Diagnosis of ionospheric radiowave propagation conditions via monitoring of shortwave broadcast signals

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Abstract

For many HF communications and surveillance systems, a knowledge of the availability and quality of HF skywave channels is a pre-requisite for efficient operations. Indeed, so important is access to information on the propagation conditions that special ionospheric sounding sub-systems are often incorporated in the overall system to provide real-time measurements of the relevant parameters, such as signal strength, maximum useable frequency, channel Doppler spread, multimode characteristics, frequency dispersion, and so on. For example, the Jindalee OTH radar system employs a backscatter sounder, oblique (one-way) sounders, vertical incidence sounders and a miniradar to support frequency management.

While these systems are irreplaceable for regional propagation, within a range of several thousand kilometres, say, they have limited ability to measure propagation characteristics over longer paths. Yet, for some purposes, which include minimising interference, avoiding contamination from auroral echoes and antipodal focussing, communicating with distant stations, understanding the effects of the terminators and modelling round-the-world propagation, there is a need to determine the main attributes of these very long range links.

In order to estimate the desired channel properties, the signal-to-noise ratio of the probing signal must be at least 10 – 20 dB, say. There are several ways to achieve this :

(i) use a high power transmitter
(ii) radiate from a high gain antenna
(iii) employ one-way propagation, not two-way
(iv) use a waveform which can be compressed by a matched filter

but there remains the problem of constructing and deploying these emitters on a global scale.

Fortunately such a network already exists – the international shortwave broadcasting community. Hundreds of powerful transmitters radiate within the HF band, from locations distributed around the world. Large, efficient antennas are the norm. The signals arrive at the reception point by primarily one-way paths. Thus, according to the criteria listed above, the broadcast signals will in general have high SNR and be suitable candidates for propagation diagnosis.

This idea is not new, however to our knowledge it has never been exploited as a sub-system of a global propagation monitoring scheme. In this paper we describe an implementation presently under development for the Jindalee OTH radar, and show how a variety of propagation parameters can be estimated from the broadcast signals and used to guide the choice of radar frequency and waveform parameters.