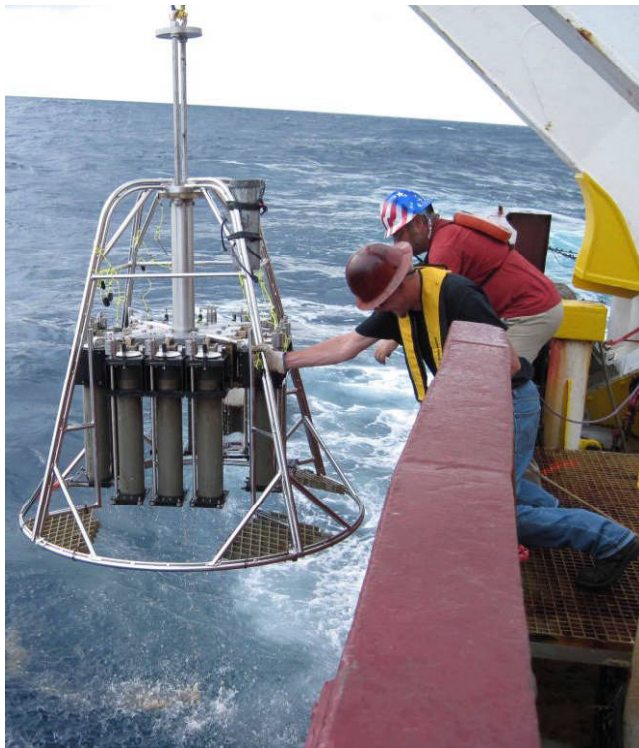


JOINT ANALYSIS GROUP, DEEPWATER HORIZON OIL SPILL:
REVIEW OF PRELIMINARY DATA TO EXAMINE OXYGEN LEVELS
IN THE VICINITY OF MC252#1, MAY 8 TO AUGUST 9, 2010



Silver Spring, Maryland
August 2011



noaa National Oceanic and Atmospheric Administration

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NOAA Technical Report NOS OR&R 26

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Foreword

The National Incident Commander for the Deepwater Horizon Oil Spill established the Joint Analysis Group (JAG) to examine the subsurface oceanographic data that was collected through the coordinated sampling efforts of vessels contracted for or owned by BP, NOAA, and academic scientists. The JAG is comprised of scientists from the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, the Bureau of Ocean Energy Management, Regulation and Enforcement, the White House Office of Science and Technology Policy, BP, and several academic institutions.

The JAG is performing three major tasks:

- Integrate the data both spatially and temporally to allow their visualization and analysis.
- Analyze the data to describe the distribution of oil and the oceanographic processes that affect its transport.
- Issue periodic reports to the National Incident Command (NIC), the Unified Command, the public, and other researchers that include visualization, analysis, and synthesis products.

This Technical Report contains the third periodic report released by the JAG.

This document is presented in its original form, with the exception of minor editorial changes and formatting.



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June 1, 2011

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Joint Analysis Group (JAG)

Review of Preliminary Data to Examine Oxygen Levels In the Vicinity of MC252#1, May 8 to August 9, 2010

1 Background

This report by the National Incident Command Joint Analysis Group (JAG) presents preliminary data on dissolved oxygen (DO₂) from 419 stations collected by the NOAA Ship *Gordon Gunter*, NOAA Ship *Henry Bigelow*, NOAA Ship *Nancy Foster*, NOAA Ship *Thomas Jefferson*, R/V *Brooks McCall*, R/V *Ferrel*, R/V *Jack Fitz*, R/V *Ocean Veritas*, and R/V *Walton Smith* near the site of the BP Deepwater Horizon (DWH) incident located in the Mississippi Canyon Lease Block area 252 (MC252) and the BP#1 wellhead (MC252#1). The data were collected from May 8 to August 9, 2010. Table 1 shows vessel and cruise dates from which data were analyzed, with notes on data processing issues. Maps 1 and 2 show the monitoring area and station locations by date. The results from these measurements were examined by the JAG as a continuation of analyses and data presented in its first two reports.¹

The Mississippi Canyon Block 252 well #1 released oil and gas for 87 days until the well was successfully capped on July 15. The National Incident Command Flow Rate Technical Group estimated that 4.93 million barrels of oil² + 10% were released from the well. Containment actions captured approximately 800,000 barrels of oil prior to the well being capped. Between April 30 and July 15, approximately 771,000 gallons of chemical dispersant were added to the oil and gas flow at the wellhead.³ Of the total oil spilled, approximately 1.2 million barrels were estimated to be naturally or chemically dispersed, the majority of that at the wellhead.⁴ Throughout the spill, hydrocarbons and other associated fractions that escaped subsea collection systems at the wellhead, most likely as a mixture of oil, gas, and hydrate,⁵ resulted in some hydrocarbons reaching the surface and some remaining at depth either dissolved in the water column and/or as small droplets.

This report uses available monitoring data to examine whether DO₂ concentrations were lower than expected at depth that can reasonably be attributed to subsurface-dispersed MC252#1 hydrocarbons and, if so, whether hypoxic conditions or significant reductions in DO₂ concentrations were observed over the period of these measurements. Hypoxia occurs when the

¹ Joint Analysis Group (JAG) Review of *R/V Brooks McCall* Data to Examine Subsurface Oil. June 2010. See http://www.noaa.gov/sciencemissions/PDFs/JAG_Report_1_BrooksMcCall_Final_June20.pdf and Joint Analysis Group (JAG) Review of Preliminary Data to Examine Subsurface Oil In the Vicinity of MC252#1 May 19 to June 19, 2010. See <http://ecowatch.ncddc.noaa.gov/jag/files/JAG%20Data%20Report%202%20FINAL.pdf>.

² A barrel of oil equals 42 gallons.

³ See <http://www.deepwaterhorizonresponse.com/go/doc/2931/853031/>.

⁴ BP Deepwater Horizon Oil Budget: What Happened To the Oil?
http://www.noaanews.noaa.gov/stories2010/PDFs/OilBudget_description_%2083final.pdf.

⁵ Oil in the Sea III: Inputs, Fates, and Effects (2003). p107-108. http://www.nap.edu/catalog.php?record_id=10388.

concentration of DO₂ in the water falls to a level that impedes aquatic life. Hypoxic conditions are generally agreed to occur when DO₂ falls below 1.4 mL/L (also expressed as 2 mg/L),⁶ though effects levels are species dependent. Hypoxia is regularly observed in the Northern Gulf of Mexico adjacent to the Mississippi River on the Louisiana and Texas continental shelf.⁷ Hypoxic conditions do not normally occur in the deep-water layer where MC252 #1 oil has been found. In fact this water layer is relatively rich in DO₂ with a spring climatological mean of 4.8±0.1 mL/L (~6.9 mg/L) at 1500-m depth.⁸

Biodegradation of hydrocarbons in the deep water by bacteria is expected to cause consumption of DO₂. The most important factors that affect biodegradation in the environment are weathering of the oil, temperature, DO₂, and nutrients. The relationships among these factors and hydrocarbon biodegradation are well known.⁹ In addition, according to an EPA laboratory study published in 2007, the biodegradation rate of chemically dispersed Prudhoe Bay crude oil at 5 °C was slower than at 20 °C but was still faster than undispersed oil.¹⁰ Dispersant effectiveness (DE) is highly dependent on turbulence (higher turbulence correlates with better DE), temperature (lower temperature correlates with lower DE), and the weight and viscosity of the crude oil (the lower the weight, the more dispersible). High DE resulted in droplet sizes in the range of 2.5 to 60 µm measured in the EPA/Department of Fisheries and Oceans wave tank in Canada using a medium-weight crude oil (Prudhoe Bay crude).¹¹ This matches the particle size range measured in the 1000- to 1300-m depth in the Gulf of Mexico at and around the MC252 wellhead. These droplet sizes are consistent with chemical dispersion based on wave tank studies of surface dispersant application. However, the extreme turbulence caused by the high oil velocity emerging from the wellhead together with the light weight of the South Louisiana crude oil (SLC), suggests that dispersion was due to a combination of physical factors and the application of dispersants. The relative importance of these factors remains under investigation.

Oxygen is utilized by bacteria in all major metabolic pathways for hydrocarbon degradation. Biodegradation of 1 L of oil at depth in the Gulf of Mexico consumes the oxygen in 320,000 L of

⁶ For DO₂, 1 mL/L is approximately equal to 1.43 mg/L.

⁷ See <http://www.gulfhypoxia.net/Overview/> for more detail on hypoxia in the Gulf of Mexico.

⁸ Garcia, H. E., R. A. Locarnini, T. P. Boyer, and J. I. Antonov, 2010. World Ocean Atlas 2009, Volume 3: Dissolved Oxygen, Apparent Oxygen Utilization, and Oxygen Saturation. S. Levitus, Ed. NOAA Atlas NESDIS 70, U.S. Government Printing Office, Washington, D.C., 344 pp.

⁹ Atlas, R.M. (1981) Microbial degradation of petroleum hydrocarbons: An environmental perspective. *Microbiol. Rev.* 45, 180–209.

¹⁰ Venosa, A.D. and E.L. Holder. 2007. "Biodegradability of dispersed crude oil at two different temperatures." *Marine Poll. Bulletin* 54: 545-553. This experiment was done with a mesophilic oil degrading culture not adapted to cold temperatures. In environments where a psychrophilic (cold-loving) microbial community has evolved, biodegradation can occur at significant rates under cold conditions.

¹¹ Li, Z., K. Lee, T. King, M.C. Boufadel, and A.D. Venosa. 2009. "Evaluating oil spill chemical dispersion efficacy in an experimental wave tank: 2. Significant factors determining in-situ oil droplet size distributions." *Environmental Eng. Sci.*, 26:1407-1418.

seawater.¹² The oxygen levels below 1.4 mL/L (or 2 mg/L) are considered to be hypoxic by oceanographers and ecologists. Therefore, the DWH Unified Incident Command (UIC) issued a directive establishing DO₂ as one of the major tracking variables in its monitoring plan.¹³ The Directive stated that if the DO₂ fell below 2 mg/L (1.4 mL/L) in the deep sea, the UIC would consider discontinuance of dispersant injection. Based on the evidence gathered to date from all available cruise data, the levels of DO₂ have not been low enough to have triggered this shutdown criterion.

Other important variables that have yet to be measured to our knowledge in the deep sea during this spill, but are necessary to determine whether biodegradation may or may not be occurring, are dissolved carbon dioxide (dissolved inorganic carbon), dissolved nitrogen (ammonium, nitrite, nitrate, and/or total Kjeldahl nitrogen), dissolved inorganic phosphorus (phosphate), and the concentrations of hydrocarbon degrading bacteria.

2 Measurement of Dissolved Oxygen

DO₂ in the deep ocean can be measured with electronic and chemical methods that vary in their precision and accuracy. These variations may encompass potential for interference from organic materials and oxidizing and reducing agents possibly present near the MC252 site. The Sea-Bird Electronics, Inc., SBE 43 in situ sensor uses a Clark polarographic-type membrane for measuring DO₂. The SBE 43 captures readings at 2-sec intervals as it is lowered and raised through the water column. The large majority of the DO₂ data used in this report comes from vertical profiles of this sensor attached to a conductivity, temperature, and depth (CTD) sensor. In situ sensors are calibrated at the factory but additional field calibrations to account for drift over time, for systematic offsets, and to validate the measurements are necessary. Besides calibration, these sensor systems are subject to a number of known issues that can affect data quality, including data transmission problems associated with the thousands of meters of conducting wire and related electrical connections, and can experience interference from contaminants in the sampled water. In addition, instrument setup, deployment, and post-processing software setting must be appropriate and consistent. An extreme case can be seen in Figure 1, which shows a problem likely associated with an electrical connection to the CTD.

DO₂ was also measured in discrete water samples collected at specific depths using Niskin 0 sample bottles during multiple cruises. The DO₂ in these samples can be tested using chemical or electronic methods implemented in a variety of ways, including commercial kits such as the LaMotte and Hach brand DO₂ field test kits. These kits are adaptations of the classic Winkler chemical titration method and are considered easier, but are significantly less precise and accurate than the original Winkler procedure. Automated Winkler chemical titration techniques

¹² Atlas, 1981. R.M. Atlas, Microbial degradation of petroleum hydrocarbons: an environmental perspective. *Microbial. Rev.* **45** (1981), pp. 180-209.

¹³ See <http://www.epa.gov/bpspill/dispersants.html#directives>.

using photometric or amperometric end-detection methods are generally considered by oceanographers to be the most accurate method with the highest precision for measuring DO₂ at sea when they are performed by a trained operator with carefully prepared reagents and standards and calibrated flasks following accepted protocols (e.g., World Ocean Circulation Experiment [WOCE], Climate Variability and Predictability [CLIVAR]). These methods can be affected by sampling errors, reagent quality, operator inconsistencies, and interference from contaminants in sampled water. On some monitoring cruises, additional DO₂ measurements from bottle samples on deck were made at times with an Extech membrane-based DO₂ probe, a YSI ProODO (optical probe), or a YSI Ecosense 200 (membrane probe). Regardless of the analytical method, measuring DO₂ in bottle samples is also complicated by the need to prevent sample contamination by atmospheric oxygen during oxygen measurement.

3 Data Analysis and Interpretation

CTD DO₂ continuous profiles collected during some cruises show significant offsets as a function of depth or density relative to DO₂ profiles from other research cruises. In addition, agreement was initially poor among different in situ measurements and discrete water bottle samples (Appendix 3) for the R/V *Brooks McCall*. The agreement significantly improved in later cruises as experience was gained and more precise methods were consistently used (Appendix 4). However, all of the DO₂ data presented here have received preliminary data quality control (QC) and quality assurance (QA) controls. Methods for data QC, QA, and processing for analysis are contained in Appendix 4.

To help examine the spatial and temporal evolution of the CTD DO₂ anomalies, it is important that the DO₂ profiles from the different cruises are compared and systematically assessed to help derive an internally consistent DO₂ data product. This process generally involves quantifying and correcting for systematic biases in the reported DO₂ profiles relative to a chosen reference. The NOAA Ship *Nancy Foster*, the R/V *Brooks McCall*, and the R/V *Ocean Veritas* conducted amperometric Winkler titrations during cruises conducted in August. However, only some of those reference data were available at the time of this report. Absent those data, the JAG considered using as a preliminary reference the World Ocean Atlas 2009 (WOA09) objectively analyzed 1-degree DO₂ annual mean climatology at standard depth levels because they provide a well-documented and representative comparative data set.⁸ The WOA09 annual O₂ climatology is derived from quality-controlled historical Winkler O₂ measurements, regardless of year of observation, from the World Ocean Database 2009 (WOD09¹⁴) (Figs. 2–4). As an exploratory first step, CTD DO₂ profiles from each cruise were adjusted to match the WOA09 reference profile over the depth range from 500 to 800 m. This depth range was preliminarily chosen because it is below the surface layer where DO₂ gradients are strong and variable and above the

¹⁴ Boyer, T.P., J. I. Antonov, O. K. Baranova, H. E. Garcia, D. R. Johnson, R. A. Locarnini, A. V. Mishonov, T. D. O'Brien, D. Seidov, I. V. Smolyar, M. M. Zweng, 2009. World Ocean Database 2009. S. Levitus, Ed., NOAA Atlas NESDIS 66, U.S. Gov. Printing Office, Wash., D.C., 216 pp., DVDs.

depths where anomalous DO₂ depressions are nominally observed. Slope and offset parameters were derived by means of linear least-squares. This method is very sensitive to differences in the slope of the CTD vs. reference-profile regression over the analysis interval (500–800 m), and as a result it was not possible to apply this method to the whole data set due to cruise-to-cruise nonsystematic variations in CTD DO₂ profiles as shown in Figure 5. These data warrant evaluation in the future using alternate approaches to allow intercomparisons. We assume that systematic biases are primarily instrumental. According to Sea-Bird, Inc., “Normal calibration drift manifests itself as a loss of sensitivity and is evident as a change of slope (and less so in offset) in the linear relationship between oxygen concentration and voltage output.”¹⁵

Because intercruise instrument offsets could not be corrected, within-cruise DO₂ profiles were used as one means of examining the relative level and trend in DO₂ depressions. The totals of all profiles considered in this report as compared to the annual mean climatology are shown in Figure 6. Examining WOD09 historical in situ DO₂ measurement made clear that we could also assume that short-term DO₂ variability among casts on a particular cruise below 1000-m depth is relatively small when compared to the magnitude of the DO₂ anomalies (see, for example, Figures 7 and 8). Winkler chemical titrations amperometric end-detection methods were available for comparison to SBE 43 measurements for data collected August 1–2 on the R/V *Ocean Veritas* and August 4–6 on the R/V *Brooks McCall*. Those data are shown in comparison with WOA09 data in Figures 9 and 10.

4 Conceptual Model

It is useful to consider a conceptual model for how monitored variables such as DO₂ would change during the course of a prolonged oil spill. Early in the event, when bacterial biomass was low, hydrocarbons would be found without an associated depression in DO₂, resulting in significant CDOM fluorescence anomalies but no appreciable DO₂ anomaly. As microbial communities develop, depressions in DO₂ would be correlated in space and time with CDOM fluorometer measurements of oil. As microbial degradation of hydrocarbons continues, DO₂ depressions will be found even in the absence of measurable fluorescence signals as oil is degraded.

Evidence suggests fluorescence measurements of oil are related to density of the water layer in which the oil is found (Fig. 13). This evidence suggests that the oil is staying primarily with the water layer described by a potential density 1027.70–1027.71 kg/m³ ($\sigma\theta$ values of 27.70 and 27.71, where $\sigma\theta$ = potential density–1000). A DO₂ drawdown due to hydrocarbon-based BOD would be expected to occur within this same water layer, though not in a one-to-one relationship when the conceptual model is considered.

¹⁵ http://7www.seabird.com/application_notes/AN64-2.htm.

Interpreting spatial and temporal patterns in DO₂ requires knowledge of the advection and diffusion in the water layer where the depression is found, as well as DO₂ utilization rates. Measurements of current velocities and direction in the deep-water layer where the oil has been found are available from an Acoustic Doppler Current Profiler (ADCP) very near the wellhead (station id 42916). During the time period of the investigation, currents are variable but predominantly southward, with stronger flows of 15–20 cm/s to the ESE, SSE and WSW (Figure 12). Because currents fluctuate and reverse, water that was transported to the northeast can flow back toward the area around the well. Because of this, distance from the wellhead does not simply correlate with time since release from the wellhead. Higher variability in both DO₂ and oil measurements near the wellhead will be expected because of these variable currents. However, the overall net transport of the deep water is to the southwest of the well. Currents will tend to flow along an isobath. As distance from the well increases, diffusion within the water layer and with adjacent water layers will tend to establish more uniform conditions.

Given this context, summary presentations of the available DO₂ observations have been compiled. The changes in DO₂ values over time (mean values in Fig. 41 and minimum values in Fig. 43) do not reveal obvious trends. Lowest values were observed in late May/early June and mid-July to present, but it is unclear if this is an artifact of the (essentially) random sampling. Conditions have not changed dramatically over time within the area sampled. Consideration of the spatial structure of the DO₂ observations (mean values in Fig. 42 and minimum values in Fig. 44) indicates little change in the range of DO₂ values with radial distance away from the wellhead. No observations have been less than 2.5 mL/L and thus have remained more than 1 mL/L above hypoxic levels (Figs. 43 and 44).

Appendix 1 presents conceptual box model analyses of the impact that biodegradation could have on the time required to reach hypoxia in the deep sea. The primary assumption of the model was that DO₂ utilized to biodegrade oil was not replenished from mixing with oxygen-rich surrounding water. Several scenarios are presented in Appendix 2 to define the upper and lower boundaries that delineate the minimum and maximum times (24 ± 5 d to 74 ± 2 d), respectively, needed for hypoxia. Results from the theoretical scenarios indicate the primary assumption, namely that mixing did not occur, was incorrect since hypoxia, which would have already occurred under these scenarios, has not been observed. Appendix 2 also compares conceptual model results with biodegradation results of the 2007 EPA laboratory study and the recent Lawrence-Berkeley study. Rates of biodegradation in the latter studies were much faster than the hypothetical scenarios, which supports the notion that mixing must have occurred in order to meet the observed DO₂ concentrations reported throughout this paper.

5 Conclusions to Date

The DO₂ measurements showing anomalies around 1000 m and extending to 1300–1400 m (identified in previous JAG reports) are interpreted as actual low values consistent with the depths of occurrence of the MC252 #1 hydrocarbons. These depressions range from ~ 0.1 mL/L

to 2.6 mL/L. The conclusions in this report are relevant for the deepwater layer in which MC252 #1 oil has been found using the data available to the JAG through August 9 (Appendix 5). Figures 14–40 show data for each cruise used to make this report’s conclusions. The SBE 43 data are plotted against water density (left scale) and use colors to identify the corresponding depth as shown on the right scale. Sample station locations included in the plot are shown relative to the wellhead on the map insert. Figures 41 and 42 show mean DO₂ values changing over space and time with reference to the mean and standard deviation for the 1-degree ocean climatology. Figures 43 and 44 show minimum DO₂ values with respect to the generally agreed upon value for hypoxic conditions (1.4 mL/L). Map 3 shows these values in relationship to the wellhead, with the highest values noted. On the basis of all the information presented in this report, the JAG conclusions to date are:

- Significant DO₂ low values (depressions) relative to background concentrations are being measured in the water layer at many stations where MC252 #1 oil has been observed. These depressions have been measured by means of different DO₂ instruments and methods.
- Measurements of the DO₂ depression have not approached hypoxic levels. Hypoxic conditions are not expected to occur in the deep-water layer where MC252 #1 oil has been observed.
- The depth layer of the DO₂ depressions is coincident with fluorescence-based measurements of MC252 oil when a fluorescence anomaly is present.
- The DO₂ depressions are most likely due to biochemical oxygen demand of MC252 hydrocarbons in the deep-water layer (Appendix 2).
- The minimum DO₂ levels in this data set were measured using the SBE 43 by the R/V *Walton Smith* on May 27 (station WS15a) about 18 km from the wellhead (2.96 mL/L) and the R/V *Ocean Veritas* on July 28 (station OV144) about 40 km from the wellhead (2.56 mL/L).
- The DO₂ depression has been found more than 80 km from the wellhead based on CTD DO₂ measurements.
- DO₂ depressions do not appear to be increasing over time, suggesting that the rate of hydrocarbon BOD is compensated by mixing with higher DO₂ waters surrounding the DO₂ depleted water layer.

- DO₂ levels should continue to be monitored using polarographic sensors and discrete samples from Niskin bottles using amperometric end-detection Winkler chemical titration methods until the end of August 2010. At that time available DO₂ and other data should be evaluated to determine if any further monitoring in support of response operations is warranted.
- This report does not discuss the broad ecosystem consequences of MC252 #1 hydrocarbons released into the environment.

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Table 1. Information for vessel data collection cruises included in this report with comments on station data quality.

<i>Vessel</i>	<i>Cruise</i>	<i>Cruise Start Date</i>	<i>Cruise End Date</i>	<i>Number of Stations</i>	<i>Number of Casts</i>	<i>Processing Comments</i>
Brooks McCall				167	178	
	Cruise 01	8-May	11-May	18	18	Stations 1-18, all bad data - no results
	Cruise 02	15-May	17-May	10	10	Stations 19-28, all bad data - no results
	Cruise 03	19-May	21-May	13	13	Stations 29-41, Cable Issue effected Dissolved Oxygen (SBE43) measurements
	Cruise 04	23-May	25-May	11	11	Stations 42-52, Cable Issue effected Dissolved Oxygen (SBE43) measurements
	Cruise 05	30-May	1-Jun	12	12	Stations 53-64, all processed without error
	Cruise 06	5-Jun	7-Jun	10	10	Stations 65-74, station 71 bad data, all others processed without error
	Cruise 07	11-Jun	13-Jun	13	13	Stations 75-87, all processed without error
	Cruise 08	17-Jun	19-Jun	12	14	Stations 88-99, stations 90 and 96 done twice. Stations 90a had problems processing the bottle data, stations 91, 92, 93 have no configuration file with which to process; stations 94 and 95 would only process on downcast only; station 96a had only two values
	Cruise 09	23-Jun	26-Jun	12	12	Stations 100-111. Station 101 had problems with the bottle data, all others processed without error.
	Cruise 11	5-Jul	7-Jul	6	6	Stations 112-117. Station 114 had a .hex file with 0 bytes. Station 112 had problems processing the bottle data.

Cruise 12	11-Jul	13-Jul	12	15	<p><i>Stations 118-130. Station 129 was done three times and station 130 was done twice. Station 126 has the data from a station numbered 128; and a station 128 was not submitted. Comments in the folder for Station 128 noted the name mixup. Station 129 did not process for bottle data. Stations 129a and 129b did not process. Station 130 had no bottle data, but 130a did process fully. Noted increase QC flags set for salinity profiles on later casts.</i></p>
Cruise 13	17-Jul	19-Jul	10	16	<p><i>Stations 131-140. Stations 132, 133, and 135 were done twice. Station 134 was done three times (134, 134A, 134B) and station 136 was done twice, although they were named 136C and 136D. Station 134 will not process and provides no error message. There was no bottle data processed for stations 132, 133, 135, and 136C. CTD problem detected on early casts through salinity and density checks (constant signal at deep depths).</i></p>
Cruise 15	29-Jul	31-Jul	13	13	Stations 141-153, all processed without error.
Cruise 16	4-Aug	7-Aug	15	15	Stations 154-168, all processed without error
Ferrel					
Cruise 02	16-Jul	19-Jul	4	5	Stations 1-4, Station 3 was done twice (3 and 3a). Station 3 was not able to process for bottle data. Station 3a would not provide an ASCII output.
Cruise 03	26-Jul	29-Jul	6	6	Stations 2, 6-10. Stations 7 and 8 are reversed, but we left as is because the maps identify Stations 7 and 8 and we didn't know which was which. Station 2 and 8(or 07?) did not have bottle data to process.

Cruise 04	31-Jul	4-Aug	3	4	Stations 1-3. Station 1 was done twice (1 and 1a). Station 1 did not process for bottle data.
Gordon Gunter					
Cruise 01	28-May	4-Jun	30	30	Stations 001-H through 030-H. Stations 016-H, 018-H, 021-H, 022-H, 024-H, and 026-H did not process for bottle data.
Cruise 03	5-Aug	7-Aug	10	10	Stations 1-10. All stations processed without error.
Henry Bigelow					
Cruise 01	3-Aug	5-Aug	30	33	Stations 1-30. Stations 1, 2a, 5, 8, 12, 13, and 28a did not process for bottle data, Stations 2b and 28c did not produce an ASCII output.
Jack Fitz					
Cruise 01	10-May	13-May	5	5	Stations 1-5, no bottle data on any stations.
Cruise 02	22-May	31-May	11	17	Stations 1-11. Station 6 does not have a .con file. No bottle data for any stations.
Cruise 03	12-Jun	20-Jun	12	15	Stations 1-12. Processed on downcast only. No bottle data for any stations.
Nancy Foster					
Cruise 01	1-Jul	18-Jul	73	73	Stations 1-75, except 28 and 29. All stations processed without error except 18, which did not process for bottle data and 35, which had 0 values in post-processed results. Fluorescence values were all recorded in voltage for both Fluorescence sensors used, so data could not be used for analysis.
Ocean Veritas					
Cruise 01	27-May	29-May	12	12	Stations 1-12. Stations 6-8 did not process for bottle data. Cable and or connector issue contaminate most of the profile data with spikes.

Cruise 02	2-Jun	4-Jun	13	13	<i>Stations 13-26, except 14. Station 13 had no .con file, Stations 15 and 16 did not process for bottle data, Stations 17-20 had no .con file. Cable and or connector issue contaminate most of the profile data with spikes.</i>
Cruise 03	8-Jun	10-Jun	14	14	<i>Stations 27-40. Cable and or connector issue contaminate most of the profile data with spikes.</i>
Cruise 04	14-Jun	16-Jun	15	15	<i>Stations 41-55. Station 41 did not process. All others processed without error</i>
Cruise 05	20-Jun	20-Jun	7	7	<i>Stations 56-62. Station 62 is the only station that processed.</i>
Cruise 06	26-Jun	28-Jun	13	13	<i>Stations 63-75. Stations 70 and 75 did not process for bottle data.</i>
Cruise 07	2-Jul	4-Jul	15	15	<i>Stations 76-90. All stations processed without error.</i>
Cruise 08	8-Jul	10-Jul	15	15	<i>Stations 91-105. All stations processed without error.</i>
Cruise 09	14-Jul	16-Jul	17	17	<i>Stations 106-122. Stations 116, 121, and 122 did not process for bottle data.</i>
Cruise 10	20-Jul	22-Jul	15	15	<i>Stations 123-137. Stations 128-132 had no .con/hex files available.</i>
Cruise 11	27-Jul	28-Jul	11	11	<i>Stations 138-148. All stations processed without error.</i>
Cruise 12	1-Aug	2-Aug	9	9	<i>Stations 149-157.</i>
Thomas Jefferson					
Cruise 02	3-Jun	7-Jun	14	14	<i>Stations 1-15, except 13. All stations processed without error.</i>
Cruise 03	8-Jun	26-Jun	57	58	<i>Stations 16-72. Station 69 was processed twice.</i>
Walton Smith					
			79	92	

Cruise 01	26-May	31-May	51	57	Stations WS01A-WS51A. Stations WS04A-11A, WS24A-25A, WS28A-29A, WS44A, WS49A did not process for bottle data.
Cruise 02	3-Jun	5-Jun	28	35	Stations WS52A-79A with some random numbers included (i.e. WS06B, 08B, 16B, 47B, 53B, 58B, 59B, 68B, 71B, 71C) Station 71A did not process. Stations 54A, 58A, 61A-66A, 59B, 68B, 69A-72A did not process for bottle data. Station numbers 65 and 74 were skipped.

Appendix 1

Estimating Biochemical Oxygen Demand of Dispersed Oil in the Deep Water

This appendix was created to provide a conceptual model to help explain or possibly visualize the impact biodegradation would have on the dissolved oxygen levels in the deep sea. The conceptual model encompasses the creation and evaluation of three scenarios that are intended to establish an upper and lower bound on the time needed for hypoxia to develop, assuming that no mixing occurs that would replenish the DO₂ lost to biodegradation. To accomplish this, the first task is to calculate the ultimate biochemical oxygen demand (BOD_{ult}) that is needed to support the first scenario.

Estimates from the published Federal Oil Budget Calculator¹⁶ indicate that the total amount of oil that was dispersed into the water column each day, based on an oil flow rate of 6.0×10^4 bbl/d, was 1.44×10^4 bbl or 2.29×10^6 L (*i.e.*, 24% of the total). Assuming the specific gravity of SLC is 0.84 kg/L, the mass of oil dispersed was approximately 1.92×10^6 kg. Not all of that oil was biodegradable (asphaltenes, resins, and some saturated cyclic compounds are much more recalcitrant than the more biodegradable constituents). If we assume conservatively the SLC was approximately 80% biodegradable [based on a 2001 hydrocarbon constituent analysis by Environment Canada¹⁷, which showed that unweathered SLC is comprised of 80.8% saturates, 12.6% aromatics, 6% resins, 0.8% asphaltenes, and 1.7% waxes and that each kg of oil biodegraded theoretically requires about 3.5 kg DO₂ for mineralization (based on stoichiometry)], the total ultimate biochemical oxygen demand (BOD_{ult}) would be approximately 5.38×10^6 kg DO₂ ($0.80 \times 1.92 \times 10^6$ kg oil \times 3.5 kg DO₂/kg oil). For each day that oil leaked from MC252 into the Gulf of Mexico, approximately this amount of DO₂ is needed to facilitate the biodegradation of the oil entrained in the underwater plume.

If we assume the dispersed oil plume in a given day takes on the shape of a rectangle 300 m thick \times 500 m wide \times 2,400 m long (dimensions explained below), the amount of seawater in that volume is 360×10^9 L. This conceptual model tracks that volume to describe its behavior and effect on dissolved oxygen at depth based on DO₂ data and stoichiometric relationships and assumes no mixing, diffusion, or advection. The DO₂ concentration needed for complete mineralization of the oil in that volume of water is about 14.9 mg DO₂/L (5.38×10^6 kg DO₂ \times 10^6 mg/kg / 360×10^9 L). This value is termed the ultimate BOD (BOD_{ult}). Although this plume is not static, it is assumed that the size of the putative rectangle is an average daily size. Thus, approximately 14.9 mg/L of DO₂ would need to be consumed to mineralize the biodegradable fraction of the oil contained in that volume of water.

In estimating the volume of water that corresponds to a 24-hour plume, the following assumptions were used:

¹⁶ http://www.noaanews.noaa.gov/stories2010/PDFs/OilBudget_description_%2083final.pdf

¹⁷ http://www.etc-cte.ec.gc.ca/databases/OilProperties/pdf/WEB_South_Louisiana_%282001%29.pdf

1. In the early parts of the incident (May and June), the observed plume near the well was confined between the depth of 1,000 and 1,300 meters. This suggests that the vertical thickness of the box should be about 300 meters.
2. The currents near the well were not steady or unidirectional, but from Acoustic Doppler Current Profiler (ADCP) data at approximately 1,100 meters from station #42916 (near the well head), a conservative estimate would give a displacement of about 2,400 meters a day. So, we can consider this as the length of the box. This is the value that corresponds to the lowest quartile of current speeds from May 2 - July 15, 2010.
3. Estimating the width was a bit more speculative, but the patchiness of the near field measurements suggests that near the source the plume was narrow and slightly filamentous. Considering the separation between stations that found an indication of the plume and those that did not, a reasonable estimate for the width of the plume is about 500 meters. Putting all these together, the daily loading from the subsurface portion of the spill would be distributed into $360 \times 10^6 \text{ m}^3$ of water ($360 \times 10^9 \text{ L}$).

The following hypothetical scenarios are suggested as upper and lower bounds on estimating the time needed to reach hypoxia in the deep sea as a result of dispersing the DWH oil. These scenarios do not consider the exertion of BOD due to methane biodegradation because the total loading of methane into the deep water at the time of this report had not been estimated.

The first scenario uses the BOD equation¹⁸ to make the calculations, which is expressed as

$$\text{BOD}_t = \text{BOD}_{\text{ult}}(1 - \exp(-kt)) \quad (1)$$

where BOD_t = BOD at time t ,

BOD_{ult} is the ultimate BOD (14.9 mg/L as calculated above), and

k = first order rate coefficient for BOD exertion.

Using the average climatological DO_2 at depth of 6.9 mg/L and the lowest DO_2 measured before the well was capped of 4.2 mg/L (which occurred on Day 37 of the spill), the maximum amount of DO_2 consumed was 6.9 – 4.2 or 2.7 mg/L. Plugging that value into the BOD equation and using $t = 37$ days over which the BOD was exerted gives a rate of exertion of 0.0054/d. To calculate the time required to reach hypoxia, we first determine the DO_2 consumption needed to reach hypoxia, which is 6.9 – 2.0 or 4.9 mg/L. Using Equation 1 above with a k of 0.0054/d, the number of days needed to reach hypoxia is 74 days. To determine how sensitive this calculation is to the length of the plume, the same calculations above were made using $\pm 20\%$ of the length. The days to hypoxia ranged from 72 to 76 d at those plume lengths, which closely bracket the 74 d time. Thus, this estimation method is fairly robust in terms of plume size effects on hypoxia.

¹⁸Metcalf and Eddy Inc. Wastewater engineering: treatment and reuse, Metcalf & Eddy Inc., 4th Edition; Tchobanoglous, G., Burton, F.L., Stensel, H.D., Eds.; McGraw-Hill Companies: New York, U.S.A., 2003.

The second scenario assumes a simpler, zero-order (or linear) consumption rate. Using the same DO₂ deficit value of 2.7 mg/L as in the first scenario and assuming that this deficit has been exerted over a period of 37 days, the BOD exertion rate results in 2.7 mg/L / 37 d or 0.073 mg/L/d. At that rate, it would take 67 d (6.9 – 2.0 or 4.9 mg/L / 0.073 mg/L/d) to reach hypoxia without DO₂ replenishment. This closely agrees with the 74 d calculated above using the BOD equation. These values represent the upper bound in time needed to reach hypoxia *assuming no mixing across the plume boundaries and therefore no DO₂ replenishment*. With mixing, however, the DO₂ levels would be constantly replenishing the deficits, so hypoxia is unlikely if these assumptions are valid.

The lower bound was estimated in the third scenario in terms of calculating the BOD in the total plume. Since this scenario uses a different rate law than the first scenario, we need to re-calculate the BOD_{ult} based on zero-order biodegradation kinetics. Again using the oil budget calculator, the total amount of oil that was dispersed chemically and physically both from deep sea injection and surface application was about 24% of the total volume of oil spilled. This amounts to 6.0×10^4 bbl/d \times 42 gal/bbl \times 0.24 \times 87 d \times 3.785 L/gal or 1.99×10^8 L oil dispersed. Assuming the specific gravity of SLC is 0.84 kg/L, the mass of oil dispersed is 1.67×10^8 kg. Assuming the SLC is 80% biodegradable and that each kg of oil biodegraded theoretically requires about 3.5 kg DO₂ for mineralization, the total BOD would be 4.68×10^8 kg DO₂. If we assume the dispersed oil plume takes on the shape of a polygon 300 m thick \times 500 m per side near the well head \times 5,000 m per side at a distance of 32 km from the well head, the amount of seawater in that volume is 2.64×10^{13} L. Thus, the DO₂ concentration needed for complete mineralization of the oil in that volume of water is 17.7 mg/L (4.68×10^8 kg \times 10^6 mg/kg / 2.64×10^{13} L). If that demand is exerted over a period of 87 d, (which was the duration of the spill), again assuming a zero-order rate behavior, the amount of DO₂ needed to satisfy that demand would be 0.203 mg/L/d (17.7 mg/L / 87 d). Using that rate of exertion, it would take 24 days (6.9 – 2.0 = 4.9 mg/L / 0.203 mg/L/d) to reach hypoxic levels assuming the lost DO₂ was not replenished at all. This scenario represents the lower bound in terms of days to hypoxia.

To test the sensitivity of the third scenario to plume length, we impose a \pm 20% variation to that dimension (25.6 to 38.4 km). At 25.6 km plume length, the days to hypoxia would be 19 d, while at 38.4 km length, the days to hypoxia would be 29 d. Thus, this estimation method is also fairly robust in terms of plume size effects on hypoxia.

The scenarios above assumed 80% of the whole oil was biodegrading, not just relatively labile alkanes. For comparison, the first-order biodegradation rate constant for total alkanes determined in EPA's 2007 laboratory study¹⁰ was 0.138/d and for PAHs was 0.057/d. The alkane first-order rate coefficient is more than 25-fold greater than the first-order rate calculated from the BOD equation above, and the PAH rate coefficient is 10-fold greater. This was despite the fact that the oil used in that study was a medium weight crude oil (Prudhoe Bay crude), which would be slightly less biodegradable than SLC. Data collected from the R/V *Ocean Veritas* and R/V

Brooks McCall by Hazen's Lawrence Berkeley group¹⁹ showed that the alkane biodegradation rate coefficient (0.310/day) was about double that reported by the 2007 EPA study. Using the same BOD consumption of 2.7 mg/L as in the second scenario, the time to hypoxia using the first-order alkane and PAH rate coefficients from the EPA laboratory study is 2.9 and 7.0 d, respectively, whereas using the Lawrence Berkeley group's first-order rate constant, only 1.3 d is needed to reach hypoxia. Again, these times assume no mixing or DO₂ replenishment.

In summary, three hypothetical scenarios were tested to determine the length of time needed for biodegradation to cause hypoxia in the deep sea ecosystem of the Gulf of Mexico. Scenarios 1 and 2 differed by the rate law imposed on the system (Scenario 1 used a 1st-order rate coefficient from the BOD equation while Scenario 2 used a zero-order rate coefficient). Yet both scenarios would result in 74 and 68 days, respectively, to achieve hypoxia, assuming that no mixing occurred that would replenish the diminished dissolved oxygen. Both methods were robust in terms of their sensitivity to the volume of the plume. These scenarios represent the upper bound in terms of time for causing hypoxic conditions in the deep sea because they were developed using a daily plume size. The third scenario took a slightly different approach in terms of the size of the plume. In this scenario, the entire mass of dispersed oil was subjected to biodegradation in a plume that reached a total volume of 2.64×10^{13} L over the 87-d duration of the spill rather than a volume created in one day, growing stepwise each day of the spill as in the first and second scenarios. In this scenario, the lower bound of 24 days to reach hypoxia resulted from the imposed conditions, which used a plume size developed over the entire duration of the spill (87 days). This scenario was also robust in terms of its lack of sensitivity to plume length. The temporal difference between the lower and upper bounds for these scenarios was approximately three-fold. At the time of this writing, it has been 129 days since the spill first occurred, yet the DO₂ concentration has not approached hypoxic levels. This likely indicates that the assumption of no mixing to replenish DO₂ from the surrounding higher DO₂-containing waters was incorrect. Mixing due to both advection and diffusion must be occurring to provide sufficient electron acceptor not only to support biodegradation of the oil hydrocarbons but also to replenish the deficit caused by that metabolism in the dispersed oil plume.

The analyses above include numerous assumptions and are provided as preliminary estimates based on expected rates of exertion of BOD, the low level of hydrocarbons present in the deep sea, the unknown nutrient concentrations available to support biodegradation, and the size of the dispersed oil plume estimated from measured ocean currents. A further unknown at present is the rate of diffusion and/or advection of dissolved oxygen from the surrounding DO₂-rich waters to the inner depths of the plume where DO₂ deficits have been observed. Lateral diffusivity of DO₂ is expected to be much greater than vertical diffusivity, but replenishment of the inner deficit due to diffusion is always much lower than advective forces from mixing of the waters at depth. Once we achieve a better understanding of these diffusive and advective forces, we will be in a better position to verify the above estimates. The estimates are conservative in terms of percent

¹⁹ Refer to Appendix 2

biodegradability of the SLC oil and the size of the dispersed oil plume but provide reasonable outcomes to scenarios in which biodegradation is occurring in the deep water. In none of the scenarios would hypoxia occur as a result of biodegradation of the dispersed oil. This latter statement has held true since the beginning of the spill.

The times to hypoxia based on the 2007 EPA laboratory study and the Hazen Lawrence-Berkeley group's analysis of deep sea biodegradation are substantially lower than the lower bound scenario described above. This could be due to many factors. The mesophilic microbial community in the EPA study, which was originally isolated from Prince William Sound in 1990 a year after the Exxon Valdez incident, was undoubtedly different in numerous aspects from that of the Lawrence-Berkeley group's, not the least of which was the psychrophilic nature of the Lawrence-Berkeley group's culture. Second, extrapolation from laboratory studies to the field is always fraught with uncertainties since microorganisms grow much better in the optimized environment of laboratory microcosms with little or no nutrient or oxygen limitations. Third, the Lawrence-Berkeley group's results are somewhat surprising and rather unexpected since the rates of biodegradation and half-lives of the various alkanes shown in Tables XX1 and XX2 in Appendix 2 of this report were similar for virtually all carbon numbers. Usually, as molecular weight increases, biodegradation rates decrease. It is possible that at least some of the observed disappearance of alkanes in that study might have been due to physical factors rather than biological, such as dilution effects. Also, their estimates are based on rapid rates of biodegradation observed for the least recalcitrant fraction (alkanes) of the oil rather than on the complex mixture of compounds that characterize SLC oil. This is understandable since only the alkanes were high enough in concentration to enable quantification. Nonetheless, we will be undoubtedly learning much more in the months to come as we continue to monitor the changes that are occurring in the deep sea.

Appendix 2

Biodegradation rates of Deep MC252 Plume



ERNEST ORLANDO LAWRENCE
BERKELEY NATIONAL LABORATORY



Center for Environmental Biotechnology
July 30, 2010

To: Mark Miller, Robert Jones, Nathalie Valette-Silver, and Al Venosa

RE: Biodegradation rates of Deep MC252 Plume (per pre-publication Embargo waiver)

To estimate biodegradation rates in the plume, four data sets representing concentrations of C13-C26 n-alkanes were used to investigate degradation of hydrocarbons in the plume. Two of the data sets were field measurements from sites included in this paper: BM57, BM58, BM53, BM54, OV011, OV010. N-alkanes were not detected in any or the other field samples. The first data set was provided by BP and included analysis of a wide number of compounds from whole water samples, including n-alkanes. This data set is inclusive of all samples with the exception of OV011. The second data set are n-alkanes quantified from the neutral lipid fraction of the PLFA analysis and represents samples collected on a 0.2 μm PES filter. Both of these data sets were taken from the same CTD deployment but analyzed by different labs.

The other two data sets represent 5°C laboratory degradation studies of degradation of source oil in microcosm water collected outside the plume with MC252 oil as the carbon source and isolates from the plume mixed as a consortia with MC252 oil. Microcosms were set up using non-contaminated water from plume depth (OV02302) sampled June 6th 2010. 100 ml of the water was placed in 125 ml serum bottles and crude oil (MC252) was added to obtain a concentration of 100 mg/L. Bottles were closed using Teflon coated rubber stoppers and were incubated at 5°C in the dark for 20 days. Samples for analysis of hydrocarbons were taken after 0, 1, 5, and 20 days of incubation. Oil Degradation in Consortia: 2 ml of oil plume depth water was enriched in 18 ml bicarb buffered minimal marine medium (Coates et al 1995) amended with 0.05 g bactopectone and 500 μL MC252 oil. From this enrichment, after four weeks, a transfer was made into fresh minimal marine media with no Carbon source. After incubation for 48 h, this was used as the inoculum for the oil degradation experiment. The experiment was initiated in 45 ml minimal marine medium with 1000 mg/L MC252 oil as the sole carbon source in triplicates at 5°C. Heat killed controls were set up in parallel to account for abiotic loss of oil hydrocarbons. Samples were withdrawn for GC-MS analyses using sterile syringes after well mixing after 0, 2, 5, and 8 days.

Degradation rate coefficients and half life (Table XX1, XX2) were calculated from the alkane data from these four sources using the 1st order rate equation (MacNaughton et al., 1999; Venosa and Holder, 2007). For field experiments, BM53, BM54, and OV011 were considered a day 0 sampling point, and BM57, OV010 were considered intermediate points (either 1 or 3 days) and BM58 was considered the final point (either 2 or 5 days), using estimated travel times of 2 – 5 days between the day 0 and final sampling points. This range is the best estimate given recorded ocean currents

(http://www.ndbc.noaa.gov/station_page.php?station=42916&unit=M&tz=STN, Hamilton, 1990).

These rate constants are similar to those reported in the literature for similar temperature and field conditions (MacNaughton et al., 1999; Brakstad and Bonaunet, 2006; Venosa and Holder, 2007; Atlas and Bragg, 2009) and despite the varying conditions only vary by a factor of 5 and represent half lives of 1.2 - 6.1 days. Given the similarity of the rate of disappearance of alkanes in the plume to the rates observed in the laboratory, it is likely that the actual degradation of alkanes lies within this range and it is also likely that the disappearance of alkanes is due in large part to biodegradation. For each data set, decay constants are similar for all alkanes measured in all samples, with the exception of the plume samples from the NL fraction collected on 0.2 μm filters. Since these results represent extraction from free phase oil or oil sorbed to the PES membrane filter, it is likely the higher rates seen for the shorter chain alkanes is due to additional losses in collected sample due to dissolution into sea water. However, there is a correlation of longer chain alkane concentration with cell densities (see figure XX1) in the plume.

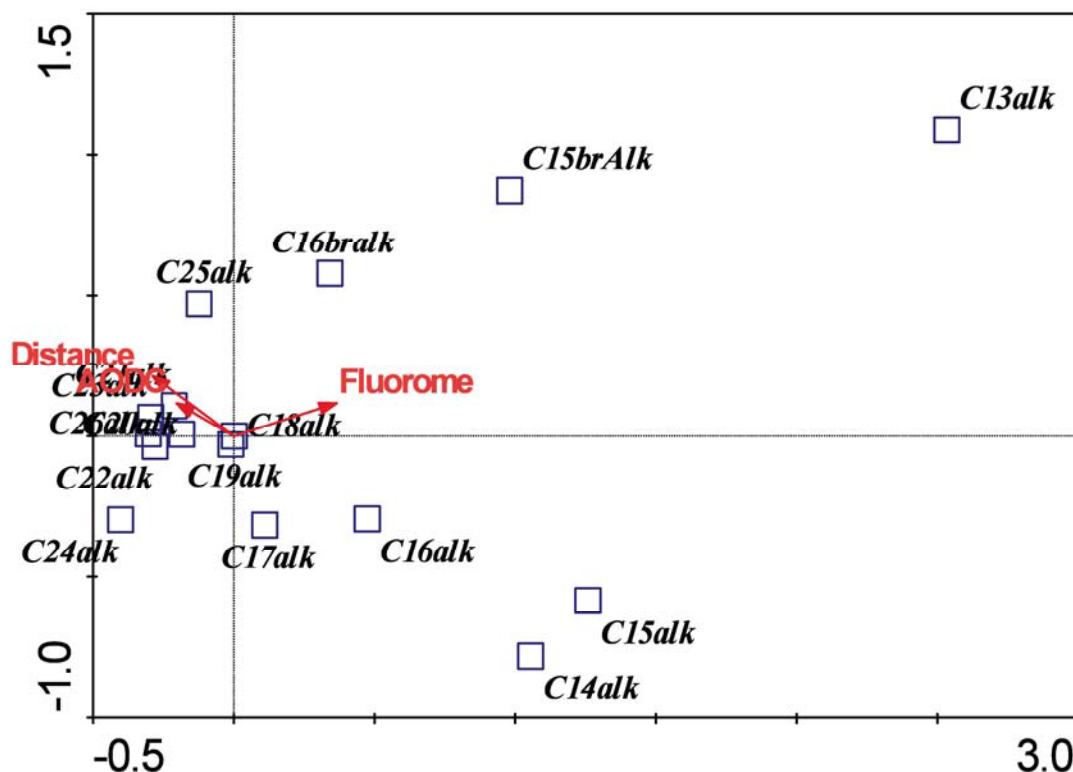
Table XX1. MC-252 crude oil alkane first order decay constants (days⁻¹) from field and laboratory

		plume samples (2 d)	plume samples (5 d)	BP data (2 d)	BP data (5 d)	Mixed Consortia, 5°C	Micro- cosm water, 5°C
	Average	0.319	0.128	0.643	0.257	0.197	0.313
n-Tridecane	C13alk	0.438	0.175	0.497	0.199	0.227	0.324
n-Tetradecane	C14alk	0.460	0.184	0.506	0.202	0.197	0.304
Pentadecane	C15alk	0.458	0.183	0.709	0.284	0.193	0.329
n-hexadecane	C16alk	0.432	0.173	0.344	0.138	0.193	0.310
n-heptadecane	C17alk	0.399	0.160	0.615	0.246	0.190	0.298
Pristane	C19teralk	0.427	0.171	0.537	0.215	0.232	0.304
n-octadecane	C18alk	0.331	0.133	0.668	0.267	0.166	0.302
Phytane	C20teralk	0.380	0.152	0.512	0.205	0.191	0.296
n-Nonadecane	C19alk	0.323	0.129	0.671	0.269	0.194	0.301
eicosane	C20alk	0.219	0.087	0.703	0.281	0.185	0.298
Heneicosane	C21alk	0.187	0.075	0.367	0.147	0.196	0.268
n-Docosane	C22alk	0.182	0.073	0.697	0.279	0.189	0.313
tricosane	C23alk	0.189	0.076	0.704	0.282	0.195	0.313
tetracosane	C24alk	0.216	0.086	0.780	0.312	0.196	0.305
n-Pentacosane	C25alk	0.248	0.099	0.904	0.362	0.195	0.338
n-hexacosane	C26alk	0.223	0.089	1.072	0.429	0.221	0.406

Table XX2. MC-252 alkane half life (days) from field and laboratory

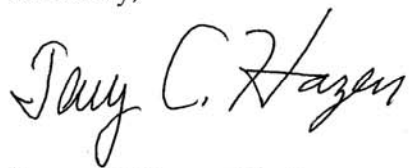
		plume samples (2 d)	plume samples (5 d)	BP data (2 d)	BP data (5 d)	Mixed Consortia, 5°C	Micro- cosm water, 5°C
	Average	2.4	6.1	1.2	2.9	3.5	2.2
n-Tridecane	C13alk	1.6	4.0	1.4	3.5	3.1	2.1
n-Tetradecane	C14alk	1.5	3.8	1.4	3.4	3.5	2.3
Pentadecane	C15alk	1.5	3.8	1.0	2.4	3.6	2.1
n-hexadecane	C16alk	1.6	4.0	2.0	5.0	3.6	2.2
n-heptadecane	C17alk	1.7	4.3	1.1	2.8	3.6	2.3
Pristane	C19teralk	1.6	4.1	1.3	3.2	3.0	2.3
n-octadecane	C18alk	2.1	5.2	1.0	2.6	4.2	2.3
Phytane	C20teralk	1.8	4.6	1.4	3.4	3.6	2.3
n-Nonadecane	C19alk	2.1	5.4	1.0	2.6	3.6	2.3
eicosane	C20alk	3.2	7.9	1.0	2.5	3.7	2.3
Heneicosane	C21alk	3.7	9.3	1.9	4.7	3.5	2.6
n-Docosane	C22alk	3.8	9.5	1.0	2.5	3.7	2.2
tricosane	C23alk	3.7	9.2	1.0	2.5	3.6	2.2
tetracosane	C24alk	3.2	8.0	0.9	2.2	3.5	2.3
n-Pentacosane	C25alk	2.8	7.0	0.8	1.9	3.6	2.0
n-hexacosane	C26alk	3.1	7.8	0.6	1.6	3.1	1.7

Figure XX1. Correspondence analysis of alkanes with distance from the plume, fluorometry data, and AODC cell counts.



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Sincerely,

A handwritten signature in black ink that reads "Terry C. Hazen". The signature is written in a cursive, flowing style.

Terry C. Hazen, Ph. D.

DOE BER Distinguished Scientist

Senior Staff Scientist

Head, Ecology Department

Head, Center for Environmental Biotechnology

Co-Director, Virtual Institute Microbial Stress and Survival

Appendix 3

Dissolved oxygen measurement methods aboard the R/V *Brooks McCall*, May 2010

(from <http://www.epa.gov/bpspill/dispersants/bp-do-methods.pdf>)

The RV Brooks McCall has been onsite at the MS Canyon 252 on three separate occasions during May, 2010. The dissolved oxygen data has been collected using several methods throughout these three segments.

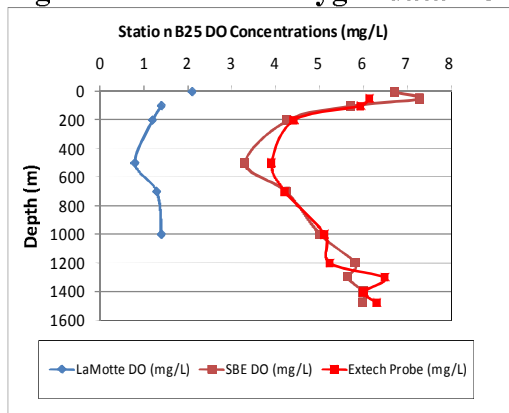
Segment 1: May 8, 2010 – May 12, 2010

On this cruise no profiling DO₂ sensor was deployed. All data from this cruise segment was acquired with the LaMotte 5860 DO₂ Field Kit. Three Niskin bottles were available, and samples were collected at 1 m, 275 m, and 550 m depths. DO₂ results with the LaMotte kit could not be compared to other available instrumentation.

Segment 2: May 13 – May 17, 2010

A new CTD unit with full ocean depth rating was acquired while in port, including a SBE DO₂ Sensor. DO₂ profiles were acquired with each cast. It was also discovered that an Extech DO700 handheld probe was available, and this was used to perform some measurements in an attempt to validate the SBE data and the LaMotte data. The Extech probe generally showed good agreement with the SBE data for the corresponding depth; however, the LaMotte Field kit data was significantly lower and did not appear to represent the structure of the dissolved oxygen profile as seen with the SBE instrument and replicated with the Extech probe. Figure 1 presents the results from Station B25 data. The agreement between the Extech probe and the SBE sensor appeared quite good while the LaMotte kit results were quite different. As a result of the lack of agreement observed by the LaMotte kit, it was believed that the Extech probe was providing more reliable results.

Figure 1. Dissolved oxygen data from station B25



Segment 3: May 19 – present

Dissolved oxygen measurements during Segment 3 were initially performed with the Extech probe and verification with the SBE data. A request was made to perform a series of colorimetric tests using fresh LaMotte kits and replicate samples. Three samples were collected

from the same Niskin bottle at two depths. Each of the samples was analyzed using a separate LaMotte kit. Extech probe measurements were also made. This was performed for three separate stations. The data are presented in the following figures. Station B35 showed

reasonable agreement between all three dissolved oxygen methodologies, but stations B34 and B37 showed poorer agreement. The results from the LaMotte kits showed a larger range of variability overall.

Figure 2. Station B34 Dissolved Oxygen Data

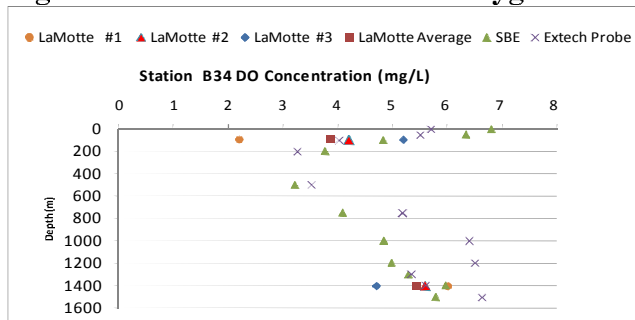


Figure 3 Station B35 Dissolved Oxygen Data

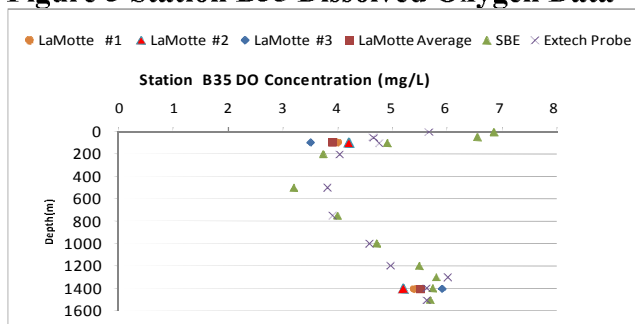
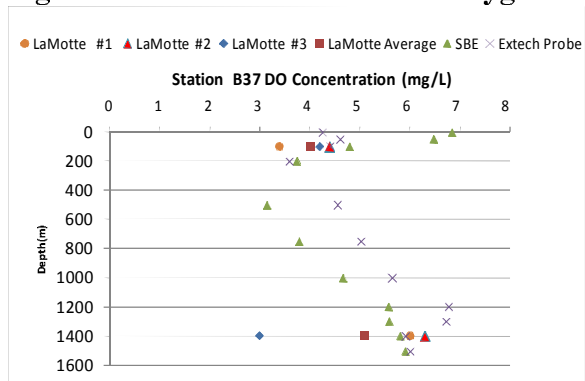


Figure 4. Station B35 Dissolved Oxygen Data



A more suitable method for validating both the SBE sensor and Extech probe data would be to employ a true Winkler titration system for these shipboard measurements, or preserve samples onboard for outside analysis. The results from these analyses indicate normal, typical levels of dissolved oxygen for the Gulf of Mexico. The low dissolved oxygen values from previous LaMotte kit measurements may be the result of reagent degradation or operator error.

Appendix 4

Methods for Data Quality Control and Processing

August 6, 2010 – R/V *Brooks McCall* Status Report - Cruise 16 - Day 3

Complied by: Leigh Stevens, Ecosystem Management and Associates (for BP)

Day 3 sampling focused on collection and analysis of DO₂ samples from a range of depths using automated titration methods, and tracking of the subsurface plume signals to the SW and WSW of the wellhead. A total of 6 CTD casts were completed, as summarized below and shown in Figure 1. No surface oiling was observed.

Station	Position from wellhead	Fluorescence signal	Signal Depth	Comment
BM162	75 km SW of the wellhead	No signal		A minor reduction in DO ₂ (~0.2mg/L) evident over 40m with a peak at 1145m.
BM163	77 km WSW of the wellhead	No signal	-	A reduction in DO ₂ (~0.5mg/L) evident over 70m between 1085m and the seabed.
BM164	85 km WSW of the wellhead	No signal	-	A reduction in DO ₂ (~0.2mg/L) evident over 50m between 1150m and the seabed.
BM165	87 km WSW	No signal	-	No reduction in DO ₂ compared to background.
BM166	90 km WSW	No signal	-	No reduction in DO ₂ compared to background.
BM167	125 km WSW	No signal	-	No reduction in DO ₂ compared to background.

Three of the days 6 casts showed a minor decrease in DO₂ compared to background values at depths where the dispersed oil plume has been consistently located previously. There was no change apparent in the background fluorometry signal, and no indicators of oil in the LISST or fluorometry data.

Much of the day's focus has been on compiling the DO₂ data from the multiple measures undertaken on board. Today, 12 water samples were collected and analyzed using the modified Winkler

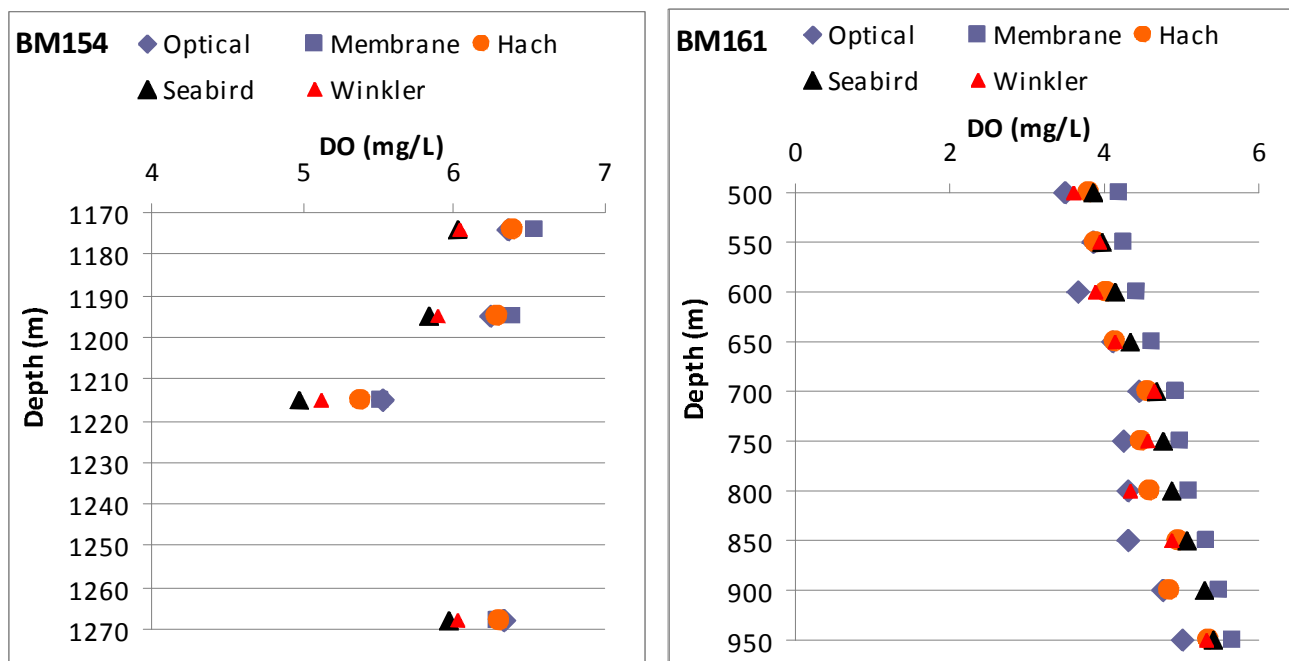
titrations to measure dissolved oxygen, 1 from >1000 m and 11 from < 1000 m. This was to achieve the 60:40 sampling ratio specified in Addendum 4 and included two additional samples. These were added because one Winkler sample collected in the morning was unable to be analyzed due to the addition of the wrong reagent during lab preparation, and another as post-processing would have been required to extract a data point from the software, which had a minor malfunction yesterday. Because of these factors, two partial data rows (SW-20100805BM16-1, SW-20100806BM16-3) were excluded to provide a balanced paired analysis. In total, during this and the previous cruise, the Brooks McCall has now conducted 100 modified Winkler titrations, excluding lab duplicates and standards. Lab standards showed the Winkler and Hach tests were capable of measuring to below 2 mg/L. The Ocean Veritas has completed 86 modified Winkler titrations. Addendum 4, Additional Requirement 4 requests a correlation between the automated Winkler titration and the probe measurements. Brooks McCall Cruise 16 paired sample correlation values are presented below:

Correlation	Seabird	Hach	Optical	Membrane
Winkler	0.83	0.86	0.75	0.81
Seabird		0.96	0.92	0.88
Hach			0.91	0.93
Optical				0.74

These correlation values show a very good relationship exists between the Seabird CTD DO₂ probe, and the other measures, particularly the Hach modified Winkler titration. The larger combined data set of Cruise 15 and 16 has not been presented as it does not include University of Miami/NOAA Winkler results, but shows a very similar outcome. The Ocean Veritas data also provide a very similar result. This extensive combined data set provides compelling evidence that the Seabird sensors are returning accurate measures of DO₂.

This conclusion is further reinforced by the ability of the sensors to measure DO₂ concentrations consistent with pre-spill conditions in the Gulf of Mexico in the upper part of a cast, then show a clear decrease in DO₂ as it passes through dispersed subsurface oil before returning to background values below the subsurface plume. This pattern has then been consistently repeated in the upcast. The ability of the sensor to repeatedly return to background DO₂ concentrations after passing through subsurface oil provides strong evidence that the CTD DO₂ sensor is not being compromised.

Representative examples of the data from Cruise 16 are presented below. Sampling within the residual subsurface plume targeted dips in DO₂. Station BM154 shows how all the measures used were able to measure the shift from background concentrations to a low point (1215 m) in a DO₂ depression accurately. Station BM161 shows the consistent relationship with measures through the water column at 50 m intervals.



Data have been submitted with the daily deliverables. No regression analyses have been performed as the data already tell such a clear story that further analysis is not considered likely to alter the conclusion in any meaningful way.

Throughout this sampling effort on the Brooks McCall the JAG would like to formally acknowledge the huge effort and contribution put in by Research Associate George Berberian (University of Miami/NOAA), Sean Kane (NOAA Environmental Scientist), and Ed Morren (Senior Scientist, Shaw Environmental). Their technical expertise, professionalism, integrity, and willingness to resolve this key question have been exemplary. The JAG would also like to acknowledge the input and feedback of the on board observers, Dr. Ken Lee, Senior Research Scientist, DFO Canada - and member of the JAG, and Kevin Larsen, EPA On-Scene Coordinator, Region 7.

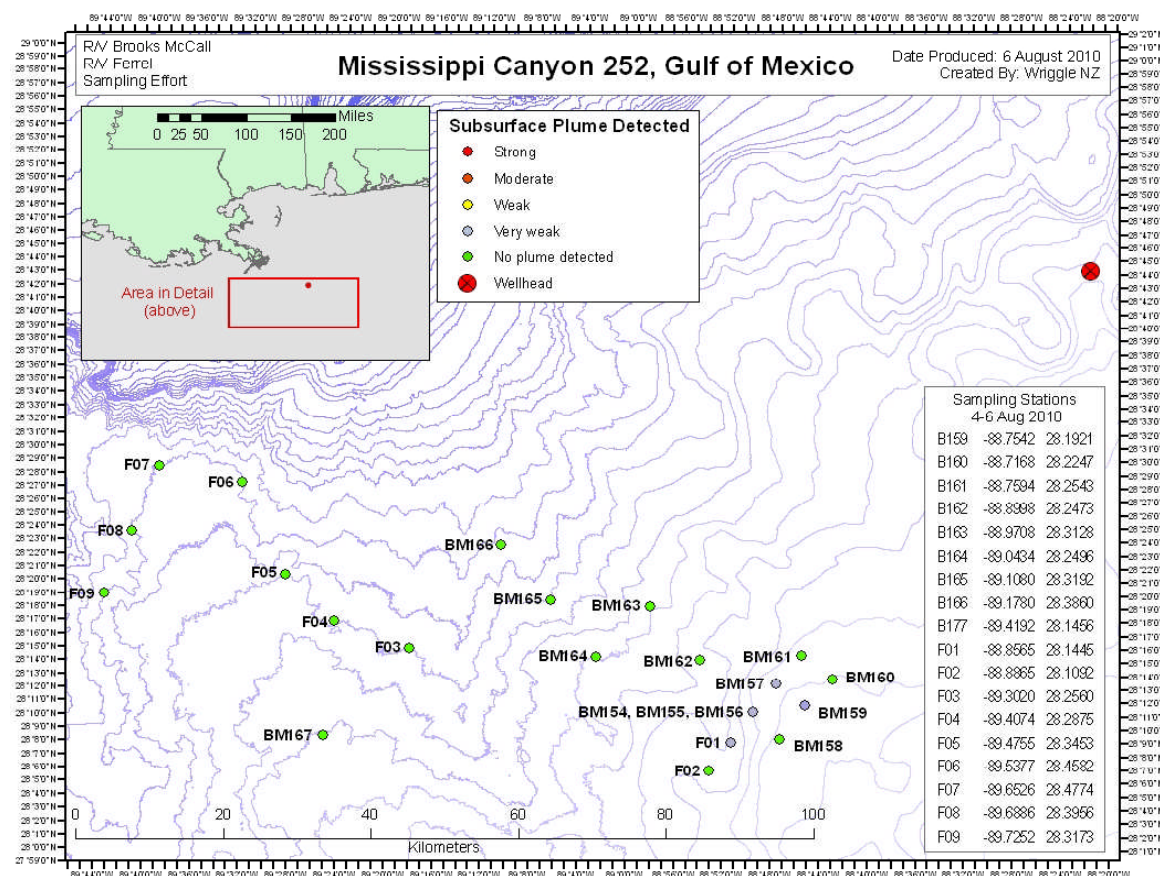
VOC monitoring has been undertaken regularly throughout the day by Josh Senter, Bureau Veritas Industrial Hygiene Specialist. No VOCs were detected above background. Again, the greatest concern today has been heat, which has been monitored and managed appropriately.

Rotox tests were completed for samples BM158 through BM161. No toxicity was apparent in any samples. Rotox tests were started for samples BM163 through BM166 (results due to be reported on 7 August 2010).

The days sampling struggled to find the residual plume identified yesterday. At water depths lower than 1000 m, the depth of the minor subsurface DO₂ signal was measured in contact with the seabed and was sampled. No residual oil was indicated at concentrations detectable by fluorescence.

The following definition has been adopted to provide common terminology on how subsurface oil is referred to:

Oil Plume: “Concentration of oil (above background) in the water column that appears to be part of a larger pattern of dispersed oil based on real-time fluorometry and LISST particle data analysis.”



General CTD Processing

In order to provide consistency across different ships, sensors, and personnel, conductivity-temperature-depth (CTD) data available to the JAG are being reprocessed from raw instrument files. To date, all CTD's being used have been manufactured by Seabird Electronics. Binary data files (hex or dat) and configuration files (con) were obtained for all casts and reprocessed at NODC using Seabird Electronics Data Processing Software version 7.20d released May 27, 2010. Raw files (all scans) were initially plotted and examined visually for instrument response issues. Following that examination, the SeaBird processing routine "Wildedit" was used with the following recommended settings to remove spikes in the data based on statistics of blocks of individual scans. *[Standard deviation for pass one: 2; Standard deviation for pass two 20; Scans block: 100; Keep data within this distance of the mean: 0; Exclude scans marked bad: yes (check)]*

Data were then pressure averaged, and files (1 dbar) for the downcast were created and plotted for a 'quicklook' review by the JAG members. Separate data files were created for comparing CTD observations to water-sample data collected concurrently using Niskin sampling bottles. These "bottle files" contain CTD observations extracted for the known depths of the Niskin bottle samples using both downcast and upcast data from the CTD. Because the water analyses are being done at different labs and require some time to complete, the bottle files are updated over time as laboratory results are received.

Initial Quality Control (QC) of the CTD casts are being conducted following a subset of checks outlined in the Global Temperature and Salinity Profile Program Real-Time Quality Control Manual (UNESCO, 2009). The following QC checks are being conducted on the temperature and salinity profiles

1. Spike
2. Top and Bottom Spike
3. Gradient
4. Density Inversion.

QC Flags are being assigned to the individual temperature and salinity observations following the GTSP procedures and nomenclature.

The coincident CTD profiles of Chromophoric Dissolved Organic Matter (CDOM) fluorescence and dissolved oxygen have not been quantitatively subjected to QC checks to date. The JAG is examining the instrument response, additional sample verification, and calibration of these sensors relative to hydrocarbons dispersed in the water column.

All CTD data are being converted to a net CDF format (CF convention) for use by JAG members as well as additional data assembly into flat files for use by GIS and visualization software

including Fledermaus. Final plots of cast and sample data are being produced for the JAG as requested.

The CTD data and available bottle data are being collated for archive at NOAA's National Oceanographic Data Center (NODC). All preliminary CTD data is also being preserved at NODC. Profile data will be subjected to additional QC checks as part of ingest into the World Ocean Database at NODC.

Chromophoric Dissolved Organic Matter (CDOM) Fluorescence

To allow valid comparisons, the following method was applied to normalize the CDOM fluorescence data among all vessels, cruises, and instruments discussed in the JAG report. A least squares linear fit was determined for each CDOM fluorescence profile between 200 and 900 m. The derived linear fit was extended through the bottom of the cast to serve as the representation of an expected linear profile of CDOM fluorescence in the region (personal communication, Robert Chen, July 6, 2010).

This linear profile was subtracted from the observed profile, and all negative values were set to zero. Statistics on the normalized profile were then calculated for depths between 1000-1300 m where the CDOM positive anomalies were observed in the individual casts.

Dissolved Oxygen Profiles from SBE43

To date, calibration of the SeaBird Electronics SBE43 Dissolved Oxygen Sensor, a Clark polarographic membrane type sensor, has not been attempted using Winkler bottle data techniques. Only sparse Winkler titration results from water samples collected are available from the Deepwater Horizon Response subsurface monitoring effort. These data are insufficient to support a broad comparison of the oxygen data collected since mid-May 2010.

During CTD processing, recommended procedures following Seabird Electronics Application Note 64-3 (SBE 43 Dissolved Oxygen (DO) Sensor -- Hysteresis Corrections) were used as outlined under "Data conversion module when Winkler Bottle Data are NOT Available." Basic statistics on the oxygen were calculated over the 1000-1300 m range for each cast having a corresponding CDOM fluorescence profile extending to the minimum depth of 1300 m.

Historical Winkler titration data from in the National Oceanographic Data Center World Ocean Atlas (WOA) 1° climatology was extracted in for the grid corresponding to the MC252 spill location and used as a basis for comparison to dissolved oxygen profiles.

Alignment to climatological and canonical profiles was evaluated for purposes of comparative analysis by the JAG. For the climatological approach, a least-squares fit between cruise-level mean profiles and the WOA values between 500-800 m was generated to evaluate systematic offsets. Using NOAA Ship *Nancy Foster* Station 69 as a basis for a canonical profile, a similar

linear alignment procedure was evaluated. This Nancy Foster station was selected as far-field profile outside the influence of the MC252 spill (~140 km). Waterfall plots of resulting “aligned” profiles from all ships and cruise were evaluated and these techniques proved insufficient to allow for robust comparative analysis. The influence of the MC252 spill on the deeper portion oxygen profiles did not allow for more traditional approaches for alignment using the typically more stable deeper values. In addition, the NOAA Ship *Nancy Foster* Mission Summary Report (*NF1013 -- Monitoring and Assessing Implications of the Deepwater Horizon Oil Spill: Potential Impacts of the Loop Current on Downstream Marine Ecosystems in the Gulf of Mexico and Florida Straits July 26, 2010*) reported “a slight deviation to the broader slope of the CTD DO₂ sensor profiles recorded between 800 m and 1000 m depth” at 84 km from the wellhead. Changes in the slope of the oxygen profile independent of depressions or calibration differences could be responsible for the alignment shortcomings.

In addition, dissolved oxygen profiles were vertically integrated over selected depth regimes to examine net changes in oxygen content over these regions as a result of the observed dissolved oxygen depressions. While informative on an individual cruise basis, this technique did not provide a basis for comparison of integrated profiles between cruises or different ships, which is attributed to calibration differences. This technique does provide for the range of integrated oxygen values during the subsurface monitoring effort.

Data Availability

Data from the subsurface monitoring associated with MC252 spill is accessible through the National Oceanographic Data Center at:

<http://www.nodc.noaa.gov/General/DeepwaterHorizon/oceanprofile.html>

Notes

Responsible NODC Divisions: Ocean Climate Laboratory (OC5) and National Coastal Data Development Center (OC6)

Appendix 5:

QA / QC JAG Oxygen Data

Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Mean (ppb QSDE)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Jack Fitz	1	JF001-C1	28.9	-88.2	5/10/2010	587	24223.51	-99	-99	-99	-99	-99	-99	-99
Jack Fitz	1	JF002-C1	29.0865	-88.02366667	5/11/2010	376	51156.52	-99	-99	-99	-99	-99	-99	-99
Jack Fitz	1	JF003-C1	28.72666667	-88.2875	5/12/2010	587	7784.90	-99	-99	-99	-99	-99	-99	-99
Jack Fitz	1	JF004-C1	28.73616667	-88.32583333	5/13/2010	553	3932.86	-99	-99	-99	-99	-99	-99	-99
Jack Fitz	1	JF005-C1	28.73766667	-88.34616667	5/14/2010	564	1936.90	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	3	BM29	28.686927	-88.423675	5/19/2010	1321	8018.92	4.02	3.67	0.18	0.01	0.41	0.03	1.64
Brooks McCall	3	BM30	28.661077	-88.452337	5/19/2010	1321	12034.11	4.03	3.71	0.15	0.15	2.95	0.44	45.62
Brooks McCall	3	BM31	28.644125	-88.426667	5/19/2010	1321	12016.22	4.26	3.91	0.18	0	0.14	0.02	1.07
Brooks McCall	3	BM32	28.683275	-88.472140	5/19/2010	1331	12051.60	3.92	3.63	0.13	0.57	8.01	1.2	172.59
Brooks McCall	3	BM33	28.709278	-88.484742	5/19/2010	1331	12063.66	4.19	3.56	0.19	0.14	1.66	0.36	43.2
Brooks McCall	3	BM34	28.715970	-88.394468	5/20/2010	1494	3722.99	4.03	3.59	0.18	0.09	1.96	0.35	27.98
Brooks McCall	3	BM35	28.728845	-88.380308	5/20/2010	1494	1744.37	4.04	3.63	0.19	0.01	0.79	0.07	3.76
Brooks McCall	3	BM36	28.732025	-88.376757	5/20/2010	1494	1257.55	4.01	3.64	0.18	1.13	12.94	2.62	341.02
Brooks McCall	3	BM37	28.729572	-88.366363	5/20/2010	1520	952.54	3.93	3.54	0.16	0.09	4.87	0.52	28.38
Brooks McCall	3	BM38	28.732028	-88.376727	5/21/2010	1545	1254.88	3.98	3.54	0.2	1.07	12.28	2.84	321.09
Brooks McCall	3	BM39	28.738703	-88.351128	5/21/2010	1544	1451.81	4.01	3.43	0.26	0	0.15	0.01	0.8
Brooks McCall	3	BM40	28.752020	-88.366777	5/21/2010	1454	1543.77	4.22	3.86	0.19	0	0.15	0.01	0.86
Brooks McCall	3	BM41	28.738343	-88.386970	5/21/2010	1495	2058.24	4.23	3.85	0.2	4.09	16.64	4.44	1224.56
Jack Fitz	2	JF001-C2	28.8755	-88.38866667	5/22/2010	64	15417.23	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	4	BM42	28.732012	-88.376773	5/23/2010	1541	1259.72	4.07	3.72	0.13	4.77	13.77	3.84	1434.87
Brooks McCall	4	BM43	28.738353	-88.386910	5/23/2010	1489	2052.38	-99	-99	-99	1	7.64	2.01	302.33
Brooks McCall	4	BM44	28.735127	-88.381882	5/23/2010	1510	1595.54	4.25	3.86	0.2	3.84	12.79	3.41	1153.93
Jack Fitz	2	JF002-C2	28.8755	-88.38866667	5/23/2010	201	15417.23	-99	-99	-99	-99	-99	-99	-99
Jack Fitz	2	JF003-C2	28.8755	-88.4425	5/23/2010	550	8216.42	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	4	BM45	28.738112	-88.407622	5/24/2010	1488	4079.68	4.22	3.92	0.17	1.87	12.17	3.03	561.88
Brooks McCall	4	BM46	28.728288	-88.400982	5/24/2010	1535	3600.17	4.03	3.75	0.12	2.22	9.8	2.38	669.17
Brooks McCall	4	BM47	28.719117	-88.391078	5/24/2010	1564	3243.18	3.98	3.56	0.19	0	0.08	0.01	0.24
Brooks McCall	4	BM48	28.735058	-88.429200	5/24/2010	1494	6201.44	3.96	3.59	0.15	1.36	6.66	1.85	409.98
Jack Fitz	2	JF004-C2	28.74666667	-88.38533333	5/24/2010	215	2120.99	-99	-99	-99	-99	-99	-99	-99
Jack Fitz	2	JF005-C2	28.75383333	-88.4045	5/24/2010	1422	4156.89	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	4	BM49	28.721390	-88.420077	5/25/2010	1528	5616.33	4.02	3.63	0.17	1.47	8.43	1.88	443.46
Brooks McCall	4	BM50	28.717822	-88.429587	5/25/2010	1512	6626.43	4.17	3.93	0.11	0.91	6.32	1.45	275.28
Brooks McCall	4	BM51	28.737658	-88.439887	5/25/2010	1473	7238.17	4.12	3.68	0.12	0.45	7.36	1.31	135.53
Brooks McCall	4	BM52	28.732007	-88.376787	5/25/2010	1541	1261.12	4.1	3.88	0.1	0.03	2.34	0.23	10.13
Jack Fitz	2	JF006-C2	28.74676924	-88.3853954	5/25/2010	-99	2131.53	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	W5001-A	28.715833	-88.408333	05/26/2010	1537	4833.08	4.17	3.84	0.18	0	0.05	0.01	0.57
Walton Smith	1	W5001-B	28.714333	-88.406667	05/26/2010	1447	4783.78	4.19	3.85	0.19	0	0	0	0
Walton Smith	1	W5001-C	28.713667	-88.407000	05/26/2010	1239	4852.11	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	W5002-A	28.730667	-88.409333	05/26/2010	1513	4327.72	4.18	3.81	0.19	2.12	7.39	2.08	633.08
Walton Smith	1	W5003-A	28.741000	-88.408500	05/26/2010	1444	4177.69	4.2	3.87	0.17	0.07	2.67	0.32	20.59
Jack Fitz	2	JF007-C2	28.74933333	-88.3835	5/27/2010	261	2120.92	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV002	28.7973	-88.758706	5/27/2010	1021	38986.54	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV003	28.66022	-88.756806	5/27/2010	1021	39096.14	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV004	28.676717	-88.362856	5/27/2010	1400	6828.84	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ01	28.856667	-89.358333	5/27/2010	55	97930.22	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ02	28.726333	-89.005000	5/27/2010	600	62554.47	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	W5004-A	28.724000	-88.408333	05/27/2010	1530	4436.85	4.19	3.85	0.17	0.85	3.17	0.81	256.19
Walton Smith	1	W5005-A	28.729667	-88.420333	05/27/2010	1503	5406.72	4.19	3.84	0.18	1.82	8.42	1.61	545.18
Walton Smith	1	W5006-A	28.725667	-88.426333	05/27/2010	1510	6071.79	4.2	3.84	0.18	1.69	10.05	2.1	508.69
Walton Smith	1	W5007-A	28.724500	-88.432833	05/27/2010	1496	6720.92	4.17	3.84	0.19	1.96	9.32	1.83	587.77
Walton Smith	1	W5008-A	28.723167	-88.442167	05/27/2010	1474	7644.73	4.16	3.87	0.18	0.81	2.17	0.59	242.87

Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Mean (ppb QSDE)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Walton Smith	1	WS009-A	28.720833	-88.449167	05/27/2010	1441	8370.66	4.16	3.83	0.18	0.91	2.78	0.6	273.28
Walton Smith	1	WS010-A	28.718667	-88.457667	05/27/2010	1381	9235.94	4.19	3.86	0.16	0.58	1.75	0.57	174.21
Walton Smith	1	WS011-A	28.718167	-88.465333	05/27/2010	1301	9979.33	4.19	3.85	0.17	0.34	1.66	0.44	102.72
Walton Smith	1	WS012-A	28.723500	-88.484000	05/27/2010	1355	11670.45	4.04	3.39	0.28	0.83	3.37	0.88	248.8
Walton Smith	1	WS012-B	28.723000	-88.482333	05/27/2010	1359	11516.93	4.07	3.46	0.26	0.57	2.16	0.67	172.46
Walton Smith	1	WS013-A	28.827333	-88.813333	05/27/2010	678	44873.08	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS014-A	28.707167	-88.516500	05/27/2010	1299	15135.11	4.15	3.83	0.17	0.14	1.88	0.29	41.21
Walton Smith	1	WS015-A	28.701833	-88.539667	05/27/2010	1319	17478.66	4.01	2.96	0.35	0.32	2.31	0.57	96.09
Gordon Gunter	1	001-H	28.909	-88.786	5/28/2010	358	45247.03	-99	-99	-99	-99	-99	-99	-99
Jack Fitz	2	JF008-C2	28.75433333	-88.39216667	5/28/2010	260	3134.05	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV005	28.807306	-88.366047	5/28/2010	1001	7126.74	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV006	28.717278	-88.385283	5/28/2010	1399	2992.18	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV007	28.807528	-87.969964	5/28/2010	1848	39518.07	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV008	28.679986	-87.967217	5/28/2010	1998	39582.55	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ03	28.691500	-88.445200	5/28/2010	1210	9329.84	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ04	28.672833	-88.463660	5/28/2010	129	12006.35	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ06	28.646000	-88.477160	5/28/2010	1191	14944.33	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ07	28.696666	-88.514660	5/28/2010	1204	15270.84	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS016-A	28.697167	-88.560000	05/28/2010	1313	19535.40	4.02	3.27	0.33	0.41	2.27	0.66	122.3
Walton Smith	1	WS017-A	28.692167	-88.577667	05/28/2010	1142	21347.46	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS018-A	28.689833	-88.595000	05/28/2010	1073	23057.70	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS019-A	28.685833	-88.614167	05/28/2010	1057	24986.22	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS020-A	28.680500	-88.631833	05/28/2010	1073	26807.10	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS021-A	28.675667	-88.651000	05/28/2010	1077	28757.92	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS022-A	28.672000	-88.668833	05/28/2010	1113	30550.80	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS023-A	28.668500	-88.687833	05/28/2010	1236	32450.17	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS024-A	28.684167	-88.687167	05/28/2010	1147	32013.67	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS025-A	28.693000	-88.657500	05/28/2010	993	28979.31	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS026-A	28.709167	-88.582167	05/28/2010	978	21409.92	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS027-A	28.712333	-88.565000	05/28/2010	1155	19695.73	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS028-A	28.721000	-88.525667	05/28/2010	1174	15750.76	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS029-A	28.726833	-88.489000	05/28/2010	1360	12111.15	4.1	3.15	0.29	0.21	2.09	0.4	63.99
Walton Smith	1	WS030-A	28.762667	-88.386000	05/28/2010	1395	3357.65	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS031-A	28.766833	-88.347000	05/28/2010	1475	3687.16	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS032-A	28.739500	-88.326667	05/28/2010	1541	3848.07	4.17	3.78	0.21	-99	-99	-99	-99
Walton Smith	1	WS033-A	28.709500	-88.348167	05/28/2010	1583	3626.10	4.15	3.8	0.19	-99	-99	-99	-99
Walton Smith	1	WS034-A	28.712167	-88.387500	05/28/2010	1578	3574.22	4.13	3.82	0.17	4.3	17.92	5.68	1293.79
Walton Smith	1	WS034-B	28.712000	-88.386500	05/28/2010	1586	3532.50	4.09	3.74	0.19	5.3	25.88	8.06	1596.56
Walton Smith	1	WS035-A	28.690833	-88.405167	05/28/2010	1518	6507.93	4.18	3.82	0.19	0	0.04	0	0.08
Gordon Gunter	1	002-H	28.931833	-88.745833	5/29/2010	359	42923.67	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	1	003-H	29.004667	-87.948500	5/29/2010	1448	50429.61	4.5	4.09	0.2	0.01	0.15	0.03	4.31
Gordon Gunter	1	004-H	28.896000	-88.017333	5/29/2010	1651	38351.31	4.39	4.05	0.2	0	0.04	0	0.29
Jack Fitz	2	JF009-C2	28.70816667	-88.38766667	5/29/2010	1592	3950.30	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV009	28.740994	-88.168814	5/29/2010	1693	19301.95	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV010	28.730275	-88.416872	5/29/2010	1184	5061.32	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV011	28.732011	-88.376789	5/29/2010	1295	1261.03	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	1	OV012	28.735442	-88.557542	5/29/2010	802	18760.23	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ08	28.704700	-88.508830	5/29/2010	1214	14472.97	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ09	28.707500	-88.533166	5/29/2010	1148	16720.34	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ10	28.708500	-88.537700	5/29/2010	1208	17133.35	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	5	BM53	28.735083	-88.381880	5/30/2010	1509	1596.41	4.39	3.85	0.2	12.22	38.03	12.91	3675.01

Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Mean (ppb QSDE)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Brooks McCall	5	BM54	28.732017	-88.376688	5/30/2010	1530	1252.42	4.32	3.48	0.23	7.71	31.62	8.69	2318.7
Brooks McCall	5	BM55	28.758013	-88.387893	5/30/2010	1325	3080.08	4.37	4	0.21	0	0.09	0.01	0.21
Gordon Gunter	1	005-H	29.097833	-88.397667	5/30/2010	354	40070.35	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	1	006-H	28.906333	-87.981667	5/30/2010	1606	41982.59	4.44	4.03	0.22	0.02	0.14	0.03	5.24
Gordon Gunter	1	007-H	29.025000	-88.128500	5/30/2010	1077	39425.14	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	1	008-H	28.802833	-88.229167	5/30/2010	1279	15193.08	-99	-99	-99	-99	-99	-99	-99
Jack Fitz	2	JF010-C2	28.72383333	-88.377	5/30/2010	260	1922.53	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS036-A	28.710167	-88.408833	05/30/2010	1549	5223.30	4.12	3.83	0.18	2.67	11.69	3.66	804.2
Walton Smith	1	WS037-A	28.709333	-88.437333	05/30/2010	1401	7686.47	4.16	3.81	0.18	1.1	6.96	1.29	331.73
Walton Smith	1	WS038-A	28.712333	-88.397167	5/30/2010	1544	4190.27	4.15	3.72	0.19	1.71	10.14	2.51	514.86
Walton Smith	1	WS039-A	28.703167	-88.474167	05/30/2010	1307	11284.65	4.14	3.71	0.22	0.46	5.2	1.04	139.37
Walton Smith	1	WS040-A	28.687833	-88.534500	05/30/2010	1403	17422.63	4.12	3.79	0.17	0.22	1.07	0.31	67.22
Walton Smith	1	WS041-A	28.681333	-88.571333	05/30/2010	1319	21075.37	4.07	3.73	0.17	0.06	0.49	0.1	18.61
Walton Smith	1	WS042-A	28.672833	-88.618167	05/30/2010	1140	25737.66	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	5	BM56	28.723547	-88.414878	5/31/2010	1530	5057.11	4.37	3.93	0.21	0.01	0.19	0.03	3.46
Brooks McCall	5	BM57	28.705093	-88.401650	5/31/2010	1500	5068.67	4.22	3.69	0.22	4.65	20.74	6.27	1400.67
Brooks McCall	5	BM58	28.672323	-88.435935	5/31/2010	1299	10020.05	4.36	3.68	0.24	0.8	15.77	2.66	239.59
Brooks McCall	5	BM59	28.638928	-88.471285	5/31/2010	1400	15094.08	4.4	4.03	0.2	0	0.07	0.01	0.36
Gordon Gunter	1	009-H	28.653833	-88.345667	5/31/2010	1725	9572.11	4.41	4.07	0.2	0	0.09	0.01	0.85
Gordon Gunter	1	010-H	28.850000	-88.264500	5/31/2010	1159	15902.77	-99	-99	-99	-99	-99	-99	-99
Jack Fitz	2	JF011-C2	28.76033333	-88.35716667	5/31/2010	1477	2610.45	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS043-A	28.650000	-88.617167	05/31/2010	1307	26475.33	4.04	3.28	0.26	0.33	15.24	1.02	98.19
Walton Smith	1	WS044-A	28.629500	-88.545333	05/31/2010	1567	21312.03	4.17	3.88	0.16	0	0.07	0.01	0.35
Walton Smith	1	WS045-A	28.683667	-88.465333	05/31/2010	1323	11458.56	4.19	3.88	0.18	0	0.14	0.02	1.3
Walton Smith	1	WS046-A	28.694833	-88.433300	05/31/2010	1338	8178.09	3.99	3.52	0.25	3.07	12.29	3.3	924.44
Walton Smith	1	WS046-B	28.693833	-88.432500	05/31/2010	1322	8165.59	-99	-99	-99	-99	-99	-99	-99
Walton Smith	1	WS047-A	28.720833	-88.397333	05/31/2010	1550	3624.50	3.97	3.32	0.22	7.41	30.17	8.89	2230.24
Walton Smith	1	WS048-A	28.732333	-88.401167	05/31/2010	1520	3507.70	3.98	3.17	0.37	1.47	5.65	1.63	441.02
Walton Smith	1	WS049-A	28.725000	-88.387833	05/31/2010	1570	2758.44	4.14	3.79	0.19	0.18	1.04	0.27	55.01
Walton Smith	1	WS050-A	28.716333	-88.378333	05/31/2010	1584	2708.68	4.13	3.79	0.2	0	0.07	0.01	0.39
Walton Smith	1	WS051-A	28.721500	-88.381000	05/31/2010	1543	2363.86	4.14	3.79	0.2	0	0.08	0.01	0.24
Brooks McCall	5	BM60	28.725908	-88.372033	6/1/2010	1498	1483.52	4.42	4.04	0.2	0	0.01	0	0.01
Brooks McCall	5	BM61	28.696512	-88.384982	6/1/2010	1400	4985.05	4.41	4.05	0.21	0	0.05	0	0.19
Brooks McCall	5	BM62	28.654526	-88.404116	6/1/2010	1400	10010.65	4.43	4.05	0.23	0	0.04	0	0.16
Brooks McCall	5	BM63	28.663980	-88.421060	6/1/2010	1341	9847.22	4.44	4.06	0.24	0.01	0.38	0.04	2.68
Brooks McCall	5	BM64	28.683393	-88.448712	6/1/2010	1368	10131.31	4.43	3.55	0.24	0.12	2.68	0.42	36.35
Gordon Gunter	1	011-H	28.849167	-88.260883	6/01/2010	660	16054.91	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	1	012-H	28.817167	-88.432833	6/01/2010	1218	10948.70	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	1	013-H	28.794667	-88.452167	6/01/2010	1317	10517.07	4.47	4.05	0.13	0	0.09	0.01	0.3
Gordon Gunter	1	014-H	28.771167	-88.481833	6/1/2010	1340	11920.30	4.51	4.24	0.14	0	0.08	0.01	0.21
Gordon Gunter	1	015-H	28.739833	-88.484667	6/01/2010	1401	11622.54	4.5	4.15	0.19	0	0.05	0	0.11
Gordon Gunter	1	016-H	28.704333	-88.481667	6/1/2010	1332	11935.26	4.46	4.05	0.21	0.01	0.28	0.04	4.07
Gordon Gunter	1	017-H	28.680500	-88.453667	6/01/2010	1383	10712.36	4.41	4.01	0.22	0.59	3.84	0.85	176.67
Gordon Gunter	1	018-H	28.655333	-88.424833	6/01/2010	1311	10855.27	4.47	4.1	0.21	0	0.08	0.01	0.84
Walton Smith	2	WS052-A	28.721167	-88.364667	06/01/2010	1567	1889.34	4.12	3.76	0.21	0	0.1	0.01	0.16
Walton Smith	2	WS053-A	28.733333	-88.384333	06/01/2010	1509	1877.56	4.13	3.78	0.21	5.03	28.68	8.3	1512.41
Walton Smith	2	WS054-A	28.728500	-88.393300	06/01/2010	1531	2902.18	4.13	3.77	0.2	1.84	22.26	4.71	554.21
Walton Smith	2	WS055-A	28.719167	-88.406167	06/01/2010	1511	4466.02	4.15	3.66	0.19	0.26	1.81	0.39	78.13
Walton Smith	2	WS056-A	28.715333	-88.393667	06/01/2010	1418	3712.39	4.16	3.8	0.19	0	0.07	0.01	0.25
Walton Smith	2	WS057-A	28.736167	-88.394833	06/01/2010	1487	2836.36	4.13	3.46	0.25	1.13	13.48	2.16	338.86
Walton Smith	2	WS058-A	28.737167	-88.382833	06/01/2010	1489	1656.72	4.07	3.23	0.37	6.8	20.22	6.05	2046.99

Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Mean (ppb QSDE)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Walton Smith	2	WS058-B	28.737500	-88.385667	06/01/2010	1492	1931.85	4.11	3.74	0.19	0.26	3.15	0.75	79.48
Walton Smith	2	WS059-A	28.737167	-88.379833	06/01/2010	1505	1363.81	4.1	3.29	0.32	3.29	17.18	4.01	989.56
Gordon Gunter	1	019-H	28.667167	-88.466833	6/02/2010	1382	12638.17	4.25	3.66	0.3	2.39	12.63	3.54	720.65
Gordon Gunter	1	020-H	28.662667	-88.476500	6/02/2010	1403	13691.37	4.27	3.69	0.25	2.3	13.03	3.48	690.87
Gordon Gunter	1	021-H	28.553333	-88.491333	6/02/2010	1692	23919.89	4.47	4.14	0.17	0	0.12	0.01	1.18
Gordon Gunter	1	022-H	28.647500	-88.532833	6/02/2010	1532	19193.91	4.46	4.15	0.17	0	0.14	0.02	1.46
Gordon Gunter	1	023-H	28.652167	-88.385667	6/02/2010	1563	9742.04	4.41	4.04	0.22	0	0.1	0.01	0.95
Gordon Gunter	1	024-H	28.653833	-88.353167	6/02/2010	1707	9447.05	4.41	4.04	0.22	0	0.11	0.01	0.64
Gordon Gunter	1	025-H	28.678000	-88.320333	6/02/2010	1466	8035.44	4.44	4.07	0.19	0	0.1	0.01	0.24
Ocean Veritas	2	OV013	28.801976	-88.391856	6/2/2010	1162	7529.81	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	2	OV015	28.740080	-88.391591	6/2/2010	1443	2519.67	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	2	OV016	28.740080	-88.391591	6/2/2010	1202	2519.67	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ11	28.720167	-88.450330	6/2/2010	1206	8498.64	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ12	28.697030	-88.509150	6/2/2010	1206	14744.87	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	1	026-H	28.702833	-88.273167	6/03/2010	1493	9894.56	4.44	4.07	0.19	0.01	0.13	0.02	2.15
Gordon Gunter	1	027-H	28.700667	-88.337667	6/03/2010	1463	4998.90	4.41	3.73	0.23	0	0.25	0.02	0.37
Gordon Gunter	1	028-H	28.706167	-88.453000	6/03/2010	1272	9232.99	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	1	029-H	28.693500	-88.435167	6/03/2010	1301	8397.25	4.44	4.1	0.22	0	0.14	0.01	0.68
Walton Smith	2	WS060-A	28.740833	-88.384667	06/03/2010	1482	1856.88	4.1	3.79	0.21	1.58	9.11	2.7	475.66
Gordon Gunter	1	030-H	28.678167	-88.425000	6/04/2010	1347	8820.61	4.42	4.05	0.22	0.01	0.15	0.03	3.07
Ocean Veritas	2	OV021	28.706500	-88.347900	6/4/2010	1502	3933.33	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	2	OV022	28.7065	-88.3479	6/4/2010	6	3933.33	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	2	OV023	28.674600	-88.329800	6/4/2010	1505	7895.19	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	2	OV024	28.675768	-88.347224	6/4/2010	1618	7166.01	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	2	OV025	28.689414	-88.361276	6/4/2010	1600	5431.16	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	2	OV026	28.707290	-88.360949	6/4/2010	1576	3461.18	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ14	29.316660	-88.187500	6/4/2010	85	66582.50	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	2	TJ15	28.879666	-89.175833	6/4/2010	89	80738.05	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ16	28.537333	-90.191230	6/4/2010	42	180078.42	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ17	28.242983	-90.317067	6/4/2010	92	199004.58	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ18	28.137833	-90.327333	6/4/2010	192	203575.99	-99	-99	-99	-99	-99	-99	-99
Walton Smith	2	WS006-B	28.726333	-88.423500	6/4/2010	1454	5784.85	4.02	3.66	0.25	2.04	16.17	4.18	613.99
Walton Smith	2	WS008-B	28.726000	-88.435667	6/4/2010	1466	6957.18	4.1	3.6	0.21	0.15	1.37	0.27	44.45
Walton Smith	2	WS061-A	28.748333	-88.397167	06/04/2010	1419	3259.07	4.16	3.76	0.18	0.1	3.34	0.45	30.37
Walton Smith	2	WS062-A	28.743333	-88.462000	06/04/2010	1426	9419.90	4.16	3.59	0.21	0.09	0.89	0.18	27.9
Walton Smith	2	WS063-A	28.733833	-88.533500	06/04/2010	1119	16408.03	-99	-99	-99	-99	-99	-99	-99
Walton Smith	2	WS064-A	28.718000	-88.601833	06/04/2010	959	23198.79	-99	-99	-99	-99	-99	-99	-99
Walton Smith	2	WS066-A	28.672667	-88.529167	06/04/2010	1436	17558.00	4.18	3.62	0.19	0.02	0.28	0.05	5.89
Walton Smith	2	WS067-A	28.742667	-88.433500	06/04/2010	1463	6631.74	4.15	3.75	0.18	0	0.07	0.01	0.48
Brooks McCall	6	BM65	28.732025	-88.376726	6/5/2010	1542	1255.02	4.36	3.91	0.21	0	0.26	0.01	0.26
Brooks McCall	6	BM66	28.729575	-88.366420	6/5/2010	1559	952.43	4.36	3.98	0.2	0.12	2.74	0.39	35.84
Brooks McCall	6	BM67	28.693435	-88.366676	6/5/2010	1595	4965.78	4.33	3.89	0.24	0.2	1.86	0.43	61.16
Walton Smith	2	WS047-B	28.720167	-88.395667	6/5/2010	1519	3528.61	4.12	3.71	0.2	0.01	0.21	0.04	3.86
Walton Smith	2	WS053-B	28.733167	-88.383667	6/5/2010	1487	1820.62	4.12	3.67	0.19	0.18	4.64	0.68	54.56
Walton Smith	2	WS059-B	28.740000	-88.378500	6/5/2010	1486	1246.22	4.13	3.63	0.2	0	0.05	0	0.21
Walton Smith	2	WS068-B	28.749833	-88.379167	06/05/2010	1444	1833.48	4.16	3.68	0.18	0	0.1	0.01	0.28
Walton Smith	2	WS069-A	28.755333	-88.369000	06/05/2010	1423	1932.89	4.16	3.79	0.17	0	0.02	0	0.03
Walton Smith	2	WS070-A	28.752833	-88.355000	06/05/2010	1468	1952.22	4.17	3.76	0.17	0	0.08	0.01	0.21
Walton Smith	2	WS071-C	28.744167	-88.346167	06/05/2010	1518	2048.57	4.18	3.74	0.19	0	0.03	0	0.13
Walton Smith	2	WS072-A	28.732167	-88.348500	06/05/2010	1550	1832.15	4.15	3.75	0.21	0	0.15	0.01	0.36
Walton Smith	2	WS073-A	28.722333	-88.357000	06/05/2010	1562	1961.91	4.16	3.75	0.19	0.15	2.59	0.36	46.09

Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Walton Smith	2	WS075-A	28.726167	-88.382500	06/05/2010	1542	2096.42	4.13	3.61	0.21	2.06	2.74	620.19
Walton Smith	2	WS076-A	28.727000	-88.377333	06/05/2010	1545	1665.46	4.11	3.69	0.19	0.18	0.48	53.8
Walton Smith	2	WS077-A	28.728333	-88.385167	06/05/2010	1536	2174.18	4.11	3.76	0.19	0.01	0.03	1.94
Walton Smith	2	WS078-A	28.774500	-88.521000	06/05/2010	1164	15702.74	-99	-99	-99	-99	-99	-99
Brooks McCall	6	BM68	28.648186	-88.366673	6/6/2010	1590	9991.18	4.33	3.82	0.22	0	0.01	0.9
Brooks McCall	6	BM69	28.697133	-88.346713	6/6/2010	1537	4928.51	4.34	3.75	0.24	0	0.02	0.84
Brooks McCall	6	BM70	28.706515	-88.330276	6/6/2010	1469	4953.23	4.36	3.99	0.2	0	0.01	0.92
Walton Smith	2	WS016-B	28.698000	-88.555667	6/6/2010	1382	19101.25	4.14	3.61	0.21	0.14	0.14	41.27
Walton Smith	2	WS079-A	28.851000	-88.489000	6/6/2010	899	17379.29	-99	-99	-99	-99	-99	-99
Brooks McCall	6	BM72	28.748163	-88.377422	6/7/2010	1457	1581.53	4.39	3.81	0.21	0.01	0.02	3.18
Brooks McCall	6	BM73	28.722980	-88.373478	6/7/2010	1575	1838.20	4.39	3.84	0.2	0	0	0
Brooks McCall	6	BM74	28.688098	-88.418302	6/7/2010	1411	7561.00	4.38	3.93	0.24	0.16	0.56	47.24
Ocean Veritas	3	OV027	28.800795	-88.504048	6/8/2010	1084	15200.30	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV028	28.800750	-88.462457	6/8/2010	1230	11728.11	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV029	28.774282	-88.462457	6/8/2010	1336	10263.08	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV030	28.670523	-88.391623	6/8/2010	1511	7919.68	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ19	27.974660	-90.318000	6/8/2010	492	209494.33	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ20	28.085983	-91.798600	6/8/2010	91	344260.38	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ21	27.884350	-91.777500	6/8/2010	197	347955.82	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ22	27.759333	-91.791666	6/8/2010	491	353488.21	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV031	28.715668	-88.366609	6/9/2010	1564	2496.75	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV032	28.715530	-88.361426	6/9/2010	1564	2549.92	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV033	28.715869	-88.371690	6/9/2010	1562	2536.71	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV034	28.718224	-88.376945	6/9/2010	1558	2460.21	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV035	28.723998	-88.384983	6/9/2010	1486	2437.34	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ24	27.128267	-93.398500	6/9/2010	827	526602.42	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ25	28.535167	-93.642833	6/9/2010	36	516586.36	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ26	28.038056	-93.728333	6/9/2010	93	531375.52	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ27	27.925167	-93.534167	6/9/2010	112	514874.97	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ28	27.906150	-93.694740	6/9/2010	102	530782.57	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV036	28.732010	-88.376790	6/10/2010	1522	1261.19	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV039	28.745000	-88.398000	6/10/2010	1415	3228.91	-99	-99	-99	-99	-99	-99
Ocean Veritas	3	OV040	28.745000	-88.422000	6/10/2010	1440	5539.58	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ29	27.776170	-93.669710	6/10/2010	170	531378.79	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ30	28.001730	-93.279880	6/10/2010	67	488701.95	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ31	27.968890	-92.720890	6/10/2010	126	435570.41	-99	-99	-99	-99	-99	-99
Brooks McCall	7	BM75	28.723622	-88.414820	6/11/2010	1531	5049.02	4.4	4.05	0.18	0	0.01	0.48
Brooks McCall	7	BM76	28.732355	-88.417212	6/11/2010	1512	5059.54	4.39	4.07	0.19	0.1	0.27	30.82
Brooks McCall	7	BM77	28.741417	-88.417597	6/11/2010	1483	5069.13	4.42	4.07	0.18	0.31	0.9	91.83
Brooks McCall	7	BM78	28.750397	-88.415992	6/11/2010	1433	5084.37	4.42	4.13	0.17	0.14	0.45	41.79
Brooks McCall	7	BM79	28.758767	-88.412258	6/12/2010	1402	5079.08	4.4	4.08	0.19	0.02	0.1	6.35
Brooks McCall	7	BM80	28.748740	-88.389343	6/12/2010	1441	2575.17	4.43	4.05	0.18	0.07	0.28	21.3
Brooks McCall	7	BM81	28.735495	-88.391867	6/12/2010	1502	2554.46	4.44	4.1	0.18	0.19	0.46	56.15
Brooks McCall	7	BM82	28.739988	-88.376563	6/12/2010	1496	1059.44	4.44	3.98	0.19	0.09	0.2	26.29
Jack Fitz	3	JF001-C3	28.27316667	-88.917	6/12/2010	1315	74742.68	-99	-99	-99	-99	-99	-99
Brooks McCall	7	BM83	28.747703	-88.427198	6/13/2010	1436	6089.00	4.44	4.04	0.22	0.05	0.11	15.11
Brooks McCall	7	BM84	28.766427	-88.406815	6/13/2010	1387	5086.42	4.43	3.84	0.2	0.15	0.32	45.52
Brooks McCall	7	BM85	28.772935	-88.399692	6/13/2010	1378	5083.68	4.42	3.78	0.21	0.18	0.36	55.5
Brooks McCall	7	BM86	28.778045	-88.391320	6/13/2010	1370	5080.46	4.4	3.8	0.21	0.13	0.31	40.14
Brooks McCall	7	BM87	28.781590	-88.381860	6/13/2010	1374	5070.99	4.39	3.83	0.21	0.11	0.29	33.9
Jack Fitz	3	JF002-C3	28.73916667	-88.38716667	6/13/2010	1497	2080.49	-99	-99	-99	-99	-99	-99

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Jack Fitz	3	JF003-C3	28.7485	-88.36683333	6/14/2010	1487	1153.94	-99	-99	-99	-99	-99	-99
Ocean Veritas	4	OV042	28.791880	-88.338926	6/14/2010	1302	6528.39	4.5	4.12	0.2	0.06	0.12	18.96
Ocean Veritas	4	OV043	28.762861	-88.353747	6/14/2010	1450	2994.09	4.44	4	0.23	0.59	0.84	178.53
Ocean Veritas	4	OV044	28.752616	-88.340081	6/14/2010	1502	2999.16	4.42	3.88	0.25	0.38	0.59	115.76
Ocean Veritas	4	OV045	28.763623	-88.323622	6/14/2010	1299	5017.27	4.47	4	0.21	0.24	0.57	72.56
Ocean Veritas	4	OV046	28.751052	-88.316943	6/14/2010	1438	5006.55	4.45	4.01	0.22	0.19	0.36	58.04
Thomas Jefferson	3	TJ32	27.918860	-92.643150	6/14/2010	299	429338.53	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ33	27.892730	-91.631970	6/14/2010	310	333975.27	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ34	27.915700	-91.199600	6/14/2010	216	292698.15	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ35	27.920000	-91.308000	6/14/2010	312	302665.65	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ36	28.079000	-91.087900	6/14/2010	110	276793.95	-99	-99	-99	-99	-99	-99
Ocean Veritas	4	OV047	28.741417	-88.417597	6/15/2010	1461	5069.13	4.52	3.97	0.23	0	0.01	0.44
Ocean Veritas	4	OV048	28.732010	-88.376790	6/15/2010	1520	1261.19	4.54	4.13	0.19	0	0.02	1.37
Ocean Veritas	4	OV049	28.780754	-88.387846	6/15/2010	1346	5195.72	4.51	3.83	0.26	0.04	0.11	13.36
Ocean Veritas	4	OV050	28.780347	-88.347809	6/15/2010	1427	5012.69	4.52	3.98	0.18	0.14	0.33	42.47
Ocean Veritas	4	OV051	28.754515	-88.357993	6/15/2010	1455	1978.32	4.55	4.16	0.18	0.18	0.45	54.04
Thomas Jefferson	3	TJ37	28.387660	-90.846370	6/15/2010	41	246033.92	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ38	28.482100	-90.488100	6/15/2010	34	209720.39	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ39	28.715700	-90.275500	6/15/2010	27	186796.01	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ40	28.862470	-90.155990	6/15/2010	21	175518.73	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ41	28.632590	-89.964810	6/15/2010	252	156910.00	-99	-99	-99	-99	-99	-99
Jack Fitz	3	JF004-C3	28.75716667	-88.36516667	6/16/2010	1059	2114.62	-99	-99	-99	-99	-99	-99
Ocean Veritas	4	OV052	28.754902	-88.291345	6/16/2010	1284	7536.05	-99	-99	-99	-99	-99	-99
Ocean Veritas	4	OV053	28.779023	-88.305090	6/16/2010	1236	7489.80	-99	-99	-99	-99	-99	-99
Ocean Veritas	4	OV054	28.798055	-88.330431	6/16/2010	1208	7507.72	-99	-99	-99	-99	-99	-99
Ocean Veritas	4	OV055	28.806069	-88.365333	6/16/2010	1160	7544.98	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ42	28.710370	-89.209400	6/16/2010	55	82599.77	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ43	29.108100	-89.844600	6/16/2010	19	150111.20	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ44	28.829100	-89.737400	6/16/2010	59	134483.79	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ45	28.967150	-89.742230	6/16/2010	48	136868.23	-99	-99	-99	-99	-99	-99
Brooks McCall	8	BM88	28.729488	-88.366357	6/17/2010	1559	961.80	4.45	4.11	0.17	0	0.01	0.32
Brooks McCall	8	BM89	28.738312	-88.386968	6/17/2010	1488	2058.01	4.44	3.85	0.22	0	0.02	1
Brooks McCall	8	BM90	28.738512	-88.436113	6/17/2010	1546	6868.68	4.41	4	0.2	0.01	0.04	3.34
Jack Fitz	3	JF005-C3	28.76183333	-88.36483333	6/17/2010	1441	2633.82	-99	-99	-99	-99	-99	-99
Jack Fitz	3	JF006-C3	28.74333333	-88.39666667	6/17/2010	582	3062.06	-99	-99	-99	-99	-99	-99
Jack Fitz	3	JF007-C3	28.75733333	-88.36983333	6/17/2010	260	2165.46	-99	-99	-99	-99	-99	-99
Brooks McCall	8	BM94	28.801513	-88.366598	6/18/2010	1263	7039.00	-99	-99	-99	-99	-99	-99
Jack Fitz	3	JF008-C3	28.75566667	-88.35816667	6/18/2010	261	2090.26	-99	-99	-99	-99	-99	-99
Brooks McCall	8	BM95	28.802070	-88.293720	6/19/2010	1243	10019.18	-99	-99	-99	-99	-99	-99
Brooks McCall	8	BM96	28.828752	-88.366687	6/19/2010	1047	10064.36	-99	-99	-99	-99	-99	-99
Brooks McCall	8	BM97	28.802875	-88.438483	6/19/2010	1276	10103.39	-99	-99	-99	-99	-99	-99
Brooks McCall	8	BM98	28.778050	-88.391312	6/19/2010	1370	5080.56	4.3	3.83	0.25	0.03	0.07	9.48
Brooks McCall	8	BM99	28.762563	-88.381593	6/19/2010	1411	3115.10	4.34	3.84	0.22	0.01	0.03	3.24
Jack Fitz	3	JF009-C3	28.75216667	-88.381	6/19/2010	1459	2144.43	-99	-99	-99	-99	-99	-99
Jack Fitz	3	JF010-C3	28.81316667	-88.40933333	6/19/2010	1106	9352.15	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ46	28.807260	-89.672760	6/19/2010	71	128030.76	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ47	28.889430	-89.511880	6/19/2010	33	113283.18	-99	-99	-99	-99	-99	-99
Jack Fitz	3	JF011-C3	28.78783333	-88.38216667	6/20/2010	1386	5743.07	-99	-99	-99	-99	-99	-99
Jack Fitz	3	JF012-C3	28.7725	-88.37283333	6/20/2010	1411	3875.37	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ48	28.866600	-89.351700	6/20/2010	58	97438.55	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ49	28.936000	-89.162800	6/20/2010	41	80937.40	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ50	29.136200	-88.927800	6/20/2010	36	70465.26	-99	-99	-99	-99	-99	-99

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Thomas Jefferson	3	TJ51	29.232740	-88.771320	6/20/2010	66	67699.13	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ52	29.230800	-88.623890	6/20/2010	67	60231.60	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ53	29.404480	-88.697850	6/20/2010	40	80772.80	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ54	29.532000	-88.492900	6/21/2010	46	89034.44	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ55	29.876100	-88.617500	6/21/2010	18	128731.11	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ56	29.866100	-88.464500	6/21/2010	23	125647.15	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	5	OV062	28.754515	-88.357993	6/22/2010	18753	1978.32	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ57	29.818400	-87.523200	6/22/2010	34	145437.77	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ58	29.731500	-87.229400	6/22/2010	176	15644.85	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ59	29.554920	-87.329870	6/22/2010	198	135860.15	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ60	29.348790	-87.652690	6/22/2010	176	97233.42	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ61	29.980470	-88.087210	6/22/2010	272	148360.37	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ62	29.251100	-88.081600	6/22/2010	191	63390.39	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	9	BM100	28.696507	-88.384957	6/23/2010	1594	4984.63	4.35	3.99	0.19	0	0.04	0	0.14
Brooks McCall	9	BM101	28.693455	-88.366730	6/23/2010	1143	4963.64	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	9	BM102	28.715060	-88.371377	6/23/2010	1582	2618.01	4.36	4.01	0.19	0	0.01	0	0.02
Thomas Jefferson	3	TJ63	29.172700	-88.483900	6/23/2010	173	49619.77	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ64	28.959800	-88.814200	6/23/2010	267	50262.50	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ65	28.822160	-89.103950	6/23/2010	204	72788.00	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ66	28.773200	-88.363420	6/23/2010	1186	3901.88	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	9	BM103	28.740107	-88.387755	6/24/2010	1480	2146.09	4.34	3.98	0.18	0.42	5.94	1.19	127.4
Brooks McCall	9	BM104	28.738168	-88.417780	6/24/2010	1495	5074.04	4.32	3.98	0.17	0.26	2.59	0.56	78.15
Brooks McCall	9	BM105	28.743882	-88.438368	6/24/2010	1454	7117.76	4.27	3.91	0.2	0	0.06	0.01	0.23
Brooks McCall	9	BM106	28.729300	-88.416593	6/24/2010	1521	5054.37	4.32	3.94	0.18	0.52	6.65	1.06	155.56
Thomas Jefferson	3	TJ67	28.802833	-88.378833	6/24/2010	1166	7295.16	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ68	28.816833	-88.304833	6/24/2010	1209	10590.66	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ69	28.817500	-88.333333	6/24/2010	1218	9374.43	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	9	BM107	28.729640	-88.390192	6/25/2010	1538	2554.44	4.34	3.82	0.2	0.71	4.01	1.11	212.71
Brooks McCall	9	BM108	28.721428	-88.386297	6/25/2010	1566	2722.98	4.34	3.88	0.2	-99	-99	-99	-99
Brooks McCall	9	BM109	28.732040	-88.376750	6/25/2010	1542	1256.10	4.36	3.99	0.17	0.89	3.53	1.14	268.56
Brooks McCall	9	BM110	28.711495	-88.407430	6/25/2010	1553	5025.22	4.34	3.99	0.17	0	0.05	0.01	0.22
Brooks McCall	9	BM111	28.756102	-88.561648	6/25/2010	1406	19257.61	4.29	3.98	0.17	0	0.02	0	0.03
Thomas Jefferson	3	TJ70	28.832833	-88.334000	6/25/2010	1209	10972.26	-99	-99	-99	-99	-99	-99	-99
Thomas Jefferson	3	TJ71	28.725000	-88.420000	6/25/2010	1210	5489.23	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	6	OV063	28.726027	-88.380862	6/26/2010	1540	1985.55	4.38	4.02	0.17	1.62	12.13	3.36	487.63
Ocean Veritas	6	OV064	28.720631	-88.380568	6/26/2010	1554	2414.76	4.39	4.03	0.17	0.02	0.53	0.08	6.72
Ocean Veritas	6	OV065	28.738276	-88.386492	6/26/2010	1472	2011.38	4.35	4	0.17	0.01	0.6	0.06	3.36
Ocean Veritas	6	OV066	28.707779	-88.403271	6/26/2010	1537	4972.41	4.36	4.01	0.18	0.67	8.64	1.85	202.17
Ocean Veritas	6	OV067	28.695697	-88.419291	6/26/2010	1456	7035.67	4.36	3.98	0.2	0.08	2.98	0.38	25.32
Thomas Jefferson	3	TJ72	28.707000	-88.427167	6/26/2010	1209	6920.01	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	6	OV068	28.701708	-88.395779	6/27/2010	1556	4990.46	4.36	3.84	0.2	0.05	0.65	0.11	13.56
Ocean Veritas	6	OV069	28.730275	-88.416872	6/27/2010	1497	5061.30	4.36	3.99	0.17	0.2	1.34	0.36	61.44
Ocean Veritas	6	OV070	28.730275	-88.416872	6/27/2010	1502	5061.30	4.35	4.01	0.17	0.13	1.27	0.22	37.97
Ocean Veritas	6	OV071	28.716192	-88.410757	6/27/2010	1523	5018.79	4.36	4.01	0.17	0.08	2.58	0.25	23.52
Ocean Veritas	6	OV072	28.705997	-88.413788	6/27/2010	1525	5889.34	4.34	3.97	0.18	0	0.16	0.02	1.49
Ocean Veritas	6	OV073	28.726027	-88.380862	6/28/2010	1542	1985.55	4.33	4	0.18	0.06	2.57	0.3	17.48
Ocean Veritas	6	OV074	28.720215	-88.367083	6/28/2010	1566	1994.00	4.34	4	0.19	0.01	0.18	0.02	1.65
Ocean Veritas	6	OV075	28.732011	-88.376788	6/28/2010	1519	1260.97	4.32	3.97	0.17	1.35	6.12	1.62	407.76
Ocean Veritas	7	OV076	28.732011	-88.376788	6/28/2010	1537	1260.97	4.25	3.91	0.19	0	0.17	0.01	0.53
Nancy Foster	1	NF001	24.42133333	-82.0025	7/1/2010	47	79967.19	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF002	24.32283333	-82.001	7/1/2010	198	806974.20	-99	-99	-99	-99	-99	-99	-99

Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Mean (ppb QSDE)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Nancy Foster	1	NF003	24.224	-81.9975	7/1/2010	585	814252.65	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF004	24.124	-82.00033333	7/2/2010	739	821197.92	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF005	24.024	-81.9995	7/2/2010	910	828522.65	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF006	23.92283333	-81.99166667	7/2/2010	1449	836563.90	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF007	23.82516667	-81.99683333	7/2/2010	1410	843414.20	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	7	OV077	28.738276	-88.386492	7/2/2010	1476	2011.38	4.22	3.91	0.19	1.86	10.58	3.2	561.02
Ocean Veritas	7	OV078	28.751320	-88.379564	7/2/2010	1432	2006.46	4.22	3.92	0.16	0.17	1.84	0.38	52.44
Ocean Veritas	7	OV079	28.738277	-88.396630	7/2/2010	1455	3003.76	4.21	3.93	0.18	0.84	9.63	1.9	254.27
Ocean Veritas	7	OV080	28.739294	-88.416913	7/2/2010	1475	4990.79	4.26	3.9	0.19	0.29	4.92	0.96	86.61
Ocean Veritas	7	OV081	28.739824	-88.437527	7/2/2010	1444	7009.42	4.29	3.91	0.21	0.01	0.14	0.02	1.87
Nancy Foster	1	NF008	23.7225	-81.99733333	7/3/2010	1562	851083.80	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF009	23.62383333	-81.991	7/3/2010	1613	859052.73	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF010	23.522	-81.99983333	7/3/2010	1635	866187.09	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF011	23.42483333	-81.999	7/3/2010	1617	873771.37	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	7	OV082	28.748448	-88.416649	7/3/2010	1424	5093.42	4.19	3.83	0.18	0.22	4.98	0.73	66.27
Ocean Veritas	7	OV083	28.757492	-88.416387	7/3/2010	1382	5384.78	4.15	3.86	0.18	0.69	7.4	1.51	207.95
Ocean Veritas	7	OV084	28.777792	-88.407763	7/3/2010	1332	6012.10	4.23	3.87	0.23	0.26	3.58	0.64	77.15
Nancy Foster	1	NF012	23.21916667	-83.252	7/4/2010	1993	802446.00	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF013	23.43483333	-83.38983333	7/4/2010	2073	774715.29	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF014	23.64833333	-83.52966667	7/4/2010	2102	747089.95	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF015	23.86116667	-83.66933333	7/4/2010	1658	719583.78	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	7	OV085	28.786948	-88.407640	7/4/2010	1308	6785.02	4.21	3.78	0.24	0.06	1.19	0.17	16.96
Ocean Veritas	7	OV086	28.787752	-88.438242	7/4/2010	1301	8967.76	4.26	3.82	0.24	0.02	0.87	0.08	5.31
Ocean Veritas	7	OV087	28.769946	-88.438824	7/4/2010	1349	7959.64	4.24	3.8	0.24	0.04	1.45	0.2	11.68
Ocean Veritas	7	OV088	28.757492	-88.416387	7/4/2010	1385	5384.78	4.19	3.76	0.21	0.22	3.91	0.64	65.48
Ocean Veritas	7	OV089	28.721636	-88.417376	7/4/2010	1517	5358.18	4.28	3.9	0.21	0	0.15	0.02	0.99
Ocean Veritas	7	OV090	28.774371	-88.462373	7/4/2010	1340	10259.38	4.27	3.81	0.24	0.02	0.28	0.04	5.23
Brooks McCall	11	BM112	28.741400	-88.346283	7/5/2010	1066	1958.49	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	11	BM113	28.745800	-88.347750	7/5/2010	1527	1973.88	4.23	3.87	0.22	0.09	1.71	0.28	28.1
Nancy Foster	1	NF016	24.07816667	-83.8105	7/5/2010	1444	691677.30	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF017	24.29283333	-83.95016667	7/5/2010	1386	664130.13	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF018	24.50816667	-84.0905	7/5/2010	1544	636546.96	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	11	BM115	28.723217	-88.357567	7/6/2010	1577	1939.46	4.14	3.73	0.22	0.05	1.23	0.21	16.05
Brooks McCall	11	BM116	28.736767	-88.346150	7/6/2010	1552	1943.82	4.21	3.91	0.2	0.16	3.47	0.54	47.49
Brooks McCall	11	BM117	28.742523	-88.352078	7/6/2010	1535	1442.10	4.19	3.89	0.17	0.04	1.12	0.17	12.66
Nancy Foster	1	NF019	25.08083333	-83.00266667	7/6/2010	33	673581.97	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF020	25.06033333	-83.091	7/6/2010	36	667956.54	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF021	25.03666667	-83.17616667	7/6/2010	40	662883.93	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF022	25.01216667	-83.26366667	7/6/2010	44	657769.94	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF023	24.989	-83.3525	7/6/2010	46	652543.04	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF024	24.97316667	-83.44183333	7/6/2010	50	646824.50	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF025	24.94683333	-83.5325	7/6/2010	52	641869.87	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF026	24.92583333	-83.61733333	7/6/2010	50	637050.97	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF027	24.90416667	-83.708	7/6/2010	63	631935.23	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF030	24.83366667	-83.99366667	7/6/2010	168	616648.48	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF031	24.81366667	-84.07766667	7/6/2010	323	612293.28	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF032	24.78	-84.23583333	7/6/2010	1347	604015.94	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF033	24.7075	-84.49933333	7/6/2010	1983	592361.67	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF034	24.63933333	-84.7655	7/7/2010	1982	581222.03	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF035	24.5655	-85.03816667	7/7/2010	378	571335.19	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF036	24.50533333	-85.2915	7/7/2010	1997	562483.21	-99	-99	-99	-99	-99	-99	-99

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Nancy Foster	1	NF037	24.438	-85.554	7/7/2010	1993	554949.82	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF038	24.377	-85.8155	7/7/2010	1986	548083.87	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF039	24.19483333	-86.52233333	7/8/2010	1458	537724.45	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF040	24.7835	-85.70133333	7/8/2010	1982	514127.68	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	8	OV091	28.751768	-88.365511	7/8/2010	1444	1514.23	4.32	4	0.16	0.01	0.23	0.03	2.83
Ocean Veritas	8	OV092	28.744873	-88.373085	7/8/2010	1457	1023.56	4.31	3.99	0.16	0.38	1.43	0.24	114.41
Ocean Veritas	8	OV093	28.738276	-88.386493	7/8/2010	7947	2011.48	4.29	3.95	0.17	0.03	1.01	0.13	8.9
Ocean Veritas	8	OV094	28.730040	-88.377441	7/8/2010	1536	1440.77	4.31	3.97	0.18	0.11	2.14	0.38	34.51
Ocean Veritas	8	OV095	28.724765	-88.366360	7/8/2010	1555	1486.08	4.31	3.98	0.18	0	0.03	0	0.06
Nancy Foster	1	NF041	25.13233333	-85.80566667	7/9/2010	1988	475418.27	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF042	25.461	-85.89833333	7/9/2010	1985	439546.64	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF043	25.86933333	-85.99783333	7/9/2010	1989	396437.82	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF044	25.51	-86.5225	7/9/2010	992	403034.39	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	8	OV096	28.693076	-88.368057	7/9/2010	1595	5009.40	4.32	3.97	0.2	0.01	0.21	0.03	1.88
Ocean Veritas	8	OV097	28.707723	-88.403559	7/9/2010	1545	4997.37	4.27	3.93	0.18	0.32	3.85	0.78	97.41
Ocean Veritas	8	OV098	28.695553	-88.419376	7/9/2010	1447	7052.57	4.24	3.9	0.19	0.3	3.61	0.72	89.79
Ocean Veritas	8	OV099	28.686359	-88.4407	7/9/2010	1328	9308.41	4.21	3.9	0.18	0.2	3.73	0.58	59.04
Ocean Veritas	8	OV100	28.689102	-88.400276	7/9/2010	1532	6400.20	4.26	3.95	0.18	0.02	0.4	0.07	6.71
Nancy Foster	1	NF045	25.24833333	-86.92016667	7/10/2010	1983	413733.49	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF046	24.7915	-86.7905	7/10/2010	1979	466002.49	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF047	24.86233333	-86.58916667	7/10/2010	1991	465909.48	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF048	24.99683333	-86.201	7/10/2010	1992	468723.43	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	8	OV101	28.716923	-88.422624	7/10/2010	1503	6028.40	4.25	3.92	0.15	0	0.2	0.02	1.23
Ocean Veritas	8	OV102	28.716676	-88.392402	7/10/2010	1554	3520.20	4.29	3.95	0.16	0.14	2.45	0.44	41.65
Ocean Veritas	8	OV103	28.705872	-88.438227	7/10/2010	1364	7932.31	4.24	3.9	0.16	0	0.15	0.02	0.96
Ocean Veritas	8	OV104	28.678488	-88.464278	7/10/2010	1369	11687.30	4.22	3.94	0.15	0.02	0.63	0.07	5.7
Ocean Veritas	8	OV105	28.757061	-88.398296	7/10/2010	1378	3800.40	4.22	3.99	0.12	0	0.12	0.02	1.23
Brooks McCall	12	BM118	28.737883	-88.397367	7/11/2010	1477	3076.01	4.25	4.02	0.11	0	0.05	0	0.09
Brooks McCall	12	BM119	28.711533	-88.365117	7/11/2010	1591	2956.25	4.34	4.03	0.15	0	0.08	0	0.11
Brooks McCall	12	BM120	28.715550	-88.382883	7/11/2010	1578	3007.47	4.27	4.01	0.14	0.01	0.29	0.04	3.29
Brooks McCall	12	BM121	28.719785	-88.387598	7/11/2010	1568	2941.02	4.29	4.01	0.14	0	0.08	0.01	0.18
Brooks McCall	12	BM122	28.708033	-88.388700	7/11/2010	1579	4017.99	4.29	4.02	0.15	0	0.12	0.01	0.73
Nancy Foster	1	NF049	25.13183333	-85.80216667	7/11/2010	1981	475654.14	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF050	25.2625	-85.44733333	7/11/2010	1990	483902.08	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF051	25.38183333	-85.09783333	7/11/2010	1987	495549.77	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF052	25.50216667	-84.75683333	7/11/2010	1992	508952.30	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF053	25.62183333	-84.409	7/11/2010	192	525092.87	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	12	BM123	28.712800	-88.375767	7/12/2010	1584	2974.16	4.3	4.11	0.12	0.19	1.86	0.29	55.77
Brooks McCall	12	BM124	28.708417	-88.377350	7/12/2010	1589	3484.99	4.31	4.09	0.13	0.34	1.67	0.37	103.12
Brooks McCall	12	BM125	28.704200	-88.378800	7/12/2010	1595	3974.15	4.31	4.09	0.13	0.83	4.06	1.03	248.46
Brooks McCall	12	BM127	28.700000	-88.441667	7/12/2010	1303	8538.36	4.16	4	0.08	0	0.07	0	0.13
Nancy Foster	1	NF054	25.9765	-83.364	7/12/2010	45	585305.49	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	12	BM128	28.695483	-88.381967	7/13/2010	1597	4990.66	4.29	4	0.15	0.1	2.09	0.35	30.31
Brooks McCall	12	BM129	28.705100	-88.382617	7/13/2010	1589	4016.27	4.27	4.03	0.15	0.2	1.42	0.38	58.71
Brooks McCall	12	BM130	28.711998	-88.371748	7/13/2010	1584	2958.58	4.29	4.02	0.17	0.55	4.24	0.99	164.04
Nancy Foster	1	NF055	27.472	-83.26516667	7/14/2010	24	523608.56	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF056	27.3155	-83.603	7/14/2010	39	496993.29	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF057	27.11783333	-84.02683333	7/14/2010	73	465743.08	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF058	26.95983333	-84.36766667	7/14/2010	144	442573.61	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF059	26.80266667	-84.7045	7/14/2010	236	421802.27	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF060	26.645	-85.04566667	7/14/2010	1988	403106.23	-99	-99	-99	-99	-99	-99	-99

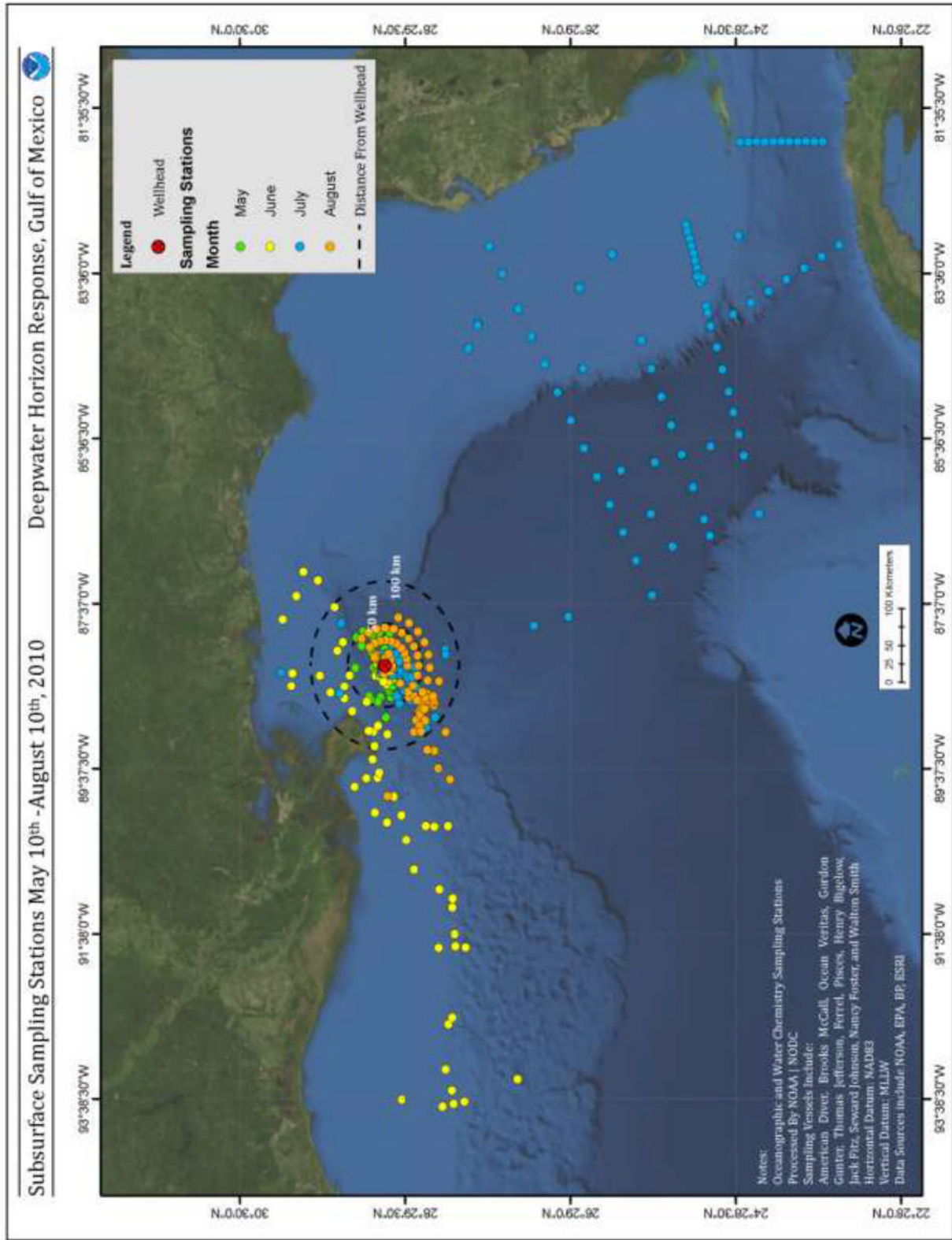
Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Mean (ppb QSDE)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Nancy Foster	1	NF061	26.4816667	-85.3873333	7/14/2010	1985	387580.04	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	9	OV106	28.731247	-88.379414	7/14/2010	1531	1524.66	4.25	3.99	0.19	0	0.09	0.01	0.17
Ocean Veritas	9	OV107	28.7130345	-88.403393	7/14/2010	1536	4606.06	4.24	4.01	0.17	0	0.06	0	0.06
Ocean Veritas	9	OV108	28.712916	-88.384273	7/14/2010	1555	3326.89	4.28	4	0.18	0	0.04	0	0.08
Ocean Veritas	9	OV109	28.696338	-88.385079	7/14/2010	1574	5006.50	4.28	4.01	0.17	0	0.04	0	0.04
Ocean Veritas	9	OV110	28.769229	-88.354335	7/14/2010	1450	3635.19	4.22	3.98	0.2	0	0.12	0.01	0.32
Nancy Foster	1	NF062	26.322	-85.728	7/15/2010	1993	375075.18	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF063	26.165	-86.0713333	7/15/2010	1990	365684.88	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF064	26.0088333	-86.4101667	7/15/2010	1990	360251.44	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF065	25.8466667	-86.746	7/15/2010	1980	359438.04	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF066	25.6885	-87.0878333	7/15/2010	1981	361938.90	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	9	OV111	28.74408	-88.468196	7/15/2010	1407	10030.37	4.23	4.03	0.15	0.03	0.76	0.07	7.68
Ocean Veritas	9	OV112	28.734271	-88.411528	7/15/2010	1486	4482.78	4.21	4.03	0.13	0.01	0.64	0.06	3.8
Ocean Veritas	9	OV113	28.725322	-88.404076	7/15/2010	1516	3995.09	4.2	4.03	0.12	0.01	0.3	0.04	3
Ocean Veritas	9	OV114	28.698	-88.407	7/15/2010	1530	6002.68	4.17	4.02	0.08	0.02	0.32	0.05	5.81
Ocean Veritas	9	OV115	28.699233	-88.340284	7/15/2010	1470	4998.69	4.31	4.03	0.21	0.01	0.33	0.04	2.8
Ocean Veritas	9	OV116	28.711779	-88.352935	7/15/2010	1566	3192.95	4.28	4.02	0.2	0.01	0.18	0.02	1.78
Nancy Foster	1	NF067	25.4945	-87.5145	7/16/2010	2001	370197.36	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF068	26.5123333	-87.7735	7/16/2010	1978	254126.82	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF069	26.9265	-87.8846667	7/16/2010	1990	206788.25	-99	-99	-99	-99	-99	-99	-99
Seward Johnson	1	SJ26	24.4415	-83.1596667	7/16/2010	97.35	708323.48	-99	-99	-99	-99	-99	-99	-99
Seward Johnson	1	SJ28	24.4445	-83.1318333	7/16/2010	110.261	710169.68	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	13	BM131	28.66814167	-88.486125	7/17/2010	1695	14103.74	3.95	3.59	0.16	0.01	0.29	0.03	1.72
Brooks McCall	13	BM132	28.65478333	-88.4738333	7/17/2010	1695	14047.12	3.98	3.65	0.16	0	0.2	0.02	1.41
Brooks McCall	13	BM133	28.63643833	-88.46702833	7/17/2010	1836	15019.25	3.95	3.62	0.16	0.01	0.59	0.04	1.65
Brooks McCall	13	BM134	28.63301667	-88.4451	7/17/2010	1300	14014.52	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF070	28.00516667	-88.1738333	7/17/2010	1978	83574.38	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF071	28.6178333	-88.4366667	7/17/2010	1429	15050.30	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF072	28.63	-88.2465	7/17/2010	1917	16767.72	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF073	28.7568333	-88.3991667	7/17/2010	1382	3858.03	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF074	29.2706667	-87.8551667	7/17/2010	231	77389.90	-99	-99	-99	-99	-99	-99	-99
Nancy Foster	1	NF075	29.9933333	-88.451	7/17/2010	17	140324.41	-99	-99	-99	-99	-99	-99	-99
Seward Johnson	1	SJ30	24.8796667	-83.6516667	7/17/2010	50.667	638003.74	-99	-99	-99	-99	-99	-99	-99
Seward Johnson	1	SJ32	24.9481667	-83.6316667	7/17/2010	52.653	634281.10	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	13	BM135	28.62048333	-88.4171667	7/18/2010	1400	13997.34	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	13	BM136	28.61849	-88.41138	7/18/2010	1493	14014.15	-99	-99	-99	-99	-99	-99	-99
Ferrel	2	BP-TN05-SS01	28.586742	-88.473869	7/18/2010	1286	19861.64	-99	-99	-99	-99	-99	-99	-99
Ferrel	2	BP-TN05-SS02	28.570944	-88.425442	7/18/2010	1349	19462.60	4	3.6	0.18	0.08	1.03	0.22	23.68
Ferrel	2	BP-TN05-SS03	28.570625	-88.320333	7/18/2010	1350	19134.93	4.01	3.61	0.19	-99	-99	-99	-99
Brooks McCall	13	BM137	28.7289	-88.22485	7/19/2010	1590	13851.80	4.3	3.97	0.18	0	0.04	0	0.04
Brooks McCall	13	BM138	28.62975	-88.29291667	7/19/2010	1785	14003.64	4.13	3.89	0.14	0	0.05	0.01	0.33
Brooks McCall	13	BM139	28.67295	-88.2087833	7/19/2010	1792	17009.27	4.25	3.99	0.14	0	0	0	0
Brooks McCall	13	BM140	28.7062	-88.22755	7/19/2010	1500	14007.56	4.28	3.95	0.18	0	0.03	0	0.11
Ferrel	2	BP-TN05-SS04	28.611472	-88.231589	7/19/2010	1743	19265.90	4.1	3.8	0.14	0.2	1.81	0.4	61.08
Seward Johnson	1	SJ35	26.3731667	-83.7721667	7/19/2010	69.531	526840.89	-99	-99	-99	-99	-99	-99	-99
Seward Johnson	1	SJ37	26.338	-84.7556667	7/19/2010	481.27	446951.21	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	10	OV123	28.649033	-88.480761	7/20/2010	1484	14978.44	4.15	3.77	0.18	0.03	0.56	0.08	10.18
Ocean Veritas	10	OV124	28.605641	-88.396858	7/20/2010	1744	15024.29	4.17	4	0.09	0.01	0.4	0.05	2.44
Ocean Veritas	10	OV125	28.550186	-88.483499	7/20/2010	1692	23840.53	4.21	3.84	0.21	0.05	1.43	0.18	15.1
Ocean Veritas	10	OV126	28.526192	-88.44795	7/20/2010	1737	24872.94	4.21	3.83	0.2	0.1	1.84	0.28	30.27
Ocean Veritas	10	OV127	28.483187	-88.474006	7/20/2010	1700	30230.73	4.26	3.7	0.23	0.02	0.32	0.05	5.99

Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Seward Johnson	1	SI39	26.3366667	-84.7585	7/20/2010	484.244	446815.33	-99	-99	-99	-99	-99	-99
Seward Johnson	1	SI41	27.7273333	-84.5171667	7/20/2010	110.234	395920.40	-99	-99	-99	-99	-99	-99
Seward Johnson	1	SI43	27.6091667	-84.2068333	7/20/2010	50.656	429353.83	-99	-99	-99	-99	-99	-99
Ocean Veritas	10	OV133	28.512829	-88.330309	7/22/2010	1593	25267.47	4.13	3.56	0.19	1.05	0.17	-99
Ocean Veritas	10	OV134	28.527014	-88.271819	7/22/2010	1604	25199.09	4.26	3.54	0.24	0.89	0.15	-99
Ocean Veritas	10	OV135	28.487966	-88.243903	7/22/2010	1600	30253.07	4.33	3.99	0.18	0.2	0.02	1.95
Ocean Veritas	10	OV136	28.467708	-88.372679	7/22/2010	1739	30042.97	4.21	3.85	0.19	1.03	0.11	15.43
Ocean Veritas	10	OV137	28.418935	-88.372093	7/22/2010	1701	35457.78	4.27	3.66	0.22	0.43	0.06	5.17
Seward Johnson	1	SI45	27.6138333	-84.2246667	7/22/2010	60.587	427503.39	-99	-99	-99	-99	-99	-99
Ferrel	3	TN05-S506	28.570219	-88.322792	7/25/2010	1399	19124.05	4.34	4.03	0.16	0	0.01	0.25
Ferrel	3	TN05-S508	28.659217	-88.11055	7/26/2010	1341	26505.89	-99	-99	-99	-99	-99	-99
Ferrel	3	TN05-S509	28.659578	-88.110994	7/26/2010	1203	26451.55	-99	-99	-99	-99	-99	-99
Ferrel	3	TN05-S510	28.570242	-88.322442	7/27/2010	1399	19129.18	4.05	3.71	0.18	0	0	0.17
Ocean Veritas	11	OV138	28.376637	-88.379316	7/27/2010	1601	40171.66	4.22	3.57	0.2	0.04	0.11	11.01
Ocean Veritas	11	OV139	28.426127	-88.580203	7/27/2010	1474	40518.38	4.07	3.66	0.17	0.53	0.11	12.92
Ocean Veritas	11	OV140	28.352121	-88.630984	7/27/2010	1491	50130.15	4.24	3.66	0.23	0.2	0.03	2.21
Ocean Veritas	11	OV141	28.446947	-88.758943	7/27/2010	1254	50289.80	-99	-99	-99	-99	-99	-99
Ocean Veritas	11	OV142	28.560495	-88.83574	7/27/2010	1091	50066.10	-99	-99	-99	-99	-99	-99
Ferrel	3	TN06-S502	29.287175	-88.714183	7/28/2010	52	69806.36	-99	-99	-99	-99	-99	-99
Ocean Veritas	11	OV143	28.419289	-88.798559	7/28/2010	1245	55241.47	-99	-99	-99	-99	-99	-99
Ocean Veritas	11	OV144	28.506489	-88.679978	7/28/2010	1339	40106.48	4.1	2.56	0.47	2.23	0.53	59.32
Ocean Veritas	11	OV145	28.595598	-88.741086	7/28/2010	1226	40005.34	-99	-99	-99	-99	-99	-99
Ocean Veritas	11	OV146	28.56298	-88.600591	7/28/2010	1456	30112.16	4.17	3.85	0.2	0.01	0.03	2.01
Ocean Veritas	11	OV147	28.466095	-88.512076	7/28/2010	1579	33435.48	4.05	3.7	0.1	0.01	0.04	3.31
Ocean Veritas	11	OV148	28.409738	-88.506047	7/28/2010	1586	38972.07	4.01	3.64	0.13	0.5	0.08	11.68
Brooks McCall	15	BM141	28.73834	-88.386975	7/29/2010	1495	2058.73	4.34	4.04	0.17	0	0	0
Brooks McCall	15	BM142	28.720555	-88.3665	7/29/2010	1580	1953.88	4.38	4.05	0.17	0	0	0.03
Brooks McCall	15	BM143	28.73853167	-88.346115	7/29/2010	1545	1941.72	4.38	4.07	0.15	0	0	0.05
Brooks McCall	15	BM144	28.75661	-88.3665	7/29/2010	1440	2052.14	4.35	4.08	0.15	0	0	0.16
Brooks McCall	15	BM145	28.70664333	-88.40268167	7/30/2010	1560	5017.29	4.35	4.05	0.17	0	0	0.03
Brooks McCall	15	BM146	28.70664333	-88.33031833	7/30/2010	1469	4940.20	4.4	4.09	0.18	0	0.09	0.11
Brooks McCall	15	BM147	28.77048	-88.23603833	7/30/2010	1381	13213.40	4.3	4.03	0.15	0	0.02	0.05
Brooks McCall	15	BM148	28	-88.23603833	7/30/2010	1370	82973.74	4.37	4.06	0.16	0	0.05	0.05
Brooks McCall	15	BM149	28.44694667	-88.75889333	7/31/2010	1269	50275.06	-99	-99	-99	-99	-99	-99
Brooks McCall	15	BM150	28.34566667	-88.77783333	7/31/2010	1427	59416.92	4.2	3.81	0.18	0	0.08	0.42
Brooks McCall	15	BM151	28.32483333	-88.93816667	7/31/2010	1194	72486.30	-99	-99	-99	-99	-99	-99
Brooks McCall	15	BM152	28.23566667	-89.129	7/31/2010	1098	93346.13	-99	-99	-99	-99	-99	-99
Brooks McCall	15	BM153	28.13108333	-88.99876667	7/31/2010	1033	91648.88	-99	-99	-99	-99	-99	-99
Ocean Veritas	12	OV149	28.325024	-88.937608	8/1/2010	1178	72429.48	-99	-99	-99	-99	-99	-99
Ocean Veritas	12	OV150	28.328528	-89.154702	8/1/2010	808	89711.41	-99	-99	-99	-99	-99	-99
Ocean Veritas	12	OV151	28.141061	-89.40698	8/1/2010	1065	121762.41	-99	-99	-99	-99	-99	-99
Ocean Veritas	12	OV152	28.291092	-88.871448	8/1/2010	1362	70155.30	4.26	3.96	0.19	0	0.02	1.25
Ferrel	4	TN08-S502	28.345247	-88.77865	8/2/2010	1350	59505.56	4.12	3.72	0.14	0.13	0.02	2.82
Ferrel	4	TN08-S503	28.447183	-88.759406	8/2/2010	1260	50307.69	-99	-99	-99	-99	-99	-99
Ocean Veritas	12	OV153	28.289597	-88.771428	8/2/2010	1509	63736.30	4.1	3.81	0.16	0	0.01	0.72
Ocean Veritas	12	OV154	28.290594	-88.811783	8/2/2010	1408	66193.49	4.12	3.72	0.19	0.02	0.05	4.76
Ocean Veritas	12	OV155	28.28729	-89.005709	8/2/2010	1067	80262.62	-99	-99	-99	-99	-99	-99
Ocean Veritas	12	OV156	28.144973	-88.855005	8/2/2010	1343	81496.06	4.16	3.18	0.4	0.06	0.11	16.72
Ocean Veritas	12	OV157	28.135657	-88.817498	8/2/2010	1604	80246.78	4.3	3.77	0.22	0	0.02	1.39
American Diver	1	AD003	28.3809	-88.74594	8/3/2010	981	54419.61	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006001	28.702	-88.33616667	8/3/2010	-99	4961.19	-99	-99	-99	-99	-99	-99

Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Mean (ppb QSDE)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Henry Bigelow	1	HB1006002	28.695	-88.33433333	8/3/2010	1026	5704.32	-99	-99	-99	-99	1.03	0.16	-99
Henry Bigelow	1	HB1006003	28.72233333	-88.32233333	8/3/2010	1403	4616.53	4.31	3.7	0.21	0.08	-99	-99	22.68
American Diver	1	AD004	28.36381	-89.03634	8/4/2010	781	77758.51	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	16	BM154	28.18251667	-88.82515	8/4/2010	1577	76398.06	4.12	3.44	0.17	0	0.09	0.01	0.24
Brooks McCall	16	BM155	28.18251667	-88.82515	8/4/2010	1421	76398.06	4.09	3.58	0.18	0	0.07	0.01	0.33
Brooks McCall	16	BM156	28.18251667	-88.82515	8/4/2010	1577	76398.06	4.12	3.47	0.17	0	0.04	0	0.16
Brooks McCall	16	BM157	28.21878333	-88.79485333	8/4/2010	1449	71389.66	4.11	3.91	0.19	0	0.05	0	0.06
Henry Bigelow	1	HB1006004	28.697	-88.22466667	8/4/2010	1677	14568.99	4.29	4.03	0.14	0.01	0.15	0.02	2.46
Henry Bigelow	1	HB1006005	28.72	-88.28633333	8/4/2010	313	8050.57	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	16	BM158	28.15030167	-88.78915667	8/5/2010	1684	77367.60	4.1	3.75	0.11	0	0	0	0
Brooks McCall	16	BM159	28.19218667	-88.75374667	8/5/2010	1402	71576.84	4.08	3.91	0.1	0	0	0	0
Brooks McCall	16	BM160	28.22439167	-88.71683833	8/5/2010	1449	66631.47	4.12	3.87	0.14	0	0.08	0.01	0.32
Brooks McCall	16	BM161	28.25436833	-88.75937167	8/5/2010	1449	66145.09	4.14	3.9	0.14	0	0.03	0	0.12
Gordon Gunter	3	GU001	28.64316667	-88.36966667	8/5/2010	1671	10534.68	4.09	3.78	0.15	0	0.12	0.01	0.22
Gordon Gunter	3	GU002	28.6475	-88.3935	8/5/2010	1453	10422.37	4.09	3.81	0.16	0.01	0.31	0.04	2.31
Gordon Gunter	3	GU003	28.5515	-88.585	8/5/2010	1532	29835.36	4.11	3.83	0.16	0.01	0.26	0.03	1.59
Henry Bigelow	1	HB1006006	28.81783333	-88.29983333	8/5/2010	1011	15963.94	-99	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006007	28.851	-88.2645	8/5/2010	1003	15989.67	-99	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006008	28.849	-88.2405	8/5/2010	119	17386.53	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	16	BM162	28.23379	-88.8996	8/6/2010	1355	76658.79	4.21	3.92	0.18	0	0.01	0	0.01
Brooks McCall	16	BM163	28.31278167	-88.97086667	8/6/2010	1154	75822.32	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	16	BM164	28.24960333	-89.04349667	8/6/2010	1158	85781.80	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	16	BM165	28.318985	-89.10806833	8/6/2010	864	86372.51	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	16	BM166	28.38584667	-89.1781	8/6/2010	718	88692.30	-99	-99	-99	-99	-99	-99	-99
Brooks McCall	16	BM167	28	-89.1781	8/6/2010	1079	114344.97	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	3	GU004	28.4575	-88.69083333	8/6/2010	1351	44553.81	4.05	3.72	0.17	0	0.19	0.02	1.13
Gordon Gunter	3	GU005	28.3465	-88.7955	8/6/2010	1427	60540.52	3.93	3.68	0.18	0.01	0.26	0.03	2.66
Gordon Gunter	3	GU006	28.2545	-88.90866667	8/6/2010	1356	75615.02	3.93	3.61	0.17	0.01	0.28	0.03	1.92
Gordon Gunter	3	GU007	28.1525	-88.7475	8/6/2010	1725	75041.68	3.85	3.72	0.13	0	0.24	0.02	1
Gordon Gunter	3	GU008	28.08383333	-88.556	8/6/2010	1951	75020.29	4.13	3.82	0.18	0	0.16	0.01	0.49
Henry Bigelow	1	HB1006009	28.72333333	-88.3235	8/6/2010	1460	4469.03	4.25	3.97	0.16	0	0.11	0.01	1.05
Pisces	1	PC001	28.46816667	-88.36616667	8/6/2010	1847	29984.89	-99	-99	-99	-99	-99	-99	-99
Pisces	1	PC002	28.4765	-88.28716667	8/6/2010	1921	30068.99	4.06	3.75	0.19	0.01	0.28	0.03	2.11
Pisces	1	PC003	28.5025	-88.215	8/6/2010	1995	30065.54	4.06	3.74	0.17	0	0.21	0.02	1.32
Pisces	1	PC004	28.544	-88.15333333	8/6/2010	2056	29985.55	4.06	3.73	0.16	0	0.14	0.01	0.29
Brooks McCall	16	BM168	28.70886167	-89.95760167	8/7/2010	55	155744.50	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	3	GU009	28.85283333	-88.27533333	8/7/2010	1205	15520.75	-99	-99	-99	-99	-99	-99	-99
Gordon Gunter	3	GU010	28.867	-88.2645	8/7/2010	1213	17417.53	-99	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006010	28.70833333	-88.336	8/7/2010	1398	4422.20	4.25	3.99	0.15	0	0.09	0.01	0.49
Henry Bigelow	1	HB1006011	28.7055	-88.39583333	8/7/2010	1424	4658.82	4.25	3.31	0.24	0	0.13	0.02	1.27
Henry Bigelow	1	HB1006012	28.77133333	-88.34116667	8/7/2010	1373	4412.95	4.22	3.92	0.17	0	0.05	0	0.1
Henry Bigelow	1	HB1006013	28.78016667	-88.37083333	8/7/2010	1287	4692.25	-99	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006014	28.76666667	-88.39983333	8/7/2010	1354	4586.91	4.22	3.93	0.15	0	0.02	0	0.02
Henry Bigelow	1	HB1006015	28.73616667	-88.41233333	8/7/2010	1469	4546.22	4.19	3.91	0.15	0	0.08	0.01	0.7
Henry Bigelow	1	HB1006016	28.704	-88.395	8/7/2010	1540	4740.20	4.21	3.83	0.17	0	0.16	0.01	1.07
Ocean Veritas	13	OV158	27.949961	-89.751912	8/7/2010	820	161777.01	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	13	OV159	28.09304	-89.620002	8/7/2010	697	142374.58	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	13	OV160	28.226164	-89.397306	8/7/2010	967	116026.02	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	13	OV161	28.300934	-89.176281	8/7/2010	880	93109.02	-99	-99	-99	-99	-99	-99	-99
Ocean Veritas	13	OV162	28.258	-88.901453	8/7/2010	1339	74840.91	-99	-99	-99	-99	-99	-99	-99
Pisces	1	PC005	28.59966667	-88.103	8/7/2010	2117	30003.88	4.04	3.76	0.16	0	0.24	0.02	0.97

Vessel	Cruise	Station Name	Latitude	Longitude	Date Sample Taken	Depth of Cast (m)	Distance to Wellhead (m)	DO ₂ Mean (mL/L)	DO ₂ Minimum (mL/L)	DO ₂ Std. Deviation (mL/L)	CDOM Mean (ppb QSDE)	CDOM Maximum (ppb QSDE)	CDOM Std. Deviation (ppb QSDE)	CDOM Integrated (ppb QSDE)
Pisces	1	PC006	28.66383333	-88.0715	8/7/2010	1774	29996.75	4.06	3.65	0.21	0	0.14	0.01	0.47
Pisces	1	PC007	28.73233333	-88.06	8/7/2010	1979	29962.36	4.02	3.65	0.21	0	0.15	0.01	0.15
Pisces	1	PC008	28.801	-88.06883333	8/7/2010	1756	29907.43	4	3.69	0.17	0	0.09	0.01	0.11
Pisces	1	PC009	28.86533333	-88.09583333	8/7/2010	1563	29969.26	3.98	3.69	0.17	0.02	0.35	0.05	4.68
Pisces	1	PC010	28.922	-88.14233333	8/7/2010	1146	29925.86	-99	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006017	28.69633333	-88.35833333	8/8/2010	1567	4747.76	4.23	3.91	0.17	0	0.1	0.01	1.41
Henry Bigelow	1	HB1006018	28.73733333	-88.266	8/8/2010	1274	9784.79	-99	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006019	28.67416667	-88.29516667	8/8/2010	1422	9926.17	4.21	3.97	0.14	0	0.07	0.01	0.22
Henry Bigelow	1	HB1006020	28.77816667	-88.3655	8/8/2010	1344	4445.89	-99	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006021	28.758	-88.33083333	8/8/2010	1407	4083.88	4.21	3.89	0.18	0	0.06	0.01	0.53
Henry Bigelow	1	HB1006022	28.7015	-88.35866667	8/8/2010	1566	4131.45	4.23	3.95	0.16	0	0.13	0.01	1.2
Henry Bigelow	1	HB1006023	28.70383333	-88.3935	8/8/2010	1003	4668.66	-99	-99	-99	-99	-99	-99	-99
Pisces	1	PC011	29.02416667	-88.03966667	8/8/2010	1250	45026.07	-99	-99	-99	-99	-99	-99	-99
Pisces	1	PC012	28.99333333	-87.96616667	8/8/2010	1564	45042.80	4.01	3.71	0.17	0.01	0.25	0.03	2.1
Pisces	1	PC013	28.8425	-87.92083333	8/8/2010	1526	45078.29	4.04	3.6	0.22	0	0.24	0.03	1.36
Pisces	1	PC014	28.73633333	-87.9055	8/8/2010	2130	45086.24	4.01	3.66	0.18	0.01	0.39	0.04	2.49
Pisces	1	PC015	28.632	-87.92133333	8/8/2010	2236	45124.64	4.06	3.69	0.17	0.02	0.34	0.05	5.25
Pisces	1	PC016	28.5335	-87.9685	8/8/2010	2231	45101.87	4.11	3.78	0.16	0.01	0.57	0.04	2.45
Pisces	1	PC017	28.45083333	-88.041	8/8/2010	2182	45095.48	4.12	3.8	0.17	0.01	0.42	0.05	3.46
Pisces	1	PC018	28.38683333	-88.13566667	8/8/2010	2026	45086.52	4.13	3.83	0.15	0.01	0.47	0.06	3.91
Pisces	1	PC019	28.346	-88.2455	8/8/2010	1981	45129.71	4.15	3.81	0.16	0.01	0.28	0.04	2.31
Pisces	1	PC020	28.332	-88.36566667	8/8/2010	1791	45108.10	4.13	3.88	0.17	0.01	0.36	0.05	3.92
Henry Bigelow	1	HB1006024	28.7455	-88.466	8/9/2010	1387	9827.69	4.16	3.9	0.18	0	0.1	0.01	1.05
Henry Bigelow	1	HB1006025	28.67683333	-88.43816667	8/9/2010	1263	9816.80	-99	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006026	28.65033333	-88.37216667	8/9/2010	1589	9771.41	4.22	3.91	0.17	0	0.14	0.02	1.5
Henry Bigelow	1	HB1006027	28.67083333	-88.293	8/9/2010	1438	10339.99	4.21	3.92	0.16	0	0.1	0.01	0.63
Henry Bigelow	1	HB1006028	28.73366667	-88.26533333	8/9/2010	1307	9862.34	-99	-99	-99	-99	-99	-99	-99
Henry Bigelow	1	HB1006029	28.696	-88.22466667	8/9/2010	1738	14604.28	4.23	3.87	0.19	0	0.07	0.01	0.62
Pisces	1	PC021	28.3455	-88.48483333	8/9/2010	1665	45137.69	4.19	3.8	0.17	0.02	0.43	0.06	5.45
Pisces	1	PC022	28.396	-88.61183333	8/9/2010	1484	44997.09	4.27	4.03	0.11	0	0.27	0.03	1.13
Pisces	1	PC023	28.28183333	-88.69333333	8/9/2010	1593	59989.53	4.18	3.94	0.15	0	0.09	0.01	0.13
Pisces	1	PC024	28.222	-88.54666667	8/9/2010	1694	59999.65	4.14	3.53	0.22	0.01	0.43	0.04	2.63
Pisces	1	PC025	28.19833333	-88.3895	8/9/2010	1983	59997.21	4.16	3.55	0.2	0.02	0.51	0.07	5.52
Pisces	1	PC026	28.211	-88.23233333	8/9/2010	2111	60001.47	4.18	3.86	0.17	0.01	0.26	0.03	2.68
Pisces	1	PC027	28.25866667	-88.08416667	8/9/2010	2232	60011.04	4.18	3.87	0.17	0.01	0.3	0.03	2.24
Pisces	1	PC028	28.3405	-87.952	8/9/2010	2222	60003.20	4.17	3.83	0.18	0.02	0.45	0.06	4.89
Pisces	1	PC029	28.44733333	-87.85016667	8/9/2010	2338	60013.91	4.09	3.74	0.2	0.01	0.35	0.04	3.27
Pisces	1	PC030	28.5765	-87.78166667	8/9/2010	2341	60009.39	4.01	3.68	0.18	0.02	0.29	0.05	5.16

Map 1. Survey area and month of station occupation for monitoring for subsurface dispersed oil.



Map 2. Detail of survey area and month of station occupation for monitoring for subsurface dispersed oil.

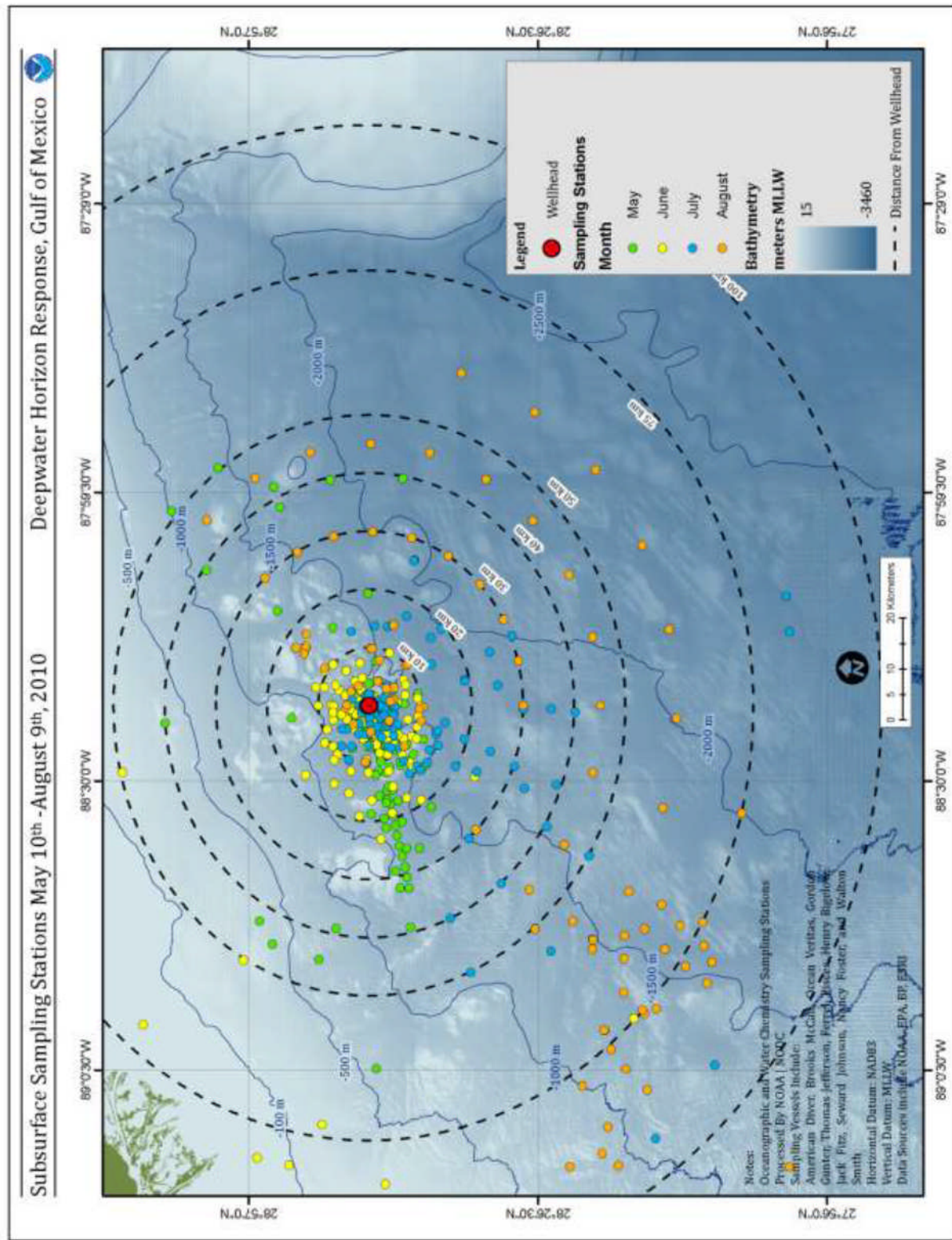


Figure 1. Poor quality CTD data from R/V *Ocean Veritas* cruise 4, most likely attributable to a faulty electrical connection between the cable and the CTD.

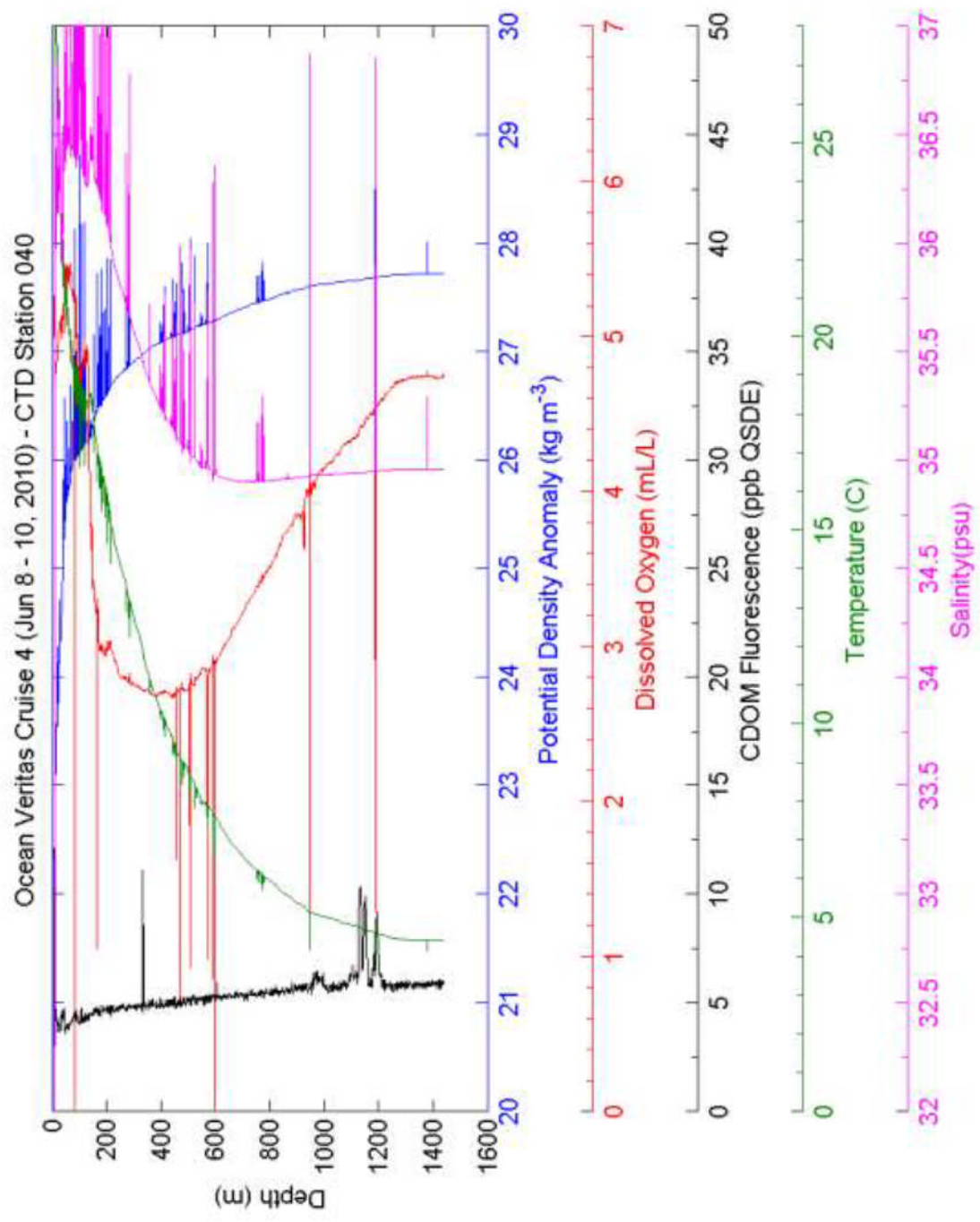


Figure 2. Historical Winkler measurements of dissolved oxygen (mL/L) around the spill site. Data are from the NODC World Ocean Database 2009. (World Ocean Atlas 2009 climatologies of dissolved oxygen using only discreet Winkler O₂ measurements).

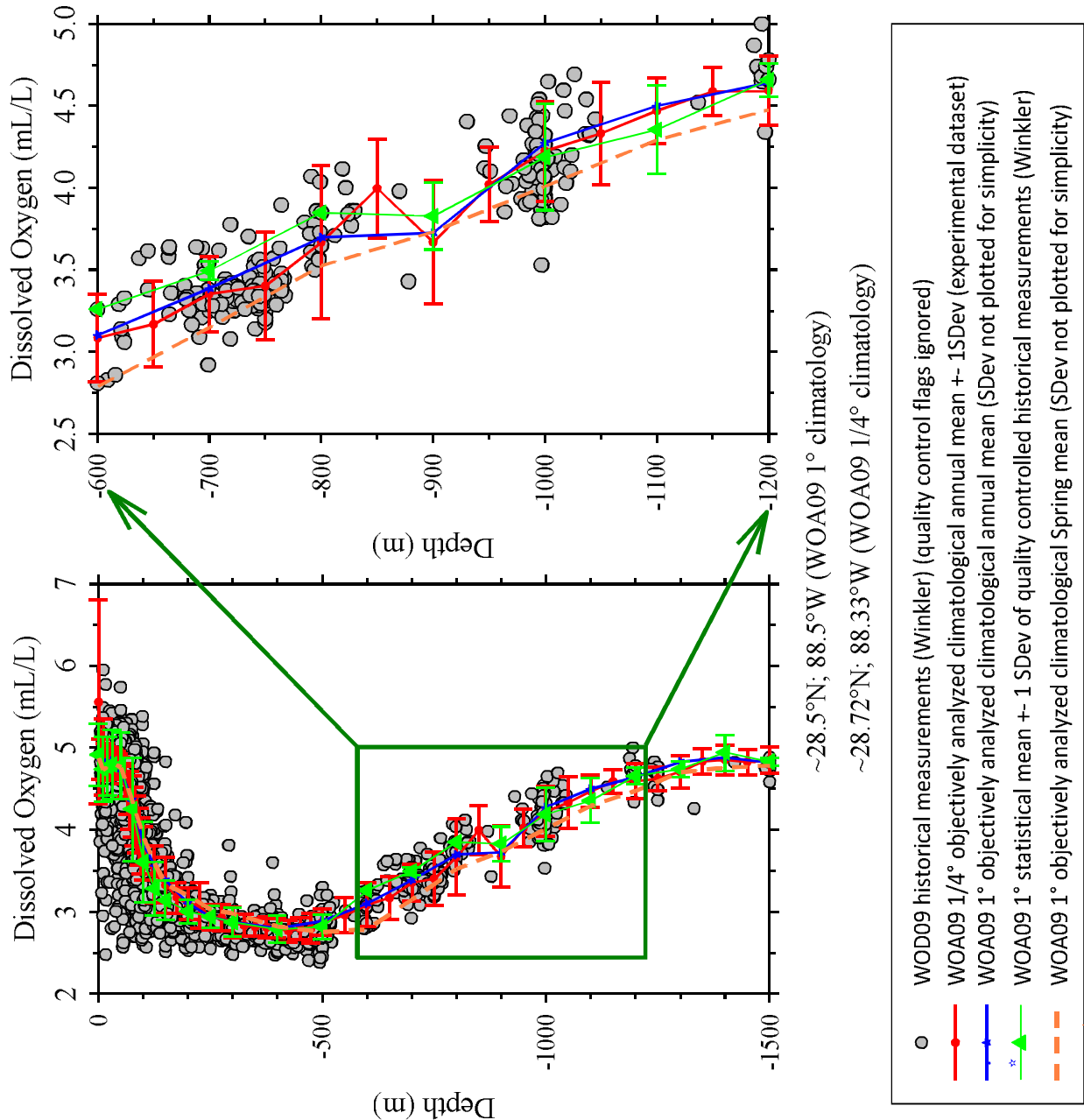


Figure 3. Historical CTD dissolved oxygen (mL/L) data available in the NODC World Ocean Database 2009.

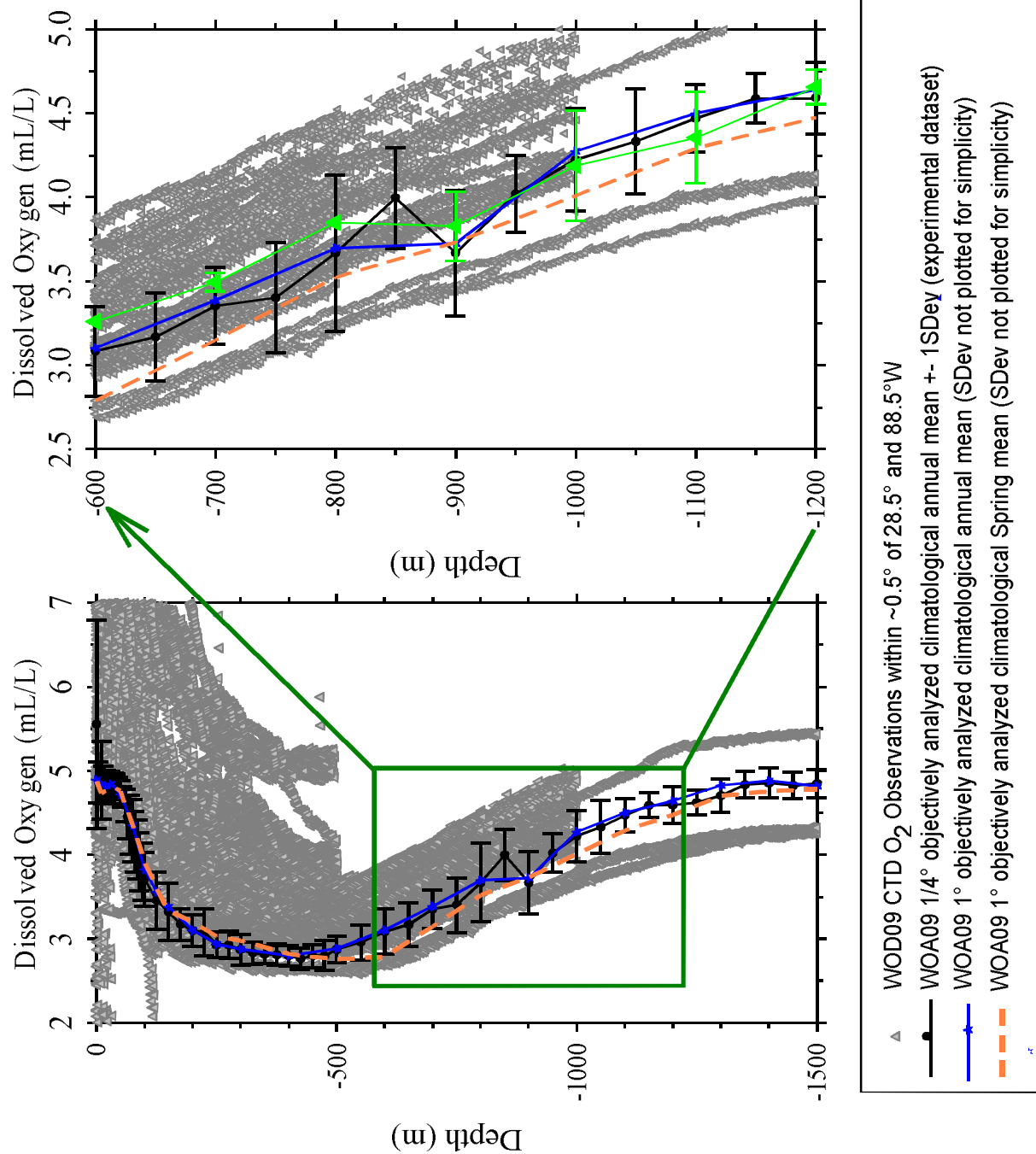


Figure 4. Annual variations in dissolved oxygen at 28.5 °N 88.5 °W based on the climatological mean DO2 from the NODC 1° World Ocean Atlas 2009.

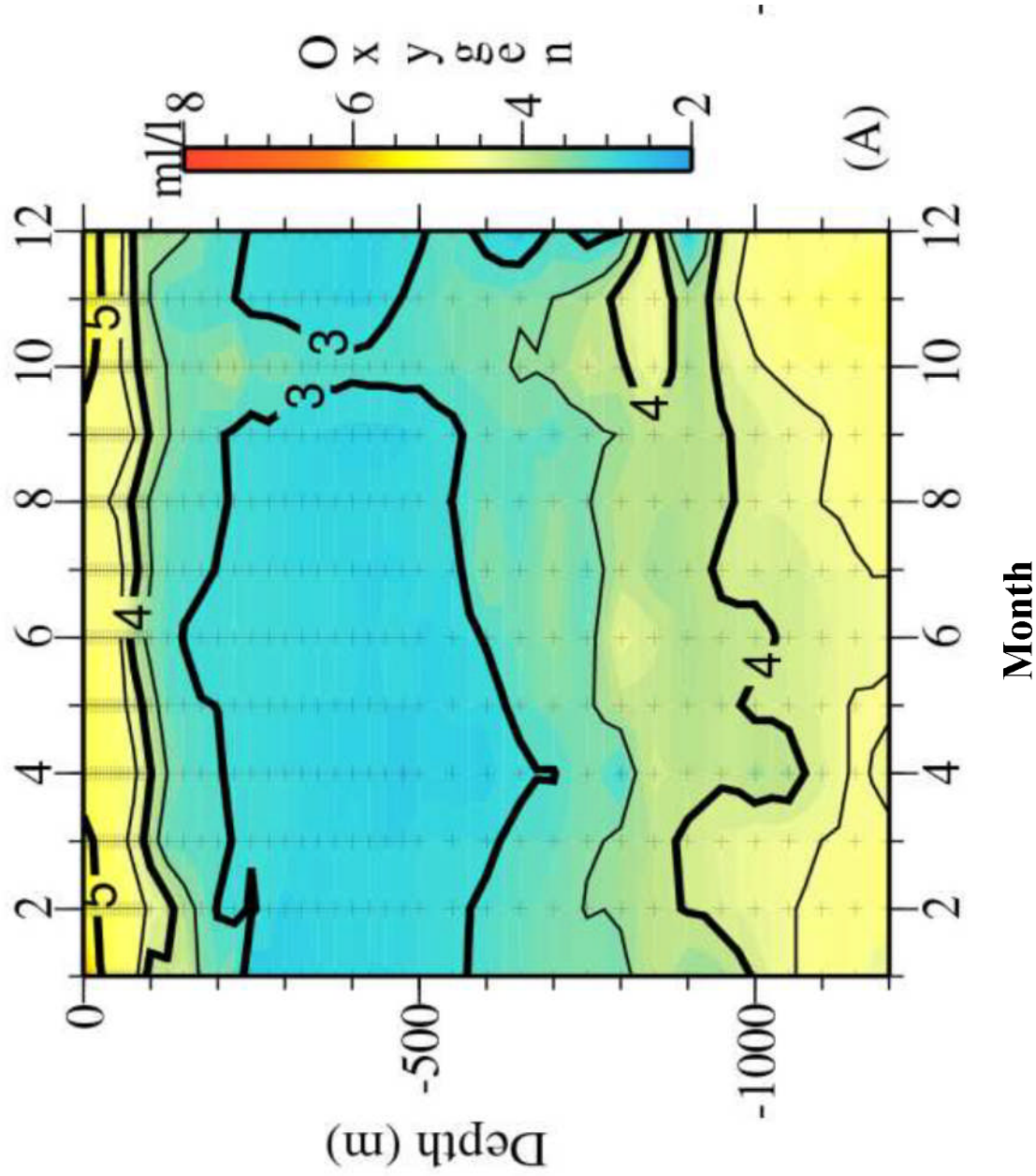


Figure 5. Variations in CTD DO₂ profile slope within the 500-800 m depth range as recorded during the R/V *Brooks McCall* and R/V *Ocean Veritas* cruises. The red line indicates the expect slope of 1.

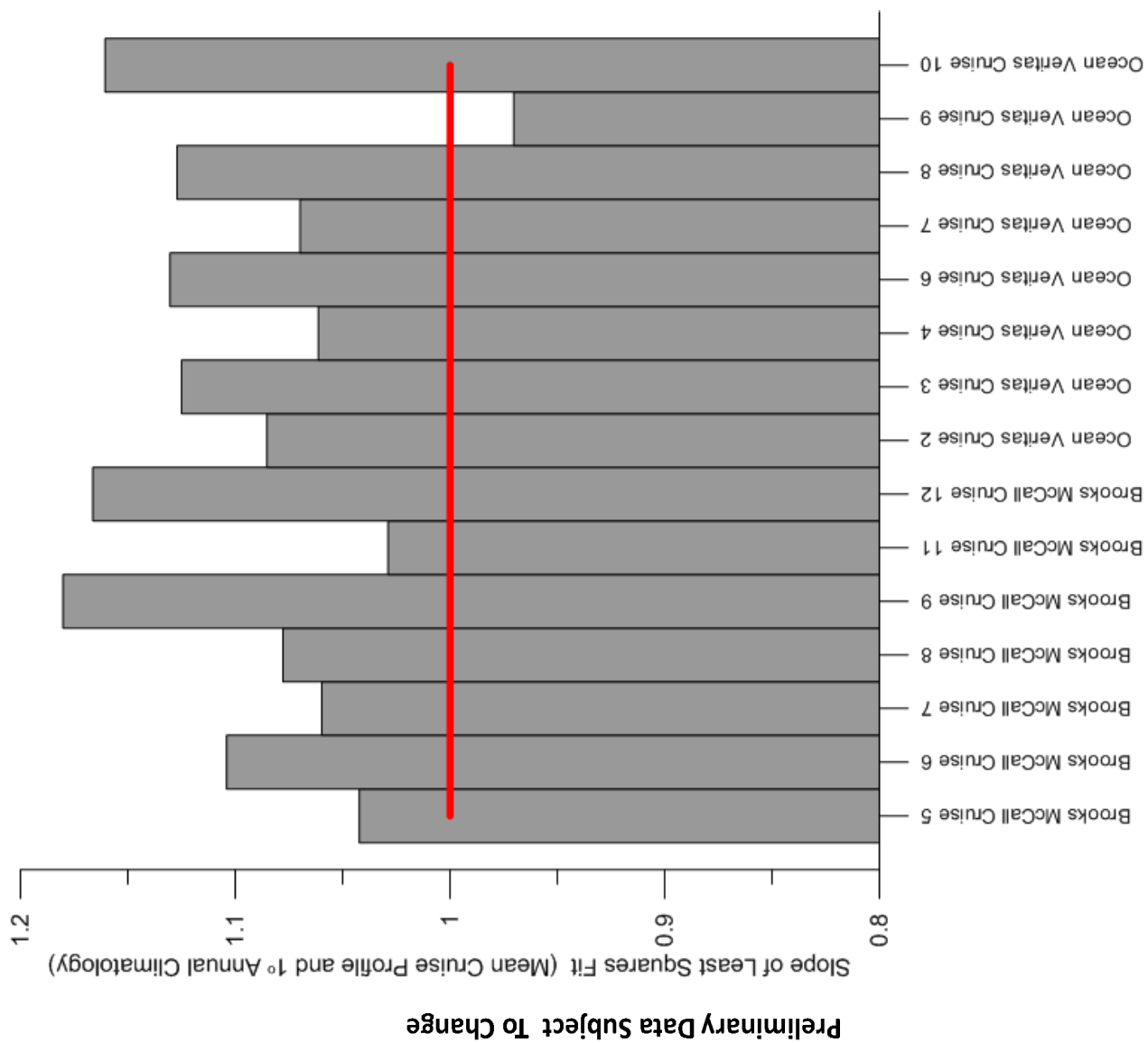


Figure 6. Dissolved oxygen profiles for 419 profiles as compared to mean and standard deviation for 1° ocean climatology for area around the wellhead. Vertical red dashed line indicates the DO₂ level for hypoxia (1.4 mL/L)

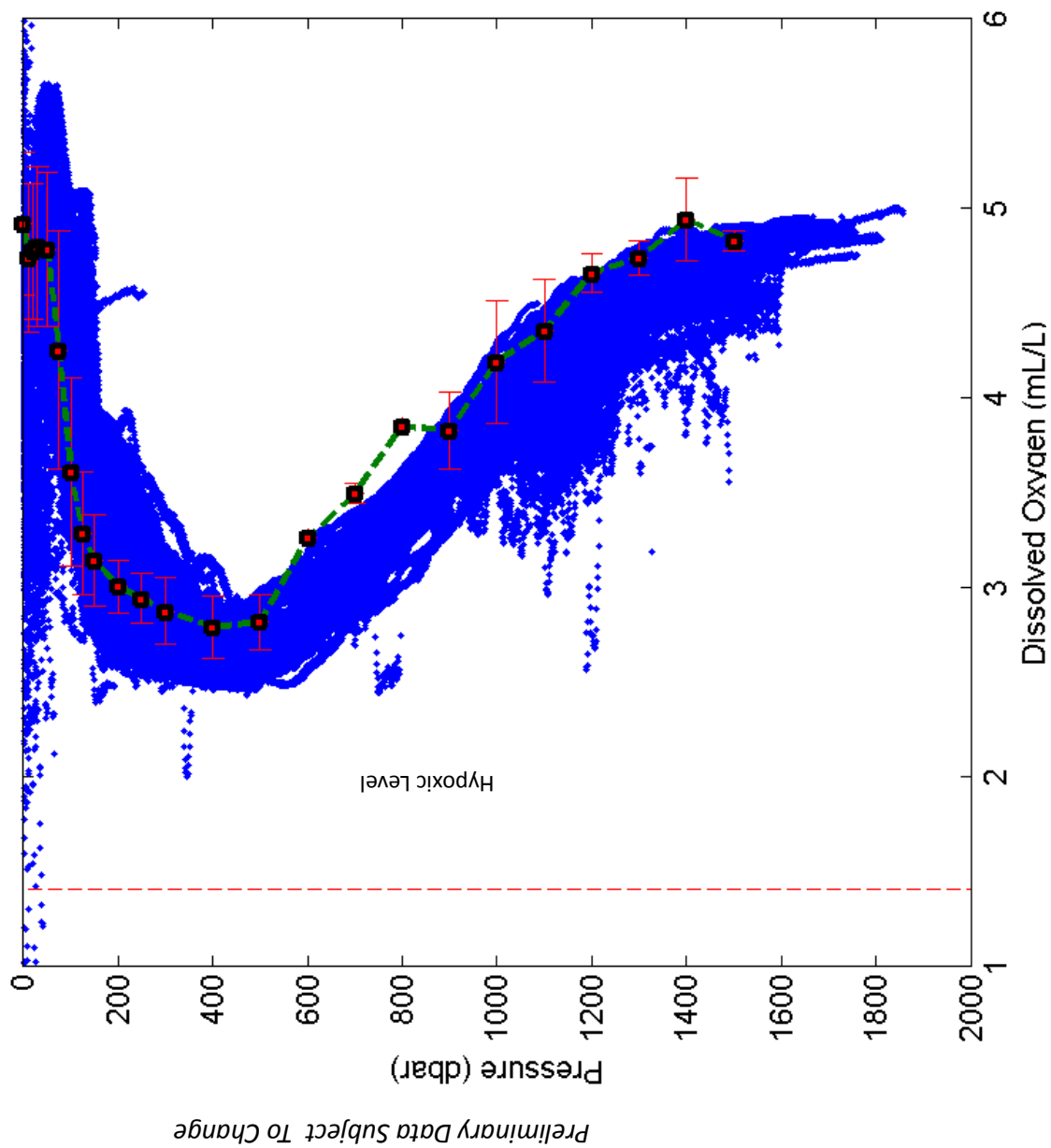


Figure 7. CDOM fluorescence, dissolved oxygen, and density profiles for R/V Walton Smith Station 15a showing the second largest DO₂ depression in the data used for this report.

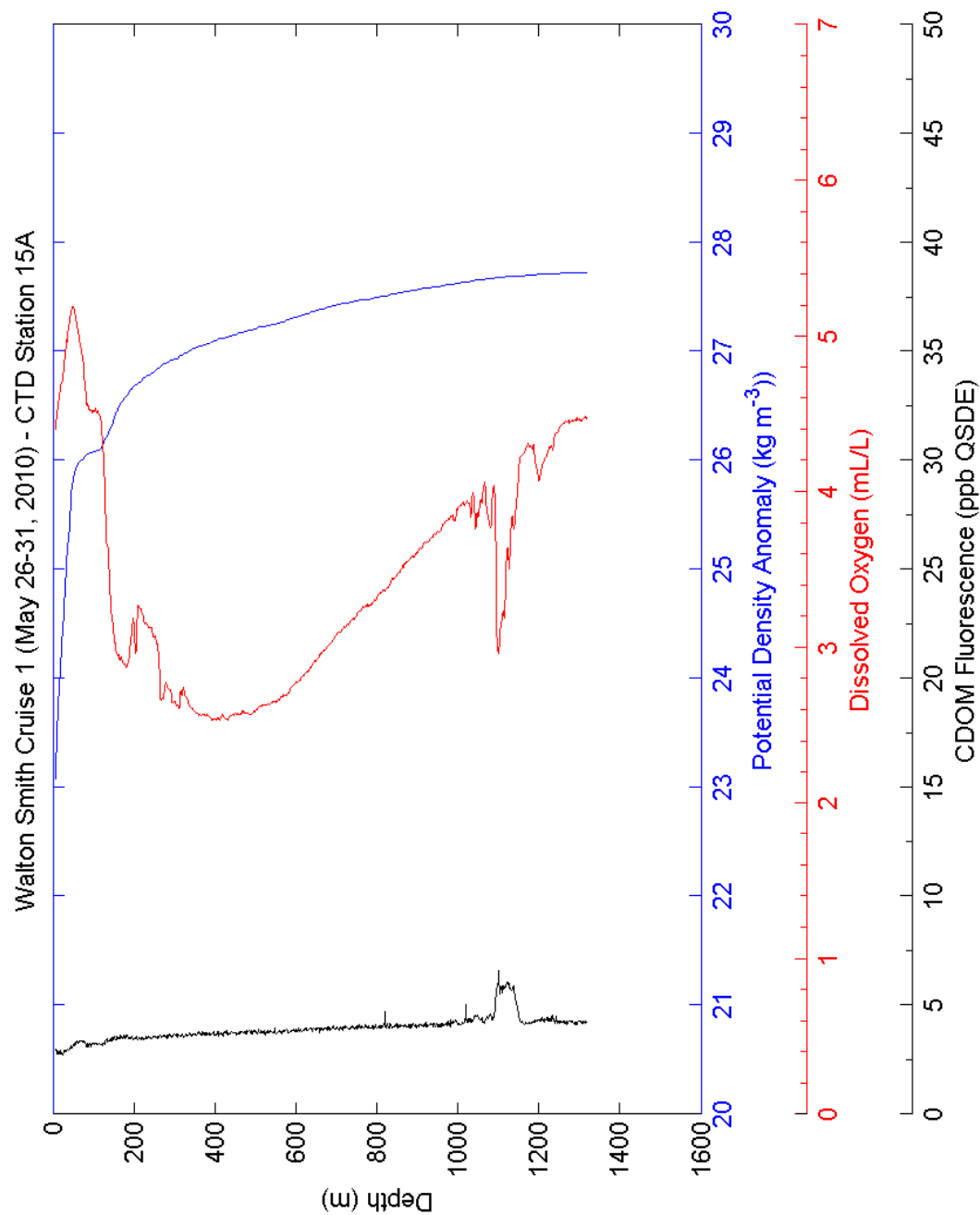


Figure 8. CDOM fluorescence, dissolved oxygen, and density profiles for R/V Ocean Veritas Station 144 showing the largest DO₂ depression in the data used for this report.

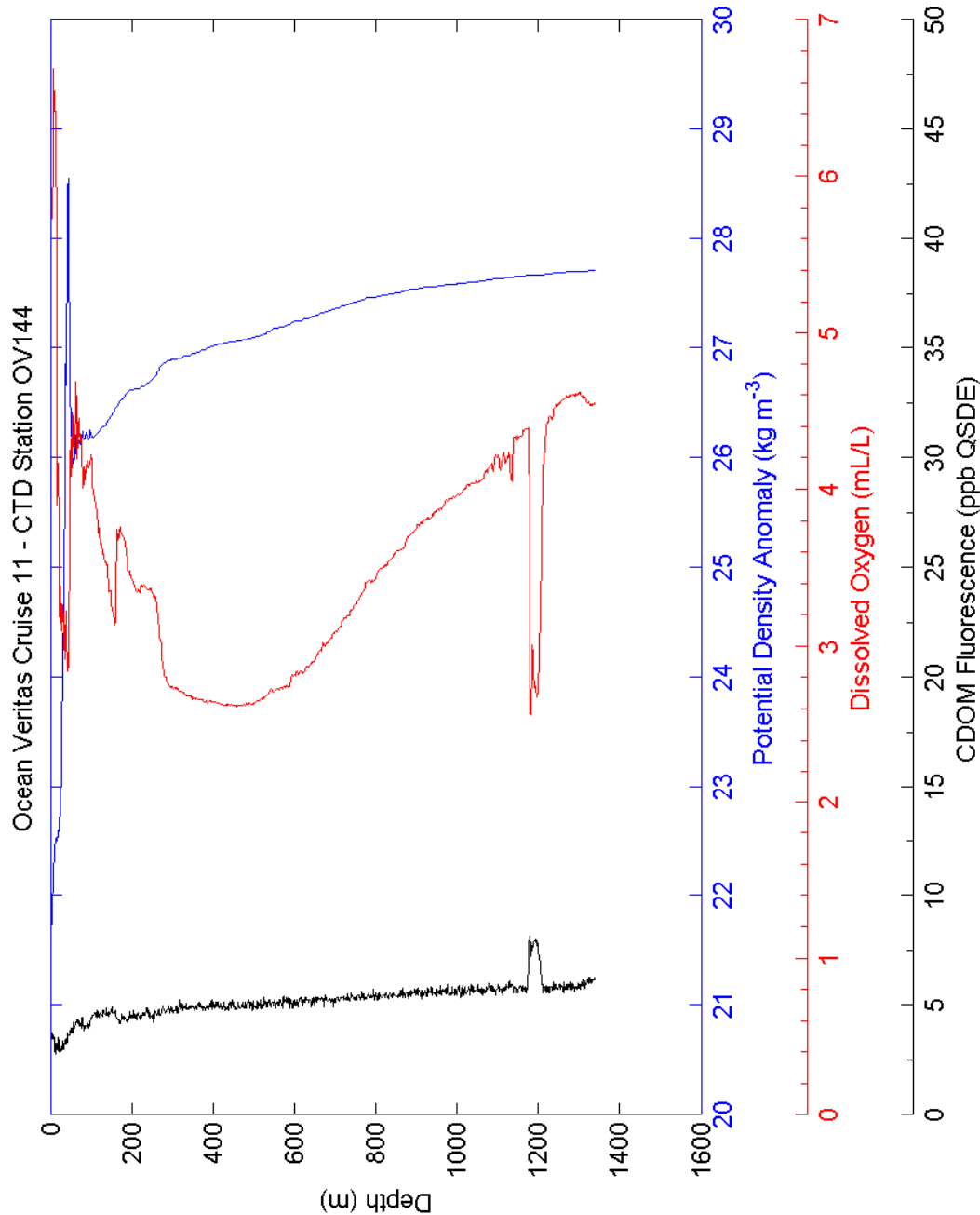


Figure 9. SBE 43 dissolved oxygen values compared to Winkler chemical titrations and the climatological mean for R/V *Ocean Veritas* data collected August 1-2.

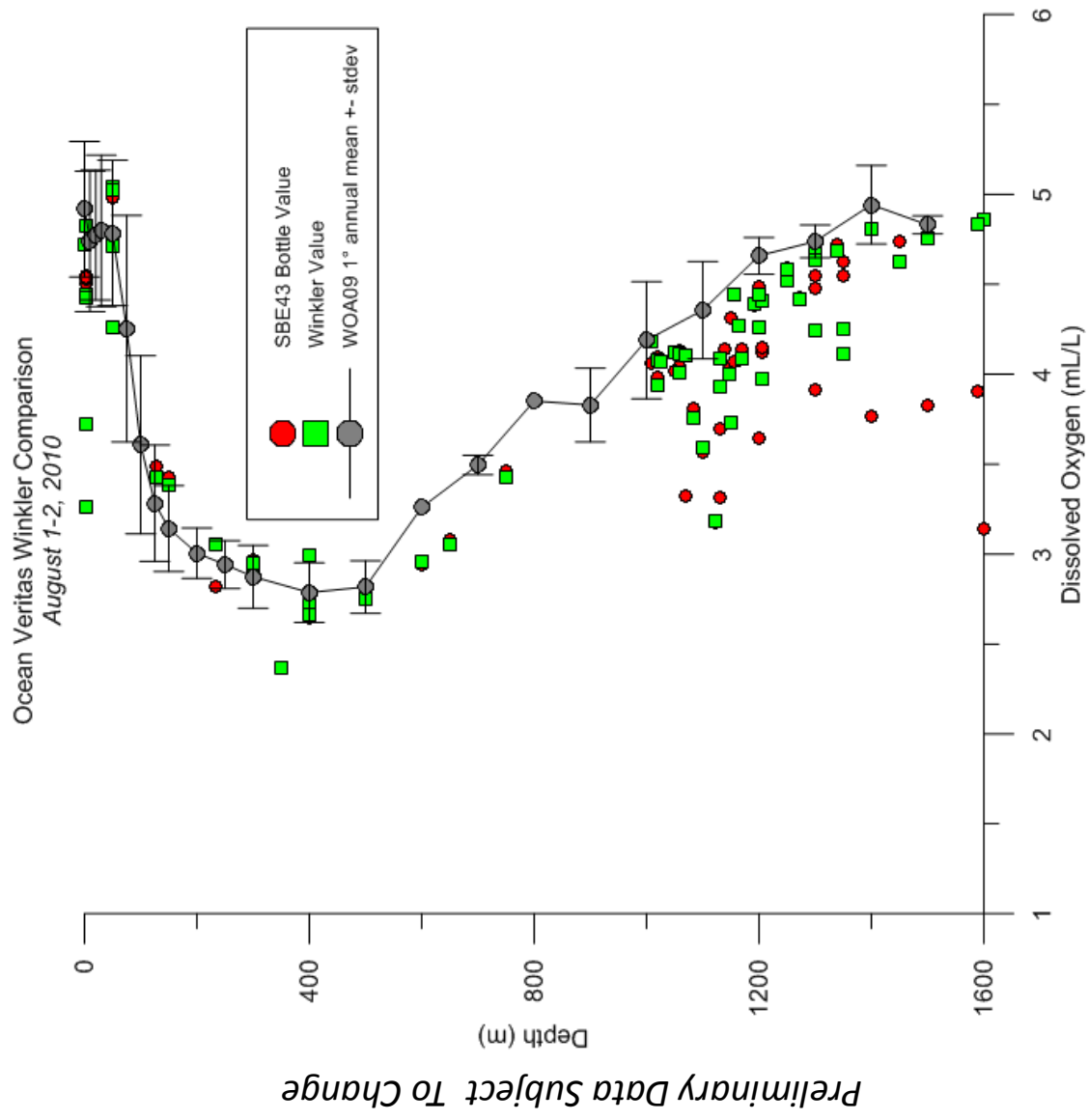


Figure 10. SBE 43 dissolved oxygen values compared to Winkler chemical titrations and the climatological mean for R/V Brooks McCall data collected August 4-6.

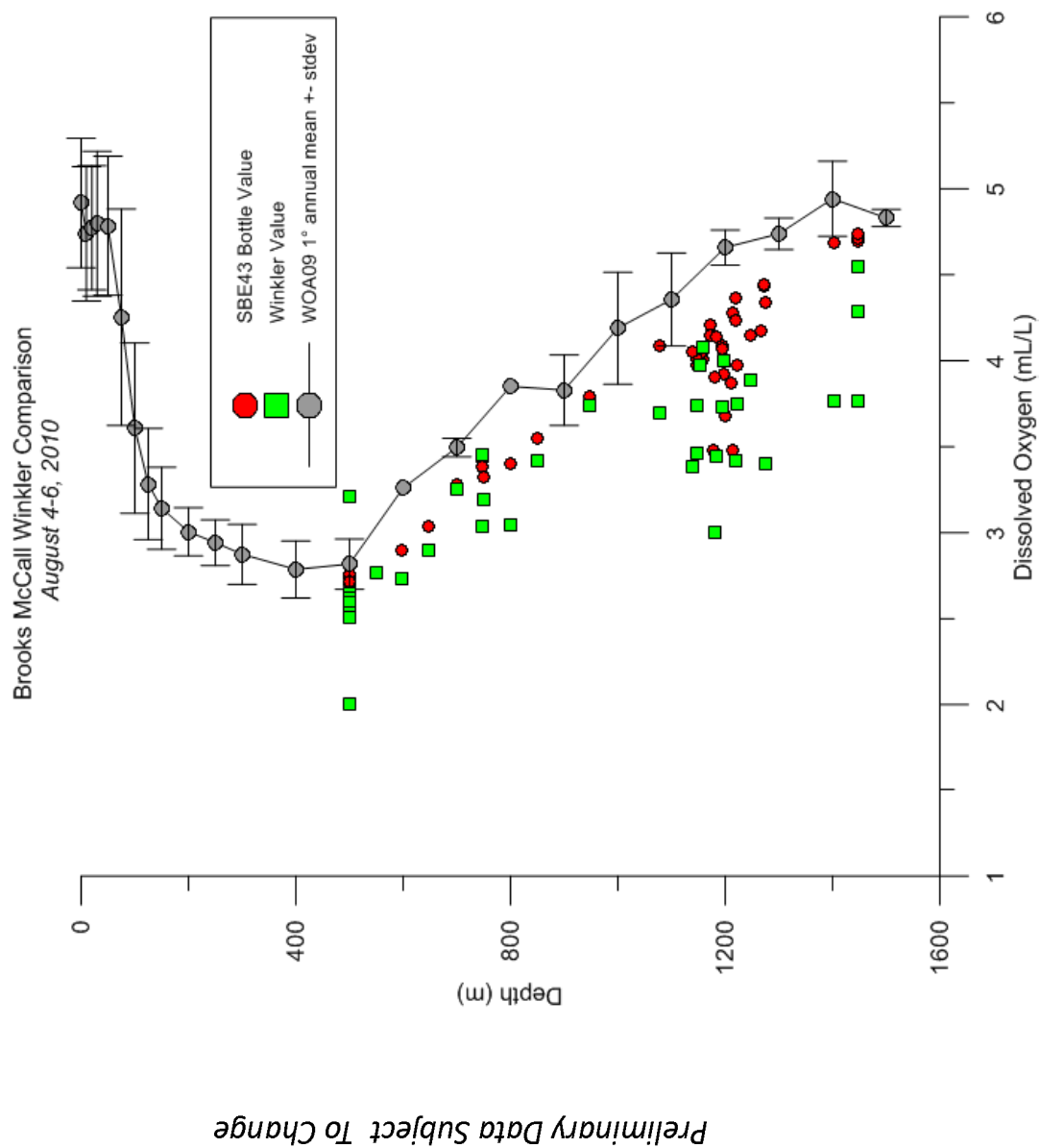


Figure 11. Raw CDOM fluorescence, dissolved oxygen, temperature and salinity profiles for R/V *Ferre*/ Station TN009-SS01, the last station where a fluorescence anomaly was observed.

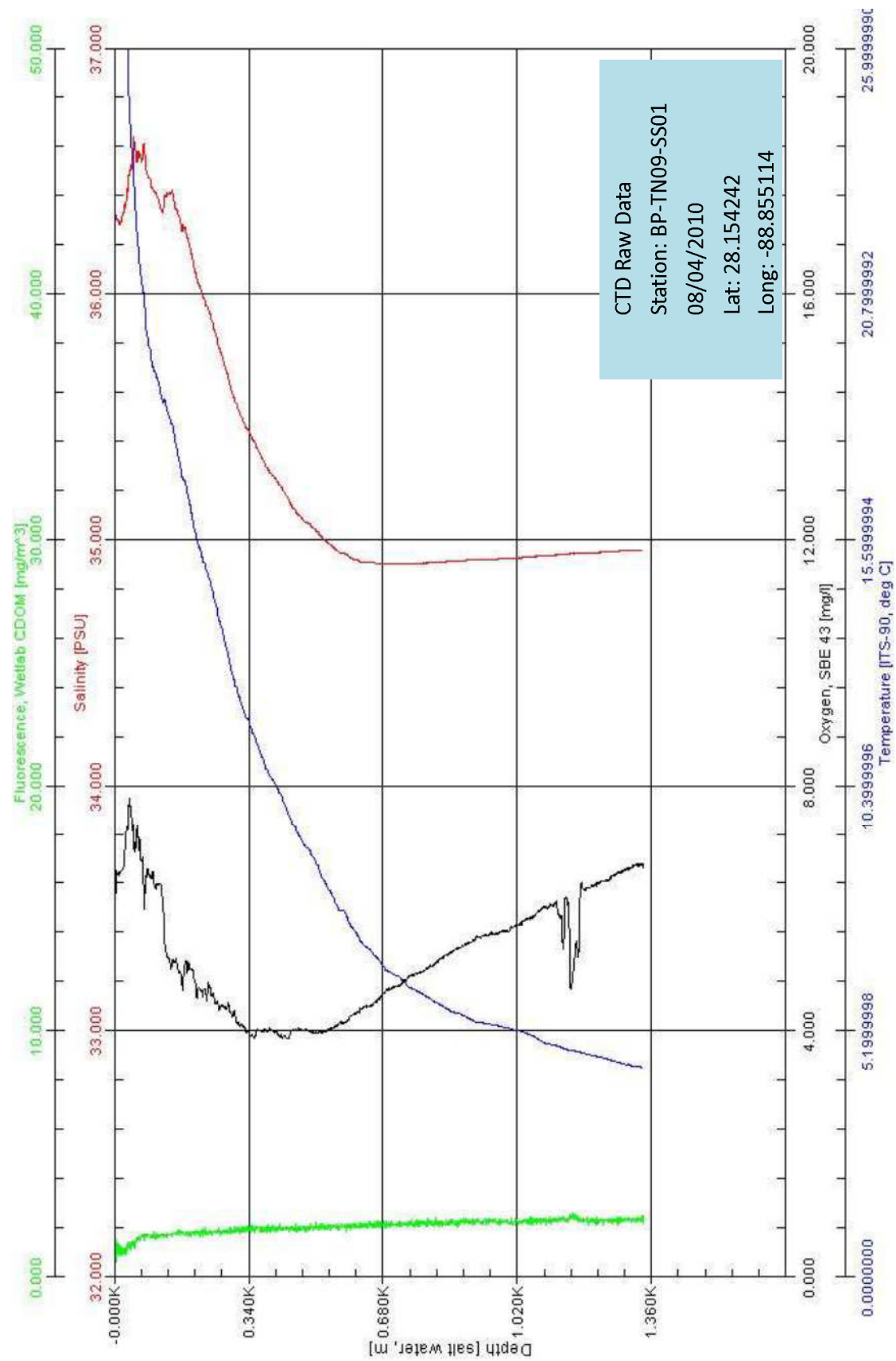


Figure 12. Current direction and velocity measured every 10 minutes at 1166-m depth near the wellhead from May 1 to July 30.

Station 42916 - Discoverer Enterprise - Mississippi Canyon 252 #2

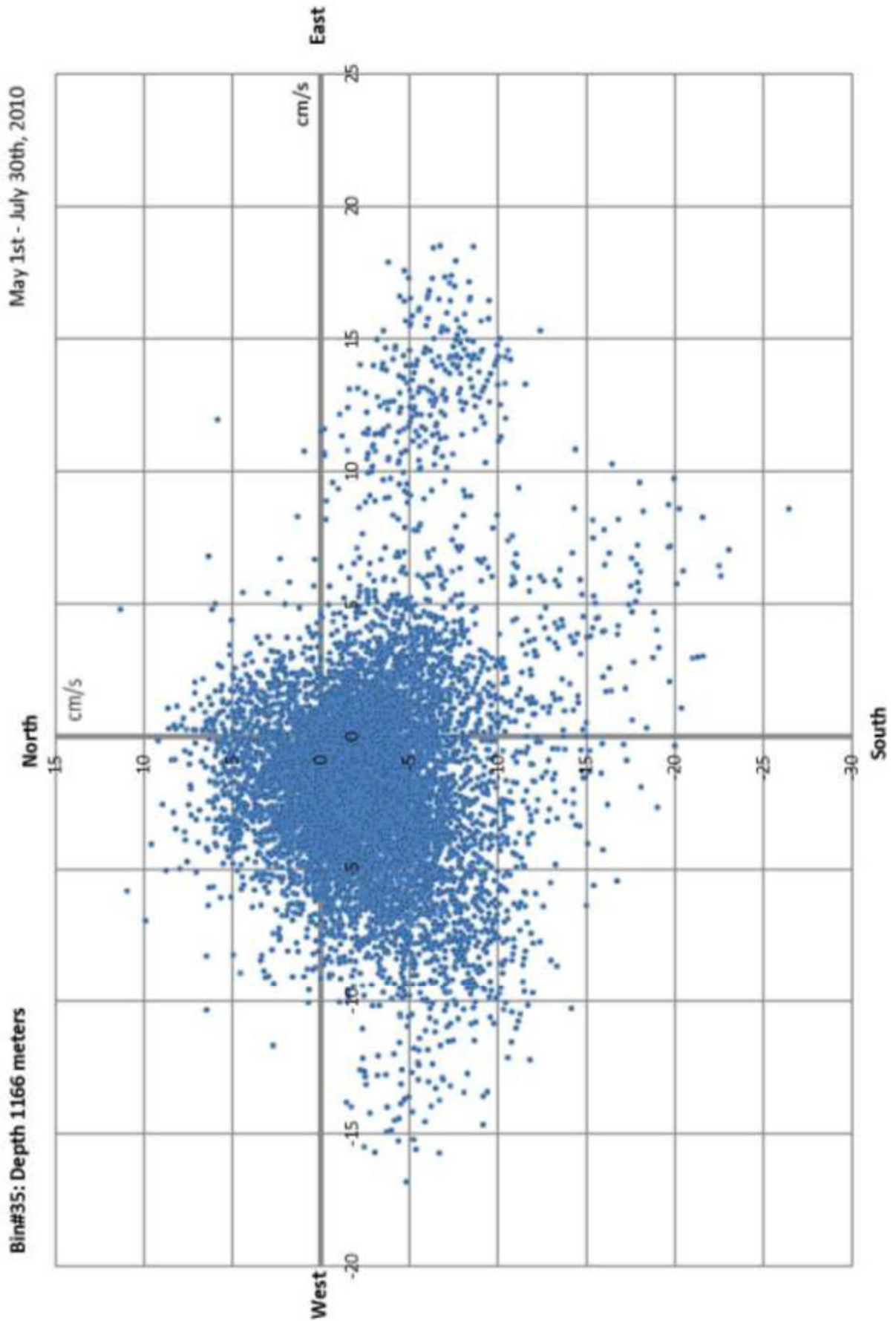


Figure 13. Normalized CDOM fluorescence plotted against potential water density showing close correspondence with a water layer having a density between 27.70 and 27.71.

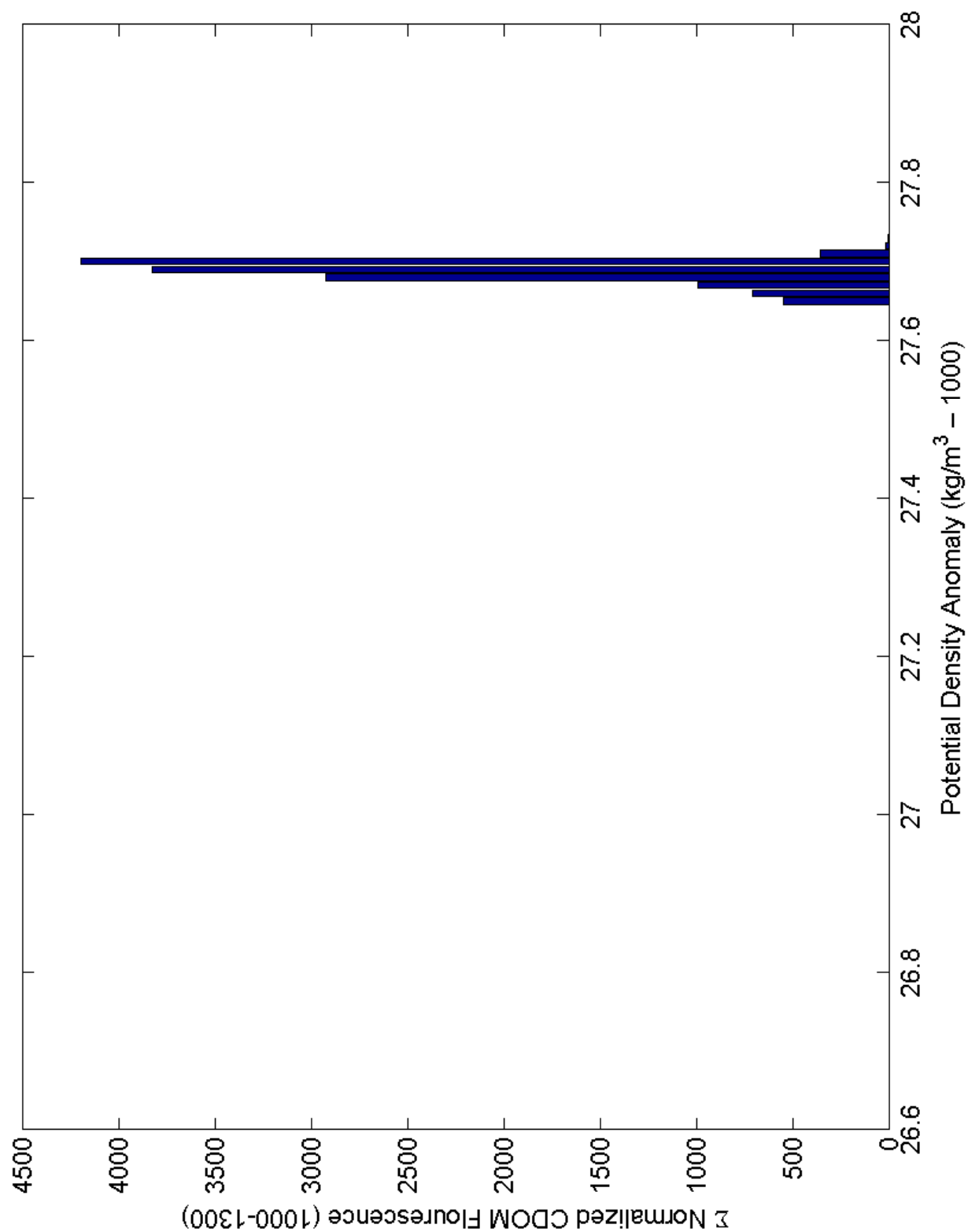
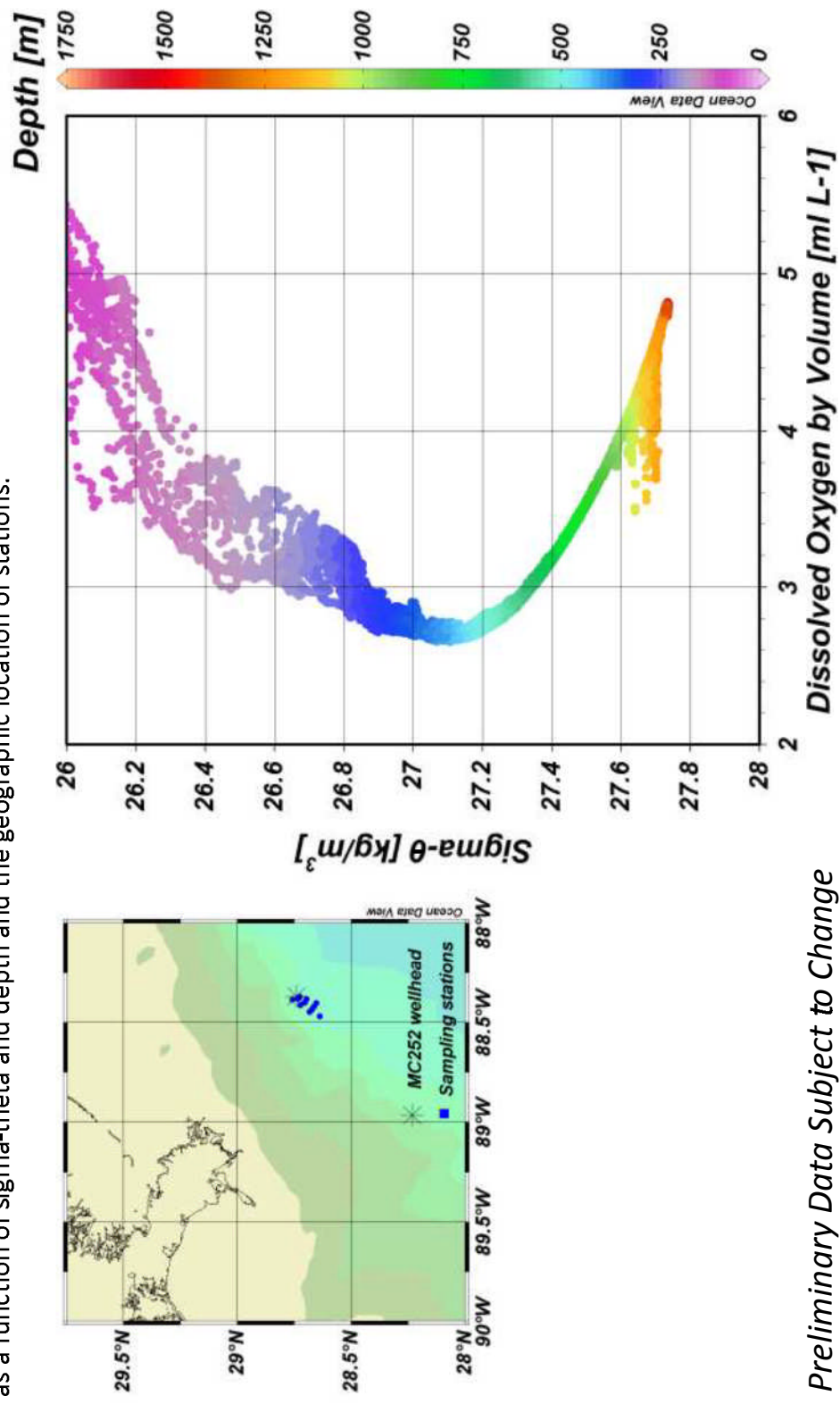
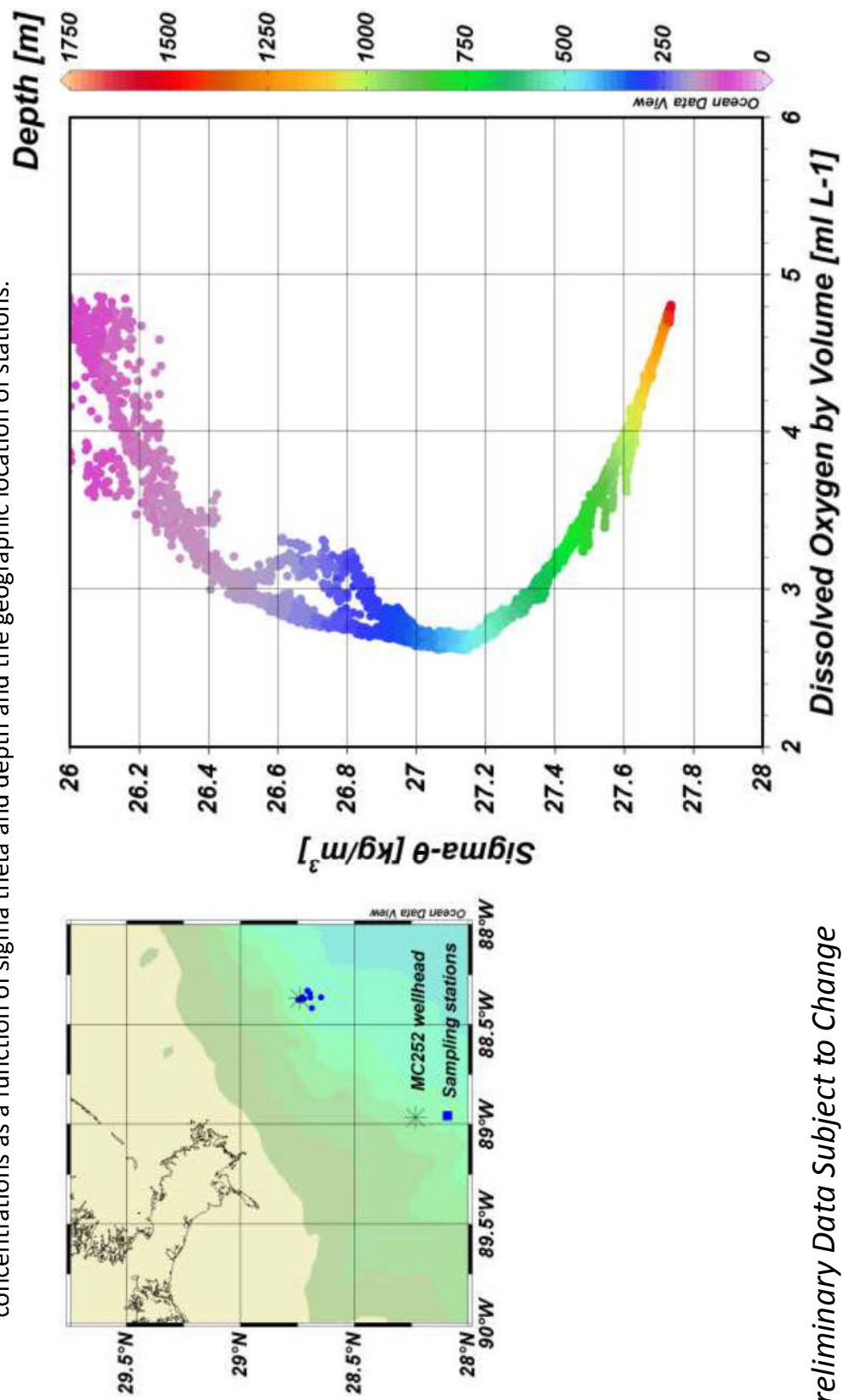


Figure 14. SBE 43 DO₂ measurements for R/V Brooks McCall cruise 5. Figure shows DO₂ concentrations as a function of sigma-theta and depth and the geographic location of stations.



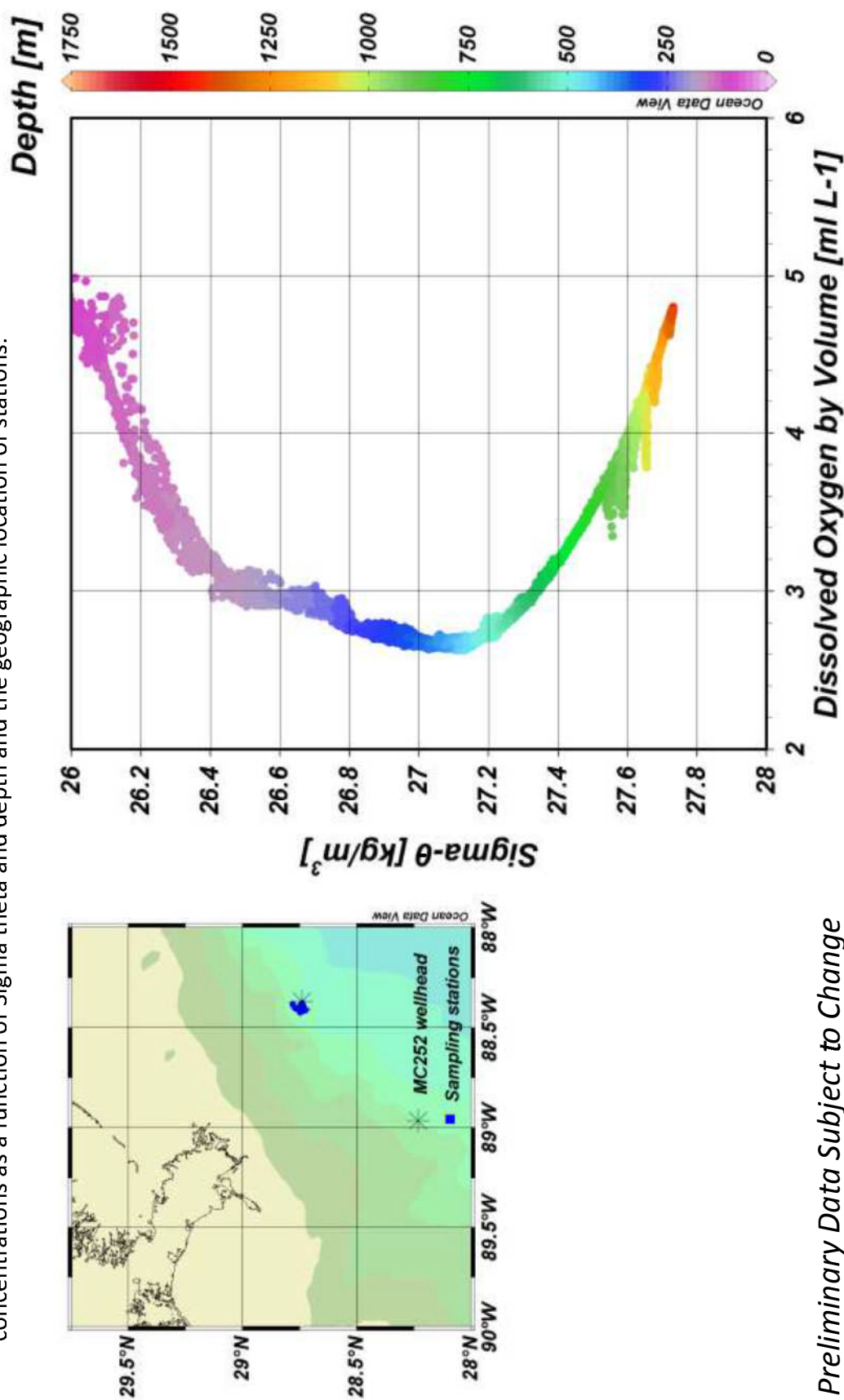
Preliminary Data Subject to Change

Figure 15. SBE 43 DO₂ measurements for R/V Brooks McCall cruise 6. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



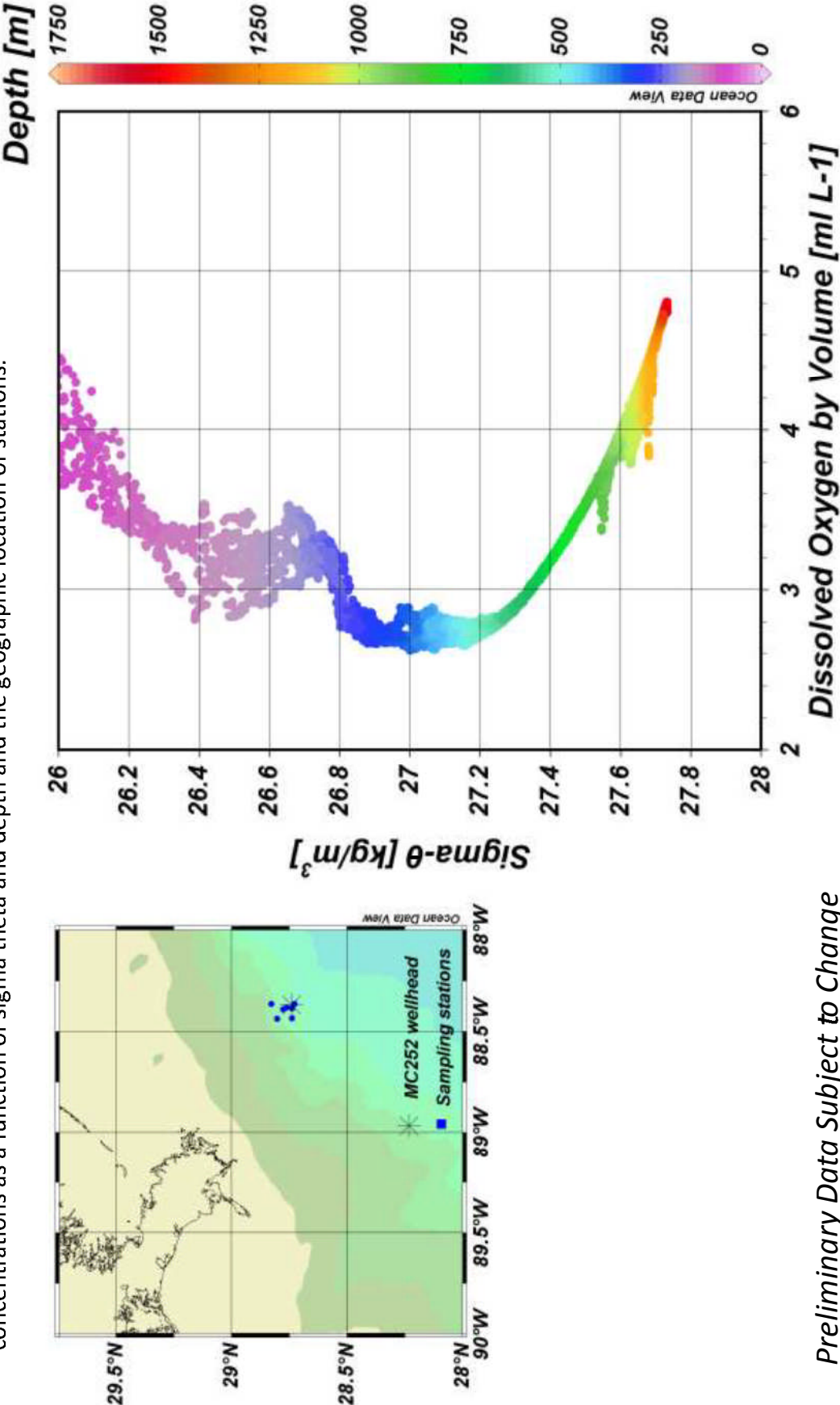
Preliminary Data Subject to Change

Figure 16. SBE 43 DO₂ measurements for R/V Brooks McCall cruise 7. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



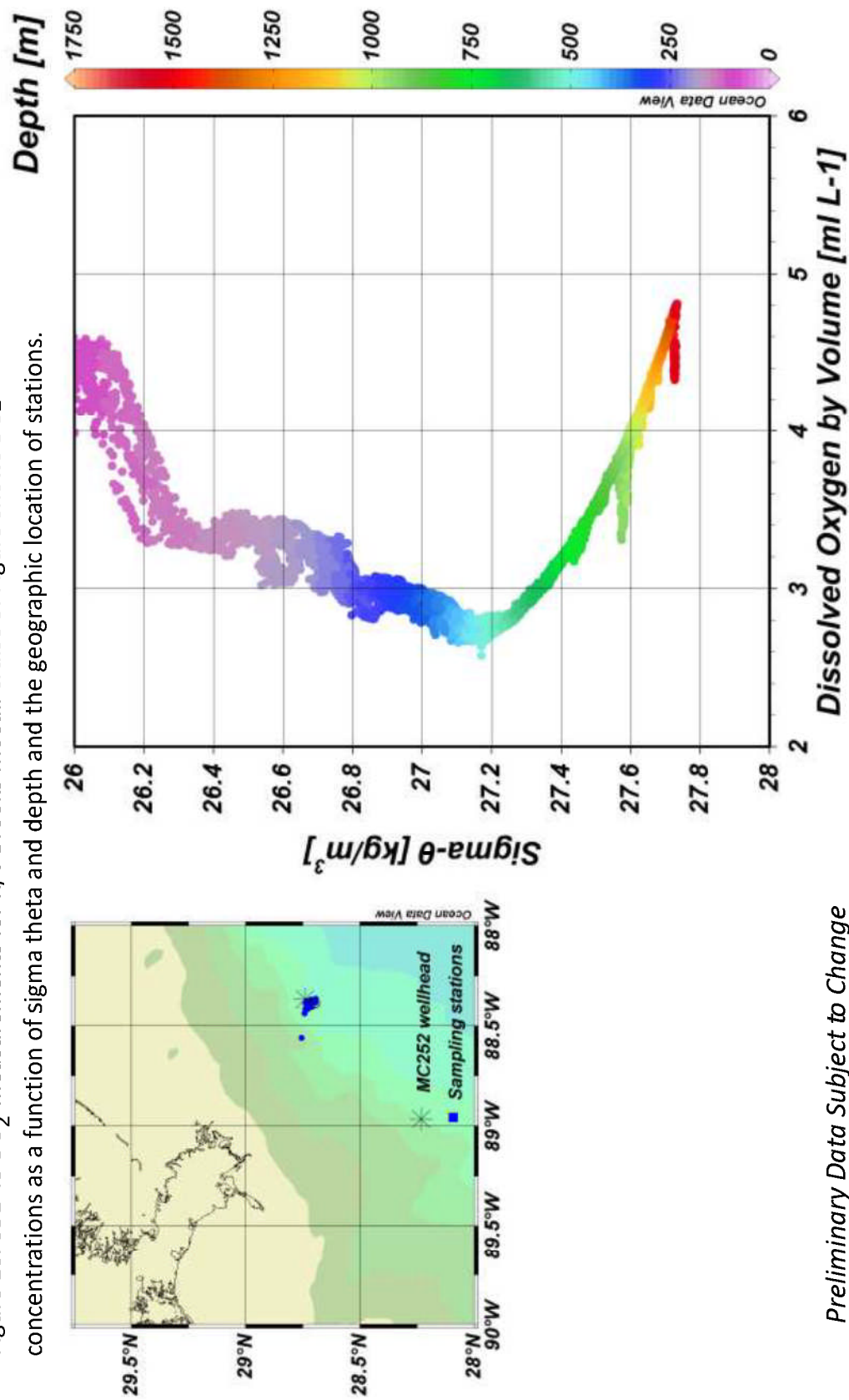
Preliminary Data Subject to Change

Figure 17. SBE 43 DO₂ measurements for R/V Brooks McCall cruise 8. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



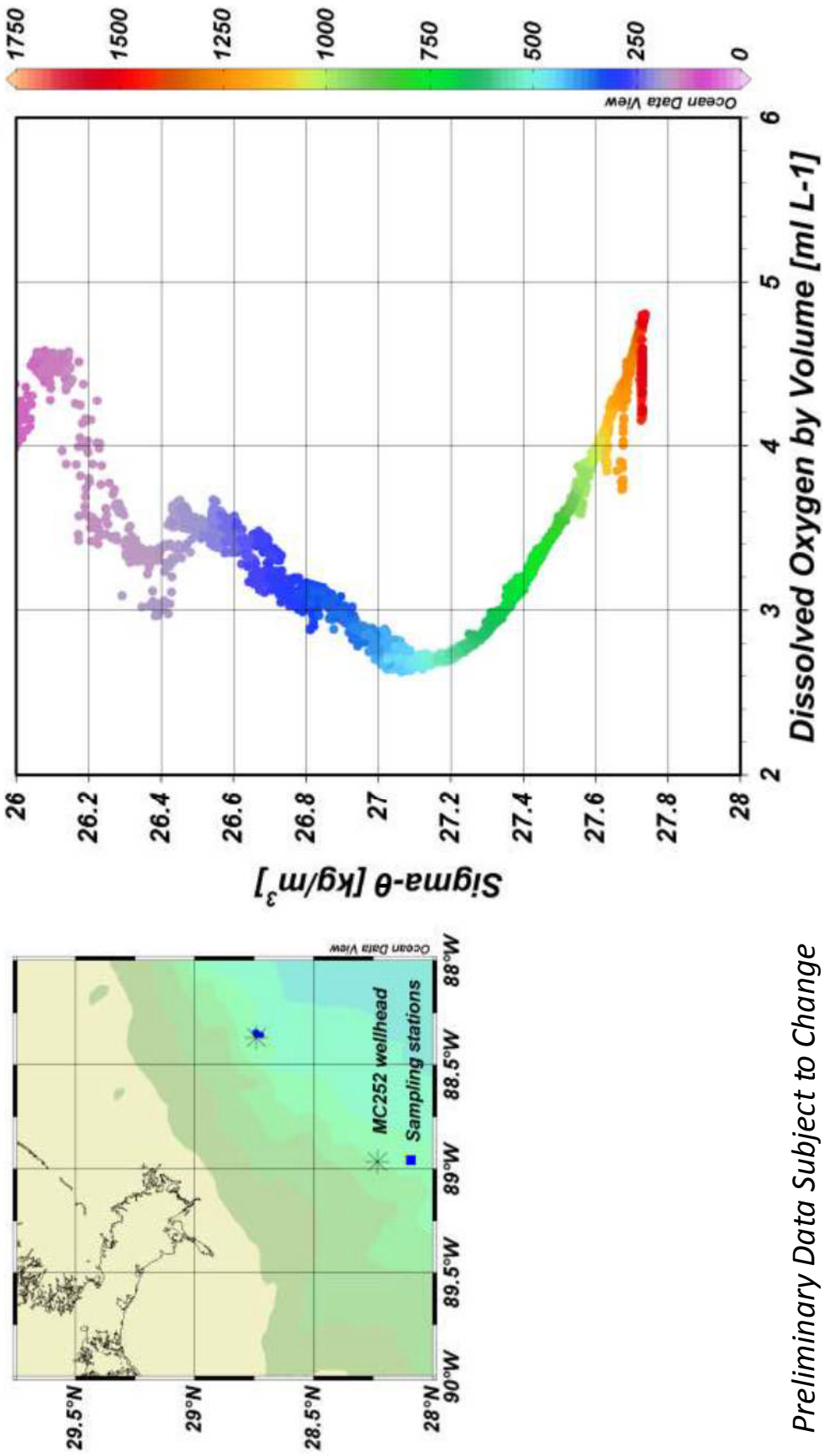
Preliminary Data Subject to Change

Figure 18. SBE 43 DO₂ measurements for R/V Brooks McCall cruise 9. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



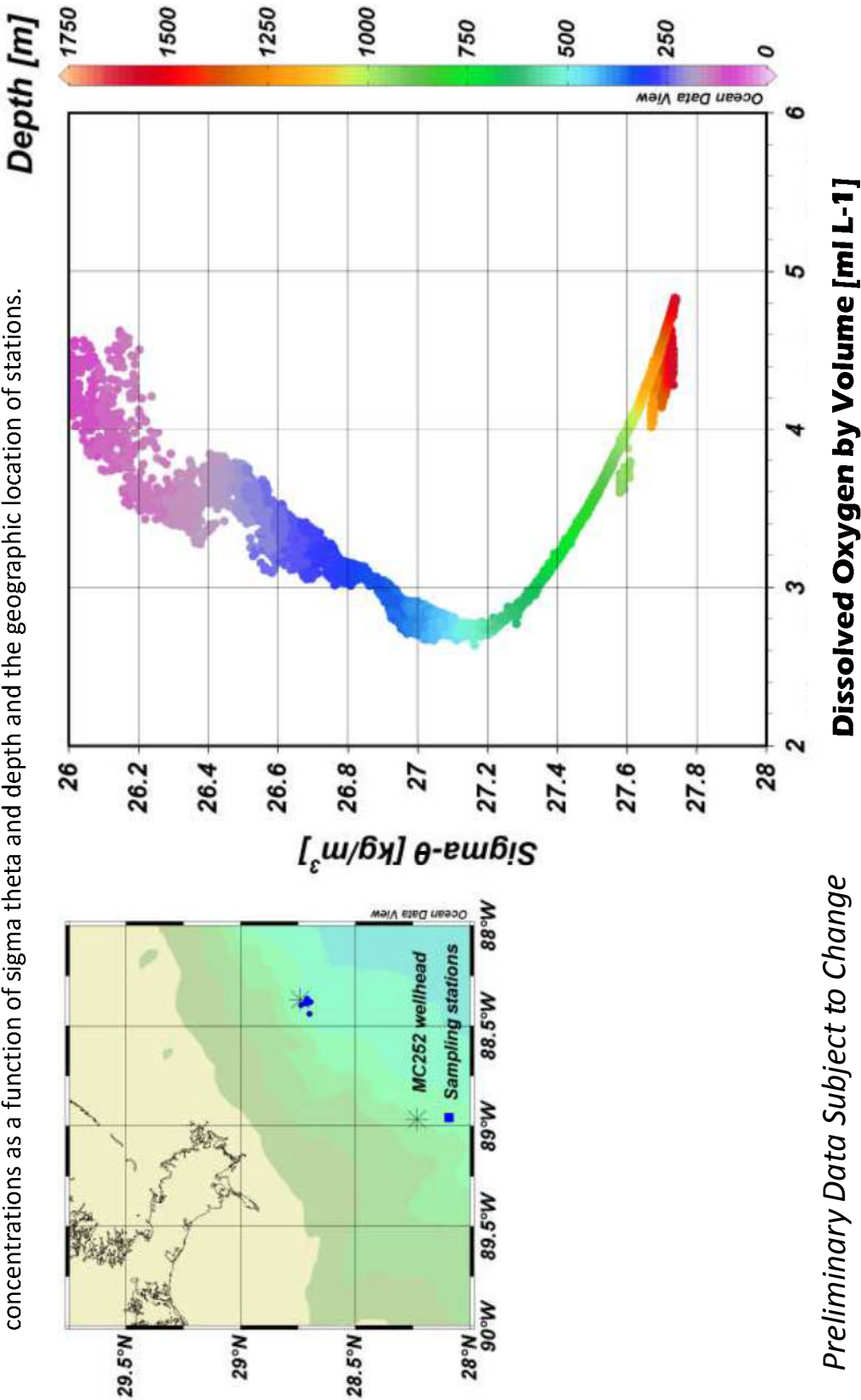
Preliminary Data Subject to Change

Figure 19. SBE 43 DO₂ measurements for R/V Brooks McCall/ cruise 11. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



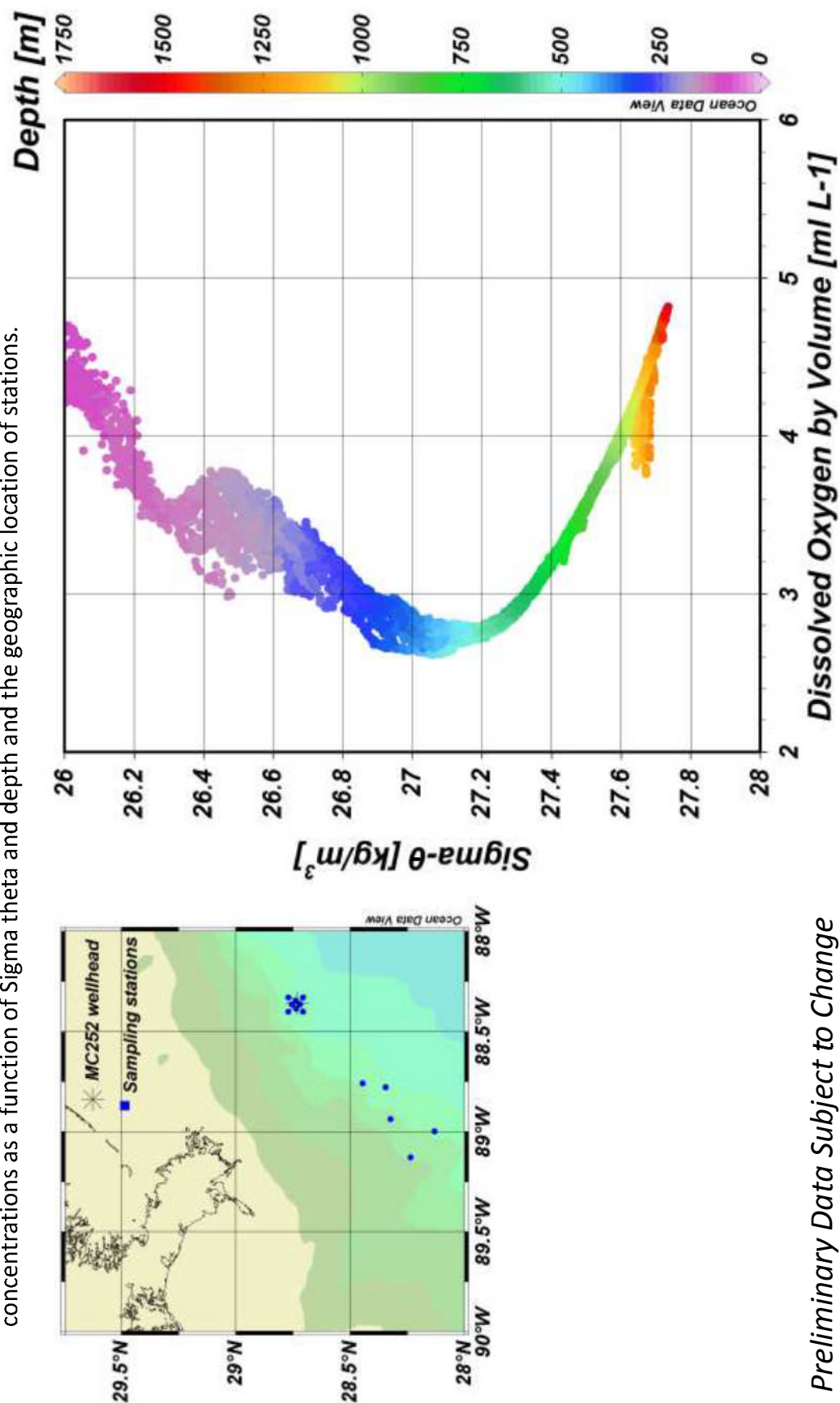
Preliminary Data Subject to Change

Figure 20. SBE 43 DO₂ measurements for R/V Brooks McCall cruise 12. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



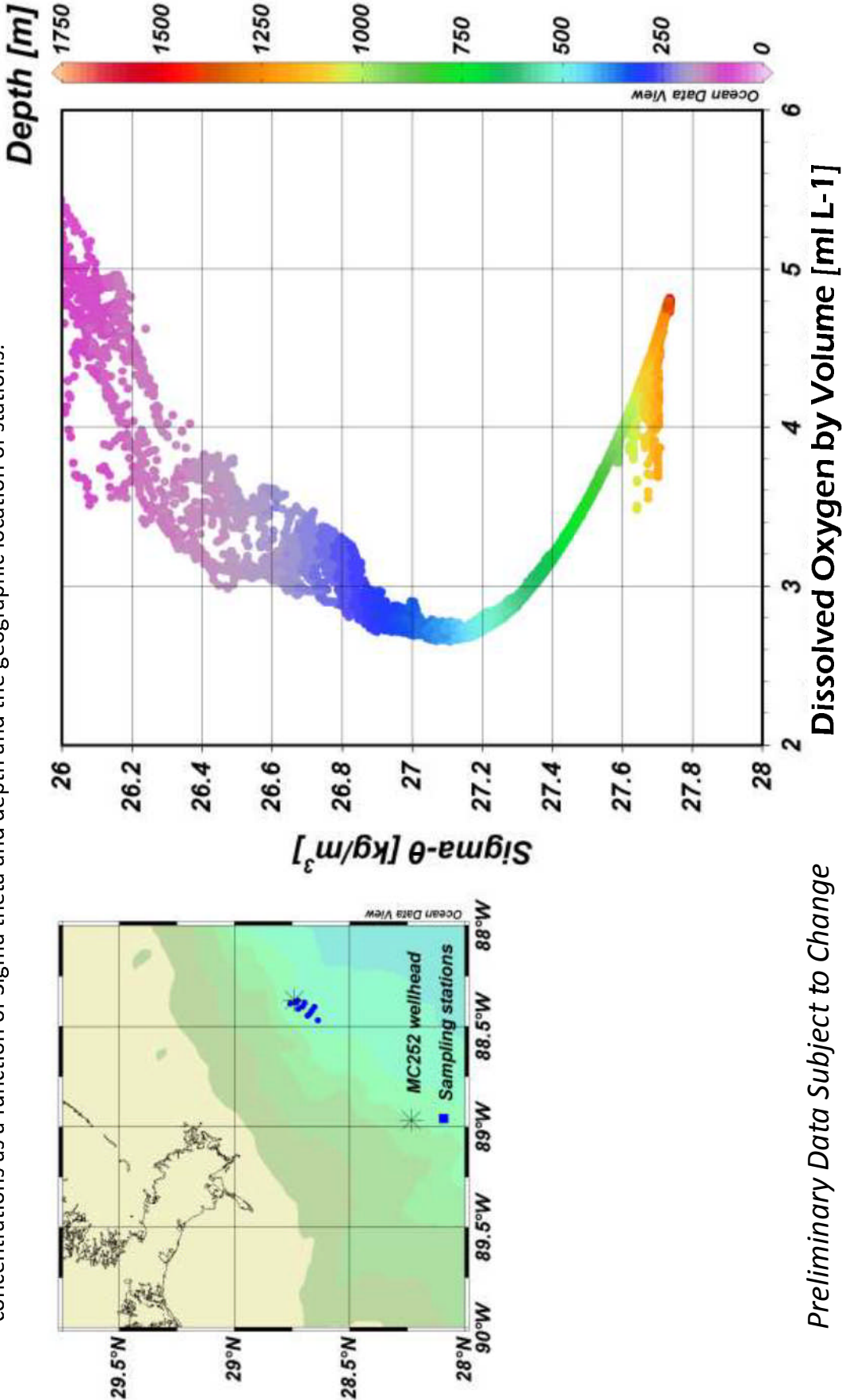
Preliminary Data Subject to Change

Figure 21. SBE 43 DO₂ measurements for R/V Brooks McCall cruise 15. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



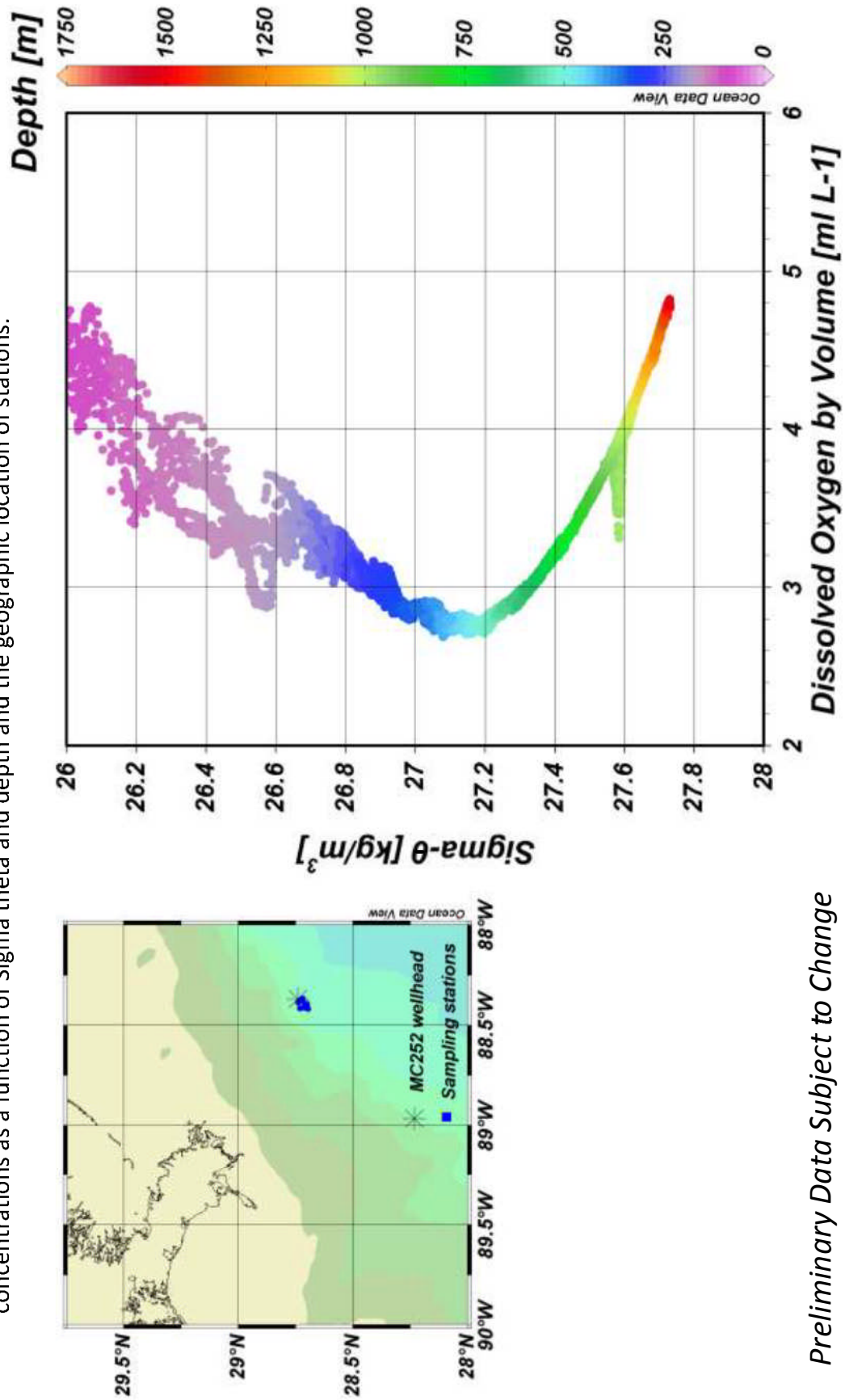
Preliminary Data Subject to Change

Figure 22. SBE 43 DO₂ measurements for R/V Ocean Veritas cruise 5. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



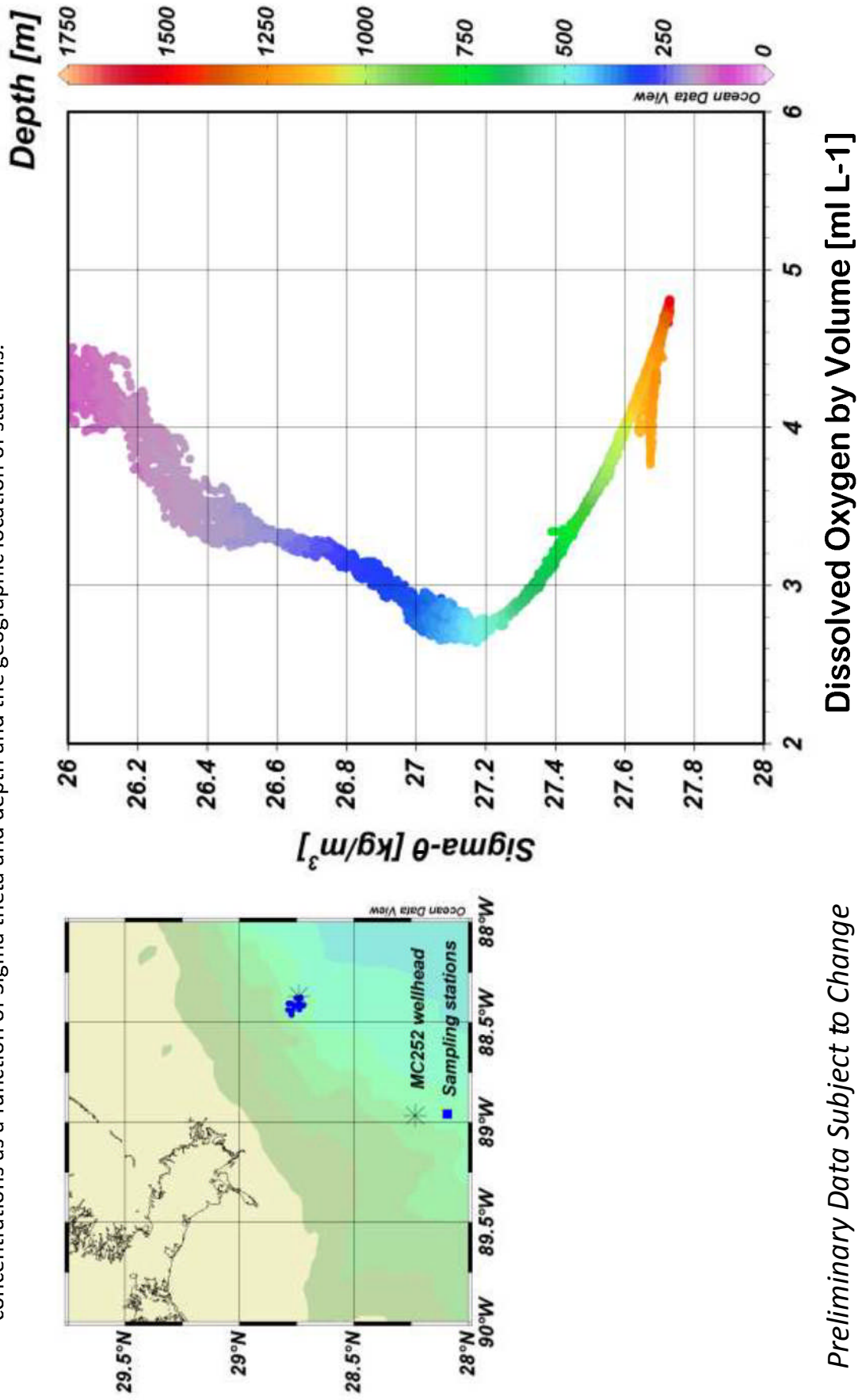
Preliminary Data Subject to Change

Figure 23. SBE 43 DO₂ measurements for R/V *Ocean Veritas* cruise 6. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



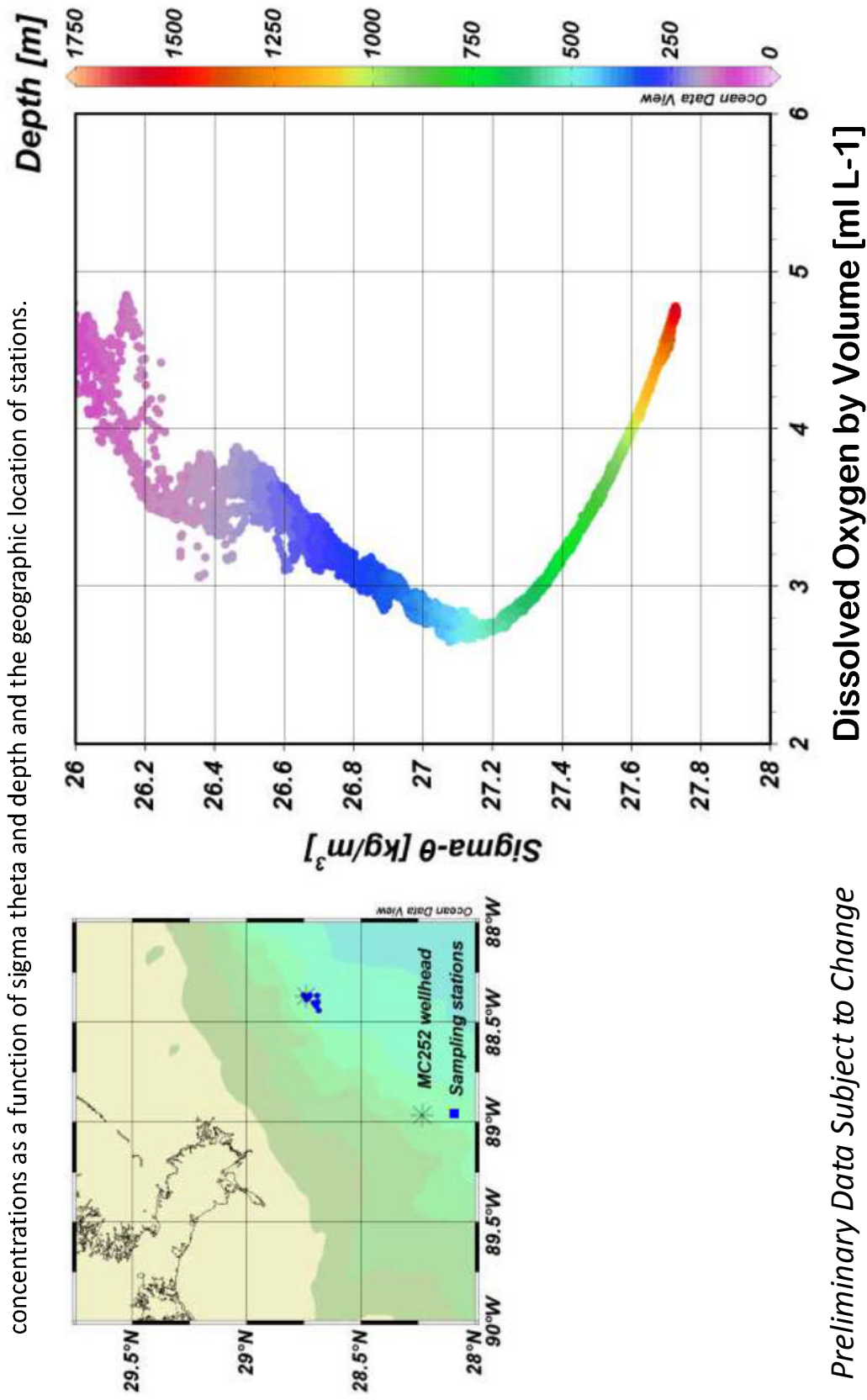
Preliminary Data Subject to Change

Figure 24. SBE 43 DO₂ measurements for R/V *Ocean Veritas* cruise 7. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



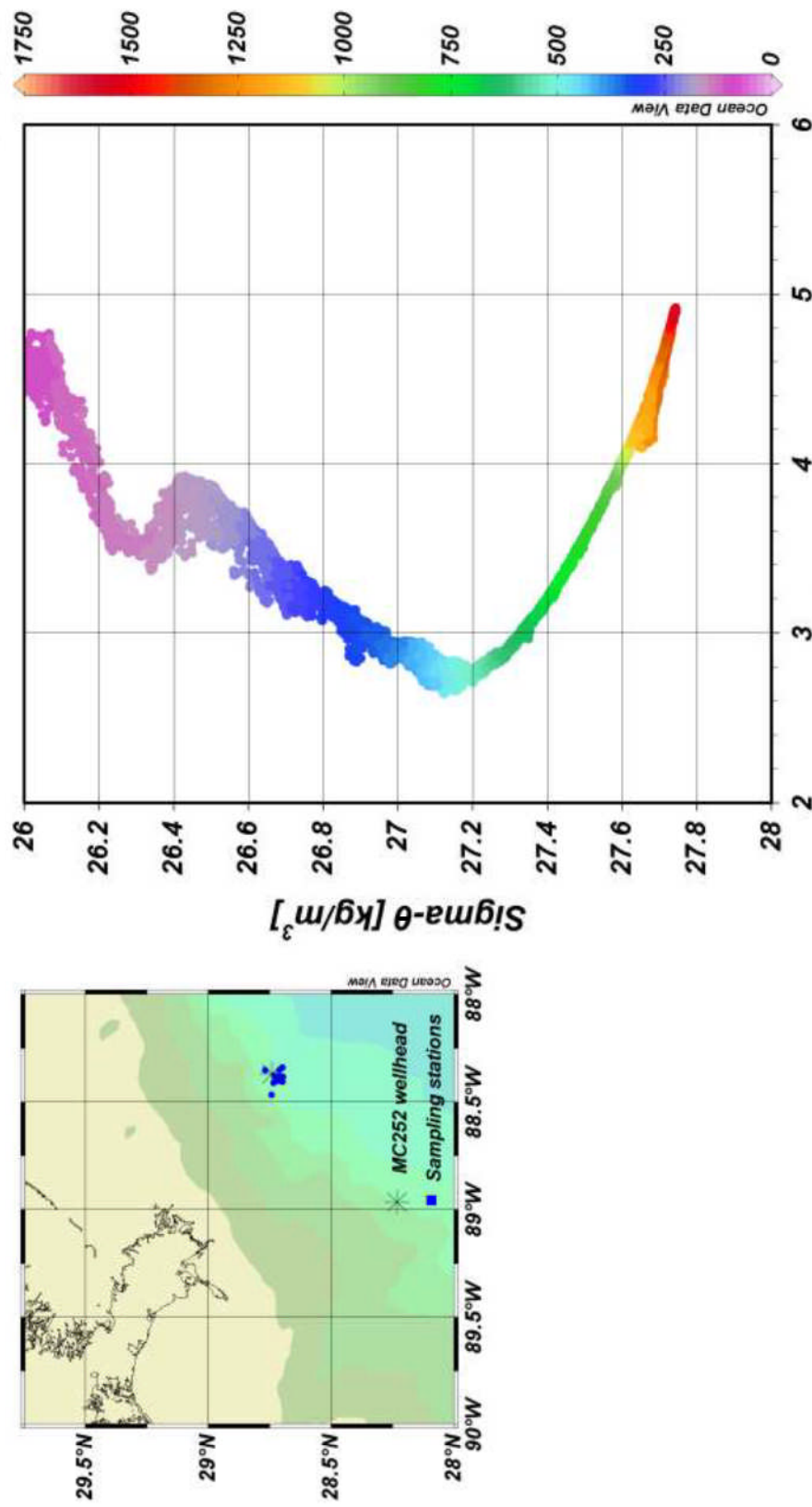
Preliminary Data Subject to Change

Figure 25. SBE 43 DO₂ measurements for R/V *Ocean Veritas* cruise 8. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



Preliminary Data Subject to Change

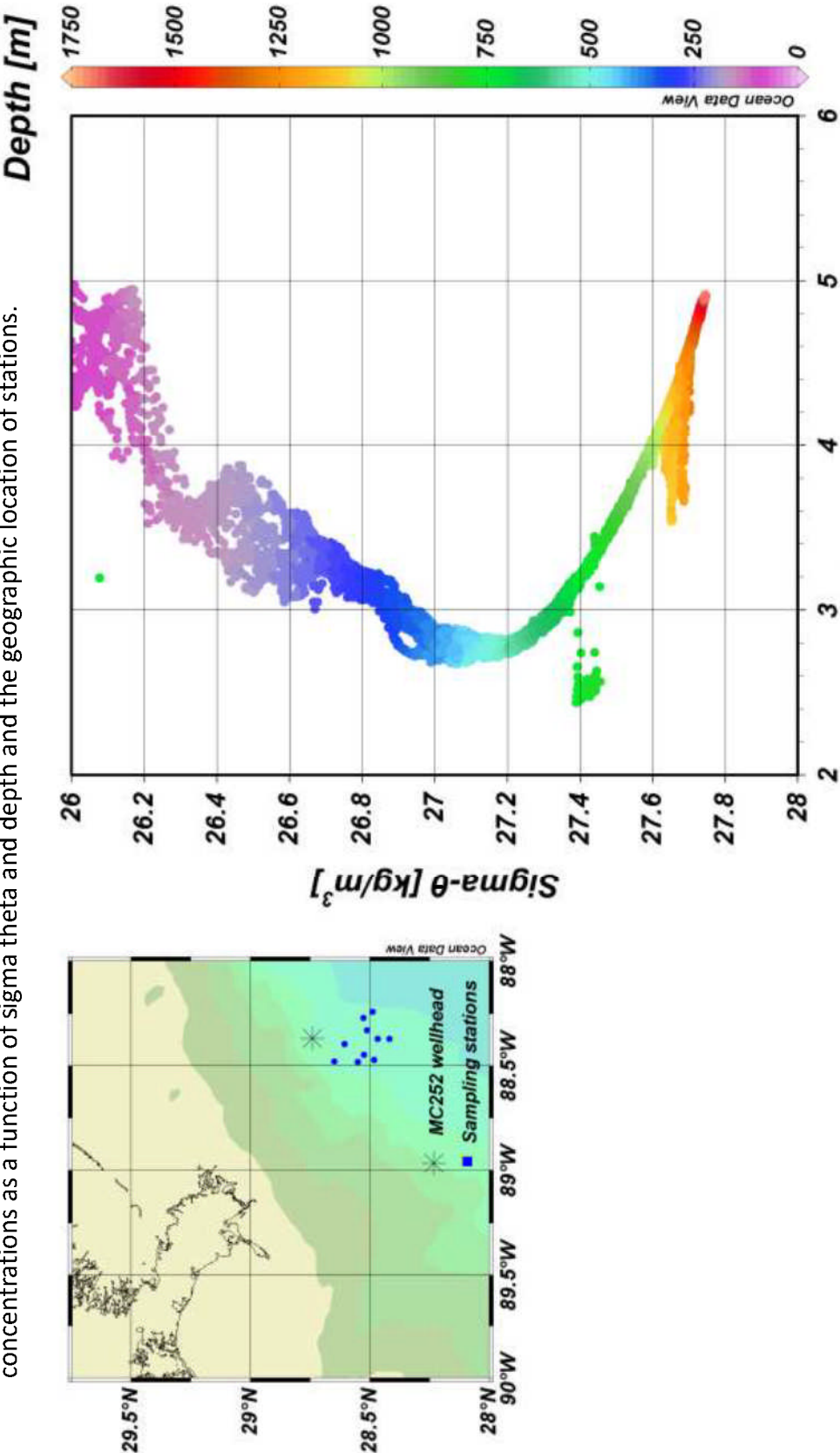
Figure 26. SBE 43 DO₂ measurements for R/V *Ocean Veritas* cruise 9. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



Dissolved Oxygen by Volume [ml L⁻¹]

Preliminary Data Subject to Change

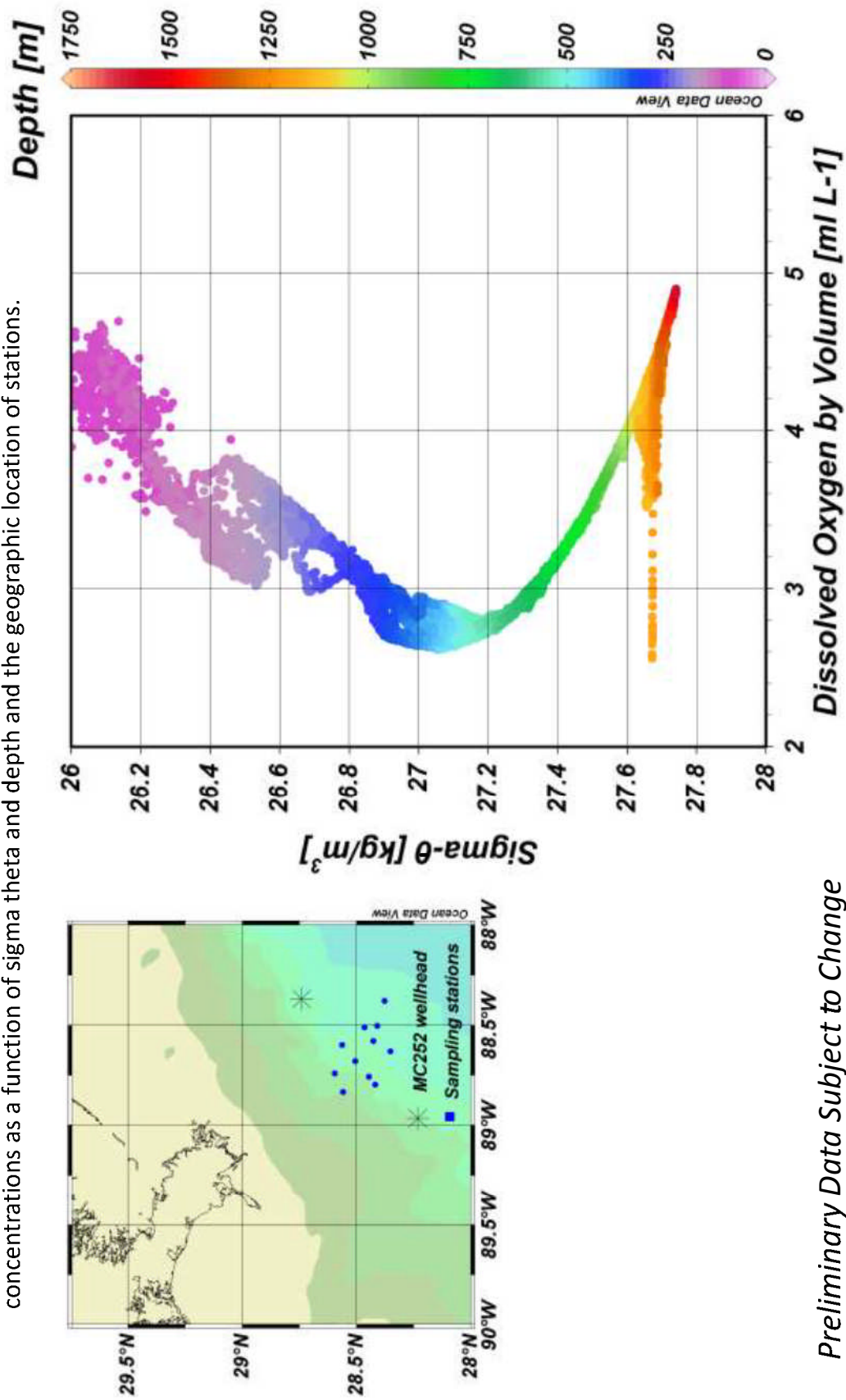
Figure 27. SBE 43 DO₂ measurements for R/V *Ocean Veritas* cruise 10. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



Preliminary Data Subject to Change

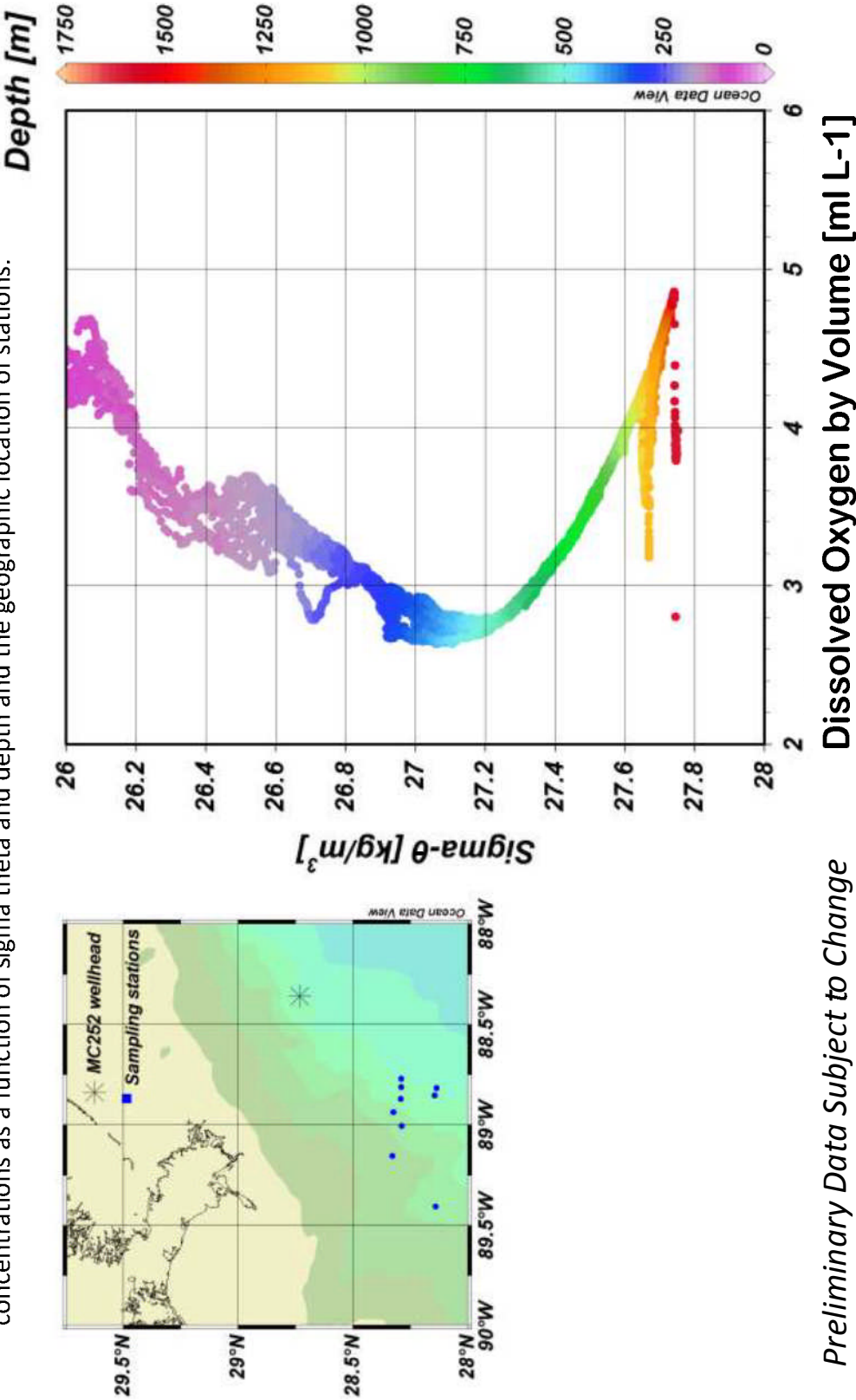
Dissolved Oxygen by Volume [ml L⁻¹]

Figure 28. SBE 43 DO₂ measurements for R/V Ocean Veritas cruise 11. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



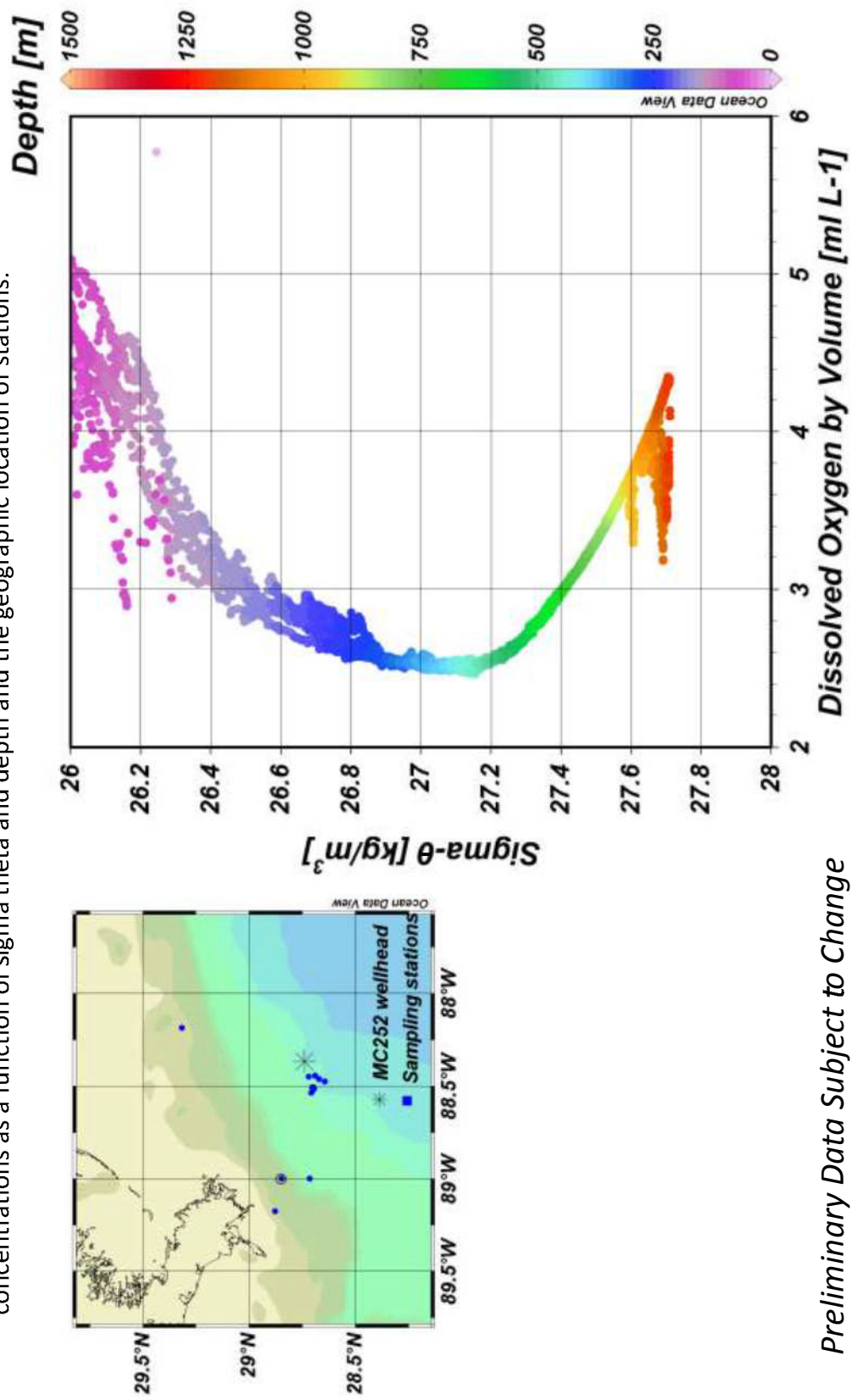
Preliminary Data Subject to Change

Figure 29. SBE 43 DO₂ measurements for R/V *Ocean Veritas* cruise 12. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



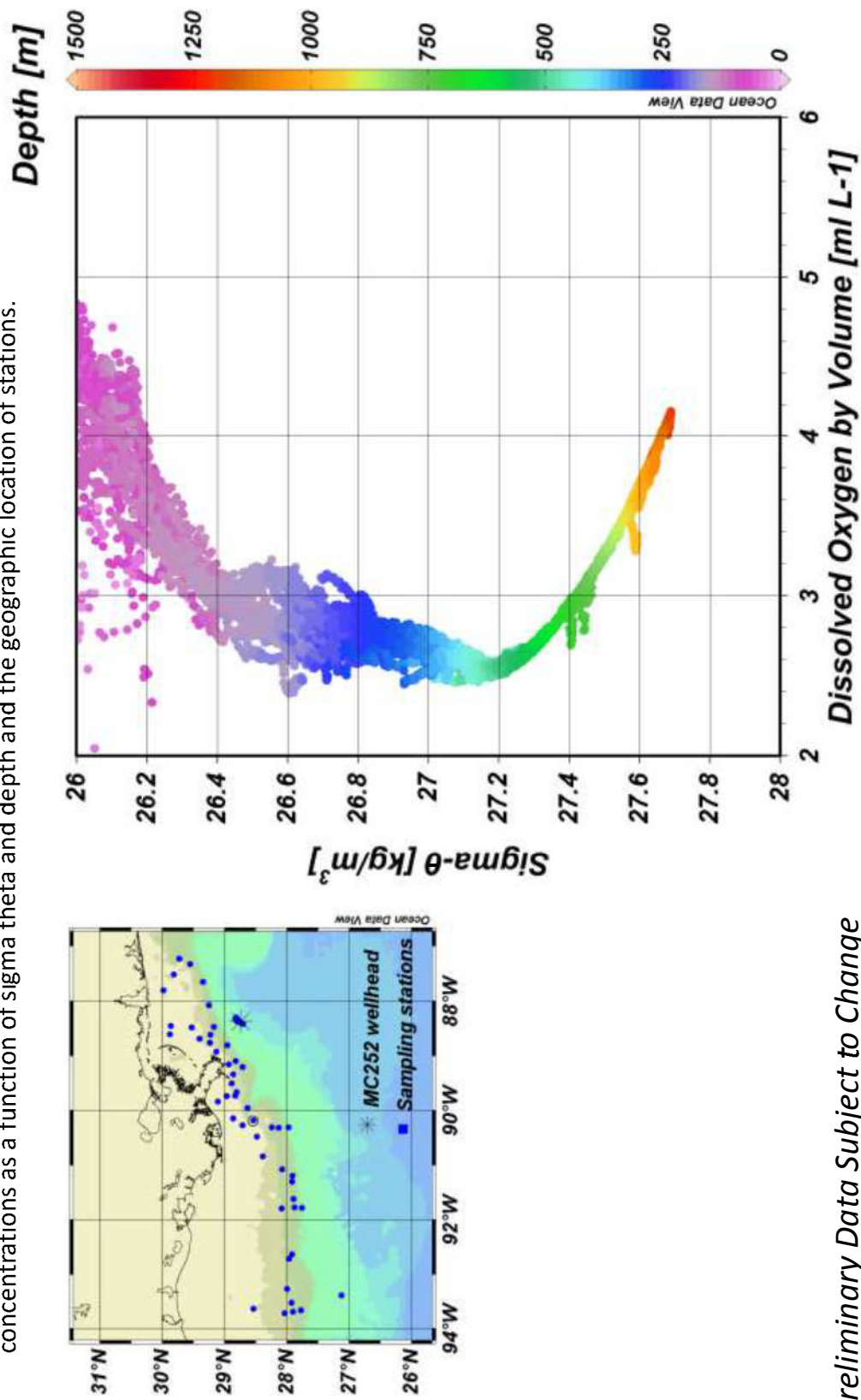
Preliminary Data Subject to Change

Figure 30. SBE 43 DO₂ measurements for R/V *Thomas Jefferson* cruise 2. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



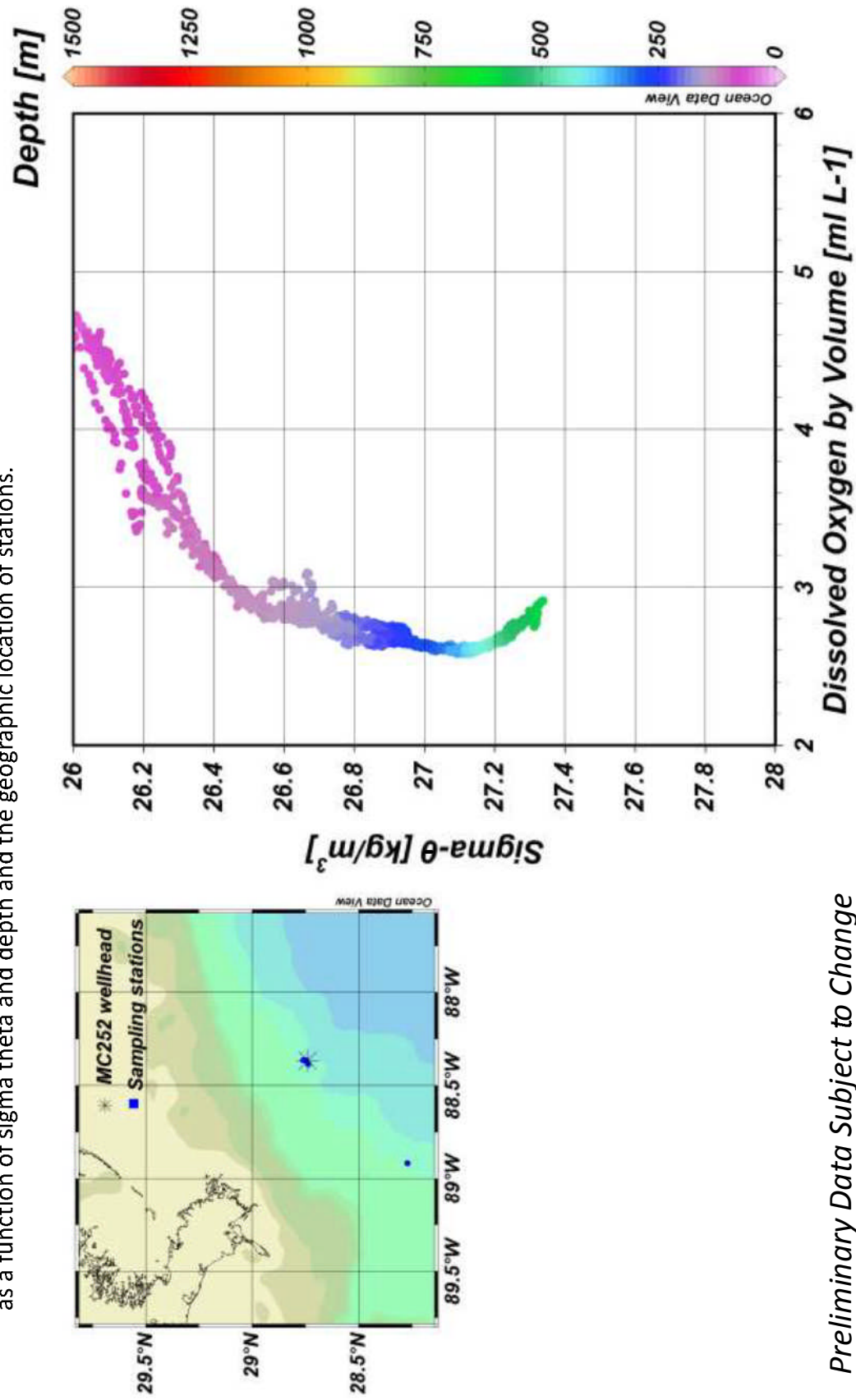
Preliminary Data Subject to Change

Figure 31. SBE 43 DO₂ measurements for R/V Thomas Jefferson cruise 3. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



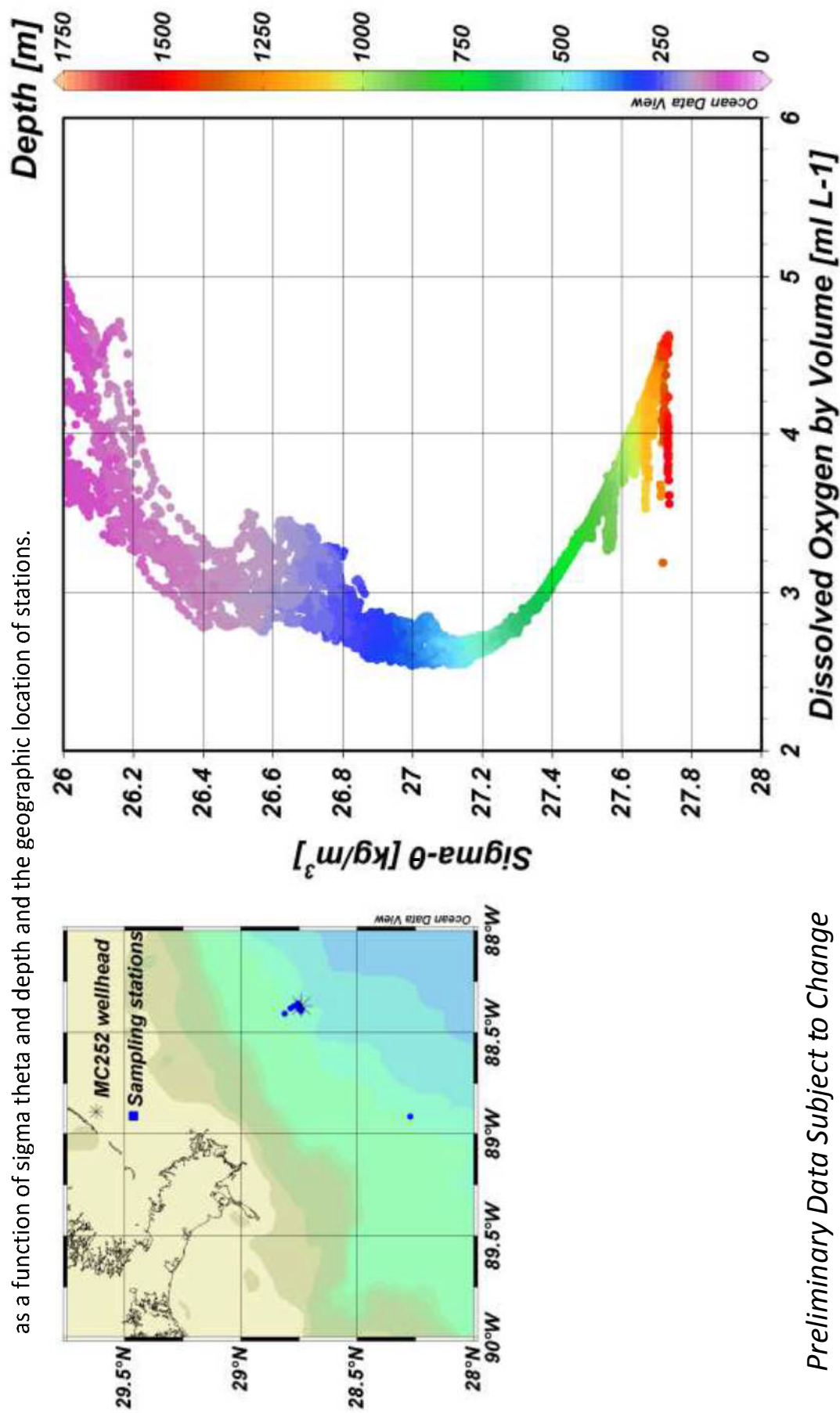
Preliminary Data Subject to Change

Figure 32. SBE 43 DO₂ measurements for R/V Jack Fitz cruise 1. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



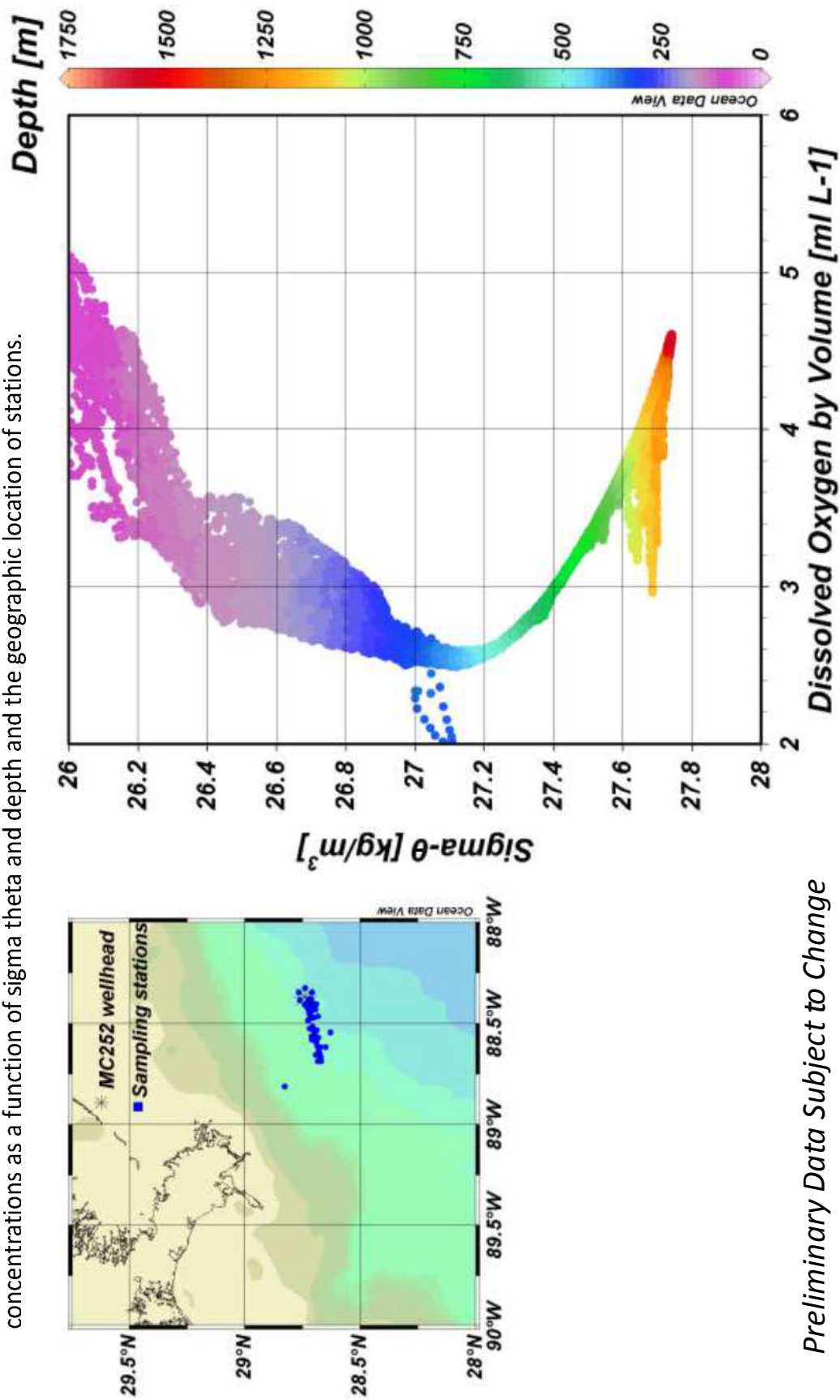
Preliminary Data Subject to Change

Figure 33. SBE 43 DO₂ measurements for R/V Jack Fitz cruise 3. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



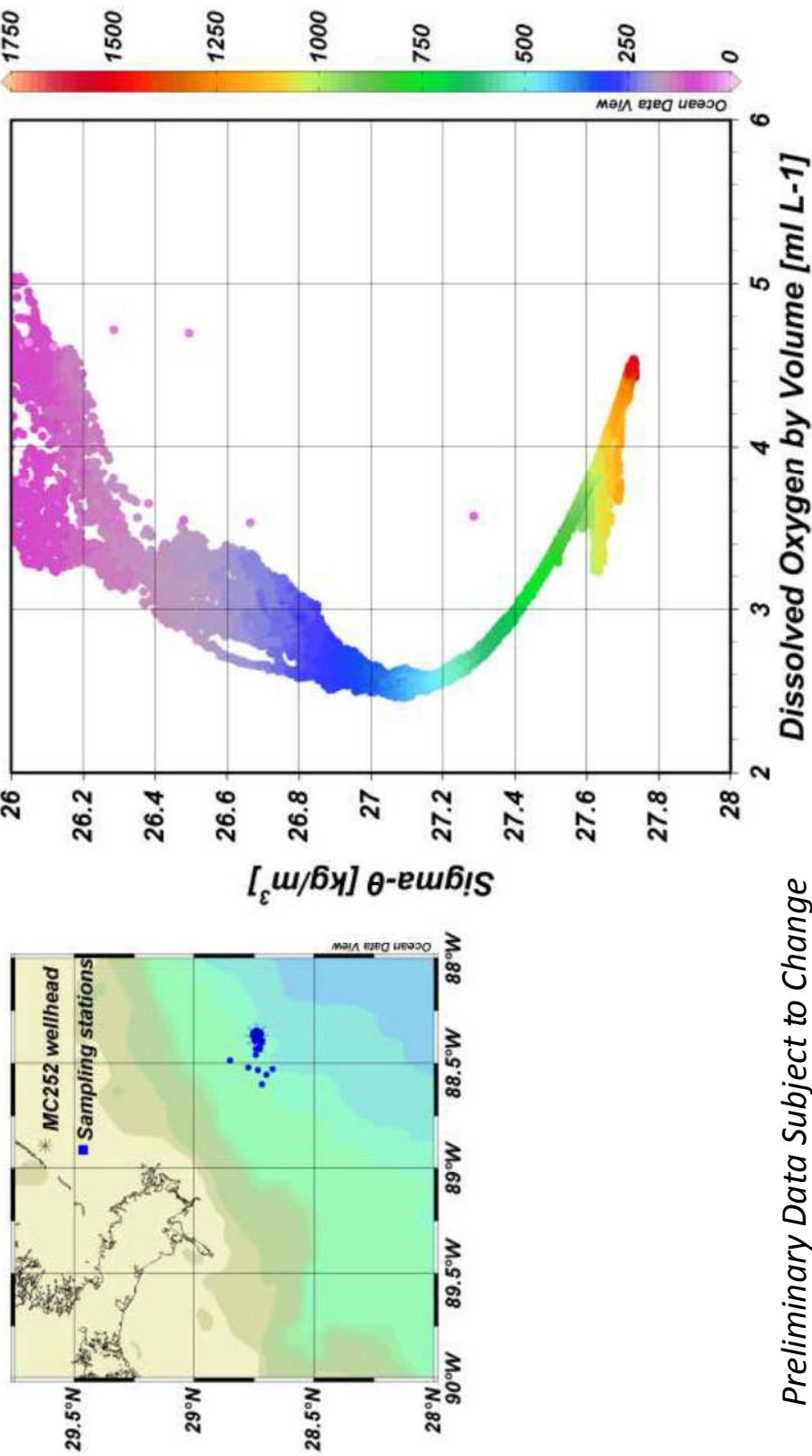
Preliminary Data Subject to Change

Figure 34. SBE 43 DO₂ measurements for R/V Walton Smith cruise 1. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



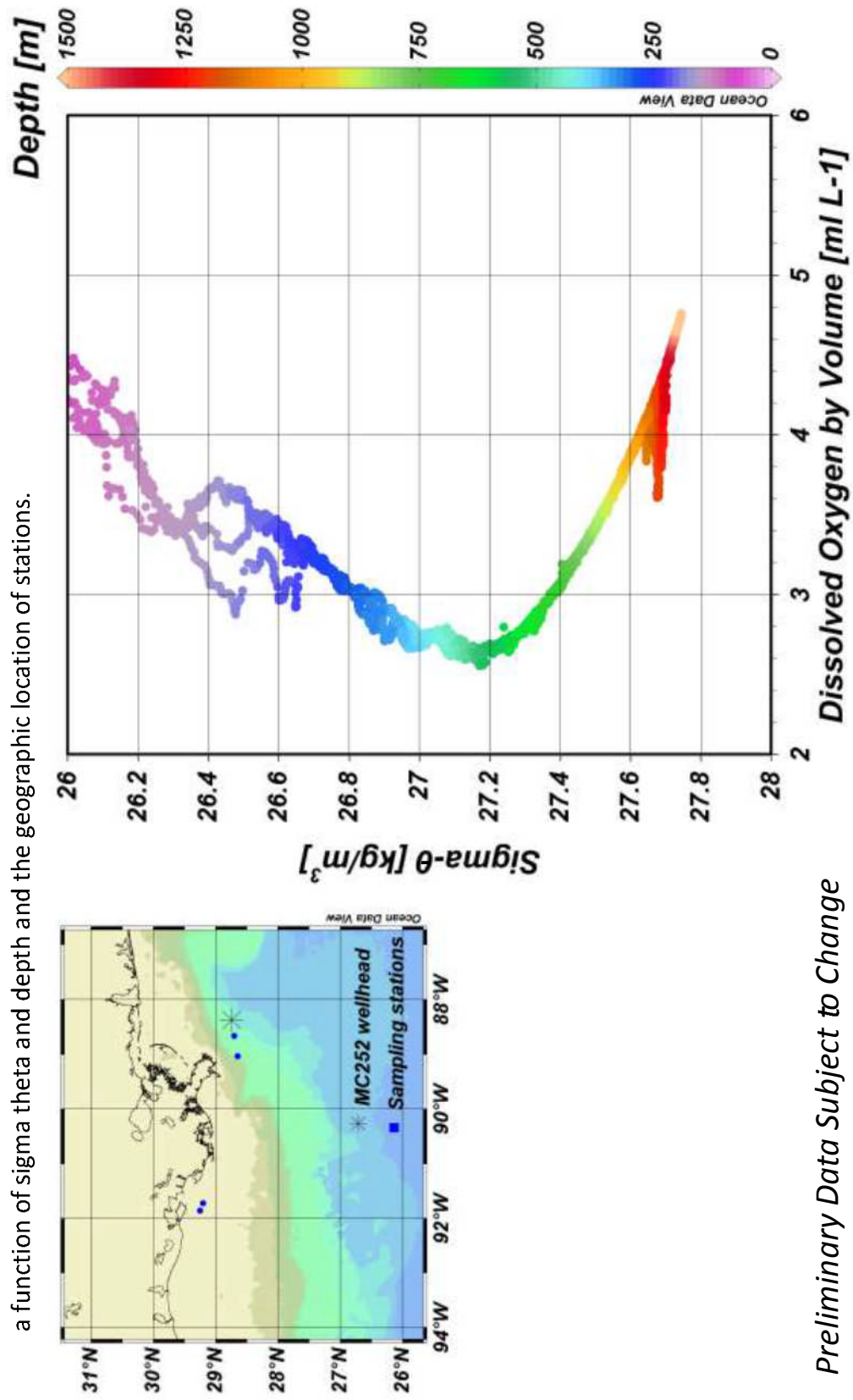
Preliminary Data Subject to Change

Figure 35. SBE 43 DO₂ measurements for R/V Walton Smith cruise 2. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



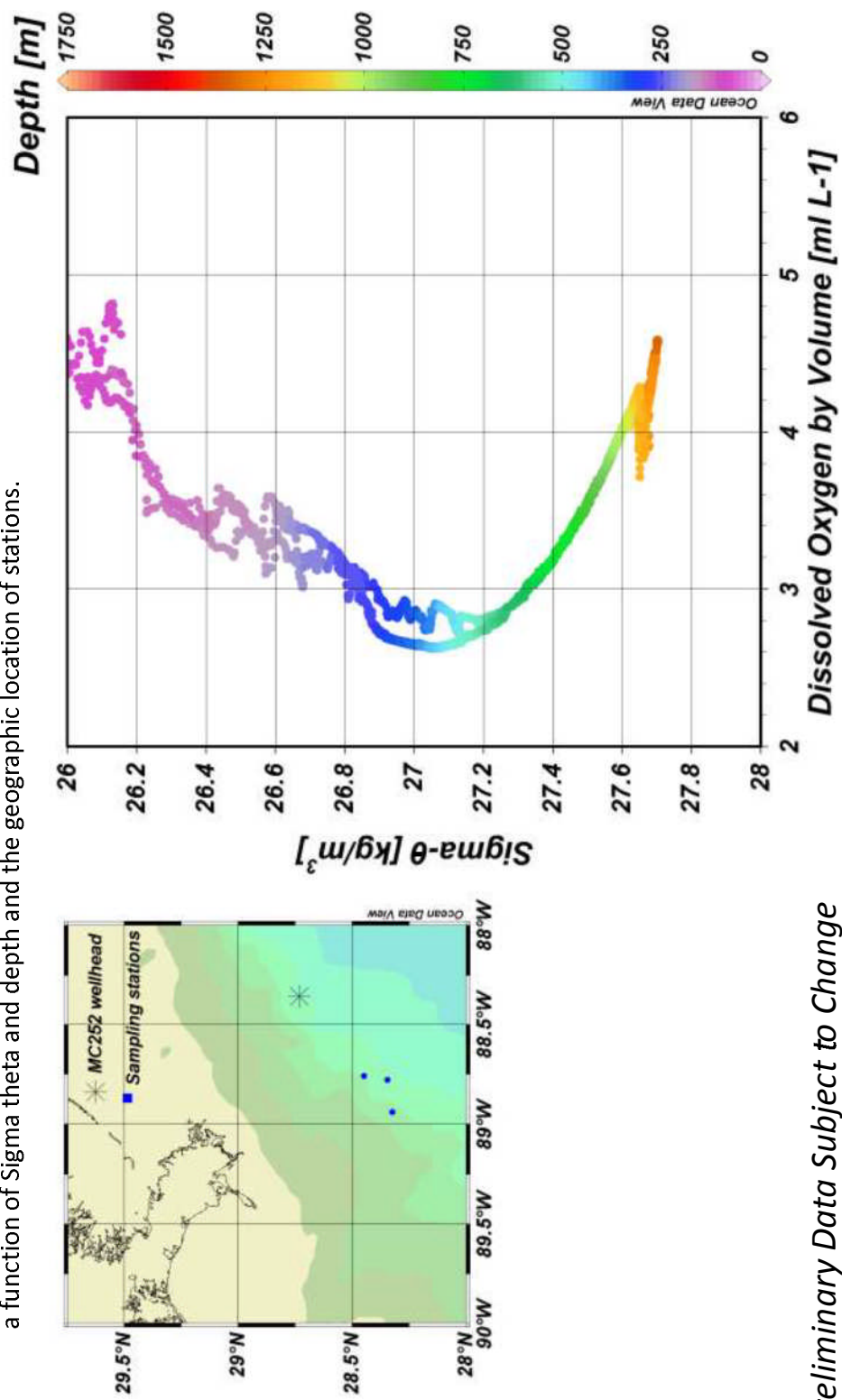
Preliminary Data Subject to Change

Figure 36. SBE 43 DO₂ measurements for R/V Ferrel/ cruise 2. Figure shows DO₂ concentrations as a function of sigma theta and depth and the geographic location of stations.



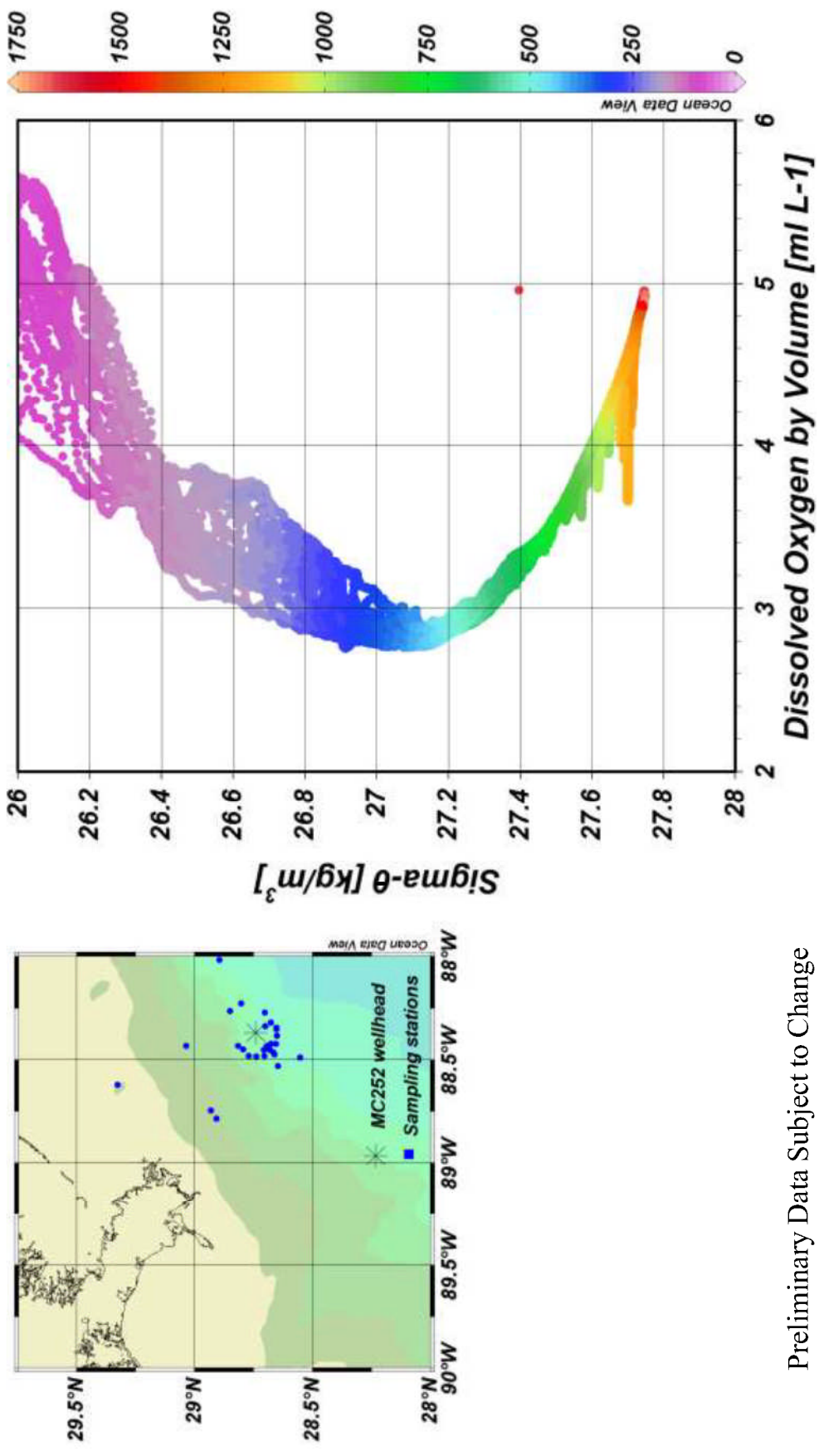
Preliminary Data Subject to Change

Figure 37. SBE 43 DO₂ measurements for R/V Ferrel/ cruise 4. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



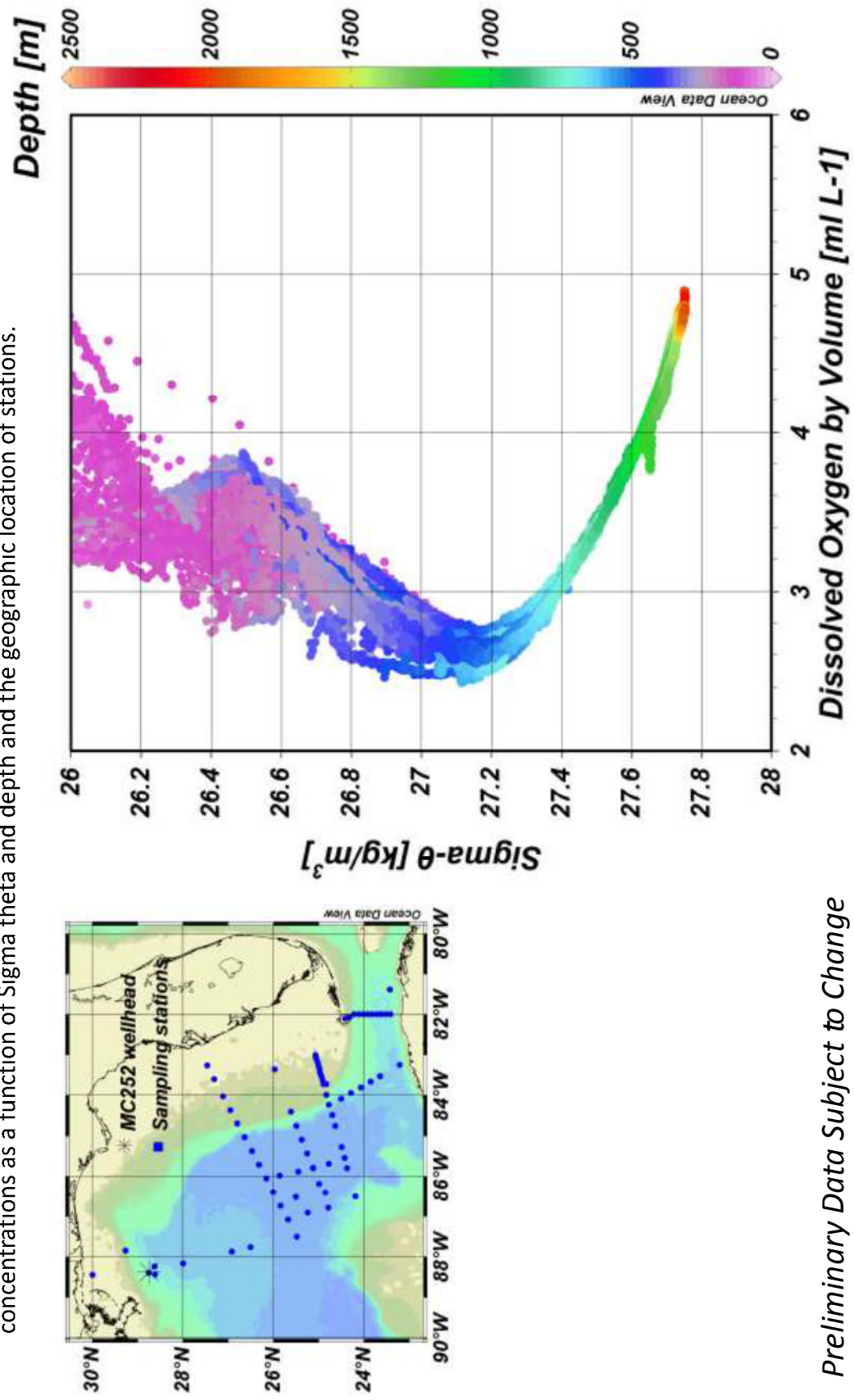
Preliminary Data Subject to Change

Figure 38. SBE 43 DO₂ measurements for R/V *Gordon Gunter* cruise 1. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



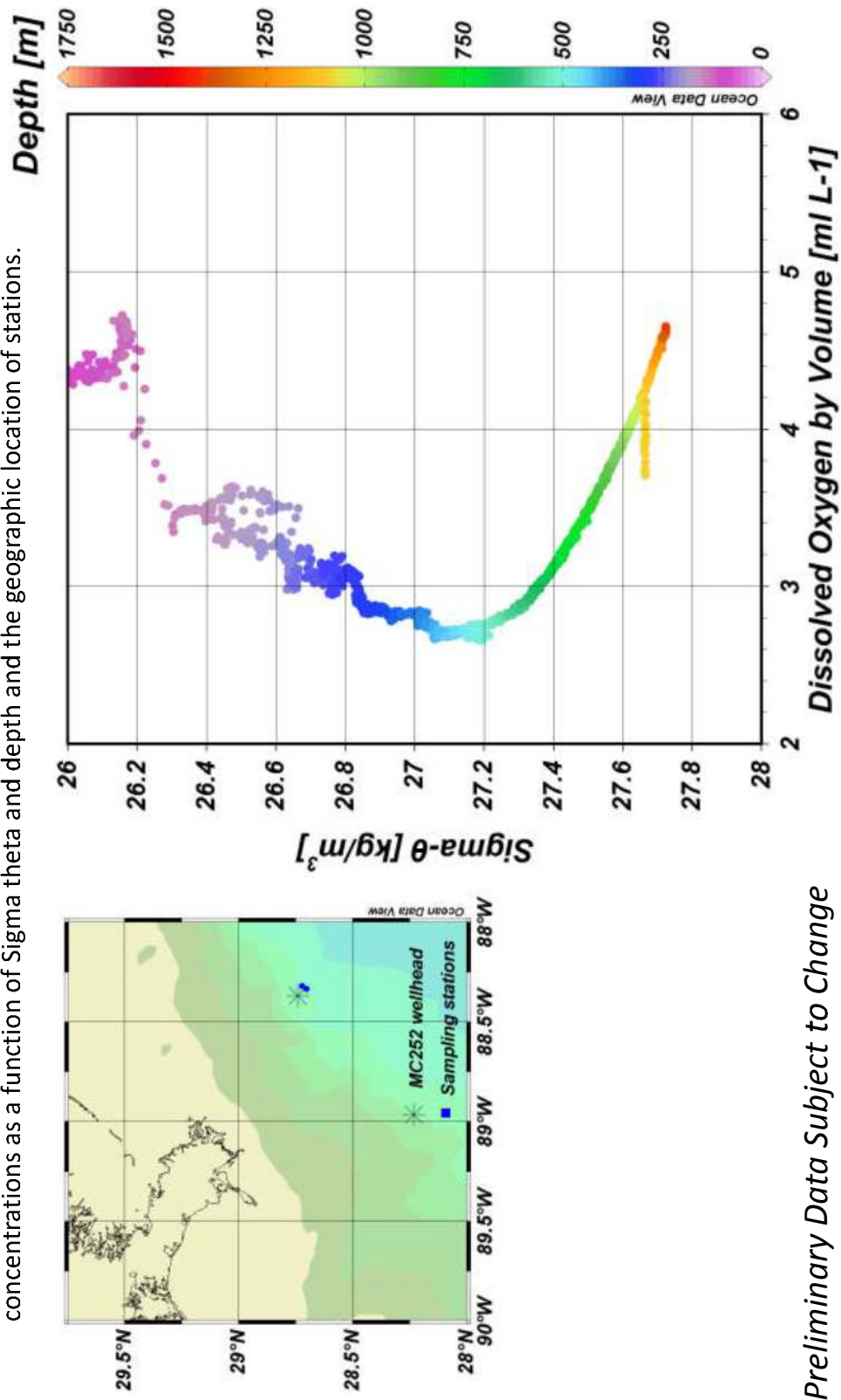
Preliminary Data Subject to Change

Figure 39. SBE 43 DO₂ measurements for R/V *Nancy Foster* cruise 1. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



Preliminary Data Subject to Change

Figure 40. SBE 43 DO₂ measurements for R/V *Henry Bigelow* cruise 1. Figure shows DO₂ concentrations as a function of Sigma theta and depth and the geographic location of stations.



Preliminary Data Subject to Change

Figure 41. Mean SBE 43 DO₂ between 1000 and 1300 m as a function of date and distance from the wellhead. NODC 1^o climatological annual mean and standard deviation shown as green lines.

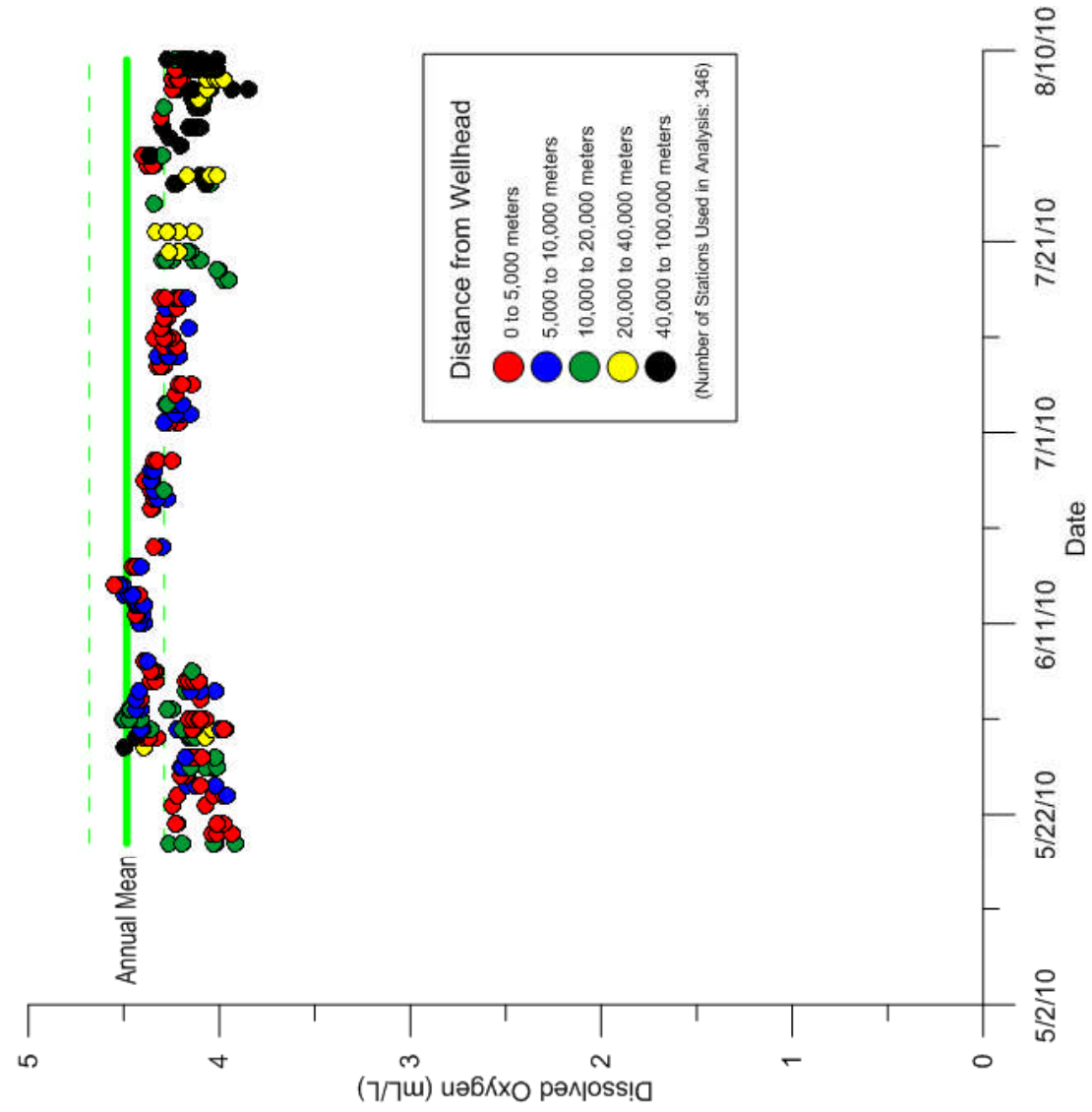


Figure 42. Mean SBE 43 DO₂ between 1000 and 1300 m as a function of distance from the wellhead and date. NODC 1^o climatological annual mean and standard deviation shown as green lines.

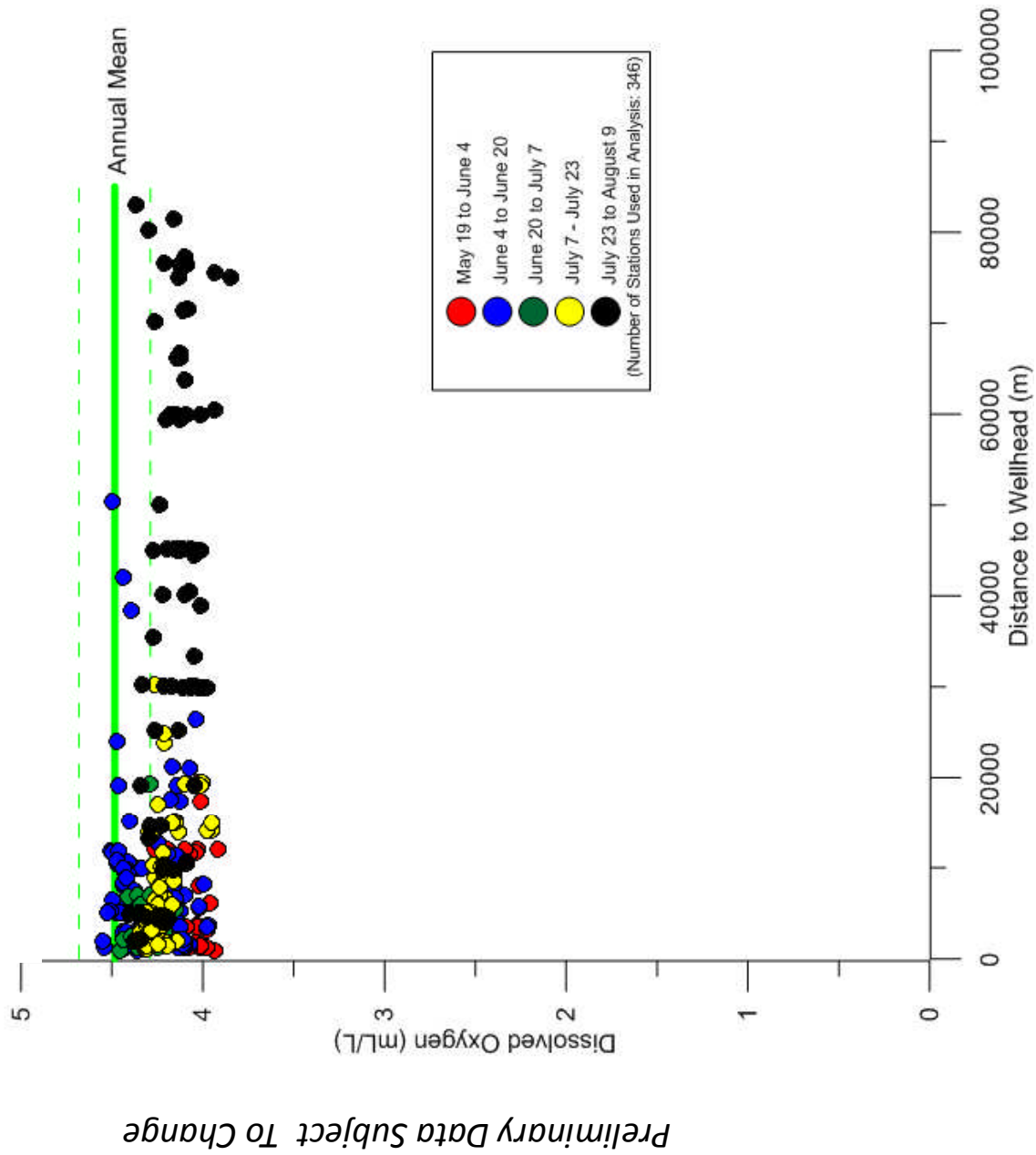


Figure 43. Minimum SBE 43 DO₂ between 1000 and 1300 m as a function of date and distance from the wellhead as compared to the level at which hypoxic conditions are considered to occur.

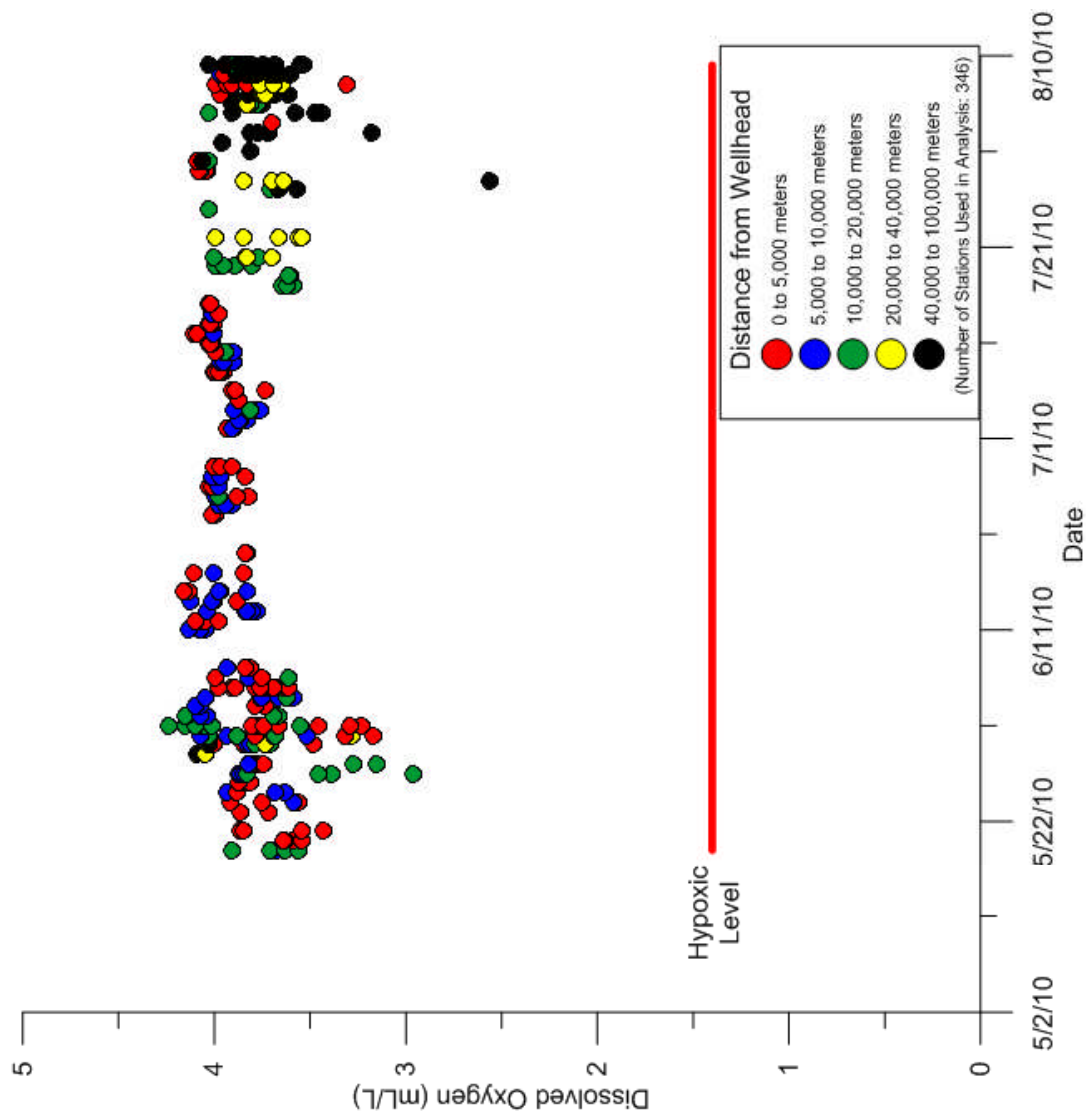
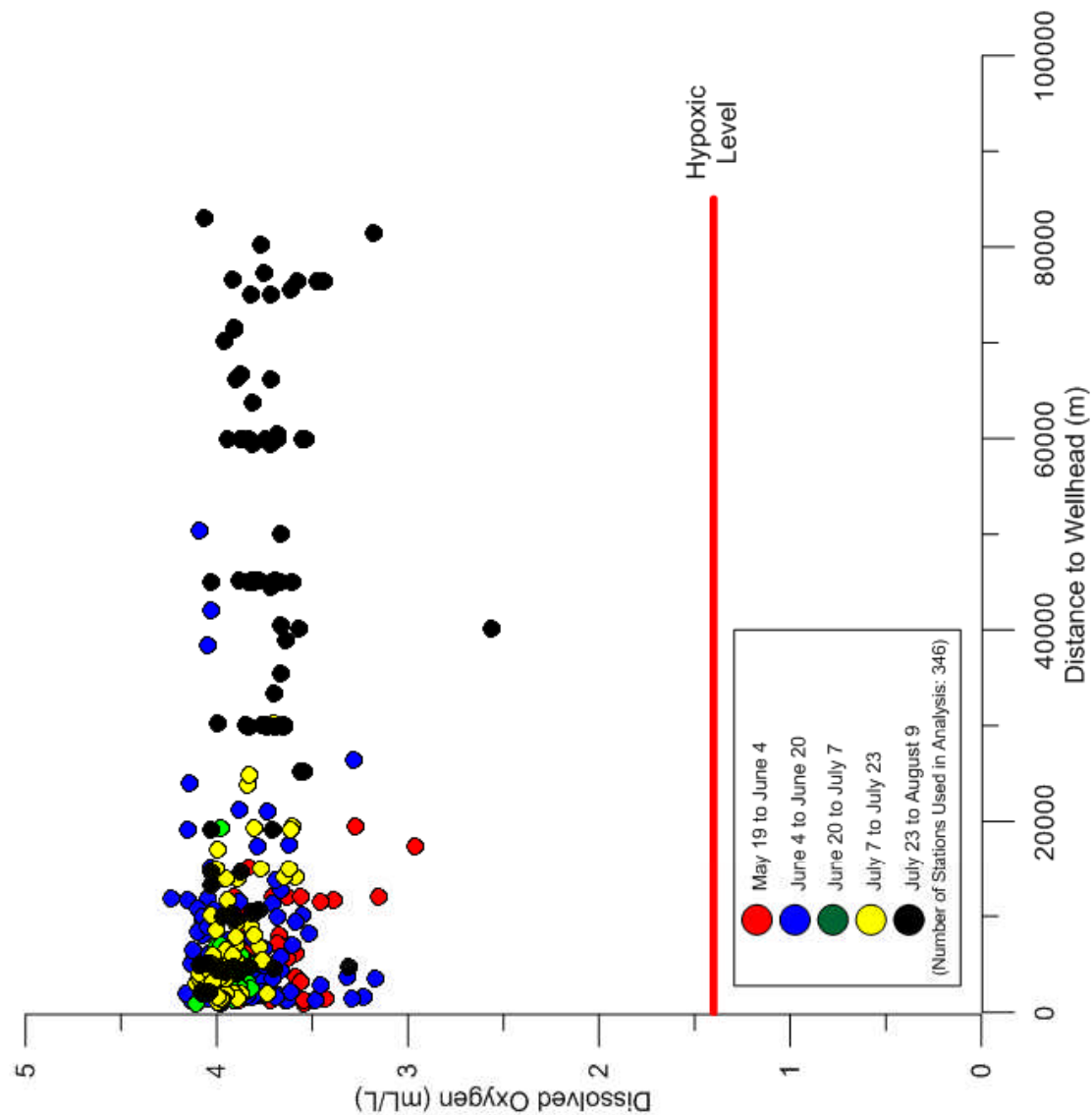
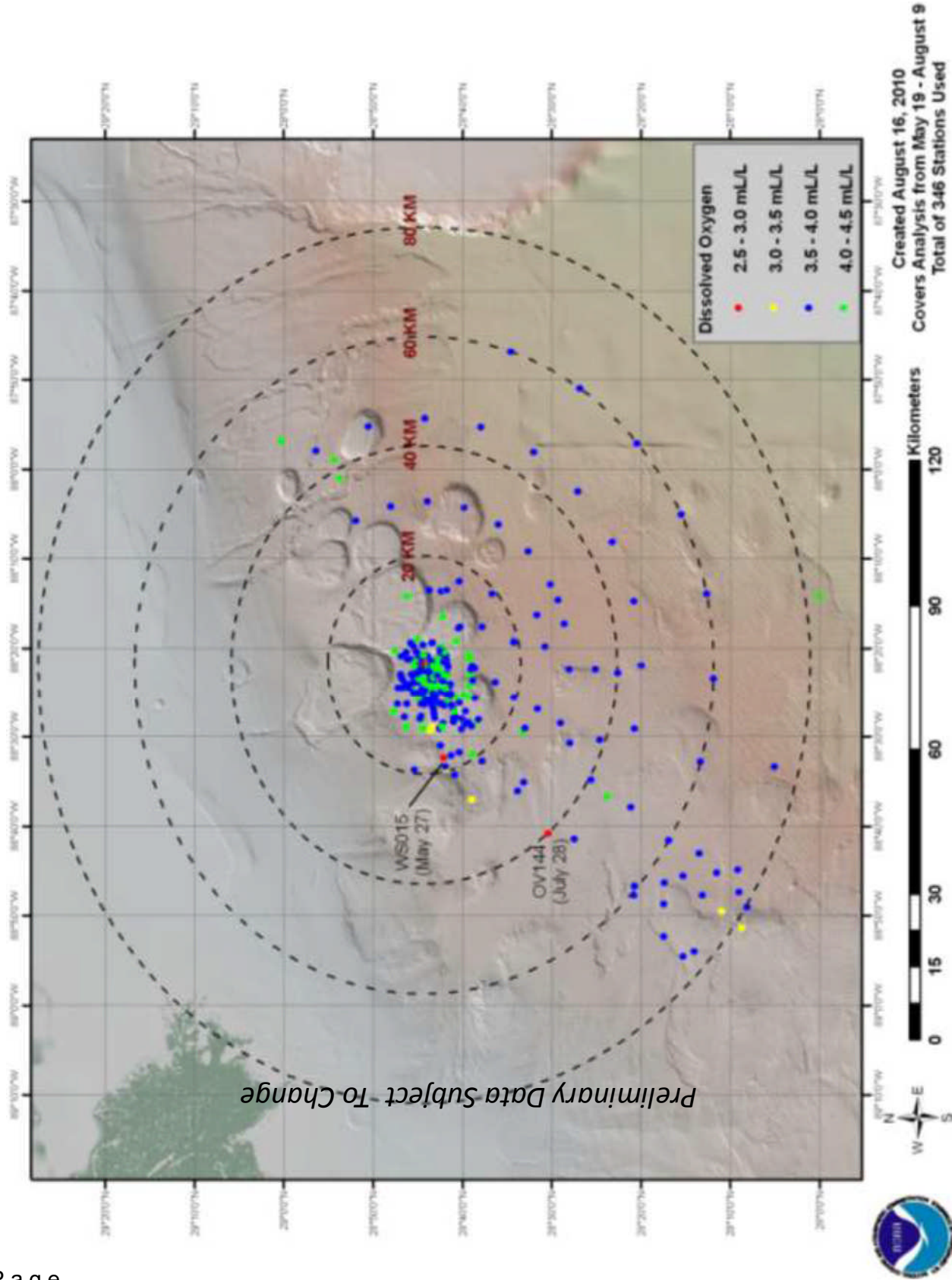


Figure 44. Minimum SBE 43 DO₂ between 1000 and 1300 m as a function of distance from the wellhead and date as compared to the level at which hypoxic conditions are considered to occur.



Map 3. Minimum SBE 43 DO₂ values measured between 1000- and 1300-m depth in relation to location.



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