

NASA Satellites Detect Changes in California's Central Valley Groundwater
NASA Ames Research Center
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Video Transcript

1. So, what exactly is this project about? What are you doing?

We wanted to see if the GRACE satellite can calculate water storage changes more easily than the models currently used. We compared GRACE with two models, C2VSIM and a GIS model, to test our hypothesis.

2. Who are you guys? Are you getting any outside help?

The five of us— Josh, Bridget, Amber, Ty, and Abdel— are from DEVELOP, a student run, student led internship program through NASA. We are located at NASA Ames Research Center. We partnered with California's Department of Water Resources.

3. Where exactly is the research taking place?

We decided to test out our hypothesis in California's Central Valley. Not only is it close to home for us, but it's a large basin with lots of groundwater use— ideal for our project. It's important to note the difference between the hydrological regions (on the left) and the groundwater basins (on the right). Hydrological regions are the areas that drain into the Central Valley aquifer, where most of the groundwater is stored. Hydrological regions are associated with GRACE in this project while groundwater basins are associated with the models, C2VSIM and GIS Change in Storage.

4. Why is this project important to people in the community?

Groundwater is crucial for agriculture and drinking water in California. It's hard to monitor groundwater in California, though, because land owners aren't required to disclose how much groundwater they pump, which is where we come in. Everyone needs to get their fair share of water, and hopefully better estimates of change in groundwater can lead to better groundwater management. As Mark Twain said, "whiskey is for drinking, water is for fighting over."

5. How are you finding the change in groundwater storage?

The models— C2VSIM and GIS Change in Storage— give change in groundwater as an output, so we just run the models and they give us numbers we then can easily turn into anomalies. GRACE is a little trickier, though, it gives change in total water storage anomalies (that is, all of the water in the region including lakes, streams, precipitation, etc.) However, what we really want is change in groundwater storage...

...We need to use this equation to convert from total water storage anomalies to groundwater storage anomalies...

...As I mentioned before, total water storage comes from GRACE...

...Soil moisture comes from a sensor called AMSR-E on the satellite Aqua...

...Snow pack data comes from SNODAS...

...And surface water comes from CDEC, the California Data Exchange Center.

6. Can you explain more about GRACE?

GRACE is a pair of twin satellites which fly in tandem. The density of the earth beneath them can be calculated from the distance they move away from each other as they fly along. The concept is based on Newton's Law of Universal Gravitation. The month-to-month change in density is due to water— whether ice, snow, or liquid. Since GRACE flies high in the air the data is only good for very large areas.

7. How did you get the models and what do they do?

Both models were given to us by the Department of Water Resources. C2VSIM gives both change in groundwater storage and total groundwater storage, is modeled data (that is, not based on observations), and can provide storage values for small areas. The GIS change in storage model extrapolates data from wells to imitate continuous data, is based on measured data, and is currently only accurate in the Sacramento River Basin.

8. What did you find out about the change in groundwater storage?

This graph shows the change in total water storage as calculated from GRACE, C2VSIM, and some other satellites which we used to check our data. They match up pretty well!...

...This graph shows the comparison of change in groundwater storage between GRACE and C2VSIM.. Although GRACE is a lot more varying than C2VSIM, they both models have similar trends and overall change in groundwater storage values...

Which is demonstrated very well by this graph. As you can see, the total changes from the entire Central Valley from both models fall within the errors of one another! It turned out that the GIS change in storage tool wasn't very comparable to GRACE and C2VSIM because it only has yearly data for one basin.

9. In conclusion, we found that GRACE and C2VSIM were comparable, there was a net decrease in groundwater storage in the Central Valley during the time period we considered, and both GRACE and C2VSIM detect seasonal variations in groundwater storage.