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An Evaluation of Low-Cost Data Collection Platforms for Structure From Motion on Subaerial Beaches and Dunes

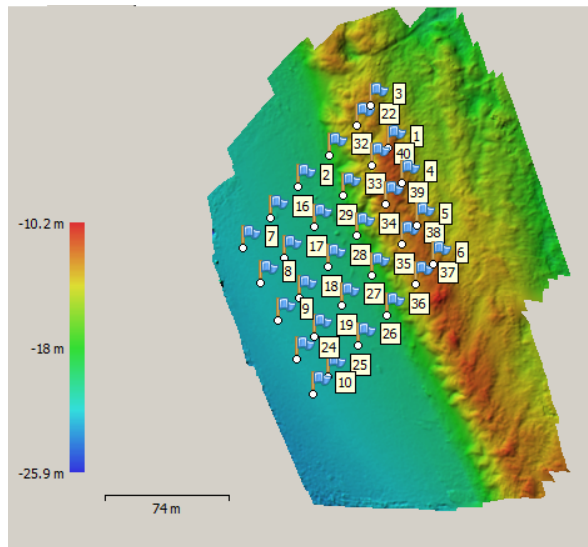
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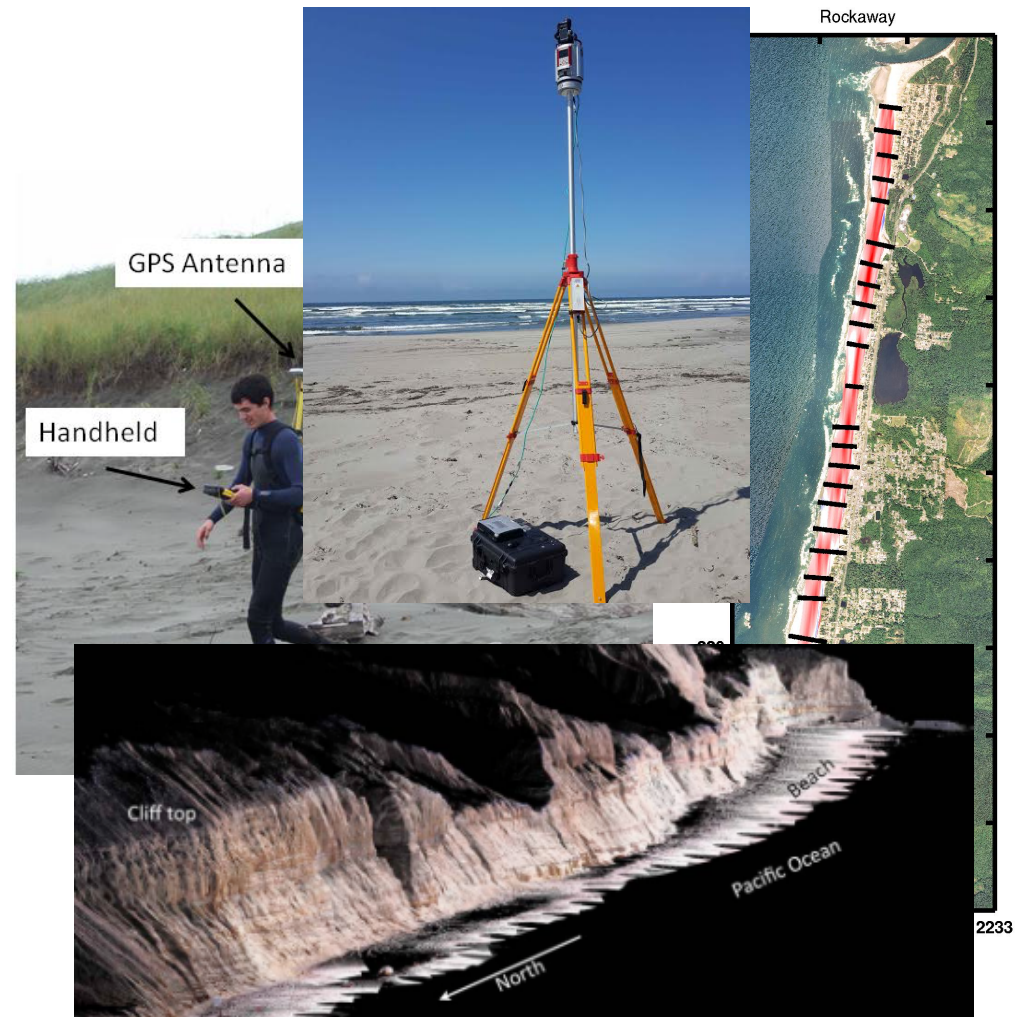
What's ahead

- Introduce a low-cost and efficient technique for geomorphic data extraction called Structure from Motion (SfM)
- Evaluation of multiple low-cost SfM data collection platforms through a cost vs. performance analysis



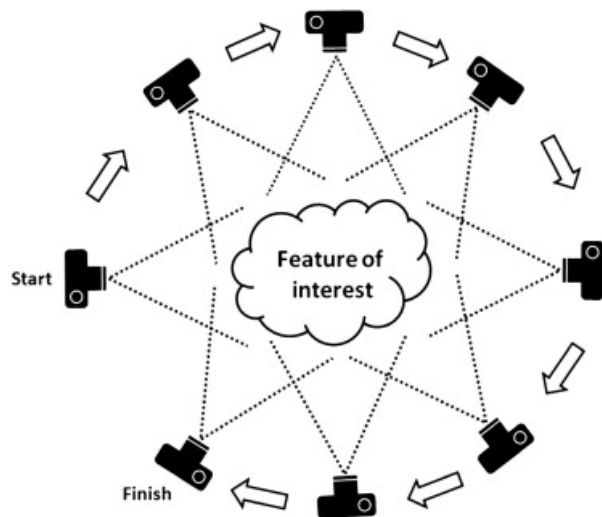
Background- measuring subaerial beach and dune morphology

- Some current methods:
 - RTK GPS- ~5cm vertical accuracy, but requires lots of time and effort for relatively little data
 - TLS- highly accurate and spatially continuous data, but expensive and necessitates a high level of training

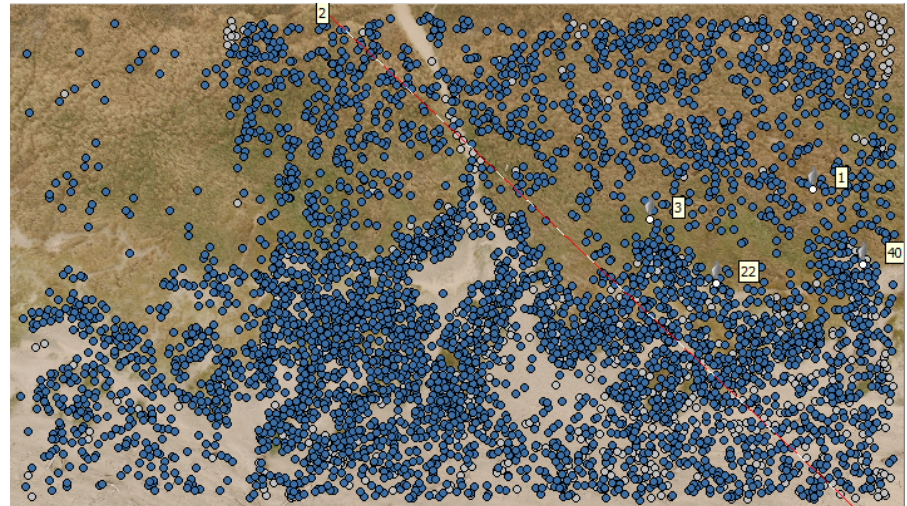


Structure from Motion: accurate, efficient, low-cost, and user-friendly

- 3-d reconstruction of a surface built from overlapping aerial photos
- Workflow:
 - Features ID'd and tracked across photos, solving automatically for camera intrinsic and extrinsic parameters, scene geometry



Westoby et al., 2012



Westoby et al., 2012

SfM is Flexible

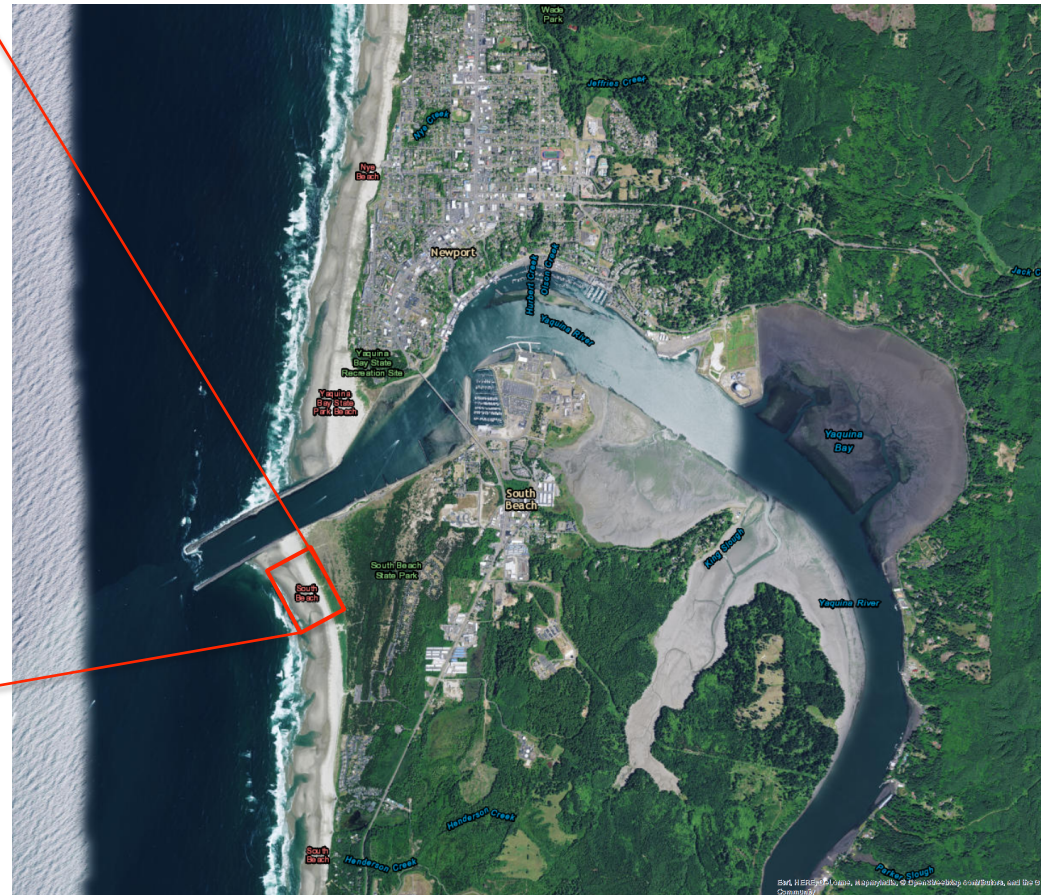
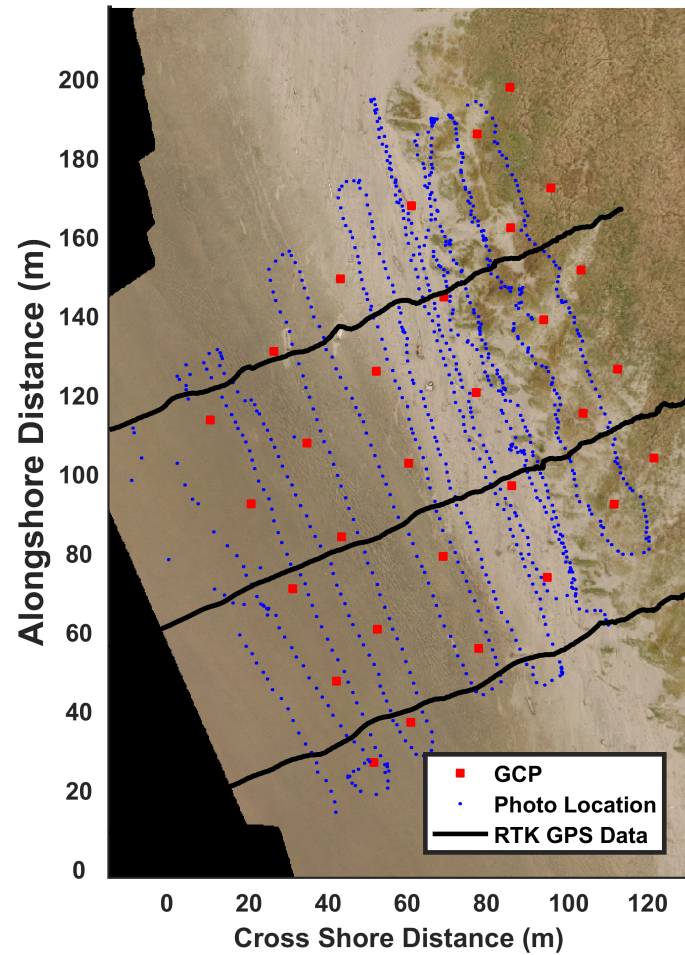
- Many applications of SfM on the coast:
 - Sea cliff retreat rates (Warrick et al., 2016)
 - Intertidal ecology (Bryson et al., 2016)
 - Subaerial beach changes (Turner et al., 2016)
- This stems partially from flexibility in data collection platform
 - UAVs, kites, poles, balloons, airplanes, and any camera



Aim of this Study

- Create quantitative comparison between low-cost SfM platforms on subaerial beaches and dunes
 - Provide outline for other SfMers to select optimal platform to obtain desired data

Study Site and Image Collection



Data Collection Platforms

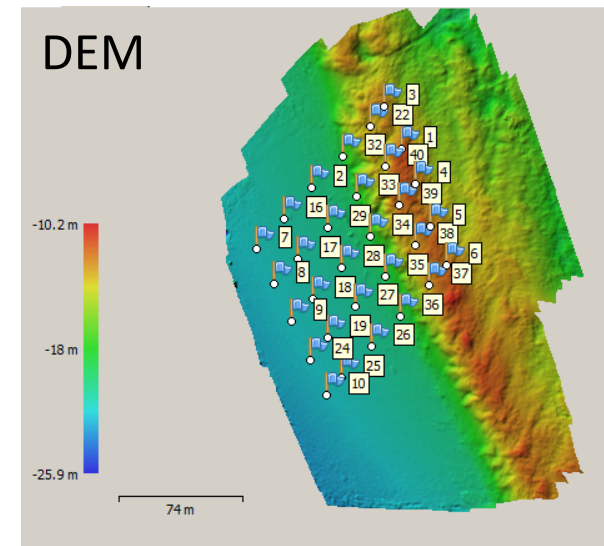
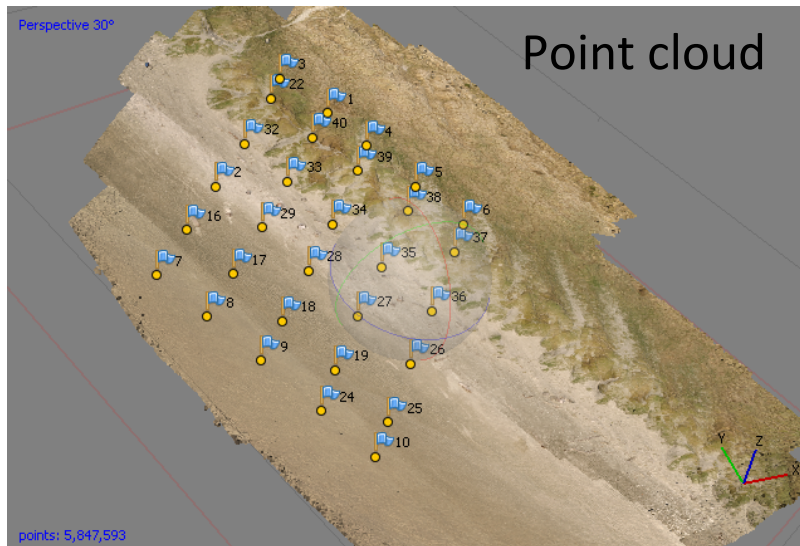


Frames

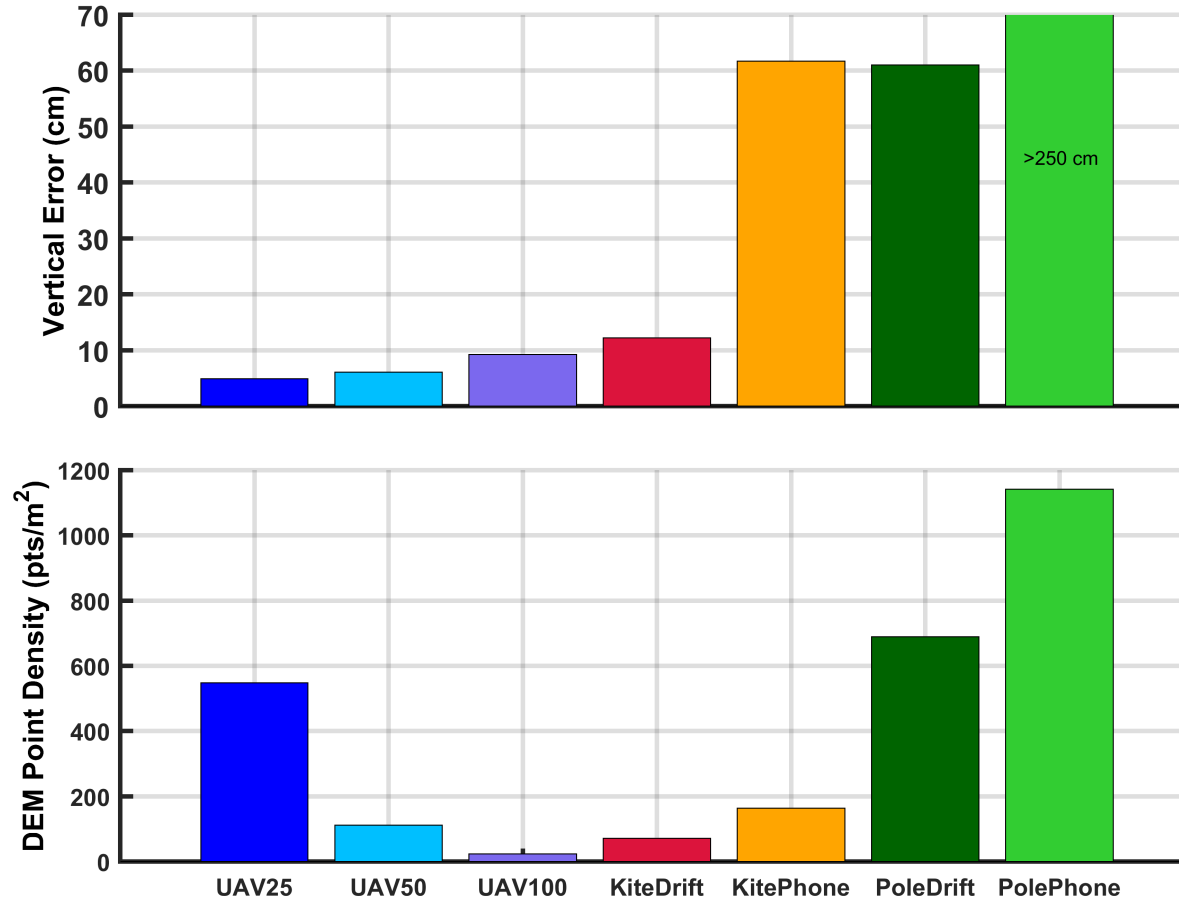
Cameras

SfM Image Processing

- Images from each platform run through SfM workflow using Agisoft Photoscan
- DEM created for each platform's data



Comparison of Platforms



Notes:

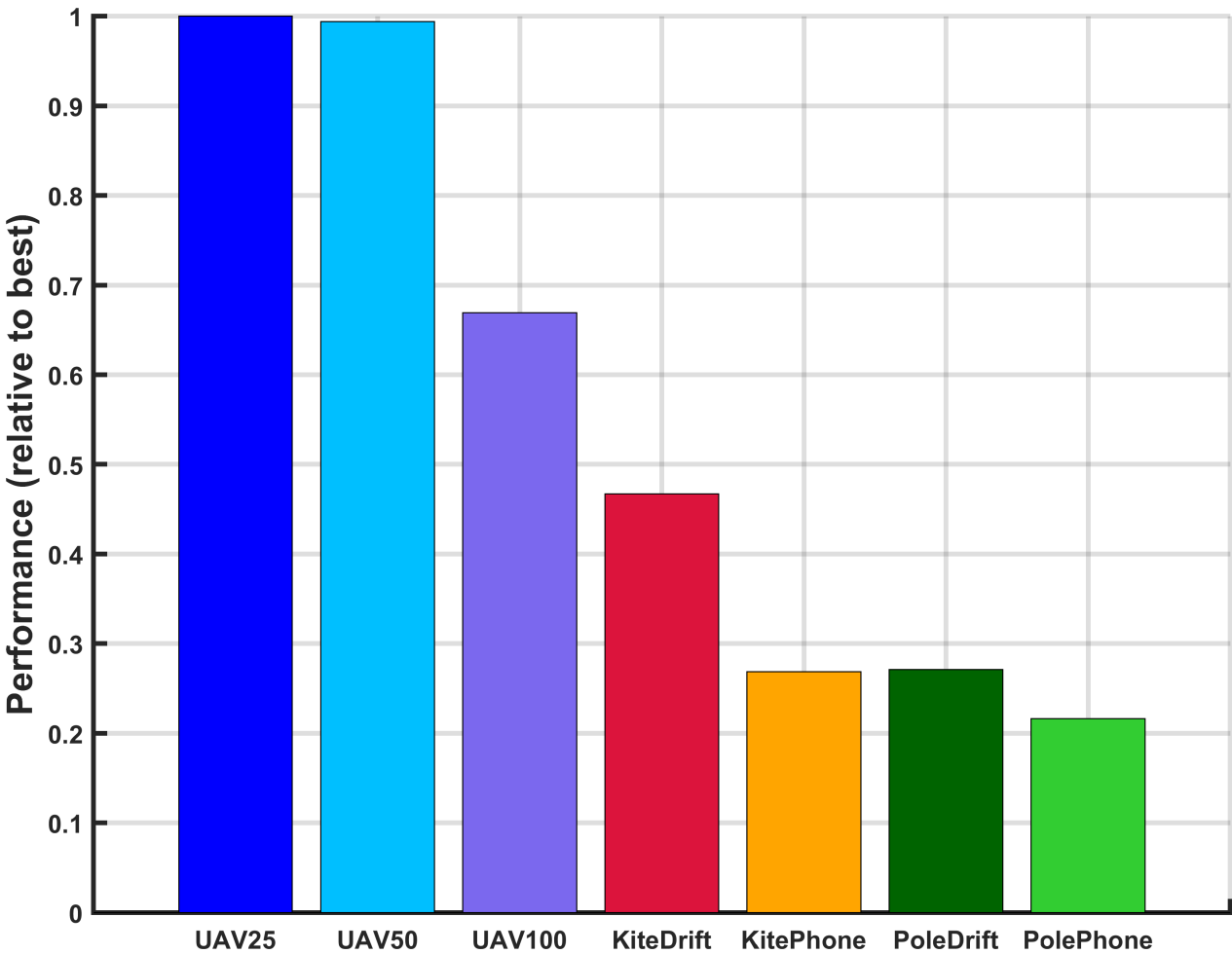
1. UAV creating very accurate DEMs, kite and pole less so
2. Pole creating very spatially dense DEMs
3. Lower quality camera producing more accurate results with kite and pole

Platform Evaluation- a Cost vs. Performance Analysis

- Compare platforms through cost vs. “performance”
- Use methods adapted from environmental systems analysis and operational research
 - Scored categories
 - Category weights

$$Performance = \frac{\sum_{i=1}^{i=n} (Score_i * Weight_i)}{n}$$

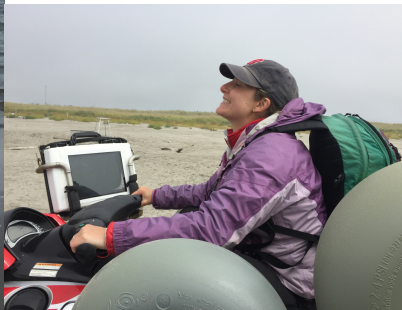
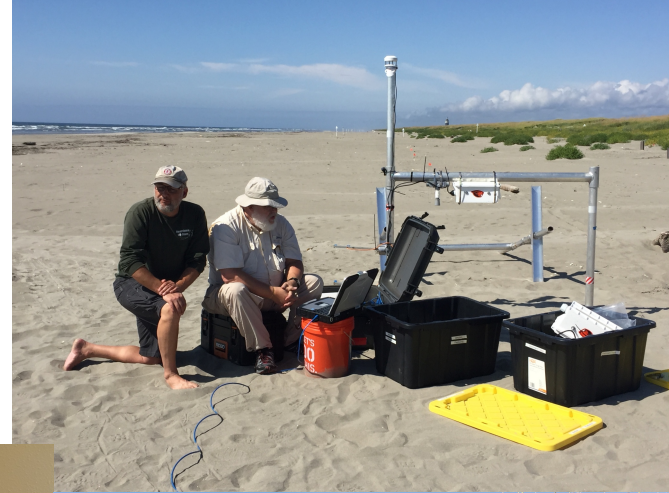
Initial Results of the Cost vs. Performance Analysis



Category	Vertical Accuracy	DEM Point Density	Proportion of Area Modeled	Time to collect photos	RMS GCP Position Error	Processing Time per Image
Weight	.61	.07	.07	.21	.02	.02

Preliminary Conclusions and Work to Do...

- UAV only platform creating consistently reliable data
- Lower cost platforms could still be useful
- To do:
 - Solidify PIs, perform full cost vs. performance analysis
 - Explain why some platforms perform better than others



Acknowledgements

- NSF grant EAR GLD 1561847 The Influence of Intertidal Sandbar Welding on Dune Growth
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