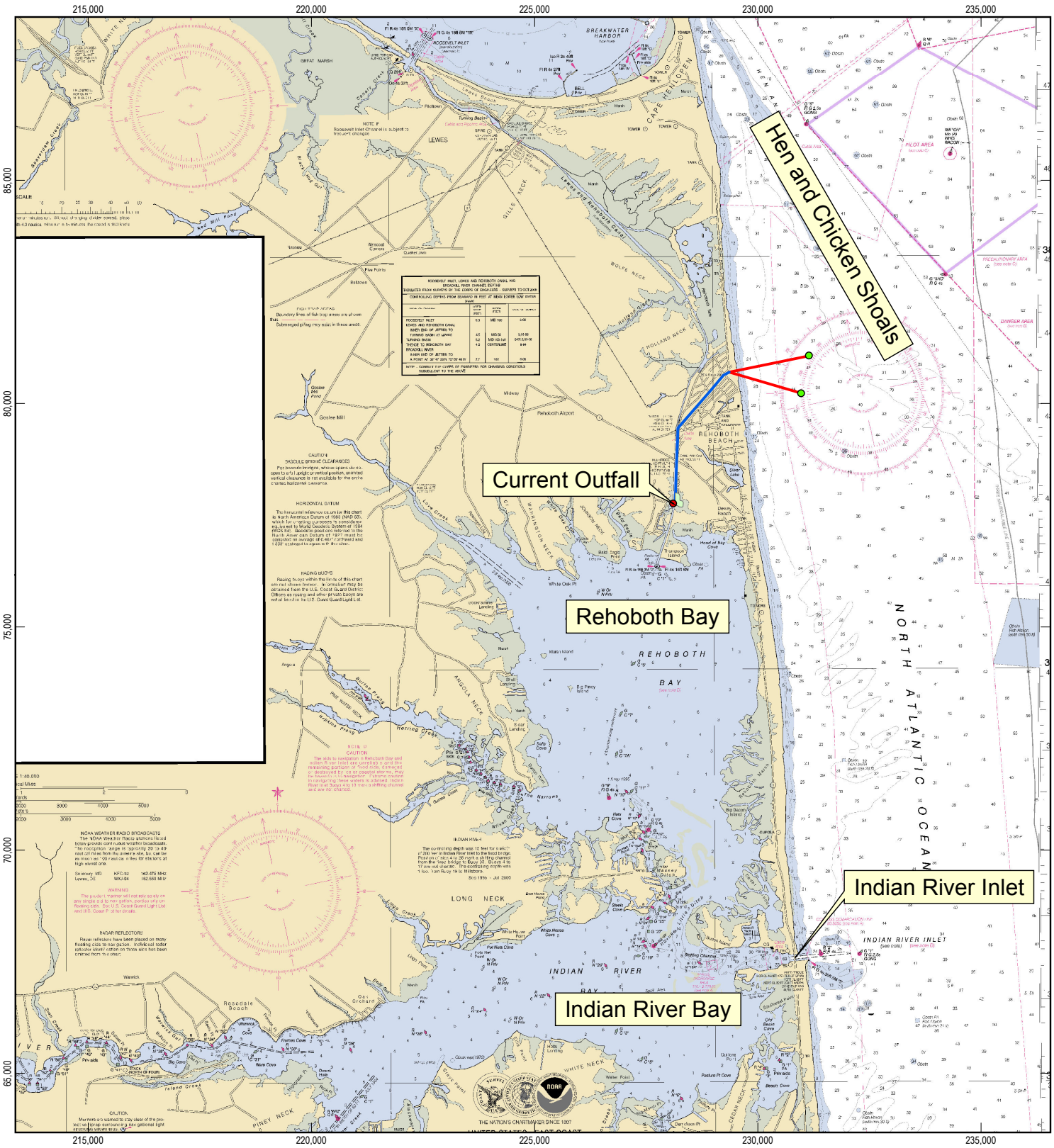
Appendix A

# Locality Map




## Legend

- Current Outfall
- Rehoboth Beach WWTP
- Potential Outfalls
- Force Main
- Potential Outfall Pipes

Paper Size ANSI A

0 0.3 0.6 1.2 1.8 2.4

Miles

Map Projection: Transverse Mercator
Horizontal Datum: North American 1983
Grid: NAD 1983 StatePlane Delaware FIPS 0700

N

GHD
CLIENTS | PEOPLE | PERFORMANCE

City of Rehoboth Beach
Ocean Outfall Project

Locality Map

| | |
|---|---|
| Job Number | 86-14327 |
| Revision | A |
| Date | 08 Dec 2011 |

Figure 1

16701 Melford Blvd Ste 330 Bowie MD 20715 USA T 240 206 6838 F 240 206 6811 E jeff.riling@ghd.com W www.ghd.com

C:\GIS DATA - Copied From Network\8614327 - Rehoboth\- Modeling Figures -\Appendix A - Locality Map.mxd

© 2011. Whilst every care has been taken to prepare this map, GHD (and DATA CUSTODIAN) make no representations or warranties about its accuracy, reliability, completeness or suitability for any particular purpose and cannot accept liability and responsibility of any kind (whether in contract, tort or otherwise) for any expenses, losses, damages and/or costs (including indirect or consequential damage) which are or may be incurred by any party as a result of the map being inaccurate, incomplete or unsuitable in any way and for any reason.

Created by:jsriling

Appendix B

# Project Data

Field Data Collection Locations

ADCP Measurements

Historical Marine Data Stations

Measured Vertical Profiles of Salinity

Measured Vertical Profiles of Temperature

Measured Vertical Profiles of Density

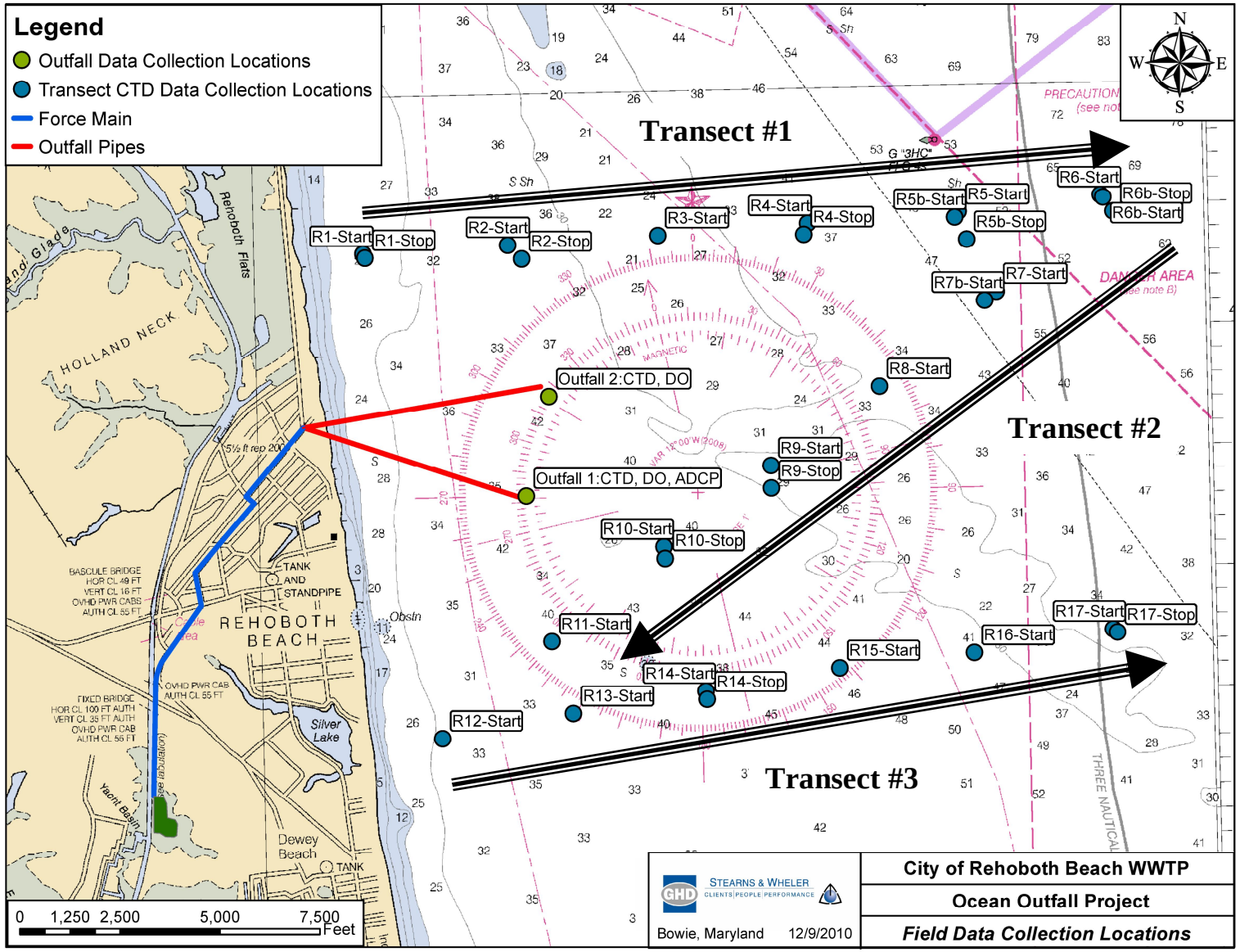
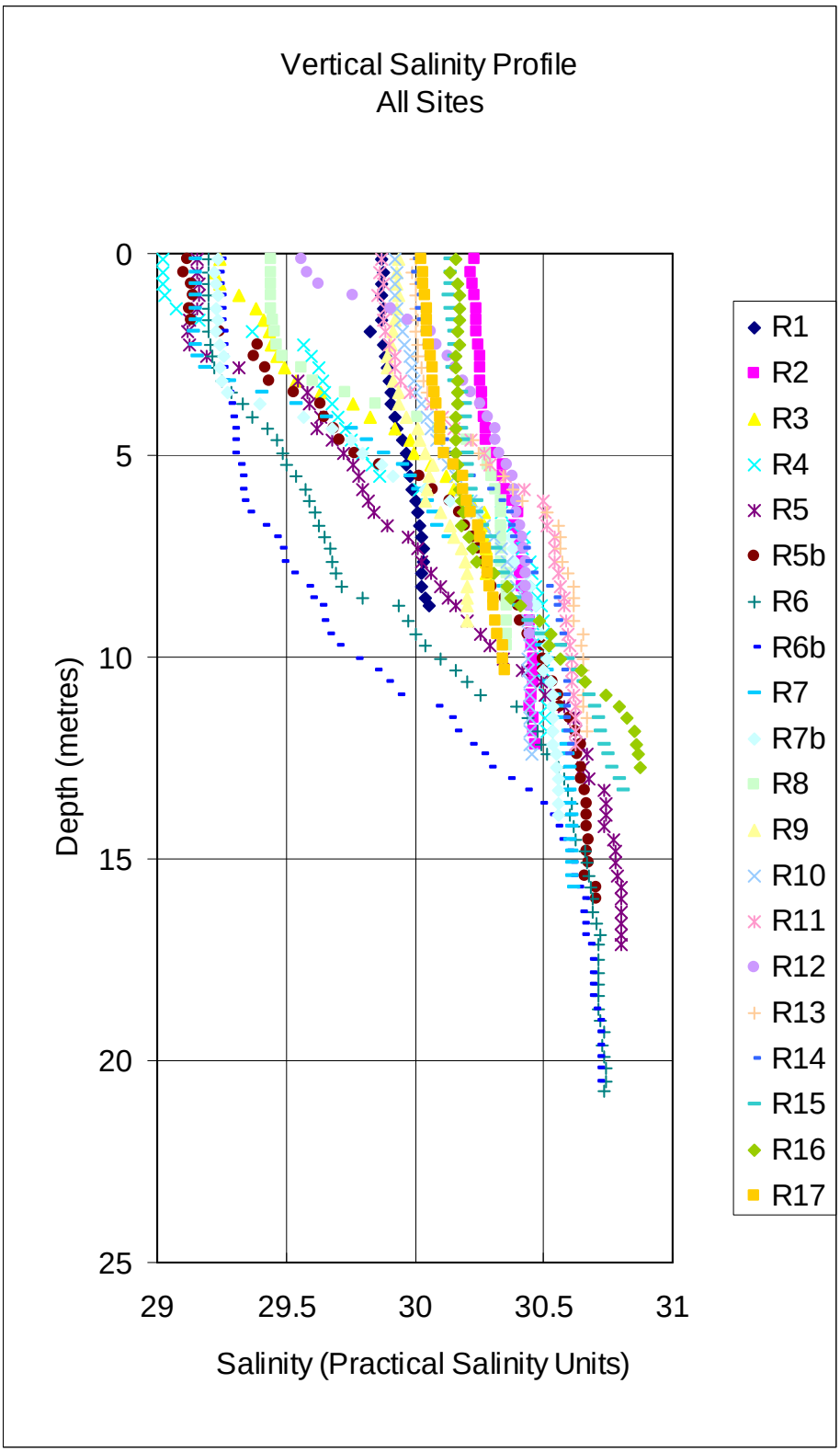
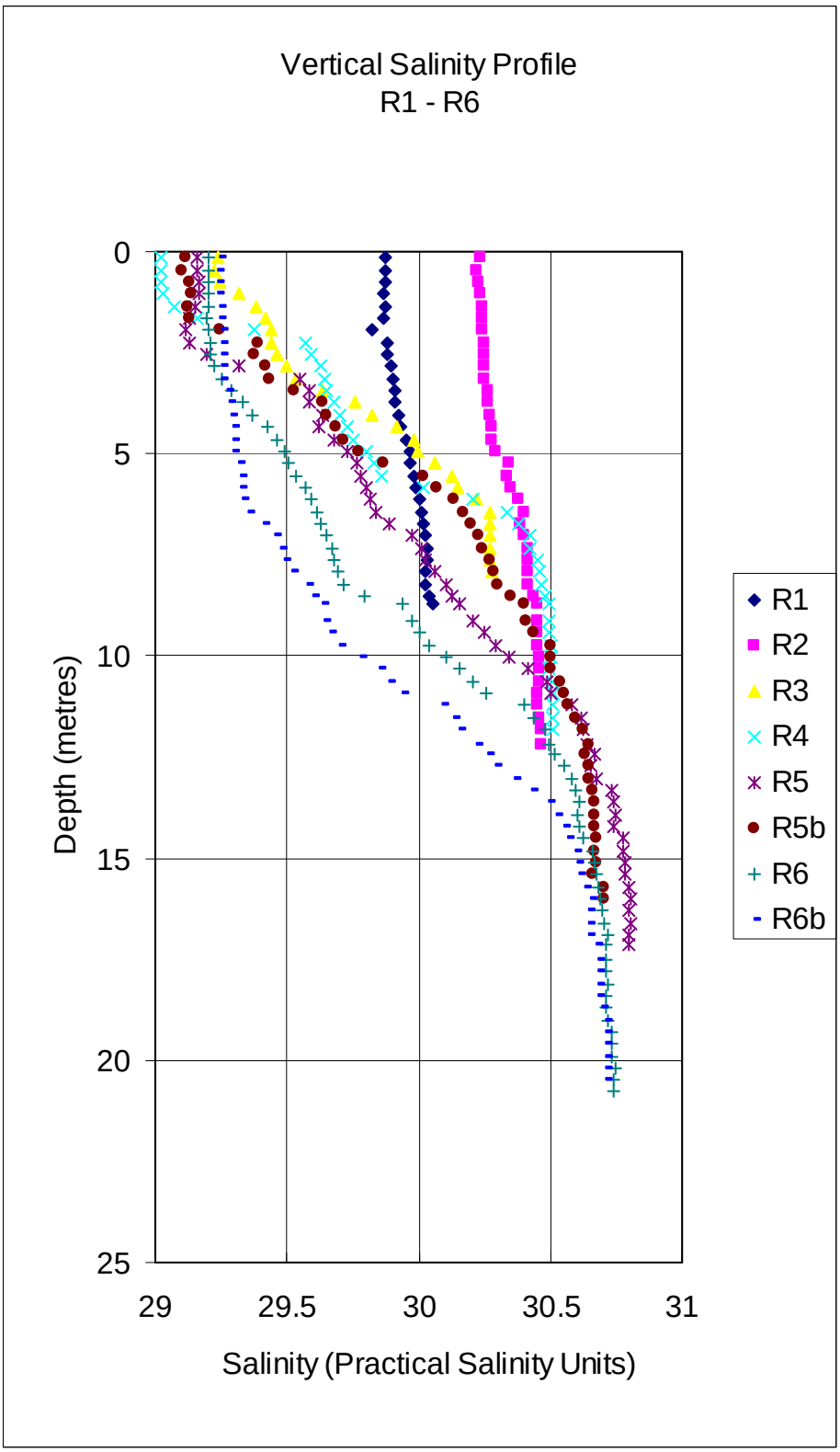



**Figure B-1** Field Data Collection Locations.

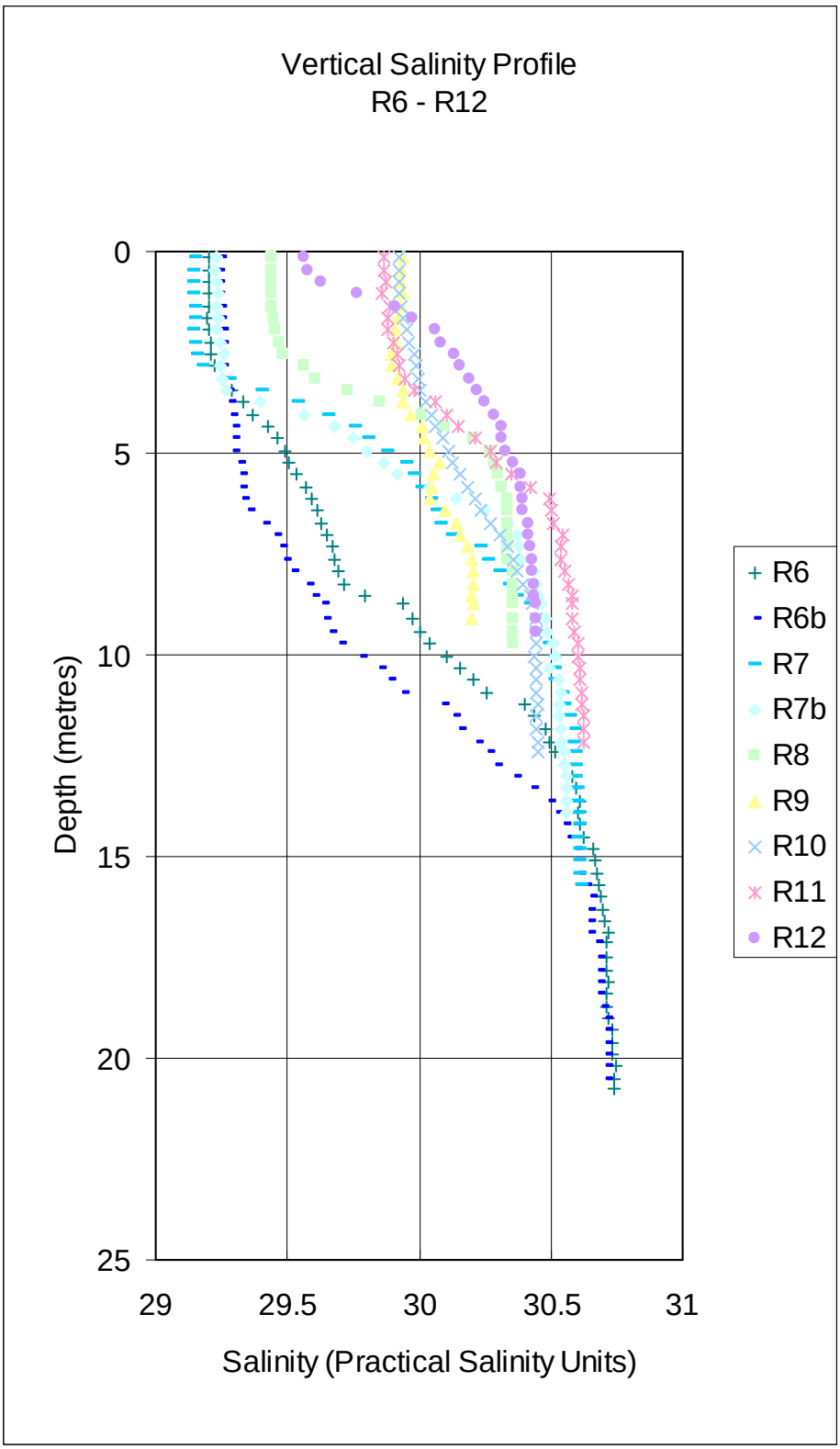
# 18 November 2010



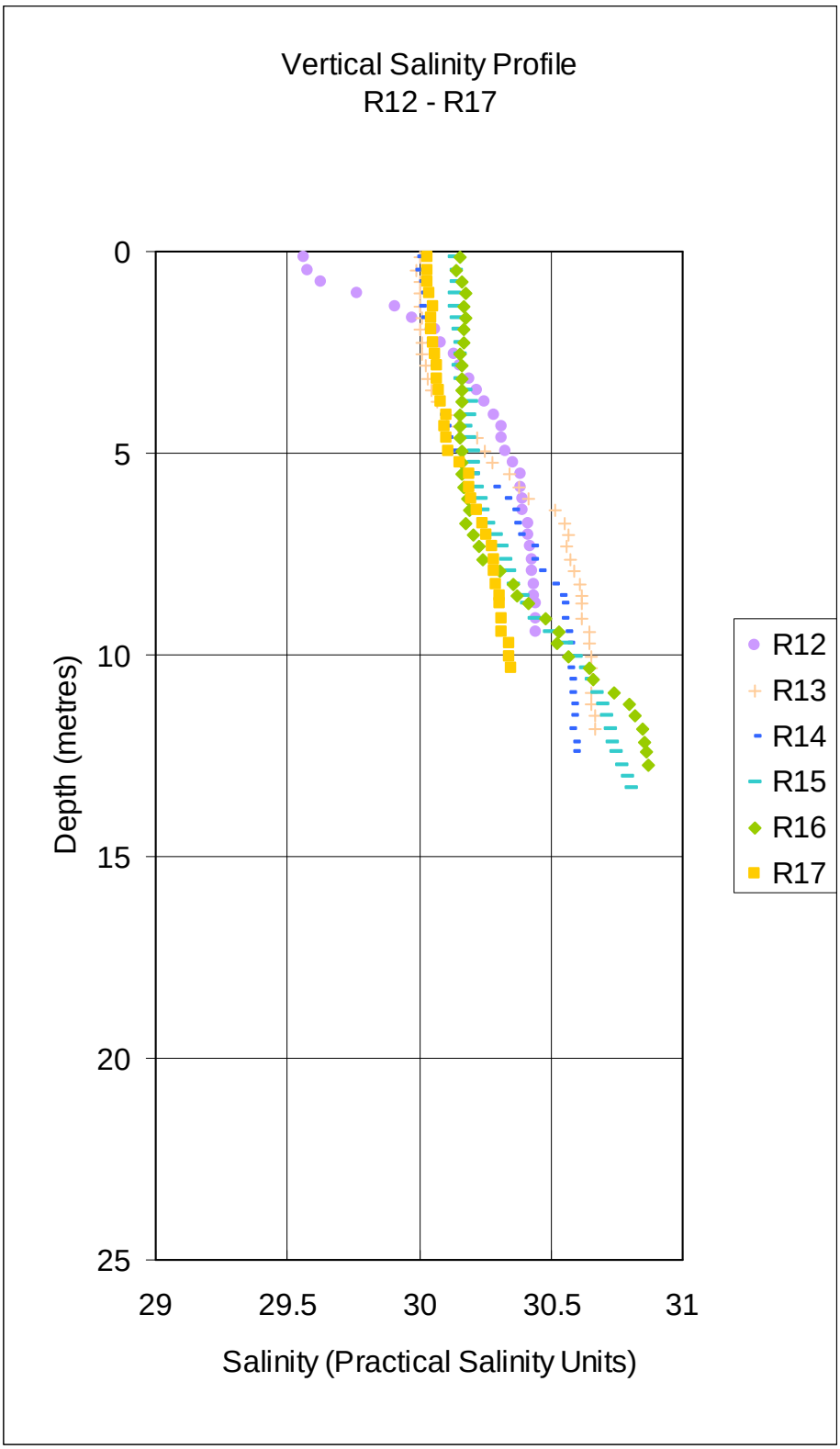

**18 November 2010:** Vertical profiles of **salinity** measured at all sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors.



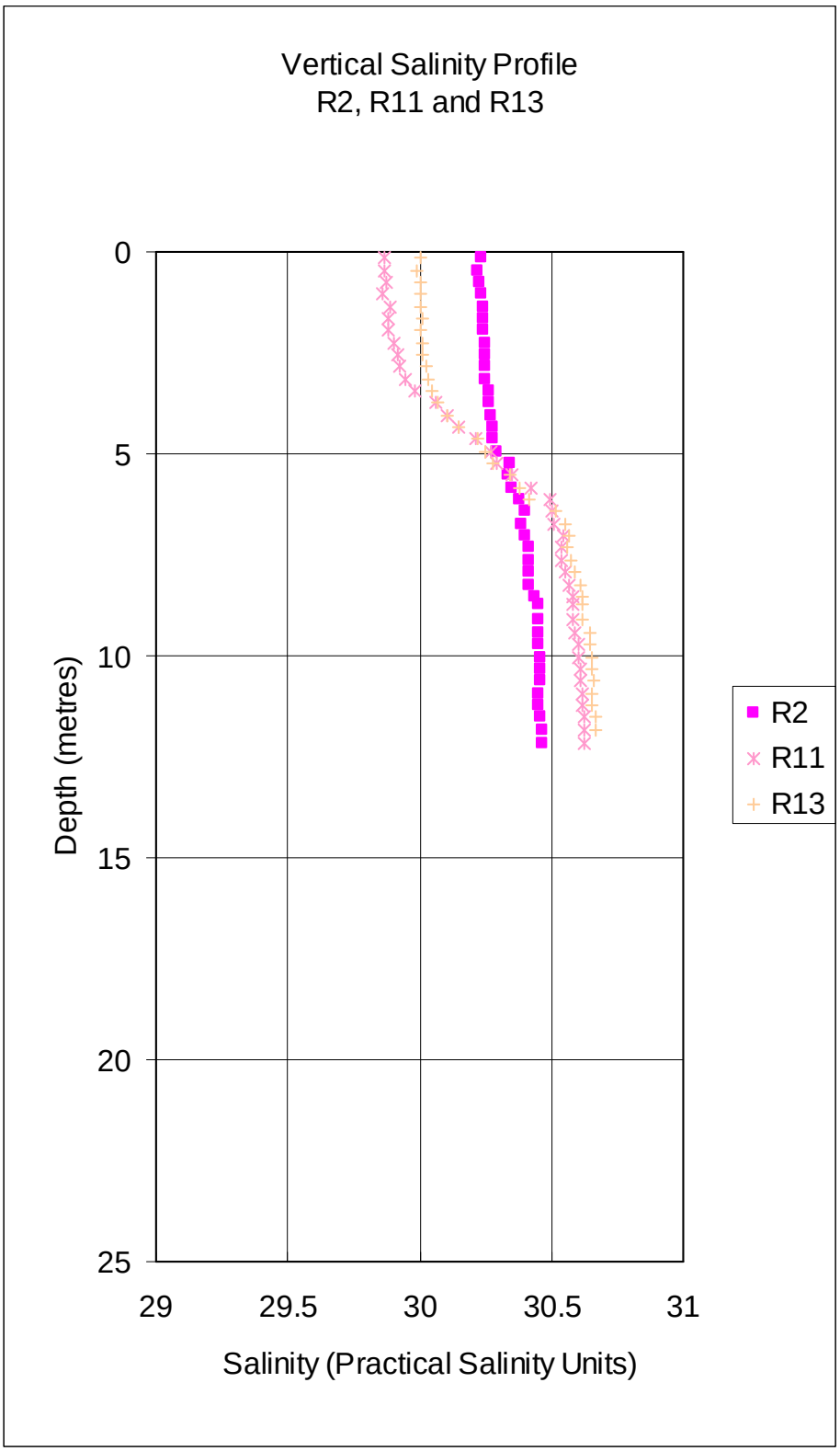

**18 November 2010:** Vertical profiles of **salinity** measured at sites R1 to R6 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



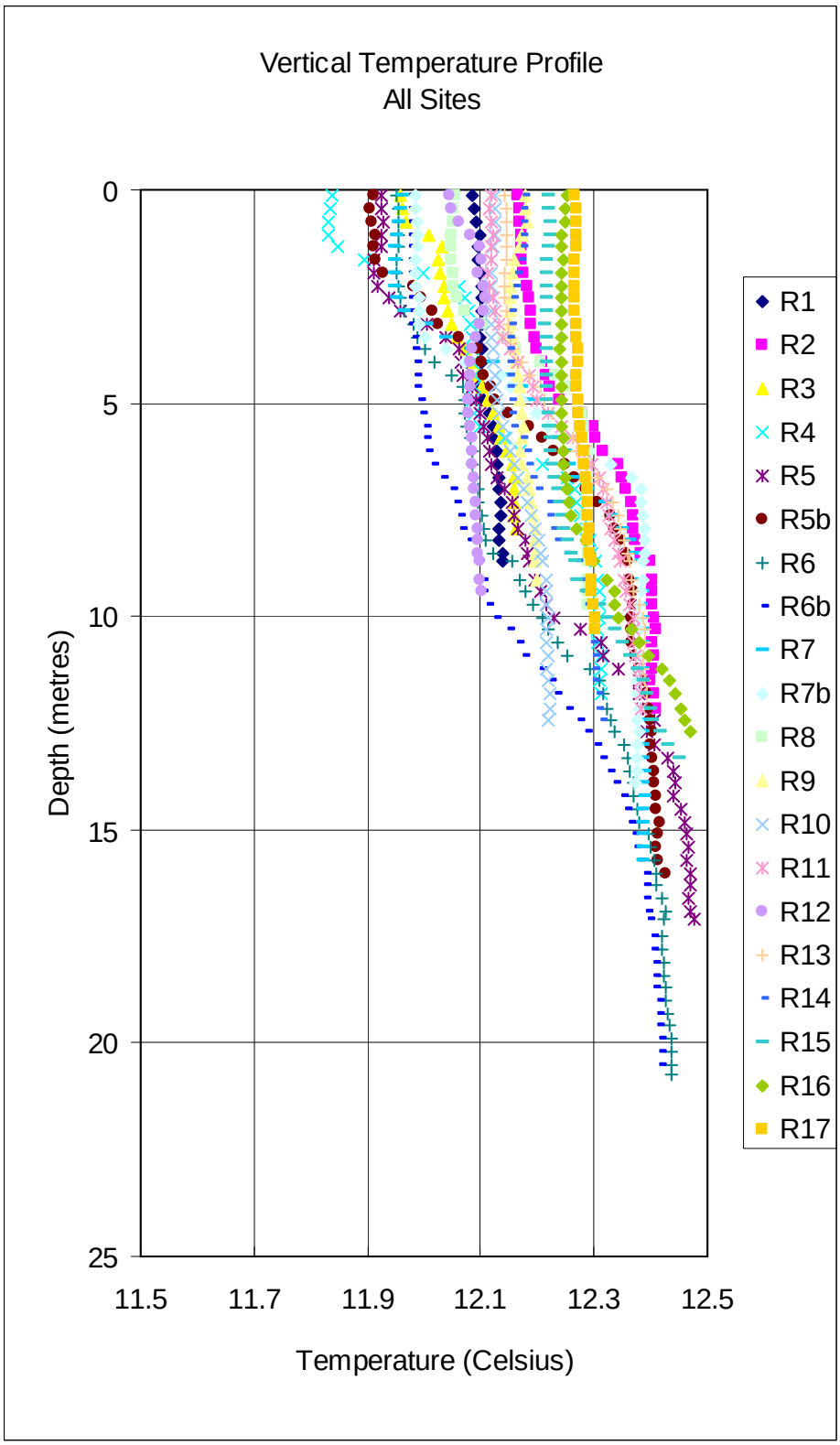

**18 November 2010:** Vertical profiles of **salinity** measured at sites R6 to R12 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



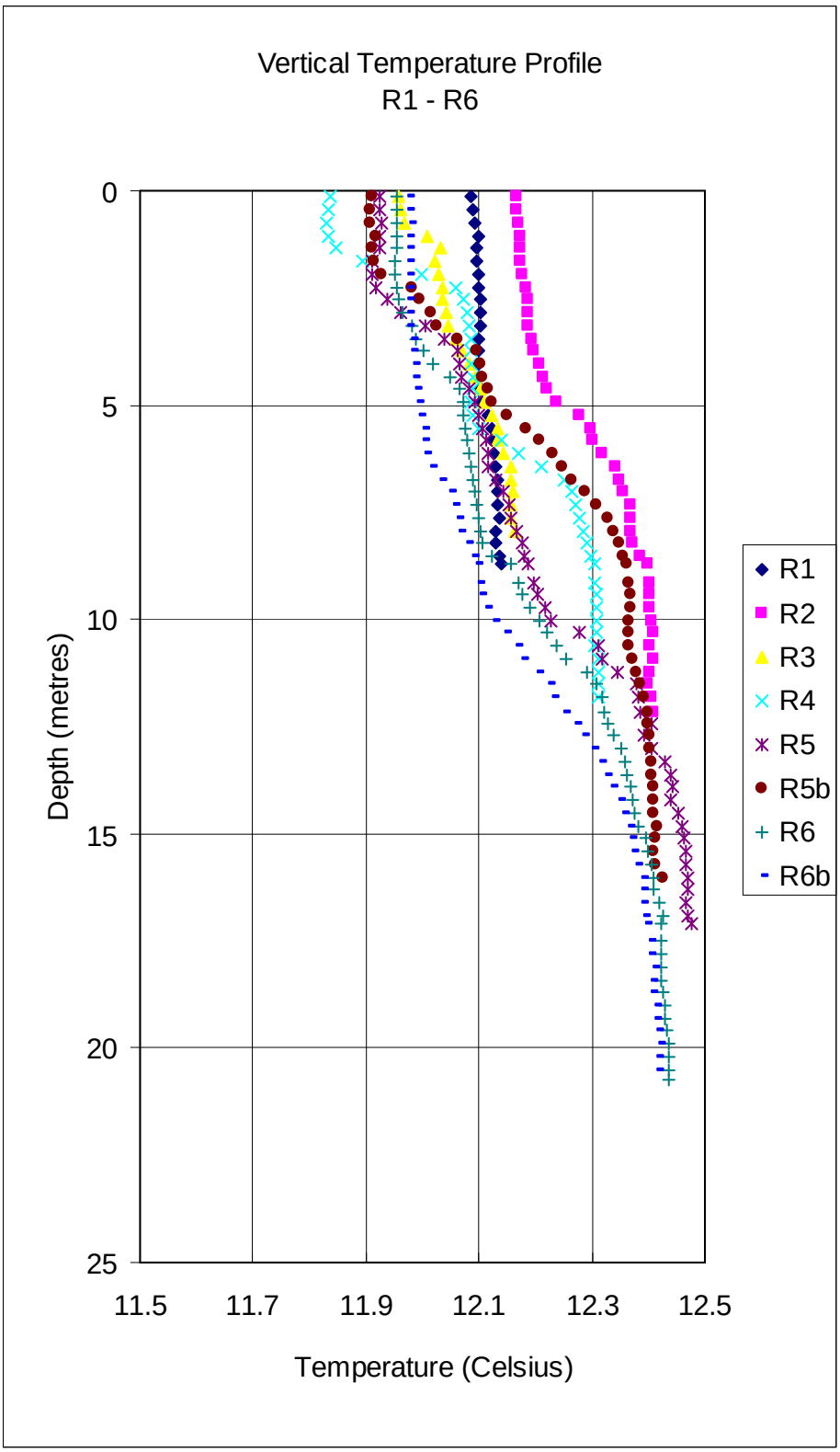

**18 November 2010:** Vertical profiles of **salinity** measured at sites R12 to R17 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



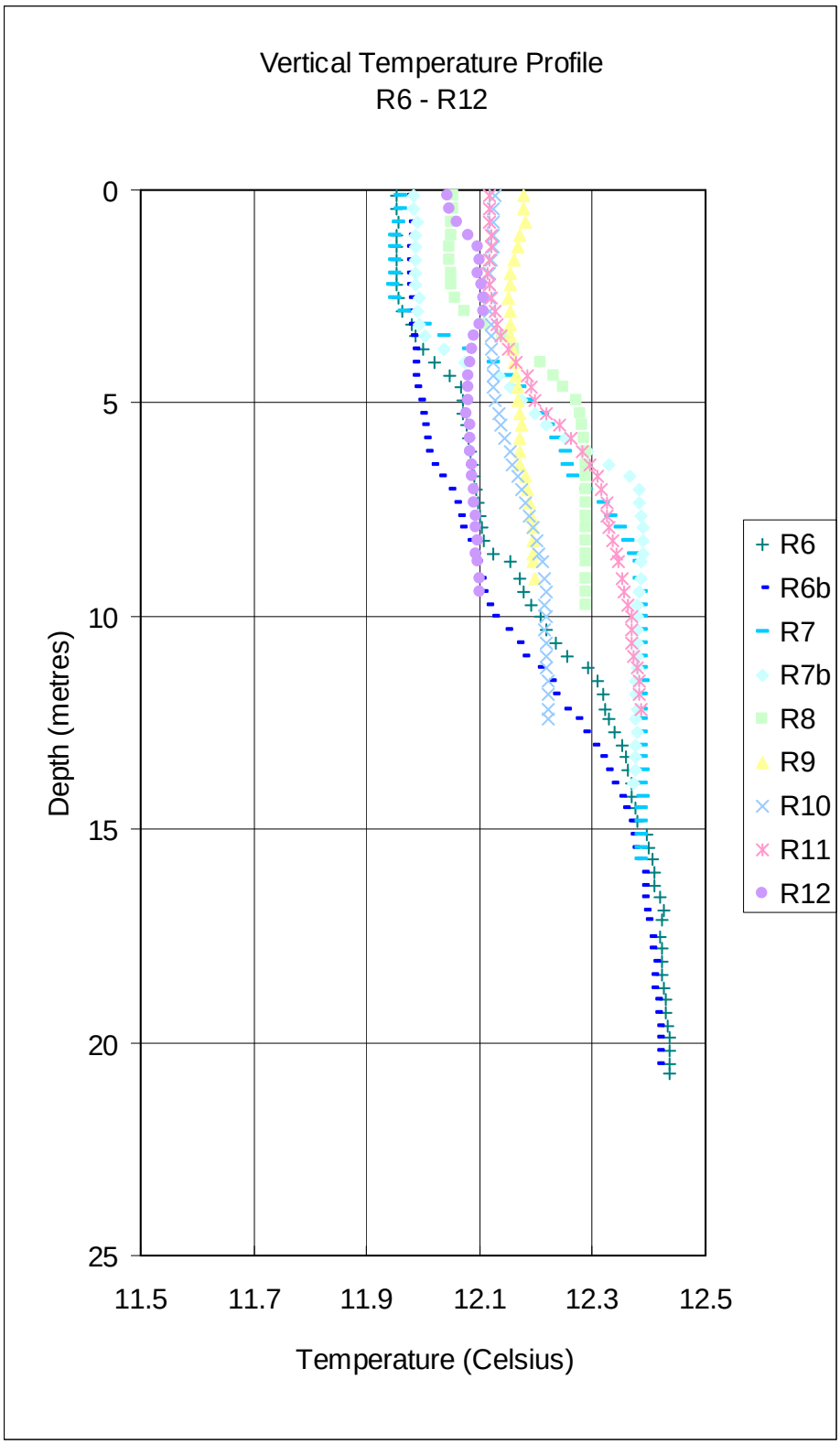

**18 November 2010:** Vertical profiles of **salinity** measured at a representative selection of sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



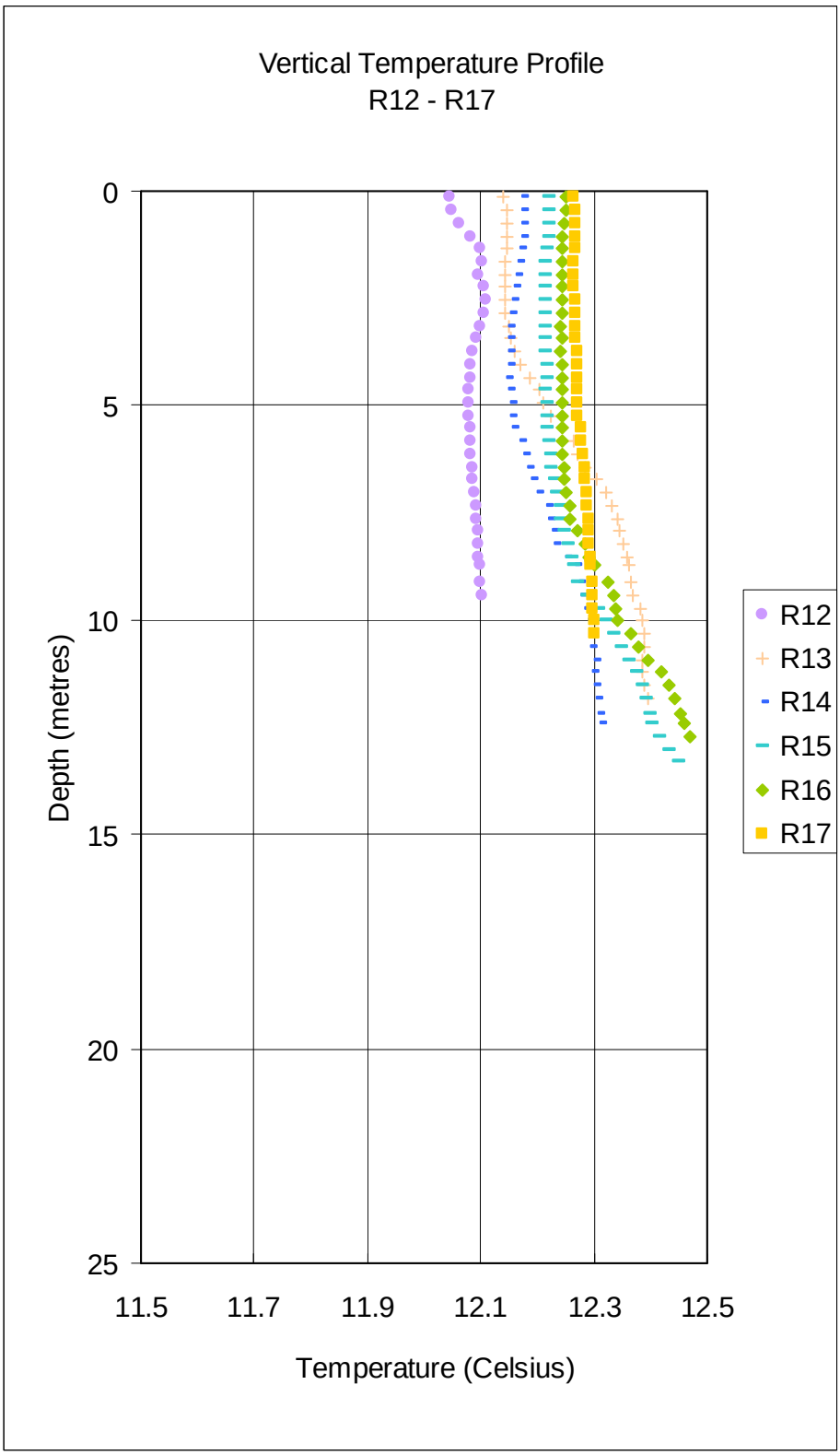

**18 November 2010:** Vertical profiles of **temperature** measured at all sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors.



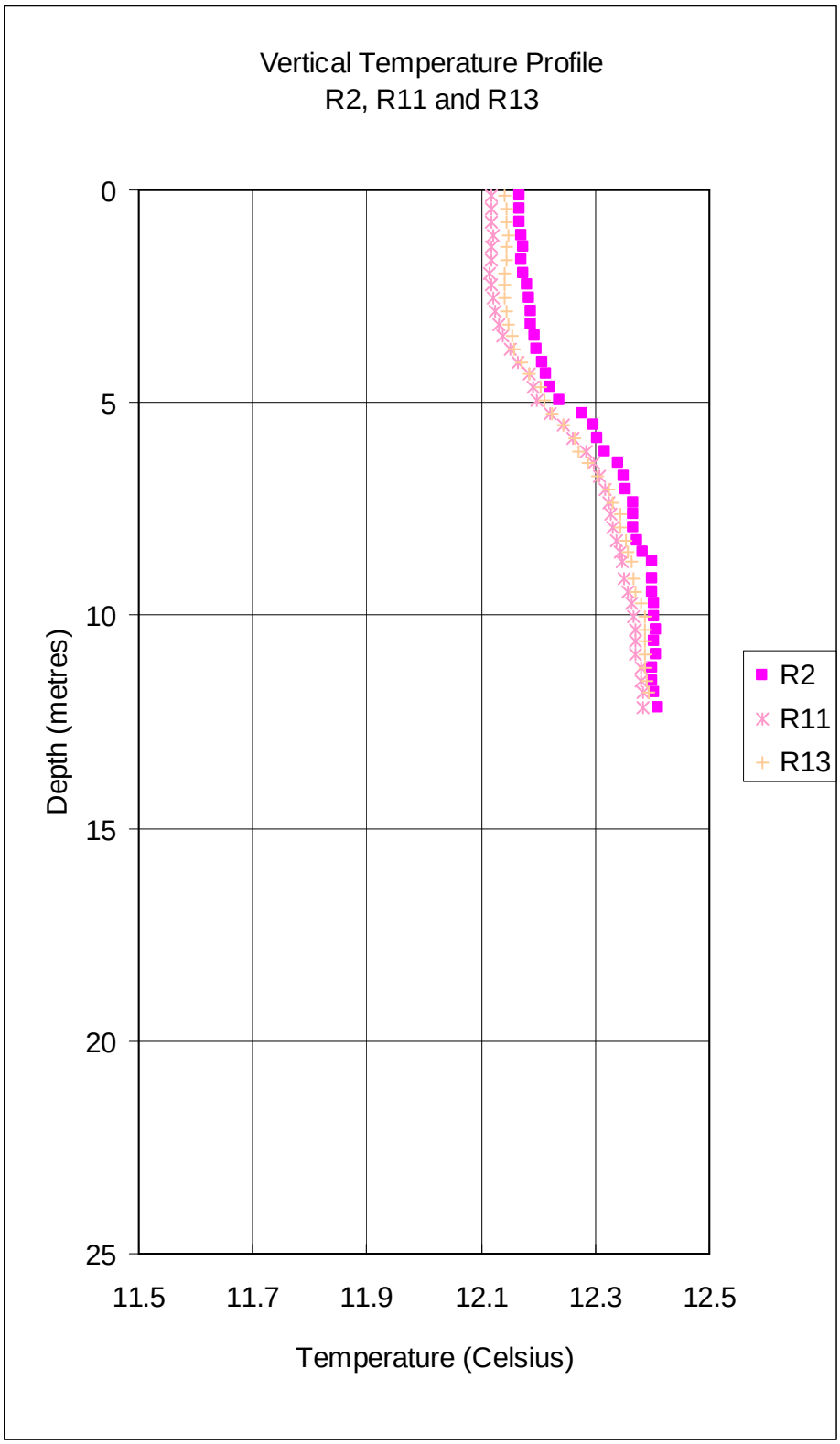

**18 November 2010:** Vertical profiles of **temperature** measured at sites R1 to R6 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



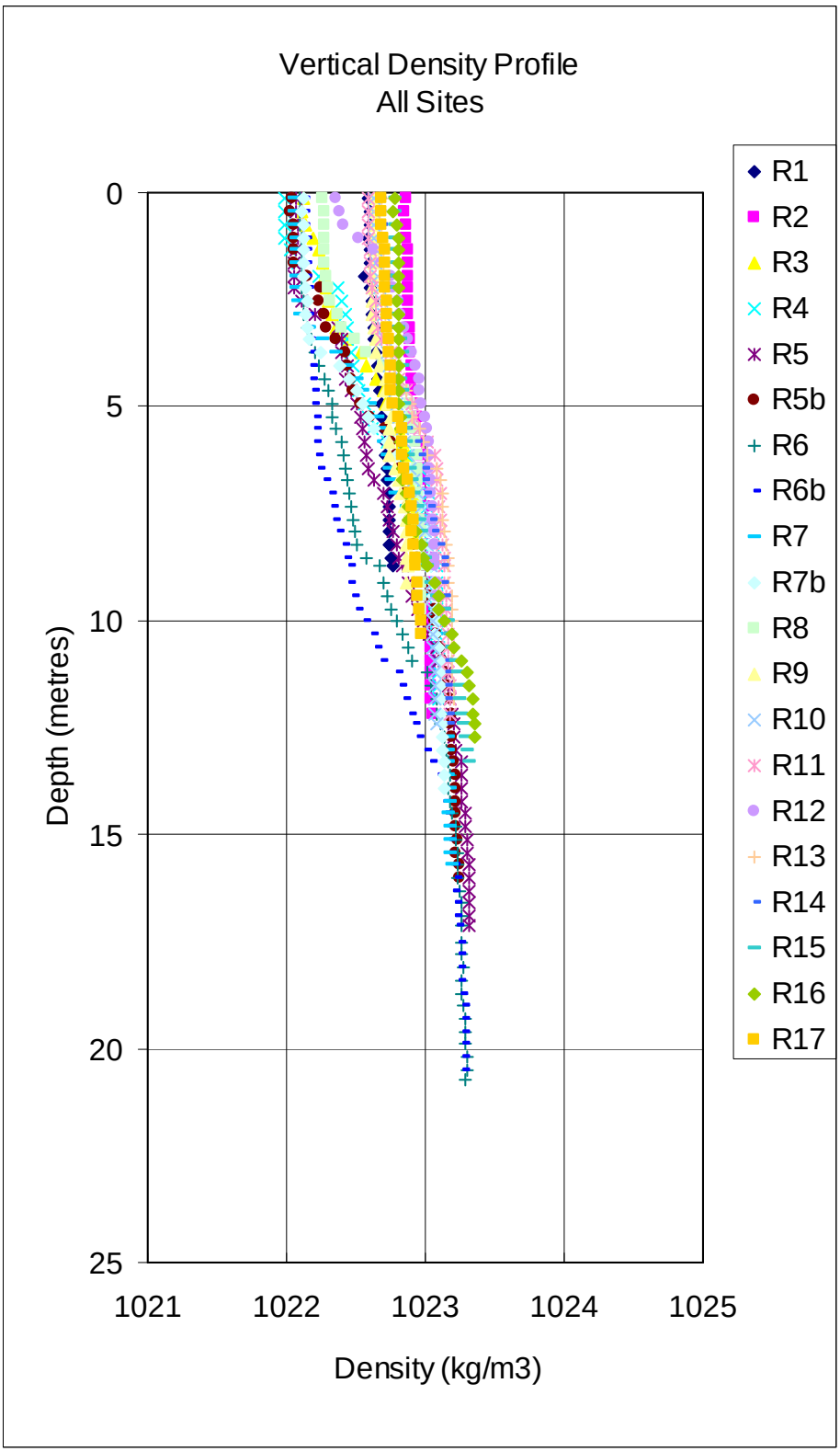

**18 November 2010:** Vertical profiles of **temperature** measured at sites R6 to R12 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



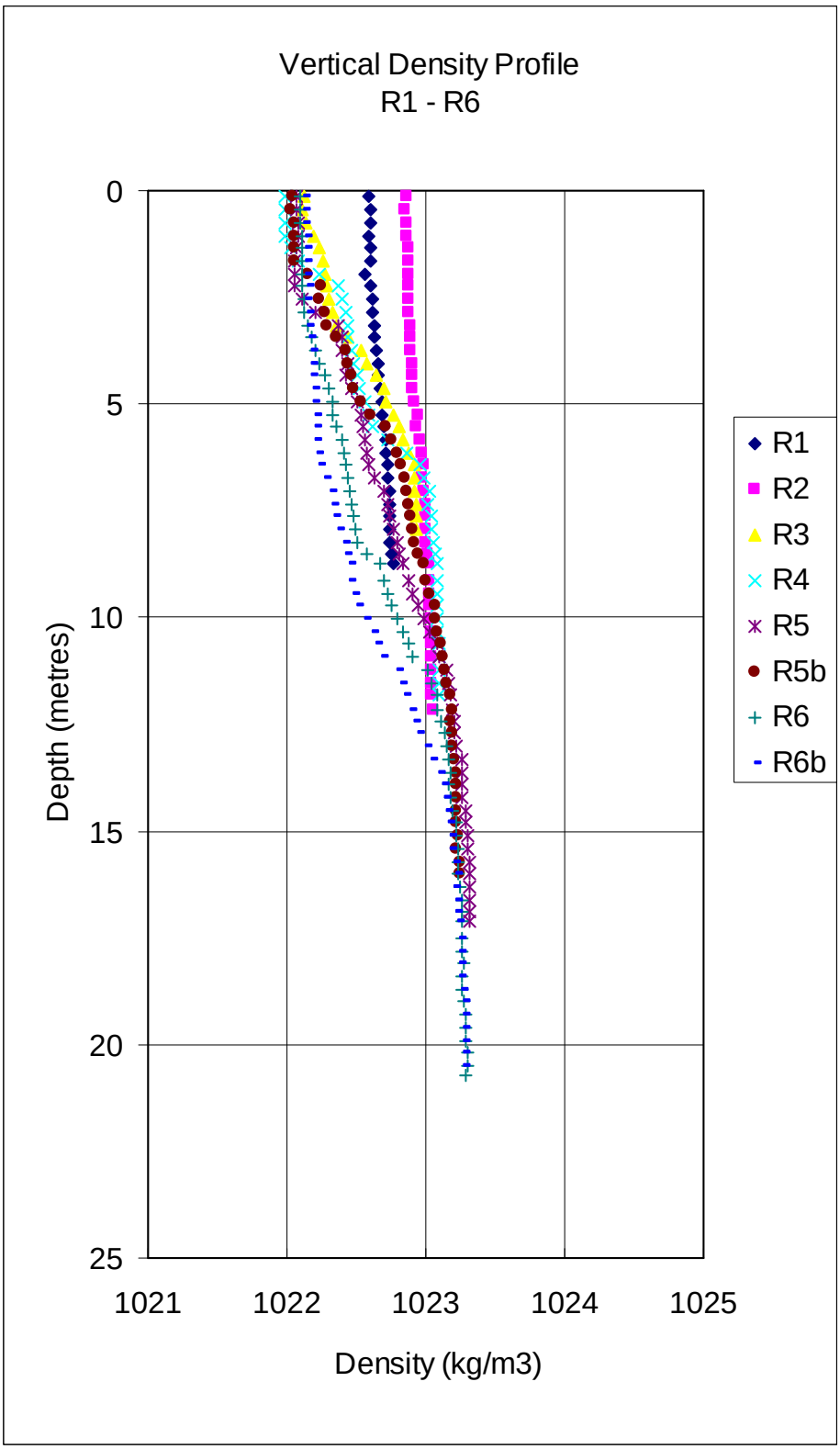

**18 November 2010:** Vertical profiles of **temperature** measured at sites R12 to R17 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



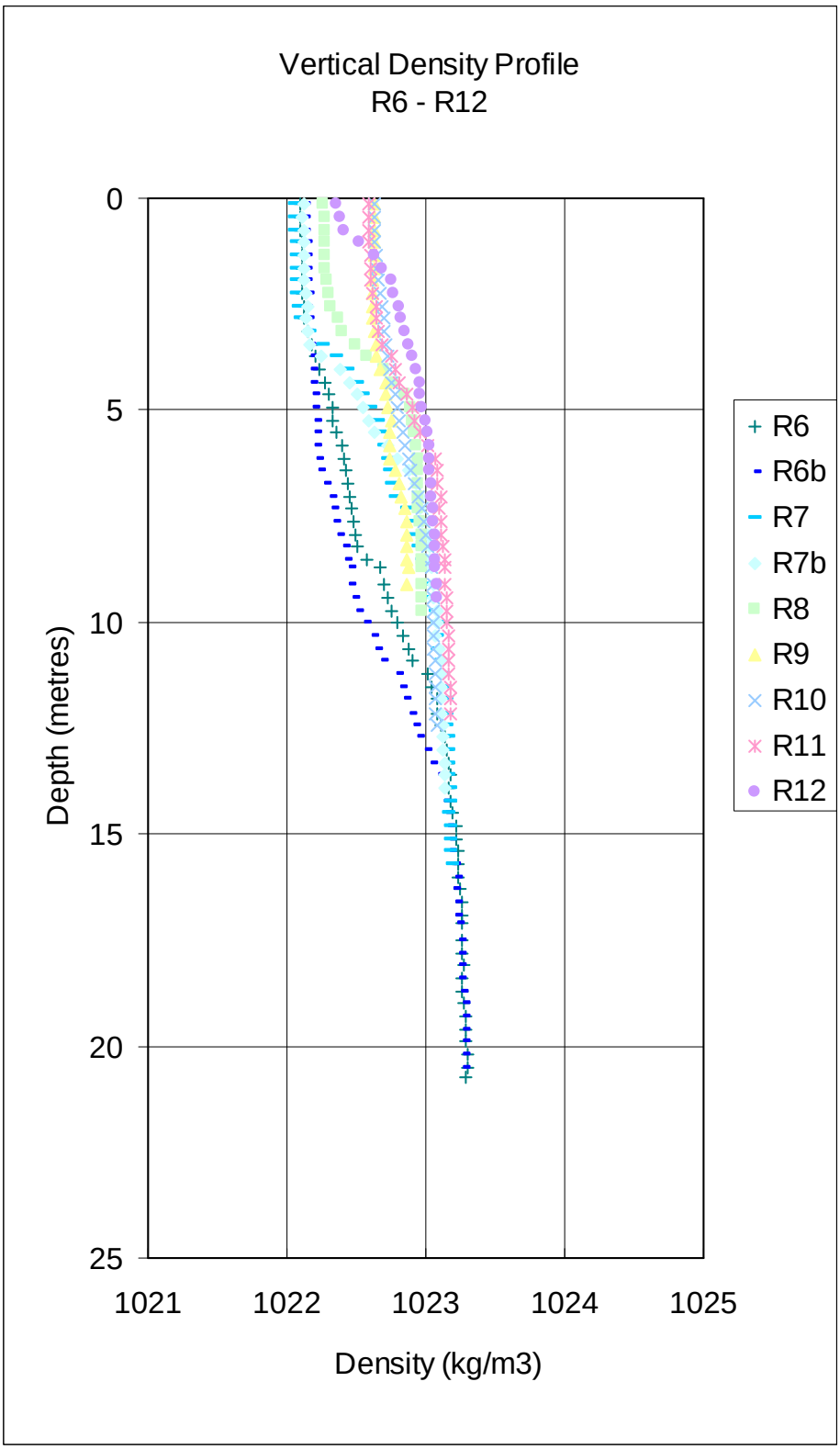

**18 November 2010:** Vertical profiles of **temperature** measured at a representative selection of sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



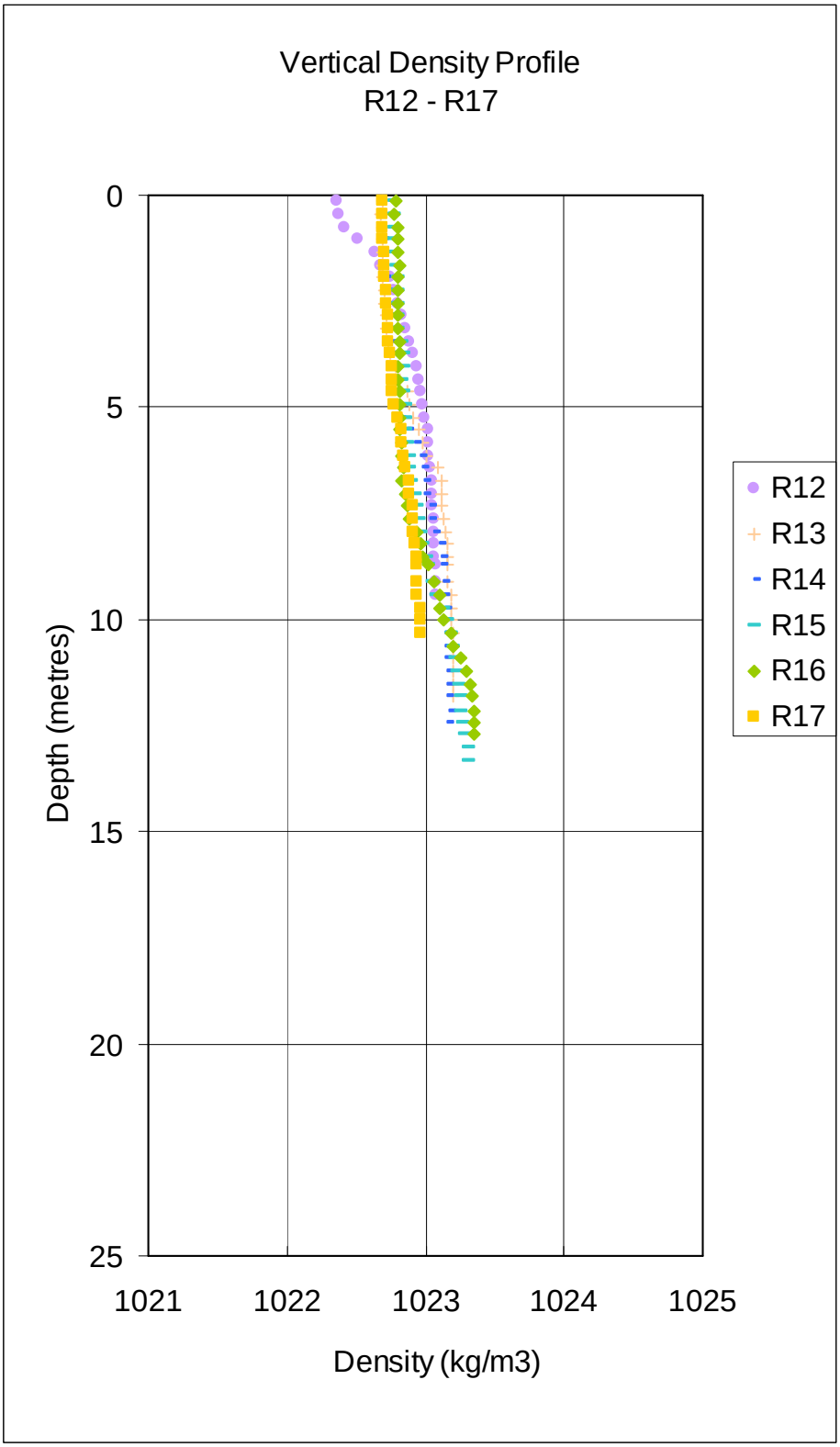

**18 November 2010:** Vertical profiles of **density** measured at all sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors.



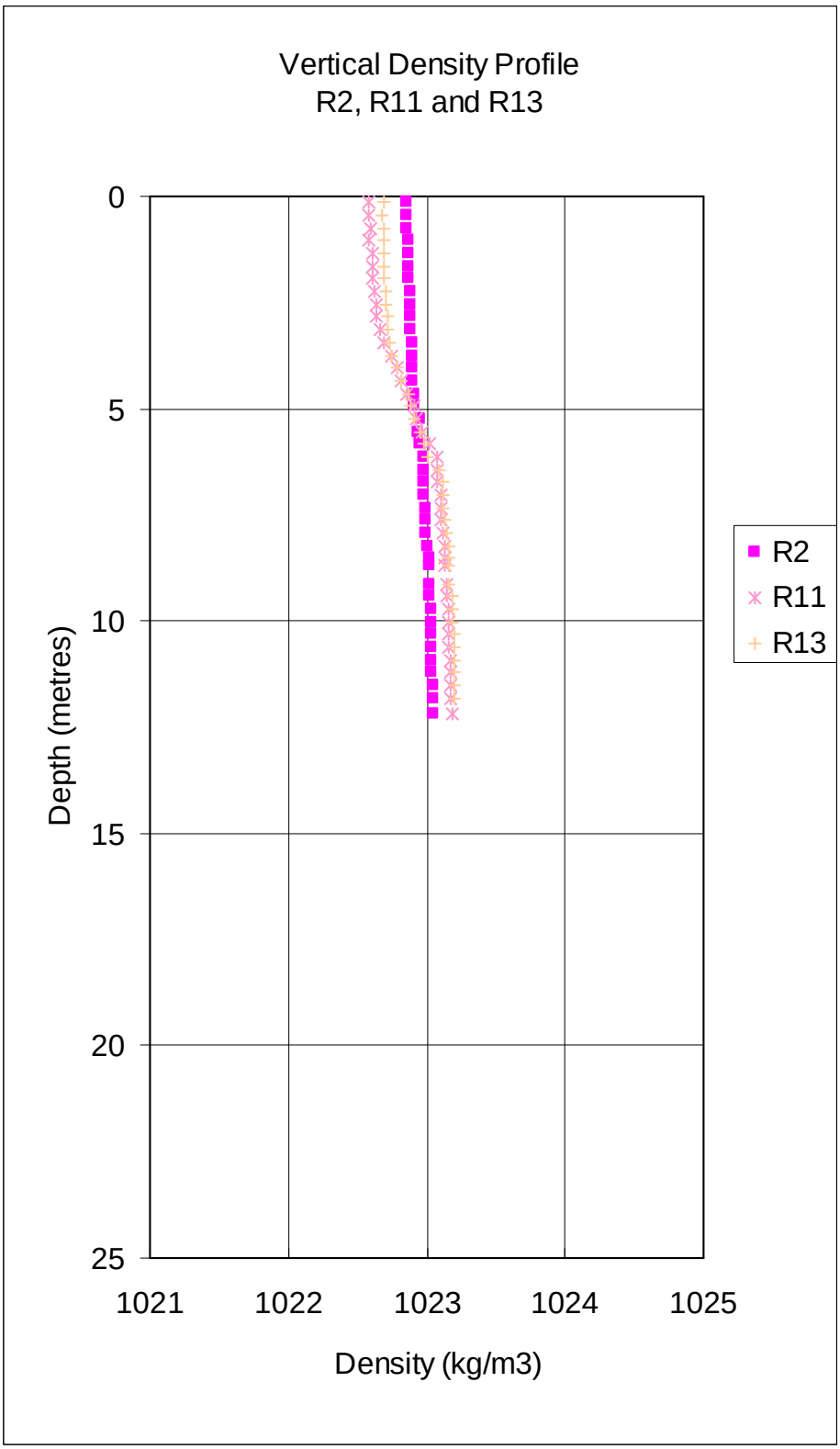

**18 November 2010:** Vertical profiles of **density** measured at sites R1 to R6 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).




**18 November 2010:** Vertical profiles of **density** measured at sites R6 to R12 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).

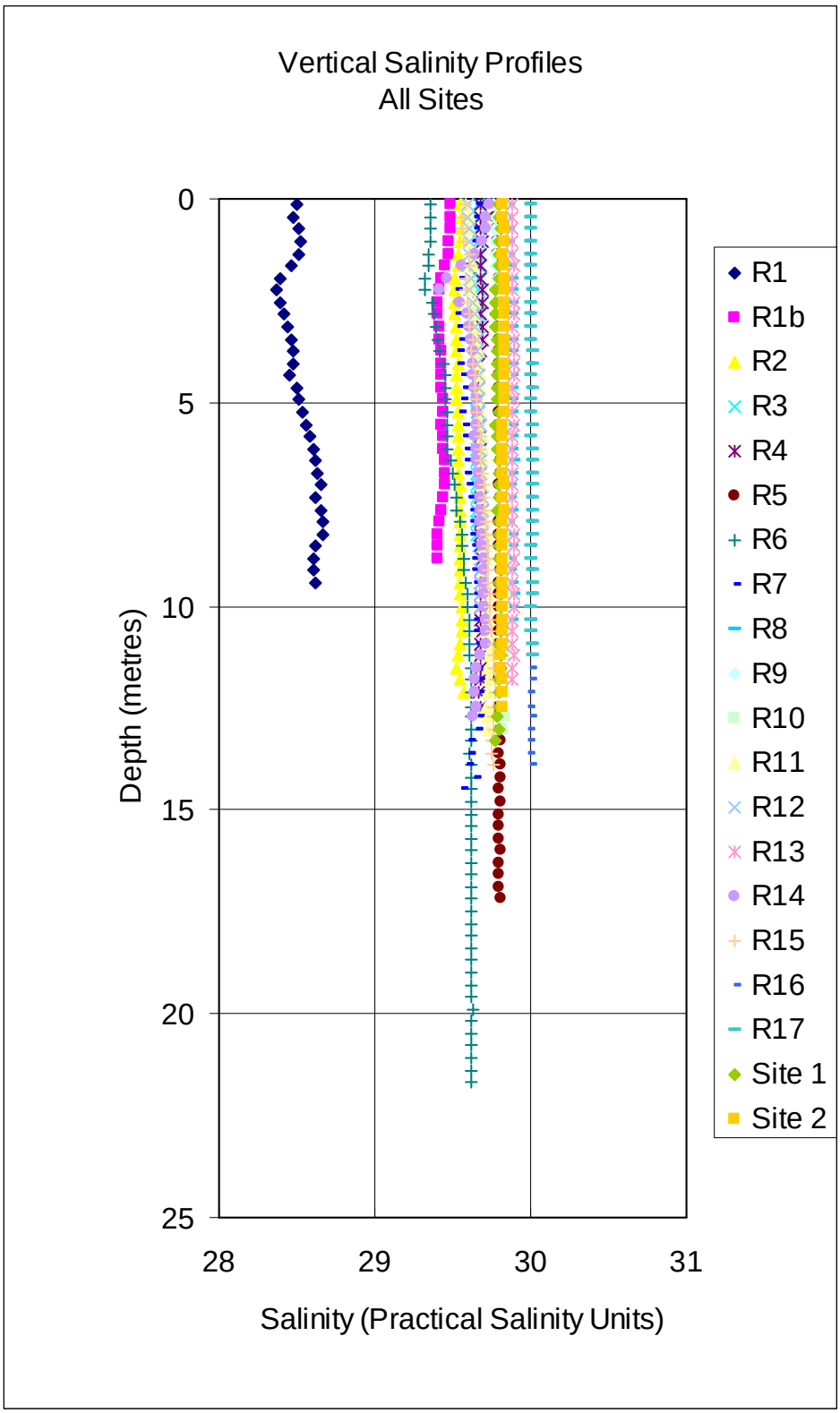



**18 November 2010:** Vertical profiles of **density** measured at sites R12 to R17 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).

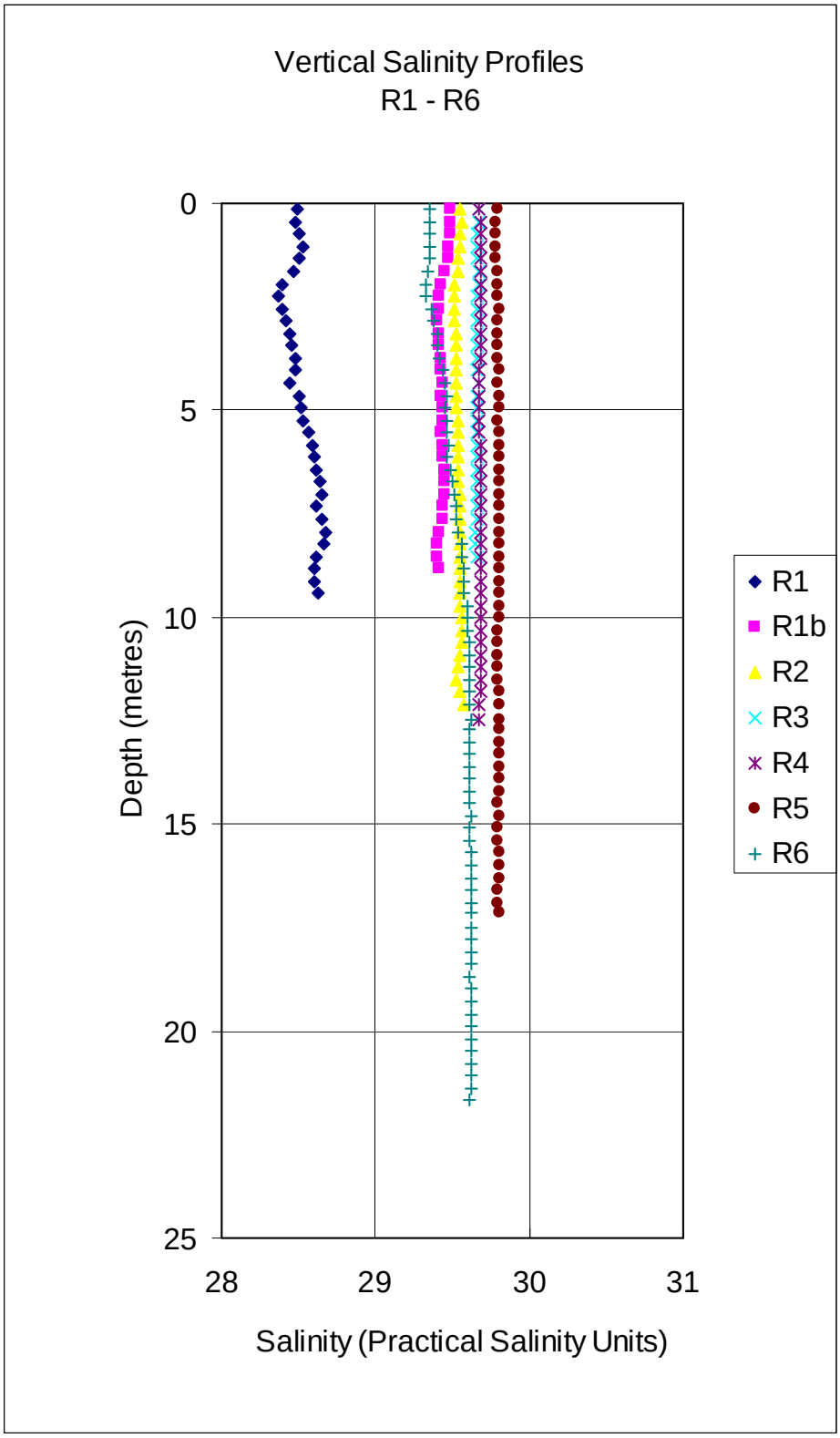



**18 November 2010:** Vertical profiles of **density** measured at a representative selection of sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).

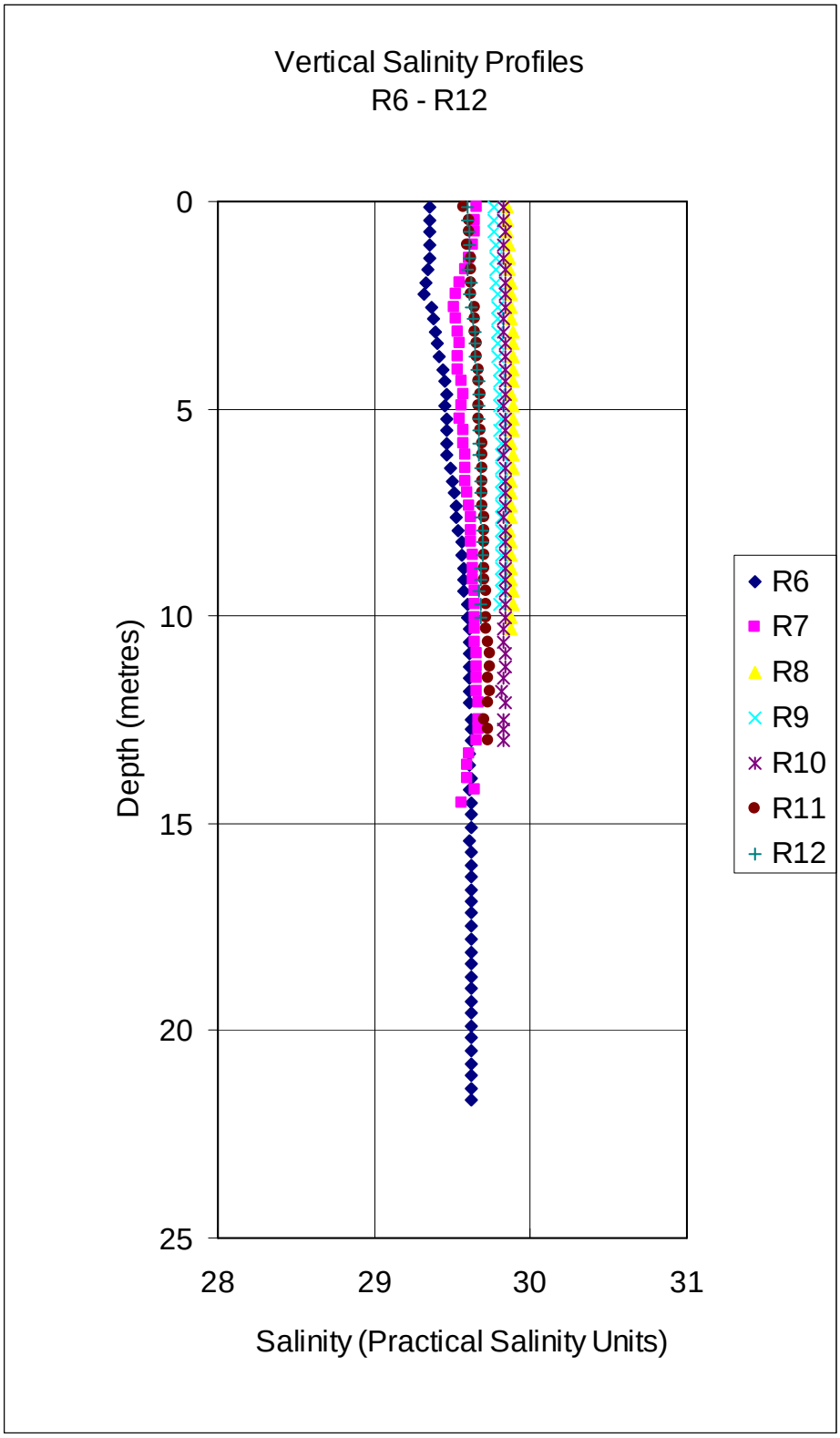
# 25 January 2011



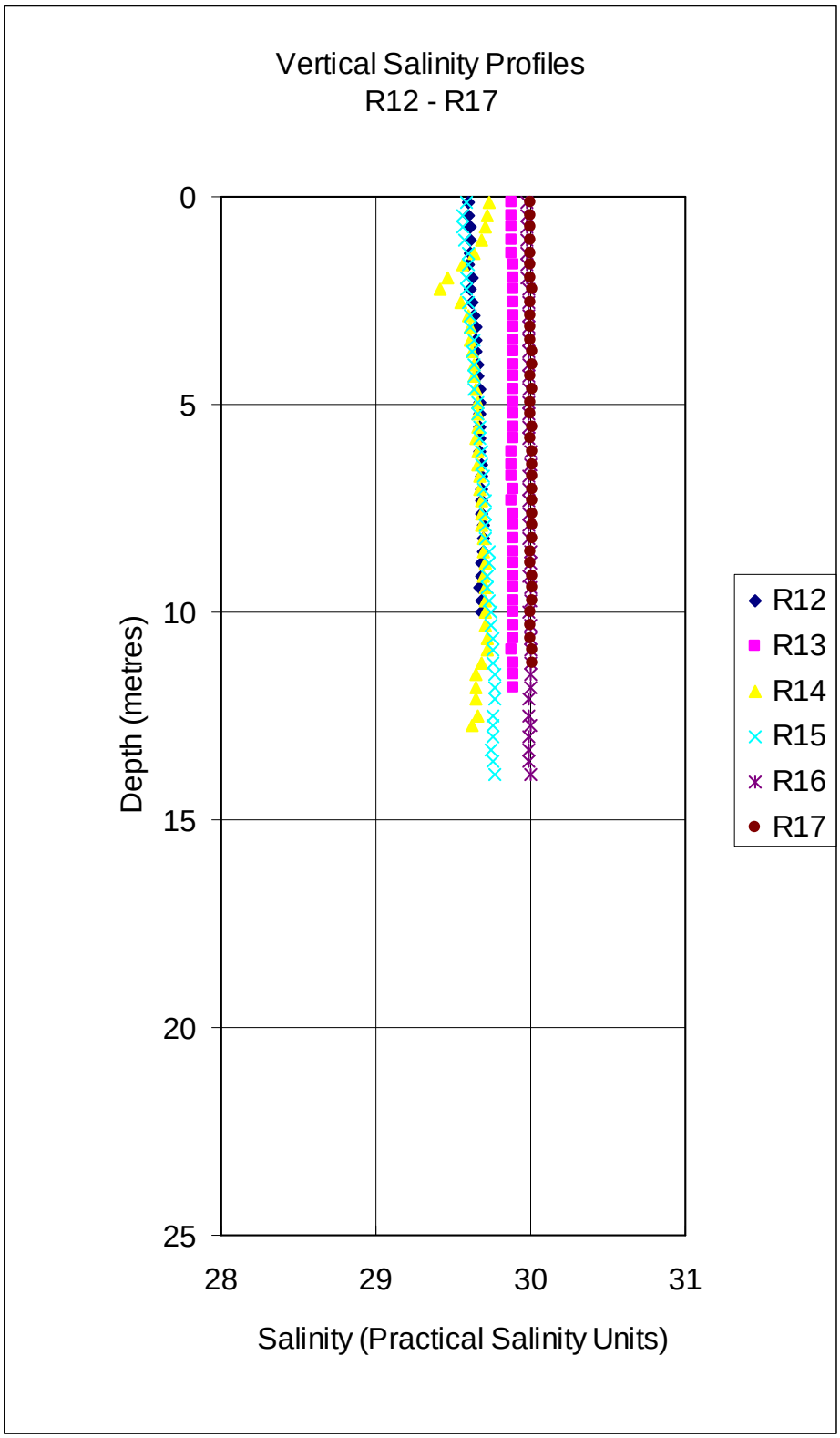

**25 January 2011:** Vertical profiles of **salinity** measured at all sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors.



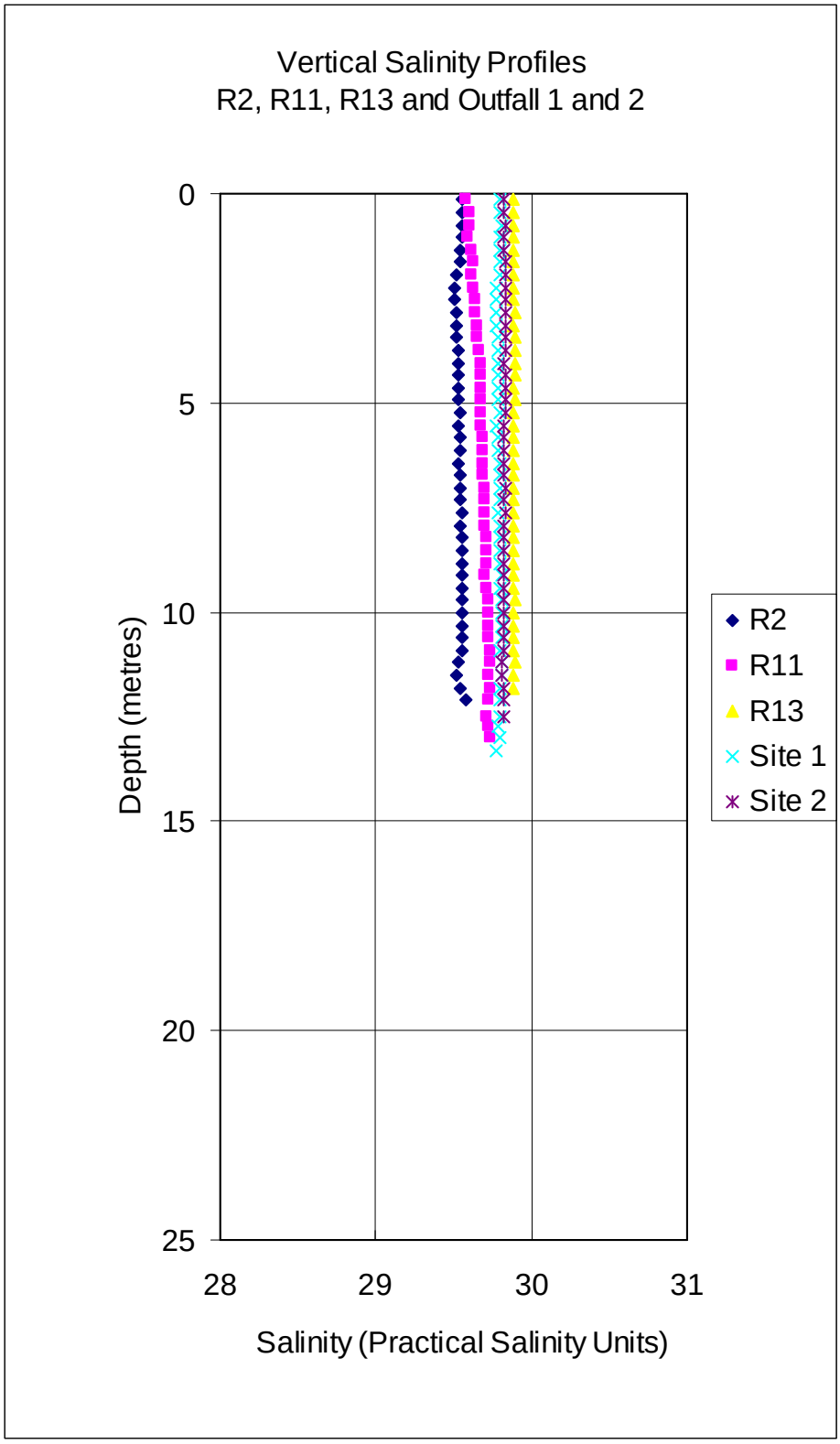

**25 January 2011:** Vertical profiles of **salinity** measured at sites R1 to R6 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



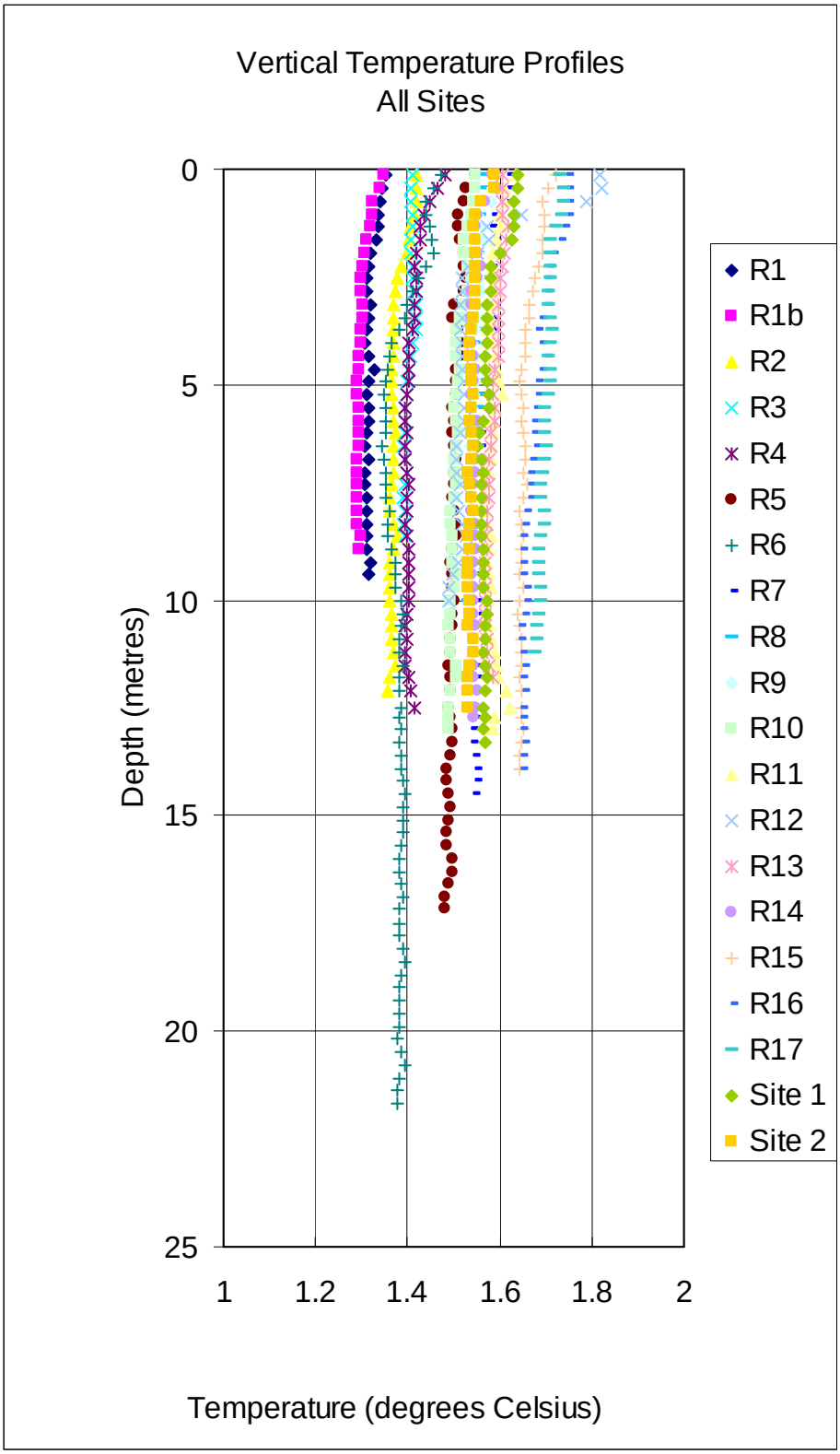

**25 January 2011:** Vertical profiles of **salinity** measured at sites R6 to R12 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



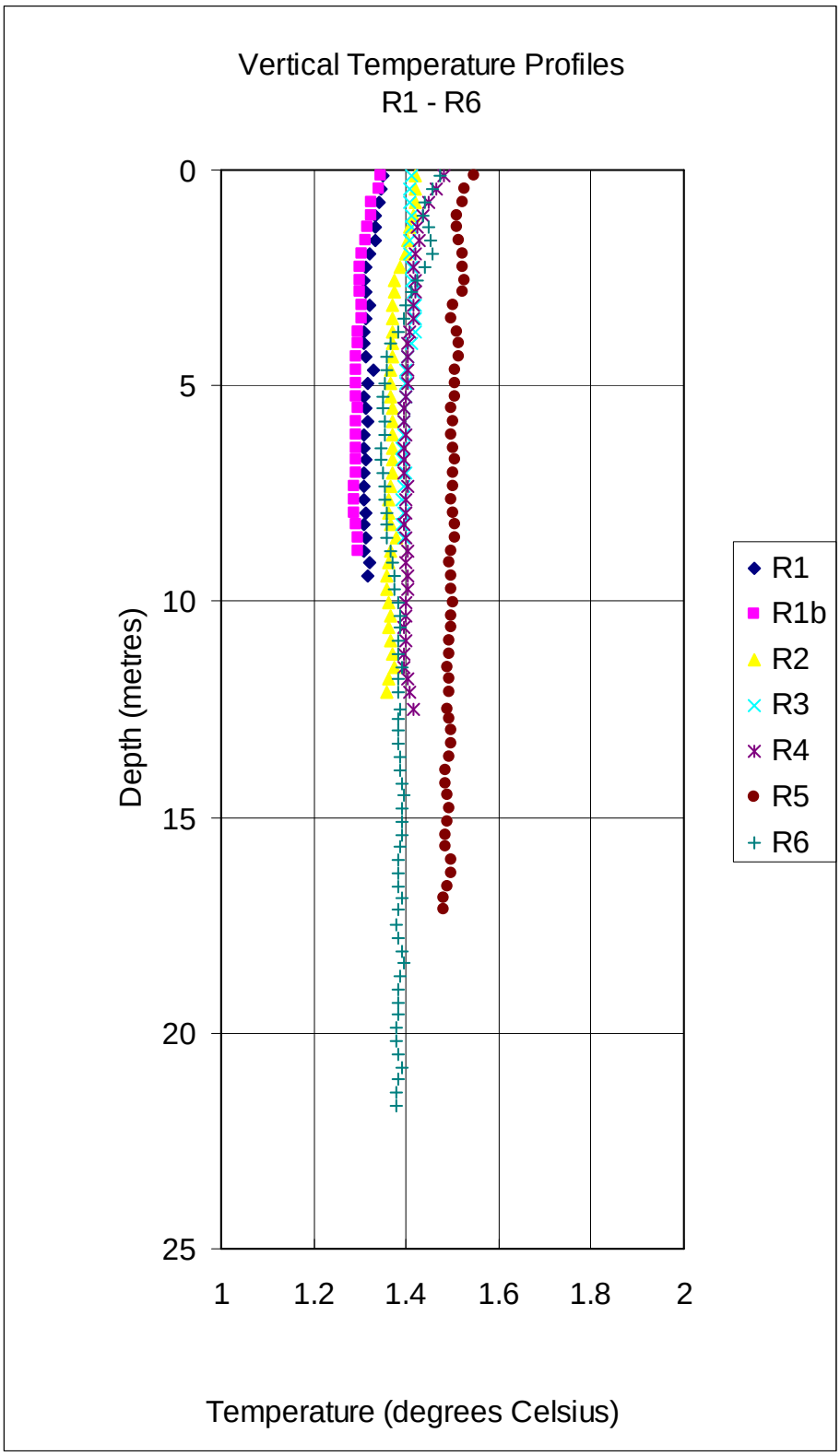

**25 January 2011:** Vertical profiles of **salinity** measured at sites R12 to R17 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



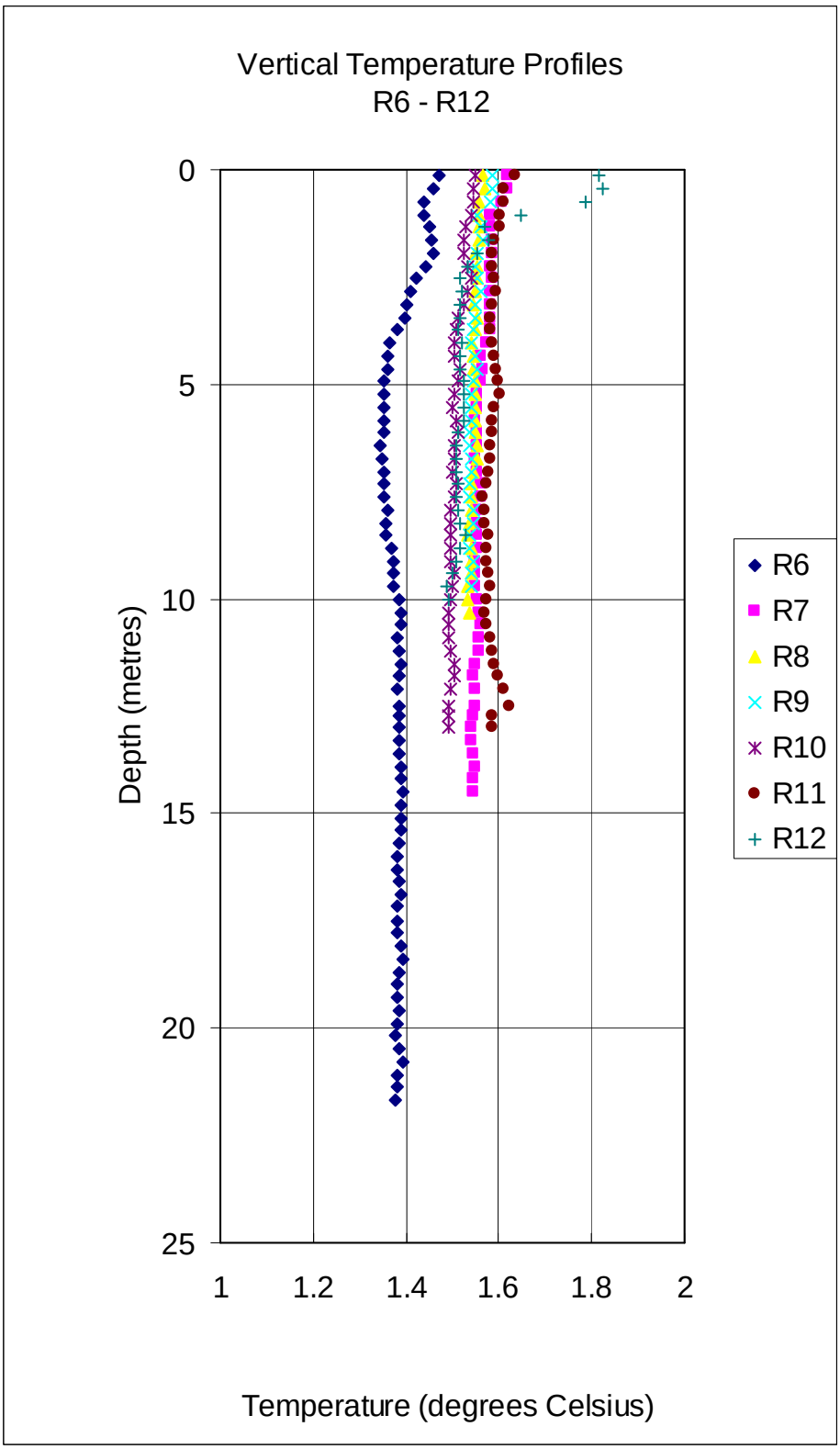

**25 January 2011:** Vertical profiles of **salinity** measured at a representative selection of sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



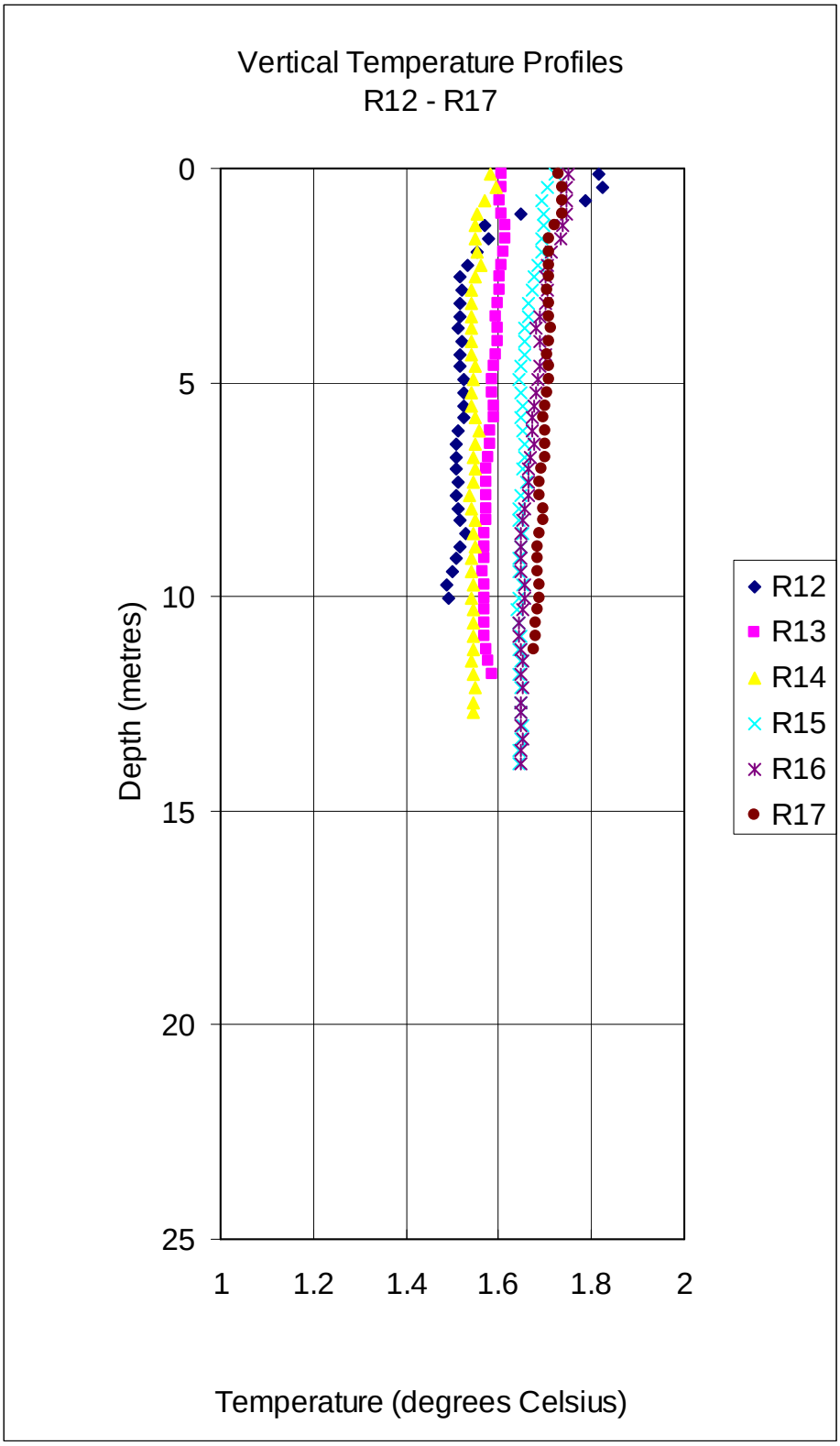

**25 January 2011:** Vertical profiles of **temperature** measured at all sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors.



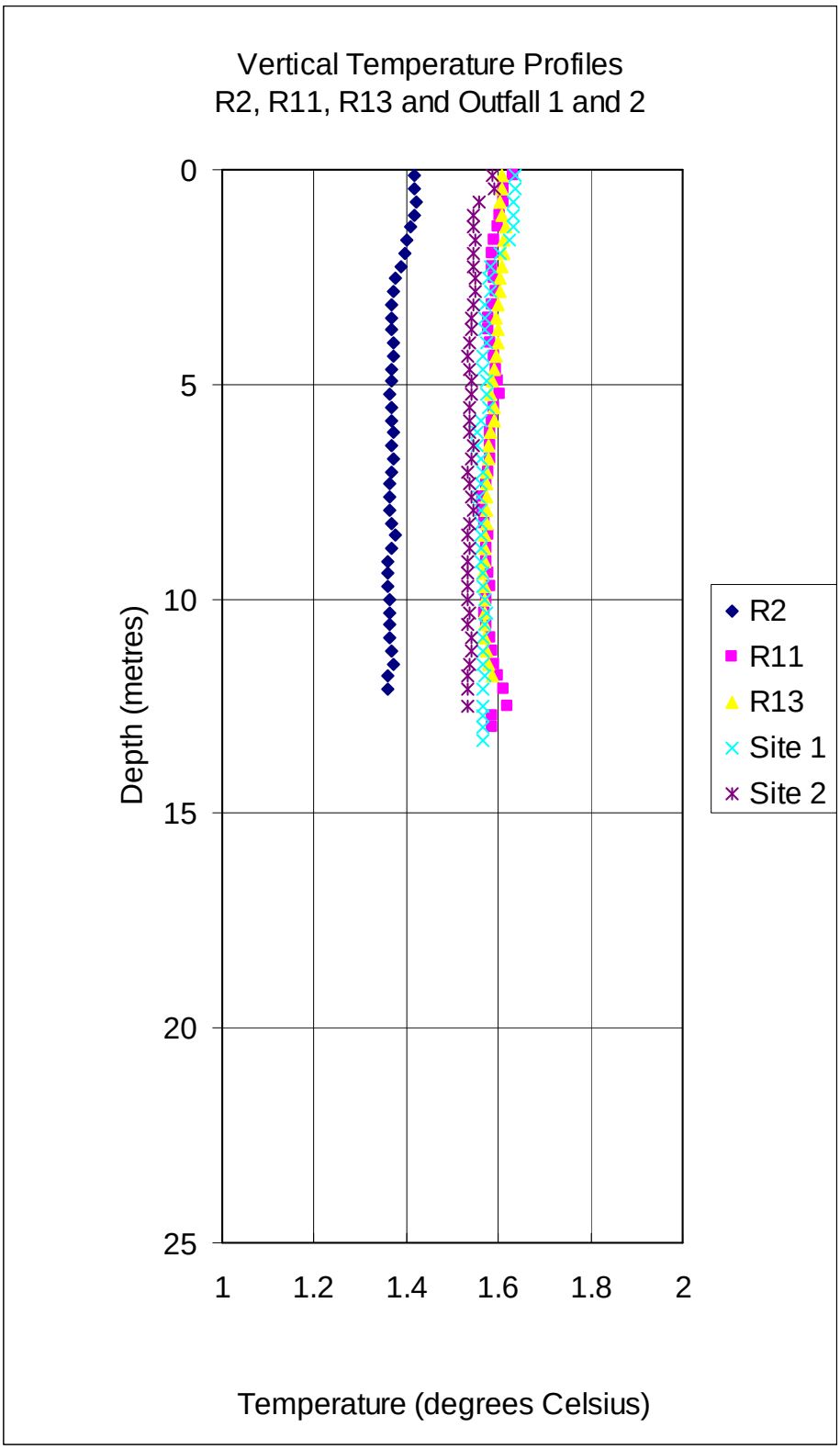

**25 January 2011:** Vertical profiles of **temperature** measured at sites R1 to R6 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



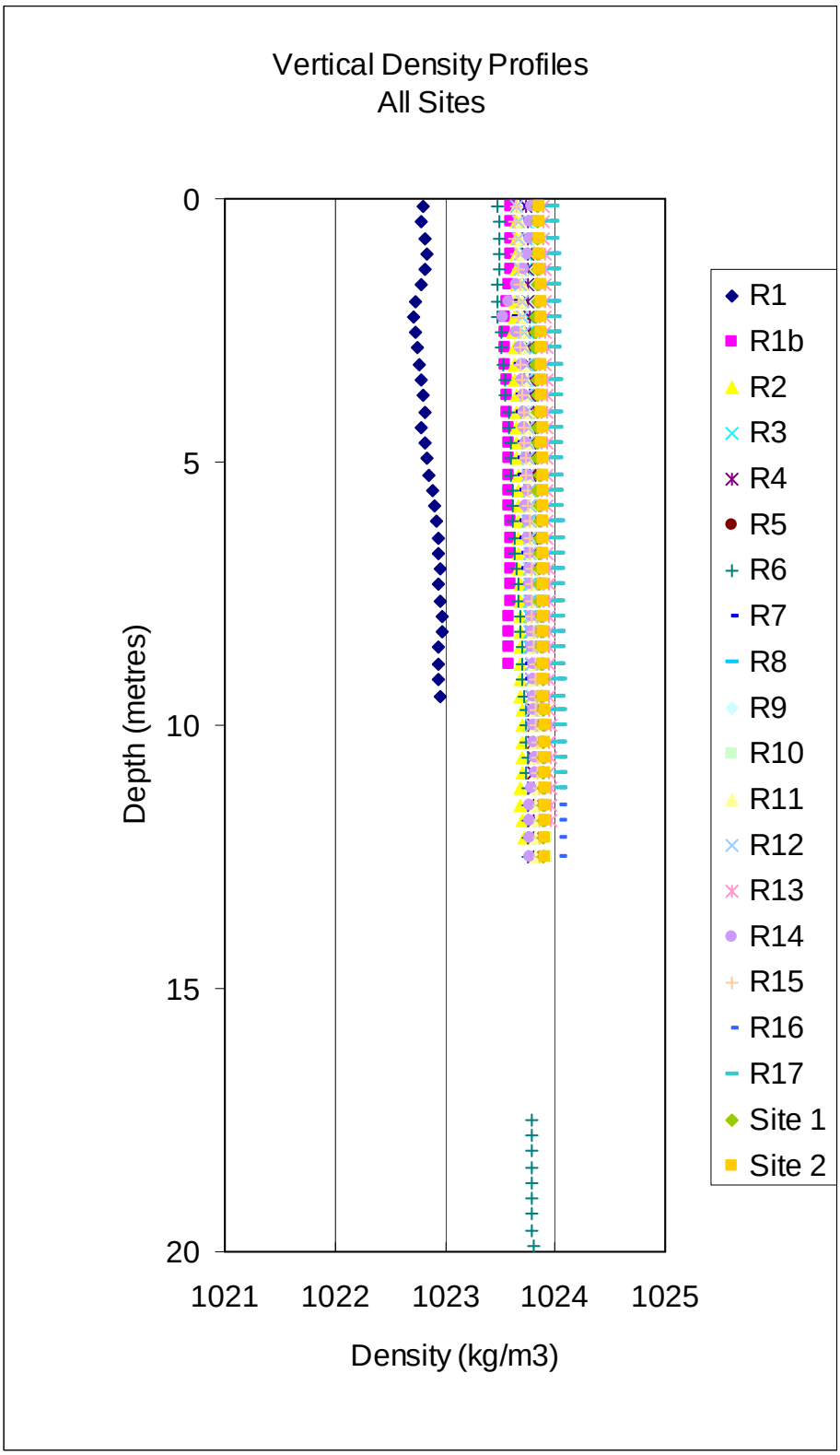

**25 January 2011:** Vertical profiles of **temperature** measured at sites R6 to R12 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



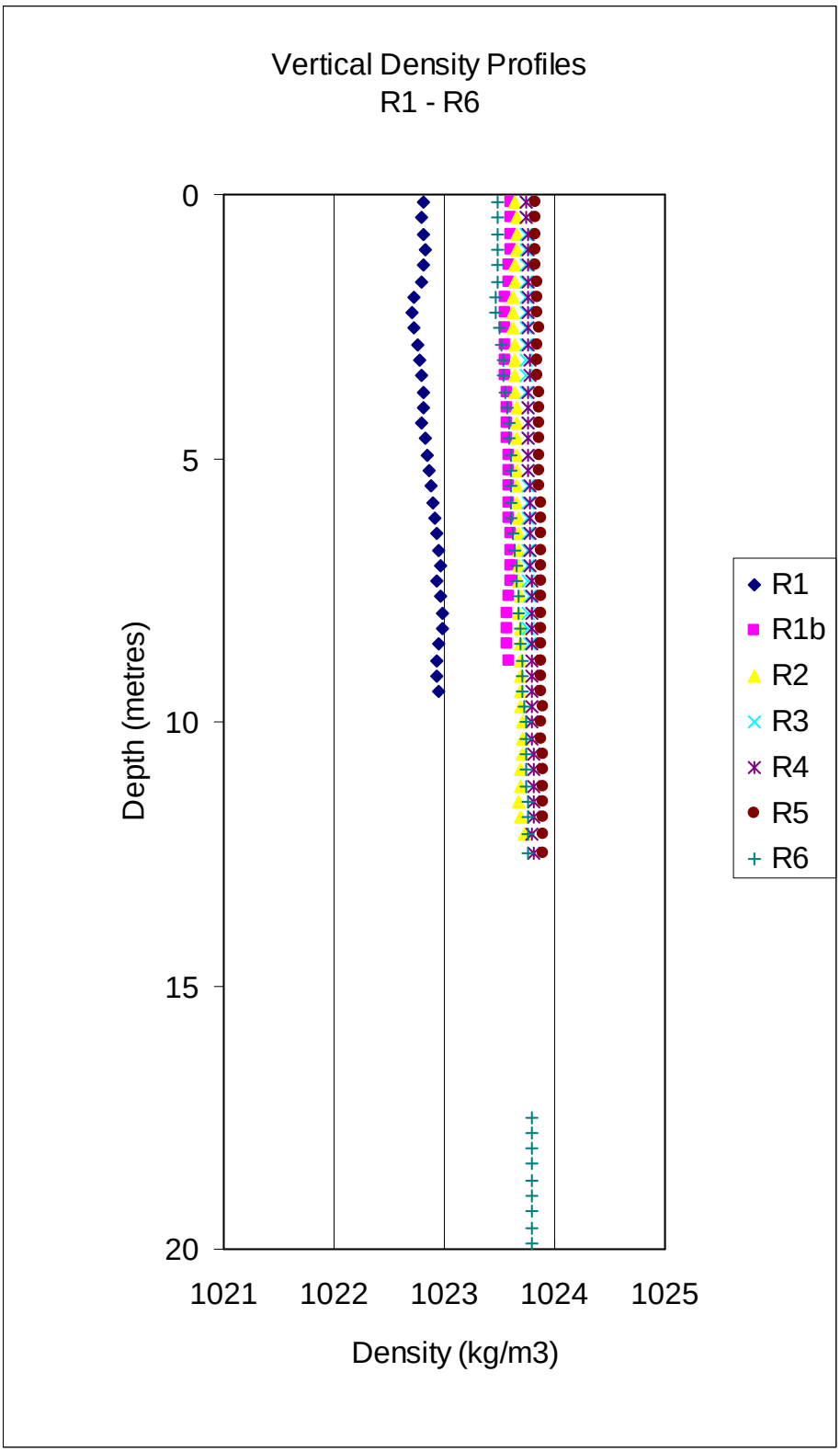

**25 January 2011:** Vertical profiles of **temperature** measured at sites R12 to R17 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



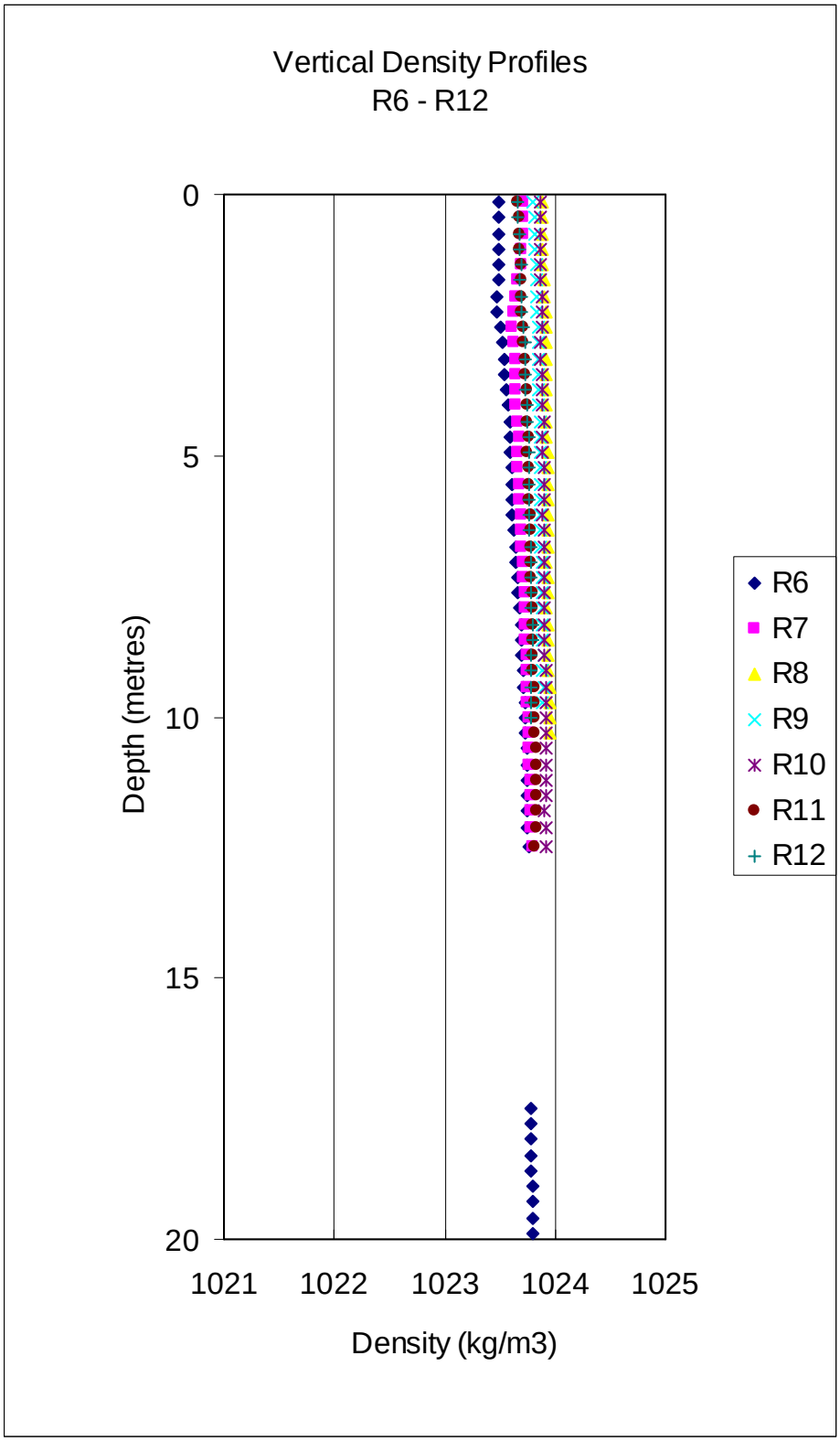

**25 January 2011:** Vertical profiles of **temperature** measured at a representative selection of sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



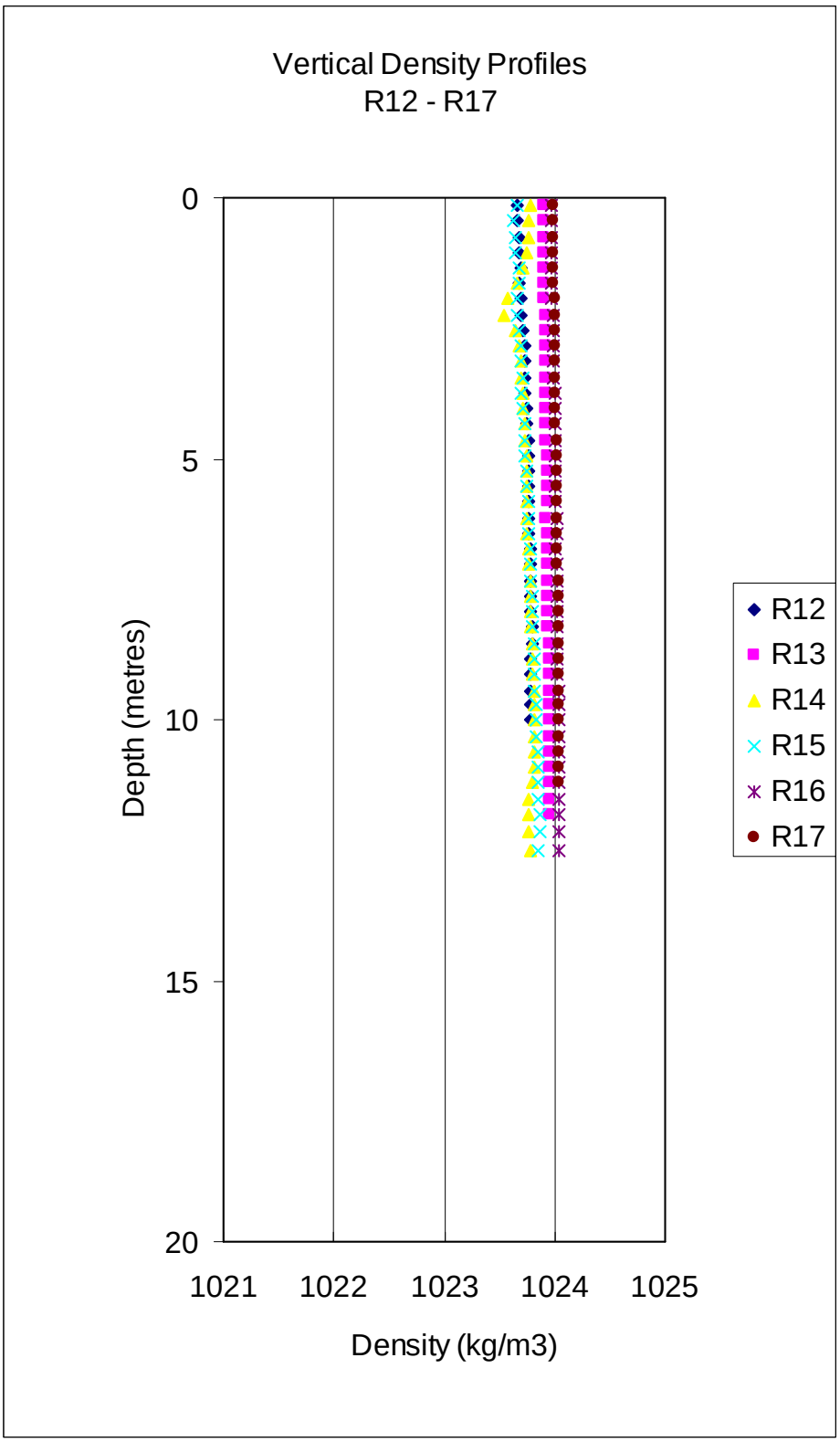

**25 January 2011:** Vertical profiles of **density** measured at all sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors.



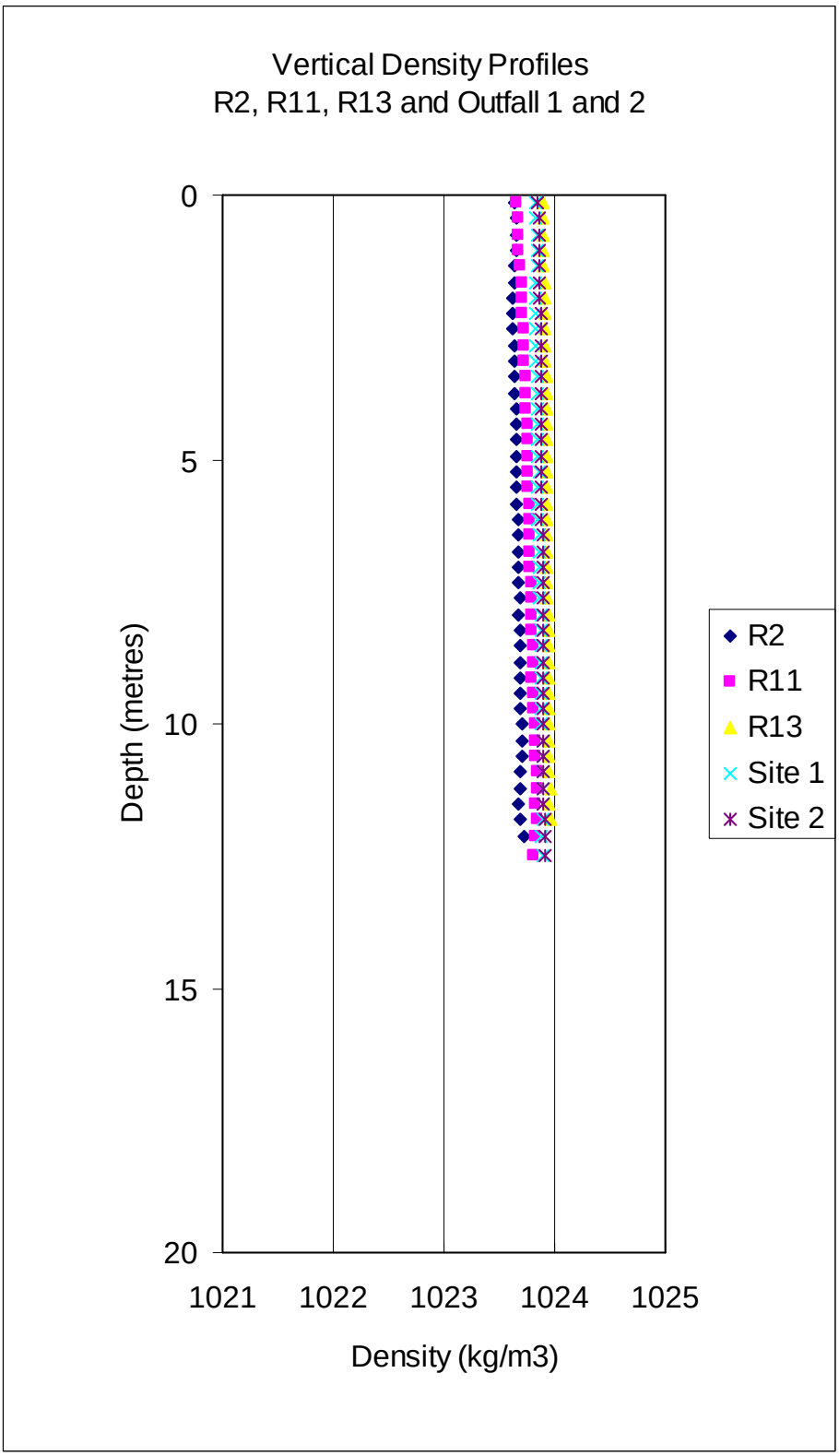

**25 January 2011:** Vertical profiles of **density** measured at sites R1 to R6 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).




**25 January 2011:** Vertical profiles of **density** measured at sites R6 to R12 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).

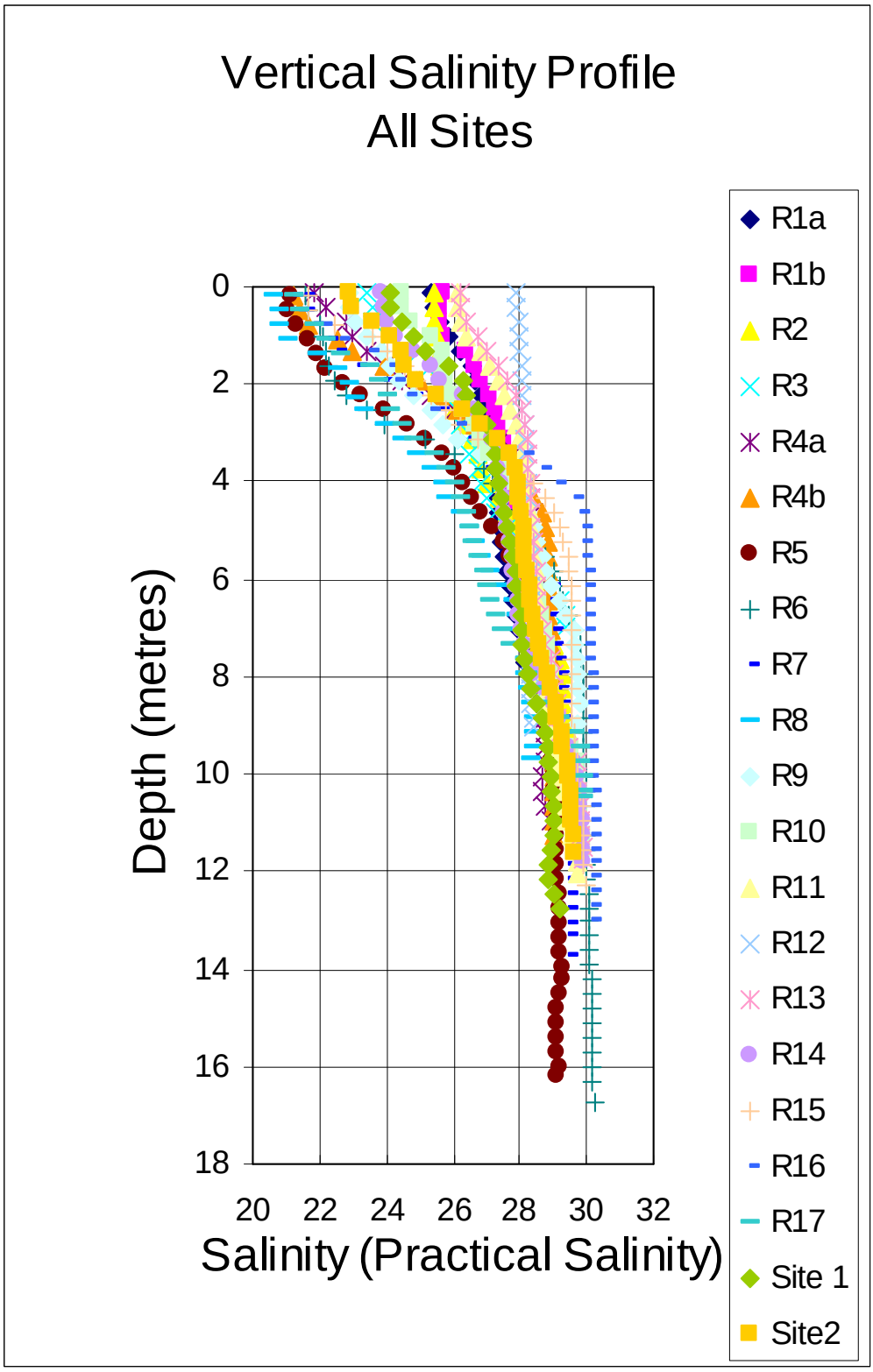



**25 January 2011:** Vertical profiles of **density** measured at sites R12 to R17 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).

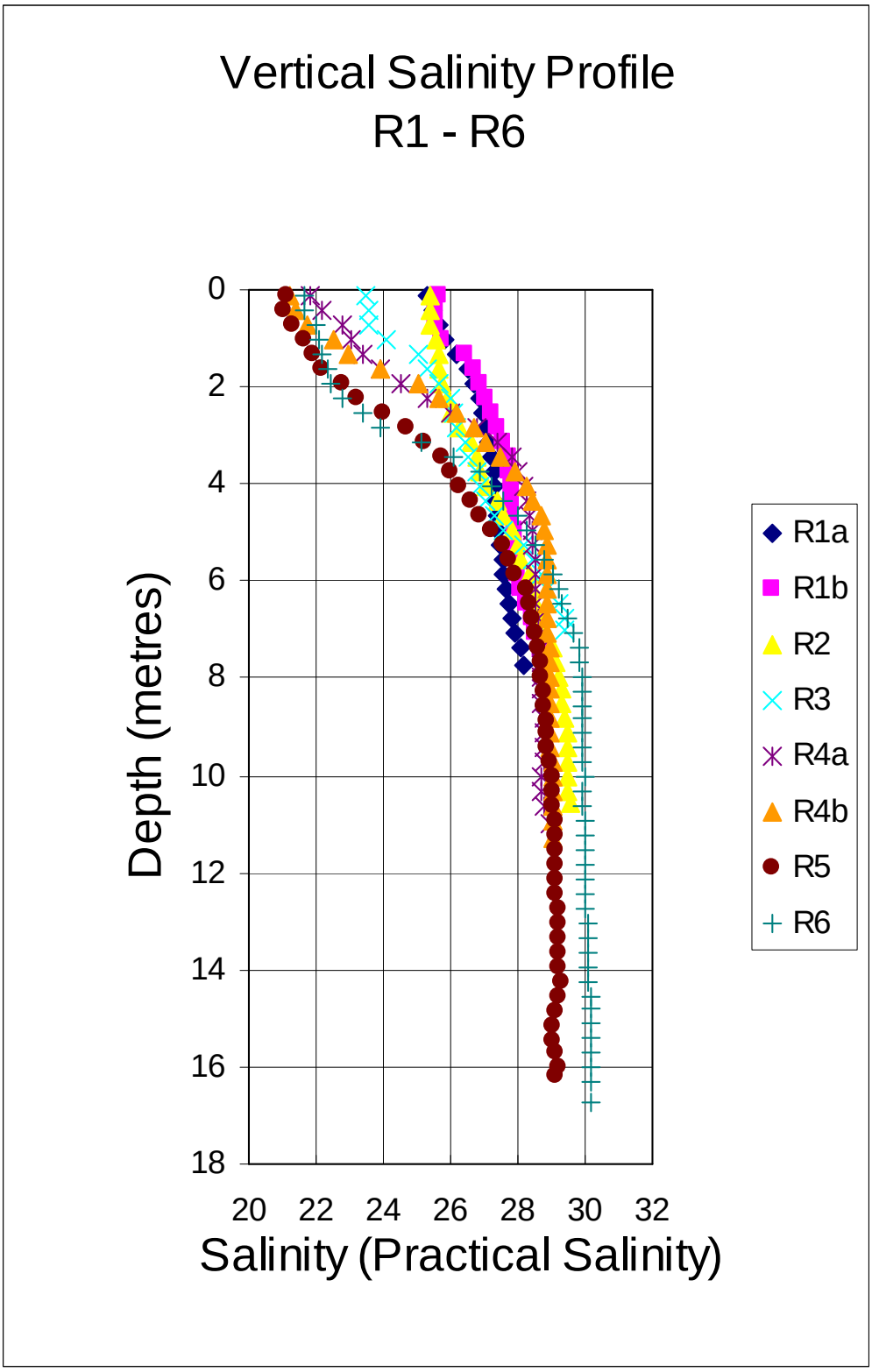



**25 January 2011:** Vertical profiles of **density** measured at a representative selection of sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).

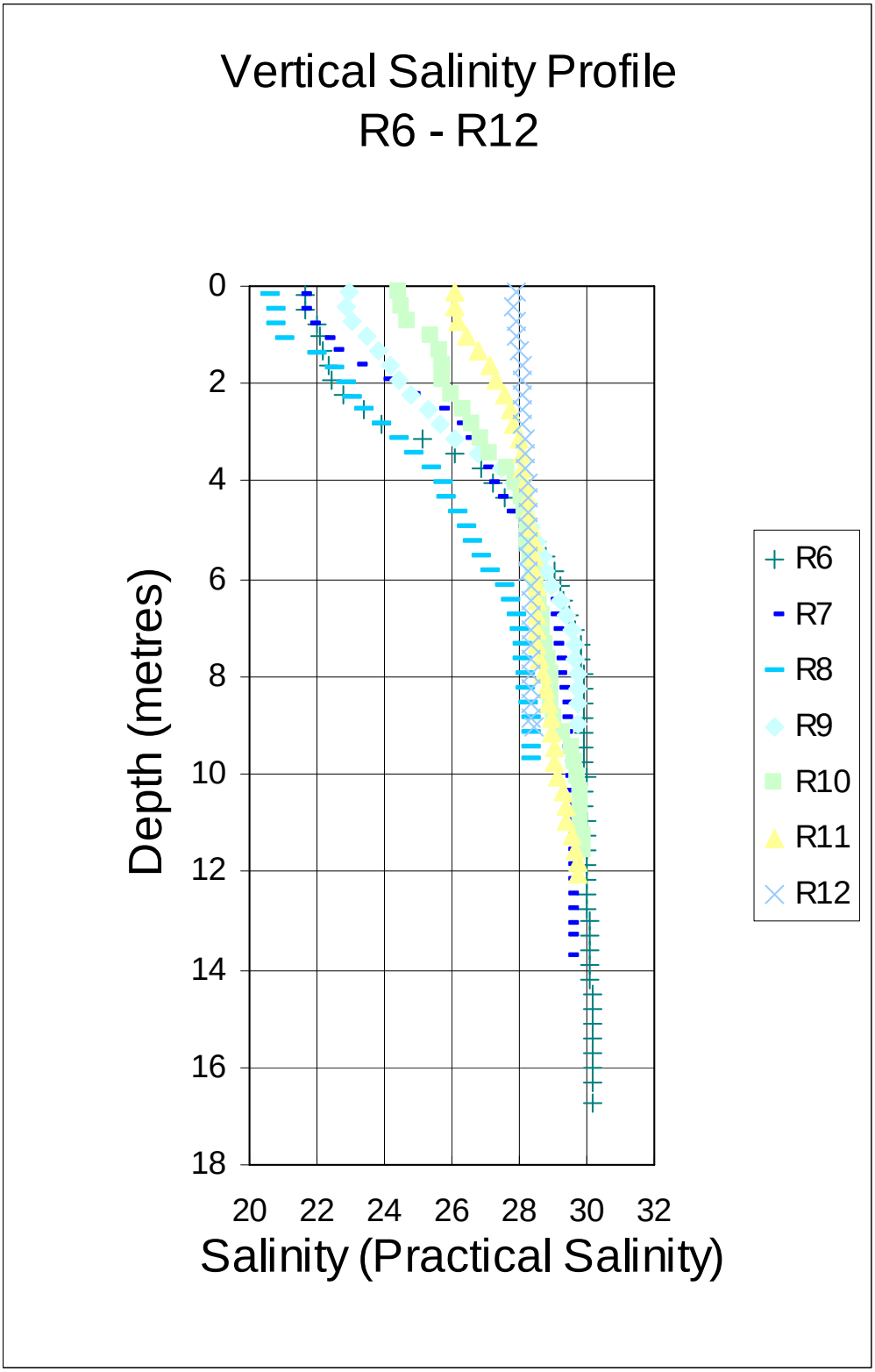
# 17 March 2011



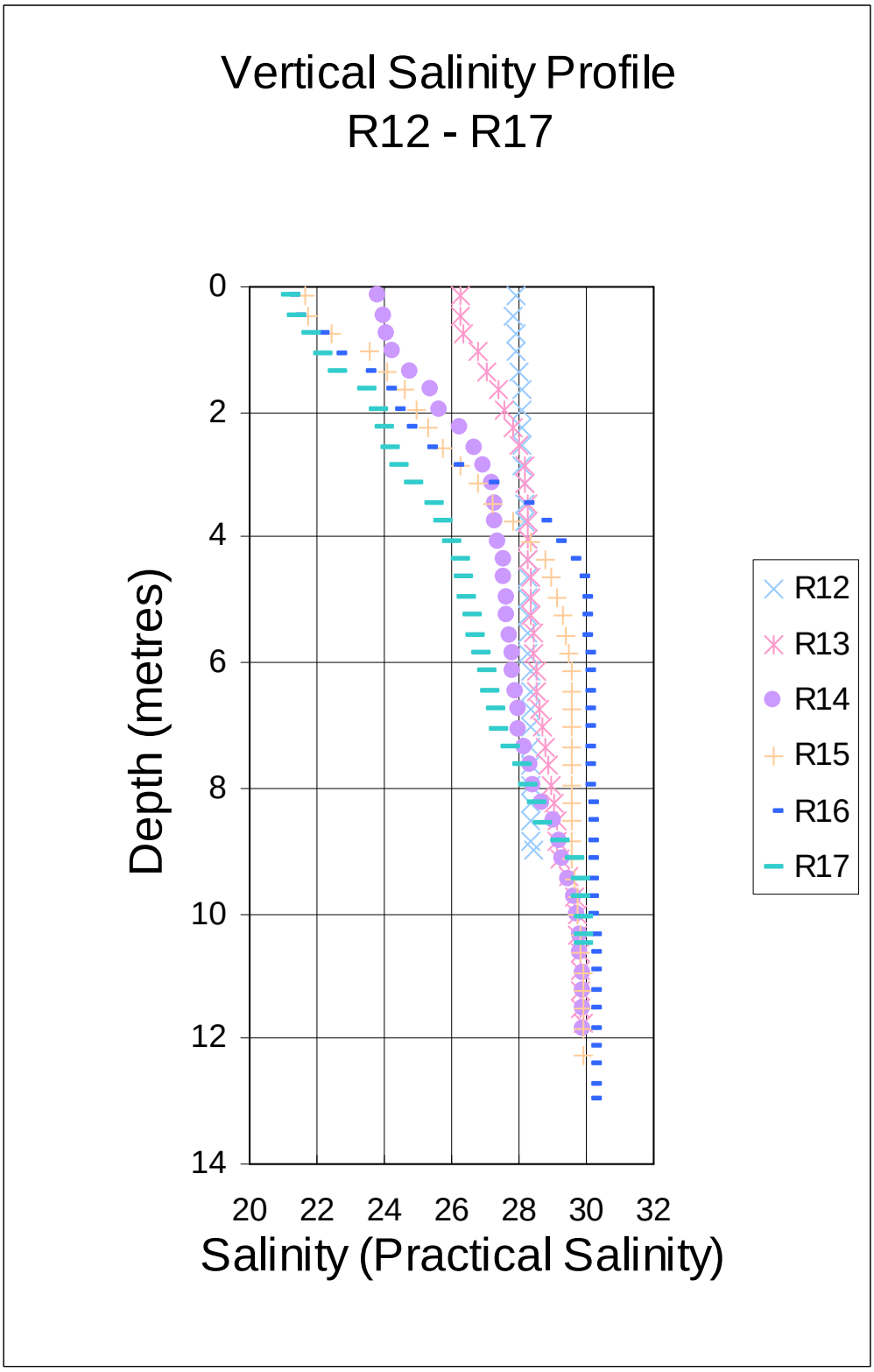

**17 March 2011:** Vertical profiles of **salinity** measured at all sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors.



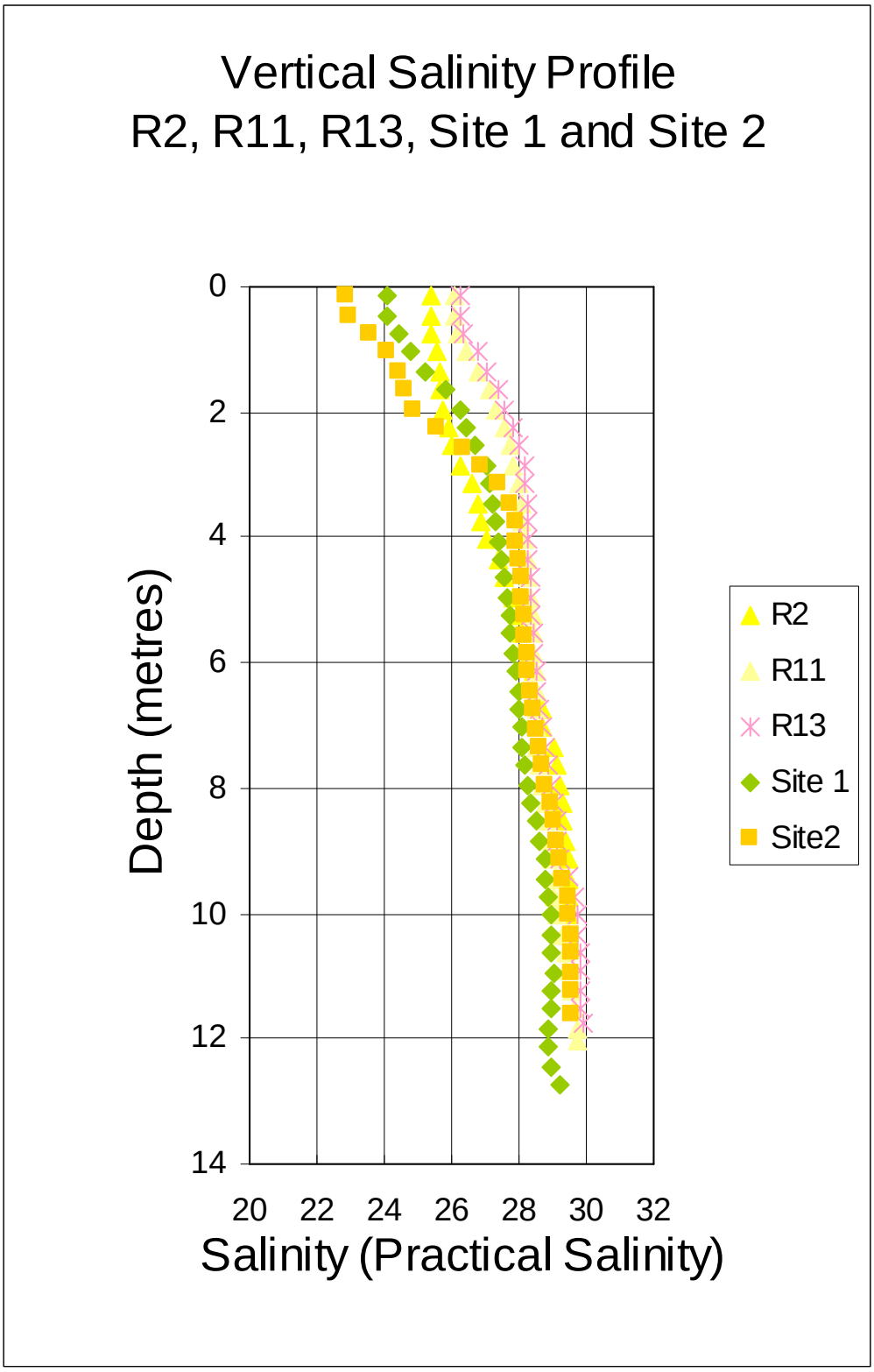

**17 March 2011:** Vertical profiles of **salinity** measured at sites R1 to R6 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



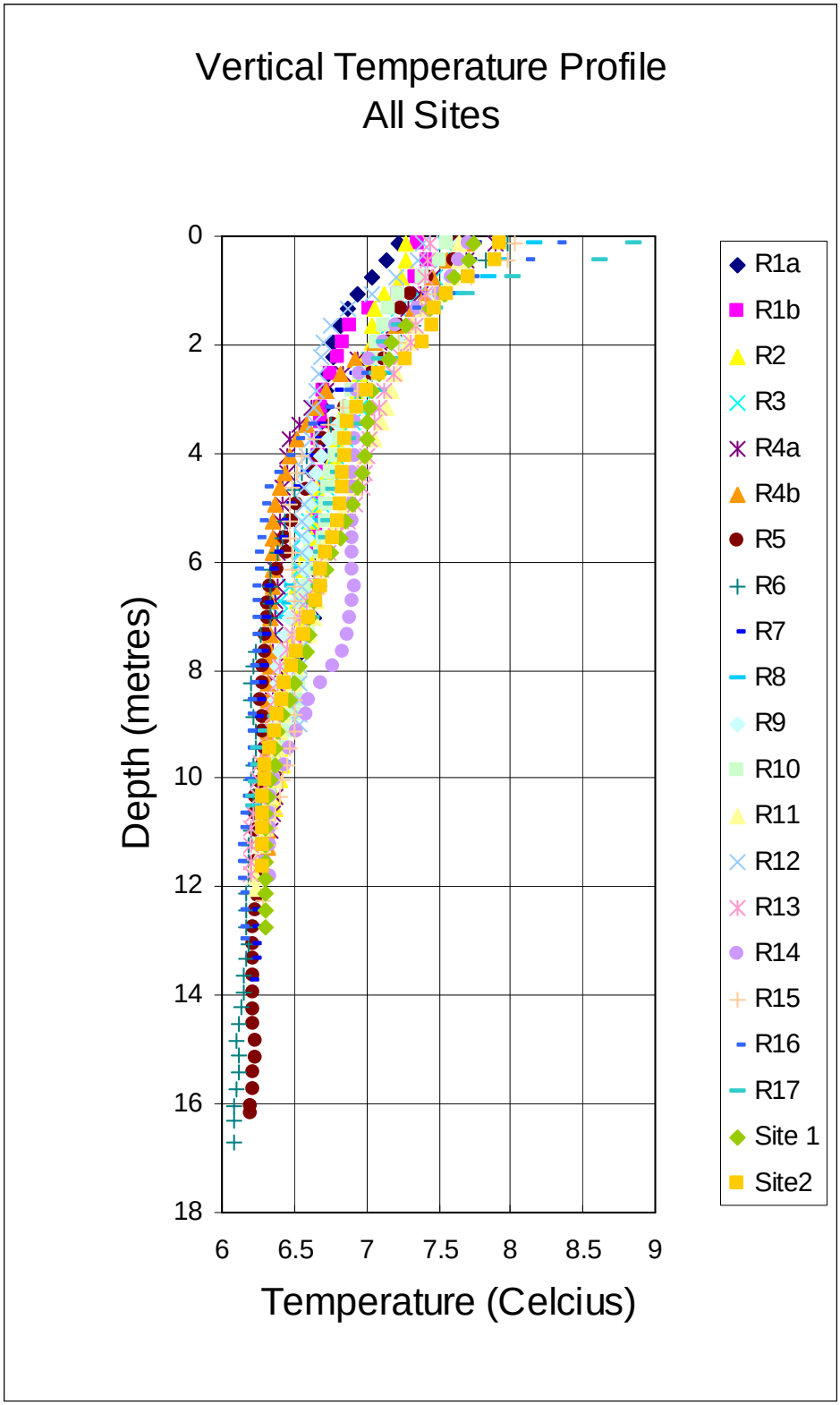

**17 March 2011:** Vertical profiles of **salinity** measured at sites R6 to R12 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



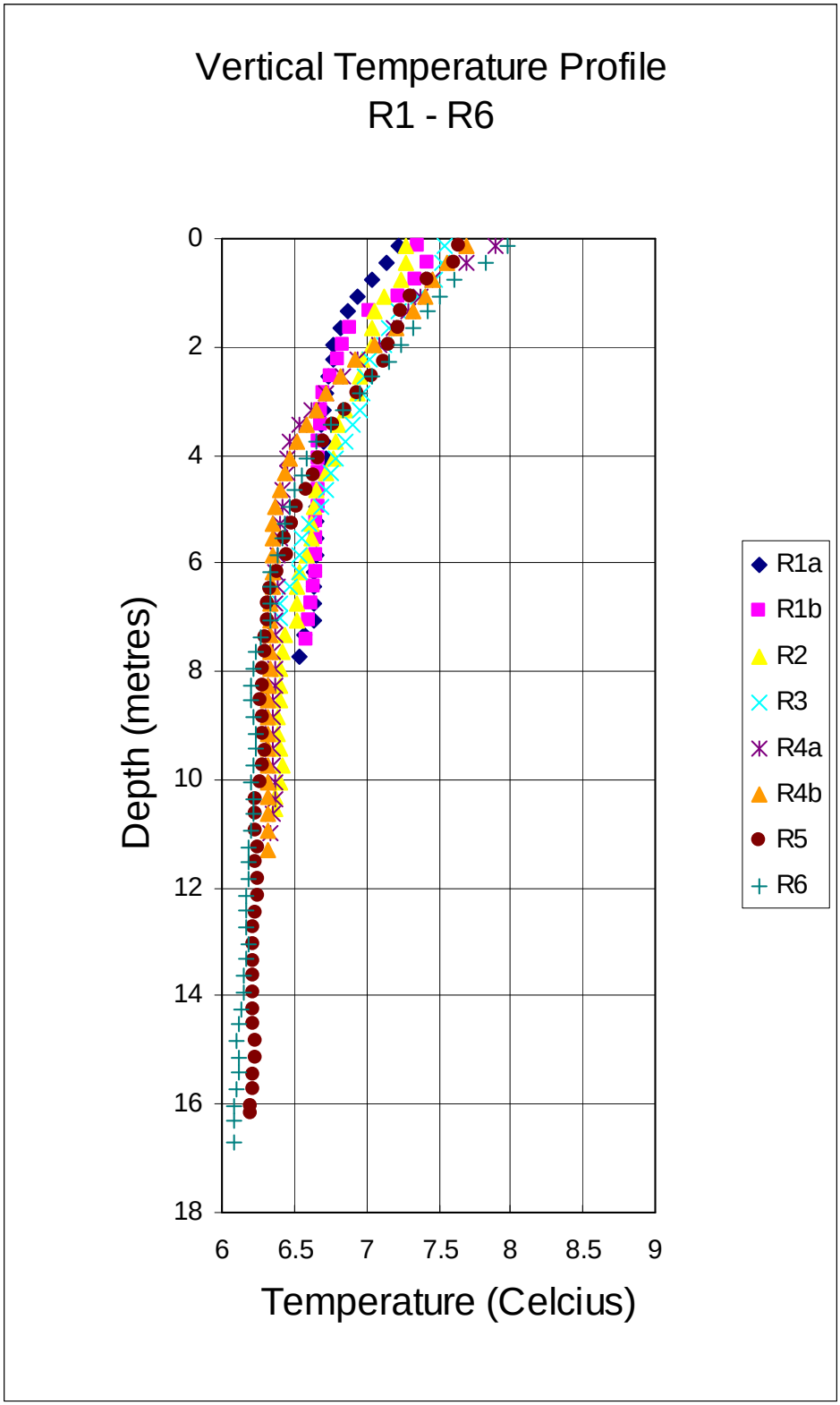

**17 March 2011:** Vertical profiles of **salinity** measured at sites R12 to R17 shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



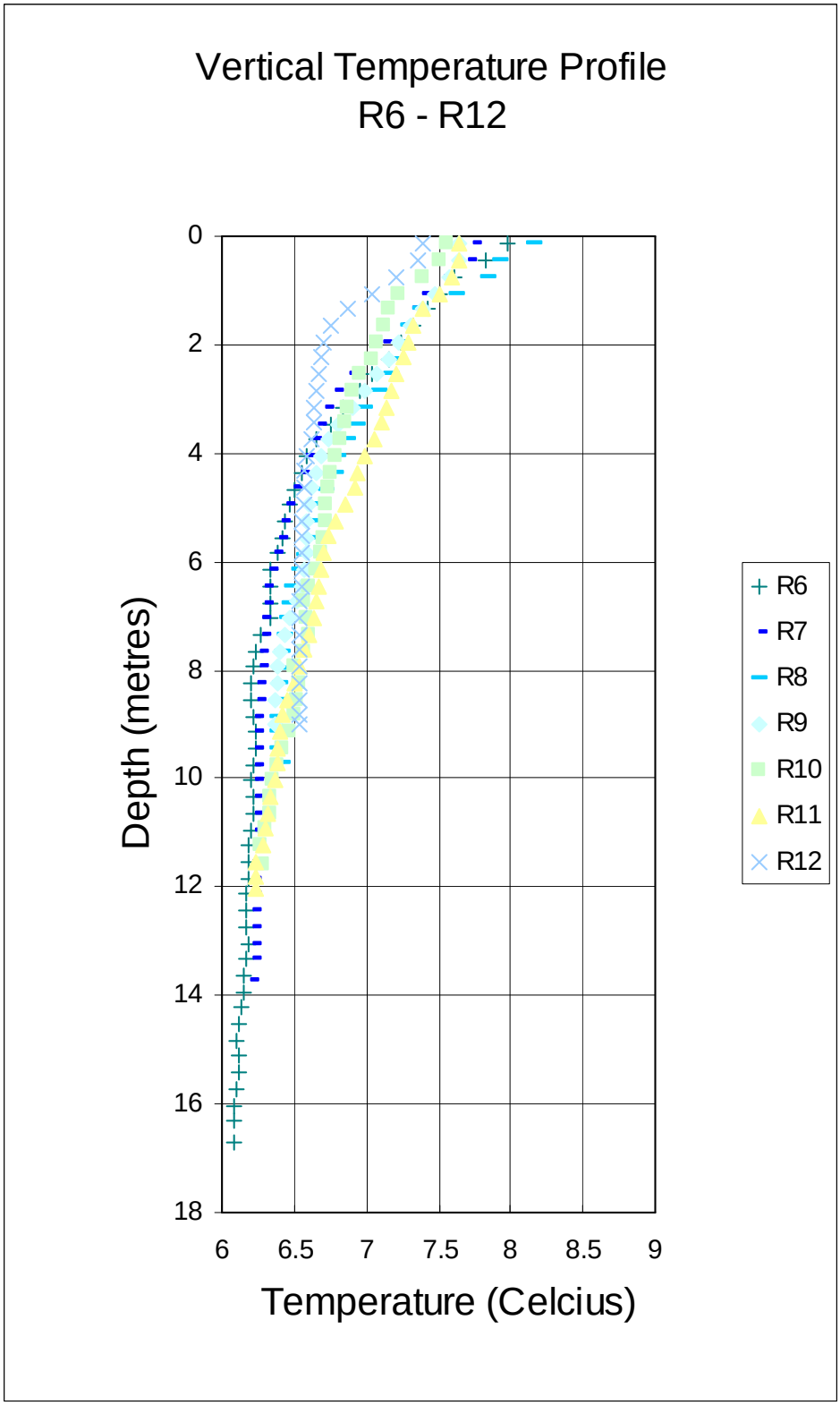

**17 March 2011:** Vertical profiles of **salinity** measured at a representative selection of sites shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



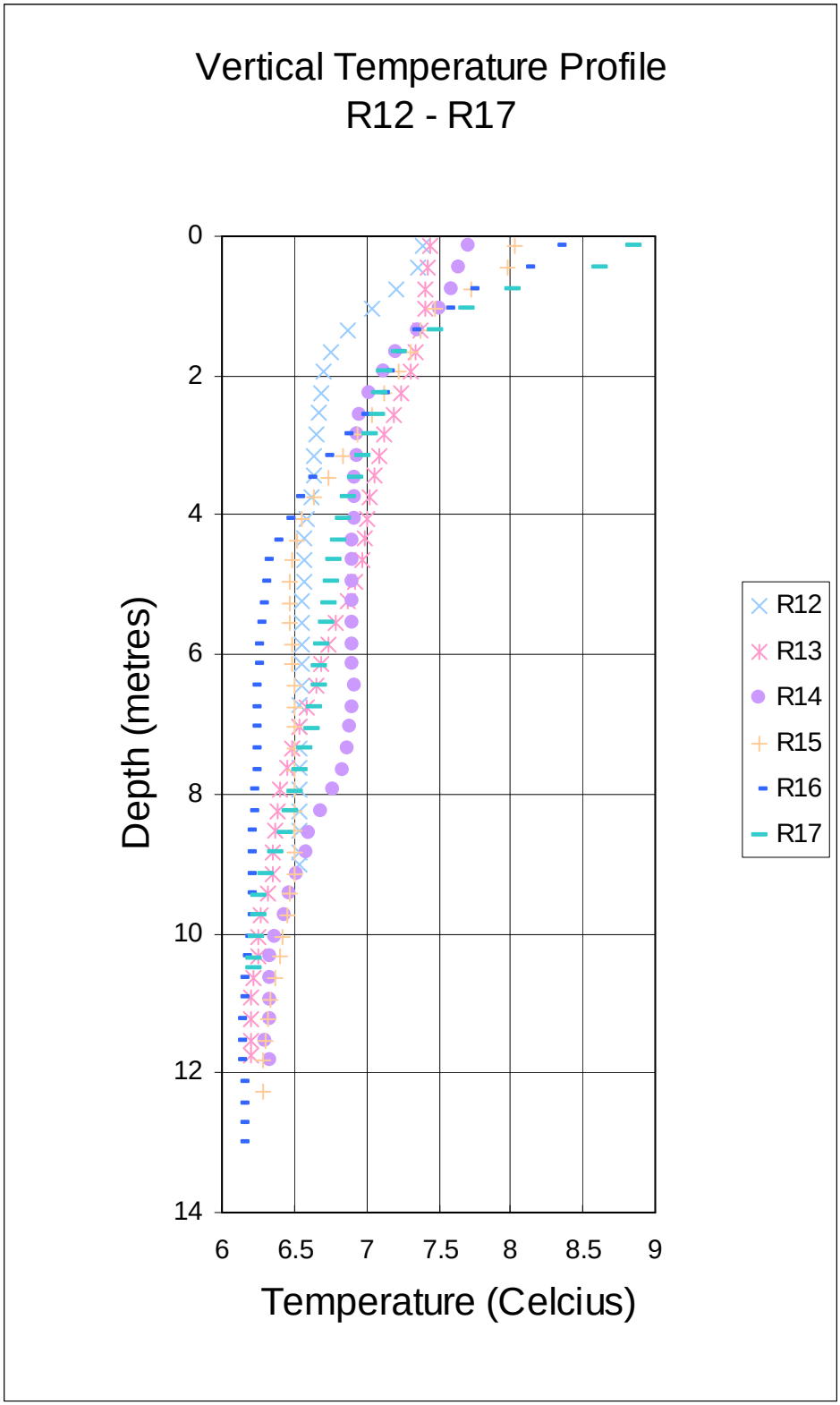

**17 March 2011:** Vertical profiles of **temperature** measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors.



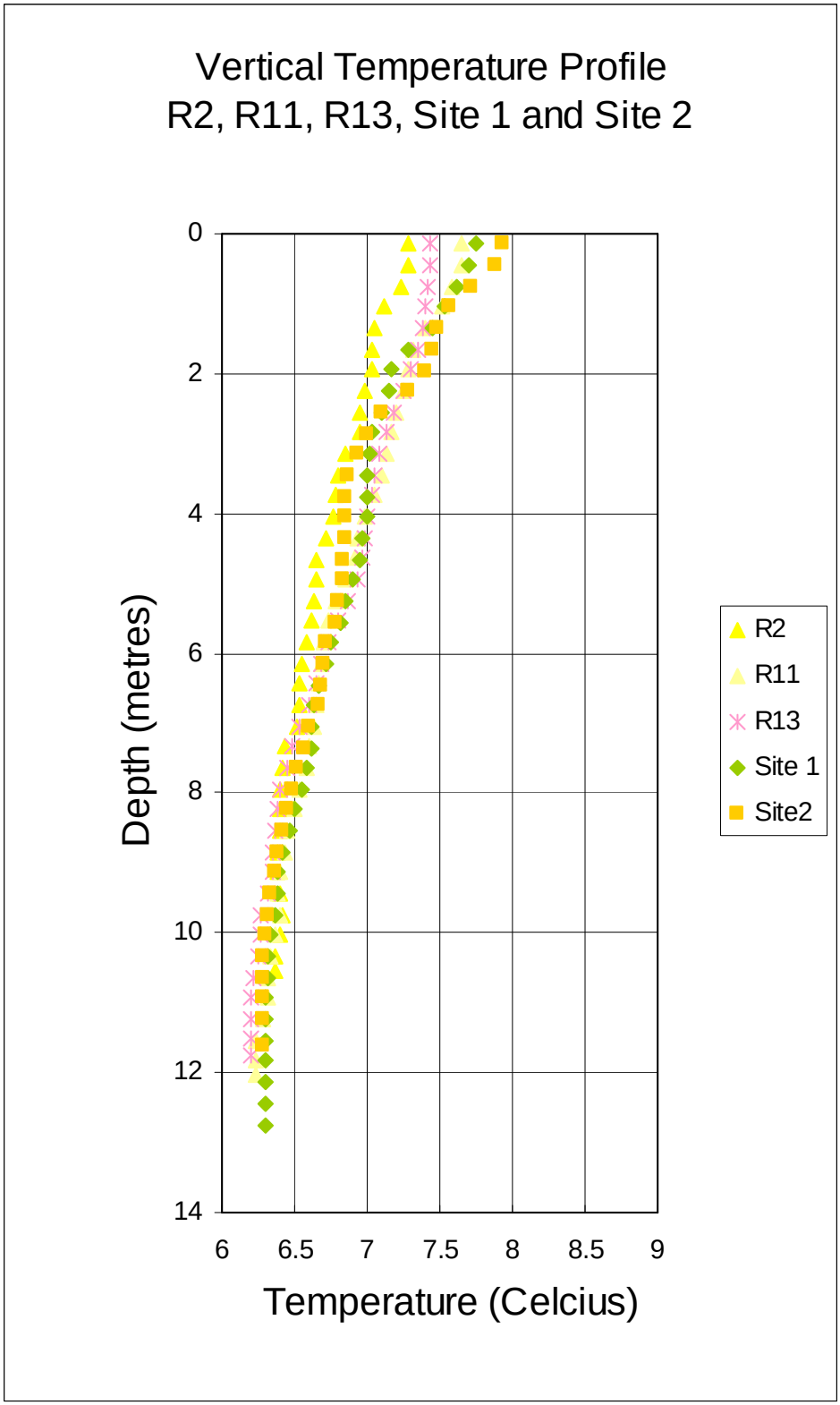

**17 March 2011:** Vertical profiles of **temperature** measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



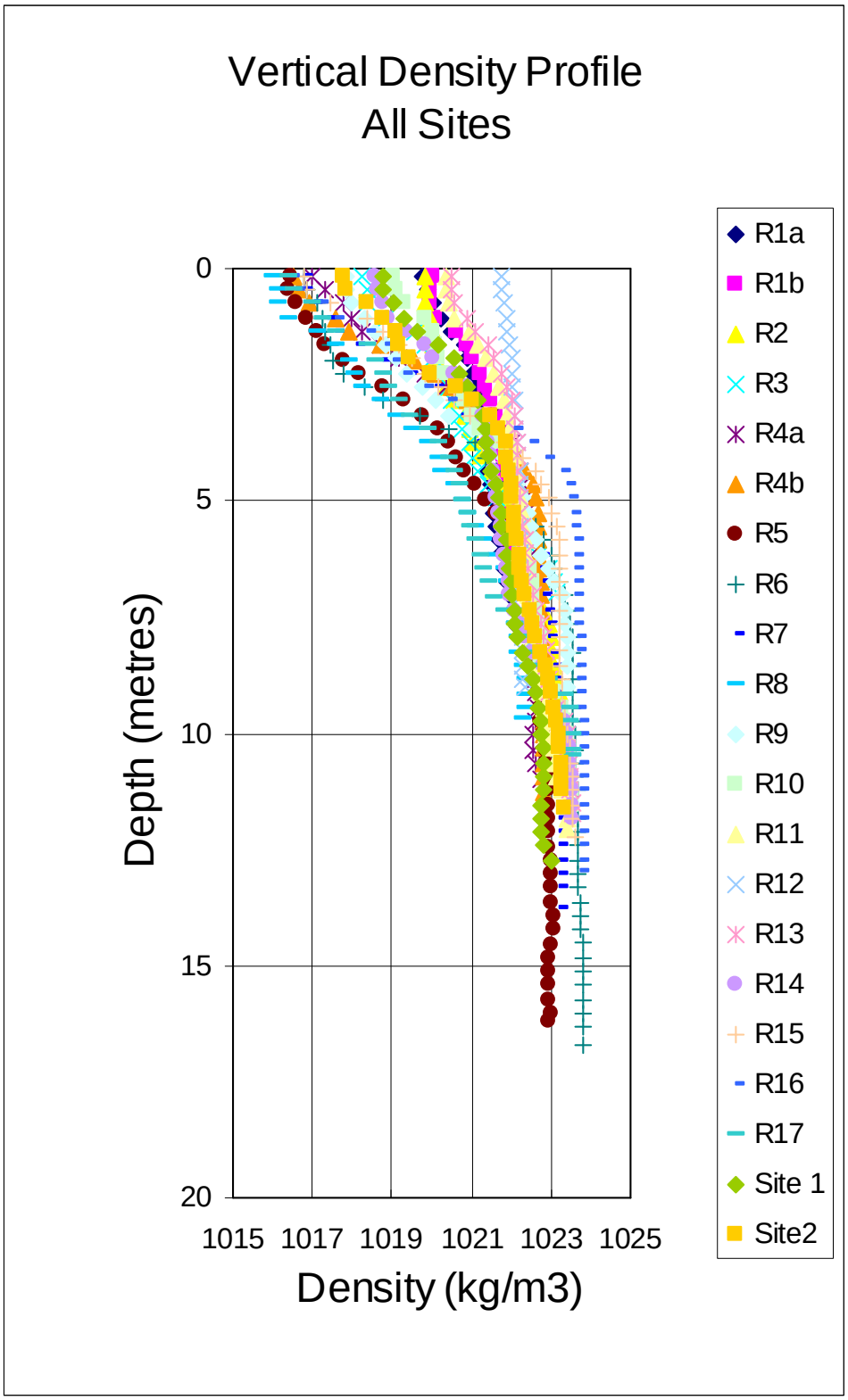

**17 March 2011:** Vertical profiles of **temperature** measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



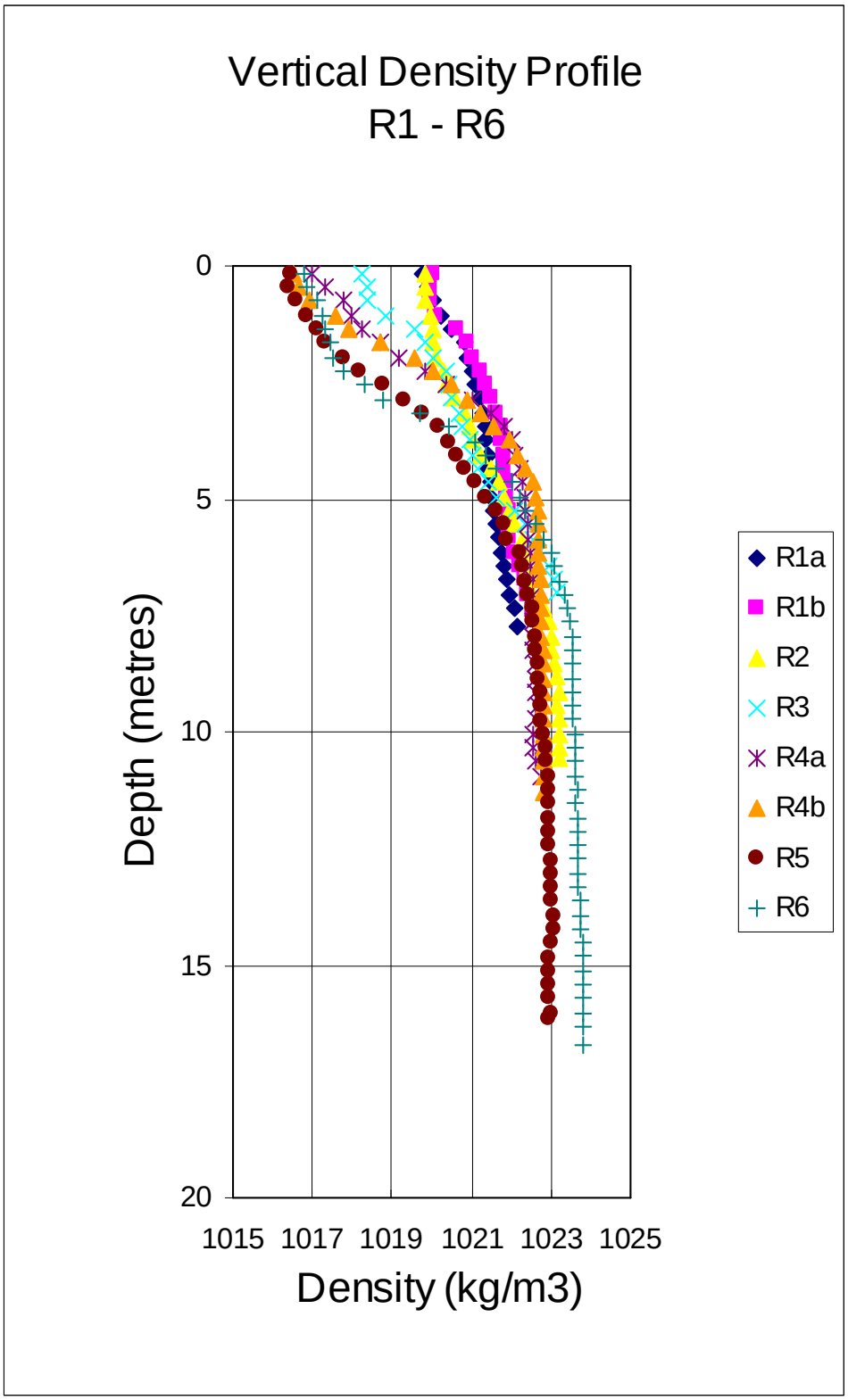

**17 March 2011:** Vertical profiles of **temperature** measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) sensors (continued).



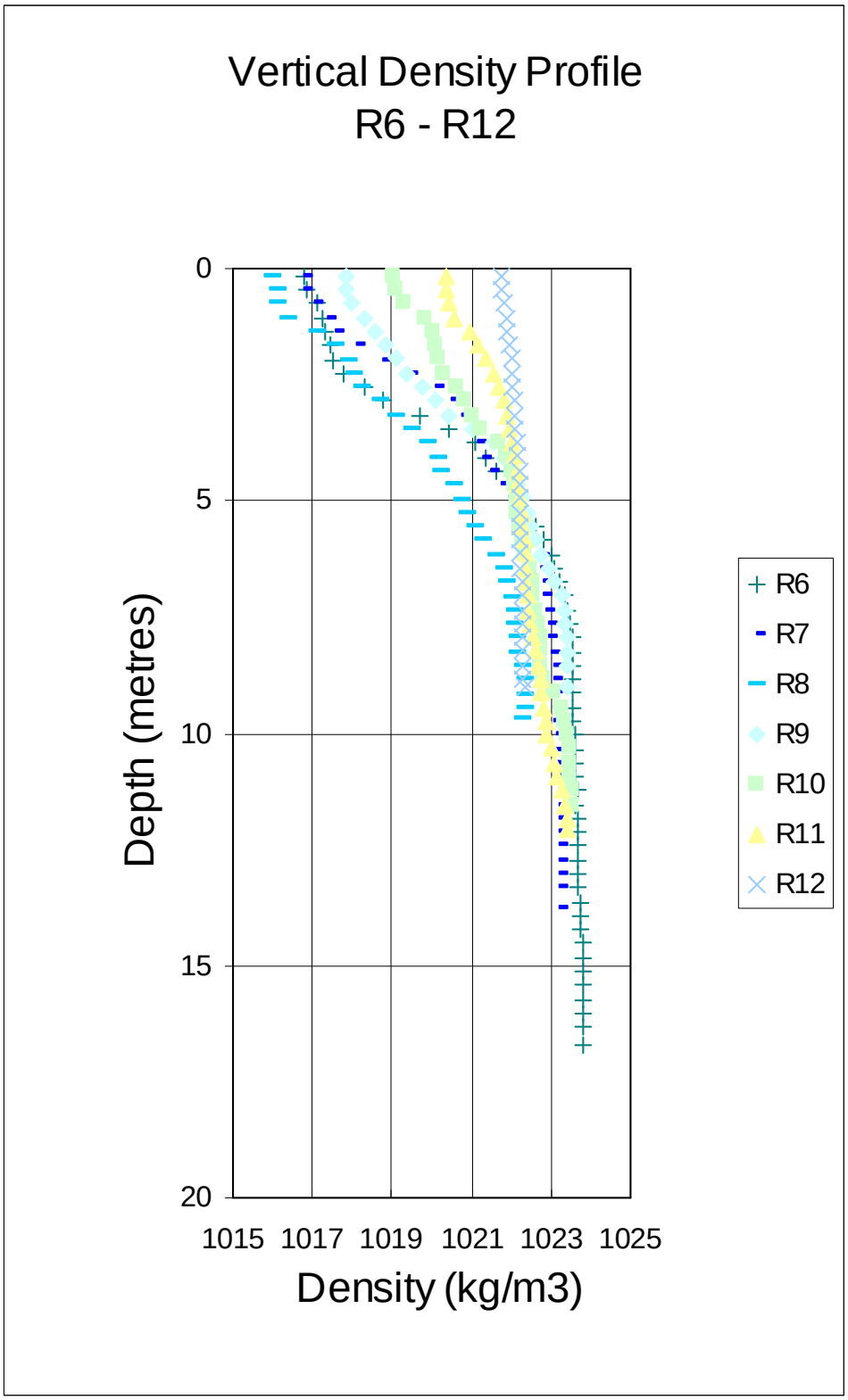

**17 March 2011:** Vertical profiles of **temperature** measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) Sensors (continued).



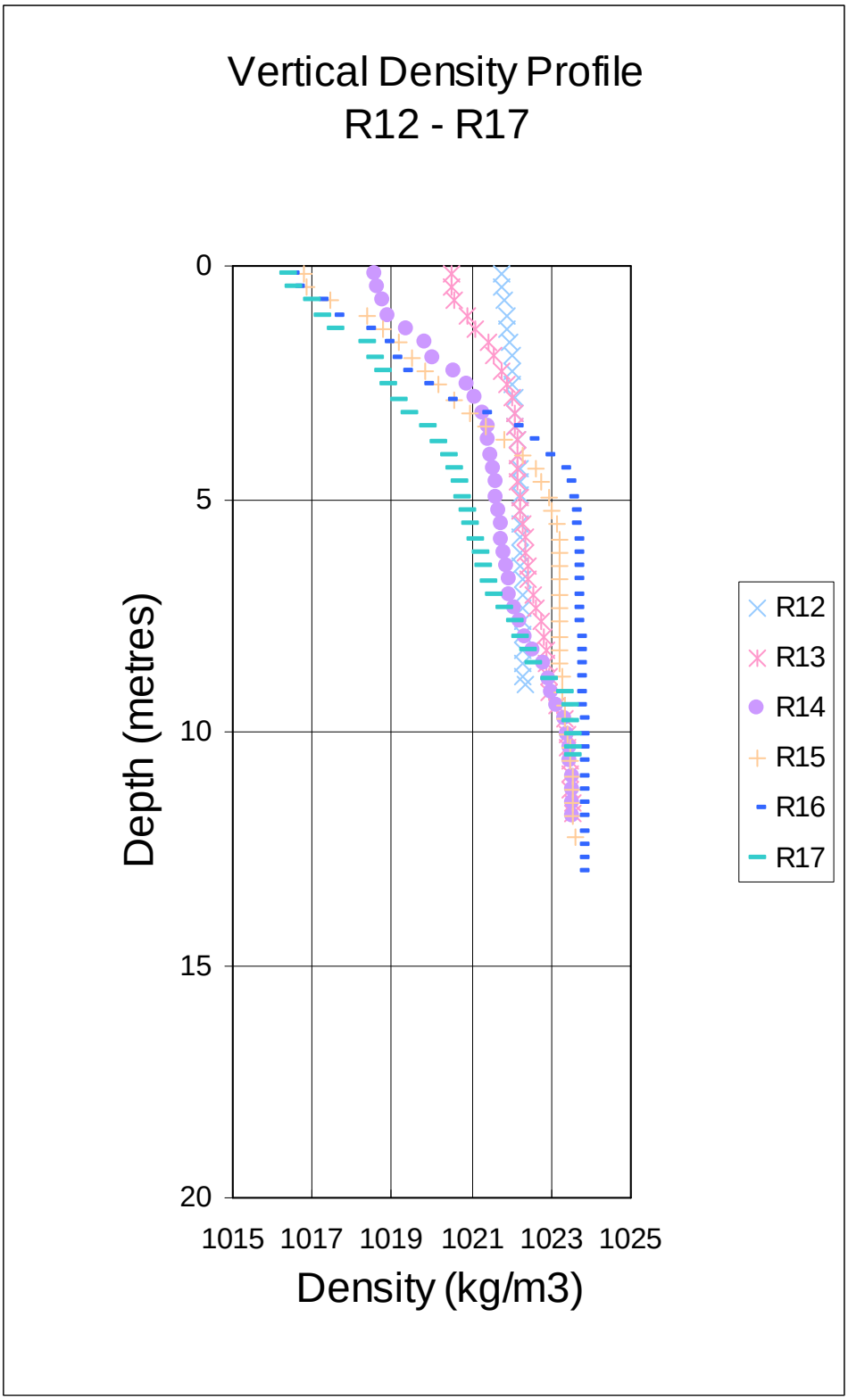

**17 March 2011:** Vertical profiles of **density** (kg/m$^3$) measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) Sensors.



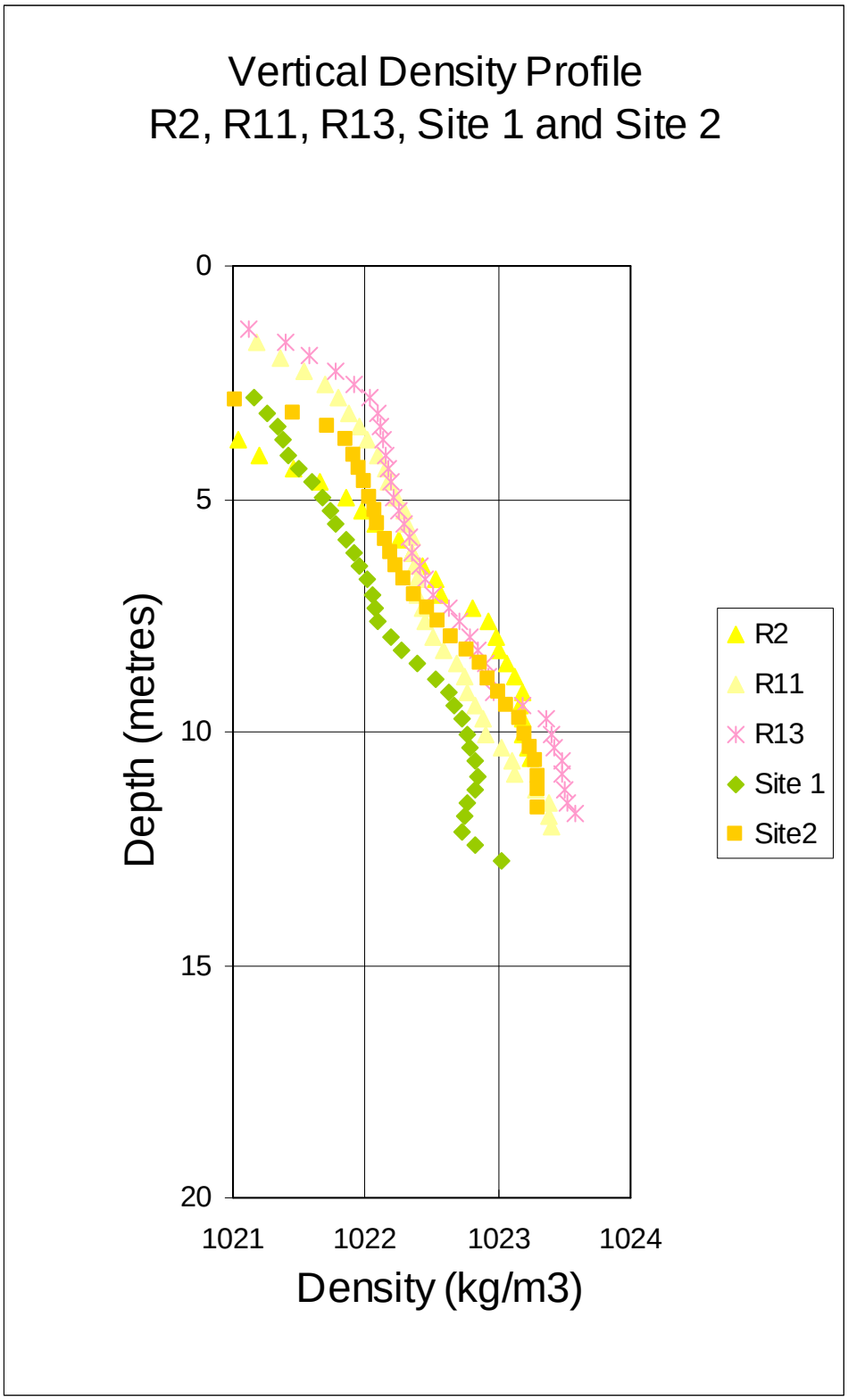

**17 March 2011:** Vertical profiles of **density** (kg/m$^3$) measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) Sensors (continued).




**17 March 2011:** Vertical profiles of **density** (kg/m$^3$) measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) Sensors (continued).

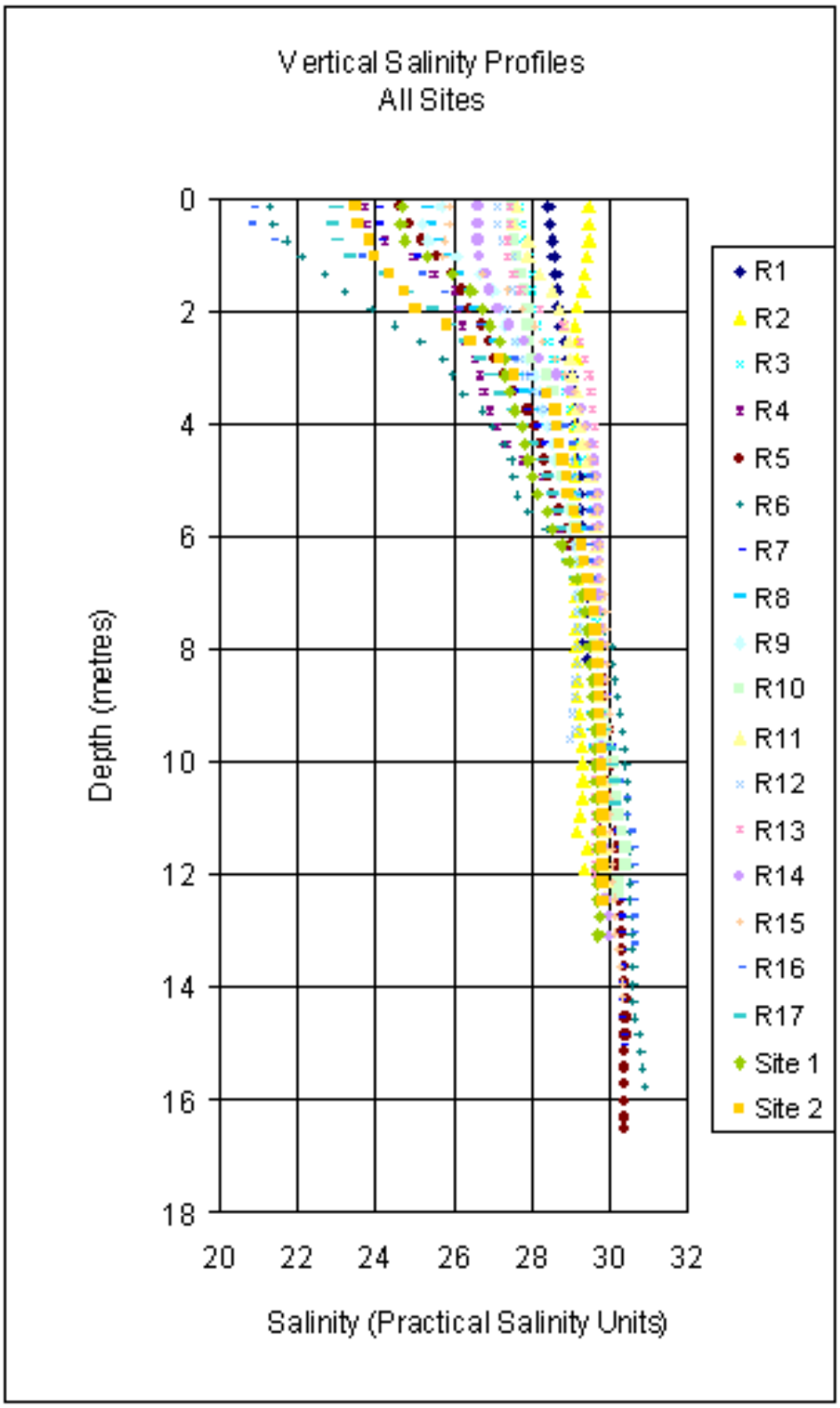



**17 March 2011:** Vertical profiles of **density** (kg/m$^3$) measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) Sensors (continued).

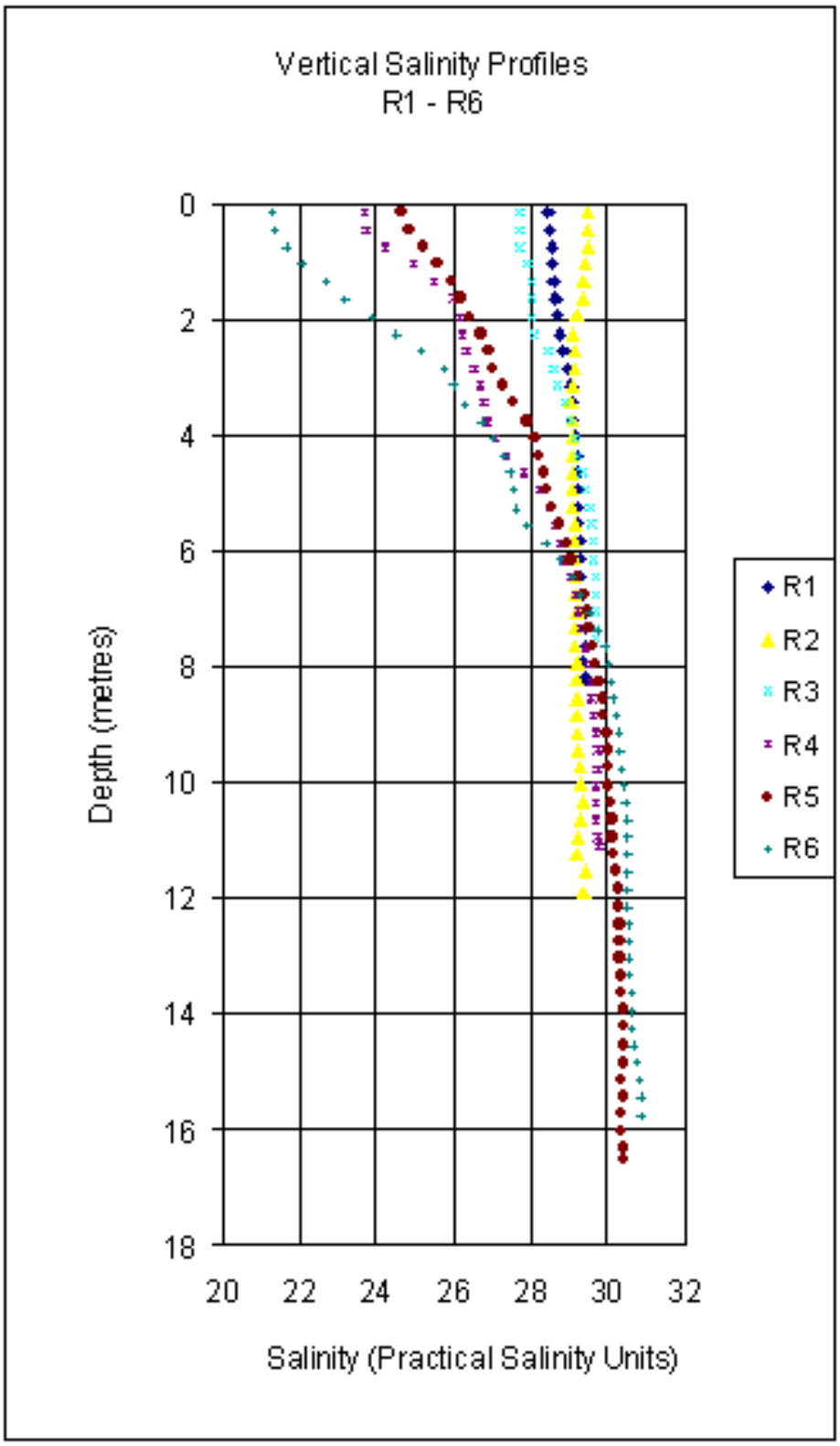



**17 March 2011:** Vertical profiles of **density** (kg/m$^3$) measured at the locations shown in Figure 3-1 using Conductivity, Temperature and Depth (CTD) Sensors (continued).

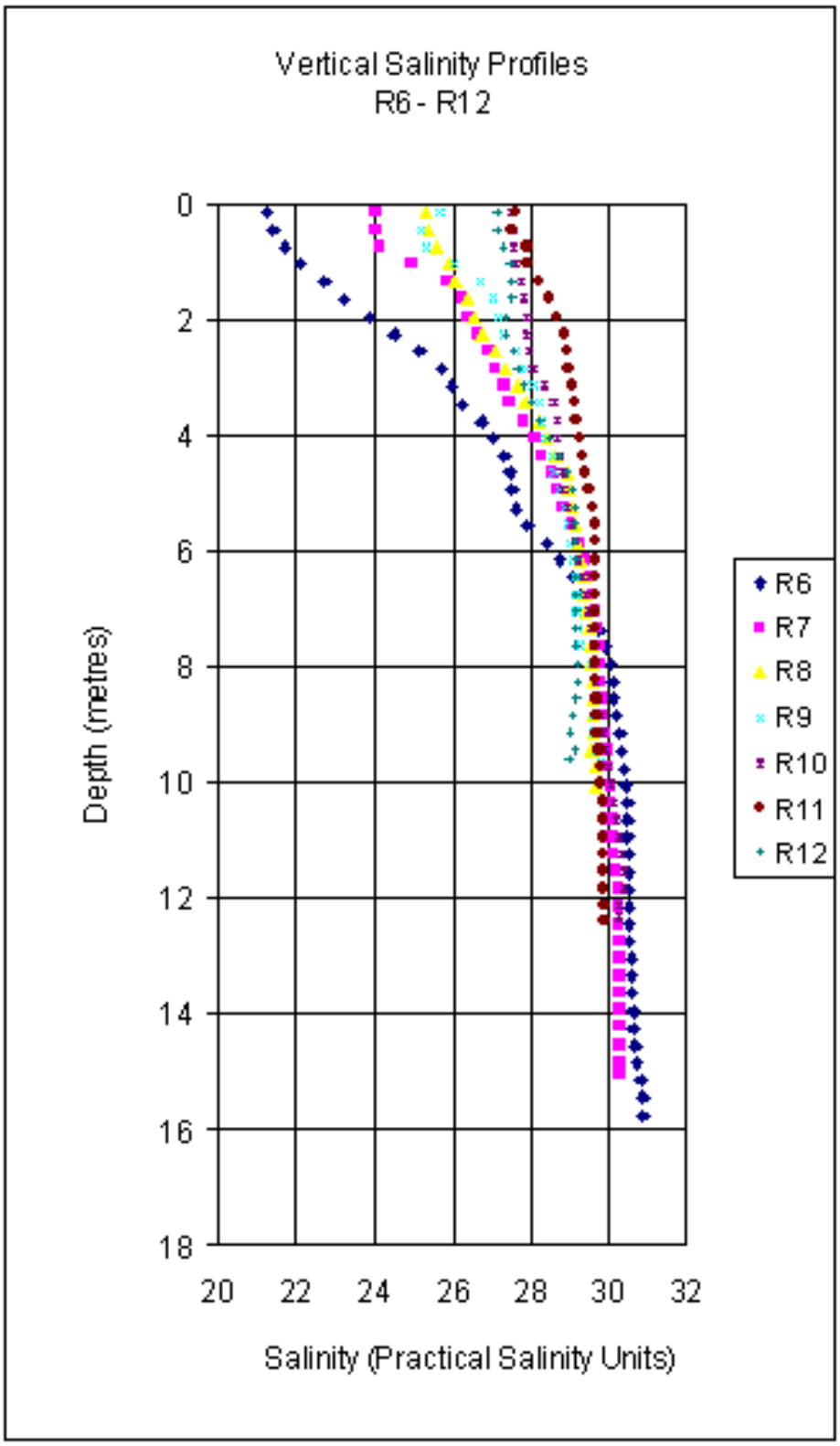
# 25 May 2011



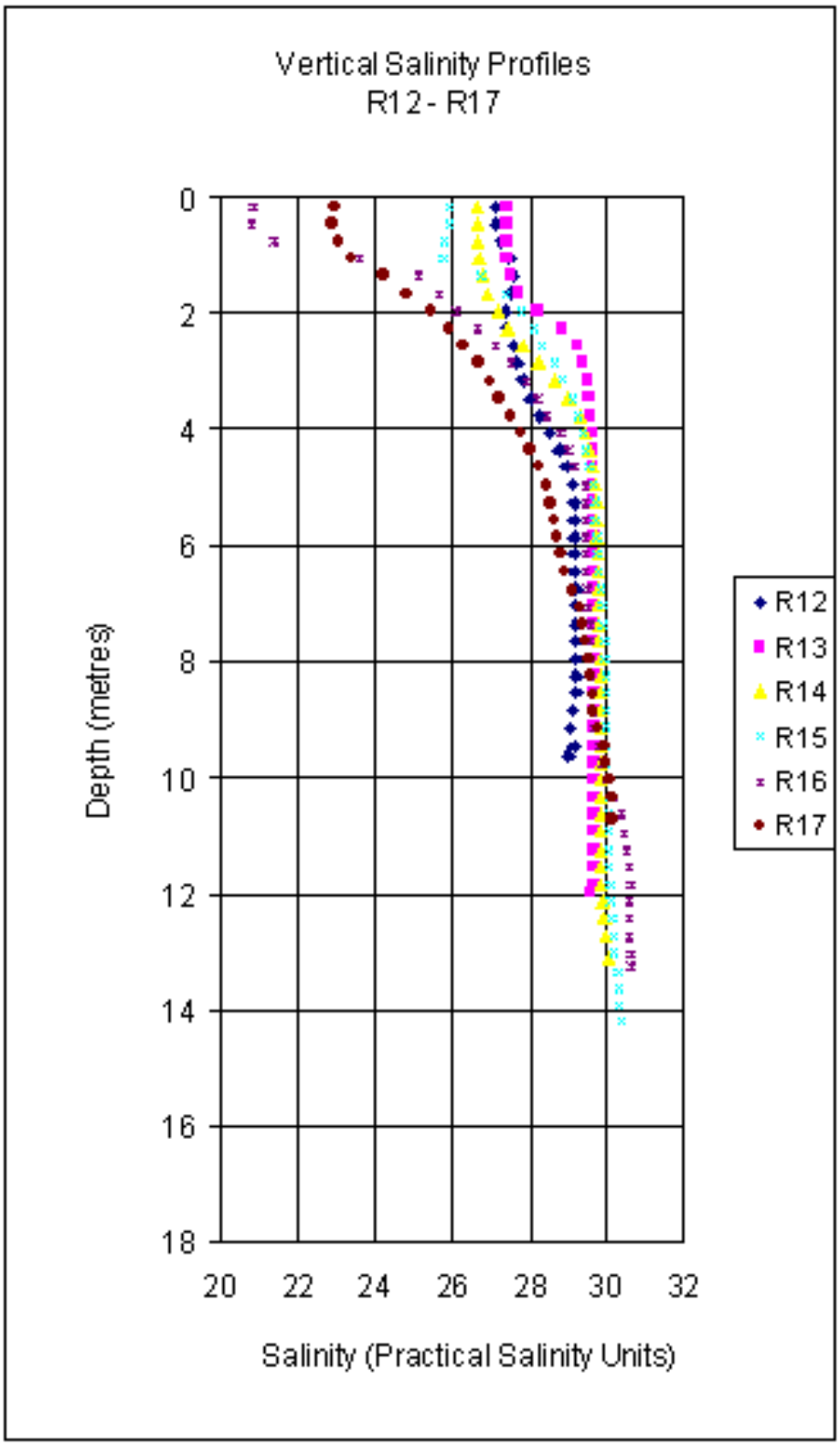

**25 May 2011:** Vertical profiles of **salinity** (all sites).



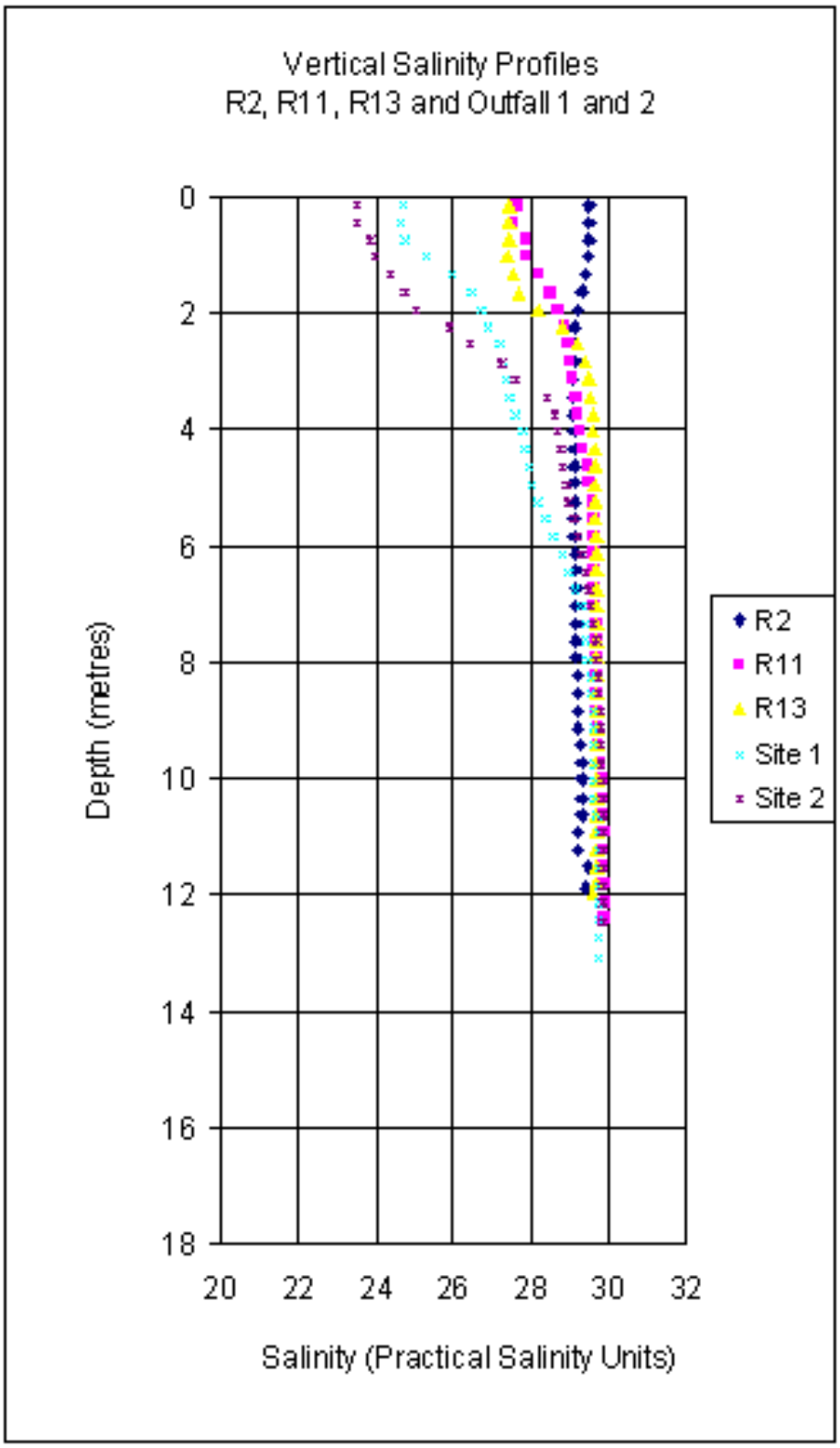

**25 May 2011:** Vertical profiles of **salinity** (sites R1-R6).



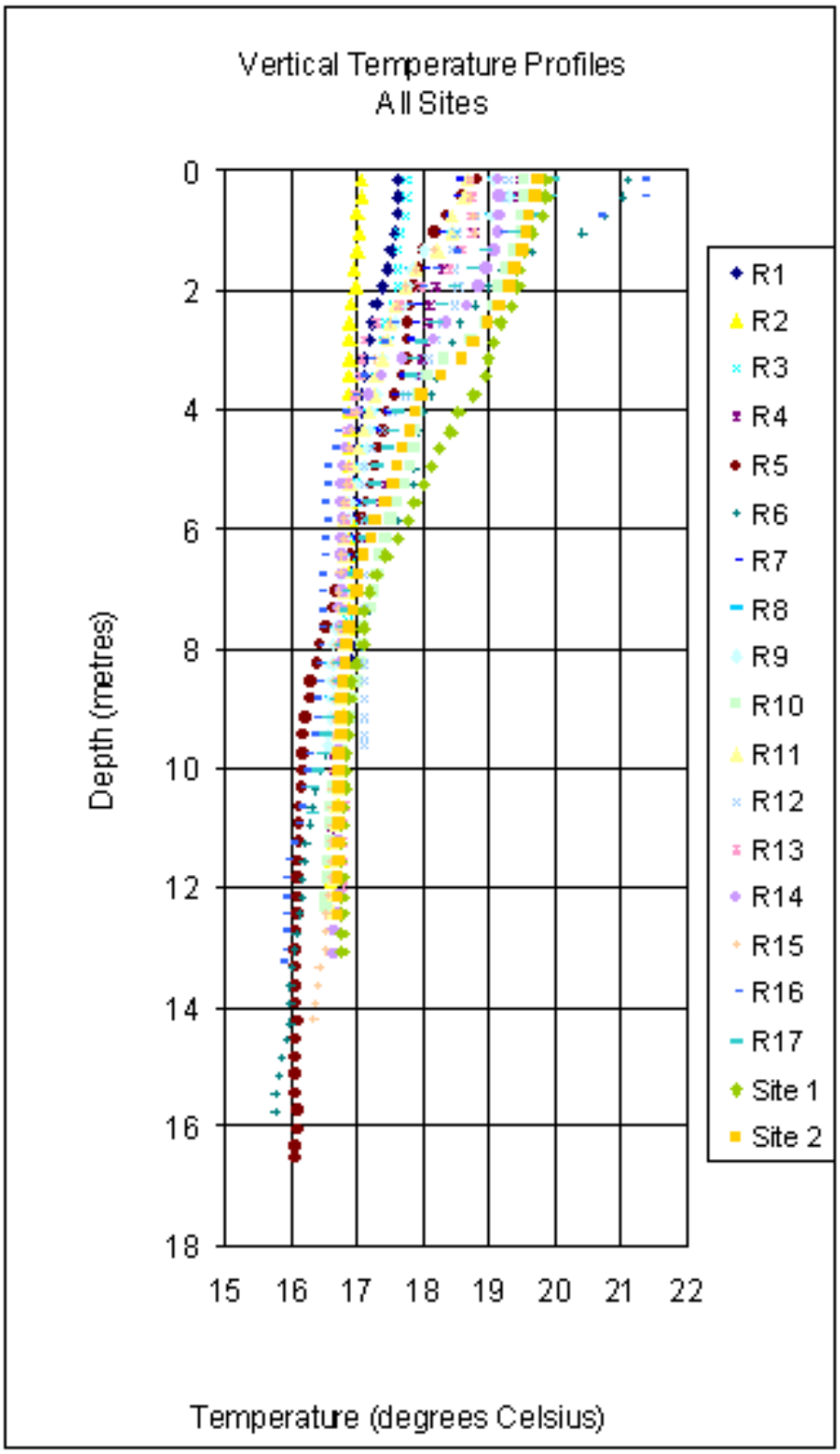

**25 May 2011:** Vertical profiles of **salinity** (sites R6-R12).



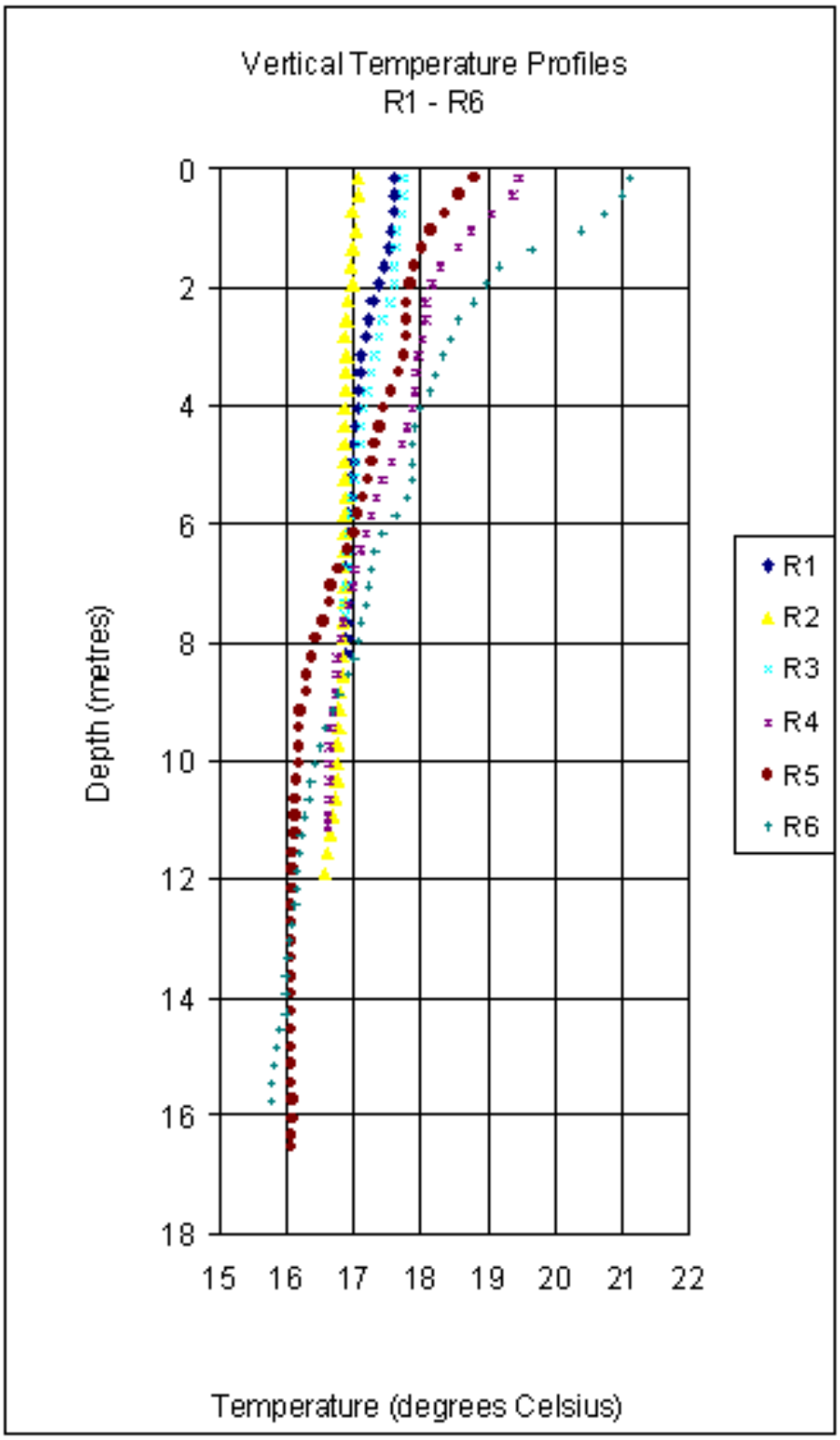

**25 May 2011:** Vertical profiles of **salinity** (sites R12-R17)



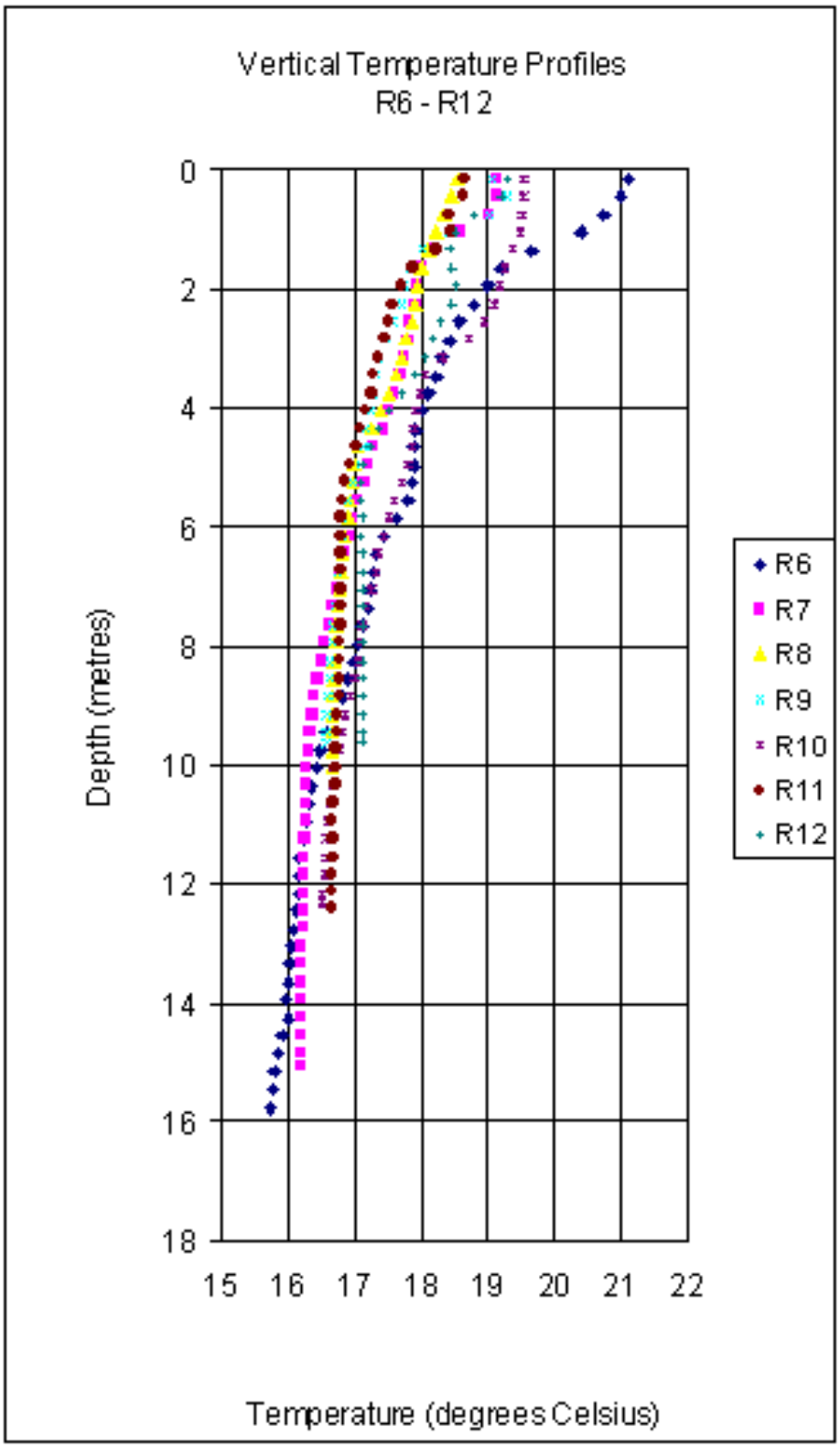

**25 May 2011:** Vertical profiles of **salinity** (sites as per Figure 3-1)



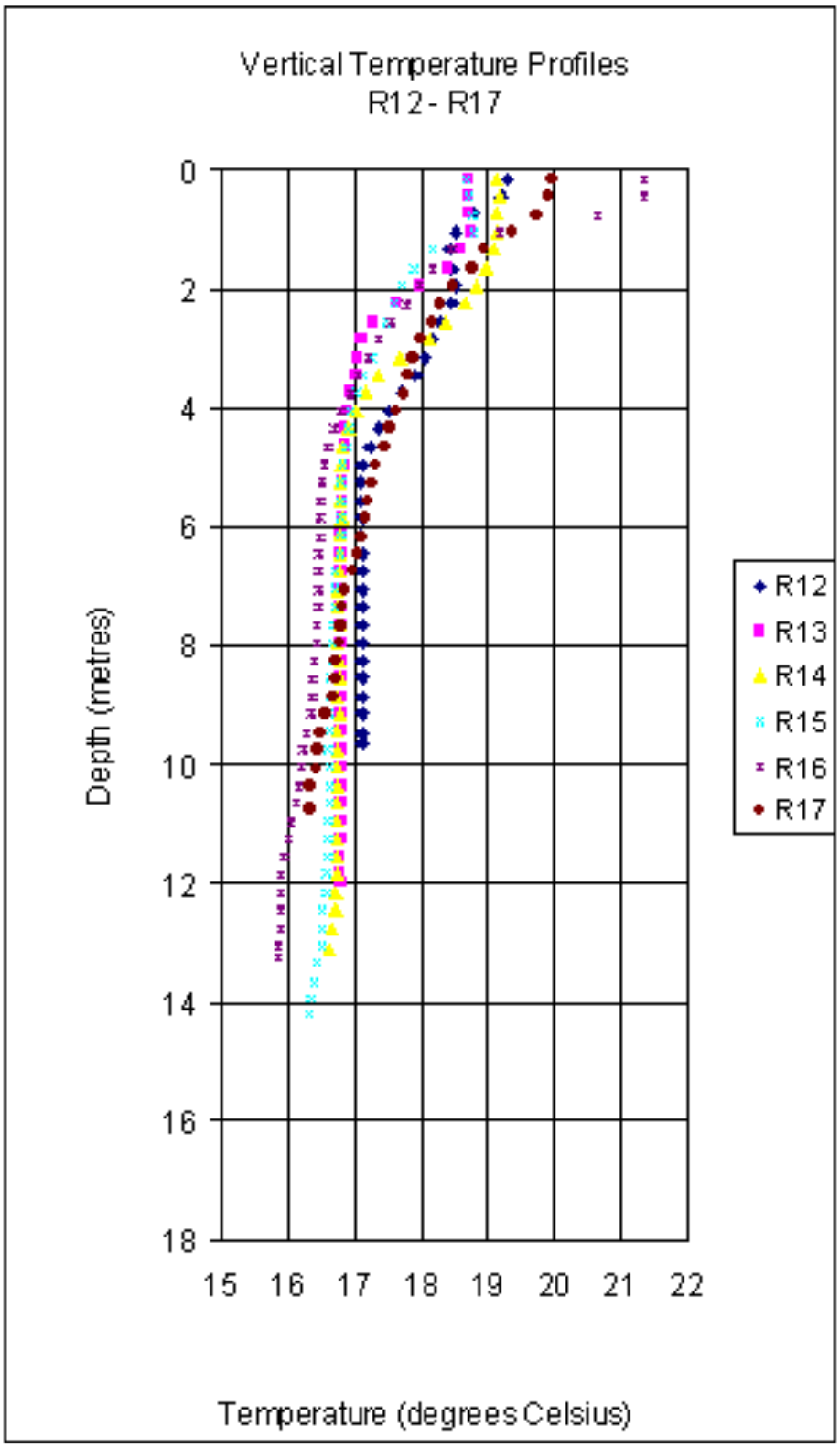

**25 May 2011:** Vertical profiles of **temperature** (all sites)



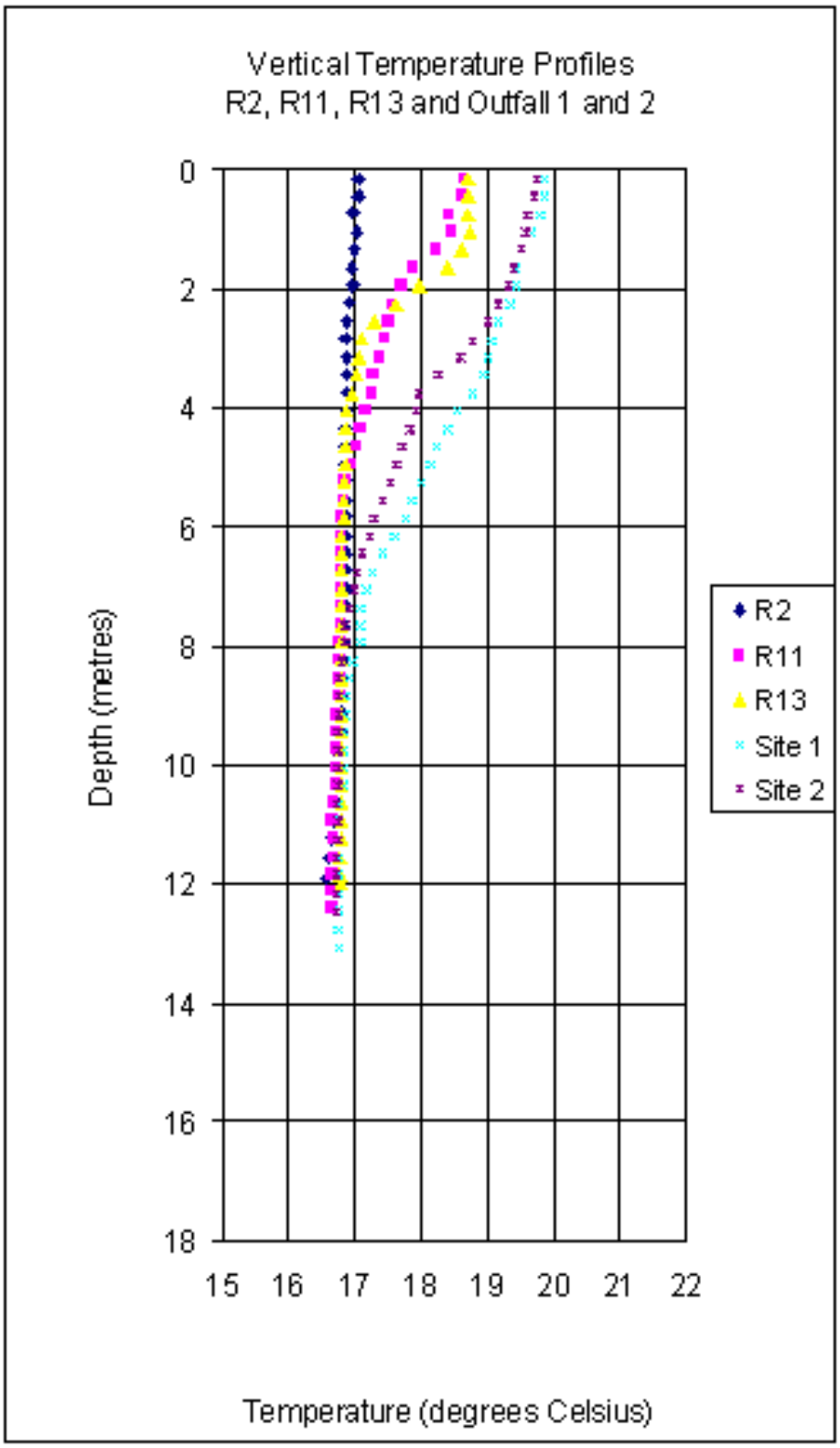

**25 May 2011:** Vertical profiles of **temperature** (sites R1-R6)



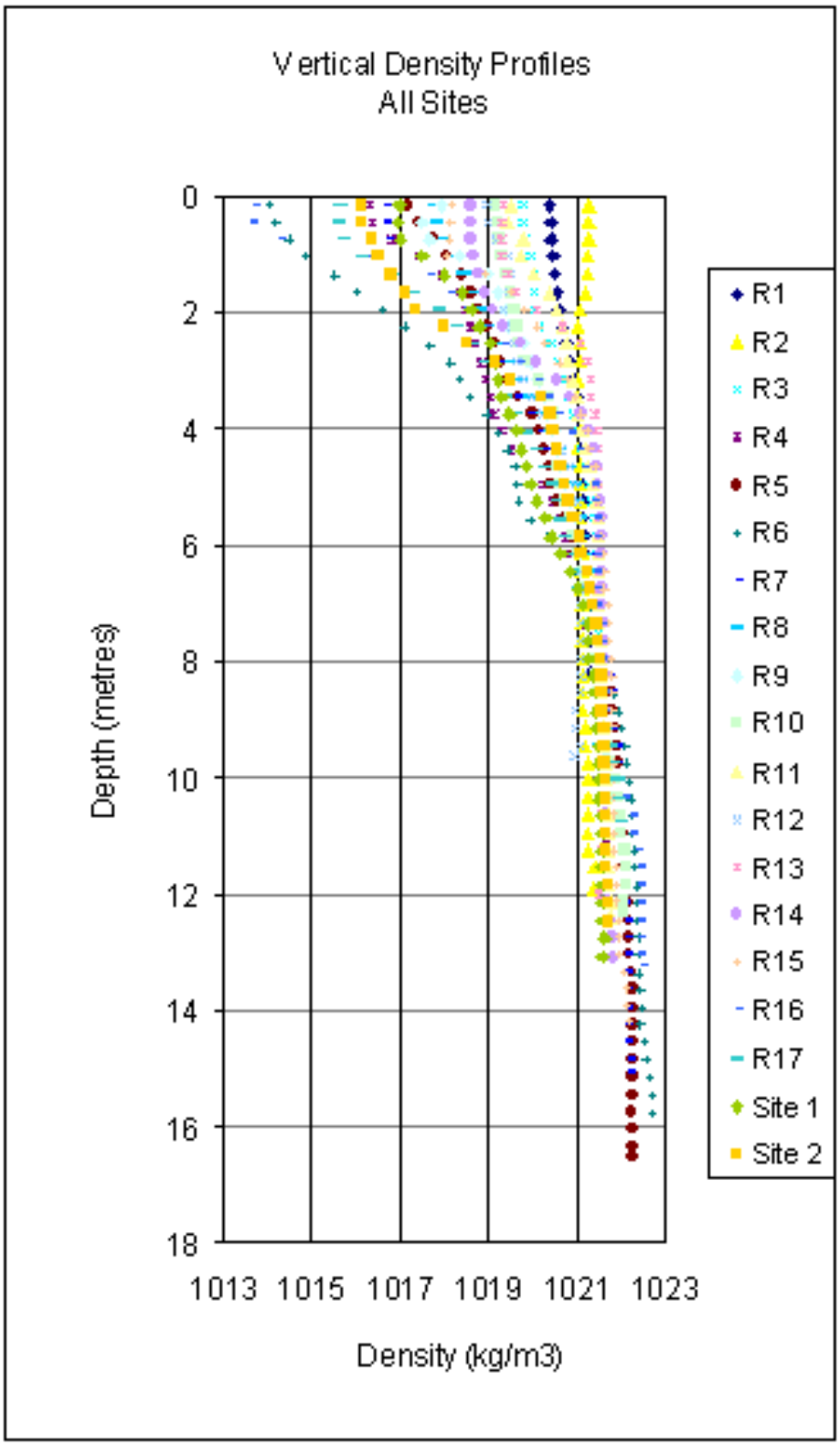

**25 May 2011:** Vertical profiles of **temperature** (sites R6-R12)



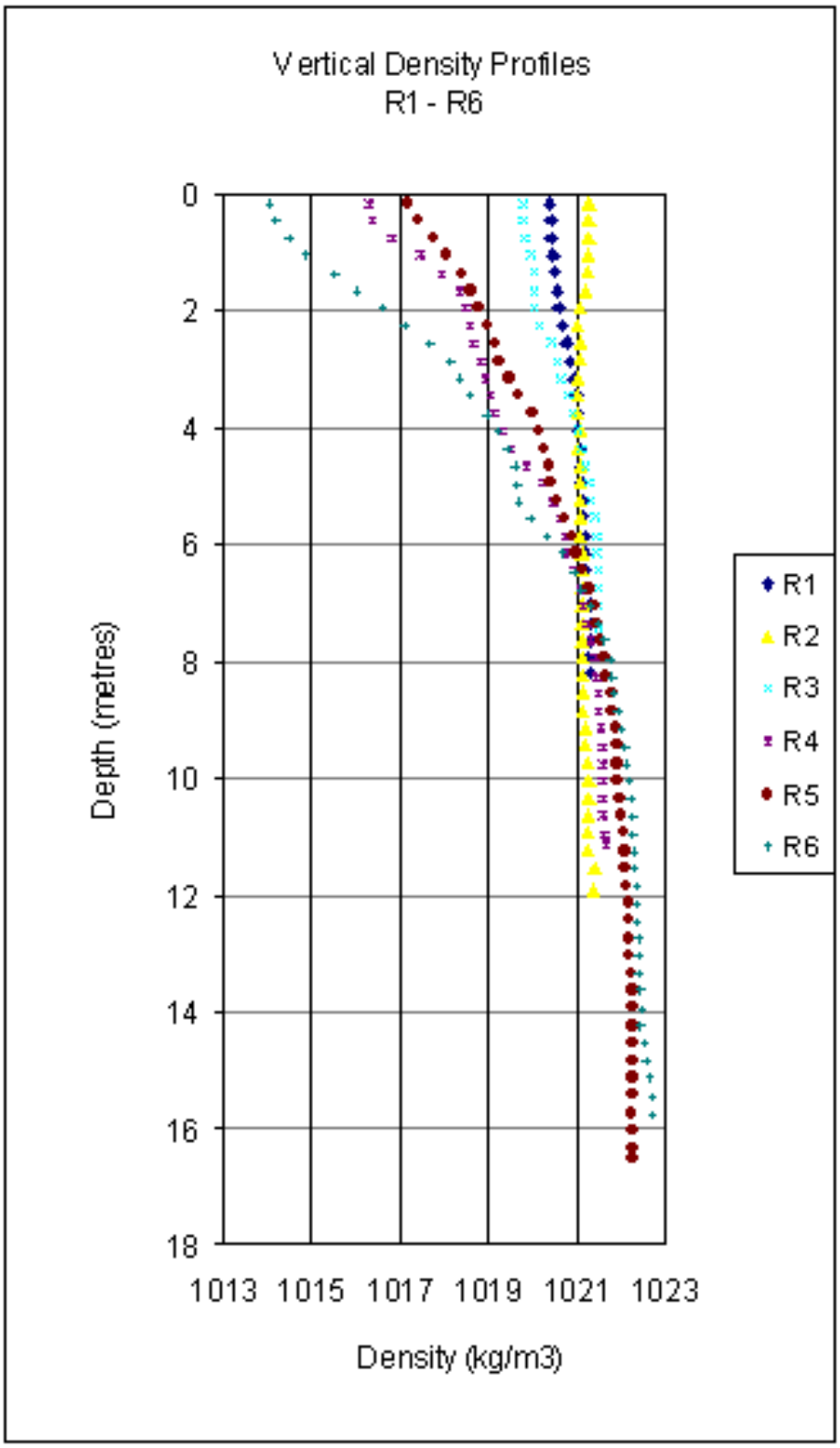

**25 May 2011:** Vertical profiles of **temperature** (sites R12-R17)



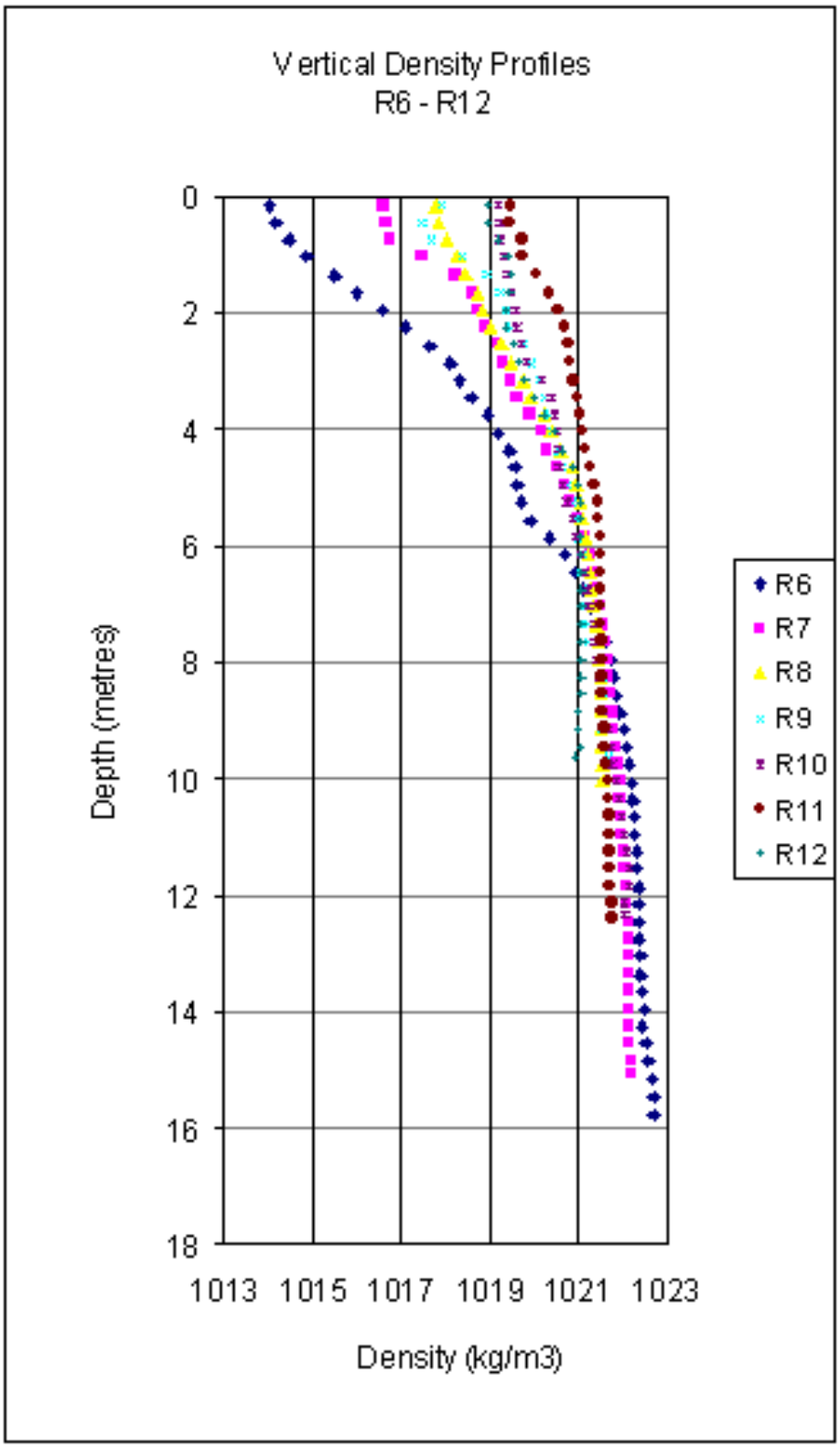

**25 May 2011:** Vertical profiles of **temperature** (sites as per Figure 3-1)



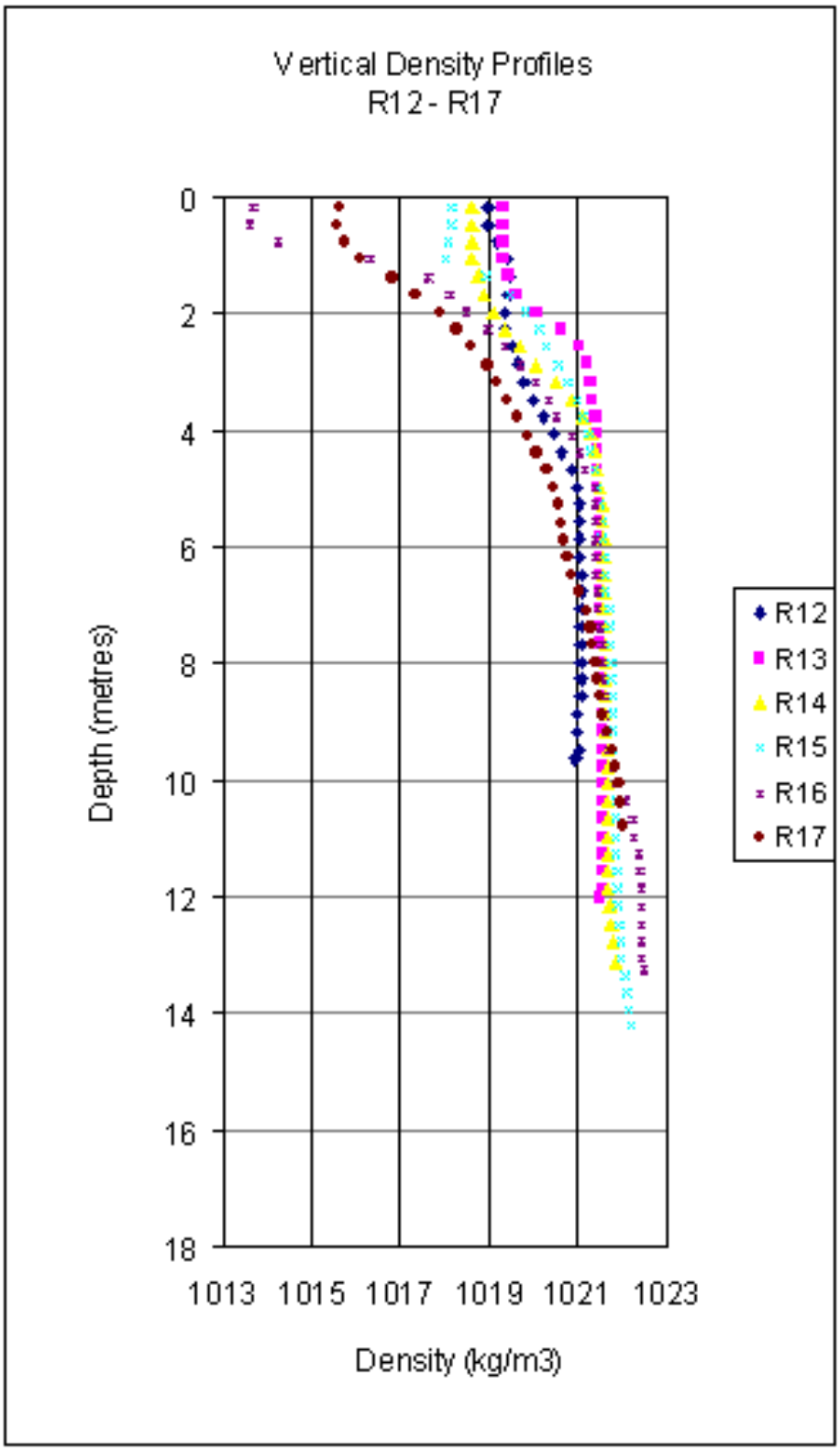

**25 May 2011:** Vertical profiles of **density** (all sites)



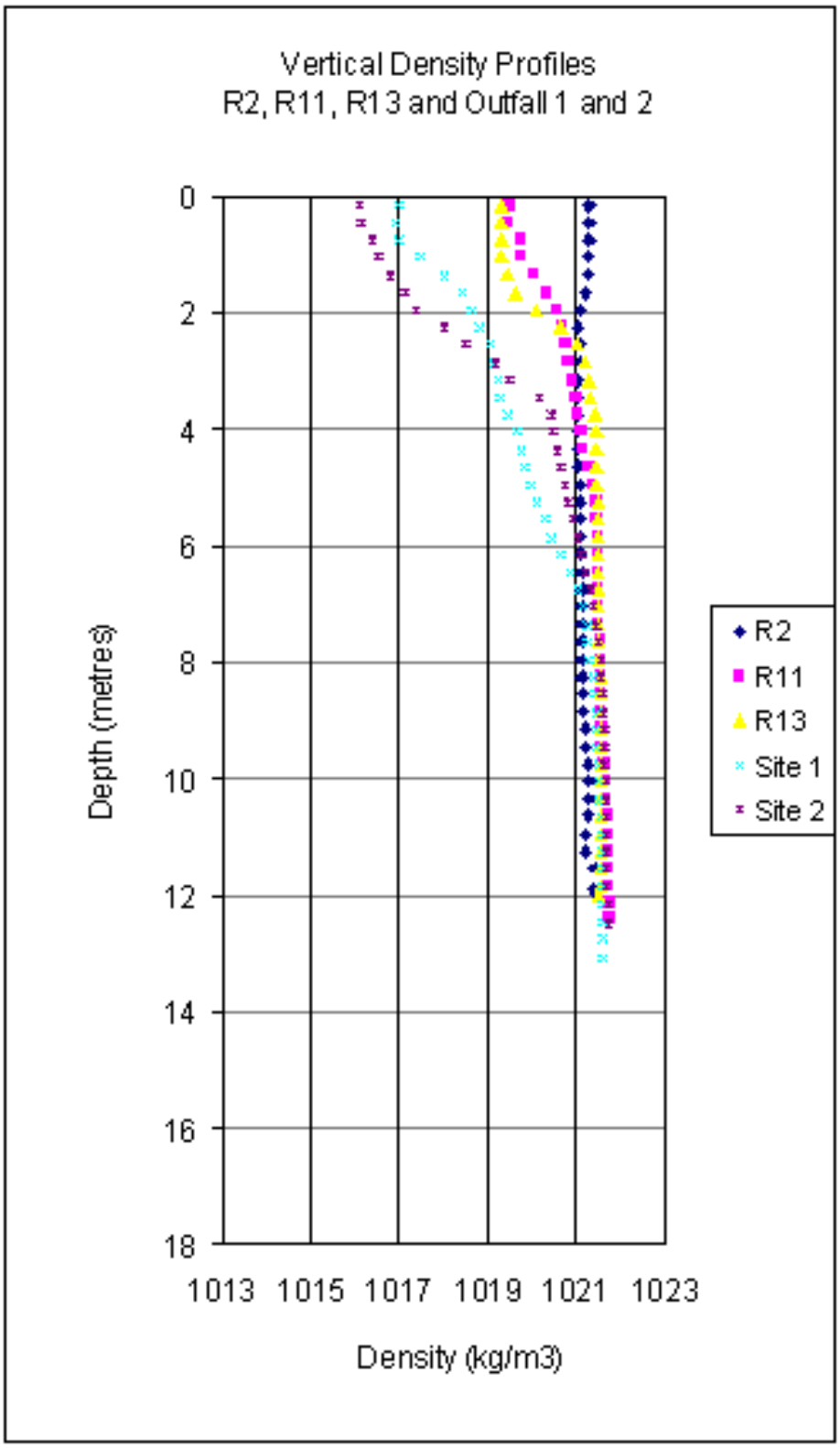

**25 May 2011:** Vertical profiles of **density** (sites R1-R6)




**25 May 2011:** Vertical profiles of **density** (sites R6-R12)

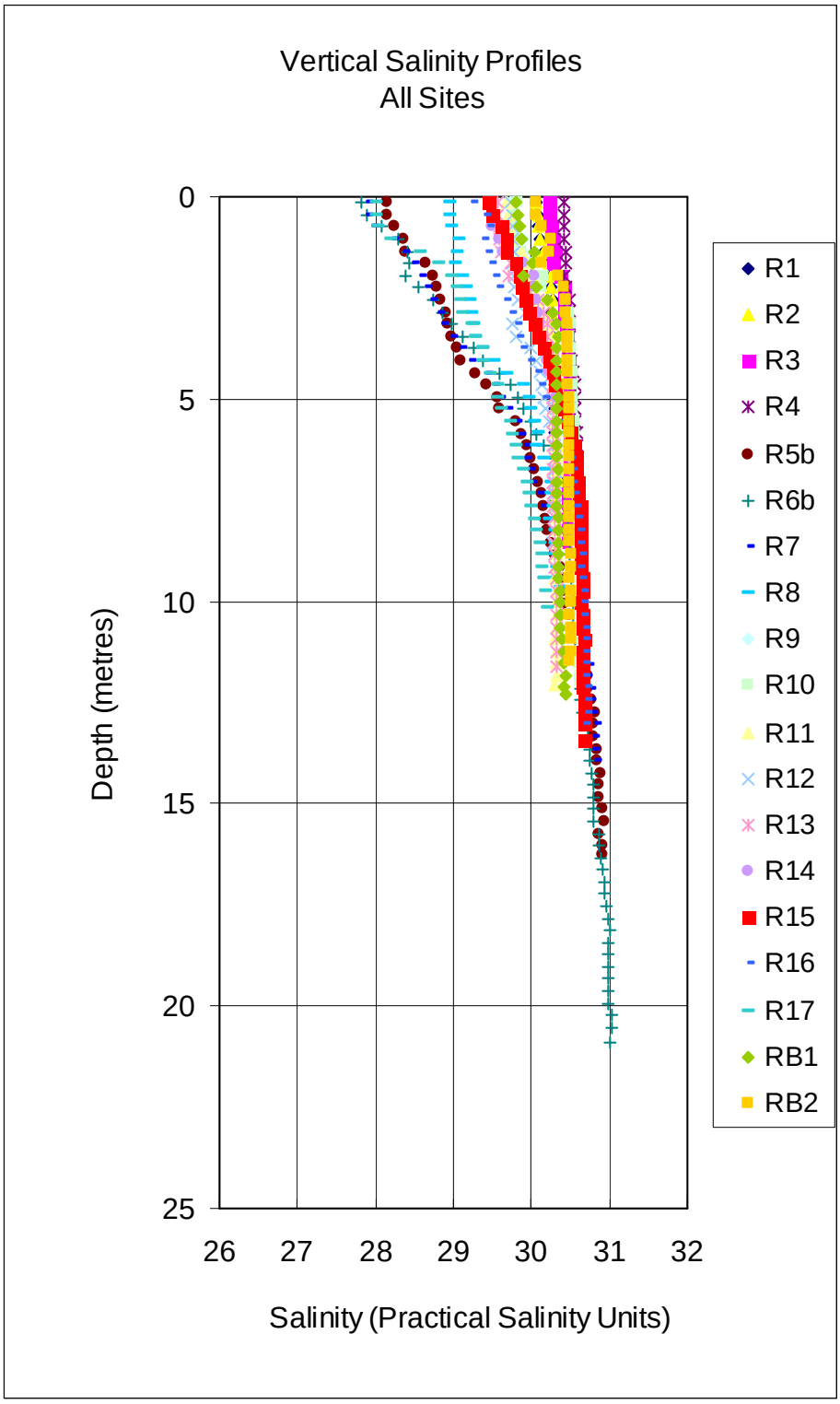



**25 May 2011:** Vertical profiles of **density** (sites R12-R17)

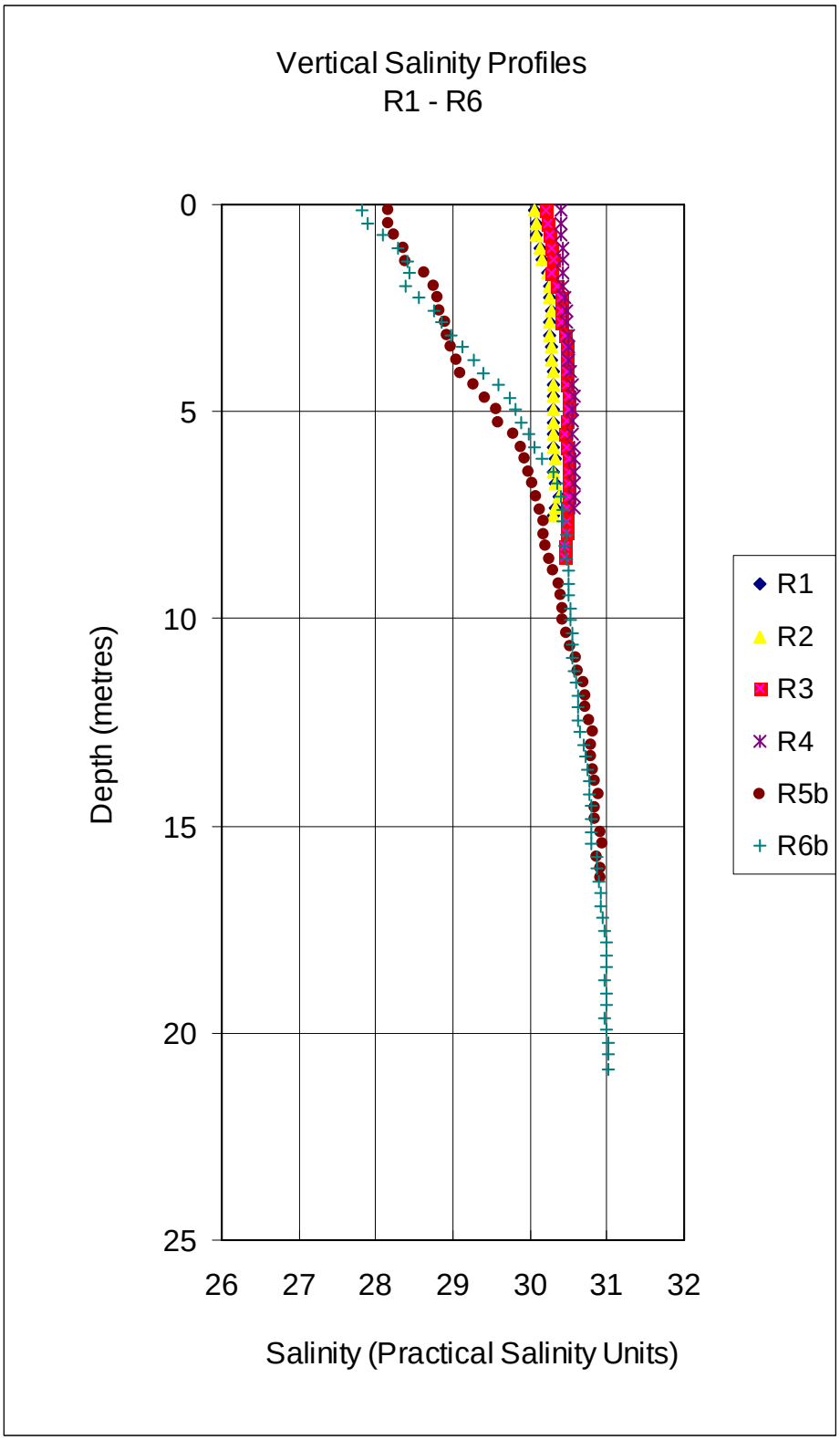



**25 May 2011:** Vertical profiles of **density** (sites as per Figure 3-1)

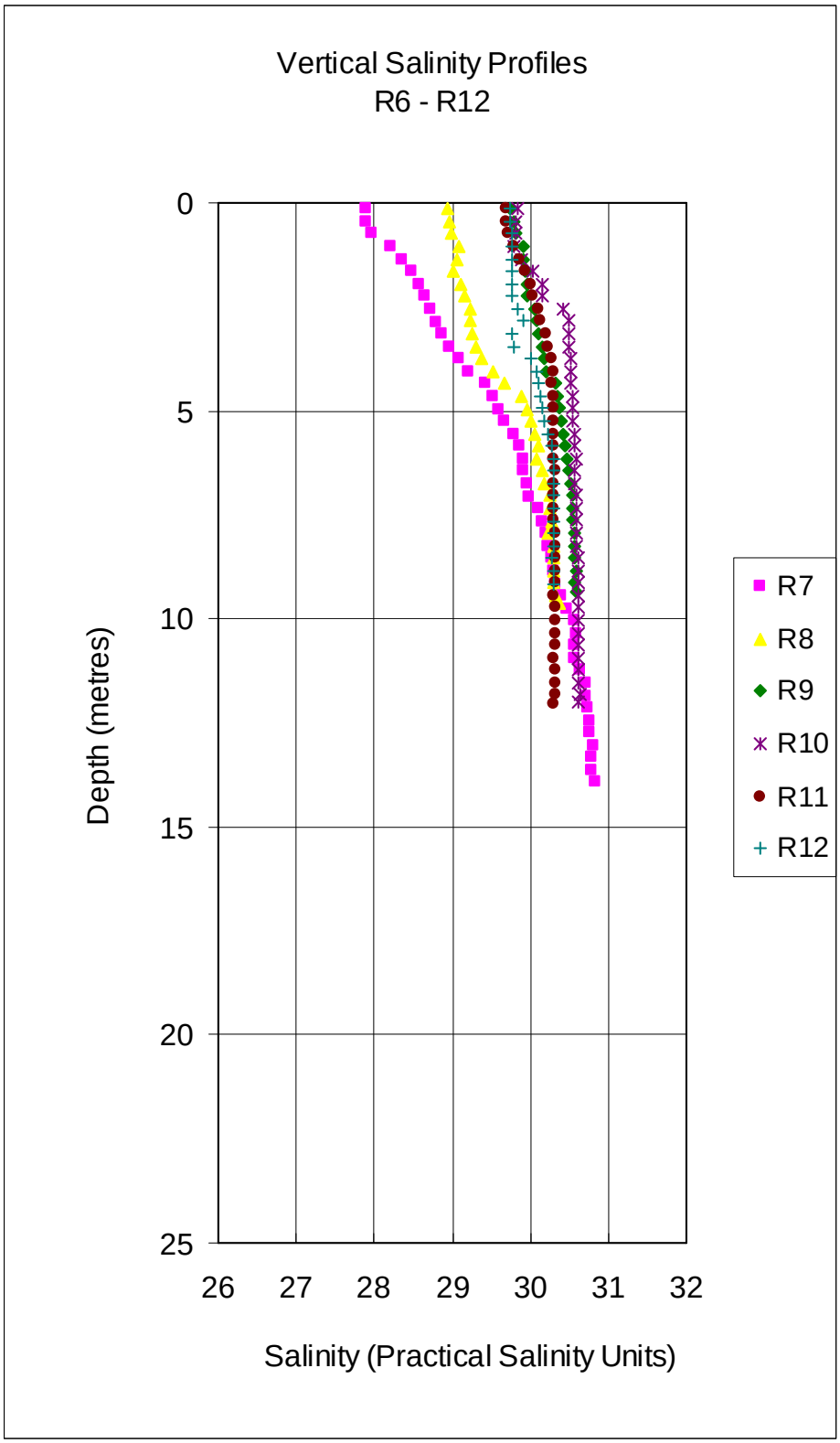
# 11 July 2011



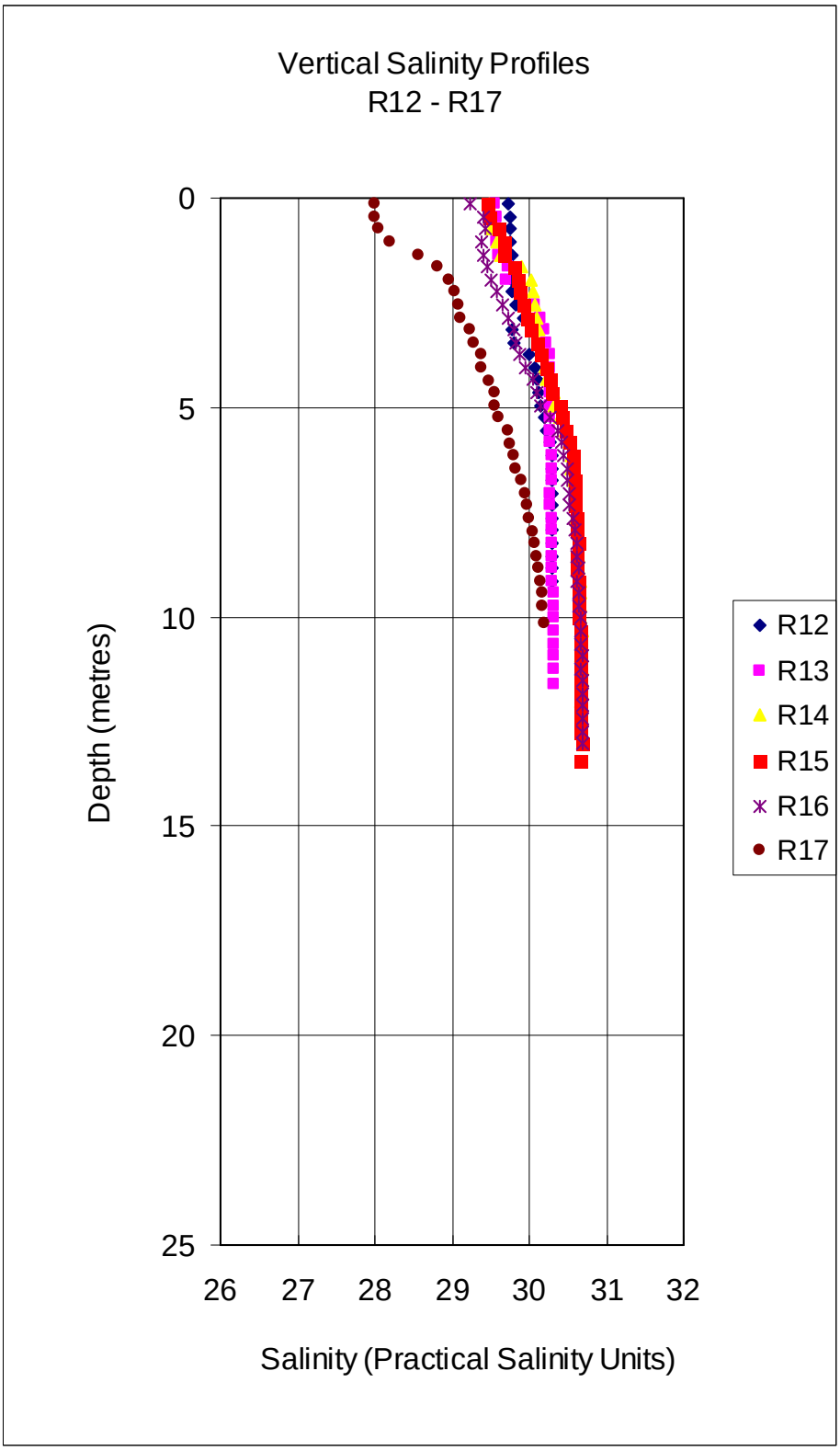

**11 July 2011:** Vertical profiles of **salinity** (all sites).



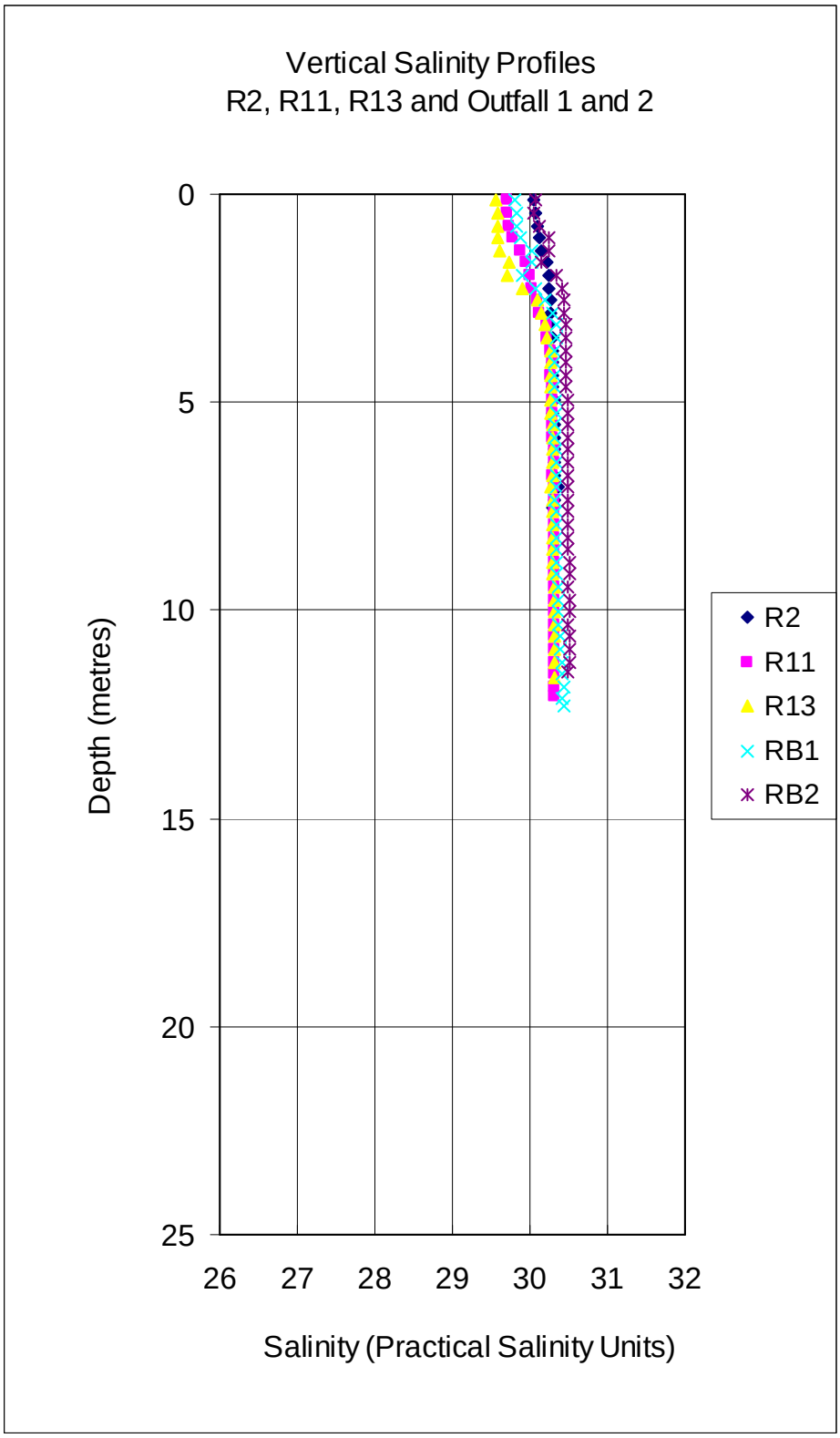

**11 July 2011:** Vertical profiles of **salinity** (sites R1-R6).



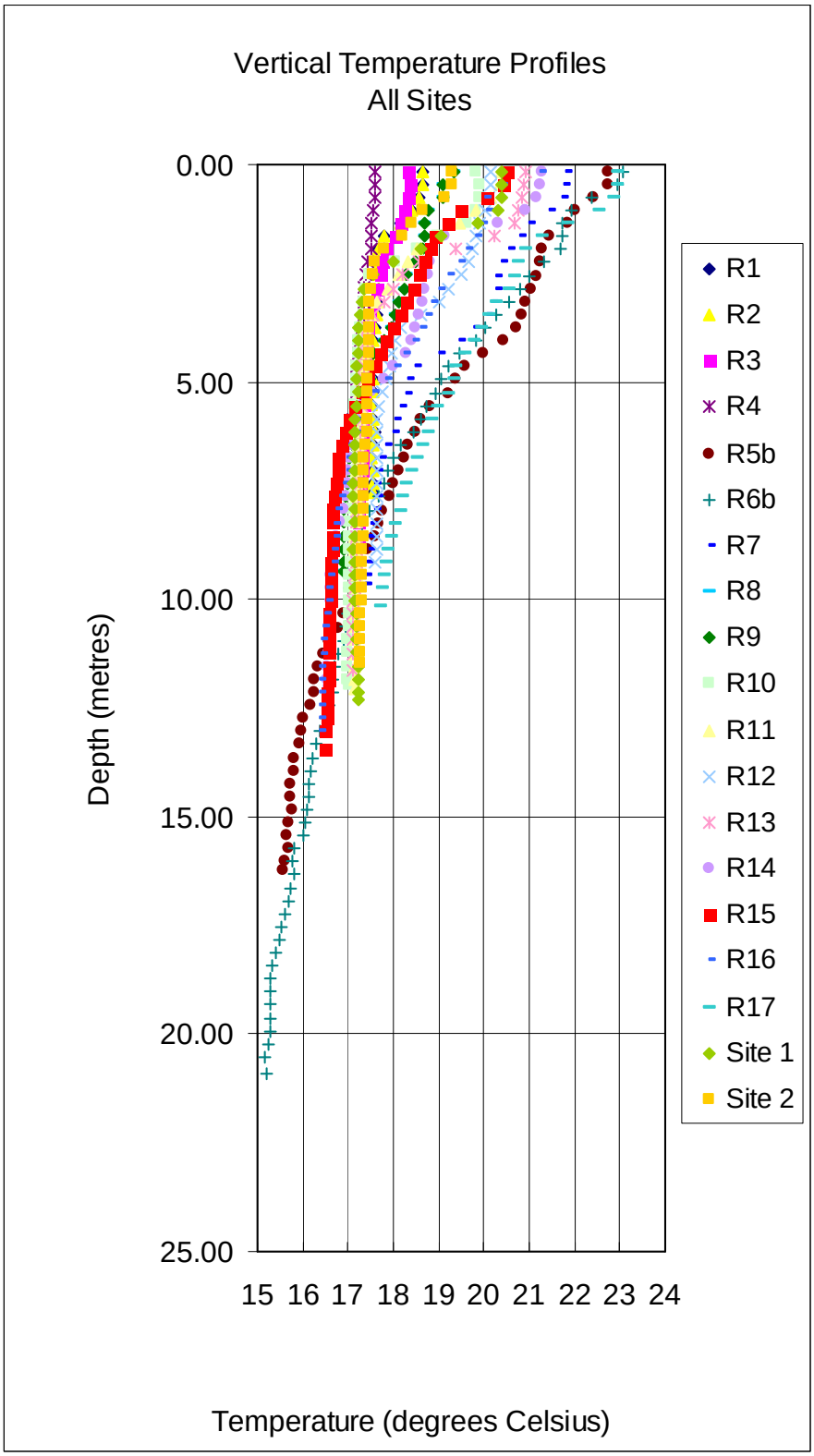

**11 July 2011:** Vertical profiles of **salinity** (sites R6-R12).



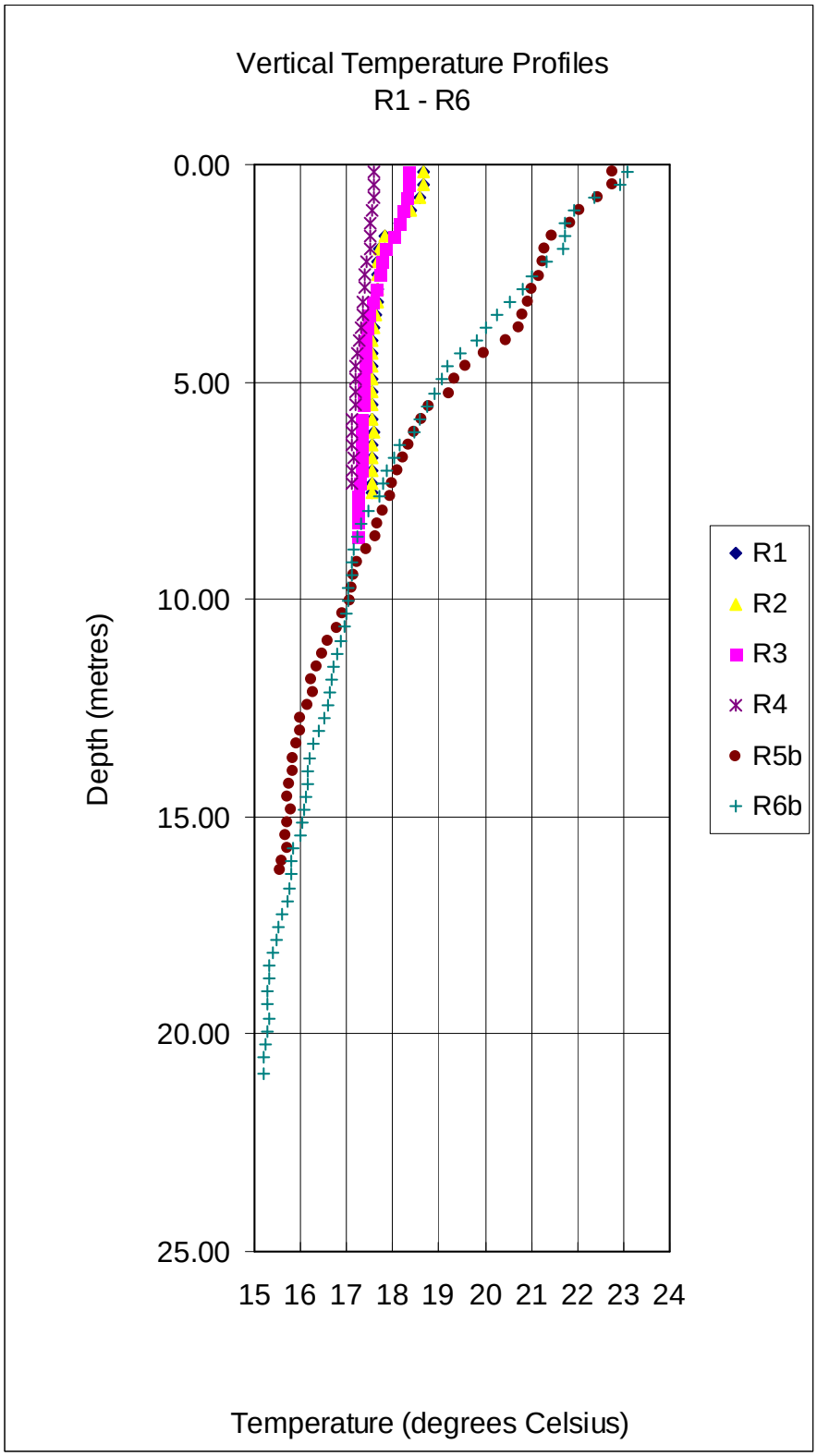

**11 July 2011:** Vertical profiles of **salinity** (sites R12-R17)



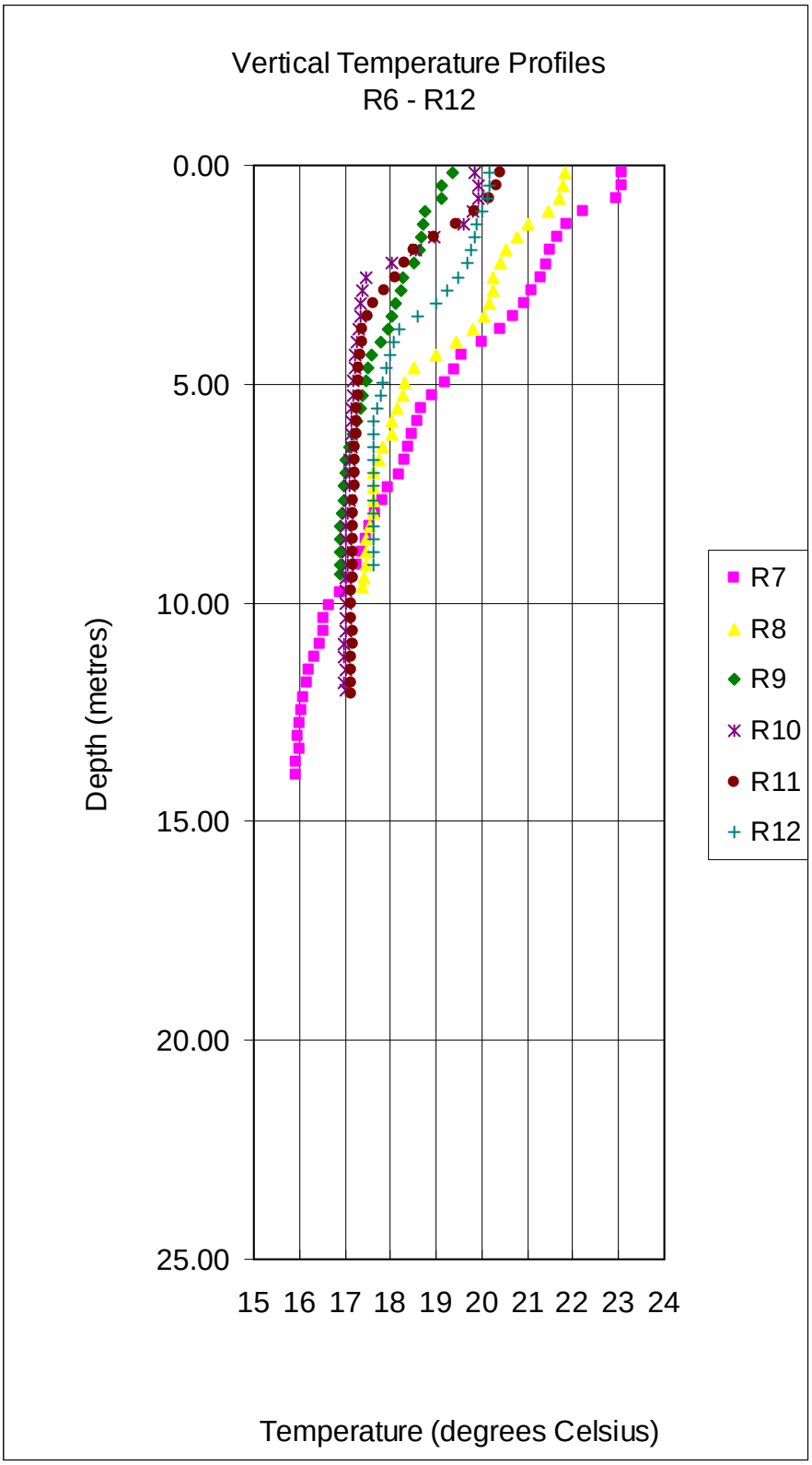

**11 July 2011:** Vertical profiles of **salinity** (sites as per Figure 3-1)



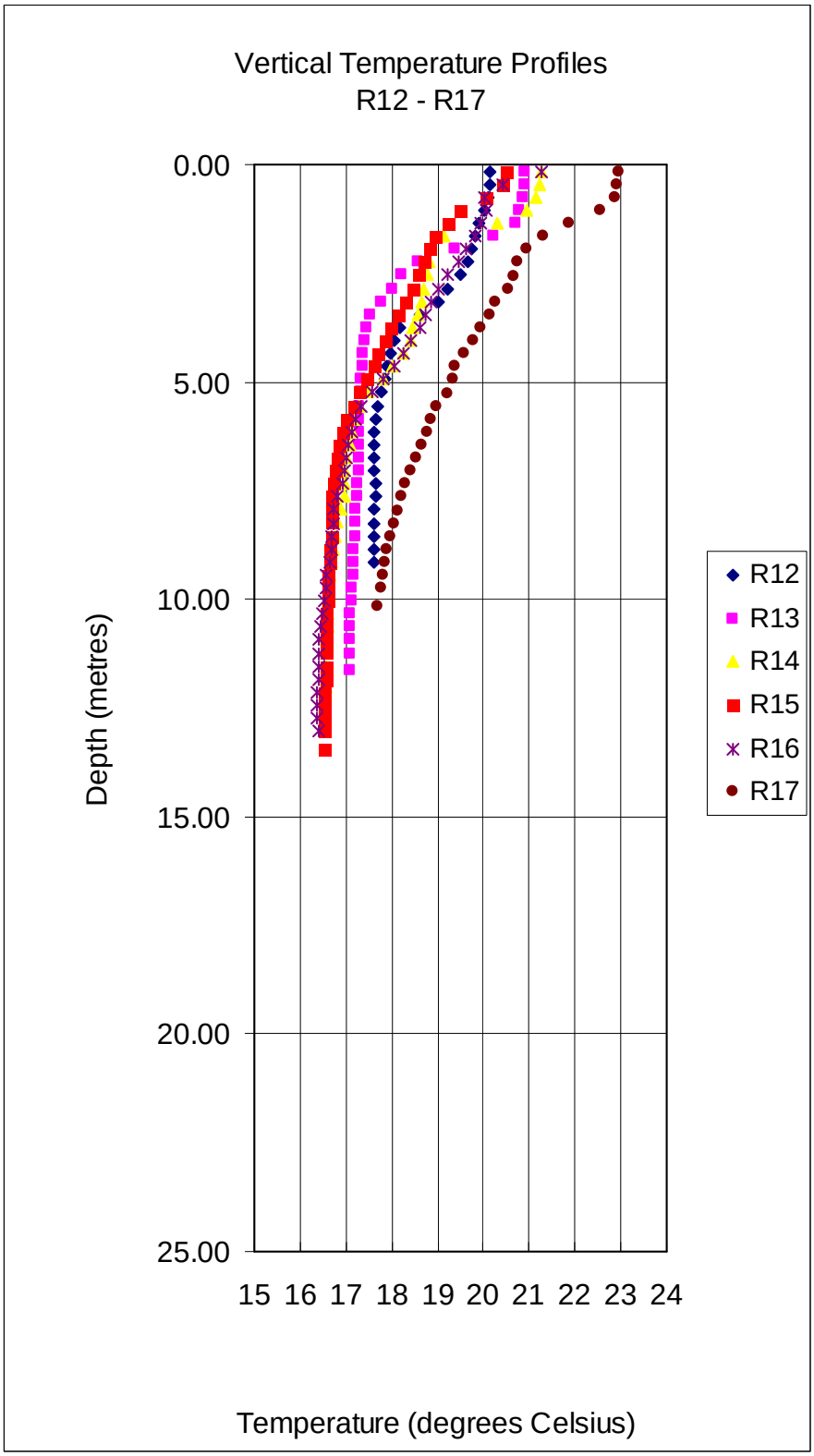

**11 July 2011:** Vertical profiles of **temperature** (all sites)



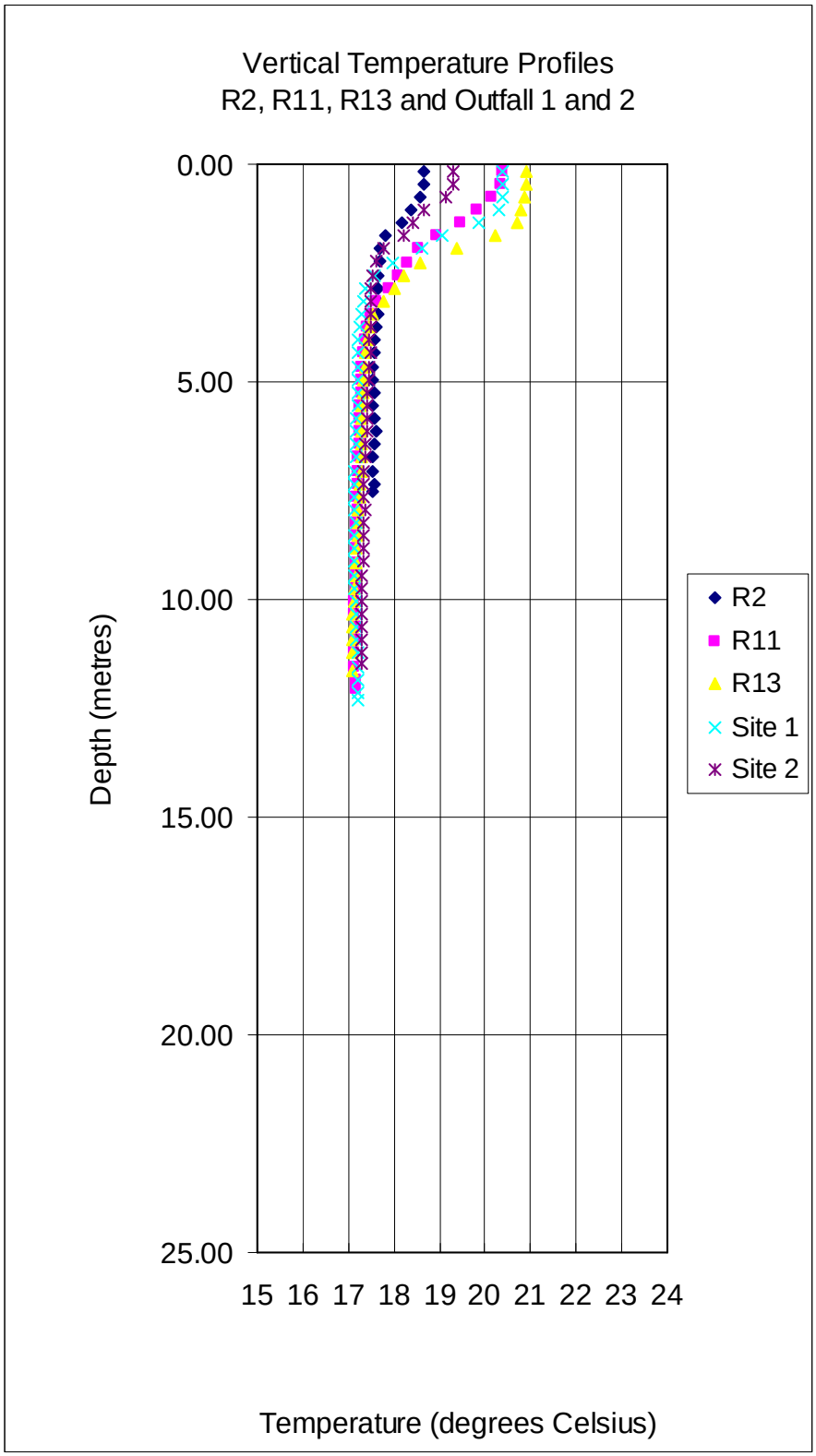

**11 July 2011:** Vertical profiles of **temperature** (sites R1-R6)



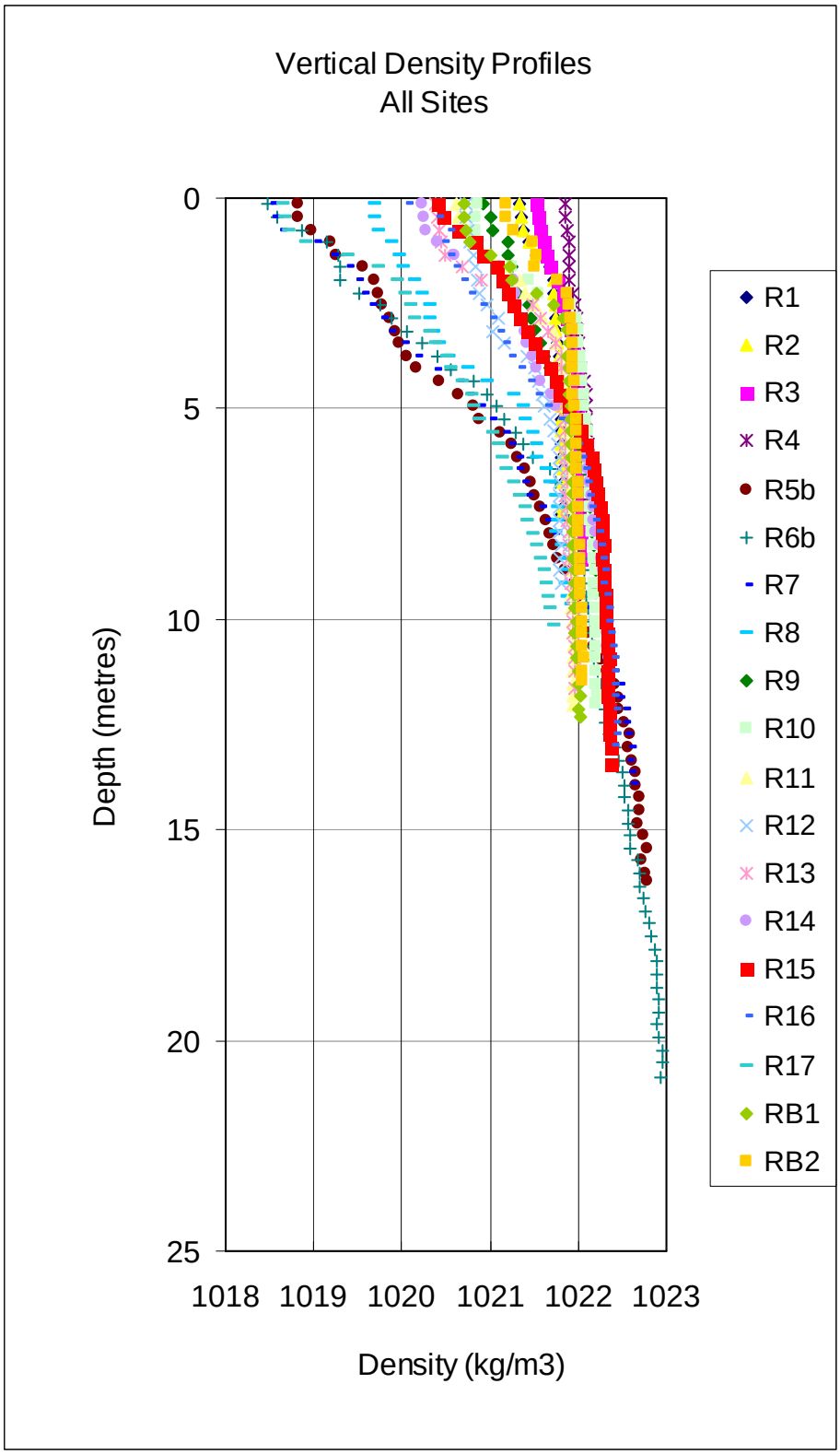

**11 July 2011:** Vertical profiles of **temperature** (sites R6-R12)



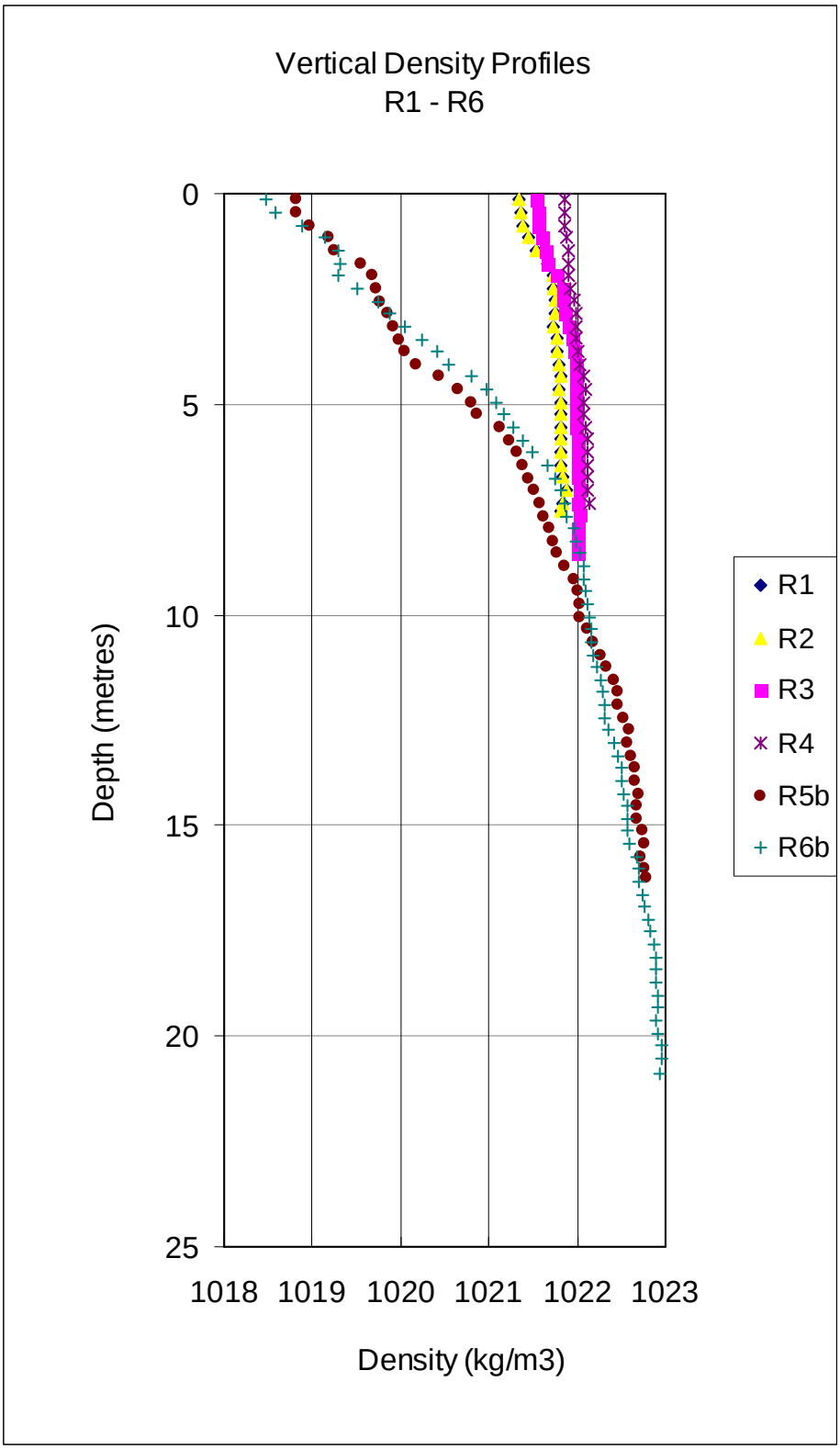

**11 July 2011:** Vertical profiles of **temperature** (sites R12-R17)



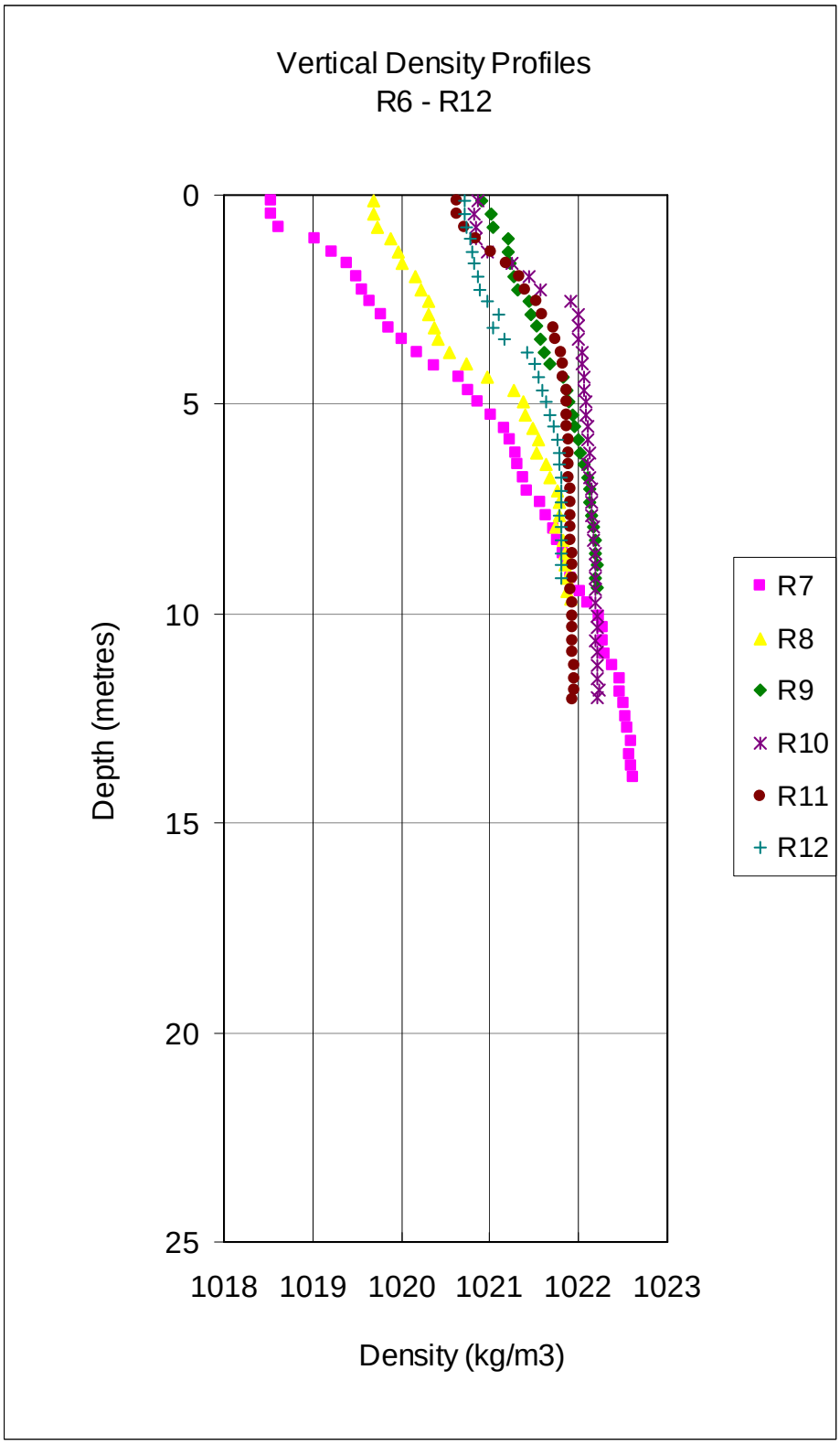

**11 July 2011:** Vertical profiles of **temperature** (sites as per Figure 3-1)



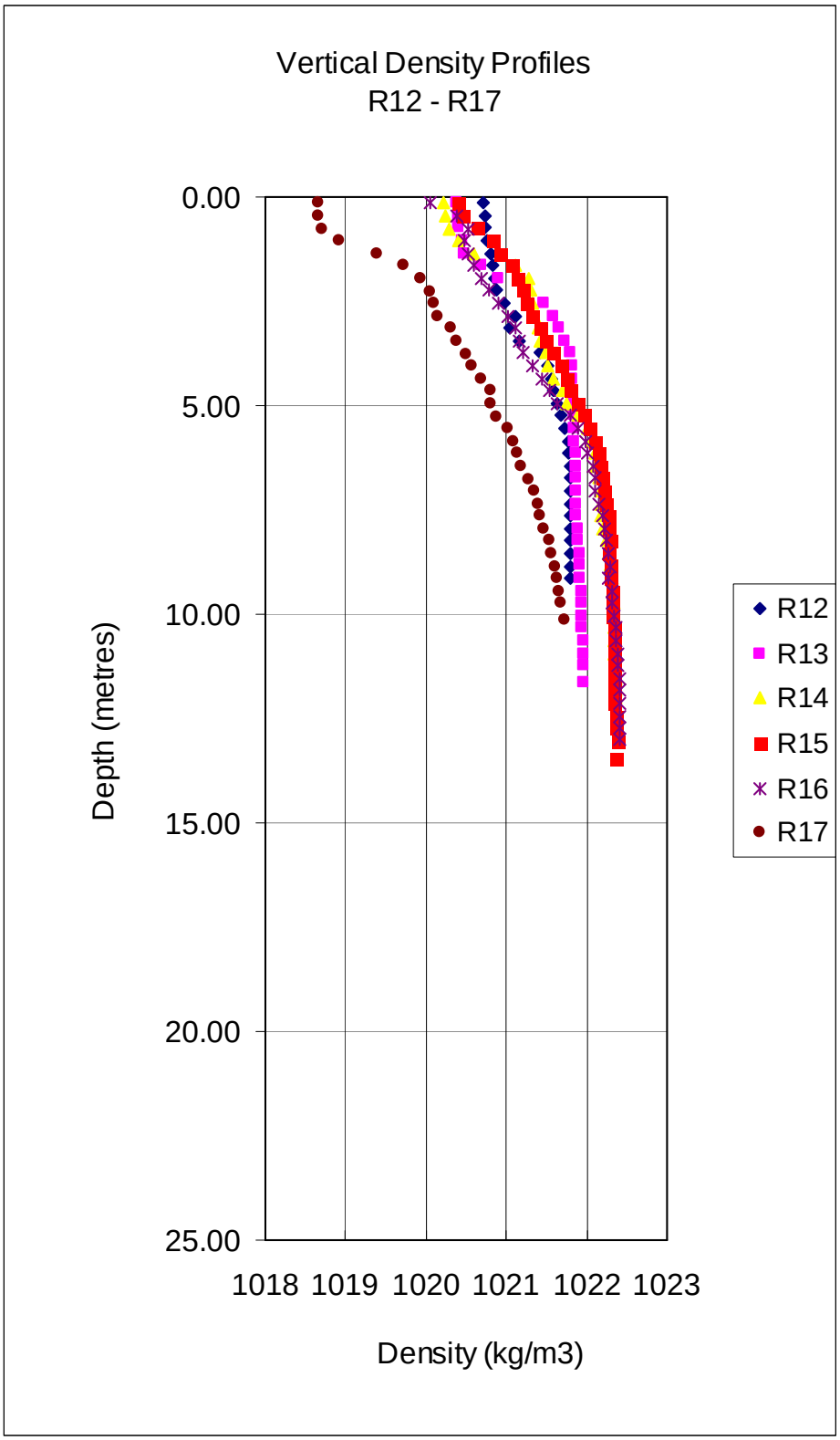

**11 July 2011:** Vertical profiles of **density** (all sites)



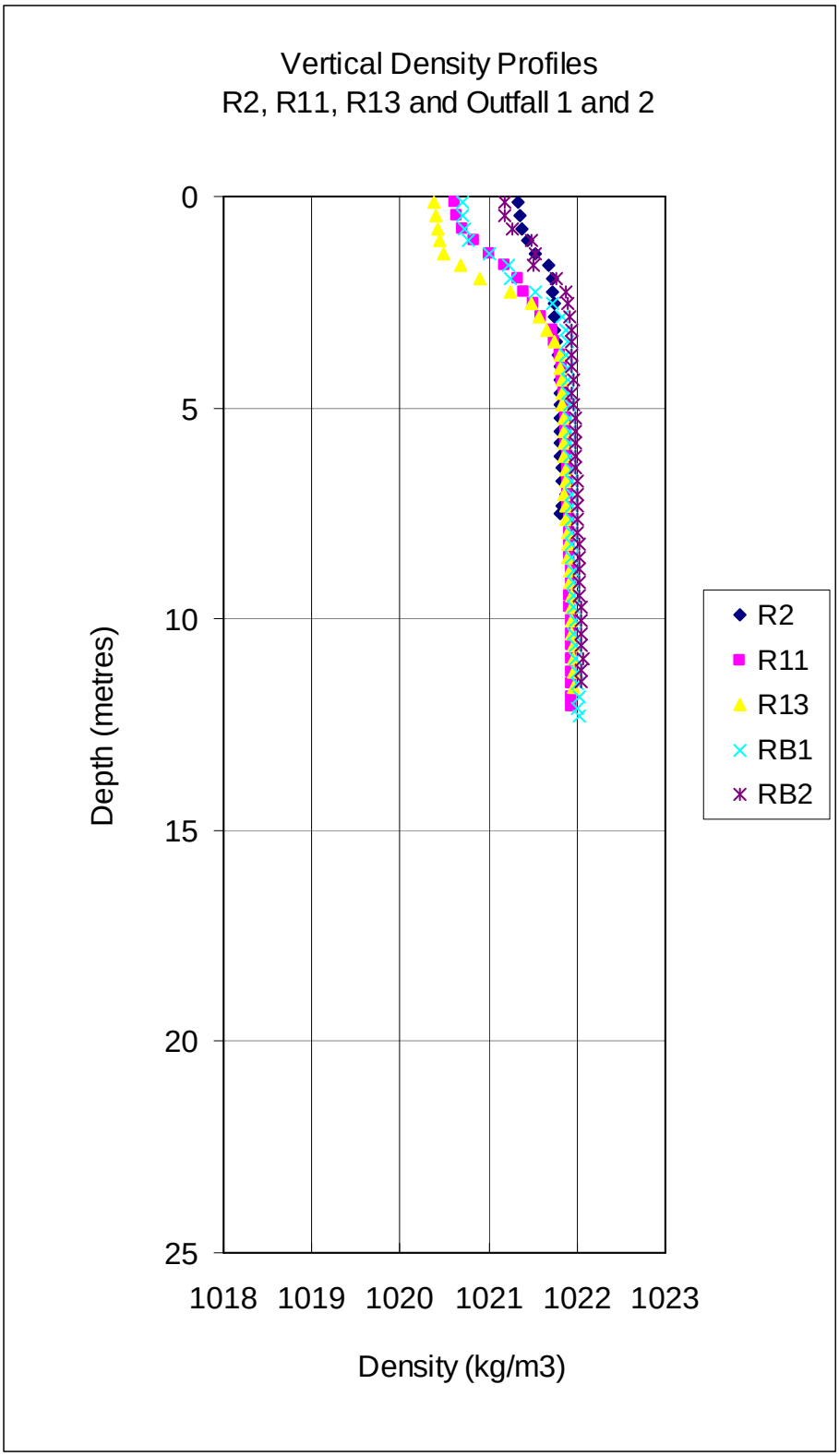

**11 July 2011:** Vertical profiles of **density** (sites R1-R6)




**11 July 2011:** Vertical profiles of **density** (sites R6-R12)

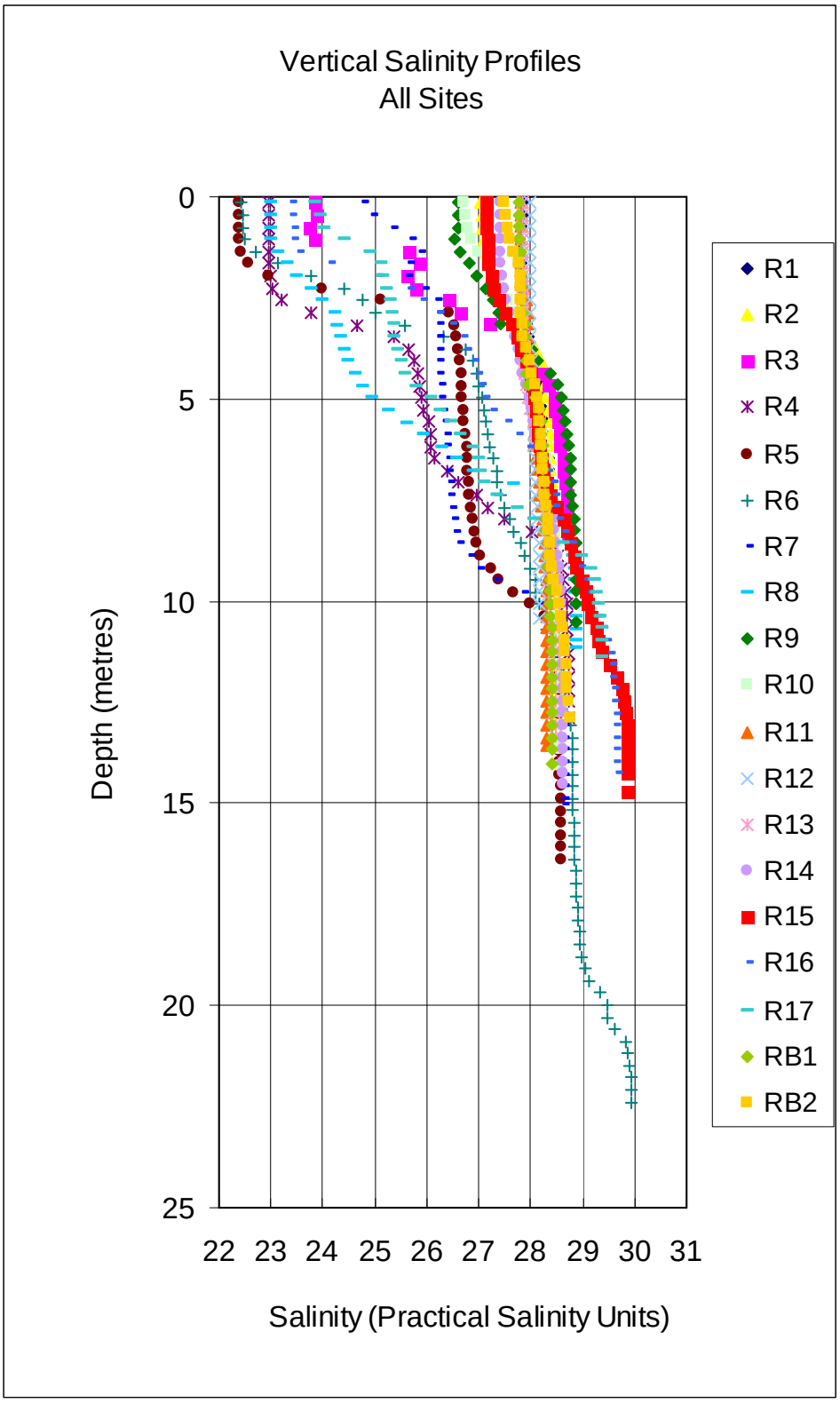



**11 July 2011:** Vertical profiles of **density** (sites R12-R17)

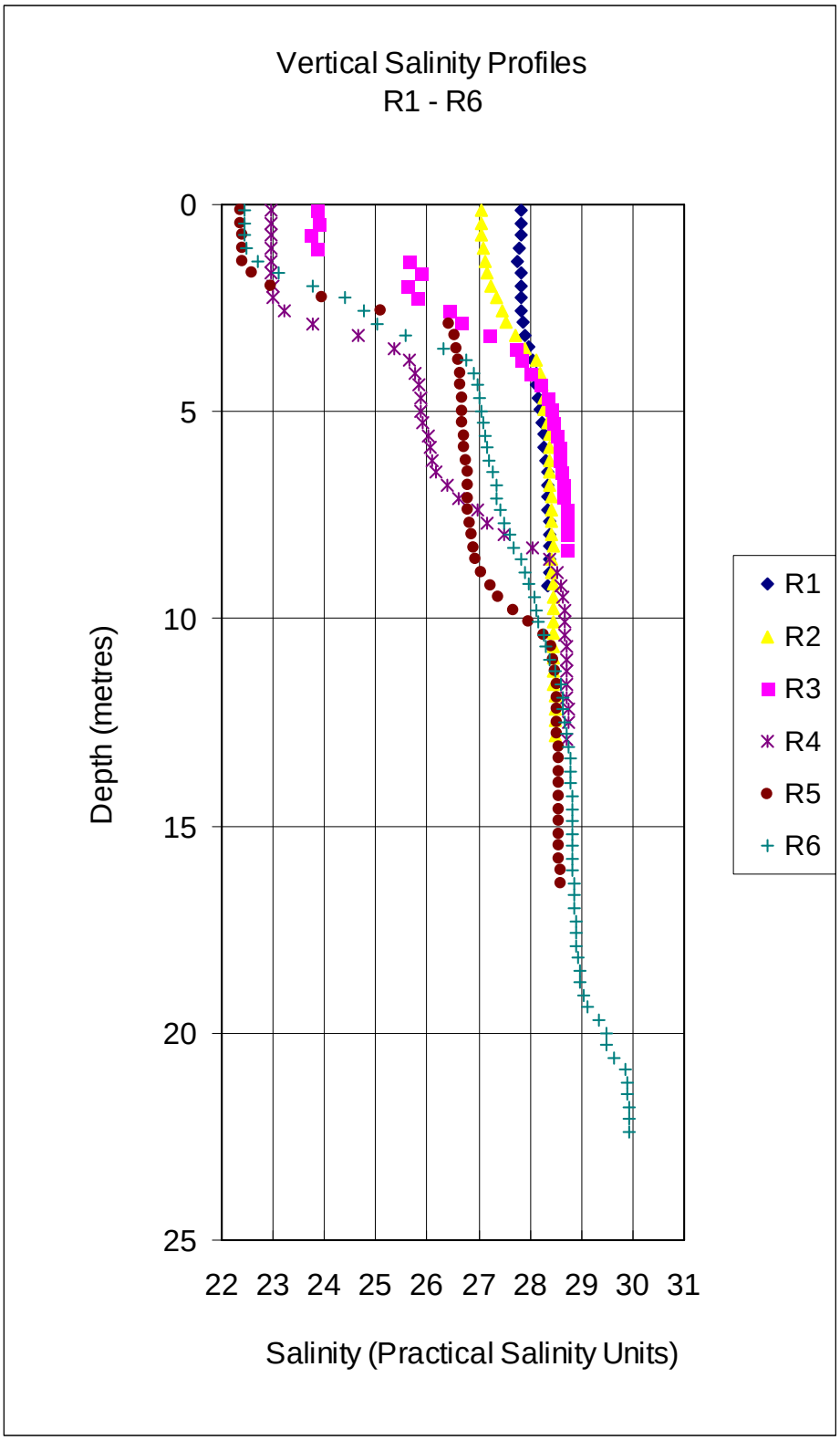



**11 July 2011:** Vertical profiles of **density** (sites as per Figure 3-1)

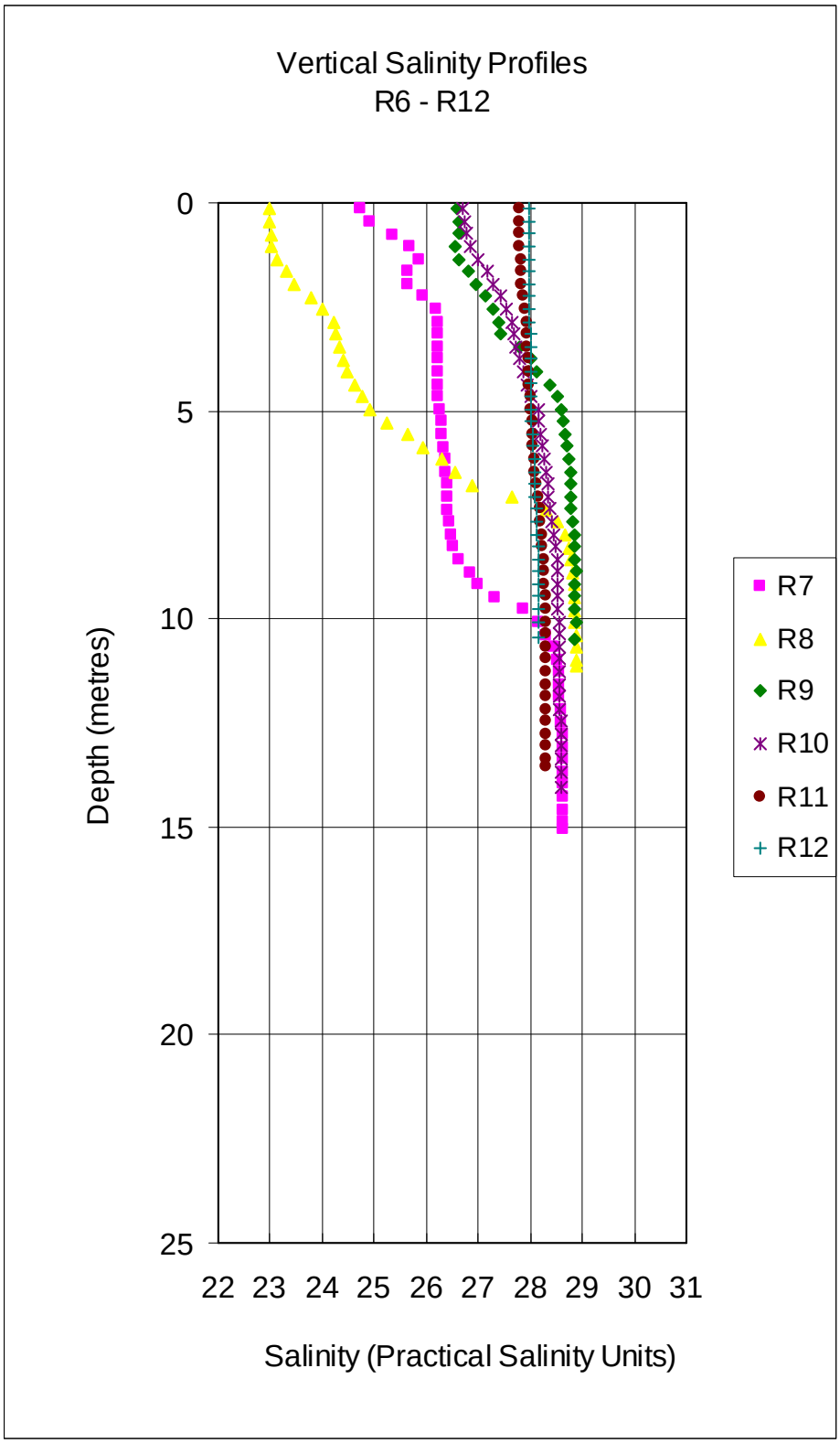
# 14 September 2011



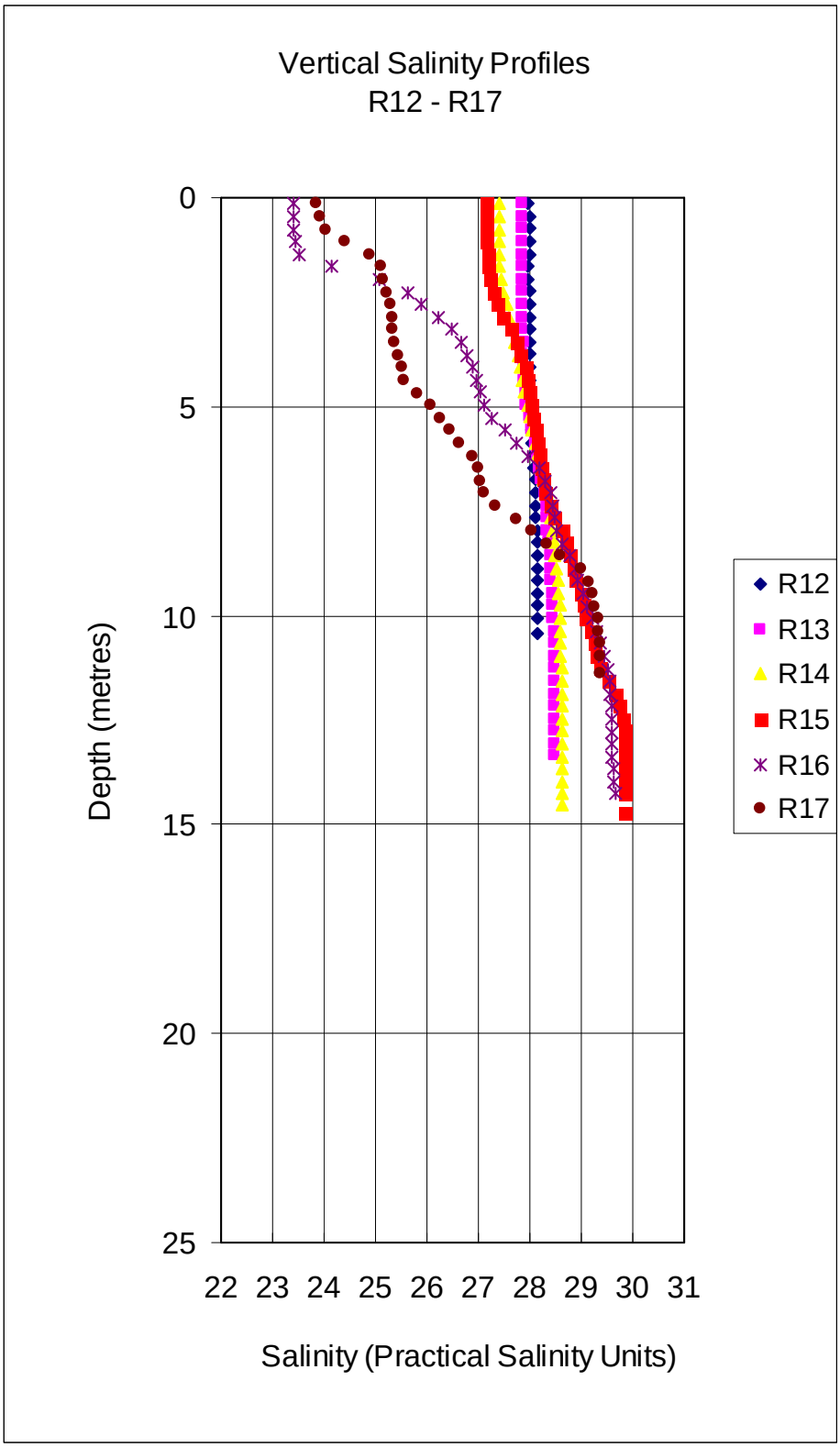

**14 September 2011:** Vertical profiles of **salinity** (all sites).



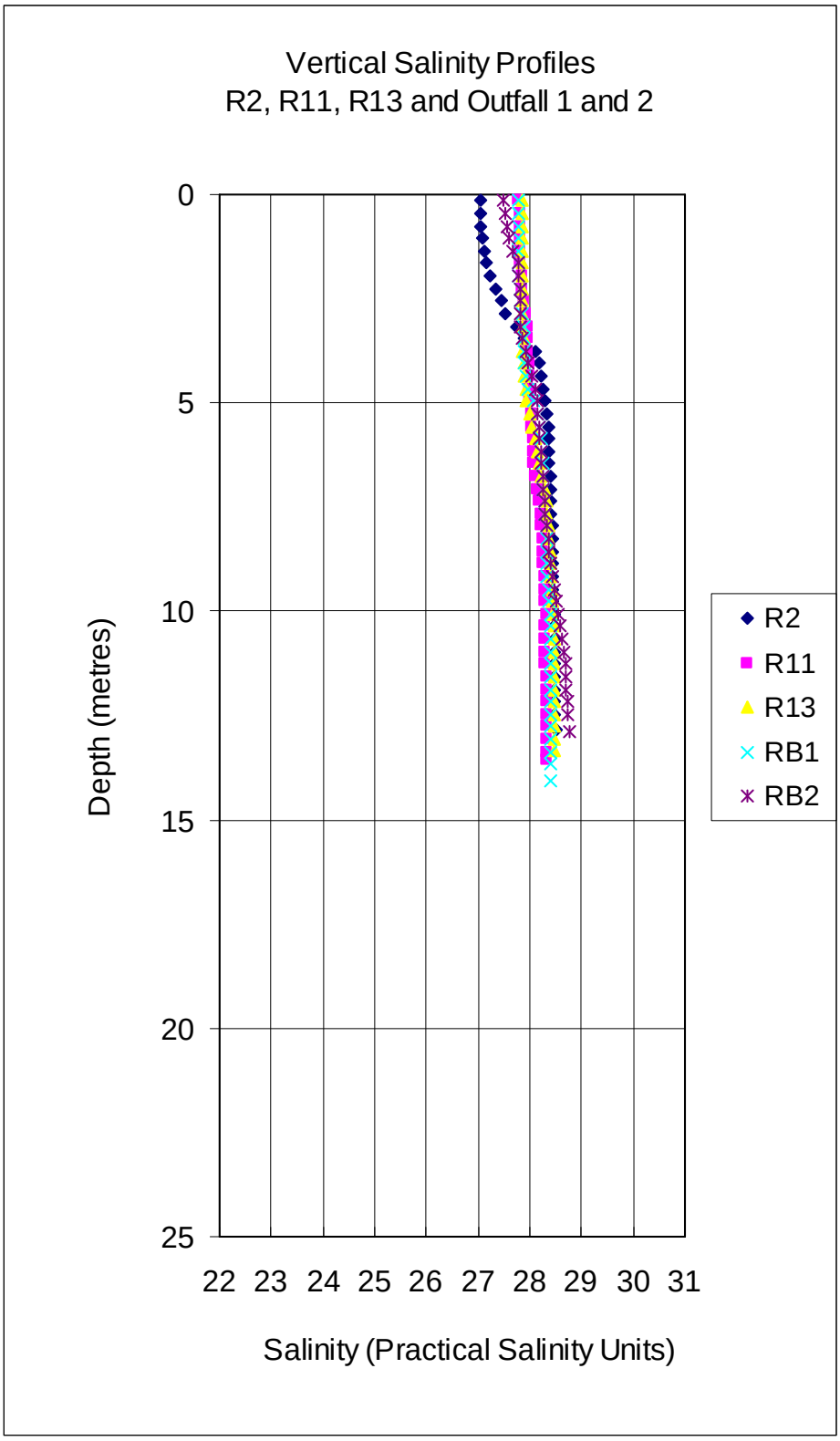

**14 September 2011:** Vertical profiles of **salinity** (sites R1-R6).



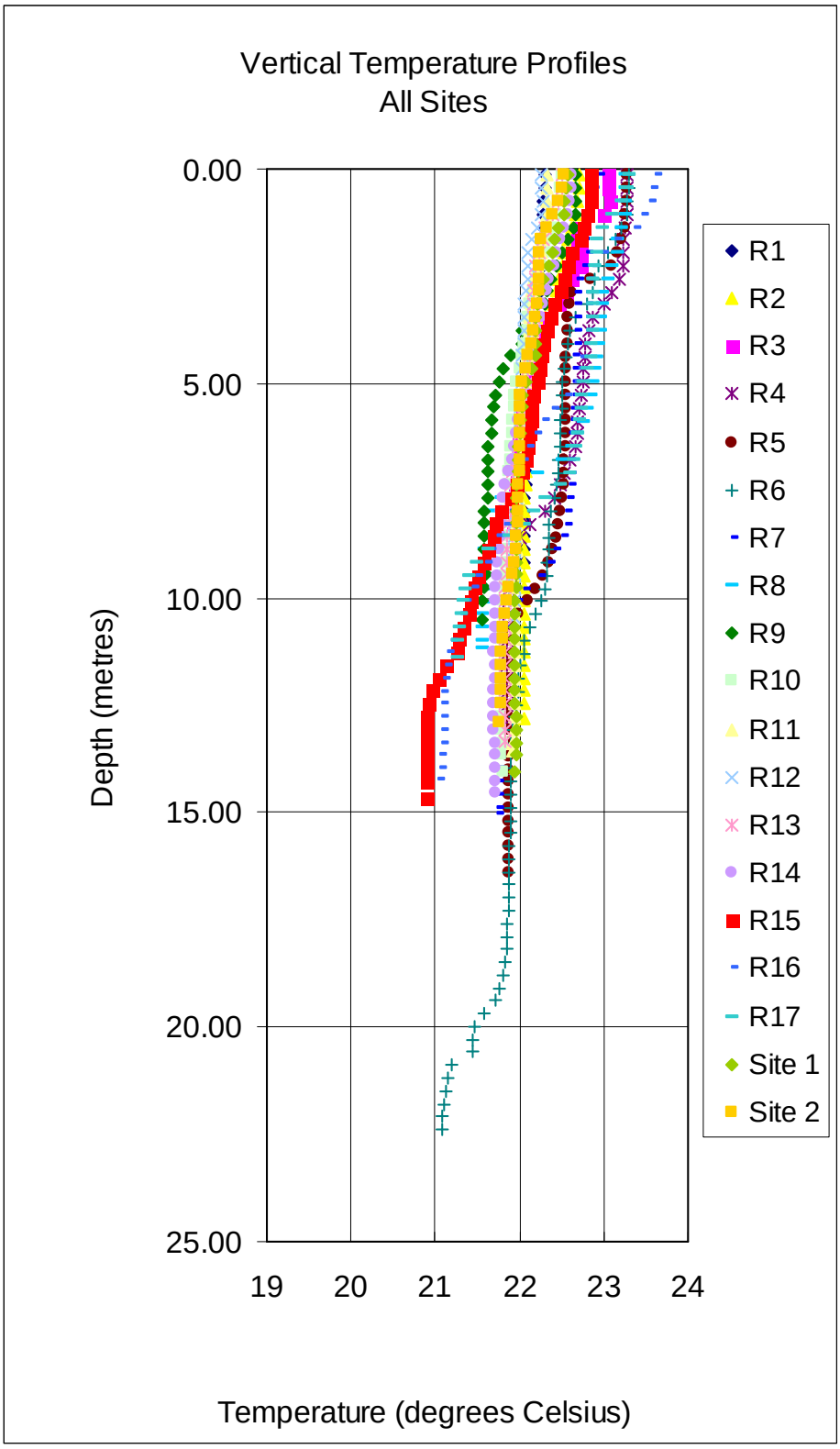

**14 September 2011:** Vertical profiles of **salinity** (sites R6-R12).



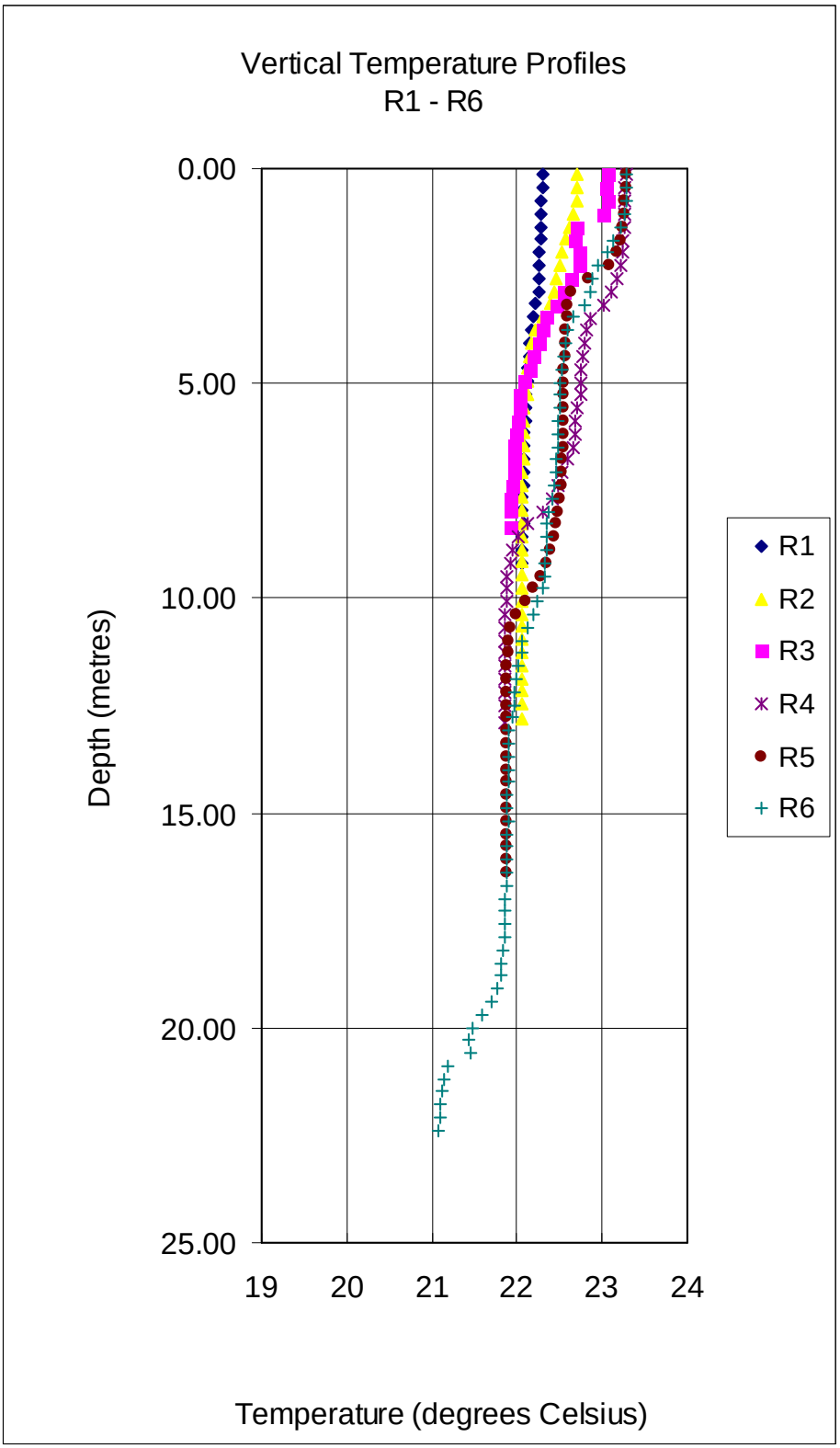

**14 September 2011:** Vertical profiles of **salinity** (sites R12-R17)



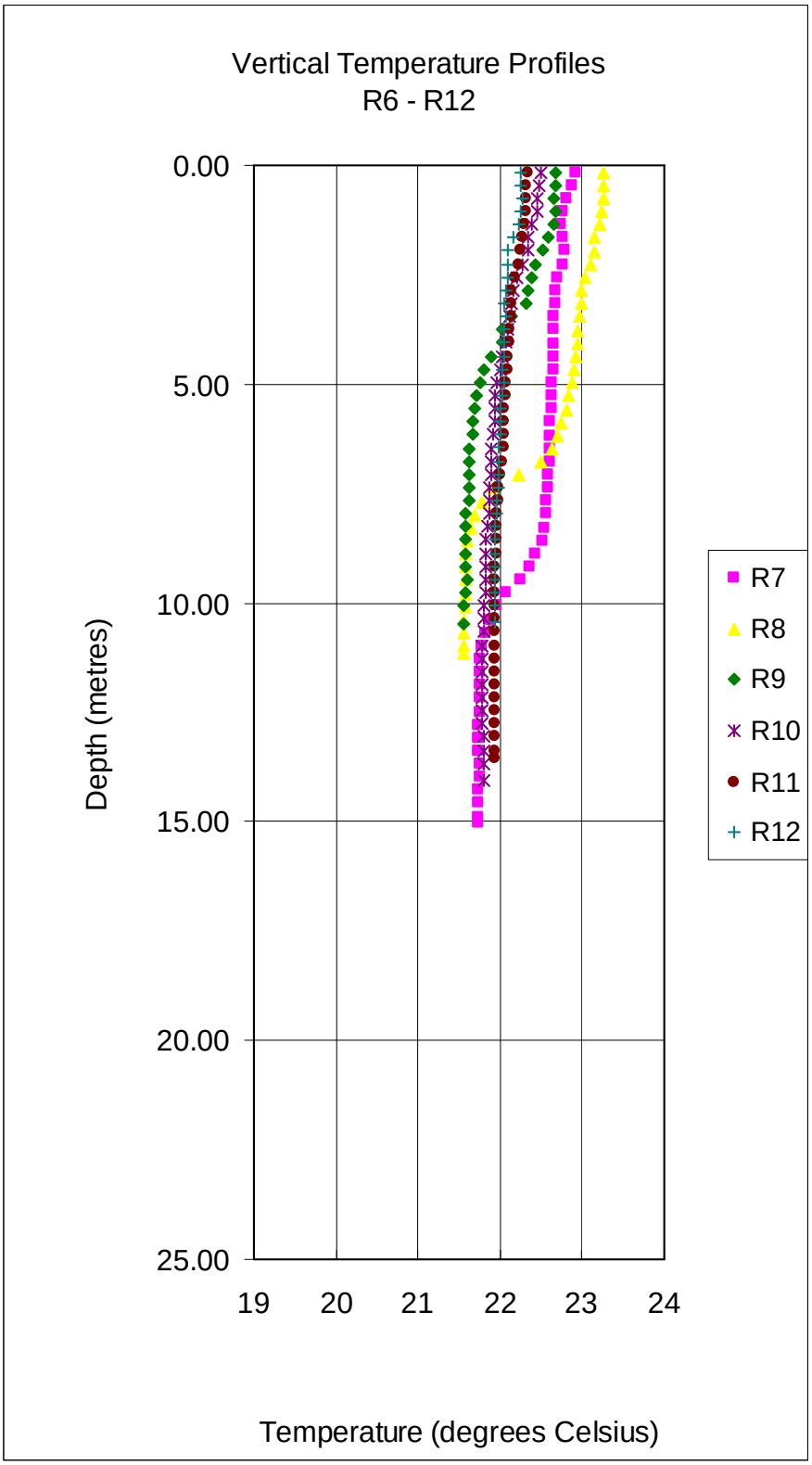

**14 September 2011:** Vertical profiles of **salinity** (sites as per Figure 3-1)



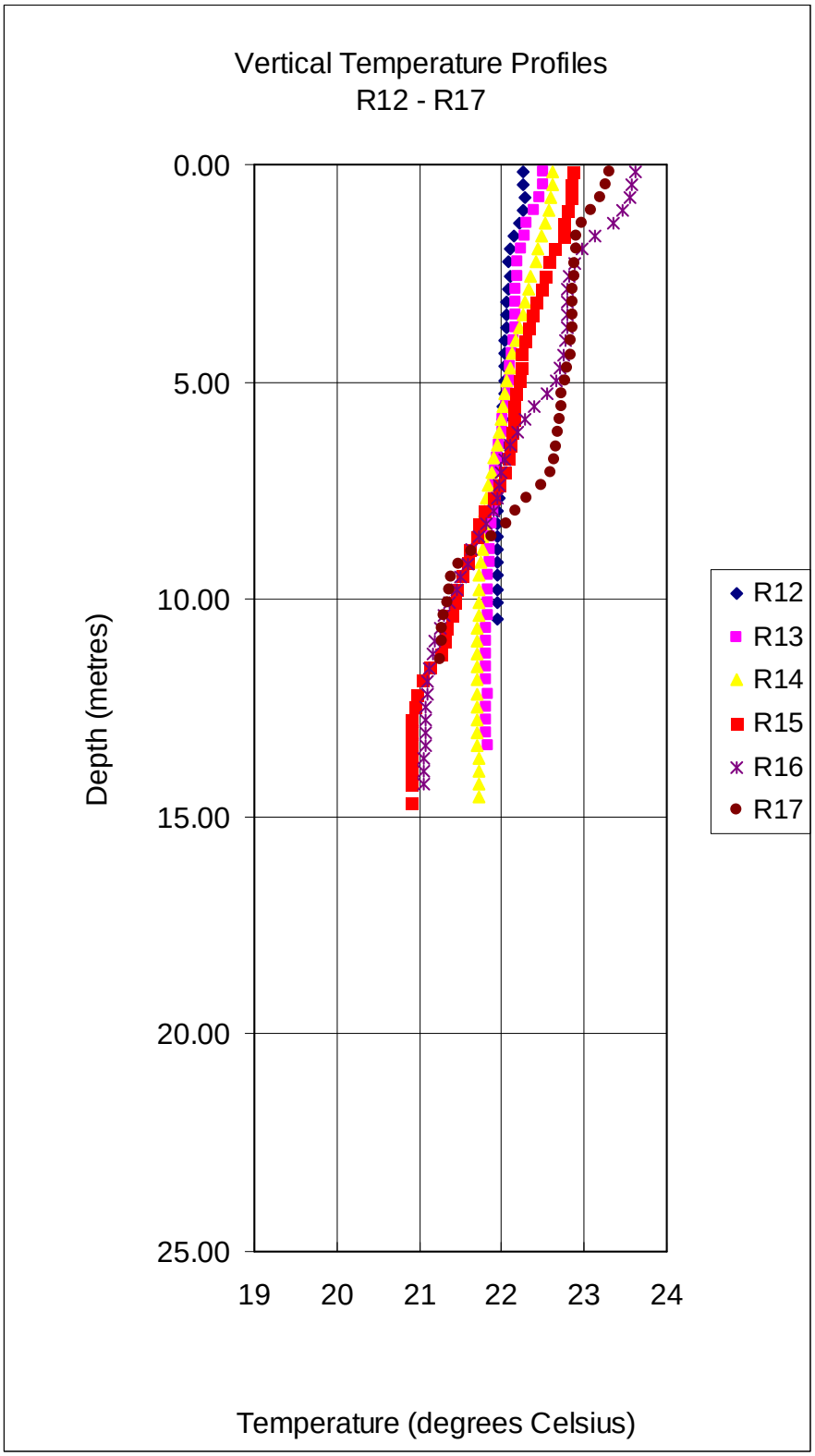

**14 September 2011:** Vertical profiles of **temperature** (all sites)



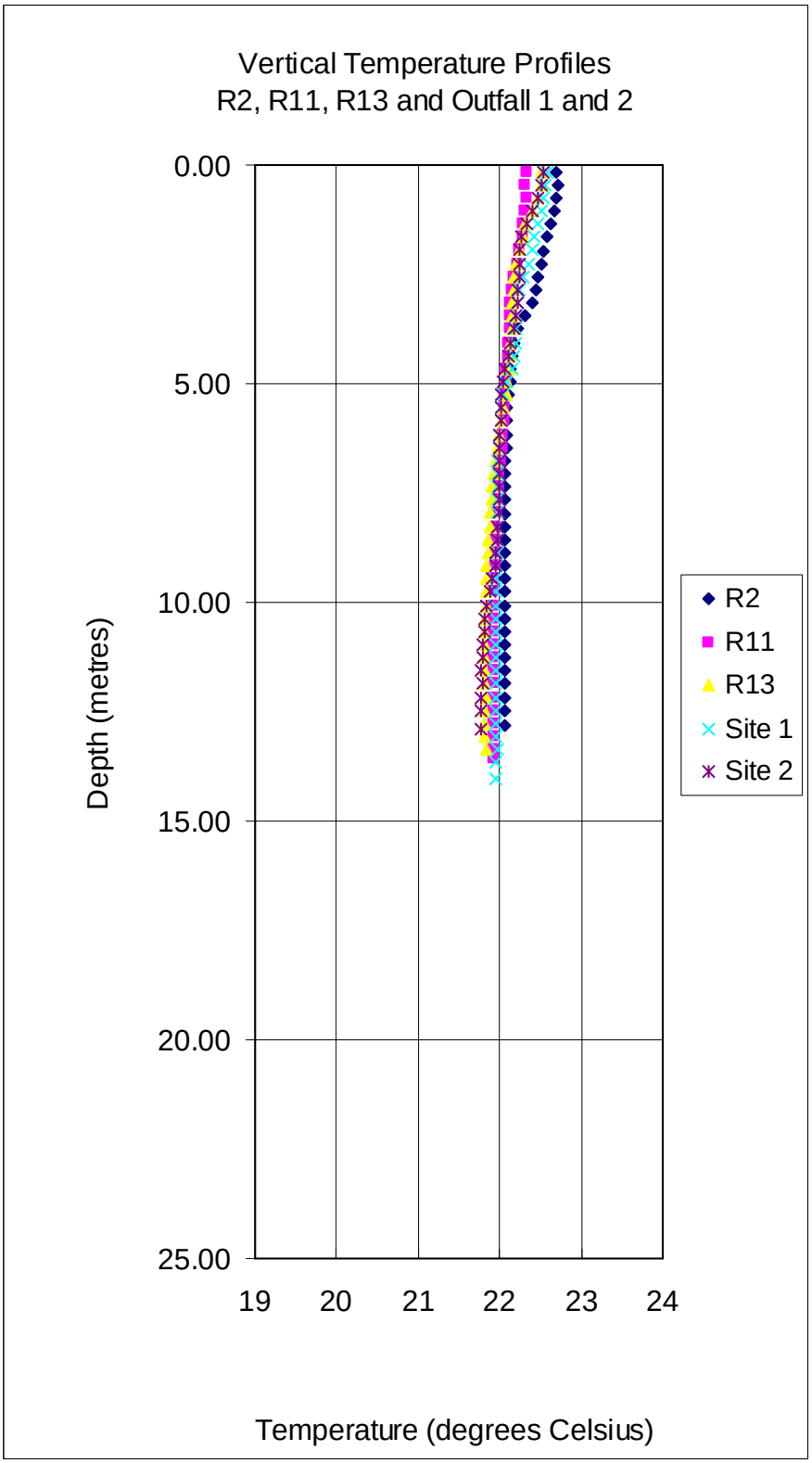

**14 September 2011:** Vertical profiles of **temperature** (sites R1-R6)



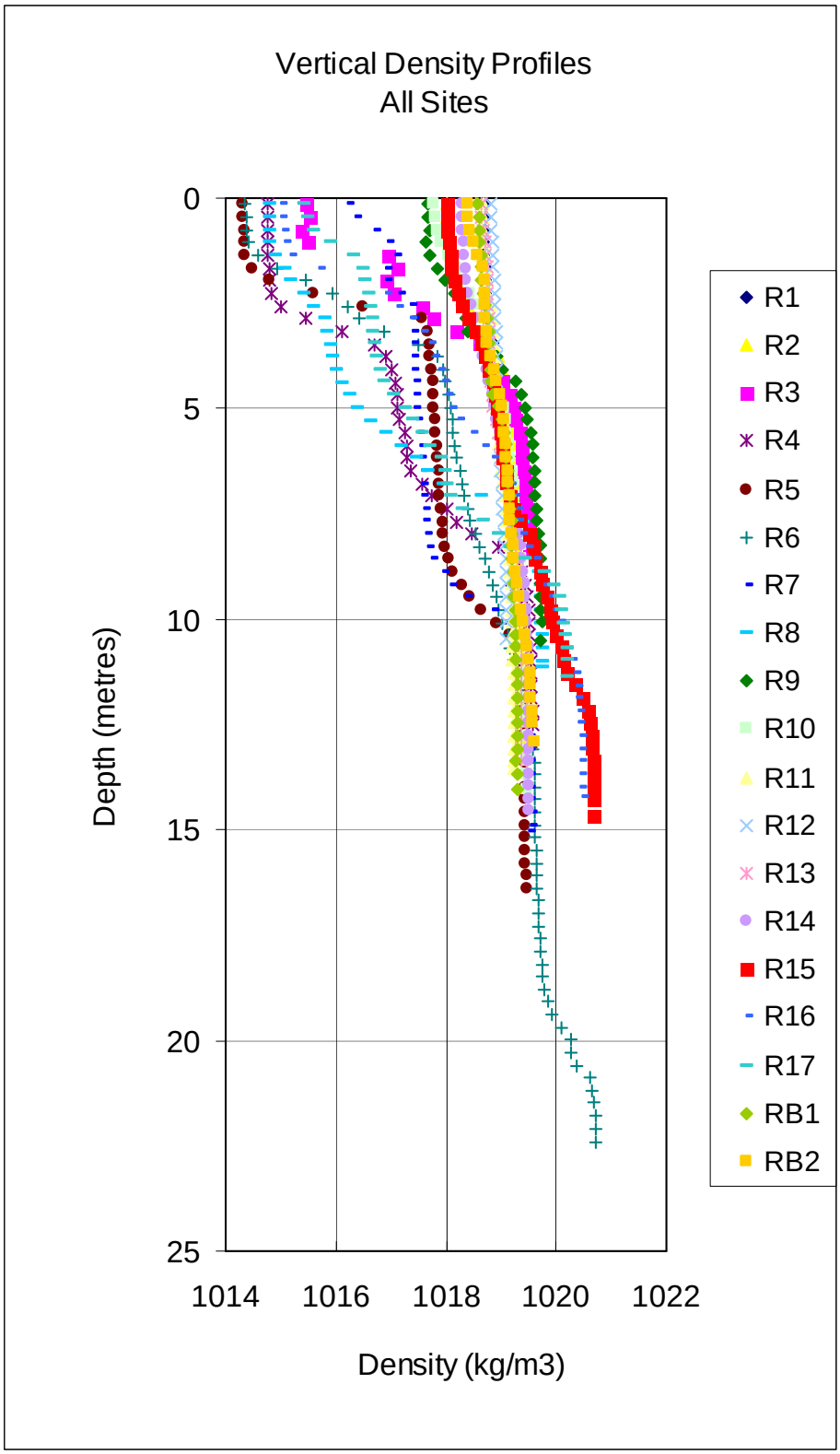

**14 September 2011:** Vertical profiles of **temperature** (sites R6-R12)



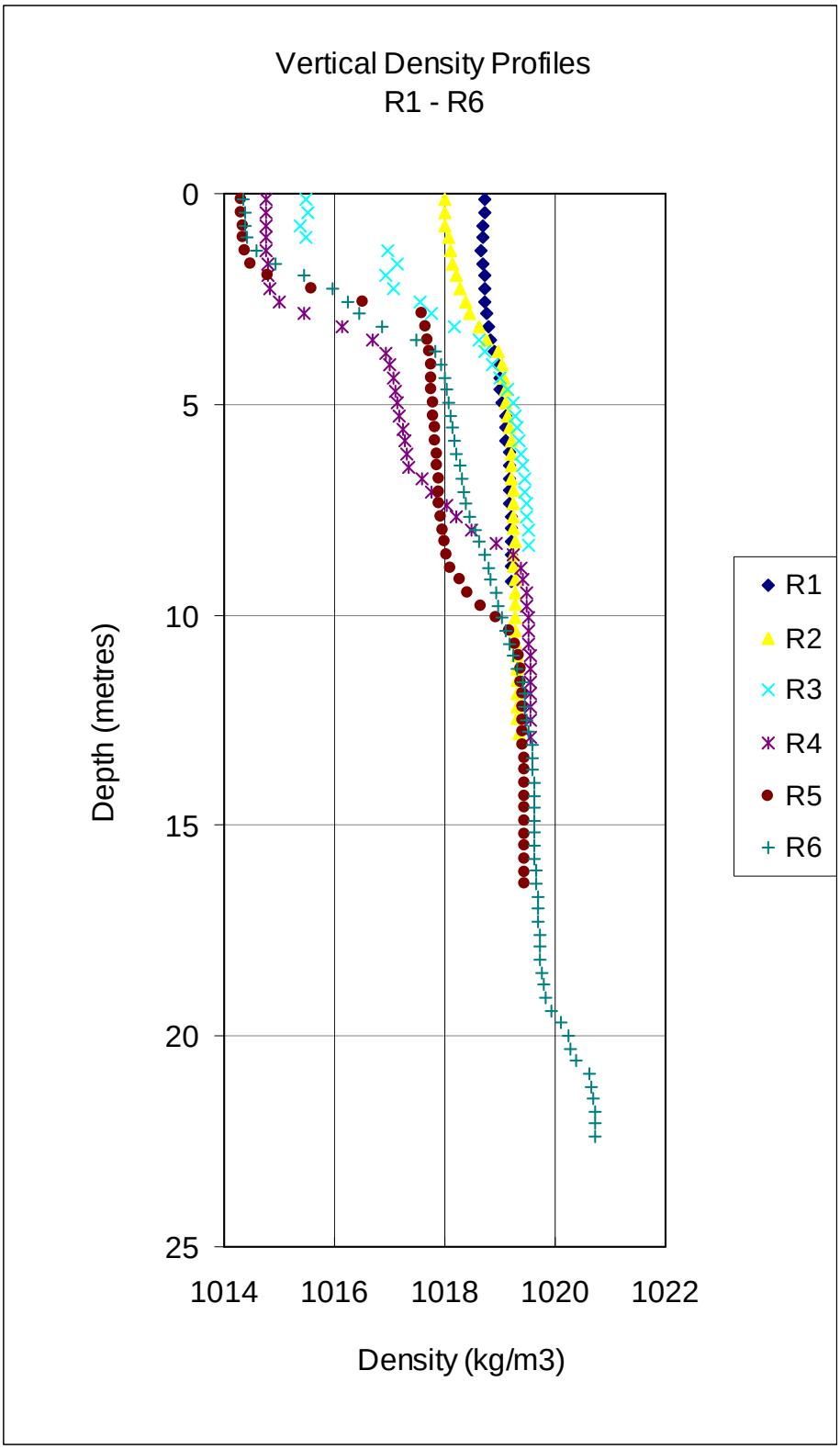

**14 September 2011:** Vertical profiles of **temperature** (sites R12-R17)



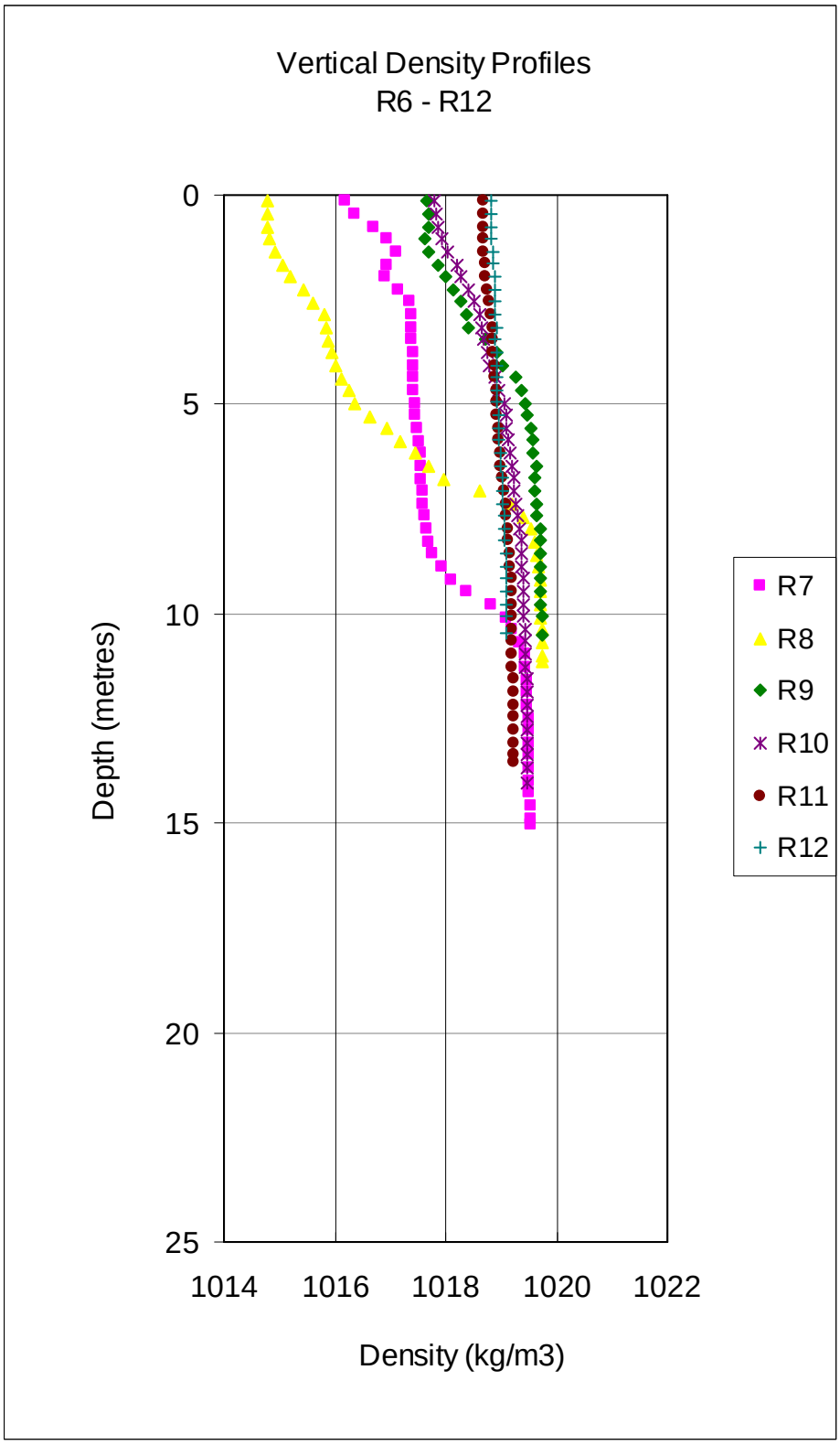

**14 September 2011:** Vertical profiles of **temperature** (sites as per Figure 3-1)



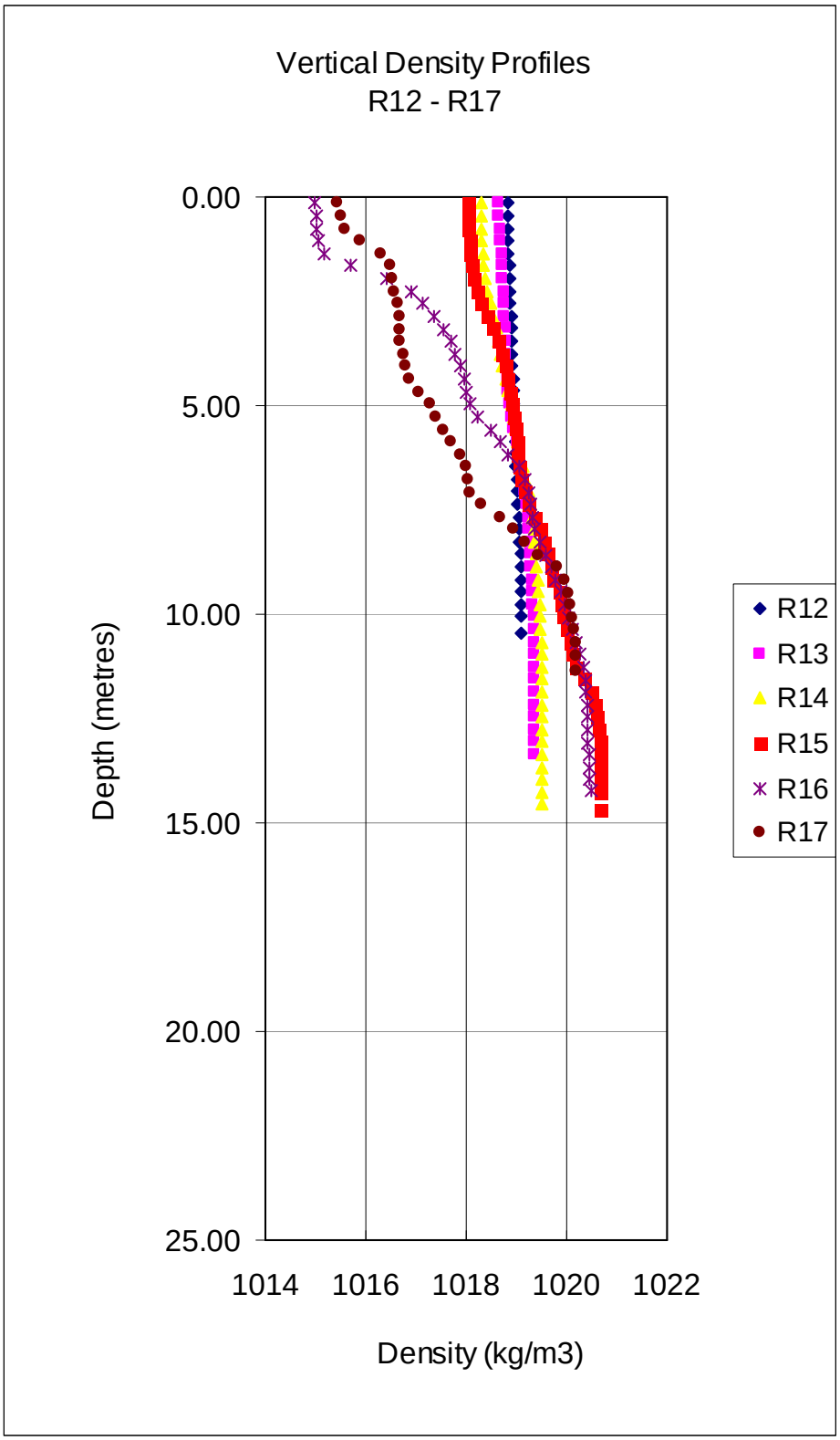

**14 September 2011:** Vertical profiles of **density** (all sites)



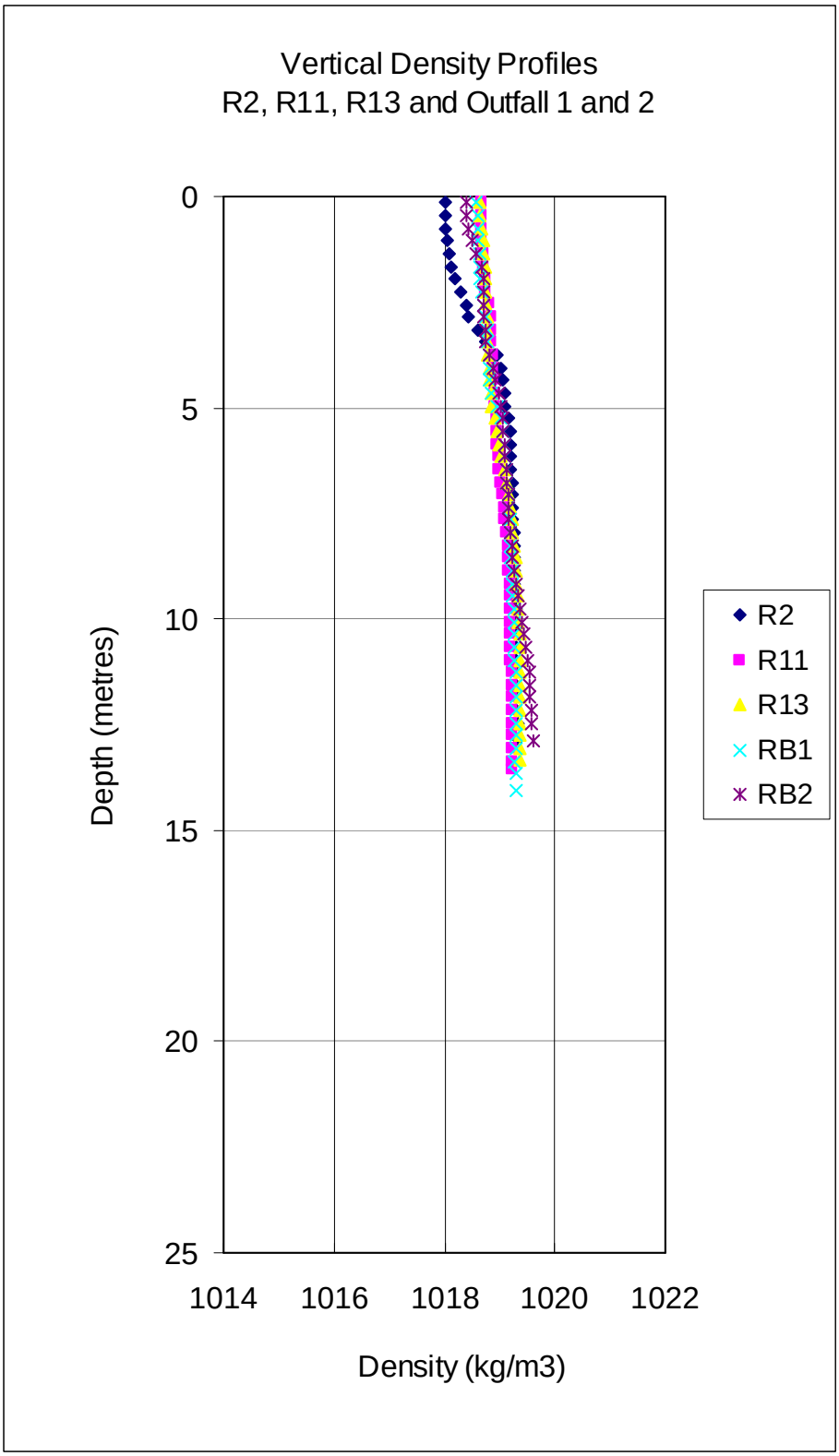

**14 September 2011:** Vertical profiles of **density** (sites R1-R6)



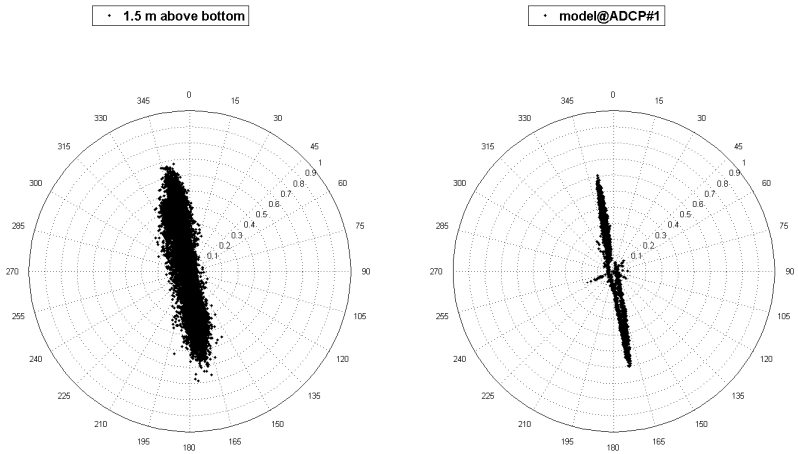

**14 September 2011:** Vertical profiles of **density** (sites R6-R12)

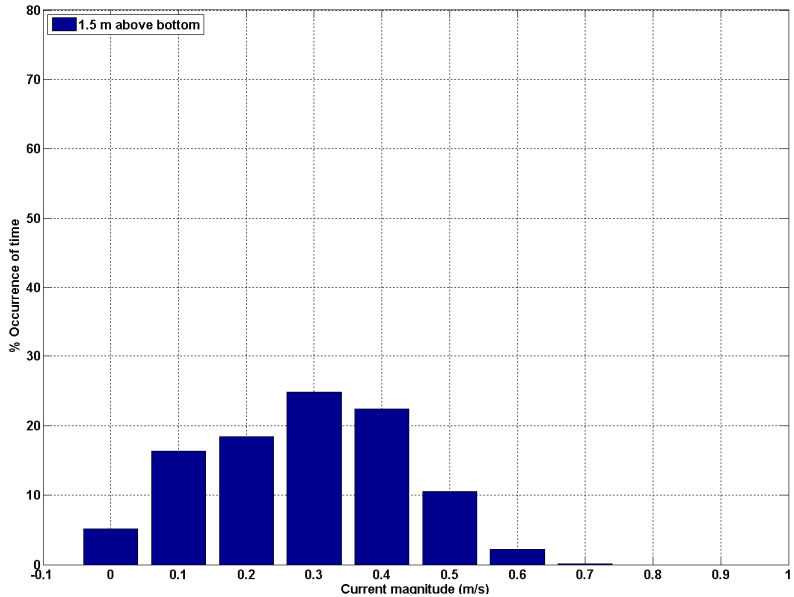



**14 September 2011:** Vertical profiles of **density** (sites R12-R17)

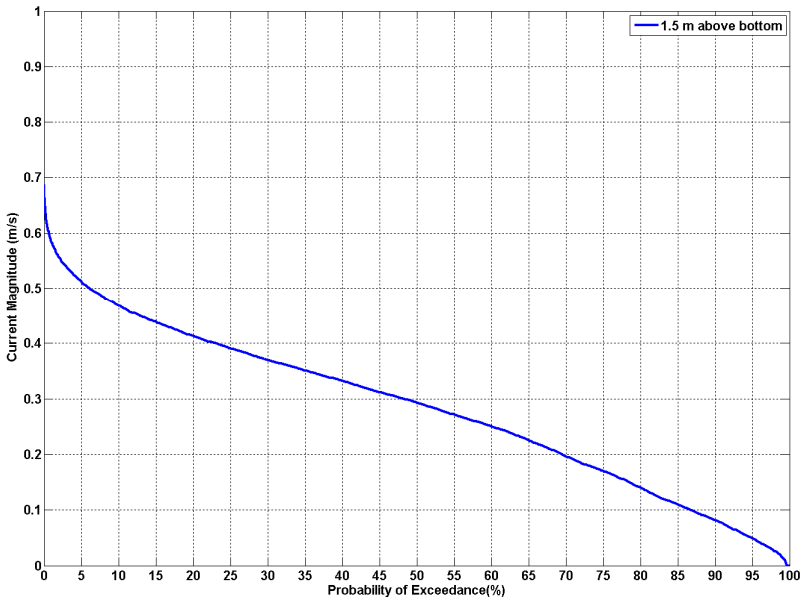



**14 September 2011:** Vertical profiles of **density** (sites as per Figure 3-1)




Current direction is in degrees relative to Magnetic North



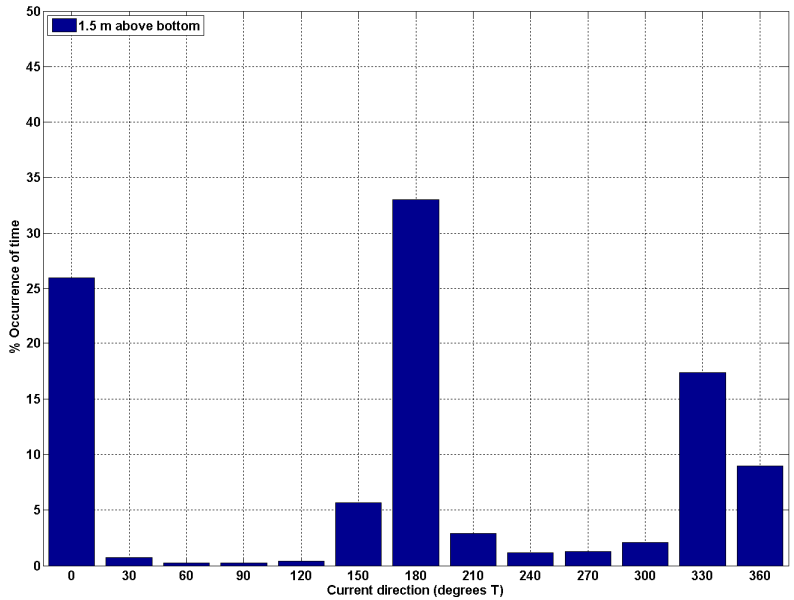




**Figure B-2a** ADCP #1 measurements **1.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

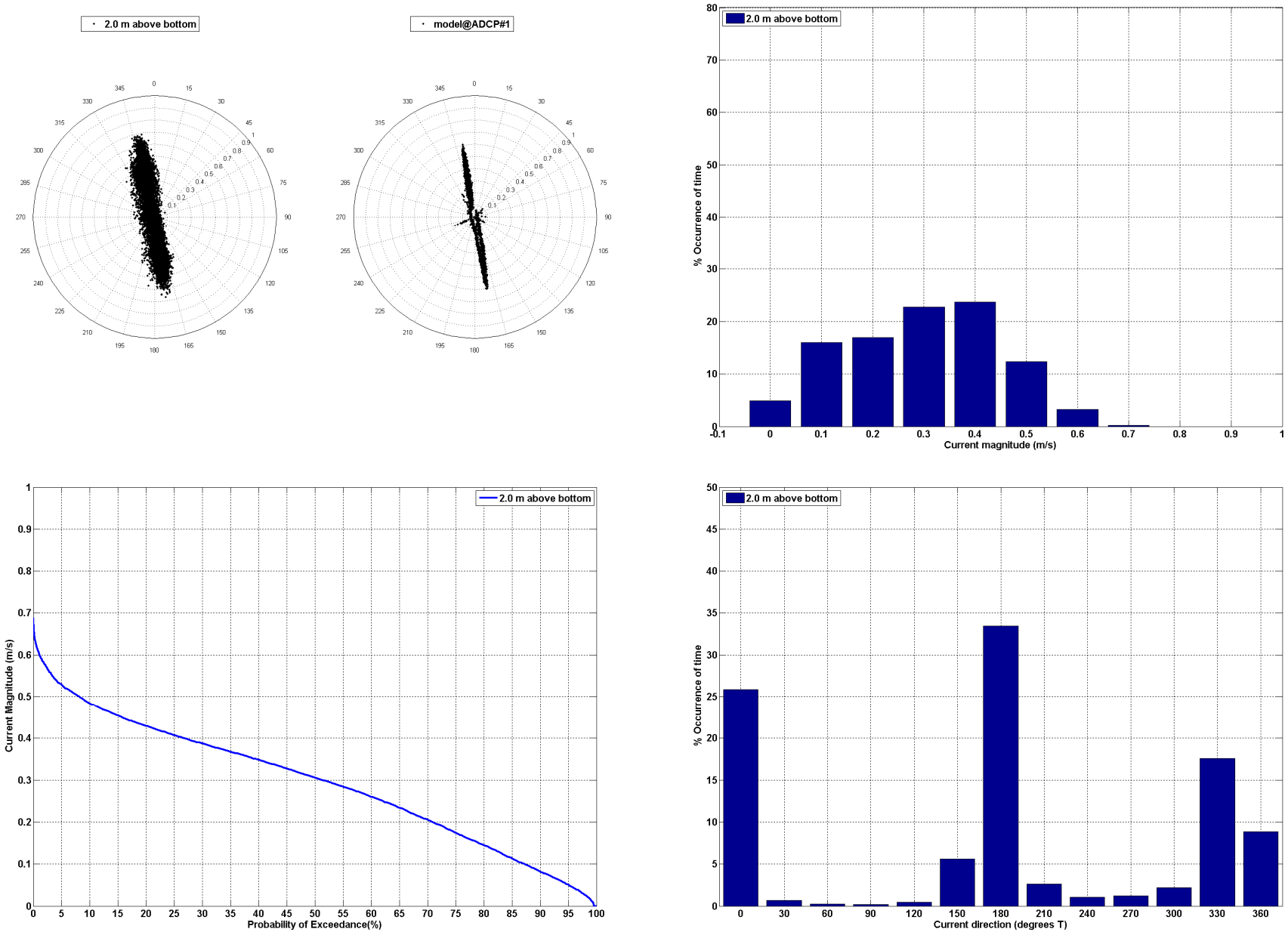



**Figure B-2b** ADCP #1 measurements **2.0** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

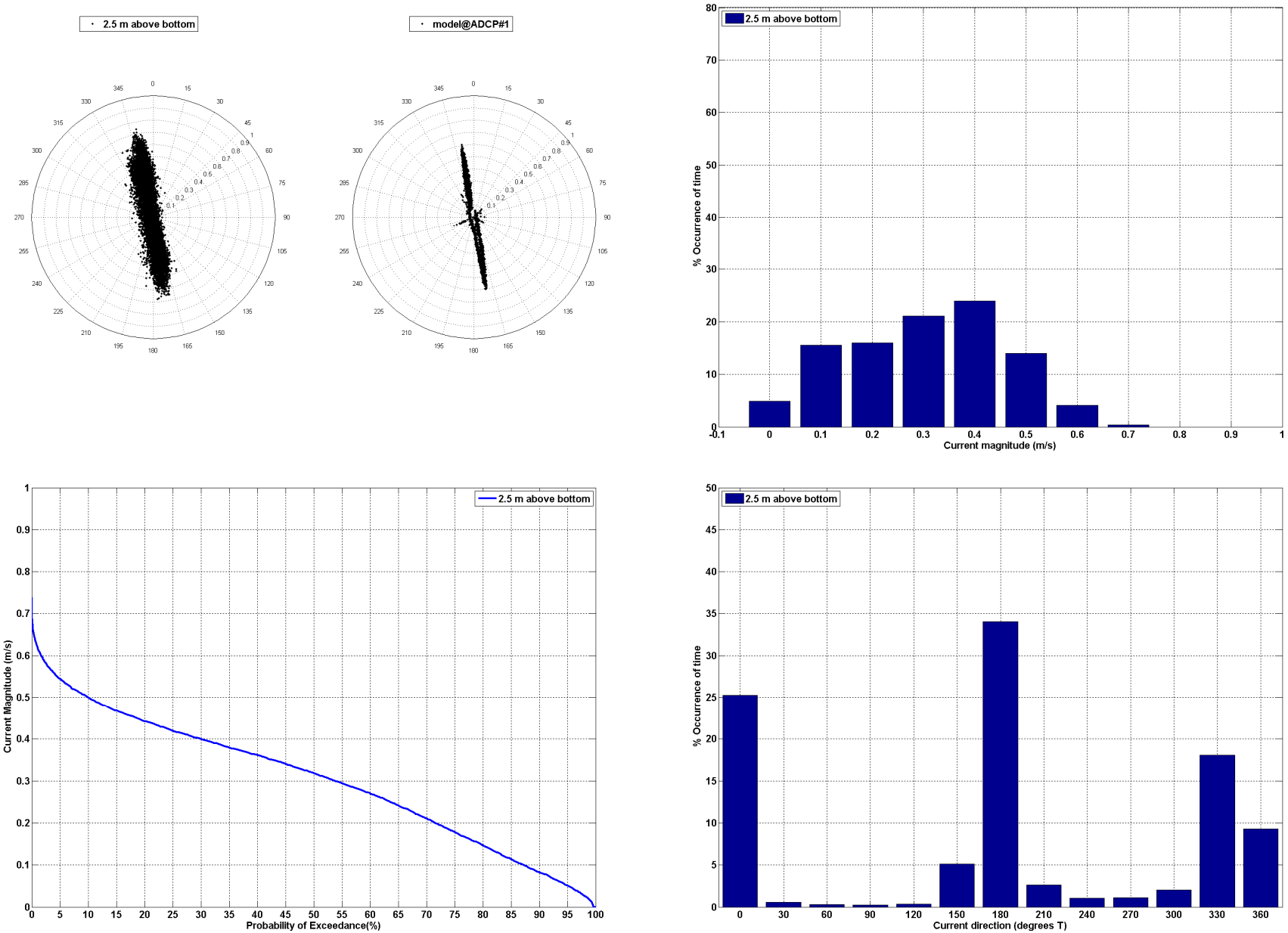



**Figure B-2c** ADCP #1 measurements **2.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

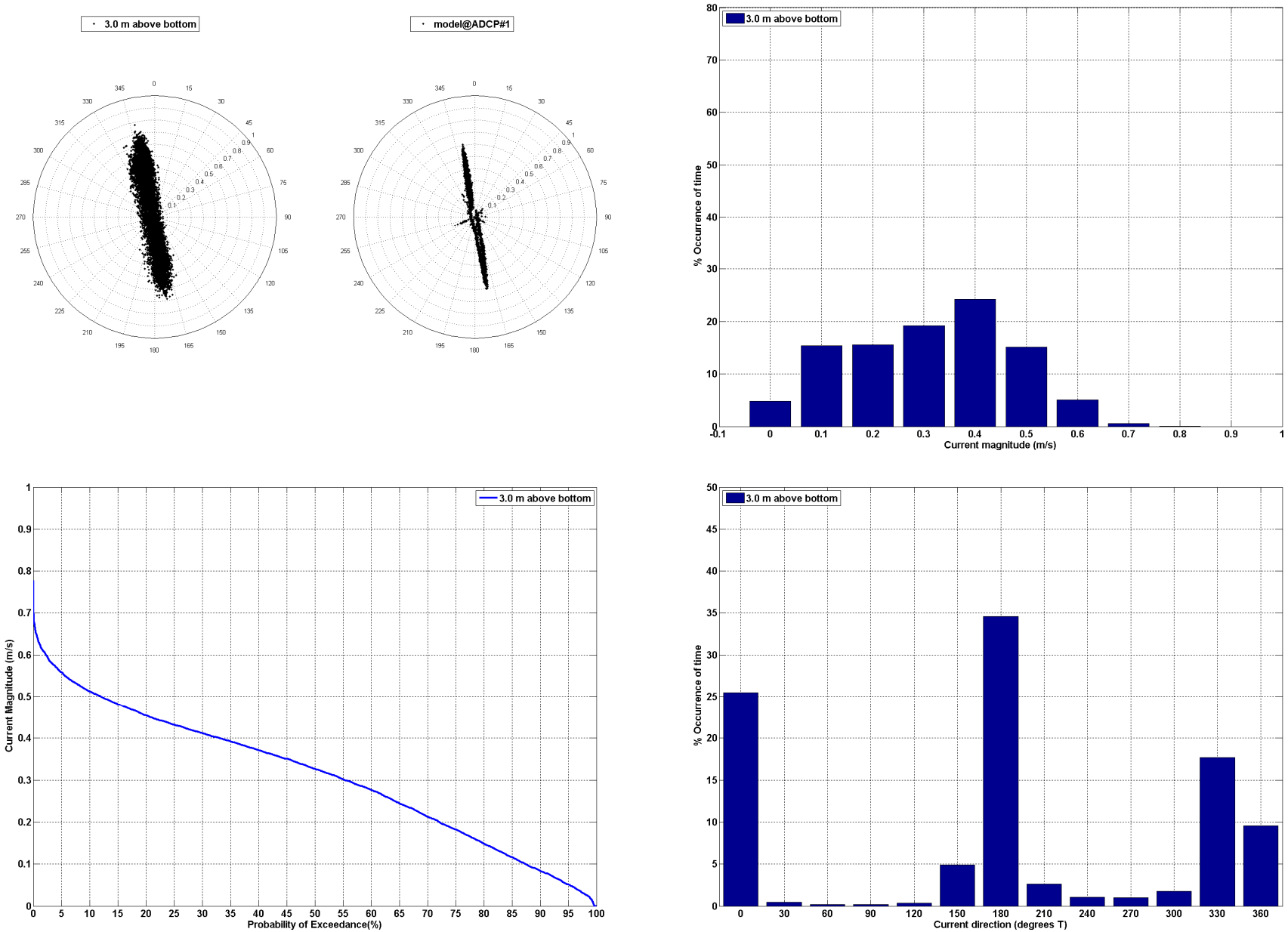



**Figure B-2d** ADCP #1 measurements **3.0** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

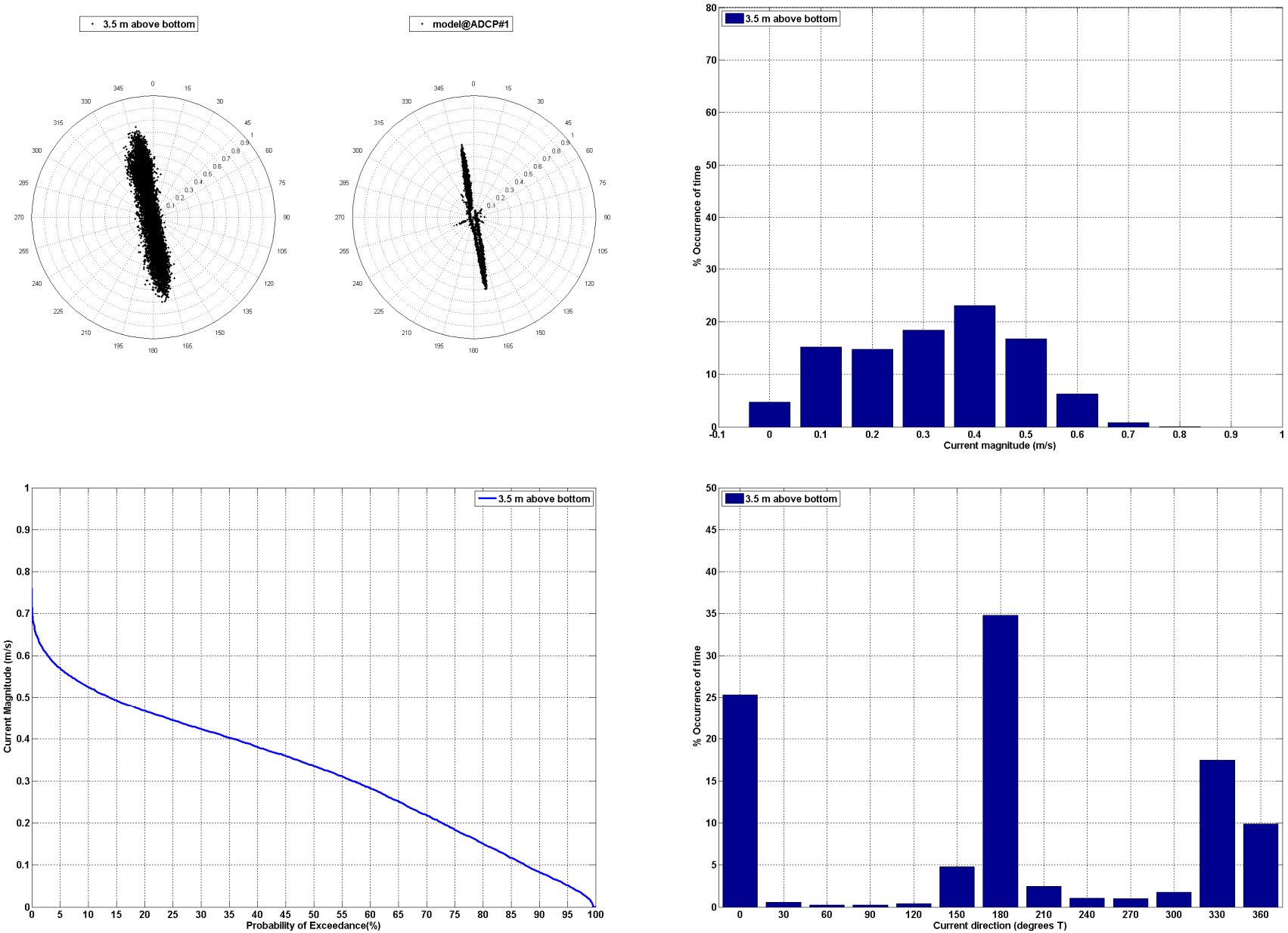



**Figure B-2e** ADCP #1 measurements **3.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

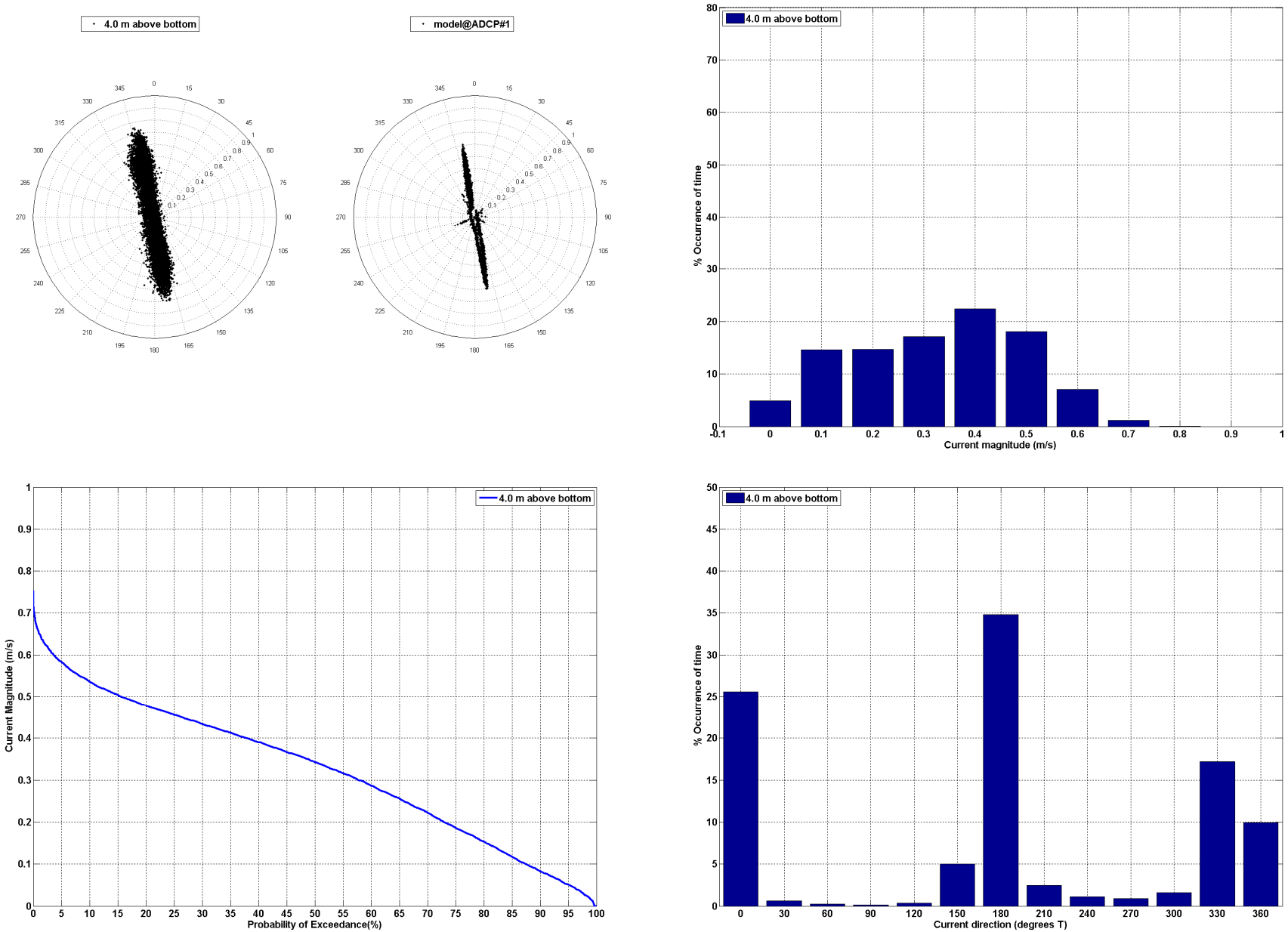



**Figure B-2f** ADCP #1 measurements **4.0** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

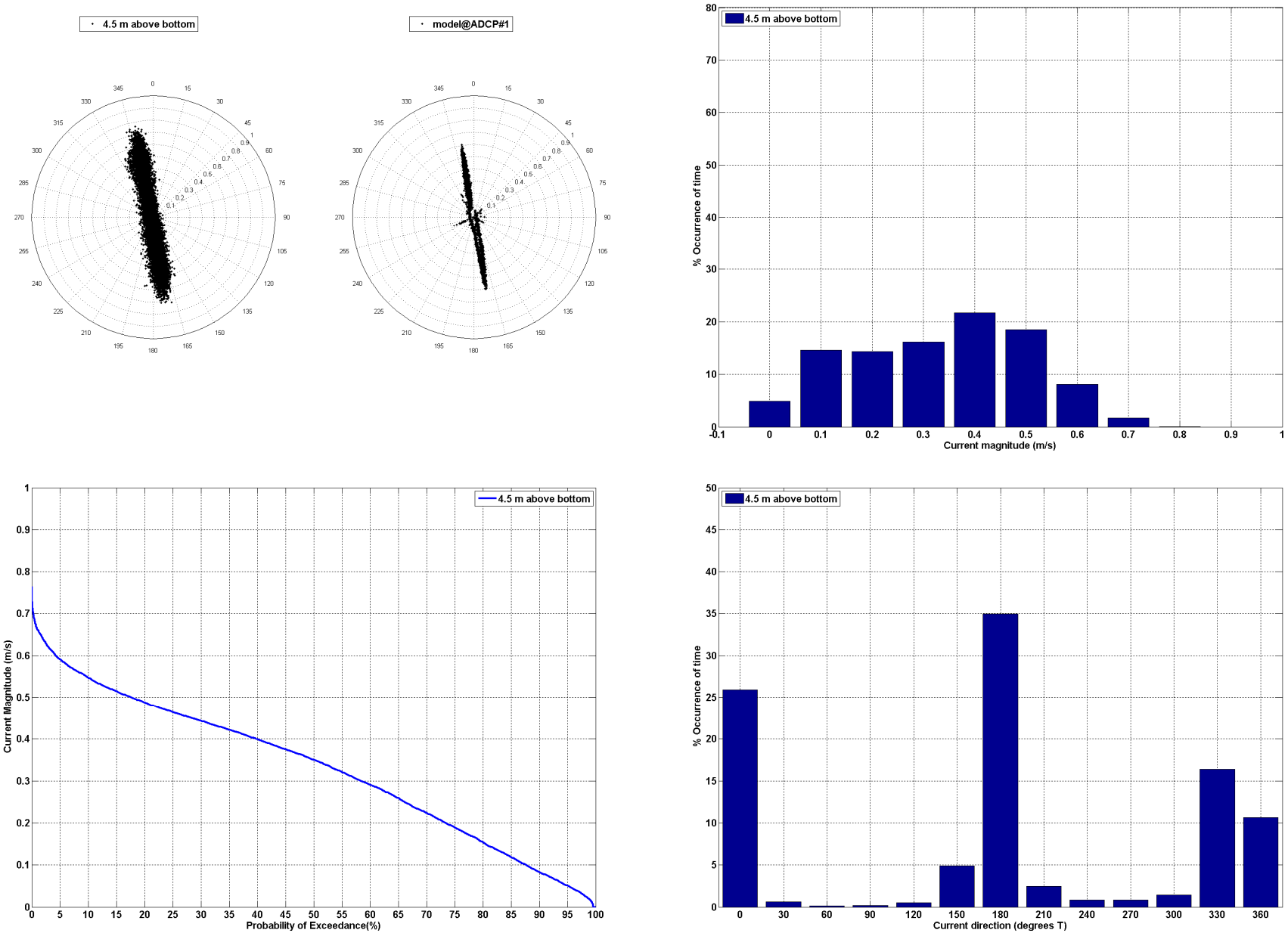



**Figure B-2g** ADCP #1 measurements **4.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

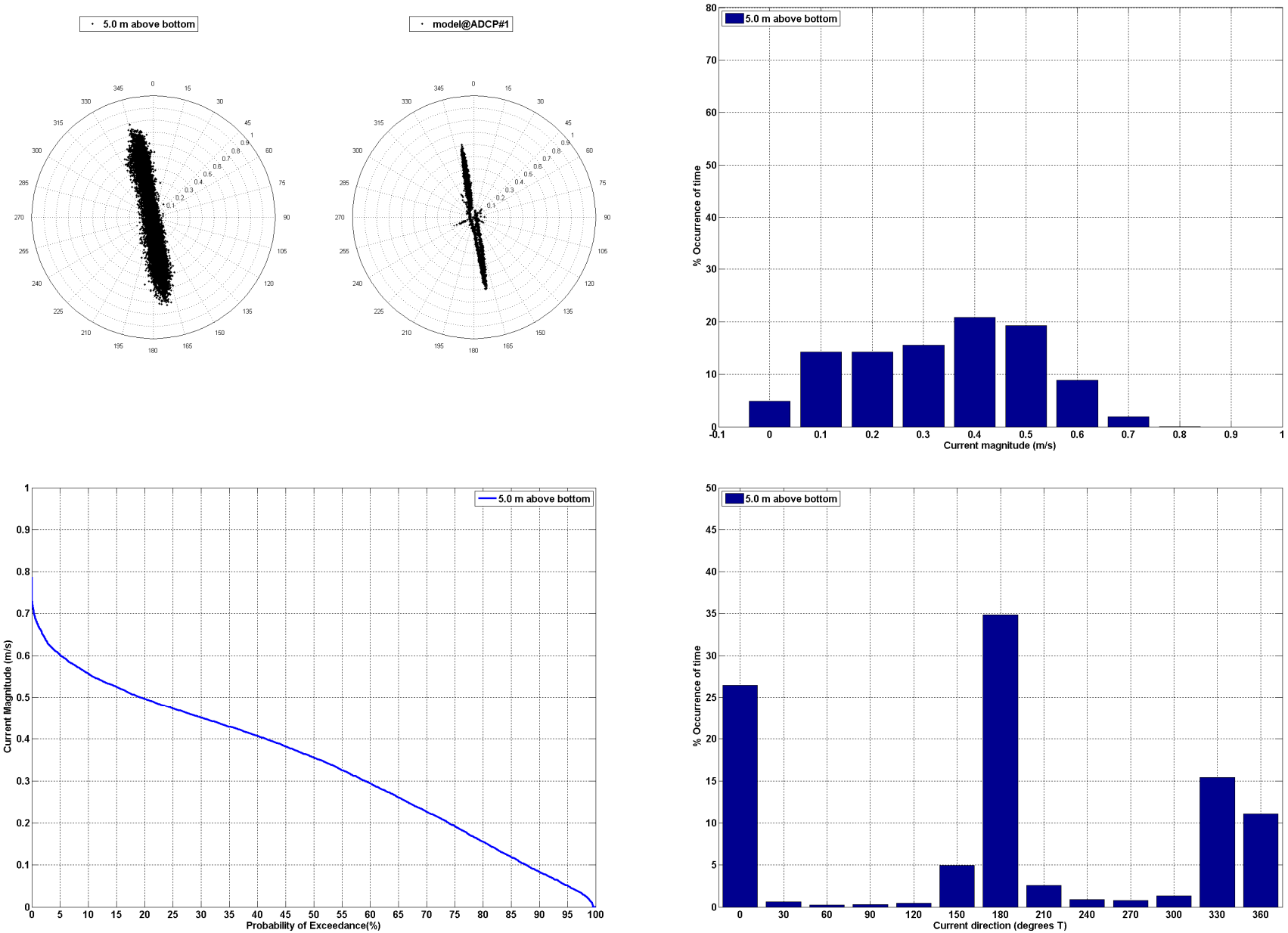



**Figure B-2h** ADCP #1 measurements **5.0** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

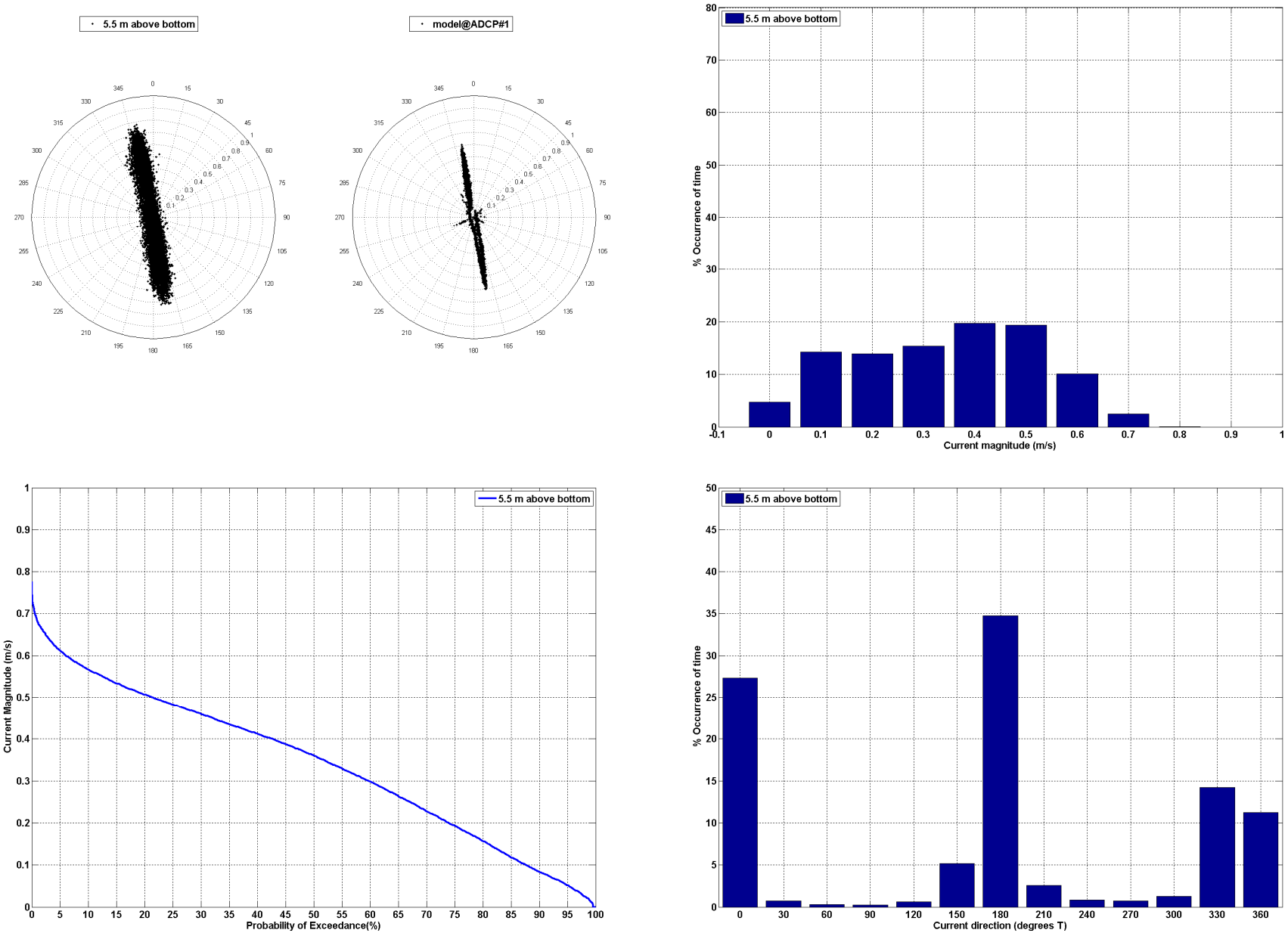



**Figure B-2i** ADCP #1 measurements **5.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

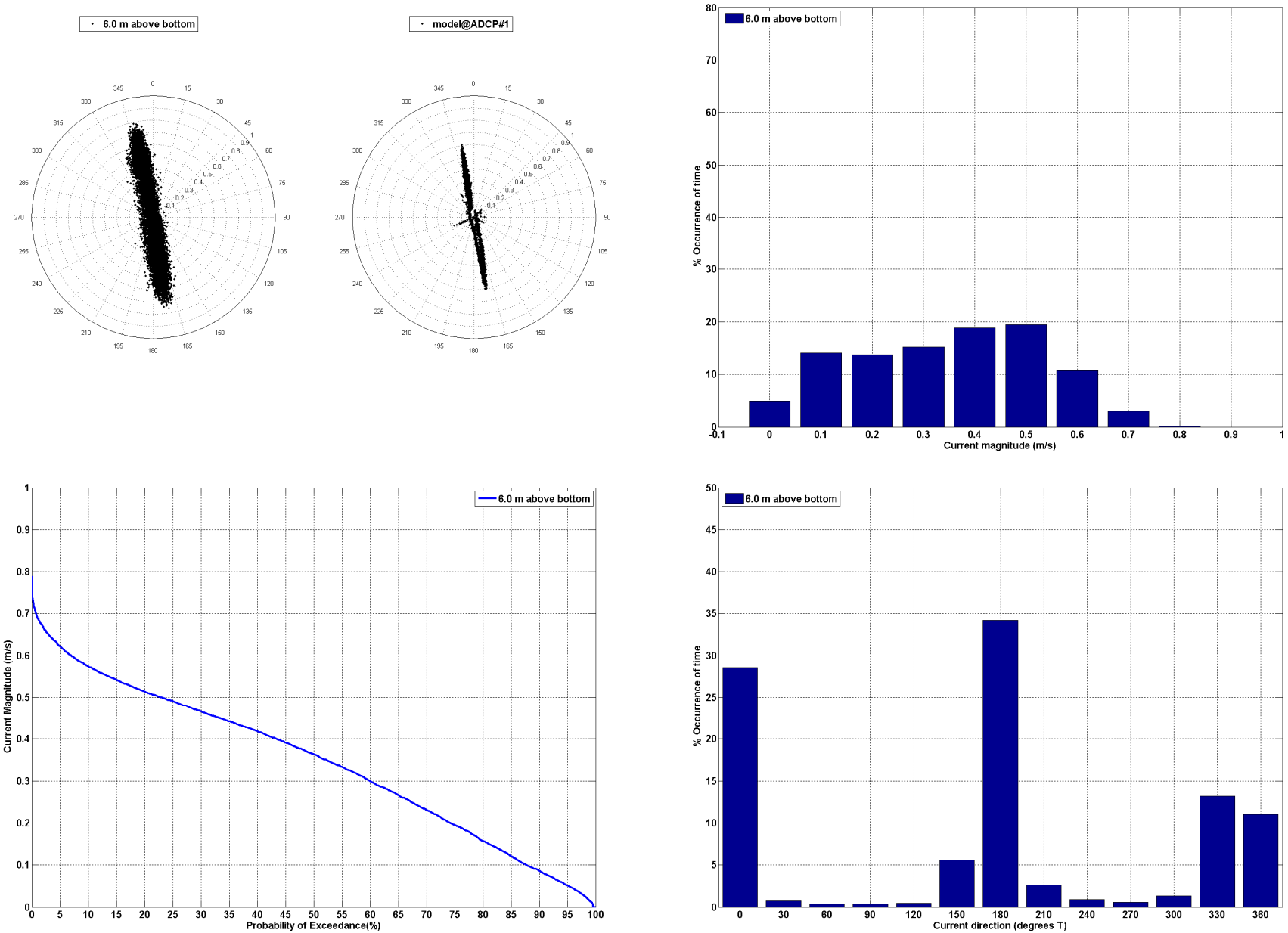



**Figure B-2j** ADCP #1 measurements **6.0** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

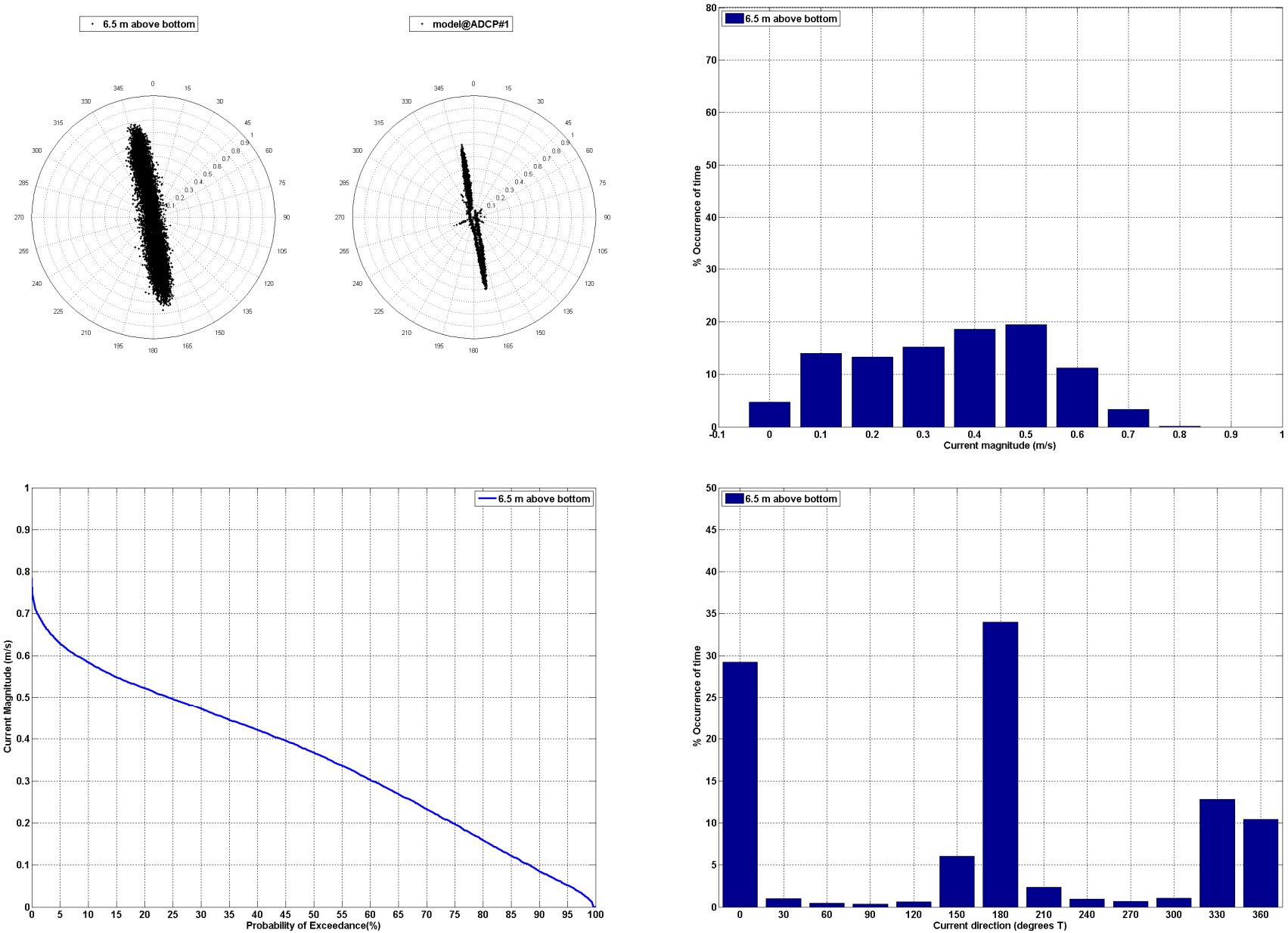



**Figure B-2k** ADCP #1 measurements **6.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

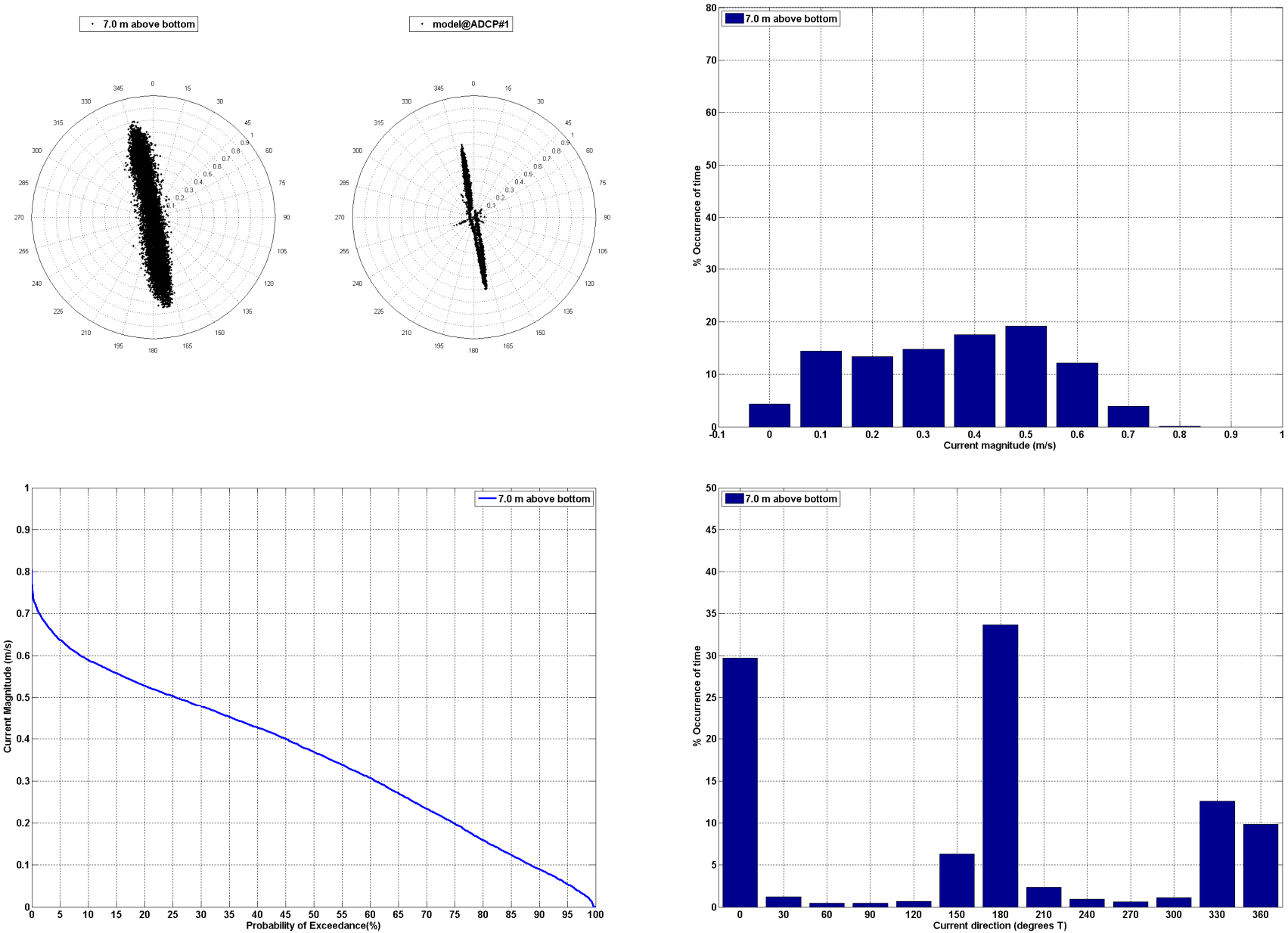



**Figure B-2l** ADCP #1 measurements **7.0** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

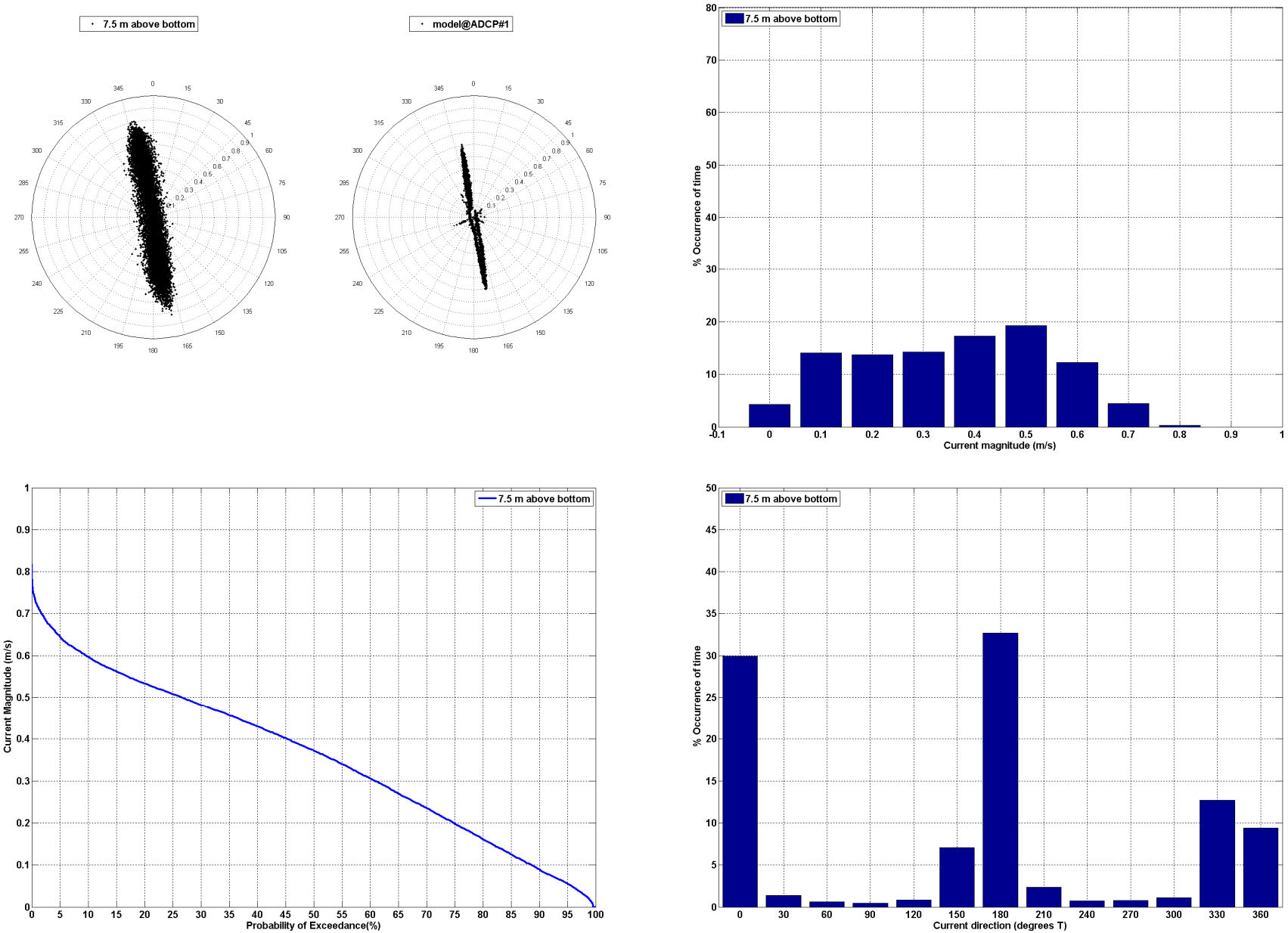



**Figure B-2m** ADCP #1 measurements **7.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

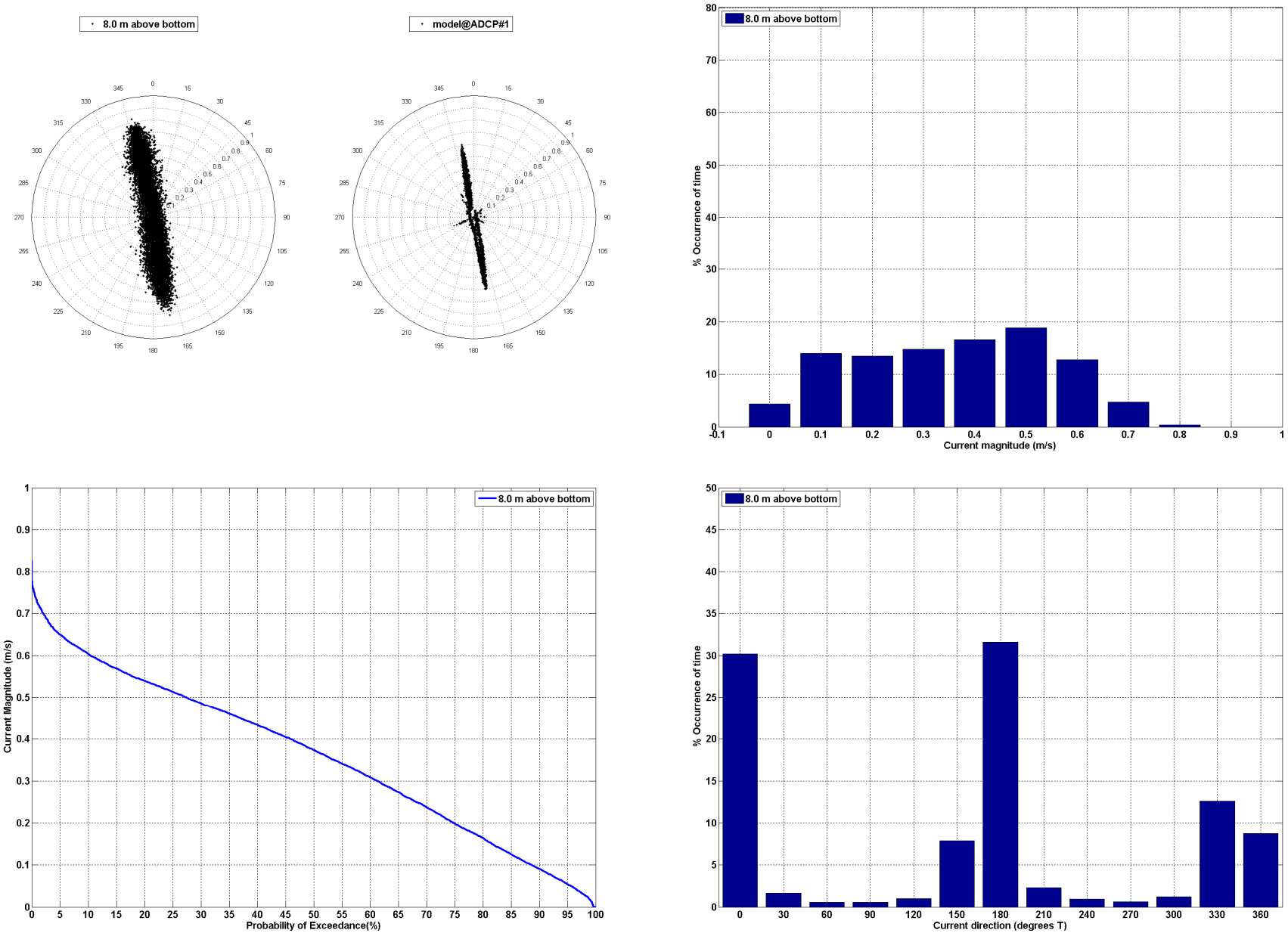



**Figure B-2n** ADCP #1 measurements **8.0** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

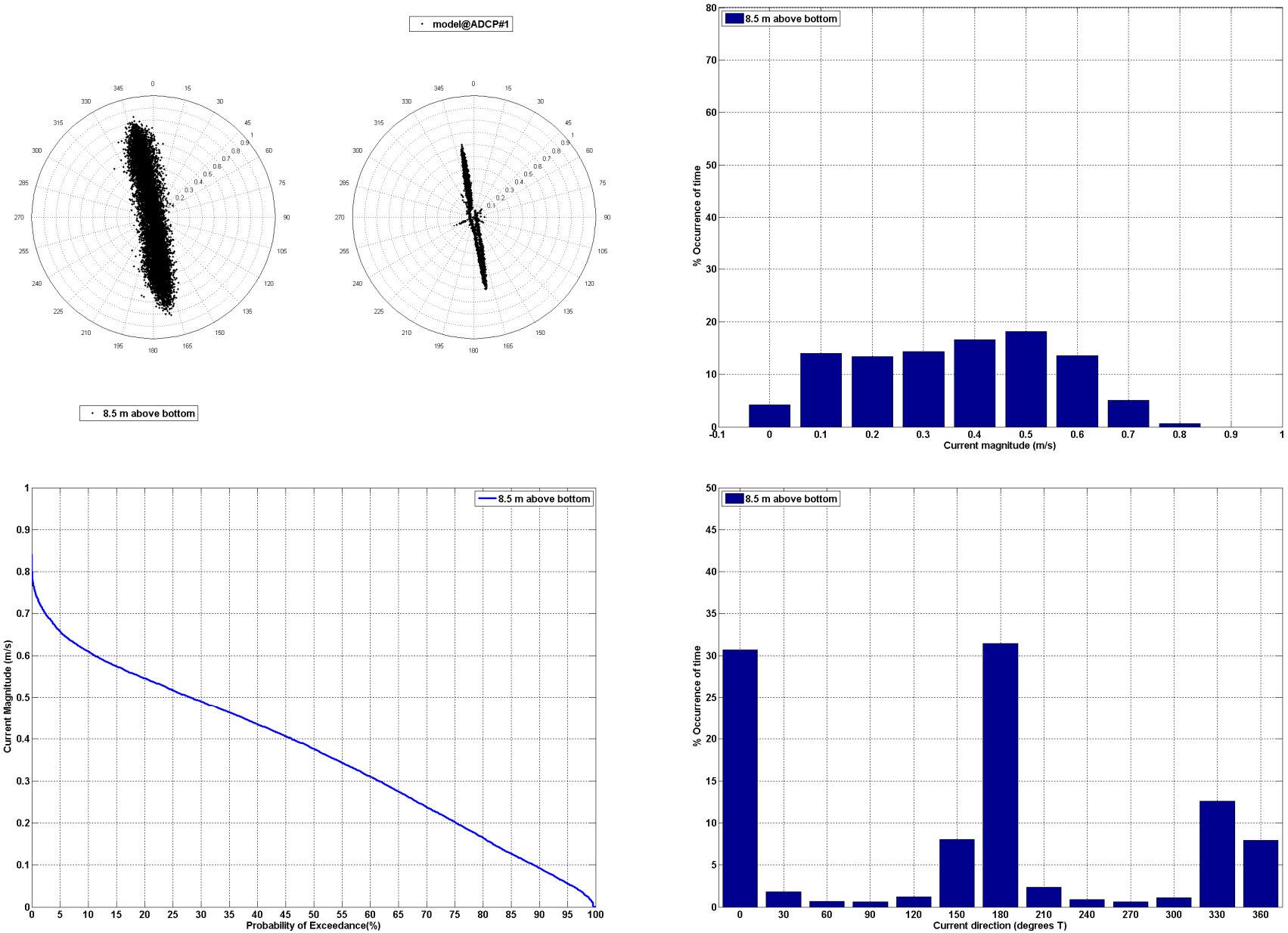



**Figure B-2o** ADCP #1 measurements **8.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

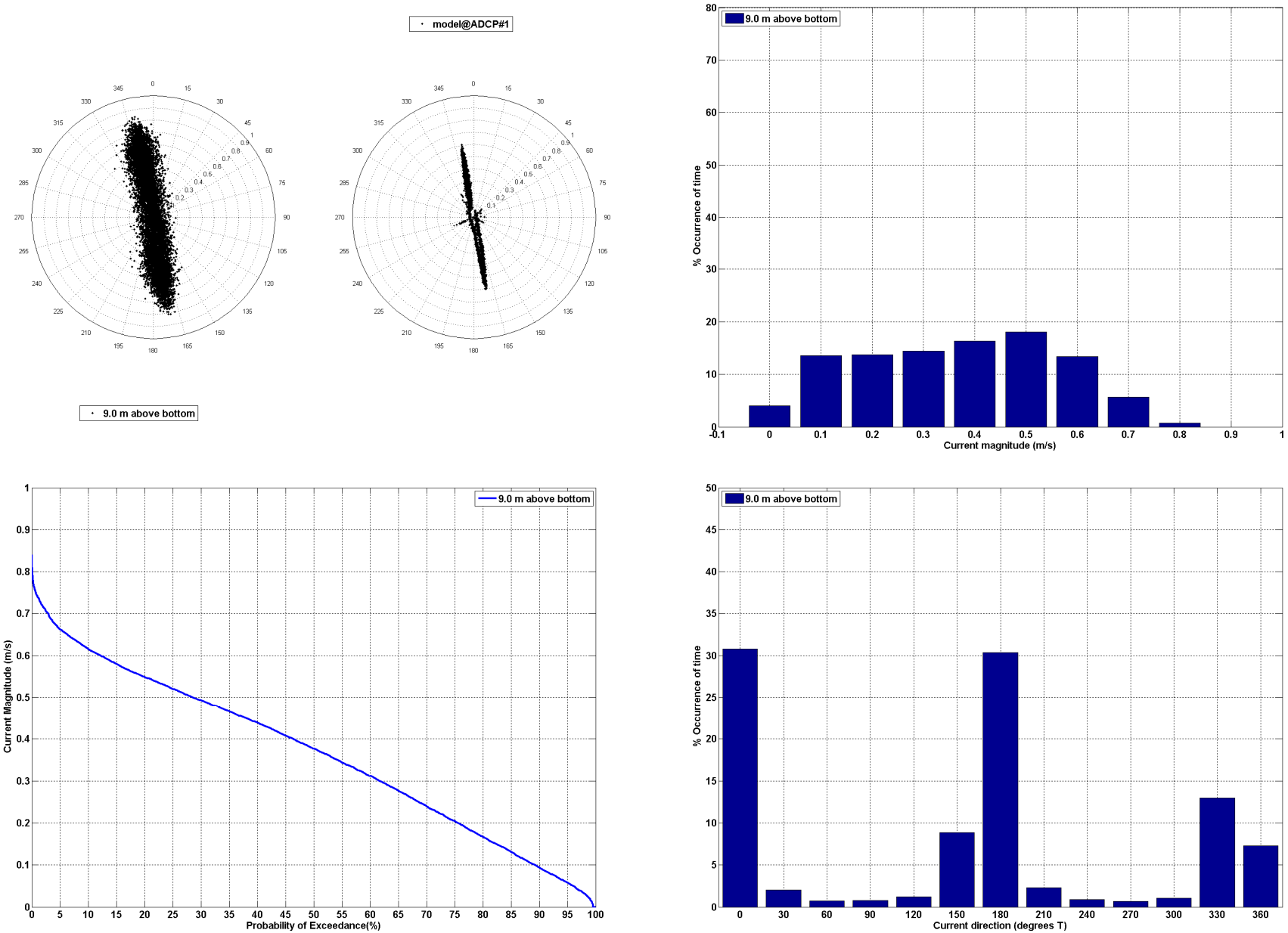



**Figure B-2p** ADCP #1 measurements **9.0** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

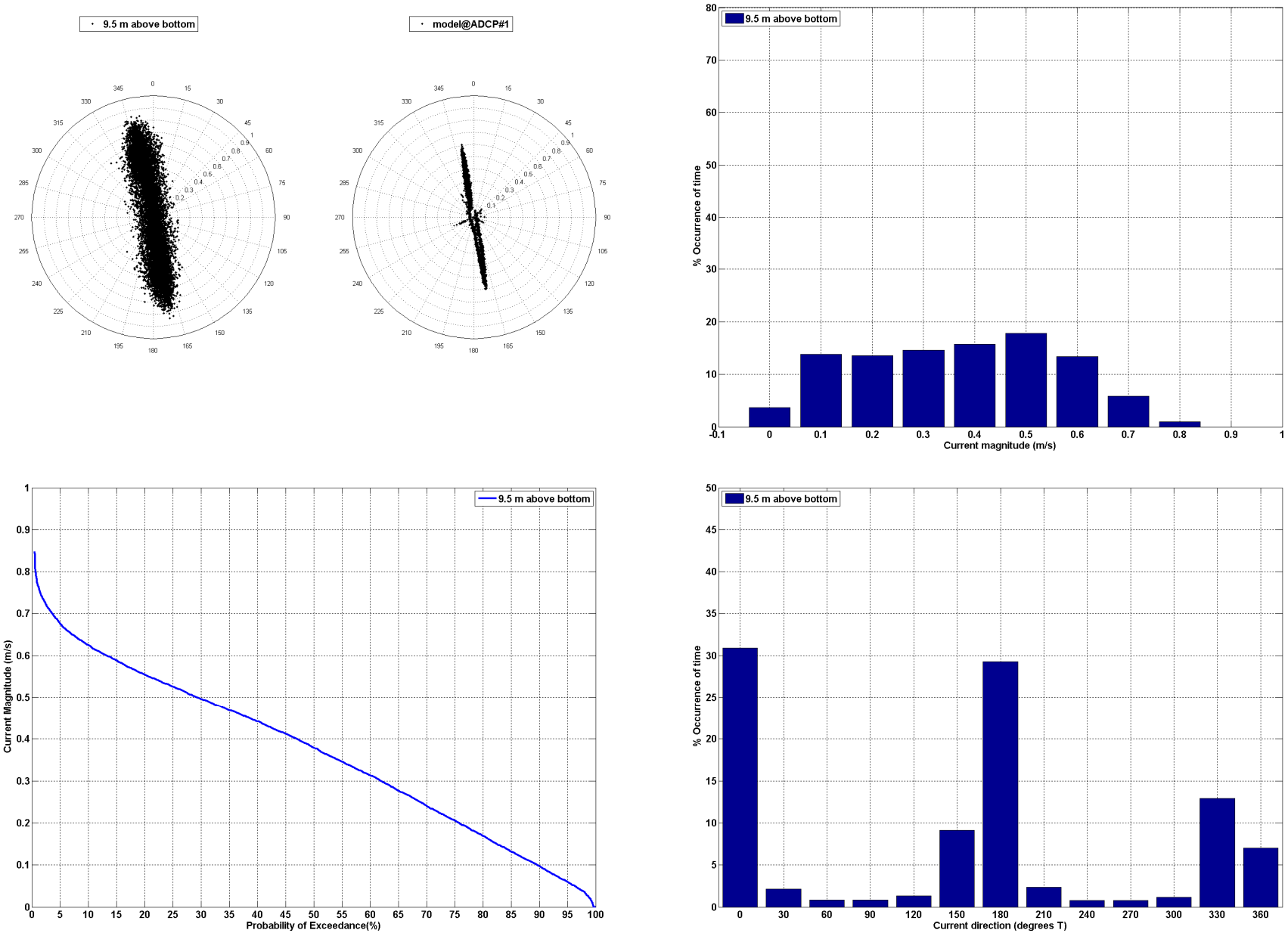



**Figure B-2q** ADCP #1 measurements **9.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

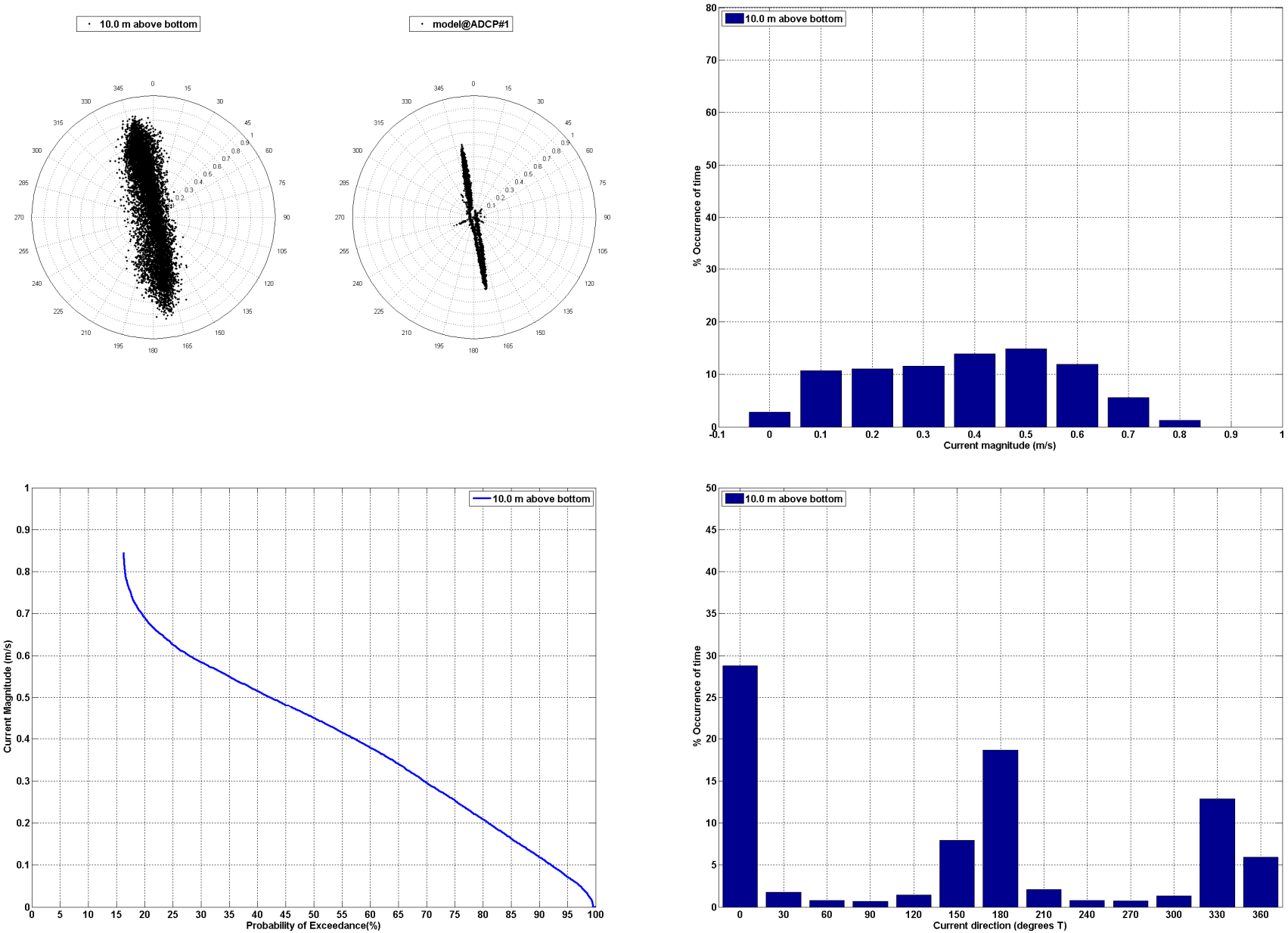



**Figure B-2r** ADCP #1 measurements **10.0** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

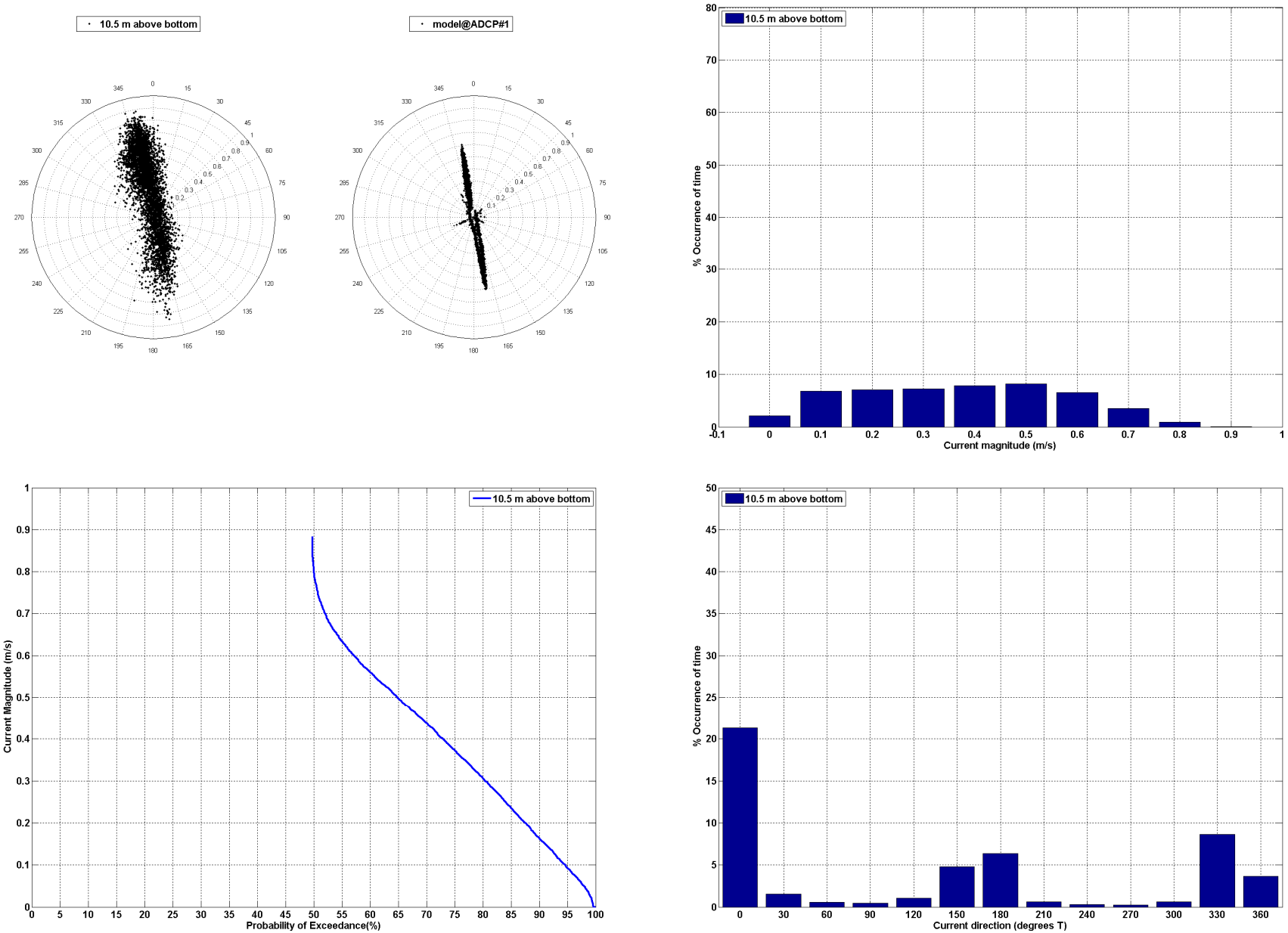



**Figure B-2s** ADCP #1 measurements **10.5** m above bottom: Polar plot of currents (top left), probability of exceedance (bottom left), histogram of current magnitude (top right) and histogram of current direction (bottom right).

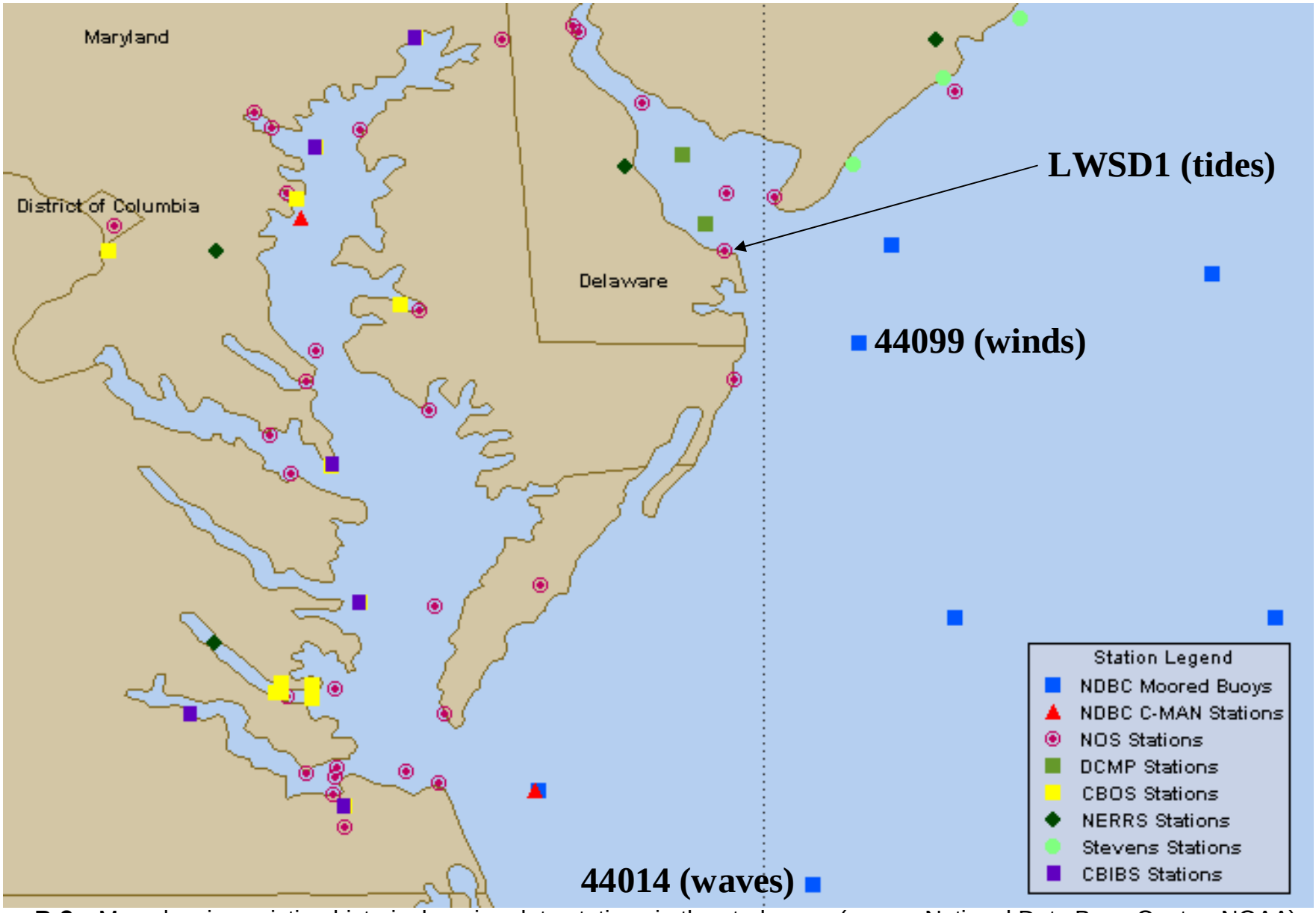



**Figure B-3** Map showing existing historical marine data stations in the study area (source National Data Buoy Center, NOAA). Project data (tides, winds and waves) has been sourced from the annotated stations.

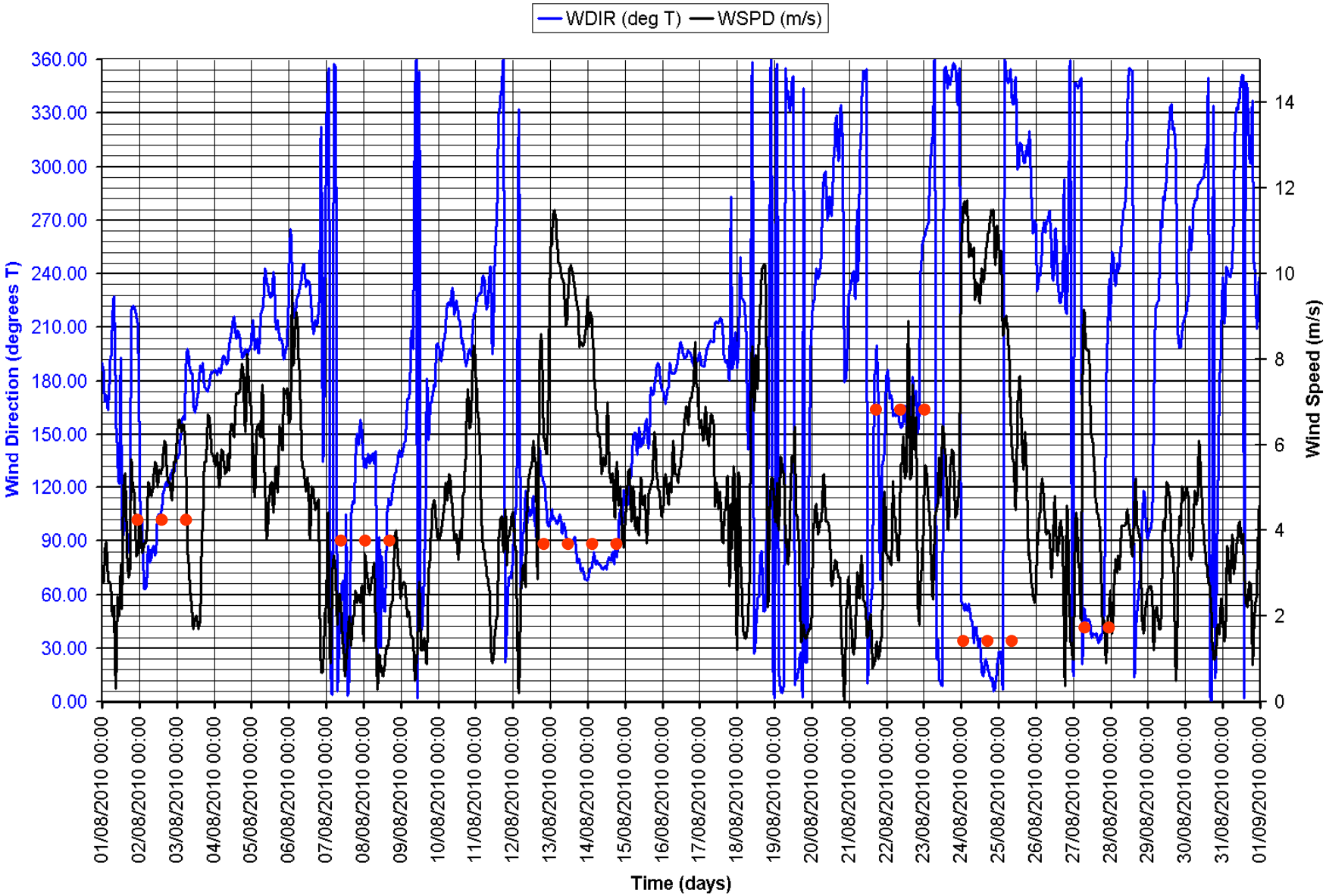



**Figure B-4a** Time histories of wind speed (black) and wind direction (blue) at station 44009 (LLNR 168) DELAWARE BAY 26 NM Southeast of Cape May, NJ for the month of August 2010.

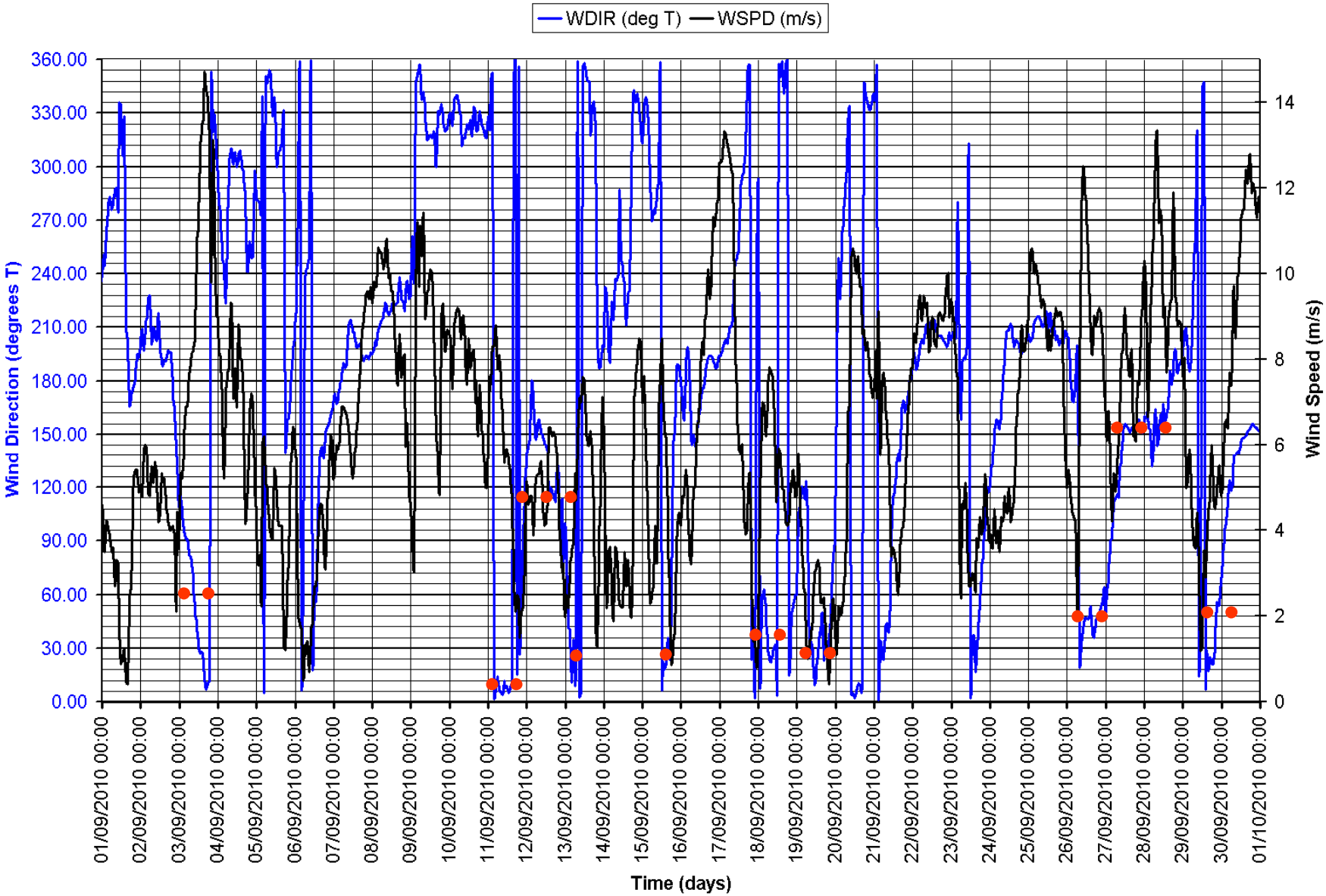



**Figure B-4b** Time histories of wind speed (black) and wind direction (blue) at station 44009 (LLNR 168) DELAWARE BAY 26 NM Southeast of Cape May, NJ for the month of September 2010.

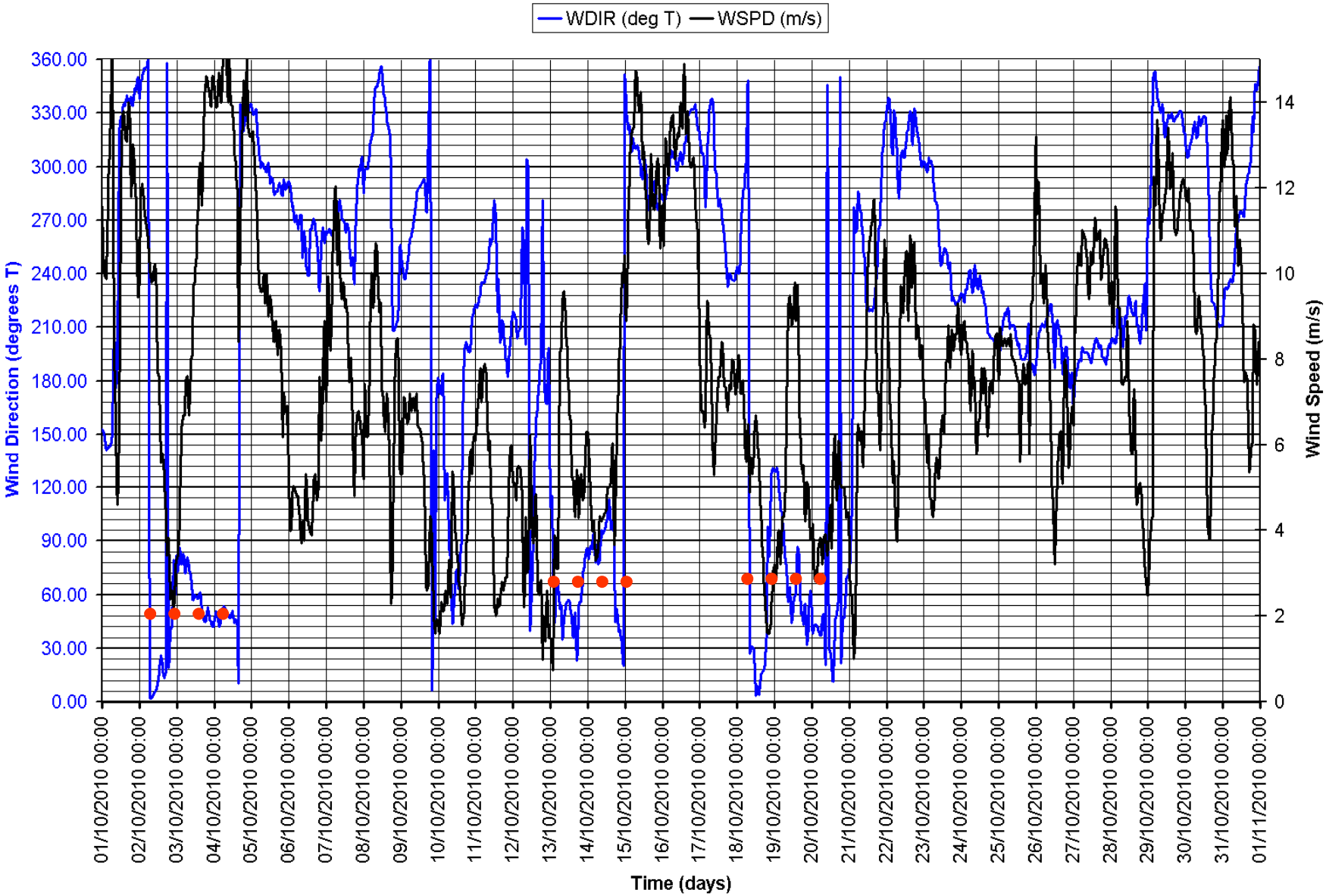



**Figure B-4c** Time histories of wind speed (black) and wind direction (blue) at station 44009 (LLNR 168) DELAWARE BAY 26 NM Southeast of Cape May, NJ for the month of October 2010.

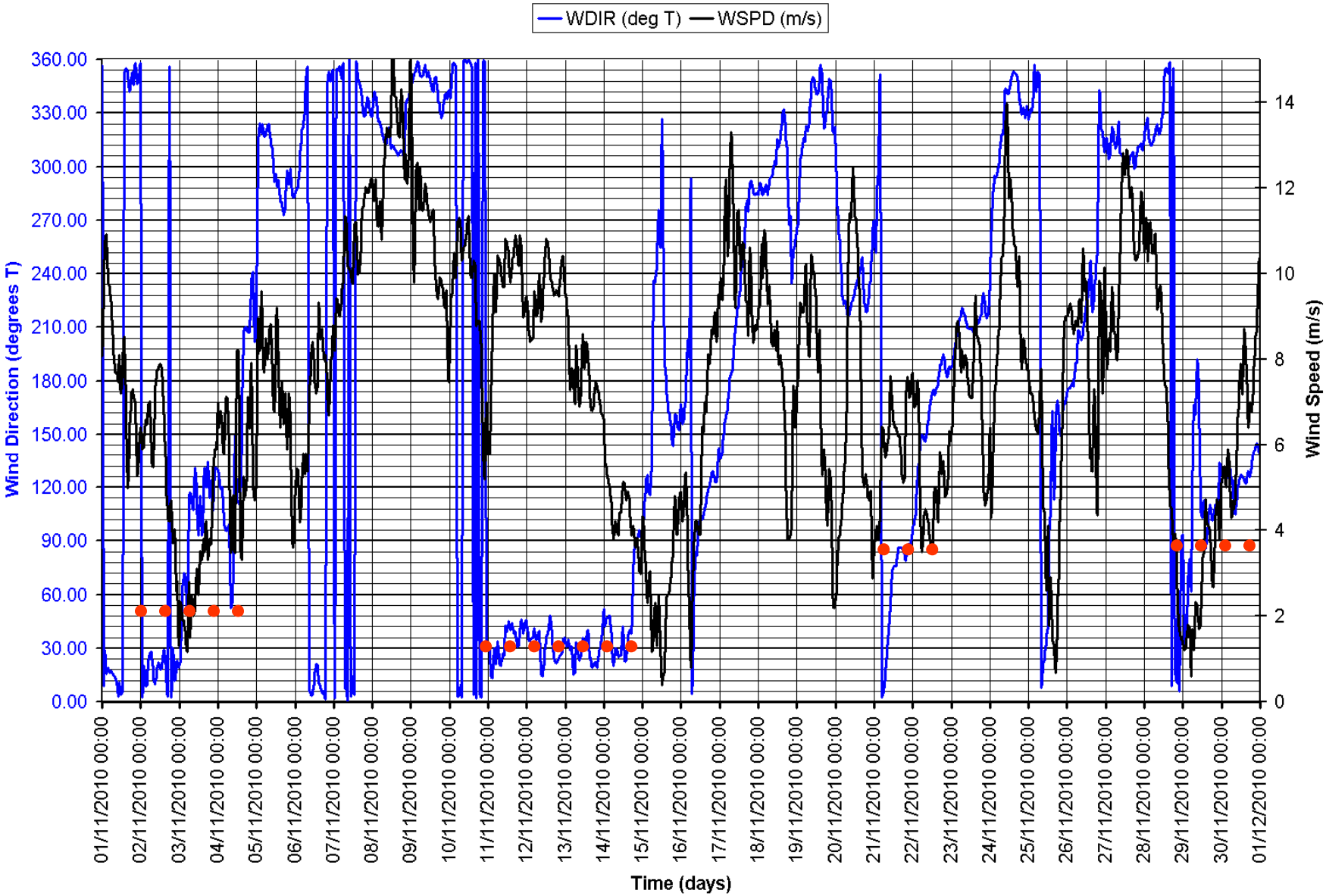



**Figure B-4d** Time histories of wind speed (black) and wind direction (blue) at station 44009 (LLNR 168) DELAWARE BAY 26 NM Southeast of Cape May, NJ for the month of November 2010.

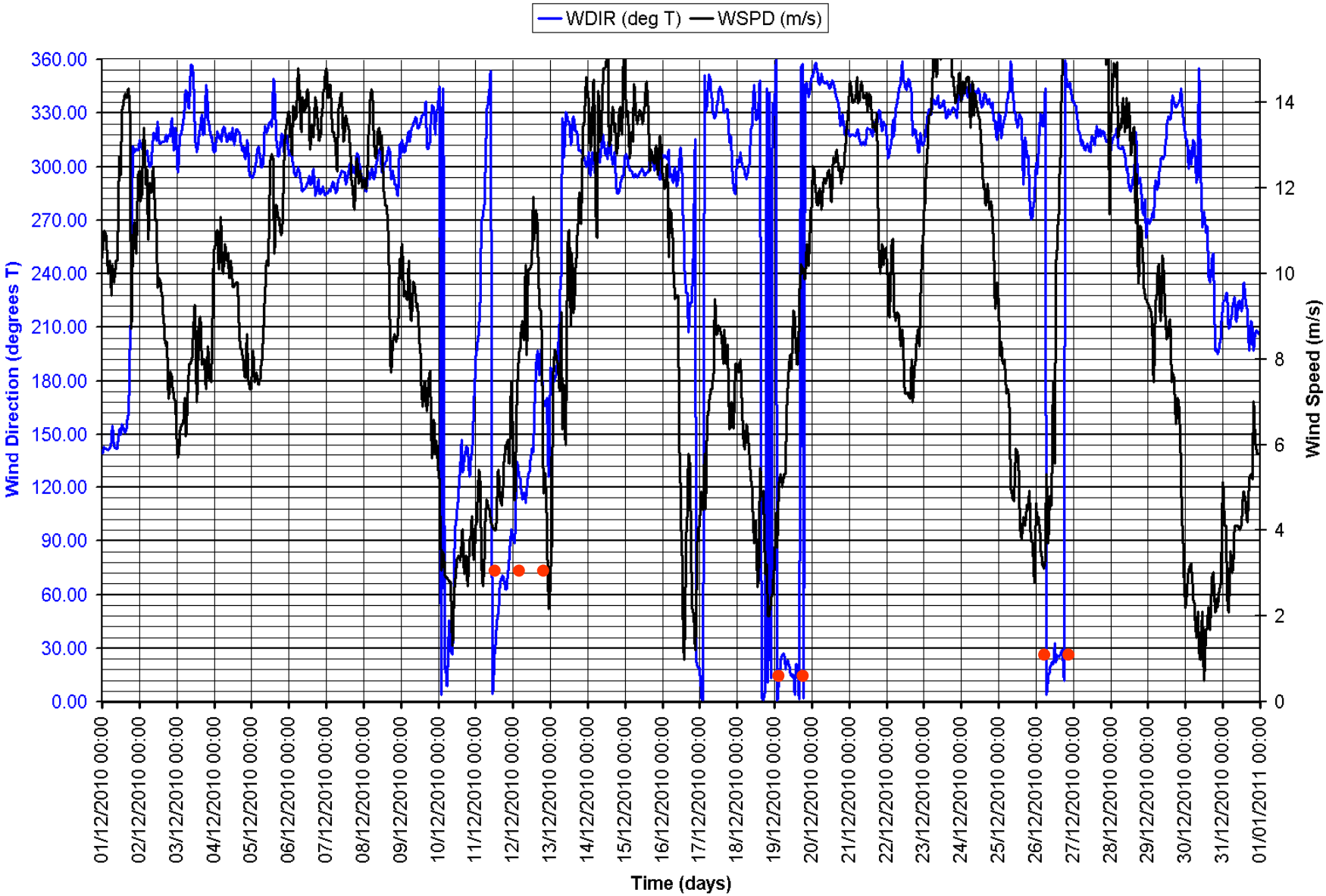
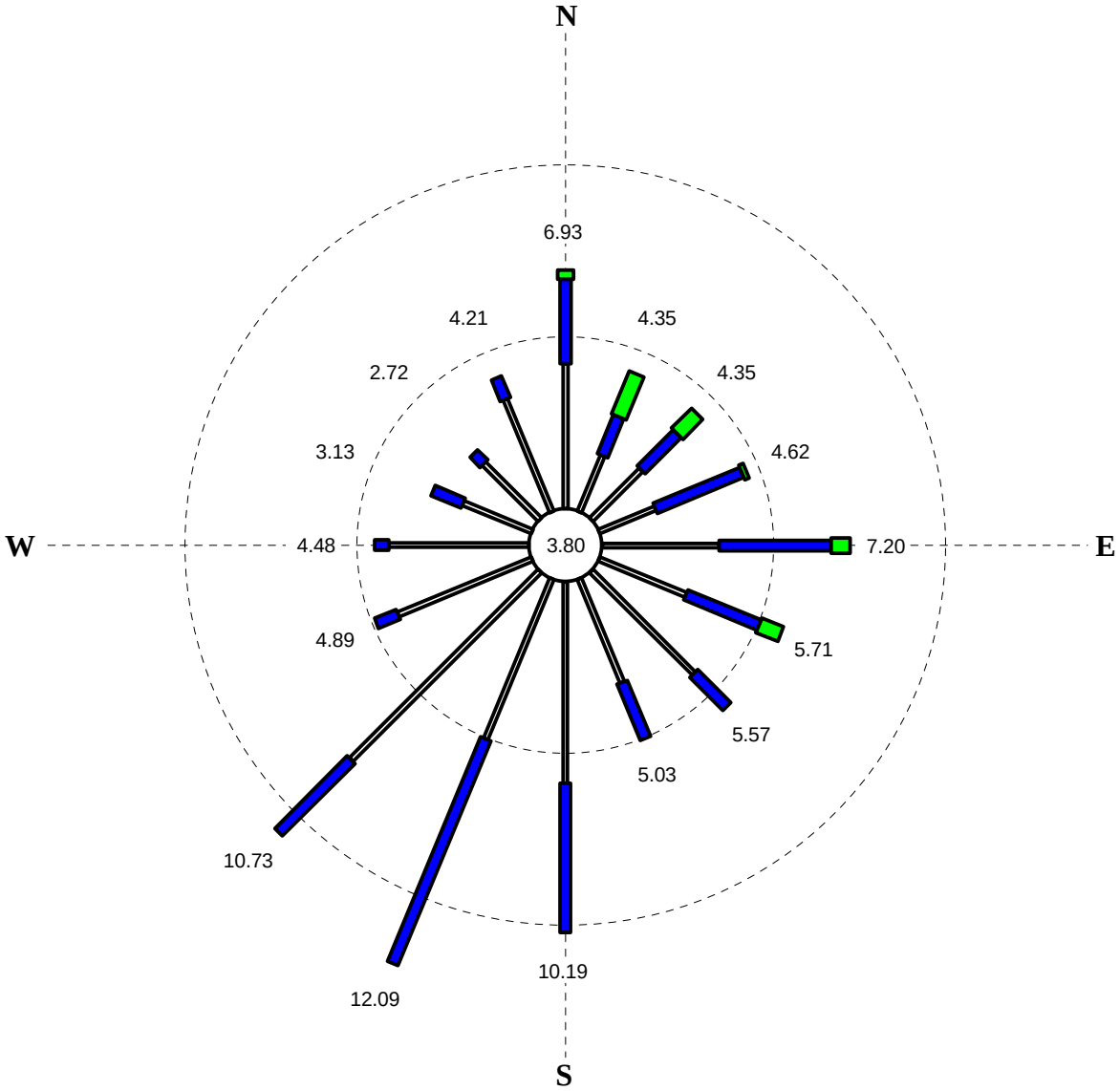
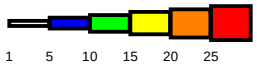



**Figure B-4e** Time histories of wind speed (black) and wind direction (blue) at station 44009 (LLNR 168) DELAWARE BAY 26 NM Southeast of Cape May, NJ for the month of December 2010.

# Joint Frequency Distribution
## For Raw Data File 44009Aug2010.csv




Wind Speed ( Meters Per Second)

Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| N | 4.21 | 2.45 | 0.27 | 0.00 | 0.00 | 0.00 |
| NNE | 1.77 | 1.22 | 1.36 | 0.00 | 0.00 | 0.00 |
| NE | 2.04 | 1.49 | 0.82 | 0.00 | 0.00 | 0.00 |
| ENE | 1.77 | 2.72 | 0.14 | 0.00 | 0.00 | 0.00 |
| E | 3.40 | 3.26 | 0.54 | 0.00 | 0.00 | 0.00 |
| ESE | 2.72 | 2.31 | 0.68 | 0.00 | 0.00 | 0.00 |
| SE | 4.21 | 1.36 | 0.00 | 0.00 | 0.00 | 0.00 |
| SSE | 3.26 | 1.77 | 0.00 | 0.00 | 0.00 | 0.00 |

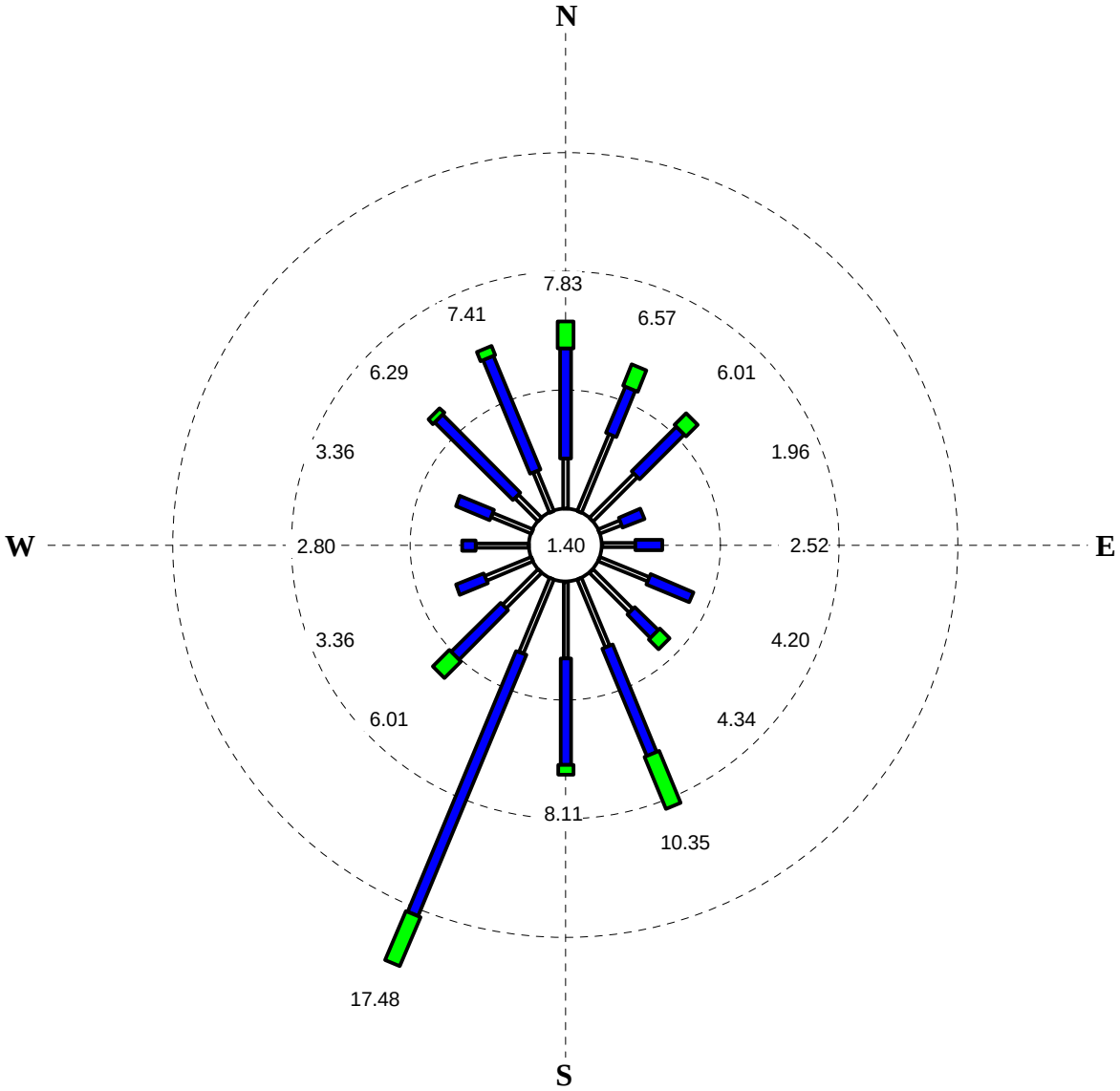
TOTAL OBS = 736 MISSING OBS = 0

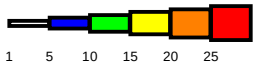
PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| S | 5.84 | 4.35 | 0.00 | 0.00 | 0.00 | 0.00 |
| SSW | 5.03 | 7.07 | 0.00 | 0.00 | 0.00 | 0.00 |
| SW | 7.74 | 2.99 | 0.00 | 0.00 | 0.00 | 0.00 |
| WSW | 4.21 | 0.68 | 0.00 | 0.00 | 0.00 | 0.00 |
| W | 4.08 | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 |
| WNW | 2.17 | 0.95 | 0.00 | 0.00 | 0.00 | 0.00 |
| NW | 2.31 | 0.41 | 0.00 | 0.00 | 0.00 | 0.00 |
| NNW | 3.53 | 0.68 | 0.00 | 0.00 | 0.00 | 0.00 |

CALM OBS = 28 PERCENT CALM = 3.80

# Joint Frequency Distribution
## For Raw Data File 44009Sept2010.csv




Wind Speed ( Meters Per Second)

Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| N | 2.10 | 4.62 | 1.12 | 0.00 | 0.00 | 0.00 |
| NNE | 3.50 | 2.10 | 0.98 | 0.00 | 0.00 | 0.00 |
| NE | 2.66 | 2.66 | 0.70 | 0.00 | 0.00 | 0.00 |
| ENE | 0.98 | 0.98 | 0.00 | 0.00 | 0.00 | 0.00 |
| E | 1.40 | 1.12 | 0.00 | 0.00 | 0.00 | 0.00 |
| ESE | 2.24 | 1.96 | 0.00 | 0.00 | 0.00 | 0.00 |
| SE | 2.38 | 1.40 | 0.56 | 0.00 | 0.00 | 0.00 |
| SSE | 3.08 | 4.90 | 2.38 | 0.00 | 0.00 | 0.00 |

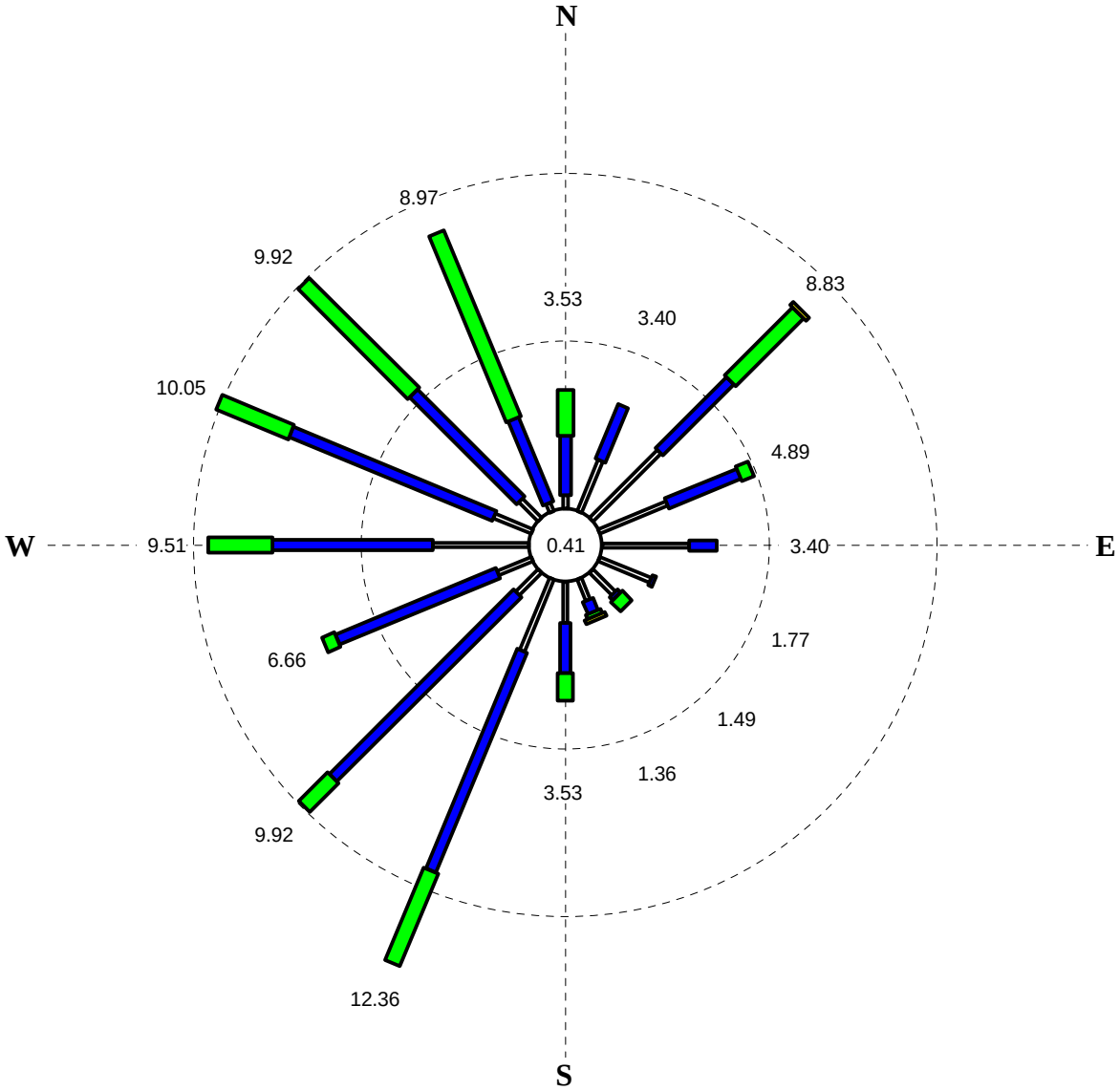
TOTAL OBS = 715 MISSING OBS = 0

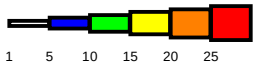
PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| S | 3.22 | 4.48 | 0.42 | 0.00 | 0.00 | 0.00 |
| SSW | 3.36 | 11.89 | 2.24 | 0.00 | 0.00 | 0.00 |
| SW | 2.10 | 2.94 | 0.98 | 0.00 | 0.00 | 0.00 |
| WSW | 2.10 | 1.26 | 0.00 | 0.00 | 0.00 | 0.00 |
| W | 2.24 | 0.56 | 0.00 | 0.00 | 0.00 | 0.00 |
| WNW | 1.82 | 1.54 | 0.00 | 0.00 | 0.00 | 0.00 |
| NW | 1.40 | 4.62 | 0.28 | 0.00 | 0.00 | 0.00 |
| NNW | 1.82 | 5.17 | 0.42 | 0.00 | 0.00 | 0.00 |

CALM OBS = 10 PERCENT CALM = 1.40

# Joint Frequency Distribution
## For Raw Data File 44009Oct2010.csv




Wind Speed ( Meters Per Second)

Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| N | 0.41 | 1.77 | 1.36 | 0.00 | 0.00 | 0.00 |
| NNE | 1.63 | 1.77 | 0.00 | 0.00 | 0.00 | 0.00 |
| NE | 2.85 | 2.99 | 2.85 | 0.14 | 0.00 | 0.00 |
| ENE | 2.17 | 2.31 | 0.41 | 0.00 | 0.00 | 0.00 |
| E | 2.58 | 0.82 | 0.00 | 0.00 | 0.00 | 0.00 |
| ESE | 1.63 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 |
| SE | 0.95 | 0.14 | 0.41 | 0.00 | 0.00 | 0.00 |
| SSE | 0.68 | 0.41 | 0.14 | 0.14 | 0.00 | 0.00 |

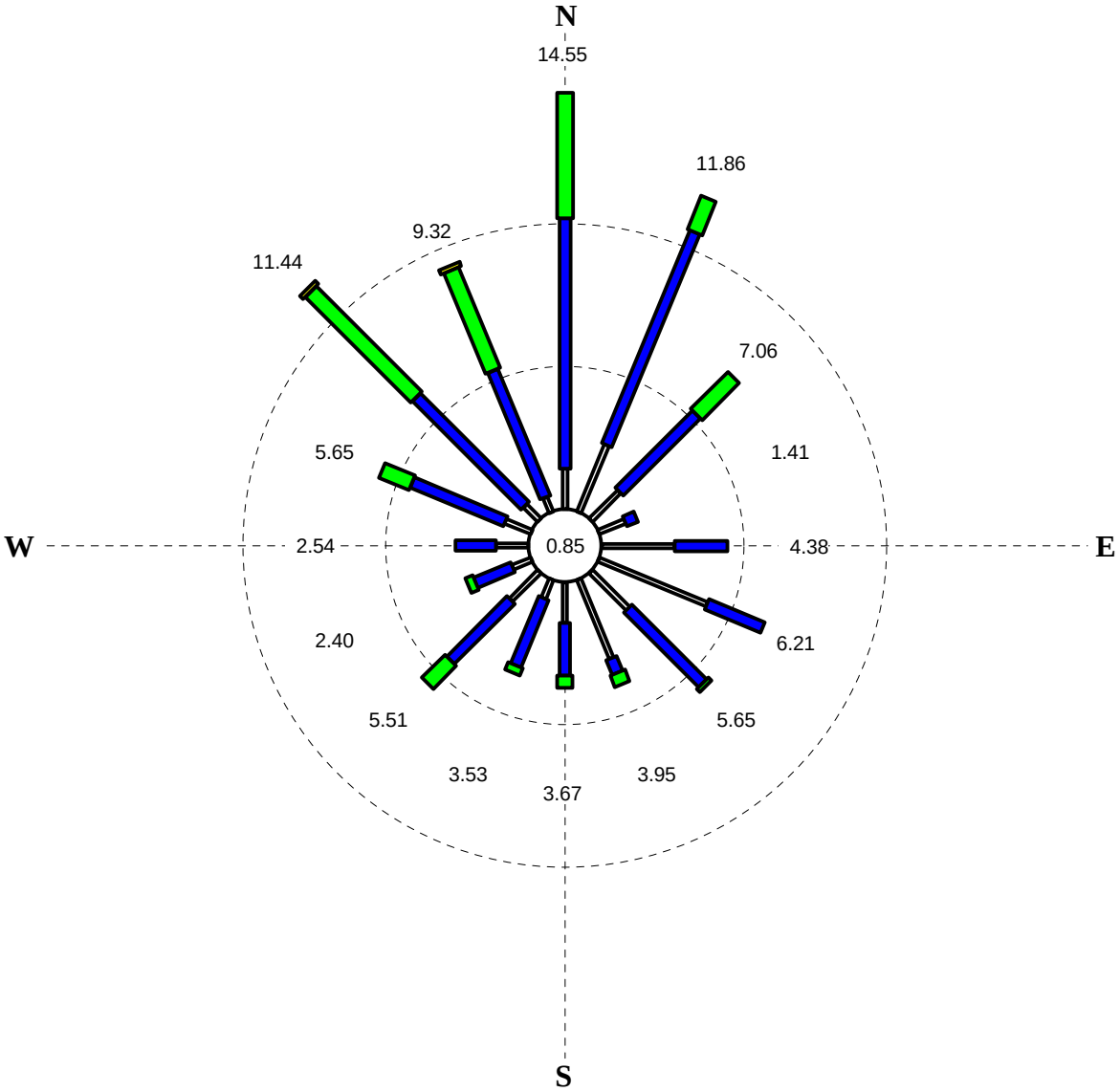
TOTAL OBS = 736 MISSING OBS = 0

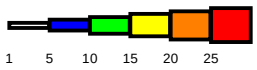
PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| S | 1.22 | 1.49 | 0.82 | 0.00 | 0.00 | 0.00 |
| SSW | 2.31 | 7.07 | 2.99 | 0.00 | 0.00 | 0.00 |
| SW | 0.95 | 7.74 | 1.22 | 0.00 | 0.00 | 0.00 |
| WSW | 1.09 | 5.16 | 0.41 | 0.00 | 0.00 | 0.00 |
| W | 2.85 | 4.76 | 1.90 | 0.00 | 0.00 | 0.00 |
| WNW | 1.22 | 6.52 | 2.31 | 0.00 | 0.00 | 0.00 |
| NW | 0.82 | 4.48 | 4.62 | 0.00 | 0.00 | 0.00 |
| NNW | 0.27 | 2.72 | 5.98 | 0.00 | 0.00 | 0.00 |

CALM OBS = 3 PERCENT CALM = 0.41

# Joint Frequency Distribution
## For Raw Data File 44009Nov2010.csv




Wind Speed ( Meters Per Second)

Calms included at center.
Rings drawn at 5% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| N | 1.41 | 8.76 | 4.38 | 0.00 | 0.00 | 0.00 |
| NNE | 2.54 | 8.05 | 1.27 | 0.00 | 0.00 | 0.00 |
| NE | 1.41 | 3.81 | 1.84 | 0.00 | 0.00 | 0.00 |
| ENE | 0.99 | 0.42 | 0.00 | 0.00 | 0.00 | 0.00 |
| E | 2.54 | 1.84 | 0.00 | 0.00 | 0.00 | 0.00 |
| ESE | 4.10 | 2.12 | 0.00 | 0.00 | 0.00 | 0.00 |
| SE | 1.84 | 3.67 | 0.14 | 0.00 | 0.00 | 0.00 |
| SSE | 2.97 | 0.56 | 0.42 | 0.00 | 0.00 | 0.00 |

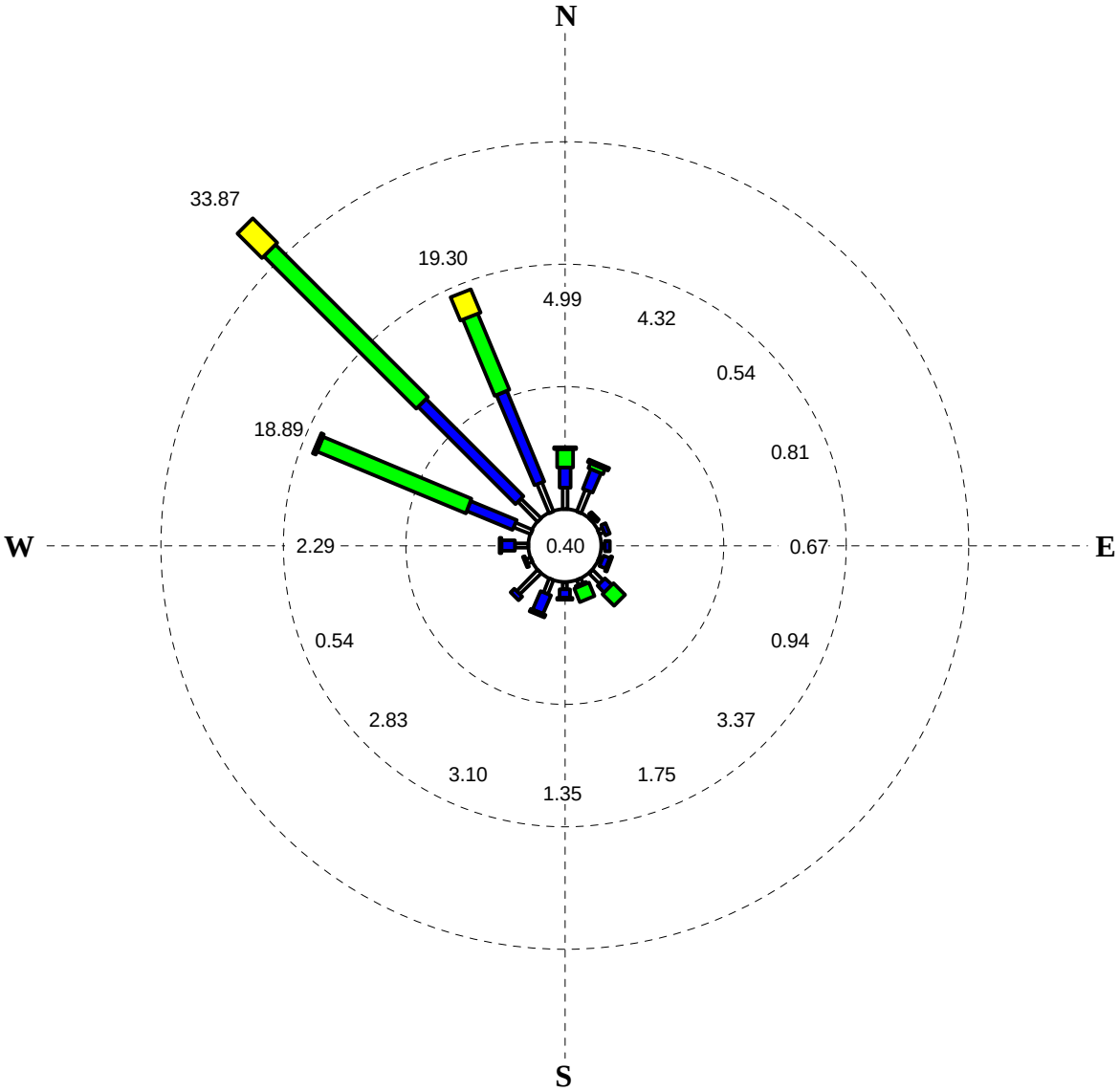
TOTAL OBS = 708 MISSING OBS = 0

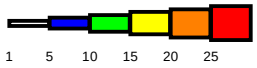
PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| S | 1.41 | 1.84 | 0.42 | 0.00 | 0.00 | 0.00 |
| SSW | 0.71 | 2.54 | 0.28 | 0.00 | 0.00 | 0.00 |
| SW | 1.41 | 2.97 | 1.13 | 0.00 | 0.00 | 0.00 |
| WSW | 0.71 | 1.41 | 0.28 | 0.00 | 0.00 | 0.00 |
| W | 1.13 | 1.41 | 0.00 | 0.00 | 0.00 | 0.00 |
| WNW | 0.99 | 3.53 | 1.13 | 0.00 | 0.00 | 0.00 |
| NW | 0.71 | 5.37 | 5.23 | 0.14 | 0.00 | 0.00 |
| NNW | 0.56 | 4.80 | 3.81 | 0.14 | 0.00 | 0.00 |

CALM OBS = 6 PERCENT CALM = 0.85

# Joint Frequency Distribution
## For Raw Data File 44009Dec2010.csv




Wind Speed ( Meters Per Second)

Calms included at center.
Rings drawn at 10% intervals.
Wind flow is FROM the directions shown.
No observations were missing.

PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| N | 1.75 | 1.62 | 1.48 | 0.14 | 0.00 | 0.00 |
| NNE | 1.89 | 1.75 | 0.40 | 0.27 | 0.00 | 0.00 |
| NE | 0.27 | 0.27 | 0.00 | 0.00 | 0.00 | 0.00 |
| ENE | 0.40 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 |
| E | 0.27 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 |
| ESE | 0.27 | 0.54 | 0.14 | 0.00 | 0.00 | 0.00 |
| SE | 1.21 | 0.81 | 1.35 | 0.00 | 0.00 | 0.00 |
| SSE | 0.40 | 0.14 | 1.21 | 0.00 | 0.00 | 0.00 |

TOTAL OBS = 741 MISSING OBS = 0

PERCENT OCCURRENCE: Wind Speed ( Meters Per Second)
LOWER BOUND OF CATEGORY

| DIR | 1 | 5 | 10 | 15 | 20 | 25 |
|---|---|---|---|---|---|---|
| S | 0.54 | 0.67 | 0.14 | 0.00 | 0.00 | 0.00 |
| SSW | 1.21 | 1.62 | 0.27 | 0.00 | 0.00 | 0.00 |
| SW | 2.43 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 |
| WSW | 0.40 | 0.14 | 0.00 | 0.00 | 0.00 | 0.00 |
| W | 1.08 | 1.08 | 0.14 | 0.00 | 0.00 | 0.00 |
| WNW | 1.48 | 4.05 | 13.09 | 0.27 | 0.00 | 0.00 |
| NW | 2.29 | 11.20 | 17.54 | 2.83 | 0.00 | 0.00 |
| NNW | 2.56 | 7.96 | 6.75 | 2.02 | 0.00 | 0.00 |

CALM OBS = 3 PERCENT CALM = 0.40

Appendix C

# Model Calibration and Verification

Calibration to Tides

Verification to Major Driving Forces

Comparisons by NOAA

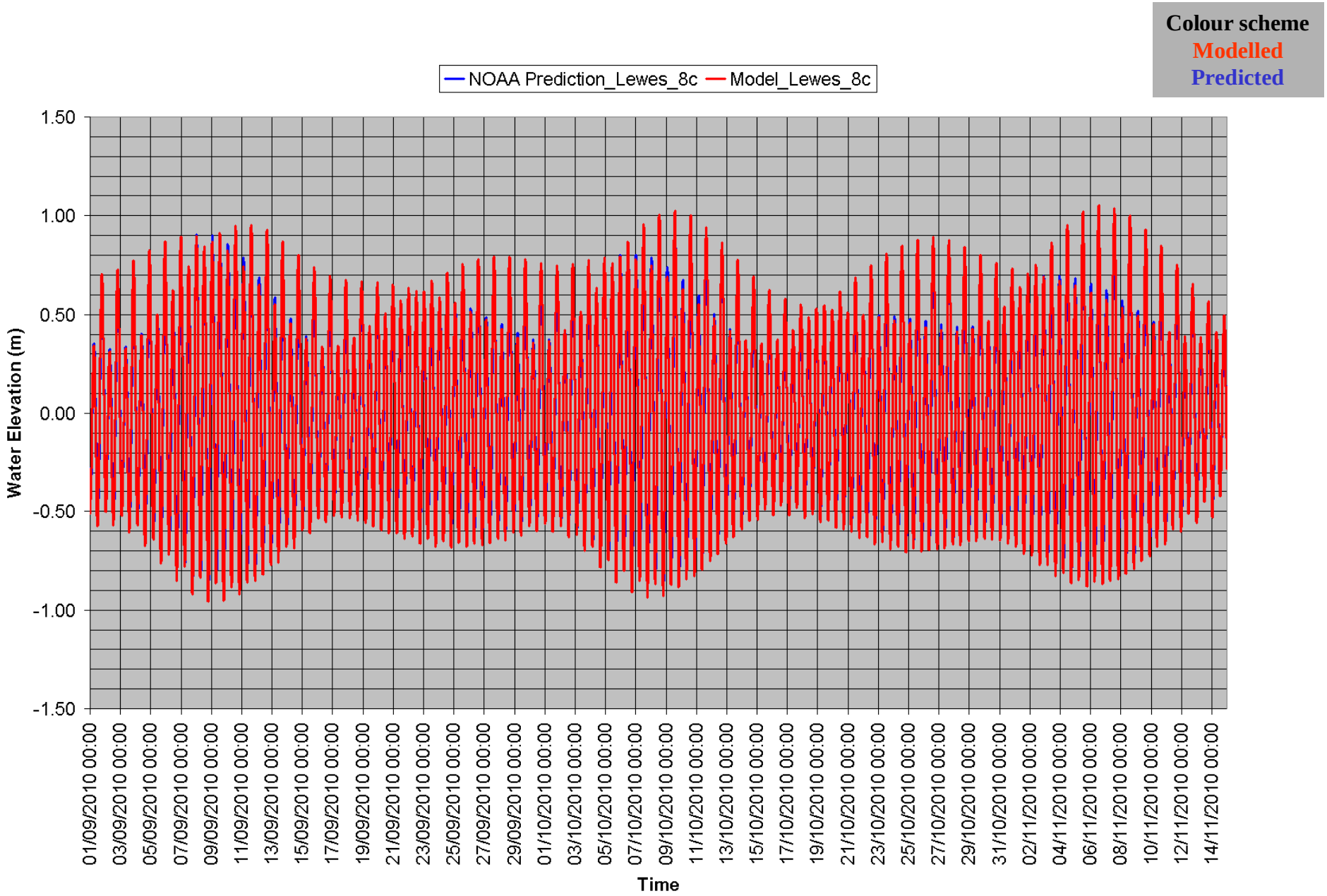



**Figure C-1** Model performance at **station Lewes** – predicted (blue) versus modelled (red) **water levels**. RMSE for the three-month simulation period =0.06 m. Prediction and simulation results based on the 8 major tidal constituents.

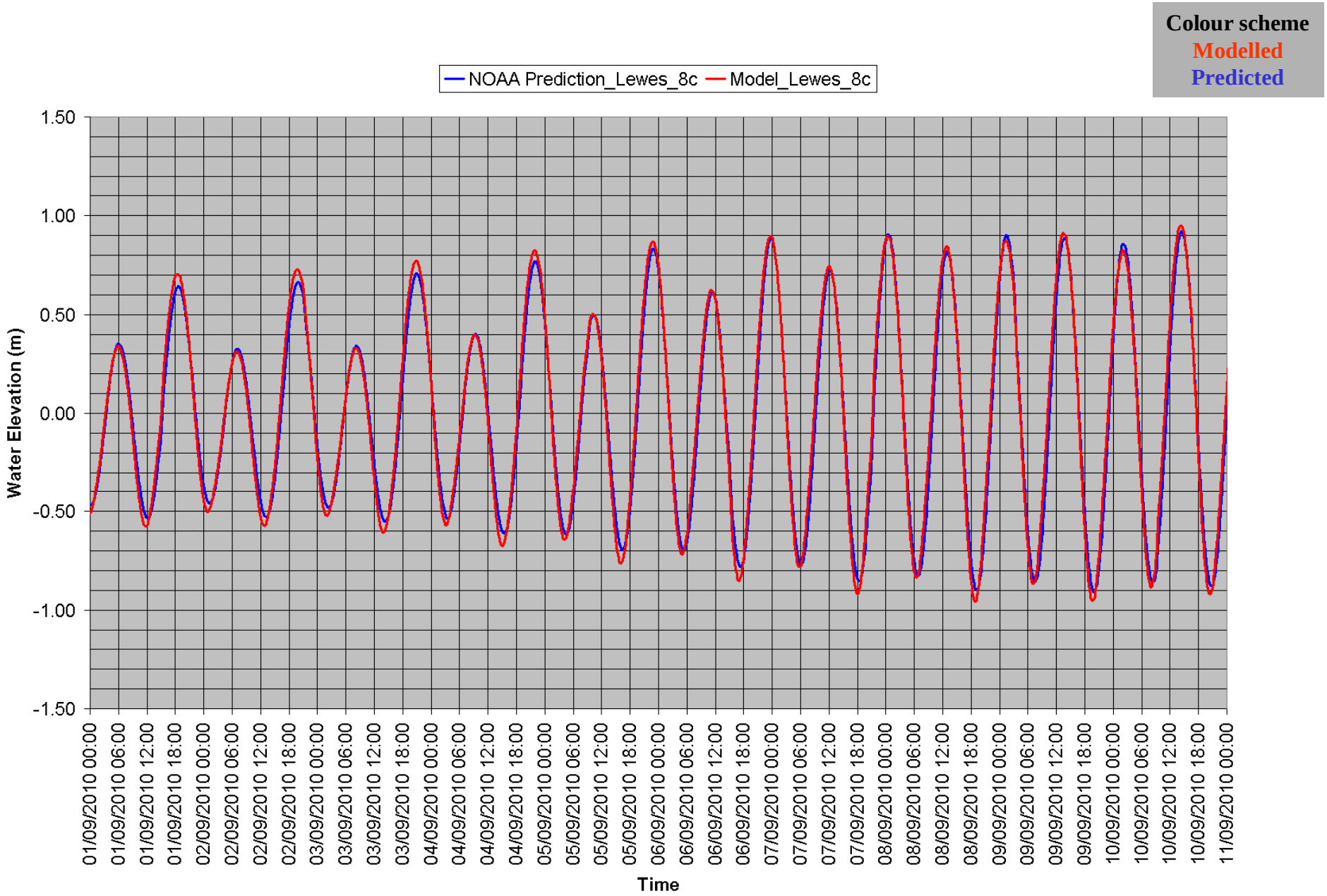



**Figure C-2** Model performance at **station Lewes** – detail view of predicted (blue) versus modelled (red) **water levels** over a period of 10 days.

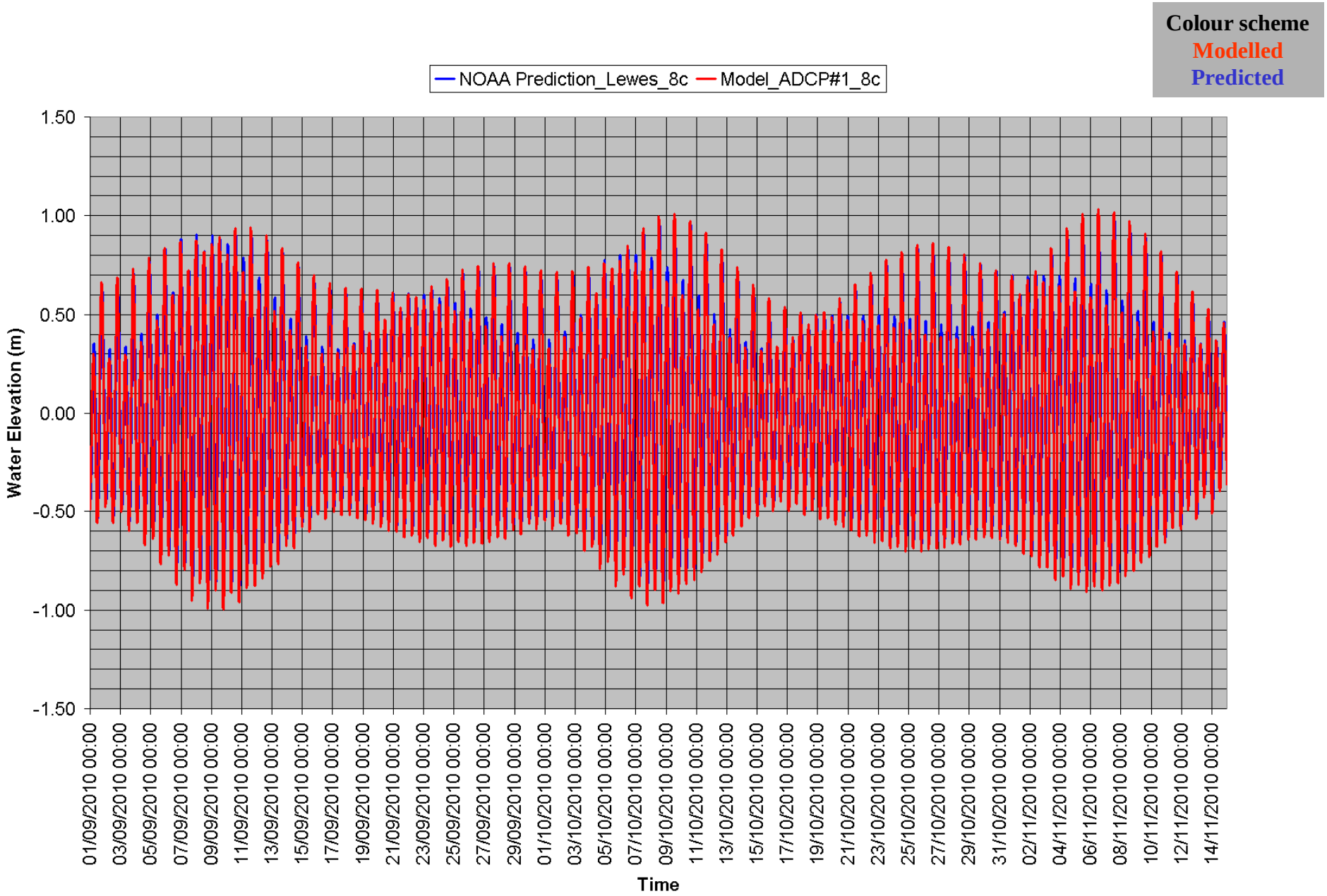



**Figure C-3** Model performance – comparison of predicted **water levels** at station Lewes (blue) versus modelled water levels (red) **at the site of deployment of ADCP#1**.

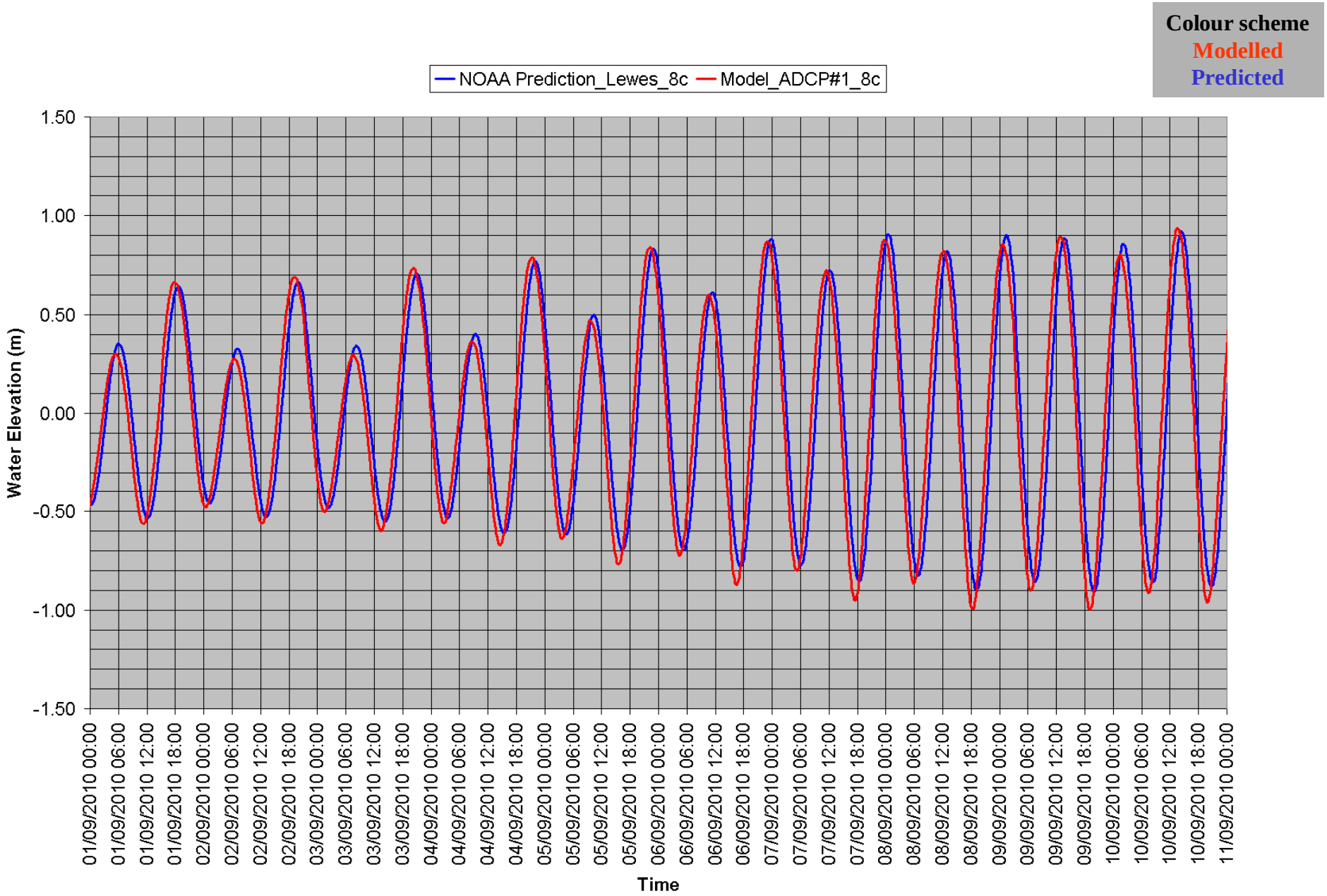



**Figure C-4** Model performance – detail view of predicted **water levels** at station Lewes (blue) versus modelled water levels (red) over a period of 10 days **at the site of deployment of ADCP#1**.

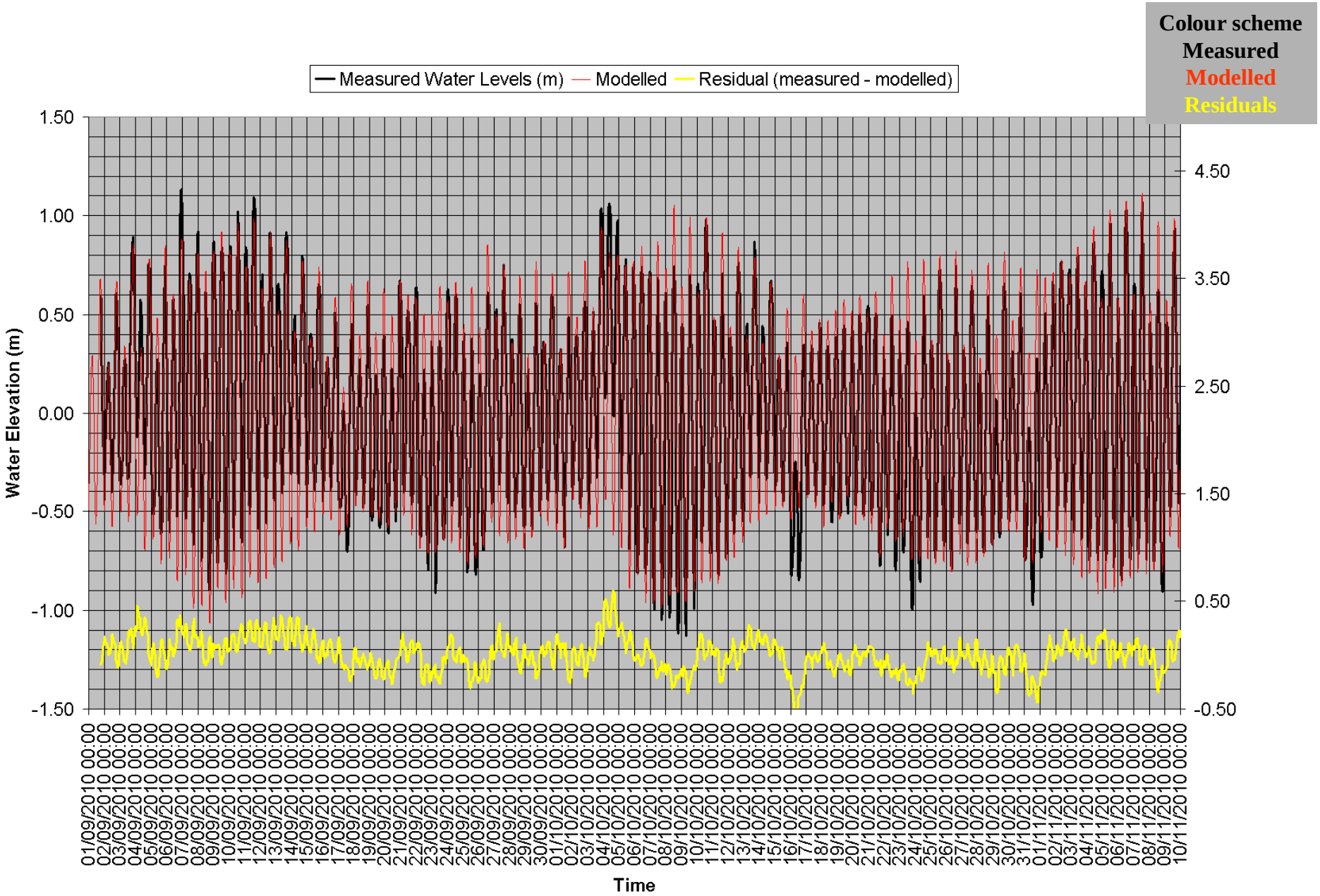



**Figure C-5** Comparison of measured (black solid line) versus modelled (red solid line) water levels at the site of ADCP #1. Model driven by the tide, winds, freshwater inflows and waves. Residuals could reach ± 0.5 m.

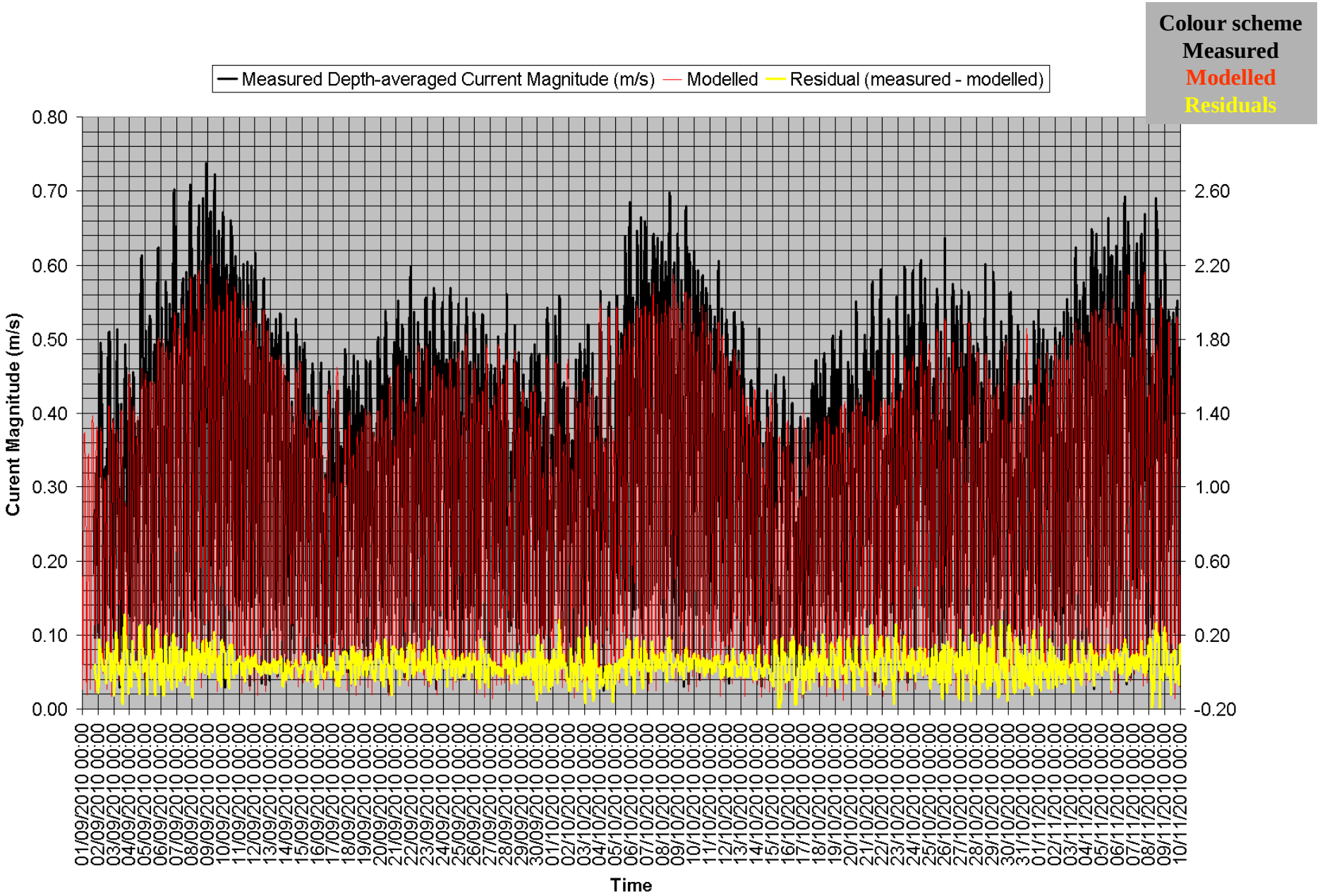
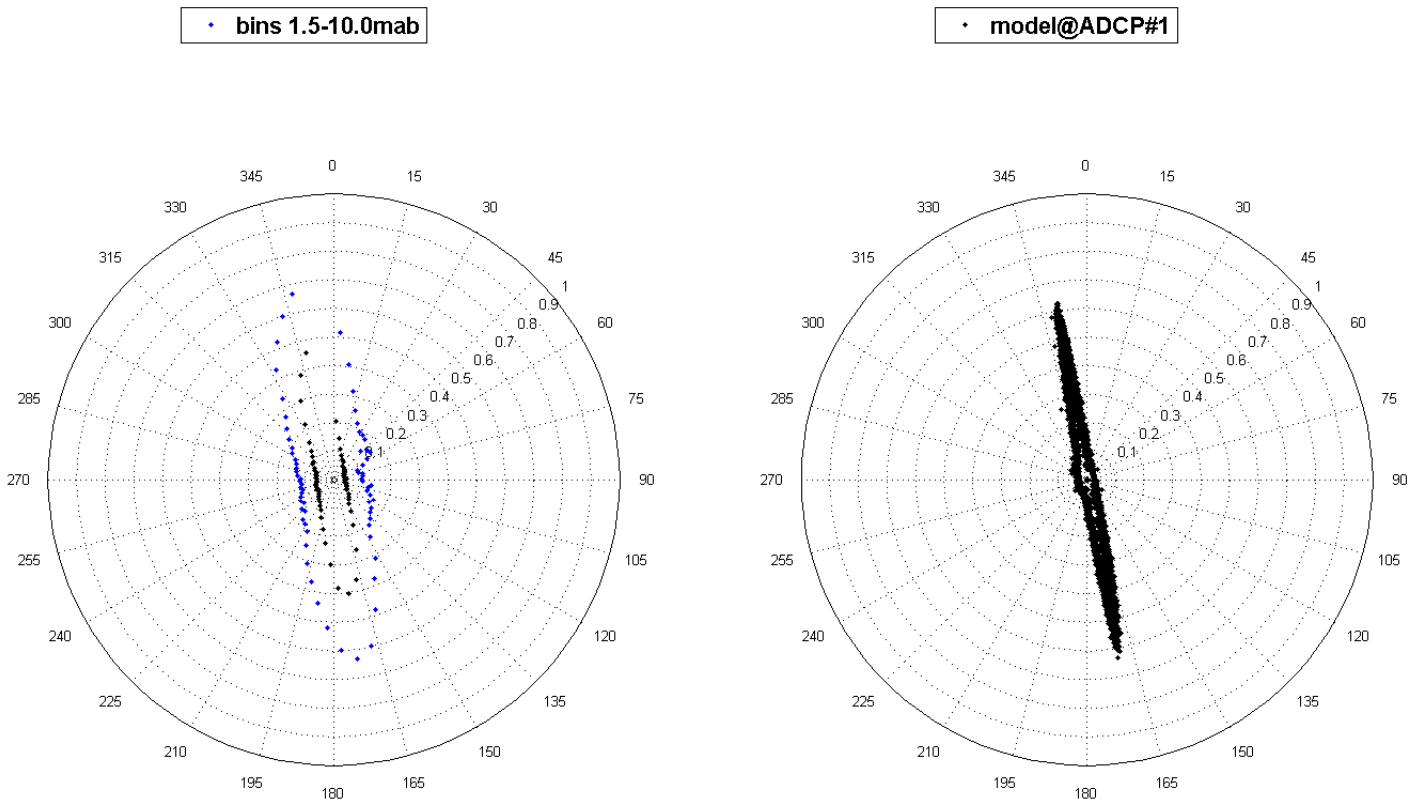



**Figure C-6** Comparison of measured (black solid line) versus modelled (red solid line) current magnitude at the site of ADCP #1. Model driven by the tide, winds, freshwater inflows and waves. Residuals could reach ± 0.25 m/s.




**95th percentile of measured currents**

**statistical mean of measured currents**

**Figure C-7** Polar plots of measured (left) and modelled (right) currents at the site of ADCP #1. Model driven by the tide, winds, freshwater inflows and waves.

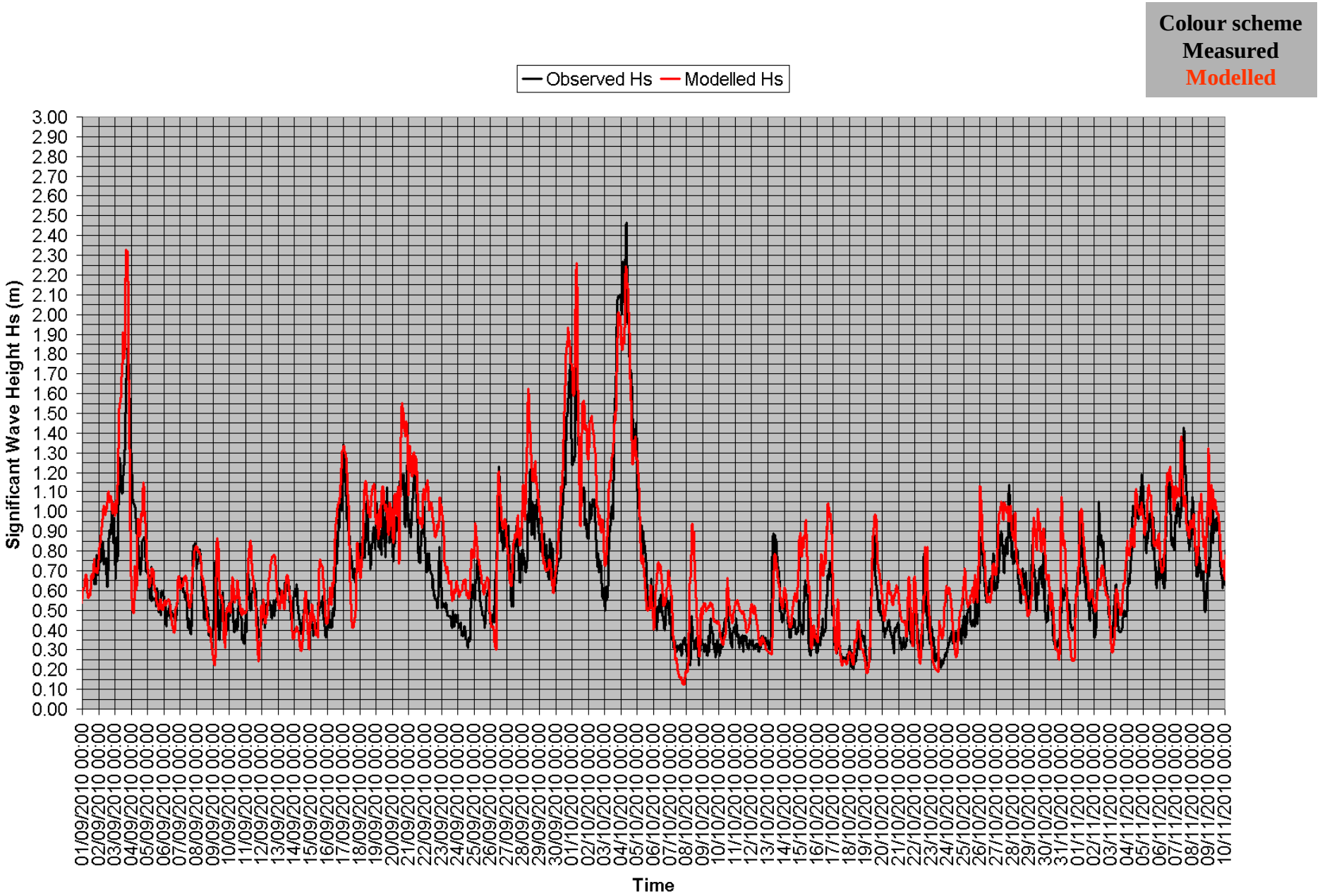



**Figure C-8** Comparison of measured (black solid line) versus modelled (red solid line) **significant wave heights** Hs (m) at the site of ADCP #1. Model driven by the tide, winds, freshwater inflows and waves.

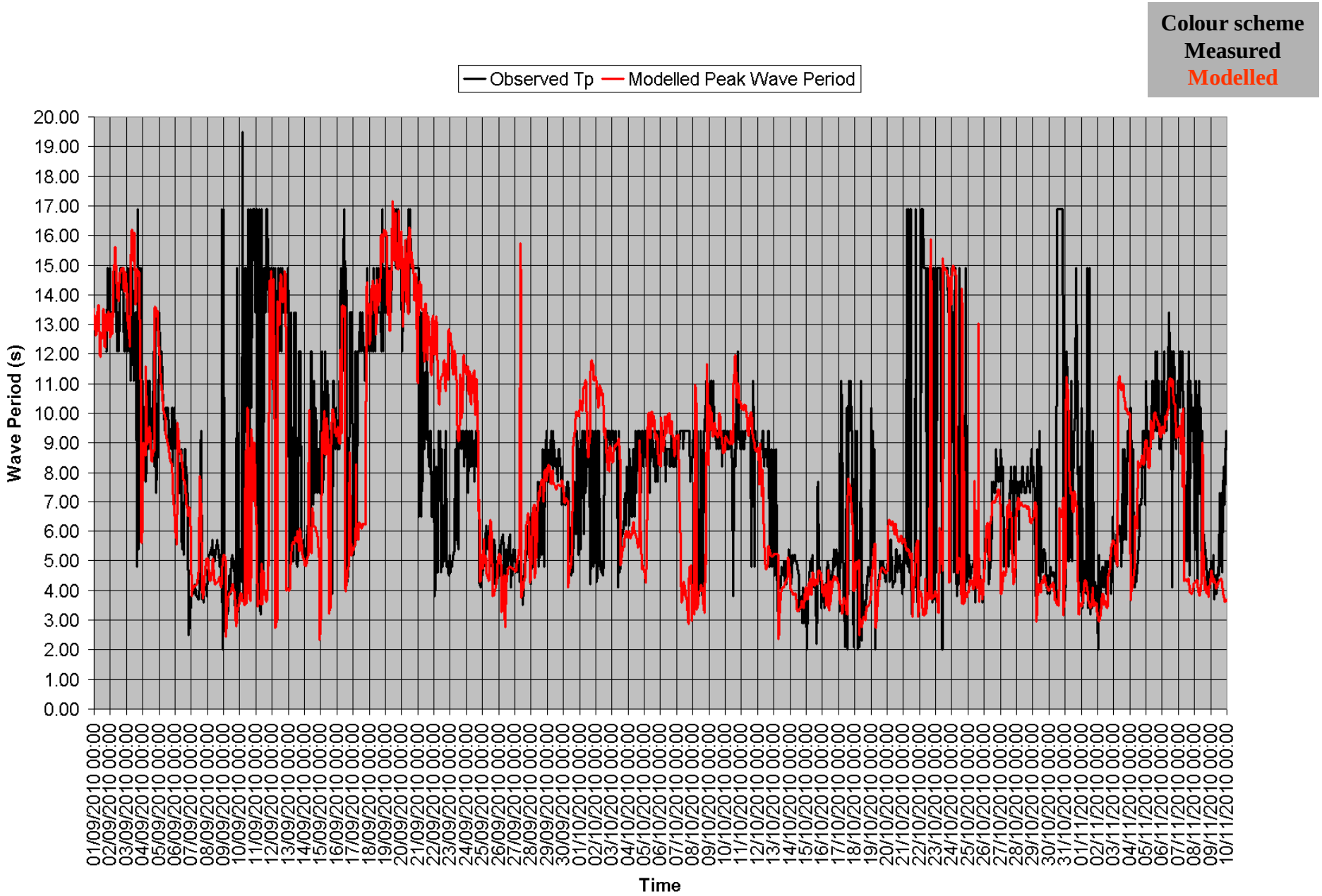



**Figure C-9** Comparison of measured (black solid line) versus modelled (red solid line) **peak wave period** at the site of ADCP #1. Model driven by the tide, winds, freshwater inflows and waves.

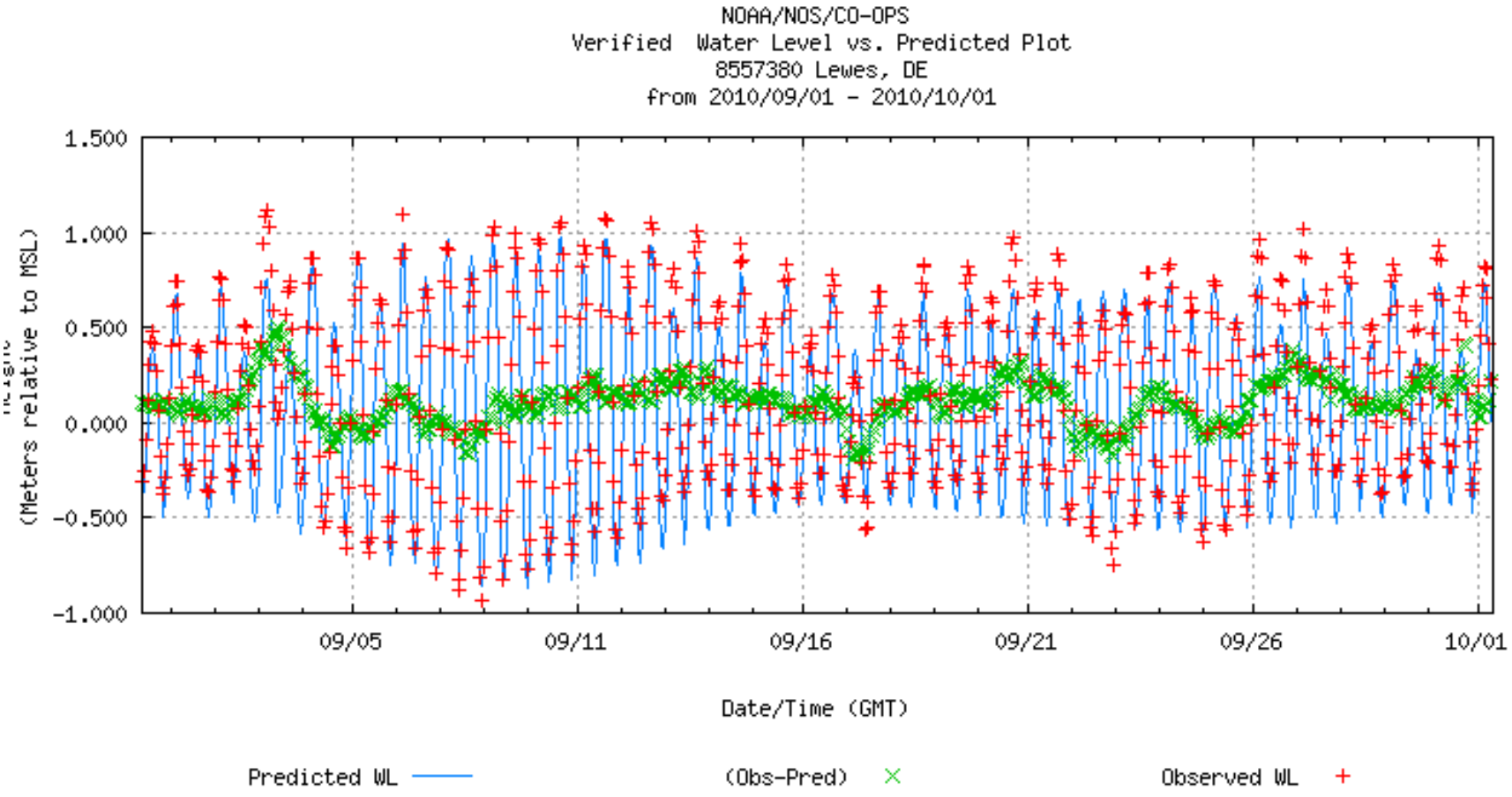



**Figure C-10** Verified (measured) versus predicted water levels at station Lewes, Delaware. Residuals as large as 0.5 m for the month of September 2010

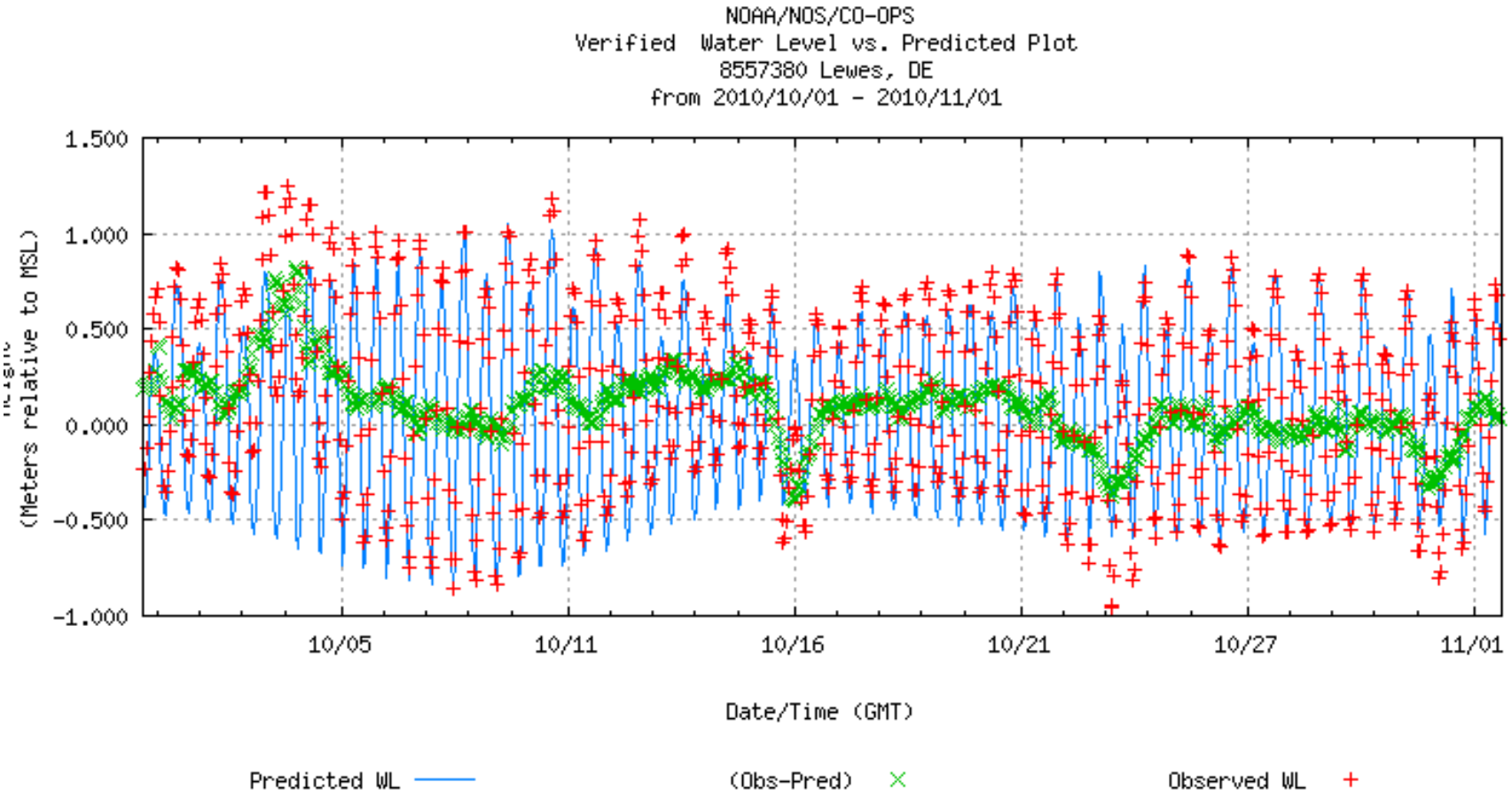



**Figure C-11** Verified (measured) versus predicted water levels at station Lewes, Delaware. Residuals as large as 0.8 m for the month of October 2010

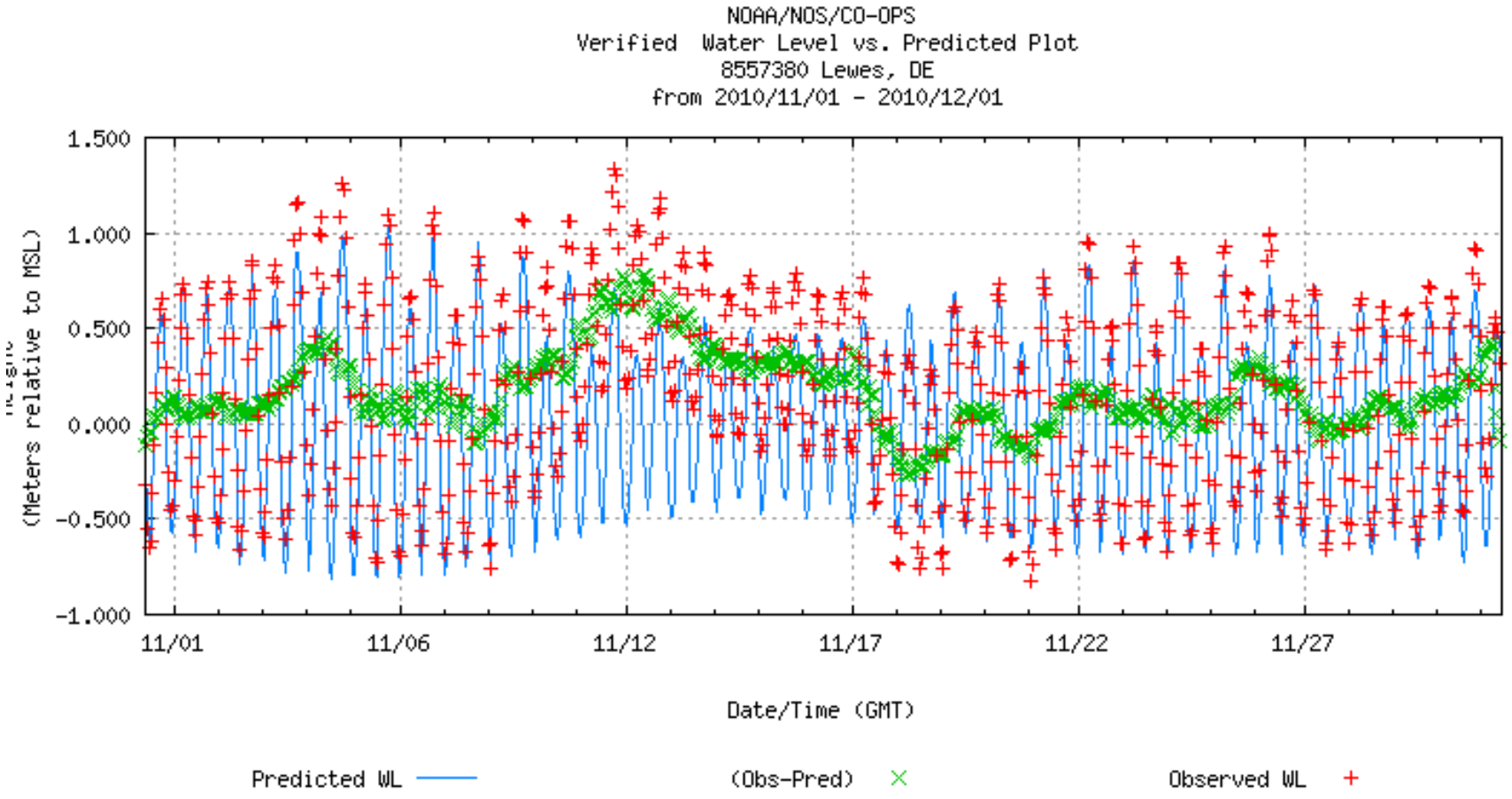



**Figure C-12** Verified (measured) versus predicted water levels at station Lewes, Delaware. Residuals as large as 0.7 m for the month of November 2010

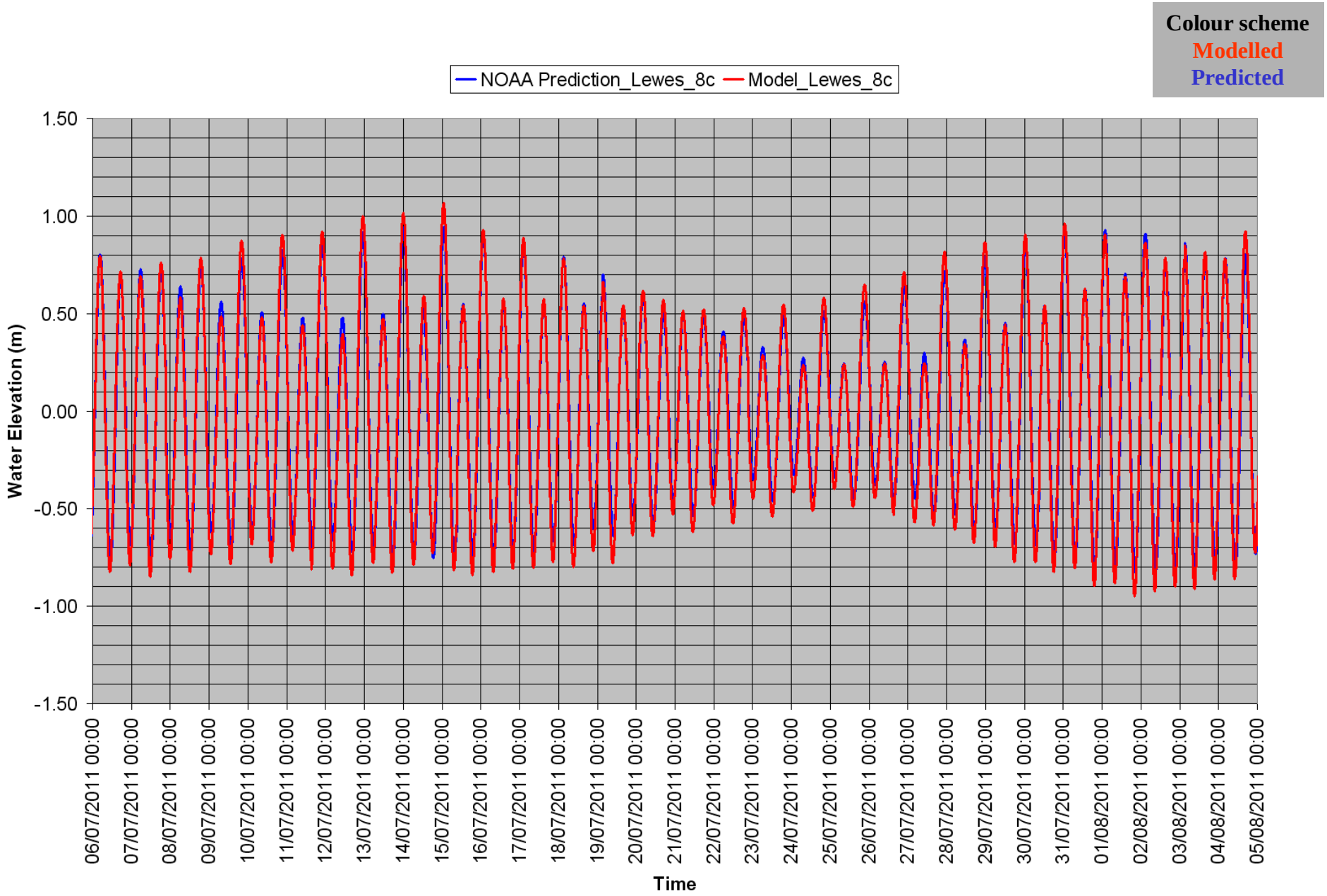



**Figure C-21** Summer 2011, model validation: Predicted (blue) versus modelled (red) **water levels at station Lewes**. RMSE for the model validation period of 63 days = 0.07 m. Prediction and simulation results based on the 8 major tidal constituents.

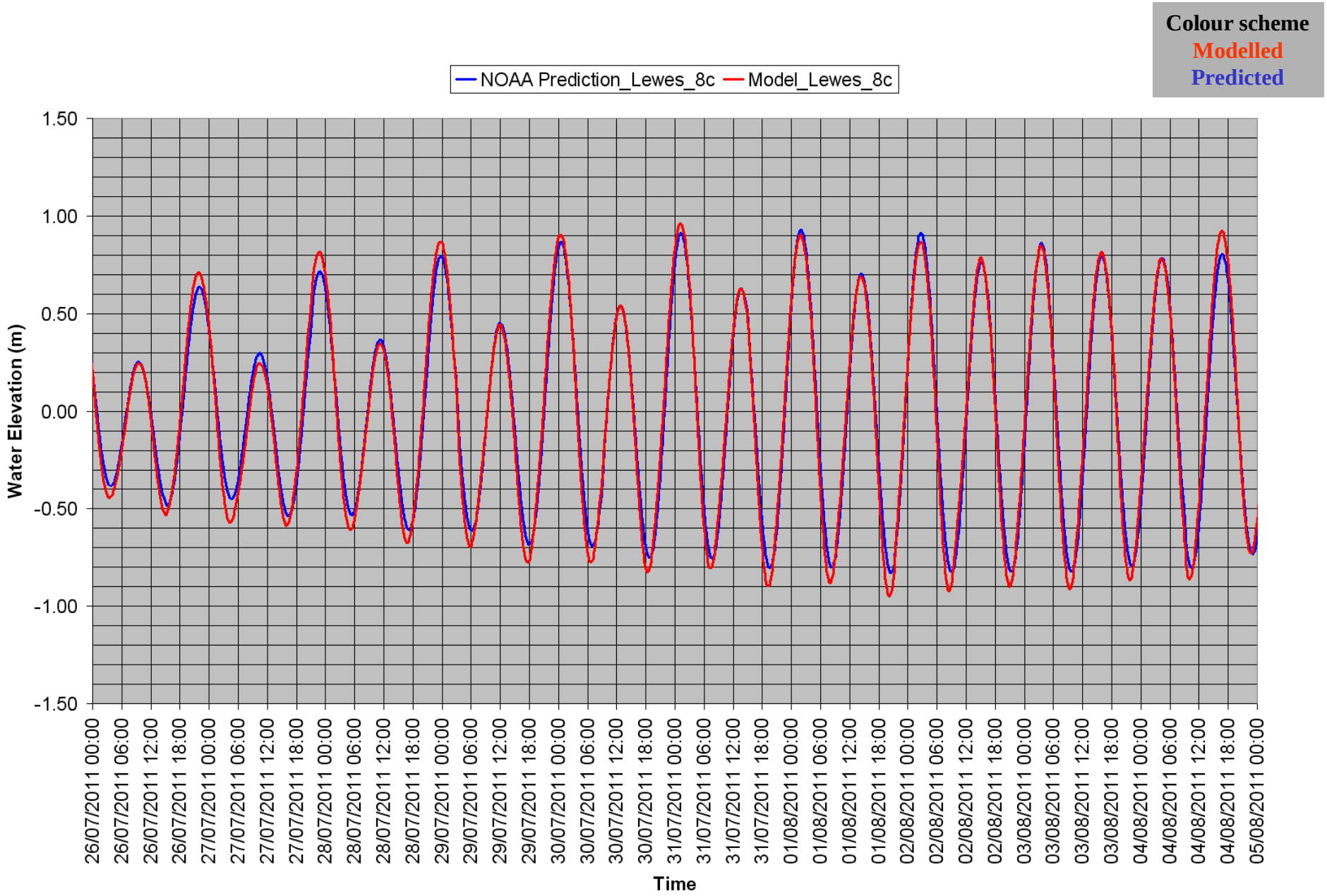



**Figure C-22** Summer 2011, model validation: Detail view of predicted (blue) versus modelled (red) **water levels** over a period of 10 days at **station Lewes**.

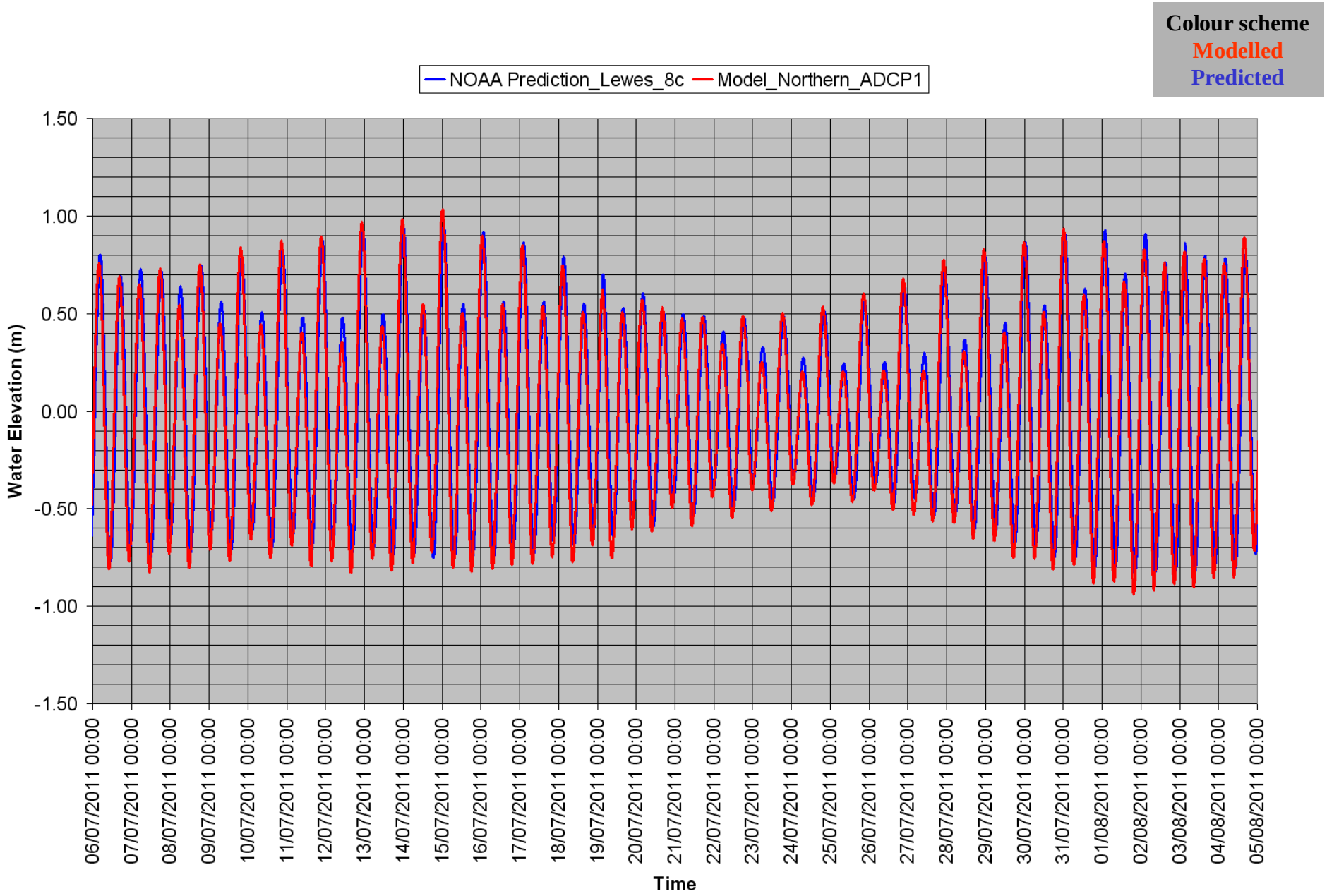



**Figure C-23** Summer 2011, model validation: Comparison of predicted **water levels** at station Lewes (blue) versus modelled water levels (red) **at the site of deployment of ADCP#1** (in the vicinity of the proposed northern outfall).

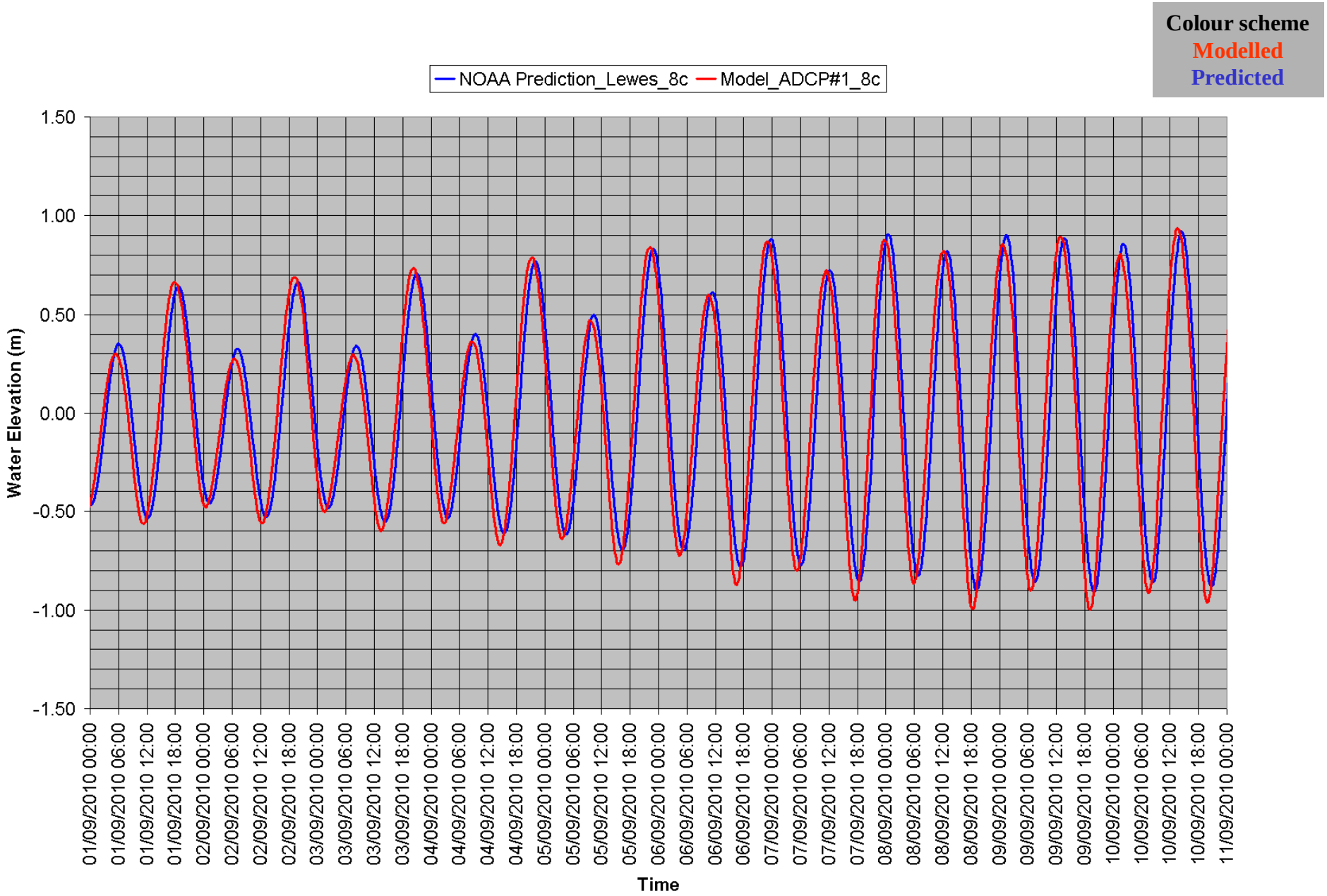



**Figure C-24** Summer 2011, model validation: Detail view of predicted **water levels** at station Lewes (blue) versus modelled water levels (red) over a period of 10 days **at the site of deployment of ADCP#1** (in the vicinity of the proposed northern outfall).

# 2011N

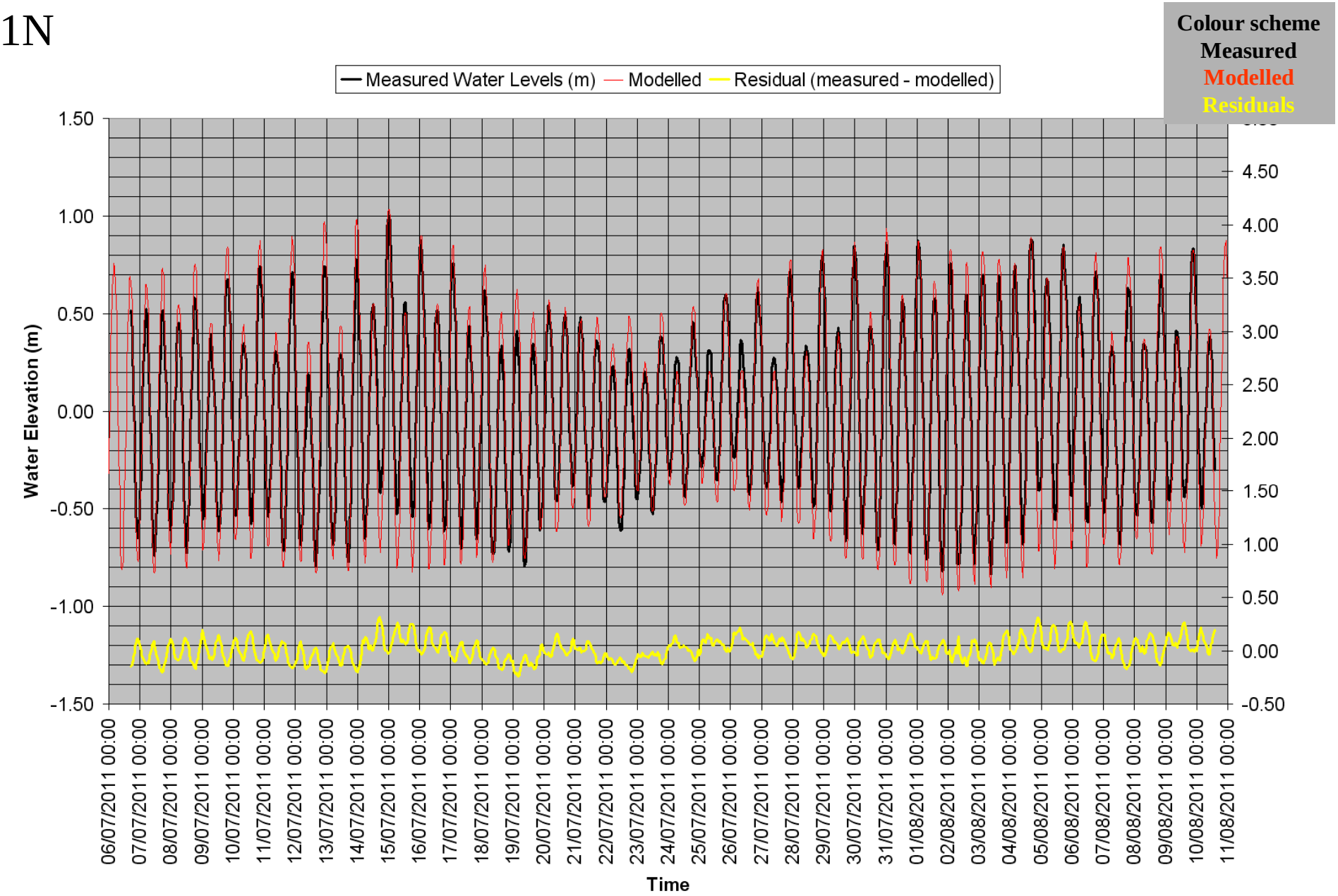



**Figure C-25** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) water levels at the site of ADCP#1 (northern outfall). Model driven by the tide, winds, freshwater inflows and waves. Residuals could reach ± 0.4 m.

# 2011N

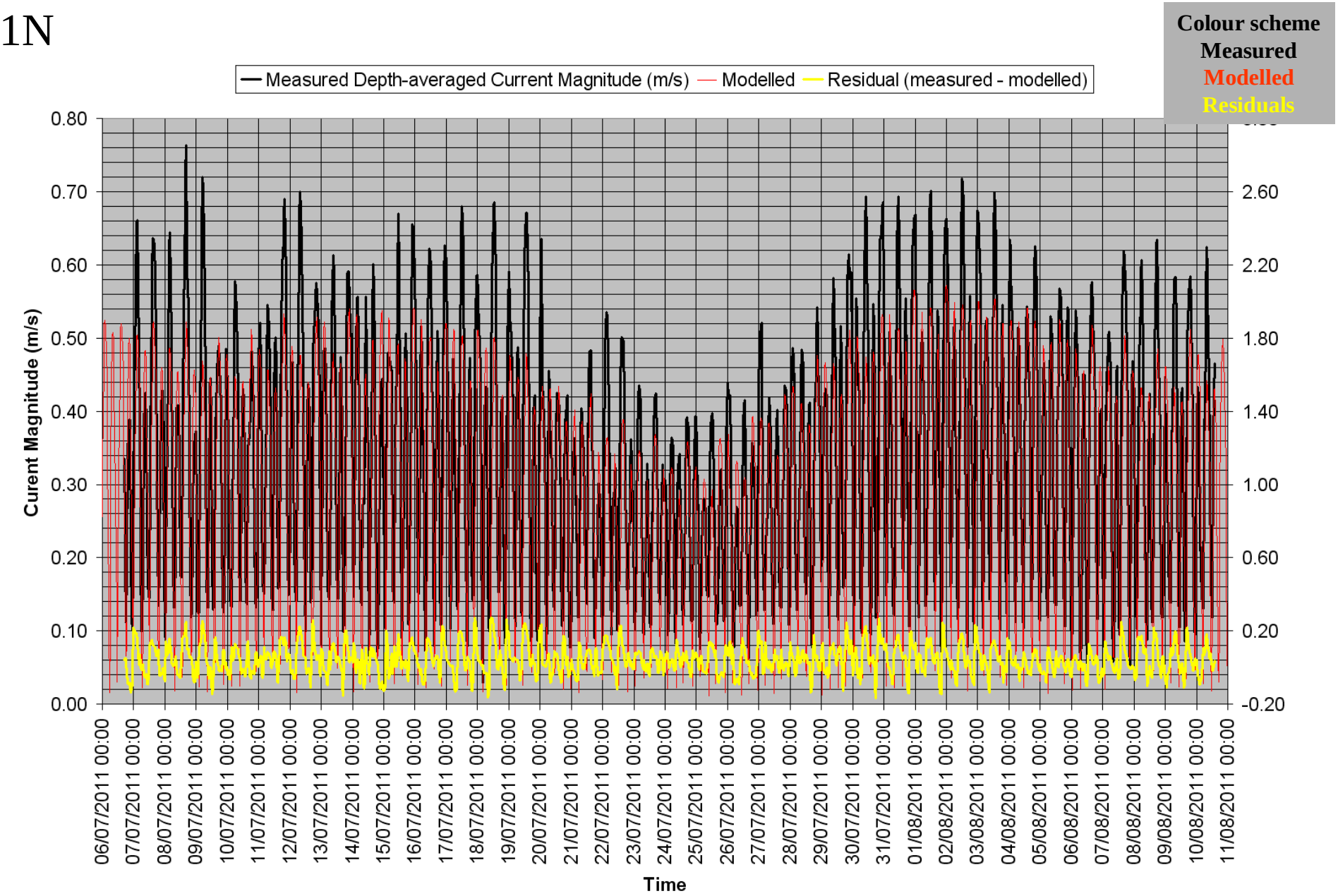



**Figure C-26** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) current magnitude at the site of ADCP#1 (in the vicinity of the proposed northern outfall). Model driven by the tide, winds, freshwater inflows and waves. Residuals could reach ± 0.25 m/s.

# 2011N

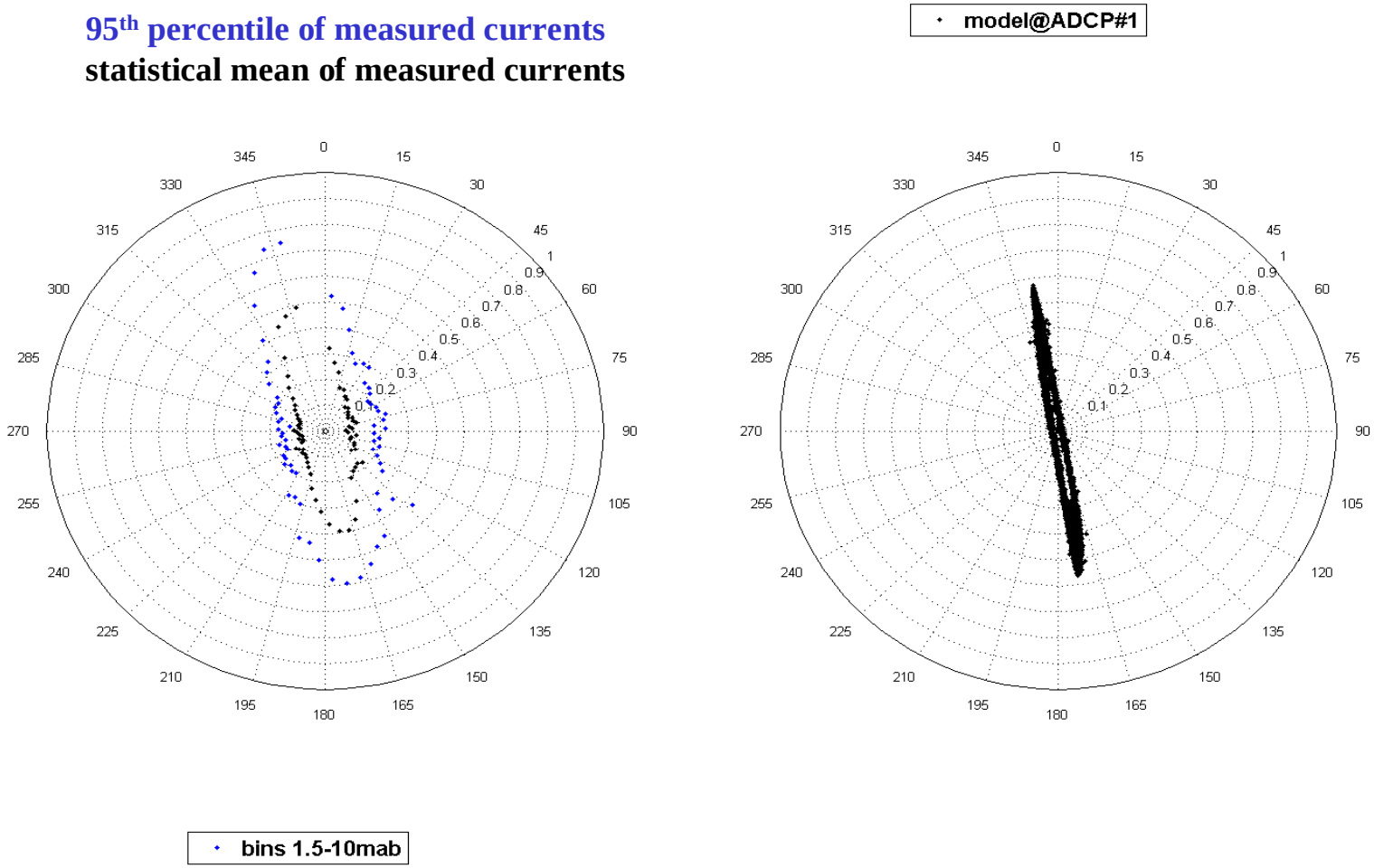



**Figure C-27** Summer 2011, model validation: Polar plots of measured (left) and modelled (right) currents at the site of ADCP#1 (in the vicinity of the proposed northern outfall). Model driven by the tide, winds, freshwater inflows and waves.

# 2011N

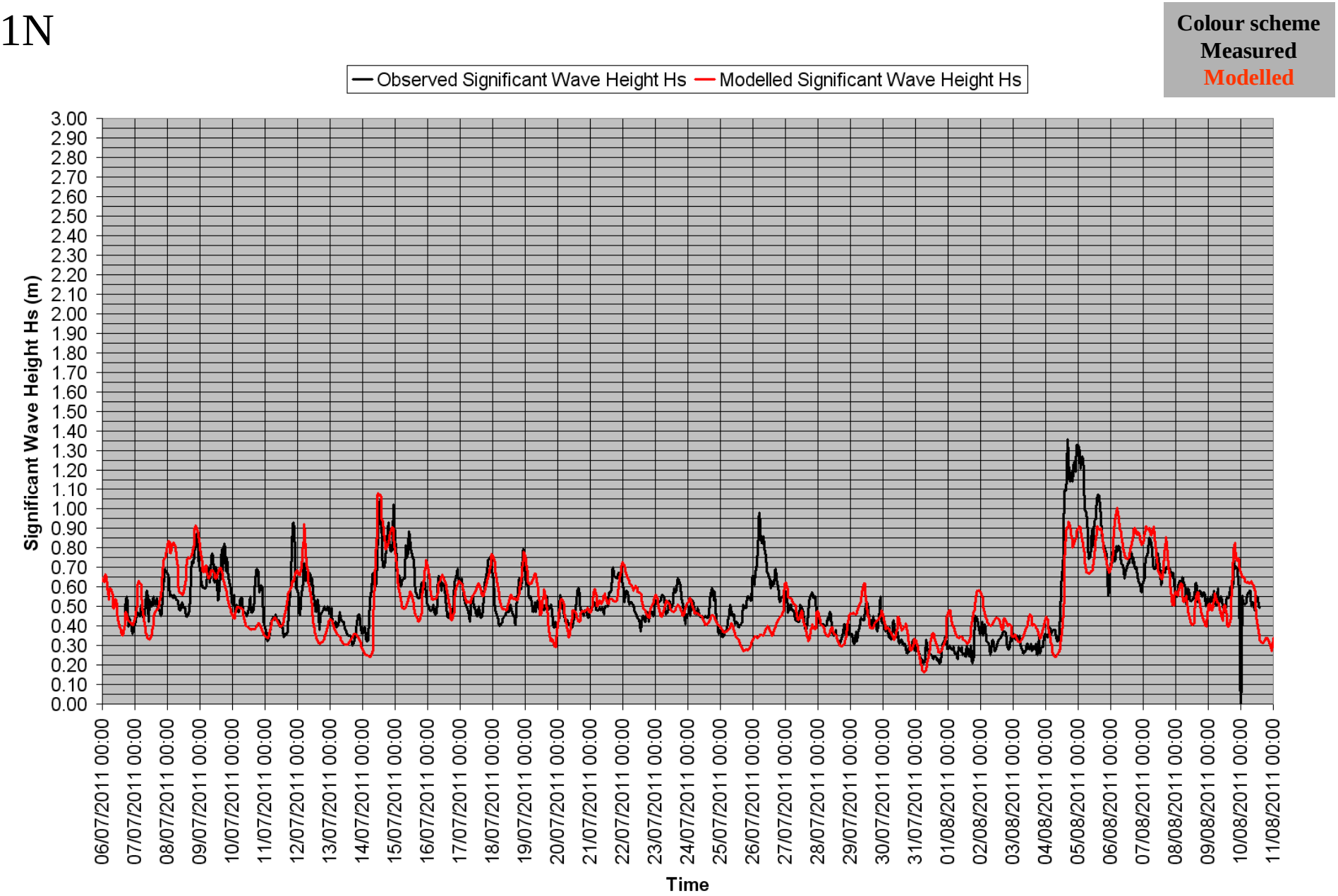



**Figure C-28** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) **significant wave heights** Hs (m) at the site of ADCP #1 (northern outfall). Model driven by the tide, winds, freshwater inflows and waves.

# 2011N

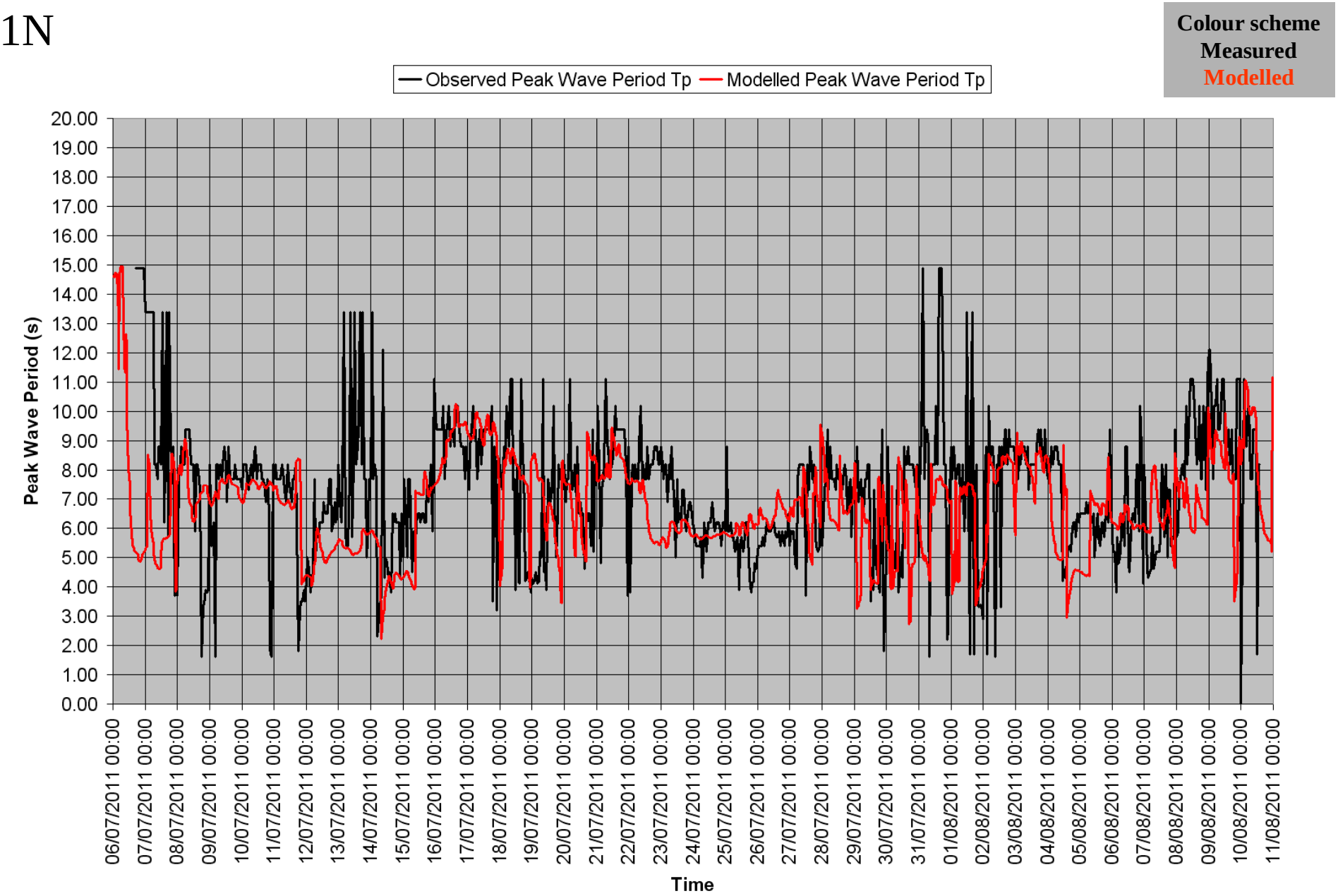



**Figure C-29** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) **peak wave period** at the site of ADCP #1 (northern outfall). Model driven by the tide, winds, freshwater inflows and waves.

# 2011S

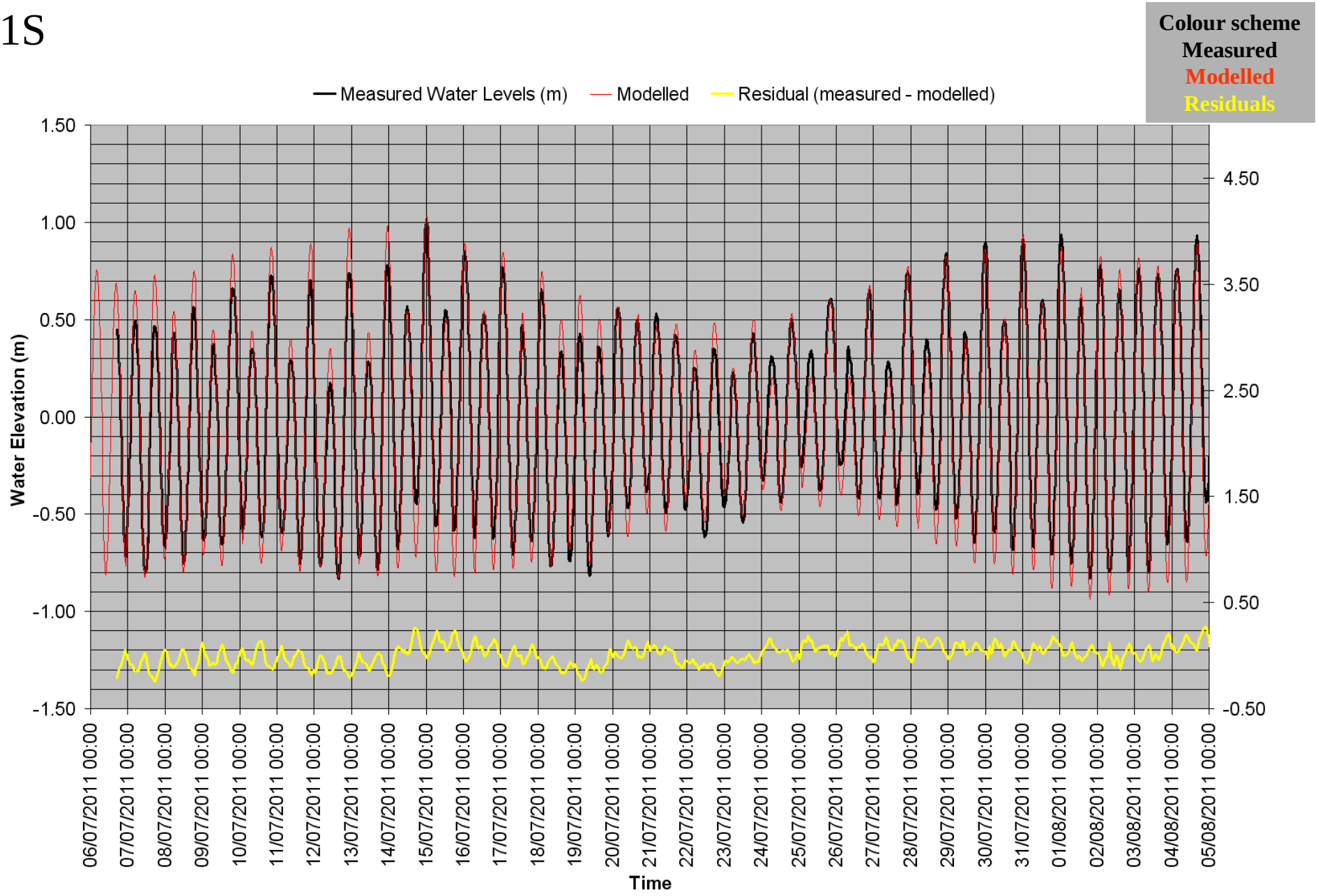



**Figure C-30** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) water levels at the site of ADCP #2 (southern outfall). Model driven by the tide, winds, freshwater inflows and waves. Residuals could reach ± 0.3 m.

# 2011S

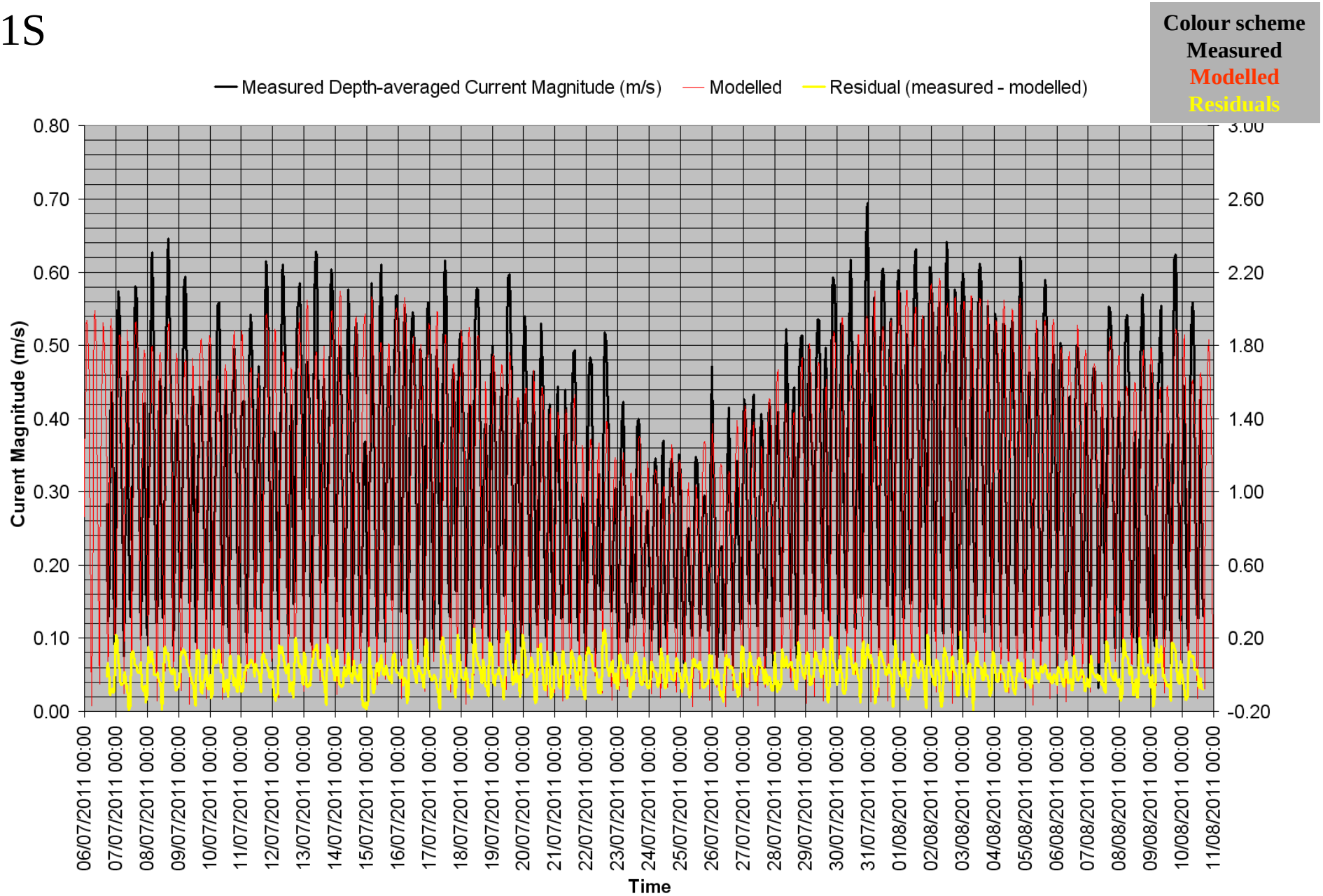



**Figure C-31** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) current magnitude at the site of ADCP #2 (southern outfall). Model driven by the tide, winds, freshwater inflows and waves. Residuals could reach ± 0.25 m/s.

# 2011S

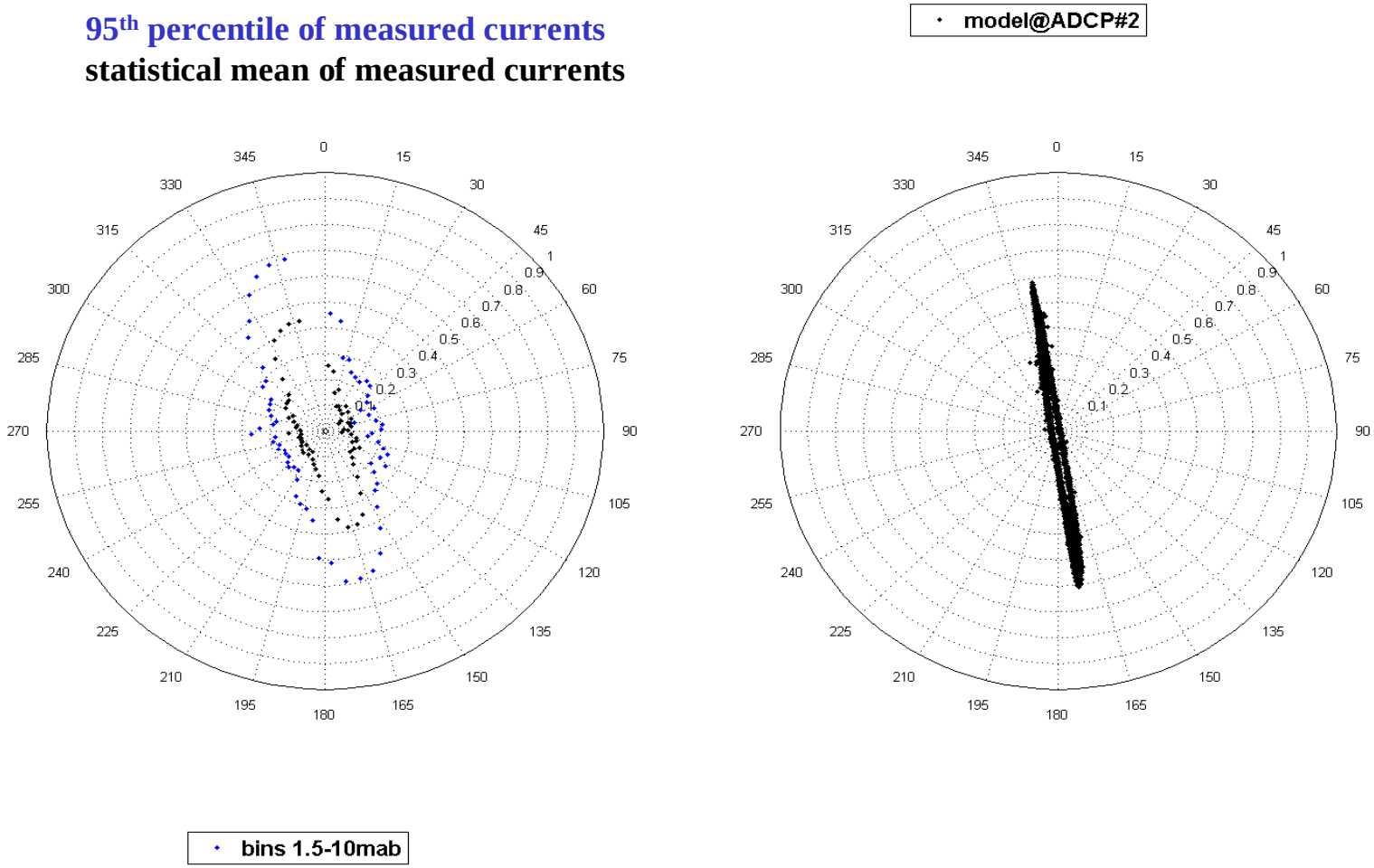



**Figure C-32** Summer 2011, model validation: Polar plots of measured (left) and modelled (right) currents at the site of ADCP #2 (in the vicinity of the proposed southern outfall). Model driven by the tide, winds, freshwater inflows and waves.

# 2011S

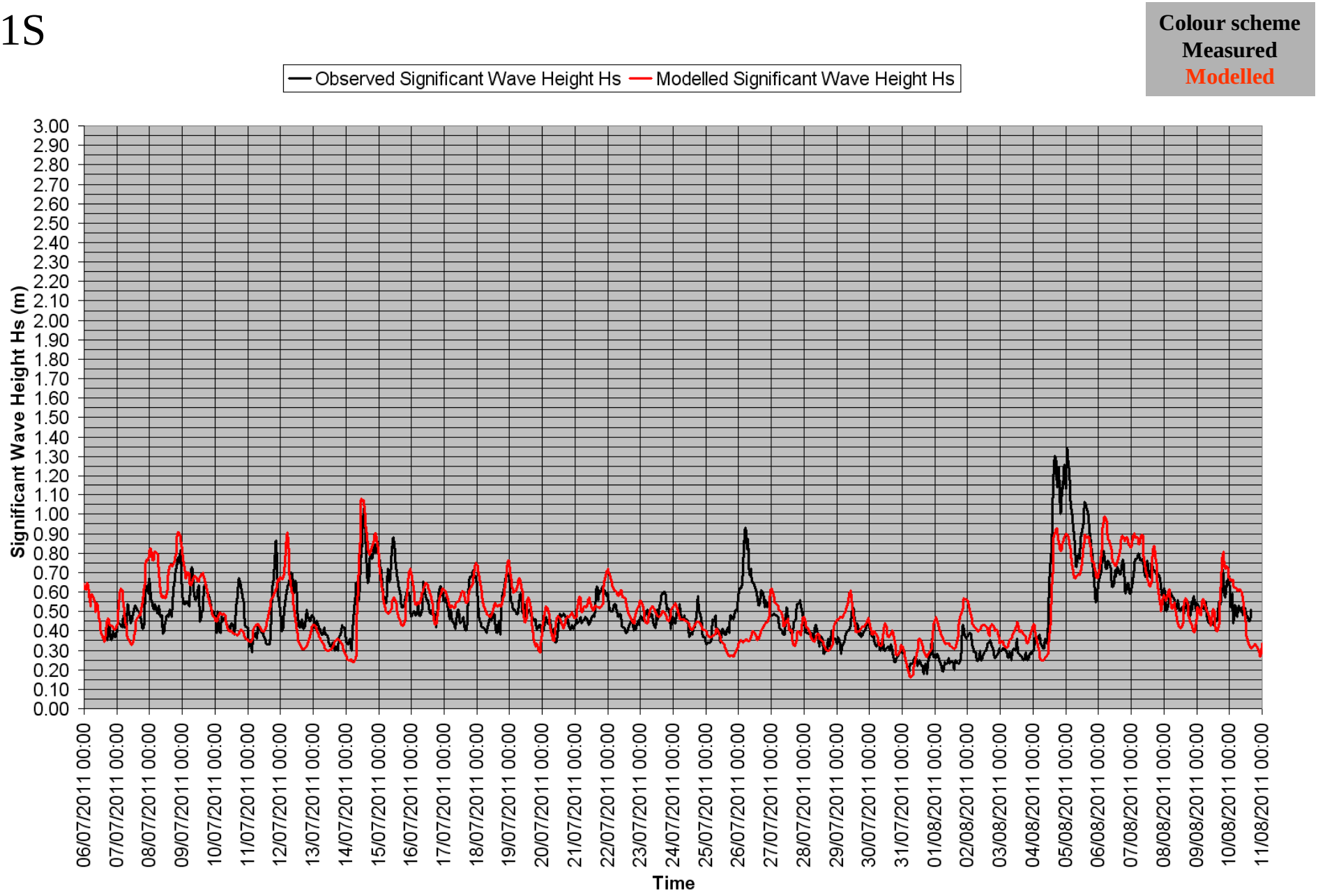



**Figure C-33** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) **significant wave heights** Hs (m) at the site of ADCP #2 (southern outfall). Model driven by the tide, winds, freshwater inflows and waves.

# 2011S

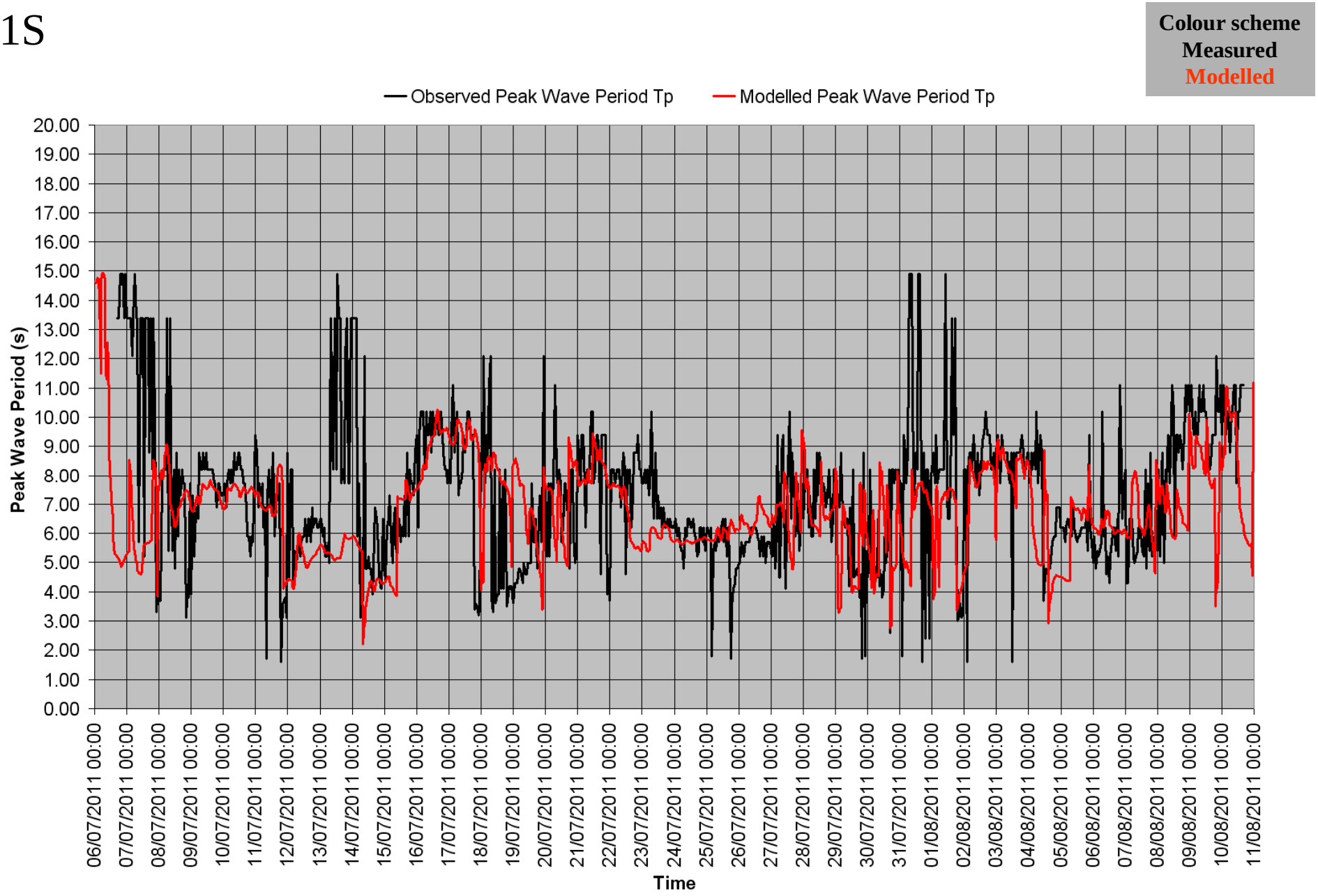



**Figure C-34** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) **peak wave period** at the site of ADCP #2 (southern outfall). Model driven by the tide, winds, freshwater inflows and waves.

# 2011S

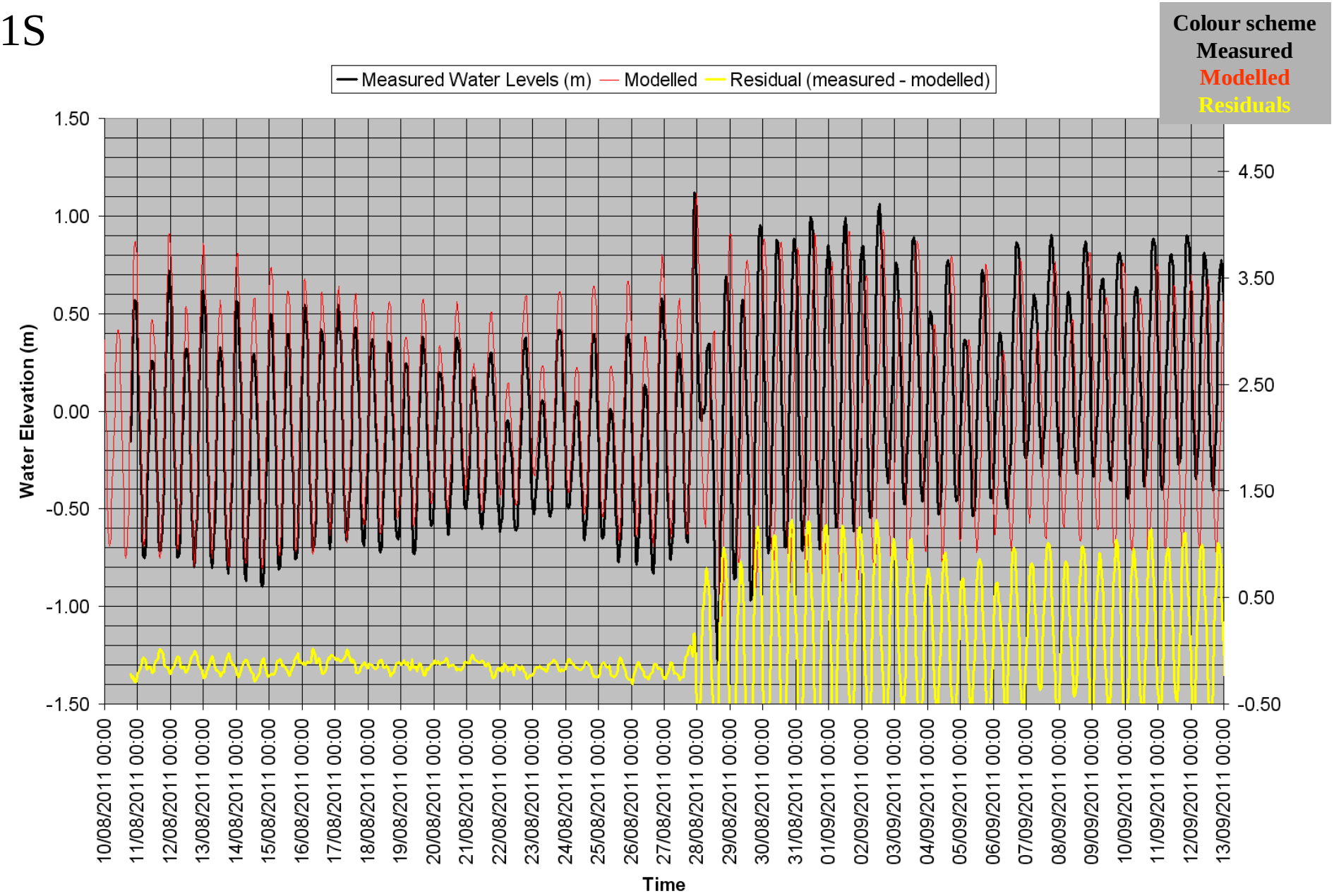



**Figure C-35** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) water levels at the site of ADCP #2 (southern outfall). Model driven by the tide, winds, freshwater inflows and waves.

# 2011S

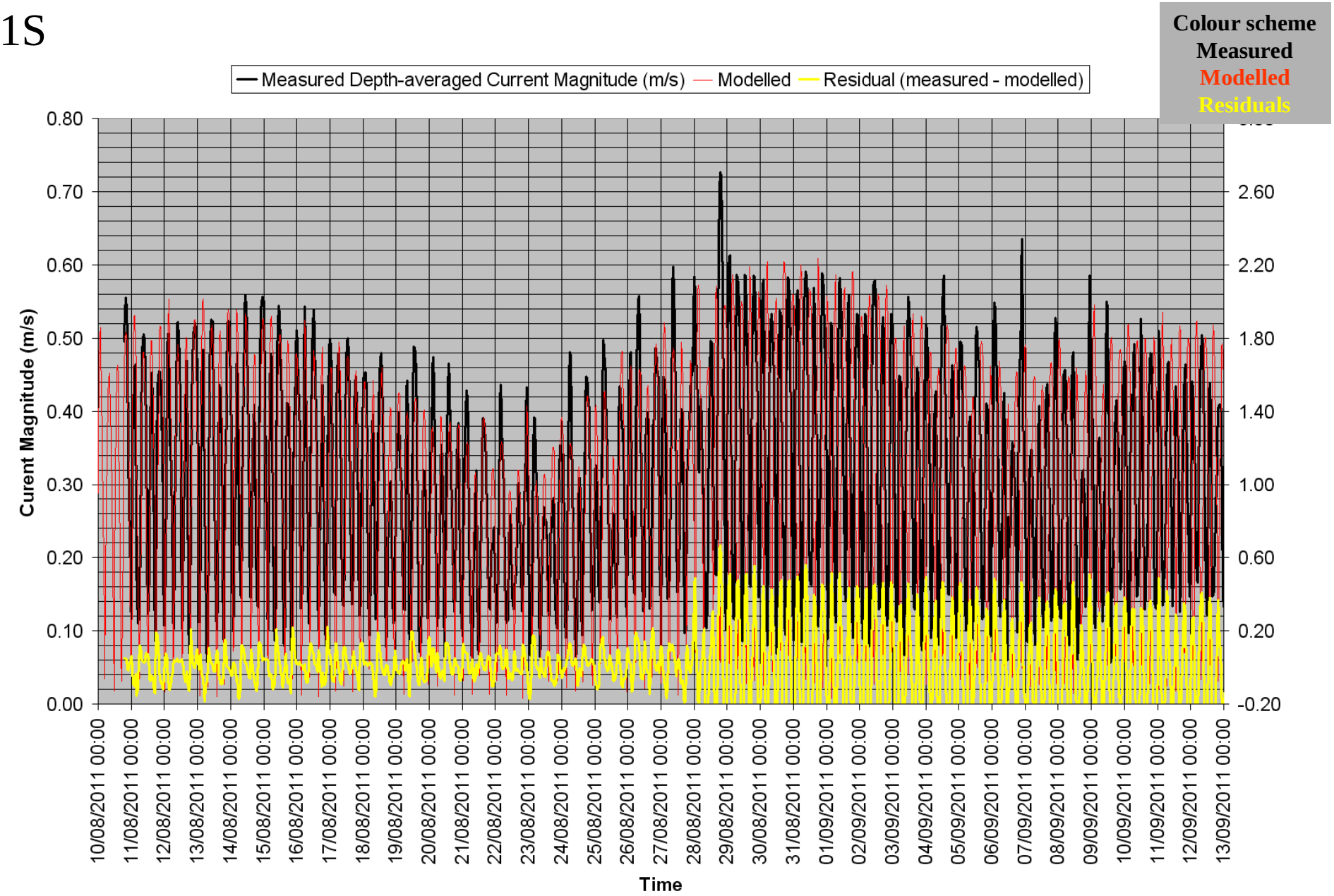



**Figure C-36** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) current magnitude at the site of ADCP #2 (southern outfall). Model driven by the tide, winds, freshwater inflows and waves.

# 2011S

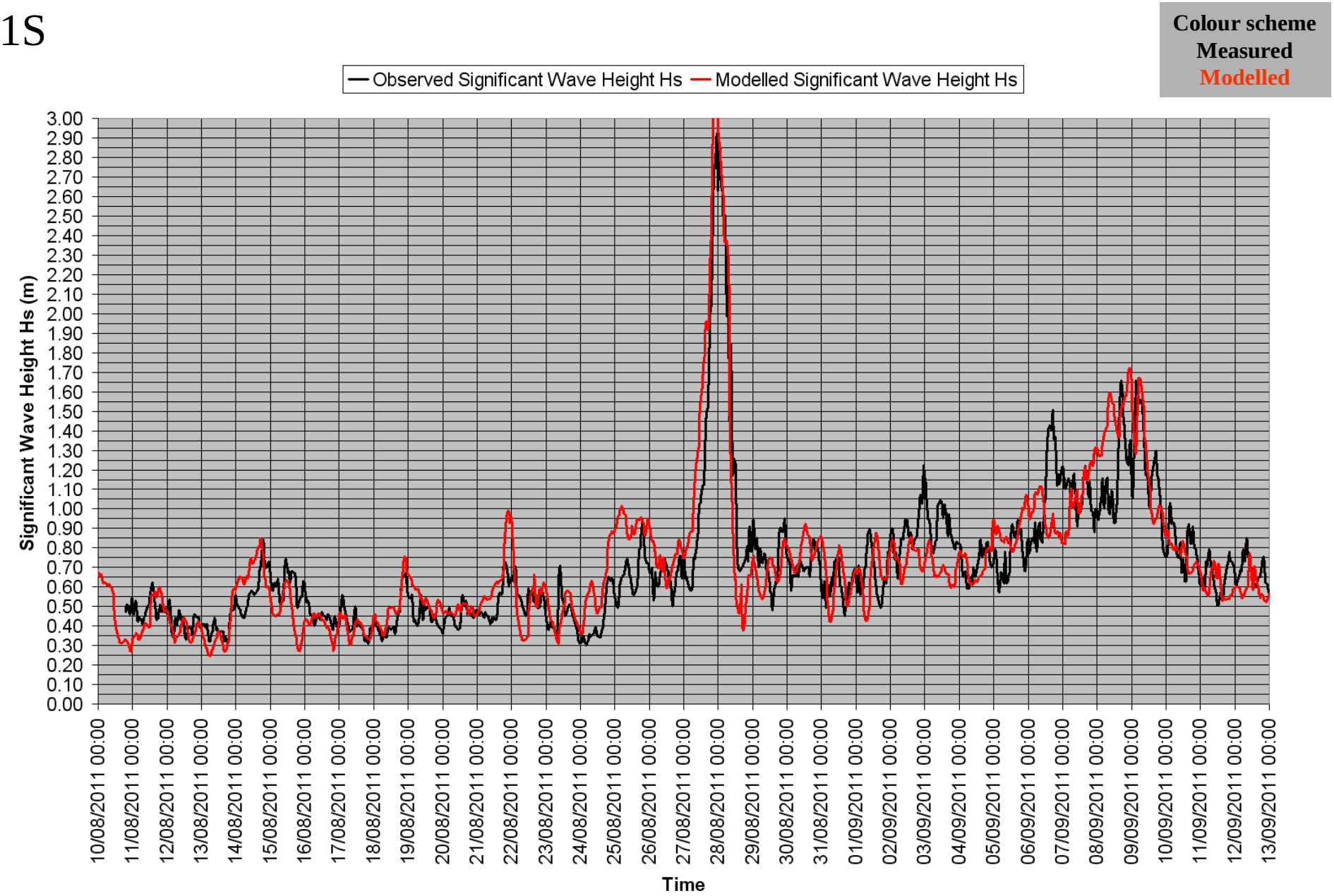



**Figure C-37** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) **significant wave heights** Hs (m) at the site of ADCP #2 (southern outfall). Model driven by the tide, winds, freshwater inflows and waves.

# 2011S

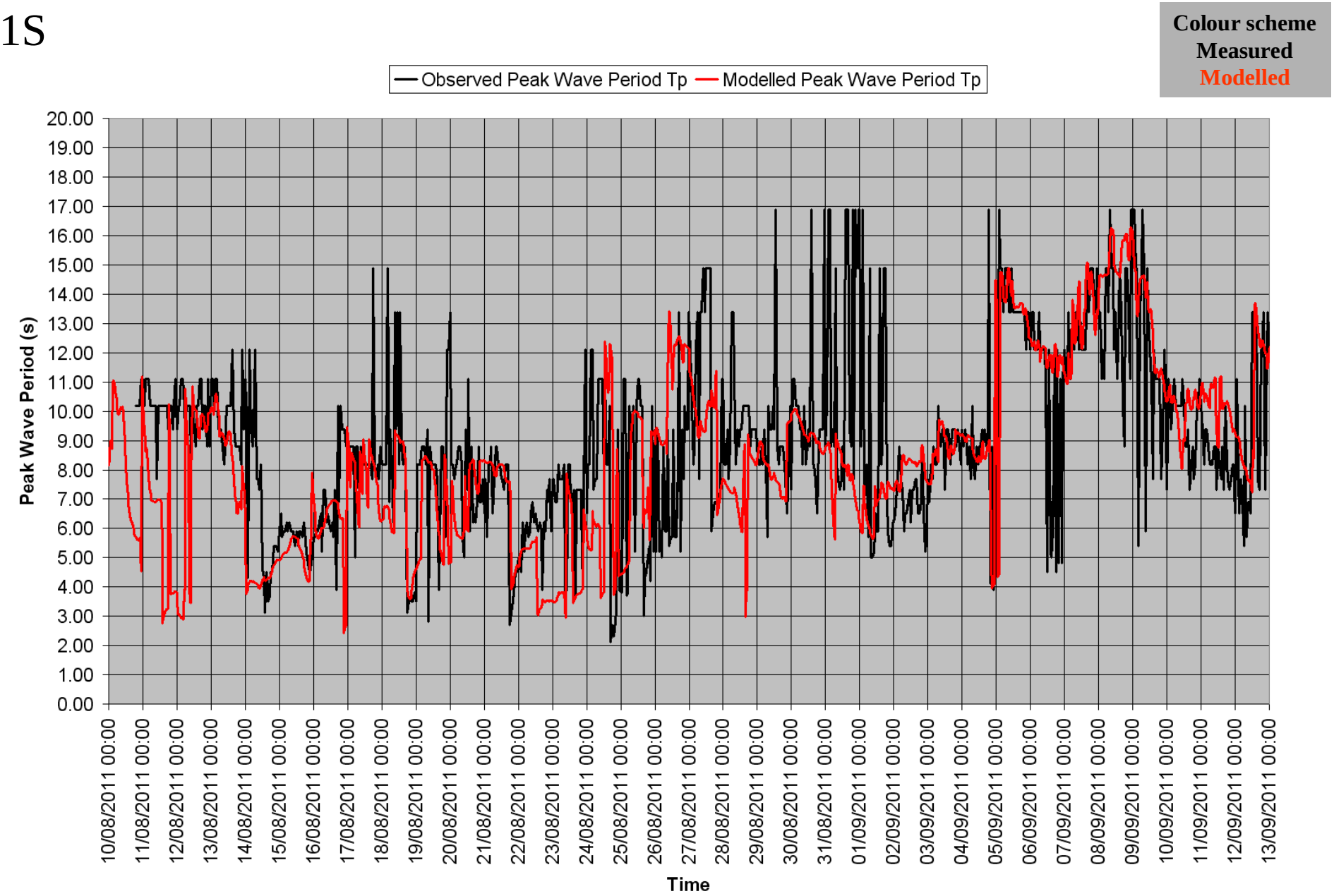



**Figure C-38** Summer 2011, model validation: Comparison of measured (black solid line) versus modelled (red solid line) **peak wave period** at the site of ADCP #2 (southern outfall). Model driven by the tide, winds, freshwater inflows and waves.

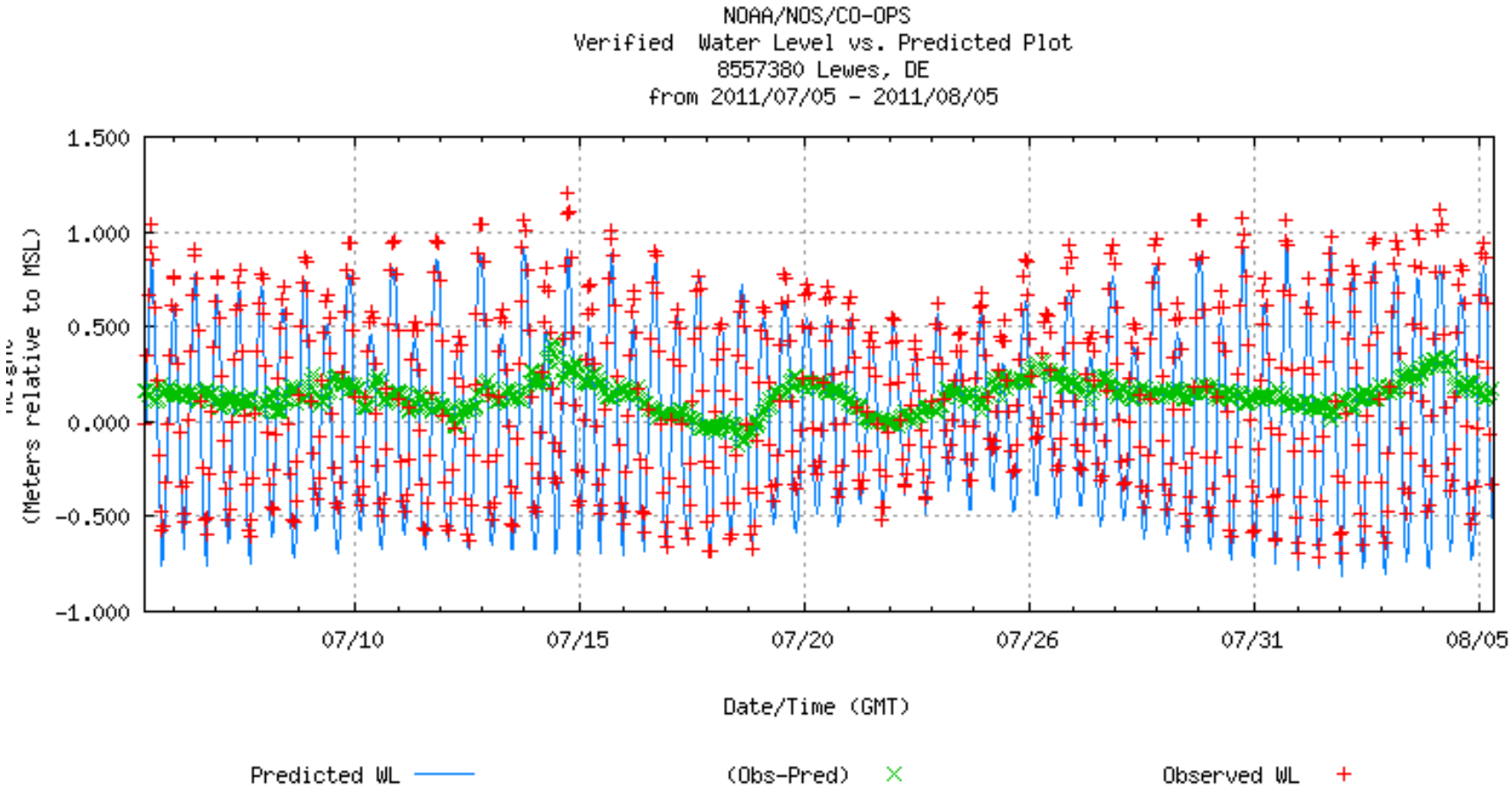



**Figure C-39** Summer 2011: Verified (measured) versus predicted water levels at station Lewes, Delaware. Residuals as large as 0.4 m for the month of July.

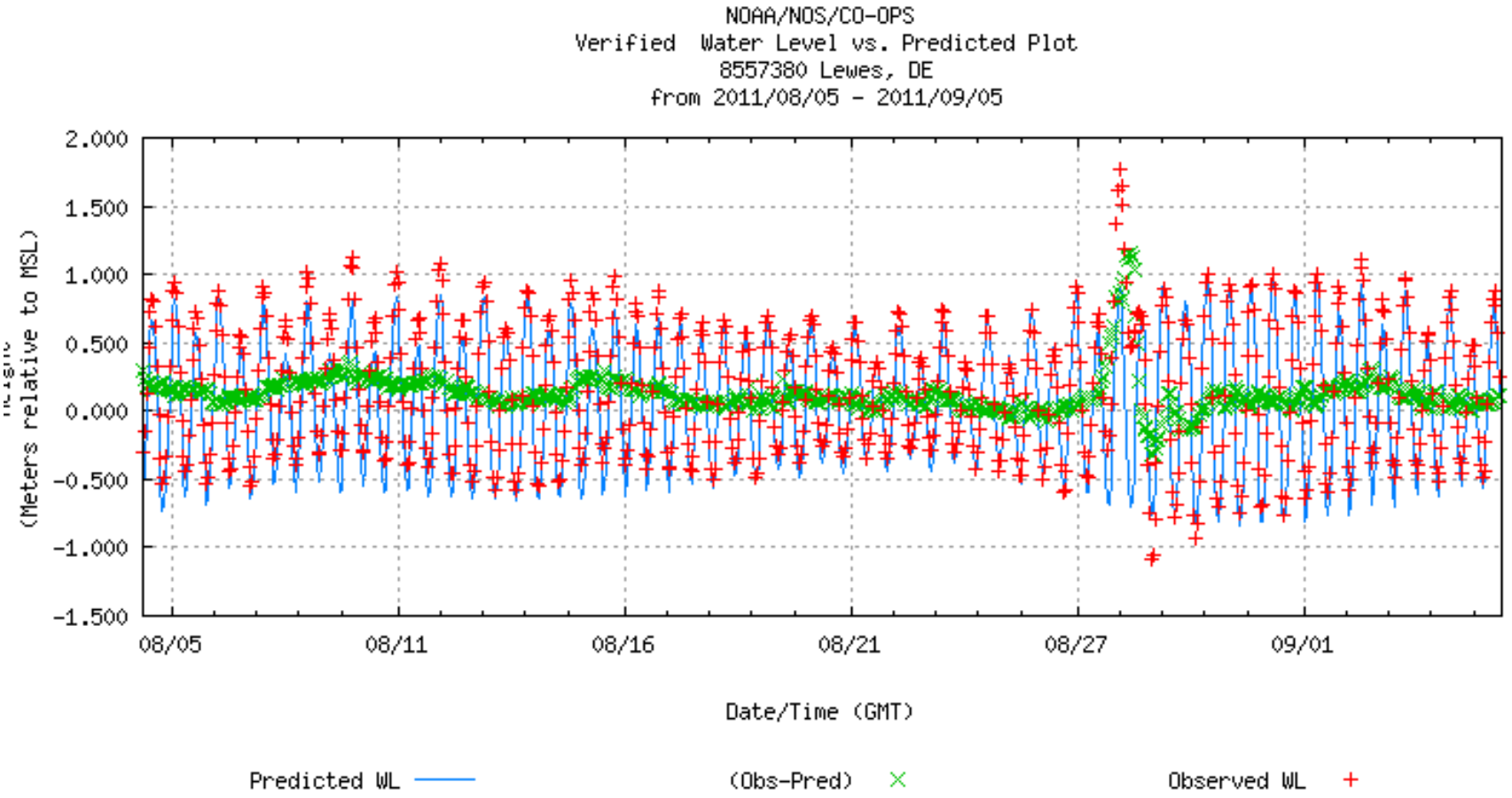



**Figure C-40** Summer 2011: Verified (measured) versus predicted water levels at station Lewes, Delaware. Residuals as large as 1.2 m during the passage of Hurricane Irene but generally less than ±0.4 for the month of August.

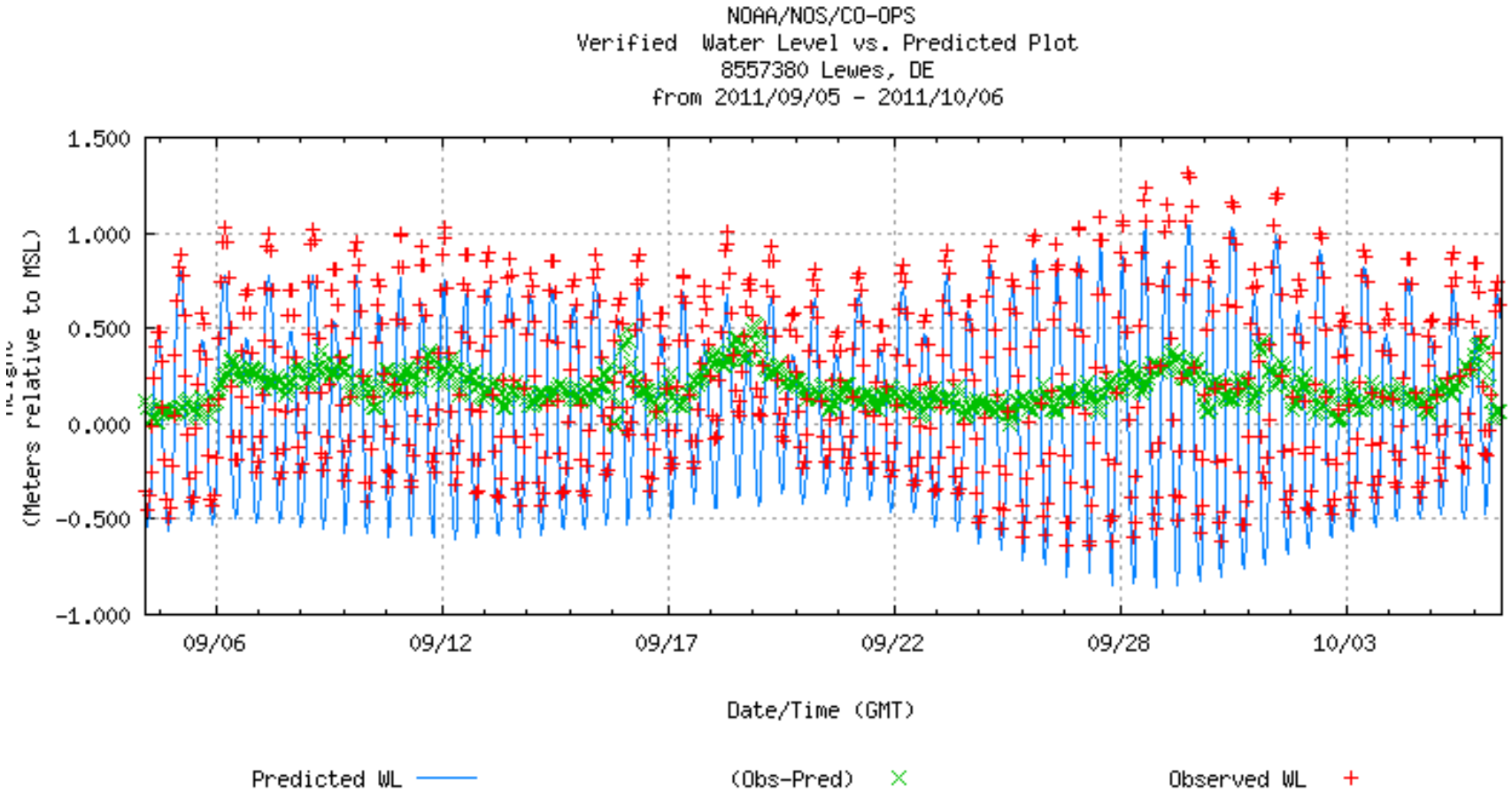



**Figure C-41** Summer 2011: Verified (measured) versus predicted water levels at station Lewes, Delaware. Residuals as large as 0.5 m for the month of September.

Appendix D

# Far-Field Modeling

Southern Outfall: Instantaneous snapshots of the plume

Southern Outfall: Percentile maps of effluent concentration

Northern Outfall: Instantaneous snapshots of the plume

Northern Outfall: Percentile maps of effluent concentration

## Notes:

•*Each figure represent an instantaneous effluent footprint*

•*A statistical prediction over a full 2.5 month period is provided as dilution map in Figure XXXX in the main text*

•*The values of concentration shown on the plots are based on the discharge of a pollutant at a concentration of 1000 mg/L. Therefore, actual concentrations arising from the outfall will need to be scaled. For example, if the discharge is released at 10 mg/L then the resultant concentrations could be only 1/100$^{th}$ of that shown*

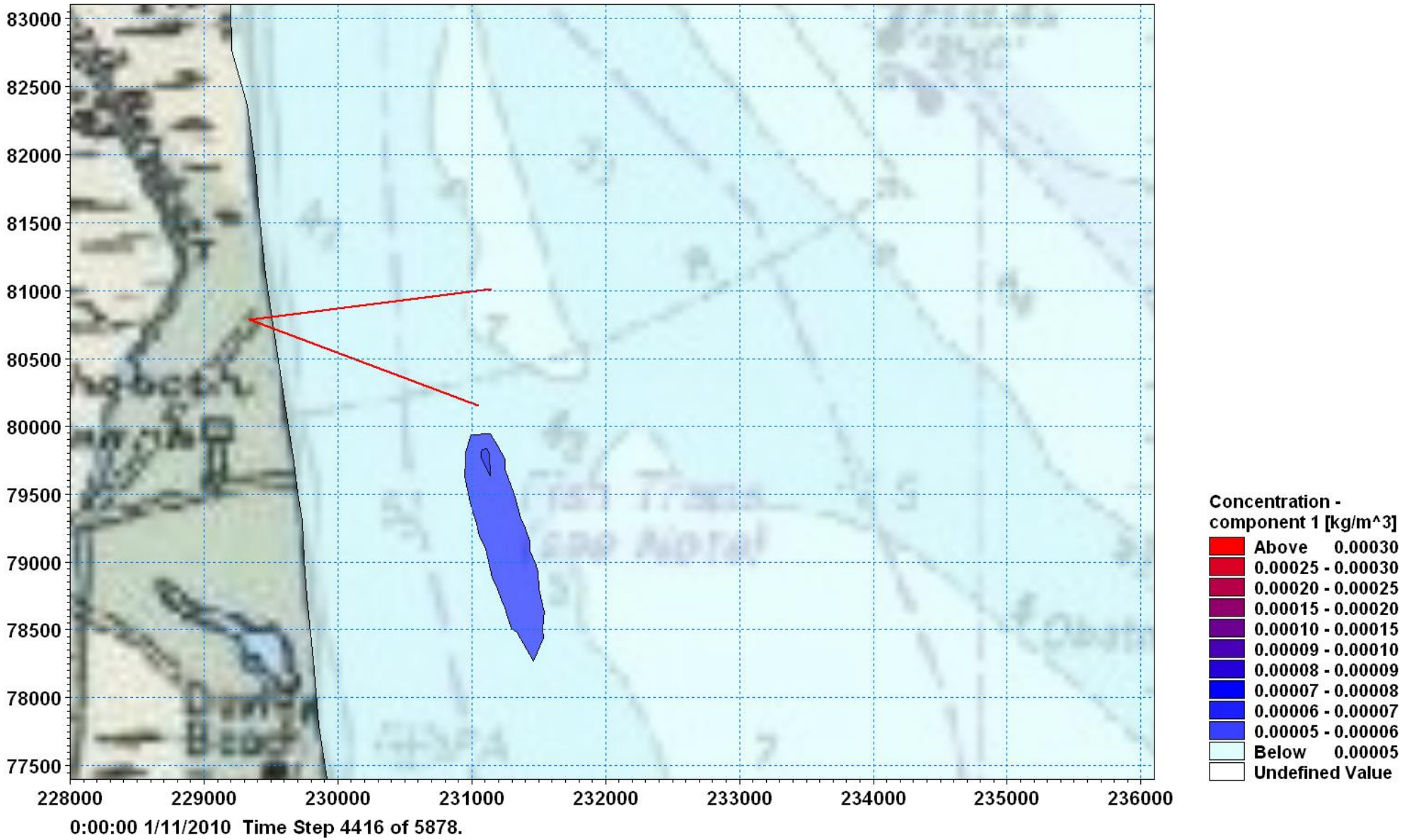



**Figure D-1a** Southern outfall, predicted footprint of the plume on Nov 1st 2010 at 0 AM.

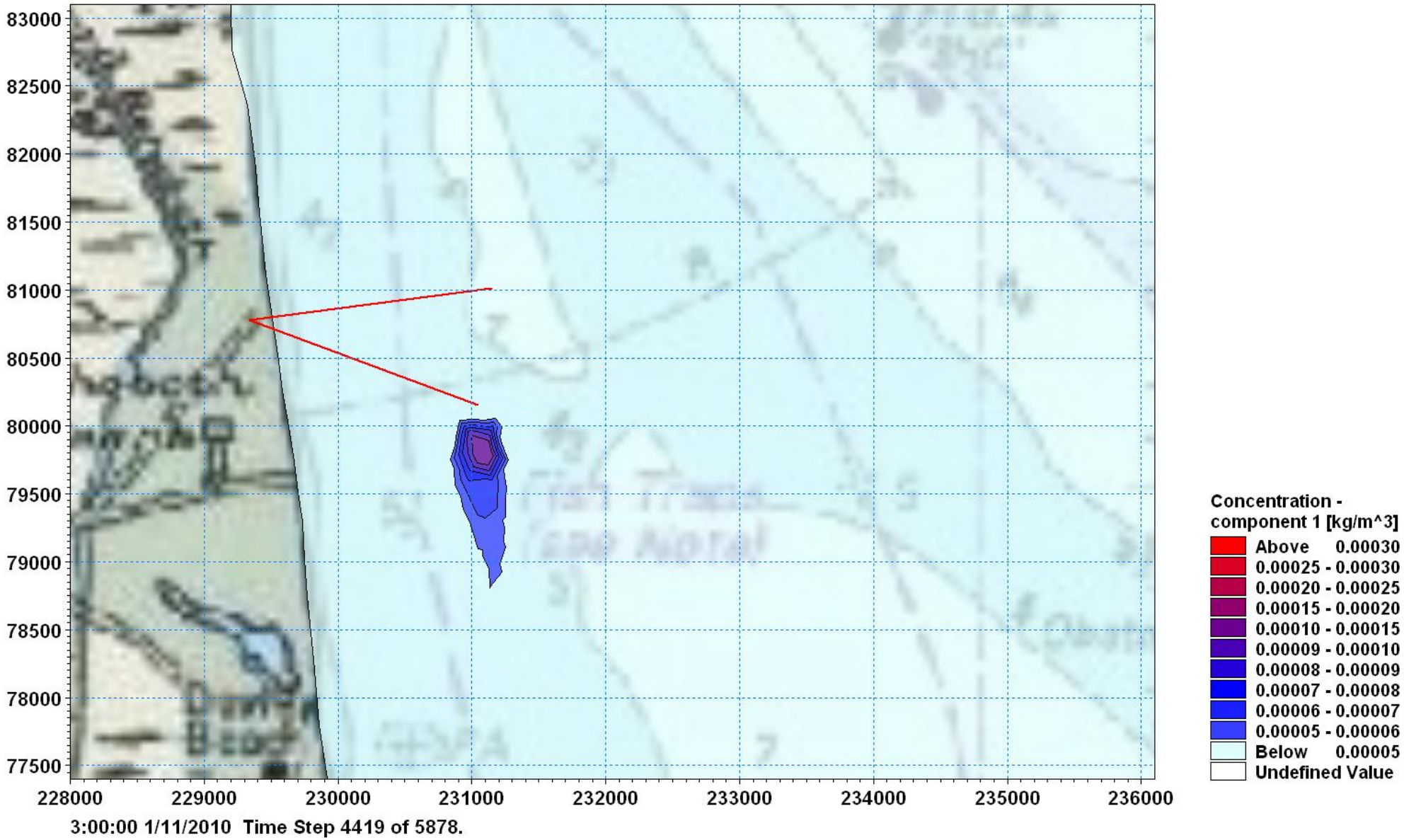



**Figure D-1b** Southern outfall, predicted footprint of the plume on Nov 1st 2010 at 3 AM.

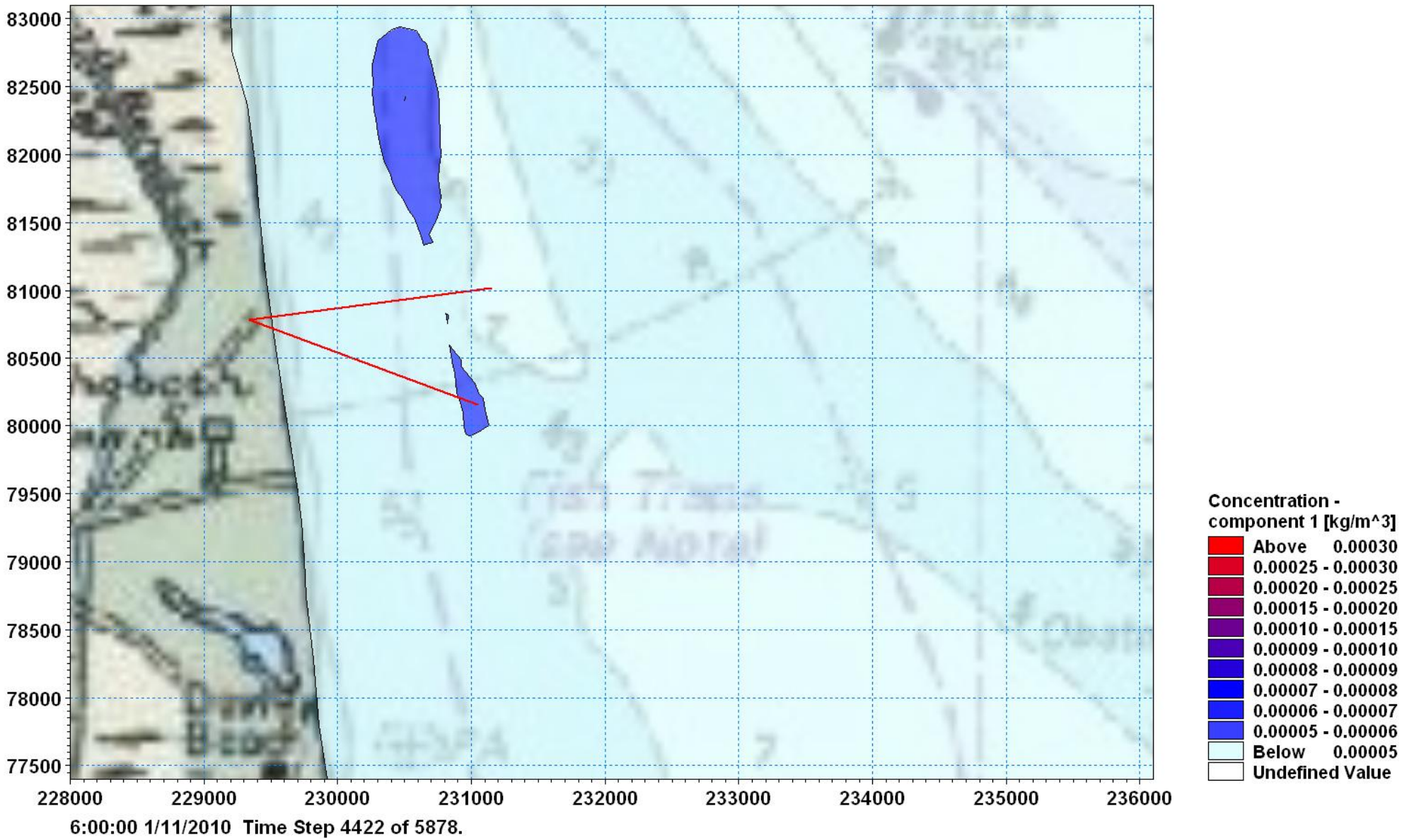



**Figure D-1c** Southern outfall, predicted footprint of the plume on Nov 1st 2010 at 6 AM.

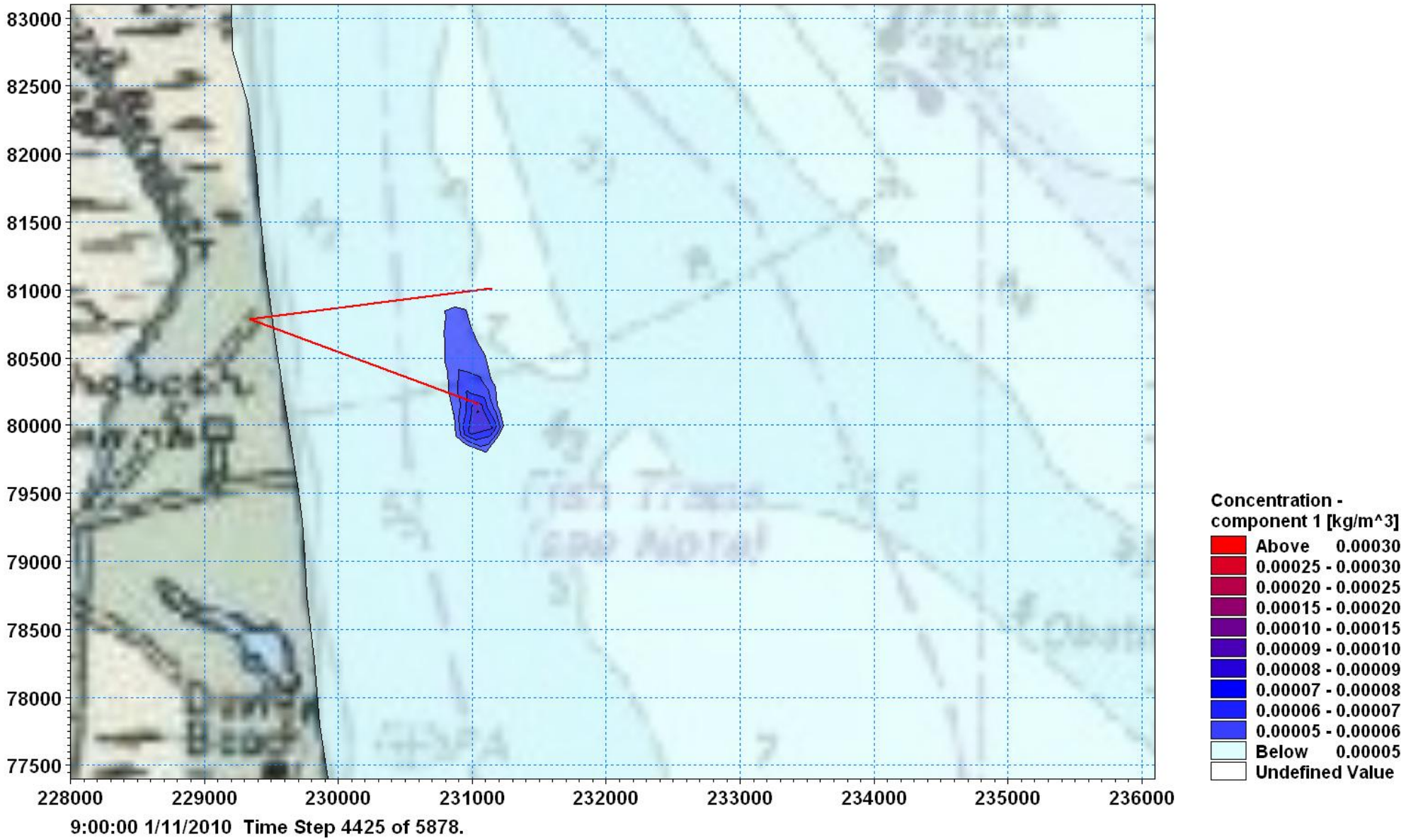



**Figure D-1d** Southern outfall, predicted footprint of the plume on Nov 1st 2010 at 9 AM.

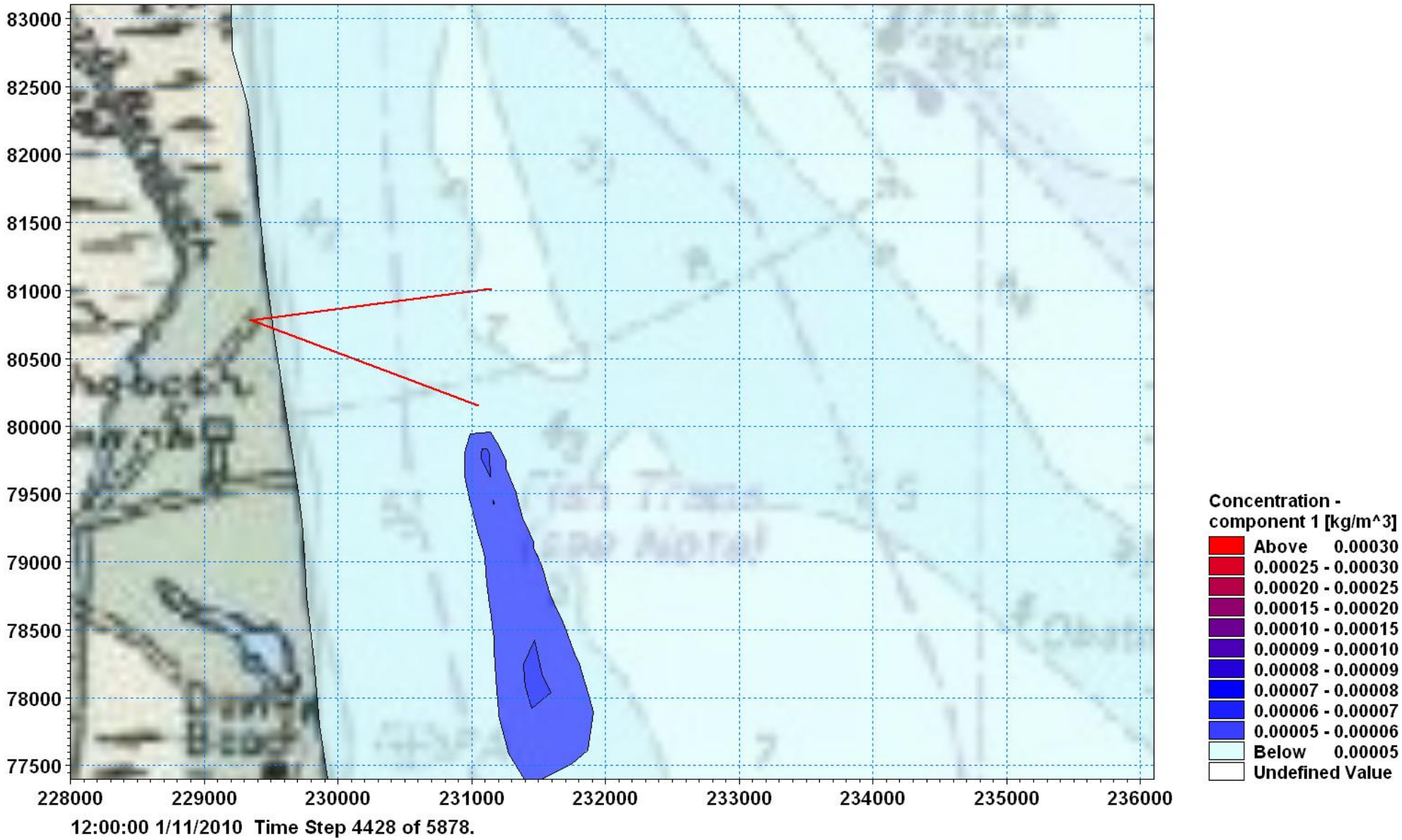



**Figure D-1e** Southern outfall, predicted footprint of the plume on Nov 1st 2010 at 12 AM.

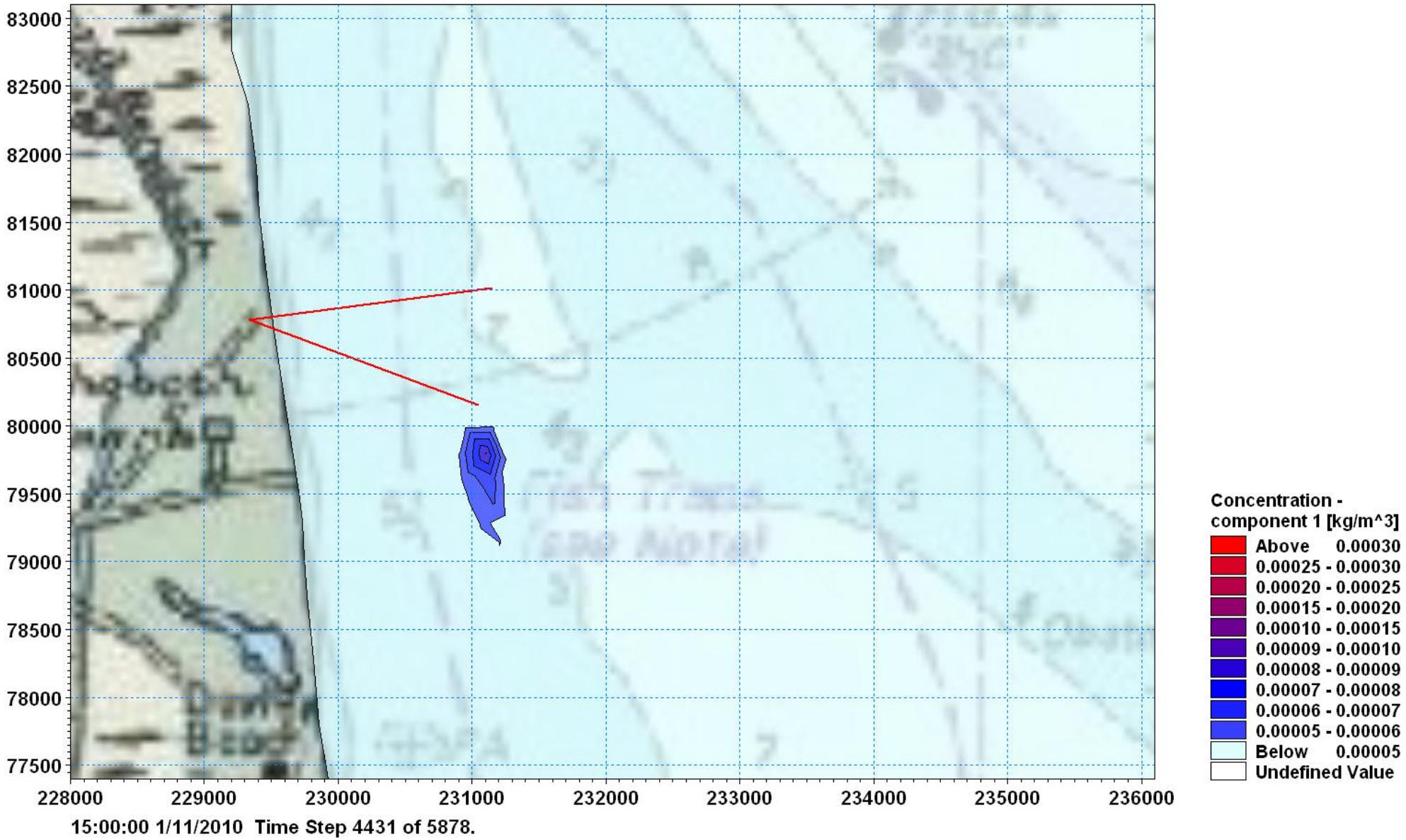



**Figure D-1f** Southern outfall, predicted footprint of the plume on Nov 1st 2010 at 3 PM.

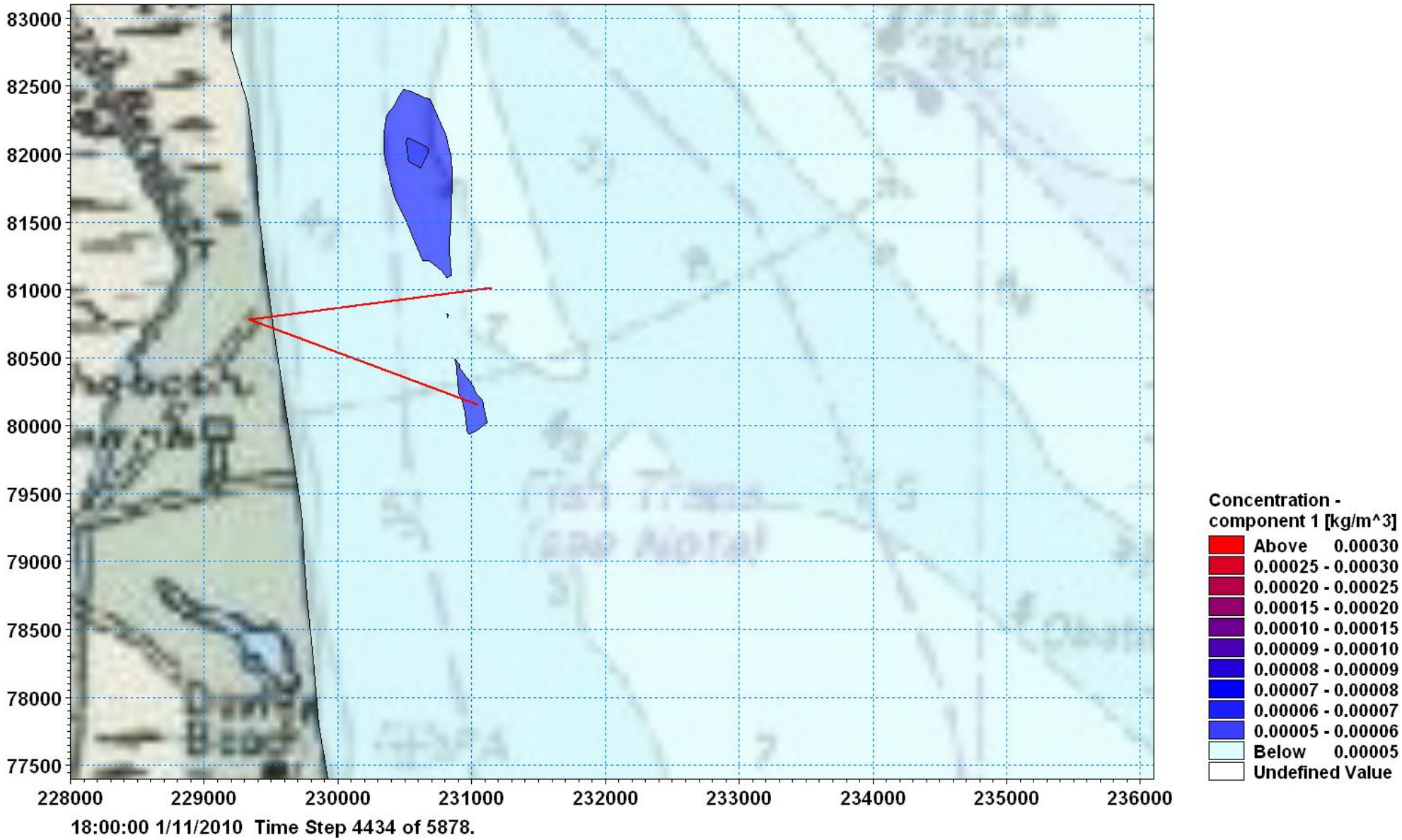



**Figure D-1h** Southern outfall, predicted footprint of the plume on Nov 1st 2010 at 6 PM.

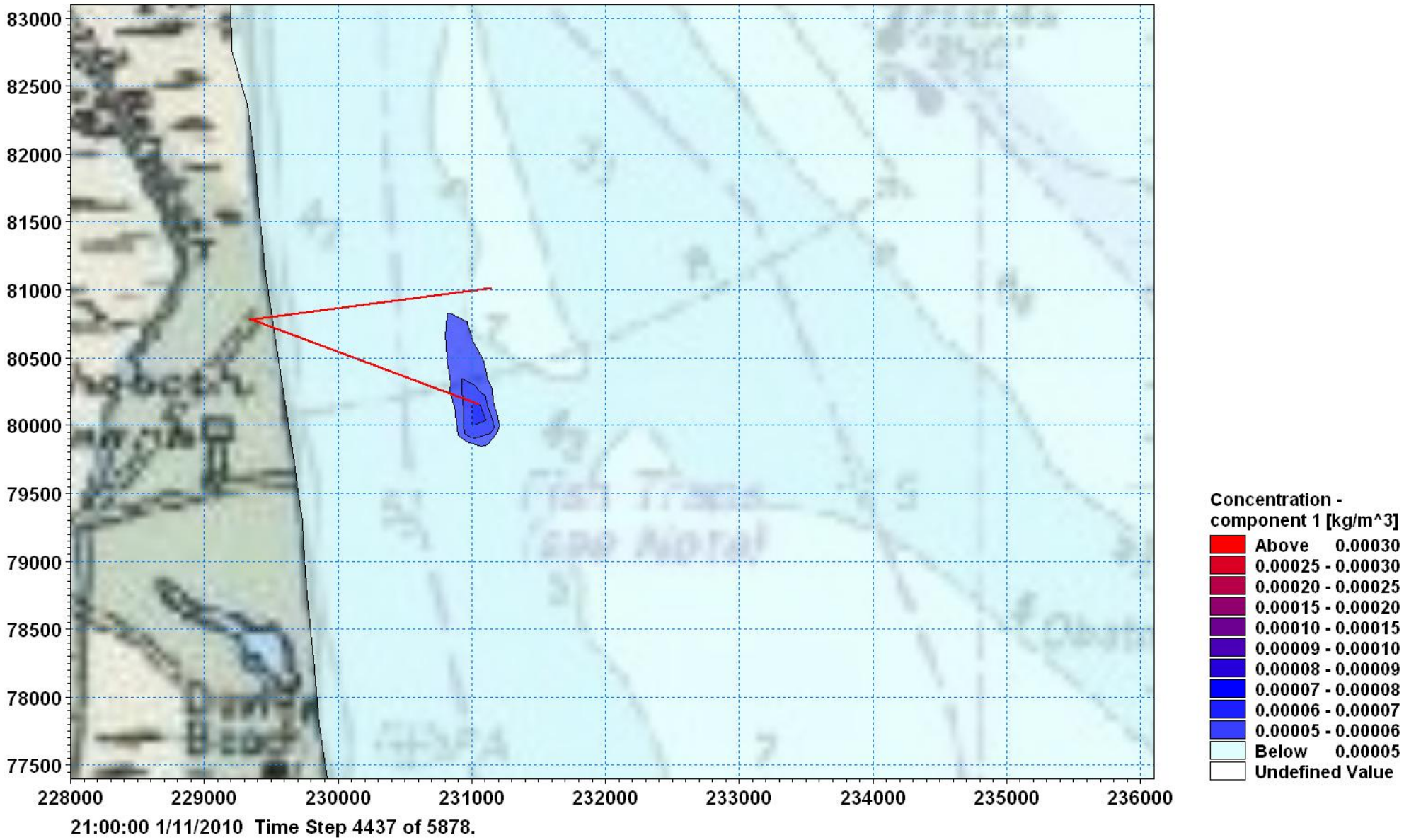



**Figure D-1g** Southern outfall, predicted footprint of the plume on Nov 1st 2010 at 9 PM.

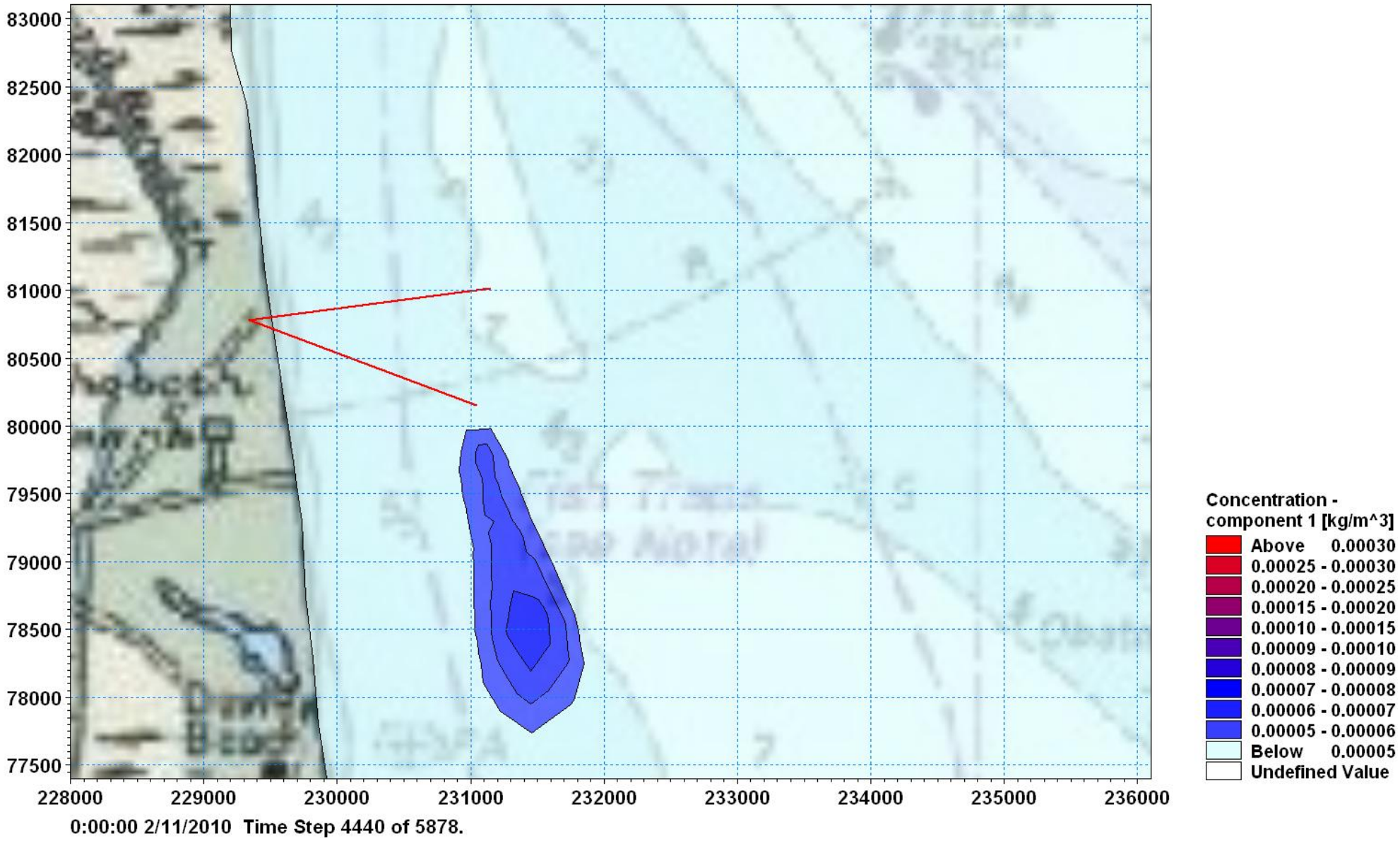



**Figure D-1h** Southern outfall, predicted footprint of the plume on Nov 2nd 2010 at 0 AM.

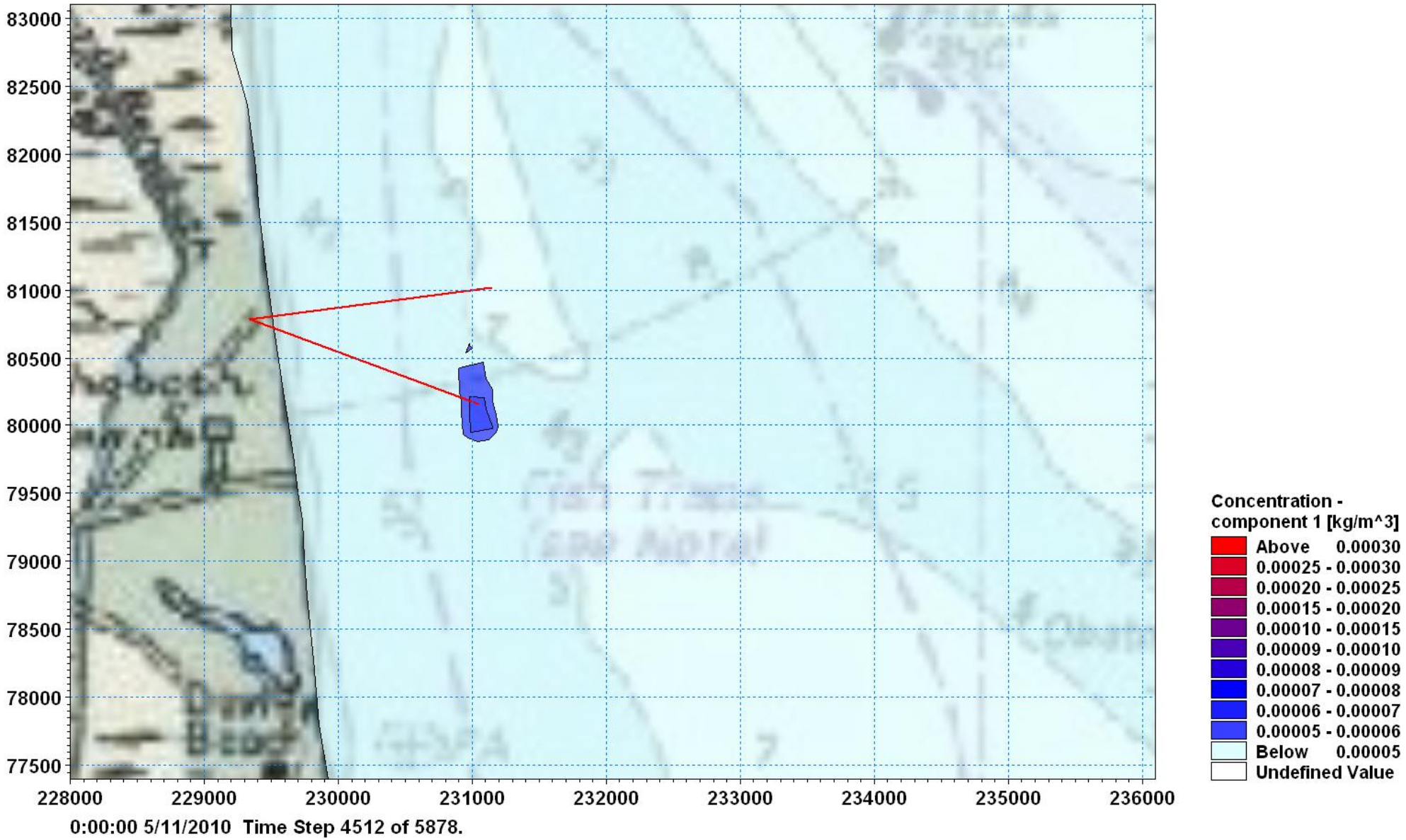



**Figure D-2a** Southern outfall, predicted footprint of the plume on **Nov 5th 2010 at 0 AM**.

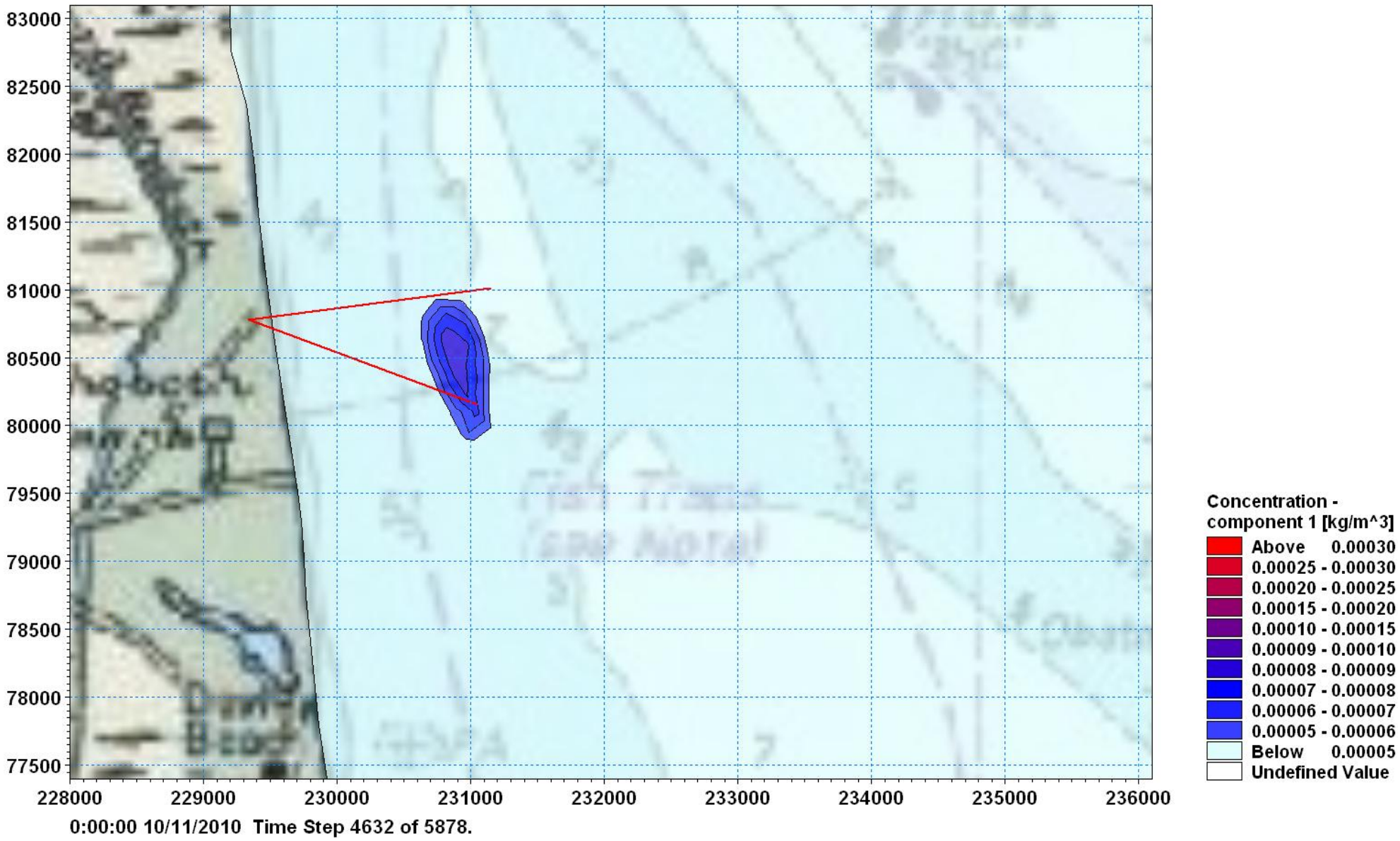



**Figure D-2b** Southern outfall, predicted footprint of the plume on **Nov 10th 2010 at 0 AM**.

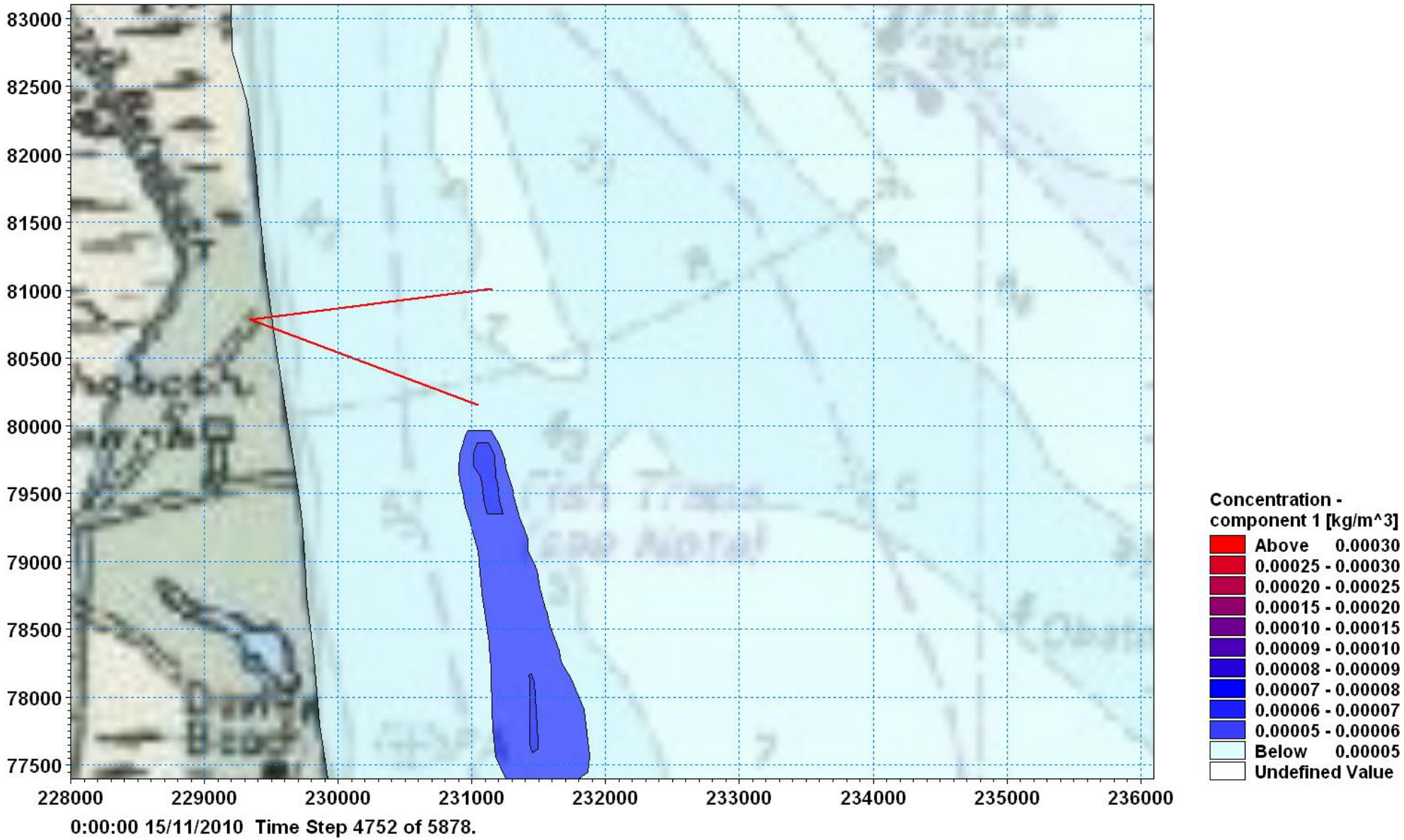



**Figure D-2c** Southern outfall, predicted footprint of the plume on **Nov 15th 2010 at 0 AM**.

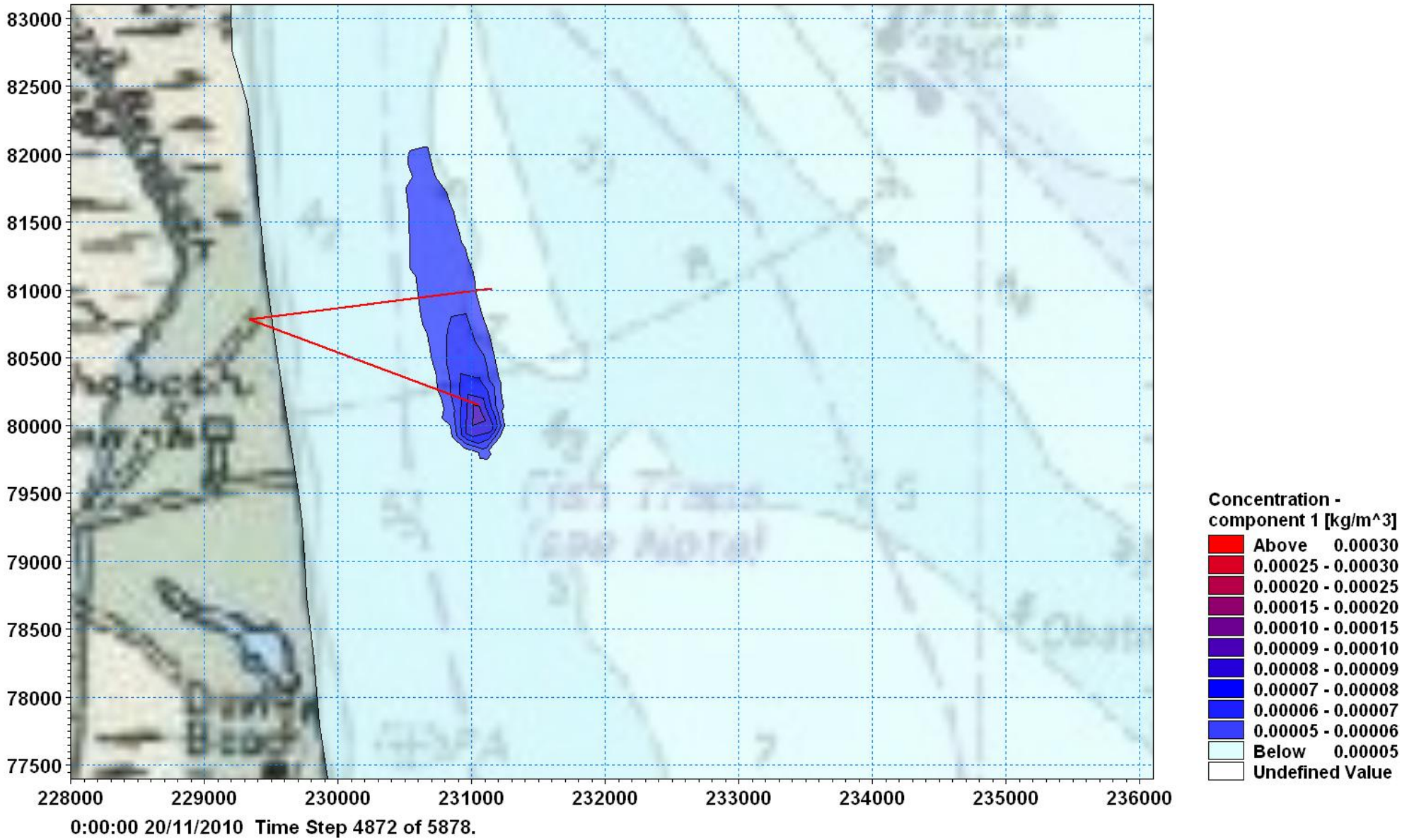



**Figure D-2d** Southern outfall, predicted footprint of the plume on **Nov 20th 2010 at 0 AM**.

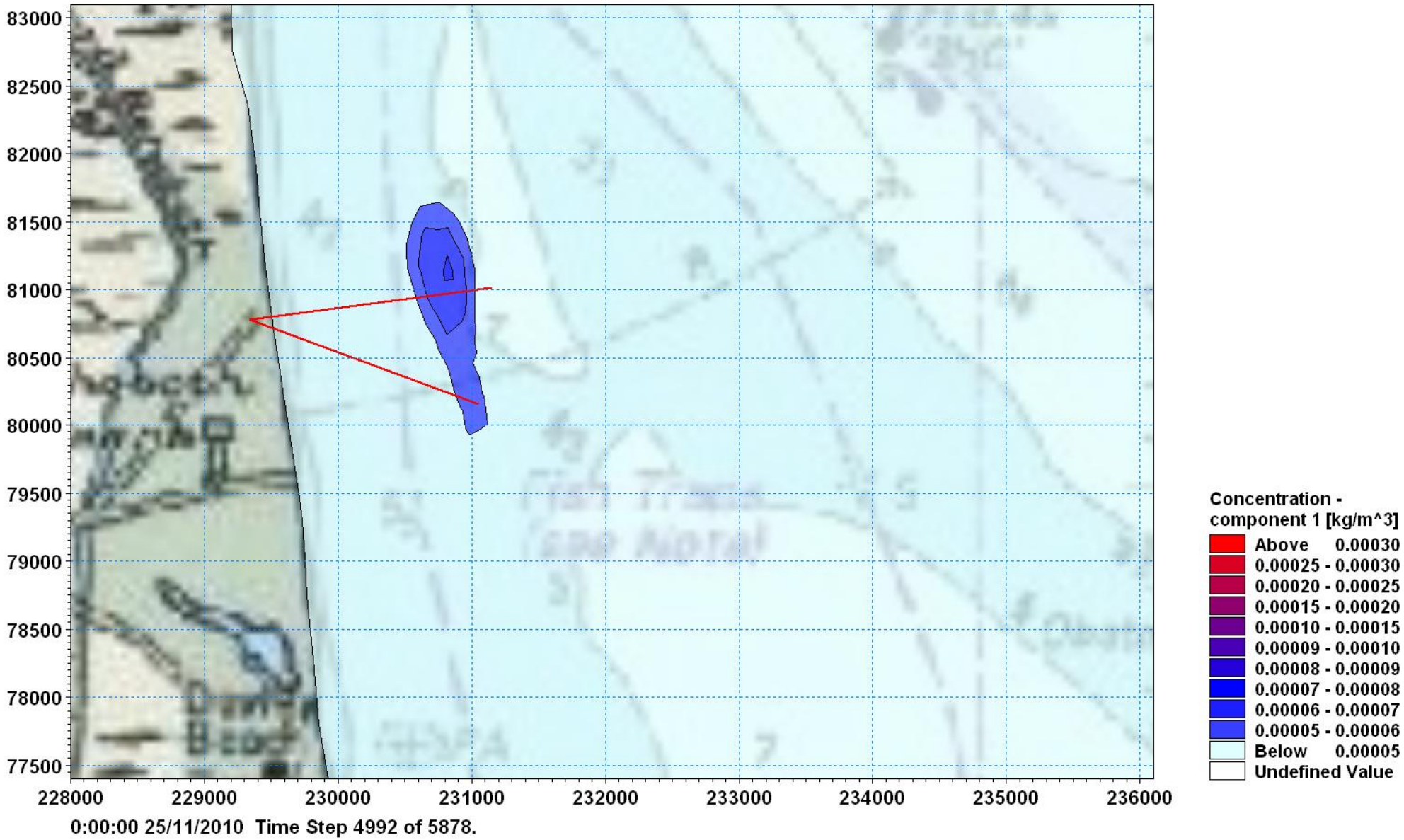



**Figure D-2e** Southern outfall, predicted footprint of the plume on **Nov 25th 2010 at 0 AM**.

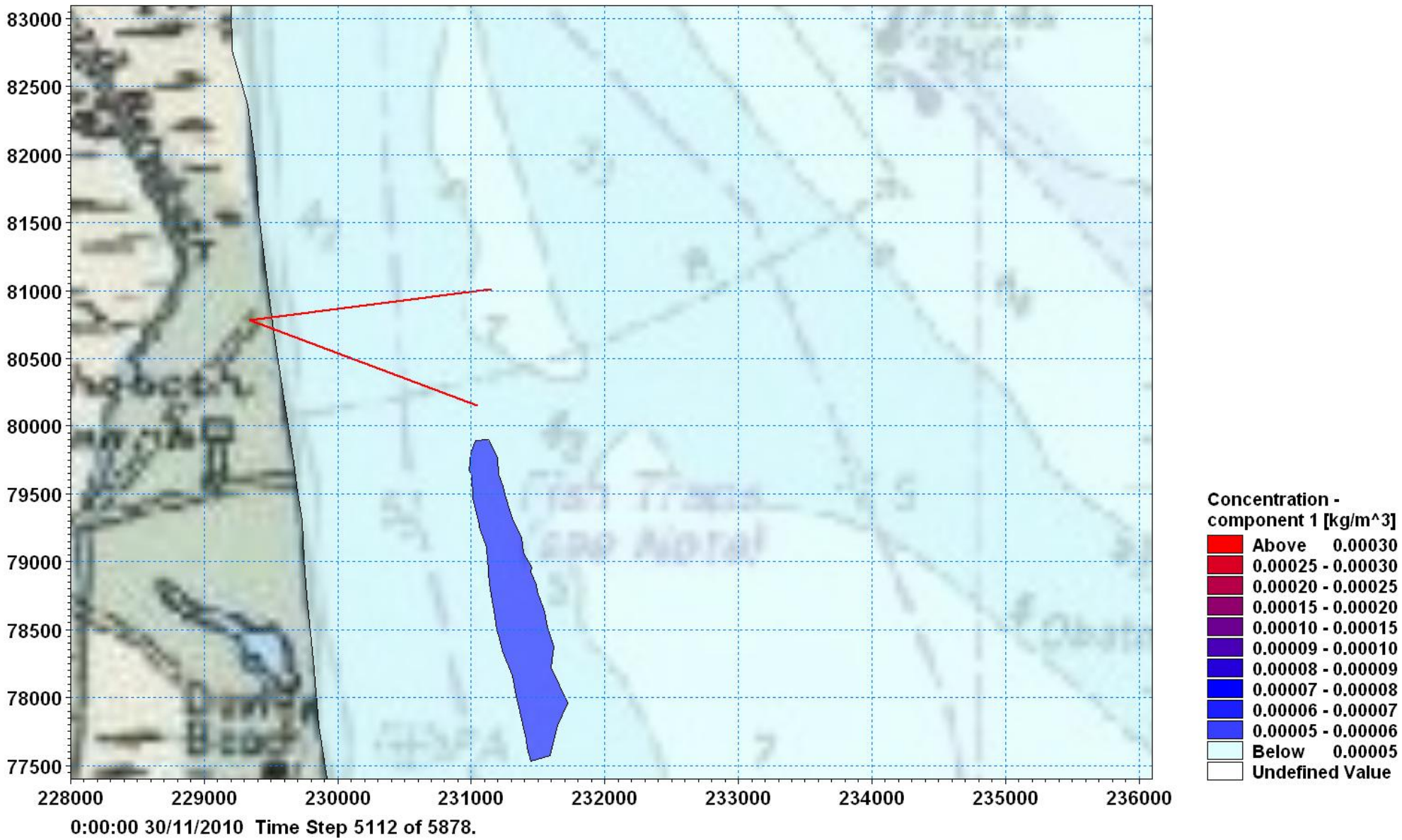



**Figure D-2f** Southern outfall, predicted footprint of the plume on **Nov 30th 2010 at 0 AM**.

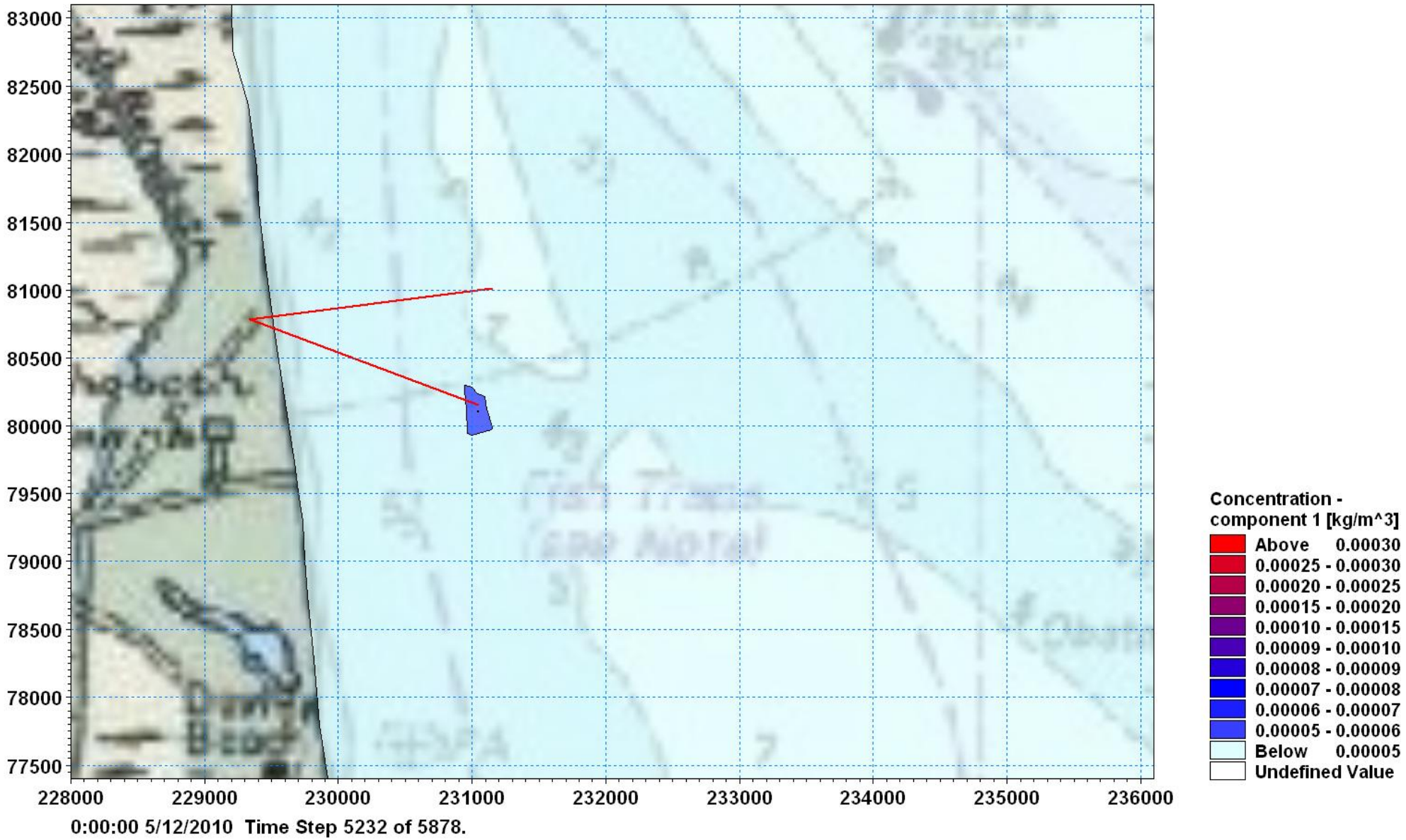



**Figure D-2g** Southern outfall, predicted footprint of the plume on **Dec 5th 2010 at 0 AM**.

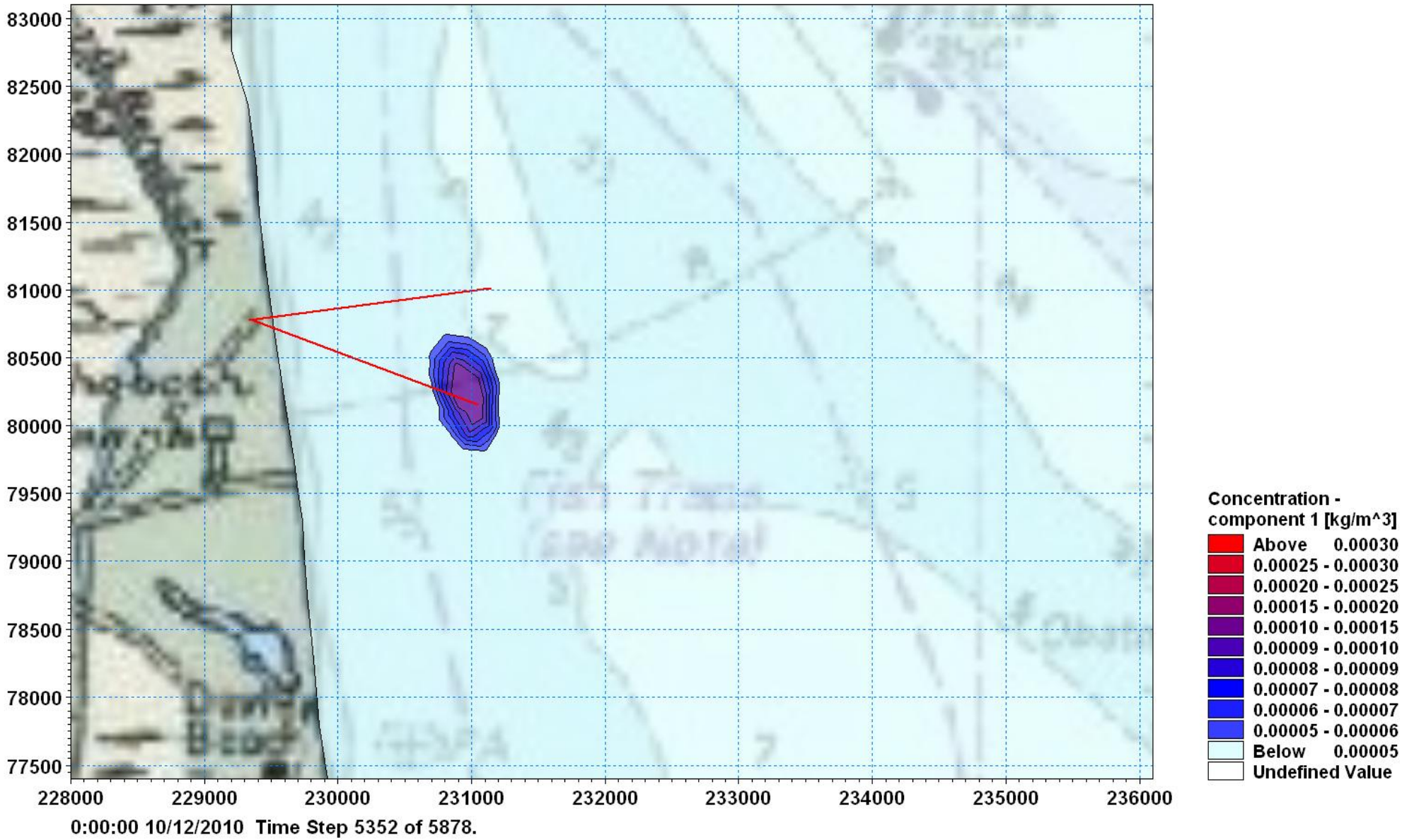



**Figure D-2h** Southern outfall, predicted footprint of the plume on **Dec 10th 2010 at 0 AM**.

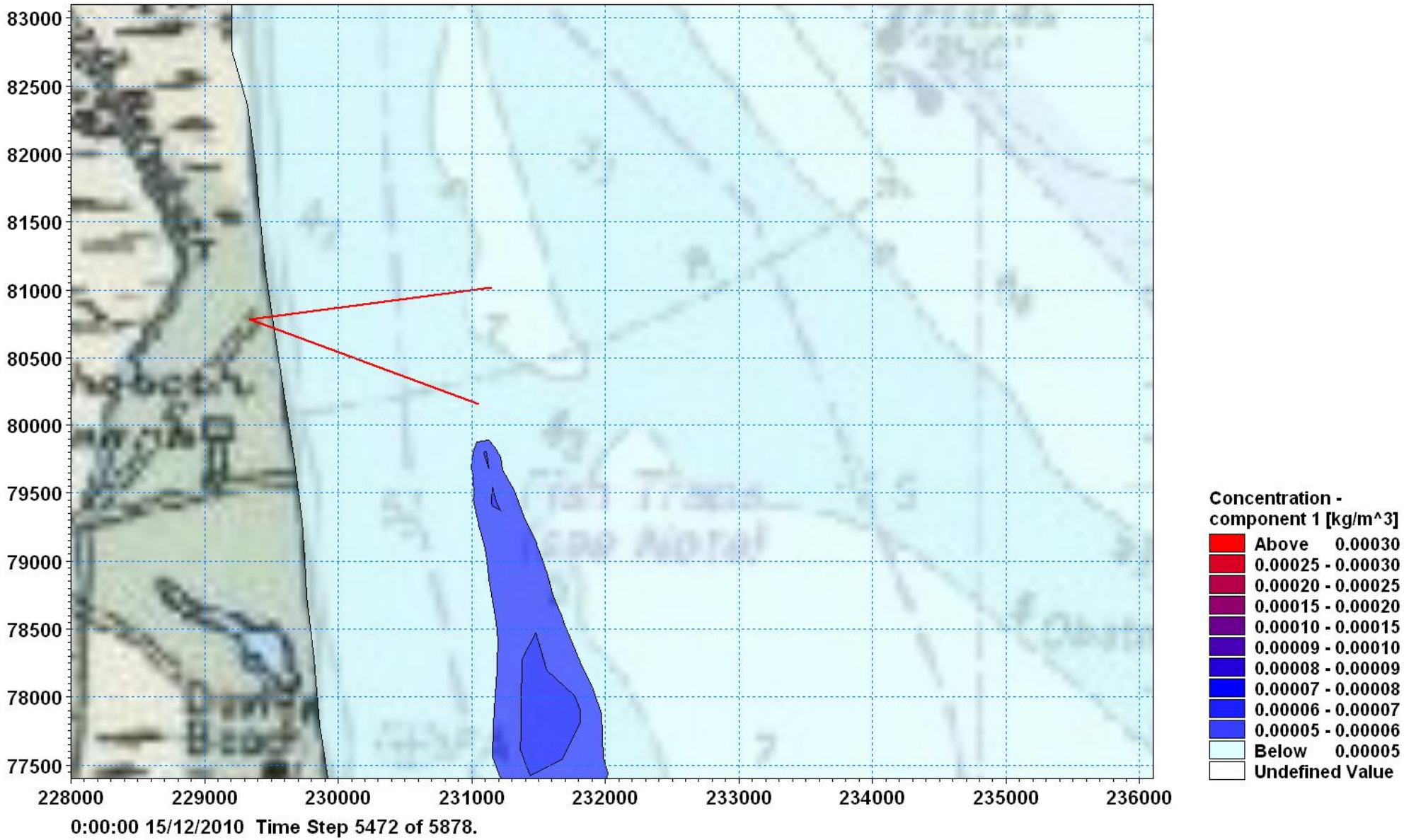



**Figure D-2i** Southern outfall, predicted footprint of the plume on **Dec 15th 2010 at 0 AM**.

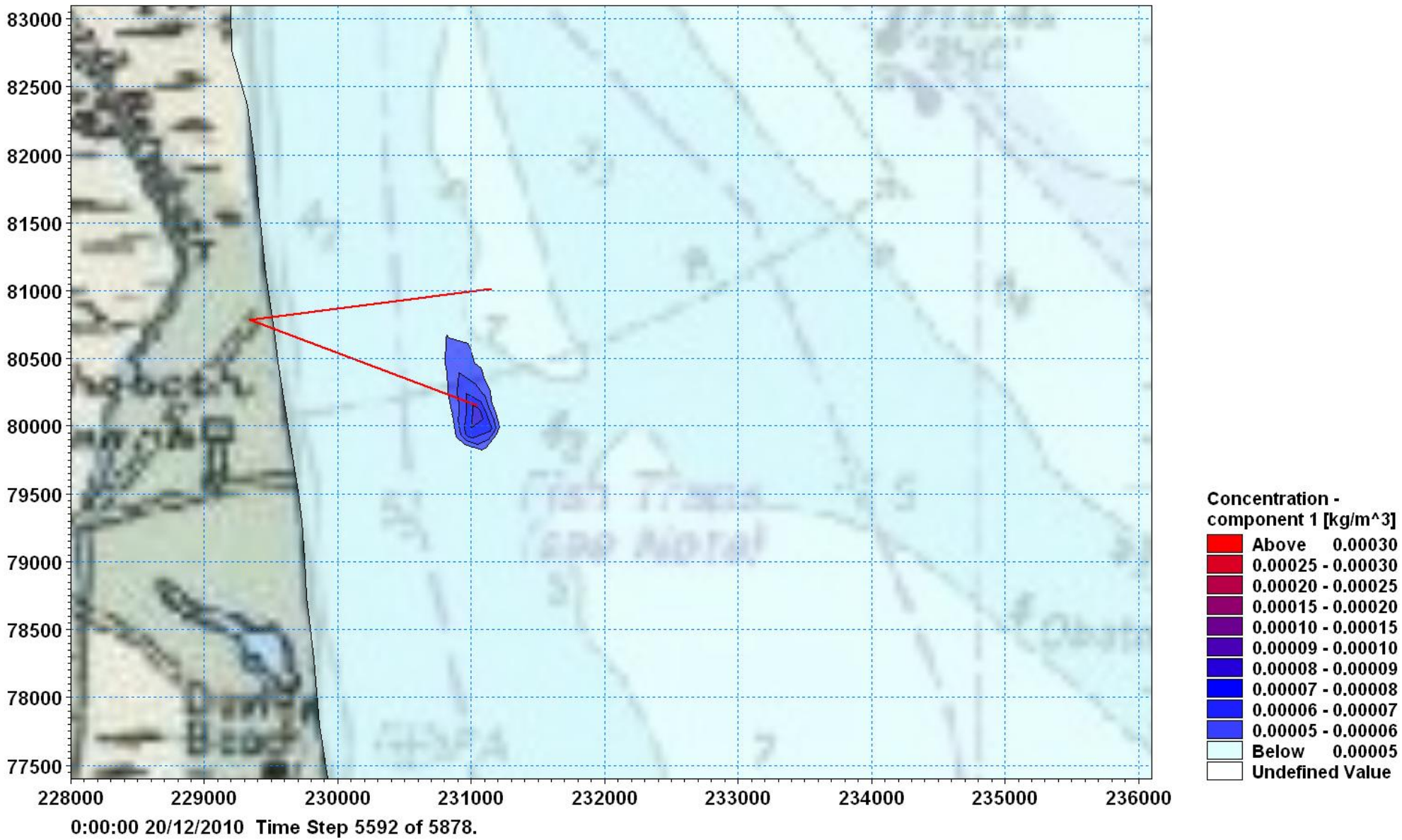



**Figure D-2j** Southern outfall, predicted footprint of the plume on **Dec 20th 2010 at 0 AM**.

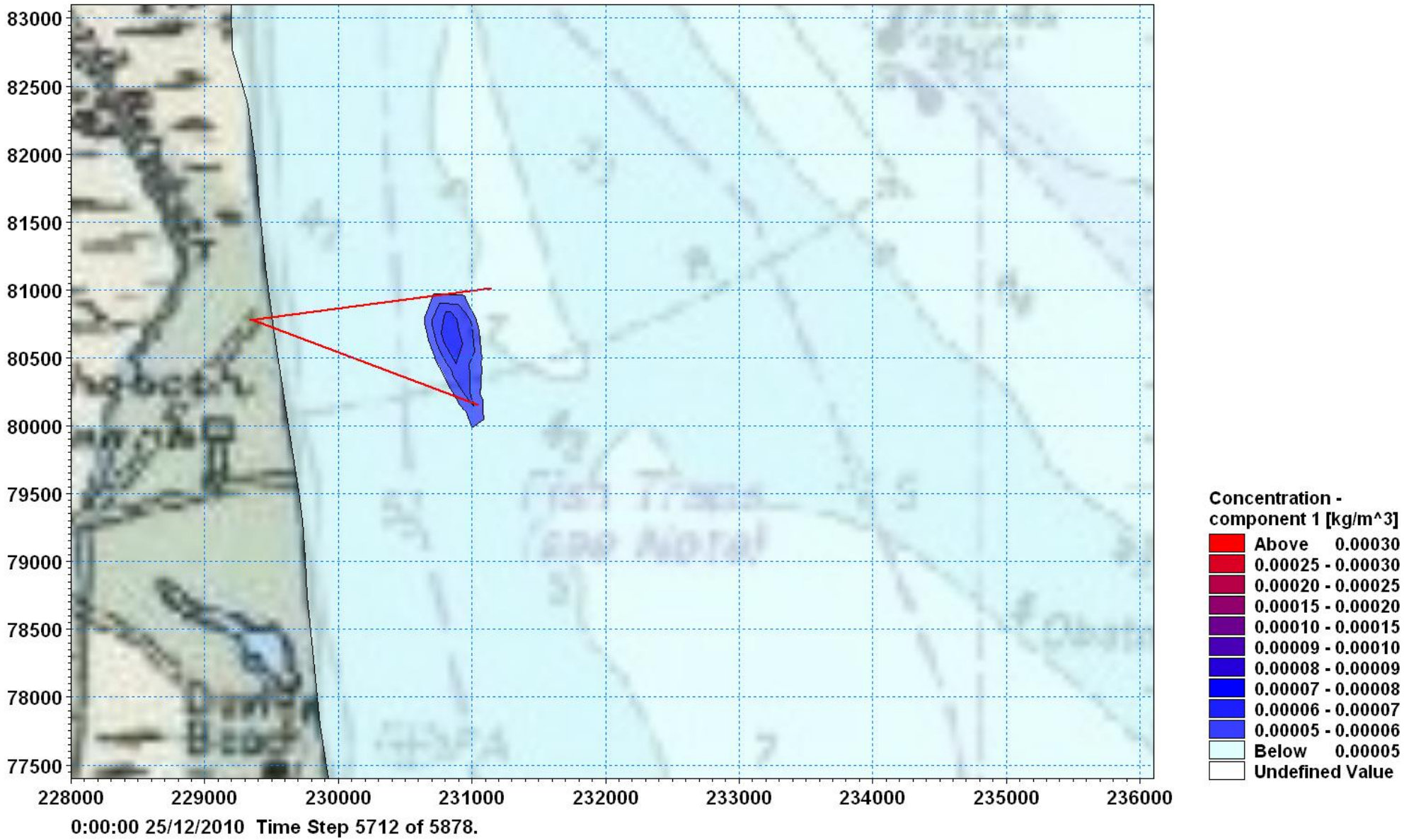



**Figure D-2k** Southern outfall, predicted footprint of the plume on **Dec 25th 2010 at 0 AM**.

Appendix E

# Near-Field Modeling

## Results

**GHD**

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