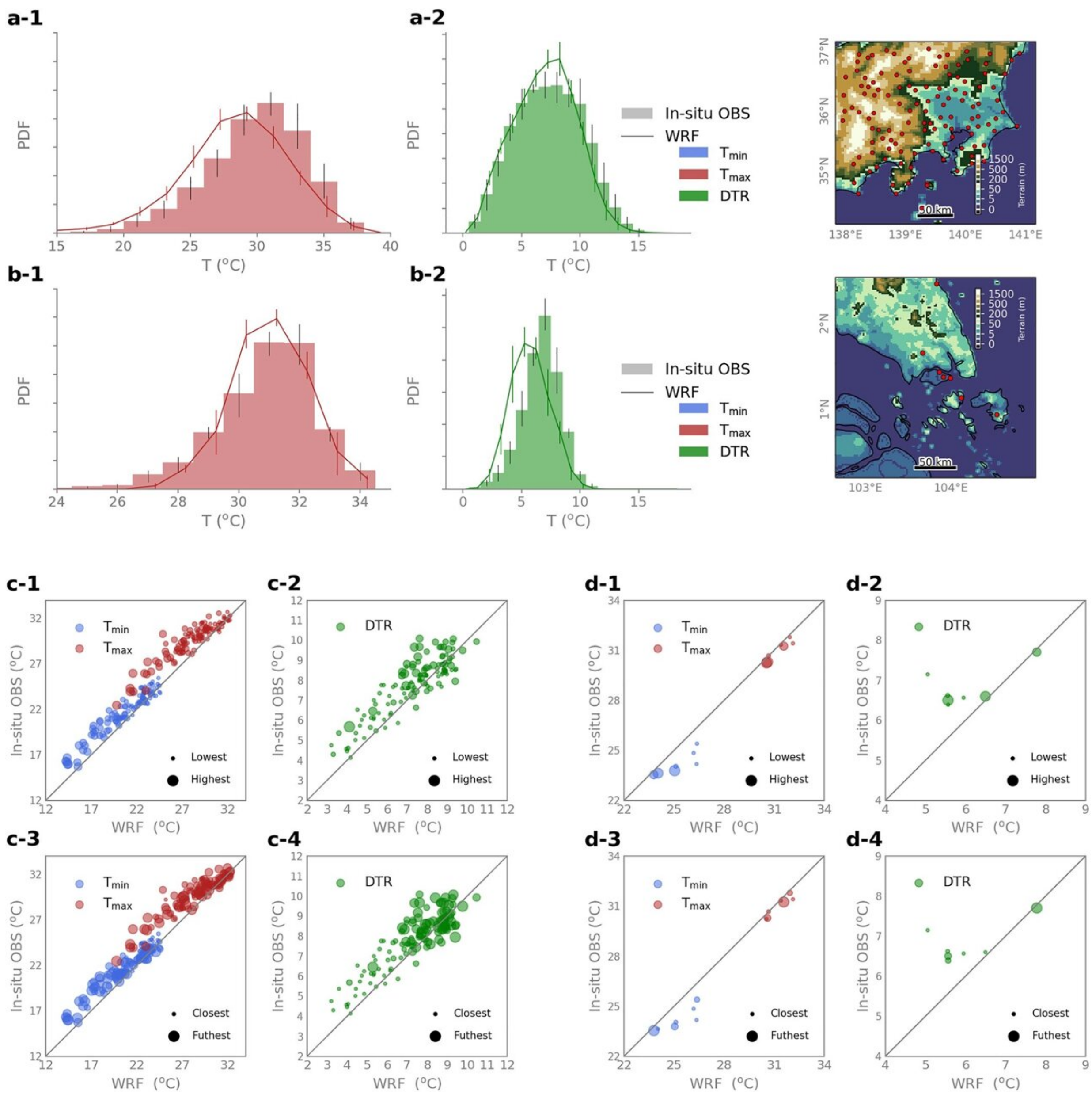
Climate change is closing daily temperature gap: Clouds could be the cause

October 25 2022



Association between the in situ observation (OBS) and the modeled Weather Research and Forecast (WRF) data. (a) Comparison of probability density distributions (PDFs) between the two for the daily maximum/minimum temperature (/) and the diurnal temperature range (DTR), that is, for the Kanto Plain (KP) simulation. The results are averaged values among observation sites, whose locations are shown on the right-side map. Error bar at each bin indicates internal-climate variability (ranging between quantiles 0.25 and 0.75 of 10 years). (b) Shows the same things with (a) but for the Malaysian Peninsula (MP) simulation. (c) Comparison between OBS and WRF regarding spatial co-relationship. In (c-1, c-2), each dot in scatter plots indicates a climate mean value. Dot's size indicates the altitude (of the observation sites) ranging from the relatively lowest to the highest. In (c-3, c-4), dot's size indicates the closest distance (of the observation site) to the coastline, ranging from the relatively closest to furthest. (d) Same with (c) but for the MP simulation. Credit: *Geophysical Research Letters* (2022). DOI: 10.1029/2022GL100029

Climate change is shrinking the difference between the daily high temperature and the daily low in many parts of the world. The gap between the two, known as the diurnal temperature range (DTR), has a significant effect on growing seasons, crop yields, residential energy consumption and human health issues related to heat stress. But why and where the DTR shrinks with climate change has been something of a mystery.

Researchers who are part of a new international study that examined the DTR at the end of the 20th century believe they have found the answer: An increase in clouds, which blocks incoming-shortwave radiation from the sun during the day.

This means that while both the daily maximum temperature and the daily minimum are expected to continue to increase with climate change, the daily maximum temperature will increase at a slower rate. The end result is that the DTR will continue to shrink in many parts of the world, but that the changes will vary depending on a variety of local conditions, researchers said.

The study, published in the journal *Geophysical Research Letters*, is the first to use high-resolution computer modeling to delve into the issue of the Earth's shrinking DTR, particularly how it is related to cloud cover.

"Clouds are one of the big uncertainties in terms of climate projections," said co-author Dev Niyogi, a professor at The University of Texas at Austin Jackson School of Geosciences. "When we do this with a very high spatial resolution modeling framework, it allows us to explicitly simulate clouds."

Lead author Doan Quang Van, an assistant professor at the University of Tsukuba Center for Computational Sciences in Japan, said this is vital for understanding the future of the DTR.

"Clouds play a vital role in the diurnal temperature variation by modulating solar radiative processes, which consequently affect the heat exchange at the land surface, " he said.

The team included scientists from the UT Jackson School's Department of Geological Sciences, the National Center for Atmospheric Research in Boulder, Shanghai University of Engineering Science, National Defense Academy of Japan, and the University of Tsukuba in Japan. The modeling work used supercomputers at the University of Tsukuba Center for Computational Sciences.

Using the supercomputers, the team was able to model the complicated interplay of land-surface processes on climate change. These include changes in land use (such as deforestation), soil moisture, precipitation, cloud cover and other factors that can affect the temperature in a local region. By creating a model with a finer resolution grid—2 square kilometer grids rather than the 100-kilometer grids used in most climate models—the researchers were able to more closely analyze the impacts of climate change.

The team focused on two areas: the Kanto region of Japan and the Malaysian peninsula. They used the 10-year period from 2005-2014 as a baseline and then ran different climate scenarios to project what will happen to the DTR in the two regions at the end of the century. They found that the temperature gap closes by about .5 Celsius in the temperate Kanto region and .25 Celsius in the more tropical Malaysian peninsula. Researchers attribute these changes in large part to increased daytime cloud coverage that would be expected to develop under these climate conditions.

The researchers said the study can help scientists improve current global climate models and aid in understanding how the shrinking DTR will affect society and the environment as the climate continues to warm.

"It is very important to know how DTR will change in the future because it modulates human, animal and plant metabolisms," said Quang Van. "It also modulates the local atmospheric circulation such as the land-sea breeze."

More information: Quang-Van Doan et al, Causes for Asymmetric Warming of Sub-Diurnal Temperature Responding to Global Warming, *Geophysical Research Letters* (2022). DOI: 10.1029/2022GL100029

Provided by University of Texas at Austin

October 25) retrieved 29 April 2024 from https://phys.org/news/2022-10-climate-daily-temperature-gap-clouds.html