



## VIPER Sounding Rocket Observations of Nighttime HF Trans-Ionospheric AM Radio Propagation at Mid-Latitudes

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The NASA VIPER (Bonnell 46.028 UE) sounding rocket flew to an altitude on 160 km off the US Atlantic coast after a successful launch at 0115 UT, 27 May 2021 (2115 local time 26 May) in order to probe the reflection, absorption, and transmission of natural and artificial VLF waves. Amongst other plasma and field diagnostics, the VIPER payload carried a single-axis wideband (0-4 MHz) continuous waveform receiver (HF RX) in order to detect spectral features associated with the local electron plasma, cyclotron, and upper hybrid frequencies.

Rather than the expected spectral features at the local plasma resonance and cutoff frequencies, the VIPER HF RX observed dozens of narrowband signals from commercial AM radio transmitters continuously through the flight through the nighttime D and E regions. The thicket of signals covered a band from well below the local electron cyclotron frequency to well above it, and showed well organized (if not yet well understood), variations in amplitude with altitude on both the up- and down-legs of the flight.

The dense network of AM transmitters along the eastern seaboard of the US, along with these detailed high-time-resolution waveform data from HF RX, present intriguing possibilities for the modeling of D-region density and collision frequency profiles.

Here we present the VIPER HF RX data, along with initial interpretations and analysis utilizing PHARLAP for HF ray tracing, as well as further possibilities in the existing and future flights of HF RX instruments on sounding rockets and satellites.

