KASI Combination Center Report

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Abstract

This report introduces the activities of the Korea Astronomy and Space Science Institute (KASI) as an IVS Combination Center and shows the current status of the combination work. It also outlines the intended tasks for 2012.

1. General Information

KASI was accepted as an IVS Combination Center in October 2008 and has prepared for regular combination operation. The KASI Combination Center combines the sessionwise products of the IVS Analysis Centers (ACs) into a final combination product.

2. Component Description

The missions of the KASI Combination Center are to create high quality combination products, to verify the combination solution of the BKG/DGFI Combination Center through cross-checking, to control the quality of the ACs' results, to provide feedback to the Analysis Centers, and to adhere to the IERS Conventions. We combine the products of individual IVS ACs at the normal equation level using the Bernese GPS Software (S/W) Version 5.0. Since the software has been developed for GPS data processing and analysis by the Astronomical Institute, University of Bern (AIUB), we have modified the software to deal with IVS analysis products properly.

3. Staff

The staff members of the KASI Combination Center are listed below.

Table 1. Personnel of the KASI Combination Center.

Jungho Cho	+82-42-865-3234	jojh@kasi.re.kr
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4. Current Status and Activities

The Bernese S/W provides the functions of stacking Normal Equations (N.E.) and estimating parameters. The inputs to the Bernese S/W are the N.E. matrices and the N.E. vectors from the daily SINEX files of the individual ACs. The outputs are daily SINEX files including combined station coordinates and Earth Orientation Parameters (EOPs).

In order to validate the modified Bernese S/W, we reanalyzed solutions of BKG, GSFC, and OPA (Table 2) that use identical analysis software, Calc/Solve, and combined them. As a prepara-

tory combination analysis, we also combined IVS analysis products of six ACs — BKG, DGFI, GSFC, IAA, OPA, and USNO (Table 2) — and then compared the residuals of individual solutions with respect to the combination solution.

Table 2. Products of individual ACs for the combination.

AC	BKG	DGFI	GSFC	IAA	OPA	USNO
Solution	bkg2010a	dgf2009a	gsf2010a	iaa2010a	opa2010a	usn2007b

(1) Test combination with 3ACs

The solutions of 144 sessions, especially XA and XE code sessions, in 2008 were combined. The outliers were not excluded in this combination. We solely compared X-pole, Y-pole, UT1, and their rates of individual solutions with respect to those of combined solutions. The residuals between individual solutions and the combined solution are shown in Figure 1. The Root-Mean-Squares (RMS) and biases of the residuals are shown in Table 3. As all three ACs use Calc/Solve, the combined solution agrees well with individual solutions except for the rates of polar motion. There are systematic variations between individual and combined solutions. We expect that they are caused by inappropriate apriori values or nutation definition.

(2) Full combination with 6ACs

We combined six main AC solutions. Figure 2 shows the residuals between individual solutions and the combined solution, and Table 4 shows their RMS and biases. In the combination, we excluded severe outliers. The RMS of the residuals are around 300 microarcseconds (μas) for polar motion, 10 microseconds (μs) for UT1, 300 microarcseconds/day ($\mu as/d$) for polar motion rates, and 20 μs for LOD. This accuracy level still is inferior to that of current BKG/DGFI Combination Center[1]. The systematic variation patterns of polar motion rates are similar with 3ACs combination.

5. Future Work for 2012

Our future work in 2012 is as follows:

- Weighting the individual solutions
- Combining whole period IVS products (1984-present)
- Comparing with BKG/DGFI Combination Center, IERS 08C04, and IGS solutions
- Providing IVS EOP format solutions (Rapid and Quarterly)

References

[1] http://ida.bkg.bund.de/IVS/index.html
BKG/DGFI Combination Center Web page.

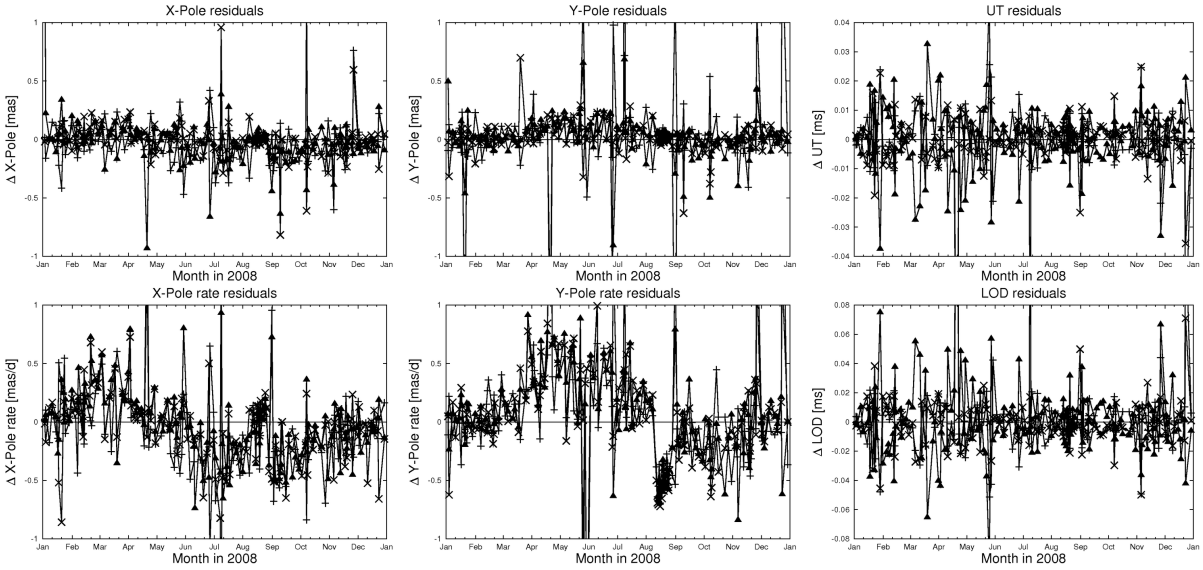

Figure 1. Internal comparison between individual solutions and KASI combination solution (Individual solutions - Combined solution). + : BKG, × : GSFC, ▲ : OPA.

Table 3. RMS and offset of the residuals between individual solutions and the combined solution.

RMS /Offset	X-Pole (mas)	Y-Pole (mas)	UT1 (ms)	X-Pole rate (mas/d)	Y-Pole rate (mas/d)	LOD (ms)
BKG_{KAS}	0.193	0.329	0.018	0.335	0.702	0.035
$-COM_{KAS}$	/-0.025	/0.055	/-0.002	/-0.049	/0.069	/0.003
GSF_{KAS}	0.163	0.432	0.013	0.308	0.481	0.025
$-COM_{KAS}$	/-0.008	/0.011	/-0.001	/-0.066	/0.086	/0.001
OPA_{KAS}	0.263	0.236	0.016	0.345	0.592	0.032
$-COM_{KAS}$	/-0.019	/0.007	/0.000	/-0.015	/0.068	/0.001

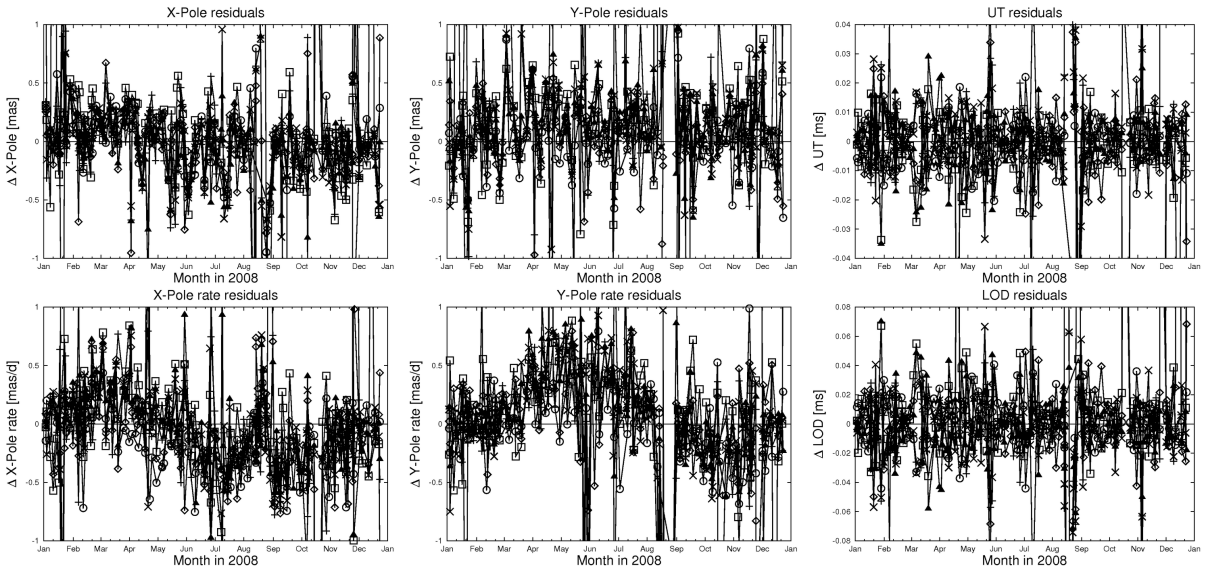

Figure 2. Internal comparison between individual solutions and KASI combination solution (Individual solutions - Combined solution). + : BKG, ⋄ : DGFI, × : GSFC, □ : IAA, ▲ : OPA, ◯ : USNO

Table 4. RMS and offset of the residuals between individual solutions and the combined solution.

RMS /Offset	X-Pole (mas)	Y-Pole (mas)	UT1 (ms)	X-Pole rate (mas/d)	Y-Pole rate (mas/d)	LOD (ms)
BKG_{KAS}	0.325	0.350	0.010	0.323	0.290	0.021
$-COM_{KAS}$	/-0.034	/0.130	/0.002	/-0.054	/0.072	/-0.003
GSF_{KAS}	0.282	0.340	0.010	0.308	0.373	0.021
$-COM_{KAS}$	/-0.012	/0.124	/0.001	/-0.034	/0.118	/-0.003
OPA_{KAS}	0.291	0.331	0.011	0.320	0.361	0.023
$-COM_{KAS}$	/-0.046	/0.119	/0.001	/-0.010	/0.129	/-0.002
DGF_{KAS}	0.276	0.312	0.011	0.334	0.320	0.021
$-COM_{KAS}$	/-0.029	/0.077	/0.000	/-0.045	/0.112	/0.000
IAA_{KAS}	0.283	0.380	0.011	0.372	0.360	0.022
$-COM_{KAS}$	/0.014	/0.160	/-0.001	/-0.039	/0.135	/0.003
USN_{KAS}	0.264	0.294	0.008	0.334	0.335	0.016
$-COM_{KAS}$	/0.031	/0.024	/-0.001	/-0.162	/0.000	/0.003