CHARACTERISING THE ULF RESPONSE TO THE SUBSTORM EXPANSION PHASE ONSET

KYLE R. MURPHY[1], I. Jonathan Rae[1], Ian R. Mann[1], David K. Milling[1], Clare E. J. Watt[1], Vassilis Angelopoulos[2], Harald U. Frey[3]

Department of Physics, University of Alberta, Edmonton, Alberta, T6G 2J1, Canada.
Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California, USA
Space Sciences Laboratory, University of California at Berkeley, 7 Gauss Way, Berkeley, CA 94720-7450, U.S.A.

Essential to solving the substorm problem is establishing a robust time-line characterising the onset and manifestation of current disruption and reconnection in the ionosphere and the magnetotail, such that one can unequivocally determine whether current disruption precedes reconnection or vice versa. We present herein a newly developed wavelet algorithm, AWESOME, which objectively determines the ionospheric onset of magnetic substorms from ground-based magnetometer observations of Ultra Low Frequency (ULF) waves, in the Pi1 and Pi2 spectral bands, observed during the initial seconds of the substorm expansion phase onset. The ability to detect the initial ionospheric disturbance during the substorm expansion phase is crucial to understanding the sequence of events during substorms. The AWESOME wavelet algorithm is validated by comparing the spatial and temporal location of the ULF onset to that of in-situ optical observations of global auroral intensifications observed by IMAGE-FUV. Finally, we present the results of a statistical superposed epoch analysis of the ULF power spectrum surrounding the substorm expansion phase onset. We show that ULF power spectra observed at substorm onset is characteristic of a power-law and stress the importance of studying the entire ULF power spectra, and in particular the Pi1 and Pi2 bands, when identifying and characterising the events leading to and following the substorm expansion phase.

Through careful analysis these waves can be used to characterise the initial seconds of the substorm expansion phase onset. We present a newly-developed wavelet algorithm waves in the Pi1 and Pi2 wave bands. Utilising the extensive network of magnetometers available in the North American sector (predominantly the CARISMA and THEMIS arrays) and wavelet algorithm, we are able to determine a localised epicentre of ULF wave power and the resulting propagation of ULF power during the substorm expansion phase onset. Further, we validate the wavelet algorithm by comparing the spatial and temporal location of the ULF epicentre to that of in-situ optical observations of global auroral intensifications observed by IMAGE-FUV as well as localised ground-based observations of small-scale auroral undulations observed at substorm onset. Finally we present the initial results of a statistical study of ULF power distributions observed at substorm onset.

The THEMIS provides the single best attempt is the single most competent mission is the key to solving the substorm paradigm suitable

Since the initial characterisation of the auroral substorm and the expansion phase in 1964 by Akasofu our understanding of the physical processes leading to, and the observations surrounding the substorm expansion phase onset have both drastically improved; however unambiguously characterising the sequence of events during the expansion phase onset has continued to elude the substorm community.

Substorm, ULF

Kyle Murphy, University of Alberta – Department of Physics, Canada, tel:+1.780.492.8179, email: kmurphy@phys.ualberta.ca