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TITLE: Transionospheric Propagation of VLF Transmitter Signals

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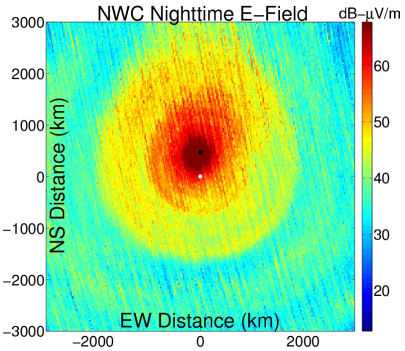
ABSTRACT BODY: Ground based Very Low Frequency (VLF, 3-30 kHz) radio transmitters may play a significant role in precipitation of inner belt (L<2.5) energetic Van Allen electrons. Initial analyses of the total contribution of VLF transmitters utilized models of transionospheric propagation, but some recent studies have suggested that those models may overestimate (by 20-100 dB) the VLF energy reaching the magnetosphere. One possible cause of this discrepancy was suggested to be conversion of wave energy into electrostatic modes in the D, E, and F regions, from ionospheric density irregularities, either natural or generated by the transmitter heating itself.

The DEMETER satellite built a six year history of continuous and global survey mode data which, when combined, yields detailed pictures of the radiation pattern from many transmitters into space at 680 km, with 25 km resolution, and clear features like the interference pattern on the ground mapped upwards. With both E and B survey mode data, we can also directly approximate the total power injected into the magnetosphere from each transmitter, separately for day and night, as well as the power arriving at the conjugate region.

We find no detectable variation of signal intensity with geomagnetic conditions. We find evidence of transmitter heating affecting the transionospheric propagation of other transmitters. We find that the power reaching the conjugate region is a large fraction of the power injected above the transmitter.

We then employ a full wave model to simulate VLF transmitter transionospheric propagation, calculating the electromagnetic fields and power flux injected into the magnetosphere. Although the model does not include ionospheric irregularities, the radiation pattern largely matches the observed one, and the total power calculated is within 6 dB of observations for every transmitter, both day and night, and across a range of low to middle latitudes and transmitter powers. We thus conclude that the effect of ionospheric irregularities on VLF wave injection into the radiation belts may be small, if present at all.

KEYWORDS: [2774] MAGNETOSPHERIC PHYSICS / Radiation belts, [2487] IONOSPHERE / Wave propagation, [2447] IONOSPHERE / Modeling and forecasting, [2443] IONOSPHERE / Midlatitude ionosphere.



The nighttime radiation pattern of NWC at 700 km altitude, derived by averaging 6 years of DEMETER survey mode data.

(No Table Selected)

Additional Details

Previously Presented Material: None of the material has been presented at a conference before.

50% of the material has been presented in a JGR Space Physics paper which is currently in press, doi:10.1029/2012JA017992.

The other 50% of the material has not been presented in any form.

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