國立中央大學大氣物理研究所書報討論

Date: 2025/10/31

Location: S1 – 713

Speaker: Y May

Advisor: Prof. Wei – Yu Chang

Connecting Theory and Observation: The Microphysical Anatomy and Evolution of ZDR Columns in Convective Storms

Abstract

Storms resulting in extreme rainfall have become a major concern in recent years. Information about the internal microphysical structure of such storms can be inferred from polarimetric radar variables (ZH, ZDR, and KDP), which are closely related to the size, shape, composition, and orientation of precipitation particles This study integrates theoretical modeling and observational analysis to examine the evolution of ZDR columns and its relationship with updraft strength.

The theoretical framework proposed by Kumjian et al. (2014) demonstrates that ZDR columns initially form aloft and extend downward as strong updrafts suspend and enlarge supercooled raindrops through continuous collection. The model reveals a strong positive correlation between ZDR column height and updraft intensity, suggesting that the ZDR column can serve as a short-term predictor of convective growth and subsequent surface rainfall.

Complementing this, the observational study by Jung and Jou (2023) over the Taipei Basin (14 June 2015) confirms these theoretical mechanisms. During the merging of convective cells, both ZDR and KDP columns intensified — graupel increased above the melting level due to strong riming, while heavy rain dominated below because of graupel melting and warm-rain coalescence.

The integration of both studies demonstrates that ZDR is a reliable indicator of strong updrafts and mixed-phase microphysical processes. Their temporal evolution provides a physical basis for short-term prediction of convective intensity and extreme rainfall, offering practical value for nowcasting and radar-based quantitative precipitation estimation in complex convective environments.

Keywords
ZDR column

Reference

Jung, C.-J., & Jou, B. J.-D. (2023). *Bulk Microphysical Characteristics of a Heavy-Rain Complex Thunderstorm System in* the *Taipei Basin. Mon. Wea. Rev.*, **151**, 877–900.

Kumjian, M. R., et al. (2014). *The Anatomy and Physics of ZDR Columns. J. Appl. Meteor. Climate.*, **53**, 1820–1843.