

What Datum Am I On

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I. The Basic Questions

Because coordinates in different datums can differ by 100's of meters (or even a kilometer in the far east), it is important to know what datum you are on. There are usually two questions :

What datum is my map or data base on?

What datum is my navigation system or survey on?

Clearly if the answer is the same, the map/data base and the position sensor can work together. Ships have gone aground when this was not so.

Today we are moving to the use of the Global Positioning System (GPS) and electronic charts and maps. However there are still plenty of paper maps around. And even electronic charts directly connected or integrated with GPS do not guaranteed that we are not making a datum error - combining material from two or more datums. This paper will try and shed some light on what datum (or datums) you are using.

II. Map Datums - Paper and Electronic

The data base of a map is usually listed in the legend of the map. In fact there are is usually both a horizontal and vertical datum listed. Today it is not uncommon to see two horizontal datums listed, one for the original map and one for some overprinting. This is how USGS has updated a lot of topographical maps from NAD27 to NAD83. But you have to read the legend carefully to notice this. In fact there are quite a few military maps issued by NIMA that use the same technique. The military maps of the Balkans distributed in the mid 1990's were on the European Datum of 1950 with annotations in the legends on how to shift the positions to WGS 84.

For computer data files the issue is much more difficult. The data from the legends of the maps is usually preserved, but often not displayed. If the map is simply scanned as an image the legend is there, but the data is not usually "registered" or set up for computer reading of accurate coordinates. If the map has been entered into a Geographical Information System (GIS) it may well be registered, but in this case the legend data is present only in an auxiliary file. This type of legend data is called "metadata".

III. Navigation and Survey Equipment Datums

What datum is GPS on? The answer depends on how the GPS receiver generated the solution. Stand alone GPS and Differential GPS (DGPS) have different answers. And there are both a general answer, and a more precise answer.

A. Standalone GPS Users

Simply put, standalone GPS users are on the datum of the ephemeris that tells the solution program the locations of the satellites. This is the datum of the stations used to collect the data for the ephemeris computation.

For the stand alone user the simple answer is WGS 84. GPS operates by measuring ranges from the satellites to the user. In order to convert these ranges into positions, the locations of the satellites at the times the measurements were made is needed. Have a range and now knowing where it is from is not useful. The time history of the satellite positions is called the ephemeris of the satellites. So a stand alone user is on the datum of the ephemeris he uses.

The usual case is for the user to use the ephemeris that is present on the signal broadcast by the satellites. This is called the Broadcast Ephemeris (BCE). This information is "on WGS84". The quotes denote that this answer is not precisely correct, or is complicated by history.

There have been Precise Ephemeris (PE's) available for over 20 years. These are post fit ephemeris based on a large set of ground stations. These are available from several civilian and military sources. There is even a civilian consortium that produces a blended set of several PE's. In the past these were used for post fit work because it was a week or more after the fact that the PE's became available. After 2000, they have become available at very short delays. There even is a rapid prediction service that generate projected PE's that are much better than BCE out to a day or so. PE's are usually on the latest International Terrestrial Reference System - ITRF2000 in 2002. If you use these, you are on ITRF 2000.

The more complex answer for the BCE's puts these also on a ITRF. An ephemeris is computed from GPS observations made at known, fixed locations. The datum of an ephemeris is determined by the coordinates used for the antennas of these observations. These locations for the Operational Control System stations have been adjusted several times. This has effectively changed the datum of WGS84 as realized by the GSP BCE's.

In order to avoid confusion, the name of the datum was not changed when the adjustments were made. A suffix was added, but not widely used or know outside the geodesy community. GPS time is counted in weeks after January 1980. The BCE datums were/are:

BCE Datum Name	Implemented	Matches
WGS 84	1980	Original WGS84
WGS 84 (G730)	1-2-1994	ITRF94
WGS 84 (G873)	9-27-1996	ITRF96

The number in the Gnnn is the GPS week number of the change.

B. Differential GPS Users

Simply put, for DGPS you are on the datum of the reference station.

With DGPS a reference station at a known location measures the errors in ranges to individual satellites and sends these to remote users over some communication link. In order to compute the errors, the reference station needs to know its position. The datum of the coordinates used for this position become the datum of all DGPS solutions that use those corrections.

C. Other Electronic Navigation Systems

Other electronic navigation systems are much like DGPS. The coordinates used for the stations that transmit the signals or transpond signals define the datum. Often these are not accurate enough for meter level distinctions to be important. However in Asia, the difference between WGS 84 and other local datums can be large. The user must take care to know which datum his navigation system and map are on.

D. Surveying

Surveying is much like DGPS. Surveying is usually done point to point. In a surveyed network there must be at least one known point. In large surveys there will be more. These are "held constant" in the analysis of the data. The datum used for this point(s) define the datum of the other surveyed points.

This is true of almost all GPS surveying as well as classical survey techniques. Data is taken at the same time with GPS receivers at different locations. The relative locations are then computed.

There is one exception, Absolute GPS Surveying. Large government agencies have to establish the primary points in remote areas. In this case a more complex post analysis is done on GPS data taken at a fixed location over several days. The analysis needs Precise Ephemeris to achieve survey quality positions. The answer is on the datum of the PE's used.