Code/phase bias products at GFZ

Zhiguo Deng

deng@gfz-potsdam.de

GFZ German Research Centre for Geosciences
Space Geodetic Techniques, Telegrafenberg, 14473 Potsdam

GFZMGX move to Un-Difference (UD) AR

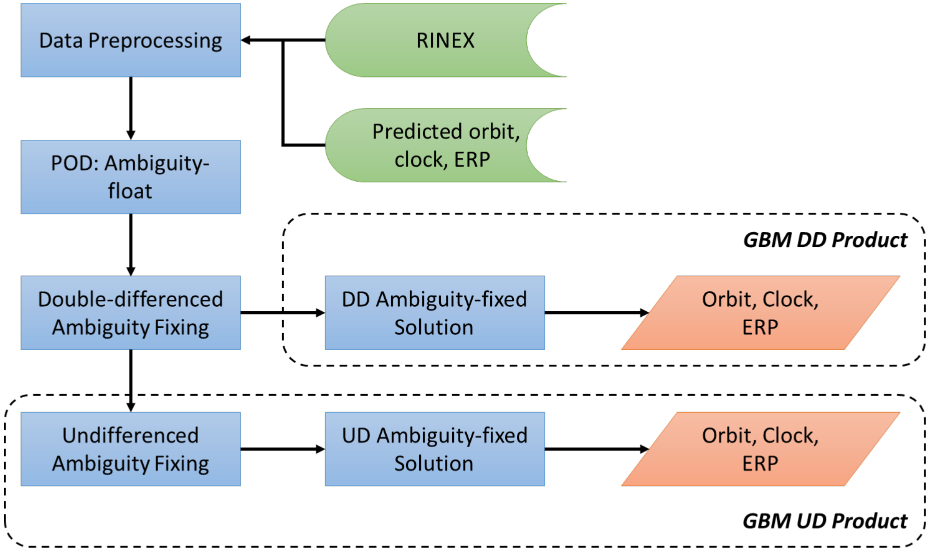
Bias product:

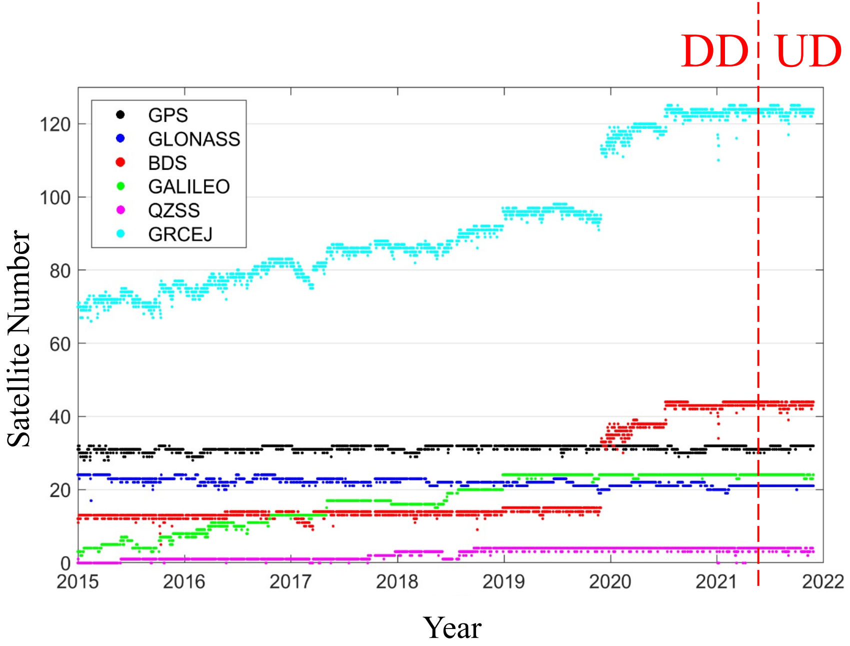
- Since DOY 176 in 2021 GFZMGX provides code/phase bias and satellite attitude products (IGSmail).
- The code/phase bias are converted from wide/narrow-lane un-calibrated-phase-delay (UPD) and ionospheric DCB bias products from CAS. (Thank Simon and CAS).

Method:

1) In GFZ multi-GNSS POD processing float solution generated, then the fixed Double-Difference (DD) AR are added in NEQ as conditions with strong constrain.
2) the daily satellite/station UPDs are determined, and the ambiguities are fixed (adding strong constrain in NEQ).
3) The clock product absorbs the daily narrow-lane UPDs ➔ Integer clock

GFZMGX move to Un-Difference (UD) AR





Why UD AR in POD?

- In GNSS data processing the AR can improve POD
- Most POD software packages use the Double-Difference (DD) from independent base-lines to do AR
- DD from **shorter baseline** reduce more errors from the global parameters (like ERP, satellite orbit+clock…) than longer baseline → **better fix-rate**
- In other word, the **shorter baseline** is **less sensitive** to the **global parameters**

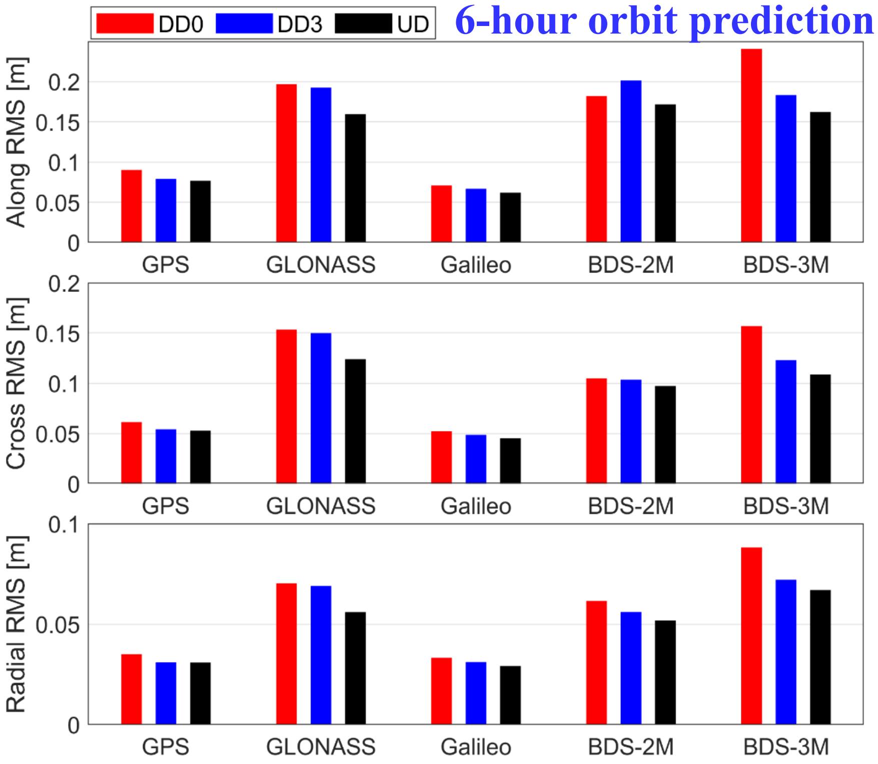
⇩

- **Longer baseline is better for POD.**
- The **Un-Difference (UD)** AR connects **all spacious ambiguities** in a session.
- The float solution is zero-baseline solution.
- The code/phase bias are global parameters.

Orbit-overlap validation DD vs. UD

	Ambiguity resolution	Baseline length
DD0	Double-differenced	0—2K km (80%)
DD3	Double-differenced	3K—4K km (90%)
UD	Undifferenced	---

- DOY 001-150 in 2021, 140 stations, 5 min
- Ambiguity resolution for GPS, Galileo and BeiDou2/3 (IGSO+MEO)
- Three solutions with different AR constrain settings



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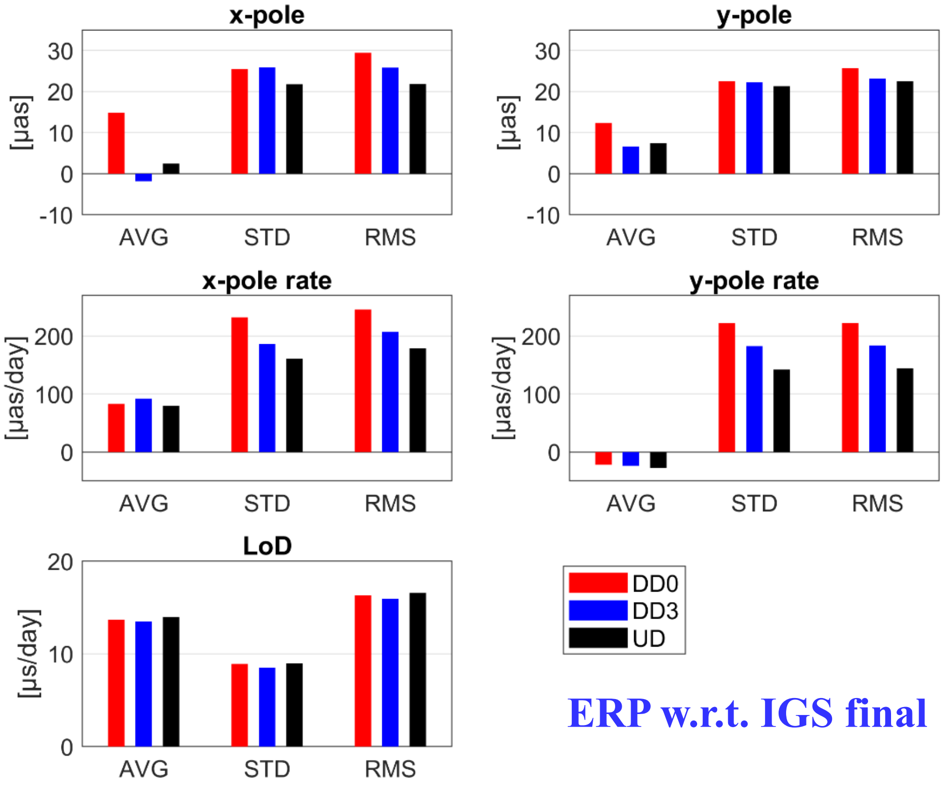
Earth Rotation Parameters (ERP) validation

- ERP are compared with IGS final solution.
- Polar motion estimates significantly improved, especially the rates
- No impact on LoD

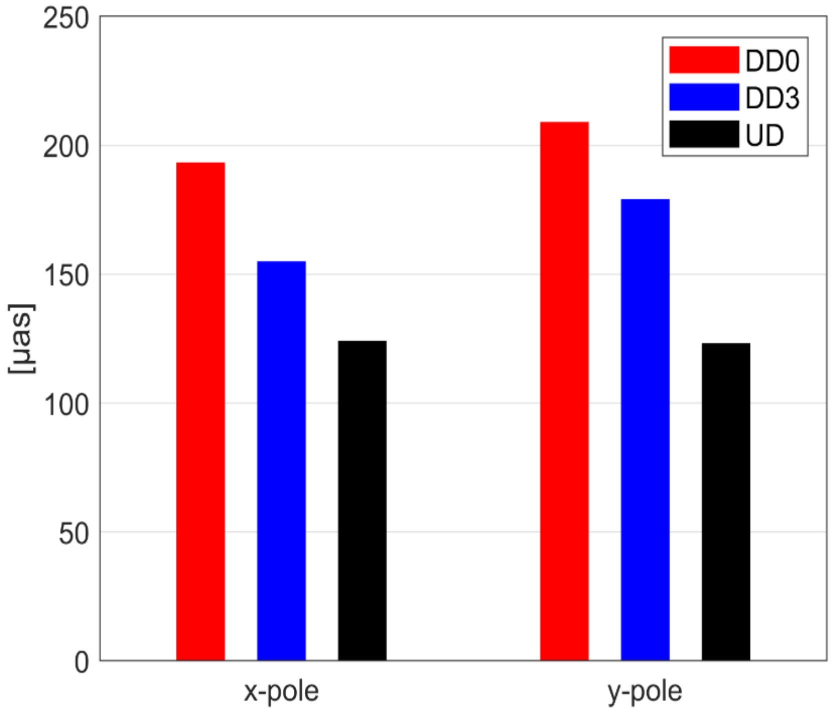


ERP w.r.t. IGS final

Day-boundary-discontinuity (DBD) of polar motion

- Polar motion DBD significantly reduced

- Mainly due to the improvement of polar motion rates



Conclusions & Outlook

- GFZMGX switched into UD since DOY 176 in 2021, provides integer clock, OSB/WL-UPD and satellite attitude.
- The impact on Earth center and station coordinate will be studied in the next step.
- In GNSS POD the UD AR can **improve** satellite orbit and polar motion significantly.

	GPS	GLOASS	Galileo	BDS2M	BDS3M
Along	15%	19%	13%	6%	33%
Cross	15%	19%	13%	7%	31%
Radial	12%	20%	12%	16%	24%

	x-pole	y-pole
Offset	26%	12%
Rate	27%	35%

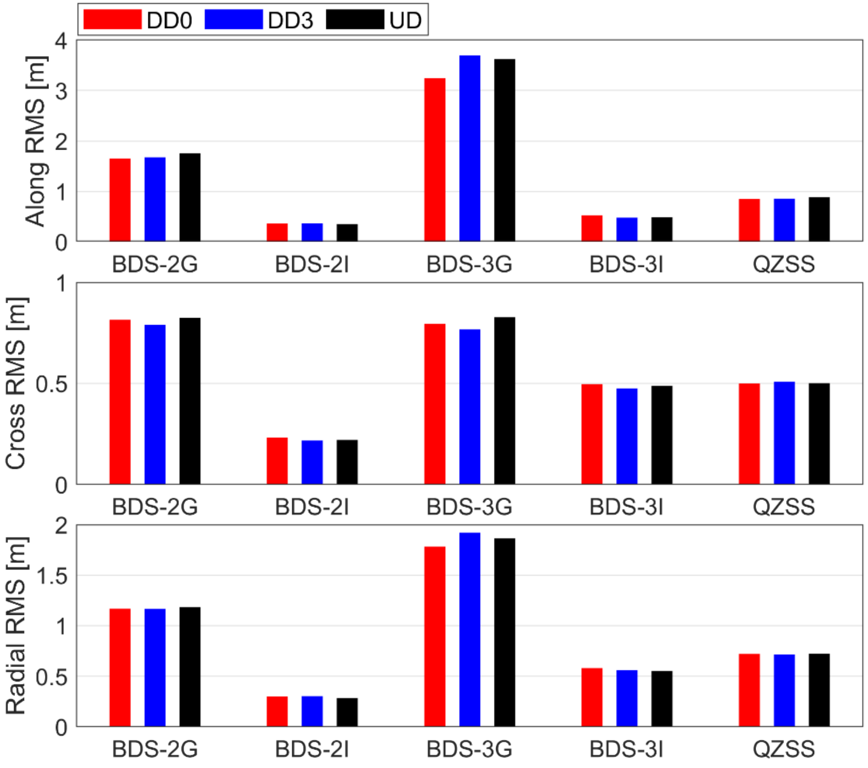
Improvement of (UD.vs.DD0) orbit overlap and EOP

Thank you for your attention

Backup

Orbit Precision: CJ (GEO/IGSO)

- Marginal impact on the orbit precision of GEO/IGSO satellite orbit precision
- GEO/IGSO have bad quality anyway
  - Tracking network
  - Solar radiation pressure modeling
- GEO/IGSO are less sensitive to ERP



Double-differenced (DD) Ambiguity Resolution

- GNSS POD

$$\rho_r^s = |\mathbf{x}^\mathbf{s} - \mathbf{R}_{\mathbf{t2c}} \cdot \mathbf{x}_\mathbf{r}|$$

$$\boldsymbol{x}^{\boldsymbol{s}}(t) = F(\mathbf{x}_\mathbf{0}^\mathbf{s}, \mathbf{v}_\mathbf{0}^\mathbf{s}, \mathbf{q}, t) + dx^s$$

- Double-differenced (DD) ambiguity resolution

$$\lambda \cdot \nabla\Delta N_{r1,r2}^{s1,s2} = \lambda_1 \cdot \nabla\Delta NL_{r1,r2}^{s1,s2} - \lambda_{WL} \cdot \nabla\Delta WL_{r1,r2}^{s1,s2}$$