

The Growing Risk from Extreme Heat Under Global Climate Change

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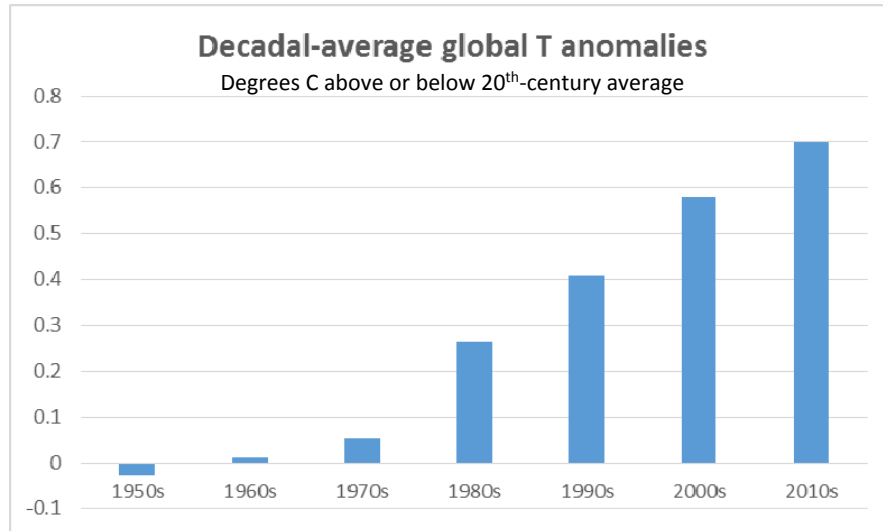
**White House Webinar on
Building Community Preparedness for Extreme Heat
May 26, 2016**

The overarching science context

Climate science has established that...

- Earth's climate is changing at a pace and in a pattern not explainable by natural influences.
- The dominant cause of the changes is an increase in the atmospheric concentrations of carbon dioxide (CO₂) and other heat-trapping gases caused primarily by fossil-fuel burning and land-use change.
- These changes are already causing harm to life, health, property, economies, and ecosystems, with more heat waves, downpours, droughts, and wildfires; more of the most powerful storms; worse smog; and major impacts on ecosystem dynamics.
- The harm will continue to grow for decades, because of the momentum in the climate system and the inertia in society's energy system.
- But the projected harm will be much smaller if we take prompt, strong evasive action—both mitigation and adaptation—than if we don't.

Each decade has been warmer than the last since the 50s

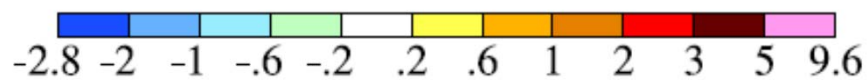
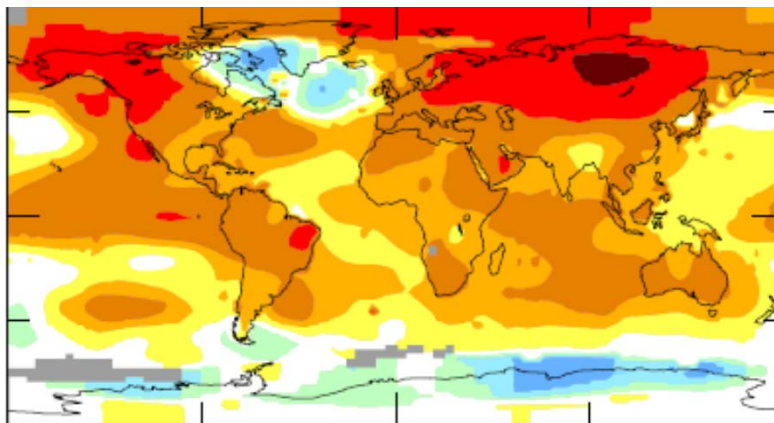


Calculated from NOAA data at <https://www.ncdc.noaa.gov/sotc/global/201513#gtemp>

The warming is not uniformly distributed

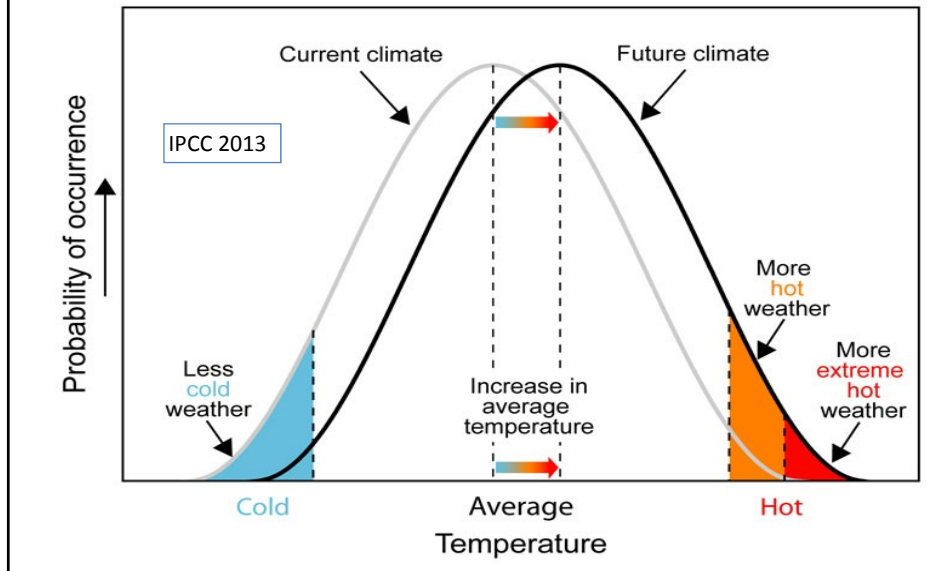
12-month mean for 2015 in °C

Global avg = 0.87°C



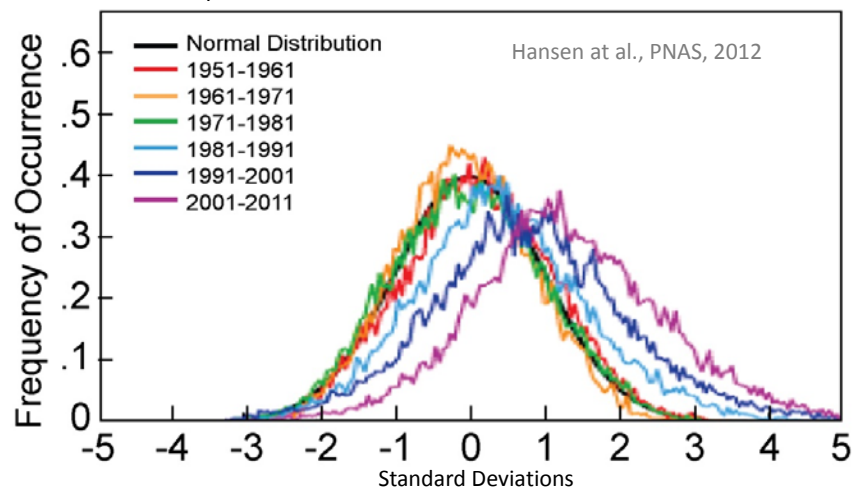
NASA Goddard Institute for Space Studies 2016

Why a small increase in average T leads to a big increase in hot weather



Observations show big increase in hot extremes

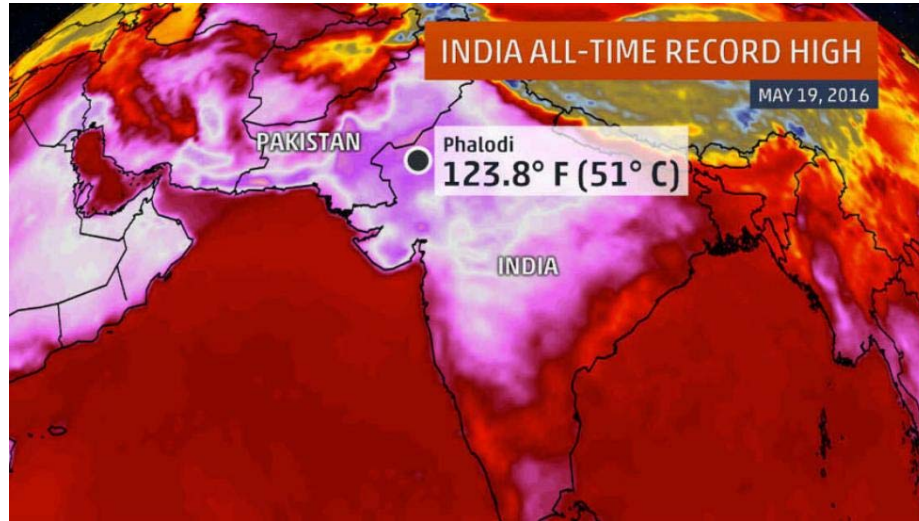
Probability distribution for Jun-Jul-Aug temperature anomaly on land in the Northern Hemisphere. Baseline normal distribution is for 1951-80.



Portion of Northern Hemisphere land experiencing $\geq 3\sigma$ summer heat in a given year increased from 0.1-0.2% in 1951-80 to 10% in 2001-2011—a 50- to 100-fold increase. A 3σ summer is one that would occur only once in 670 years under the baseline climate.

6

South Asia this month provides a sobering example



Source: The Weather Channel, 5-20-2016

It's not just about temperature: Humidity combines with T to create discomfort & danger.

The highest heat-index values ever recorded were 173°F in Saudi Arabia in 2003 & 163°F in Iran in 2015.

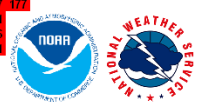
(Washington Post, 07-31-15)

Nine of the ten deadliest heat waves on record have occurred since 1980, six of them since 2000. (International Disaster Database)

Extreme heat poses particularly high risks for children, the elderly, & the disadvantaged.

Temperature (°F)	Relative Humidity (%)																				
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	
80	77	78	78	79	79	79	80	80	80	81	81	82	82	83	84	84	85	86	86	87	
81	78	79	79	79	79	80	80	81	81	82	82	83	84	85	86	86	87	88	88	90	
82	79	79	80	80	80	81	81	82	83	84	84	85	86	88	89	90	91	93	95	97	
83	79	80	80	81	81	81	82	82	83	84	85	86	87	88	90	91	93	95	97	99	
84	80	81	81	81	82	82	83	83	84	85	86	88	89	90	92	94	96	98	100	103	
85	81	81	82	82	82	83	84	84	85	86	88	89	91	93	95	97	99	102	104	107	
86	81	82	83	83	84	84	85	85	87	88	89	91	93	95	97	100	102	105	108	112	
87	82	83	83	84	84	85	86	87	88	89	91	93	95	98	100	103	106	109	113	116	
88	83	84	84	85	85	86	87	88	89	91	93	95	98	100	103	106	110	113	117	121	
89	84	84	85	85	86	87	88	89	91	93	95	97	100	103	106	110	113	117	122	127	
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94	87	89	90	90	91	93	95	97	100	103	106	110	114	119	124	129	135	141	148	155	
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100	93	94	96	97	100	102	106	109	114	118	124	129	136	143	150	158	165	171	177	184	
101	93	95	97	99	101	104	108	112	116	121	127	133	140	147	155	162	169	175	181	188	
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120	110	116	122	130	138	148	158	170	182	191	198	205	211	217	223	229	235	241	247	253	
121	111	117	124	132	141	151	162	174	186	195	202	209	215	221	227	233	239	245	251	257	
122	111	118	125	134	143	154	165	178	189	197	204	211	217	223	229	235	241	247	253	259	
123	112	119	127	136	146	157	169	182	193	201	208	215	221	227	233	239	245	251	257	263	
124	113	120	129	138	148	160	172	184	195	203	210	217	223	229	235	241	247	253	259	265	
125	114	121	130	140	151	163	176	187	198	206	213	220	226	232	238	244	250	256	262	268	

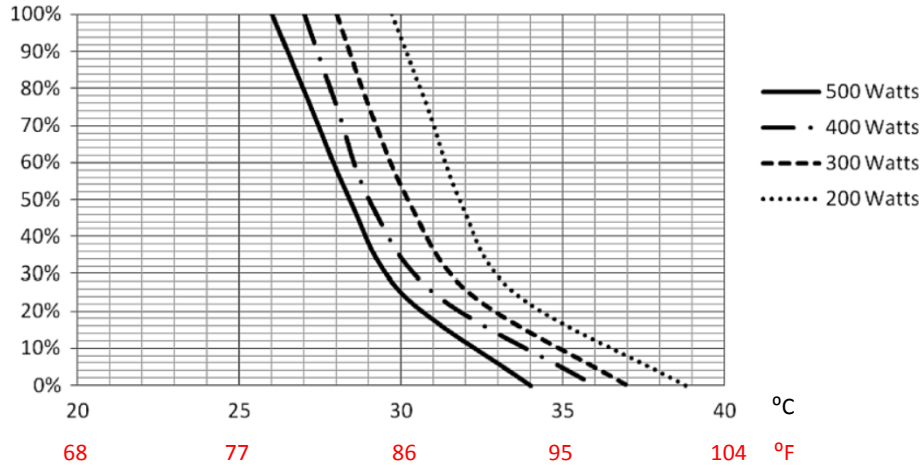
Heat Index



Extreme Danger	Heat stroke likely.
Danger	Sunstroke, muscle cramps, and/or heat exhaustion likely. Heatstroke possible with prolonged exposure and/or physical activity.
Extreme Caution	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Caution	Fatigue possible with prolonged exposure and/or physical activity.

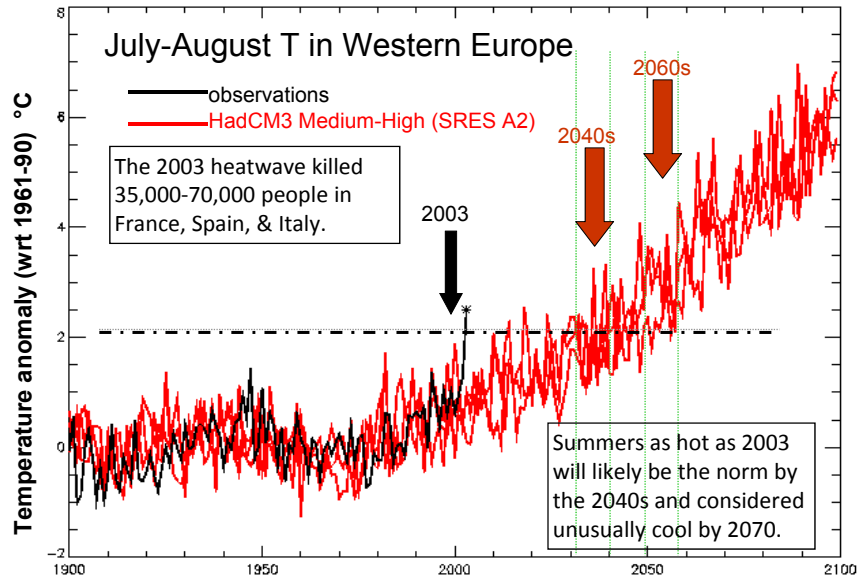
Working outdoors becomes inefficient and then impossible as heat & humidity increase

Work capacity (%) as a function of WBGT (degrees C) at 4 work intensities (Watts); acclimatized workers



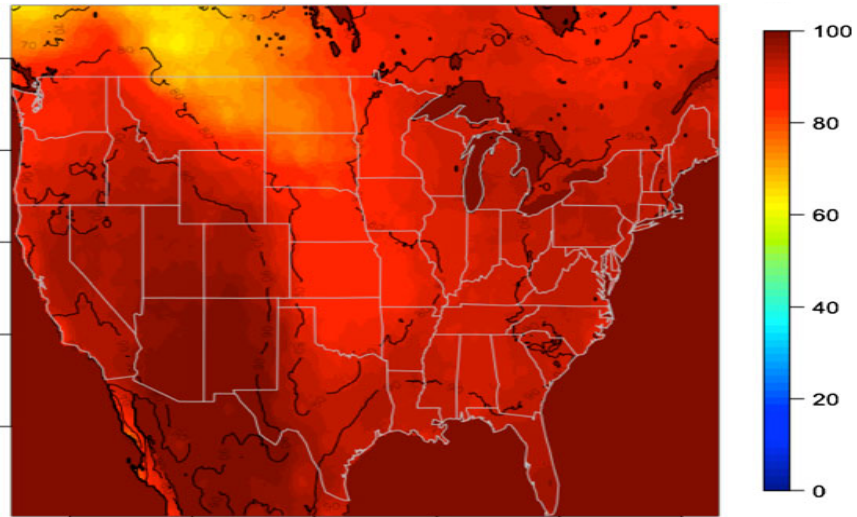
Kjellstrom et al., Archives of Environmental & Occupational Health, May 2015

What's expected going forward: Europe



Redrawn from Stott et al., NATURE 432, pp 610-614, 2 December 2004

What's expected going forward: United States



The policy questions

What should we do?

There are only three options:

- Mitigation, meaning measures to reduce the pace & magnitude of the changes in global climate being caused by human activities.
- Adaptation, meaning measures to reduce, through building preparedness & resilience, the adverse impacts on human well-being resulting from the changes in climate that do occur.
- Suffering the adverse impacts and societal disruption that are not avoided by either mitigation or adaptation.

Concerning the three options...

- We're already doing some of each.
- What's up for grabs is the future mix.
- Minimizing the amount of suffering in that mix can only be achieved by doing a lot of mitigation and a lot of adaptation.
 - Mitigation alone won't work because climate change is already occurring & can't be stopped quickly.
 - Adaptation alone won't work because adaptation gets costlier & less effective as climate change grows.
 - We need enough mitigation to avoid the unmanageable, enough adaptation to manage the unavoidable.

**What does adaptation for extreme heat
look like?**

That's the focus of the rest of this White House webinar.