Recent estimates of groundwater (GW) availability in California have indicated declines in GW levels that may pose a threat to the sustainability of this region. The Gravity Recovery and Climate Experiment (GRACE) can be used to estimate variations in total water storage (TWS) and are therefore used to estimate GW storage changes. However, using GRACE data in the Central Valley aquifer (CVA) is challenging due to its coarse spatial resolution. In this study, we used a statistical downsampling approach, developed in previous climate research, to attempt to downscale GRACE GW storage estimates to the sub-region scale within the CVA. Historical data from the California Department of Water Resources’ (DWR) C2VSim model (1924–2003) were used to generate the theoretical framework for the linear model. Downscaled GRACE-derived GW storage estimates were compared to C2VSim GW storage estimates from October 2004 to September 2010. Downscaling of GRACE data produced favorable results for the entire study period, although significant improvements must be made for GW storage estimates on a monthly basis. Additionally, future research must address the influence of errors on the downscaled GRACE-derived GW storage estimates. With additional research, the incorporation of these new methods for estimating variations in GW storage in highly productive aquifers may improve water management techniques in California.

### Methods

#### GRACE-derived GW storage Estimates

#### Downscaling GRACE Data

1. A linear equation was generated using C2VSim GW storage as the x- and y-axes to obtain a split for downsampling.
2. The new release 5 GRACE-derived GW storage data were then downscaled.
3. Linear equation generated from step 1 and step 2 is applied to the GRACE GW storage data at each of the 21 sub-regions and then interpolated to obtained the downsampled GRACE GW estimate.

### Results

#### Monthly Downscaled Results

#### Downscaled GRACE Estimates for Study Period

### Conclusions

- Total change in GW storage for the CVA from C2VSim (-20.70 ± 0.01 km^3) and GRACE (-20.74 ± 0.75 km^3) were comparable.
- Downscaling produced favorable results for the 21 sub-regions for the CVA during the entire study period, although it was less successful on a monthly basis.
- Groundwater storage estimates from downsampled GRACE data agreed with C2VSim with an r² of 0.63.
- Future research should focus on the error of downscaled GRACE estimates and modifications to the methodology for incorporation into groundwater management techniques.

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### Background

- Deviations in the Earth’s gravitational field are attributed to variations in total water storage.
- Currently, the DWR uses a hydrological model (C2VSim) to assess changes in GW storage.
- GW storage anomalies from GRACE are calculated by subtracting snowpack (SP), surface water (SW), and soil moisture (SM).
- Downscaling techniques can be used to further refine GRACE.

### Objectives

- Update groundwater storage estimates for California’s Central Valley using release 5 GRACE data and revised C2VSim calculations.
- Downscale GRACE-derived groundwater estimates to the sub-region level to improve the usefulness of newly released GRACE data by water management agencies.

### Study Area

- **The Central Valley aquifer (yellow), and the Central Valley Hydrologic Region (BR)(green).** The yellow region depicts the 21 C2VSim modeled sub-regions used for downscaling GRACE.

### Link

- The DEVELOP National Program