Radiative Cooling of Joule Heating Events in MHD Simulations of the Solar Corona

Charalambos Kanella and Boris V. Gudiksen

Abstract

Context Statistical studies shows that nanoflares (Glencross1975,Parker1983a) alone are not enough to heat the solar corona. Nanoflares in cooperation with slow-burning current-sheets could be another mechanism able to heat the corona, since both are manifestations of different degree of magnetic field distortion. Both mechanisms unable to be observed with the current instrumentation, are however apparent in MHD simulations in Bifrost code.

Aim: Our goal is twofold: First, to observe the manifestation of each mechanism in SDO/AIA intensity maps, Emission Measure (EM) analysis, and time-lag maps in cross correlation analysis, even when assuming better resolution than that of the AIA instruments. Second, to set limitations on what can be deduced from the specific instruments and methods in observations.

Methods: We identify 3-D heating events in the simulated solar corona in several timesteps, and we synthesize the 6 EUV/AIA filters, calculate cross-correlation maps between pairs of filters, and compute Emission Measure (EM).

Results: We find that cooling at the sites of heating events responds immediately, proceeds quickly from hotter to cooler AIA filters, and it is significantly lower than in diffuse regions. Diffuse regions are regions that combine slow-burning current-sheets, and a group of small-scale unresolved heating events unable to be detected. The signal at each pixel in synthesized 2-D images consists of a group of multiple 3-D heating events (strands). In EM analysis, we also find multi-thermal structures, which when embedded within diffuse regions form small loops. We also identify traces of compressible waves initiated at the location of heating events that travel along strands; this observation strengthens our belief that waves distort the magnetic field generating current sheets or enhancing already-existing ones. In the time-lag maps of AIA filters cross-correlation analysis, we place a 600 sec upper limit; time-lags in QS above that limit are biased by lateral flows.