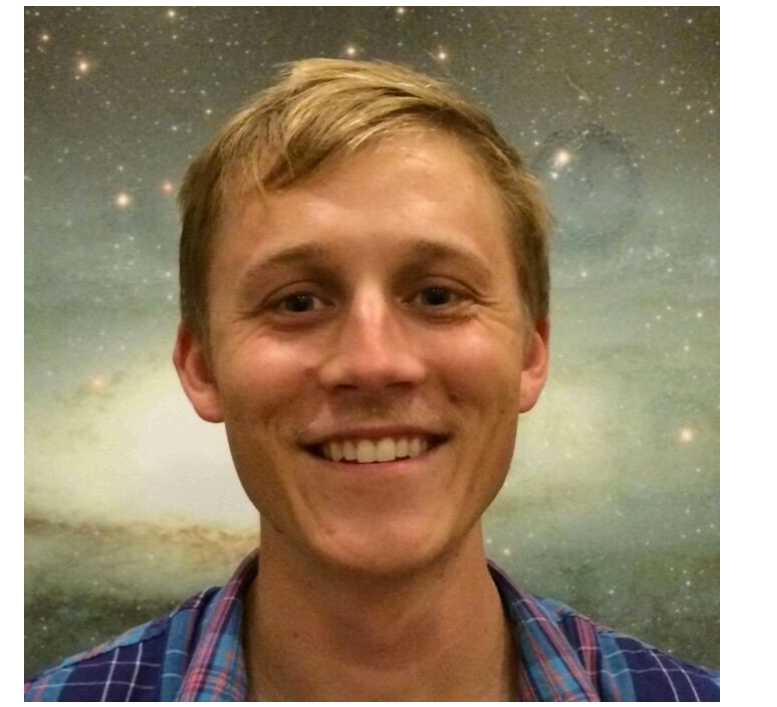




An Automated All-Sky Search for Superflares with TESS

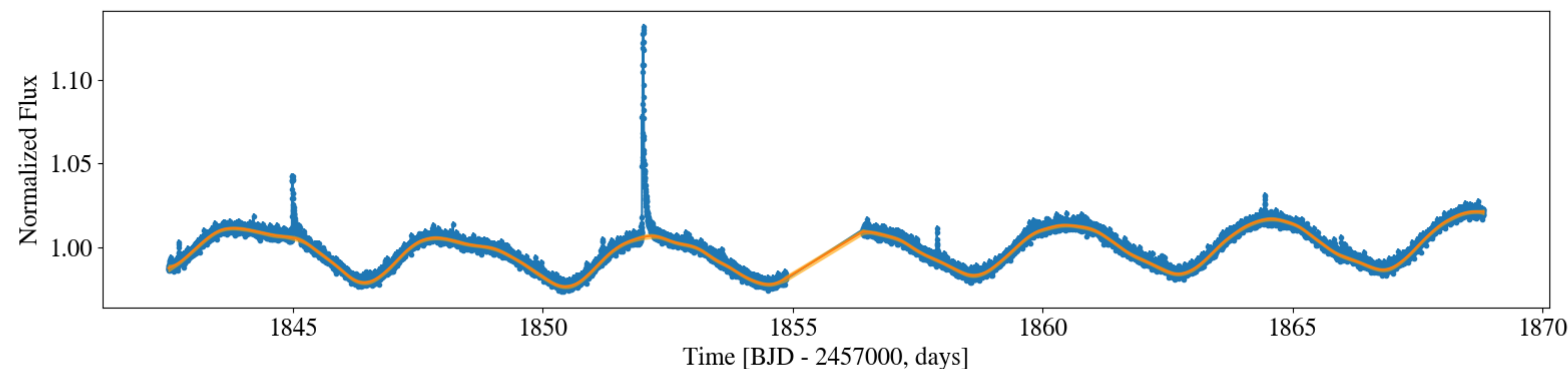
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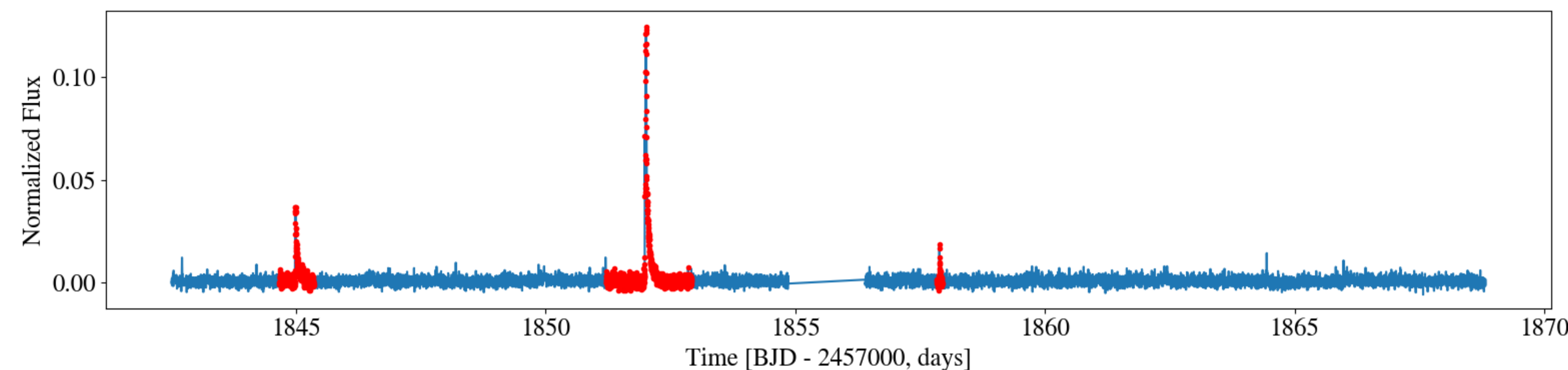
We use an automated pipeline to identify and characterize flare events from all stars observed during the first two years (sector 1-26) of the TESS mission.

First, rotationally-modulated variability is modeled and removed



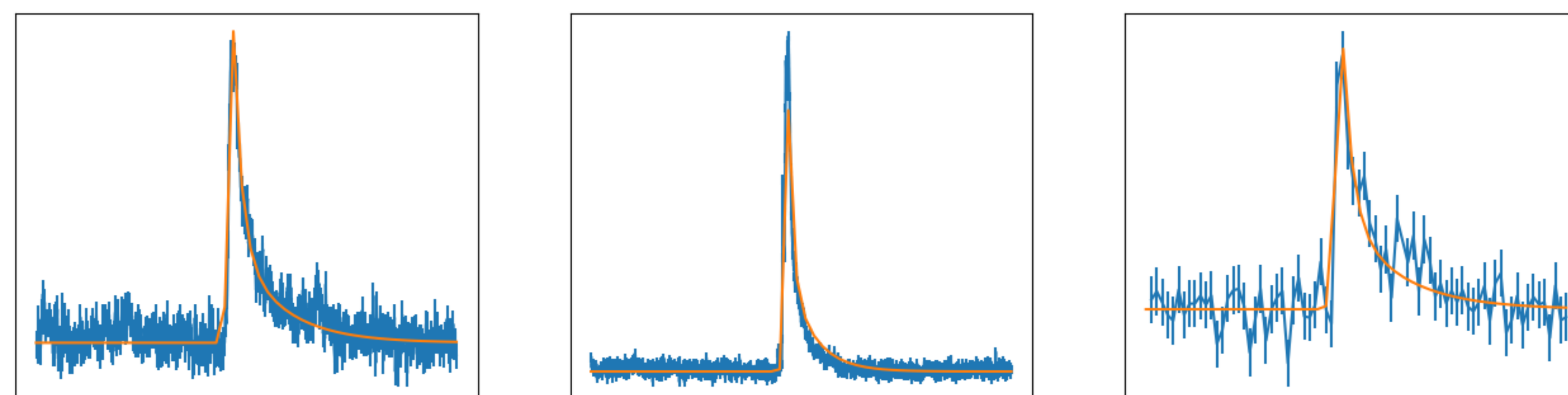
We iteratively fit a gaussian process model to each light curve using a quasi-periodic kernel. Because flare events are strong and nonperiodic, they do not fit well to the model and are thrown out over a few iterations of rejection and refitting. The result is a model which captures only the rotationally modulated variability of the star, which is then subtracted from the data.

Next, flare candidates are identified in the detrended light curve



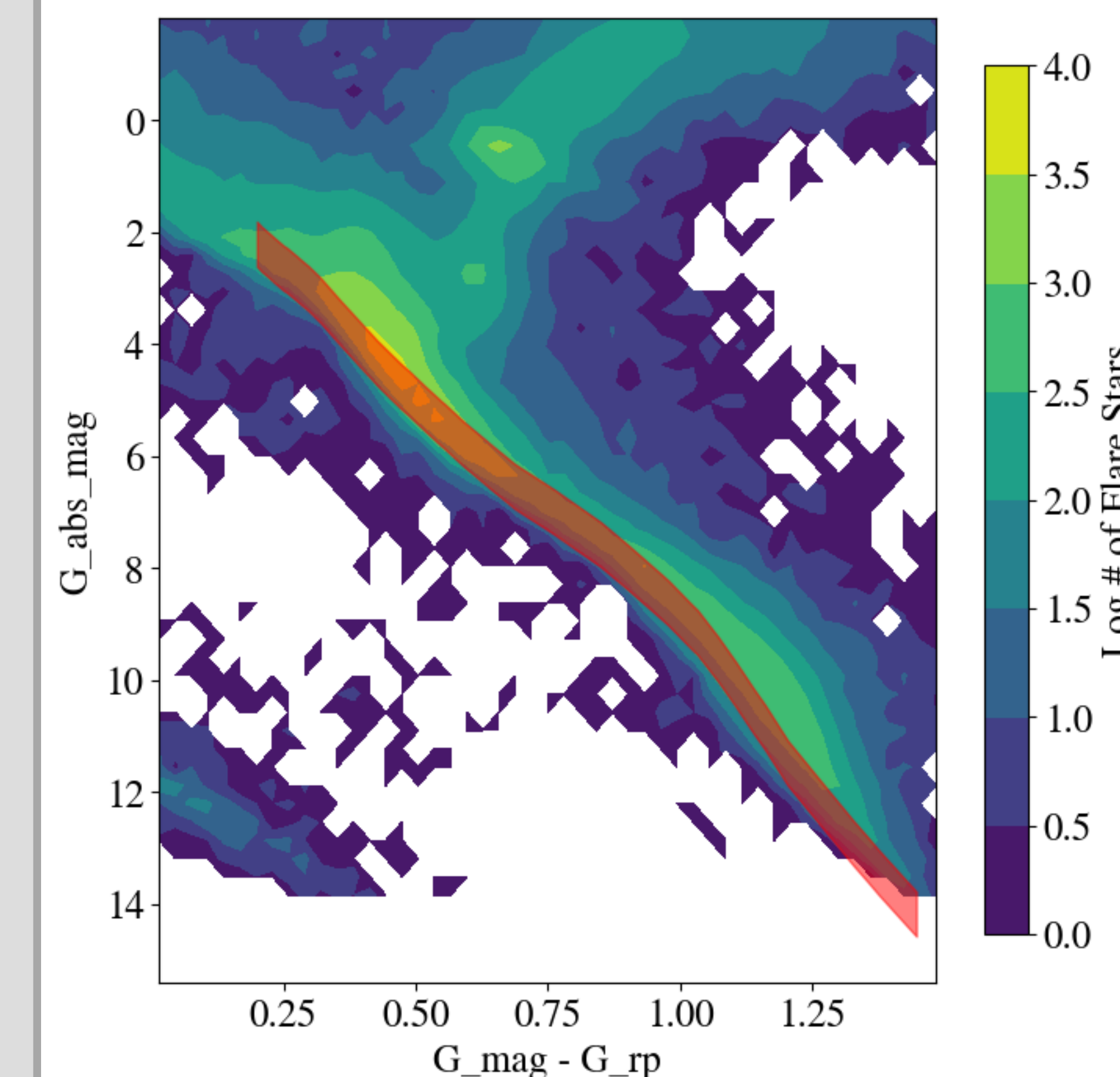
Candidate epochs belonging to flare events are then identified using the change-point analysis technique described in Chang et al. 2015.

Flares are vetted by fitting a model to the candidate events



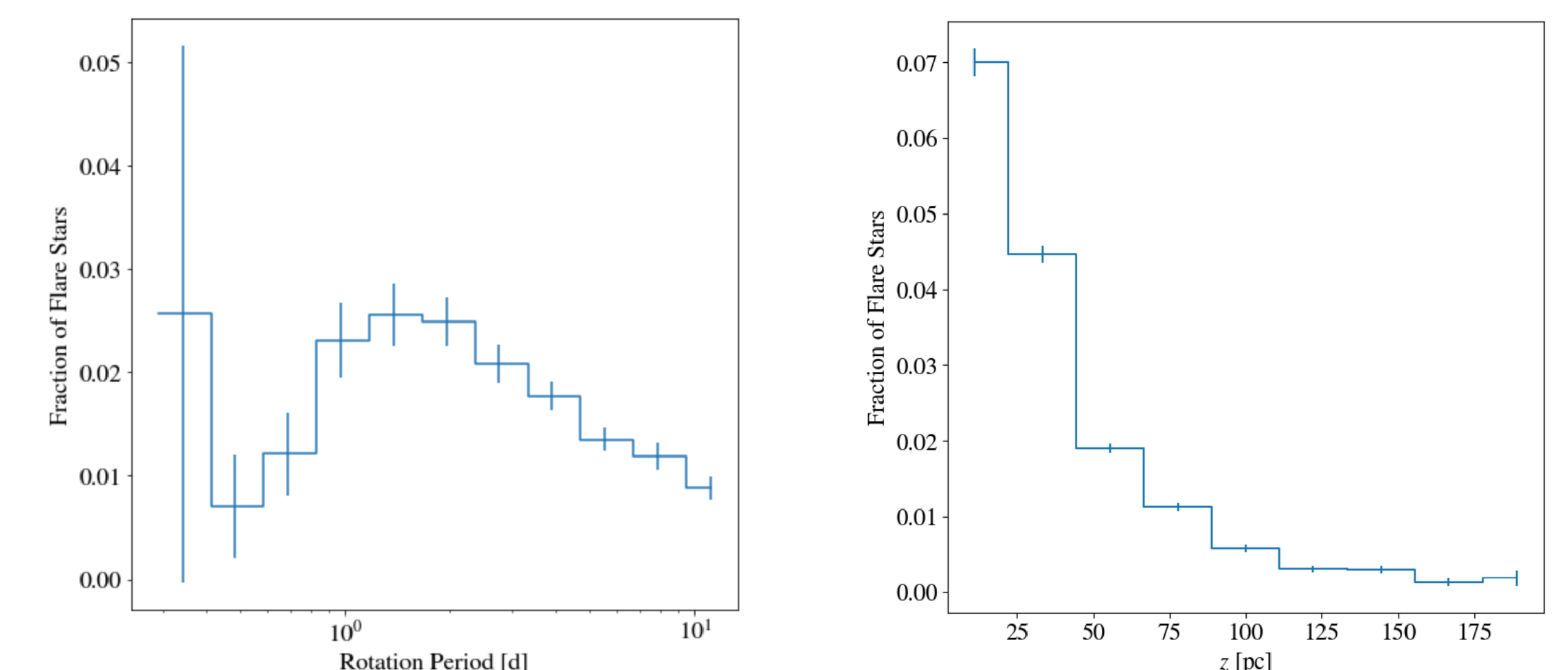
Both a gaussian and an analytic flare model (Davenport et al. 2014) are fit to the events. Only in cases where the flare model fits better with reasonable parameters are candidates marked as 'true' events.

Detailed information about the flare event and the star requires a luminosity estimate



TESS does not provide color information for targets, so we crossmatch with GAIA and use it's multi band photometry combined with distance measurements to estimate absolute magnitudes. Following a similar methodology to Davenport & Covey 2018, we use the GAIA color information to obtain the luminosity of the targets by interpolating onto a ZAMS isochrone. To avoid contamination from unresolved binaries and giants, we only use targets which fall close enough to the isochrone (shown in red). After crossmatching with GAIA, we are left with 27,229 flare events from 7,260 different stars.

Our large sample size allows for flare demographics on a galactic scale



The left-hand panel shows the fraction of flaring vs non-flaring stars in the sample, binned by the rotation rate of the star. A clear decrease in the fraction of flare stars is visible beyond ~2 days, which is consistent with gyro chronology models. On the right, we show the fraction of flare stars binned by galactic height. The diminishing trend with galactic height is consistent with the idea that flare rate decreases with age. As a byproduct of the gaussian process modeling, we provide rotation period measurements for roughly 80,000 stars.

References:

Chang, S. W., Byun, Y. I., & Hartman, J. D. 2015, ApJ, 814, 35
Davenport, J. R. A., Hawley, S. L., Hebb, L., et al. 2014, ApJ, 797, 122
Davenport, J. R. A., & Covey, K. R. 2018, ApJ, 868, 151