Testing and Validating the Parallel Next Generation National Water Resources Model Framework

SESSION NUMBER: 121

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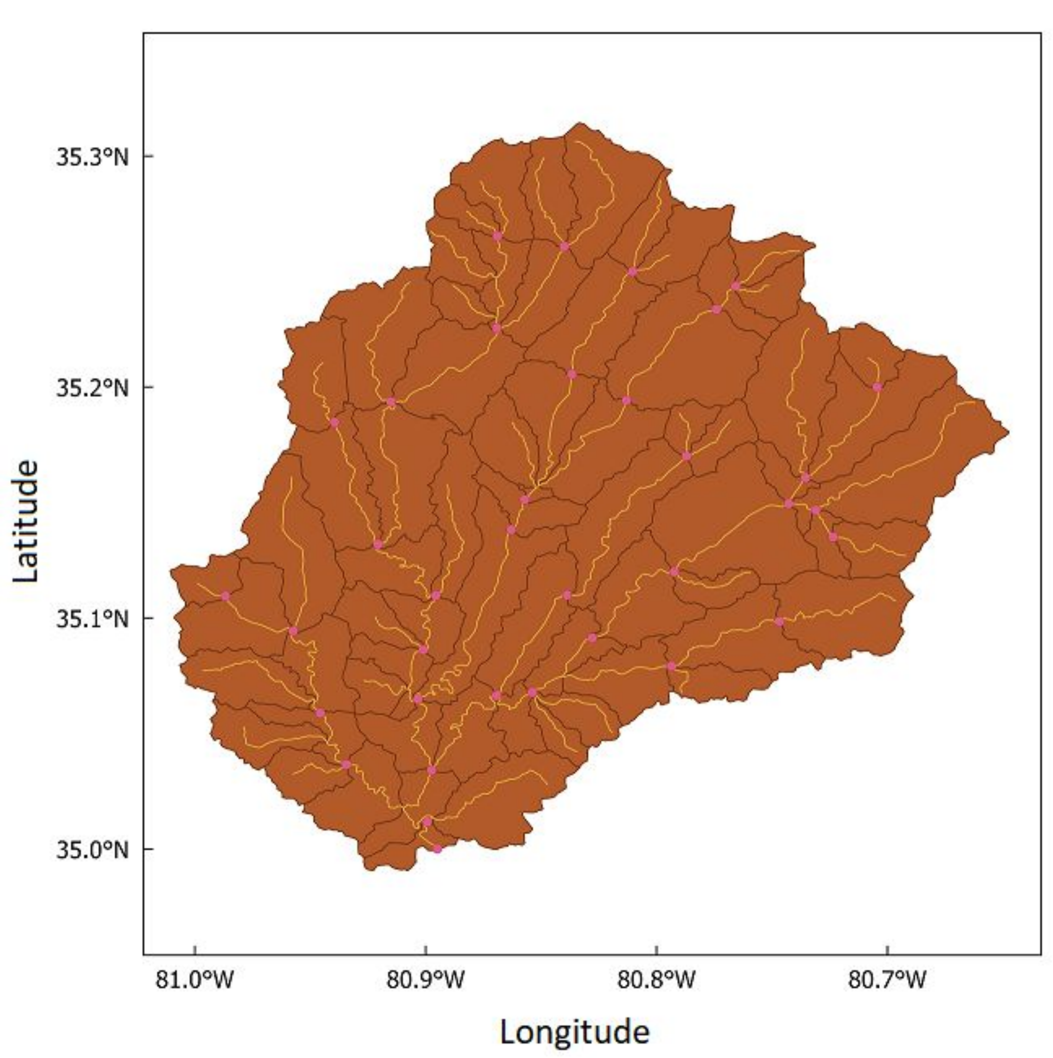
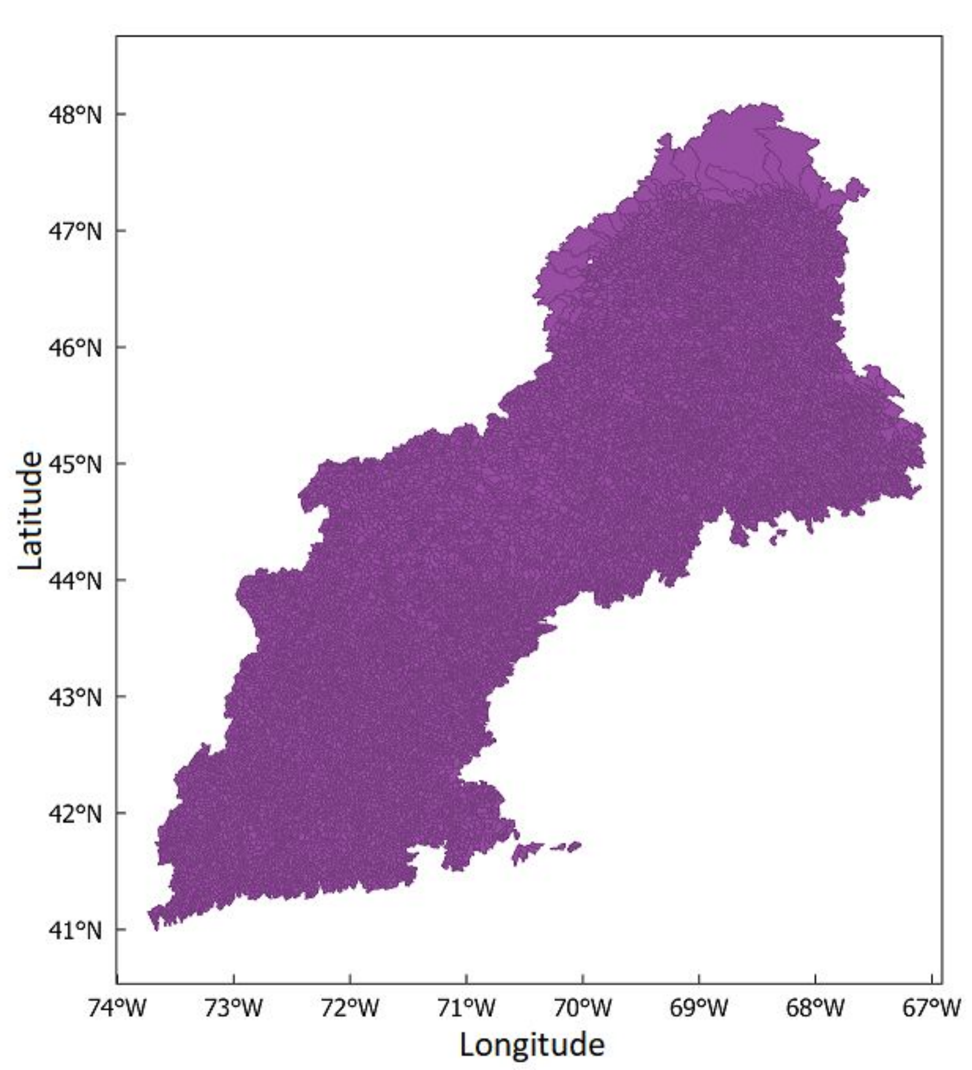
OWP OFFICE OF WATER PREDICTION

❖ **Goal: Ensure the reliability and bug-free implementation of the Ngen code during the scale up process in CPU cores and domain size.**

Sugar Creek Domain



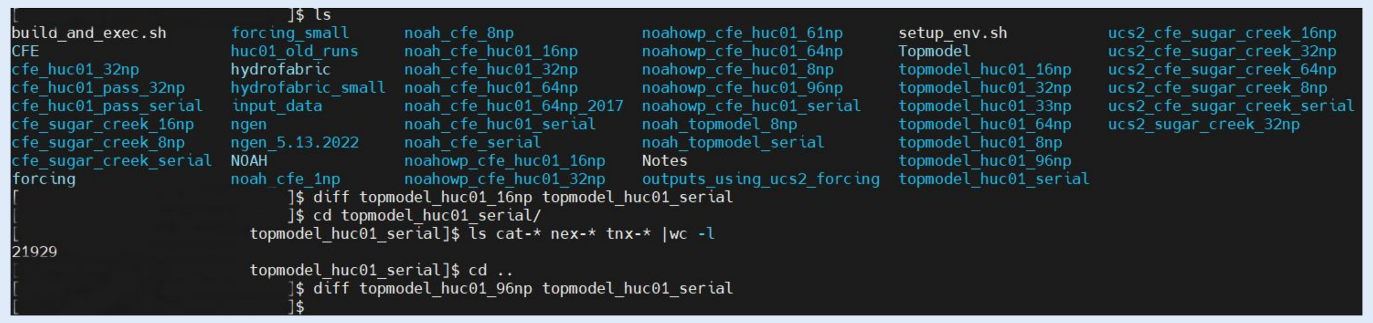
HUC01 Domain



We have demonstrated a technique for executing models not designed for distributed processing in parallel environments.

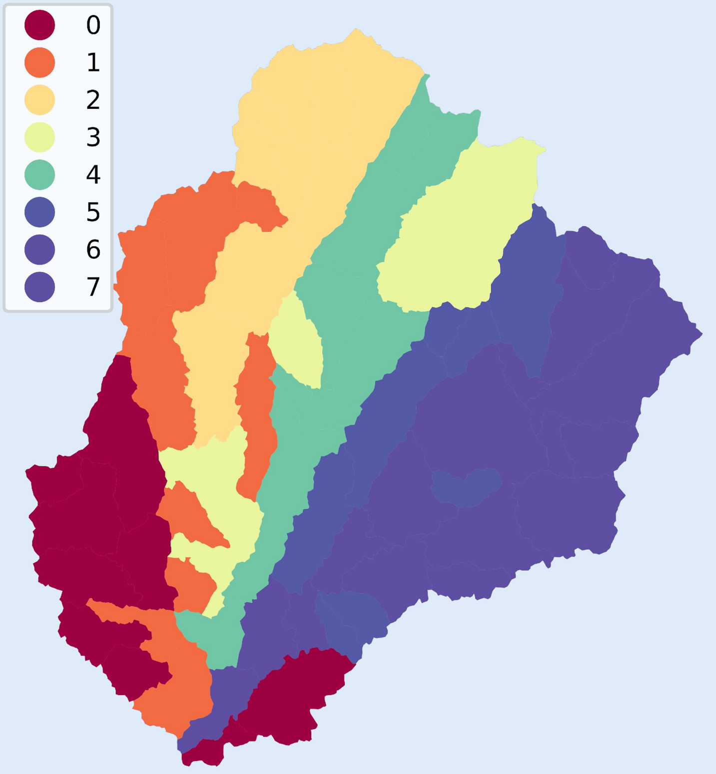
❖ **We demonstrate the Ngen[1] framework generates consistent results in both serial and parallel modes across:**
(1) various compute scales (number of CPU cores)
(2) various spatial domain scales

❖ **Validated with Linux diff and Custom scripts/visualization**



❖ **Hydrologic Domains for Test Runs**
*** Sugar Creek (top left figure)**
67 catchments, 36 nexuses
*** Huc01, (bottom left figure)**
14632 catchments, 7297 nexuses
*** A small sample testing hydrofabric (not shown)**
33 catchments and 18 nexuses

❖ **Computational Setup:**
*** BMI-CFE model on Sugar Creek domain:**
1, 8, 16, 32, 64 CPU cores (top right figure)
*** Noah-OWP-CFE on HUC01 domain running:**
1, 16, 32, 64, 96 CPU cores (results not shown)
*** Noah-OWP-Topmodel on HUC01 domain running:**
1, 8, 16, 32, **33**, 64, 96 CPU cores (bottom right figure)



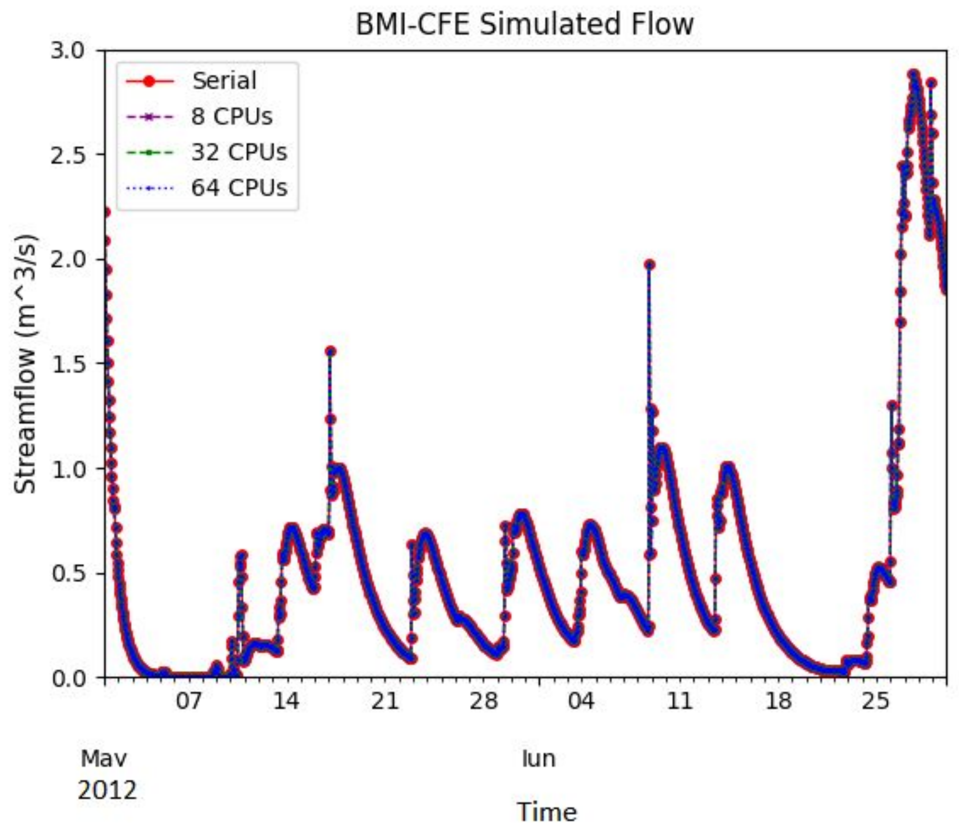
Example parallel partitioning of Sugar Creek Domain with 8 compute resources.

❖ **Serial and parallel computations using Ngen produce identical results. This suggests the correctness of the parallel computation code across various compute scales.**

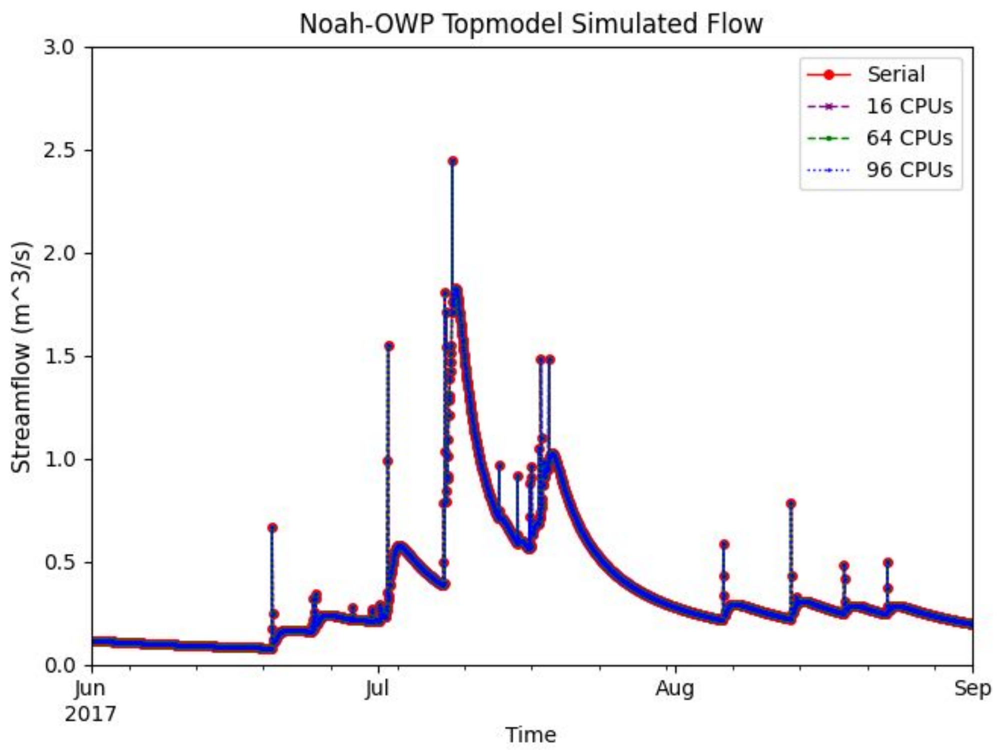
❖ **The Ngen produces identical results for serial and parallel computation with vastly different sized domains, suggesting it can be used with various spatial domain scales, from regional to continental.**

❖ **Brief technical background for the parallelization scheme**
*** Boost graph based hydrofabric network with proper topological order[2]**
*** Partition of the hydrofabric network on to MPI ranks using depth first search from tail water to the head water**
*** Asynchronous communication at shared nexus locations**
*** Basic model interface (BMI)[3]**

Hydrograph for a typical catchment in Sugar Creek domain showing the streamflow from serial run and parallel runs are all identical.



Hydrograph for a typical catchment in HUC01 domain showing the streamflow from serial run and parallel runs are all identical.



ACKNOWLEDGEMENTS:
Mike Johnson, Hydrofabric
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REFERENCES:
1. https://github.com/NOAA-OWP/ngen
2. https://www.boost.org/doc/libs/1_79_0/libs/graph/doc/table_of_contents.html
3. https:// bmi.readthedocs.io/en/latest/

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