

# Graded Practice 1

## Astroinformatics I

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## A Introduction

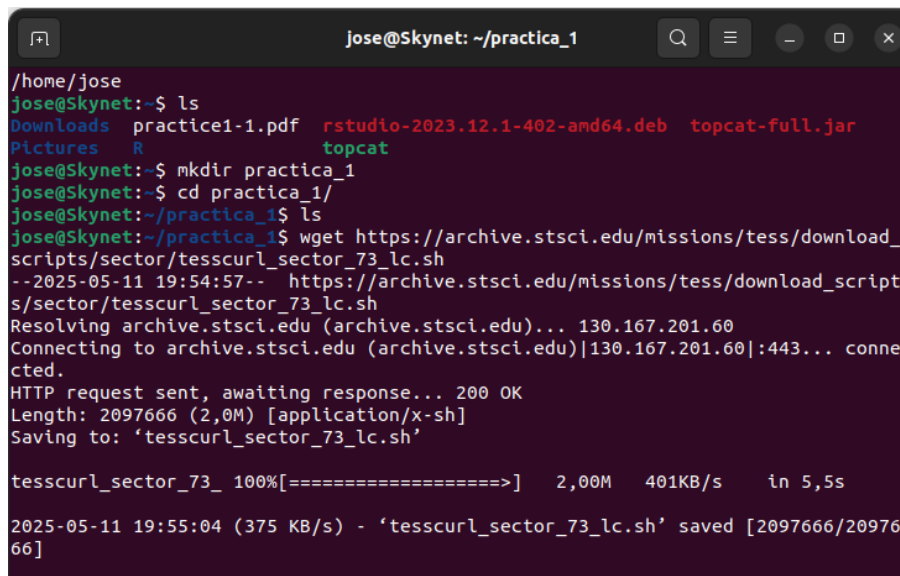
For the completion of this practice, tutorials 2 and 3 provided during the course were used as references [Hernitschek, 2025a,b]. All the work was carried out in a Linux environment using the Ubuntu 22.04 LTS platform<sup>1</sup>. Additionally, to install the TOPCAT software, the procedure indicated on the GNU Astronomy Utilities website was followed<sup>2</sup>. Likewise, the writing of this practice was done in L<sup>A</sup>T<sub>E</sub>X, using the Overleaf platform<sup>3</sup>.

## B Practice Development

### Problem 1

The first objective was to download the script `tesscurl_sector_73_lc.sh` from the website [https://archive.stsci.edu/tess/bulk\\_downloads/bulk\\_downloads\\_ffl-tp-lc-dv.html](https://archive.stsci.edu/tess/bulk_downloads/bulk_downloads_ffl-tp-lc-dv.html).

To do this, a terminal was opened and a folder named "practica\_1" was created. The command `cd` was used to enter this folder, and the file was downloaded using the `wget` command. The procedure is shown in Figure 1.



```
jose@Skynet: ~/practica_1
/home/jose
jose@Skynet:~$ ls
Downloads  practice1-1.pdf  rstudio-2023.12.1-402-amd64.deb  topcat-full.jar
Pictures   R                topcat
jose@Skynet:~$ mkdir practica_1
jose@Skynet:~$ cd practica_1/
jose@Skynet:~/practica_1$ ls
jose@Skynet:~/practica_1$ wget https://archive.stsci.edu/missions/tess/download_scripts/sector/tesscurl_sector_73_lc.sh
--2025-05-11 19:54:57-- https://archive.stsci.edu/missions/tess/download_scripts/sector/tesscurl_sector_73_lc.sh
Resolving archive.stsci.edu (archive.stsci.edu)... 130.167.201.60
Connecting to archive.stsci.edu (archive.stsci.edu)[130.167.201.60]:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 2097666 (2.0M) [application/x-sh]
Saving to: 'tesscurl_sector_73_lc.sh'

tesscurl_sector_73_ 100%[=====] 2,00M 401KB/s in 5.5s

2025-05-11 19:55:04 (375 KB/s) - 'tesscurl_sector_73_lc.sh' saved [2097666/2097666]
```

Figure 1: Procedure for downloading the script.

To execute the script, the location of Bash in Ubuntu was verified using the command `which bash`, which returned the path `/usr/bin/bash`. Then, the `vi` command was used to insert this path in the first line of the script. The `chmod +x` command was used to grant execution permissions to the script. Finally, the script was executed using the command `./tesscurl_sector_73_lc.sh`.

When 15 files had been downloaded, the process was stopped using the "CTRL+C" keyboard shortcut. The entire procedure is shown in Figure 2.

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<sup>1</sup>Available at <https://releases.ubuntu.com/jammy/>

<sup>2</sup>GNU Astronomy Utilities is available at [https://www.gnu.org/software/gnuastro/manual/html\\_node/TOPCAT.html](https://www.gnu.org/software/gnuastro/manual/html_node/TOPCAT.html)

<sup>3</sup>Available at <https://www.overleaf.com/>

```

jose@Skynet: ~/practica_1
jose@Skynet:~/practica_1$ which bash
/usr/bin/bash
jose@Skynet:~/practica_1$ vi tesscurl_sector_73_lc.sh
jose@Skynet:~/practica_1$ chmod +x tesscurl_sector_73_lc.sh
jose@Skynet:~/practica_1$ ./tesscurl_sector_73_lc.sh
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total   Spent    Left     Speed
100 1918k  100 1918k    0     0   381k    0  0:00:05  0:00:05 --:--:--  517k
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total   Spent    Left     Speed
100 1918k  100 1918k    0     0   434k    0  0:00:04  0:00:04 --:--:--  434k
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total   Spent    Left     Speed
100 1918k  100 1918k    0     0   388k    0  0:00:04  0:00:04 --:--:--  445k
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total   Spent    Left     Speed
100 1918k  100 1918k    0     0   589k    0  0:00:03  0:00:03 --:--:--  589k
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total   Spent    Left     Speed
100 1918k  100 1918k    0     0   473k    0  0:00:04  0:00:04 --:--:--  473k
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
           Dload  Upload   Total   Spent    Left     Speed
100 1918k  100 1918k    0     0   556k    0  0:00:03  0:00:03 --:--:--  555k
% Total    % Received % Xferd  Average Speed   Time    Time     Time  Current

```

Figure 2: Steps for executing the script.

Figure 3 shows a list of the downloaded files as well as the file count.

```

jose@Skynet: ~/practica_1
jose@Skynet:~/practica_1$ ls
tess2023341045131-s0073-0000000001750268-0268-s_lc.fits
tess2023341045131-s0073-0000000001755406-0268-s_lc.fits
tess2023341045131-s0073-0000000001947463-0268-s_lc.fits
tess2023341045131-s0073-0000000001950736-0268-s_lc.fits
tess2023341045131-s0073-0000000002006984-0268-s_lc.fits
tess2023341045131-s0073-0000000002008765-0268-s_lc.fits
tess2023341045131-s0073-0000000002014191-0268-s_lc.fits
tess2023341045131-s0073-0000000002104696-0268-s_lc.fits
tess2023341045131-s0073-0000000002105589-0268-s_lc.fits
tess2023341045131-s0073-0000000002149979-0268-s_lc.fits
tess2023341045131-s0073-0000000002152411-0268-s_lc.fits
tess2023341045131-s0073-0000000002234692-0268-s_lc.fits
tess2023341045131-s0073-0000000002234723-0268-s_lc.fits
tess2023341045131-s0073-0000000002236015-0268-s_lc.fits
tess2023341045131-s0073-0000000002237045-0268-s_lc.fits
tesscurl_sector_73_lc.sh
jose@Skynet:~/practica_1$ ls -l | wc -l
16
jose@Skynet:~/practica_1$

```

Figure 3: Downloaded FITS files.

## Problem 2

To convert the format of the 15 files from FITS to CSV, the TOPCAT software was used. To run TOPCAT, the command `./topcat` was executed.

The procedure was carried out individually for each file. First, the FITS file was opened, as shown in Figure 4.

Then, the same file was saved in CSV format, as shown in Figure 5. This procedure was repeated for all 15 FITS files. A view of the generated CSV files is shown in Figure 6.

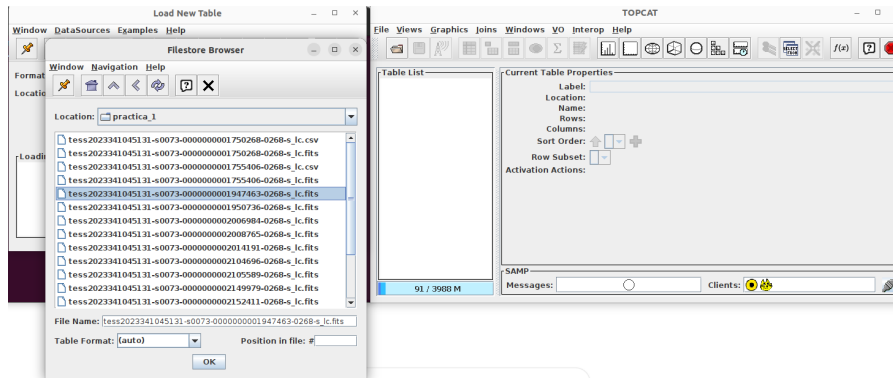


Figure 4: Opening the FITS file.

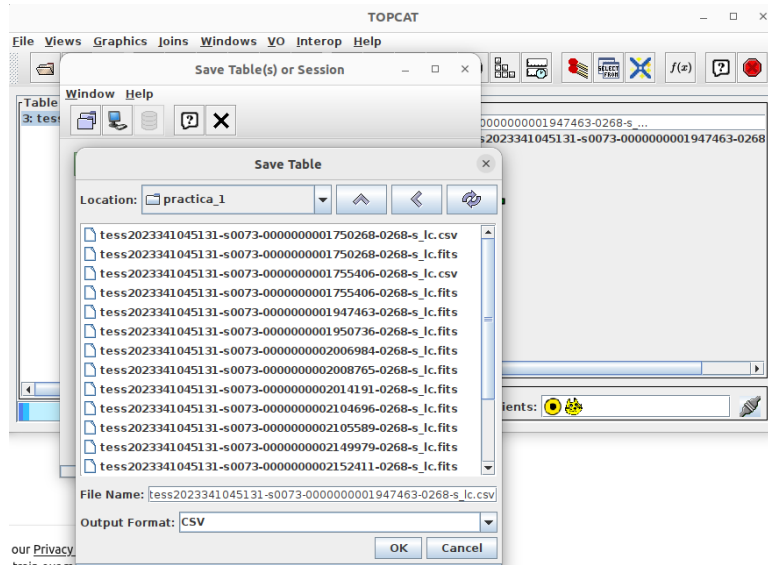


Figure 5: Saving the file in CSV format.

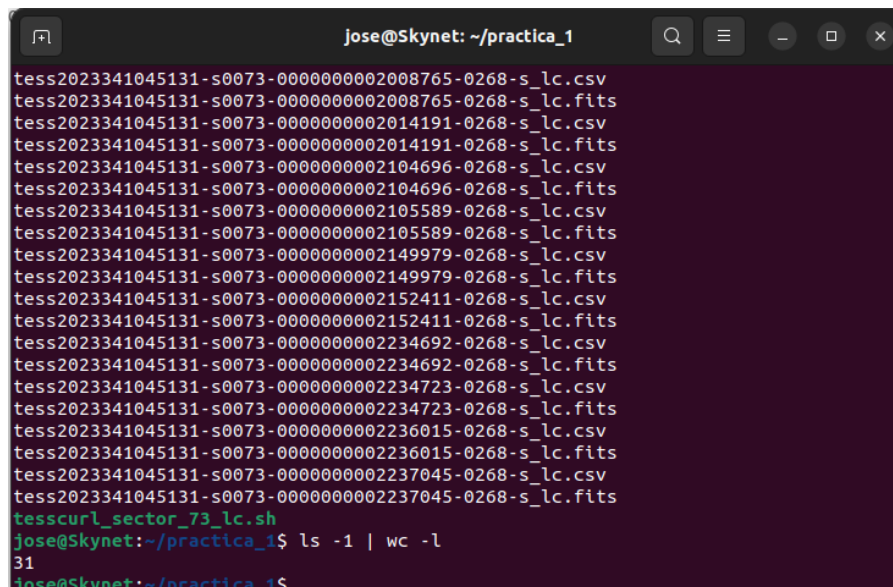
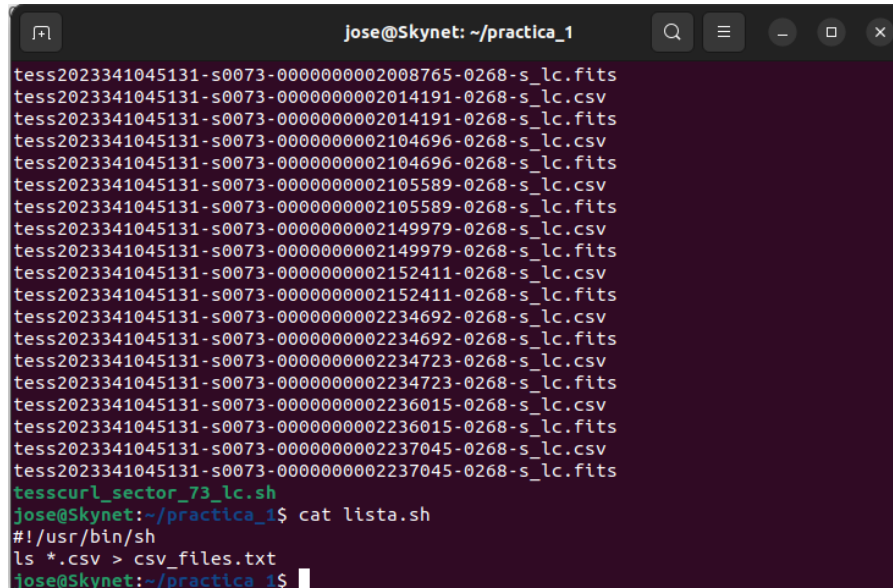


Figure 6: List of CSV files.

### Problem 3

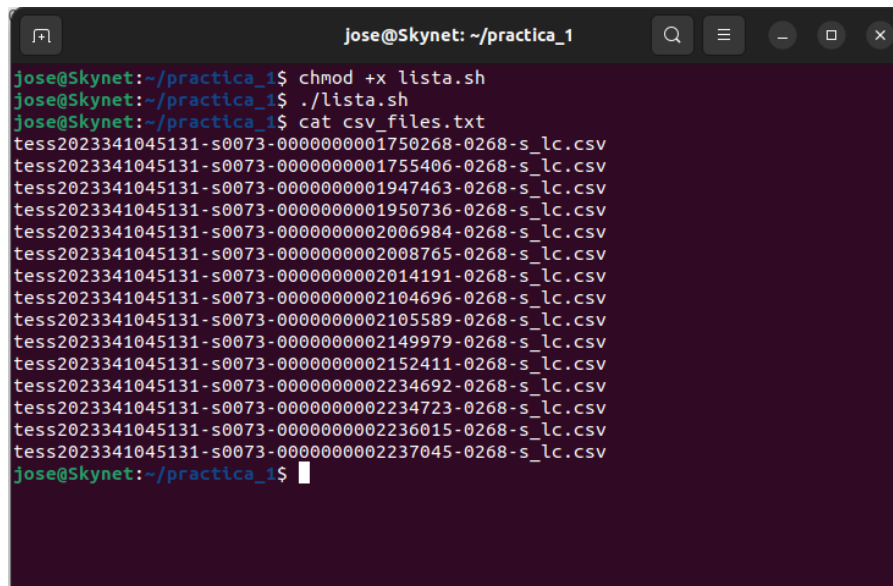
A script named `lista.sh` was written to list all the CSV file names, exporting them into a text file called `csv_files.txt`. The content of the script is shown in Figure 7.



```
jose@Skynet: ~/practica_1
tess2023341045131-s0073-0000000002008765-0268-s_lc.fits
tess2023341045131-s0073-0000000002014191-0268-s_lc.csv
tess2023341045131-s0073-0000000002014191-0268-s_lc.fits
tess2023341045131-s0073-0000000002104696-0268-s_lc.csv
tess2023341045131-s0073-0000000002104696-0268-s_lc.fits
tess2023341045131-s0073-0000000002105589-0268-s_lc.csv
tess2023341045131-s0073-0000000002105589-0268-s_lc.fits
tess2023341045131-s0073-0000000002149979-0268-s_lc.csv
tess2023341045131-s0073-0000000002149979-0268-s_lc.fits
tess2023341045131-s0073-0000000002152411-0268-s_lc.csv
tess2023341045131-s0073-0000000002152411-0268-s_lc.fits
tess2023341045131-s0073-0000000002234692-0268-s_lc.csv
tess2023341045131-s0073-0000000002234692-0268-s_lc.fits
tess2023341045131-s0073-0000000002234723-0268-s_lc.csv
tess2023341045131-s0073-0000000002234723-0268-s_lc.fits
tess2023341045131-s0073-0000000002236015-0268-s_lc.csv
tess2023341045131-s0073-0000000002236015-0268-s_lc.fits
tess2023341045131-s0073-0000000002237045-0268-s_lc.csv
tess2023341045131-s0073-0000000002237045-0268-s_lc.fits
tesscurl_sector_73_lc.sh
jose@Skynet:~/practica_1$ cat lista.sh
#!/usr/bin/sh
ls *.csv > csv_files.txt
jose@Skynet:~/practica_1$
```

Figure 7: Script that lists CSV files.

Figure 8 shows the content of the generated text file.



```
jose@Skynet:~/practica_1$ chmod +x lista.sh
jose@Skynet:~/practica_1$ ./lista.sh
jose@Skynet:~/practica_1$ cat csv_files.txt
tess2023341045131-s0073-0000000001750268-0268-s_lc.csv
tess2023341045131-s0073-0000000001755406-0268-s_lc.csv
tess2023341045131-s0073-0000000001947463-0268-s_lc.csv
tess2023341045131-s0073-0000000001950736-0268-s_lc.csv
tess2023341045131-s0073-0000000002006984-0268-s_lc.csv
tess2023341045131-s0073-0000000002008765-0268-s_lc.csv
tess2023341045131-s0073-0000000002014191-0268-s_lc.csv
tess2023341045131-s0073-0000000002104696-0268-s_lc.csv
tess2023341045131-s0073-0000000002105589-0268-s_lc.csv
tess2023341045131-s0073-0000000002149979-0268-s_lc.csv
tess2023341045131-s0073-0000000002152411-0268-s_lc.csv
tess2023341045131-s0073-0000000002234692-0268-s_lc.csv
tess2023341045131-s0073-0000000002234723-0268-s_lc.csv
tess2023341045131-s0073-0000000002236015-0268-s_lc.csv
tess2023341045131-s0073-0000000002237045-0268-s_lc.csv
jose@Skynet:~/practica_1$
```

Figure 8: Content of the `csv_files.txt` file.

### Problem 4

A script named `dividir.sh` was written to split the file `csv_files.txt` into 3 text files. Each text file contains the names of 5 elements from the original list (`csv_files.txt`). Figure 9 shows the content of the script as well as its execution.

```
jose@Skynet: ~/practica_1
jose@Skynet:~/practica_1$ cat dividir.sh
#!/usr/bin/sh
lista_0="csv_files.txt"
split -l 5 "$lista_0" part_

mv part_aa parte1.txt
mv part_ab parte2.txt
mv part_ac parte3.txt
jose@Skynet:~/practica_1$ chmod +x dividir.sh
jose@Skynet:~/practica_1$ ./dividir.sh
jose@Skynet:~/practica_1$ cat parte1.txt
tess2023341045131-s0073-0000000001750268-0268-s_lc.csv
tess2023341045131-s0073-0000000001755406-0268-s_lc.csv
tess2023341045131-s0073-0000000001947463-0268-s_lc.csv
tess2023341045131-s0073-0000000001950736-0268-s_lc.csv
tess2023341045131-s0073-0000000002006984-0268-s_lc.csv
jose@Skynet:~/practica_1$ cat parte2.txt
tess2023341045131-s0073-0000000002008765-0268-s_lc.csv
tess2023341045131-s0073-0000000002014191-0268-s_lc.csv
tess2023341045131-s0073-0000000002104696-0268-s_lc.csv
tess2023341045131-s0073-0000000002105589-0268-s_lc.csv
tess2023341045131-s0073-0000000002149979-0268-s_lc.csv
jose@Skynet:~/practica_1$ cat parte3.txt
tess2023341045131-s0073-0000000002152411-0268-s_lc.csv
tess2023341045131-s0073-0000000002234692-0268-s_lc.csv
tess2023341045131-s0073-0000000002234723-0268-s_lc.csv
tess2023341045131-s0073-0000000002236015-0268-s_lc.csv
tess2023341045131-s0073-0000000002237045-0268-s_lc.csv
jose@Skynet:~/practica_1$
```

Figure 9: Execution of the script that splits the `csv_files.txt` file.

## Problem 5

In this step, each CSV file was plotted. For this, TOPCAT was used: each file was opened, and the columns `TIME` and `PDCSAP_FLUX` were selected for the horizontal and vertical axes, respectively. Each graph was then saved in PDF format. The procedure is shown in Figure 10.

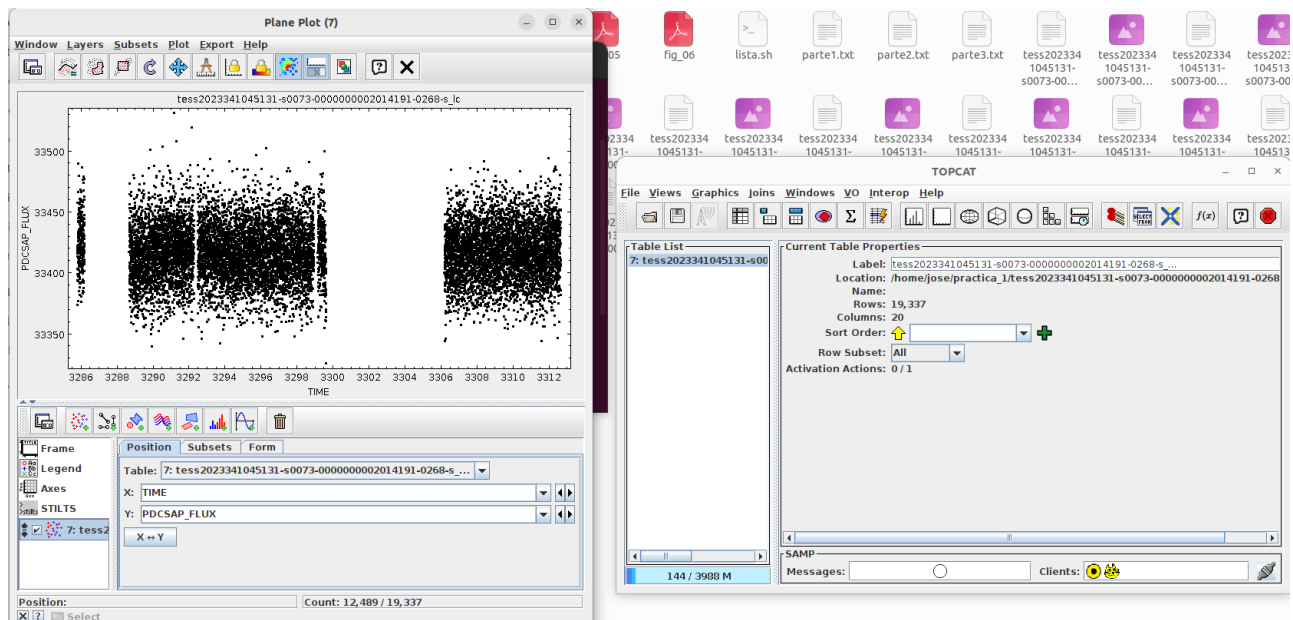


Figure 10: Plotting each CSV file.

The resulting plots are shown in Figure 11.

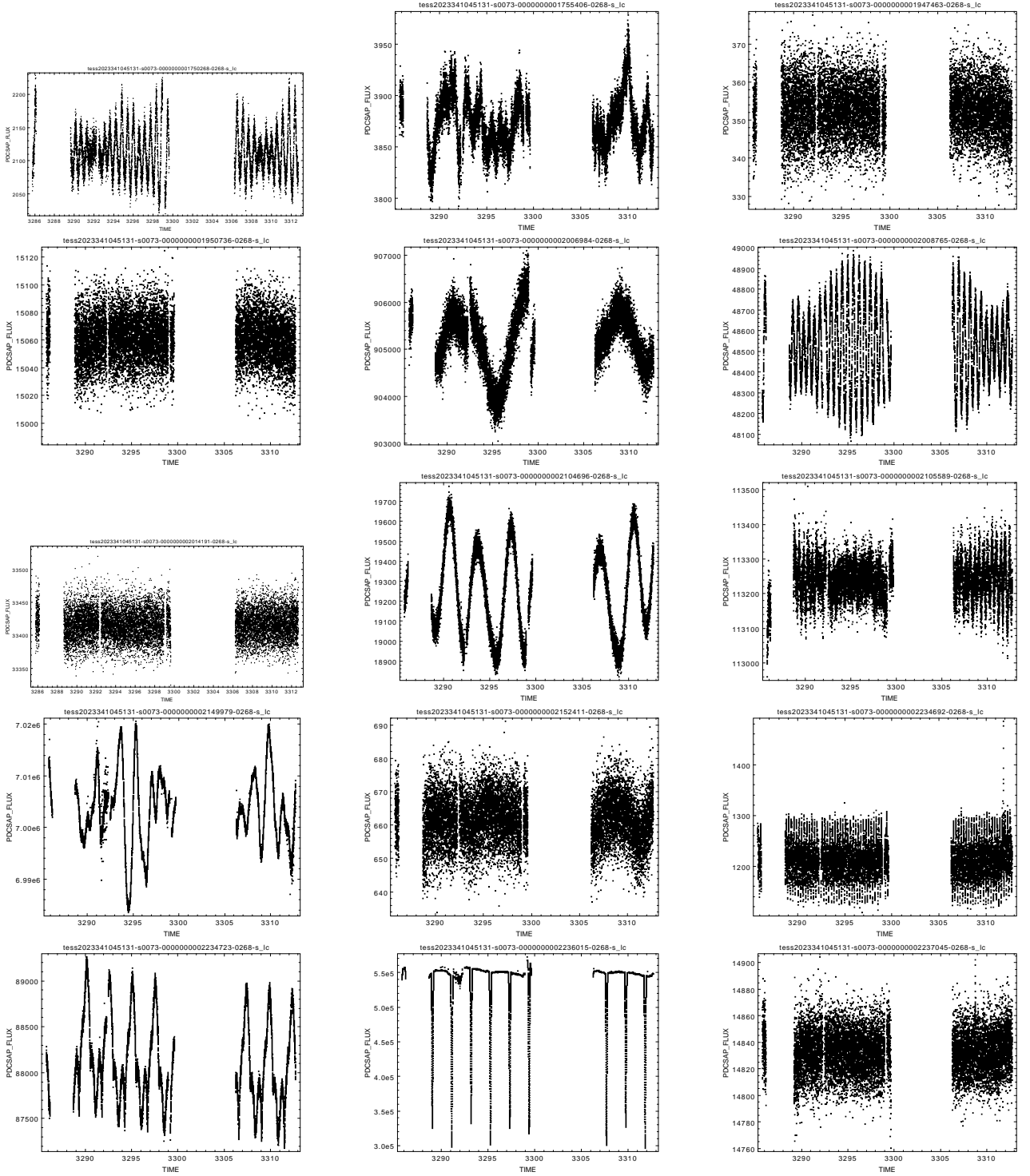


Figure 11: Set of 15 generated plots.

## C Problems and Solutions Encountered

- One problem encountered was the need to modify the Bash path in the file `tesscurl_sector_73_lc.sh`, as the script would not run otherwise. The `which` command was used to find the correct Bash location.
- Another issue was that the script uses the `curl` command. The solution was to install this tool using `sudo apt-get install curl`.
- Batch conversion from FITS to CSV was attempted but not possible. Therefore, the format had to be changed individually for each file.

- It was also noted that TOPCAT does not automatically append the `.csv` extension to files. While this did not cause issues within TOPCAT, it could lead to problems when opening files with other programs. As a result, the extension was added manually to each file name.
- Additionally, saving the light curve plots in PNG format resulted in poor image quality. However, saving them in PDF format significantly improved the quality.

## References

- N. Hernitschek. Tutorial 2. [https://github.com/ninahernitschek/astroinformatica\\_I\\_2025\\_1/blob/main/tutorial2.pdf](https://github.com/ninahernitschek/astroinformatica_I_2025_1/blob/main/tutorial2.pdf), 2025a. PDF available on GitHub.
- N. Hernitschek. Tutorial 3. [https://github.com/ninahernitschek/astroinformatica\\_I\\_2025\\_1/blob/main/tutorial3.pdf](https://github.com/ninahernitschek/astroinformatica_I_2025_1/blob/main/tutorial3.pdf), 2025b. PDF available on GitHub.