

Combination of IGS Real-Time Global Ionospheric Maps at CAS: Method and Analysis

Ningbo WANG^{*1}, Yan ZHANG¹, Zishen LI¹, Ang LIU¹, Ang LI¹, Andrzej Krankowski²

1 Aerospace Information Research Institute (AIR), Chinese Academy of Sciences (CAS)

2 Space Radio-Diagnostics Research Center (SRRC), University of Warmia and Mazury in Olsztyn

[*wangningbo@aoe.ac.cn](mailto:wangningbo@aoe.ac.cn)



- ▶ SSR correction transmission via Ntrip portal
- ▶ Supporting [RTCM-SSR](#) and [IGS-SSR](#) (Orbits, Clock offsets, URA, Code/Phase Biases, Global Ionosphere, Ionospheric Quality Indicator)
- ▶ Supporting GPS, BDS-2/3, GLONASS and Galileo constellations
- ▶ Supporting all trackable signals (IGS-MGEX network)
- ▶ CAS server: cas-ip.gipp.org.cn, port: 2101 (**L1 phase center**)
- ▶ IGS server: products.igs-ip.net, port: 2001 (**L1 phase center**)
- ▶ Mountpoints: [SSRA00CAS1](#) (IGS-SSR), [SSRC00CAS1](#) (IGS-SSR),
[SSRA00CAS0](#) (RTCM-SSR), [SSRC00CAS0](#) (RTCM-SSR)

Overview of RT-GIMs provided by different ACs

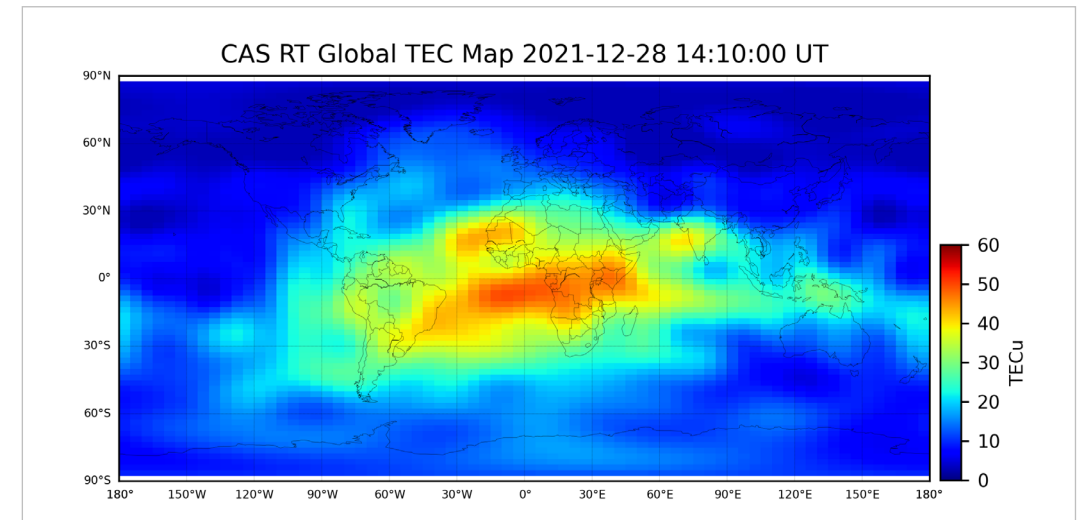
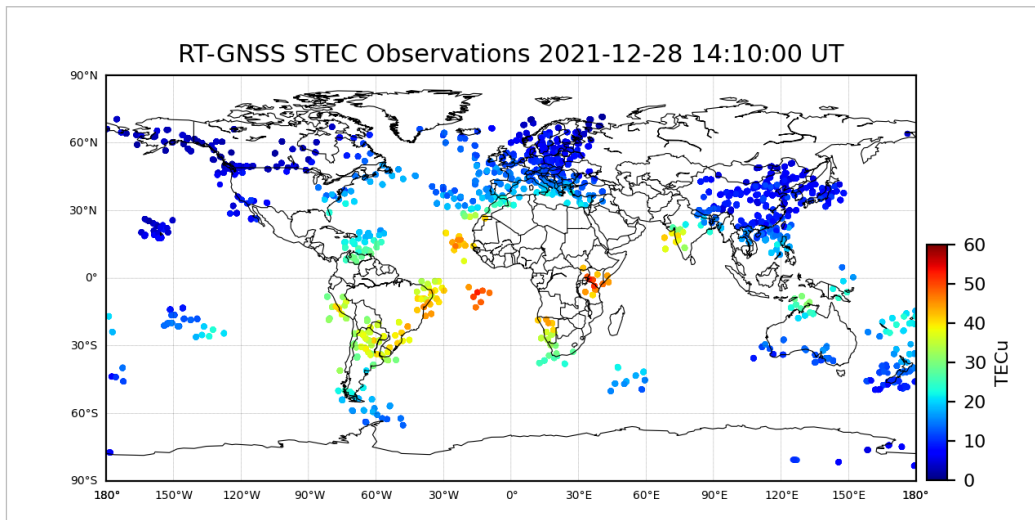
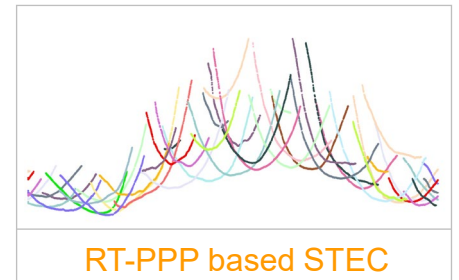
AC	Caster	Mountpoint	Interval
CAS*	products.igs-ip.net:2101	SSRA00CAS0, SSRC00CAS0 (RTCM-SSR) SSRA00CAS1, SSRC00CAS1 (IGS-SSR)	60s
CNES	products.igs-ip.net:2101	SSRA00CNE0, SSRC00CNE0 (RTCM-SSR) SSRA00CNE1, SSRC00CNE1 (IGS-SSR)	60s
UPC	products.igs-ip.net:2101	IONO00UPC1 (IGS-SSR)	15s
WHU	58.49.94.212:2101	IONO00WHU0 (RTCM-SSR)	60s
NRCan**	rt.cacsa.nrcan.gc.ca:12107	IONO00NRC0 (RTCM-SSR)	30s

* CAS RT-iono streams with quality indicators are also accessible from cas-ip.gipp.org.cn:2101 (IONO*)

** NRCan RT-iono streams are NOT openly accessible to public by now

CAS RT-GIM Computation using IGS-RTS

- ▶ A predicting-plus-modeling approach was applied for RT-GIM generation since 2017
- ▶ Extraction of RT ionospheric observables: carrier-to-code leveling (CCL, G+R+E+C)
- ▶ Handling of satellite and receiver DCBs: pre-estimated, 3-day solution
- ▶ Global ionospheric VTEC modeling: SH expansion up to degrees 15
- ▶ RT ionospheric STEC observations: transferring from CCL to **PPP-based solution**

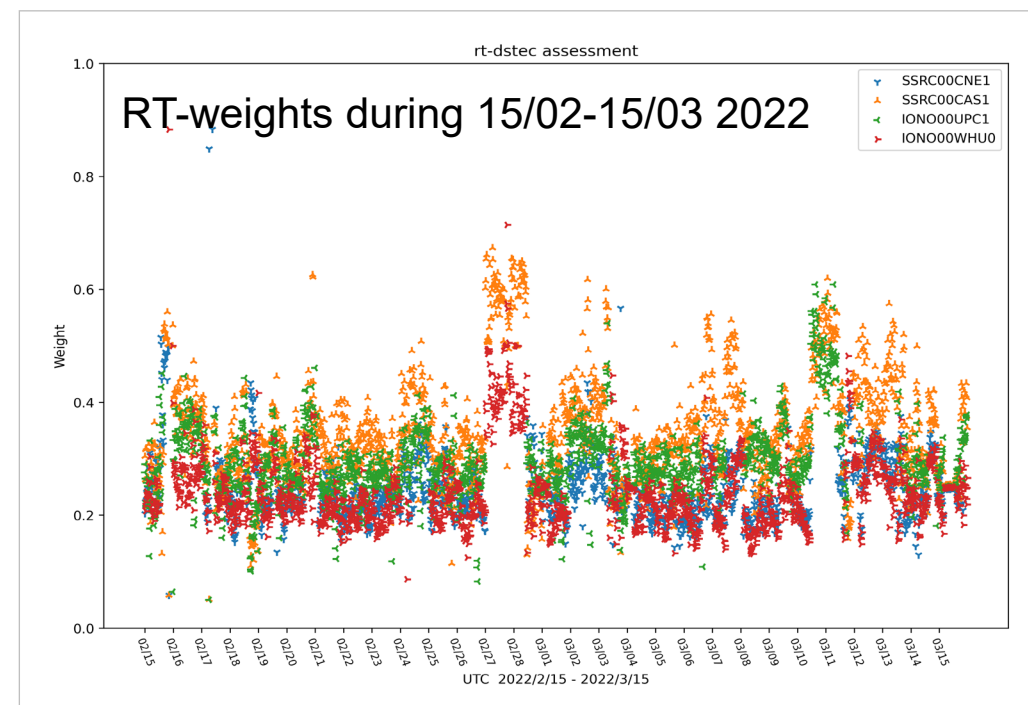
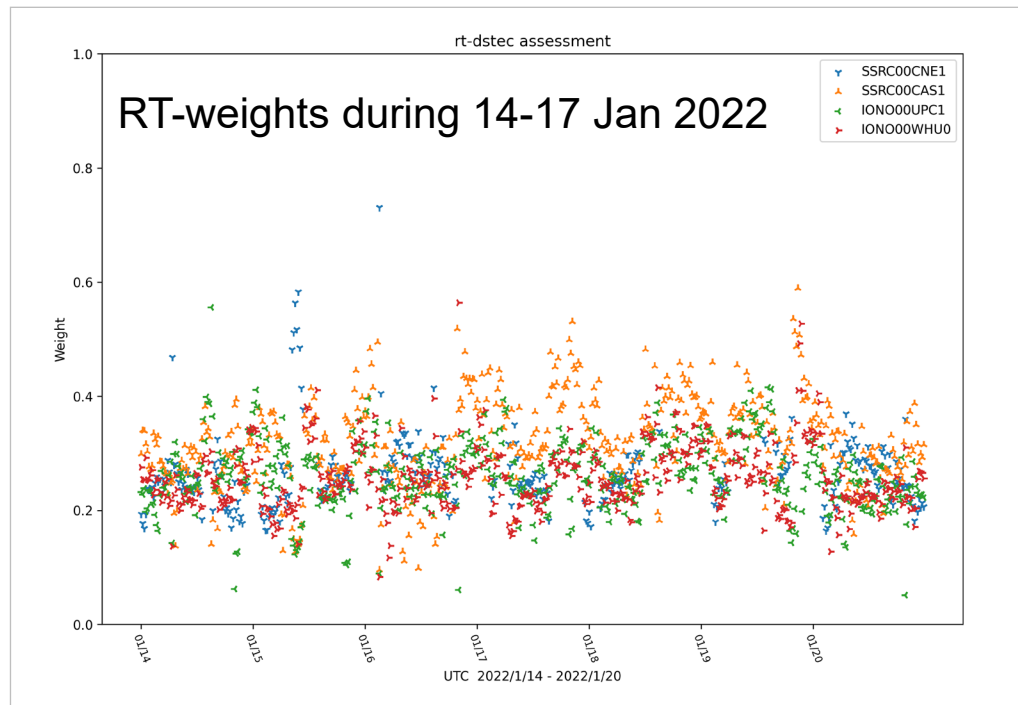


Overview of RT ionospheric streams used for CAS RT-GIM combination

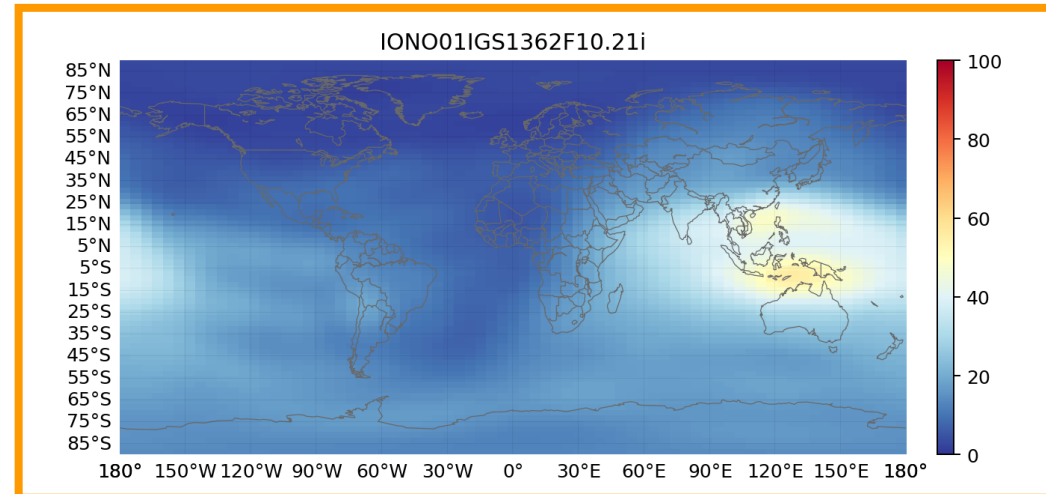
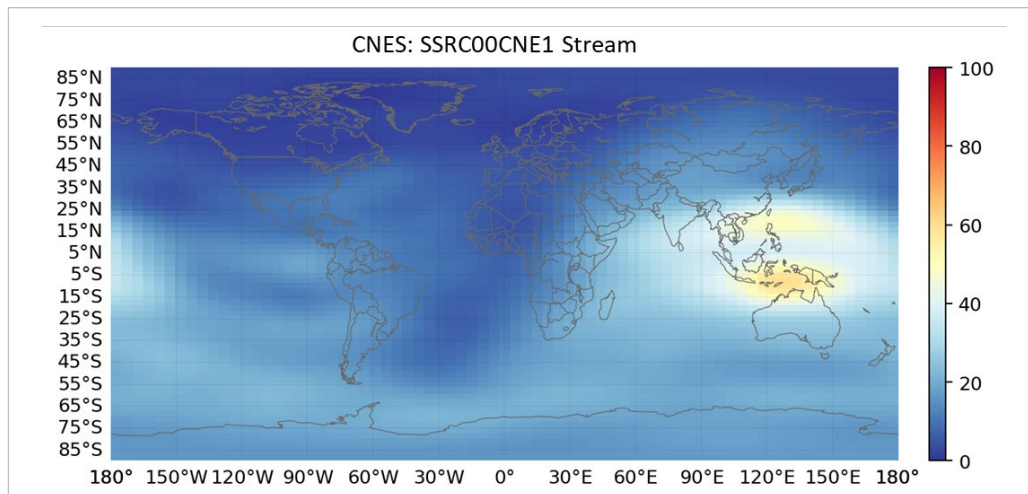
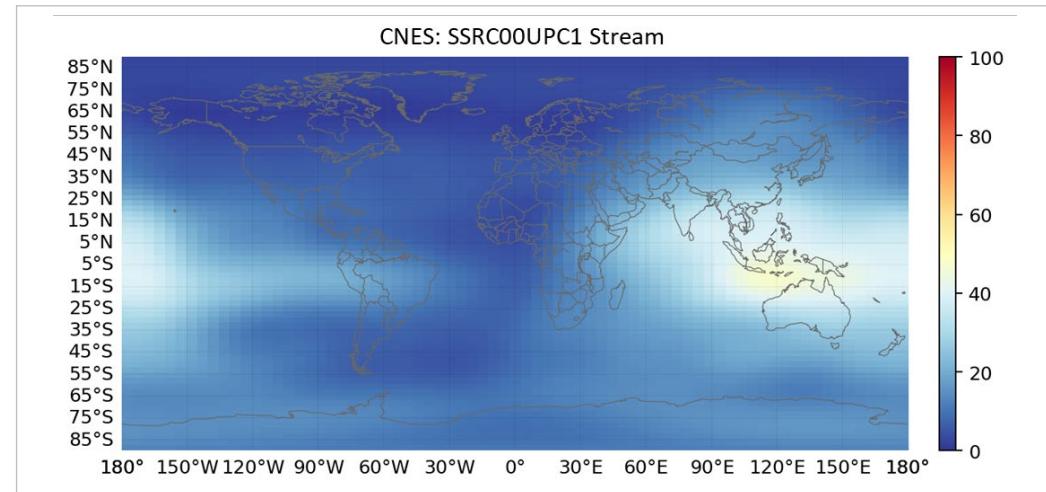
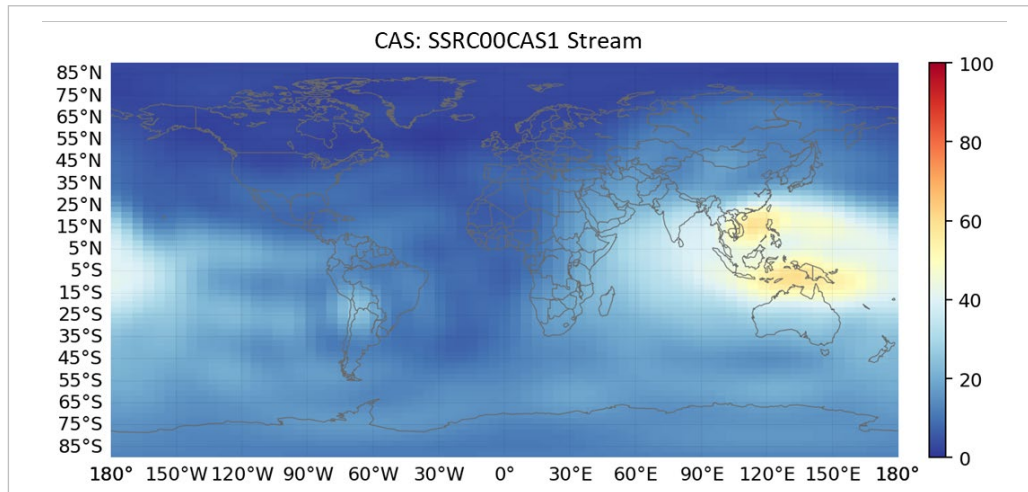
AC	Caster	Mountpoint	Interval
CAS	products.igs-ip.net:2101	SSRC00CAS1 (IGS-SSR)	60s
CNES	products.igs-ip.net:2101	SSRC00CNE1 (IGS-SSR)	60s
UPC	products.igs-ip.net:2101	IONO00UPC1 (IGS-SSR)	15s
WHU	58.49.94.212:2101	IONO00WHU0 (RTCM-SSR)	60s
UPC-combined	products.igs-ip.net:2101	IONO00IGS0 (IGS-SSR)	15s
CAS-combined*	products.igs-ip.net:2101	IONO01IGS0 (RTCM-SSR)	60s
		IONO01IGS0 (IGS-SSR)	

* CAS combined RT-GIMs are also accessible from CAS caster cas-ip.gipp.org.cn:2101

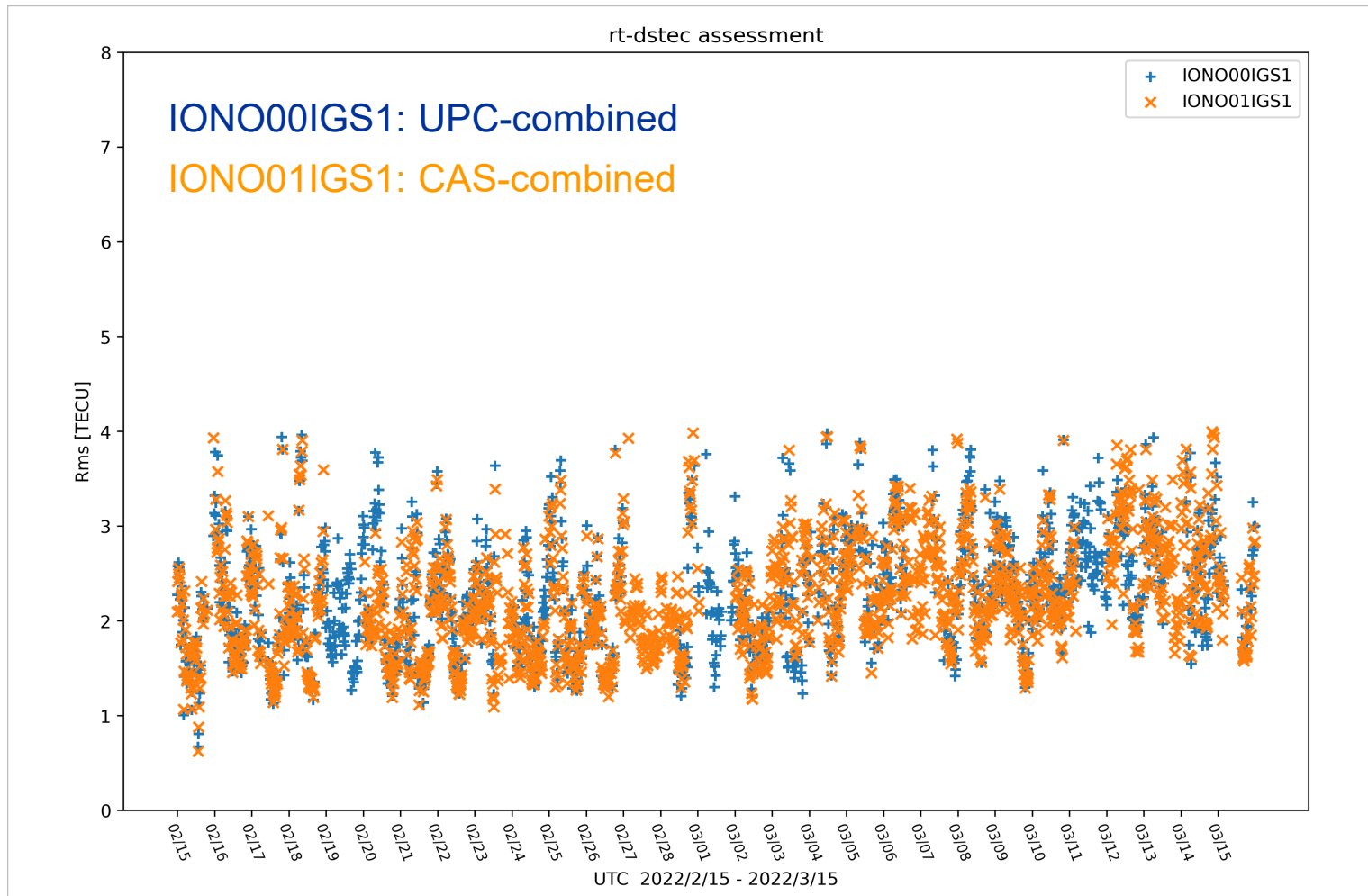
- ▶ Input streams: SSRC00CAS1, SSRC00CNE1, IONO00UPC1 and IONO00WHU0
- ▶ RT-combination strategy: a time-varying RT-GNSS dSTEC analysis method
- ▶ Station network for RT-GIM weighting: 30-35 stations, G(L1/L2)+E(E1/E5a)+C(B1/B3)
- ▶ Generated streams: IONO01IGS0 (RTCM-SSR) + IONO01IGS1 (IGS-SSR)



Snapshot of CAS-combined RT-GIM

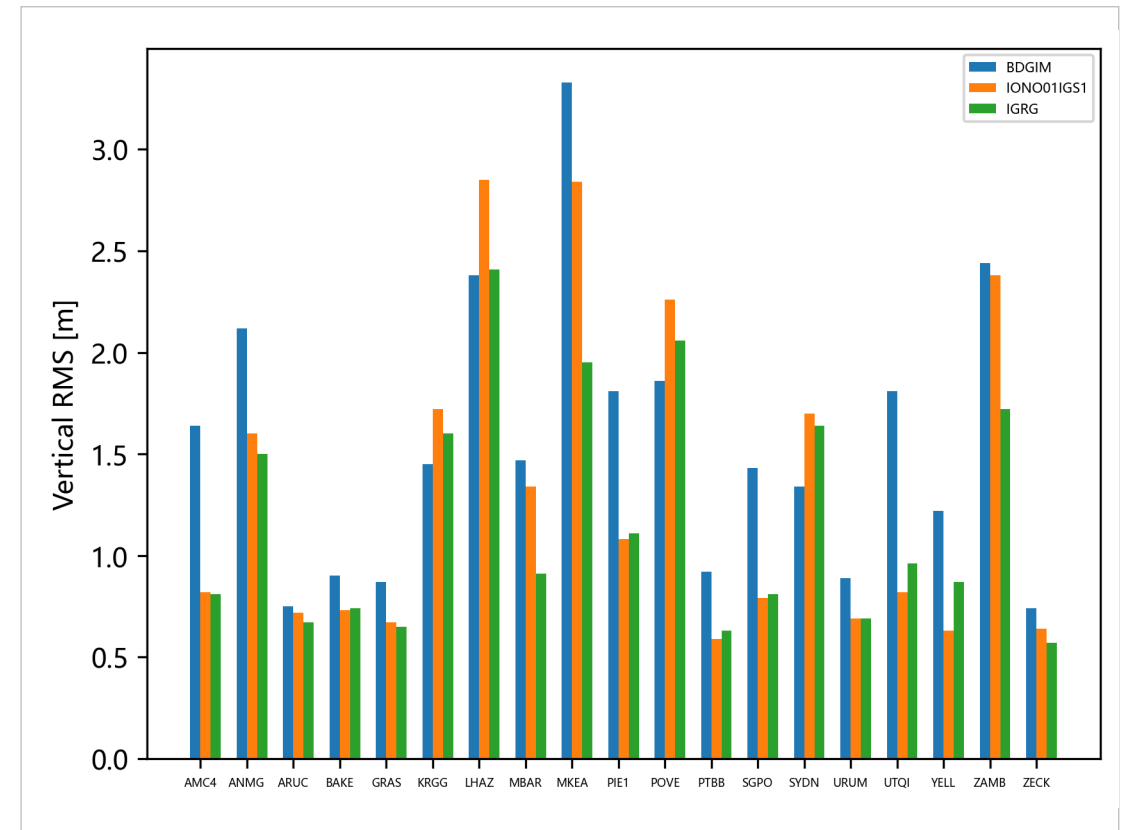
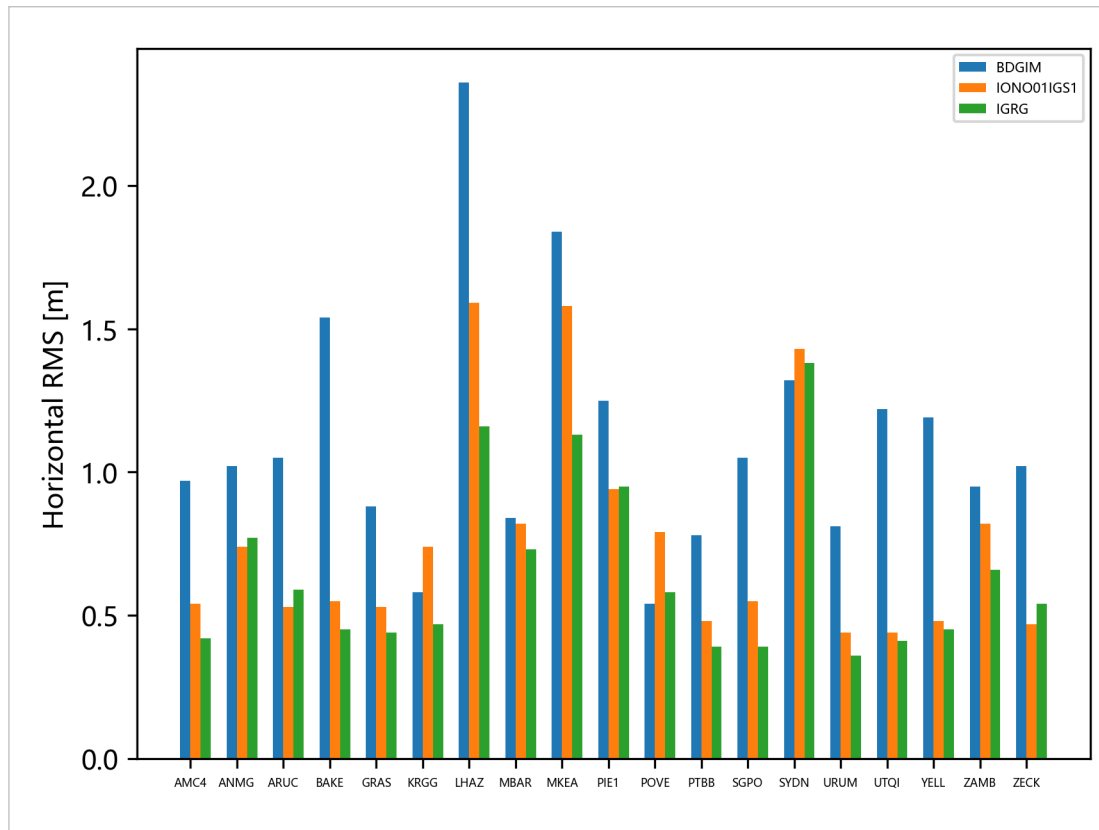


RT-dSTEC Analysis: Comparison b.w.t CAS- and UPC-combined RT-GIMs

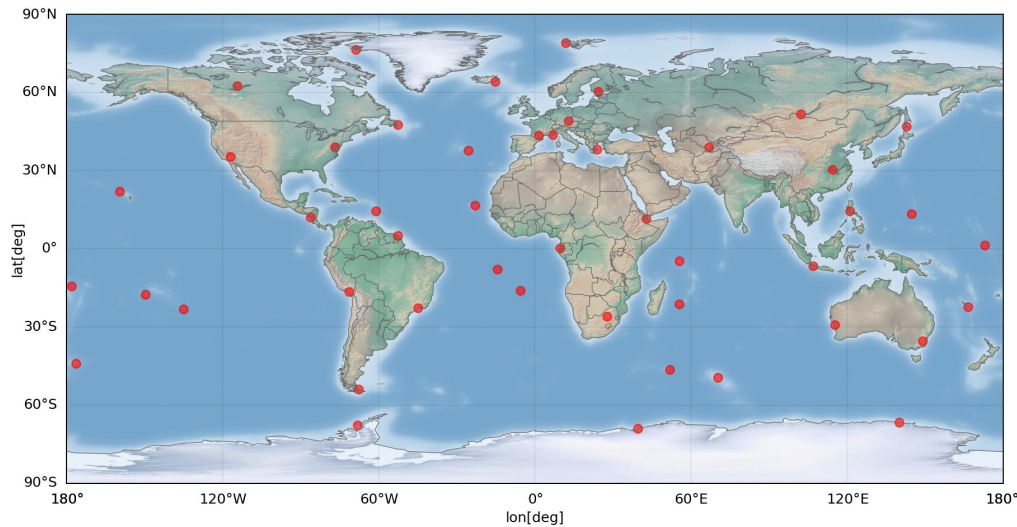


SF-PPP Analysis: Comparison b.w.t. BDGIM, IGRG and RT-GIM

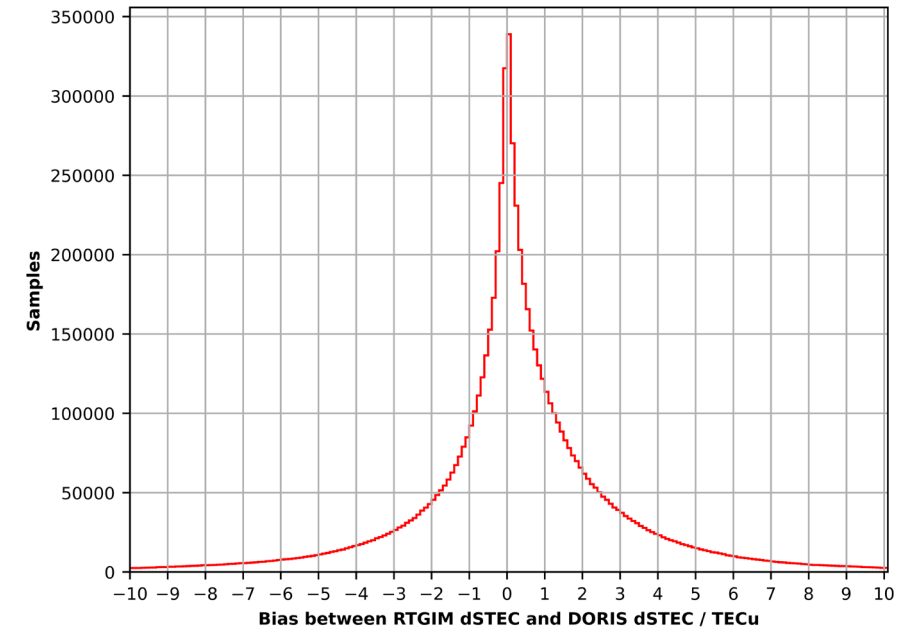
- ▶ **BDGIM**: BDS-3 global broadcast ionospheric model
- ▶ **igr**: IGS rapid-GIM, **IONO01IGS1**: CAS-combined RT-GIM



DORIS dSTEC Analysis: Jason-3 NRT DORIS Data

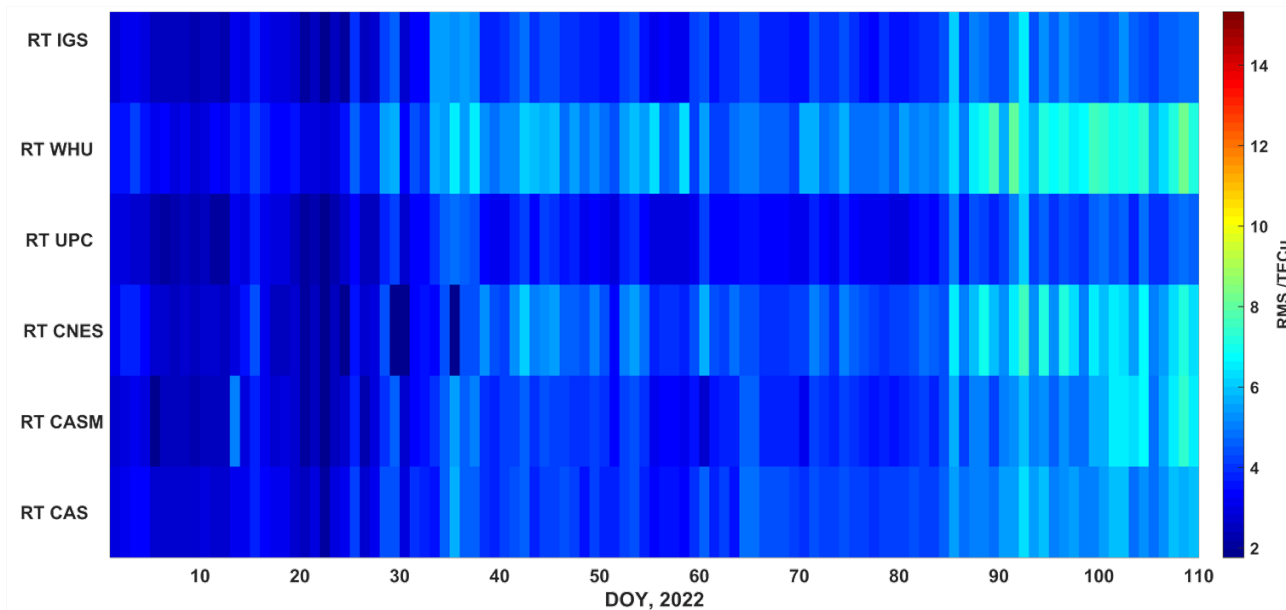


Selected DORIS beacons and co-located IGS stations

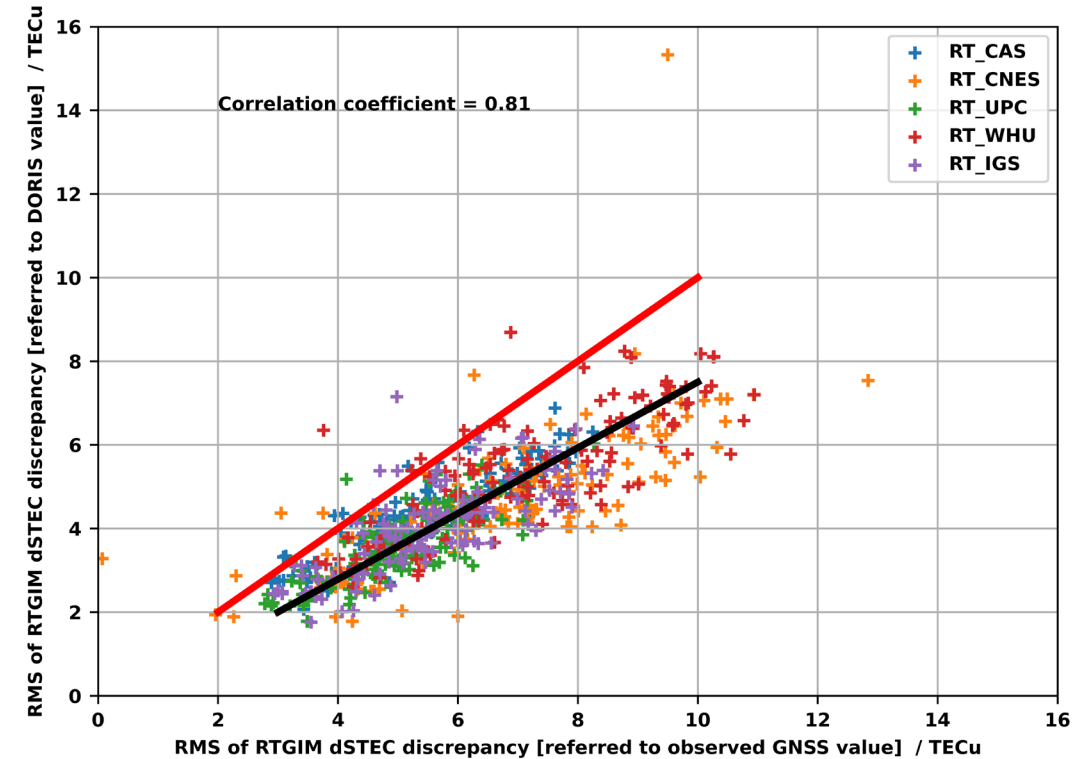


Bias distribution btw RT-GIM dSTEC and DORIS-dSTEC

DORIS dSTEC Analysis: Jason-3 NRT DORIS Data



RMS series w.r.t. DORIS dSTEC



Consistency bwt DORIS & GNSS dSTEC assessment

- ▶ **CASM**: CAS combined RT-GIM
- ▶ **RT-CAS**: CAS generated RT-GIM

- ▶ CAS combined IGS RT-GIM was officially **available from the IGS-RTS** since January 2022
products.igs-ip.net:2101 IONO01IGS0 (RTCM-SSR) & IONO01IGS1 (IGS-SSR)
- ▶ Continued **validation of CAS combined RT-GIMs** with multi-source data
GNSS-dSTEC
DORIS-dSTEC
GNSS SF-PPP
- ▶ CAS combined RT-GIM is open to public, please feel free to contact
wangningbo@aoe.ac.cn (Ningbo WANG)