Appendix B: Auxiliary Data Blocks

GPS/GLONASS-Related Data Block

If single-frequency GPS users apply precise ephemerides and precise satellite clock information—which always refers to the ionosphere-free linear combination (LC)—as well as IONEX TEC maps to eliminate or greatly reduce ionosphere-induced errors, they may also be interested in having a set of differential (P1–P2) code bias (DCB) values for the satellites to correct their P1-, or C/A-code measurements accordingly (to make them consistent to LC satellite clocks—or vice versa). P1–P2 satellite and receiver DCBs, b_{sat} and b_{rec}, are commonly estimated together with TEC parameters using the relationship

$$c\,(b_{\mathrm{sat}} + b_{\mathrm{rec}}) = (\mathrm{P1} - \mathrm{P2})_{\mathrm{observed}} - (\mathrm{P1} - \mathrm{P2})_{\mathrm{corrected}},$$

where P1 and P2 denote the dual-band code observables P1 and P2 in meters, or alternatively C/A and $\mathrm{P2}' = \mathrm{C/A} + (\mathrm{P2} - \mathrm{P1})$ (as generally provided by cross-correlation-style receivers). The satellite DCB correction for P1-code measurements may be written as

$$\mathrm{P1}_{\mathrm{corrected}} = \mathrm{P1}_{\mathrm{observed}} - \kappa_2\, c\, b_{\mathrm{sat}}$$

or for corresponding LC satellite clock values T_{LC} (gathered from IGS SP3 orbit or clock RINEX files) as

$$T_{\mathrm{corrected}} = T_{\mathrm{LC}} + \kappa_2\, b_{\mathrm{sat}},$$

where $\kappa_2 = -\nu_2^2/(\nu_1^2 - \nu_2^2) = -1.546$ is the second LC factor, ν_i is the frequency of the i-th carrier, c is the vacuum speed of light, and b_{sat} is the DCB of the SV considered. $T_{\mathrm{corrected}}$ represents a P1-compatible satellite clock value. To correct C/A-code measurements, the additional consideration of IGS P1–C/A (P1–C1) DCB values is recommended.

Important note: P1–P2 satellite DCBs, b_{sat}, are related to the interfrequency "group delays," τ_{GD}, broadcast by the GPS system:

$$\tau_{\mathrm{GD}} = \kappa_2\, b_{\mathrm{sat}} + \tau_0.$$

There may be an arbitrary offset, indicated by τ_0. b_{sat} and b_{rec} estimates are usually given in such a way that the zero-mean condition $\sum b_{\mathrm{sat}} = 0$ is fulfilled. In this case, τ_0 should correspond to the mean $\sum \tau_{\mathrm{GD}}/n_{\mathrm{sat}}$.

Since DCB information is a by-product of the TEC determination when analyzing dual-band code measurements, satellite and receiver DCB estimates may be included in IONEX files. The *GPS/GLONASS*-related data block has to be labelled with "`DIFFERENTIAL CODE BIASES`" (see examples in Tables 2 and 3).

Caution: More than one "auxiliary data" block is basically allowed in a single file. Unknown records within such a block shall be skipped.

Table 1: Differential code biases—format definitions

	HEADER LABEL (Columns 61-80)	DESCRIPTION	FORMAT	
	PRN / BIAS / RMS	Pseudo random number (PRN), differential (P1-P2) code bias value and its RMS error in nanoseconds. Note that 'PRN' consists of a character indicating the satellite system ('G' or blank for GPS and 'R' for GLONASS) and the actual PRN number (2 digits).	3X,A1,I2.2, 2F10.3,34X	
*	STATION / BIAS / RMS	Satellite system flag as used for the PRN-specific values, name of station (or of receiver-carrying satellite), code bias value and RMS error in ns. In case of combined receivers, an entry related to each satellite system must be expected. Special note: Within the IGS, the station name has to consist of the IGS 4-figure abbreviation followed by the DOMES number (A4,1X,A9,6X).	3X,A1,2X, A20,2F10.3, 14X	
*	COMMENT	Comment lines are allowed.	A60	*

(Records marked with "*" are optional)

Table 2: Differential code biases—example 1: GPS-only results

```
----|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|

DIFFERENTIAL CODE BIASES                                    START OF AUX DATA
    01     0.000     0.000                                  PRN / BIAS / RMS
    02     0.000     0.000                                  PRN / BIAS / RMS
...
    31     0.000     0.000                                  PRN / BIAS / RMS
      BRUS 13101M004           0.000     0.000              STATION / BIAS / RMS
      TOW2 50140M001           0.000     0.000              STATION / BIAS / RMS
      WILL 40134M001           0.000     0.000              STATION / BIAS / RMS
...
DCB values in ns; zero-mean condition wrt satellite values  COMMENT
DIFFERENTIAL CODE BIASES                                    END OF AUX DATA

----|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|
```

Table 3: Differential code biases—example 2: GPS/GLONASS-mixed results

```
----|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|

DIFFERENTIAL CODE BIASES                                    START OF AUX DATA
   G01     0.000     0.000                                  PRN / BIAS / RMS
   G02     0.000     0.000                                  PRN / BIAS / RMS
...
   G31     0.000     0.000                                  PRN / BIAS / RMS
   R01     0.000     0.000                                  PRN / BIAS / RMS
   R02     0.000     0.000                                  PRN / BIAS / RMS
...
   G  BRUS 13101M004           0.000     0.000              STATION / BIAS / RMS
   R  BRUS 13101M004           0.000     0.000              STATION / BIAS / RMS
   G  TOW2 50140M001           0.000     0.000              STATION / BIAS / RMS
   R  TOW2 50140M001           0.000     0.000              STATION / BIAS / RMS
   G  WILL 40134M001           0.000     0.000              STATION / BIAS / RMS
   R  WILL 40134M001           0.000     0.000              STATION / BIAS / RMS
...
DCB values in ns; zero-mean conditions wrt satellite values COMMENT
DIFFERENTIAL CODE BIASES                                    END OF AUX DATA

----|---1|0---|---2|0---|---3|0---|---4|0---|---5|0---|---6|0---|---7|0---|---8|
```