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Velocity characteristics of evaporated plasma using Hinode/EIS

Ryan O. Milligan

NASA-GSFC

Brian R. Dennis

NASA-GSFC

Abstract. It is widely assumed that the process of chromospheric evaporation plays a crucial role in producing much of the EUV and X-ray emission observed during solar flares. Previous studies have relied primarily on the detection of blueshifts of a single, high-temperature emission line (e.g. Ca XIX on Yohkoh/BCS, Fe XIX on SOHO/CDS). With the launch of Hinode, the EUV Imaging Spectrometer (EIS) now offers us the opportunity to diagnose this fundamental process across a range of high temperatures, at high spatial, spectral and temporal resolution. In this study, the advanced capabilities of EIS were used to measure Doppler shifts in 15 emission lines covering the temperature range T=0.05-16MK during the impulsive phase of a C-class flare on 2007 December 14. Blueshifts indicative of the evaporated material were observed in six emission lines from Fe XIV-XXIV (2-16 MK). Upflow velocity was found to scale with temperature as v_{up} (km/s) = 5-17 T (MK). Although the hottest emission lines, Fe XXIII and Fe XXIV, exhibited upflows > 250 km/s, their line profiles were found to be dominated by a stationary component in stark contrast to the predictions of the standard flare model. Emission from O VI-Fe XIII lines (0.5-1.5 MK) was found to be redshifted by v_{down} (km/s) = 60-17 T (MK) and was interpreted as the downward-moving plug characteristic of explosive evaporation. These downflows occur at temperatures significantly higher than previously expected. Both upflows and downflows were spatially and temporally correlated with HXR emission observed by RHESSI that provided the properties of the electron beam deemed to be the driver of the evaporation. The energy contained in the electron beam was found to be $> 5 \times 10^{11}$ ergs/cm/s which is consistent with the value required to drive explosive chromospheric evaporation from hydrodynamic simulations.