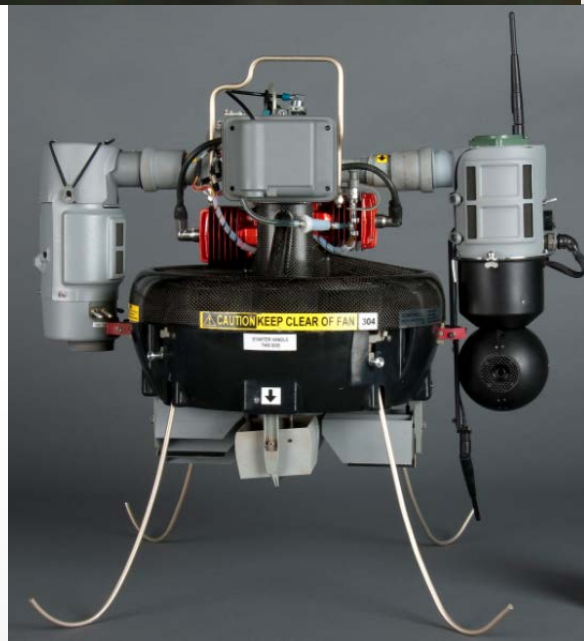
OSMRE UAS Program 2018

Background

OSMRE UAS Study 2012-2014

- 45 UAS flights conducted
- 22 mine permits
- 12,739 acres viewed
- Evaluate quality of data collected
- Evaluate multiple applications
- Evaluate effective use for the AR region
- Cost-benefit of UAS proven
- Multiple Systems tested
- Required non-OSMRE pilots
-



Current Status
OSMRE UAS Team
2015-2018

- OSM's UAS Team officially formed in 2017
  - Mission: Incorporate UAS into OSM's aviation program, guide the use of UAS in SMCRA and national airspace
- Missions completed through 2018
  - IN – AML (Prime Farmland)
  - TN – Landslide
  - PA – Isabella PA
  - AL – AML (July 2018)
- >10 OSMRE staff carded under DOI (More pilots coming soon!!)
- Finalized National Aviation Plan and SOP
  - MCR currently has 2 pilots, AR region has 10+

UAS classes

OSMRE:

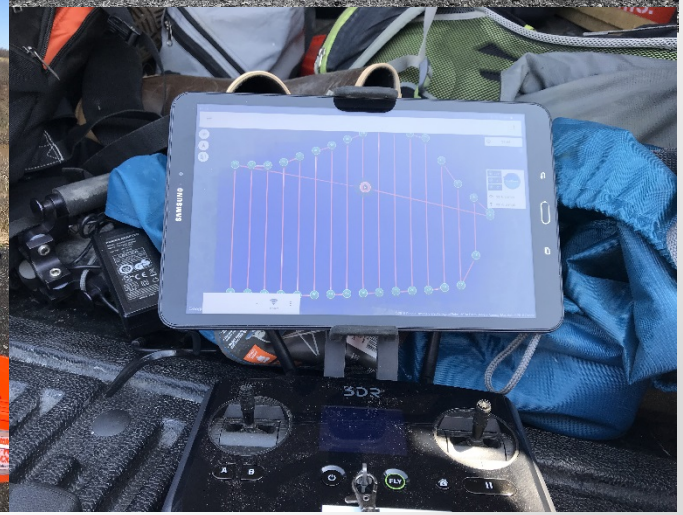
- 3DR Solo UAS (multiple)
- DJI – Soon (2019?)
- Firefly VTOL (soon - western region)

SMCRA states:

- DJI Phantom 4 (KY, AK, WV, PA, WY, others?)
- Fixed wing UAS (e-bee) – VA
- DJI Inspire 2 (VA)

UAS Data Collection (Isabella)

- 10 flights over two days using a 3DR Solo Quadcopter
- 3DR Tower App used on a Samsung tablet
- Ricoh camera took 1 photo per second
- Between 400-760 photos per flight
- Luke and his team



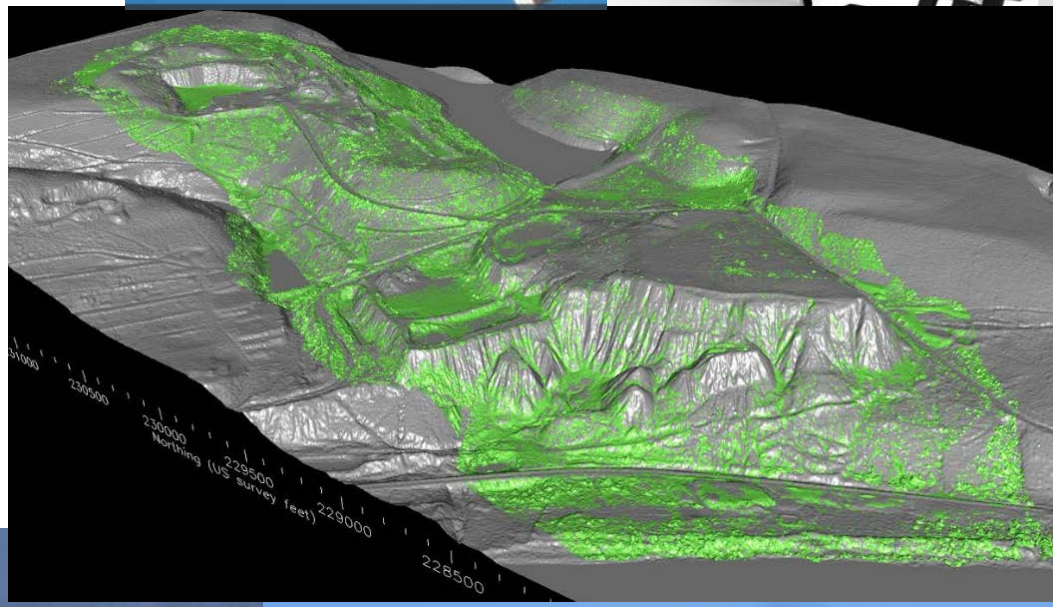
Applications

Agriculture

- Crop Monitoring/Plant Health
- Multispectral analysis - NDVI Mapping

Aerial Photography and Videography

- Inspections (AML and TitleV)
- Feature identification (highwalls, slides)
- Construction Site Monitoring
- Thermal Imagery (mine fires)
- Surface Water investigation



Surveying / 3D modeling

- Contour Mapping
- Orthomosaic Images
- Volumetric Calculations
- Point Clouds
- DEMs/DTMs

Future

- LiDAR collection

Sensors (Cameras)

Standard RGB Cameras

- GoPro
- Ricoh GR II
- MAPIR RGB

Multispectral Cameras

- MicaSense

Thermal Cameras

- FLIR

Lidar Sensors (future)

- Yellowscan, etc.

Basic Components

- Frame and Landing Gear
- Propellers
- Brushless Motors with motor mounts
- Batteries, typically Lithium Ion or Lithium Polymer
- Electronic Speed Controllers
- Flight Controller, IMU, accelerometer
- Compass, gyroscope
- GNSS Module
- Antenna and Receiver
- Gimbal w/ motor, controller unit
- Camera/Sensors
-

Workflow

- Flight is Requested
  - By states/tribes/OSM
- Flight Planning
  - What platform and sensors needed
  - Flight path determined
  - Project Aviation Safety Plan, Risk Assessment
  - NOTAM Filed, Airport Towers contacted
- Flight is conducted by FAA licensed/DOI carded pilots
- Raw Data Captured and Stored
- Data processing
  - Photos are filtered, geotagged, processed (i.e. Agisoft Photoscan, etc)
- Deliverable Product and Data Storage
  - 3D models, Contour Maps, DEMs, Point Clouds, Orthomosaics
  - Photos, Videos

Software

Photogrammetry

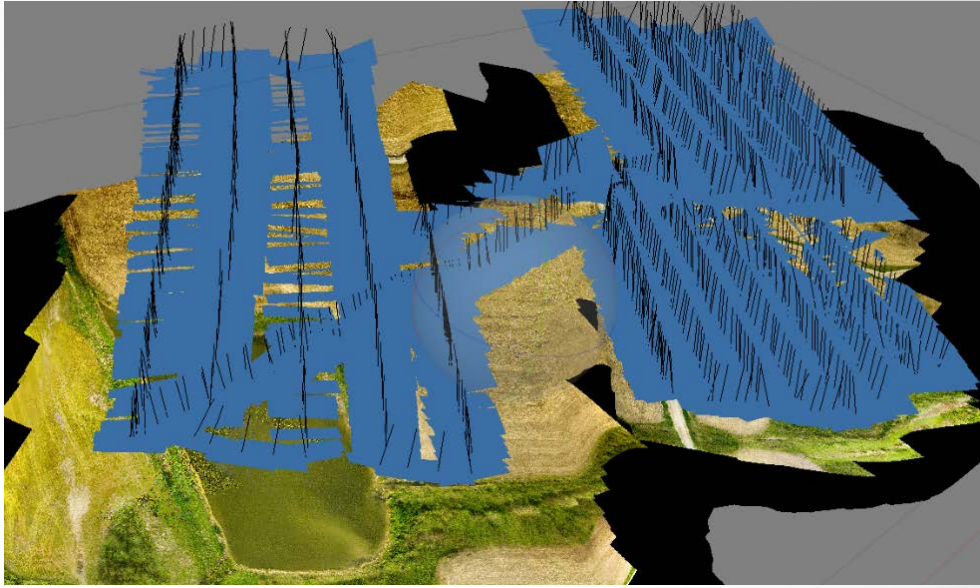
- Autodesk ReCAP
- AgiSoft Photoscan
- ESRI Drone2Map
- Pix4d
- Global Mapper V.19
- Drone Deploy (cloud based)

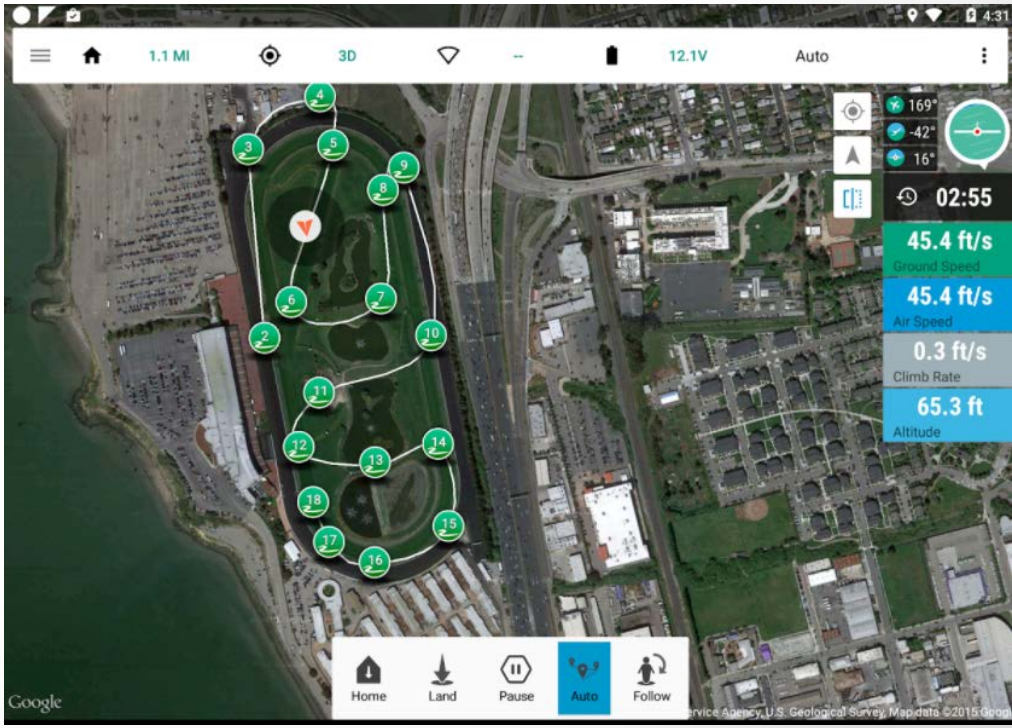
Additional Software

- Geosetter
- Photoshop/Lightroom
- Premier, AfterEffects
- VLC Player

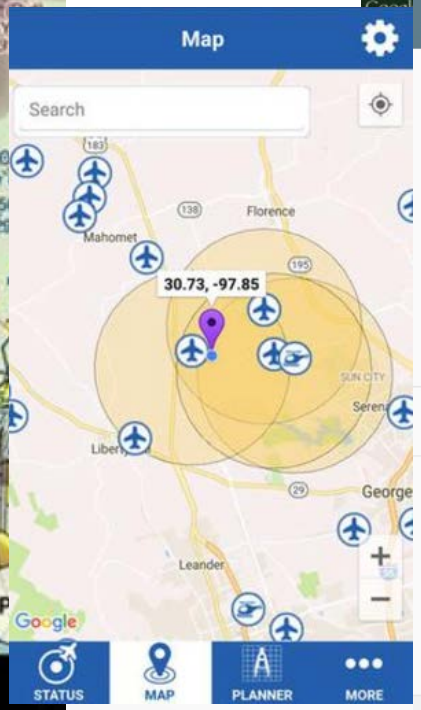
Ground Control Software

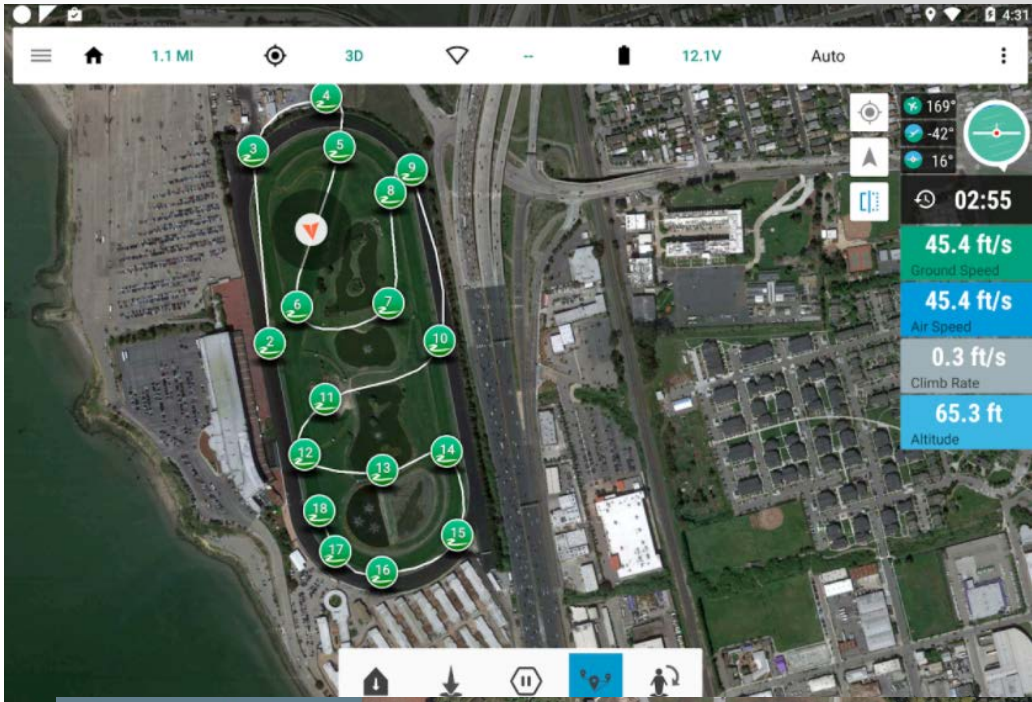
- Solo UAS App
- Tower App
- Mission Planner

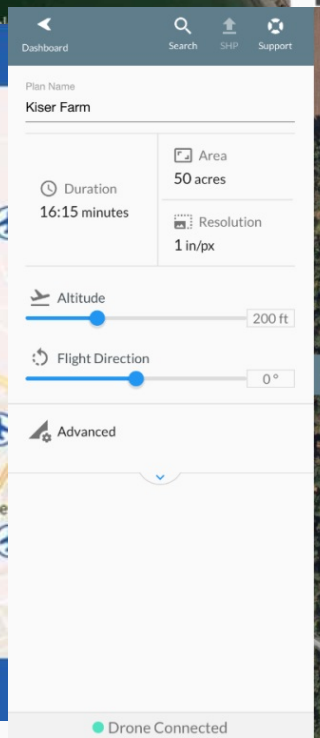


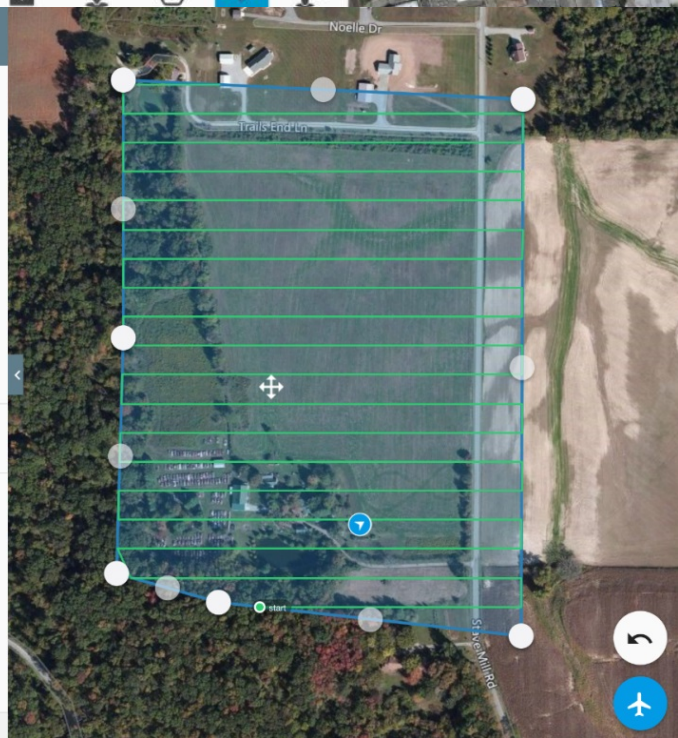


Smartphone/Tablet Apps



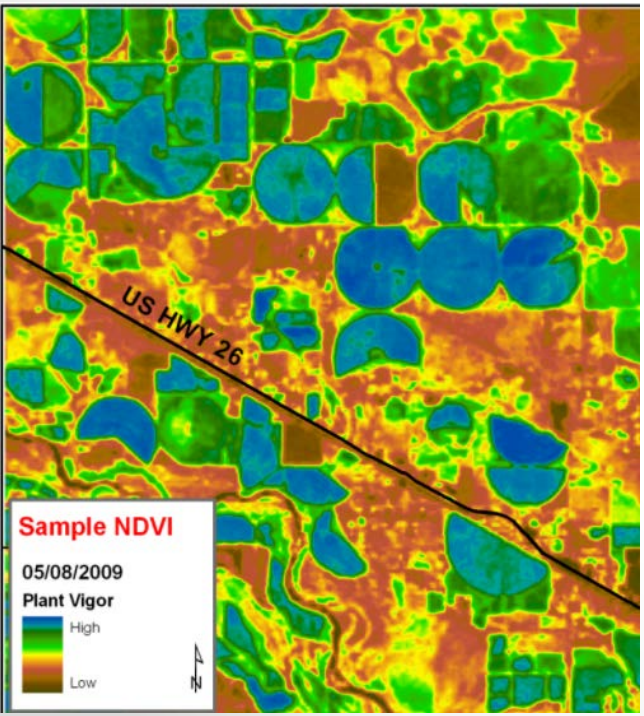


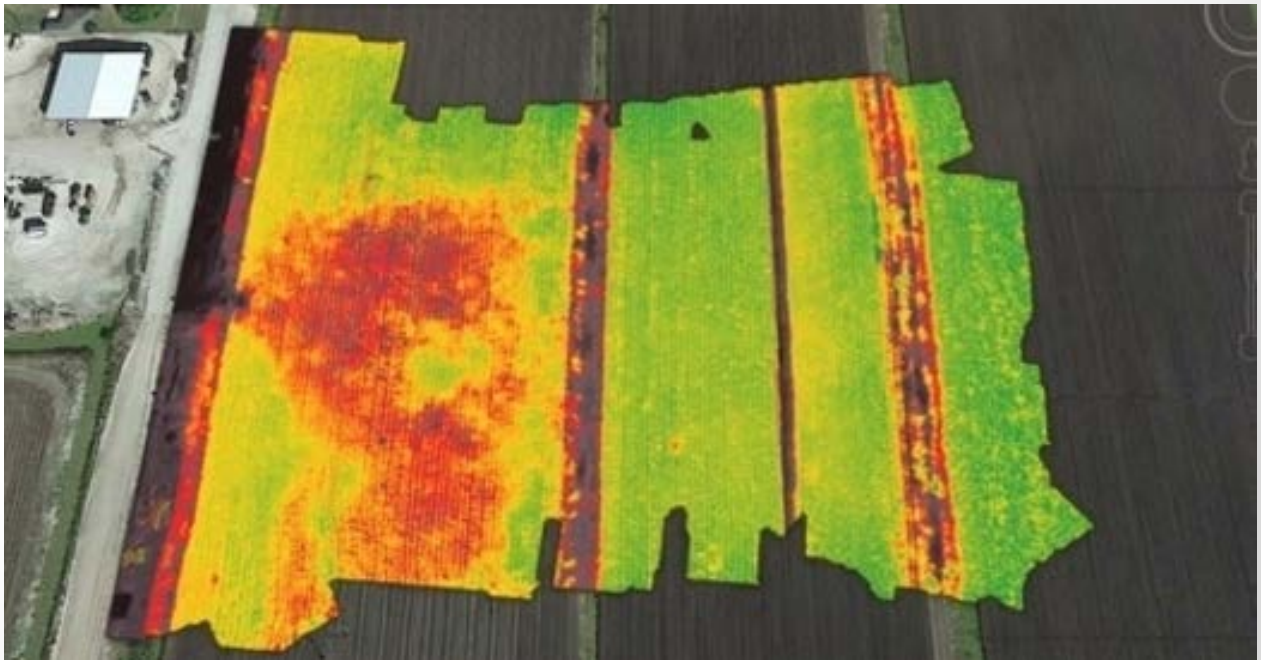




NDVI

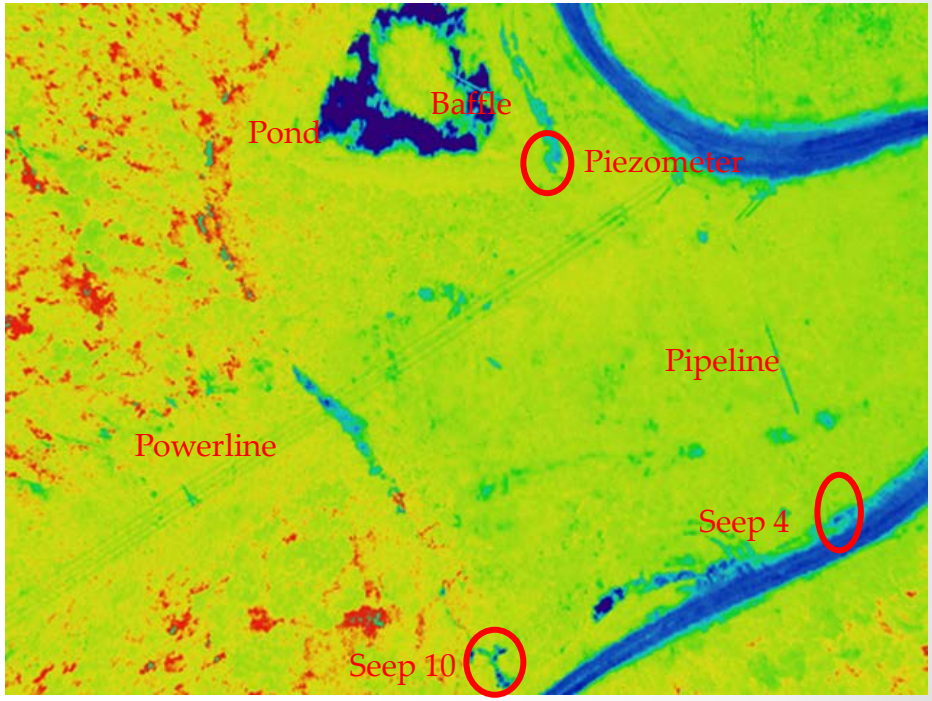
- Normalized Difference Vegetative Index
- Ratio of Near Infrared & Visible (RGB) wavelengths and intensity
- Measure crop health, vegetative abundance by chlorophyll absorption and reflection of these bands





What else can we do with the data?

- Color Infra-red-
  - Plants, soil moisture and water clarity
- NDVI images
  - *Intensity and density of vegetation*

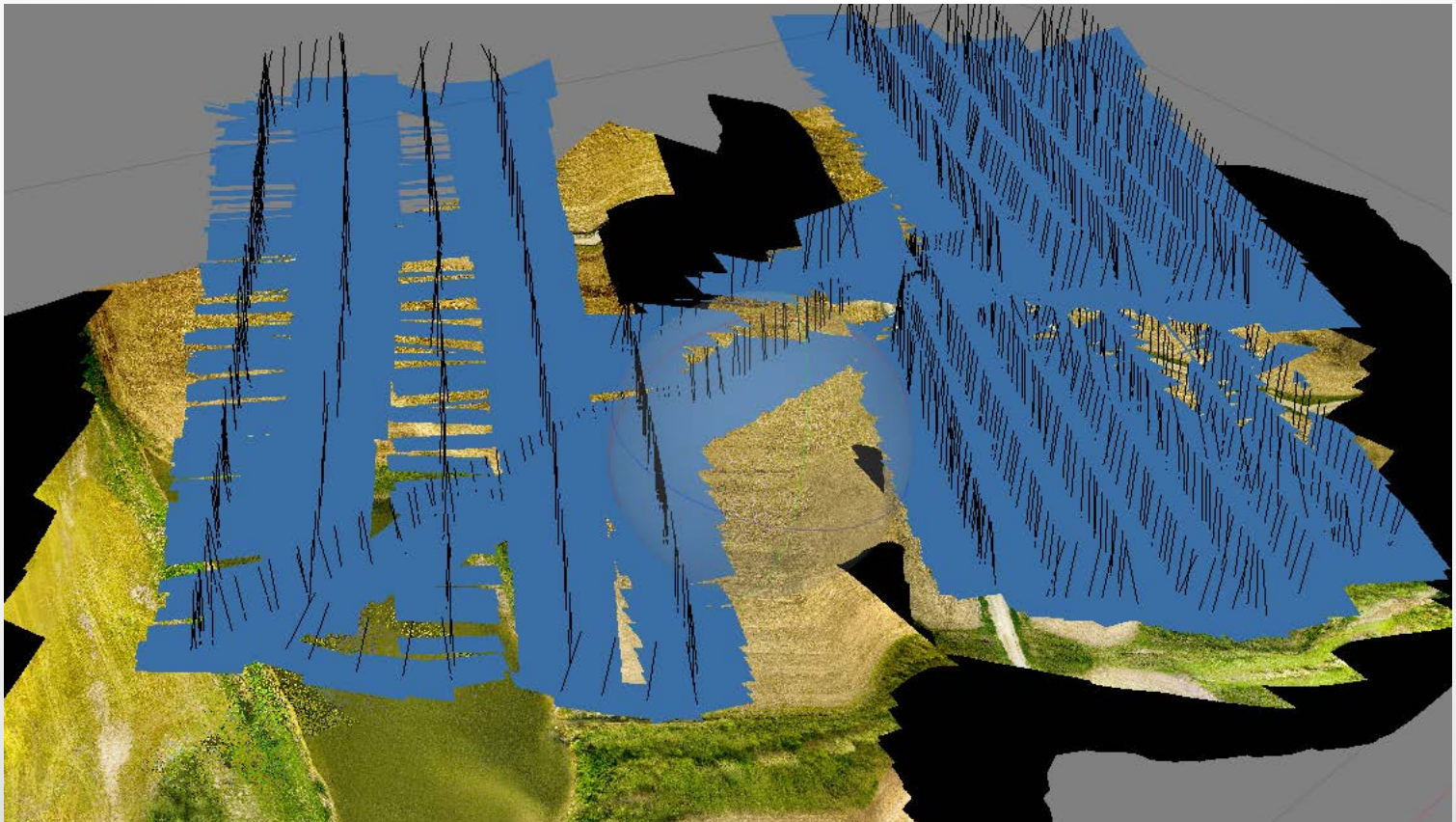


Site Documentation

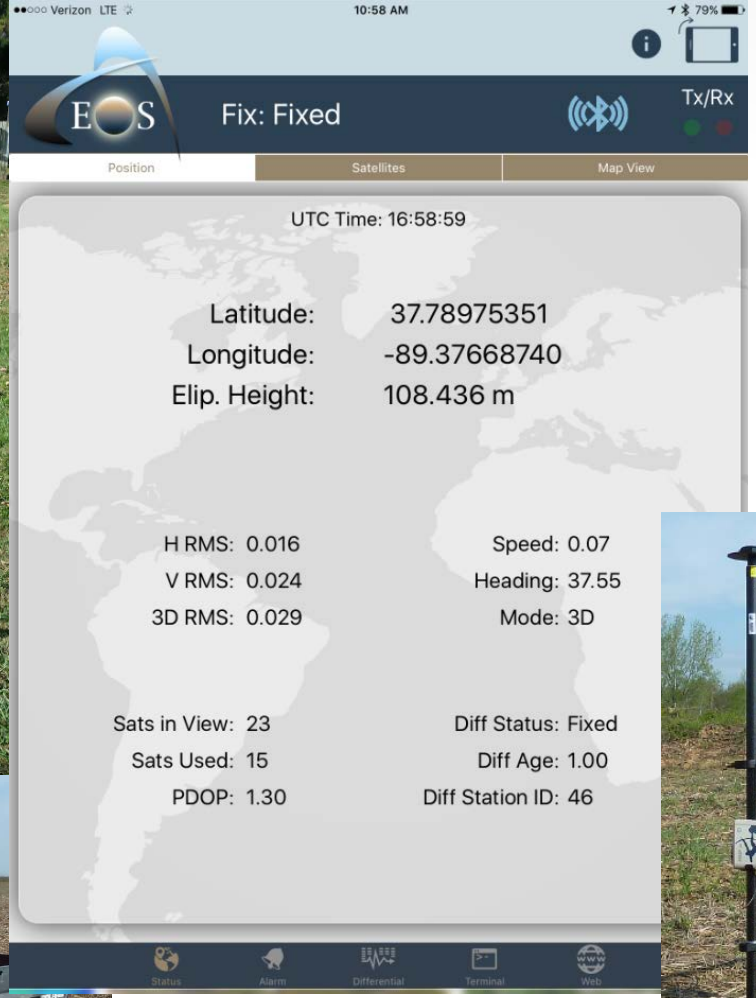
Credit: Daniel Kestner - VA

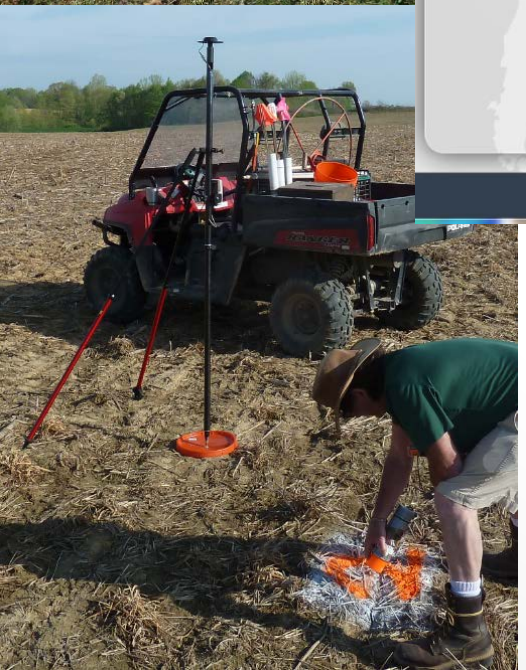
Aerial Photogrammetry

- Overlapping photos, pixel matching is used to measure distances between objects and build depth
- Modern Software makes this process much faster and easier
- Coupled with GPS, barometers and other on-board sensors, combined with Ground Control Points.

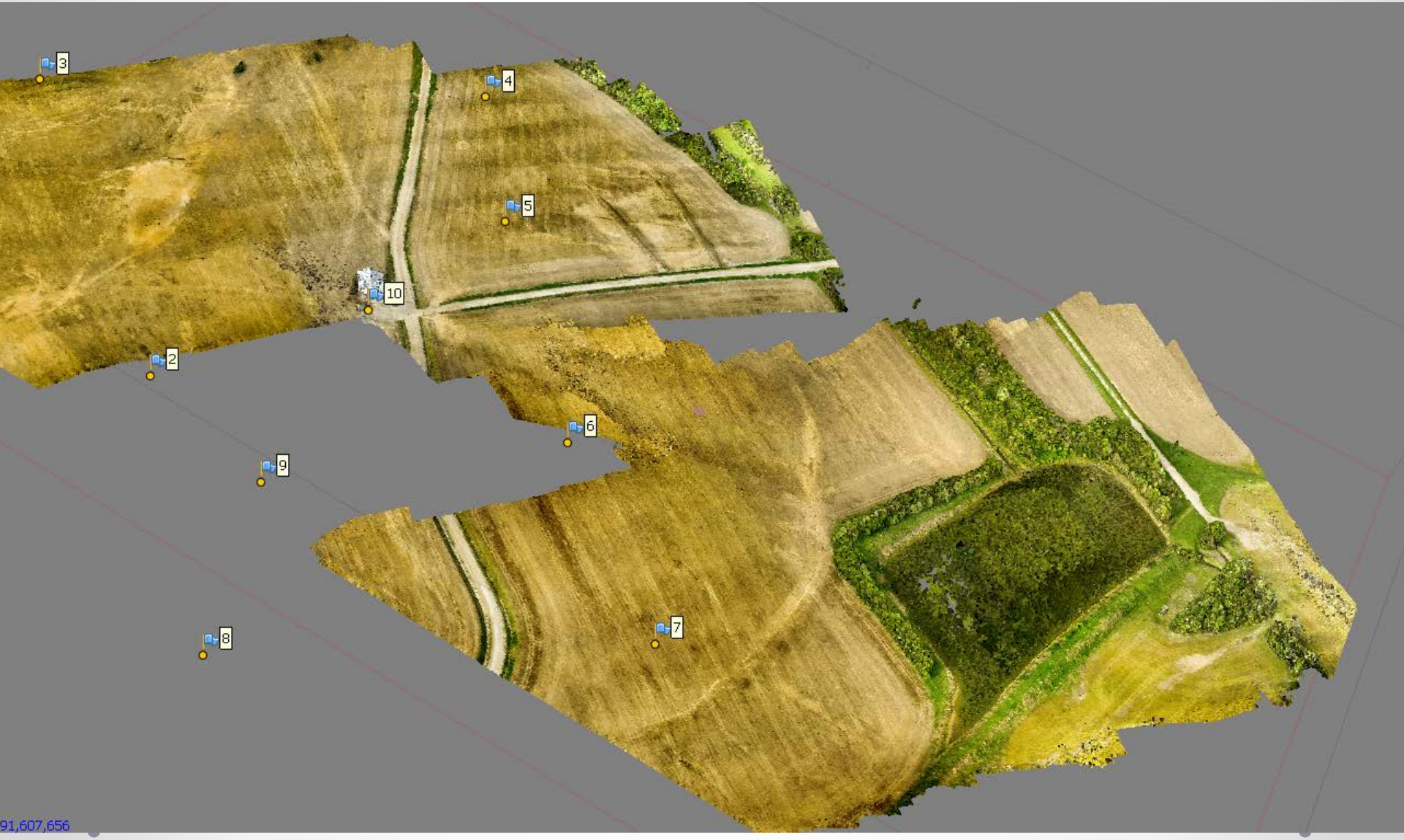


Establishing Ground Control





Dense Point Cloud – Agisoft Photoscan



Dense Point Cloud – Agisoft Photoscan

Dense Point Cloud – Agisoft Photoscan

Orthomosaic stitched together from 1200+ images

Each pixel contains RGB and Elevation information

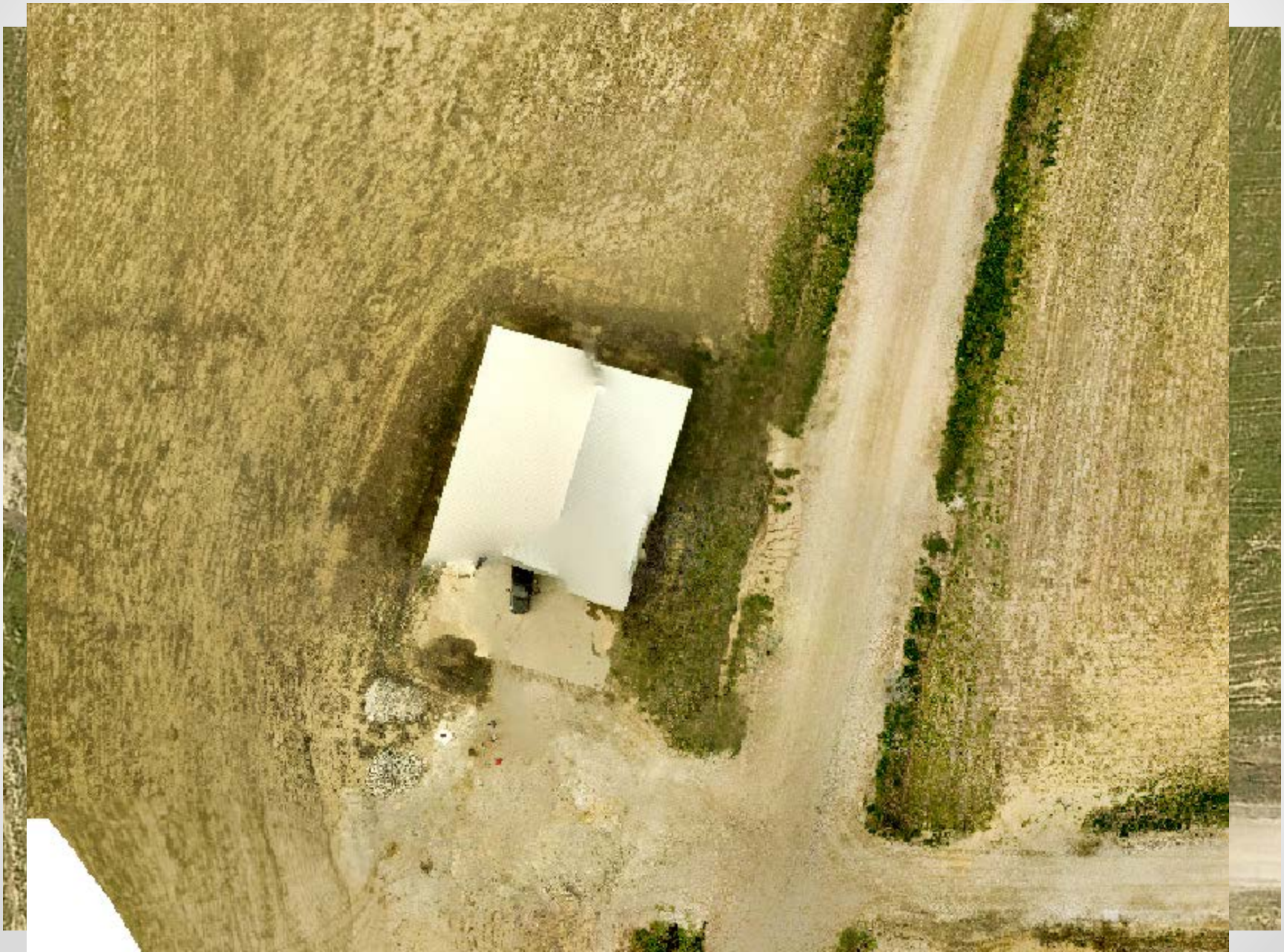
10cm GSD

Orthomosaic stitched together from 400+ images

Each pixel contains RGB and Elevation information

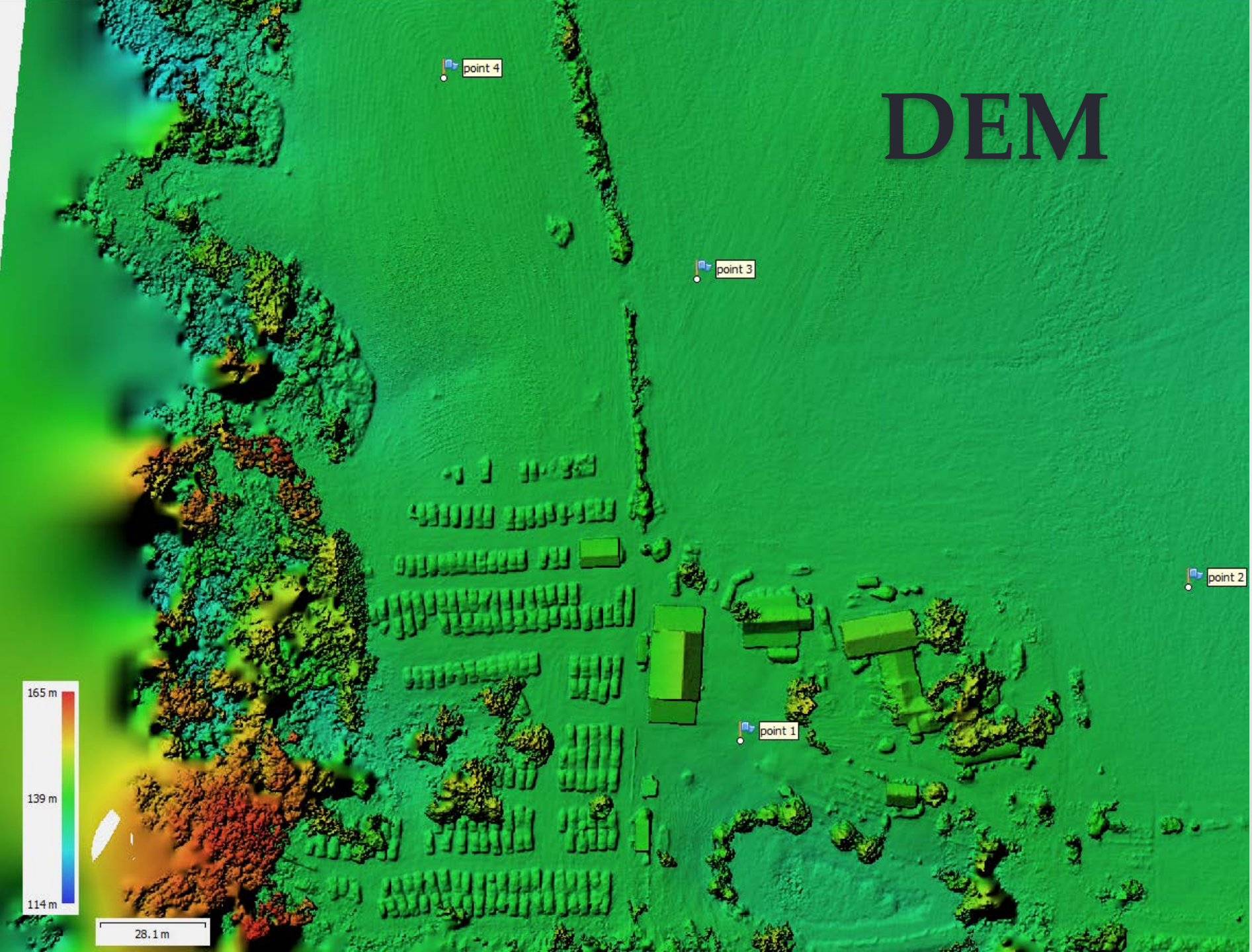
2cm GSD.

UAS vs Satellite

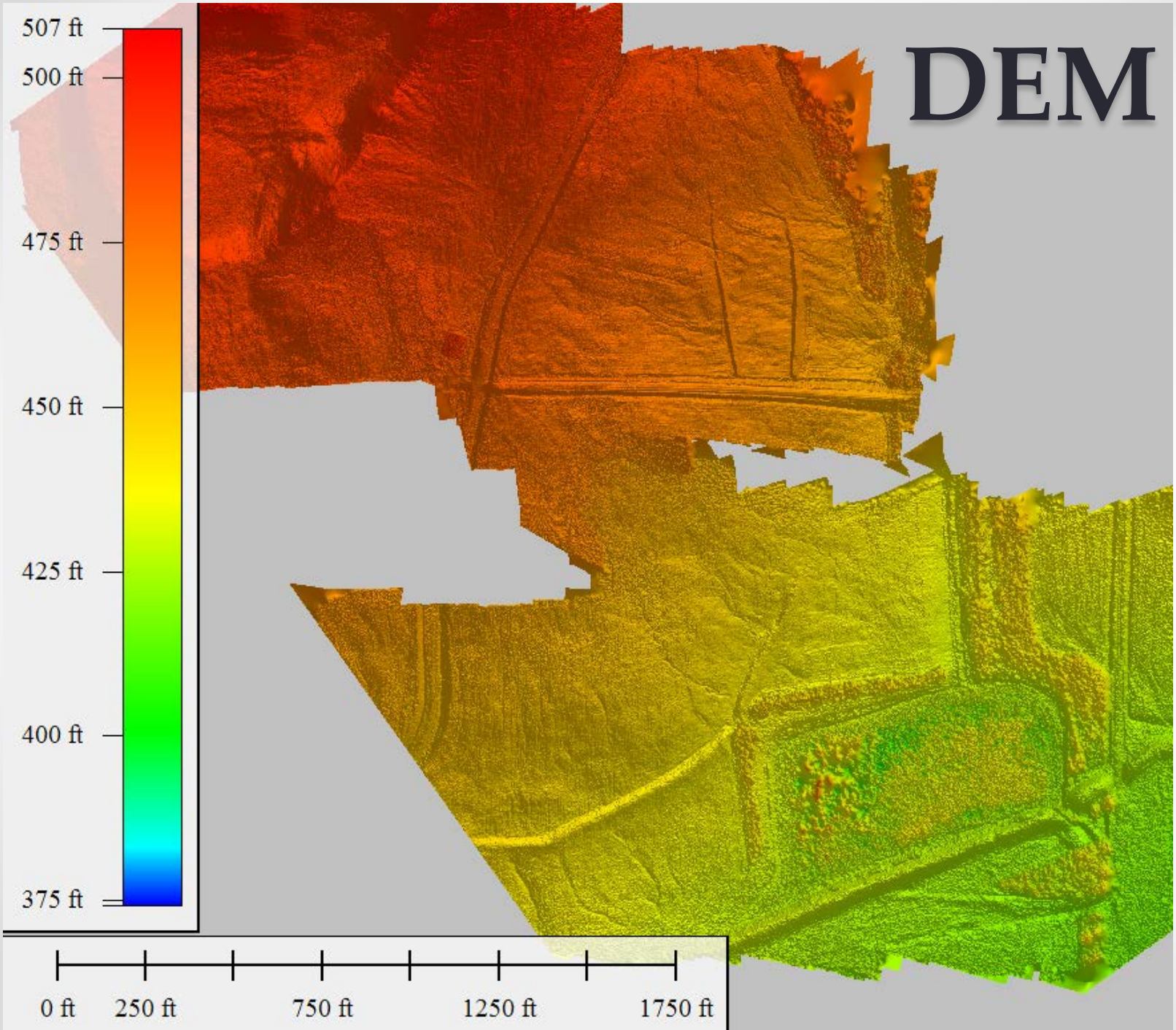


UAS vs Satellite

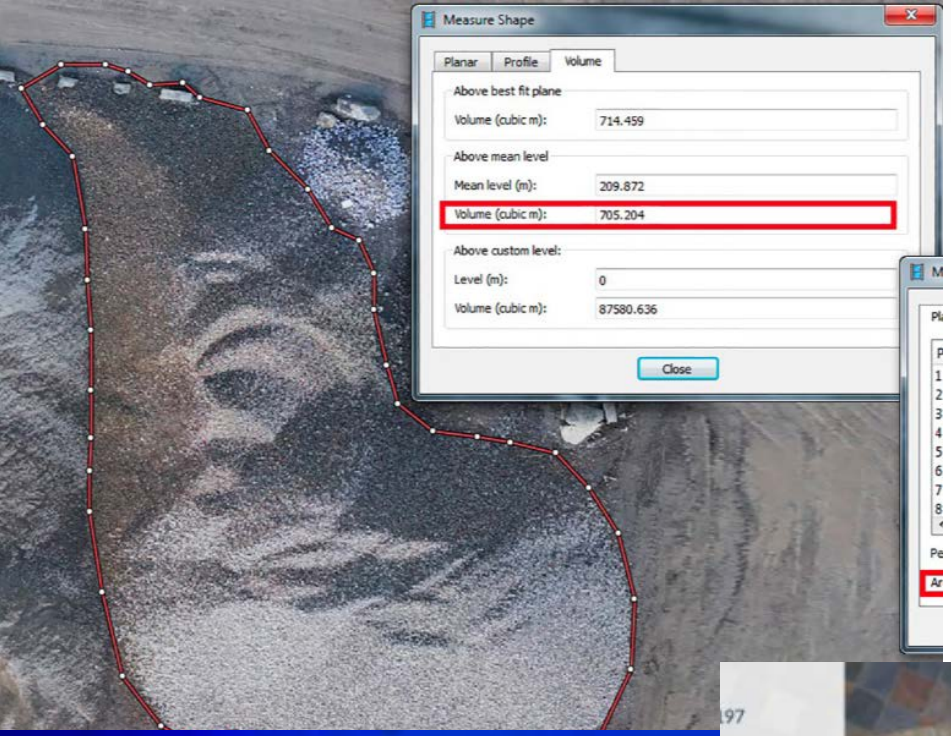
DEM

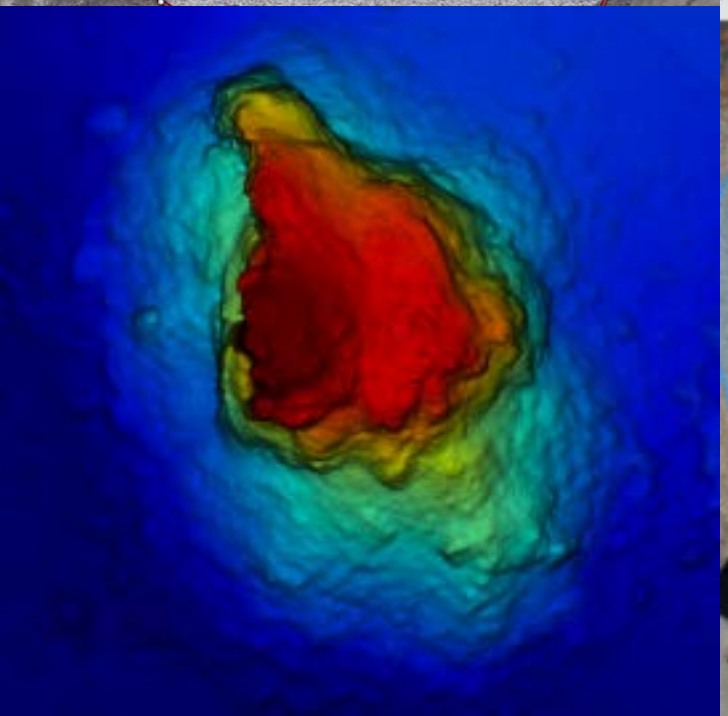


DEM

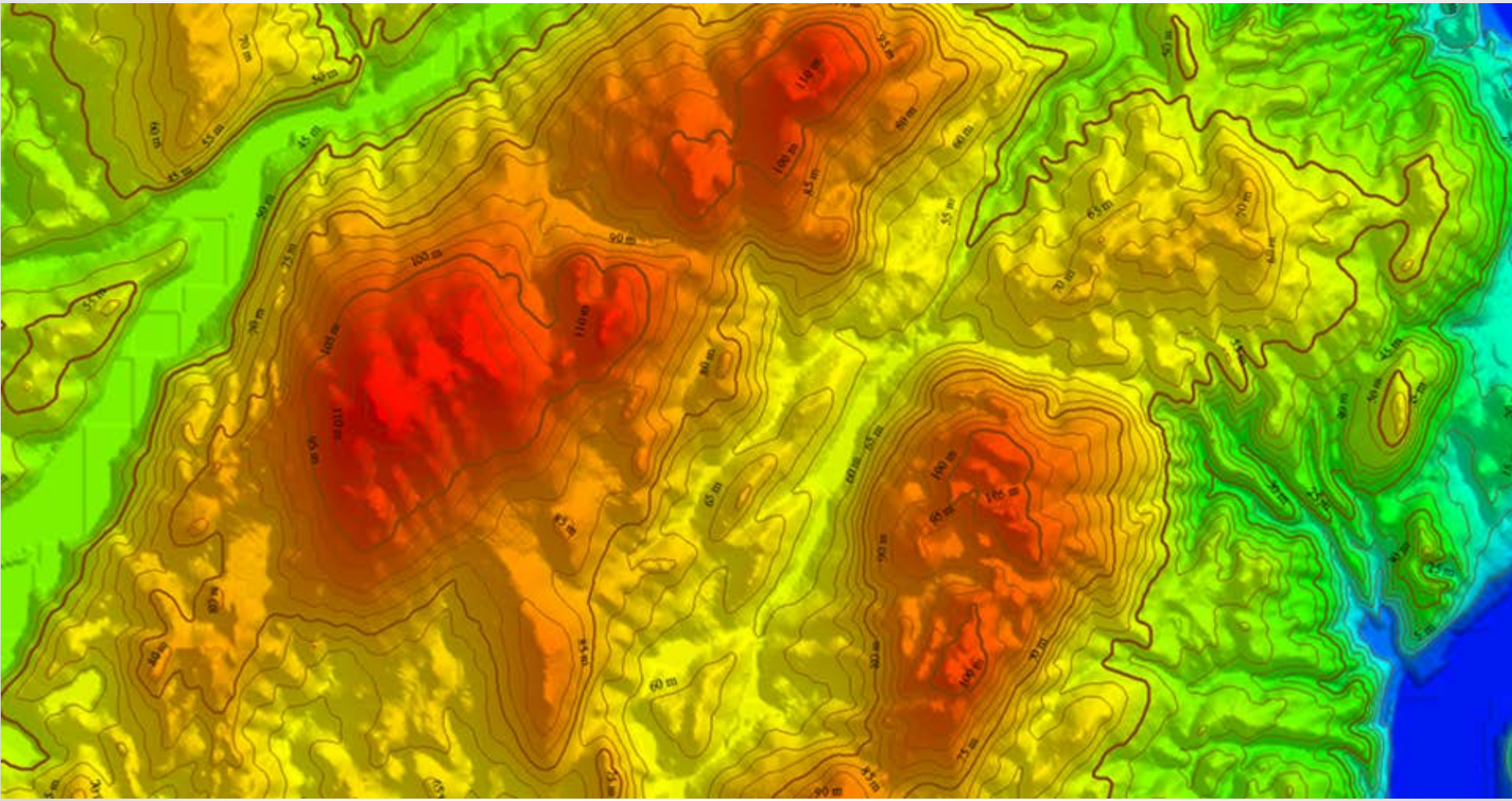

507 ft
500 ft
475 ft
450 ft
425 ft
400 ft
375 ft
0 ft
250 ft
750 ft
1250 ft
1750 ft

Volumetrics

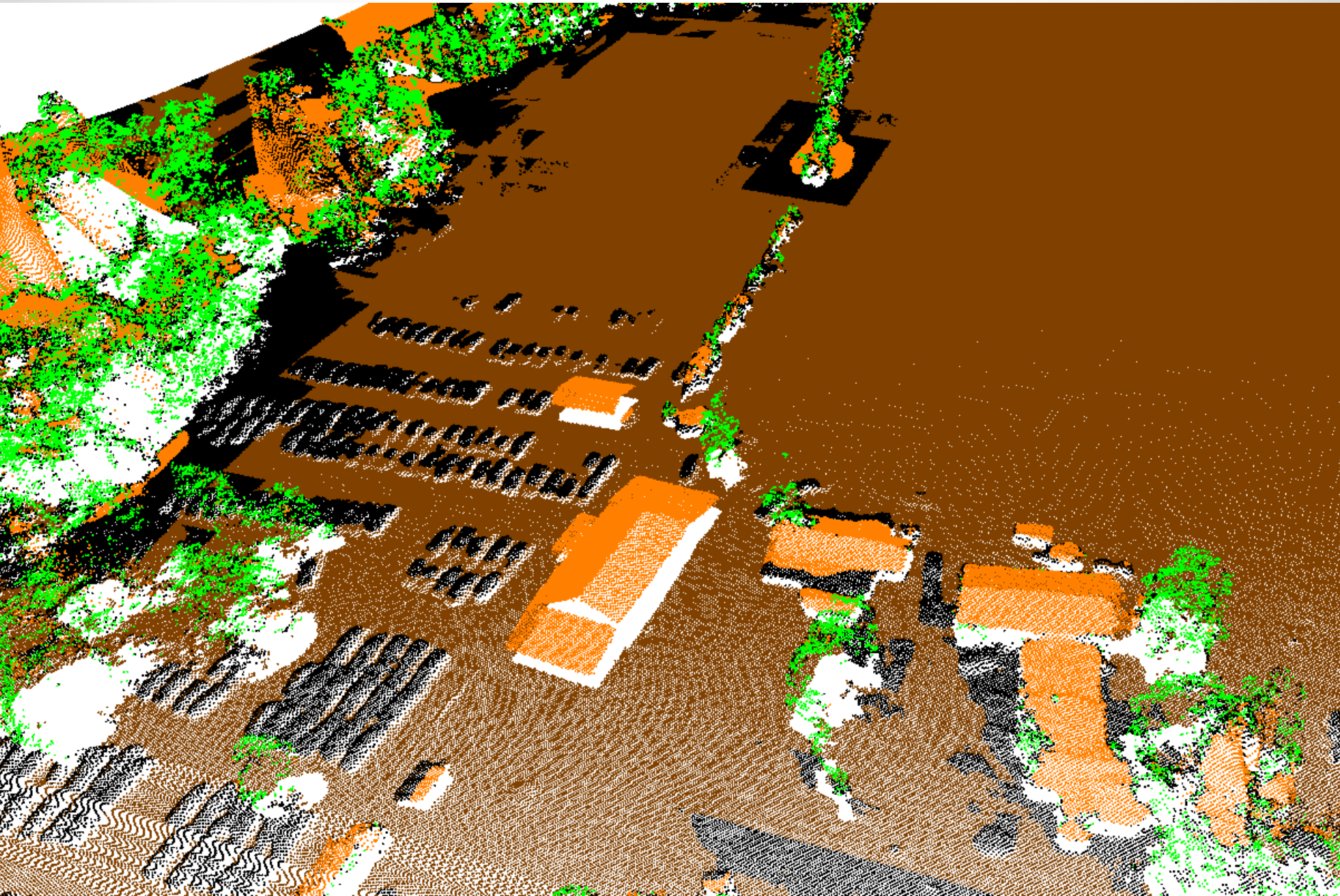




Contour Maps from UAV flight



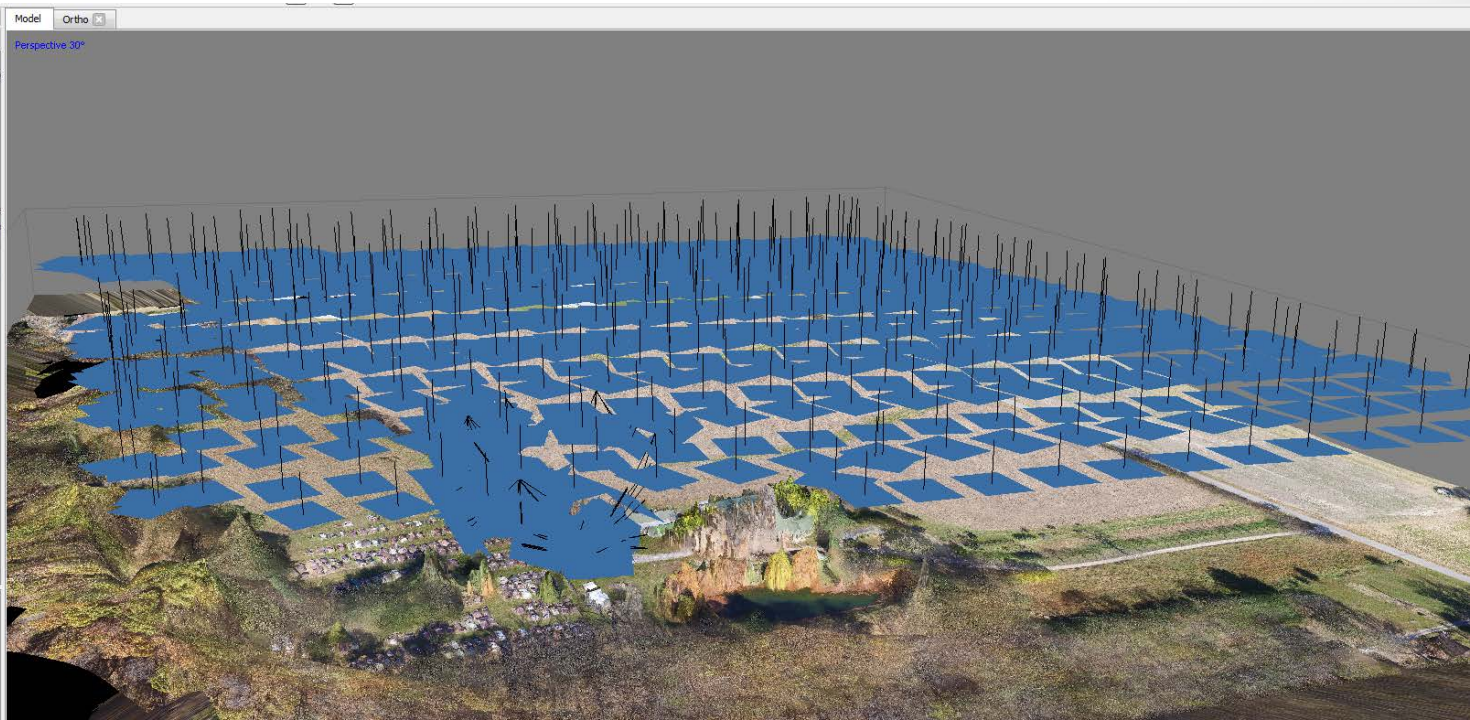
Classifying Point Clouds



3D PDF

Accuracy

- By including RTK (survey-grade) ground control points, you can typically achieve 2-5cm absolute accuracy.
- Without ground control, the internal GPS of the UAV, coupled with the photogrammetry software will typically allow for 1-3 meter absolute accuracy. Relative accuracy typically 2-3x the ground sampling distance (cm per pixel).



Challenges

- Data storage! (At OSM and state level)
- Testing/Adoption of software
- Funding (UAVs, sensors, software, training, travel)
- Pilot Training, Certification, Maintenance
- Recordkeeping (annual audits)
- PII (privacy concerns) & state grant funding

FAA Part107 Operational Limitations

- FAA 14 CFR Part107 Rules – Final in Aug 2016
- Pass FAA part 107 test, $150
- Unmanned aircraft must weigh less than 55 lbs. (25 kg)
- Visual line-of-sight (VLOS) only
- Daylight-only operations
- Maximum altitude of 400 feet above ground level (Lifted for carded DOI operators under blanket COA)
- Minimum weather visibility of 3 miles from control station
- No operations from a moving vehicle or aircraft, except from a watercraft on the water
- Requires preflight inspection by the operator

PII:

- If you wish to purchase and/or operate UAS systems to support your SMCRA program, you must identify, in your grant application or amendment narrative, your policies and procedures to safeguard PII, including the title and numbering reference (ex. STATE Directive 12-3456, State policy on protecting PII, civil rights and liberties). You must be willing to make those policies/procedures available upon request.
- *From OSM Grant Terms: State, local, tribal, and territorial government recipients of Federal grant funding for the purchase or use of Unmanned Aircraft Systems for their own operations must have in place policies and procedures to safeguard individuals' privacy, civil rights, and civil liberties prior to expending such funds*
- Presidential Memo, OPM-11
- Grant narrative will include brief description of how you will use UAS, and cite your state regulation/policy that will ensure PII compliance.

Getting OSMRE to Fly for you

- Go to: https://www.osmre.gov/programs/TDT.shtm
- Or email us at uas-team@osmre.gov
- You will receive a project form to fill out
- Once project if received a UAS team member will be in contact with you to discuss the project
- A project safety plan will be developed
- OSMRE plans and flies the site
- We offer processing of your UAS data as staff is available to do so

Questions?

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