The Hilbert-Huang Transform (HHT) as a tool for characterizing dynamical features of Mercury’s and Venus’ magnetospheres

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The interaction between the interplanetary medium and planetary environments gives rise to different phenomena according to the spatio-temporal scales. Here we apply for the first time a novel data analysis method, i.e., the Hilbert-Huang Transform, to discriminate both local and global properties of Venus’ and Mercury’s environments as seen during two MESSENGER flybys. Hence, we may infer that the near-Venus environment is similar in terms of local and global features to the ambient solar wind, possibly related to the induced nature of Venus’ magnetosphere. Conversely, the near-Mercury environment presents some different local features with respect to the ambient solar wind, due to both interaction processes and intrinsic structures of the Hermean environment. Our findings support the ion kinetic nature of the Hermean plasma structures, with the foreshock and the magnetosheath regions being characterized by inhomogeneous ion-kinetic intermittent fluctuations, together with MHD and large-scale fluctuations, the latter being representative of the main structure of the magnetosphere. We also show that the HHT analysis allow to capture and reproduce some interesting features of the Hermean environment as flux transfer events, Kelvin-Helmholtz vortex, and ULF wave activity, thus providing a suitable method for characterizing physical processes of different nature. Our approach demonstrate to be very promising for the characterization of the structure and dynamics of planetary magnetic field at different scales, for the identification of different planetary regions, and for the detection of the “effective” planetary magnetic field that can be used for modelling purposes.