Operational Hydrologic-Hydraulic-Coastal Ensemble Prediction System in Urban Watersheds: Runoff and Combined Sewer Overflow (CSO) Forecasts in the City of Hoboken, New Jersey

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Integrated Prediction Framework

- Operational and fully automated on the Pharos (lighthouse) supercomputer (1,320 cores).
- 72 hours forecast horizon.
- 4 forecast cycles per day.
- 125 ensemble members.

(Saleh et al., 2016; Blumberg et al., 2015; Georgas et al., 2014)
Stevens Northwest Atlantic Prediction (SNAP) model domain, the NYHOPS 3D 125-member Ensemble linked to offshore SNAP & HYDRO-river ensembles.
Stevens Flood Advisory System

www.stevens.edu/SFAS
River Discharge Forecasts
Operational NYHOPS

For this event and At this station

- AHPS
- ECMWF ENS Control
- GEFS Control
- SREF NMB Control
- ECMWF D & SREF ARW
- Median HYDRO NYHOPS
- GFS Deterministic

Station ID: 1367500

Rondout Creek at Rosendale, NY
Drainage area = 383 m²

Minor flood level

Observed  AHPS  Median

Time

Water-Level (ft NAVD88)

Dec 23 12:00  Dec 24 00:00  Dec 24 12:00  Dec 25 00:00  Dec 25 12:00  Dec 26 00:00  Dec 26 12:00  Dec 27 00:00  Dec 27 12:00  Dec 28 00:00  Dec 28 12:00  Dec 29 00:00  Dec 29 12:00

0  5  10  15  20  25  30  35  40  45  50

0  0.5  1.0  1.5  2.0  2.5  3.0  3.5  4.0  4.5  5.0  5.5  6.0
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The City of Hoboken

- Population density of 15,140/km², increased by 30% between 2000 and 2010.
- 94% impervious coverage.
- Vulnerable to storm surges and frequent flash floods and back water flow.
- Combined sewer overflow.
- Sea level rise.
- Hurricane Irene & Sandy damage.
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Local Scale Application in Hoboken

- Rainfall‐runoff processes.
- Dual drainage system represented by the street network, junctions and pipes.
- Full dynamic wave equations [backwater effects, pressurized flow, flow reversal].

http://www.hobokennj.org
Local Scale Application in Hoboken

Boundary conditions

Meteorological Component

- Three-dimensional Coupled Ocean/Atmosphere Mesoscale Prediction System (COAMPS®), Naval Research Laboratory (Hodur, 1997).
- Urban Canopy Parameterization.
- 5 nests with horizontal resolutions of 27, 9, 3, 1 and 0.333 km (Pullen et al., 2003; Pullen et al., 2015).

http://www.nrlmry.navy.mil/coamps-web/web/home
Local Scale Application in Hoboken

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Local Scale Application in Hoboken

Boundary conditions

Coastal Component

New York Harbor Observing and Prediction System (NYHOPS)
Local Scale Application in Hoboken

[Retrospective forecast of Hurricane Irene issued on August 25, 2011 at 6:00 pm]

Boundary Conditions

- COAMPS Precipitation
- NYHOPS Water Level

Water Elevation Profile: Node H5-MO-792 - H5-MO-816

Street
Pipe
Local Scale Application in Hoboken

[Retrospective forecast of Hurricane Irene issued on August 25, 2011 at 6:00 pm]

Boundary Conditions

**COAMPS Precipitation**

**NYHOPS Water Level**

Water Elevation Profile: Node H5-MO-792 - H5-MO-816

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Pipe
Local Scale Application in Hoboken

[Retrospective forecast of Hurricane Irene issued on August 25, 2011 at 6:00 pm]
Local Scale Application in Hoboken

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[SWMM2GE module]
Local Scale Application in Hoboken

[Retrospective forecast of Hurricane Irene]
Local Scale Application in Hoboken

[Retrospective forecast of Hurricane Irene]
Operational Hydrologic-Hydraulic-Coastal Ensemble Prediction System

Coastal Component

<table>
<thead>
<tr>
<th>Meteorological Forcing</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Ensemble members</td>
<td>(21)</td>
</tr>
<tr>
<td>GEFS</td>
<td>(51)</td>
</tr>
<tr>
<td>ECMWF</td>
<td>(26)</td>
</tr>
<tr>
<td>Deterministic members</td>
<td></td>
</tr>
<tr>
<td>NAMx2,GFS(+e),ECMWF.</td>
<td></td>
</tr>
</tbody>
</table>

- 2016-01-10 Flood Event was Predicted 3 days in advance.
- Ensemble usually envelopes the observations well
Operational Hydrologic-Hydraulic-Coastal Ensemble Prediction System

Example of Precipitation Ensemble Members used as inputs to the framework
Operational Hydrologic-Hydraulic-Coastal Ensemble Prediction System

Example of Precipitation Ensemble Members used as inputs to the framework:

- CMC (21)
- GEFS (21)
- SREF (26)
- ECMWF (51)

Observed
Precipitation from 125 Ensemble Members
Operational Hydrologic-Hydraulic Ensemble Prediction System

Runoff Forecasts in the City of Hoboken, NJ
Summary & Perspectives


• City of Hoboken Retrospective forecast of Hurricane Irene.

• Monitoring CSO sensors.

• Spread in precipitation inputs and data assimilation.

• Ensemble post-processing techniques.

• Interesting perspectives for efforts focused on integrating the stormwater best management practices, water quality and climate change scenarios.

• Potential of linking traffic flow models to predict potential traffic delays and congestion problems.
Weather and Climate Ensembles for Hydrologic Forecasting and Scenario Analysis

Merci pour votre attention

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2016 HEPEX Workshop - Ensemble for Better Hydrological Forecasts - 6-8 June 2016, Québec, Canada