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

Observations combined with a Model forecast...

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

This is all deterministic. There is no uncertainty.
WRF-Hydro & DART ... HydroDART

Channel-Bucket-Only

USGS Streamflow Obs

* EAKF
* Enhanced Inflation (El Gharamti, 2018)

Python environment

github.com/NCAR/wrf_hydro_py.git
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

20+” of rain

Local point maximum rainfall may be higher than shown. See the NHC public advisories for the latest tropical cyclone information.
More than 50,000 links, about 100 gauges

Localization occurs along the reaches, not just based on horizontal distance. Upstream & Downstream.

Exploded view to show detail

100 km localization distance is used here for visualization only.
Time-Averaged Streamflow: Open Loop Mean

Average of 15 August to 15 October

Streamflow (cms) is M^3/s
Average of 15 August to 15 October

1488 hourly assimilation cycles
80 members

This is the only reach where we removed water!
Streamflow & Precipitation Time-Series at Gauge: ID 02087324 (-78.61, 35.81)

- Assimilated Observations
- Rejected Observations
- Forcing engine Precipitation
- Open Loop: Time-Avg RMSE = 10.6 cms
- Prior Mean: Time-Avg RMSE = 4.3 cms
- Posterior Mean: Time-Avg RMSE = 3.9 cms

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

- Open Loop Spread, Time-Avg = 0.0 cms
- Prior Spread, Time-Avg = 0.6 cms
- Posterior Spread, Time-Avg = 0.3 cms
- Inflation Mean, Time-Avg = 1.1
Gauge 02105769 ... downstream

Stream flow (cms)

Precipitation (mm/hr)

Assimilated Observations
Rejected Observations
Forcing engine Precipitation
Open Loop: Time-Avg RMSE= 344.9 cms
Prior Mean: Time-Avg RMSE= 545.9 cms
Posterior Mean: Time-Avg RMSE= 544.9 cms

Ensemble Spread and Inflation Time-Series at Gauge: ID 02105769 (-78.31, 34.41)

Open Loop Spread, Time-Avg= 0.2 cms
Prior Spread, Time-Avg= 4.6 cms
Posterior Spread, Time-Avg= 4.5 cms
Inflation Mean, Time-Avg= 1.0
10 gauges from the middle of the domain

The 'central' gauge
Observation Rejection is (currently) a problem.

The number of observations available to the assimilation cycle

- the number of observations actually assimilated.

An example of when an observation gets rejected

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

\[ \sigma_{\min} = 0.2 \text{ cms} \]

\[ x = \text{streamflow} \]
The Open Loop bucket has more water ... the assimilation is lowering the water in the bucket – adding more water to the streamflow.
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