RAL/EOL SEMINAR SERIES

Radar Synthesis Tools for Real-Time Hurricane and Heavy Rainfall Analysis

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1-2 PM (MT) FL2-1022 or Virtual | Watch Live

Open-source synthesis tools, including the Spline Analysis at Mesoscale Utilizing Radar and Aircraft Instrumentation (SAMURAI), which is part of the Lidar Radar Open Software Environment (LROSE), are critical for retrieving meaningful kinematic and microphysical properties to support scientific research. These tools support ground-based and airborne platforms, a variety of scanning strategies, single- and dual-polarization radars, and Doppler velocity and echo fields. This talk highlights a range of applications of these tools in order to improve operational hurricane analysis products and our understanding of the processes responsible for heavy rainfall.

The first part of this talk highlights recent CSU work, in collaboration with NCAR and NOAA, that seeks to improve surface wind estimates from hurricane reconnaissance flights, which are needed to diagnose the storm intensity and determine the radial extent of 34-, 50-, and 64-kt winds. The CSU Surface Winds from Aircraft with a Neural Network (SWANN) model was developed to improve wind reduction factors from flight-level observations (DesRosiers et al. 2025). For NOAA flights, quality-controlled tail Doppler radar radials and in situ HDOBs are analyzed together with SAMURAI; the flight-level wind field is fed alongside contextual information (e.g., storm motion, intensity) into SWANN. SWANN was applied in near real time during the 2024 and 2025 Atlantic hurricane seasons as part of the NOAA Hurricane and Ocean Testbed (HOT). SWANN estimates from NOAA flights into Hurricane Melissa (2025) compare favorably with the NHC Best Track intensity. In addition, SWANN exhibits realistic wind reduction azimuthal asymmetries around the storm expected due to storm motion. *(Continues)*

The second part of this talk uses radar data from the 2022 NSF-funded Prediction of Rainfall Extremes Campaign in the Pacific (PRECIP) to improve our understanding of the processes behind heavy rainfall. This study tests two PRECIP hypotheses: 1) extreme rainfall events result from fundamentally distinct processes or simply stronger forcings with an optimal combination of ingredients and 2) collection and accretion are the most important microphysical processes in high intensity precipitation, while vapor deposition and aggregation are more important in lower intensity, long duration events.

Doppler radar data from the PRECIP 2022 field campaign, centered on the National Center for Atmospheric Research's (NCAR) S-Pol radar, are synthesized with data from nearby operational and research radars in SAMURAI to produce three-dimensional kinematic analyses over the Taiwan Strait. Polarimetric data from S-Pol are analyzed with LROSE applications to produce three-dimensional polarimetric and derived microphysical and precipitation fields. Grid points are classified by the estimated near-surface rain rate, enabling statistical analysis of the three-dimensional structure of the nearby polarimetric and kinematic fields. The analysis shows that heavy rain in the mei-yu front does not result from fundamentally different dynamic processes compared to ordinary rainfall, but rather that distributions of dynamic variables associated with heavy rainfall are just progressively stronger on average than in lighter rain (DeHart and Bell 2025). Heavily raining grid points also exhibit a systematic shift towards increased collision-coalescence processes. In the mixed-phase and ice-phase regions, the collocated polarimetric and kinematic observations allow us to better assess the microphysical processes involved in heavy rain production. Event Website