**Lab 3 | Errors and Differential Correction**

**Introduction**

In this lab you will work with and analyze the results of uncorrected, real-time differentially corrected, and post-processed differentially corrected data. The results should be displayed on one map with different colors and/or symbology. Additionally, you will create a table showing the different precisions and the accuracy of each data collection technique.

**Instructions**

Complete the hands-on exercises described throughout the lab and answer any questions in **bold**.

**Deliverables**

Answer the questions throughout the lab and produce any outputs, as instructed. Your lab document should be typed, well organized, and submitted based on the “how to” guidelines provided in the course syllabus.

***Part I – GPS Survey***

*Step 1: Base Map*

* Create an ArcMap document with a base image of the track on Sylvania’s campus.  This works best if the features you choose to map are ones that can be seen in the aerial imagery (painted field lines, etc).

*Step 2: Data Collection set-up*

* You are going to create five different rover files; each of the first four files will contain one point while the fifth file will contain a line and a polygon.
* Go to the track and find a corner to map.
* Turn on TerraSync, and navigate to the status view. Wait until you have enough satellites.

*Step3: Collecting Uncorrected point*

* Go to Setup, Real-time Settings
* Under Choice 1 make sure *Use Uncorrected GNSS* is selected. Click OK.
* Go to Data, New File. Give the file a name (Uncorrected). Choose the Generic data dictionary, and click Create.
* Confirm the antenna height as the height you will be holding the GPS unit in meters.
* Under Options make sure the logging interval is 1 second and click on log later.
* Select Point generic and click Create.
* In the Comment box enter “Uncorrected”.
* Stand precisely on the marked corner, and click Log.
* When you have recorded a minimum of 30 positions, click OK (if you clicked OK after entering something in the comment box without recording positions, make sure you click No and then click Log); OK to confirm end feature then click Close and Yes to close the rover file.

*Step 4: Collecting SBAS point*

* Go to Setup, Real-time Settings
* Under Choice 1 select Integrated SBAS; choice two should be Use Uncorrected GNSS, real-time age limit: 1 minute. Click OK.
* Go to Data, New File. Give the file a name (SBAS). Choose the Generic data dictionary, and click Create.
* Confirm the antenna height.
* Under Options make sure the logging interval is 1 second and click on log later.
* Select Point generic and click Create.
* In the Comment box enter “SBAS”.
* Stand precisely on the marked corner (in the same spot as before), and click Log.
* When you have recorded a minimum of 30 positions, click OK (if you clicked OK after entering something in the comment box without recording positions, make sure you click No and then click Log); OK to confirm end feature then click Close and Yes to close the rover file.

*Step 5: Collect Corrected point*

* Go to Data, New File. Give the file a name (Corrected). Choose the Generic data dictionary, and click Create.
* Confirm the antenna height.
* Under Options make sure the logging interval is 1 second and click on log later.
* Select Point generic and click Create.
* In the Comment box enter “Corrected”.
* Stand precisely on the marked corner (in the same spot as before), and click Log.
* When you have recorded a minimum of 30 positions, click OK (if you clicked OK after entering something in the comment box without recording positions, make sure you click No and then click Log); OK to confirm end feature then click Close and Yes to close the rover file.

*Step 6: Long residence time point*

* Go to Setup, Real-time Settings
* Under Choice 1 select Use Uncorrected GNSS; click OK.
* Go to Data, New File. Give the file a name (Long). Choose the Generic data dictionary, and click Create.
* Confirm the antenna height.
* Under Options make sure the logging interval is 1 second and click on log later.
* Select Point generic and click Create.
* In the Comment box enter “Long”.
* Stand precisely on the marked corner (in the same spot as before), and click Log.
* **When you have recorded a minimum of *600 positions*,** click OK (if you clicked OK after entering something in the comment box without recording positions, make sure you click No and then click Log); OK to confirm end feature then click Close and Yes to close the rover file.

*Step 7: Collect Line and polygon*

* Go to Data, New File. Give the file a name (Lines). Choose the Generic data dictionary, and click Create.
* Confirm the antenna height.
* Under Options make sure the logging interval is 1 second and click on log later.
* Select line generic and click Create.
* In the Comment box enter “Path”.
* Determine a path along one of the track lines of about 20 meters to walk. Click Log and slowly walk the path in a straight line. When you get to the end of your line click OK, confirm end feature, but **DO NOT CLOSE THIS ROVER FILE**.
* Select Area generic and click create.
* In the Comment box enter “Box”.
* Walk a box using some guides/markers on the track (doesn’t have to be the full length of the track). Click Log and slowly walk the perimeter of your polygon; before you get back to where you started stop walking and click OK; confirm end feature, and close this rover file.
* Turn off TerraSync and head back to the lab.

*Step 8:*  Connect your Juno to the computer and transfer all your rover files to your lab folder on your thumb drive using the Data Transfer Utility in Pathfinder Office.

*Step 9:  Post-process the rover file with the “Corrected:” point feature.*

* Start the Differential Correction Utility.
* Browse to the rover file that has your “Corrected” feature, and click Next.
* Leave the settings at Automatic…, click Next.
* Make sure the settings are
	+ Output corrected positions only
	+ Smart automatic rover filtering
	+ Re-correct real-time positions
* Click Next.
* Click Select for the Base Provider Search; click update list, which does an Internet search for the closest base station files. Select the closest station or the one with the highest integrity index value (remember balance); click OK.
* Click Use reference position from base provider, click Confirm Base data, and click Next.
* Select where you want the files to go and/or overwrite and click Start.
* If you get the error message “Unable to transfer files”, click the back button twice and select a different base station, then proceed.
* Click confirm if all of the files are there.
* Check to make sure that most of the positions were corrected; **you will need to email me the differential correction report as part of the lab**. Ensure that the log file has everything.

*Step 10: Export data to shapefiles.*

* Export all of your rover files one at a time. Under Utilities, Export, select the file, choose the export folder, and select ESRI Shapefile as the export setup. **Each file should end up in its own folder so you don’t overwrite anything**.
* Make sure the coordinate system is correct in the export utility window. *Remember you will have to Define Projection in ArcMap.* Also select Export Coordinates As “XYZ”. This will give you the coordinates for the point features in your shapefile attribute table.
* In the position filter tab, filter by GPS Position Info: 3D (4 or more SVs), Max PDOP Any, Max Any
	+ Remember, to export the “Uncorrected” rover file you will need to check the “Uncorrected” box under the position filter tab.
	+ For the other rover files, in the position filter tab, **uncheck** the Uncorrected filter button (if it was previously checked).
	+ You can leave all the other boxes checked.
* Click on the Attributes tab and select the following attributes to be exported into your shapefile (be sure to note all of the possible attributes):

 All Feature Types

* + PDOP
	+ Correction Status
	+ Receiver Type
	+ Date Recorded
	+ Data file name
	+ Total positions
	+ Filtered positions

 Point Features

* + Height
	+ Vertical Precision
	+ Horizontal precision
	+ Standard deviation
	+ Position

 Line Features

* + Length (2D)
	+ Length (3D)
	+ Average Horiz. precision

 Area Features

* + Area (2D)
	+ Perimeter (2d)
	+ Average Horiz. precision

*Step 11: Analyze the data in a GIS*

* Open ArcMap and look at the shapefiles for the Uncorrected, SBAS, Post, Long, Path, and Box features over your base layer.
* Change the colors and symbols and be sure the legend has the correct names for each feature.
* Mark the point(s) on the map where you actually collected the data.
* Save a JPG color map with all of the required map elements.

*Step 12: Written Analysis*

* Create a table that shows average horizontal precisions for each of your features; label this column Accuracy (68%).
* In ArcMap, measure actual accuracy of each point feature (don’t worry about the line and polygon). Record this value in your table under a new column as External.

In less than a page discuss the following questions.

1. **How well does each of your types of features match the real world (assuming that the base photo is fairly accurate)? How do they compare to each other? (Ignore the line and polygon for now).**
2. **Which point had the best internal accuracy (68% precisions) and which point had the best external accuracy?**
3. **Are the 2D lengths of the lines different than the 3D lengths? Why is this the case, which is most accurate?**

***LAB DELIVERABLES****.*

Email your lab document with:

* Answers to questions (above),
* Accuracy/External table (step 12),
* Map (step 11) with all of the map elements (title, scale, legend, north arrow, etc),
* Differential correction report (step 9).