GOAL: to get the light curve produced by the existing simulation to account for what affects the ROTSE telescope data such as the astrophysical effects, ccd camera effects, scheduling, and data quality. As of right now, the simulation produces an ideal light curve: a continuous line with no outliers or error bars. However, we want the simulation to produce a light curve that simulates what should be observed by the telescope. This means that some of the light data needs to be thrown out and/or altered accordingly. The atmosphere (some of the astrophysical effects) would cause some data to not be detected by the telescope. ROTSE was only scheduled to take data at certain times (see Dr. Kehoe for specific times) which means any data that the simulation thinks was taken during the day (for example) should be thrown out as ROTSE only took data at night for certain periods of time. The CCD effects will cause some uncertainty in the data points and some other consequences that affect data when using a CCD camera. Below is my plan for how to edit the ideal light curve to account for these effects. These are the best solutions I could find so far, but if something doesn't work the way I thought, feel free to find another solution.

Please see MESA documentation on rotsehub/rotsesim for specific directions on running the simulation.

[Updated MESA documentation](https://docs.google.com/document/d/1H4NkG11O-I70TJNMtj4pVtBJ7cyJJrzRzXpdV-7qMQE/edit)

1. Once you are able to run the simulation as it is right now including using the phot\_per\_sec.py to produce the light curve, please read the documentation on MESA's website: <http://mesa.sourceforge.net/index.html> and become very familiar with the software.
2. \*make sure to make a copy of the rsp\_Cepheid directory into your home directory before making any changes\*
3. The first change I recommend is to use pgstar (<http://mesa.sourceforge.net/pgstar.html>) to have Mesa produce a luminosity history (light curve). If this can produce a light curve that is exportable and editable in the same way the excel plot from the original simulation is, this should be used. Before replacing the excel technique completely, make sure that the mesa pgstar output of the luminosity history is in agreement with the excel plot. If this cannot be done, keep the excel technique and apply the following changes anyway.
   1. \*\*For future uses of the Cepheid simulation, editing pgstar will be very important if you are trying to find other information other than the light curve. Pgstar plots can plot a lot of information about the star's evolution. So, even if the luminosity history is not usable, I highly recommend learning how to use pgstar and playing around with its capabilities\*\*
4. Then you will have to request the EARTH GRAM software from NASA <https://software.nasa.gov/software/MFS-32780-2> . It is open to the public, but you have to be approved to access it. Make a guest account and make sure to be specific about what you are requesting the software for. Do not just say "for undergraduate research". I think that this simulation should work for our purposes, however, all the information I could find about it was very vague so there is a possibility that it won't be compatible with our work. If it is, try to use it on the simulated light curve. (edit: This is no longer a viable option, Earthgram does not have the capabilities we need)
5. To simulate the ccd effects, download CCD camera simulator: <https://cdn.diffractionlimited.com/help/maximdl/Setup_CCD_Camera_Simulator.htm> and try to apply this to the simulation lightcurve data as well.
6. Since the scheduling issues are unique to ROTSE, I think the best way to get rid of the data that was "taken" by the simulation when ROTSE was not scheduled to take data would be to write a code in python.
7. As for the error bars, this might be the most difficult part. To determine the uncertainty, it might be useful to use a standard value that is an average that is in agreement with the uncertainty that is inherent to using a CCD detector, if that is the case, the CCD camera simulator might account for this.

If you have any questions about this plan or running MESA, feel free to email me: [ckuczek22@jcu.edu](mailto:ckuczek22@jcu.edu)

Any questions about the telescope or cepheids would be best directed to Dr. Kehoe