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Space Weather Modelling for the High-latitude Aeronautical HF Radio Prediction Service (HARP)

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Extended Abstract

Aircraft operating in remote and high-latitude regions are required to maintain HF (3–30 MHz) radio communications with air traffic control (ATC) at all times. However, absorption of radio waves in the auroral and polar ionosphere often causes HF communications failure and the consequent expense of rerouting aircraft to lower latitudes. This paper describes a European Space Agency funded feasibility study for a High-latitude Aeronautical Radio Prediction service (HARP) (https://business.esa.int/projects/harp), intended to operate 24/7 at the UK Met Office Space Weather Operations Centre. HARP will predict HF communications availability based on real-time and multi-day forecasts of Space Weather conditions including solar flares, solar energetic proton events, and interplanetary coronal mass ejections. It will incorporate real-time solar X-ray and energetic particle flux measurements from the NOAA GOES satellites, geomagnetic activity K_p and D_{st} index estimates derived from *in situ* solar wind measurements from the NOAA DSCOVR spacecraft, and data from arrays of ground-based riometers which measure the ionospheric absorption of 30 MHz cosmic background noise. These data are assimilated into a real-time model of Polar Cap Absorption [1, 2], a model of auroral absorption [3], and a 'shortwave fadeout' model [4] parameterized by the X-ray flux which is elevated during solar flares. Three-day forecasts of the near-Earth solar wind environment will be provided by the WSA–Enlil model [5].

HARP implements 3-D ray tracing to determine HF signal coverage, and will determine communications availability based on multiple random realizations of electron density structures (e.g. polar patches, and F-region sun-aligned arcs) embedded in a background International Reference Ionosphere (IRI) with parameters R_z and IG optimized to fit real-time ionosonde measurements and dual-frequency Global Navigational Satellite System measurements of Total Electron Content. Simulations using a selection of aeronautical frequency bands will provide a service recommendation of the best operating frequencies for each air traffic region.

This paper presents the data assimilative ionospheric models used, a summary of aeronautical user requirements (from discussions with an airline, an ATC, and an HF comms service provider), the real-time and forecast data input requirements, and initial developments of a prototype html-based user interface.

2. References

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