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Raindrop size distribution effects on radar rainfall estimation and heavy-rainfall forecasts over orography

by

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Abstract: Extreme rainfall over complex terrain remains difficult to forecast. Orography-driven convection is often small-scale and develops rapidly, and such features are often poorly captured in the model's initial state. Doppler weather radar observations help address this by providing high-resolution reflectivity and radial velocity data on rainfall and winds. This talk follows that information from radar measurement to rainfall estimation and short-range prediction, with particular attention to the raindrop size distribution (DSD) assumption embedded in this pathway. Radar reflectivity is converted to rainfall through a reflectivity–rainfall power law, a step that depends on assumptions about the DSD. The same assumption enters radar data assimilation, where reflectivity and radial velocity observations are linked to model variables through an observation operator. Assimilating these observations into a numerical model can improve short-term heavy-rainfall forecasts, but the operator typically assumes a single fixed DSD. Results from our X-band dual-polarization radar study over Réunion Island during tropical cyclone Batsirai show why this simplification can be problematic over orography, where the drop spectrum varies with terrain, height, and storm structure. Vertically pointing Micro Rain Radar observations, including those from IIST's Ponmudi Cloud Observatory, provide a way to examine how the DSD evolves through the atmospheric column and how this information can support improved reflectivity operators and forecasts of heavy rainfall over mountains.

About the speaker: Thiruvengadam P is an Assistant Professor in the School of Earth, Environmental, and Sustainability Sciences (SEESS) at IISER Thiruvananthapuram. He earned his Ph.D. from IIT Bombay, where he worked on improving extreme-precipitation forecasts over the Indian region through Doppler weather radar data assimilation; during his doctoral research, he was awarded a Fulbright–Kalam Climate Fellowship to conduct part of it at the School of Meteorology, University of Oklahoma. He holds an M.Tech and a B.E. in Geoinformatics from the University of Madras and Anna University, respectively. He subsequently held postdoctoral positions at the University of Oklahoma, working on machine-learning approaches to ensemble data assimilation, and at the Laboratoire de l'Atmosphère et des Cyclones, where he studied Indian Ocean precipitating systems using X-band polarimetric radar. His research spans radar meteorology, variational and ensemble data assimilation, and extreme rainfall forecasting.