あらせ衛星搭載のPWE/WFCによって計測した波形データの較正手法の評価

北原 理弘 [1]; 松田 昇也 [2]; 加藤 雄人 [1]; 笠原 禎也 [3]; 小嶋 浩嗣 [4]; 疋島 充 [5]
[1] 東北大・理・地球物理; [2] ISAS/JAXA; [3] 金沢大; [4] 京大・生存圏; [5] 宇宙研

Evaluation of the calibration method of waveform data measured by the PWE/WFC on board the Arase satellite

Masahiro Kitahara[1]; Shoya Matsuda[2]; Yuto Katoh[1]; Yoshiya Kasahara[3]; Hirotsugu Kojima[4]; Mitsuru Hikishima[5]
[1] Dept. Geophys., Grad. Sch. Sci., Tohoku Univ.; [2] ISAS/JAXA; [3] Kanazawa Univ.; [4] RISH, Kyoto Univ.; [5] ISAS

The Waveform Capture (WFC) is a receiver of the Plasma Wave Experiment (PWE) on board the Arase satellite. The WFC measures the electric and magnetic field waveform in the frequency range from a few Hz to 20 kHz and aims to detect plasma waves related to the electron acceleration, such as whistler mode chorus emissions. A new type of instruments named Software-type Wave-Particle Interaction Analyzer (S-WPIA) is also installed in the Arase satellite to measure energy and momentum exchange between plasma waves and particles directly and quantitatively. The S-WPIA requires the high-accuracy calibration of both amplitude and phase of waveform data with a reasonable processing load so as to realize the onboard calibration. Generally, the signal passed through a receiver should be transformed into spectra in the frequency domain, be calibrated using a transfer function of the system, and be inverse-transformed into the time domain. In the case of actual data processing, raw data is filtered by a window function in the time domain before applying short time Fourier transform to reduce the side lobe effect. However, a non-negligible gradient of a transfer function causes the phase shift of a window function and thereby calibrated waveform data are distorted in the time domain. To eliminate the effect of the window function shift, we suggest several methods to calibrate waveform data accurately by performing simulation using simple sinusoidal signal and transfer function. In consequence, the following two methods can reduce error to less than several percent of the input wave amplitude; (1) a Tukey-type window function with a flat top region and (2) modification of the window function by estimating a phase shift at each frequency from the gradient of a transfer function. We also apply these methods to actual data of the wave electric field observed by the PWE/WFC and compare the calibrated data using the proposed methods with a limited data window to the data calibrated using a whole data points with a rectangular window function. We conclude that the difference is less than several percent of the amplitude at the frequency range of a few to ten kHz and that, on the contrary, the phase of waveform is slightly shifted in the lower frequency range due to the limited data window. We need to take account of the relation between the frequency range of the electromagnetic waveform and the window function in interpreting observation results.