New Hydrometeorological Instrument Cluster at Inglefield Land, NW Greenland

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November 21, 2022

Abstract

Mass loss from the Greenland Ice Sheet (GrIS) is a primary contributor to sea level rise, but substantial uncertainty exists in estimates of future ice sheet losses. Surface mass balance (SMB) models, the current leading approach to sea level rise projection, anticipate continued dominance of runoff as a mass loss pathway. Despite their preeminence, SMB models in vulnerable northern environments lack adequate field validation, particularly for error-sensitive runoff estimates. We have installed a cluster of high quality field instruments at the Minturn Elv, a proglacial river site in Inglefield Land, NW Greenland to provide discharge and weather datasets for the validation and refinement of climate/SMB runoff models. The instrument cluster has meteorological, hydrological, and time lapse camera instrumentation, including a vented water level stage recorder, single shot and scanning lidars, time lapse cameras, and in situ ADCP discharge and terrestrial scanning lidar measurements. The instrument suite provides novel flow and weather datasets with the opportunity to evaluate experimental approaches to stage measurement in adverse, high-latitude areas. Inglefield is a uniquely advantaged location because proglacial runoff is dominated by SMB processes operating on the ice surface without interference from subglacial hydrology. Overall, our hydrometeorological instrument cluster at Inglefield Land will provide one of the few validation datasets for regional climate models outside of Southwest Greenland.

New Hydrometeorological Instrument Cluster at Inglefield Land, NW Greenland

Presenter:

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Greenland Ice Sheet (GrIS) Melt

- GrIS melt has contributed ~11 mm of sea level rise (SLR) since 1992
- GrIS melt projected to contribute an additional ~8-18 cm of sea level rise by 2100
- Mass loss primarily through calving and runoff
  - Runoff is dominant (~2/3 of mass loss)
  - Dominance of runoff expected to increase in the future (82-94% of mass loss in 2100 years)

"As a rule of thumb, for every centimeter in global sea level rise, another 6 million people are exposed to coastal flooding around the planet"

- Andrew Shepherd, University of Leeds

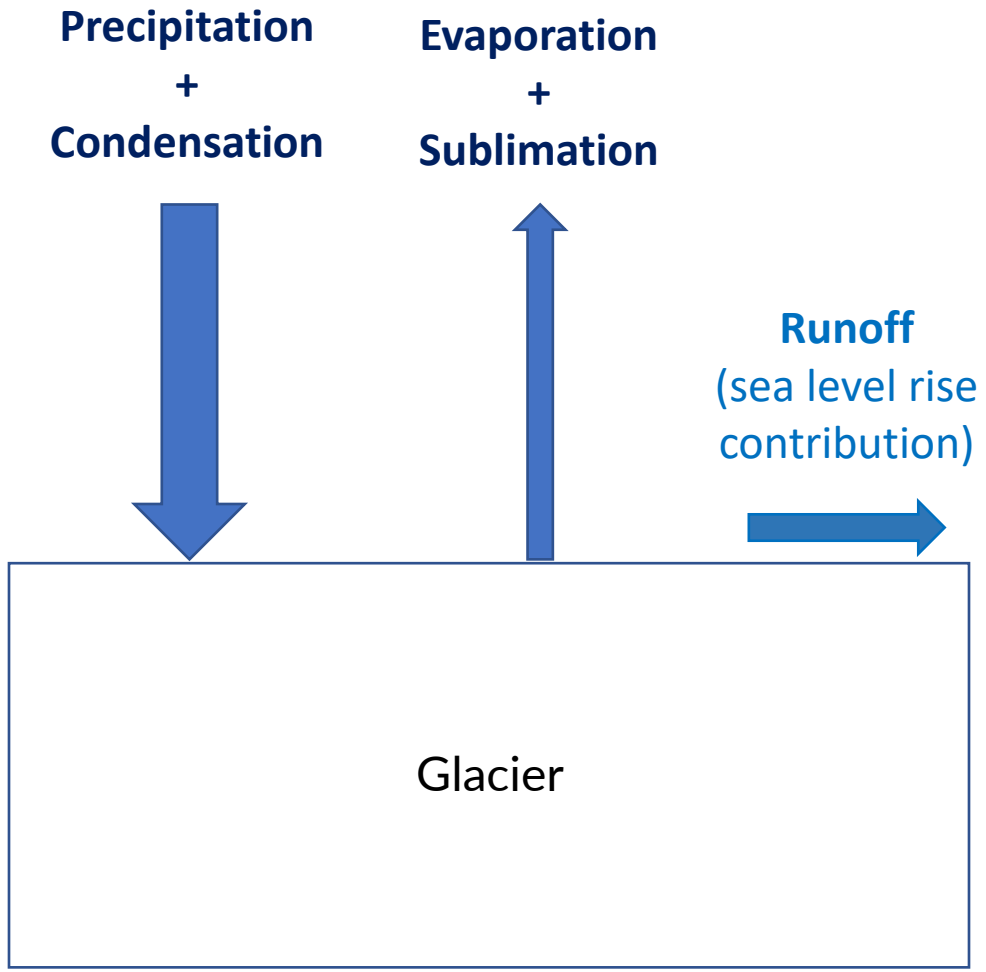
Project goal: Validation of RCM Runoff

Simplified Surface Mass Balance (SMB):

SMB = Precipitation + Condensation
– Evaporation
– Sublimation
– Runoff

SMB from models (e.g. can measure ice sheet volume, flow, and gravimetric potential from satellites)

Runoff: Leftover term, highly susceptible to error in other terms




ME19WS03
NAO
Old Camp
Greenland
Jan Mayen
Reykjavik
Image Landsat / Copernicus
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US Dept of State Geographer
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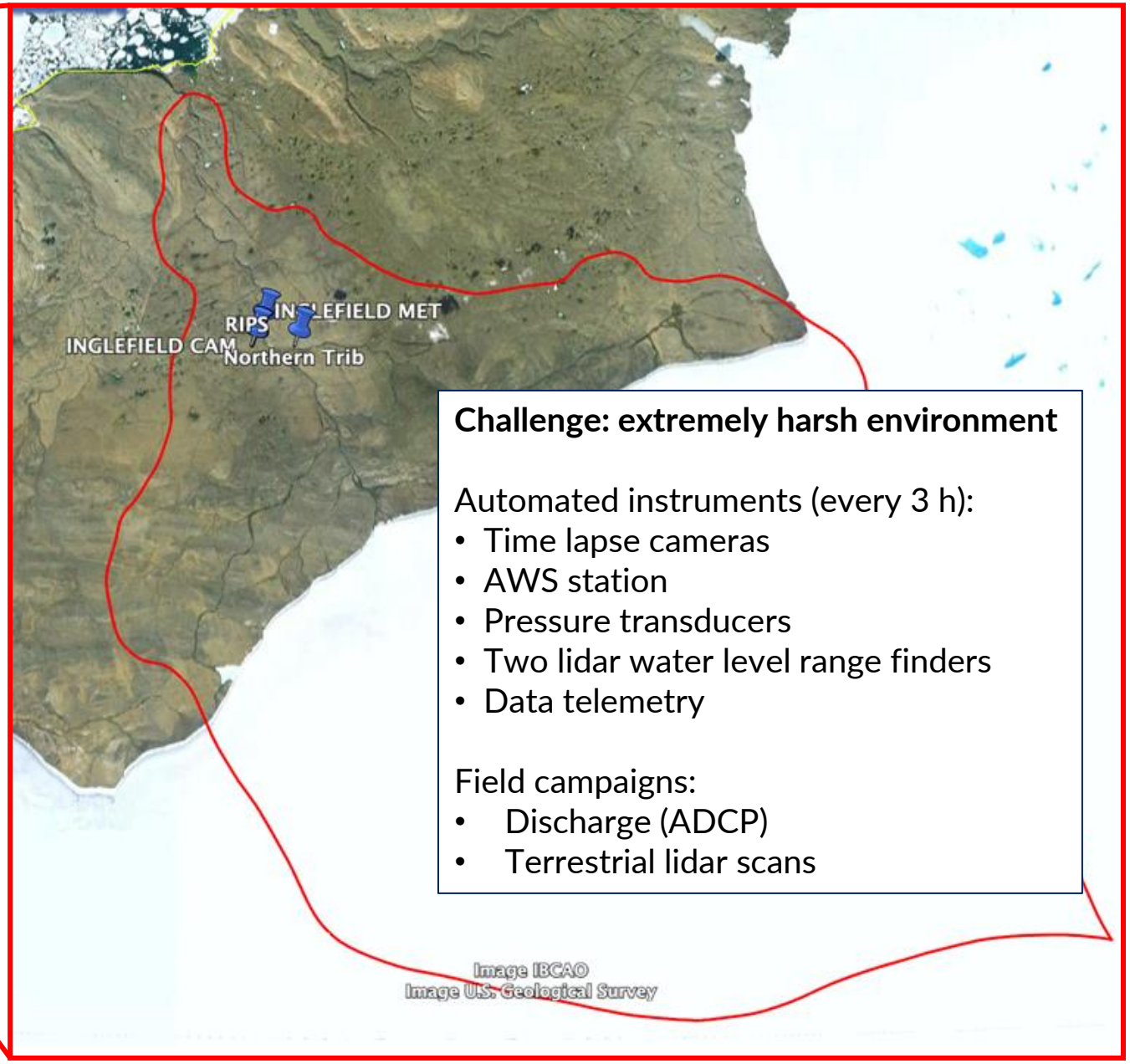
New Inglefield Land hydrometeorological instrument cluster:



Challenge: extremely harsh environment

Automated instruments (every 3 h):

- Time lapse cameras
- AWS station
- Pressure transducers
- Two lidar water level range finders
- Data telemetry

Field campaigns:

- Discharge (ADCP)
- Terrestrial lidar scans

Why measure proglacial runoff in NW Greenland?

SW Greenland ≠ NW Greenland

- Virtually all supraglacial runoff enters moulins, crevasses prior to reaching the proglacial zone (Smith et al. 2018)
- Englacial, subglacial delays thus confound direct validation of SMB runoff from proglacial discharge

- Grounded ice sheet
- Minimal englacial/subglacial interference
- Ideal location for validating modelled SMB runoff with proglacial discharge measurements

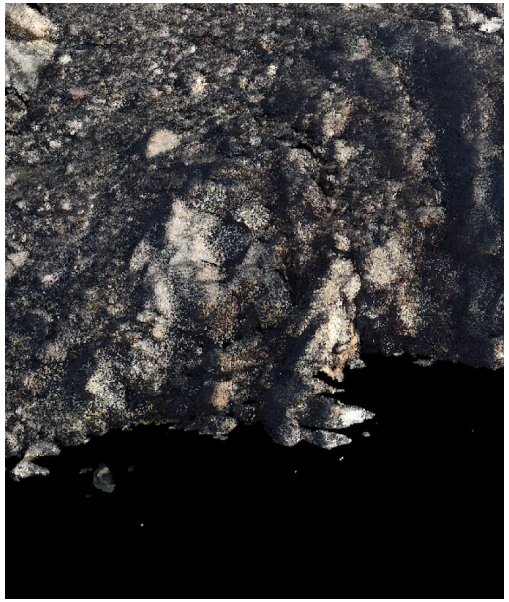
Visuals from Larry Smith

Imagery and Meteorological Datasets

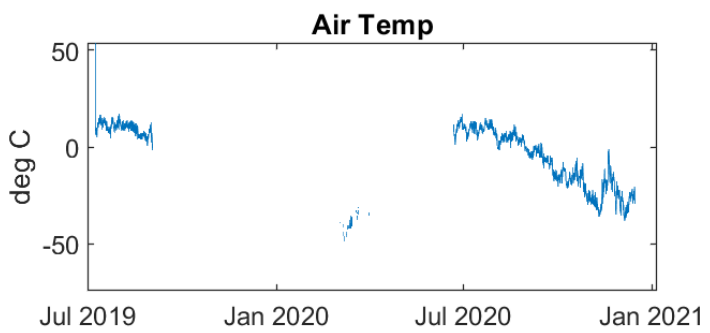
Time lapse cameras (2019-) on left and right bank transmit an image every 1.5 hours

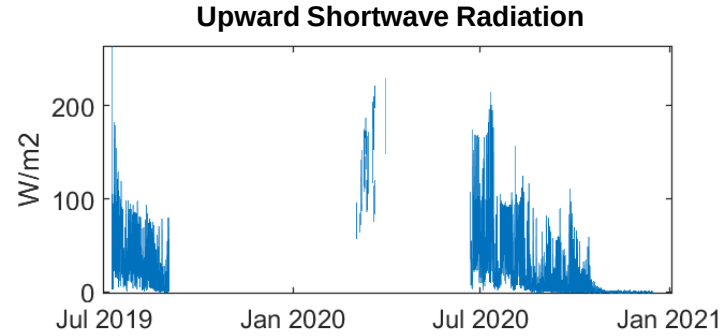
Left bank:
2019-07-22
16:30

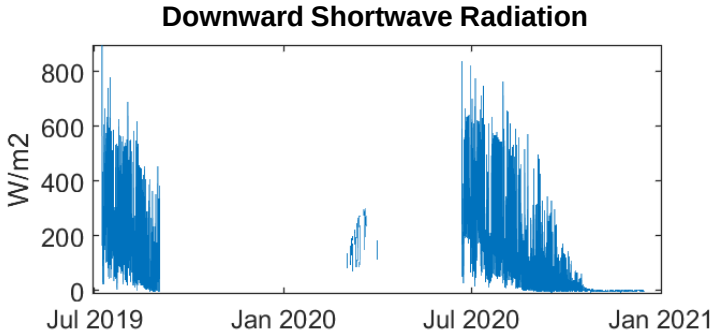
High Resolution Terrestrial Lidar Scan
Captured July 2019

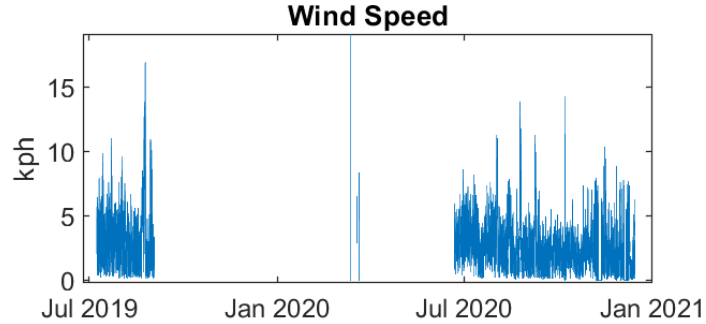


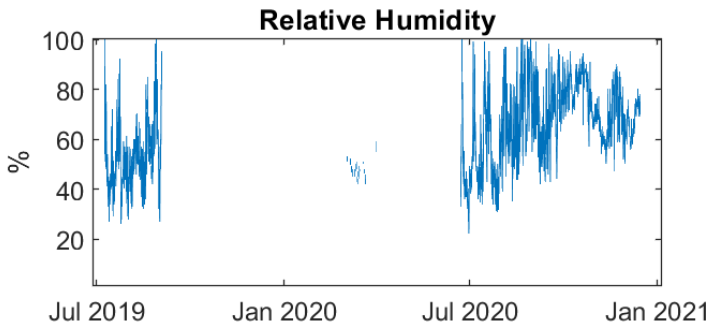
Automated Weather Station (AWS)

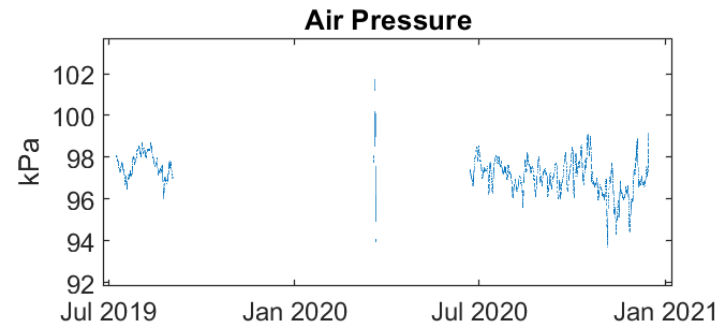






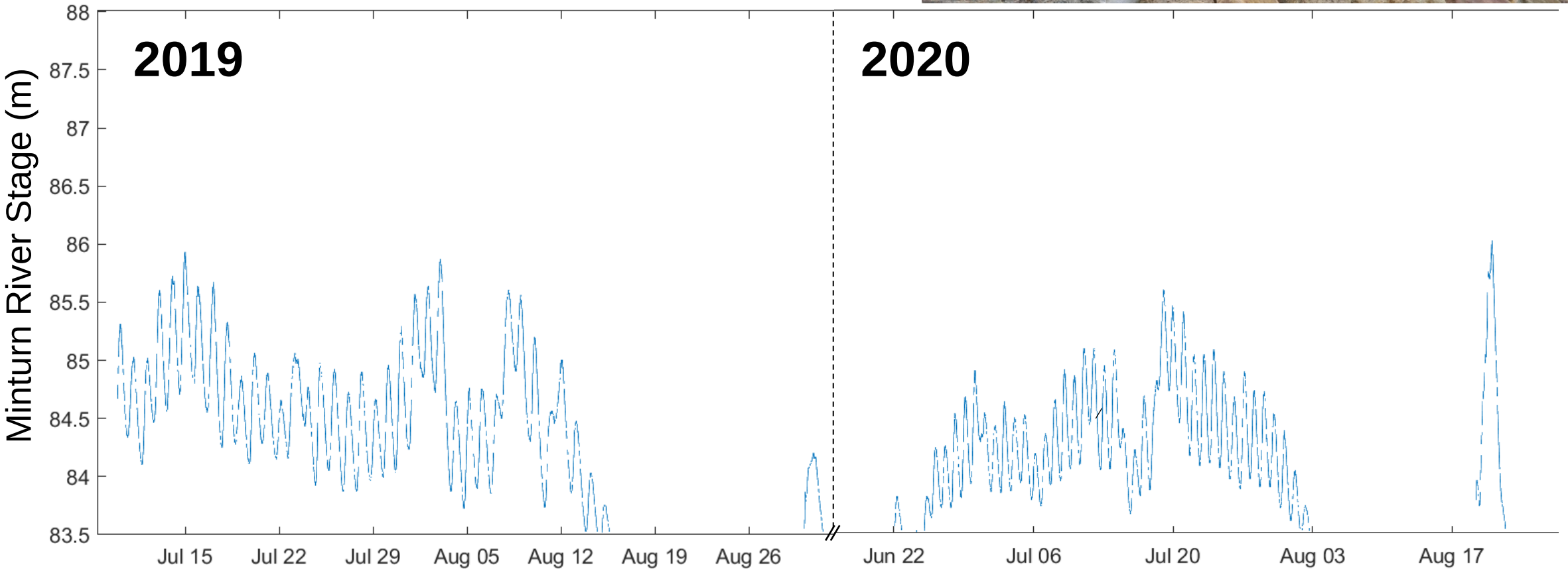




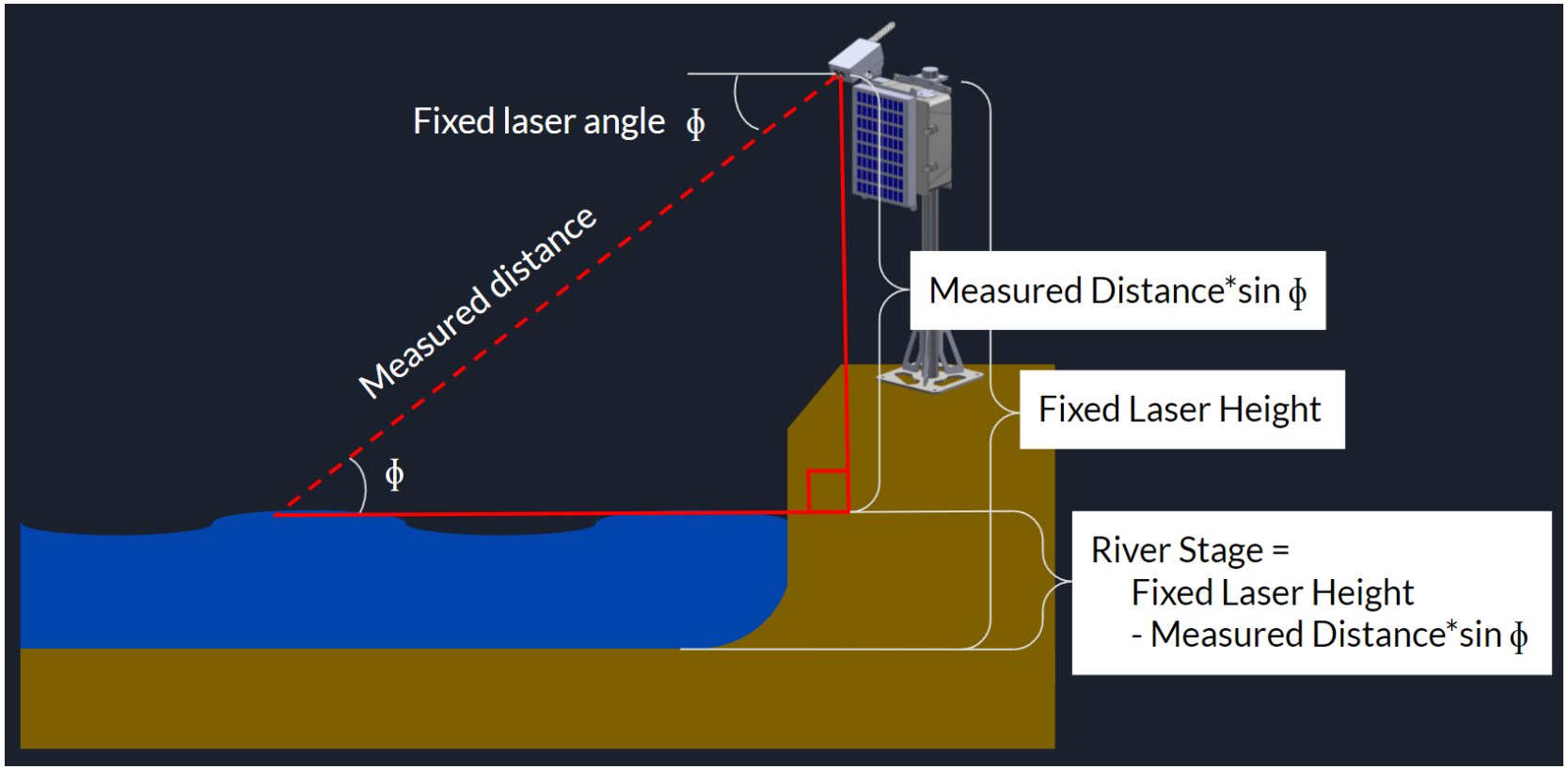


Stage: Sutron's Constant Flow Bubbler

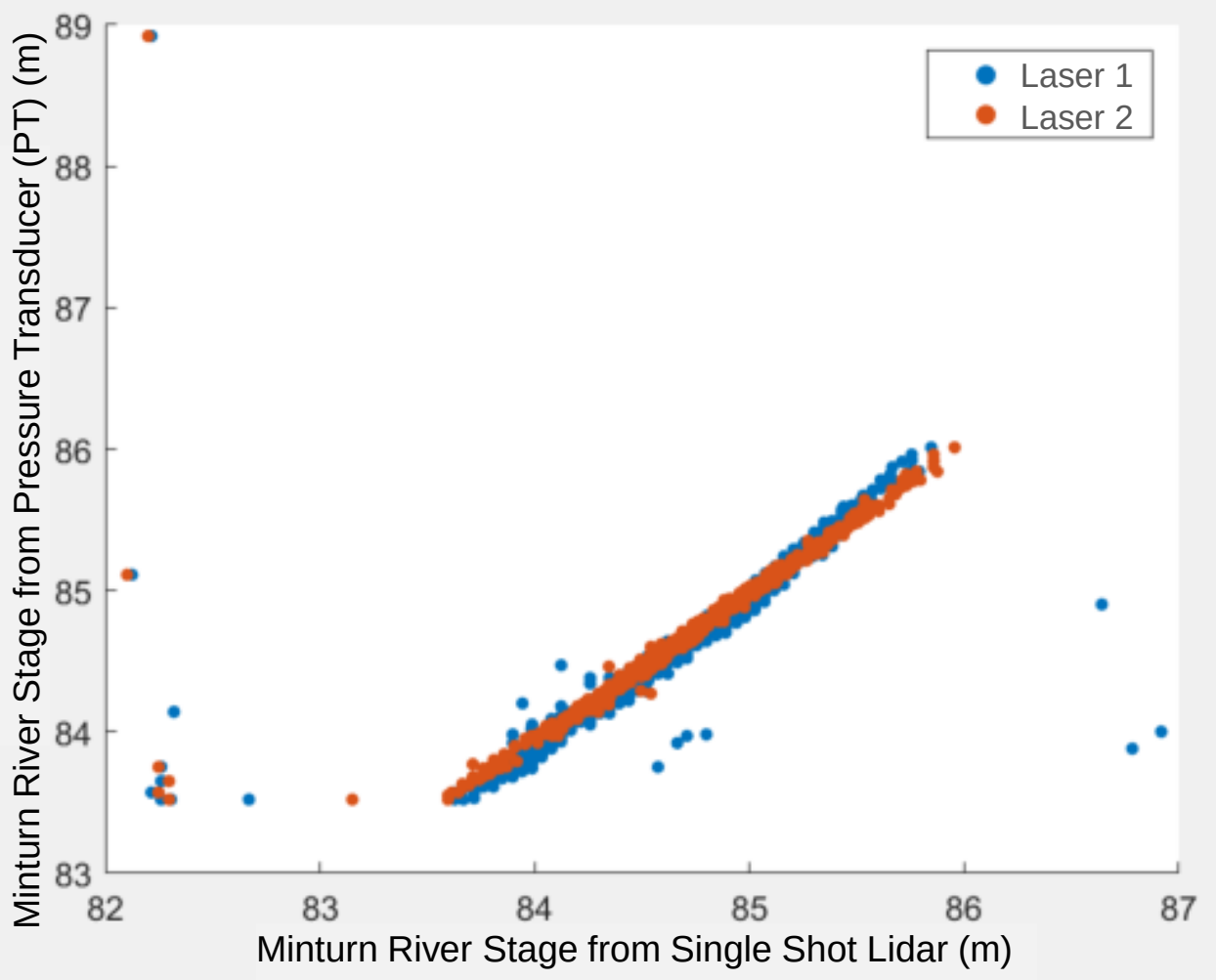
ADCP discharge measurements will be collected in 2022 to build stage-discharge rating curve

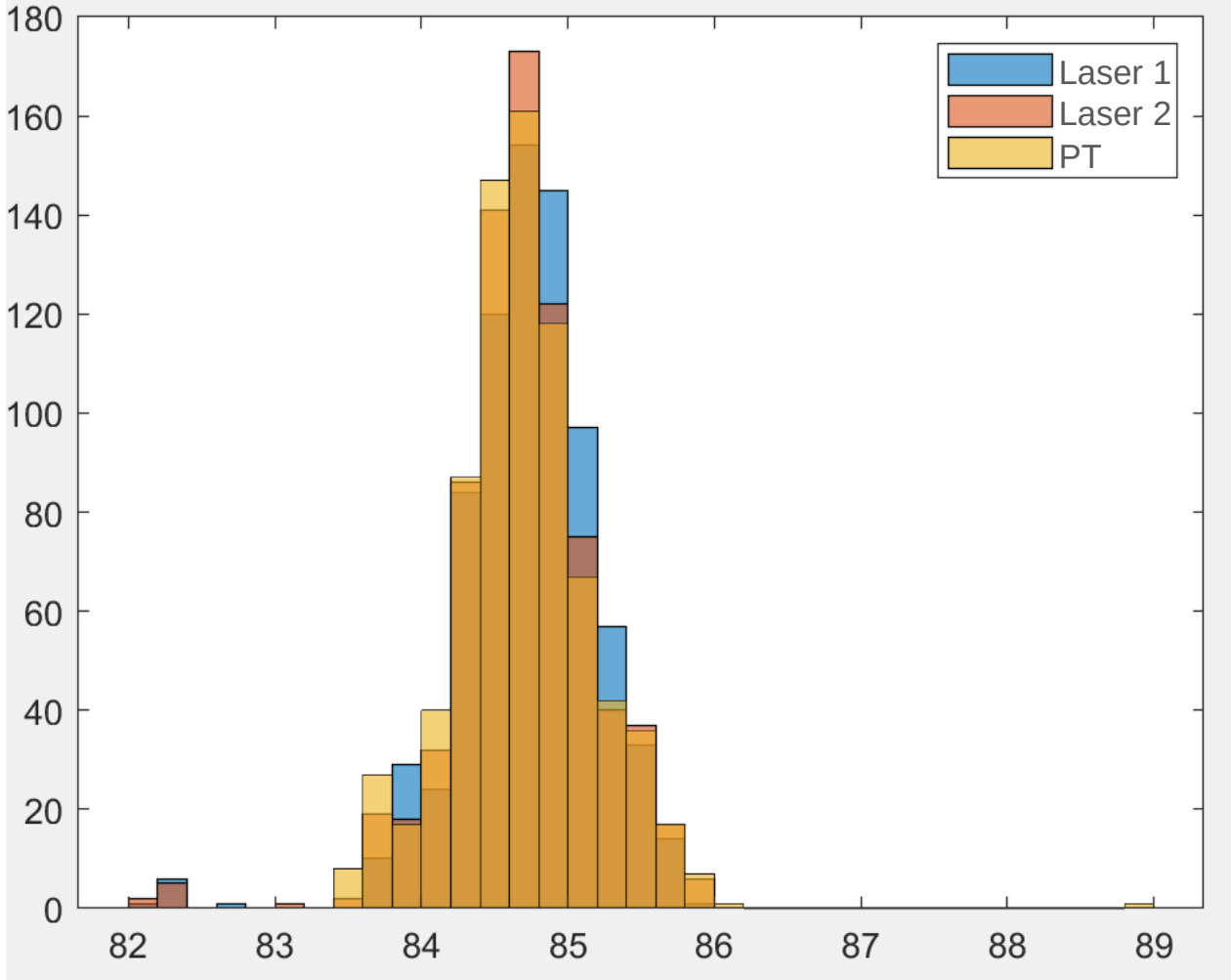


Can Minturn River stage be monitored with automated single beam lidar?

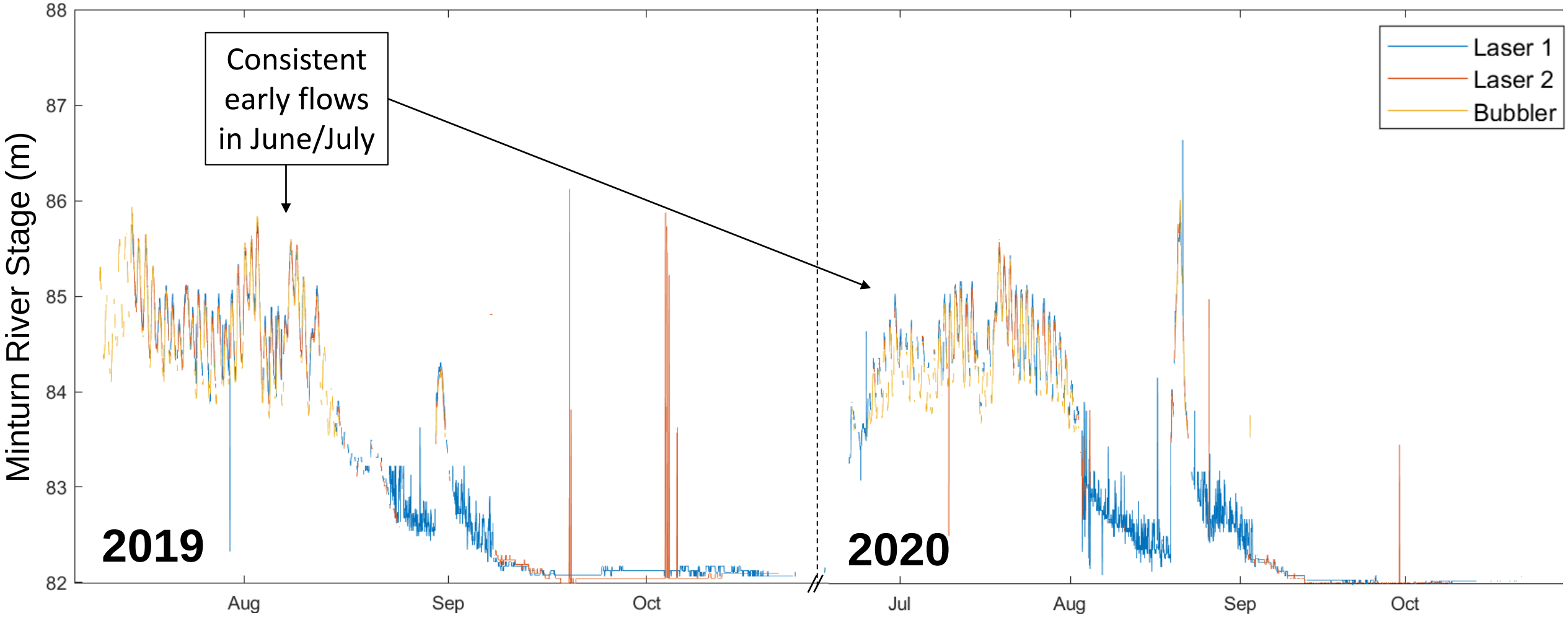


Can Minturn River stage be monitored with automated single beam lidar? YES

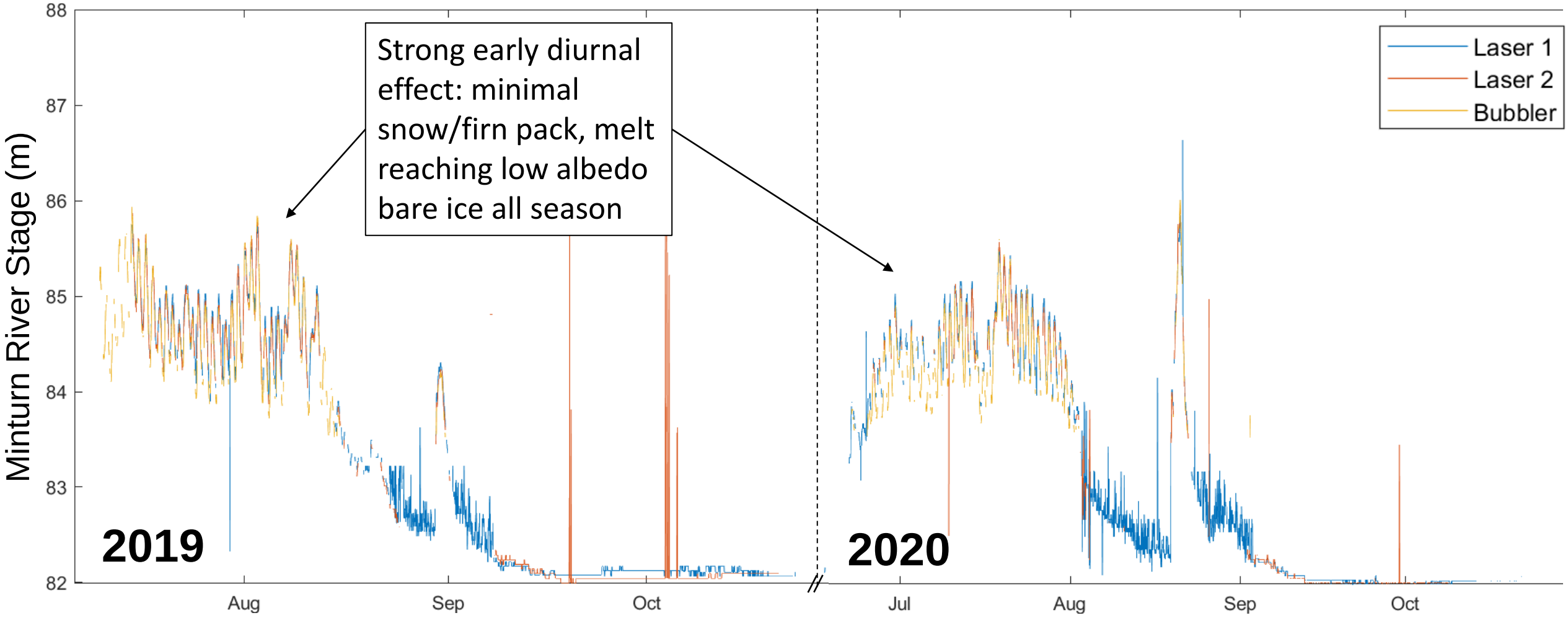




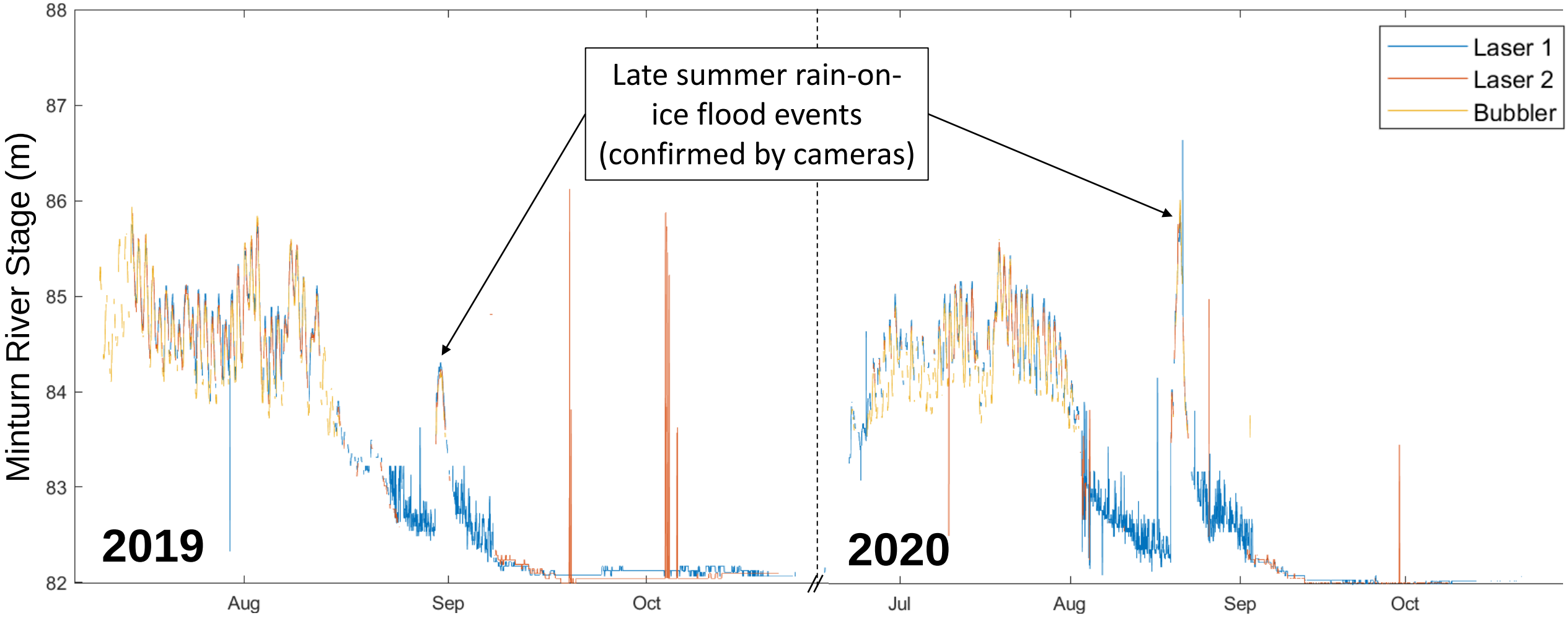
NW Greenland Hydrology



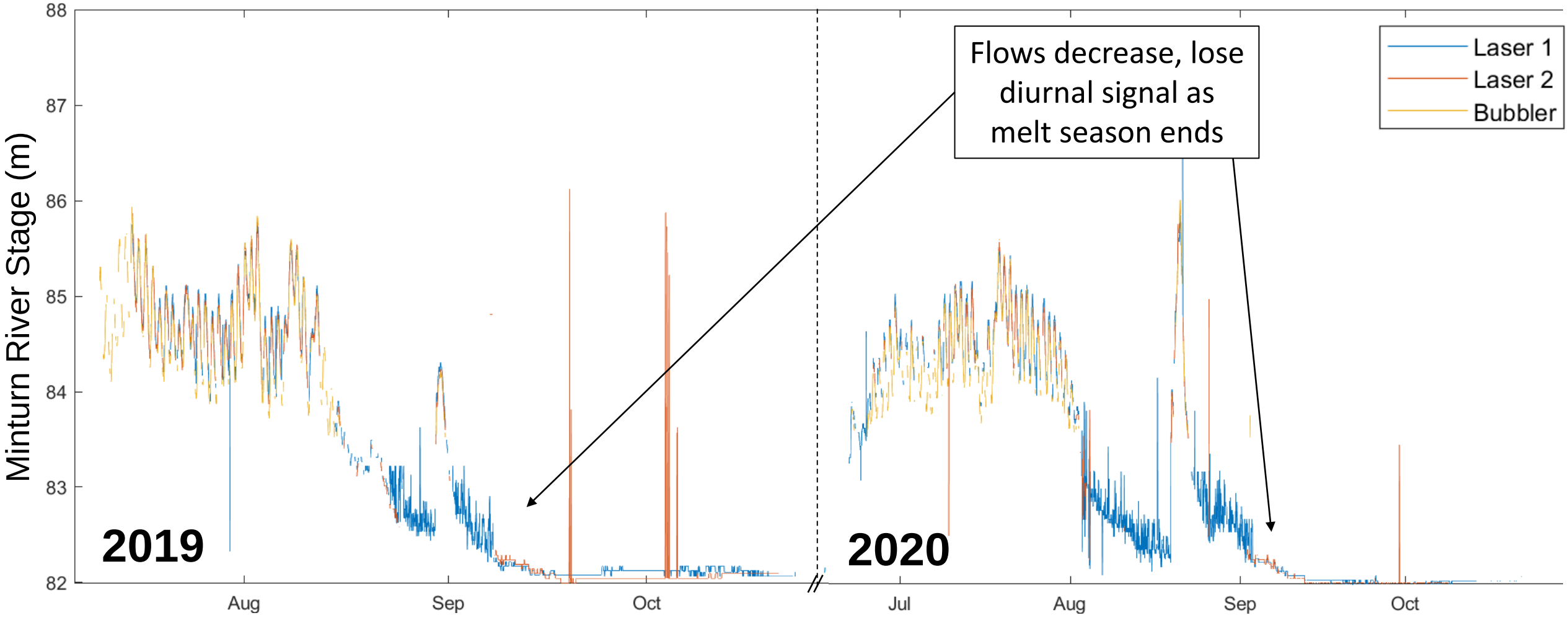
NW Greenland Hydrology



NW Greenland Hydrology



NW Greenland Hydrology



Takeaways:

- We are collecting novel hydrometeorological datasets from understudied NW Greenland
  - Minimal subglacial activity in this region: excellent dataset for SMB validation
- Automated lidar range finder measures Minturn River levels with accuracy comparable to traditional pressure transducer approaches
- NW Greenland proglacial outflows are high in July and August (like SW Greenland) with early onset of diurnal cycle suggesting low snow/firn storage
- Rain on ice floods observed in August
- 2019-2021 data being processed for public release (PROMICE)

Funded by NASA Cryosphere Program project 80NSSC19K0942