CRA application to ensembles

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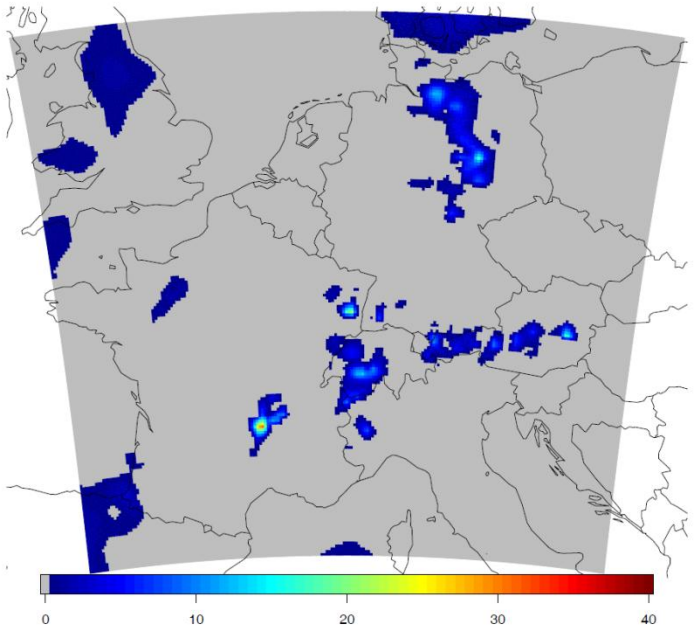
COSMO-Ru2-EPS ensemble reruns for MesoVICT case 1

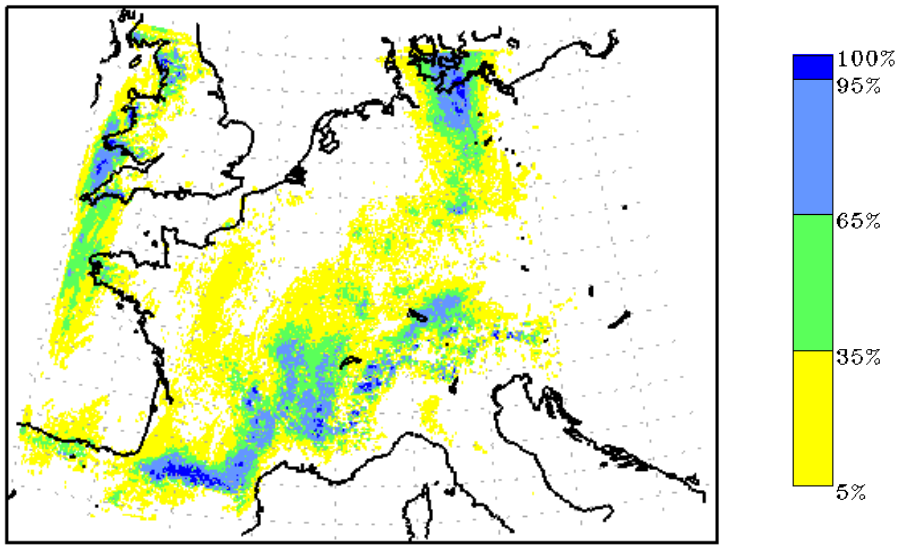
- Initial data 2007061912, from ECMWF EPS initial and boundary conditions with 25 km grid step
- Full 51-members ensemble is calculated
- A date from case 2 is being calculated now

20070620, 18-21h precipitation

VERA observation data



COSMO-Ru2 EPS probabilities of 3h precip >0.2mm



High probabilities correspond better to obs field

Setup of experiments

- MesoVICT case 1
- VERA analysis (not yet probabilistic), 8 km grid step
- COSMO-E, as it is already interpolated to VERA grid

  (Manfred Dorninger said that he is going to interpolate to VERA grid all the reruns made for MesoVICT, but COSMO-Ru2-EPS is not yet interpolated)

Object-based verification of ensembles

- Starting point: A paper of Johnson and Wang "Verification and Calibration of Neighborhood and Object-Based Probabilistic Precipitation Forecasts from a Multimodel Convection-Allowing Ensemble", 2012.

Defining object probabilities

12.5% probability (1 out of 8) of
Dark grey forecast object occurring

87.5% probability (7 out of 8) of
Dark grey forecast object occurring

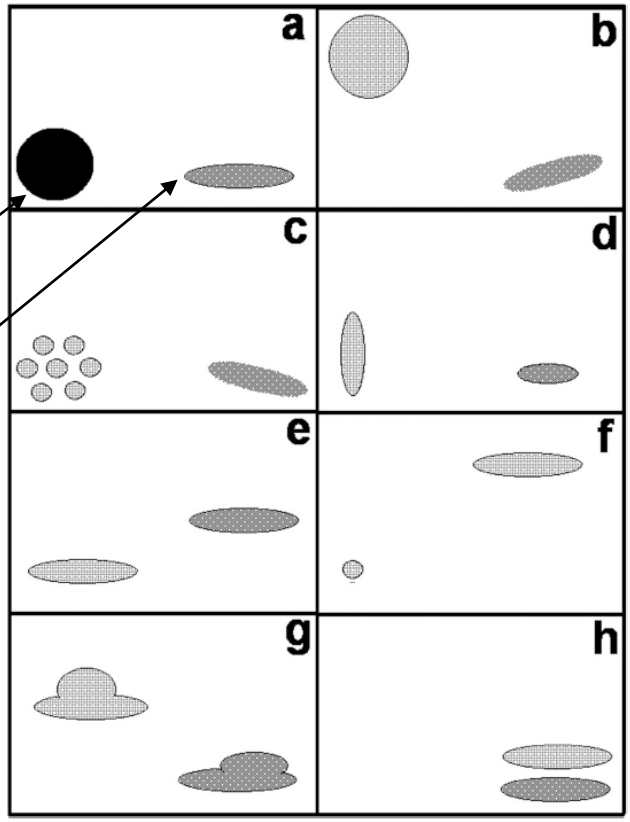
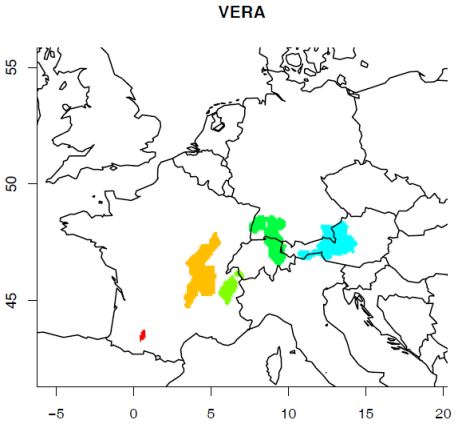


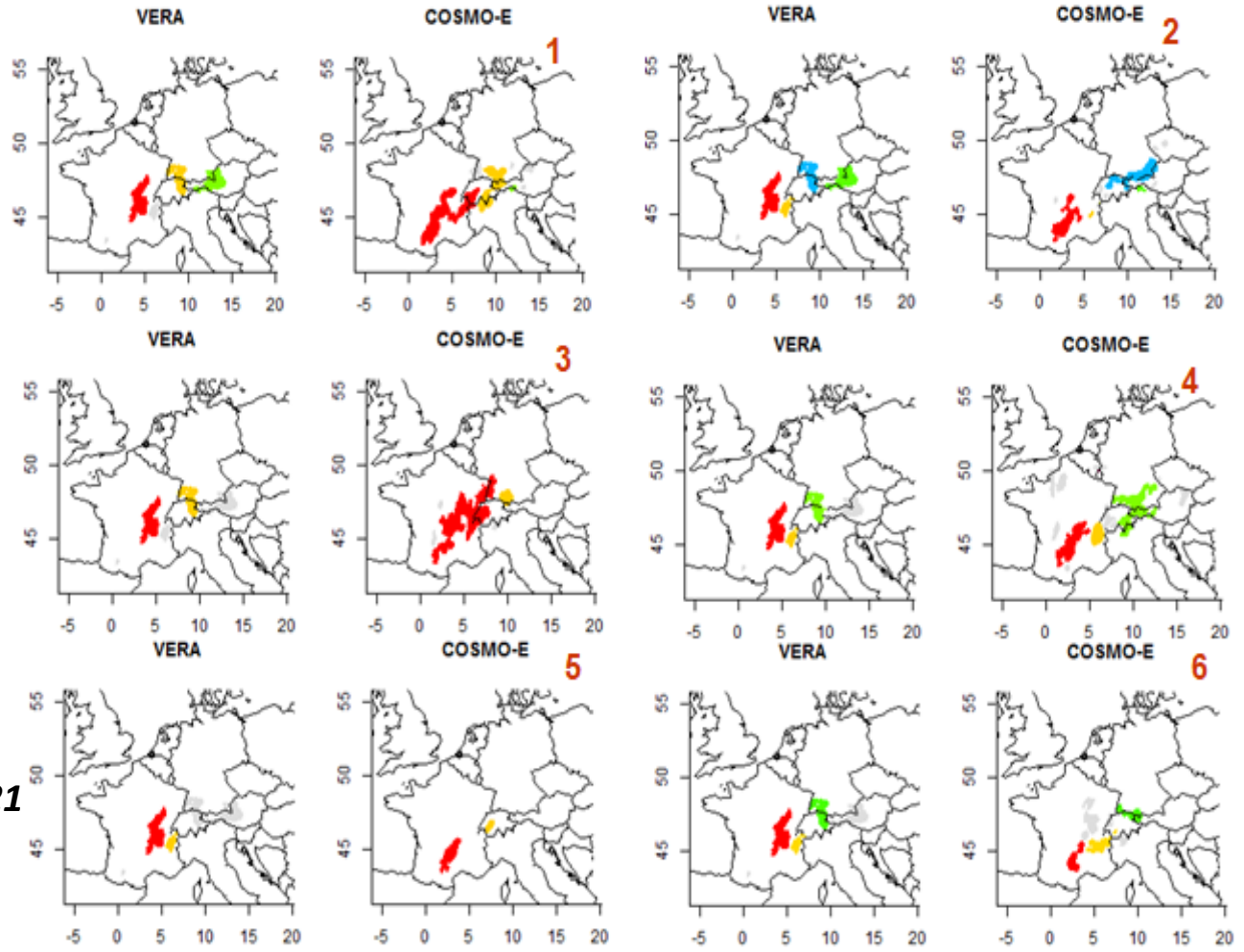
FIG. 3. A hypothetical ensemble of eight object-based forecasts, showing (a) the forecast objects of interest and (b)–(h) seven other members' forecasts. Forecast objects in (b)–(h) are colored black if they match the black forecast object of interest, dark gray if they match the dark gray forecast object of interest, and light gray if they do not match any forecast objects of interest. Such an ensemble of forecasts would result in 12.5% (87.5%) uncalibrated forecast probability of the black (dark gray) forecast object occurring.

Object matching for EPS, MesoVICT case 1

Probability of each observed object is found and the ensemble skill can be estimated using the usual scores, the BSS, for example



2007062021
COSMO-E ensemble,
first 6 of 21 members,
precip threshold >0.5 mm/1h
Probabilities of each of 5 observed
objects:
1/21 20/21 10/21 19/21 14/21
Minboundmatch



Difficulty of such an approach:

No merging of objects is possible as the list of observed objects must be the same for matching with all ensemble members

If we want to verify forecasted probabilities of objects, we have to choose objects of one ens. member as the reference

Actually, CRA scores cannot be calculated like this, only the traditional probabilistic scores applied to probabilities of objects

Plans:

To try other approaches to ensembles:

1) To calculate location, volume, fine pattern errors for each ensemble member, and to average them.

2) To identify objects using the probability threshold (like in Gallus William A. Jr., 2010: Application of Object-Based Verification Techniques to Ensemble Precipitation Forecasts, Weather and Forecasting, Vol.25, pp.144-158)

CRA in SpatialVx 0.6.1. Some testing on geom.cases

Forecast field

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0
0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	5.0	0.0
0.0	0.0	0.0	5.0	15.0	5.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	15.0	20.0	15.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	5.0	15.0	5.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

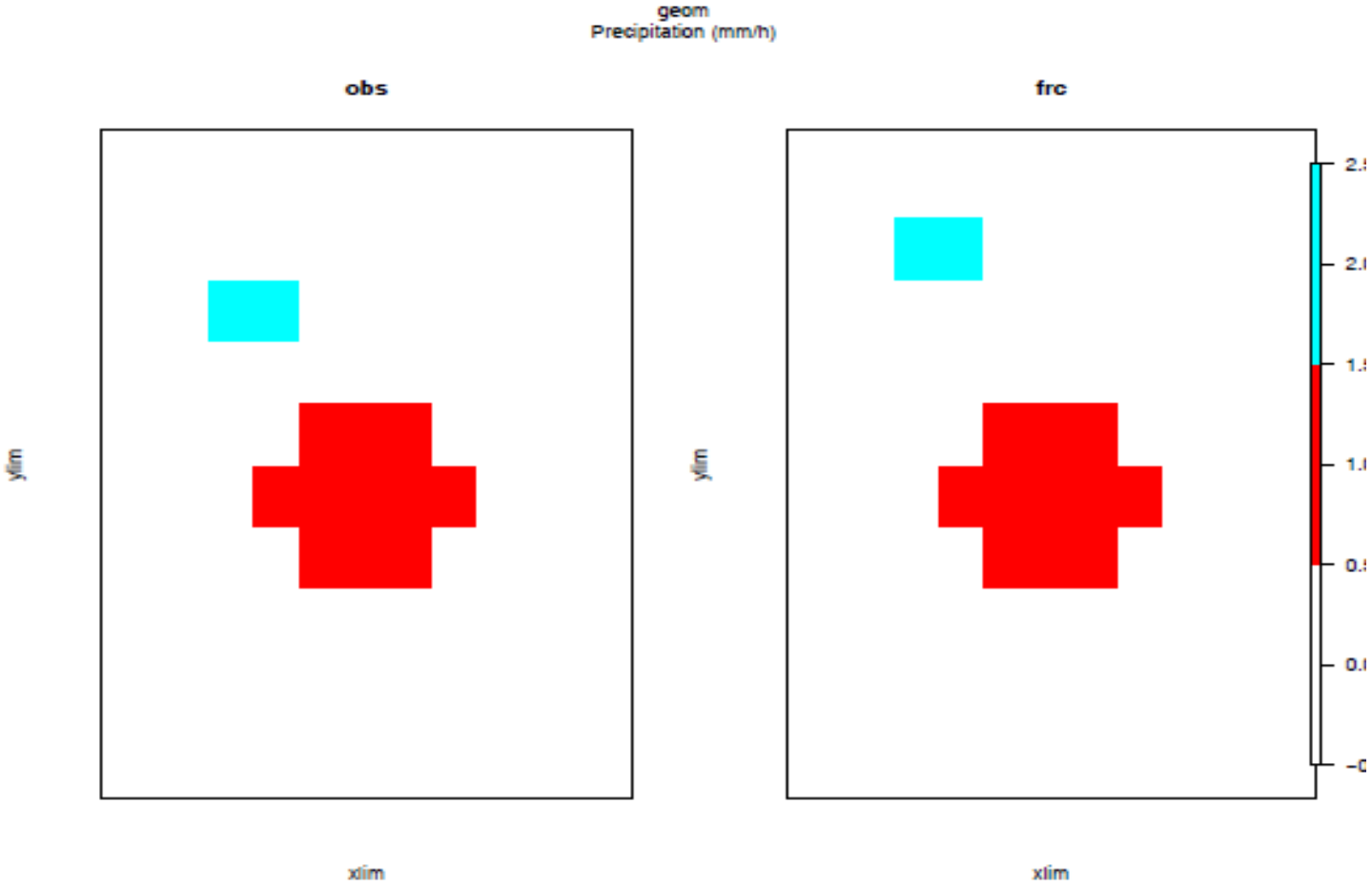
Observation field

0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0
0.0	0.0	0.0	0.0	5.0	0.0	0.0	5.0	0.0	0.0
0.0	0.0	0.0	5.0	20.0	5.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	20.0	30.0	20.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	5.0	20.0	5.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

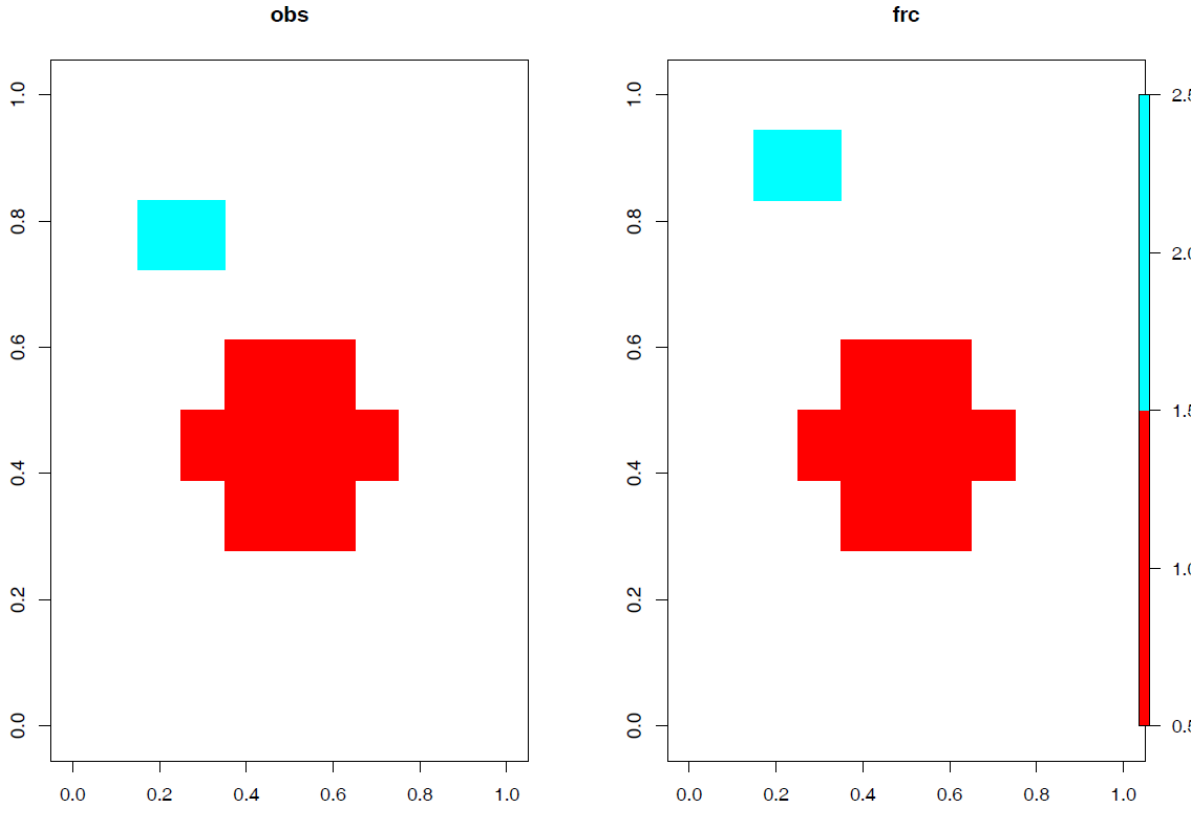
This feature is shifted one point in Y axis

This feature is Not shifted, but The volume is greater the forecast field

Features, no smoothing



Matched features (same in Minboundmatch, centmatch criteria 2)



CRA – Contiguous Rain Area (E.E. Ebert, J.L. McBride 2000)

http://www.cawcr.gov.au/projects/verification/CRA/CRA_verification.html

MSEtotal = MSEdisplacement + MSEvolume + MSEpattern

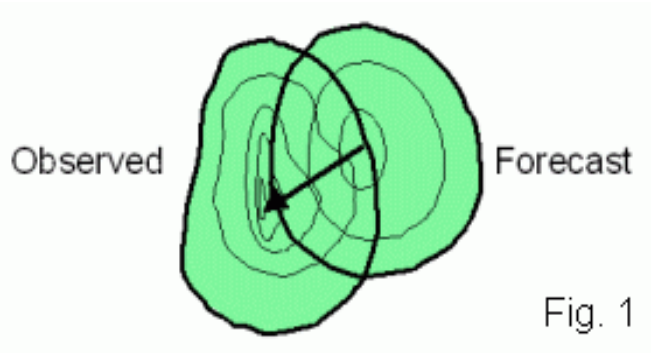


Fig. 1

MSEdisplacement = MSEtotal – MSEshifted

MSEvolume = (***F*** - ***X***)2
where ***F*** and ***X*** are the CRA mean forecast and observed values after the shift.

MSEpattern = MSEshift – MSEvolume

The CRA concept is easy to understand,
but there are many important issues and nuances in application of the CRA

CRA results

ir	x	y	MSE.total	MSE.shifted	MSE.displace	MSE.volume	MSE.pattern
1	0.0000	0.0000	1.8182	1.8182	0.0000	0.0744	1.7438
2	0.0000	1.0000	0.9091	0.4545	0.4545	0.0083	0.4463

1) For the 1st pair, most of the error comes from the fine-scale pattern, why?.. There should be only volume difference

2) For the 2nd pair, there should be only the displacement error present, the volume being the same, but there are also errors from volume difference and pattern.

Further bug-fixing is needed.

Thank you for your attention!