Human Heat Vulnerability: The Development of a Web-Based Tool for Predicting Heat Stress Among High School Athletes

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**Background**

- Wet-Bulb Globe Temperature (WBGT) is a better metric of heat severity than heat index (HI), as it includes not only air temperature, humidity, but also solar radiation, and wind speed
- SERCC and CISA created a five day WBGT forecast tool that currently covers Virginia and North Carolina and will soon be expanded to rest of the continental US
- Uses inputs from the gridded National Weather Service’s NDFD model for Wet-Bulb Globe Temperature (WBGT) is a better metric of heat severity than heat index (HI)

**Methodology**

**Data**

* Measured data:
  - Observations were taken during football practice times at seven high schools across North Carolina during late summer to early fall of 2019

**Model data:**

- Two models were used: National Blend of Models (NBM) and National Digital Forecast Database (NDFD)
- Four runs of the input forecast data per day (00Z, 06Z, 12Z, 18Z)
- NDFD model had less forecast data than NBM model
  - NDFD: hourly (0-36), 3-hourly (39-192), 6-hourly (198-264)
  - NBM: hourly (0-36), 3-hourly (39-120), 6-hourly (123-264)

**Methods**

- Biases were calculated for a range of forecast hours (from 6 – hours to five – days in advance using the following formula:

  \[ \text{Bias} = \text{forecast}\ \text{WBGT} - \text{measured\ WBGT} \]

**Results**

**Summary Data Table**

<table>
<thead>
<tr>
<th>High School</th>
<th>Landscape Type</th>
<th>Percentage of Observations</th>
<th>Average Wind Speed (mph)</th>
<th>Average WBGT Bias (Temp)</th>
<th>Total # of Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Open</td>
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<tr>
<td>Farmville Central HS</td>
<td>52 (14)</td>
<td>61 (10)</td>
<td>35 (5)</td>
<td>35 (5)</td>
<td>94 (19)</td>
</tr>
<tr>
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<td>61 (11)</td>
<td>35 (5)</td>
<td>35 (5)</td>
<td>94 (19)</td>
</tr>
<tr>
<td>High Point HS</td>
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<td>61 (10)</td>
<td>35 (5)</td>
<td>35 (5)</td>
<td>94 (19)</td>
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<tr>
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<td>61 (10)</td>
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<td>35 (5)</td>
<td>94 (19)</td>
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<tr>
<td>Farmville HS</td>
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<td>61 (12)</td>
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<td>35 (5)</td>
<td>94 (19)</td>
</tr>
<tr>
<td>Rocky Mount HS</td>
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<tr>
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<td>61 (12)</td>
<td>35 (5)</td>
<td>35 (5)</td>
<td>94 (19)</td>
</tr>
</tbody>
</table>

**Figure 3: High school locations across North Carolina where measurements were taken. Source: ArcGIS**

**Discussion and Future Research**

**Discussion**

- The morning hours have a greater bias than evening hours
- Microclimate/landscape has major influence in WBGT forecast bias
- Lower wind speeds have much greater influence on bias than higher wind speeds
- WBGT Tool will be improved by incorporating landcover information (e.g. surface roughness) to account for differences across microclimates.

**Future Research:**

- Mapping and exploring vulnerability to heat acclimatization on a variety of factors such as:
  - Behavioral/environmental factors (ex. poverty)
  - Health related factors (ex. asthma)

**Acknowledgements:**

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