# MMM SEMINAR SERIES

## *Tropical Cyclone Predictability: opportunity at the air-sea interface*

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In addition to initial conditions, uncertainty in model physics can also influence the practical predictability of tropical cyclones. The surface-exchange coefficients are one such aspect of model physics which are highly uncertain, especially at high wind speeds, and are well-known to be important model parameters influencing the intensity and structure of tropical cyclones in numerical simulations. In the first part, the influence that various magnitudes of uncertainty in the surface exchange coefficients of momentum ($C_d$) and enthalpy ($C_k$) can have on an otherwise highly predictable major hurricane (Hurricane Patricia, 2015) is compared with that resulting from climatological environmental initial condition uncertainty and the intrinsic limit for this case. As the systematic uncertainty in $C_d$ and $C_k$ is reduced from 40% to 1%, the simulated uncertainty in the intensity and structure is substantially reduced and approaches the intrinsic limit when uncertainty is reduced to 1%. If $C_d$ and $C_k$ are perturbed stochastically in time and space, instead of systematically, it is shown that the influence on the simulated intensity and structure is negligible and nearly identical to the intrinsic limit, regardless of the magnitude of the stochastic $C_d$ and $C_k$ perturbations.

In the second part, an ensemble Kalman filter (EnKF) with one-step-ahead smoothing is introduced for the purposes of parameter estimation. The potential for this system to provide new constraints on the surface-exchange coefficients of momentum ($C_d$) and enthalpy ($C_k$) is then explored using a series of observing system simulation experiments (OSSEs). One major benefit of the developed EnKF with one-step-ahead smoothing is that it allows for simultaneous updates of the rapidly evolving model state variables found in tropical cyclones using a short assimilation window and a long smoother window for the parameter updates, granting sufficient time for sensitivity to the parameters to develop. Overall, OSSEs demonstrate potential for this approach to accurately constrain parameters controlling the amplitudes of $C_d$ and $C_k$, but the degree of success in recovering the true model parameters varies throughout the tropical cyclone lifecycle. The relative success of parameter estimation in recovering the true model parameter values also has sensitivity to the ensemble size and smoothing forecast length, each of which are explored.

**Thursday, 14 April 2022, 2:00pm**
NCAR-Foothills Laboratory, 3450 Mitchell Lane
FL2-1022, Large Auditorium

**Seminar will also be live webcast**
***https://operations.ucar.edu/live-mmm***
Participants may ask questions during the seminar via Slido.