

Navy ONR/NSF-UNOLS Dec. 17, 2020
Scientific Committee on Oceanographic Aircraft Research (SCOAR)

Coast Guard 2020 Manned/Unmanned Aircraft Ops 2020 & 2021 plans

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CG C-130 ONR & NOAA Research 2020 & 2021 Plans

CG transition from C-130-H (Hercules) to C-130-J (Super Hercules) at Kodiak Air Station completed (now 5 aircraft, although 1 is going to Hono).

C-130-Js differ in having entirely integrated comms system throughout aircraft, and 4 blades on H props, 6 blades on J props

Speed: 366 mph for H; 417 mph for J

Cargo: J holds 9K lbs more

Range: 1208 mi for H; 2000 mi for J

Crew: 5 for H (2 pilots, navigator, engineer, loadmaster)

3 for J (2 pilots, loadmaster)

Cost: \$30.1M for H; \$48.5M for J

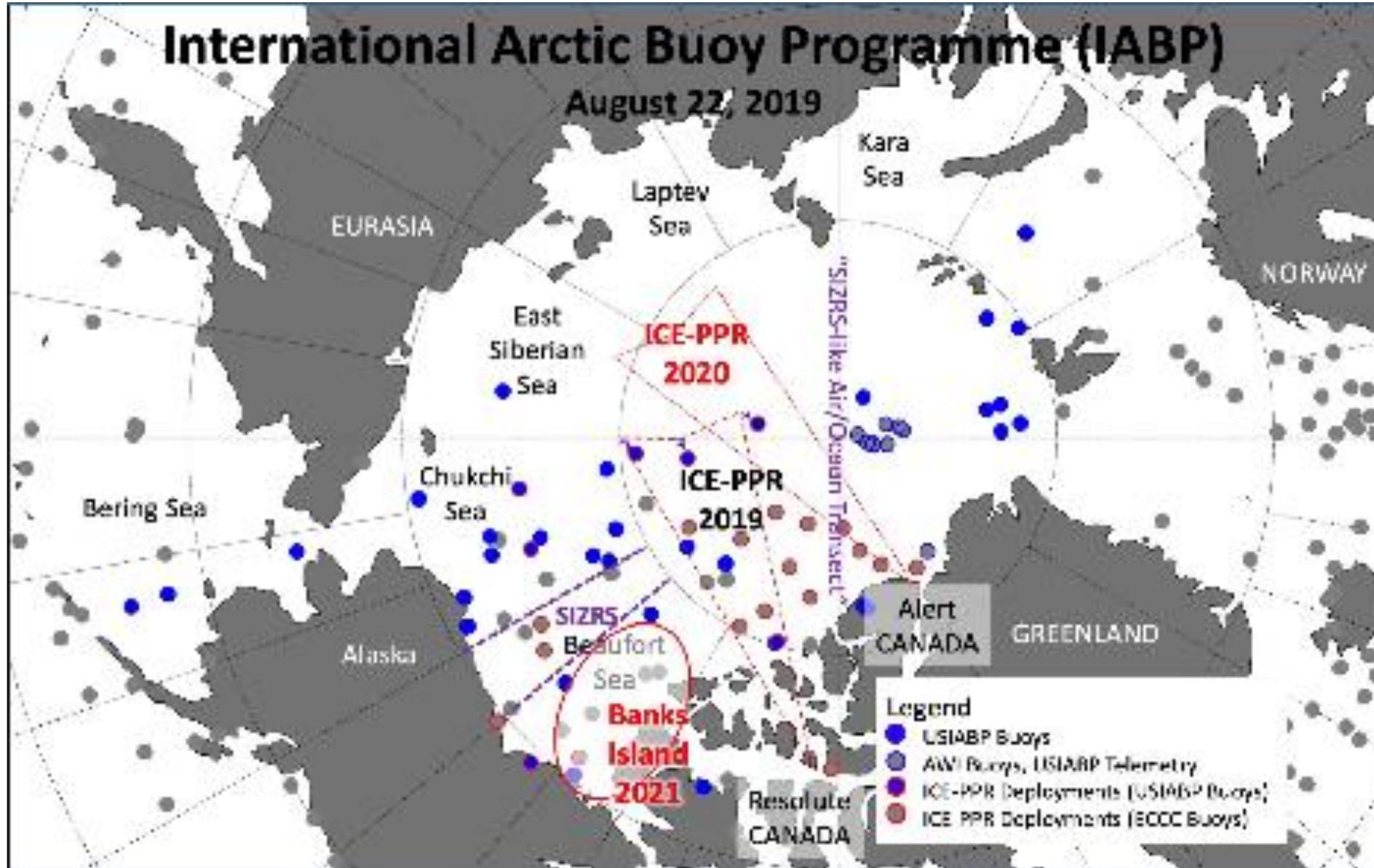
Shorter landing strip requirements for J

Anti-icing system

ONR UW/APL C-130 Uses/Planned Uses

- Due to covid, ONR's UW APL did only 1 CG C-130 flite in Sept. 2020, which was joint w Kevin Wood at NOAA/PMEL deploying 4 Alamo floats (3 worked immediately, other maybe had delayed packaging dissolving) and 4(-5?) AXCTDs on the North Slope 150oE trackline as in past.
- In 2021 ONR and UW would like to use CG C-130s as in the past for deployment of airdrop buoys and xCTDs but instead of over the Beaufort Sea, they would like to switch to the most data sparse area, north of Greenland's Lincoln Sea toward the Pole.
- Operations in that area will begin in 2021. The International Ice Patrol AvDet notes that because of covid in 2021 they will be flying the C130s out of Cape Cod via St. John's Labrador, and that the distance to the intended op area is actually shorter from Kodiak.
- In 2021 IIP will also be flying to Iceland for the Arctic Council meeting in mid-April for a joint SAR/OSR operation. Most of the other IIP flights will be from Cape Cod to just off Labrador in 2021.

ONR UW/APL C-130 Uses/Planned Uses showing 2021 area of interest as ICE-PPR 2020 (as no C130 ops in 2020 due to covid)



NOAA C-130 Planned Use in 2021

NOAA needed to modify their setup to switch from operations in C-130-H to C-130-J due to lack of direct comms access and sampling window.

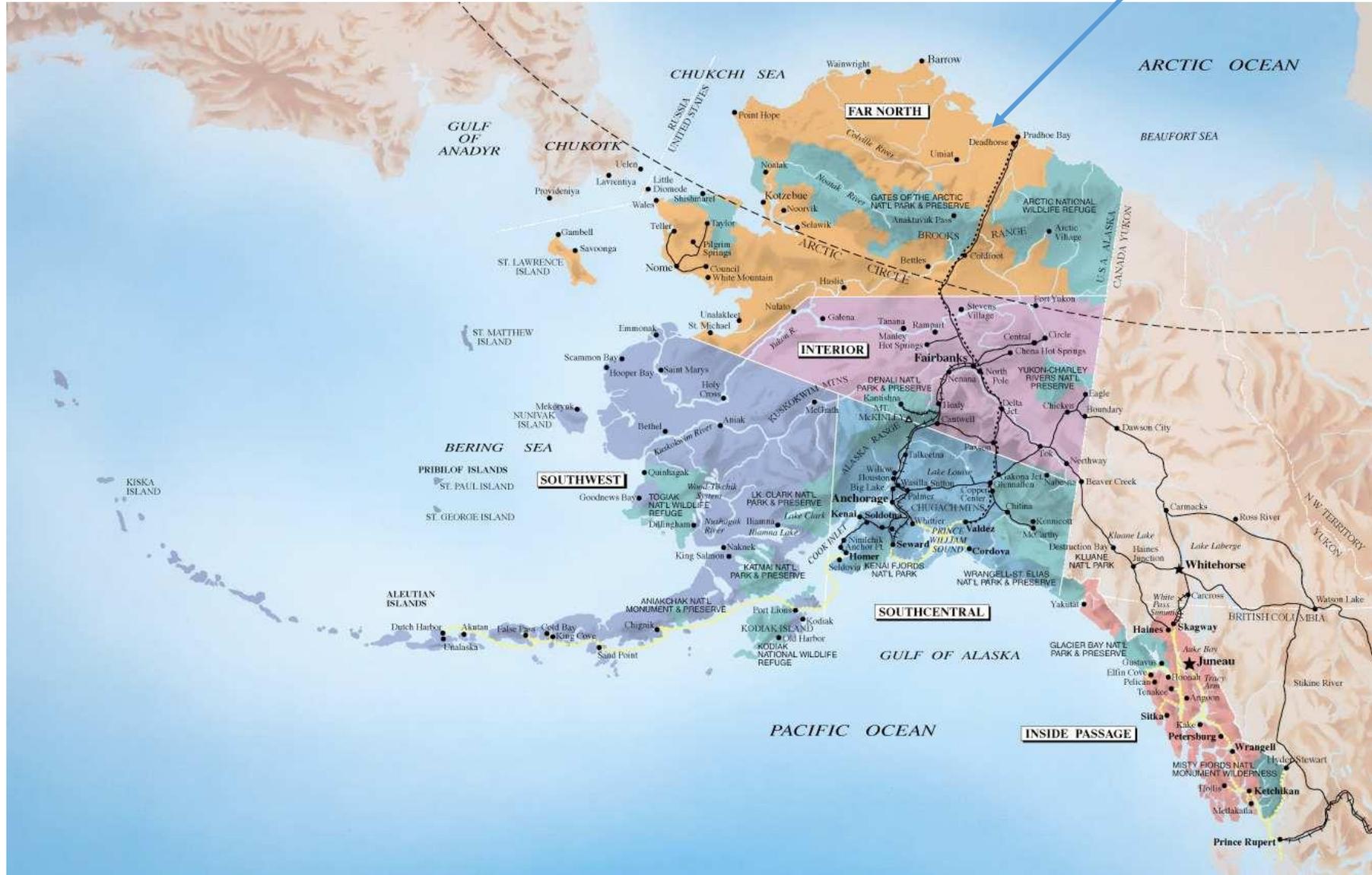
So, they made the required changes in their equipment, and plan to resume flight ops in 2021 continuing the bi-monthly flights out of Kodiak conducting profiling of radiatively important trace gases (RITS) sampled through a door window on the aircraft.

Termination of Oliktok Point Northern Air Corridor

- DoE, which has managed the UAS facility at Oliktok Point, and which obtained a UAS air corridor from Oliktok Point toward the Pole is temporarily closing the UAS facility there, and will not seek renewal of the northerly air corridor (shown in following slides).
- The reason for this is that they would like to upgrade facilities at Oliktok Point, and to do so will shut down operations there in 2020 to get ready for a major Arctic UAS field campaign in 2021 jointly with NOAA and NWS.
- They will abandon the northern air corridor due to changes in FAA UAS regulations, and the anticipated implementation of the FAA funded NASA UTM (Unmanned Air Traffic Management) system, so that the UAS air corridor is no longer expected to be necessary.

DOE doings: Change to Oliktok UAS ops, incl. Offshore corridor

Oliktok Point

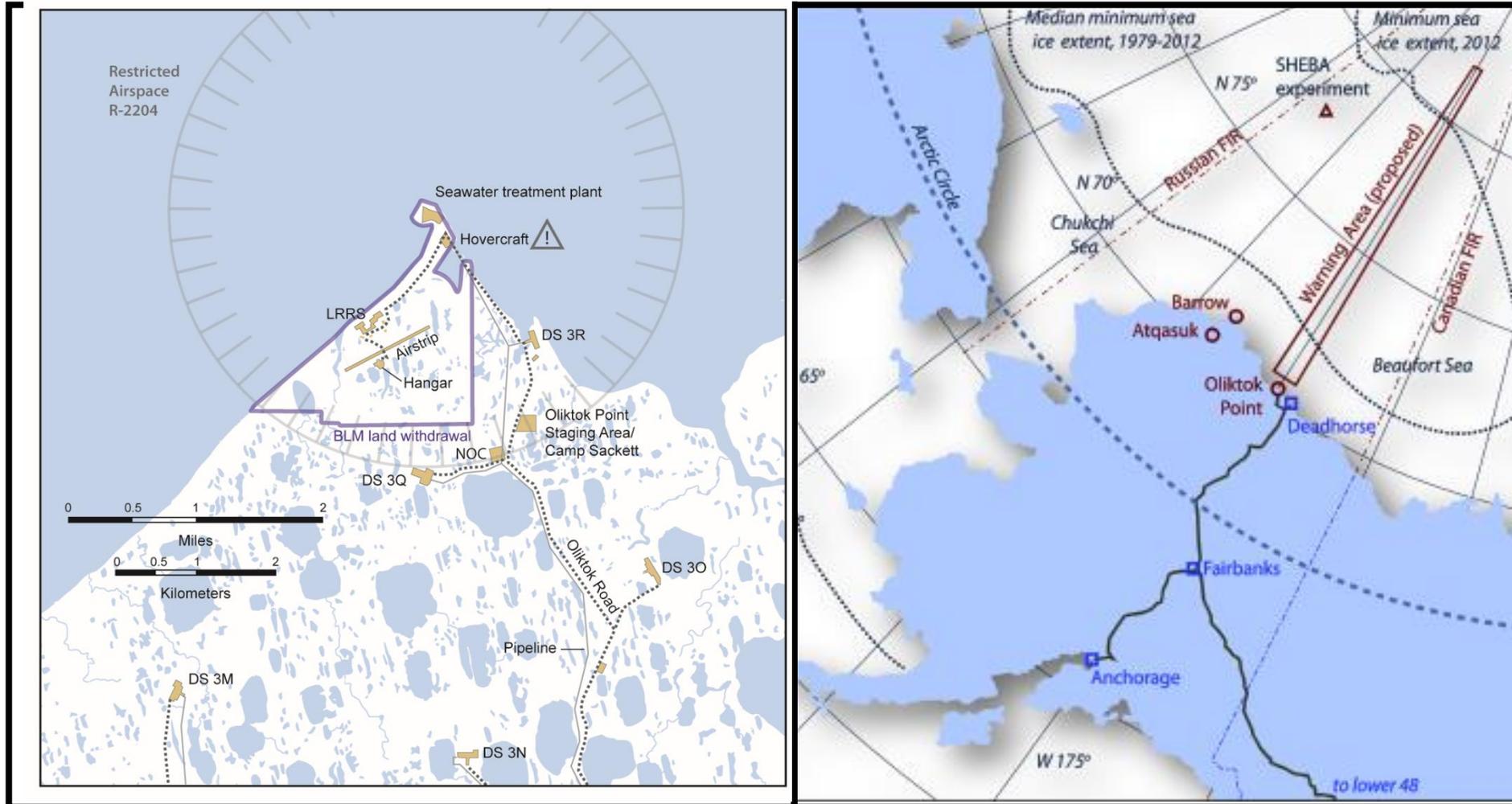


Oliktok Point, Alaska

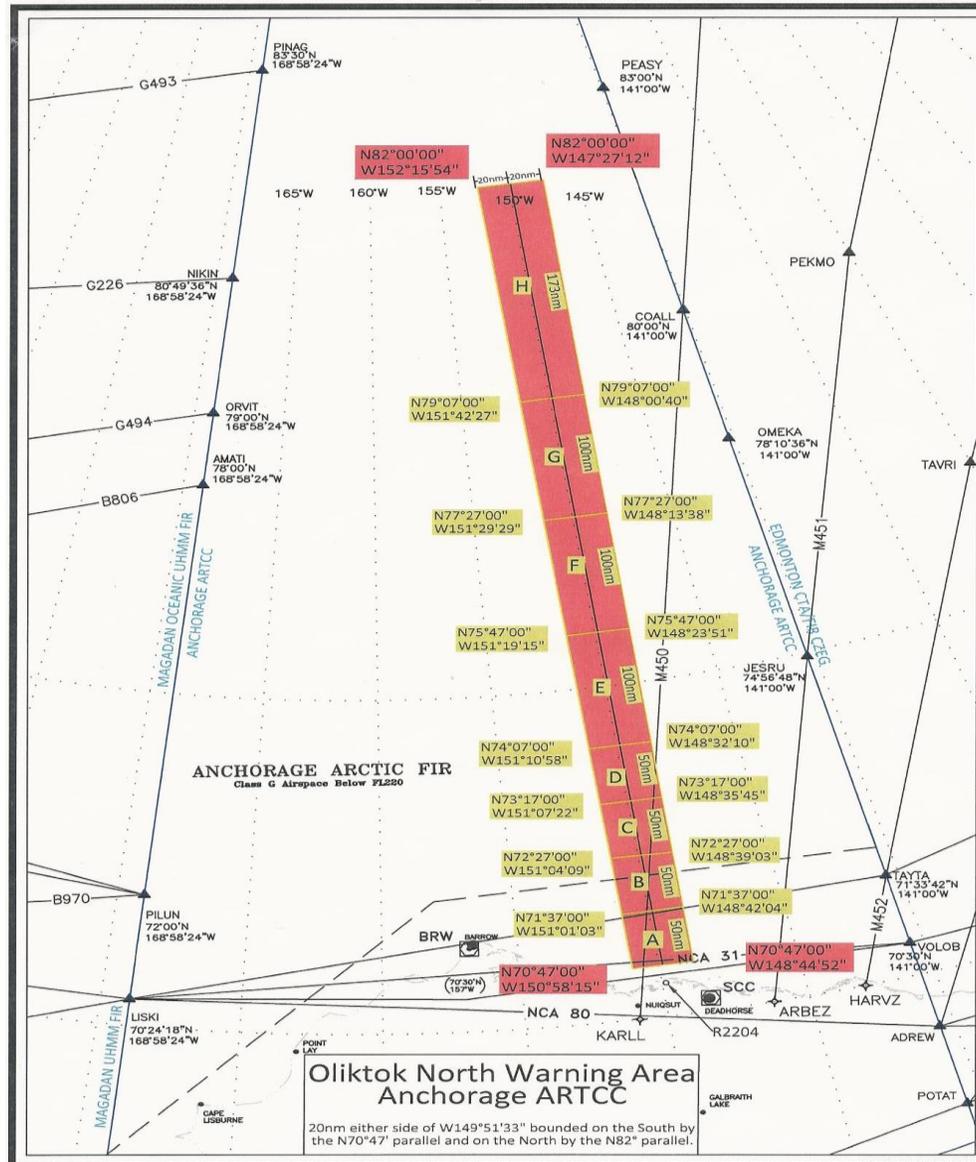


Oliktok Point Alaska

Oliktok Restricted Air Space and Warning Area Concept



Warning Area W220



Other UAS news: eLORAN & radios for GPS-denied ops & control

- In 2018 POTUS determined US needed a backup PNT (Position, Navigation and Timing) in case of GPS outage or jamming, signing the National Timing Resilience & Security Act as part of the CG Budget re-authorization, mandating Sec. Transportation file a report by mid-2019, which has been delayed til end of 2020.
- This followed Feb. 2018 Russian GPS jamming of NATO exercises off Norway, and follow-on by Russians with capability to jam GPS 6000km from coast. Russians have also been jamming aircraft off Alaska, although to date no ships off Alaska, despite Aug. 2020 mil exercises and forced removal of US fishing vessels well within US EEZ, which caused a lot of concern about where CG, Navy and AF were during all this, and why there was no warning to the fishing vessels, many of which had to cut and abandon their gear in the water to avoid being rammed by Russian military vessels.
- So, the solution proposed is called e-LORAN which stands for enhanced-LORAN.
- Tests of e-LORAN were finally conducted by DoT in March and August of 2020.

Other UAS news: eLORAN & radios for GPS-denied ops & control

- What is e-LORAN? Before GPS positions were determined from overlapping timed radio signals from multiple stations of a national LORAN-C system operated by the CG.
- In 2010, after GPS, the 19 mainland US LORAN-C stations were shut down in 2010, but CG was not allowed to get rid of them - they are still in place with their broadcast antennas. (European LORAN-C shutdown at the end of 2015.) Due to GPS jamming by N. Korea, only S. Korea currently uses eLORAN, in fact specifically for UAS.

Navigation in GPS-Denied Environments

Key facts about eLORAN

- eLORAN operates at @100kHz: @1000 fold lower than LORAN-C
- eLORAN operates at 1 Million Watts power: >>LORAN-C; 5×10^6 x >GPS
- eLORAN stations range=@1600 mi: @0% signal loss @1200mi & @6% loss @1600mi
- Due to greater power, eLORAN works well in cities, inside buildings, underground, and underwater to at least 10m depth (which can be improved with modulation) with underwater distance falloff comparable to air
- eLORAN is a completely digital: stations are unmanned and designed for no maintenance for 40+ years (although a central manned operation center is required)
- eLORAN positional accuracy depends on number of overlapping stations, with three stations giving accuracy of +/-8m, but trials have demonstrated accuracy of +/-3.5m (which will not be the case everywhere however).
- eLORAN systems include a cesium clock: timing accuracy from a single station ranges from @1-10nanoseconds

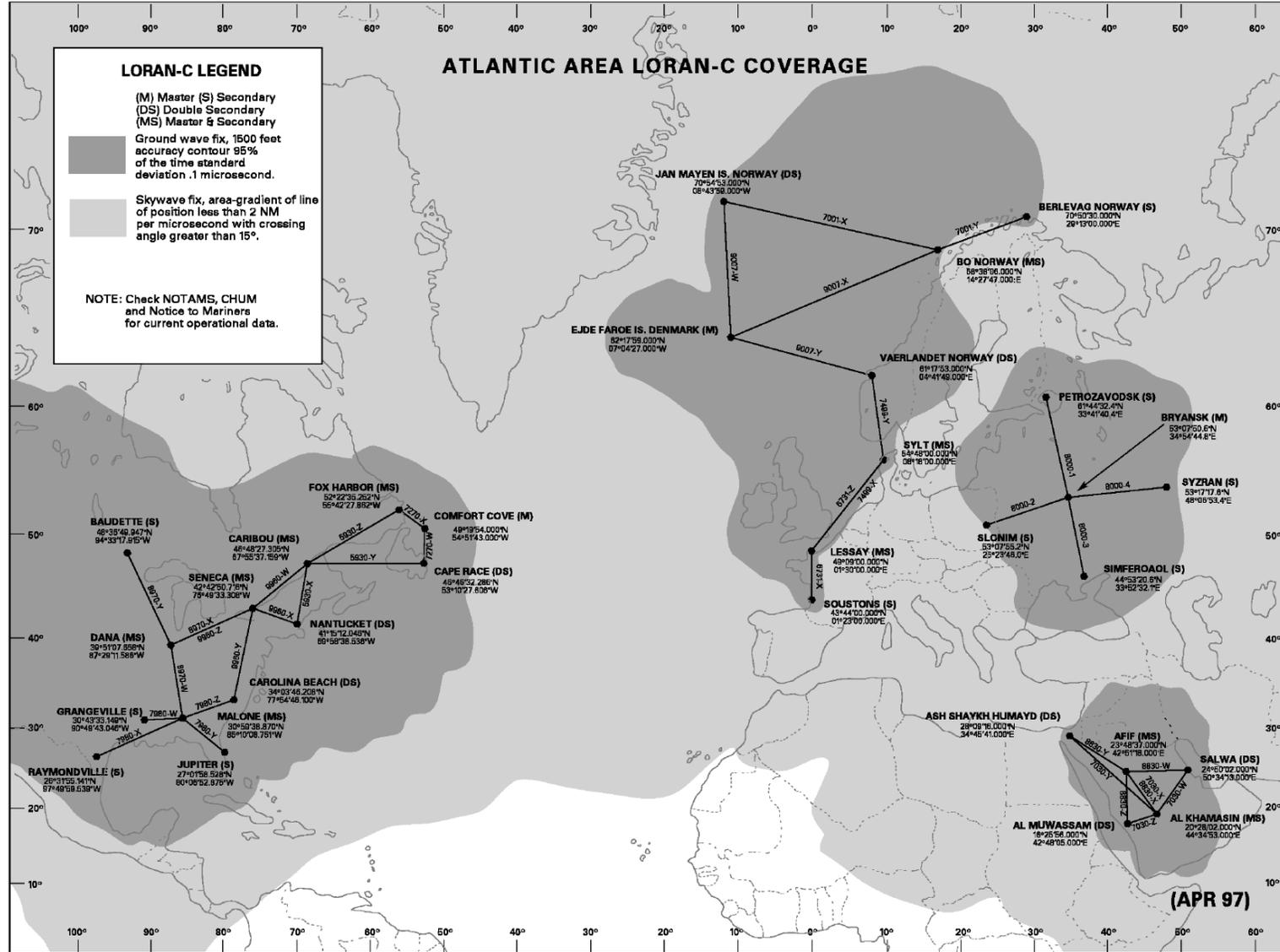
Navigation in GPS-Denied Environments

Key facts about eLORAN

- eLORAN systems can use and need the equivalent antenna system from LORAN-C stations; if unavailable or at new sites a portable antenna system can be used
- eLORAN has a one-way data channel for command and control use (as for unmanned systems) with a bandwidth of >1Kbps, which can be sent to single or multiple systems and is encrypted.
- eLORAN signals are encrypted to prevent access from unauthorized users and as a defense against possible spoofing
- eLORAN systems are not subject to snow, hoarfrost or ice on antennas because of their very low frequency
- eLORAN systems come in a 40' van, but the transmitter components are modular and can be shipped/housed in small containers
- eLORAN receivers include a credit-card sized receiver and similarly sized antenna, with power requirements for both similar to GPS receivers, ie @1 Watt. The cost of both of these systems will be <\$50. Thus they are suitable for unmanned systems: in the air, on the surface or underwater.

Navigation in GPS-Denied Environments

North Atlantic LORAN Stations (as of 2006), but missing Station at Cape Farewell, Greenland



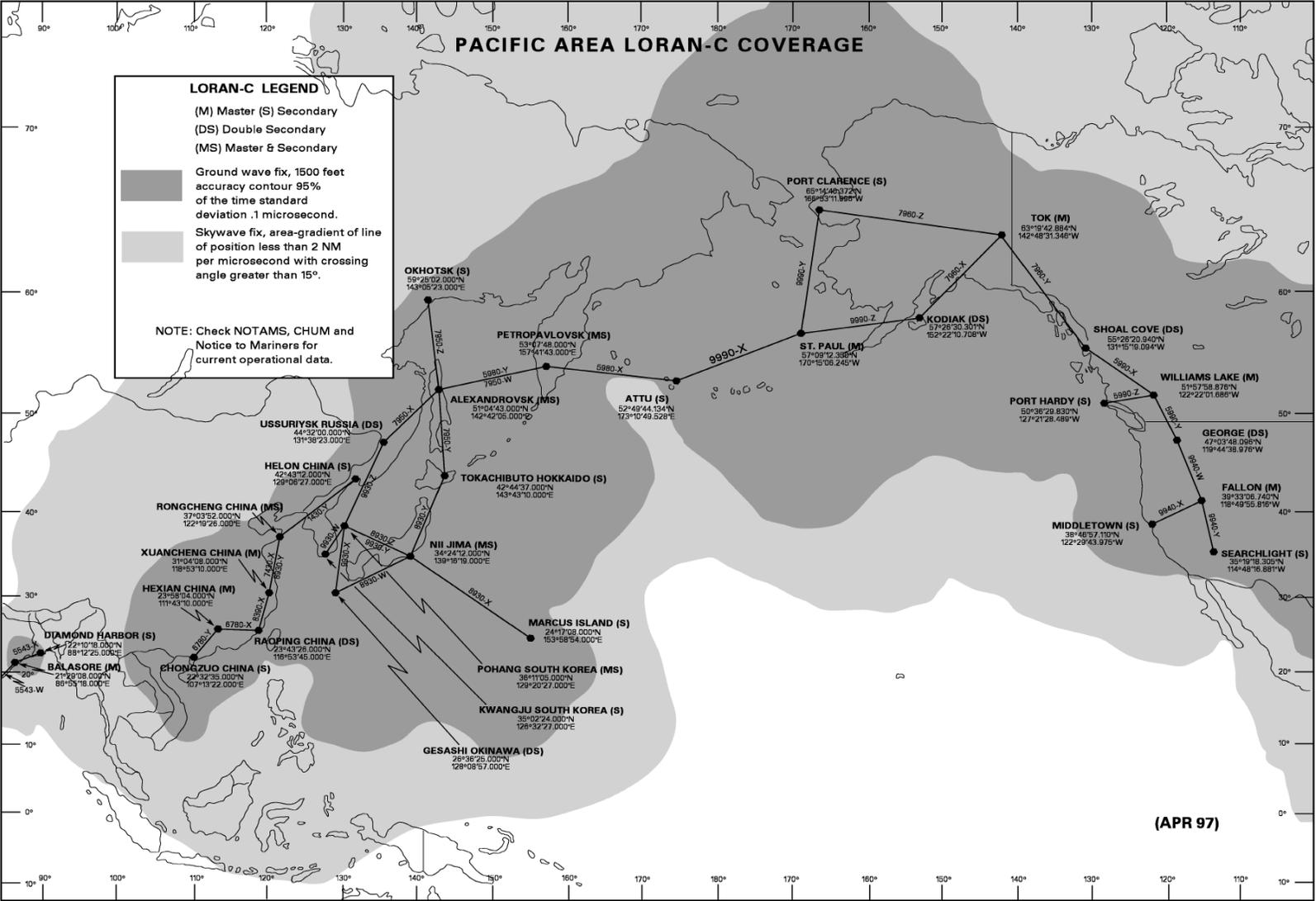
LORAN CHART COVERAGE

Chapter 10

ATLANTIC LORAN C 10-1

Navigation in GPS-Denied Environments

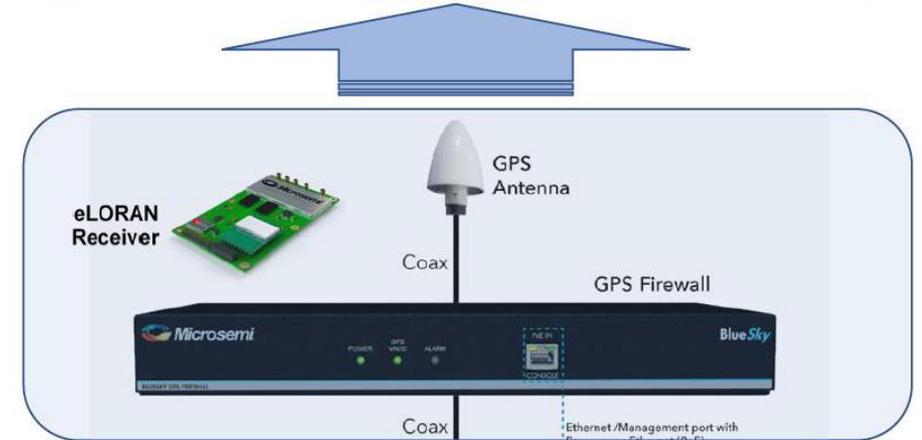
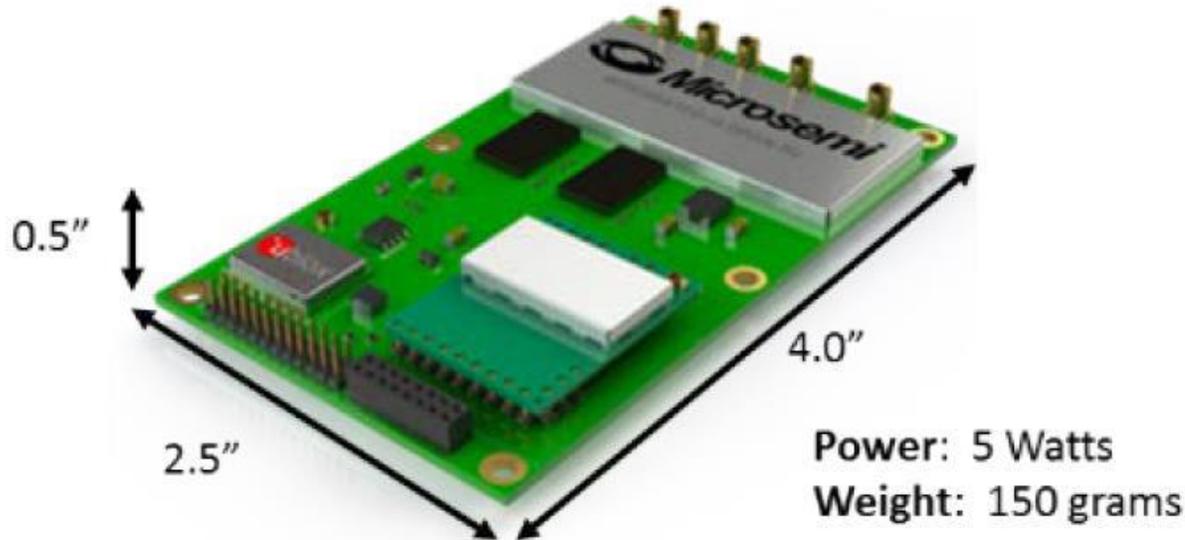
Alaska and North Pacific LORAN Stations



10-2 PACIFIC LORAN C

Navigation in GPS-Denied Environments

eLORAN Receiver module



Critical Infrastructure



Figure 3.2.1-4. Integrating the eLoran/GPS receiver, eLoran antenna, GPS antenna, and BlueSky technology protects against spoofing and jamming attacks and delivers a hardened GPS signal to end-users that only requires them to change their GPS antenna to the BlueSky PNT antenna.

Navigation in GPS-Denied Environments

- Planning eLORAN demo in west (@Lake Tahoe area) in 2021 to include gliders, AUVs and UAS both in water and under-ice.
- Working on planning demo for Arctic: UK has approved funding for install of 6 eLORAN stations, and Norway for at least 2, construction of which will start in 2021, with system completion estimated in 2023.
- Also of note work by my NTNU colleagues using long-range radio for GPS-denied navigation, see: 2019 Intl. Conf. UAS (ICUAS) ms: “Field Test Results of GNSS-denied Inertial Navigation aided by Phased-Array Radio Systems for UAS” K. Gryte, et al., NTNU.
See: http://folk.ntnu.no/torarnj/icuas_pars_ins_final.pdf

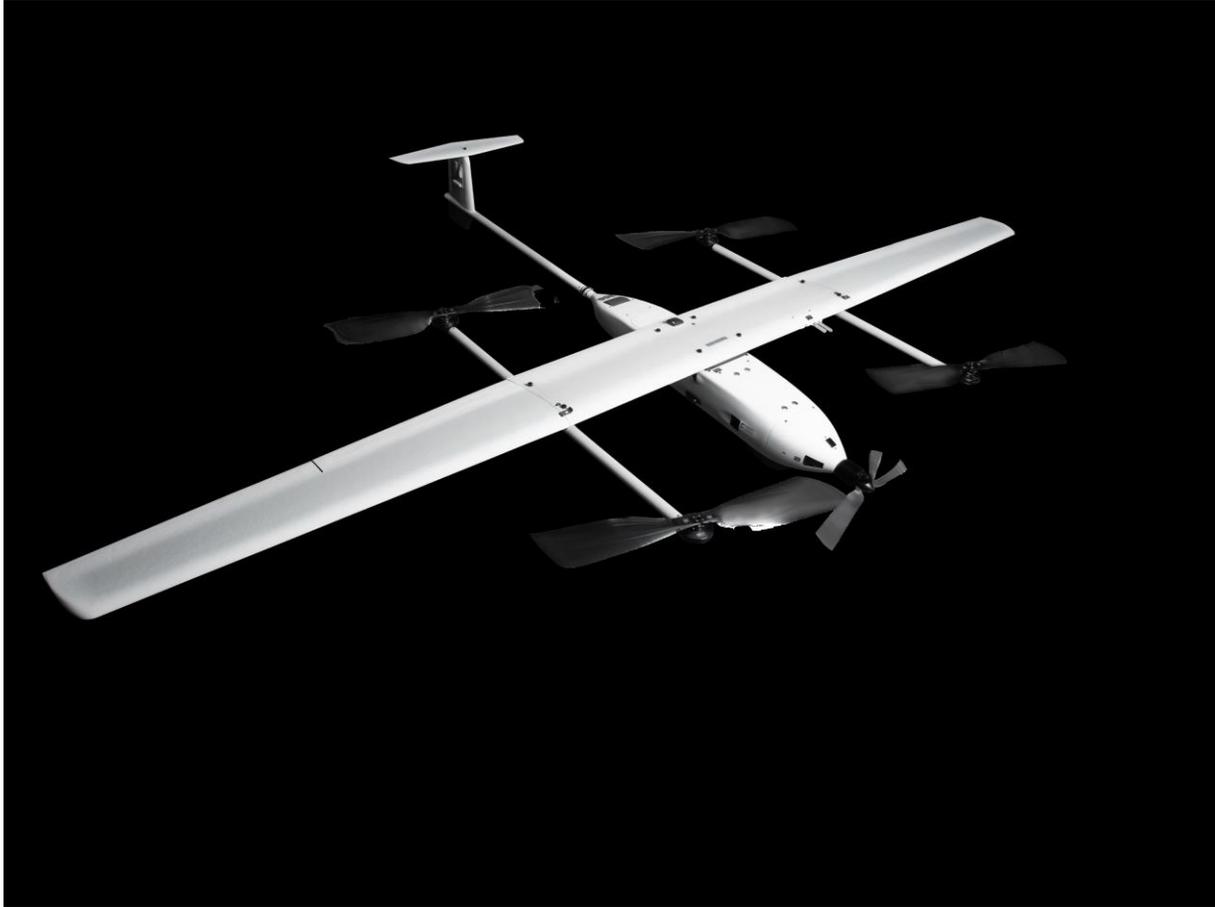
Other CG UAS News: general

- Congressional CG funding in 2019 required Nat. Acad. Scis. to review CG use and cost benefits of UxS.
- Report was just released: “Leveraging Unmanned Systems for Coast Guard Missions (2020), <https://doi.org/10.17226/25987>
- Main recommendations are for CG to develop a UxS strategy document, and to establish funding for UxS ops. Report notes that CG RDC funding for UxS ops is far smaller than Navy or NOAA as % of budget. CG HQ is forming a WG to address recommendations.

Other CG UAS News: specific – comms tests of interest to CG, NORTHCOM & ONR ICE-PPR

- CG, NORTHCOM, and ONR ICE-PPR (Intl. Collaborative Engagement Program for Polar Research) are interested in testing and improving high latitude comms. This includes studies of ducting.
- In order to do useful ducting studies in the arctic, vertical profiles of rH are needed, as well as studies of ice cover and ice leads. To conduct these operations, use of a UAS is necessary.
- CG has coordinated with UAF ACUASI to contract with Precision Ops out of Oregon, for use of a Stalker XE VTOL UAS. We were not able to get on PSTAR Arctic 2020/2021 cruise due to covid and time constraints, but will try to use on HEALY 2021 Baffin Bay cruise.

Stalker XE VTOL UAS



Wingspan 12'

Length 7'

Weight 24 lbs

Payload 5.5 lbs

Speed 30(-39) knots

Comms range 32 nmi

Aircraft range 200 nmi

All-weather ops

Hand, rail, Bungee or VTOL launch

Glide or VTOL recovery

Range dependent on battery/ops choices:

1 – battery only = 2 hours for VTOL, 4 hr for horizontal flight

2 – propane fuel cell = 8 hours

They tend to not use VTOL for launch/recovery because of battery use, but for ships would be best.

Other CG UAS News: UAS &ASV for Port/Harbor security

Demo done in Port of LA in Feb. 2020 with MANTA ASV and quadrotor UAS. Another demo planned for Port of San Diego in April 2021



Questions?

