Global warming won't mean more stormy weather

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A storm developing over the Bali Sea. Credit: Frédéric Laliberté

A study led by atmospheric physicists at the University of Toronto finds that global warming will not lead to an overall increasingly stormy atmosphere, a topic debated by scientists for decades. Instead, strong storms will become stronger while weak storms become weaker, and the cumulative result of the number of storms will remain unchanged.

"We know that with global warming we'll get more evaporation of the oceans," said Frederic Laliberte, a research associate at U of T's physics department and lead author of a study published this week in *Science*. "But circulation in the atmosphere is like a heat engine that requires fuel to do work, just like any combustion engine or a convection engine."

The atmosphere's work as a heat engine occurs when an air mass near the surface takes up water through evaporation as it is warmed by the Sun and moves closer to the Equator. The warmer the air mass is, the more water it takes up. As it reaches the Equator, it begins to ascend through the atmosphere, eventually cooling as it radiates heat out into space. Cool air can hold less moisture than warm air, so as the air cools, condensation occurs, which releases heat. When enough heat is released, air begins to rise even further, pulling more air behind it producing a thunderstorm. The ultimate "output" of this atmospheric engine is the amount of heat and moisture that is redistributed between the Equator and the North and South Poles.

"By viewing the atmospheric circulation as a heat engine, we were able to rely on the laws of thermodynamics to analyze how the circulation would change in a simulation of global warming," said Laliberte. "We used these laws to quantify how the increase in water vapour that would result from global warming would influence the strength of the atmospheric circulation."

The researchers borrowed techniques from oceanography and looked at observations and climate simulations. Their approach allowed them to test global warming scenarios and measure the output of atmospheric circulation under warming conditions.

"We came up with an improved technique to comprehensively describe how air masses change as they move from the Equator to the poles and back, which let us put a number on the energy efficiency of the atmospheric heat engine and measure its output," said Laliberte.

The scientists concluded that the increase in water vapour was making the process less efficient by evaporating water into air that is not already saturated with water vapour. They showed that this inefficiency limited the strengthening of atmospheric circulation, though not in a uniform manner. Air masses that are able to reach the top of the atmosphere are strengthened, while those that can not are weakened.

"Put more simply, powerful storms are strengthened at the expense of weaker storms," said Laliberte. "We believe atmospheric circulation will adapt to this less efficient form of heat transfer and we will see either fewer storms overall or at least a weakening of the most common, weaker storms."

More information: Constrained work output of the moist atmospheric heat engine in a warming climate, *Science*, www.sciencemag.org/lookup/doi/ … 1126/science.1257103

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