Positioning Performance of BeiDou Navigation Satellite System

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5th Meeting of the ICG, Beijing, China, 5-9, November 2012

Status of BeiDou Navigation Satellite system

Sept.: 4GEO+5 IGSO+2MEO (In this presentation)
2012: 5GEO+5IGSO+4MEO (Operational Satellites, Regional Service )
2020: 5GEO+3IGSO+27MEO (Operational Satellites, Global Service )
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Precise Orbit & Clock Determination

Software used

- GPS products for IGS Combination
- GLONASS products for IGS Combination
The COMPASS Experimental Tracking Network (CETN), which is operated by GNSS Research Center, Wuhan University (WHU) with cooperation of our research partners around the world.
Precise Orbit & Clock Determination

Parameters

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<td>Sun, Lunar, Planetary</td>
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<td>BERN 9 parameters</td>
<td>BERN 9 parameters</td>
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Overlap difference

Results for 4GEO+5IGSO+2MEO

One month RMS
1-30, Sept. 2012

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SLR Validation

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Allan Variance for GEO: CO3

Hadamard Variance for GEO: CO3
Precise Orbit & Clock Determination

Allan Variance for IGSO: CO8

Hadamard Variance for IGSO: CO8
Signal in Space (SIS) Accuracy is an index of statistical result of SIS User Range Error (SIS URE). Derived BD-2 SIS URE formulas:

\[
URE_{BD2\text{GEO/IGSO}}^2 = \sqrt{(0.9843R - T)^2 + 0.0078(C^2 + A^2)}
\]

\[
URE_{BD2\text{MEO}}^2 = \sqrt{(0.9814R - T)^2 + 0.0185(C^2 + A^2)}
\]

- R: radial error
- C: cross error
- A: along error
- T: clock error

* assumed that Earth Radius = 6371 km, mask angle = 0 deg, BD2 GEO/IGSO Altitude =36000 km, BD2 MEO Altitude =21500 km
Positioning Performance of BeiDou

SISRE of broadcast ephemeris

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- URE caused by ionosphere parameters, and

Ionosphere difference between model of IGS and parameters from BeiDou

visible working satellites of BeiDou with 4+5+2 satellites

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PDOP (95%)  Positioning Accuracy (95%)

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Positioning Performance of BeiDou

- SPP results of Beijing Station (U:16->6m; EN:11->5m)
Positioning Performance of BeiDou

- SPP results of Wuhan Station (U:15->10m; EN:8->5m)
Positioning Performance of BeiDou

- SPP results of Perth Station (U:15→10m; EN:8→5m)

![Graph showing positioning performance](image)
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Multi-GNSS Application

• Navigation performance

Stand alone results (single frequency)

the vertical direction accuracy seems to be significantly improved when using GPS + Glonass + Beidou!
Multi-GNSS Application

- RTK performance

Multi-GNSS combination baseline kinematic resolutions

- Glonass
- BeiDou
- GPS
- GPS + BeiDou
- GPS + Glonass + BeiDou

Epoch (30s)
Multi-GNSS Application

- PPP performance
POD of BeiDou, better than 10cm in redial direction

For navigation users, 8-15 m (95%), using BeiDou along with 4 GEO + 5 IGSO + 2 MEO constellation

For navigation users, the Multi-GNSS combined results can be improved significantly compared with only one system used.

Short baseline relative positioning, 1-3 cm, using BeiDou only, and Kinematic relative positioning can be improved 20% by combining BeiDou and other GNSS, compared with other GNSS only.

PPP at cm level using BeiDou precise O&C products, multi-GNSS PPP is more stable and with better accuracy.
Thanks for your attention!