Trends in Irrigation and Streamflow in the National Climate Assessment – LDAS using the NASA Land Verification Toolkit software

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Introduction

The heavily interconnected nature of the U.S. hydrologic system means that studies of the impact of climate change cannot be reliant on individual metrics. Instead, observing the connections between a wide variety of metrics are necessary to fully understand how the hydrologic system is changing. The aim of this project is to investigate recent trends in streamflow and irrigation in particular, using the National Climate Assessment – Land Data Assimilation System (NCA-LDAS) dataset.

Background

Figure 1: The Land Verification Toolkit (LVT) and many of its available land datasets

The NASA Land Verification Toolkit (LVT) software is a data postprocessor designed to evaluate and analyze the output of the Land Information System (LIS) against numerous land datasets (Fig. 1). It is capable of a wide variety of tasks, from temporal and geospatial transformations to the use of statistical verification metrics. For this project, LVT was used to calculate a variety of useful indicators and metrics from LIS output data.

The NCA-LDAS is a model dataset produced by LIS combining best-available observations and remotely sensed data used to support the generation of hydrologic climate indicators. It extends at a 1/8th degree scale across the continental United States daily from 1979 to the present. The NCA-LDAS dataset is available to the public at the NASA GES DISC.

Methods / Approach

The three types of metrics used in this project were mean, correlation, and trend. All were calculated over a variety of time scales over varying parts of the NCA-LDAS dataset.

Also tested were the effects of varying metric computation frequencies and the confidence intervals used in Mann-Kendall tests to determine the statistical significance of detected trends. LVT output was generated in NetCDF format, and the GrADS (Grid Analysis and Display System) software was used to open and plot the data using scripts.

Results

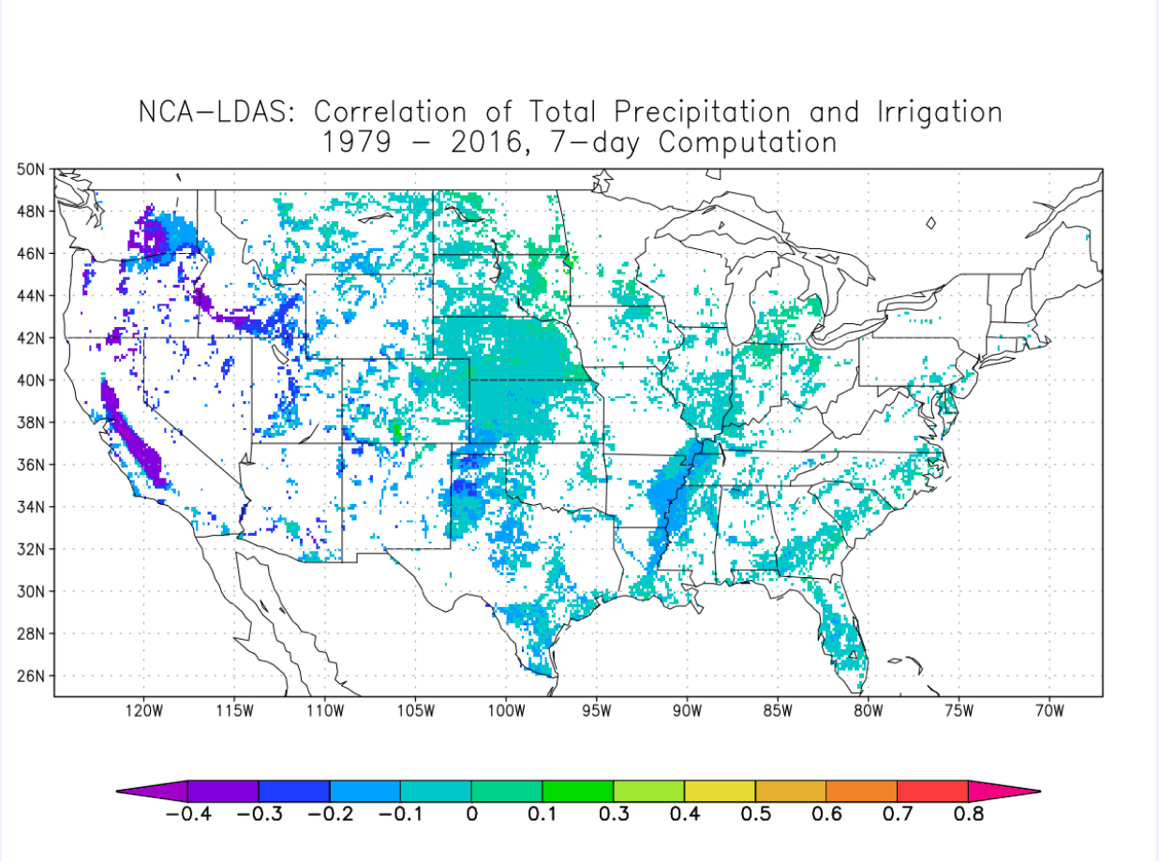

Figure 2: Correlation of precipitation and irrigation

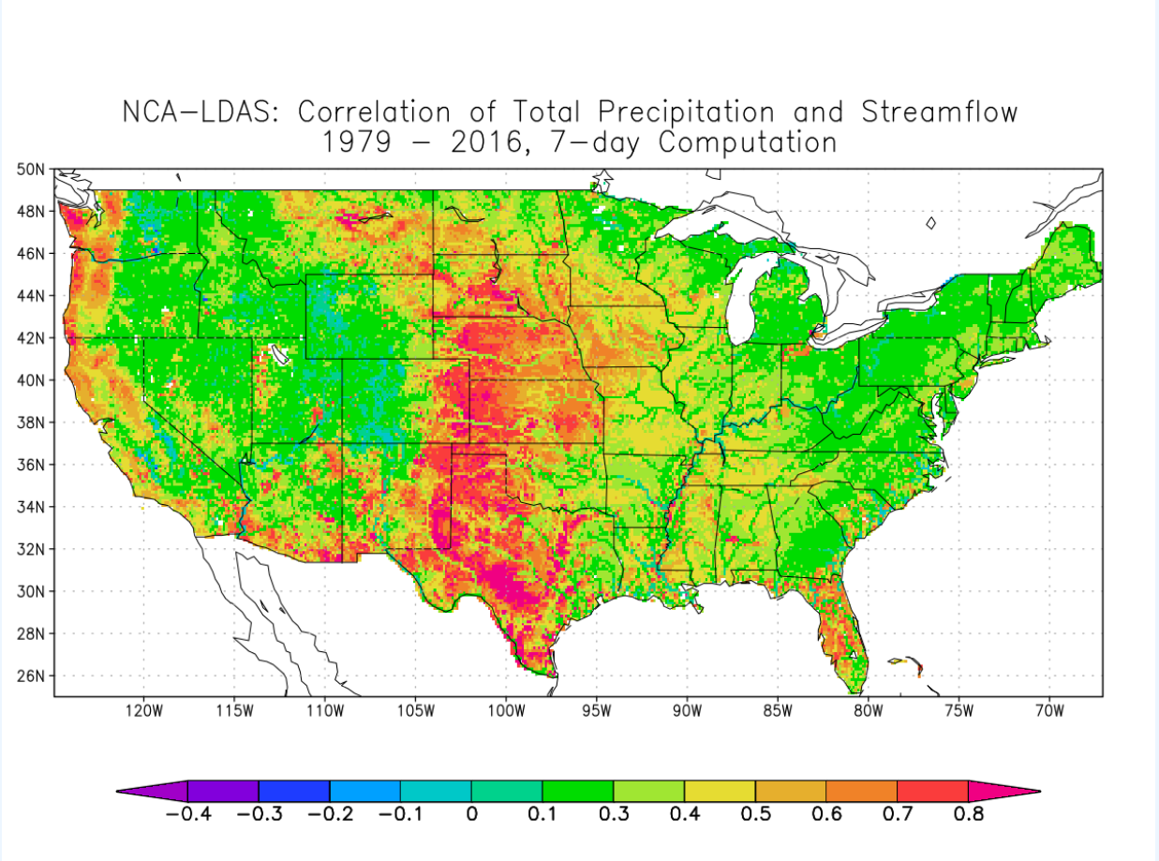

Figure 3: Correlation of precipitation and streamflow

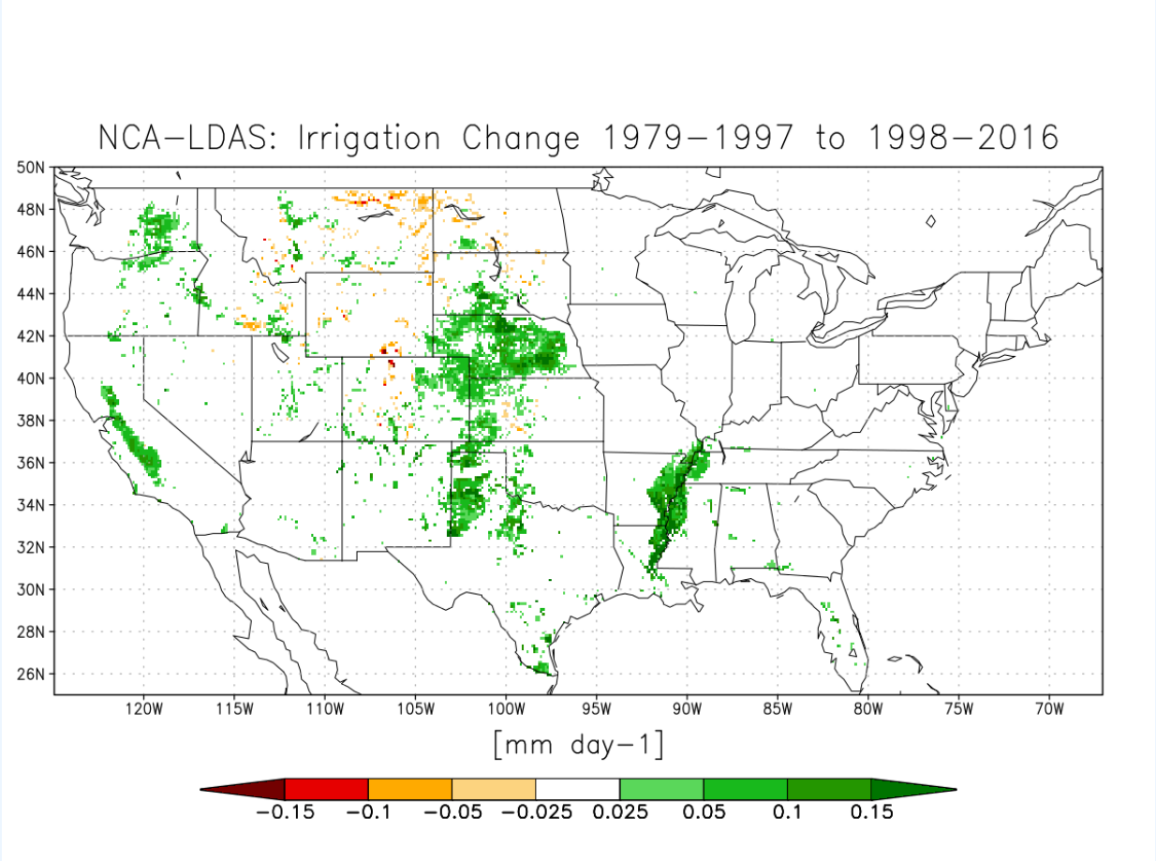

Figure 4: Mean irrigation change

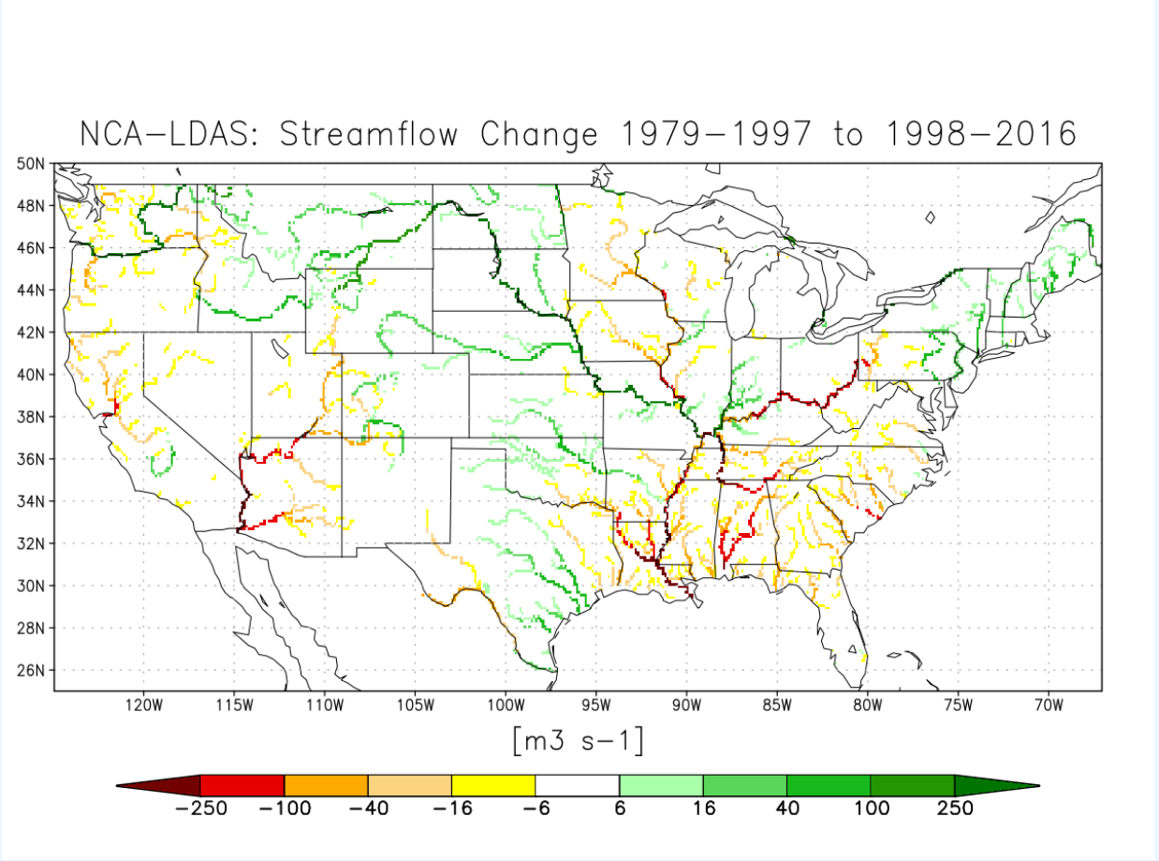

Figure 5: Mean streamflow change

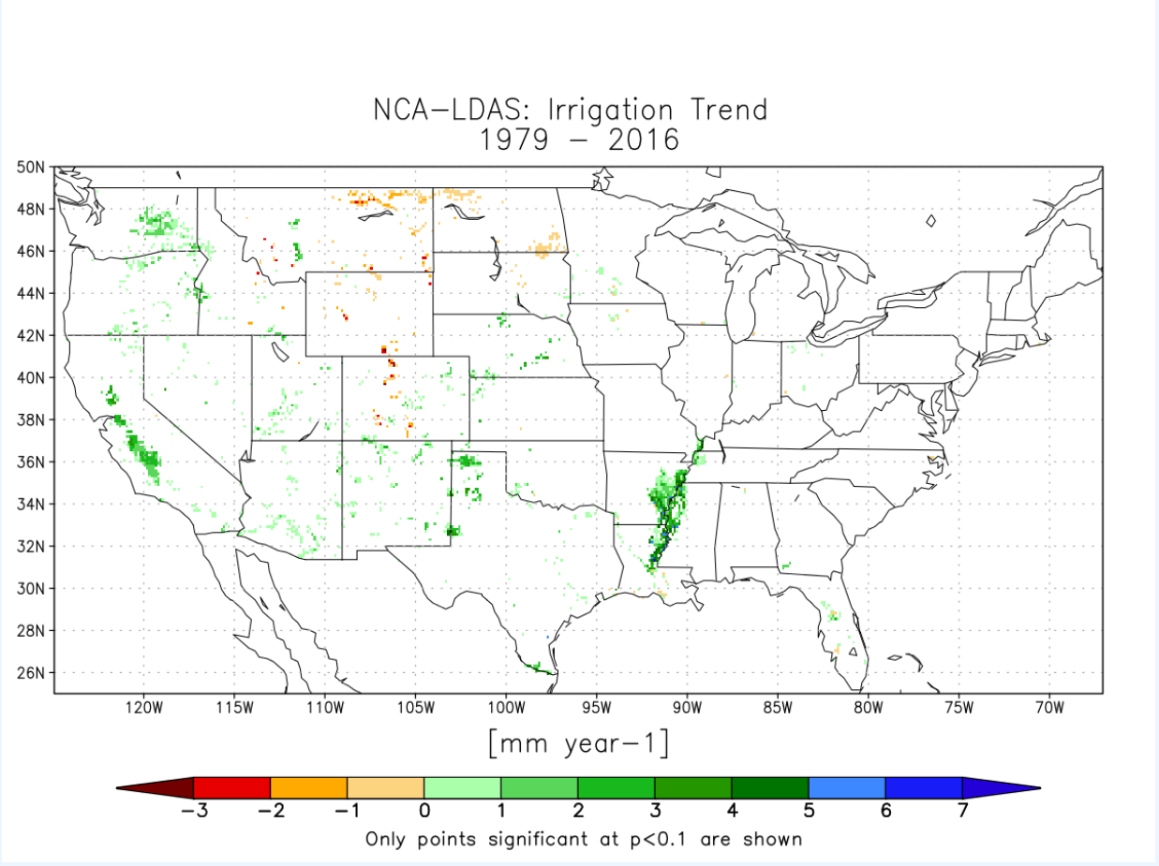

Figure 6: Annual irrigation trend

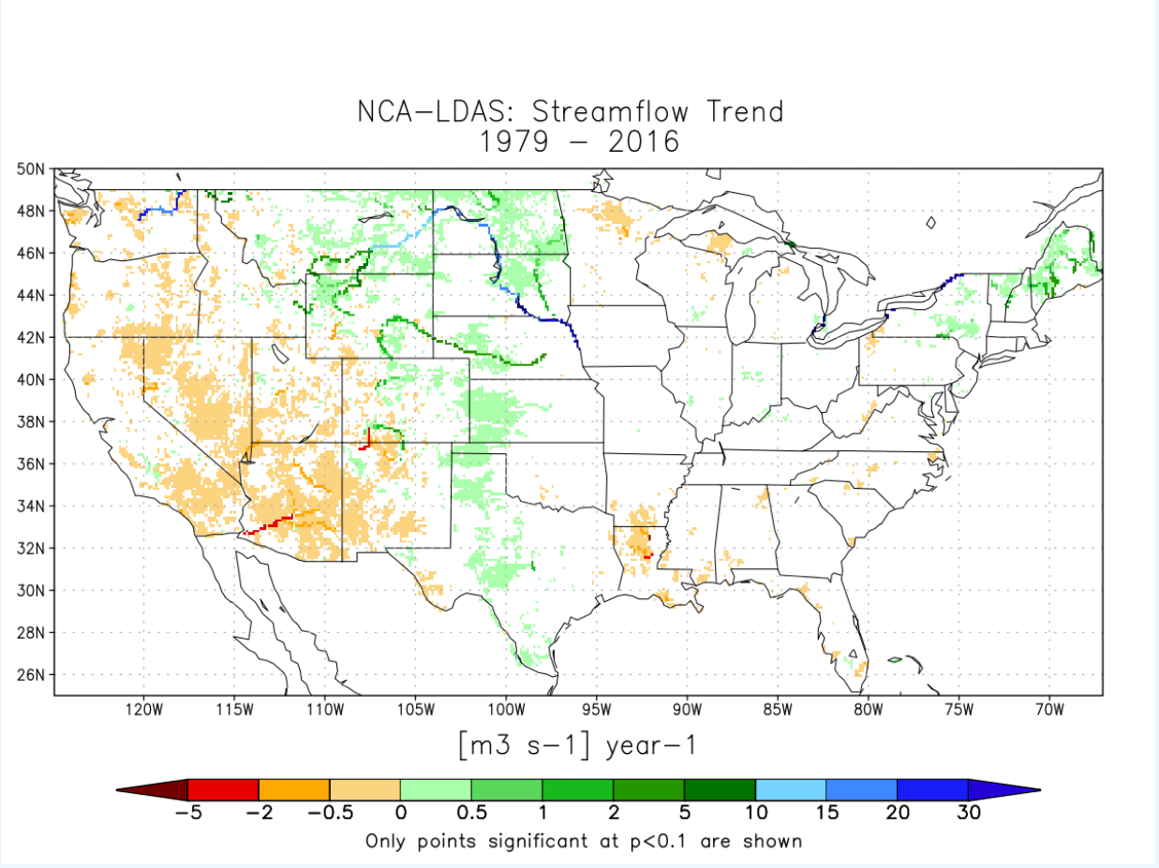

Figure 7: Annual streamflow trend

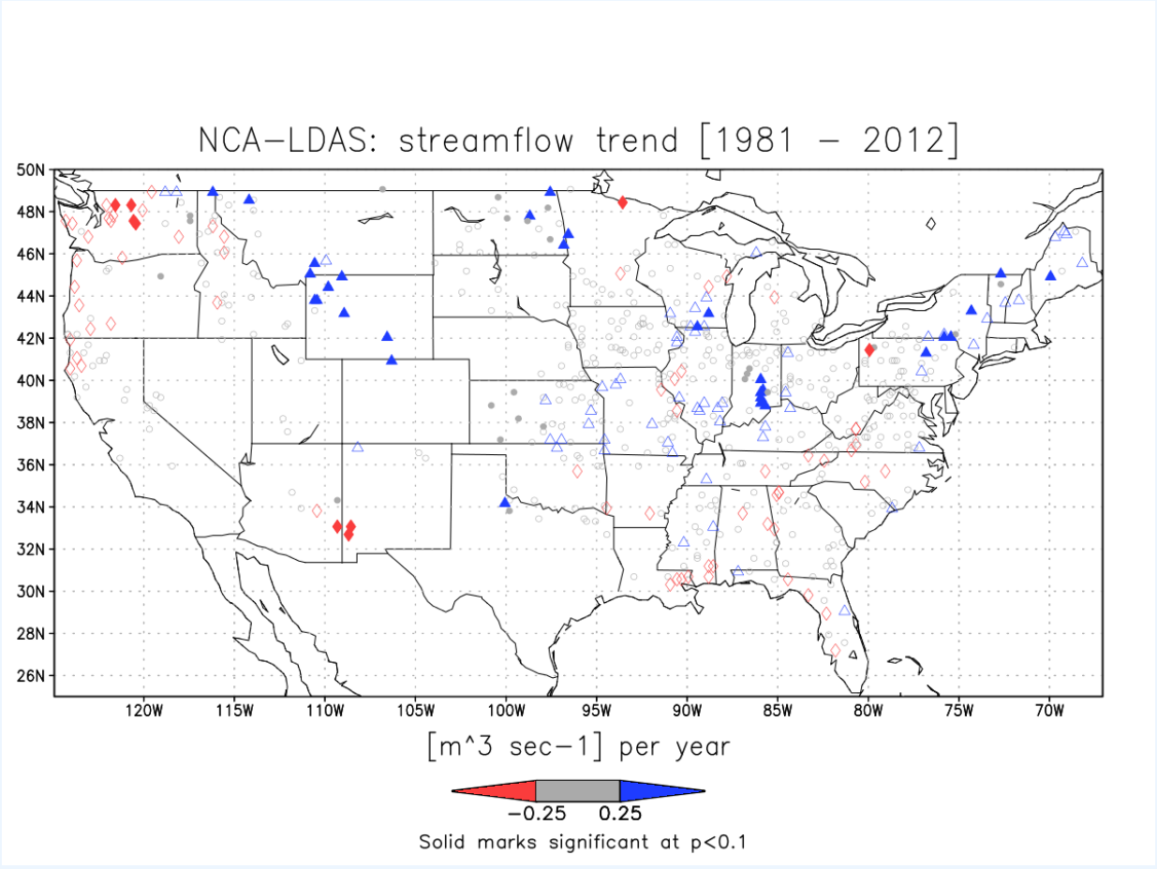

Figure 8: Modeled streamflow trend at USGS streamflow gauge sites

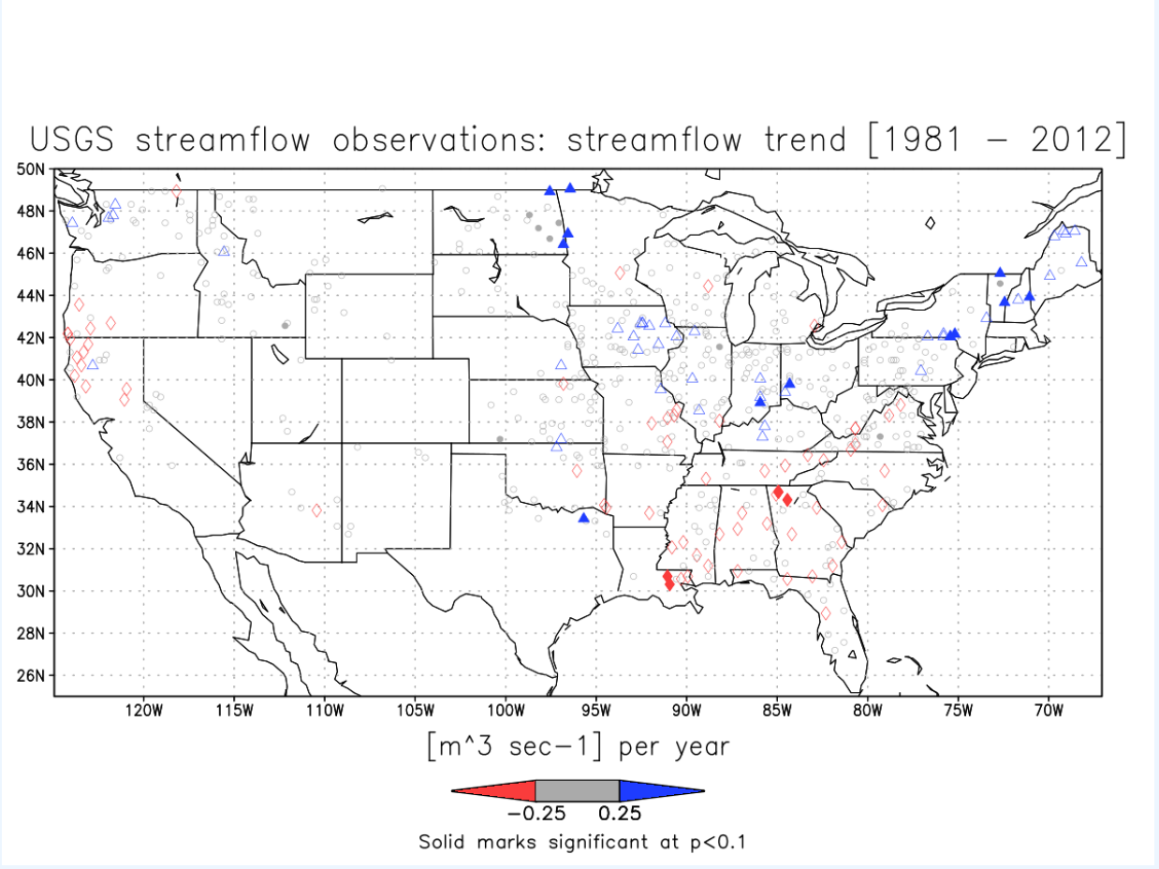

Figure 9: Observed streamflow trend at USGS streamflow gauge sites

Discussion and Conclusions

Correlation of Total Precipitation with Irrigation (Fig. 2) and Streamflow (Fig. 3):

- Positive 7-day correlation of precipitation and streamflow
- Most positive correlation in the Great Plains in areas of low streamflow; correlation decreases in larger rivers due to increased lag time farther downstream
- Negative correlation of precipitation and irrigation
- Most negative correlation in the West, highlighting irrigation occurring in dry summer periods

Irrigation (Fig. 4) and Streamflow (Fig. 5) Change 1979-1997 to 1998-2016

- Large increases in irrigation water usage across the country
- Streamflow increases concentrated in the northern Rocky Mountains, Great Plains, and Northeast

Trends in Irrigation (Fig. 6) and Streamflow (Fig. 7) calculated with the Mann-Kendall technique

- Most significant increases in water usage in the Mississippi River Valley and the Central Valley of California
- Positive trend in streamflow in the Great Plains and negative trend in the Southwest

Streamflow trends in NCA-LDAS (Fig. 8) and USGS streamflow observations (Fig. 9)

- NCA-LDAS model trends correspond well with USGS observations
- USGS observations less likely to show a statistically significant trend

References / Acknowledgements

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