Investigating the organized convective systems over the tropics and monsoon region and their cross-scale interactions using process-oriented observations and cloud-resolving models.

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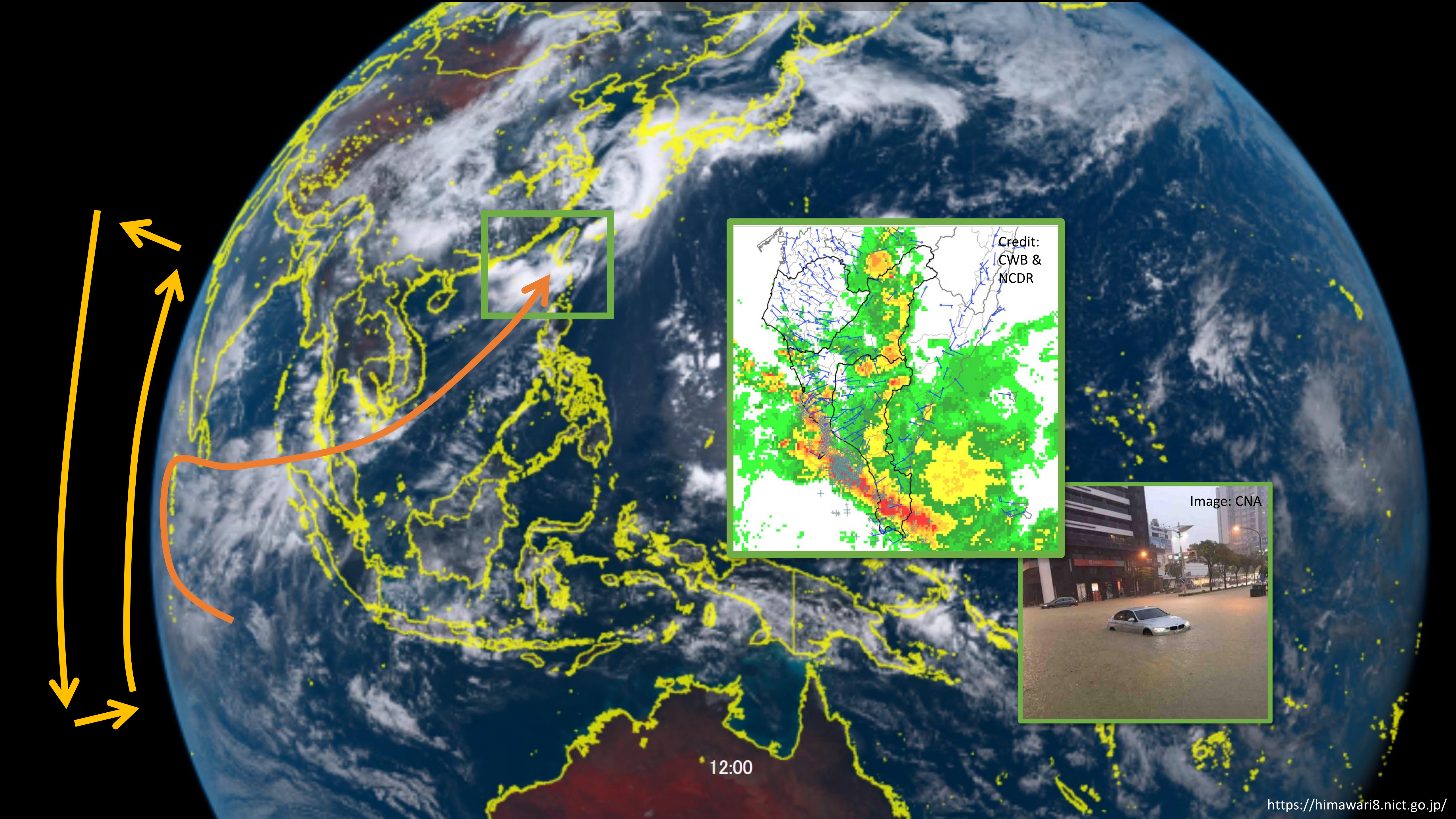
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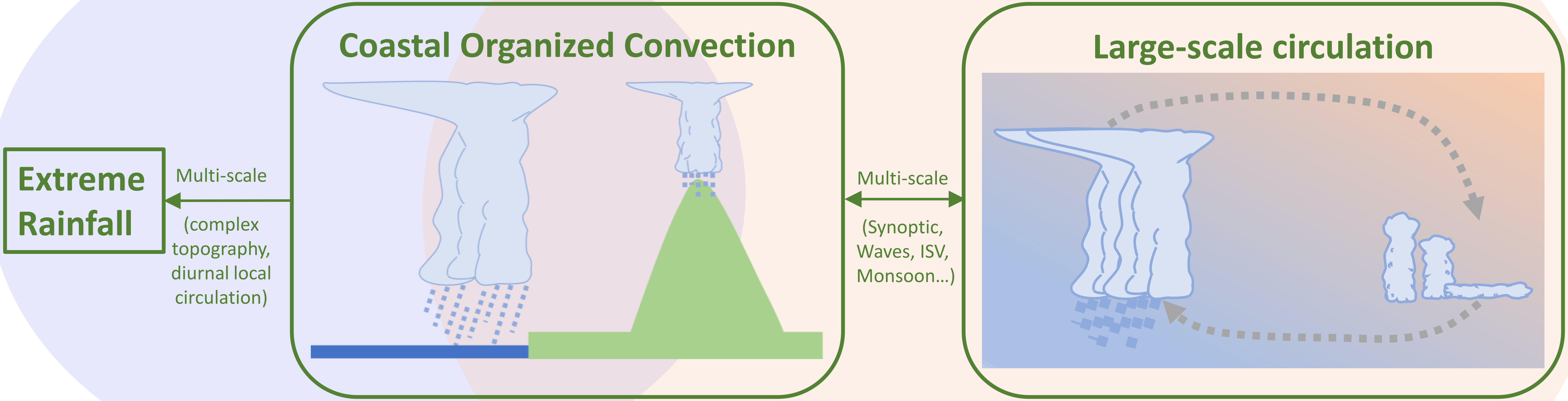
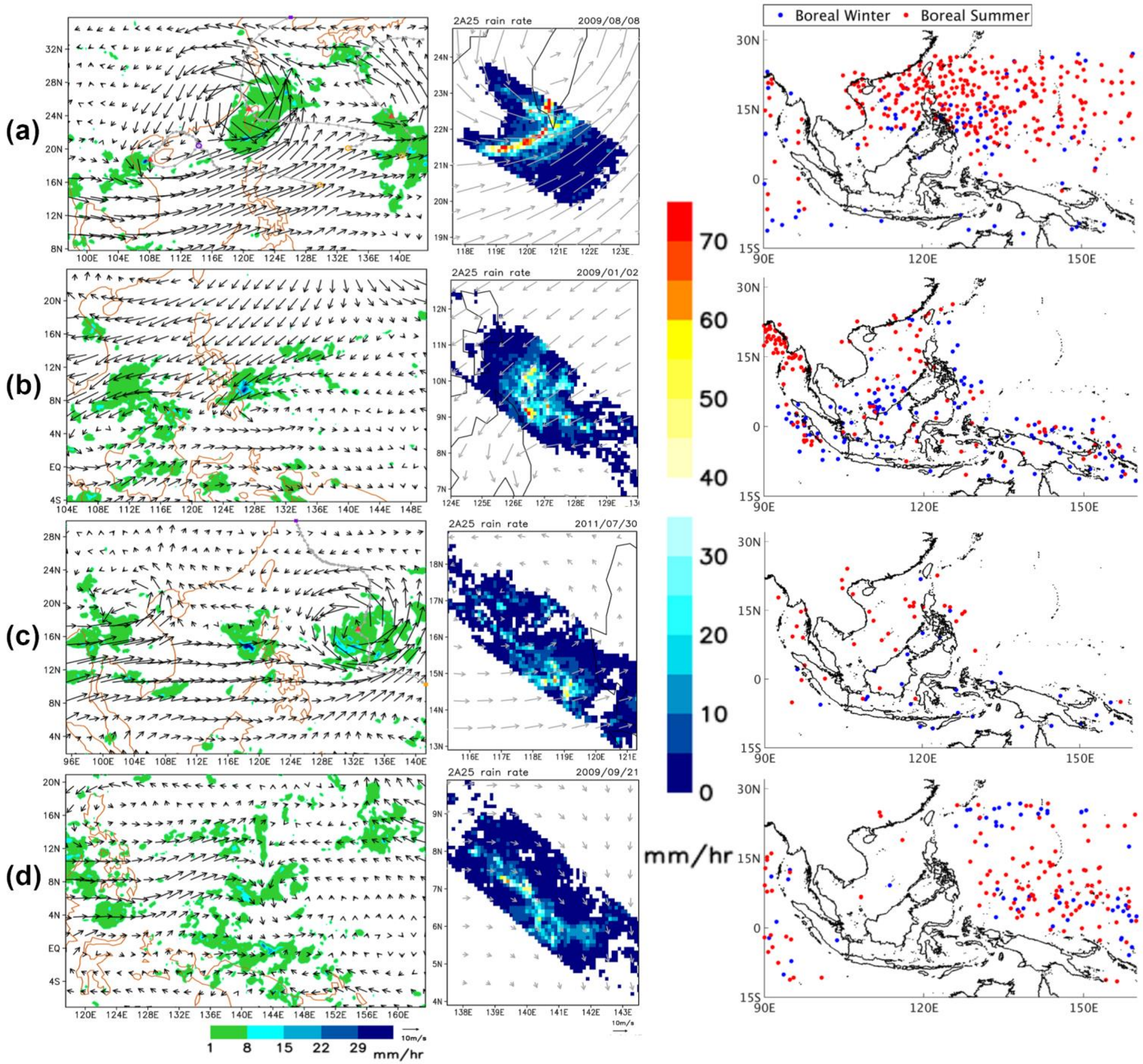
The multi-scale processes of organized convection over Tropics and monsoon region

- Organized convection over MC land and ocean remains an issue in global cloud-resolving models [Su et al., 2022, JMSJ]



- Explore the relationship between extreme rainfall, coastal MCS, and synoptic flow/monsoon circulation using satellite observations: TRMM PR [Jian et al., 2021, JMSJ] and CloudSat [Chen et al., 2021, GRL]

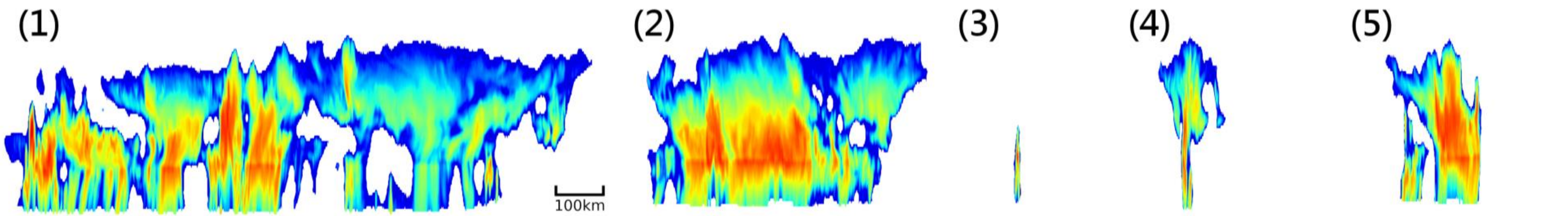


Synoptic-scale flow patterns and coastal topography are the key ingredients for extreme rainfall systems over the Asian-Australian monsoon region

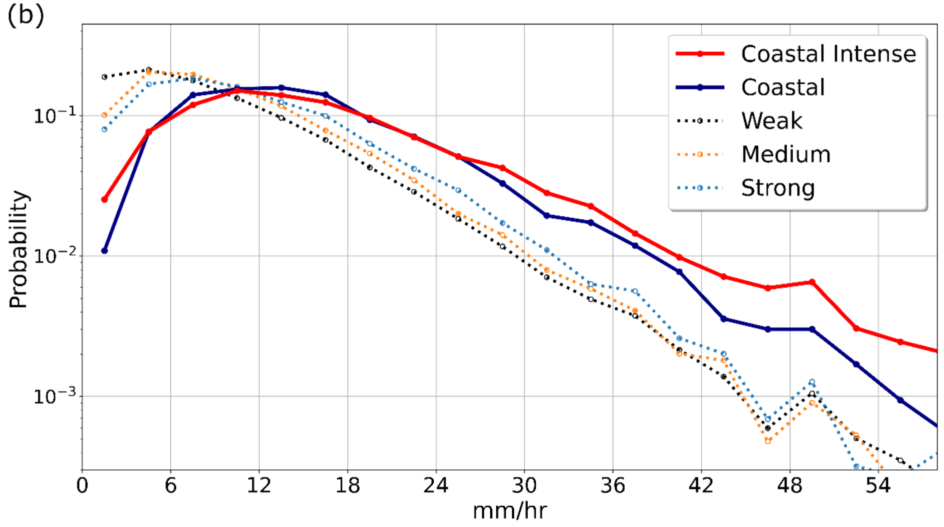
- The 916 extremely extensive (>271 km) and intense (> 60.7 mm hr^{-1}) rainfall systems in 17-yr TRMM observations over AAM region are classified into four categories: Vortex, Coastal, Coastal with Vortex, and None of above.
- Areas with seasonally high total column water vapor and low-level vertical wind shear is tightly associated with the coast-related extreme precipitation systems.
- The internal structures of the extreme precipitation systems are similar: wide convective core and broad stratiform

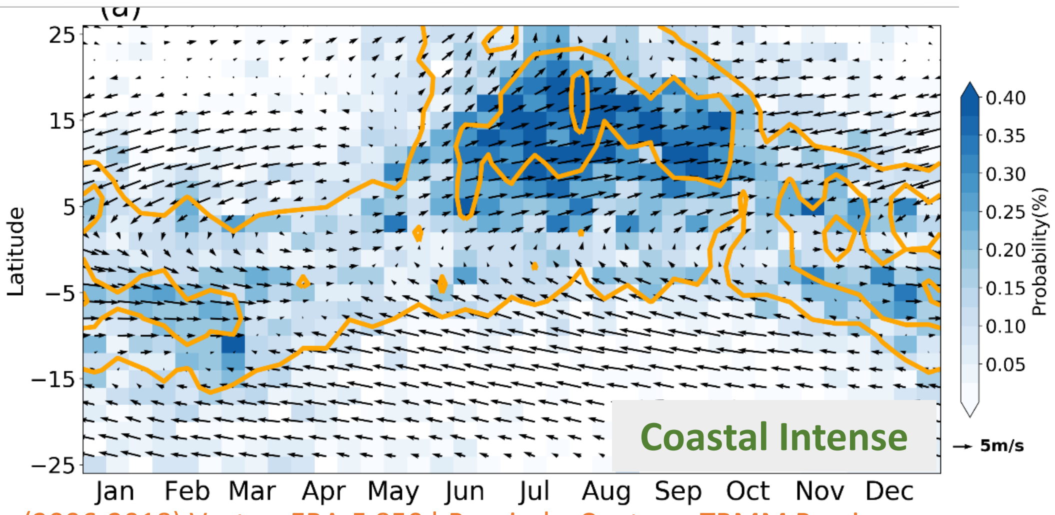
Jian, Hong-Wen, et al., 2021, JMSJ)

Machine Learning Classification Identifies Coastal Intense Convection Regime over AAM Tightly Associated with Extreme Rainfall and Monsoon Evolution



	Coastal Intense	Coastal	Weak	Medium	Strong
n=	4901	5309	65529	18816	18827
Avg. Size (pixel):	32163 ± 11698	15975 ± 3973	1236 ± 2149	4858 ± 4354	4106 ± 2725
Avg. Scale (km):	1195 ± 367	614 ± 142	91 ± 129	243 ± 193	181 ± 114
Avg. Top (km):	15.7 ± 1.1	15.7 ± 0.9	8.2 ± 2	13.7 ± 1.4	14.7 ± 1.3
0dBz >10km (%):	99.8	100	0	100	100
10dBz >10km (%):	64.6	100	0	0	100



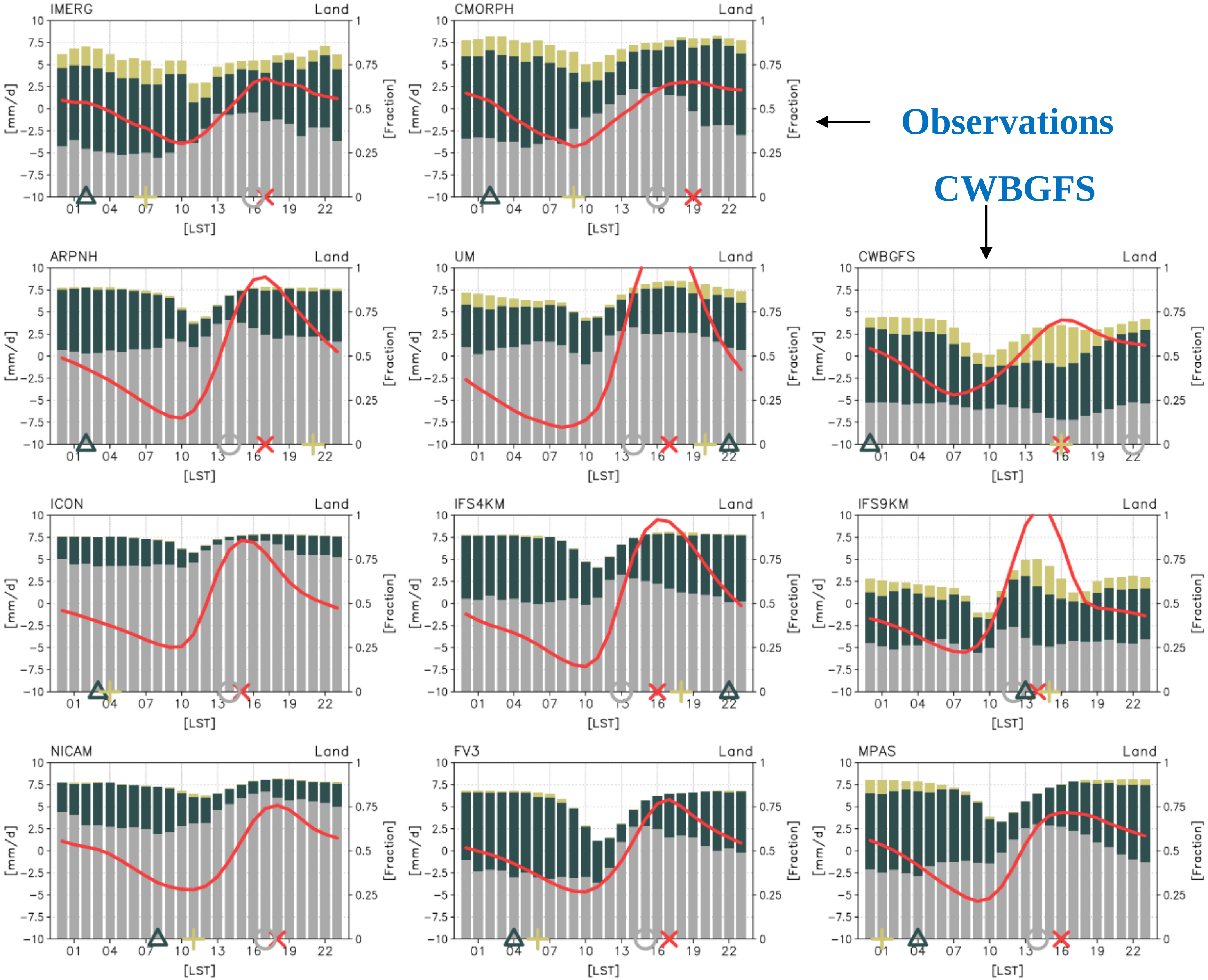


(2006-2018) Vector: ERA-5 850 hPa winds; Contour: TRMM Precip.; Shading: regime occurence

- Five Distinct Convective Cloud Regimes are identified from ~0.11 million deep convective cloud systems in 13-yr CloudSat observations over AAM region
- Cluster Analysis based on Cloud Physical Properties
- Coastal intense and coastal regimes exhibit extreme rainfall, strong cloud radiative effects, and clear coupling to monsoon evolution

(Chen, Peng-Jen et al., 2021, GRL)

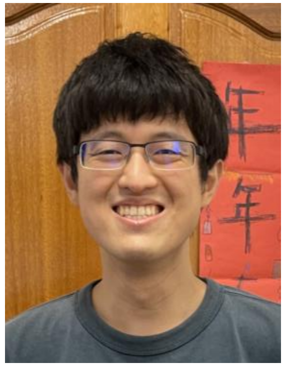
Object-based Evaluation Reveals Underestimation of Large Rainfall System Over MC in DYAMOND Global Cloud-Resolving Models



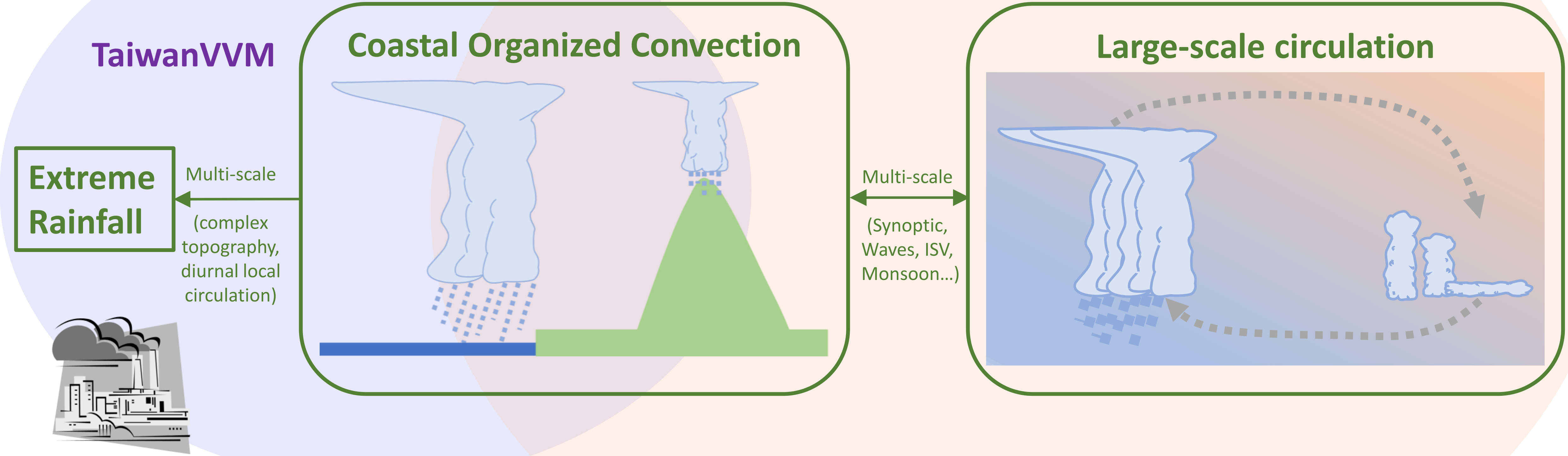
- DYAMOND: 40-day hindcast experiments (1 Aug–10 Sep, 2016) of global storm-resolving models
- CWBGFS: grey-scale GCM with unified convection scheme

- Most models (DYAMOND and CWBGFS) simulate insufficient numbers of large (> 300 km) OPS over MC ocean
- Most DYAMOND models underestimate the contribution of large OPS to the diurnal rainfall over MC land.
- Most DYAMOND models have unrealistic sensitivity of precipitation variability to precipitation system size

(Su, Chun-Yian, et al., 2022, JMSJ)

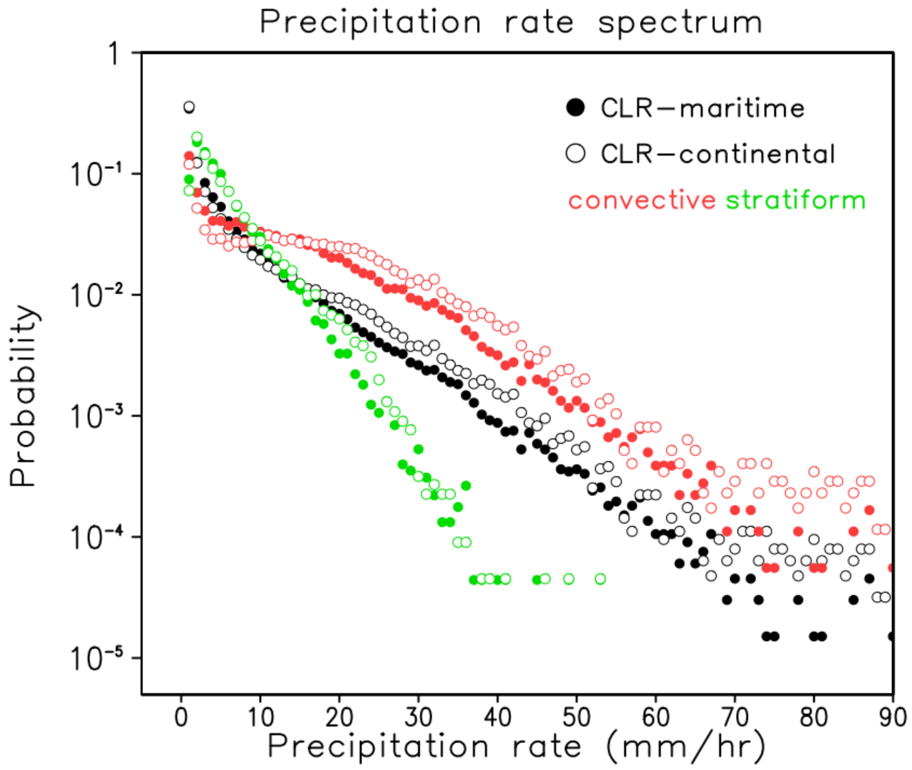


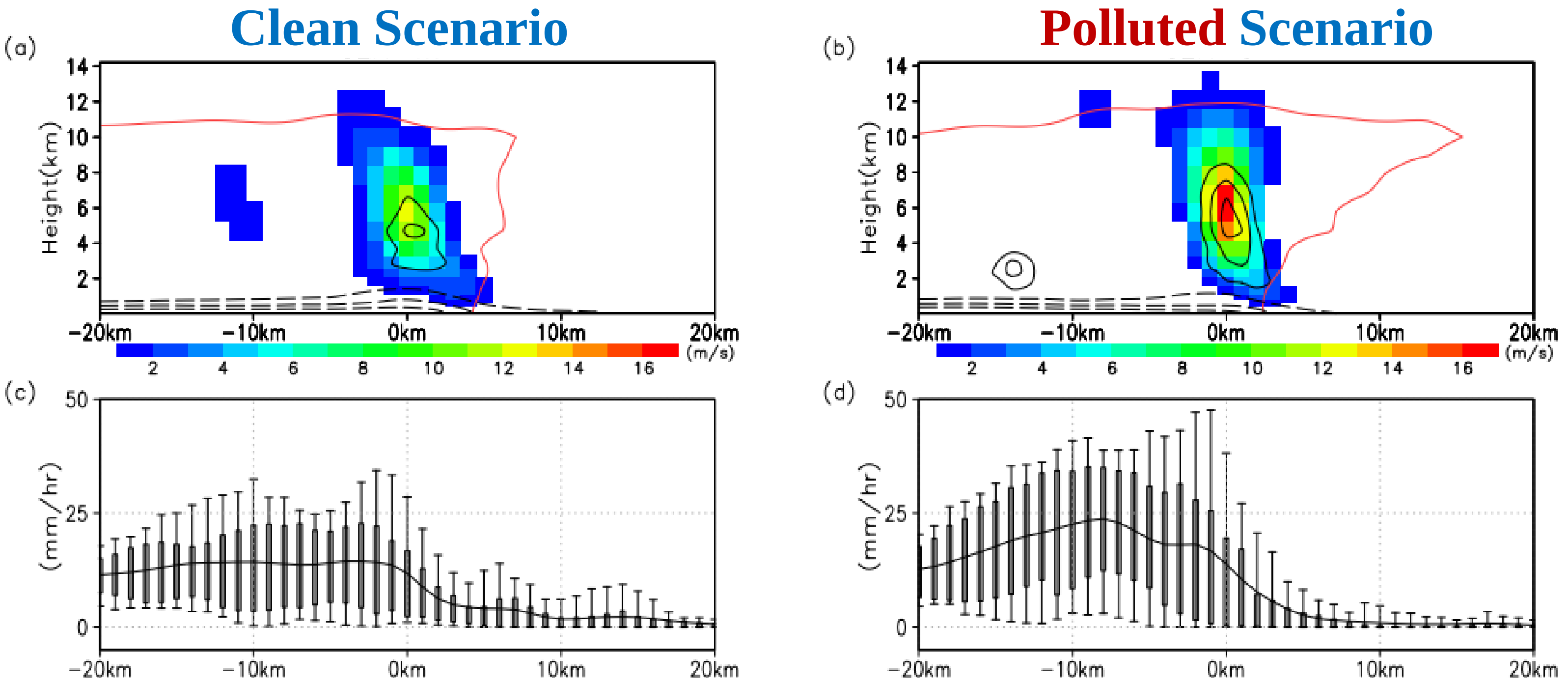
The multi-scale processes of organized convection over Tropics and monsoon region



- Scenario-based assessment of aerosol influences on extreme rainfall of land DC over complex topography under weak synoptic forcing [Chang et al., 2021, ACP]

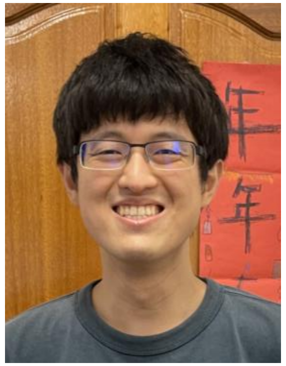
Increasing CCN Influences the Convective Structure in Coastal MCS and Enhances the Probability of Extreme Precipitation: A Case Study of SCS





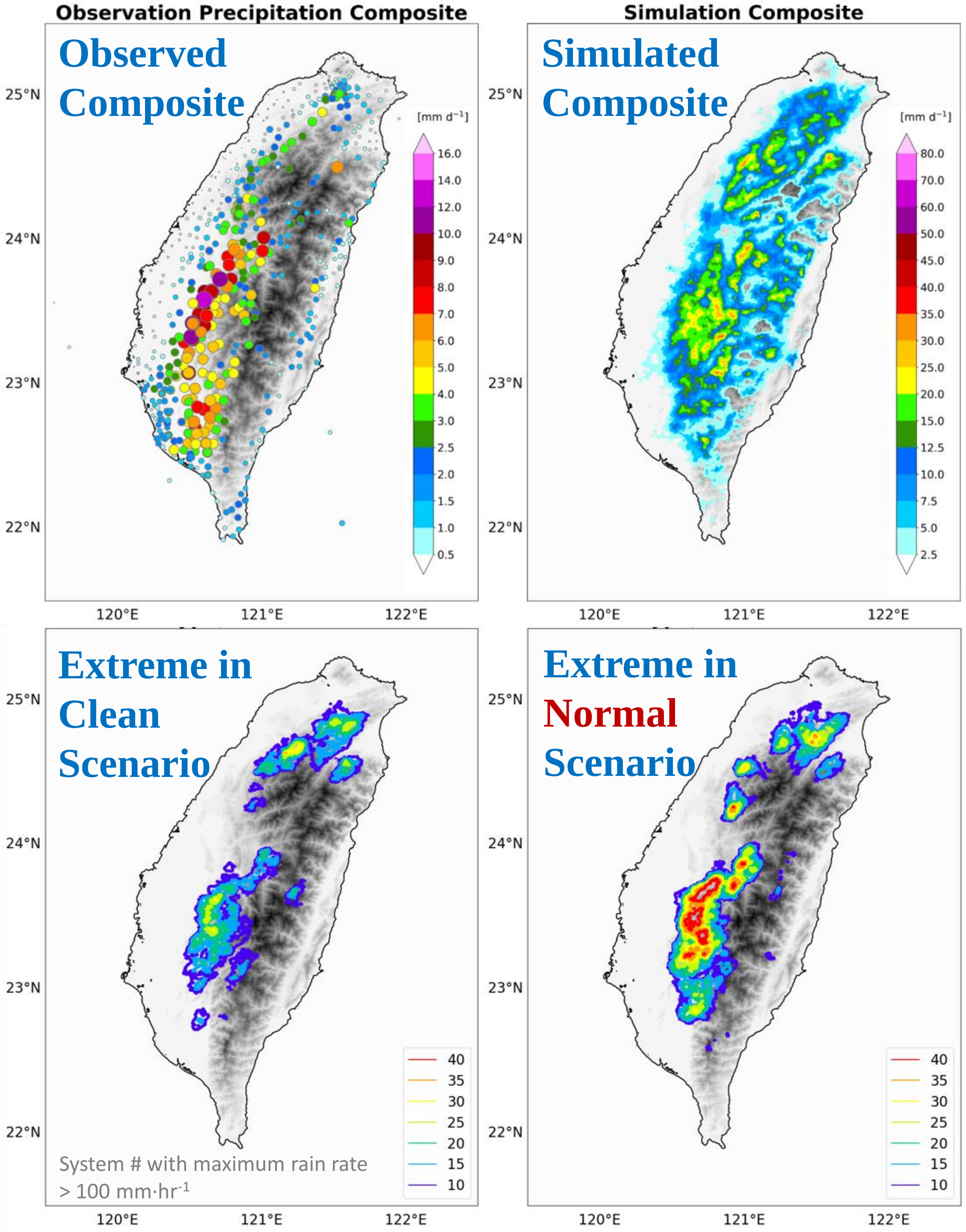
Composited mean vertical cross-sections of vertical velocity (color shading), latent heating by cloud drops diffusional growth (black contours), radar reflectivity greater than 15 dBZ (red contour), and equivalent potential temperature perturbation (black dashed contours). Error bars: 10th-90th percentile, whiskered boxes: 1st-3rd quartile, and lines: mean value of precipitation rate.

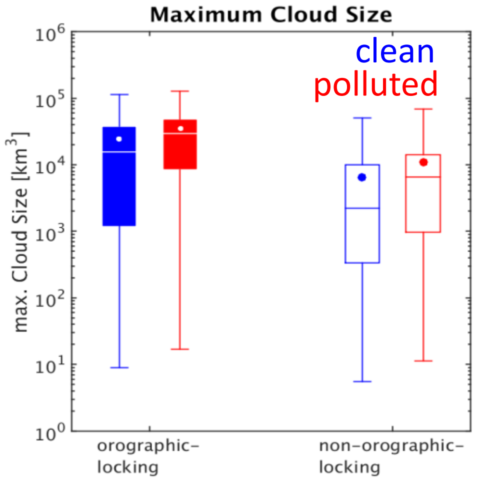
- A case of mesoscale convective system over SCS near Taiwan coast during SW monsoon flow is simulated.
- The polluted simulation exhibits stronger extreme precipitation and updraft.
- The enhanced latent heat release from faster diffusion growth of cloud drops contributes to stronger extreme updraft in the polluted simulation. Cold pool is weaker, which also leads to a more optimized convection structure and enhanced extreme updraft. **(Su, Chun-Yian, et al., 2020, TAO, SCS special issue)**



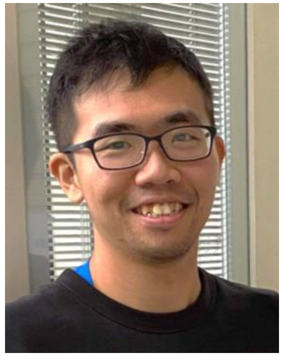
Increasing CCN Enhances the Convection Organization and Extreme Precipitation over DC rainfall hotspots in Taiwan: Storyline Approach

- TaiwanVVM semi-realistic LES (500-m) simulations of 30 cases of summertime weak synoptic afternoon thunderstorm over Taiwan
- Observed hotspots of the orographically-locked convection in diurnal cycle rainfall climatology are well simulated.
- By tracking the convection system life cycle, the convection initiation is delayed, convection organization is enhanced, and the number of extreme convection systems is increased over the hotspots in the polluted scenario



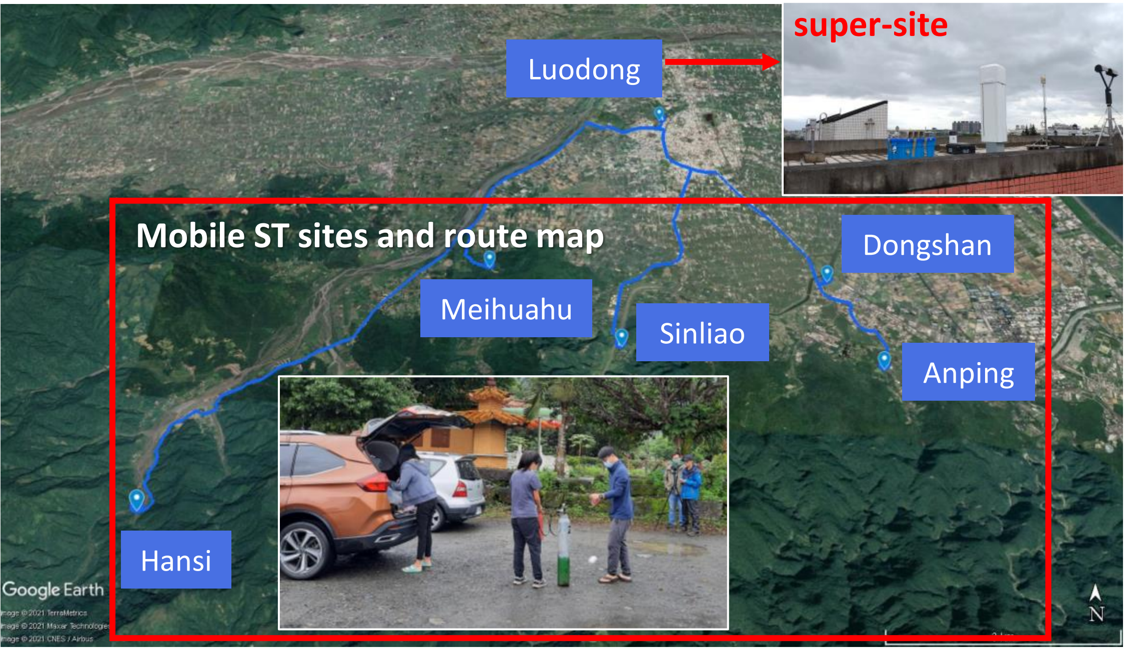


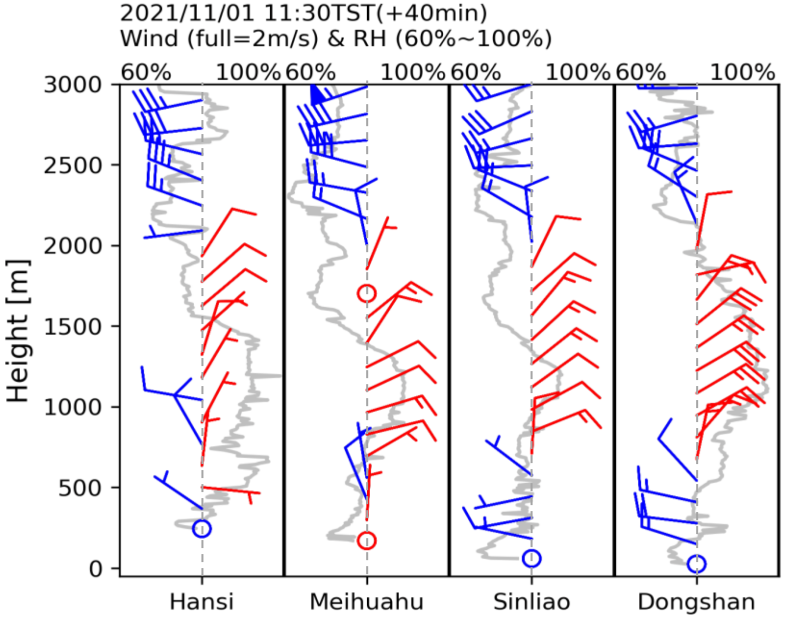
(Chang, Yu-Hung, et al., 2021, ACP)



2021 YESR: Mobile Storm Tracker Sounding Observations

Turbulence Induced by Terrain-circulation-precipitation Interaction

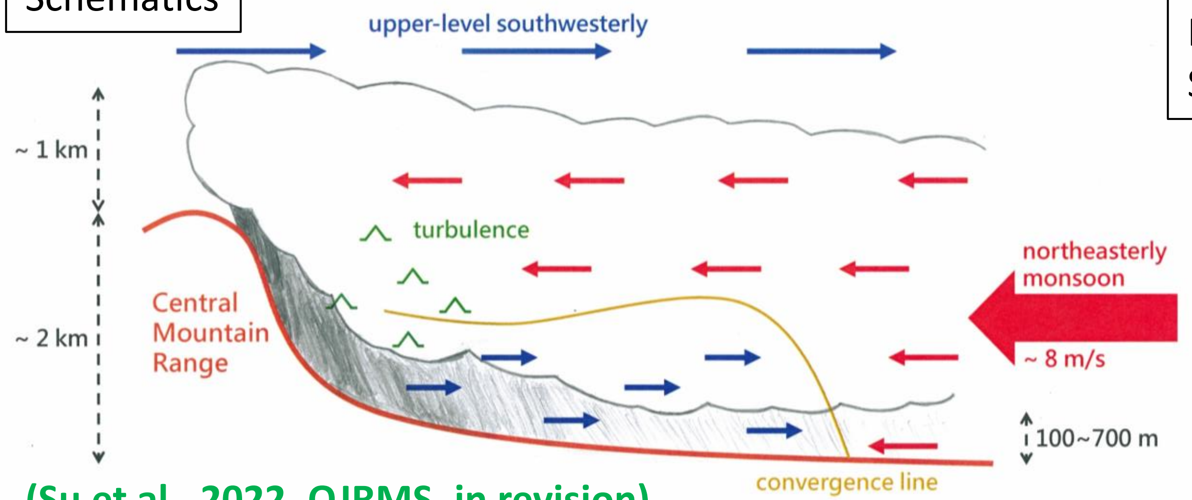




- Turbulence in the low level was more significant and moist layer (RH>80%) was thicker in the inner valley (Hansi) than in the foothill sites (Meihuahu & Singliao)
- Over the plain (Dongshan), the layer of strong northeasterlies well corresponded to high RH above the low-level reverse flow.

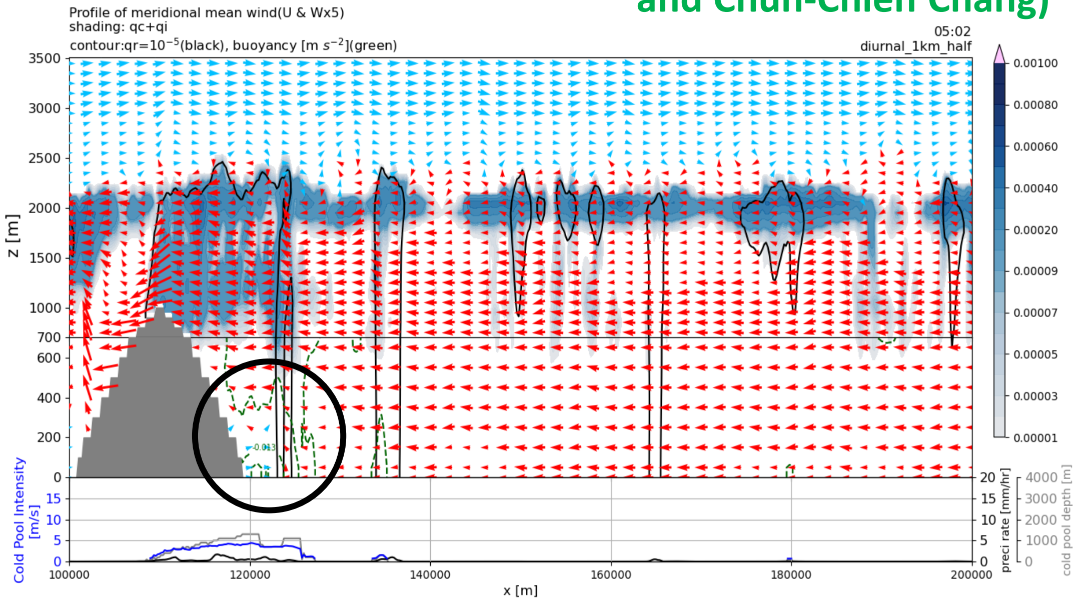
(Credit: Yu-Hung Chang and Chun-Chieh Chang)

Schematics



(Su et al., 2022, QJRMS, in revision)

VVM Idealized Simulation



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