FEATURES

Solving Earth's Climate Puzzle: Prof. Yen-Ting Hwang's 10-Year Quest

:Intro-video of Professor Yen-Ting Hwang.

Scientists are often considered serious people prone to solitude. However, Prof. Yen-Ting Hwang of the Department of Atmospheric Sciences at National Taiwan University (NTU), breaks from that mold. She is open and warm, and has a relentless passion for discovery.

Prof. Yen-Ting Hwang, recipient of the 2025 Taiwan Outstanding Women in Science Awards: Rising Star Award.

Now starting her 12th year as a faculty member at NTU, Prof. Hwang specializes in large-scale climate dynamics and air-sea interactions. These phenomena belong to areas of physics concerning the movement of air on a global scale—thermodynamics, fluid mechanics, and more. In layman's terms, she studies how the wind blows: how large-scale, long-term atmospheric patterns influence droughts, wildfires, and heatwaves, and where fronts and typhoons will travel.

Prof. Hwang holds a bachelor's degree in Physics from NTU and a PhD in Atmospheric Sciences from the University of Washington, Seattle. Her passion for decoding the natural world through the lens of physics began at NTU. A course on atmospheric dynamics taught by Prof. Chun-Chieh Wu sparked her interest

in using elegant physical equations to explain complex atmospheric behavior. Later, through her work in the lab of Prof. Chih-Hong Chueh at the Institute of Astronomy and Astrophysics, she became aware of the interconnected world of theory, simulation, and observation.

Today, she leads the Climate Dynamics and Global Change Laboratory, where she encourages students to arm their curiosity with logic to build knowledge step by step. Ten years ago, she was enchanted by the beauty of nature and the satisfaction of understanding its patterns. Now, she is drawn to the very processes through which humanity accumulates and refines that understanding.

Prof. Hwang weighing in with the Climate Dynamics and Global Change Research Group.

Finding Direction Through Mistakes

Concerning her recent recognition as a recipient of the 2025 Taiwan Outstanding Women in Science Award, Prof. Hwang openly admits,

"This award-winning research began with a flaw in my PhD thesis."

Prof. Hwang enthusiastically interpreted the equation written on the white board.

Determined to uncover why her original hypothesis had been overturned by later studies, together with Sarah Kang and other team members, they reached out to nine climate centers around the world, convincing them to run simulations to test unexplored ocean mechanisms. It took ten years to uncover what had previously been overlooked.

What Prof. Hwang's team discovered through exploring the oceanic mechanism was astonishing: atmospheric pollutants with a lifetime of just two weeks, through reflecting sunlight, can alter sea surface temperatures and influence climate patterns for decades. In other words, today's climate still bears the imprint of industrial emissions from the 1980s.

Amid the sweeping changes driven by human-induced climate change—across the atmosphere, ocean, sea ice, and land—Prof. Hwang examines emerging mechanisms through observation and simulation. Her goal is not only to deepen our understanding of the Earth system, but also to identify and explain the gaps between current climate models and the real world. She often works hand-in-hand with international climate scientists, inviting them to test her ideas, seeking to confirm deep theoretical thinking with collaborative validation.

Knowledge Buildup through Interdisciplinary Exchanges

"In science, each of us might just be a small cog in a much larger machine," she says. But for Prof. Hwang, collaborative problem-solving is deeply fulfilling. Take the cloud feedback meetings she regularly organizes as an example: experts in theory, simulation, and observation are brought together to discuss everything from cloud microphysics to global energy budgets. Through such interdisciplinary exchanges, everyone advances together—a process of productive interaction that she finds incredibly thrilling.

The Cloud Feedback Model Intercomparison Project (CFMIP) has been a key chapter in her intellectual journey. She once spent two or three years trying to use theory to explain how climate models predict future mid-latitude storm tracks—without success. Eventually, she realized that her theoretical framework was missing one critical factor: clouds. Unlike theory, climate models did include clouds.

So, she turned her attention to how Southern Ocean clouds influence tropical circulation—an approach that caught the attention of the CFMIP team. She was soon invited to join as a scientific committee member.

"That was the first time I had joined a large international collaboration," she says, eyes lighting up at the memory. Through her experiences with CFMIP, she witnessed science unfold across generations and borders, with experienced researchers offering support and guidance. She has since led major multi-model comparison projects within the group.

"When someone truly wants to find answers," she says, "other scientists will step up to help. I love that part of science—how we build knowledge together, across time and geography."

From the Poles to the Tropics: Understanding Global Connections

Prof. Hwang's award-winning research focuses on how climate changes in the mid- to high latitudes influence the tropics. More specifically, her studies explore how phenomena like sea ice melt, ozone depletion, and industrial aerosol emissions affect the equatorial cold tongue and warm pool regions.

"These insights directly improve climate prediction and help us refine climate models," she explains. The cold tongue and warm pool are critical to El Niño dynamics and serve as the engine behind large-scale atmospheric circulation. Changes here affect where droughts and heatwaves occur—some of the most pressing extreme events we face.

Looking ahead, Prof. Hwang plans to focus even more on the equatorial Pacific. She plans to analyze satellite data dating back to 1979 to track how various factors have altered this region's temperature—and to forecast when the cold tongue might become warmer than the surrounding warm pool. Such a shift would have profound implications for global climate patterns.

Science with a Human Touch

"I want to do science that connects with people.," she says. Prof. Hwang loves thinking, guessing, imagining—and above all, the process of testing and interpreting those ideas. Atmospheric science may be rooted in hard physics, but to her, it is also deeply personal, deeply human.

With unflagging passion, Prof. Hwang continues to push boundaries—mapping the unknown, one idea at a time.

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