

# 'Weather jiu-jitsu' could help us combat extreme weather

By Mikala Kass, ASU News  
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In jiu-jitsu, a fighter can defeat a larger, stronger opponent with a few carefully placed, strategic moves. Arizona State University scientist [Upmanu Lall](#) wants to apply that same principle to extreme weather.

Imagine redirecting the 2012 Hurricane Sandy harmlessly into the ocean or raising the low temperature of the 2021 Texas freeze event by 50 degrees Fahrenheit. According to a [new essay in PLOS Water](#) by Lall and ASU graduate student [Qin Huang](#), controlling extreme weather may be a real possibility in the future — and one that researchers should begin exploring now as these extremes happen more frequently.

“We don't want to control the atmosphere all the time, because that would make it a very boring planet,” says Lall, director of the [ASU Water Institute](#). “But we want to control it so that when there is a weather event that is likely to be very impactful, we can steer it away, towards a harmless area. That's weather jiu-jitsu.”

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Lall is the director of the ASU Water Institute and a professor in the School of Complex Adaptive Systems in the Rob Walton College of Global Futures. The institute and college are both part of the [Julie Ann Wrigley Global Futures Laboratory](#).

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Below, Lall and Huang answer questions about the new research challenge they're proposing.

## **Question: What is “weather jiu-jitsu,” and why should we develop it?**

**Lall:** Jiu-jitsu's central concept is that you leverage the strength of the person you want to defeat. It turns out that the way some weather works lends itself to that strategy. The amount of energy involved in the way the jet stream moves is very large. There are times and places where things are kind of unstable. Near an instability, slight nudges or perturbations can make things diverge rapidly. Now imagine that, just like with jiu-jitsu, we poke it gently where there is an instability and make it go in the direction that we want. That's kind of what we are trying to do.

We have a lot of different types of weather extremes that have a big impact on society: hurricanes, atmospheric rivers, droughts, deep freezes and heat waves. We built structures to protect us — for example, dams to stop floods. But a lot of our weather-protective infrastructure in the U.S. is now beyond its design life. And then if you add climate change into the mix, we are just getting a lot more exposure to these things.

**Q: Cloud seeding — dispersing a harmless substance like salt or silver iodide into the clouds to help water droplets or ice crystals form — has been around for 80 years. Is that an example of an approach you might use in weather jiu-jitsu? How is the idea of weather jiu-jitsu broader than just cloud seeding?**

**Lall:** Cloud seeding is one mechanism which we know works. And it's cheap. There are other ideas there that we still are thinking about, but we haven't dug into them as much.

When rain forms due to cloud seeding, it releases terawatts of energy into the atmosphere. We were looking at what else would release that much energy for us, and one interesting thing is a lightning rod. This is a special lightning rod, where you point a bunch of lasers into a cloud and you focus them to roughly intersect. All the lightning in the atmosphere then zooms into that spot and discharges there, and through the laser into the ground. Again, it's jiu-jitsu, because we are taking a simple light beam, and we could leverage it to create up to a terawatt hour of energy discharge.

**Q: How can AI help us predict extreme weather and understand how and when to intervene?**

**Huang:** AI-based weather forecast models from a number of sources are proving to be more accurate, especially for longer duration forecasts, than the models currently used by operational weather forecast agencies. We used Aurora, an AI model that has been shown to be the most accurate of the ones currently available.

In the example of Hurricane Sandy, the Aurora AI model correctly predicted that Sandy would hit New York City and New Jersey five days prior to landfall. This gave us confidence in its skill. Then, we used specific criteria to identify theoretically suitable places for perturbation of the storm tracks and implemented a simulated cloud seeding experiment at the selected location. As a result of this perturbation, changes in the winds led to Sandy being diverted out to sea, keeping New York and New Jersey safe. Other experiments like this show similar promise.

It's very easy to run those forecasts with AI. The computation is very fast, especially with the [ASU Sol supercomputer](#). The best part about AI is that it accelerates everything and improves efficiency while keeping comparable accuracy for extreme weather prediction.

In [another recent paper](#), we show that small changes in initial conditions would have big outcomes that we can control when working with idealized weather models.

**Q: In Arizona, we have heat waves, drought, flash floods and wildfires. Are any of those potentially good candidates for a weather jiu-jitsu approach?**

**Lall:** In the Arizona context, one thing we have thought about but not worked on yet is preventing drought. The difference between a drought year and a normal year in the upper Colorado Basin may be 10 storms versus 14 or 15 storms in the season. That's it. So the question is, can we do a weather jiu-jitsu trick to get a few more storms in there? If that were to work, we could avoid severe droughts, or at least come up with a more regular situation.

**Q: Could a small intervention in one place accidentally make weather worse in a different area?**

**Lall:** Definitely, it can. That's why the precision control of jiu-jitsu is important. The first part we want to demonstrate is that we can have this kind of control, that this kind of thing is possible. And then the question is, how does one do it responsibly? So we are breaking it into those two phases.

**Q: What is the next step for scientists? Are there key breakthroughs that we need to progress this research?**

**Lall:** We have to demonstrate that we can control the process. What we know from how robots are controlled is that the control mechanism is continuous. You're continuously observing what the robot is doing, and if the robot starts to do the wrong thing, the correction is applied immediately. If you've seen a Waymo at a red light, it wants to turn right, and it nudges forward, stops, nudges forward, stops. That's continuous control.

We now need to demonstrate that we can do that. Every nudge that you make, you look at the result, you observe and you decide what you're doing next. Once we have that, I think it will be time to actually get in a plane and try it.

The idea would be to use cloud seeding in a safe testing area like the ocean where there is no risk to people. For example, if there's a storm in the southern hemisphere that will just stay over the ocean, we would try to disrupt that over the ocean and see if we can control its behavior.

*This story originally appeared on [ASU News](#).*

## Main image



In jiu-jitsu, a fighter can defeat a larger, stronger opponent with a few carefully placed, strategic moves. ASU researchers want to apply that same principle to extreme weather. Illustration by

