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Insight: how has the recycling rate of atmospheric moisture changed over the past 20 years?

Many numerical models predict that atmospheric moisture recycles at a lower rate over time in response to global warming. However, recent observations do not agree with these predictions. Now, researchers at the University of Houston, Caltech, and JPL, all in the US, have analysed new meteorological data and put forward an assessment that could reconcile experiment and calculations. They show that atmospheric moisture recycling rates have decreased over oceans worldwide during the past two decades. In particular, the recycling rate has increased in high-precipitation regions around the equator and decreased in low-precipitation regions located on either side of the equator during this time.

The hydrological cycle, which involves the atmosphere, surface and biosphere, is extremely important for humans. The atmospheric branch of this cycle, in which water vapour leaves the surface by evaporation and returns to the surface by precipitation, is crucial for weather and climate.

The variation of the strength of the hydrological cycle in the global atmosphere can be expressed by a parameter known as the "recycling rate", which is defined as the ratio between precipitation and water vapour. A new study (http://iopscience.iop.org/1748-9326/6/3/034018/fulltext) in **Environmental Research Letters** has looked at linear trends in global precipitation, water vapour and recycling rate in the latest meteorological data sets.

The researchers report that global precipitation has changed by around 0.08–0.26% per decade from 1988 to 2009. Such a linear trend is much weaker than that for global water vapour (at 1.01% per decade). Comparing the two leads to the conclusion that the recycling rate of global atmospheric moisture has actually decreased in response to global warming. According to the team, it now appears that observations and model simulations for recycling rate agree with each other. However, the researchers still urge caution when interpreting trends in precipitation at the global scale. This is because global precipitation, which is controlled by the atmospheric circulation and cloud microphysics, is more complicated.

In addition to studying how atmospheric moisture recycling rates vary over time at the global scale, the researchers have explored how recycling rate patterns evolve over specific areas. They found that, over the

past two decades, the recycling rate has increased in the high-precipitation regions around the equator (that is, in the intertropical convergence zone (ITCZ)) and decreased in the low-precipitation regions located on both sides of the equator. Further studies suggest that temporal changes in precipitation levels are more pronounced than those in water vapour levels. This results in a positive recycling rate trend in the high-precipitation regions and a negative recycling rate in the low-precipitation ones.

"We believe that the positive trend of precipitation in the ITCZ is probably associated with the rich-get-richer mechanisms suggested by some numerical simulations, but the physics behind the negative trend of precipitation in the low-precipitation areas, which we call a poor-get-poorer phenomenon, has not yet been explored very well," explained team leader Yuk Yung.

About the author

Yuk Yung is a professor at Caltech. Liming Li and Xun Jiang are researchers from University of Houston. Moustafa Chahine, Edward Olsen, Eric Fetzer and Luke Chen are scientists from Caltech/JPL.