Exceptional service in the national interest

SAND2013-4872C

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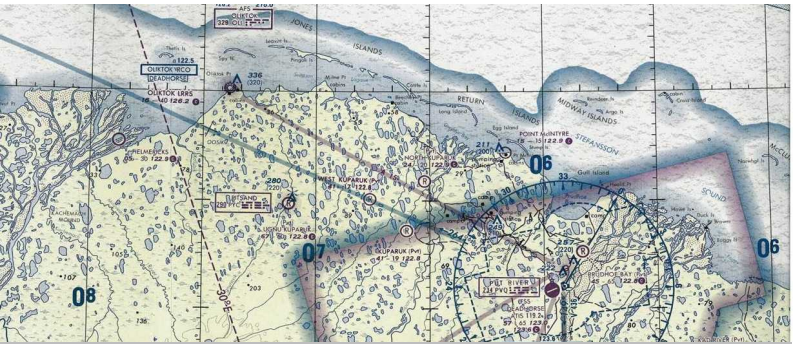

DOE Climate Research in the Arctic: Facilities, Science Objectives, and Challenges

Mark Ivey

North Slope of Alaska ARM Facility Manager

Sandia National Laboratories

U.S. DEPARTMENT OF ENERGY

NNSA Nuclear Security Administration

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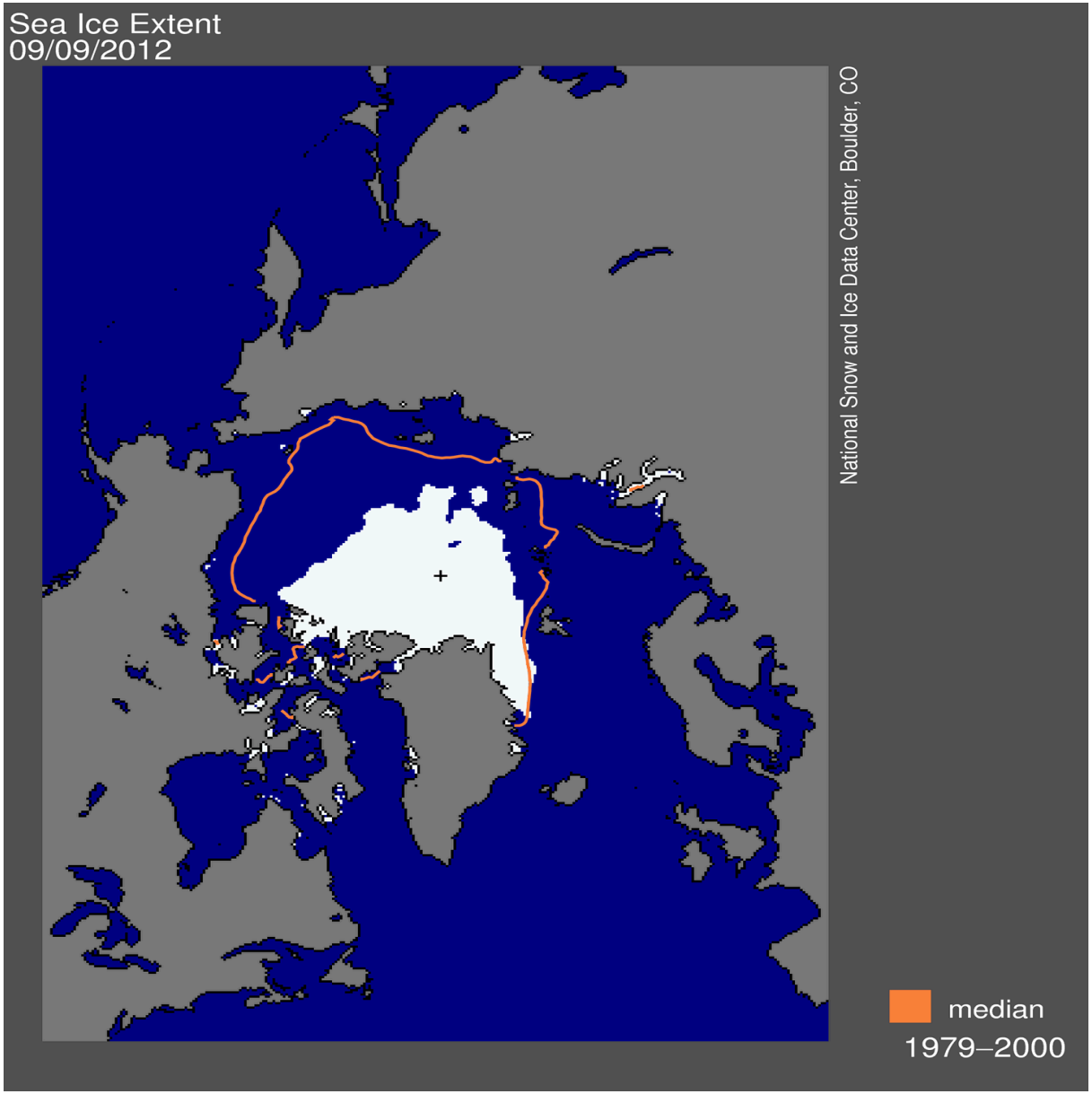

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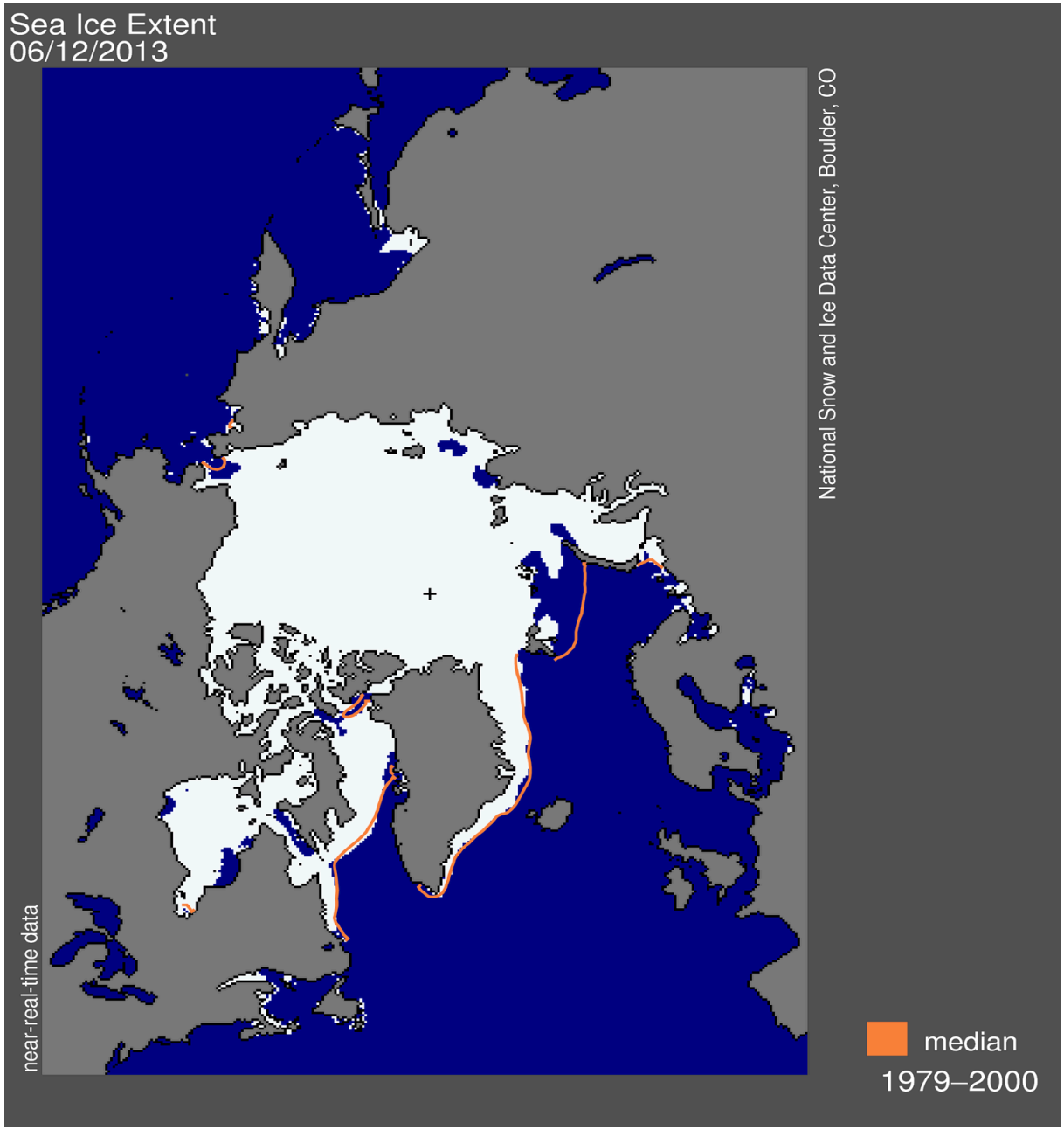

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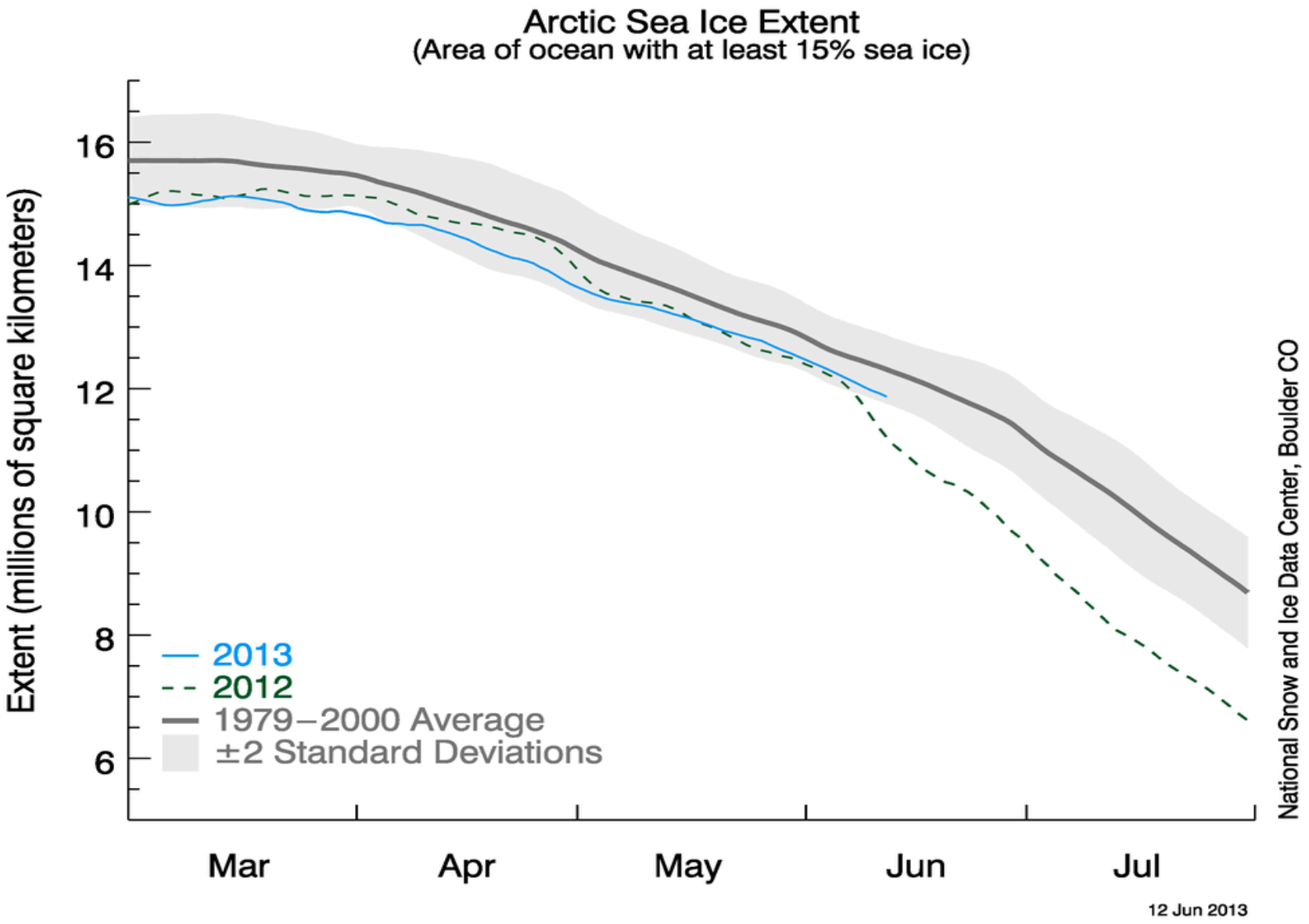
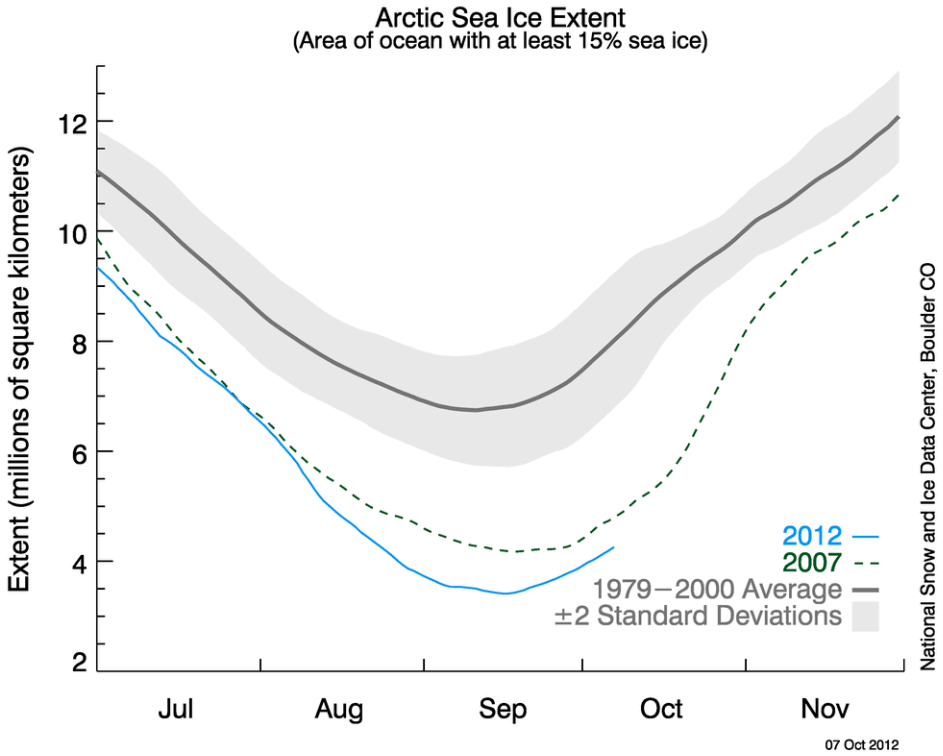
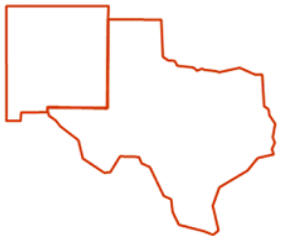

Arctic Sea Ice Extent
(Area of ocean with at least 15% sea ice)
Extent (millions of square kilometers)
16
14
12
10
8
6
2013
2012
1979–2000 Average
±2 Standard Deviations
Mar
Apr
May
Jun
Jul
National Snow and Ice Data Center, Boulder CO
12 Jun 2013





= 1 million square kilometers

Mitigating Climate Change by Reducing BC
Why Arctic?

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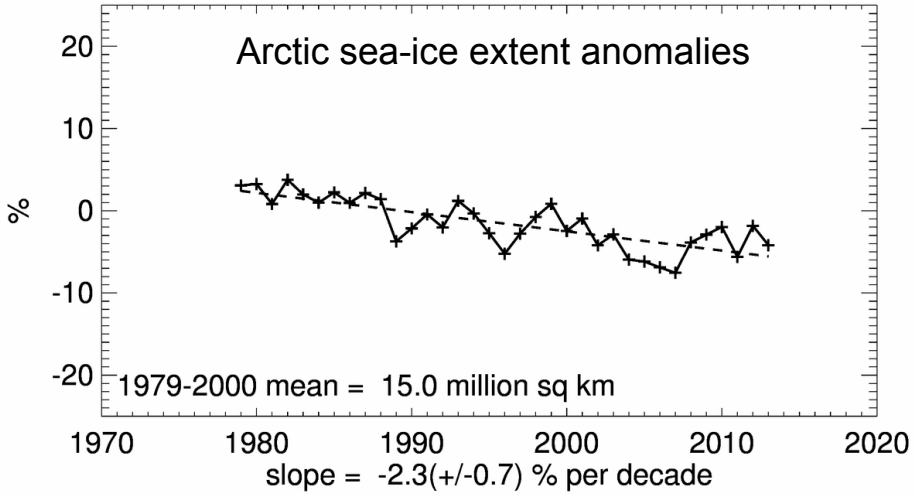
Impact of BC on Arctic climate

- BC may be responsible for enhanced Arctic warming and increased sea-ice loss
- Small particles easily transported to high latitudes
- Enhanced warming leads to more tundra fires
- More fires, more BC, positive feedback
- Arctic climate affects global climate

Tundra fire in Alaska

Declining Arctic sea-ice



Transport of BC into the Arctic

"Arctic Haze" observed during 2008 NASA ARCPAC Campaign

Methane and Climate Change
What do we not know?

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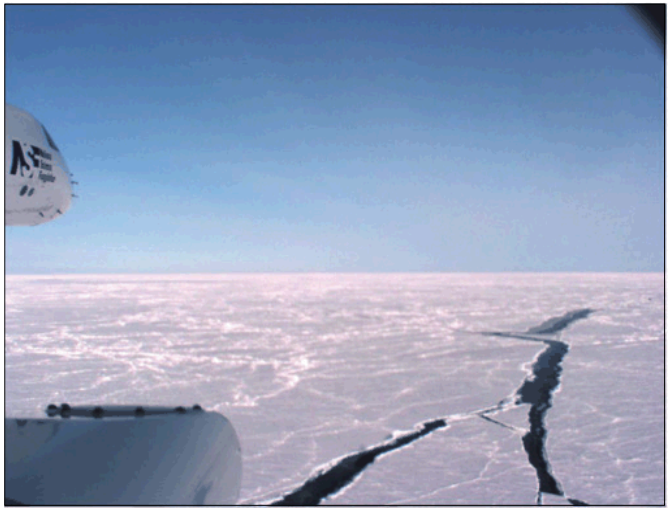
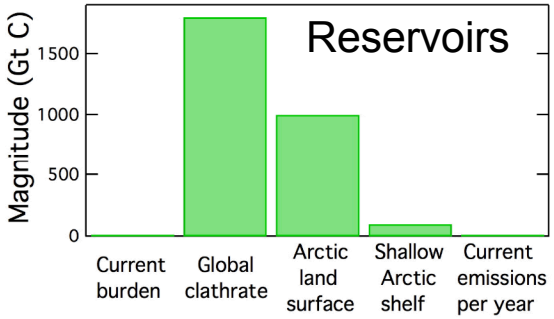
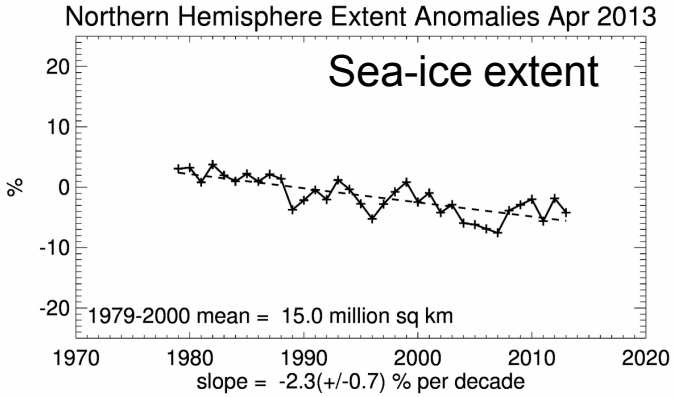


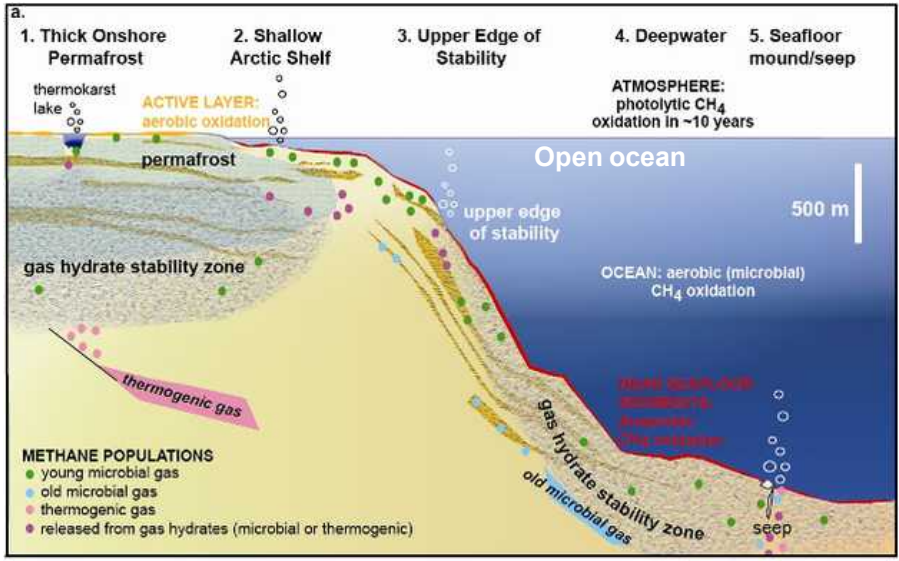
Large uncertainties in sources and reservoirs

- Current natural sources (ocean, wetlands) are uncertain
- Changes in methane growth rates are not understood
- Reservoir sizes (clathrates, permafrost) are highly uncertain
- Response of reservoirs to climate change is not known
- Feedbacks are not included in climate models



Kort et al., 2012





Ruppel, Nature Knowledge, Hydrates/Climate, April 2011

DOE Atmospheric Radiation Measurement (ARM) Program Mission and Vision Statements

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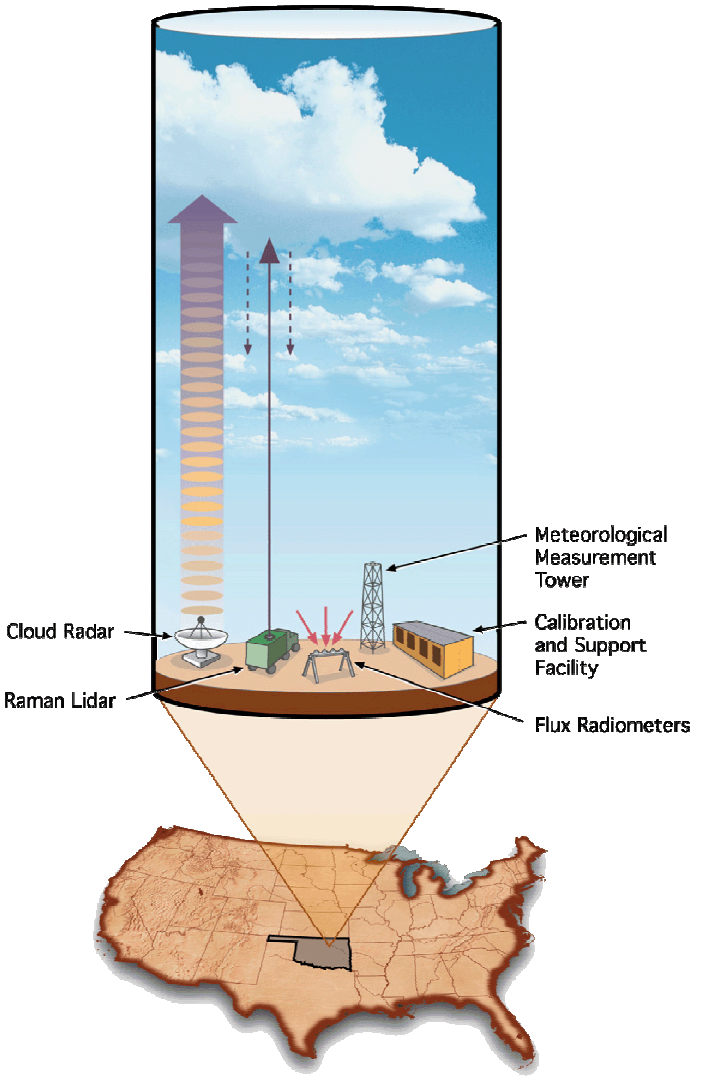
Mission

The ARM Climate Research Facility, a DOE scientific user facility, provides the climate research community with strategically located in situ and remote sensing observatories designed to improve the understanding and representation, in climate and earth system models, of clouds and aerosols as well as their interactions and coupling with the Earth's surface.

Vision

To provide a detailed and accurate description of the earth atmosphere in diverse climate regimes to resolve the uncertainties in climate and earth system models toward the development of sustainable solutions for the Nation's energy and environmental challenges.



Source: http://www.arm.gov/about/mission

DOE ARM Program, Arctic Interests and Mission

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- DOE User Facilities at Barrow and Oliktok
- Recent Field Campaigns on the North Slope
- Inland Facility at Atqasuk -- No Longer Active, Still Available for Field Campaigns
- AMF3/Oliktok Deployment
- Unmanned Aerial Systems and Tethered Balloons
- http://www.arm.gov/sites/nsa

ARM Climate Research Facilities in Alaska

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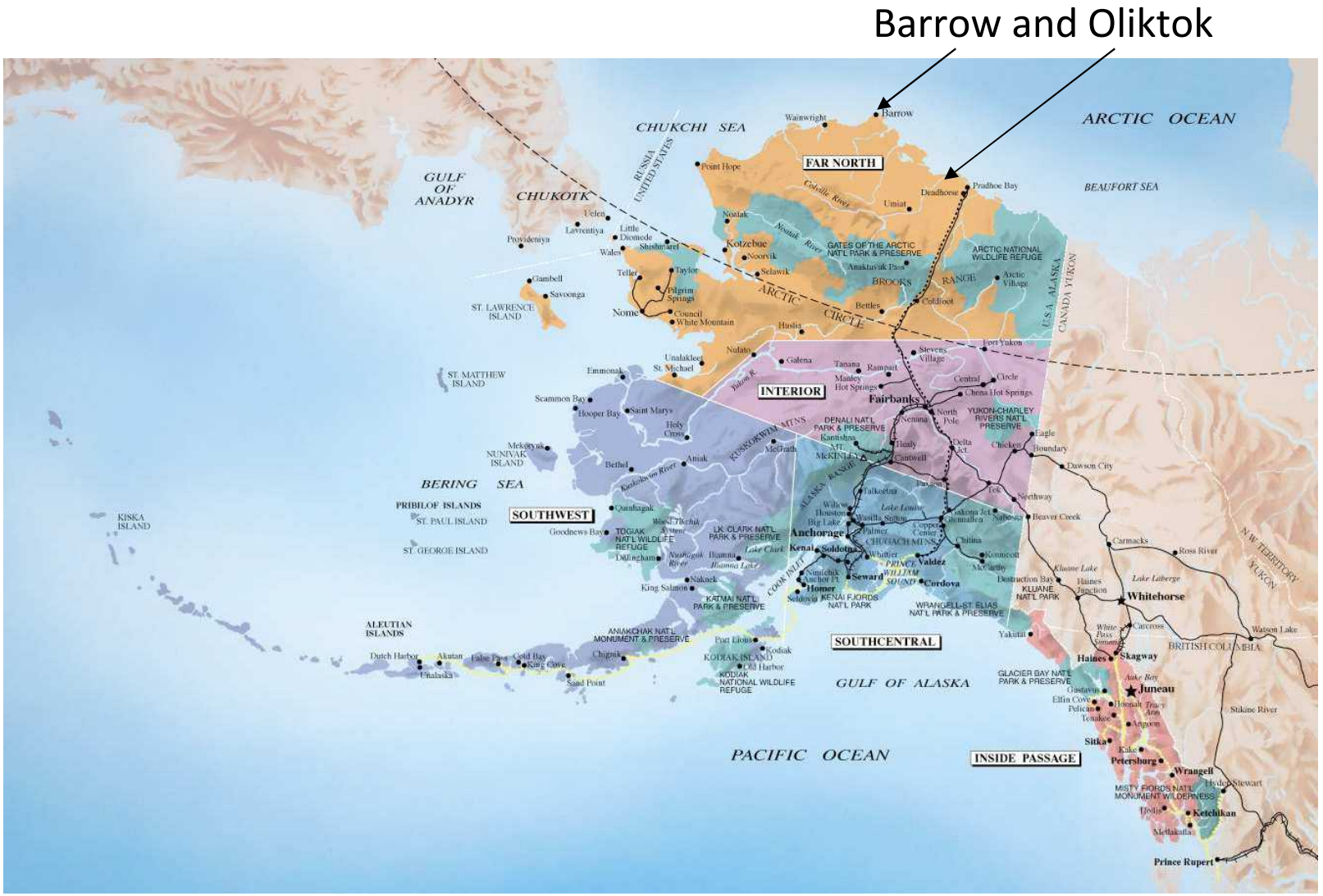
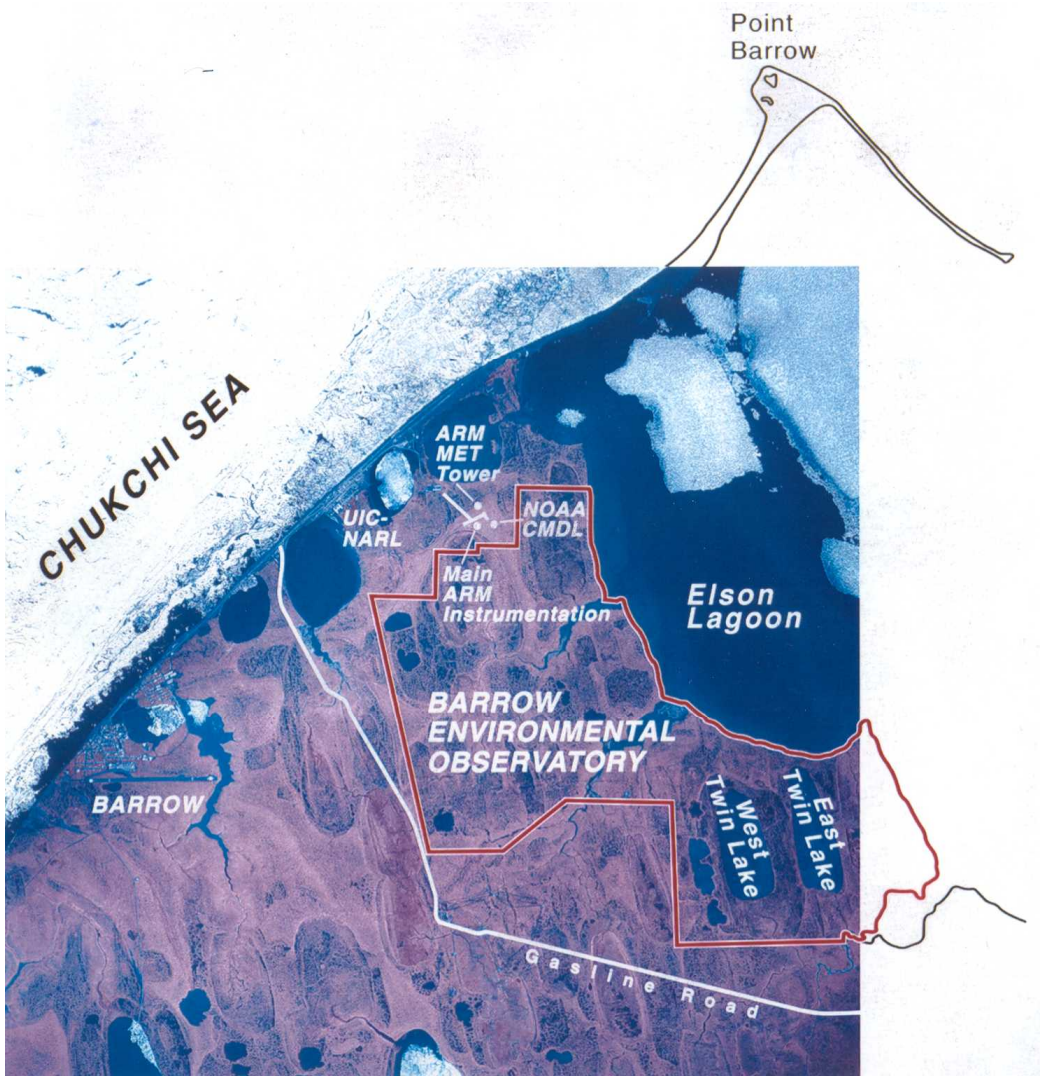


Barrow


Point
Barrow
CHUKCHI SEA
ARM
MET
Tower
UIC-
NARL
NOAA
CMDL
Main
ARM
Instrumentation
Elson
Lagoon
BARROW
ENVIRONMENTAL
OBSERVATORY
BARROW
West
Twin Lake
East
Twin Lake
Gasline Road

Categories of Instrumentation at Barrow

- Surface Meteorological Sensors
- Wind, Temperature and Humidity Profilers
- Cloud Observation Instrumentation
- Downwelling Radiation Sensors
- Upwelling Radiation Sensors
- Aerosol Instrumentation
- Gas Instrumentation

Additions with ARRA Funding:

- Scanning instruments
- Radars
- 3D and 4D cloud profiles

Barrow Existing Facilities and ARRA Additions

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DOE ARM Facility in Atqasuk

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DOE ARM Facility in Atqasuk (continued)

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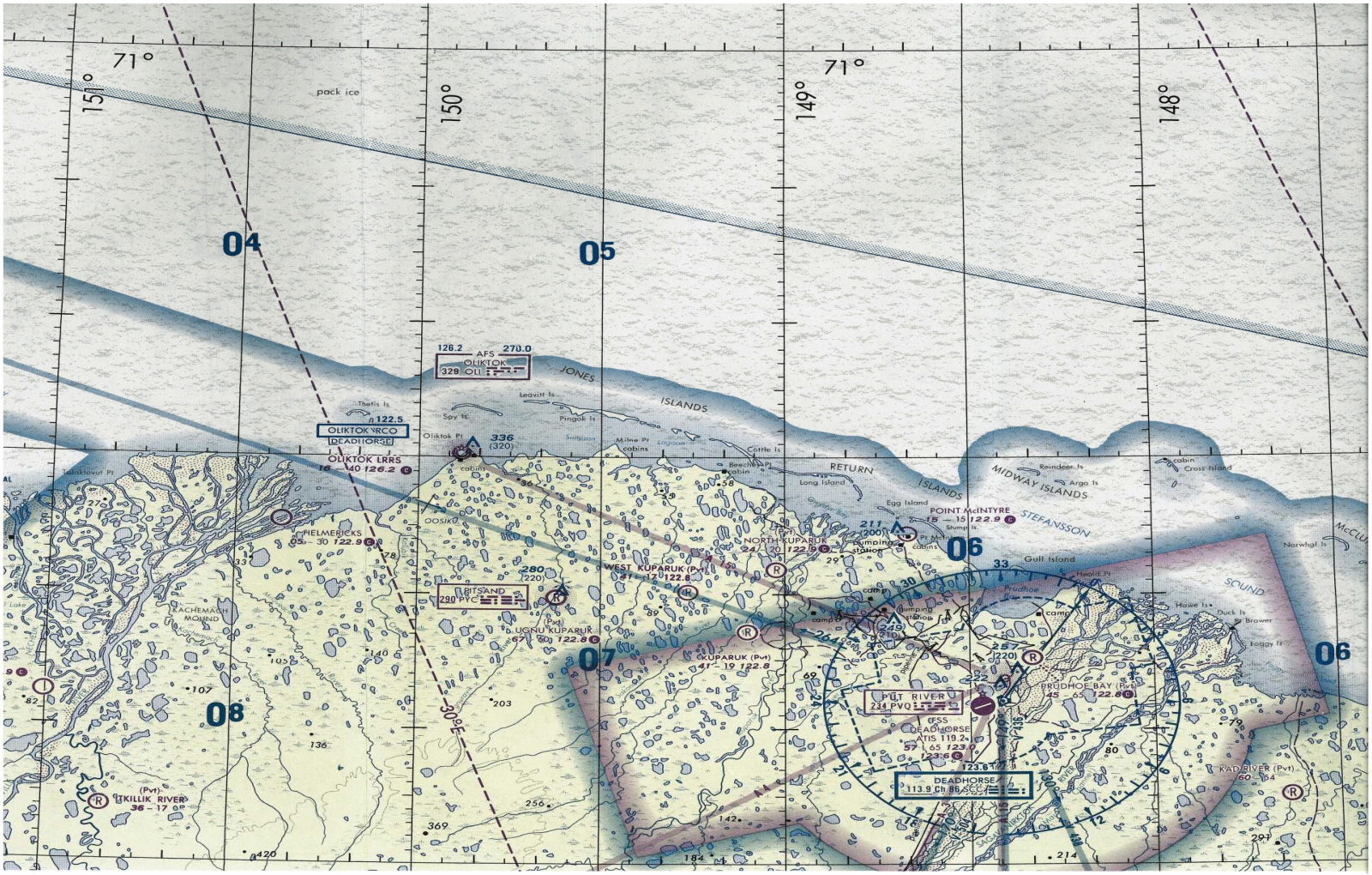
Oliktok Point, Alaska

Oliktok Point Region

Oliktok Point Region (continued)

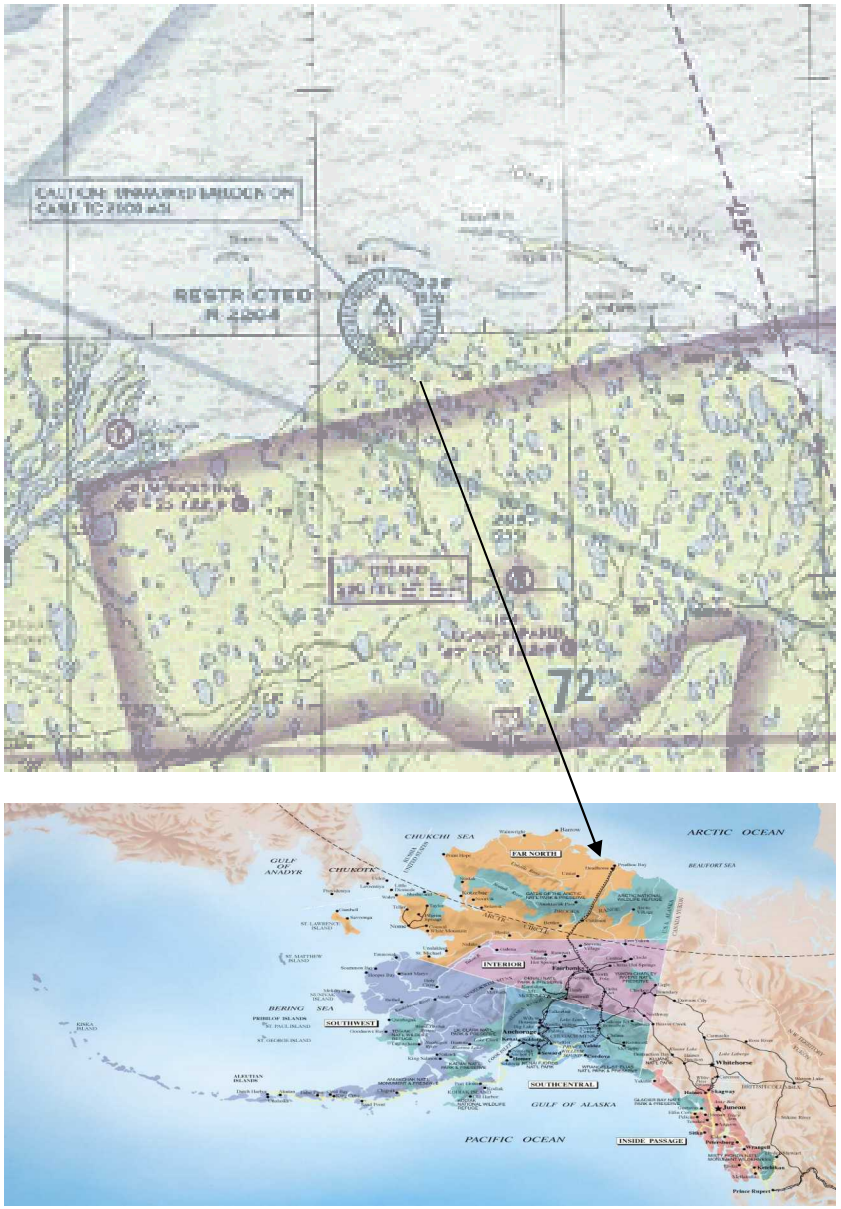


USAF Oliktok Point Long Range Radar Station

Sandia has a permit from the USAF for use of selected facilities at Oliktok Point, just as Sandia has a permit for use of selected areas on Kirtland AFB; Oliktok is one of several old Distant Early Warning (DEW Line) radar stations that are still active.

Restricted Airspace R2204 at Oliktok Point

Originally obtained by Sandia for a field experiment at Oliktok in 2004 (Mixed-Phase Arctic Cloud Experiment [M-PACE]); It's airspace that, when activated (at DOE discretion), DOE controls; Restricted Airspace is the mechanism through which FAA keeps non-participating aircraft out of an area.



Oliktok LRRS

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Oliktok LRRS (continued)

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Barrow Existing Facilities and ARRA Additions

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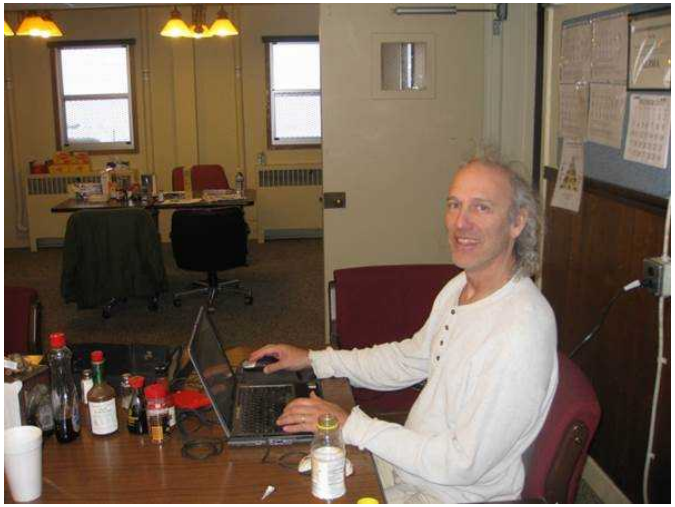

Existing Hangar at Oliktok Point

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Presently, we have access to the hanger and the area around it, as well as to lodging and other services at Oliktok LRRS.

Note that Oliktok is embedded in the Prudhoe Bay Oil Fields, and is about 40 miles from Deadhorse/Prudhoe Bay Airport.

Tethered Balloon Operations at Oliktok

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ALTOS Campaign – Balloon Operations

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ALTOS Campaign

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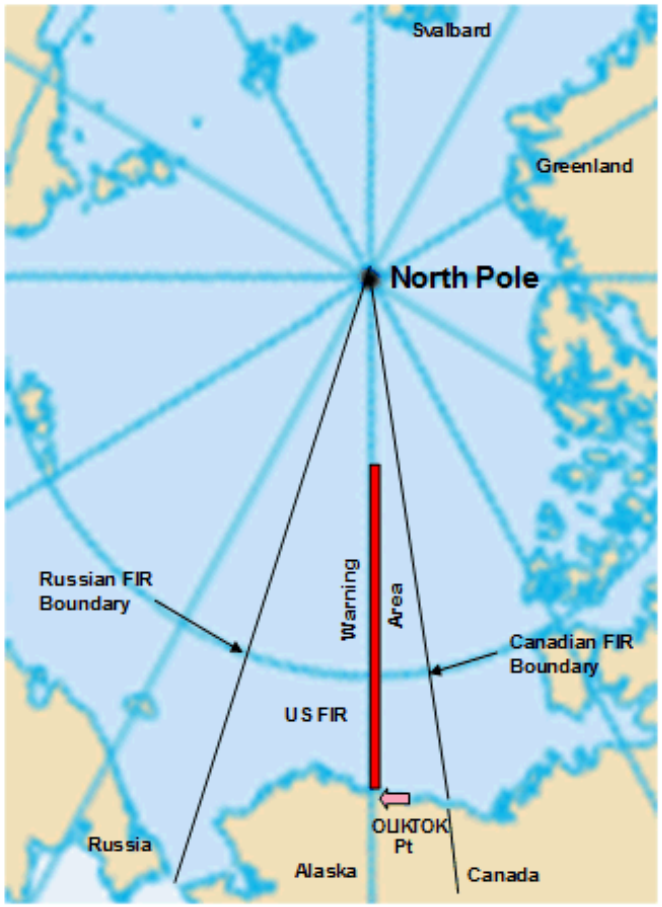
A Step Towards an Artic Climate Observatory

DOE has requested from the FAA the creation of a Warning Area over International Waters adjoining Oliktok to accommodate unmanned aircraft flights and other research activities out over the Arctic Ocean focused on the rapid retreat of the sea ice; Warning Areas confer similar advantages to Restricted Airspace.

Proposed Warning Area (in red)

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



Unmanned Aircraft in the Artic

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