Multifractal analysis on rainfall rate obtained by radars and the numerical model CReSS during 3 Typhoon cases in 2012 in S. Korea

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The year 2012 was the year when the landfall of typhoons reached its most frequency in South Korea during the last decades. Typhoon Khanun, Bolaven, and Sanba struck South Korea passing through Jeju island to the Korean peninsula in July, August, and September leading to severe damages.

The precipitation is a such a complex, multiscale process that it is hard to represent it with the help of a set of equations without involving parametrizations of implicit scales. However, with the development of multifractals framework, it became possible to define stochastic processes modeling rainfall with the help of a few physically meaningful parameters. These parameters characterize how the cascade process concentrates the "activity" of a field (e.g., the precipitation rate above a given threshold) at smaller and smaller scales on smaller and smaller fractions of the space sets the smaller and smaller fractals (e.g., Parisi and Frisch (1985), Schertzer and Lovejoy (1987)). Despite the benefits of the multifractal framework, there had not been many studies of typhoons since Chygyrynskaia et al. (1995) and Lazarev et al. (1995) on 1D multifractal analysis of the wind field.

In this study, the datasets from S-band radars in Jeju Island operated by KMA (Korea Meteorological Administration) are collected, as well as from simulations of the mesoscale numerical model CReSS (Cloud-Resolving Storm Simulator). Then the rainfall rate was obtained by calculating the Z-R relationship for each typhoon. With the obtained rainfall rate, the multifractal analysis was performed with the help of Trace Moments (Schertzer and Lovejoy, 1987) and Double Trace Moment (Lavallée et al., 1992) to quantify the mean intermittency with the help of its fractal co-dimension C_1 and its multifractality index α, which measures how fast the intermittency evolves for higher order statistics with a large amount of space-time data. By performing the same analysis for the CReSS simulations, we can compare the multifractal structures of the rain rate field estimated respectively by radars and CReSS.

By looking at the typhoon structure with the approach of multifractals framework, it will give the detailed physical meaning of the evolution of the typhoon in each altitude and by comparing with the numerical model, it proves the possibility of prediction of the rainfall intensity of the typhoons. In the end, this new approach of the development on the typhoon might have impeded significant progress in predicting typhoon evolution prediction. These results will be presented in detail at the conference.

Keywords: Multifractals, Typhoon