Homework 4

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Problem 1:

The carrier phase double difference is defined as the difference between the single differences between the carrier phase measurements between two different satellites and locations. This is calculated by taking the difference between the carrier phase measured at location A (PRDU) and location B (INWL) seen in equation 2 of the homework. This is to be done both satellite 1 (satellite 15) and satellite 2 (satellite 18). Once this is done, the double difference can be found by taking the difference between the phase differences at satellite 1 and satellite 2 seen in equation 3 of the homework. The resulting double difference for the carrier phase can be seen below in the plot of the double difference against time:

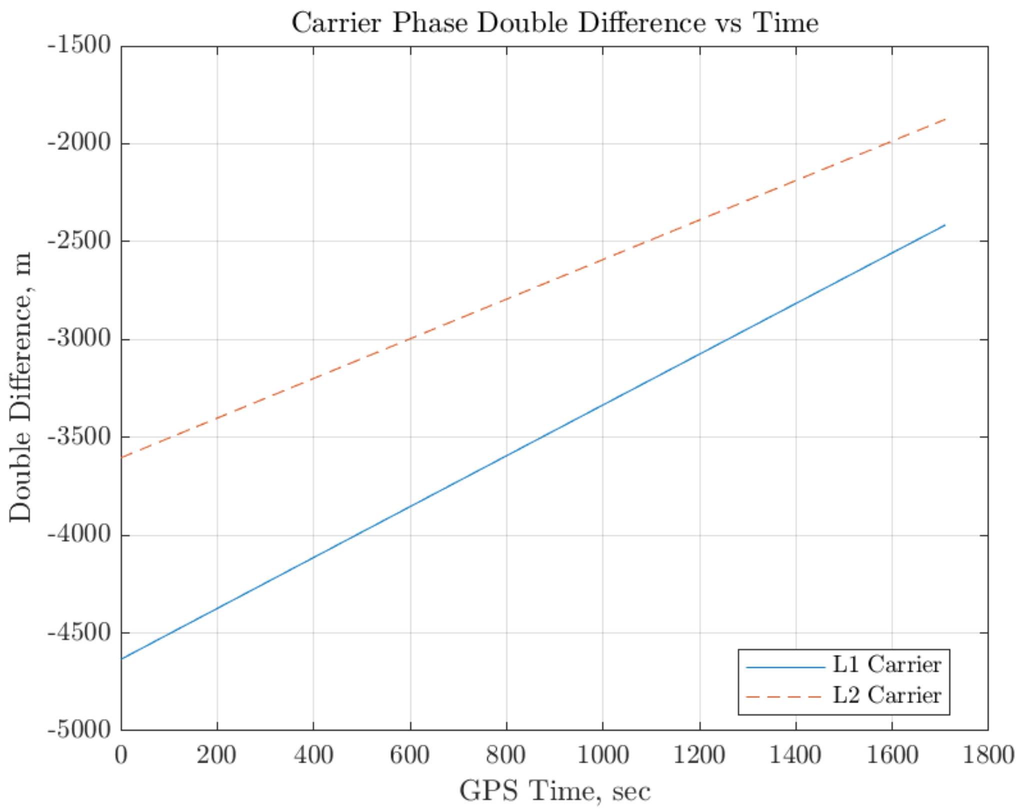

Figure 1 – Carrier Phase Double Difference

Similar to the carrier phase double difference, the pseudorange double difference can be calculated by taking the difference between pseudorange measurements at two different locations then taking the difference between the difference between the two locations for two satellites as described in the equation on page 21/31 of the week 9/10 notes. The resulting double difference against time can be seen in the plot below in figure 2, it can be seen that the pseudorange double difference does not vary between the L1 and L2 carrier phases since it does not depend on the carrier phase like the carrier phase double difference does.

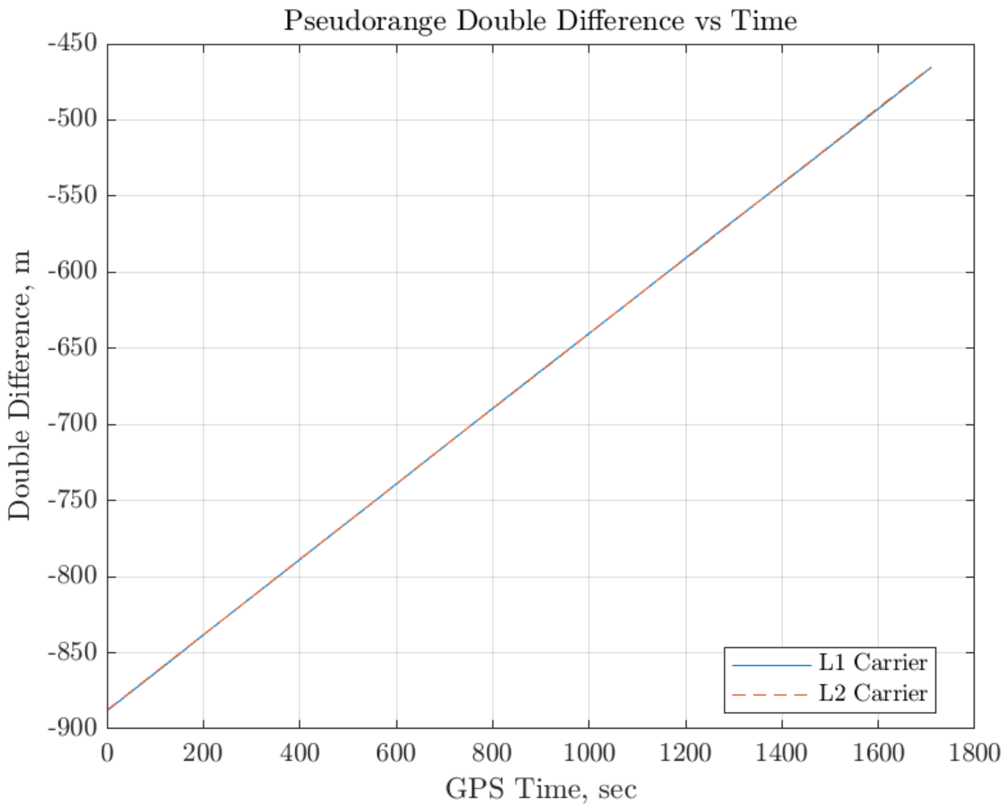

Figure 2 – Pseudorange Double Difference

<u>Problem 2</u>:

Using the two double differences, the integer ambiguity for the carrier phase double difference can be found. This is done by using the equation seen on page 23/31 of the week 9/10 notes which takes the difference between the pseudorange double difference and the carrier phase double difference multiplied by time. This difference will result in an error so the values must be rounded to get the integer ambiguity after the average is taken. This is done because the assumption that there are no cycle slips over time. The unrounded and unaveraged integer ambiguities can be seen below in figure 3. Once this calculation is done and the value are averaged and then rounded, the resulting integer ambiguity that was calculated turned out to be 30 for both L1 and L2 carrier phases.

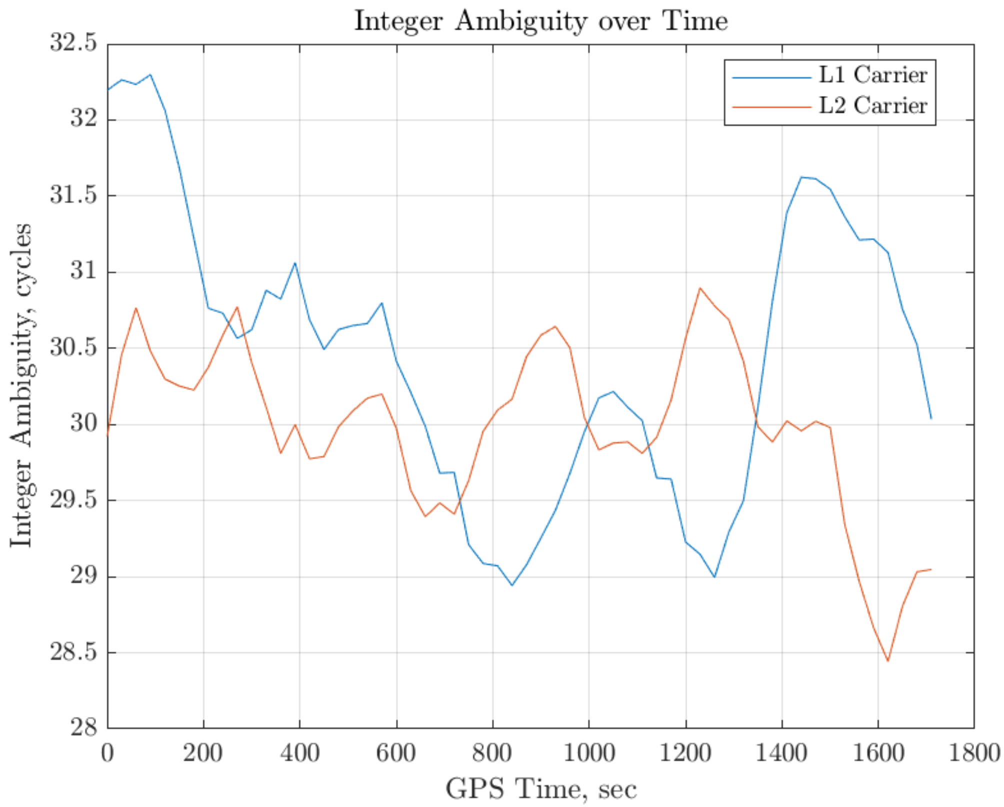

Figure 3 – Integer Ambiguity (unrounded, unaveraged)

Problem 3:

Using the estimate of the integer ambiguity from problem 2, the carrier phase measurements can be used to produce a very accurate estimate of the geometric distance. This is done by taking the definition of the geometric distance in equation 4 of the homework and plugging it in to equation 3 of the homework, then solving for the geometric distance. This results in the estimated distance equation which is the double difference in carrier phase which is added to a constant integer ambiguity then multiplied by the negative of the wavelength of the specified carrier. To test the accuracy and error between the estimate and the true distance, the true distance must be first calculated. This is done by using the distance equation 4 in the homework as well. The unit vectors from the satellite must be calculated which is done by subtracting orbital location of the satellite and the location of the location in cartesian coordinates, this gives the position vector and must be divided by the magnitude of the position at each time step to get the unit vector. Once the unit vectors are calculated at each time step for each satellite, take the dot product between the difference between the unit vectors for the second and first satellites and the true position vector between the first and second locations. The true position vector between the first and second locations are found by subtracting the position of each location in cartesian coordinates that were given in the homework files. The error between the true and estimated distance can be found through their difference which is plotted against time in figure 4 and the actual estimates plotted against time in figure 5.

The bias in the estimate is the average of the error over time for each carrier, this was calculated by using the mean() command in MATLAB on the error time series. The resulting biases were 0.0617 meters for L1 and 0.0608 meters for L2. The standard deviation of the error was found by using the std() on the error time series. The resulting standard deviations of the error were calculated as 0.0161 meters for L1 and 0.0174 meters for L2.

Figure 4 – Error in Geometric Range Estimates

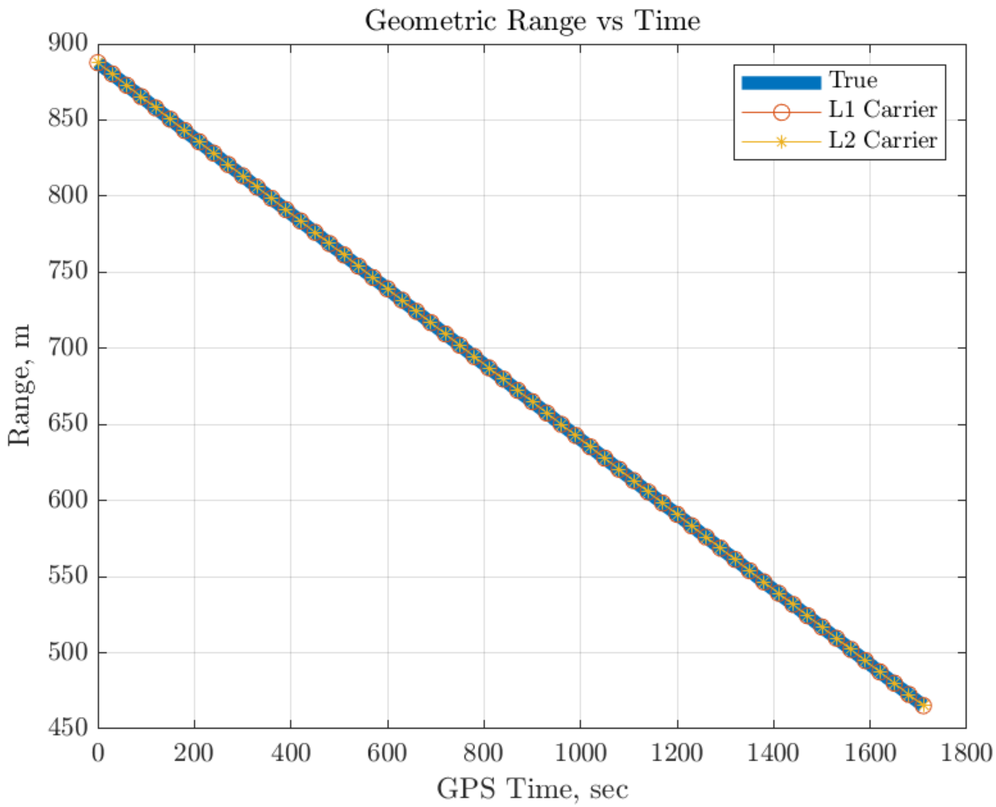

Figure 5 – Geometric Range Estimates