I would like to thank all the reviewers for their helpful reviews. I appreciate their independent viewpoints. Their concerns and constructive assistance aided greatly to the finalization of this paper. In an effort to improve the quality of this submission I have addressed each of the reviewers' concerns below. Any concerns that are addressed in a prior review will be referenced to the original response. An additional general proofread of the paper produced a variety of smaller edits and clarifications to make the writing smoother and more grammatically accurate.

Response to Review 1

Major Points:

A. I agree that Figure 1 is confusing to look at. To simplify this, I have merged the two into a single image. I have also cleared the distinction between flat space locations (unprimed) and the curved space locations (primed) in this example of open curvature. I additionally spend more time describing the image and the various components of it.
B. I use two different curvature metrics (1 for the 1D model and another for the comprehensive model). I initially didn't want to list what they were as they were nonrealistic examples, but I can see why they would be deemed important. The curvature metrics are explicitly stated in the revised version as well as additional mention as to why polynomials are an exaggeration.
C. I felt that the explanation that K can be modeled with a series of exponentials is better placed in the theory section. I mentioned that ideally the FLRW metric would be the best representation, but exponentials are a good approximation. I also added in the 1D and Comprehensive Model sections as to why I use a polynomial. I use them for clear and obvious test cases that show the effect in a much easier to see way than a subtle exponential.
D. I have clarified the former Equation 3 to now state that K is a function of φ, θ, and r. I also rearranged the right side of the equations to show the positional component ϒ is based on φ and θ while the time component T is based on the r observable. I also added detail as to why the r observable is used to represent the time component of K.
E. For this point I modified the statement to be general for open and general for closed. Of course you can always find test cases that are different (eg. All values become zero) but these are typically trivial or cases that are physically obscene. The phrase "in general" also does not imply "always" so we cover the possibility of edge cases.
F. I initially avoided the mean angle values as this was a nonrealistic test case and placing in the values would give too much credit to the randomly chosen curvature metric. However, now that I am specifically mentioning the chosen curvature, I include those values as numerical examples.

Minor Points:

a. I added a paragraph explaining some implications of global curvature and why we might seek it out. I did not choose to move paragraph 5 as I feel it is a good connecting point.
b. The FLRW metric is the equations that govern the shape. Reworded.
c. Addressed where K comes from with regard to the equations.
d. The tension is on the value of the curvature and it exists because the two different methods produce different results. Reworded.

e. I explain a bottom-up approach because I felt that I should address the two main methods and then mention which one I used. That way I show what I am doing compared to other possible options.
f. Clarified equation 1 time and space components.
g. Clarified that the 1D reference point is at zero/the origin.
h. For the test model I chose the distribution to be homogeneous and isotropic because on the universal scale the distribution of galaxies is in fact homogeneous and isotropic. I add that when looking at supernova data the incoming data will obviously not be.
i. Equations are restructured to clear this up confusion between r observable and time dependency.
j. Formatting is made such that images fit on pages without leaving too much whitespace.
k. Removed the paragraph as a whole and incorporated the info in other locations.
l. I modified the last paragraph of the Comprehensive Model to better summarize the current state of CURVFAM.
m. I updated the abstract to include a line mentioning the paper presents only the logical framework and baseline code of CURVFAM.

Response to Review 2

<u>Major Points:</u>

A. Figure 2 was originally made to be a general example much like Figure 1. However I can see where the ambiguity lies in the explanation and where I reference Figure 2. As such I have modified the script to say that Figure 2 is an example curvature (sinusoidal).
B. See 1B.
C. This needed some clarification. I added a short paragraph explaining how the curved space calculations are the same as flat space. It is the location of the objects that is being shifted when the curvature metric is applied. It should be clearer now that the calculations are all similar with only the data set changing.

<u>Minor Points:</u>

a. This sentence is a summary of the rest of the paragraph which explains the two methods. Rather than restate the same citation in the next line, I cite the sources with their individual descriptions in the paragraph.
b. Figure 1 has been restructured. See 1A.
c. I have added the particular curvature function I used. Now there is a direct connection between the plot and the curvature. The question of density and distribution is solely a product of the curvature used.
d. The units would be whatever units the data is in or the user chooses. In Figure 3 they are simply there as a placeholder. Additionally, Figure 2 is a general example whereas Figure 3 is a specific example.
e. Added a statement on how the metric used for the Comprehensive Model section is a closed space metric.
f. Added a brief bit about the loss of spatial uniformity resulting in loss of angular uniformity. The specifics of the plots (such as maximums and values) are simply products of the nonrealistic metric I chose to use.

g. Added descriptive word “supernova” to describe which data is available.

Response to Review 3

Major Points:

A. Gave an example of how a certain object’s observables would change in the case of the test metric. The specific curvature metric equations are given by the user. As for the other parts, I left those behind the scenes because the point of this is to explain what the program does for the user and what the user needs to do. The explicit details of how the code works is in the code itself.
B. Added code to GitHub and mentioned in the paper where to find the code.

Minor Points:

a. See 1B.
b. See 1A.
c. See 1D.
d. While I briefly mention that there are other universal simulators in the abstract, I provide the citations to some examples when they are mentioned more specifically in the introduction.

Response to Review 4

Major Points:

None

Minor Points:

a. At current, the FLRW metric and the density parameters do not play a major role in CURVFAM (they are part of general relativity and will be included when CURVFAM is relativity compatible). At that stage their importance and significance to CURVFAM will be better described. Currently, the cited papers provide more comprehensive definitions.
b. I added a description of the parts to Equation 1.
c. See 1A.
d. Equation 2 is cleared up. As for a reference, this equation is the classic path length formula. The citation is math.
e. See 1B.
f. See 1D.
g. I added clarity as to why r can be used to represent time. As for radial compression without time also being compressed, this is difficult to do with observables since we cannot perceive distance without the effects of time as well (finite speed of light). They are linked.
h. Decreased point size as well as sample size to make images clearer.
i. The concept of space not being curved the same way everywhere is exactly why the components of the curvature metric depend on location and time. Otherwise they would

only depend on time. I added a bit explaining why I chose a homogenous, isotropic universe and how real-world data would not be so perfect.

Response to Review 6

Major Points:

A. In response 1B I address the addition of the exact metrics. The code does not change when the metrics are applied. The code is made to handle that.
B. Added a paragraph at the end of Section 4 to give possible uses of CURVFAM at current. CURVFAM is meant to be more than what it is currently. As such, the powers of the current stage are limited. This publication is focused on the background knowledge as well as an update as to where the progress is currently.
C. Added line with GitHub link.

Minor Points:

a. Added description of K before describing the methods of determination.
b. Reworded the caption for Figure 2.
c. Redid the title.

Response to Review 7

Major Points:

A. I have added a bit mentioning how real-world data would look different from the uniform examples that I use. I also address how the future implementations of the code will include a fitting algorithm. As such, the code will be optimized for real-world data.

Minor Points:

a. Considering the research nature of this work and the complexity of implementing general relativity, a timeline cannot be created for future rollouts.

Response to Review 8

Major Points:

A. See 1B.
B. I added a paragraph at the end of Section 4 detailing what CURVFAM can be used for at the current stage. The general point of this paper is to introduce a project that I am currently working on and describe where I am currently at. The main goal is the completion of the project at which point full descriptive writeups will be created as well as all manner of implementations and uses.

Minor Points:

a. I added an extra line directly contrasting top-down and bottom-up approaches. Hopefully this helps clear it up.
b. I added clarification to the parts of Equation 1.
c. Added a definition for the word “observable”.
d. Added a line mentioning that uniformly distributed points are points even spaced along a line.
e. Obviously, it would be silly to attempt to model an infinite universe with finite processing power. I add mention that the points go out to a finite location. The reference point is at the origin because observables are with reference to the reference point. Therefore all values are zero (or undefined) at the reference point.
f. See 1D.

Again, I wish to send my deepest regards to all the reviewers for their constructive responses. They have all helped significantly in making this work a better presentation of the research.