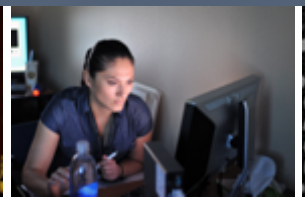
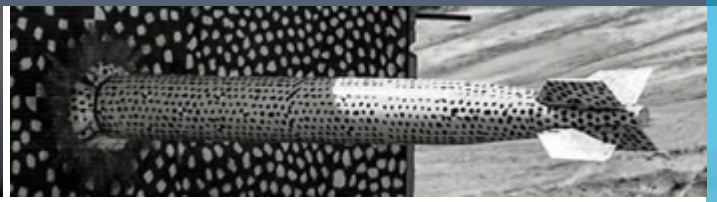
SAND2022-13582C

NASA LIS HYDROLOGIC FORECASTS FOR HYDROPOWER OPTIMIZATION IN THE UPPER COLORADO BASIN





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Collaborators: Dr. James Prairie; Dr. Sarah Baker; Dr. Paul Miller; Dr. John Lhotak; Dr. Michelle Stokes

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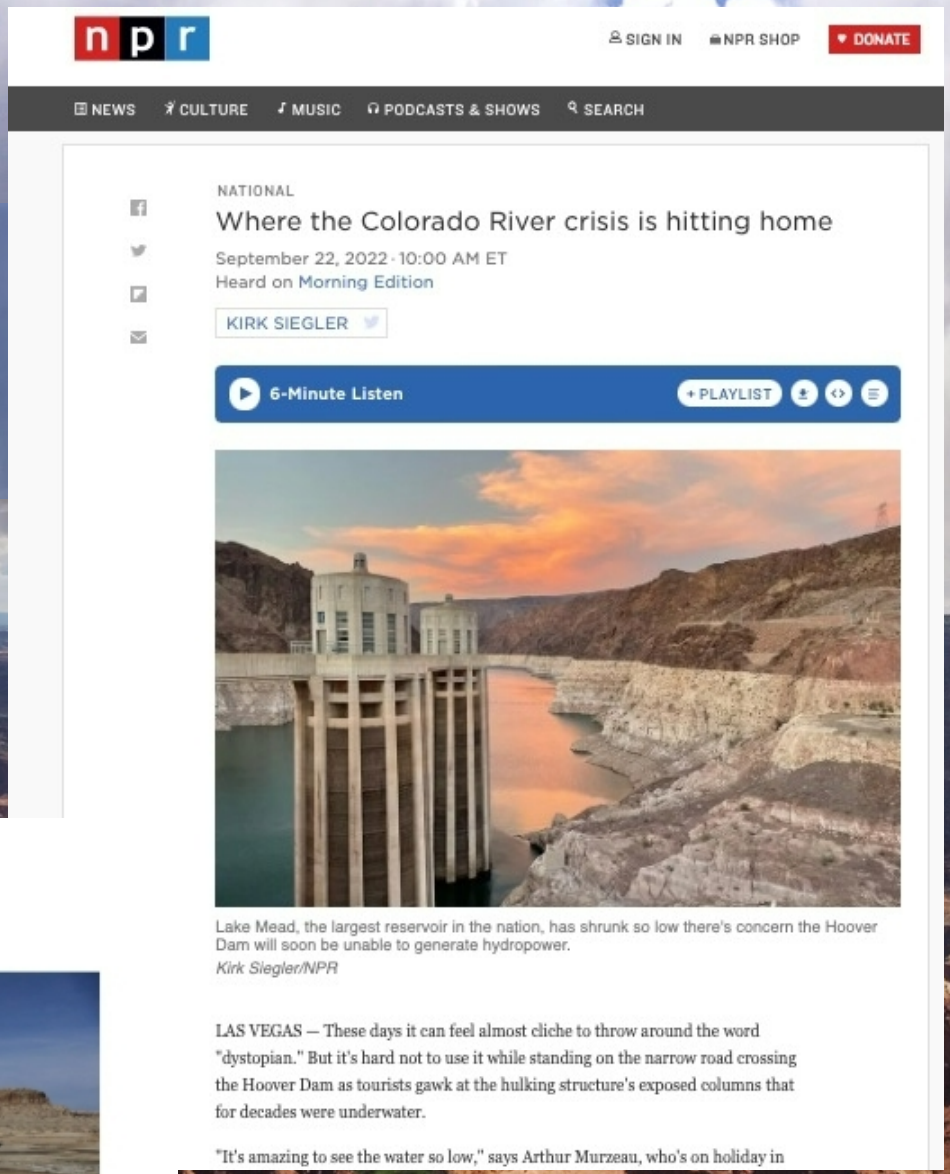
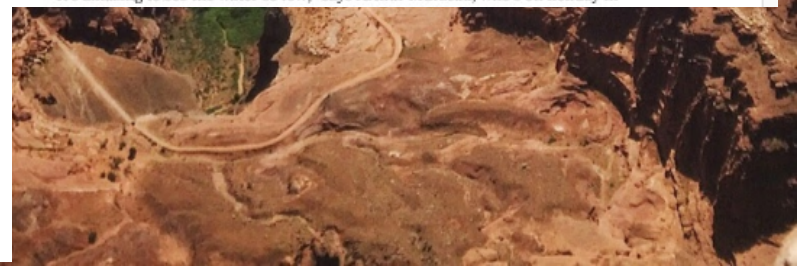
Background and Introduction

- Water in the Colorado River Basin (CRB) supports 35 to 40 million people in 7 states & 29 federally recognized tribes.
- Water levels in some basins (including at Lake Mead and Lake Powell) are hitting record low.





Objective

- Bureau of Reclamation (Reclamation) manages a number of cascading reservoirs in the CRB.
- Reclamation uses the streamflow forecasts produced by the Colorado River Basins River Forecast Center (CRBFC) for preparing the outlooks for reservoir elevations and operating conditions.
- The CRBFC forecasts are used by Reclamation, Western Area Power Management (WAPA) and other water managers in seven states of the basin for making decisions on scheduling operations of reservoirs, electricity production and irrigation.
- Through this project, we are working with our collaborators from CRBFC and Reclamation to improve the seasonal forecasts.

The hydrologic forecasts uses the Ensemble Streamflow Prediction (ESP) approach, which essentially based on the climatology.

ESP shows systematic overestimation in the forecasts from the past several years.

NASA LIS Hydrologic Forecasts for Hydropower Optimization in the Upper Colorado Basin

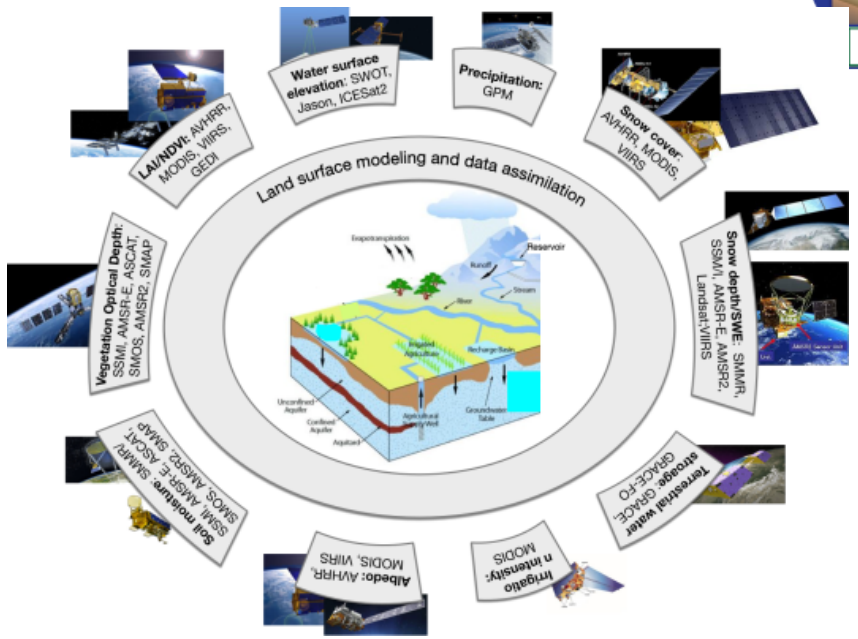
Project Period: 2023 – 2025

Project Objectives

1. Hydrologic Forecasting using NASA LIS & comparing with existing forecast models,
2. Initialize the forecasts with initial conditions informed by remote sensing inputs
3. Incorporation of LIS forecast in reservoir operation, and
4. Quantification of the societal value of improved forecast (application on hydropower as an example).

NASA Land Information System (LIS; lis.gsfc.nasa.gov)

- An infrastructure for land hydrology modeling and data assimilation
- Vision: Use all available observational information to provide simultaneous constraints on the water budget estimation
- Several successful examples LIS-based end-user environments



LIS-based environment at US Air Force Weather employs SMAP and GPM data to support NWP, transboundary water, food security, and other military applications.

NEWS | NOVEMBER 19, 2019

NASA Soil Data Joins the Air Force

Military weather forecasters. Credit: U.S. Air Force

› Larger view

LIS-based environments support USAID's Famine Early Warning Systems Network (FEWSNET)

July 1, 2019

When Drought Threatens Crops: NASA's Role in Famine Warnings

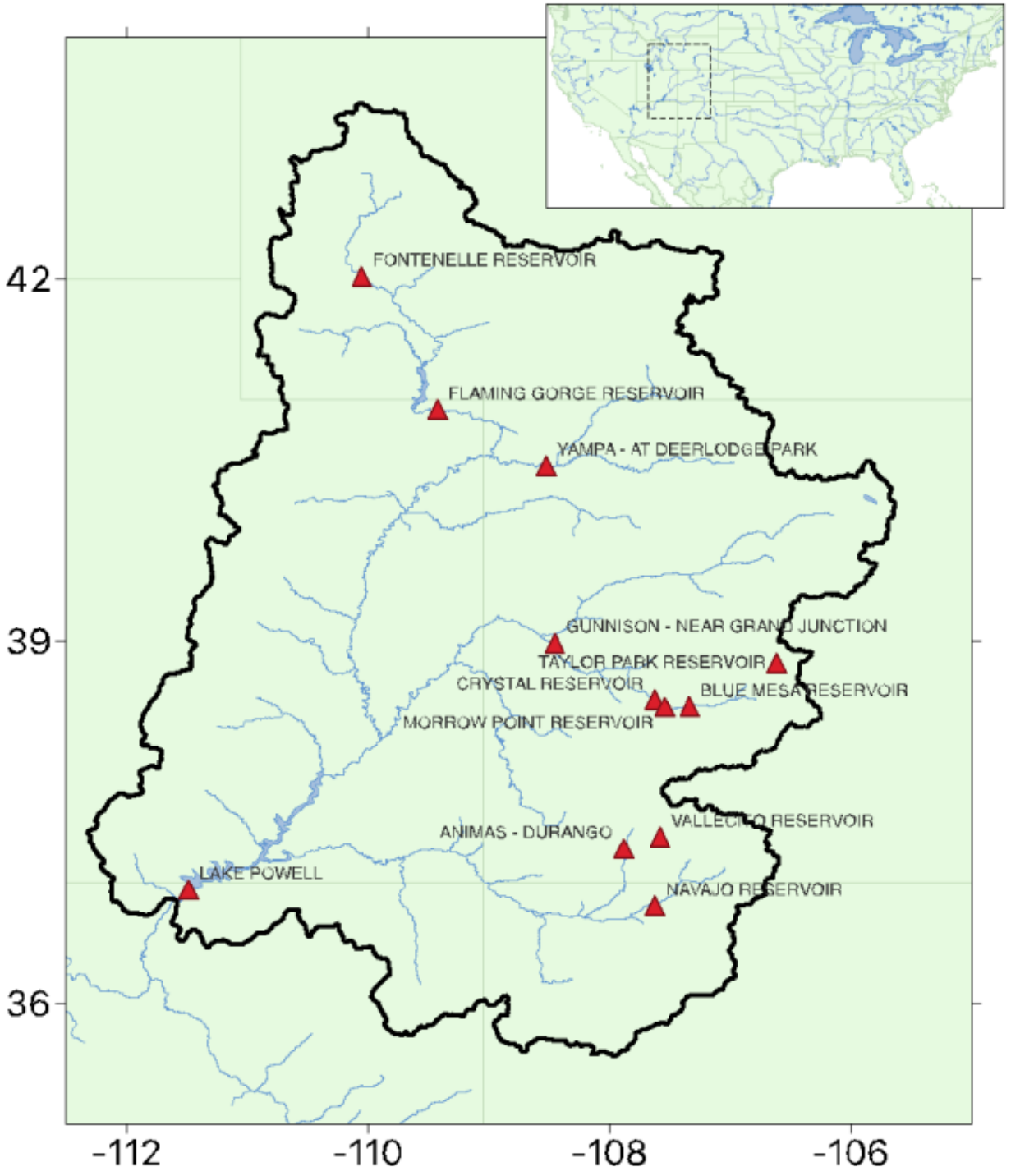
NASA's satellite imagery and model forecasts regularly help agricultural and aid agencies to monitor the performance of crops worldwide and prepare for food shortages.

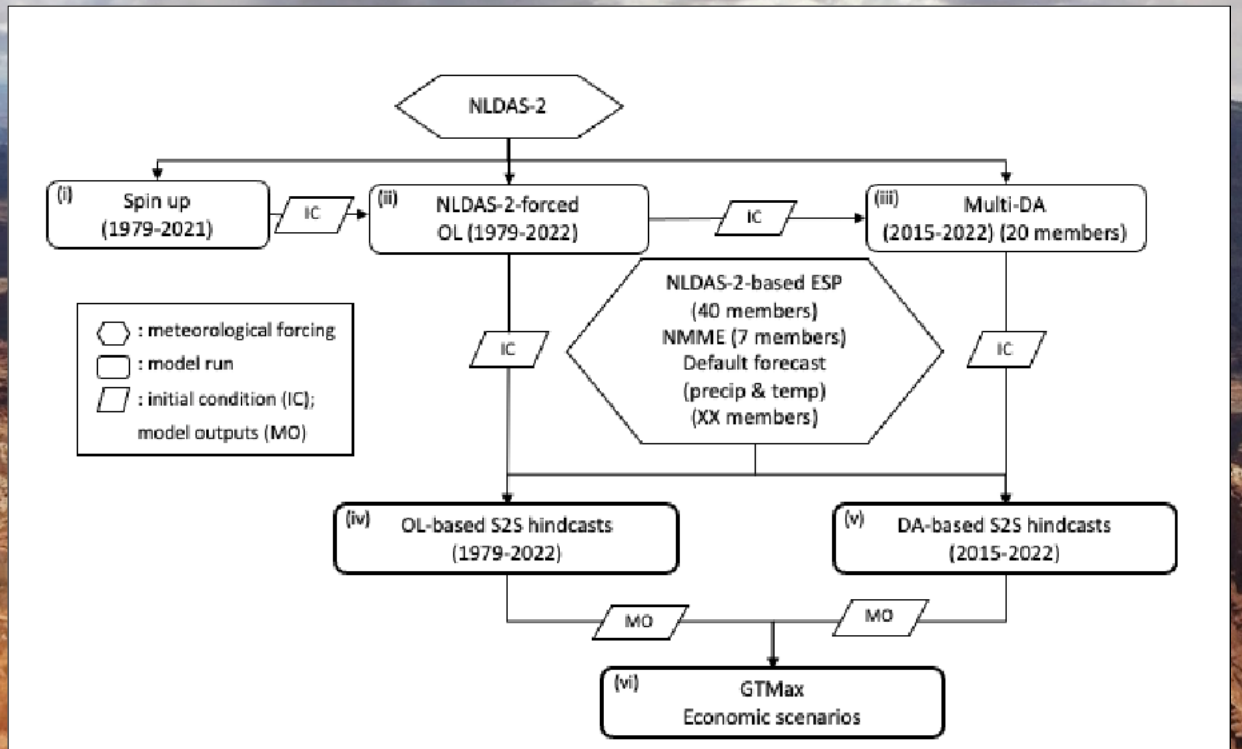
"In the 1970's the U.S. realized that drought impacts on global agriculture were severely affecting trade and food aid decisions, while ground based information and forecasting of drought was very limited," said Brad Doorn, water resources program manager in the Earth Science Division at NASA Headquarters, Washington. "Earth observations from space provide

Follow the Freshwater: By predicting droughts and floods and tracking blooms of algae, NASA's view of freshwater around the

Other: NOAA, NRL, NCAR, UK met office, Bureau of Meteorology Australia, Universities

Eleven reservoirs in upper colorado river basin

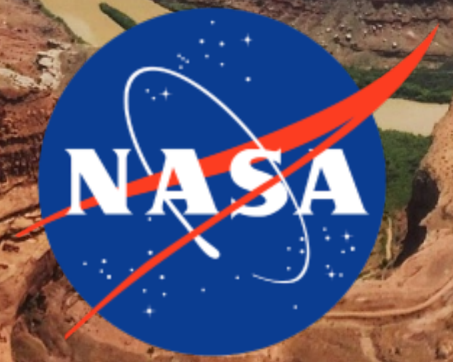




GTMax - Generation and Transmission Maximization to quantify the electricity generation and water releases

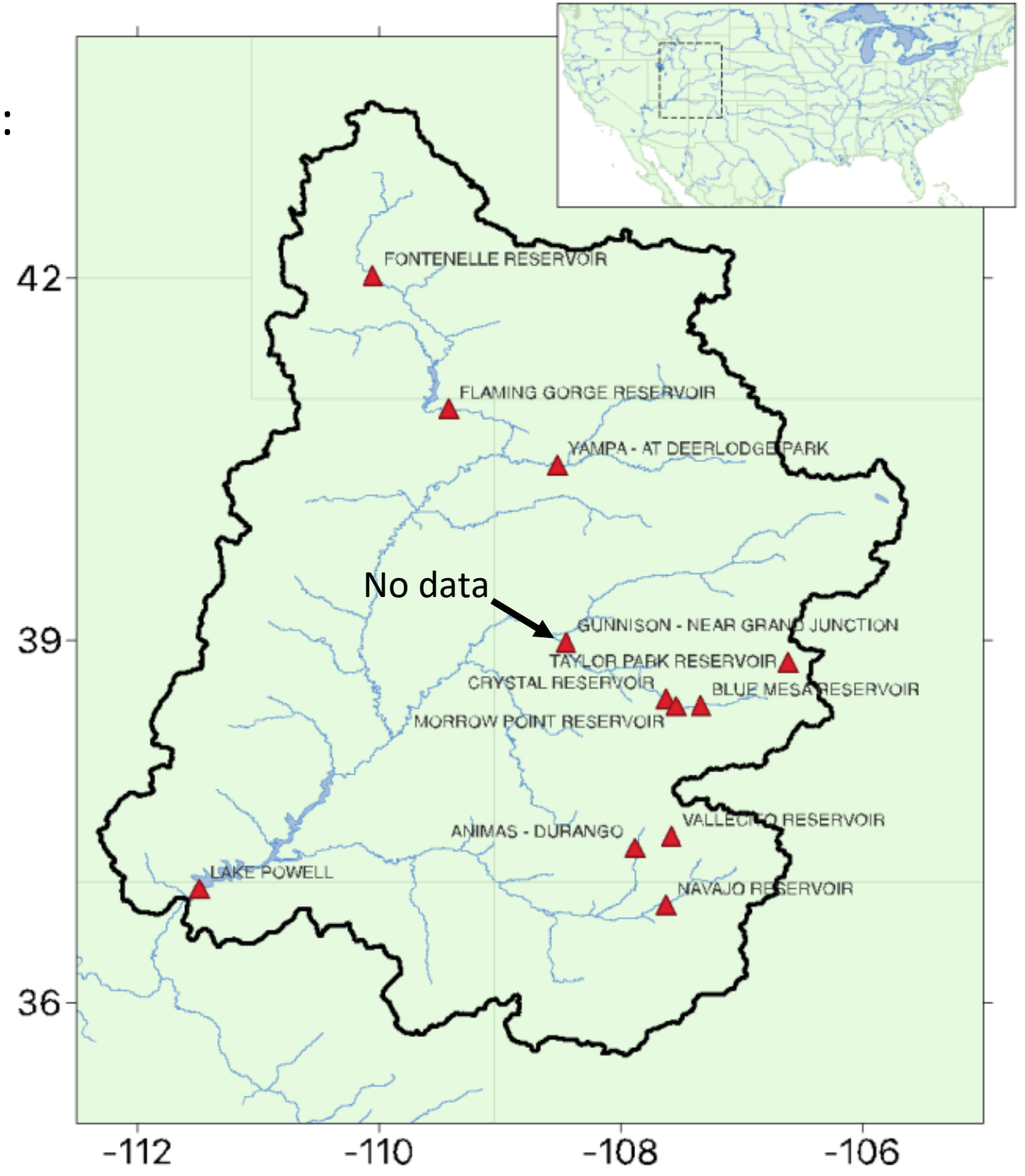
Activities completed

- Established connection with stakeholders by conducting periodic meetings with stakeholders and collaborators.
- Collected data including that from stakeholders (NOAA)
- Completed preliminary evaluation of available meteorological forcings

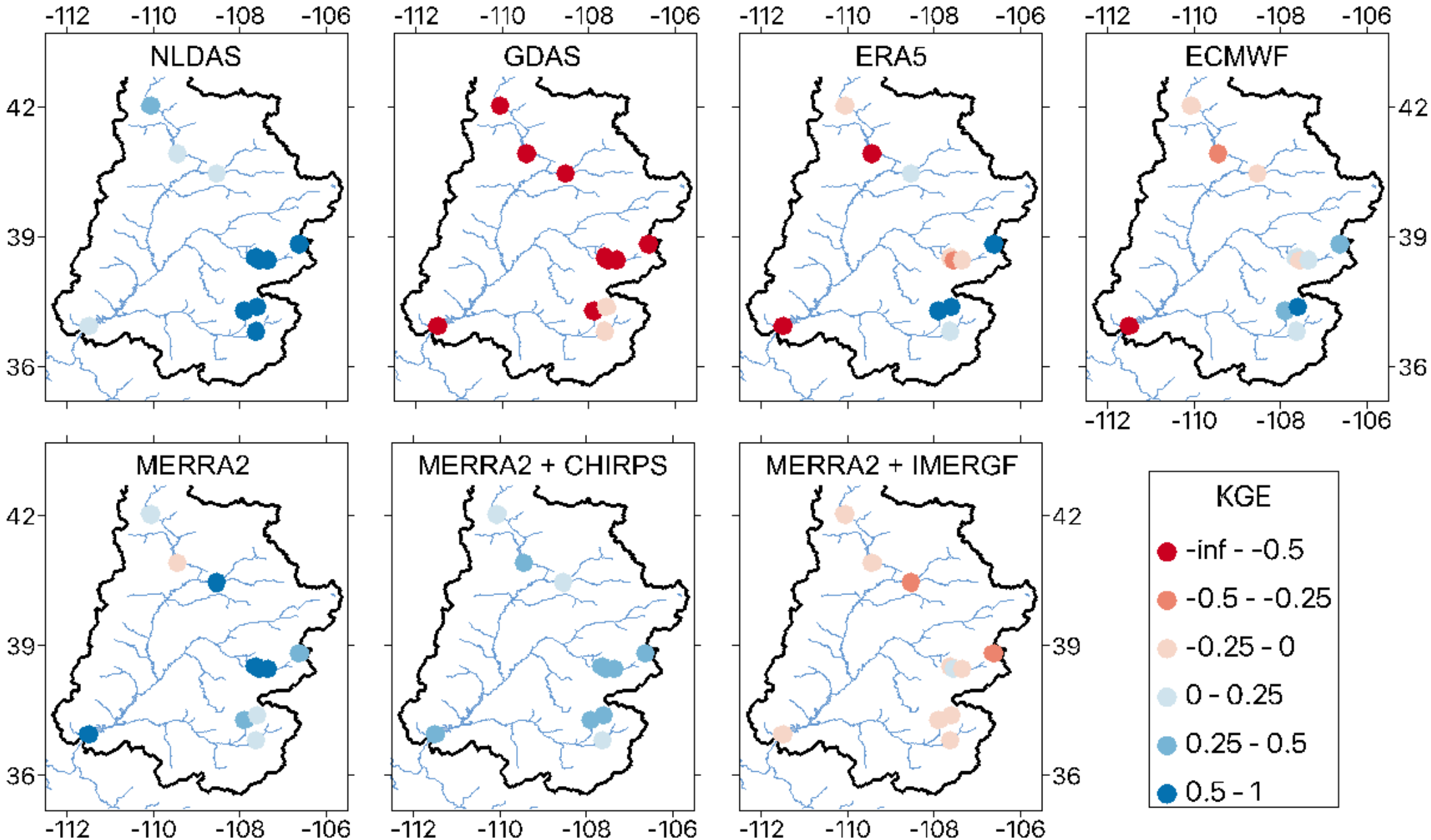


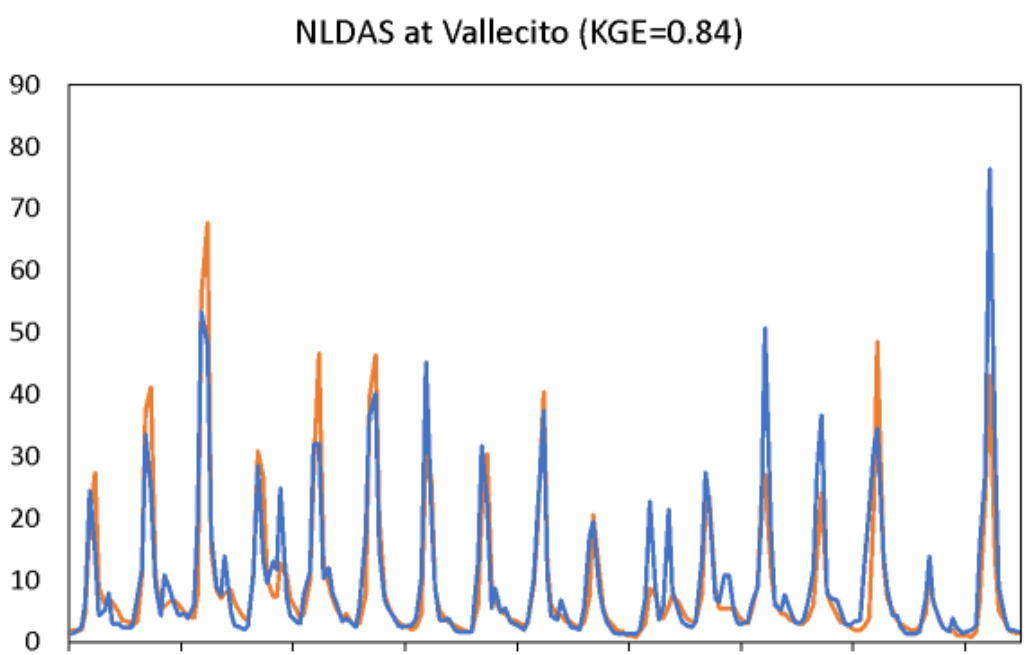
Preliminary evaluation of available met. Forcings:

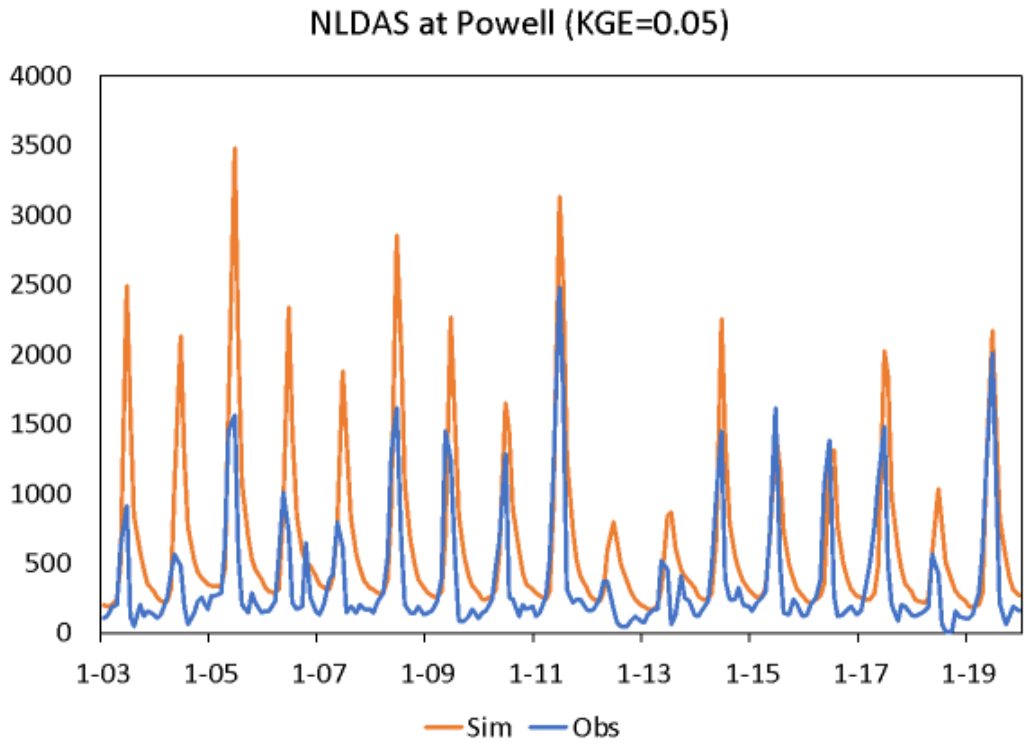
1. Seven datasets:
   - NLDAS
   - GDAS
   - ERA5
   - ECMWF
   - MERRA2
   - MERRA2+CHIRPS
   - MERRA2+IMERGF
2. LIS set up:
   - NoahMP401+HyMAP
   - 0.1 deg spatial resolution
   - 20-yr spin up
   - 18-yr runs (2003-2019)
3. Evaluation at 11 locations with available unregulated monthly streamflow estimates

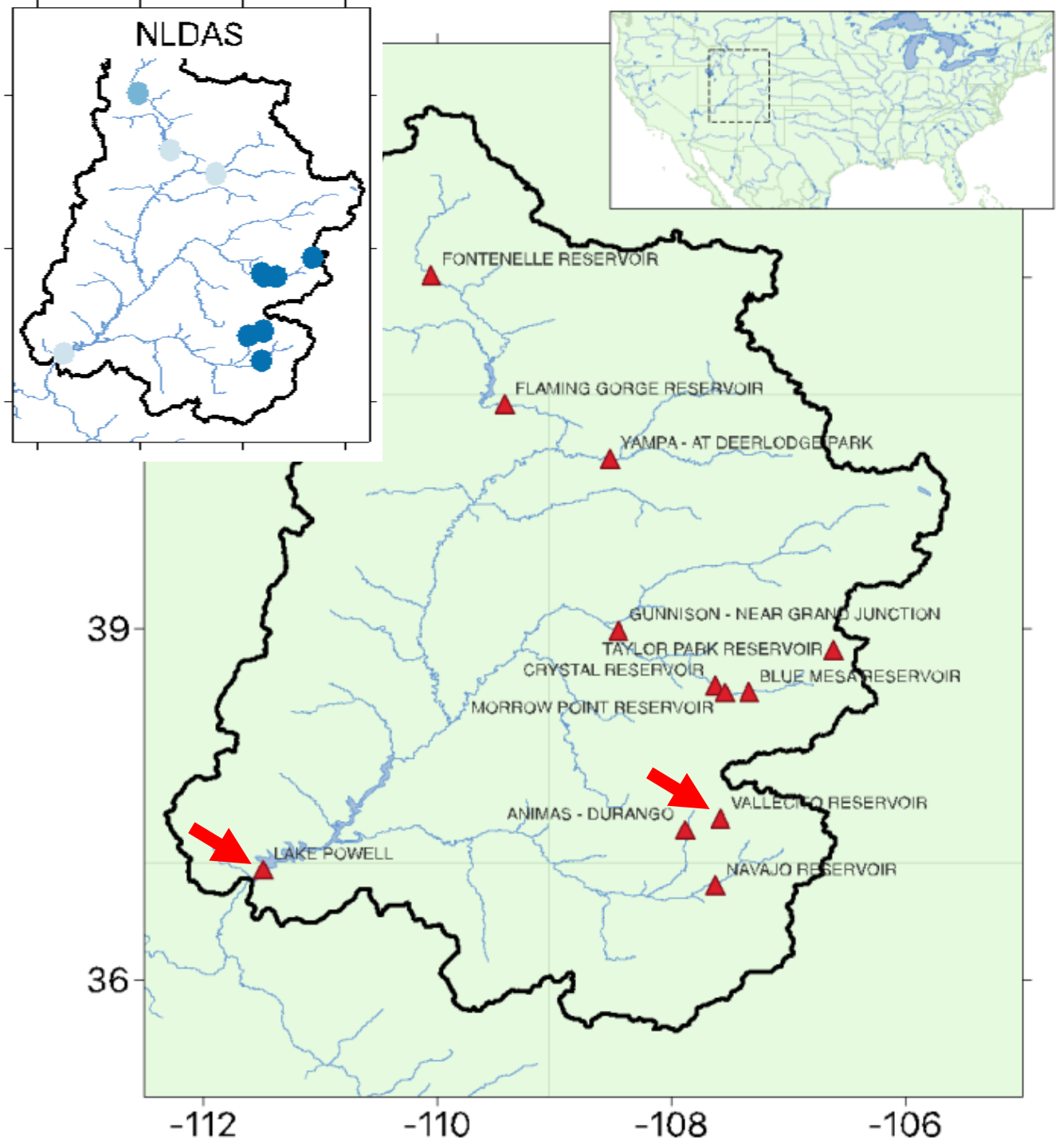


Monthly streamflow (2003-2019)




NLDAS at Vallecito (KGE=0.84)
90
80
70
60
50
40
30
20
10
0


NLDAS at Powell (KGE=0.05)
4000
3500
3000
2500
2000
1500
1000
500
0
1-03
1-05
1-07
1-09
1-11
1-13
1-15
1-17
1-19
Sim
Obs

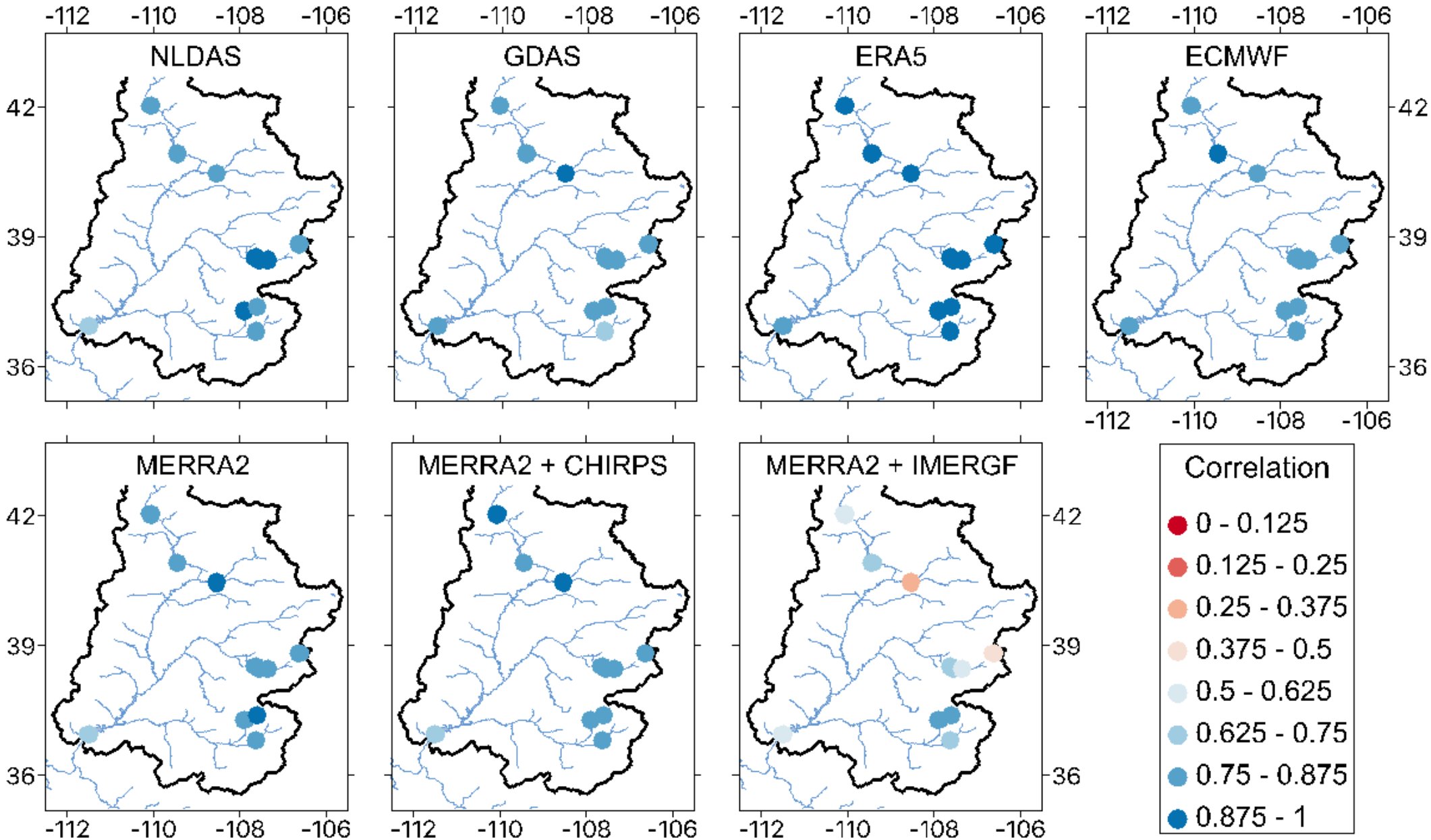

NLDAS
FONTENELLE RESERVOIR
FLAMING GORGE RESERVOIR
YAMPA - AT DEERLODGE PARK
GUNNISON - NEAR GRAND JUNCTION
TAYLOR PARK RESERVOIR
CRYSTAL RESERVOIR
BLUE MESA RESERVOIR
MORROW POINT RESERVOIR
ANIMAS - DURANGO
VALLECITO RESERVOIR
LAKE POWELL
NAVAJO RESERVOIR
39
36
-112
-110
-108
-106

Activities FY 2023

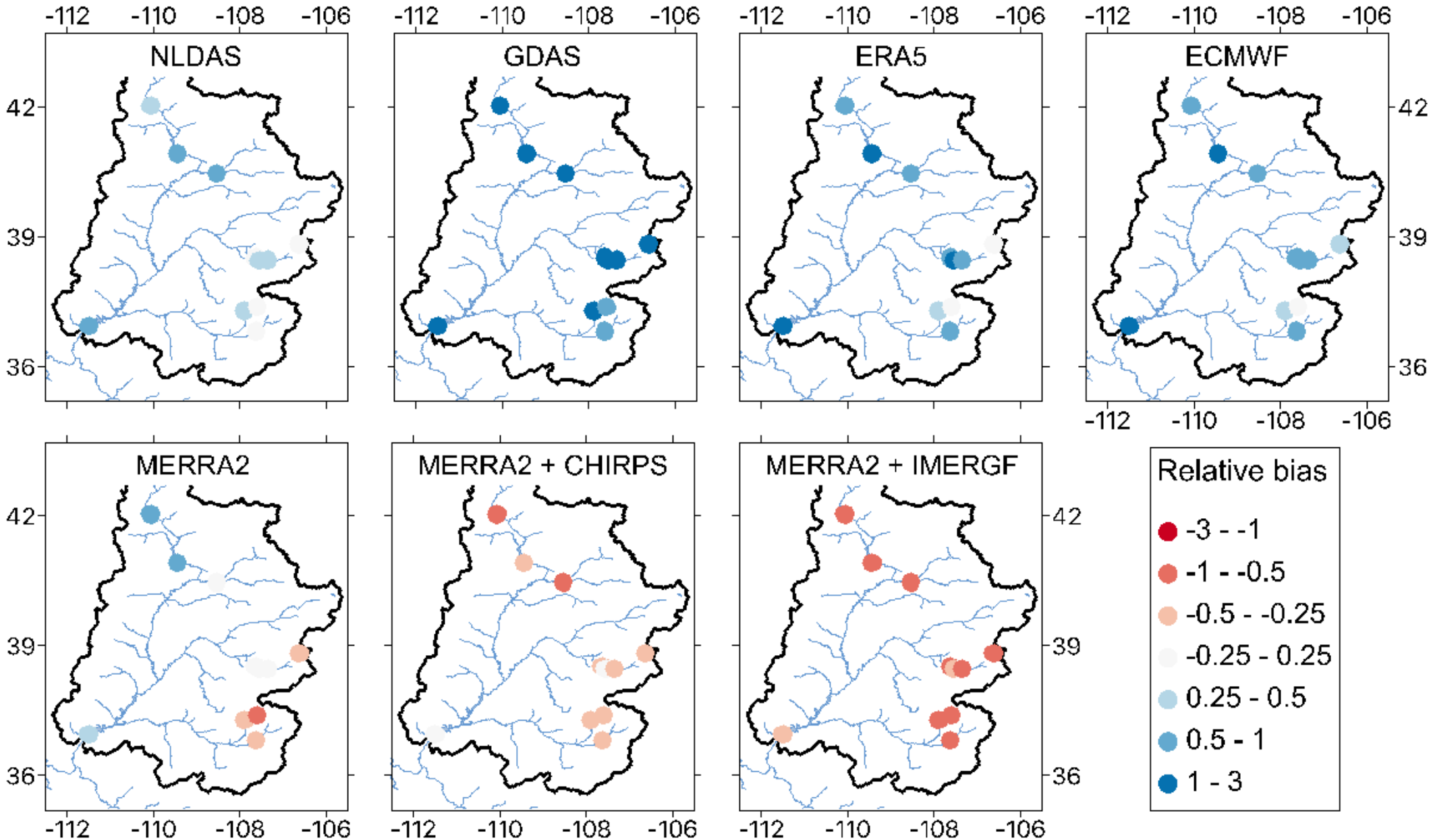
- Continue working with stakeholders and collaborators by sharing progress and asking for feedbacks.
- Complete hydrologic forecast for ..locations
- Model set up for economic analysis


Thank you!

Monthly streamflow (2003-2019)



Monthly streamflow (2003-2019)



Monthly streamflow (2003-2019)