

Prime Meridian (93) August 31, 2018

In the summer of 2018, South East England sweltered and the Northern Hemisphere was swept by an intense heatwave.

Super-heatwaves & our future world:

This is climate science not science fiction. Politicians, policy-makers and environmentalists must continually adjust their plans for protecting ecology and human communities, as research evolves.



Ripening wheat in the fields about Longfield, Kent. On the afternoon of July 28, 201, some of them were still green. After days of hot sunshine, rain and winds had arrived in South East England on July 27. Further heatwaves followed shortly in August.

Beyond the 2018 summer heatwave: "We are running out of choices for the future"

Press release from Camilo Mora of the University of Hawaii at Manoa, 2017.

In this issue we provided quick outlines about the threats.

We give selective quotes from *ScienceDaily* and science journals and references for the more involved climate campaigners, who may want to check out the key research for themselves.

The heatwave of 2018 has helped people's minds to focus powerfully on the disturbing consequences of our warmer planet.

Last year, two particularly thought-provoking studies from published in science journals from Camilo Mora of the University of Hawaii at Manoa, and co-workers. They were reviewed in the web site from the university and on Science Daily. Both papers were deadly serious, had titles worthy of the apocalypse.

Global risk of deadly heat.

"For heatwaves, our options are now between bad or terrible."

Most of these explanations from Mora and colleague (quoted in Science Daily) are grim reading. June 19, 2017.

"The human body can only function within a narrow range of core body temperatures around 37°C."

The abstract in *Nature Climate Change* explained: "Around 30% of the world's population is currently exposed to climatic conditions exceeding this deadly threshold for at least 20 days a year. By 2100, this percentage is projected to increase to ~48% under a scenario with drastic reductions of greenhouse gas emissions and ~74% under a scenario of growing emissions. An increasing threat to human life from excess heat now seems almost inevitable, but will be greatly aggravated if greenhouse gases are not considerably reduced."

From ScienceDaily: "Numerous examples, such as the 2003 European heatwave that killed approximately 70,000 people, the 2010 Moscow heatwave that killed 10,000 people and the 1995 Chicago heatwave that killed 700 people are staggering examples of the risk to life posed by heatwaves. But beyond these highly cited examples, little was known about how common such killer heatwaves are."

"The study also found that the greatest risk to human life from deadly heat was projected for tropical areas. This is because the tropics are hot and humid year round, whereas for higher latitudes the risk of deadly heat is restricted to summer."

Camilo Mora, Bénédicte Dousset, Iain R. Caldwell, Farrah E. Powell, Rollan C. Geronimo, Coral R. Bielecki, Chelsie W. W. Counsell, Bonnie S. Dietrich, Emily T. Johnston, Leo V. Louis, Matthew P. Lucas, Marie M. McKenzie, Alessandra G. Shea, Han Tseng, Thomas W. Giambelluca, Lisa R. Leon, Ed Hawkins, Clay Trauernicht. Global risk of deadly heat. *Nature Climate Change*, 2017; DOI: 10.1038/NCLIMATE3322

University of Hawaii at Manoa. "Deadly heatwaves expected to continue to rise." ScienceDaily. ScienceDaily, 19 June 2017. <www.sciencedaily.com/releases/2017/06/170619120507.htm>.

Twenty-Seven Ways a Heat Wave Can Kill You: Deadly Heat in the Era of Climate Change.

Camilo Mora of the University of Hawaii at Manoa and his fellow researchers carried out a systematic investigation of deadly physiological effects on the human body from extreme heat. They recognised five different physiological mechanisms which can influence seven body organs.

These physiological mechanisms are ischemia (oxygen reduction follows restriction of blood supply); heat cytotoxicity (toxic to cells); inflammatory response (to body tissues); disseminated intravascular coagulation (blood clots obstruct small blood vessels); rhabdomyolysis (with products caused by skeletal muscle breakdown).

Organs	Mechanisms				
	Ischemia	Heat Cytotoxicity	Inflammatory Response	Disseminated Intravascular Coagulation	Rhabdomyolysis
Brain	①	⑦	⑬	⑳	
Heart	②	⑧	⑭		
Intestines	③	⑨	⑮	㉑	
Kidneys	④	⑩	⑯	㉒	㉕
Liver	⑤	⑪	⑰	㉓	㉖
Lungs		⑫	⑱	㉔	㉗
Pancreas	⑥		⑲		

“In a recent analysis, [Mora, C. *et al.*, previous page] we found that by 2100, under current emission of greenhouse gases, 3 of 4 people in the world will be exposed to deadly heat conditions every year, with a higher occurrence of these conditions in intertropical areas . . . The impacts will manifest differently with perhaps larger economic burdens of adaptation for the wealthy and higher death tolls for the poor”
Mora, C. *et al.* *Circulation: Cardiovascular Quality and Outcomes.* 2017;10:e004233.

“Our synthesis reveals the multitude of ways to die during a heat wave and provides a worrisome glimpse into what a warming planet may have in store for us.”
Mora, C. *et al.* *Circulation: Cardiovascular Quality and Outcomes.* 2017;10:e004233.

“At times, the impacts of deadly heat are not measured in human lives, but in the numbers of people imprisoned indoors. In the last two years, for instance, millions of Americans have been told to stay indoors in cool places to avoid dangerous heat outdoors”
November 9, 2017 ScienceDaily.

Camilo Mora, Chelsie W.W. Counsell, Coral R. Bielecki, Leo V Louis. Twenty-Seven Ways a Heat Wave Can Kill You: Deadly Heat in the Era of Climate Change. *Circulation: Cardiovascular Quality and Outcomes*, 2017 DOI: [10.1161/CIRCOUTCOMES.117.004233](https://doi.org/10.1161/CIRCOUTCOMES.117.004233).

University of Hawaii at Manoa. "Brace yourself for coming heatwaves, there are at least 27 ways they can kill you." ScienceDaily. ScienceDaily, 9 November 2017. <www.sciencedaily.com/releases/2017/11/171109093248.htm>.

Humid heat waves at different warming levels.

Another team emphasised the threat of super-heatwaves in August, 2017. The lead author was Simone Russo of the European Commission, Joint Research Centre, Ispra, Italy and co-workers.

These researches claimed in *Nature Com. Scientific Reports*: "Considering the effect of humidity at 1.5° and 2° global warming, highly populated regions, such as the Eastern US and China, could experience heat waves with magnitude greater than the one in Russia in 2010 (the most severe of the present era). The apparent temperature peak during such humid-heat waves can be greater than 55°C."

Simone Russo, Jana Sillmann, Andreas Sterl. Humid heat waves at different warming levels. *Scientific Reports*, 2017; 7 (1) DOI: [10.1038/s41598-017-07536-7](https://doi.org/10.1038/s41598-017-07536-7)

European Commission, Joint Research Centre (JRC). "Super-heatwaves of 55°C to emerge if global warming continues." *ScienceDaily*. *ScienceDaily*, 9 August 2017. <www.sciencedaily.com/releases/2017/08/170809073802.htm>

Longer and more frequent marine heatwaves over the past century.

The dangers of heatwaves, present and future, continue to reverberate. The implications of this study, published in April 2018, looked at the serious implications of a warming sea. The lead author Eric Oliver, from the Dalhousie University of Canada and co-workers, discussed the work in *ScienceDaily*.

"While some of us may enjoy the warmer waters when we go swimming, these heatwaves have significant impacts on ecosystems, biodiversity, fisheries, tourism and aquaculture. There are often profound economic consequences that go hand in hand with these events." *ScienceDaily* April 10, 2018.

"Heatwaves are important climatic extremes in atmospheric and oceanic systems that can have devastating and long-term impacts on ecosystems, with subsequent socioeconomic consequences." Abstract in *Nature Communications*.

Eric Oliver announced:

"From 1925-2016, the study found the frequency of marine heatwaves had increased on average by 34% and the length of each heatwave had increased by 17%. Together this led to a 54% increase in the number of marine heatwave days every year.

Our research also found that from 1982 there was a noticeable acceleration of the trend in marine heatwaves" and:

"With more than 90% of the heat from human caused global warming going into our oceans, it is likely marine heatwaves will continue to increase." *ScienceDaily* April 10, 2018.

Eric C. J. Oliver, Markus G. Donat, Michael T. Burrows, Pippa J. Moore, Dan A. Smale, Lisa V. Alexander, Jessica A. Benthuisen, Ming Feng, Alex Sen Gupta, Alistair J. Hobday, Neil J. Holbrook, Sarah E. Perkins-Kirkpatrick, Hillary A. Scannell, Sandra C. Straub, Thomas Wernberg. Longer and more frequent marine heatwaves over the past century. *Nature Communications*, 2018; 9 (1) DOI: [10.1038/s41467-018-03732-9](https://doi.org/10.1038/s41467-018-03732-9)

University of New South Wales. "Hotter, longer, more frequent -- marine heatwaves on the rise: Researchers connect the data to show an accelerating trend for marine heatwaves in our oceans." *ScienceDaily*, 10 April 2018. <www.sciencedaily.com/releases/2018/04/180410164134.htm>.

“Heat waves, sporadic events of extreme heat, pose a threat to human life.” Camilo Mora: ScienceDaily, 9 November 2017.

Taking effective action.

Do any of these events have to actually happen before the politicians take determined action? We appear to be well on the way, but the most extreme cases might be avoided. So, what can any of us do?

Most people have few options to impact climate change, be they individuals or members of associations. It is essential, however, that as many people as possible give no respite to the politicians. As campaigners, we must not allow them to avoid their responsibilities. Too many politicians fall back on their stock responses; assertions of confidence, that everything is already in hand, or otherwise, that failure must be found at the feet of their rivals (and sometimes it is). However, climate science continues to advance - and fast. The research outlined in this issue were all published since the Paris Agreement (Le Bourget, France) was held in late 2015 and was signed on April 22, 2016.

“Climate change has put humanity on a path that will become increasingly dangerous and difficult to reverse if greenhouse gas emissions are not taken much more seriously,” says Mora. **“Actions like the withdrawal from the Paris agreement is a step in the wrong direction that will inevitably delay fixing a problem for which there is simply no time to waste.”** Camilo Mora: ScienceDaily, June 19, 2018.

There is an urgent need for campaigners to keep in touch with climate research and to ensure that the politicians do likewise.

Prime Meridian

Prime Meridian is published by the Ecospheres Project, a research and media collaboration. This newsletter follows global environmental issues alongside the cycle of the seasons in South East England. It steps back to look at the Earth in its astronomical context and it pursues the search for other habitable worlds.

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