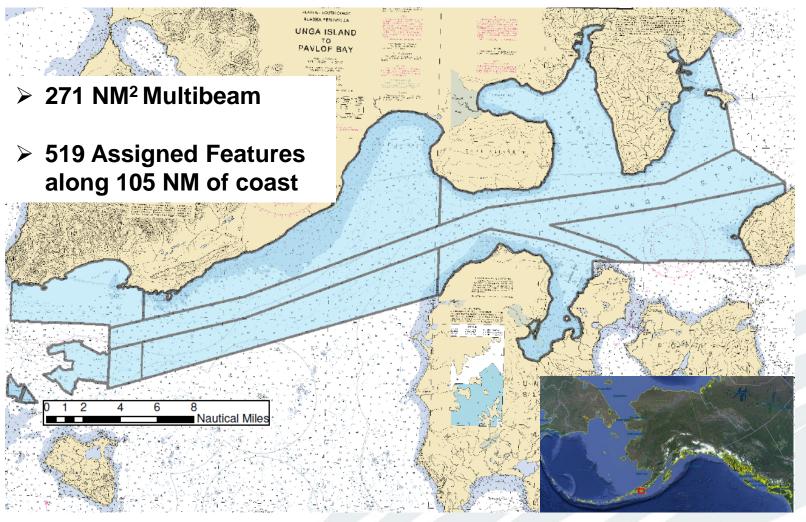
## **Shoreline Verification with Unmanned Aerial Systems**



Tim Smith, TerraSond Limited Alaska Coastal Mapping Summit February, 2018 TERRAS ND

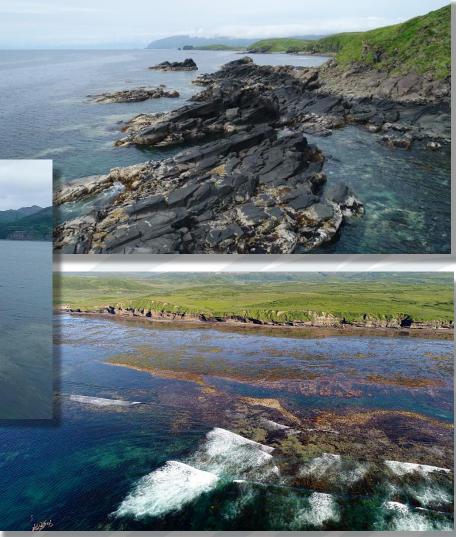
## **Pavlof Islands and Vicinity Project Area**



## **Common Shoreline Features**

- Rocks & Islets
- Ledges & Reefs
- Foul Areas & Kelp





Photos from this project via UAS

## **Vessel-based Investigation Methodology**

Investigation via Skiff:

- Navigate to assigned features
- Ranges and bearings
- Visually estimate heights







## **Vessel-based Investigation Methodology**

Some problems with skiff-based approach:

- Can't approach features
- Low-confidence measurements
- What is NOT seen?
- Low efficiency
- Safety concerns







## **UAS (Drone) Equipment**

DJI Phantom 4 Professional (P4P):

- ➢ 3 lbs
- GNSS positioning
- ~ 20 minute flight time (real-world)
- Camera 20 megapixel, gimbal stabilized
- > Affordable, simple



### **Mission Planning**



55°21'26.59" N 161°26'00.56" W elev -1 ft eye alt 7494 ft 🔘

**V**F

## Launch

- Manually-controlled launch
- > After clear of vessel, initiate pre-planned mission



## **Automatic Photo-taking**

- 2-second photo interval
- 45 km/hr normal flight speed
- > 120 m (~ 400') altitude

- > At least 3 photos per object
- > Average 375 photos per mission





> Manually-controlled recovery



### **Processing**

#### Examining hundreds of photos individually not an option...

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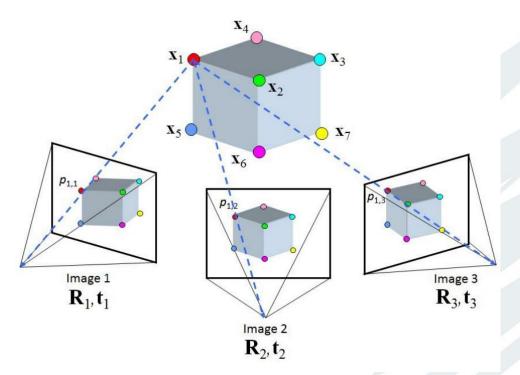
**TERRAS** 

Offline availability: Not available

## Processing

- Agisoft PhotoScan Professional
- Ortho-rectified photomosaics AND 3D-point clouds via SfM

"Structure from motion (SfM) is a photogrammetric range imaging technique for estimating three-dimensional structures from two-dimensional image sequences" - Wikipedia



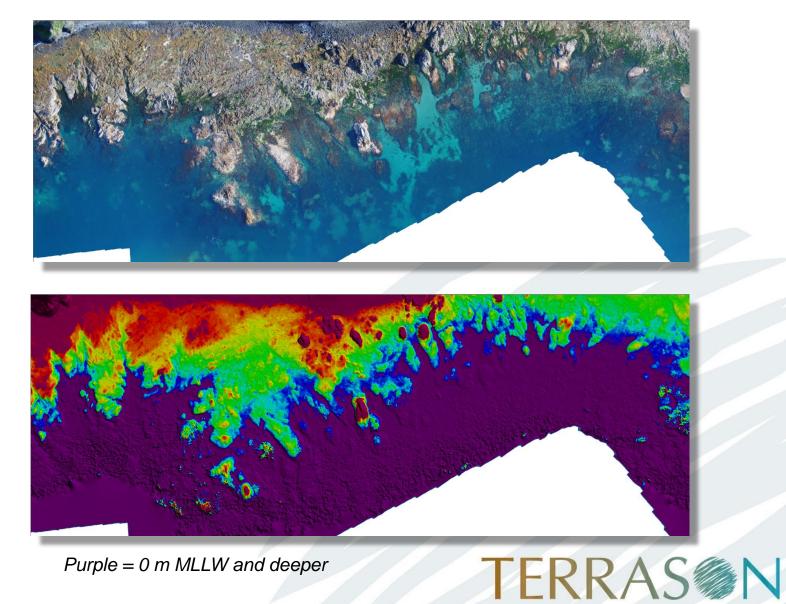
Important elements:

- Minimum 3 photos per object
- Common tie points
- Photo position (geotag) for absolute positioning

ZAS

 Perspective (nadir to oblique)

## **Processing Products**

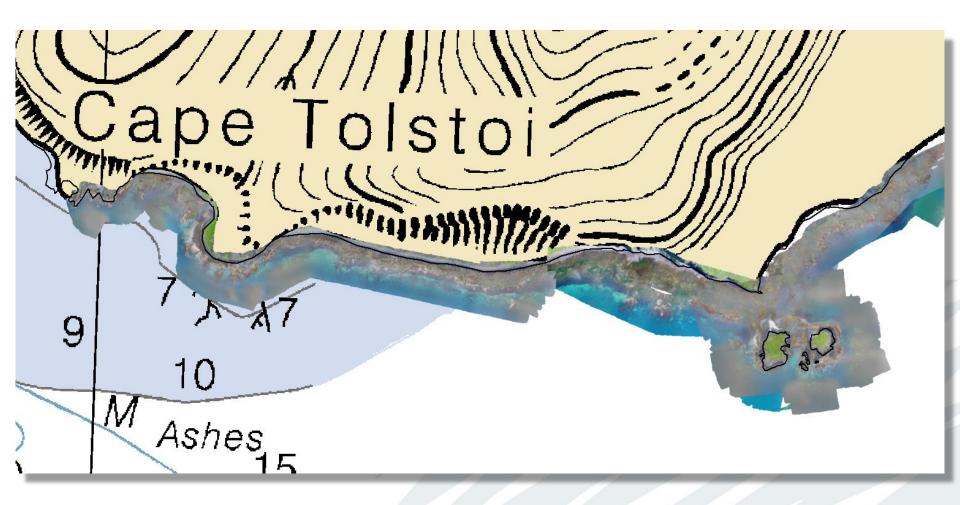


Purple = 0 m MLLW and deeper

#### Ortho

#### DEM

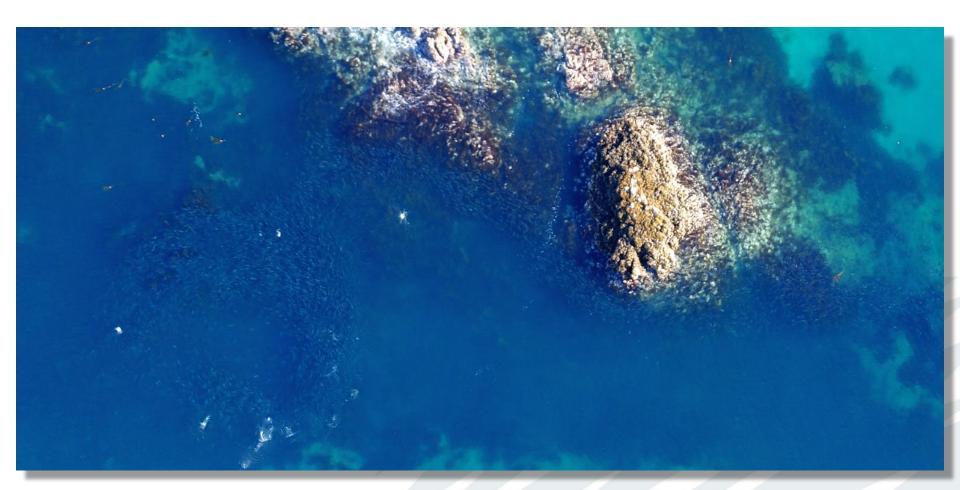
### **Ortho-photomosaics**



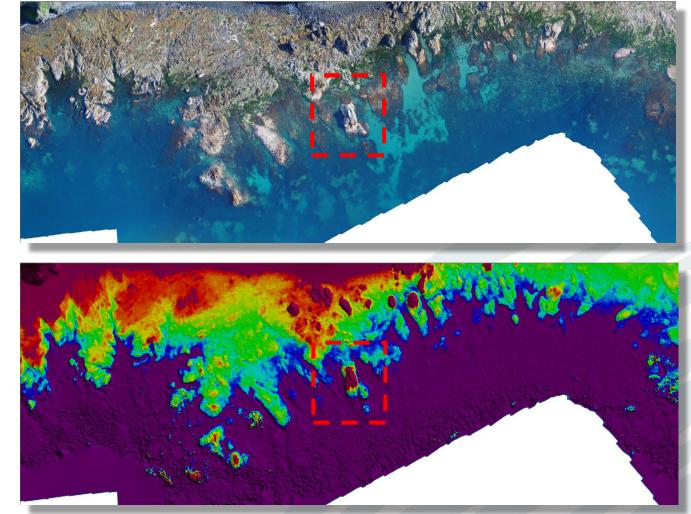
### **Ortho-photomosaics**



### **Ortho-photomosaics**



### **SfM Derived DEMs**

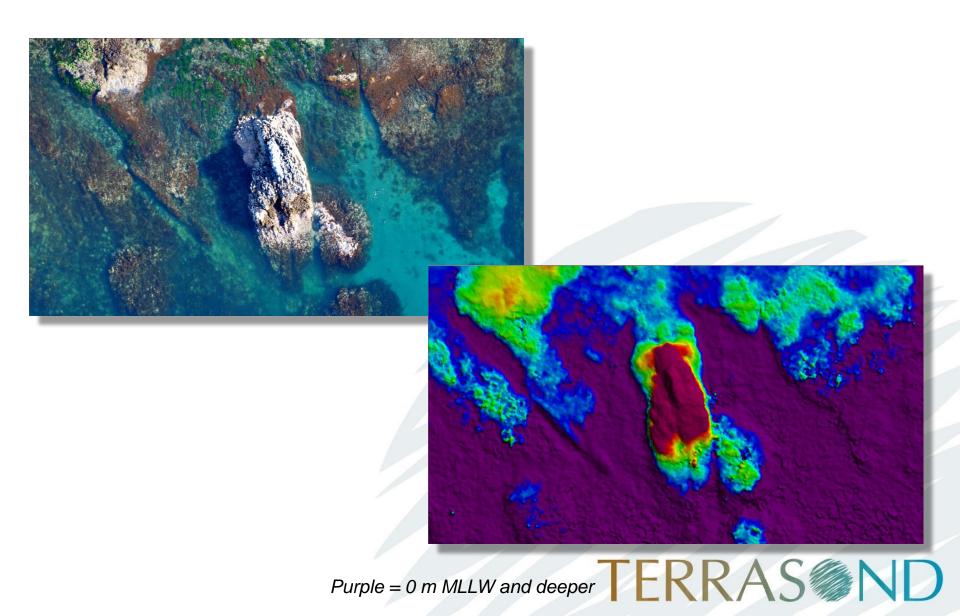


Purple = 0 m MLLW and deeper

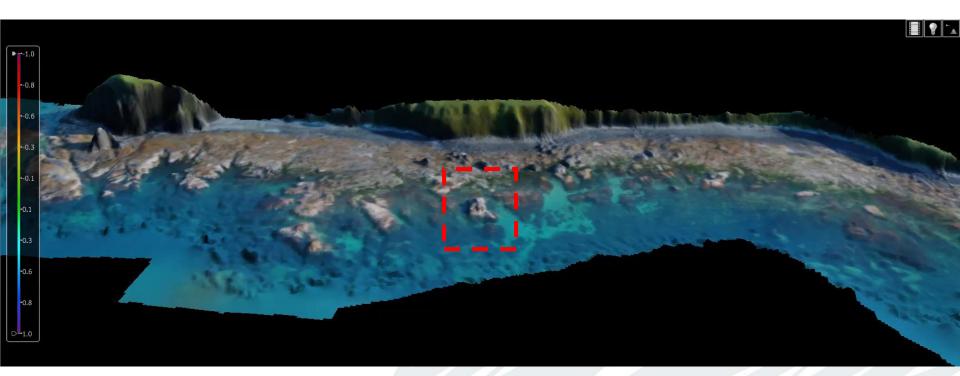
#### Ortho

#### DEM

### **SfM Derived DEMs**

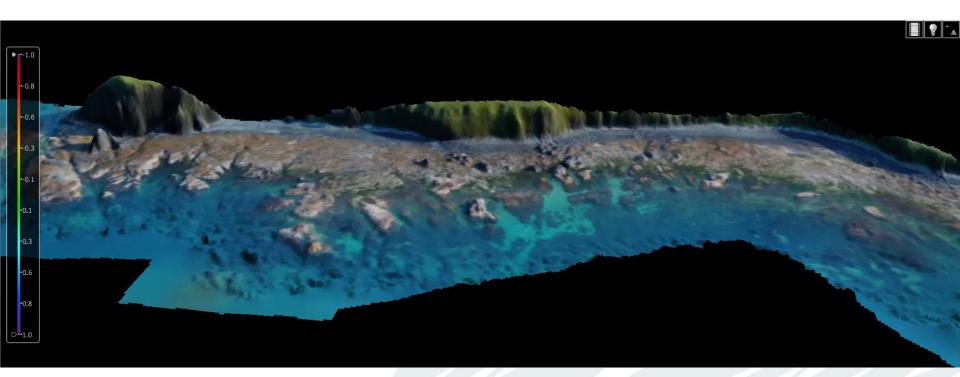


## **Ortho-DEM Drape (in CARIS HIPS)**



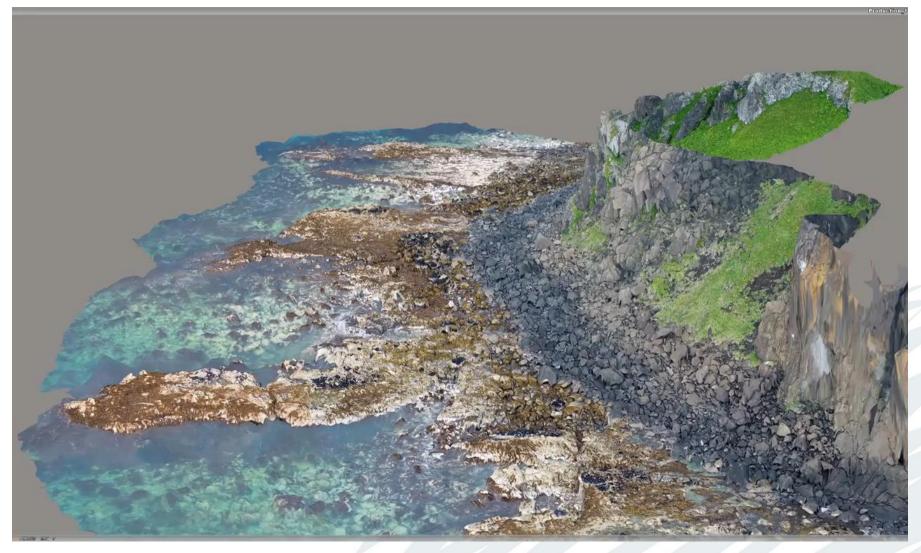
## Purple = 0 m MLLW and deeper TERRAS ND

## **Ortho-DEM Drape (in CARIS HIPS)**

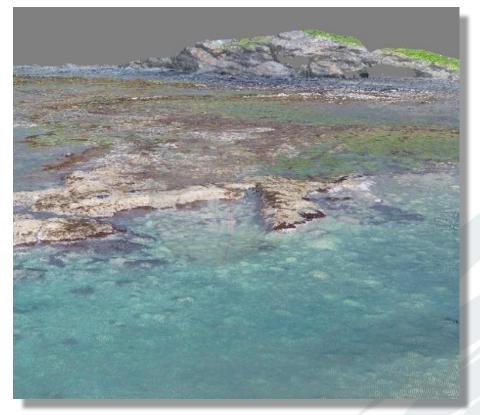


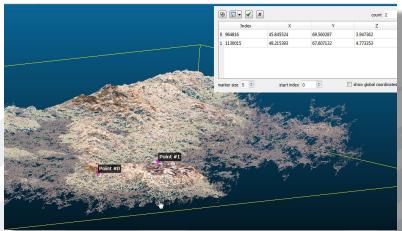
## Purple = 0 m MLLW and deeper TERRAS ND

### **Ortho-DEM Drape**



### **Point Cloud Adjustment to MLLW**





### **Point Cloud Adjustment to MLLW**



#### **Verification of Assigned Features**

- SfM products overlaid with assigned features
- Features verified and deconflicted

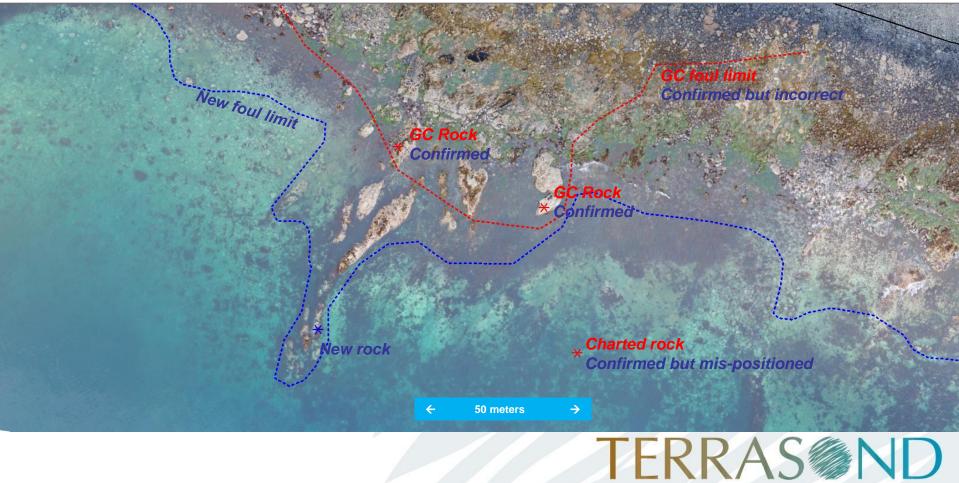
Assigned features



#### **Verification of Assigned Features**

- SfM products overlaid with assigned features
- Features verified and deconflicted

Assigned features Verification results



#### **Verification of Assigned Features**

- SfM products overlaid with assigned features
- Features verified and deconflicted

Assigned features



#### **Verification of Assigned Features**

- SfM products overlaid with assigned features
- Features verified and deconflicted

Assigned features Verification results



Compared to traditional, vessel-based investigation:

### **PROS**:

✓ Quality

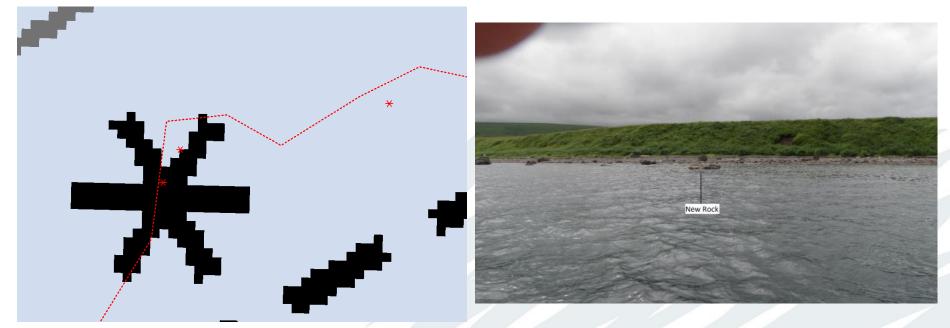
#### Quantitative - not estimated / interpolated



Compared to traditional, vessel-based investigation:

### **PROS**:

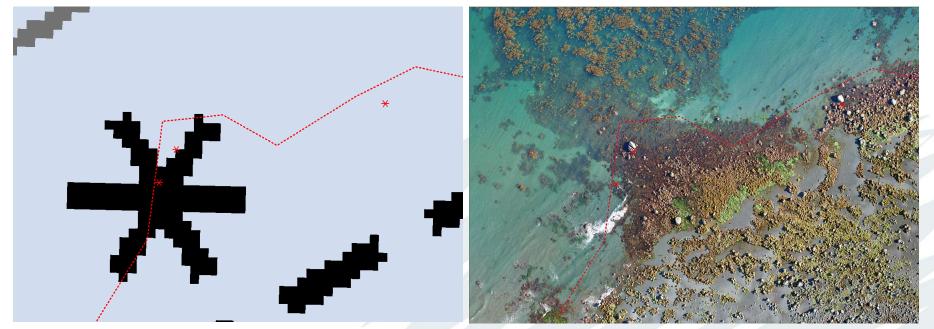
Comprehensive – wholistic view of the shoreline area



Compared to traditional, vessel-based investigation:

**PROS**:

Comprehensive – wholistic view of the shoreline area



Compared to traditional, vessel-based investigation:

## **PROS**:

- ✓ Quality
- ✓ Efficiency

- About 2 NM per 15-20 minute flight
- No skiff deployment
- Reposition larger vessel between flights

TERRAS

• Two drones airborne at once



Compared to traditional, vessel-based investigation:

## **PROS**:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity





- Simple, off-the-shelf
- Fits in a small case
- Easy to learn

Compared to traditional, vessel-based investigation:

### **PROS**:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY



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#### STAY ON THE BIG BOAT, DRINK COFFEE, INVESTIGATE SHORELINE!

Compared to traditional, vessel-based investigation:

### **PROS**:



✓ SAFETY



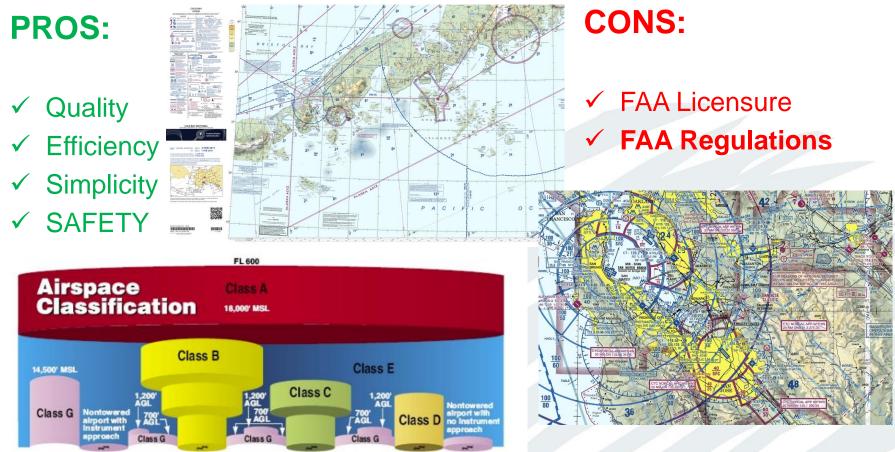
### CONS:

 $\checkmark$ 



**FAA Licensure** 

Compared to traditional, vessel-based investigation:



Compared to traditional, vessel-based investigation:

### **PROS**:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY

- Probably MORE windcapable
- But, precipitation & visibility are concerns

### CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations

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✓ Different Wx Windows



Compared to traditional, vessel-based investigation:

### **PROS**:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY

## CONS:

✓ FAA Licensure
✓ FAA Regulations
✓ Different Wx Windows
✓ Training & Procedures

Compared to traditional, vessel-based investigation:

### **PROS**:

- ✓ Quality
- ✓ Efficiency
- ✓ Simplicity
- ✓ SAFETY

### CONS:

- ✓ FAA Licensure
- ✓ FAA Regulations
- ✓ Different Wx Windows
- ✓ Training & Procedures

TERRAS

More Data

- ~ 200 GB raw
- ~ 1 TB processed (larger than the CARIS dataset)

# **Summary / Looking Forward**

- Took over 25,000 photos
- > 200 km of coastline
- 700 features

- Will continue to use!
- Shoreline, scouting, documentation
- New technology
- Other Possibilities:



- Full shoreline verification (with ground control)
- Bathymetry from SfM...

## **Questions?**



3D rendering from SfM of Unga Point ATON

