

Using a Web-Based Tool to Forecast Local Variations in Wet Bulb Globe Temperature

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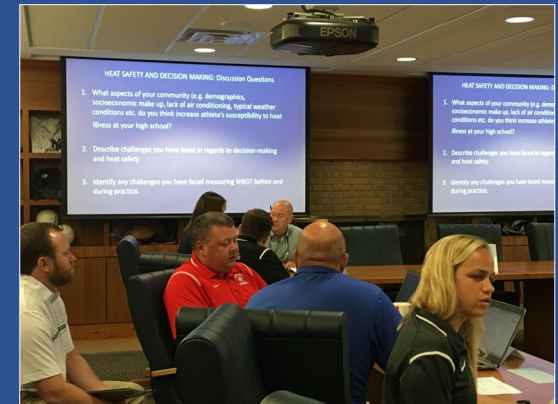
University of North Carolina at Chapel Hill

Outline

- Brief background on heat stress, wet bulb globe temperature (WBGT) and its spatial variations across the landscape
- 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

SERCC and CISA Heat Research and Outreach Program

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



Wet bulb globe temperature (WBGT) provides an accurate measure of heat stress and is increasingly used athletic and occupational settings



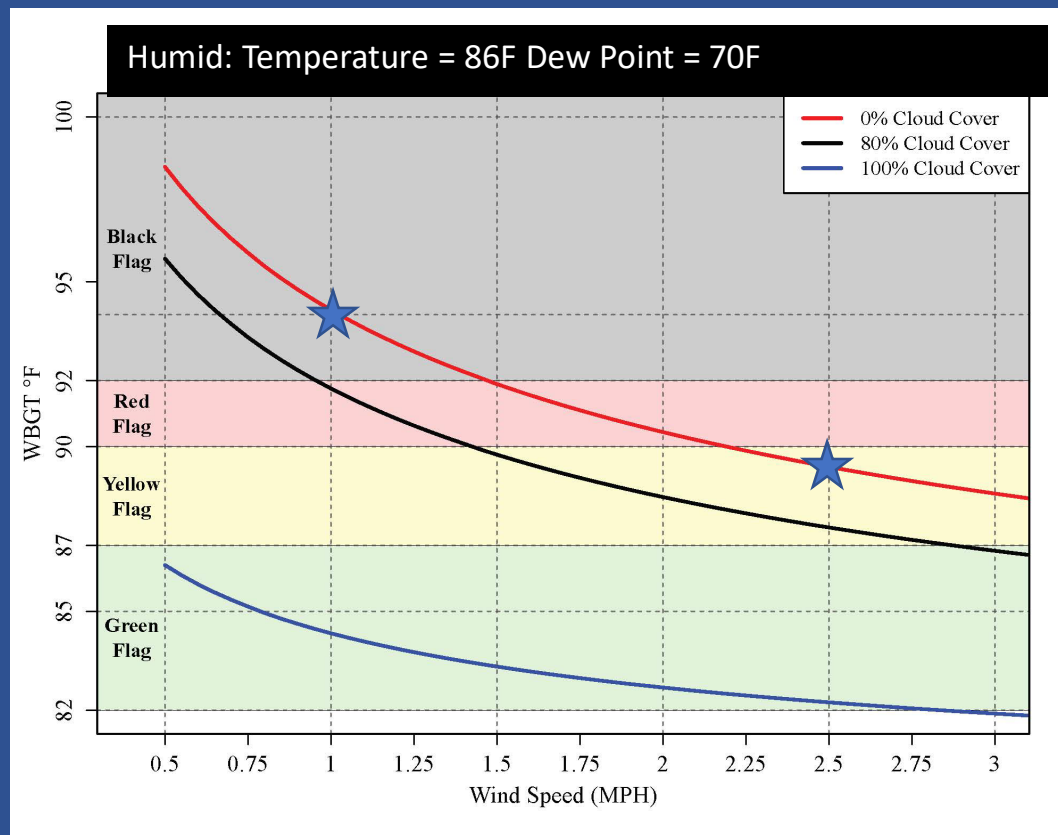
Many states have developed guidelines for high school sports

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

- Note that these guidelines vary slightly from state to state

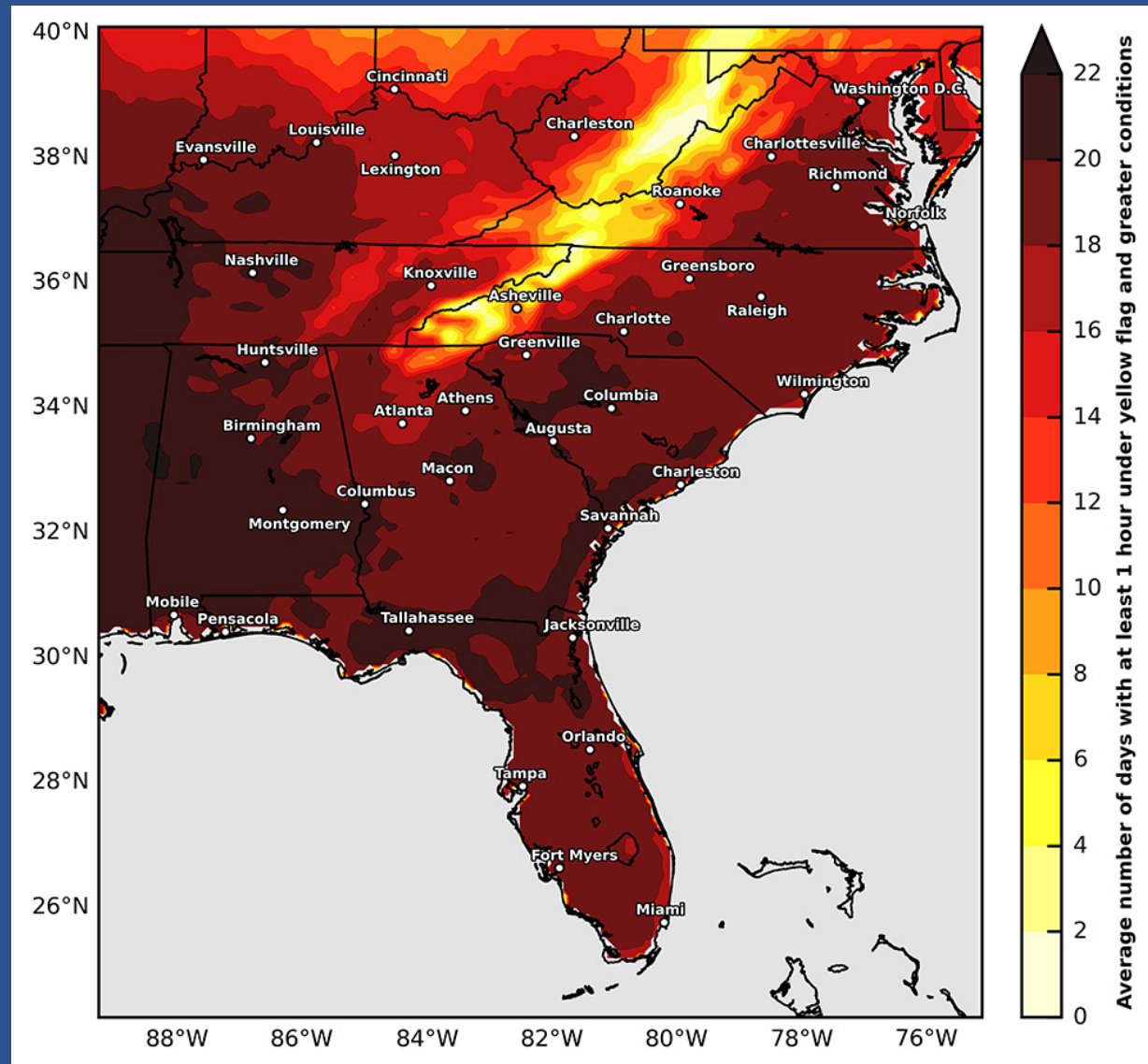
Local variations of heat stress (WBGT) dictated largely by wind speed in sunlit areas



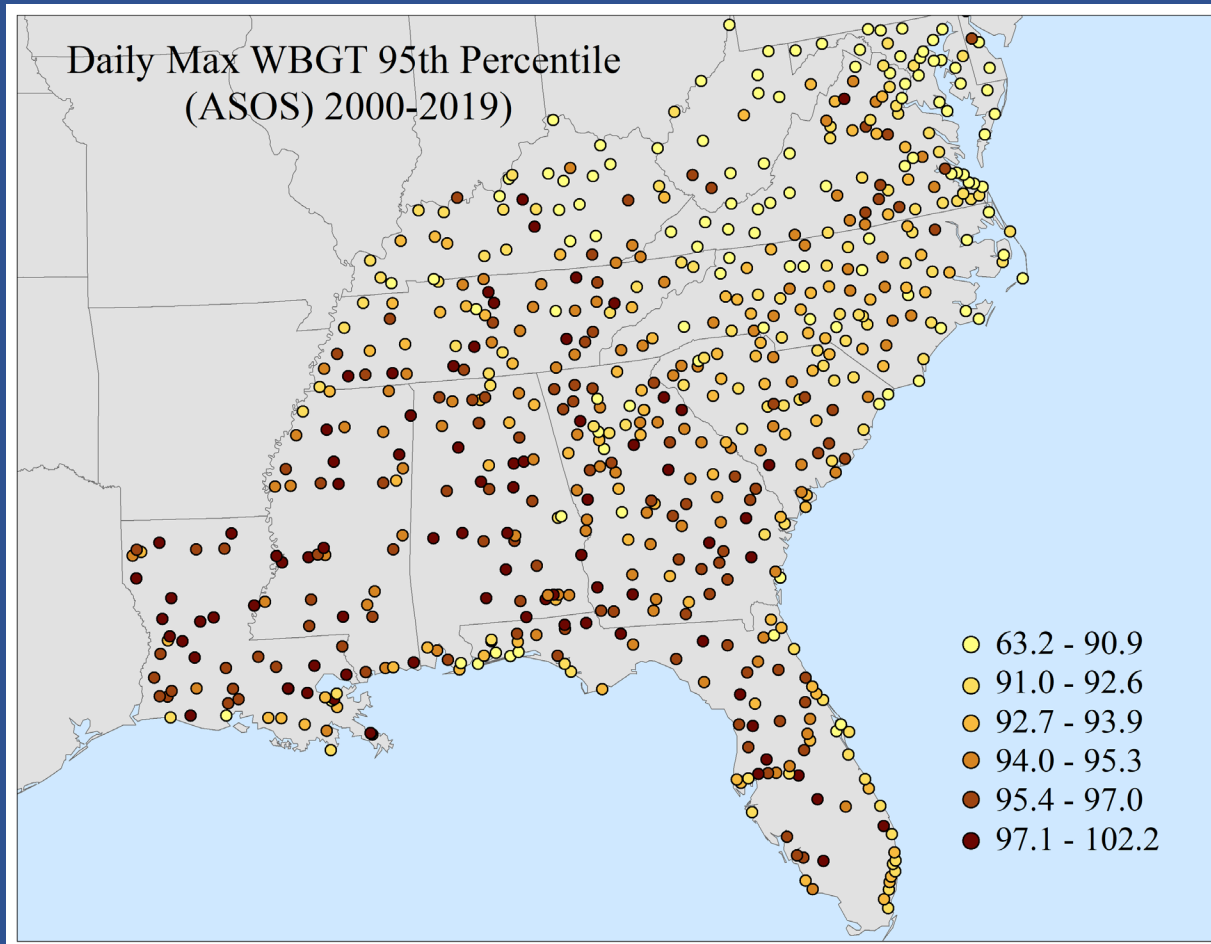
- The greatest local variations of WBGT) occur on the hottest, most dangerous days

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

Hours of
Yellow Flag and
greater
May-Sept



Much local variation in WBGT that relates to landscape, specifically surface roughness



Estimations of WBGT at weather stations across SE

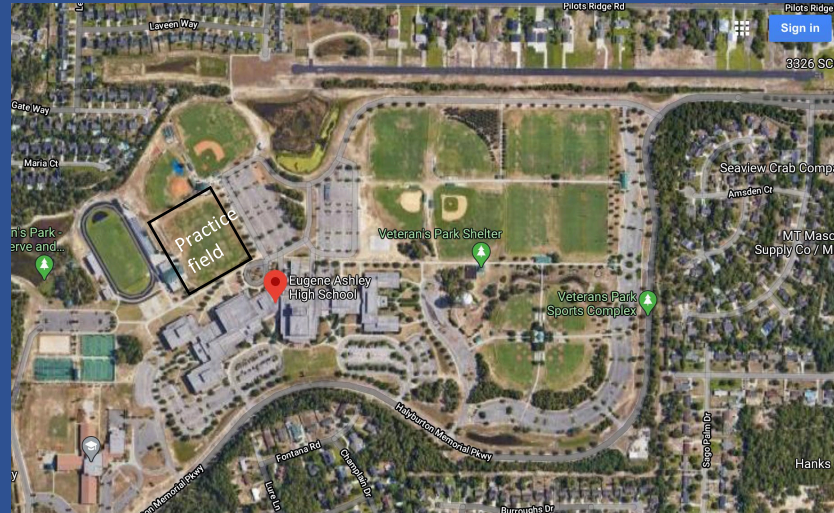
Field work reveals much local variation in WBGT which ties to wind speed variation

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*

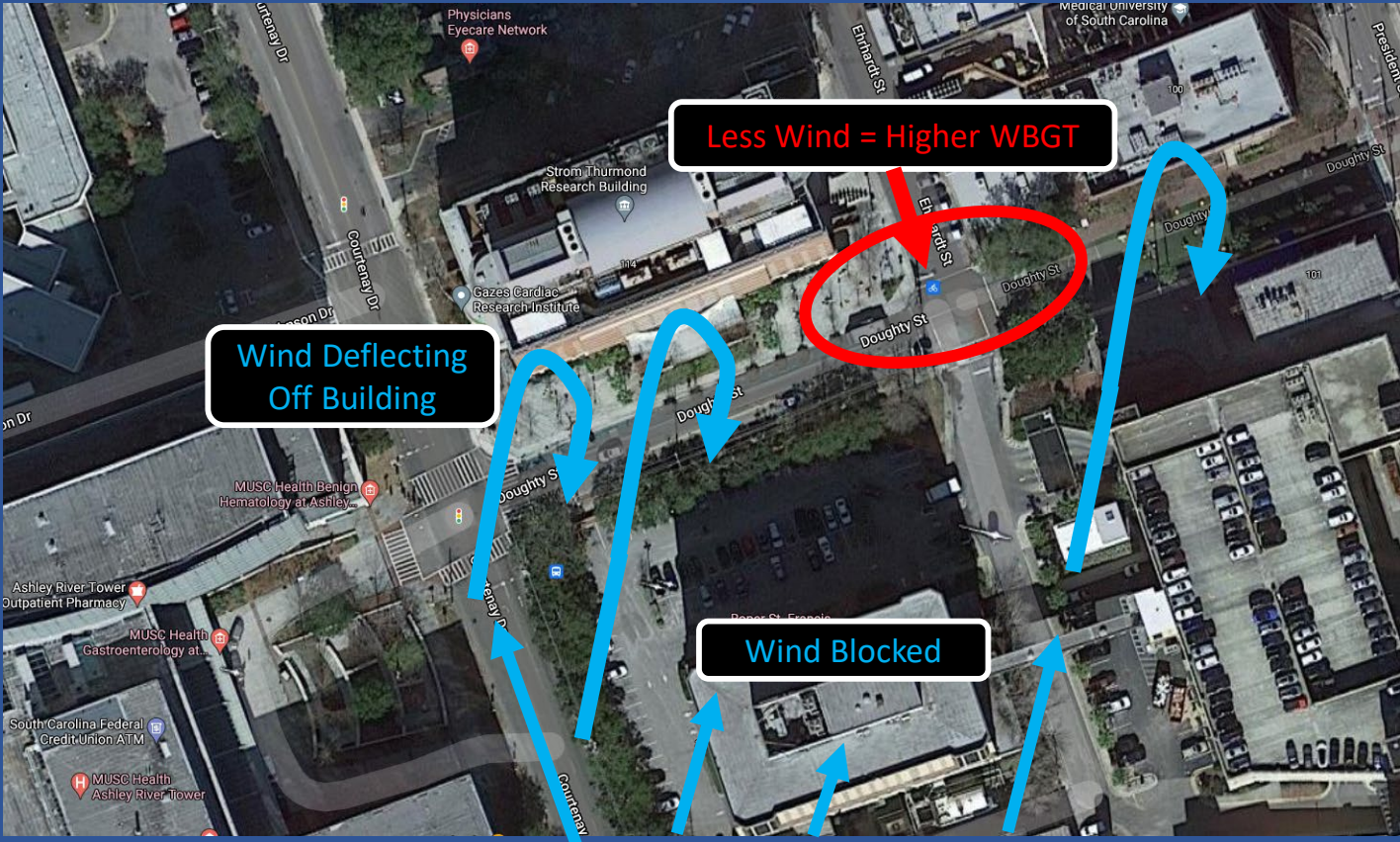
- 2) Adjacent to wetland

➤ *Exceptionally moist*





Charleston Medical District:
Urban Heat Island Pilot Study

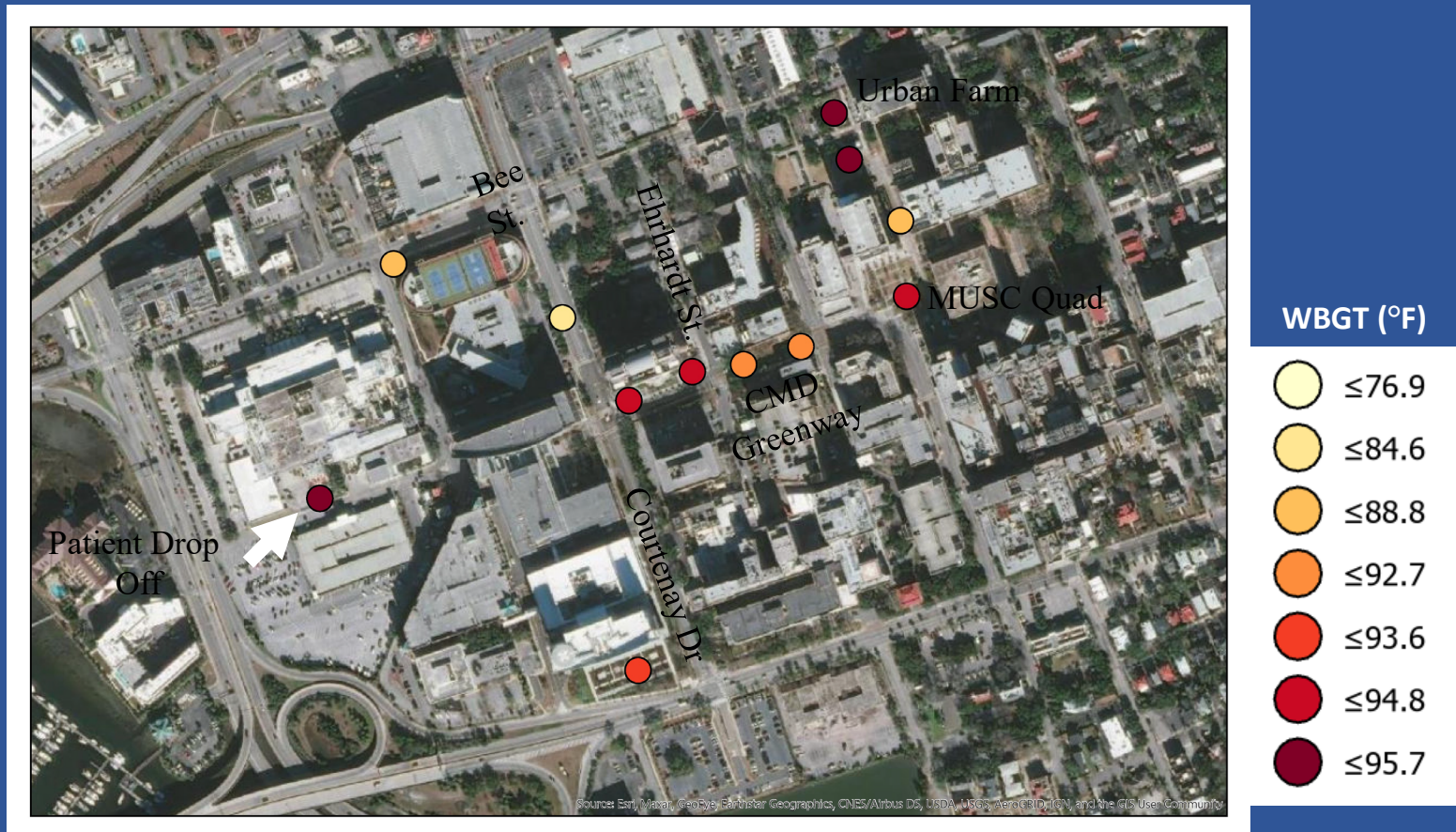


Wind Deflecting Off Building

Less Wind = Higher WBGT

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 (NDFD & NBM) 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.

MISSOURI (37.558789311325, -77.360874931701) KENTUCKY VIRGINIA NORTH CAROLINA SOUTH CAROLINA ALABAMA MISSISSIPPI GEORGIA LOUISIANA ARKANSAS TENNESSEE MISSOURI

Map Satellite

Choose a Model Wed Jun 9 1PM Submit

Wet Bulb Globe Temperatures for Richmond, VA

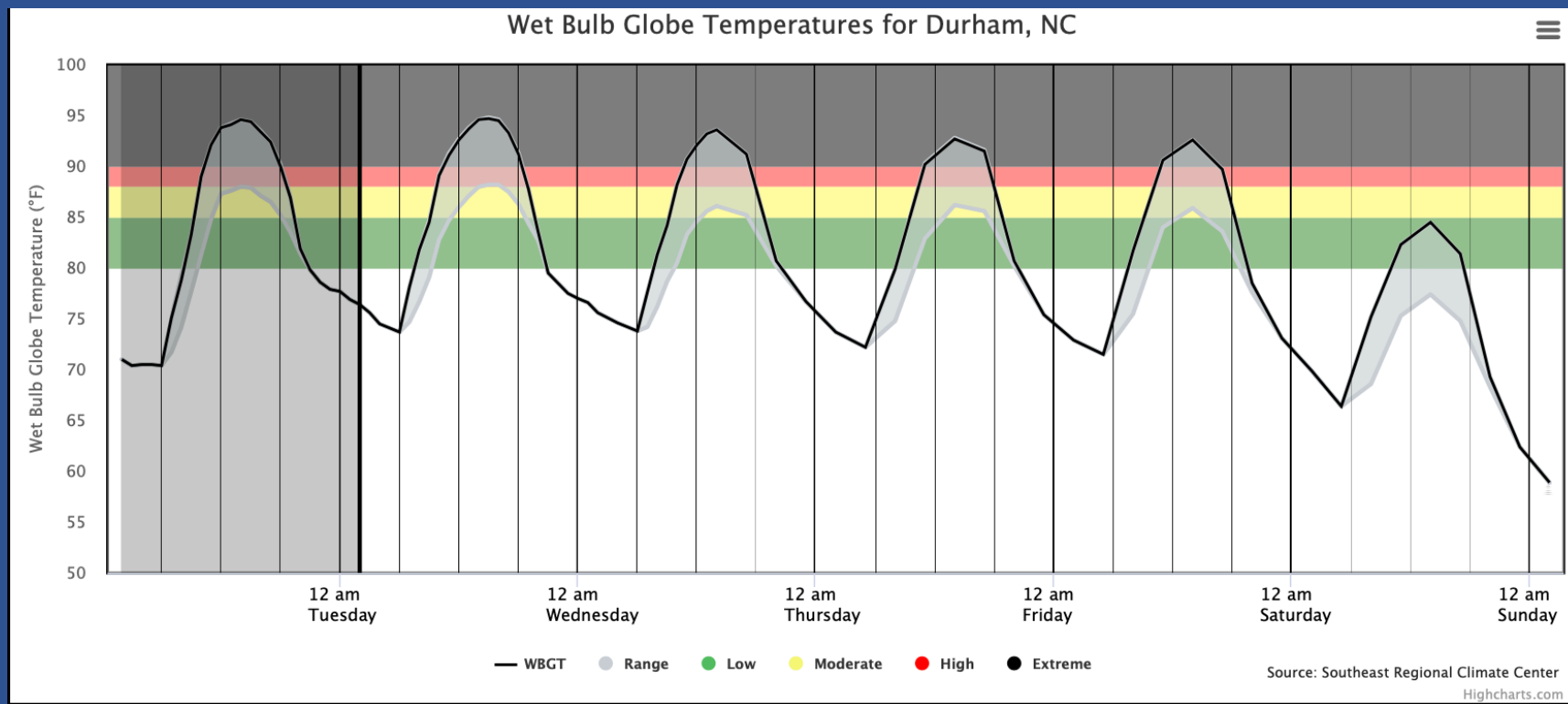
Wet Bulb Globe Temperature (°F)

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

WBGT Range Low Moderate High Extreme

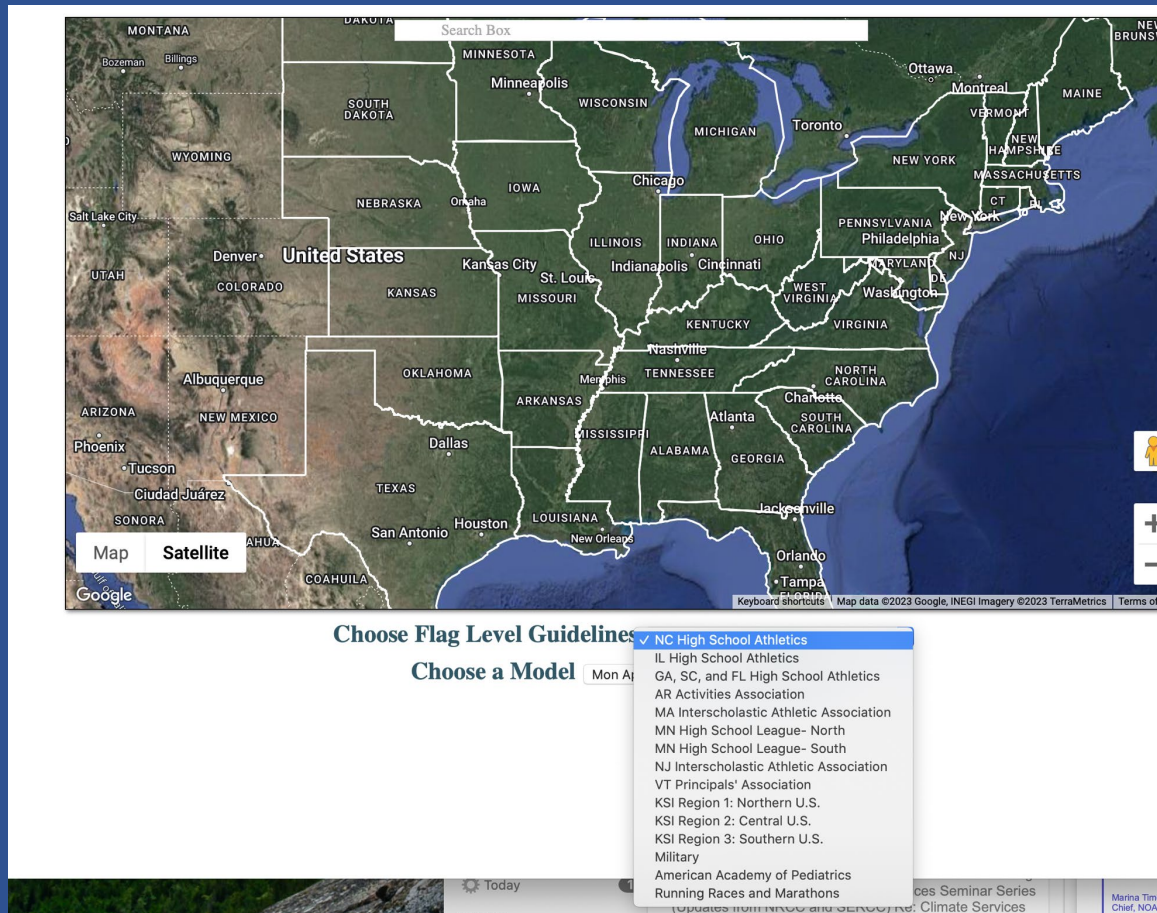
Wet Bulb Globe Temperature Tool

Expanded view of output



New features:

- 1) Model domain expanded to eastern two-thirds of US (May 2022)
- 2) Menu of flag level guideline options added (August 2022)



The screenshot displays a web application interface. At the top, there is a search box. Below it is a map of the United States, showing state boundaries and major cities. The map is overlaid with a blue shaded region representing the model domain, which covers the eastern two-thirds of the United States. Below the map, there is a dropdown menu titled "Choose Flag Level Guidelines". The menu is currently open, showing a list of options. The first option, "NC High School Athletics", is selected and highlighted in blue. Other options include "IL High School Athletics", "GA, SC, and FL High School Athletics", "AR Activities Association", "MA Interscholastic Athletic Association", "MN High School League- North", "MN High School League- South", "NJ Interscholastic Athletic Association", "VT Principals' Association", "KSI Region 1: Northern U.S.", "KSI Region 2: Central U.S.", "KSI Region 3: Southern U.S.", "Military", "American Academy of Pediatrics", and "Running Races and Marathons".

Choose Flag Level Guidelines

Choose a Model

- NC High School Athletics
- IL High School Athletics
- GA, SC, and FL High School Athletics
- AR Activities Association
- MA Interscholastic Athletic Association
- MN High School League- North
- MN High School League- South
- NJ Interscholastic Athletic Association
- VT Principals' Association
- KSI Region 1: Northern U.S.
- KSI Region 2: Central U.S.
- KSI Region 3: Southern U.S.
- Military
- American Academy of Pediatrics
- Running Races and Marathons

New features (continued)

3) More accurate estimation of clear sky radiation (implement in June/July)

4) Increase spatial granularity of the model from 2.5km² to 500m (implement in June/July)

- Estimate surface roughness from satellite derived vegetation data across a range of spatial scales and use it to downscale wind using logarithmic wind profile
- Validate with wind and WBGT measurements. Most accurate scheme blends surface roughness estimations across 4 spatial scales of roughness

Surface Roughness Weighted Average:							
	Best scheme	weights (%) for each scale tested					
Scale (m)	1	2	3	4	5	6	7
30	10	10	15	15	25	25	10
100	25	50	35	50	40	25	20
250	50	25	35	20	25	25	40
500	15	15	15	15	10	25	30

- Seven weighting schemes investigated to see which one best predicts weather station WBGT

THANK YOU!

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