NuSTAR’s Search For High Temperature And Non-Thermal Emission From Quiescent Active Regions

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Hard X-ray (HXR, >2 keV) observations are crucial for understanding the energy release in the solar atmosphere as they provide information about the hottest material and accelerated particles. RHESSI is successfully able to study this in large flares down to events many orders of magnitude smaller (microflares). To go beyond RHESSI we require X-ray telescopes with higher sensitivity and dynamic range to probe the weak signatures from even smaller impulsive events (“nanoflares”). HXRs from high temperature (> 5MK) or non-thermal sources could indicate that (an unresolvable ensemble of) tiny flares are responsible for maintaining the hot corona. As a step towards a dedicated solar spacecraft, an opportunity presents itself with NASA’s NuSTAR. Launched in 2012, NuSTAR is an astrophysics mission using X-ray focusing optics to produce highly sensitive imaging spectroscopy. Most of NuSTAR’s time is spent on targets outside of the solar system but some is devoted to the Sun; solar observations began in late 2014 (Grefenstette et al. 2016 ApJ). NuSTAR has observed quiescent/non-flaring active regions from its first observations late in 2014, finding sources between 3.1-4.4 MK. These data placed strict upper limits on higher temperature emission (Hannah et al. 2016 ApJL). These observations had limited spectral dynamic range due to short effective exposures (duration and high deadtime), restricting our ability to detect higher temperature or non-thermal emission. With weakening solar activity since then we also present further observations during 2015 and 2016 with considerably longer exposures (in part due to the decreasing detector deadtime) and discuss our results in the context of the thermal emission observed with SDO/AIA and Hinode/XRT.