MADOCALIB ver.1.0b (beta ver.) Manual

QZSS Strategy Office, Cabinet Office

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Contents

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I Overview

This manual describes how to use the MADOCA-PPP* (Multi-GNSS Advanced Orbit and Clock Augmentation - Precise Point Positioning) test library called MADOCALIB. The purpose of distributing MADOCALIB is to facilitate the user algorithm implementation of MADOCA-PPP. MADOCALIB is constructed based on RTKLIB and functions of PPP-AR and message conversion copyrighted by the third party and provides RNX2RTKP.

RNX2RTKP is a utility for post-process positioning. It implements a processing mode called PPP (Precise Point Positioning) to make use of MADOCALIB. In this processing mode, the following functions are added to RTKLIB ver.2.4.3b34:

- To use the Galileo E1-E5a signal for PPP calculation
- To read the Compact SSR message of MADOCA-PPP
- To select GNSSs to be used for PPP calculation, and
- To select frequencies to be used for PPP calculation for each GNSS

Users can refer to its output as a reference to achieve the performance criteria of MADOCA-PPP.

MADOCALIB also has a processing mode called PPP-AR (Precise Point Positioning-Ambiguity Resolution). Please note that the performance of MADOCA-PPP with the PPP-AR method is currently not defined in the specification documents but the PPP-AR mode will be continuously improved with the expectation of better performance than the PPP mode.

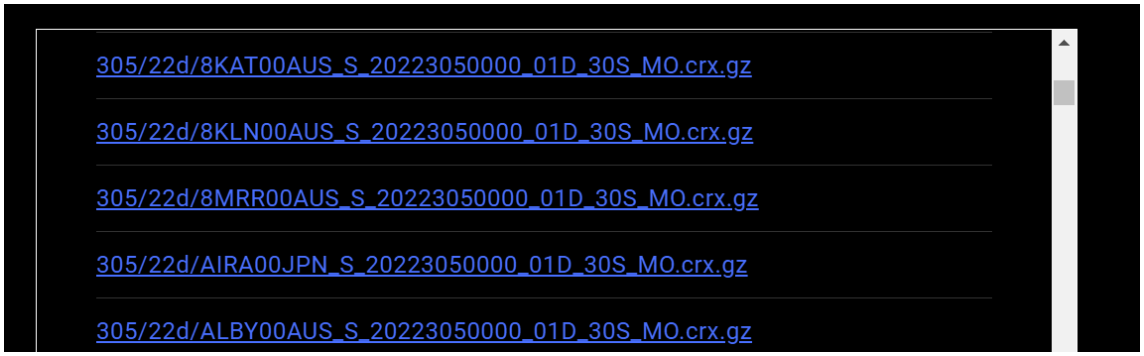
* Trial service since Sep. 30 2022

II Usage of Utilities

To run the MADOCALIB the following files are required.

a) RINEX OBS and NAV
b) ATX file (.atx)
c) QZSS L6 correction data (.l6)
d) Configuration file (.conf)

1． The RINEX OBS and NAV data can be downloaded from the following MIRAI's URL.
https://go.gnss.go.jp/mirai/miraiarchive/



RINEX OBS files are saved in Compact RINEX format, so converting them to RINEX v3 is required. The RNXCMP (a tool that converts the Hatanaka compact RINEX format (extension crx) is used to convert to the commonly used RINEX format (extension rnx)) and can be obtained from the following URL：
https://terras.gsi.go.jp/ja/crx2rnx.html

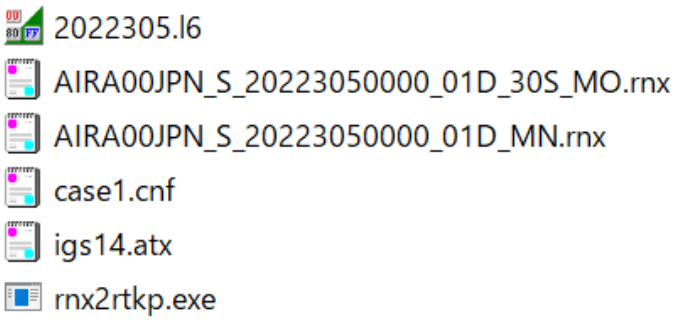
For Windows 64-bit environment, download RNXCMP_4.1.0_Windows_mingw_64bit.

2. The antenna phase information file (e.g. igs14.atx) can be obtained from the below URL.
https://cddis.nasa.gov/Data_and_Derived_Products/GNSS/GNSS_product_holdings.html
*For monitoring stations that do not use the same combination of antenna and radome used for IGS stations, a dedicated antenna phase information file needs to be used instead of the above file.

3. The QZSS L6 correction data can be downloaded from the following QZSS Web URL. Since the files are separated for each hour, they need to be integrated according to the time to be evaluated. (For example, a file for one day on Dec.1, 2022 is generated by executing the command type 2022335* >2022335all.l6 at the Command Prompt.)
https://sys.qzss.go.jp/dod/en/archives.html

4. As for the configuration file, the following sample file included in the MADOCALIB package can be used.
- sample.conf ("case1.conf" in the following description)

5. Place the following files in the Windows local environment.
・RINEX OBS, NAV files
・igs14.atx
・L6 archive data (extension l6)
・conf file (case1.cnf)
・rnx2rtkp.exe



6. The following settings are required in the conf file to process for PPP/PPP-AR.
6-1. Describe the path of the ANTEX file (igs14.atx) in the conf file.
Example: See lines 108 and 109 below.
file-satantfile= (specify the path where igs14.atx is saved)

file-rcvantfile= (Specify the path where igs14.atx is saved)

6-2. Setting the PPP-AR mode to ON

(Noted: 6-2 is skipped for PPP mode)

By setting the following,

Line 14: pos1-ionoopt=est-stec

Line 25: pos2-armode=continuous

The following settings are (current) recommended values.

Line 28 pos2-arthres=2.5

Line 36 pos2-armaxiter=99

Line 80 stats-prniono=0.01

※"stats-prniono" is the process noise of the ionospheric delay estimate in the extended Kalman filter, and this value should be tuned to an appropriate value according to the user's analysis.

6-3. Setting the used navigation satellite systems

Example: See line 24 below.

Line 24: pos1-navsys=29 (GPS+GLO+GAL+QZS)

If you want to use PPP with GPS+GAL+QZS, you should set the sum of these numbers to "25" because GPS is "1", GAL is "8", and QZS is "16".

6-4. Setting the used signals

The setting in line 4 below should be fixed for PPP using L1+L2 or L1+L5 signals.

Line 4: pos1-frequency=l1+2

Additionally, you should set the types of signals and frequencies of used GPS and QZSS with the options on lines 47-50 below.

In the example below, L1C/A and L2P of GPS IIR-M, L1C/A and L2P of GPS IIF, L1C/A and L2P of GPS IIIA, and L1C and L5 of QZSS are used.

Line 47: pos2-siggpsIIR-M=0

Line 48: pos2-siggpsIIF=0

Line 49: pos2-siggpsIIIA=0

Line 50: pos2-sigqzs1_2=0

```
# rtkpost options (2023/01/23 07:37:19, v.2.4.3 b34)
pos1-posmode      =ppp-kine   # (0:single,1:dgps,2:kinematic,3:static,4:movingbase,5:fixed,6:ppp-kine,7:ppp-static,8:ppp-fixed)
pos1-frequency    =l1+2       # (1:l1,2:l1+2,3:l1+2+3,4:l1+2+3+4,5:l1+2+3+4+5)
pos1-soltype      =forward    # (0:forward,1:backward,2:combined)
pos1-elmask       =10         # (deg)
pos1-snrmask_r    =off        # (0:off,1:on)
pos1-snrmask_b    =off        # (0:off,1:on)
pos1-snrmask_L1   =0,0,0,0,0,0,0,0,0
pos1-snrmask_L2   =0,0,0,0,0,0,0,0,0
pos1-snrmask_L5   =0,0,0,0,0,0,0,0,0
pos1-dynamics     =off        # (0:off,1:on)
pos1-tidecorr     =on        # (0:off,1:on,2:otl)
pos1-ionoopt      =dual-freq  # (0:off,1:brdc,2:sbas,3:dual-freq,4:est-stec,5:ionex-tec,6:qzs-brdc)
pos1-tropopt      =est-ztd    # (0:off,1:saas,2:sbas,3:est-ztd,4:est-ztdgrad)
pos1-sateph       =brdc+ssrapc # (0:brdc,1:precise,2:brdc+sbas,3:brdc+ssrapc,4:brdc+ssrcom)
pos1-posopt1      =on         # (0:off,1:on)
pos1-posopt2      =on         # (0:off,1:on)
pos1-posopt3      =on         # (0:off,1:on,2:precise)
pos1-posopt4      =on         # (0:off,1:on)
pos1-posopt5      =off        # (0:off,1:on)
pos1-posopt6      =off        # (0:off,1:on)
pos1-exclsats     =           # (prn ...)
pos1-navsys       =29         # (1:gps+2:sbas+4:glo+8:gal+16:qzs+32:bds+64:navic)

pos2-armode       =off        # (0:off,1:continuous,2:instantaneous,3:fix-and-hold)
pos2-gloarmode    =on         # (0:off,1:on)
pos2-bdsarmode    =on         # (0:off,1:on)
pos2-arthres      =3
pos2-arthres1     =0.9999
pos2-arthres2     =0.25
pos2-arthres3     =0.1
pos2-arthres4     =0.05
pos2-arlockcnt    =0
pos2-arelmask     =0          # (deg)
pos2-arminfix     =10
pos2-armaxiter    =1
pos2-elmaskhold   =0          # (deg)
pos2-aroutcnt     =5
pos2-maxage       =30         # (s)

pos2-syncsol      =off        # (0:off,1:on)
pos2-slipthres    =0.05       # (m)
pos2-rejionno     =30         # (m)
pos2-rejgdop      =30
pos2-niter        =1
pos2-baselen      =0          # (m)
pos2-basesig      =0          # (m)
pos2-siggpsIIR-M  =0          # (0:L1C/A-L2P,1:L1C/A-L2C)
pos2-siggpsIIF    =0          # (0:L1C/A-L2P,1:L1C/A-L2C,2:L1C/A-L5)
pos2-siggpsIIIA   =0          # (0:L1C/A-L2P,1:L1C/A-L2C,2:L1C/A-L5)
pos2-sigqzs1_2    =0          # (0:L1C-L5,1:L1C/A-L2C)
out-solformat     =llh        # (0:llh,1:xyz,2:enu,3:nmea)
out-outhead       =on         # (0:off,1:on)
out-outopt        =on         # (0:off,1:on)
out-outvel        =off        # (0:off,1:on)
out-timesys       =gpst       # (0:gpst,1:utc,2:jst)
out-timeform      =hms        # (0:tow,1:hms)
out-timendec      =3
out-degform       =deg        # (0:deg,1:dms)
out-fieldsep      =
out-outsingle     =off        # (0:off,1:on)
out-maxsolstd     =0          # (m)
out-height        =ellipsoidal # (0:ellipsoidal,1:geodetic)
out-geoid         =internal   # (0:internal,1:egm96,2:egm08_2.5,3:egm08_1,4:gsi2000)
out-solstatic     =all        # (0:all,1:single)
out-nmeaintv1     =0          # (s)
out-nmeaintv2     =0          # (s)
out-outstat       =2          # (0:off,1:state,2:residual)
stats-eratio1     =300
stats-eratio2     =300
stats-errphase    =0.003      # (m)
stats-errphaseel  =0.003      # (m)
stats-errphasebl  =0          # (m/10km)
stats-errdoppler  =1          # (Hz)
stats-stdbias     =30         # (m)
stats-stdiono     =0.03       # (m)
stats-stdtrop     =0.3        # (m)
stats-prnaccelh   =10         # (m/s^2)
```

```
stats-prnaccelv    =10         # (m/s^2)
stats-prnbias      =0.0001     # (m)
stats-prniono      =0.001      # (m)
stats-prntrop      =0.0001     # (m)
stats-prnpos       =0          # (m)
stats-clkstab      =5e-12      # (s/s)
ant1-postype       =llh        # (0:llh,1:xyz,2:single,3:posfile,4:rinexhead,5:rtcm,6:raw)
ant1-pos1          =90         # (deg|m)
ant1-pos2          =0          # (deg|m)
ant1-pos3          =-6335367.6285 # (m|m)
ant1-anttype       =*
ant1-antdele       =0          # (m)
ant1-antdeln       =0          # (m)
ant1-antdelu       =0          # (m)
ant2-postype       =llh        # (0:llh,1:xyz,2:single,3:posfile,4:rinexhead,5:rtcm,6:raw)
ant2-pos1          =90         # (deg|m)
ant2-pos2          =0          # (deg|m)
ant2-pos3          =-6335367.6285 # (m|m)
ant2-anttype       =
ant2-antdele       =0          # (m)
ant2-antdeln       =0          # (m)
ant2-antdelu       =0          # (m)
ant2-maxaveep      =0
ant2-initrst       =off        # (0:off,1:on)
misc-timeinterp    =off        # (0:off,1:on)
misc-sbasatsel     =0          # (0:all)
misc-rnxopt1       =
misc-rnxopt2       =
misc-pppopt        =
misc-rtcmopt       =
file-satantfile    =C:¥Users¥                                ¥igs14.atx
file-rcvantfile    =C:¥Users¥                                ¥igs14.atx
file-staposfile    =
file-geoidfile     =
file-ionofile      =
file-dcbfile       =
file-eopfile       =
```

```
file-blqfile       =
file-tempdir       =
file-geexefile     =
file-solstatfile   =
file-tracefile     =
```

7. Finally, start the Command Prompt and move to the folder containing rnx2rtkp.exe specified in step 5.

8. Execute the following command.
   Command format：
   rnx2rtkp.exe -k conf file OBS file NAV file L6 file -o output file

   Example：
   rnx2rtkp.exe -k case1.cnf AIRA00JPN_S_20223050000_01D_30S_MO.rnx AIRA00JPN_S_20223050000_01D_MN.rnx 2022305.l6 -o test.pos

```
C:¥Users¥      ¥Documents¥MADOCALIB_Ver20230310¥app¥consapp¥rnx2rtkp¥test>rnx2rtkp.exe -k case1.cnf AIRA00JPN_S_202230500
00_01D_30S_MO.rnx AIRA00JPN_S_20223050000_01D_MN.rnx 2022305.l6 -o test.pos
```

   A file (test.pos) containing time series positioning results of PPP/PPP-AR is obtained.
   Contents of test.pos (below, excerpt)

```
% inp file  : 2022305.l6
% obs start : 2022/11/01 00:00:00.0 GPST (week2234 172800.0s)
% obs end   : 2022/11/01 23:59:30.0 GPST (week2234 259170.0s)
% pos mode  : PPP Kinematic
% freqs     : L1+2
% solution  : Forward
% elev mask : 10.0 deg
% dynamics  : off
% tidecorr  : on
% ionos opt : Iono-Free LC
% tropo opt : Estimate ZTD
% ephemeris : Broadcast+SSR APC
% navi sys  : GPS GLONASS Galileo QZSS
% amb res   : OFF
% amb glo   : ON
% val thres : 3.0
% antenna1  : TRM59800.00     SCIS   ( 0.0000  0.0000  0.0000)
%
% (lat/lon/height=WGS84/ellipsoidal,Q=1:fix,2:float,3:sbas,4:dgps,5:single,6:ppp,ns=# of satellites)
%  GPST                  latitude(deg) longitude(deg)  height(m)   Q  ns   sdn(m)   sde(m)   sdu(m)  sdne(m)
2022/11/01 00:00:30.000   31.824066930  130.599603839   317.5378   6  10   5.6549   4.6959  13.5839   3.8675
2022/11/01 00:01:00.000   31.824062670  130.599600488   315.7118   6  10   3.8492   3.2461   8.7689   2.6211
2022/11/01 00:01:30.000   31.824058088  130.599596931   314.6124   6  10   2.9487   2.5608   6.1608   2.0060
2022/11/01 00:02:00.000   31.824060184  130.599598877   314.7080   6  15   1.9846   1.8364   3.9528   1.2629
2022/11/01 00:02:30.000   31.824059503  130.599598927   314.1128   6  16   1.4869   1.4819   2.9045   0.9127
```

※Special notes for compiling MADOCALIB by yourself:

In MADOCALIB, MinGW-w64, which is the 64-bit version of MinGW (Win32) recommended for compiling on Windows, is used as the gcc compiler capable of generating Windows executables.