RÉPUBLIQUE FRANÇAISE
Liberté
Égalité
Fraternité

METEO FRANCE

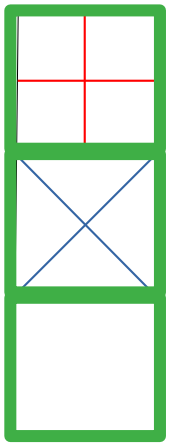
New Neighborhood-based CRPS

J. Stein and F. Stoop
DirOP/COMPAS
Météo-France
ACCORD 16/04/2021

Outline

- Presentation of the neighborhood and CRPS
- Inclusion of the neighborhood in the CRPS
- Comparison of probabilistic and deterministic QPF
- Conclusions

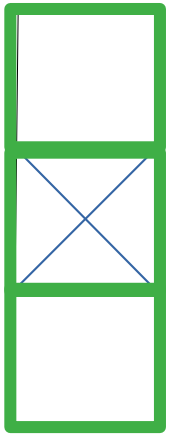
Presentation of the neighborhood and CRPS



1 FA

1 MISS

1 Cor Rej



1 Cor Rej

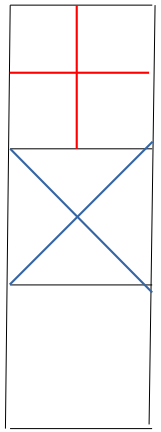
1 MISS

1 Cor Rej

Classical Tables of contingency

Presentation of the neighborhood and CRPS

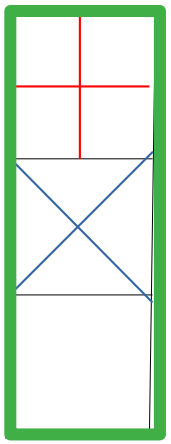
- Reward forecasts of events spatially slightly misplaced



1 FA

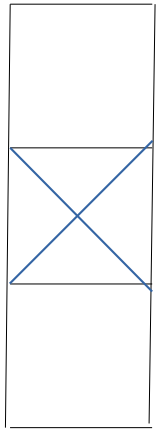
1 MISS

1 Cor Rej



Regional frequency

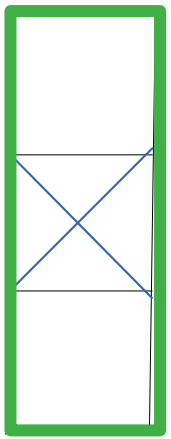
FORECAST	OBSERVED
1/3	1/3
1/3	1/3
0/3	1/3



1 Cor Rej

1 MISS

1 Cor Rej



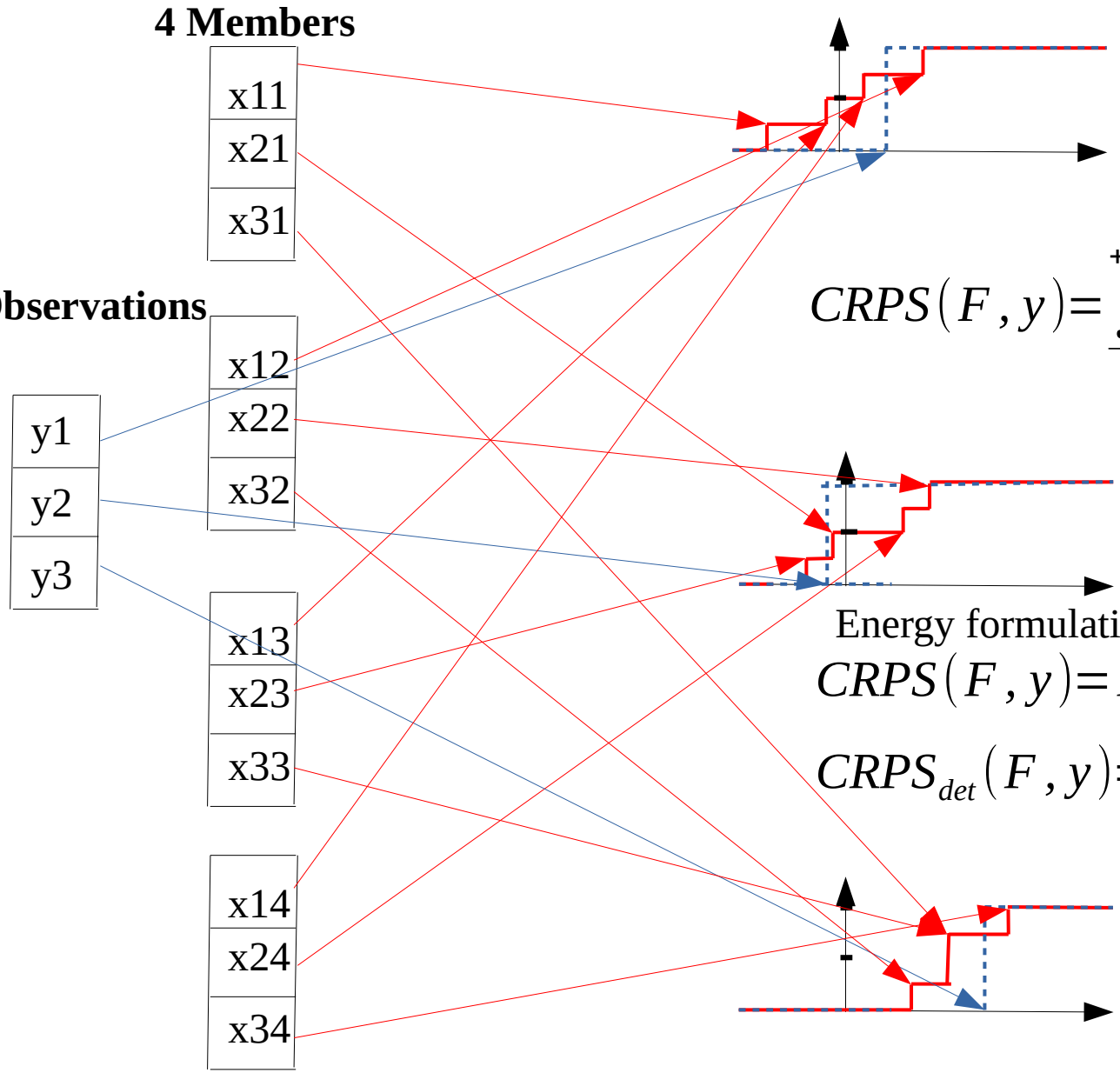
Regional frequency

FORECAST	OBSERVED
0/3	1/3
0/3	1/3
0/3	1/3

Classical Tables of contingency

FSS (Robert and Lean 2008)
and BSS (Amodei and Stein 2009)

Classical CRPS



(Hersbach 2000)

$$CRPS(F,y)=\int_{-\infty}^{+\infty}\left(F(x)-H(y-x)\right)^2 dx$$

Energy formulation (Gneiting and Raftery 2007)

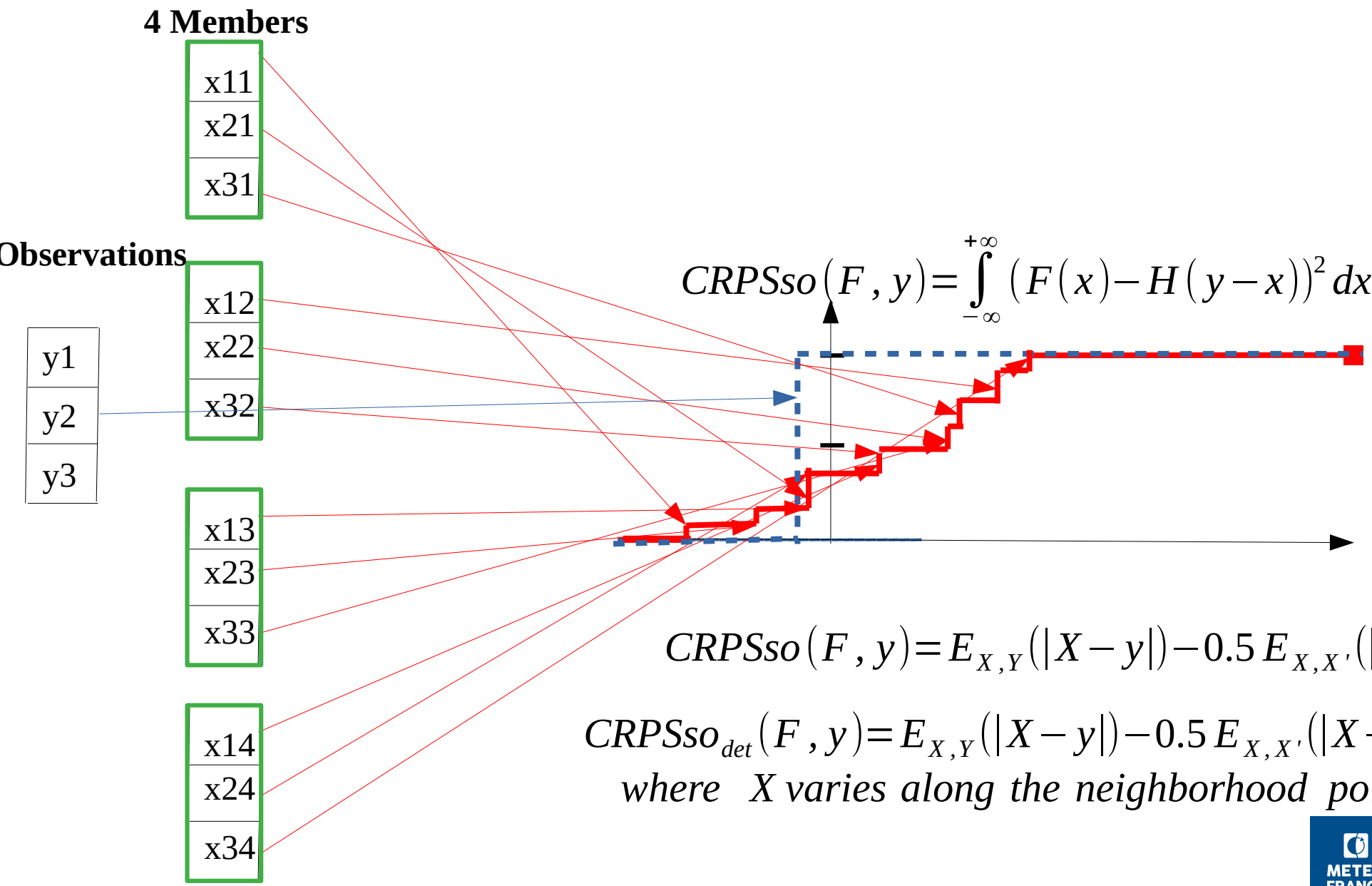
$$CRPS(F,y)=E_{X,Y}(|X-y|)-0.5\,E_{X,X'}(|X-X'|)$$

$$CRPS_{det}(F,y)=MAE(x,y)=|x-y|$$

Outline

- Presentation of the neigborhood and CRPS
- Inclusion of the neighborhood in the CRPS
- Comparison of probabilistic and deterministic QPF
- Conclusion

CRPSso : increase of the number of Members



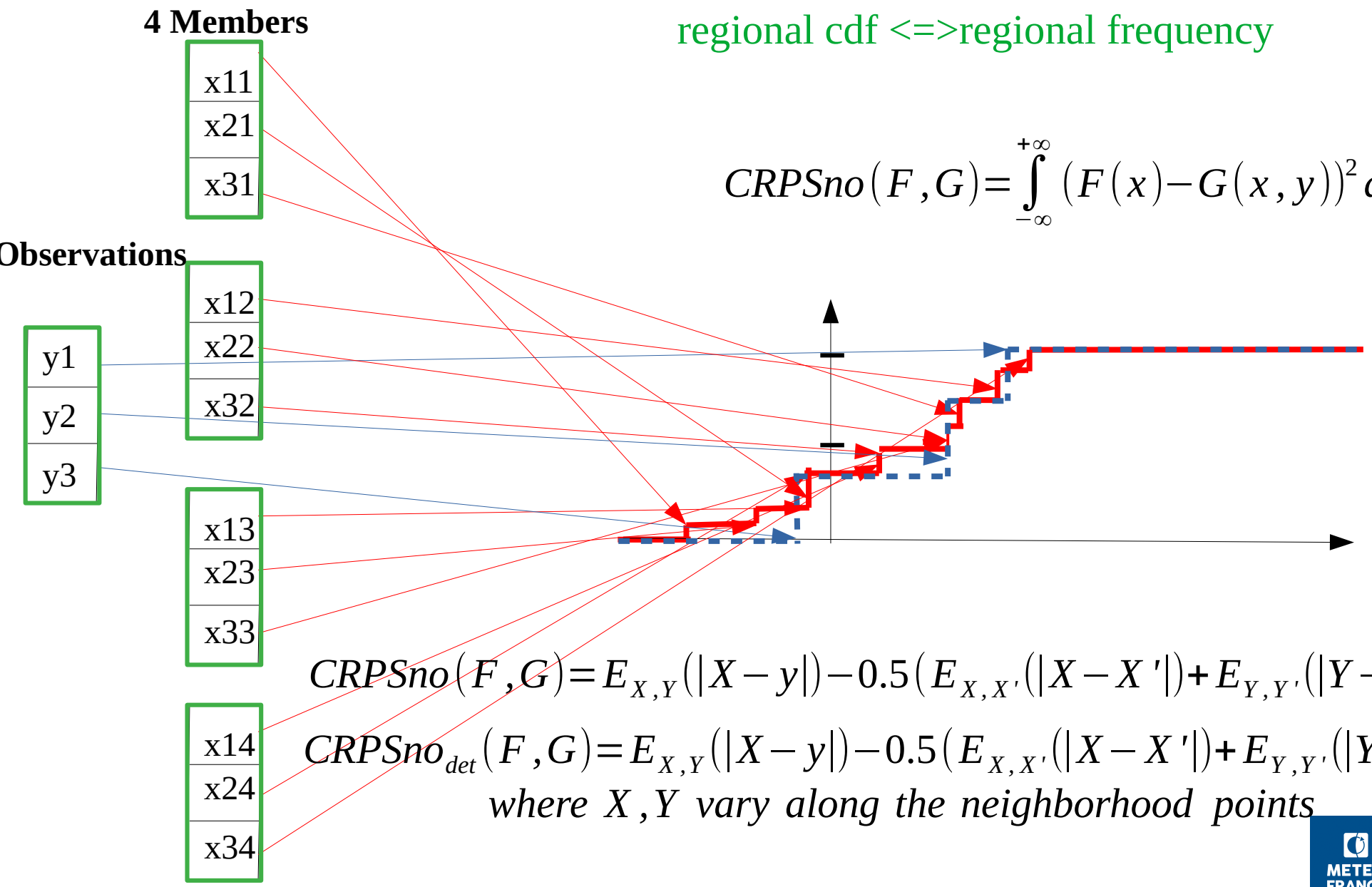
$$CRPSso(F, y) = \int_{-\infty}^{+\infty} \left(F(x) - H(y-x)\right)^2 dx$$

$$CRPSso(F, y) = E_{X,Y}(|X-y|) - 0.5\, E_{X,X'}(|X-X'|)$$

$$CRPSso_{det}(F, y) = E_{X,Y}(|X-y|) - 0.5\, E_{X,X'}(|X-X'|)$$

where X varies along the neighborhood points

CRPSno : comparison at the neighborhood scale



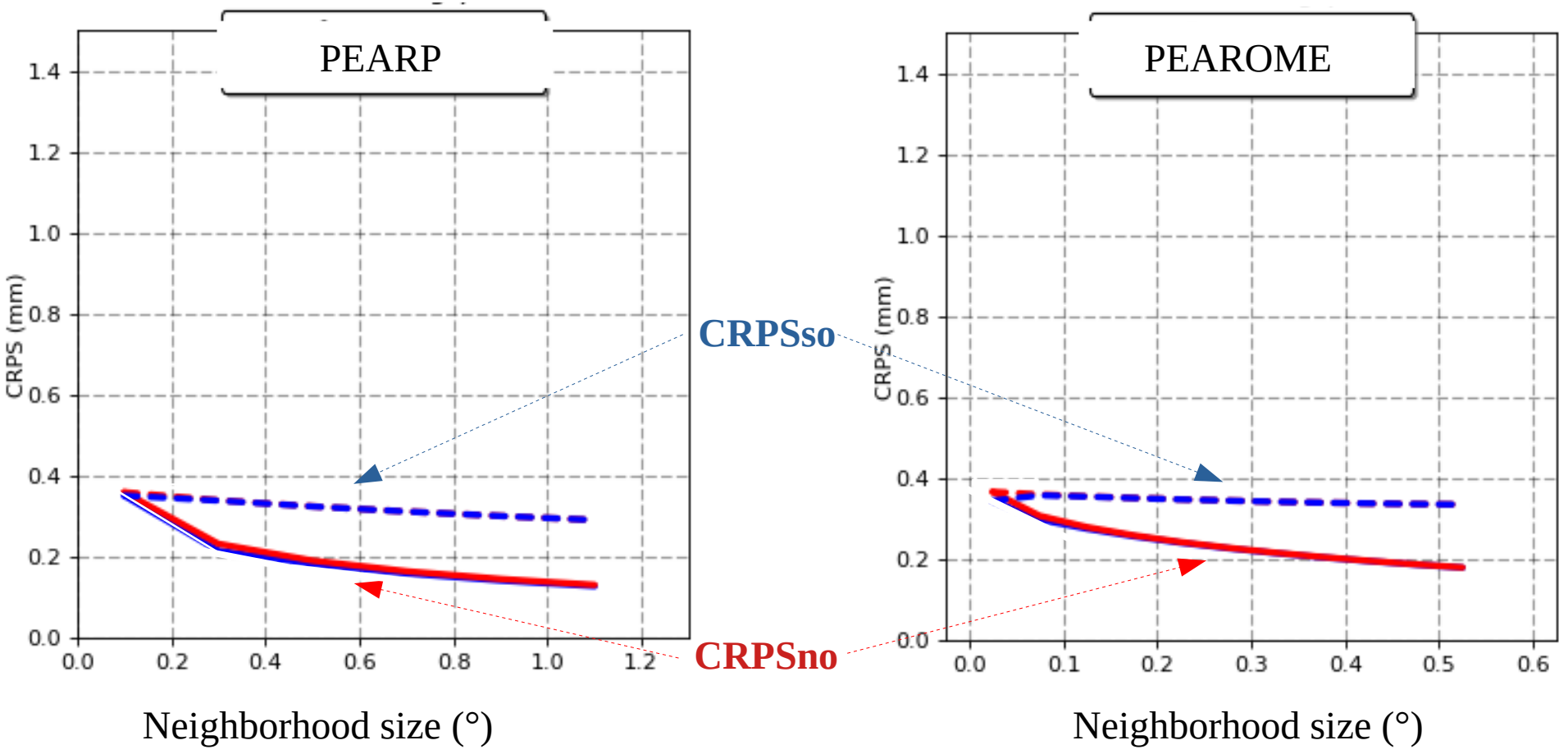
Outline

- Presentation of the neigborhood and CRPS
- Inclusion of the neighborhood in the CRPS
- Comparison of probabilistic and deterministic QPF
- Conclusion

Models and observations

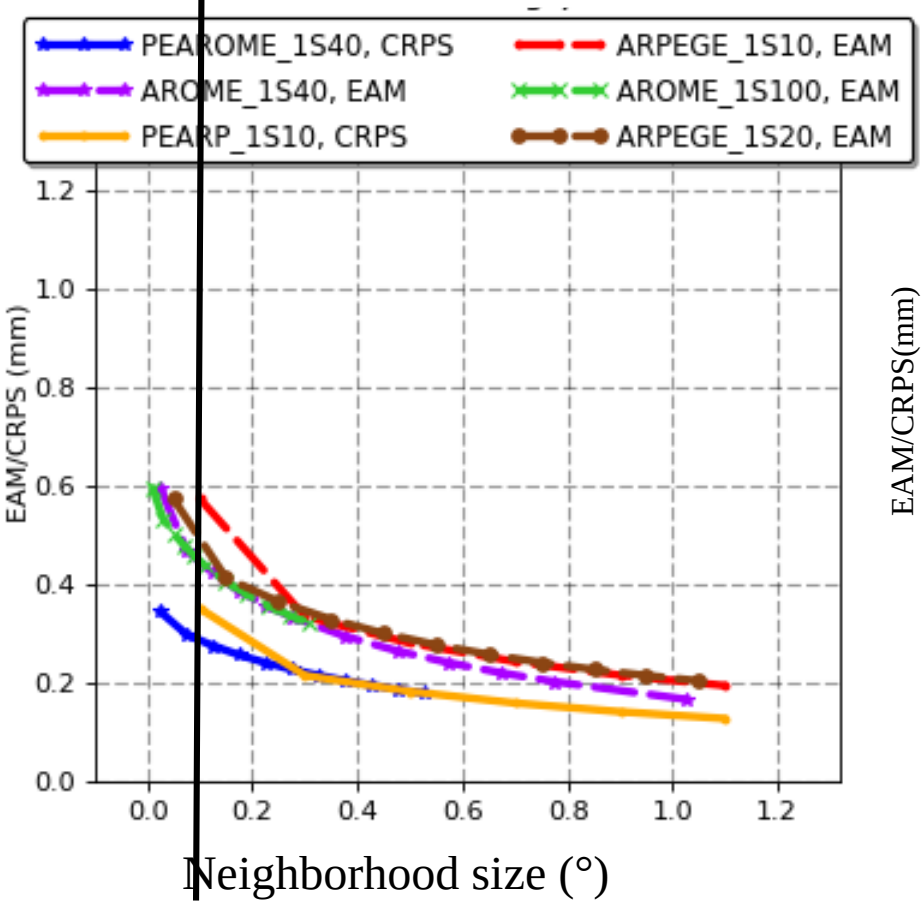
- **ARPEGE** : hydrostatic global model ; 5 km over France
- **PEARP** : 35 hydrostatic global forecasts ; 7,5 km over France ; Singular vectors + EDA and 10 physics
- **AROME** : non-hydrostatic LAM nested in ARPEGE ; 1.3 km over France
- **PEAROME** : 16 non-hydrostatic forecasts nested in PEARP ; 2,5 km over France ; EDA and stochastic physics
- **ANTILOPE** : data fusion between french radar observations and raingaujes ; 1 km grid over France
- **Verification of QPF accumulated during 3 hours** : from 01 october to 31 december 2019 over France

2 CRPS for the 3 months period valid at D+1 18 UTC



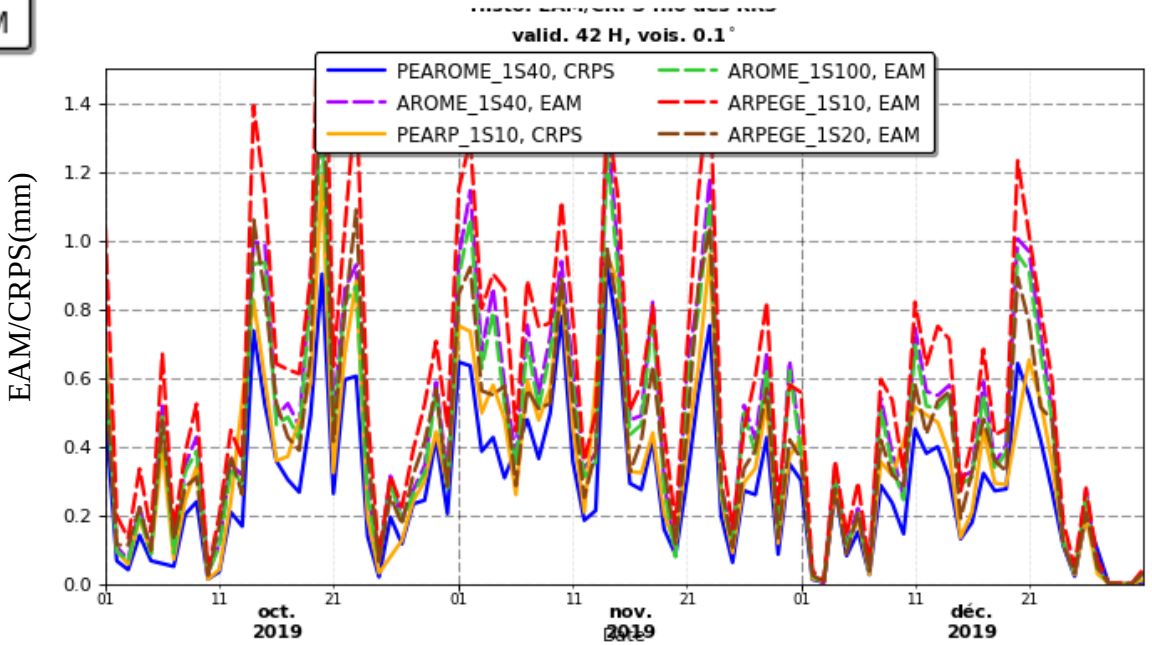
CRPSno valid at D+1 18 UTC for 4 forecasts

CRPSno averaged on 3 months



Neighborhood size (°)

Time serie of daily CRPSno for 1.0 ° neighborhood

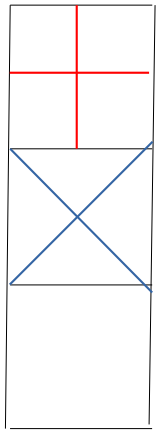


Conclusions

- Developpement of a neighborhood-based CRPS including regional CDF.
- Deterministic limit of CRPS comparable to CRPS for the ensembles of forecasts.
- CRPSso => impact of enlarging the number of members by using neighboring points to improve the CDF at the central point.
- CRPSno => observed and forecast CDF at the scale of the neighborhood.
- CRPSno => benefit of high-resolution ensembles at the resolution of low-resolution ensembles.
- CRPSno => convergence for larger neighborhoods : part of the double penalty is absorbed by using an ensemble of forecasts versus a deterministic forecast.
- Stein and Stoop (2021) submitted to Monthly Weather Review

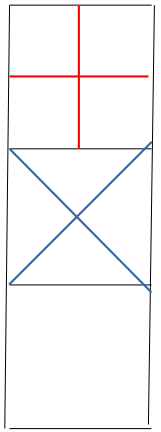
Presentation of the neigborhood and CRPS

- Reward forecasts of events spatially slightly misplaced



1 FA

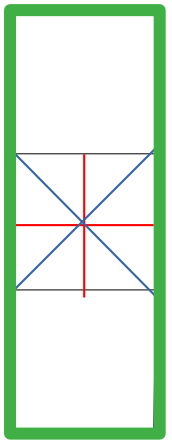
1 MISS



Regional frequency

=1/3 FORECASTED

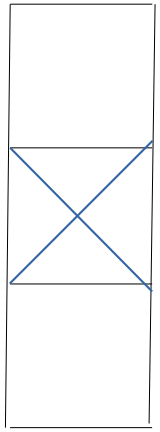
=1/3 OBSERVED



Error compensation

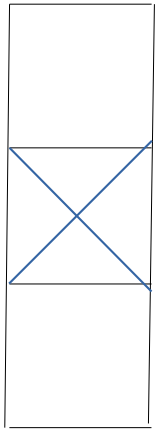
1 Cor Rej

1 HITS



1 Cor Rej

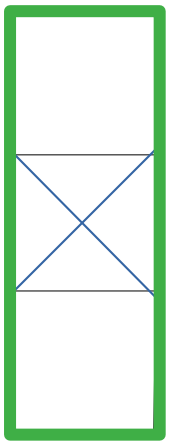
1 MISS



Regional frequency

=0/3 FORECASTED

=1/3 OBSERVED



Error compensation

1 Cor Rej

1 MISS

Classical Tables of contingency

FSS (Robert and Lean)
and BSS (Amodei and Stein)

New Tables of contingency
(Stein and Stoop 2019)

Unfair and fair estimators of CRPS (Ferro 2014)

- Unfair estimator (u) of CRPS are obtained by using biased estimator of the dispersion => CRPSuso, CRPSuno

$$E_{X,X'}\left(\left|X-X'\right|\right)=\frac{1}{Members^2}\sum_{m=1}^{Members}\sum_{n=1}^{Members}\left|X\left(m\right)-X'\left(n\right)\right|$$

- Fair estimator (f) of CRPS are obtained by using unbias estimator of the dispersion => CRPSfso, CRPSfno

$$E_{X,X'}\left(\left|X-X'\right|\right)=\frac{1}{Members\left(Members-1\right)}\sum_{m=1}^{Members}\sum_{n=1}^{Members}\left|X\left(m\right)-X'\left(n\right)\right|$$