Analytic and Experimentation Capabilities for Arctic High Frequency (HF) Communications

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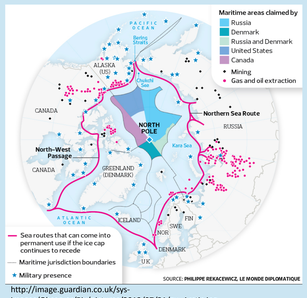
Background

Operational Need: Freedom of Movement

HF technology, due to the long range coverage and affordability, is a natural and critical technology to be evaluated and matured in order to help fill critical capability needs, particularly for improving long range communications



http://image.guardian.co.uk/sys-images/Observer/Pix/pictures/2012/07/21/gu_Arctic.jpg

- Changing Arctic climate has led to increased accessibility
- Increased military and commercial activities
- Challenging HF communications in the Arctic due to ionospheric behavior and lack of infrastructure
- Limited satellite comms coverage; HF is important for "day without space"
- Determine envelope of Arctic HF comms needed for operations

DoD's Arctic Strategy Recognizes Space Weather Impacts

The U.S. and in particular the DoD recognizes the need to address future communications in the arctic and have a strategy to support that. Key challenges for high-latitude electronic communications are called out. The DoD will "provide assured, resilient, and cost-effective polar communications capabilities"

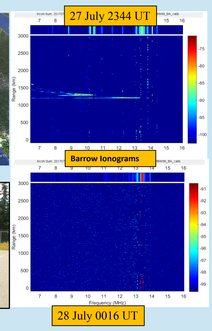
https://dod.defense.gov/Portals/1/Documents/pubs/2016-Arctic-Strategy-UNCLAS-cleared-for-release.pdf

Operating and Testing in the Arctic

MITRE Looking at Operational Needs and Challenges

There are a host of Department of Defense, federal, academic, and research organizations operating and testing in arctic regions.

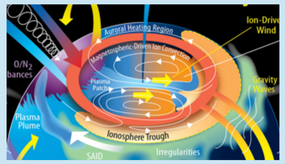
In July 2017, MITRE performed an HF test from Anchorage, AK to Barrow, AK. Outages were observed during testing, and the auroral oval was a key influencer for HF communications performance. An outage is pictured in the ionograms here.



HF Challenges in the Arctic

Availability of HF Communications

The ionospheric trough, auroral, and polar cap regions impact HF communications differently. The auroral oval moves as a function of time and Kp and is key to understanding operational performance. In the arctic, HF reliability depends on the trough, sporadic E, anomalous ionization in F2, and absorption. Given this, to maximize mission availability, opportunities for multipoint modeling and regional modeling improvements have been identified.



https://svs.gsfc.nasa.gov/4641

Proposed Method

Operational Opportunity for HF Arctic Communication: Multipoint Networking

Hypothesis: Auroral trough impacts HF communication availability
Objective: Create a network with frequency management to improve availability

MITRE has a proposal to build off previous work by Goodman to implement a geographically diverse, multipoint network using strategic node selection for arctic ionospheric impacts and creates a frequency management system leveraging real-time data. Proposed locations are pictured to operate in auroral trough region.

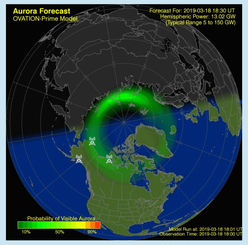
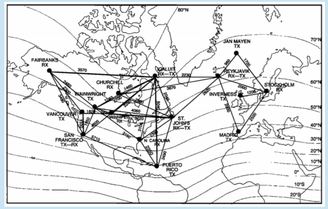


Image created using the Ovation map tool from NOAA



Goodman, 1997.

A previous MITRE project performed a gap analysis on existing HF communications models, improved the remote capabilities and arctic viability of the MITRE experimental HF system, and identified and tested an approach to data analysis that leveraged existing geomagnetic indicators. This previous work lays the ground work to implement a real time system based on sounders and uses nowcasts and forecasts in a frequency management system as proposed by Goodman.

Operators and decision makers would be more effective with accurate information for:

- Geographically diverse, multipoint network
- Range of performance and frequencies, especially in the area of the auroral trough
- Availability

Future Directions

Proposed HF Multipoint Test Network

This installation and test would collect key communications data and demonstrate a system relay and frequency management capability leverages real time data.

To test HF networking, we could leverage supporting information from the research community and collaborate with arctic test planners on HF communications planning especially to gain additional input on test scenarios.

Recommended Work

- Create multipoint HF communications frequency planning tool

Continuing work

- Analysis on existing HF communications models performance in the arctic
- Develop recommendations for HF communications P2P modeling and additional key parameters
- Leverage upcoming test events (US Coastguard Healy 2019 and ICEX 2020)

MITRE Test Teams and antennas during 2017-2018 select Arctic testing activities

Contact Information

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References

1. J. Goodman, "A long-term investigation of the HF communication channel over middle- and high- altitude paths," Radio Science, vol. 32, no. 4, July - Aug, pp. 1705-1715, 1997.
2. "Impact of the auroral ionosphere on HF radio propagation", D. V. Blagoveshchensky (2011).

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