Previous Research Summary

My research journey has centered on improving our understanding and prediction of complex atmospheric processes, with a particular focus on the diurnal convection cycle during the Indian Summer Monsoon (ISM). The ISM is a dynamic system that exhibits variabilities across diurnal, intra-seasonal, and inter-annual timescales. Among these, the diurnal convection cycle plays a crucial role in dictating the spatial and temporal distribution of precipitation, yet it remains one of the most challenging aspects for global and regional climate models to accurately simulate. Through extensive observational analysis and climate modeling, my work has revealed significant limitations in how current models represent the diurnal cycle of precipitation, particularly when using cumulus parameterization schemes. My findings highlight the need for more advanced modeling approaches that can better capture the intricate processes driving diurnal convection, which is fundamental for reliable climate predictions in monsoon regions.

Expanding beyond regional climate simulations, my recent work has focused on enhancing global weather prediction capabilities through satellite data assimilation using the NICAM-LETKF (Nonhydrostatic Icosahedral Atmospheric Model - Local Ensemble Transform Kalman Filter). This research is aimed at improving the forecast accuracy of small- to meso-scale intense precipitation systems in the global tropics, which are notoriously difficult to predict due to their localized and rapidly evolving nature. By integrating high-frequency satellite observations into the NICAM-LETKF framework, my research seeks to enhance the model's ability to accurately capture these intense precipitation events, which are critical for mitigating the impacts of severe weather in tropical regions. This work represents a significant step forward in global forecasting, leveraging the wealth of data provided by satellite observations to refine and improve predictive models.

In parallel, another research also addresses the challenges of predicting extreme weather events in urban environments at large eddy scales. Urban areas, with their dense populations and intricate infrastructures, are particularly susceptible to the effects of extreme weather. The unique atmospheric conditions in cities, such as urban heat islands, complicate the prediction of weather events, necessitating high-resolution modeling techniques that can capture these localized phenomena. My research employs large eddy simulation models to better understand and predict how extreme weather develops and behaves in urban settings. This work is essential for improving the resilience of cities to climate-related disasters, providing critical insights that can inform urban planning and policy decisions aimed at mitigating the impacts of extreme weather.

Collectively, these research efforts form a comprehensive approach to understanding and predicting atmospheric processes across a range of scales and environments. From improving our grasp of the diurnal cycles in monsoon regions to enhancing global forecasts through satellite data assimilation, and refining extreme weather predictions in urban areas, my work aims to bridge the gap between fundamental climate science and practical applications.