

Understanding Local Variations in Wet Bulb Globe Temperature (WBGT) and Tailoring the WBGT Forecast Tool to Local Environments

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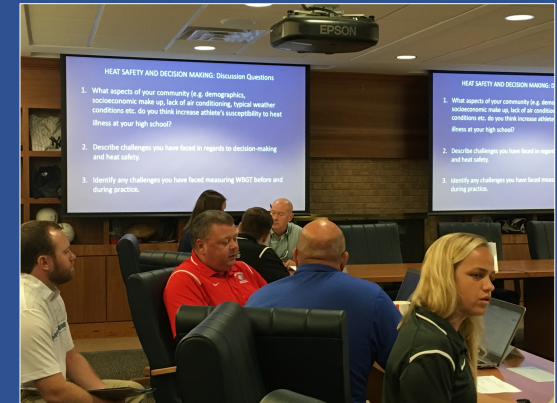


Outline

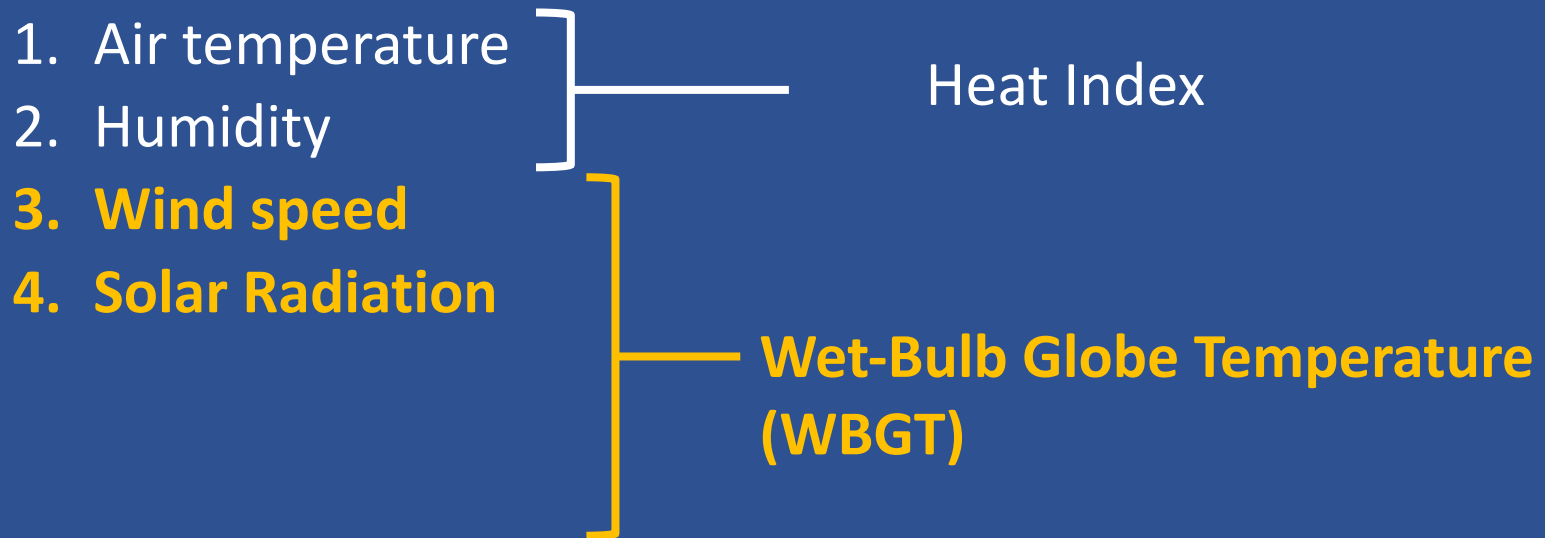
- Provide a background on heat stress, wet bulb globe temperature (WBGT) and its spatial variations
- Describe the web-based tool that predicts WBGT over next 5 days across the SE US.
- Summarize current work to tune the tool to the local scale & incorporate the influence of the landcover

CISA/SERCC Heat Research and Outreach Program

- Field work measuring variables that affect heat over different landcover types— e.g. different athletic surfaces
- Web-based tool that predicts WBGT over next 5 days across the SE US.
- Site visits to various high schools across the region
- Engagements with athletic directors, trainers and coaches on heat safety



Measures of Heat Stress



➤ Many states have developed requirements for high school sports practice

Wet bulb temperature (WBGT) football practice guidelines

WBGT Index (F)	Athletic Activity Guidelines
Less than 80	Unlimited activity with primary cautions for new or unconditioned athletes or extreme exertion; schedule mandatory rest / water breaks (5 min water / rest break every 30 min)
80 - 84.9	Normal practice for athletes; closely monitor new or unconditioned athletes and all athletes during extreme exertion. Schedule mandatory rest / water breaks. (5 min water / rest break every 25 min)
85 - 87.9	New or unconditioned athletes should not practice. Well conditioned athletes should have more frequent rest breaks and hydration as well as cautious monitoring for symptoms of heat illness. Schedule frequent mandatory rest / water breaks. (5 min water / rest break every 20 min) Have immersion pool on site for practice.
88 - 89.9	All athletes must be under constant observation and supervision. Remove pads and equipment. Schedule frequent mandatory rest / water breaks. (5 min water / rest break every 15 min) Have immersion pool on site for practice.
90 or Above	SUSPEND PRACTICE

- Guidelines for North Carolina

➤ OCEA has strict guidelines for worker exposure to heat stress


Work/Rest and Water Consumption Table

Applies to average sized, heat-acclimated soldier wearing BDU, hot weather. (See TB MED 507 for further guidance.)

Easy Work		Moderate Work		Hard Work	
<ul style="list-style-type: none"> • Weapon Maintenance • Walking Hard Surface at 2.5 mph, < 30 lb Load • Marksmanship Training • Drill and Ceremony • Manual of Arms 		<ul style="list-style-type: none"> • Walking Loose Sand at 2.5 mph, No Load • Walking Hard Surface at 3.5 mph, < 40 lb Load • Callisthenics • Patrolling • Individual Movement Techniques, i.e., Low Crawl or High Crawl • Defensive Position Construction 		<ul style="list-style-type: none"> • Walking Hard Surface at 3.5 mph, ≥ 40 lb Load • Walking Loose Sand at 2.5 mph with Load • Field Assaults 	

Heat Category	WBGT Index, F°	Easy Work		Moderate Work		Hard Work	
		Work/Rest (min)	Water Intake (qt/hr)	Work/Rest (min)	Water Intake (qt/hr)	Work/Rest (min)	Water Intake (qt/hr)
1	78° - 81.9°	NL	½	NL	¾	40/20 min	¾
2 (GREEN)	82° - 84.9°	NL	½	50/10 min	¾	30/30 min	1
3 (YELLOW)	85° - 87.9°	NL	¾	40/20 min	¾	30/30 min	1
4 (RED)	88° - 89.9°	NL	¾	30/30 min	¾	20/40 min	1
5 (BLACK)	> 90°	50/10 min	1	20/40 min	1	10/50 min	1

- The work/rest times and fluid replacement volumes will sustain performance and hydration for at least 4 hrs of work in the specified heat category. Fluid needs can vary based on individual differences (± ¼ qt/hr) and exposure to full sun or full shade (± ¼ qt/hr).
- **NL** = no limit to work time per hr.
- **Rest** = minimal physical activity (sitting or standing) accomplished in shade if possible.
- **CAUTION: Hourly fluid intake should not exceed 1½ qts. Daily fluid intake should not exceed 12 qts.**
- If wearing body armor, add 5°F to WBGT index in humid climates.
- If doing Easy Work and wearing NBC (MOPP 4) clothing, add 10°F to WBGT index.
- If doing Moderate or Hard Work and wearing NBC (MOPP 4) clothing, add 20°F to WBGT index.

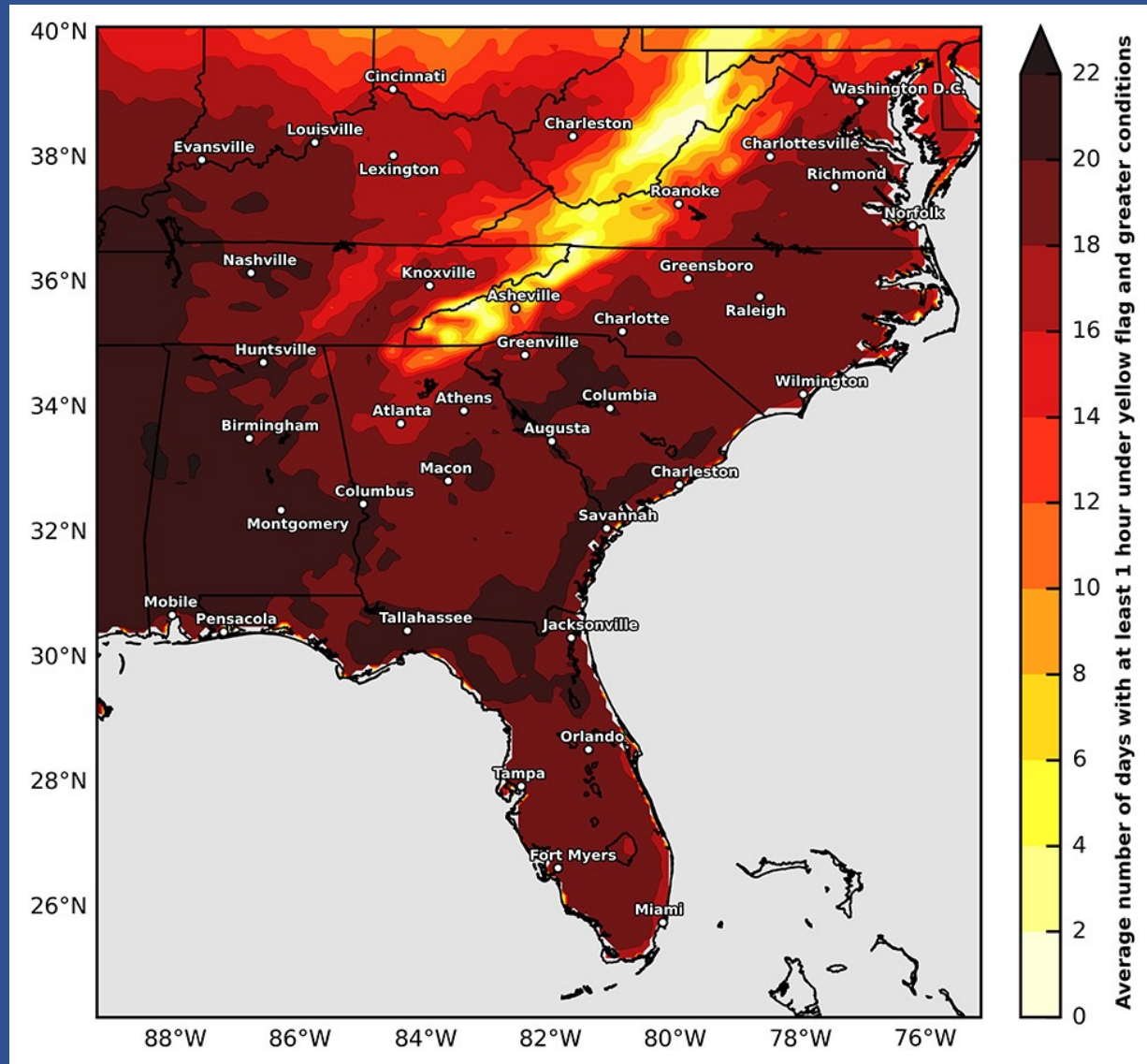


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Regional patterns of heat stress (WBGT) across SE U.S

Hours of
Yellow Flag and
greater
May-Sept



Local patterns of heat stress (WBGT) across a landscape

1. Surface type

Asphalt/concrete is hottest, especially if it is dark colored

Artificial turf is hotter

Natural grass is hot.

2. Degree of shade.

Surfaces that have been shaded most of day are the coolest

3. Openness of landscape

Closed (lots of trees/buildings nearby) -Hottest (lowest wind speeds)

Open (few trees/buildings) – Coolest (highest wind speeds)

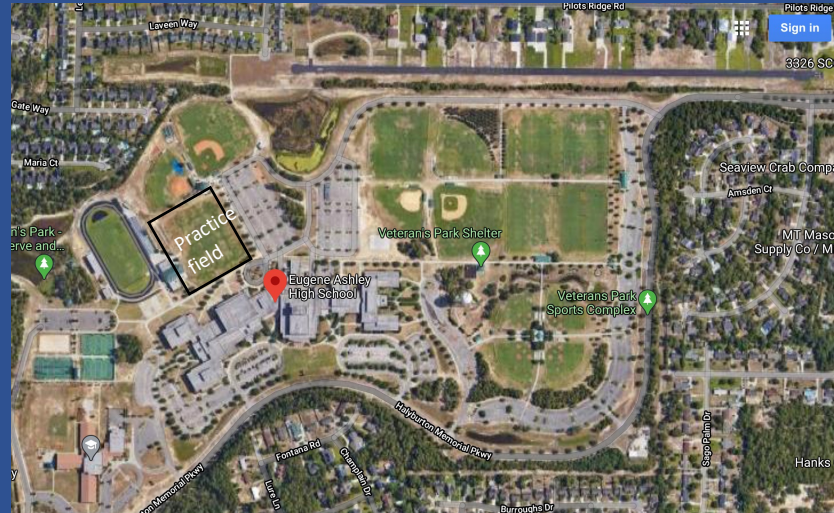
Field work reveals much local variation in WBGT which ties to wind speed variation

Open Landscape: Ashley HS, Carolina Beach, NC

Football Practice field

- 1) Few trees
- 2) Flat land
- 3) Sea breeze in afternoon

Steady breeze on many days



Extremely Sheltered: Cedar Ridge HS, Hillsborough, NC

Football Practice field

- 1) Sheltered - Ringed by forest & 60 feet below high school

➤ *Little or no wind*

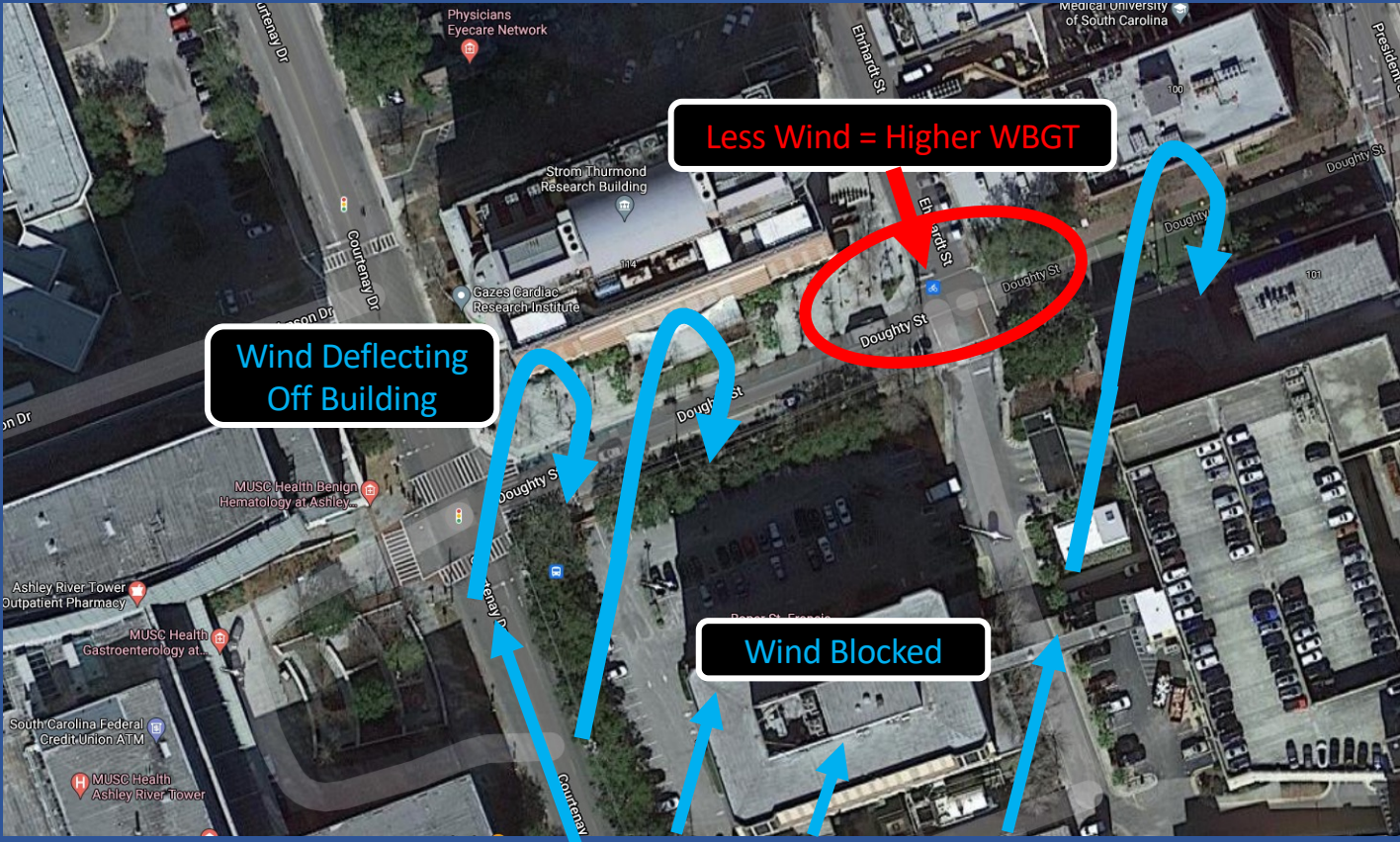
- 2) Adjacent to wetland

➤ *Exceptionally moist*





Charleston Medical District:
Urban Heat Island Pilot Study

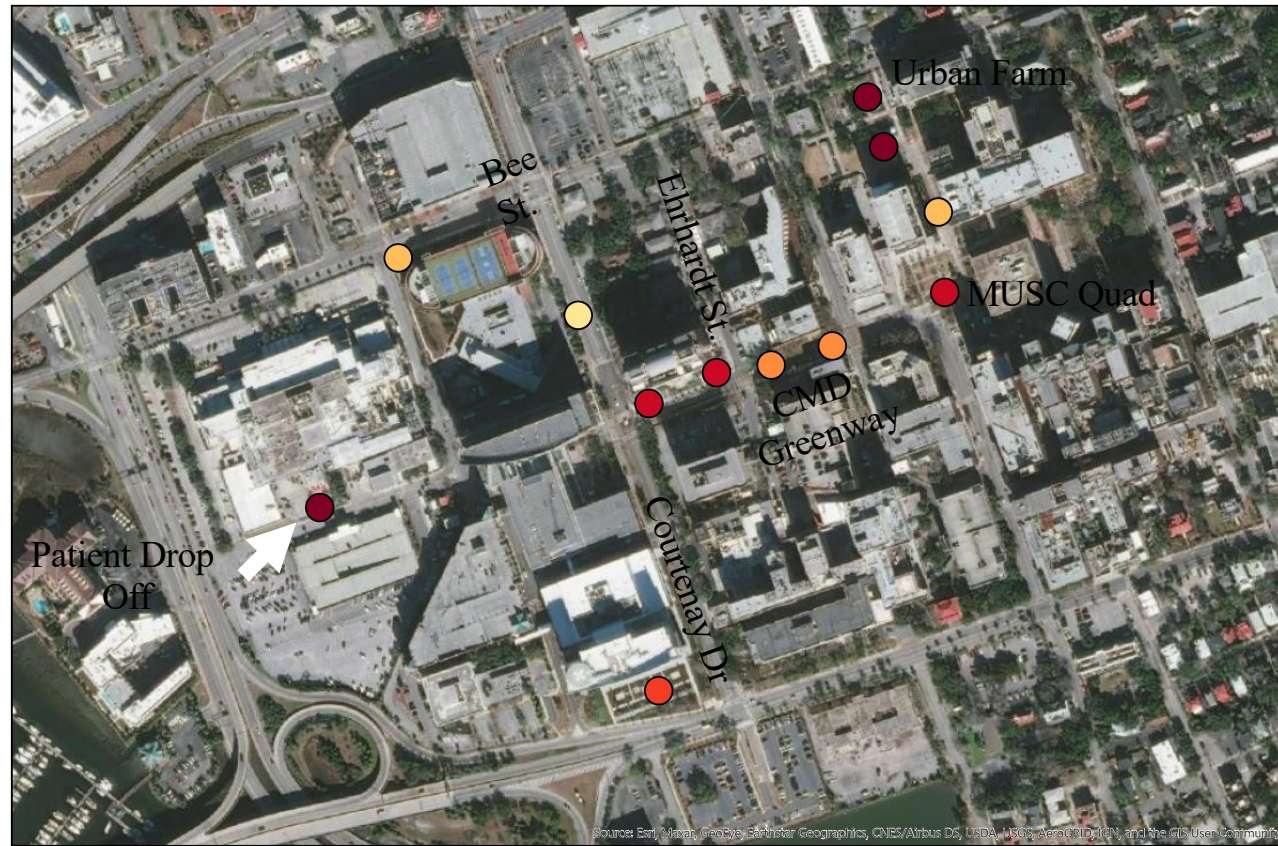


Less Wind = Higher WBGT

Wind Deflecting Off Building

Wind Blocked

Maximum WBGT at each location



The wet bulb globe temperature (WBGT) prediction tool

<https://convergence.unc.edu/tools/wbgt/>

Ingests hourly gridded forecasts from the National Weather Service used to estimate WBGT

1. Air temperature
2. Relative humidity / dew point temperature
3. Pressure
4. Wind speed
5. Degree of cloud cover
6. Sun azimuth angle

Wet Bulb Globe Temperature Tool

<https://convergence.unc.edu/tools/wbgt/>

- Generates a 5-day forecast
- Provides background information on WBGT and use of the tool

ABOUT US CLIMATE EXTREMES VULNERABILITY TOOLS RESEARCH FAQ

Wet Bulb Globe Temperature (WBGT) Tool

What is WBGT How to measure WBGT Understanding the Tool FAQ Contact Us

1. Type your location/address in the white box or select a location within the southeast region on the map below.
- NC, VA, SC, GA, FL, AL, MS, TN, KY
2. Click the “Submit” button at the bottom of the map and scroll down the page to see the forecast.
If you would like to see an earlier forecast, select a model time in the white box (at the bottom) and click the “Submit” button.
3. Scroll further down the page to see the WBGT activity guidelines.

Choose a Model Wed Jun 9 1PM Submit

Wet Bulb Globe Temperatures for Richmond, VA

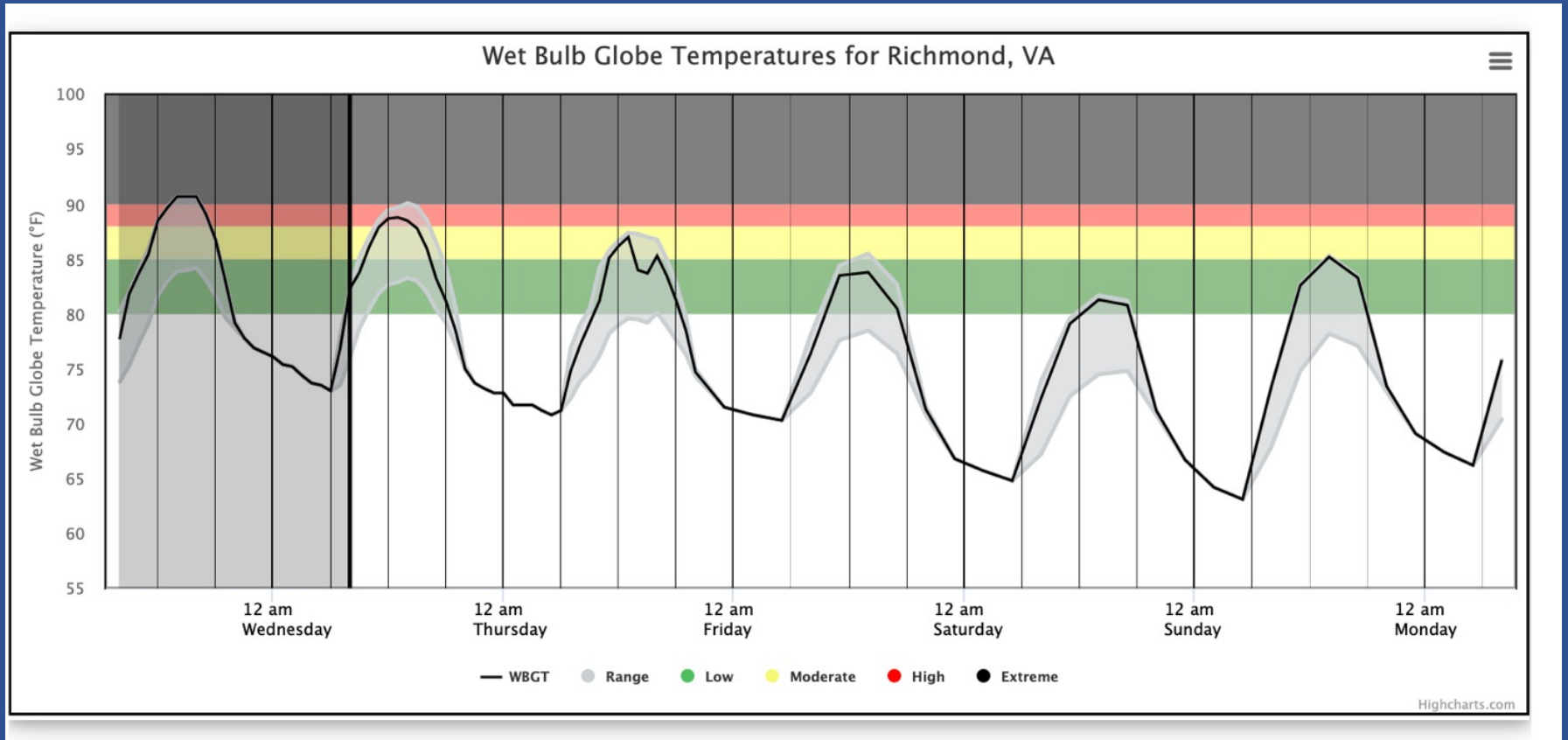
Wet Bulb Globe Temperature (°F)

12 am Wednesday 12 am Thursday 12 am Friday 12 am Saturday 12 am Sunday 12 am Monday

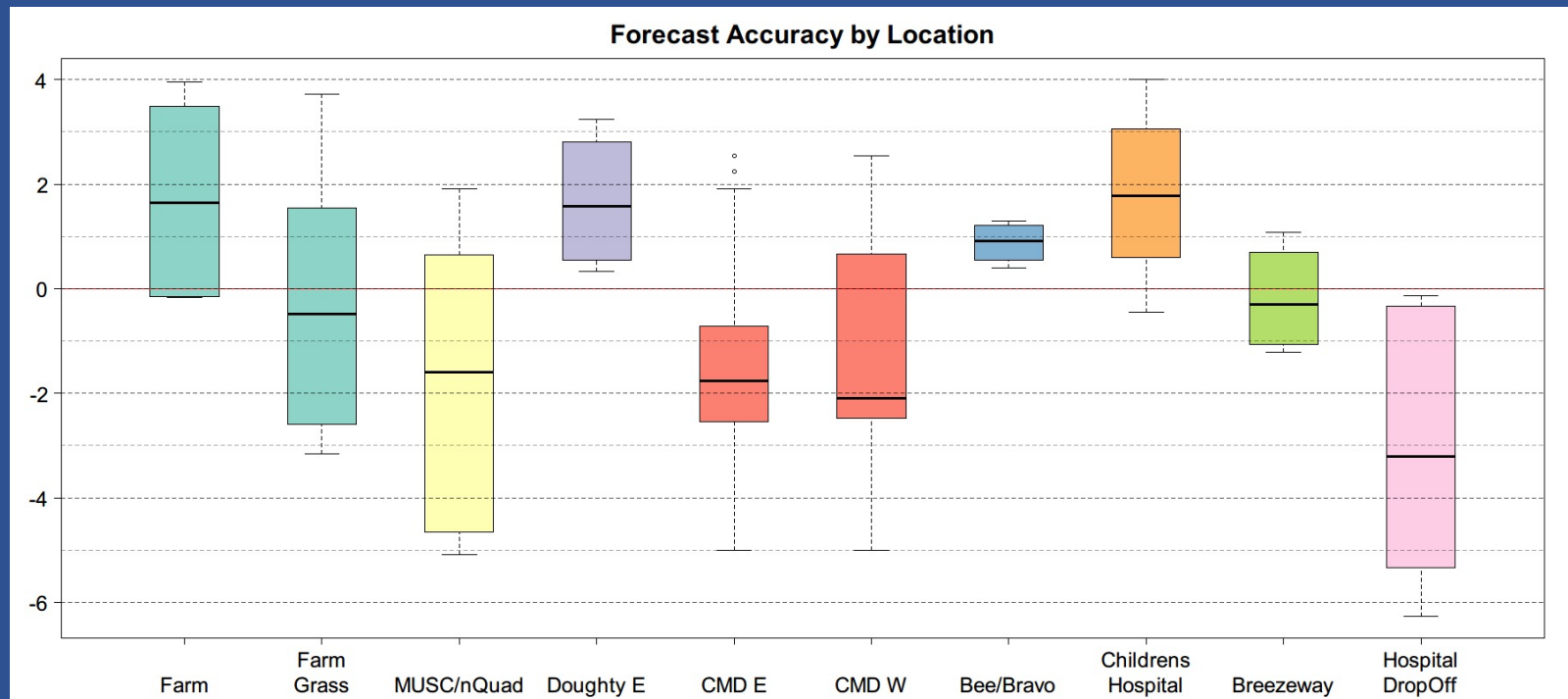
WBGT Range Low Moderate High Extreme

Wet Bulb Globe Temperature Tool

Expanded view of output



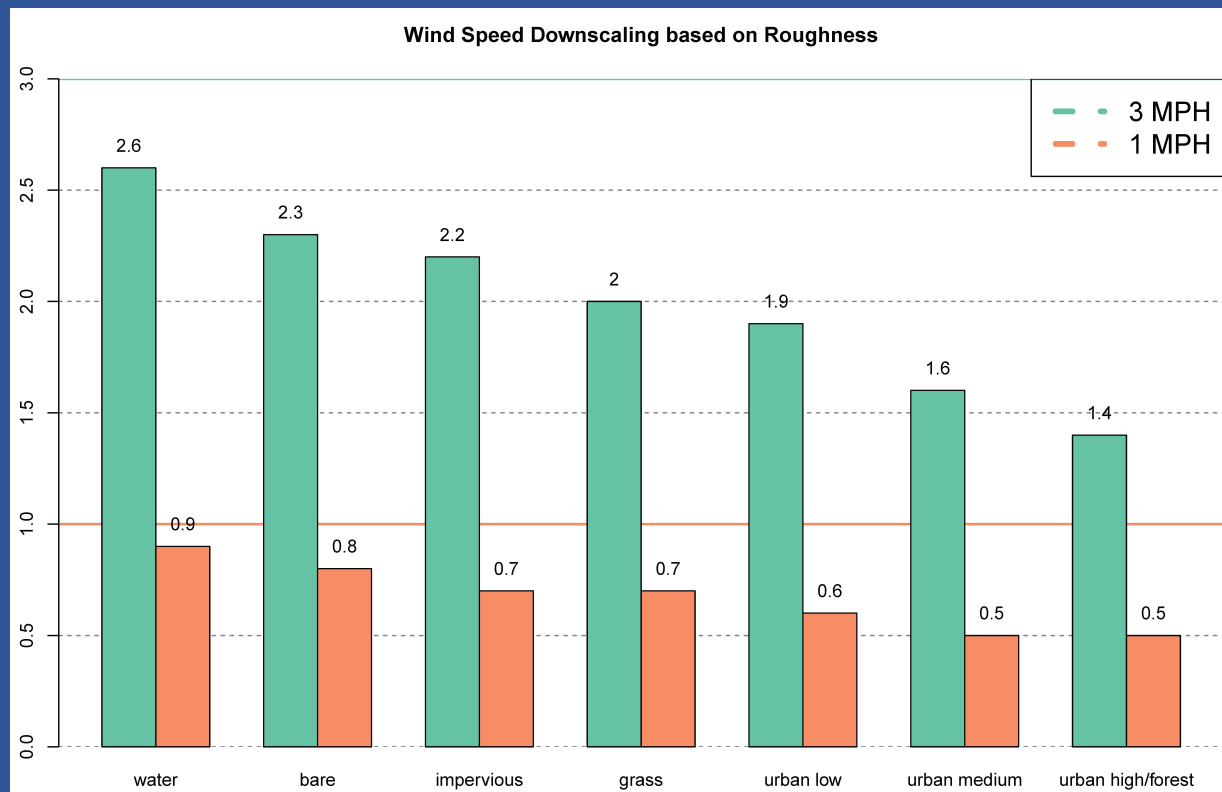
Forecast Accuracy



Forecast *MINUS* Observed

Current Work:

Incorporate landcover information for more accurate WBGT forecast (more accurate wind speed forecast)



Rougher surface, slower winds, higher WBGT

Thank You

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