Section 10

Forecast verification: methods and studies.

The contiguous rain area (CRA) method application for the Caucasus and Alpine regions

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Abstract

The hourly precipitation forecasts in the mountainous regions of Caucasus (Sochi region) and the Alps are verified using the object-based Contiguous Rain Area (CRA) method [2]. The forecasts under the study are made in the framework of the WMO WWRP project FROST-2014 (FROST - Forecast and Research in the Olympic Sochi Testbed) [6] and the MesoVICT (https://www.ral.ucar.edu/projects/icp/) project. Several results of the application of object-based method to ensembles are given.

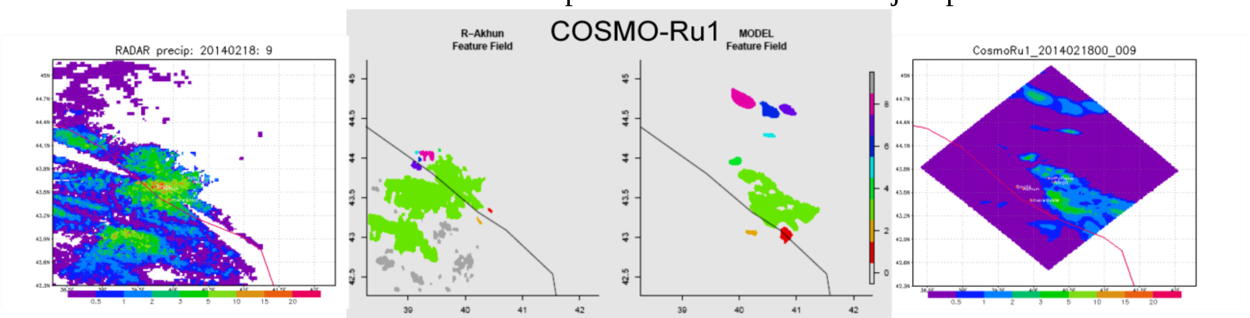
Introduction

The traditional point-wise verification of precipitation and other inhomogeneous fields is not enough for high-resolution models, as it can suffer from the double-penalty problem, when a point of forecasted event is shifted relative to the point of observed event [4]. To tackle this issue, numerous spatial verification methods have therefore been developed in the last decade.

The FROST-2014 archive of winter weather observations and high-resolution forecasts provided the base for validation of nowcasting and forecasting systems over the complex terrain. In [6], some results of deterministic verification were given, and it was noted that they should be complemented by spatial verification. The software based on the free R SpatialVx package was created; it includes the neighborhood and object-based methods at present. This paper focuses on object-based approaches. In the CRA, the total mean squared error of object forecast is decomposed into shift, mean volume, and small-scale pattern components. The objects, as connected sets, are identified by thresholding: the field is smoothed using a convolution smoother and set to a binary image where everything above a given threshold is set to one [1].

Results of deterministic study

In the Sochi region, COSMO-Ru1 and COSMO-Ru2 deterministic systems (1.1 and 2.2 km grid spacing, respectively) were used as the model data and the radar data (Sochi) with 1 km grid spacing, as reference data. In Fig. 1, an example of matched pairs of radar and COSMO-Ru1 precipitation objects are shown (the same colors indicate matched pairs) along with the corresponding CRA scores. Precipitation threshold is 1 mm/h. Initial precipitation fields are also shown. According to these scores, most of the total MSE error comes from the small-scale pattern errors for most object pairs.



ir	x	y	MSE.total	MSE.shift	MSE.displace	MSE.volume	MSE.pattern
1	45.4021	-36.5179	0.0028	0.0023	0.0005	0.0000	0.0022
2	-2.7630	-17.8333	0.0011	0.0007	0.0004	0.0000	0.0007
3	159.7069	2.3035	0.1246	0.0820	0.0426	0.0027	0.0793
4	45.9893	-16.9170	0.0014	0.0012	0.0002	0.0000	0.0012
5	164.7442	25.5963	0.0011	0.0006	0.0005	0.0000	0.0006
6	159.3112	74.1525	0.0037	0.0033	0.0004	0.0000	0.0033
7	204.6084	85.0732	0.0032	0.0013	0.0019	0.0000	0.0013
8	85.7776	83.9482	0.0068	0.0036	0.0031	0.0000	0.0036

Figure 1. An example of matched pairs of radar and COSMO-Ru1 precipitation objects (the same colors indicate matched pairs) along with the corresponding CRA scores

Analysis of about 30 such precipitation cases during the Sochi-2014 Olympic Games enabled the following conclusions:

-Reasonable matching is the most difficult stage in the application of object-based methods; much depends on the matching function. Each case still requires eye-ball analysis.

-For lower thresholds meaning usually wider features, main errors result from the fine-scale structure, for higher thresholds, location errors are more significant overall.

Preliminary results of the application of object-based methods to ensembles

The spatial methods were tested on the MesoVICT ensemble data first. The Swiss COSMO-E ensemble system was used. The VERA station analysis with 8 km grid spacing was used as the reference data. The probability of each observed object was found by comparing it with objects in each ensemble field. A similar procedure was described in [5]. In Fig. 2, the object pairs are plotted for the first six members, and the resulting probabilities for each of the observed objects are given. Then, the occurrence of each precipitation object can be estimated using the standard probabilistic scores, such as the Brier Skill Score. The limitation of such an approach is that no merging of objects is possible as the list of observed objects must be the same for matching with all ensemble members and only the fact of object occurrence can be estimated.

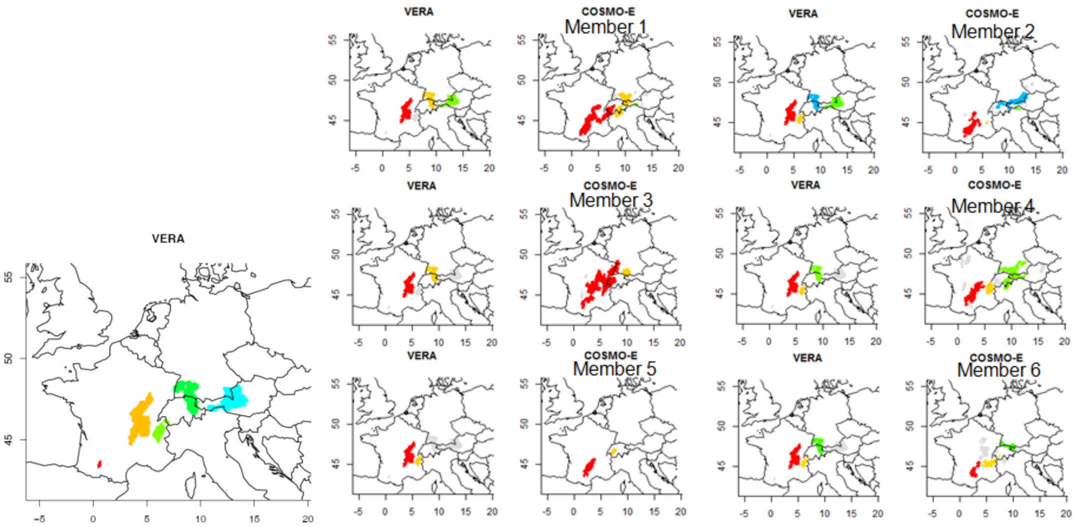


Fig. 2. Objects in the first 6 of 21 members of COSMO-E ensemble paired to observed VERA objects, colors indicated pairs, grey objects are unmatched. Date: 2007062021, precipitation threshold 0.5 mm/1h. Probabilities of each of 5 observed objects: 1/21 20/21 10/21 19/21 14/21.

Therefore, the next step will be to try also other approaches:

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

2) To identify objects using the probability threshold [3] and then to calculate CRA scores as for deterministic case.

It is also planned to use spatial methods to verify nowcasting and short-range forecasts, where the problem of processing large amount of data arises.

References

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