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Sarah Carter, a ranger at Death Valley National Park in California, takes a temperature reading at the park's weather station.

METEOROLOGY

The weather observers on climate change's front lines

From Death Valley to Antarctica, the science of temperature records is heating up.

BY ALEXANDRA WITZE

On a searing day in late July, Katie Martyr was more worried about watering her wilting plants than whether she was witnessing history.

That morning, Martyr — a horticulturalist at the Cambridge University Botanic Garden in the United Kingdom — made her usual stop at a small box on a pole in the garden. She opened the box's door to reveal the data logger that continuously records the air temperature,

and wrote down the previous day's maximum: 38.7°C. Hours later, she learnt that this was the hottest temperature ever officially recorded in Britain.

As climate change raises temperatures around the globe, Martyr and other weather observers find themselves on the front lines. Making today's measurements as accurate as possible is crucial to understanding future change, says Manola Brunet, a meteorologist at Rovira i Virgili University in Tarragona, Spain. "We need to know how weather and climate extremes are

changing — how much and how fast," she says.

Already, scientists have documented how the hottest temperature of the year, as recorded at nearly 9,000 weather stations worldwide, has risen faster than the mean annual temperature during the past three decades¹.

And temperatures are smashing records faster than they used to. This July was the hottest month ever recorded globally, and nine of the ten hottest Julys have come since 2005. When news of the record heat in Cambridge broke, Martyr found herself thrust into ▶

► the spotlight as a public face of extreme weather. “I felt a mixture of elation but also sadness,” she says. “To have a temperature like that — there are consequences globally if this is to continue.”

National meteorological agencies around the world maintain long-term records of temperature, rainfall and other weather data. The all-important temperature measurement must be taken in shade above a natural surface, such as grass or sand, rather than asphalt. Many official weather stations, including the one in the Cambridge garden, are mounted inside elevated boxes called Stevenson screens. These are painted white to reflect as much of the Sun’s heat as possible, and slashed with louvres for ventilation.

In California’s Death Valley National Park — one of the hottest places on Earth — the Stevenson screen rises above the desert floor behind the park headquarters. Every morning at 8 a.m., a park ranger unlocks a gate, opens the door to the Stevenson screen and reads a mercury thermometer that displays the hottest temperature of the previous 24 hours.

“It’s an exciting thing to go out and check,” says Sarah Carter, a ranger at the park who oversees the temperature measurements.

HOT ON THE TRAIL

Globally, both night-time and daytime temperatures have been rising over the past century, with nights outpacing days². But it’s the jaw-dropping daytime highs that often capture the most attention. Tourists in Death Valley often take selfies in front of an unofficial temperature display at the visitors’ centre — especially when the reading passes 120°F (49°C).

Whenever temperature measurements

approach world-record territory, the World Meteorological Organization (WMO) springs into action. Its world weather and climate extremes team collects and validates extreme observations from around the globe³. The hottest temperature reading it considers official is a searing 56.7°C measurement taken in Death Valley in July 1913.

But there are hints that the record could soon fall. In June, the WMO team confirmed that two readings of 54.0°C — one from Kuwait in July 2016 and one from Pakistan in May 2017 — are the highest temperatures observed anywhere in the past three-quarters of a century.

The reading in Pakistan was taken by a weather observer at Turbat airport in the country’s southwest. It wasn’t obvious at the time that the reading might be more than a national record, says Nadeem Faisal, director of the climate-data centre at the Pakistan Meteorological Department in Karachi. But the following day, a weather observer in Australia pointed out that it could be a record for all of Asia.

The WMO committee that started investigating the potential record was already looking into a 54.0°C reading taken in Mitribah, Kuwait. The thermometers from both sites were shipped to a metrology laboratory in Italy for further study.

After calibrating the thermometers against each other, the WMO team concluded that the Kuwait instrument had measured 53.87°C (with an uncertainty of 0.08 degrees), whereas the one from Pakistan had measured 53.72°C (with an uncertainty of 0.40 degrees). They are now the third and fourth highest temperatures recognized by the WMO and officially the highest ever recorded in Asia, the team reported in June⁴.

And deserts aren’t the only places setting records. Several sites in Antarctica have been battling for the hottest-temperature record on the coldest continent. Last year, the WMO team ruled that a 17.9°C reading taken in March 2015 by a Czech weather station near the Antarctic peninsula was off by nearly one degree, thanks to high solar radiation and low wind speed around the weather sensor. A 17.5°C reading taken the following day at a nearby Argentinian base now holds the record⁵.

It might not stand for long. Global warming has increased the chance that the hottest daily and monthly temperature readings around the globe will rise⁶. Climate scientists have found that the July heatwave that baked much of western Europe, including Martyr’s garden, was up to 3°C warmer than it would have been without human-induced climate change.

And that means there are probably more record-breaking temperatures to come. Randall Cerveny, a meteorologist at Arizona State University in Tempe who oversees the WMO group, says that the team is much busier than he expected when it was set up in 2007.

“I was anticipating we would have one to two investigations every couple of years,” he says. “Now there are a lot of extremes that we have to evaluate.” ■

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MARINE SCIENCE

‘Ecological grief’ grips scientists

Researchers documenting the decline of the Great Barrier Reef say their work takes an emotional toll.

BY GEMMA CONROY

When Australia’s Great Barrier Reef, the world’s largest coral-reef system, was hit by record-breaking marine heatwaves that bleached two-thirds of it in 2016 and 2017, many researchers were left in a state of shock.

Social scientist Michele Barnes witnessed this disaster at first hand. She works at the

Australian Research Council Centre of Excellence for Coral Reef Studies in Townsville, which is adjacent to the reef. Barnes decided to interview scientists and others working on the reef to investigate their responses to this climate-change-driven catastrophe.

Barnes, who is still analysing her results, was surprised that many of the scientists whom she interviewed felt intense grief and sadness about the reef’s deterioration. *Nature* has also spoken

to several coral-reef scientists not involved in Barnes’s study who echo those sentiments.

“I now feel much more hopeless, and there’s a deeper anxiety breaking through,” says John Pandolfi, a marine ecologist at the University of Queensland in Brisbane, Australia.

Pandolfi has been studying ecosystem dynamics in the Great Barrier Reef for more than 30 years. The consecutive bleaching events that began in 2016 triggered mass death of the reef’s coral cover, which caused a drastic shift in its species composition. Pandolfi is now investigating new configurations of species that have arisen because of human impacts.

An emerging body of research shows that many people feel loss due to environmental degradation caused by global warming, a phenomenon called ‘ecological grief’. Although researchers are often on the front lines of ecosystem collapse, few studies have investigated the mental and emotional consequences of such work.

For Pandolfi, the consequences he worries about are those that his children — now 17 and 20 — will face as a result of climate change. “I