

Ensemble Streamflow Assimilation with Coupled WRF-Hydro and DART

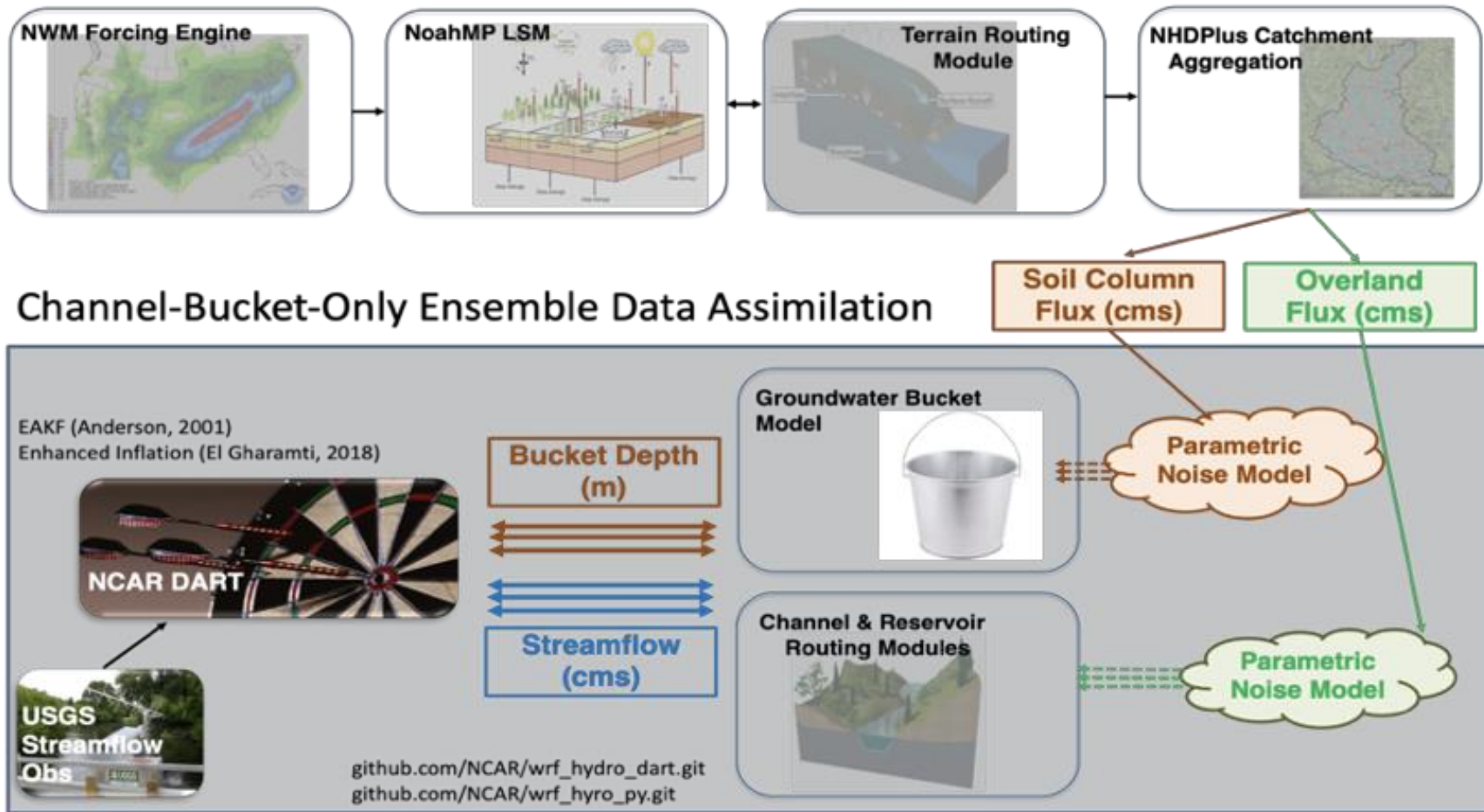
Seong Jin Noh¹, James McCreight², Moha El Gharamti²,
Tim Hoar², Arezoo Rafieeiniasab², Ben Johnson²

¹Kumoh National Institute of Technology, Gumi, Gyeongbuk, South Korea

²National Center for Atmospheric Research, Boulder, Colorado, USA

May 8, 2020

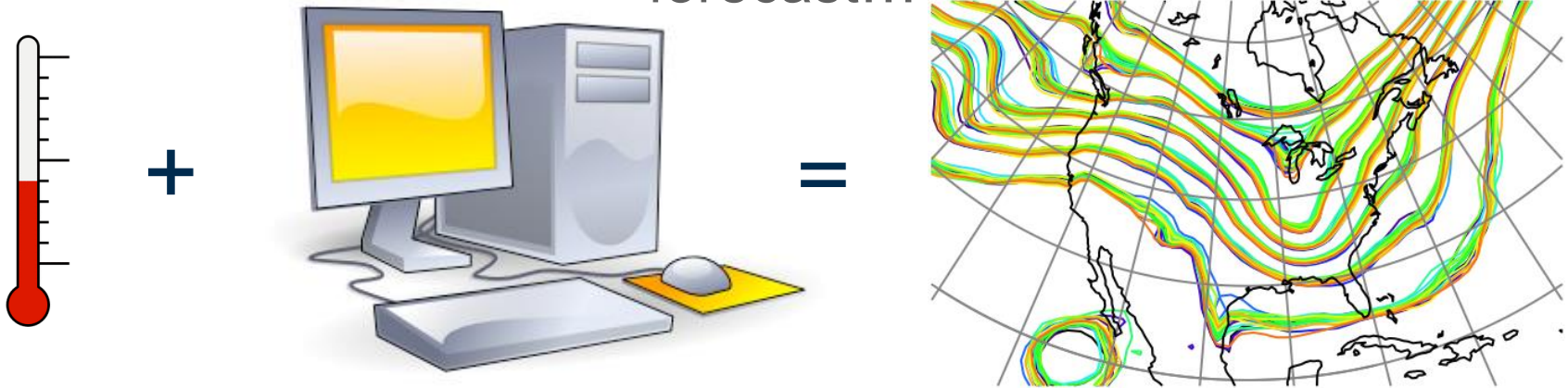
Study objective



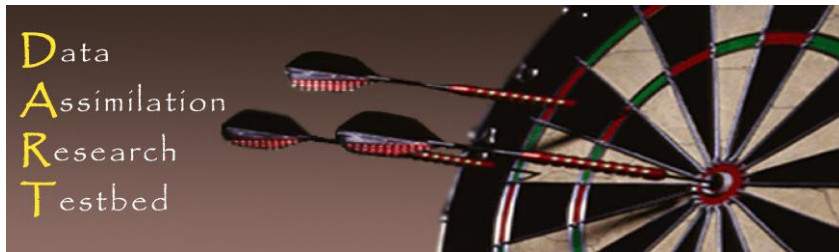
The objective is to implement a real-time ensemble streamflow DA for WRF-Hydro and demonstrate its value for short-range forecasting

Data Assimilation using DART

Observations combined with a Model
forecast...



... to produce an analysis.

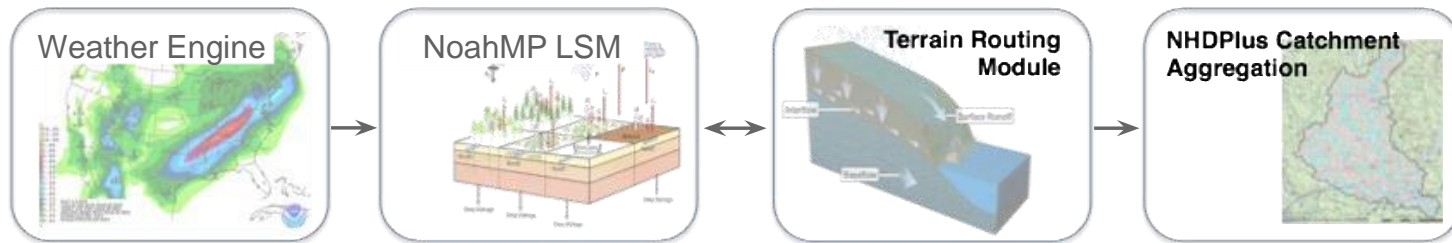


Overview article of the Data Assimilation Research Testbed (DART):

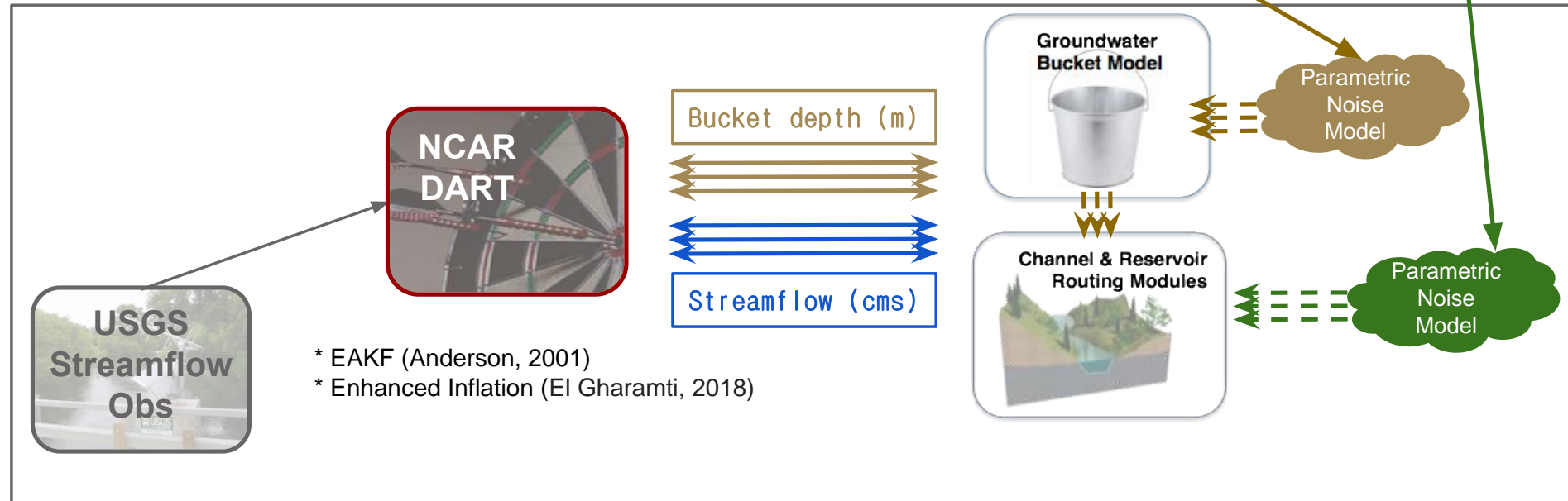
Anderson, Jeffrey, T. Hoar, K. Raeder, H. Liu, N. Collins, R. Torn, A. Arellano, 2009: The Data Assimilation Research Testbed: A Community Facility.

Bull. Amer. Meteor. Soc., **90**, 1283–1296. doi:10.1175/2009BAMS2618.1

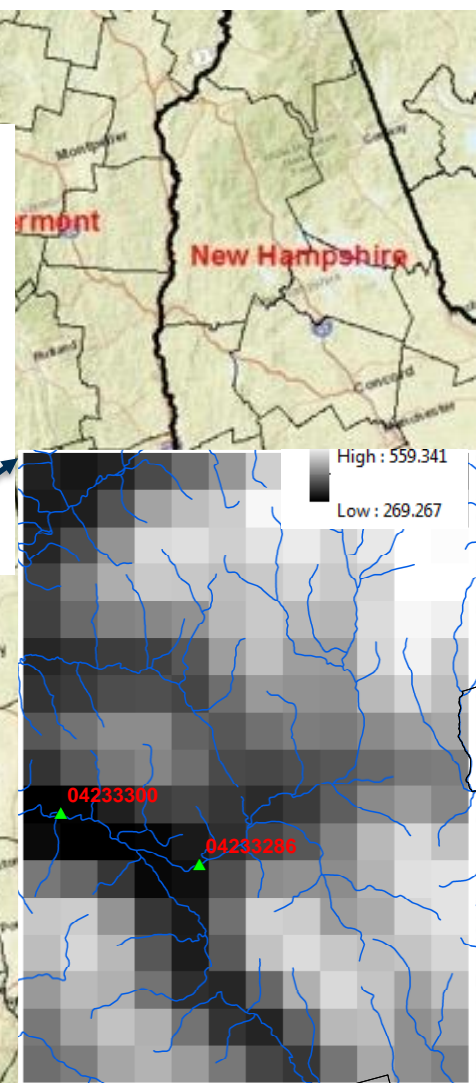
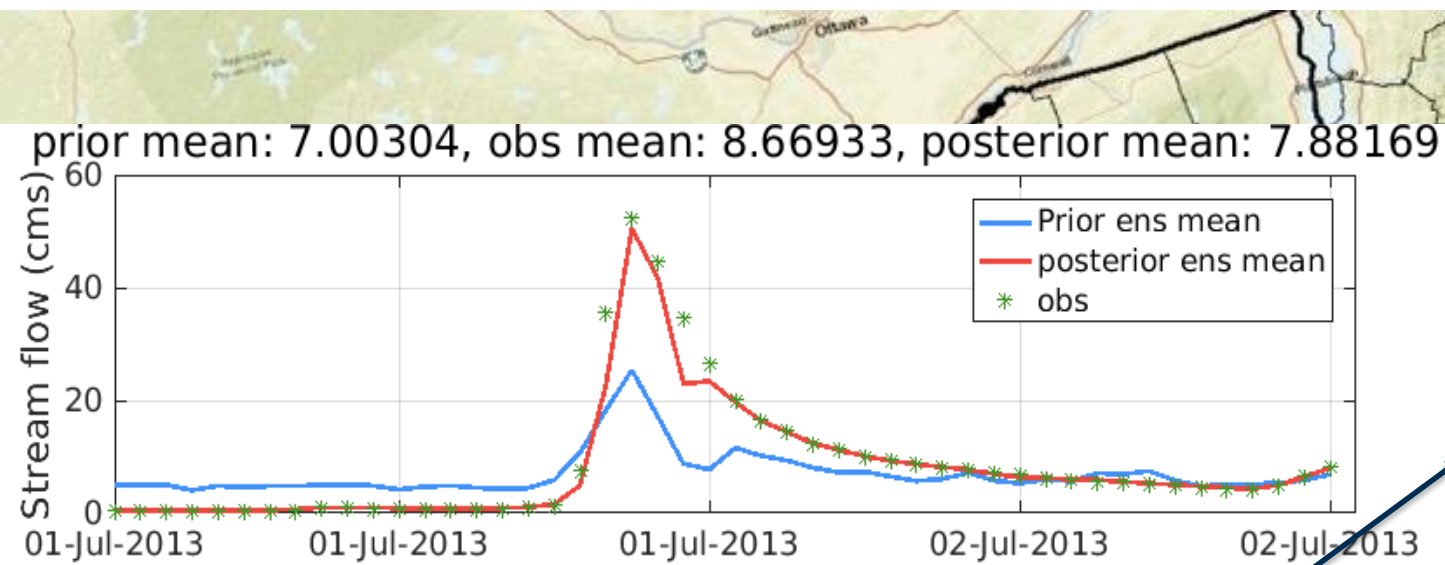
WRF-Hydro & DART HydroDART



Channel-Bucket-Only Ensemble Data Assimilation



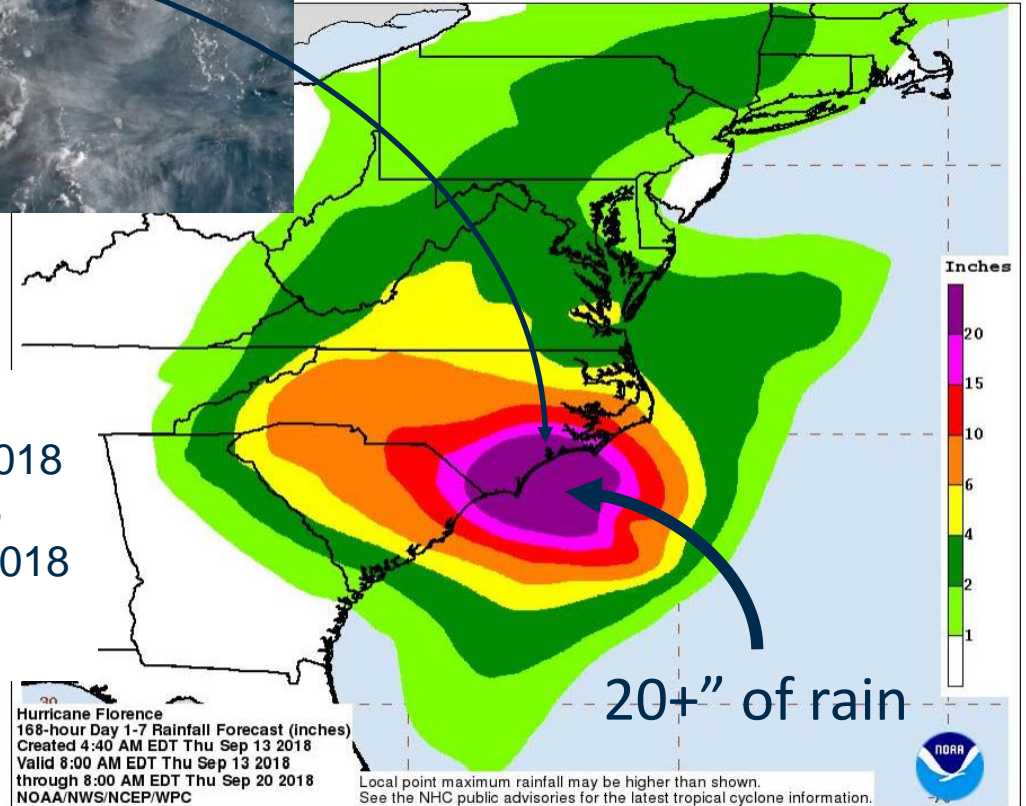
DA test result at small domain



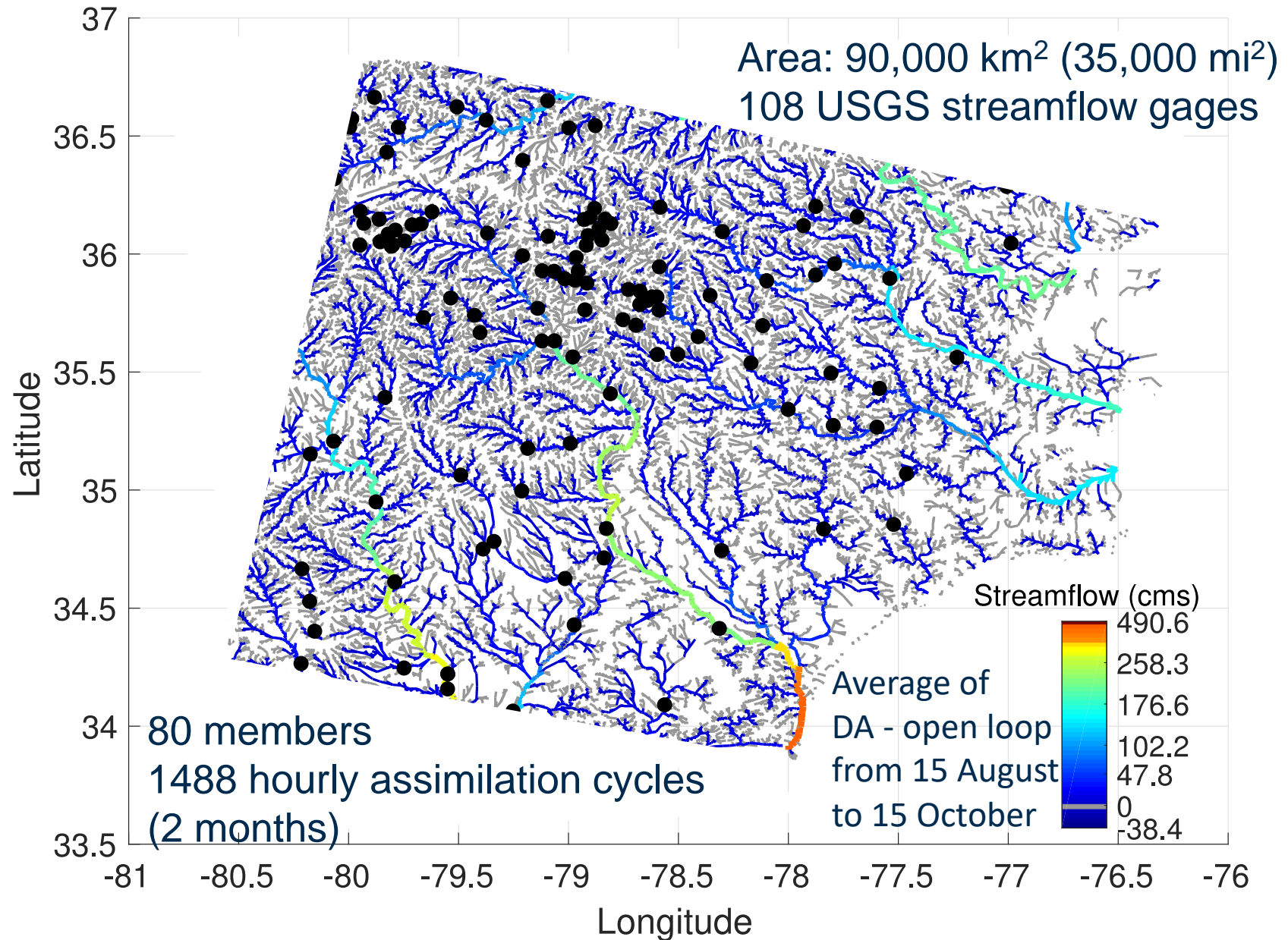
Regional-scale experiment: Hurricane Florence

Hurricane Florence made landfall near Wrightsville Beach, North Carolina at **7:15 a.m. ET September 14 2018**, as a Category 1 storm. The GOES East satellite captured this geocolor image at 7:45 a.m. ET

168-hour Day 1-7 Rainfall Forecast
Created 4:40 AM EDT Thu Sep 13 2018
Valid 8:00 AM EDT Thu Sep 13 2018
Through 8:00 AM EDT Thu Sep 20 2018
NOAA/NWS/NCEP/WPC



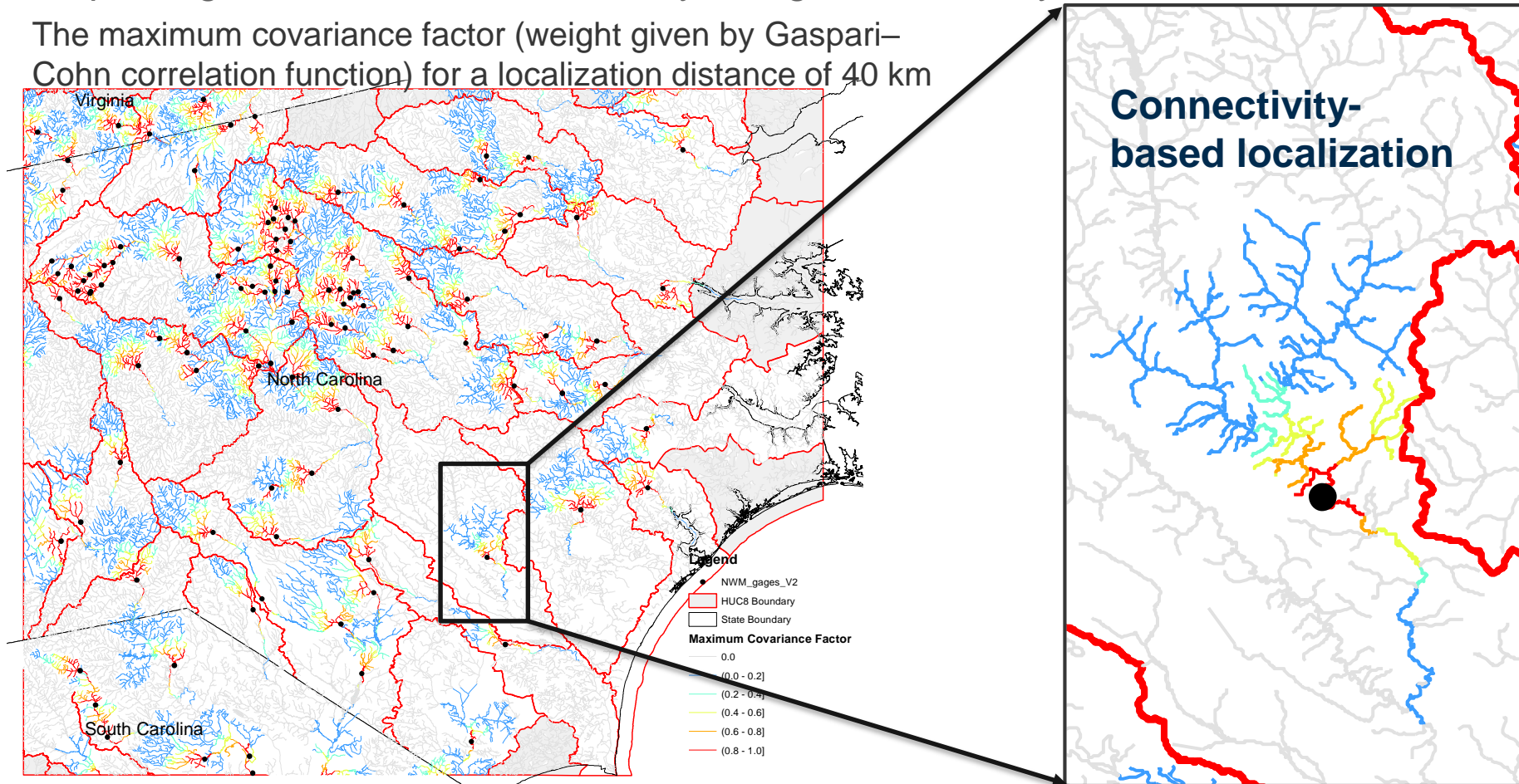
Regional-scale experiment: streamflow analysis



Along-the-stream localization

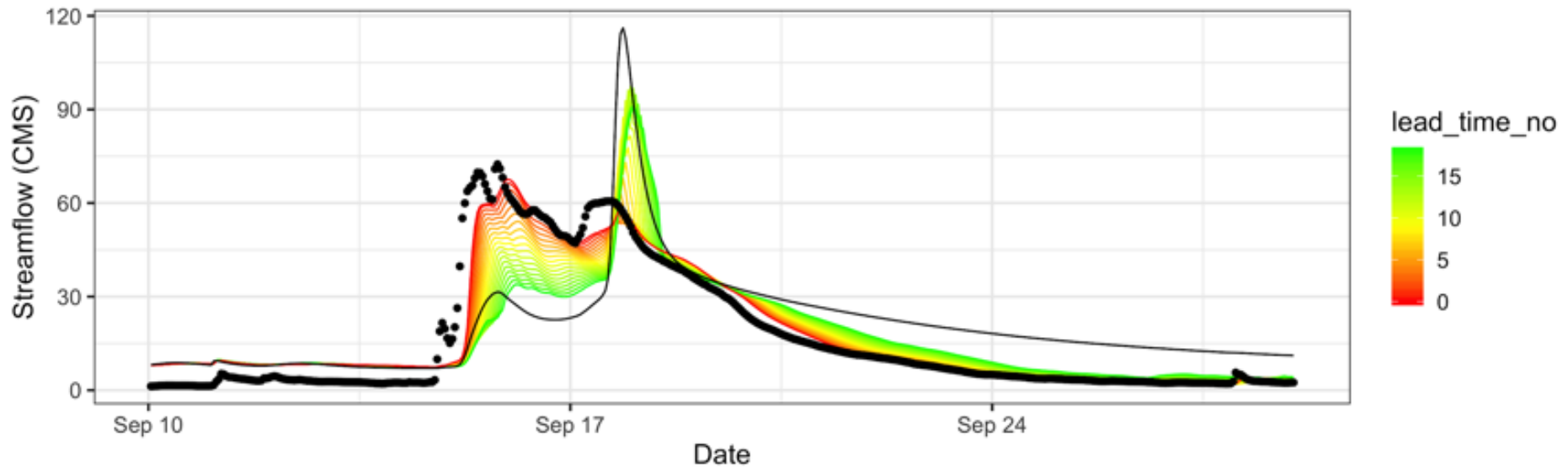
- Assimilation of streamflow observations into all the state variables in the vicinity may not be physically appropriate
- 'Along-the-stream localization' allows streamflow information to be used for updating the states based on the hydrologic connectivity

The maximum covariance factor (weight given by Gaspari–Cohn correlation function) for a localization distance of 40 km

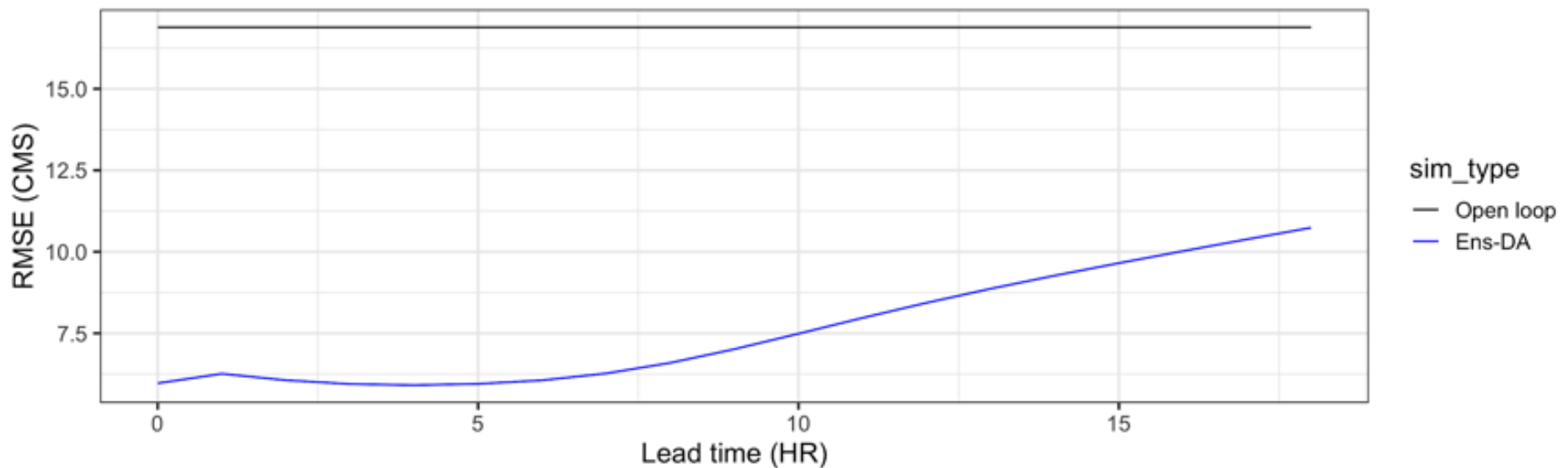


DA vs. open loop: Example forecasts

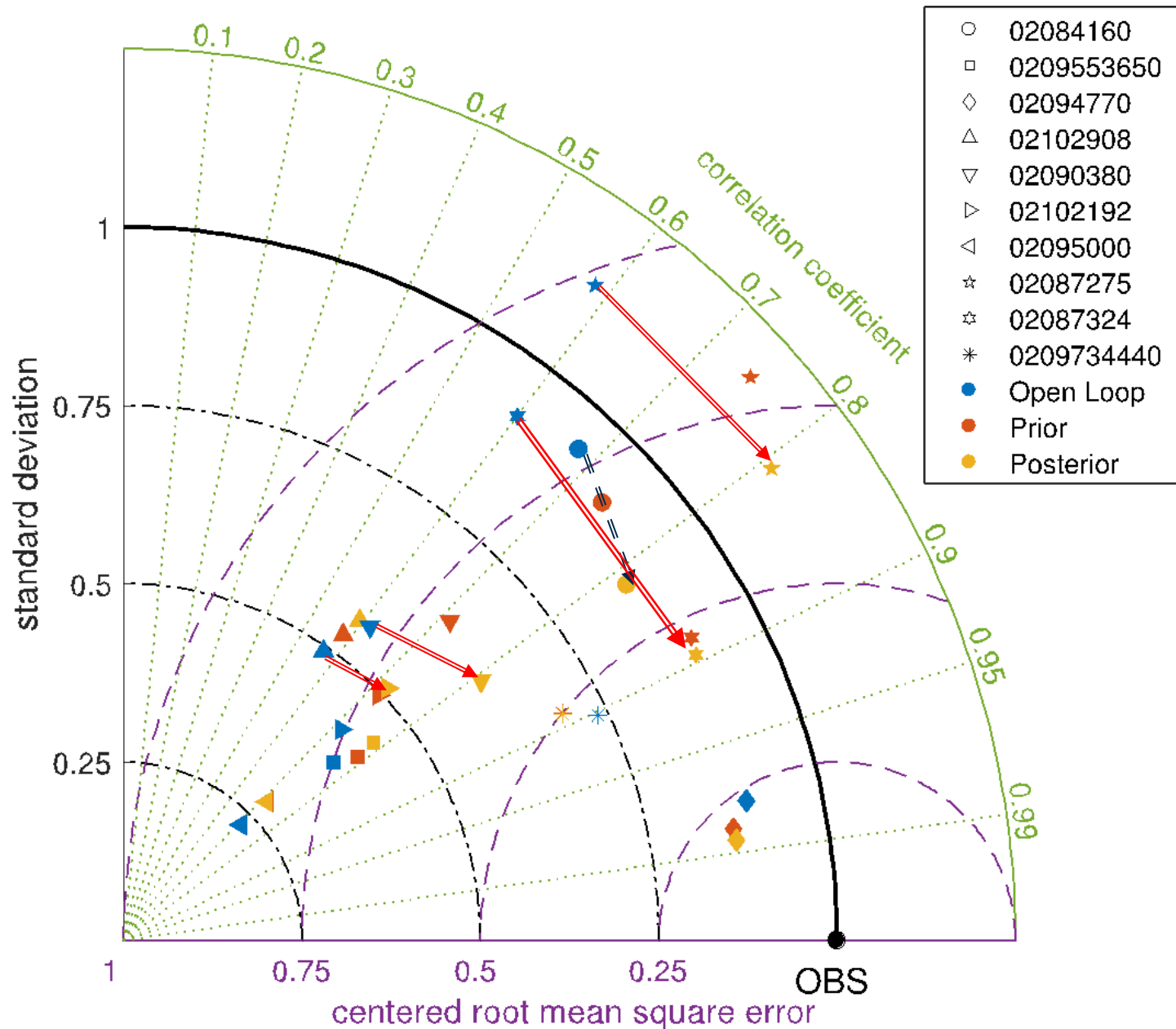
Ens DA at USGS gage: 02087324



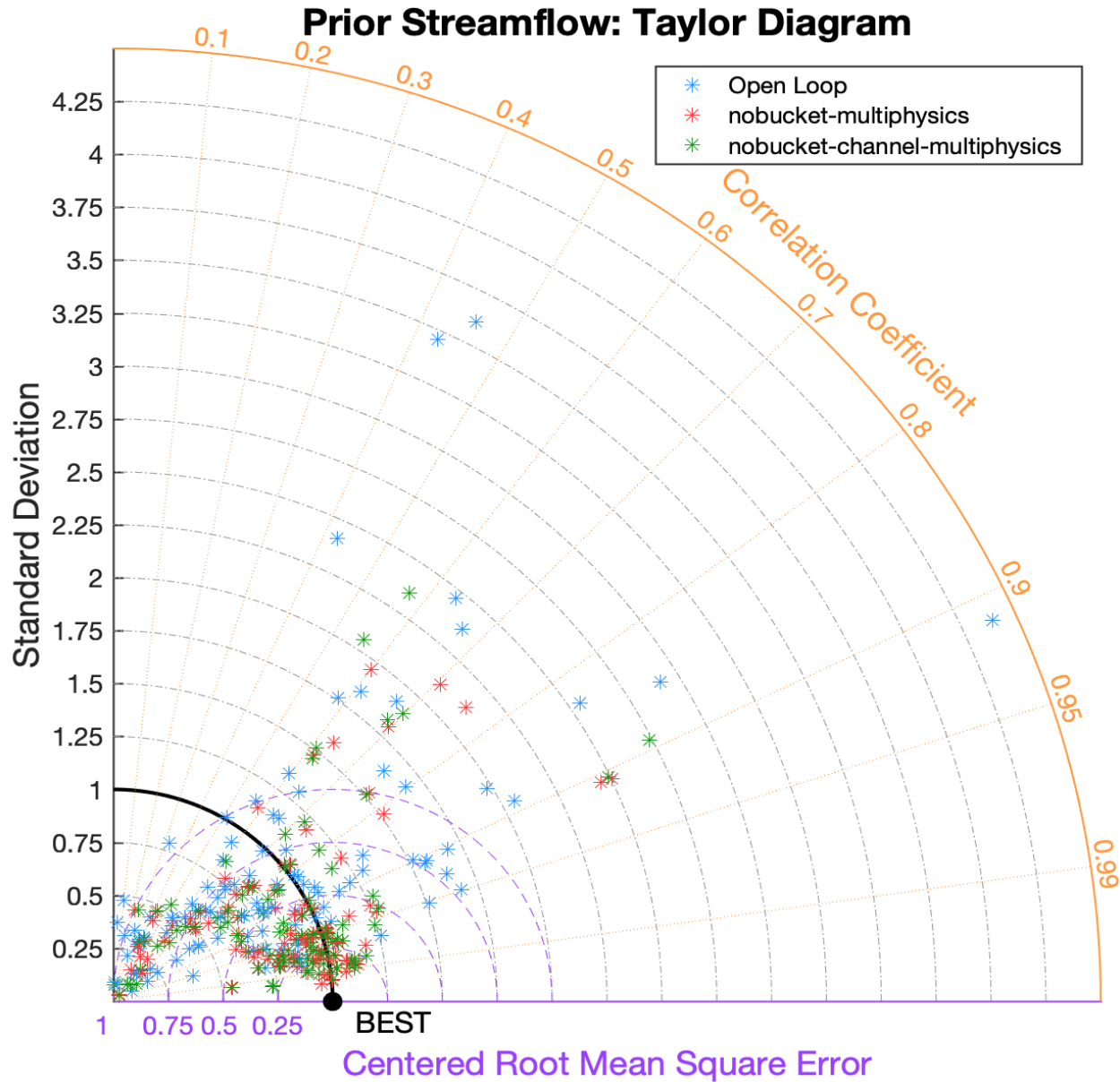
RMSE at USGS gage: 02087324



DA vs. open loop: Taylor diagram (10 gages)



DA vs. open loop: Taylor diagram (108 gages)



Summary statistics: Deterministic measure

Hurricane Florence domain, 108 gages

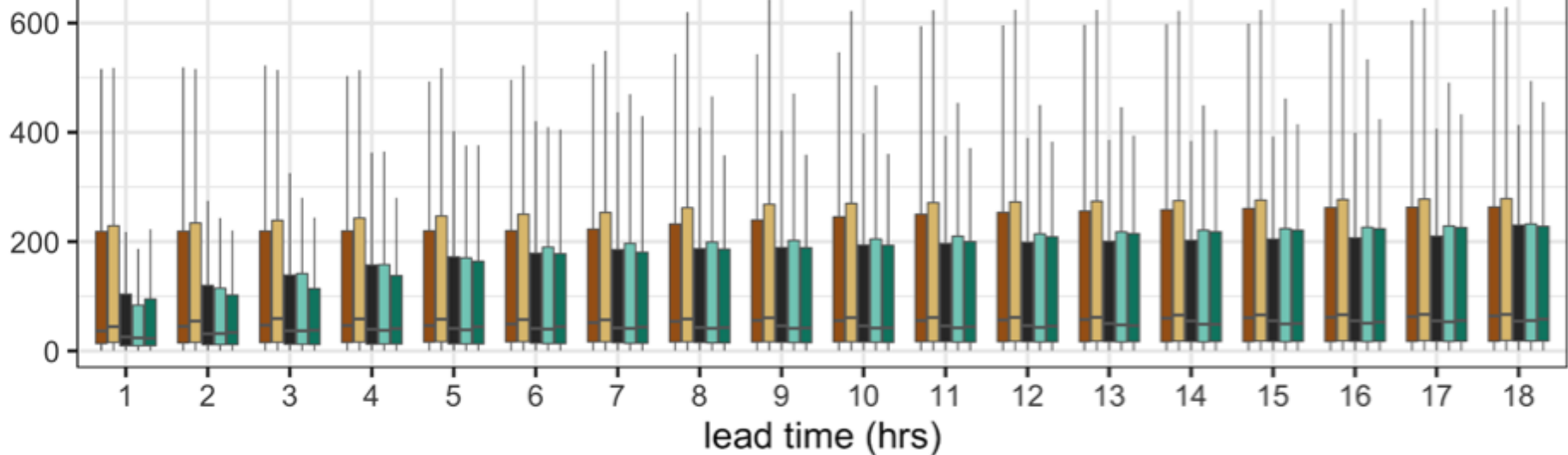
Full month: 2018-09-07 00:00 - 2018-10-01 00:00

Experiment

- open-loop-multiphysics (olm)
- nudging (ndg)
- nobucket-channel-multiphysics (ncm)
- nobucket-multiphysics (nm)
- bucket-multiphysics (bm)

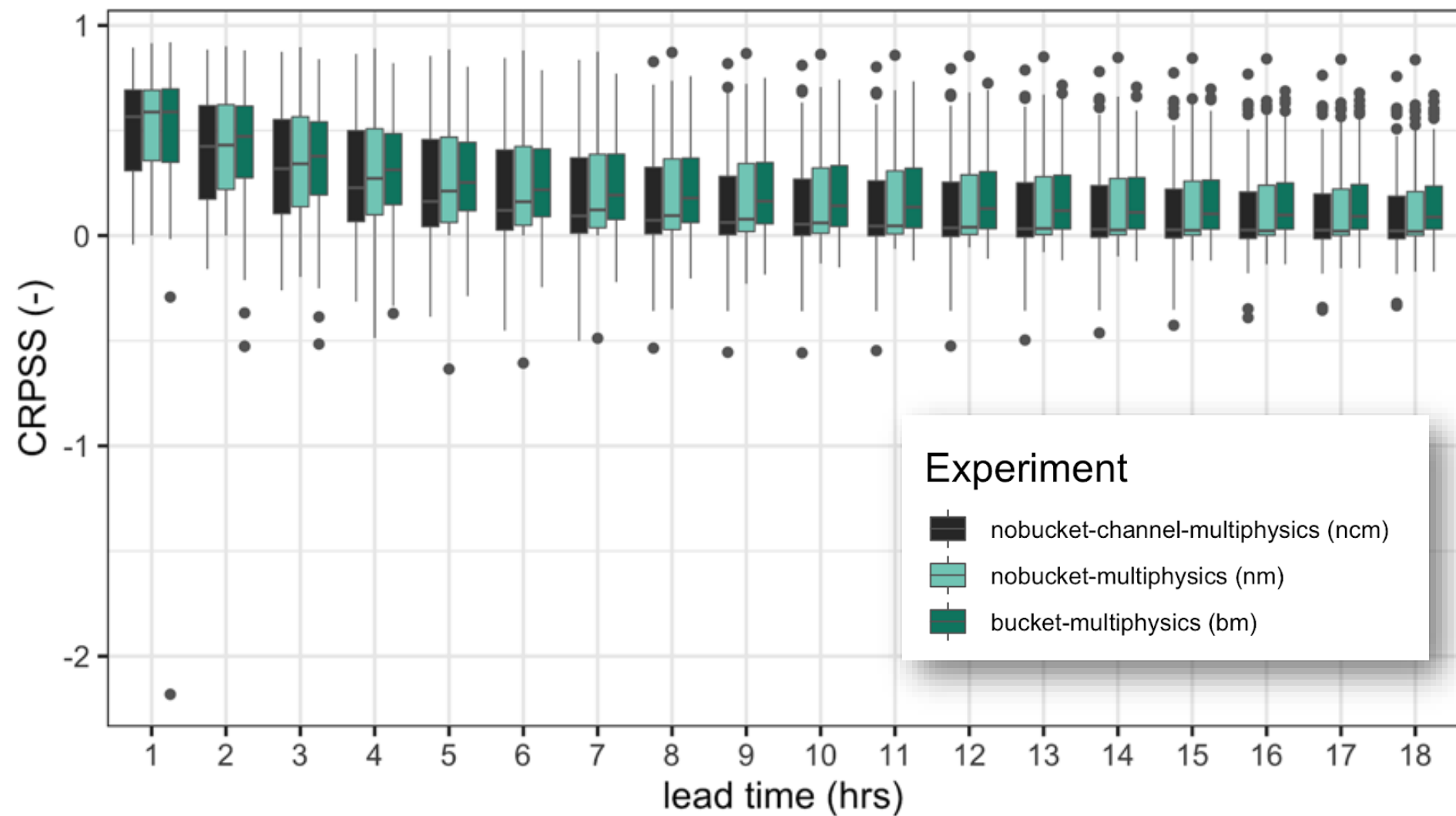
RMSE (cms)

Main flooding: 2018-09-16 00:00 - 2018-09-20 23:00



Summary statistics: Probabilistic measure

Hurricane Florence domain, 108 gages



Summary

- **Hydro-DART**, an ensemble DA framework for WRF-Hydro using DART, was developed and tested at small and regional scales
- A **multi-configuration ensemble** with different physical parameters (e.g., Manning's roughness and channel geometry) was used for having ensemble additional variability
- **Along-the-stream localization** scheme was proposed for updating the states based on the hydrologic connectivity
- **Ensemble DA forecasts shows improvements** over the open loop and the nudging deterministic forecasts
- A study on anamorphosis and spatially-correlated noise to avoid non-physical state updates and forcings perturbation is under way



THANK YOU

seongjin.noh@gmail.com