APPLICATION OF LOCAL WAVELET CORRELATION TO ESTIMATION OF BOUNDARY NORMAL VELOCITY OF PLASMA DISCONTINUITIES FROM MULTI-POINT SATELLITE MEASUREMENTS

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ABSTRACT

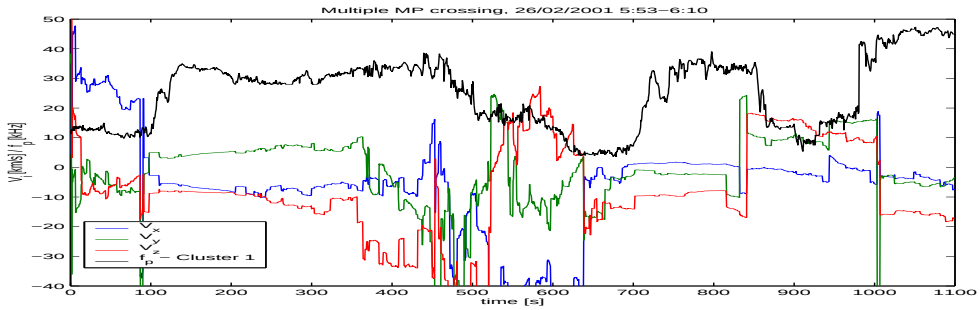
We present a technique for determination of the velocity vector of a moving plasma structure (e.g. boundary) crossed by a group of satellites. This approach is based on the application of local wavelet correlation which allows to determine the relative time shift of two signals containing similar structures. The time shifts between observations of the same structure by different satellites are then used to estimate the velocity of the structure. This method allows to compute the time shift locally, revealing the time dependence of the velocity with unprecedented temporal resolution. Applications to CLUSTER data (WHISPER and FGM) are presented.

DESCRIPTION OF THE METHOD

In the case of a satellite array crossing a plasma discontinuity, the information on the time delays between the structure crossings by individual satellites is an essential input for characterization of the orientation and motion of the discontinuity [2]. We propose a method for automatic determination of the time delays based on the idea of local wavelet correlation [1], modified for application to satellite data. In this approach the signals are correlated scale-by-scale using a sliding window, whose size is adapted to the analyzed scale. This adaptive window ensures equal contribution of different scales to the correlation and allows for good time resolution. Comparing to the classical techniques which often rely on visual inspection and comparison of the signals, this method can be applied to unknown datasets in a systematic way.

APPLICATION TO CLUSTER

At the poster are presented several cases of application of the local correlation to CLUSTER data (plasma density as measured by WHISPER and magnetic field from FGM). To estimate the normal velocity of a boundary from the time lags, we assumed planarity and uniform velocity of the structure on the spatial scales given by the satellite separation. However, the timing information can be equally well used for more sophisticated analysis which loosens the assumptions by taking into account additional information [2]. An example of velocity vector components obtained for multiple magnetopause crossing as observed by WHISPER is shown in the figure below (The plasma frequency in kHz [black line] is shown for easier readablity.). As can be seen, the velocity is significant only if some significant structures exist in the signal. Validation criteria were also developed to eliminate parts of the signal, where the normal is undefined or misidentified.



REFERENCES

[1] J. Perrin, B. Torrésani, P. Fuchs, "Stereoscopic Images Matching Using a Localized Correlation Function", *IEEE Transactions on Image Processing*, 2001 (preprint)

[2] M.W. Dunlop, T.I. Woodward, "Multi-Spacecraft Discontinuity Analysis: Orientation and Motion", G. Paschmann, P. Daly (eds.), *Analysis Methods for Multi-Spacecraft Data*, 1998