

### **Explaining Polarization Reversals in STEREO Wave Data**

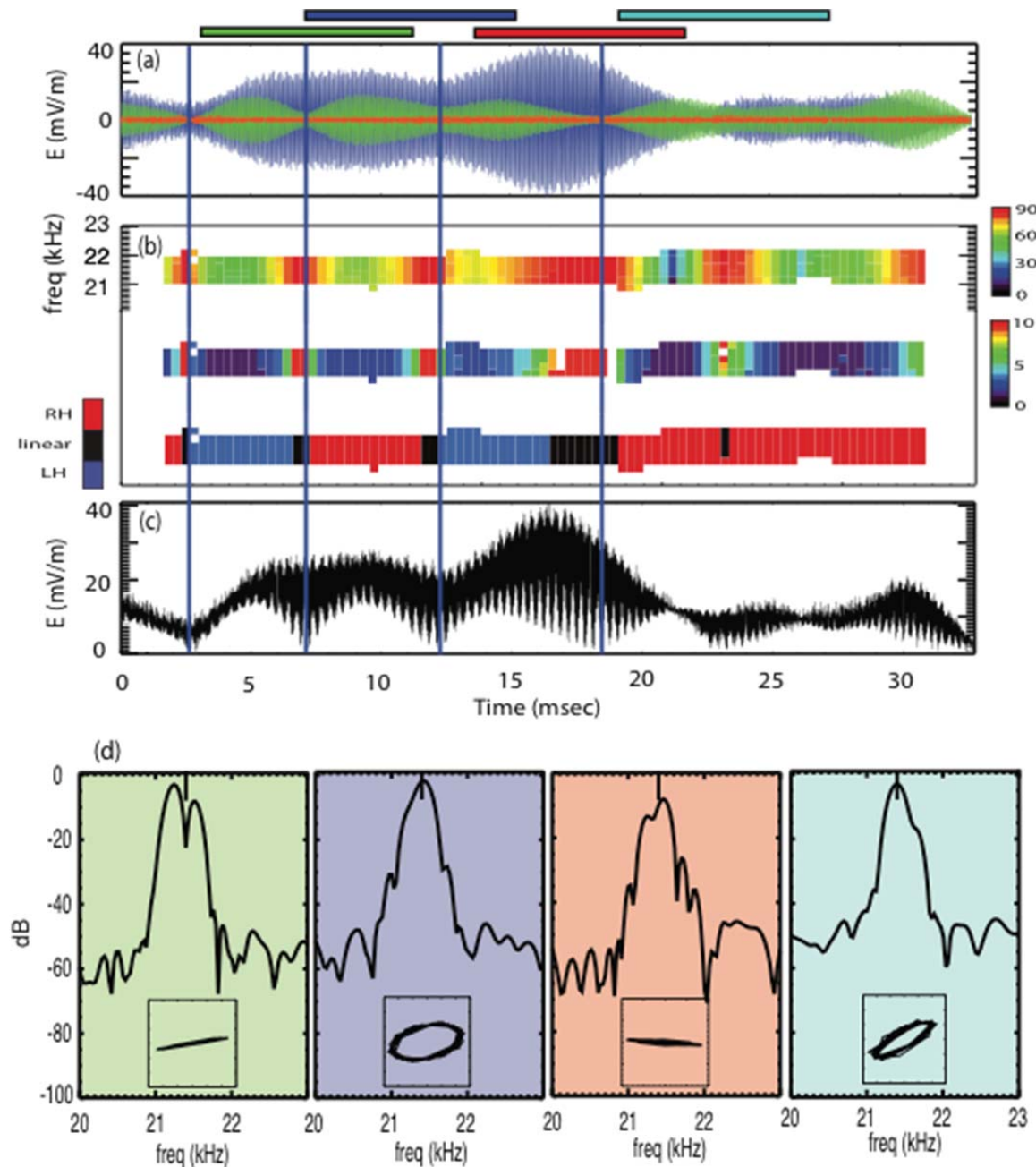
Breneman et al., 2012 is a follow-up study to Breneman et al., 2011 regarding STEREO observations of apparent reversals in polarization occurring for large amplitude lightning and VLF transmitter waves. The reversals are explained as the beating of parent and daughter waves created from a four-wave decay of the original whistler into short-wavelength lower hybrid waves and field-aligned density striations. The effect is observed via a change in polarization of the overall waveform: right-hand polarization when the original whistler dominates, linear polarization when the lower hybrid waves dominate and left-hand polarization due to a phasing effect between overlapping right-hand polarized whistlers and linearly polarized lower hybrid waves. The observed waves satisfy the four-wave decay equations of Lee and Kuo, 1984. In addition, the lower hybrid waves are observed with a Doppler-shift, due to the STEREO velocity, consistent with that which would be observed with the predicted lower hybrid wavelength.

This research identifies a potentially important loss mechanism for VLF wave energy traversing the ionosphere, helping to explain why simple ray tracing models predict more VLF energy in the inner radiation belts than is actually observed.

Breneman, A., Cattell, C., Wygant, J., et al., (2012), *Journal of Geophysical Research (Space Physics)*, 117, 4317. *Explaining polarization reversals in STEREO wave data.*

Breneman, A., C. Cattell, J. Wygant, K. Kersten, L. B. Wilson III, S. Schreiner, P. J. Kellogg, and K. Goetz (2011), *Large-amplitude transmitter-associated and lightning-associated whistler waves in the Earth's inner plasmasphere at  $L < 2$* , *J. Geophys. Res.*, 116, A06310, doi:10.1029/2010JA016288.

Lee, M. C., and S. P. Kuo (1984), *Production of lower hybrid waves and field-aligned plasma density striations by whistlers*, *J. Geophys. Res.*, 89, 10,873–10,880, doi:10.1029/JA089iA12p10873.



STEREO burst waveform capture of a large amplitude electric field ( $E$ ) showing polarization reversals. This particular waveform is a whistler mode wave associated with the ground transmitter call sign NPM, detected during a STEREO Earth-flyby on November 6<sup>th</sup>, 2006.

(a) Burst waveform where the blue, green and orange colors represent the  $x$ ,  $y$  and  $z$  directions respectively. Data are in field-aligned coordinates where the magnetic field lies along the  $z$  axis and the wave vector is defined to lie in the  $x$ - $z$  plane. (b) Frequency/time spectra of the wave normal angle, ellipticity  $E_x/E_y$  and handedness. Note that the second and third spectra are offset in the  $y$ -direction for clarity. For the handedness spectrum, red(blue) represent right(left) hand polarizations with respect to the magnetic field and black represents linear polarization, defined as  $E_x/E_y \geq 8$ . Vertical lines are included to indicate the locations of the polarization reversals. (c) Wave magnitude  $|E| = \sqrt{E_x^2 + E_y^2 + E_z^2}$ . (d) Four snapshots of the frequency spectrum ( $y$ -direction) for the times given by the colored panels above Panel 1a. The inset hodograms show the polarization in the  $x$ - $y$  plane for representative times within each snapshot.