Mesh-independent River Modeling in the Sagavanirktok River Basin

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BACKGROUND

Accurate representation of river systems in Earth System Models (ESMs) is crucial for understanding and predicting hydrological processes. The use of mesh-independent river models offers flexibility in accommodating various mesh systems and configurations across different spatial scales. In this poster, we showcase two studies focusing on the representation of the Sagavanirktok River Basin (SRB) in Alaska, employing different discretization approaches.

HILLSLOPE-BASED DISCRETIZATION

The first study aims to develop a high-resolution, nested watershed model by integrating the permafrost-hydrology-enabled Advanced Terrestrial Simulator (ATS) with the Model for Scale Adaptive River Transport (MOSART). In this application, the entire SRB is discretized into over 4000 hillslope units. Preliminary findings (**Figure 1**) indicate that the streamflow predictions obtained from the ATS-MOSART coupling exhibit good agreement with the observations from USGS gauges in a small headwater catchment comprising 36 hillslope units.

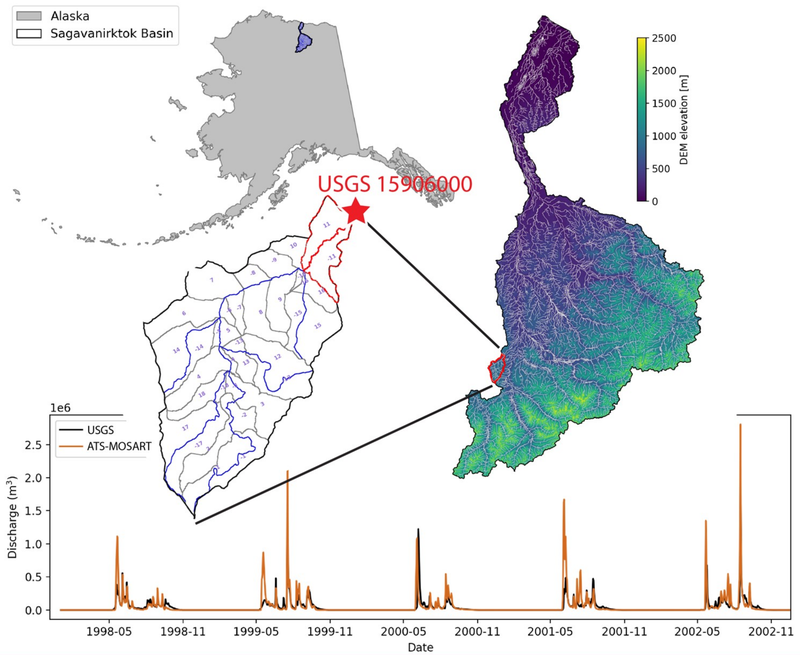

Figure 1 *Sag River discretization for ATS-MOSART coupling configuration. Bottom plot shows daily routed streamflow compared with USGS gauge observations for a small headwater catchment at station 15906000.*

GLOBAL UNIFIED UNSTRUCTURED MESH

Collaborating with the Integrated Coastal Modeling (ICoM) project, we construct a global unified Model for Prediction Across Scales (MPAS) mesh to seamlessly connect river, land, and ocean components in the Energy Exascale Earth System Model (E3SM) (**Figure 2**).

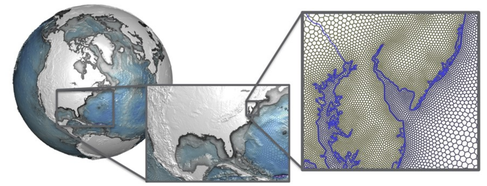

Figure 2 *Illustration of a global unified MPAS mesh*

By comparing MOSART's performance on the hillslope-based discretization, the MPAS mesh and the traditional latitude-longitude based mesh(**Figure 3**), we found that the MPAS-based MOSART results are in close agreement with the results from other approaches, while providing additional flexibility in meshing and advantages in land-ocean coupling.

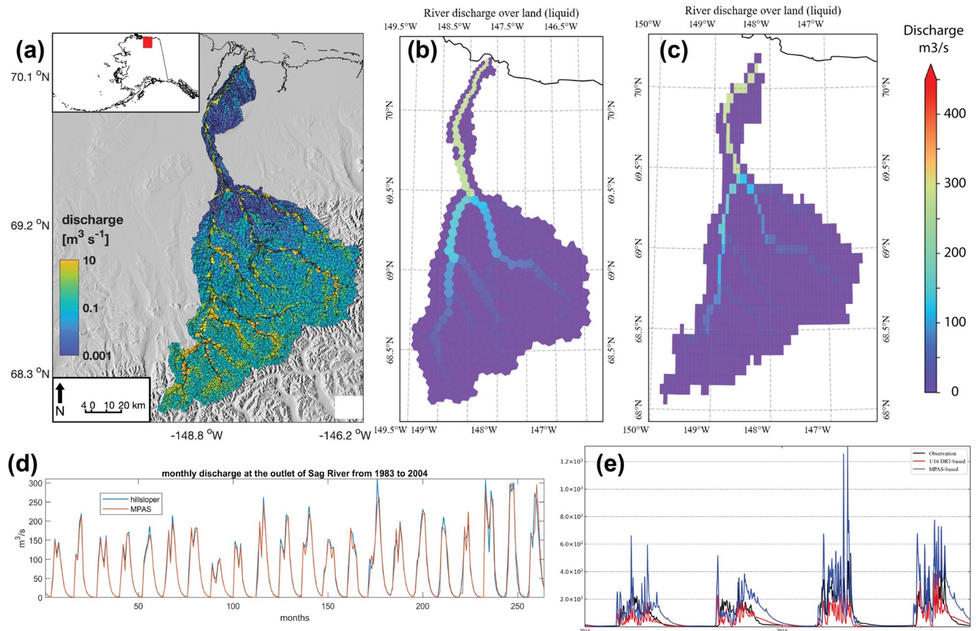

Figure 3 *Comparison of MOSART routed annual mean discharge in the Sag River Basin using three different discretization methods: (a) ATS hillslope discretization, (b) MPAS unstructured discretization, and (c) 1/16th latitude-longitude structured discretization. The model was forced by the Global Reach-level Flood Reanalysis (GRFR) runoff. (d) provides a monthly discharge comparison between (a) and (b) at the outlet of the Sag River Basin. (e) compares MPAS (b), lat-long (c) configurations with USGS observed discharge at station 15908000.*