Storm Characterization in the Yucatan Peninsula

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Description and Motivation

Yucatan coast subject to storm impacts (mid latitude anticyclonic systems & tropical cyclonic systems) Latest hurricane Rina Oct 2011

Image taken from Historical Hurricane Tracks NOAA
Description and Motivation

STORM IMPACTS

Flooding in urban coastal areas

Overtopping

Infrastructure Damage

Erosion
Methodology

Wave hindcast (1979-2008)

Storm definition

Classification parameter

Final Classification

Classification procedures
Conclusions

• A 5-class intensity scale for wave storms in the Yucatan coast is presented

• The obtained classification reflects the increase in wave storm properties as storm category increases from weak (Hs=2.8 duration 23 hrs) to extreme (Hs = 6.5 duration 146h)

• Storminess trends suggest an increase in number of storms and storm energy.

<table>
<thead>
<tr>
<th></th>
<th>Hs max</th>
<th>Tp max</th>
<th>Dur</th>
<th>Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(m)</td>
<td>(seg)</td>
<td>(h)</td>
<td>(m²h)</td>
</tr>
<tr>
<td>Weak</td>
<td>I</td>
<td>2.8</td>
<td>9.3</td>
<td>23</td>
</tr>
<tr>
<td>Moderate</td>
<td>II</td>
<td>4</td>
<td>10.6</td>
<td>45</td>
</tr>
<tr>
<td>Significant</td>
<td>III</td>
<td>4.7</td>
<td>11.6</td>
<td>75</td>
</tr>
<tr>
<td>Severe</td>
<td>IV</td>
<td>5.9</td>
<td>12.3</td>
<td>97</td>
</tr>
<tr>
<td>Extreme</td>
<td>V</td>
<td>6.5</td>
<td>12.5</td>
<td>146</td>
</tr>
</tbody>
</table>
Details of the study

Wave data
Identification of wave events

Storm definition

Hs threshold > 2 m
Minimum duration > 12 hr

Storm classification based on “energy content”

\[ E = \int Hs^2 \, dt \]
Details of the study

Identified wave events

- 421 storms
- 384 storms
- 376 storms
- 360 storms

- All identified storms were integrated into a single data set
Details of the study

Spatial variation

September 2002 Hurricane ISIDORE

- **Hs=5m**
  - Ec=2042 m$^2$h
  - D=144h

- **Hs=4m**
  - Ec=1543 m$^2$h
  - D=153h

- **Hs=6.8m**
  - Ec=2426 m$^2$h
  - D=129h
Details of the study

Storm classification

cluster analysis (solid line) + supervised classification (dashed line).
Details of the study

Classification

Mean values per storm class

- $H_s$ (peak of the storm)
- $T_p$ (peak of the storm)
- Storm energy
- Storm duration

Legend:

- I
- II
- III
- IV
- V

Axes:

- $T_p$ (s) on the y-axis
- $H_s$ (m) on the x-axis
- Storm energy ($m^2 \cdot h$) on the right axis
- Duration (days) on the right axis
Details of the study

Storm seasonal distribution

[Bar chart showing the seasonal distribution of storms by class.]

- Class I
- Class II
- Class III
- Class IV
- Class V

Months: January (J), February (F), March (M), April (A), May (M), June (J), July (JUL), August (A), September (S), October (O), November (N), December (D).
Details of the study

Storms directional distribution
# Details of the study

## Storm classification

<table>
<thead>
<tr>
<th>Storm Classification</th>
<th>Hs max (m)</th>
<th>Tp max (seg)</th>
<th>Dur (h)</th>
<th>Energy (m²h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak (I)</td>
<td>2.8</td>
<td>9.3</td>
<td>23</td>
<td>150</td>
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<tr>
<td>Moderate (II)</td>
<td>4</td>
<td>10.6</td>
<td>45</td>
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<td>Significant (III)</td>
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<td>11.6</td>
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<tr>
<td>Severe (IV)</td>
<td>5.9</td>
<td>12.3</td>
<td>97</td>
<td>1321</td>
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<tr>
<td>Extreme (V)</td>
<td>6.5</td>
<td>12.5</td>
<td>146</td>
<td>2480</td>
</tr>
</tbody>
</table>

- Weak ~x2.3
- Moderate ~x6
- Significant ~x16
Details of the study

Application for coastal management:
Preliminary assessment of the storm-induced inundation hazard

Run-up assessment for 25 profiles along the Yucatan coast

\[ R_u = 1.1 \left( 0.35 \beta_f \left( H_o L_o \right)^{1/2} + \frac{H_o L_o (0.563 \beta_f^2 + 0.004)^{1/2}}{2} \right) \]

Run up : Stockdon et al. (2006)
Details of the study

Preliminary runup assessment

Runup class V storm
Runup class IV storm
Runup class III storm
Runup class II storm
Runup class I storm
Details of the study

Storminess trends
Number of storms per year
Details of the study

Storminess trends
Storm energy content per year

![Graph showing storm energy content per year](image.png)
Concluding remarks

• A 5-class intensity scale for wave storms in the Yucatan coast is presented

• The obtained classification reflects the increase in wave storm properties as storm category increases from weak (Hs=2.8 dur 23 hrs) to extreme (Hs = 6.5 duration 146h)

• Storminess trends suggest an increase in number of storms and storm energy.

• Preliminary run up results suggest that the highest potential flooding are in Hunucma and San Felipe regions
Acknowledgments

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