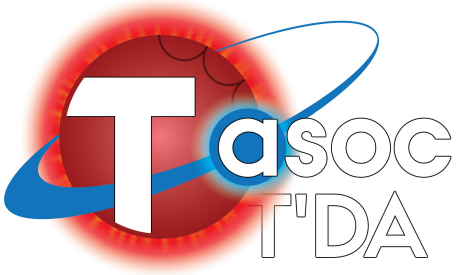

T'DA Data Release Notes

Data Release 0 for TESS Sector 1

TASOC-0001-01

TESS Data for Asteroseismology (T'DA)

Mikkel N. Lund & Rasmus Handberg, Editors

October 13, 2018

This report is prepared by the Coordinated Activity T'DA of the TESS Asteroseismic Science Consortium (TASC), which is responsible for light curve preparation for asteroseismology.

The data summarised in this report can be queried via the TESS Asteroseismic Science Operation Center (TASOC)[1] data base. We are in the process of also making the data available as a High Level Science Product (HLSP) on The Mikulski Archive for Space Telescopes (MAST)[2].

For this release of light curves of TESS Objects of Interest (TOIs) a special version of the TASOC pipeline is adopted, where apertures are produced from calibrated target pixel files using the TASOC Photometry pipeline, doing aperture photometry using a procedure similar to that adopted in K2P[2] (Lund et al. 2015). Light curves are subsequently corrected for systematic effect using the KASOC Filter (Handberg & Lund 2014).

The TASOC pipeline used to generate the data is open source and available on GitHub[3].

[1] https://tasoc.dk
[2] https://archive.stsci.edu/tess/
[3] https://github.com/tasoc

These notes are the collective effort of the 100+ members of the TESS Data for Asteroseismology (T'DA) Coordinated Activity, lead by

Lund, Mikkel N., T'DA Chair, TASC SC
Handberg, Rasmus, T'DA Chair, TASC SC
Tkachenko, Andrew, T'DA sub-chair for classification, TASC SC
White, Timothy, T'DA sub-chair for saturated stars
von Essen, Carolina, T'DA sub-chair for timing verification

The following members deserve a special notice for their important contributions to the T'DA efforts:

Hall, Oliver
Buzasi, Derek
Carboneau, Lindsey
Chontos, Ashley
Pope, Benjamin
Hansen, Jonas S.
Mikkelsen, Kristine
Mortensen, Dina S.
Emborg, Nicolas
Armstrong, David
Bugnet, Lisa
Garcia, Rafael
Hon, Marc T. Y.
Kuszlewicz, James
Bell, Keaton
Bedding, Tim
Molnár, László

Pointing

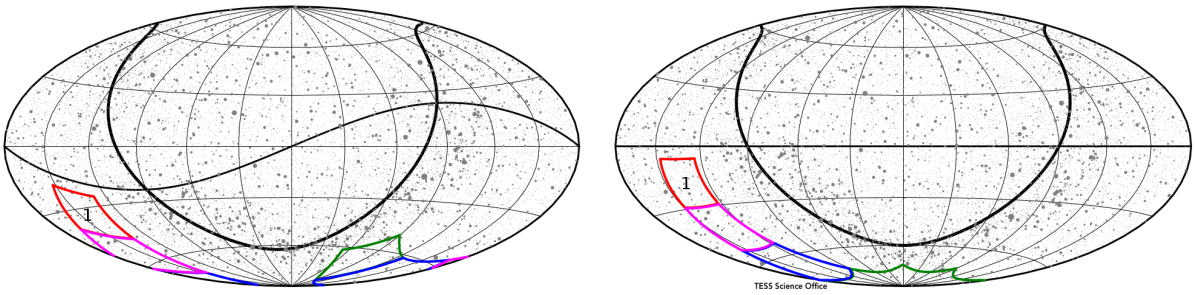

Figure 1: Pointing and FOV for Sector 1 observations in celestial coordinates (left) and ecliptic coordinates (right). See Table 2 for detailed pointing information. Camera 1 (red) is annotated for reference. Thin black line is ecliptic, thick black line is the galactic plane. Illustrations adopted from tess.mit.edu.

Table 1: Information on timing of observations in Sector 1.

Sector	Orbits	Cadence	First Cadence (TBJD)	Last Cadence (TBJD)	First Candece (UTC)	Last Cadence (UTC)	Nstart	Nend	Ntot
1	9–10	LC (1800s)	–	–	–	–	–	–	–
1	9–10	SC (120s)	1325.30	1353.18	25-07-2018 19:09:59	22-08-2018 16:21:27	70444	90519	20075

Note. – TBJD = "TESS Barycentric Julian Date" (BJD - 2457000); "Nstart" is the cadence number of the first observation; "Nend" is he cadence number of the last observation; "Ntot" is the total number of cadences.

Table 2: Information on the Sector 1 FOV.

	Sector	RA (deg)	DEC (deg)	Roll (deg)	Ecliptic Longitude (deg)	Ecliptic Latitude (deg)
Bore sight	1	352.6844	-64.8531	-137.8468	315.8	-54
Camera 1	1	324.5670	-33.1730	–	315.8	-18
Camera 2	1	338.5766	-55.0789	–	315.8	-42
Camera 3	1	19.4927	-71.9781	–	315.8	-66
Camera 4	1	90.0042	-66.5647	–	315.8	-90

Note – "Bore sight" is the spacecraft centre pointing vector, at the middle of the camera array, midway between cameras 2 and 3. All coordinates are in degrees (J2000).

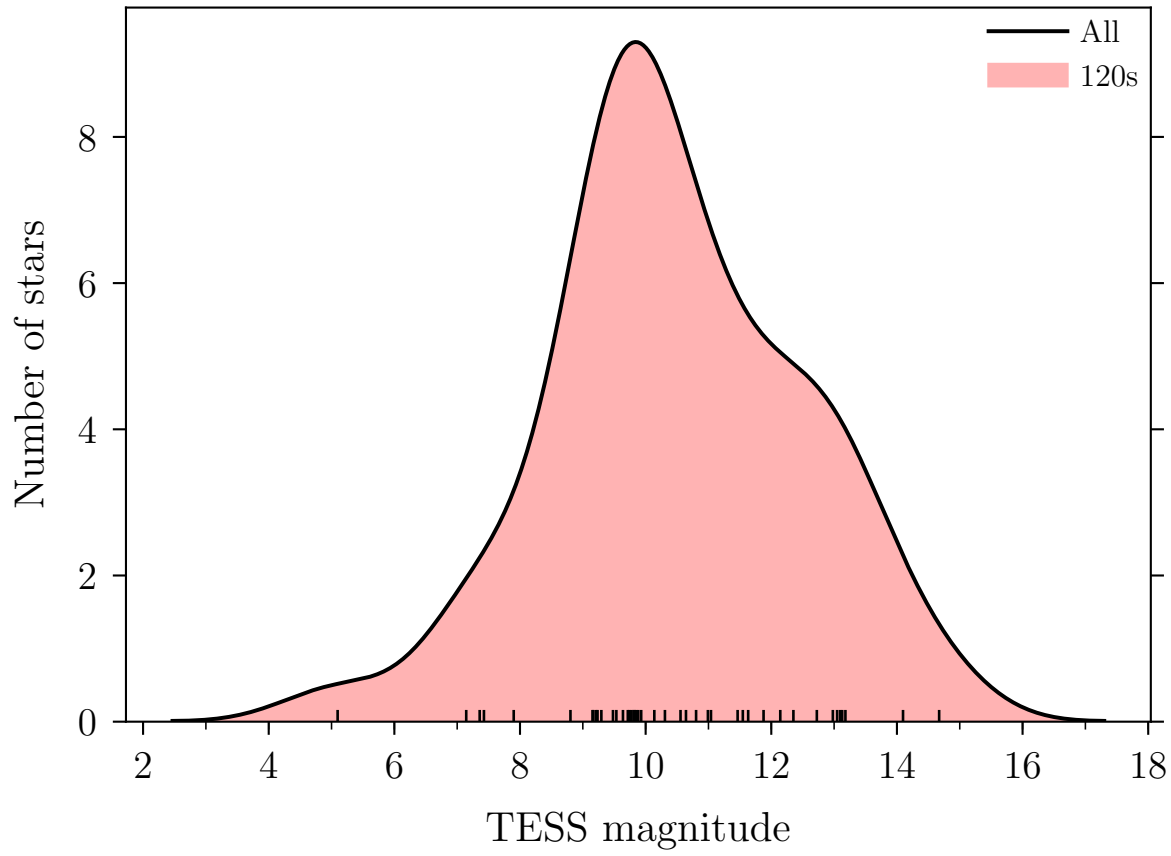

Figure 2: Magnitude distribution for stars covered by this release.

Targets

For this release 43 TOI targets with publicly released target pixel data (TPD) have been analysed. These targets are primarily of interest to TASC WGs 1+2 (planet hosting stars and solar-like oscillators). The magnitude distribution for extracted targets is shown in Figure 2.

Please note that this data is optimised for asteroseismology, and therefore the planetary transit signals have been intentionally removed.

Data format

The primary data format for extracted and corrected light curves is FITS (Flexible Image Transport System), and is provided in a compressed gzip format. A FITS light curve file produced by T'DA and stored on TASOC will be named following the structure:

`tess{TIC ID}-s{sector}-c{cadence}-dr{data release}-v{version}-tasoc_lc.fits.gz`

The "TIC ID" (TESS Input Catalog identifier) of the star is zero (pre-)padded to 11 digits, the "sector" is be zero (pre-)padded to 2 digits, the "cadence" is in seconds and zero (pre-)padded to 4 digits, the "data release" is zero (pre-)padded to 2 digits and refers to the official release of the data from the mission, the "version" is zero (pre-)padded to 2 digits and refers to the version of the TASOC processing of the data (counting from 1). As an example, the star with TIC ID 62483237, observed in sector 1 in SC (120 sec) and part of the first data release and first TASOC processing will have the name:

`tess00062483237-s01-c0120-dr00-v01-tasoc_lc.fits.gz`

Each light curve FITS file has four extensions: a "Primary" header with general information on the star and the observations; a "LIGHTCURVE" table with time, raw flux, corrected flux, etc.; a "SUMIMAGE" with an image given by the time- averaged pixel data; and an "APERTURE" image. The information provided in the FITS file is intended to mimic that provided in the official TESS products – please consult the "TESS Science Data Products Description"[4] for more information.

Photometry

The photometric quality of the reduced and corrected light curves is summarised in Figure 3, which shows the root-mean-square (RMS) noise in parts-per-million (ppm) as a function of TESS magnitude - the RMS is given on a 1 hour time scale and as the point-to-point Median-Differential-Variability (MDV) (corresponding to RMS on time scale of observing cadence). Two stars are found to lie below the expected noise at their respective magnitudes, the only immediate cause for this appears to be that both stars lie relatively close to the edge of the 11×11 pixel stamp. Figure 4 shows the sizes of the defined apertures as a function of TESS magnitude. Generally the TASOC apertures are larger than those from the Science Processing and Operations Center (SPOC) pipeline. One star (near TESS mag $\sim$10.6) fall below the general trend – this star has a bright neighbouring star within the 11×11 pixel stamp resulting a smaller mask for the dimmer primary target.

[4] https://archive.stsci.edu/missions/tess/doc/EXP-TESS-ARC-ICD-TM-0014.pdf

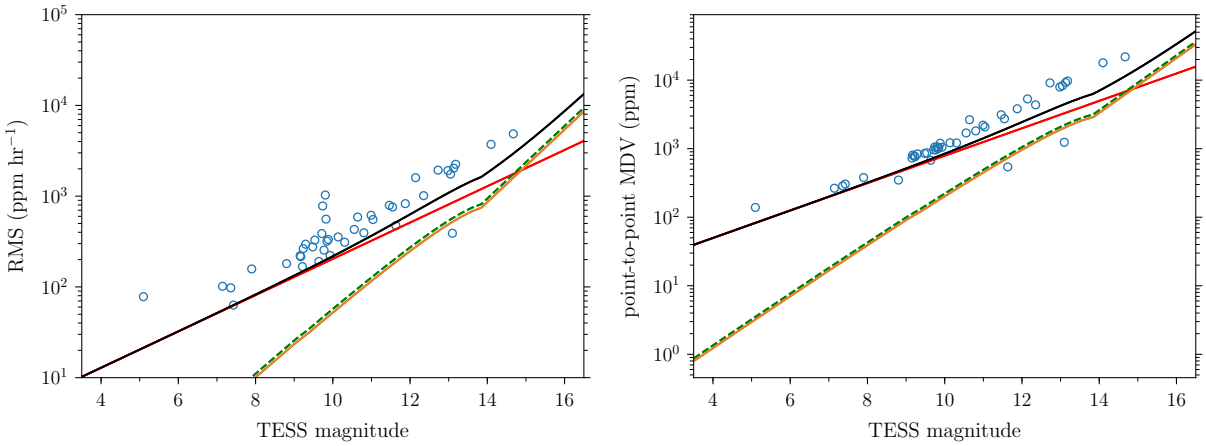

Figure 3: RMS noise on 1 hour time scale (left) and the point-to-point Median-Differential-Variability (MDV) (right) for stars covered by this release. The lines give the predicted noise estimates following Sullivan et al. (2015) (red full: shot noise; yellow full: read noise; green dashed: zodiacal noise; black full: total noise).

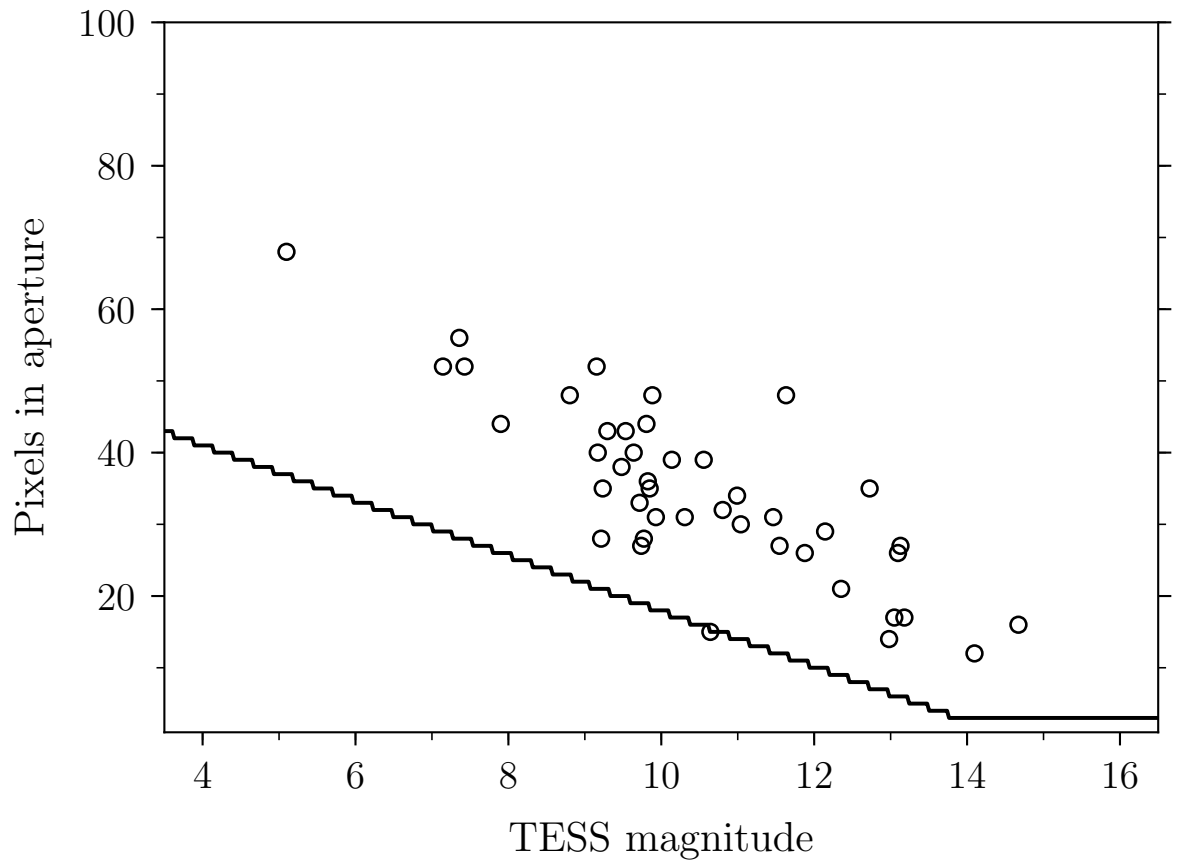

Figure 4: Pixel in apertures as a function of TESS magnitude. The full line attempts to approximate the relation shown in Sullivan et al. (2015).

References

Handberg, R., & Lund, M. N. 2014, MNRAS, 445, 2698

Lund, M. N., Handberg, R., Davies, G. R., Chaplin, W. J., & Jones, C. D. 2015, ApJ, 806, 30

Sullivan, P. W., Winn, J. N., Berta-Thompson, Z. K., et al. 2015, ApJ, 809, 77