Simulating River Processes in a Coupled Earth System

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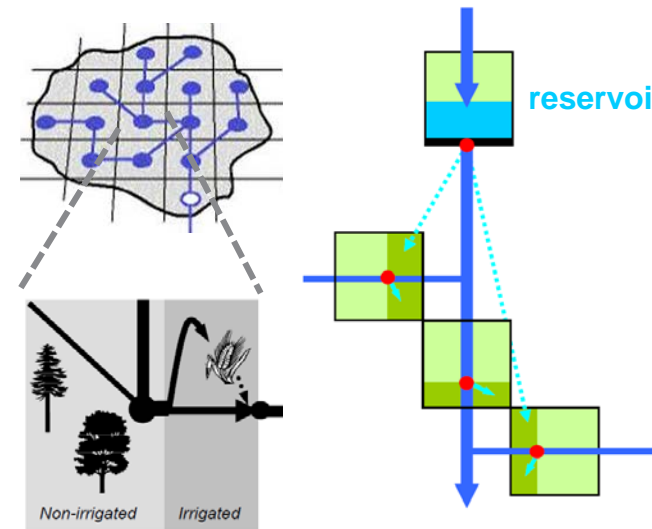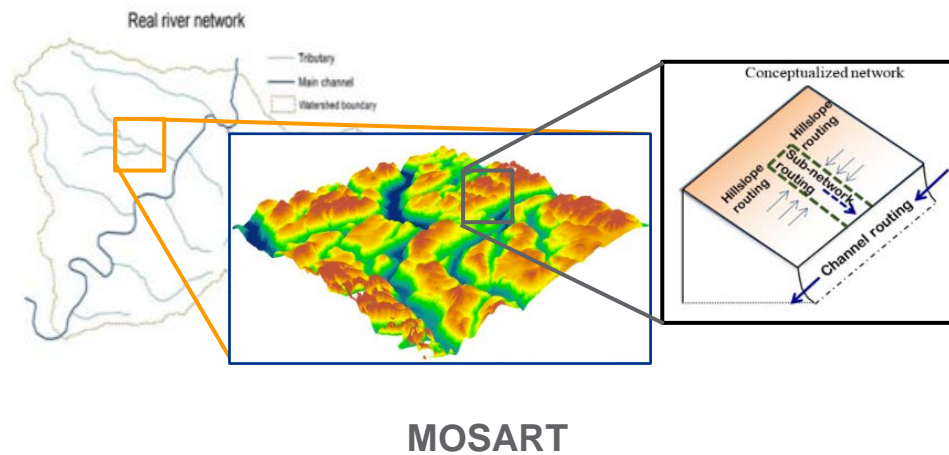[3]Los Alamos National Laboratory

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October 26, 2020

Background: Modeling river processes in E3SM

MOSART

MOSART – Water management

MOSART-inundation

ELM - MOSART two-way irrigation coupling

(Hong-Yi Li et al, 2013,2015; Luo et al., 2017; Voisin et al., 2013; Zhou et al., 2020)

Existing E3SM capability in modeling river processes

- Land runoff fluxes to river
- River routing to ocean
- Floodplain representation
- Water management (e.g., dam operating rules)
- Two-way irrigation coupling
- Tri-grid configuration

Next generation river modeling in E3SM

Current E3SM	New development for next generation E3SM	ESMD support
River routing on lat-long grid	River routing on unstructured grid or at watershed scale	ICoM and InteRFACE
River streamflow forced by ELM	River streamflow forced by ATS which represents permafrost processes	InteRFACE
River-Ocean one-way coupling	River-Ocean two-way coupling so that storm surge could travel inland through backwater effect	ICoM

Representing river network on unstructured mesh that connects land, river, and ocean
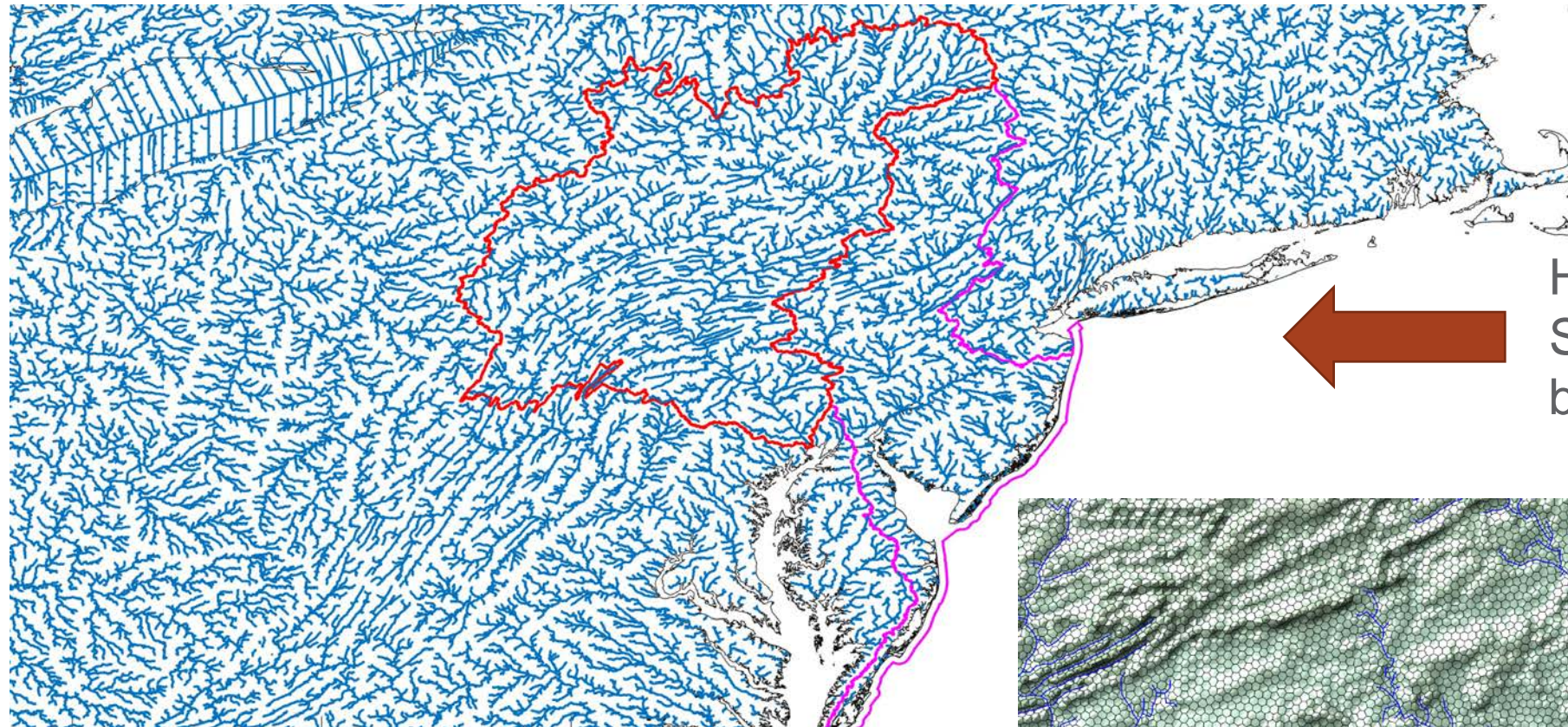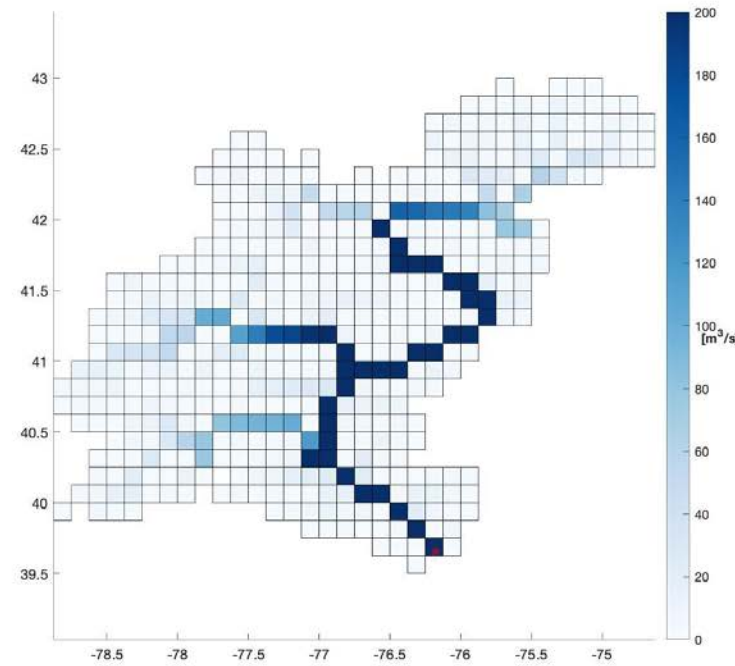

HydroSHED River network in Susquehanna and Delaware River basins and surrounding area
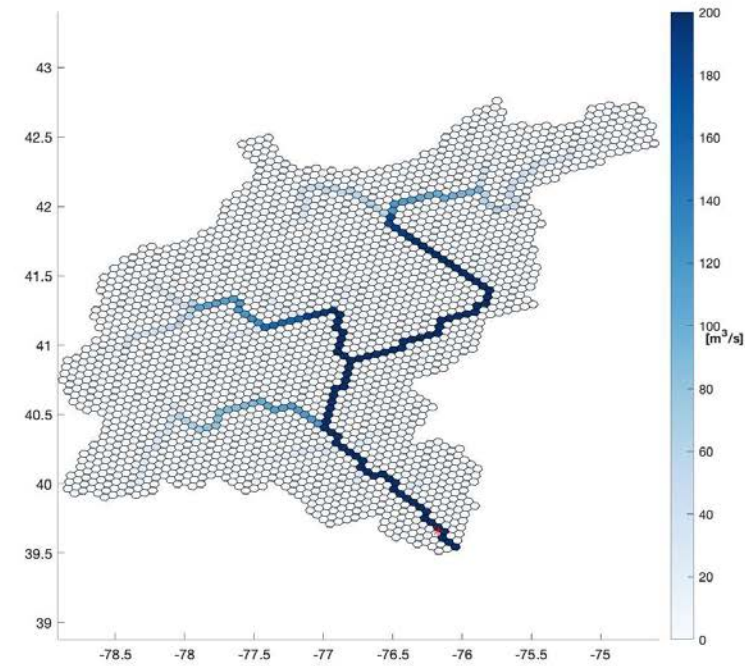
Unstructured mesh that connects land, river, and ocean, with river network burnt in
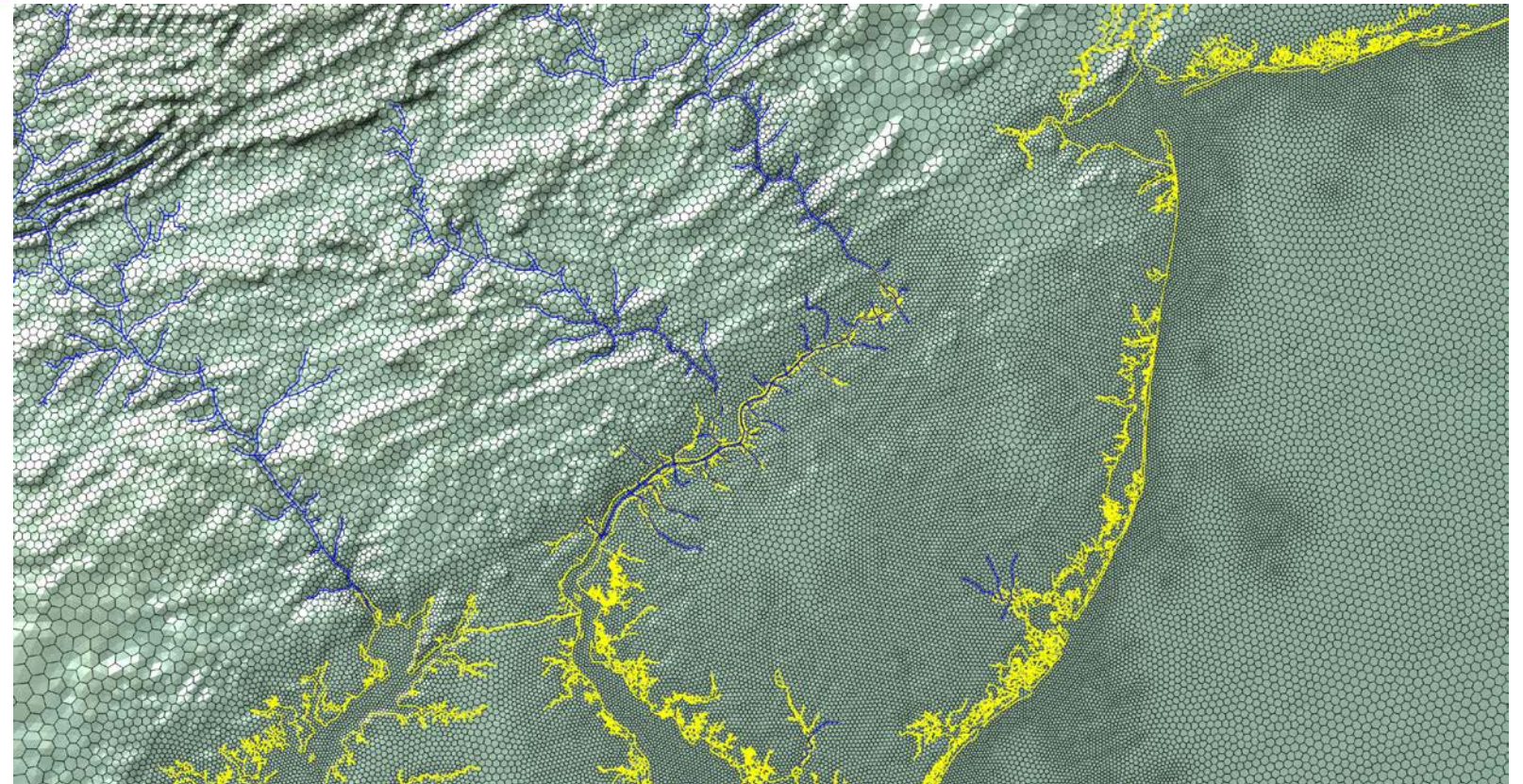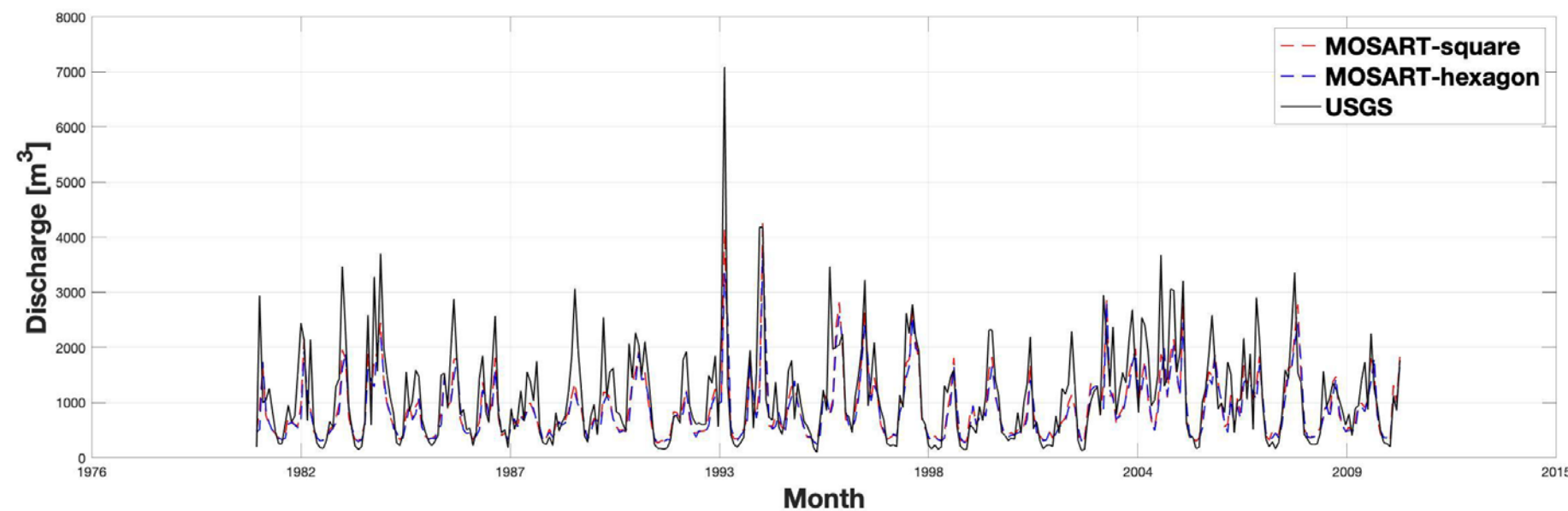
Susquehanna River discharge simulated using two different meshes

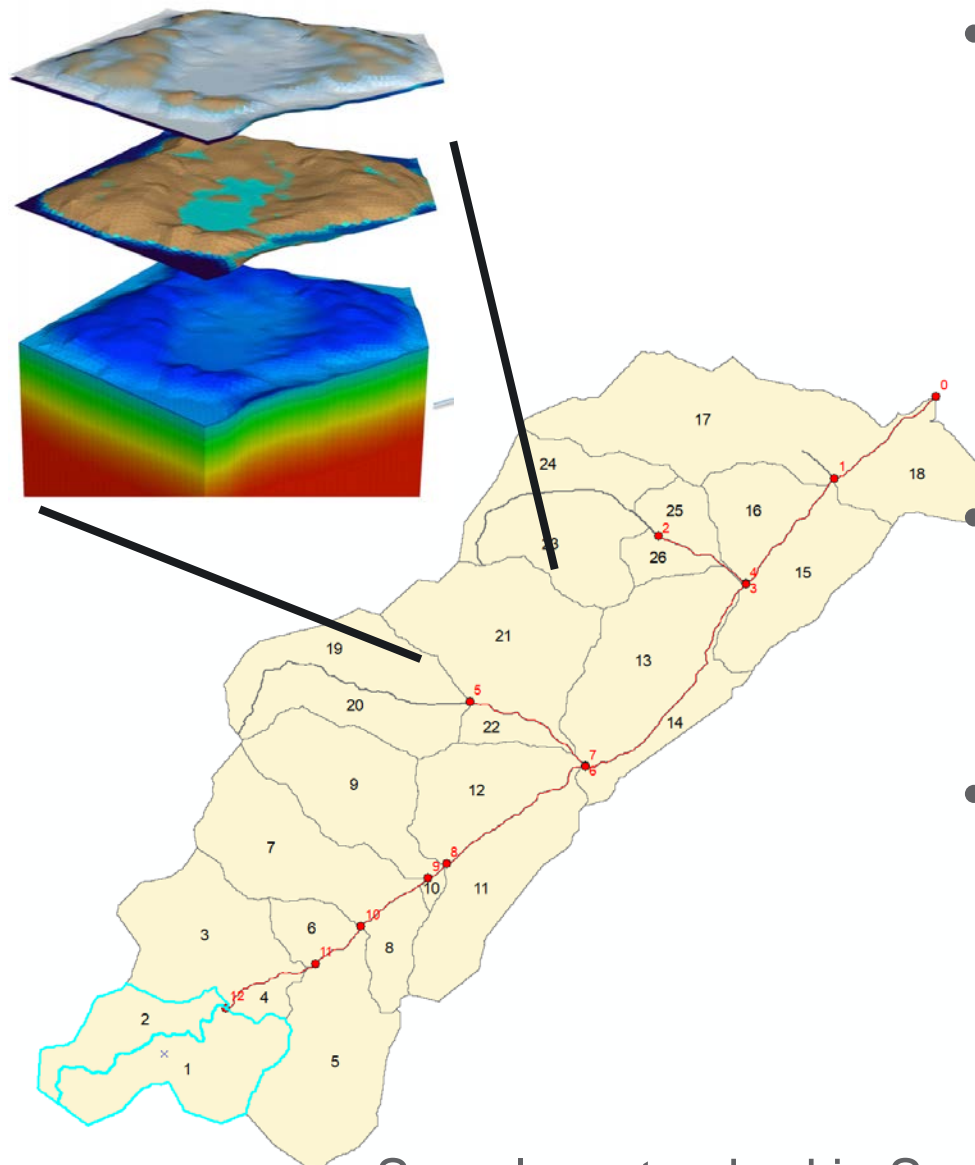River network represented using lat-long (square) grid

River network represented using hexagon mesh grid

Simulated river discharge at the outlet of Susquehanna River compared with USGS gauge data

River routing on watershed-based river network and ATS-MOSART coupling (in progress)

- Advanced Terrestrial Simulator (ATS) is a high-resolution 3D land model that could simulate permafrost processes such as freeze/thaw cycles in the arctic soil, snow melt and runoff, subsurface flow due to infiltration, and ice melt, soil subsidence due to the melting ice, and biogeochemical processes in the vegetation layer.

- Coupling integrated hydrology and permafrost enabled ATS with MOSART, we will develop a high-resolution, nested watershed model for E3SM.

- The ATS-MOSART framework will be used to explore how snowmelt timing, rate of seasonal thaw layer development, and convective precipitation events will influence riverine fluxes in the Arctic watersheds

Sample watershed in Sag River basin for
ATS-MOSART coupling tests