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The onset of outflows in NOAA 11117 using SDO

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Introduction

Coronal outflows have been observed at the edges of active regions. Outflows have been detected by TRACE (Winebarger et al. 2001), SUMER (Peter 1999) and Hinode/EIS (Kosugi et al. 2007).

These persistent outflows have larger speeds in spectral lines that are formed at T > 1 MK (Del Zanna 2008), they are found at the edges of active regions and are unchanged over a long period of time. It has been suggested that these persistent outflows could be caused by chromospheric evaporation following magnetic reconnection (Del Zanna 2008), global plasma circulation (Marsch et al. 2008), compression of fieldlines (Murray et al. 2010; Harra et al. 2012) or reconnection of outer loops (Harra et al. 2008; Baker et al. 2009).

EIS observations show that these outflows are associated with "open" coronal magnetic field lines (Baker et al. 2009). It has recently been shown that emerging flux into an active region can produce new and enhanced outflows which have been shown through simulations to be caused by a mixture of compression and magnetic reconnection (e.g. Harra et al. 2012).

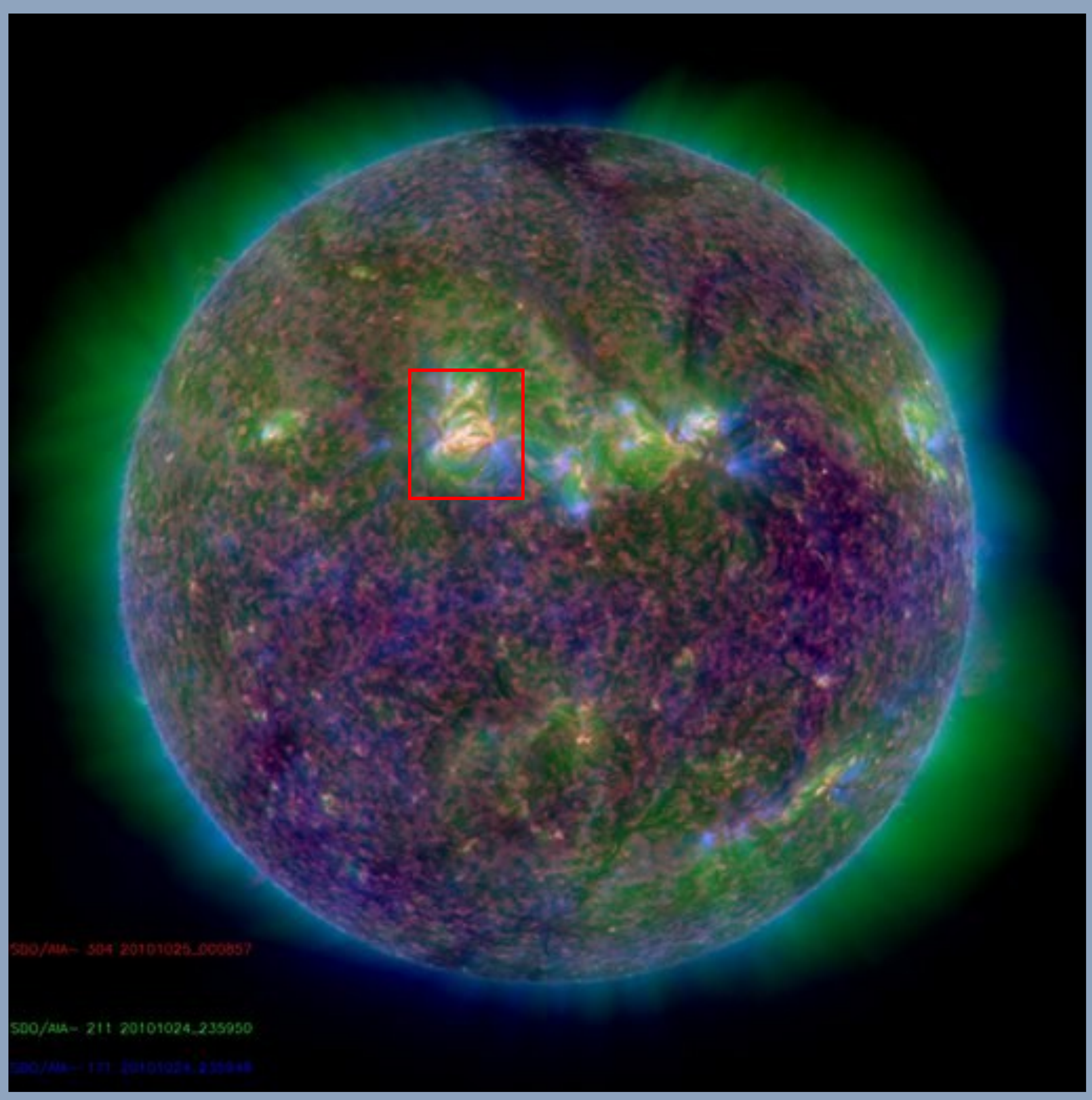

Figure 1 shows a 304Å, 211Å and 171Å composite image of the Sun. The red box shows the area of the Sun we are studying.

Results

In this work, we choose an example of a region that emerged into quiet Sun. We present the results of a study using the Solar Dynamics Observatory (SDO) of the emergence of active region NOAA 11117 which was present on the solar disk between 21st October and 31st October 2010.

We choose this active region because it isn't influenced by any other solar phenomena such as coronal holes or filaments and because we can examine the entire emergence of this active region. By using the high spatial resolution and high temporal cadence of SDO, we are able to determine when in the formation of the active region that the onset of these persistent outflows started.

We measure the outflows by measuring the change in length of a loop strand over time (shown in Figure 2). The onset time was found by looking for black/white features in the running difference movie for the AIA data that were not associated with any "closed" loop systems.

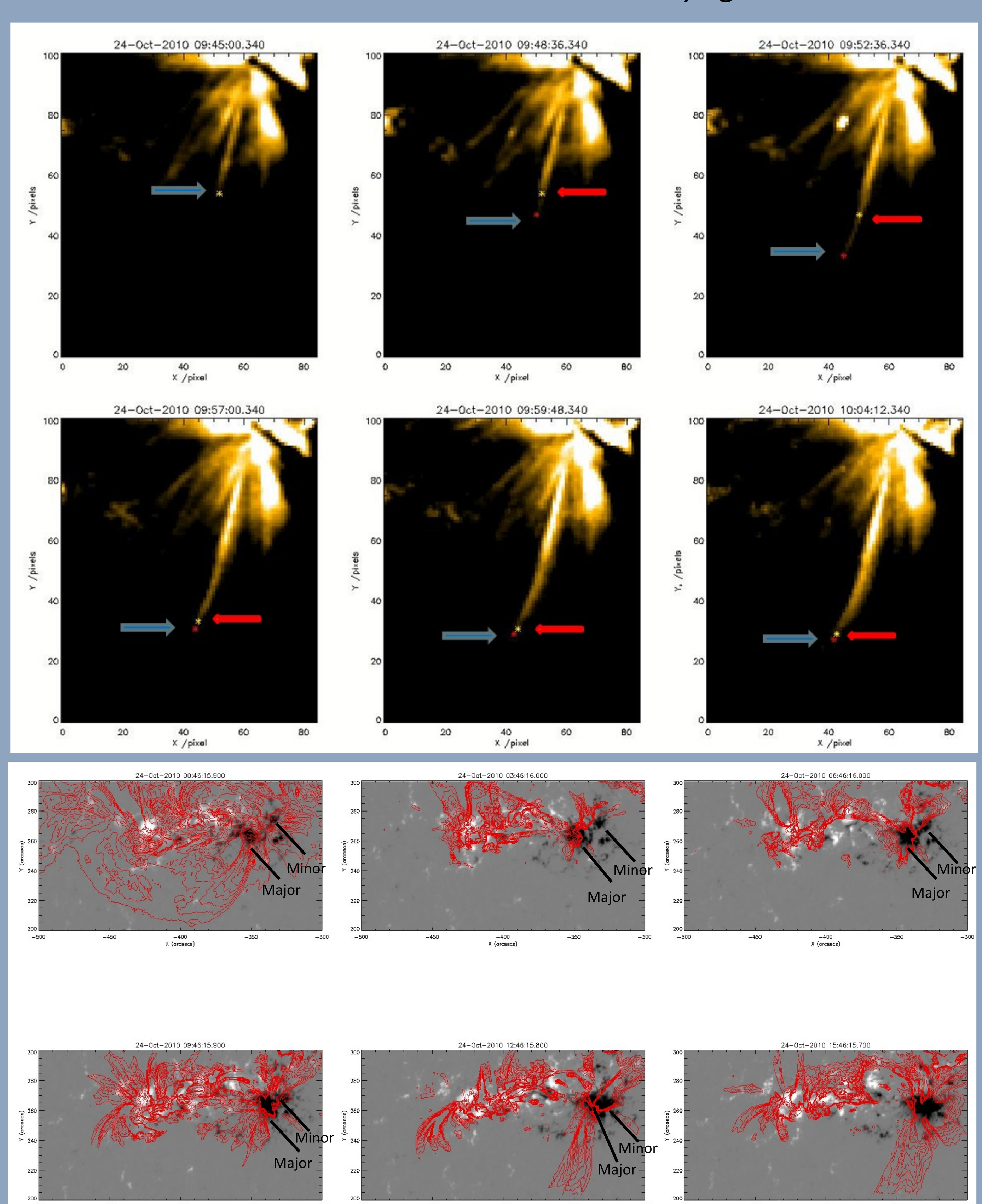

Figure 2 (top) shows how the outflows were measured using the AIA 171Å data. The arrows represent the positions of the leading edge in a previous image (red) and the position of the leading edge in the current image (blue). Figure 2(bottom) shows the HMI magnetogram data before and after the onset of the outflows. The AIA 171Å data is overlaid on the HMI data and is shown in red. "Major" and "Minor" refer to two negative polarities on the west side of the active region. "Major" refers to the larger polarity and "Minor" to the smaller one.

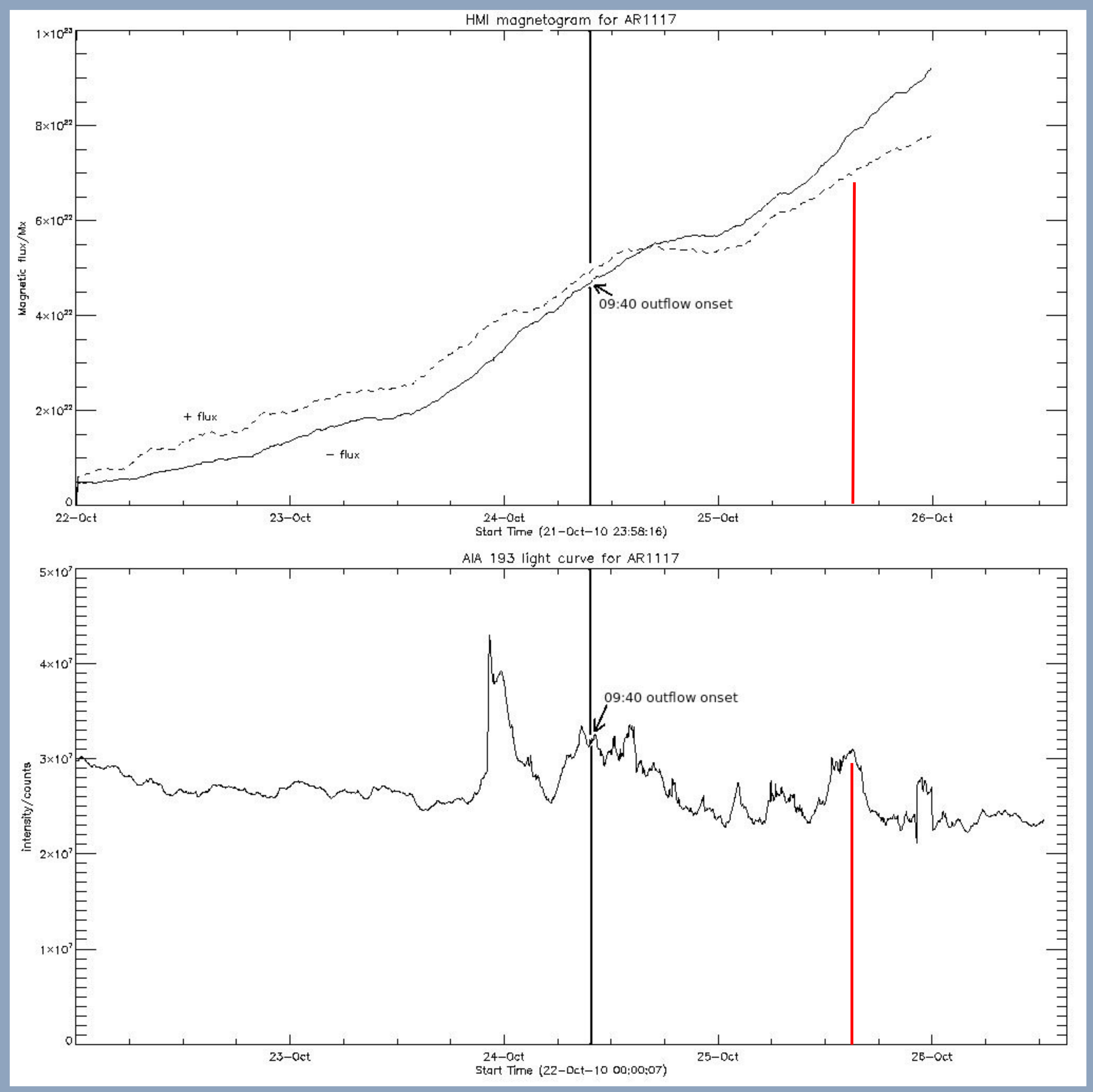

Figure 3 shows the magnetic flux evolution (top) and light curve at 193Å (bottom) of the emerging flux region. The outflow onset time is also represented by the bold black vertical lines and the peak outflow velocity is represented by the red vertical line.

Discussion

We start to see outflows at approximately 09:45 on the 24th October 2010. The velocity of the outflows at this time are approximately 9 +/- 2 kms^{-1} . The outflow velocity peaks at approximately 50 +/- 6 kms^{-1} on 25th October 2010 at 15:45 which is represented as the red line in figure 3. By comparing the AIA data with the HMI magnetogram data we can begin to understand what the magnetic field is doing at this time. The HMI images before 09:45 shows little activity with regards to "open" fieldlines and it is important to note that the major negative polarity and the minor negative polarity (shown in figure 3 (bottom)), do not start to coalesce until 09:46. By 15:46, it is very difficult to tell these two polarities apart. We therefore conclude that compression of magnetic field lines is causing the outflows and the compression starts to occur when the minor negative polarity merges with the major negative polarity. This does mean that it has taken approximately 58 hours since the first emergence of flux before the outflows start.

References

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