UAS Coastal Mapping Activities at an Island Campus

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JALBTCX 15th Annual Airborne Coastal Mapping and Charting Workshop
June 10-12, Mobile AL

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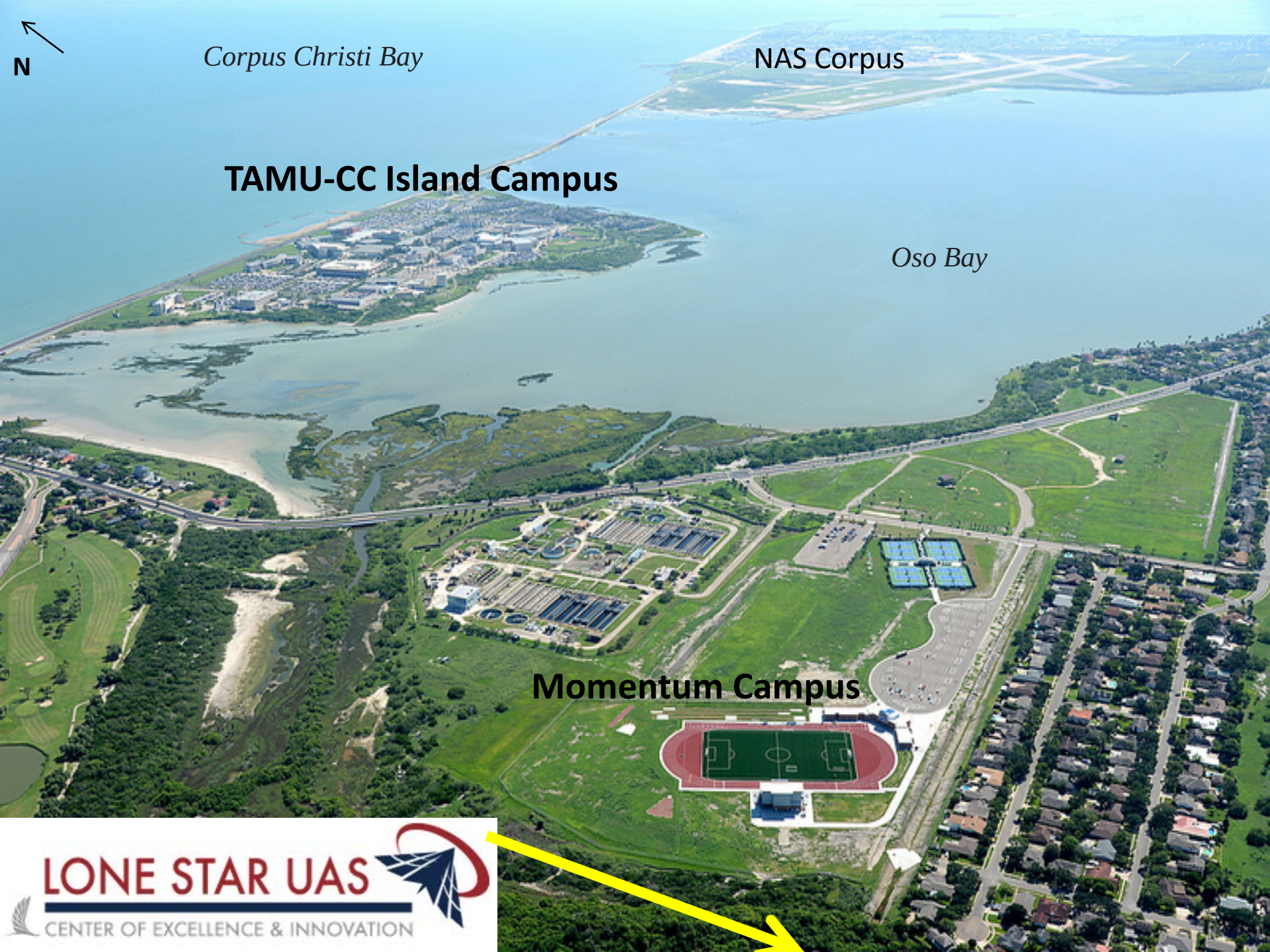
Overview

- Lone Star UAS Center (LSUASC) FAA Test Site
- UAS-based mapping examples
  - Medium-scale
  - Small-scale
    - Imagery vs Lidar-derived topography



LONE STAR UAS
CENTER OF EXCELLENCE & INNOVATION

Lead Institution and State Agency

- Texas A&M University-Corpus Christi (TAMU-CC)
  - UAS operations since 2011: 30 flights, 32.1 hours w/ RS-16 UAS
  - FAA Certificate of Authorization (**COA**) over a maritime area
  - Unmanned Systems Lab, Wind Tunnel facility

- Texas A&M University Engineering Experiment Station (TEES)
  - Seven COAs, 2012-2013
    - Center for Autonomous Vehicles and Sensor Systems: CANVASS
    - Unmanned Flight Laboratory
    - Center for Robotic-Assisted Search and Rescue: CRASAR

    …..other labs

The Lone Star UAS Team

(16 entities, 5 with universities)

Texas A&M University-Corpus Christi (TAMU-CC)	Texas Tech University (Lubbock, Texas)
Texas A&M Engineering Experiment Station (TEES)	Bay Area Houston Advanced Technology Consortium (BayTech)
Camber Corporation (Huntsville, Alabama)	Texas Department of Transportation/Aviation
Governor's Office of Aerospace, Aviation and Defense	Jerry Thompson Associates (JTA, Washington, D.C.)
Chase Field Industrial Complex (Beeville, Texas)	Aviation Specialties (Sierra Vista, Arizona)
University of Texas at Arlington Research Institute (UTARI)	Modern Technology Solutions Inc. (MTSI, Alexandria, Virginia)
Southwest Research Institute (SwRI, San Antonio, Texas)	AvMet Inc. (Reston, Virginia)
University of Texas at San Antonio (UTSA)	Charles Johnson Airport (Port Mansfield, Texas)

Test Site Status

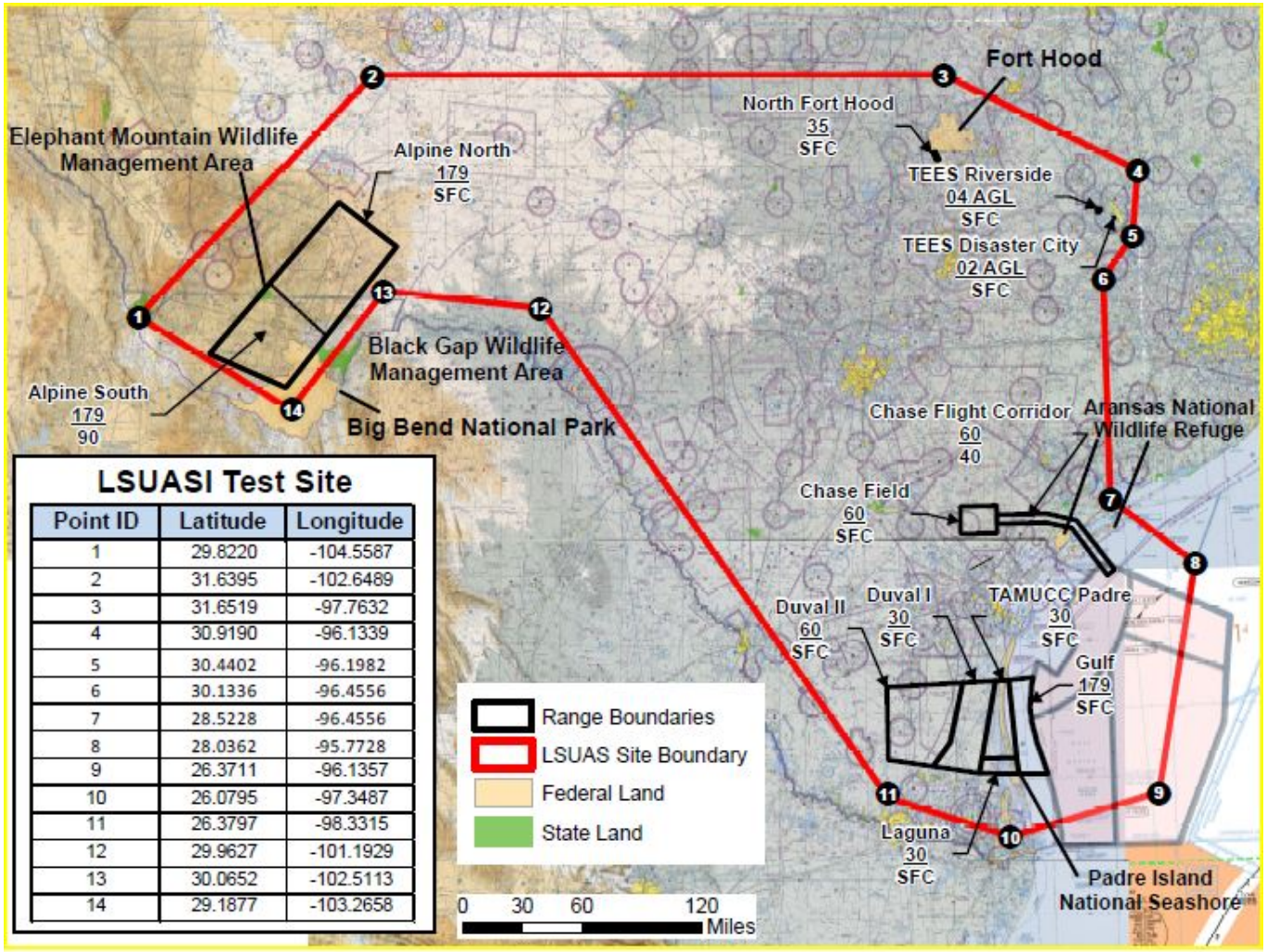
- FAA proposal submitted on May 3, 2013
- Awarded by FAA on Dec. 30, 2013
- 2014 actions under way
  - Develop capabilities

    Mission Control Center, Electronics / Systems Lab, Integrated Data Environment
  - Advisory board/executive director
  - COA applications proposed to FAA

  → Outreach

    - Public: safety, privacy, environmental impact
    - Industry, state, national

Lone Star UAS Test Site Ranges



LSUASI Test Site

Point ID	Latitude	Longitude
1	29.8220	-104.5587
2	31.6395	-102.6489
3	31.6519	-97.7632
4	30.9190	-96.1339
5	30.4402	-96.1982
6	30.1336	-96.4556
7	28.5228	-96.4556
8	28.0362	-95.7728
9	26.3711	-96.1357
10	26.0795	-97.3487
11	26.3797	-98.3315
12	29.9627	-101.1929
13	30.0652	-102.5113
14	29.1877	-103.2658

6100 mi^2, 11 geographically diverse ranges (4 coastal), sparsely populated coastlines

TAMU-CC Padre Range
(active COA)

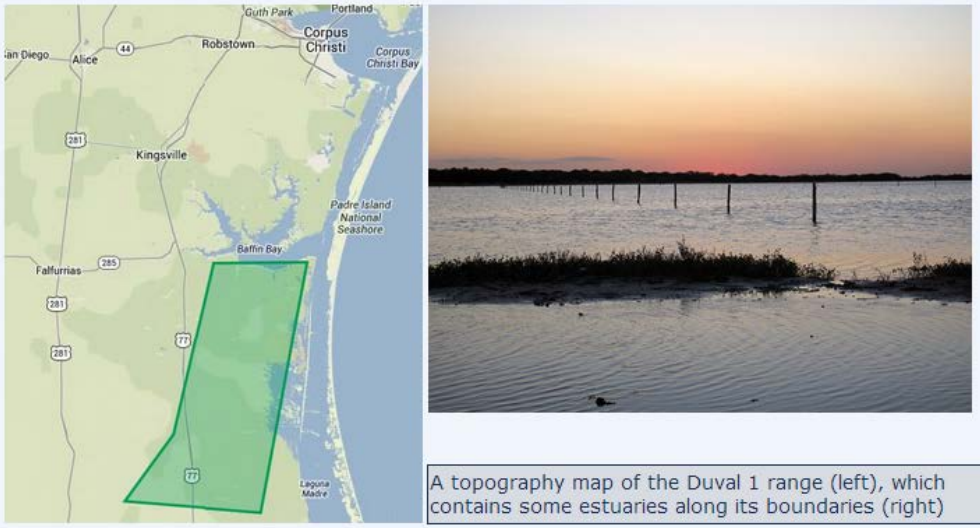
- Approx. 38 mi. north to south
- Approx. 450 sq. mi.
- Approx. 36 mi. south of campus (as crow flies)

Laguna & Duval I Range

A topography map of the Laguna Range (left) and an aerial view along Texas' Laguna Madre (right)

Laguna Range

- 17 mi E-W, ~11 mi N-S
- Directly below Padre range
- Charles R. Johnson airport in Port Mansfield for launch / recovery

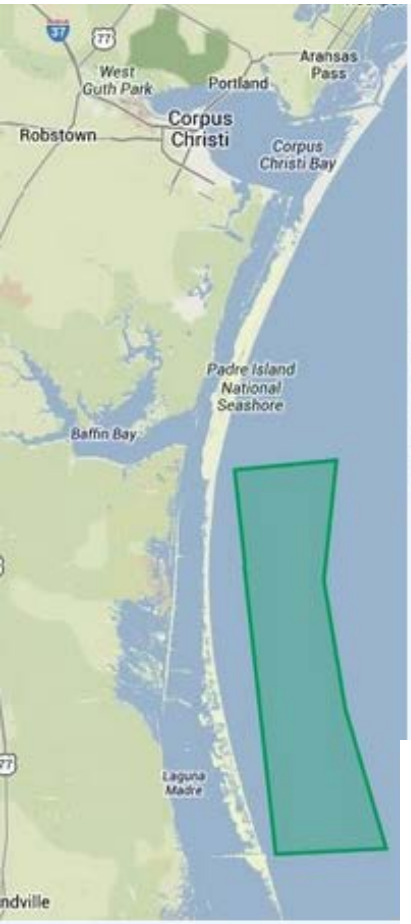


A topography map of the Duval 1 range (left), which contains some estuaries along its boundaries (right)

Duval Range

- ~800 square miles
- Adjacent to Padre range
- Covers critical estuarine habitat in Baffin Bay & Laguna Madre

Gulf Range



Open Gulf range within state waters

- 41 NM x ~11 NM
- ~450 NM^2
- ALT - SFC to 18000 ft

Proposed use is for medium to large-scale UAS to launch from Charles R. Johnson Airport in Laguna Madre Range

FAA Research Focal Areas

- UAS system safety and data gathering
- UAS airworthiness
- Command & control link issues
- Control station layout and certification
- Ground and airborne sense-and-avoid technologies
- Environmental impacts of UAS operations

LSUASC R&D teams working on different aspects of above

Lone Star UAS Test Site Expertise

- FAA operations and coordination
- COA development
- UAS acquisition, operations and maintenance
- UAS range operations (autonomous and manual)
- Payload integration, assembly &testing
- Help with UAS vendor negotiations
- Integration/development and verification of ground control station

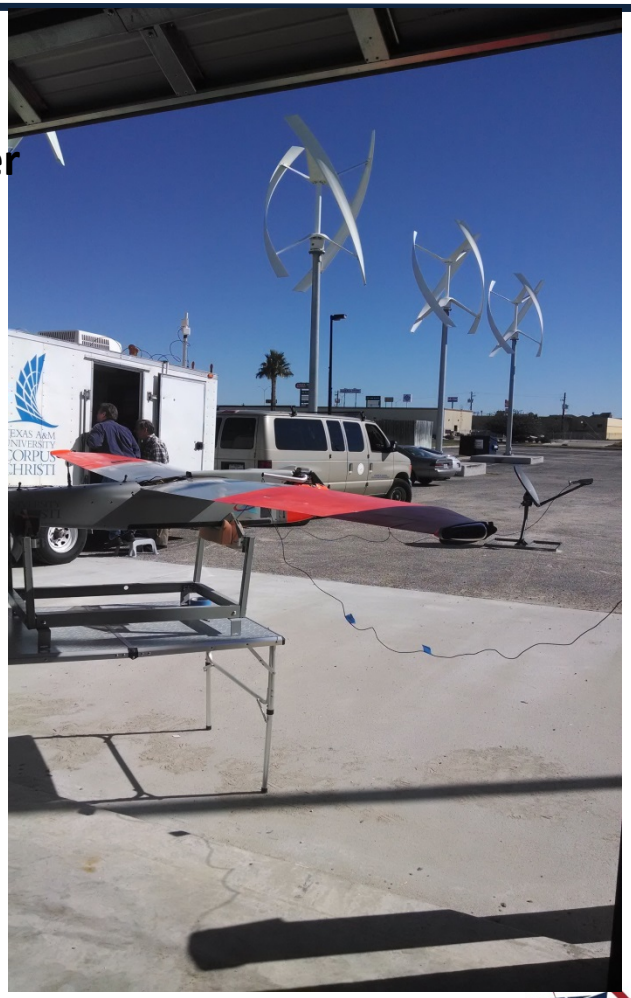
→ ***Proposal support to estimate costs for range use***

→ ***Fees charged for services (e.g. COA or lab use) but not airtime***

Command Centers

Mission Control Center

Mobile Control Center

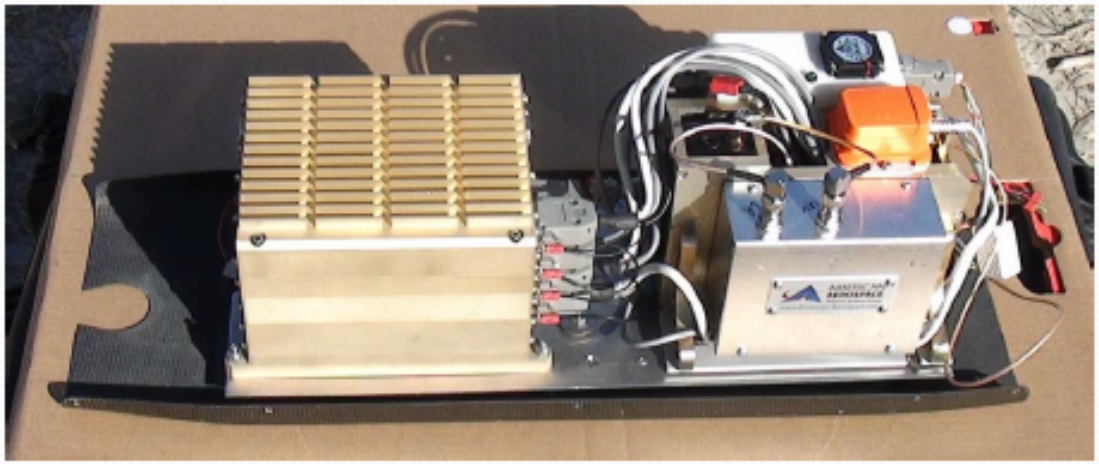


Electronics Lab/ Systems Integration Lab (Notional)

TAMU-CC American Aerospace RS-16

Win
MG
End
Ceil
Max
Payl
Payl
Payl
Lau
Rec

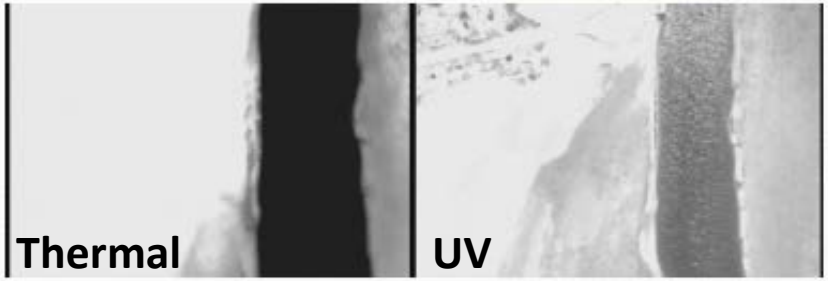
AAAI Three-Band HDVMP October 10, 2012								
					1,000' AGL		3,000' AGL	
Camera	Type	Band (microns)	Pixels (MPx)	HFOV	Ground Sample Distance (Inches)	Swath Width (Ft)	Ground Sample Distance (Inches)	Swath Width (Ft)
Ultraviolet	Interlaced	0.3 to 0.4	0.307	18.4	6	324	18.2	972
Infrared	Interlaced	8 to 12	0.307	18.4	6	324	18.2	972
Visible	Progressive	.45 to .65	2.073	18.4	2	324	6	972
				52	6.1	976	18.3	2928



Imaging Payload (25 lb): UV , Visible (RGB), Thermal IR

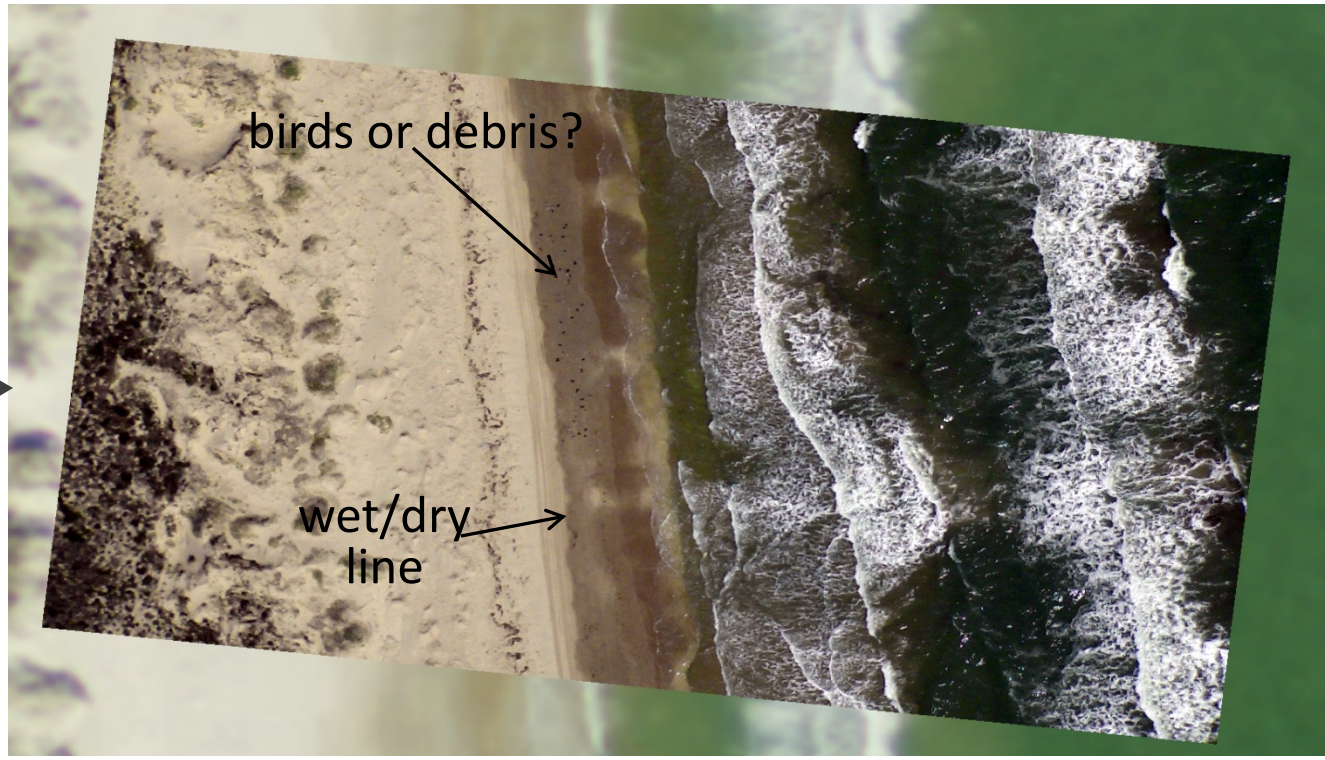
March 2013 Flight over Laguna Madre

- Sample images



Applications include mapping seagrass, bird habitat, inundation, shoreline, oil…
Petroleum targets: crude oil, distillate, gasoline, diesel

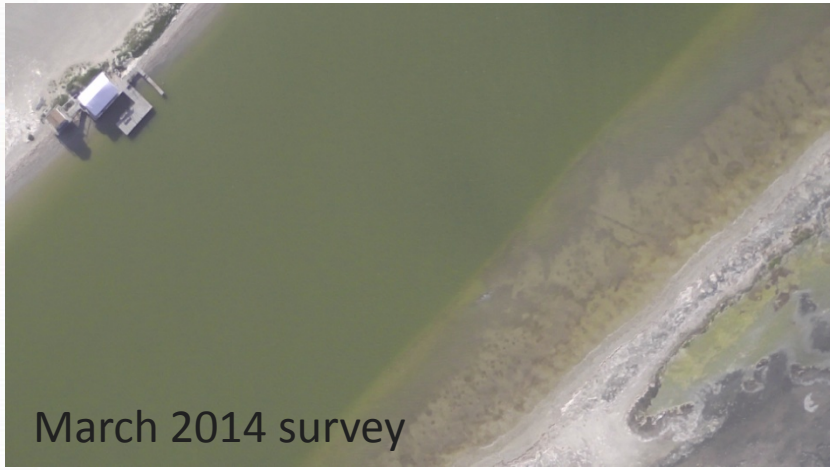
Example: Shoreline Mapping
Padre Island National Seashore



~ 2 km swath of
overlapping imagery

~15 cm ground resolution at 1200'AGL
~120 m x 170 m area

RS-16 LaunchVideo



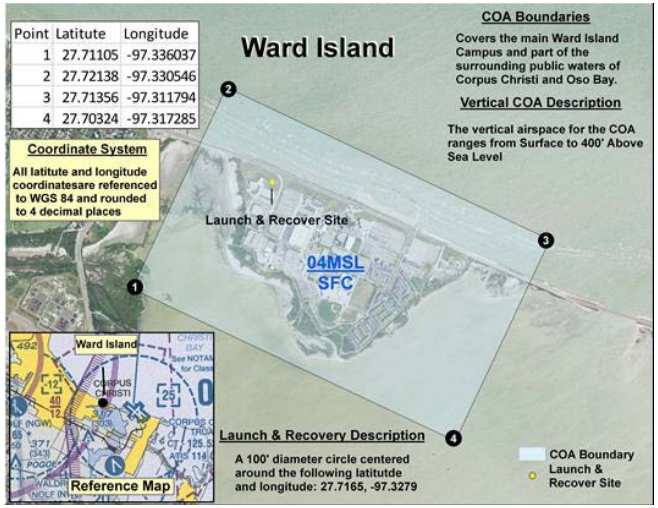
http://www.youtube.com/watch?v=E6jppmODs-0

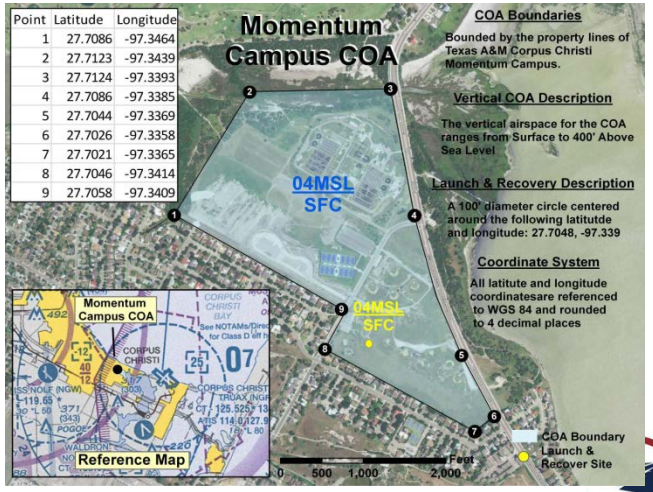
RS-16 Operations lead by Dr. David Bridges

TAMUCC Campus COA
(senseFly eBee)

1.5 lbs, 3 ft wingspan, < 27 mph wind
45 minute flight time, ~4 mi^2 area
3cm/pixel resolution

*COA Altitude – SFC to 400 ft
*Can only fly when NAS CC closes (Sunday 8-10 AM)





Imaging Payload

Visible Spectrum Camera (RGB)

- Canon IXUS 127 HS
- 16 Megapixels, ~0.3 lbs

Near-Infrared Camera (NIR,B,G)

- Canon Powershot ELPH 110 HS
- 16 Megapixels, ~0.3 lbs

Sensors are modified for auto capture

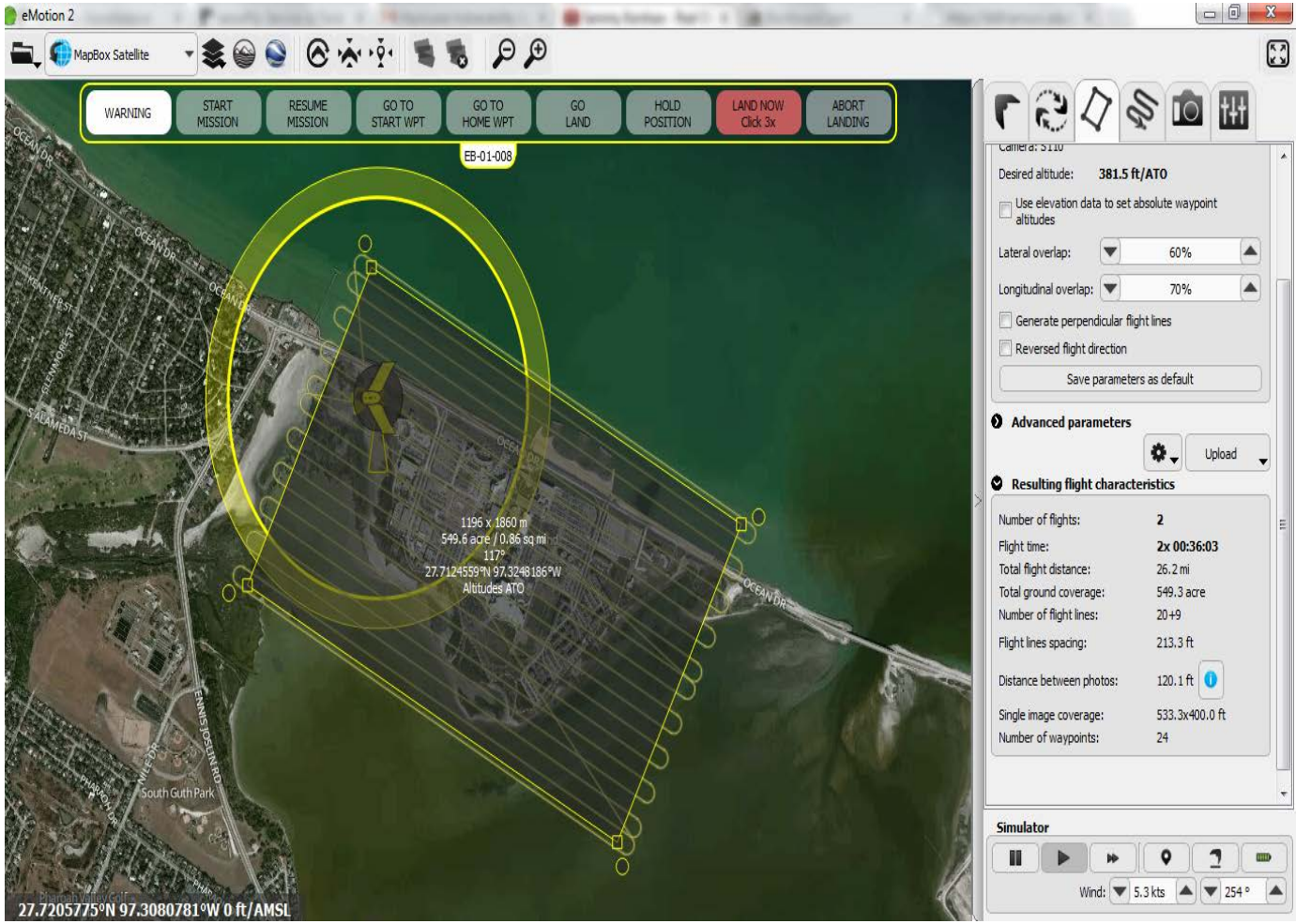
Command-and-Control Software
eMotion 2

<u>Mission Planning</u>

- Select flying height, overlap
- Create area to map

<u>Command-and control</u>

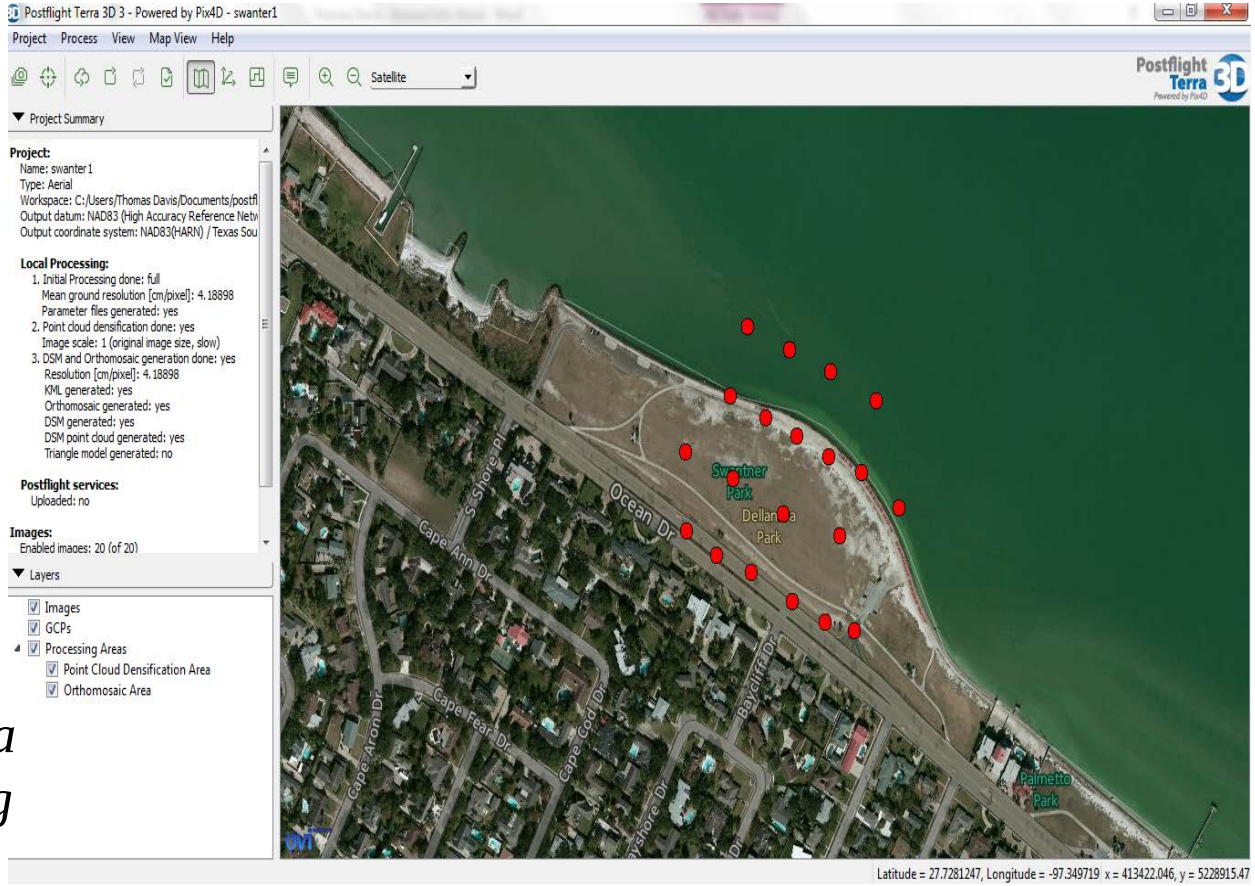
- Real-time tracking
- Flight information



Post-Processing Software
Postflight Terra 3D

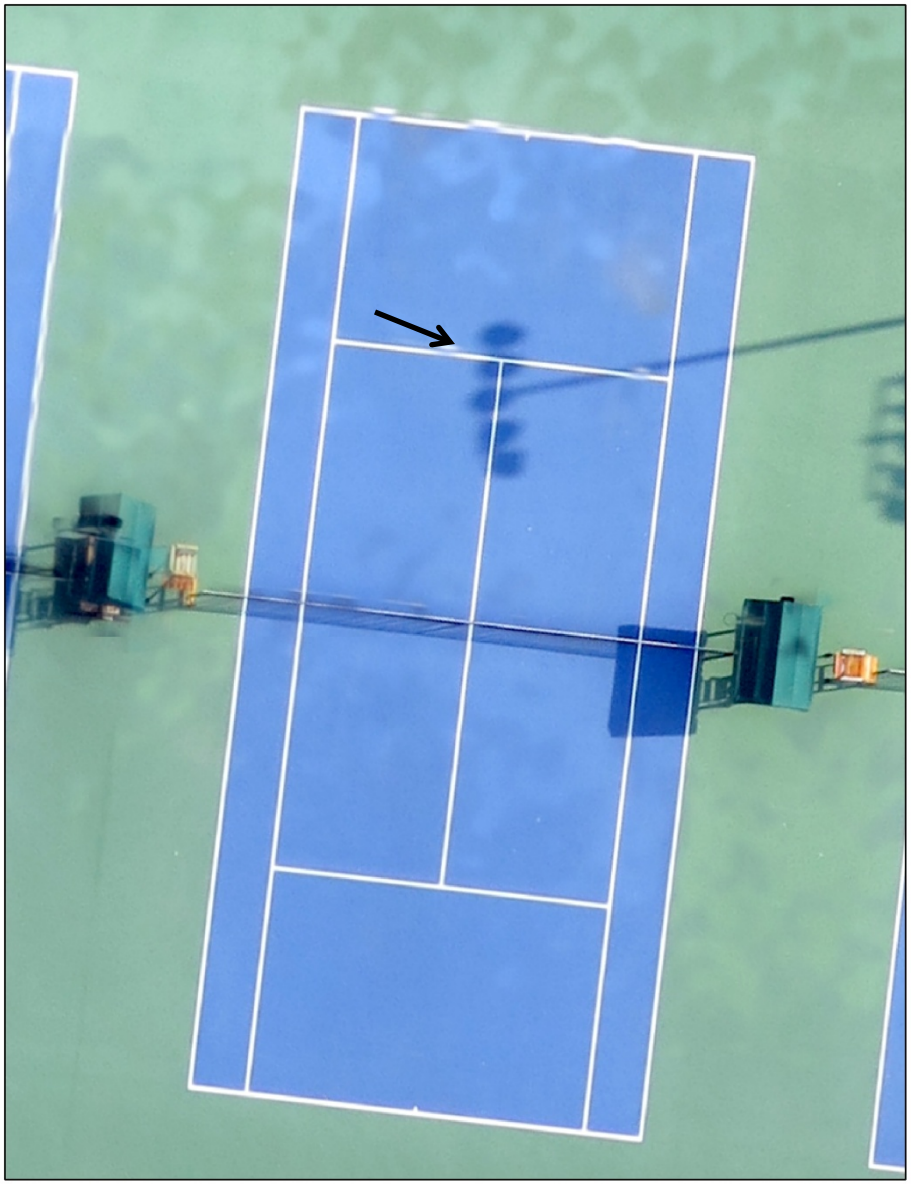
Pix 4D engine

- Orthomosaic
- DSM
- Point Clouds



3D information derived via automated feature tracking from image to image →

Structure from Motion (SfM)



Applications:
Facilities assessment and coastal hazards monitoring

Preliminary eBee Accuracy Assessment

Thomas Davis, TAMU-CC Student
Starts work for USACE New Orleans District in July

Study Area

- Data collected by vendor's personal platform
- Winds ~21 mph
- Fly height ~300ft (70% overlap)

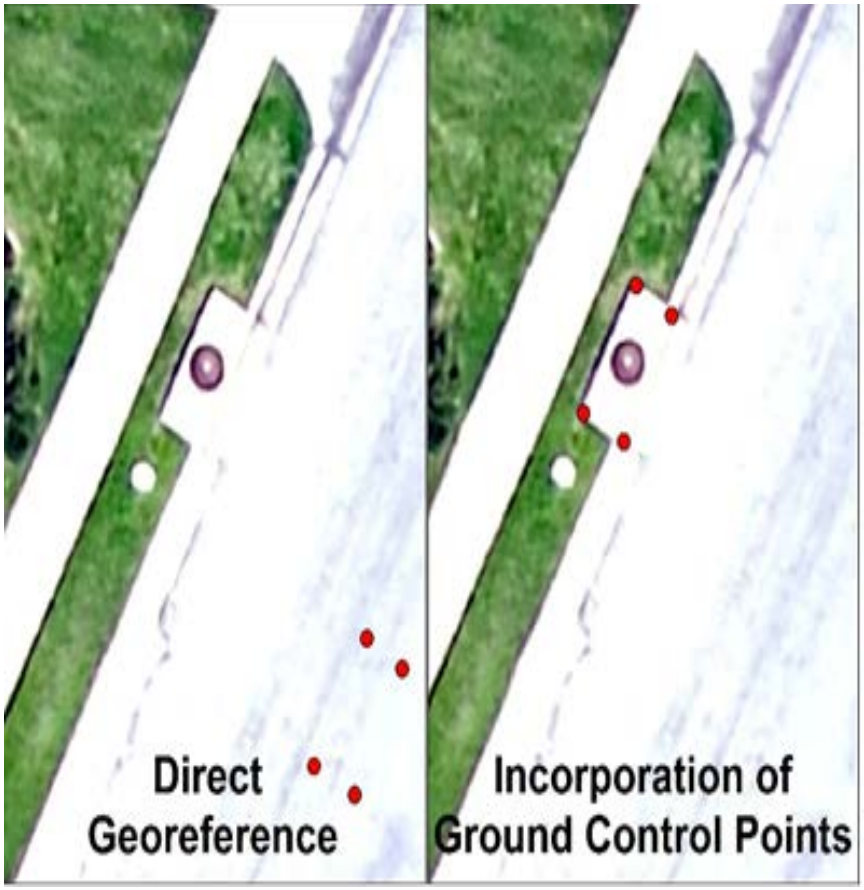
→ *Horizontal*: Orthomosaics created with & without GCPs

→ *Vertical*: Airborne Lidar vs eBee-derived DEMs

GCP Locations

- Total of 6 GCP
- Differential GPS (< 2 cm)
- Collected after flight
- Used concrete corners easily detected in images

Horizontal Results



Relative accuracy ok

Distance between image and ground coordinates (independent check points)

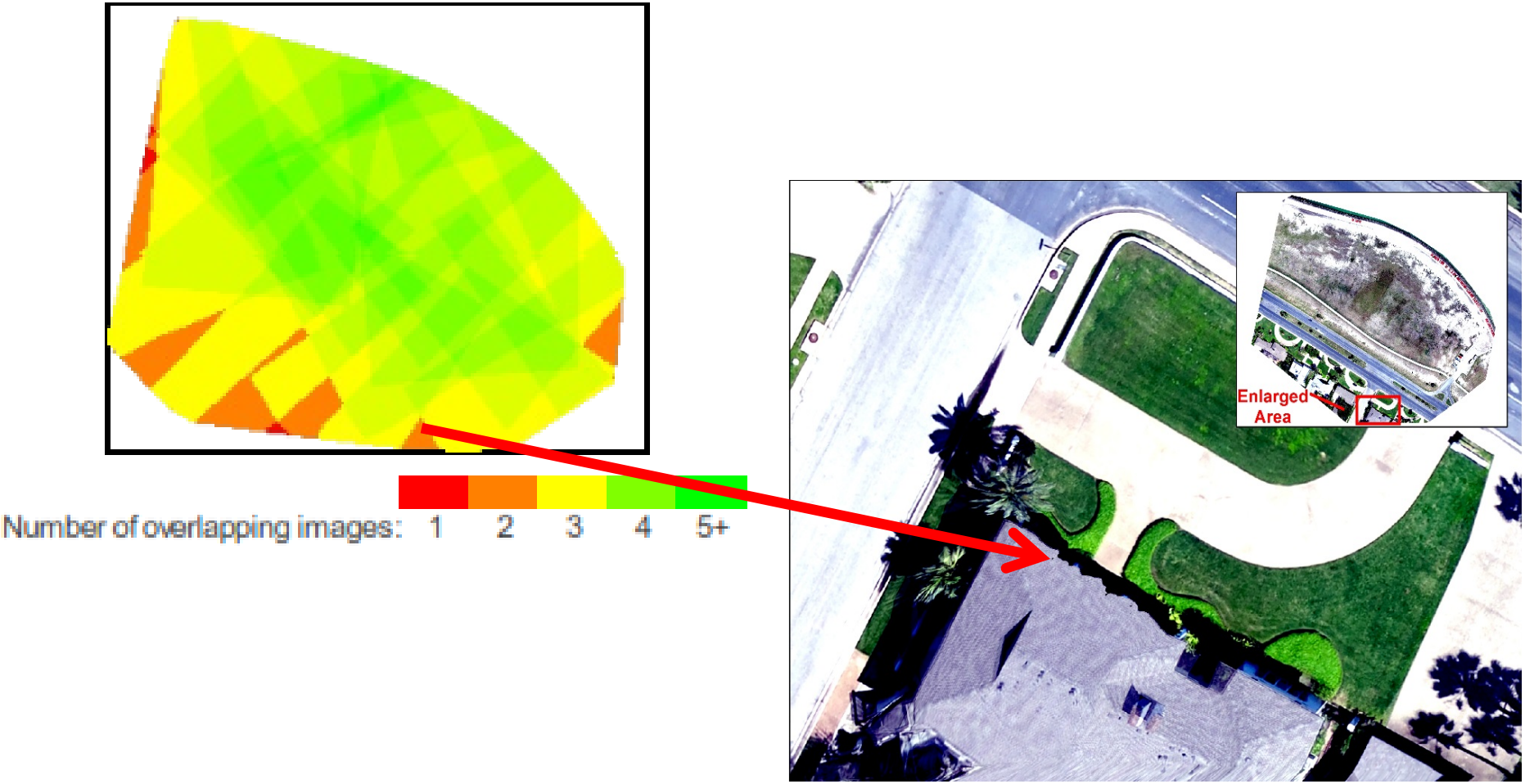
Direct Georeferencing

Average distance:	19.5 feet
Std Dev:	0.71 feet

Inclusion of GCP

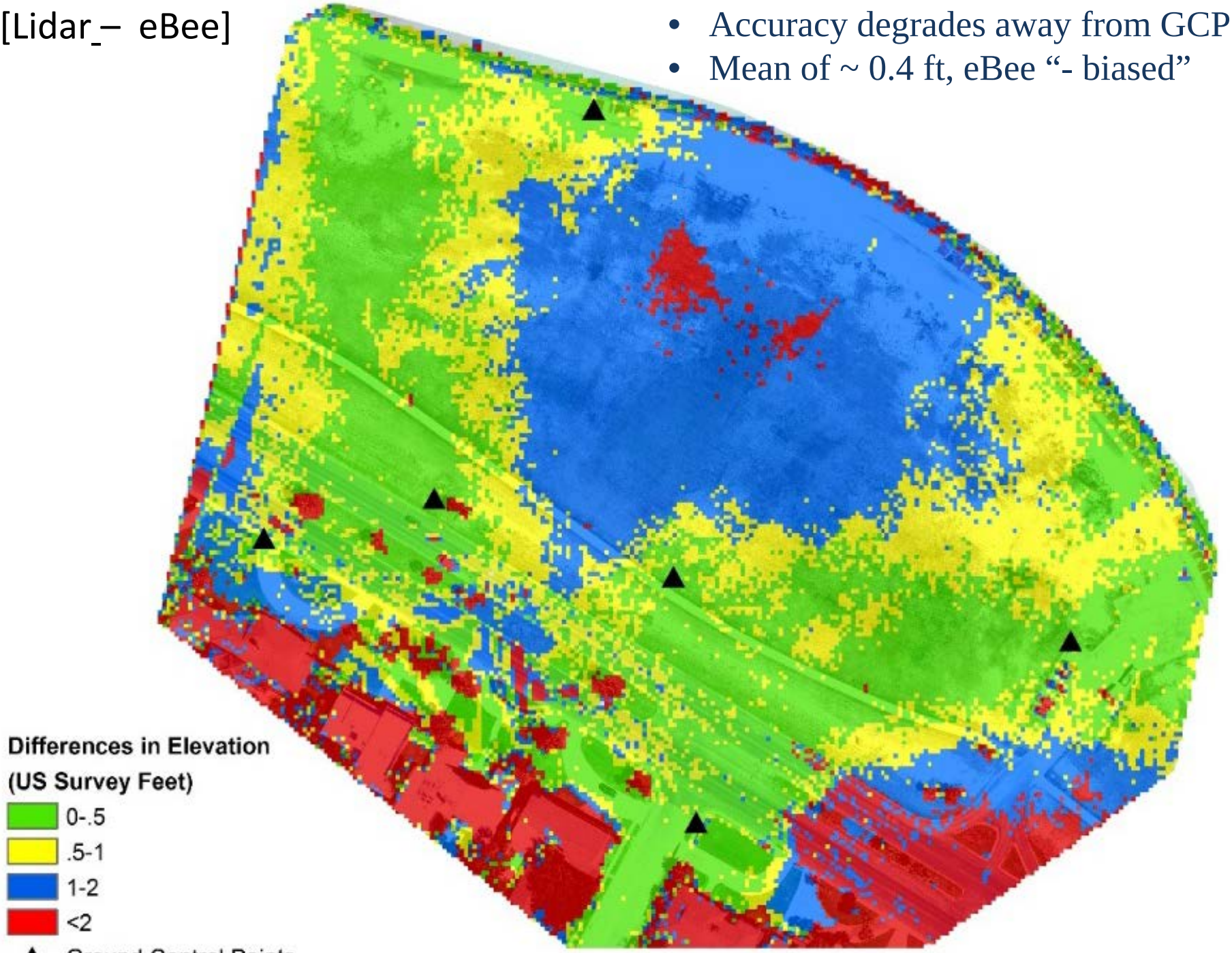
Average distance:	0.27 feet
Std Dev:	0.10 feet

Edge Distortion is Function of Image Overlap



[Lidar_– eBee]

- Accuracy degrades away from GCPs
- Mean of ~ 0.4 ft, eBee "- biased"



Current work is to assess impact of varying terrain & flight conditions

Thank You JALBTCX!

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LONE STAR UAS
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Lone Star UAS Test Site
http://lsuasc.tamucc.edu/

Lights & Mirrors Reigning Champion with Kris Shrestha – 2011…

Lone Star UAS Test Site Research

- UAS system safety and data gathering
  - **TAMUCC, UTARI, AvMet Inc.**
- UAS airworthiness
  - **TEES, TAMUCC, SWRI**
- Command & control link issues
  - **TEES, UTARI**
- Control station layout and certification
  - **TAMUCC, TEES, Texas Tech**
- Ground and airborne sense-and-avoid technologies
  - **TAMUCC, TEES, SWRI, UTARI**
- Environmental impacts of UAS operations
  - **SWRI**

TAMU-CC Research Centers

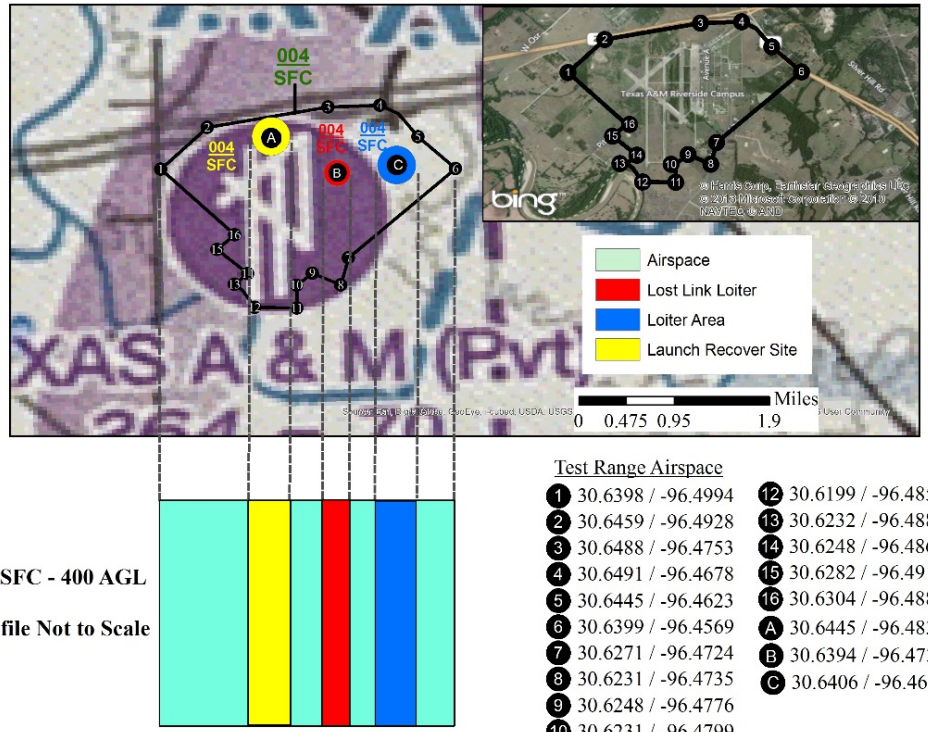
iCore

Unmanned Systems Lab

Geospatial Computing Lab

Wind Tunnel

TAMU/TEES Riverside Range



Test Range Airspace

1	30.6398 / -96.4994
2	30.6459 / -96.4928
3	30.6488 / -96.4753
4	30.6491 / -96.4678
5	30.6445 / -96.4623
6	30.6399 / -96.4569
7	30.6271 / -96.4724
8	30.6231 / -96.4735
9	30.6248 / -96.4776
10	30.6231 / -96.4799
11	30.6198 / -96.4798
12	30.6199 / -96.4859
13	30.6232 / -96.4888
14	30.6248 / -96.4869
15	30.6282 / -96.4913
16	30.6304 / -96.4888
A	30.6445 / -96.4836
B	30.6394 / -96.4738
C	30.6406 / -96.4651

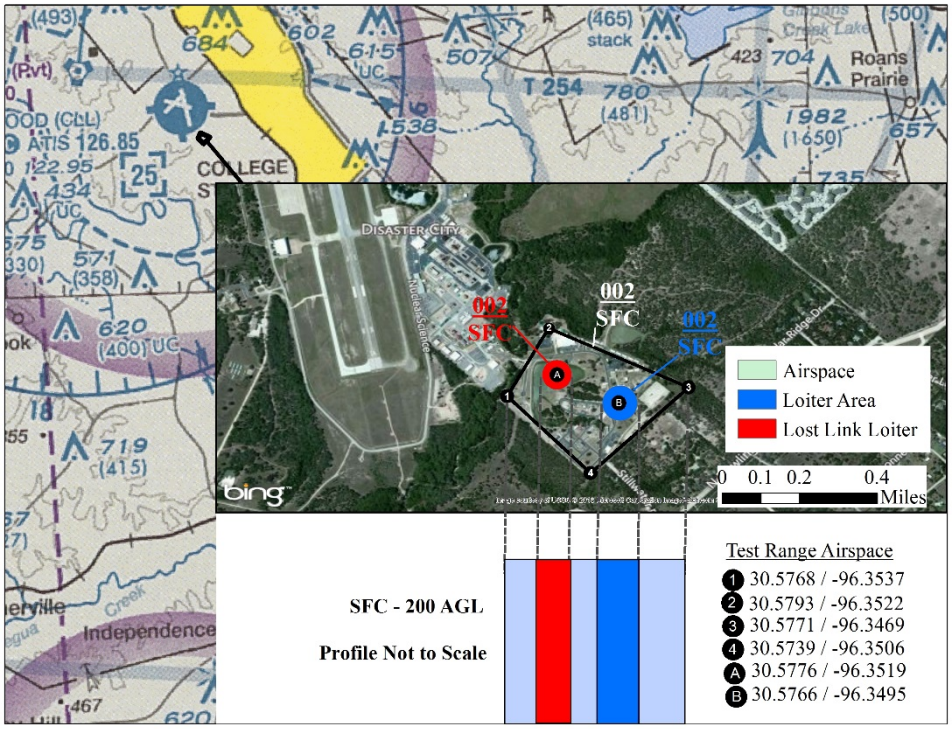
Airspace Dimensions

- ALT: SFC to 400’
- 2.2 NM east-west,
- 1.8 NM north-south

Texas A&M Flight Test Station

- Former military airbase
- 7,000’x150’ runway
- No functioning control tower

TAMU/TEES Disaster City Range



Dimensions of the Airspace:

- ALT: SFC to 200’
- ~0.4 NM east-west
- ~0.3 NM north-south

Center for Robotics Search and Rescue
Dr. Robin Murphy

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