Processing the Pixel Cloud to Make River Products: Philosophies & Challenges

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Cuayahoga River, Ohio

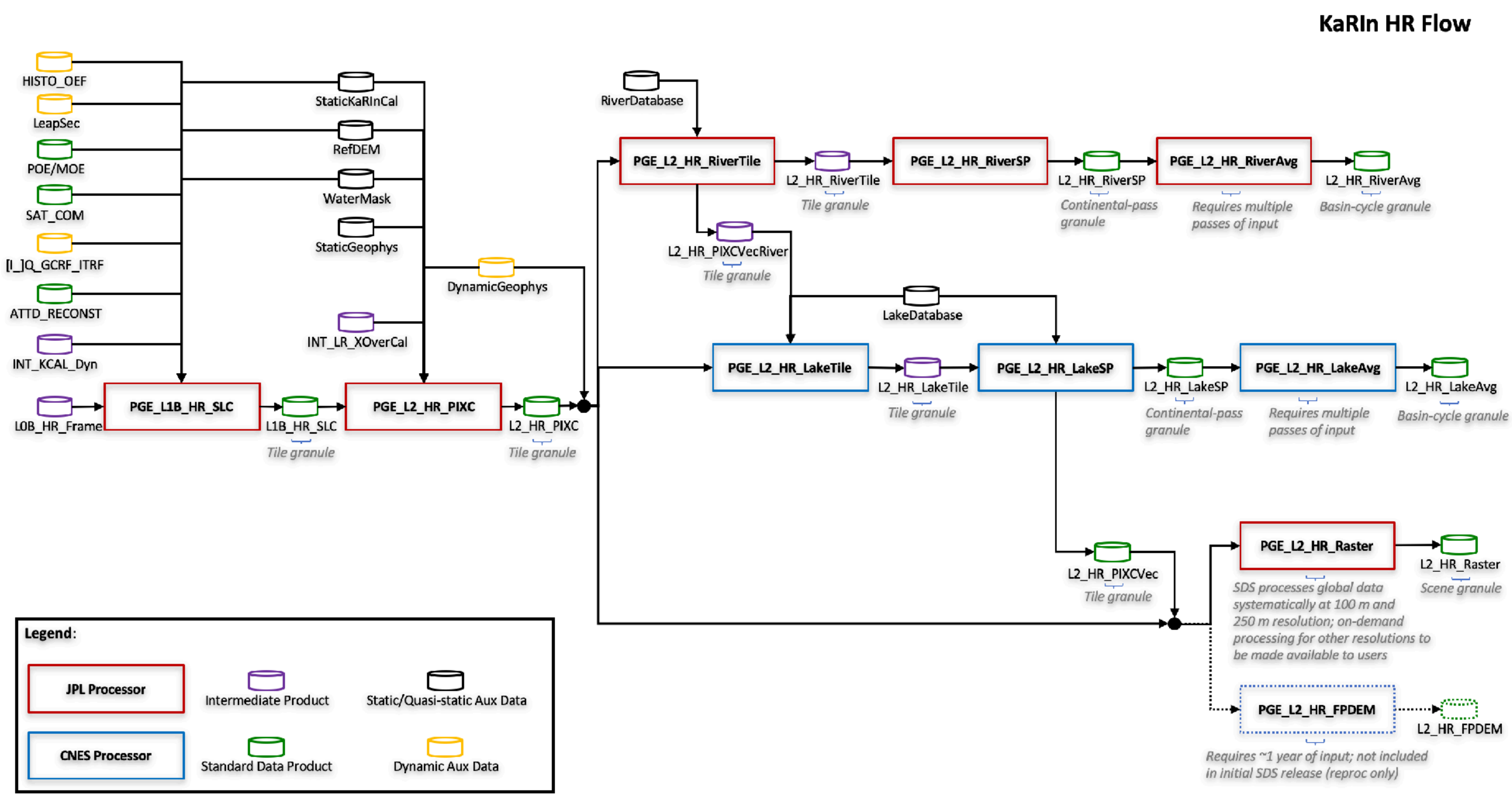
"A river is a river not a line" - Patty Griffin.

However, SWOT river data products are one-dimensional.

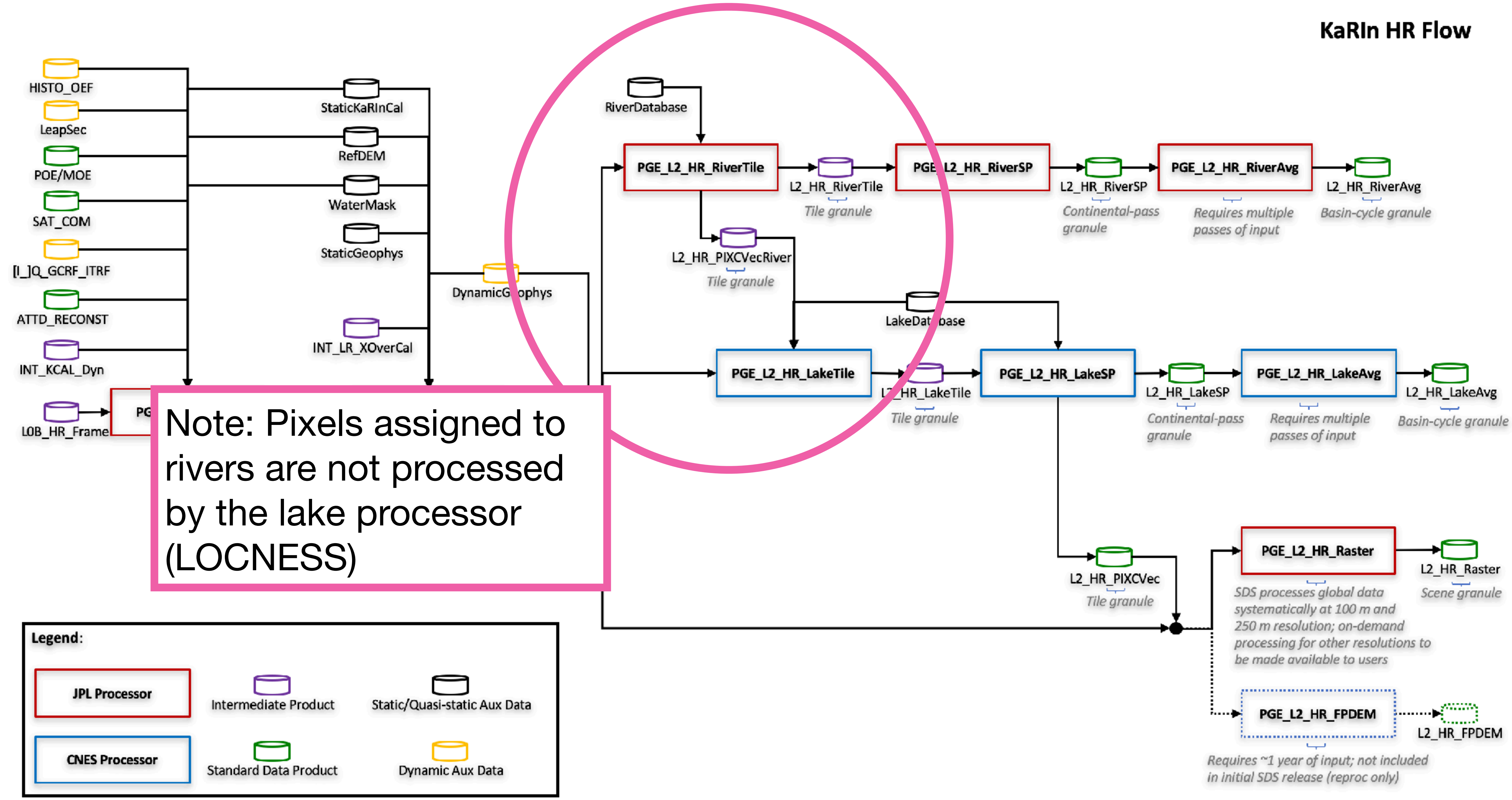
The 1-d approach to rivers works well most of the time, but is sometimes problematic.

Today: Challenges in the river vector data products, philosophy, and solutions

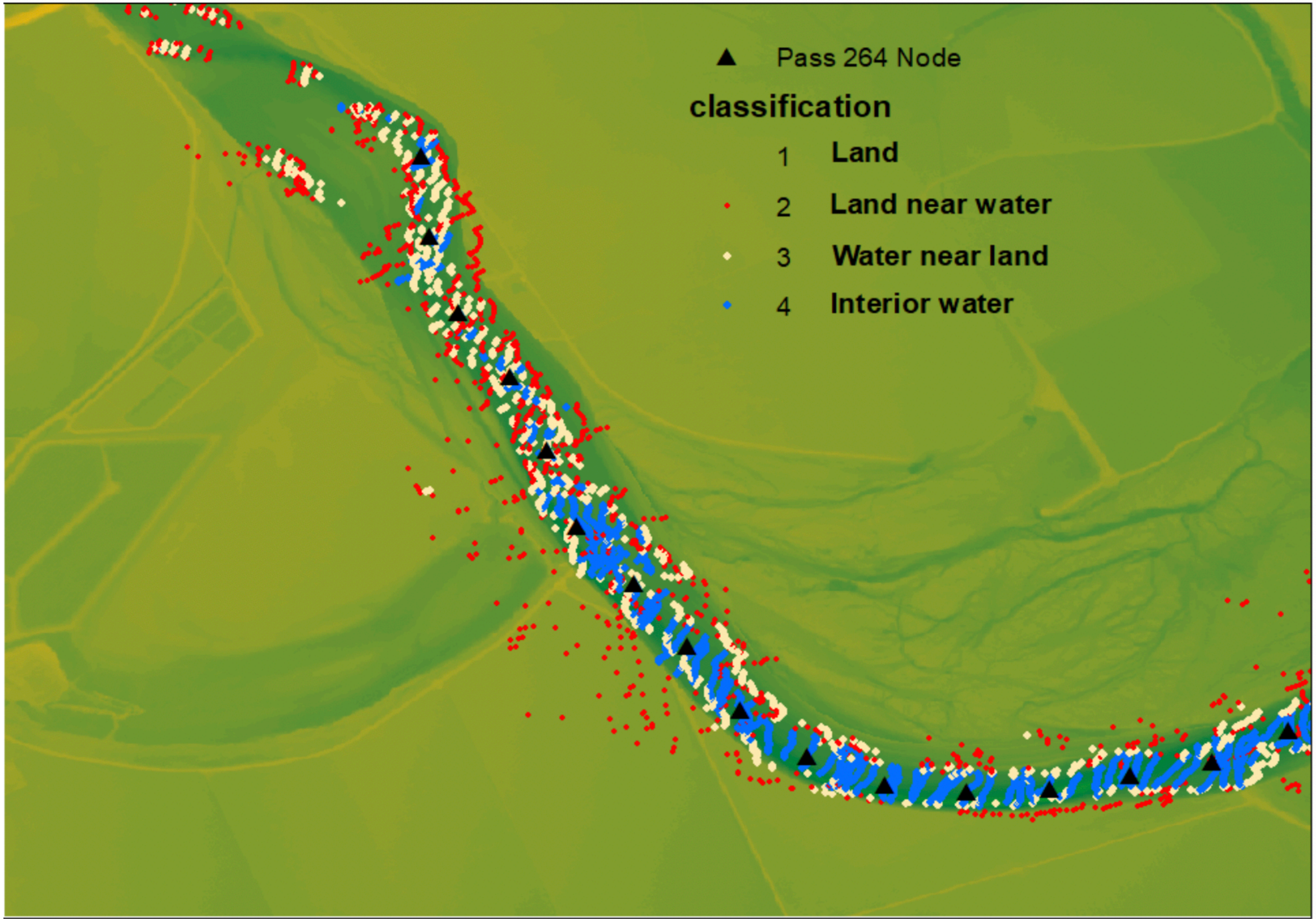
High-resolution processor flow chart



High-resolution processor flow chart



Note: Pixels assigned to rivers are not processed by the lake processor (LOCNESS)



RiverObs maps pixels to centerline nodes

Each pixel mapped to nearest node at 200 m intervals along river centerline.
See talk at 2018 Science Team meeting.

(Simplified) assignment algorithm, applied reach by reach

Prior to assignment, water is 4-connect segmented at the tile level

1. All pixels within a tile are (preliminarily) assigned to the closest (Euclidean) node in the reach.

2. Only those determined to be “river” pixels (labeled “in_channel”) as determined by following two steps are kept; others are unassigned, using the following algorithm:

    1. All pixels whose closest node distance (normal to centerline) is less than a threshold distance (“max_distance”) are (preliminarily) assigned as “river”.

    2. All pixels contiguous with the dominant segment for a particular reach are assigned to nodes. “Dominant segment” is defined by the largest (computed by number of pixels) contiguous set of pixels that satisfy step 2: note that these will only be the pixels “close” to the reach; it will not be e.g. the largest set of pixels in the tile. “contiguous” is determined based on segmenting pixels at the tile scale. “dominant” is determined at reach scale.

3. If steps 1 and 2 assign pixels to multiple reaches, the “best” reach is chosen based on the minimum node distance.

Assignment Algorithm Performance

- We have assessed this algorithm performance across a range of rivers using the HR simulator: the Tanana, Platte, Sacramento, and Po.

- The algorithm works remarkably well, even in somewhat complex environments. Width errors have uniformly been far less than science requirements, e.g. See slides from last ST18.

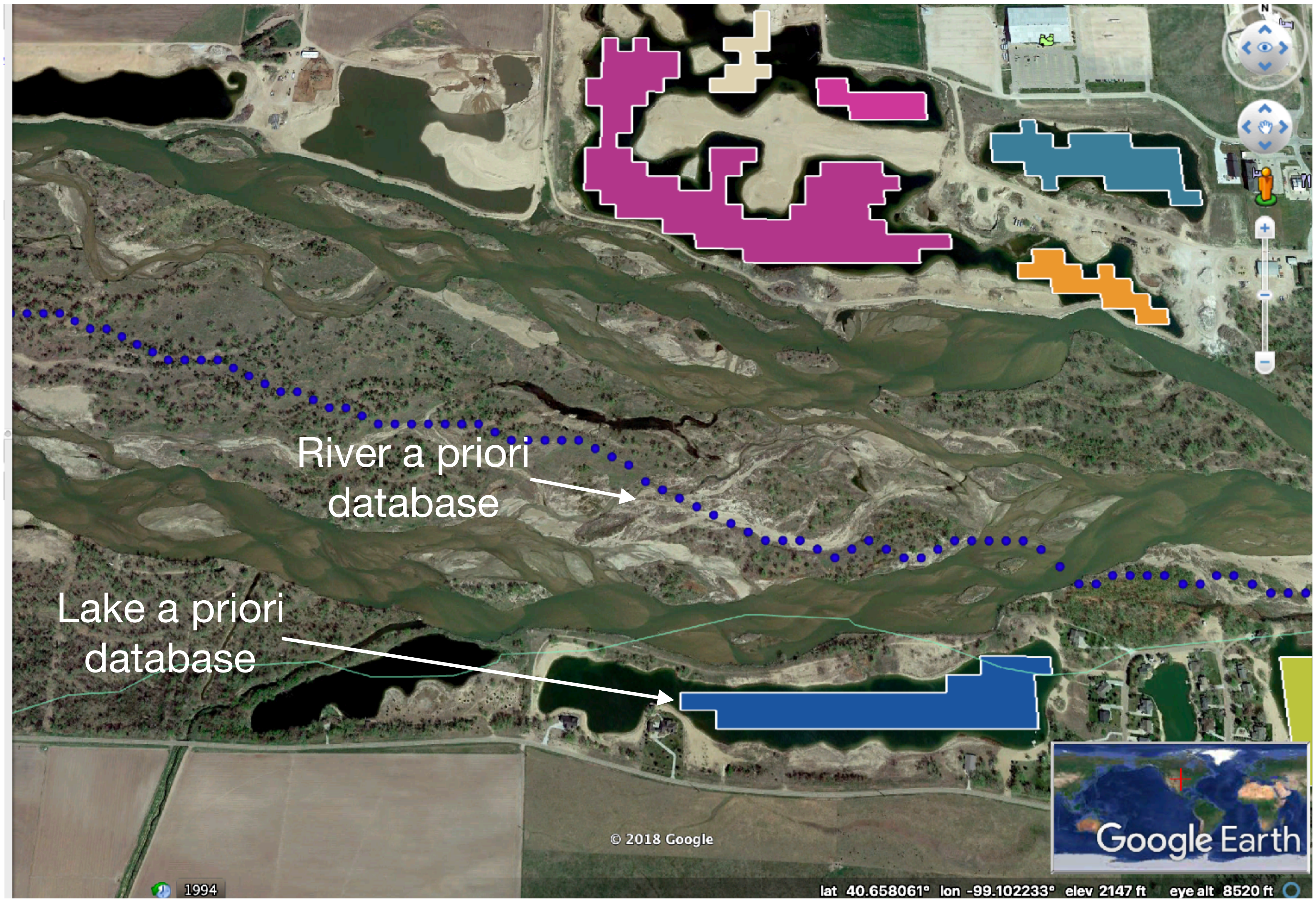
- The algorithm uses 1) proximity of pixels to river centerline, and 2) contiguity of pixels to perform mapping.

- Where assumptions are violated, there will be issues. The following slides are a tour of known issues we have explored

Interface Between Rivers and Lakes

- This is the issue is currently our top priority
- Efforts are ongoing at JPL to diagnose the extent of the problems, and to improve pixel assignment
- This is discussed in detail during the afternoon lakes session

Multi-channel rivers where channels are far from the river centerline

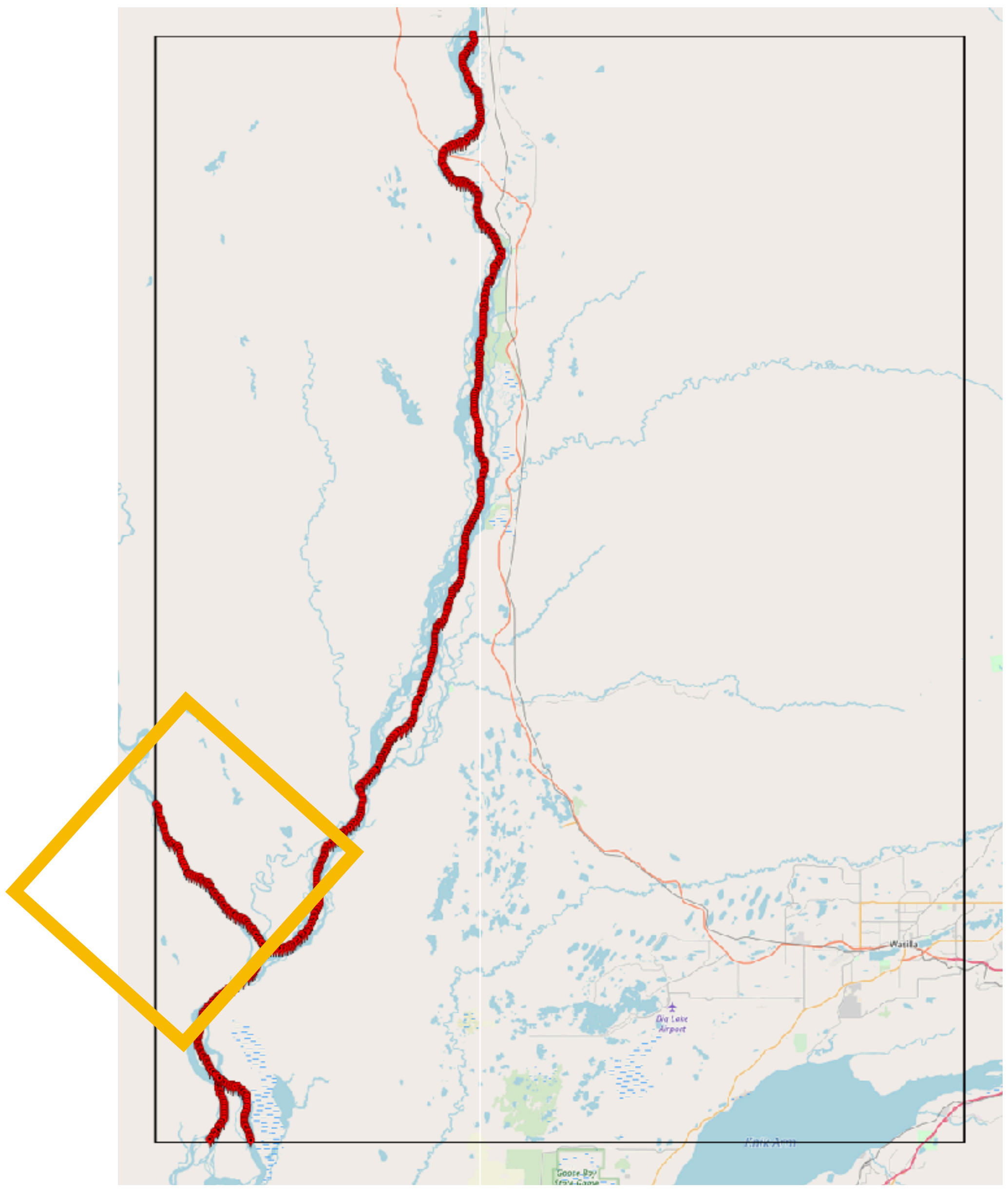


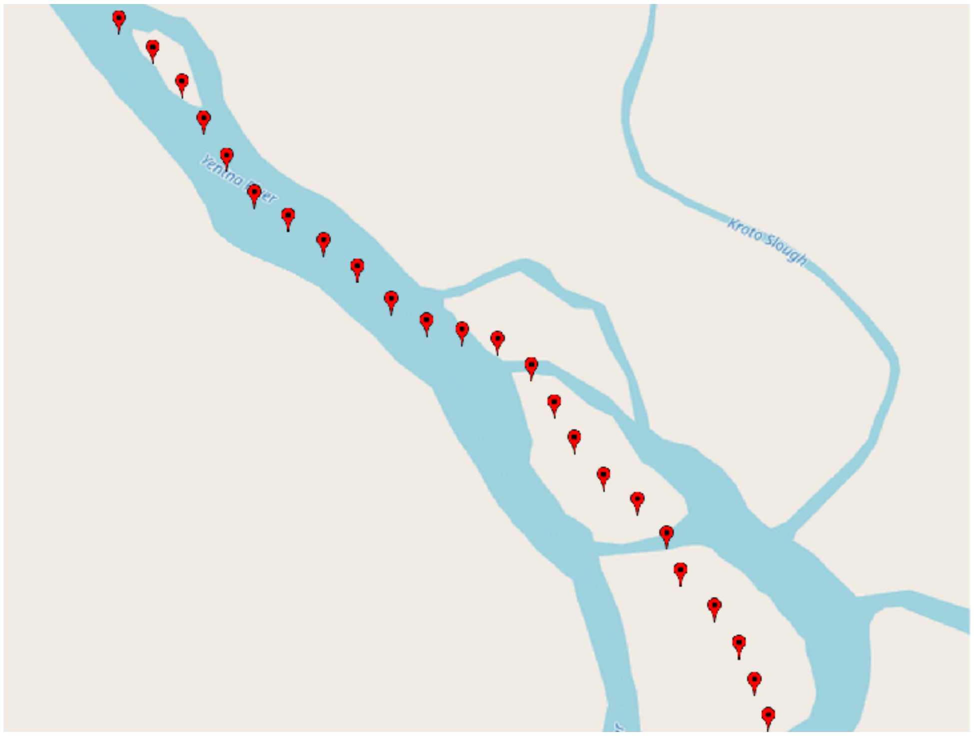
Platte River. GRWL measured 150-200 m width. Distance to either channel complex is 300 m.

Worst case, RiverObs does not pull any river pixels. Only happens if 1) entire river is not contiguous at tile level; or 2) centerline does not come within “max distance” of any pixels at reach scale.

Unclear how to fix. Goal - assess extent of problem (limited?). Currently backburner.

Tributaries not in a priori database connected to main stem



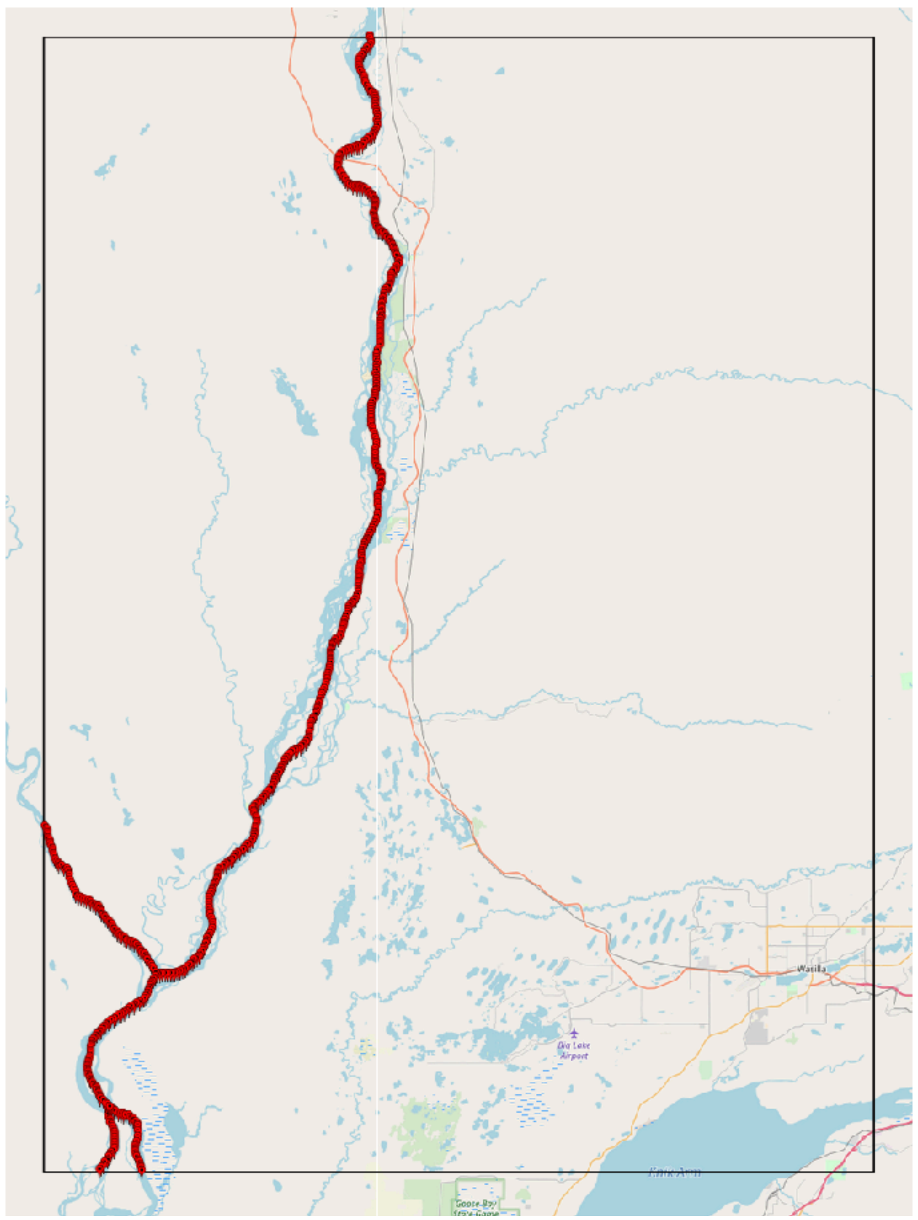


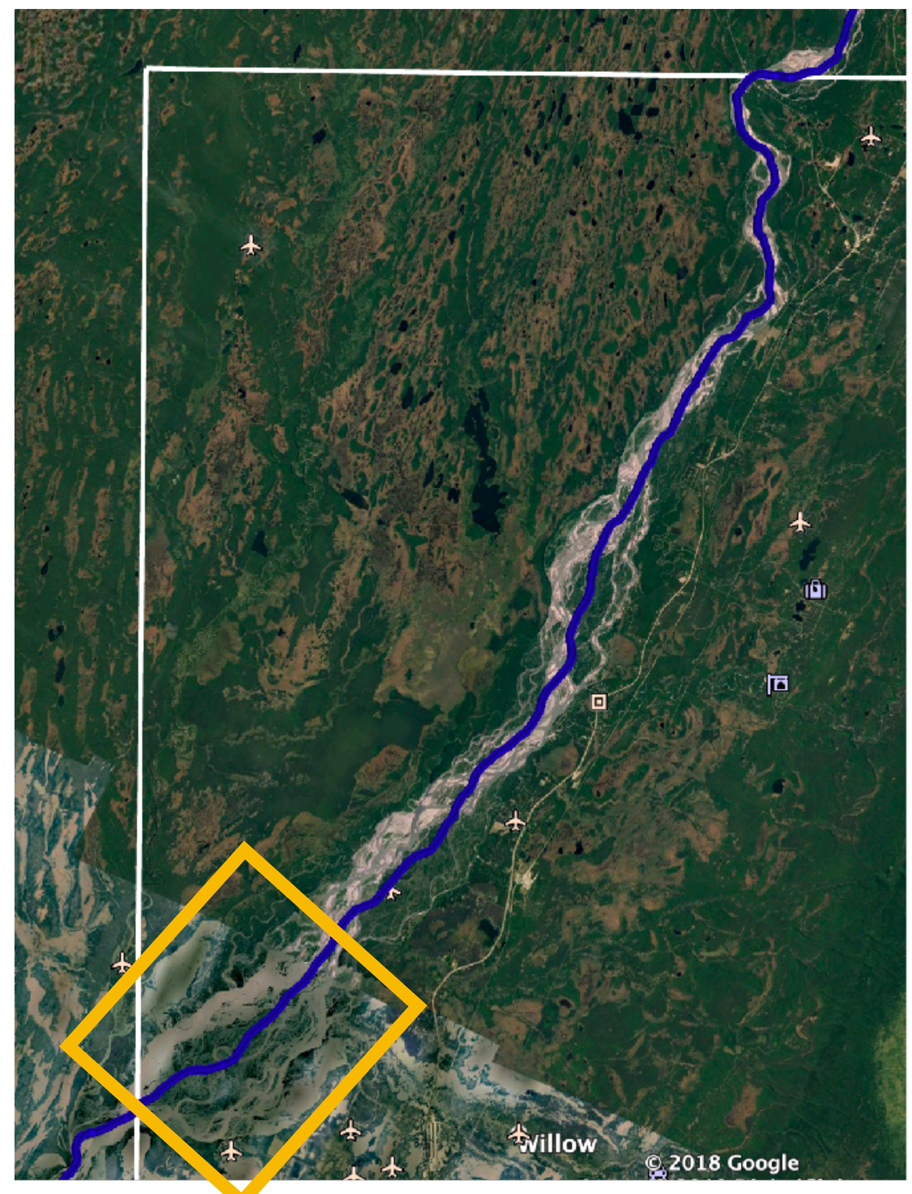
Yentna River, Alaska. (Lake database is not plotted here)

The Kroto slough is about 70 m wide. If it's contiguous, its pixels will be added to main stem nodes.

Ubiquitous. Significant issue. Backburner for now; plan is to fix during mission by adding tribs using SWOT data.

Lakes connected to rivers via measurable channels

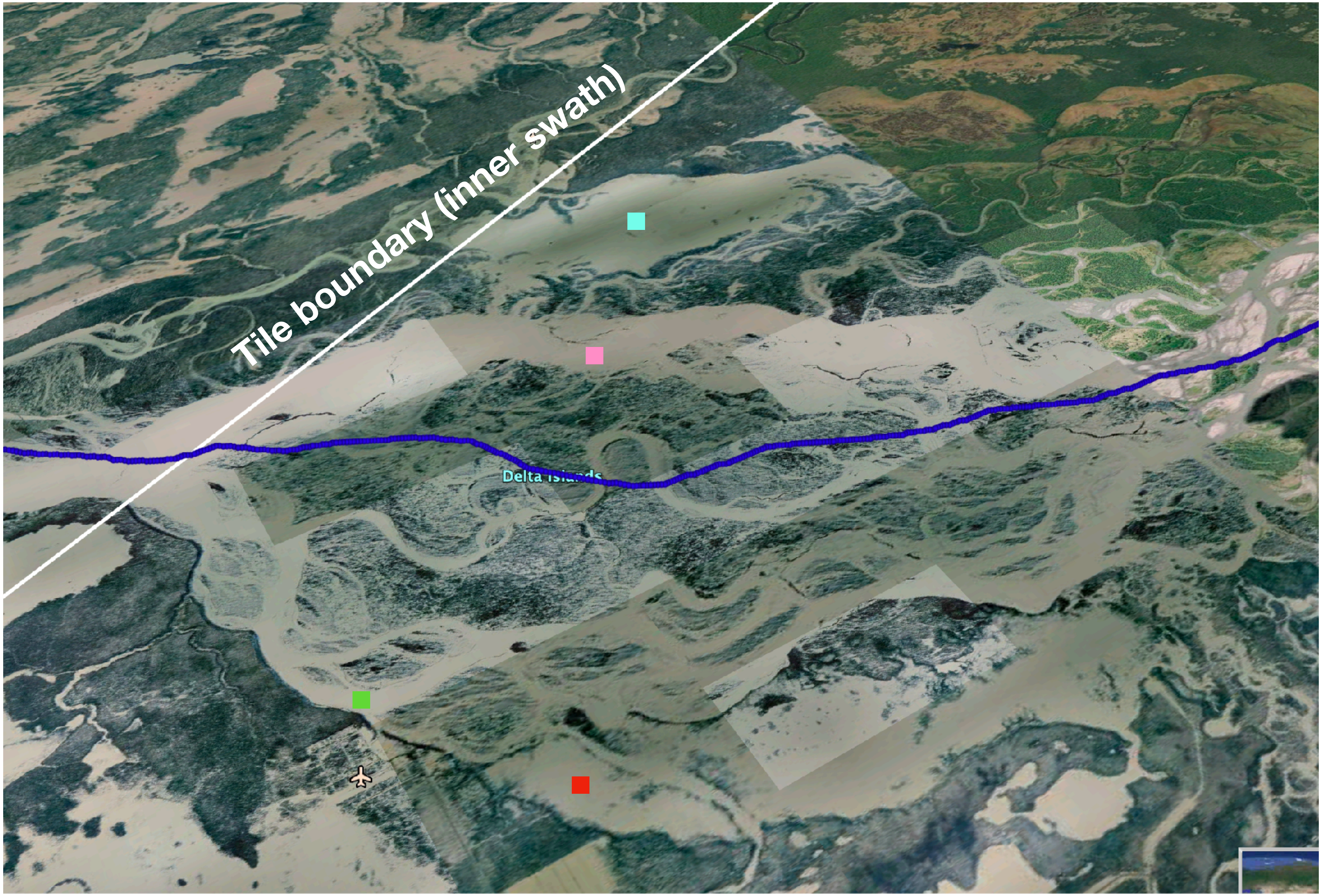




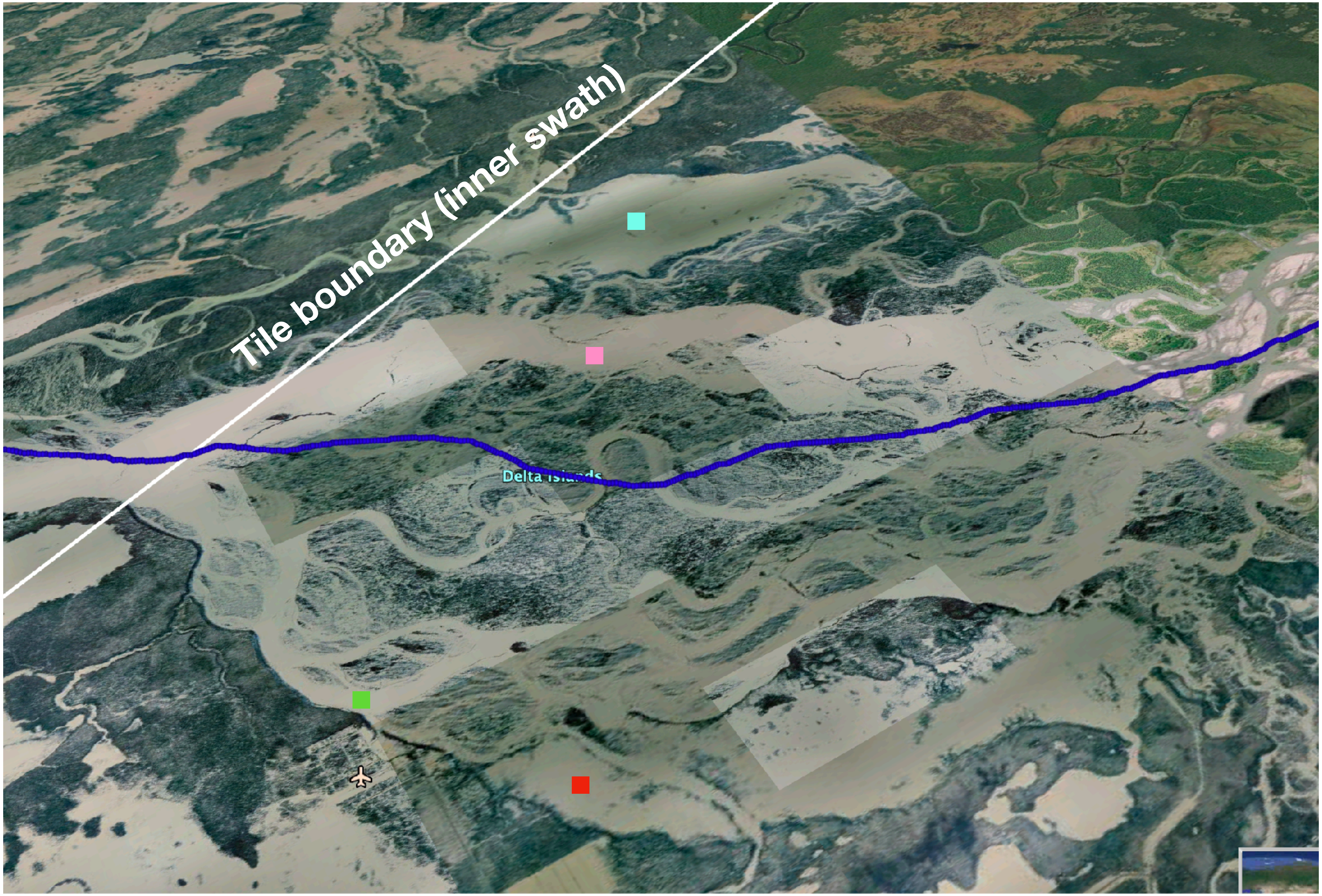
Susitna River, Alaska. Lidar scene ID=316. No lake database plotted here

Arbitrary tile boundary shown for pass 470 (white)

Focus (next slide) on one reach in orange box

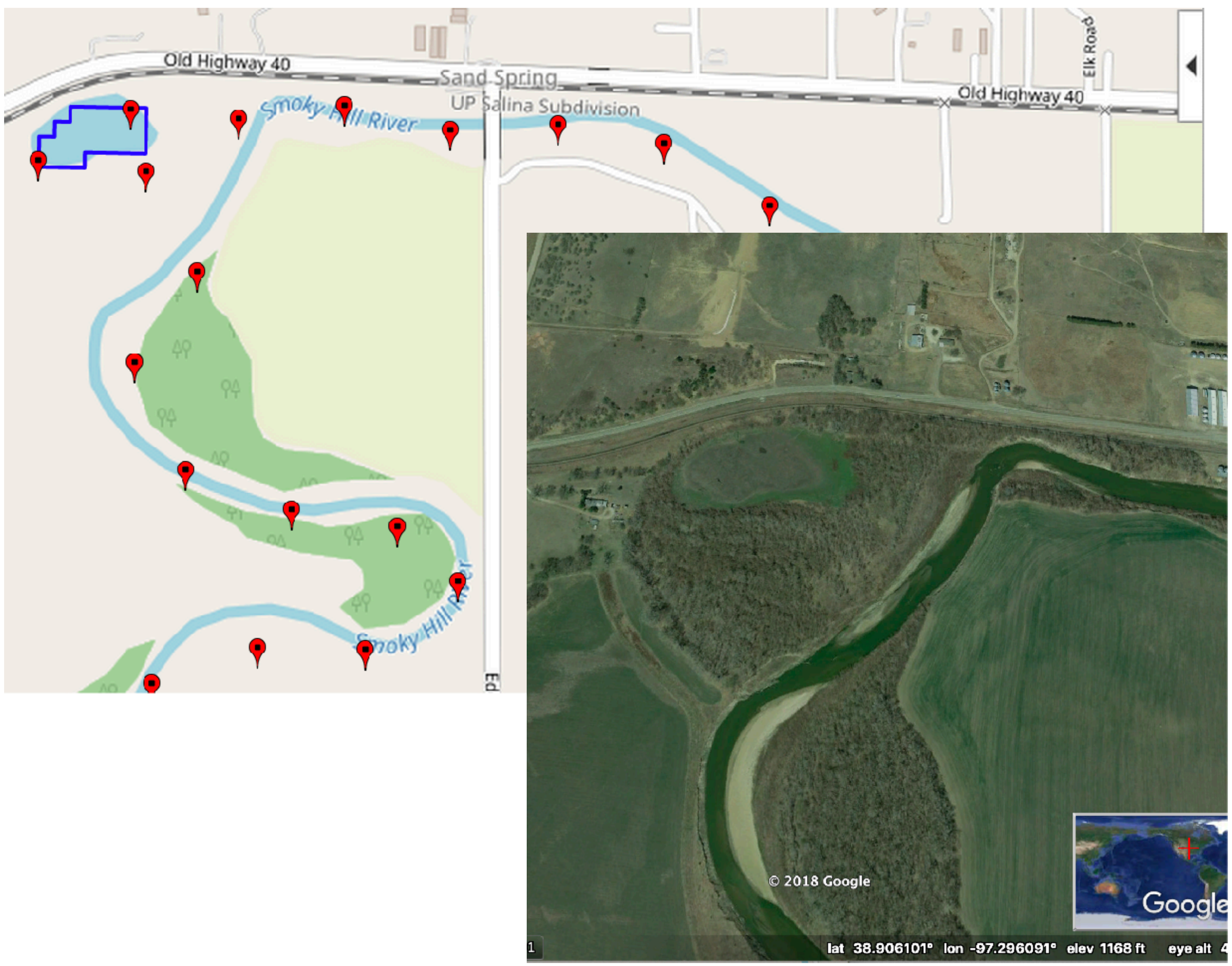


This is ~10 km (one reach). GRWL widths here are ~900 m. Pink, green squares: ~2 & 3 km from centerline, respectively. Pixels along the small channel (140 m wide) meet “max width” criterion, and are also contiguous with main channel, green and pink squares. Channels connecting lakes containing cyan &red squares to river are ~150 m wide, so will be included.



Philosophy: rather have all pixels attached than a kluge solution.
Assumption: users of global products would like to have pixels attached to clearly see high inundation in widths, etc. Will have impact on discharge product of course.
Goal assess extent of problem. Currently on backburner.

River course has changed and a priori centerline is inaccurate

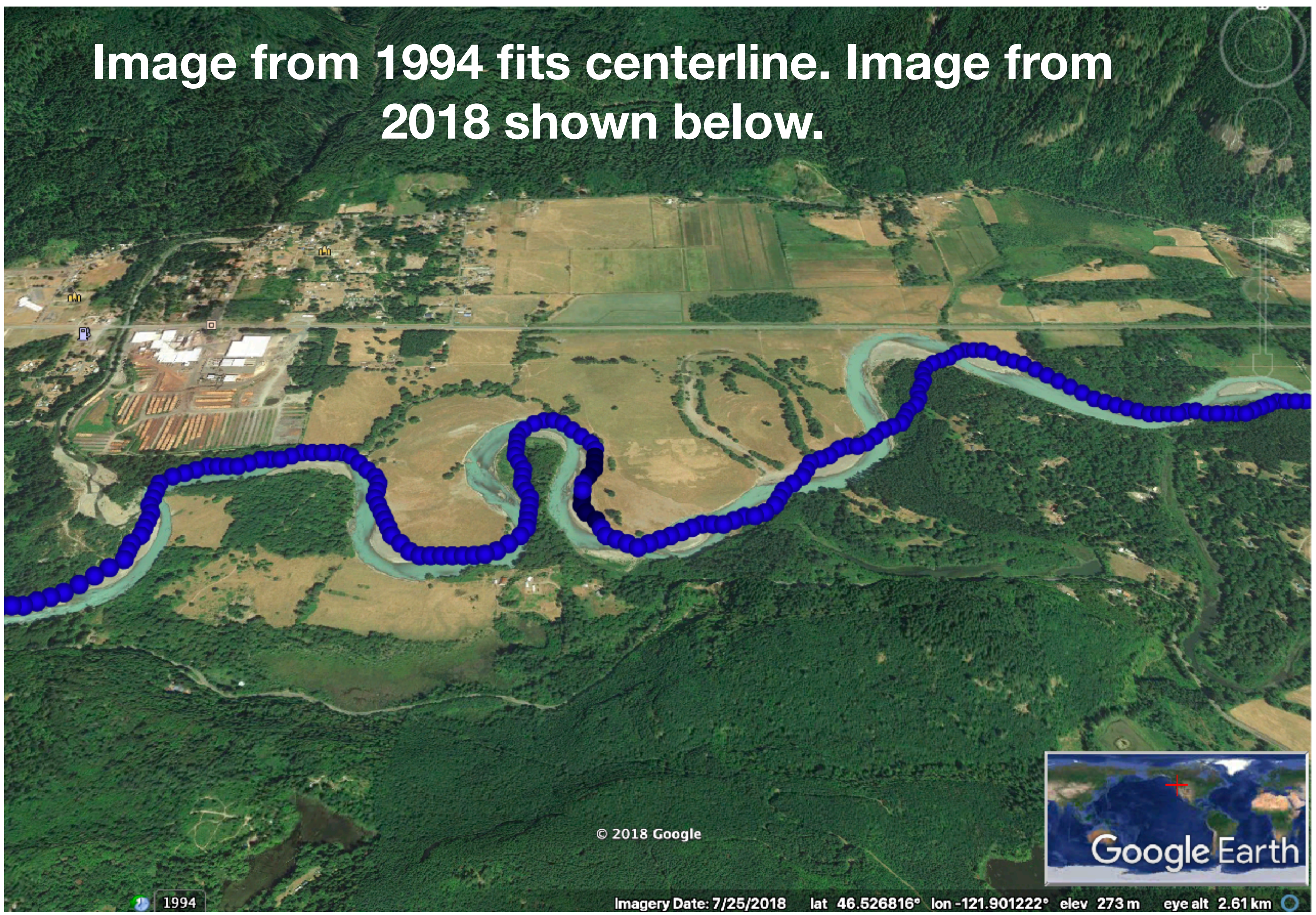


On the Smoky Hill River, Kansas, the GRWL centerline (red markers ~nodes) is from the 1990s. A small lake has since been formed where the river used to flow.

Pixels from the lake will likely be mapped onto the river, and will likely introduce height errors. No lake pixels will remain.

Occurs rarely, significant problems. Fix is manual changes to the a priori database? Not trivial to identify globally.

River course has changed and a priori centerline is inaccurate



On the Cowlitz River, Washington (lidar scene 730) this has happened as well.

Widths through here are around 75 m. This is about 4 km of river flow distance.

As long as river pixels are contiguous, there is no problem here, because the dominant segment is going to be the river. Could possible get thrown by this in context with a large lake, however.

Will be handled by updating centerline with SWOT data.

Philosophy: Summary & Discussion

- In complex river environments, users should work with the raster data product, or (perhaps) the pixel cloud point data for expert users

- Basically, when pixels are contiguous with the river system they will be attached to the river vector data products. This has the advantage that for global studies looking at inundated area, we will avoid low bias. It will lead to awkward products in some local environments

- We are working to characterize extent of these problems, as we are able.

- Fixes will be undertaken as possible, weighing how often these problems occur, how bad they are, and how easy a fix is