Preliminary Report of Geodetic Site Survey of Co-Located Space Geodesy Systems at NASA GGAO, Greenbelt, Maryland

January 12, 2008

This preliminary report has been updated to include all of the geodetic survey observations taken at the Goddard Geophysical and Astronomical Observatory (GGAO) during the November 2007. Existing survey control monuments and piers where selected for the survey to provide redundant ties between all of the survey control monuments, piers, the MOBLAS 7 and NGSLR (formerly know as SLR2000) laser systems, and VLBI MV-3 antenna.

Limited survey observations where made to the IGN DORIS antenna system and are included in the report. The reference point used for the DORIS antenna observations was the red painted ring on the antenna (representing the location of the antenna phase center). To connect the VLBI MV-3 to the site survey scheme, a special survey target was attached near the apex of the antenna quadripod. Survey observations in the form of horizontal directions and zenith distances were made to this target. Five (5) of the site survey scheme ground control monuments/piers where utilized for these observations. The VLBI MV-3 antenna was rotated to the four cardinal azimuth directions and various elevation angles for the observations. A total of forty-five (45) target locations where observed requiring eighteen (18) hours of observation time.

The observed survey data was reduced and set up into a primary ground survey data file, and four individual data files for the VLBI MV-3 antenna observations. These survey data files where then adjusted using the HAVAGO 3-dimensional adjustment software program. Final HAVAGO data from the VLBI MV-3 adjustments were used as input for the software program circle-fit to determine corrections to the antenna preliminary geodetic position and height.

Two separate HAVAGO adjustments on the observed survey data were made to produce final results, referenced to both the IGN ITRF2000 and the ITRF2005 solutions. The coordinates of survey control monument "CDP Station 7105" where held constrained for the HAVAGO adjustments. The "X, Y, and Z" coordinates of survey control monument "CDP Station 7105" were obtained from the IGN solution as published. The ITRF2000 (Epoch 1997.0) coordinates used where listed in the IGN ITRF web site under the file ITRF2000_SLR_SSC and the ITRF2005 (Epoch 2000.0) coordinates under the file ITRF2005_SLR_SSC for DOMES #4045M105.

The results of these preliminary HAVAGO adjustments indicate that the field survey observations where well within the expected error tolerances. The circle-fit adjustment results resulting from the HAVAGO adjustments confirm that the VLBI MV-3 antenna is

stable and level. Excellent results were obtained from the VLBI MV-3 antenna observation adjustments and circle-fit results.

PRELIMINARY GEODETIC POSITIONS AND HEIGHTS
ITRF2000 (Epoch 1997.0)

GEODETIC COORDINATES

Station	Latitude (d m s)	Longitude (d m s)	Height (m)
CDP STATION 7105	39 01 14.17743	76 49 39.69784	19.194
CDP STATION 7125	39 01 12.96879	76 49 38.80939	18.506
CDP STATION 7108	39 01 18.93310	76 49 35.55081	13.743
NGSLR (NOV 07)	39 01 12.96614	76 49 38.92636	22.202
MOBLAS 7 (NOV 07)	39 01 14.17721	76 49 39.69924	22.330
MV-3 (NOV 07)	39 01 18.93333	76 49 35.55076	16.811
DORIS (NOV 07)	39 01 12.25145	76 49 40.42727	20.431

CARTESIAN COORDINATES

Station	X (m)	Y (m)	Z (m)
CDP STATION 7105	1130719.632	-4831350.577	3994106.539
CDP STATION 7125	1130745.668	-4831368.035	3994077.148
CDP STATION 7108	1130794.760	-4831233.814	3994217.045
NGSLR (NOV 07)	1130743.594	-4831371.522	3994079.412
MOBLAS 7 (NOV 07)	1130720.155	-4831352.961	3994108.508
MV-3 (NOV 07)	1130795.303	-4831236.130	3994218.982
DORIS (NOV 07)	1130711.287	-4831391.921	3994061.174

PRELIMINARY GEODETIC POSITIONS AND HEIGHTS
ITRF2005 (Epoch 2000.0)

GEODETIC COORDINATES

Station	Latitude (d m s)	Longitude (d m s)	Height (m)
CDP STATION 7105	39 01 14.17782	76 49 39.69970	19.195
CDP STATION 7125	39 01 12.96918	76 49 38.81125	18.507
CDP STATION 7108	39 01 18.93348	76 49 35.55267	13.745
NGSLR (NOV 07)	39 01 12.96652	76 49 38.92822	22.203

MOBLAS 7 (NOV 07)	39 01 14.17759	76 49 39.70110	22.331
MV-3 (NOV 07)	39 01 18.93372	76 49 35.55262	16.812
DORIS (NOV 07)	39 01 12.25183	76 49 40.42913	20.432

CARTESIAN COORDINATES

Station	X (m)	Y (m)	Z (m)
CDP STATION 7105	1130719.587	-4831350.581	3994106.549
CDP STATION 7125	1130745.623	-4831368.039	3994077.158
CDP STATION 7108	1130794.715	-4831233.818	3994217.055
NGSLR (NOV 07)	1130743.549	-4831371.526	3994079.422
MOB-7 (NOV 07))	1130720.110	-4831352.965	3994108.518
MV-3 (NOV 07)	1130795.258	-4831236.134	3994218.992
DORIS (NOV 07)	1130711.242	-4831391.925	3994061.184

MOBLAS 7 SYSTEM ECCENTRICITIES FROM CDP STATION 7105

Delta North	**Delta East**	**Delta Up**
-0.007 m	-0.034 m	+3.136 m
Delta X	**Delta Y**	**Delta Z**
+0.524 m	-2.384 m	+1.969 m

NGSLR SYSTEM ECCENTRICITIES FROM CDP STATION 7125

Delta North	**Delta East**	**Delta Up**
-0.082	-2.814	+3.696
Delta X	**Delta Y**	**Delta Z**
-2.074	-3.488	+2.264

VLBI MV-3 ANTENNA ECCENTRICITIES FROM CDP STATION 7108

Delta North	Delta East	Delta Up
+0.007 m	+0.001 m	+3.068 m
Delta X	**Delta Y**	**Delta Z**
+0.543 m	-2.316 m	+1.937 m

DIFFERENTIAL COORDINATES FROM SLR MOBLAS 7 TO SLR NGSLR

Delta North	Delta East	Delta Up
-37.347 m	+18.592 m	-00.128 m
Delta X	**Delta Y**	**Delta Z**
+23.439 m	-18.561 meters	-29.096 m

DIFFERENTIAL COORDINATES FROM SLR MOBLAS 7 TO VLBI MV-3

Delta North	Delta East	Delta Up
+146.669 m	+99.794 m	-5.521 m
Delta X	**Delta Y**	**Delta Z**
+75.148 m	+116.831 m	+110.474 m

DIFFERENTIAL COORDINATES FROM SLR NGSLR TO VLBI MV-3

Delta North	Delta East	Delta Up
+184.016 m	+81.202 m	-5.394 m
Delta X	**Delta Y**	**Delta Z**
+51.709 m	+135.392 m	+139.570 m

SLR MOBLAS 7 CALIBRATION DATA

MOBLAS 7 TO CAL-PIER C	Calibration Distance:	170.527 meters
	Elevation Angle:	-01.6616 degrees
	Geodetic Azimuth:	105.0124 degrees
MOBLAS 7 TO CAL-PIER B3	Calibration Distance:	174.835 meters
	Elevation Angle:	-01.7362 degrees
	Geodetic Azimuth:	95.5146 degrees
MOBLAS 7 TO CAL-PIER A	Calibration Distance:	106.674 meters
	Elevation Angle:	-03.1324 degrees
	Geodetic Azimuth:	64.9365 degrees

SLR NGSLR CALIBRATION DATA

NGSLR TO CAL-PIER C	Calibration Distance:	146.284 meters
	Elevation Angle:	-01.8866 degrees
	Geodetic Azimuth:	92.6656 degrees
NGSLR TO CAL-PIER B3	Calibration Distance:	156.793 meters
	Elevation Angle:	-01.8890 degrees
	Geodetic Azimuth:	82.4611 degrees
NGSLR TO CAL-PIER A	Calibration Distance:	113.584 meters
	Elevation Angle:	-2.8769 degrees
	Geodetic Azimuth:	43.3595 degrees

This report has been updated to include all of the survey control monuments occupied during the November 2007 geodetic survey. Also included are the observations to the VLBI MV-3 antenna and the IGN DORIS antenna to connect these to the survey ground control network.

In addition, more field survey observations, in the form of Global Positioning System (GPS) data, will be collected. This data will be processed and combined into this HAVAGO adjustment for a final GGAO site geodetic survey HAVAGO adjustment. It is expected that some additional conventional survey measurements will also be made. This data will also be included in the final site HAVAGO adjustment. These preliminary values could change by varying amounts once the final HAVAGO adjustment is complete. All survey data will also be adjusted using the GeoLab3 software and the results will be compared with the HAVAGO adjustment results

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Revised
Jim Long
January 29, 2008