

Department of Energy's Utilization of Unmanned Aerial Systems for Environmental Monitoring

The Second UAS Mini-Workshop

OFCM – November 8th, 2012

Rickey Petty

AAF Program Manager



U.S. DEPARTMENT OF
ENERGY

Office
of Science

Office of Biological
and Environmental Research

Overview

- DOE's Mission Relevancy
- Atmospheric Radiation Measurement (ARM) Climate Research Facility
 - DOE ARM UAV History
 - DOE Presence in the TWP
- BER Arctic climate activities



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ENERGY
LEADING BASIC RESEARCH
FOR A SUSTAINABLE FUTURE

ENVIRONMENT
UNDERSTANDING CLIMATE CHANGE AND
IMPROVING THE ENVIRONMENT

INNOVATION
BUILDING RESEARCH INFRASTRUCTURE AND
PARTNERSHIPS THAT FOSTER INNOVATION

DISCOVERY
UNRAVELING NATURE'S
DEEPEST MYSTERIES

SCIENCE.DOE.GOV

Why DOE?

The Energy-Climate Nexus

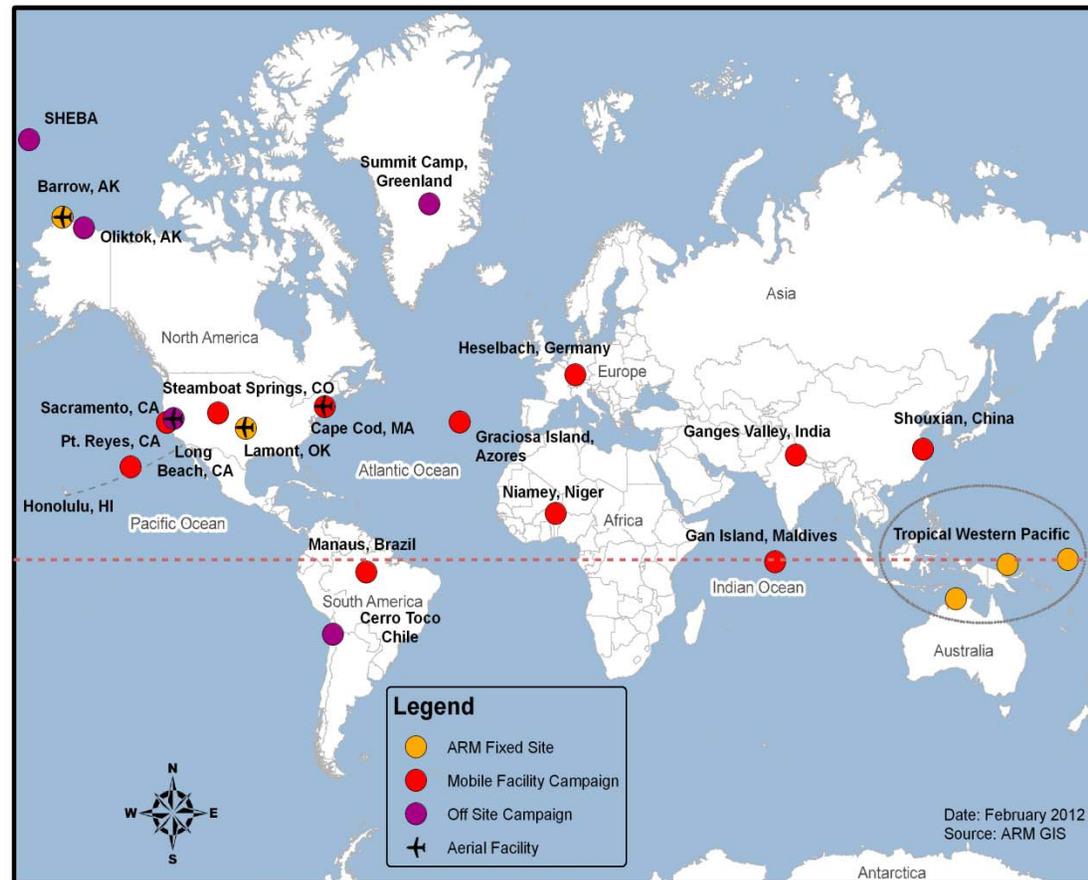
Greenhouse gases are emitted during energy production...
and climate change will impact energy production

DOE seeks to:

- Understand the effects of GHG emissions on Earth's climate and the biosphere
- Provide world-leading capabilities in climate modeling and process research on clouds and aerosols, and the carbon cycle
- Provide unique, world-leading capabilities in cloud and aerosol observations and large scale ecological experiments
- Build foundational science to support effective energy and environmental decision making



ARM's Global Reach





ARM-UAV conducted 12 major field campaigns 1993-2006

Field Campaigns :

- Fall 1993, Edwards AFB, CA
- Spring 1994, Northern OK
- Fall 1995, Northern OK
- Spring 1996, Northern OK
- Fall 1996, Northern OK
- Fall 1997, Northern OK
- Spring 1999, PMRF Kauai, HI
- Summer 1999, Monterey, CA
- Winter 2000, Northern OK
- Fall 2002, Northern OK
- Fall 2004, North Slope, AK
- Winter 2006, Darwin, Australia



GA-ASI "GNAT 750"
(F93, S94)



Grob "Egrett"
(F95, S96)



GA-ASI "Altus I" (F96, F97)



GA-ASI "Altus II"
(Su99)



Proteus(F04, W06)



Twin Otter
(F93, S94, F95, S96, F96,
F97, Sp99, Su99, W00)

ARM's History with UAVs

- Demonstrated how measurements from UAVs contributed to the understanding of cloud and radiative processes.
- Data collected used in the study of radiative transfer processes through clouds, evaluation of cloud parameterizations, & development of cloud remote sensing methods.
- Total of 8 campaigns / 140h science flights/ 3 UAV platforms (**GNAT -750, Altus, and Altus II**).
- Stephens, G. L., Ellingson, R.G., et. al.; BAMS, Vol. 81, No. 12, December 2000.

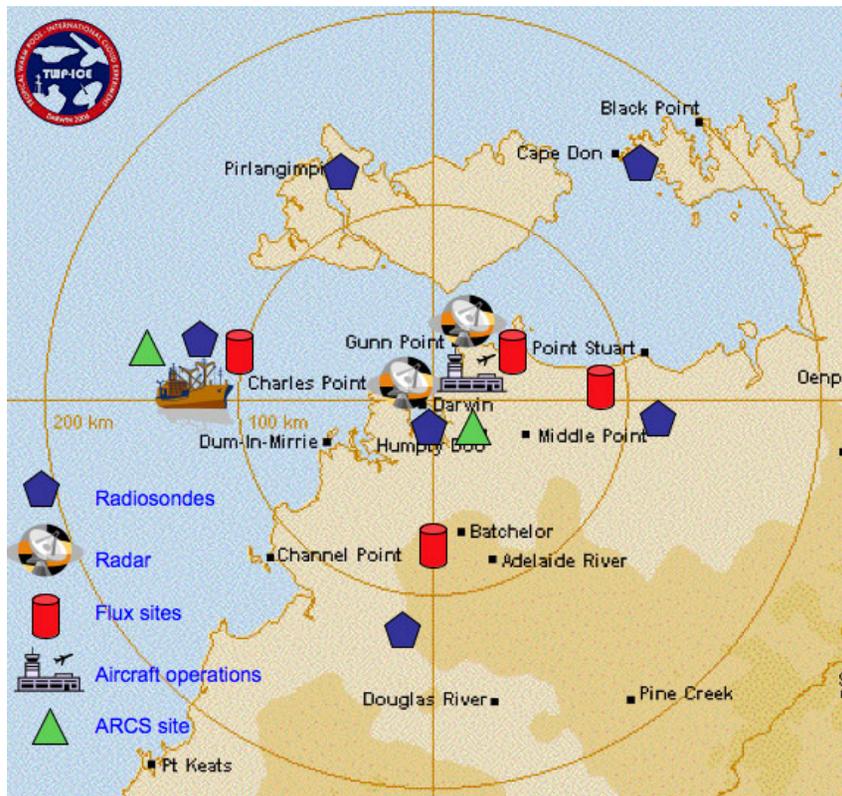
Tropical Western Pacific



- established in 1996
 - consists of three climate research facilities:
 - the [Manus](#) facility on Los Negros Island in Manus
 - Papua New Guinea (established in 1996)
 - [Nauru](#) facility on Nauru Island, Republic of Nauru (1998); and
 - [Darwin](#) facility in Darwin, Northern Territory, Australia (2002).

Tropical Western Pacific

TWP-ICE Experiment 2006

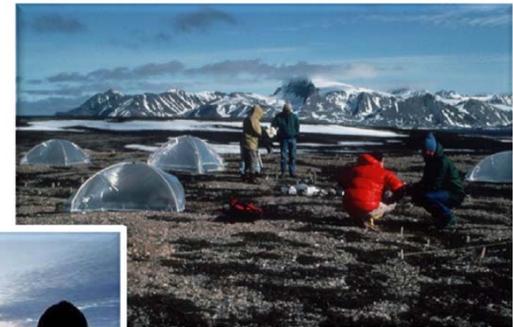


A Few Science Objectives

- Collected measurements of the cirrus microphysics and relate them to storm intensity and proximity
- Improve and evaluate cloud property retrievals from satellite/compare to ground-based remote-sensing measurements.
- Measure the dynamical and radiative impacts of the cloud systems.

BER Arctic climate science

- The Arctic is vitally important to Earth's climate:
 - It is a globally sensitive region
 - It is changing faster than any other region
 - It has vast reservoirs of carbon and ice
 - Melting Arctic permafrost will release massive amounts of carbon
 - Melting Arctic ice has major impacts on ocean circulation
- Major knowledge and observation gaps limit scientific progress
 - Arctic is poorly represented in global climate models
 - Arctic processes needed by Earth System Models are understudied



**North Slope of Alaska, Oliktok Point:
A hosting capability for studies of
low cloud and the retreating
Arctic Ocean sea ice**



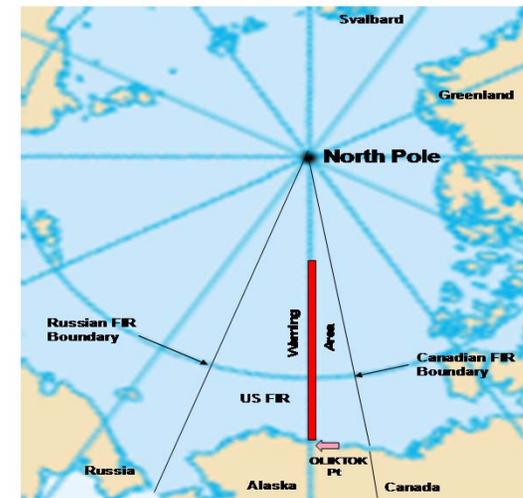
**Portable facilities on land at USAF
Oliktok Point Long Range
Radar Station (permit from USAF)**

**Aerial Facilities: DOE- owned
restricted airspace over Oliktok
Point, and an offshore Warning Area
requested from FAA giving access
to a slice of the Arctic Basin
extending most of the way to the
North Pole**

Next use: ALTOS, fall 2010

**Proposed
Warning
Area
(in red)**

**FIR =
Flight
Information
Region
(relevant
country
controls
flight in
that region)**



Science questions for DOE UAV operations in the North Slope of Alaska

- How well do climate models capture the atmospheric thermodynamic state over the Arctic basin?
- What is the profile of atmospheric composition?
- What is the climatological distribution of clouds and aerosols in the deep Arctic and what are their relationships to the thermodynamic environment?

A Step Towards an Arctic Climate Observatory: Warning Area over International Waters.



DOE has requested from the FAA the creation of a Warning Area over International Waters adjoining Oliktok to accommodate unmanned aircraft flights and other aviation related research activities out over the Arctic Ocean focused on the rapid retreat of the sea ice; Warning Areas confer similar operational advantages as Restricted Airspace, but over international waters. The gap exists because it is FAA policy to only create warning areas over international waters. The gap can be spanned with an FAA granted certificate of authorization on an experiment by experiment basis.

UAV Operations at Oliktok October 22nd- November 2nd :Engineering Evaluations and Flight Tests

BAT-3

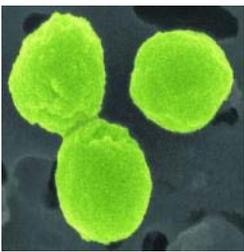
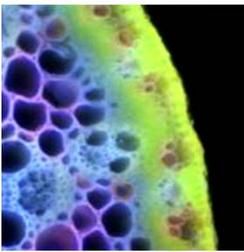
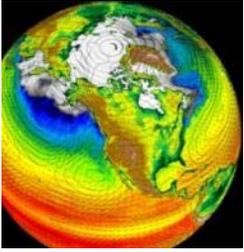


Aeryon Scout



SBIR Atmospheric Measurement Technology

- Instrument Package for Characterization of Aerosols, Turbulence, and Surface Characteristics in the Arctic (NSA footprint expansion).
- Greenhouse Gas and Carbon Isotope Measurements from UAVs (NGEE)



Thank you!

Rickey Petty

Rick.Petty@science.doe.gov

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