**Gravity Lab**

**GEOP572 – Geodetic Methods**

**Assigned 14 October 2015. Due 21 October 2015**

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The goal of this lab is to better understand (a) sources of error, (b) instrument drift and earth tidal corrections, and (c) learn to establish a base station. You will be provided with three sets of data. There will be two spreadsheets that include relative gravity data from the Alamogordo area. Then, there will be a folder of text files with modeled tides for each of the locations. Finally, there will be a folder with the station description sheets and pictures of the sites.

I encourage you to look at the University of Texas at El Paso Pan American Center for Earth and Environmental Studies gravity database of the United States:

<http://research.utep.edu/default.aspx?tabid=37229>

They have some of the most current base station measurements for the United States. They also have compiled aeromagnetic measurements for most of the United States as well.

The USGS has a list of all of the IGSN71 stations in the United States at

<http://geomaps.wr.usgs.gov/gump/gravity_base_stations/>

Unfortunately, New Mexico currently has the incorrect file posted. I have a copy of the New Mexico data, if needed.

**Required tasks are in bold. Time of day is listed in Greenwich Mean Time, not Mountain Daylight Time, for both measurements and tidal models**.

**Task 1. Explore short baseline station**

*Exercise*: Using the data provided in tightshortsurvey\_noplot.xlsx, the base station information provided, and possibly the tidal accelerations, find the absolute gravity for station 2 and compare it to the measured absolute gravity from the station description. We are going to do this a few different ways. The key for station IDs and the IGSN71 station designation is provided in the spreadsheet.

Assume that we are using station 1 as the base and are attempting to find the absolute gravity at station 2. The survey was completed in under 2 hours.

**Using the software of your choice, plot the raw relative gravity data for both stations as a function of time (hours from first measurement or time of day).**

As a first cut, find the mean relative gravity measurement for both stations, and then, using the difference in mean relative gravity between station 1 and 2 and the absolute measurement at station 1**, predict the absolute gravity at station 2.**

As a second cut, use the differences and time between measurements between base station measurements (station 1) to estimate the instrument drift and earth tide corrections. In other words, find the rate of change of drift and tides by subtracting measurement 1.i from measurement 1.i+1 and dividing by the difference in time of measurement. A measurement at station 2 falls between each of the pairs of measurements at station 1, so you can then use the drift rate to find a drift correction that you subtract from the measured relative gravity. Once you have made these corrections, **plot the corrected data.** Then, using the mean drift- and tide-corrected data for stations 1 and 2, **find the absolute gravity value for station 2. Compare this value with the established value.**

As a third cut, use the provided tidal model results for stations 1 and 2 to correct for the tides, and then estimate the instrument drift in a similar way as in the second cut. Plot the corrected values. Then, estimate, for the third time, the absolute gravity value for station 2.

**Compare your different results to themselves (internal to the estimates) and to the station 2 absolute gravity listed in the station description**.

**Compare your corrected results (which you plotted) with each other. Using photos, station descriptions and cursory notes on weather and/or traffic, discuss at least four likely sources of error for each station. Then, discuss the effects of noise on your correction methods**.

Remember that differencing noisy data exacerbates the noise, but allows for drift corrections to be made.

**Task 2. Explore long baseline survey**

*Exercise*: This is basically the same as for the short baseline survey, but now the differences in acceleration are greater, we will use two reference stations to find the new base station acceleration, and the travel times are greater between the stations. The datafile is regionalbasestation\_noplots.xlsx. Once again, the datafile has the key for station IDs and station designations. When you open the datafile, notice that the final loop was not completed (I did not re-occupy stations 4 and 2). Throughout the day, large convective cells were sweeping through the region. At the end of the day, there were 50 mph winds with a large cell sweeping north toward the final two stations.

First, **plot the raw gravity data versus time. Time can either be date and time of day, or can be elapsed time from earliest measurement**.

As a very rough cut, **find the mean relative accelerations for all three stations. Using these values, estimate the absolute gravity at station 4 using station 2, then station 3, and then average of both estimates.**

More precisely, use the tidal model results for each station to correct the raw data (subtract tidal acceleration from raw data). Then, find the drift rate using stations 2 and 3, and correct the tidally-corrected data for drift. You will now have overlapping drift rates. Calculate the drift using station 2 only, station 3, only, and then, during overlapping times, average the rates. **Plot all three drift rates as a function of time.** **Discuss why we cannot correct for both tides and instrument drift from the differences in raw data.** Think about the timing of measurements. **Plot the corrected data for all three stations using the three different drift rates.** Using the corrected data for stations 2, 3, and 4, **estimate the absolute gravitational acceleration at station 4.**

**Compare and discuss both the simple mean estimation (do not ever do this in real life) and the tide- and drift-corrected absolute gravity estimation for station 4 to the measured absolute gravity in the station designation.**

**Compare and discuss your corrected results (which you plotted) with each other. Using photos, station descriptions and cursory notes on weather and/or traffic, discuss at least four likely sources of error for each station. Then, discuss the effects of noise on your correction methods**.