Watershed Model Benchmarking and Analysis within International Land Model Benchmarking system

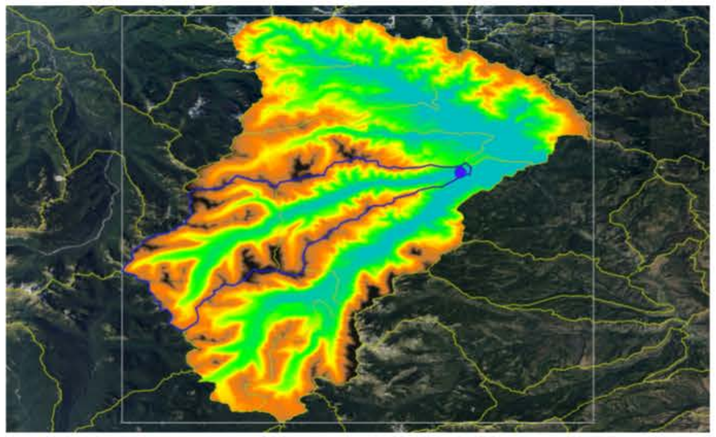
Jitendra Kumar (kumarj@ornl.gov), Nathan Collier, Forrest M. Hoffman
Oak Ridge National Laboratory

ILAMB-Watersheds

- Benchmarking of numerical process-based hydrological models against a suite of standardized reference datasets and statistical metrics is essential to evaluate the accuracy of processes represented by the model.
- The International Land Model Benchmarking (ILAMB) project is a model-data intercomparison and integration project designed to improve the performance of the land component of Earth system models.
- New developments within ILAMB enables the capabilities to benchmark and evaluate watershed scale models, such as Advanced Terrestrial Simulator (ATS), Soil Water Assessment Tool (SWAT), and National Water Model (NWM).
- ILAMB allows evaluation and comparison of routed and un-routed models.
  - un-routed models: flows are integrated over contributing area [which can be provided in any geospatial vector format such as shapefile, GeoJSON etc], corresponding to gauge station.
  - routed models: read hydrographs from models corresponding to gauge station.

Application to American River Watershed

- We applied ILAMB to benchmark hydrological model simulations conducted at American River Watershed (ARW) in Washington State. A number of routed (ATS, SWAT, SWM) and un-routed (E3SM Land Model) simulations were conducted over the watershed forced with same drivers from DAYMET.
- Observations from USGS Gauge station present in the watershed were used as benchmark data within ILAMB.

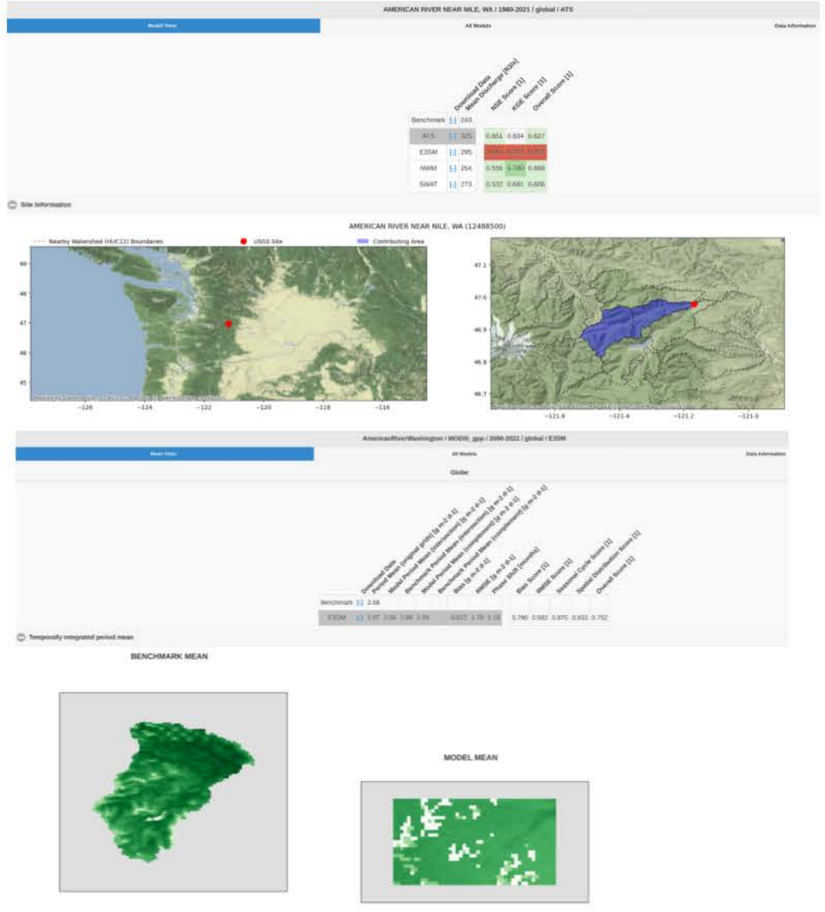


Benchmark Datasets

- ILAMB data repository contains a number of global gridded hydrological datasets (https://www.ilamb.org/datasets.html)
- Leveraging REST-based APIs from USGS, ILAMB automates the download and necessary processing of hydrological data from USGS gauge stations.
- ILAMB also provides utility tools, not tightly integrated within ILAMB, to automate the download of remote sensing-based datasets (such as GPP, LAI, ET etc.) from NASA AppEEARS and perform necessary post-processing.

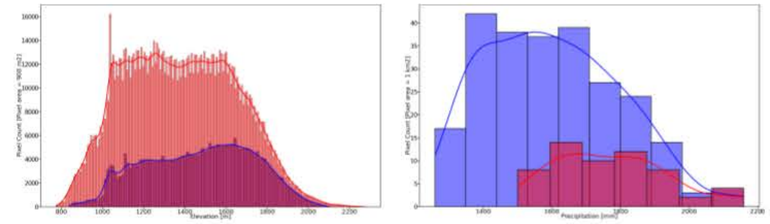
Illustrative ILAMB Results

ILAMB integrates four routes/un-routed models for ARW in a unified dashboard for analysis leveraging gridded and point based observations. Evaluation encompass hydrological and biogeochemical variables in the models.



Ongoing Work

- *Scale mismatch*: catchment/contributing area represented by modeled vs observed hydrological flow processes may be vastly different in scale and characteristics, thus adding uncertainties in benchmark statistics. For ex. comparison of probability density functions of elevation (physical characteristics of watershed), and precipitation (meteorological forcing) across modeled (HUC10) and observed (HUC12) contributing show that they represent statistically (Two-sample Kolmogorov-Smirnov test and k-sample Anderson Darling test) different distributions, and thus their comparison may be highly uncertain.



- *Regional scale synthesis*: While the accuracy of hydrological models may vary across watersheds, the watershed scale metrics can be synthesized to provide a regional scale aggregate accuracy metrics and statistics to provide better insights in variability in model performance and potential patterns across space.
- *Additional metrics*: A richer set of evaluation metrics can be calculated to be better captures the model performance in terms of capturing high/low flows, potential temporal shift or bias, etc.
- *Watershed biogeochemistry*: Evaluation of hydrological processes can be expanded beyond flow processes to include thermal (ex. stream temperature) and biogeochemical processes (ex. DOM, DOC, pH) for which observations are available at USGS gauge stations.

Additional Resources

- ILAMB-Watershed Tutorial: https://github.com/rubisco-sfa/ILAMB-Watersheds/blob/main/doc/tutorial.md
- Sample outputs: https://www.ilamb.org/~nate/step3/
- ILAMB v2.7: https://github.com/rubisco-sfa/ILAMB