

## NOAA Unmanned Aircraft Systems (UAS) Program

CDR Phil Hall
Office of Oceanic and Atmospheric Research
23 June 2011

## Tools for Building UAS Capacity

Requirements
Documentation
and Trade Studies

Observing System
Simulation
Experiments and
Information
Management

**Partnerships** 

UAS Platform and Payload Demonstrations



NOAA UAS for Improved Situational Awareness and Scientific Understanding



Airspace, Safety, Training and Operational Procedures



## NOAA-UAS-Roadmap

	Innovate	Incubate		Integrate
	STEP 1 Identifying Promising Technologies	STEP 2 Optimizing Observing Strategies	STEP 3  Testing and Optimizing Concept of Operations	STEP 4 Implementing Operations to Address NOAA Goals
High Impact Wx	Long Endurance High and Low Altitude Transportable	High Resolution Imaging Vertical Meteorological Profiles Ocean Surface Meteorology	Tropical Storms Winter Storms Atmospheric River Storms Flooding Fire Weather	Weather-Ready Nation Sustainable Coastal Communities Climate Adaptation and Mitigation
Polar Monitoring	Long Endurance High and Low Altitude Transportable Quiet	High Resolution Imaging  Vertical Meteorological Profiles  Air Chemistry	Sea Ice Conditions Storm Forecasting Wildlife Assessment Air Chemistry Disaster Response	Climate Adaption and Mitigation Sustainable Ocean Ecosystems Arctic Strategy National Ocean Policy
Marine Monitoring	Long Endurance High, Medium, and Low Altitude Transportable Quiet	High Resolution Imaging Ocean Color Air Chemistry	Wildlife Assessment Fisheries Law Enforcement Marine Debris Coastal Ecosystems Disaster Response	Sustainable Ocean Ecosystems Sustainable Coastal Communities Arctic Strategy National Ocean Policy



### Antarctic Wildlife Assessment



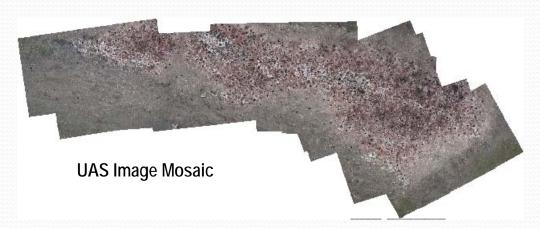
Sample species on Cape Shirreff, Antarctica



UAS with Olympus EL-1 Camera



**UAS Operator with Vehicle** 



Project Leads: Wayne Perryman (NOAA/ SWFSC) and LCDR Nancy Ash (NOAA/AOC)



Single UAS Image



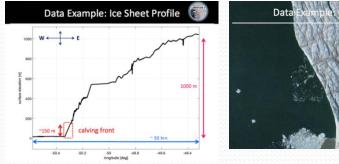
## Polar Monitoring - Greenland Glacier and Ice Seal

Testbed Co-leads: Dr. Elizabeth Weatherhead (University of Colorado) and Dr. Robyn Angliss (NOAA/ National Marine Mammal Laboratory Partners: Greenland Glacier Study / University of Colorado and BAE Systems -Advanced Ceramics Research

Bering Sea Ice Seal Study / University of Alaska- Fairbanks and Boeing - Insitu

Greenland Glacier Study - 2008

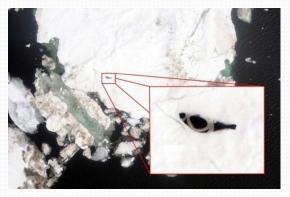




Images courtesy of James Maslanik, University of Colorado

Bering Sea Ice Seal Study - 2009





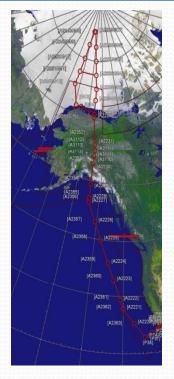
Images courtesy of Greg Walker, University of Alaska - Fairbanks



### Global Hawk Pacific (GloPac) Experiment

A partnership between NASA, NOAA, and Northrop Grumman







- Mission Scientists: Paul Newman (NASA/GSFC) and David Fahey (NOAA/ESRL)
- First Global Hawk flight north of 65° N.
- First Global Hawk mission to have pole to pole command and control, and payload communications links.

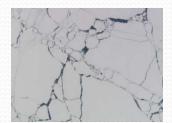


#### One Mission - Two Oceans



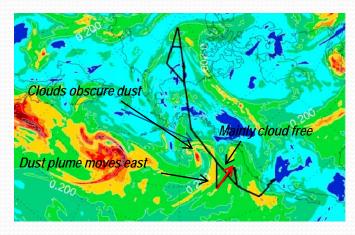
#### 23 April 2010 Global Hawk Accomplishments

- Flight endurance 28.6 hrs; Flight range 9700 nm;
- Maximum altitude 19.9km; Maximum latitude 85N
- First time any Global Hawk has ever traveled north of 70 latitude
- Collected, recorded, and relayed real-time readings of in situ stratospheric ozone, water vapor, methane, carbon monoxide, nitrous oxide, hydrogen, and sulfur hexofluoride concentrations along entire flight track
- Captured high definition visible imagery of sea ice
- Cloud Physics Lidar remotely sensed dust concentrations crossing the Pacific Ocean from 31 March 2010 Gobi Desert dust storm

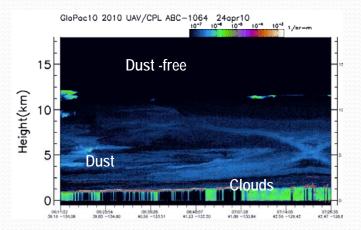




High definition visible images of sea ice captured by NASA Airborne Compact Atmospheric Mapper



NASA aerosol model forecast and Global Hawk flight track



Aerosol vertical profile observed by Cloud Physics Lidar along red arrow of flight track above



# UAS Mission Flexibility and Profiling Capability

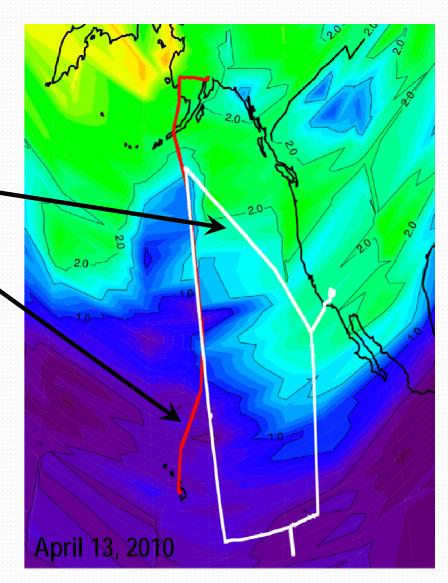
GloPac demonstration of aircraft profiling and satellite underflight

GloPac GH track in white

HIPPO NCAR GV in red

Aura satellite track follows the western side of GloPac flight

Ozone data from Microwave Limb Sounder (MLS), figure courtesy of Dr. Karen Rosenlof (NOAA)





# Winter Storms and Pacific Atmospheric Rivers (WISPAR) Experiment









Mission Scientists: Gary Wick (NOAA/ESRL) and Michael Black (NOAA/AOML)

Partners: Yucheng Song (NOAA/NCEP), Janet Intrieri (NOAA/ESRL), Ryan Spackman (CU), NASA, NSF/NCAR

Dropsonde System – NCAR development / NOAA and NSF sponsorship 88 sonde total capacity

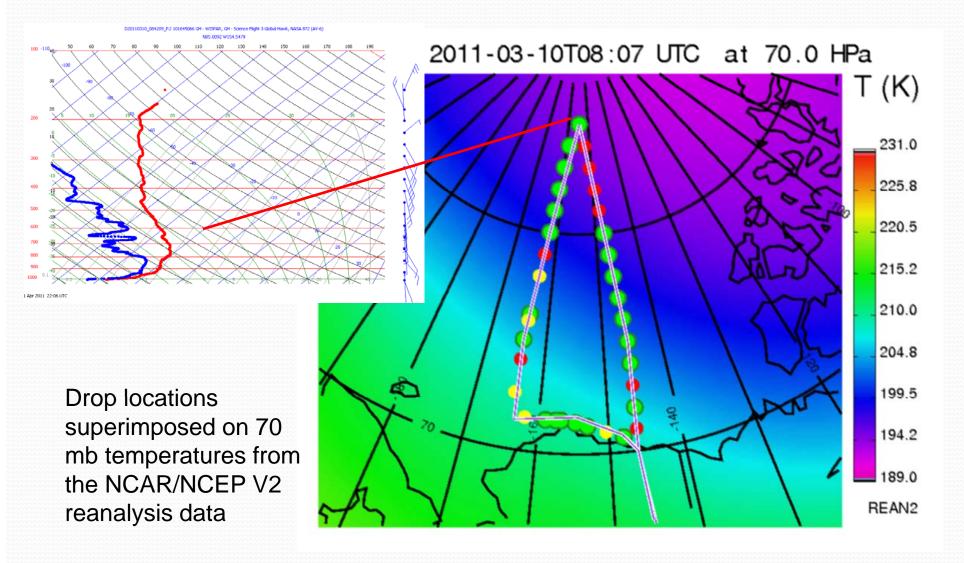
First dropsonde release from a Global Hawk

## Dropsonde Release Video





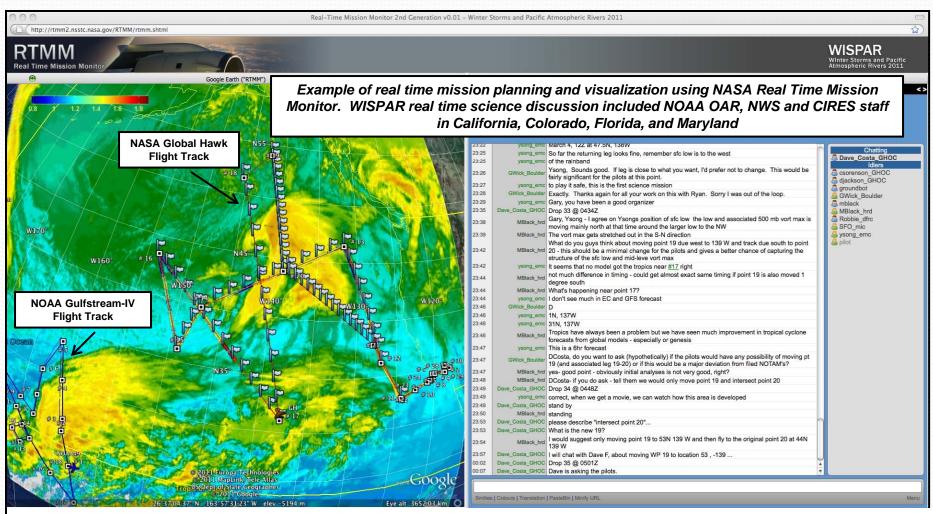
## WISPAR Arctic Dropsonde Mission 9-10 March 2011



Courtesy of Leslie Lait, Paul Newman (NASA GSFC)



#### WISPAR Winter Storm Mission 3-4 March 2011

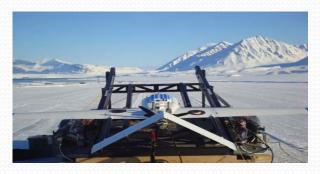


Winter storm mission flown on the eastern side by the NOAA Gulfstream-IV and on the western side by NASA Global Hawk. The Global Hawk historically released 70 dropsondes in a single flight covering 8000 nmi. The Global Hawk also remotely sensed atmospheric temperature and water vapor profiles continuously during the 24 hour mission using the NASA JPL High-Altitude Monolithic Microwave Integrated Circuit Sounding Radiometer (HAMSR).



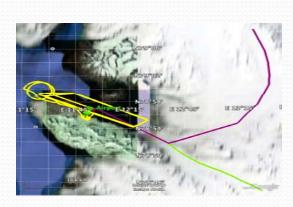
## Soot Transport, Absorption, and Deposition Study (STADS)

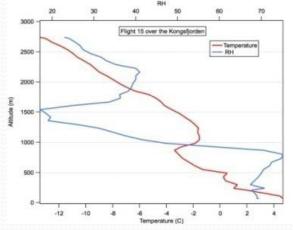
5 April - 7 May 2011

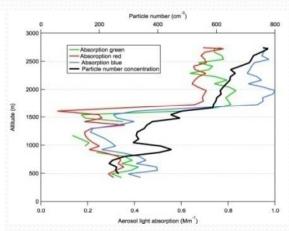












NOAA component of the Coordinated Investigation of Climate-Cryosphere Interactions (CICCI) collaboration with Norwegian and Russian scientists

STADS Mission Scientists: Tim Bates and Patricia Quinn (NOAA/ESRL)



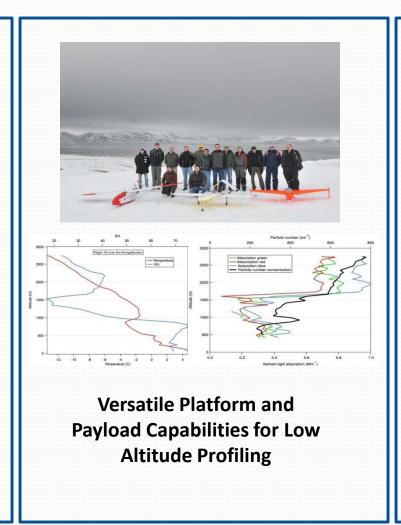
# Wide Range of Innovative UAS Observing Solutions

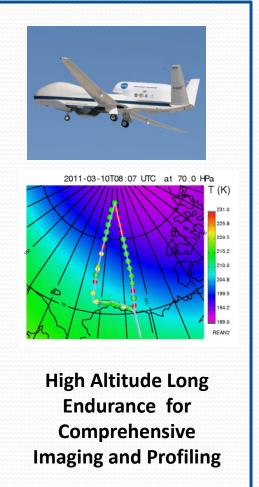






Quiet and Easily
Transportable for High
Resolution Imaging







## Gale UAS

#### July 2011



Performance Attribute	Estimated Performance
Mission Weight	8.0 lbm
Cruise Speed	42 kts
Dash Speed	110 kts
Stall Speed	22 kts
Mission Endurance	60 minutes



## Future Capabilities



Vehicle: Puma AE

Manufacturer: AeroVironment

Launch: Hand Launch

Recovery: Belly

Cruise Speed (knots): 20-45

Range (nm): 56

Payload (lb): ~2

Endurance (hr): 2

Ceiling (ft): 500

BLOS C2 Capable: No

LOS C2 Range (nm): 8.1

#### Data Sources:

Manufacturer's Online Specification accessed 08/30/10. Range Calculated.

## 2011 Partnership with Army UAS Program

#### Potential 2012 Missions

- Marine Debris
- National Marine Sanctuary Surveys
- Fisheries Law Enforcement
- Wildlife Assessments
- Beach and Shoreline Patrols



### Next Steps

- Optimizing UAS observing strategies for:
  - Sea ice information
  - Wildlife assessments
  - Air quality and atmospheric chemistry process studies
  - Oceanic meteorological information
  - Real-time data delivery
  - Fast, effective image processing
- Identifying promising UAS technologies for:
  - Methane impact studies
  - Gravity and elevation information
  - Coastal mapping
  - Inland flooding and meteorological information



### Contact Information

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