NASA technology powers a new understanding of heat stress in dairy cows

A recent study in the Journal of Dairy Science® demonstrates that NASA’s open access weather data tools can shed new light on the production impacts of heat stress on dairy cows


Just like humans, dairy cows experience heat stress during extreme temperatures, which can negatively impact their health, welfare, and overall milk production. Given these effects, and our increasingly warming global climate, it is essential for dairy scientists to be able to measure heat stress in dairy cows.

Up until now, however, there have several challenges to getting accurate weather data for this kind of analysis, especially in rural locations.

The study’s lead senior investigator Flavio S. Schenkel, PhD, Professor of the Centre for Genetic Improvement of Livestock and the Department of Animal Biosciences at the University of Guelph, explained, “Two things have made heat analysis more crucial. We know the climate is increasing in temperature and will likely continue to do so, even in traditionally temperate regions such as Canada.”

This trend is further exacerbated by the dairy industry’s gains in dairy cow production, making modern herds extremely prone to heat stress.

Professor Schenkel added, “Improvements in animal nutrition and biotechnology as well as genetic selection have greatly improved the amount of milk produced per cow, increasing the amount of metabolic body heat they produce and potentially reducing their ability to cope with high temperatures.”
Studying heat tolerance in dairy cattle—which helps the research community understand how to best combat its negative effects—requires accurate and comprehensive weather data. Typically, this information comes from a network of weather stations, which can have limitations including gaps in data, recording errors introduced by humans or faulty sensors, and inconsistencies between stations due to different collection methods and instruments. These stations are also often sparse in rural areas, missing data crucial for remote dairy herds.

For these reasons, the research team set out to understand if there was a possible alternative weather data resource. They found a promising option in the National Aeronautics and Space Administration’s Prediction of Worldwide Energy Resources—or NASA POWER. The open source tool—often used in renewable energy and sustainable building research—collects and optimizes global weather data from satellites, ocean and land surface measurements, aircraft and ship reports, and space-borne radar systems to provide data from 1981 to near-real time.

Professor Schenkel said, “Our team wanted to understand whether NASA POWER could be the alternative weather source we need for accurate dairy cattle heat tolerance studies, and then to use it to quantify the effects of heat stress in our own local Canadian Holsteins.”

The researchers compared weather data collected between 2009 and 2019 for more than 1,200 weather stations across Canada with NASA POWER data from the same time period.

Professor Schenkel outlined, “Our team found that more than half of the 1,272 weather stations from the Canadian network had yearly and daily data gaps and did not meet our standards for use in our analysis, which highlights how restrictive weather station data can be when studying heat stress, especially on rural dairy farms.”

The replacement of weather station observations with NASA POWER data eliminated the restrictions imposed by weather station networks, often from rural areas, and allowed the team to more accurately
analyze weather impacts to test-day milk production records from nearly 1 million Holstein cows in Canada.

The study found that cows experiencing heat stress, as indicated by high temperature-humidity index (THI) values, had reduced milk production compared to cows in cooler conditions. The paper also describes that threshold responses to changes in THI for milk, fat, and protein yield are each unique and that several days each year THI was above each trait’s respective thresholds. This research shines new light onto the effects of environmental stressors on food production during heat stress events in Canada.

While the authors were careful to emphasize the importance of continued research, their work demonstrates the potential of NASA POWER to help us better understand the impacts of weather on milk production and dairy cow welfare and inform decision-making for farmers.

Professor Schenkel concluded, "We hope this study highlights the value of innovative approaches to research and the potential for these tools to help us address some of the most pressing challenges facing dairy today."

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Notes for editors
The article is “Phenotypic analysis of heat stress in Holsteins using test-day production records and NASA POWER meteorological data,” by Paige L. Rockett, Ivan. L. Campos, Christine F. Baes, Dan

Full text of this study is also available to credentialed journalists upon request; contact Jess Townsend, American Dairy Science Association, at +1 217 239 3331, jesst@assochq.org, or Eileen Leahy at +1 732 238 3628, jdsmedia@elsevier.com. Journalists wishing to interview the authors should contact the senior author, Flavio S. Schenkel, PhD, Centre for Genetics Improvements of Livestock and the Department of Animal Biosciences, University of Guelph, at Schenkel@uoguelph.ca.

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