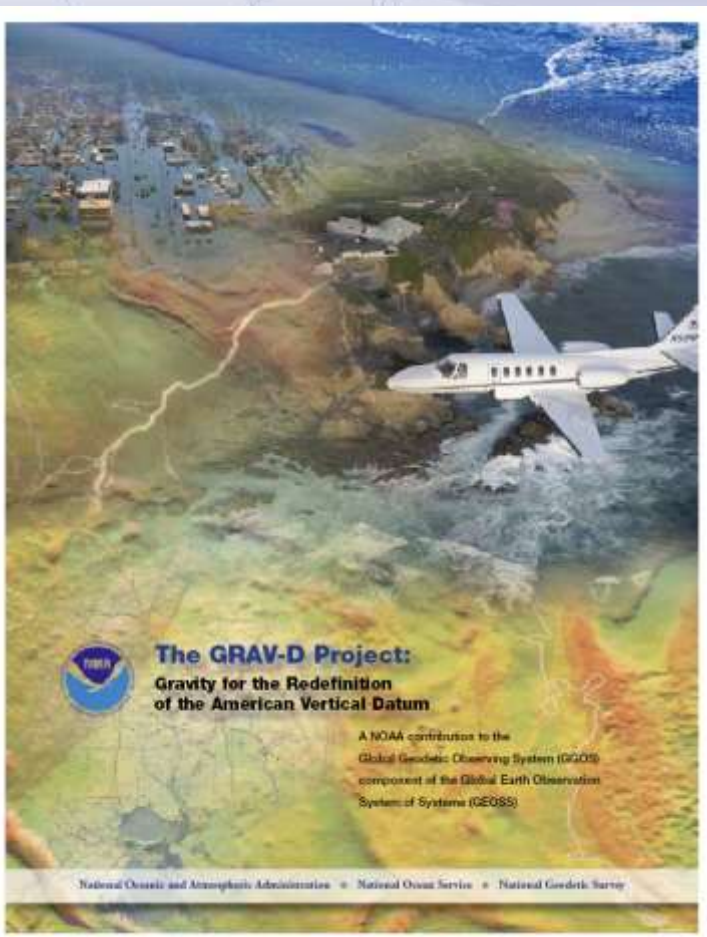
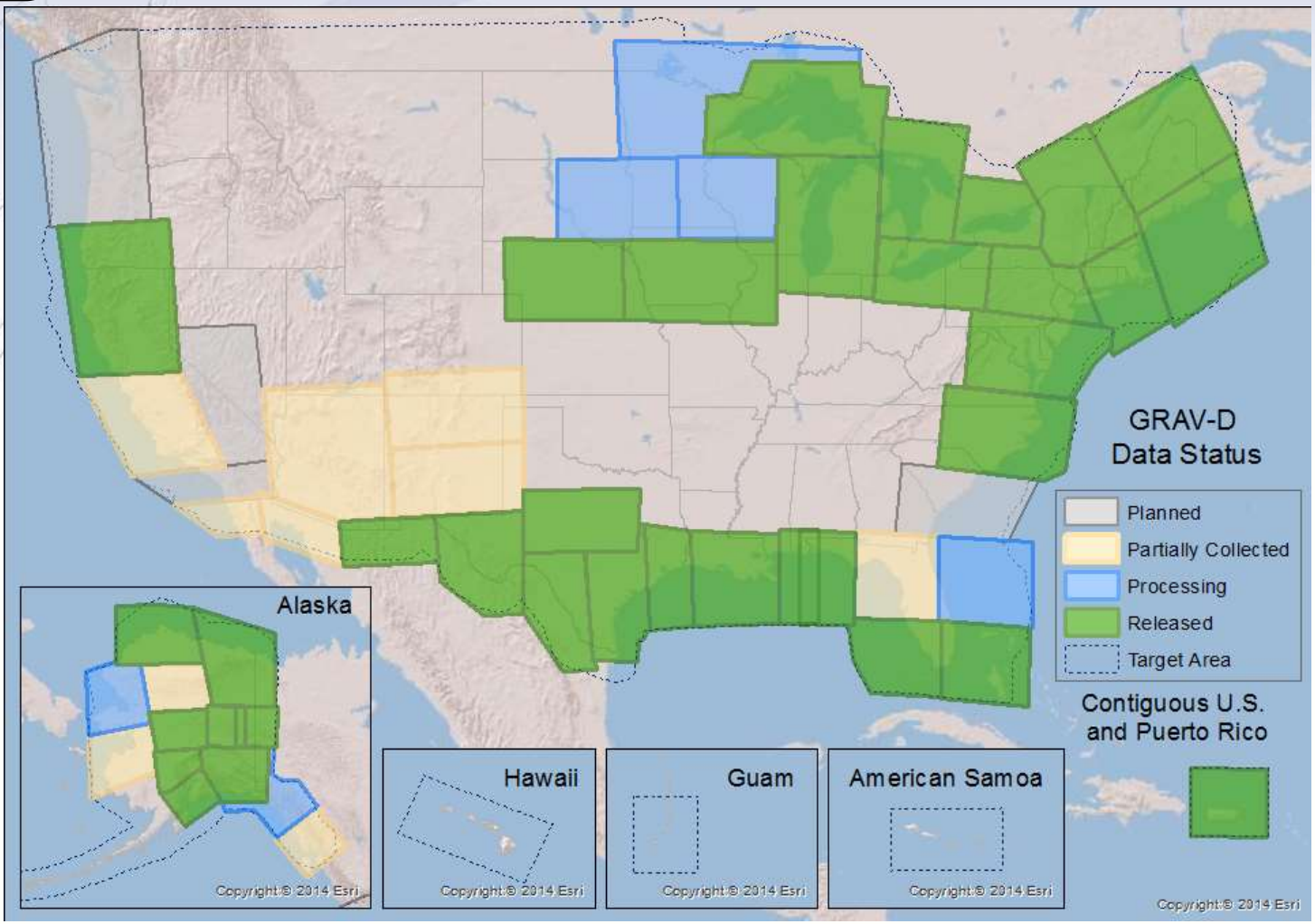
GRAV-D Project Overview



- **Overall Target**: 2 cm accuracy orthometric heights from GNSS and a geoid model
- **GRAV-D Goal**: Create gravimetric geoid accurate to 1 cm where possible using airborne gravity data
- **GRAV-D**: Two thrusts of the project
  - Airborne gravity survey of entire country and its holdings
  - Long-term monitoring of geoid change

Gravity for the Redefinition of the American Vertical Datum (GRAV-D)



https://www.geodesy.noaa.gov/GRAV-D/

GRAV-D Aircraft

- US NOAA
  - Gulfstream Turbo Commander Jet Prop
  - NOAA P-3 Hurricane Hunter
- US Bureau of Land Management
  - Pilatus PC-12
- Dynamic Aviation (contractor)
  - King Air 200T
- Fugro (contractor)
  - Cessna Conquest
  - King Air E-90A
- Aurora Flight Sciences (contractor)
  - Centaur OPA

Pilatus PC-12

King Air 200T

Centaur OPA

Cessna Conquest

NOAA P-3 (background)
NOAA Turbo Commander (foreground)

Current North Carolina GRAV-D Survey

Centaur OPA

- Optionally piloted aircraft system based on Diamond DA42MNG
- Aurora Flight Sciences Modified for Multi-role
  - Manned (certified)
  - Unmanned
  - Hybrid
- UAV performance with ability to operate in unrestricted airspace
- Key attributes:
  - One system, multi-roles
  - Safety & reliability
  - Heavy fuel, low burn diesel engines
  - Multi-Payload Ready
  - Low acquisition & life cycle costs

Centaur OPA Specifications

Avionics	Garmin G1000 Glass Cockpit
Airframe	General Aviation Diamond DA-42
Engine	Twin, Austro AE300, Heavy Fuel
Altitude	18k ft manned; 25k ft unmanned
Size	Wingspan: 44 ft, Gross Weight: 4400 lbs
Efficiency	~6-8 gal per hour
Range	2000 nmi
Speed	Loiter: 85kts, Cruise: 135-160kts, Dash: 175 kts
Weather	Anti-icing, non-freezing rain
Runway	Paved or Grass, 2000+ ft
Payload Power	Up to 5.6kW dedicated via separate bus
Other	Low noise, Non-militaristic look

Modes of Operation - Manned

Manned Mode: Fly like any normal manned aircraft with pilot on-board and in control--sensor operator can be on-board aircraft or at ground station

Operational Benefits:

- Fly in unrestricted airspace
  - Use system as any normal aircraft to perform mission/services
  - Put system in operation immediately and then switch to long-duration UAV ops when airspace is approved (Ex: Disasters)
  - Traverse areas (countries) where UAV ops are not permitted to get to a location to perform UAV ops (Ex: Africa, Antarctica)
- Small footprint operations
  - Self-transport system—eliminates need for shipping containers & transport vehicles
- High precision flight controls & navigation

Modes of Operation - Unmanned

Unmanned Mode: Fly like any UAV – air vehicle operator and sensor operator control system from the fixed or mobile ground station

Operational Benefits:

- Perform dull or dangerous missions removing crew from harms way
- Extends operational coverage time

Modes of Operation - Hybrid

Hybrid Mode: Fly like a UAV, but a "hands-off" safety pilot is on-board the aircraft – control of the vehicle is from the ground station

Operational Benefits:

- Allows use of the aircraft in restricted airspace with UAV control
  - Realistic unmanned testing can be performed almost anywhere (Ex: Testing Sense-n-Avoid technologies and airspace integration capabilities)
  - Realistic UAV training can be performed almost anywhere
  - Eliminates need for a COA or the expense of a controlled range location to operate
  - Robot can fly aircraft during dull missions to take stress off pilot (Ex: Large area geo mapping in a "lawn mowing" pattern is extremely dull.)

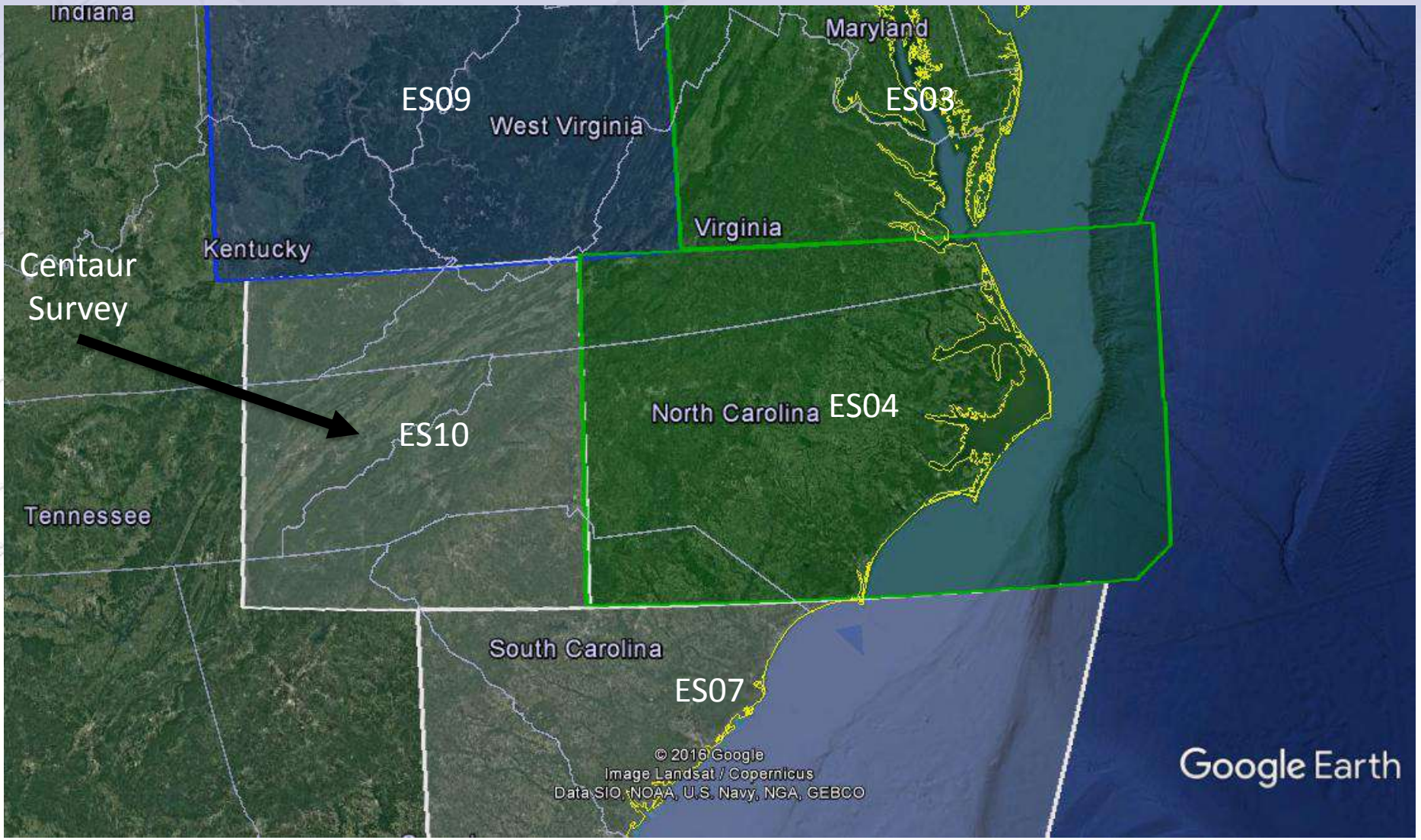
Centaur Payloads

Payload Weight	➢ Up to 800 lbs
Accommodations	➢ Dedicated power bus @ 5.6kW peak ➢ Mounting in nose, aft baggage, back seats, and belly pod
Capabilities	➢ EO/IR, Full Motion Video ➢ Laser Range Finder ➢ SAR, ISAR, GMTI, DMTI ➢ Multi-INT ➢ Data Links (11, 16, NATO-1) ➢ Ship Track (AIS) ➢ Comm Relay/Bridging (HAVEQUICK, SINCGARS, ANW2, TTNT, IW, SRW, P-25, CDL, Vortex, more…)
Payload Types	➢ EO/IR (up to 15"): Star Safire III/380HD, Wescam MX-15HDi, others ➢ Radar: 1700B, SeaSpray 5000E, Thales IMaster, NG STARLite, others ➢ LIDAR: Riegl 560, others ➢ AIS: Shine Micro, SAAB, others ➢ Multi-INT, EW, Comm

TAGS7 Gravimeter

- Micro-g Lacoste Turn-key Airborne Gravity System
- Size: 23 x 21 x 22 inches (from 28 x 22 x 33 in.)
- Weight: 73 kg (from 140 kg)
- Additional improvements:
  - 20 Hz data rate (from 1 Hz)
  - Improved temperature control
  - Improved tolerance of turbulence
  - More robust platform design

Installation


Indiana
ES09
West Virginia
Maryland
ES03
Virginia
Kentucky
Centaur
Survey
ES10
North Carolina
ES04
Tennessee
South Carolina
ES07
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Relative and Absolute Gravity Meters

County Boundary Surveys in Progress

- Mitchell-Yancey
- Cabarrus – Rowan (report submitted to the counties)
- Harnett – Wake
- Chatham – Harnett – Wake
- Alamance – Guilford
- McDowell – Mitchell
- Jackson – Macon
- Davie – Yadkin
- Bladen – Columbus – Brunswick
- Greene – Lenoir (plats recorded)
- Granville – Franklin
- Rutherford - Polk