Coastal Hazards 101
The “Who, What, When, Where and Why” of Coastal Storms

John Cannon,
NOAA/National Weather Service
University of Southern Maine
November, 2017

Long term Scale

Storm Scale

Portland Sea Level

Portland Tide gauge = global ocean over last century 1.8 mm/yr (IPCC, 2007).
In Maine, this is the fastest in past 3000 years.
Satellite altimetry (1993-2003) = global sea level 3.1 ± 0.7 mm/yr (IPCC, 2007)
Separate the 5 tropical cyclones from the 5 extratropical.

Images courtesy NCDC
Features similar to those in tropical systems are often found in strong fall/winter coastal storms.
Heavy rain associated with “extratropical transition” (Hurricane Floyd initially over warm...then cold SST)
Other Historical "Gulf Stream Fed" Storms

The Perfect Storm

Patriot's Day Storm
October 30th Wind Storm

Maximum Wind Gusts
Valid: October 29-30, 2017

National Weather Service
Gray Maine

Follow Us: weather.gov/Gray
Power Outages Maine

- Jan 1998 Ice Storm: 300,000
- Oct 2017 Wind Storm: 5,000,000

Flash Flooding
Erosion below the dune structure at Surf Street in Saco.
Storm Surge 2.81 feet

TOP 18 STORM SURGES AT PORTLAND (Reference Height MLLW: 1912-2018)

1. 4.3’ – Mar 3, 1947
2. 4.1’ – Mar 1, 1914
3. 3.9’ – Dec 14, 1917
4. 3.6’ – Feb 19, 1972
5. 3.5’ – Nov 26, 1950
   3.5’ – Feb 7, 1978 (Blizzard of ’78)
   3.5’ – Oct 30, 1991 (Perfect Storm)
8. 3.3’ – Nov 30, 1945
   3.3’ – Aug 31, 1954
10. 3.2’ – Dec 2, 1942
11. 3.1’ – Mar 16, 1956
12. 3.0’ – Jan 15, 1940
   3.0’ – Feb 7, 1951
14. 2.9’ – Nov 13, 1925
15. 2.8’ – Oct 30, 2017
   2.8’ – Dec 9, 2009
17. 2.7’ – Apr 16, 2007 (Patriot’s Day Storm)
18. 2.7’ – Feb 25, 2010
A Conceptual Model of a Storm that Produces a Significant Storm Surge and Large, Battering Waves in ME/NH

Feb 26th, 2010 Intense Nor’easter Produced Significant Erosion/Damage
The Wave vs. Coastal Inundation Paradox
Which is the greater impact for your location ???

The Patriot’s Day Storm, 2007
Saco, Maine
Wave Runup “Hotspots” and NECOFS DOMAIN

ETSS: Variation of the SLOSH winds off GFS

ESTOFS: Uses ADCIRC model and GFS winds. Provides water levels for WWIII. Bias +/- ???

NECOFS Model Domain UMass Dartmouth and Wave Run-up Sites (uses WRF and MM5 winds/atmos pressure and FVCOM_SWAVE)
Coastal Flood Hotspots

Granite Point Road Biddeford during the Coastal Flooding and Heavy Rain Blood Moon Storm: (October 2015)
A Coastal Front Driven Flash Flood
(August, 2014)
Precip Analysis

**Observed Storm Total Rainfall**
- August 13 - 14, 2014

**Precip.net**

### Precipitation Accumulation Return Period
- 3-Hour

### Extreme Precipitation Estimates

<table>
<thead>
<tr>
<th>Storm Duration</th>
<th>5min</th>
<th>10min</th>
<th>15min</th>
<th>30min</th>
<th>60min</th>
<th>120min</th>
<th>1hr</th>
<th>2hr</th>
<th>3hr</th>
<th>6hr</th>
<th>12hr</th>
<th>24hr</th>
<th>48hr</th>
<th>1yr</th>
<th>2yr</th>
<th>5yr</th>
<th>10yr</th>
<th>25yr</th>
<th>50yr</th>
<th>100yr</th>
<th>200yr</th>
<th>500yr</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1yr</strong></td>
<td>0.26</td>
<td>0.39</td>
<td>0.49</td>
<td>0.64</td>
<td>0.80</td>
<td>1.01</td>
<td>1yr</td>
<td>0.69</td>
<td>0.99</td>
<td>1.19</td>
<td>1.53</td>
<td>2.00</td>
<td>2.62</td>
<td>2.91</td>
<td>1yr</td>
<td>2.32</td>
<td>2.80</td>
<td>3.20</td>
<td>3.91</td>
<td>4.44</td>
<td>1yr</td>
<td></td>
</tr>
<tr>
<td><strong>2yr</strong></td>
<td>0.32</td>
<td>0.49</td>
<td>0.62</td>
<td>0.81</td>
<td>1.02</td>
<td>1.30</td>
<td>2yr</td>
<td>0.88</td>
<td>1.51</td>
<td>1.94</td>
<td>2.49</td>
<td>3.21</td>
<td>3.56</td>
<td>4.06</td>
<td>2yr</td>
<td>2.85</td>
<td>3.43</td>
<td>3.91</td>
<td>4.66</td>
<td>5.27</td>
<td>2yr</td>
<td></td>
</tr>
<tr>
<td><strong>5yr</strong></td>
<td>0.38</td>
<td>0.59</td>
<td>0.74</td>
<td>1.00</td>
<td>1.27</td>
<td>1.64</td>
<td>5yr</td>
<td>1.10</td>
<td>1.92</td>
<td>2.46</td>
<td>3.15</td>
<td>4.06</td>
<td>4.54</td>
<td>5.44</td>
<td>5yr</td>
<td>3.59</td>
<td>4.36</td>
<td>4.97</td>
<td>5.85</td>
<td>6.55</td>
<td>5yr</td>
<td></td>
</tr>
<tr>
<td><strong>10yr</strong></td>
<td>0.43</td>
<td>0.67</td>
<td>0.85</td>
<td>1.16</td>
<td>1.51</td>
<td>1.95</td>
<td>10yr</td>
<td>1.30</td>
<td>2.30</td>
<td>2.95</td>
<td>3.78</td>
<td>4.84</td>
<td>5.44</td>
<td>10yr</td>
<td>10yr</td>
<td>4.28</td>
<td>5.24</td>
<td>5.97</td>
<td>6.96</td>
<td>7.72</td>
<td>10yr</td>
<td></td>
</tr>
<tr>
<td><strong>25yr</strong></td>
<td>0.51</td>
<td>0.81</td>
<td>1.03</td>
<td>1.42</td>
<td>1.89</td>
<td>2.47</td>
<td>25yr</td>
<td>1.63</td>
<td>2.91</td>
<td>3.74</td>
<td>4.80</td>
<td>6.12</td>
<td>6.94</td>
<td>25yr</td>
<td>25yr</td>
<td>5.41</td>
<td>6.67</td>
<td>7.59</td>
<td>8.76</td>
<td>9.61</td>
<td>25yr</td>
<td></td>
</tr>
<tr>
<td><strong>50yr</strong></td>
<td>0.57</td>
<td>0.92</td>
<td>1.18</td>
<td>1.66</td>
<td>2.24</td>
<td>2.96</td>
<td>50yr</td>
<td>1.93</td>
<td>3.50</td>
<td>4.51</td>
<td>5.76</td>
<td>7.31</td>
<td>8.34</td>
<td>50yr</td>
<td>50yr</td>
<td>6.47</td>
<td>8.02</td>
<td>9.12</td>
<td>10.42</td>
<td>11.34</td>
<td>50yr</td>
<td></td>
</tr>
<tr>
<td><strong>100yr</strong></td>
<td>0.66</td>
<td>1.07</td>
<td>1.37</td>
<td>1.95</td>
<td>2.65</td>
<td>3.53</td>
<td>100yr</td>
<td>2.29</td>
<td>3.13</td>
<td>4.19</td>
<td>5.40</td>
<td>6.89</td>
<td>8.73</td>
<td>10.03</td>
<td>100yr</td>
<td>7.73</td>
<td>9.65</td>
<td>10.96</td>
<td>12.41</td>
<td>13.39</td>
<td>100yr</td>
<td></td>
</tr>
<tr>
<td><strong>200yr</strong></td>
<td>0.75</td>
<td>1.23</td>
<td>1.59</td>
<td>2.28</td>
<td>3.15</td>
<td>4.22</td>
<td>200yr</td>
<td>2.22</td>
<td>3.71</td>
<td>5.02</td>
<td>6.48</td>
<td>8.26</td>
<td>10.44</td>
<td>12.07</td>
<td>200yr</td>
<td>9.24</td>
<td>11.61</td>
<td>13.18</td>
<td>14.79</td>
<td>15.81</td>
<td>200yr</td>
<td></td>
</tr>
<tr>
<td><strong>500yr</strong></td>
<td>0.91</td>
<td>1.50</td>
<td>1.96</td>
<td>2.83</td>
<td>3.96</td>
<td>5.34</td>
<td>500yr</td>
<td>3.42</td>
<td>6.36</td>
<td>8.22</td>
<td>10.48</td>
<td>13.23</td>
<td>15.42</td>
<td>500yr</td>
<td>500yr</td>
<td>11.71</td>
<td>14.83</td>
<td>16.81</td>
<td>18.65</td>
<td>19.73</td>
<td>500yr</td>
<td></td>
</tr>
</tbody>
</table>
Regeneration: Southern End of the Line

Portland
Hotspots For Combined Fresh and Salt Water Flooding

Figure 2: Map of Goosefare Brook watershed land cover.
Norlun Trough Conceptual Model
Coastal Front Development: Waterspouts

Thanksgiving Day – Phippsburg, 2005
<table>
<thead>
<tr>
<th>Rank</th>
<th>Depth</th>
<th>Date</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>14.49</td>
<td>20-21 Oct 1996</td>
<td>Old Orchard Beach</td>
</tr>
<tr>
<td>2</td>
<td>9.53</td>
<td>6-7 Oct 1962</td>
<td>Ocean Park</td>
</tr>
<tr>
<td>3</td>
<td>8.23</td>
<td>9-10 Oct 1998</td>
<td>Camp Ellis</td>
</tr>
<tr>
<td>4</td>
<td>8.15</td>
<td>19-20 Aug 1991</td>
<td>Camp Ellis</td>
</tr>
<tr>
<td>5</td>
<td>6.77</td>
<td>18-19 Jun 1922</td>
<td>Camp Ellis</td>
</tr>
</tbody>
</table>
“Meteo-Tsunami” Boothbay Harbor, Oct. 2008
Communicating Vulnerability

RISK OF DIRECT LANDFALL BY SANDY MON-TUE

HIGH
MEDIUM
LOW

GFS model
Tuesday night

Canadian model
Wednesday morning
POTENT STORM SYSTEM TONIGHT THROUGH THURSDAY

- Biggest impacts: minor coastal flooding, isolated power outages, and possible minor river and urban flooding.

- Coastal Flooding
  - Greatest surge and waves Tonight
  - Minor coastal flooding possible tonight and Thursday

- Rainfall:
  - Mainly tonight
  - Up to two inches with locally higher amounts in the mountains.

- Wind: Gusts:
  - Localized 40 – 50 mph gusts possible (Mainly along coastal areas)

Related Pages: Coastal Flooding and Flooding
Emergency Responders use of Coastal Information: Readying and Deploying Resources

Reverse 911/Code Red

Be a Force of Nature: Prepare & Stay Safe! #FallSafety

“Activation”

CERT COMMUNITY EMERGENCY RESPONSE TEAM
MIND MAP OF A COASTAL RESIDENT

COGNITIVE

Knowledge about:
- Hurricanes
- Forecasts
- Surge
- Elevation of Home
- Etc.

World View
- Personality Traits
- Mental Models

Sees world as safe or scary
- Risk aversive or risk seeking
- "Surge is just flooding"

AFFECTIVE

Feelings about:
- Hurricanes
- Forecasts
- Home safety
- Travel, Etc.
- "This is scary!"

SOCIAL

Relationships
- Interactions
- Networks
- "What are they going to do?"
What makes people decide to respond to a warning message?

- Believe danger is real
- Fear for self or loved ones
- Know how to respond
- Have resources to respond

Level of risk is unacceptable and they can do something to reduce it.
Paddle Craft Risk
Cold Water Beach Hazards Statement

**What:** In conjunction with the United States Coast Guard (USCG) Sector Northern New England a “Paddle Craft Risk product” has been created to identify the combination of warm days when a significant number of paddle boaters are expected on the coastal waters and extremely cold waters that increase the risk of hypothermia for capsize incidents.

**Criteria:** The following six criteria to the right were established with the USCG to identify heightened risk days.

**Issuance:** The program will be in effect from April 15 to Columbus day. When all 6 of the criteria are forecasted for a Friday, Saturday, Sunday or holiday a Beach Hazard Statement will be issued by the National Weather Service Gray and/or Caribou offices after collaboration with the USCG. The goal is to make people aware of the hazard of the cold coastal waters of the Gulf of Maine.

**Your Role:** When a Beach Hazard Statement is issued for your region, it is a notification to initiate a public outreach effort to bring awareness to this unique coastal water hazard.

<table>
<thead>
<tr>
<th>Weather Element</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cloud Cover</td>
<td>&lt; 60 %</td>
</tr>
<tr>
<td>Max Temperature (MaxT)</td>
<td>&gt; 60 F</td>
</tr>
<tr>
<td>Significant Wave Height</td>
<td>&lt; 3 feet</td>
</tr>
<tr>
<td>Sea Surface Temperature (SST)</td>
<td>&lt; 60 F</td>
</tr>
<tr>
<td>Wind Speed</td>
<td>&lt; 20 kts</td>
</tr>
<tr>
<td>MaxT minus SST</td>
<td>&gt; 15 F</td>
</tr>
</tbody>
</table>

**Resources:**
- Portsmouth, NH to Stonington, ME Forecast [www.weather.gov/gyx/](http://www.weather.gov/gyx/)
- Stonington, ME to Eastport, ME Forecast [www.weather.gov/car/](http://www.weather.gov/car/)
Thanks for your time !!!!!
Questions/Comments ???

john.w.cannon@noaa.gov