Precise Orbit Determination by using MADOCA on JSS3

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● **Abstract**

Satellite Navigation Unit has been generating the precise orbit and clock products of GNSS satellites by using MADOCA (Multi-GNSS Advanced Demonstration tool for Orbit and Clock Analysis), and been providing to user via network routinely. On the JSS3, we aim to realize fast computation for the long-term data analysis and simulation.

Ref. URL: https://ssl.tksc.jaxa.jp/madoca/public/public_index_en.html

● **Reasons and benefits of using JAXA Supercomputer System**

To improve the MADOCA products accuracy, we need to do long-term data analysis. By using JSS3, we have been expecting the reduction of the data analysis time.

● **Achievements of the Year**

In this fiscal year, we used JSS3 for the following research and development:

1) Backup analysis for MADOCA routine analysis

2) Implementation of simulated analysis function using new observable for MADOCA

2-1) Generation of simulated observation data

2-2) Precise orbit determination simulation using simulated observation data

3) Positioning analysis using MADOCA products

3-1) Evaluation of Precise Point Positioning (PPP) accuracy (Fig.1)

3-2) Reanalysis of PPP routine analysis results

3-3) Evaluation results of PPP accuracy using MADOCA products which were generated with different Solar Radiation Pressure models (SRP models) (Fig.2)

3-4) Investigation of PPP accuracy degradation events

4) Simulation of the Navigation system with Accurate G-sensor & Ion-thruster (NAGI) and Fitting processing to the broadcast ephemeris format

5) Ensemble clock simulation by using the clock ensemble software (CHRONOS) and it's evaluation (Fig.3)
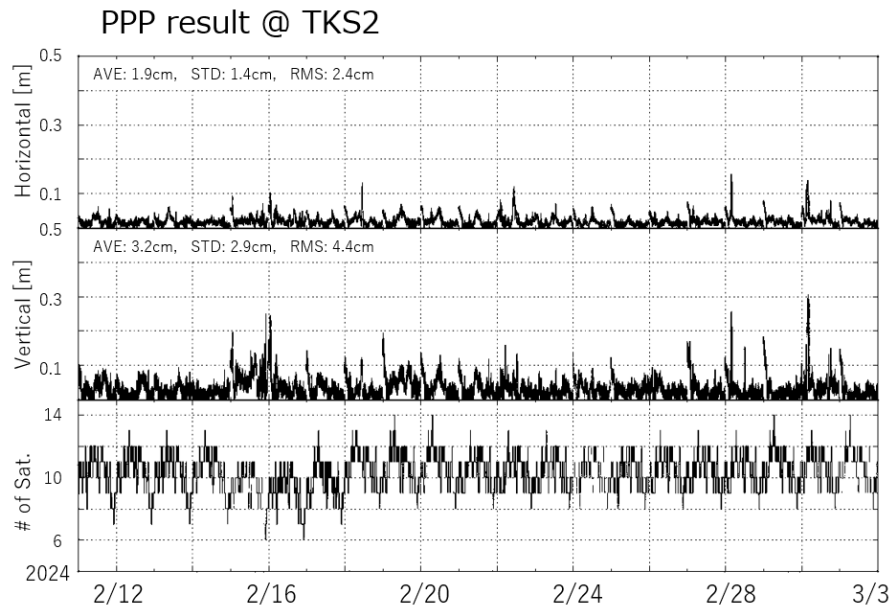
PPP result @ TKS2

Fig. 1: The PPP results analyzed by using MADOCA products which generated using Tensor hybrid model (upper: Horizontal displacement [m], middle: Vertical displacement [m], lower: Number of satellites used in PPP analysis). We used JSS3 to improvement of Tensor hybrid model.
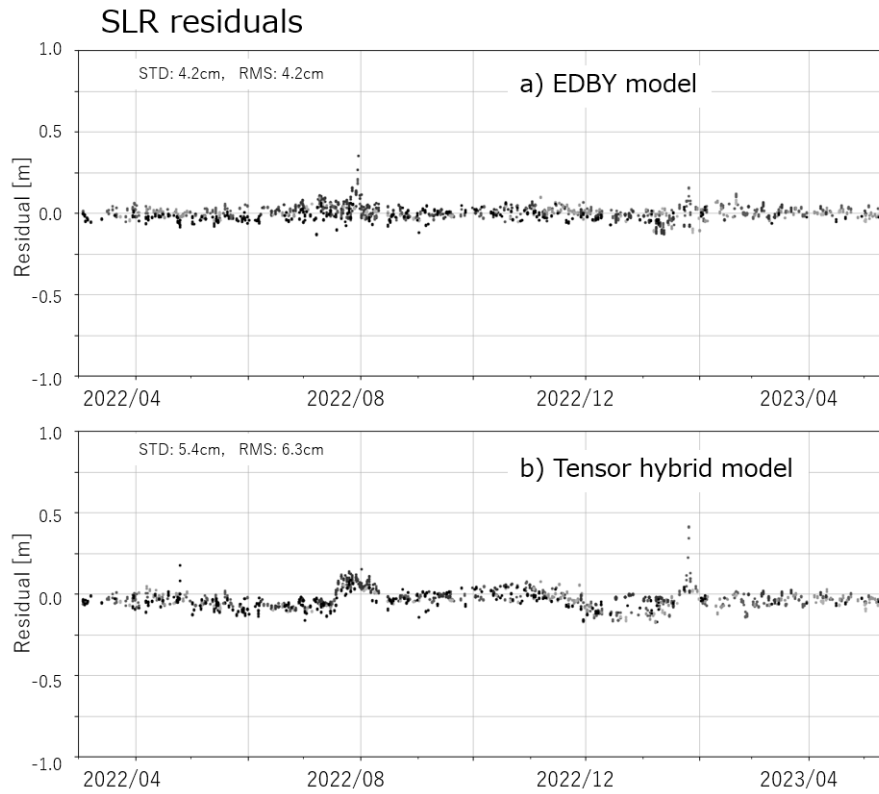
SLR residuals

Fig. 2: Evaluation results of PPP accuracy using MADOCA products which were generated with different SRP models (SLR residuals). a) EDBY model and b) Tensor hybrid model.
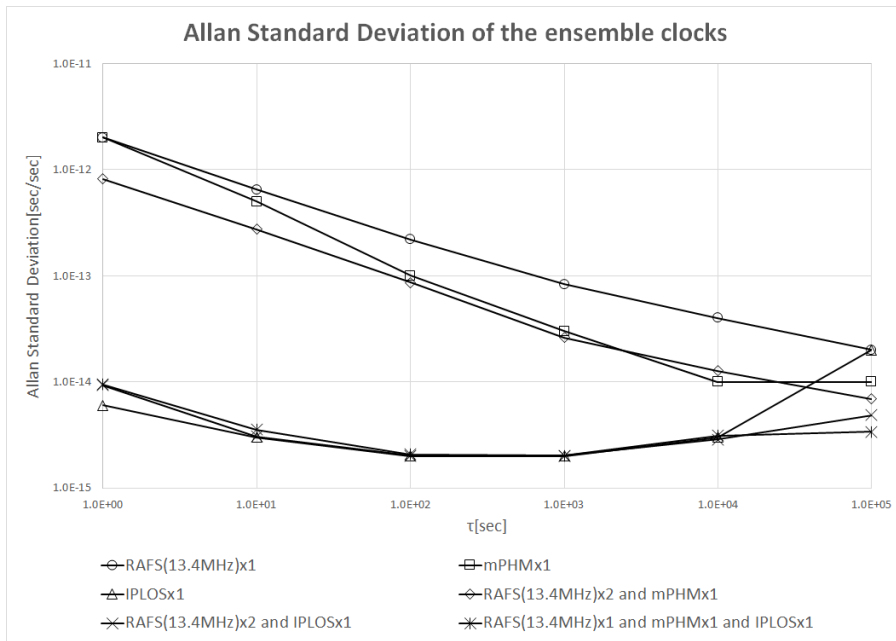
Fig. 3: Allan deviation results of the ensemble clocks which were calculated by CHRONOS. Circle: Rubidium Atomic Frequency Standard (RAFS), Square: Mini Passive Hydrogen Maser (mPHM), Triangle: Iodine Photonic Local Oscillator System (IPLOS) that we are currently under development at Satellite Navigation Unit. Rhombus, Cross, Asterisk: Ensemble clock results calculated from the configurations shown in the legend.

● **Publications**

N/A

● **Usage of JSS**

● **Computational Information**

Process Parallelization Methods	N/A
Thread Parallelization Methods	OpenMP
Number of Processes	1
Elapsed Time per Case	30 Minute(s)

- **JSS3 Resources Used**

Fraction of Usage in Total Resources[*1](%): 0.31

Details

Computational Resources		
System Name	CPU Resources Used (core x hours)	Fraction of Usage[*2](%)
TOKI-SORA	0.00	0.00
TOKI-ST	0.00	0.00
TOKI-GP	0.00	0.00
TOKI-XM	0.00	0.00
TOKI-LM	0.00	0.00
TOKI-TST	2,431,120.35	39.86
TOKI-TGP	0.00	0.00
TOKI-TLM	712.07	2.00

File System Resources		
File System Name	Storage Assigned (GiB)	Fraction of Usage[*2] (%)
/home	1,119.00	0.93
/data and /data2	28,110.00	0.17
/ssd	0.00	0.00

Archiver Resources		
Archiver Name	Storage Used (TiB)	Fraction of Usage[*2] (%)
J-SPACE	0.00	0.00

[*1]: Fraction of Usage in Total Resources: Weighted average of three resource types (Computing, File System, and Archiver).

[*2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.

● **ISV Software Licenses Used**

ISV Software Licenses Resources		
	ISV Software Licenses Used (Hours)	Fraction of Usage[2] (%)
ISV Software Licenses (Total)	0.00	0.00

[2]: Fraction of Usage：Percentage of usage relative to each resource used in one year.