

GNSS Precise Point Positioning Workshop

Multiple Constellation PPP with RTKLIB v.2.4.2

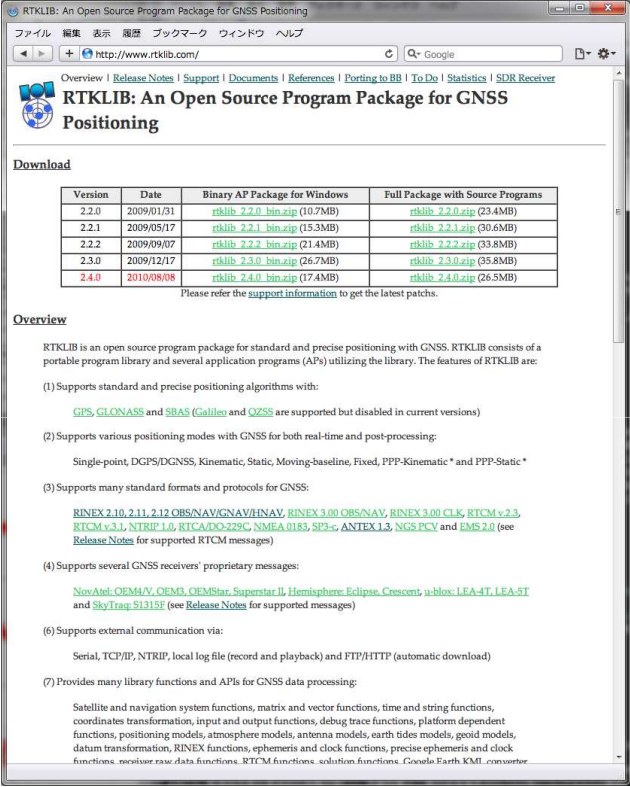
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RTKLIB

- **An Open Source Program Package for GNSS Positioning**
 - Has been developed since 2006
 - The latest version 2.4.2 is distributed under BSD license
- **Portable APIs and Useful APs**
 - "All-in-one" package for Windows
 - CLI APs for any environments



The screenshot shows the RTKLIB website with a navigation menu and a 'Download' section containing a table of versions. Below the table is an 'Overview' section with detailed features.

Version	Date	Binary AP Package for Windows	Full Package with Source Programs
2.2.0	2009/01/31	rtklib_2.2.0_bin.zip (10.7MB)	rtklib_2.2.0.zip (23.4MB)
2.2.1	2009/05/17	rtklib_2.2.1_bin.zip (15.3MB)	rtklib_2.2.1.zip (30.6MB)
2.2.2	2009/09/07	rtklib_2.2.2_bin.zip (21.4MB)	rtklib_2.2.2.zip (33.8MB)
2.3.0	2009/12/17	rtklib_2.3.0_bin.zip (26.7MB)	rtklib_2.3.0.zip (35.8MB)
2.4.0	2010/08/08	rtklib_2.4.0_bin.zip (17.4MB)	rtklib_2.4.0.zip (26.5MB)

Please refer the [support information](#) to get the latest patches.

Overview

RTKLIB is an open source program package for standard and precise positioning with GNSS. RTKLIB consists of a portable program library and several application programs (APs) utilizing the library. The features of RTKLIB are:

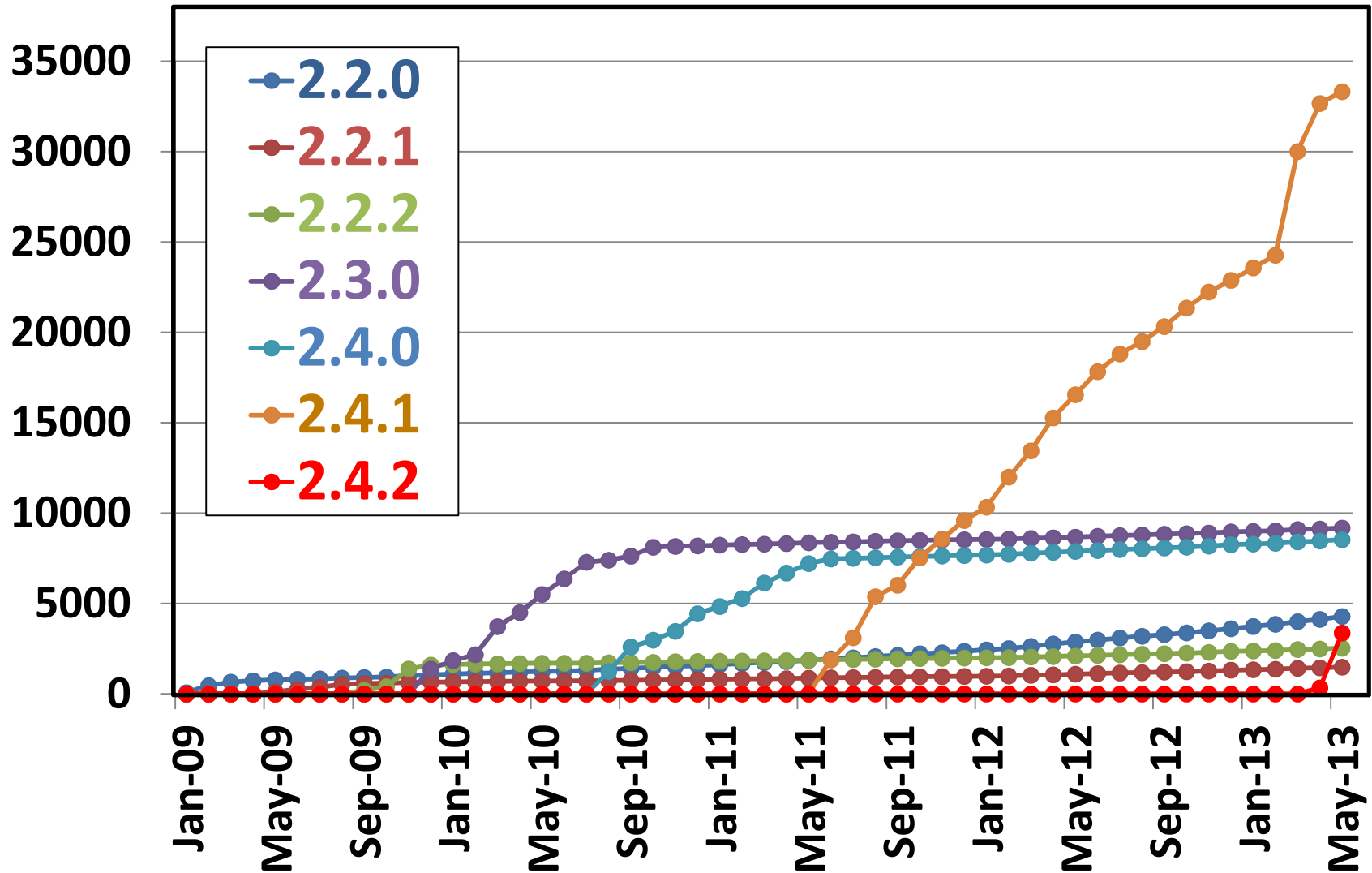
- (1) Supports standard and precise positioning algorithms with:
[GPS](#), [GLONASS](#) and [SBAS \(Galileo\)](#) and [QZSS](#) are supported but disabled in current versions
- (2) Supports various positioning modes with GNSS for both real-time and post-processing:
Single-point, DGPS/DGNSS, Kinematic, Static, Moving-baseline, Fixed, PPP-Kinematic * and PPP-Static *
- (3) Supports many standard formats and protocols for GNSS:
[RINEX 2.10_2.11](#), [2.12 OBS/NAV/IONO/HRNAV](#), [RINEX 3.00 OBS/NAV](#), [RINEX 3.00 CLK](#), [RTCM v2.3](#), [RTCM v3.1](#), [NTRIP 1.0](#), [RTCA/DO-228C](#), [NMEA 0183](#), [519-c](#), [ANTEX 1.3](#), [NGS-PCV](#) and [IMS 2.0](#) (see [Release Notes](#) for supported RTCM messages)
- (4) Supports several GNSS receivers' proprietary messages:
[NovAtel OEM4V](#), [OEM3](#), [OEMStar](#), [Superstar II](#), [Hemisphere Eclipse](#), [Crescent](#), [ublox](#): [LEA-4T](#), [LEA-5T](#) and [SkyTrag S131SE](#) (see [Release Notes](#) for supported messages)
- (6) Supports external communication via:
Serial, TCP/IP, NTRIP, local log file (record and playback) and FTP/HTTP (automatic download)
- (7) Provides many library functions and APIs for GNSS data processing:
Satellite and navigation system functions, matrix and vector functions, time and string functions, coordinates transformation, input and output functions, debug trace functions, platform dependent functions, positioning models, atmosphere models, antenna models, earth tides models, geoid models, datum transformation, RINEX functions, ephemeris and clock functions, precise ephemeris and clock functions, receiver raw data functions, RTCM functions, solution functions, Google Earth KML converter

<http://www.rtklib.com> or
<https://github.com/tomojitakasu/RTKLIB>

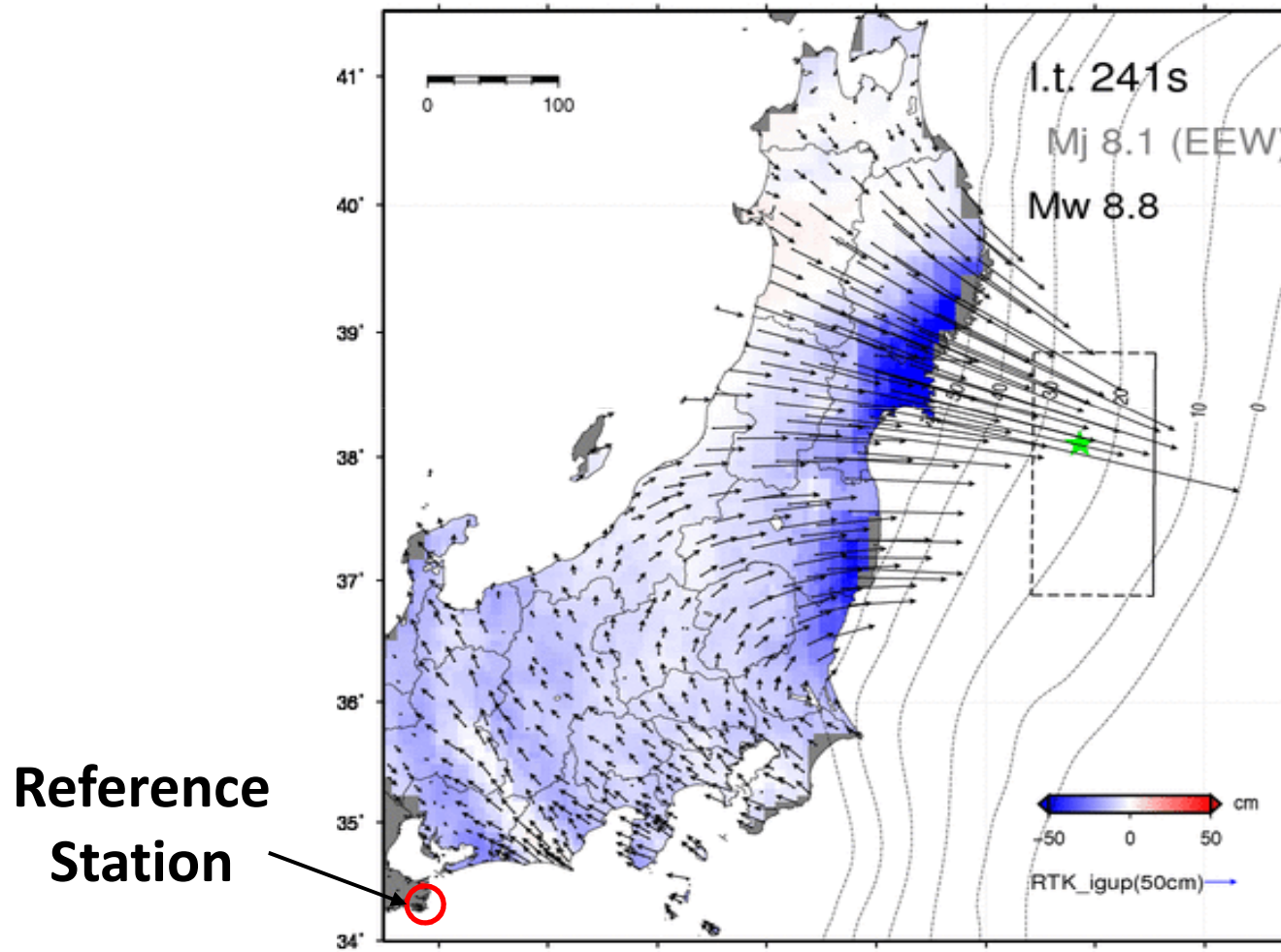
RTKLIB: Features

- **Standard and precise positioning algorithms with:**
 - GPS, GLONASS, QZSS, Galileo, BeiDou and SBAS
- **Real-time and post-processing by various modes:**
 - Single, SBAS, DGPS, RTK, Static, Moving-base and PPP
- **Supports many formats/protocols and receivers:**
 - RINEX 2/3, RTCM 2/3, BINEX, NTRIP 1.0, NMEA0183, SP3, RINEX CLK, ANTEX, NGS PCV, IONEX, RTCA-DO-229, EMS,
 - NovAtel, JAVAD, Hemisphere, u-blox, SkyTraq, NVS, ...
- **Supports real-time communication via:**
 - Serial, TCP/IP, NTRIP and file streams

of Downloads



Application of RTKLIB



Y. Ohta et al., Quasi real-time fault model estimation for near-field tsunami forecasting base on RTK-GPS analysis: Application to the 2011 Tohoku-Oki earthquake (Mw 9.0), JGR-solid earth, 2012

RTK vs. PPP

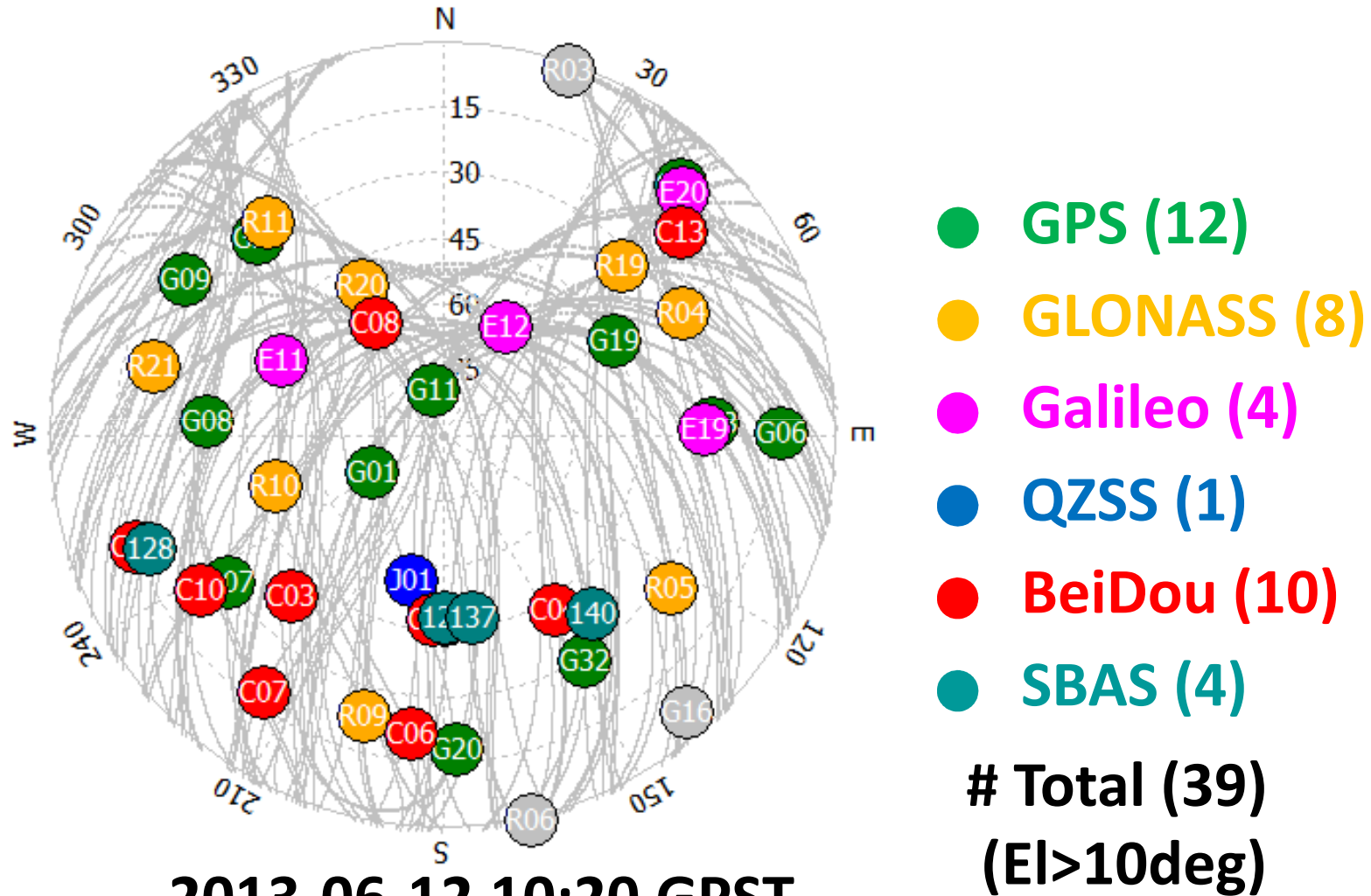
	RTK	Real-Time PPP
Coverage	Local/Regional ($< 1000\text{km}$)	Global
Typical Accuracy	1-3 cm HRMS	2-10 cm, much depending on orbit/clock quality
Effect of Ref Movement	Hard to separate ref and user movement	Less effect by distributed ref stations
System Complexity	Simple, at least one ref station	Complicated, need many ref stations
Latency of Corrections	$\sim 1\text{ s}$	5 \sim 25 s
Biases	Basically cancelled by DD	Need careful handling

Which is better depends on AP requirement and technology level. RTKLIB offers both. They are user-selectable by option settings.

New Features by v.2.4.2

- **Galileo and BeiDou supported**
- **Full RINEX 3 compliant, multi-signal supported**
- **RTCM 3.2 MSM and SSR for all GNSSs supported**
- **BINEX, NovAtel OEM6 and NVS supported**
- **Google Earth/Map View by RTKPLOT**
- **Satellite visibility analysis with NORAD TLE**
- **Data downloader AP: RTKGET added**
- **Data format conversion by STRSVR or STR2STR**
- **License Change: GPL v3 -> BSD 2-clause**

Multi-Constellation GNSS



2013-06-12 10:20 GPST
Visibility at Tokyo by RTKPLOT

RINEX Support

Ver.	OBS Data						NAV Messages						Met	CLK	GEO BRDC
	G	R	E	J	C	S	G	R	E	J	C	S			
2.10	O	O	O	O	O	O	N	G	N	N	-	H	-	-	-
2.11	O	O	O	O	O	O	N	G	N	N	-	H	-	-	-
2.12	O	O	O	O	O	O	N	G	N	N	-	H	-	-	-
3.00	O	O	O	O	O	O	N	N	N	N	N	N	-	C	-
3.01	O	O	O	O	O	O	N	N	N	N	N	N	-	C	-
3.02*	O	O	O	O	O	O	N	N	N	N	N	N	-	C	-

G: GPS, R: GLONASS, E: Galileo, J: QZSS, C: BeiDou, S: SBAS

* Based on draft (2012-12), O/N: RTKLIB Extension

RTCM 3 Support

Message	GPS	GLOASS	Galileo	QZSS	BeiDou	SBAS
OBS Compact L1	1001~	1009~	-	-	-	-
Full L1	1002	1010	-	-	-	-
Compact L1/2	1003~	1011~	-	-	-	-
Full L1/2	1004	1012	-	-	-	-
Ephemeris	1019	1020	1045/6*	1044*	-	-
MSM 1	1071~	1081~	1091~	1111*~	1121*~	1101*~
2	1072~	1082~	1092~	1112*~	1122*~	1102*~
3	1073~	1083~	1093~	1113*~	1123*~	1103*~
4	1074	1084	1094	1114*	1124*	1104*
5	1075	1085	1095	1115*	1125*	1105*
6	1076	1086	1096	1116*	1126*	1106*
7	1077	1087	1097	1117*	1127*	1107*
SSR Orbit Corr.	1057	1063	1240*	1246*	-	-
Clock Corr.	1058	1064	1241*	1247*	-	-
Code Bias	1059	1065	1242*	1248*	-	-
Combined	1060	1066	1243*	1249*	-	-
URA	1061	1067	1244*	1250*	-	-
HR-Clock	1062	1068	1245*	1251*	-	-
Antenna Info	1005	1006	1007	1008	1033	

* based on draft, ~ only encode

PPP Models in v.2.4.2

	v.2.4.1	v.2.4.2
Satellites	GPS, GLO and QZS	GPS, GLO, QZS and GAL
Troposphere	Standard-Atmosphere NMF + Gradient	Standard or GPT NMF or GMF + Gradient
Ionosphere	Iono-Free LC (L1-L2)	Iono-Free LC (L1-L2, L1-L5) or IONEX for single-freq
Tidal Displacement	Solid Earth Tide: IERS 1996 Step 1 + Step 2 K1 radial only	Solid Earth Tide: IERS DEHANTTIDEINEL.F Ocean Tide Loading: IERS 2010 with BLQ Pole Tide: IERS 2010 with IGS ERP
Ambiguity Resolution	No (FLOAT)	Yes with CNES Products (Experimental)

PPP Demos

- **Post-Processing PPP:**
 - GPS and GLONASS
 - Orbit/Clock: MADOCA Rapid Products
 - Interval: 30 s
 - PPP kinematic mode
- **Real-Time PPP:**
 - GPS (no GLONASS)
 - Orbit/Clock: IGS RT Orbit/Clock
 - Interval: 1 s
 - PPP kinematic mode

Future Plans

- **RTKLIB v.2.4.3, ...**
 - Fixing bugs
 - Full BeiDou support for all modes
 - Compliant to finalized versions of standard formats
 - API Reference Manual.
- **RTKLIB v.2.5.0 in 2015 (?)**
 - Implementing newer features
 - Full Support for PPP-AR
 - Real-Time PPP service by QZSS LEX/L6b (?)
 - ...

Summary

- Introduction of RTKLIB
- Multiple-Constellation Support by v.2.4.2
- PPP Demos by v.2.4.2
- Future Plans

**<http://www.rtklib.com> or
<https://github.com/tomojitakasu/RTKLIB>**

I greatly appreciate your feedback. It will be very helpful to improve RTKLIB.