Initial results from the NASA SnowEx 2020 L-band campaign at Cameron Pass, Colorado

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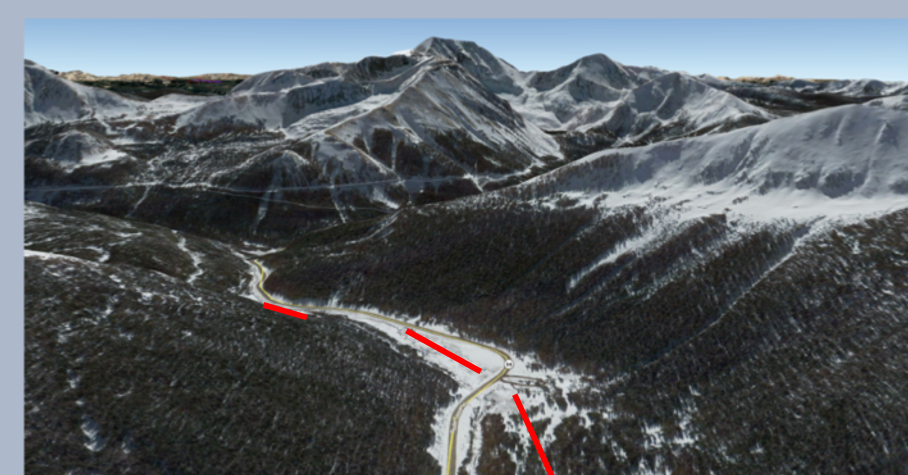
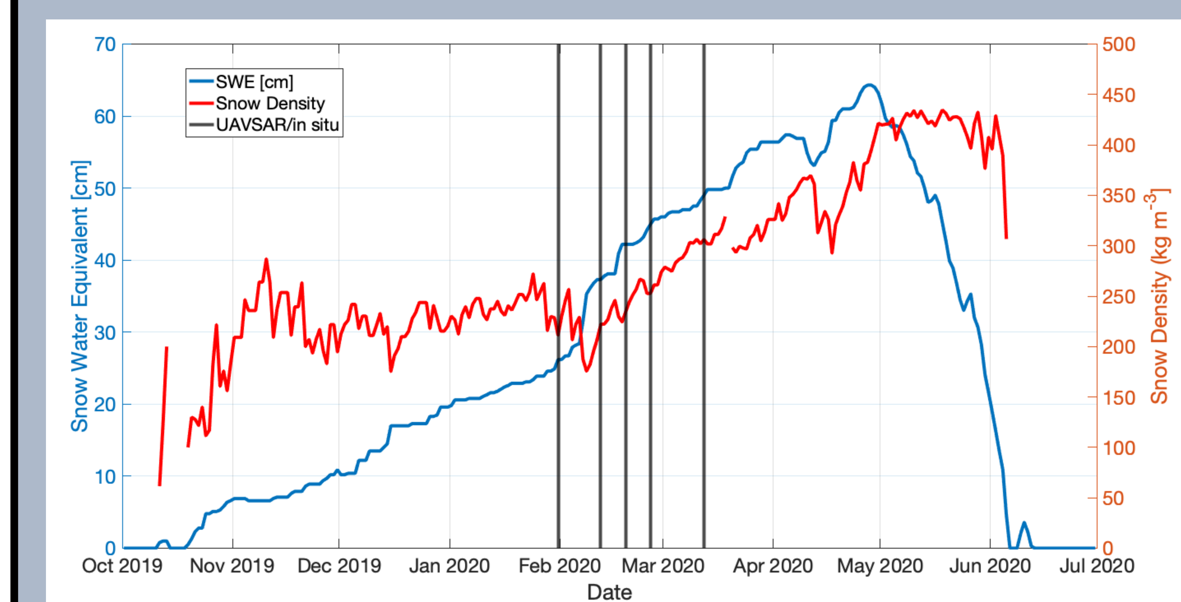
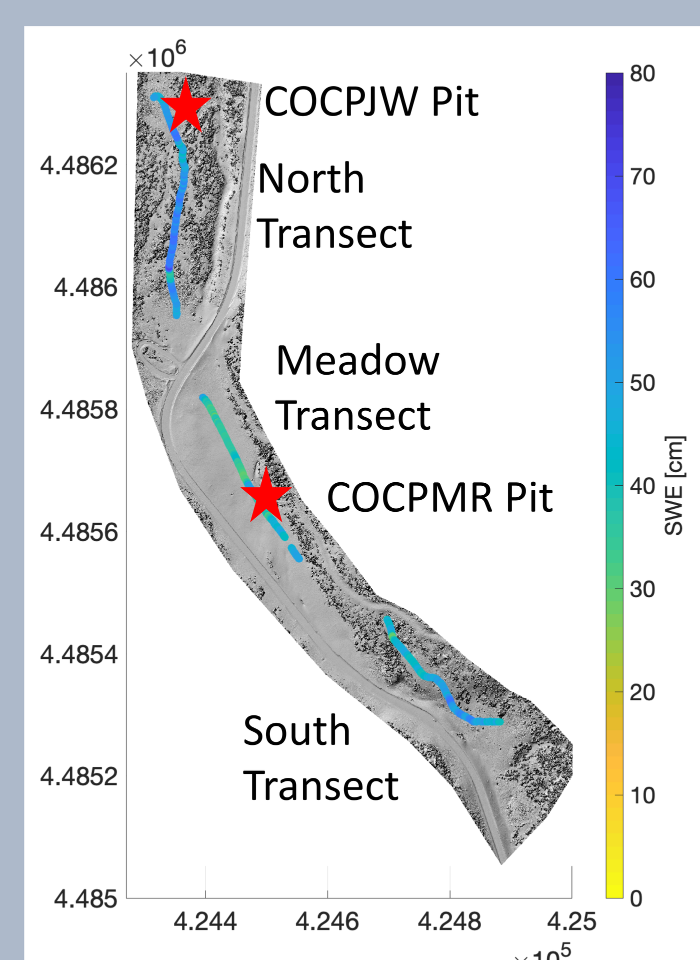
Overview of 2020 Campaign



- Cameron Pass is a high-elevation (~3100 m) site in north-central Colorado.
- The median snowpack at the Joe Wright SNOTEL station is ~180 cm or ~60 cm of snow water equivalent (SWE).
- During the SnowEx 2020 campaign, repeat observations were made along three 300 m transects (noted in red on oblique image to the right) to assess the ability of L-Band InSAR to measure SWE changes.

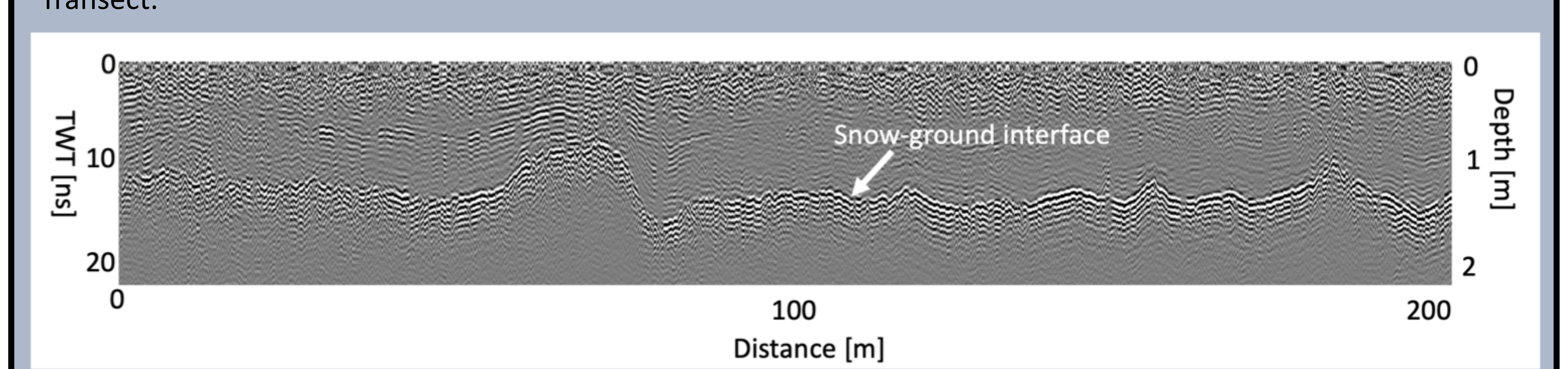


- Five NASA-JPL UAVSAR flights occurred at Cameron Pass between January 31 and March 12, 2020, during which ~25 cm of SWE accumulated at the Joe Wright SNOTEL site.
- Snow density was between 225 and 325 kg/m³ during the field campaign.



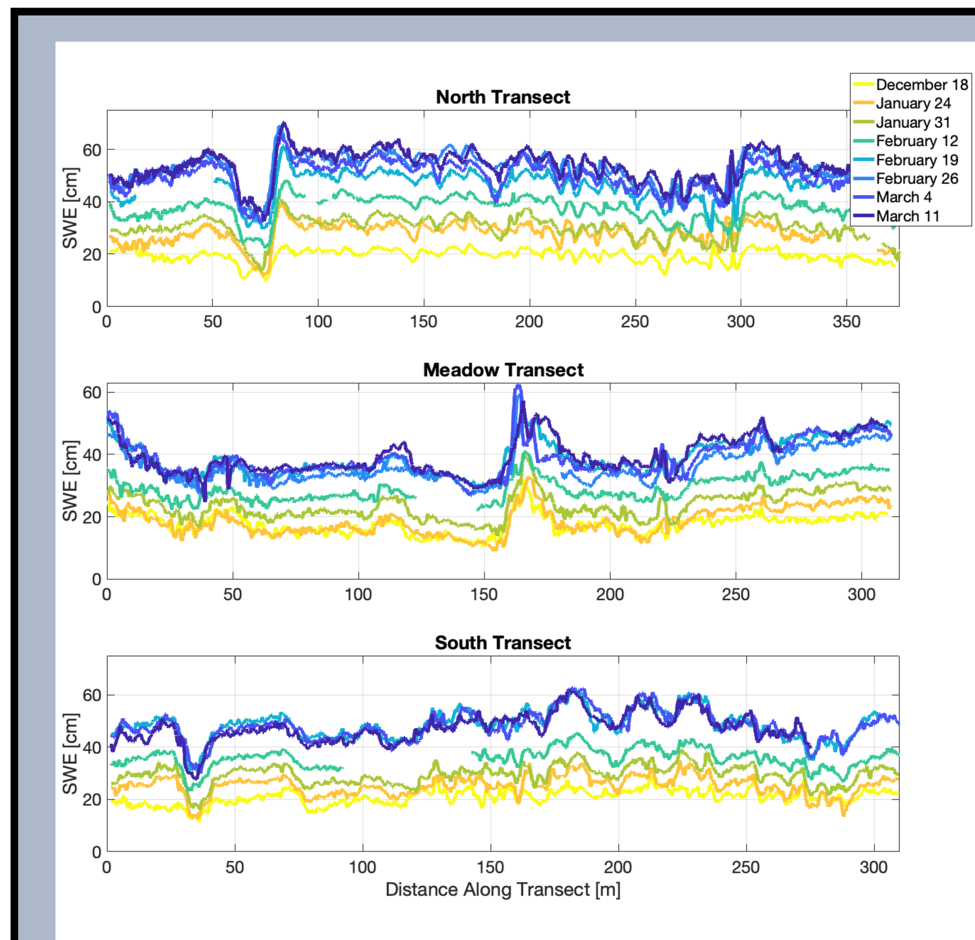
- Field observations included the standard suite of pit observations at two sites (COCPJW and COCPMR; marked by red stars).
- In addition, we conducted repeat surveys along three ~300 m transects that covered a range of canopy and aspect/slope conditions. Along these transects, we manually probed snow depths at ~3 m intervals with a GPS enabled probe and collected ground-penetrating radar (GPR) observations using a Sensors and Software system with a 1 GHz antenna.
- Lastly, we completed repeat terrestrial lidar scans with support from UNAVCO and Structure from Motion (SfM) surveys to measure distributed snow depths.

Photos of COCPJW snowpit observations, manual probing along Meadow Transect, and GPR survey along North Transect.

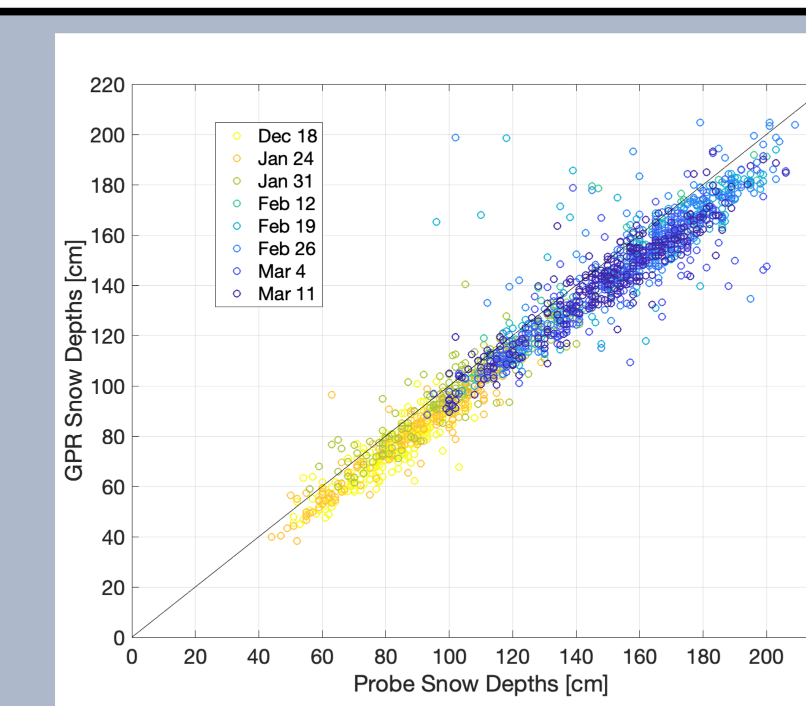


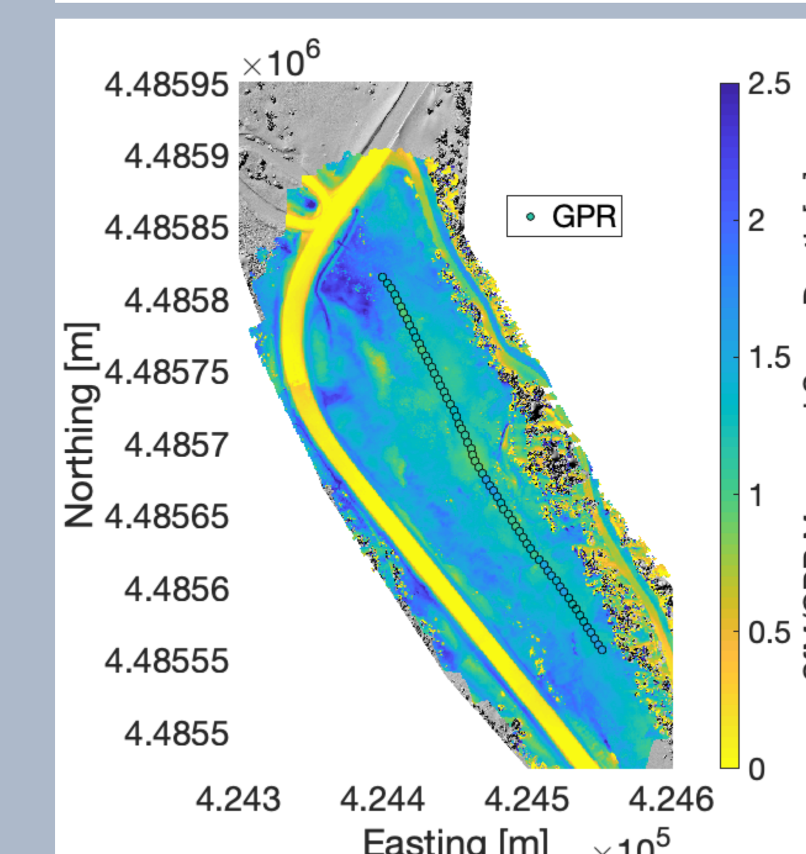
Radargram from North Transect showing bright reflector at snow-ground interface.

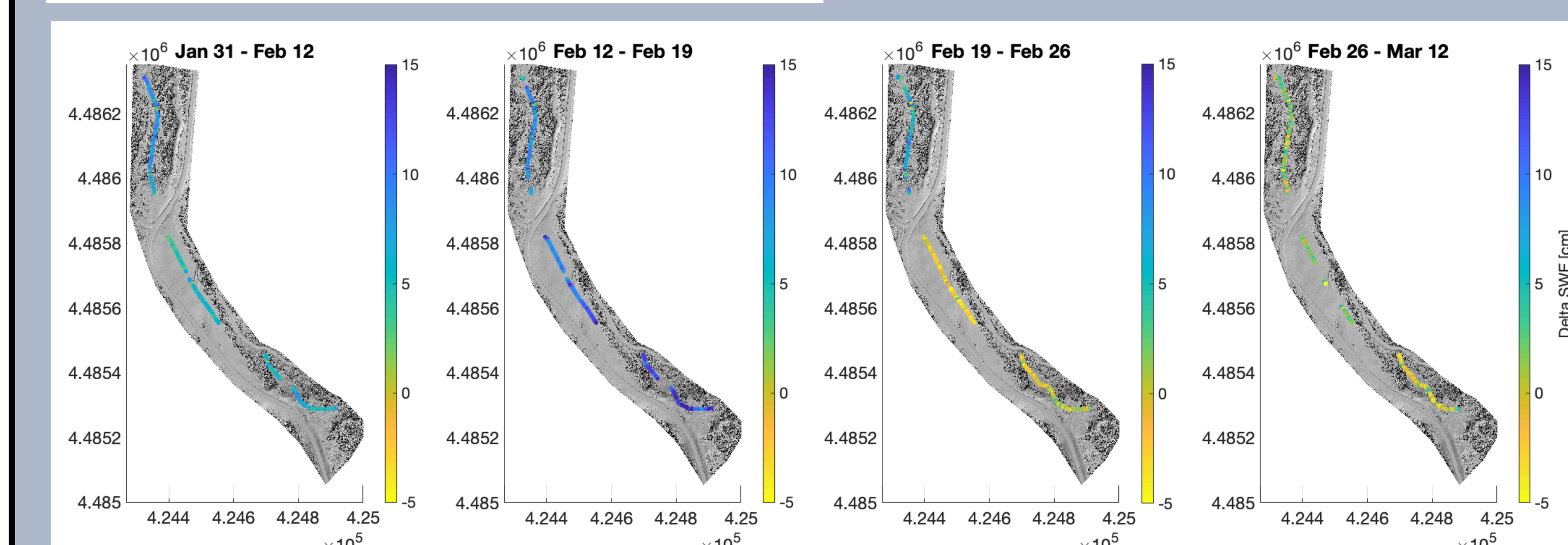
In Situ Observations



- GPR observations reveal spatiotemporal variations in SWE along the three transects.
- The most pronounced accumulation period occurred between January 31 and February 26, which coincided with four UAVSAR flights.
- Snow depths/SWE were greatest along the North Transect, which has extensive canopy cover and minimal solar radiation.
- There was strong agreement (r^2=0.97) between manual probe-derived snow depths and GPR-derived snow depths, but a consistent 8 cm bias, which we attribute to a layer of compressed vegetation at the ground-snow interface.



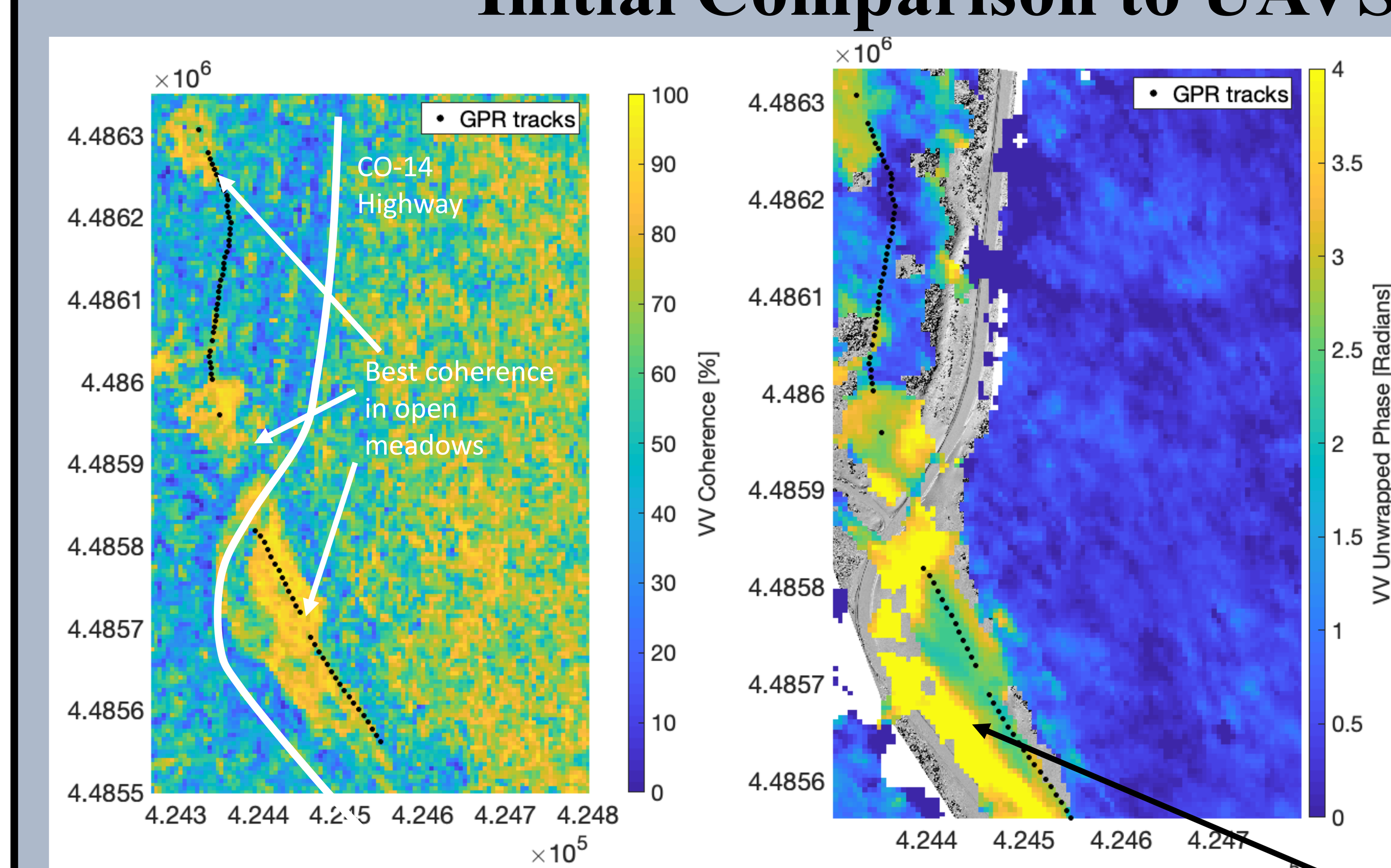


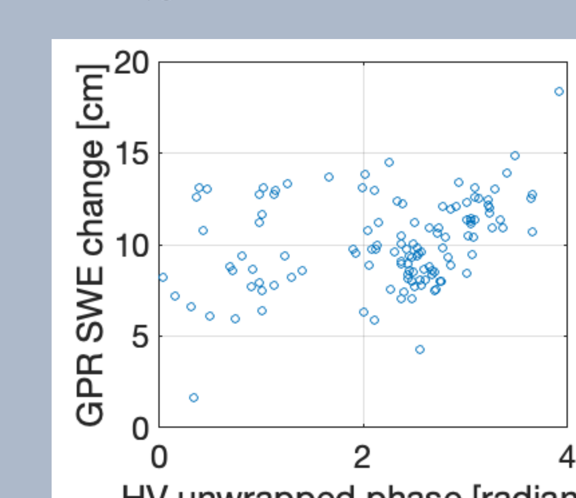


- The five UAVSAR flights result in four intervals (shown above) for detecting SWE change
- Given the unique topographic/canopy setting of each transect, SWE changes over each interval were highly variable. For example, all transects were strongly positive between Feb 12 to Feb 19, while between Feb 19 and Feb 26, the north transect was weakly positive and the meadow transect was negative.

- UAS SfM flights were performed as conditions allowed, yielding distributed snow depth maps for many survey dates.
- Preliminary analysis shows good agreement with GPR-derived snow depths.

Initial Comparison to UAVSAR InSAR





- Initial comparison between GPR SWE change and HV unwrapped phase between Feb 12-19.
- This is the focus of ongoing work!

- Initial results from UAVSAR InSAR pair from February 12 and 19 shows coherence between 30-90%, with the best coherence in open meadow/slopes
- VV unwrapped phase exhibits coherent pattern in open meadows, with pronounced phase changes associated with snowplow operations

Data Access

Both raw and Level 1 (TWT, depth, SWE) GPR products have been submitted to NSIDC.

Pit/probe data will be submitted jointly with other time-series sites.

SnowEx17 GPR data (Webb et al., 2019) is available here: https://doi.org/10.5067/G21LGCNLFSC5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