River Validation
Field data collection and processing

Colin J Gleason
on behalf of US and French river validation teams
(>50 people!)

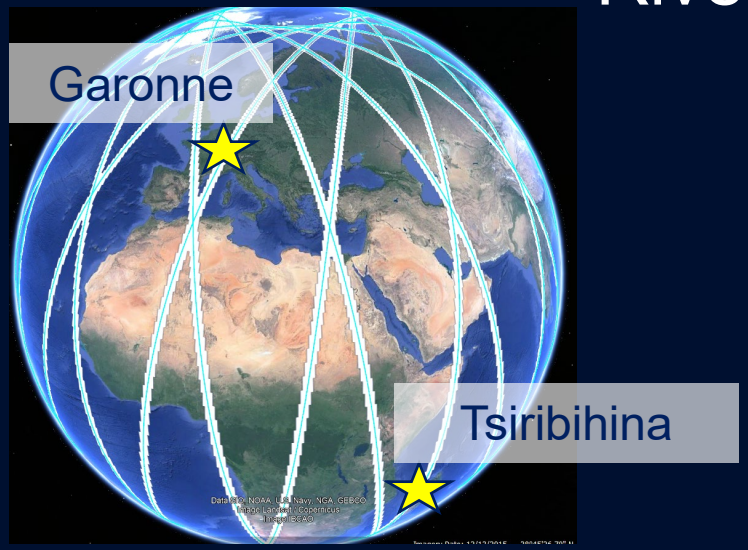
Outline

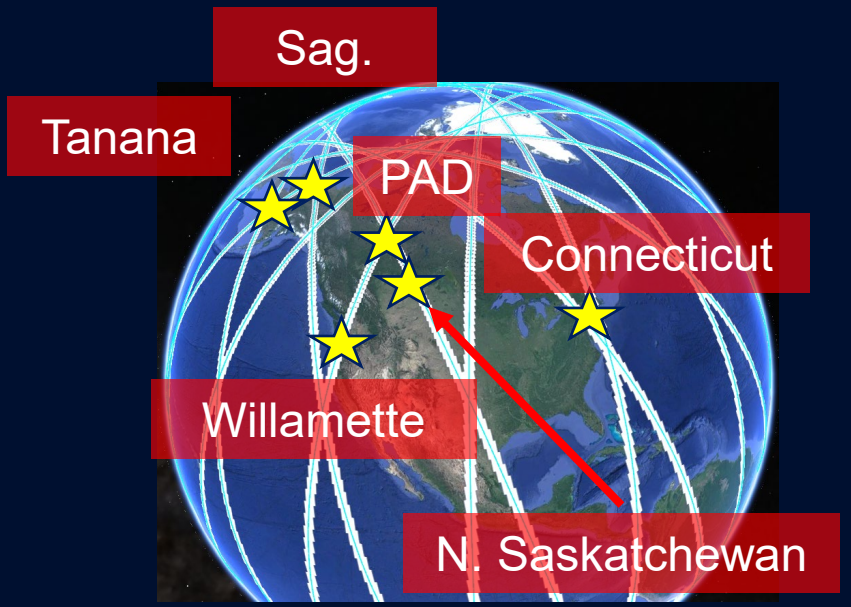
- River selection/characteristics
- Field data collection and processing
- 'Tier 3' validation
- Critical assessment

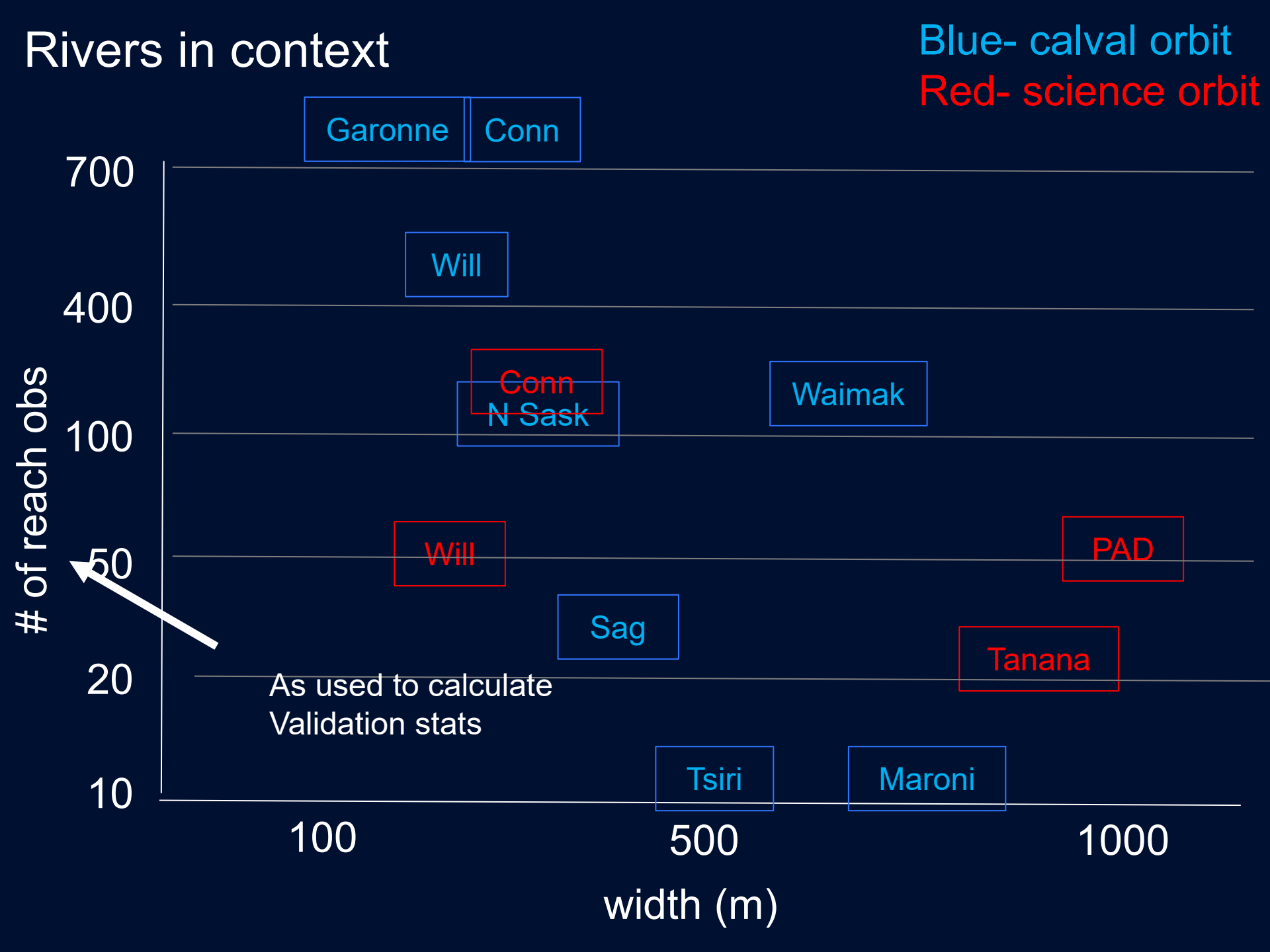
River selection process

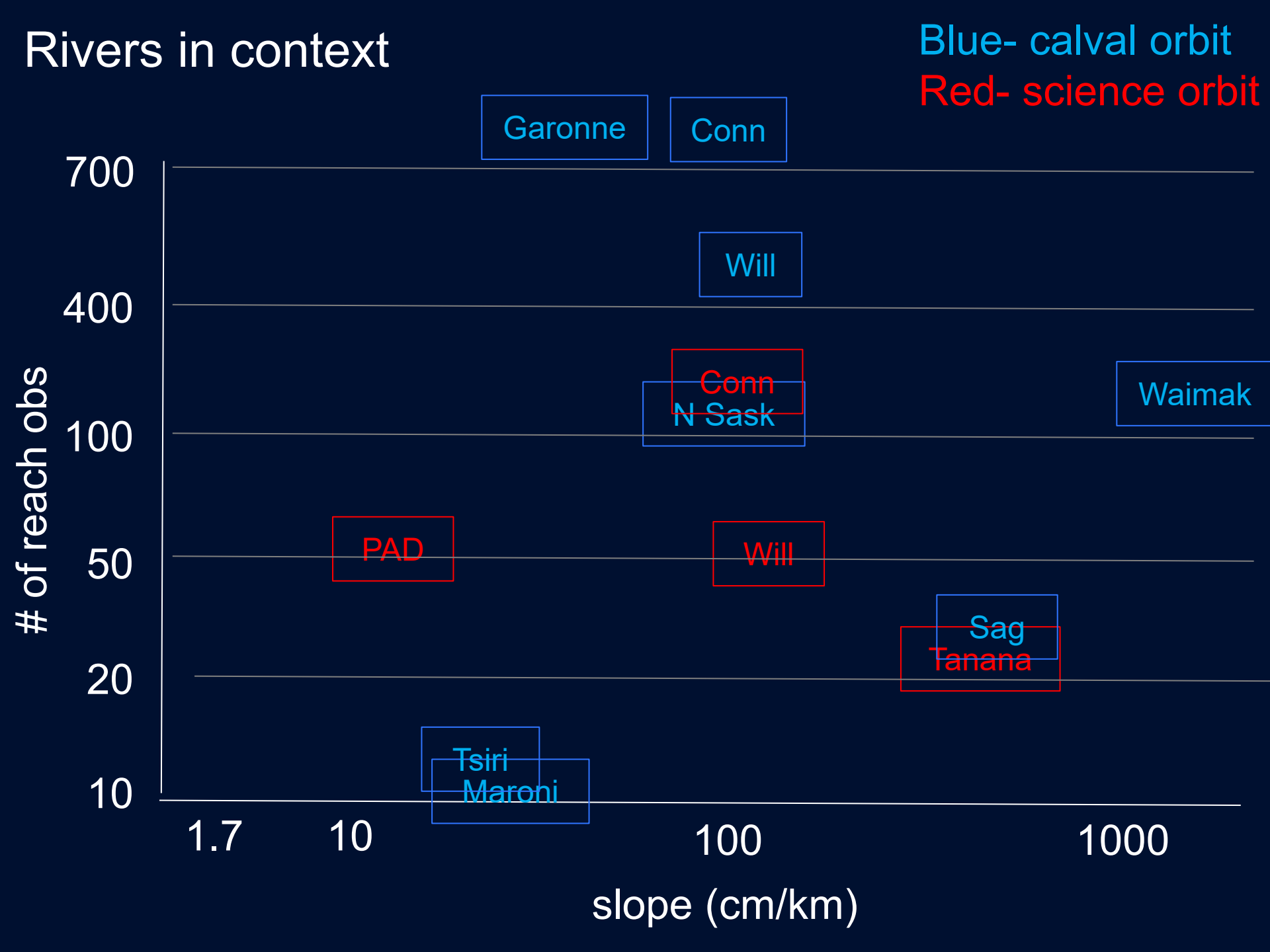
- Support troubleshooting engineering and science validation
- 'Walk before we run'
- Cover a range of hydraulically interesting features
- Unequal distribution of measurements

Rivers used for formal validation






Rivers in context
Blue- calval orbit
Red- science orbit
Garonne
Conn
Will
Conn
N Sask
Waimak
Will
PAD
Sag
Tanana
Tsiri
Maroni
700
400
100
50
20
10
# of reach obs
As used to calculate
Validation stats
100
500
1000
width (m)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Tsiri
Maroni
700
400
100
50
20
10
# of reach obs
1.7
10
100
1000
slope (cm/km)

Rivers in context

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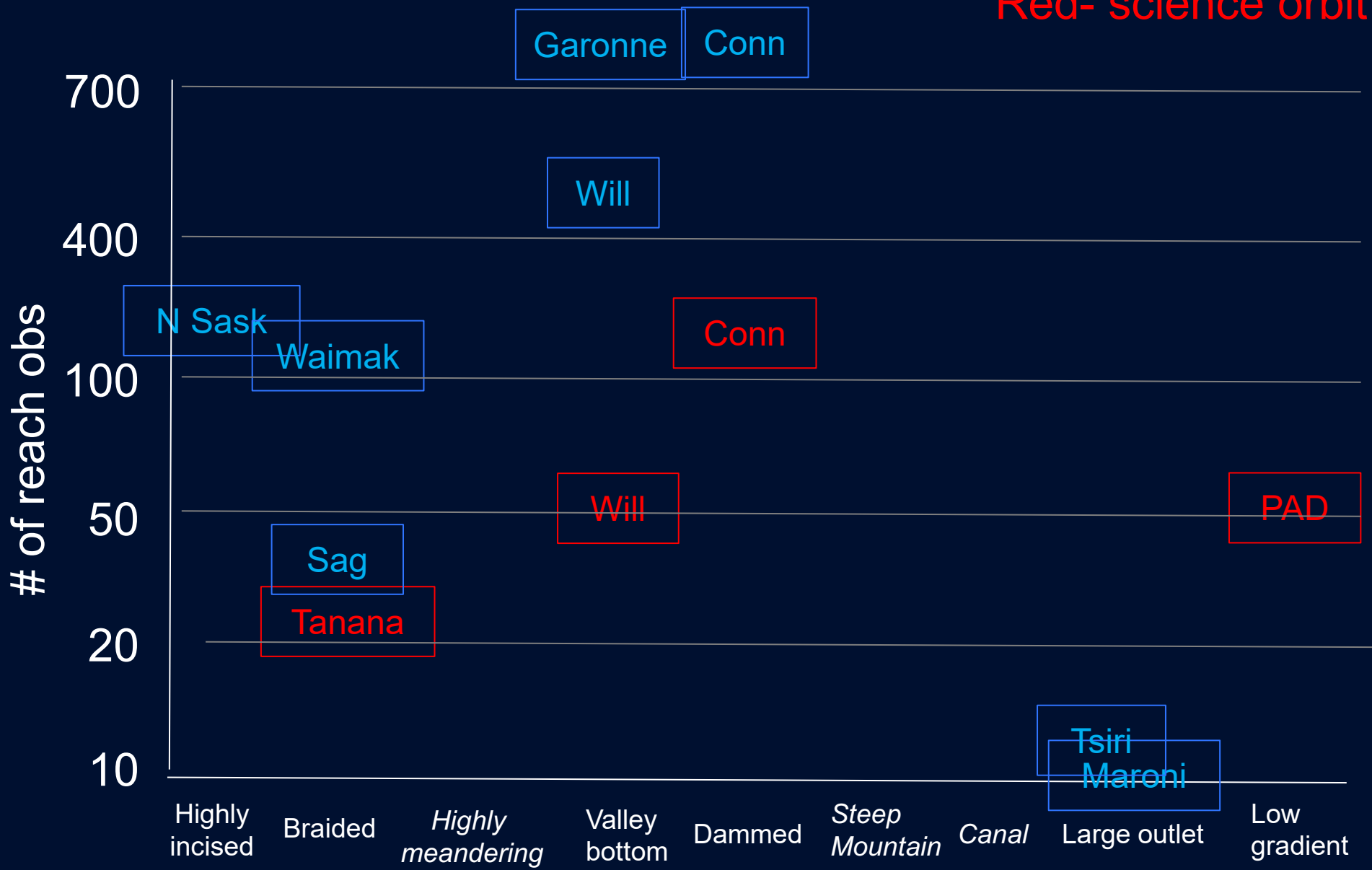
Red- science orbit



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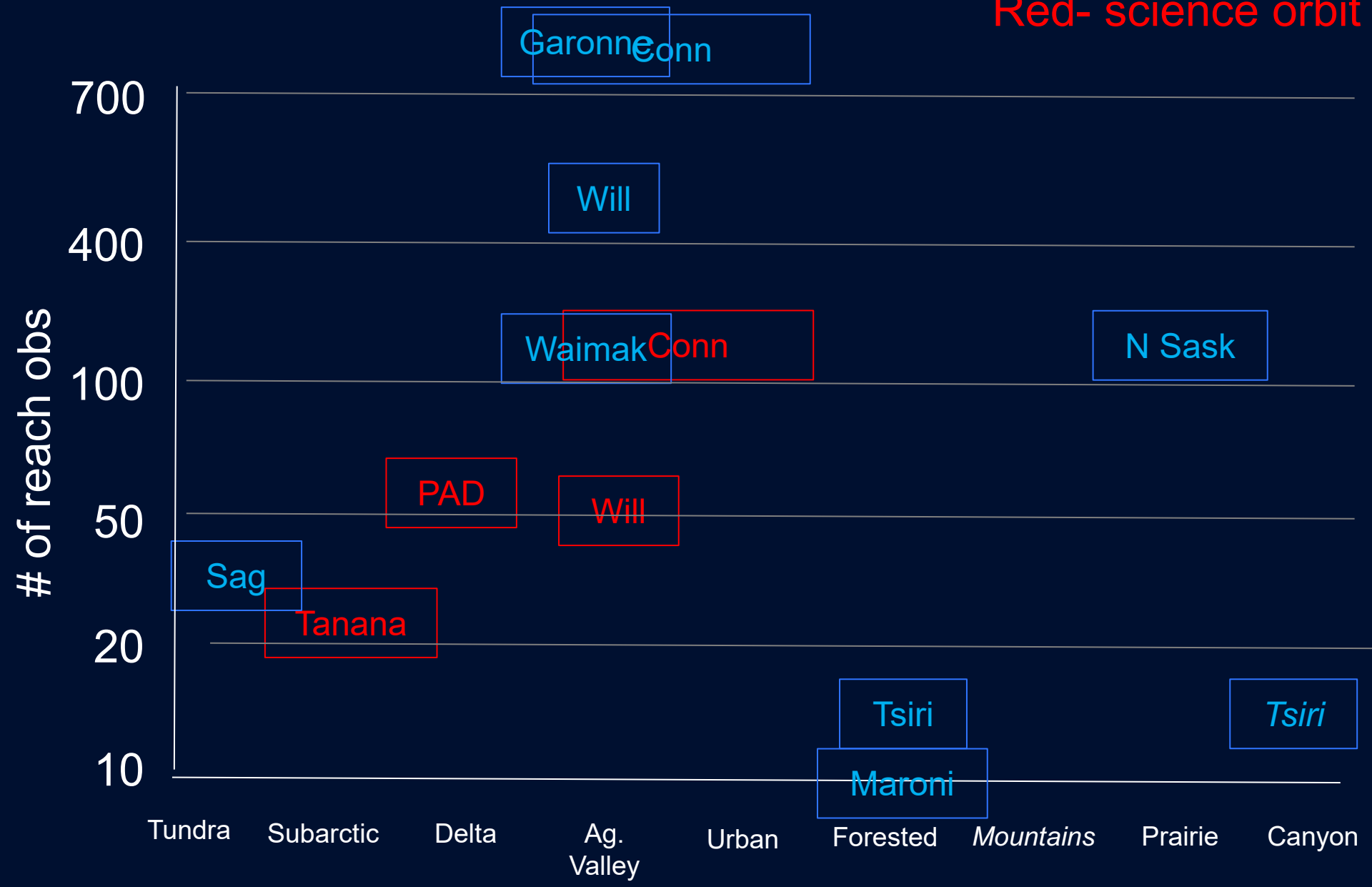

River calval processing chain

Processing
Field water level -> WSE
Flagging
QA/QC

Create SWORD Products
Reach WSE
Reach slope
Node WSE
Node Slope
Reach area

Developmental validation
Identify gross errors in SWOT
Identify gross errors in field data
Define conventions
Validate 'upstream' SWOT data
Kickoff SWOT algo changes

Validation
Assess SWOT performance

Collect field data

GNSS processing
Geoids
Ellipsoids
Other effects

How did we measure?

Aerial data
- Imagery
- Lidar
- High res. satellites

Humans
- Work hard
- Strict data entry control
- Professionally trained and certified: safety, wilderness medicine, science, boating

GNSS
- Measures elevations as SWOT does
- Geoid, ellipsoid, pole tide, solid earth tide
- Records every 1s
- Can take >1hr to traverse a reach
- 'drifts'

Static water level sensing
- Records at points
- Pressure transducers
- Microstations
- High temporal sampling
- Poor spatial sampling

Mobile water level sensing
- Move through the reach
- Good spatial coverage
- Poor temporal coverage

Stationary water level sensing

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Mobile water level sensing

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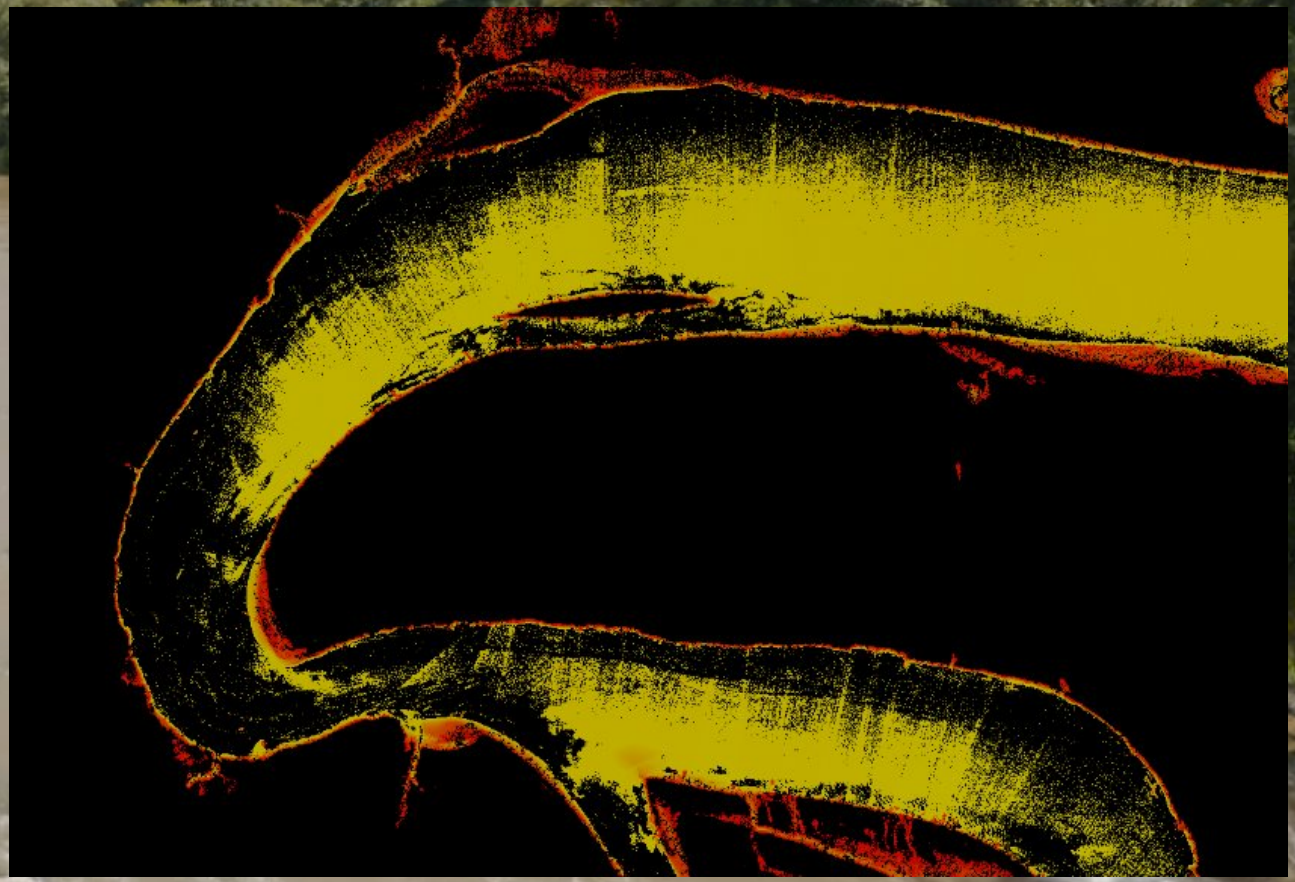
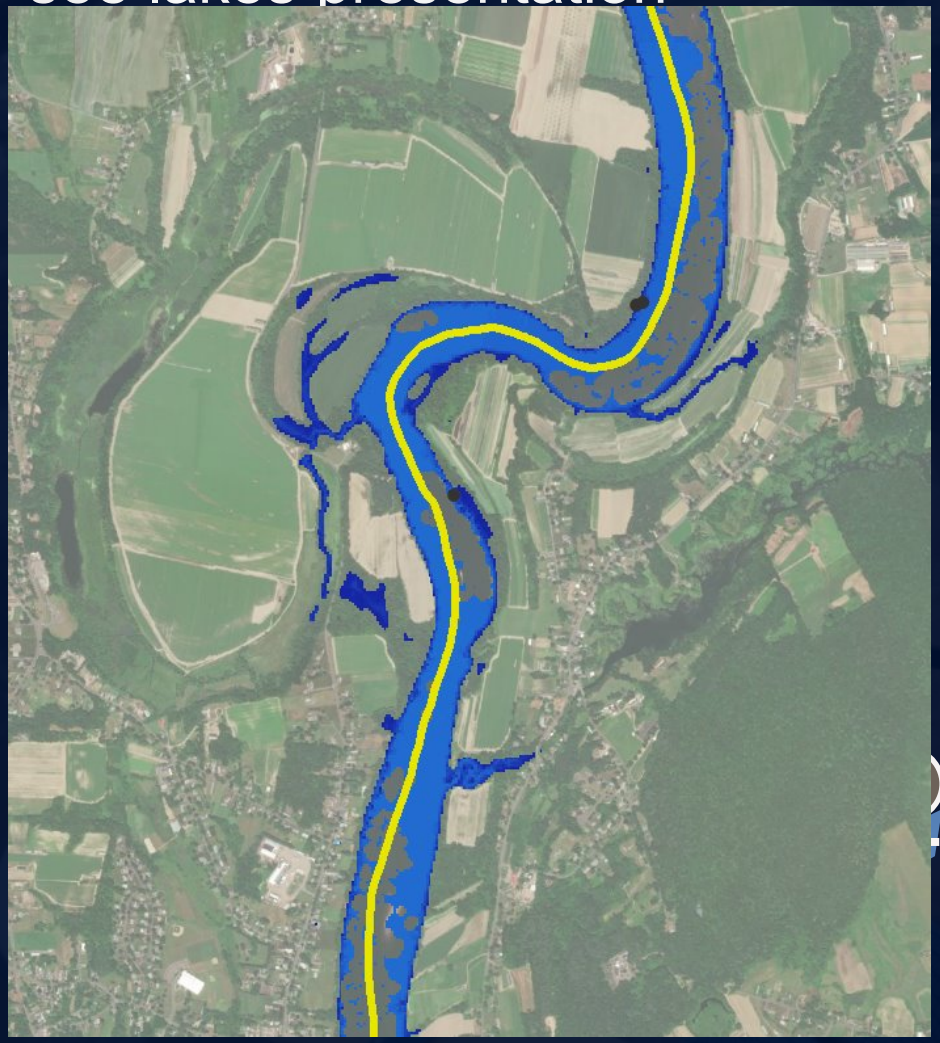


Surface area sensing

French

Not a focus for rivers- see lakes presentation



US

- Commissioned aerial photography
  - Flown coincident to SWOT within ~1hr
  - 'river following' coverage
  - Validates area
- Commissioned aerial lidar
  - When collected, collected coincident with airphotos
  - Much lidar coverage in NZ
  - Other lidar coverage limited
  - Validates area
  - Validates height

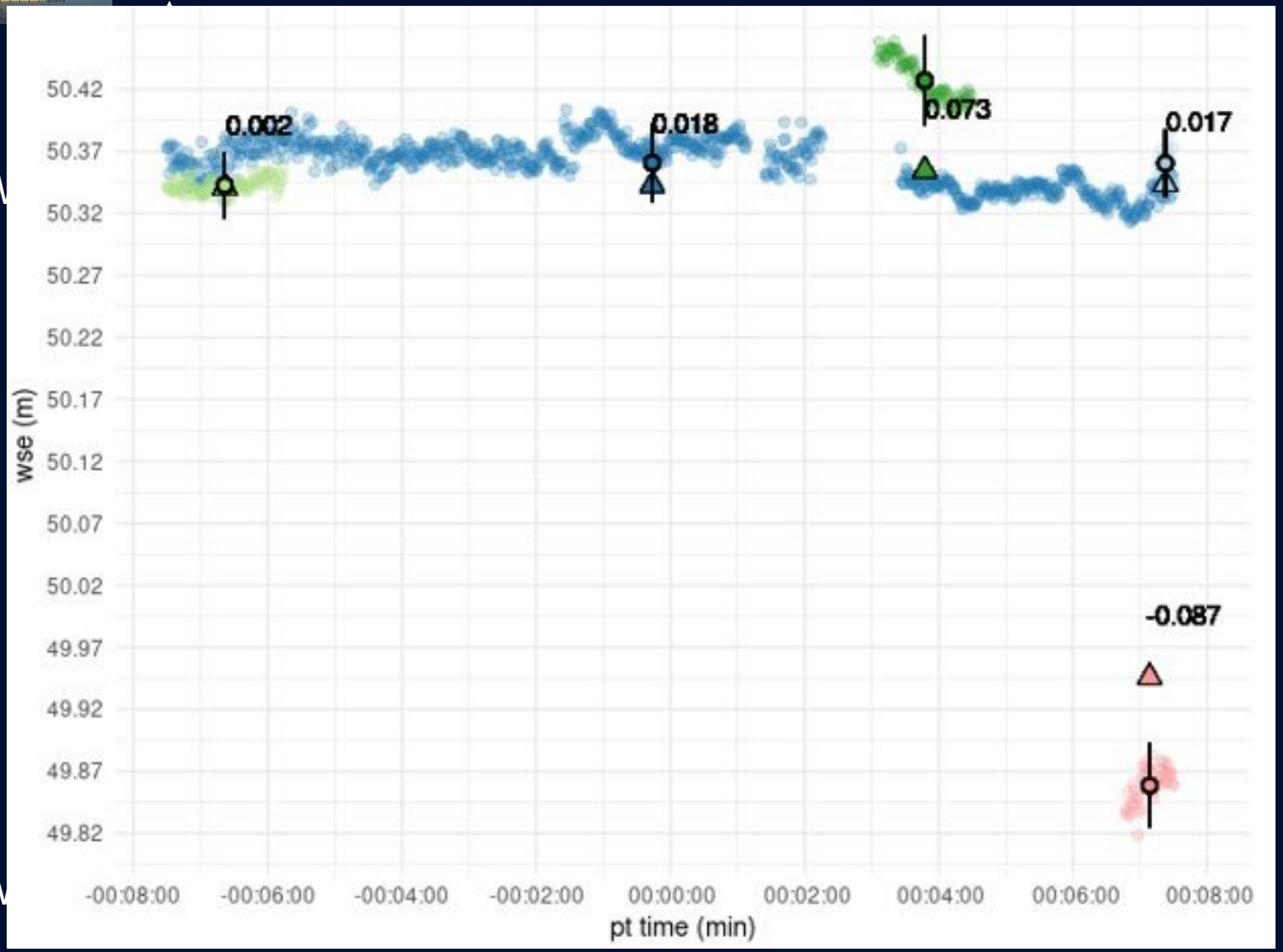
GNSS processing

US and France

- PPP post processing
- Resolve ellipsoid, geoid, earth tides, atmospheric interference
  - Gives 'WSE' as SWOT does
- Filtered to <5cm uncertainty in the vertical
  - Affected strongly by bridges/powerlines
- Returns x,y, WSE with uncertainty

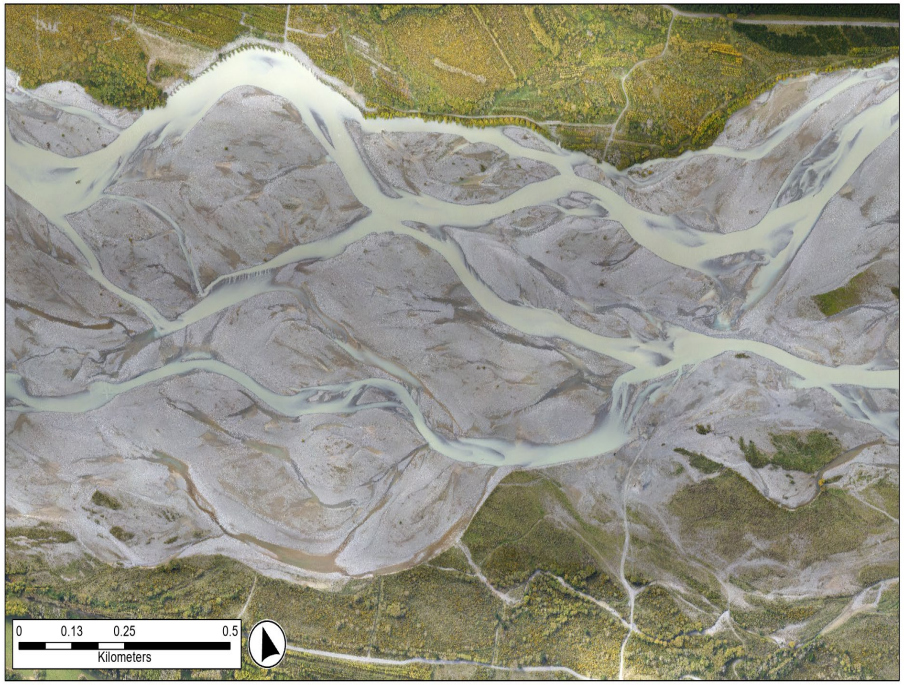
Data processing: WSE from water level

PT WSE(t) = PT Level(t) + Offset

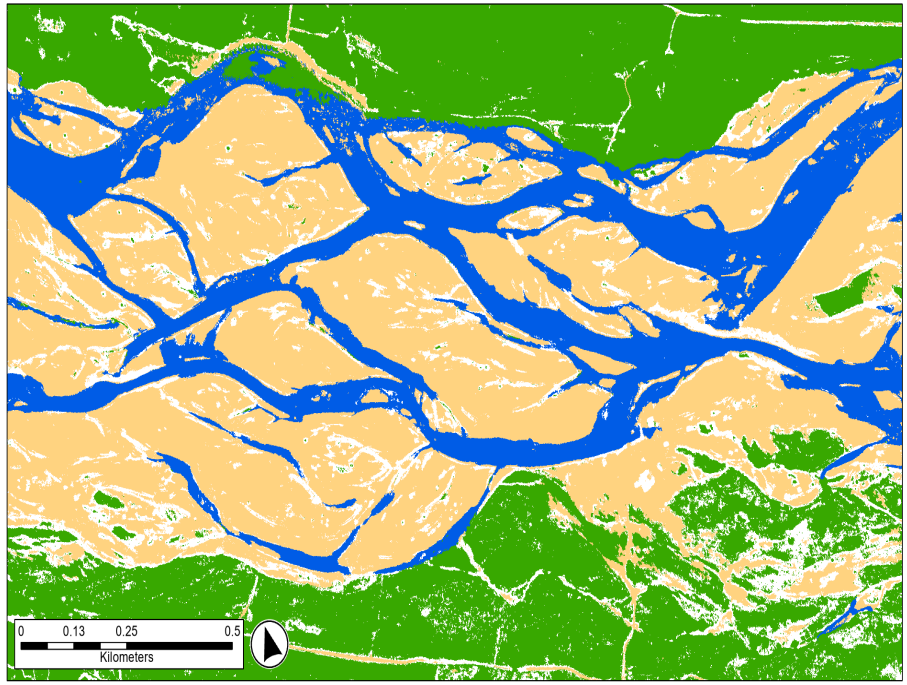


Data processing: area from aerial imagery

Aerial Imagery



Water classification



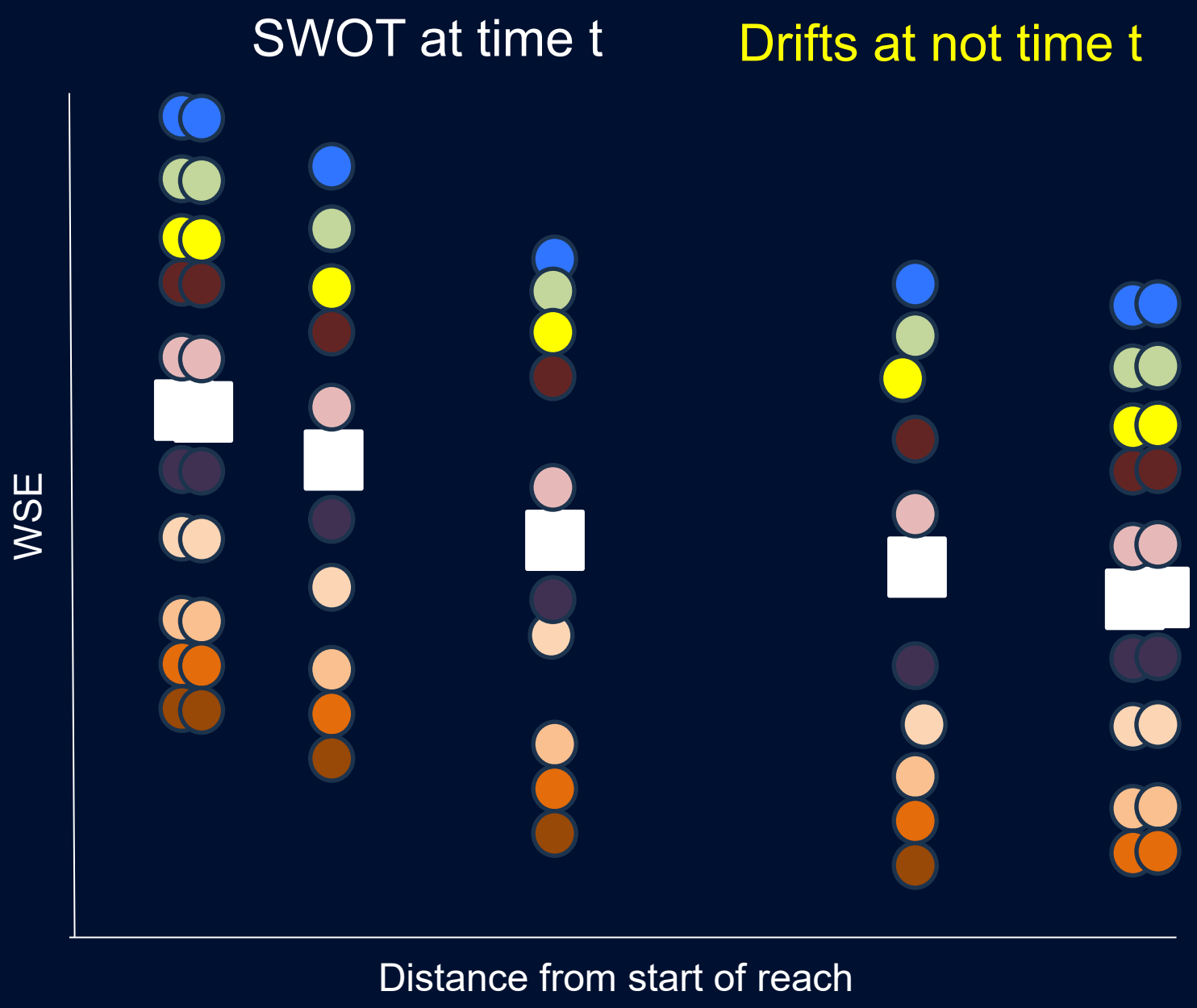
Courtesy of UNC and UC (NZ)

Matching field observations to SWOT times

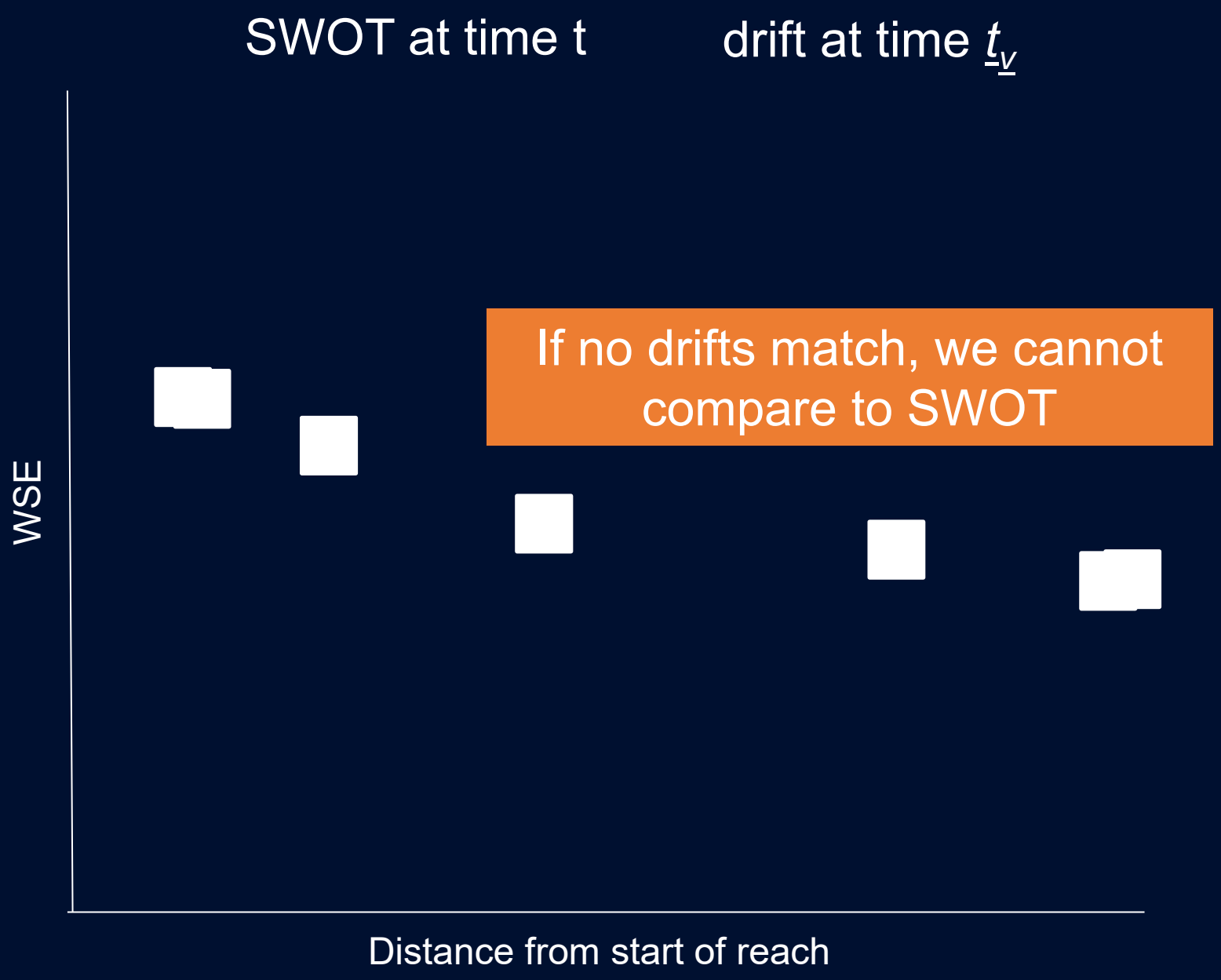
US

- PTs are always coincident (15min)
  - PT Slope therefore always 'direct'
  - PT reach averages always 'direct'
- 'drift matching'
  - Drifts can take >1hr to complete for a reach, and SWOT is ~instant
  - Rivers change their shape nonlinearly with changes in flow
  - Philosophy- we want to preserve the precision and accuracy of original measurements
  - Therefore, from a library of drifts, we select those that are most likely to represent the river profile at the time of SWOT, using PTs

Matching field observations to SWOT times



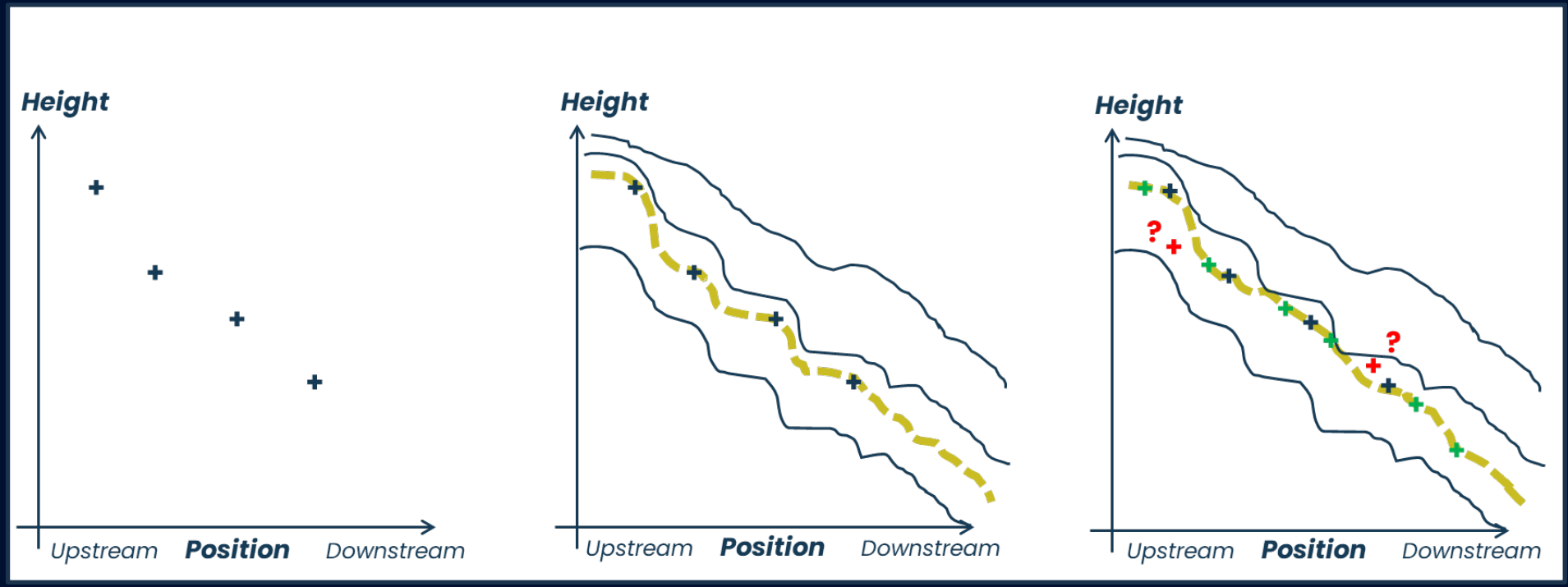
Matching field observations to SWOT times



Matching field observations to SWOT times

Garonne:

- 7 profile 'library' creates a basis for station interpolation
- Station data (hourly) are used to reconstruct a probable water level given celerity and the library
- Error increases with distance from stations



- No matching for Maroni/Tsiribihina

"Tier 1" summary

Mobile
Static
Aerial
GNSS makes field levels into WSE
Instruments, instrument placements are different
Spacetime averaging is different

"Tier 3" validation

- USGS operates thousands of n.r.t water level gauges
- *not* directly comparable with SWOT WSE
- Relative WSE *is* directly comparable

T3 algorithm:

1. calculate relative WSE for SWOT and gauge
2. Locate gauges on SWORD
3. Assign gauge to node
4. compare

Caveats and confidence

SWORD
- Reach length, distance from true centerline, apparent errors

Reach averaging
- SWOT is ~instantaneous, profiles take time
- PTs/stations are point based
  - >40 points needed for a non biased reach average
  - We have at most 7 points per reach
  - Absolute reach averaged field WSE and SWOT WSE not expected to converge
  - Relative field and SWOT WSE expected to agree

Caveats and confidence

Time matching to SWOT

- US method relies on having enough 'drifts in the library'
  - Benefit- no added error in profile
- French method for Garonne has increasing WSE error as function of distance from station
  - Benefit- 'best guess' for all SWOT obs
- Maroni/Tsiribihina method is not matched to SWOT

Slope

- Only US method designed to calculate field slope as SWOT does (PTs at reach ends, with redundancy)

Caveats and confidence

Coverage

- We've covered a spread of morphologies, slopes, and widths, but data are obviously limited
- Temporal coverage sufficient

Precision

- Stations/PTs measurement precise to <1cm
  - When deployed to measure slope, very precise
- GNSS measurement precise to <5cm
- Reach averaging added error varies by site and time
  - And by method

Bottom line

- We have thousands of field to SWOT comparisons
- Field measurements are well understood
- Field measurement precision + spacetime averaging error is sufficient to assess SWOT river performance
- Largest sources of field error:
  - Averaging to SWORD reach at SWOT time
  - Transit time differences
  - SWORD issues (affects field and SWOT)
- Field data much more precise at node scale