Podcast Interview: Bridget Scanlon

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Global hydrologic models are increasingly being used to study climate and human effects on water resources worldwide. However, such models have evolved over time and their current applications often vary widely, raising concerns about their reliability in studies on global hydrology. In a recent PNAS article, Bridget Scanlon, a hydrogeologist at the Jackson School of Geoscience at the University of Texas at Austin, compared data from the Gravity Recovery and Climate Experiment, or GRACE, satellite mission with seven global hydrologic models to study changes in water storage around the globe. I spoke with Scanlon at the 2018 American Association for the Advancement of Science meeting in Austin, Texas. Scanlon begins by describing GRACE.

Scanlon: GRACE is two satellites that are about 400 kilometers above the land surface and the two satellites are separated by about 200 kilometers spacing. They are controlled primarily by changes in water storage at a monthly time scale. These satellites move in a certain polar orbit, and sometimes people refer to them as Tom and Jerry because they track each other. When the satellites go over an area that's getting wetter or getting flooded, the leading satellite speeds up, the distance between them increases, and we track that. If they're going over an area that's going through drought, then the leading satellite would slow down and the distance between the satellites would decrease. So, by measuring the distance between the satellites then we can track the changes in water storage at approximately a monthly time scale.

PNAS: For the PNAS article, Scanlon and colleagues compared GRACE data with seven global models, including water resource and land surface models, in 186 river basins from 2002-2014. In a number of instances, the researchers found disparities between GRACE and the models. Scanlon explains:

Scanlon: The main conclusion from this study is that the models are underestimating the water storage trends that we see from GRACE. They're underestimating the declines in water storage that are related primarily to irrigation and human intervention. But they're also underestimating the rises in water storage that we see from climate variability. For example, in the Amazon, GRACE estimated water storage increases of about 40 cubic kilometers per year and the models estimated trends ranging from about 11 cubic kilometers per year to about minus 70 cubic kilometers per year. The models also underestimated the declines in water storage in for example a very human impacted basin like the Ganges. The Ganges is the basin where we had the largest declines in water storage from GRACE, and the models underestimated that decline, or some of the models estimated a rise in water storage over the 12-year period. In the Okavango region, it's an area with internally drained basins and it has been experiencing wetter than normal conditions and so water storage has been increasing. So, GRACE estimated a large increase in water storage. But all the models did not get that increase in storage. They were all pretty flat over time.

PNAS: Scanlon points to the water storage capacity of the models as one possible explanation for the discrepancies. She says that the models may lack sufficient water storage capacity to accommodate for a range of changes in water storage, including soil moisture, groundwater, or surface water storage. The study also addressed human and climate influences on changes in water storage by assessing net trends in global water storage.

Scanlon: When we looked at the net impact of water storage globally by summing overall 186 basins, we get a net trend. So GRACE, we got a trend of about 70-80 cubic kilometers per year, and saw a positive increase in land water storage. So, GRACE includes human and climate impacts. Then if we want to estimate the impact of humans then we ran the hydrologic models with and without human intervention, and those ranged from 56-86 cubic kilometers per year. If we subtracted the human impact from GRACE then we're left with the climate impact. So, what we find is that the net impact of climate is about twice that of humans at those scales. But of course, locally humans can have a much greater impact than climate in basins like the Ganges. Global scale, over considering all these basins, climate variability had a greater impact than humans over this approximately decadal period.

PNAS: Scanlon says the findings might have implications for agencies that often depend on global models to inform water planning strategies. For instance, long-term predictions cannot be made with GRACE, she says. But by using the variety of data sources available, uncertainties can be constrained, helping to improve model-based predictions related to water storage.

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