Nanoflare Properties throughout Active Regions: Comparing SDO/AIA Observations with Modeled Active Region Light Curves

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Coronal plasma in active regions is typically measured to be at temperatures near ~1-3 MK. Is the majority of the coronal plasma in hydrostatic equilibrium, maintained at these temperatures through a form of quasi-steady heating, or is this simply a measure of the average temperature of widely varying, impulsively heated coronal plasma? Addressing this question is complicated by the fact that the corona is optically thin: many thousands of flux tubes which are heated completely independently are contributing to the total emission along a given line of sight. There is a large body of work focused on the heating of isolated features - coronal loops - which are impulsively heated, however it is the diffuse emission between loops which often comprises the majority of active region emission. Therefore in this study we move beyond isolated features and analyze all of the emission in an entire active region from all contributing flux tubes. We investigate light curves systematically using SDO/AIA observations. We also model the active region corona as a line-of-sight integration of many thousands of completely independently heated flux tubes. The emission from these flux tubes may be time dependent, quasi-steady, or a mix of both, depending on the cadence of heat release. We demonstrate that despite the superposition of randomly heated flux tubes, different distributions of nanoflare cadences produce distinct signatures in light curves observed with multi-wavelength and high time cadence data, such as those from SDO/AIA. We conclude that the majority of the active region plasma is not maintained in hydrostatic equilibrium, rather it is undergoing dynamic heating and cooling cycles. The observed emission is consistent with heating through impulsive nanoflares, whose energy is a function of location within the active region.

This research was supported by an appointment to the NASA Postdoctoral Program at GSFC/NASA.