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The nature of small-scale, nonlinear structures observed in boundary and turbulent regions in space

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Based on in situ satellite measurements, electrostatic solitary waves are often observed wherever boundaries and turbulence are encountered in space, for example at shocks and magnetopause crossings and throughout magnetosheaths. These solitary waves are nonlinear and coherent in nature, usually in the form of isolated bipolar and tripolar pulses in the waveform data. They are often the signature of potential structures, for instance Bernstein-Greene-Kruskal or acoustic mode electron and ion solitary waves, passing by the spacecraft. How these solitary waves are generated through various instabilities has been the subject of several studies. Whether these electrostatic solitary waves, once generated, affect major processes occurring in these regions is still not well understood, but there is no question that they provide insight into the state of the plasma. We present multi-spacecraft Cluster Wideband plasma wave receiver observations obtained in some of these boundary and turbulent regions, showing the presence of electrostatic solitary waves. The characteristics of these solitary waves are presented and compared across various regions. Using identical WBD waveform receivers on at least two different Cluster spacecraft as an interferometer, we provide an initial assessment of whether these solitary waves can propagate over large distances without changing their nature, or whether they are intrinsically unstable and thus more likely to affect the plasma locally. Since spacecraft separations are at least as large as tens of km, we gain additional insight not afforded by interferometric measurements made on only one spacecraft with antenna separations on the order of 100 m or less.