A Spherical Harmonics Method for Analyzing Coherent Structures of Large-scale Convections in Monsoon Regions

Tri W. HADI[1], Faiz R. FAJARY[1], Shigeo YODEN[2]

[1] *Bandung Institute of Technology, Bandung, Indonesia*
[2] *Kyoto University, Kyoto, Japan*

Monsoon is associated with planetary scale atmospheric circulations and migrating convective systems. In particular, monsoon intraseasonal variability has been extensively studied in many previous works. The wave number – frequency analysis method developed by Wheeler and Kiladis (1999), hereafter WK99, serves as a powerful tool for those studies focusing on the roles of convectively coupled equatorial waves, Madden-Julian Oscillation (MJO), and other zonally propagating tropical disturbances. However, more recent studies (e.g., Ray and Zhang 2010; Kim et al. 2014) pointed out the importance of tropics – extra tropics interactions related to MJO lifecycle. In this context, we argue that the WK99 method cannot be readily extended for analyzing the latitudinally varying components of the tropical disturbance.

We propose the Spherical Harmonics (SH) method as a tool for analyzing spatial and temporal structures of large-scale convections associated with the intraseasonal variations. Application of the SH and Fourier transform analyses to long-term global Outgoung Long-wave Radiation (OLR) data yielded separate composite spectra that show symmetric and asymmetric equatorial wave signatures. It is also found that SH reconstruction of OLR data filterred around an asymmetric singular spectrum resembles the structures of Intertropical Convergence Zone (ITZC). Further SH analysis of vertially integrated moisture transport vectors (calculated from ERA-Interim data) indicate a striking coherence between the convectively coupled equatorial waves and spatio-temporal structures of moisture divergence/convergence in both tropical and extra-tropical parts of the monsoon regions. It is also demonstrated that comparisons between GCM outputs and observations are more straigthforward with the SH method.

Key words: monsoon, intraseasonal variability, equatorial waves, spherical harmonics

References

Kim, D., and Coauthors, 2014: *J. Climate*, **27**, 111-125.

Ray, P., and C. Zhang, 2010: *J. Atmos. Sci.*, **67**, 515–528.

Wheeler, M., and G. N. Kiladis, 1999: *J. Atmos. Sci.*, **56**, 374–399.