THE EVER MOVING DATUM, EVER CHANGING EARTH CONUNDRUM

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Being "star" based, one of the many things GPS has reinforced is the fact that the physical Earth is a dynamic structure, continually changing shape and dimension over time. This means of course that any given measurements of the Earth must be considered not in three dimensions (XYZ) but in four (XYZ and Time). Since the satellites in the GPS system are not conditional on the local movement of the Earth, that presents surveyors with a relatively new set of problems when using established coordinate systems such as State Plane and UTM or even user defined systems based on "accurate" global values (latitude, longitude and ellipsoid height). As more and more spatial information is integrated into our daily lives (GIS, location based services, etc) the disparities between a "fixed" measuring platform and a constantly changing target become more acute. This document will be confined in a general way to the two most basic Earth changes (the movement of the center of mass of the Earth and shifts in the "local" Earth surface) and specifically how this movement is realized and dealt with in the ***Trimble Business Center*** (***TBC***) software.

To begin, in the context of this document the word *accuracy* is meant to describe how well a position on the Earth is known and can be repeated (global coordinates like latitude/longitude/height) and the word *precision* is meant to describe how well the relationships between several points on the Earth are known and can be repeated within themselves (delta XYZ). At the end of the day, a boundary surveyor is more concerned with property corners relative to the section or legal monuments that control the survey (*precision*) as opposed to their *global* accuracy. However, if the surveyor publishes a boundary survey purported to be on an accurate basis (required for State Plane/UTM) or wants to make the survey portable across a multitude of coordinate systems (**highly recommended**), then both *accuracy* and *precision* are in play.

The datum discussed here will be generally the basic WGS84 which is the foundation of the GPS system and GRS80 which is the basis for NAD83. Of first note is the fact that the ellipsoidal structure of the two are for all practical purposes the same, that is the semi major/semi minor and flattening parameters are virtually identical for a vast majority of survey purposes. Furthermore, in the <u>original</u> realization of the NAD83 datum, both NAD83 and WGS84 shared the same physical center of mass of the Earth which is why when using the ***NAD83 (Conus)*** datum in ***TBC*** the ***Local*** and ***Global*** lat/longs/hts will be identical (the ***Molodensky*** transformation values are set to zero). Over time however, the center of the WGS84 ellipsoid shifts with the current dynamic center of mass of the Earth which means that the WGS84 and NAD83 lat/long/hts are no longer the same. To account for the differences there have been new realizations of NAD83. This is evidenced by using the ***NAD83 CORS96*** and ***NAD83 2011*** datum transformation in ***TBC*** wherein a seven parameter transformation performs the shift between the two datum (NAD83 and WGS84) and the ***Local*** and ***Global*** lat/long/ht values are not the same. Since its inception, the NGS OPUS utility has been based on the NAD83 CORS 96 *2002.00* realization but on July 15th, 2012 that changed to NAD83 2011 *2010.00* (the last number in the name, *2002.00* and *2010.00* refers to the epoch date in time). The new realization of NAD83 also includes adjustment of the CORS stations themselves.

Dealing with all this is basically a matter of choosing the appropriate system in the ***TBC*** software; however there are a couple of issues here:

TBC Ver 2.70+ will do the following when either the ***NAD83 (Conus) (Molodensky)*** or ***NAD83 (Conus) CORS96*** or ***NAD83 2011*** (both are Seven Parameter) datum are chosen when creating a ***Project/selecting a coordinate system*** and either CORS data sheets or OPUS XML files are imported (note that both ***NAD83 (Conus)*** and ***NAD83 2011*** come stock in ***TBC***, ***NAD83 CORS96*** must be created as in the next section):

Example 1. Using the ***NAD83 (Conus) (Molodensky)*** datum which is the default when selecting ***US State Plane 1983*** from the ***Coordinate System Manager*** means using the original realization of GRS80 (note that the Molodensky transformation values are set at zero).

If a OPUS XML file or CORS station datasheet is imported into ***TBC*** the ***Local*** values will match exactly with the NAD83 values on the datasheet/XML, even though the CORS/XML datasheet may actually be in NAD83 2011. Note too that the ***Global*** values will also exactly match the ***Local*** values.

Example 2. Setting up a ***Project*** using a ***NAD83 (Conus) CORS96*** or ***NAD83 2011 State Plane*** coordinate system means using a ***Seven Parameter Datum Transformation*** to either the CORS96 Epoch 2002 or 2011 Epoch 2010 realization of NAD83.

If an OPUS XML file or CORS station datasheet is imported into ***TBC*** the ***Local*** values will match exactly with the NAD83 values on the datasheet/XML, even though the CORS/XML datasheet may actually be in NAD83 2011. Note that the ***Global*** values have been transformed (both the ***Global*** values and the ***Grid*** coordinates have been derived from the imported NAD83 values that have been transformed and projected).

NOTE: The new ***NAD83 2011*** datum is the basis for the new ***Geoid12A*** and should also be used with the new ***NGS Absolute Antenna*** models.

VRS USERS BEWARE!!!!

As of ***Survey Controller Version 12.49*** and ***Access Ver 2012.20*** – when using a VRS system the Trimble data collectors ASSUME that the broadcast position is WGS84. If that is **NOT** the case (many VRS systems are now broadcasting a NAD83 2011 position) **AND** the controller coordinate system/datum transformation is using the seven parameter transformation (as referenced above in the NAD83 COR96 and NAD83 2011 systems), **ALL VALUES WILL BE WRONG!!!!!!!** For example, if the VRS is in fact broadcasting NAD83 2011 and Colorado State Plane NAD83 2011 is used as the coordinate system, the Trimble data collector will interpret the broadcast lat/long/height as WGS84 (which is incorrect) and the transformed ***Local*** value and projected ***Grid*** coordinates will also be incorrect.

The work around is to use the original NAD83 (Conus) coordinate systems in the controllers and then transform the values using HTDP as necessary.