Submesoscale Dynamics in the South China Sea
Cruise Report - RR1306
R/V Roger Revelle, 18-27 May 2013

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1. Objectives

This effort was intended as a pilot for future investigations of submesoscale dynamics and their role in the energy cascade in the Kuroshio-influenced northeastern South China Sea. Specific objectives for this cruise included:

- Characterize the dominant spatial and temporal scales and how they vary as a function of bathymetry and distance from Luzon Strait (Kuroshio influence).
- Identify areas of elevated mesoscale and submeoscale variability to inform upcoming experiments.
- Characterize the internal tide and develop approaches for internal wave and submesoscale variability.

2. Cruise Plan

- Conduct 36h repeat UCTD surveys, followed by 12h VMP sections, along lines r3, r4 and r2.
- Deploy two gliders (Jane and Husker) at r3, recover at end of cruise.
- Recover moorings m1 and m2 near end of cruise.

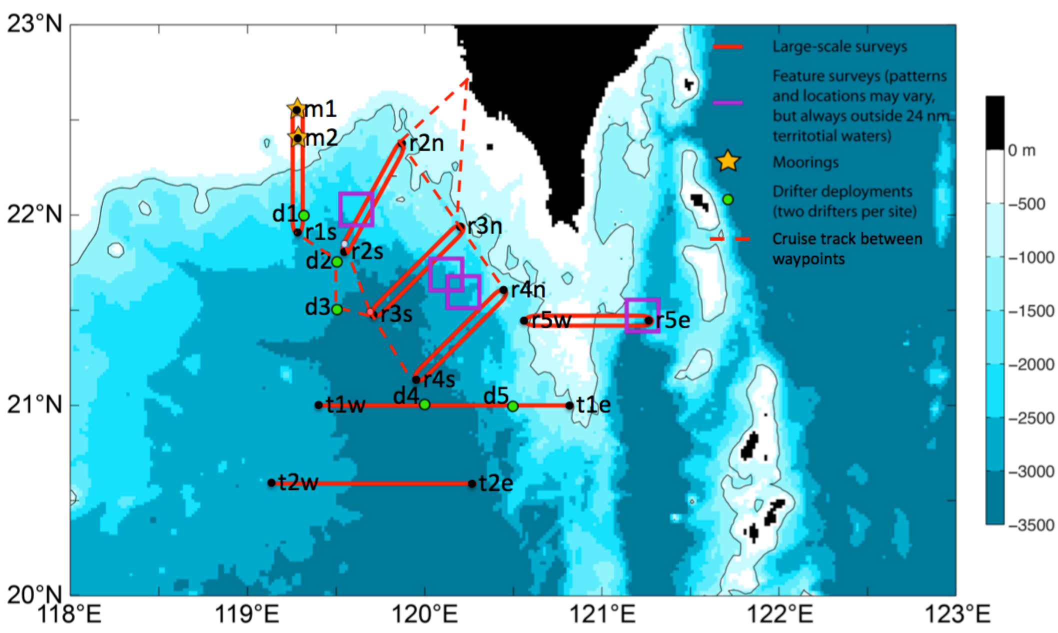


Figure 1. *Planned sampling activities. Red lines mark survey tracks, with labels indicating waypoints. Green dots mark drifter launch positions (leg 1) and yellow stars indicate mooring positions. Purple squares mark areas for intensive surveys, which were not occupied due to time limitations.*

18 May

16:00	depart Kaosiung, transit to r3n
22:00	begin r3 UCTD survey (36 h)

19 May

~08:00	break r3 UCTD survey
	glider deployment (Jane & Husker)
~10:00	resume r3 UCTD survey

20 May

16:00	end r3 UCTD survey
	begin r3 VMP survey

21 May

04:00	end r3 VMP survey
	transit to r4 (N or S, whichever is closest)
08:00	begin r4 UCTD survey

22 May

20:00	end r4 UCTD survey
	begin r4 VMP survey

23 May

08:00	end r4 VMP survey
	transit to r2
16:00	begin r2 UCTD survey

24 May

all day	continue r2 UCTD survey

25 May

04:00	end r2 UCTD survey
	begin r2 VMP survey
16:00	end r2 VMP survey
	transit to m1
20:00	begin mooring recoveries (daylight needed?)

26 May

10:00	end mooring recoveries
	transit to gliders
16:00	arrive at gliders, recover
	possible VMP profiling at r3 to fill remaining time
	transit to Kaohsiung

27 May

08:00 return Kaohsiung

3. Operations Summary

Favorable weather extended through the entire cruise, allowing efficient operations and fast transits between sampling sites. As a result, additional measurements were collected along a re-defined section R1, and in a short, second occupation of R3.

18 May

Depart Kaosiung
UCTD test on transit between r2n and r3n
R3 UCTD survey

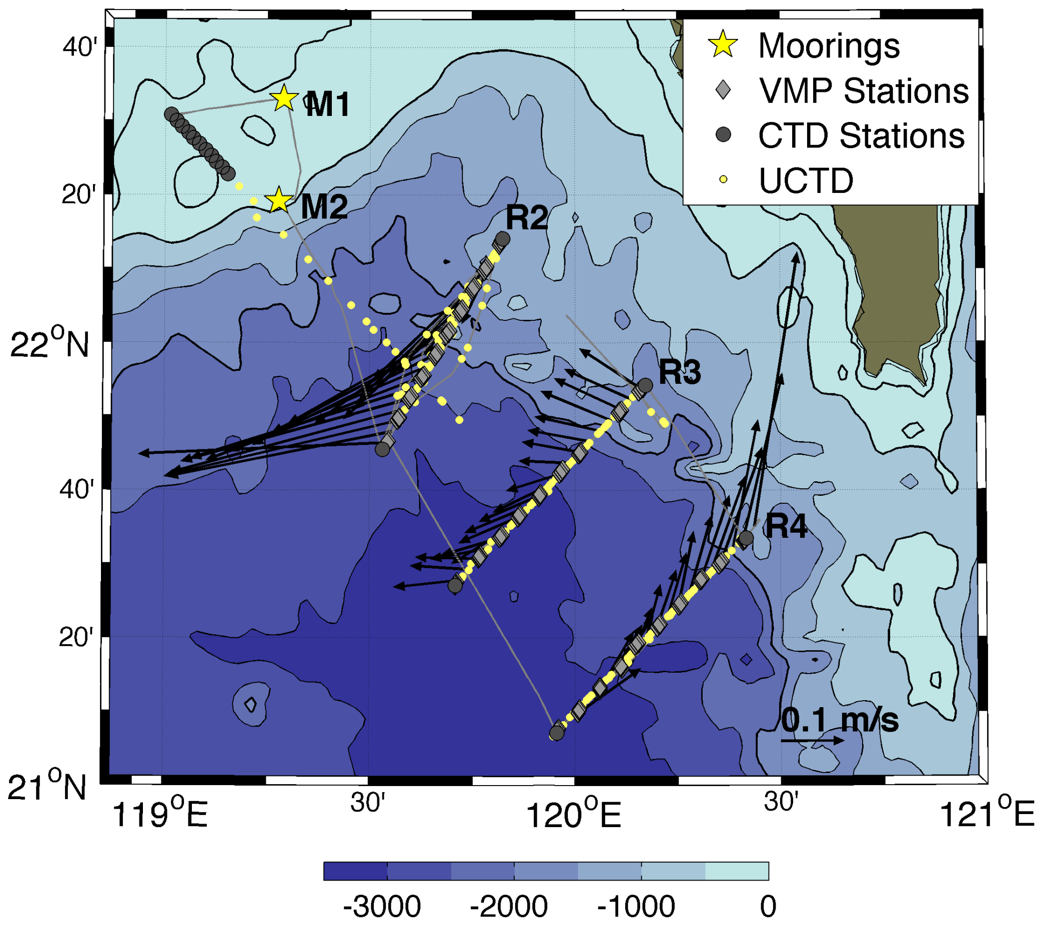


Figure 2. *Cruise track for RR1306. Yellow dot marked repeat UCTD survey lines (36 hours for R2, R3 and R4, 24 hours for the NW-SE line, designated 'R0'). Vectors mark depth-average (0-200 m) velocities, time-averaged over the entire ~48-hour occupation of each line. Note the scale vector in the lower right corner.*

19 May

R3 UCTD survey
Deploy gliders Husker and Jane

20 May

R3 UCTD survey
R3 VMP survey
R4 UCTD survey

21 May

R4 UCTD survey

22 May

R4 UCTD survey
R4 VMP survey

23 May

R2 UCTD survey

24 May

R2 UCTD survey
R2 VMP survey

25 May

R2 VMP survey
Recover moorings M2 and M1
R1 survey, starting at NW end using CTD
New R1 coordinates:
r1n-2: 22° 30.8 N, 119° 0.9 E
r1s-2: 21° 49.8 N, 119° 42.0 E

26 May

R1 CTD/UCTD survey
Recover gliders Husker and Jane
Second UCTD occupation of R3 (approximately 8 hours)

27 May

Return Kaohsiung

4. Narrative

Time in local unless otherwise specified.

18 May 2013

The sole UCTD probe to return from Leg 1 appears to have a cracked conductivity cell. Cell shows flex and there's a crackling when it is touched. Windows laptop brought for UCTD unstable with Bluetooth adapter installed. Shift to another machine for probe download. Otherwise UCTD build-out proceeds well.

Glider and MVP prep nearly complete. Targeting glider deployments post-breakfast on 19 May.

Plan to steam to r2n, then deploy UCTD for testing and training on the transit to r3n. Begin science operations once testing complete.

We spool spectra onto the UCTD drum on the transit from Kaohsiung to r2n by paying out most of the line with a few shackles fixed to the end for tensioning. At the end of the spooling operation, the winch clutch refuses to disengage, such that the drum will no longer free-spool. Attempts to fix this fail. We swap out our winch unit for WHOI's, only to find that the power connectors are incompatible (our UCTD uses an ungrounded, 2-pin plug, WHOI's a grounded, 3-pin), and that we do not have the power cable for the WHOI unit. Bulkhead connectors are epoxied into the housing bodies, and cannot be easily swapped. Clutch is also difficult to swap. After noticing that the 3-pin connector is configured identically to the 2-pin connector (but with the added pin), we decide to remove the third pin from the WHOI bulkhead to allow the 2-pin power cable to work. This also requires a little rewiring inside the winch box. We also have to swap mounting brackets for the deployment arm, as the APL unit's arm is incompatible with the WHOI unit's bracket. After this, we are able to drop the modified WHOI UCTD winch onto the stand and get to work.

Begin R3 survey at ~00:00. Set SOG at 8 knots to minimize stress on the system.

<u>19 May 2013</u>

UCTD work continues. Complete first pass of R3 survey at ~05:00. Set drop time to 140 seconds, which yields profiles to > 200m.

One cast (30 min of tow-yow) that returned no data. Speculation that this is due to the magnet being removed in a way that shut the probe off again.

We've been streaming at ~8 knots, profiling to ~200 m. This yields roughly 1 profile every 10 minutes, for 2.4 km horizontal resolution.

First section shows relatively gentle gradients, suggesting that 2.5 km resolution is adequate, and that we could space the profiles out further, if necessary for operational reasons.

Some odd 'noise' in the data- periods of rapid oscillation. Uncertain of cause.

Reterminate UCTD line at 06:00, Slight fraying on the loop, though uncertain if this was created in the process of separating the termination loop from the probe. We do not have enough high-strength leader to allow retermination every 6 hours, so we are going to try to stretch this timetable. Will check termination at 6, 8, 10 and 12 hours, with the target of reterminating every 12h, at the change of the watch.

Another data dropout- this time collecting ~10 scans and then quitting. Further tests suggest that failure to initiate logging occurs when the probe is still connected via Bluetooth when the magnet is removed. New protocol:

(1) close Bluetooth connection in software from the download computer, (2) remove magnet, (3) try to reconnect Bluetooth- should fail if probe is logging. This allows us to check comms (if it communicates, it is not logging data, so no communication is interpreted as logging) prior to deployment.

Glider Jane (OSU) and Husker (WHOI) deployed at ~13:00. Jane over the side, Husker using the RHIB. Revelle remains on site until both glider operators have assessed system health.

Continue R3 UCTD survey.

Depth range decreases toward the end of the night. No significant changes in background currents. It appears that the winch is seeing increased friction when free-spooling. Investigations during the down period (VMP survey) show that this is caused by brake shoe dust accumulating around the pads. Once enough accumulates, this creates friction even when brakes are open. Once the system is cleaned, the spool spins freely. Add brake cleaning to the 36-h maintenance routine.

<u>20 May 2013</u>

Finish a 36-hour occupation of R3 around noon. We've completed repeats of the section.

Section plots reveal that probe 0136 developed a temperature sensor drift, likely beginning sometime in the evening of 19 May. The signature first manifests as a seam in the salinity section plots, but the root cause is a temperature drift in 0136.

Conduct a 500-m CTD cast at the end of the line to provide calibration data for UCTD and VMP. Cast uses Revelle's new handling system, eliminating the need for science to assist with CTD overboarding. Transmissometer does not function during this cast- it appears to have a strong temperature dependence. Switch to secondary unit- Wayne is investigating.

Begin 12-hour VMP section across R3, conducted as discrete stations, with 3 profiles taken at each point. Profiles initially range to 150 m. Skip on station due to the presence of a longline float and uncertainty about what might be stretched out around it. Instead, the time is used to extended profile depth to 200 m for the final two VMP sites.

End the VMP section with another CTD cast.

UCTD refurbishment conducted during VMP operations. Winch opened and cleaned, removing brake dust and easing the rotation of the spool. Both probes inspected (no visual signs of damage), flushed with water and Triton-X. We conduct test casts of 0135 and 0136 on the transit between R3 and R4. Probe 0136 has degraded, and now shows a 5°C offset from 0035. Cannot determine root cause of this problem, but retire 0036 in favor of 0002.

Transit to R4 and begin UCTD survey.

21 May 2013

Probe 002 damaged overnight- conductivity cell appears to be cracked at one end, and nose cone shows signs of trauma (damage that looks like it came from a drop or a collision). This was caught quickly, as the watch standers were assessing data quality and could see the offset. Probe was retired and our last spare, 010, was brought into play. We are now down to two working probes, 035, which has been in use since the start of the cruise, and 010.

Continue R4 UCTD survey.

22 May 2013

Continue R4 survey, followed by CTD cast and the MVP section.

At the second MVP station, cable gets caught and torn on the sheave cheek, forcing retermination. This goes quickly, causing only an hour delay. Alter operation to ensure that the initial lift occurs when VMP is directly under the block, rather than off to the side.

23 May 2013

Transit to R2 to begin UCTD survey

At ~11:00, probe 010 is deployed without dummy plugs on its connectors. Alejandra spotted the missing the error while the first profile was being executed, and the probe was recovered immediately. Pins show clear signs of corrosion. Clean with Electrowash and connect via Bluetooth. Probe communicates. Battery voltage normal (4.1V) and data stream does not show the noise we expected. We will continue using this probe.

Subsurface currents directed offshore parallel to the orientation of the R2 line. Uncertain of what drives this, and would like to have sections oriented perpendicular to the existing R2 line. Complete R2 surveys as planned, but plot out a perpendicular section that originates west of the mooring sites, to be occupied following mooring recoveries on 25 May.

24 May 2013

Complete R2 survey at ~22:00, followed by CTD cast and R2 VMP section.

25 May 2013

Finish R2 VMP at ~09:00, followed by a CTD cast at the northern end of the line. Transit to mooring M2, arriving at noon.

Radiometer drift.

Recover M2. Mooring shows significant gooseneck barnacle growth on mooring line and instruments, despite the relatively short (3-week) deployment. Winch level wind is stiff, and winch gives off an odd, acrid odor toward the end of the operation.

Recover M1. First pass lines up well, but approach is rapid and we miss the hook. Second pass is perfect. Similar levels of growth, but oddly, very little on the upward-looking ADCP cage. No issues with the TSE. Smell may have been burn-off after a long storage period.

Transit slightly west to the new R1, retargeted to cross the strong currents seen in R2. Begin on the shallow shelf using Revelle's CTD, to avoid risking the two remaining UCTD probes. Execute a series of casts, spaced at 2-km intervals, to within 10 m of the bottom. We reach the 150 m isobath at roughly 00:30, when problems with the CTD handling system (perhaps related to a series of bad warps deeper on the drum) and waning time motivate us to switch back to the UCTD. This allows us to progress more rapidly down the survey line while maintaining horizontal resolution, but prevents us from sampling close to the bottom.

26 May 2013

Finish the first pass along R1 and turn northward for a second occupation. Run the second occupation north until 10:30, as late as possible while still leaving sufficient time to ensure daylight glider recoveries. The second occupation extends northward far enough to see the currents reverse, but falls short of reaching the slope and shelf.

Recover Husker using the RHIB, and then Jane.

Begin reoccupation of R3 at roughly 16:00. Continue until 00:30, at which point we break off to steam for Kaohsiung.

5. UCTD / VMP Surveys

Lines R3, R4 and R2 (Fig. 2) were each sampled over 48-hour spans, consisting of rapidly-repeated (4-5 hour) occupations with the UCTD and shipboard underway systems, followed by a 12-hour, multiple station section sampled using the VMP.

Line R1 was modified to run roughly perpendicular to R2, partially in response to westward and southwestward mean currents observed across R2. Sampling over the shallow shelf was restricted to the conventional CTD, as the UCTD lacks the ability to sense the bottom. This resulted in the shallow region being sampled more slowly, with the UCTD employed as the waters deepened. Time constraints allowed

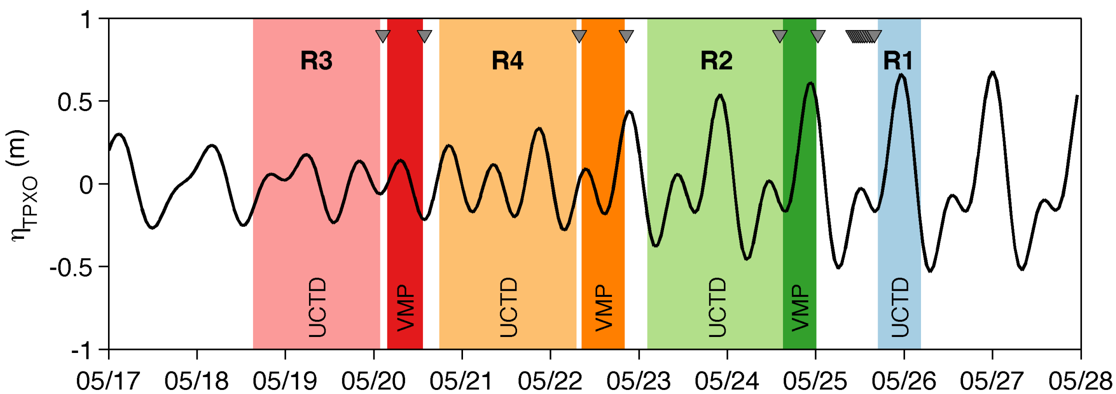


Figure 3. *Tidal displacement from TPXO. Colored bars mark UCTD (light) and VMP (dark) survey periods, with grey triangles marking the timing of CTD casts.*

only a single occupation of the full section, with two additional repeats of the deeper region.

TPXO tidal displacements (Fig. 3) show that R3 was occupied during neap tide, with R2 and R1 sampled during the spring tide and R4 during the transition.

Winds remained weak (Fig. 4) and seas calm throughout the cruise.

Warmer, more saline Kuroshio-influenced waters appear in all sections (Fig. 6; the high-salinity branch that runs along the right boarder, relative to the fresher, cooler South China Sea waters). The separation between Kuroshio and South China Sea watermasses, along with mixing lines between them, is especially clear in θ - S diagrams derived from glider-based profiles (Figs. 25 and 27). Kuroshio waters appear more concentrated in the eastern basin (Fig. 7), with clear signatures even in the northern sections (Fig. 8, R3, R4).

Repeat surveys show 36-h mean currents (Fig. 2) to the north at R4, northwest at R3 and west at R4 (roughly following the bathymetry at R2 and R3).

Individual sections of velocity, potential temperature, salinity and potential density for R1 (Fig. 9), R2 (Figs. 10-13), R3 (Figs. 14-17) and R4 (Figs. 18-22) show prominent isopycnal displacements that may be associated with internal tides or solitary waves. Relatively weak fronts also appear in these sections, along with interleaving that may be the signature of mixing and subduction driven by the strong atmospheric forcing experienced during RR1304, the first leg of this program.

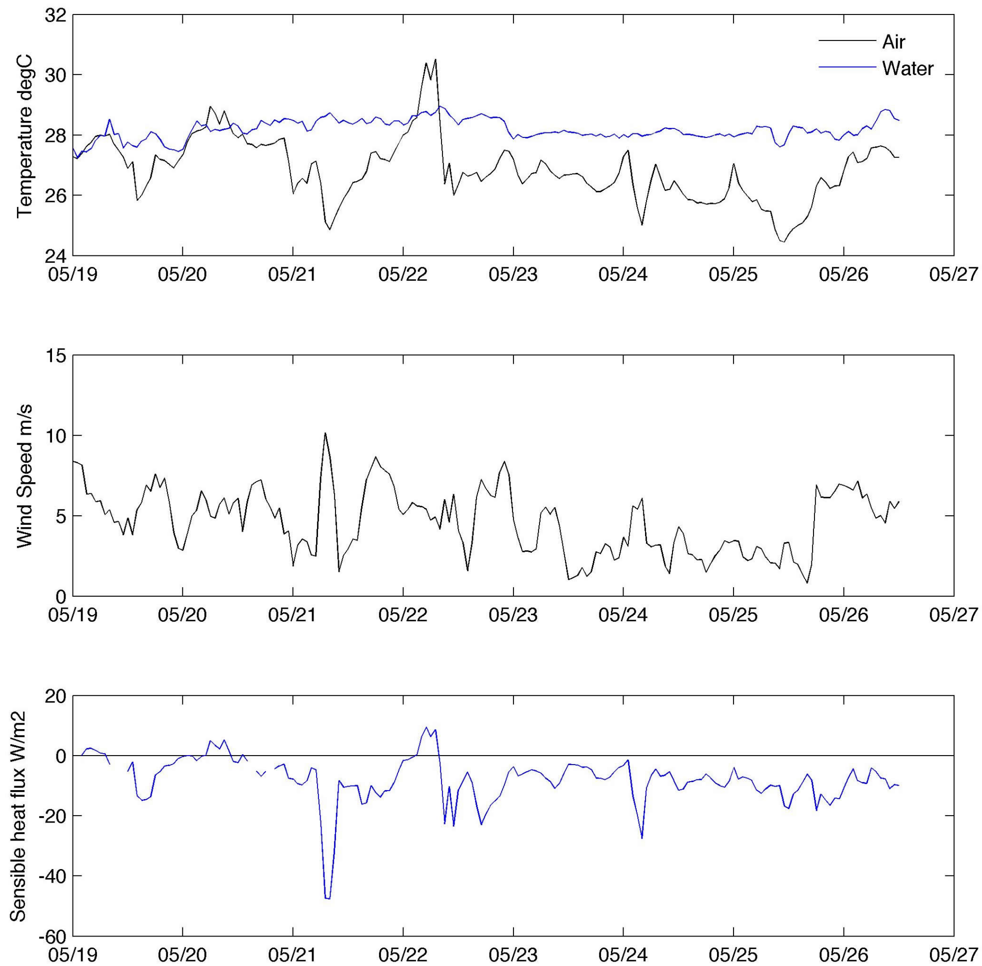


Figure 4. *Temperature (air and sea surface), wind speed and sensible heat flux from R/V Revelle's underway systems.*

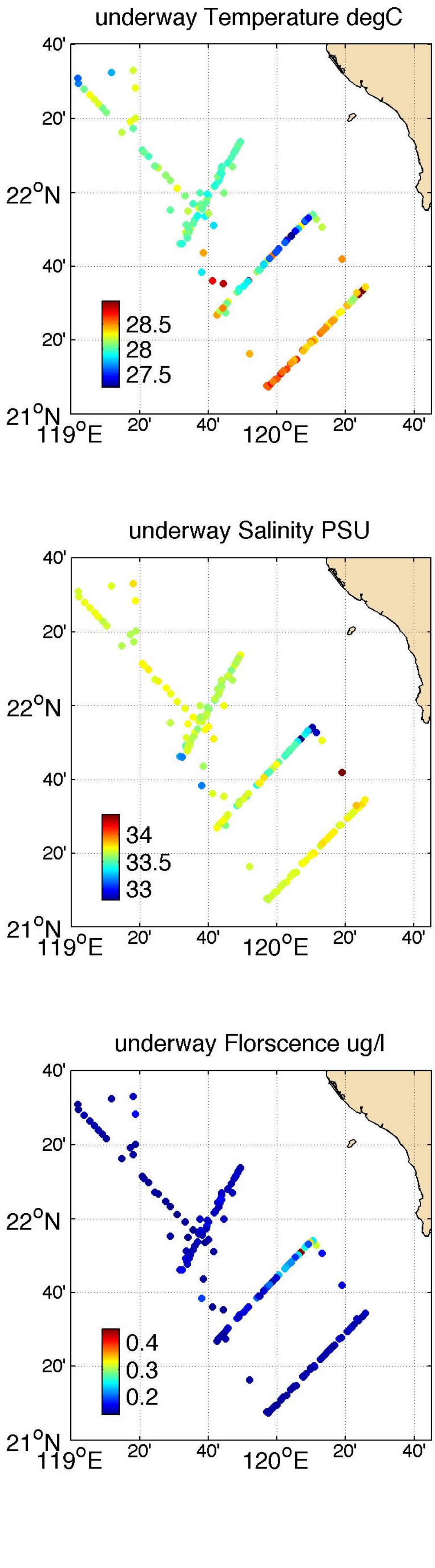
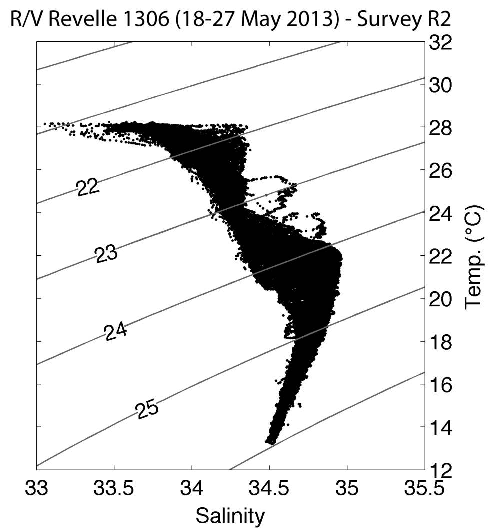
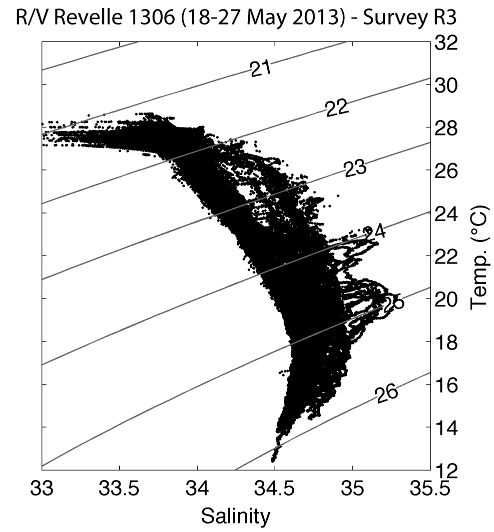


Figure 5. *Temperature and salinity from R/V/ Revelle's underway system and chlorophyll fluorescence from fluorometers operated by W. Slade (Sequoia Scientific). Measurements collected at ~5-m depth) .*





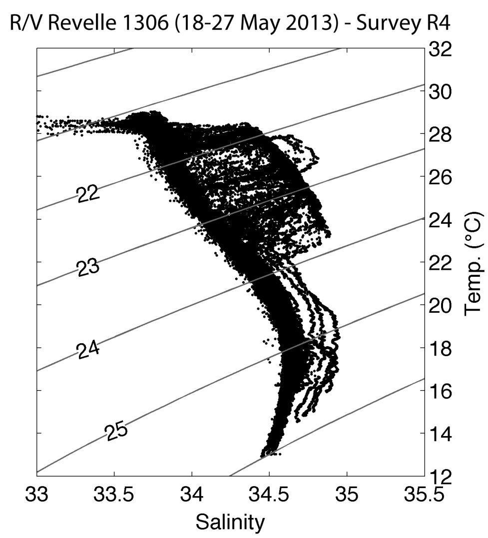


Figure 6. *Potential temperature- salinity diagrams from 36-hour UCTD surveys at R2, R3 and R4.*

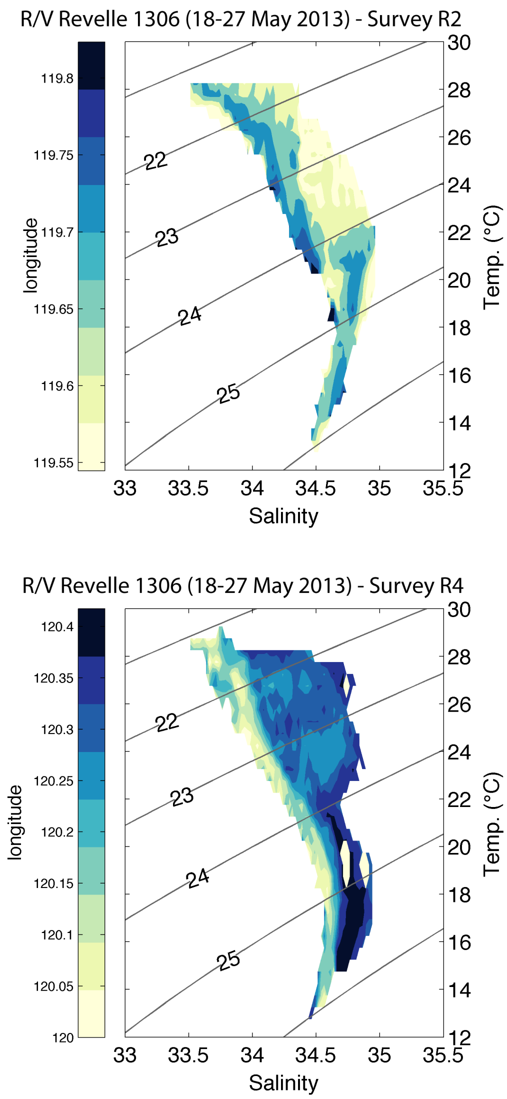
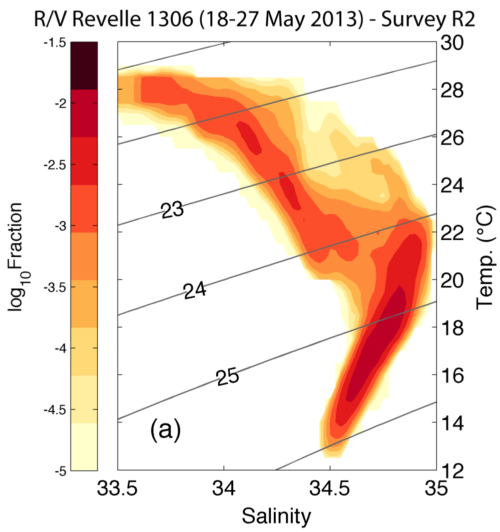
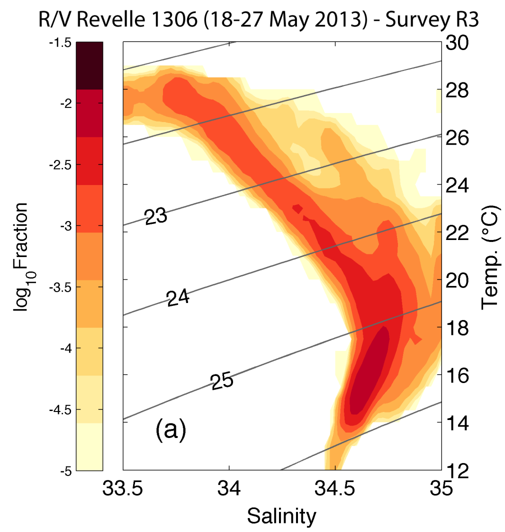


Figure 7. *Potential temperature- salinity diagrams, colored by longitude, from 36-hour UCTD surveys at R2, R3 and R4.*





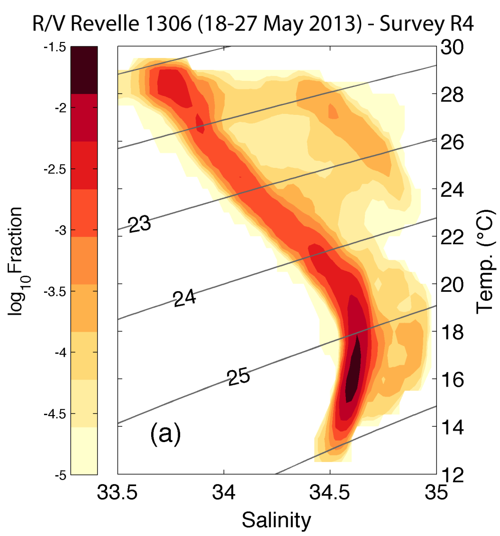
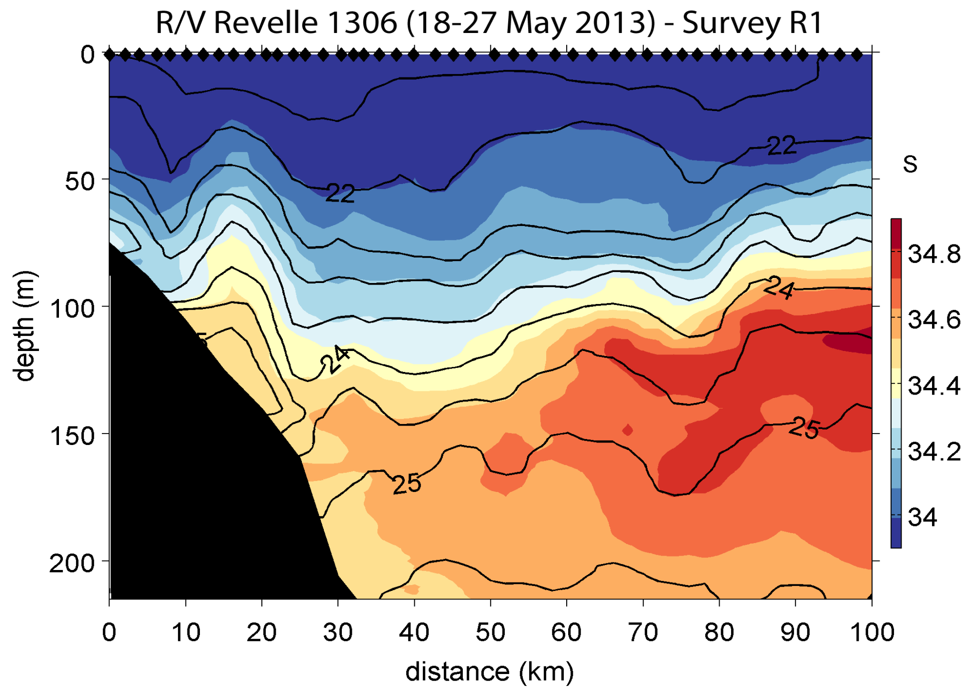


Figure 8. *Potential temperature- salinity diagrams, colored by fraction of observations, from 36-hour UCTD surveys at R2, R3 and R4.*



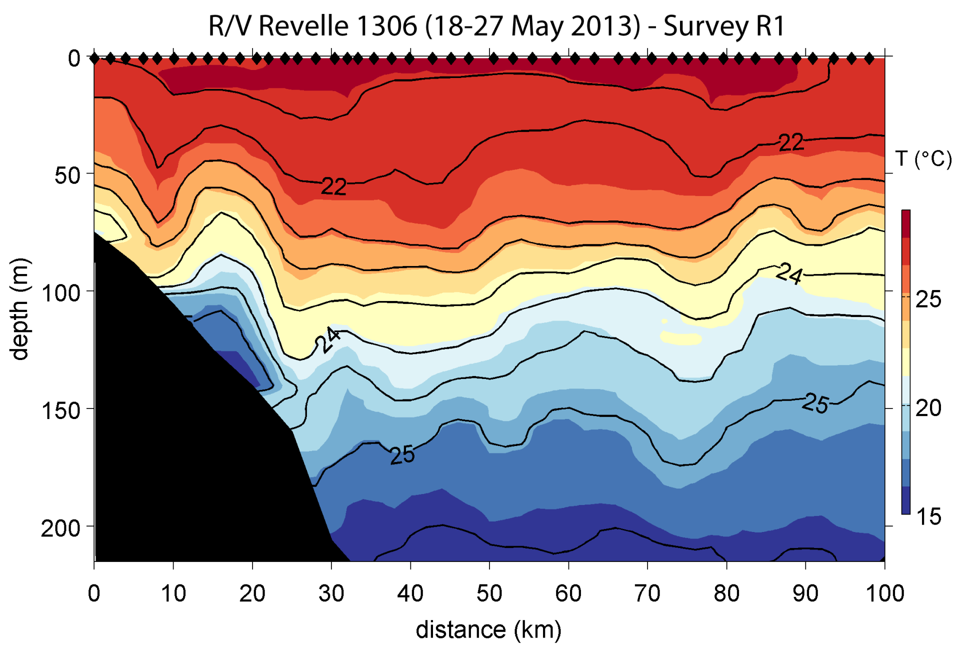


Figure 9. *(top) Salinity (colors), potential density (contours) and (bottom) Temperature (colors) and potential density (contours) for the first occupation of R1, with CTD data extending over the shallow shelf.*

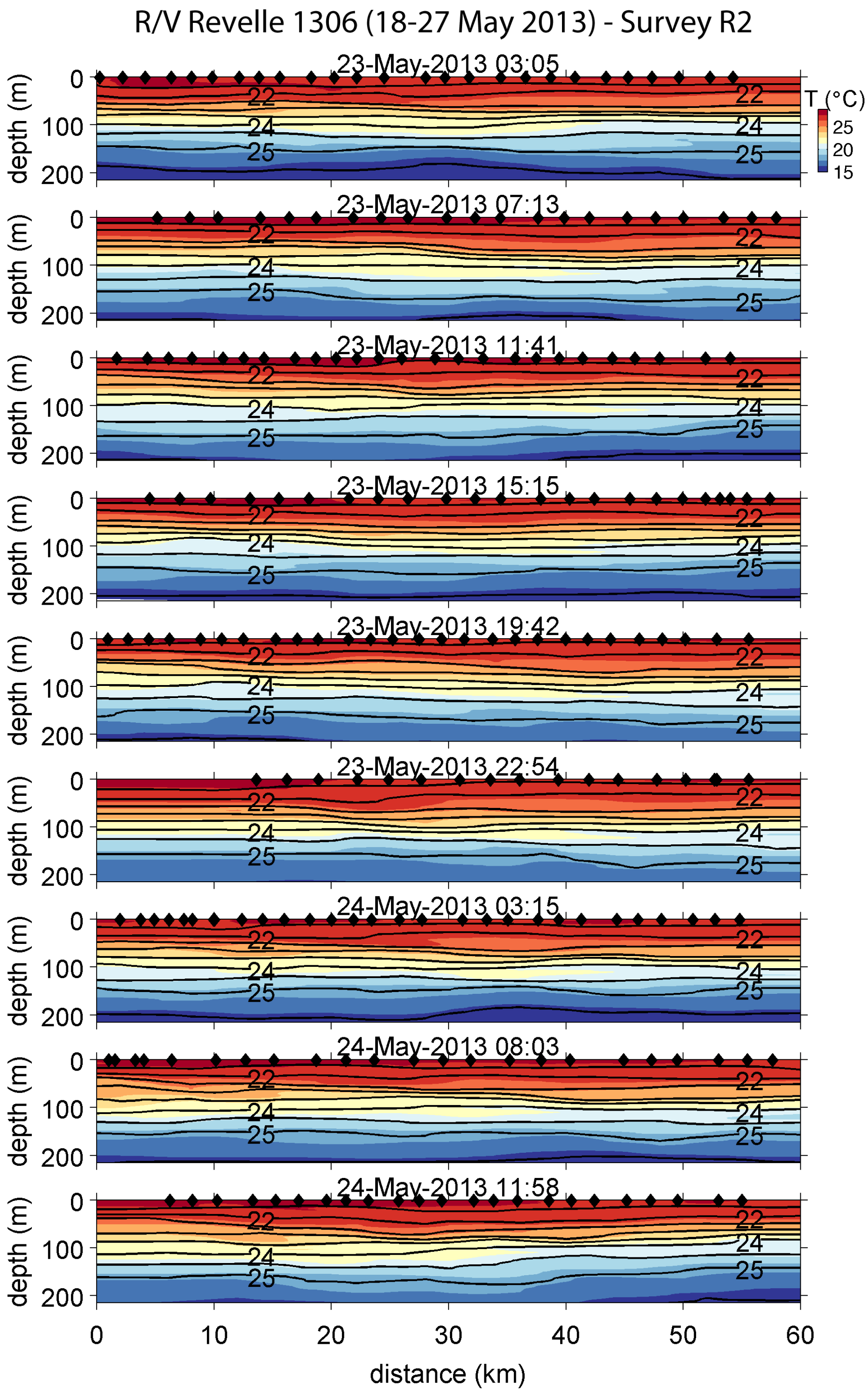


Figure 10. *Temperature (colors) and potential density (contours) for 9 occupations of R2.*

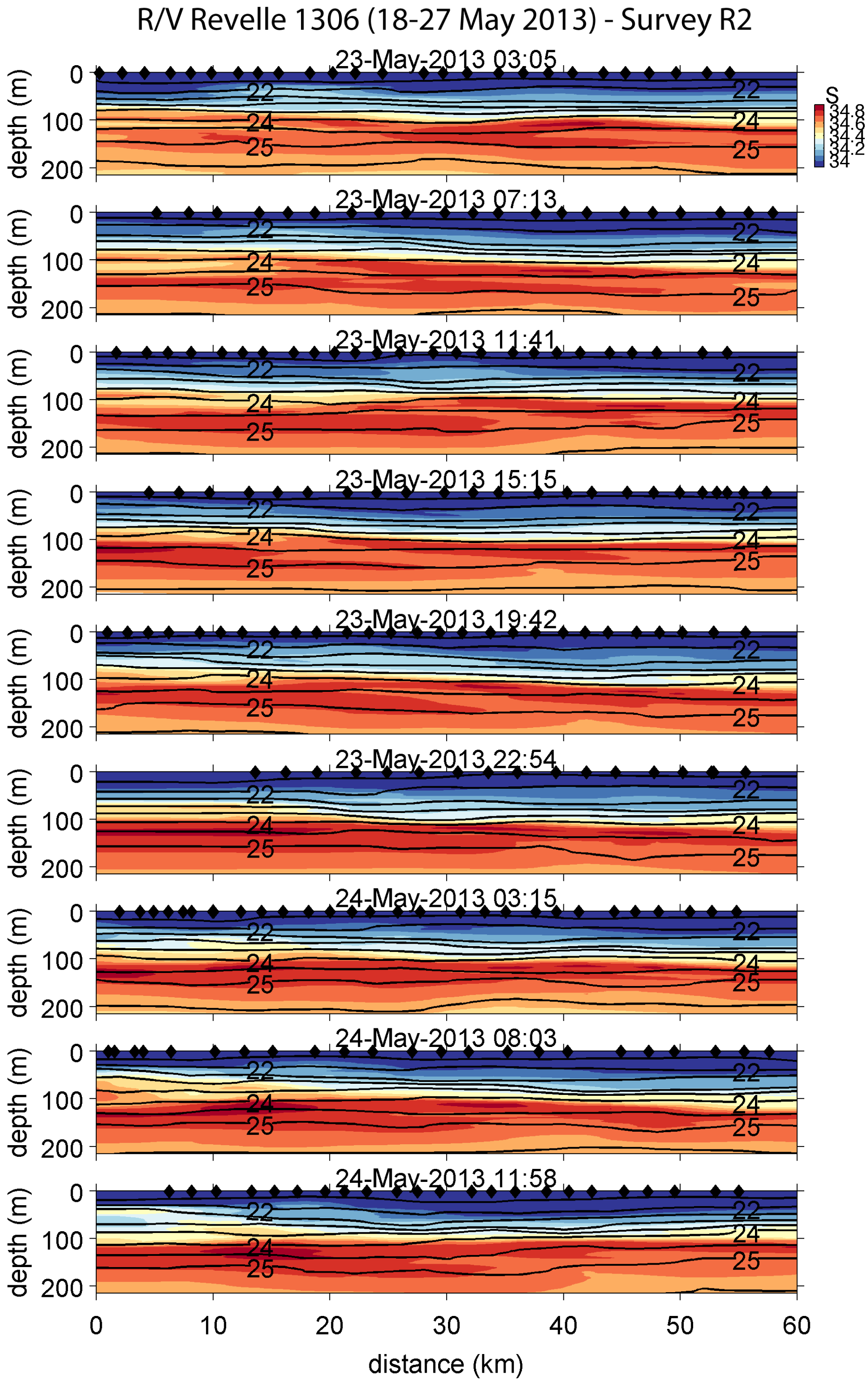


Figure 11. *Salinity (colors) and potential density (contours) for 9 occupations of R2.*

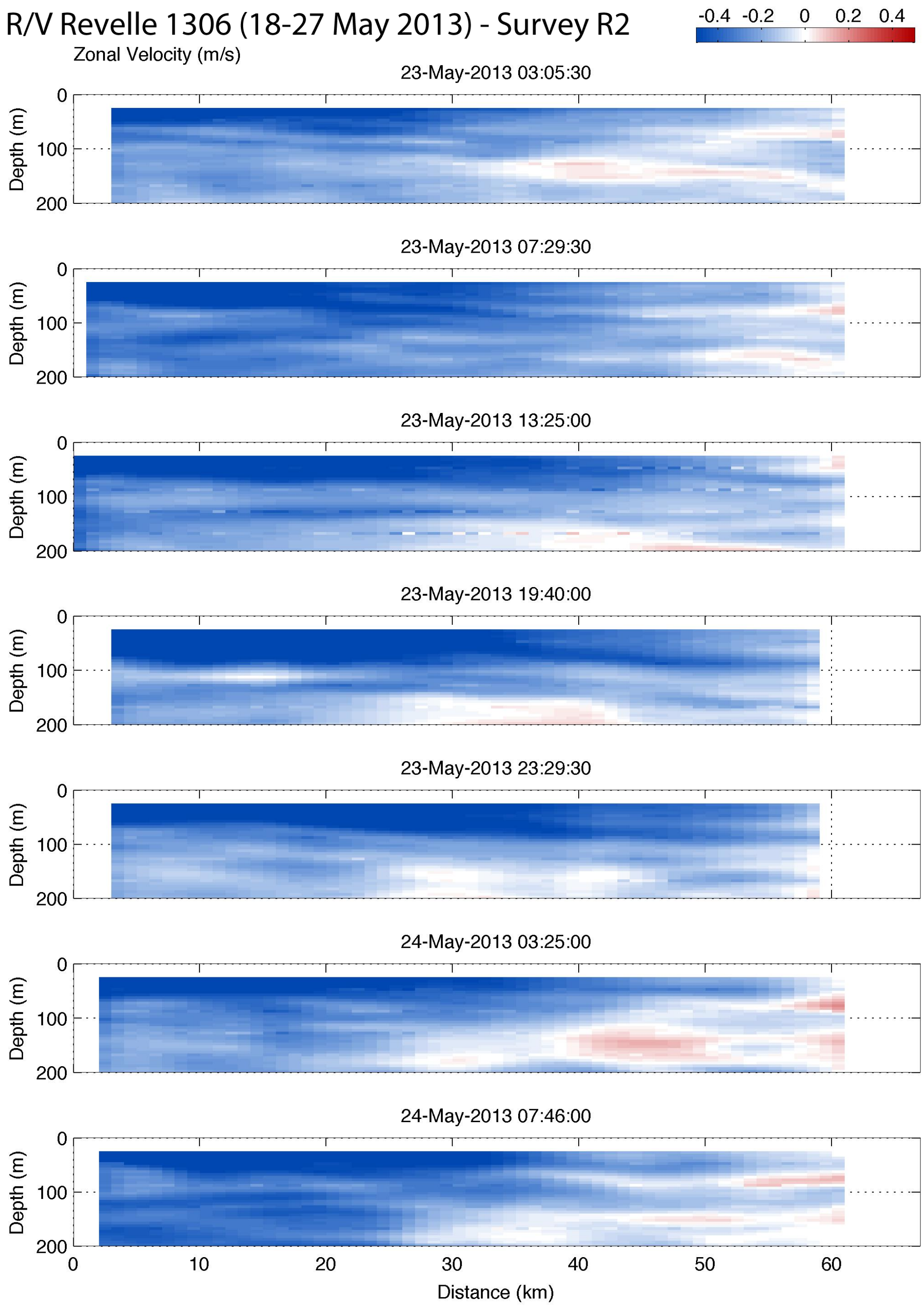


Figure 12. *Eastward velocity for the 7 occupations of line R2.*

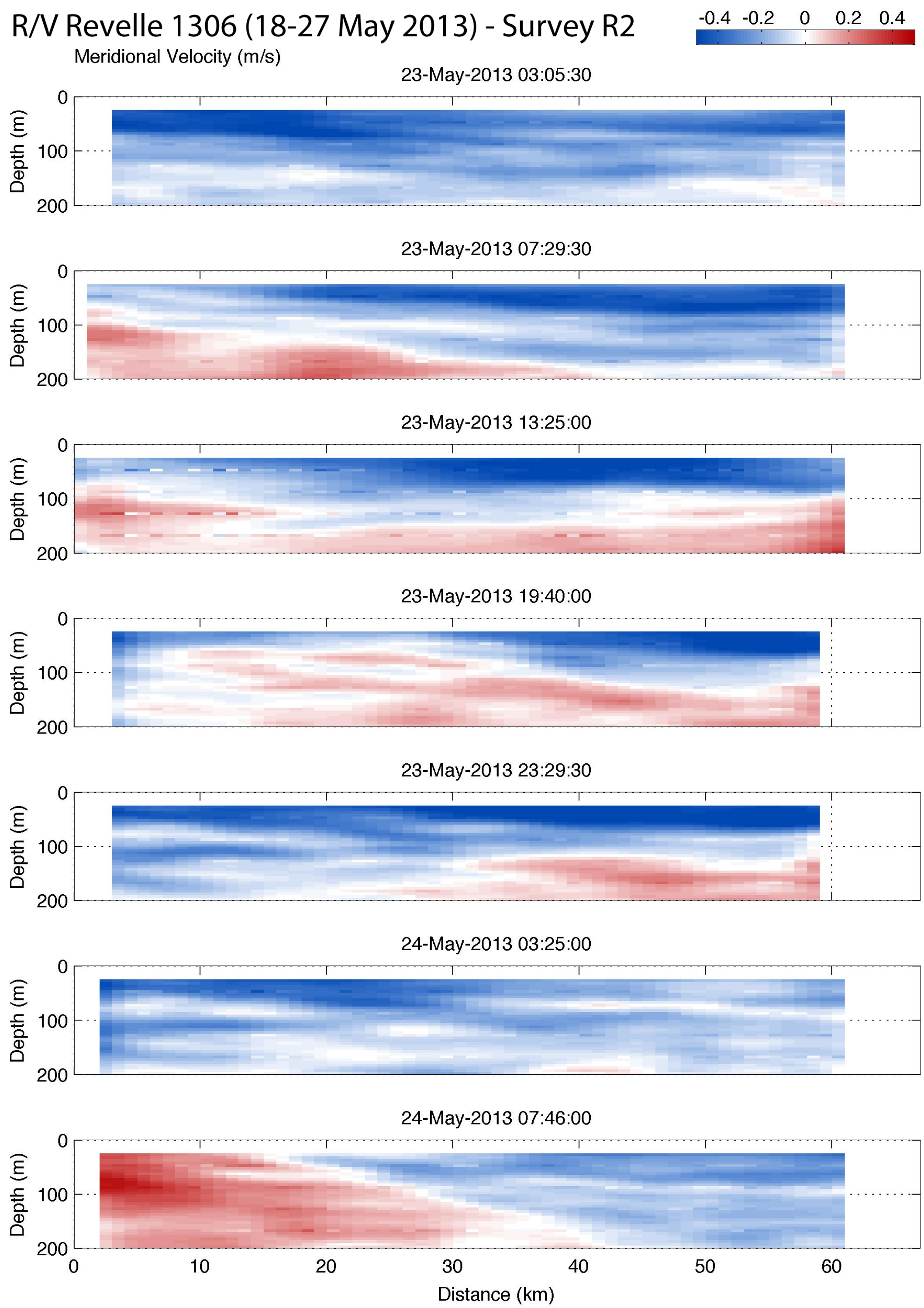


Figure 13. *Northward velocity for 7 occupations of line R2.*

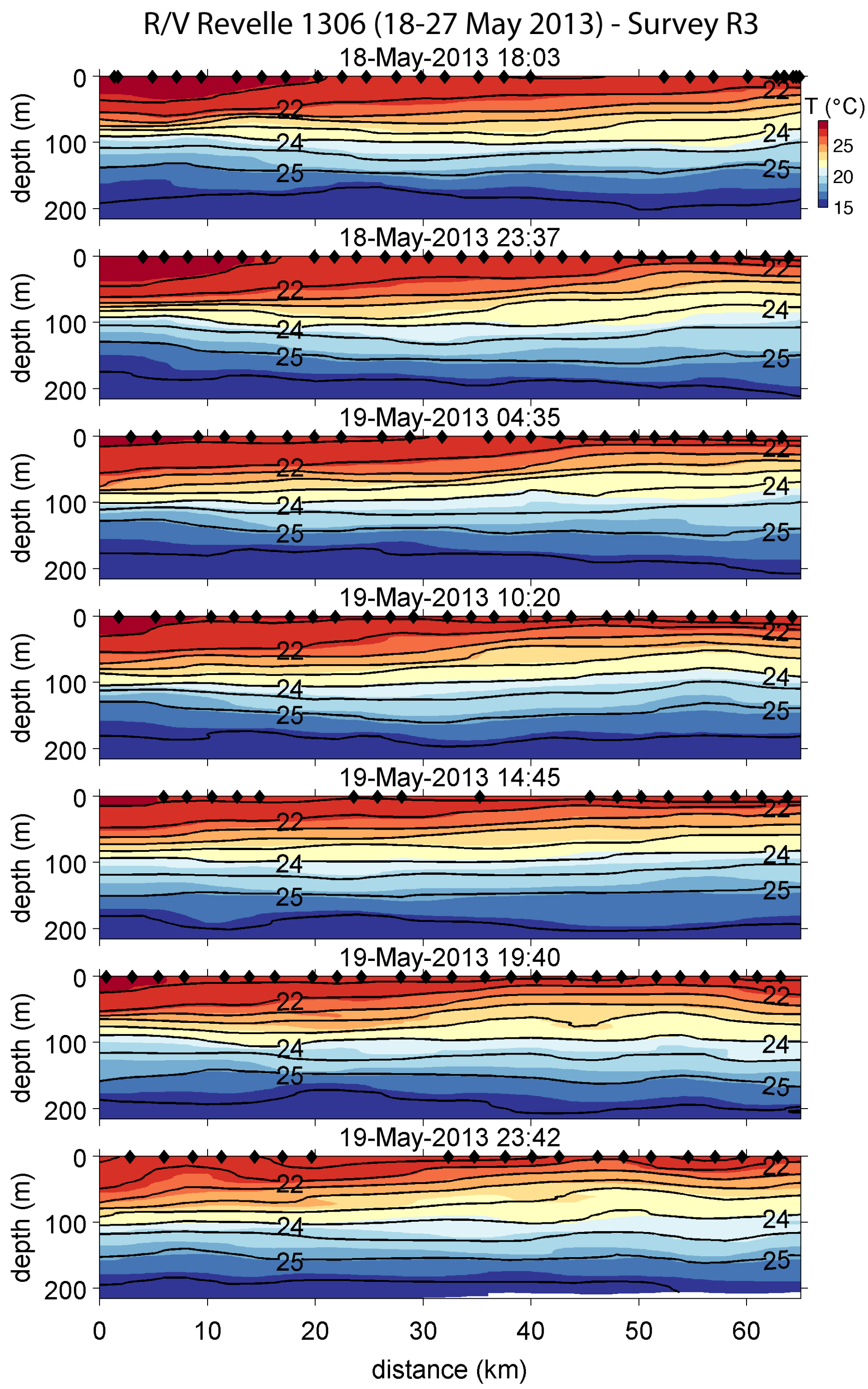


Figure 14. *Temperature (colors) and potential density (contours) for 7 occupations of R3.*

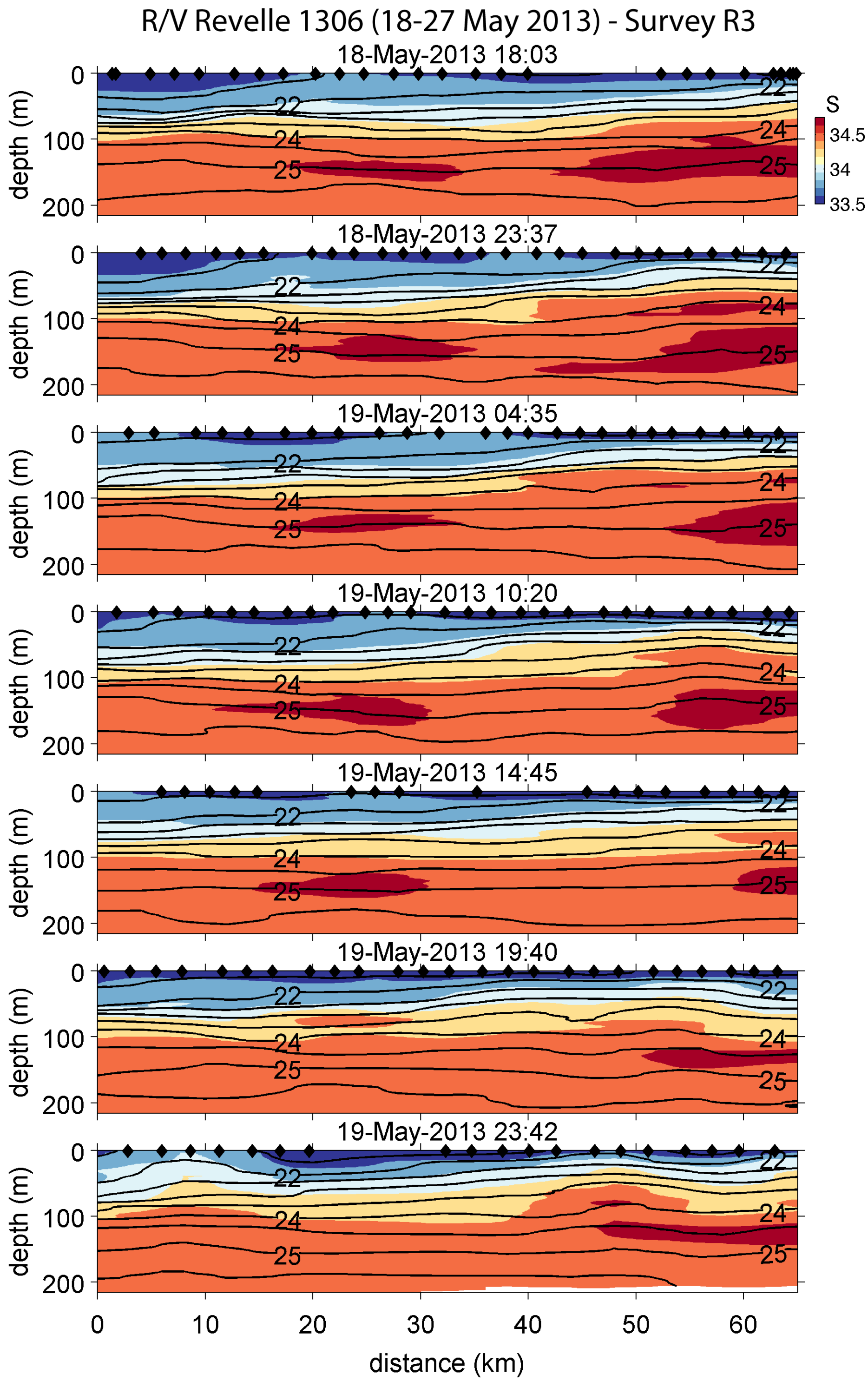


Figure 15. *Salinity (colors) and potential density (contours) for 7 occupations of R3.*

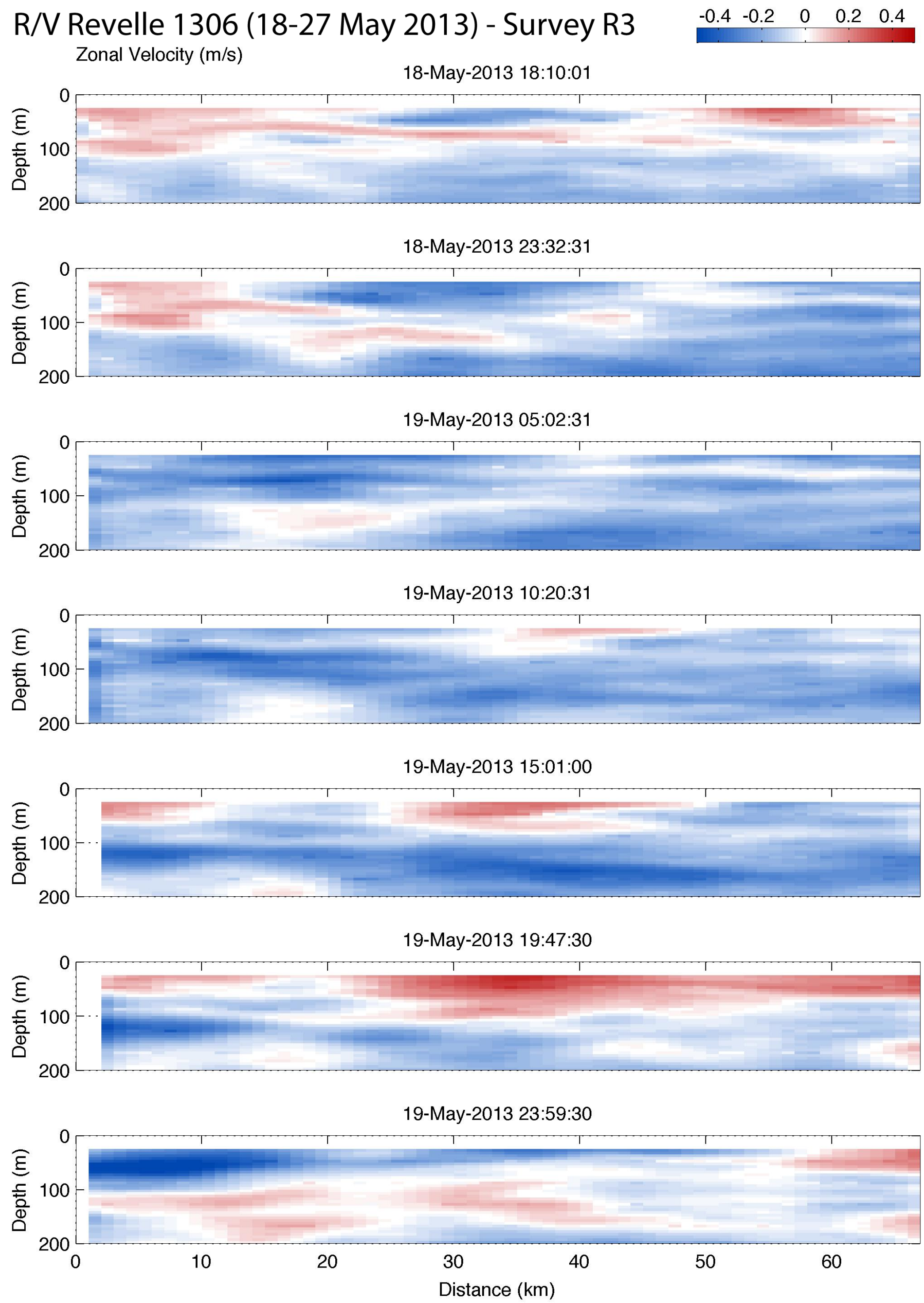


Figure 16. *Eastward velocity for 7 occupations of line R3.*

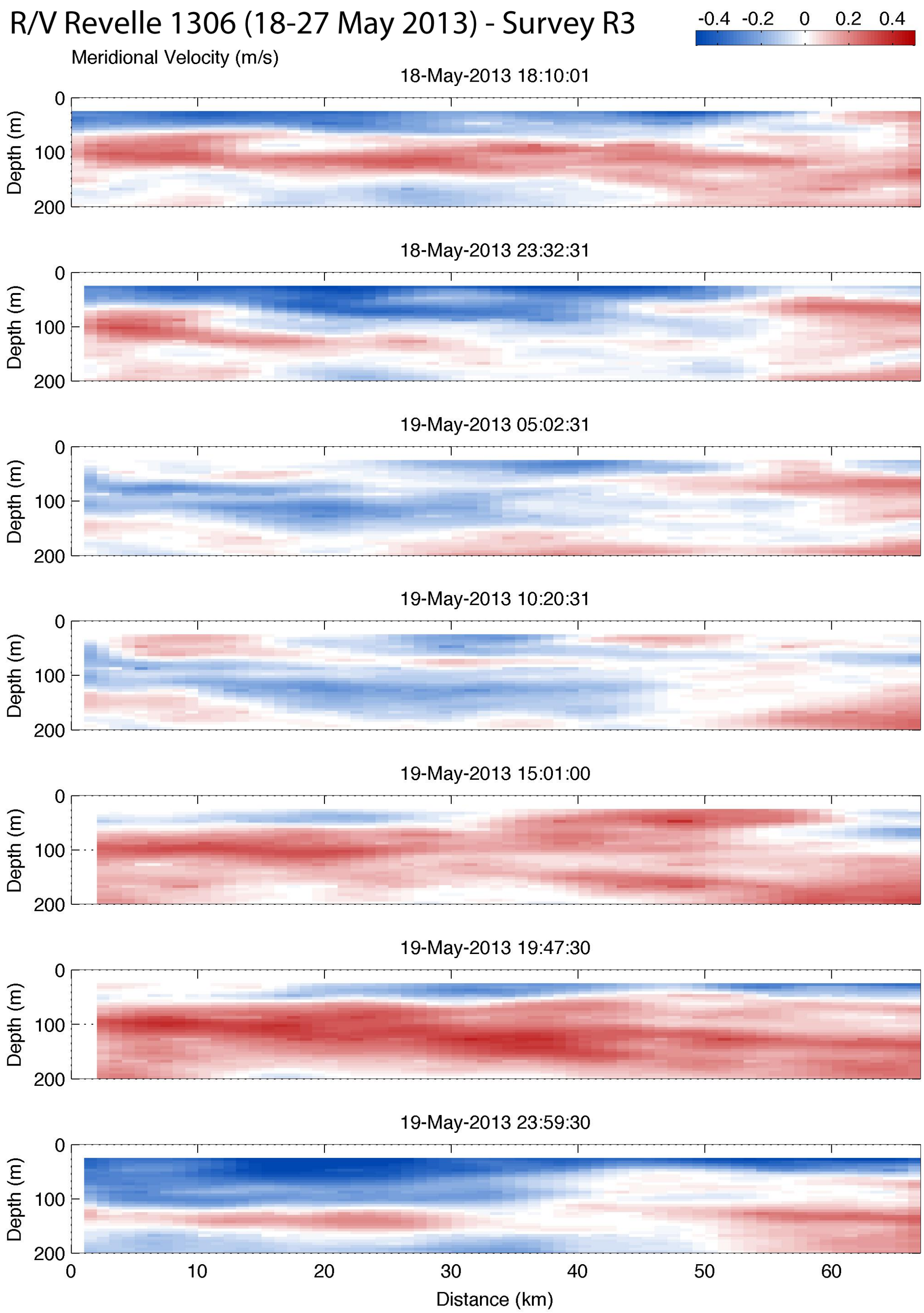


Figure 17. *Northward velocity for the 7 occupations of line R3.*

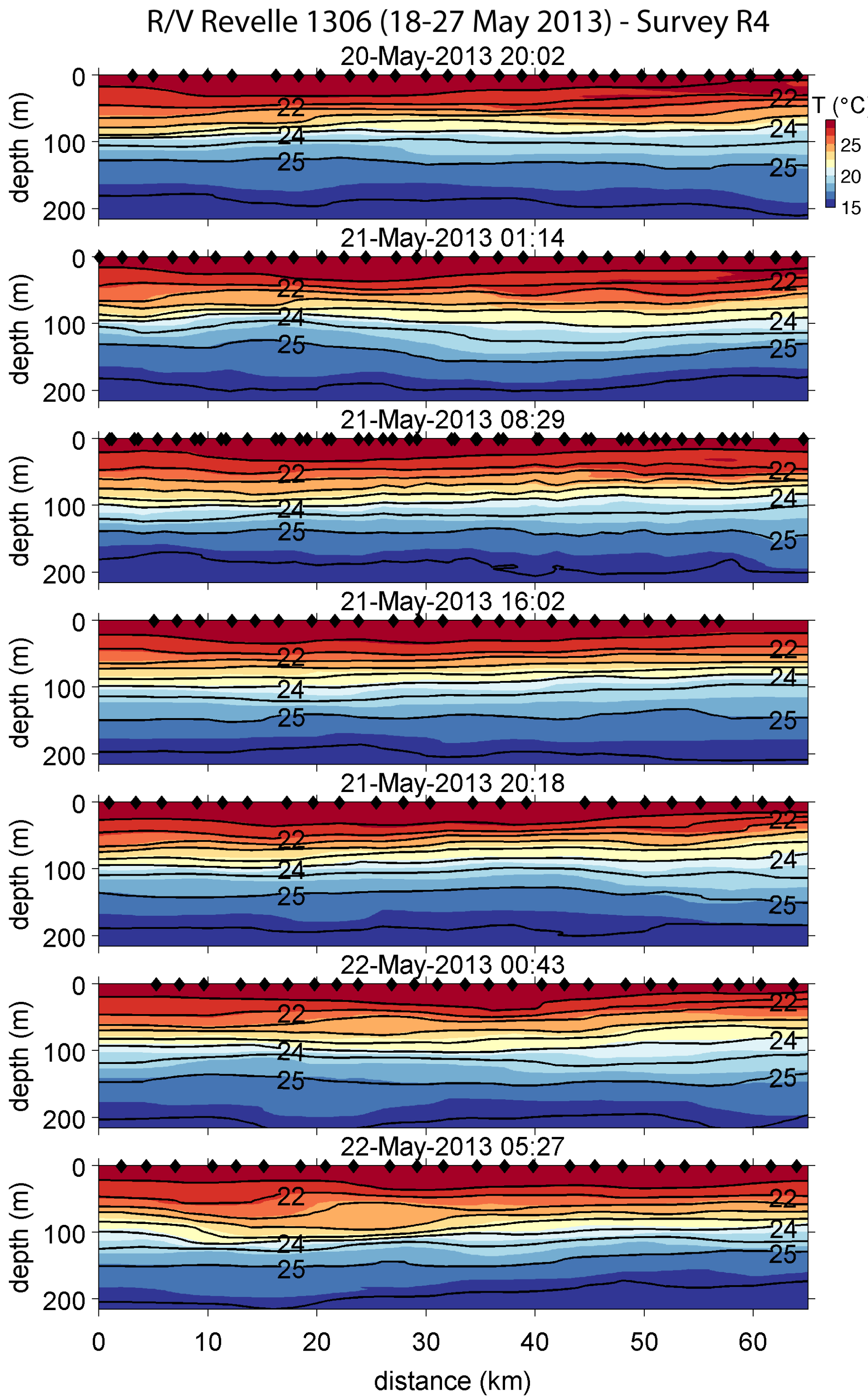


Figure 18. *Temperature (colors) and potential density (contours) for 7 occupations of R4.*

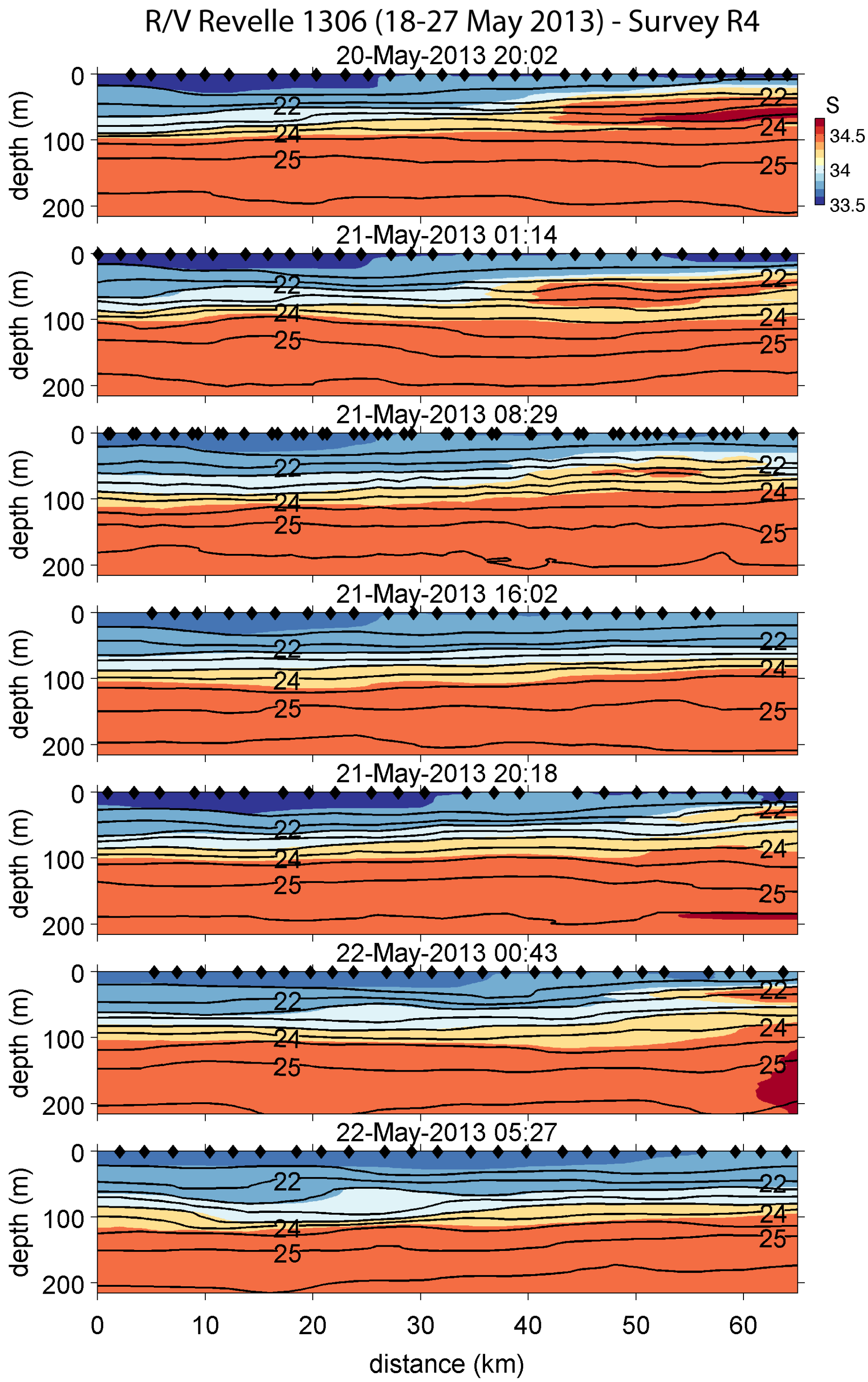


Figure 19. *Salinity (colors) and potential density (contours) for 7 occupations of R4.*

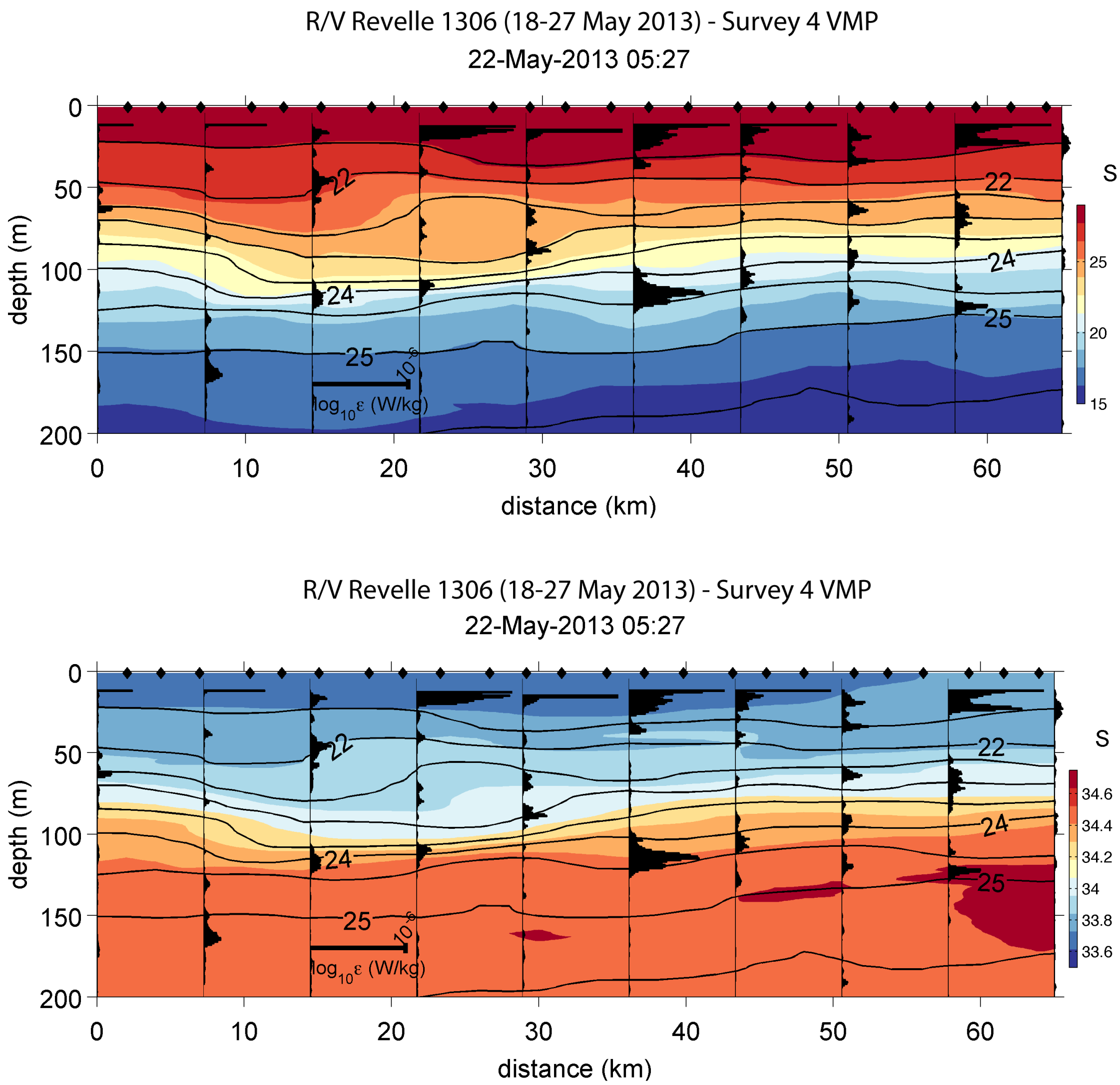


Figure 20. *(top) Temperature (colors) and potential density (contours) and (bottom) Salinity (colors) and potential density (contours), with dissipation rate ε for the Vertical Microstructure Profiler (VMP) occupation of R4.*

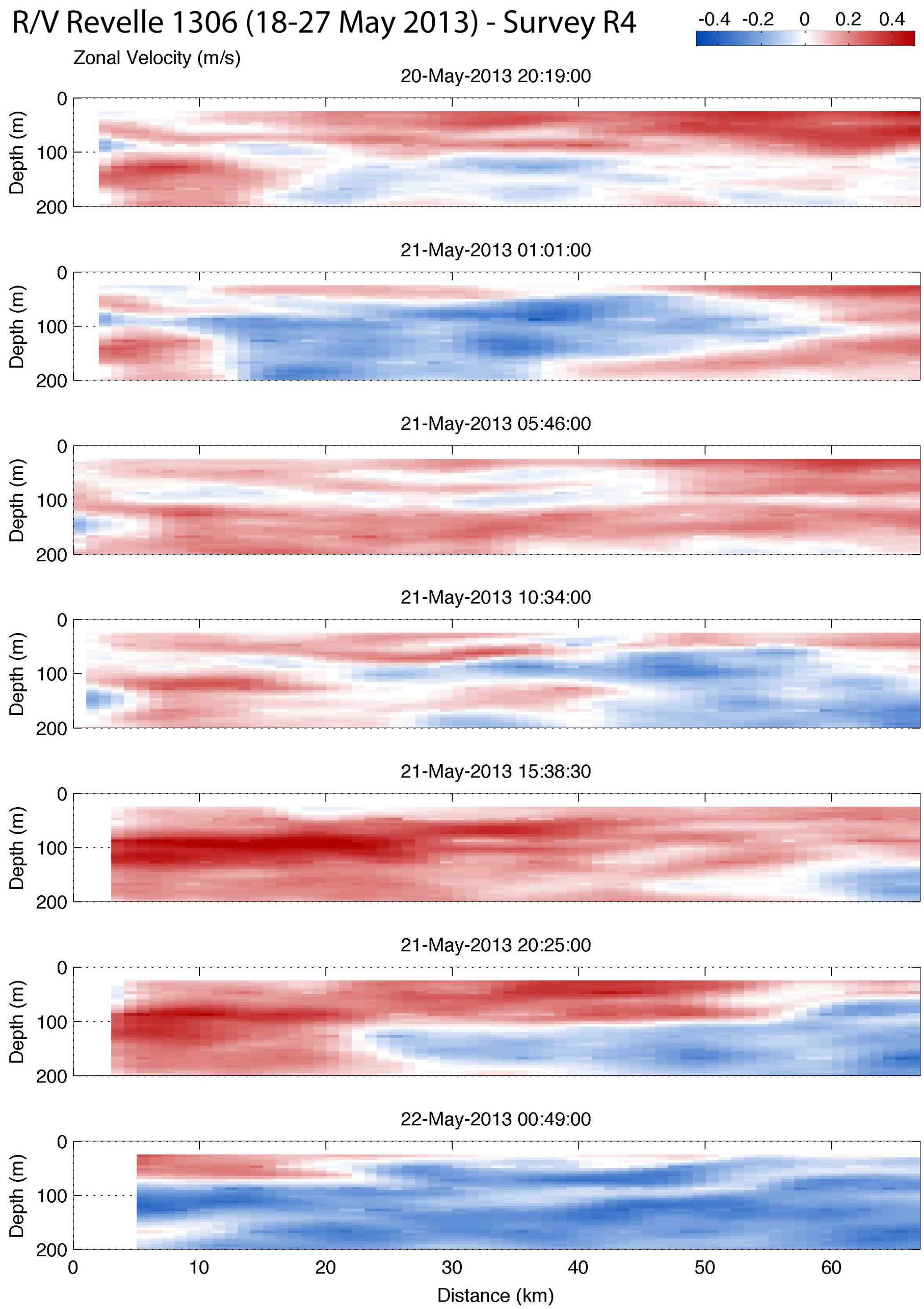


Figure 21. *Eastward velocity for the 7 occupations of line R4.*

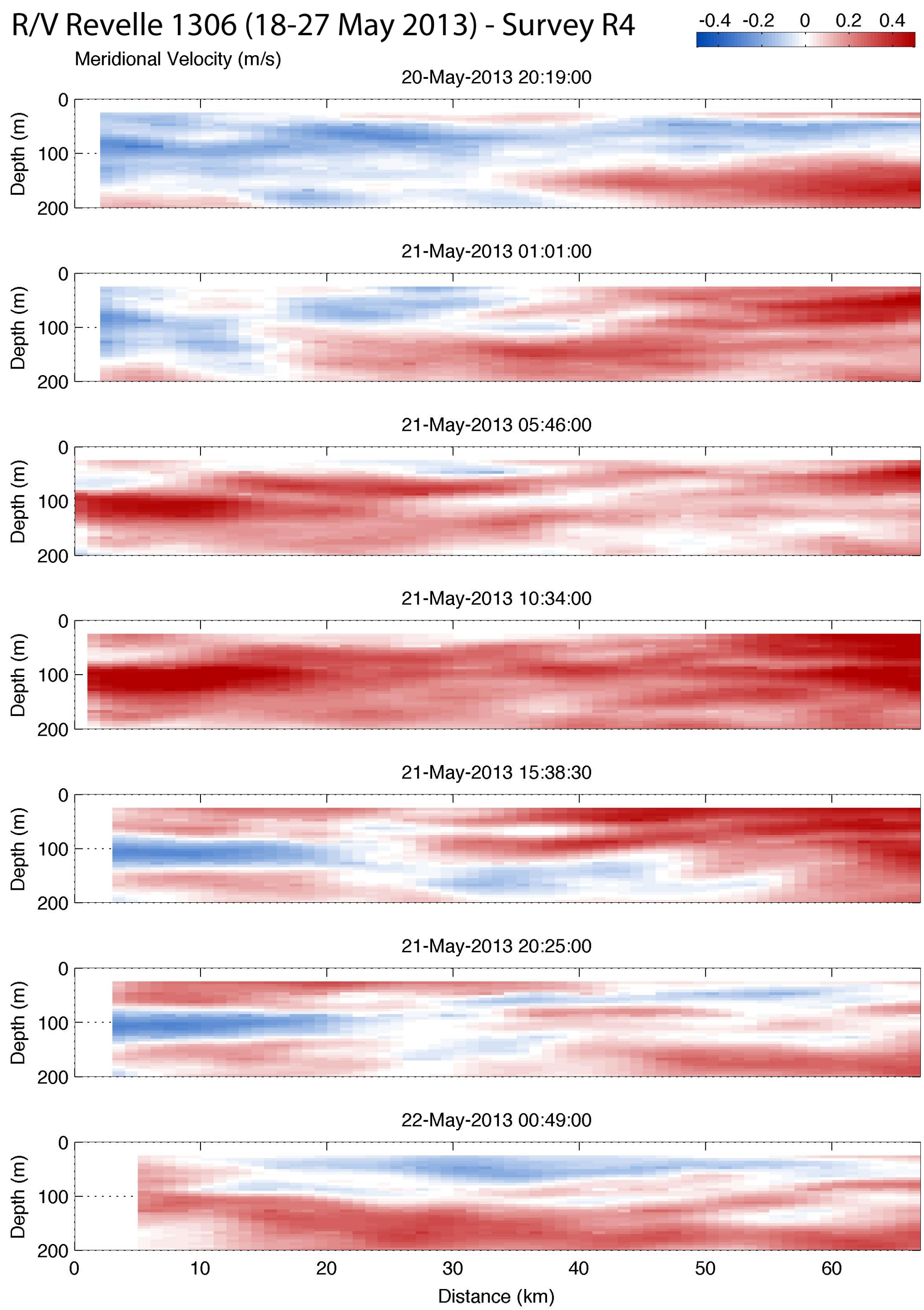


Figure 22. *Northward velocity for the 7 occupations of line R4.*

6. Glider Operations

Two gliders were deployed R1306:

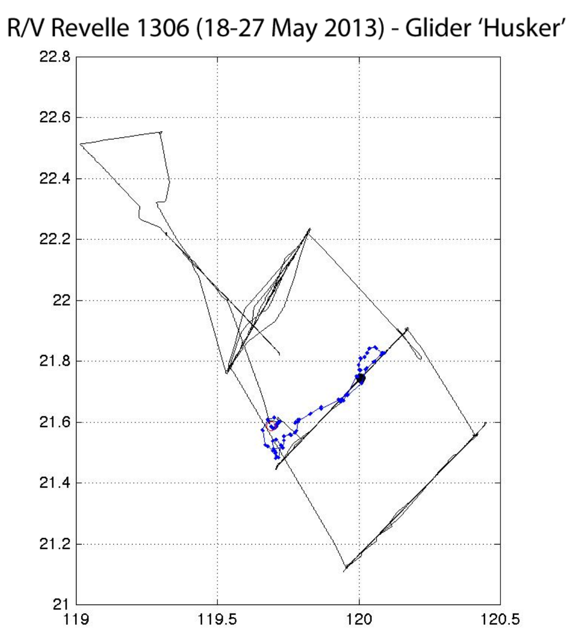
Husker (WHOI, St. Laurent): Teledyne/Webb Slocum 200 m glider equipped with CTD (SBE 41) and Rockland Scientific MicroRider turbulence sensors; shear and temperature microstructure.

Jane (OSU, Shearman): Teledyne/Webb Slocum 200 m glider equipped with CTD (SBE 41), optics (WETLabs chl a fluorescence, 650 nm backscatter and CDOM fluorescence) and 2 MHz Nortek Aquadop acoustic current meter for estimating turbulent dissipation rates.

Glider Jane was deployed from RV Roger Revelle on Sun May 19 04:43 UTC at 11956.119, 2140.470 over the side, and glider Husker was deployed using the RHIB the same day at 05:30 UTC at 11956.231, 2140.494. Both gliders were flown along line R3 (Fig. 23) departing in opposite directions; Husker to the NE and Jane to the SW. Glider tracks were offset 1 nm to the E from the actual ship track for safety.

Gliders continuously occupied the line until recovery. Both Husker and Jane traversed about two complete occupations of the line.

Husker was recovered on Sun May 26 08:15 UTC at 11941.227, 2135.315, using the RHIB. Jane was recovered the same day at 08:45 UTC at 11943.020, 2135.950, over the side of the Revelle.



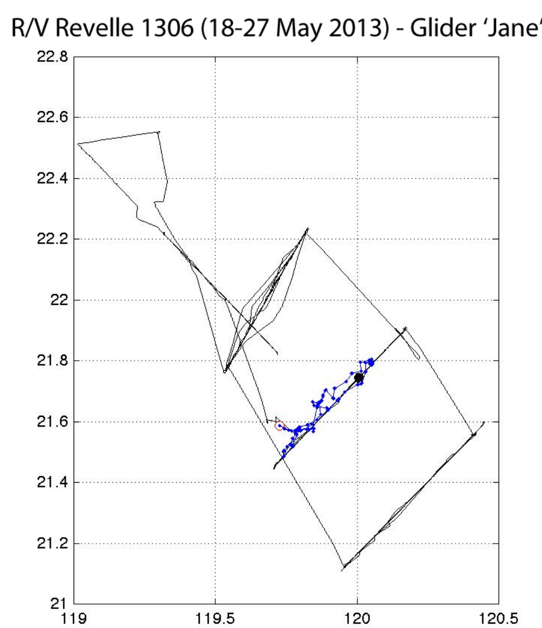


Figure 23. *Blue marks indicate profile locations for gliders Husker (WHOI, left) and Jane (OSU, right). The light grey line marks R/V Revelle's track.*

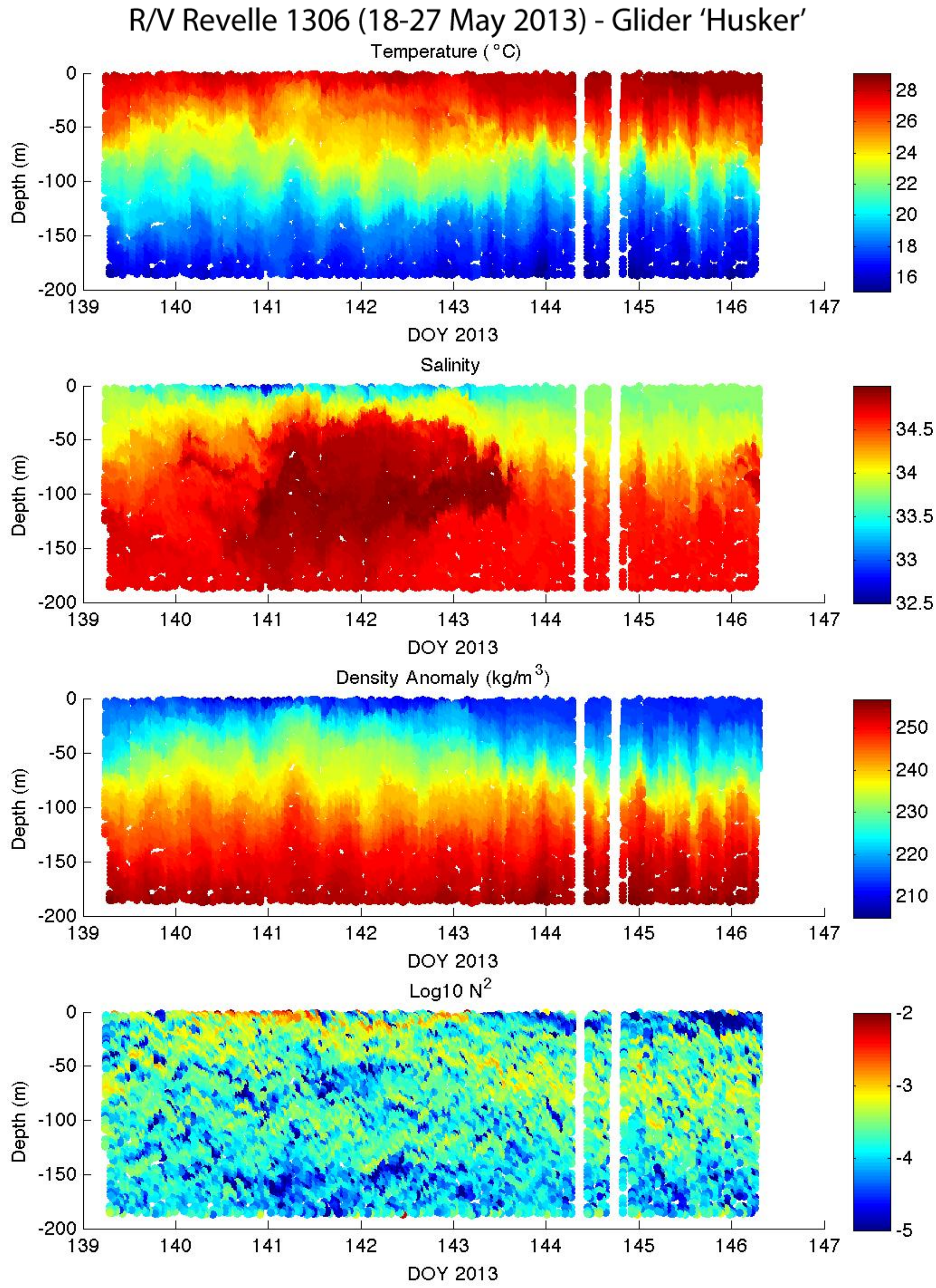


Figure 24. *Time series of (top to bottom) temperature, salinity, density anomaly and buoyancy frequency (log_{10}) from glider 'Husker'.*

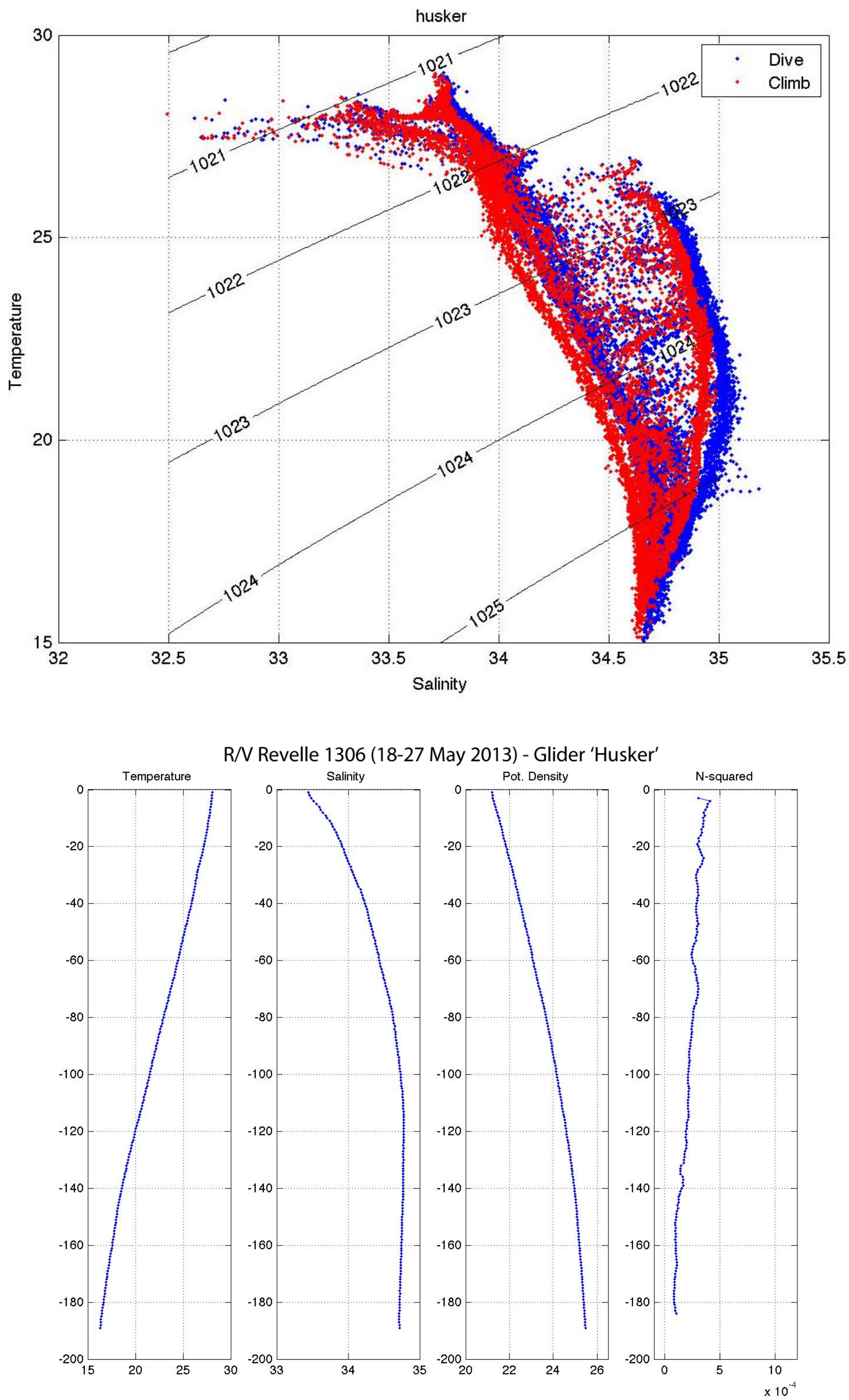


Figure 25. *(top) Potential-temperature-salinity diagram and (bottom) mission-average profiles of temperature, salinity, potential density and buoyancy frequency for glider 'Husker'. In the top panel, blue symbols mark measurements collected while diving, while red marks measurements collected during the climb.*

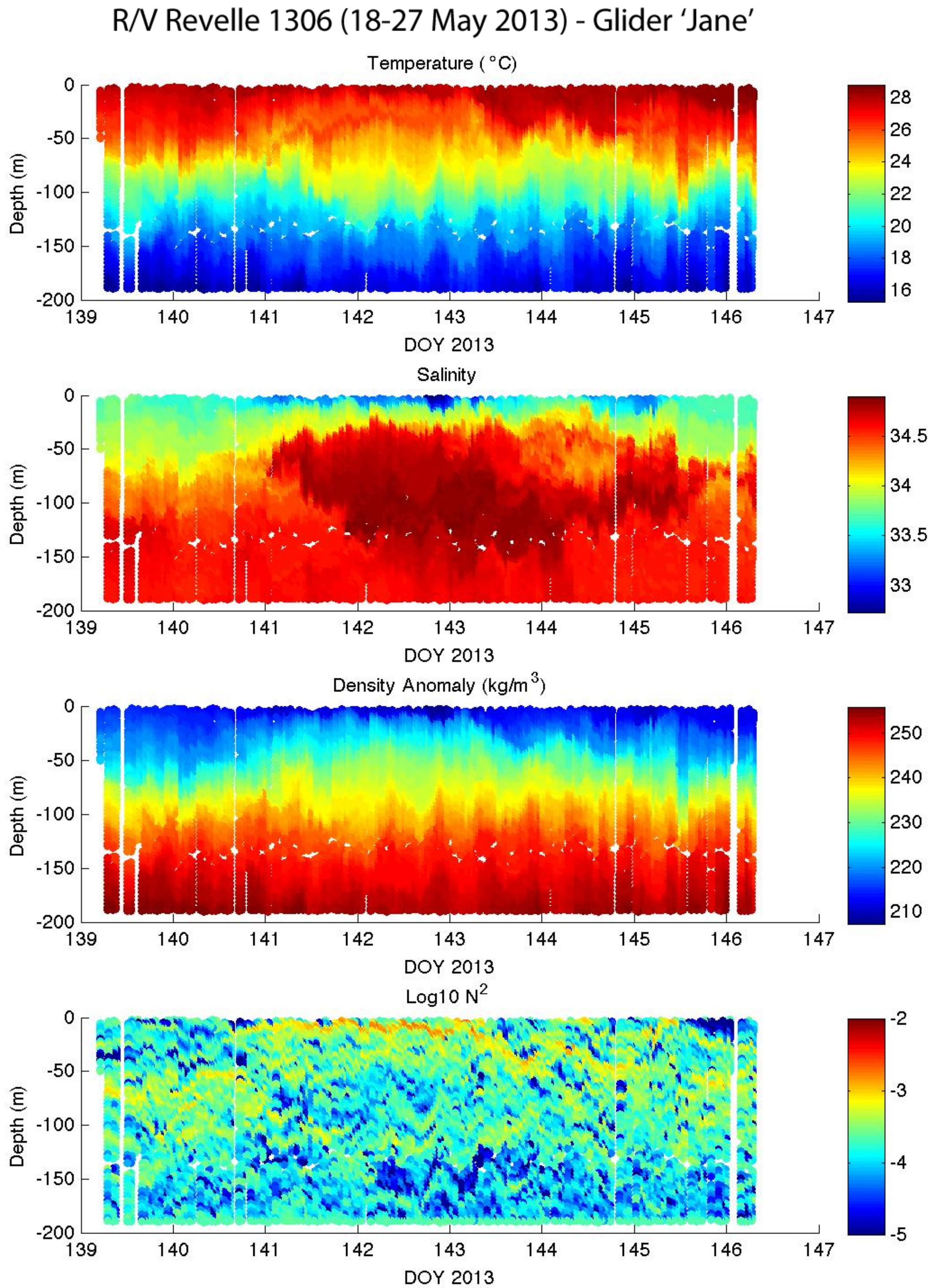
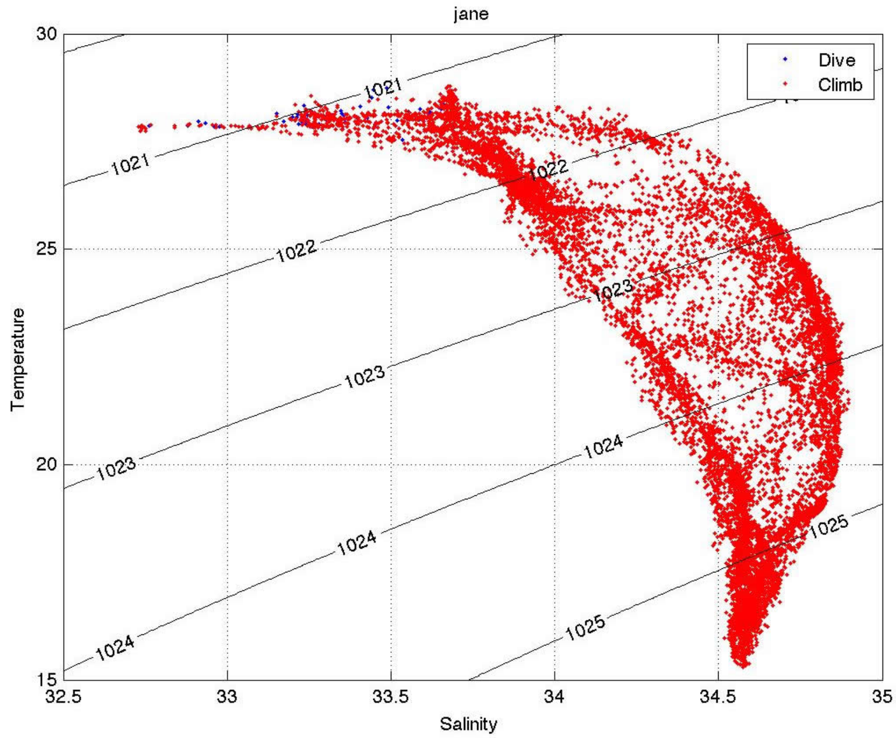


Figure 26. *Time series of (top to bottom) temperature, salinity, density anomaly and buoyancy frequency (log_{10}) from glider 'Jane'.*



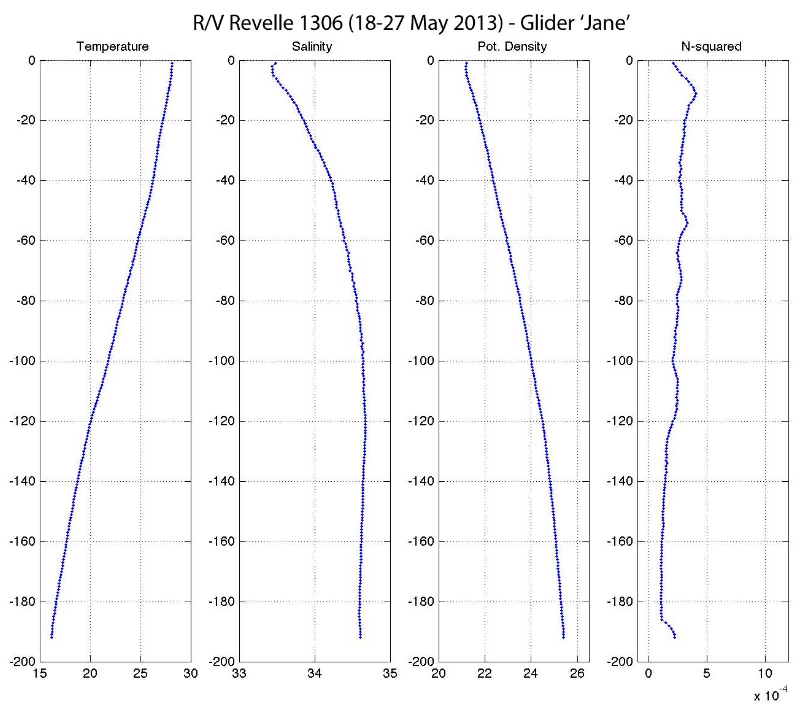


Figure 27. *(top) Potential-temperature-salinity diagram and (bottom) mission-average profiles of temperature, salinity, potential density and buoyancy frequency for glider 'Jane'. In the top panel, blue symbols mark measurements collected while diving, while red marks measurements collected during the climb.*

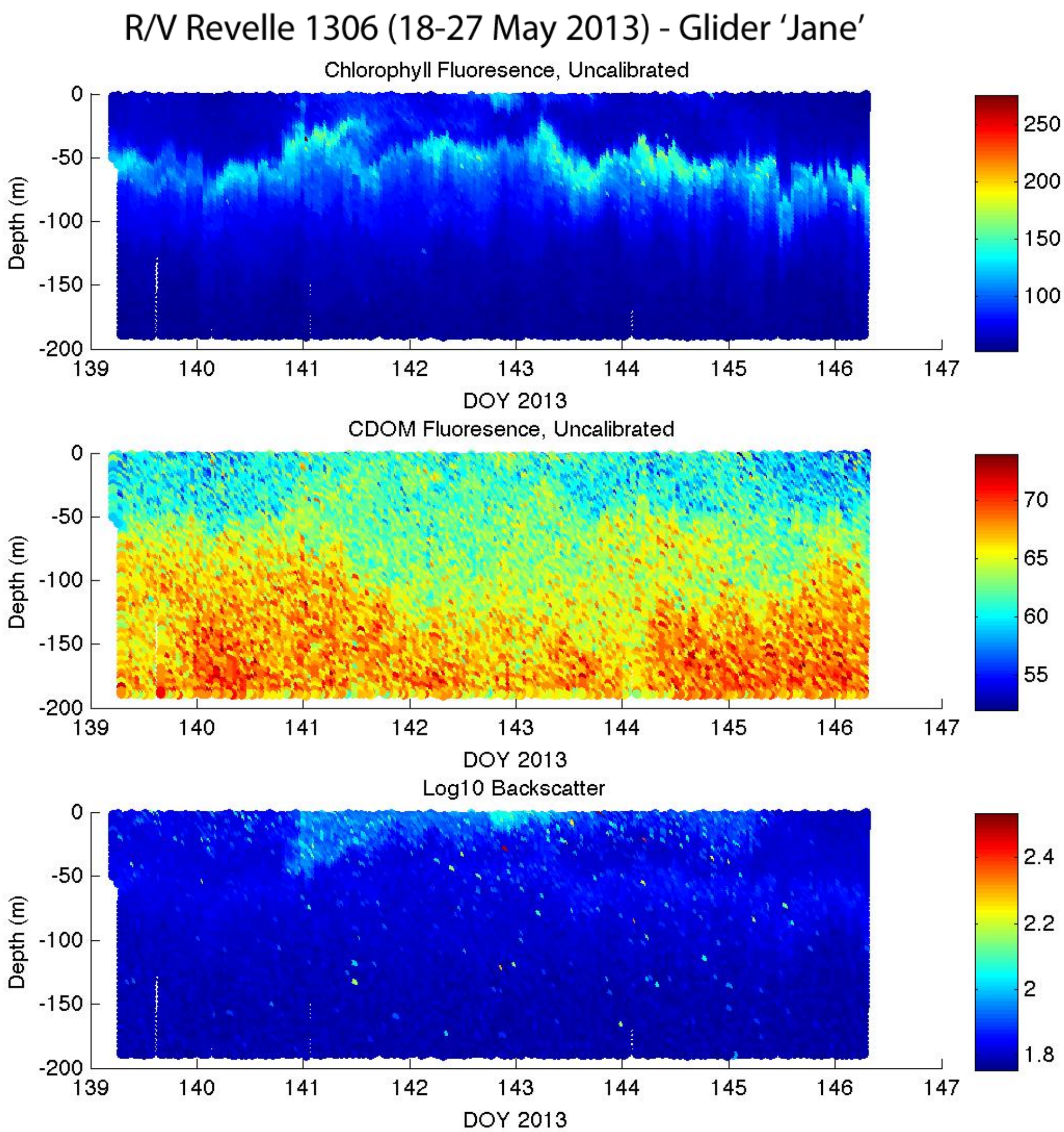


Figure 28. *Time series of (top to bottom) chlorophyll fluorescence, CDOM fluorescence and particle backscatter (log_{10}), all uncalibrated, from glider 'Jane'.*

7. Moored Measurements

Two moorings were deployed during the first leg of this effort and recovered at the end of this cruise. Positions are plotted in Fig. 2 and tabulated in Table 1. Results from the mooring operation will be reported separately, though subtidal variability is summarized here.

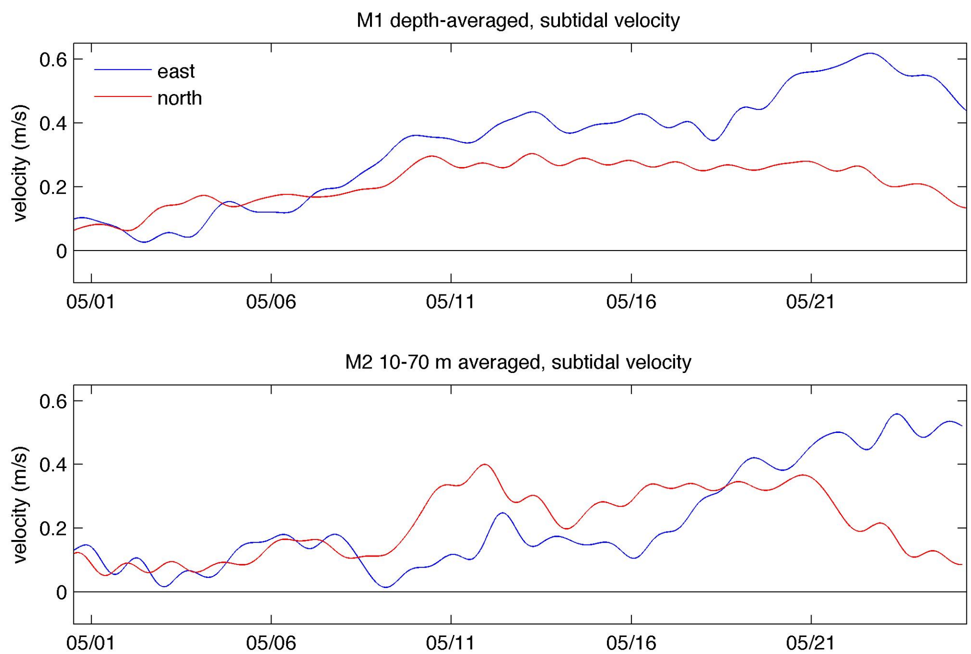


Figure 29. *Depth-average velocity, low pass filtered to isolate variability at frequencies below the tidal band, at M1 and M2 (Fig. 2). In contrast to the westward currents observed at R2, to the south, the moorings captured northeastward flow.*

8. Optical Sampling

As part of the bio-optics portion of the 2013 ONR efforts in the South China Sea (PI E. Boss, University of Maine), a variety of in-line instrumentation was used to continuously analyze surface waters from the R/V Revelle's uncontaminated seawater supply. These instruments monitored particle beam attenuation and absorption spectra, particle backscattering, as well as chlorophyll fluorescence. Measurements of the surface water volume scattering function from 0.1-150° and P12 & P22 elements of the scattering Mueller matrix from 15-150°, at 515 nm illumination were also made from the ship's flowthrough system.

The specific instruments used for measurements of particle optical properties were:

(1) AC-S (absorption and attenuation meter, Wetlabs, Inc.) – Measures absorption (“a”) and attenuation (“c”) of light at hyperspectrally within the visible spectrum (400-750nm).

(2) BB-3 (three wavelength backscattering meter, Wetlabs, Inc.) – Measures backscattered light at three visible wavelengths

(3) WetStar Chlorophyll-a fluorometer (WET Labs, Inc.) – Uses blue excitation and measures red stimulated fluorescence for estimating chlorophyll biomass.

(4) LISST-VSF (Sequoia Scientific, Inc.) – Measures laser scattering as a function of forward angle (~0.1-15°) by detection from 32 concentric light detectors. A rotating prism “eyeball” also scans along the laser beam to measure the scattering at angles up to 150°. Additional polarization optics allows measurement of other Mueller scattering matrix elements.

All instruments except the LISST-VSF were operated with continuous flow from yearday 138 to 145. A custom chamber to house the BB-3 was designed and built by Giorgio Dall’Olmo (Plymouth Marine Lab, UK). Sample seawater was diverted periodically through a 0.2-micron filter (GE Osmonics Memtrex, 0.2 micron) using a computer-controlled actuated valve (FlowControl, Sequoia Scientific) in order to provide filtered seawater blanks throughout the cruise (typically two per hour). These blanks are used to estimate calibration independent particle optical properties with the ac-s and BB3 (Slade et al. 2010; Dall’Olmo et al. 2009), and to compensate for instrument drift and bio-fouling between cleanings. This method allows for measurement of particulate absorption and attenuation spectra at or below the manufacturer specified accuracy for the ac-s and BB3.

Several measurements per day were made using the LISST-VSF (Agrawal, Pottsmith, and Slade 2012) fitted with a custom flow-through chamber. Measurements were made by first filling and flushing the flow chamber with seawater from the uncontaminated seawater supply for >15 min. After the measurement was made, the flowing seawater was stopped and trapped in the cell, and then recirculated in a closed loop through a 0.2-micron filter cartridge using a peristaltic pump. This method was used to allow for a long recirculation period of ~1 hour, at which point measurements of the filtered seawater blanks were made.

A surface floating hyperspectral radiometer system (HyperPro, Satlantic) was also deployed at noon ±2 hours during this cruise. The system consists of hyperspectral radiance and irradiance sensors, measuring the downwelling sky irradiance just above the water surface and the upwelling radiance just below the water surface. The output product of the HyperPro system after data processing is hyperspectral remote-sensing reflectance from ~400 to 800 nm.

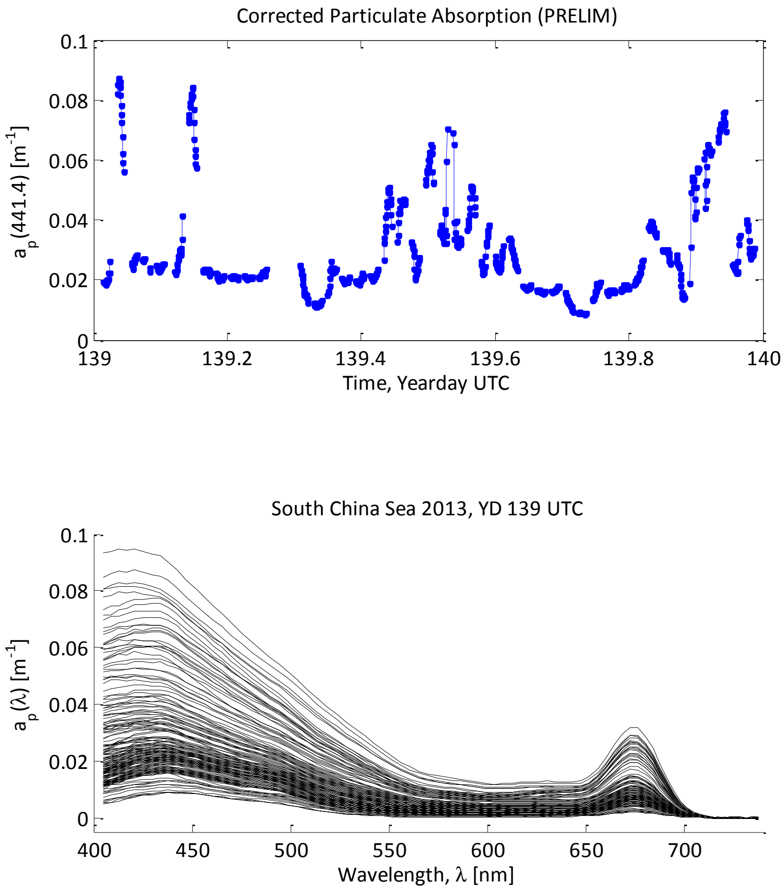


Figure 30. *(Top) time series plot of a single day of ac-s particle absorption from surface waters along the cruise track. Significant finescale variability is observed throughout the day. (Bottom) example particle absorption spectra from the same day are dominated by phytoplankton.*

Data from the underway system (ac-s and BB-3) have undergone preliminary processing and will be made available after full processing, post-cruise. Data from the LISST-VSF and HyperPro radiometer system will be processed post-cruise. A preview of the ac-s time series and spectra is provided here in Fig. 30. Similar daily timeseries and spectra of particulate absorption and attenuation are included in the Optics directory of the cruise archive. The full dataset will be available by contacting the investigator (Wayne Slade) and will be posted to the NASA SeaBASS data archive. A full description of data processing will be made available with the dataset and posted to SeaBASS.

9. Waypoints

waypoint	latitude			longitude			depth (m)
r1n	22	31.934	N	119	17.088	E	100
r1s	21	53.253	N	119	17.093	E	2500
r1n-2 (actual)	22	30.8	N	119	0.9	E	< 100 m
r1s-2 (actual)	21	49.8	N	119	42.0	E	3000 m (?)
r2n	22	13.500	N	119	49.153	E	1400
r2s	21	46.911	N	119	32.703	E	2700
r3n	21	53.184	N	120	9.078	E	1250
r3s	21	27.646	N	119	42.957	E	3050
r4n	21	33.433	N	120	24.642	E	1300
r4s	21	7.642	N	119	57.601	E	3330
r5e	21	25.803	N	121	16.782	E	2350
r5w	21	26.084	N	120	33.875	E	1250
m1	21	36.934	N	119	17.088	E	100
m2	22	29.196	N	119	17.316	E	300

10. Personnel

Science Party

Craig Lee (Chief Scientist)	APL-UW
Ben Jokinen	APL-UW
Ken Decoteau	WHOI
Anthony Kirincich	WHOI
Scott Worrilow	WHOI
Pei-Chi Chuang	OSU
Zen Kurokawa	OSU
Gonzolo Saldias	OSU
Alejandra Sanchez	OSU
Kipp Shearman	OSU
Emily Shroyer	OSU
Wayne Slade	Sequoia Scientific
Hsi-He Chen	NSYSU
Ke-Hsien Fu	NSYSU
Ya-Ling Kuo	NSYSU
Tai-Yi Lee	NSYSU
Li Lin	NSYSU
Chun-Kai Liu	NSYSU
Chung-Hung Lu	NSYSU
Hui-Ju Chuang	CPC Corporation
Yi-Lung Huang	CPC Corporation
Yi-Wen Peng	CPC Corporation
Ben Cohen	SIO-UCSD
Matt Durham	SIO-UCSD

R/V Revelle Crew

Thomas Desjardins	Master
Eric Wakeman	1st Mate
Melissa Turner	2nd Mate
Sean Diaz	3rd Mate
Peter Steiner	Boatswain
Patrick Redmond	AB
Kevin Moran	AB
Kevin Gillette	AB
Brian Nellis	OS
Jay Erickson	Sr. Cook
Richard Buck	Cook
Dave Herman	Chief Engineer
Steve Saint-Martin	1st Assistant Engineer
Justin Deane	2nd Assistant Engineer
Ammar Marsuq	3rd Assistant Engineer
Armando Cortez	Electrician
Scott Myers	Oiler
Craig Hunt	Oiler
Jeremy Farlow	Oiler
Eddie Angeles	Oiler
Marcus Anderson	Wiper

Science Watch Schedule

00:00 – 12:00	12:00 – 00:00
Kipp Shearman	Craig Lee
Ke-Hsien Fu	Ben Jokinen
Scott Worrilow	Emily Shroyer
Alejandra Sanchez	Anthony Kirincich
Wayne Slade	Pei-Chi Chuang
Tai-Yi Lee	Gonzolo Saldias
Li Lin	Hui-Ju Chuang
Ya-Ling Kuo	Yi-Lung Huang
Hsi-He Chen	Yi-Wen Peng
Chung-Hung Lu	
Chun-Kai Liu	

References

Agrawal, YC, HC Pottsmith, and WH Slade. 2012. “A Submersible Optical VSF Sensor with Polarization.” In *Ocean Sciences Conference 2012, Salt Lake City, UT*.

Dall’Olmo, G, T K Westberry, M J Behrenfeld, and W H Slade. 2009. “Significant Contribution of Large Particles to Optical Backscattering in the Open Ocean.” *Biogeosciences* 6: 947–967. http://digitalcommons.library.umaine.edu/sms_facpub/120/.

Slade, Wayne H., Emmanuel Boss, Giorgio Dall’Olmo, M. Rois Langner, James Loftin, Michael J. Behrenfeld, Collin Roesler, and Toby K. Westberry. 2010. “Underway and Moored Methods for Improving Accuracy in Measurement of Spectral Particulate Absorption and Attenuation.” *Journal of Atmospheric and Oceanic Technology* 27 (10) (October): 1733–1746. doi:10.1175/2010JTECHO755.1. http://journals.ametsoc.org/doi/abs/10.1175/2010JTECHO755.1.