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Identifying the main driver of active region outflows

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Abstract. Hinode's EUV Imaging Spectrometer (EIS) has discovered ubiquitous outflows of a few to 50 km/sec from active regions (ARs). The characteristics of these outflows are very curious in that they are most prominent at the AR boundary and appear over monopolar magnetic areas. They are linked to strong non-thermal line broadening and are stronger in the hotter EUV lines. The outflows persist for at least several days. Whereas red-shifted down flows observed in AR closed loops are well understood, to date there is no general consensus for the mechanism(s) driving blue-shifted AR-related outflows. We use Hinode EIS and X-Ray Telescope observations of AR 10942 coupled with magnetic modeling to demonstrate for the first time that the outflows originate from specific locations of the magnetic topology where field lines display strong gradients of magnetic connectivity, namely quasi-separatrix layers (QSLs), or in the limit of infinitely thin QSLs, separatrices. The strongest AR outflows were found to be in the vicinity of QSL sections located over regions of strong magnetic field. We argue that magnetic reconnection at QSLs, separating closed field lines of the AR and either large-scale externally connected or 'open' field lines, is a viable mechanism for driving AR outflows which are likely sources of the slow solar wind. In fact, magnetic reconnection along QSLs (including separatrices) is the first theory to explain the most puzzling characteristics of the outflows, namely their occurrence over monopolar areas at the periphery of ARs and their longevity.