When to Use Differential GPS in Place of Bottom Track

DGPS Is Used When:

- The River Bed is Unstable
- Bottom Track Velocities are Biased

Not Used When:

- The River Bed is stable
- The Bottom Speed is Less than 1/60 of the Water Speed (i.e. less than 1 ft/minute bottom movement per 1 ft./sec water speed)

Why use Differential GPS instead of Bottom Track?

The primary function of bottom-track is to measure the ADCP's speed-over-bottom and detected range-to-bottom. In the discharge calculation, these two pieces of information are used to

1. Calculate the absolute water velocity by subtracting the boat's velocity from the relative velocity measured by the ADCP,
2. Estimate the cross-sectional area of the transect.

There are some environmental conditions that make it difficult for the ADCP to make unbiased bottom track measurements. Biases can occur when

- The bottom is non-stationary and moves with the flow,
- There is a very heavy layer of suspended sediment moving along with the flow, and the ADCP falsely detects the bottom in the moving suspended sediment layer,
- When the bottom is out of range.

In each of these cases, it is necessary to have an external means for estimating the boat's velocity.

Differential GPS (dGPS) provides this means to estimate the boat's velocity while underway. The dGPS calculates the boat's position to an accuracy of about 1-3m and supplies it every second or so. These waypoints can be differentiated to calculate the boat's velocity. In the following, we will outline the different ways in which you can utilize GPS. TRANSECT v. 4.04 and higher incorporates the GPS data into the real-time calculation of discharge.

Overview of GPS and Differential GPS (dGPS)

The Global Positioning System, GPS, is a system of 24 earth-circling satellites and several control stations here on earth. GPS receivers are designed to track the signals transmitted by the satellites that are within line of site (typically 6 to 12 satellites) and use their signals to calculate the receiver's position on the earth in longitude and latitude

coordinates. The military maintains the system, and they apply a "smearing affect" to the satellite's signals for national defense protection. This smearing is called Selective Availability (S/A), and because of its effect, the best positional accuracy you can expect to attain with a regular GPS receiver is somewhere between about 30 to 100. By using differential GPS, the positional accuracy can be improved to 1-3 m.

The differential in dGPS means that differential corrections are subtracted from the GPS data to remove the intentionally applied Selective Availability. In differential GPS, two receivers are used: one as the base reference station, and the other as a roving station. The base station "knows" its exact location, and as it receives the S/A signals from the satellites, it calculates it's "smeared" position and subtracts it from its known position to determine a differential correction. The base station then transmits this signal to the roving station. The roving station receives this correction and applies it to the GPS positions it has calculated from tracking the satellites overhead. The output is a differential GPS position with a much higher accuracy than the original GPS position. There are several sources for differential corrections, and they will be described in the next section.

Sources of Differential Corrections:

U.S. Coast Guard dGPS Beacons – the Coast Guard operates a number of beacons along the coast that transmit differential corrections. These can be received for free using a beacon receiver on the boat. The output from the beacon is then simply input to the GPS receiver to apply the differential corrections in real-time. This configuration can provide about 1-3 m horizontal and 5 m vertical position accuracy.
You will need: GPS receiver (see the section on GPS Receiver Requirements), beacon receiver for receiving Coast Guard differential corrections.

Private Differential Correction FM Transmission Service – The differential corrections are transmitted over FM radio and received on the boat using a low cost radio receiver. The transmission range from the transmitter at the base station and the roving station on the boat is limited to 50-75 km. Two major suppliers are Accqpoint and Differential Correction, Inc., and there is a subscription fee associated with their services.
You will need: GPS receiver, radio receiver for receiving FM transmitted differential corrections, subscription to private service.

Private Differential Correction Data Satellite Transmission Service - a system of private satellites transmit differential corrections and are received by the subscriber at their roving GPS station. The differential satellite acts as a virtual base station. The user must pay a subscription fee and purchase a receiver capable of receiving the private party corrections. This option may provide the best solution in remote areas such as South

America where the nearest base station may be thousands of kilometers away. Omnistar is one such provider of differential corrections.
You will need: GPS receiver, special receiver for receiving satellite-transmitted differential corrections, subscription to private service

Your Own Base Receiving Station and Radio Link – if none of the above sources of differential corrections are available to you, it is necessary to purchase your own base station. This solution requires that you set up the base station in a fixed location and allow it to zero in on its position. This can take several hours. Once this is accomplished, the base station tracks the satellites above and calculates differential corrections to the GPS station on your boat. You must purchase two radios and obtain an FCC license to transmit the signal from the base to the rover. The advantage of this method is that the base can be positioned in very close proximity to the roving GPS resulting in very accurate positions. The drawbacks to this solution are the additional cost of the base station, the radios, and the radio license.
You will need: GPS base station that can track at least 6 satellites and calculate and output differential corrections, GPS receiver, two radios – one to receive and one to send the differential corrections, FCC radio license.

GPS Receiver Requirements

The GPS receiver listed in the configurations in the previous section must be capable of performing the following:

- Track at least 6 satellites,
- Receive differential corrections and using them to calculate differential positions,
- NMEA-0813 output: GGA (GPS position data) and optionally GSA (GPS satellite statistics),
- One-second updates preferred.