8th Asia-Pacific Conference on Plasma Physics, 3-8 Nov, 2024 at Malacca

Persistent Upflows and Downflows at Active Region boundaries Observed by SUTRI and AIA

Yuchuan Wu[1,2], Zhenyong Hou[3], Wenxian Li[1,4], Xianyong Bai[1,2,4], Yongliang Song[1,4], Xiao Yang[1,4], Ziyao Hu[1,2], Yuanyong Deng[1,2,4], Kaifan Ji[5]

[1] National Astronomical Observatories, Chinese Academy of Sciences

[2] School of Astronomy and Space Science, University of Chinese Academy of Sciences

[3] School of Earth and Space Sciences, Peking University,

[4] Key Laboratory of Solar Activity and Space Weather, National Space Science Center, Chinese Academy of Sciences

[5] Yunnan Observatories, Chinese Academy of Sciences

e-mail (speaker): wuyc@bao.ac.cn

From EUV and X-ray imaging observations, quasi-periodic upflows and downflows along the fan-structures at active region boundaries have been observed for decades. Upflows have faster velocity, while downflows have slower velocity. They are considered to be part of the chromosphere-corona mass-cycle.[1] Plasma in the chromosphere is impulsively heated to transition region and coronal temperature, exhibiting as high-speed upflows. Then these upflows experience radiative cooling process and the previously heated materials will slowly return to the chromosphere, producing slow downflows. For upflows in open loops, some plasma can be ejected into space and this makes upflows a source of solar wind. [2,3]

Solar Upper Transition Region Imager (SUTRI), China's first telescope to detect the solar transition region, provides full-disk solar observations at Ne VII 465 Å line formed at a temperature of 0.5 MK in transition region, which has been rarely explored. Atmospheric Imaging Assembly (AIA) provides full-disk solar observations in multiple bands, including 131, 171, 193, 304 Å.

With SUTRI and AIA observations from 2022 September 21 to 2022 September 30, we find 17 persistent opposite flows occurring along the active region coronal loops. The upflows are prominent in the AIA 193 Å images with a velocity of 50-200 km s^{-1}, while the downflows are best seen in the SUTRI 465 Å and AIA 131 Å images with a slower velocity of tens of kilometers per second.[4] We noticed that these events can be divided into two categories: downflows only appear in the low-temperature passbands in category 1, and appear both in the low- and high-temperature passbands in category 2. This indicates that some downflows only contain cold plasma, and other downflows are mixtures of cold plasma and hot plasma. We also use the chromosphere-corona mass-cycle to explain upflows and downflows, and some upflows can enter space and become a source of solar wind.

This research provides more upflows and downflows events, which are in agreement with previous results. We complement chromosphere-corona mass-cycle by movement of plasma at 0.5 MK, and prove SUTRI's ability in detecting solar transition region plasma.

This research is supported by the National Key R&D Program of China, the Youth Innovation Promotion Association CAS and the National Natural Science Foundation of China.

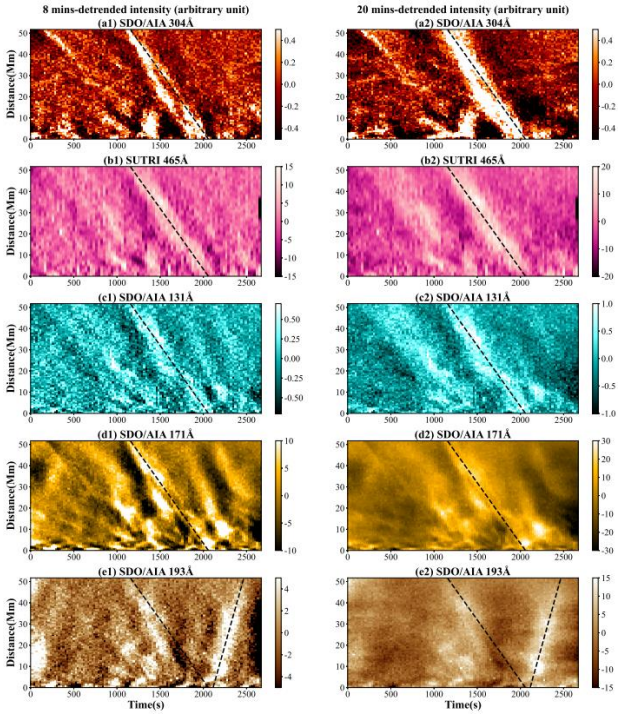

Figure 1 Space–time plots of the detrended intensity signal. The black dashed lines show the identified upflows and downflows.

References

[1] McIntosh, S.W., Tian, H., Sechler, M., & De Pontieu, B. 2012, ApJ, 749, 60

[2] Raouafi, N. E., Stenborg, G., Seaton, D. B., et al. 2023, ApJ, 945, 28

[3] Kumar, P., Karpen, J.T., Antiochos, S.K., et al. 2023, ApJ, 943, 156

[4] Wu, Y., Hou, Z., Li, W., et al. 2024, ApJ, 965, 109