Geophysical Research Abstracts
Vol. 19, EGU2017-1370, 2017
EGU General Assembly 2017

Multifractal Analysis of Typhoons: the case study of Bolaven (2012)

Jisun Lee (1,2), Igor Paz (1,3), Abdellah Ichiba (1), Ioulia Tchiguirinskaia (1), Daniel Schertzer (1), Dong-In Lee (2), and Hung-Chi Kuo (4)

(1) HM&Co, École des Ponts, UPE, Champs-sur-Marne, France, (2) Pukyong National University, Busan, Republic of Korea, (3) Instituto Militar de Engenharia, Rio de Janeiro, Brazil, (4) National Taiwan University, Taipei, Taiwan

Multifractals have become rather standard tools to analyze and simulate meteorological and hydrological data, especially radar data that have the rare advantage of providing space-time (3D+1) fields. However, in spite of their inherent capacity to deal with extreme multiscale phenomena like typhoons, as well as an increased availability of higher quality data, there had been not so many multifractal studies of typhoons since pioneering studies (Chygyrynsakaia et al 1994, Lazarev et al 1994), which relied on time series data obtained from 1D aircraft or balloon trajectories.

This lack of new developments might have impeded significant progress in predicting typhoon evolution prediction. We therefore decided to jointly understand the dynamics and rainfall by multifractal space-time analysis with the help of the joint measurements of the Typhoon Bolaven by three Doppler S-band radars. This experimental set-up not only provided accurate estimates of the rainfall intensity, but also of the 3 components of the wind velocity. Typhoon Bolaven is one of the typhoons that caused the largest damages with severe rainfall all over Korea including Jeju Island with more than 250 mm in 2 days in 2012. It was regarded as the most powerful storm to strike the Korean Peninsula in nearly a decade, with wind gusts measured up to 186 km h-1.

The three radars were respectively located in Gosan, and Seongsan, in Jeju Island, and Jindo, in southwest of Korea peninsula, i.e. all around the region where the typhoon intensity was the largest. The largest distance between the radars was approximately 100km, and the rainfall and wind velocity were estimated on a grid of $360\times360\times60$ every ten minutes.

The multifractal analysis of this large amount of data (space time Trace Method and Double Trace Method) was performed to better understand through scales the fast transformation of potential energy into kinetic energy and the premier role of convection. In particular, this analysis confirms power-law falloff of the probability of the extremes. Furthermore, the multifractal analysis provides more detailed insights of the energy efficiency that was previously analyzed on a global scale (Lee et al. 2015) and defines a framework to improve the prediction of typhoon intensity evolution.

Reference

Chygyrynsakaia et al. (1994) Unified multifractal atmospheric dynamics tested in the tropics: part [U+2160], horizontal scaling and self criticality, Nonlin. Proc. Geophys, 1, 105-114
Lazarev et al. (1994) Multifractal analysis of tropical turbulence: part [U+2161]: vertical scaling and the unified scaling of atmospheric dynamics, Nonlin. Proc. Geophys. 1, 115-123
Lee et al. (2015, September). Characteristics of the energy efficiency in Typhoon Bolaven(2012) and Typhoon Tembin(2012). Poster presented at the 37th Conference on Radar Meteorology, AMS. Norman, OK, USA