Summary of COASTAL Act Activities

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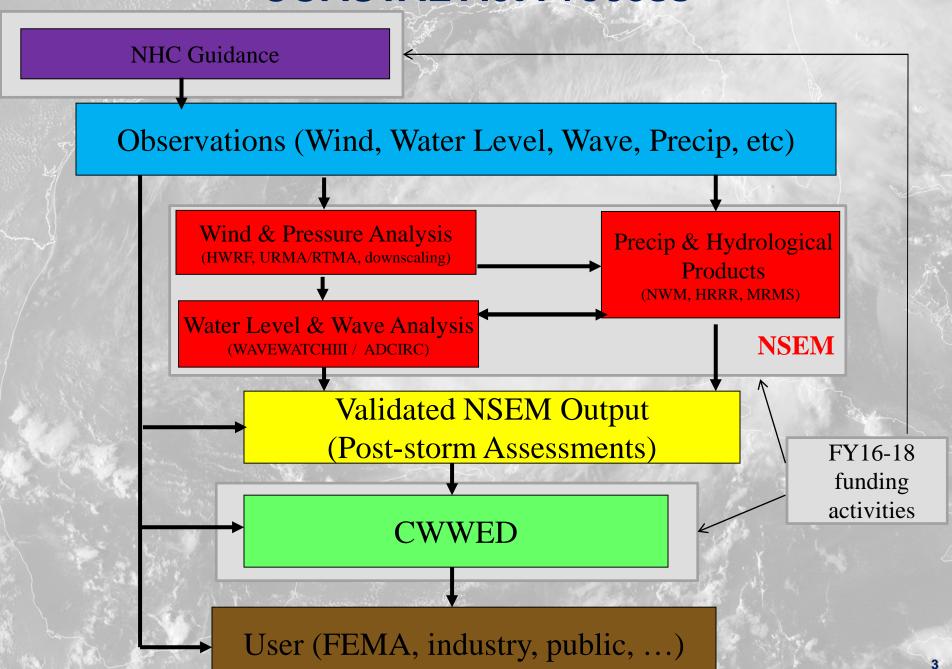**Nicole P. Kurkowski (NWS)**
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Overview

- COASTAL Act Process
- Status of FY16-18-Funded COASTAL Act Activities and Timeline
- Accomplishments
- Next steps (6-months)
- CWWED GWS Demonstration

COASTAL Act Process

COASTAL Act NSEM/CWWED Timeline

	FY16		FY17						FY18				FY19				FY20				FY21			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
#1 - CWWED			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛
#2 - DEMS			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	⬛	⬛	⬛	⬛				
#3 - WW3-ADCIRC			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛
#4 - WW3			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩												
#5 - ADCIRC Grid									🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟥						
#6 - ADCIRC Validation			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥				
#7 - URMA/RTMA								🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛
#8 - HWRF			🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛
#9 - Wind Downscaling						🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	🟥	🟥						
#10 - NWM Coupling								🟩	🟩	🟩	🟩	🟩	🟥	🟥	🟥	🟥	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛
#11 - NWM - Precip/Meso											🟩	🟩	🟥	🟥	🟥	🟥	⬛	⬛	⬛	⬛	⬛	⬛	⬛	⬛
#12 - Infrastructure												🟩	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥				

🟩 Completed
🟥 Planned
⬛ Future Funding Required

With FY16-18 funding, approximately 60% of the NSEM will be developed.

With consistent, full FY19 and FY20 funding, the NSEM and CWWED will be completed in 2021.

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Status of FY16-18-Funded COASTAL Act Activities

Twelve (12) sub-projects were designated for developing individual components of the NSEM and CWWED using the funding in the FY16 - 18 CJS:

Sub-Project 1: Develop certified CWWED, by completing the federated CWWED core, linking the CWWED to the NSEM, completing agreements for archiving NSEM output and with all Covered Data providers, establishing linkages to data (enabling FEMA to access the CWWED). Develop GIS-based web mapping service (GWS). Status: CWWED v1.0 is now operating. Data agreements with covered data providers have been established. GIS-based Web Services (GWS) interface has been developed to seamlessly integrate with the CWWED. A connection between the CWWED covered data and NSEM has been established. Users are able to access available covered data and NSEM output via the GWS interface in the development environment.

Sub-Projects 2-11: Develop components necessary to establish the NSEM (see next slides)

Sub-Project 12: **NHC guidance necessary for placement of observations, etc** (see next slides)

Status of FY16-18-Funded COASTAL Act Activities (cont'd)

NSEM: Storm Surge & Waves

Sub-Project 2: Development of improved and updated seamless digital elevation models (**DEMs**), used in retrospective hurricane and storm surge models.

Status: DEMs for NJ/DE, North Carolina, and East Coast of Florida have been completed.

Sub-Project 3: Coupling of wave (WAVEWATCH III – WW3) and storm surge (ADCIRC) models.

Status: The two-way coupled ADCIRC-WAVEWATCH III modeling system continues to be tested and validated for multiple storms, including hindcasts for Hurricanes Ike, Isabel, Andrew, Sandy, and Irene. Additional validation is needed to address any model instabilities or issues that may arise. The 2017 and 2018 tropical cyclones will now be included in the validations and hence the team is working on restructuring the prioritized list of storms.

Status of FY16-18-Funded COASTAL Act Activities (cont'd)

NSEM: Storm Surge & Waves (cont'd)

Sub-Project 4: Testing with **improved scalability of WW3 for very high resolution domains** to develop accurate simulations of total inundation.

Status: Implicit scheme solver and domain decomposition have been completed for high resolution WW3 execution in the nearshore. The code has been validated and merged into the official repository. Memory improvement for large grids to resolve high resolution models is underway.

Sub-Project 5: Develop updated surge/wave grid along the Atlantic and Gulf Coasts by refining to nearshore and overland regions, updating levees and structures, incorporating latest bathymetry/topography.

Status: The NJ/DE DEM has been integrated into the Hurricane Surge On-Demand Forecast System (HSOFS) grid and validated. Additional DEM integrations are underway.

Sub-Project 6: Validation studies on high-resolution inundation grids; collection of water level and accurate wind data; skill assessment techniques will be employed for hurricane hindcast simulations; testing/revising of storm surge model; resolution requirements analysis.

Status: Coupled hindcasts for Hurricanes Ike, Isabel, Andrew, Sandy, and Irene have been conducted. Additional validation is underway.

Status of FY16-18-Funded COASTAL Act Activities (cont'd)

NSEM: Wind & Surface Pressure Analyses

Sub-Project 7: Provide consistent starting point for NSEM **wind analysis** using URMA (2.5km) and HWRF (2km) **high-resolution reanalyses and reforecasts**. Status: High-resolution HWRF retrospectives have been executed with multiple configurations for Hurricanes Ike, Isabel, Andrew, Sandy, and Irene. Additional retrospectives are being generated with an updated HWRF land/sea mask.

Sub-Project 8: Generate 1 and 2.5 km wind and surface pressure analysis datasets, using observations of wind, surface pressure, air-sea temperature (HWRF used as best-estimate), along with highest topography and land surface datasets. Create interface for HWRF gridded background field to be fed into URMA. Prototype wind, gust, surface pressure and air-sea analyses for use by wave and surge model input.. Status: Wind and surface pressure analyses have been generated for multiple storms. The interface between HWRF background fields and URMA/RTMA has been completed.

Sub-Project 9: Investigate development of **wind downscaling** technique. Status: Continued validation and testing underway for multiple storms. A full end-to-end high resolution wind analysis / downscaling (HWRF - URMA/RTMA - downscaling) interface has been demonstrated.

Status of FY16-18-Funded COASTAL Act Activities (cont'd)

NSEM: Hydrological Products

Sub-Project 10: Develop model infrastructure to **couple freshwater** (NWM) **and coasta**l (ADCIRC) processes for named storm event simulation.
Status: The NWM has been piloted in the Delaware Bay / River basin utilizing the Extratropical Surge and Tide Operational Forecast System (ESTOFS) boundary conditions. The coupled (NWM-ESTOFS) system will be developed over the next year. NEMS/NUOPC infrastructure training occurred in Oct 2018 to assist the Office of Water Prediction (OWP) in initiating the development of a NEMS/NUOPC cap for the National Water Model to be compatible with that of ADCIRC.

Sub-Project 11: Generate high resolution observed and modeled precipitation data for future incorporation into the NWM. Status: 15-min MRMS QPE product has been completed. The15-min precipitation accumulation in the HRRR model is underway.

Status of FY16-18-Funded COASTAL Act Activities (cont'd)

Model Guidance / Infrastructure

Sub-Project 12: NHC guidance necessary to better inform placement of observations, with longer lead times and greater accuracy. Status: Planning underway to extend storm surge guidance lead time from 48 to 72 hours, improve accuracy (location and depth), and extend spatial coverage to better enable inter-agency partners (e.g. USGS) in a timely placement of observations (e.g. storm-tide sensors, gauges) with spatial accuracy. Storm surge model optimization work is nearly complete. Hiring of storm surge/wave developers is underway.

Note: The **NSEM** will be approximately 60% developed once Sub-Projects 2-10 have been completed (FY16-18 funding).

With consistent, full FY19 and FY20 funding, the NSEM and CWWED will be completed in 2021.

Accomplishments

- **2019 AMS Annual Meeting** (Phoenix, AZ) "17th Symposium on the Coastal Environment - Session 2" accepted: 6 COASTAL Act presentations will be featured

- **CWWED v1.0** is now operating. **GWS interface** developed and available in dev environment

- **DEM**s generated for NJ/DE, North Carolina, and East Coast of Florida

- High resolution **WW3** code has been validated and checked into official repository

- NJ/DE DEM has been integrated into **HSOFS grid**

- **HWRF land/sea mask** updated to resolve high resolution features

- **Interface** between HWRF background fields and **URMA/RTMA** completed

- **End-to-end** high resolution **wind analysis / downscaling** (HWRF – URMA/RTMA – downscaling) interface demonstrated

- 15-min **MRMS** QPE product completed.

https://www.weather.gov/sti/coastalact

Next Steps (6 months)

- 2018 AGU Fall Meeting (Washington DC) – 2 presentations; 1 poster
- AMS 2019 (Phoenix, AZ) 17th Symposium on the Coastal Environment Session #2 (6 presentations)
- Feb 20-21 Annual COASTAL Act Meeting (College Park, MD)
- Advance internal policy directives
- Coordination with FEMA on formula, 90% accuracy requirements
- Anticipated progress on sub-projects:
  - **#1 (CWWED) –** Continue to test and revise beta version of GWS. Continue to build protocols to covered datasets as they become available.
  - **#2 (DEMS) –** Continue development on DEMs in targeted areas (e.g. Puerto Rico, Virgin Islands and SE Atlantic)
  - **#3 (WW3-ADCIRC) –** Coupled validation studies on high-resolution inundation grids. Complete testing for multiple storms.

Next Steps (6 months) (cont'd)

o **#4 (WW3) –** Complete memory analysis and initial conversion from global to local arrays toward memory optimization.

o **#5/6 (ADCIRC) –** Coupled validation studies on high-resolution inundation grids. Complete simulations for multiple storms.

o **#7 (URMA/RTMA) –** Complete full analysis for multiple hurricanes.

o **#8 (HWRF) –**Continue work on retrospective storms.

o **#9 (downscaling) –**Generate time history of mean winds and gusts for multiple hurricanes. Develop automated interface between wind downscaling and WW3-ADCIRC component of NSEM.

o **#10 (NWM) –** Demonstrate regional NWM mesh, driven by ADCIRC boundary conditions. Initiate work on coupled NWM-ADCIRC infrastructure.

o **#11 (Precip) –**15-min MRMS accumulation product implemented in operational MRMS v12 build.

o **#12 (Infrastructure)** – Hire developers. Complete surge model optimization.

Thank you!

Two-day, **Annual COASTAL Act Meeting**
(February 2018; College Park, MD)

CWWED GWS Demonstration

Background Slides

Acronyms

- ADCIRC – Advanced CIRCulation model – high resolution storm surge prediction model
- CWWED – Coastal Wind and Water Event Database
- DEM – Digital Elevation Model
- ESRL - Earth System Research Laboratory
- ESTOFS – ADCIRC-based Extratropical Surge and Tide Operational Forecast System
- HRRR – High-Resolution Rapid Refresh
- HWRF – Hurricane Weather Research Forecast model
- MRMS – Multi-Radar/Multi-Sensor System
- NSEM – National Storm Event Model
- NSSL – National Severe Storms Laboratory
- NWM – National Water Model
- OAR – Oceanic and Atmospheric Research
- QPE – Quantitative Precipitation Estimation
- URMA – Unrestricted Mesoscale Analysis
- USGS - US Geological Survey
- WW3 – Wave Watch III model

Background

- On July 6, 2012, the President signed Biggerts-Waters Flood Insurance Reform Act, which incorporated legislation known as the **Consumer Option for an Alternative System to Allocate Losses (COASTAL) Act.**

- COASTAL Act intends to help FEMA determine the extent to which wind vs. water damage in cases of "indeterminate losses" (or "slab cases").

- A loss is indeterminate when little tangible evidence beyond a building's foundation remains for the proper adjustment of insurance claims for homes totally destroyed by a tropical system (water damage is covered by NFIP; wind damage is covered by private insurers).

- This will enable a more timely claims adjustment process, by avoiding litigation over the cause of the damage.

Background

- The COASTAL Act requires NOAA to produce detailed "post-storm assessments" following certain named tropical systems that impact the U.S. and its territories.

  - The assessments will be produced using a new NOAA hindcast model that indicates the strength and timing of damaging winds and water at a given location in the impact area.

  - The assessments must be submitted to FEMA within 90 days after DHS and NOAA deem a storm "reasonably constitutes a threat."

  - NOAA is required to make post-storm assessment results and obs from the storm available to the public via a new online database.

- The post-storm assessment output (assuming it meets 90% accuracy at the location in question) will then be incorporated in the COASTAL Formula (managed by FEMA). The formula will consider other non-geophysical data (e.g. structure data) to determine the extent to which water vs. wind contributed to the destruction (thereby determining the cost responsibility between NFIP and private home insurers).

Coastal Wind and Water Event Database (CWWED)

- NOAA established Version 0.1 of the CWWED in July 2013, per the Act's requirements. It will be repository for the storm observations ("covered data") used in the NSEM.

- CWWED will transition from prototype to experimental status upon the completion of the NSEM.

- CWWED will also be the platform for retrieving post-storm assessment results (produced by the NSEM) for a given location in the area covered by the NSEM.

- Quality Control will be <u>critical</u>, given the application of data for legal purposes. Therefore, CWWED will be a "federated database" in which data may or may not reside at the same physical location as the database core server (i.e. in most instances the database will operate by pointing to data in other databases).

- Will require data sharing and dissemination agreements with external partners in some cases.

Named Storm Event Model (NSEM)

- NSEM will be collection of separate, but interdependent, model products that provide time-dependent analyses of specific meteorological and hydrologic factors that contribute to indeterminate losses.

- The three main model product areas will be:
  - Storm Surge / Waves
  - Wind and Surface Pressure Analyses
  - Precipitation and Hydrologic Development

Post-Storm Assessment Package

- Post-Storms Assessments will be in the form of gridded spatial and temporal output from the NSEM, which will include verification info for specific points on land within the realm of the assessment area.

- The Assessment Data will be accessed via the CWWED.

- FEMA will be able to access the point-specific info for the purposes of inputting values into the COASTAL Formula for determining the cause(s) of damage for the indeterminate loss in question.

- NOAA developed a CONOPS that establishes realistic and cost-efficient activation procedures and timelines for Post-Storm Assessments.

NOAA Deliverables

- Jan 2, 2013: NOAA (OFCM) must identify all Federal, state, private and academic efforts and systems capable of collecting "covered data." *COMPLETED*

- April 2, 2013: NOAA (OFCM) must send to Congress a plan for the collection of covered data, including a gap assessment of data systems and coverage. *COMPLETED IN APRIL 2013; STILL AWAITING ADMINISTRATION CLEARANCE*

- **July 6, 2013: NOAA shall establish a database for the collection and compilation of covered data (the *Coastal Wind and Water Event Database*). *ESTABLISHED IN JULY 2013, BUT STILL IN DEVELOPMENT***

- **December 28, 2013: NOAA must "develop by regulation" the *Named Storm Event Model*. *IN DEVELOPMENT***

- December 28, 2013: NOAA must establish the protocol for collecting covered data. *INTERAGENCY PROTOCOL COMPLETE; INTERNAL NWS PROTOCOL IN DEVELOPMENT*

Data Collection Protocol

- Data collection protocol was required to be established by Dec. 28, 2013. NOAA met this deadline.

- NOAA wrote the protocol as an annex to the National Plan for Disaster Impact Assessments: Weather and Water Data (NPDIA), FCM-P33-2010.

- NPDIA is an interagency document spearheaded by OFCM in 2010, which provides specific guidance for interagency response to weather and water related disaster impacts.

- NWS will issue an internal Directive that governs the activation of the data collection and assessment processes, as well as funding.

Agency Responsibilities

- NOAA Deliverables:
  - Data collection plan (the *COASTAL Act Capabilities Development Plan* or CACDP)
  - Data collection protocol
  - Coastal Wind and Water Event Database (CWWED)
  - Named Storm Event Model (NSEM)
- GAO must audit NOAA's data collection efforts, including the cost-effectiveness of the approach
- FEMA must develop the COASTAL Formula and NAS will evaluate the formula's effectiveness.

CWWED Expected Users

- FEMA analysts and claim adjusters, who are accessing the post-storm assessment results for incorporation into the COASTAL Formula.

- Modelers and researcher from the insurance, risk-analysis and academic communities to access the database with the intent of retrieving data for development of their own models.

- General public, including homeowners (or their attorneys) facing storm damage claims of all sorts (not just indeterminate losses).

Interagency Coordination

- Joint Action Group for the COASTAL Act Post-Storm Analysis (JAG/CAPSA)

  - Sept. 2012: OFCM established JAG/CAPSA to meet the interagency coordination requirements of the Act.

  - Subordinate to Interdepartmental Committee for Meteorological Services and Supporting Research (ICMSSR).

  - Co-chaired by NOAA, USACE and USGS.

  - NIST, USDA, NASA, FEMA, and the Digital Hurricane Consortium have also participated in JAG/CAPSA as either members or technical advisors.

- JAG/CAPSA took lead on taking inventory of available data and systems. JAG/CAPSA also worked with WGPDIA and NOAA in drafting the interagency data collection protocol.

General Challenges Still Remain

- **Observations**
  - Surface observation density not high enough to support wind analyses at high accuracy
  - Water level observation network also insufficiently dense
  - Mobile sensor network may not be sufficient
  - Durability of sensors in the most destructive hurricanes uncertain
- **Response capability**
  - NOAA and interagency partners currently unable to meet statutory requirements for COASTAL Act response operations, including several timelines/deadlines
  - Implementation would be enhanced with option for state-by-state assessments and more flexible triggers and decision points