Can Global Cloud-Resolving Models Simulate the Object-Based Precipitation Systems over the Northwest Pacific?

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Objectives

1. Assess the life cycles and structural characteristics of object-based precipitation systems using a raincell tracking algorithm.
2. Utilize satellite-retrieved precipitation data (GPM-IMERG) to evaluate the performance of precipitation systems within the global cloud-resolving models datasets (DYAMOND) over the Northwest Pacific region.

Model Simulations and Observation

1. *GPM-IMERG / CERES SSF*

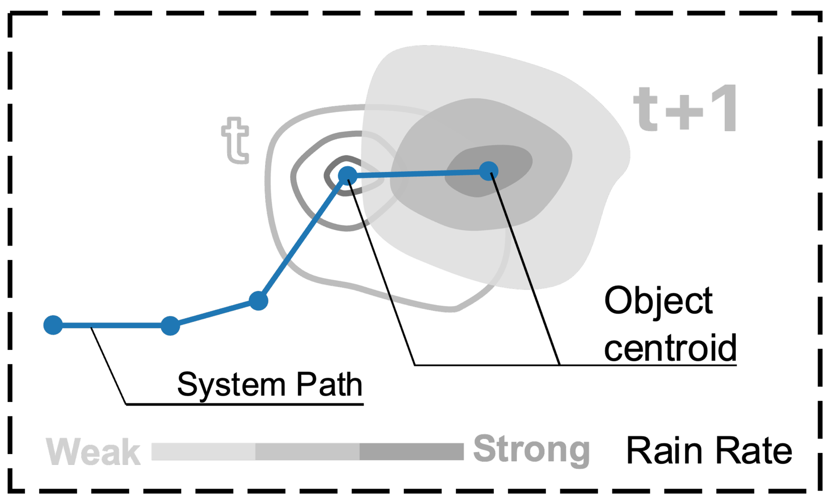
   In terms of observation, integrated precipitation data derived from multiple satellite sources are utilized to generate product known as GPM-IMERG (30-minutes, 0.1-deg). As for outgoing longwave radiation, data from the CERES instruments installed on the Terra and Aqua satellites are employed (level-2, 20km).

2. *DYAMOND*

   An intercomparison project was conducted among international global cloud-resolving models (3km~10km), focusing on a 40-day hindcast simulation starting from August 1st, 2016. A total of nine model datasets were analyzed, including simulation of CWBGFS. To ensure consistency in the analysis, the final 38 days were considered, and the data was gridded to a resolution of one hour and 15 kilometers.

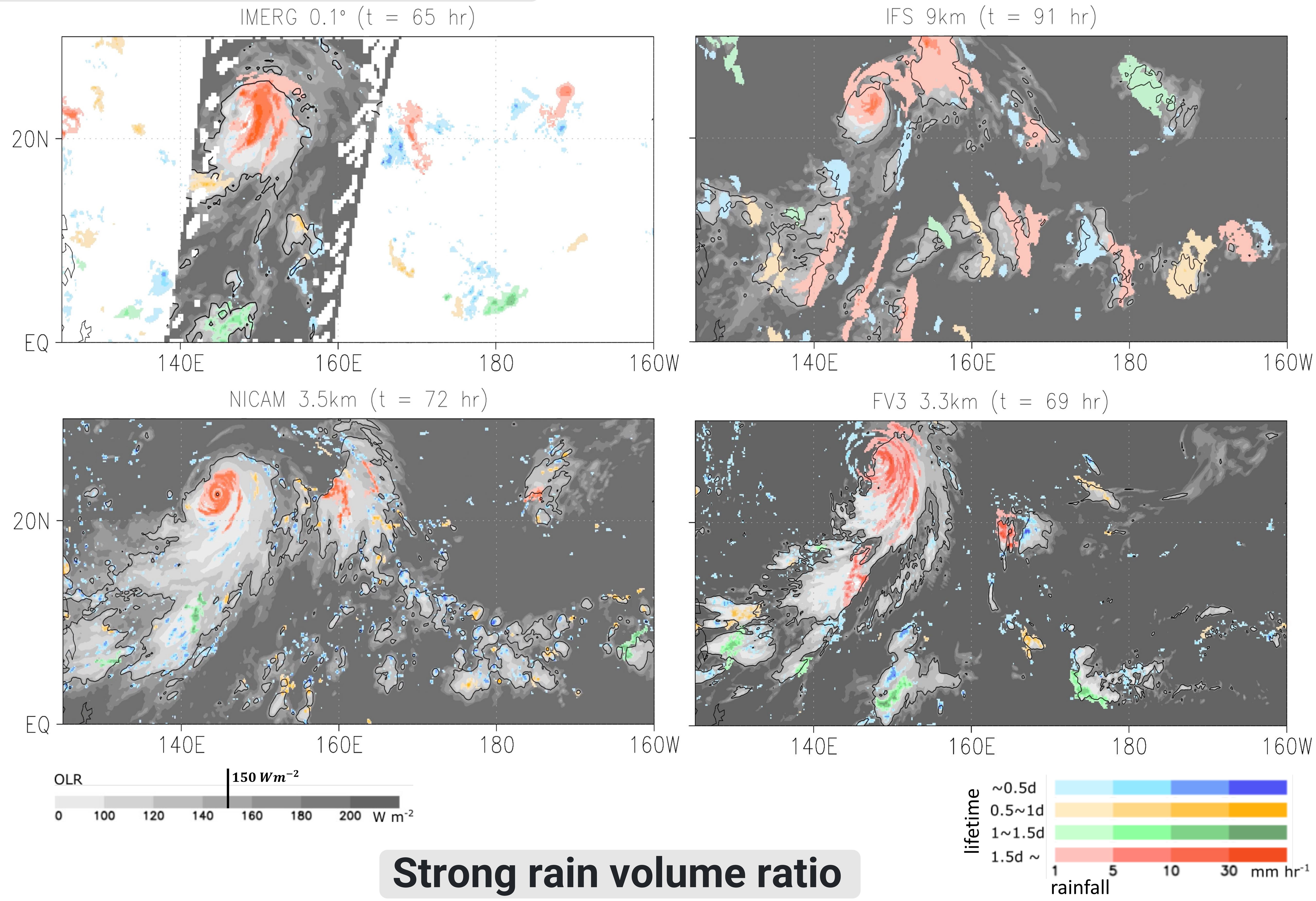
Tracking of the Object-based Precipitation Systems

The object-based precipitation systems are identified and examined whether the overlapping parts exist among the precipitation objects $(rainfall\ pixels \geq 1mm\ hr^{-1})$ in two continuous timesteps by the iterative rain cell tracking algorithm.



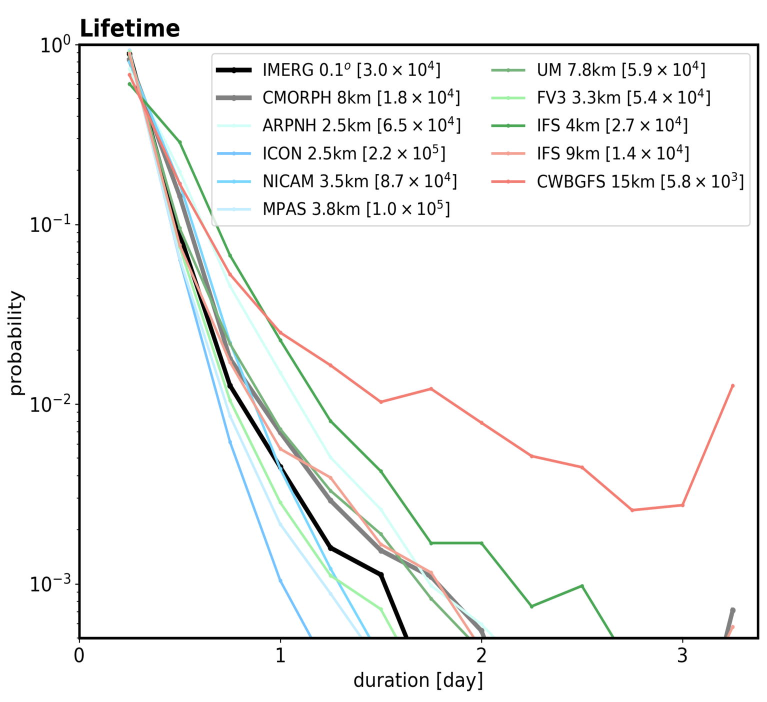
Structures of the Object-Based Precipitation Systems

1. NICAM generates relatively smaller convective systems compared to cloud areas, and numerous isolated rainfall systems with shorter lifecycles over the ocean.
2. FV3, in comparison to NICAM, exhibits a closer proportion of observed cloud areas and precipitation, with a tendency to produce squall-line like systems.
3. In IFS9KM, there is a tendency for widespread mild precipitation, with cloud areas predominantly concentrated around regions of heavy rainfall. The occurrence of substantial weak precipitation systems is attributed to the influence of gravity waves.

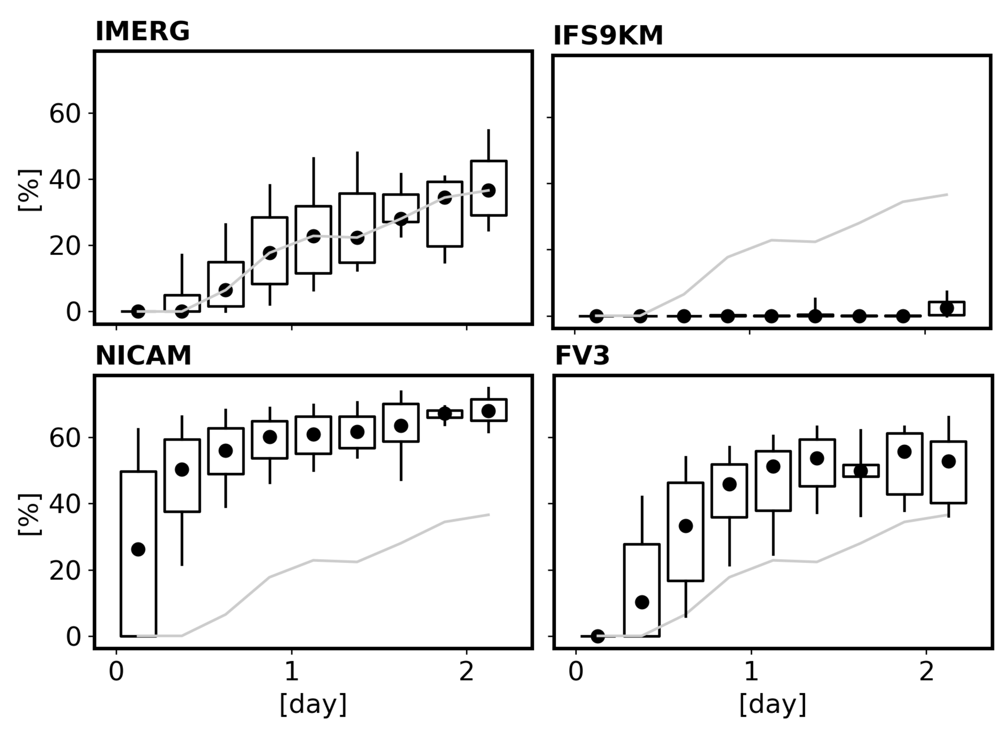


lifetime distribution

The object-based systems in ICON and NICAM exhibit fewer long-lived systems. Conversely, CWBGFS and IFS-4km produce a higher number of long-lived systems. FV3 demonstrates a closer alignment with IMERG observations.



Strong rain volume ratio



As the lifespan increases, there is a trend of approaching linearity in the observed strong volume ratio. The IFS-9KM does not exhibit significant changes with increasing lifespan. Conversely, NICAM and FV3 show a high ratio occurring in systems with shorter lifespans.

Conclusions

The lifecycles of convective systems have been identified and compared with observations. From the lifetime distribution, the models exhibit significant dispersion in terms of long-lived systems. Additionally, even systems with similar lifecycle ranges show notable differences in convective structure compared to observations.

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