Simulation of Dynamic Spectra of Transionospheric Pulse Pairs

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Trans Ionospheric Pulse Pairs are VHF signals consisting of exactly two broadband pulses, each with duration of few microseconds. The time separation of the pulses is typically tens of microseconds. Each pulse exhibits frequency dispersion indicative of sub-ionospheric origin. These emissions were distinguished from other naturally occurring radio emissions and were suspected to be associated with thunderstorms because they were recorded onboard satellite when lightning activity was within the satellite's VHF horizon. In the present paper, we try to explain the dynamic spectra two pulses of TIPPs by considering the propagation of electromagnetic waves generated during lightning discharge in two different modes. The lightning discharge is represented by the combination of two Dirac delta functions. First one for the ground to cloud discharge current and the other one is cloud to ionosphere discharge. The Maxwell's equations are solved to derive the expression for wave-electric field as a function of frequency and distance. The exact time-dependence of the propagating non-monochromatic signal for the realistic ionospheric (IRI) model is numerically computed along with the IGRF model for the variation of gyrofrequency with altitude. It is observed that the separation between two signal pulses depends on the pulse separation of the excitation source; however, the intensity of the signal depends directly on the pulse height of the source current.