

A Proposed Regional System of Categorizing WBGT for Athletic Outdoor Policy

Minh Phan¹
Castle Williams¹
Andrew Grundstein¹
Bud Cooper ²

¹Department of
Geography



²Department of
Kinesiology

Questions/Feedback

#WBGTCleveland



Overview

- What is the wet-bulb globe temperature (WBGT)?
- What kind of WBGT policies already exist?
- Do WBGT patterns exist throughout the contiguous United States?
- Are specific regions more at risk for exertional heat illnesses?
- How can current guidelines be altered to account for climatological effects?
- How can we use this information to affect athletic policy in the future?

What is Wet-Bulb Globe Temperature?

- The WBGT integrates the influences of sun exposure, air temperature, humidity, and windspeed.
- Computed as a weighted average of the wet-bulb temperature (**WB**), the dry-bulb temperature (**DB**), and the globe temperature (**GT**) as follows (Yaglou and Minard, 1957):

$$\text{WBGT} = 0.7 \cdot \text{WB} + 0.2 \cdot \text{GT} + 0.1 \cdot \text{DB}.$$

Introduction to Research

- Exertional heat illnesses affect thousands of athletes each year across the United States.
- Current guidelines are in place for the contiguous United States by the American College of Sports Medicine (ACSM).
- Their “one size fits all” approach does not account for regional variations in acclimatization to heat.

90th Percentile WBGTs



25.9 °C

Seattle, WA



38.2 °C

Phoenix, AZ



34.6 °C

Atlanta, GA



28.2 °C

Boston, MA

Current ACSM Guidelines

WBGT (°C)	Activities restriction
18.4-22.2°C	Normal Activities
22.3-25.6°C	Normal activity. Monitor fluid intake.
25.7-27.8°C	Normal activity. Monitor fluid intake.
27.9-30.0°C	Plan intense or prolonged exercise with discretion; watch at-risk individuals carefully.
30.1-32.2°C	Limit intense exercise and total daily exposure to heat and humidity; watch for early signs or symptoms.
>32.3°C	Cancel exercise; uncompensable heat stress exists for all athletes.

Methodology

- WBGT data were obtained from a WBGT climatology (1991-2005) developed using weather station observations and a physically based WBGT model (Liljegren et al., 2008; Grundstein et al., In Press).
- This dataset includes hourly WBGTs for 217 stations across contiguous United States.
- Oppressive heat was determined using the 90th percentile warm season (May-September) WBGT for each station. These data were gridded along interpolated across the contiguous U.S.
- Three heat safety classes were developed using the 90th percentile WBGT, using thresholds of: $\geq 32.3^{\circ}\text{C}$, $\geq 31^{\circ}\text{C}$, and $\leq 29^{\circ}\text{C}$.

Results

WBGT Contour Patterns



Figure 1: There is considerable regional variability in extreme warm season WBGT values.

Regionalized Categories

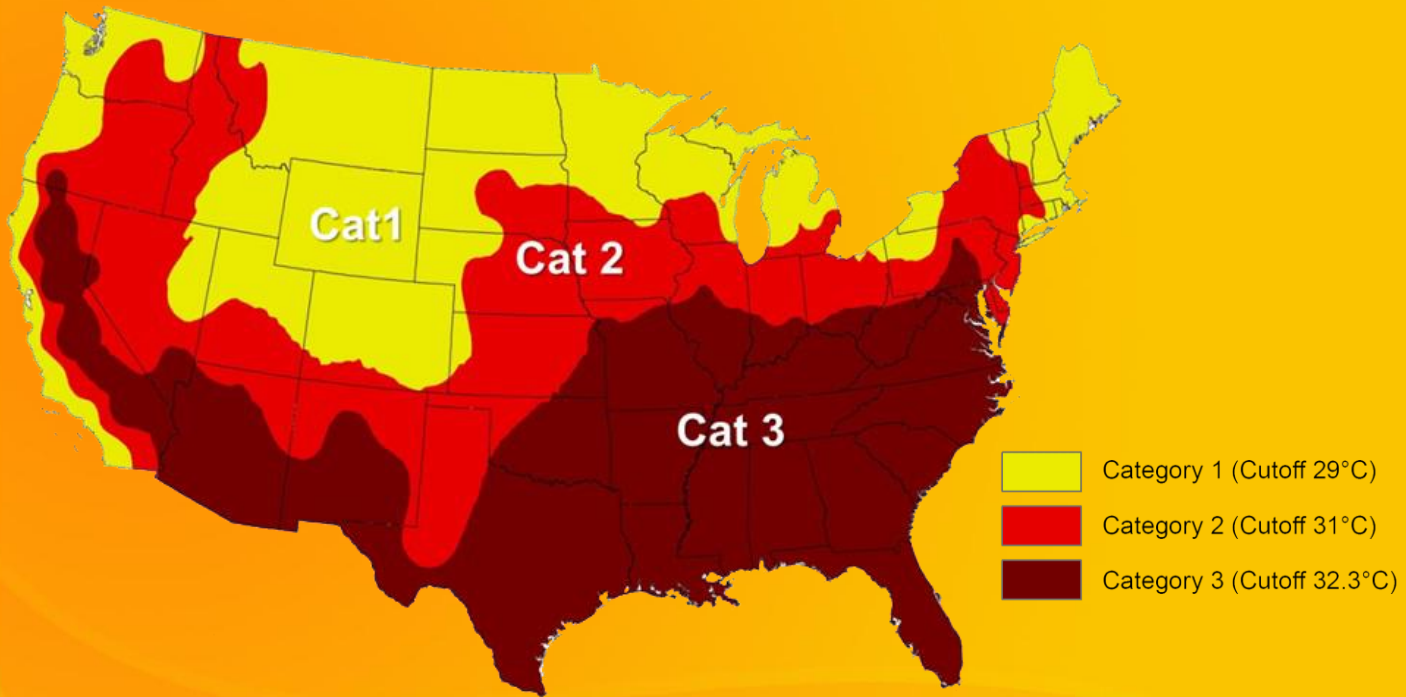


Figure 2: Our heat safety map captures the variability and provides geographically diverse thresholds that account for acclimatization.

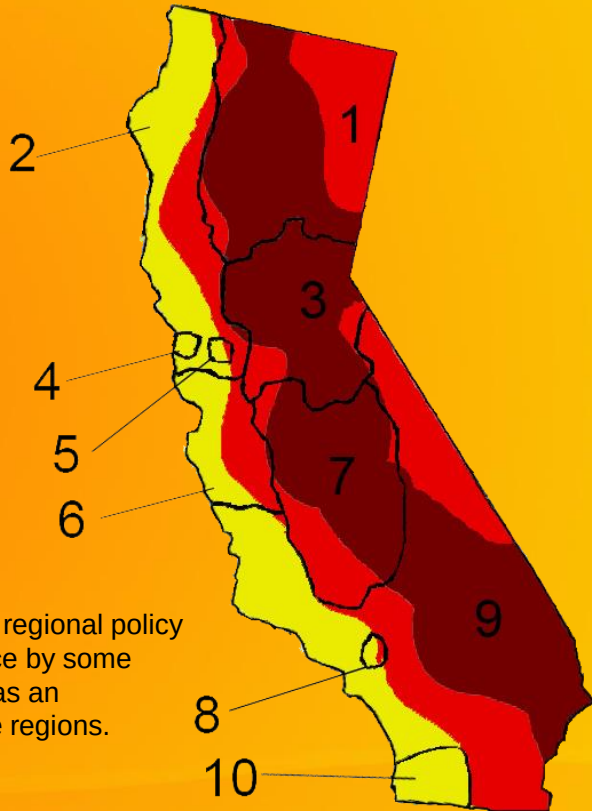
Cat 3 (°C)	Cat 2 (°C)	Cat 1 (°C)	<i>Proposed Activity Guidelines</i>
< 25.7	< 24.4	< 22.4	Normal activities, monitor fluids
25.7-27.8	24.4-26.5	22.4-24.5	Normal activities, monitor fluids
27.9-30.0	26.6-28.7	24.6-26.7	Plan intense or prolonged exercise with discretion
30.1-32.2	28.8-30.9	26.8-28.9	Limit intense exercise and total daily exposure to heat and humidity
≥32.3	≥31.0	≥29.0	Cancel exercise

Current ACSM Guidelines

WBGT (°C)	Activity Restrictions
22.3-25.6°C	Normal activity. Monitor fluid intake.
25.7-27.8°C	Normal activity. Monitor fluid intake.
27.9-30.0°C	Plan intense or prolonged exercise with discretion; watch at-risk individuals carefully.
30.1-32.2°C	Limit intense exercise and total daily exposure to heat and humidity; watch for early signs or symptoms.
>32.3°C	Cancel exercise; uncompensable heat stress exists for all athletes.

Cat 3 (°C)	Cat 2 (°C)	Cat 1 (°C)	<i>Proposed Activity Guidelines</i>
< 25.7	< 24.4	< 22.4	Normal activities, monitor fluids
25.7-27.8	24.4-26.5	22.4-24.5	Normal activities, monitor fluids
27.9-30.0	26.6-28.7	24.6-26.7	Plan intense or prolonged exercise with discretion
30.1-32.2	28.8-30.9	26.8-28.9	Limit intense exercise and total daily exposure to heat and humidity
≥32.3	≥31.0	≥29.0	Cancel exercise

California Case Study



- 1. Northern
- 2. North Coast
- 3. Sac-Joaquin
- 4. San Francisco
- 5. Oakland
- 6. Central Coast
- 7. Central
- 8. Los Angeles
- 9. Southern
- 10. San Diego



Figure 3: Example of how our regional policy would affect guidelines in place by some states like California, which has an abundance of variable climate regions.

California Case Study

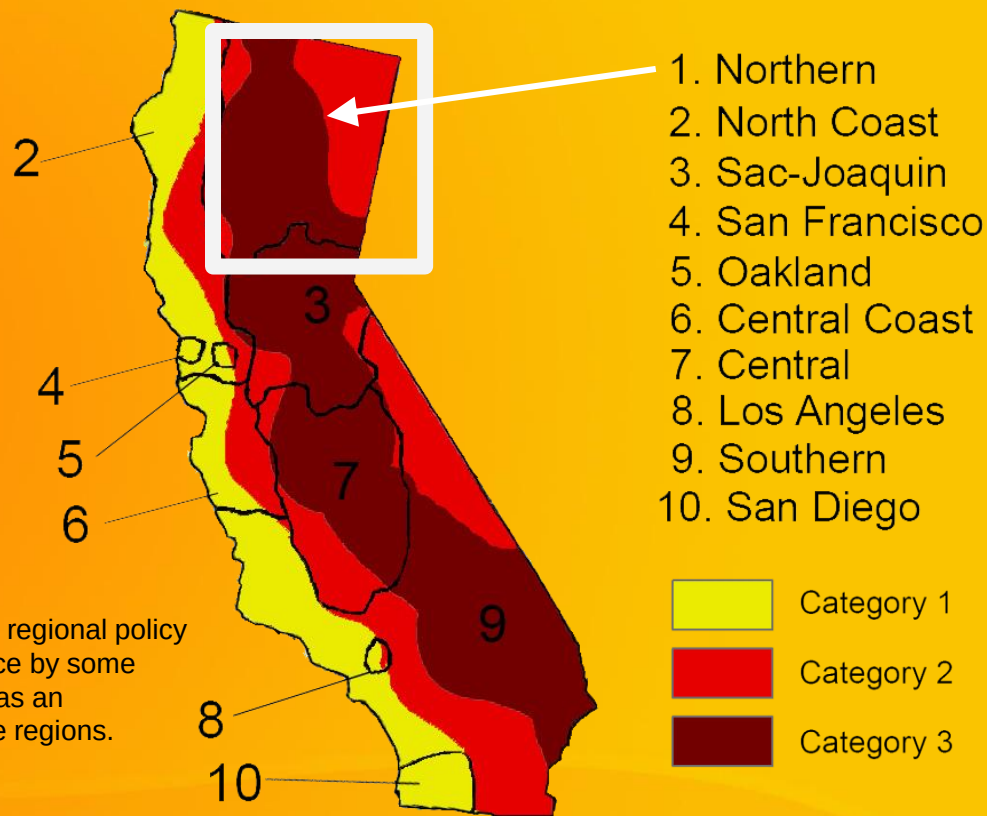


Figure 3: Example of how our regional policy would affect guidelines in place by some states like California, which has an abundance of variable climate regions.

What we hope to accomplish

- While professional and collegiate level athletic programs have already adopted strong heat safety policies, there is considerable variations in state policies for high school interscholastic athletes (Korey Stringer Institute – KSI, 2014).
- At present, only 13 states have developed heat policy guidelines for athletic participation that meet suggestions by the National Athletic Trainers Association (NATA) and the KSI (Casa and Csillan 2009; KSI 2014).
- Many other states are actively working to improve their policies, and we hope that our regional heat safety information may be of use in guiding and informing heat safety policy decisions in the future.

WBGT in the Spotlight



2014 FIFA WORLD CUP™ - GROUP G

ESPN **USA 0-1 POR** **39:27**

COOLING BREAK RULE

- DETERMINED BY WBGT OVER 89.6°F
- STOPPAGE AT 30' & 75', 3 MINUTES IN LENGTH

Thank you!

Questions?

#WBGTCleveland



Wet-Bulb vs. Wet-Bulb Globe

Wet-Bulb Temperature

- the lowest temperature that can be reached under current ambient conditions by the evaporation of water.
- Largely determined by both actual air temperature (dry-bulb temperature) and the amount of moisture in the air ([humidity](#)).

WBGT

Heat Index

Measured in the sun



Measured in the shade



Uses temperature



Uses relative humidity



Uses wind



Uses cloud cover



Uses sun angle



