Patterns of Multidecadal Atlantic Hurricane Variability

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The multidecadal variability of the tropical N. Atlantic ocean and atmosphere, particularly sea surface temperature and vertical wind shear, strongly modulates basin-wide Atlantic hurricane activity.
There have been more than twice as many major hurricanes per year during the contemporary warm period compared to the last cool period. These statistics reflect basin-wide activity and the environmental parameters are typically measured in the Main Development Region.

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>Tropical Storms</th>
<th>Category 1–2</th>
<th>Category 3–5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1970–1994</td>
<td>9.3</td>
<td>4.3</td>
<td>3.5</td>
<td>1.5</td>
</tr>
<tr>
<td>1995–2015</td>
<td>14.7</td>
<td>7.2</td>
<td>4.1</td>
<td>3.4</td>
</tr>
</tbody>
</table>

These statistics reflect basin-wide activity and the environmental parameters are typically measured in the Main Development Region.

Are there any regional patterns of variability that may be relevant but missing from these types of analyses?
Leading EOFs of SST and shear (VWS)

What effect do these regional patterns of multidecadal variability have on hurricanes?

6-hourly intensification rates near/along the U.S. coast

**Table 2 | Probabilities of exceedance of 6-hour intensification rates near the US coast**

<table>
<thead>
<tr>
<th></th>
<th>HU (ΔV ≥ 5 kt)</th>
<th>MH (ΔV ≥ 5 kt)</th>
<th>HU (ΔV ≥ 10 kt)</th>
<th>MH (ΔV ≥ 10 kt)</th>
<th>HU (ΔV ≥ 15 kt)</th>
<th>MH (ΔV ≥ 15 kt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1947–1969</td>
<td>0.310 ± 0.028</td>
<td>0.230 ± 0.047</td>
<td>0.079 ± 0.016</td>
<td>0.061 ± 0.027</td>
<td>0.022 ± 0.009</td>
<td>0.016 ± 0.014</td>
</tr>
<tr>
<td>1970–1992</td>
<td>0.429 ± 0.047</td>
<td>0.468 ± 0.110</td>
<td>0.147 ± 0.034</td>
<td>0.228 ± 0.093</td>
<td>0.058 ± 0.022</td>
<td>0.101 ± 0.067</td>
</tr>
<tr>
<td>1993–2015</td>
<td>0.263 ± 0.032</td>
<td>0.239 ± 0.060</td>
<td>0.086 ± 0.020</td>
<td>0.096 ± 0.041</td>
<td>0.033 ± 0.013</td>
<td>0.031 ± 0.024</td>
</tr>
</tbody>
</table>

Values are the probabilities (and their 95% confidence intervals) that the 6-hour intensity change was equal to or exceeded 5 kt, 10 kt or 15 kt for hurricanes (HU) and major hurricanes (MH) near the US coast in each of the three 23-year periods.

Major hurricanes that approach or move along the U.S. coast are **3 to 6 times less likely** to rapidly intensify during warm periods.
## Hurricane Matthew

**IRMA**

<table>
<thead>
<tr>
<th>TIME (HR)</th>
<th>0</th>
<th>6</th>
<th>12</th>
<th>18</th>
<th>24</th>
<th>36</th>
<th>48</th>
<th>60</th>
<th>72</th>
<th>84</th>
<th>96</th>
<th>108</th>
<th>120</th>
</tr>
</thead>
<tbody>
<tr>
<td>V (KT) NO LAND</td>
<td>140</td>
<td>139</td>
<td>142</td>
<td>148</td>
<td>146</td>
<td>147</td>
<td>146</td>
<td>142</td>
<td>135</td>
<td>124</td>
<td>110</td>
<td>86</td>
<td>66</td>
</tr>
<tr>
<td>V (KT) LAND</td>
<td>140</td>
<td>139</td>
<td>142</td>
<td>146</td>
<td>147</td>
<td>146</td>
<td>142</td>
<td>99</td>
<td>52</td>
<td>35</td>
<td>29</td>
<td>28</td>
<td>27</td>
</tr>
<tr>
<td>V (KT) LGEM</td>
<td>140</td>
<td>136</td>
<td>135</td>
<td>134</td>
<td>134</td>
<td>131</td>
<td>97</td>
<td>50</td>
<td>34</td>
<td>29</td>
<td>27</td>
<td>27</td>
<td></td>
</tr>
</tbody>
</table>

**Storm Type**

- TROP TROP TROP TROP TROP TROP TROP TROP TROP TROP TROP TROP

**Shear (KT)**

- 4 4 4 4 6 9 14 20 31 42 47 46 42

**Shear Adj (KT)**

- 4 2 1 -1 -1 1 2 0 7 3 -7 -1 1

**Shear Dir**

- 249 295 319 300 283 303 268 245 224 204 214 210 217

**SST (C)**

- 29.5 29.7 29.7 29.8 29.9 30.0 29.9 29.9 29.4 28.7 27.8 26.5 25.2

**POT. INT. (KT)**

- 162 165 164 166 167 168 167 168 160 148 135 119 106

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J. Kossin, Atlantic Climate Variability Workshop, 8 Sept 2017
Regionally reduced shear during the last cool period allowed major hurricanes to survive at higher latitudes.
Summary

Atlantic multidecadal variability is best considered in terms of its pattern rather than via MDR averages.

Important regional differences (sign changes) exist in the SST and shear co-variability, which causes large regional differences in how hurricanes are modulated by the multidecadal variability in the basin.

An important unanswered question then is whether we can expect another cool phase, and if one emerges, how well will the previous cool period serve as an analog?