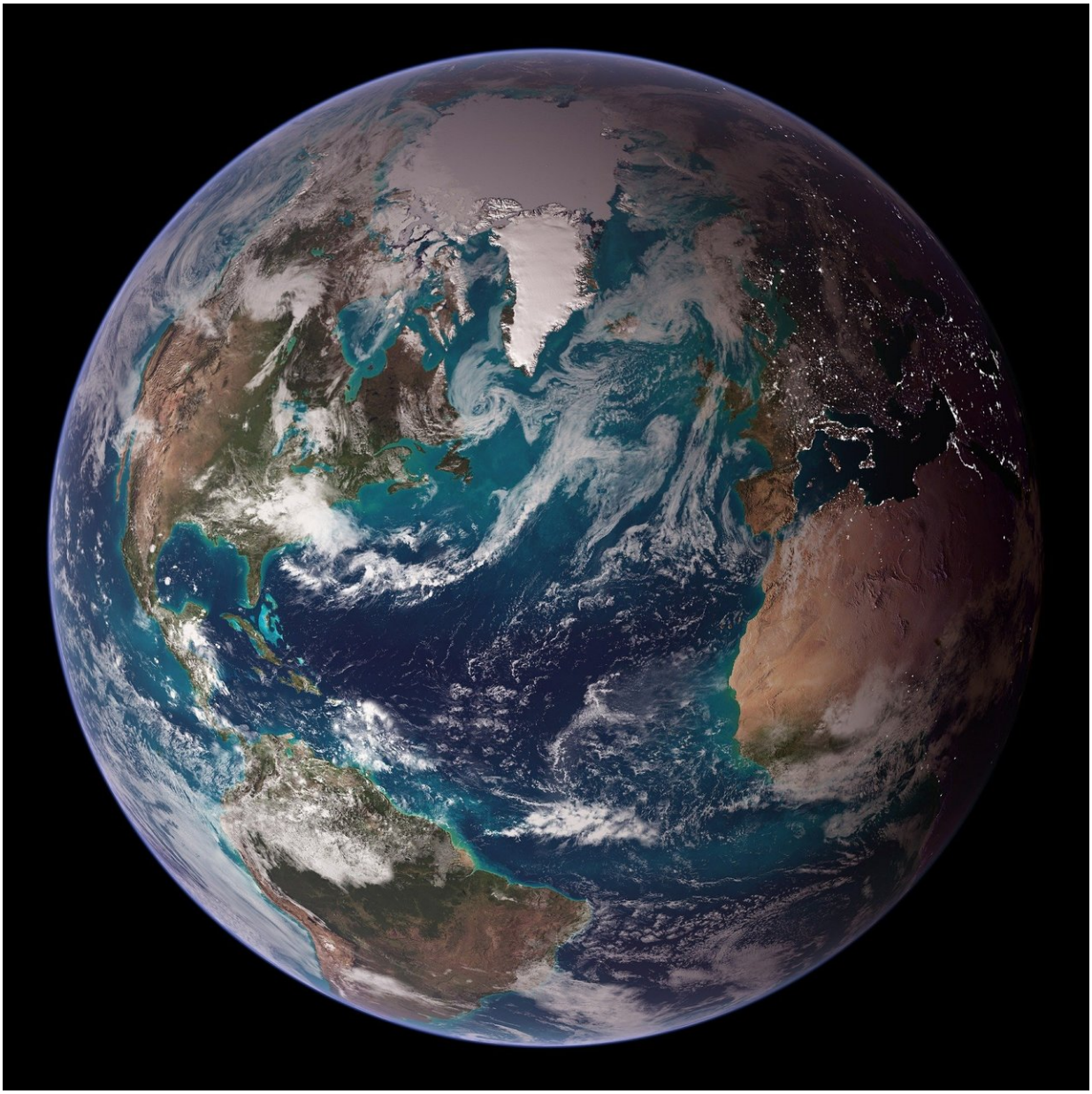
Rain or snow? Humidity, location can make all the difference, new map shows

March 20 2018



Credit: CC0 Public Domain

University of Colorado Boulder researchers have created a map of the Northern Hemisphere showing how location and humidity can affect precipitation, illustrating wide variability in how and why different areas receive snow or rain.

32 degrees Fahrenheit is commonly considered to be the air temperature threshold for rain versus snow, thus informing meteorological forecasting and climate simulations. The new findings, however, show that coastal areas have a cooler threshold for rain, meaning that even temperatures below freezing might not produce snow. Inland and mountainous areas, meanwhile, are likelier to see flurries even when temperatures are several degrees above freezing.

"In Denver, Colorado, it might be 40 degrees and snowing. But in Charleston, South Carolina, it could be 28 degrees and raining," said Noah Molotch, Director of the Center for Water Earth Science & Technology (CWEST) at CU Boulder and a co-author of the study. "This study shows these fine-grain differences on a hemisphere-level scale for the first time."

The research, which compiled nearly 18 million precipitation observations spanning over 100 countries and four continents across the Northern Hemisphere, was published today in the journal *Nature Communications*.

The ability to differentiate rain from snow has important ramifications for Earth's hydrologic cycle and water management, especially in drought-stricken areas of the American west. Winter snowfall is estimated to provide water storage for one billion people worldwide

while climate warming could increase the amount of future rain-on-snow events, raising the risk of flooding.

"Snow and rain differ greatly in the ways they affect climate," said Ben Livneh, an assistant professor in CU Boulder's Department of Civil, Environmental and Architectural Engineering and a co-author of the study. "Snow acts as a water reservoir and reflects incoming sunlight, whereas if the same amount of precipitation falls as rain, that can dramatically change water resource management decisions."

To date, land surface models have typically predicted rain and snow based on a single, consistent air temperature threshold: snow below it and rain above it. But the CU Boulder researchers found that the threshold is not static and that relative humidity and surface pressure play an important role as well.

"The rain-snow air temperature threshold is primarily a function of relative humidity and methods incorporating humidity and elevation are more likely to predict rain and snow correctly," said Keith Jennings, a graduate researcher in CU Boulder's Institute of Arctic and Alpine Research (INSTAAR) and the lead author of the study. "If you just use 32 degrees Fahrenheit across the board, your estimates will be wrong in lots of places."

The continental U.S. had the most rain-snow variability of any country included in the study. Some of the coolest northern hemisphere thresholds were observed in the southeastern United States while the Rockies and intermountain West had some of the warmest thresholds.

The new study could inform the future of climate and land surface modeling as researchers look for ways to predict snowfall versus rainfall more accurately, especially in areas crucial for freshwater, agriculture and biodiversity. Future research will look to improve the map and

simulations by incorporating even more meteorological data points from around the world.

"The great thing about this research is that anyone can observe these variables right in their own backyard," said Molotch. "The topic lends itself well to future citizen science."

More information: Keith S. Jennings et al, Spatial variation of the rain–snow temperature threshold across the Northern Hemisphere, *Nature Communications* (2018). DOI: 10.1038/s41467-018-03629-7

Provided by University of Colorado at Boulder