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Neighborhood-based CRPS

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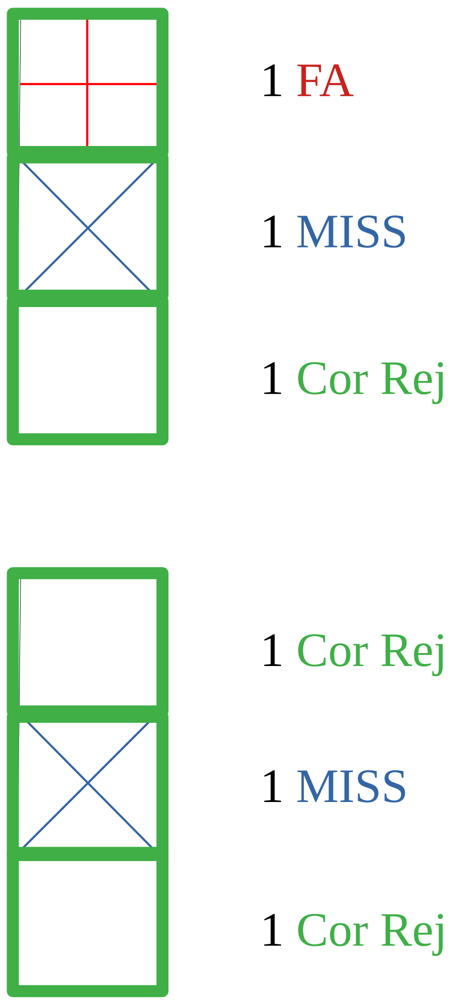
Outline

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

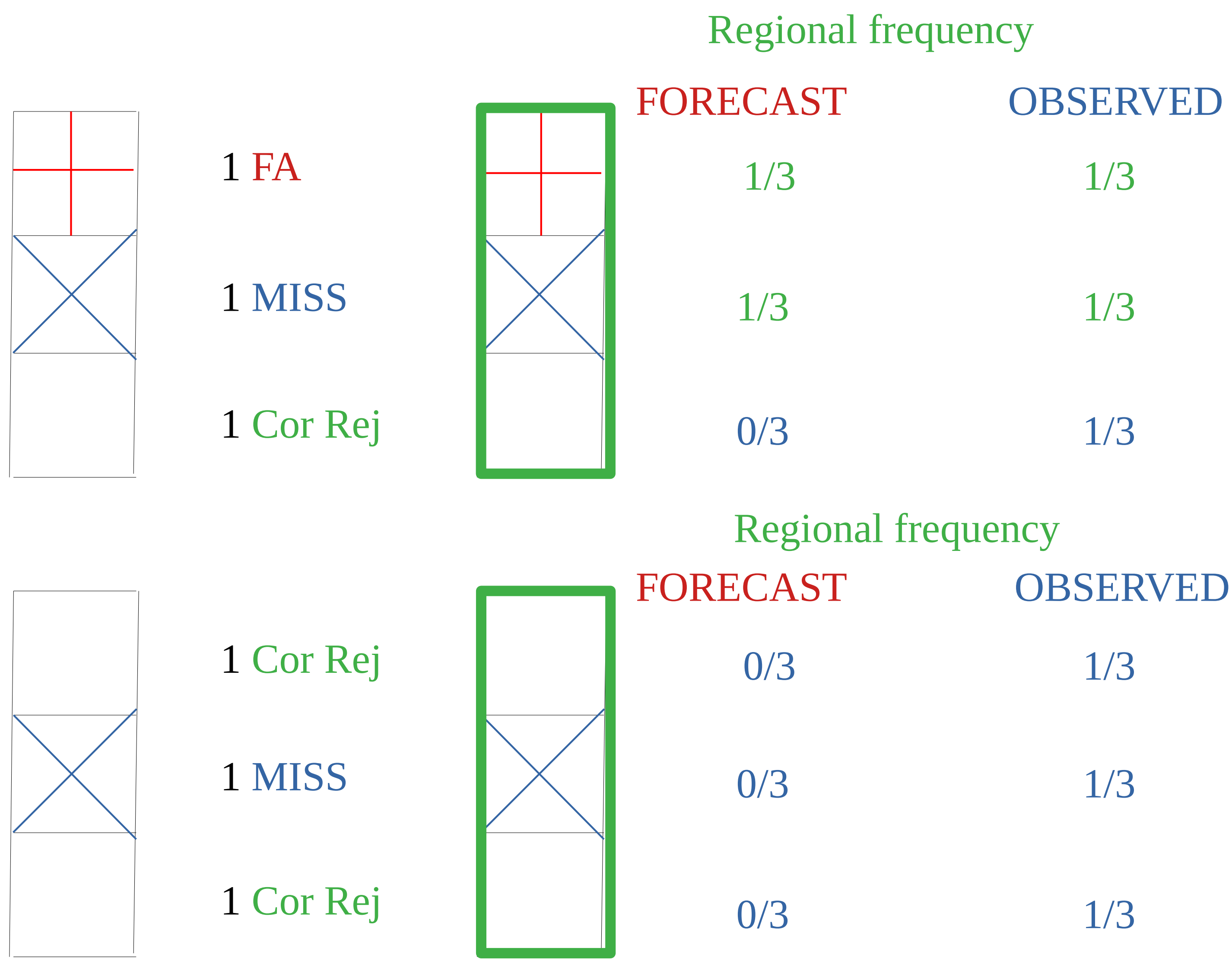
Presentation of the neighborhood and CRPS



Classical Tables of contingency

Presentation of the neighborhood and CRPS

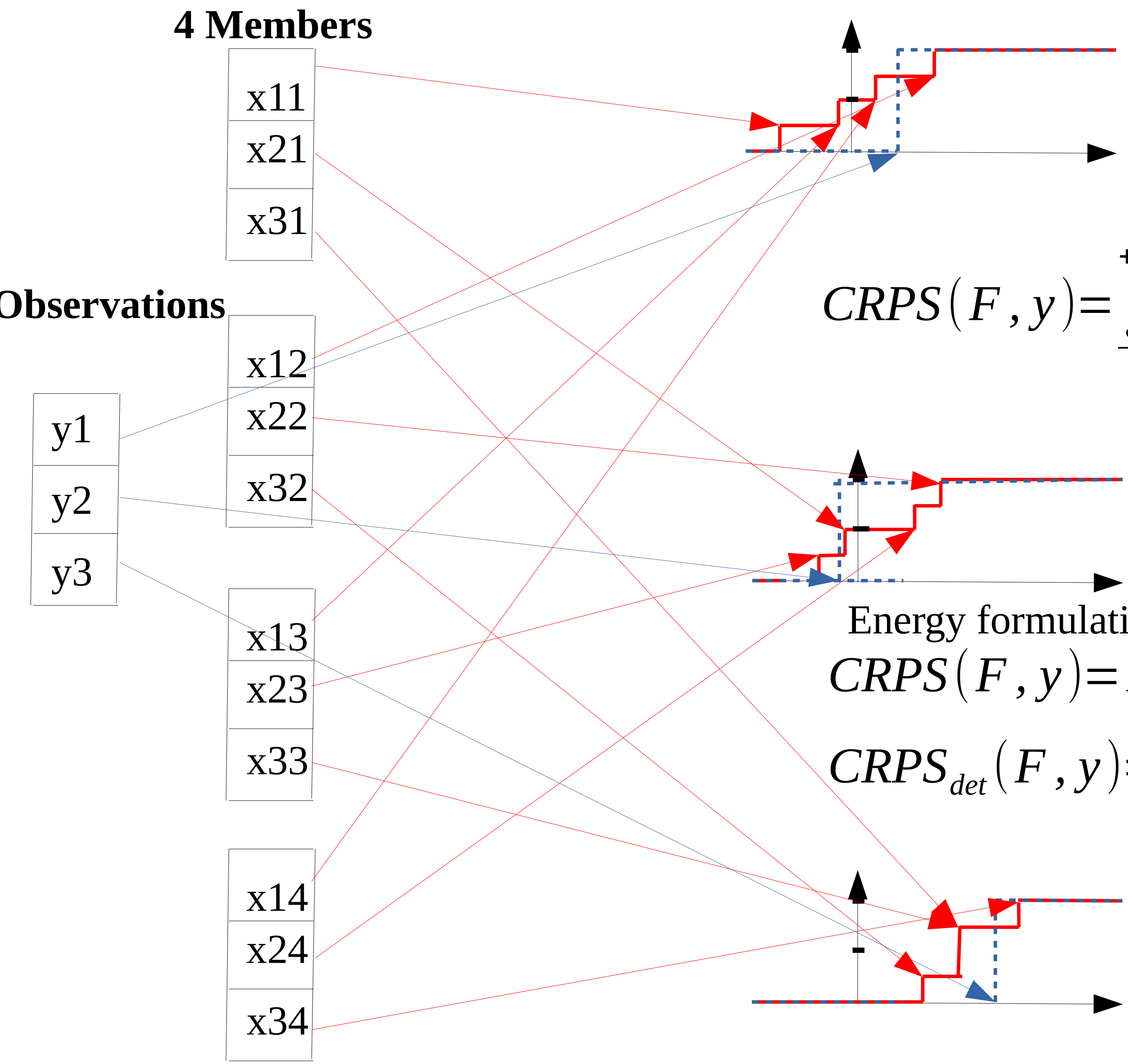
- Reward forecasts of events spatially slightly misplaced



Classical Tables of contingency

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

Classical CRPS



(Hersbach 2000)

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

Energy formulation (Gneiting and Raftery 2007)

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

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

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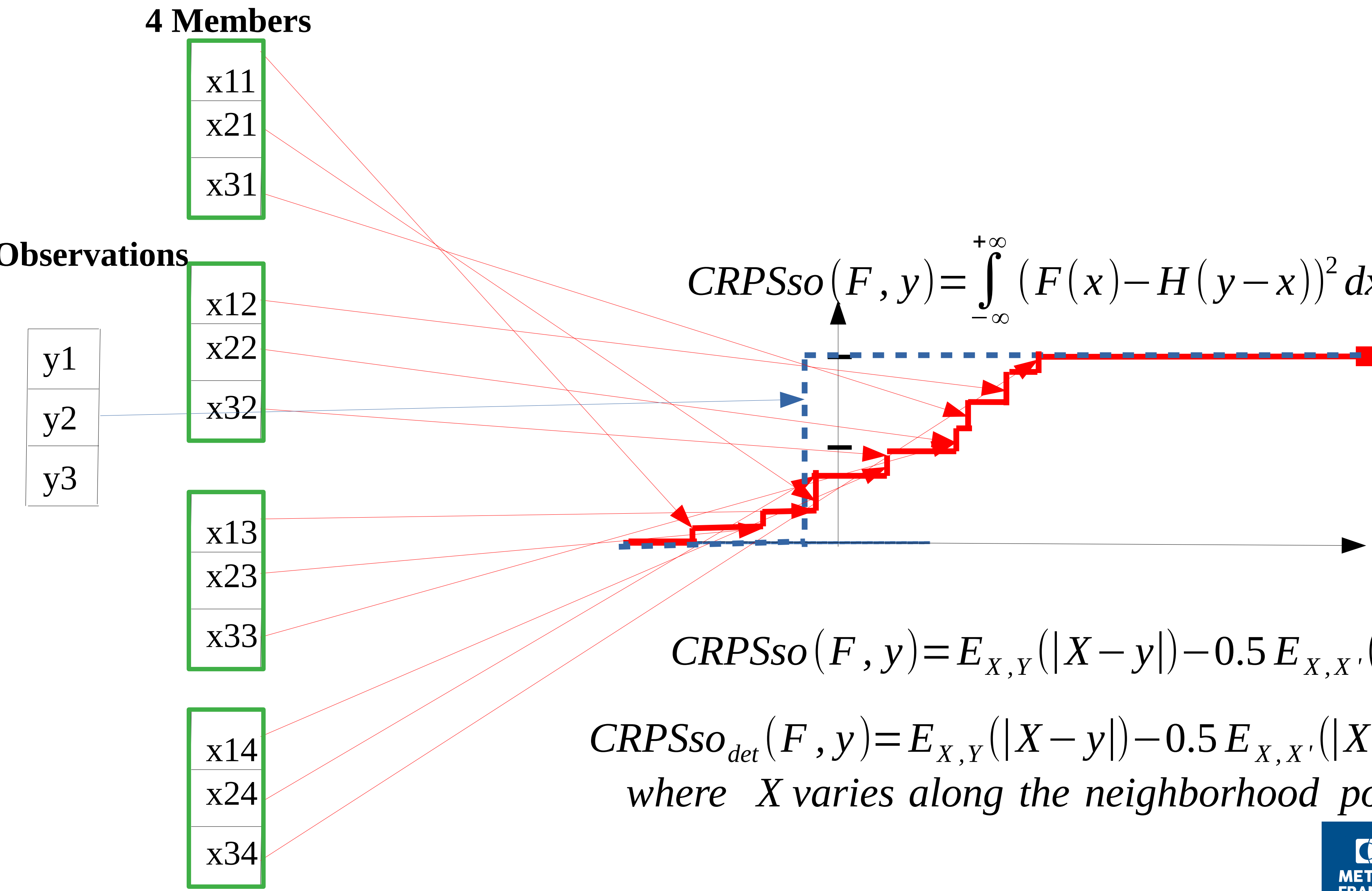
CRPSso : increase of the number of Members



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

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

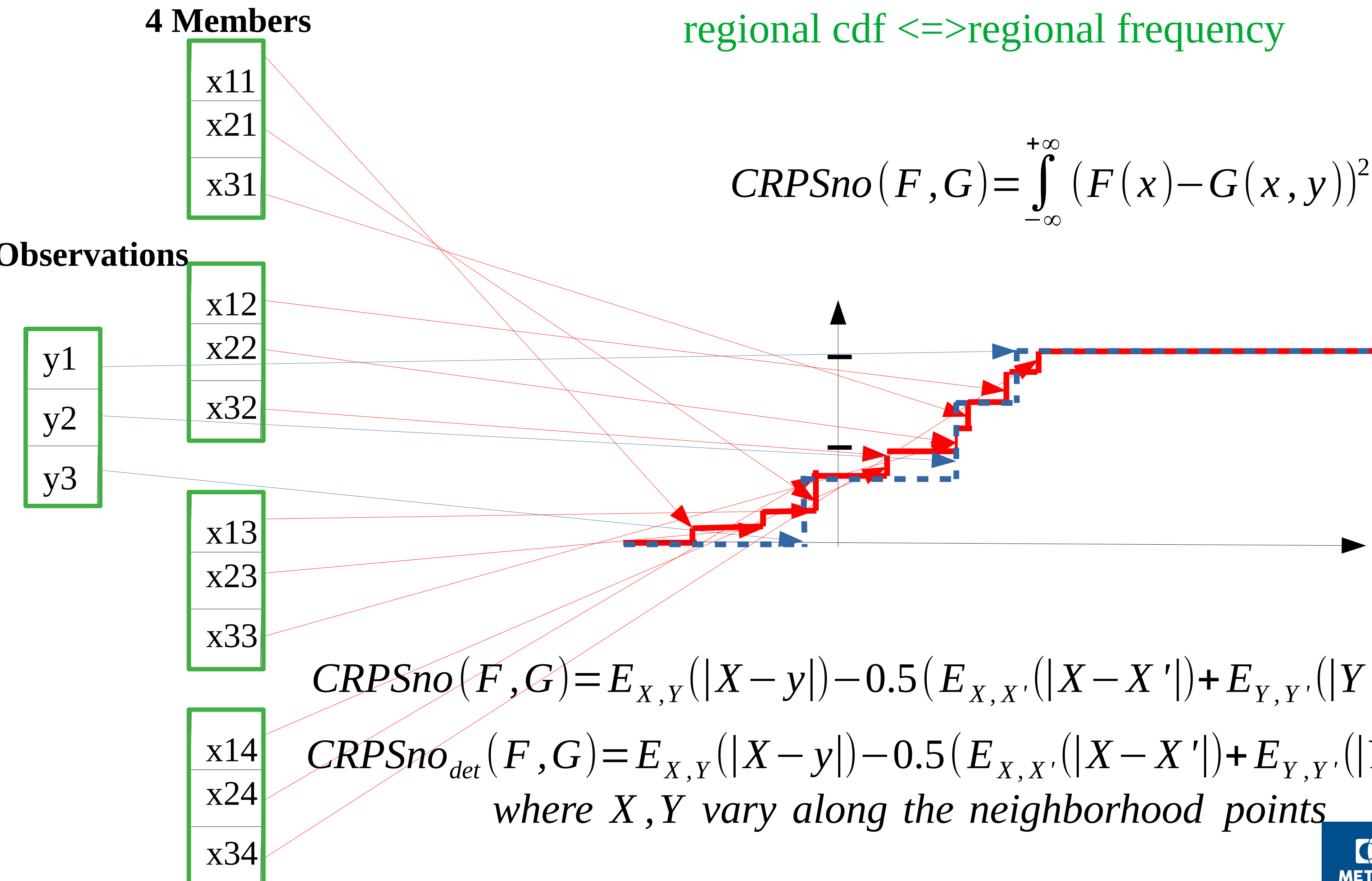
$$CRPSso_{det}(F,y)=E_{X,Y}(|X-y|)-0.5\,E_{X,X'}(|X-X'|)$$

where X varies along the neighborhood points

CRPSno : comparison at the neighborhood scale

regional cdf <=>regional frequency

$$CRPSno(F,G)=\int_{-\infty}^{+\infty}(F(x)-G(x,y))^2\,dx$$



$$CRPSno(F,G)=E_{X,Y}(|X-y|)-0.5(E_{X,X'}(|X-X'|)+E_{Y,Y'}(|Y-Y'|))$$

$$CRPSno_{det}(F,G)=E_{X,Y}(|X-y|)-0.5(E_{X,X'}(|X-X'|)+E_{Y,Y'}(|Y-Y'|))$$

where X, Y vary along the neighborhood points

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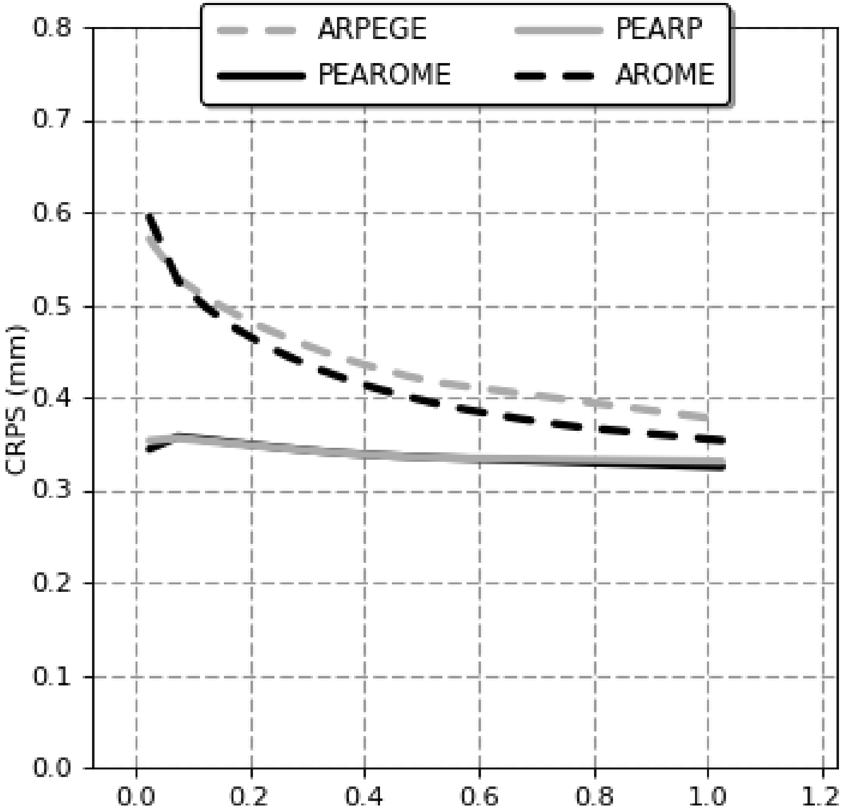
Models and observations

- **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 on the same grid (2,5 km)** : from 01 october to 31 december 2019 over France

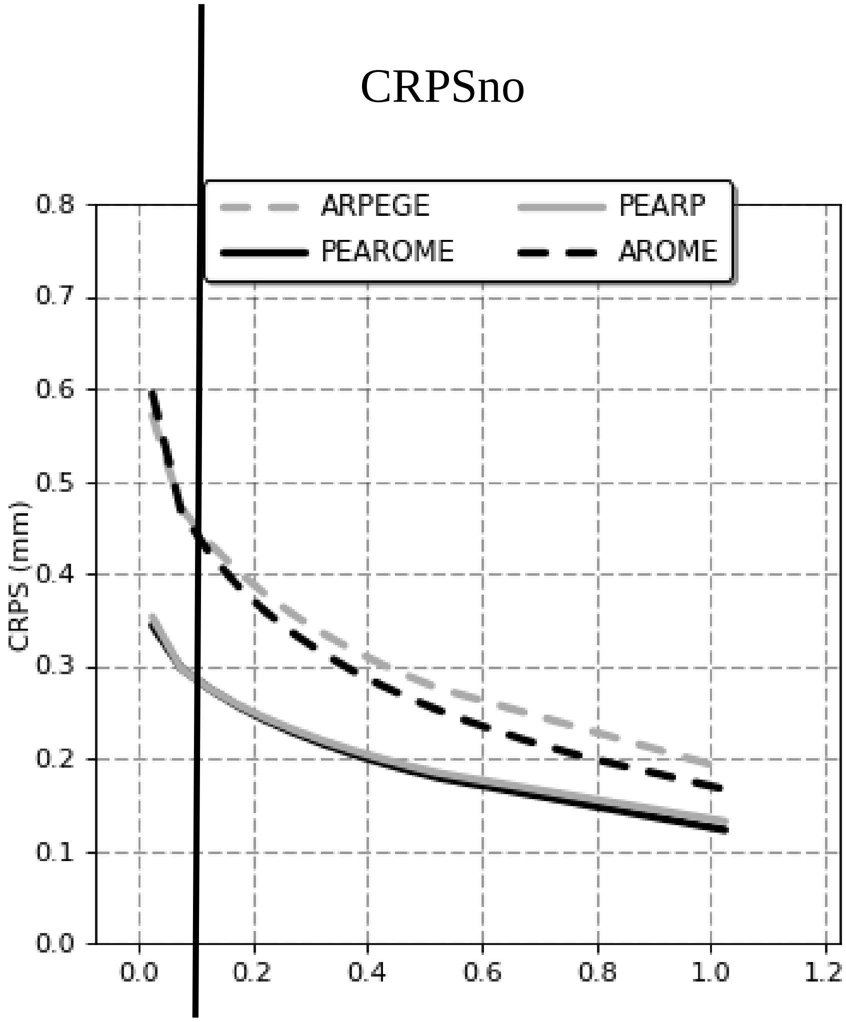
2 CRPS for the 3 months period valid at D+1 18 UTC

CRPSso



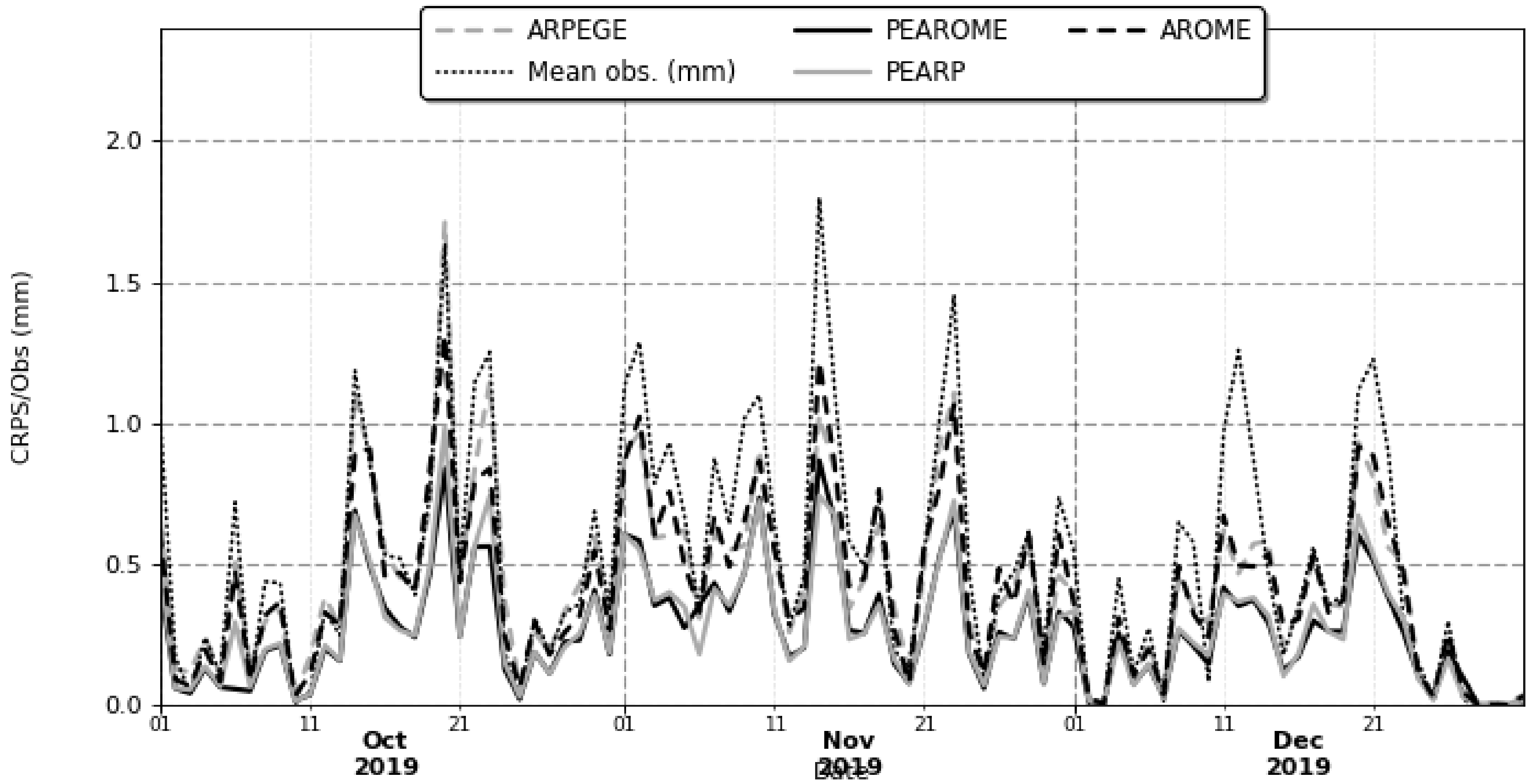
Neighborhood size (°)

CRPSno



Neighborhood size (°)

CRPSnoand mean observation valid at D+1 18 UTC

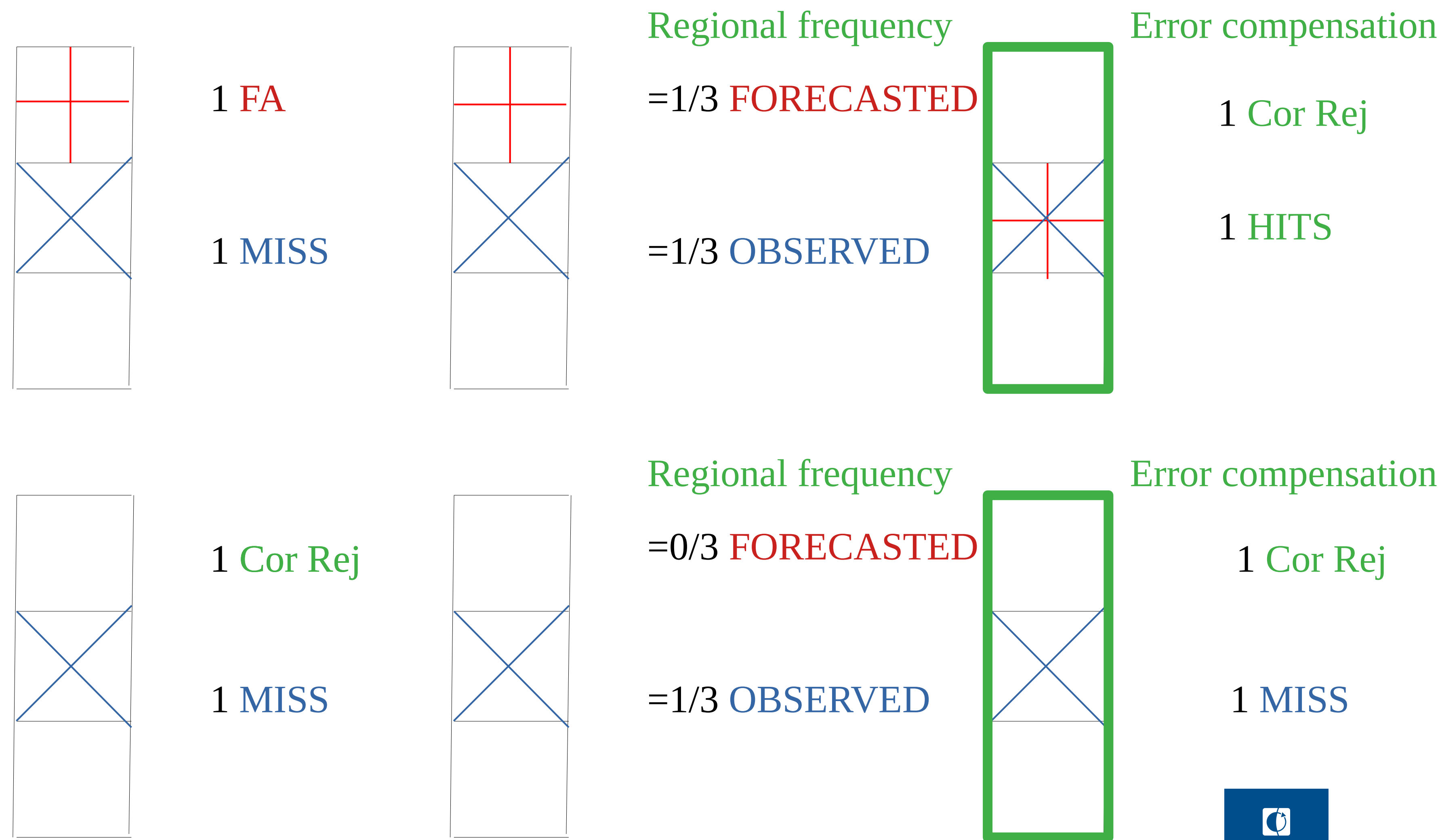


Conclusions

- Developpement of a neighborhood-based CRPS using the 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 => comparison of observed and forecast CDF at the scale of the neighborhood.
- A large 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



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

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

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

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