Extension of the SAL method for verification of high resolution ensemble forecasts

Le Duc[1], Kazuo Saito[2], Hiromu Seko[2]
[1]JAMSTEC, [2]MRI/JMA

Introduction

The spatial verification methods have been developed in recent year in response to the need for new precipitation verification methods at high resolution forecasts. SAL (Wernli et al., 2008) is such a method that evaluates precipitation forecasts in terms of structure, amplitude and location errors. In this study, we extend SAL into 3-dimension for 1-hour precipitation ensemble forecast.

SAL

SAL is classified into the object-based methods which quantify forecast errors by comparing forecasted rainfall objects with the observed ones. A rainfall object is defined as a 2-dimensional contiguous rainfall area. Fig. 1 illustrates this concept of rainfall objects.

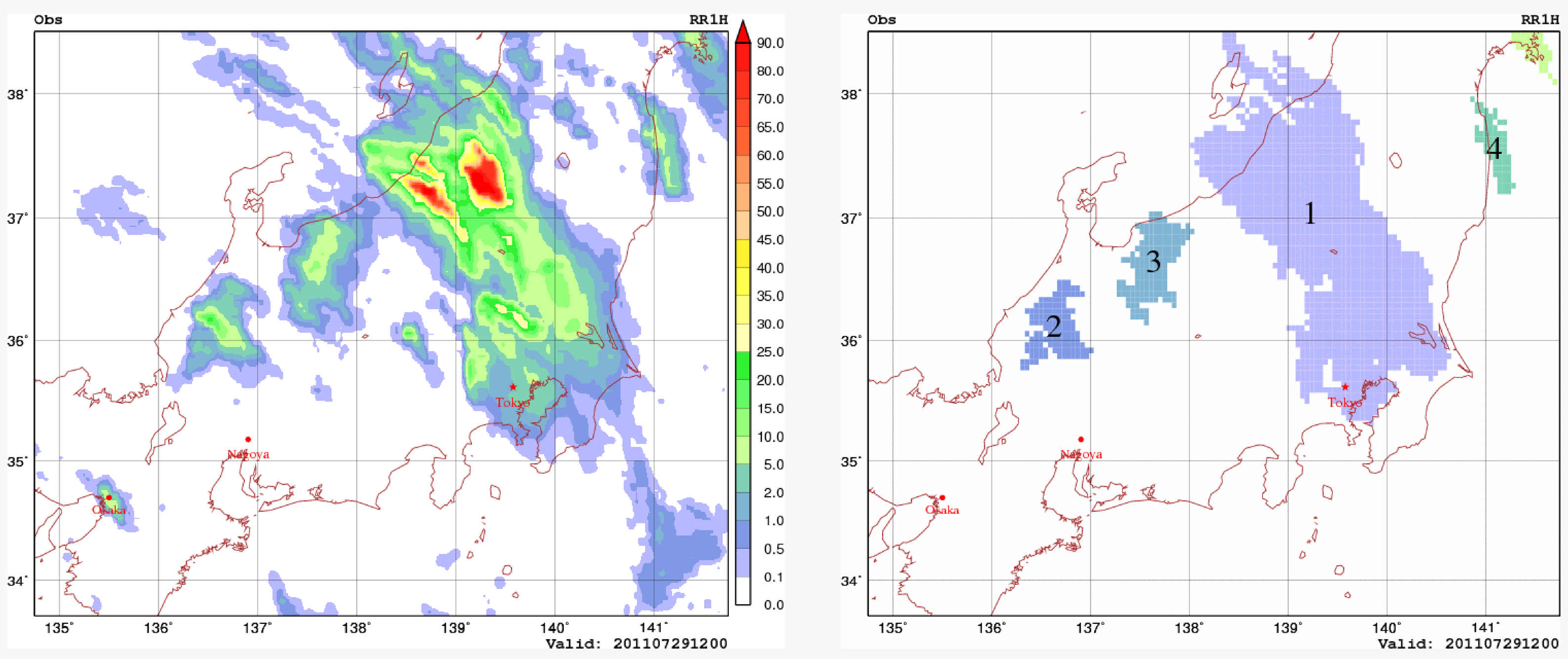

Fig. 1: Detection of rainfall objects from a rain field

For each rainfall object SAL extracts 3 important properties: amplitude (rain amount), structure (defined as the amplitude scaled by the maximum rainfall inside the object, which can be made more clear in Fig. 2), and location (centroid). The forecast performance is then summarized in 3 parameters S, A, and L, which gives the name SAL:

S=2*(S_fcst-S_obs)/(S_fcst+S_obs) where S_fcst, S_obs are the mass-weighted structures of all objects.

A=2*(V_fcst-V_obs)/(V_fcst+V_obs) where V_fcst, V_obs are the total volumes.

L = |C_fcst-C_obs|/D_max + 2*|SPD_fcst-SPD_obs|/D_max where C_fcst, C_obs are the centroids of all objects, SPD_fcst, SPD_obs the corresponding spreads, and Dmax the maximum length of the verification domain.

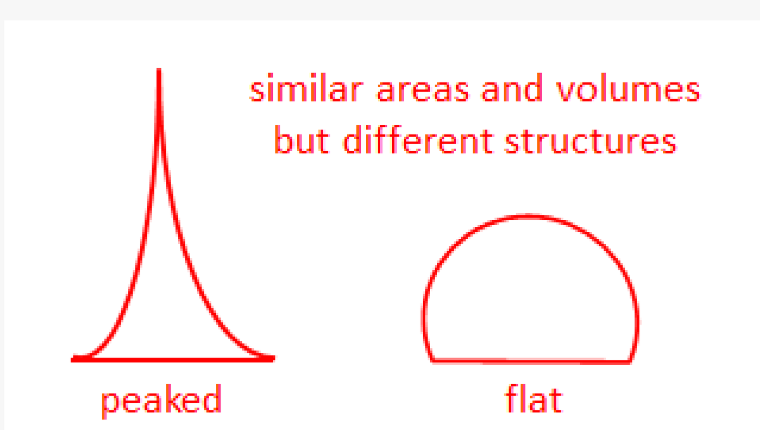

Fig. 2. Meaning of rainfall structures

These parameters can be visualized in a compact form called SAL diagram (sea the upperleft of Fig. 3a).

Extended SAL

Since we focus on short time (1-hour) rainfall forecast, rainfall objects are considered in 3-dimension which includes the time dimension. Location errors will be divided into centroid errors and spread errors. These errors now contain both spatial and timing errors due to the use of 3-dimensional objects. Besides structure and amplitude, two additional properties: intensity (90th percentile of the rain field inside an object) and area are also examined. To apply SAL for ensemble forecast we use medians of object properties of ensemble members.

Experiment and verification results

We conducted two 11-member NHM-based ensemble prediction systems MF10km and MF2km with the resolutions of 10 km and 2 km, the later nested inside the former with a 6-hour lag, for 15 days in the summer of 2010. The verification results are shown in Fig. 3.

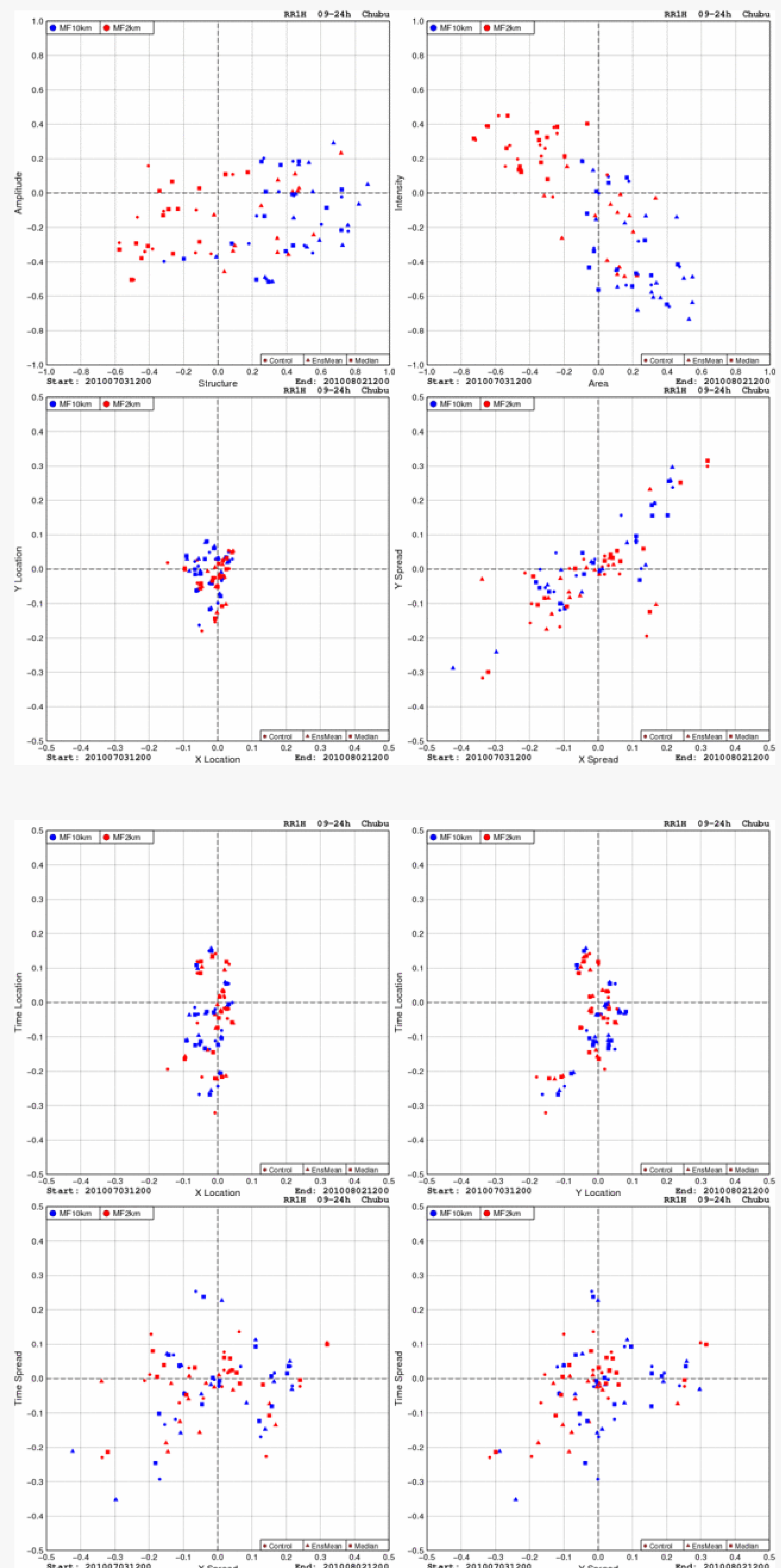

Fig. 3: SAL diagrams of MF10km and MF2km forecasts

These diagrams reveal some interesting facts about performances of MF10km and MF2km. Both systems underestimate rain volumes. MF2km overestimates rain intensity while MF10km underestimates. Combined with the fact that MF10km produces larger rain areas than those of observation whereas MF2km produces smaller rain areas, MF10km and MF2km result in flat and peaked rain structures, respectively. Two systems have small displacement spatial errors. However, in terms of timing errors the rainfall systems are usually forecasted early by MF10km.

References

Wernli, H., Paulat M., Hagen M., and Frei C., 2008: SAL—A novel quality measure for the verification of quantitative precipitation forecasts. Mon. Wea. Rev., 136, 4470–4487