From Observations to Service Delivery: Challenges and Opportunities in Maritime Weather

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Bottom Lines (up front)

• Experienced forecasters issue warnings and forecasts, and relates their impacts. Forecast models produce guidance.
• Observations are critical inputs to the weather forecast process.
• Fully coupled models should lead to improved maritime forecasts. Closer interaction among the ocean/weather and research/operational communities are keys to success.
• Product and service delivery to ships at sea must be modernized!
Global Commerce is Maritime Commerce!

Goods valued at US$13 trillion & 2 billion passengers per year travel at sea!

Source of 2014 total ship tracks and background: marinetrack.com
Marine Extratropical Cyclones

80+ hurricane force events/year in the NH!

**TOP:** heat map of total distribution of hurricane force low centers and hurricane force wind events (i.e., Greenland tip jets with no associated low center) for the winter season 2016/17.

**RIGHT:** bar chart comparison of hurricane force wind events between each ocean basin for the previous two winter seasons and multi-year average.

WWW.OPC.NCEP.NOAA.GOV
TWITTER.COM/NWSOPC
FACEBOOK.COM/NWSOPC
Maritime Extreme Weather
Ships at risk in the 21st Century

Sinking of US Cargo Vessel SS El Faro
Atlantic Ocean, Northeast of Acklins and Crooked Island,
Bahamas
October 1, 2015

Accident Report
NTSB/MAR-17/01
PB2018-100342

Maritime Transportation
Extreme Weather Task Force:
A Report to Congress
February 2018
Overview

1. What is “Weather Ready”?

2. Can we be *Maritime* “Weather Ready”?

3. How can we strengthen our *global* maritime weather enterprise?
   – Observations
   – Forecasting
   – Dissemination
NWS Strategic Outcome: A Weather- and Water-Ready Nation

“Ready, Responsive, Resilient”

Becoming a Weather-Ready Nation is about building community resiliency in the face of increasing vulnerability to extreme weather, water and climate events

Better forecasts and warnings
Consistent products and services
Actionable environmental intelligence
Connecting forecasts to decisions

Involves the entire US Weather, Water and Climate Enterprise WORKING TOGETHER
Impact-based Decision Support Services

Generating forecasts and warnings + Connecting those forecasts/warnings with impacts = IDSS

Forecast and Warning Products

Forecaster relationships

Impact-based Decision Support Services
Achieving a *Maritime Weather Ready Nation*

To prevent loss of lives and property at sea and enhance the economy:

- **Strengthen core partnerships:**
  - US Coast Guard
  - Shipping industries
  - Private sector weather providers

- **Extend range of maritime forecasts beyond 4 days by optimizing:**
  - Observations (*in situ* and satellite)
  - Model predictions (earth system prediction capability)
  - Forecasts (and *forecasters*)
  - Dissemination/distribution to ships
    - Prepare to move past WEFAX

- **Integrate services:**
  - Arctic: wind/wave/ice
  - Inundation: topo/hydro/bathy/ocean/weather
Surface Analysis
Wind/Wave Analysis

WIND / WAVE ANALYSIS (FEET)
ISSUED: 00:57 UTC 31 MAY 2018
VALID: 00:00 UTC 31 MAY 2018
FCSTR: MILLS

SIGNIFICANT WAVE HEIGHT IS SHOWN (THE AVERAGE HEIGHT OF THE HIGHEST ONE THIRD OF THE WAVES)

SOURCE: NHC

NOAA NCEP - Ocean Prediction Center
ocean.weather.gov
96-Hour Surface Forecast
96-Hour Wind/Wave Forecast

96-HR WIND & WAVE FCST (METERS)
ISSUED: 17:05 UTC 30 MAY 2018
VALID: 12:00 UTC 03 JUN 2018
FCSTR: SHAN

SIGNIFICANT WAVE HEIGHT IS SHOWN [THE AVERAGE HEIGHT OF THE HIGHEST ONE-THIRD OF THE WAVES]

NWS/NCEP - Ocean Prediction Center
ocean.weather.gov
HIGH SEAS FORECAST FOR METAREA IV
NWS OCEAN PREDICTION CENTER WASHINGTON DC
2330 UTC WED MAY 30 2018

CODDE: 31:04:01:00:40/4/A0E/NIW/CCODE
SUPERSEDED BY NEXT ISSUANCE IN 6 HOURS

SEAS GIVEN AS SIGNIFICANT WAVE HEIGHT...WHICH IS THE AVERAGE
HEIGHT OF THE HIGHEST 1/3 OF THE WAVES. INDIVIDUAL WAVES MAY
BE MORE THAN TWICE THE SIGNIFICANT WAVE HEIGHT.

SEE ANNOUNCEMENT OF PLANNED INHABITANT 1-3 TO I-4 MIGRATION
IN 2018 AT OCEAN.WEATHER.GOV/GNOSS_NOTICE.PHP (LOWERCASE).

ONLY YOU KNOW THE WEATHER AT YOUR POSITION. REPORT IT TO THE
NATIONAL WEATHER SERVICE. EMAIL US AT
VOSOPS@NOAA.GOV (LOWERCASE).

FOR INFORMATION ON ATLANTIC ICEBERGS SEE INFORMATION FROM
NORTH AMERICAN ICE SERVICE AT HTTPS://OCEAN.WEATHER.GOV/ATL_TAB.SHTML

SECURE
NORTH ATLANTIC NORTH OF 33N TO 67N AND WEST OF 35W

SYNOPSIS VALID 1800 UTC MAY 30,
24 HOUR FORECAST VALID 1800 UTC MAY 31.
48 HOUR FORECAST VALID 1800 UTC JUN 01.

...STORM WARNING...  
LOW 65N62W 1008 MB MOVING SE 10 KT. WITHIN 100 NM W SEMICIRCLE
WINDS 40 TO 50 KT. ALSO WITHIN 400 NM W AND NM
SEMICIRCLES AND BETWEEN 360 NM AND 600 NM NE QUADRANT WINDS 25
to 40 KT. SEAS 8 TO 14 FT. " EXTERIOR LTE 300 NM NE QUADRANT
WINDS 20 TO 30 KT. SEAS 8 TO 14 FT.

24 HOUR FORECAST LOW 63N4W 994 MB, WITHIN 420 NM S AND SW
AND 300 NM QUADRANT WINDS 25 TO 35 KT. SEAS 8 TO 14 FT.

24 HOUR FORECAST LOW 41N14W 997 MB, WITHIN 480 NM SE...420 NM
SW AND 180 NM W QUADRANTS WINDS 25 TO 35 KT. SEAS 8 TO 14 FT.

...STORM WARNING...  
LOW 65N62W 1008 MB MOVING NW 10 KT. OVER ICE FREE WATERS N OF
62N BETWEEN GREENLAND AND 57W WINDS 25 TO 35 KT. SEAS TO 9 FT.
12 HOUR FORECAST LOW 67N64W 994 MB, N OF 60N BETWEEN 50W AND
60W WINDS 25 TO 35 KT. SEAS 8 TO 14 FT.

24 HOUR FORECAST LOW ASSIMILATED AT LOW 67N63N 991 MB, N OF 63N
BETWEEN GREENLAND AND 50W S WINDS 35 TO 50 KT. SEAS 11 TO 21 FT.
" EXTERIOR LTE 600 NM SE QUADRANT WINDS 25 TO 35 KT. SEAS 8 TO
14 FT.  

48 HOUR FORECAST LOW WELL N OF AREA, FROM 60N TO 65W BETWEEN
40W AND 55W S WINDS 25 TO 35 KT. SEAS 8 TO 14 FT. ALSO OF A
LINE FROM 60N64W TO 54N53W WINDS 20 TO 30 KT. SEAS TO 11 FT.

...GALE WARNING...  
LOW 32N75W 1015 MB MOVING E 20 KT. FROM 31N TO 33N BETWEEN 54W
AND 56W WINDS TO 25 KT. SEAS TO 8 FT.

24 HOUR FORECAST LOW 32N61W 1006 MB, FRONT TO EXTEND FROM NEW
LOW 43N62W 1004 MB TO 35N4W TO FIRST LOW. WITHIN 150 NM E OF
THE FRONT N OF 35W WINDS 25 TO 35 KT. SEAS 9 TO 13 FT.
" EXTERIOR LTE THE REGION BOUNDED BY A LINE FROM 45N3W TO 33N3W TO
31N6W TO 35N6W WINDS 20 TO 30 KT. SEAS 11 TO 15 FT.

48 HOUR FORECAST LOW 41N6W 1006 MB, FRONT TO EXTEND FROM THE
LOW TO 36N6W TO 31N4W. """" IN 240 NM NE SEMICIRCLE AND 180 NM
E OF THE FRONT WINDS 25 TO 40 KT. SEAS 9 TO 18 FT.

...SYNOPSIS AND FORECAST.  
LOW 33N62W 1016 MB MOVING SE 15 KT. N OF 31N BETWEEN 150 NM S
SEMICIRCLE WINDS 25 TO 35 KT. SEAS TO 8 FT.

24 HOUR FORECAST LOW 33N3W 1009 MB, EFF A LINE OF AREA AND CONDITIONS DIMINISHED.

24 HOUR FORECAST WITHIN 120 NM E OF A LINE FROM 63N4W TO
64N4W AREA OF S TO SW WINDS 25 TO 35 KT. SEAS LESS THAN 8 FT.

48 HOUR FORECAST WITHIN 120 NM E OF A LINE FROM 64N4W TO
66N4W S TO SW WINDS 20 TO 30 KT. SEAS 11 TO 15 FT.

48 HOUR FORECAST BETWEEN 120 NM S OF A LINE FROM 37N7W TO
34N7W AREA OF SW WINDS 25 TO 35 KT. SEAS LESS THAN 8 FT.

56 community practice runs are possible.  
" NBW 85% OCEAN WEATHER SERVICE
NATIONAL WEATHER SERVICE
...DENISE FOG, VSBY OCCASIONALLY LESS THAN 1 NM WITHIN 180 NM N OF
A LINE FROM 40N5W TO 49N7W TO 47N4W.

24 HOUR FORECAST DENISE FOG BETWEEN 33W AND A LINE FROM 56N5W TO
47N4W.

48 HOUR FORECAST DENISE FOG FROM 55W TO 59W BETWEEN 35W AND
42W...BETWEEN A LINE FROM 61N5W TO 61N4W TO 49N4W AND ANOTHER
LINE FROM 60N5W TO 58N4W TO 45N3W... AND WITHIN 120 NM OF
41N6W.

HIGH 44N4W 1024 MB MOVING SE 15 KT.

24 HOUR FORECAST HIGH 40N4W 1021 MB.

48 HOUR FORECAST 37N 39N 1018 MB.

FORECASTER REINERT, OCEAN PREDICTION CENTER.
NATIONAL HURRICANE CENTER MIAMI FL
ATLANTIC FROM 87N TO 31N W OF 35W INCLUDING CARIBBEAN SEA AND
GULF OF MEXICO
SYNOPSIS VALID 1800 UTC WED MAY 30.
24 HOUR FORECAST VALID 1800 UTC THU MAY 31.
48 HOUR FORECAST VALID 1800 UTC FRI JUN 01.

...WARNING...  
LOW 29N9W 944 MB MOVING E 20 KT. FROM 28N TO 31N BETWEEN 74W AND
76W WINDS 20 TO 25 KT. SEAS LESS THAN 8 FT.

12 HOUR FORECAST WINDS 20 KT OR LESS. SEAS LESS THAN 8 FT.

24 HOUR FORECAST S OF 21N BETWEEN 76W AND 78W WINDS 20 TO 25 KT.
SEAS LESS THAN 8 FT.

36 HOUR FORECAST WINDS 20 KT OR LESS. SEAS LESS THAN 8 FT.

ATLC 06 HOUR FORECAST COLD FRONT ALONG 31N BETWEEN 75N AND 62N.
" NBW 85% OCEAN WEATHER SERVICE
NATIONAL WEATHER SERVICE  
... SYNOPTIC AND FORECAST.
ATLC 06 HOUR FORECAST COLD FRONT ALONG 31N BETWEEN 75N AND 62N.
" NBW 85% OCEAN WEATHER SERVICE
NATIONAL WEATHER SERVICE
Successful Outcome: Avoiding extreme weather

48 hours prior to storm:
- 46 ships in the polygon
- Hurricane Force Wind Warning Issued

During storm:
- Ships heed warnings
- 13 ships in the polygon
Decision Support Services
“March Madness” 2018

Shipping Density
03 Mar 18, 13:30Z

Sector Hampton Roads
Marine Safety Information Bulletin
Commander
United States Coast Guard
Sector Hampton Roads
4000 Coast Guard Blvd
Portsmouth, VA 23703
MSISB Number: 18-648
Date: March 1, 2018
Phone: (757) 668-5580
E-Mail: HamptonRoadsWaterway@uscg.mil

Inclement Winter Weather Advisory
Sector Hampton Roads Port Entrance Closure and Restrictions

Due to the forecasts of storm force winds and heavy seas at the entrance to Chesapeake Bay, the Captain of the Port (COTP) Hampton Roads will be imposing the following restrictions:

- Negotiate at 3 a.m. Friday, March 2, 2018, no vessels may enter or depart from the Chesapeake Bay, and no vessels over 2,000 gross tons may move within the port without obtaining permission from the COTP or his designated representative. These restrictions are anticipated to last until approximately 12 p.m. on Saturday, March 3, 2018, but are subject to adjustment based on conditions.

Vessels under 2,000 gross tons will be permitted to move within the port, but should do so with caution, as high winds and rough seas are expected.
Maritime Weather Observations
Significant Wave Height

JASON-3 Altimeter
28 Mar 16, 14:20-16:21Z
Maritime Weather Observations
Ocean Surface Vector Winds

Bright red indicates 65 kt winds, low-end hurricane force (>63 kt)

Maroon and brown indicate storm force winds, 48 - 63 kt

Yellow and orange indicate gale force winds, 34 - 47 kt
Coastal Storm
Feb 7-8, 2016

96-hr forecast chart issued Thursday afternoon, Feb 4, depict hazardous conditions Sunday and Monday, Feb 7-8:

96-hr forecast issued 3:01 pm EST Thursday, Feb 4, valid Monday, Feb 8, 7:00 am EST

Analysis valid Monday, Feb 8, 7:00 am EST
Coastal Storm
Feb 7-8, 2016
Observations:
Extreme Weather, 7-8 Feb 2016

Ships at sea, as reported via automated information systems, 8 Feb, 00Z:
Observations:
Extreme Weather, 7-8 Feb 2016

Buoys and ships
8 Feb, 00Z:
Observations:
Extreme Weather, 7-8 Feb 2016

Ships only
8 Feb, 00Z:

Two ships are reporting weather
Observations received via Twitter are not distributed via GTS
Observations:
Extreme Weather, 7-8 Feb 2016

METOP ASCAT
8 Feb, 03Z:

Bright red indicates 65 kt winds, low-end hurricane force (>63 kt)

Maroon and brown indicate storm force winds, 48-63 kt

Yellow and orange indicate gale force winds, 34-47 kt
Observations:
Extreme Weather, 7-8 Feb 2016

Nearby buoy (highest recorded wind speeds: 50 kts gusting to 64 kts):

Wave heights increased from 4m to 7m in 1 hour!
Forecasting Challenge
Gulf Stream North Wall Effect

04 Mar 2018, 00Z
GOES-E - SST (2 km)

Jason-2 altimeter
Significant waves
40 - 41.4 ft

Significant Wave height (feet)
Forecasting Challenge
Integrating wind, wave, sea ice, and iceberg information

http://www.natice.noaa.gov
Challenge: Forecasting in the Arctic

Improve Arctic forecasts by integrating wind, wave, and sea ice information
Getting the product to ships at sea:
Sent as a Traditional WEFAX Product...
What the ship should see:
... yet the ship often sees:
... and sometimes sees:
Getting the forecast to ships
S-412 Weather Overlays

Improving safety by linking the authoritative Navigation and Weather pictures
JCOMM Vision for Services and Forecast Systems

• New structure, to reflect evolving requirements of the metocean community
• Enhance the positioning of NMHS as the authoritative voice on national marine services
• Continued focus on safety of life and property in the coastal zones, on the high seas, and in polar regions
  – Improve alignment to support metocean forecasts and maritime safety information
JCOMM Vision for Services (cont’d)

- Build resiliency in maritime service delivery with the identification of marine Global Data Processing and Forecasting System centers and arrangements for their backup
- Provide support and response for marine environmental emergencies
- Increase focus on disaster risk reduction in the coastal and marine environments
New Services & Forecasting Systems
Program Area Structure

SFSPA Chair

Vice Chair
WMO Systems (GDPFS, WIS, GMAS)

Vice Chair
Met-Ocean Services
Regulatory material

Vice Chair
Quality Management, Competency

Vice Chair
IOC Ocean Systems

Oversight of
cost recovery strategies and coordination group

WWMIWS
Committee

ETSI
Routine services to shipping

National Marine Services
Focal Points

ETMEER
Ad hoc services to agencies
For pollution
And emergency response

ETOOFs (Ocean core services)
Marine focused GDPFS Centres.
Oceans (SSHA, ocean circulation etc).
ENSO.

ETDRR
Sendai Framework.
Storm Surges.
Waves.
MHEWS.
Tsunami liaison.
etc

Task Team

Task Team

Task Team

Additional Task Teams may be set up as needed, for specific items
Improving Maritime Weather Services

• How can we strengthen our Global Maritime Weather Enterprise?
  – Communicate
    • Among the metocean and ops/research communities
    • Understand end user requirements and decision processes
    • Develop integrated products and services that meet requirements and help users make optimal decisions
  – More observations, where and when we need them
  – Improve dissemination of products
  – Build partnerships with commercial weather providers and distributors to ensure authoritative hazardous weather warnings are disseminated
Thank you