Climate Change Impacts on Groundwater Contribution to the Streamflow Across a Mesoscale Precambrian Shield Watershed in Northeastern Ontario

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Introduction & Objectives

- Climate change is one of the most alarming stressors that humanity is facing in 21st century (Giri et al., 2019), affecting many components of hydrologic cycle (Immerzeel, 2008). Groundwater as a part of hydrological cycle is usually less directly impacted by climate change, but the changes in timing and volume of precipitation (Lee et al., 2014) and atmospheric alteration in climate can have a notable impact on subsurface hydrology (Bates et al,, 2008) and groundwater resources.
- The Sturgeon River-Lake Nipissing (SN) (Fig 1) Precambrian Shield watershed is characterized by spatial heterogeneity that contributes to the complexity in estimating impacts of climate change on hydrological processes and streamflow; the study of climate change impacts on water resources, especially groundwater-surface water interactions are so limited.
- The main objective of this study is to**: evaluate the SN watershed response to the climate change scenarios with focus on changes in groundwater-surface water interactions for three periods of 2020-2040, 2041-2061 and 2062-2082 by using isoWATFLOOD hydrologic model.**

Data and Methods

- Observational data: 4-hr time step temperature and relative humidity, daily precipitation from 3 weather stations, 6 gauging stations, 12 stable isotopes of water sampling points across the SN watershed.
- Climate change scenarios: 8 Global Circulation Models (GCMs), 2 emission scenarios (RCP 4.5 & RCP 8.5), baseline: 1990-2019,
- Future periods: 2020-2040, 2041-2061, 2062-2082.
- Hydrologic model: **isoWATFLOOD** (Holmes, 2016), a semi-physically based distributed hydrologic model which use both isotopes and discharge to calibrate the model. Using SWIs as an additional calibration tool results in more better simulation of hydrological processes in model.

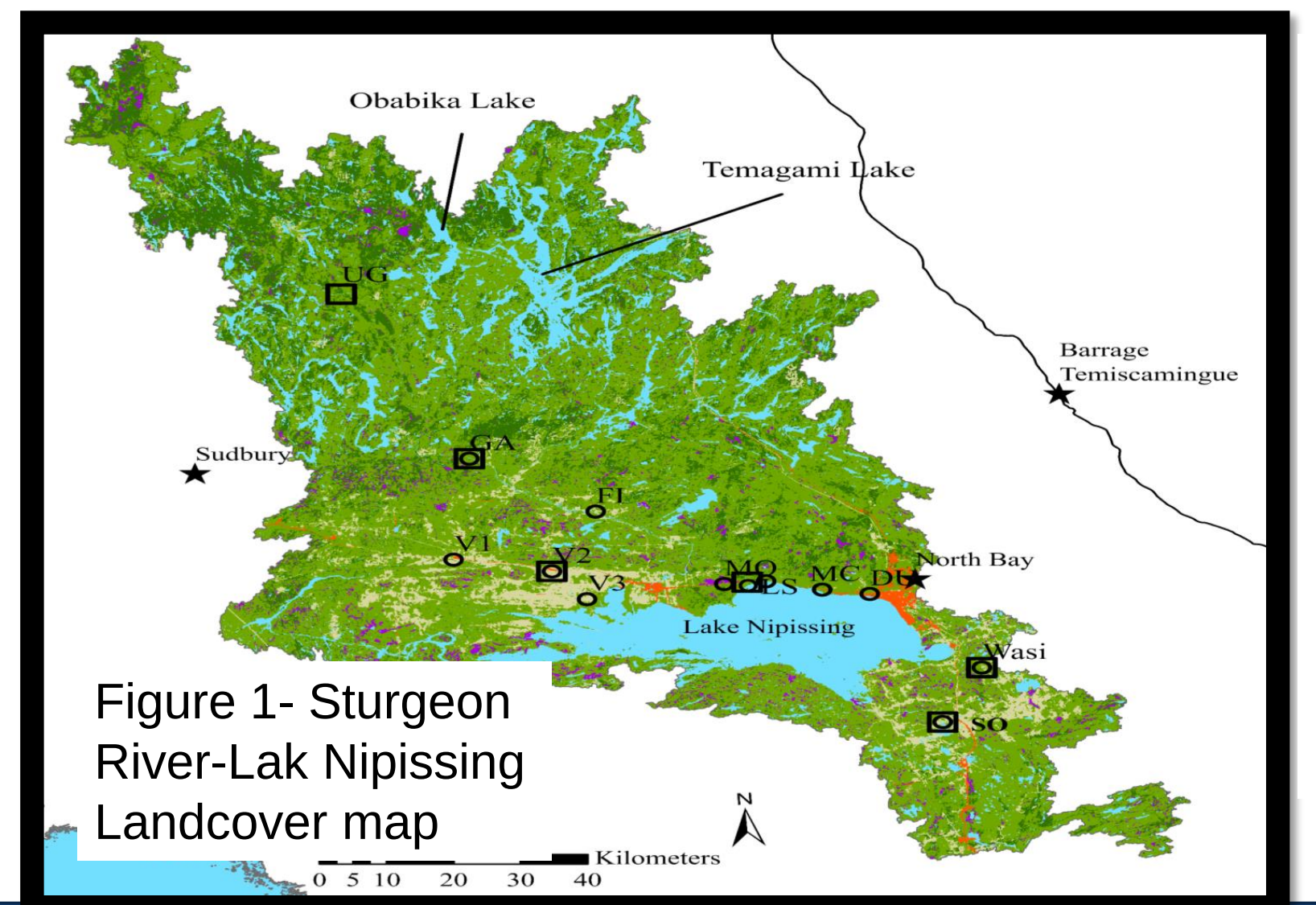
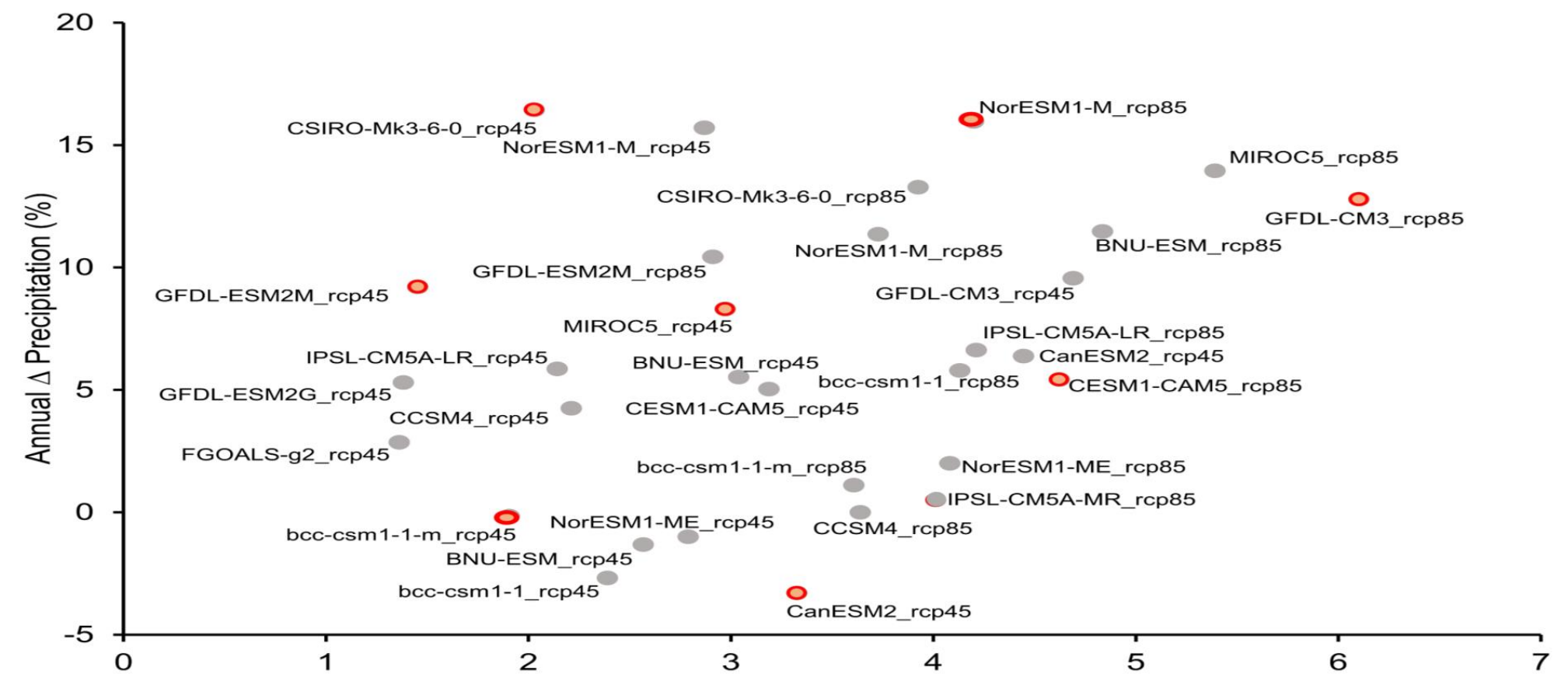
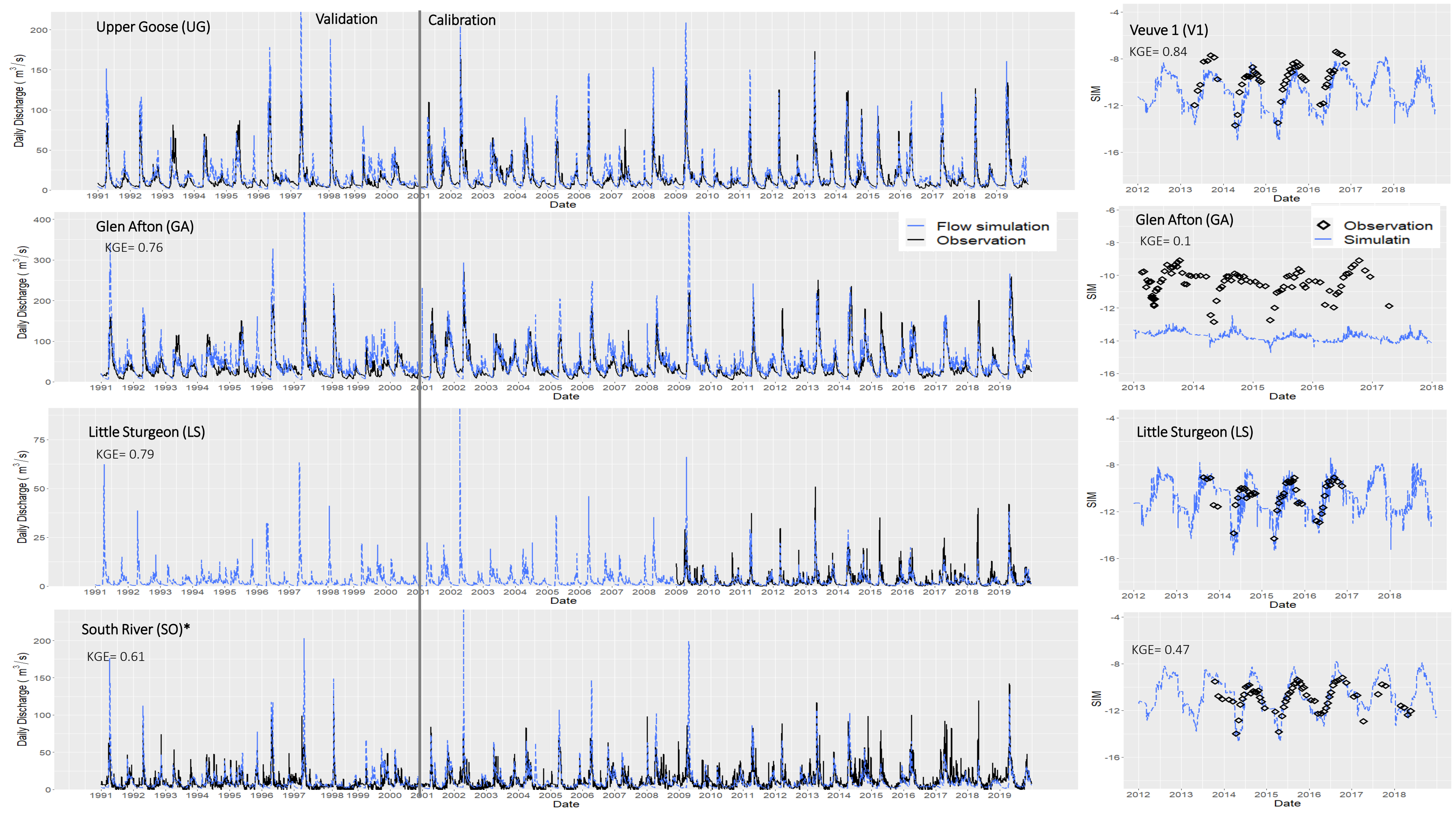


Figure 1- Sturgeon River-Lak Nipissing Landcover map



Climate change scenario selection using k-mean clustering approach (Casajus et al., 2016)

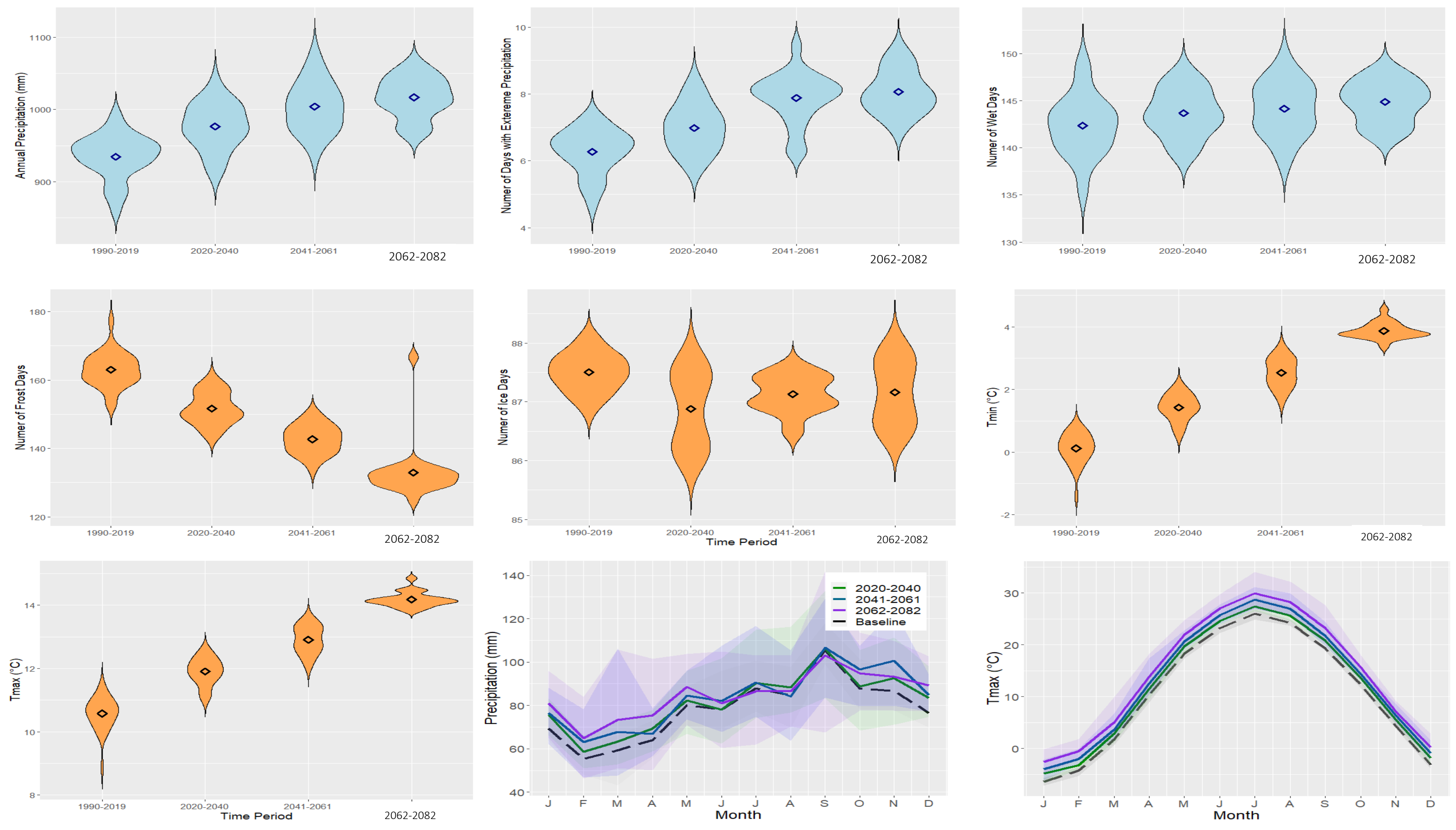
Calibration & Validation



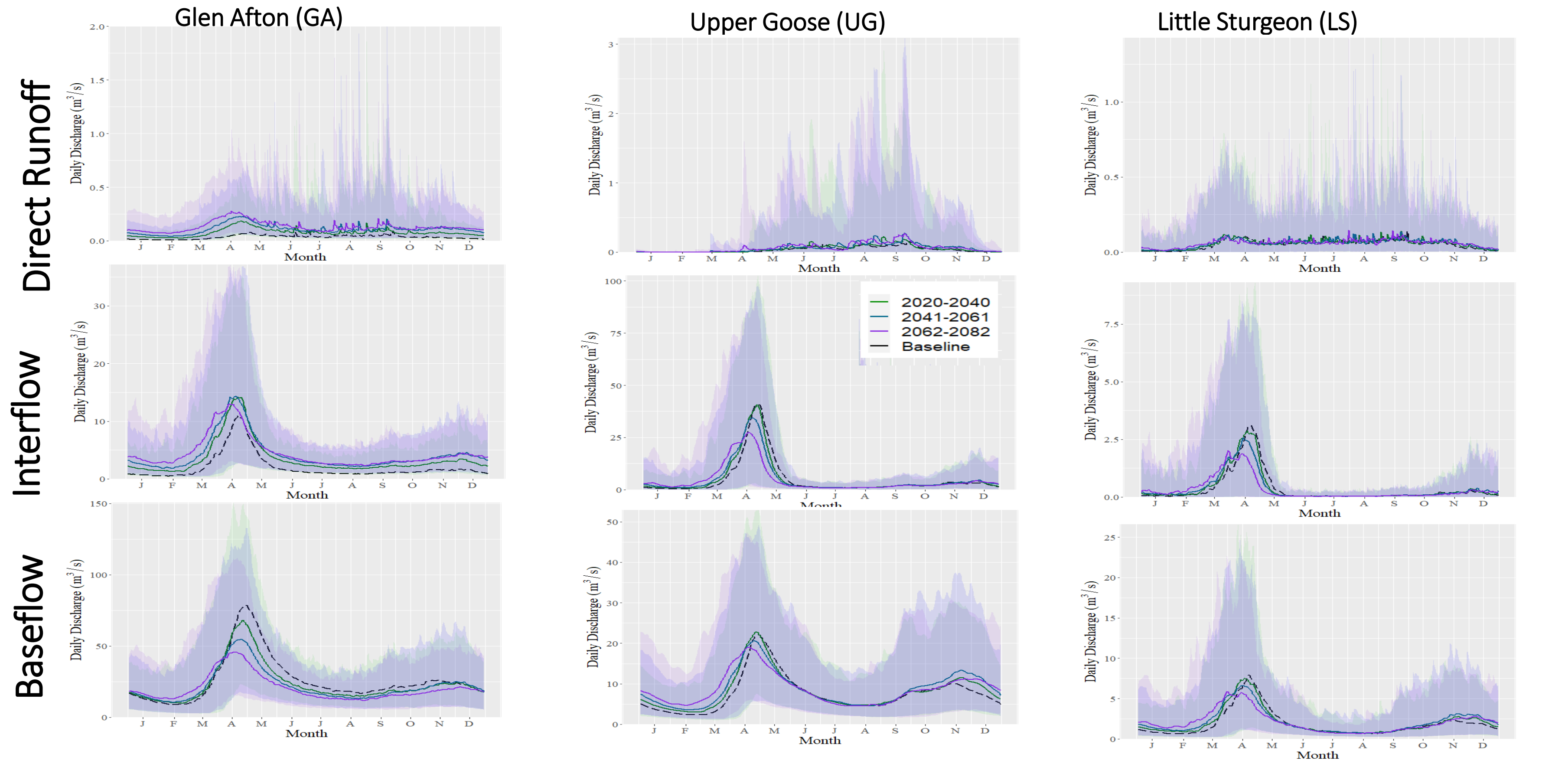
- Model was able to simulate discharge (KGE > 0.6) and isotope signature (KGE> 0.45 except GA) of discharge very well.
- The mean KGE-Q= 0.73 and KGE-O= 0.64 during calibration period.

* The South River catchment, excluded from calibration to validate model results spatially highlights model performance.

Meteorological changes



Ground water contribution



Simulated flow components in 3 catchments across SN watershed.

- % groundwater contributions to streamflow will not change much from the baseline period (1991-2019), but streamflow is projected to increase in fall and winter, therefore the groundwater contribution rate will increase.

Take Home messages

- isoWATFLOOD is able to simulate discharge and SWIs accurately across SN watershed.
- Despite these substantial changes, isoWATFLOOD predicted that the % groundwater contributions to streamflow will not change much from the baseline period (1991-2019). But the baseflow contribution to streamflow during Winter and late Fall will be increased and a trend toward earlier a lower rate peakflow during Spring freshet is detectable.
- Predictions from the distributed model suggest that changes in groundwater contribution rates to streamflow over the next 60 years should be considered in future water resources management and infrastructure plans.

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