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Fan-spine topology formation through two-step reconnection driven by twisted flux emergence

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Abstract. We address the formation of three-dimensional (3D) nullpoint topologies in the solar corona by combining Hinode/XRT observations of a small dynamic limb event, which occurred beside a non-erupting prominence cavity, with a zero-beta MHD simulation. To this end, we model the boundary-driven "kinematic" emergence of a compact, intense, and uniformly twisted flux tube into a potential field arcade that overlies a weakly twisted coronal flux rope. The expansion of the emerging flux in the corona gives rise to the formation of a nullpoint at the interface of the emerging and the pre-existing fields. We unveil a two-step reconnection process at the nullpoint that eventually yields the formation of a broad 3D fan-spine configuration above the emerging bipole. The first reconnection involves emerging fields and a set of large-scale arcade field lines. It results in the launch of a torsional MHD wave that propagates along the arcades, and in the formation of a sheared loop system on one side of the emerging flux. The second reconnection occurs between these newly formed loops and remote arcade fields, and yields the formation of a second loop system on the opposite side of the emerging flux. The two loop systems collectively display an anenome pattern that is located below the fan surface. The flux that surrounds the inner spine field line of the nullpoint retains a fraction of the emerged twist, while the remaining twist is evacuated along the reconnected arcades. The nature and timing of the features which occur in the simulation do qualititatively reproduce those observed by XRT in the particular event studied in this paper. Moreover, the two-step reconnection process suggests a new consistent and generic model for the formation of anemone active regions in the solar corona. Financial support by the European Commission through the FP6 SOLAIRE Network and the FP7 SOTERIA project are gratefully acknowledged.