

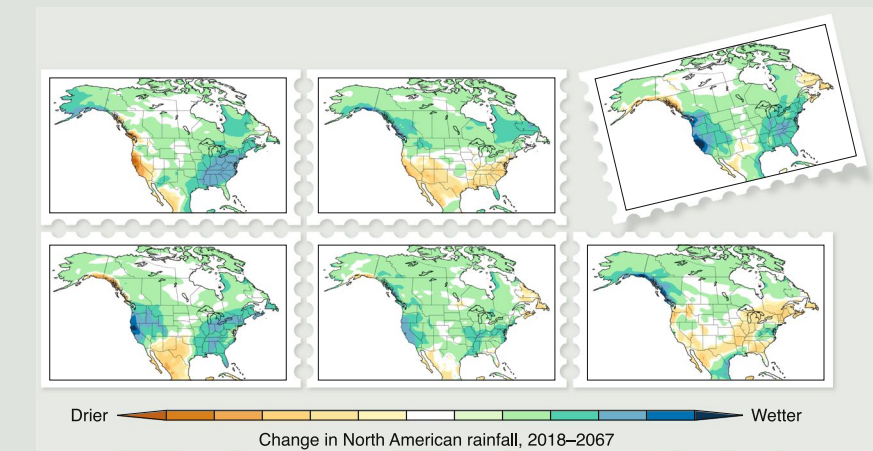
## ANNIVERSARY RETROSPECTIVE

## Embracing an uncertain future

As decision-makers all over the world prepare for climate change, many share a basic question: what changes will my community experience? Scientists have the tools to provide answers; the Earth system is being observed as never before, and climate models have been carefully developed to show what the future could hold. For many places in the world, however, tidy answers remain stubbornly out of reach.

When I entered the field five years ago, I was optimistic that accurate regional climate prediction was just a matter of a few model improvements and the proper projection of future greenhouse gas emissions. I soon realized that I was overlooking a key aspect of climate change uncertainty — natural variability. As Deser and colleagues reported, regionally, temperature and precipitation fluctuate in an unpredictable fashion as a result of nonlinear processes in the climate system (*Nat. Clim. Change* 2, 775–779; 2012). These fluctuations, which manifest year-to-year and decade-to-decade, obscure anthropogenic change in the near term.

Though natural variability introduces irreducible uncertainty into climate projections, its influence can be accounted for. For instance, Deser et al. used a large ensemble of climate model simulations that are identical aside from initial atmospheric state to show how the influence of natural variability differs by process, region and season. Each member of the large ensemble comes from the same model and is forced with the same greenhouse gas emissions, aerosol concentrations, volcanic eruptions and solar radiation. Yet, each member still shows a different possible climate future, due to natural



Credit: Adam Phillips, NCAR

variability. In the case of Seattle, winter precipitation is projected to either increase or decrease by up to 20% by 2060.

I encountered Deser et al. at the end of my first year, when the direction of my own research was uncertain. I had proposed a project that was not going to be funded and I was not sure how to proceed. Fortunately for me, my advisor hosted a workshop on regional climate prediction, which was attended by lead author, Clara Deser. She gave an incredible presentation on the role of internal atmospheric circulation variability in regional climate change; the societal implications were clear, the quantitative methods were accessible, and most importantly, there were open questions to be answered.

The experience inspired me to base my PhD research on understanding what drives climate variability in order to

contextualize climate change. I chose to investigate how the land surface feedback contributes to summer temperature variability in the Northern Hemisphere mid-latitudes, where intense future heat waves are a concern. As I look towards my postdoctoral research, I am still optimistic that we as climate scientists can present useful projections of regional climate change to decision-makers. It is just a matter of embracing uncertainty. □

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