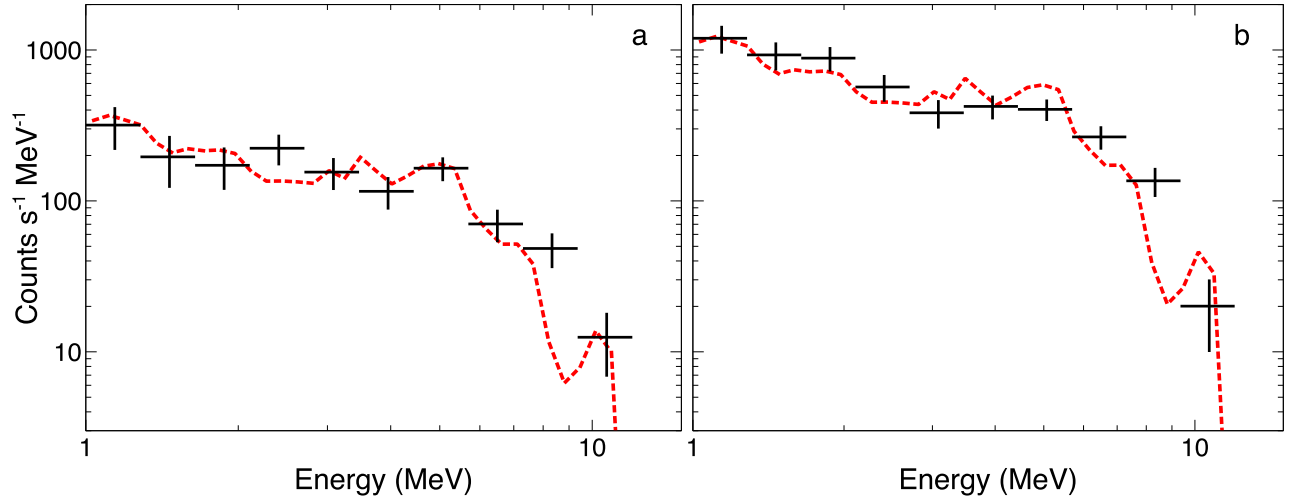
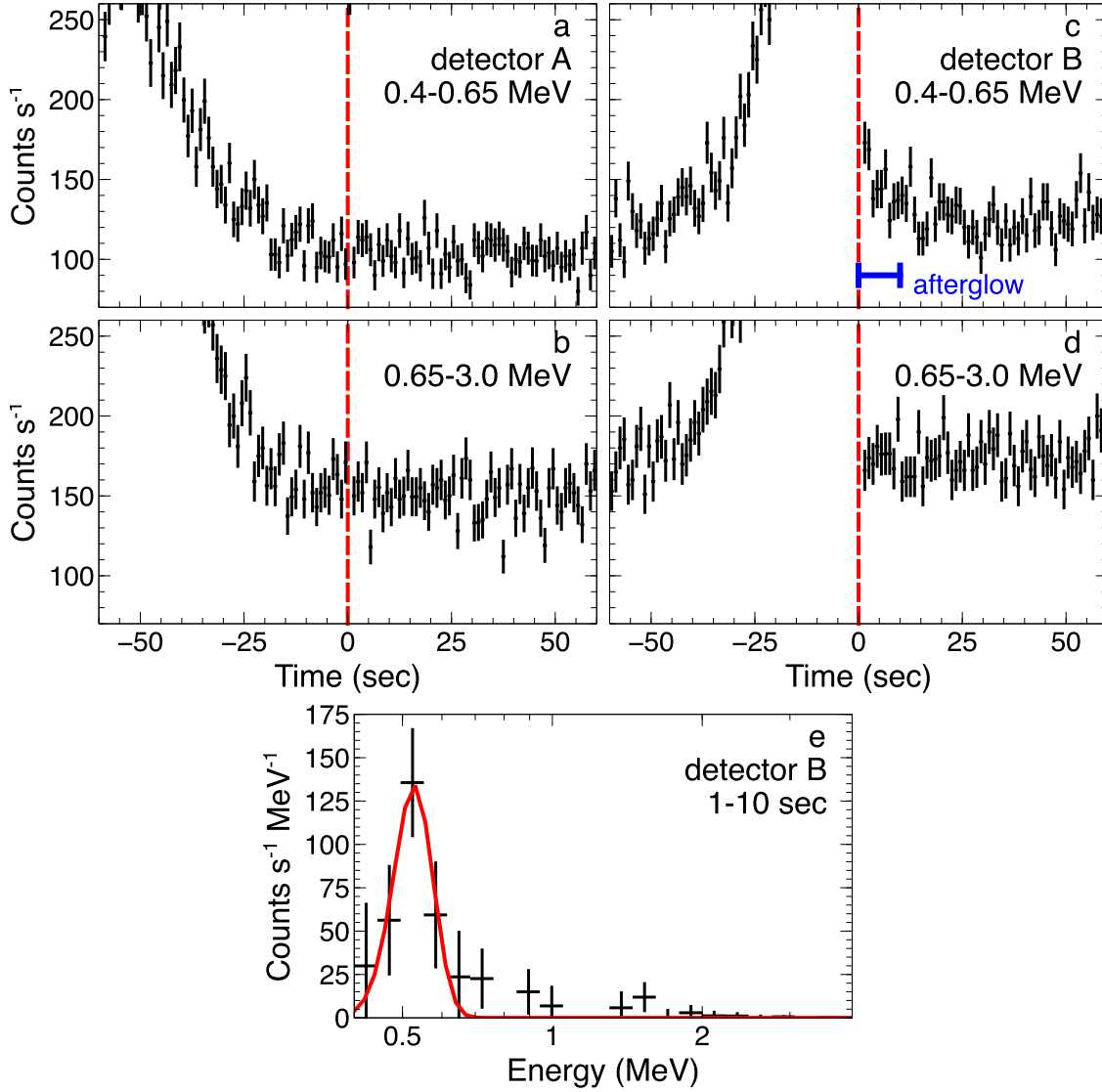
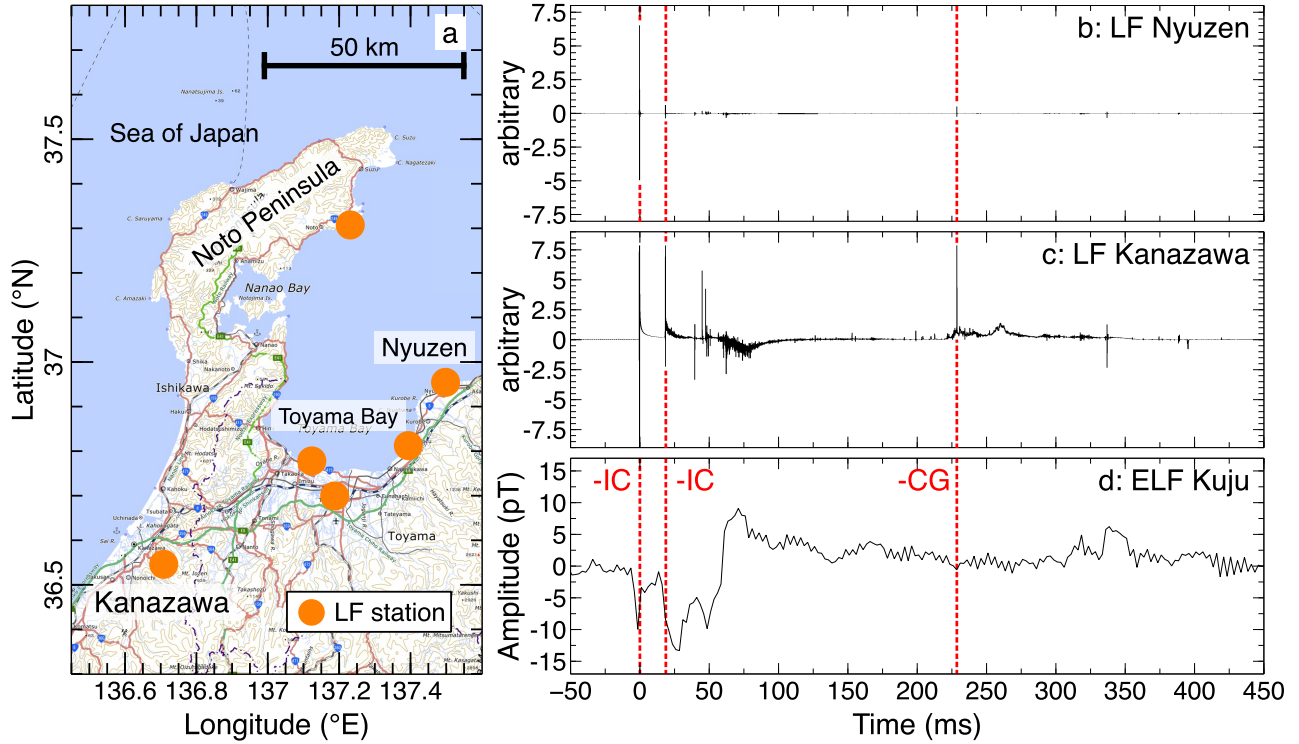




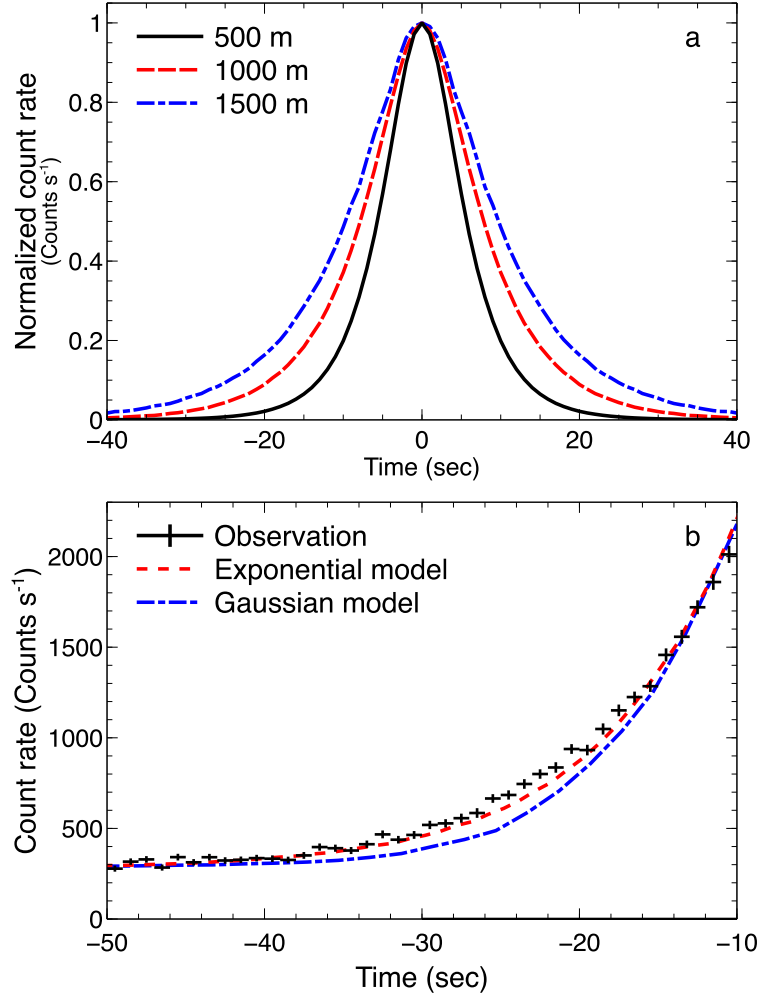
Supplementary Figure 1: Energy Spectra of short-duration burst. Background-subtracted spectra of the short-duration burst extracted from $50 \text{ ms} < t < 200 \text{ ms}$ obtained by detectors A (a) and B (b) with 1σ statistical errors. Dead-time correction was applied, but the detector responses were not corrected. Data bins in 12–20 MeV are consistent with 0. The simulation model (red dashed line) normalised to fit the observed spectra was overlaid.



Supplementary Figure 2: Count-rate histories and spectrum of annihilation line. a–d: Count-rate histories with 1-second bins in the (a and c) 0.4–0.65 MeV and (b and d) 0.65–3.0 MeV bands for detectors A and B, respectively. The timing of the lightning discharge is indicated by red dashed lines. An afterglow observed by detector B is shown by a blue allow in panel c. e: Background-subtracted spectrum of detector B extracted from 1 s < t < 10 s. The detector responses were not corrected. The best-fitting model with a Gaussian function is overlaid by a red line. The error of each data point is at 1 σ confidence level.



Supplementary Figure 3: Waveform of radio-band observations. **a:** A Map of Noto Peninsula and Toyama Bay. The LF stations are marked by orange circles. **b,c:** LF waveform recorded by Nyuzen and Kanazawa stations. Timing of three pulses detected by JLDN are presented by red dashed lines. Several pulses recorded by the Kanazawa station were saturated because of proximity to the pulse sources. **d:** ELF waveform recorded by Kuju station. Frequency characteristics were corrected. The waveform amplitude was converted to the orthogonal component against the direction-of-arrival of the lightning pulse.



Supplementary Figure 4: Monte Carlo simulations of gamma-ray glow. **a:** Simulation results of count-rate histories with uniform-disk models. Black, red, green and blue lines show the models with altitudes of 500, 1000, 1500 and 2000 m, respectively. The disk radius is 50 m. The maximum count rate of each model is normalised to 1. The wind velocity is fixed to 19.3 m s⁻¹. **b:** Comparison between the observed count-rate history and simulation results. The exponential model (red) and Gaussian model (blue) are overlaid. The errors of the observed data points are at 1 σ confidence level.