NOAA and UAS

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1985 Hurricane Elenna taken from the Space Shuttle
“We must move new but proven observing systems into an operational environment and redirect associated resources and research toward exploring new technologies, such as unmanned aerial vehicles, to meet future requirements.”

Æ VADM Conrad C. Lautenbacher, August 2005
A top NOAA Priority

Acquiring political legitimacy

Requires international collaboration
Improved Observations Hold the Key to Saving Lives, Property and Resources

Examining the state of the planet’s natural resources

Improving weather forecasts

Understanding global climate change

Understanding the rate of Arctic Ice melt

Improved hurricane track and intensity predictions

Fire Weather
GAP between satellites and surface-based sensors

Unmanned Aircraft Systems have great potential to fill this gap and take observations to complement our existing platforms

What are the gaps?
The UAS “System”

System is comprised of Subsystems

- Airframe (Platform)
- Avionics (electronic equipment that controls aircraft)
- Communication:
  * Line of Site (LOS)
  * Satellite (OTH)
- Ground Control:
  * Fixed
  * Mobile:
    - Vehicle
    - Vessel
    - Hand
- Launch and recovery
- Payload:
  * Communications relays
  * Sensors:
    - Scientific
    - Operational
  - Remote
  - In situ
  - Optical
  - Infrared
  - Radar
  - Hyperspectral
  - AIS
  - Etc…
UAS “System”
Altair/Predator B Communications and Control

Equipped with C-Band: transmits line-of-sight signals short distances
Ku-band satellite data link to provide over-the-horizon mission capabilities
(>150 miles)

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High Altitude Long Endurance (HALE) UAS

HA = High Altitude: working altitudes > 45k feet

LE = Long Endurance, i.e. airborne for 25 hours or more

Loitering capability allows us to track the evolution of systems, e.g. a weather system, forest fire, volcanic plume, etc

Payload capability varies; large payloads can support broad sensor suite. Examples: Global Hawk, Zephyr, Altair

NOAA’s International Arctic Campaign
Medium Altitude Long Endurance (MALE) UAS

MA = Medium Altitude: working altitudes to 25k feet
LE = Long Endurance, i.e. airborne up to 20+ hours

Similar capabilities to HALE UAS

Because MALE UAS are operating at lower altitudes, they can transmit more detailed imagery of targets

Examples: GA-ASI Gnat, Predator B
Low Level UAS

Working altitudes 150-1000 feet AGL
Endurance up to 5+ hours
Cruise speeds 20-50 mph, increasing with weight
Operating Radius about 10 miles
Fly low and slow, inexpensive, may be expendable
Good for missions not needing large payloads or long endurance
No runway needed; can be launched/recovered from anywhere – by hand or catapult or from bow of ship
Inadequate payload capacity for digital datalinks

Examples: Aerosonde, Scan Eagle, Sierra, Silver Fox, Mantra

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Aerosonde release from its transport vehicle on the runway at the NASA Wallops flight Facility
APPLICATIONS

“dull, dirty & dangerous”
Hurricane Prediction

Extending Hurricane Prediction Lead Time

3-Day Forecast Observing Area
Hurricane Prediction

Extending Hurricane Prediction Lead Time

3-Day Forecast Observing Area

5-Day Forecast Observing Area
“Aerosonde” in Ophelia, 9/16/05

NASA Wallops Flight Facility, Wallops Island, VA.  7:30-5:30 EDT

NOAA satellite image of Tropical Storm Ophelia taken on Sept. 16, 2005, at 9:15 a.m. EDT
“Aerosonde” in Ophelia, 9/16/05

FIRST EVER TROPICAL CYCLONE FLIGHT BY AEROSONDE

Satellite image of Tropical Storm Ophelia (intensity = 55 kt), with flight tracks shown:

Aerosonde (blue) just after WP-3D Orion (red) penetration across the eye

Courtesy of Joe Cione and Frank Marks (OAR/AOML)
Hurricane Prediction

High Altitude Long Endurance (HALE) UAS

Remote Sensing

Dropsondes
$p, T, V$

P = Atmospheric pressure
T = Air temperature
V = Wind speed and direction

Low Altitude UAS mini-Airplanes
45kg payload: Air-sea exchange
5kg payload: $p, T, V$
Aerosonde range ~1000m
1-way “no station time” range is ~ 500nmi from Key West (yellow curve)
Firefighters employ hand held radios connecting them to each other, their command post, and the tankers.

Firefighters receive HALE images on their PDA.

Smoke jumpers & firefighters arrive.

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NASA/USDA-FS Fire Mission

Summer 2006
• 23 hour flight with pod, 43K ft.
• 21 hour flight without pod, 48K ft. altitude
• continental NAS with FAA COA under new rules.

Mobilized for the October 28 Esperanza, California fire which covered 40,200 acres- a category 1 fire (top priority). Four firefighters lost their lives

The emergency flight was requested by the Incident Command Team, the State of California Office of Emergency Services, and the Governor's Office.
A UAS base would address Alaska's unique environmental threats.
Existing Network:
Sparse network of **surface observations** in the Arctic

**Satellite observations:**

**Geostationary** ~38,000km above the equator
Instruments have constant view of mid-lats and tropics, but a limited view of the poles.

**Polar orbiting** ~800km
Capture more detail because of lower altitude but complete coverage takes time.
But difficulty in distinguishing between clouds and ice because radiative properties are similar – clouds and snow/ice have similar temperatures and similar albedos.
Arctic Surface Observing Stations and Buoys

Black Triangles: International Arctic Buoy Program (IABP) Buoys
Red Dots: Global Climate Observing System (GCOS) points

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Ice Thickness Remains a Problem

- 5-10 cm
- much thicker
18 model outputs from the same A1B scenario that has CO2 global mean increasing to 720 ppm by 2100 (current global mean ~ 380ppm). Darkest red = 1 C/decade (10C/century), Yellow = 0; green is slightly negative, and due to ocean circulation changes.
“Strawman” route for HALE UAS over the Arctic ice. Profiles of state variables and forcing are made at the 20 points shown. Under each point is a AUV to observe the temperature, salinity and ice depth at the same geographic point.
UAS Research Applications in Alaska

- Fisheries
- Arctic Ice monitoring strawman route
- Mammal Monitoring
- Transboundary Air Pollution from Asia
- Wild Fires
- Coastal Erosion
- Pipeline
UAS Applications in the Gulf Region

- Oil Platforms
- Hurricane Forecasting
- Hurricane aftermath
  - Katrina (New Orleans)
- Dead Zone
  - Harmful algal blooms

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Northwest Hawaiian Islands Marine National Monument: world’s largest marine sanctuary and one of the most pristine marine ecosystems in the world, nearly untouched by humans. 1,400 miles long, 100 miles wide, and home to more than 7,000 species, many seen nowhere else in the world.
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Altair Mission, Channel Islands and eastern Pacific, 2005

Tropical Storm Ophelia Sept 2005, NASA Wallops Aerosonde launch

Feb 2006, Point Upolu, Hawaii, NOAA NMSP
Silver Fox and Manta Project to monitor marine mammals

Altair Mission, Channel Islands and eastern Pacific, 2005

3M in 2008 President’s budget
QUESTIONS?

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