Transforming between vertical coordinate systems and datums is one the most frequent questions asked about G-LiHT lidar data products.  A rather nice introduction to transformations is provided in this [presentation](https://www.ngs.noaa.gov/GEOID/PRESENTATIONS/2007_02_24_CCPS/Roman_C_PLSC2007notes.pdf) from the NGS, which describes a deceivingly simple equation:

H = h-N

where,

H=orthometric height (distance along plumb line from topographic surface to geoid; e.g., G-LiHT DTM elevations)

h=ellipsoid height (distance from topographic surface to mathematical approximation of the shape of the Earth, e.g., WGS84 or NAD83)

N=geoid height (distance from ellipsoid to shape that the surface of the oceans would take under the influence of Earth's gravity and rotation alone, e.g., EGM96, GEOID12B)

If you want to convert orthometric heights from one geoid to another (e.g., EGM96 to NADV 88), you have to compute the spatially varying offsets between the two geoids.  It should be noted that [NAVD 88](https://www.ngs.noaa.gov/PUBS_LIB/NAVD88/navd88report.htm) is a “hybrid or composite geoid” that biases the NGS gravimetric geoid with local benchmarks (e.g., tidal station at Pointe-au-Pere,Rimouski, Quebec, Canada).  Also, [EGM96](https://www.ngs.noaa.gov/PUBS_LIB/EGM96_GEOID_PAPER/egm96_geoid_paper.html) is a global, spherical harmonic model of the Earth’s gravitational potential, and technically not a gravimetric geoid.

I used the [LILA site](ftp://fusionftp.gsfc.nasa.gov/G-LiHT/FL_Everglades_LILA_May2015/lidar/) in Florida for this example, which has lat/lon coordinates of 26.4873/-80.2170 and G-LiHT DTM elevation (EGM96) of ~5 m.  I looked up the geoid height for both [EGM96](http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm96/intpt.html) and [NADV 88](https://www.ngs.noaa.gov/cgi-bin/GEOID_STUFF/geoid12B_prompt1.prl), which tells me the geoid heights (N) are -27.54 and -25.62 m, respectively.  Thus, I should expect a difference between EGM96 and NAVD 88 of ~2 meters.  However, one should note that errors and uncertainties associated with field/aircraft measurements and [models](https://vdatum.noaa.gov/docs/est_uncertainties.html) can be quite substantial, often up to 1 m or more.

To convert the G-LiHT DTM geotiffs, I used both GDAL, numpy and VDatum (all freeware).  I also used QGIS (also free) to view the results.

If you don’t have Python, numpy and GDAL on your computer, install [Anaconda](https://www.continuum.io/downloads).  It’s very straightforward and installs with numpy.  GDAL can be installed afterwards by typing “conda install gdal” from the command line.

Next you’ll want to convert all the the “not a numbers” (NaN) in the G-LiHT geotiff to zero:

gdal\_calc.py -A FL\_Everglades\_LILA\_May2015\_DTM.tif --outfile=no\_zeros.tif --calc="nan\_to\_num(A)"

Then you’ll want to convert the geotiff to Arc/Info ASCII Grid format (NOTE: VDatum only ingests ASCII files without missing values):

gdal\_translate -of AAIGrid no\_zeros.tif asci\_dtm.asc

Lastly, install [VDatum](https://vdatum.noaa.gov/) and all its core geoids (I had to do this one by one) and run it like the screenshot below.  It should output a new layer in NAD83 NADV88.

