National Aeronautics and Space Administration

InSAR subsidence, geologic composition, and groundwater estimation in California's Central Valley

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Program: FY22 R&TD Topics
Strategic Focus Area: Earth Science Data Analysis

Objectives:

Create a **multimodal data fusion and multivariate sequence-to-sequence transformation tool** to estimate InSAR subsidence, groundwater, precipitation, and geologic composition data in California's Central Valley

Background:

- California's Central Valley is responsible for **$17 billion of annual agricultural output**, producing approximately one quarter of the nation's food
- In some regions of the Central Valley, the land surface is sinking at a rapid rate - as much as **20 cm per year** during droughts - due to continued groundwater pumping
- **Limited data availability and spatial/temporal uncertainty** in the available data have hampered understanding the complex dynamics of groundwater and subsidence

Approach and Results:

- Multimodal data integration & LSTM spatiotemporal models
- Geologic composition estimation: R=0.88 using InSAR; Random Forest R=0.85; Decision Tree R=0.65
- Groundwater estimation: R2 of LSTM =0.92; Decision Tree = 0.71; Random Forest = 0.83
- InSAR subsidence estimation: R2 of LSTM =0.95; Decision Tree = 0.81; Random Forest = 0.86

Significance/Benefits to JPL and NASA:

- Remote geologic composition estimation using InSAR
- Future groundwater and subsidence estimations
- NISAR, NASA Decadal Survey Observables: Mass Change (MC), Surface Deformation and Change (SDC)

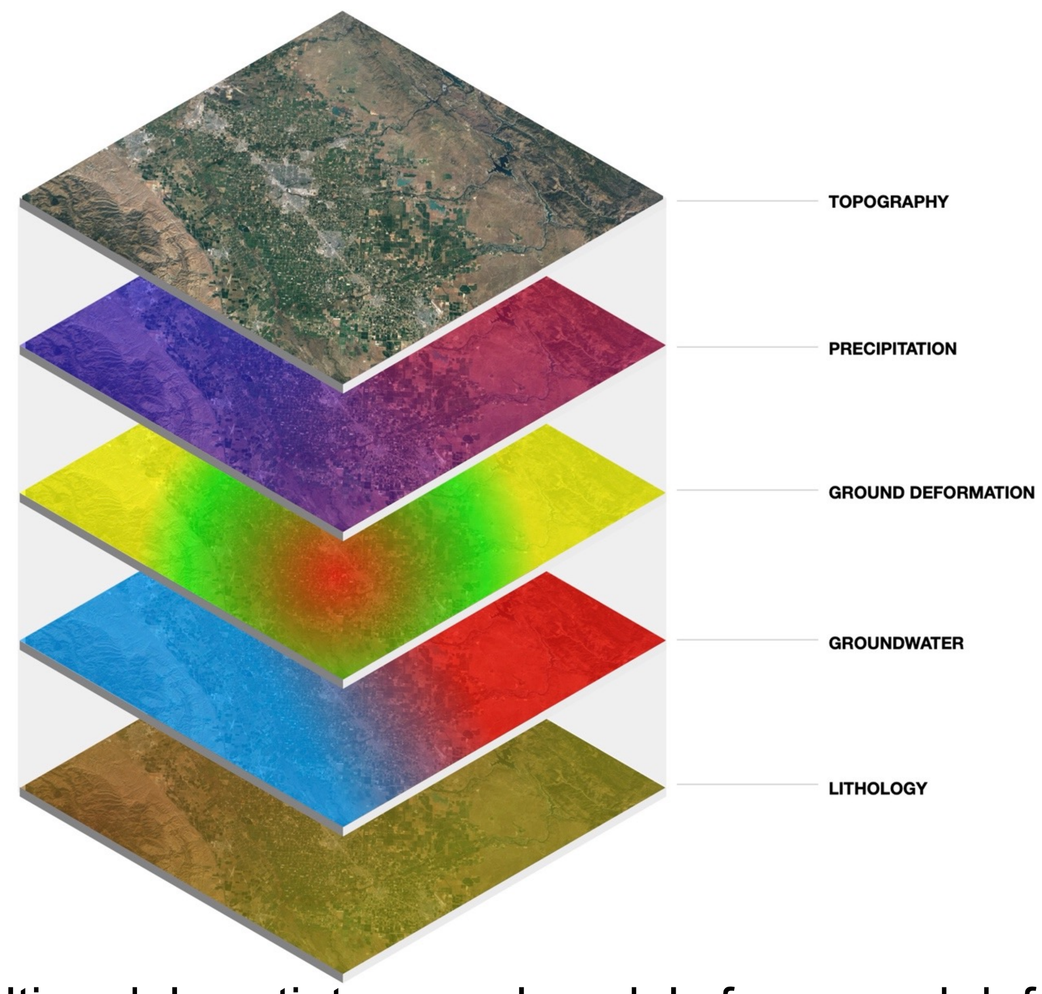

Figure 1. Multimodal spatiotemporal models for ground deformation, groundwater availability, and geologic composition estimation

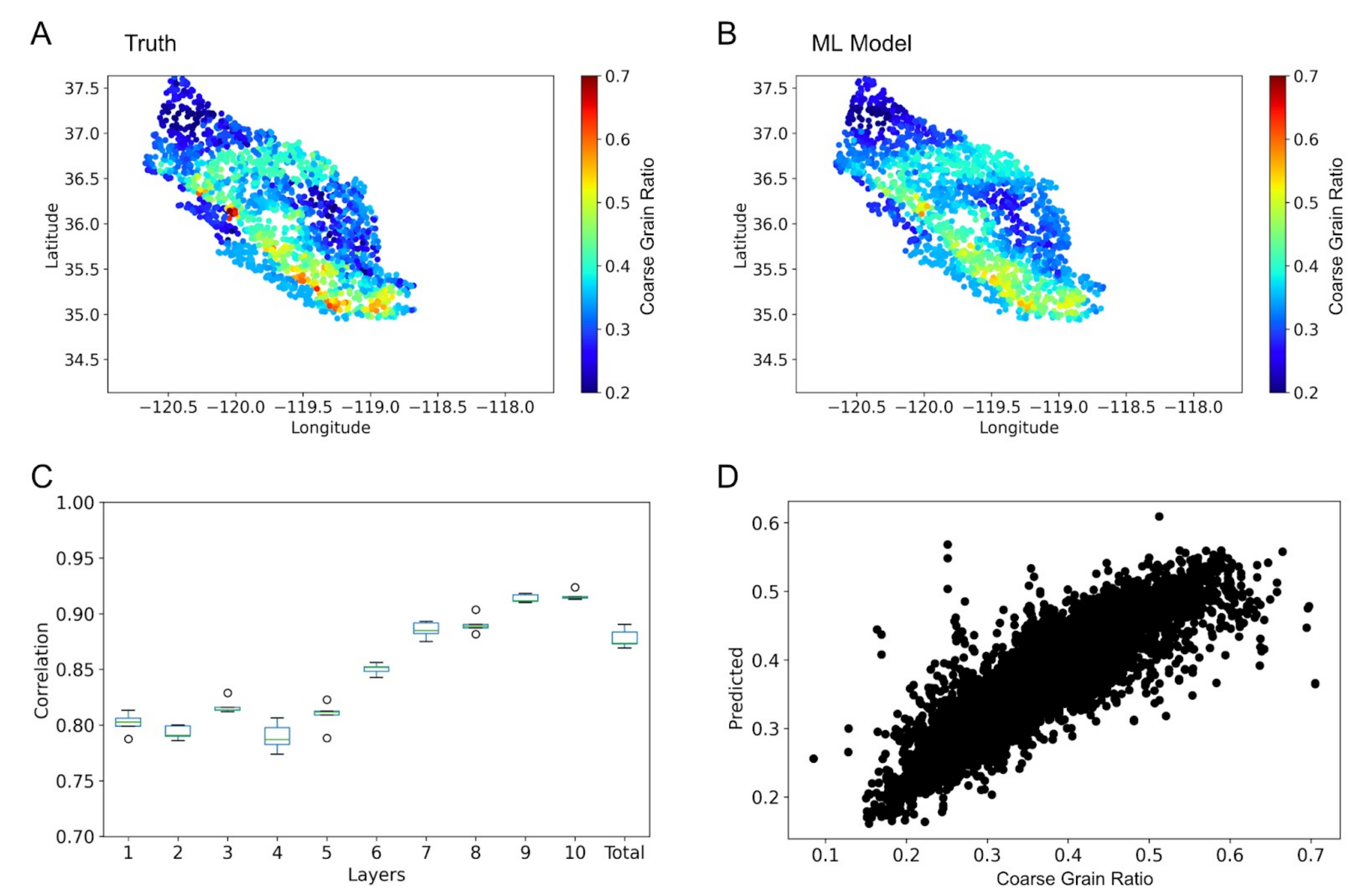

Figure 2. Geologic composition prediction using InSAR land deformation data. (A) Ground truth coarse grain ratio of the entire layer and (B) estimated coarse grain ratio. (C) Correlation between model output and ground truth at different layers of geologic composition. (D) Scatter plot between the ground truth and estimated geologic composition of the entire layer (R=0.88).

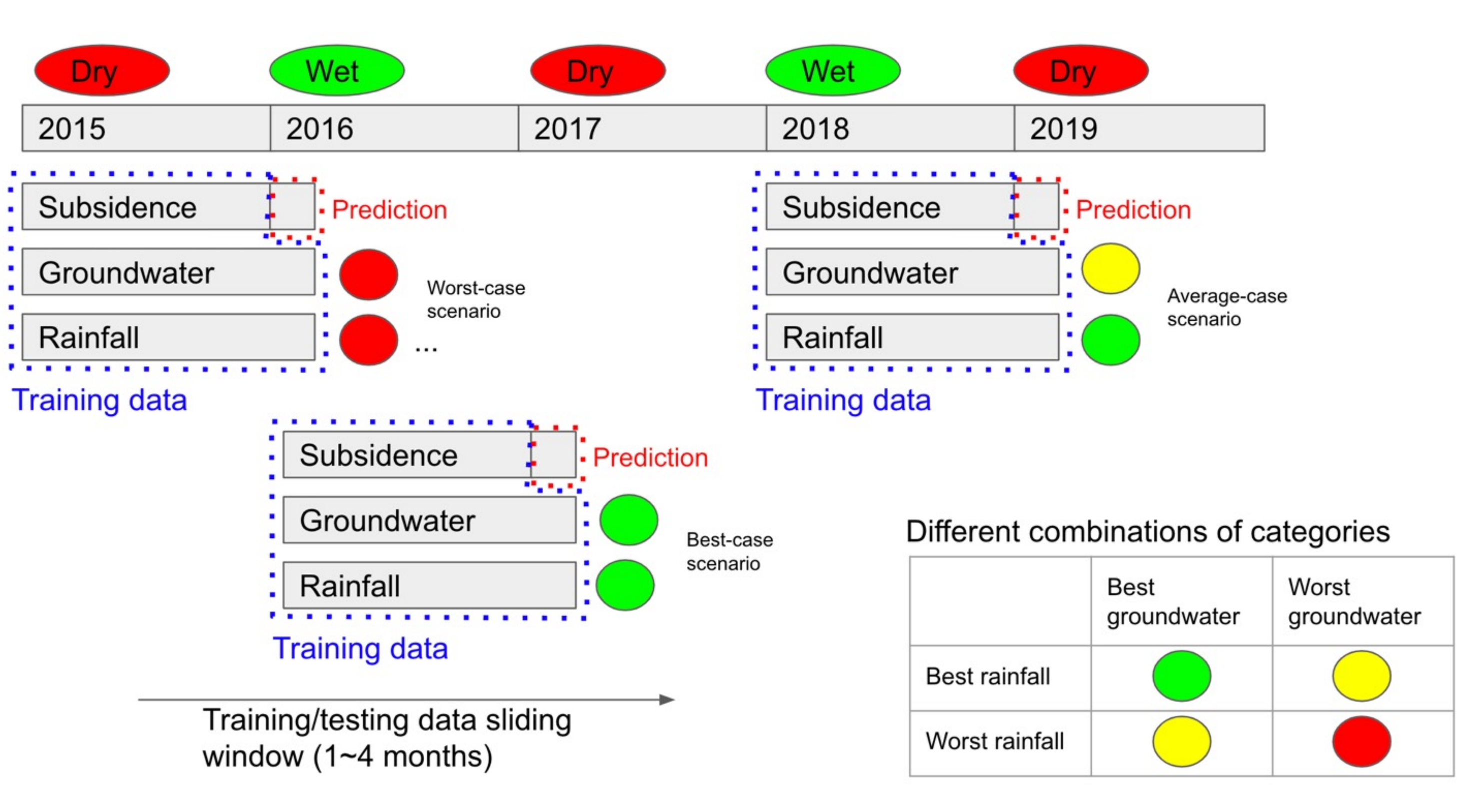

Figure 3. Multivariate spatiotemporal forecasting, including subsidence, precipitation, and groundwater

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Publications:

Kyongsik Yun, Kyra Kim, Anshuman Pradhan, John Reager, Zhen Liu, Michael Turmon, Alexander Huyen, Thomas Lu, Venkat Chandrasekaran, Andrew Stuart, "Filling the gap: Estimation of soil composition using InSAR, groundwater depth, and precipitation data in California's Central Valley", *AGU 2021*

Kyongsik Yun, Kyra Kim, John Reager, Zhen Liu, Caitlyn Chavez, Michael Turmon, "Remote estimation of geologic composition using interferometric synthetic-aperture radar in California's Central Valley", submitted to Neural Information Processing Systems 2022

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