

Recent AirSWOT Results for Rivers

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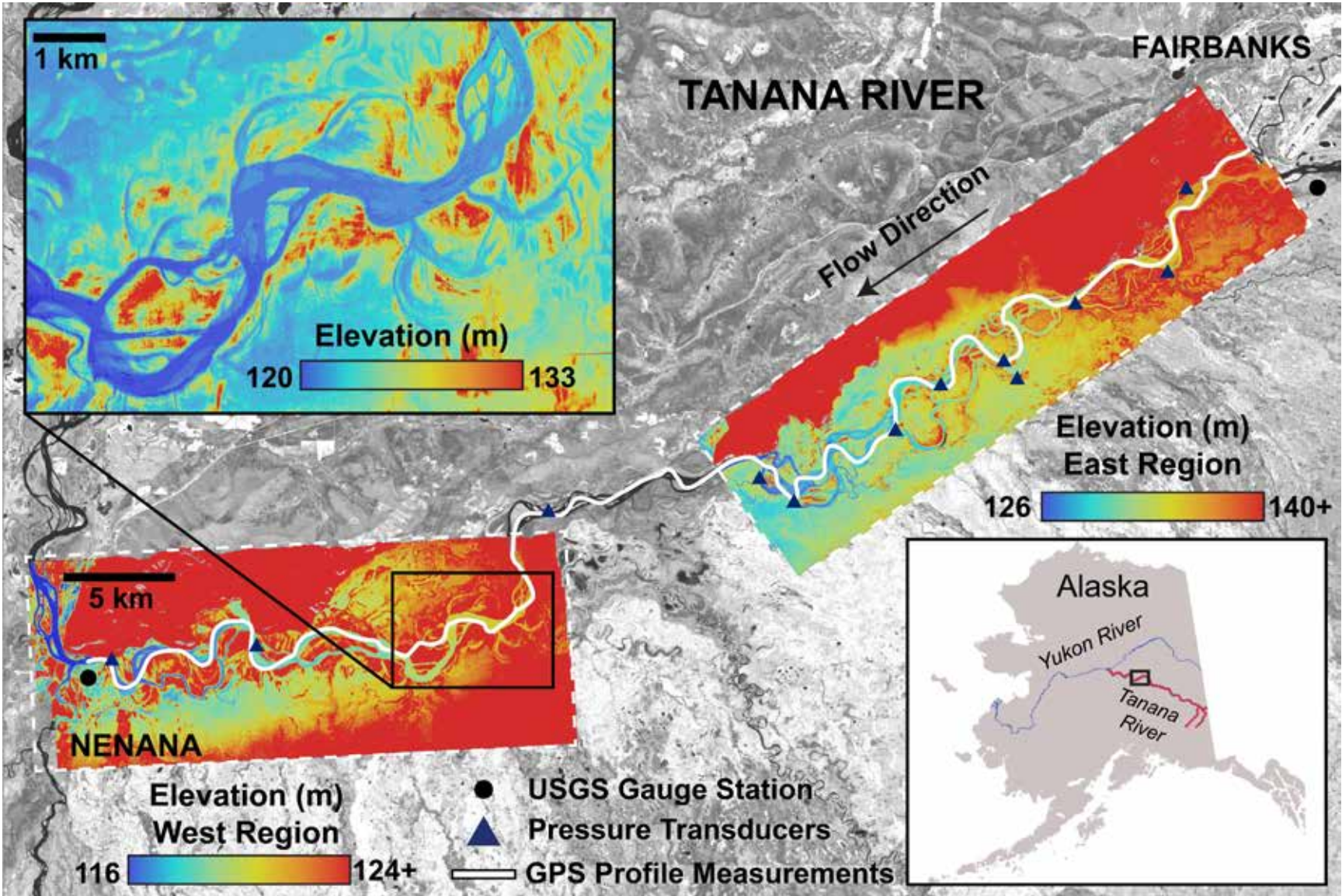
SWOT ST Meeting 2018

Montreal, Canada



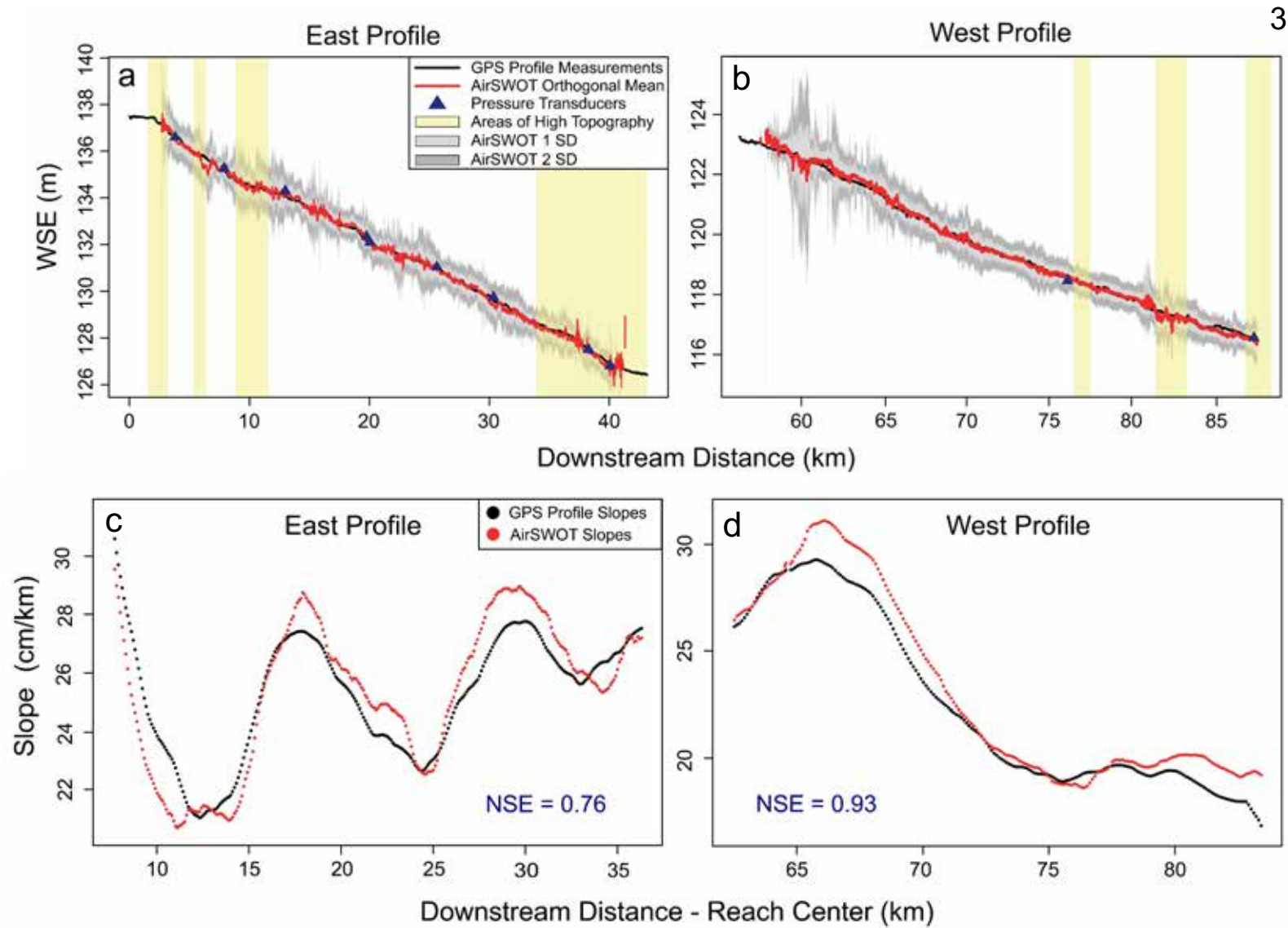
Outline

- ❖ Recap from last meeting
- ❖ More validation from 2015 AirSWOT campaigns:
 - Tanana River & Yukon River (June), Willamette River (March)
- ❖ Results beyond validation



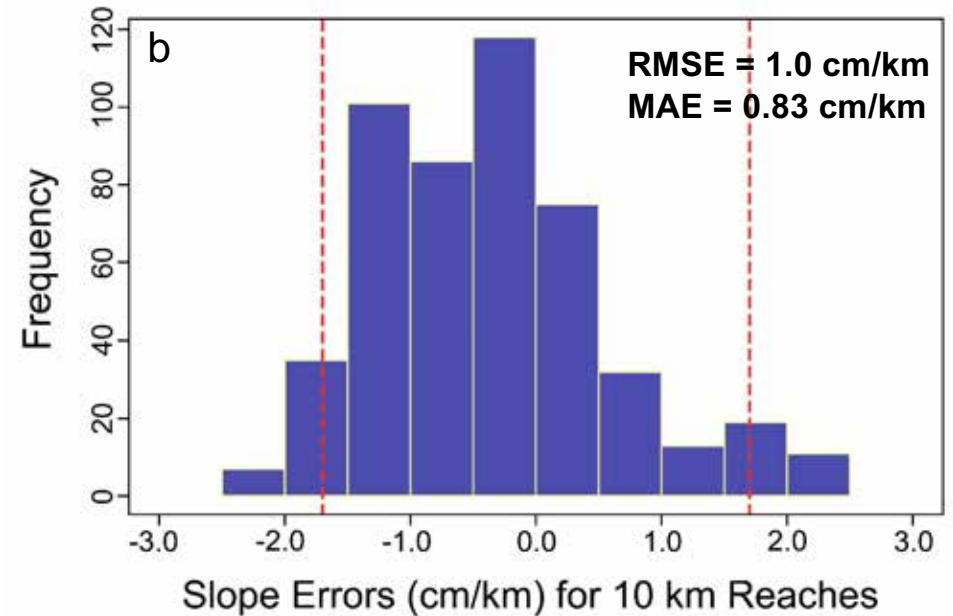
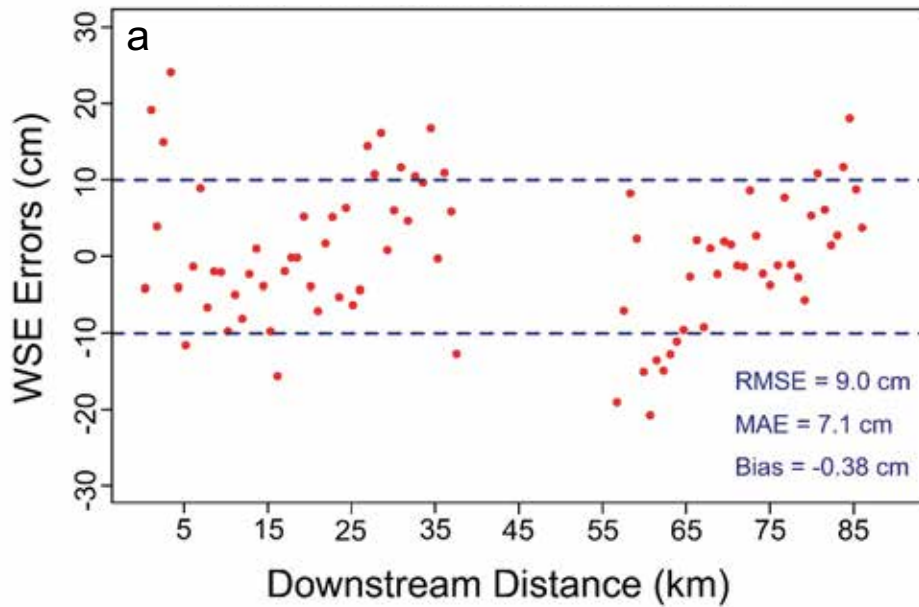
Tanana
06/09/15

WSE Profiles & Slopes



Altenau et al. (2017)

Tanana: WSE & Slope Errors



AirSWOT detects decimeter-level accuracies in WSEs and centimeter-level accuracies in slopes.

Initial results suggest AirSWOT is capable of producing SWOT-quality measurements of river WSEs and slopes.

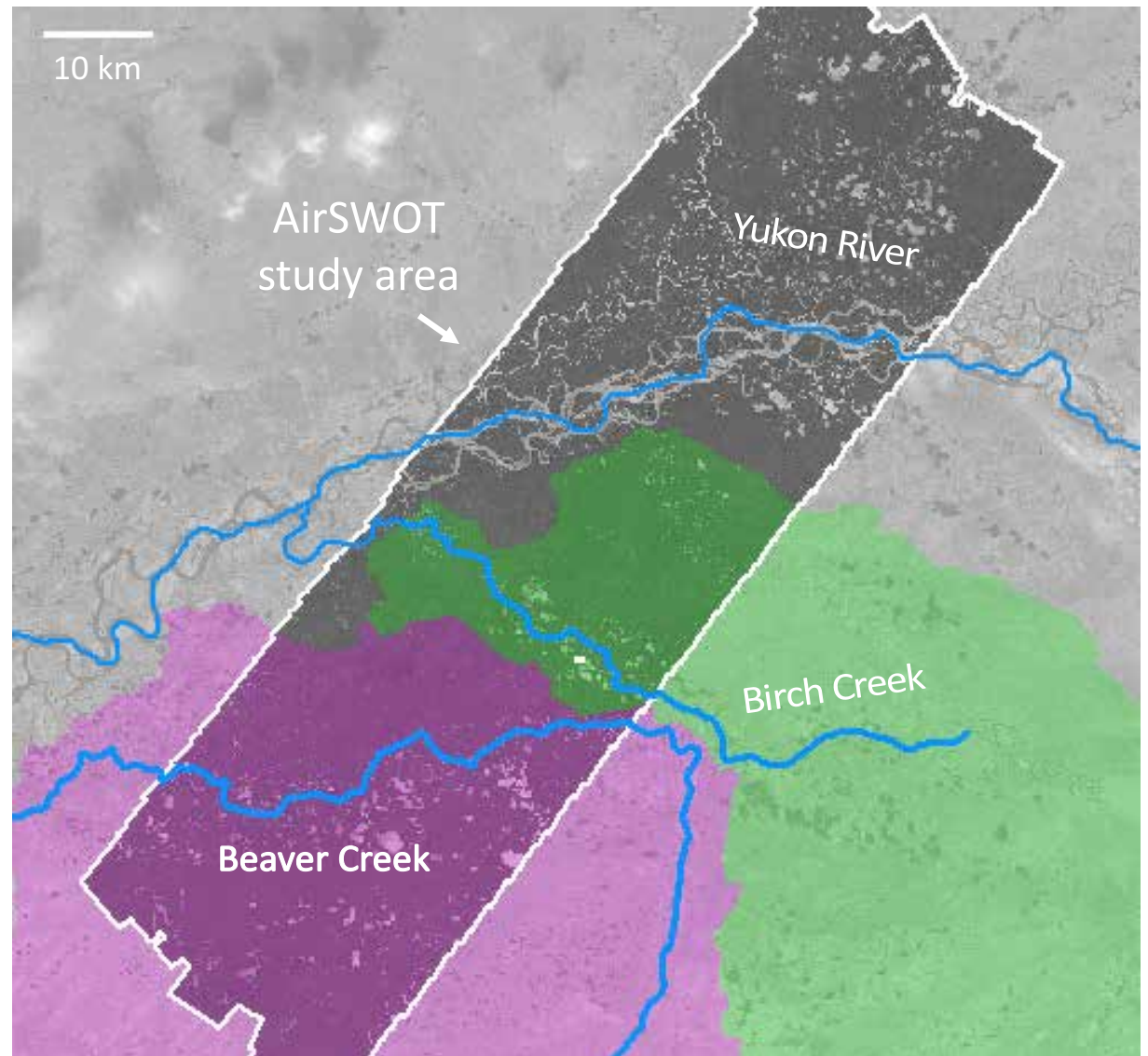
Yukon River, Alaska

AirSWOT Flight:
June 15, 2015

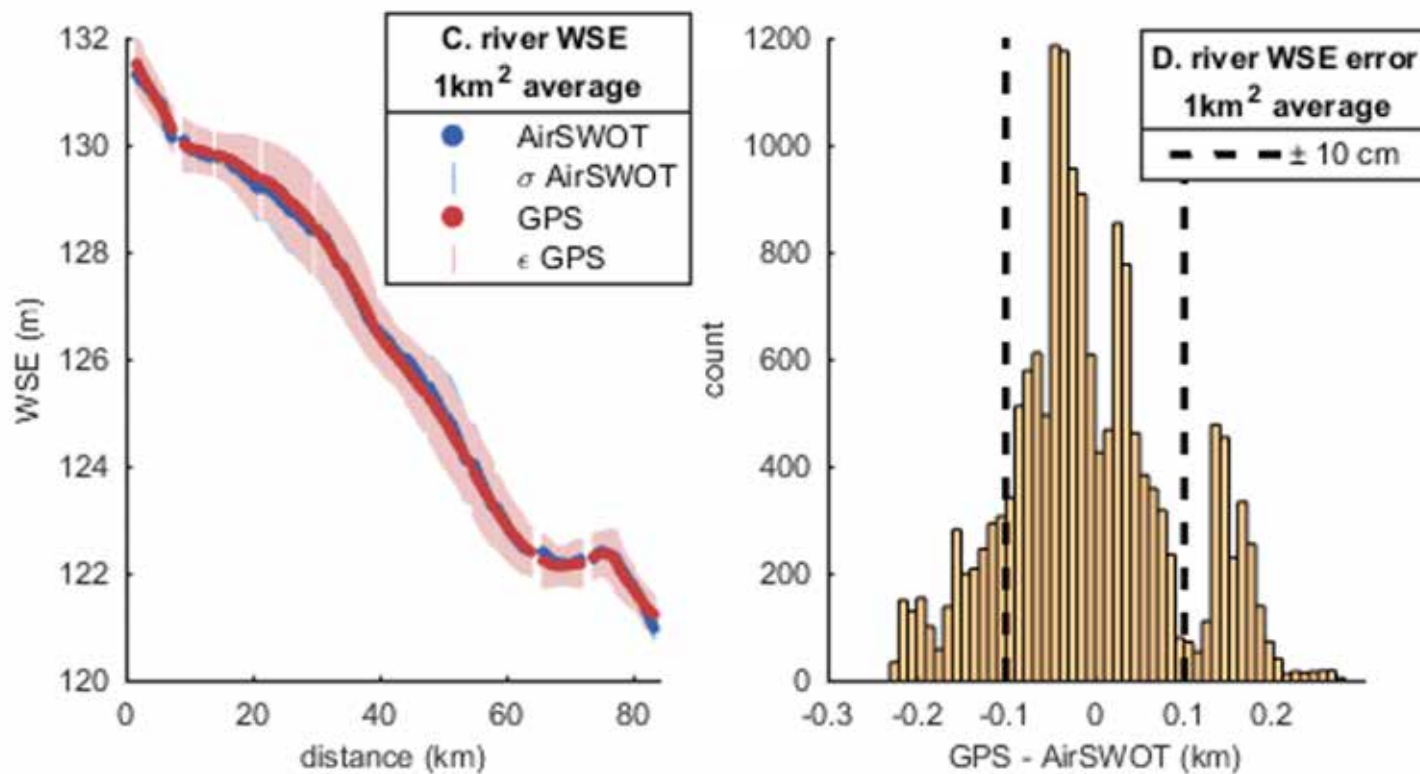
10 Lines

Mapped ~80 km
of the Yukon
River and two
smaller tributaries

Slides Courtesy of L. Pitcher, UCLA



Yukon WSE Results

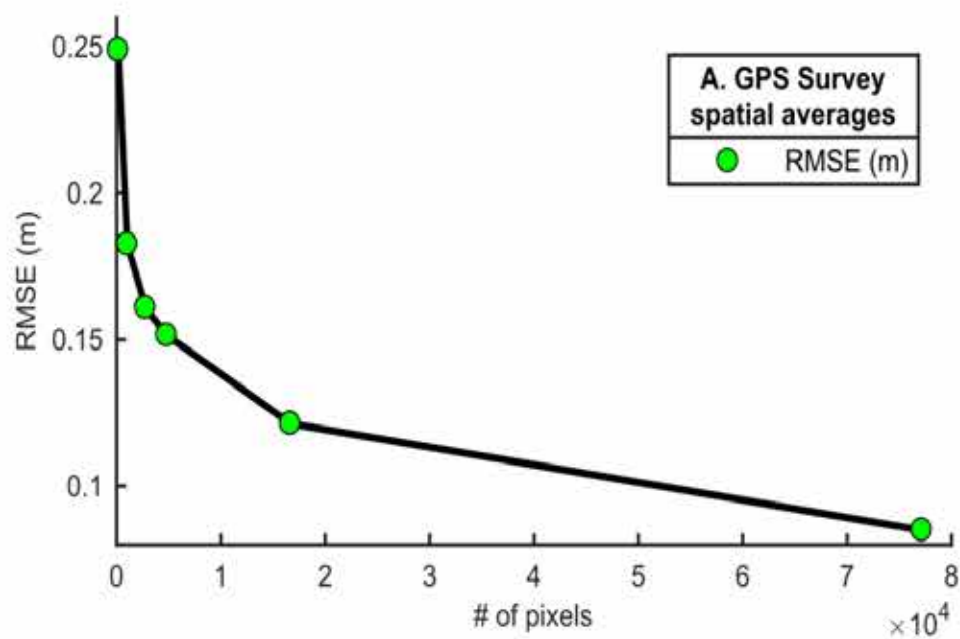


AirSWOT resolves 1 km² river WSEs with RMSE = 7 cm

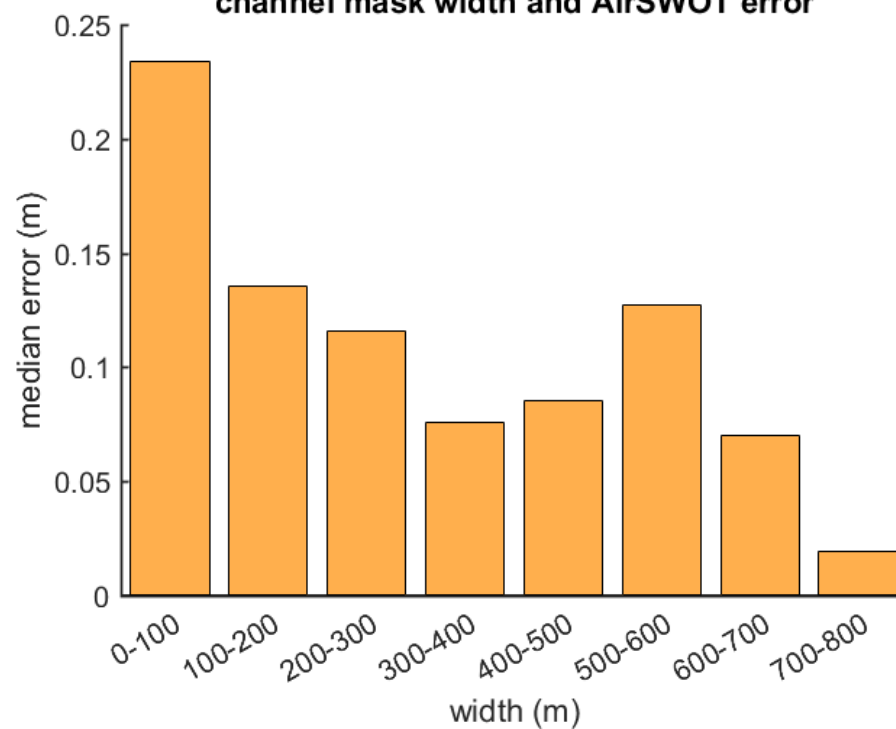
73% of 1km² reaches meet SWOT mission requirement of ± 10 cm

Yukon WSE Error Characteristics

number of pixels and AirSWOT error



channel mask width and AirSWOT error

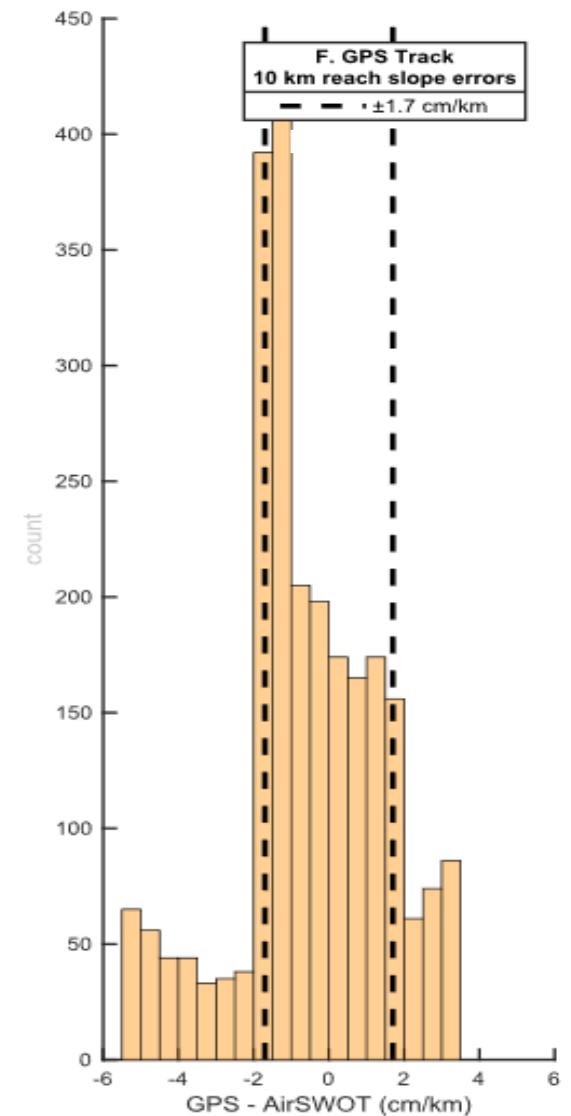


Yukon Slope Results

remove reaches <100 m wide
establish 10 km downstream reaches
remove reaches <80% data coverage

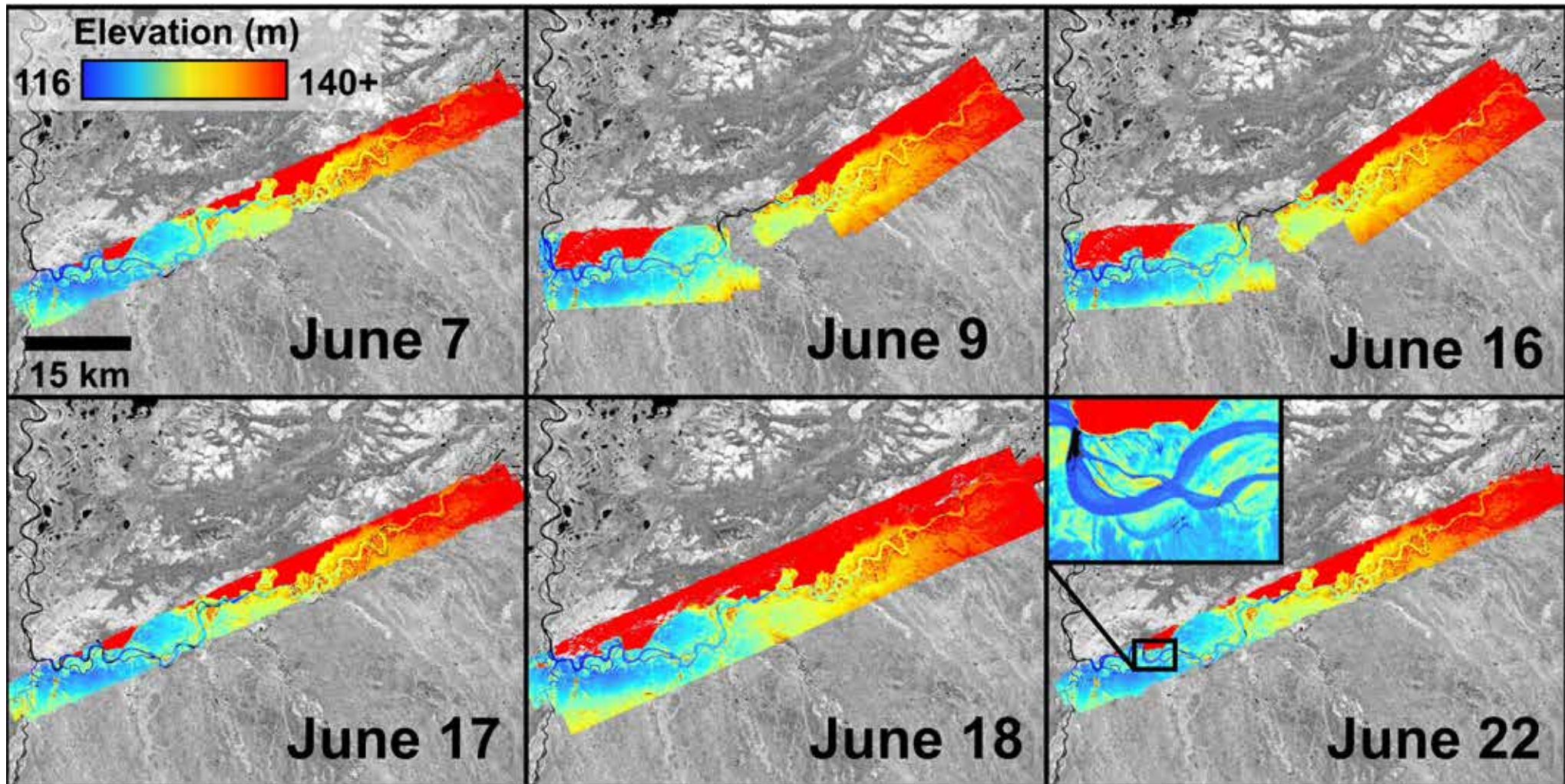
AirSWOT resolves **river slope** along **10 km** reaches to **± 1.7 cm/km** in **64%** of samples with an **RMSE = 1.5 cm/km**

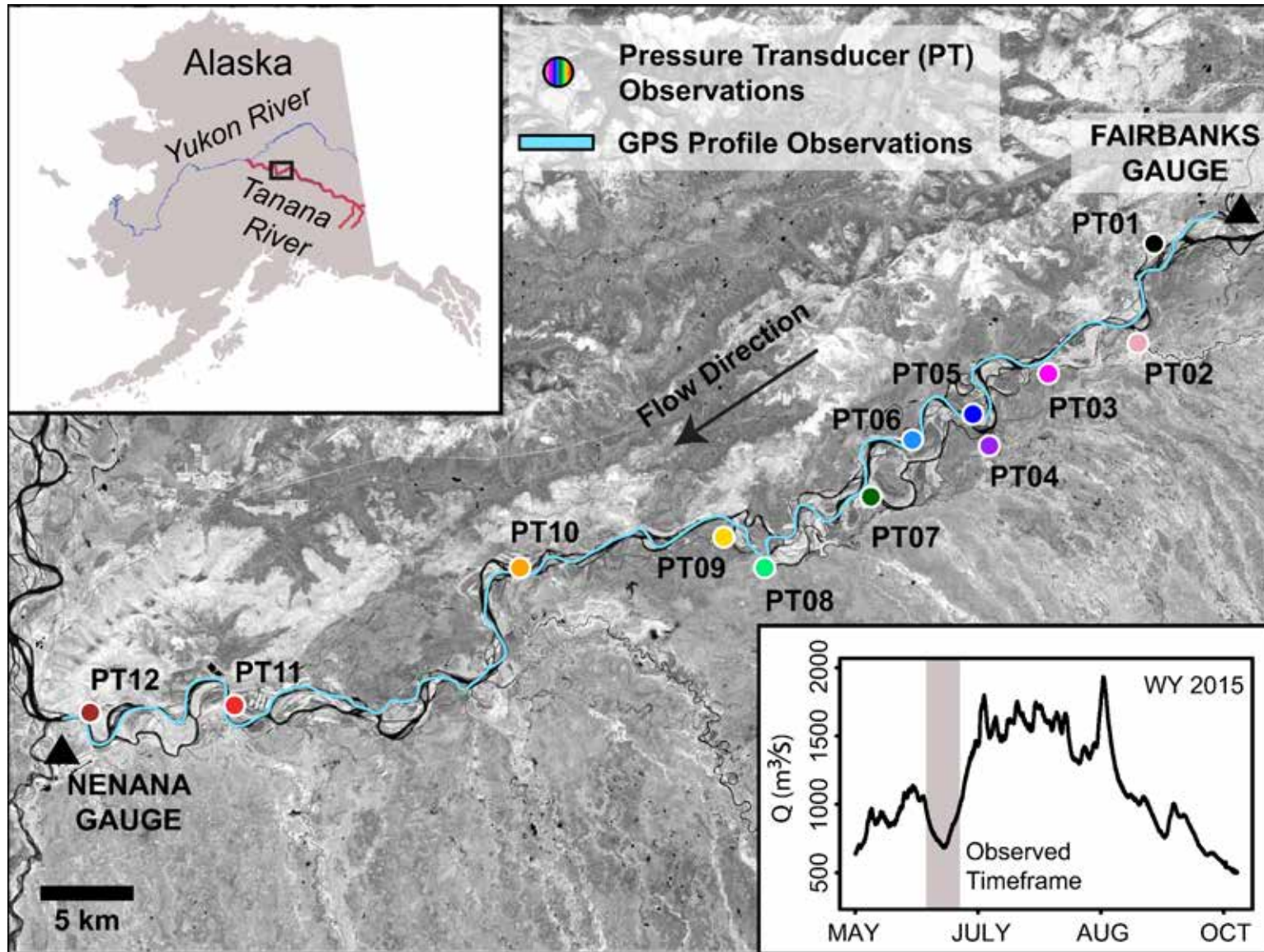
Slides Courtesy of L. Pitcher, UCLA



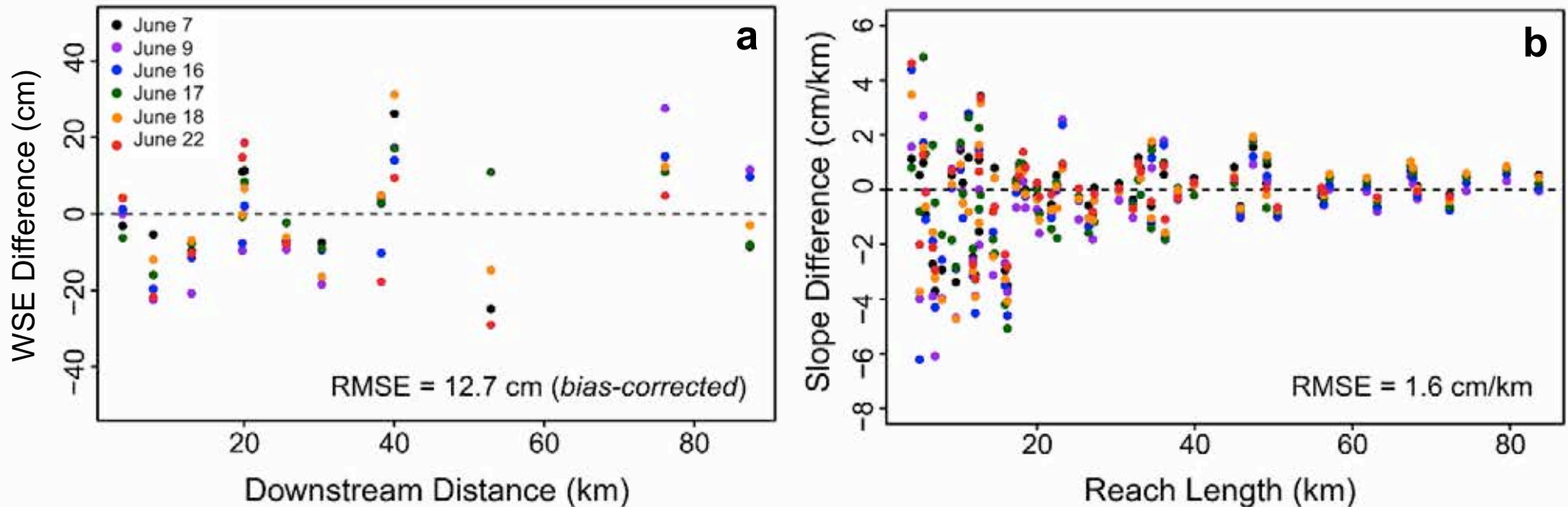
Tanana: 3 weeks, 6 AirSWOT flights

9

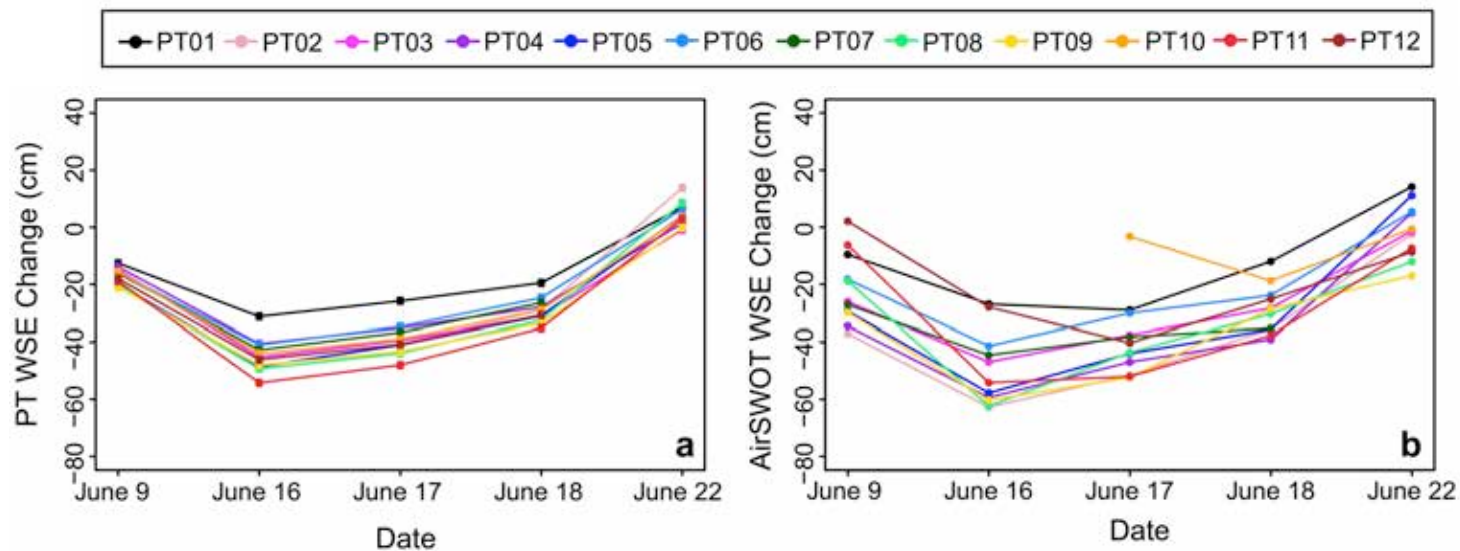




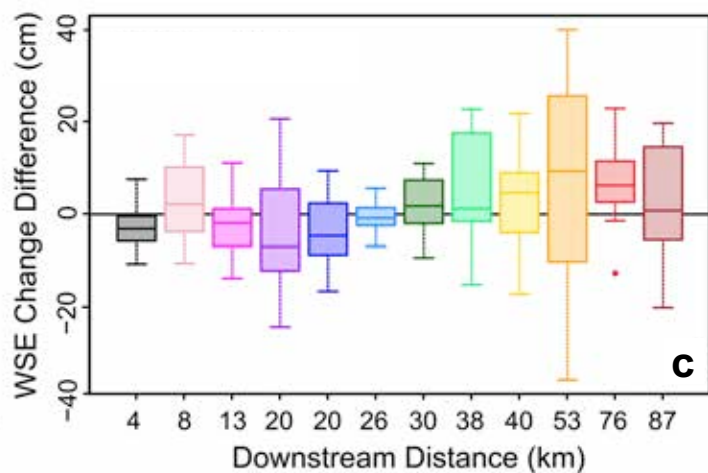
Tanana WSE & Slope Errors



A **consistent spatial bias is observed** on each date ranging from **-18 to -24 cm**. WSE RMSE with bias = 25 cm. Half the RMSE is due to the bias with a **bias-corrected RMSE of 12.7 cm**.



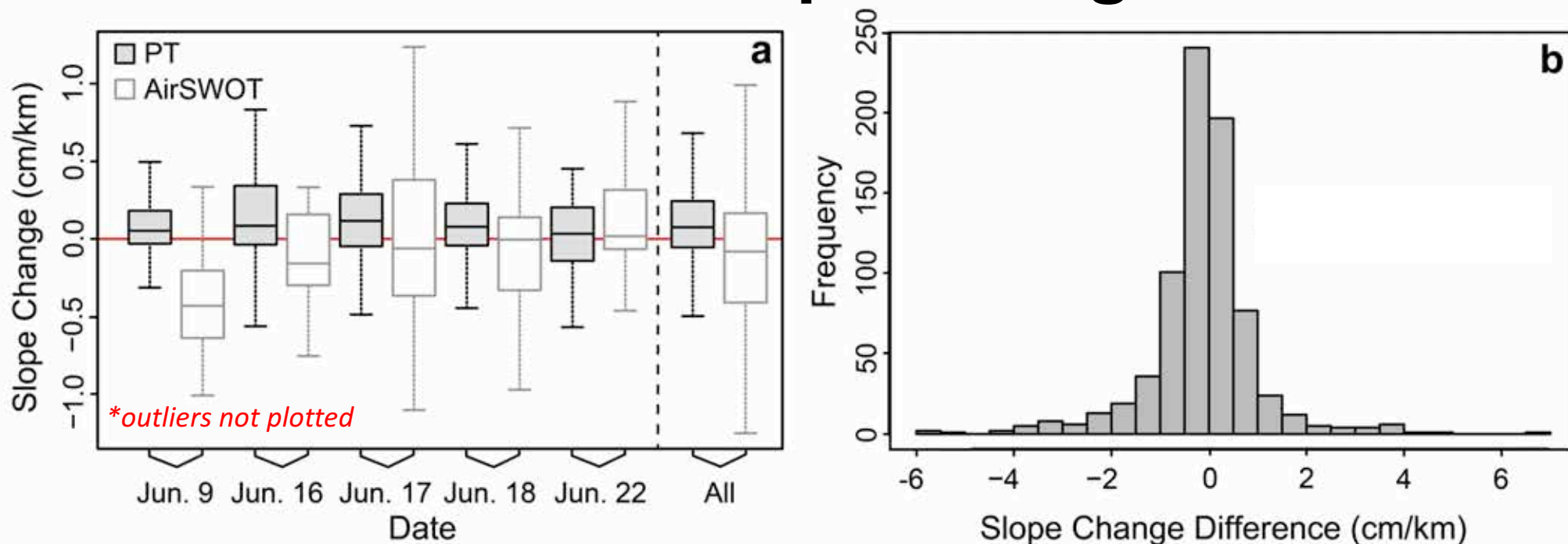
Tanana WSE Changes



AirSWOT captures the same general pattern in WSE changes as in situ measurements.

RMSE = 10.4 cm for 1 km² areas.

Tanana: Slope Changes

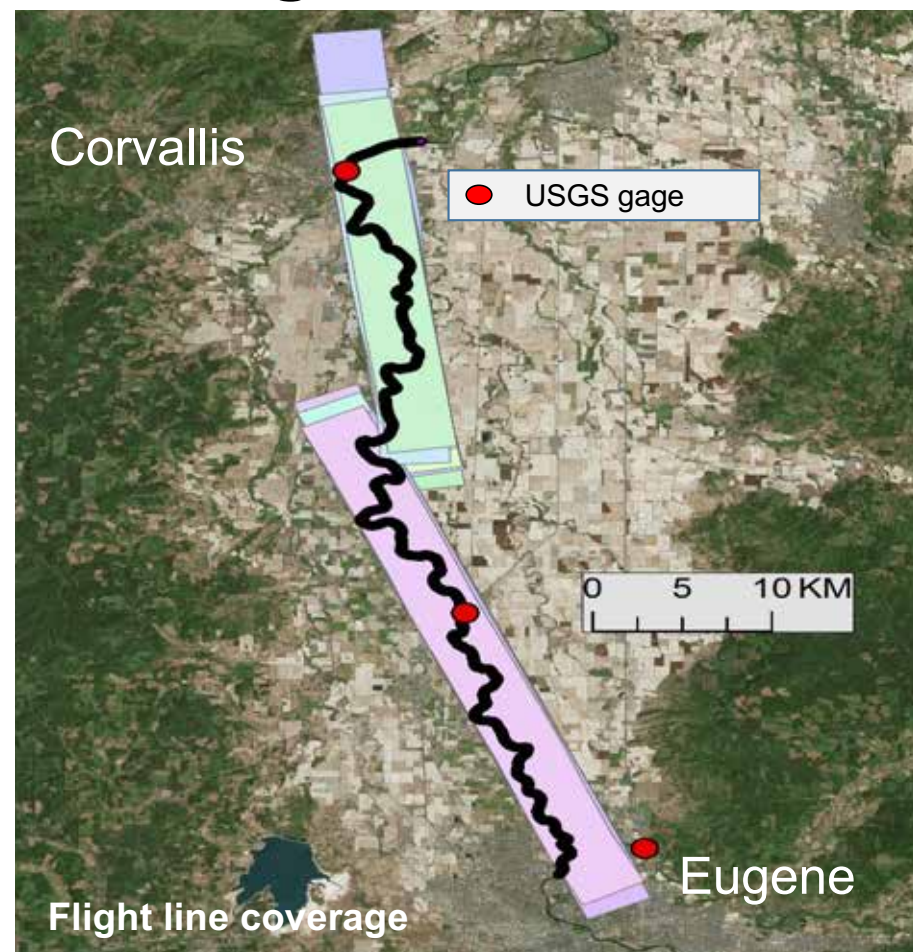
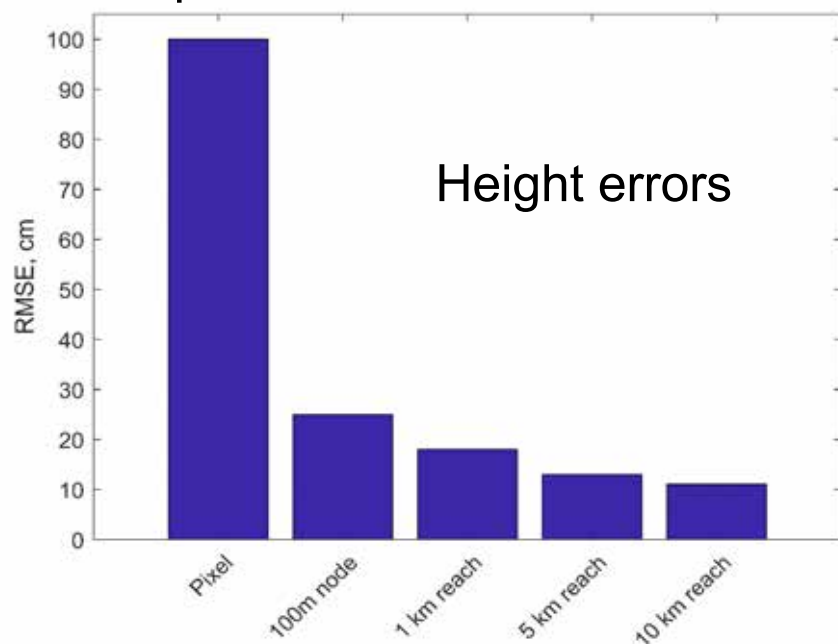


Observed slope changes are well below AirSWOT's accuracy for daily slope measurements.

Additional measurements along more dynamic rivers or over larger hydrologic events are needed for validation.

Willamette River, Oregon

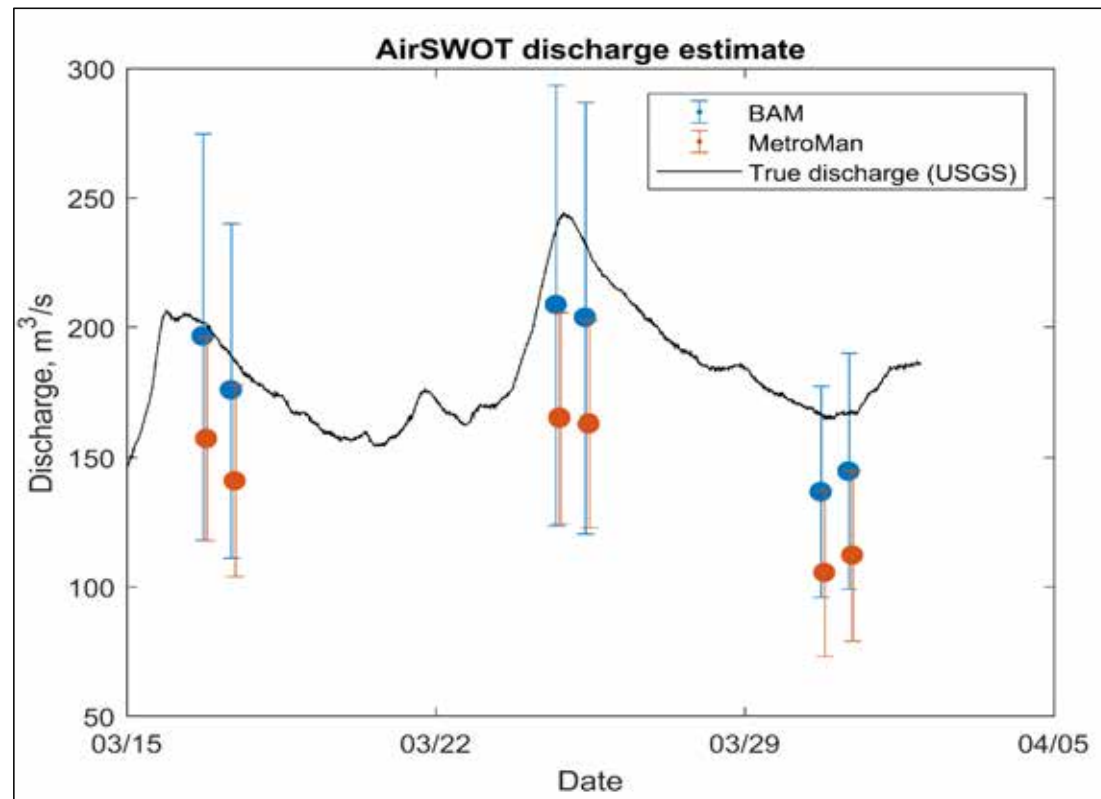
- Flights from March 2015
- 6 flight days, 35 total 'lines'
- 75 km stretch of river
- For 10 km reaches:
 - WSE error: 11 cm
 - Slope error: 3 cm/km



Slides Courtesy of S. Tuozzolo, Ohio State

Willamette discharge inversion results

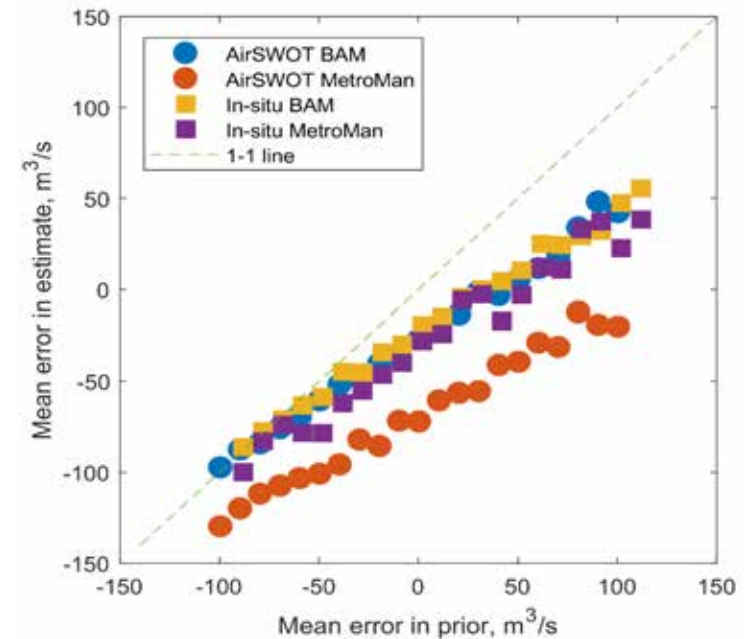
- 40 km stretch with minimal lateral inflow
- WSE, width, slope calculated for four 10km reaches
- Results (2 algorithms):
 - **BAM nRMSE = 12%**
 - **MetroMan nRMSE = 30%**
- This is an encouraging first result:
 - **Most of the error is in the bias**
 - No prior information other than mean Q from global model



Slides Courtesy of S. Tuozzolo, Ohio State

Willamette discharge inversion results

- Caveat: discharge inversion was moderately sensitive to first guess/prior estimate of Q
- AirSWOT & algorithms do add information: slopes of prior vs estimate error < 1
- This is not due solely to measurement error in AirSWOT: results using Willamette in situ data are broadly similar
- Future work: explore inversion with variational data assimilation



Algorithm case	Bias-bias slope
● AirSWOT BAM	0.71
● AirSWOT MetroMan	0.58
■ In situ BAM	0.68
■ In situ MetroMan	0.69
True mean flow, AirSWOT: 199 m ³ /s	
True mean flow, in-situ: 188 m ³ /s	

Conclusions

- ❖ Results suggest that AirSWOT can provide SWOT-quality measurements of river WSE and slope.
- ❖ Meeting the SWOT mission accuracy for WSEs can be difficult due to uncertainties in the aircraft's position and phase unwrapping.
- ❖ AirSWOT consistently resolves accurate slope measurements and is capable of capturing detailed spatial variations in slope.
- ❖ Preliminary discharge inversions are encouraging, yet sensitive to prior discharge estimation.
- ❖ More AirSWOT data coming: ABoVE campaign (2017)