Research Interests

How does water cycle change with future global warming trend? How and why water cycle is changing? How can we use our knowledge and technology to understand the dominant processes that influences water resources? My research interests lie in the large-scale hydrological cycle, using multiple techniques, including ground observations, remote sensing, land surface modeling, and river routing modeling.

Current Research

I am a Ph.D. candidate at the University of Texas at Austin. My current work centers on the application of land surface model simulations to understand the faith of the water over the land.

1. Impact of parameterizations on drought monitoring

   To investigate the critical hydrological processes during drought, we use a land surface model, Noah-MP, to simulate water availability and investigate how different parameterizations affect the modeled water deficit. We conduct a series of experiments with runoff schemes, vegetation schemes, and plant rooting depth. Overall, the results suggest that using different parameterizations can influence the modeled water availability, especially during drought. The drought-induced vegetation responses not only interact with water availability, but also affect the ground temperature. Leaf area index from dynamic vegetation is better simulated in wet years than dry years. Less positive biases in runoff and less negative biases in evapotranspiration are found in simulations with groundwater, dynamic vegetation, and deeper rooting zone depth.

2. The role of data assimilation in streamflow simulation

   Runoff and streamflow are critical components of the water cycle and, reflecting integrated information on dominant hydrologic processes over the entire watersheds. Gauges precisely measure streamflow, but the large-scale spatiotemporal variation in streamflow is poorly understood. We evaluate the impact of multi-sensor land data assimilation (DA) on intraseasonal-to-interannual availability of runoff. Multiple experiments with the assimilation of different combinations of remote-sensing datasets are conducted using Community Land Model version 4 (CLM4). Different land states are updated upon the assimilated remote-sensing datasets (AMSR-E, MODIS, and GRACE). All experiments are clustered into two large groups, showing GRACE-DA are dominant the runoff results. Snow-DA-induced runoff differences are pronounced in high and mid-latitude. GRACE-DA improves the spatial pattern of streamflow over high latitude during summer and autumn. This study indicates the limitation of modeling the large-scale hydrological cycle and shows how data assimilation can help improve streamflow estimation.

3. Flood prediction for decision-making

   Hurricanes bring heavy rain and lead to catastrophic flooding. The damage and fatalities due to Hurricane Harvey underscore the urgency for the understanding and improving forecast skill for the decision-making process. In this study, we utilize the WRF-Hydro/National Water Model in predicting floods during Hurricane Harvey in 2017 to support the decision-making for preparedness of hospital evacuation. By linking synoptic weather forecasts to streamflow forecasts, we seek to provide a comprehensive understanding of the performance of the integrated hydrological modeling framework.

4. Estimating soil moisture profile variations using in-situ soil moisture

   TxSON is an intensive soil moisture observation network near Fredericksburg in central Texas. Upscaled (3, 9, 36 km) data are available to examine the spatial scale dependency of current weather models and climate models. The data from lab calibration could be used for redefining the soil porosity and hydraulic conductivity. I propose to use soil moisture profile (5, 10, 20, 50 cm) to examine the vertical damped and delayed responses to examine how surface soil moisture related to root zone in semi-arid regions.

Future Research Plans

While studying the large-scale hydrological cycle, I have come across several questions related to the carbon cycle. Some specific questions that I hope to explore with your group include but not limited to:

1. Vegetation regulation on streamflow and TWS

   - What is the contribution of plant water content to total water storage (TWS) anomalies? What is the spatial pattern?
   - How are TWS and streamflow seasonal variation regulated by transpiration? How does that relate to the two water worlds hypothesis?
   - How does the ecosystem control water residence time?

2. Interannual variability of the carbon cycle

   - What are disparities from observations and models in interannual variability of carbon sink?
   - Where are the hotspots that contributed to the global interannual variability of the global carbon sink?
   - How is that related to hotspots of land-atmosphere interactions?

The interactions between the carbon cycle and the water cycle is a broad field with many interesting research questions. Combining my compelling experience and your expertise, I can create unmeasurable value with your group and explore the unknown area in ecohydrology.