The UNIGRAZ ESA H-ESC tool STEREO+CH - Upgrade and Preparation for Cycle 25

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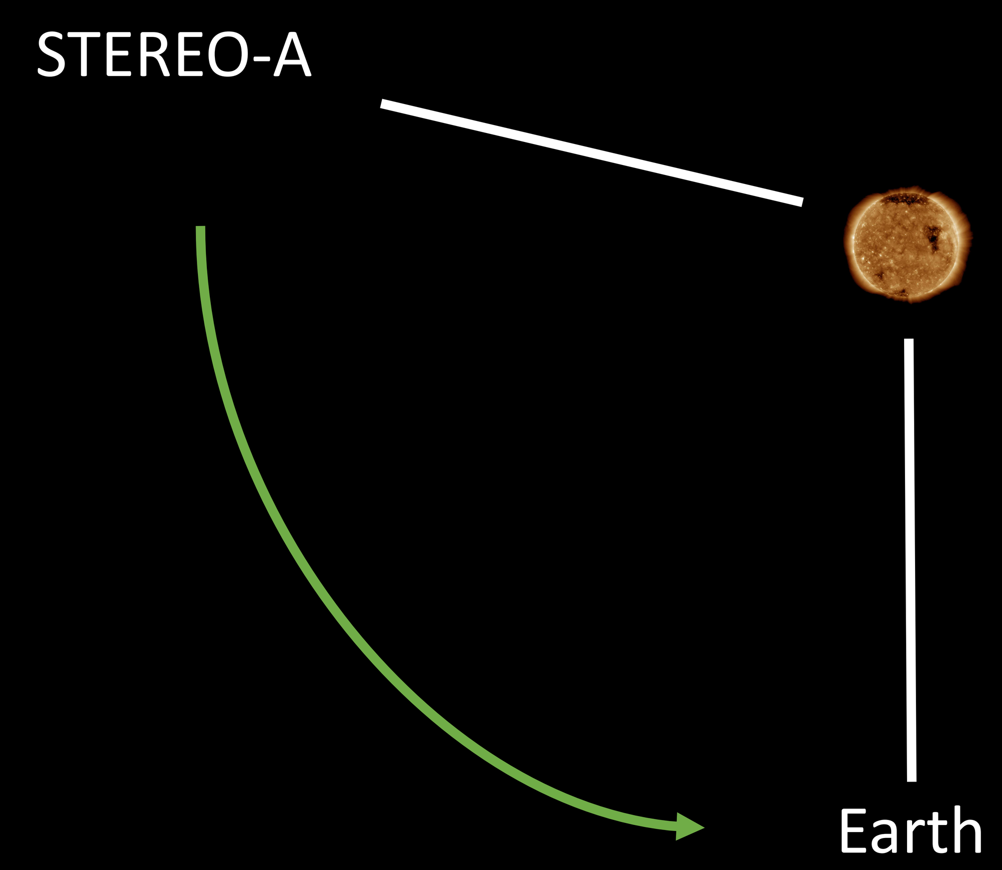


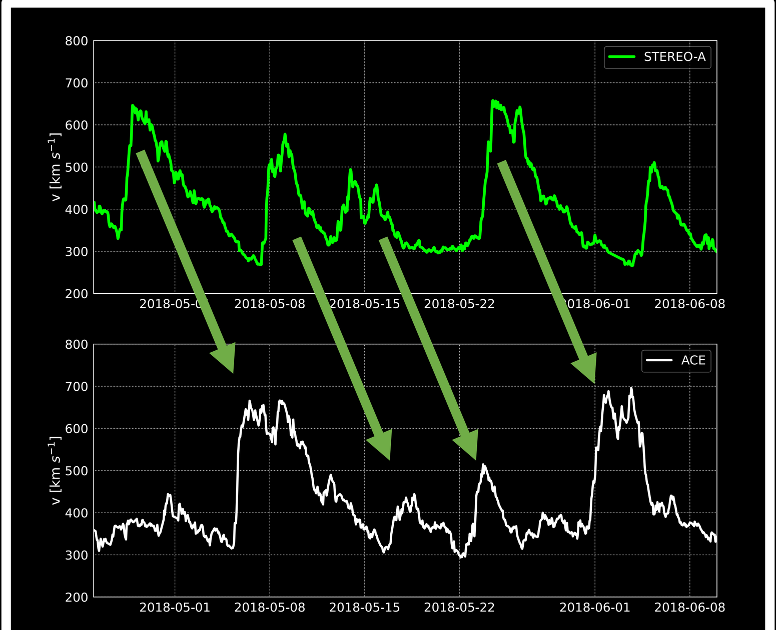
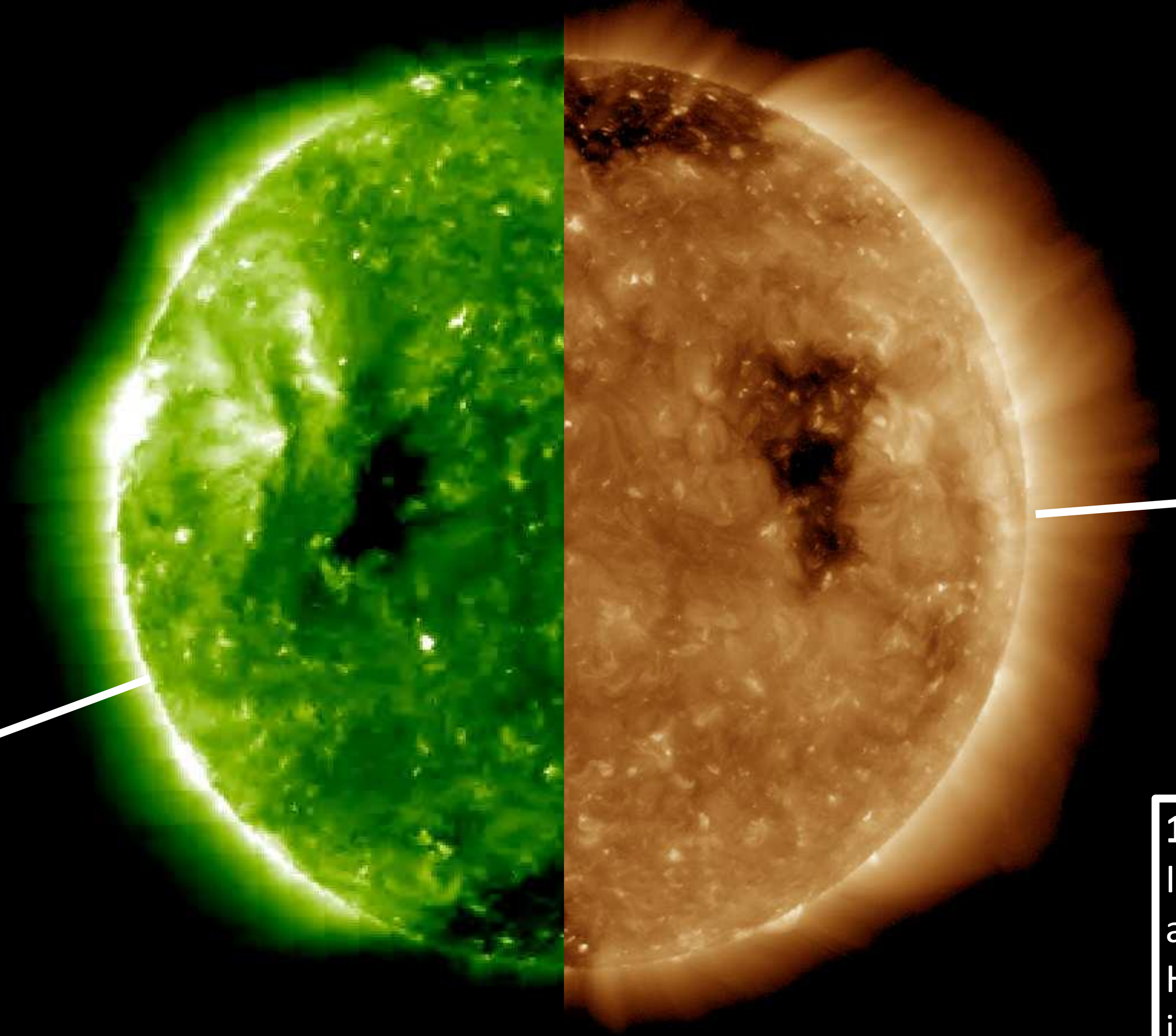


Figure 1: STEREO data compared to ACE data.

STEREO+CH uses persistence modelling from the postition of STEREO-A to L1.



SDO – Colatitue information

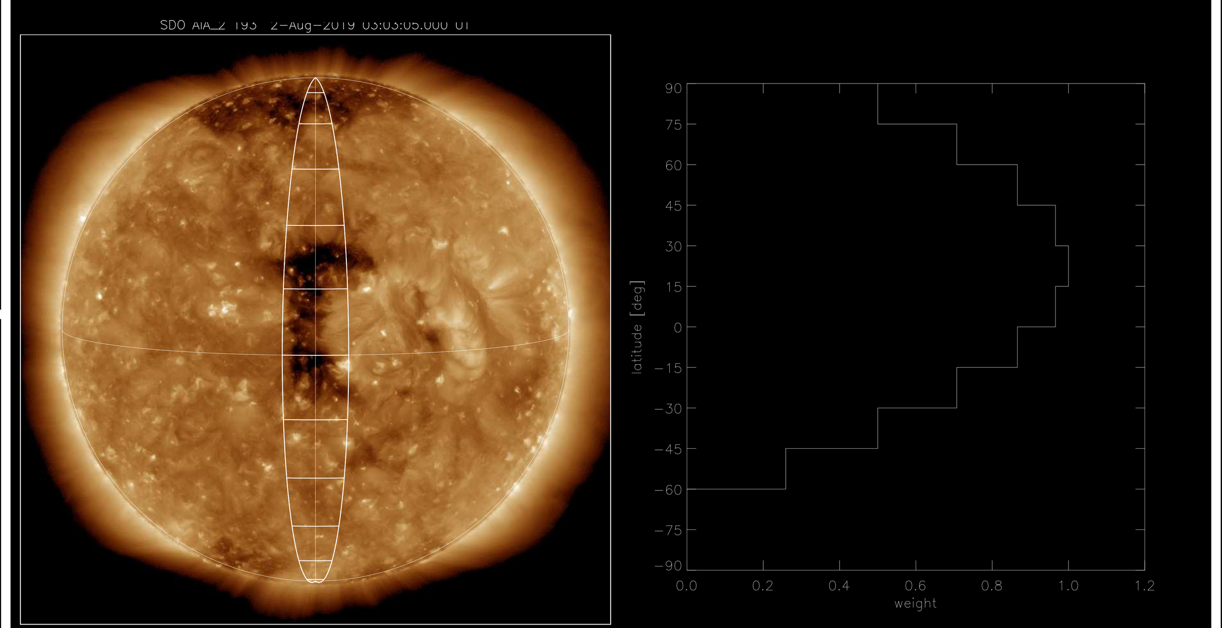


Figure 3: Weights (right) being applied to SDO image data (left) according to the spacecraft's latitude

STEREO-A – Colatitue information

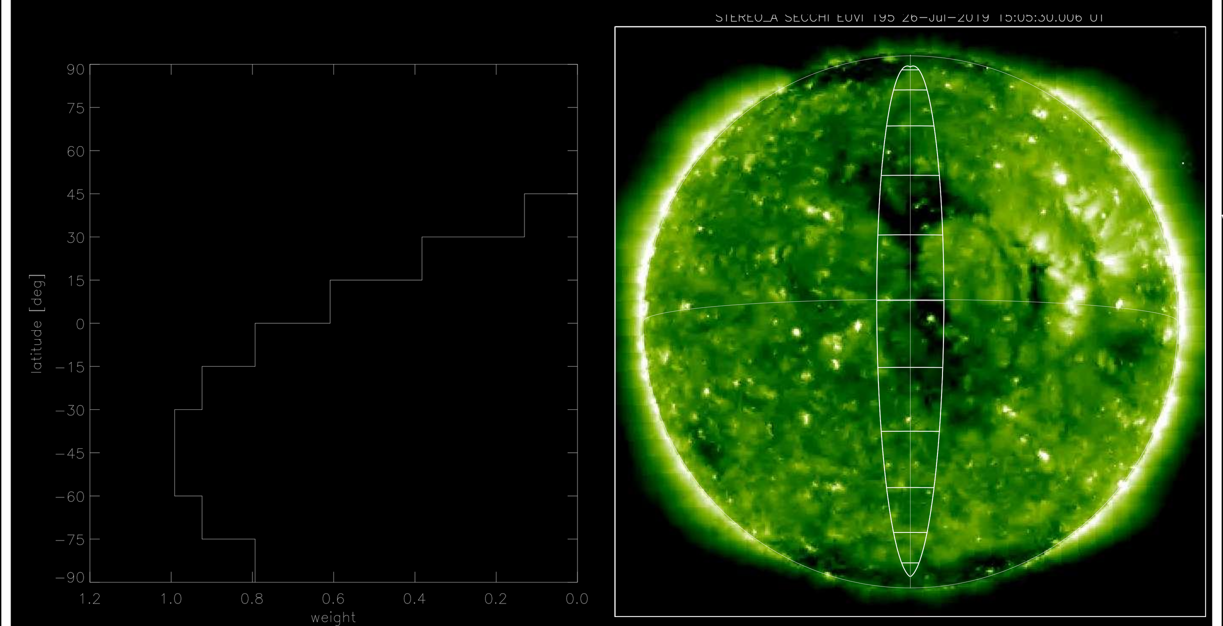


Figure 2: Weights (left) being applied to STEREO image data (right) according to the spacecraft's latitude

1. Colatitude Information:
In order to more accurately track the CH evolution and related high-speed streams, we apply weights to the latitudinal segments where the CHs are being detected (cf. Hofmeister et al., 2018). Milošić et al. (2023) showed that this approach can statistically improve the prediction of high-speed streams from CH areas.

STEREO+CH is an UNIGRAZ ESA H-ESC tool (see QR code) that is based on a persistence model (Temmer, Hinterreiter & Reiss, 2018). The solar wind velocity is first measured in-situ by STEREO-A and then shifted by the time it takes the Sun to rotate by the separation angle between STEREO-A and the Earth. As an uncertainty estimate, it tracks the evolution of the coronal holes from their appearances in EUV image data in STEREO-A to SDO. For this uncertainty estimate we present two upgrades:

1. **Colatitude information**, 2. **Dynamic thresholding**.

The upgrades cause the amount ACE in-situ data within the uncertainty range of the model to **increase from 25.1% to 31% (illustrated in Figure 6)**.

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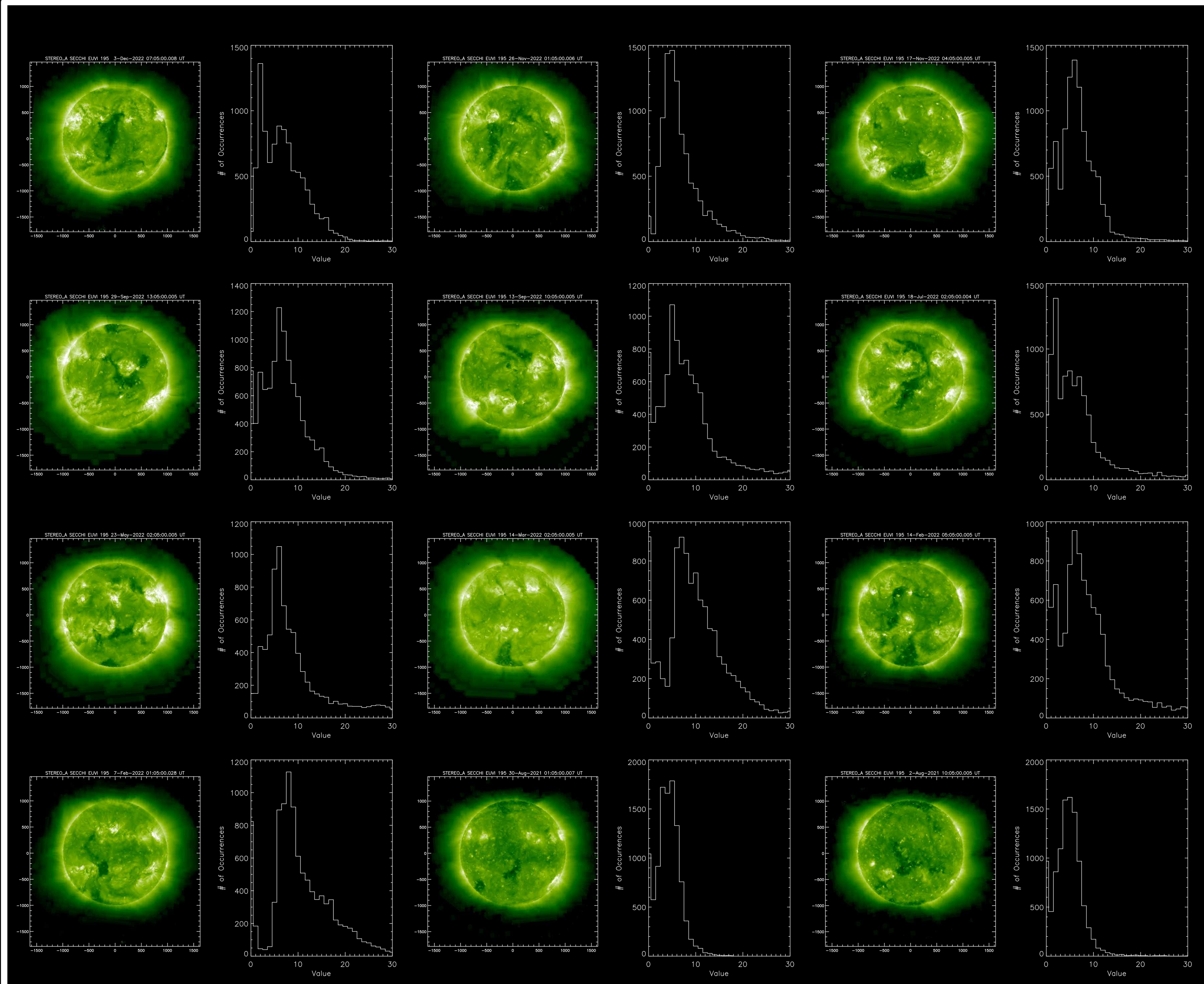

Figure 4: 195 Å images captured by the EUV camera aboard STEREO-A and their corresponding histograms.

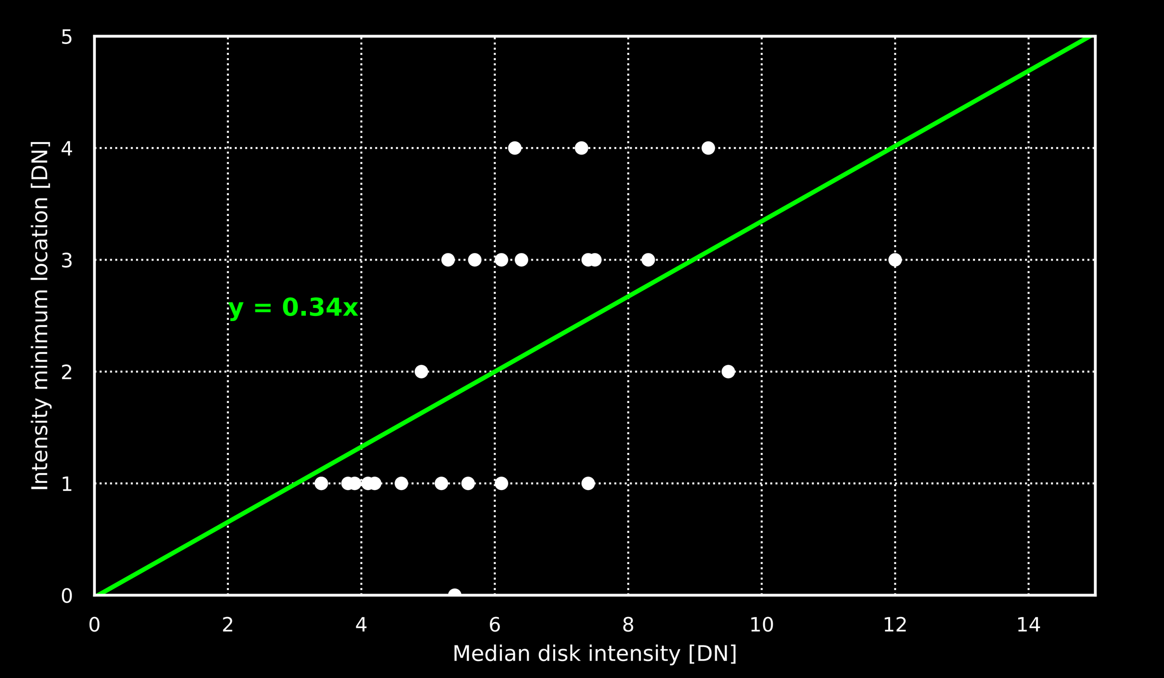

Figure 5: Linear fit through the data gathered from the histograms in Figure 4 for determining the optimal threshold for coronal hole extraction..

2. Dynamic Thresholding:
Heinemann et al. (2019) developed a dynamic thresholding technique for the CATCH tool for more accurate extraction of coronal hole areas using SDO data. This has been tested here and replicated for 195 Å images from STEREO-A (Figures 4 & 5). By manually finding the local minima in the histograms and fitting them against the median values we found that an optimal threshold for these data is a constant threshold of **34%** of the median value.

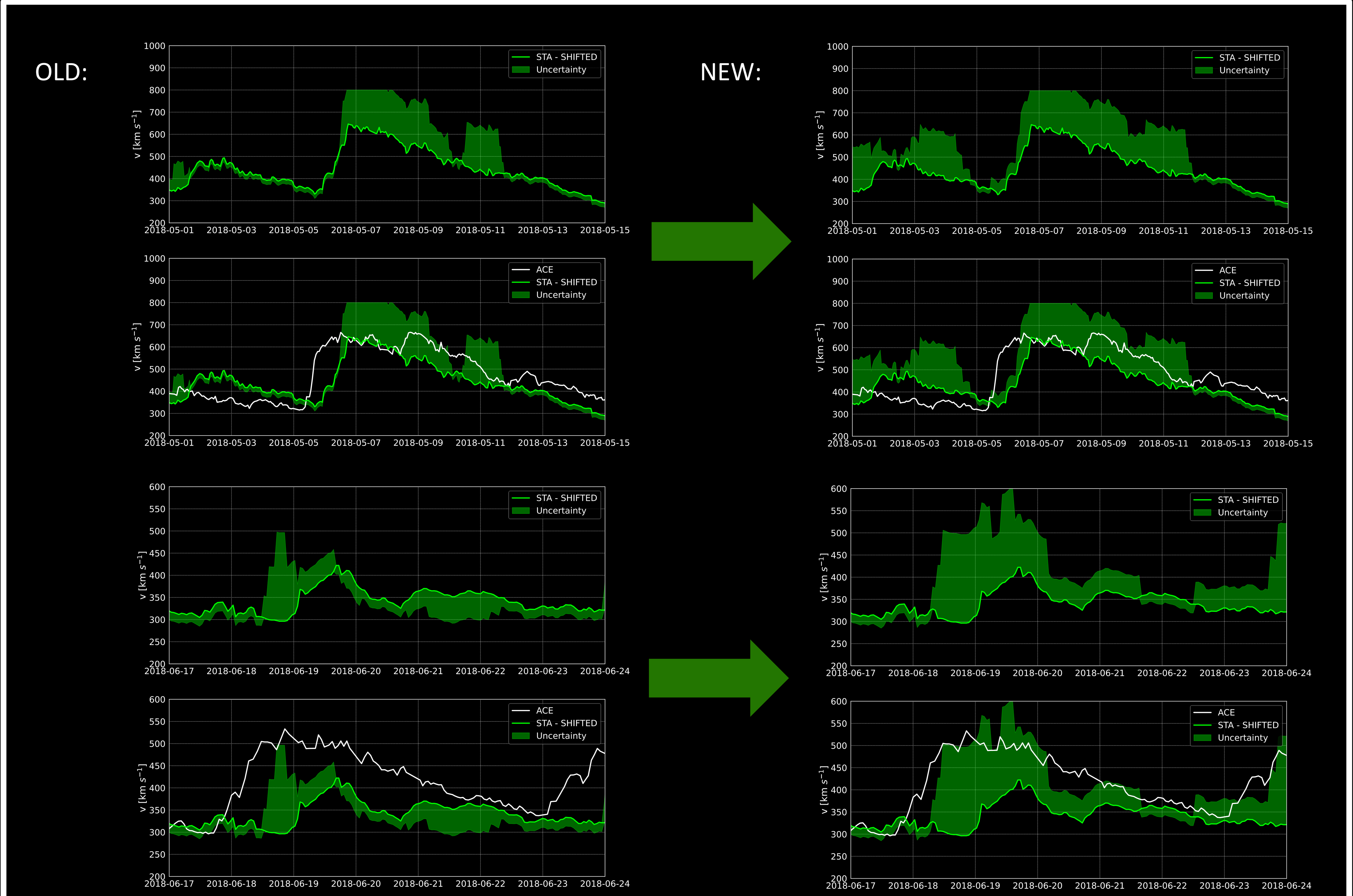

Figure 6: Examples of the Model compared to in-situ data before and after the upgrades

Temmer, M., Hinterreiter, J., and Reiss, M. A., "Coronal hole evolution from multi-viewpoint data as input for a STEREO solar wind speed persistence model", Journal of Space Weather and Space Climate, vol. 8, 2018. doi:10.1051/swsc/2018007.

Milošić, D., Temmer, M., Heinemann, S. G., Podladchikova, T., Veronig, A., and Vršnak, B., "Improvements to the Empirical Solar Wind Forecast (ESWF) model", Solar Physics, vol. 298, no. 3, 2023. doi:10.1007/s11207-022-02102-5.

Heinemann, S. G. et al., "Statistical Analysis and Catalog of Non-polar Coronal Holes Covering the SDO-Era Using CATCH", Solar Physics, vol. 294, no. 10, 2019. doi:10.1007/s11207-019-1539-y.

Hofmeister, S. J., Veronig, A., Temmer, M., Vennerstrom, S., Heber, B., and Vršnak, B., "The Dependence of the Peak Velocity of High-Speed Solar Wind Streams as Measured in the Ecliptic by ACE and the STEREO satellites on the Area and Co-latitude of Their Solar Source Coronal Holes", Journal of Geophysical Research (Space Physics), vol. 123, no. 3, pp. 1738–1753, 2018. doi:10.1002/2017JA024586.