



## Digital HF communications for the polar regions – a low-cost alternative to satellite?

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Communications within the polar regions pose unique technical challenges, due to the physical isolation, lack of infrastructure and extreme weather conditions. Geostationary satellite links are widely used, but they cannot function poleward of 80 degrees due to the curvature of the Earth. Low-earth-orbit systems like Iridium and ARGOS will function all the way to the poles. However, they are expensive, particularly for experiments requiring long time-series. Transferring data by Iridium satellite phone costs of the order of 60USD per megabyte. HF (i.e. 3-30 MHz) radio signals propagate via the ionosphere, allowing long distance transmission beyond the horizon. Ranges of thousands of kilometres can be easily achieved with relatively low transmission powers when propagation is favourable. The polar ionosphere is, however, a challenging environment for radio signals – the signals often reflect from multiple regions of the ionosphere and by multiple hops with intermediate ground reflections producing multipath effects. As the ionosphere is moving, these signals are also subject to very significant Doppler shifts that add to the complexity of the environment. These effects may make data communications at polar latitudes difficult or impossible at times and often only at low data rates. In this paper we discuss our experiments to use modern signal-processing and modulation techniques for digital transmission on HF, offering a similar speed to satellite but without paying the high cost of satellite airtime. Using an HF channel simulator developed by Warrington et al based on measurements of propagation at high latitudes, we have tested the performance of an OFDM-based modem derived from the Digital Radio Mondiale standard used for digital HF broadcasting and found that it outperforms current military modems developed by NATO (STANAG 4285 and 4539). The NATO modems were developed for operation in mid-latitude regions and thus it is unsurprising that they do not perform particularly well in the more demanding polar channels. We have also conducted on-air experiments over a 1600km test link between Halley and Rothera stations in Antarctica, and present the results showing the availability and capacity of this data link. We will also show how HF systems can provide inexpensive data communications for autonomous instruments, field parties, aircraft and ships operating in and around the Arctic and Antarctic.

### References:

Warrington, E. M., A. J. Stocker, and D. R. Siddle (2006), Measurement and modeling of HF channel directional spread characteristics for northerly paths, *Radio Sci.*, 41, RS2006, doi: 10.1029/2005RS003294.