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Automated clustering to identify plasma regimes on the dayside of Earth's magnetosphere, magnetosheath, and solar wind regions

Drew L. Turner[(1)], Vicki Toy-Edens[(1)], Wenli Mo[(1)], and Savvas Raptis[(1)]
(1) Johns Hopkins Applied Physics Laboratory; drew.turner@jhuapl.edu

We present results from a new, automated clustering machine learning algorithm developed to identify different plasma regimes from MMS observations on the dayside regions of near-Earth space. Using a reasonably small, yet carefully tailored set of input parameters, the automated clustering algorithm, which employs a Gaussian Mixture Model (GMM), distinguishes plasma into four regimes: pristine solar wind, ion foreshock, magnetosheath, and magnetosphere. We apply this algorithm to the full dataset of MMS observations (8-years). From comparison with a combination of hand-labeled subsets of the data, we show that the new algorithm successfully classifies plasma regimes with 97.6% accuracy. The dataset of all labeled data, at 1-minute resolution, has been publicly released. From the classified data, we identify all quasi-parallel and quasi-perpendicular bow shock crossings plus magnetopause crossings in the data from the simple combination of transitions between different regimes. New statistical results, including comparison to historic bow shock and magnetopause models plus the development of new boundary models trained on these MMS data, are also presented. We finish with a description of our ongoing effort to use these data to train a new, generative synthetic data model for collisionless shocks, parameterized by upstream conditions.