Nonlinear Mode Conversion of VLF Waves over Arecibo, Puerto Rico

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We investigate a mechanism occurring in the ionosphere that can cause nonlinear mode conversion of incident VLF radio waves into lower hybrid waves. Both the Spread-F and Sporadic-E structures can provide the density irregularities for this mechanism to occur. Since the irregularities in Sporadic-E have shorter scale than those produced in Spread-F, it is expected that the mode converted lower hybrid waves in E-region will have much higher intensity than those in F-region. Based on the proposed hypothesis, this mechanism will broaden the spectrum of the incident VLF waves. To simulate this scenario and corroborate this mechanism, experiments were conducted using the 430 MHz Incoherent Scatter Radar (ISR) at Arecibo Observatory, Puerto Rico. The ground based Naval Transmitter code-named NAU was the source transmitting 40.75 kHz VLF waves continuously at 100 kW power. Electrons accelerated by mode-converted lower hybrid waves along the earth magnetic field were detected by the ISR Radar in the form of weak plasma lines in both E-region and F-region. The detected plasma lines possessed symmetric spectrum features, showing that the accelerated electron streams were bi-directional. It indicates that the mode-converted electrostatic wave could propagate at either direction along the earth magnetic field. The intensity of the plasma lines detected in E-region was about an order of magnitude higher than those detected in F-region as expected.