

# Compass calibration of deployment NWZQ1109

Tórshavn · February 2013



**Karin Margretha H. Larsen**  
**Regin Kristiansen**  
**and Ebba Mortensen**

# Contents

Introduction.....	3
Quality control and calibration .....	3
Report format .....	4
NWZQ1109.....	9
NWZQ1205.....	11

## Introduction

This report documents the compass calibration of RDI Workhorse Sentinel ADCP (SN 0936) at deployment NWZQ1109. The ADCP compass could not be properly calibrated prior to deployment. A calibration rig (NWZQ1205) containing two Aanderaa current meters was therefore deployed for a day close to the NWZQ1109 mooring before planned recovery. Table 1 lists the details of the two moorings while Figure 1 shows the deployment location. The deployments are identified by an 8-character label where the first four characters indicate the site while the last characters show year and month of deployment.

The NWZQ1109 data are presented in Mortensen et al, 2012 (Mortensen et al, 2012. THOR ADCP Deployments in Faroese Waters 2011 - 2012. Havstovan nr. 12-03, Technical Report), so here we only present the meta data for the deployment. The data for the NWZQ1205 calibration rig are presented as in standard reports and those details are described below.

## Quality control and calibration

The Aanderaa speed and direction data have been calibrated using calibration coefficients from the manufacturer. Temperatures and pressure data are uncalibrated. In the Aanderaa current meter, several speed and compass readings are taken during a sampling interval, while the temperature readings are taken once at the end of the interval only. At the end of the interval, the instrument stores a vector average of the velocity for the whole sampling interval, as well as the temperature readings. In the data file, the time of each record is the middle of the speed-averaging interval. In the calibration procedure the direction has been corrected for magnetic declination by adding a constant. The actual correction is shown in the mooring meta

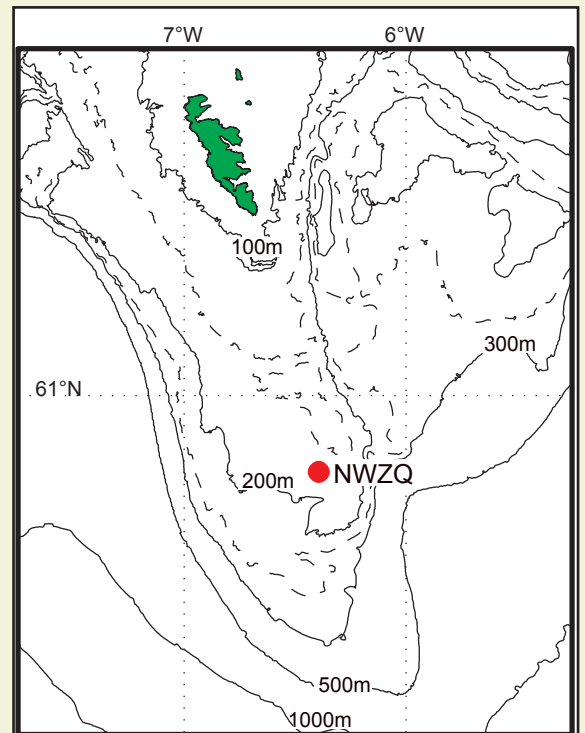


Figure 1. Map of the study area. The NWZQ location is indicated by a red dot.

Table 1. List of deployments with information on duration and range of valid data. All depths are in meters.

Deployment	Bottom depth	Int. min.	Valid data period	Dur. days	No. bins	Depthrange	Instrument type
NWZQ1109	169	20	2011 09 04 - 2012 05 19	258	17	30 - 158	ADCP
-	169	5	2011 09 04 - 2012 05 19	258	-	168	Starmon
NWZQ1205	169	5	2015 05 18 - 2012 05 19	1	-	94 - 144	2xAanderaa

data (p 9). The data have been quality controlled by a standard procedure based upon data variation with time in relation to neighbouring bins (spikes). The editing has been done manually using an interactive graphical software package developed by the FAMRI, based upon MATLAB. The editing has been done with a philosophy of minimal interference. Thus, only observations which were considered clearly erroneous were flagged.

## NWZQ1109 compass calibration

The NWZQ1109 ADCP heading and direction has been corrected for magnetic declination and compass offset, by adding a constant. The value of the constant was found from the calibration rig, NWZQ1205 as outlined below:

The ADCP data were converted to standard ASCII format, but without correction for magnetic declination. An ADCPs ensemble time is the time of the first ping of the ensemble. The ADCP was set up with 24 pings per ensemble uniformly spaced over a time interval of 20 min. The Aanderaa data were also converted to their standard ASCII format, but with a correction of  $-6^\circ$  for magnetic declination at the deployment location. As mentioned above the time of an Aanderaa record is in the centre of the interval, where direction is recorded at the end of the interval only. Since the Aanderaa instruments had 5 min intervals, these data were averaged to a 20 min interval serie, with a time stamp equal to the ADCP time at the beginning of the averaging period such that the timing of the averaged Aanderaa serie is in accord with the ADCP data.

Figure 2 shows the direction from the two Aanderaa instruments and the observed direction from the ADCP at similar depth levels as the Aanderaa data \*). Since the direction continuously increases from 0 to 360 two times in the observational period, a linear regression was made on the data for each of these periods.

At both 94 and 144 meter depth (ADCP bin 10 and 4, respectively) the regression analysis showed that only a constant offset needs to be added to the ADCP data to correct the direction. The offset value

for each interval was  $13.3^\circ$  and  $12.2^\circ$  at 94m and  $4.9^\circ$  and  $2.8^\circ$  at 144m, respectively. The recorded speed during the deployment at the Aanderaa instruments was between 150 and 650 mm/s and, according to the Aanderaa and ADCP specifications, the accuracy of all three instruments thus was  $\pm 5^\circ$  (Aanderaa instruments have a different accuracy at very low and very high velocities). The discrepancy between the offset for the two layers is thus close to the limit of the range of the accuracy of the instruments. Since we only use one constant for all observations of direction in the data set, the ADCP compass deviation is calculated as the average of these two values (ADCP compass deviation =  $8^\circ$ ). As seen in Figure 3 this results in a better fit for the upper depth layer (94m), but a worse fit for the lower layer (144m). Still, this is believed to be the overall best fit.

The result of this compass calibration strongly recommends a factory calibration of the ADCP compass.

## Report format

This report contains first a drawing of the NWZQ1109 mooring and details of that deployment. Then there are a number of pages for deployment NWZQ1205 where the first page has a drawing of the mooring and details of the deployment. After that, there are some pages describing the data from the individual instruments on the mooring.

The description of the Aanderaa current meter data includes first a text page listing metadata information in the header and showing the list of parameters in the data file with a tally of the number of records flagged and not flagged for error in each parameter. Any comments to the data are then listed. The rest of the text page describes features of the velocity observations in the series. First is shown the residual current, defined as the vectorial average of all non-flagged records. Next are shown the results of tidal analysis on the series. The number of records interpolated before the analysis is listed as well as the number that could not be interpolated (too large gap), followed by the filters used before the tidal analysis is performed.

*\*) The calibration was done in September 2012. Unfortunately, the depths of the NWZQ1109 and NWZQ1205 instruments were slightly incorrect and these were updated in January 2013. According to the new depth values, bin 9 and 3 should have been used for the calibration, but that would not significantly change the result. All depth values listed here regarding the calibration are the corrected Aanderaa depths.*

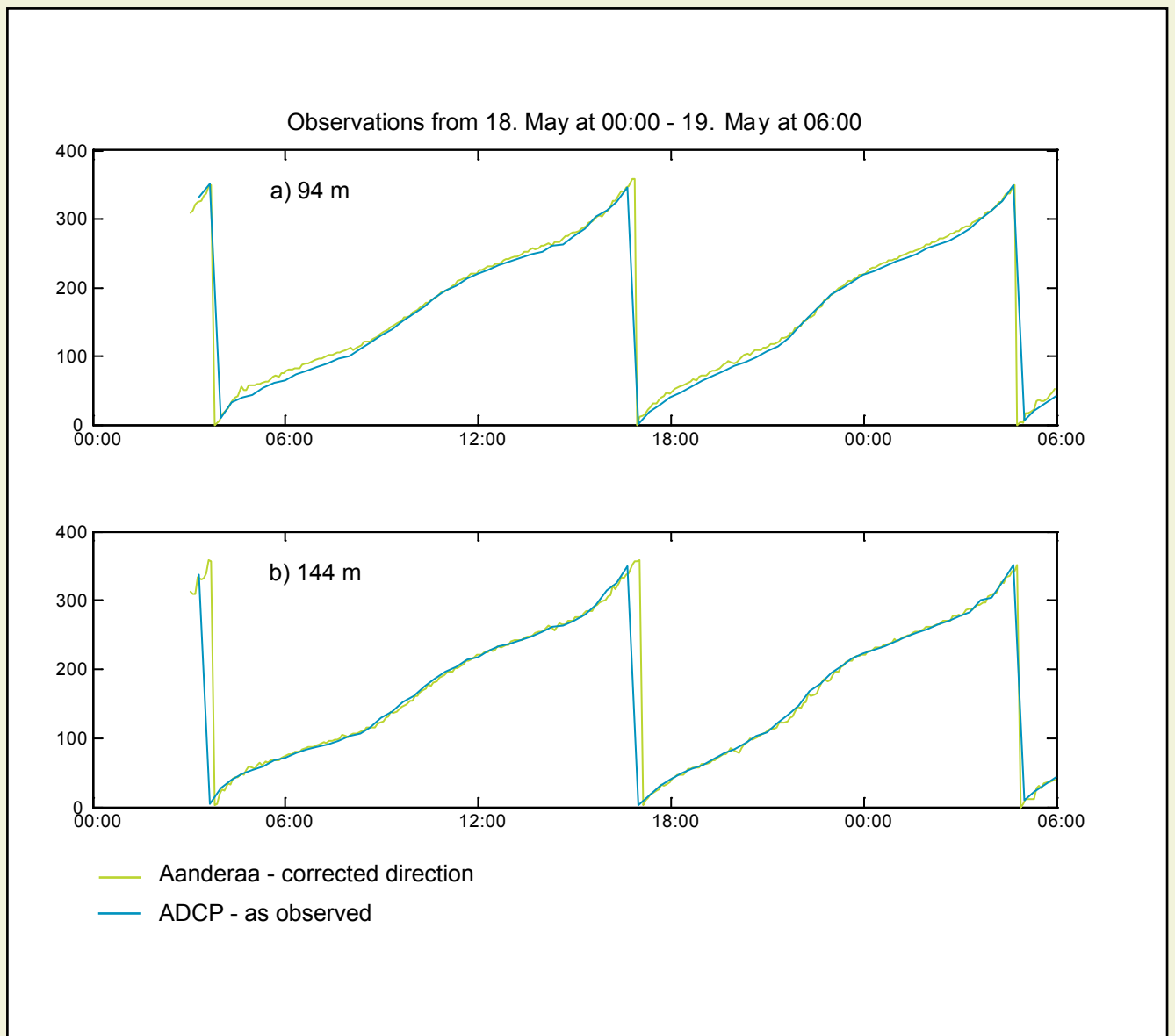


Figure 2. Direction at a) 94m depth and b) 144m depth from the two Aanderaa current meters on NWZQ1205 and bin 10 and bin 4, respectively, from the ADCP at NWZQ1109. The Aanderaa direction (green) is corrected for magnetic declination ( $-6^\circ$ ) while the ADCP data are shown uncorrected (blue).

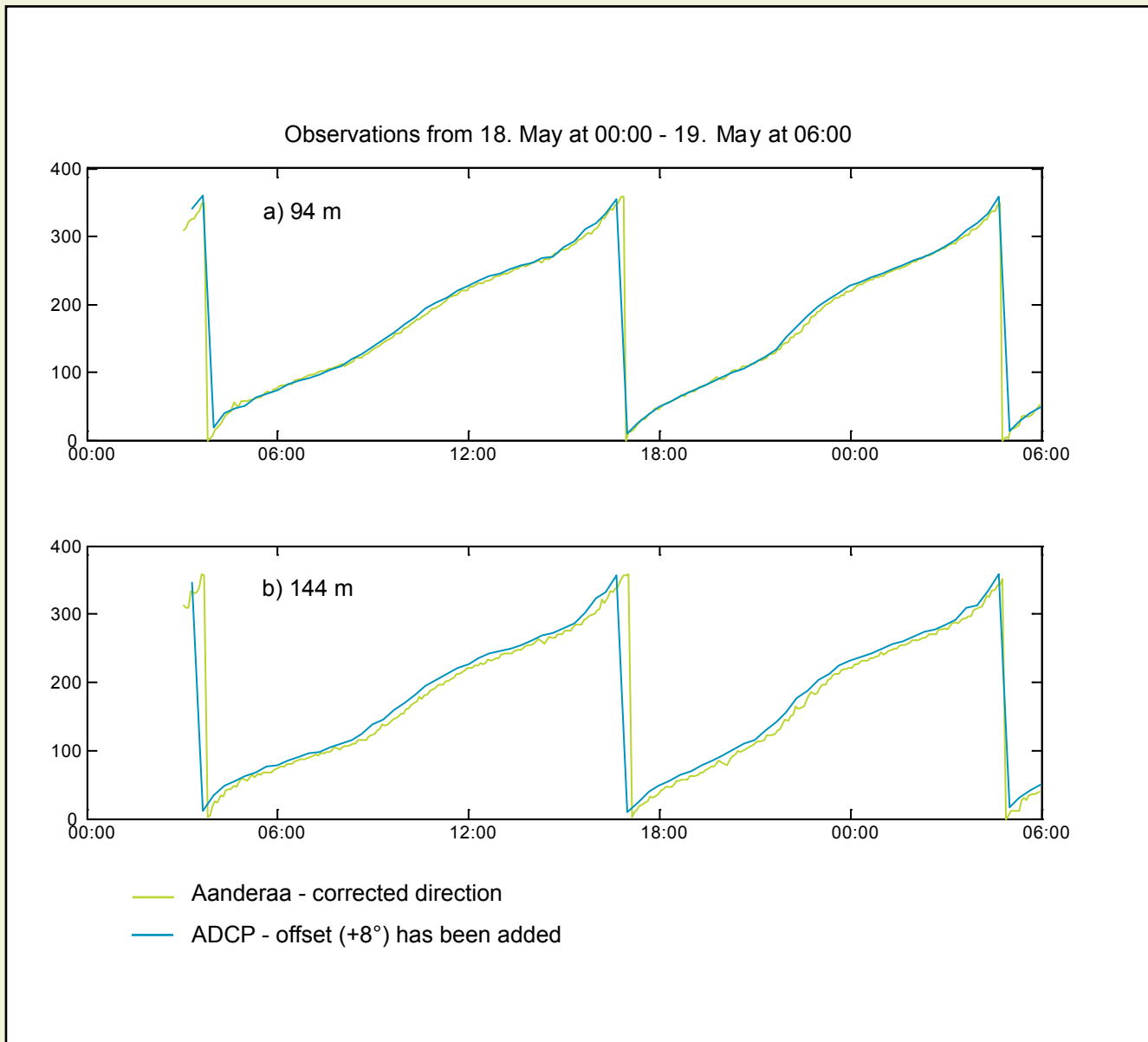


Figure 3. Direction at a) 94m depth and b) 144m depth from the two Aanderaa current meters on NWZQ1205 and bin 10 and bin 4, respectively, from the ADCP at NWZQ1109. The Aanderaa direction (green) is corrected for magnetic declination (-6°) while the ADCP data (blue) are added an offset +8°, as described in the text.

Five dominant constituents are listed and for each constituent, amplitude and Greenwich phase lag are shown for the east (E-ampl and E-gpl) and the north (N-ampl and N-gpl) velocity components respectively, followed by the characteristics of the tidal ellipse, its major and minor semi-axes, the inclination (Incl) of the ellipse, its Greenwich phase lag (Grphl), and whether it rotates cyclonically (C) or anticyclonically (A). The definitions of the tidal ellipse parameters are shown in Figure 4. The tidal constants were computed by an adapted version of the Foreman FORTRAN package. Finally, on the Aanderaa text page, is a table listing the directional current distribution as relative numbers of observations in parts per thousand. The table also lists for each direction interval, the total number (in ppt), the relative flux (direction weighted by the speed), the average speed and the maximum speed. Then one or two pages show plots of the listed parameters as a function of time and one page shows the progressive vector diagram.

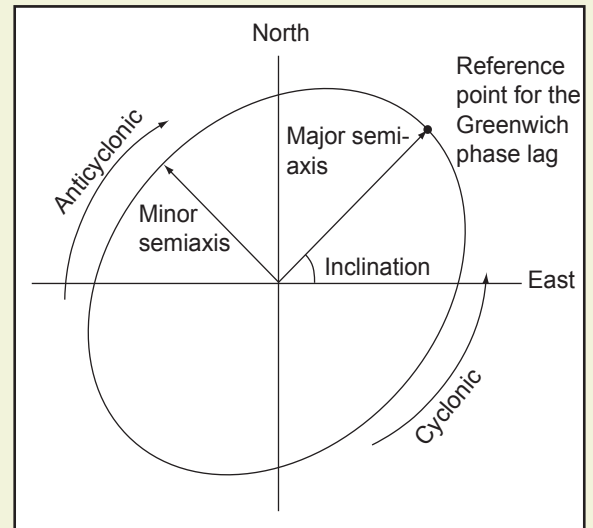


Figure 4. Parameters of the tidal ellipse for a given constituent. The reference point for the Greenwich phase lag is always chosen to be above the east-west axis.





## NWZQ1109

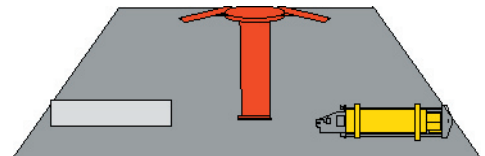
**Latitude:** 60°50.008'N  
**Longitude:** 006°23.553'W  
**Echo sounding depth:** 166 m  
**Bottom depth corr.:** 169 m  
**Time of deployment:** 4/9 - 2011 0146 UTC  
**Time of recovery:** 19/5 – 2012 0755 UTC

### ADCP:

**Instrument no.:** RDI ADCP 0936  
**Instrument frequency:** 300 kHz  
**Height above bottom:** 1 m  
**Depth:** 168 m (corr.)  
**Time of first data:** 4/9 – 2011 0200 UTC  
**Time of last data:** 19/5 – 2012 0739 UTC  
**Sample interval:** 20 min  
**No. of ensembles:** 18594  
**Pings per ens.:** 24  
**Binlength:** 8 m  
**Depth of first bin:** 158 m (corr.)  
**No. of bins:** 17

### Starmon:

**Instrument no.:** 0656  
**Height above bottom:** 1 m  
**Time of first data:** 4/9 – 2011 0150 UTC  
**Time of last data:** 19/5 – 2012 0740 UTC  
**Sample interval:** 10 min  
**No. of ensembles:** 37188  
**Instrument depth:** 168 m



### Data:

All data ok. ADCP heading is calibrated against calibration mooring NWZQ1205.



## NWZQ1205

**Latitude:** 60°50.000'N  
**Longitude:** 006°23.520'W  
**Echo sounding depth:** 166 m  
**Bottom depth corr.:** 169 m  
**Time of deployment:** 18/05 - 2012 02:51 UTC  
**Time of recovery:** 19/05 - 2012 07:16 UTC

### Aanderaa (NWZQ1205-094):

**Instrument no.:** RCM7 9741  
**Height above bottom:** 75 m  
**Depth:** 94 m (corr.)  
**Time of first data:** 18/05 - 2012 02:57UTC  
**Time of last data:** 19/05 - 2012 07:12UTC  
**Sample interval:** 5 min  
**No. of records:** 340  
**Compass declination:** -6°

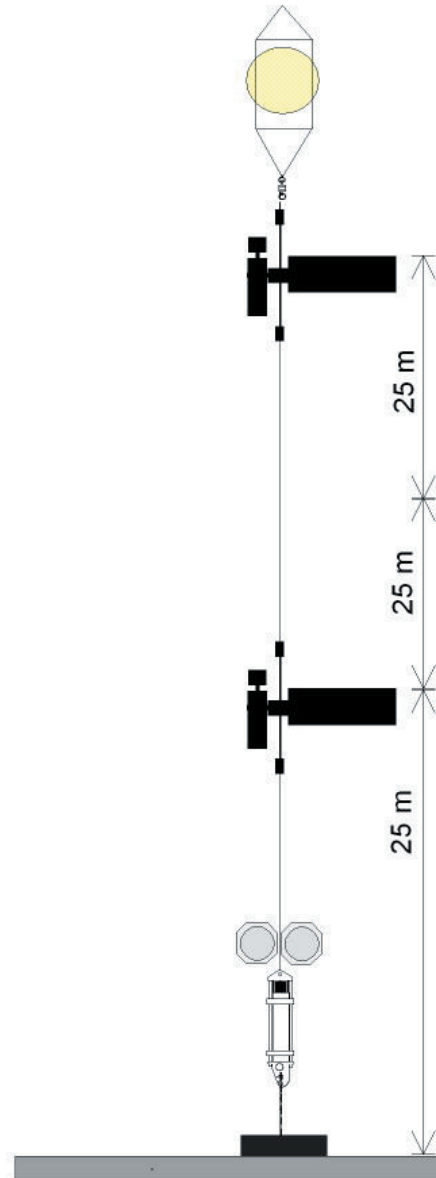
### Aanderaa (NWZQ1205-144):

**Instrument no.:** RCM7 9742  
**Height above bottom:** 25 m  
**Depth:** 144 m (corr.)  
**Time of first data:** 18/05 - 2012 02:57UTC  
**Time of last data:** 19/05 - 2012 07:12UTC  
**Sample interval:** 5 min  
**No. of records:** 340  
**Compass declination:** -6°

### Data:

Ok.

Temperature and pressure are not calibrated.



# NWZQ1205-094 Aanderaa 9741

Deployment: NWZQ1205 analyzed from beginning to end  
 Instrument no.: 9741  
 Instrument type: Aanderaa  
 Latitude: 60 50.000 N  
 Longitude: 06 23.520 W  
 Bottom depth: 169  
 Instrument depth: 94  
 Number of records: 340  
 Time of first record: 2012 05 18 02 57  
 Time of last record : 2012 05 19 07 12  
 Time between records (min.): 5.000

Parameters	Records OK	Records flagged
Column 1 : Recno		
Column 2- 4: Date		
Column 5- 6: Time		
Column 7 : Temp	340	0
Column 8 : Speed	340	0
Column 9 : Direct	340	0
Column 10 : Press	340	0

## Comments

Residual current: 41 mm/sec towards: 169 degrees

## TIDAL ANALYSIS

Error flagged records interpolated for velocity: 0, records not int.: 0  
 Tidal analysis on data passed through 3 filters: A12, A12, and A13

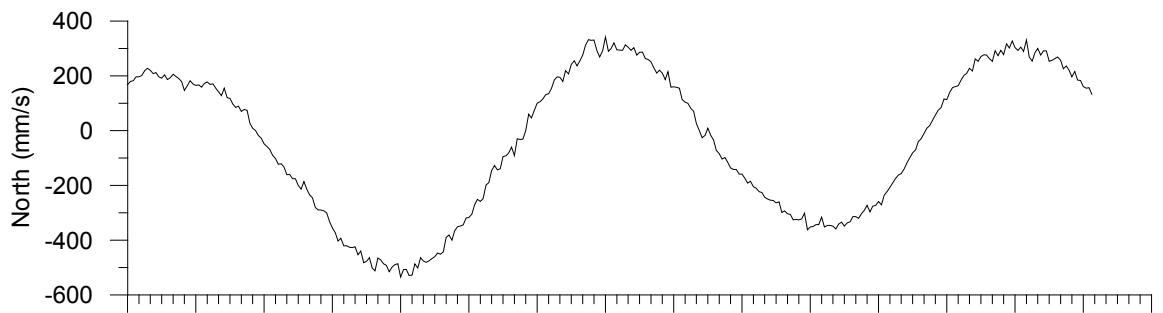
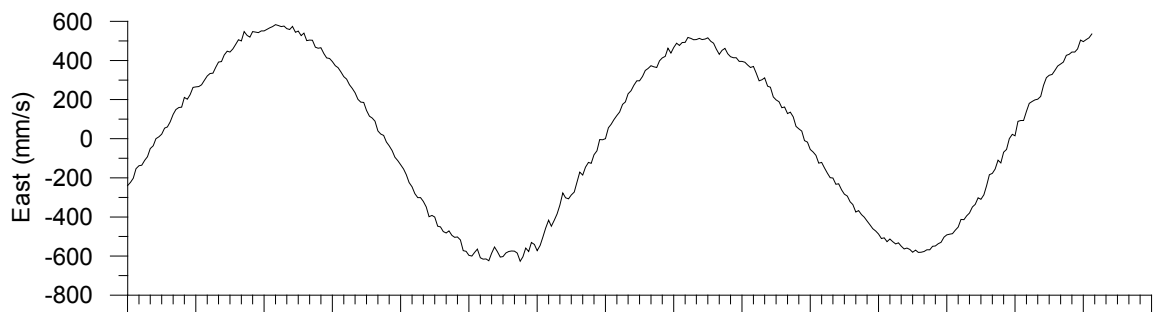
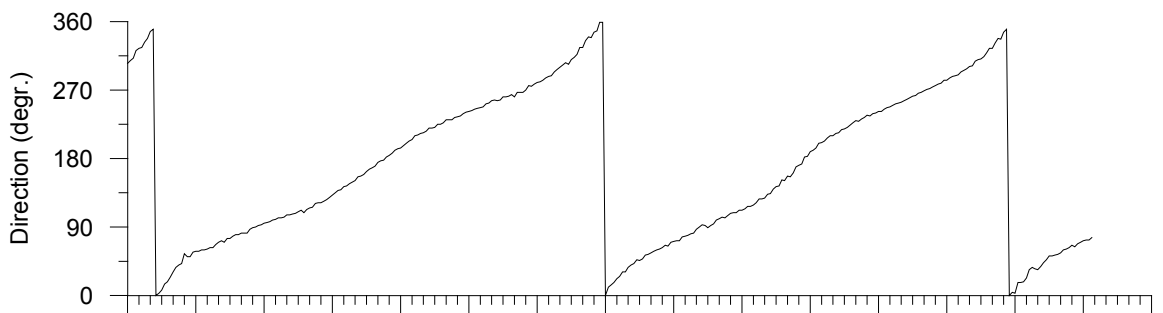
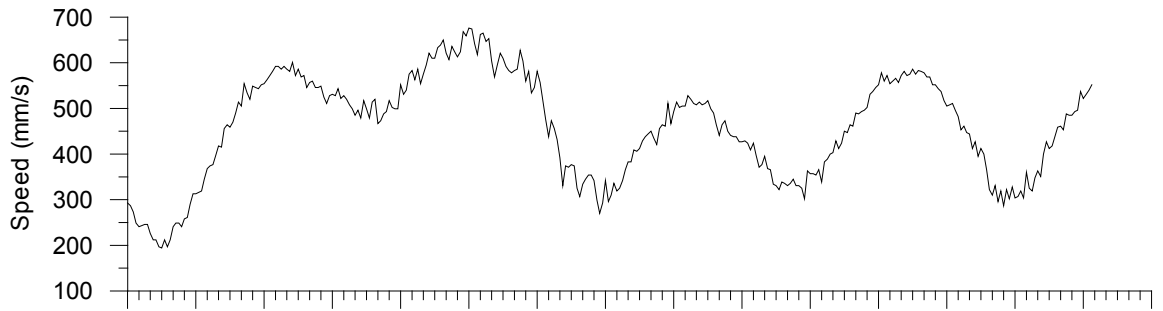
Const	Freq c/hr	E-ampl mm/sec	E-gpl deg	N-ampl mm/sec	N-gpl deg	Major mm/sec	Minor mm/sec	Incl deg	Grphl deg	R
O1	.03873065	29	347	48	239	49	26	105	230	A I
K1	.04178075	27	221	45	112	47	25	106	103	A
M2	.08051140	526	264	326	182	530	321	8	258	A
S2	.08333334	184	300	105	217	185	104	6	296	A I
M4	.16102280	20	70	23	308	27	15	129	284	A

## DIRECTIONAL CURRENT DISTRIBUTION (for all nonflagged observations in series)

Relative number of observations in parts per thousand (ppt) grouped into speed and direction intervals (of 30 degree width centred around the directions shown)

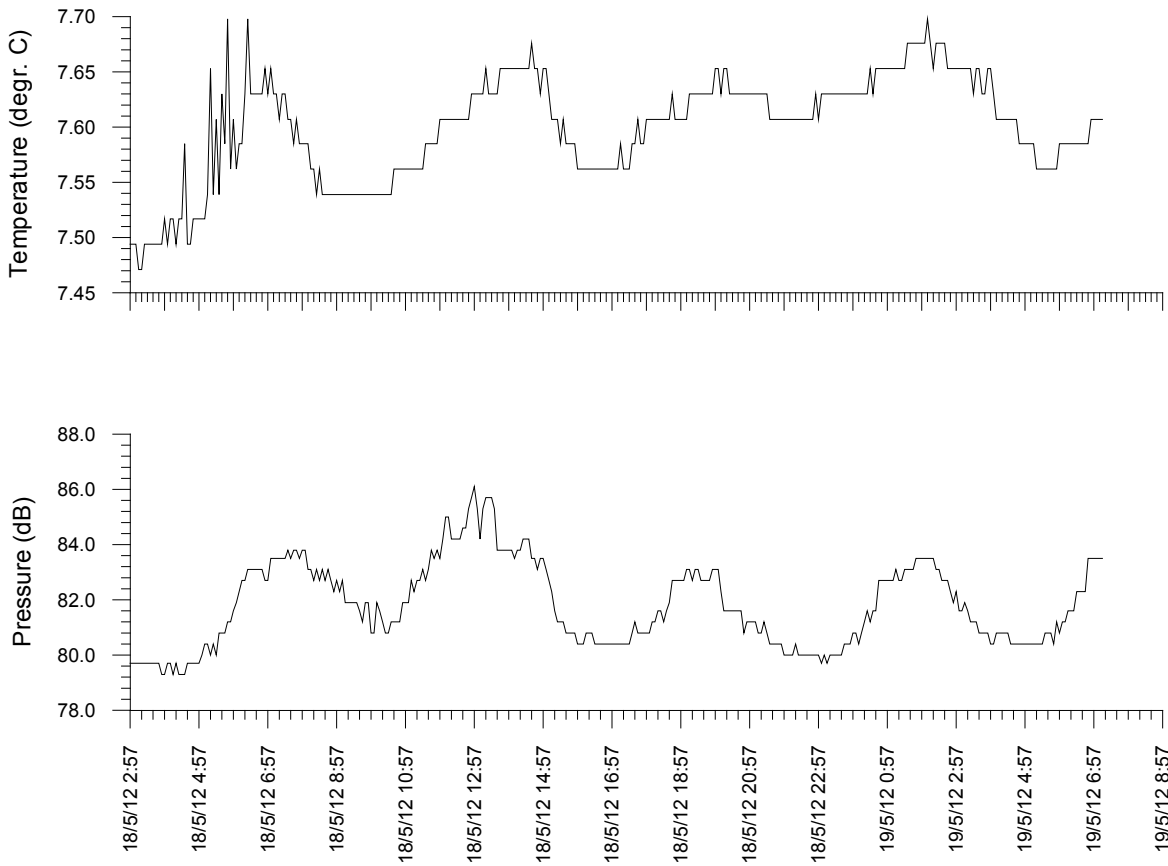
Speed intervals (mm/s)	Direction intervals												All dir.	
	15	45	75	105	135	165	195	225	255	285	315	345	Tot	Acc
0 - 50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50 - 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100 - 150	0	0	0	0	0	0	0	0	0	0	0	0	0	0
150 - 200	9	0	0	0	0	0	0	0	0	0	0	0	9	9
200 - 300	12	21	0	0	0	0	0	0	0	0	18	26	76	85
300 - 400	35	44	12	0	26	24	29	0	0	3	38	21	232	318
400 - 500	0	47	50	47	3	24	12	32	0	29	12	0	256	574
500 - 600	0	0	68	62	38	9	24	24	74	47	0	0	344	918
600 - 700	0	0	0	3	0	0	0	38	41	0	0	0	82	1000
Total (ppt)	56	112	129	112	68	56	65	94	115	79	68	47		
Rel.flux (ppt)	34	89	138	126	68	52	63	113	149	88	50	30		
Avg.spd (mm/s)	283	365	489	516	463	426	449	551	598	507	342	296		
Max.spd (mm/s)	360	461	554	601	549	520	583	668	676	581	444	354		

# NWZQ1205-094 Aanderaa 9741



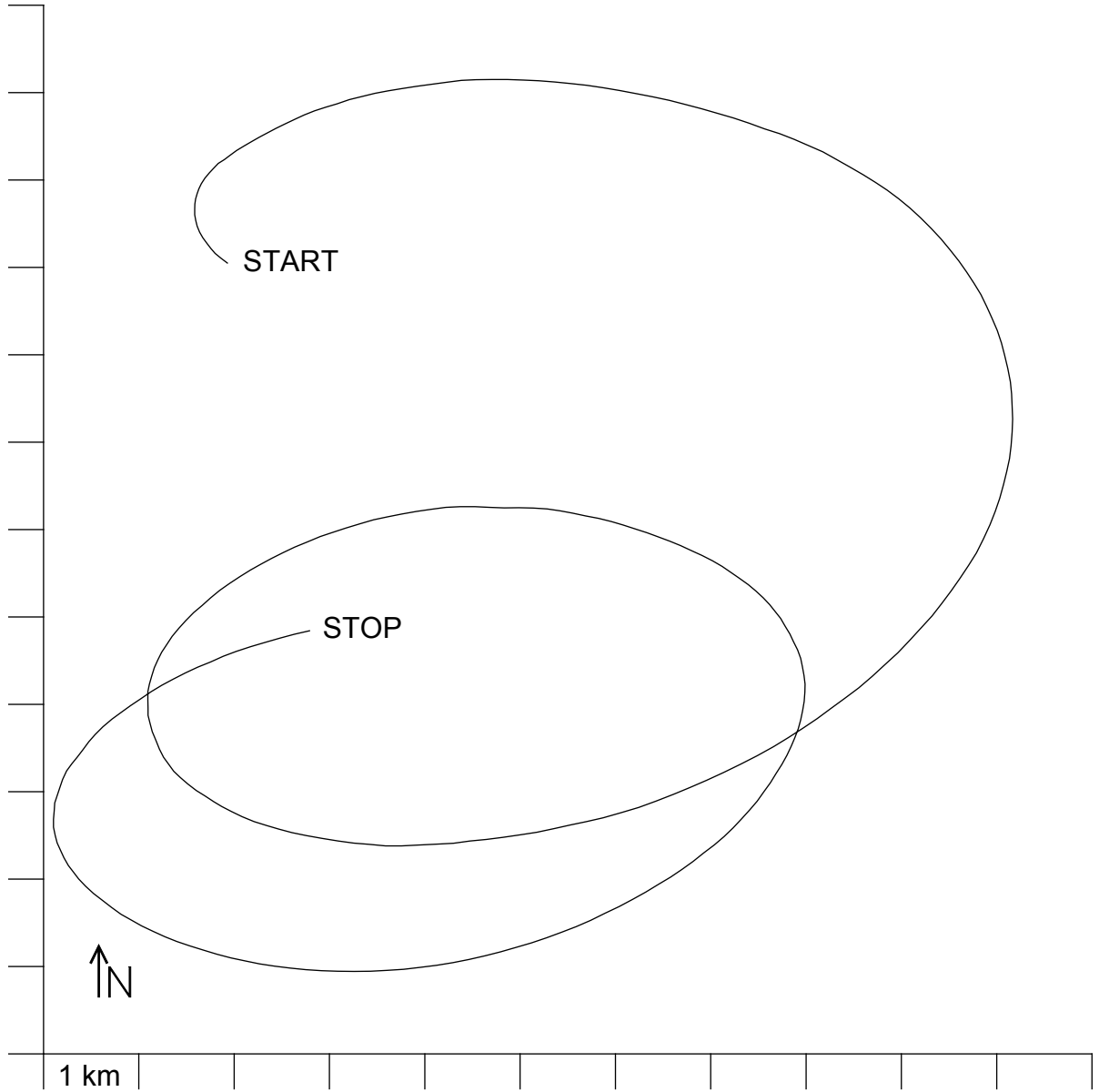
18/5/12 2:57 18/5/12 4:57 18/5/12 6:57 18/5/12 8:57 18/5/12 10:57 18/5/12 12:57 18/5/12 14:57 18/5/12 16:57 18/5/12 18:57 18/5/12 20:57 18/5/12 22:57 19/5/12 0:57 19/5/12 2:57 19/5/12 4:57 19/5/12 6:57 19/5/12 8:57

# NWZQ1205-094 Aanderaa 9741



NWZQ1205-094 Aanderaa 9741

NWZQ1205\_094  
Instrument: Aanderaa 9741



# NWZQ1205-144 Aanderaa 9742

Deployment: NWZQ1205 analyzed from beginning to end  
 Instrument no.: 9742  
 Instrument type: Aanderaa  
 Latitude: 60 50.000 N  
 Longitude: 06 23.520 W  
 Bottom depth: 169  
 Instrument depth: 144  
 Number of records: 340  
 Time of first record: 2012 05 18 02 57  
 Time of last record : 2012 05 19 07 12  
 Time between records (min.): 5.000

Parameters	Records OK	Records flagged
Column 1 : Recno		
Column 2- 4: Date		
Column 5- 6: Time		
Column 7 : Temp	340	0
Column 8 : Speed	340	0
Column 9 : Direct	340	0
Column 10 : Press	340	0

## Comments

Residual current: 30 mm/sec towards: 152 degrees

## TIDAL ANALYSIS

Error flagged records interpolated for velocity: 0, records not int.: 0  
 Tidal analysis on data passed through 3 filters: A12, A12, and A13

Const	Freq c/hr	E-ampl mm/sec	E-gpl deg	N-ampl mm/sec	N-gpl deg	Major mm/sec	Minor mm/sec	Incl deg	Grphl deg	R
O1	.03873065	37	355	42	236	48	28	128	212	A I
K1	.04178075	35	229	39	109	45	26	128	85	A
M2	.08051140	431	264	273	192	443	253	16	255	A
S2	.08333334	152	300	87	228	155	81	14	292	A I
M4	.16102280	7	99	9	286	11	1	125	284	A

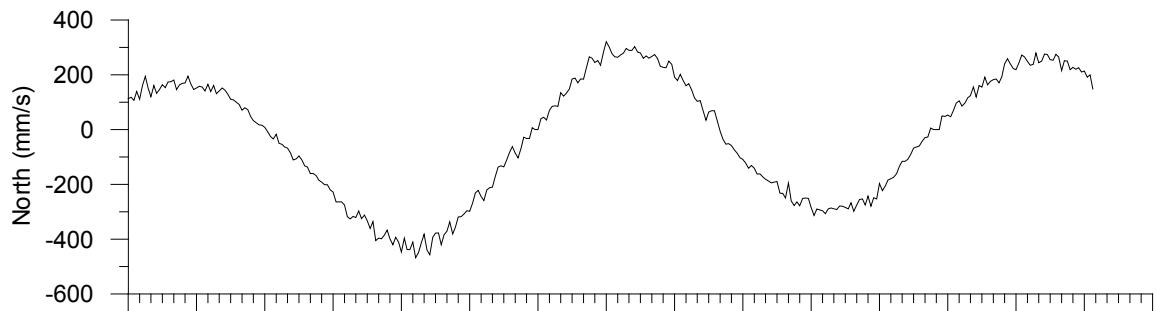
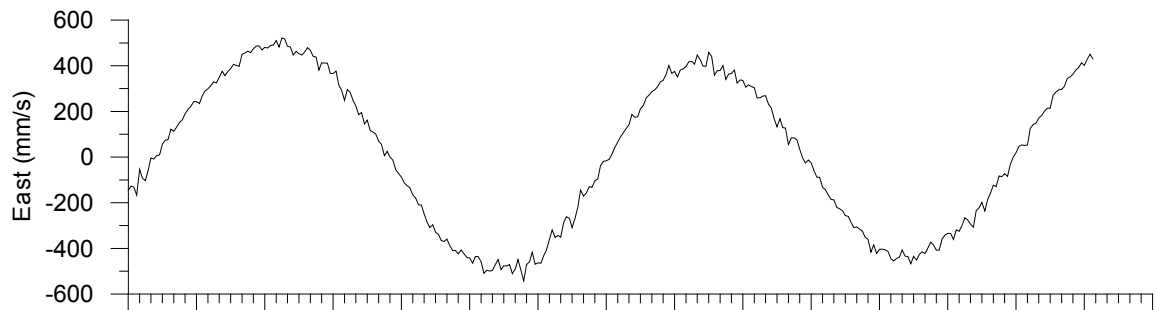
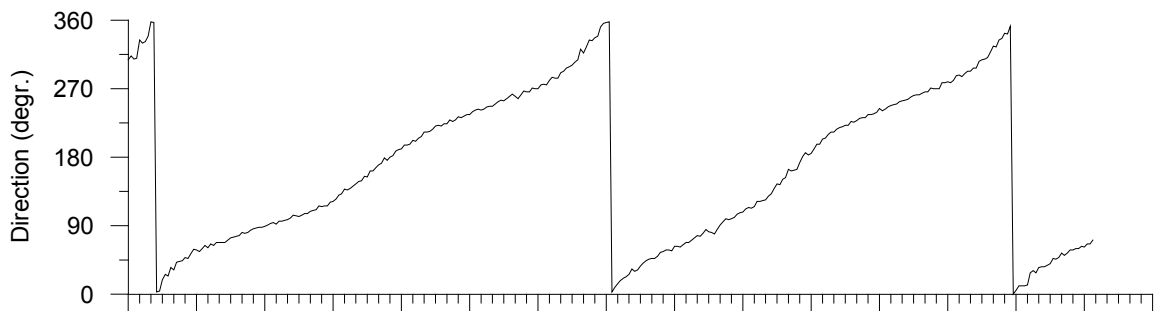
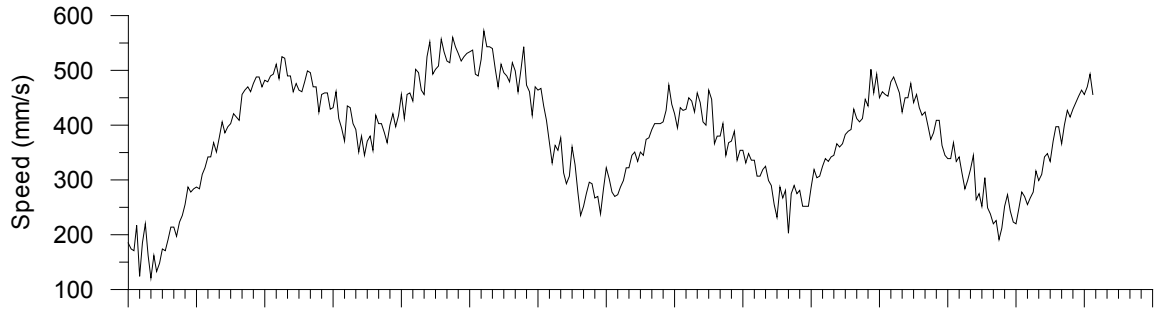
## DIRECTIONAL CURRENT DISTRIBUTION (for all nonflagged observations in series)

Relative number of observations in parts per thousand (ppt) grouped into speed and direction intervals (of 30 degree width centred around the directions shown)

Speed intervals (mm/s)	Direction intervals												All dir.	
	15	45	75	105	135	165	195	225	255	285	315	345	Tot	Acc
0 - 50	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50 - 100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
100 - 150	6	0	0	0	0	0	0	0	0	0	0	6	12	12
150 - 200	9	3	0	0	0	0	0	0	0	0	12	9	32	44
200 - 300	35	35	0	0	15	21	12	0	0	12	32	32	194	238
300 - 400	12	50	35	35	26	21	21	24	6	53	9	6	297	535
400 - 500	0	35	91	59	21	9	26	29	91	12	0	0	374	909
500 - 600	0	0	0	9	0	0	3	50	29	0	0	0	91	1000
Total (ppt)	62	124	126	103	62	50	62	103	126	76	53	53		
Rel.flux (ppt)	41	113	142	118	58	44	61	127	158	70	34	33		
Avg.spd (mm/s)	252	346	426	435	358	335	376	468	473	349	246	235		
Max.spd (mm/s)	351	473	493	525	461	418	502	560	572	467	360	322		

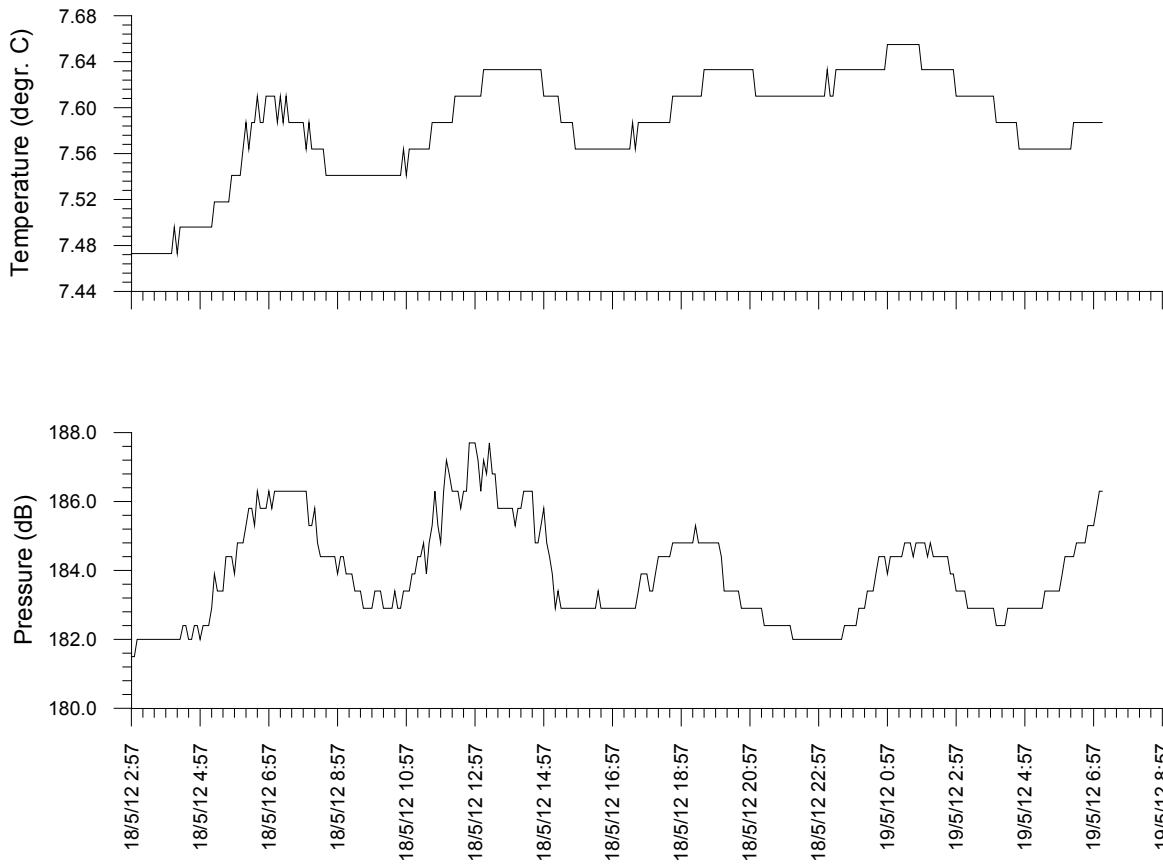


# NWZQ1205-144 Aanderaa 9742



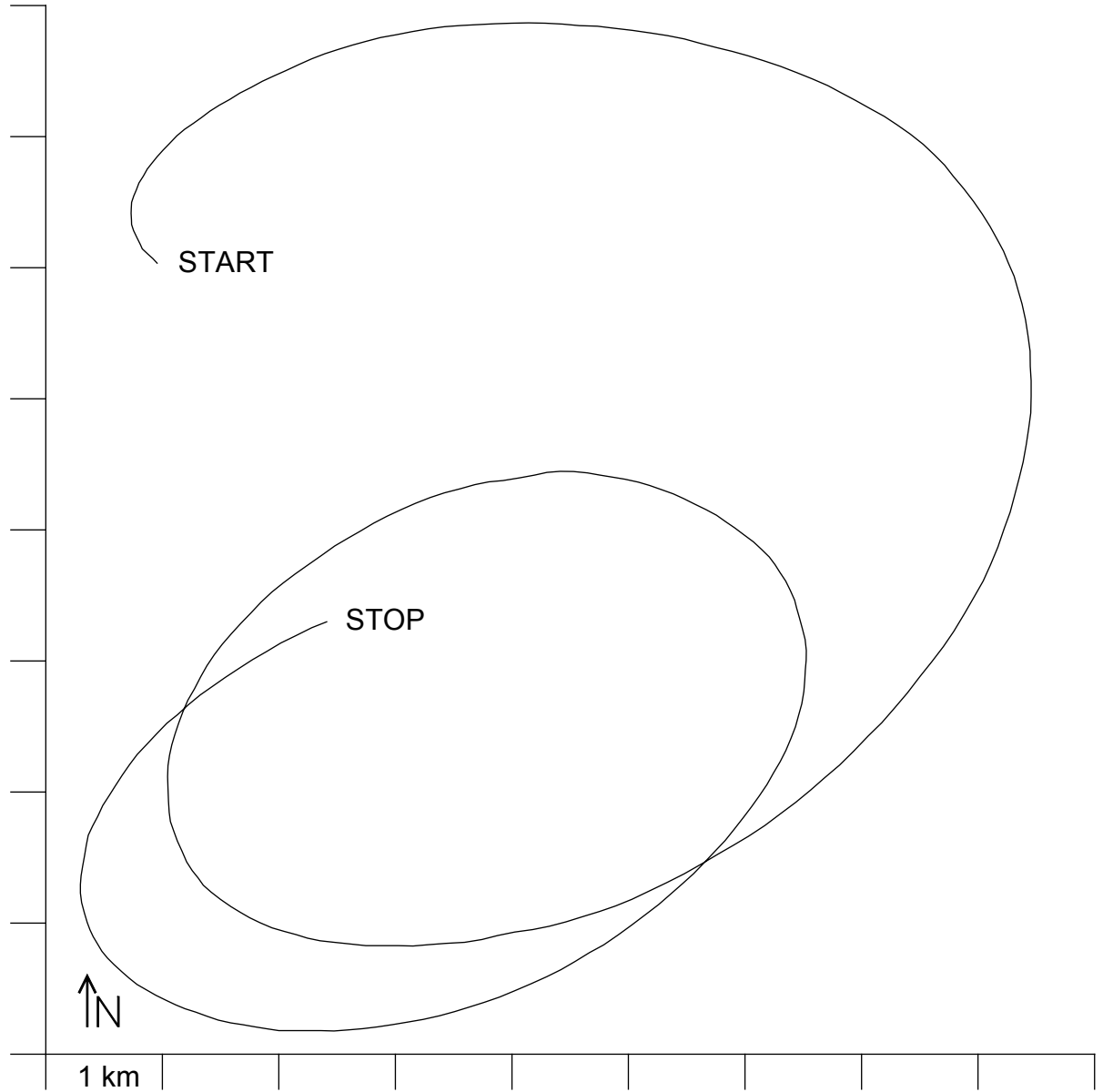
18/5/12 2:57  
18/5/12 4:57  
18/5/12 6:57  
18/5/12 8:57  
18/5/12 10:57  
18/5/12 12:57  
18/5/12 14:57  
18/5/12 16:57  
18/5/12 18:57  
18/5/12 20:57  
18/5/12 22:57  
19/5/12 0:57  
19/5/12 2:57  
19/5/12 4:57  
19/5/12 6:57  
19/5/12 8:57

# NWZQ1205-144 Aanderaa 9742



NWZQ1205-144 Aanderaa 9742

NWZQ1205\_144  
Instrument: Aanderaa 9742





**HAVSTOVAN**  
FAROE MARINE RESEARCH INSTITUTE

P.O. Box 3051 · Nóatún 1  
FO-110 Tórshavn  
Faroe Islands

Tel +298 35 39 00  
hav@hav.fo  
www.hav.fo