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UAS, Tethered Balloons, and the US DOE ARM Program Facilities at Oliktok Point, Alaska

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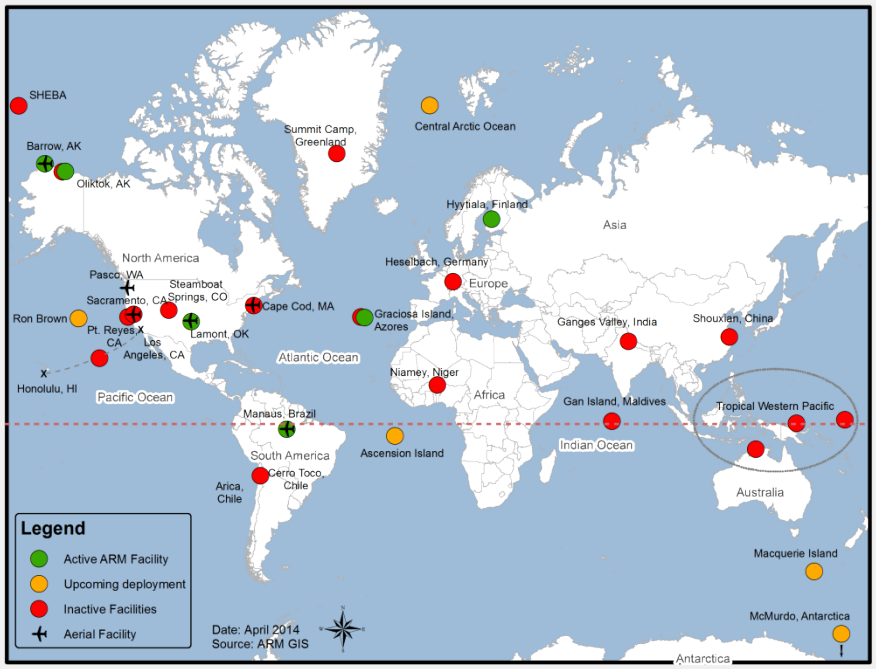
Summary :

- DOE ARM Program
- Oliktok Point Facilities and Restricted Area
- Past ARM –funded Campaigns at Oliktok
- MIZOPEX
- Process for Flight Approval
- Third ARM Mobile Facility (AMF3)
- Background Slides

ARM Climate Research Facility

- ARM is a DOE Office of Science user facility
- ARM Mission is to provide research community with observations need to improve understanding and representation in climate models of clouds and aerosols, including their interactions, radiative impacts, and coupling with the Earth's surface.
- ARM facilities include:
  - Highly instrumented long-term fixed sites in different climate regimes
  - Mobile facilities available for 6 month – 2 year deployments
  - Aerial facilities for intensive or routine flight campaigns including two dedicated aircraft (G-1 and Cessna 206)



ARM Next Generation Motivation

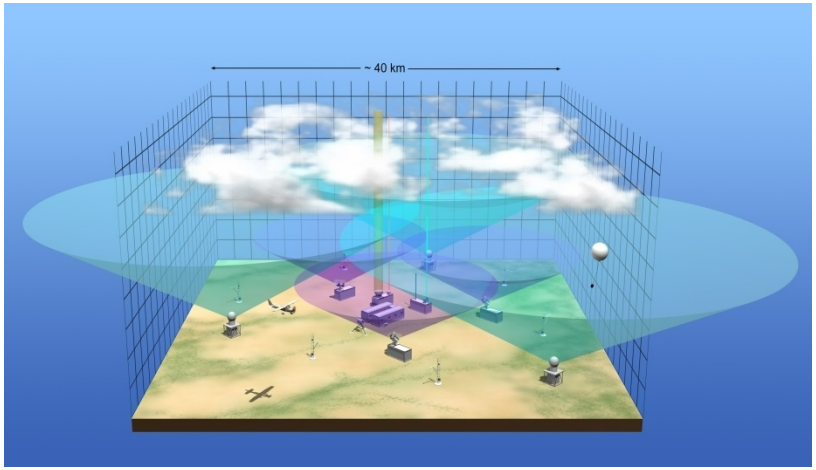
- ARM research community is increasingly interested in **questions of scale** and **interactions between processes** that cannot be fully addressed with observations alone.
- Next generation climate models with higher and/or variable spatial resolution require information on spatial variability within **next generation climate model domains.**
- Two workshops recommended that ARM couple a **denser observational network with routine large-eddy simulation [LES] scale modeling** to create integrated observational-modeling datasets to provide a strong constraint to process studies as well as a basis for parameterization development for the next generation of climate models.
- **Long-term, routine high-resolution modeling**, rather than case studies, will take advantage of ARM observational strengths and examine processes covering a broad range of atmospheric regimes

Next Generation ARM

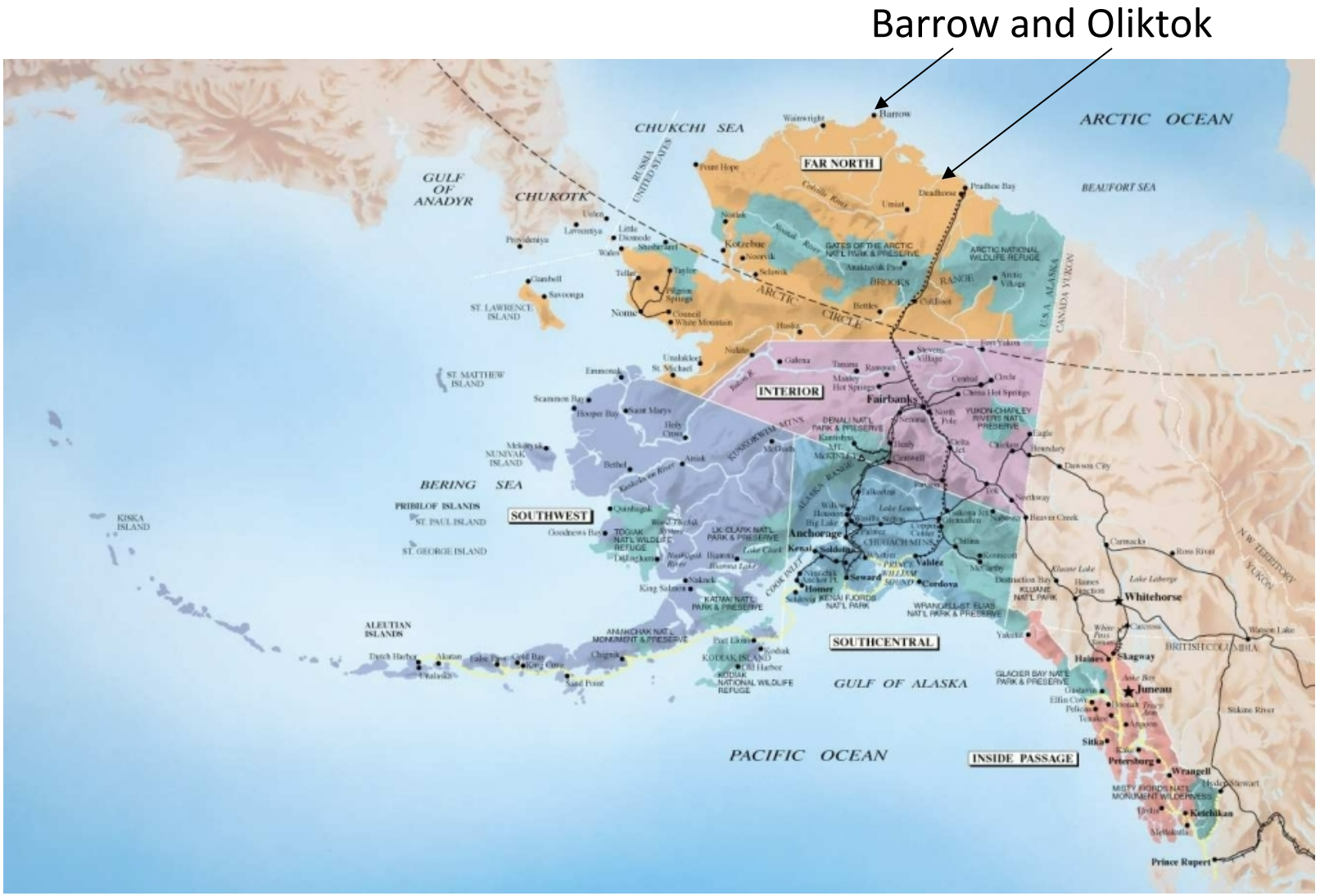
Next-Generation ARM will better integrate high density observations and high-resolution modeling with the continued goal of improving climate models

The reconfiguration includes:

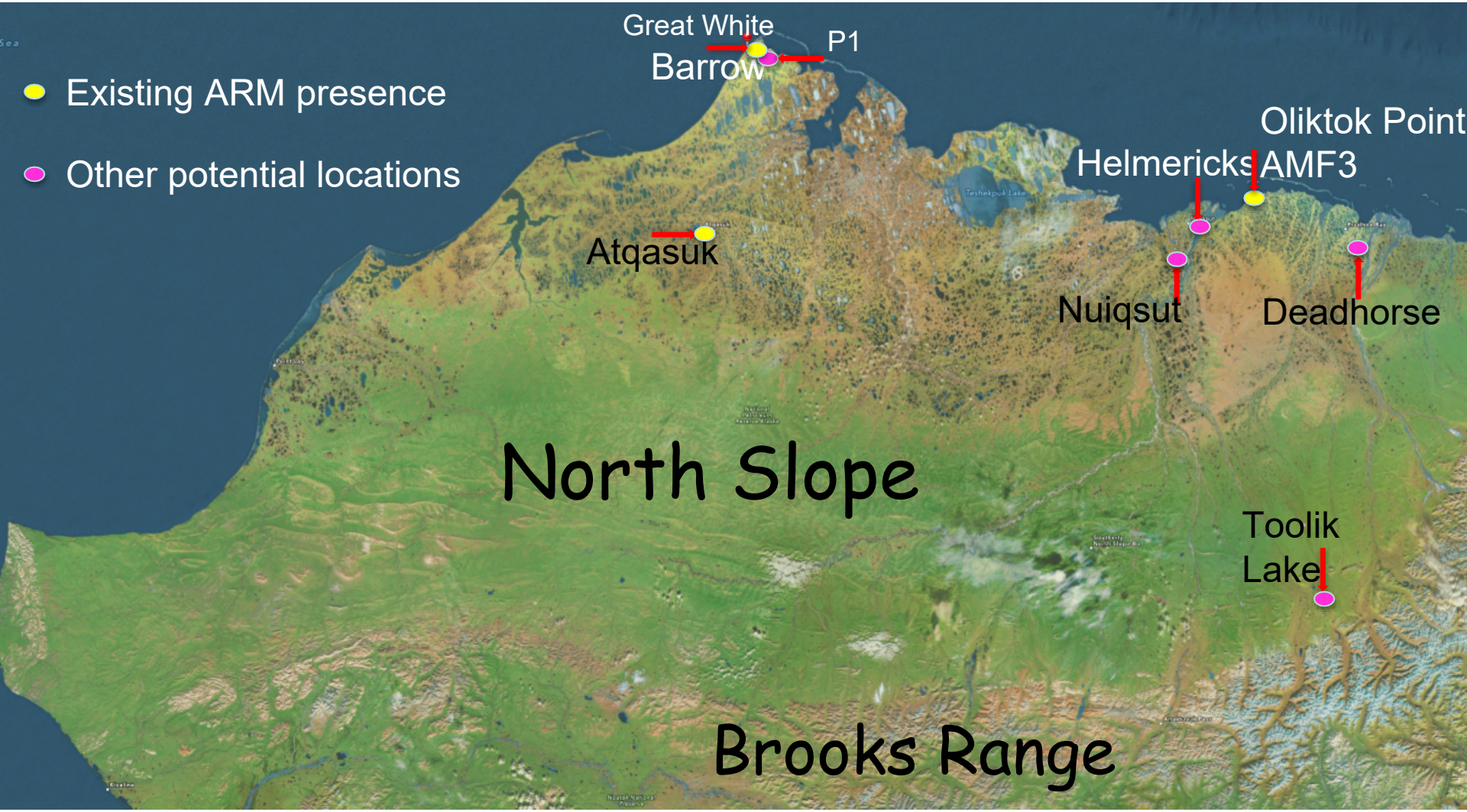
- Optimization of the ARM measurement facilities for process studies, model evaluation, and development
- Implementation of 2 “mega-sites” at Southern Great Plains and North Slope of Alaska with focus on observing spatial variability of cloud, boundary layer, and surface properties
- Closure of the TWP sites and use of instrumentation for the mega-sites
- Development of a routine high resolution modeling strategy for mega-sites
- Development of a data processing strategy to bridge measurements and models



ARM Climate Research Facilities in Alaska



ARM on the North Slope



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AMF Restricted Air Space

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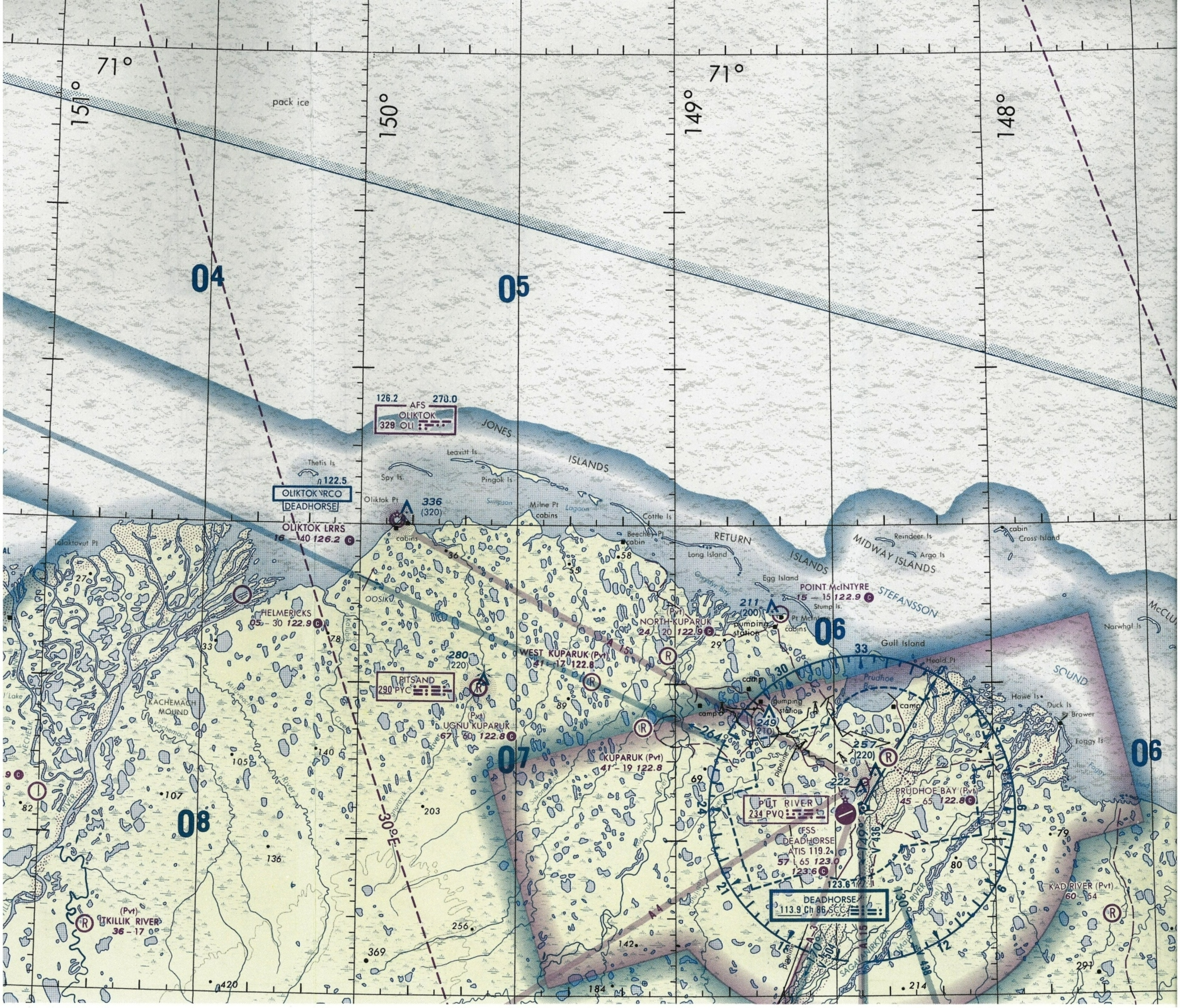

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Oliktok Point, Alaska

Oliktok Point Alaska

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.

Existing Hangar at Oliktok Point

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.

ALTOS Balloon Operations

Photos: Ted Fisher, SPEC

October 2012: NMSU Flights

The “BAT” UAS

Aeryon Scout, Battery Powered QuadCopter

MIZOPEX
July-August, 2013

Marginal Ice Zones Observations and Processes EXperiment

Wing Span: 20 ft.
Length: 11.8 ft.
Height: 4.6 ft
Wing Area: 42.4 sq. ft.
Empty Weight: 215 lbs.
Gross Weight: 370 lbs.
Max Speed: 80 kts.
Cruise Speed: 55 kts.
Stall Speed (clean): 30 kts.
Rate of Climb: 550 ft./min.

- Power Plant: 3W 2-stroke piston engine; 1.5 horsepower
- Wingspan: 10.2 feet (3.1 meters)
- Length: 3.9 feet (1.19 meters)
- Weight: 39.7 lbs (18 kilograms)
- Speed: 55-80 mph
- Endurance: 20 + hours
- Operating Altitude: SFC to 16,000 feet air ground level

1.5 lbs total weight
Electric propulsion/battery
Based on “Stryker F27C”

MIZOPEX Science Goals

- Clarify relationships between ocean skin temperatures and subsurface temperatures
- Understand row these temperatures evolve over a summer season
- Measure Variability in sea ice thickness, age, and albedo in the Marginal Ice Zone
- Study interaction of SST, salinity, and ice conditions during the melt cycle
- Perform validations of satellite-derived SST and sea ice concentration fields

MIZOPEX Payloads

- SIERRA
  - "MIS = Microspectrometer Instrumentation Suite: Up- and down-looking broadband solar pyranometers, narrow-view spectrometers, IR thermometers (NASA WSFC)"
  - Nikon 700 = digital EO camera with GPS
  - "BESST = Ball Experimental Sea Surface Temperature imaging radiometer (scanning, continually-calibrated radiometer)“
  - "BOBCAT camera = high resolution, fast sample rate digital EO camera"
  - JADE thermal camera = high-performance thermal imager
  - CULPIS = CU Lidar Profiling and Imaging System (nadir-viewing near-IR lidar)
  - SlimSAR = X-band synthetic aperture radar
  - Snow Radar = CReSIS snow radar
  - Riegl Q240i = scanning lidar

MIZOPEX Payloads (as of March 2013)

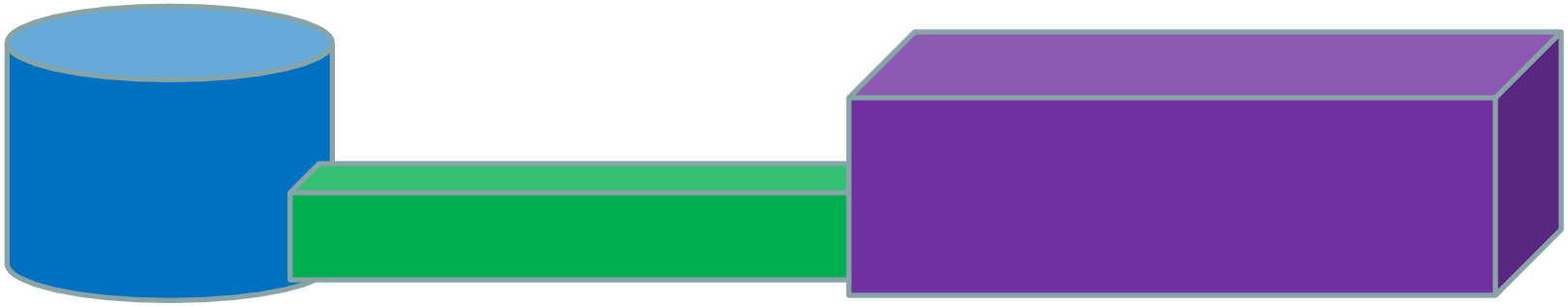
- ScanEagle
  - BESST
  - Ariel L-band nadir-viewing radiometer (salinity)
  - Bobcat EO camera
  - ATOM thermal camera
  - CULPIS
  - NanoSAR synthetic aperture radar
  - "Air Deployed Micro Buoy system = air-dropped, recording buoys. 3 sub-surface temperature measurements to 2m depth"

- DataHawk
  - Self-Deploying Surface Sensor (one-way aircraft) = same as ADMB measurements but to 10m depth

NASA Flight Plan

MIZOPEX Flight Requirements:

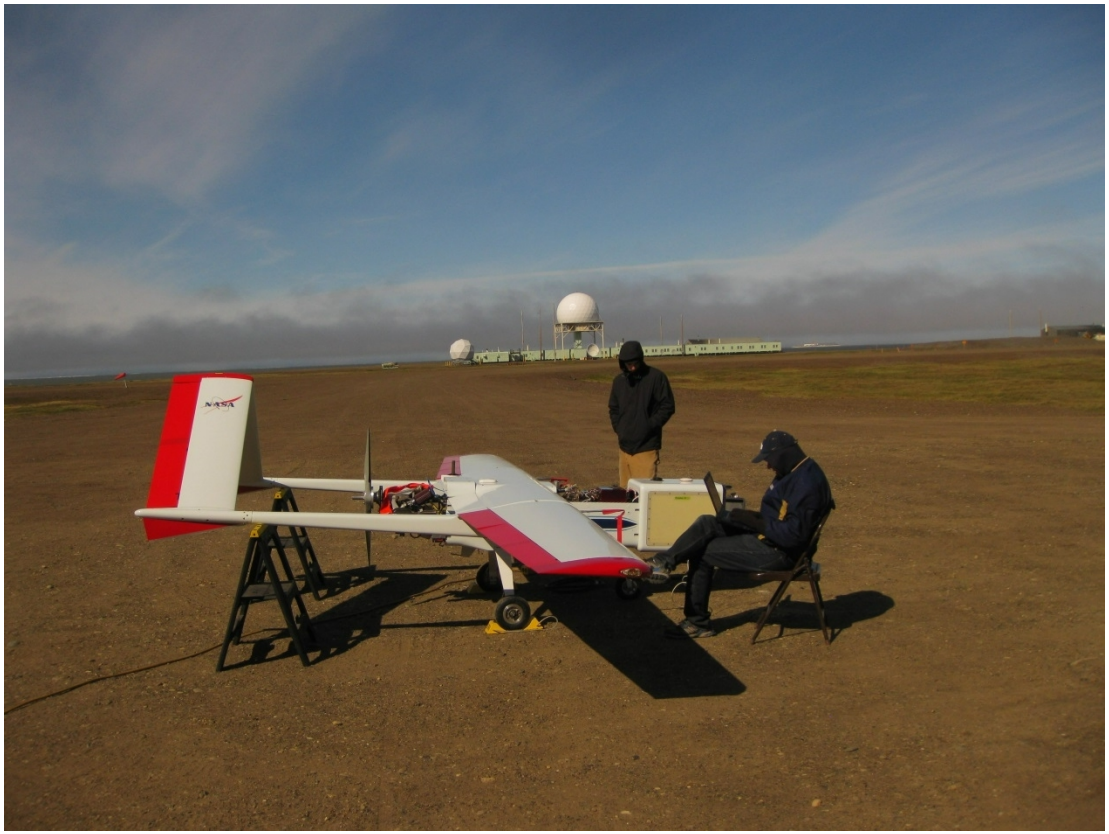
- Cliff Sweatte, FAA
- Certificate of Authorization
- Temporary Altitude Reservation Corridor
- R-2204
- Operation under “Due Regard” in International Airspace
- NASA Flight Readiness Review and Risk Management Review
- NASA QA Review
- X-band Raytheon “Sentinel” Aircraft Radar

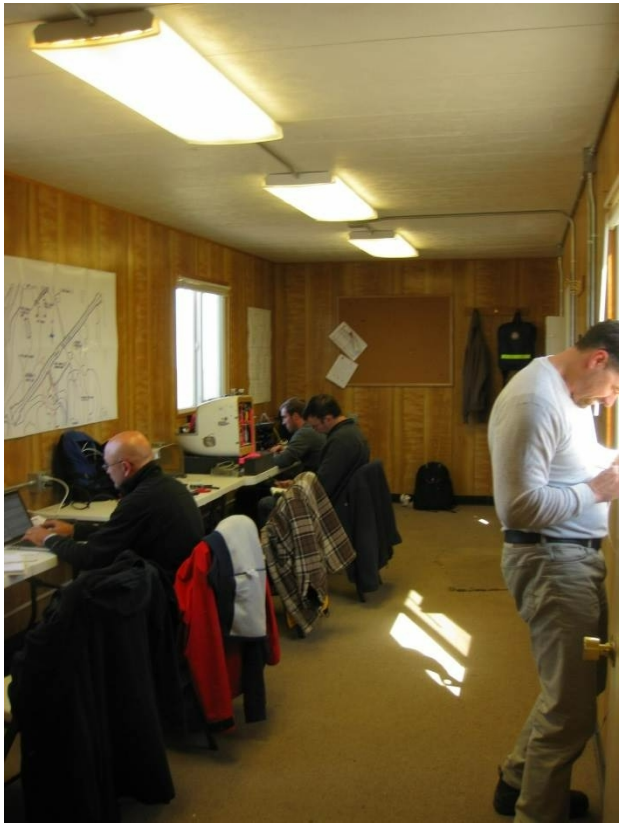


R-2204 “ALTRV” corridor International Airspace

Raytheon Sentinel Radar

Sierra Flight and Ground Crew





Process: From Proposal to Wheels Up

- Proposal(s) by PI to Sponsoring Agency
- IOP Proposal to ARM
- FAA Discussions and Applications
- DOE/Sandia User Agreement
- Experimental Plan
- DOE/Sandia Safety Reviews
- Flight Readiness Reviews
- Restricted Area Letter of Procedure, Notifications
- Flight Approvals
- FAA Anchorage Traffic Management Coordination

Infrastructure: AMF3

ARM Instruments

Infrared Thermometer
Equivalent blackbody brightness temperature.

Multifilter Rotating Shadowband Radiometer: Spectral measurements of direct, diffuse, and total solar irradiances

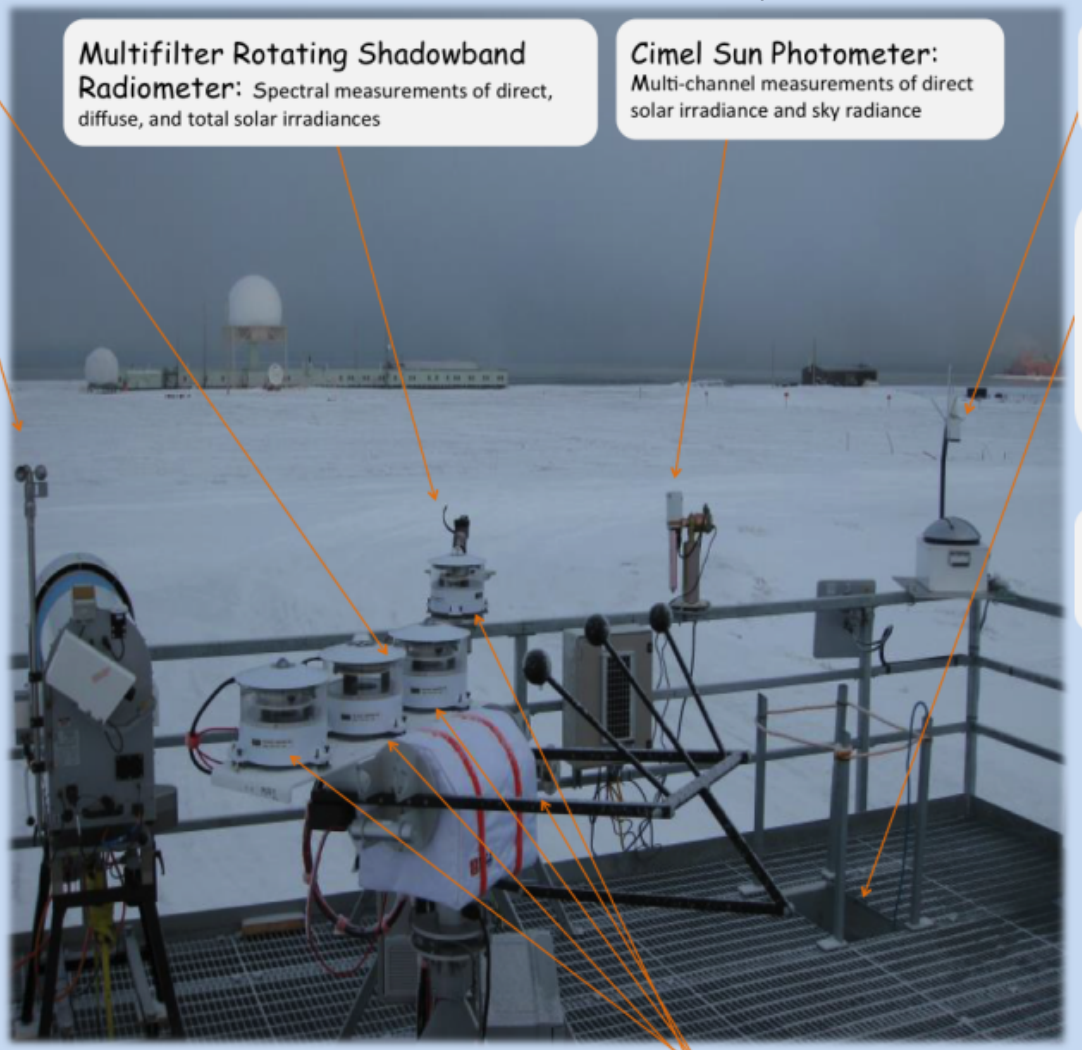
Cimel Sun Photometer:
Multi-channel measurements of direct solar irradiance and sky radiance

Total Sky Imager:
Hemispheric sky images during daylight hours

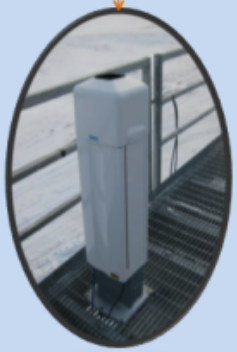
Microwave Radiometer
Column-integrated amounts of water vapor and liquid water.

Micropulse & High Spectral Resolution Lidars:
Aerosol and optically thin clouds overhead, phase discrimination

Surface and Tower Meteorological Instrumentation:
Wind speed, wind direction, air temperature, dew point, and humidity



Vaisala Ceilometer:
Cloud-base height.



Sky Radiation: Downwelling broadband shortwave (solar), longwave (infrared), and ultraviolet irradiances.

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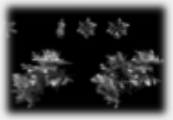


The Multi-Angle Snowflake Camera
High resolution stereographic images of hydrometeors.

High spectral resolution lidar (Barrow) & Raman lidar (AMF3): Profile of aerosol and optically thin clouds, phase discrimination and water-vapor mixing ratios

Doppler Lidar: Range- and time-resolved measurements of radial velocity and attenuated backscatter.

Eddy Correlation Flux Measurement System: Turbulent fluxes of momentum, sensible heat, latent heat, and carbon dioxide

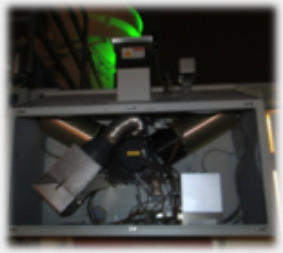
Total Precipitation Sensor: Precipitation, temperature and wind speed

Radar Wind Profiler: Wind profiles and backscattered signal strength between 0.1 km and 5 km and virtual temperature profiles between 0.1 km and 2.5 km.

RADARS: Ka/W-band Scanning Cloud Radars: Fully polarimetric dual-frequency system with horizon-to-horizon scanning capability out to 50 km

X (Barrow) or C (AMF3)-band Precipitation Radar: Volume scans out to 100 km

KAZR – Ka-Band Zenith Radar: High resolution Doppler spectra profiles



The Atmospheric Emitted Radiance Interferometer (AERI) measures the absolute infrared spectral radiance (watts per square meter per steradian per wavenumber) of the sky directly above the instrument.

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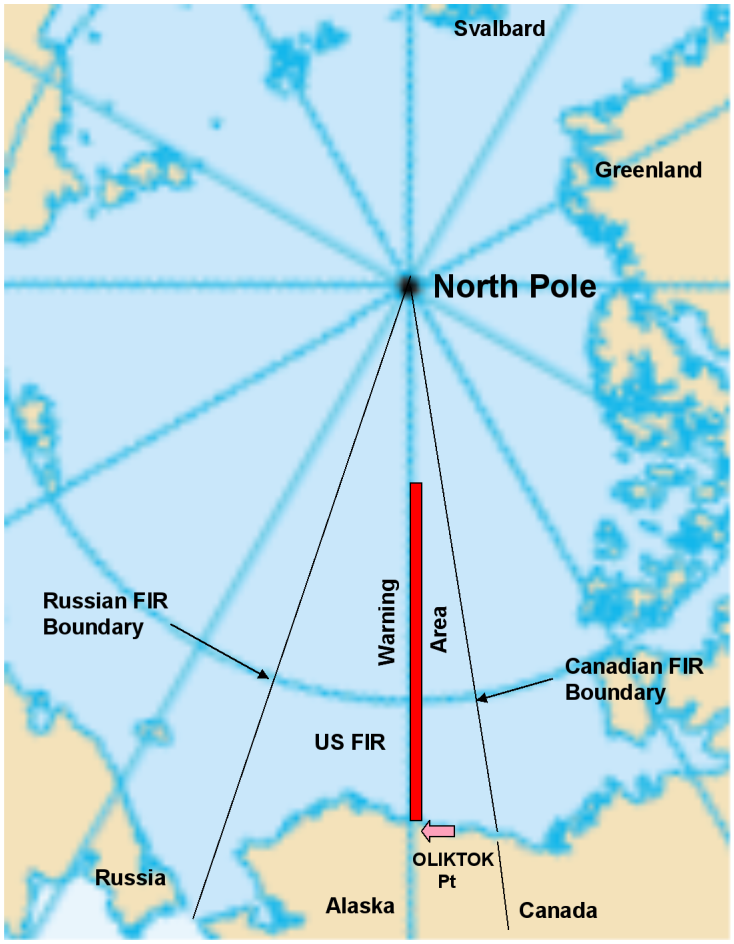
A Step Towards an Arctic Climate Observatory

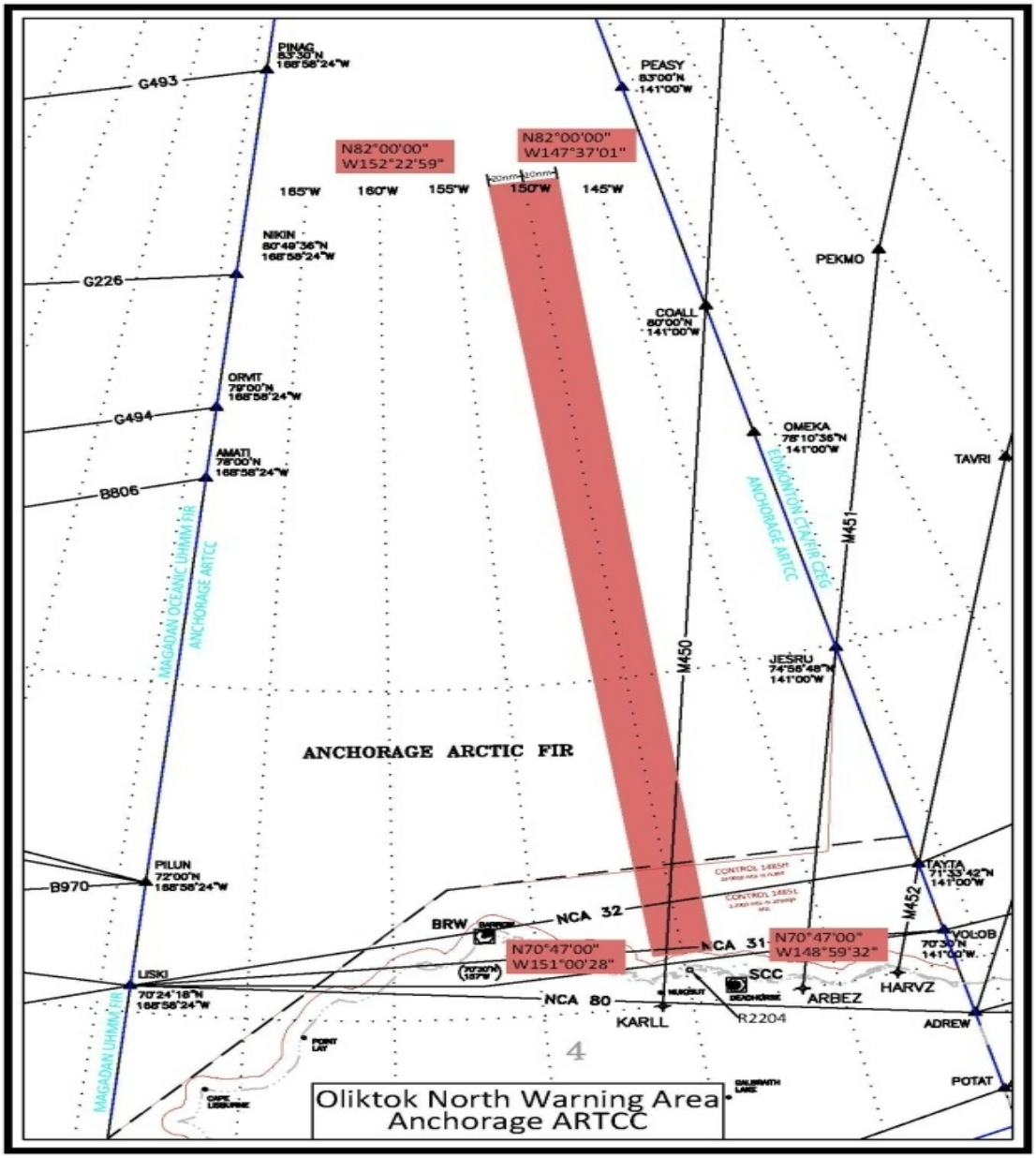
DOE has requested from the FAA the creation of a Warning Area over International Waters adjoining Oliktok to accommodate unmanned aircraft flights and other research activities out over the Arctic Ocean focused on the rapid retreat of the sea ice.

Proposed Warning Area (in red)

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



Revised Warning Area Charting



DOE ARM User Facility Model

- DOE Sponsorship for Baseline Measurement
- PI-proposed, DOE-funded field campaigns and measurements
- Long term and short term “IOPs”
- Cooperation with Collaborating agencies, universities, private sector

Oliktok Pt. Arctic Research Facility

- DOE User Facility Designation
- Approved by DOE
- Proprietary and Non-Proprietary Agreements
- Provides framework for liability issues
- Provides process for Flight Safety approvals
- Pending IOP Requests for Oliktok Facility

Oliktok LRRS

Oliktok LRRS

Photos: Ted Fisher, SPEC

ALTOS

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