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The effect of wavelet denoising on the propagation time delay of solar wind discontinuities

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Estimations of boundary normals of solar wind discontinuities are known to be affected by small-scale fluctuations. Wavelet denoising is used to reduce the influence of these fluctuations. Minimum variance analysis of the magnetic field (MVAB) is used to predict the propagation time delay of solar wind structures between the Advanced Composition Explorer (ACE) spacecraft orbiting the L1 libration point and the Cluster spacecraft near the Earth's magnetopause. The estimated delay times are compared with the observed ones to obtain a quantitative measure of the method's accuracy. The influence of wavelet denoising on the performance of MVAB estimations is discussed and analysed. We investigate the effects of the length of the analysis time interval on the accurate estimation of the propagation time delays by the MVAB method. We find that wavelet denoising of the time series prior to application of MVAB can improve significantly the prediction accuracy. Improved results are obtained when the parameters of the wavelet denoising (e.g. denoising threshold, wavelet basis) are adapted to each event individually. The results show that when all optimisations are applied the difference between the real (observed) time delay and the estimation provided by MVAB is less than 2 minutes for almost 90% of the 356 discontinuities from our database.