



Cluster Multi-spacecraft Observations of Electrostatic Solitary Waves, VLF Saucers and Broadband Wave Bursts in the Auroral Downward Current Region

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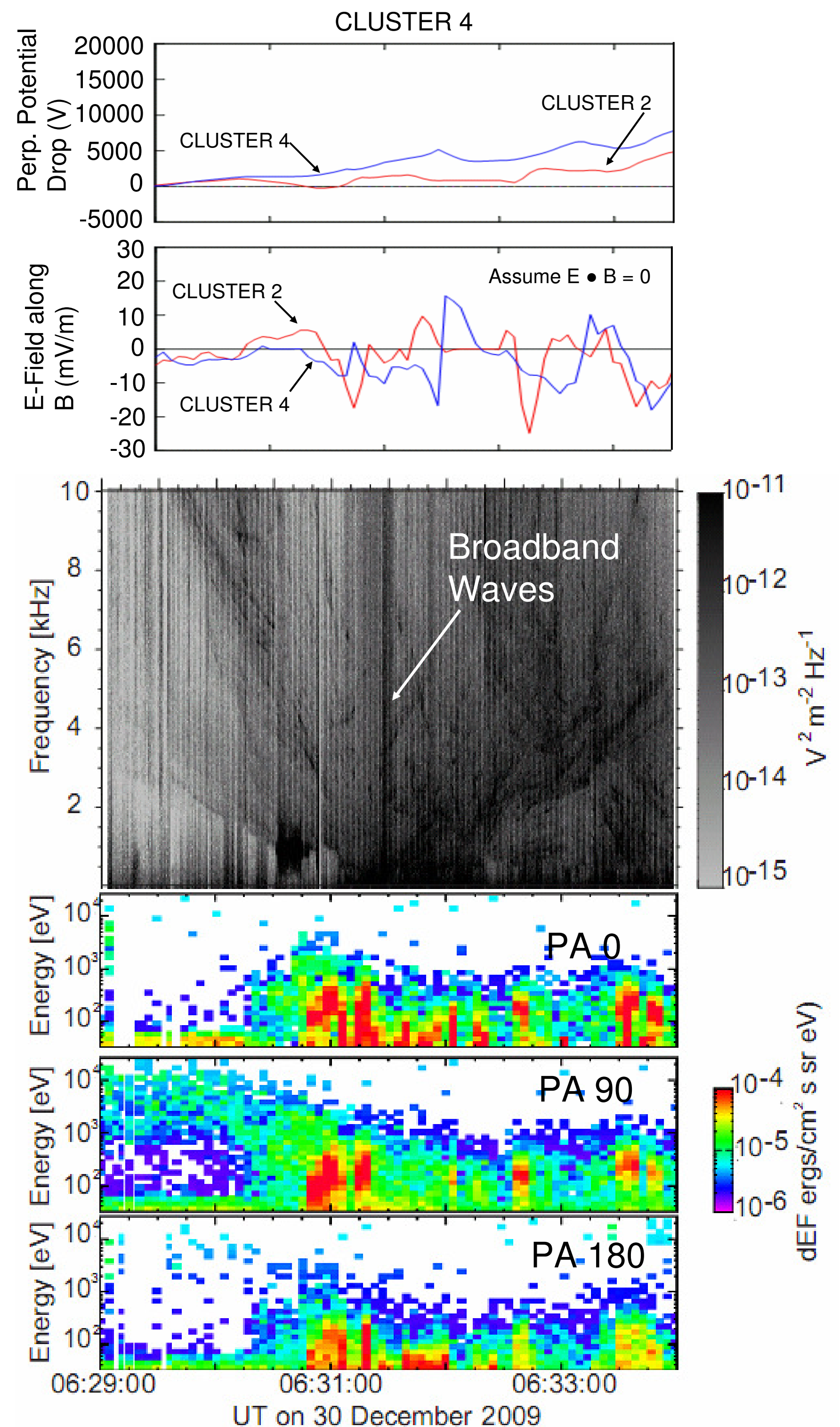
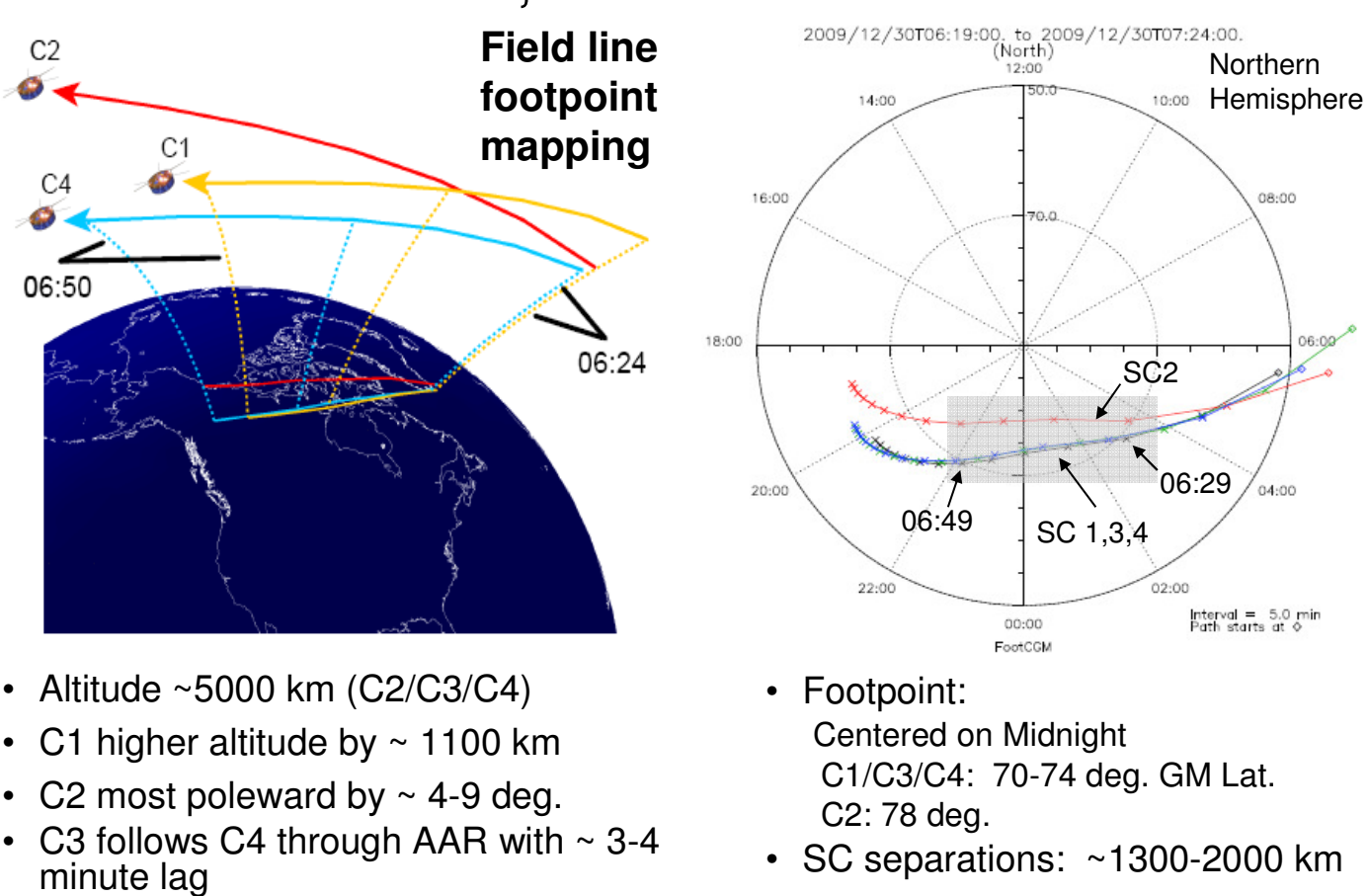
ABSTRACT

The four Cluster spacecraft have been transiting Earth's auroral acceleration region at certain times of the year since 2008. The Wideband Data (WBD) plasma wave receiver mounted on each of the four spacecraft obtains high time resolution waveforms in several different frequency bands which span the frequency range from 100 Hz to 577 kHz. We present WBD data obtained simultaneously on more than one Cluster spacecraft in and near the auroral downward current region in the frequency band of 100 Hz to 9.5 kHz. This frequency band is well suited for observing VLF saucers (V-shaped structures in a wave spectrogram) and some electron scale Electrostatic Solitary Waves (ESWs). We analyze multi-spacecraft events in which VLF saucers are observed, and investigate the phenomenon of broadband bursts of waves at the vertex of many of these saucers. We explore the possibility that the saucers are on flux tubes carrying intense, upgoing energetic electron fluxes. We investigate the conclusion, based on FAST satellite data, that broadband waves, consisting of ESWs, are observed only in conjunction with upgoing field-aligned ionosphere electrons that are intense and accelerated (10 eV-10 keV).

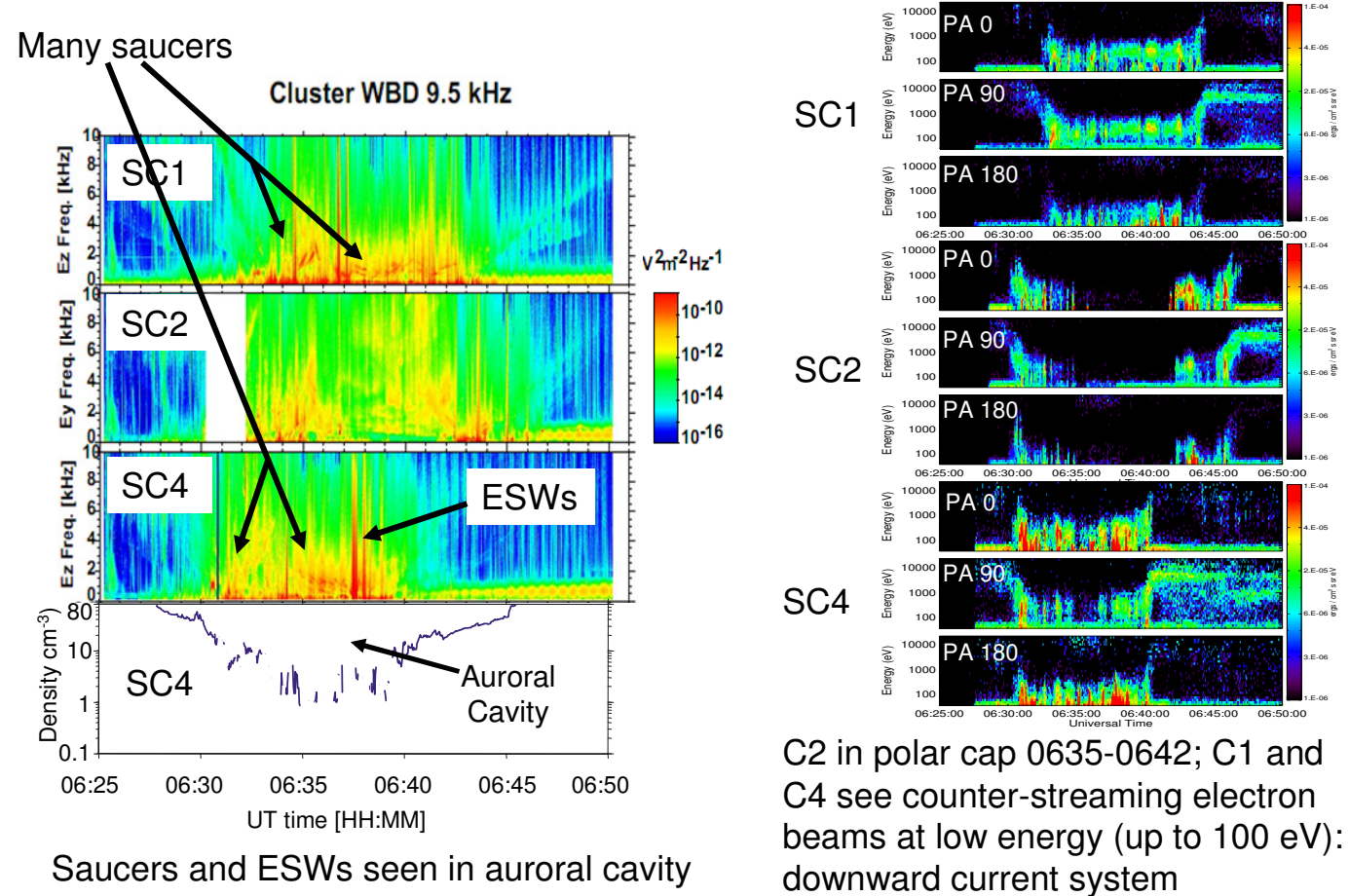
1. Orbit and spacecraft configuration 2009-12-30

4. Saucers and Supporting Data 2009-12-30

Cluster Spacecraft Trajectory December 30, 2009: 06:24-06:50 UT

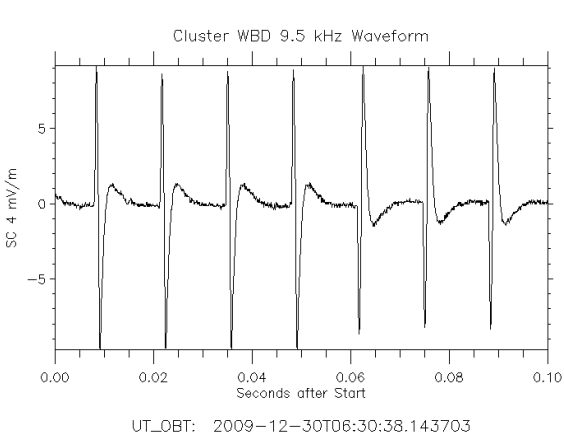


2. Overview 2009-12-30



3. ESWs 2009-12-30

Broadband waves are found at the vertex of the saucers (See Secs. 4 and 7). The mode of the WBD waveform instrument for these days is not sufficient to resolve the ESWs thought to make up the broadbands because the ESW time durations are too short. A sample of ESWs prior to saucer observation on 2009-12-30 is shown at right.



Middle Panel: Zoom of a saucer with several arms and vertex at 06:31:30 on Cluster spacecraft 4. Start of another saucer is seen at far right. Top two panels: ~ 3-4 kV perpendicular potential drop along the orbit and electric field fluctuations associated with this downward current region. Bottom 3 panels: Counterstreaming low energy electron beams observed near the vertex consistent with a downward current system.