P1-C1 DCB determination using a high gain antenna coupled to the LCI method. Receiver type impact

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In the collected signal dataset, only 8 GPS satellites were recorded. For the moment, the P1-C1 DCB could only be computed for 4 GPS satellites, block IIA and IIF : PRN 04, 13, 23 & 32. For block IIF & IIRM, we are currently working on issues due to the presence of M code.

For P code, we assumed 1 chip spacing discriminators for all receiver, and 20 MHz BW as it is the bandwidth that is likely to be used by geodetic receivers. It also provide a reference against which the P1-C1 bias is computed for receiver that don’t produce P1 observations.

For C/A code, 1 chip, 0.1 chip and 0.05 chip narrow discriminators as well as 0.05 chip SDC discriminators have proved to show distinct behavior.

We would need to make measurement of all the 32 GPS satellite to have a better picture. Short term stability of the P1-C1 biases could also be studied using a calibrated antenna with the ICL method.

Comparisons of computations derived from HGA+LCI method with GNSS receiver measurements

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C1 DCB determination using an High Gain Antenna (HGA)

Methodology: The correlation function distortions are determined with an accuracy enabling to determine tracking errors at the centimeter level. This is done using a reasonably sized (several meters) High Gain Antenna and the Long Coherent Integration (LCI) method in which the signal is coherently integrated over several tens of seconds. Discussion about this method can be found in [1]. Then the tracking error is computed taking into account the receiver bandwidth and discriminator type. Using a directional antenna allows not to be bothered by the multipath error.

Measured correlation function:

- Perfect correlation function
- Correlation function maximum
- Tracking error according to discriminator type:
  - Ref. used triangle
  - Ideal reference triangle

P1-C1 bias determination: The LCI are done on C/A and P code coprimes, using synchronized code replica. The absolute P1-C1 bias is simply obtained by differentiating. It is the absolute P1-C1 DCB provided the antenna and RF recording chain are calibrated, and the calibration curve is accounted for. In the example below, the reference replicas was obtained by tracking P code with 1 chip spacing and a receiving BW greater than the satellite transmit BW (Our signal recorder had a 62.5 MHz BW).

P1-C1 difference with CODE P1-C1yymm.DCB file (in meters) for several receiver types:

- PRN 9, 1, 23 and 27. The values contained in the CODE file P1C1yymm.DCB is close to be an average of the 2 types of receivers.

Conclusions:

- As a constellation “zero mean” constraint is applied to the DCB computed using un-calibrated GNSS receivers or published by CODE, an offset is applied to match to the DCB computed using the HGA+LCI method (dotted curve on the graph).

- We have found that the JPS LEGACY receiver closely match the P1-C1 computed for a 20 MHz RF BW, a 1 chip spacing for P code, and a 0.1 chip spacing for the C/A code discriminator with a 2 cm accuracy. (orange curves)

- The DCB published by CODE are close to those computed for a 20 MHz RF BW, a 1 chip spacing for P code, and a 0.1 chip spacing for the C/A code discriminator with a 2 cm accuracy. (orange curves)

- It is interesting to notice that the PRN 23 satellite has a very stable bias when computed from the HGA data whereas it has one of the largest variation when computed from GNSS network and applying the constellation zero mean constraint.

References:
