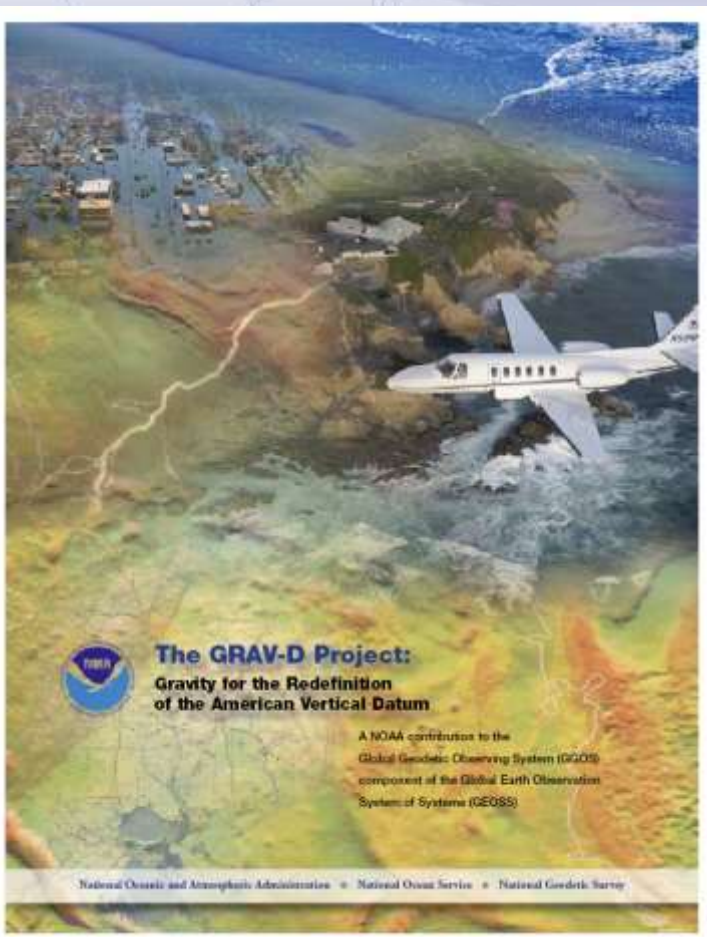
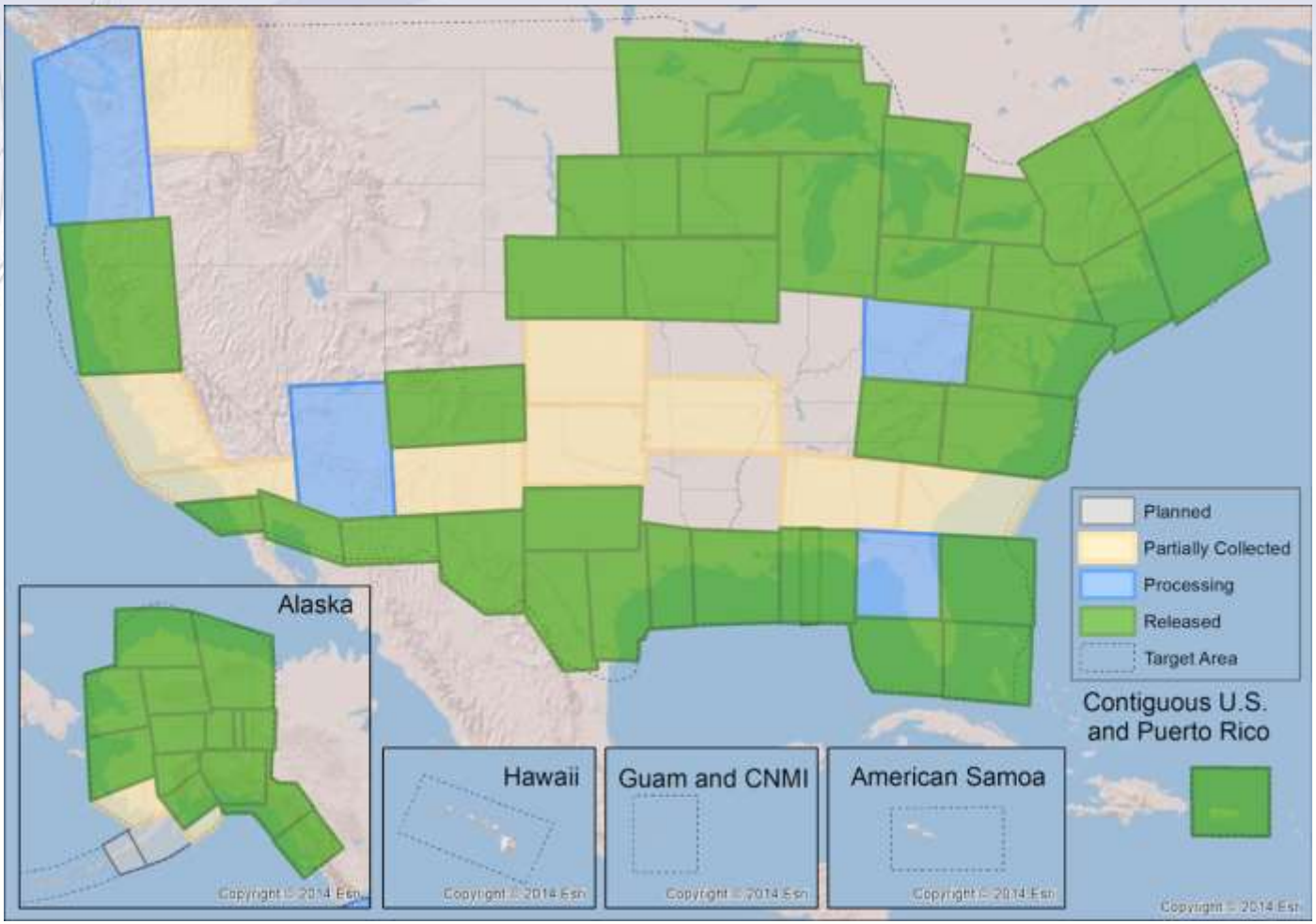
GRAV-D Project Overview



- **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)



March 2018

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

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

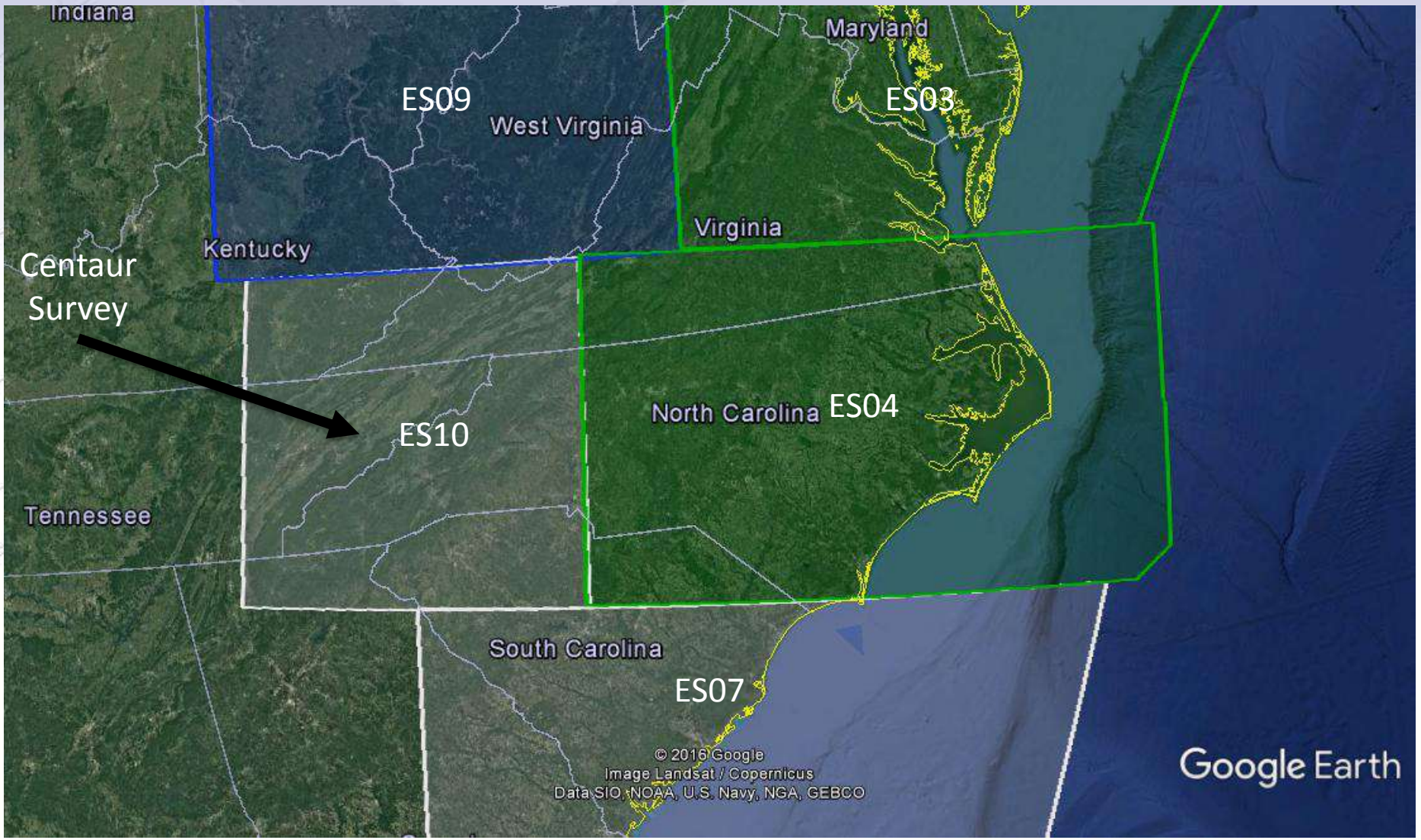
Modes of Operation - Hybrid

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.)

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

ELLIPSOID – GEOID RELATIONSHIP

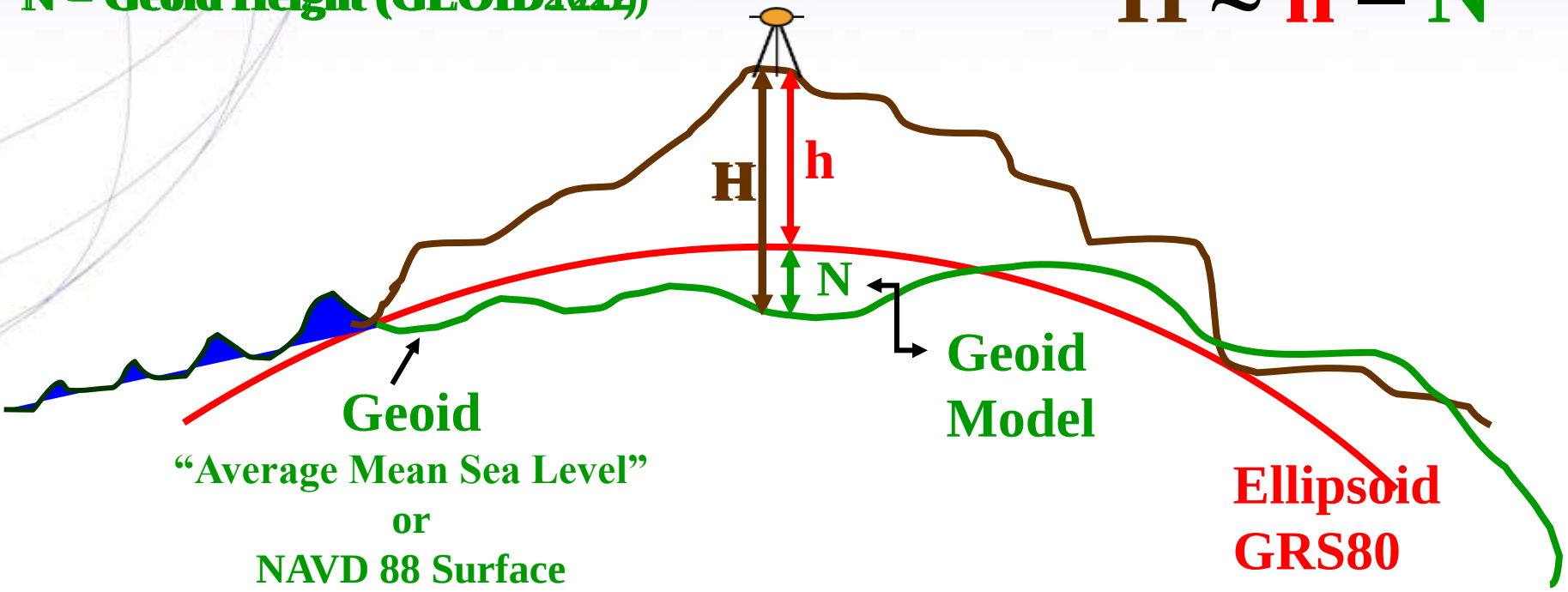
H = Orthometric Height (NAVD 88, 2022)

h = Ellipsoid Height (NAD 83 (2011))

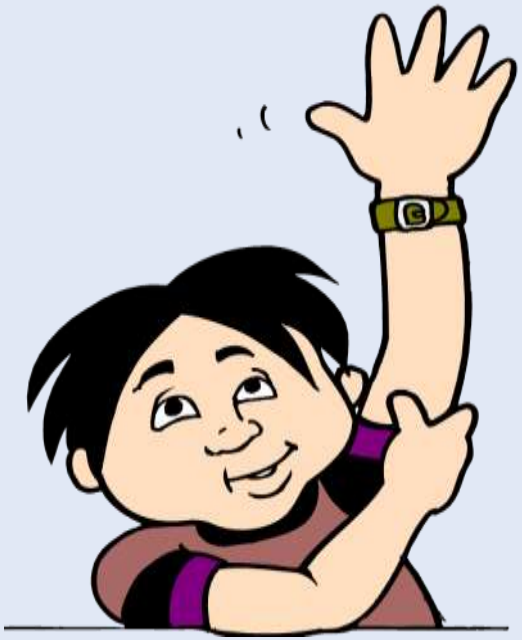
N = Geoid Height (GEOID18, 22)

$$H = h - N$$

$$H \approx h - N$$



Questions?



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