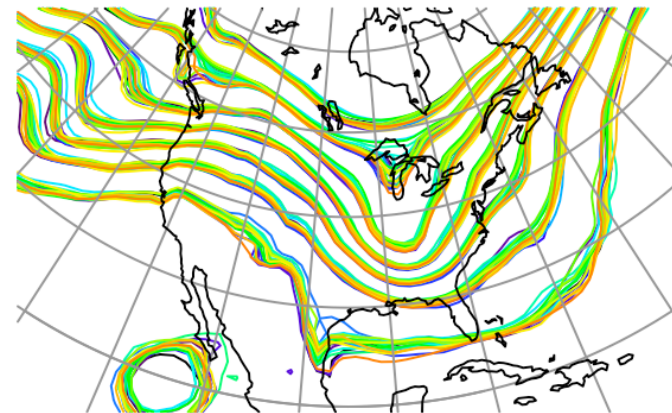




# Hydro-DART: Ensemble Streamflow Assimilations with WRF-Hydro and the Data Assimilation Research Testbed.



©UCAR 2018

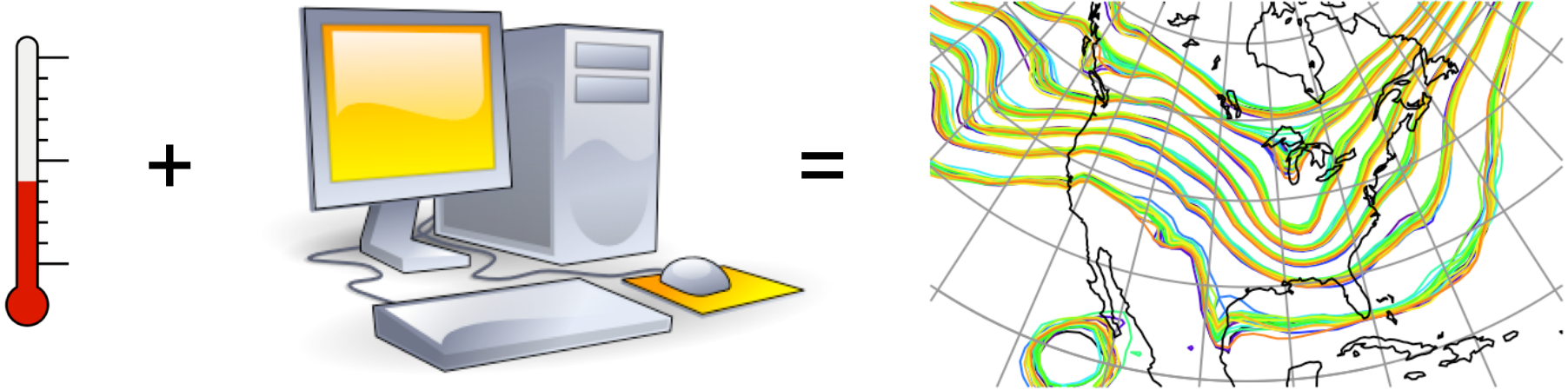


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NCAR | National Center for  
UCAR | Atmospheric Research

# What is Data Assimilation?

Observations combined with a Model forecast...



... to produce an analysis.

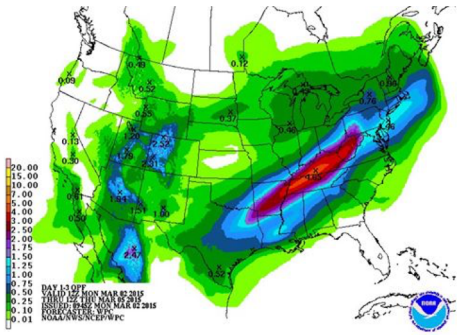
Overview article of the Data Assimilation Research Testbed (DART):

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](https://doi.org/10.1175/2009BAMS2618.1)

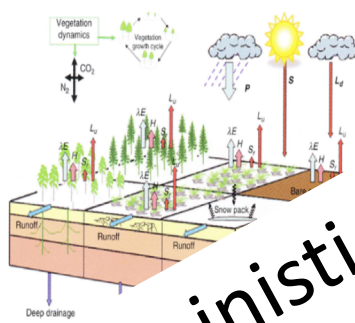
# The Big Picture

Weather Forcing Engine

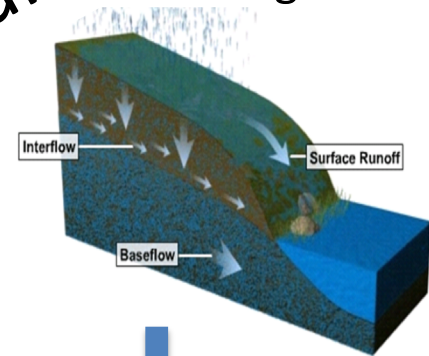


WRF-Hydro: <https://www.ral.ucar.edu/projects/wrf-hydro>

NoahMP LSM



Routing Module

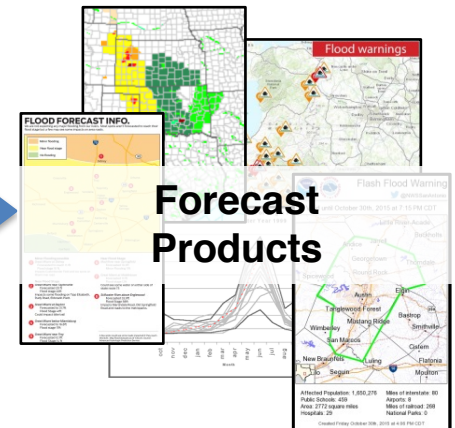
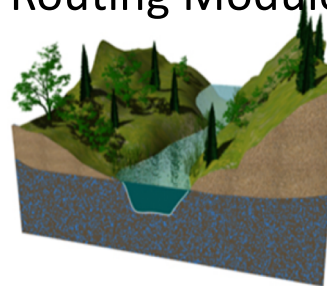


This is all deterministic. There is no uncertainty.

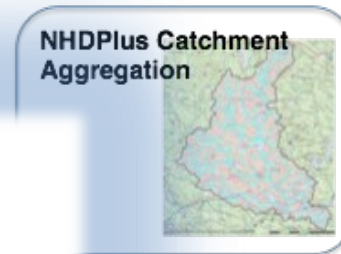
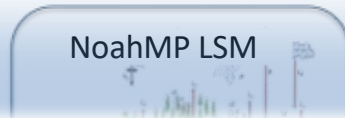
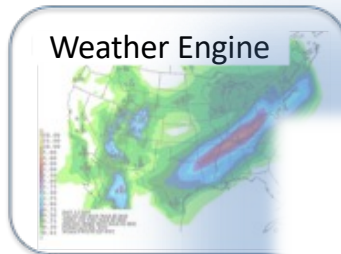
NHDPlus



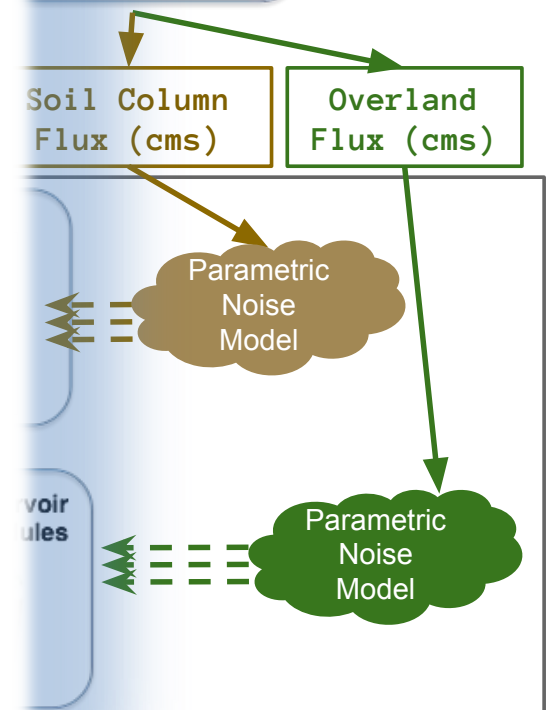
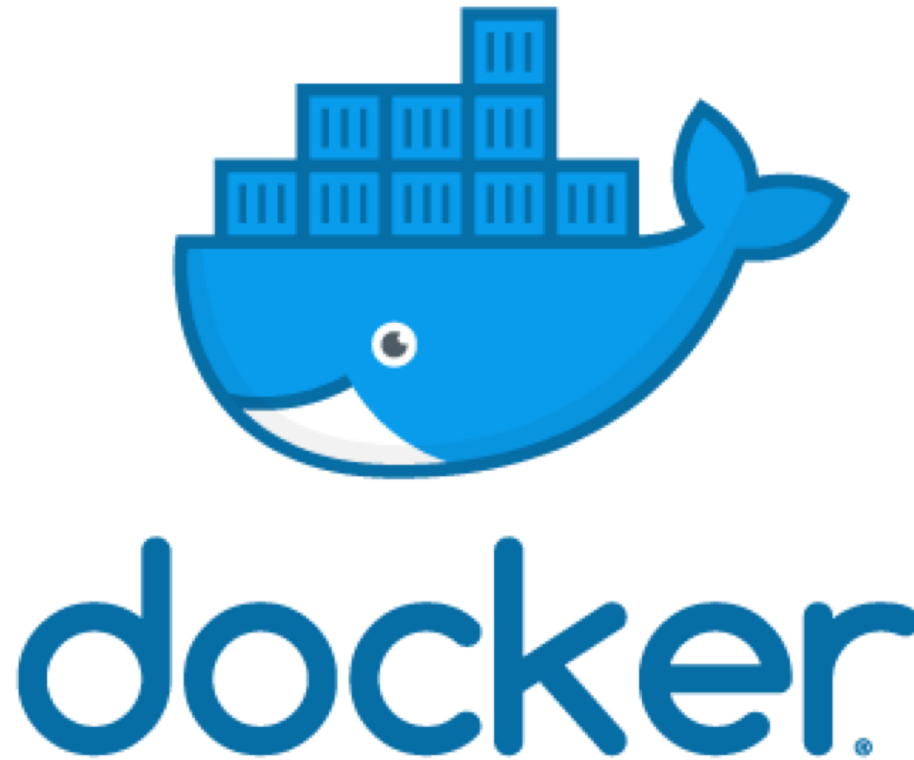
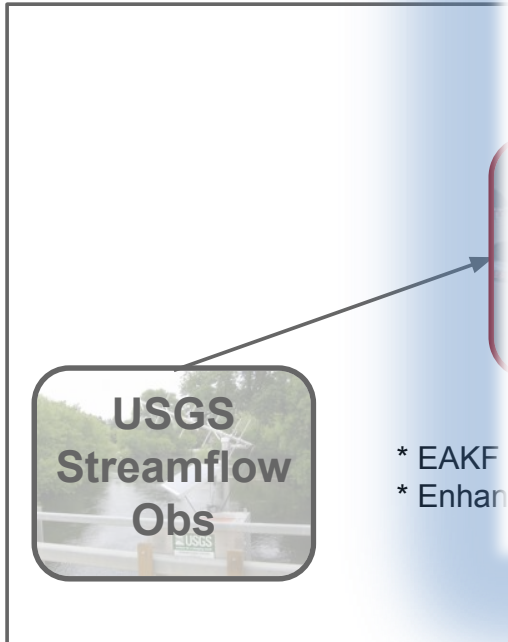
Channel & Reservoir Routing Module



# WRF-Hydro & DART ... HydroDART



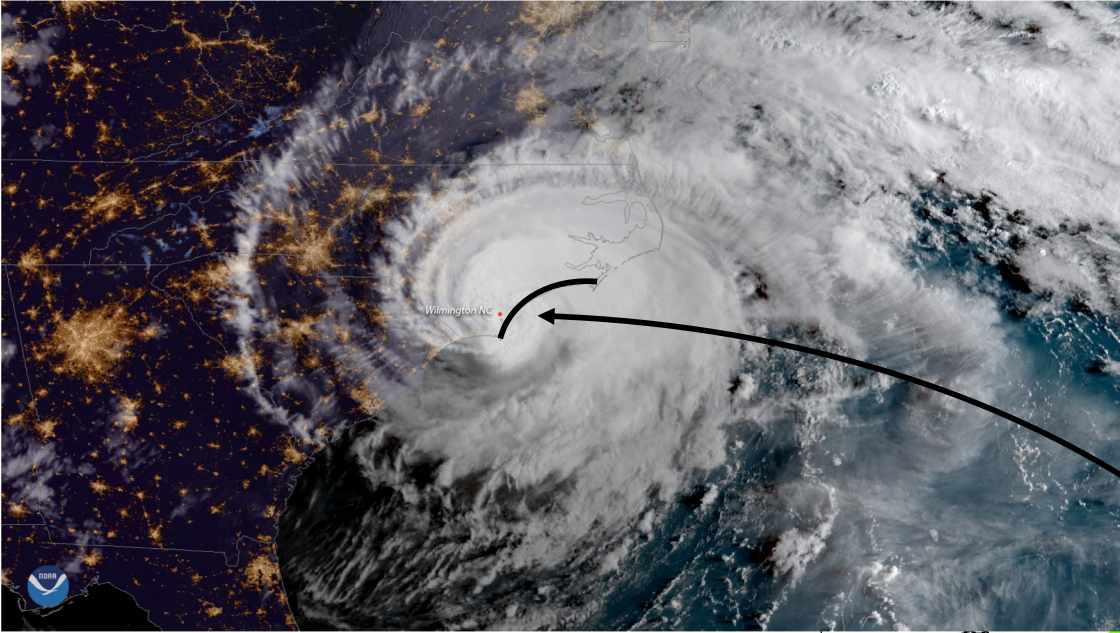
Channel-Bucket-Only



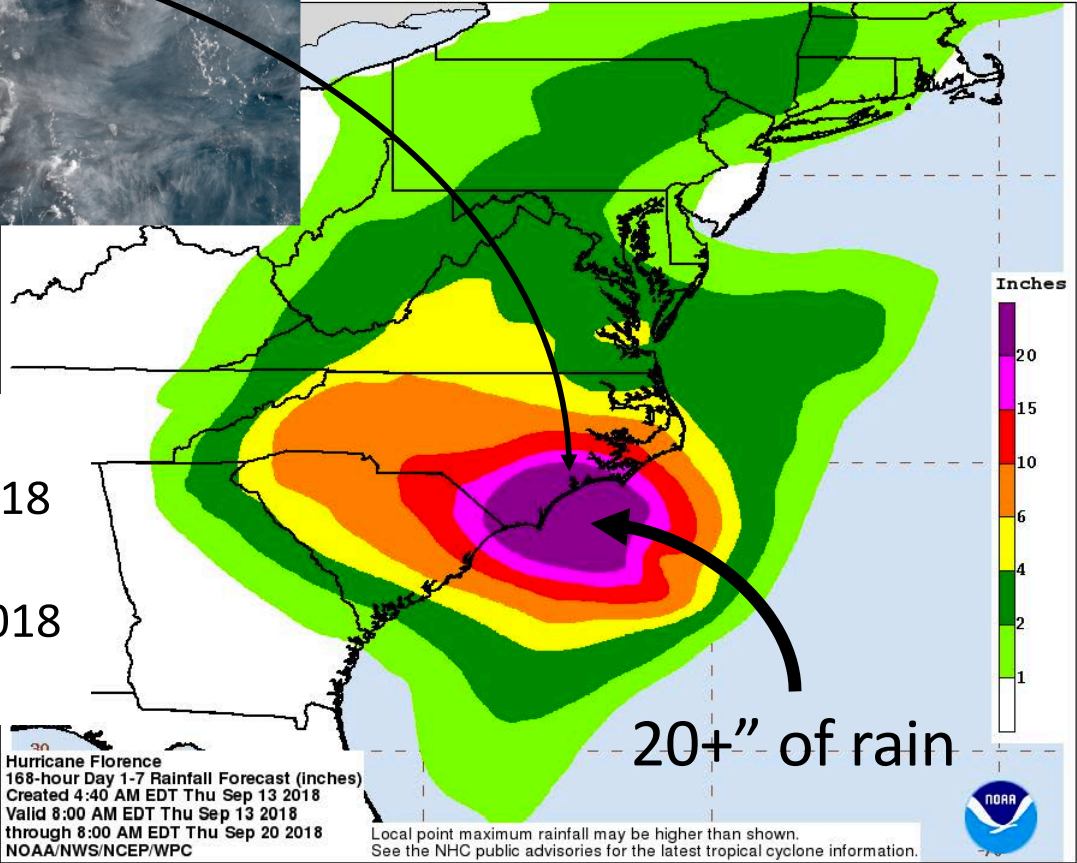
Python environment

[github.com/NCAR/wrf\\_hydro\\_py.git](https://github.com/NCAR/wrf_hydro_py.git)

# Hurricane Florence



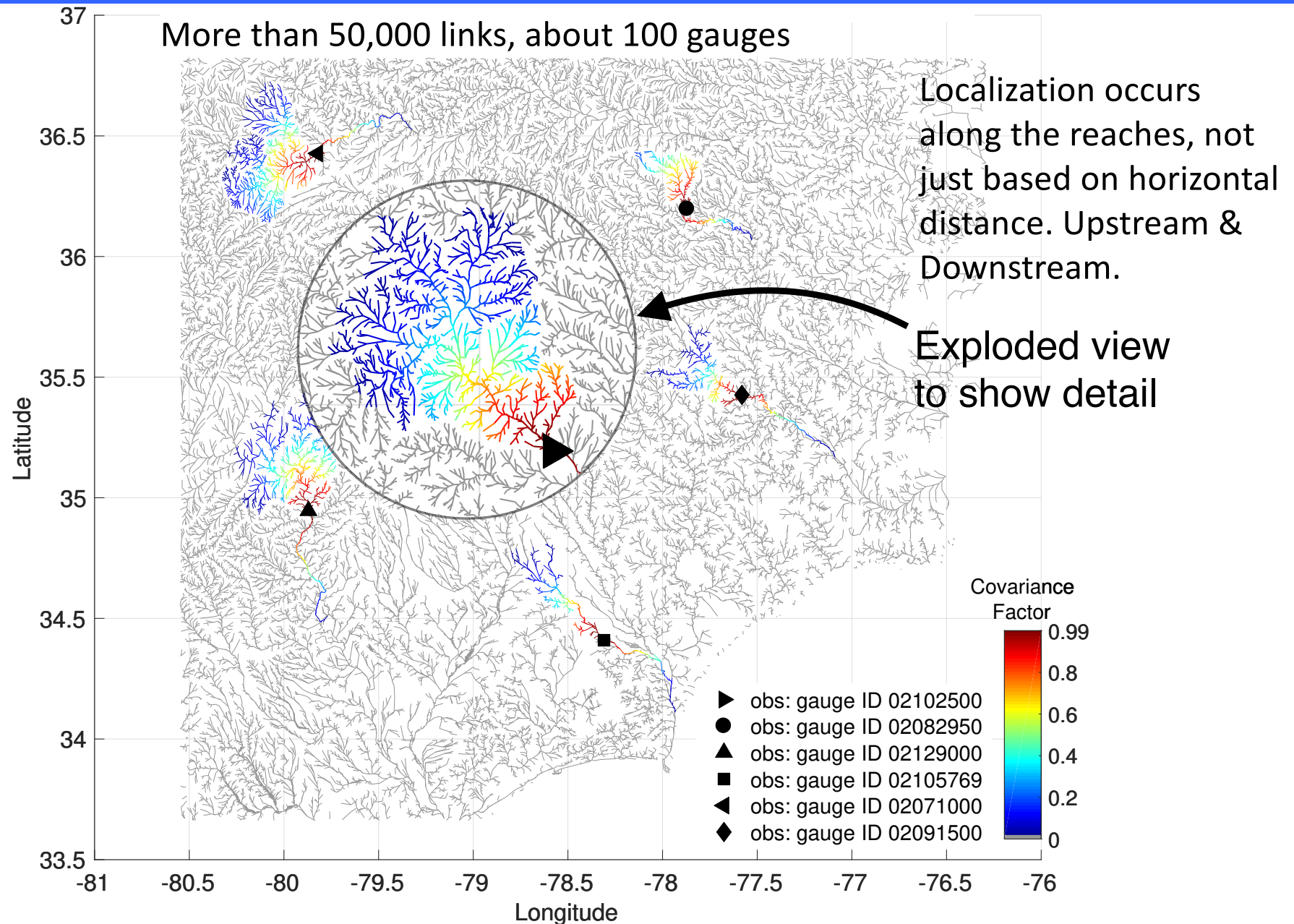
Hurricane Florence made landfall near Wrightsville Beach, North Carolina at **7:15 a.m. ET September 14**, as a Category 1 storm. The GOES East satellite captured this geocolor image at 7:45 a.m. ET



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

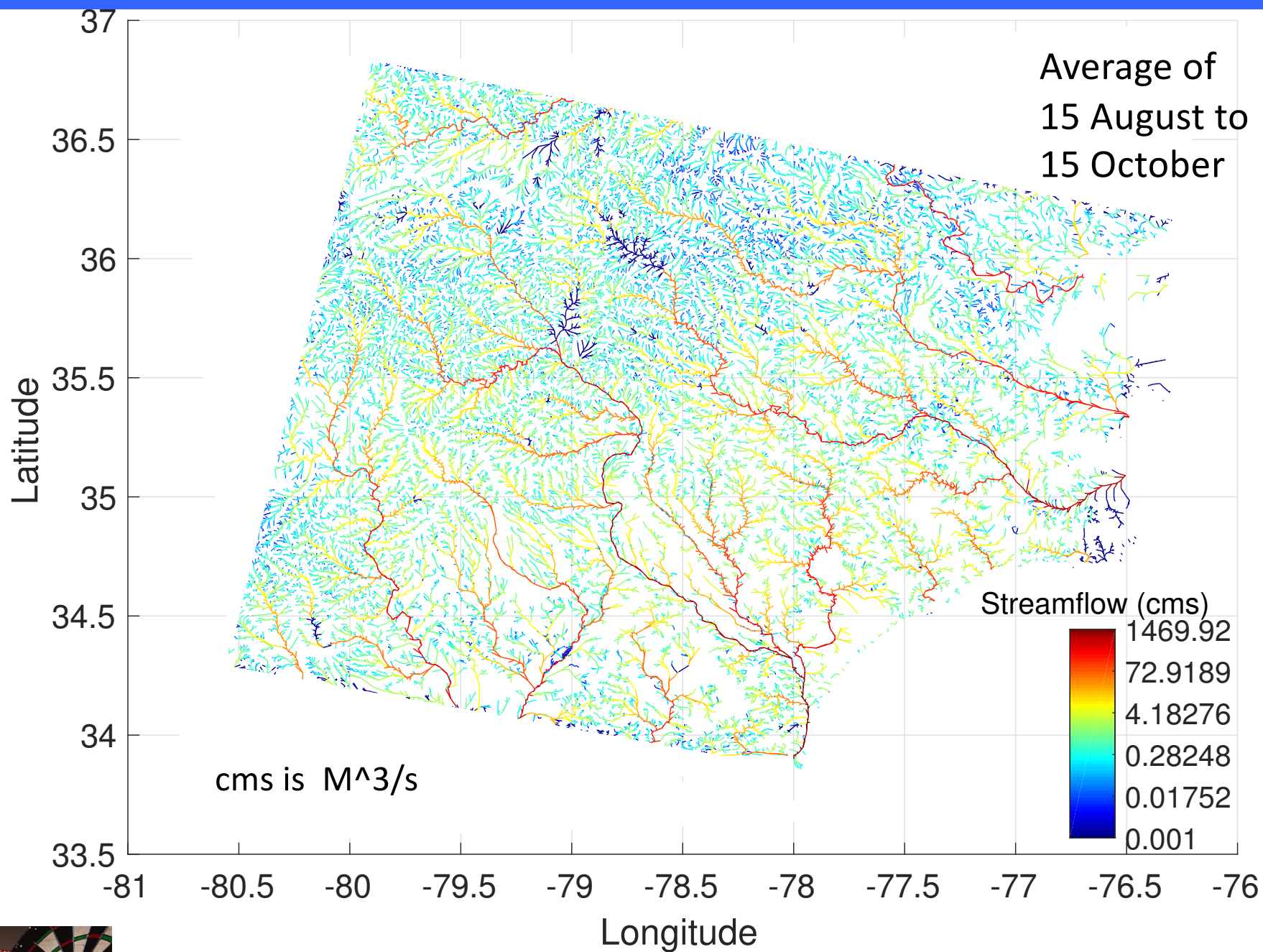


# Florence Domain : localization

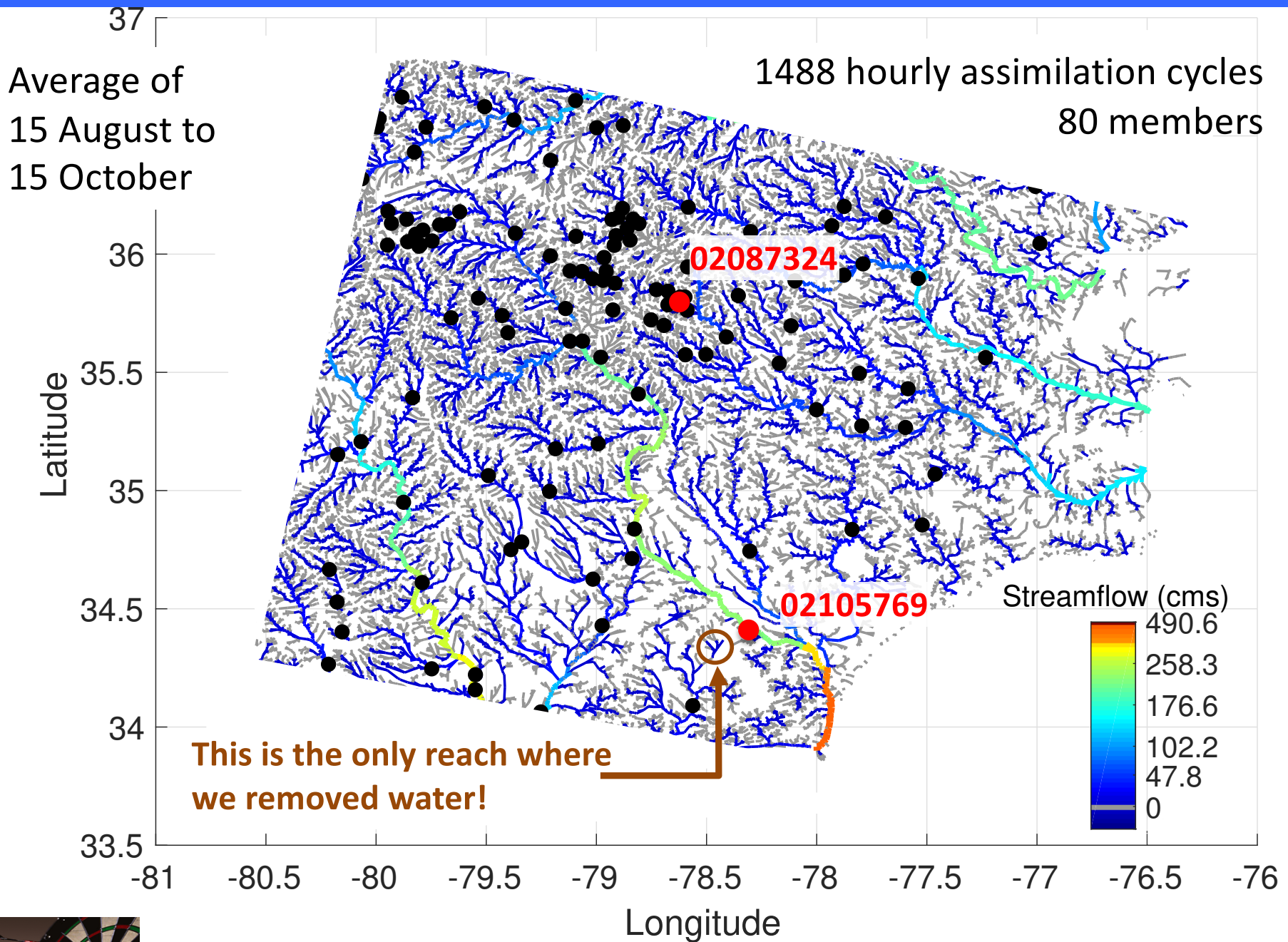


100 km localization distance is used here for visualization only.

# Time-Averaged Streamflow: Open Loop Mean



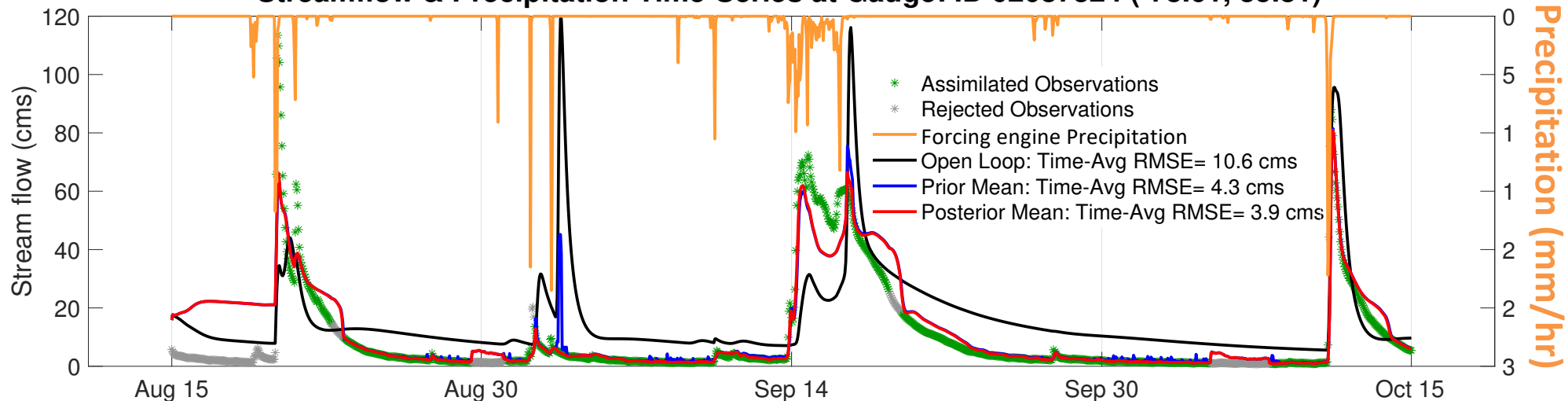
# Posterior Mean – Open Loop Mean



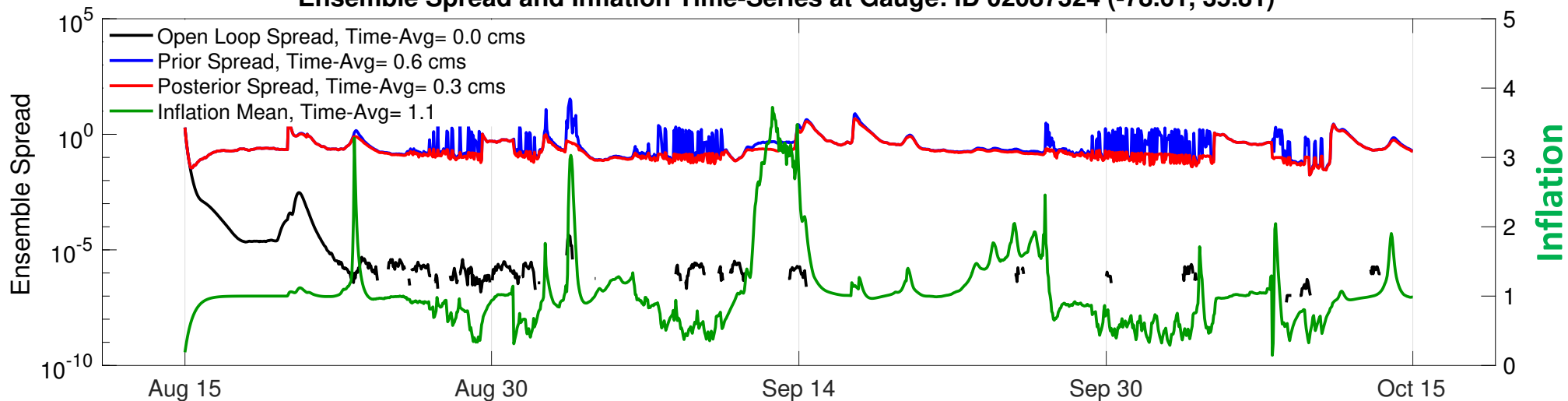


# Gauge 02087324 ... central

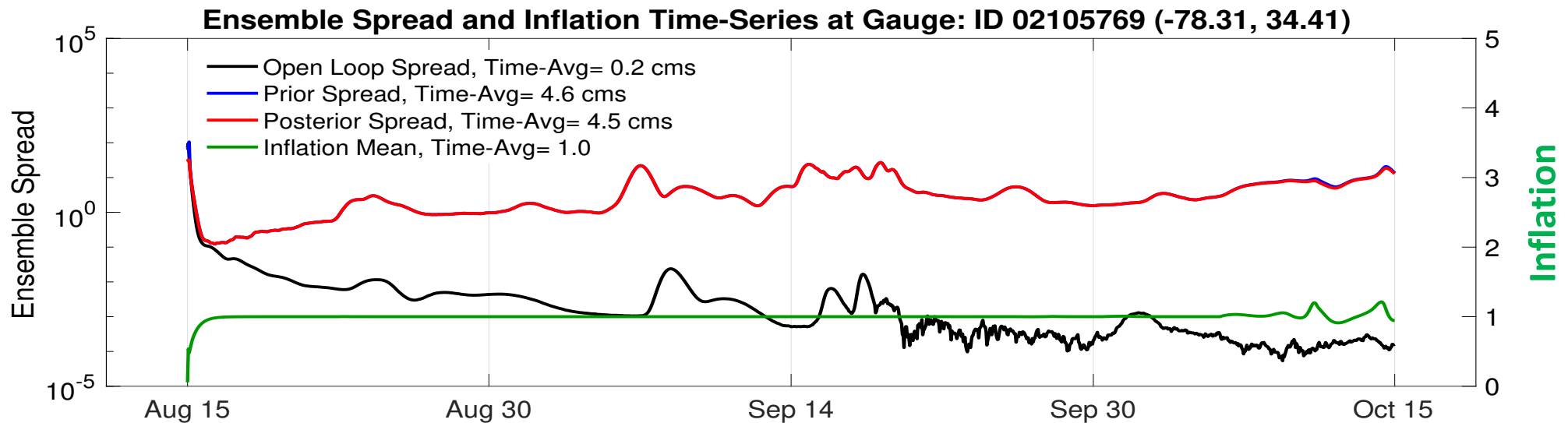
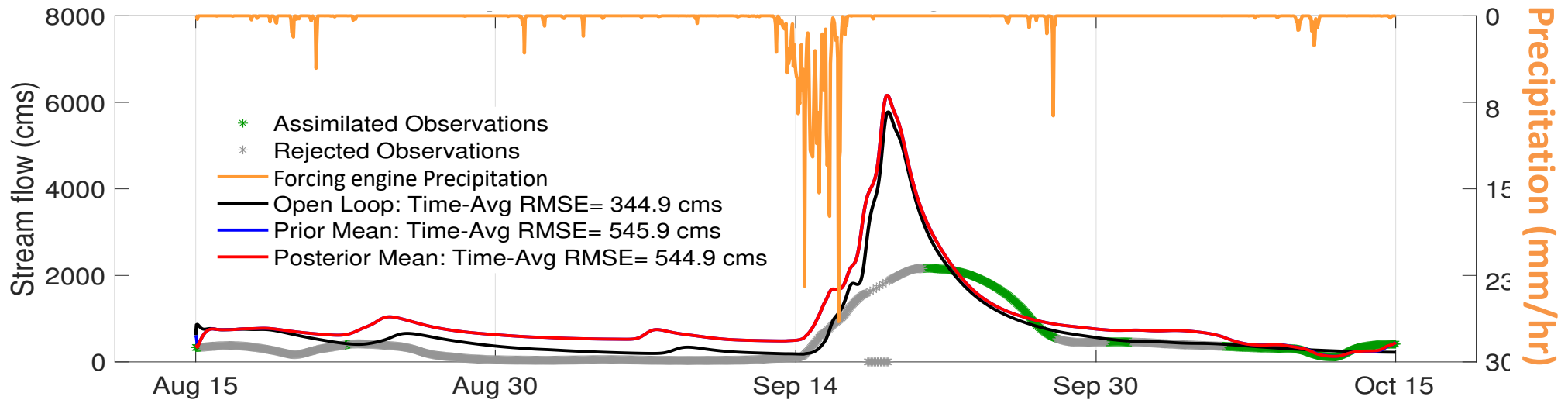
## Streamflow & Precipitation Time-Series at Gauge: ID 02087324 (-78.61, 35.81)



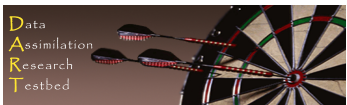
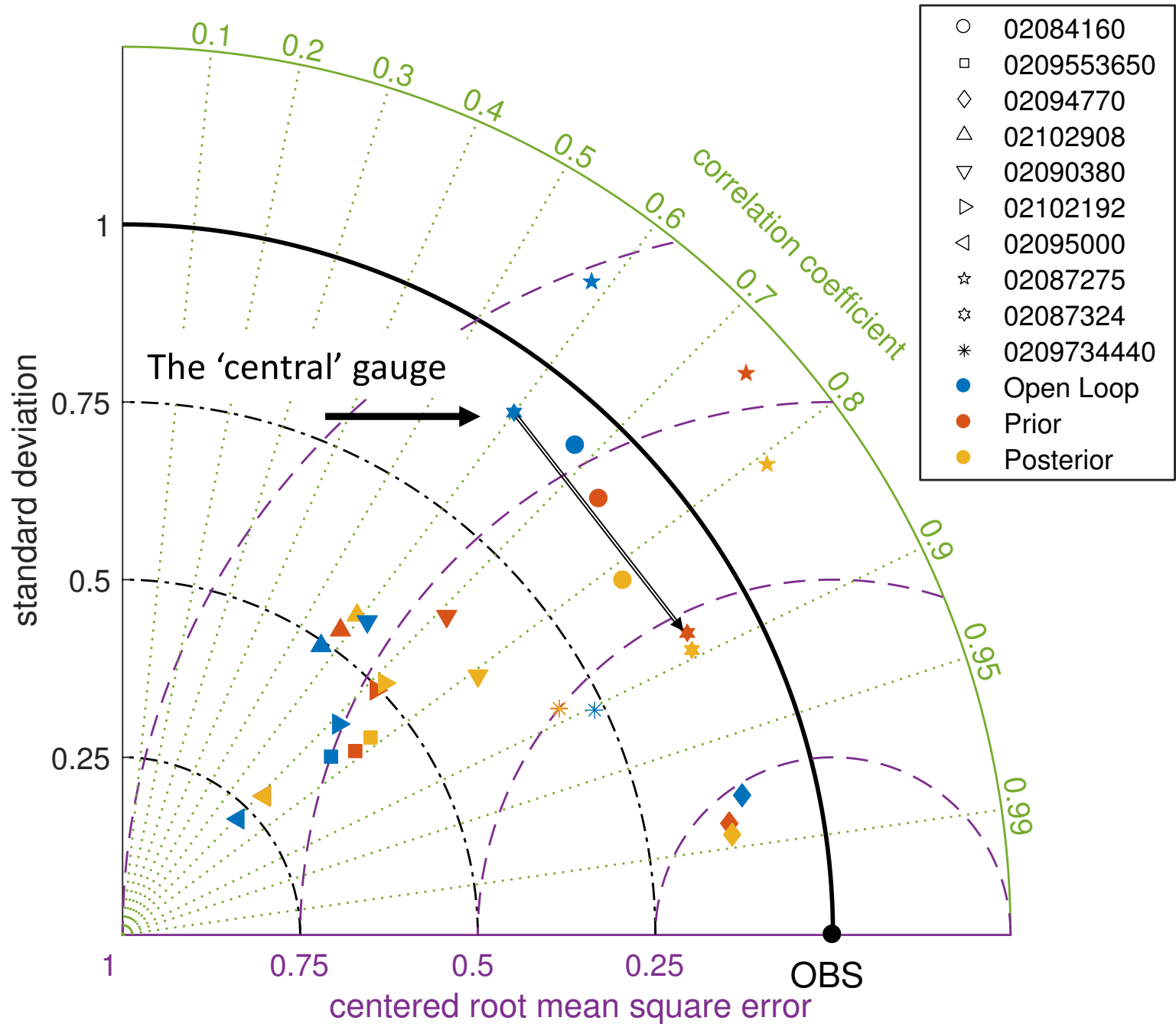
## Ensemble Spread and Inflation Time-Series at Gauge: ID 02087324 (-78.61, 35.81)



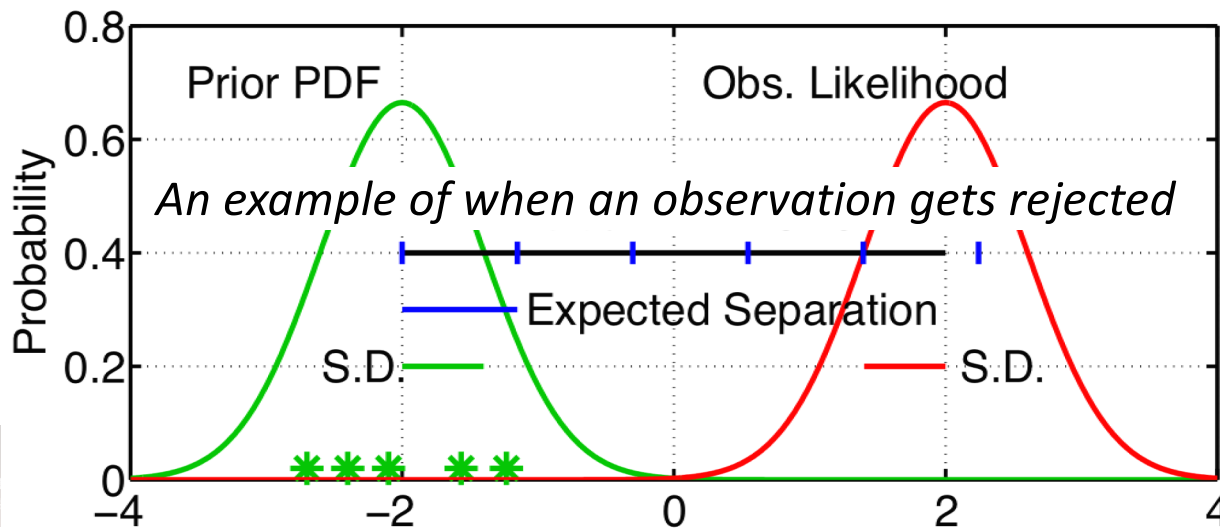
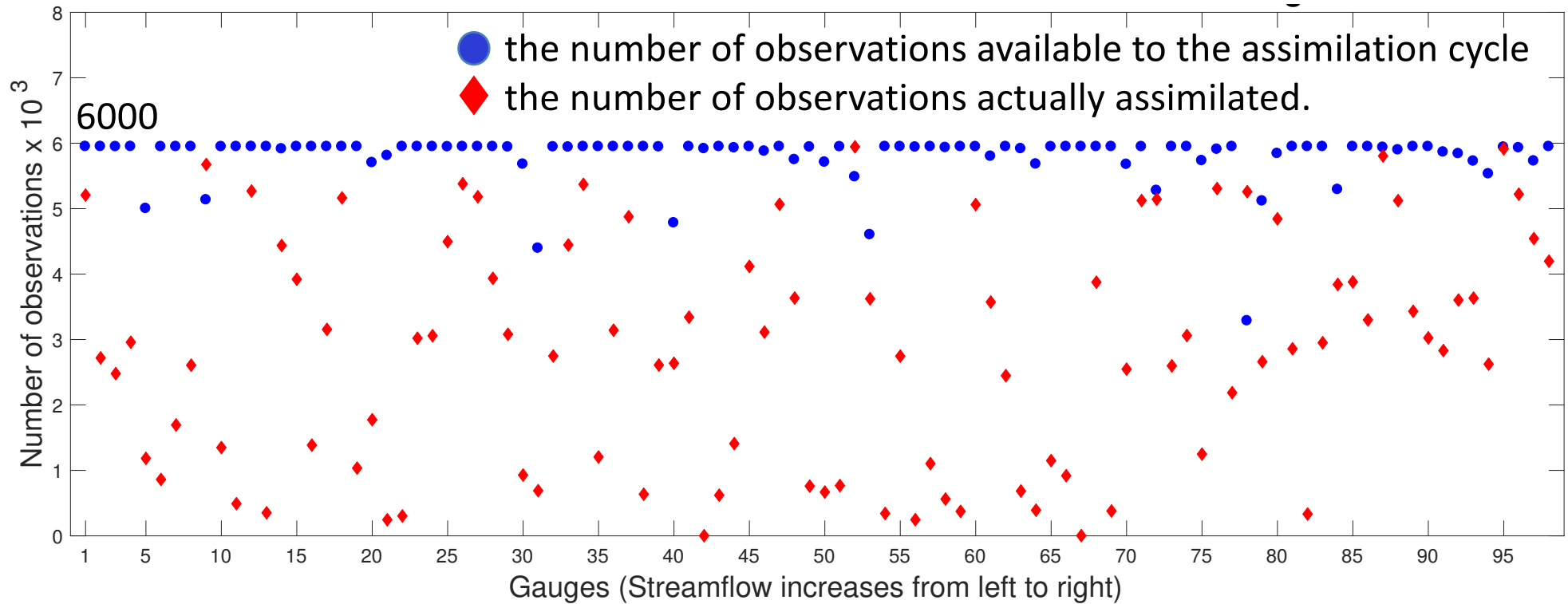
# Gauge 02105769 ... downstream



# 10 gauges from the middle of the domain



# Observation Rejection is (*currently*) a problem.



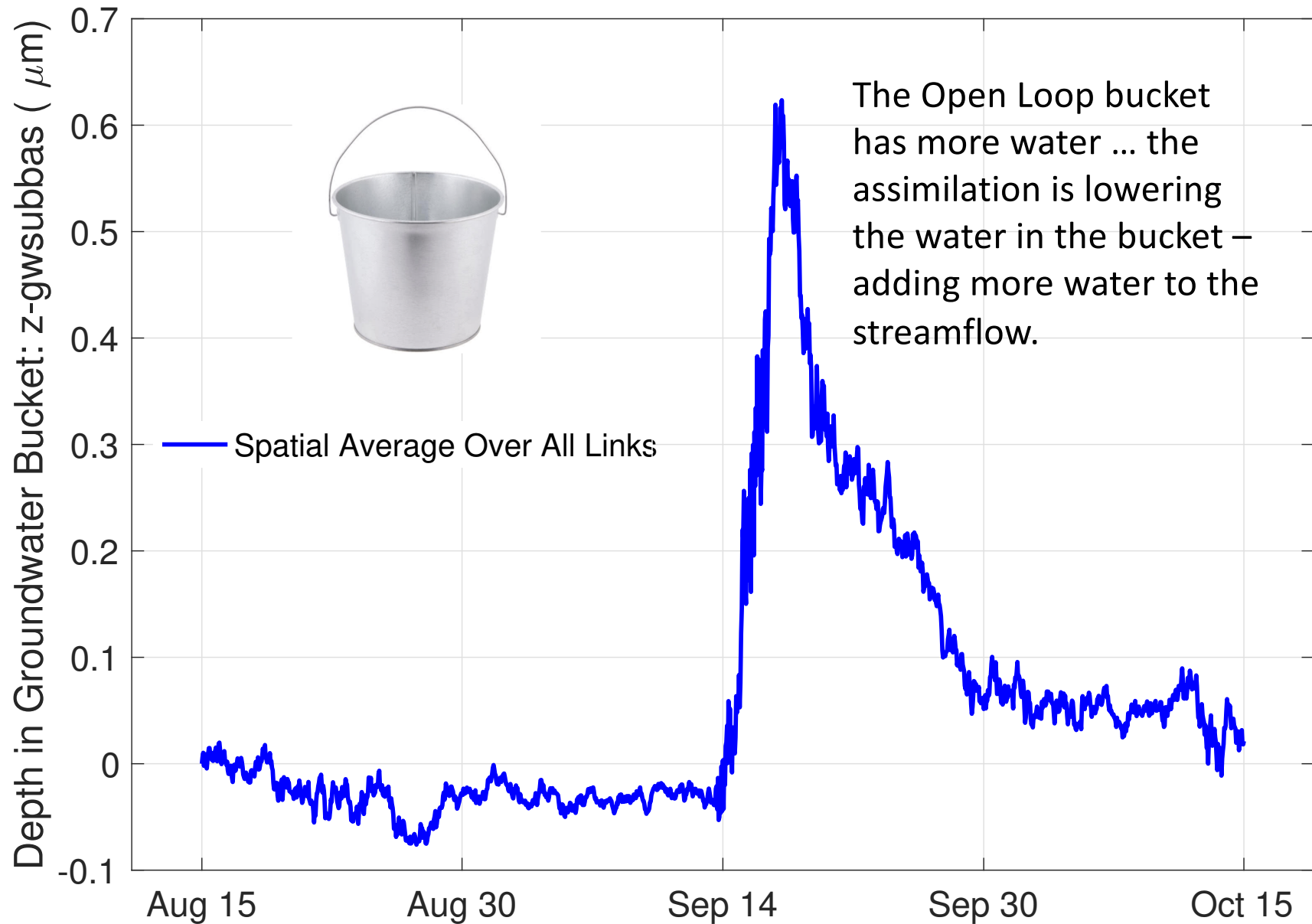
The observation error variance  $\sigma_{obs}$  is key, and is being explored.

$$\sigma_{obs} = \max[\sigma_{min}, \mathcal{N}(0, 0.2x)]$$

$$\sigma_{min} = 0.2 \text{ cms}$$

$$x = \text{streamflow}$$

# Open Loop – Prior Mean



# For more information:

*CAM*      *GCOM*      *CAM-Chem*      *PBL\_1d*      *ROMS*      *NOAH-MP*  
*GITM*              *WRF-Hydro*              *CICE*              *WACCM*

*CLM*

*AM2*

*SQG*



*POP*

*BGRID*

*COAMPS*

[www.image.ucar.edu/DAReS/DART](http://www.image.ucar.edu/DAReS/DART)

*WRF*

*MITgcm\_ocean*

[dart@ucar.edu](mailto:dart@ucar.edu)

*MPAS\_ATM*

*NCOMMAS*

*WACCM-X*

*MPAS\_OCN*

*TIEGCM*

*COAMPS\_nest*

*WRF-Chem*

*NAAPS*

*PE2LYR*

*CABLE*

*CM1*