The contiguous rain area (CRA) method application for the MesoVICT cases in the framework of the COSMO INSPECT project

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Abstract

The CRA method using the R SpatialVx package is applied for the MesoVICT cases. Different precipitation accumulations and thresholds are verified. The influence of the matching function choice is studied. The outcomes are compared with those obtained earlier for the Caucasus Sochi region, another mountainous terrain. Preliminary results for the method application to the ensemble data are given.

Verification setup

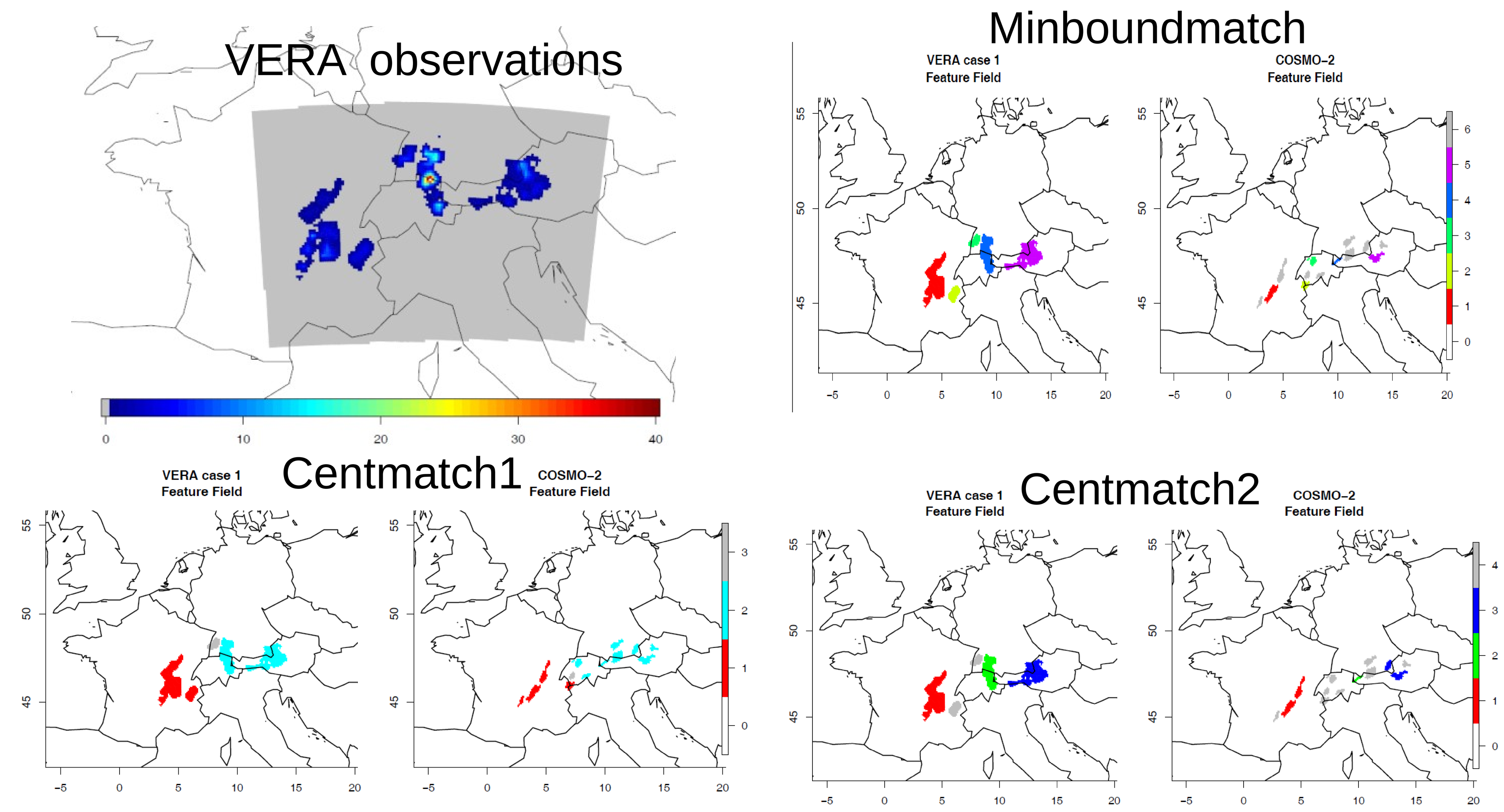
In the framework of MesoVICT (Mesoscale Verification Intercomparison over Complex Terrain, phase 2 of the ICP, https://ral.ucar.edu/projects/icp/), a set of cases is provided to compare various spatial verification methods.
VERA observation analysis is used as reference data in this study.
The Swiss COSMO-2 deterministic model and COSMO-E ensemble system are used as model data (both with 2.2 km grid step).
Free R SpatialVx package (https://cran.r-project.org/web/packages/SpatialVx/index.html) developed by E.Gilleland contains most part of existing spatial methods, including identifying, matching, and merging features in observed and forecasted fields.
Identification of objects: first, the field is smoothed using a convolution smoother, and then it is set to a binary image where everything above a given threshold is set to one (Davis et al, 2006). Features are identified by groups of contiguous "events", features less than ~36*36 km are omitted from analysis.
Matching functions used:
Minboundmatch (in single matches mode): each object is paired to only one object according to the smallest minimum boundary separation
Centmatch: Objects are matched, if the centroid distance D is less than

1) the sum of the sizes of the two objects in question (size is the square root of the area of the object) (D=1)
2) the average size of the two objects in question (D=2)

Centmatch doesn't merge objects explicitly, but determines possible merges applied if ***MergeForce*** function is run after *centmatch* (**used in this case**), It is possible for more than one object to be matched to the same object in another field.

Experience gained from studies on deterministic models

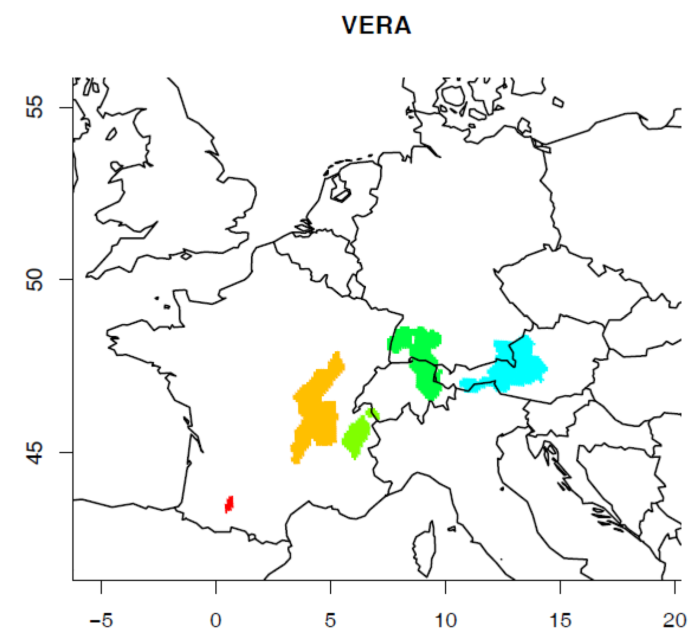
Reasonable matching is the most difficult stage in the application of features-based methods.
For lower precip thresholds, and thus, wider features, centmatch gives more reasonable results overall
For higher thresholds, centmatch often leaves everything unmatched due to small features areas. Minboundmatch seems more promising, with a minimum boundary separation distance beyond which features should not be matched



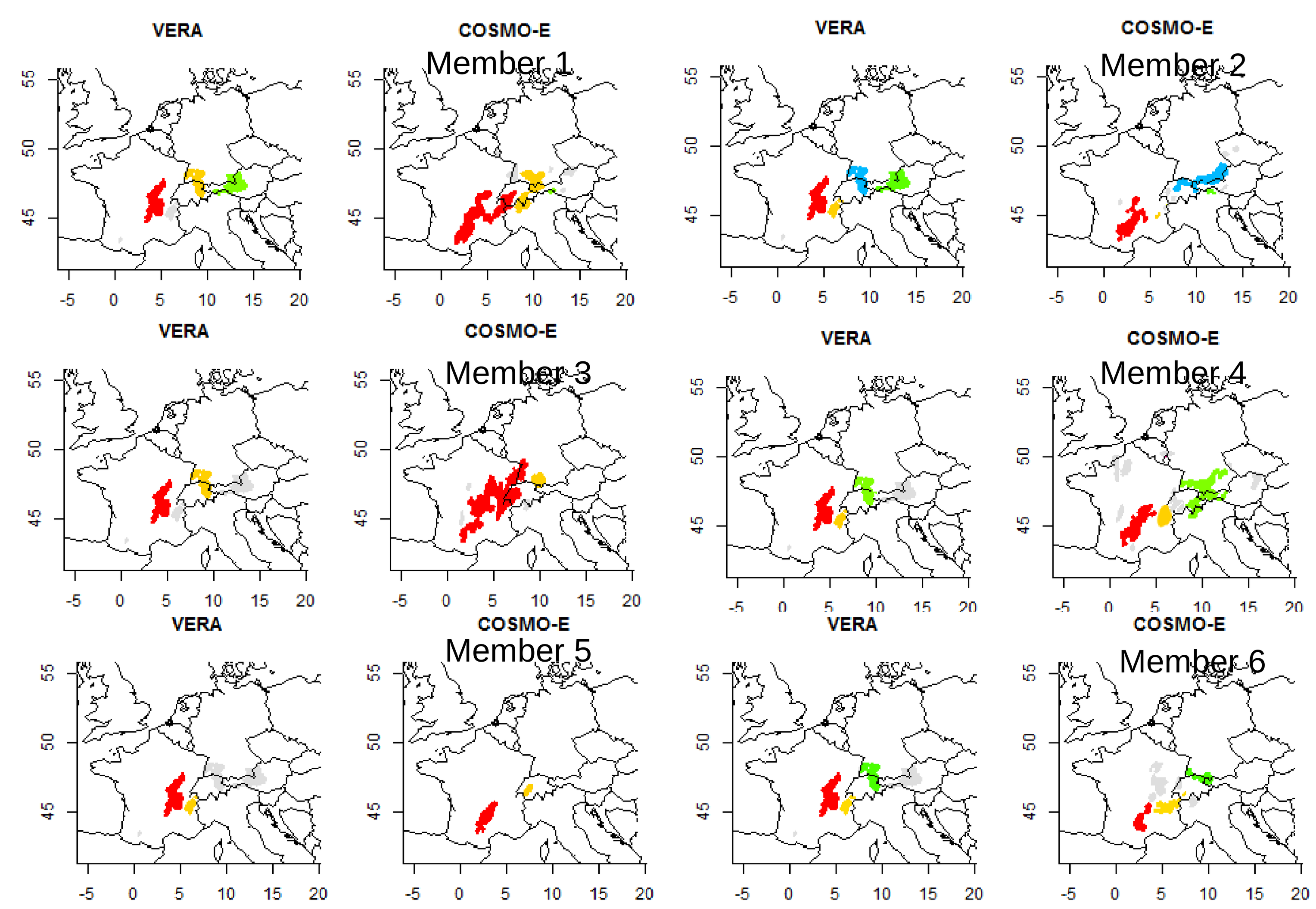
Example: 2007062021, absolute VERA precip maximum during MesoVICT Case 1, Model: COSMO-2, precip threshold > 0.5 mm/1h

Application of an object-based method to ensemble forecasts

Starting point: method proposed in Johnson and Wang, 2012.
In this study, probability of each observed object is found and can be estimated using BSS, for example.
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, thus centmatch cannot be applied.



Minboundmatch: 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



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 (Gallus 2010)

It is planned to use spatial methods to verify nowcasting and short-range forecasts, thus the main problem is to process huge amount of data.

Referenes:

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Davis, C., B. Brown, and R. Bullock, 2006: Object-based verification of precipitation forecasts. Part I: Methodology and application to mesoscale rain areas. Mon. Wea. Rev., 134, 1772–1784.
Johnson and Wang, 2012: "Verification and Calibration of Neighborhood and Object-Based Probabilistic Precipitation Forecasts from a Multimodel Convection-Allowing Ensemble", Monthly and Weather Review, Vol. 140, pp. 3054-3077