# Impact of foreshock transients on the Earth’s nightside magnetosphere and ionosphere

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The density and flow perturbations associated foreshock transients can result in dynamic pressure changes in the magnetosheath, thus distorting the magnetopause and driving disturbances within the magnetosphere and ionosphere. In this paper, we present three events from multiple spacecraft observations to show that transient foreshock perturbations associated with an IMF directional discontinuity can persist as they propagate to the mid-tail magnetosheath ($X < -40\ R_E$) together with the discontinuity and disturb the nightside magnetopause. We show observations that these transients can enhance compressional magnetic field waves within the nightside magnetosphere, drive Pc-5 magnetic field perturbations on the ground traveling from the dayside toward nightside, and generate localized ionospheric flow vortex on the nightside. We also present results from a 3D global hybrid simulation of an rotational IMF discontinuity using the ANGIE3D (AuburN Global hybrId codE in 3-D) code. The simulation shows that transient plasma and field perturbations are formed in front of the foreshock with characteristics consistent with a foreshock bubble (FB). The FB subsequently propagates into the magnetosheath, and as it propagates tailward to the mid-tail together with the discontinuity it continuously causes localized and transient distortion of the flank magnetopause, as well as field-aligned currents into the ionosphere. Therefore, our observations and simulations demonstrate that foreshock transients can have a global impact on the nightside magnetosphere and ionosphere.

Keywords: foreshock transient, multi-spacecraft observation, magnetotail, nightside magnetosphere and ionosphere, 3D global hybrid simulation, ULF waves

 