

Building a global storm database

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Mesoscale convective systems are a class of large storms, ranging in size from approximately 10 to 1,000 kilometers, that play a key role in Earth's energy and hydrological cycles. Credit: Stephanie King | Pacific Northwest National Laboratory

A new global database built by researchers at Pacific Northwest National Laboratory (PNNL) captures characteristics and rainfall data of strong thunderstorms from the past 20 years. Including storms in both midlatitude and tropical zones is key to capturing how contrasting storm behavior and corresponding precipitation could affect populated regions of the globe.

Mesoscale convective systems (MCSs) are a class of large storms, ranging in size from approximately 10 to 1,000 kilometers, composed of multiple thunderstorms organized by mesoscale circulation. They are long-lived, tend to grow overnight, and are the largest source of extreme precipitation that can trigger flooding globally, playing a key role in Earth's energy and hydrological cycles.

Accurately representing these systems in next-generation, high-resolution global climate models requires knowing where these storms form, how much energy they have, and how much rain they carry.

Capturing global MCS data has historically presented a major challenge to researchers. "Most of the common tracking techniques that work in the tropics are poorly suited to midlatitude regions, like the U.S.," said Zhe Feng, a PNNL Earth scientist.

A new study, led by Feng and Ruby Leung—a PNNL Earth scientist and Battelle fellow—presents the first dataset of tracked MCSs over the areas of the Earth where they significantly affect rainfall, including populated regions in the midlatitudes. They tracked the storms by coupling high-resolution infrared satellite images and rainfall datasets. This combined approach generated a more complete view of MCSs than either technique can on its own.

This new [storm](#)-tracking database contains 20 years of data from the tropics and midlatitudes, covering the vast majority of MCSs globally

from 2000 to 2019. The work was recently published as the cover article in JGR Atmospheres and selected as an editor's highlight paper.

The team found that the longest-lived and heaviest-raining MCSs are found over subtropical oceans, while the most intense storms mainly occur over land. MCSs also account for more than half of the rainfall in the studied regions.

Moving toward advanced MCS studies

The MCS database will be particularly powerful when coupled with Earth system models, such as the U.S. Department of Energy's Energy Exascale Earth System Model (E3SM), Leung, E3SM's chief scientist, said. Connecting this long-term data with models of large-scale environmental processes can help scientists better understand the role of MCSs in global extreme rainfall, circulation, and flood hazards. "The technique we developed to observationally track MCSs can also be used in climate simulations to understand how MCS characteristics change with global warming," said Leung.

The database will enable researchers to understand how changes in Earth's climate alter MCS behavior, connecting weather and climate. Any evolution or alterations in the climate over the past 20 years can be correlated with MCS intensity, lifetime, or other behaviors. Drawing these factors together brings unique opportunities for researchers to answer questions that previously would have required using multiple data sources and substantial background work in order to begin.

After recently presenting the new database at a workshop, Feng said: "I've already had several people reach out to me about starting new collaborations."

More information: Zhe Feng et al, A Global High-Resolution

Mesoscale Convective System Database Using Satellite-Derived Cloud Tops, Surface Precipitation, and Tracking, *Journal of Geophysical Research: Atmospheres* (2021). [DOI: 10.1029/2020JD034202](https://doi.org/10.1029/2020JD034202)

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