Signal and Noise Separation from Satellite Magnetic Field Data Using Independent Component Analysis: Prospect of Magnetic Measurements without Mast and Noise Source Information

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We propose an application of the independent component analysis (ICA) to separate satellite-induced time-varying noises from magnetic data obtained by onboard multiple magnetometers. The ICA is a method of estimating source signals observed at multiple sites so that estimated source signals are statistically independent of each other. Since satellite noises are clearly independent of external natural variations, the ICA is expected to separate the satellite noises. We applied the ICA to the magnetic data measured by the first Quasi-Zenith Satellite (QZS-1) that has two triaxial fluxgate magnetometers without an extendable mast. First, we removed the long-period trend from the original data. Then, we applied the FastICA to the detrended data and obtained six independent components (ICs). Satellite-induced noises were successfully classified into three ICs (noise ICs). Natural signals are represented by the rest three ICs (signal ICs). Finally, we restored the observed signals from the signal ICs. We confirmed that amplitude and waveform of natural phenomena were not altered by the processing. We also proposed the method of automatic determination of noise ICs using the *D* score, which is similar to the normalized coefficient of variance of the mixing vectors. We confirmed that the three largest *D* scores, which give the noise ICs, are much larger than the three smallest *D*, which give the signal ICs. The automatic determination of noise ICs by this method was 95% identical to that by visual inspection. These results demonstrated that the ICA method can provide for mast-less magnetic observations in future satellite missions.

Keywords: satellite magnetic observations, independent component analysis, saparation of satellite-induced noises, mast-less magnetic observations, statistical signal processing