Work, Heat, and Climate Change: Outdoors and Indoors

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Intergovernmental Panel on Climate Change (IPCC)
Fifth Assessment

ISEE/ISES/ISIAQ Conference, Basel, Aug 2013

What is possibly the largest economic impact of climate change as well as one of the major threats to health?

- Storms, floods, droughts, wildfires?
- Malaria, dengue, meningitis?
- Heat waves?
- Malnutrition?

Climate Vulnerability Monitor 2012, DARA

Estimates climate change impacts to 2030, US$ Billions

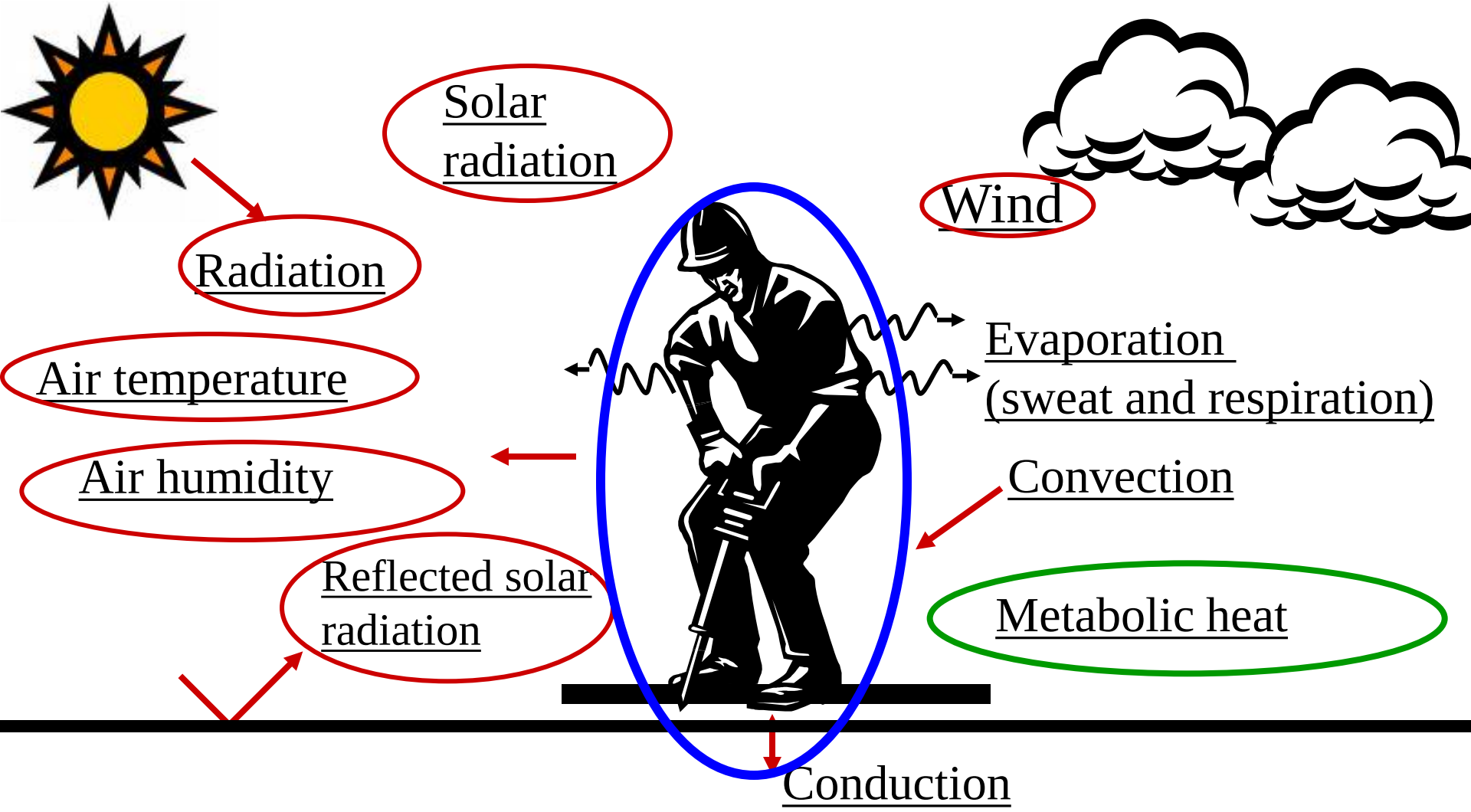
Impact component	Total global net cost; in brackets, % of total climate		Net cost in 2030 in specific country types		
	2010	2030	Developing, low GHG emitters	Developing, high GHG emitters	Developed
Total climate change costs	609 (100%)	4345 (100%)	1730(100%)	2292 (100%)	179 (100%)
Labor Productivity loss due to increased workplace heat	**311** (51%)	**2436** (56%)	1035(60%)	1364 (60%)	48 (27%)
Clinical Health impacts costs	23 (3.7%)	106 (2.4%)	84 (4.9%)	21 (0.9%)	0.002 (0.001%)

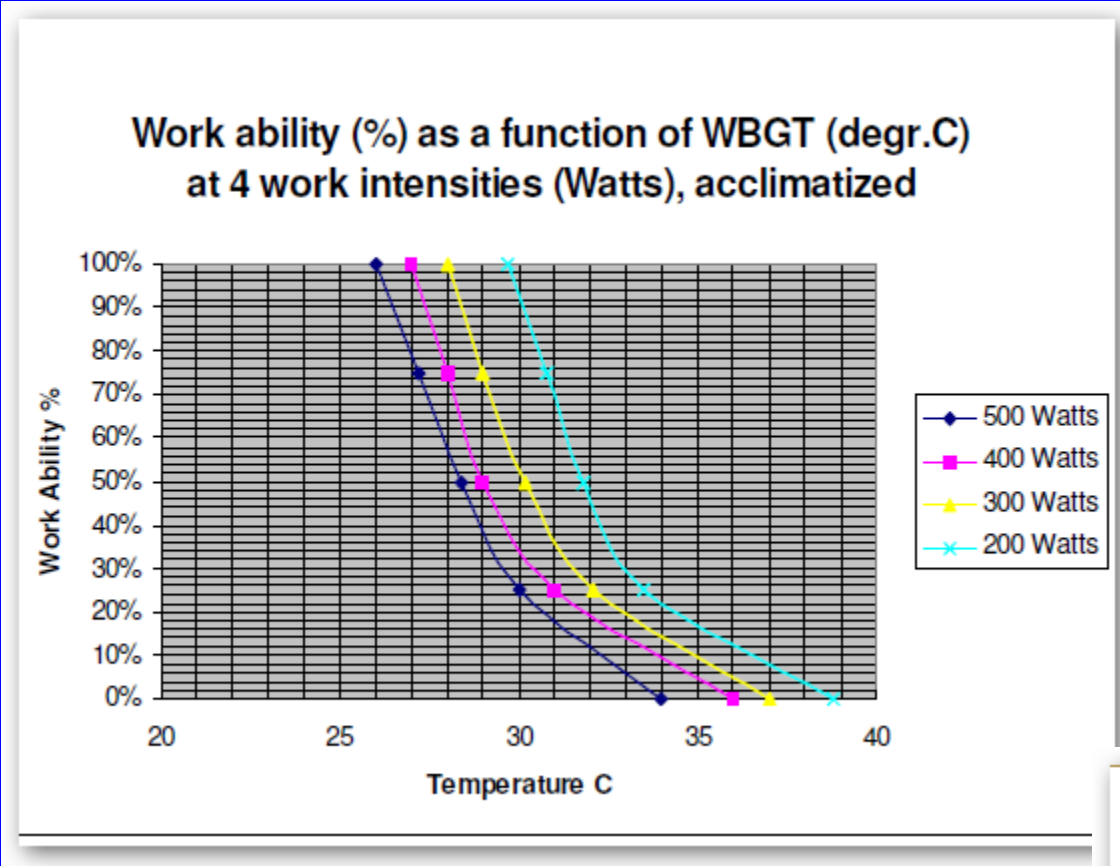
DARA Report, 2012

- Fractional increases in global temperature can translate into tens of additional hot days with each passing decade.
- (Loss of) labour productivity is estimated to result in the largest cost to the world economy of any effects analysed
- Trillions of US$ by 2030
- Not peer-reviewed and only one report, but indicates potential scale of the issue

Heat exchange of worker performing physical work in hot weather

Heat stress = Environmental + metabolic heat loads - heat loss





Wet Bulb Globe Temperature =

Function of

- temperature,
- humidity,
- wind speed, and
- radiative energy, e.g., sunlight

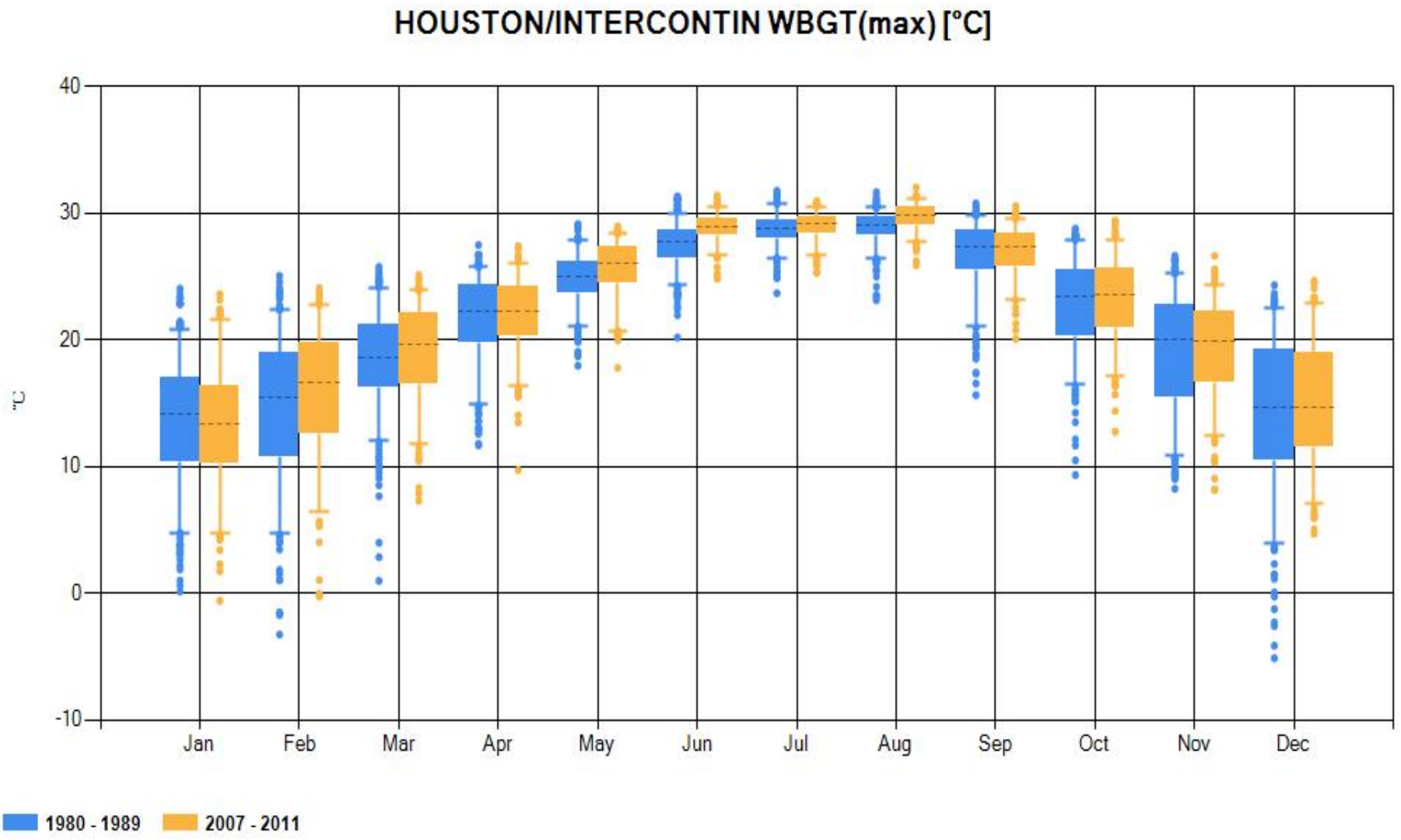
- No epidemiology needed
- Basic thermodynamics and human physiology from exposure chamber studies
- The science is 60 years old – US military research in the 1950s and much since
- **Refers to healthy workers – not the most vulnerable**

Effects of heat exposure

- Sweating, dehydration, salt loss
- Loss of ability to work intensively
- Loss of perceptual motor performance
- Increased accident risk

- Increased body temperature (>38 °C)
- Heat stroke
- Unconsciousness
- Death

An example: Dallas airport -- Monthly distribution of WBGTmax with 25% (7-days) and 10% (3-days) limits and outliers



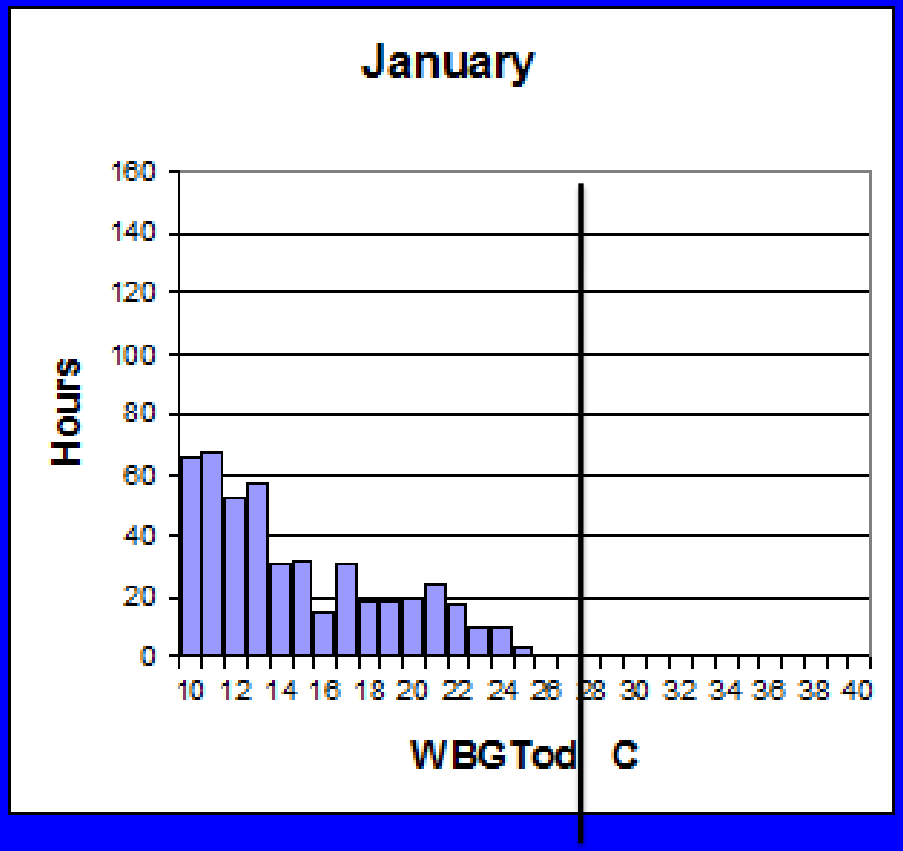
Heat stress: a common hazard in outdoor workplaces in tropical countries

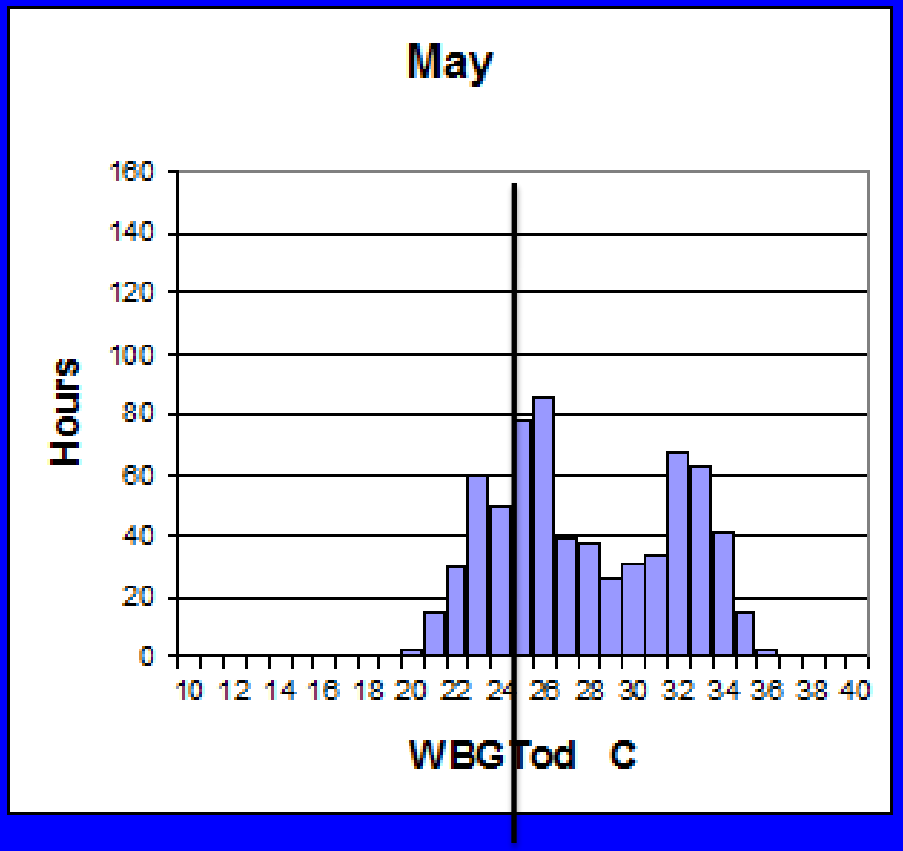
Sugar cane cutting, Nicaragua

Hourly heat exposure situation:

Heat index (WBGT) outdoors in Delhi, 1999. Hours each month at each WBGT level, January + May (coolest and hottest months).

WBGT = 26 °C cut-off point for work capacityimpact risk



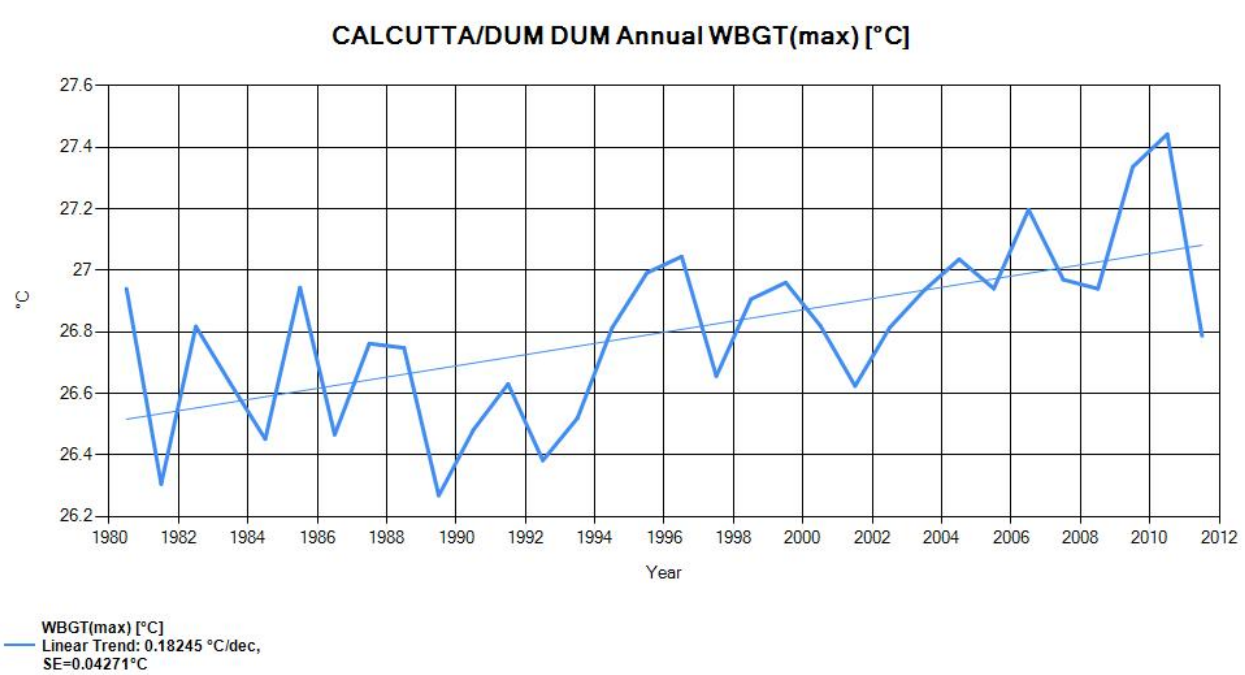


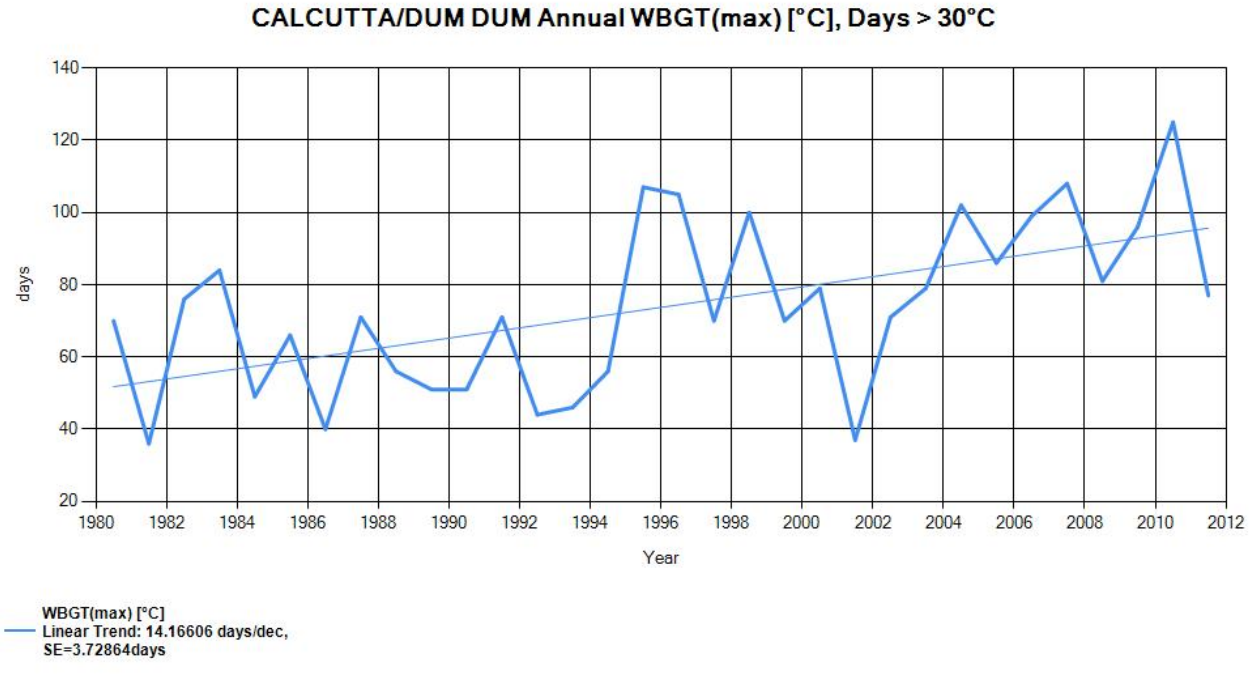
Time trends, 1980-2012 for Kolkata

Upper curve = Average annual WBGTmax, **from 26.5 to 27.1 C**

Lower curve = Annual number of days when WBGTmax is > 30 C, **from 52 to 96 days** (increases 14 days per decade)

outputs from **Hothaps-Soft**





Hot also inside factories: Le Lai shoe factory No 2, Haiphong

2 hour longer workdays in summer due to fixed daily output targets

India studies

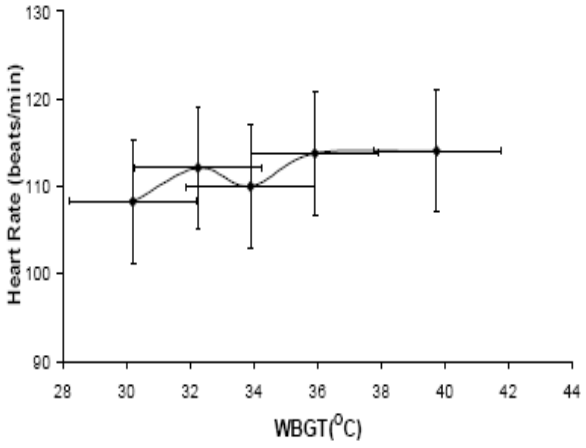
Hourly WBGT data for Summer 2013 - Residential complex, Chennai

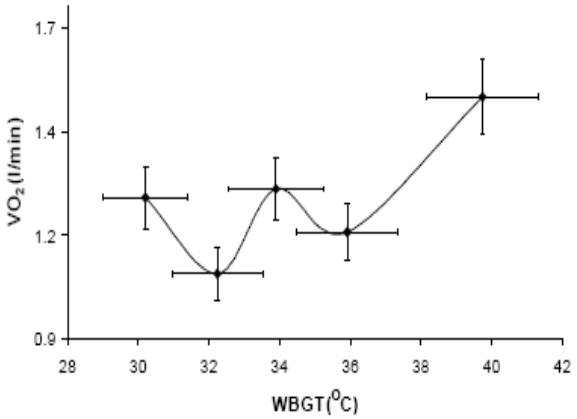
Date	Location	Work Category	WBGT (^{0}C)									Ambient temp(^{0}C)
			8:00-9:00	9:00-10.00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14.00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	
21/05/2013	Ironing Room -G-Block	Heavy 500W	-	-	-	35.3	34.5	34.4	34.5	34.0	34.7	34.4	34.5
22/05/2013			34.2	34.3	34.7	35.1	35.7	36.0	35.0	35.4	35.7	35.1	35.1
23/05/2013			32.6	33.2	33.1	34.3	34.0	33.8	33.8	33.7	33.9	34.1	33.6
24/05/2013			34.3	34.0	34.7	34.8	35.4	34.6	35.8	35.7	35.3	34.8	34.9
25/05/2013			30.5	30.3	30.2	30.7	30.7	31.3	31.6	31.6	32.1	33.2	31.2
21/05/2013	Ironing Room -C-Block	Heavy 500W	-	-	-	34.1	34.3	33.9	32.7	32.7	33.0	33.6	33.5
22/05/2013			32.4	32.8	34.2	34.8	35.2	34.6	34.5	34.8	34.8	34.6	34.2
23/05/2013			31.5	32.8	32.5	32.8	33.2	34.5	34.6	34.6	35.0	35.5	33.7
24/05/2013			32.7	33.5	34.4	34.4	35.2	34.9	34.5	35.6	35.4	35.2	34.6
25/05/2013			31.1	30.9	32.3	32.8	33.3	33.5	34.1	34.6	35.5	35.5	33.3
21/05/2013	Ironing Room -D2-Block	Heavy 500W	-	-	-	34.2	34.0	33.2	33.6	34.4	34.8	34.8	34.1
22/05/2013			32.4	33.8	34.1	34.9	35.7	34.5	35.5	36.3	35.9	35.7	34.9
23/05/2013			31.5	34.6	34.5	34.7	35.6	35.2	35.1	36.4	35.8	36.7	35.0
24/05/2013			32.5	32.3	32.3	32.2	32.1	32.1	32.5	32.9	33.6	33.7	32.6
25/05/2013			30.4	30.4	30.7	35.1	33.0	31.6	31.7	31.6	34.8	34.6	32.7

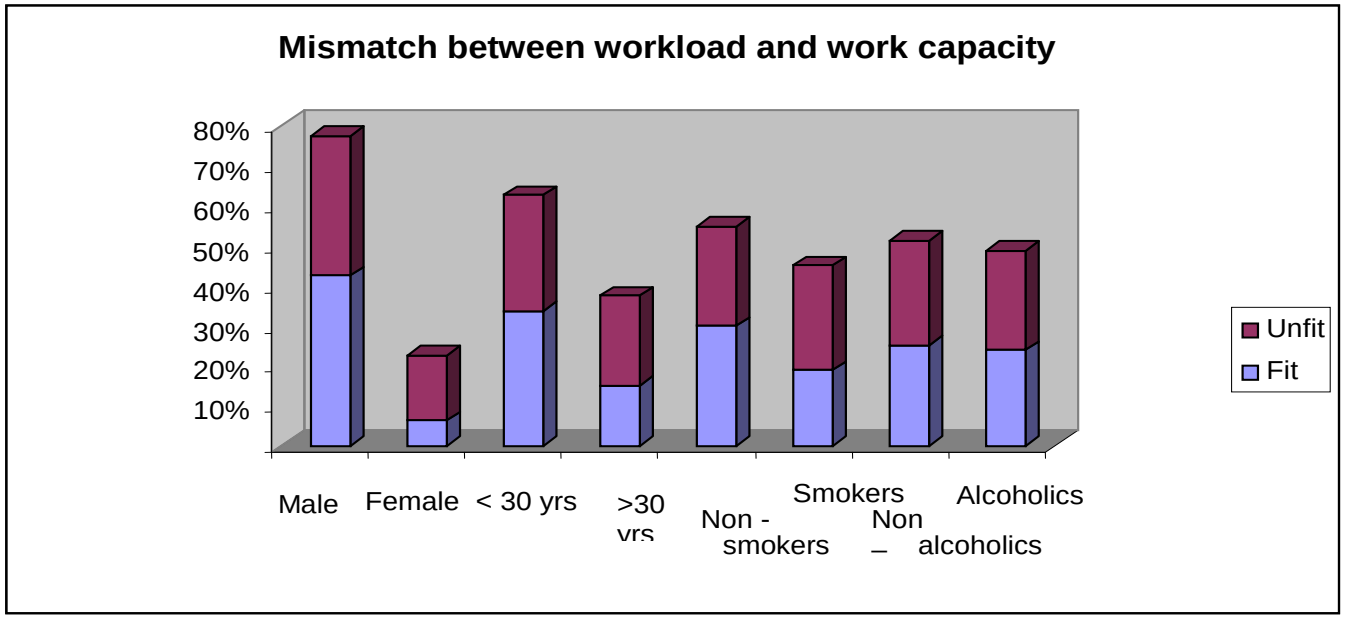
Hourly WBGT data for Winter 2013 - Residential complex, Chennai

Date (dd/mm/yy)	Location	Work category	WBGT (°C)										Ambient temp(°C)
			8:00-9:00	9:00-10.00	10:00-11:00	11:00-12:00	12:00-13:00	13:00-14.00	14:00-15:00	15:00-16:00	16:00-17:00	17:00-18:00	
9/1/13	Security area (Outdoor)	Heavy	-	-	-	-	29.3	28.3	28.5	29.0	-	-	28.8
9/1/13	Security area (Outdoor)	Heavy	-	-	-	-	32.2	30.1	29.4	29.2	32.2	-	30.6
10/1/13	Ironing area-D block (Indoor)	Moderate	-	-	-	32.2	31.7	36.9	32.9	-	-	-	33.4
10/1/13	Near Iron box (Indoor)	Moderate	-	-	-	32.6	32.6	34.4	33.8	31.5	33.5	35.0	33.3
11/1/13			30.0	30.0	29.5	30.3	33.6	33.7	32.2	34.3	35.6	33.5	32.3
12/1/13			29.8	32.5	34.0	31.4	32.5	32.9	30.4	31.9	31.3	33.4	32.0
13/1/13			29.1	29.1	32.7	33.9	33.0	32.7	33.9	33.7	34.9	31.2	32.4
14/1/13			28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8	28.8
10/1/13	Residence (Indoor)	Light	27.8	28.9	29.6	30.1	30.3	30.3	30.1	30.4	30.1	29.4	29.7
11/1/13			27.9	28.6	29.4	29.6	30.4	30.6	30.9	30.4	29.4	28.6	29.6
12/1/13			27.4	27.9	28.5	29.1	29.4	29.4	29.4	29.6	29.3	28.6	28.9
13/1/13			25.8	27.1	28.4	28.8	29.0	29.3	29.6	29.3	29.2	28.5	28.5
14/1/13			25.4	26.5	27.6	28.0	28.7	29.5	28.0	27.8	28.2	28.3	27.8

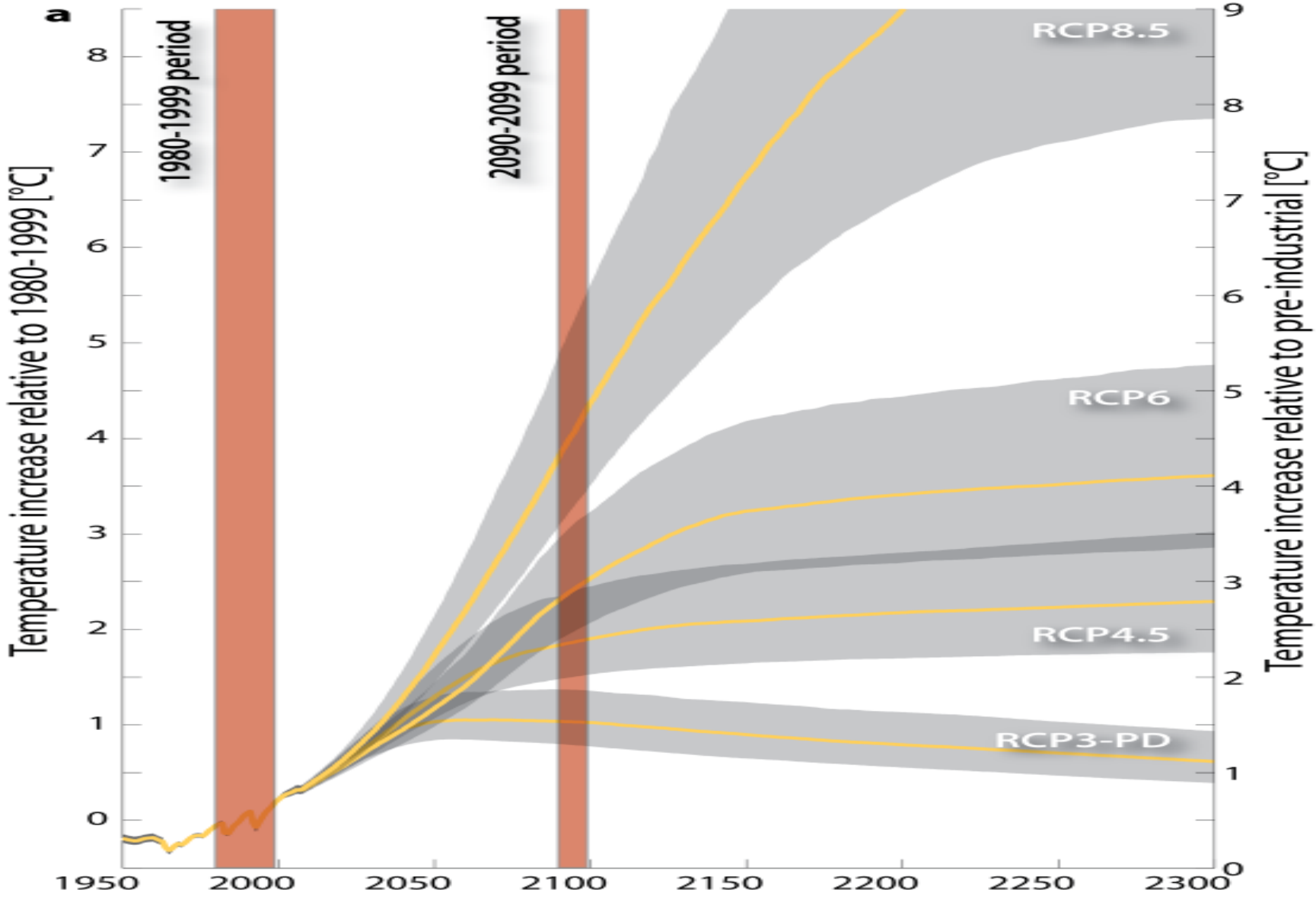
Physiological responses (GJ and TN sites)







WHAT ABOUT CLIMATE CHANGE?



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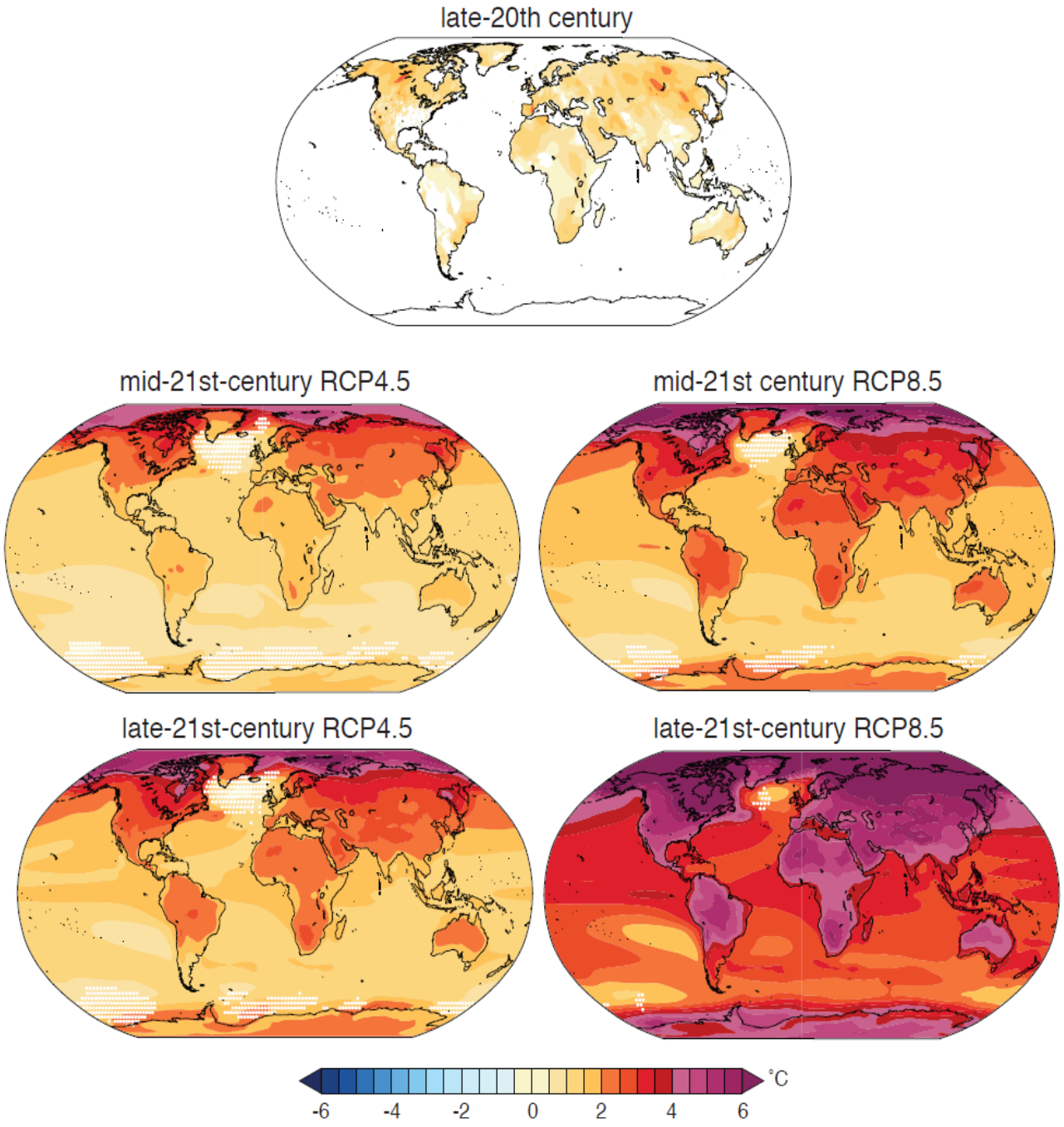
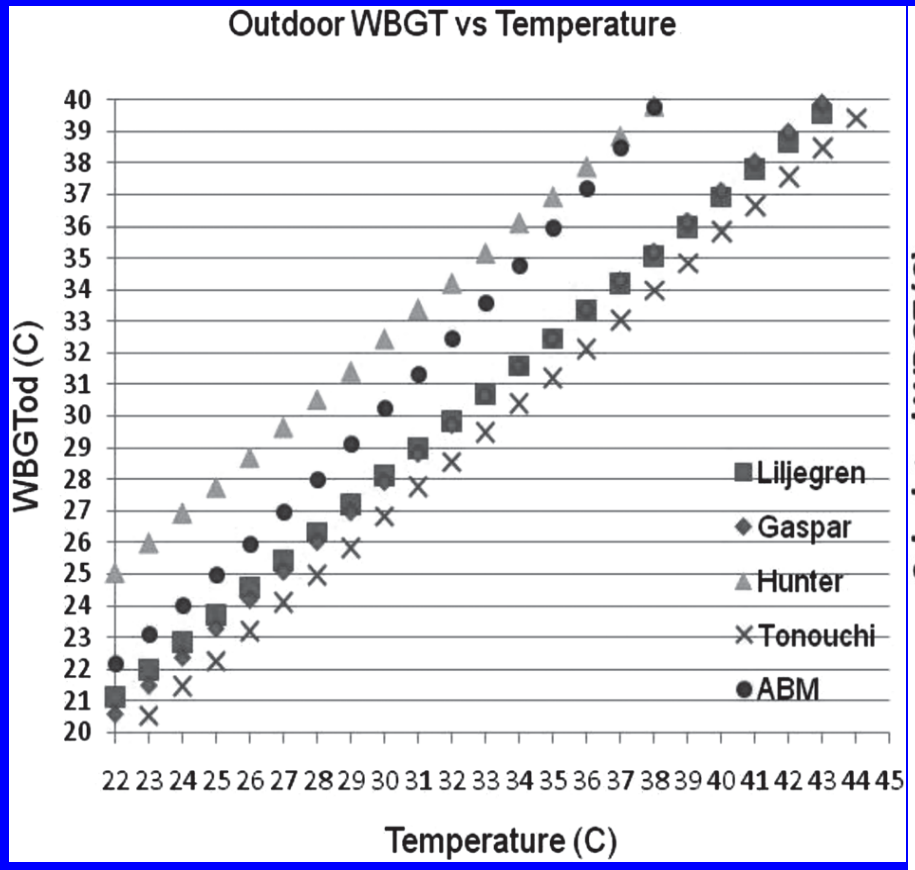
Change of **annual average temp** during 20th century and projected changes for 21st century

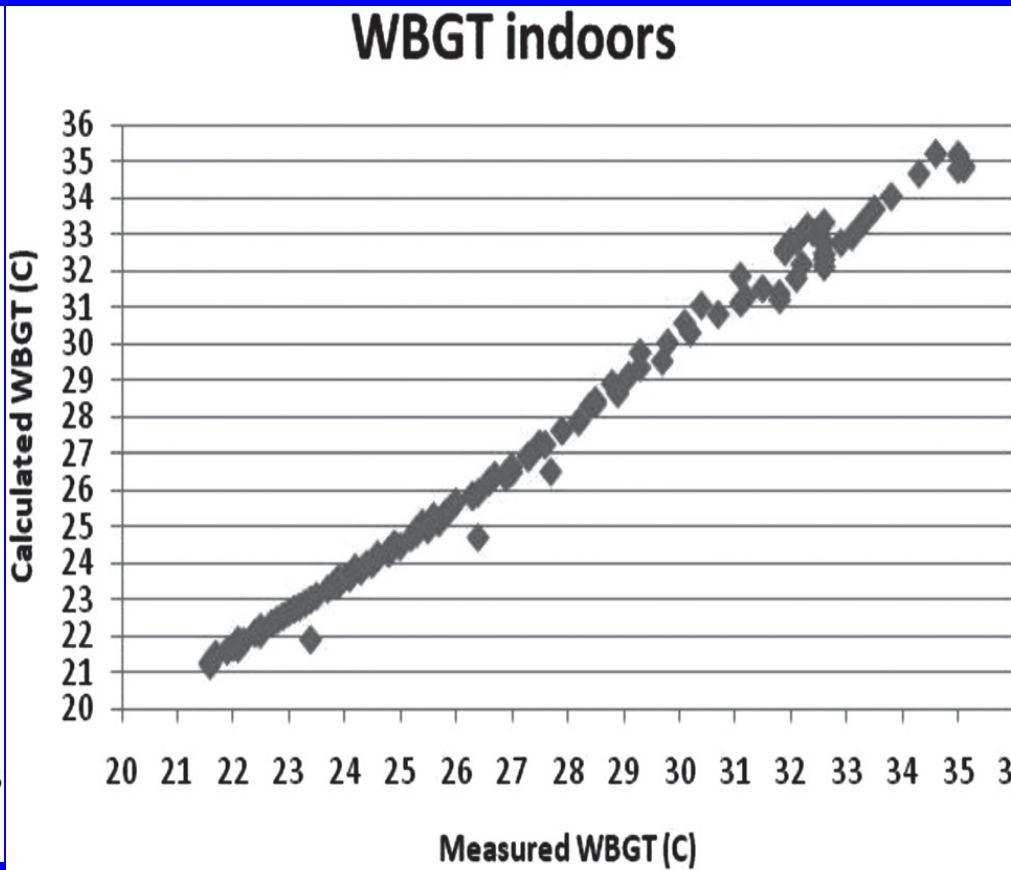
But need to estimate WBGT



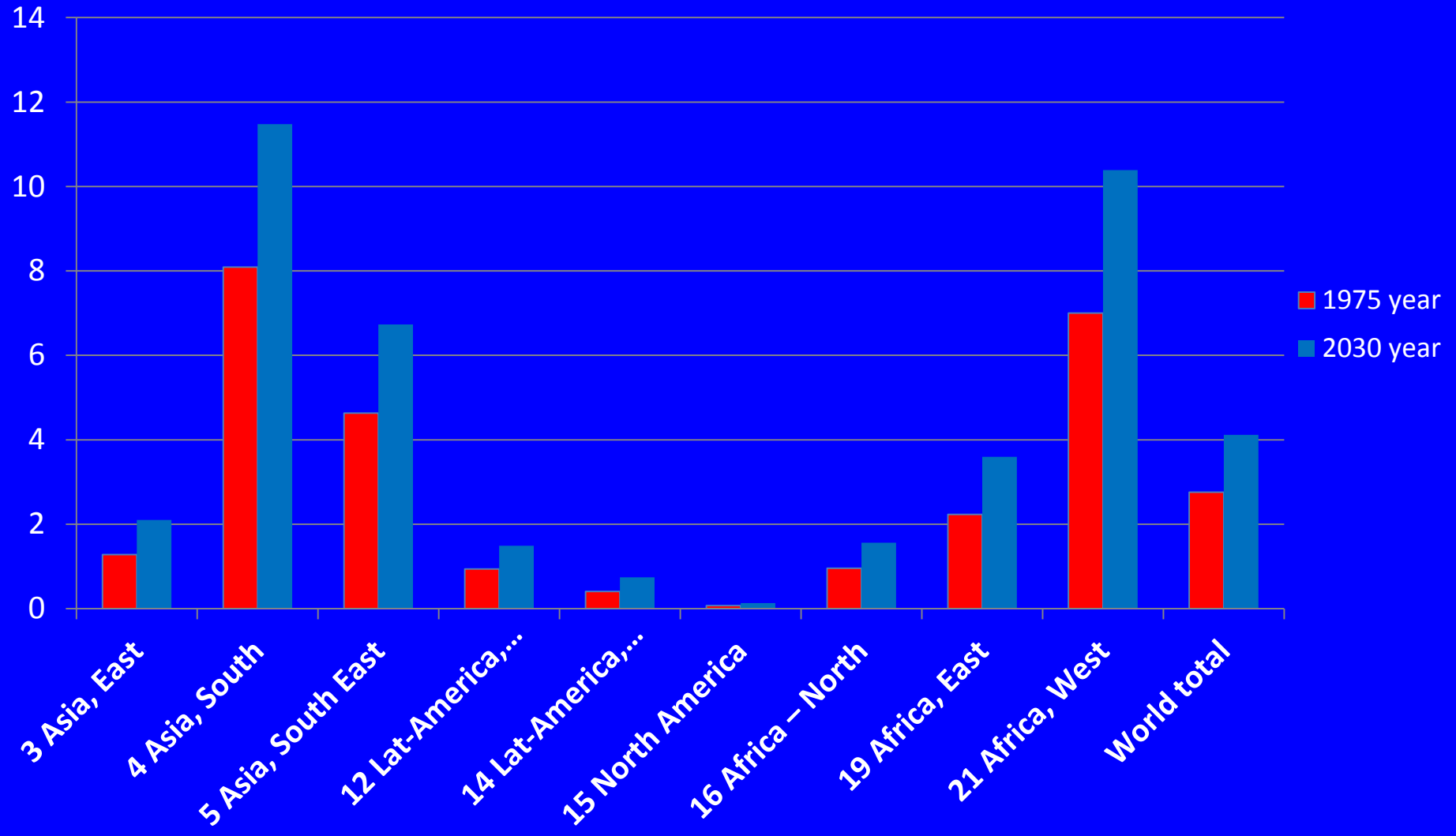
Calculating Workplace WBGT from Meteorological Data: A Tool for Climate Change Assessment

Bruno Lemke and Tord Kjellstrom,
Industrial Health 2012, 50, 267–278

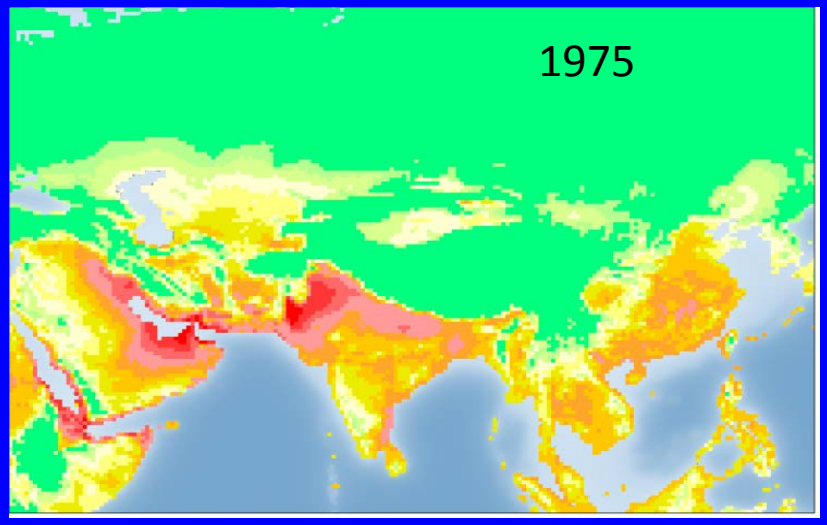


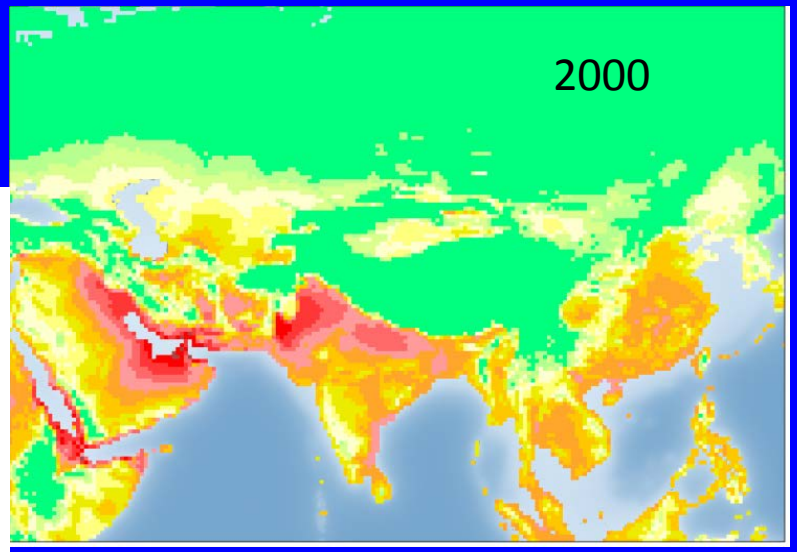


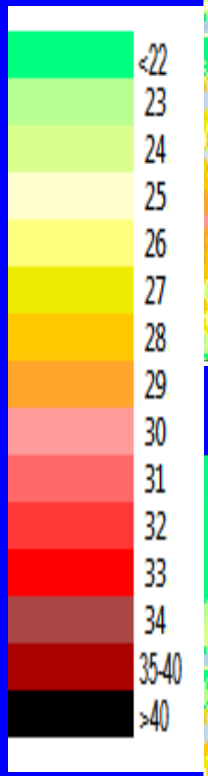
Work capacity loss (% of daylight hours) in 2030 based on regional climate change (average of 3 models), population in 2030 and estimated workforce distribution in 2030

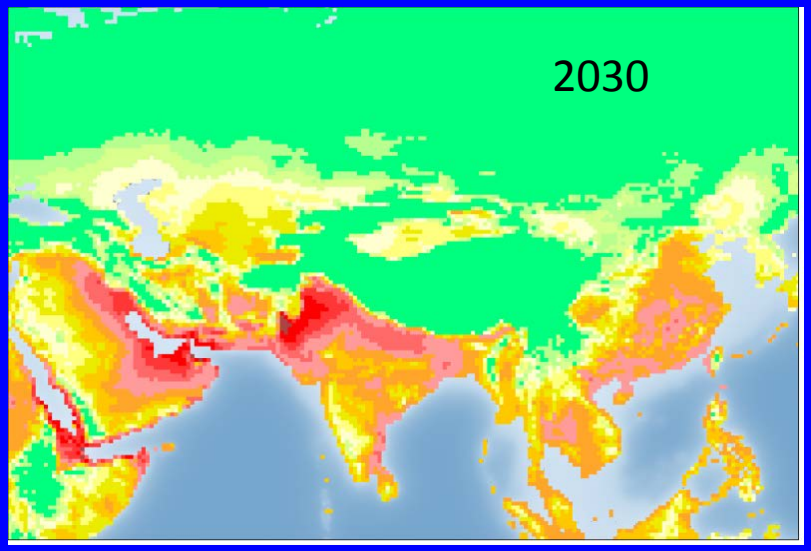


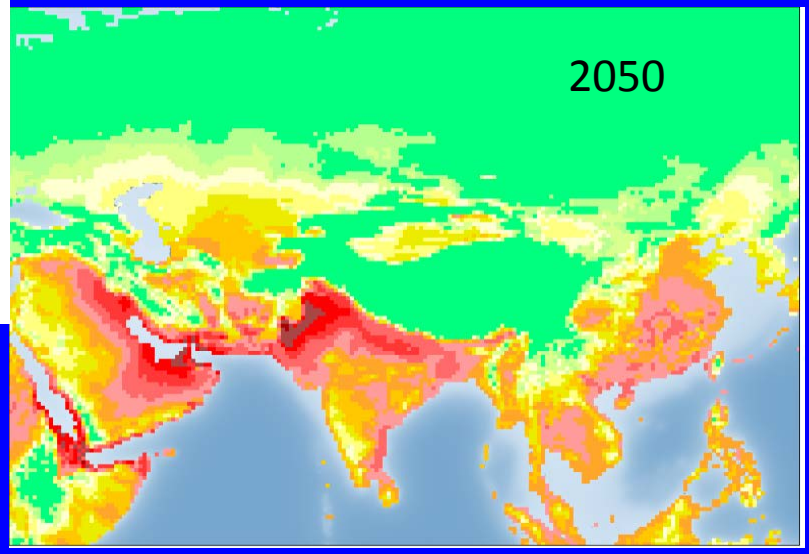
July afternoon WBGT in 1975 and 2000 (based on recordings); 2030 and 2050 (based on models)











Key points

Global climate change is ongoing, mostly human-induced, and will continue

Local climate conditions and changes influence the extent of many public health risks, including occupational health risks

A variety of examples of likely heat and other climate impacts already occur, and some effects related to ongoing climate change have been identified

Current and future heat exposures are a threat to work productivity and the local economy, as well as clinical health

True inside as well as outside

Table 1 | The four RCPs

Name	Radiative forcing
RCP8.5	>8.5 W
RCP6.0	~6 W m^{-2} at s
RCP4.5	~4.5 W m^{-2} at
RCP2.6	Peak at ~3 W the

Table TS.5. *Best estimate, likely ranges and very likely lower bounds of global mean equilibrium surface temperature increase (°C) over pre-industrial temperatures for different levels of CO_2-equivalent radiative forcing, as derived from the climate sensitivity.*

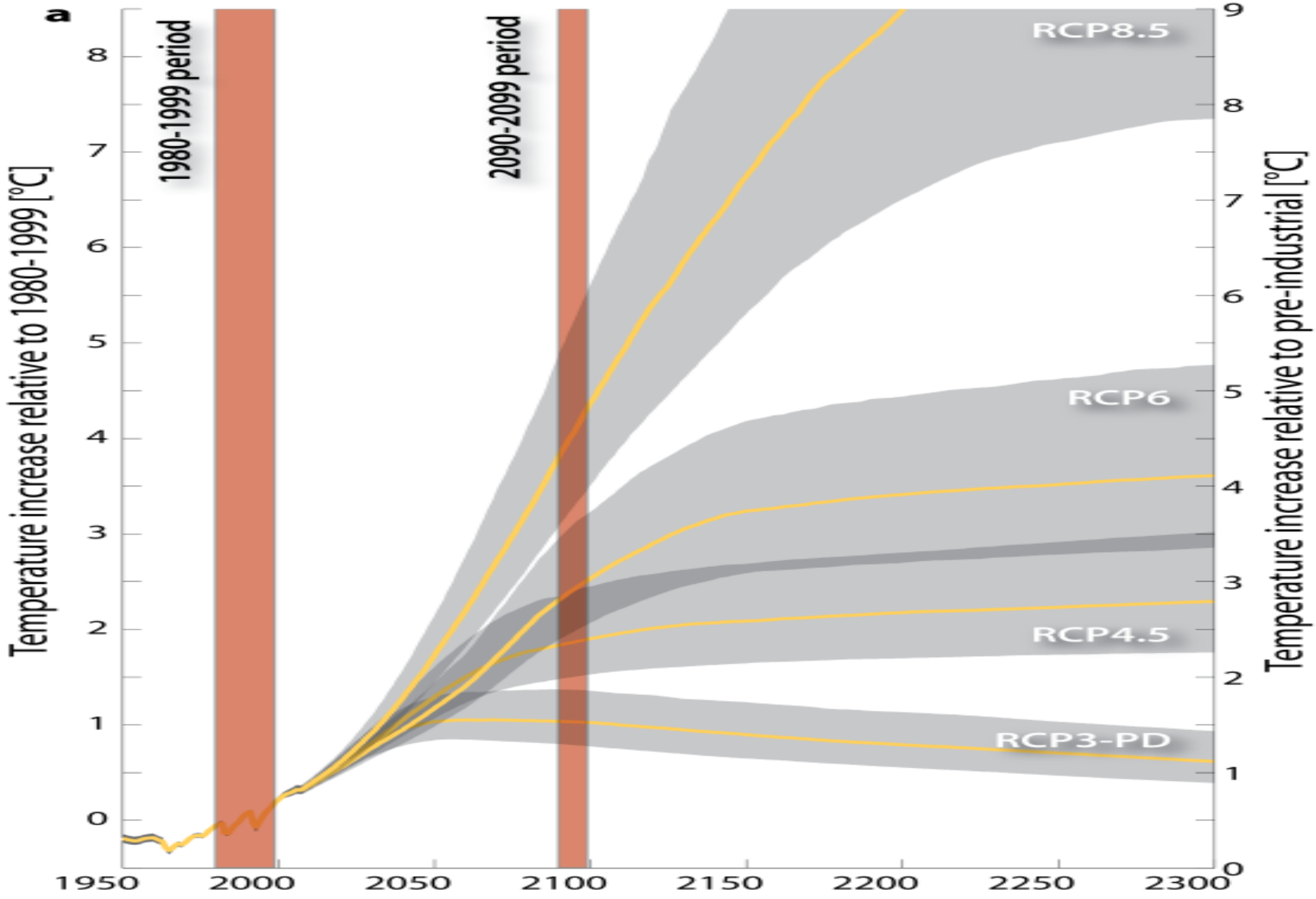
Max temps committed but not yet reached by 2100

Equilibrium CO_2–eq (ppm)	Temperature Increase (°C) Best Estimate	*Very Likely* Above	*Likely* in the Range
350	1.0	0.5	0.6–1.4
450	2.1	1.0	1.4–3.1
550	2.9	1.5	1.9–4.4
650	3.6	1.8	2.4–5.5
750	4.3	2.1	2.8–6.4
1000	5.5	2.8	3.7–8.3
1200	6.3	3.1	4.2–9.4

***Draft* IPCC Fifth Assessment**

Where is the limit?

- Obviously human society cannot exist on Venus, with 460 degree temperatures (860 F)
- But what is the temperature threshold between that on Earth (14 C, 57 F) and Venus where human society as we know it ceases?
- When even the most healthy and least vulnerable populations cannot be protected?



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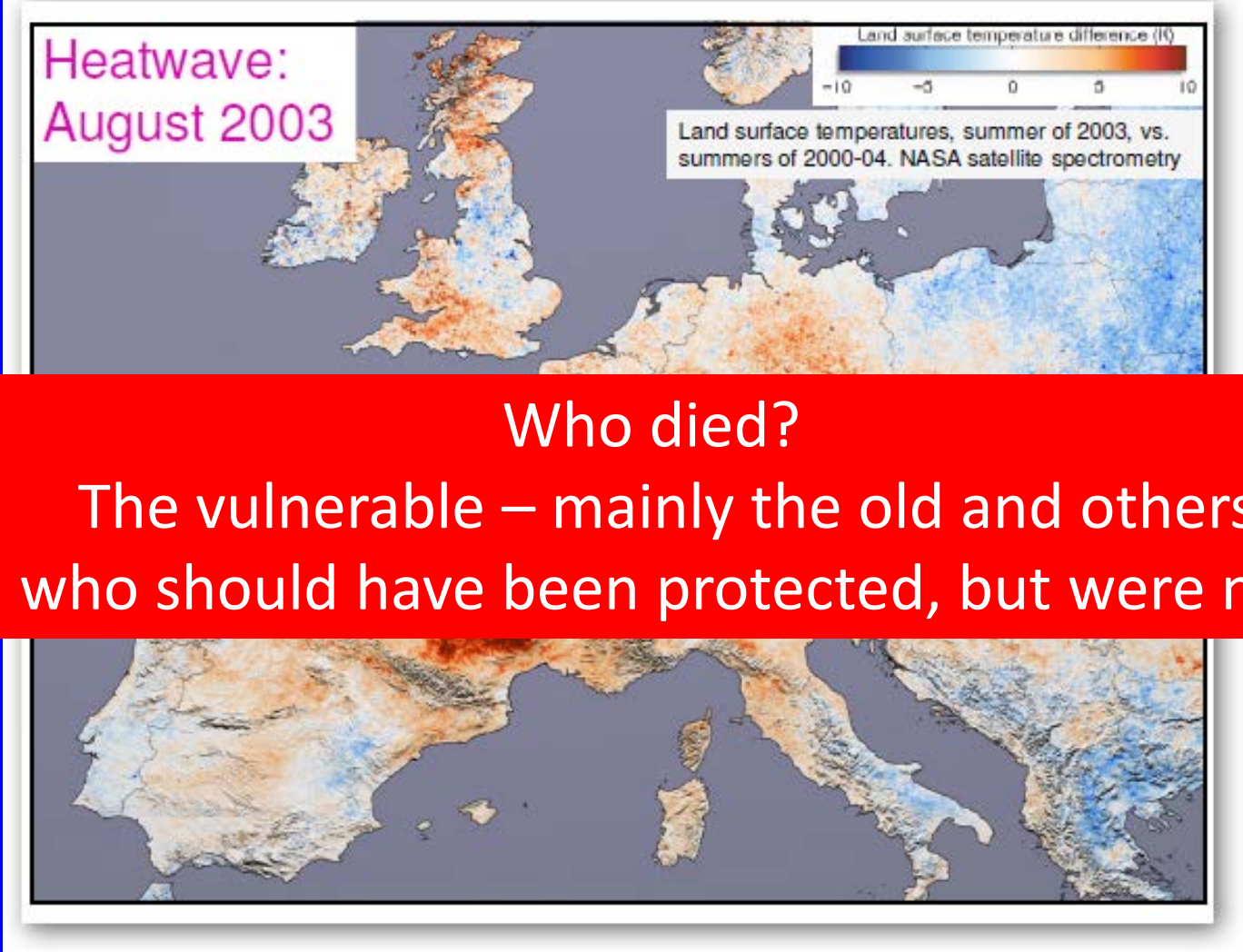
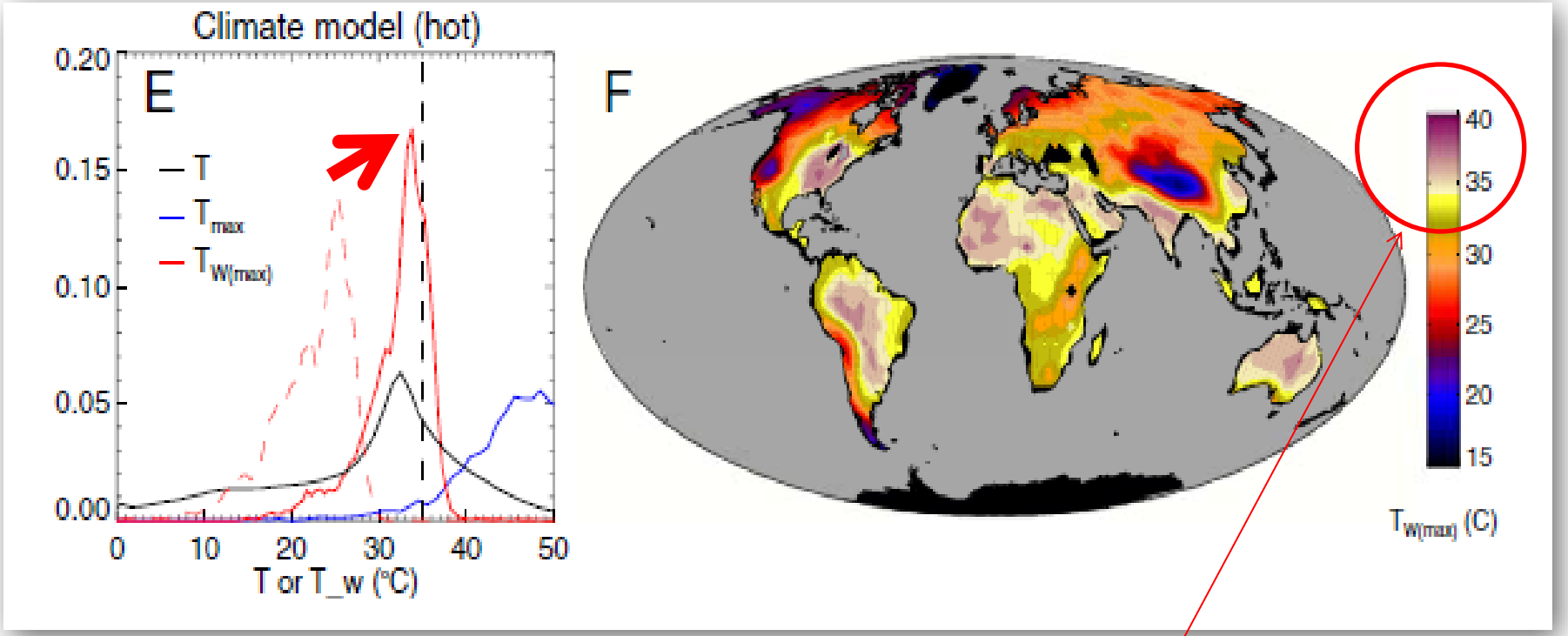
What most people consider with heat stress



Who died?

The vulnerable – mainly the old and others who should have been protected, but were not

Approximate 9-deg world



Places where people cannot work outdoors

Sherwood & Huber, PNAS, 2010

What is coming?

- Very few places exist on Earth now where people cannot work outdoors nearly every day of the year with appropriate work practices
- More and more of such places with global warming if nothing is done
- When in major populated areas will it be possible only to work outdoors in winter or at night?
- Then only in the winter at night?
- Then what?
- Where will the last Olympics be held, both winter and summer versions? If outdoors.

Science Fiction has many examples of colonies on other planets

Colony on Extraterrestrial Planet in *Aliens II*

Yes, we can live in space colonies on Earth

- But what are the energy requirements of doing so?
- And climate implications of this energy– and the positive feedback?
- Who will build and maintain these colonies? – outdoor work
- What happens in poor parts of the world?
- What happens to workers first, both indoors and out?
- What are the implications for life as we know it?

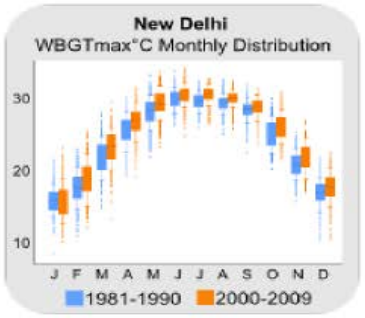
- **Website: ClimateCHIP.org**

Climate CHIP

Home CHIPs Analysis Tools Resources About Us

Climate Change Health Impact & Prevention

Climate CHIP is a non-profit website supported by charitable grants from organizations and individuals concerned about local and global threats to human health and society from climate change. We aim to provide a range of information and resources about heat stress and other health impacts of climate change.



Climate CHIPs

The Climate CHIP team is working towards producing a series of reports and other interactive resources on the health effects of climate change.

Health effects of climate change
Climate CHIPs
Your Area: Climate data

Information & Resources

The Climate CHIP team has published widely.

Our Publications
Our Powerpoints

Analysis Tools

Climate CHIP offers a number of tools to help you understand the effects of climate change in your area of the world.

Hothaps-Soft
Heat Stress Index Calculation

News & Events

National Science Symposium - Safeguarding Human Health in Cities under Climate Pressures

8 August 2013, Canberra, Australian

This Symposium will showcase new research on "Urbanism, Climate Adaptation and Health" led by the National Centre for.....more

http://climatehealthandcities2013.eventbrite.com/

Collection of scientific papers on Workplace Heat and Occupational Health

The journal Industrial Health (from the Japan National Institute of Occupational Health) published in February 2013 a.....more

http://www.jniosh.go.jp/en/indu_hel/2012.html#2013

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