DORIS-dSTEC Product Descriptions (draft-version)

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Product overview

CAS DORIS dSTEC product provides differential slant total electron content (dSTEC) observations derived from dual-frequency DORIS measurements collected by low Earth orbit (LEO) satellites. The product is generated and maintained by the Chinese Academy of Sciences (CAS) and is intended for global ionospheric research and related scientific applications. The DORIS-dSTEC observable represents the change in slant TEC along a continuous DORIS observation arc, referenced to a selected epoch within the arc. By differencing, instrumental biases and slowly varying errors are largely eliminated, making the product well suited for ionospheric variability studies.

Product file assess

CAS DORIS dSTEC product is publicly available from CAS regional data center through

https://data.bdsmart.cn/pub/product/iono/doris/dstec/$YYYY/$DOY

where

- YYYY denotes the four-digit year
- DOY denotes the three-digit day of year

Product data format

The DORIS dSTEC product is distributed as plain text (ASCII) files with whitespace-separated columns. Each file consists of:

- header section containing metadata,
- single column-header line, and
- data section with epoch-wise records.

Long filename convention

Final product (post-processed)

CAS0OPSFIN_{yyyy}{ddd}0000_DRS_{SAT}_ION.DSTEC.gz

NRT product (near-real-time processed)

CAS0OPSNRT_{yyyy}{ddd}0000_DRS_{SAT}_ION.DSTEC.gz

where

- yyyy is the four-digit year
- ddd is the day of year
- SAT is the three-character satellite identifier

File header specification

The header provides mission, instrument, and processing metadata to ensure traceability. Typical header keywords include:

- Satellite (name, series) - mission and platform identification

- Antenna (type, series) - DORIS beacon antenna information
- Receiver (type, series) - receiver type and processing chain identifier
- Receiver coordinates - Cartesian coordinates of the receiver, if applicable

The exact set of header fields may vary depending on mission configuration and processing version.

Example:

```
Satellite(nameseries):HY-2C                          2020-066A
 Antenna(type,series):STAREC                         DORIS
Receiver(type,series):DGXX                           CHAIN1
 Receiver coordinates:0.000              0.000                0.000
```

The header section is terminated by a delimiter line (e.g., a sequence of hyphens). The column header and data records follow immediately thereafter.

File body Specification

The column-header line defines the data fields. A typical header reads:

Date(GPST) PRN SAT_ID STEC[TECU] dSTEC[TECU] Sat_Ele Sat_Azim Ipp_Lat Ipp_Lon Sat_Ele_M Sat_Azim_M Ipp_Lat_M Ipp_Lon_M Max_Epoch

The individual fields are defined as follows:

- Date(GPST): observation epoch in GPS Time, formatted as YYYY/MM/DD hh:mm:ss.ss.
- PRN: DORIS beacon identifier (format Lnn or Lnnn).
- SAT_ID: internal satellite or platform identifier used in CAS processing.
- STEC [TECU]: slant total electron content at the observation epoch, expressed in TEC units.
  arc.
- dSTEC [TECU]: differential slant TEC relative to the reference epoch of the corresponding observation
- Sat_Ele [deg.]: satellite elevation angle at the observation epoch.
- Sat_Azim [deg.]: satellite azimuth angle at the observation epoch.
- Ipp_Lat, Ipp_Lon [deg.]: latitude and longitude of the ionospheric pierce point (IPP) at the observation epoch.
- Sat_Ele_M, Sat_Azim_M [deg.]: Satellite elevation and azimuth angles at the epoch of maximum elevation within the arc (Max_Epoch). These values are repeated for all records belonging to the same arc.
- Ipp_Lat_M, Ipp_Lon_M [deg.]: IPP latitude and longitude at the arc's maximum-elevation epoch.
- Max_Epoch (GPST): Epoch of maximum satellite elevation within the arc, formatted as YYYY/MM/DD hh:mm:ss.ss. Records sharing the same PRN, SAT_ID, and Max_Epoch are typically associated with the same continuous observation arc.

Example:

Date(GPST)	PRN	SAT_ID	STEC[TECu]	dSTEC[TECu]	Sat_Ele	Sat_Azim	Ipp_Lat	Ipp_Lon	Sat_Ele_M	Sat_Azim_M	Ipp_Lat_M	Ipp_Lon_M	Max_Epoch
2025/09/22 00:16:42.86	L152	345	-1046391.63	0.00	20.0200	301.88	-60.97	124.50	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:16:49.86	L152	345	-1046392.30	-0.67	19.9000	303.35	-60.79	124.78	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:16:52.86	L152	345	-1046392.37	-0.74	19.8400	303.97	-60.71	124.90	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:16:59.86	L152	345	-1046392.89	-1.26	19.7000	305.42	-60.53	125.17	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:02.86	L152	345	-1046392.95	-1.32	19.6300	306.04	-60.45	125.28	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:09.86	L152	345	-1046394.06	-2.43	19.4500	307.47	-60.26	125.55	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:12.86	L152	345	-1046394.83	-3.20	19.3700	308.08	-60.18	125.66	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:19.86	L152	345	-1046395.39	-3.76	19.1700	309.48	-59.98	125.92	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:22.86	L152	345	-1046395.87	-4.24	19.0800	310.08	-59.90	126.03	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:29.86	L152	345	-1046396.29	-4.66	18.8600	311.46	-59.71	126.29	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:32.86	L152	345	-1046396.82	-5.19	18.7600	312.04	-59.62	126.40	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:39.86	L152	345	-1046397.84	-6.21	18.5100	313.39	-59.43	126.65	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:42.86	L152	345	-1046397.84	-6.21	18.4000	313.96	-59.34	126.75	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:49.86	L152	345	-1046399.15	-7.52	18.1400	315.28	-59.14	127.00	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:52.86	L152	345	-1046399.55	-7.92	18.0200	315.84	-59.05	127.10	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:17:59.86	L152	345	-1046400.67	-9.04	17.7400	317.13	-58.85	127.34	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:02.86	L152	345	-1046401.05	-9.42	17.6100	317.67	-58.76	127.44	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:09.86	L152	345	-1046402.36	-10.73	17.3100	318.93	-58.56	127.68	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:12.86	L152	345	-1046402.55	-10.92	17.1800	319.46	-58.47	127.78	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:19.86	L152	345	-1046402.99	-11.36	16.8600	320.68	-58.26	128.01	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:22.86	L152	345	-1046403.24	-11.61	16.7200	321.19	-58.17	128.11	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:29.86	L152	345	-1046403.56	-11.93	16.3900	322.38	-57.95	128.34	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:32.86	L152	345	-1046403.81	-12.18	16.2500	322.88	-57.86	128.44	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:39.86	L152	345	-1046403.87	-12.24	15.9100	324.02	-57.64	128.66	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:42.86	L152	345	-1046404.04	-12.41	15.7600	324.51	-57.55	128.76	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:49.86	L152	345	-1046404.49	-12.86	15.4100	325.62	-57.33	128.98	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:52.86	L152	345	-1046404.82	-13.19	15.2600	326.09	-57.23	129.08	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:18:59.86	L152	345	-1046405.64	-14.01	14.9000	327.17	-57.01	129.29	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:19:02.86	L152	345	-1046405.87	-14.24	14.7400	327.62	-56.91	129.39	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:19:09.86	L152	345	-1046406.64	-15.01	14.3700	328.66	-56.68	129.60	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:19:12.86	L152	345	-1046406.76	-15.13	14.2100	329.10	-56.58	129.70	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:19:19.86	L152	345	-1046407.56	-15.93	13.8400	330.11	-56.35	129.91	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:19:22.86	L152	345	-1046407.80	-16.17	13.6800	330.53	-56.25	130.00	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:19:29.86	L152	345	-1046408.52	-16.89	13.3000	331.50	-56.01	130.21	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:19:32.86	L152	345	-1046408.92	-17.29	13.1400	331.91	-55.91	130.30	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:19:39.86	L152	345	-1046409.69	-18.06	12.7500	332.85	-55.67	130.51	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86
2025/09/22 00:19:42.86	L152	345	-1046410.07	-18.44	12.5900	333.24	-55.56	130.60	20.02	301.88	-60.97	124.50	2025/09/22 00:16:42.86

Useful information

[1] Liu, A., Wang, N., Dettmering, D., Li, Z., Schmidt, M., & Yuan, H. (2023). Using DORIS data for validating real-time GNSS ionosphere maps. Advances in Space Research, 72(1), 115-128.

[2] Wang, N., Liu, A., Li, Z., & Dettmering, D. (2024). Near-Real-Time DORIS Data for GNSS-based Ionospheric Maps: Validation and Combination. IDS Analysis Working Group Meeting, November 2023.

[3] IDS WG NRT Ionospheric Applications. *https://ids-doris.org/ids/organization/working-groups.html*