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Multifractal analysis and comparison of the rain rate of the typhoon Bolaven (2012) estimated by radar and the CReSS meso-scale model

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In August 2012, Typhoon Bolaven struck South Korea passing through Jeju island to Korean peninsula leading to severe damages. However, most of the studies were focused on the binary interaction between Bolaven and Tembin, the so-called Fujiwhara effect between nearby typhoons, whereas this study is devoted to detailed structure and mechanisms of Bolaven itself across scales, particularly their strong intermittency. This is achieved by a multifractal analysis and comparison of the rain rate estimated respectively by radars and the meso-scale model CReSS. Surprisingly, there had not been so many multifractal studies of typhoons (see however, Chygyrynskaia et al., 1995; Lazarev et al, 1995 on 1D multifractal analysis of the wind field) in spite of the inherent capacity of multifractals to deal with extreme multiscale phenomena like typhoons, as well as an increased availability of higher quality data. This lack of new developments might have impeded significant progress in predicting typhoon evolution prediction. Fortunately, it was possible to collect data from AWS (Automatic Weather System) and a S-band radar in Jeju island that are operated by KMA (Korea Meteorological Administration), as from simulations of the mesoscale CReSS model. This large amount of space time data was analyzed 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. There were missing radar data, unfortunately reported as zero values, at the lowest altitudes due to the minimum radar beam elevation angle of 0.5 degrees, whereas the multifractal analysis was performed on the same area of 256 km x 256 km at various altitudes. This bias yields spurious estimates of the mean intermittency, C_1, that decrease with the altitude, whereas multifractality index estimates evolve in the opposite manner. Fortunately, this bias does not affect the estimates α=1.42 and C_1=0.114 at 5 km altitude. This bias, yields a complex evolution of the extremes with respect to the altitude and especially a sharp contrast between 1 km and 5km. In the latter unbiased case, empirical and semi-theoretical scaling moment functions put clearly on evidence the existence of a critical order of divergence of statistical moments q_D = 3. This extreme behavior is also missed by the current CReSS outputs that are limited to an average over the altitude However, this is presumably also the case for the modeled rainfall rate at various altitudes, although it would be interesting to have the possibility to check it directly. On the other hand, we are working to better assess the statistical bias induced by the radar missing data at low altitude and to remove it from the multifractal analysis. This is important to improve the prediction of the typhoon intensity evolution.