

Assessing the spatial and temporal variability of water storage within the Aral Sea watershed using GRACE and TRMM data: 2001-2011

Kirk Zmijewski and Richard Becker

The University of Toledo

Department of Environmental Sciences

kirk.zmijewski@utoledo.edu, richard.becker@utoledo.edu





Study Objectives

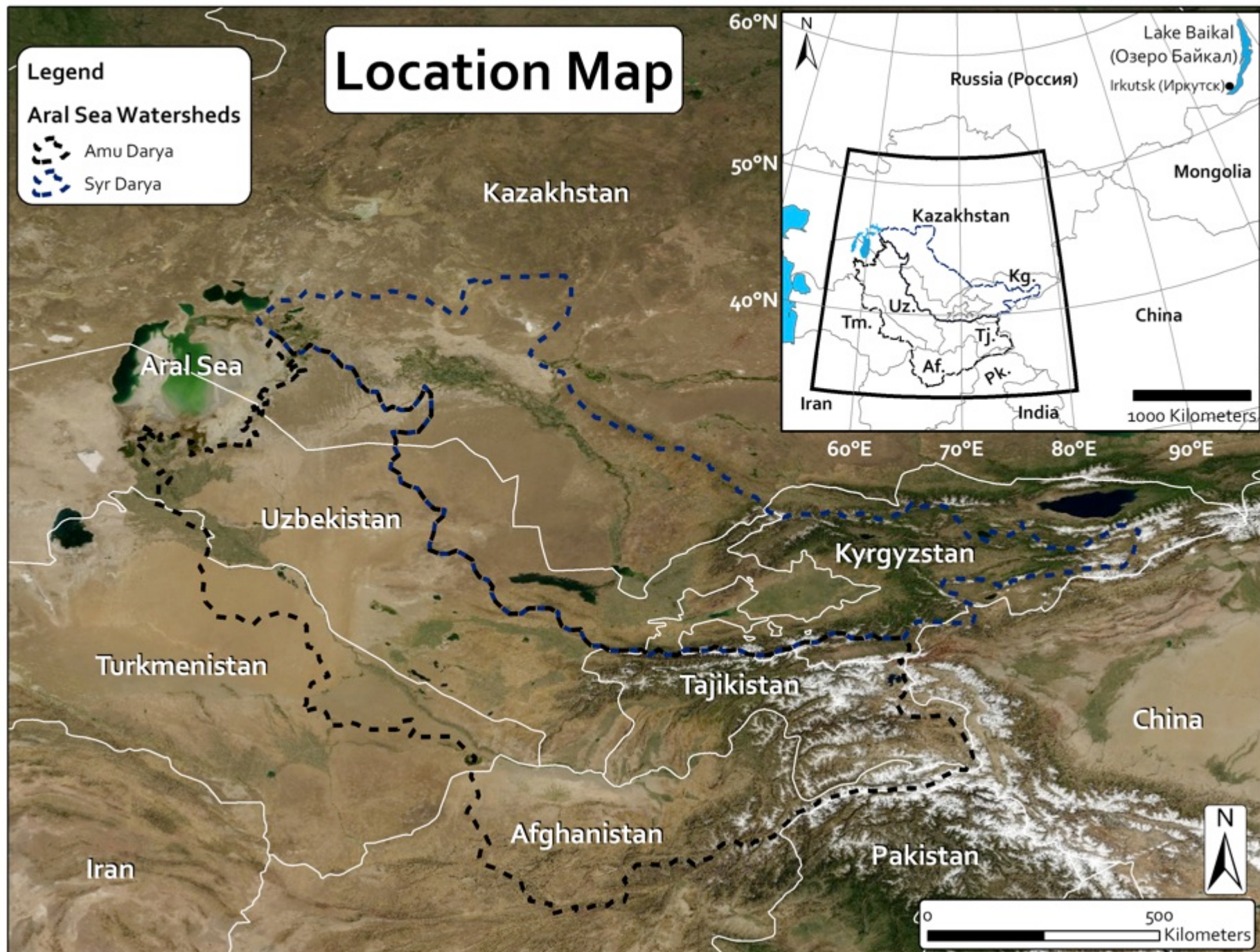
- Determine water storage trends in the Aral sea watershed
- Use local precipitation records to determine historical rainfall patterns
- Use TRMM (Tropical Rainfall Measuring Mission) to supplement rainfall records
- Use GRACE (Gravity and Climate Experiment) data to determine annual gravity change

Legend

Aral Sea Watersheds

- Amu Darya
- Syr Darya

Location Map

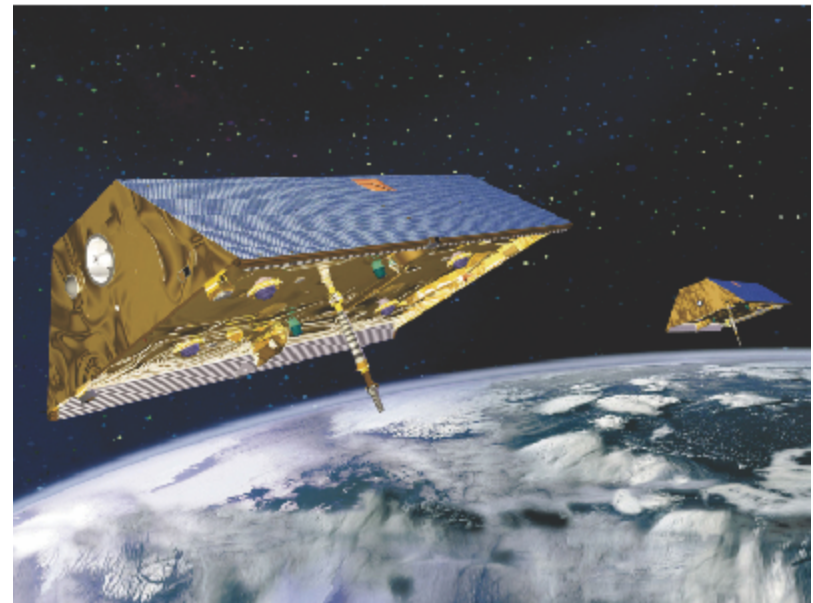
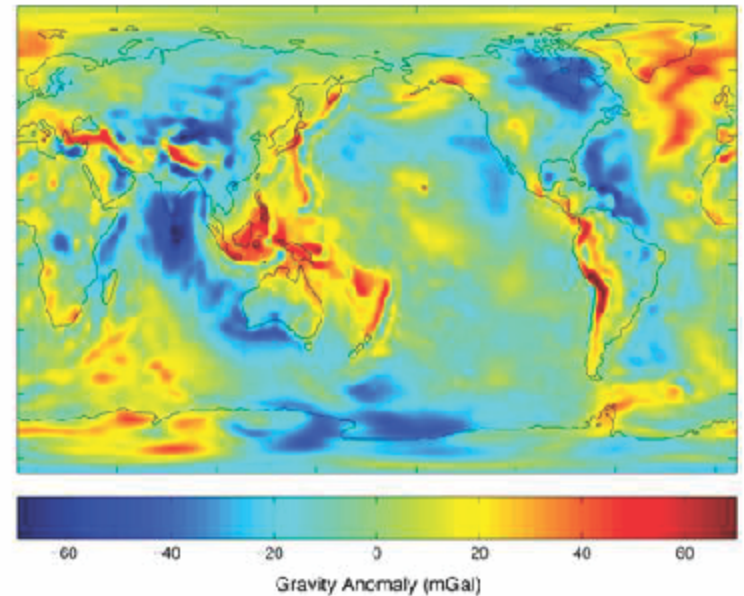




GRACE

- GRACE A and B
 - Same orbit, K-band microwave used to monitor distance
 - Gravity anomalies (e.g. mountains, subduction zones) cause acceleration/ deceleration of satellites
 - Repeat measurements (monthly) capture variability in gravity which is water flux

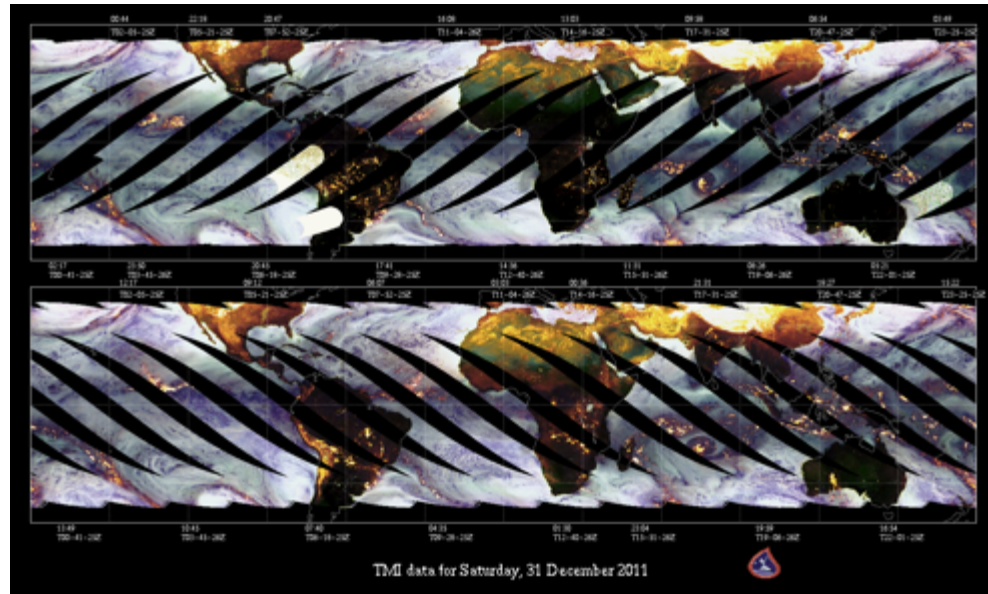
<http://grace.jpl.nasa.gov/data/>



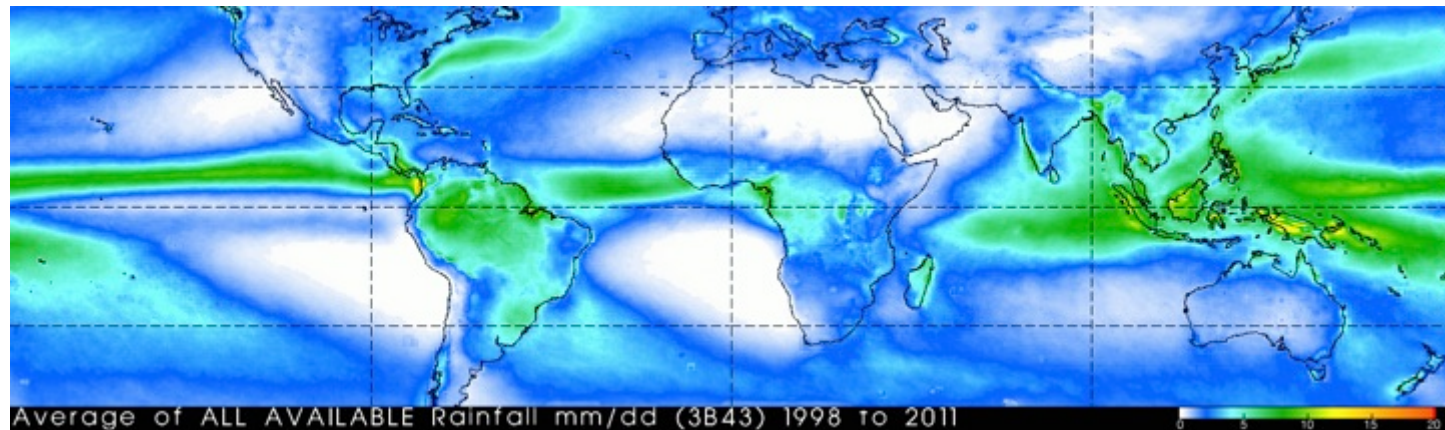


TRMM

- Uses Precipitation Radar (PR) and TRMM Microwave Imager (TMI) to provide global weather data
- Record from 1997-present
- Obtains realtime 3-Hour and 7-day rainfall rates
 - Derived products include total monthly precipitation rates
- 0.25 x 0.25 degree grid, 50N-50S



<http://trmm.gsfc.nasa.gov/>

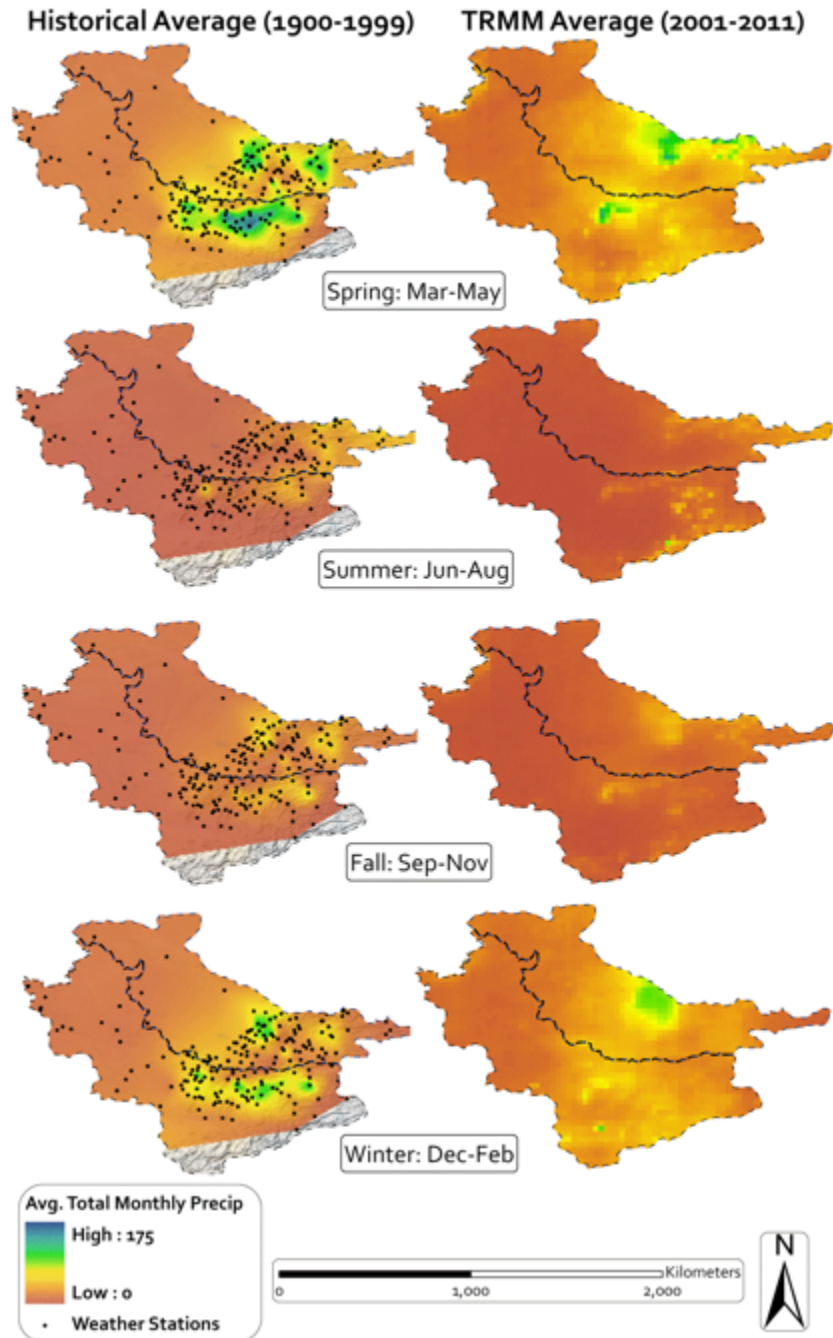




TRMM Validation

- 191 Weather Stations were used to compare monthly precipitation to TRMM data
- Values for TRMM based rainfall rates were statistically similar to historical averages

Aral Sea Watershed Seasonal Rainfall:

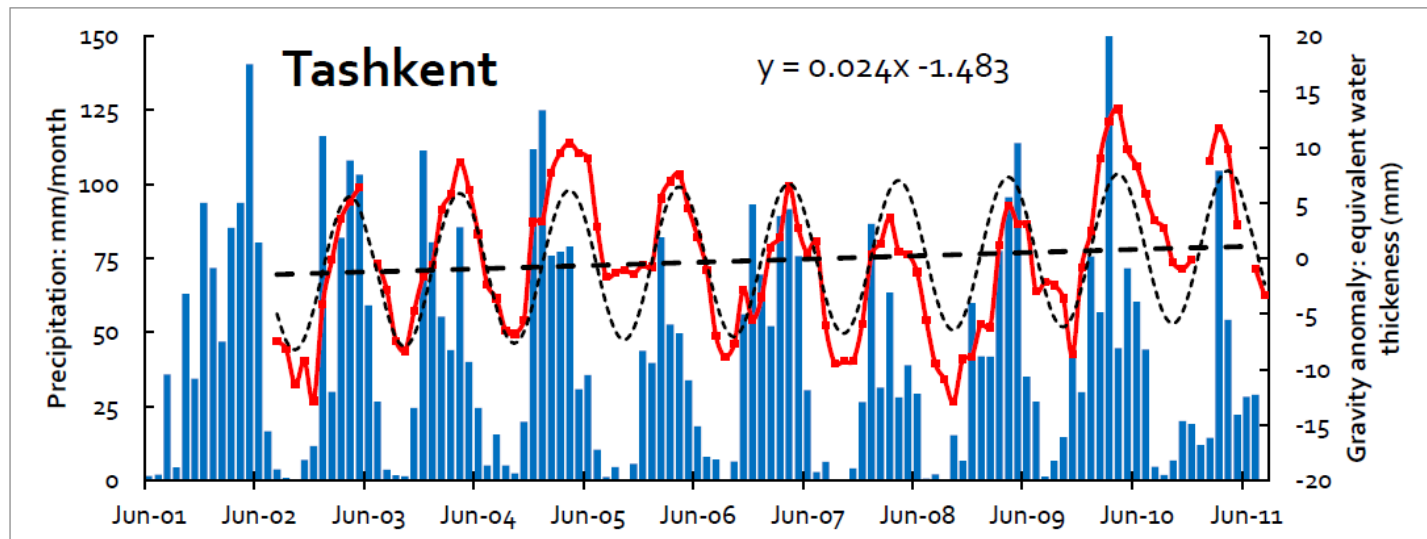
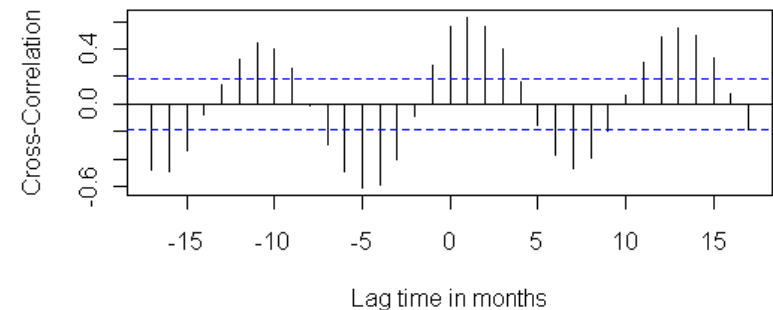




Methods

- An annual periodic function was fit to the gravity data
 - Linear model was used to determine trend
- Gravity response compared to precipitation using a cross correlation function

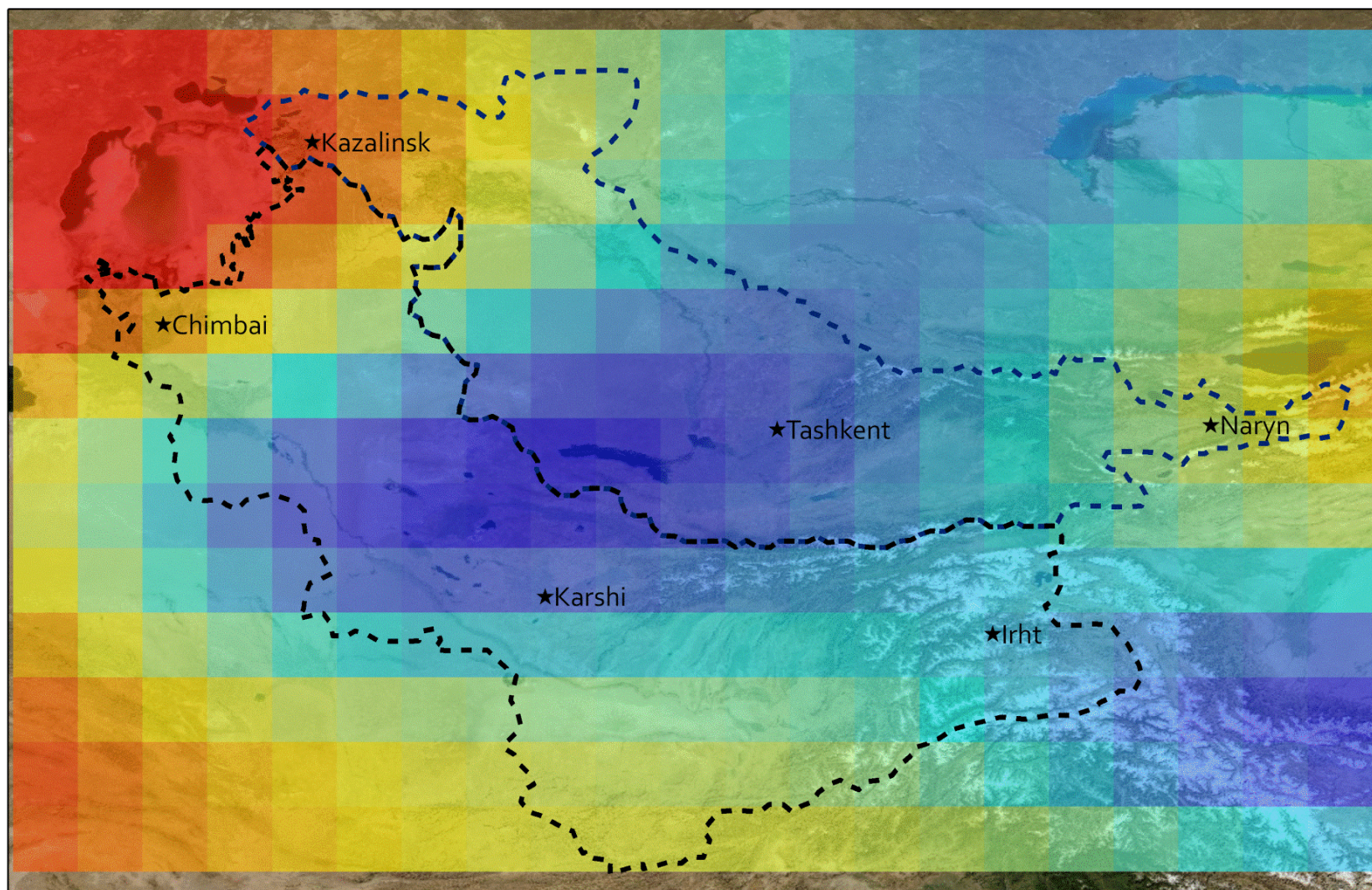
Tashkent: Gravity vs. Precipitation





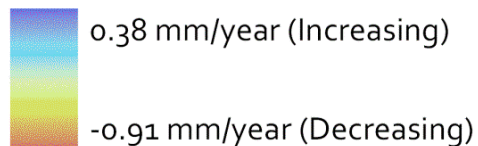
Results

Change of Gravity Anomaly Mean (Water Storage): 2002-2011

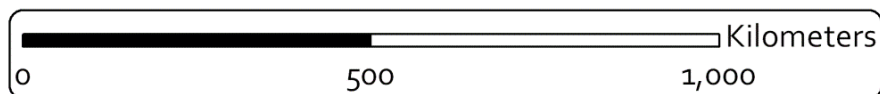


Change in Water Storage

Slope of Linear Model



Amu Darya
Syr Darya





Ongoing research

- Expand method to a larger region
 - Inner Mongolia and China drylands
- Continued data acquisition will allow higher confidence in future trend models

Thanks!



kirk.zmijewski@utoledo.edu

