On 3 August 2010 at ~1800 UT the onset of a geomagnetic storm was observed in the Sym-H ground magnetic index. The main phase of the storm lasted ~24 hours before a gradual recovery lasting ~3 days. On 4 August, during the peak magnetic disturbance of the storm, a high velocity (> 1000 m/s) channel of ionospheric plasma flow lasting ~6.5 hours was observed in the pre-midnight sector ionosphere, at a magnetic latitude of ~55 degrees south, by the Falkland Islands HF radar. Coincident data from the near-conjugate northern hemisphere Blackstone HF radar confirm the existence of a similar feature located at the equivalent northern magnetic latitude. In this paper we discuss the influence of the storm on the ionospheric conditions and investigate the nature of high velocity flow channel. We interpret these observations as evidence for a sub-auroral ion drift (SAID), understood to result from polarisation electric fields that form at the inner edge of the plasma sheet as a result of charge separation caused by the penetration of partial ring current ions to a lower L-shell than plasma sheet electrons. We find that variations in the latitude and magnitude of the SAID are related to both the ring current strength and variations in the inferred size of the polar cap, suggesting that the electrodynamics of the nightside sub-auroral region are driven by a combination of the effects of processes in the inner magnetosphere and the level of solar wind-magnetosphere coupling.