



The Impact of Gamma-Ray Burst (GRB-221009A) on the Ionosphere

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On October 9th, 2022, a powerful gamma-ray burst was detected and may very well signify the birth of a new black hole. The event was detected by the Fermi Gamma-Ray Burst Monitor (GBM) at 1316:59 UTC and by the Swift observatory at 1410:17 UTC. It was unusually bright and persisted for an unusually long period of time. This GRB is noted as being the brightest burst recorded, with over 5000 photons being recorded with an energy of at least 0.5 TeV, and the largest being 18 TeV. The Ionospheric Radio Lab (IRL) at the University of Florida operates a network of extremely low frequency (ELF) and very low frequency (VLF) radio receivers across the United States and in Antarctica. These receivers continuously track the amplitude and phase of the subionospherically-propagating VLF signals and continually monitor the ELF/VLF band for natural radio emissions. These VLF signals are sensitive to changes in the ionospheric electron density along the path of propagation and are therefore useful as detectors of ionospheric changes. This system of receivers automatically processes the American VLF Navy transmitter signals, but also stream the broadband (150 Hz – 42 kHz) radio signals to disk. Very little response to this enormous event was detected in the American signals, but the European VLF transmitter signals, which were extracted from broadband data in post-processing, indicate clear responses.

In this paper, we present measurements VLF transmitter signals that clearly responded to GRB-221009A. We detect changes in the ionosphere in response to both the 1316 UTC and at 1410 UTC event times noted above. Although we successfully detect the gamma-ray burst using VLF remote sensing of the ionosphere, at the time of this writing, we have not detected any broadband radio bursts in the ELF/VLF band that were associated with the burst, as was detected together with soft gamma ray repeater 1806–20.