SATELLITE LASERRANGING OBSERVATIONS IN1998

Summary - Satellite laserranging observations havebeencontinuedbyafixed type satellite laserranging StationattheSimosatoHydrographicObservatory(JHDLRS-1) andbyatransportableone (HTLRS).

Keyword: satellitelaserranging(SLR)-global geodesy - JHDLRS-1-HTLRS

This is a report of the satellitelaserranging (SLR) observationsmade attheSimosatoHydrographic Observatory byafixedtypesatellitelaserrangingstationcalledJHDLRS-1(Sasakietal.,1983) and by a Transportable one calledHTLRS (Sasaki, 1988) . This report contains the lists of data obtained at these stations in1997

Previous data obtainedby the JHDLRS-1 appearintheSeriesofAstronomyandGeodesy , Data Report of Hydrographic Observations for theperiodfrom1982to1985,andintheSeriesofSatellite Geodesyfrom1986 to 1997;those obtained bytheHTLRSappearintheDataReportofHydrographic Observation,SeriesofSatellite Geodesy,No.3-12.

1.Observation

Theroutine rangingobservationfor Lageos-I,Starlette, and Beacon(BE)-Cstartedin April1982by theJHDLRS-1under themutual cooperationbetweentheHydrographic Departmentofjapan(JHD)andthe National Aeronautics andSpaceAdministration(NASA)of the UnitedStatesof America. InAugust1986, the Japanese first Geodetic Satellite "Ajisai" waslaunched and itstracking observation bytheJHDLRS-1 started. Thereafter,15 satelliteswereaddedintheroutineobservation:"ERS-1"inJuly1991,"TOPEX/ POSEIDON"inAugust 1992 , "Lageos-II"inOctober1992,"Stella"inSeptember1993, "Meteor-3" in January1994,"Etalon-1","Etalon-2"inNovember1994,"ERS-2"inMay 1995,"GFZ-1"inJune1995, "GPS-35","GPS-36"inAugust 1995,and"ADEOS"inOctober 1996,"DIADEMIC", "DIADEMID"in May1997and"WESTPAC-1"inJuly1998.

Therange observation for Lageos-I,StarletteandAjisai,bytheHTLRSstartedinDecember1987in a campaignstyle . Lageos-II,ERS-1, TOPEX / POSEIDON and Stella havebeenalsoobservedby the HTLRS.TherangeobservationsbytheHTLRSatoff-lyingislandsandatsomecoastalareashavebeen carriedoutasfollows.

Jan.	1988-	Mar.	1988	:TitiSima
Jul.	1988-	Sep.	1988	:IsigakiSima
Jan.	1989-	Mar.	1989	: MinamitoriSima
Jul.	1989-	Sep.	1989	:OkinawaSima
Oct.	1989 -	Nov.	1989	:Tusima
Sep.	1990-	Oct.	1990	:OkiShoto
Dec.	1990-	Feb.	1991	:Minami-DaitoSima
Aug.	1991-	Nov.	1991	:Tokai
Jan.	1992-	Mar.	1992	:IwoSima
Aug.	1992-	Oct.	1992	:Wakkanai
Jan.	1993-	Mar.	1993	:HatizyoSima
Jan.	1994-	Mar.	1994	:Makurasaki
Jul.	1994-	Oct.	1994	: Oga
Feb.	1995-	Mar.	1995	:Bisei

Jul.	1995- Aug.	1995	:Bisei
Jan.	1996- Mag.	1996	:Tyosi
Sep.	1996- Dec.	1996	:TitiSima
Jul.	1997- Nov.	1997	:Isigaki Sima
Aug.	1998- Nov.	1998	: IsigakiSima

Themajorspecificationsofthe JHDLRS- 1 and theHTLRSarelistedin Table1andTable2 (Sasaki etal.,1983,Sasaki,1988). Thelocationsofthesystemsandfiducialstonemarkerssetupnearthesystems areshowninTable3 (Takemura,1983) and Table4.

Theobservation scheduleoftheJHDLRS-1wasmadebyselectingpasseswhosemaximum elevation were over 30degreesfor Starlette,Ajisai,ERS-1, ERS-2,TOPEX/POSEIDON,Stella,Etalon-1, Etalon-2andGFZ-1,ADEOS,GPS-35,GPS-36,andover30degreesinthenighttimeand35degreesinthe daytimeforLageos-IandLageos-II.Theobservationschedule of theHTLRSwasmadebyselectingpasses whose maximumelevationswereover20degrees onlyinthenighttime.Whenthe HTLRSwasinoperation, thesame criterion wasappliedtotheJHDLRS-1.RoutineobservationwasnotcarriedoutonSaturdayand Sunday.Thepriorityoftheselectionforsimultaneoustransitswasin the orderof Ajisai, Lageos,ERS, TOPEX/POSEIDON,Starlette,Stella,GFZ-1,Etalon,andGPS.

IRV orbital elementsofthesatellitesobtainedfromtheGoddardSpaceFlightCenter(GSFC) of NASA via ftp were usedfor schedulingandtracking. The trackingwascarriedoutwhen the elevationof satelliteswas above 20degrees.Thetemperature,atmosphericpressureandrelativehumiditywere measuredoncein a pass.Beforeandafterrangingsatellites,therangingcalibrationsweremadebyusinga groundtarget.

In order toimprov ranging precision,the JHDLRS-1 hasbeen upgradedseveraltimes.A Micro-Channel-Platephotomultiplierwas introduced in the JHDLRS-1 inJanuary 1985.A GPS clock was introduced into the JHDLRS-1in December 1988 tomonitor and correcttheatomicclock usedinthe system,andithasbeeninoperation since April 1989.AGPSclockhasbeenalsousedintheHTLRS.A laser subsystem of the JHDLRS-1 was upgradedtoaQuantelYAG 460-5atthebeginningof june 1990. Receivingelectronics wasalsoupgradedandRMSwasimprovedinDecember1993.

The total numbers ofreturns andpassesobtained by theJHDLRS-1 atSimosatoandby the in1998arelistedinTable5.

2.Polynomialfittingandpreliminaryanalysisofrange data

False rangedata wereremovedbyavisualrejectionsystem.ThesystemworksonCRTscreensby applying a filterofpolynomial fitting tomeasuredrangeitself byuseoftheon-sitecomputer.Preliminary values of standarddeviationforeachpasswereestimatedinthisprocess

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A partofobtaineddata,namedquick-look (QL) data,were senttotheGSFCfromSimosatowithin onedaythroughINTERNET.QLdataofTOPEX/POSEIDONwassenttotheGSFCfromSimosatowithin 8 hoursthroughINTERNET. QL dataofERS-1,ERS-2,andGFZ-1werealsosenttotheDeutsches Geodatisches Forschungsinstitut (DGFI) withinoneday throughINTERNET.Alltherangedata, after Applicationof the correction ofthe internal time delayof the SLRsystemsobtained bythegroundtarget ranging, named full-rate(FR)data,wererecordedonaharddiskinMERIT-IIFormat(CSTG,1987) together withthesatelliteID,thestation ID,thetransmittedtimecorrected intoUTC (USNO MC),the meteorological data,the preliminarymeasurementstandard deviationandsomepreprocessingindications. All theFRdataweresenttotheGSFC

Theweightedmeanrangeprecisionsestimatedbyusingthepolynomialfittingforallthedata obitainedbytheJHDLRS-1in1998are5.8cmforLageos-I,5.2cm for Lageos-II,4.0cmforStarlette,5.0cm forAjisai,4.6cmforERS-1,3.9cmforERS-2,4.3cmforTOPEX/POSEIDON,6.8cmforStella,11.2cm for Etalon-1, 9.4cmforEtalon-2,and3.9cmforGFZ-1,4.7cm forGFO-1,9.8cmforGPS-36,7.6cmforWEST-PAC-1,respectively,asshowninTable.

The QL data sent to the GSFC were used to update orbitalelements. These dataweretransferred from theGSFCtotheCenterforSpaceResearch(CSR)oftheUniversityofTexasatAustinandwereused for theestimation of the polar motion and the variation of angularvelocity of the earth rotation by processingwiththeSLRdatafromothersitesintheworld.AlltheFRdatawerealsoanalyzedintheCSR and other SLR analysis centers, and moreprecisevaluesfortheearthrotationparametershavebeen estimated.TheFRdatasenttotheGSFCwereusedtodetectcrustalmovementsandglobalplatemotions.

The JHD hasbeen processingFRdataobtainedatSimosato andotherSLRsitesbyusinganoriginal orbital processor(Sasaki, 1984) andGEODYN-II/SOLVEmadeby NASA (Eddyetal.,1990).Aresultof thegeodeticcoordinatesforthecrosspointofazimuthandelevationaxesoftheJHDLRS-1,obtainedasthe Marine GeodeticResult (TatsunoandFujita,1994),is33° 34' 39."700N,135° 56'13."337E,101.62m for latitude, longitude andheightabovethereferenceellipsoid of 6378137m semi-major axis and 1/ 298.257223563flattening,repectively.

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Table1.PrincipalSpecifications ofSatelliteLaserRangingStationof theSimosatoHydrographicObservatory(JHDLRS-1)

Subsystem	Specification
Mount configuration	Elevationoverazimuth/Coude path
Angularresolution	20bits(1.2arcsec)
Transmitter diameter	17cm
Receiver diameter	60cm
Laserwavelength	532nm
Outputenergy	125mJ
Laser pulsewidth	100ps
Repetitionrate	4pps
Receiver detector	Micro-Channel-PlatePMT
Flighttime counter	20psresolution
Frequencystandard	Rubidiumoscillator
Timecomparison	GPS (TrueTime,XL-DC602)
Computer	32-bitspersonal computer withharddisks, 3.5inchfloppydiskdrive,printer,CRTsandaTA

Table2.PrincipalSpecificationsoftheHydrographic Department Transportable Satellite Laser Ranging Station(HTLRS)

Subsystem	Specification
Mount configuration	Elevationoverazimuth/Coude path
Angularresolution	20bits(1.2arcsec)
Transmitter diameter	10cm
Receiver diameter	35cm
Laserwavelength	532nm
Outputenergy	50mJ
Laser pulsewidth	50-100ps
Repetitionrate	5pps
Receiver detector	Micro-Channel-Plate PMT
Flighttime counter	20psresolution
Frequencystandard	Cesiumoscillator
Timecomparison	GPS (MAGNAVOX,MX4200)
Computer	16-bitspersonal computerswithharddisks 3.5inchfloppydiskdrive,printer,CRTsandamodem

Table3.GeodeticcoordinatesofJHDLRS-1

Location	SideID	Coordinates (TokyoDatum)		
		°	'	"
CrosspointofAz.andEl.axes ofJHDLRS-1	International 7838 Domestic SHO-L	33 135	34 56	27.496N 23.537E 62.44m
Thefiducialstone marker at theSimosatoHydrographic Observatory	Domestic SHO-H0	33 135	34 56	28.078N 23.236E 58.36m

Table 4. GeodeticcoordinatesofHTLRS

Location	SideID	Coordinates (TokyoDatum)		
		°	'	"
CrosspointofAz.andEl.axes ofHTLRSatIsigakiSima	International 7307	24 124	21 10	5.3546N 36.1016E 55.32m
Thefiducialstone marker at theIsigaki Sima	Domestic Isigaki-H1	24 124	21 12	54.1213N 57.3078E 73.50m

Table5.DataacquisitionatSimosatoHydrographicObservatoryin 1998

Satellite	No.ofranges	No.ofpasses	RMS
Ajisai	203,506	184	5.0
ERS-1	17,079	36	4.6
ERS-2	23,306	50	3.9
Etalon-1	1,576	6	11.2
Etalon-2	7,899	11	9.4
GEOS-3	5,663	14	4.9
GFO-1	5,456	16	4.7
GFZ-1	1,464	4	3.9
GPS-36	375	3	9.8
LAGEOS-1	74,933	66	5.8
LAGEOS-2	114,688	82	5.2
Starlette	49,788	92	4.0
Stella	29,413	54	6.8
TOPEX	84,789	87	4.3
WESTPAC-1	598	5	7.6