

Geophysical Research Abstracts
Vol. 16, EGU2014-15087, 2014
EGU General Assembly 2014
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Predictions and observations of HF radio propagation in the northerly ionosphere: The effect of the solar flares and a weak CME in early January 2014.

Jonathan Hallam (1), Alan J. Stocker (1), Mike Warrington (1), Dave Siddle (1), Nikolay Zaalov (2), Farideh Honary (3), Neil Rogers (3), David Boteler (4), and Donald Danskin (4)

(1) University of Leicester, Department of Engineering, Leicester LE1 7RH, United Kingdom (sto@le.ac.uk), (2) Radiophysics Division, Research Institute of Physics, St. Petersburg State University, 198904 Petrodvoretz, Russia, (3) Department of Physics, Lancaster University, U.K., (4) Geomagnetic Laboratory, Geological Survey of Canada, 7 Observatory Crescent, Ottawa, K1A 0Y3, Canada

We have previously reported on a significant new multi-national project to provide improved predictions and forecasts of HF radio propagation for commercial aircraft operating on trans-polar routes. In these regions, there are limited or no VHF air-traffic control facilities and geostationary satellites are below the horizon. Therefore HF radio remains important in maintaining communications with the aircraft at all times. Space weather disturbances can have a range of effects on the ionosphere and hence HF radio propagation - particularly in the polar cap. While severe space weather effects can lead to a total loss of communications (i.e. radio blackout), less intense events can still cause significant disruption. In this paper we will present the effect of a series of M and X class solar flares and a relatively weak CME on HF radio performance from 6 to 13 January 2014. This is an interesting interval from the point of view of HF radio propagation because while the solar effects on the ionosphere are significant, except for an interval of approximately 12 hours duration, they are not so intense as to produce a complete radio blackout on all paths. Observations of the signal-to-noise ratio, direction of arrival, and time of flight of HF radio signals on six paths (one entirely within the polar cap, three trans-auroral, and two sub-auroral) will be presented together with riometer measurements of the ionospheric absorption. Global maps of D-region absorption (D-region absorption prediction, DRAP) inferred from satellite measurements of the solar wind parameters will be compared with the HF and riometer observations. In addition, a ray-tracing model using a realistic background ionosphere and including localised features found in the ionospheric polar cap (e.g. polar patches and arcs) will be used to model the expected and observed HF radio propagation characteristics.