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MHD Modeling of a Shock Created by Ceres' Temporary Atmosphere

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Dawn has been in orbit about Ceres since 2015. While approaching Ceres, Dawn's Gamma Ray and Neutron Detector (GRaND) detected bursts of energetic particles in its exterior scintillators. In the strongest of these events, Dawn was in its survey orbit at a distance of $\sim$10 Ceres radii. The temporal flux and energy of the electrons is compatible with being an electron foreshock. We use a single-fluid magnetohydrodynanic (MHD) model to constrain the atmospheric density and bow shock size that would be needed to replicate the geometry of the electron foreshock. Shock geometries are calculated for different source conditions using solar wind values extrapolated from 1 AU. We find that a temporary atmosphere with a vapor production rate $\sim$9 kgs$\hat{}$-1 would have created a bow shock at Ceres. This production rate is similar to those observed by the International Ultraviolet Explorer and the Herschel Space Observatory.