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(G*) Application of kinetic and regression techniques to measurements made with fixed-bias needle Langmuir probes.

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Fixed-bias multi-needle Langmuir probes consisting of several cylindrical probes biased to different potentials can be used to measure plasma parameters on satellite without the need of sweeping bias voltages. Compared to a single Langmuir probe for which voltage is varied periodically in time, fixed bias probes enable measurement with a significantly higher sampling rate and, owing to the high orbital speed of satellites, a much higher spatial resolution when used to diagnose space plasma. The inference of plasma parameters from needle probes is typically based on the Orbit Motion Limit theory (OML) which assumes an infinitely long cylindrical probe, and the absence of nearby objects. These assumptions are rarely satisfied in an actual experimental setup. In this study, three-dimensional kinetic simulations are used to compute currents collected by needle probes on the Norsat-1 satellite, and create a synthetic data set, or solution library. This is then used to construct regression models to infer plasma densities and satellite floating potentials from four-tuples of collected currents. Two regression approaches are considered, consisting of radial basis functions (RBF) and deep learning neural networks. Regression results and OML results will be compared and assessed when the assumptions made in the OML theory are not fully satisfied. The use of regression techniques rather than purely analytic expressions is shown to lead to more accurate inference techniques for measuring plasma parameters in space, than those based on analytic approximations.

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