ICoM

Integrated Coastal Modeling

A hexagonal mesh-based routing method for land surface and hydrologic models

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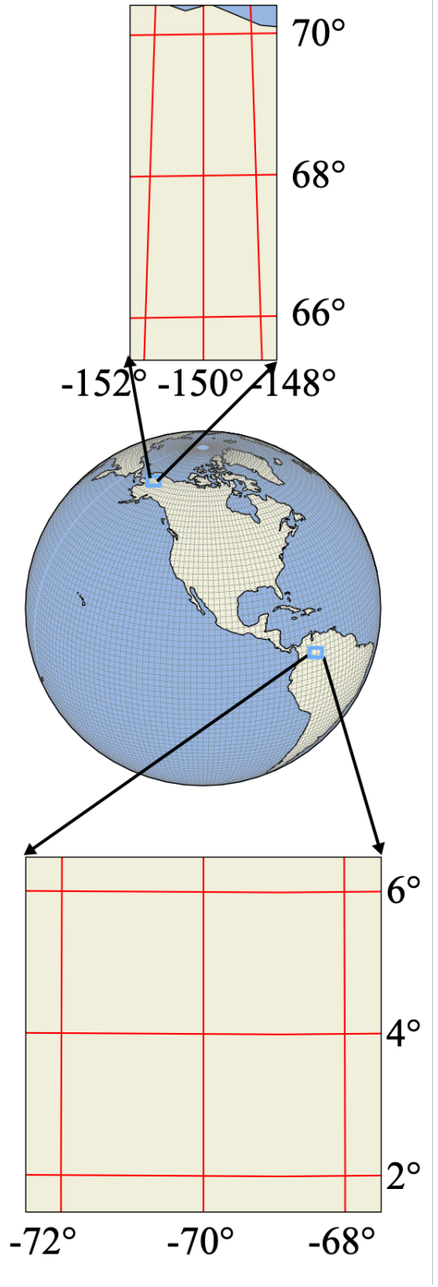
PNNL is operated by Battelle for the U.S. Department of Energy

ICoM is funded by multiple programs in the Earth and Environmental Systems Sciences Division of DOE's Office of Science

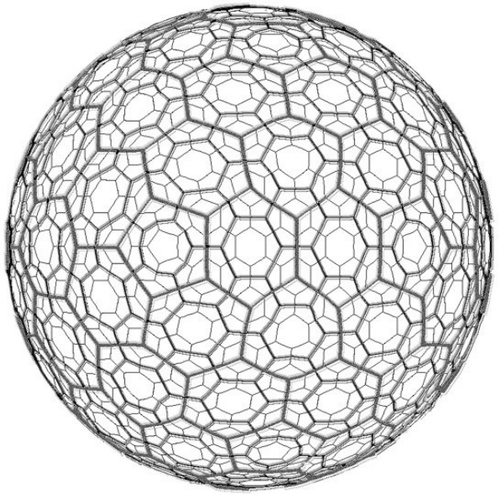
Background

- Flow routing is a critical component in hydrologic models.
- Most existing hydrologic models use square grids (latitude-longitude, etc.) as spatial discretization, which has several limitations.

1. Adjacency
2. Diagonal travel path
3. Sphere coverage



(Liao, et al. 2020 EMS)



A review of existing methods

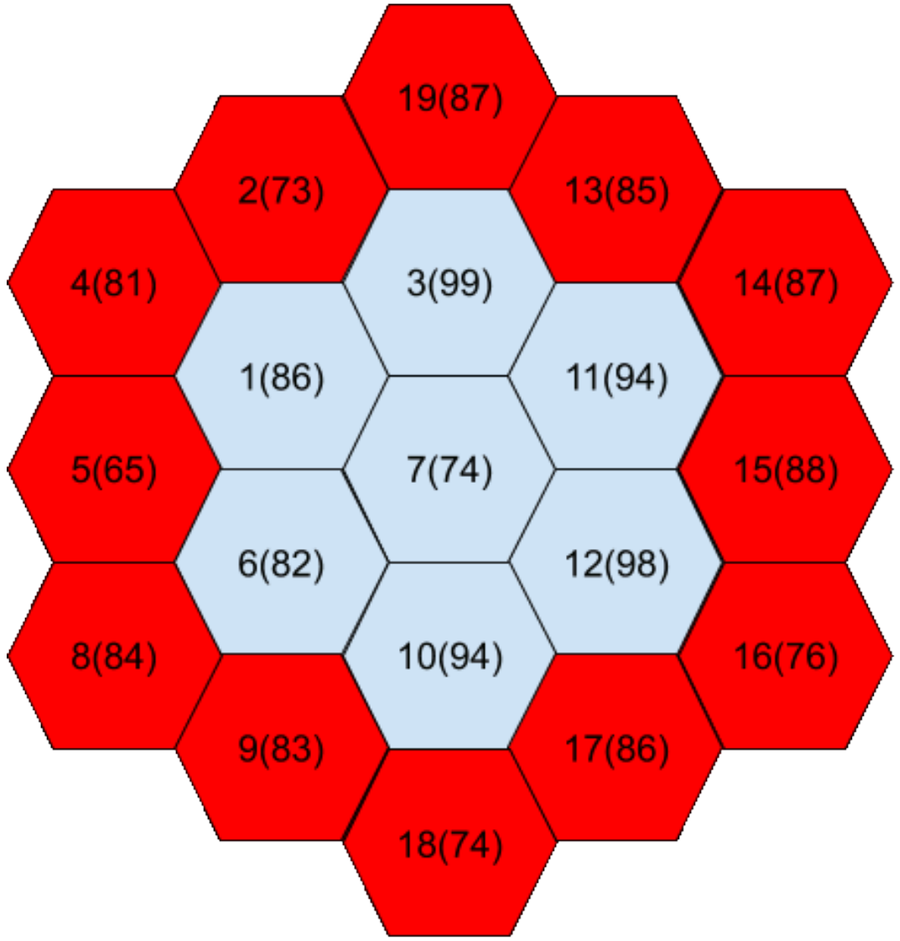
- Advanced DEM spatial resampling.
- Alternative DEM such as TIN.
- “Stream burning”, aka, DEM reconditioning.
- Guided flow direction definition based on high resolution hydrography.
- …

(Liao, et al. 2020 JAMES, in prep)

- ➢ None of them is available under the hexagon grids.
- ➢ They interfere each other in practice.
- ➢ Minimize the modification to elevation.

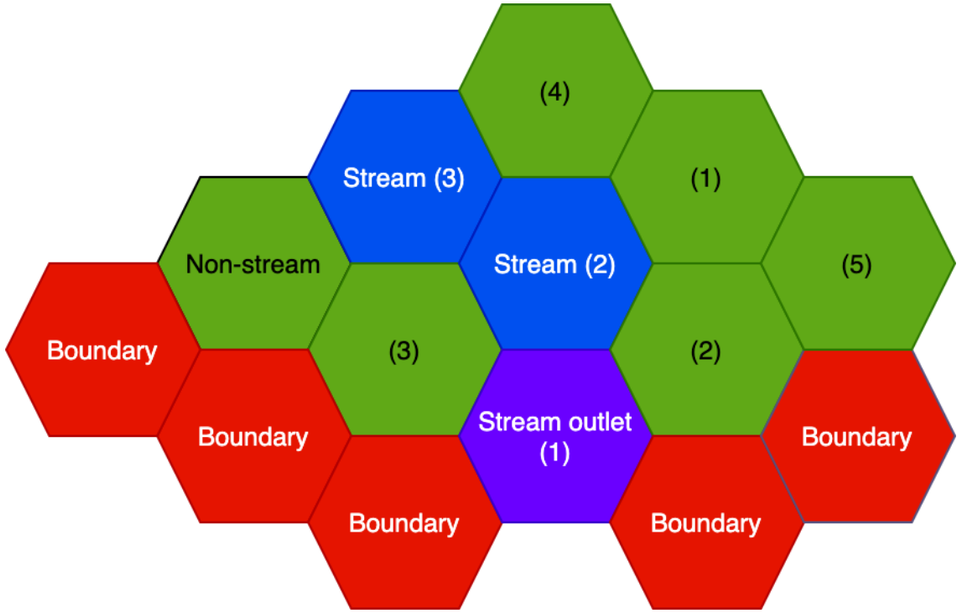
Method part 2: Hybrid breach-filling stream burning

Original depression filling



(Liao, et al. 2020 EMS)

Stream burning depression filling



A hybrid approach:

1. Elevation will be modified only once;
2. Breaching in stream channel and filling on land.

(Liao, et al. 2020 JAMES, in prep)

Model experiments

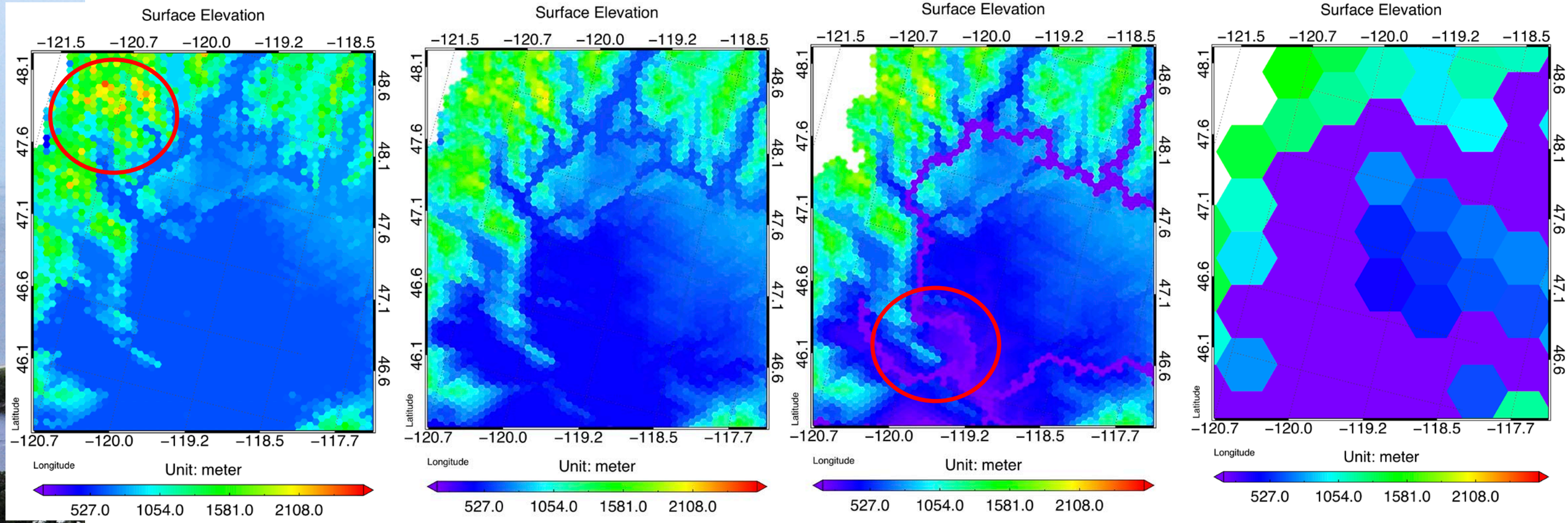
Table 2. Simulation configurations.

Case	Resolution	Resample method	Stream burning
1	$5km$	Nearest	Off
2	$5km$	Nearest	On
3	$5km$	Mean	Off
4	$5km$	Mean	On
5	$10km$	Nearest	Off
6	$10km$	Nearest	On
7	$10km$	Mean	Off
8	$10km$	Mean	On
9	$20km$	Nearest	Off
10	$20km$	Nearest	On
11	$20km$	Mean	Off
12	$20km$	Mean	On
13	$40km$	Nearest	Off
14	$40km$	Nearest	On
15	$40km$	Mean	Off
16	$40km$	Mean	On

We applied the model to the Columbia River Basin (CRB). CRB is the drainage basin of the Columbia River in the Pacific Northwest region of North America. The drainage area of CRB is approximately 6.7 * 10^5 km^2.

(Liao, et al. 2020 JAMES, in prep)

Model results: elevation

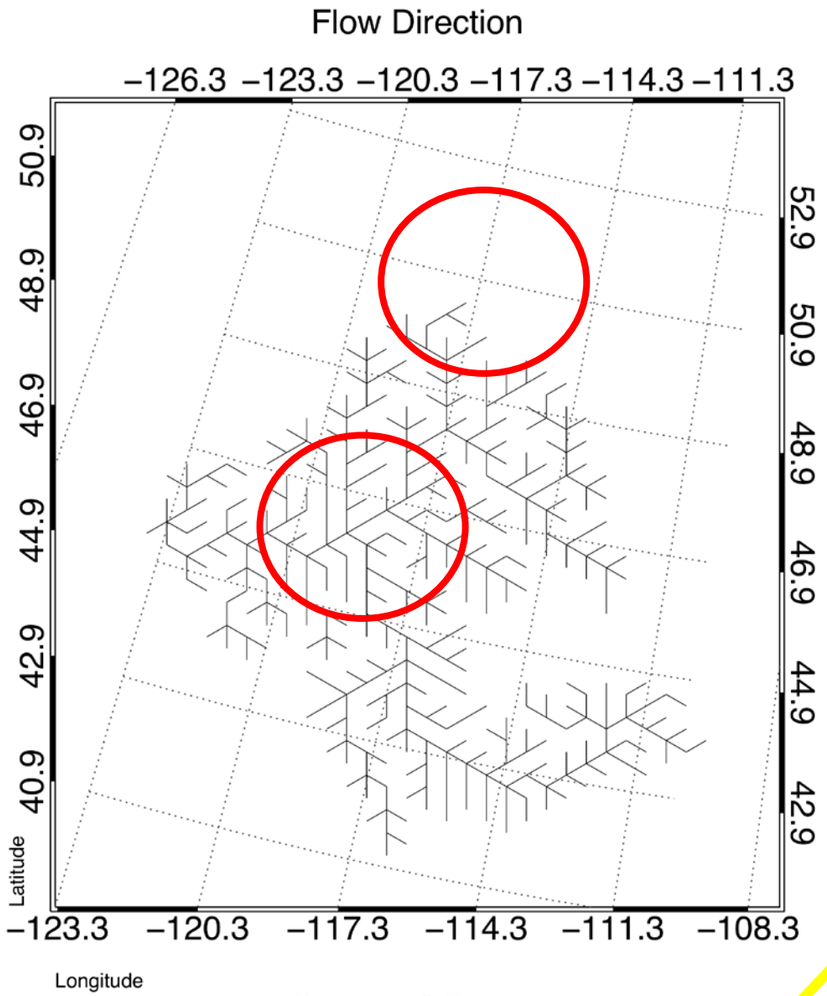


Case 1 **Case 3** **Case 4** **Case 16**

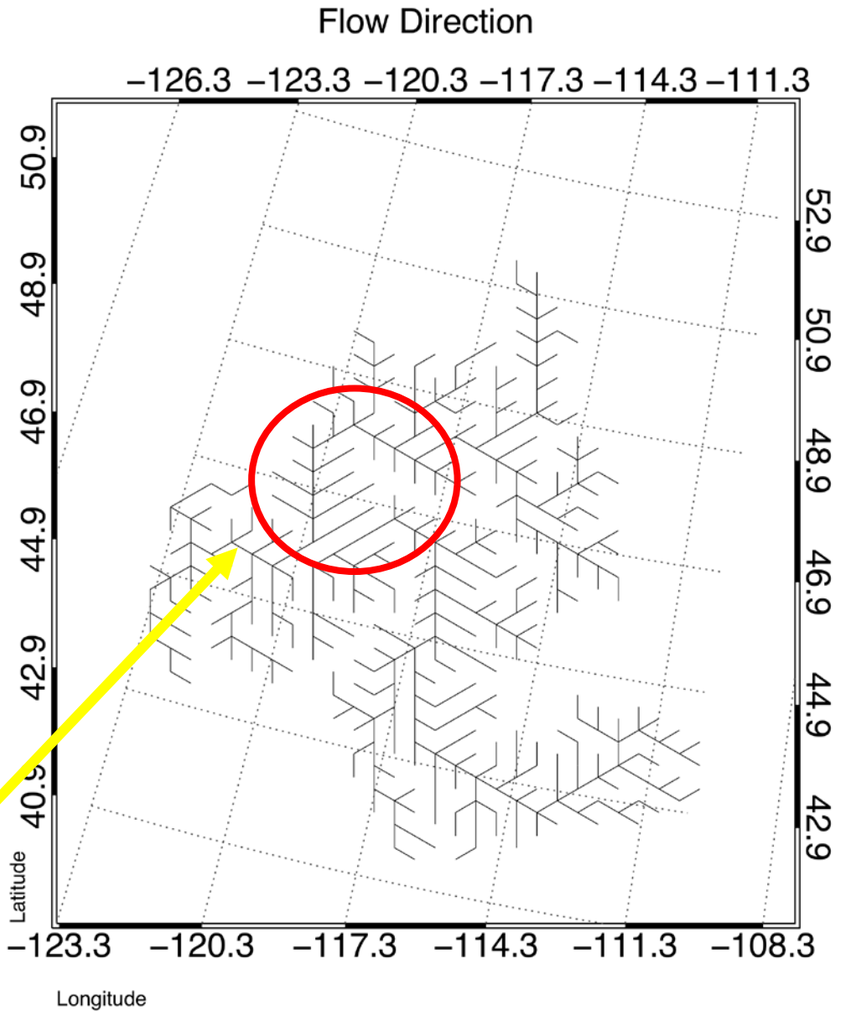
HexWatershed modifies elevation even at coarse resolution so that water always goes into stream channels.

(Liao, et al. 2020 JAMES, in prep)

Model results: flow direction



Case 13

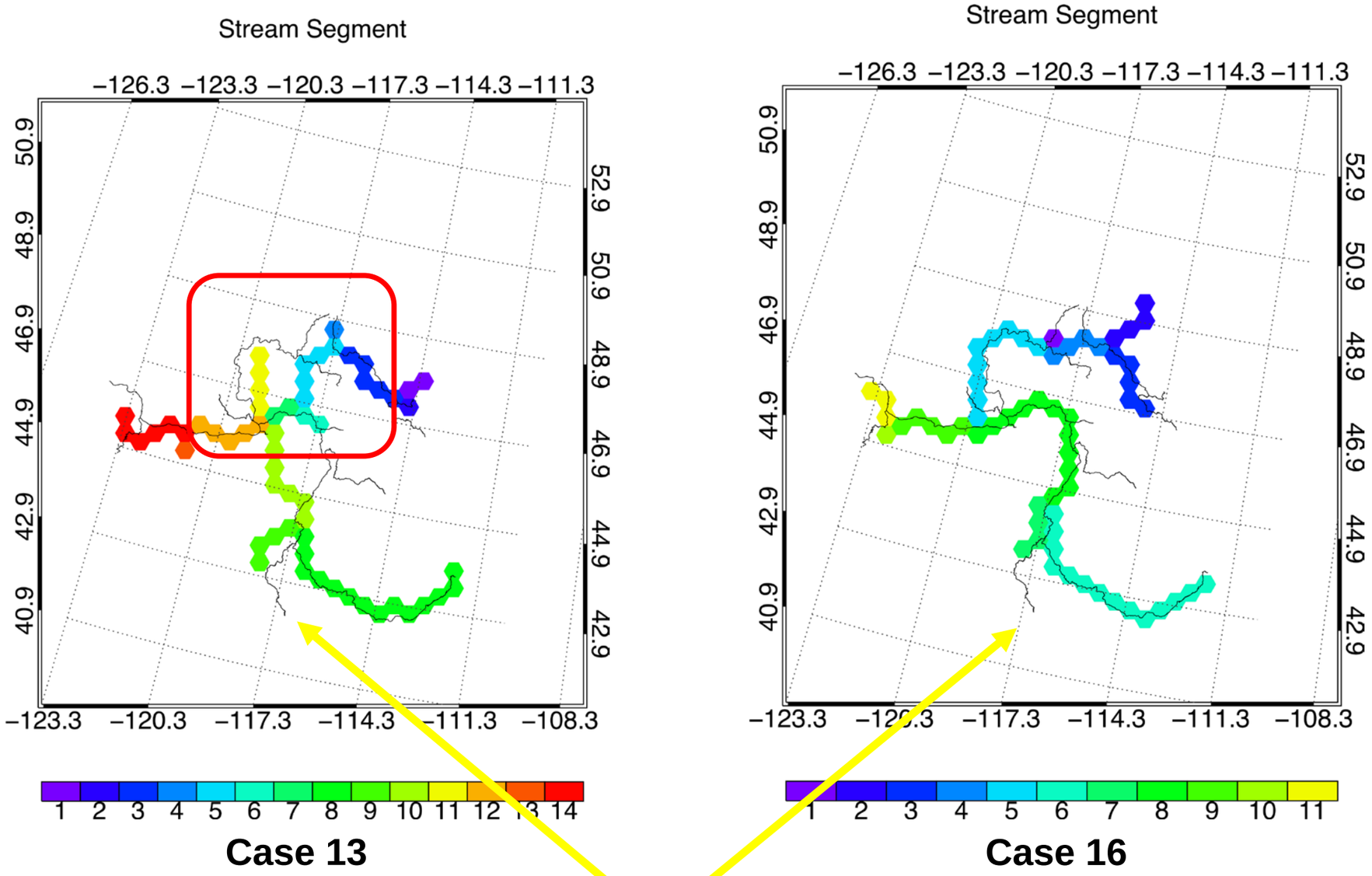


Case 16

Flow direction is consistent with actual stream channels when stream burning is enabled.

(Liao, et al. 2020 JAMES, in prep)

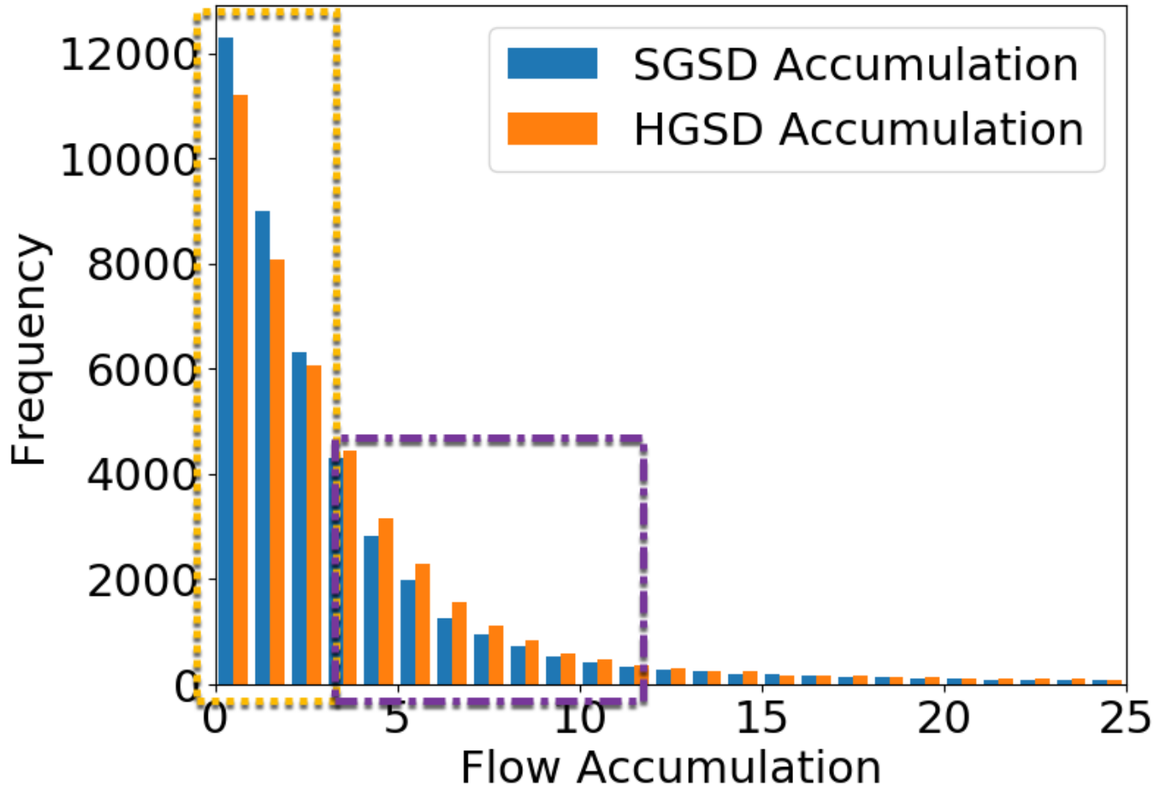
Model results: stream channel

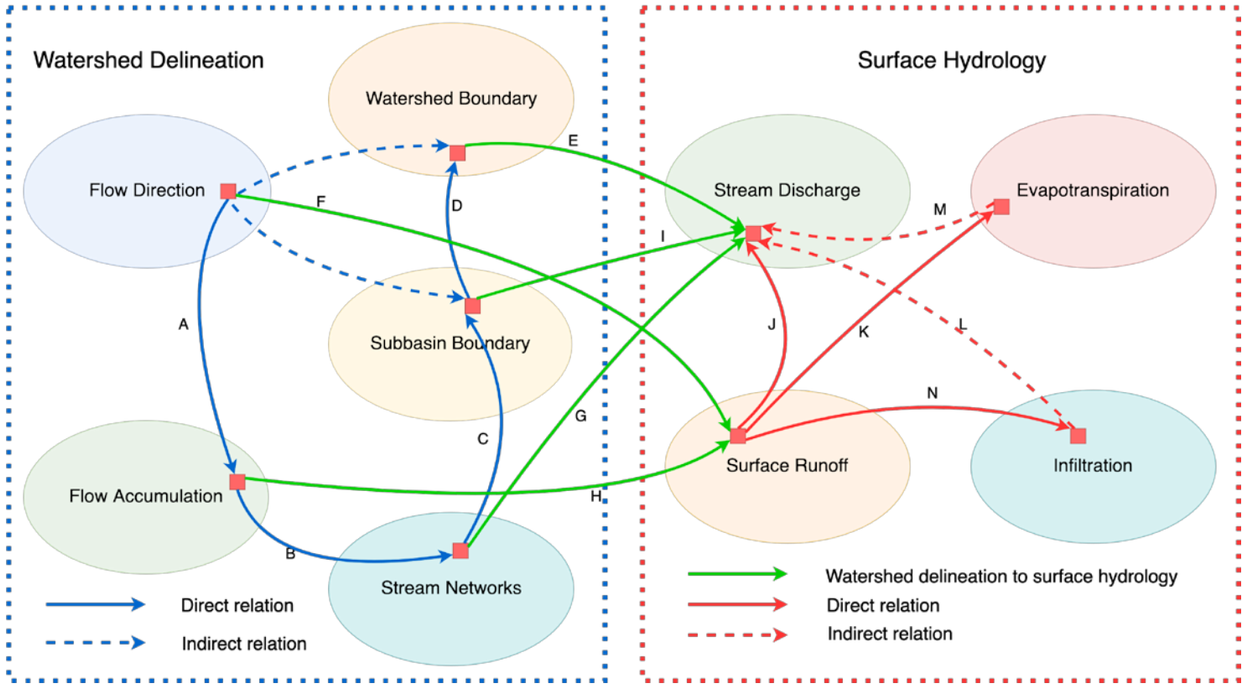


Stream segment is almost identical to **NHD flow line** when stream burning is enabled.

(Liao, et al. 2020 JAMES, in prep)

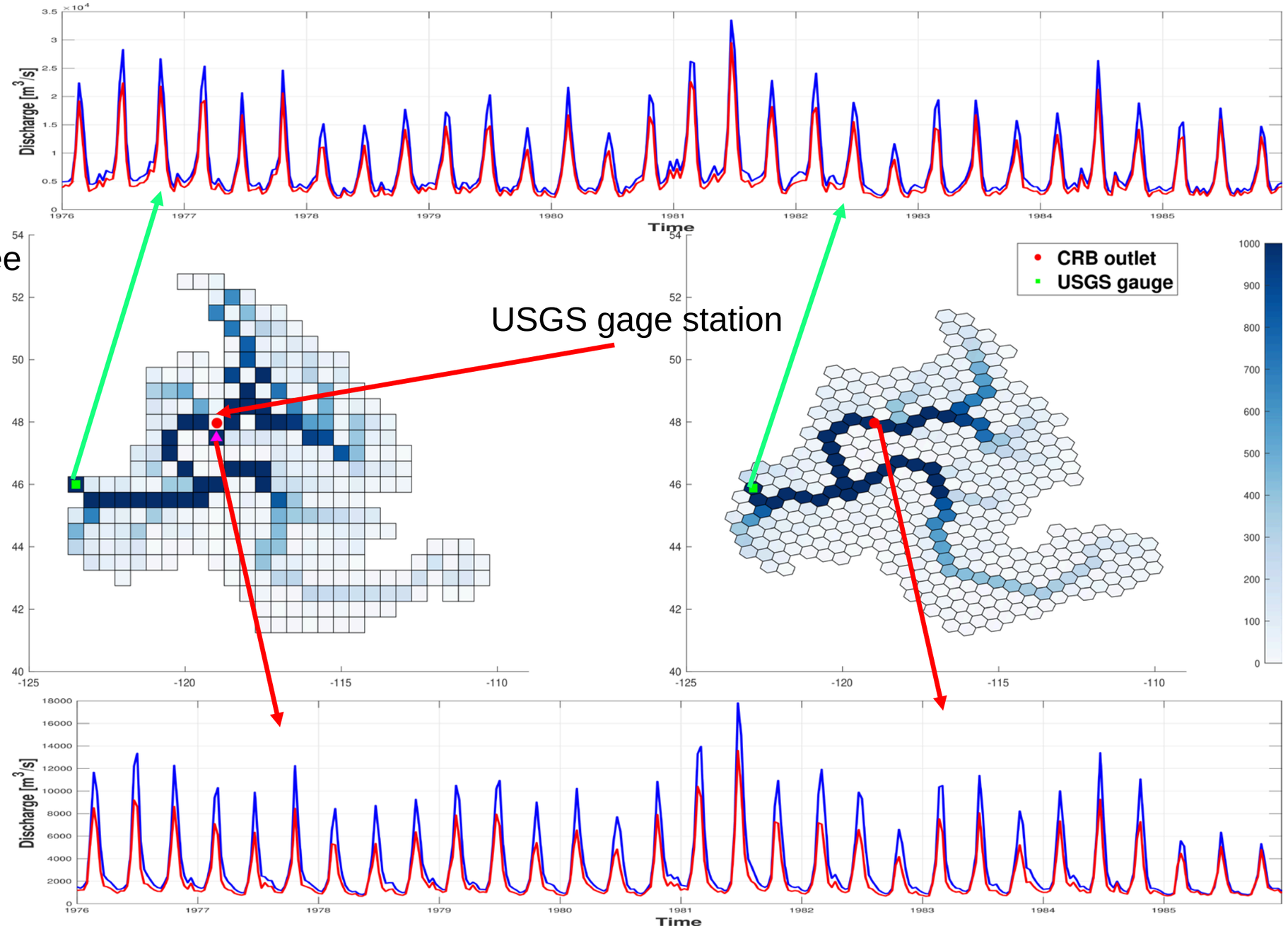
The impact of mesh grid on hydrologic simulation





"HexWatershed produces less spatial variability in flow accumulation."
And it may affect all the dependent hydrologic processes.

(Liao, et al. 2020 EMS)

Evaluation of impact of mesh grid on hydrologic simulations

1/2 degree
~40km