CORE Operation Center 2014 Annual Report

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Abstract This report gives a synopsis of the activities of the CORE Operation Center from January 2014 to December 2014. The report forecasts activities planned for the year 2015.

1 Changes to the CORE Operation Center's Program

The Earth orientation parameter goal of the IVS program is to attain precision at least as good as 3.5 μs for UT1 and 100 μas for pole position.

The IVS program, which started in 2002, used the Mark IV recording mode for each session. The IVS program began using the Mark 5 recording mode in mid-2003. By the end of 2007, all stations were upgraded to Mark 5. Due to the efficient Mark 5 correlator, the program continues to be dependent on station time and media. The following are the network configurations for the sessions for which the CORE Operation Center was responsible in 2014:

- IVS-R1: 49 sessions, scheduled weekly and mainly on Mondays, six to 13 station networks
- RDV: Six sessions, scheduled evenly throughout the year, 14 to 16 station networks
- IVS-R&D: 12 sessions, scheduled monthly, six to 14 station networks
- CONT14: 15 sessions, scheduled continuously during a two week period, 17 station networks

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2 IVS Sessions from January 2014 to December 2014

This section describes the purpose of the IVS sessions for which the CORE Operation Center is responsible.

- IVS-R1: In 2014, the IVS-R1s were scheduled weekly with six to 13 station networks. During the year, 20 different stations participated in the IVS-R1 network, but there were only eight stations that participated in at least half of the scheduled sessions—Wettzell (49), Tsukuba (44), Ny-Ålesund (43), Fortaleza (37), Hart15m (36), Hobart12 (31), Yarragadee (30), and Katherine (29). Sejong and Tianma65 participated in the IVS-R1 sessions for the first time during 2014.
  The purpose of the IVS-R1 sessions is to provide weekly EOP results on a timely basis. These sessions provide continuity with the previous CORE series. The "R" stands for rapid turnaround because the stations, correlators, and analysts have a commitment to make the time delay from the end of data recording to the analysis results as short as possible. The time delay goal is a maximum of 15 days from the end of data recording to the end of correlation. Sixty-two percent of the IVS-R1 sessions were completed in 15 or fewer days. The remaining 38% were completed in 16 to 42 days [16 days (five), 17 days (four), 22 days (two), 23 days (one), 26 days (one), 27 days (three), 28 days (one), and 42 days (one)]. Participating stations are requested to ship disks to the correlator as rapidly as possible or to transfer the data electronically to the correlator using e-VLBI. The "1" indicates that the sessions are mainly on Mondays.

- RDV: There are six bi-monthly coordinated astrometric/geodetic experiments each year that use the full ten-station VLBA plus up to six geodetic stations.
  These sessions are being coordinated by the geodetic VLBI programs of three agencies: 1. USNO performs repeated imaging and correction for source structure; 2. NASA analyzes this data to determine a high accuracy terrestrial reference frame, and 3. NRAO uses these sessions to provide a service to users who require high quality positions for a small number of sources. NASA (the CORE Operation Center) prepares the schedules for the RDV sessions.
- R&D: The purpose of the twelve R&D sessions in 2014, as decided by the IVS Observing Program Committee, was to test the 512 Mbps recording mode for the CONT14 Campaign (RD1401 and RD1402); vet sources for GAIA proposal (RD1403, RD1404, RD1406, RD1408, RD1410, and RD1412), and observe the Chang'E-3 Lander with VLBI (RD1405, RD1407, RD1409, and RD1411). Two extra R&Ds were added during 2014 to support the four requested Chang'E-3 Lander sessions.

3 Current Analysis of the CORE Operation Center's IVS Sessions

Table 1 provides the average formal errors for the R1, R4, RDV, and CONT14 sessions from 2014. The R1 session formal uncertainties are not significantly different from the 2012-2013 errors. The R1 and R4 polar motion and nutation uncertainties for 2014 sessions are 10-20% better than for 2012-2013. R1 and R4 UT1 uncertainties were comparable to those in 2012-2013. R1 uncertainties could be further reduced if we used a GPS a priori model to obtain the post-earthquake behavior at Tsukuba or if we estimated global spline parameters for the post-seismic displacement at Tsukuba instead of estimating the TSUKUB32 position for each session after the earthquake, thereby weakening its contribution to EOP.

It is not clear why RDV polar motion uncertainties are about 10% larger for 2014 than 2013. The RDV formal errors are not significantly different than for R1 and R4 experiments. This is due to the increasing number of stations in R1 and R4 sessions as well as better global geometry. For comparison, we also included the formal uncertainties for the CONT11 and CONT14, which are much better than for any of the networks discussed above that observed in 2014.

Table 2 shows EOP differences with respect to the IGS series for the R1, R4, RDV, CONT11, and CONT14 series. The WRMS differences were computed after removing a bias, but estimating rates does not affect the residual WRMS significantly. Both the R1 and R4 series for 2014 have better WRMS agreement in X-pole, Y-pole, and LOD for 2014 than for the corresponding full series from 2000 to 2014. Adopting the improved GPS a priori model strategy mentioned above improves the R1 agreement with IGS by 20%. The X-pole and Y-pole biases of the R1 and R4 sessions relative to IGS are significant and are likely due to reference frame bias. In 2014, there appear to be some performance issues regarding the RDV sessions given that the WRMS agreement for polar motion and LOD are significantly worse than for the full period of observing since 2000. Over that full period 2000-2014, the RDVs have the best agreement with IGS of all the series. For comparison with the 2014 operational sessions discussed here, we included the statistics for both the CONT11 and CONT14 sessions, which have the best WRMS agreement with IGS most likely because the CONT networks were unchanged over the respective periods of continuous observing. The X-Pole agreement with IGS for CONT14 is significantly better than for CONT11. This is expected because the CONT14 network has better geometry than CONT11.

4 The CORE Operations Staff

Table 3 lists the key technical personnel and their responsibilities so that everyone reading this report will know whom to contact about their particular question.

5 Planned Activities during 2015

The CORE Operation Center will continue to be responsible for the following IVS sessions during 2015:

- The IVS-R1 sessions will be observed weekly and recorded in Mark 5 mode.

- The IVS-R&D sessions will be observed ten times during the year.
- The RDV sessions will be observed six times during the year.

Table 1 Average EOP Formal Uncertainties for 2014.

Session Type	Num	X-pole (μas)	Y-pole (μas)	UT1 (μs)	DPSI (μas)	DEPS (μas)
R1	49	60(67,73)	55(66,63)	3.2(3.1,3.4)	86(105,110)	33(42,44)
R4	51	59(68,70)	57(66,67)	2.7(2.9,2.8)	112(120,124)	45(49,49)
RDV	6	59(54,48)	57(54,48)	2.7(2.8,2.5)	82(82,68)	34(33,28)
CONT11	15	38	37	1.7	42	17
CONT14	15	40	41	1.8	41	14

Values in parentheses are for 2013 and then 2012.

Table 2 Offset and WRMS Differences (2014) Relative to the IGS Combined Series.

		X-pole		Y-pole		LOD	
Session Type	Num	Offset (μas)	WRMS (μas)	Offset (μas)	WRMS (μas)	Offset (μs/d)	WRMS (μs/d)
R1	49(664)	-45(15)	84(93)	55(47)	86(87)	3.4(1.3)	15(17)
R4	51(656)	7(-7)	73(106)	63(50)	82(108)	2.9(1.9)	13(17)
RDV	6(90)	40(60)	91(83)	58(46)	78(69)	5.3(0.1)	19(14)
CONT11	15	43	35	27	30	6.5	6
CONT14	15	10	25	89	33	1.0	5

Values in parentheses are for the entire series (since 2000) for each session type.

Table 3 Key Technical Staff of the CORE Operations Center.

Name	Responsibility	Agency
Dirk Behrend	Organizer of CORE program	NVI, Inc./GSFC
Brian Corey	Analysis	Haystack
Ricky Figueroa	Receiver maintenance	ITT Exelis
John Gipson	SKED program support and development	NVI, Inc./GSFC
Frank Gomez	Software engineer for the Web site	Raytheon/GSFC
David Gordon	Analysis	NVI, Inc./GSFC
Ed Himwich	Network Coordinator	NVI, Inc./GSFC
Dan MacMillan	Analysis	NVI, Inc./GSFC
Katie Pazamickas	Maser maintenance	ITT Exelis
David Rubincam	Procurement of materials necessary for CORE operations	GSFC/NASA
Braulio Sanchez	Procurement of materials necessary for CORE operations	GSFC/NASA
Dan Smythe	Tape recorder maintenance	Haystack
Cynthia Thomas	Coordination of master observing schedule and preparation of observing schedules	NVI, Inc./GSFC