

## Observations and Modeling of Ionospheric Disturbances Triggered by Rockets

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This study presents two-dimensional structure of disturbances wave signatures in ionospheric electron density resulting from the rocket transit using the rate of change of the total electron content (TEC) derived from ground-based GPS receivers around Japan and Taiwan. From the TEC maps constructed for the recent five rocket launches around East Asia region, features of the V-shape shock wave fronts in TEC perturbations are prominently seen. These fronts, with period of 100-600 sec, produced by the propulsive blasts of the rockets appear immediately and then propagate perpendicular outward from the rocket trajectory with supersonic velocities between 800-1200 m/s for both events. Following the initial shock wave feature, various disturbances waves in TEC are seen. Twenty minutes after the rocket transits, delayed electron density perturbation waves propagating along the bow wave direction appear with phase velocities of 800-1200 m/s. According to the propagation character, these delayed waves may be generated by rocket exhaust plumes at earlier rocket locations at lower altitudes. The upward propagating disturbance waves due to exhaust plumes from lower altitude are also reconstructed by comprehensive model calculations.

Keywords: Ionospheric Disturbance Waves, Rocket Exhaust