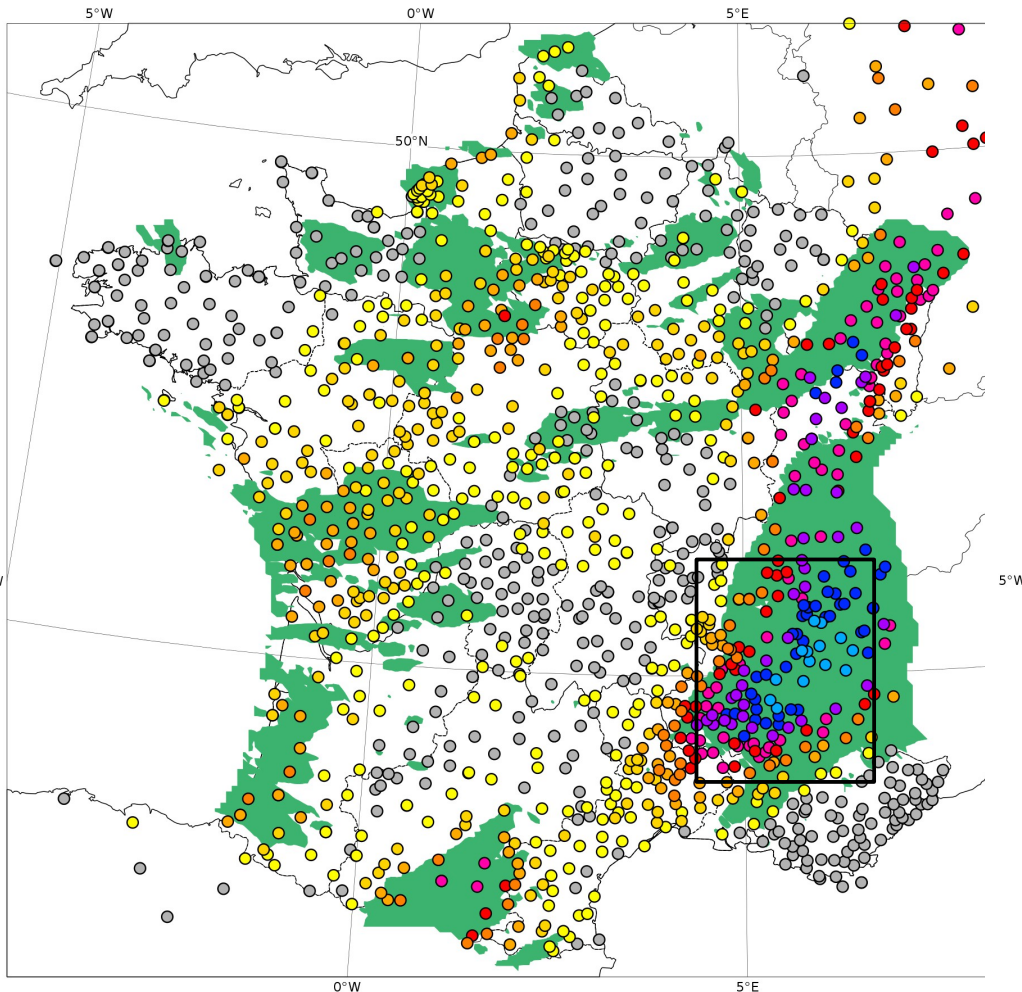
- No change on scores until the limit is reached

Centered random sampling : Comparison with the uniform random sampling

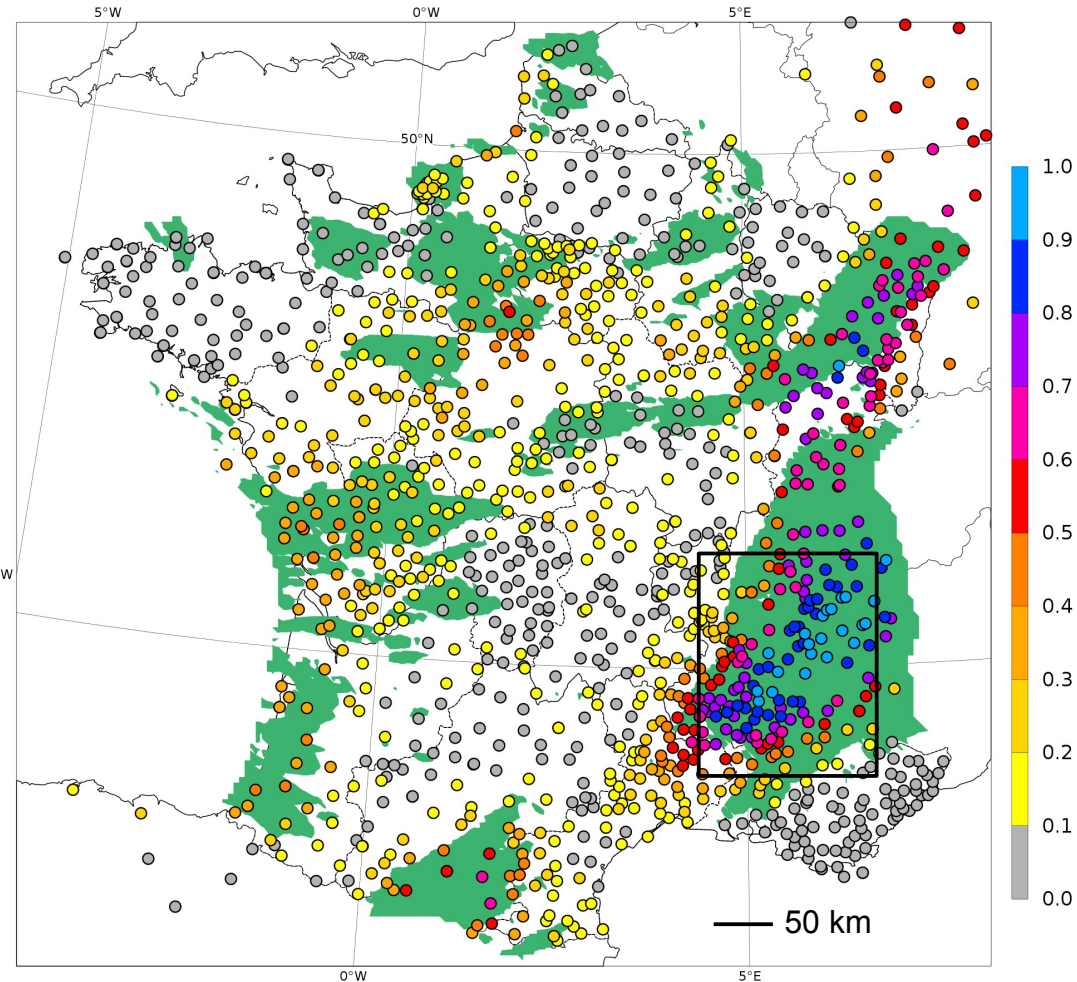
Probability $RR > 1\text{mm}$ with uniform
spatialization (20 gridpoints radius)

Probability $RR > 1\text{mm}$ with centered
spatialization (20 gridpoints radius)

2014062818+12prec3Md-obs.png



2014062818+12prec3Md-obs.png



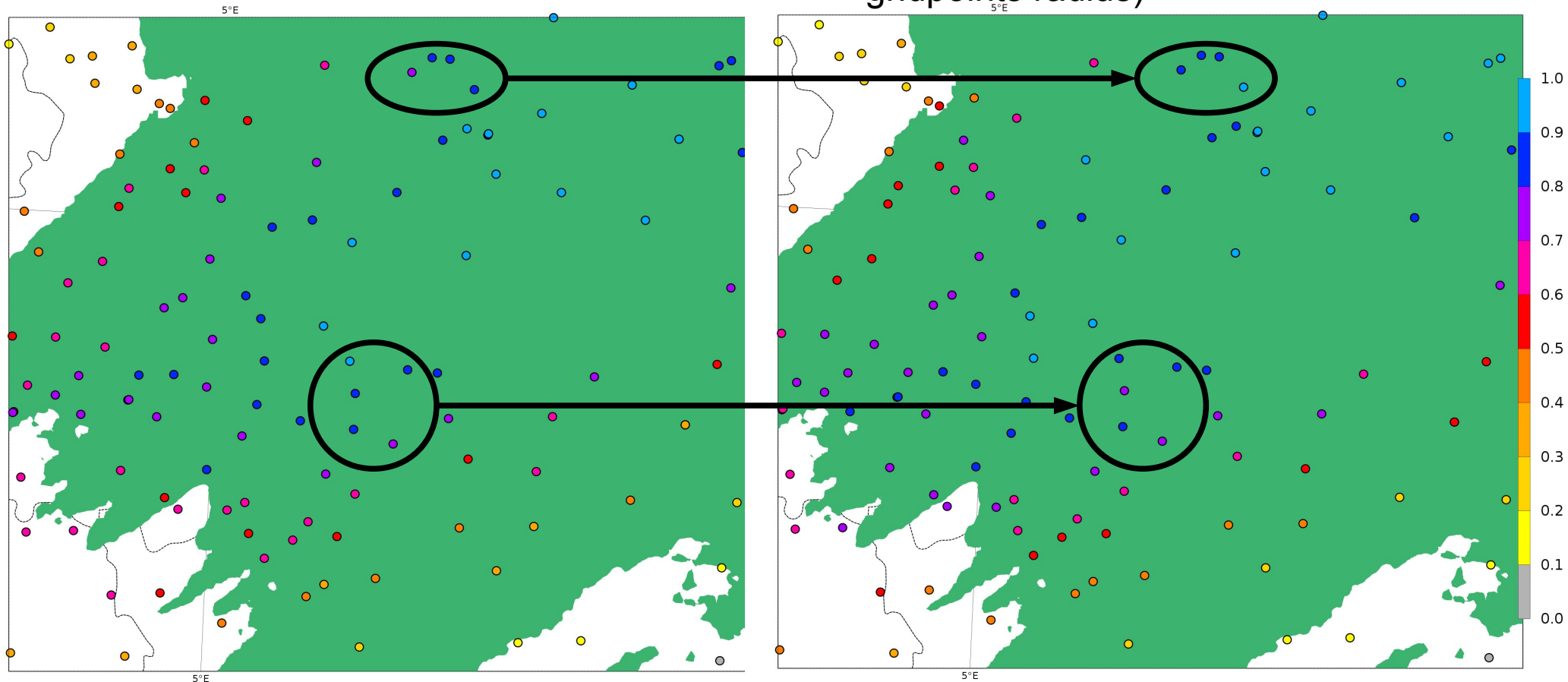
Area where $RR > 1\text{mm}$ was observed (radar + rain gauges)

Centered random sampling :

Comparison with the uniform random sampling

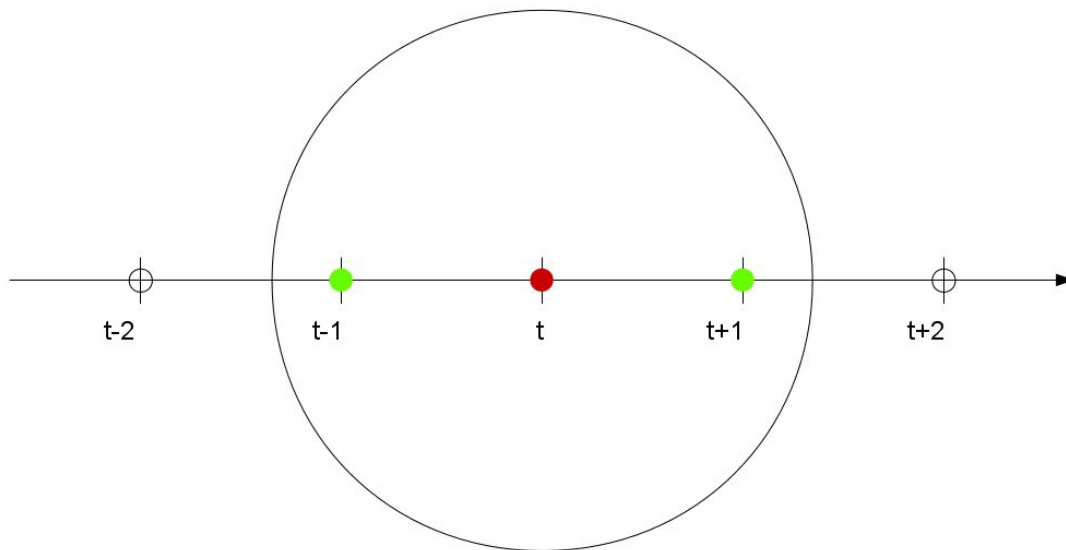
Probability $RR > 1\text{mm}$ with uniform spatialization (20 gridpoints radius)

Probability $RR > 1\text{mm}$ with centered spatialization (20 gridpoints radius)



Area where $RR > 1\text{mm}$ was observed (radar + rain gauges)

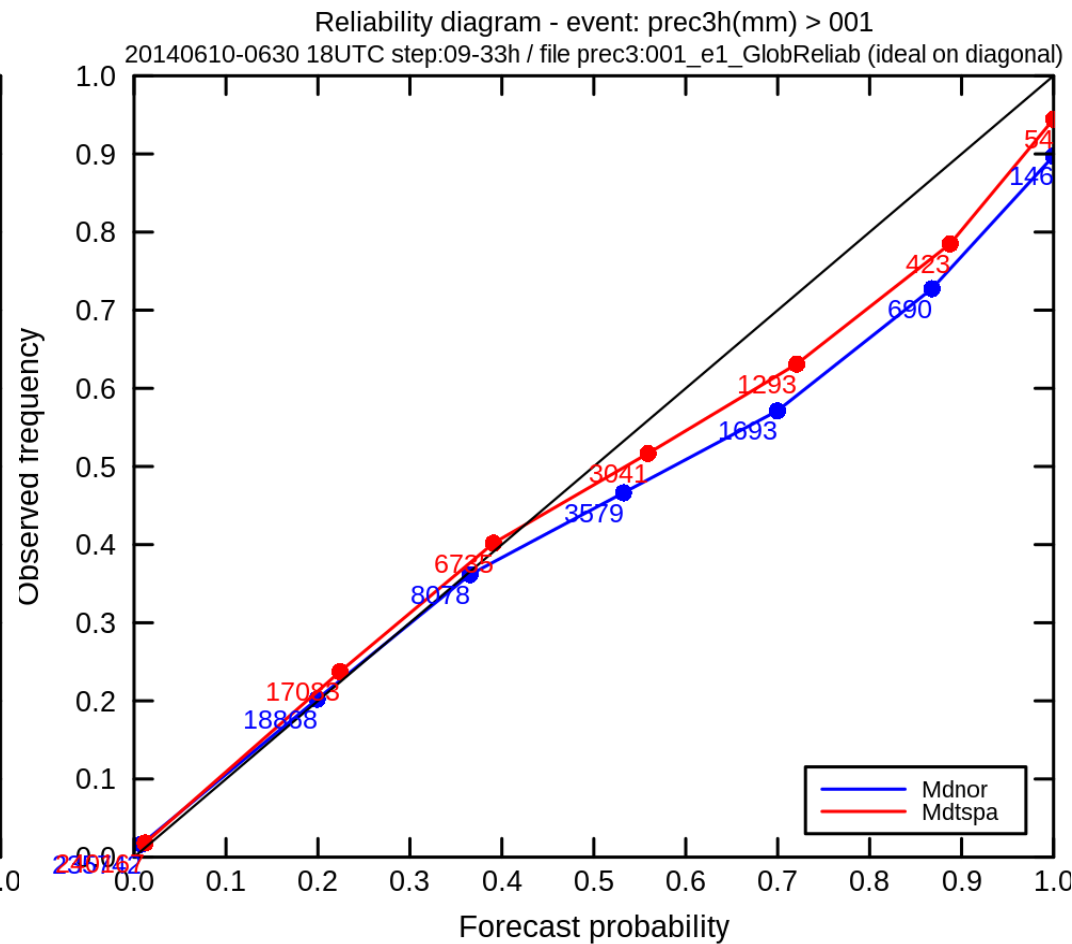
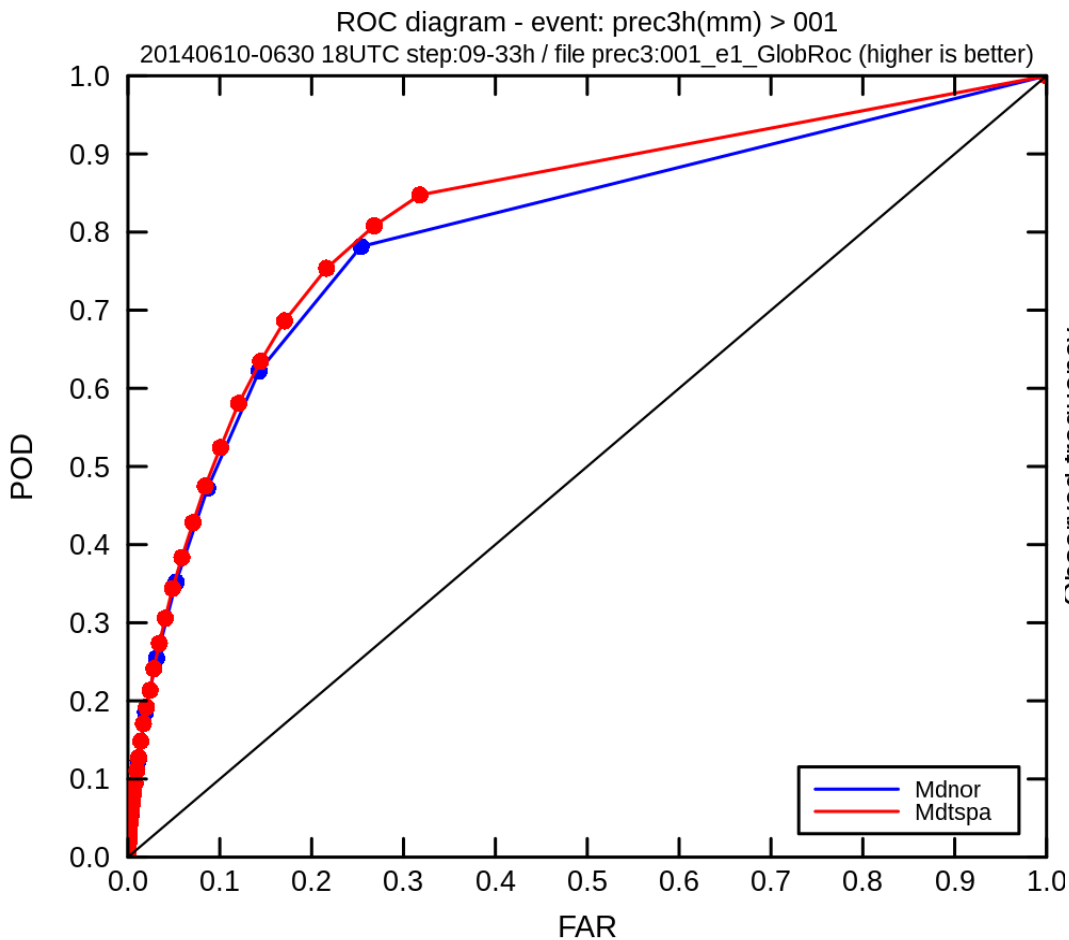
Temporal neighbourhood processing



Red point : Forecast point
Green points : Additional points used
in neighbourhood processing

- Goals : the same as the geographical spatialization, and take into account the temporal uncertainties in the model scenario

Temporal neighbourhood processing : scores



Blue : Raw ensemble Red : Temporally spatialized ensemble with one hour radius

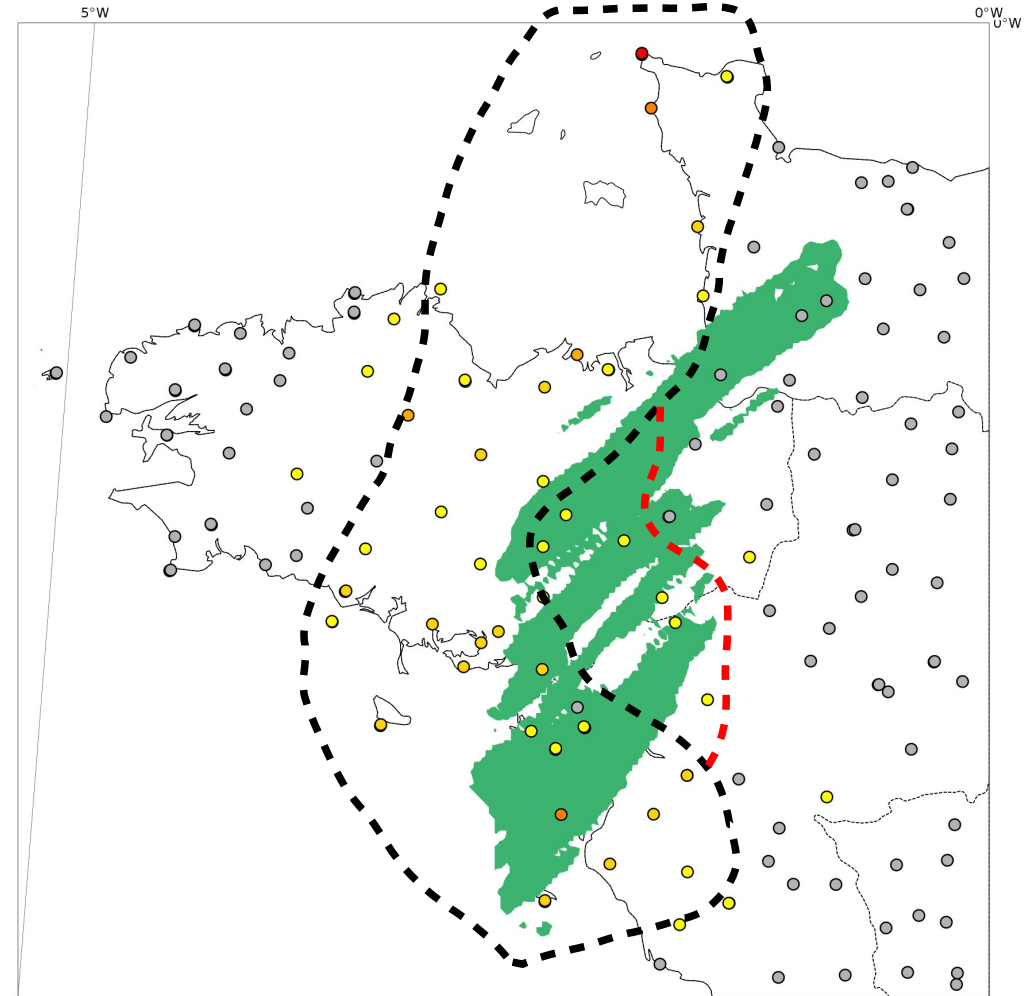
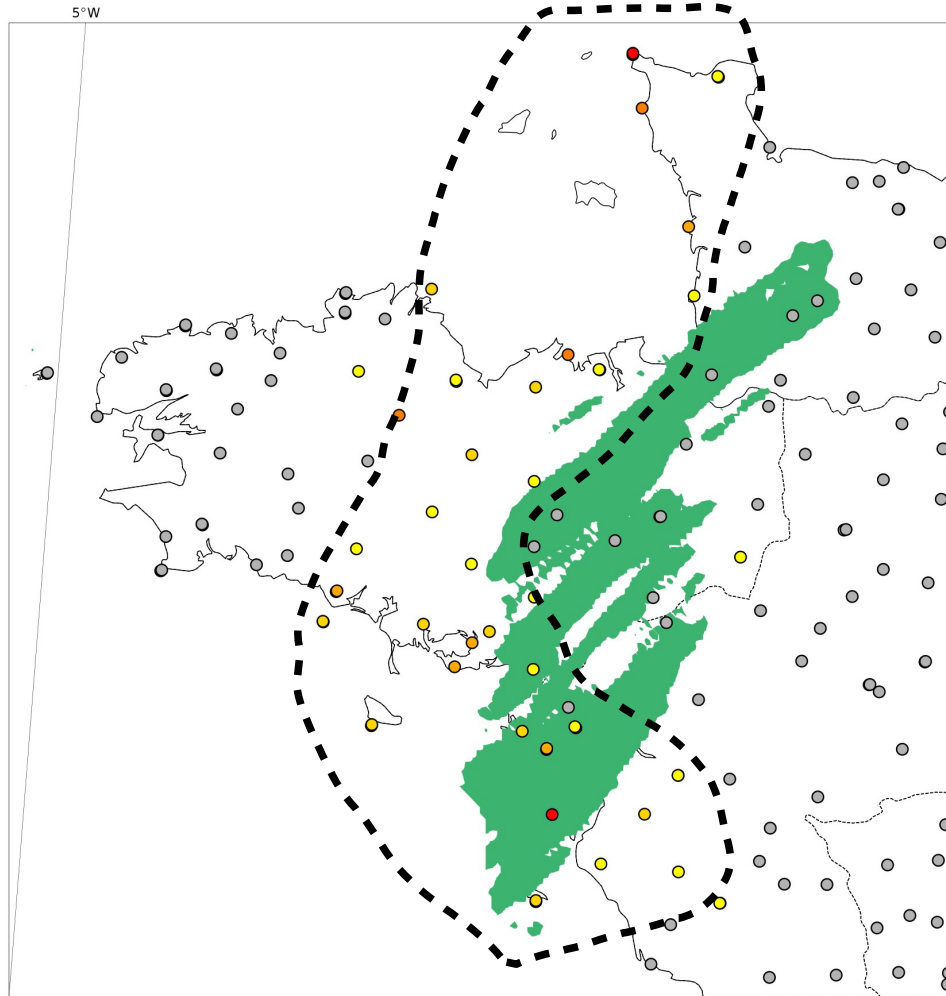
Temporal neighbourhood processing : Impact on probabilities

Probability $RR > 1\text{mm}$ before
temporal spatialization

Probability $RR > 1\text{mm}$ after
temporal spatialization

2014062618+12prec3Md-obs.png

2014062618+12prec3Md-obs.png



Area where $RR > 1\text{mm}$ was observed (radar + rain gauges)

Conclusion

- Up to a certain limit (around 15-20 gridpoints radius (~50 km)) :
 - Improves reliability, ROC Area, Economic value
 - No effect on bias scores like mean bias and FB
- Similar effect with temporal spatialization

Thank you for your attention.