

PPP-RTK & Open Standards Symposium

# PPP Ambiguity Resolution Implementation in RTKLIB v 2.4.2

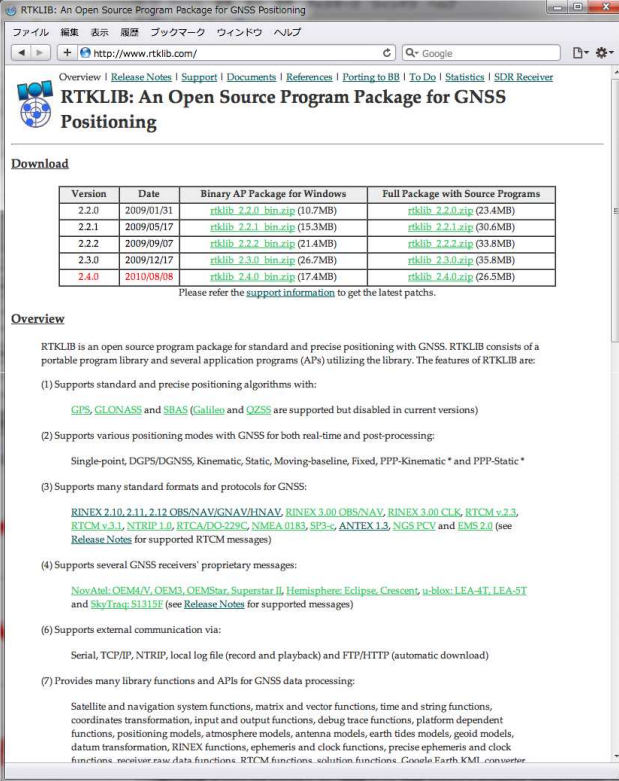
 Tokyo Univ. of Marine Science and Technology

**Tomoji TAKASU**

March 12-13, 14, 2012, @Frankfurt am Main, Germany

# RTKLIB

- **An Open Source Program Package for GNSS Positioning**
  - Distributed under GPLv3 license
  - Has been developed by the author since 2006
- **Portable Library + Several APs**
  - "All-in-one" package for Windows
  - Portable CUI APs on 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	<a href="#">rtklib_2.2.0_bin.zip</a> (10.7MB)	<a href="#">rtklib_2.2.0.zip</a> (23.4MB)
2.2.1	2009/05/17	<a href="#">rtklib_2.2.1_bin.zip</a> (15.3MB)	<a href="#">rtklib_2.2.1.zip</a> (30.6MB)
2.2.2	2009/09/07	<a href="#">rtklib_2.2.2_bin.zip</a> (21.4MB)	<a href="#">rtklib_2.2.2.zip</a> (33.8MB)
2.3.0	2009/12/17	<a href="#">rtklib_2.3.0_bin.zip</a> (26.7MB)	<a href="#">rtklib_2.3.0.zip</a> (35.8MB)
2.4.0	2010/08/08	<a href="#">rtklib_2.4.0_bin.zip</a> (27.4MB)	<a href="#">rtklib_2.4.0.zip</a> (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:

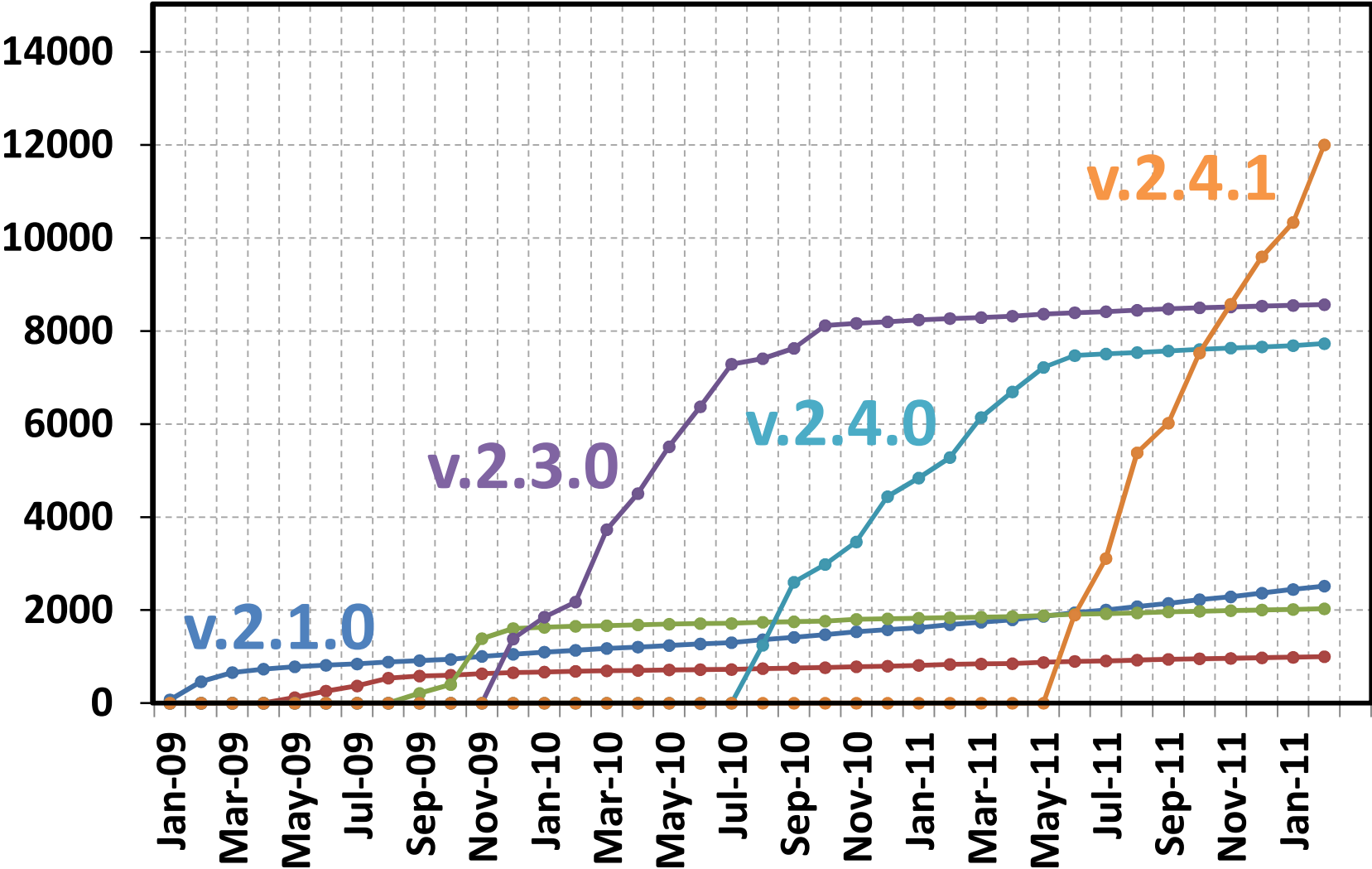
- (1) Supports standard and precise positioning algorithms with:  
[GPS](#), [GLONASS](#) and [SBAS](#) ([Galileo](#)) and [QZSS](#) are supported but disabled in current versions)
- (2) Supports various positioning modes with GNSS for both real-time and post-processing:  
Single-point, DGPS/DGNSS, Kinematic, 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/GNAV/HNAV, [RINEX 3.00](#) OBS/NAV, [RINEX 3.00 CLK](#), [RTCM v.2.3](#), [RTCM v.3.1](#), [NTRIP 1.0](#), [RTCA/DO-229C](#), [NMEA 0183](#), [SP3-s](#), [ANTEX 1.3](#), [NGS PCV](#) and [FMS 2.0](#) (see [Release Notes](#) for supported RTCM messages)
- (4) Supports several GNSS receivers' proprietary messages:  
[NovAtel OEM4/V](#), [OEM3](#), [OEMStar](#), [Superstar II](#), [Hemisphere](#), [Eclipse](#), [Crescent](#), [u-blox](#): [LEA-4T](#), [LEA-5T](#) and [SkyTraq S1315E](#) (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, [Crescent Earth KML converter](#)

<http://www.rtklib.com>

# RTKLIB: Features

- **Standard and precise positioning algorithms with:**
  - GPS, GLONASS, SBAS, QZSS, (Galileo)
- **Positioning mode for real-time and post-processing:**
  - Single, SBAS, DGPS, RTK, Static, Moving-base and PPP
- **Supports many formats/protocols and receivers:**
  - RINEX 2.x/3.0, RTCM v.2/v.3, NTRIP 1.0, NMEA0183, SP3, RINEX CLK, ANTEX, NGS PCV, IONEX, RTCA-DO-229, EMS, ...
  - NovAtel, JAVAD, Hemisphere, u-blox, SkyTraq, Furuno, ...
- **Supports real-time communication via:**
  - Serial, TCP/IP, NTRIP and file streams

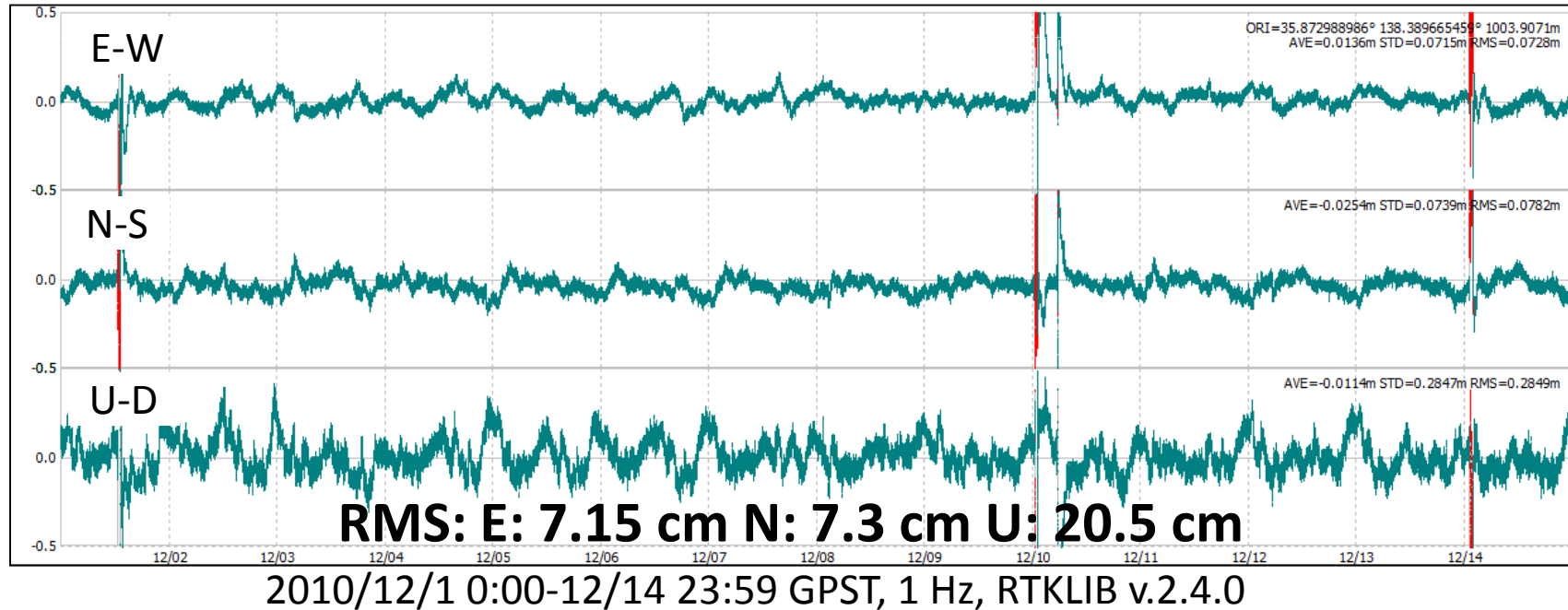
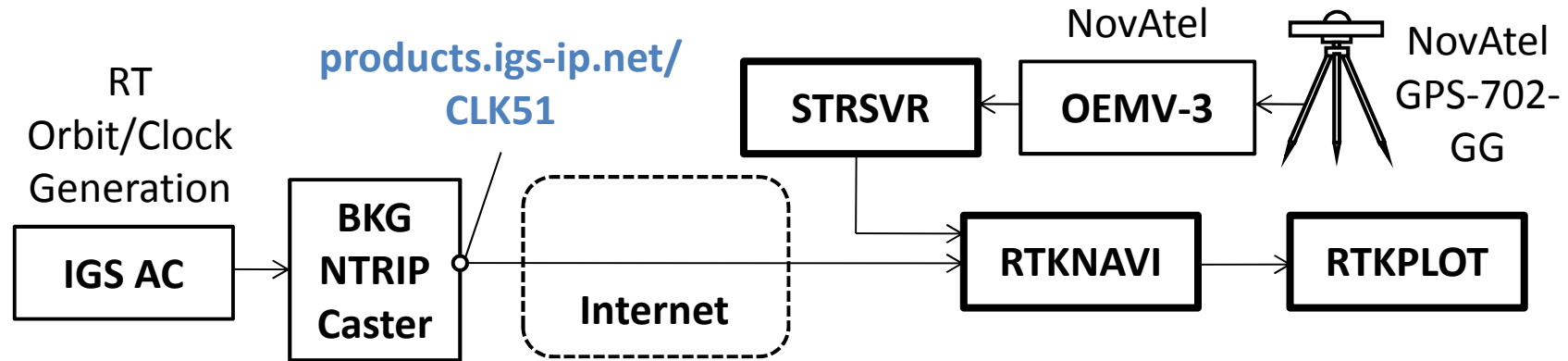
# RTKLIB: # of Downloads



# RTKLIB v.2.4.1

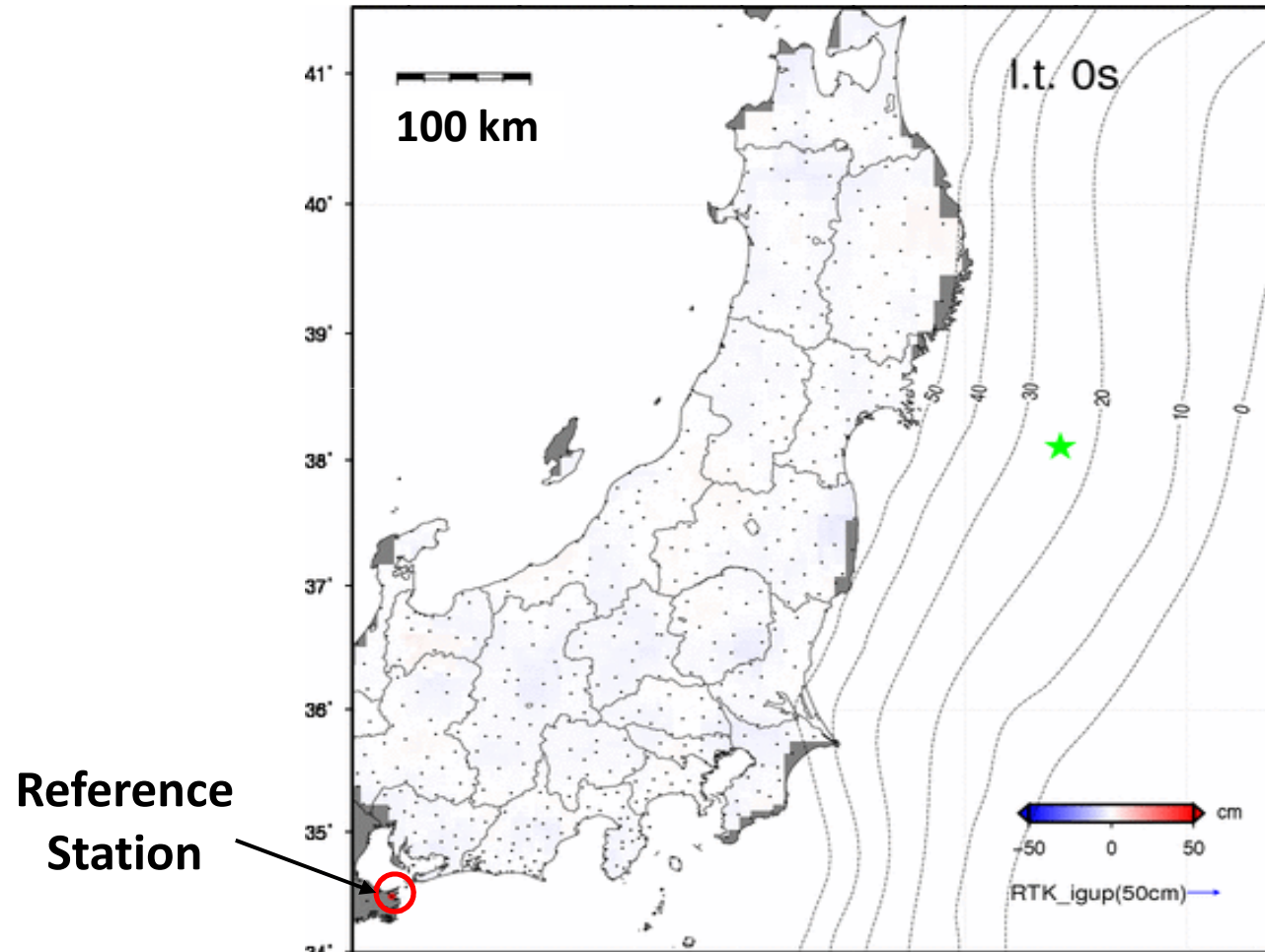
- **Released on June 11, 2011**
- **QZSS supported, Galileo enabled**
- **Real-time and post-processing PPP**
  - EPH/CLK: RTCM3 SSR (MT 1057-1068) for RT
  - EPH/CLK: SP3 and RINEX CLK for PP
- **Long-baseline RTK up to 1,000 km**
  - Auto-download of IGU ephemeris
  - Explicit STEC estimation by EKF without LC
  - AR by LAMBDA/MLAMBDA with "partial fixing"

# Real-time PPP with RT-IGS



# Long-Baseline RTK

2011-3-11 15:45 JST Tohoku-Oki Earthquake (Mw=9.0)



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

# RTKLIB v.2.4.2

- **Release in summer, 2012**
- **Support of Galileo**
  - RINEX 2 and 3, RTCM 3 ?
  - NovAtel OEM6, JAVAD GREIS
- **RTCM output and conversion**
- **RTCM MSM support (TBD)**
- **PPP model improvement**
- **GUI FTP tool for GNSS products/data**
- **License change: GPLv3 to BSD**



# PPP Models in v.2.4.2

	<b>v.2.4.1</b>	<b>v.2.4.2</b>
Satellites	GPS, GLO and QZS	GPS, GLO, QZS and GAL
Troposphere	Standard-Atmosphere NMF + Gradient	GPT NMF or GMF + Gradient
Ionosphere	Iono-Free LC (L1-L2)	Iono-Free LC (L1-L2, L1-L5) or STEC estimation (opt)
Tidal Displacement	Solid Earth Tide: IERS Step 1 + Step 2 K1 radial only	Solid Earth Tide: DEHANTTIDEINEL.F (opt) Ocean Tide Loading: IERS 2010 with BLQ Pole Tide: IERS 2010 with IGS ERP
Ambiguity Resolution	No (FLOAT)	Yes (opt)

# PPP-AR in v.2.4.2 (1/2)

- **Several ways depending on ephemeris/clock provider (server-side implementation)**
  - UPD or FCB, phase-clock, decoupled-clock, JPL, ...
  - User-side models need highly compatible to server-side: satellite yaw, phase windup, satellite PCV, DCB, ...
  - No standard
- **v.2.4.2 only supports phase-clock by CNES**
  - RINEX phase-clock with WL-bias for post-processing
  - RTCM SSR + extension for WL-bias for real-time
  - UPD by GFZ is still under consideration

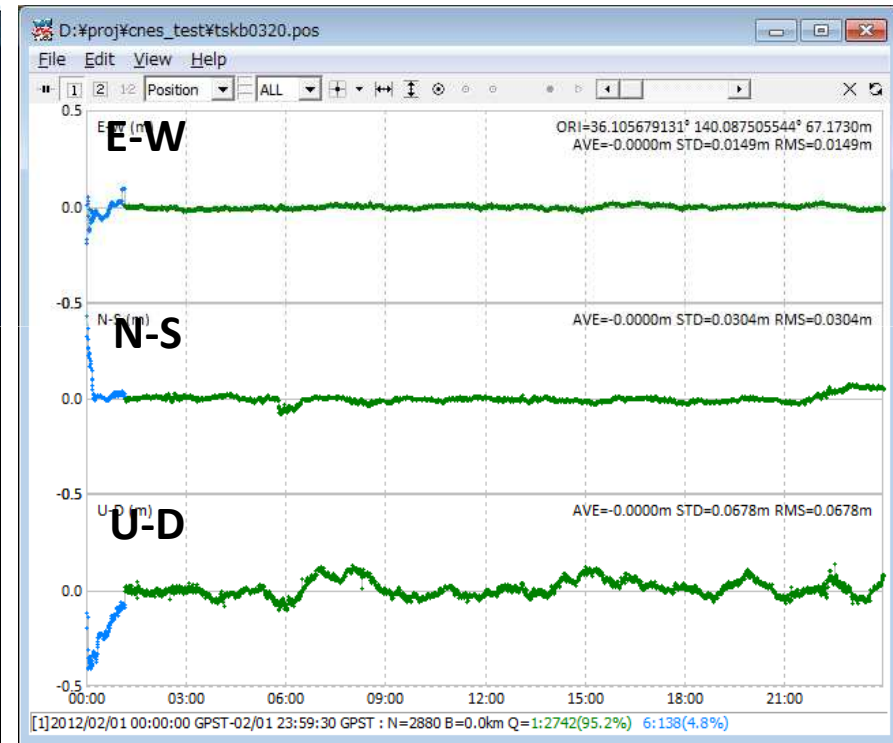
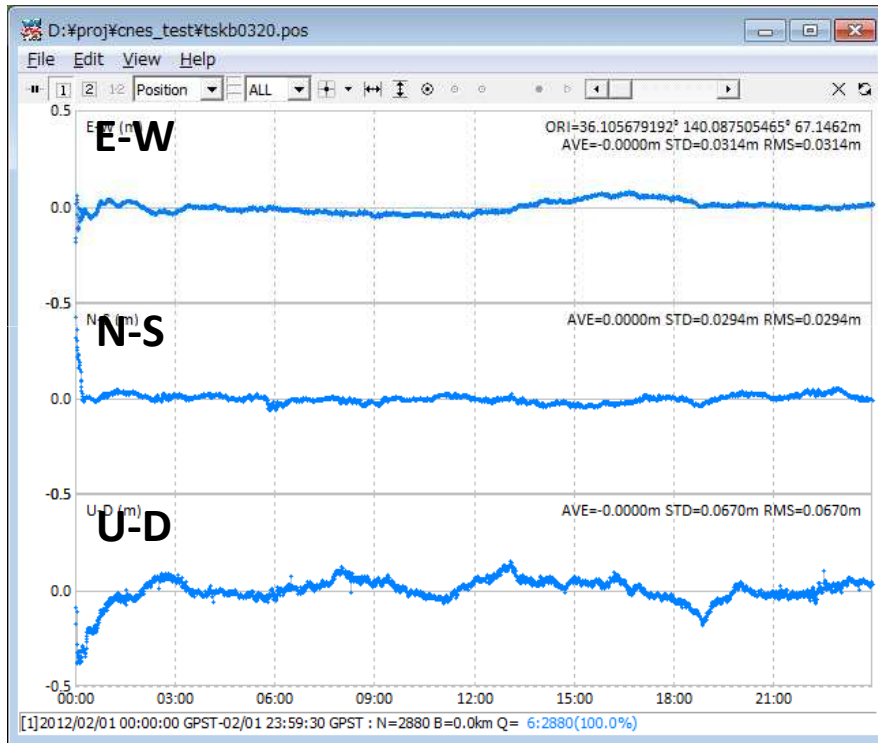
# PPP-AR in v.2.4.2 (2/2)

- **Conventional WL-LC/NL-rounding (implemented)**
  - Slow convergence
  - Validation threshold is sensitive to avoid miss-fix
- **ILS for LC/NL after WL-rounding**
  - Improved convergence (expected)
  - May be "partial-fixing" is necessary
  - Large noise due to iono-free LC
- **STEC estimation and ILS with partial fixing**
  - Basically the same as long-baseline RTK in v.2.4.1
  - Need separated UPD for L1 and L2

# WL-LC/NL-Rounding

FLOAT

FIXED



**RMS E: 3.05, N: 2.16, U: 6.30 cm**

**RMS E: 1.31 N: 2.09 U: 4.52 cm**

**IGS TSKB, 2011-2-1 0:00:00-23:59:30 GPST, by RTKPOST 2.4.2 beta**

**EPH/CLK: C2T16733.SP3 + C2T16733.CLK provided by CNES**

# JAXA Multi-GNSS PPP Project

- **Precise orbit/clock determination for real-time PPP**
  - GPS, GLONASS, QZSS and Galileo
- **RTKLIB (v.2.5.0?) will be used for PPP-client**
- **First phase for post-processing is finishing**
  - GPS <2 cm, GLO <5 cm, QZS <6 cm (3DRMS)
- **Second phase for real-time will start in April**
  - Latency and CPU power are still issues
  - GLONASS AR with receiver inter-channel bias estimation
- **JAXA requests PPP-AR involved ...**

# Summary

- **Introduction of RTKLIB**
- **RTKLIB v.2.4.1 Features**
- **RTKLIB v.2.4.2 Features**
- **PPP-AR in v.2.4.2**
- **JAXA Multi-GNSS PPP Project**