Horizontal and Vertical Control Report

Project Metadata

Project Name	North Coast of Kodiak Island, AK
Project Number	OPR-P136-RA-17
General Locality	Kodiak Island, AK
State or Territory	Alaska
Field Unit	NOAA Ship *Rainier*
Chief of Party	Benjamin K. Evans, CDR/NOAA
Project Start Date	2017-04-20
Project End Date	2017-08-14
Field Year	2017
DAPR Version	2017 RA-DAPR Final

Horizontal and Vertical Control Report
NOAA Ship *Rainier* (S221)
OPR-P136-RA-17
Survey of North Coast of Kodiak Island, AK
H12996, H12997, H12998, H12999, H13000, H13001, H13002 and H13003
Hydrographic Letter Instructions dated 03/09/2017
Chief of Party: Commander Benjamin K. Evans, NOAA

A. VERTICAL CONTROL

I. Project

The tidal datum for this project was Mean Lower Low Water (MLLW). The operating National Water Level Observation Network (NWLON) station at **Kodiak Island, AK (945-7292)** served as datum control for the survey area and provided preliminary water level reducers during data acquisition. Project Instructions required no subordinate tide stations to be installed for project OPR-P136-RA-17.

II. Tidal Zoning Application

A preliminary Tidal Constituent and Residual Interpolation (TCARI) grid based on **Kodiak Island, AK (945-7292)** was provided by CO-OPS in file P136RA2017.tc. On the following dates, CO-OPS provided Final Tide Note accepting the preliminary TCARI grid as the final grid for registry numbers in project OPR-P136-RA-17:

Registry Numbers	Date
H12997	06 JUN 2017
H13002	06 JUL 2017
H12998, H12999	01 AUG 2017
H12996, H13000, H13001	11 AUG 2017
H13003	10 OCT 2017

III. Ellipsoid Referenced Zoned Tides

OPR-P136-RA-17 Project Instructions required acquiring survey data vertically-referenced to the ellipsoid. With the exception of registry number H13003, this was accomplished through the creation of Ellipsoid Referenced Zoned Tides (ERZT) models. A 1000m resolution separation model was generated for each survey sheet using Smoothed Best Estimate of Trajectory (SBET) data combined with final approved TCARI grid P136RA2017.tc. For further details and results of ERZT for each sheet, see individual Descriptive Reports and for details about the process, see the DAPR submitted for this project.

B. HORIZONTAL CONTROL

I. Horizontal Positioning Control

For project OPR-P136-RA-17, horizontal control was managed by a combination of
1) Applanix SmartBase processing/virtual base station network
2) Applanix SingleBase processing using an installed GNSS base station (Trimble Net R9 Receiver).

3) Applanix SingleBase processing using an established CORS site (AC67 PILLARMTN_AK2006).

Site ID	Base Station ID
AC18	USHAGAT_IsAK2008
AC26	CAPE_GULL_AK2008
AC29	MIDDLETON_AK2014
AC34	OldHarbor_AK2006
AC38	QUARTZ_CRKAK2005
AC39	SHUYAKISSPAK2006
AC43	SEAL_ROCKSAK2007
AC67	PILLARMTN_AK2006
AC79	MONTAGUE2_AK2010
9715	*Woody*

Table 1. CORS/UNAVCO and Base Stations used for this project

II. Soundings and Detached Positions

Applanix POSPac SingleBase Processing and SmartBase Processing were the methods used for horizontal positioning and kinematic correction on all hydrographic survey data acquired during OPR-P136-RA-17. SingleBase processing was the preferred method and SmartBase processing was used as a secondary method when SingleBase data were missing, incomplete, or causing spurious results. SingleBase solution processing utilizes an installed GNSS base station "*Woody"* (Figure 1) to calculate corrections in the form of a Smoothed Best Estimate of Trajectory (SBET) for a roving receiver (e.g. ship and survey launches). SmartBase solution processing utilizes a virtual reference station created from a network of CORS/UNAVCO permanent stations to do the same for a roving receiver operated within the network (Figure 2). The data were processed through the GNSS-Inertial Processor in the Forwards, Backwards and Combine mode with the Roll, Pitch and Heading Initialization set to initialize from the real time solution and the Lever Arm Standard Deviation ideally known to three centimeters or better.

All data were then processed using Applanix POSPac MMS 7.1.5. Post-processed position correctors were not applied to any detached positions acquired in this project.

Rainier's POSMV systems are configured to use WAAS for improving GPS accuracy, since DGPS is not available in all of the ship's assigned project areas.

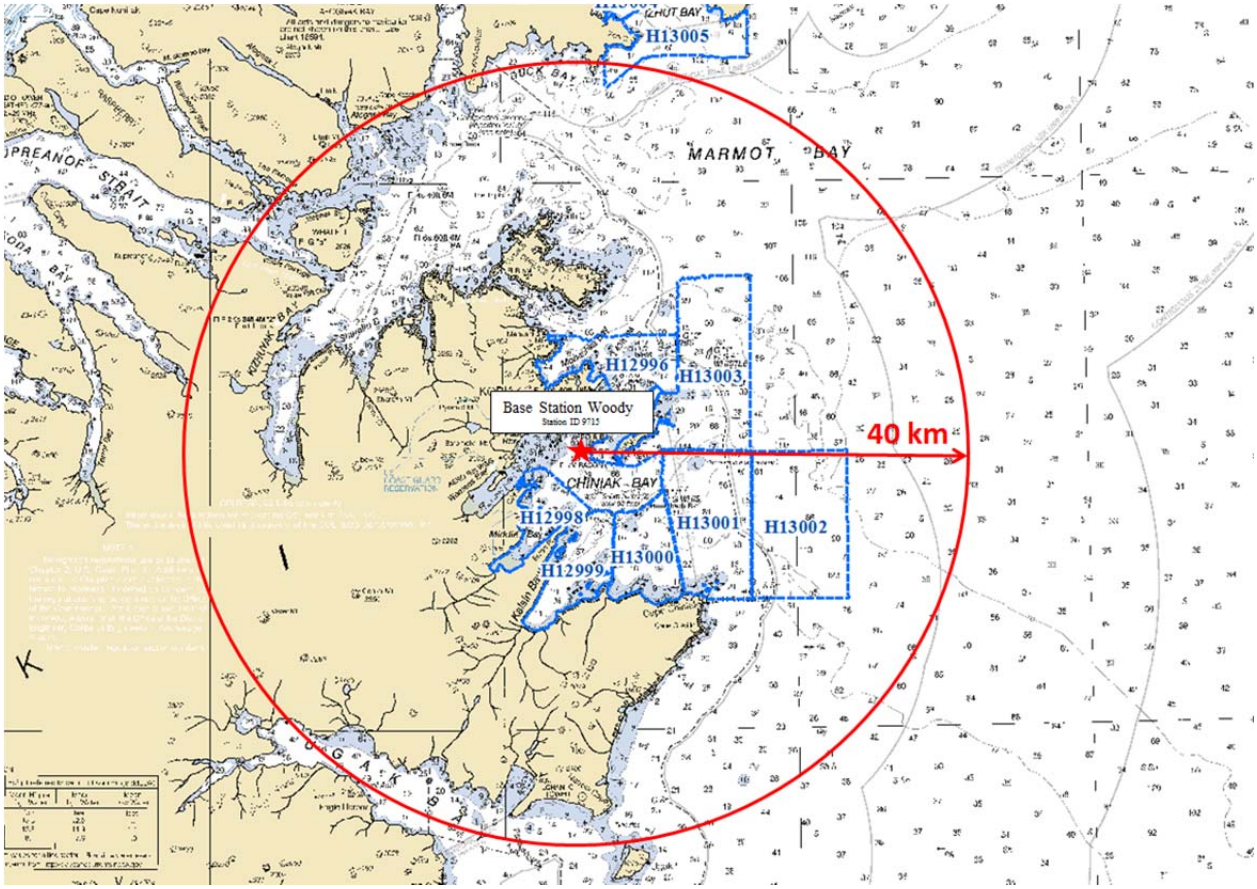

Figure 1 Installed GNSS Station with 40 km ring.

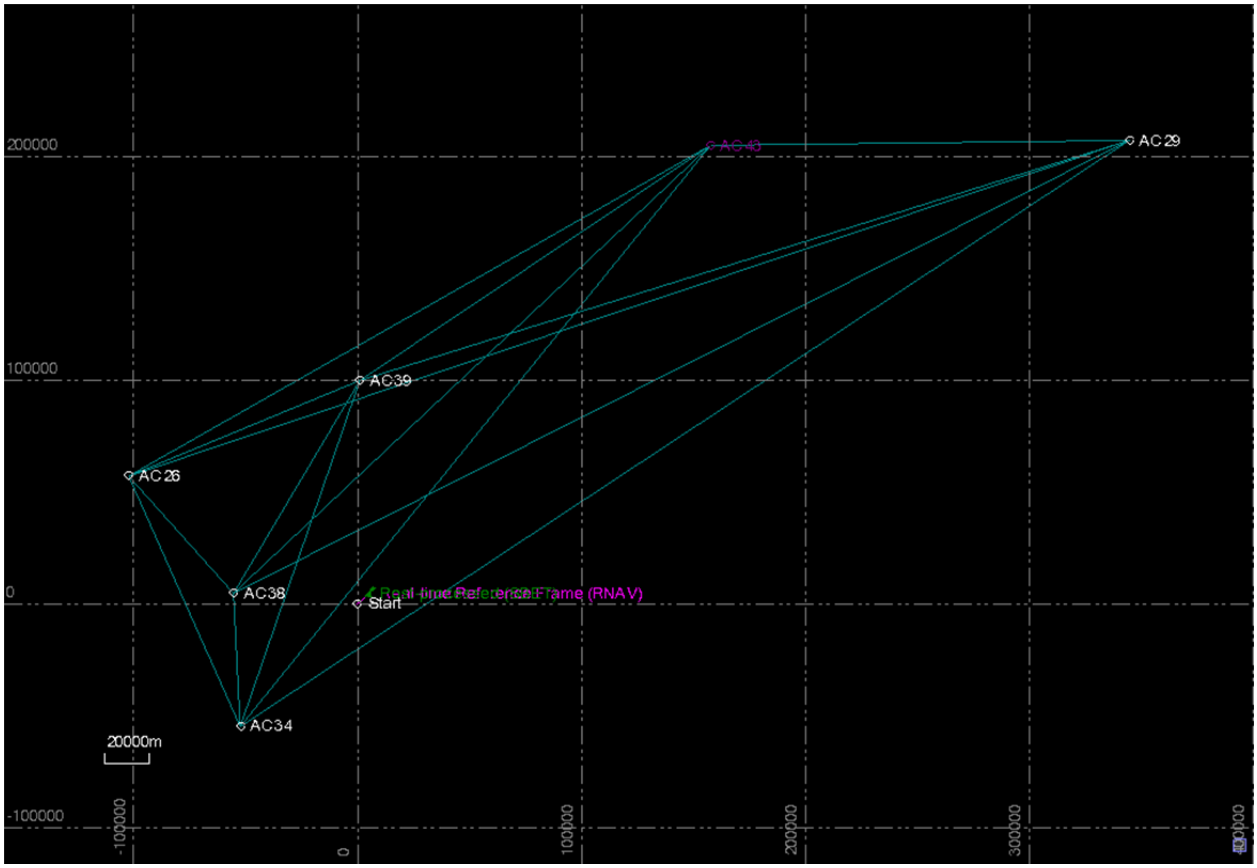

Figure 2: Typical Smart-Base virtual network for OPR-P136-RA-17.

III. Quality Control

All data were processed using Applanix POSPac MMS version 7.1. To ensure compliance with the positional accuracy requirements of Sections 3.1 and 3.2 of the *NOS* Hydrographic Surveys Specifications and Deliverables Manual (HSSD, April 2017) the following checks were conducted:

- North, east and down position error Root Mean Square (RMS) time series plots of the vessel data were reviewed, and the max values were recorded. A majority of the data acquired by the survey launches and ship were found to have a max RMS value of less than 0.07m. Values of higher than 0.07m were specifically logged.
- The vessel altitude time series plot was reviewed for anomalous jumps. If a spike or anomaly was found in the altitude or accelerometer bias time series, they were compared against one another and noted in the log. For additional details see corresponding Descriptive Reports.
- Calibrated installation parameters (i.e. the lever arm from the IMU to the primary GPS antenna) were checked for consistency. These offsets were evaluated on a daily basis and compared to all other data sets acquired by a given vessel for a given survey sheet.
- The processed Positional Dilution of Precision (PDOP) for each vessel file was nominally less than 3. For the most part, each vessel had a maximum daily PDOP of 2.1 to 2.7 with some larger spikes momentarily during drops in GPS satellite reception. The minimum number of satellites and maximum PDOP were recorded for each vessel day. Instances in which the PDOP values exceeded 3 or the number of satellites was less than 5 were noted in the QC logs.

- Sounding data positioned with files that had issues noted above were reviewed following application to verify they did not introduce any artifacts.

IV. Aids to Navigation

There were no fixed aids to navigation assigned within the limits of the project.

V. Horizontal Control Activities

A GNSS base station was installed by *Rainier* personnel at a central location within the project area to ensure sufficient coverage. The base station (*Woody,* Table 2) was installed at the south end of Woody Island, east of the port of Kodiak on day number (DN) 115 with two external 12V batteries and six solar panels in parallel. The site was chosen for its unobstructed view of the sky in all directions and its central location within the project area. Historic monuments were nearby, but were deemed to be inferior locations due to access or sky obstruction concerns. No monument was installed for this occupation. The extensive CORS and UNAVCO base station network permitted Smart-Base solutions with near equivalent quality solutions, compared to Single Base solutions, and short baselines. The base station was recovered on DN 189. The data acquisition rate was set to one sample every second.

Woody, Woody Island		Serial Number
Receiver	Trimble Net R9	5034K69715
Antenna	Trimble Zephyr GNSS	1441031030

Table 2: ***Equipment installed at Woody Island***

Table 3 shows the latitude, longitude, and ellipsoid height of each base station established for this project in IGS08 coordinates. The coordinates were obtained using NGS OPUS processing performed on a 24 hour observation file.

Station Name	N. Latitude	W. Longitude	Ellipsoidal Height
	(Err (m))	(Err (m))	(Err (m))
Woody	57° 45’ 39.600688” (0.012)	152° 21’ 2.68883” (0.017)	45.685 (0.011)

Table 3: ***Base Station coordinates at Woody Island***

VI. Site Descriptions

Woody horizontal control station was established on an open point at the south end of Woody Island, east of the port of Kodiak. The site was selected as it provided a safe location well out of the tidal range, acceptable access by small boat, clear views of the sky in all directions, and at a location central to anchorage and survey operations which allowed near daily Freewave Data Modem (UHF) download of Trimble .T02 files. (Figures 3-7).

Figure 3: Woody GNSS Antenna and solar panel array.

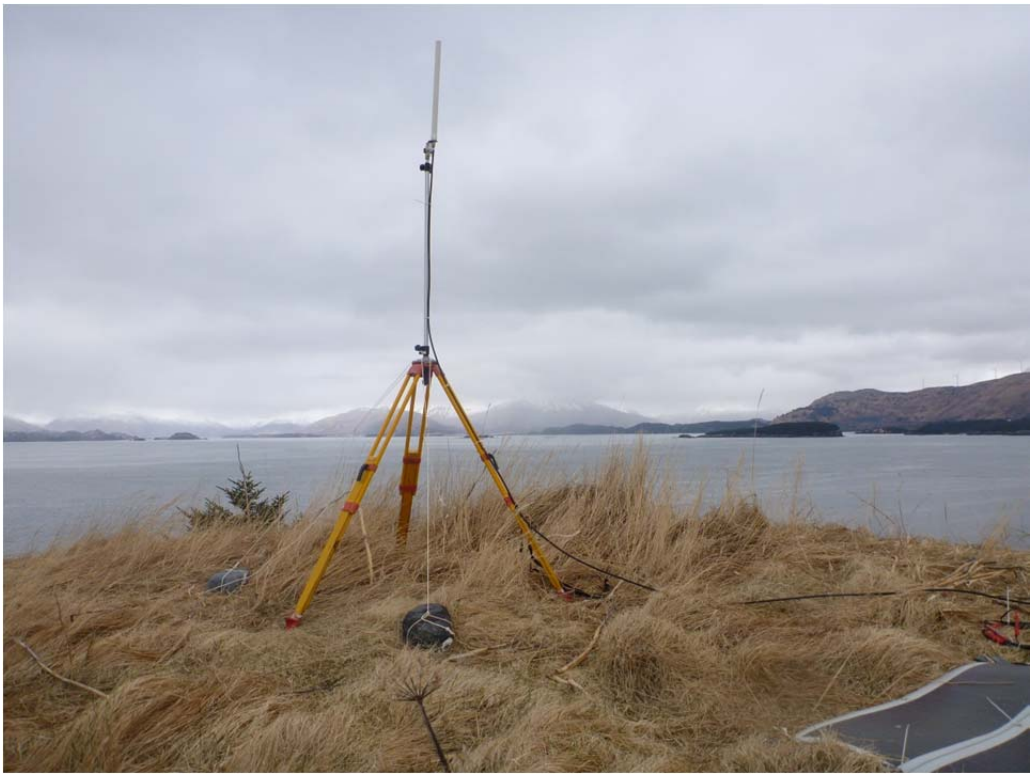

Figure 4: Woody antenna looking south.

Figure 5: Woody antenna looking east.

Figure 6: Woody antenna looking north.

Figure 7: Woody antenna looking west.

C. APPROVAL

As Chief of Party, I have ensured that the field surveying and processing procedures used during this project meet the requirements of the National Ocean Service (NOS) Hydrographic Surveys Specifications and Deliverables (HSSD), dated April 2017, and Office of Coast Survey (OCS) Field Procedures Manual (FPM), dated April 2014.

I acknowledge that all of the information contained in this report is complete and accurate to the best of my knowledge.

Approved and Forwarded: Digitally signed by EVANS.BENJAMIN.K.1237217094 Date: 2018.02.13 17:23:53 -08'00'

_____

Benjamin K. Evans
Commander, NOAA
Commanding Officer, NOAA Ship *Rainier*

In addition, the following individuals were also responsible for overseeing horizontal and vertical control operations for this project:

Control Officer:

WALKER.COLLIN.HARRISON.1523758540
2018.01.29 08:03:04 -08'00'

Collin Walker
Ensign, NOAA

Control Officer:

GAHLINGER.GREGORY.JOS.1100701304
Digitally signed by GAHLINGER.GREGORY.JOS.1100701304
Date: 2018.01.29 15:49:10 -08'00'
27JAN2018

Gregory Gahlinger
Hydrographic Senior Survey Technician, NOAA Ship *Rainier*

Chief Survey Technician:

JACOBSON.JAMES.BRYAN.1269664017
I have reviewed this document
2018.01.30 13:28:52 -08'00'

James B. Jacobson
Chief Survey Technician, NOAA Ship *Rainier*

Field Operations Officer:

BROO.SCOTT.EDWARD.1396599976
2018.01.29 08:16:13 -08'00'

Scott Broo
Lieutenant, NOAA