PRISim vs pyuvsim 1.3 reference simulation comparison

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ABSTRACT

This memo presents the second out of three comparisons between PRISim and pyuvsim reference simulations. We compare the reference simulation visibilities in both frequency and delay domain. The differences between the two simulations is several orders of magnitude smaller than the visibilities.

1. Introduction

PRISim and pyuvsim both created a simulation of 12 identical sources at zenith and focuses on the frequency axis. PRISim reference simulation contains 2 times, 6144 frequencies and 1 polarization. Pyuvsim reference simulation contains 2 times, 6144 frequencies and 4 polarizations. This is the second of the three initial comparisons that we are going to conduct between pyuvsim and PRISim reference simulations.

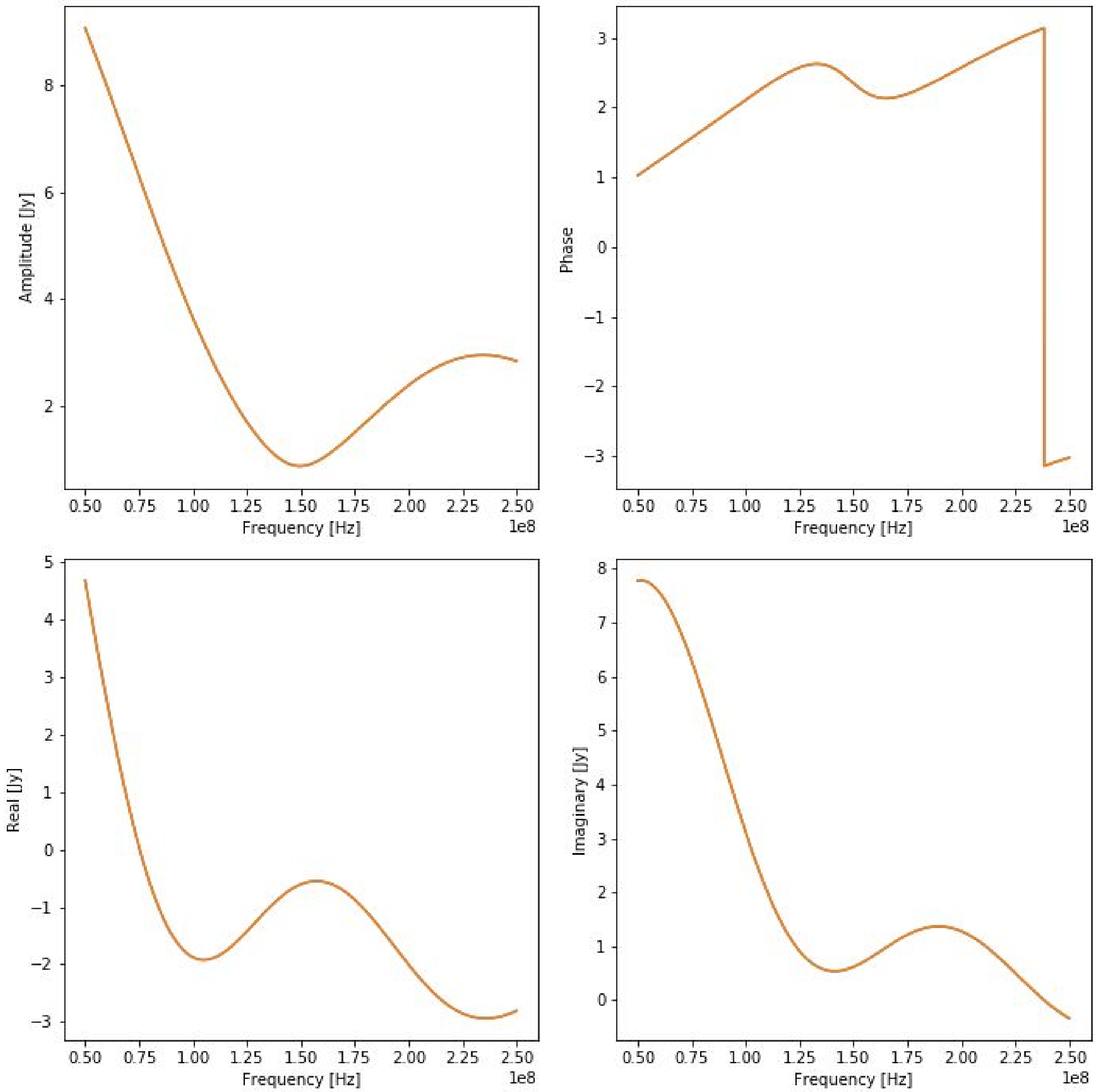
2. Discussion

2.1 Frequency Domain Comparison

To compare 1.3 pyuvsim and PRISim simulations, we first plotted amplitude, phase, real and imaginary components of visibilities over frequency.

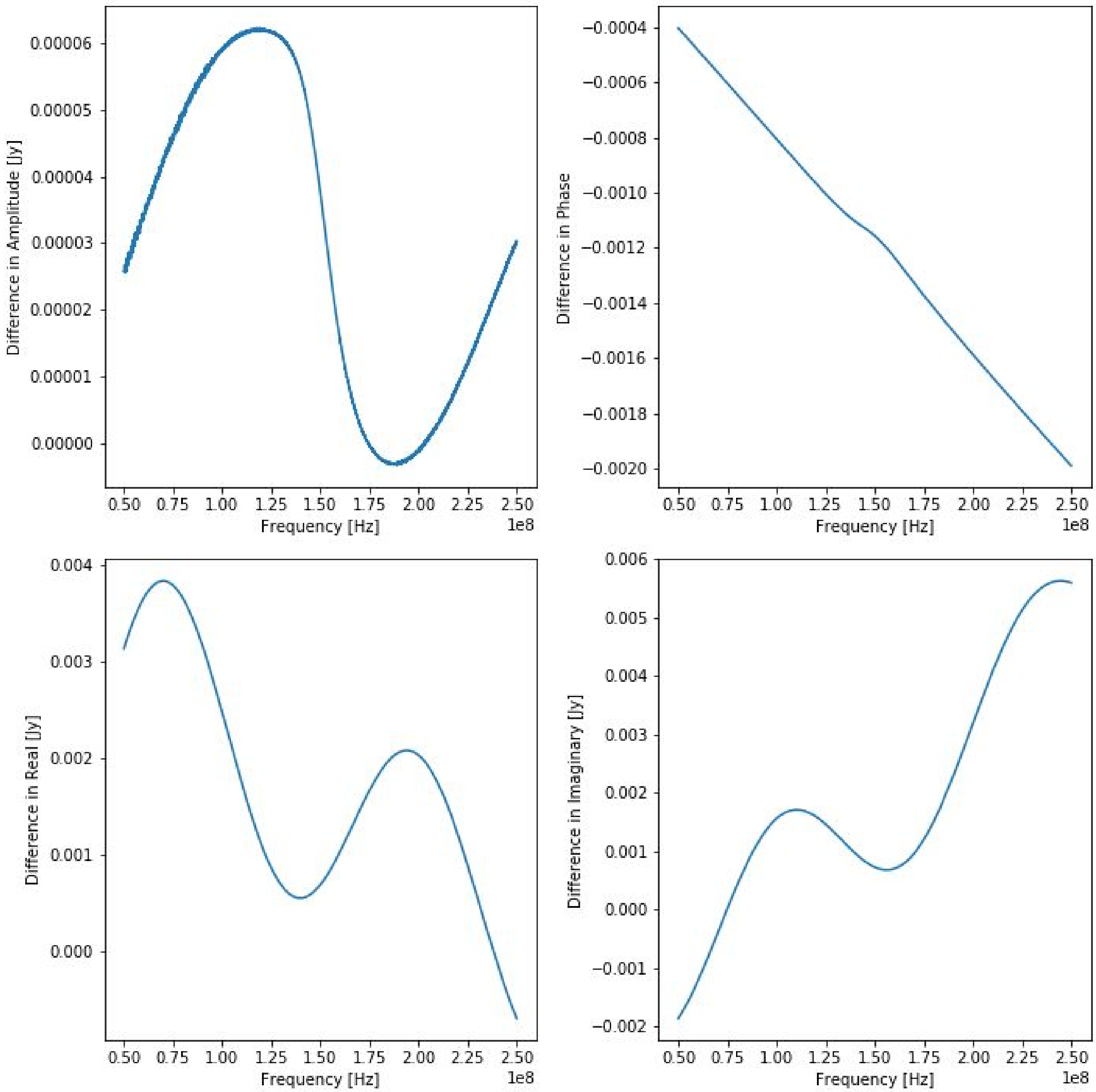
Initially the frequencies of pyuvsim and PRISim simulations did not match. PRISim simulation kept frequency channel width constant at 32552.0 Hz, meanwhile pyuvsim simulation kept bandwidth constant at exactly 200MHz, with frequency channel width 32552.08333Hz. This is a small effect, but for a fair comparison, a new pyuvsim file was created with a constant frequency channel width as PRISim.

Then when we plot amplitudes/phases/real/imag of both pyuvsim and PRISim on the same plot over frequency:

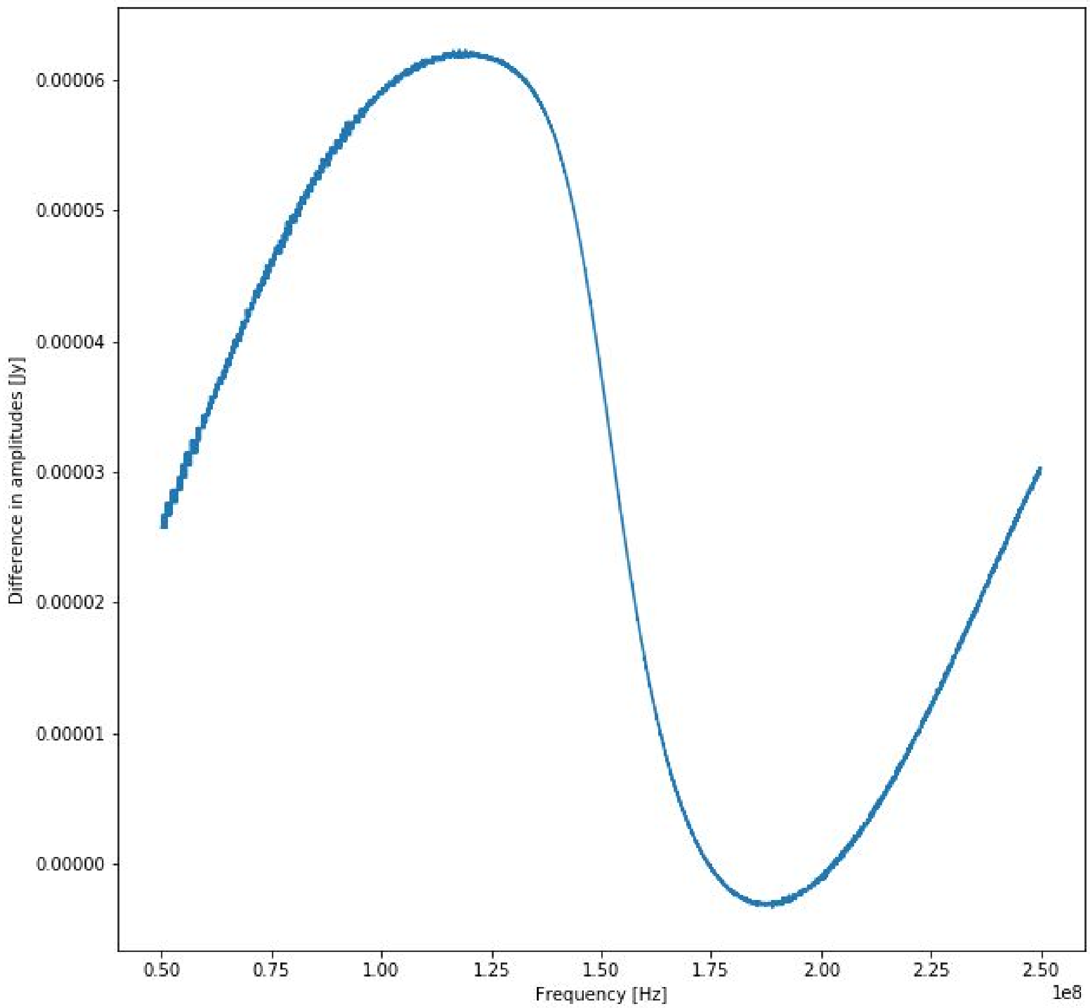


As we can see pyuvsim and PRISim do not differ significantly.

However, when we subtract the amplitudes/phases/real/imag then we can see that they're slightly different:



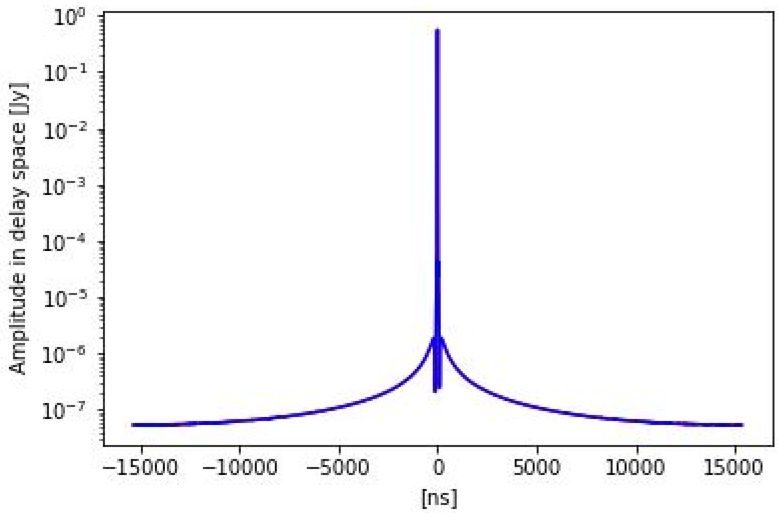
If we zoom in, on the plot of the difference between amplitudes, then we can notice that the line is not smooth:



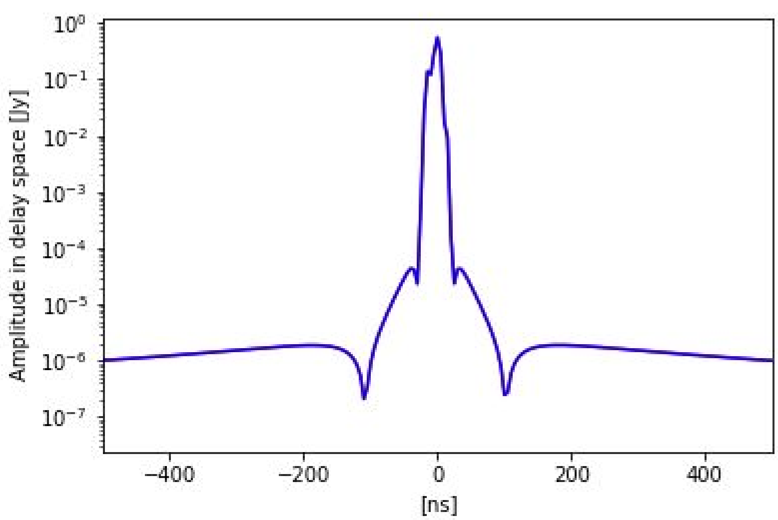
Initially, we assumed that this jaggedness is caused by the difference in frequencies. However, once the frequencies in pyuvsim and PRISim 1.3 reference simulations became the same, the jaggedness didn't disappear. However, the scale of this plot is 5 orders of magnitude smaller than the original amplitude plot so this jaggedness is very small.

2.2 Delay Domain Comparison

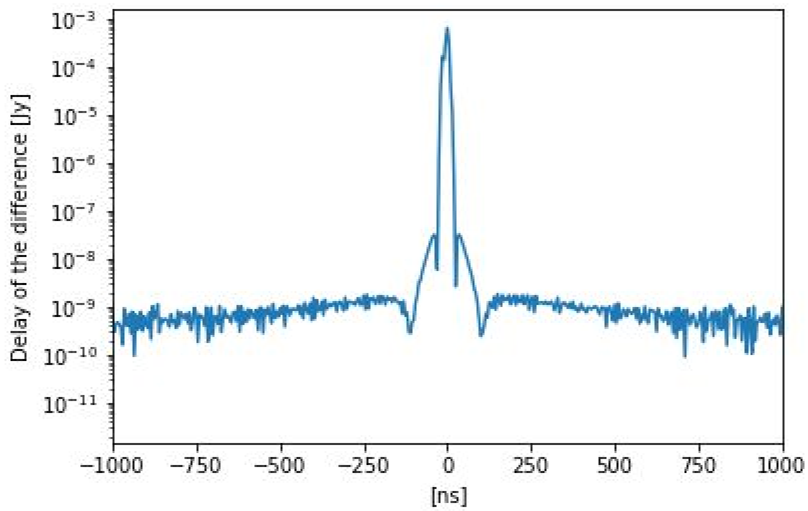
We also compare pyuvsim and PRISim amplitude in delay space using a Blackman-Harris window in our delay transform to enhance dynamic range:



If we zoom into the middle of the plot above, we get the following plot:



However, when we subtract complex visibilities in frequency domain, then do a delay transform using a Blackman-Harris window and plot the amplitude:



As we can see, the plot has a shape largely consistent with the Blackman-Harris window which was applied when taking delay transform.

3. Conclusion

In conclusion, the PRISim and pyuvsim 1.3 reference simulation visibilities only differ at 5 orders of magnitude smaller. This difference could be due to phasing. It's unclear what caused the jaggedness in the difference between amplitudes, but it is at least 6 orders of magnitude smaller than the value of amplitude.