Report

A comparison of a new generation vessel mounted current meter and buoy operated current profilers

Abstract

Nortek's vessel-mounted ADCP current survey package – called Signature VM – opens up new and unprecedented opportunities to the community, while offering operational convenience and reduced complexity. Data quality can be safeguarded, and both errors and initial installation time can be substantially reduced by using an integrated system where each module is pre-qualified
The system is introduced late 2017. Recently the state of the art survey vessel the Geo Focus, owned by the company Geo Plus, has been equipped with a Signature VM. This document presents the results of a comparison trail made between the Signature VM on board of the vessel and two field operated buoy mounted current meters.

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1.0 Introduction

Within the vessels current operational area two buoys are installed that collect local wave height and current information. The buoys are operated by Van Oord Dredging and Marine Contractors, who make use of the survey vessel Geo Focus. In this document we present a straight forward comparison of the collected data between the both buoy systems and the Signature VM mounted on of the vessel.

Figure 1: The Geo Plus vessel Geo Focus; a 35m Hybrid survey and ROV support vessel.

2.0 Performed measurements and instrument settings

On April 7, 2018 two sets of measurements where performed in close perimeter of the two buoys. Both buoys are equipped with a NORTEK 400KHz Aquadopp current profiler. The vessel Geo Focus is equipped with a NORTEK Signature500 VM (500KHz).

Figure 2 and 3: A NORTEK Aquadopp Profiler mounted in a TRIAXYS™ with Currents Buoy (left) The NORTEK Signature500 VM hull mounted on the vessel Geo Focus (right)

Multiple lines are sailed per buoy including one "stationary" measurement per buoy location. The buoys collect current information based on a 5 minute average started each hour. For a tight comparison this report only describes the data which is recorded near the full hour.

2.1 Location of the buoys

Name	Easting	Northing	Latitude	Longitude
NORTH_TAB03132_TAS05532	500604.17	5709838.11	51°32.378613'N	003°00.522695'E
SOUTH_TAB02692_TAS05372	499700.00	5706050.00	51°30.334937'N	002°59.740650'E

Table 1: Location of both buoys, located in the Belgium North Sea. The comparison measurements with the NORTEK Signature VM system have taken place in close perimeter of both buoys. The geographical distance between both buoys is roughly 4 km.

2.2 Instrument settings

Description	Buoy mounted current meter	NORTEK Signature VM
Mounting depth:	0.48 m	1.25 m
Blanking:	1.24 m	0.50 m
Cell size:	1.00 m	0.50 m
Number of cells:	20	Full depth
Measurement interval:	1 h	1 s
Measurement duration:	5 Min	Various per survey line
Time:	UTC+0	UTC+0
Doppler processing technique:	Narrow band	Broadband
Operating frequency:	400 KHz	500 KHz

Table 2: Settings of the current profilers. Both current meters on the buoys are set-up using the same configuration.

2.3 Processing

The datasets from the buoys contain time, velocity magnitude and directional data per cell and is delivered pre-processed. The data is based on 5 minute averages, started at each full hour.

The data from the Signature has been selected using the VM review software and is later presented using the USGS Velocity Mapping Toolbox (VMT). No advanced filtering on amplitudes, correlation or interpolation has taken place. The last 10% in depth, the side lobe contaminated area near the bottom, has been cut off.

The data of both systems are collected using different cell resolutions and a different number of cells. The covered area within the water column differs marginally between the systems. The Signature VM system grossly collects data between 2-22m of depth, after a 10% cut off for side lobe reflections. The both buoys grossly collect data between 2-22m of depth. For comparison purposes all data measured over the water column is averaged to one direction and one velocity magnitude value.

2.4 Sea state condition

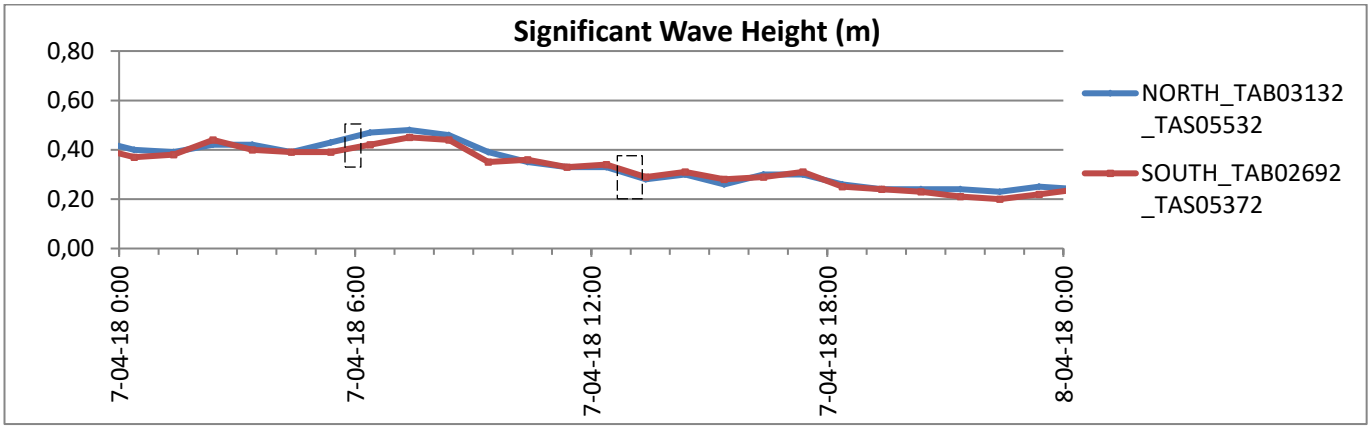

Figure 4: Wave height information of April 7, 2018 recorded by both buoys. The boxed areas indicate the periods of the comparison measurements made. The left boxed area corresponds with the measurements made at the Northern buoy and at the right the Southern buoy.

3 Results

3.1 Buoy data comparison

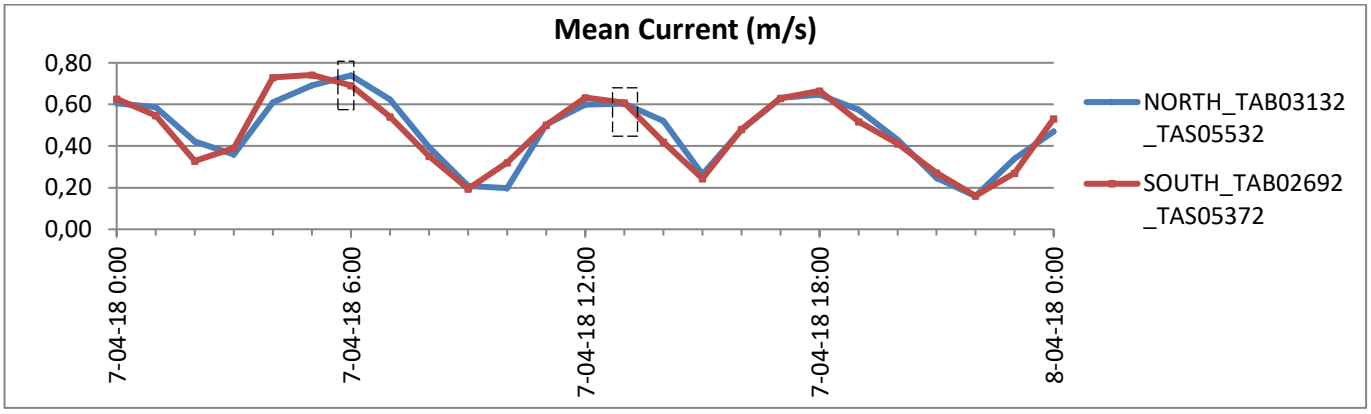

Figure 5: Display of the velocity magnitude data averaged over the water column. Data of the Northern buoy is displayed in blue, the Southern in red.

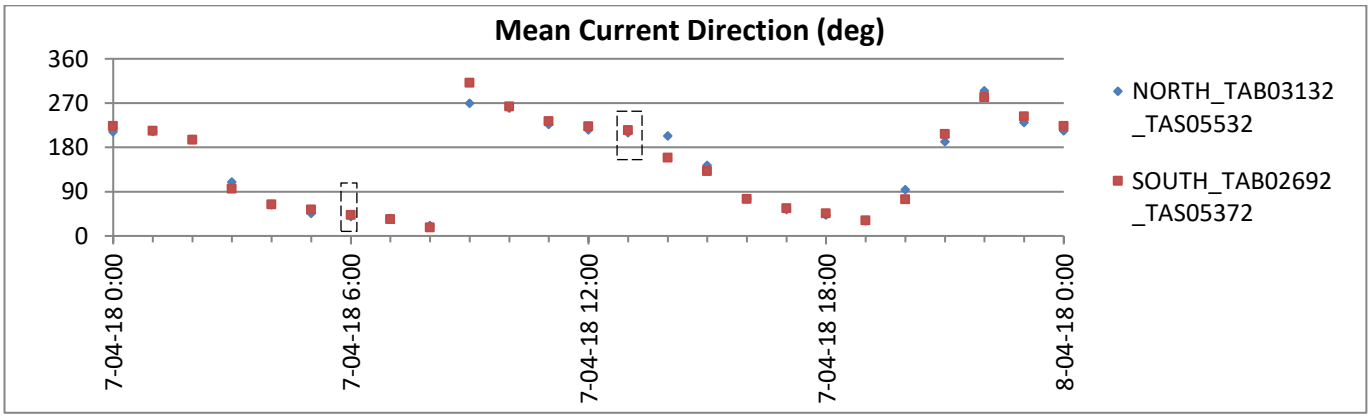

Figure 6: Display of the directional current data, averaged over the water column.

Name	Overall mean difference (m/s)	Standard deviation over the mean difference time series (m/s)	Mean difference (degrees)	Standard deviation over the mean difference time series (degrees)
NORTH_TAB03132_TAS05532 – SOUTH_TAB02692_TAS05372	0,01	0,06	0,52	14,92

Table 3: Differences between both buoys based on the displayed dataset of April 7, 2018.

3.2 Comparison Signature VM – Northern Buoy

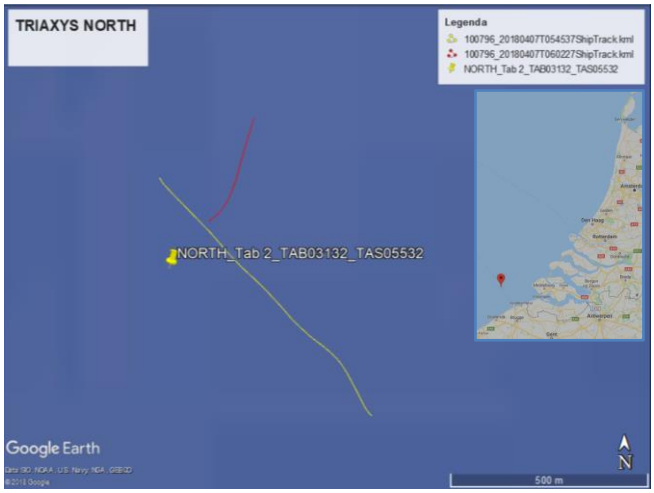

Figure 7: The red market situated on the map insert locates the position of the two buoys in the Belgium North Sea. The yellow pin point identifies the location of the Northern buoy.
Two lines have been recorded around 06:00h:

- *Line T054537 in yellow represents a sailed line.*
- *Line T060227 in red represents a drift line, without using the propeller.*
- *The file name represents the UTC time at start of the line.*

3.2.1. Buoy data recorded during comparison measurement taken at 6:00 AM, April 7

Name	Time start-stop UTC+0	Mean Current (m/s)	Mean Direction (degrees)
NORTH_TAB03132_TAS05532	6:00-6:05	0,74	39,35
SOUTH_TAB02692_TAS05372	6:00-6:05	0,69	42,25

Table 4: Recorded data from the both buoys at 6:00h, April 7. Data from the Southern buoy is given as a secondary reference.

3.2.2. Signature VM data recorded around 6:00 AM, April 7

Name	Time start-stop UTC+0	Mean Current (m/s)	Standard deviation over all depth averaged ensembles (m/s)	Mean Direction (degrees)	Standard deviation over all depth averaged ensembles (degrees)
T054537	5:45-5:53	0,70	0,05	40,96	3,27
T060227	6:02-6:07	0,75	0,04	38,17	2,98

Table 5: Signature VM data of lines T054537 and T060227

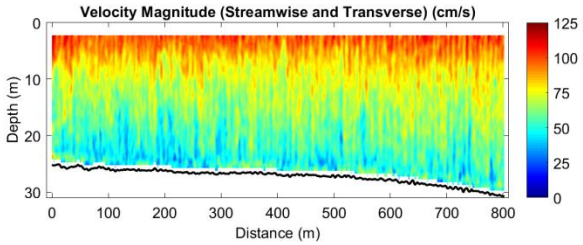

Figure 8: Velocity Magnitude Line T054537

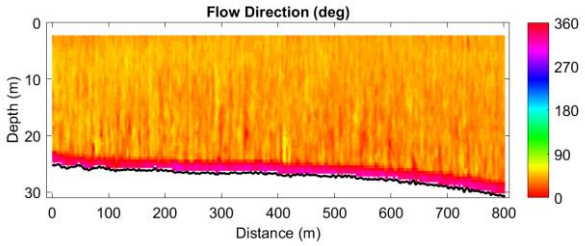

Figure 9: Flow Direction Line T054537

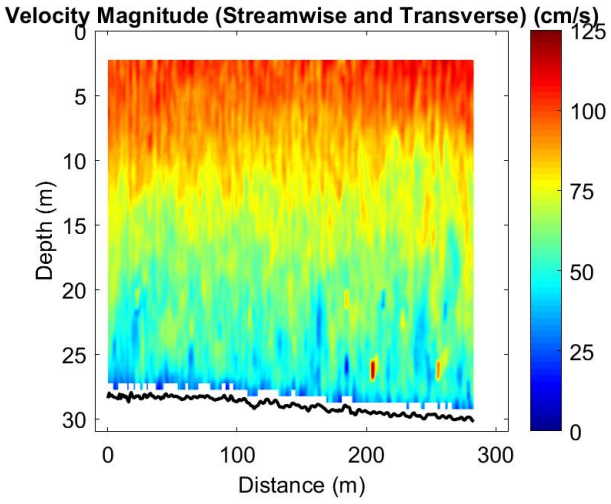

Figure 10: Velocity Magnitude Line T060227

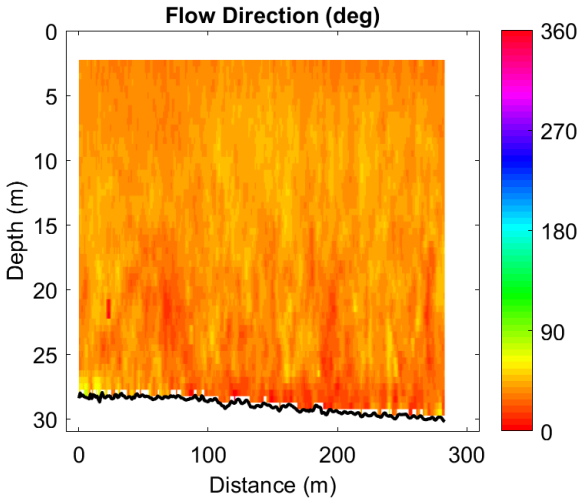

Figure 11: Flow Direction Line T060227

Above graphs present data over the full water column, including data that has been cut off afterwards for a 10% side lobe containment correction.

3.3 Comparison Signature VM – Southern Buoy

Figure 12: The yellow pin point identifies the location of the Southern buoy. Three lines have been recorded around 13:00h:

- *Line T124653 in red*
- *Line T130154 in yellow*
- *Line T131304 in green*

3.3.1. Buoy data recorded during comparison measurement taken at 13:00h, April 7

Name	Time start-stop UTC+0	Mean Current (m/s)	Mean Direction (degrees)
NORTH_TAB03132_TAS05532	13:00-13:05	0,60	209,25
SOUTH_TAB02692_TAS05372	13:00-13:05	0,61	214,80

Table 6: Recorded data from the both buoys at 13:00h, April 7. Data from the Northern buoy is given as a secondary reference.

3.3.2. Signature VM data recorded around 13:00h, April 7

Name	Time start-stop UTC+0	Mean Current (m/s)	Standard deviation over all depth averaged ensembles (m/s)	Mean Direction (degrees)	Standard deviation over all depth averaged ensembles (degrees)
T124653	12:46-12:51	0,57	0,03	220,45	2,18
T130154	13:01-13:07	0,56	0,03	219,20	2,57
T131304	13:13-13:17	0,54	0,02	217,74	2,14

Table 7: Signature VM data of lines T124653, T130154 and T131304

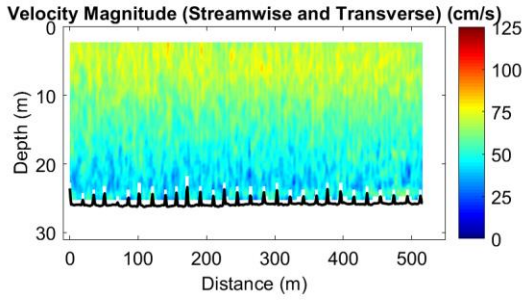

Figure 13: Velocity Magnitude Line T124653

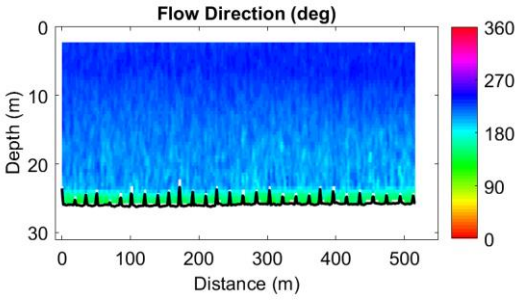

Figure 14: Flow Direction Line T124653

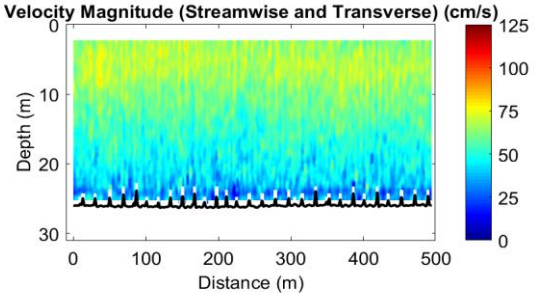

Figure 15: Velocity Magnitude Line T130154

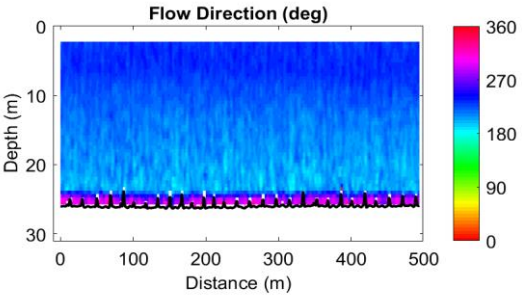

Figure 16: Flow Direction Line T130154

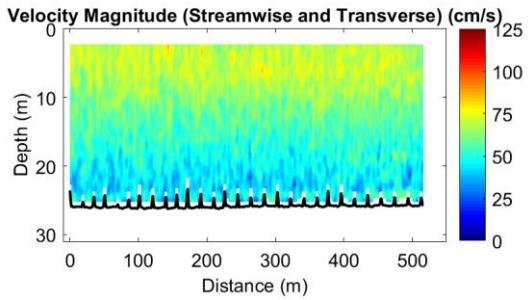

Figure 17: Velocity Magnitude Line T131304

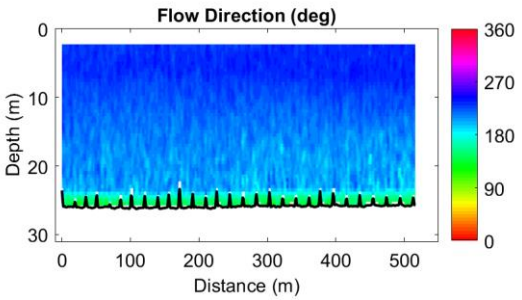

Figure 18: Flow Direction Line T131304

Above graphs present data over the full water column, including data that has been cut off afterwards for a 10% side lobe containment correction.

4.0 Review of data and Conclusions

Sea state:

Sea state has been low (H_s<0.50m) and became less during the day. Any side effects due to the sea state can be ruled out.

Inter buoy comparison:

The data between the buoys appears to correlate well. The data contains some outliers which are responsible for the higher deviation. The presented data is based on averaged values, no raw data for further investigation about the reason of the outliers is available. As the buoys are in within a relative small distance some minimal tidal related offset in time is present, but not taken into account.

Northern buoy comparison:

Around 6:00h tide is running towards North around the maximum available flood current. The increasing velocities and decreasing current direction of the two Signature VM measurements are in line with the expectations, as can be verified in figure 5 and 6.

Measured velocities and direction from the Signature VM [1,2] compare very well with the measured values from the nearby positioned Northern buoy [3]

1. [T054537; 0,70 m/s, 40,96°]
2. [T060227; 0,75 m/s, 38,17°]
3. [0,74 m/s, 39,35°]

Southern buoy comparison:

Around 12:00h tide is running towards South around the maximum available ebb current. The decreasing velocities and decreasing current direction of the three Signature VM measurements are in line with the expectations, as can be verified in figure 5 and 6.

Measured velocities and direction from the Signature VM [1,2,3] compare well with the measured values from the nearby positioned Southern buoy [4]

1. [T124653; 0,57 m/s, 220,45°]
2. [T130154; 0,56 m/s, 219,20°]
3. [T131304; 0,54 m/s, 217,74°]
4. [0,61 m/s, 214,80°]

Acoustic interference:

The data acquired around 13:00h is contaminated with acoustic interference from a secondary acoustic source. This is not only present as periodic spikes in the bottom tracking depth of figures 13-18 but also contaminates the velocity data from two of the four acoustic ADCP beams. It needs further investigation to be able to verify if this can be allocated as a cause for the slightly underestimated current magnitude based from these datasets. In case the marginal effect can be assigned to interference, further determination of the secondary acoustic source may reduce or even eliminate any contamination effects.

Overall conclusion:

Not only the data recorded by the two buoys, as well as the Signature VM system consequently follow the tidal trend which is reflected in figures 5 and 6. The recorded differences are minimal and well within the tolerances of which may be expected measuring from moving platforms. The comparison confirms a proper operation of the systems.