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Analysis of Hall Effect Thruster Environmental Interactions using Extended Convergent Cross Mapping[1] CESAR HUERTA, Jacobs Engineering Group Inc, DANIEL ECKHARDT, ROBERT MARTIN, JUSTIN KOO, Air Force Research Lab, RQRS — Although Hall-effect thrusters are a widely used form of space propulsion, many details of their operational behavior are not well understood. Studying the relationship between time-varying measurements at different locations in and around the HET can reveal the causal links between the discharge and cage currents and how the ground facility may be coupled to thruster operation, for example. Determining causality in a nonlinear dynamical system can be accomplished with Convergent Cross Mapping, which uses reconstructions of a signal by way of shadow manifolds of another signal to determine causality [2]. Extended convergent cross mapping resolves the direction of causality by sweeping across a range of time delays, seeking a characteristic delay between the signals. Hence, if X causes Y, Y cross maps X with a negative delay since information of $Y(t)$ is encoded in X's past. In this work, eCCM is applied to HET simulations and experimental measurements. For the simulations, eCCM is applied at different input voltages to show the effects of operational parameters on information dynamics. eCCM results of measurements in nominal and breathing are used to construct a causality network map to visualize information flow in the system.

[1]Distribution Statement A: Approved for Public Release; Distribution is Unlimited. PA Clearance #20307
[2]Sugihara et al. Science 2012

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