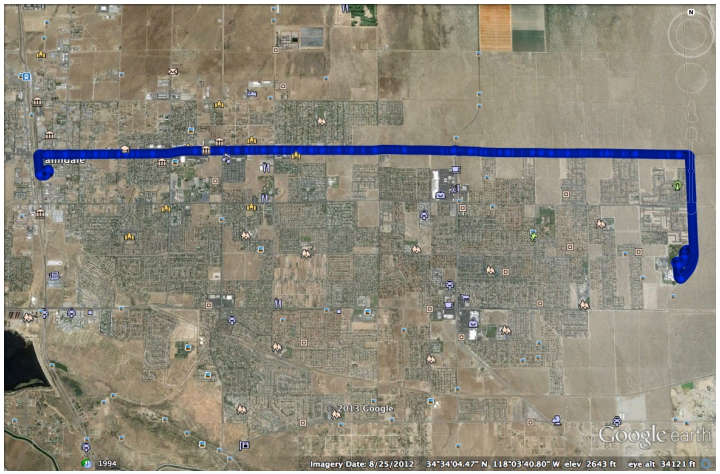
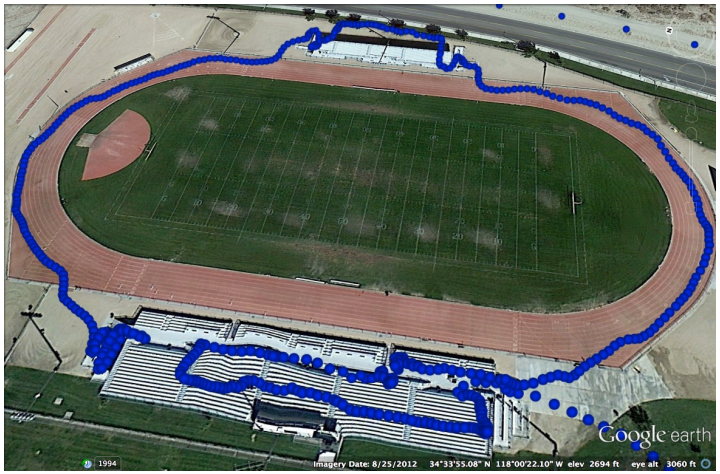
# Small Satellites for Secondary Students: Altitude Measurements

- Compare the GPS altitude measurements between the three instruments to observe if they are consistent with each other.
- *Time permitting*: Compare the GPS altitude measurements to the barometric altitude.

- By exporting our data as a .kml file we were able to confirm the accuracy of the GPS latitude and longitude data:

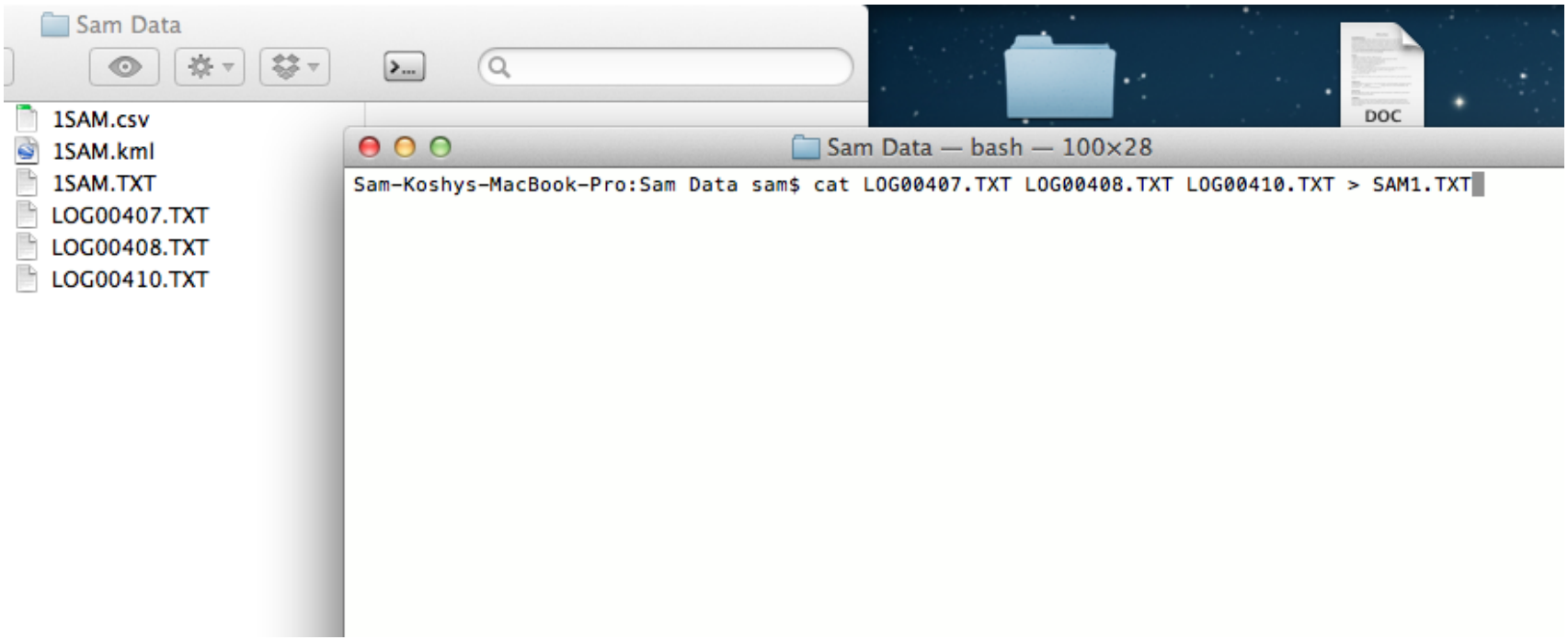




- Every time the GPS lost connection and reconnected with the device a new .txt file was created. Hence, if we were to only choose the biggest file, a lot of data would have been lost.
- We needed to convert the time to a more accessible format (such as PDT) for presentation purposes

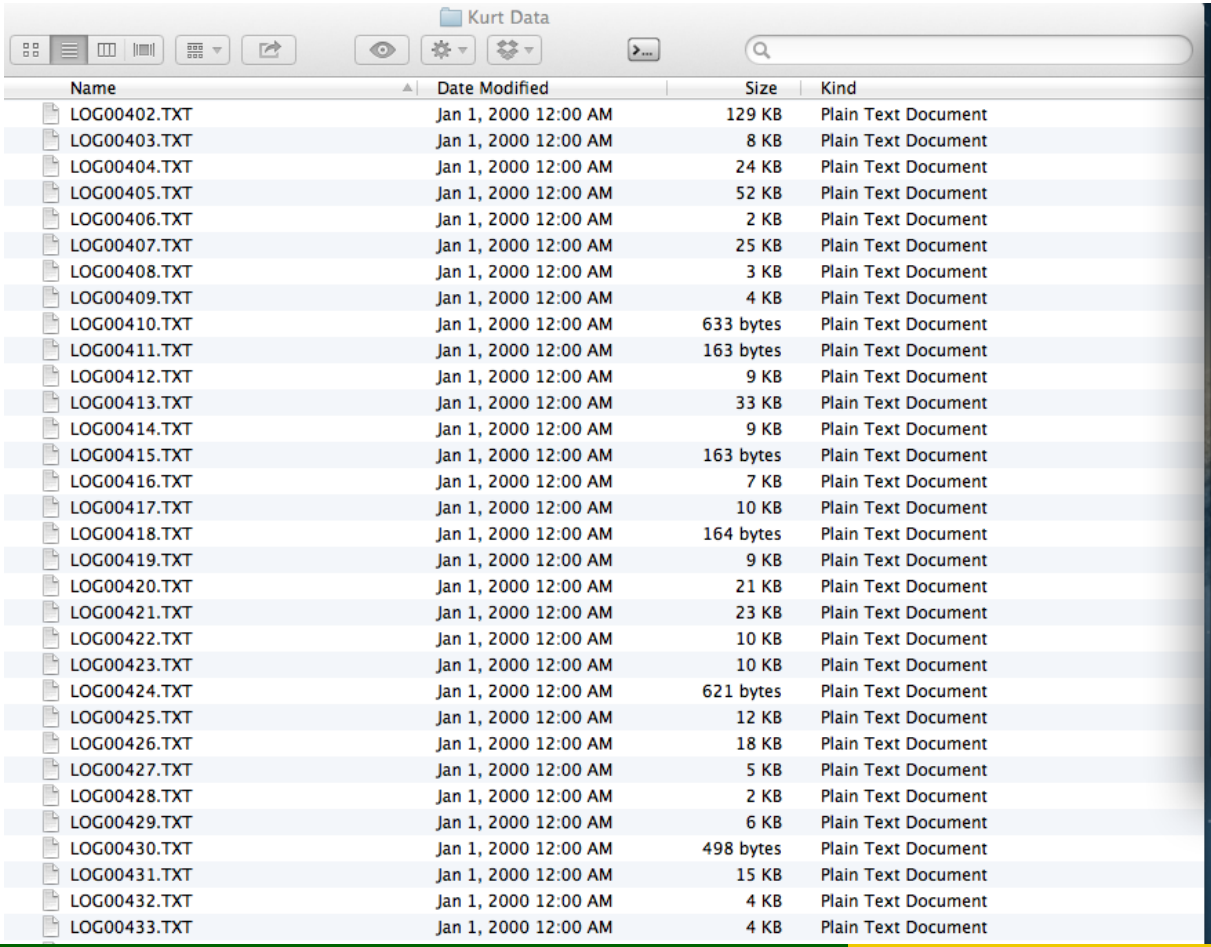
# Combining the various .txt files

- A single line of code in the UNIX shell was able to *concatenate* the various .txt files into a single one



# Combining the various .txt files

- Combining the files is easy to do even when there are hundreds of them, as was the case for Kurt.



# Converting the time to PDT

- In the newly exported .csv file create a column of the time differential between each successive measurement
- Convert this new column to the time format HH:MM:SS using the formula: =TEXT(C3,"00\:00\:00")+0
- Input the starting time in PDT (found in the original .txt file) and add the time differential to each successive row

| Time (PDT) | Delta t (s) | Delta t (s) | Time (s) | Lon | Lat | Alt | E |
|---|---|---|---|---|---|---|---|
| 8:24:36 | | | 55476 | -118.007627 | 34.5639137 | 822.2 | |
| 8:24:37 | 0:00:01 | 1 | 55477 | -118.007635 | 34.5639175 | 823.1 | |
| 8:24:38 | 0:00:01 | 1 | 55478 | -118.007636 | 34.5639197 | 824.1 | |
| 8:24:39 | 0:00:01 | 1 | 55479 | -118.007639 | 34.5639257 | 824.6 | |
| 8:24:43 | 0:00:04 | 4 | 55483 | -118.007651 | 34.5639295 | 828.4 | |
| 8:24:44 | 0:00:01 | 1 | 55484 | -118.007652 | 34.5639357 | 829.4 | |
| 8:24:45 | 0:00:01 | 1 | 55485 | -118.007655 | 34.5639408 | 830.6 | |
| 8:24:46 | 0:00:01 | 1 | 55486 | -118.007658 | 34.5639405 | 831.1 | |
| 8:24:47 | 0:00:01 | 1 | 55487 | -118.007663 | 34.5639313 | 830.8 | |
| 8:24:48 | 0:00:01 | 1 | 55488 | -118.007667 | 34.5639242 | 830.6 | |
| 8:24:49 | 0:00:01 | 1 | 55489 | -118.007669 | 34.5639217 | 830.4 | |
| 8:24:50 | 0:00:01 | 1 | 55490 | -118.007673 | 34.5639172 | 830.2 | |
| 8:24:51 | 0:00:01 | 1 | 55491 | -118.007677 | 34.5639223 | 830.7 | |
| 8:24:52 | 0:00:01 | 1 | 55492 | -118.007679 | 34.5639237 | 830.7 | |
| 8:24:53 | 0:00:01 | 1 | 55493 | -118.007681 | 34.5639233 | 830.5 | |

# Altitude with respect to what?

- The listed altitude is in meters and is the MSL altitude (MSL altitude is the distance above where sea level would be if there were no land).

Example:

```
$GPGGA,092725.00,4717.11399,N,00833.91590,E,1,8,1.01,499.6,M,48.0,M,,0*5B
```

| *Field No.* | *Example* | *Format* | *Name* | *Unit* | *Description* |
|---|---|---|---|---|---|
| 0 | $GPGGA | string | $GPGGA | - | Message ID, GGA protocol header |
| 1 | 092725.00 | hhmmss.sss | hhmmss.ss | - | UTC Time, Current time |
| 2 | 4717.11399 | ddmm.mmmm | Latitude | - | Latitude, Degrees + minutes, see Format description |
| 3 | N | character | N | - | N/S Indicator, N=north or S=south |
| 4 | 00833.91590 | dddmm.mmmm | Longitude | - | Longitude, Degrees + minutes, see Format description |
| 5 | E | character | E | - | E/W indicator, E=east or W=west |
| 6 | 1 | digit | FS | - | Position Fix Status Indicator, See Table below and Position Fix Flags description |
| 7 | 8 | numeric | NoSV | - | Satellites Used, Range 0 to 12 |
| 8 | 1.01 | numeric | HDOP | - | HDOP, Horizontal Dilution of Precision |
| 9 | 499.6 | numeric | msl | m | MSL Altitude |
| 10 | M | character | uMsl | - | Units, Meters (fixed field) |
| 11 | 48.0 | numeric | Altref | m | Geoid Separation |
| 12 | M | character | uSep | - | Units, Meters (fixed field) |
| 13 | - | numeric | DiffAge | s | Age of Differential Corrections, Blank (Null) fields |

- The GPS altitude appears to be consistent but better data is expected from the rocket launch.