Weekly research updates

Summer 2024

Alexandra Rochon

Week 1 - 22/05

- Settling in, organizing work flow for the summer
- Signed up for CRAQ summer school
- Read cadieux 2024, damiano 2024, doyon 2024, greene 2023
- Lit Review → lot of overlap/connections with previous research modeling ice coverage for water worlds (supervised by Gomez, Navarro)
- Made most modifications to report from Cowan/Dang comments
- Started designing CASCA poster
- Overlooked Eureka! docs

week 2 - 27/05

- Downloaded Eureka! on my laptop, no issue
- For tutorial, data files are too large to download locally (77GB) so I only used a few files (segmented)
- Error in import statements when running Eureka but adding path/to/libs solved it + additional debugging, missing template file for S1 MIRI lrs, environment variable for CRDS installation,
- Having trouble with the tutorial which is adapted for NIRSpec data and I keep getting errors with the practice data for MIRI…
- Tried with the LHS1140 data downloaded last week, starts to run without error but runs out of memory so will need to use cluster.
- Worked on CASCA poster
- Emailed Luc Turbide to ask about documentation for the clusters…

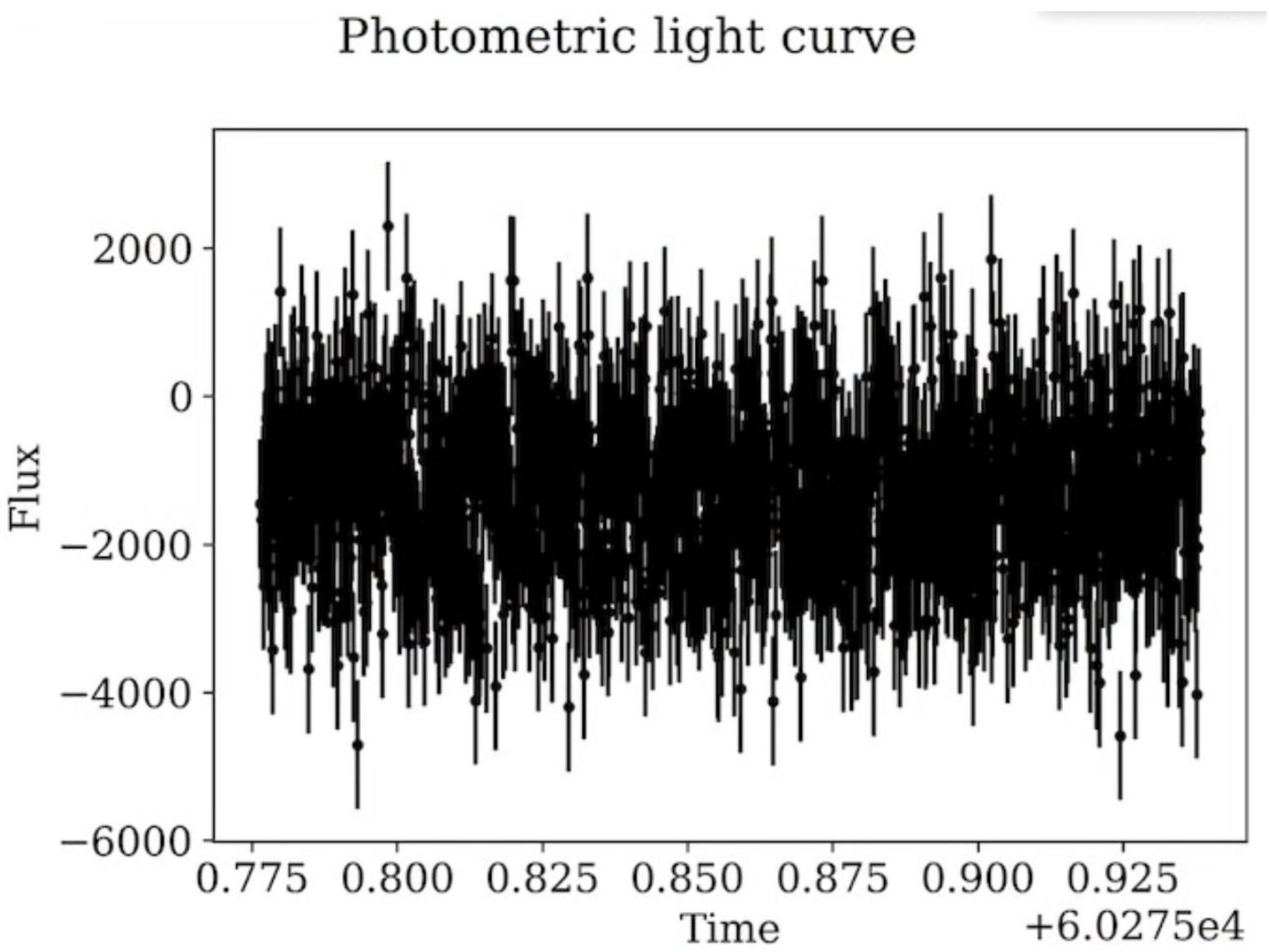
week 3 - 03/06 - CASCA

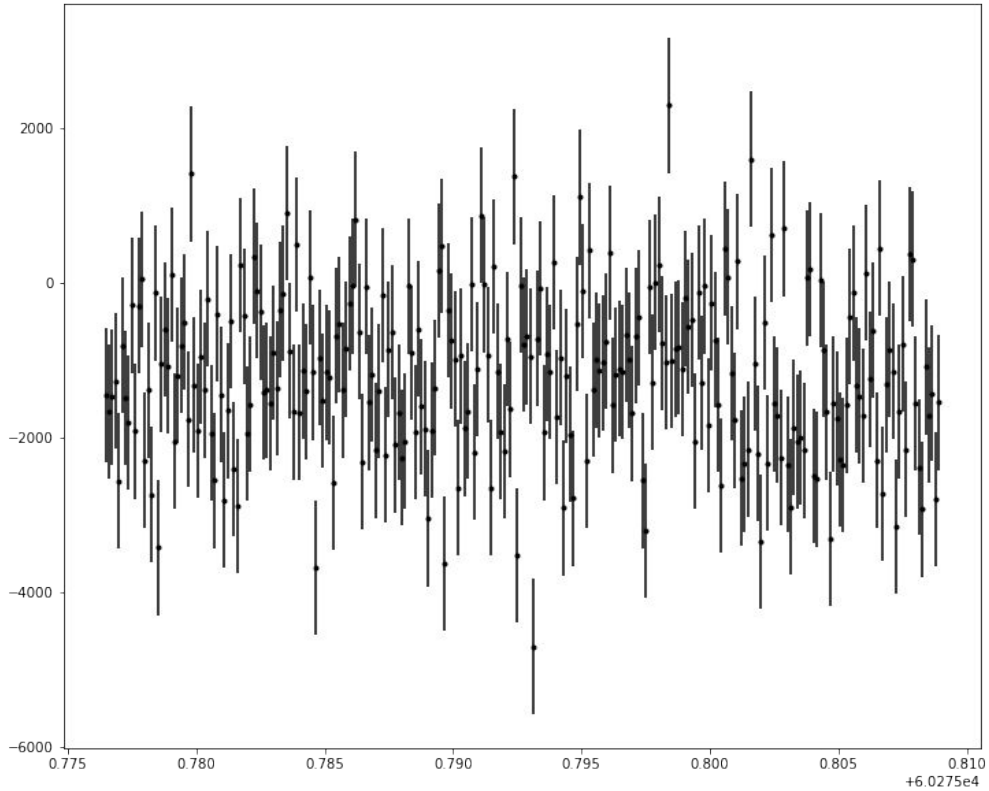
- Finished poster + printed
- Attended JWST, Exoplanets 1 & 2 talks and most of the telescopes and award talks.
- Presented the poster, had lots of interesting discussions and questions!
- Filling up CSA final report
- Created a Parsec account
- Read Cadieux et al. 2024b (spectrophotometric transits of LHS1140 b, stellar activity in the spectra from unocculted stellar faculae, no spots, flat spectra suggesting high mean molecular weight atmosphere, GCMs exclude mini-neptune scenario, h2 atmosphere also excluded, tentative detection of N2 Rayleigh scattering)

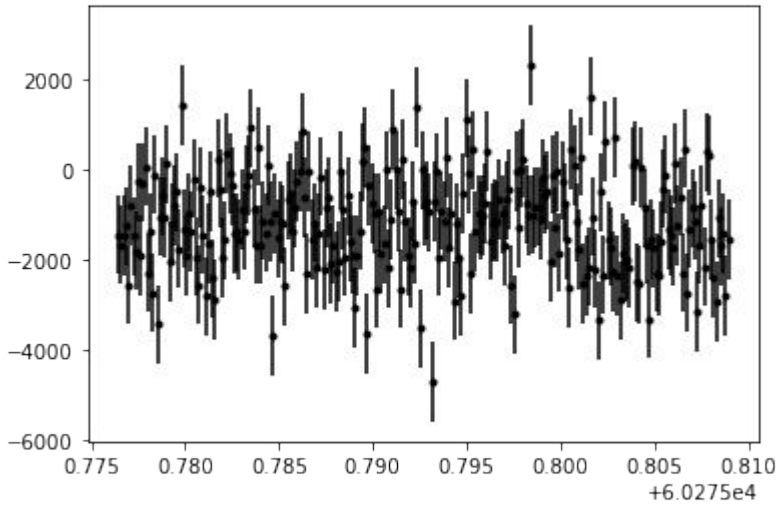
→ Will be getting Eureka! up and running on the cluster ? / use parsec with Lisa's computer at home and attempt to get a LC

week 4 - 10/06

- Downloaded LHS1140 c data onto Lisa's computer
- Set up template files to run Stages 1-3, after some debugging, and having to change xwindow, ywindow and ctr_guess (value between 1-255), obtained a LC! Worth testing if this param influence the LC produced, but the original window size gave index out of bounds error
- Uploaded the dataset to a jupyter notebook to identify the eclipse
- Reproduced the output plots from Stage 3 (to make sure I had the right dataset and get familiar with it) and changed time array with Astropy to something more legible + added Time of mid Eclipse on the graph
- Re-ran stages 1-3 to recenter the first guess centroid (which was definitely off, used the DS9 image to estimate), not discard first and last frame (recommended for MIRI TSO), change aperture and background annulus size (referred to greene2023 for params)

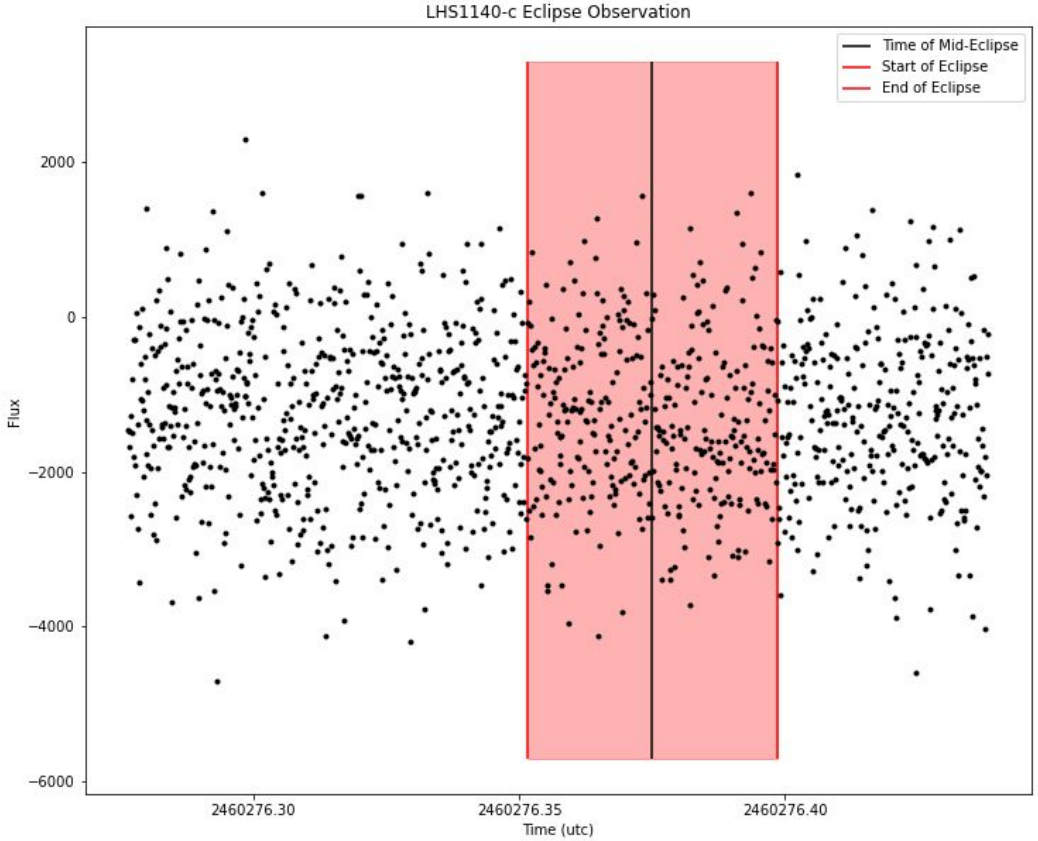

Photometric light curve
2000
0
−2000
−4000
−6000
Flux
0.775
0.800
0.825
0.850
0.875
0.900
0.925
Time
+6.0275e4





Remade the plot with bigger fig size, x axis is shorter than expected because this is only the first segment (datasets saved separately

week 4 - 10/06


LHS1140-c Eclipse Observation
Time of Mid-Eclipse
Start of Eclipse
End of Eclipse
2000
0
−2000
−4000
−6000
Flux
2460276.30
2460276.35
2460276.40
Time (utc)

week 4 - 10/06

- Tested a range of values for aperture photometry size ([4,12]) and annulus size of 12 (inner) to 30 (outer)
- Stage 1 takes > 1 hour, stage 2 < 1 min, stage 3 ~ 10 min for a single aper value
- All params chosen are described here: https://docs.google.com/document/d/1tNnxkA_-CplqPSZAkI4FFosvilsa9cWYQKUf5o2lObc/edit?usp=sharing
- Things to check on for better fit:

```
WARNING: The selected meta.wave_min (1.5) is smaller than the shortest wavelength (15.0)!!
  If you want to use wavelengths shorter than 15.0, you will need to decrease your ywindow lower limit in Stage 3.
```

```
Traceback (most recent call last):
  File "/Users/lisadang/Desktop/LHS1140c/DataAnalysis/JWST/LHS1140_trials/run_eureka.py", line 31, in <module>
    s5_meta = s5.fitlc(eventlabel, ecf_path=ecf_path, s4_meta=s4_meta)
NameError: name 's4_meta' is not defined
```

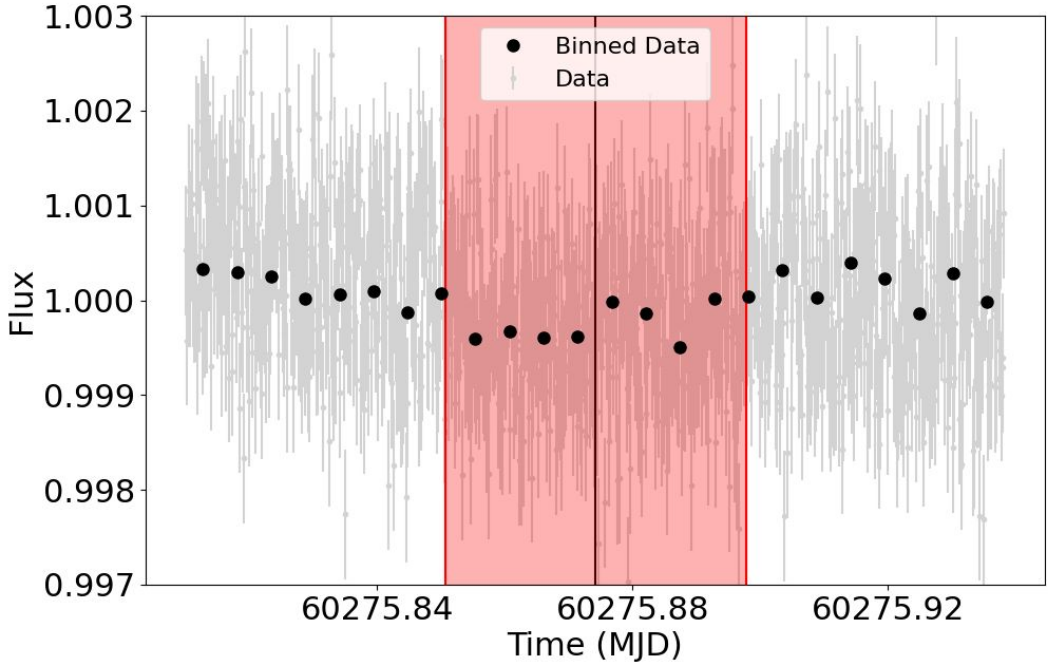
when running stage 5 without s4 at the same time i.e. can't run only S5

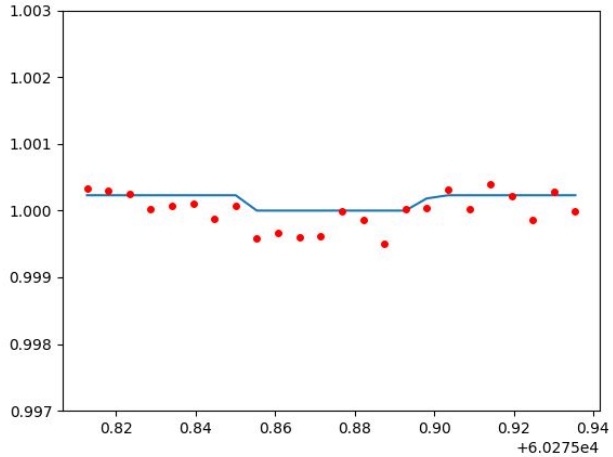
Échéancier été 2024 - iREx

DATE	Tâches
10 juin - 16 juin	- Run Eureka stages 1-3 - Get first eclipse fit with S5 - Make plots
17 juin - 23 juin	- Focus on writing / correcting KELT-20b paper - Re-remove deviant points with same photometry as Zoe - Run decorrelation & update figures (if possible)
24 juin - 30 juin (4 days)	- CRAQ summer school ? - Run decorrelation & update figures for KELT-20b - Get through emcee & batman tutorials
1er jul - 7 jul (4 days)	- Visite à l'OMM - Run decorrelation & update figures for KELT-20b - Get through emcee & batman tutorials
8 jul - 14 jul	- Run new LHS1140c data on Eureka! - Custom fit for LHS1140c
15 jul - 21 jul	- Custom fit for LHS1140c
22 jul - 28 jul	- Custom fit for LHS1140c
29 jul - 4 août	- Custom fit for LHS1140c
5 août - 11 août	- Wrap up LHS1140c code and figures - Wrap up KELT-20b paper
12 août - 18 août	- Wrap up LHS1140c code and figures - Wrap up KELT-20b paper
19 août - 23 août	- Wrap up LHS1140c code and figures - Wrap up KELT-20b paper - End of summer presentation
Fin du stage	

Link : https://docs.google.com/document/d/1f5VsDUVYKmAf5gFwv0jzXOLCG5EChO37aBOn8QKC6mM/edit?usp=sharing

- made a figure for the DDT
- quickly experimented with overlaying a batman transit on the graph which we decided wasn't necessary for the proposal



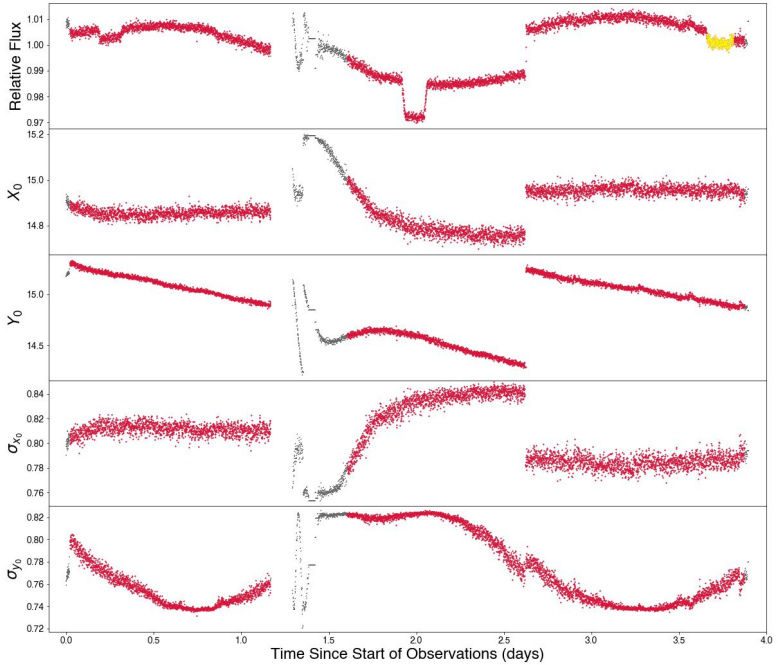


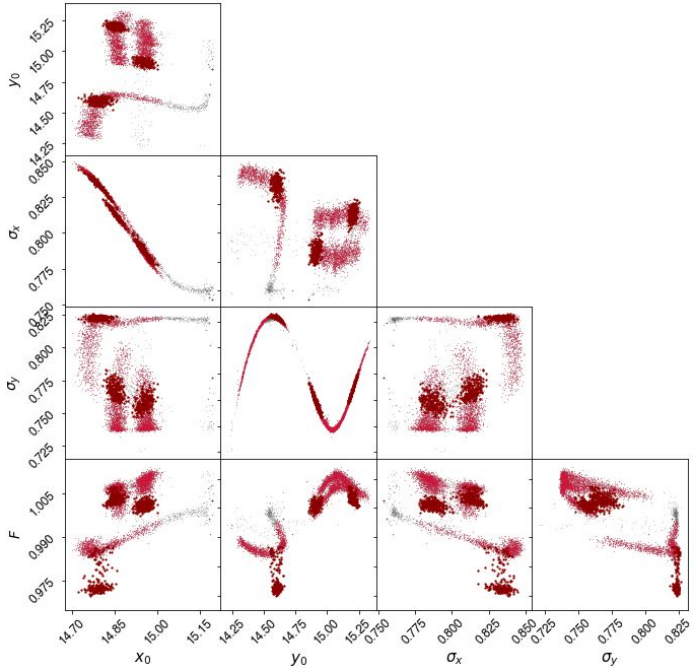
week 5 - 17/06

- Went to QC to receive Excelle Science award for Women in traditionally men-dominated areas of studies!
- Got a hard drive to be able to handle the JWST data and cleaned up my computer (which couldn’t keep up anymore)
- Debugged LaTeX for KELT-20b paper and corrected most comments
  - didn’t touch EBM section (discuss later)
  - added figure comments for modifications on final version once decorrelation is re-run
  - added questions for lisa (mostly to clarify some comments from the report)
  - re-wrote some sections / sentences which were confusing

week 5 - 17/06

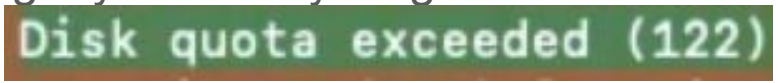
- Re-binned the BLISS/polynomial data cubes + started decorrelation
- Made some plots





week 5 - 17/06

- All of zoe's directories are empty + no pickle files for the data
- Got the photometry from Lisa's hard drive
- Set up the decorrelation with manually inputting the planet properties (no pkl)
- Ran BLISS + 2-5 POLYs, PSFW true
- Uploaded the data to compute canada using rsync → very long due to error but now fixed (permission issue)



- lot of decorrelation debugging due to all datafiles being gone → internet downloaded data from pickle file needs to be replaced, remade all the directories and downloaded the data, downloaded the phoenix fits files and kept same version for consistency

week 6 - 24/06 - CRAQ summer school

- Continuing to debug decorrelation.py
- Locally made a .pkl file using Zoe's code
- Issue with astropy:

OSError: No SIMPLE card found, this file does not appear to be a valid FITS file. If this is really a FITS file, try with ignore_missing_simple=True
Done

- Reran Eureka! stage 3 with better background annulus and range of aperture
  - center from S2 could be moved by 1-2 pixels maybe

week 6 - 24/06 - CRAQ summer school

- Issue with connecting to genesis → times out
- for decorrelation: tried re downloading the data and uploading it to CC with rsync, deleting all ._ duplicate files (long!)
- decorrelation is running!! for BLISS-POLY → PLD before end of week hopefully and PFSW true/false next week
- CRAQ summer school: 3-days of presentations seminar style and learning activities using Jupyter notebooks, learned about applications of ML to many areas of astrophysics (mostly galaxy/cosmology/black holes etc. not as much exoplanets), how certain types of algorithm are trained and the basics of neural networks and training them by minimizing the loss function

week 7 - 01/07 - Visite OMM

- Observed 2 nights, such a great experience!! and learned so much
- First night: ideal (photometric) conditions no wind/clouds for a good part of the night, stargazed and identified multiple sky objects (milky way; constellations likes cassiopeia, dippers, scorpio, sagittarius, ; andromeda (faintly); mars; jupiter; saturn; red giants; shooting stars), used CPAPIR and PESTO instruments to observe two targets (galaxy and brown dwarfs), some issues with the air pressure in the vessie supporting the big mirror, had a 2.5 hour guided visit of the observatory, observed from 9:30 pm to 3:30 am
- Second night: (slept during the day) heavy cloud coverage and some rain, no observing possible, changed the CPAPIR instrument to the ocular to prepare for ASTROfest, unplugged and unscrewed the first instrument, removed it using the lift, installed the second and spent a few hours rebalancing the telescope with steel plates in the North-South / Declination / Right Ascension directions, hoped to observe with the optical but it was too rainy

week 7 - 01/07 - Visite OMM

- Signed up for Ambassadrices du ciel d’été et des Perséides
- Signed up to volunteer for the astronomy kids camp (10-12 yrs old) to give a 10 min presentations (5 times - 1h30) on my research
- last pld decorrelation started on friday didn’t work because of ignoreFrames keyword → switched to false to match zoe’s analysis (i think), can’t verify since all results from zoe’s runs are deleted

- issue connecting to genesis fixed itself, but couldnt access eureka outputs from lisas computer through parsec → will upload all of the data
- haven’t looked at the S5 eureka output because of this

recap of the past 3 weeks (no group meetings)

- Excelle Science in QC, CRAQ, OMM
- Spent most of my time debugging decorrelation and working on the KELT-20b paper, made some plots, fixed all the comments, started an in-depth lit review
- Re-ran eureka with better aperture sizes and a few S5 trials (was waiting on access to the data and results to upload to Genesis and CC) → debugged that for a while but now everything is up on Genesis

week 8 - 08/07

- Decorrelation wasn’t done at the beginning of the week (taking a long time), says it’s still running but no changes to the sbatch file in the last 24hrs & don’t have access to parsec/eureka to upload the data to Genesis and to review the S5 results
- Filled out expense form for OMM
- Coding hours notes:

    cd - : control z

    z : like cd but learns paths in memory so that you don’t need the full path

    vim plugins shortcuts

    ssh keys on both computers (don’t use passphrase) to connect more rapidly → only two commands ssh key_gen ssh copy_id or ssh-copy_id -i ~/path/to/key

    htop and screen

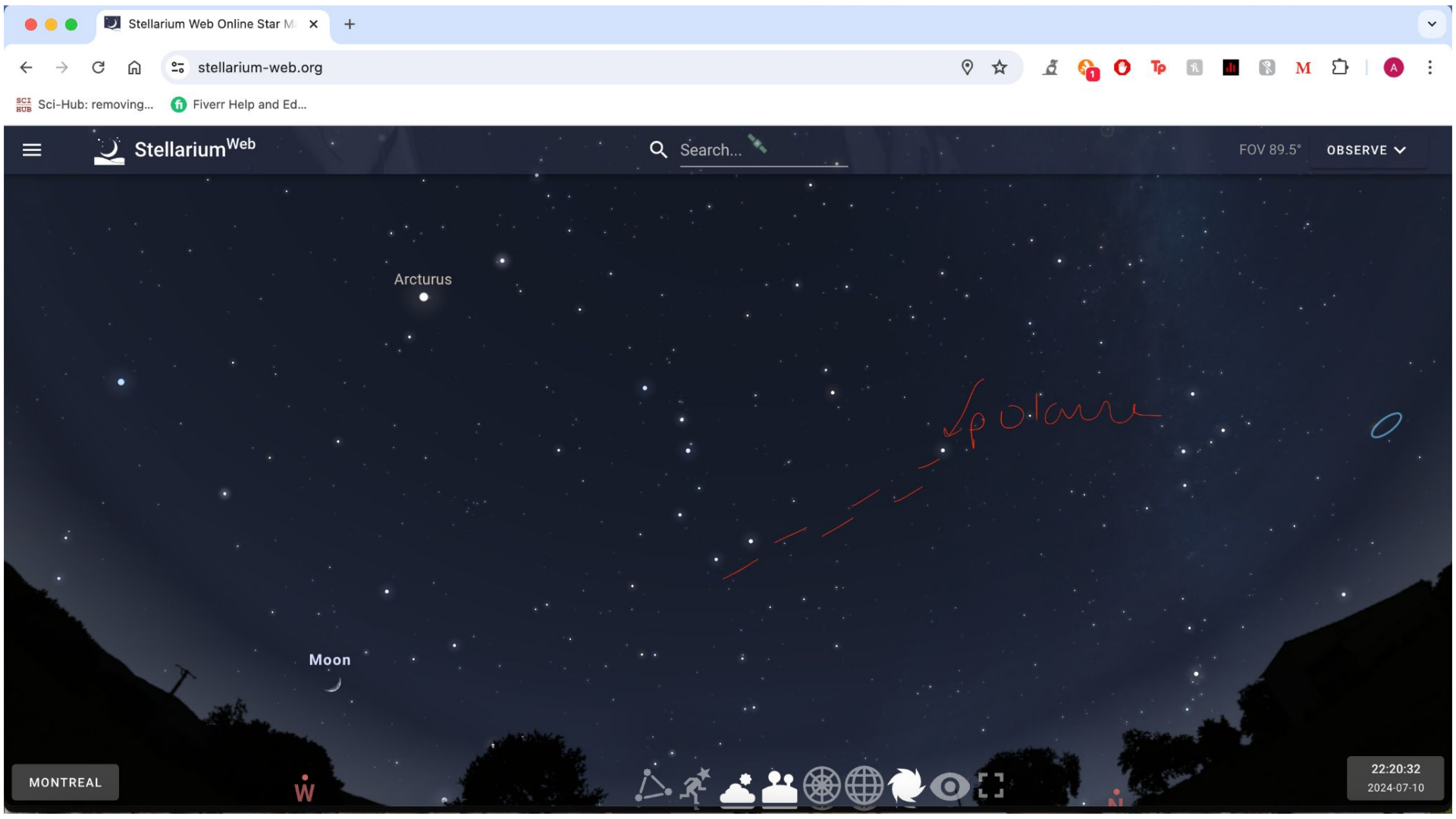
week 8 - 08/07

- went to coding hour to get help with rsync through remote connect from lisa's computer to upload data to genesis (jumping through venus) which is complicated without a .config file

  rsync -avz -p 5822 -e 'ssh -J arochon@venus.astro.umontreal.ca:5822' /Users/lisadang/Desktop/LHS1140c/Data/JWST
- still raises an error but file transfer works…
- Started KELT-20b lit. review and added all of the ADS library papers to the bibliography and downloaded pdfs
- Added photometry details to the paper

week 8 - 08/07 - Training Perséides

- App Stellarium pour map du ciel intéractive, astropheric pour prévision conditions detaillées d'observation, windy pour images en temps réel, https://darksitefinder.com/map
- 3 constellations pour identifier la voie lactée: Cassiopée, Cygne, Sagittaire (for sagittarius A*)
- triangle d'été
- objet de ciel profond:
  - cassiopée pour trouver M31 / andromède et le carré (pegase
  - L'anneau de la lyre dans le triangle d'été (sur un côté)
  - graveyard? in hercules
- La lune croissante se couche pendant la nuit et décroissante se lève pendant la nuit


Stellarium Web Online Star M
stellarium-web.org
Sci-Hub: removing...
Fiverr Help and Ed...
StellariumWeb
Search...
FOV 89.5°
OBSERVE
Arcturus
Moon
MONTREAL
22:20:32
2024-07-10

ongoing tasks

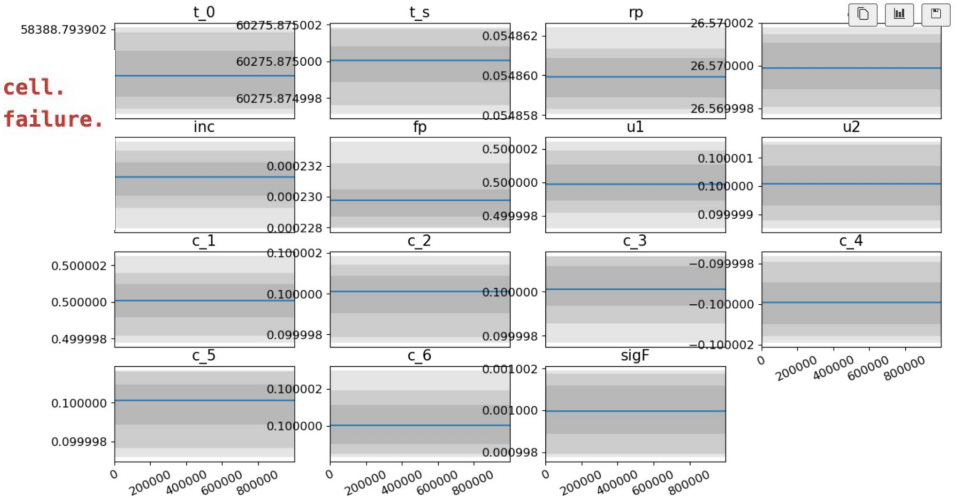
- Fix decorrelation for PLDs
- Re-read the paper
- Look at papers for kelt-20b, add bullet pt 2-line summary des papers (lit review)
- Get better S5 fit for LHS1140
- Get custom fit for LHS1140
- Analyze change in psf by normalizing (stack + median) and stacking and make movie
- prepare for presentation for Camp de jour on my research (~10 min)

week 8 - 08/07

- Used Lisa's notebook draft to set up an MCMC to fit the LHS1140c eclipse with BATMAN
- Notebook works without issue but the MCMC posterior is flat…
- the kernel crashes sometimes → will upload on CC and set up parallel processing to see if it runs faster / without crashing

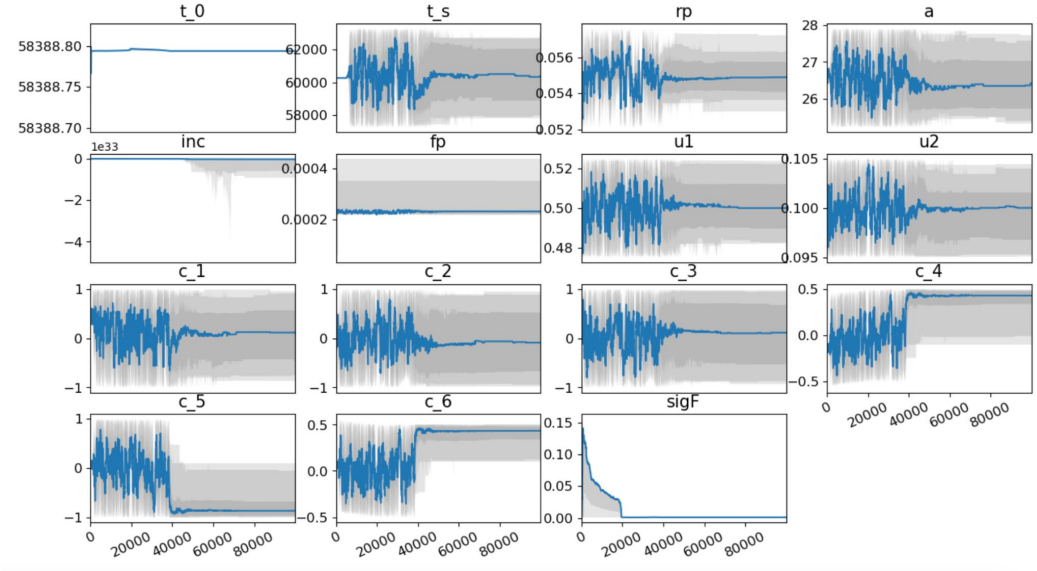
```
The Kernel crashed while executing code in the current cell or a previous cell.
Please review the code in the cell(s) to identify a possible cause of the failure.
Click here for more info.
View Jupyter log for further details.
```

ValueError: Initial state has a large condition number. Make sure that your walkers are linearly independent for the best performance



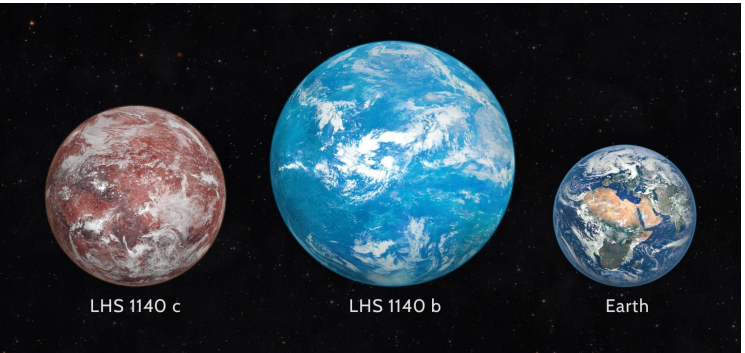
week 8 - 08/07

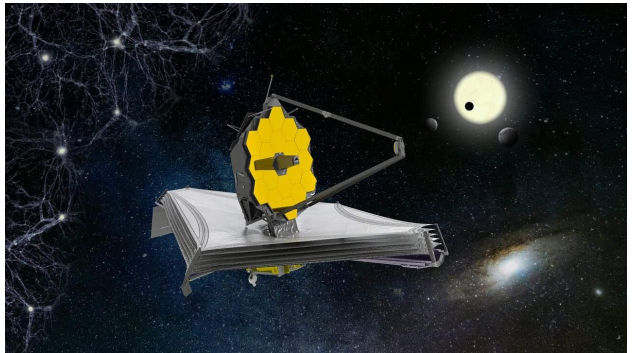
- increasing scatter in initial position, increasing prior bounds and not fitting binned data fixed it
- still need CC to prevent kernel crashing (running out of memory most likely)

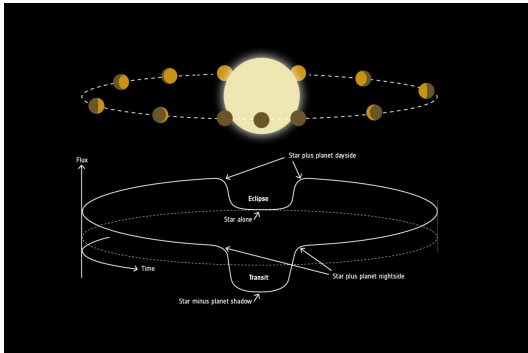


week 9 - 15/07

- prep présentation camps de jour:
    - se présenter, demander noms (4-5 enfants par gr)
    - demander / recap cest quoi une exoplanète
    - période de question à la fin (sur la présentation ou autre)
    - image de JWST ?
    - image du système LHS1140 et buts du projet
    - image d’un transit/éclipse





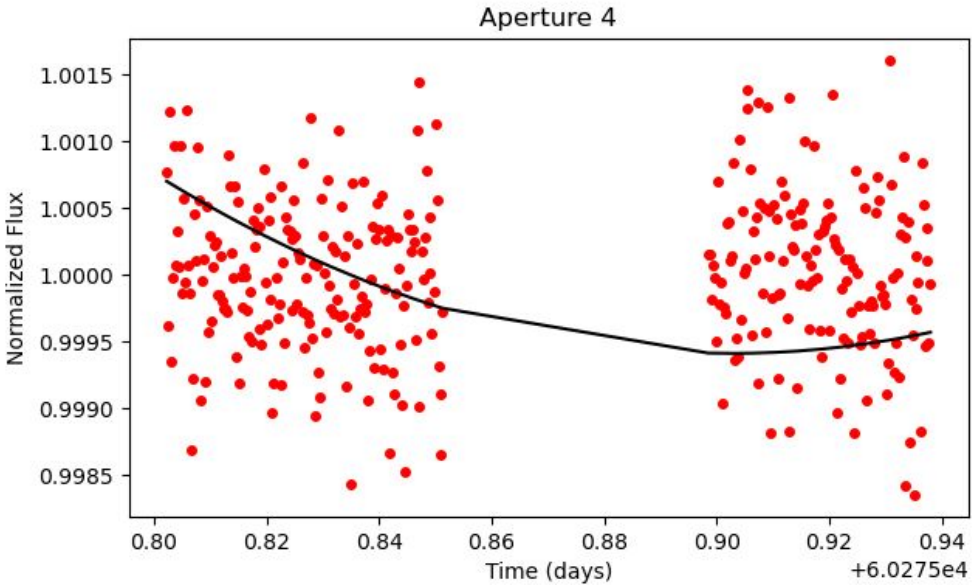


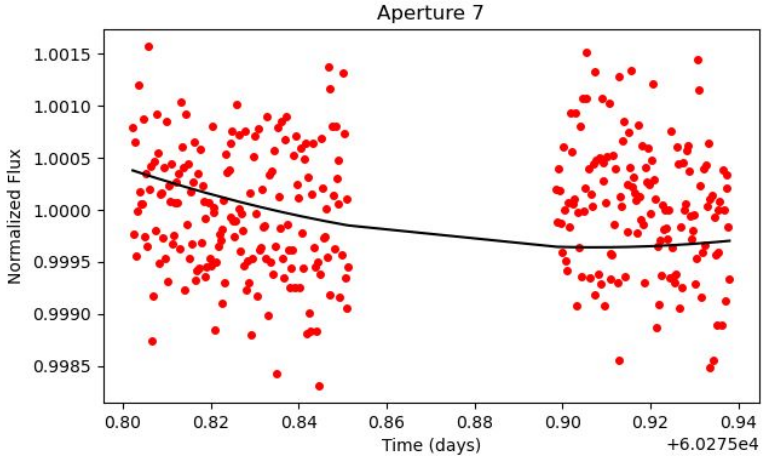
week 9 - 15/07

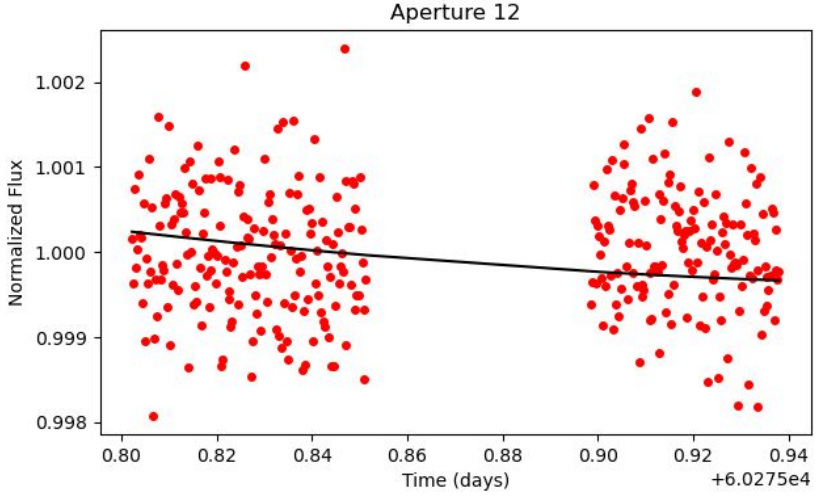
- Présentation camp de jour s’est très bien passée! Vraiment fun de voir les jeunes motivé.es par l’espace et les sciences, leurs posters étaient bien réussis
- Défense de thèse Radica + séminaire Greene, interesting to learn about the scope and gaps in characterizing exoplanets, great example of how to give a good talk
- Recap CASCA at iREx café

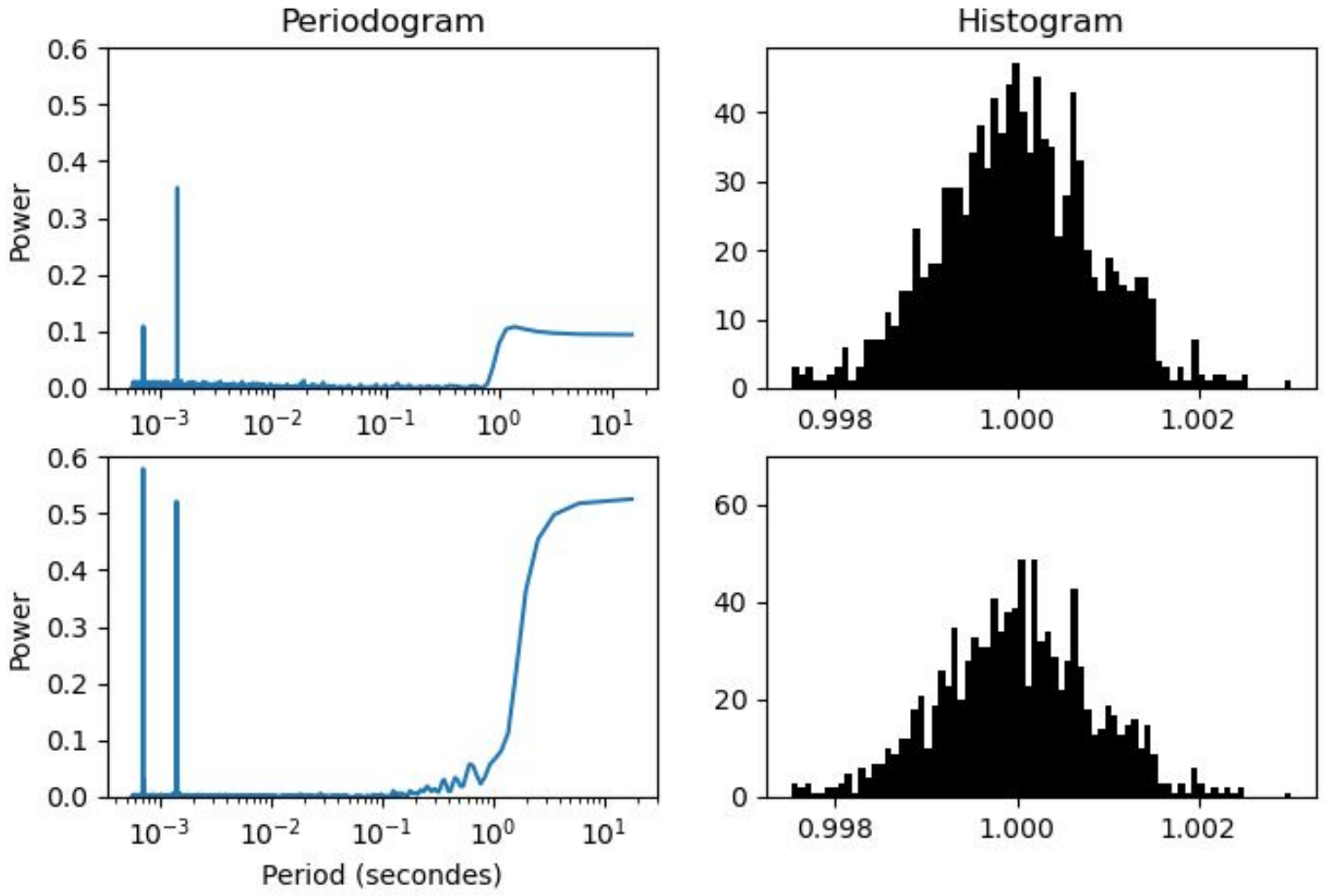
week 9 - 15/07

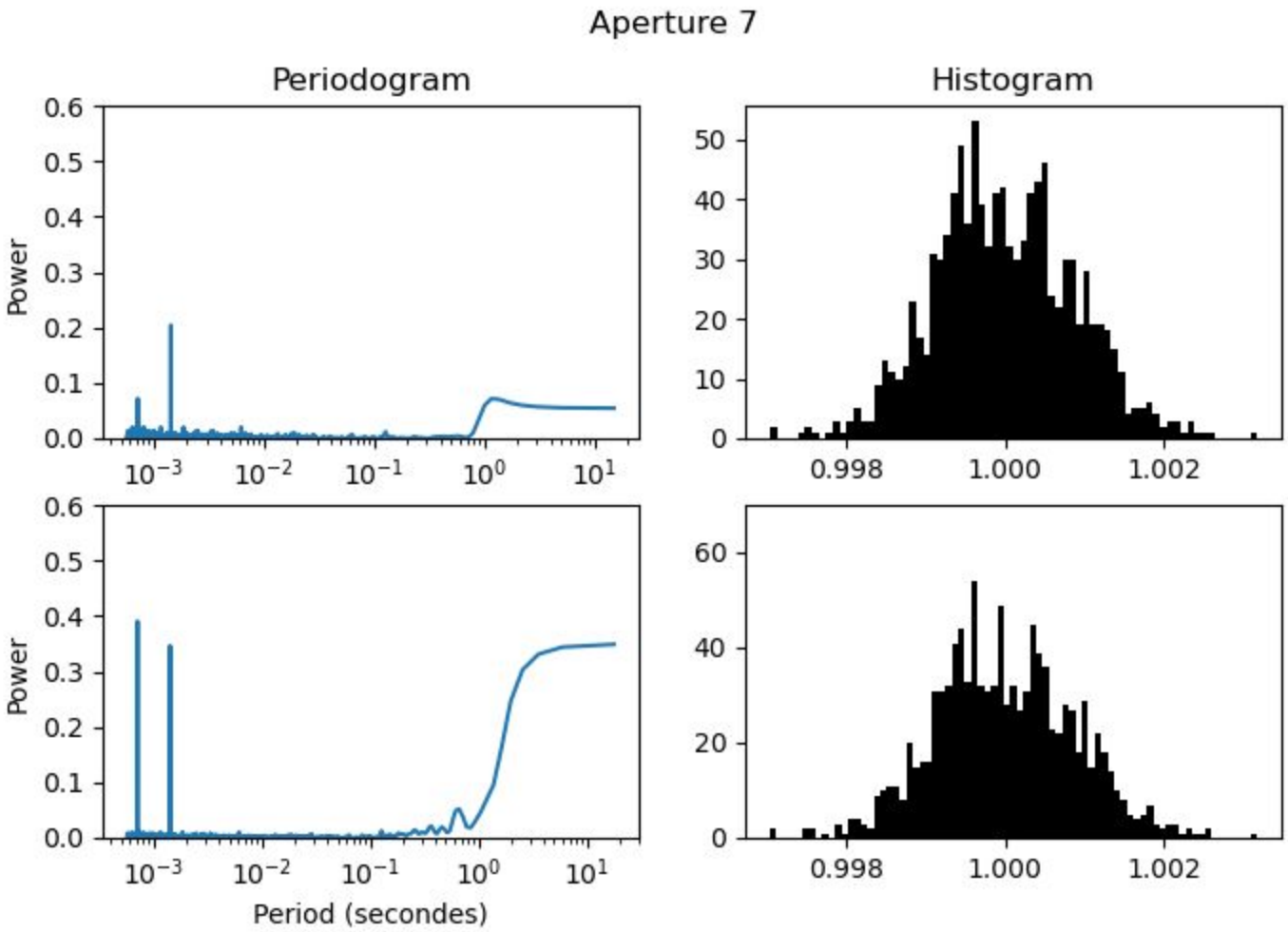
- Stats on the data of LHS1140-c Stage 3 for 3 aperture sizes [4, 7, 12]
- Min / max / middle value tested
- Very high frequency / short periodicity in the signal ~ milliseconds, the unit time for the measurements is ~ 11 seconds
- std of residuals for each aperture > each error bars
- error bars are very small, calculated at each point but std ~10^-7
- this is for normalized data, and I compared the full (‘raw’) flux with the one where i removed first 200 pts (~36 mins), the eclipse and 2nd degree linear trend
- see if using boxcar makes a diff?

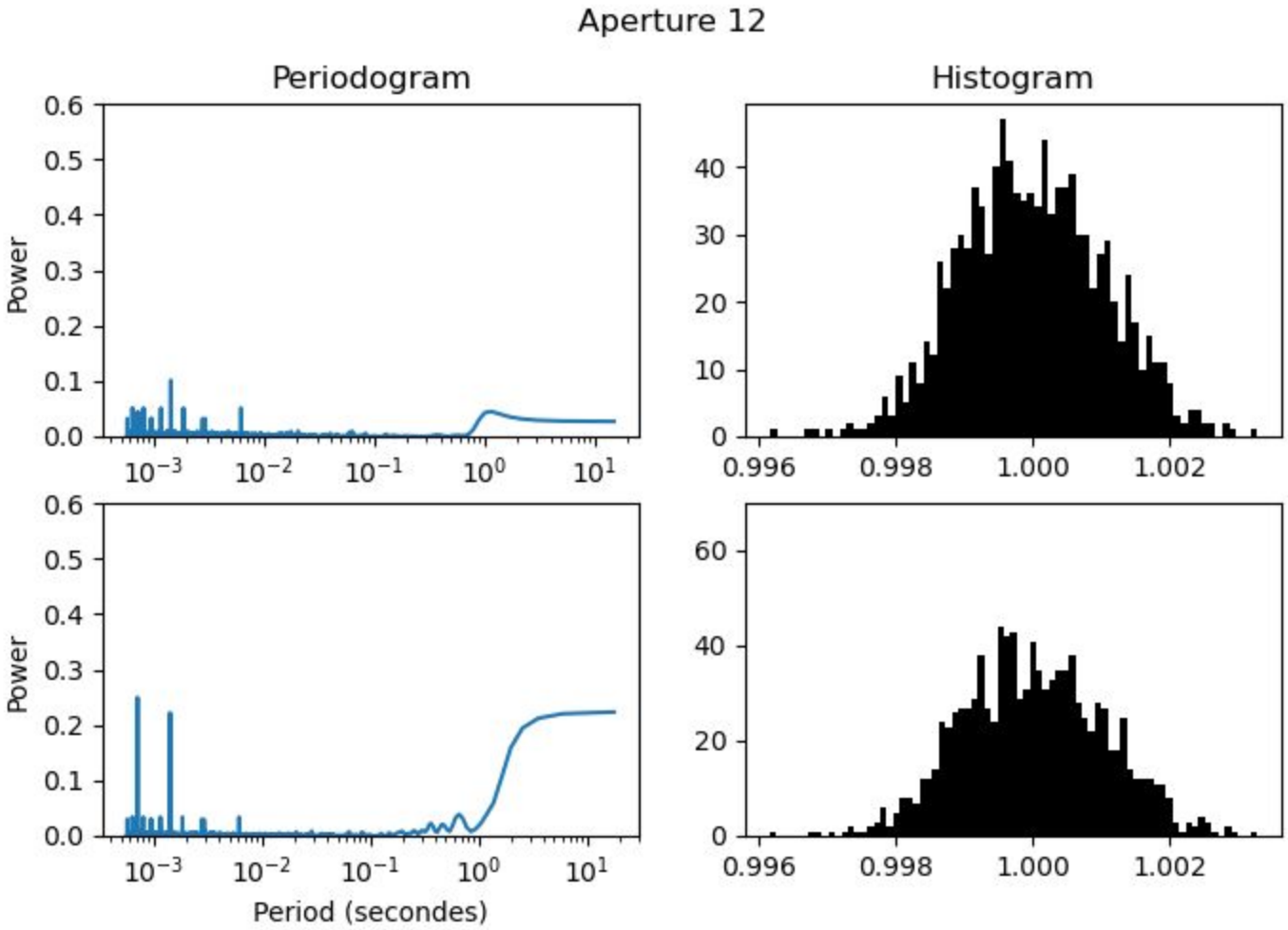

Aperture 4
Normalized Flux
1.0015
1.0010
1.0005
1.0000
0.9995
0.9990
0.9985
0.80
0.82
0.84
0.86
0.88
0.90
0.92
0.94
Time (days)
+6.0275e4


Aperture 7
Normalized Flux
1.0015
1.0010
1.0005
1.0000
0.9995
0.9990
0.9985
0.80
0.82
0.84
0.86
0.88
0.90
0.92
0.94
Time (days)
+6.0275e4


Aperture 12
Normalized Flux
1.002
1.001
1.000
0.999
0.998
0.80
0.82
0.84
0.86
0.88
0.90
0.92
0.94
Time (days)
+6.0275e4

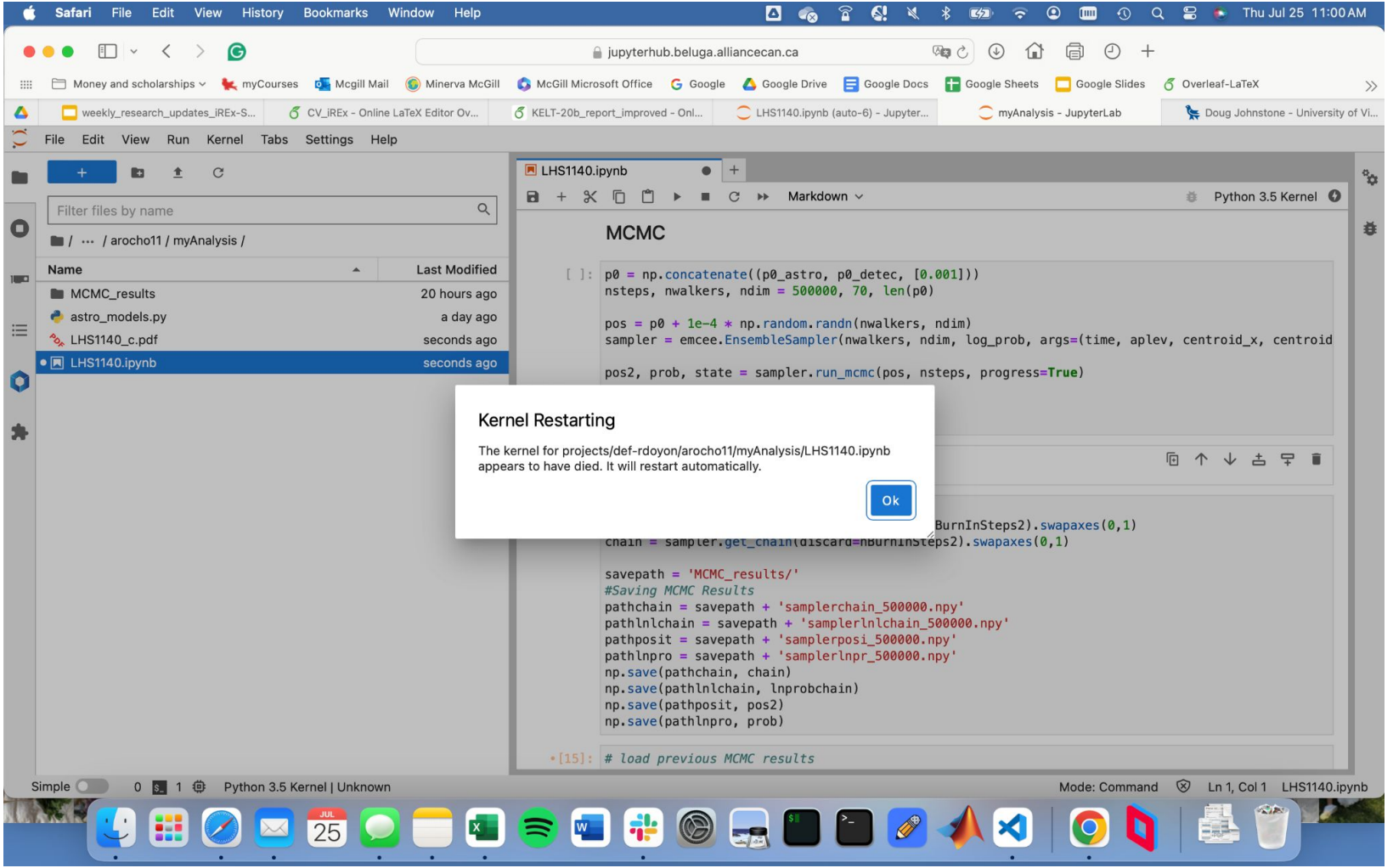

Aperture 4
Periodogram
Histogram
Power
Power
Period (secondes)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
40
30
20
10
0
60
0.998
1.000
1.002

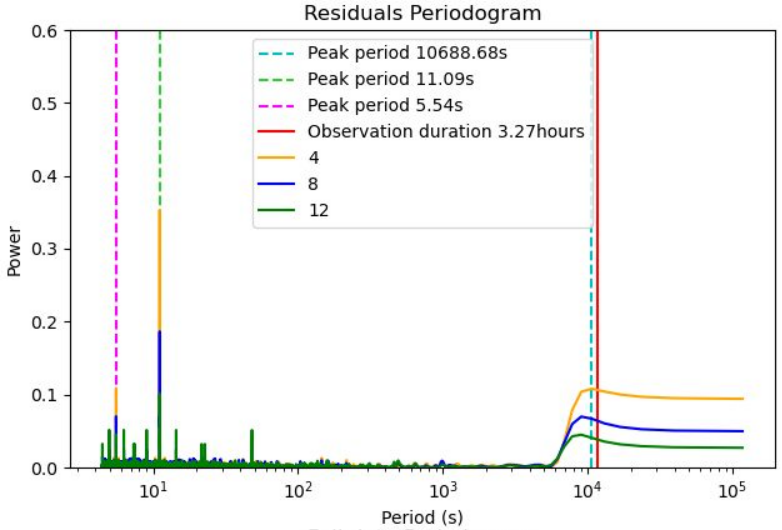

Aperture 7
Periodogram
Histogram
Power
Power
Period (secondes)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
50
40
30
20
10
0
60
0.998
1.000
1.002

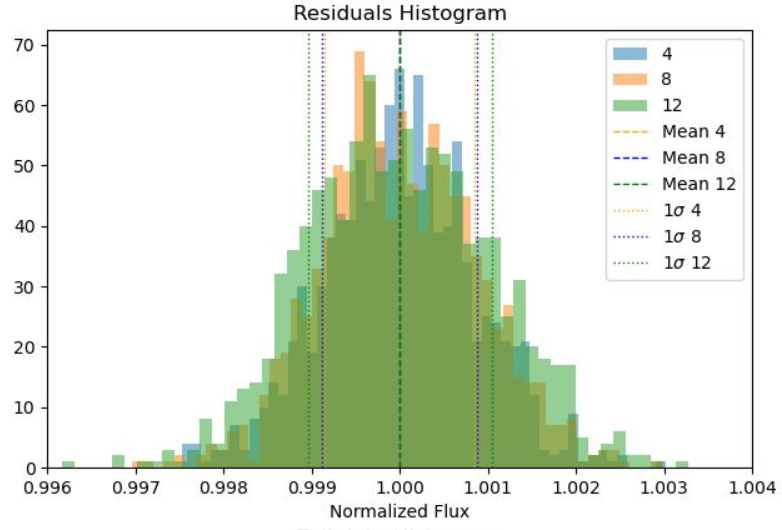

Aperture 12
Periodogram
Histogram
Power
Power
Period (secondes)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
0
10
20
30
40
60
0.996
0.998
1.000
1.002

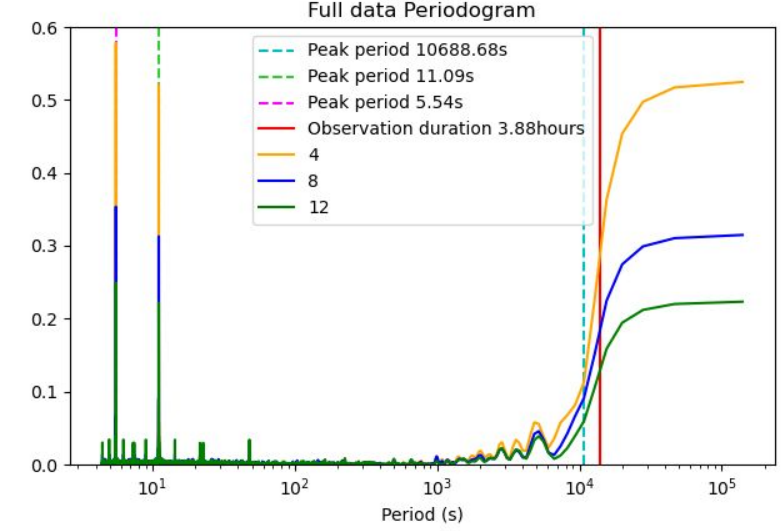
week 10 - 22/07

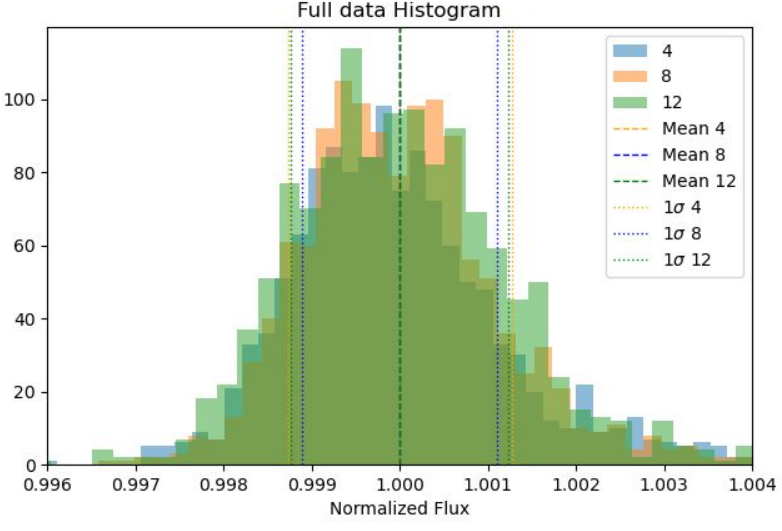
- finalized plots for stats
- downloaded new eclipse observations and ran S1-S3 (lost access to parsec for a few days before i could check results)
- iREx cafe: Hogg and Foreman-Mackey () for MCMC
- uploaded the MCMC notebook to CC to be able to do longer runs
    - created python venv
    - pip installed all necessary packages including ipykernel
    - created kernel and connected to CC
- Issues:
    - works well but kernel still crashes at times when trying to produce a corner plot
    - very slow wifi? everything takes a while to download 24/07


Safari File Edit View History Bookmarks Window Help
Thu Jul 25 11:00 AM
jupyterhub.beluga.alliancecan.ca
Money and scholarships
myCourses
Mcgill Mail
Minerva McGill
McGill Microsoft Office
Google
Google Drive
Google Docs
Google Sheets
Google Slides
Overleaf-LaTeX
weekly_research_updates_iREx-S...
CV_iREx - Online LaTeX Editor Ov...
KELT-20b_report_improved - Onl...
LHS1140.ipynb (auto-6) - Jupyter...
myAnalysis - JupyterLab
Doug Johnstone - University of Vi...
File Edit View Run Kernel Tabs Settings Help
Filter files by name
/ ... / arocho11 / myAnalysis /
Name
Last Modified
MCMC_results
20 hours ago
astro_models.py
a day ago
LHS1140_c.pdf
seconds ago
LHS1140.ipynb
seconds ago
LHS1140.ipynb
Markdown
Python 3.5 Kernel
MCMC
[ ]:
p0 = np.concatenate((p0_astro, p0_detec, [0.001]))
nsteps, nwalkers, ndim = 500000, 70, len(p0)
pos = p0 + 1e-4 * np.random.randn(nwalkers, ndim)
sampler = emcee.EnsembleSampler(nwalkers, ndim, log_prob, args=(time, aplev, centroid_x, centroid
pos2, prob, state = sampler.run_mcmc(pos, nsteps, progress=True)
Kernel Restarting
The kernel for projects/def-rdoyon/arocho11/myAnalysis/LHS1140.ipynb appears to have died. It will restart automatically.
Ok
BurnInSteps2).swapaxes(0,1)
chain = sampler.get_chain(discard=nBurnInSteps2).swapaxes(0,1)
savepath = 'MCMC_results/'
#Saving MCMC Results
pathchain = savepath + 'samplerchain_500000.npy'
pathlnlchain = savepath + 'samplerlnlchain_500000.npy'
pathposit = savepath + 'samplerposi_500000.npy'
pathlnpro = savepath + 'samplerlnpr_500000.npy'
np.save(pathchain, chain)
np.save(pathlnlchain, lnprobchain)
np.save(pathposit, pos2)
np.save(pathlnpro, prob)
•[15]:
load previous MCMC results
Simple
0
1
Python 3.5 Kernel | Unknown
Mode: Command
Ln 1, Col 1
LHS1140.ipynb


Residuals Periodogram
Peak period 10688.68s
Peak period 11.09s
Peak period 5.54s
Observation duration 3.27hours
4
8
12
Power
Period (s)


Residuals Histogram
4
8
12
Mean 4
Mean 8
Mean 12
1σ 4
1σ 8
1σ 12
Normalized Flux


Full data Periodogram
Peak period 10688.68s
Peak period 11.09s
Peak period 5.54s
Observation duration 3.88hours
4
8
12
Period (s)


Full data Histogram
4
8
12
Mean 4
Mean 8
Mean 12
1σ 4
1σ 8
1σ 12
Normalized Flux

Residuals:

Aperture: 4

 mean: 1.0000000000244904

 std: 0.0008558676513334198

 Noise ratio: 1.2835943508461207

Aperture: 6

 mean: 1.0000000000070268

 std: 0.0008668216588924773

 Noise ratio: 1.2783701495580815

Aperture: 8

 mean: 1.0000000000055949

 std: 0.0008843538384293633

 Noise ratio: 1.285247991637901

Aperture: 10

 mean: 1.0000000000063378

 std: 0.0009500678479668648

 Noise ratio: 1.3432155407675108

Raw:

Aperture: 4

 mean: 1.0

 std: 0.0012714981347602423

 Mean errorbar: 0.0006667742427888127

 Std errorbar: 2.9206476081306554e-07

Aperture: 6

 mean: 1.0

 std: 0.0011344638971379406

 Mean errorbar: 0.0006780678187707433

 Std errorbar: 2.3586147784511548e-07

Aperture: 8

 mean: 1.0

 std: 0.00110874348543068

 Mean errorbar: 0.00068808031149098

 Std errorbar: 1.986539224714436e-07

Aperture: 10

week 10 - 22/07 - preliminary MCMC results

MCMC result:

t_0 = 58388.793880996614 +4.193165659671649e-05 -4.5296415919438004e-05

t_s = 60275.87458289097 +0.002787817094940692 -0.0032121105905389413

rp = 0.05506173467380886 +0.0008191403337815817 -0.0007393392220503003

a = 25.274082077253283 +0.9800218535391494 -0.6966691758915431

inc = 89.91949784953567 +0.18413352904651958 -0.35765556915214347

fp = 0.000241297090362802 +4.46323598359081e-06 -8.169091570172027e-06

u1 = 0.5164327142805235 +0.016438403545689706 -0.016419949335354123

u2 = 0.10221763479711649 +0.00328321891399877 -0.0032542622785926845

c_1 = 0.6614899730277459 +0.5533846932858221 -0.7470833097530731

c_2 = -0.07778005448846098 +0.5973015004921931 -0.7138558915007689

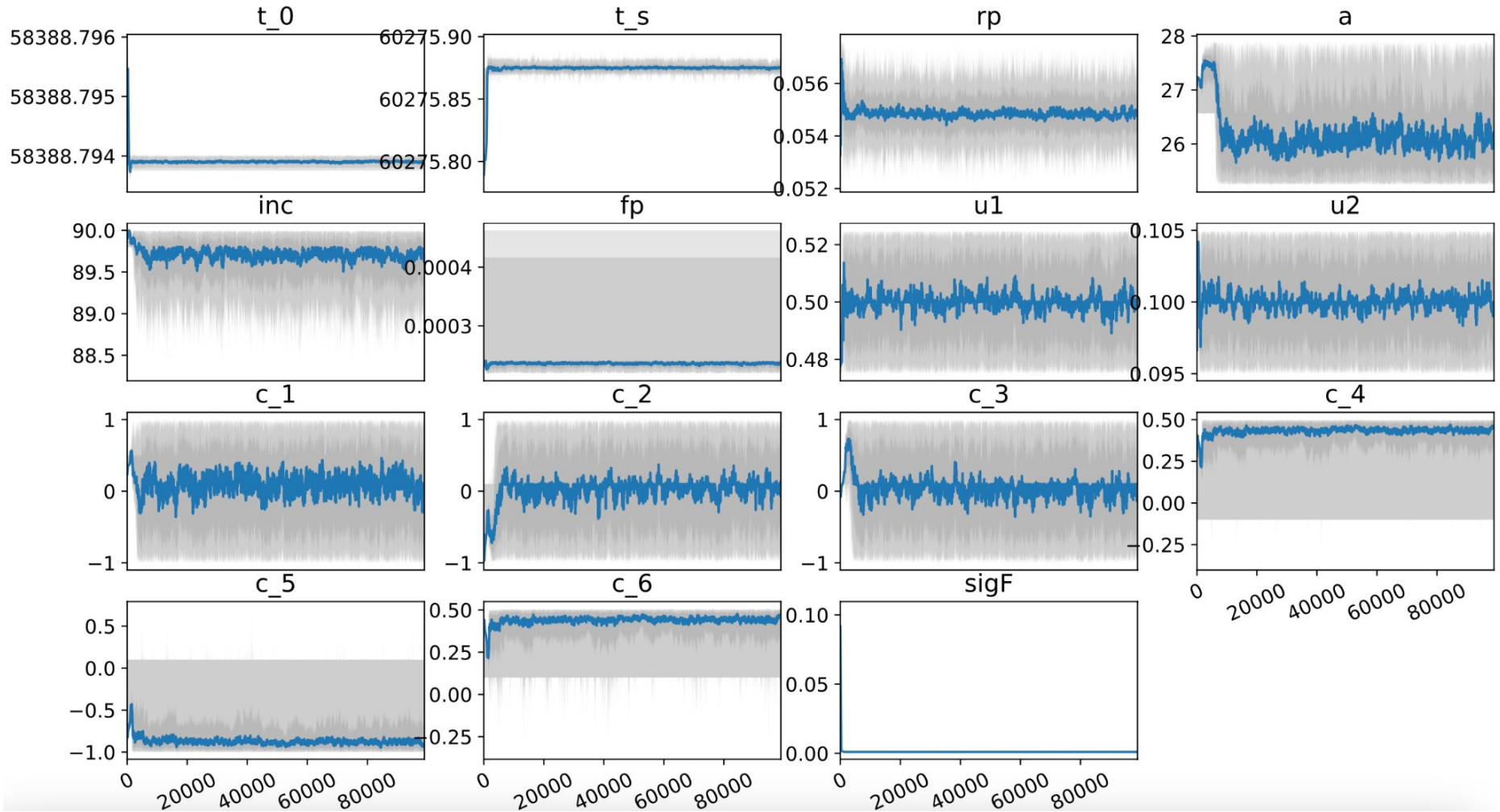
c_3 = 0.09067991848528945 +0.5714613348510034 -0.73361262522156

c_4 = 0.4958221717017377 +0.047333995838935605 -0.12510300690990628

c_5 = -0.9973857698315058 +0.2512887621117508 -0.09527794173867477

c_6 = 0.5015027473446447 +0.04781885957912052 -0.1263969789074776

sigF = 0.001026225536318521 +2.2621319999963172e-05 -2.2818259082180376e-05


t_0
58388.796
58388.795
58388.794
t_s
60275.90
60275.85
60275.80
rp
0.056
0.054
0.052
a
28
27
26
inc
90.0
89.5
89.0
88.5
fp
0.0004
0.0003
u1
0.52
0.50
0.48
u2
0.105
0.100
0.095
c_1
1
0
−1
c_2
1
0
−1
c_3
1
0
−1
c_4
0.50
0.25
0.00
−0.25
c_5
0.5
0.0
−0.5
−1.0
c_6
0.50
0.25
0.00
−0.25
sigF
0.10
0.05
0.00
0
20000
40000
60000
80000

meeting 25/07 - preliminary MCMC results

TO DO:

to improve the MCMC results and solve the memory issues

- graph lnprob as a fcr of steps + param ✓
- parallel processing ✓
- cut chains in nsteps and nwalkers ✓
- polynomial in time for detec model
- corner plot only plot contour ✓

week 11 - 29/07

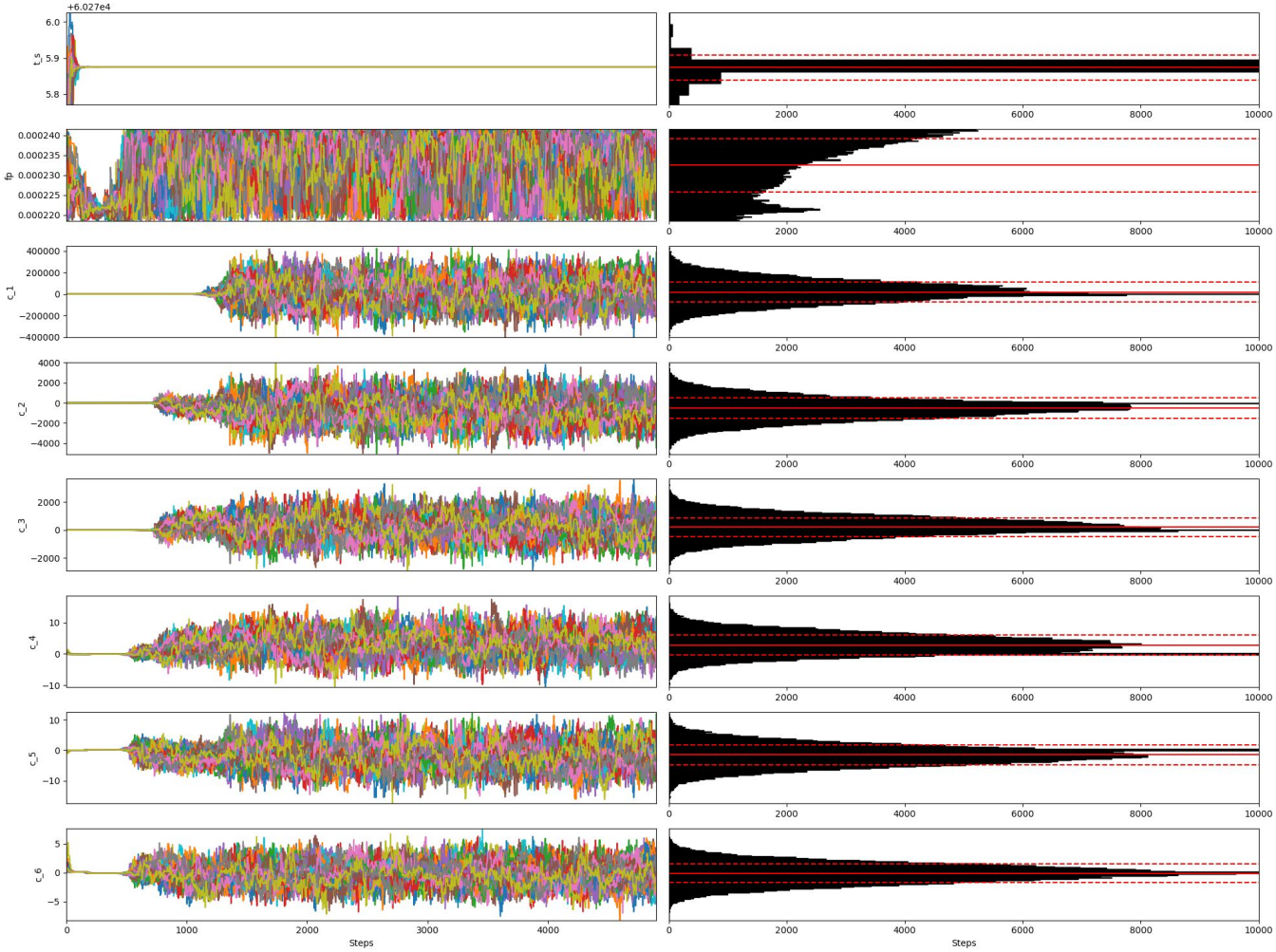
- Made lnprob and chain plots
- Implemented multiprocessing and ran it on CC
- Still getting an issue with corner plot `WARNING:root:Too few points to create valid contours` maybe due to problem in the chain, not converged enough…
- some parameters converge but in a wide range of values and other have two peaks (or high prob. area)
- jupyterhub still crashed (cant access more memory without lagging out at launch) and no progress bar (very long) for multiprocessing so unsure if its working? but no errors
- 2nd LHS1140c eclipse gone through S1-S3 of Eureka!, centroid seems a to be a few pixels off

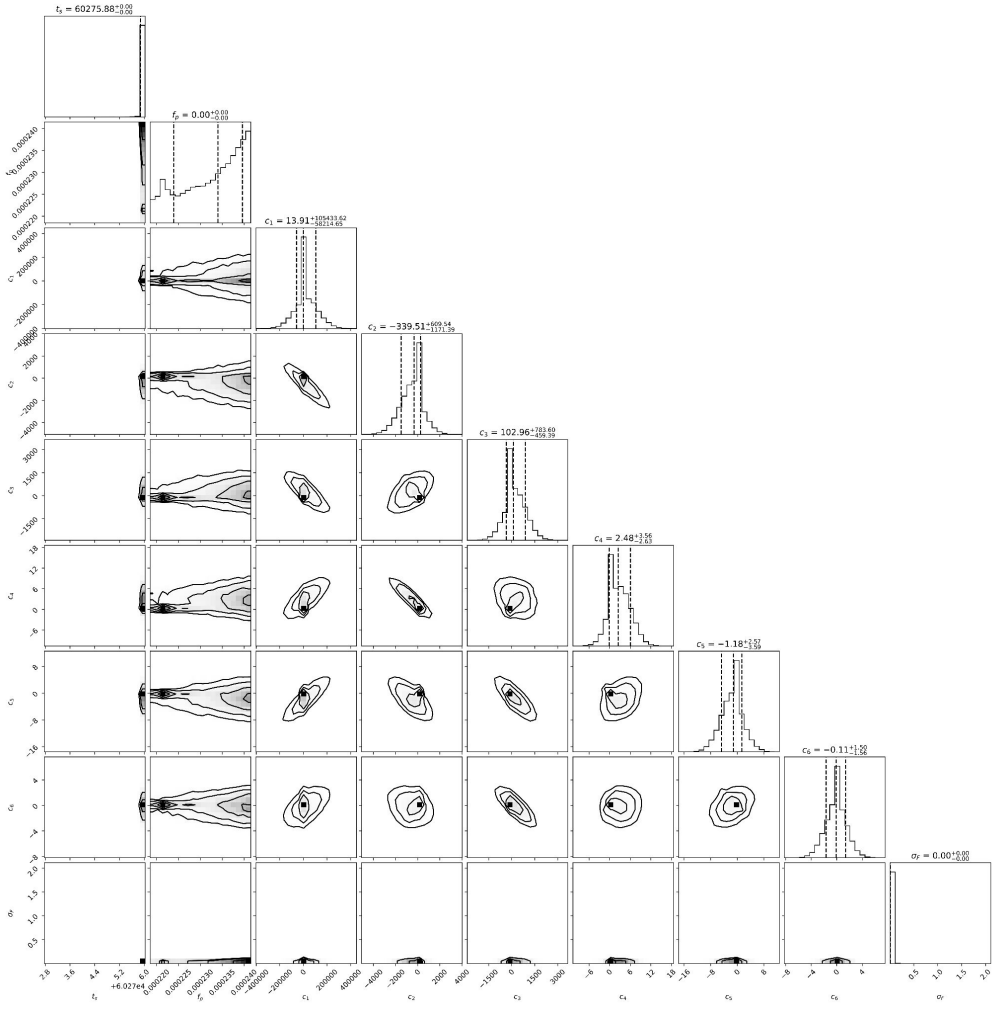
week 11 - 29/07

Meeting on 01/08:

- will review the eureka! outputs for the two new observations during the week of the presentations
- focusing for next week on getting a good fitting routine down with emcee to have results for the presentation
- for week of the presentation, fit new eclipses and prepare for presentation
- reduce number of params being fitted and fix t0 (t_secondary remains free)
- later step → let e (and w) be free params

- reproduced the distribution graph with histogram
- reduced the params and ran the MCMC for 5000 steps twice
- fp poorly constrained


+6.027e4
t_s
fp
c_1
c_2
c_3
c_4
c_5
c_6
Steps
Steps


$t_s = 60275.88^{+0.00}_{-0.00}$
$f_p = 0.00^{+0.00}_{-0.00}$
$c_1 = 13.91^{+105433.62}_{-5814.65}$
$c_2 = -339.51^{+609.54}_{-1171.39}$
$c_3 = 102.96^{+783.69}_{-459.39}$
$c_4 = 2.48^{+3.56}_{-2.63}$
$c_5 = -1.18^{+2.97}_{-1.58}$
$c_6 = -0.11^{+1.50}_{-1.66}$
$\sigma_r = 0.00^{+0.00}_{-0.00}$
+6.027e4
t_s
f_p
c_1
c_2
c_3
c_4
c_5
c_6
σ_r

week 12 - 05/08

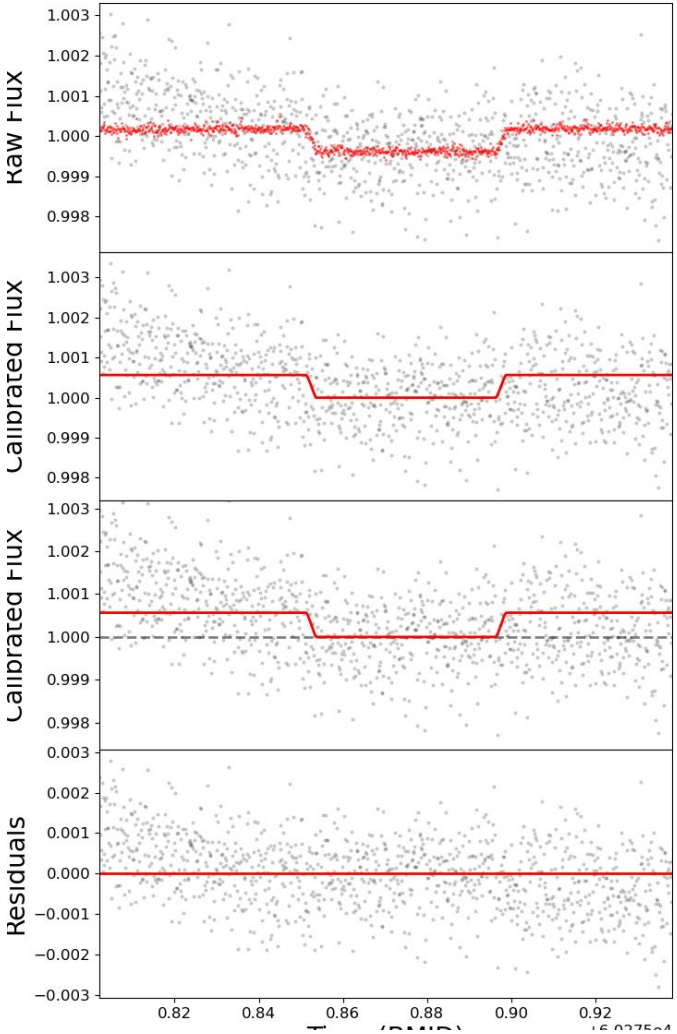
- downloaded 3rd eclipse observations and ran S1-S3
- saved to hard drive
- reran S3 for the 2nd eclipse with better centroid

meeting:

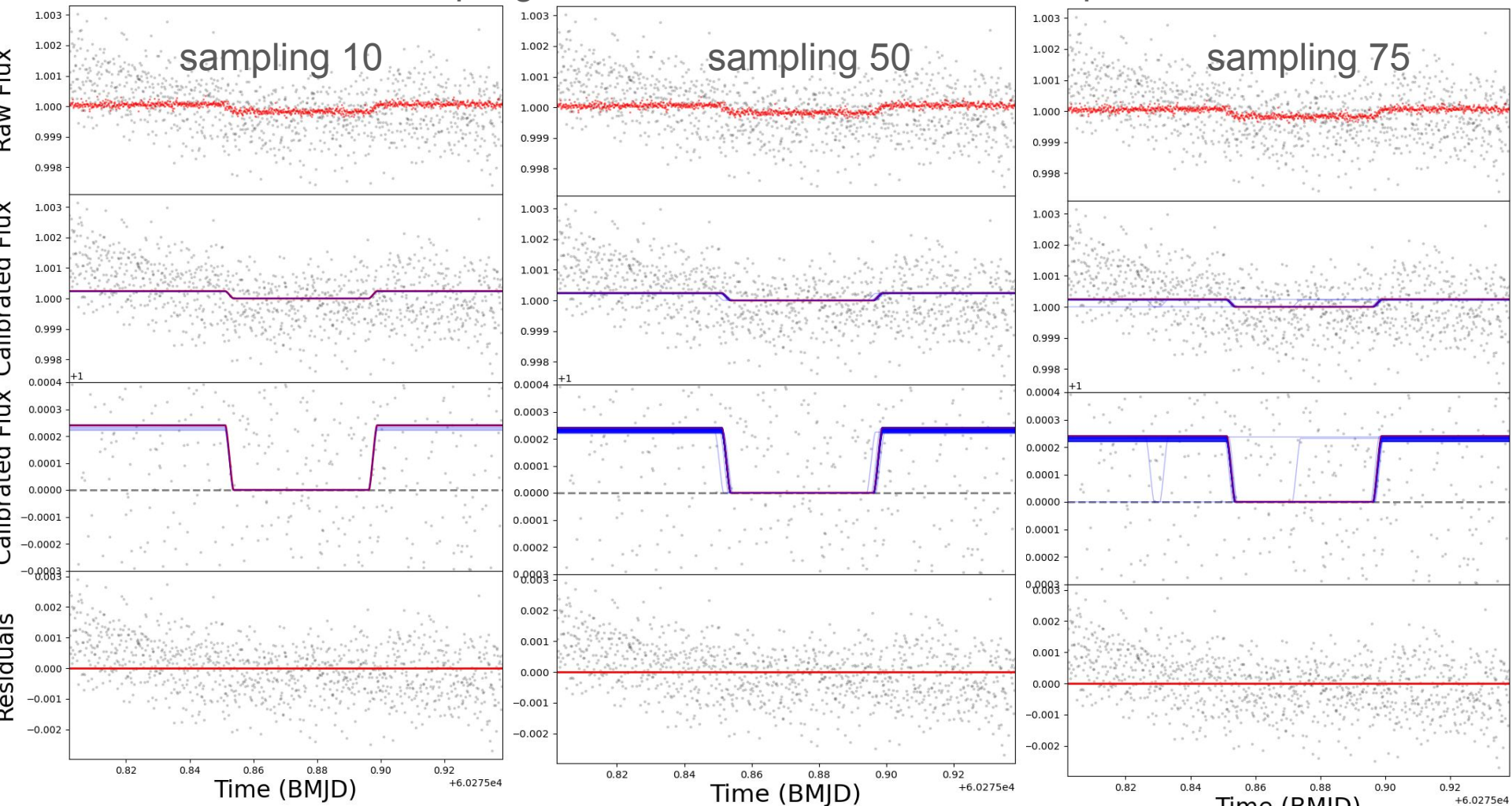
- remove prior on fp to see if better constrained ✓
- reproduce spca models 3 panel plot ✓
- one line (best fit) vs random sampling of chain (multiple lines) ✓
- calculate BIC and chi square ✓
- rednoise (allen) plot ✓
- repeat residual analysis with MCMC results ✓
- later add time polynomial to systematics model

first try at SPCA 3 panel best fit plot

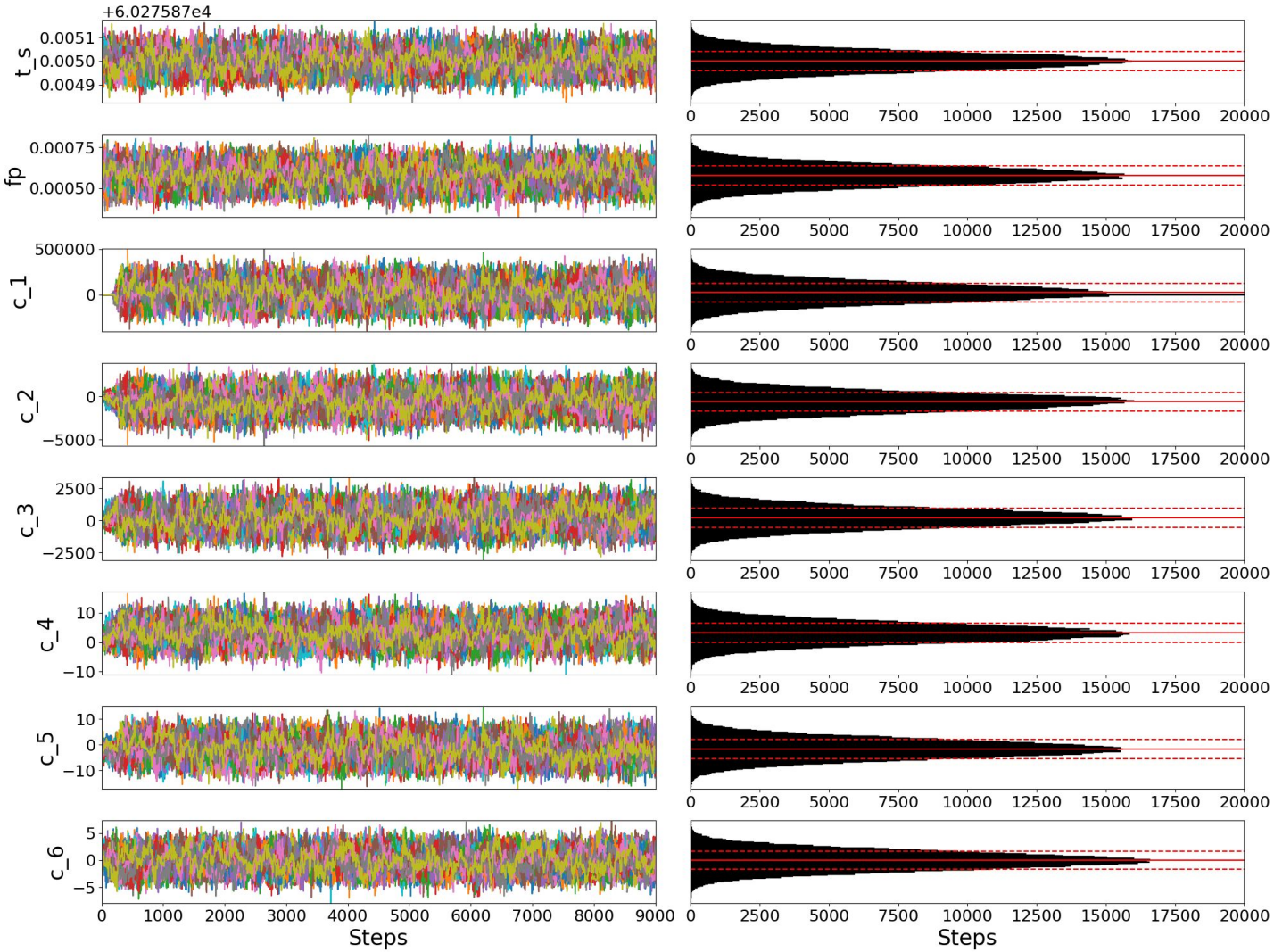
- will try again with less constrain on fp
- wil try again with random sampling of MCMC
- panel 1: black dots are raw flux, red line is astro model * detec model
- panel 2: black dots flux / detec model, red line is astro model, dashed line y = 1
- panel 3: same as 2, zoomed in
- panel 4: residuals, flux / detec - astro, red line y = 0

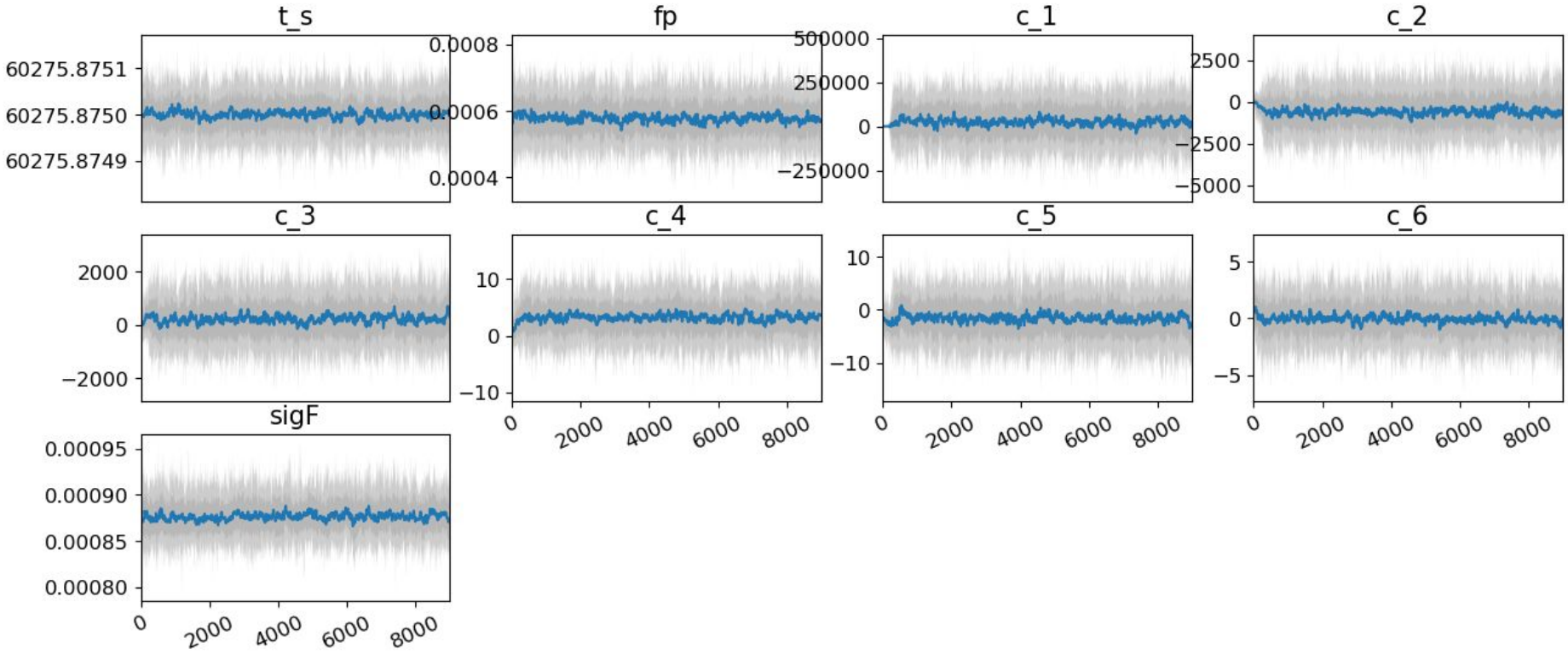


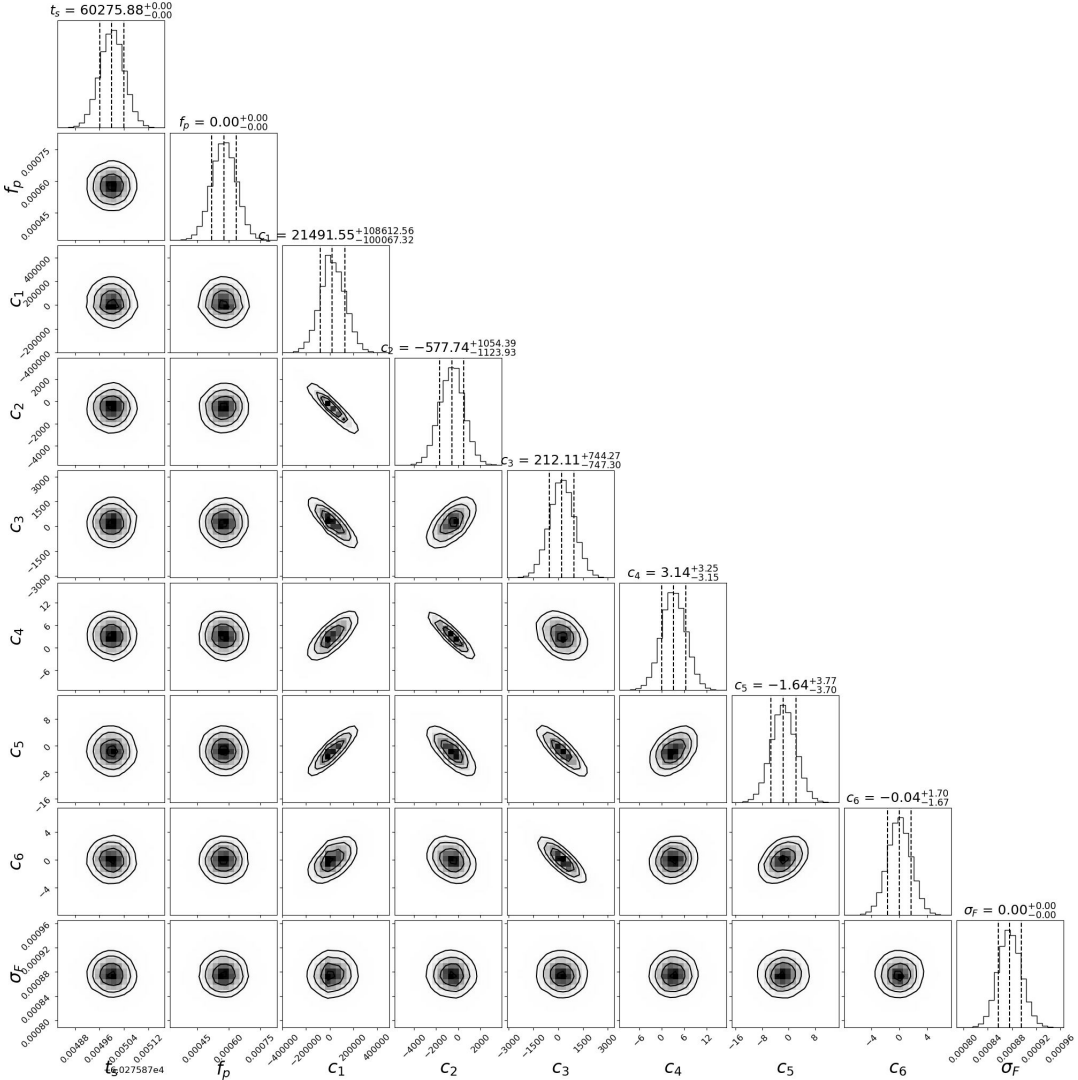
Random sampling from chain to see constraint on fp

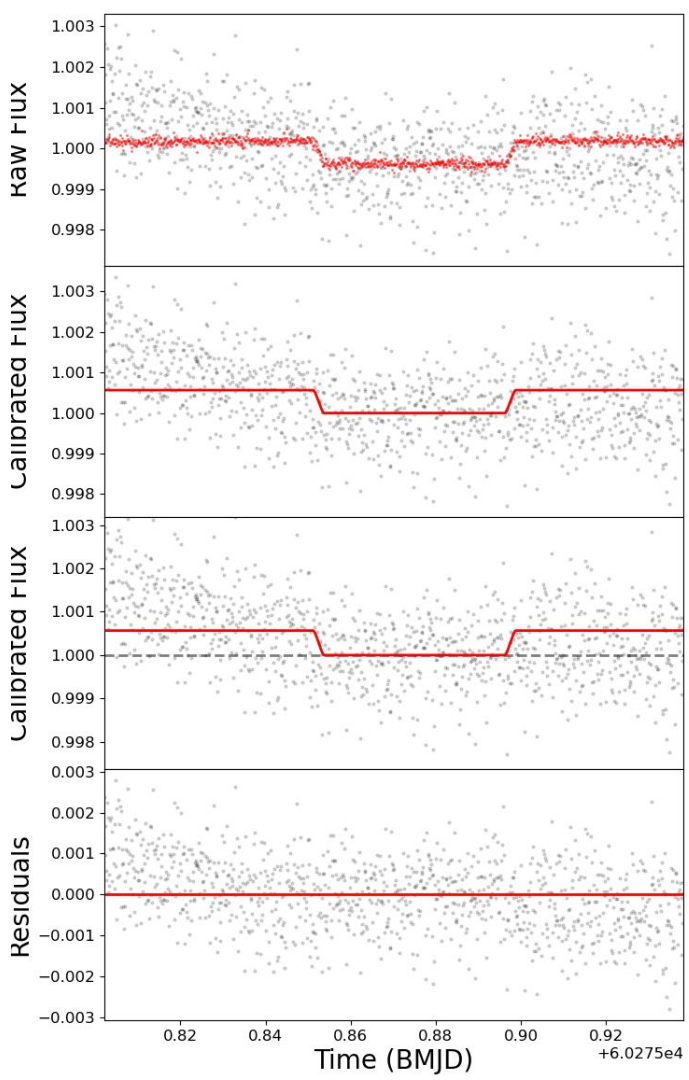


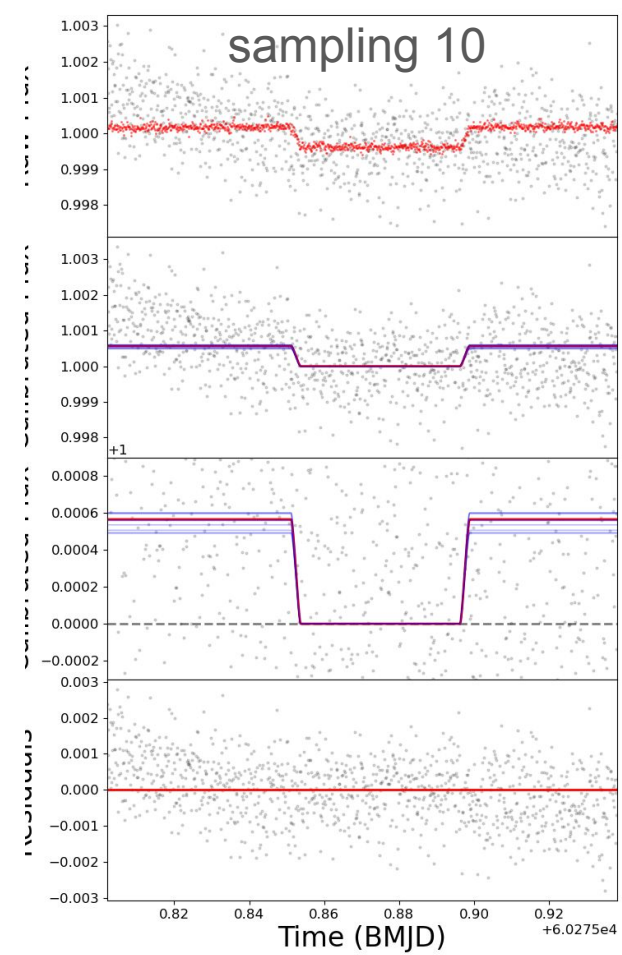
distribution for each parameter in p0, without tight prior on fp like before for 50 walkers 10000 steps

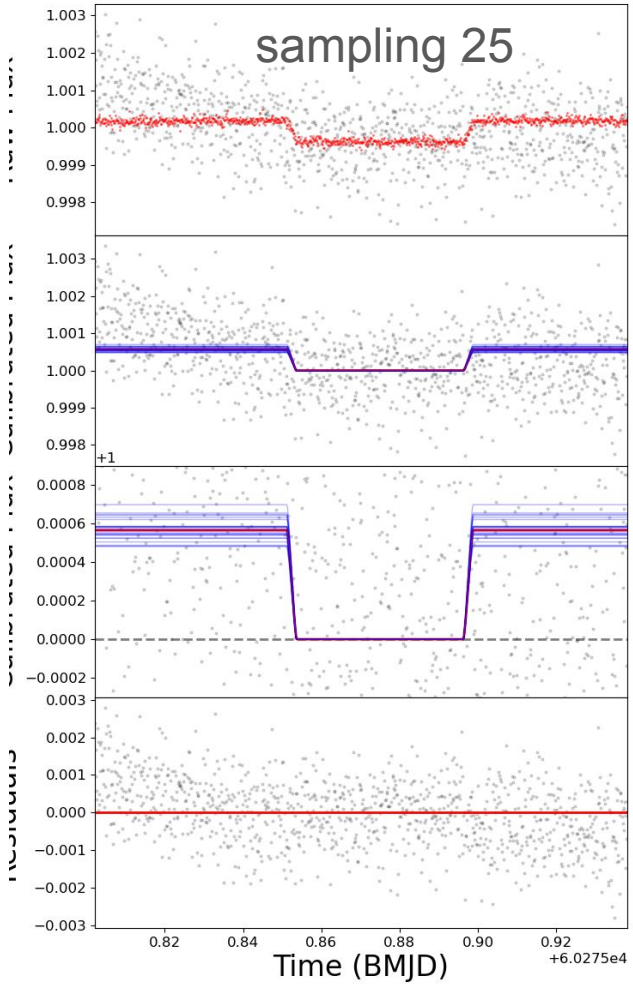


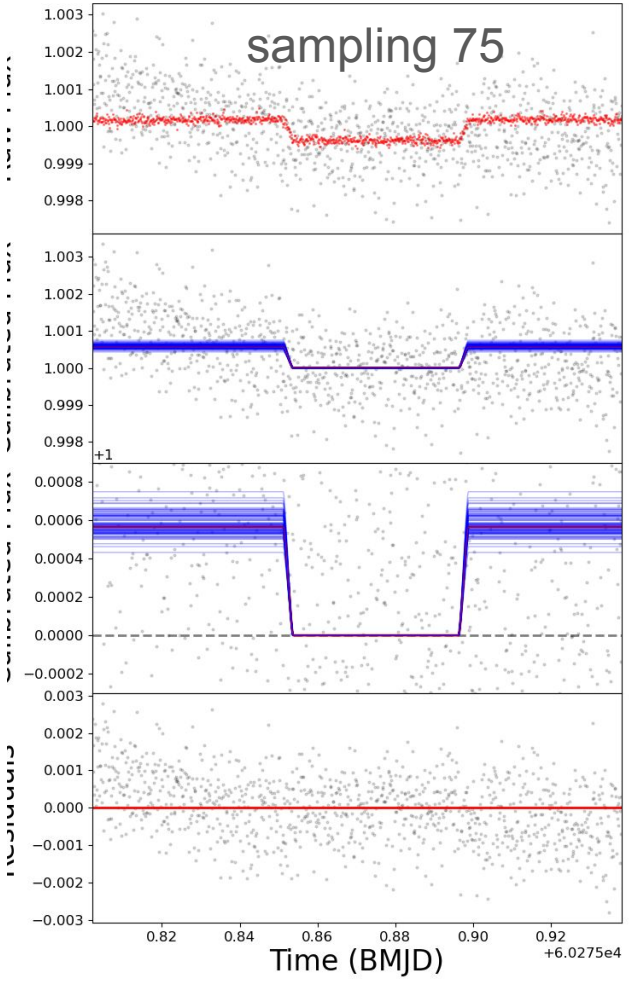

t_s
60275.8751
60275.8750
60275.8749
fp
0.0008
0.0006
0.0004
c_1
500000
250000
0
−250000
c_2
2500
0
−2500
−5000
c_3
2000
0
−2000
c_4
10
0
−10
c_5
10
0
−10
c_6
5
0
−5
sigF
0.00095
0.00090
0.00085
0.00080
0
2000
4000
6000
8000

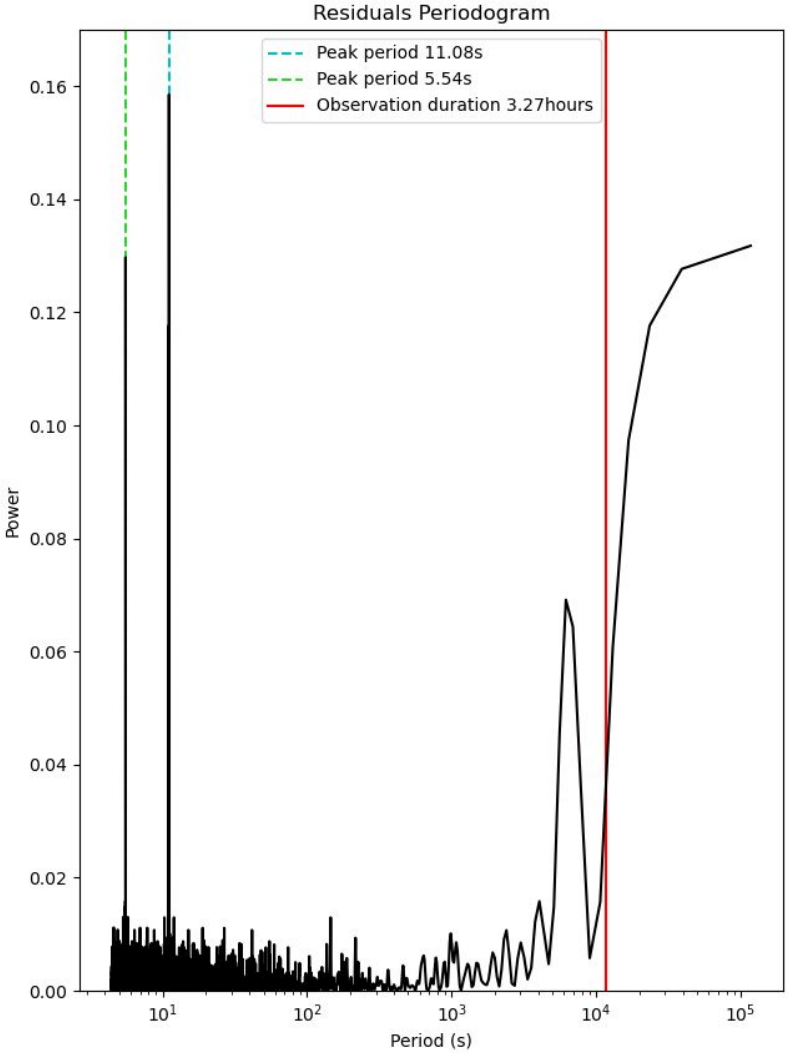

$t_s = 60275.88^{+0.00}_{-0.00}$
$f_p = 0.00^{+0.00}_{-0.00}$
$c_1 = 21491.55^{+108612.56}_{-100067.32}$
$c_2 = -577.74^{+1054.39}_{-1123.93}$
$c_3 = 212.11^{+744.27}_{-747.30}$
$c_4 = 3.14^{+3.25}_{-3.15}$
$c_5 = -1.64^{+3.77}_{-3.70}$
$c_6 = -0.04^{+1.70}_{-1.67}$
$\sigma_F = 0.00^{+0.00}_{-0.00}$
t_s
f_p
c_1
c_2
c_3
c_4
c_5
c_6
σ_F
+6.027587e4

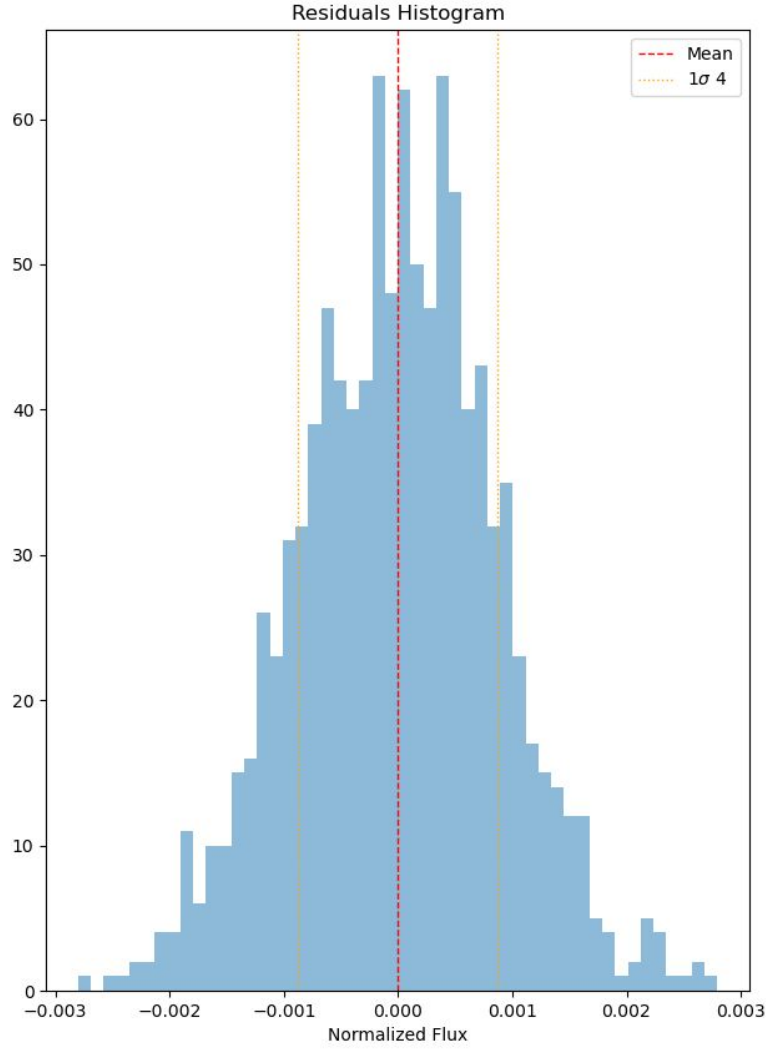

Raw Flux
Calibrated Flux
Calibrated Flux
Residuals
Time (BMJD)
+6.0275e4


sampling 10
Time (BMJD)
+6.0275e4


sampling 25
Time (BMJD)
+6.0275e4


sampling 75
Time (BMJD)
+6.0275e4


Residuals Periodogram
Peak period 11.08s
Peak period 5.54s
Observation duration 3.27hours
Power
Period (s)
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
10^1
10^2
10^3
10^4
10^5


Residuals Histogram
Mean
1σ 4
Normalized Flux
0
10
20
30
40
50
60
−0.003
−0.002
−0.001
0.000
0.001
0.002
0.003

week 12 - 05/08

RECAP

- figs are all results of 10000 steps, 50 walkers MCMC (very fast), decent convergence but not perfect
- for data of 1 eclipse, 1 aperture (4)
- still need to improve detector model by adding a polynomial function in time (currently only corrects for centroids), clearly doesn’t pick up the ramp/exponential
- still need to compare different aperture sizes and look at other eclipses data
- BIC and chi^2 calculations

week 12 - 05/08

Meeting:

- temperature calculations t_eq and t_brightness to compare expected vs derived for albedo 0
- measured eclipse flux in mJy (using eureka)
- graph of noise ratio as a fct of aperture
- sur les residuels (sans la section pente), calculer std et comparer aux barres d’erreur (de cette section) et calculer noise ratio
- eclipse depth en ppm

week 13 - 12/08

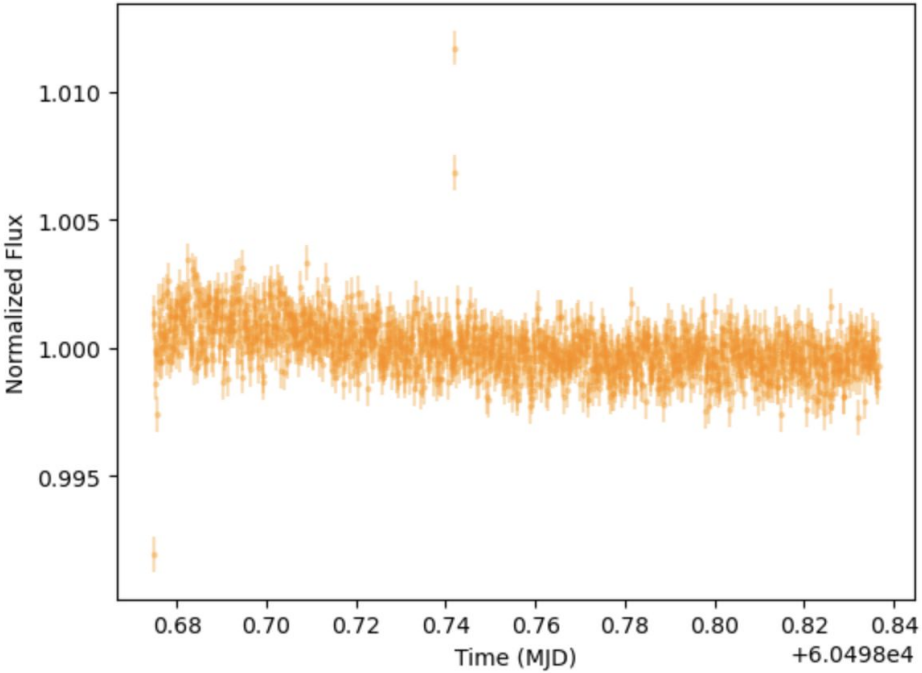
Corrections:

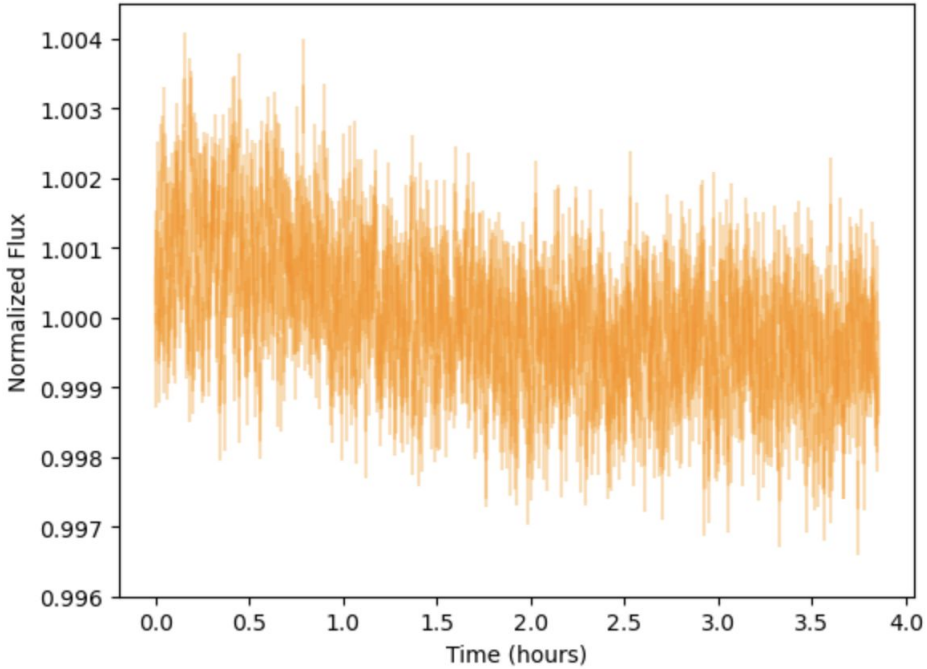
- Planet to star radius ratio changed to the value reported by cadieux et al. 2024
- discarded the first 55 mins of observations
- removed a linear trend obtained using polyfit on the binned data (with eclipse removed, nbin=50)

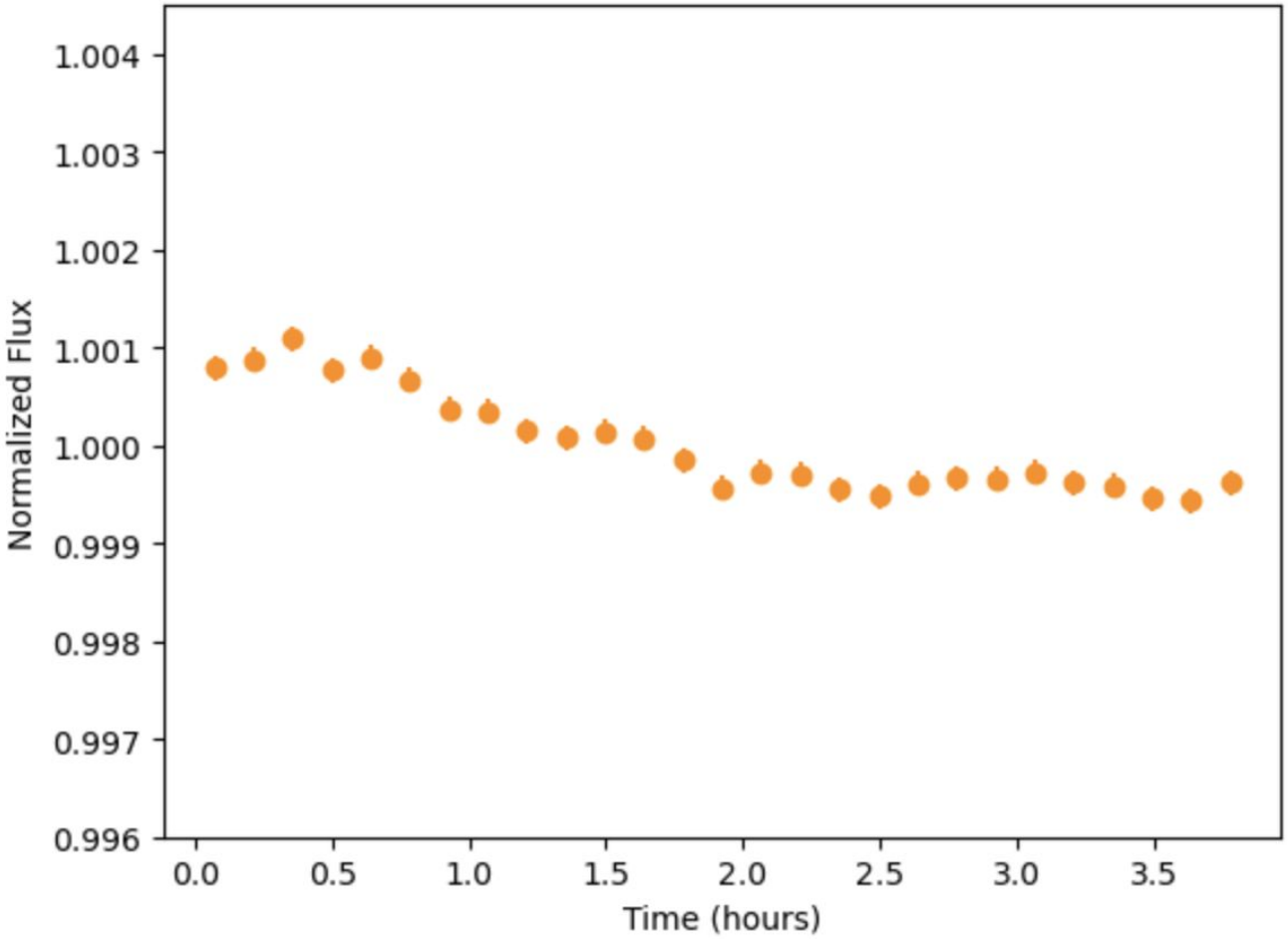
First fall meeting

- First look at eclipses 2 and 3
- Options of future work:
  - Time dependent polynomial to improve E1 fit
  - Remove exponential ramp for better E1 fit
  - Fit eclipses 2 and 3
  - Joint fit of all three eclipses

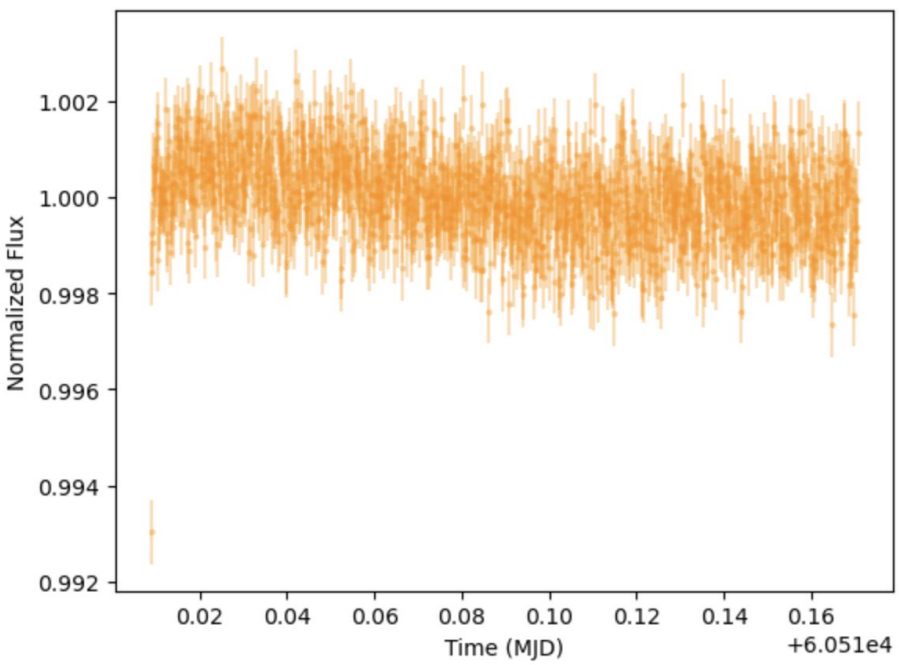
Eclipse 2

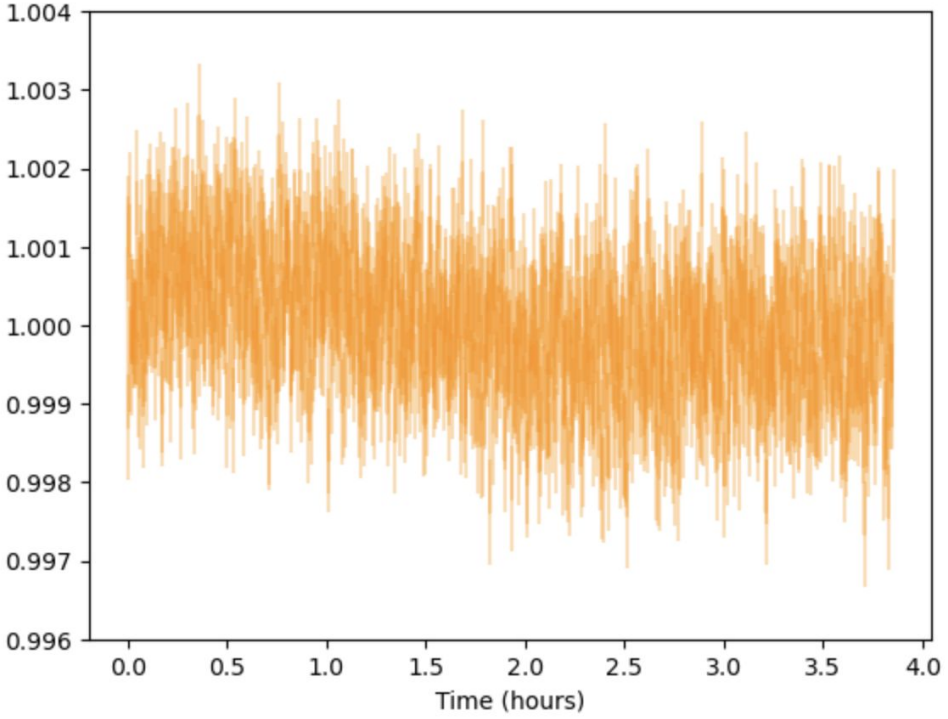

Normalized Flux
1.010
1.005
1.000
0.995
0.68
0.70
0.72
0.74
0.76
0.78
0.80
0.82
0.84
Time (MJD)
+6.0498e4

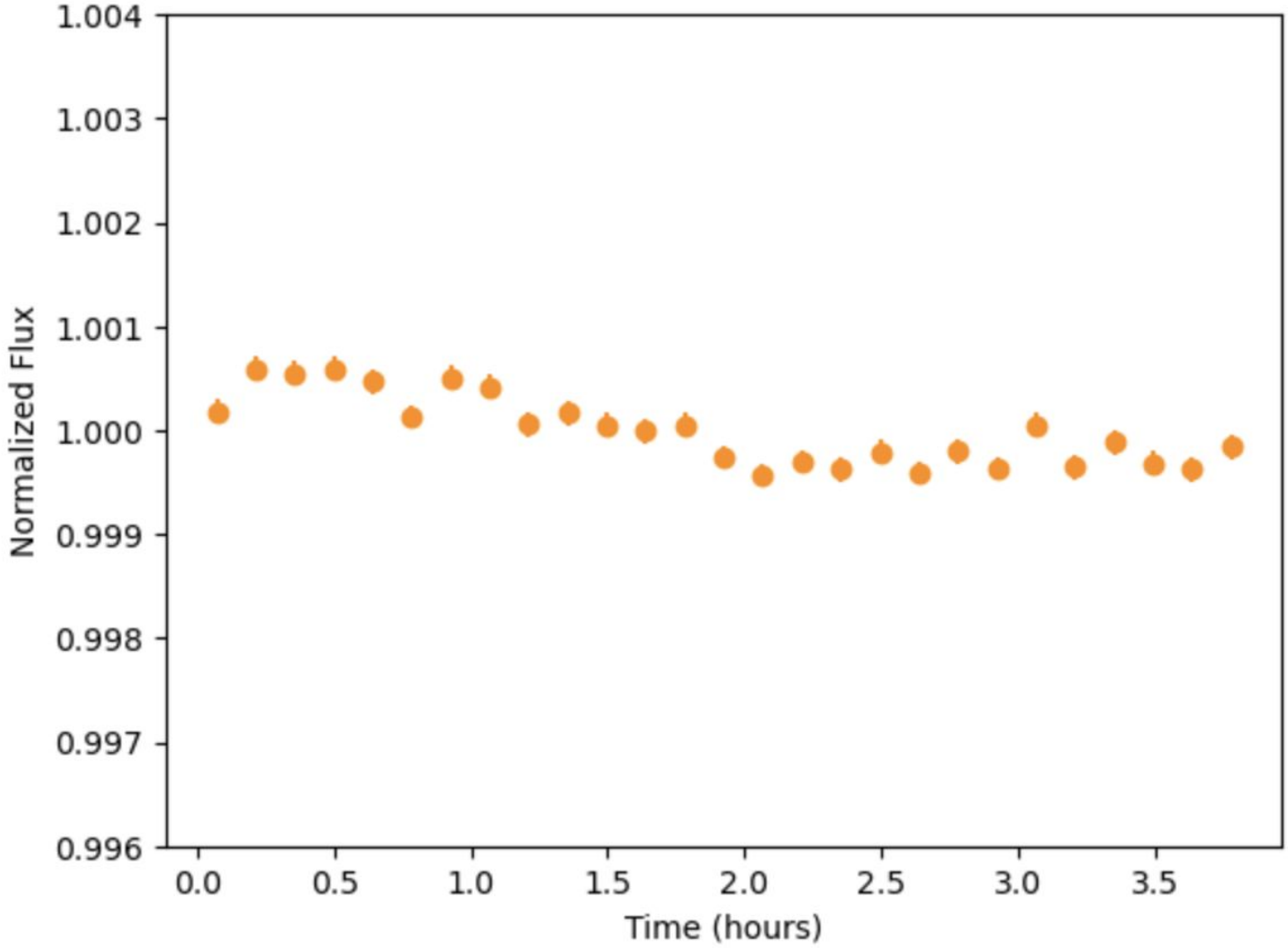

Normalized Flux
1.004
1.003
1.002
1.001
1.000
0.999
0.998
0.997
0.996
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Time (hours)


1.004
1.003
1.002
1.001
1.000
0.999
0.998
0.997
0.996
Normalized Flux
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Time (hours)

Eclipse 3


Normalized Flux
1.002
1.000
0.998
0.996
0.994
0.992
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
Time (MJD)
+6.051e4


1.004
1.003
1.002
1.001
1.000
0.999
0.998
0.997
0.996
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
Time (hours)

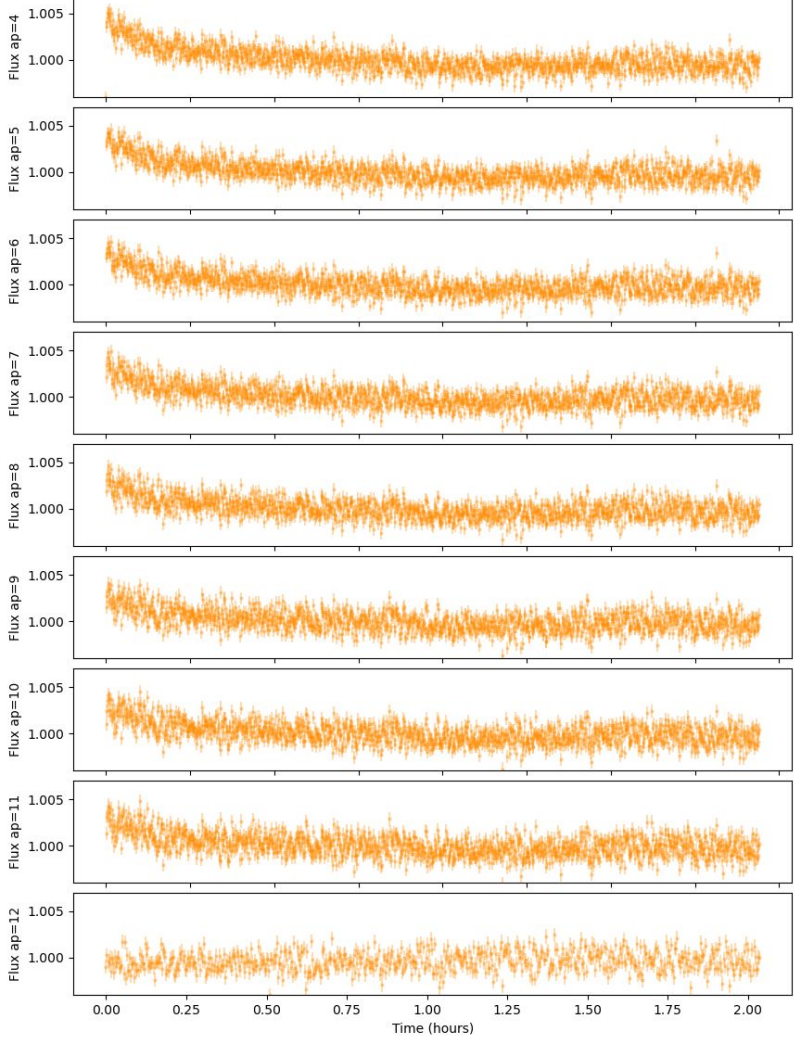

1.004
1.003
1.002
1.001
1.000
0.999
0.998
0.997
0.996
Normalized Flux
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Time (hours)

À faire

- graph comparison aperture size (linear)
- run code w all aperture to verify eclipse depth consistent
- ajouter exponentiel dans le model
- faire une table avec comparaison des différents modeles avec BIC
- essayer GP

Fall week 1 - 19/09

- tested all apertures to see if results are consistent (ap {4, 12})
- accidentally used the wrong prior for t_s (used the timing of eclipse 2 (second observation) and found eclipse depth consistent with expected value ~235 ppm??
- uniform analysis and tried to reproduce the results with this analysis



all apertures lc, first 55 mins removed

RESULTS - linear trend removed, centroid model

Aper 4
t_s = 60275.87508915765 +0.003335488450829871 -0.0016104815804283135
fp = 0.0004522759820060 94 +5.740073513149397e-05 -5.628954440227267e-05

Aper 5
t_s = 60275.87511492361 +0.000986358179943636 -0.002309812858584337
fp = 0.0004135544280438749 +5.672550201267008e-05 -5.6636536841636945e-05

Aper 6
t_s = 60275.87502677938 +0.00134581996826455 -0.002069789421511814
fp = 0.0003891600748143702 +5.822631032344135e-05 -5.7398851520612006e-05

Aper 7
t_s = 60275.87512344254 +0.001265683320525568 -0.001606775404070504
fp = 0.0003940098114543159 +5.7455705628271564e-05 -5.827271619687291e-05

Aper 8
t_s = 60275.875193806714 +0.0010244510631309822 -0.0015160965922405012
fp = 0.0003931729011408448 +5.775569697490611e-05 -5.8157692384029484e-05

Aper 9
t_s = 60275.875360695165 +0.0011602993326960132 -0.0014423889515455812
fp = 0.0004206910664847803 +6.176732139075104e-05 -6.225641618947975e-05

Aper 10
t_s = 60275.875521755304 +0.001130929078499321 -0.0013872302079107612
fp = 0.0004103689533232 0807 +6.300473269836657e-05 -6.3241964662599 87e-05

Aper 11
t_s = 60275.875684543396 +0.0011043444465030916 -0.0008848693687468767
fp = 0.0004011984254379047 +6.638834007938085e-05 -6.594226853439658e-05

Aper 12
t_s = 60275.87549914863 +0.0012194833252578974 -0.0009026367697515525
fp = 0.0004211290352992 3203 +7.095329019112038e-05 -7.056634131298329e-05

Lisa - Spitzer Mega paper

- wrote the code to find the time of transit for each planet and convert it into a latex string
- some planets are giving errors → need to be looked at on a case by case basis
- need to format sig figs in latex
- double check uncertainties? and eclipses? and order?

Table 1.

Planet	t_0 (D)
Qatar-2b	$57895.5275204305^{8.645266643725336e-05}_{-8.374304161407053e-05}$
WASP-34b	$58761.80556220038^{0.0006417421172955073}_{-0.0006292429388849996}$
WASP-140b	$58485.98415511575^{0.0001401478293701075}_{-0.0001341187889205476}$
WASP-52b	$58199.13050826767^{9.084364137379453e-05}_{-8.936495578382164e-05}$
WASP-77Ab	$57722.30933927315^{0.0001408430907758884}_{-0.0001343296607956290 2}$
KELT-14b	$57774.549581021056^{0.0002110233544954 0988}_{-0.0002072324932669 2894}$
HAT-P-23b	$57766.331308495035^{0.0002097134638461 2843}_{-0.0001984248956432566}$
KELT-20b zoe	$58537.90028082125^{0.0001785611893865 2799}_{-0.0001807459921110 4214}$
HD189733b	$55188.5525607311^{9.045928891282529e-06}_{-9.670562576502562e-06}$
Qatar-1b	$58241.516897372305^{5.804531247122213e-05}_{-6.029681389918551e-05}$
HD209458b	$55215.90869679723^{9.354823851026595e-05}_{-8.935724326875061e-05}$
WASP-14b	$56042.68746418817^{0.0001263805170310 6612}_{-0.0001241275167558 3422}$
WASP-19b	$55786.91853736096^{1.863631041487679e-05}_{-1.798004086595028 6e-05}$
HAT-P-7b	$55430.08095438272^{1.350176171399653e-05}_{-1.322614116361364 7e-05}$
KELT-1b	$57313.78017686092^{0.0023819325797376223}_{-0.0024022068464 8957}$
KELT-16b	$58395.004136432275^{0.0002026725996984169}_{-0.0001795145872165449}$
MASCARA-1b	$58547.20200058259^{0.0017967859894270077}_{-0.0019502536888467148}$
WASP-121b	$58145.99384083428^{9.703374234959483e-05}_{-9.849616617430001e-05}$

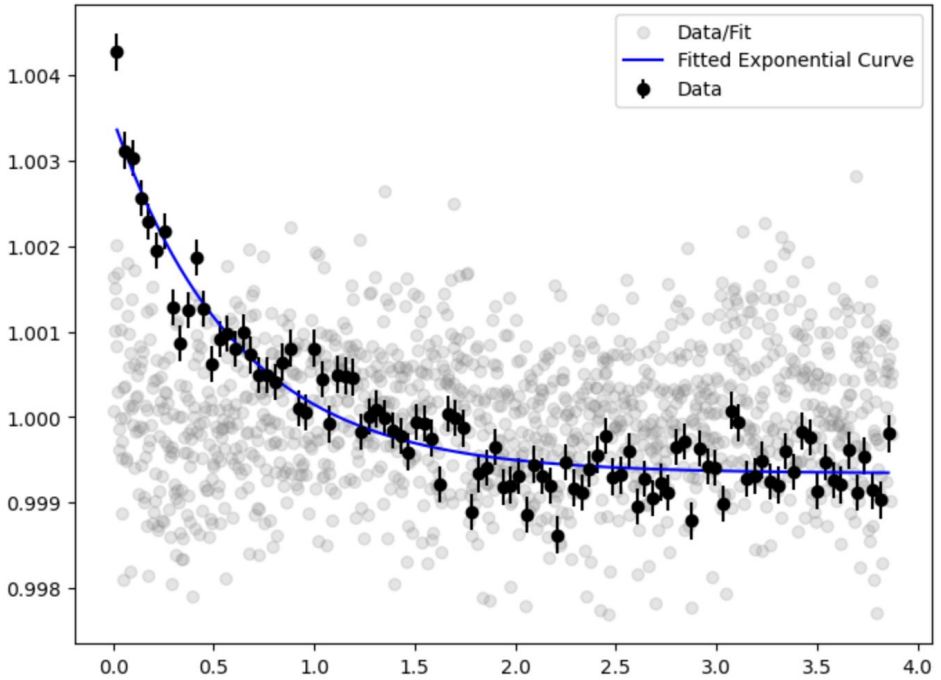
NOTE—In the table, uncertainties are rounded to one significant figures and the parameter values are rounded to match the precision of their associated errors.

À faire

- ratio du flux psf (ap5) et anneau (ap12 - ap5) en fonction du temps (from raw full flux - not normalized)
- make plot and use that as fct of time for decorrelation mode F_measured = E(t) + c1*lambda
- fit exponential to full array and include it in the model
- montrer banane pour trois eclipses
- fit banane avec quadratique

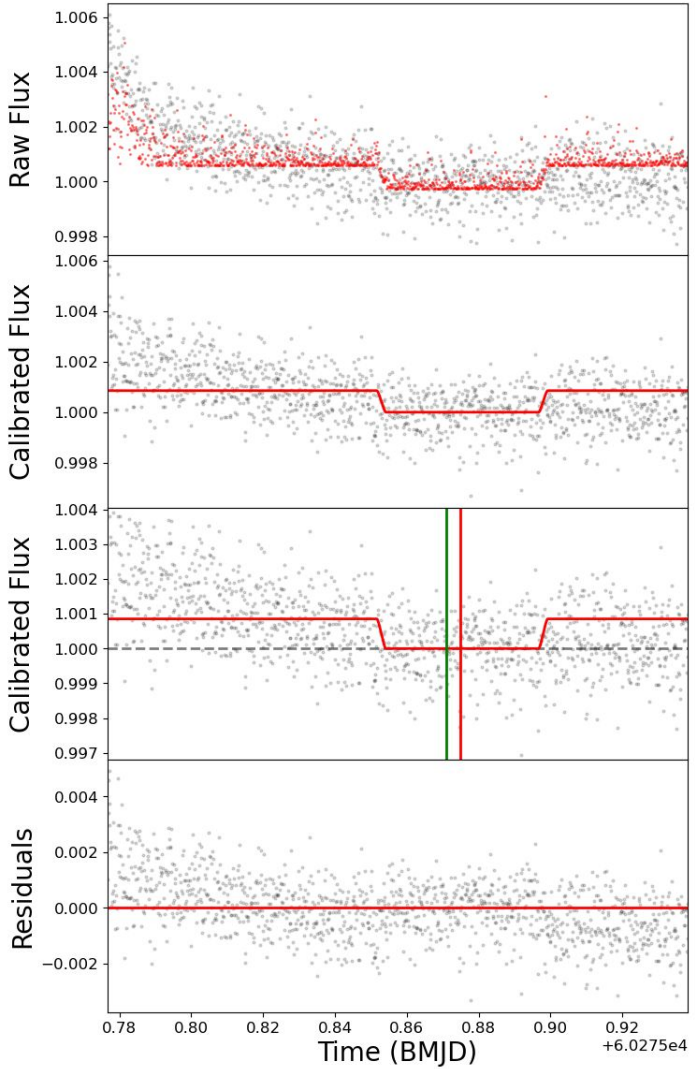
Fall week 2 - 26/09

- when using the wrong prior for t_s (used the timing of eclipse 2 (second observation) and found eclipse depth consistent with expected value ~235 ppm but very poorly constrained
- preliminary exponential fit using scipy.optimize.curvefit, not yet included in the MCMC, removed from the raw data before centroid decorrelation
- Needs to be fitted on the normalized data with begining of observations set to zero (not in bmjd) otherwise produces a flat line
- In black binned data points (n=100), only discard first 2 points, blue line is exponential trend and grey points are raw data / trend

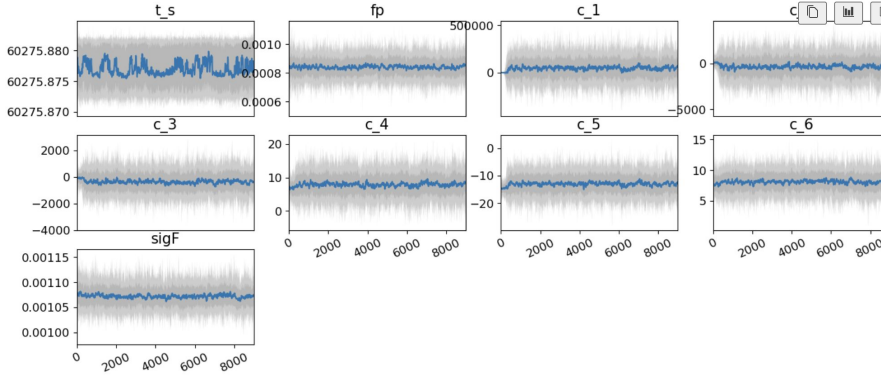


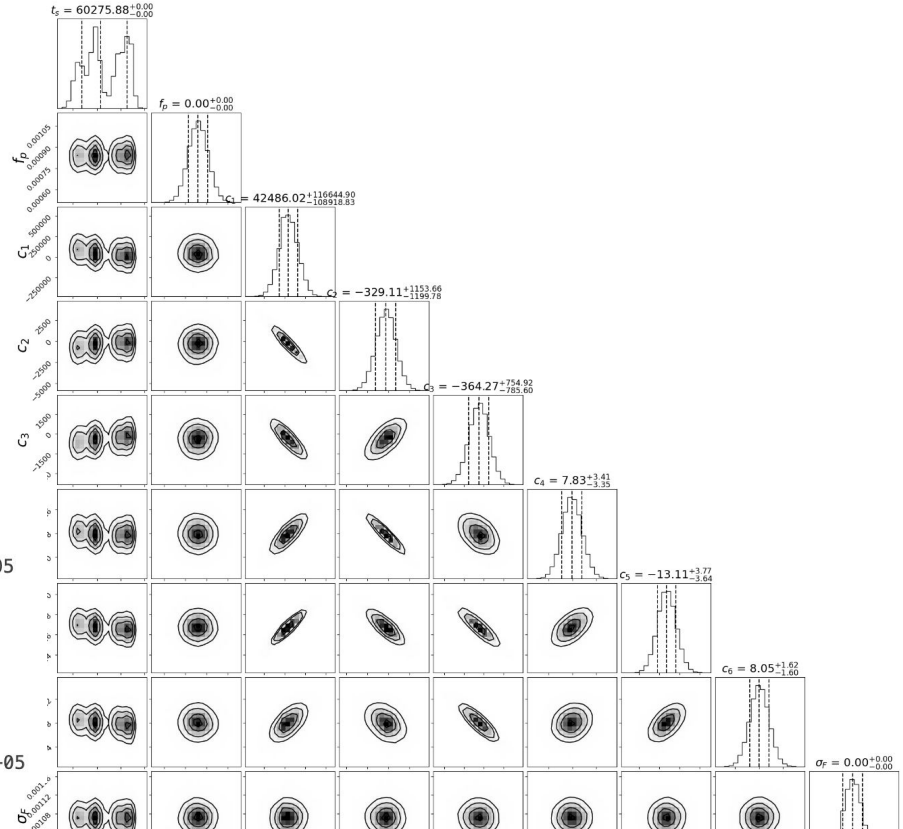
First attempt

- difficulty aligning the time axis → see if adjusting param c could fix this



t_0 poorly constrained



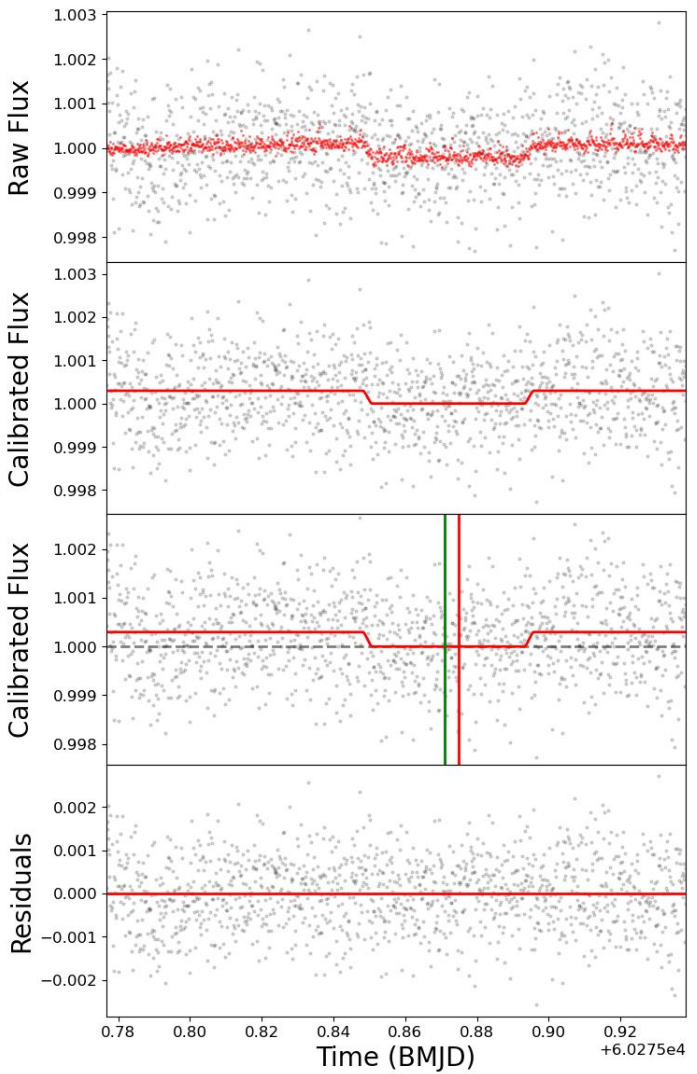


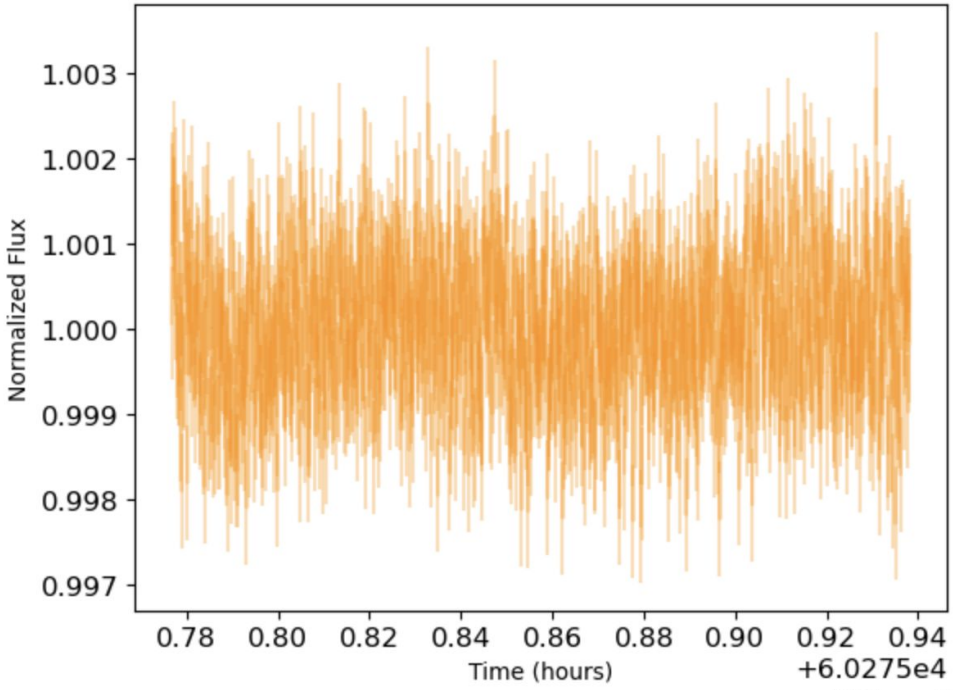
MCMC result:

```
    t_s = 60275.87545576146  +0.004481154363020323  -0.003104410097876098
     fp = 0.0008537800908722539  +6.955872690132749e-05  -6.867897793216284e-05
    c_1 = 27490.10823693285  +116644.90247895717  -108918.82623043684
    c_2 = -262.4585991688416  +1153.6567660393337  -1199.781260412668
    c_3 = -172.6806856401762  +754.9158341067366  -785.595705962581
    c_4 = 7.9192522878140705  +3.4095858916527764  -3.353356142921041
    c_5 = -13.84789972992782  +3.7675094518800147  -3.6446751048300943
    c_6 = 7.65091614908095  +1.6202689786616933  -1.600249169343341
  sigF = 0.0010671629795055532  +2.114475066415547e-05  -2.1059430765275585e-05
```

Second attempt

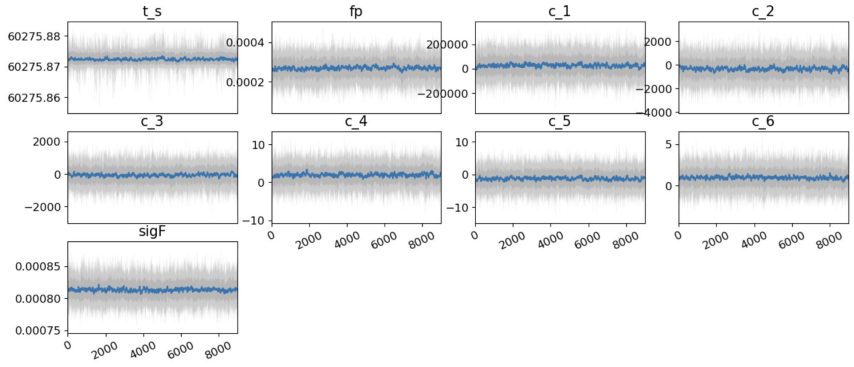
- detrended the raw flux with the exponential centered at 0
- gives much better result!
- Still need to make sure this is a proper fix (or find a better method)
- fs = 296 ppm +/- 53 ppm (5sigma)
- delta T_secondary = 4.2858652293

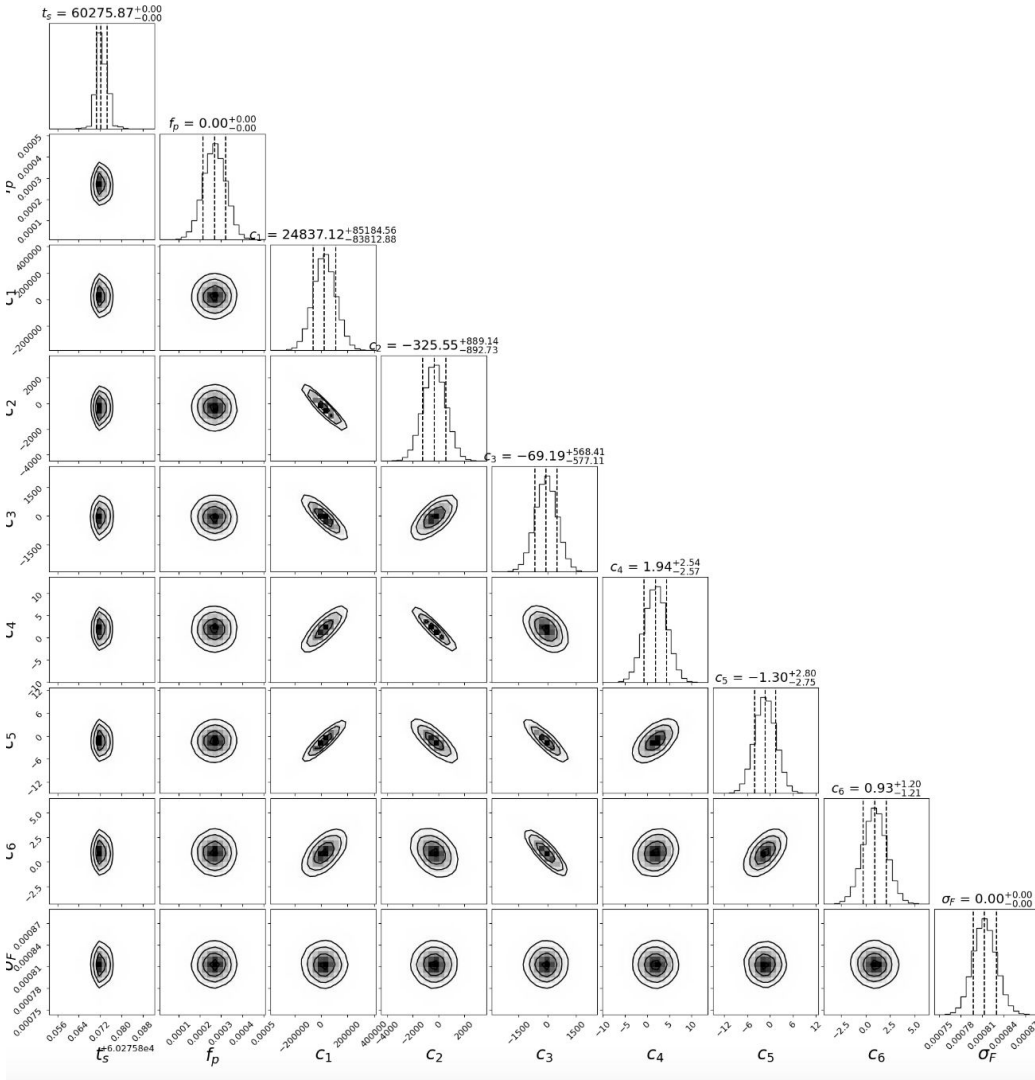


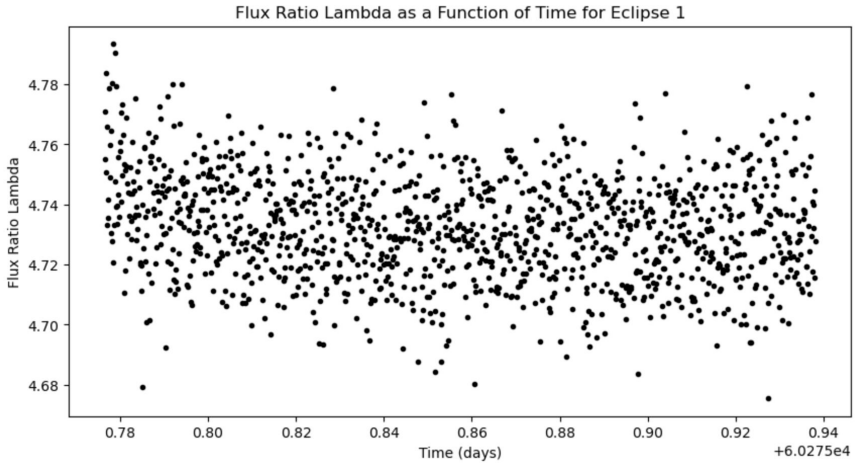


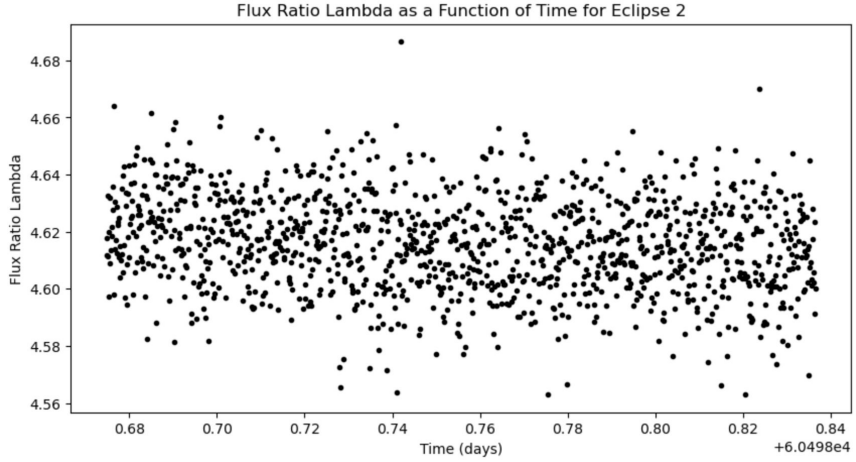
MCMC result:

```
  t_s = 60275.8720237047  +0.0023792973152012564  -0.0016579450239078142
   fp = 0.0002960993796929716  +5.286259020325295e-05  -5.3200333213123 94e-05
  c_1 = 13992.59268817908  +85184.55755634591  -83812.87523648371
  c_2 = -162.24197969360728  +889.1395223039043  -892.7290826525124
  c_3 = -59.036540790749655  +568.4052236570029  -577.1050892158222
  c_4 = 1.3680838280317122  +2.540688663224564  -2.5720237134115638
  c_5 = -1.463683731235447  +2.8030295780251784  -2.7462520252899134
  c_6 = 0.9705160998007669  +1.204324611038119  -1.2057320684294486
sigF = 0.0008095795491855337  +1.650384465236819e-05  -1.5833784795611238e-05
```

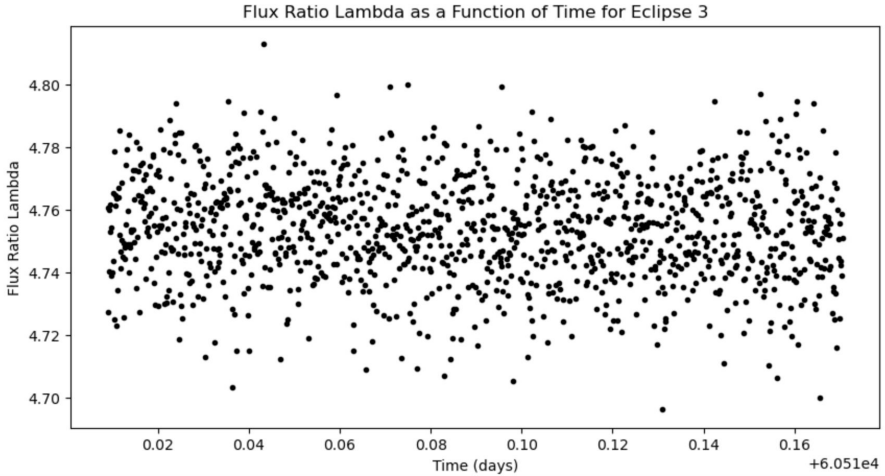

t_s
fp
c_1
c_2
c_3
c_4
c_5
c_6
sigF

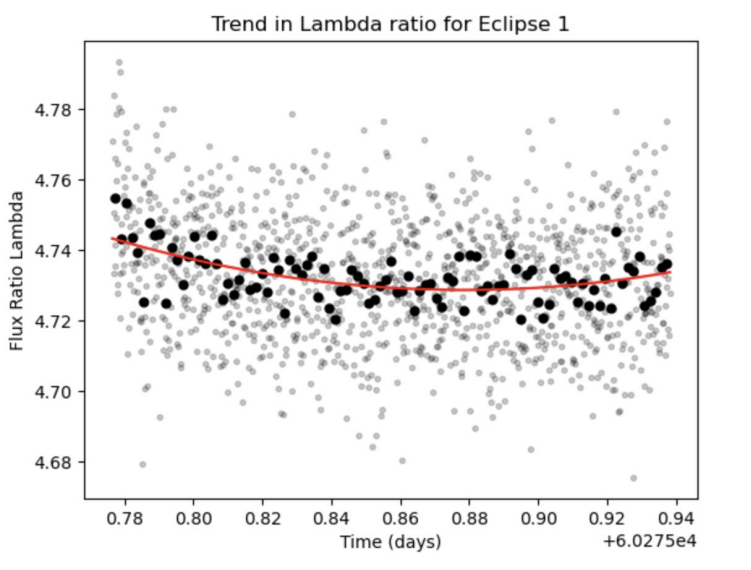

$t_s = 60275.87^{+0.00}_{-0.00}$
$f_p = 0.00^{+0.00}_{-0.00}$
$c_1 = 24837.12^{+85184.56}_{-83812.88}$
$c_2 = -325.55^{+889.14}_{-892.73}$
$c_3 = -69.19^{+568.41}_{-577.11}$
$c_4 = 1.94^{+2.54}_{-2.57}$
$c_5 = -1.30^{+2.80}_{-2.75}$
$c_6 = 0.93^{+1.20}_{-1.21}$
$\sigma_F = 0.00^{+0.00}_{-0.00}$
t_s
f_p
c_1
c_2
c_3
c_4
c_5
c_6
σ_F

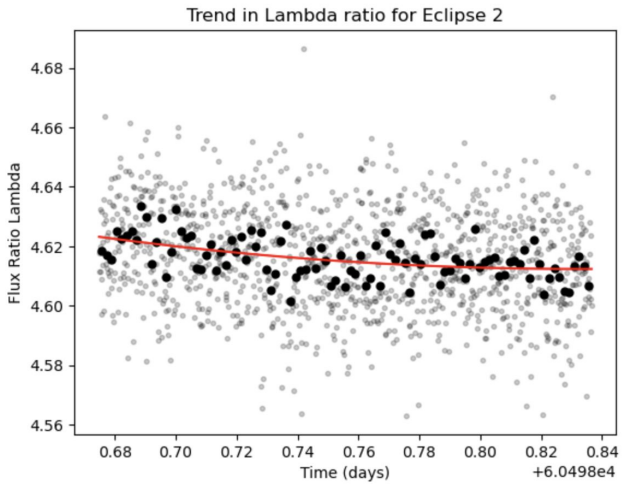




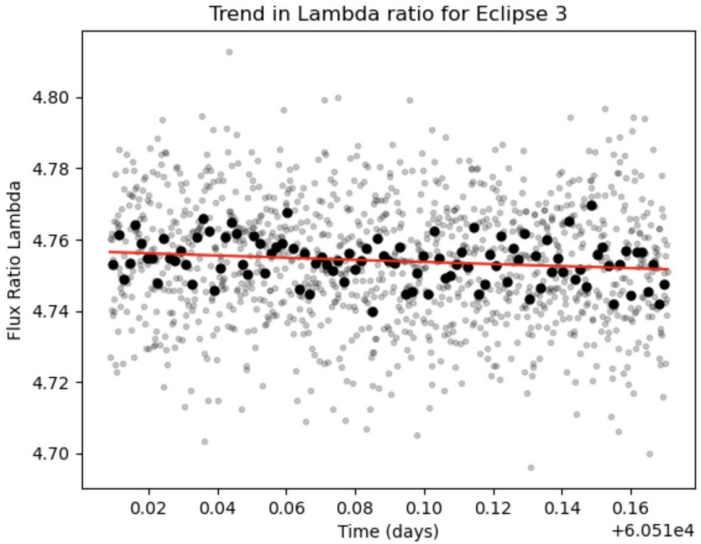
- ratio of flux of psf / annulus
- add errorbars







- quick curvefit (2d polynomial) for the ratio of flux psf / annulus



FRQNT proposal

- expect detailed, doable, specific project proposals for master’s
- Eclipse photometry?
- LHS 1140 b,c?
- JWST proposals?
- 1 page, due in a week

Décrire avec clarté et cohérence la recherche proposée, son originalité, les éléments de méthodologie et l'aperçu du cadre conceptuel, de façon à en démontrer la pertinence.

note

- BFE → flux bave sur pixels à côté

à faire

- modele comparison:
  - linear trend
  - polynome 2nd degree
  - exp
  - double exp
  - no centroid / centroid degree 1 / degree 2
- include fp, bic, eclipse
- aller rechercher les données zieba
- envoyer à etienne les 2 autres eclipses, batman function and parameters of eclipse (ts and width (t1-t4)
- passer la 3e eclipse dans le MCMC
- get lc in mJy for JWST figures

Fall week 3 - 03/10

- submitted FRQNT!
- Ran Eureka S3 to get LC in mJy for JWST proposal
- started building the model compare: included the exponential in the MCMC, tested a model ‘exp+linear’ and made plots, exp causes issues bc needs absolute time (centered at 0) to do calculations, can’t be in MJD
- uploaded eclipses 2 and 3 on genesis

à faire

- calculer RMS sur données brutes (np.convolve faire la différence avec les données et prendre la std)

Fall week 24/10

- no meeting last week (reading break + JWST proposals)
- NSERC-CGS-M application (project proposal + references)
- for the proposal:
  - fit eclipses 2 and 3 with batman / centroid model using the MCMC
  - Removed a 2D polynomial trend, but there is no ramp like with e1 so it is completely different
  - The timing and eclipse depth aren't constrained as well as the first eclipse (larger uncertainties, shallower eclipse)
  - Eclipse 1 fit is from exponential only,
  - Haven't managed to integrate Etienne's exponential parameters, maybe a time scale issue?
- Implemented and tested the following model combinations: exponential, exponential + linear, polynomial (3D), linear, exponential + polynomial
- working on, all with centroids (currently no centroids), double exponential
- need to make comparative plot now that i have working model

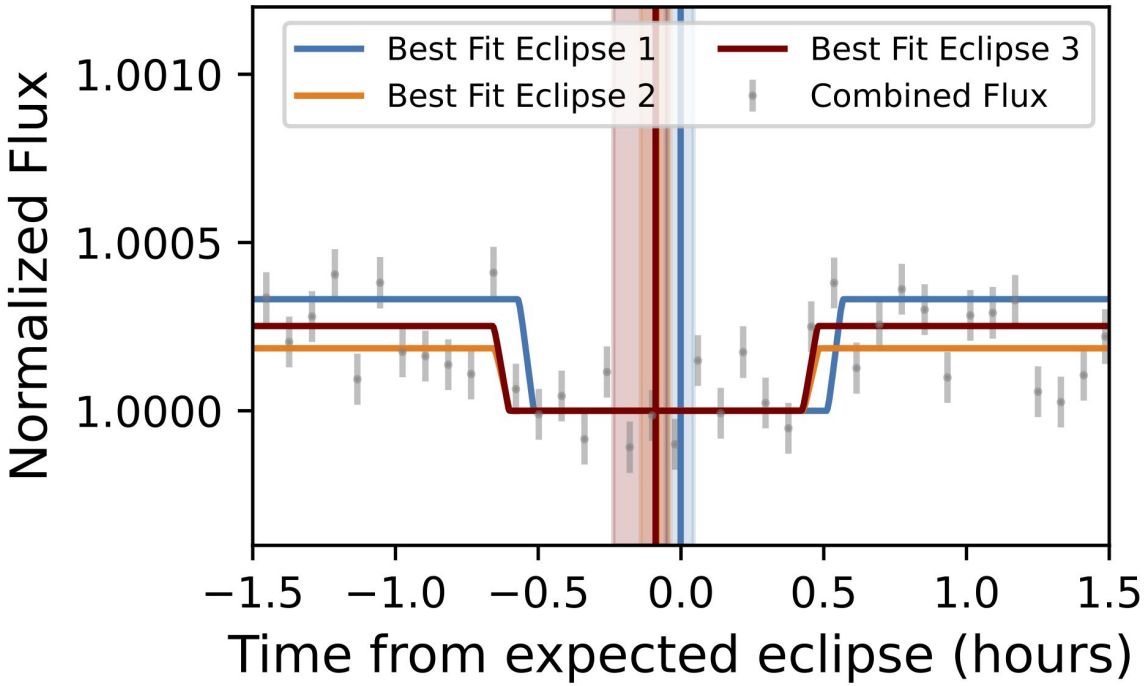
proposal figures

final figure

3 eclipses binned together

overlapping fits + estimated timing and uncertainty

centered at expected timing

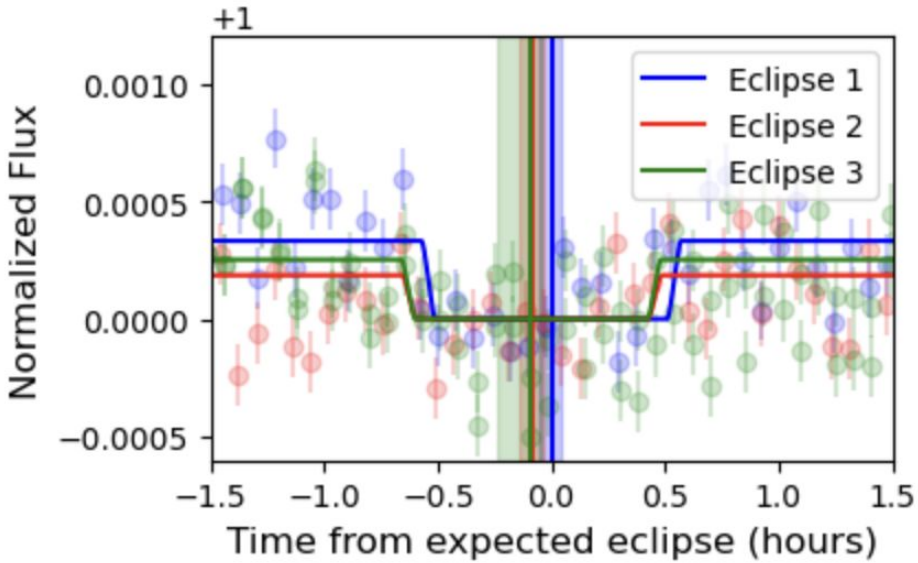


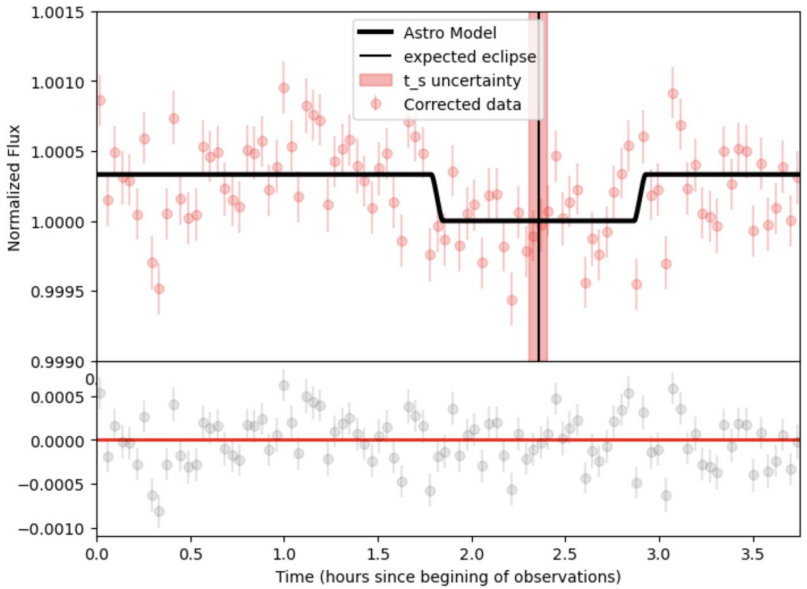
other versions

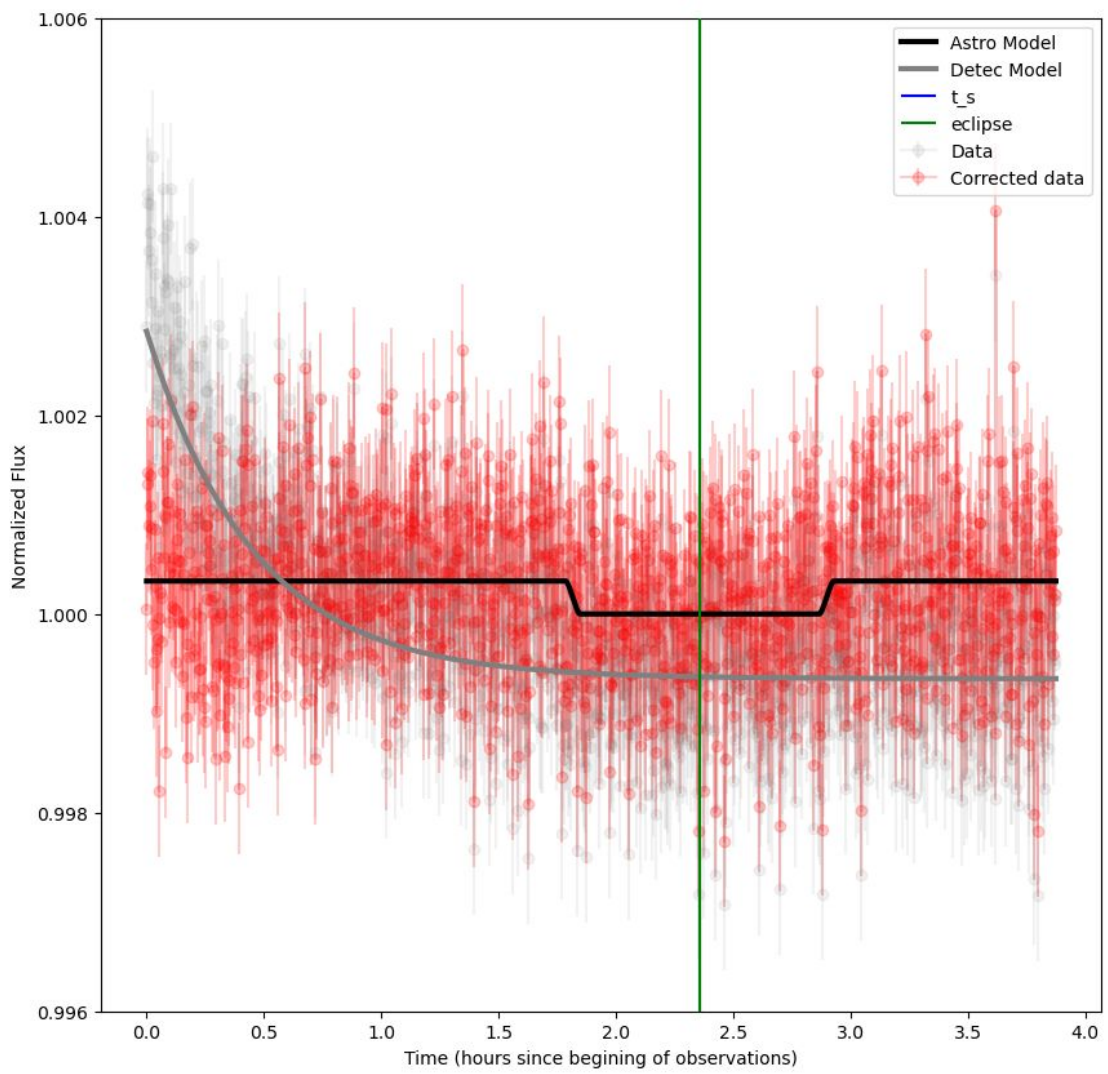
all three eclipses and their own fits

a bit noisy

e2 and e3 aren't super well constrained





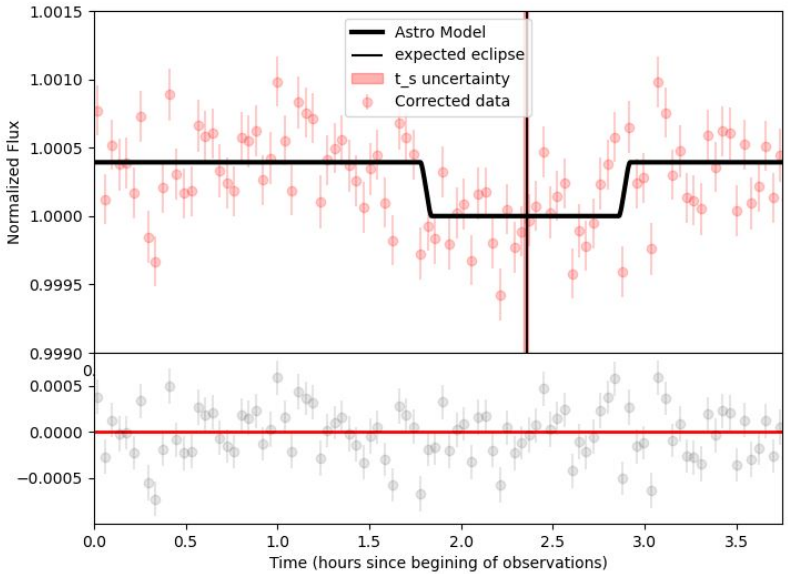


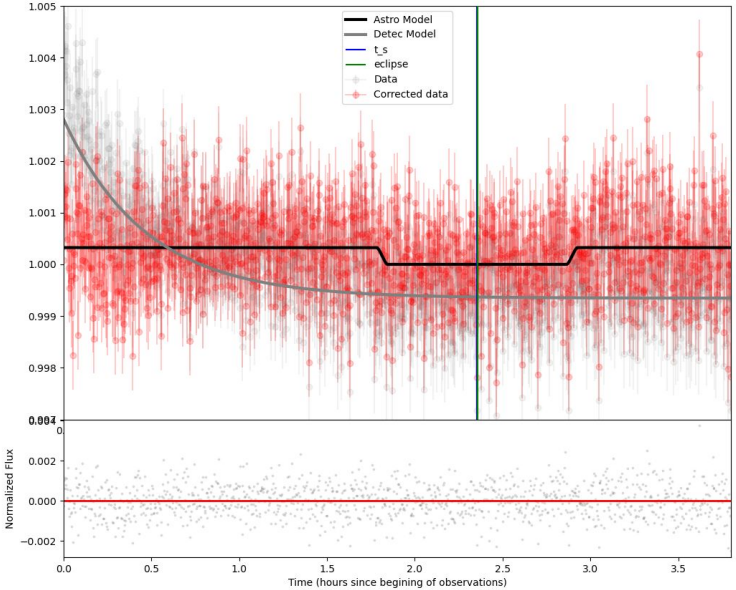
exponential correction e1
RMS 810 ppm
timing of eclipse is same as expected value (overlapping blue / green lines)

All models: exponential

t_s = 2.3547243614739815 +0.045854173692250644 -0.0527589061881546 (h- 2.358589777140878)
fp = 0.00032398707243913577 +5.360428359960632e-05 -5.410135642869773e-05

RMS = 810.553281638424 ppm
chi2 = 1261.803615472046
BIC = -16634.554431339307

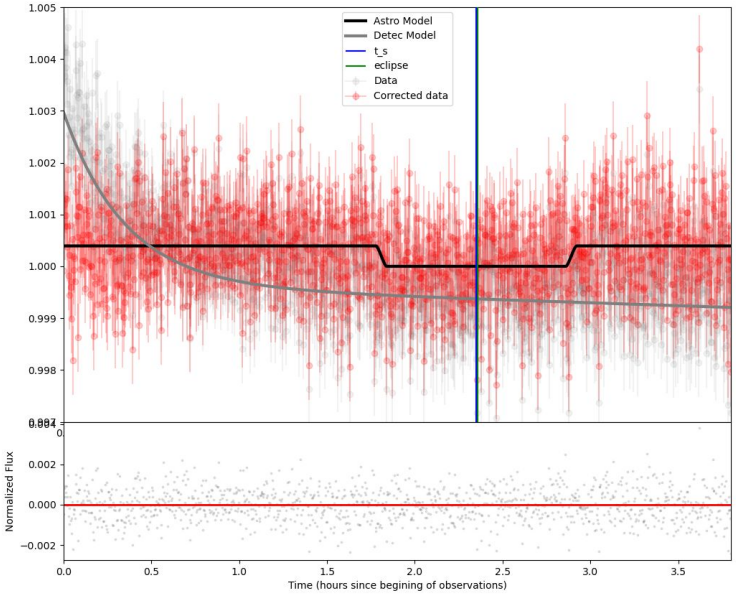


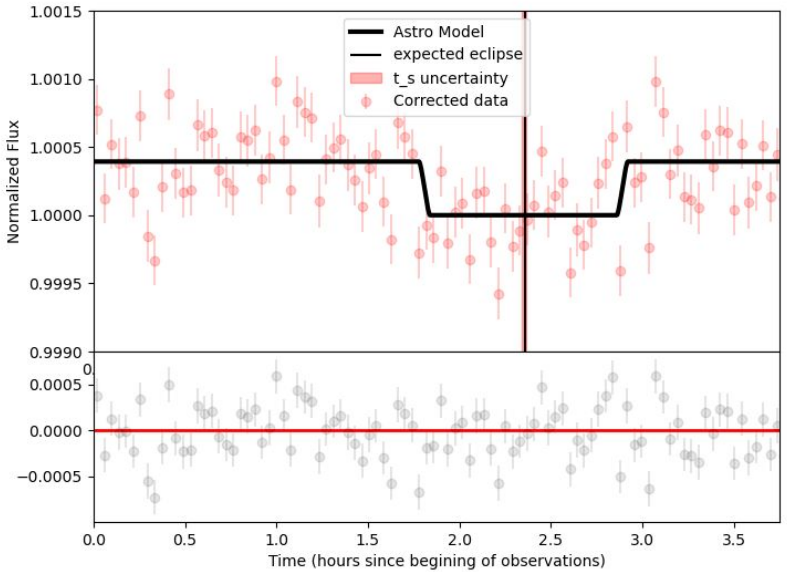


All models: exponential + linear

t_s = 2.3498684189533745 +0.01386041209878508 -0.012102833318474726
fp = 0.00039325076437021354 +6.073504288704723e-05 -6.295358870331481e-05

RMS = 809.2721725256163 ppm
chi2 = 1262.196899747444
BIC = -16624.422003288793

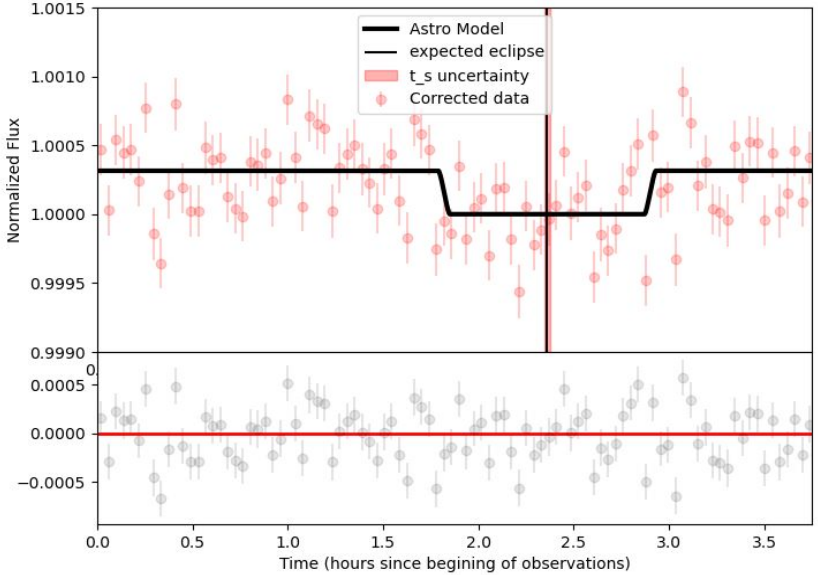


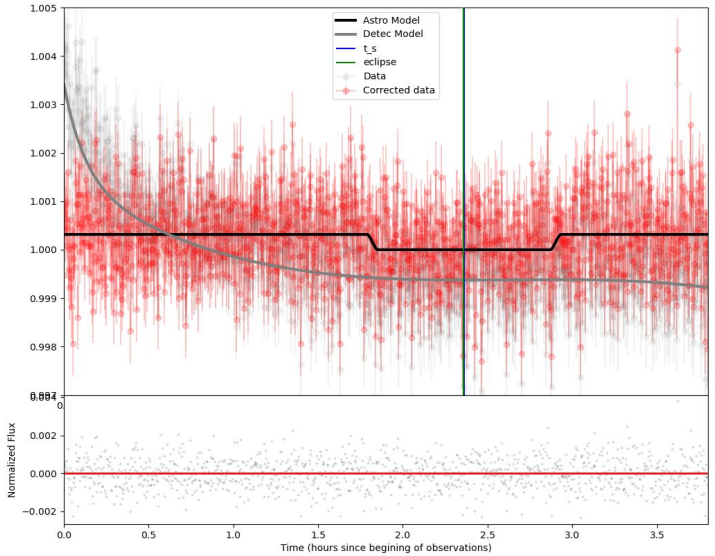


All models: exponential + poly (deg. 3)

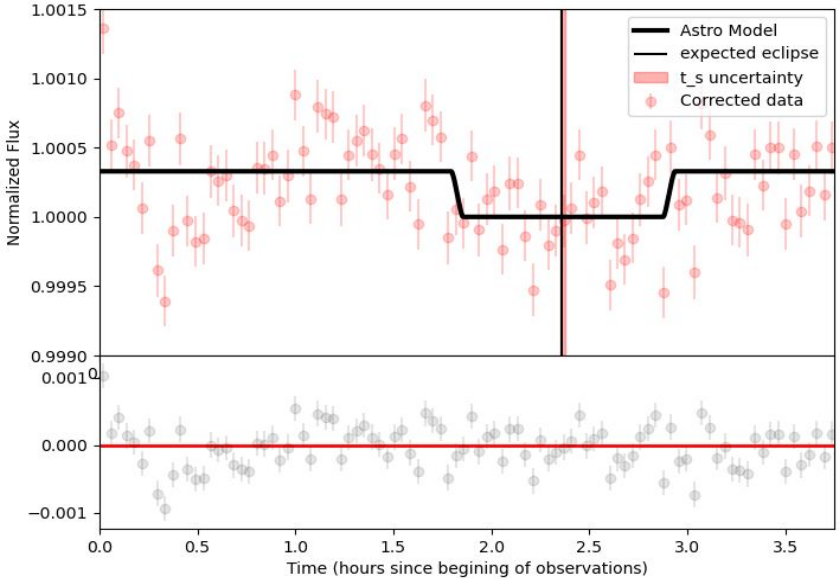
t_s = 2.361154786380652 +0.013145621445754152 -0.013635346446678742
fp = 0.00031515849629186796 +8.093609718098671e-05 -7.792111758051445e-05

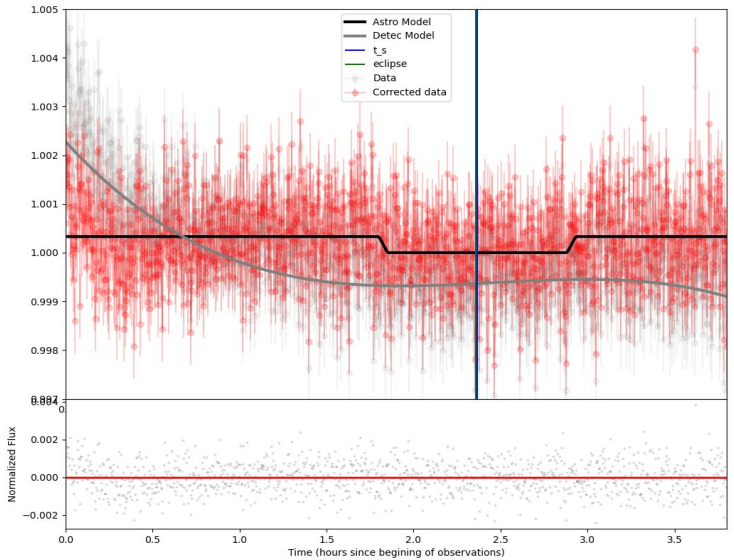
RMS = 806.2666413564913 ppm
chi2 = 1262.0055262519409
BIC = -16619.37028181088
RMS2 = 0.005002367109972471





All models: polynomial (deg. 3)





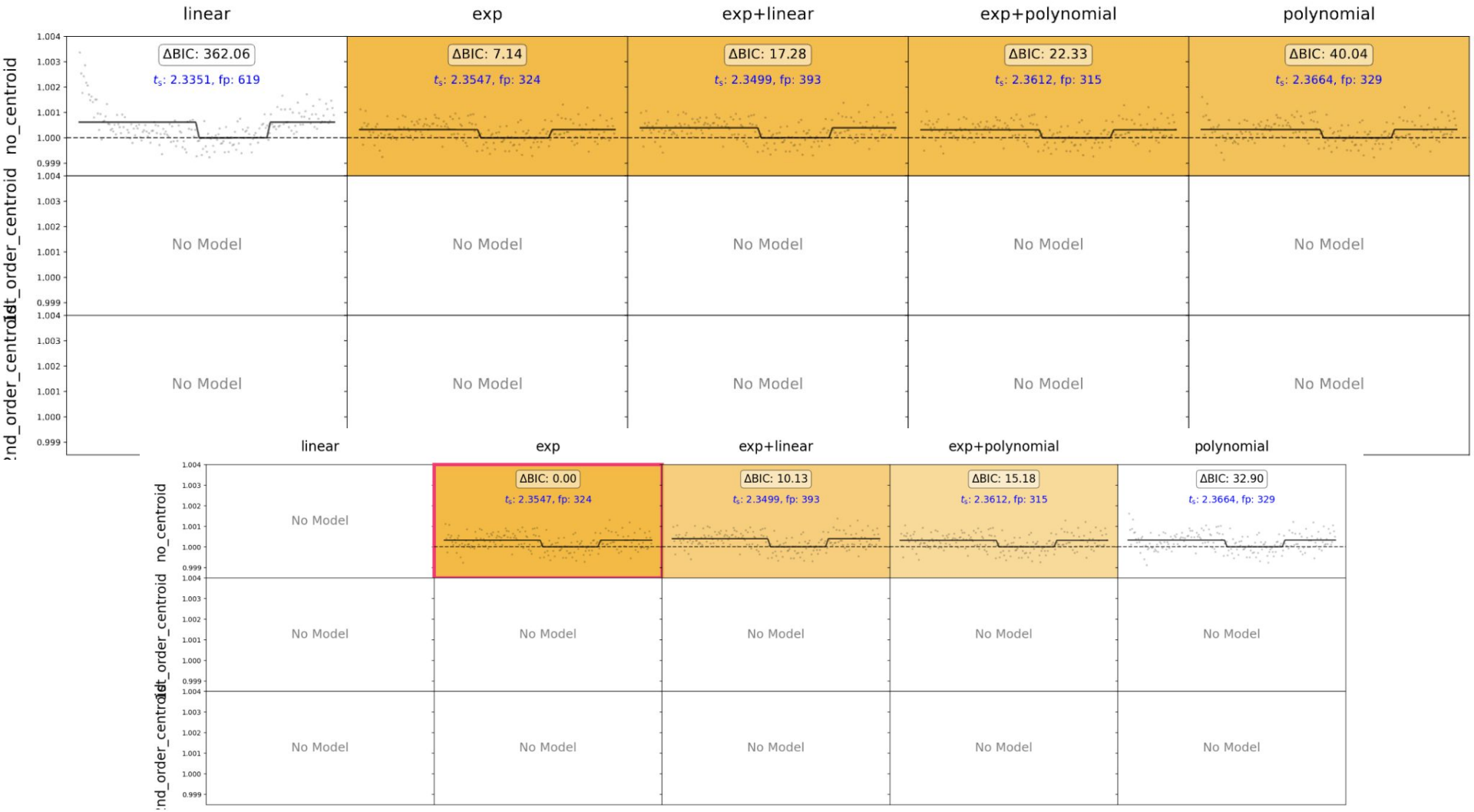
À faire

- ajouter double exponentiel
- mettre dans une figure
- comparer avec/sans centroid

Fall week 31/10

- made comparative plot
- re-included centroids in the model

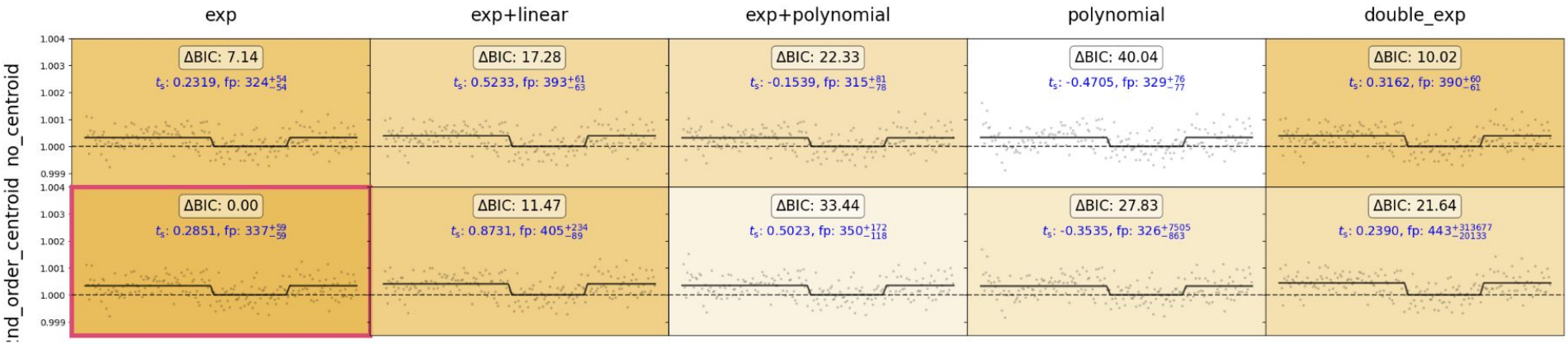
- Need to change t_s to time from expected eclipse
- need to include double eclipse and centroids in comparative plot
- (later) make allen plot comparison


linear
exp
exp+linear
exp+polynomial
polynomial
no_centroid
1st_order_centroid
2nd_order_centroid
ΔBIC: 362.06
t_s: 2.3351, fp: 619
ΔBIC: 7.14
t_s: 2.3547, fp: 324
ΔBIC: 17.28
t_s: 2.3499, fp: 393
ΔBIC: 22.33
t_s: 2.3612, fp: 315
ΔBIC: 40.04
t_s: 2.3664, fp: 329
No Model
ΔBIC: 0.00
t_s: 2.3547, fp: 324
ΔBIC: 10.13
t_s: 2.3499, fp: 393
ΔBIC: 15.18
t_s: 2.3612, fp: 315
ΔBIC: 32.90
t_s: 2.3664, fp: 329

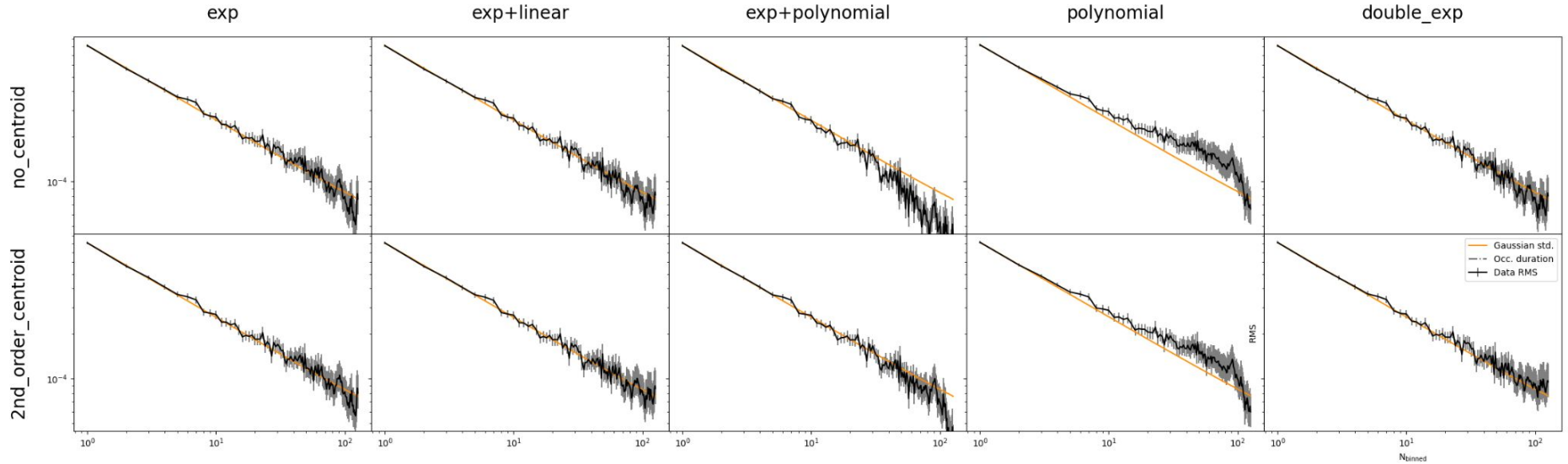
Fall week 07/11

- some centroid models are poorly constrained
  - maybe longer MCMC run would help (but already takes a bit more time to run through the steps)
  - maybe multiplying the models isn't the best way to run them simultaneously
  - need to try 1st order centroids
- could do a latex table to compare RMS for each model not just BIC with plot
- Created Github repo for this code
- Started running different models for e2

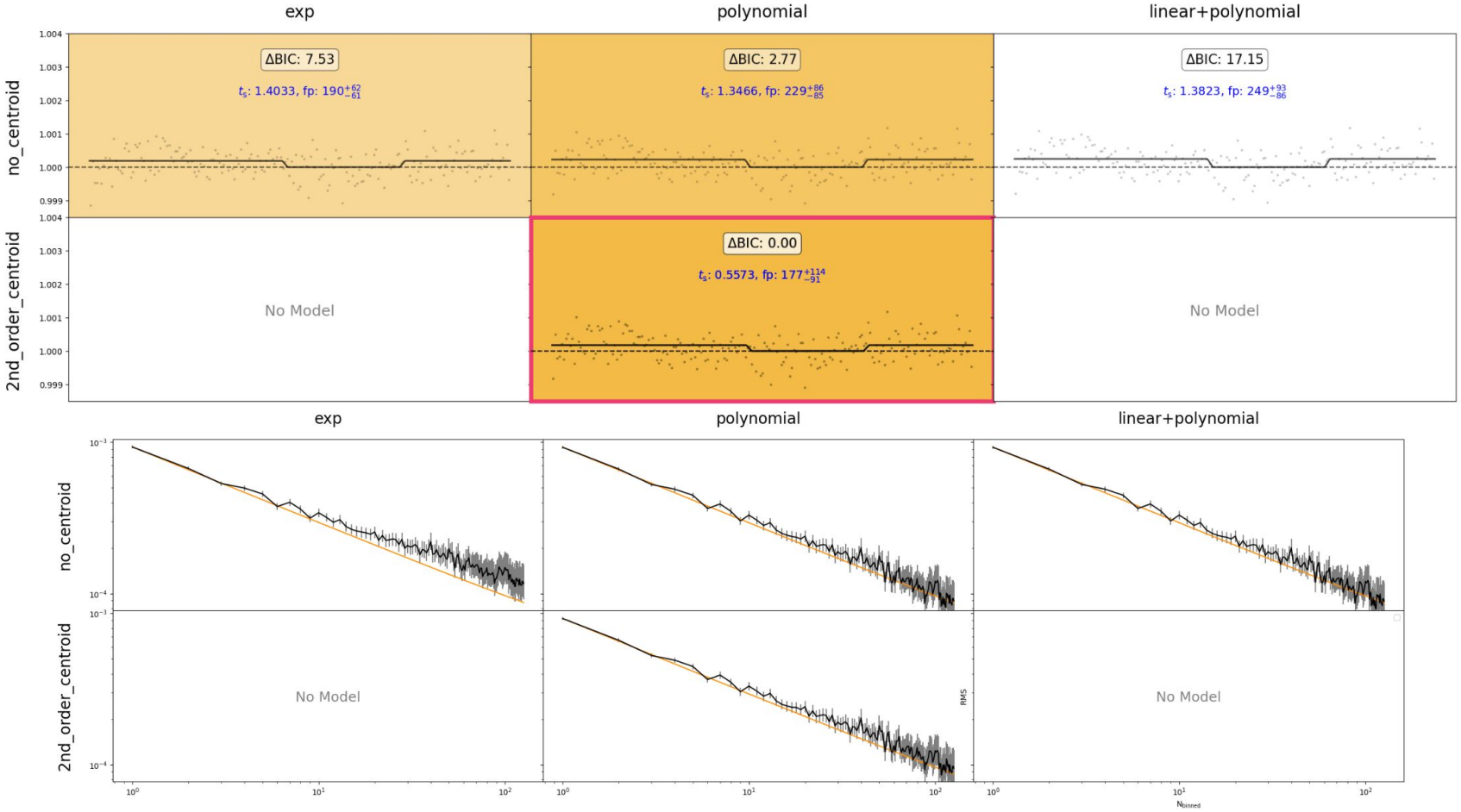
All models comparison t_s in minutes since expected eclipse



Some models are very poorly constrained with uncertainty on fp orders of magnitude bigger than value, need to add time axis


exp
exp+linear
exp+polynomial
polynomial
double_exp
no_centroid
2nd_order_centroid
Gaussian std.
Occ. duration
Data RMS
RMS
N_binned

Eclipse 2


exp
polynomial
linear+polynomial
no_centroid
2nd_order_centroid
ΔBIC: 7.53
t_s: 1.4033, fp: 190^{+62}_{-61}
ΔBIC: 2.77
t_s: 1.3466, fp: 229^{+86}_{-85}
ΔBIC: 17.15
t_s: 1.3823, fp: 249^{+93}_{-86}
ΔBIC: 0.00
t_s: 0.5573, fp: 177^{+114}_{-91}
No Model
No Model
No Model
RMS
N_{binned}

À faire

- Faire moyenne pondérée des valeurs de fp avec l’erreur
- Identifier le meilleur modèle pour chaque éclipse

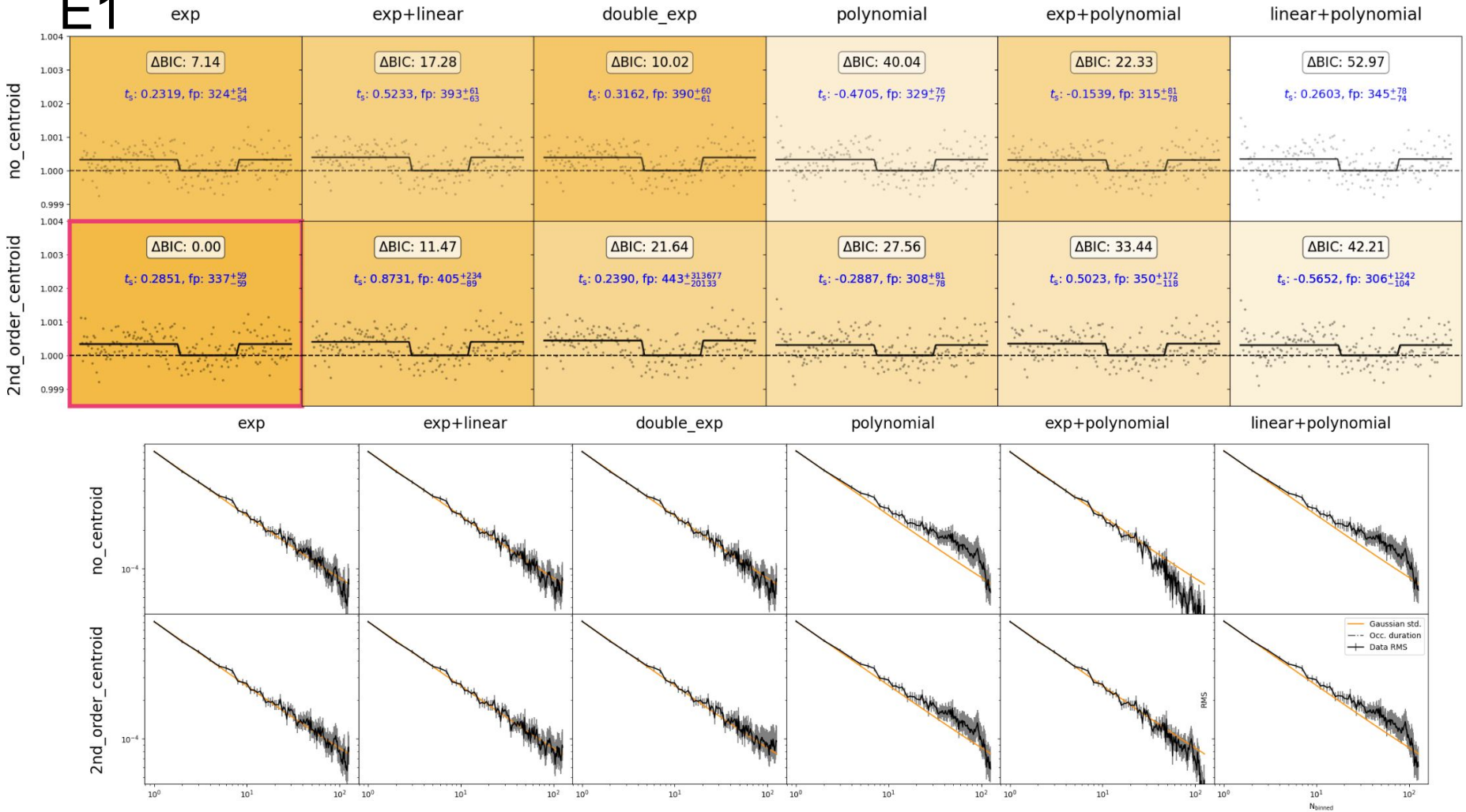
Fall week 21/11

- e2 well fitting model is double exponential with centroids, but it is a reversed exponential
- tried every model for each eclipse
- calculated the weighted mean of eclipse depth for each eclipse

- worked on NSERC proposal, need to write plain word summary
- started applying to UdeM → deadline unclear

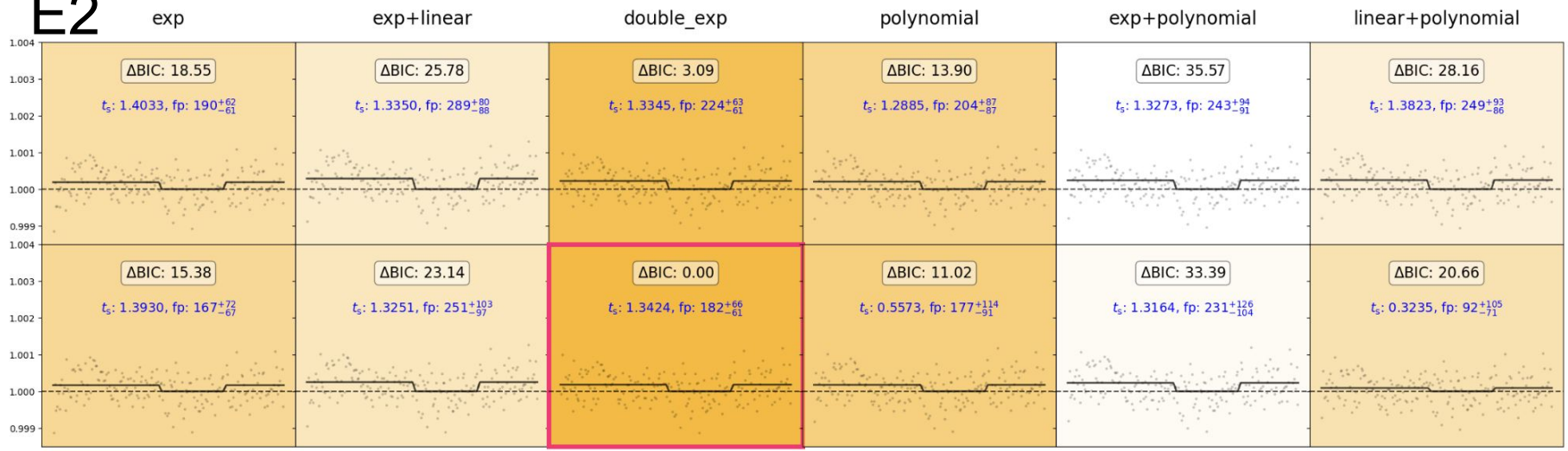
- will calculate the best fit mean for all eclipse

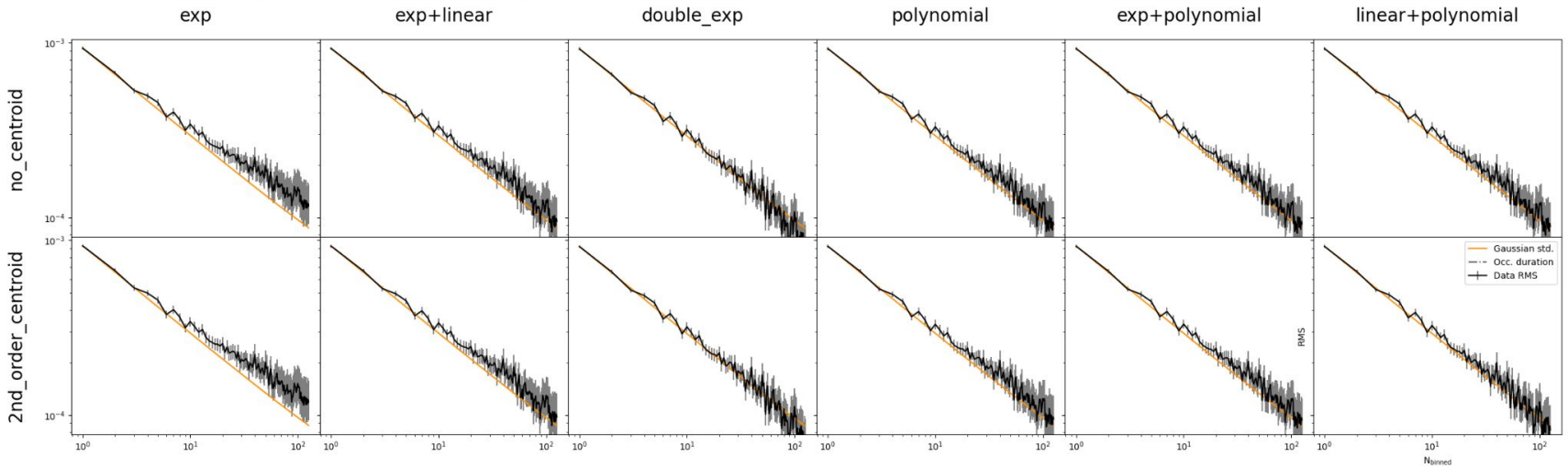
E1


exp
exp+linear
double_exp
polynomial
exp+polynomial
linear+polynomial
no_centroid
2nd_order_centroid
ΔBIC: 7.14
t_s: 0.2319, fp: 324^{+54}_{-54}
ΔBIC: 17.28
t_s: 0.5233, fp: 393^{+61}_{-63}
ΔBIC: 10.02
t_s: 0.3162, fp: 390^{+60}_{-61}
ΔBIC: 40.04
t_s: -0.4705, fp: 329^{+76}_{-77}
ΔBIC: 22.33
t_s: -0.1539, fp: 315^{+81}_{-78}
ΔBIC: 52.97
t_s: 0.2603, fp: 345^{+78}_{-74}
ΔBIC: 0.00
t_s: 0.2851, fp: 337^{+59}_{-59}
ΔBIC: 11.47
t_s: 0.8731, fp: 405^{+234}_{-89}
ΔBIC: 21.64
t_s: 0.2390, fp: $443^{+313677}_{-20133}$
ΔBIC: 27.56
t_s: -0.2887, fp: 308^{+81}_{-78}
ΔBIC: 33.44
t_s: 0.5023, fp: 350^{+172}_{-118}
ΔBIC: 42.21
t_s: -0.5652, fp: 306^{+1242}_{-104}
1.004
1.003
1.002
1.001
1.000
0.999

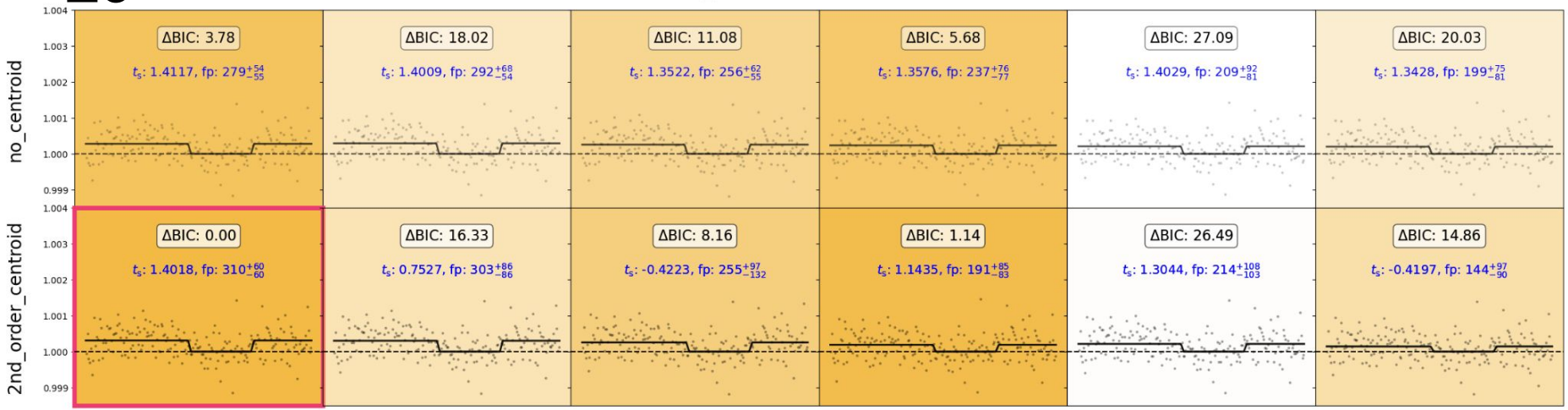
exp
exp+linear
double_exp
polynomial
exp+polynomial
linear+polynomial
no_centroid
2nd_order_centroid
Gaussian std.
Occ. duration
Data RMS
RMS
N_{binned}

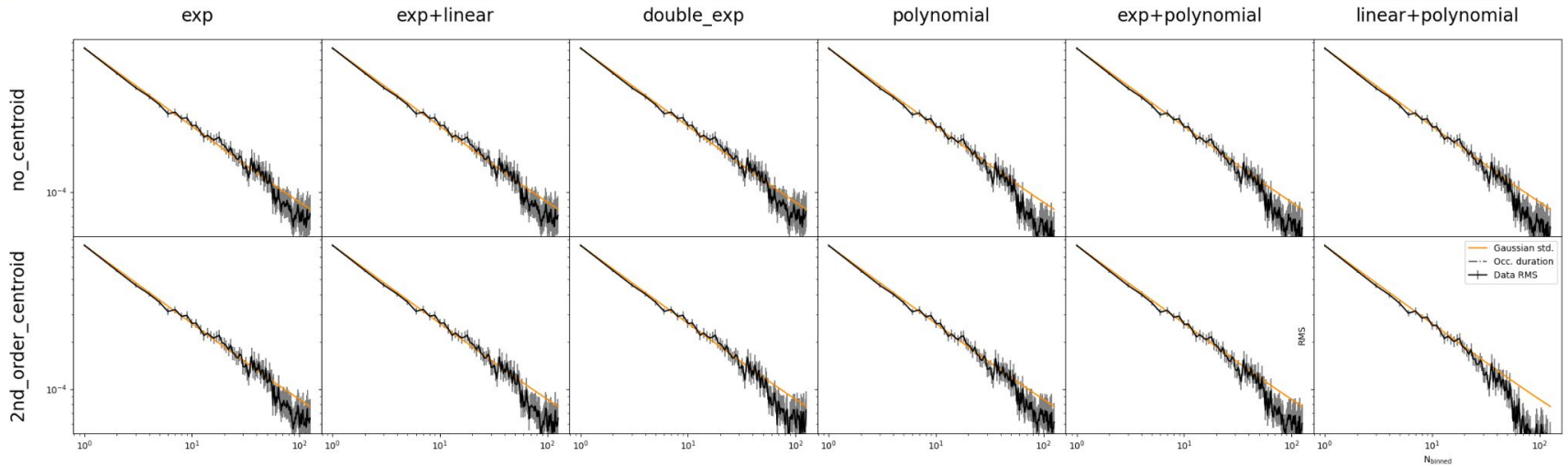
E2


exp
exp+linear
double_exp
polynomial
exp+polynomial
linear+polynomial
no_centroid
2nd_order_centroid
ΔBIC: 18.55
t_s: 1.4033, fp: 190^{+62}_{-61}
ΔBIC: 25.78
t_s: 1.3350, fp: 289^{+80}_{-88}
ΔBIC: 3.09
t_s: 1.3345, fp: 224^{+63}_{-61}
ΔBIC: 13.90
t_s: 1.2885, fp: 204^{+87}_{-87}
ΔBIC: 35.57
t_s: 1.3273, fp: 243^{+94}_{-91}
ΔBIC: 28.16
t_s: 1.3823, fp: 249^{+93}_{-86}
ΔBIC: 15.38
t_s: 1.3930, fp: 167^{+72}_{-67}
ΔBIC: 23.14
t_s: 1.3251, fp: 251^{+103}_{-97}
ΔBIC: 0.00
t_s: 1.3424, fp: 182^{+66}_{-61}
ΔBIC: 11.02
t_s: 0.5573, fp: 177^{+114}_{-91}
ΔBIC: 33.39
t_s: 1.3164, fp: 231^{+126}_{-104}
ΔBIC: 20.66
t_s: 0.3235, fp: 92^{+105}_{-71}


exp
exp+linear
double_exp
polynomial
exp+polynomial
linear+polynomial
no_centroid
2nd_order_centroid
Gaussian std.
Occ. duration
Data RMS
RMS
N_{binned}

E3


exp
exp+linear
double_exp
polynomial
exp+polynomial
linear+polynomial
no_centroid
2nd_order_centroid
ΔBIC: 3.78
t_s: 1.4117, fp: 279^{+54}_{-55}
ΔBIC: 18.02
t_s: 1.4009, fp: 292^{+68}_{-54}
ΔBIC: 11.08
t_s: 1.3522, fp: 256^{+62}_{-55}
ΔBIC: 5.68
t_s: 1.3576, fp: 237^{+76}_{-77}
ΔBIC: 27.09
t_s: 1.4029, fp: 209^{+92}_{-81}
ΔBIC: 20.03
t_s: 1.3428, fp: 199^{+75}_{-81}
ΔBIC: 0.00
t_s: 1.4018, fp: 310^{+60}_{-60}
ΔBIC: 16.33
t_s: 0.7527, fp: 303^{+86}_{-86}
ΔBIC: 8.16
t_s: -0.4223, fp: 255^{+97}_{-132}
ΔBIC: 1.14
t_s: 1.1435, fp: 191^{+85}_{-83}
ΔBIC: 26.49
t_s: 1.3044, fp: 214^{+108}_{-103}
ΔBIC: 14.86
t_s: -0.4197, fp: 144^{+97}_{-90}


exp
exp+linear
double_exp
polynomial
exp+polynomial
linear+polynomial
no_centroid
2nd_order_centroid
Gaussian std.
Occ. duration
Data RMS
RMS
N_{binned}

```
Weighted average of fp for e1: 351.7348233707502
Weighted average of fp for e2: 179.79343209180328
Weighted average of fp for e3: 238.1908985634695
```

- all models are well fit by either an exponential or a double exponential

Running longer convergence runs for poorly constrained fits

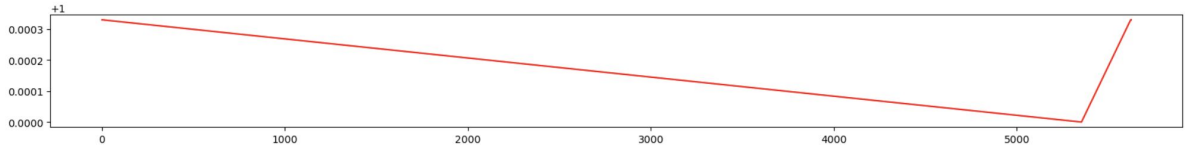
- takes about 15-30 minutes per model
- e1 double_exp_2nd_order_centroid still poorly converged
- a few of the models might need even more time but all the uncertainties decreased to =< OOM of 230 ppm

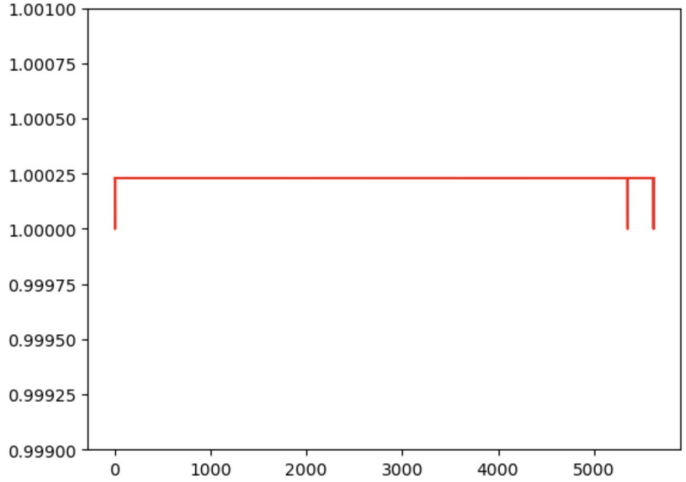
Joint fit

- exponentials are annoying
- can’t set segments of the array to zero to apply the function (because exponentials)
- i’m not sure batman can fit multiple eclipses at a time along one time axis (periodic signal), it works if i give a set t_s but it’s

  giving the mcmc trouble → currently fitting one

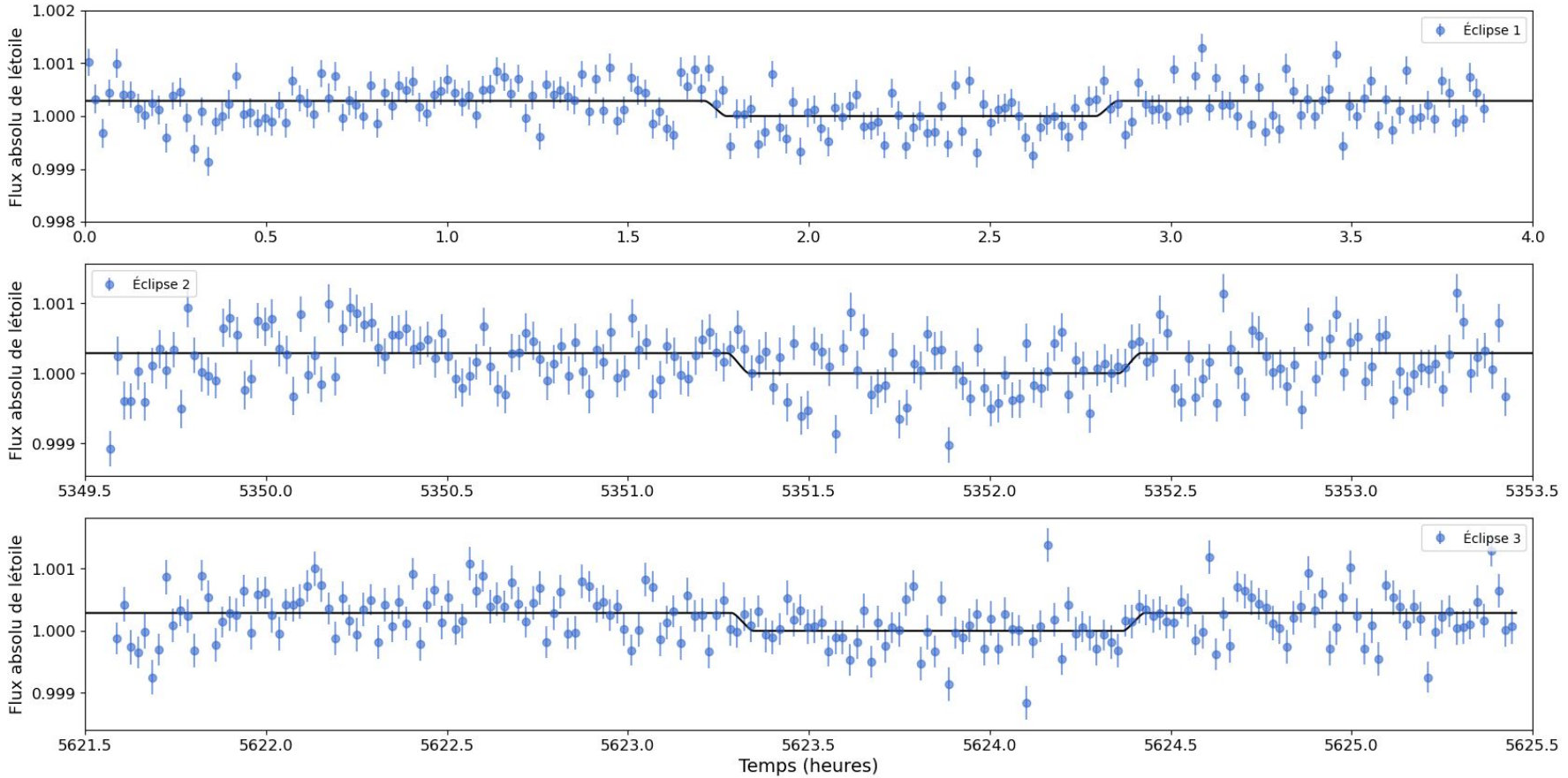
  gigantic eclipse instead





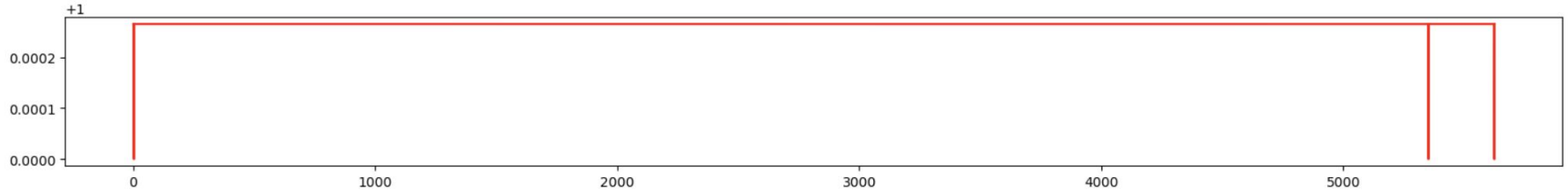
Fall week 28/11

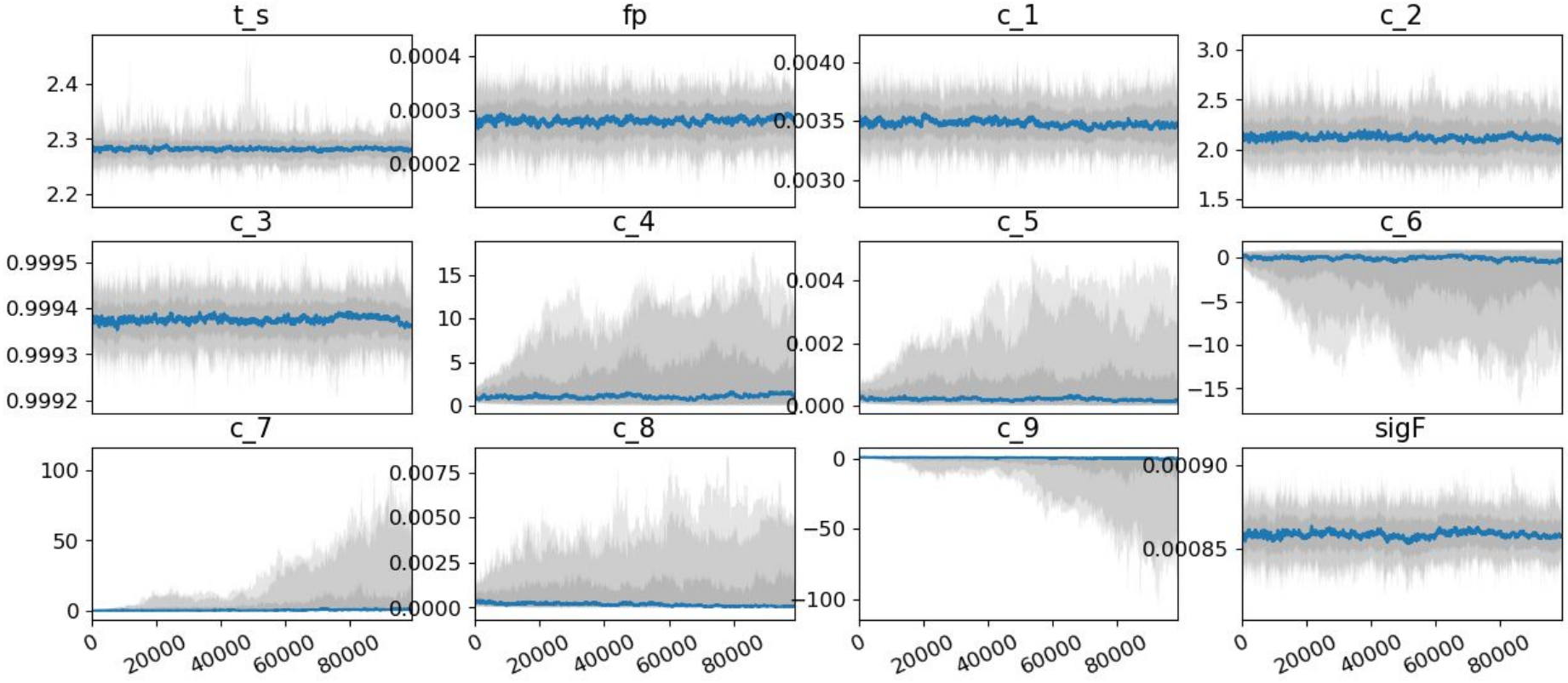
- Joint fit! wint simple exponentials only, need to include other models (if necessary) and centroid detrending (this adds many more parameters so it might be hard to get the MCMC to converge)
- Similar results as last week otherwise
- Will be writing up documentation / description of the code to make sure it is usable/accessible to someone else!

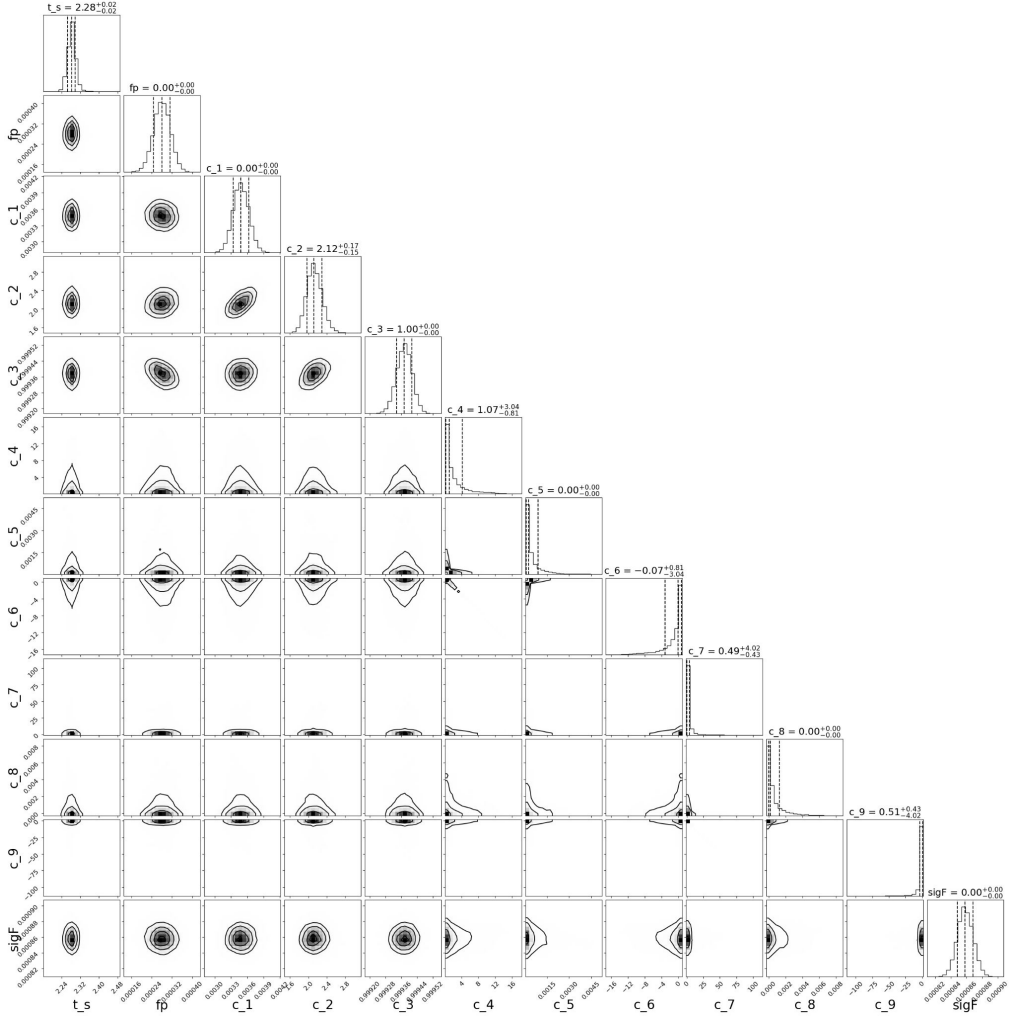


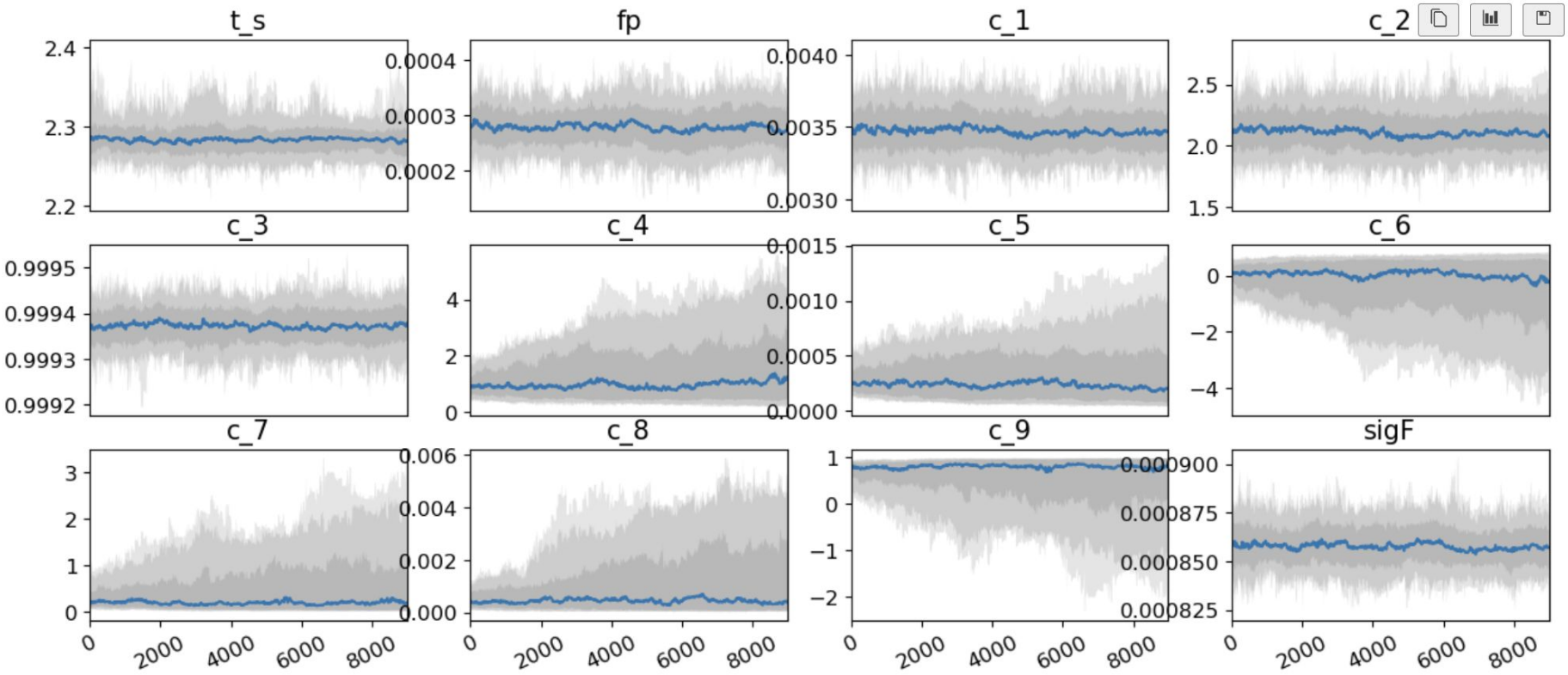
fp = 287 +/-35

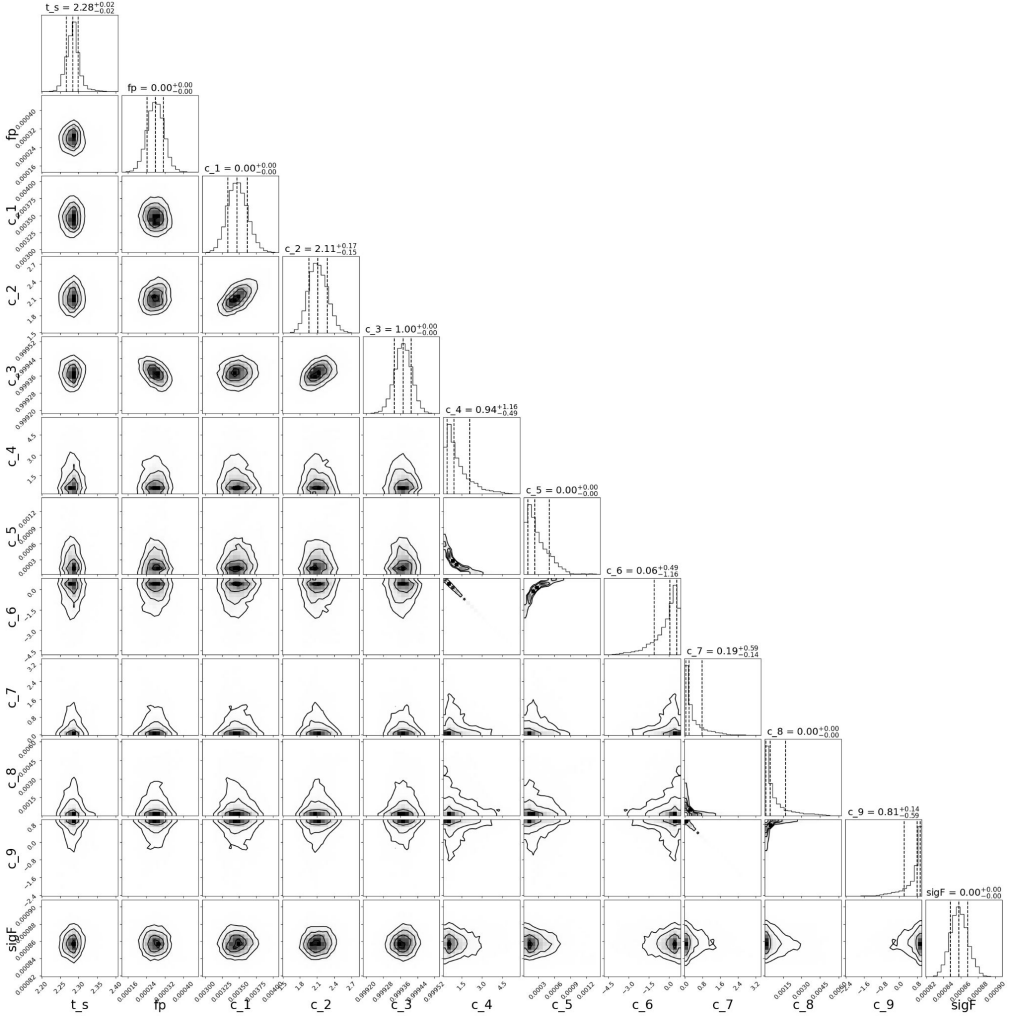
t_s = 4.5 min +/- 1min without ANY prior on t_s

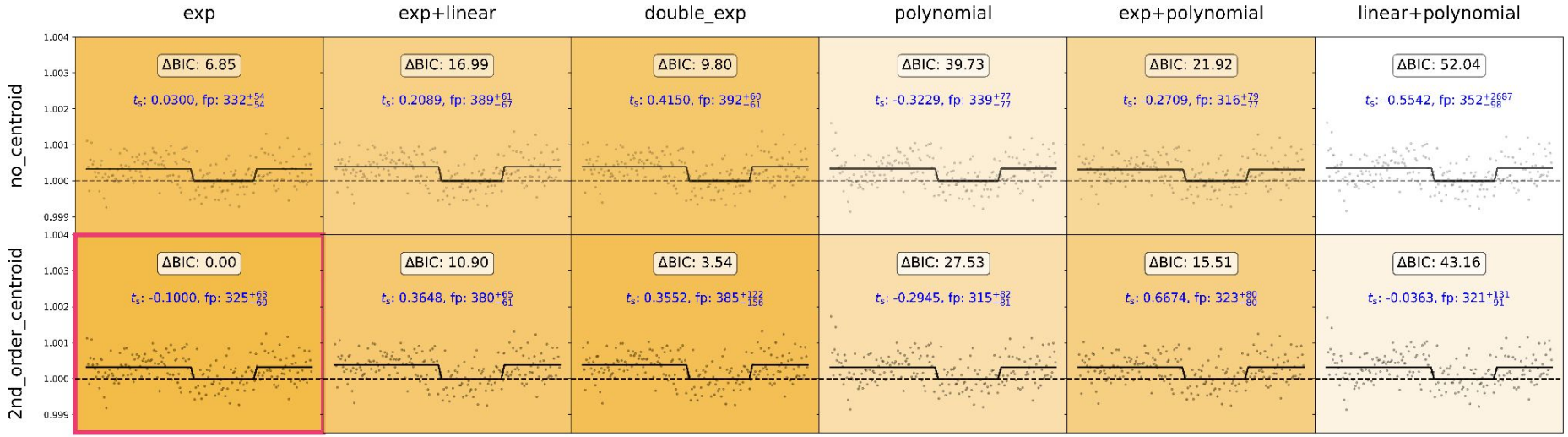

+1
0.0002
0.0001
0.0000
0
1000
2000
3000
4000
5000

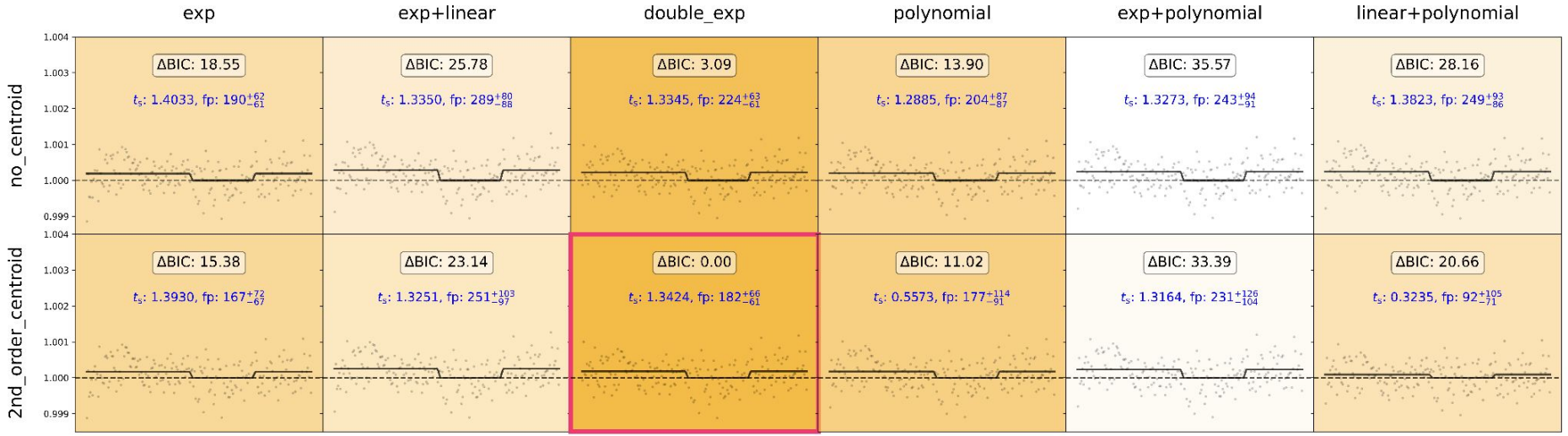

t_s
fp
c_1
c_2
c_3
c_4
c_5
c_6
c_7
c_8
c_9
sigF
0
20000
40000
60000
80000

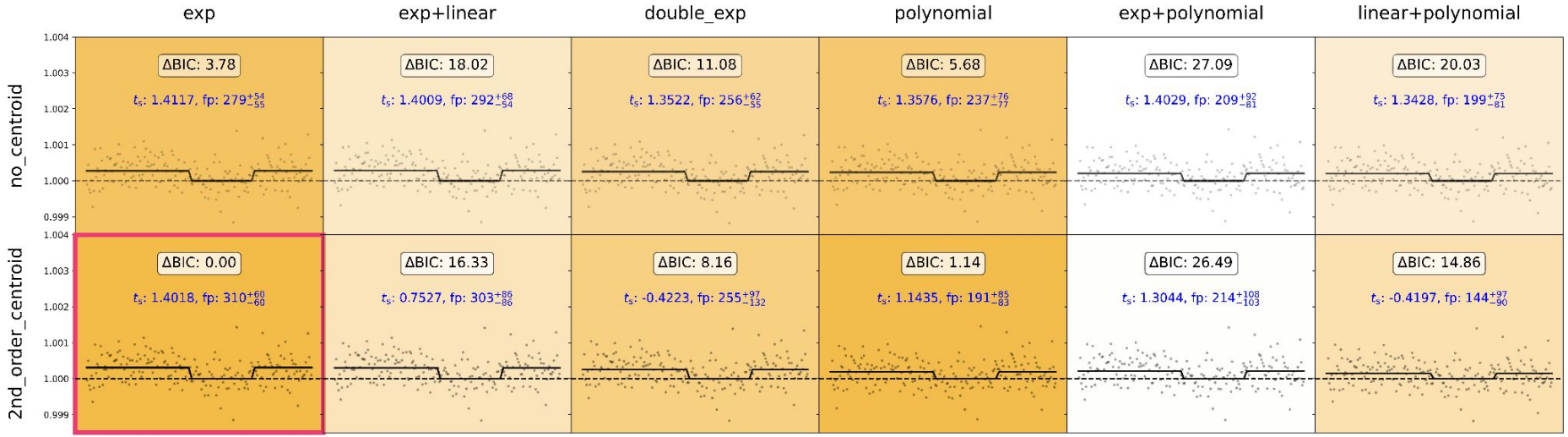

t_s = 2.28$^{+0.02}_{-0.02}$
fp = 0.00$^{+0.00}_{-0.00}$
c_1 = 0.00$^{+0.00}_{-0.00}$
c_2 = 2.12$^{+0.17}_{-0.15}$
c_3 = 1.00$^{+0.00}_{-0.00}$
c_4 = 1.07$^{+3.04}_{-0.81}$
c_5 = 0.00$^{+0.00}_{-0.00}$
c_6 = −0.07$^{+0.81}_{-3.04}$
c_7 = 0.49$^{+4.02}_{-0.43}$
c_8 = 0.00$^{+0.00}_{-0.00}$
c_9 = 0.51$^{+0.43}_{-4.02}$
sigF = 0.00$^{+0.00}_{-0.00}$
t_s
fp
c_1
c_2
c_3
c_4
c_5
c_6
c_7
c_8
c_9
sigF


t_s
fp
c_1
c_2
c_3
c_4
c_5
c_6
c_7
c_8
c_9
sigF
0
2000
4000
6000
8000


t_s = 2.28$^{+0.02}_{-0.02}$
fp = 0.00$^{+0.00}_{-0.00}$
c_1 = 0.00$^{+0.00}_{-0.00}$
c_2 = 2.11$^{+0.17}_{-0.15}$
c_3 = 1.00$^{+0.00}_{-0.00}$
c_4 = 0.94$^{+1.16}_{-0.49}$
c_5 = 0.00$^{+0.00}_{-0.00}$
c_6 = 0.06$^{+0.49}_{-1.16}$
c_7 = 0.19$^{+0.59}_{-0.14}$
c_8 = 0.00$^{+0.00}_{-0.00}$
c_9 = 0.81$^{+0.14}_{-0.59}$
sigF = 0.00$^{+0.00}_{-0.00}$
t_s
fp
c_1
c_2
c_3
c_4
c_5
c_6
c_7
c_8
c_9
sigF

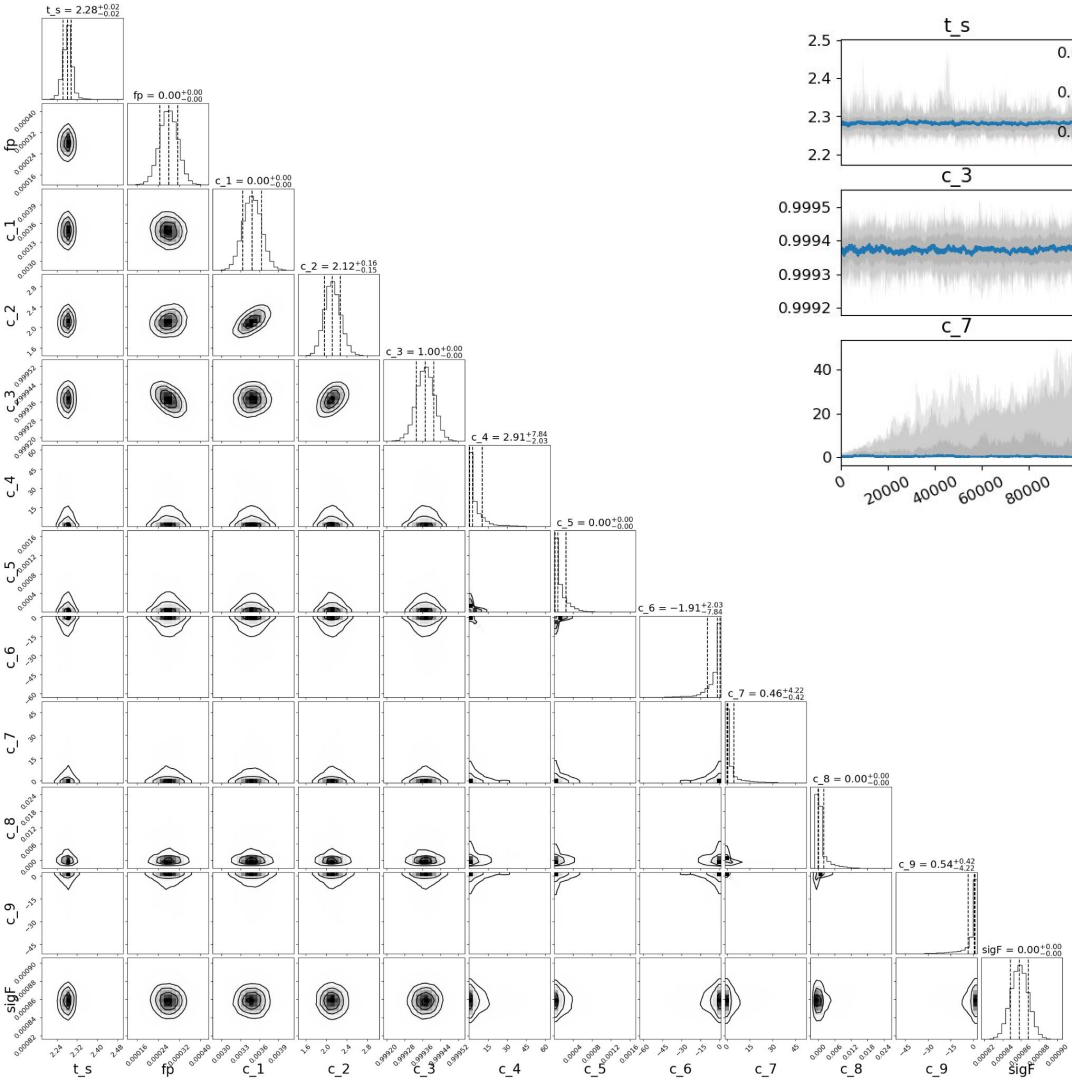

exp
exp+linear
double_exp
polynomial
exp+polynomial
linear+polynomial
no_centroid
2nd_order_centroid
ΔBIC: 6.85
t_s: 0.0300, fp: 332^{+54}_{-54}
ΔBIC: 16.99
t_s: 0.2089, fp: 389^{+61}_{-67}
ΔBIC: 9.80
t_s: 0.4150, fp: 392^{+60}_{-61}
ΔBIC: 39.73
t_s: -0.3229, fp: 339^{+77}_{-77}
ΔBIC: 21.92
t_s: -0.2709, fp: 316^{+79}_{-77}
ΔBIC: 52.04
t_s: -0.5542, fp: 352^{+2687}_{-98}
ΔBIC: 0.00
t_s: -0.1000, fp: 325^{+63}_{-60}
ΔBIC: 10.90
t_s: 0.3648, fp: 380^{+65}_{-61}
ΔBIC: 3.54
t_s: 0.3552, fp: 385^{+122}_{-156}
ΔBIC: 27.53
t_s: -0.2945, fp: 315^{+82}_{-81}
ΔBIC: 15.51
t_s: 0.6674, fp: 323^{+80}_{-80}
ΔBIC: 43.16
t_s: -0.0363, fp: 321^{+131}_{-91}
1.004
1.003
1.002
1.001
1.000
0.999

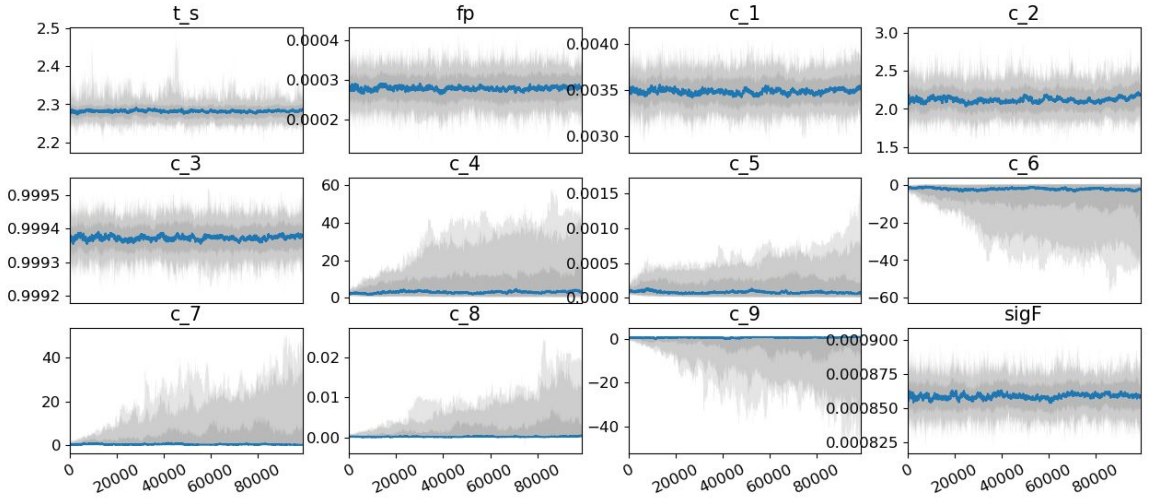

exp
exp+linear
double_exp
polynomial
exp+polynomial
linear+polynomial
no_centroid
2nd_order_centroid
ΔBIC: 18.55
t_s: 1.4033, fp: 190^{+62}_{-61}
ΔBIC: 25.78
t_s: 1.3350, fp: 289^{+80}_{-88}
ΔBIC: 3.09
t_s: 1.3345, fp: 224^{+63}_{-61}
ΔBIC: 13.90
t_s: 1.2885, fp: 204^{+87}_{-87}
ΔBIC: 35.57
t_s: 1.3273, fp: 243^{+94}_{-91}
ΔBIC: 28.16
t_s: 1.3823, fp: 249^{+93}_{-86}
ΔBIC: 15.38
t_s: 1.3930, fp: 167^{+72}_{-67}
ΔBIC: 23.14
t_s: 1.3251, fp: 251^{+103}_{-97}
ΔBIC: 0.00
t_s: 1.3424, fp: 182^{+66}_{-61}
ΔBIC: 11.02
t_s: 0.5573, fp: 177^{+114}_{-91}
ΔBIC: 33.39
t_s: 1.3164, fp: 231^{+126}_{-104}
ΔBIC: 20.66
t_s: 0.3235, fp: 92^{+105}_{-71}
1.004
1.003
1.002
1.001
1.000
0.999


exp
exp+linear
double_exp
polynomial
exp+polynomial
linear+polynomial
no_centroid
2nd_order_centroid
ΔBIC: 3.78
t_s: 1.4117, fp: 279^{+54}_{-55}
ΔBIC: 18.02
t_s: 1.4009, fp: 292^{+68}_{-54}
ΔBIC: 11.08
t_s: 1.3522, fp: 256^{+62}_{-55}
ΔBIC: 5.68
t_s: 1.3576, fp: 237^{+76}_{-77}
ΔBIC: 27.09
t_s: 1.4029, fp: 209^{+92}_{-81}
ΔBIC: 20.03
t_s: 1.3428, fp: 199^{+75}_{-81}
ΔBIC: 0.00
t_s: 1.4018, fp: 310^{+60}_{-60}
ΔBIC: 16.33
t_s: 0.7527, fp: 303^{+86}_{-86}
ΔBIC: 8.16
t_s: -0.4223, fp: 255^{+97}_{-132}
ΔBIC: 1.14
t_s: 1.1435, fp: 191^{+85}_{-83}
ΔBIC: 26.49
t_s: 1.3044, fp: 214^{+108}_{-103}
ΔBIC: 14.86
t_s: -0.4197, fp: 144^{+97}_{-90}
1.004
1.003
1.002
1.001
1.000
0.999

Fall week 05/12

- Continued running joint fit for longer, restarting with previous best fit parameters each time
- Wrote README file and commented the code.


t_s = 2.28^{+0.02}_{-0.02}
fp = 0.00^{+0.00}_{-0.00}
c_1 = 0.00^{+0.00}_{-0.00}
c_2 = 2.12^{+0.16}_{-0.15}
c_3 = 1.00^{+0.00}_{-0.00}
c_4 = 2.91^{+7.84}_{-2.03}
c_5 = 0.00^{+0.00}_{-0.00}
c_6 = −1.91^{+2.03}_{-7.84}
c_7 = 0.46^{+4.22}_{-0.42}
c_8 = 0.00^{+0.00}_{-0.00}
c_9 = 0.54^{+0.42}_{-4.22}
sigF = 0.00^{+0.00}_{-0.00}
t_s
fp
c_1
c_2
c_3
c_4
c_5
c_6
c_7
c_8
c_9
sigF


t_s
fp
c_1
c_2
c_3
c_4
c_5
c_6
c_7
c_8
c_9
sigF
0
20000
40000
60000
80000