Tempest news

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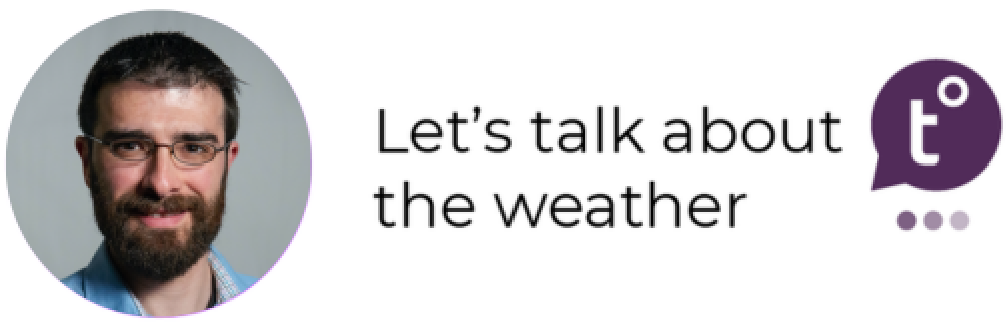
TEMPEST NEWS | MAY 2023



As Dr. Marty Ralph and Dr. Jason Cordeira sat across the table at a local Chipotle for lunch, they mused the idea of an intensity scale similar to that of hurricanes or tornadoes for the more frequently occurring atmospheric rivers being seen in parts of the world. Marty drew the concept of the scale, based on the intensity and duration, on the back of a napkin. It was something that had been brewing in his mind for a while, but it was the first time that he talked about it with colleagues. We sat down with Dr. Jason Cordeira this month to learn more about the scale and its intended uses.

Q: WE'VE HEARD THE TERM ATMOSPHERIC RIVERS A LOT MORE IN RECENT MONTHS. FOR THOSE WHO DON'T KNOW, WHAT EXACTLY IS AN ATMOSPHERIC RIVER?

A: An atmospheric river is part of a larger storm system. You might be familiar with storms on the East Coast like **nor'easters**, or **mid-latitude cyclones**, or Pacific winter storms; the atmospheric river is the part of those storms that contain strong winds and lots of moisture. When you multiply those two parameters together, you get water vapor flux, which is literally a river of water vapor in the sky. When that comes on shore, in places like California, where you have high terrain, the mountains essentially wring out the water vapor into precipitation.

Q: ARE THESE EVENTS EXPECTED TO BECOME MORE FREQUENT AND INTENSE, AS WE'VE SEEN WITH HURRICANES?

A: The amount of water vapor that's in the air is related to temperature, so if temperatures continue to increase worldwide, and especially over the Pacific basin, we can expect the amount of water vapor in the air to also go up. There are projections that the wind speeds might actually come down a little bit. But with the increasing moisture, we should still at least expect atmospheric rivers of similar intensity that may last a little bit longer. And when we talk about increasing temperatures, you know, atmospheric rivers, they can deliver lots of snow, as we found out this past winter, but also rain. If it's a little bit warmer, then maybe we get less snow and more rain. So that could impact water resources, especially in places like California that depend on snow for that slow melt into the summertime to help sustain water resources through the dry season.

Q: ARE THERE ANY SPECIFIC AREAS THAT PRODUCE MORE INTENSE ATMOSPHERIC RIVERS OR TIMES OF YEAR THEY ARE WORSE?

A: Since atmospheric rivers are part of larger storm systems, they usually follow what we call the storm track. The storm track follows the jet stream, which follows the sun. So as the sun moves into the northern hemisphere and our summertime begins, most atmospheric rivers and storms also move to the north. Then in the wintertime, when the Sun moves into the southern hemisphere, the storm track moves farther south. That's why California and the West Coast of the US get a majority of their atmospheric rivers during what we call the cool season from October-November through February and March, but sometimes it bleeds over on either end. So there's definitely a wet and a dry season, as most listeners and readers might know. We get our atmospheric rivers on the west coast in the winter. That's when they also tend to be strongest.

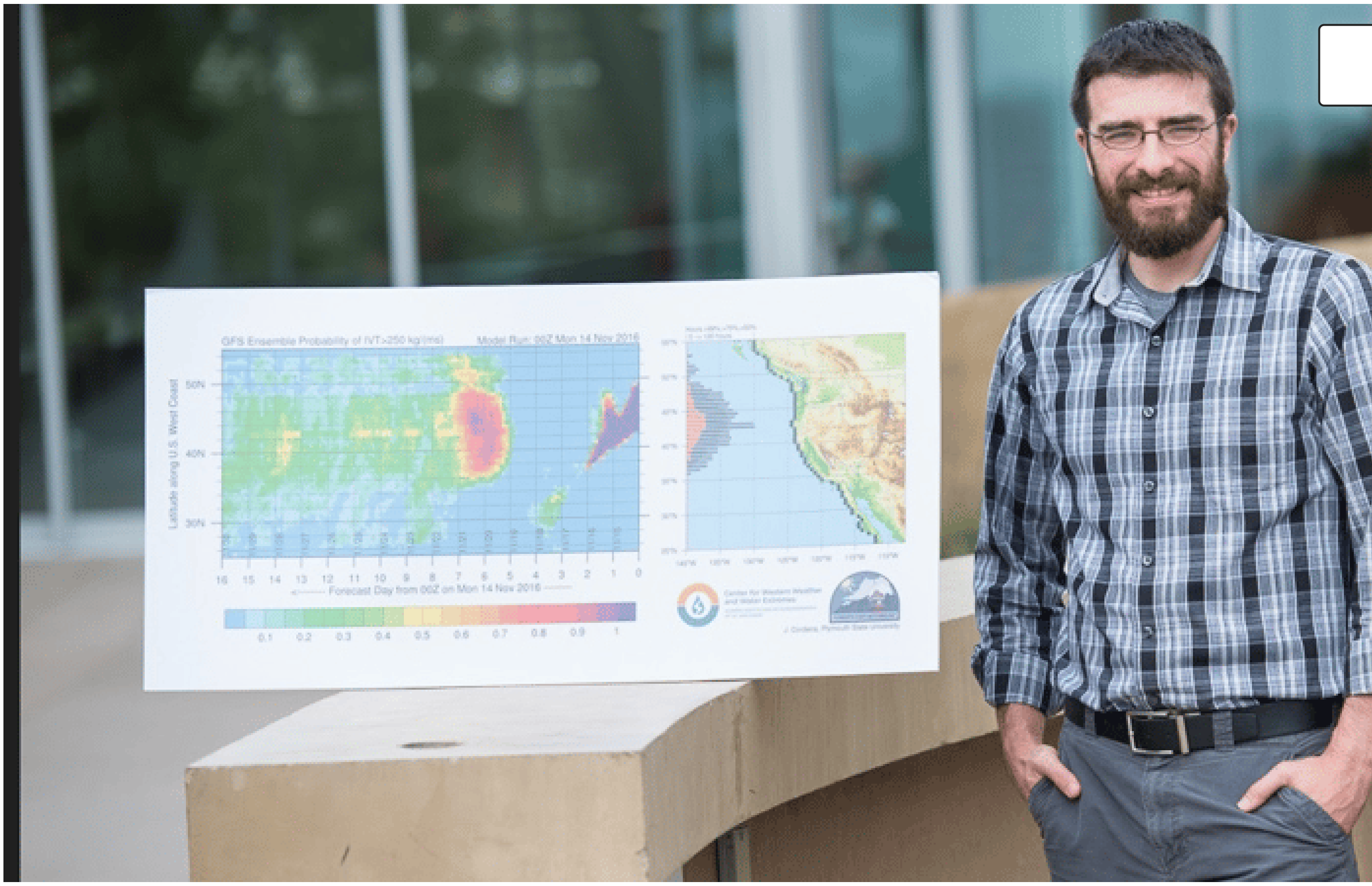
Atmospheric rivers occur worldwide. In Europe, for example, where there'll be heavy rain and snow in places like Portugal and France and England and Norway. There have even been atmospheric rivers documented in Antarctica. On the West Coast, they tend to be particularly impactful because of the high terrain of the Sierra Nevada going up to two to three kilometers or even higher, or you know, 10,000 fe plus, on the East Coast, even though we get a lot of atmospheric rivers, the mountains aren't as high so we don't get as much rainfall.

Q: AFTER THE IDEA CAME TO BE, HOW WAS THE INTENSITY SCALE ACTUALLY BROUGHT TO LIFE?

A: When Marty Ralph came up with this idea for the AR scale, the first thing he wanted to do was communicate that AR's (atmospheric rivers) are both beneficial and hazardous. The benefits and the hazards are obviously related to rainfall and flooding. So that has both duration components, how long it rains can impact the benefits and hazards, as well as the intensity. Those were sort of the two-parameter spaces that we consider for the AR scale.

The other piece that I think is a crucial component of how the AR scale came to be is that all of the different authors on that study come from different organizations or disciplines. So you'll notice several individuals from the USGS, NOAA, the National Weather Service, academia, and state water in California. So it really took all of these collaborators working together to tell the entire atmospheric river benefits and hazards story. Once we got all together, we sort of hashed out how different durations and different intensities sort of work together to produce that spectrum from benefits to hazards.

Atmospheric rivers have a parameter that we use called Integrated Water vapor transport. It roughly goes from zero to 1000, and we broke it up into 250 unit blocks. So you get a rating of 1,2,3,4 or 5. Once you get over five, you're over 1000. As for the duration, there's been a number of studies that show that anything that lasts for more than about a day is significant, and two days can become pretty hazardous. So we use that space to assign numbers one through five, very similar to what other rankings do for sort of tornadoes and hurricanes, but based on water vapor in the sky, rather than wind, which we use with those other storms.



Q: WILL WE ALL START TO HEAR THE AR SCALE REFERRED TO ON THE NEWS SOON?

A: We also have a number of tools and outreach materials that we use to educate people about what the scale is and what it isn't. The National Weather Service has not adopted it widely yet. So it's a work in progress. Take a hurricane, for example. A Category 1 hurricane is the lowest on the scale, but it can still produce a lot of impacts. So if you have a category five, or we call it an AR 5 event, and it's an October, and it's been really dry, it's not going to be hazardous, it's just going to replenish the reservoirs, and everyone will be really happy. So there's a push, rightfully so within the meteorological community, to warn and to do forecasts based on actual impacts, not just on some scale number. So rather than saying, “Oh, this is an AR 4 event,” they'll say, “This is going to bring 6-10 inches of rain, or it's going to produce two feet of snow, and these are the actions that you need to take." Rather than saying this is a really hazardous event. So rankings and scales can be really useful for situational awareness and for communicating to emergency managers or the media to give them an idea of how this storm compares to past storms. But it doesn't necessarily give you the full story in terms of what actions to take for a particular event. So it's a tool in the toolbox for situational awareness but needs to be combined with other forecasts.

The scale has global applications as well. There are published papers on the use of the AR scale in South America, in countries like Chile and Portugal, New Zealand, Australia. There was recently a study that looked at using the scale globally. And it does work. The numbers that we came up with on the West Coast are roughly similar to what they are globally, with the exception of some places like Antarctica, where we actually have to reduce the numbers a little bit because the storms are just that much weaker.

Q: WHAT'S NEXT FOR YOU GUYS?

A: At the **Center for Western Weather and Water Extremes**, we do a lot of different research activities to improve the forecasting of atmospheric rivers. So it's not just the situational awareness piece. One of the activities that we're engaged in is actually using the aircraft that the hurricane hunters use in the summertime on the East Coast. We use them in the wintertime on the West Coast to fly the atmospheric river storms 234 days before they make landfall in California. Using those observations allows us to improve our weather models so we can actually make better predictions of precipitation, which can be actionable. You know, more so than, say, the situational awareness provided by the air scale. So that's one example.

We're also running tailored weather models on our own supercomputer. We're engaging in collaborative research with water managers and the California Department of Water Resources to sort of take our immunological perspective to help inform their hydrologic perspective on how to operate there regarding forests and dams. So as Marty Ralph likes to call it a research and operations partnership. So we work hand in hand with the people who are using our information to make sure it's being used most effectively.

Q: ARE THERE ANY OTHER APPLICATIONS FOR THE AR SCALE?

A: One of the activities we're engaged in is forecast-informed reservoir operations. I don't know if you've heard that phrase. Traditionally, the Army Corps and the Department of Water Resources manage reservoirs in California based on what are called rule curves. So if at a certain time of year, if the water in the reservoir is above a certain level, they have to let the water out, and if it's below a certain level, that they can let the water keep accumulating when it's running off the mountains and into the reservoirs.

A few years ago, there was a case up in Lake Mendocino, which is north of Santa Rosa, where the water was above a certain level, so they let it all out because that was what the rule curve based on what current climatology told them to do. And then it did not rain again for the rest of the year, so the water never recovered. That was the start of the drought in the early 2000s, like 2015-2016. So there was this idea t use the weather forecast, and if it didn't show that it was going to rain, maybe we just hold on to that water for a little bit longer. We sort of gauged our risk based on whether or not there was going to be another big storm in the forecast. And then, if there was going to be a storm, we let out the water. So over the last seven or eight years, CW3E has championed this use of weather forecasting to inform reservoir operations. So when we talk about improving weather forecasts by flying the planes into them or improving situational awareness, that's all part of this broader climate resiliency, or climate adaptation program, to ask, can we better manage the water in California using weather forecasts?

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Researchers and farmers in Uganda are working together to reintroduce Coffea Liberica, a species of coffee that is more resistant to climate change than its better-known current replacements, Coffea Arabica and robusta. As factors like climate change and its effects like droughts or pests and disease are challenging the coffee industry, efforts to revive the production of Coffea Liberica and other wild species of coffee could help secure the future of the coffee industry.

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Scientists around the globe are taking notice of the Earth's rapidly warming oceans due to climate change and natural weather patterns like the impending El Niño. Higher ocean temperatures since the last El Niño has scientists bracing for a big appearance from the warm weather pattern. Pockets of the Earth’s oceans have been rapidly warming over the past few weeks, which could have severe impacts on marine life and weather systems around the world if El Niño moves in as predicted.

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