Earth's atmosphere, which extends from the surface to about 10 miles in altitude. This layer is significant because it is Earth's most abundant greenhouse gas. The amount of water vapor in the atmosphere is not only determined by greenhouse gases but also by factors such as temperature, pressure, and humidity. Increases in greenhouse gases, such as carbon dioxide, lead to warming, which in turn increases the amount of water vapor absorbed into the atmosphere. This feedback effect amplifies the warming caused by greenhouse gases, leading to a spiral cycle. Consequently, the warming of the atmosphere will result in more water vapor being absorbed, leading to further warming. This is known as the water vapor feedback. 

With the availability of new observational data, researchers have been able to quantify the strength of this feedback. Scientists from NASA have used data from the Atmospheric Infrared Sounder (AIRS) instrument on the Aqua satellite to measure the humidity throughout the lowest 10 miles of the atmosphere. They have found that the amount of water vapor is highest at tropical latitudes, particularly over South Asia, where monsoon thunderstorms can release water vapor that rises 2 miles above the land. The distribution of water vapor in the atmosphere is not only a result of the interplay between water vapor, temperature, and other greenhouse gases but also the extent of its contribution to global warming. The question of how much warming will result from increased water vapor has been a matter of debate. However, recent studies have confirmed experimentally what existing climate models had anticipated theoretically. The research team used novel data from the AIRS instrument combined with global observations of shifts in temperature to confirm experimentally that the warming of the atmosphere is amplified by increased water vapor. This highlights the importance of understanding the role of water vapor in climate change. Climate scientists around the world have been using data sets like these to build a comprehensive picture of the interplay between water vapor, carbon dioxide, and other atmosphere-warming gases. The NASA-funded research was published in the American Geophysical Union's Geophysical Research Letters. 

The finding that tropical cyclones readily absorb water vapor from the atmosphere is significant because it confirms that this natural water vapor collector is potent enough to double the climate forcing caused by increased levels of carbon dioxide in the atmosphere. The new data set shows that as surface temperature increases, so does atmospheric water vapor. The water vapor feedback amplifies the warming caused by greenhouse gases and highlights the importance of understanding the role of water vapor in climate change. The findings might help explain why global surface temperatures have not risen in line with greenhouse warming, say researchers. The findings might help explain why global surface temperatures have not risen as expected due to increased greenhouse gas emissions. The research team is now working on developing a more comprehensive model that includes the water vapor feedback to better predict future climate changes. 

Andrew Dessler and colleagues from Texas A&M University and NASA's Goddard Space Flight Center have found that tropical cyclones readily absorb water vapor from the atmosphere, validating the role of the gas as a critical component of climate change. 

The distribution of atmospheric water vapor, a significant greenhouse gas, varies across the globe. During the summer and fall of 2005, this visualization shows what most vapor collects at tropical latitudes, particularly over South Asia, where monsoon thunderstorms swept the land. (Credit: NASA) 

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“That number may not sound like much, but add up all of that energy over the entire Earth surface and you find that water vapor is trapping a lot of energy,” Dessler said. “We now think the water vapor feedback is extraordinarily strong, capable of doubling the warming due to carbon dioxide alone.”

Because the new precise observations agree with existing assessments of water vapor’s impact, researchers are more confident than ever in model predictions that Earth’s leading greenhouse gas will contribute to a temperature rise of a few degrees by the end of the century.

“This study confirms that what was predicted by the models is really happening in the atmosphere,” said Eric Fetzer, an atmospheric scientist who works with AIRS data at NASA’s Jet Propulsion Laboratory in Pasadena, Calif. “Water vapor is the big player in the atmosphere as far as climate is concerned.”

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