



ISTITUTO NAZIONALE
di Oceanografia e di Geofisica Sperimentale



DOLCEVITA-2 CRUISE

26 May – 15 June 2003

REPORT OF DRIFTER-RELATED ACTIVITIES

by

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1. Introduction

As part of the ONR-sponsored DOLCEVITA project, releases of drifters were conducted in the northern Adriatic during the DOLCEVITA-2 cruise onboard R/V Knorr between 26 May and 15 June 2003. The drifter measurements were concentrated in selected mesoscale circulation features and were made in concert with towed vehicle, hydrographic and optical measurements. This report contains a brief description of the drifter systems used, details about their deployments and recoveries, and a preliminary description and interpretation of the drifter results.

2. Instruments and Methods

2.1 Drifter Systems

All drifters were tracked by, and telemetered data to, the Argos satellite system. Most drifters transmitted at 90 s intervals to three satellites (NOAA 15 and 16 and ADEOS-2). In order to guarantee the transmission of all the data of the optical (SVP/OCM) and thermistor chain (CODE/Tz) drifters, these drifters were programmed to transmit every 60 s to 7 satellites (Argos-multi satellite service). Various drifter types were used during the cruise. They include:

- 1) CODE and CODE-GPS (Figure 1) surface drifters manufactured by Technocean, Cape Coral, FL, USA. which provide surface currents and sea surface temperature (SST). The GPS upgrade on some of the drifters allows positioning at hourly intervals.



Figure 1. Preparing a CODE-GPS drifter for deployment.

- 2) SVP surface drifters (Figure 2) with a holey-sock drogue centered at 50-m nominal depth manufactured by Clearwater, Watertown, MA, USA. These instruments provide currents at 50 m and SST. For operations in shallow waters, the tether was reduced to center the drogue at 30-m depth. They are equipped with GPS receivers that sample position every half hour.

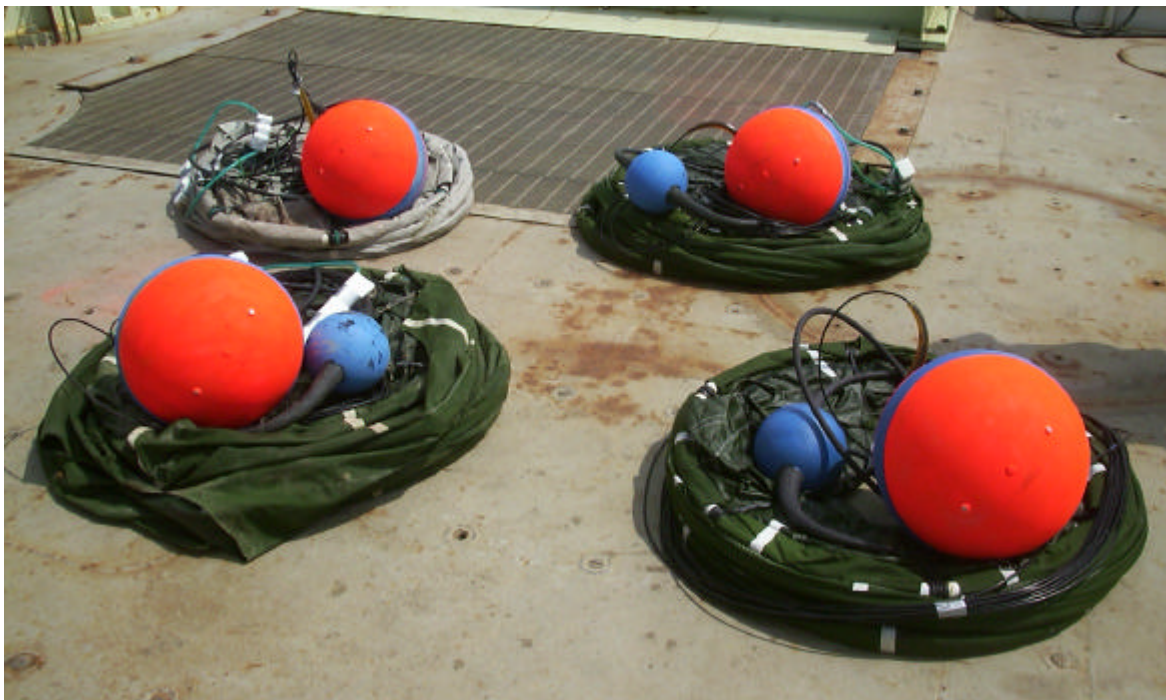


Figure 2. Four SVP drifters with holey-sock drogue (green and grey), intermediate float (light blue) and surface ball (red).

- 3) SVP/OCM surface drifters (Figure 3) with a drogue centered at 15-m depth produced by Metocean Data Systems Limited, Dartmouth, Nova Scotia, Canada. These drifters measure near-surface currents, SST, upwelling radiance and downwelling irradiance at visible wavelengths. They also have GPS positioning at half-hour intervals.
- 4) CODE/Tz surface drifters (Figure 4) with a thermistor chain manufactured by Metocean. They have 10 thermistors to measure the water temperature at 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 m. They also measure surface currents and SST. GPS fixes are sampled every half hour. For the applications in shallow water, the chain length was reduced to 30 m (see Table 1).

- 5) CMOD (XAN-3) surface drifters (Figure 5) with a thermistor chain manufactured by Metocean. In addition to the temperatures at various depths (2.5, 7.5, 10, 12.5, 17.5, 20, 25, 32.5, 40, and 50 m), these instruments measure surface currents, SST and surface air pressure and temperature. For the applications in shallow water, the chain length was reduced to 30 m (see Table 1).



Figure 3. SVP/OCM drifters with sock drogues. The irradiance meters can be seen on the top of the red surface balls.

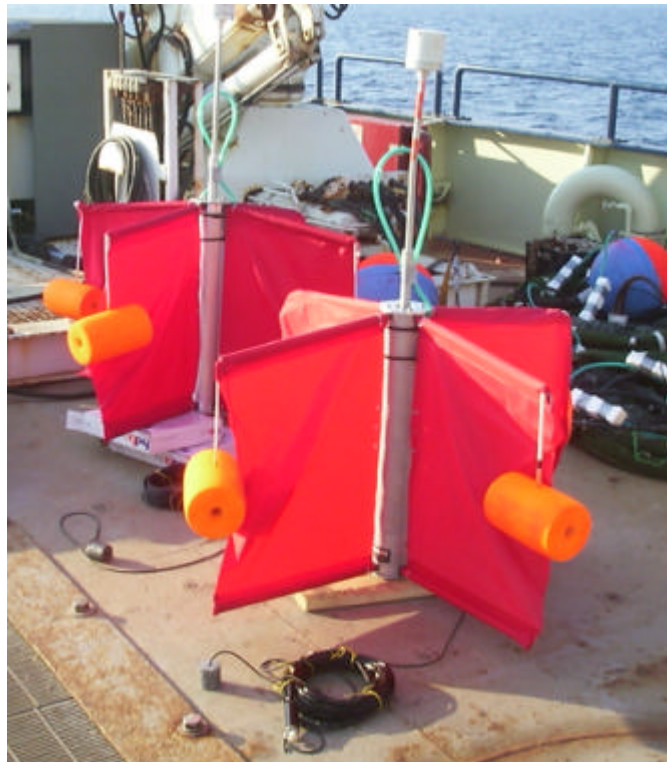


Figure 4. Two CODE/Tz drifters with thermistor chains.



Figure 5. CMOD (XAN-3) drifters with thermistor chains.

Thermistor number	CODE/Tz (33353)	CODE/Tz (33354)	CMOD
T1	5	3	2.5
T2	5	6	6.5
T3	10	9	9
T4	15	12	11.5
T5	15	15	15.5
T6	20	18	18
T7	23	21	21
T8	26	24	24
T9	30	27	27
T10	30	30	30

Table 1. Thermistors depths of the drifters for which the chain was shorten to 30 m. All depths are in meters.

2.2 Drifter Deployment and Recovery Operations

The drifters were generally deployed at the beginning of the small-scale surveys conducted with the Trisoarus towed vehicle. The small-scale surveys during which drifter were deployed were carried out in three areas of the northern and middle Adriatic: the Mid Adriatic Filament (MAF) or the northeastern part of the Mid Adriatic Pit (also called Jabuka Pit), the North Adriatic Filament (NAF) near the tip of Istria (off Pula), and the Po River Plume (Figure 7).

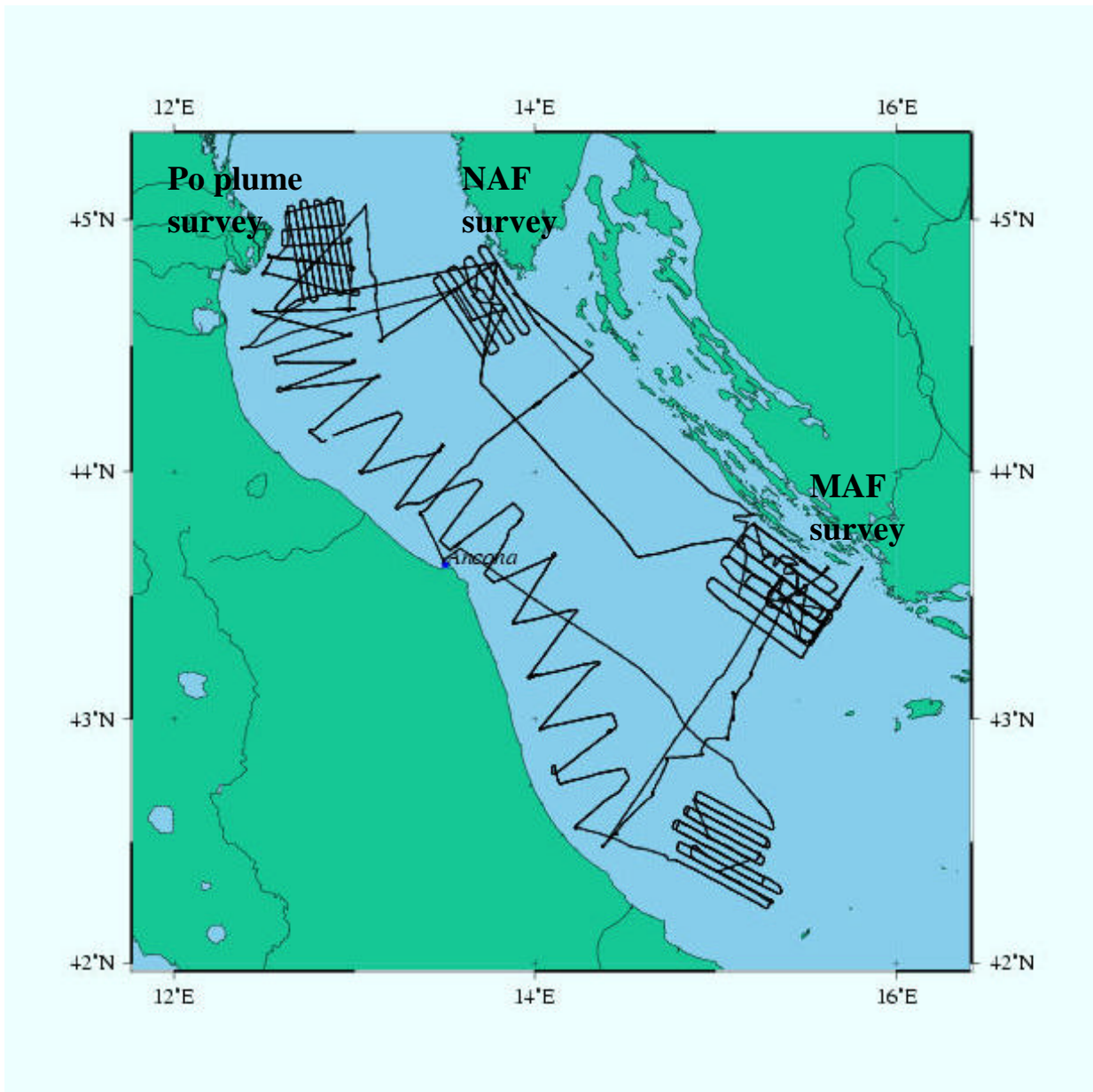


Figure 7. Ship track of R/V Knorr during the DOLCEVITA-2 cruise in the northern and middle Adriatic. The small-scale surveys are shown.

The drifters were either released before the towed vehicle was put in the water or during the first leg of the survey. All drifters were generally deployed upstream of the mesoscale features sampled so that they stayed in the vicinity of the towed vehicle. In this way the vehicle, shipboard ADCP and drifter data were all concentrated on the same features. CODE and CODE-GPS drifters in their cardboard boxes were deployed from the port side of the ship while it was steaming at ~7 knots and towing the vehicle. All the other drifters with drogues or thermistor chains were deployed from the stern at ship speeds varying in 1-2 knots (Figures 8 and 9). These deployments were performed with the Trisoarus vehicle parked in the water at a fixed intermediate depth (not profiling).



Figure 8. Deploying an optical drifter (SVP/OCM) from the stern. The drogue is being paid out before tossing the surface ball.



Figure 9. An SVP/OCM drifter just after deployment. The surface ball (bottom left) and drogue (before sinking, top right) are clearly seen.

Some GPS drifters were recovered after the vehicle had performed once or many times the full small-scale survey. The drifter data were downloaded from the Argos telnet data distribution system using cellular phone at least on a daily basis. These provided information on the drifter location with a few hours delay. Once the ship was in the vicinity of the drifters (1-2 nm), the IESM direction finder mounted near the ship's bridge provided us with up-to-date GPS

locations. All drifters recovered were taken out of the water using grappels and hooks on the starboard side of the ship (Figure 10).

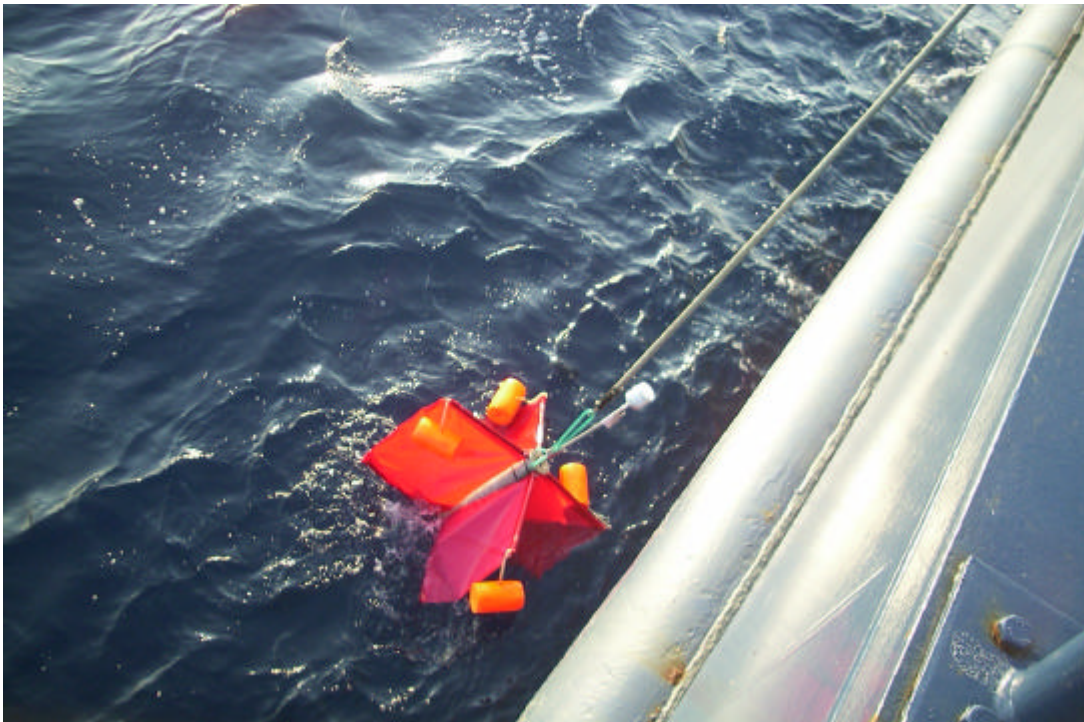


Figure 10. Recovering a CODE/Tz drifter.

2.3 Details about Drifter Deployment and Recoveries

Three regular CODE drifters were deployed near the Po River Delta during the initial basin-wide survey on 27-28 May 2003 . The deployment locations were close to the ones where drifters were deployed in May 2003 during the ADRIA03 cruise. The deployment coordinates are listed in Table 2.

DOLCEVITA_2- PO DEPLOYMENTS

Number	Type	Status	Switched On	Deploy date/time	Longitude	Latitude	SST	SSS
37691	CODE	Used	27/05/2003 20:50	27/05/2003 23:29	12 37.45	44 42.32	21.15	32.52
37735	CODE	Used	27/05/2003 20:50	27/05/2003 23:58	12 34.42	44 39.90	19.23	33.8
37748	CODE	New	27/05/2003 20:51	28/05/2003 1:07	12 41.43	44 40.94	19.32	34.21

Table 2. Deployment information for the drifters deployed near the Po River Delta.

A total of 12 drifters were deployed during the small-scale survey on the northeastern flank of the MAP (or Jabuka Pit) on 28-29 May 2003 to survey the MAF. Three of these drifters were successfully recovered on 31 May after having spent about 2.5 days in the water. Three CODE/GPS drifters were released on 2 June 2003 during the first execution of a smaller survey

embedded in the larger survey. On 4 June 2003, three drifters were recovered after more than 6 days in the water. The deployment and recovery details for all the drifters deployed near the MAP are listed in Tables 3 and 4.

DOLCEVITA_2- JABUKA PIT DEPLOYMENTS

Number	Type	Status	Switched On	Deploy date/time	Longitude	Latitude	SST	SSS
33353	CODE/TZ	Used	28/05/2003 13:00	29/05/2003 3:05	15 27.225	43 35.468	18.26	38.2
33354	CODE/TZ	Used	28/05/2003 13:00	29/05/2003 5:31	15 19.860	43 39.496	19.08	38.35
33355	SVP/OCM	Used	28/05/2003 13:00	29/05/2003 3:28	15 23.682	43 35.377	18.85	38.39
33356	SVP/OCM	Used	28/05/2003 13:00	29/05/2003 5:11	15 19.844	43 37.441	19.12	38.38
37682	CODE/GPS	New	28/05/2003 22:30	28/05/2003 23:56	15 16.590	43 37.220	19.42	38.37
37683	CODE/GPS	New	28/05/2003 22:30	29/05/2003 0:23	15 19.970	43 35.420	19.13	38.47
37680	CODE/GPS	New	28/05/2003 13:00	29/05/2003 0:52	15 23.650	43 33.510	18.86	38.35
4001	SVP 50m	New	29/05/2003 03:50	29/05/2003 4:13	15 27.072	43 37.624	18.43	38.2
4020	SVP 50m	New	29/05/2003 03:50	29/05/2003 4:39	15 23.602	43 39.523	18.58	38.35
11605	CMOD	New	29/05/2003 01:15	29/05/2003 2:47	15 27.228	43 33.505	18.11	38.21
11629	CMOD	New	29/05/2003 01:20	29/05/2003 3:47	15 23.692	43 37.465	18.74	38.37
11915	CMOD	New	29/05/2003 01:30	29/05/2003 5:50	15 16.640	43 39.448	19.38	38.35
37680	CODE/GPS	New	02/06/2003 12:19	02/06/2003 13:01	15 34.732	43 32.844	20.83	38.25
37684	CODE/GPS	New	02/06/2003 12:24	02/06/2003 13:36	15 29.935	43 30.281	20.66	38.21
37666	CODE/GPS	New	02/06/2003 12:48	02/06/2003 14:12	15 25.010	43 32.844	20.77	37.965

Table 3. Deployment information for the drifters deployed near the Jabuka Pit.

DOLCEVITA_2- JABUKA PIT RECOVERIES

Number	Type	Recovery date/time	Longitude	Latitude	SST	SSS
33353	CODE/TZ	31/05/2003 17:24	15 28.589	43 19.163	19.17	38.28
33355	SVP/OCM	31/05/2003 18:46	15 23.588	43 29.123	19.32	38.37
37680	CODE/GPS	31/05/2003 19:42	15 22.711	43 28.802	20.25	38.27
37682	CODE/GPS	4/06/2003 06:20	15 9.484	43 42.661	21.63	38.35
4020	SVP 50m	4/06/2003 07:04	15 10.370	43 47.816	21.32	38.24
33354	CODE/TZ	4/06/2003 07:38	15 06.073	43 49.122	21.41	38.28
33356	SVP/OCM	4/06/2003 08:25	15 12.757	43 49.638	21.38	38.26

Table 4. Recovery information for the drifters deployed near the Jabuka Pit.

Fourteen drifters were released off the southern tip of the Istrian Peninsula (off Pula) as part of the small-scale survey to sample the NAF. They were released on 4-5 June 2003 and six of them were retrieved on 6 June 2003 after about 1 day in the water. Since the local bathymetry varied near 40 m, the CMOD XAN-3 and the CODE/Tz thermistor chains were reduced to a length of 30 m. Likewise, the tether of the SVP drifters were shortened to center the drogue at about 30-m depth. Deployment and recovery details are listed in Tables 5 and 6.

DOLCEVITA 2- PULA DEPLOYMENTS

Number	Type	Status	Switched On	Deploy date/time	Longitude	Latitude	SST	SSS
11535	CMOD 30m	New	04/06/2003 9:45	04/06/2003 18:59	13 45.79	44 47.50	21.98	37.75
11526	CMOD 30m	New	04/06/2003 9:50	04/06/2003 20:42	13 53.77	44 38.65	21.14	37.77
33353	CODE/TZ	Used	04/06/2003 14:42	05/06/2003 02:26	13 42.54	44 43.16	21.76	37.74
33354	CODE/TZ	Used		05/06/2003 03:08	13 46.51	44 38.92	19.55	37.72
33355	SVP/OCM	Used	04/06/2003 14:44	04/06/2003 19:26	13 47.83	44 45.17	21.78	37.73
33356	SVP/OCM	Used		04/06/2003 20:18	13 51.82	44 40.91	20.55	37.96
4020	SVP 30 m	New		04/06/2003 23:32	13 46.22	44 42.99	21.78	37.75
3999	SVP 30m	Used	04/06/2003 14:46	04/06/2003 23:09	13 48.05	44 41.10	20.87	37.89
4010	SVP 15m	Used	04/06/2003 14:45	04/06/2003 19:53	13 49.71	44 43.08	19.55	37.72
37682	CODE/GPS	New		05/06/2003 05:56	13 42.81	44 38.81	20.49	37.74
37685	CODE/GPS	New	04/06/2003 14:40	05/06/2003 06:13	13 41.12	44 40.70	21.33	37.74
37749	CODE	New	04/06/2003 14:51	04/06/2003 22:44	13 50.38	44 38.66	21.13	37.65
37750	CODE	New	04/06/2003 14:50	04/06/2003 23:57	13 44.22	44 45.26	21.75	37.72
35498	CODE/GPS	Used	04/06/2003 17:40	05/06/2003 02:47	13 44.44	44 41.09	21.84	37.74

Table 5. Deployment information for the drifters deployed south of Pula.

DOLCEVITA 2- PULA RECOVERIES

Number	Type	Recovery date/time	Longitude	Latitude	SST	SSS
33353	CODE/TZ	6/06/2003 03:36	13 39.267	44 41.902	22.21	37.63
33355	SVP/OCM	6/06/2003 03:56	13 40.865	44 40.844	22.67	37.72
33356	SVP/OCM	6/06/2003 04:38	13 49.529	44 39.748	20.49	37.7
33354	CODE/TZ	6/06/2003 05:14	13 43.924	44 37.298	20.15	37.77
37682	CODE/GPS	6/06/2003 05:42	13 39.656	44 36.227	20.26	37.42
37685	CODE/GPS	6/06/2003 06:48	13 33.133	44 43.471	21.54	37.72

Table 6. Recovery information for the drifters deployed south of Pula.

In the next survey concentrated on the Po River plume, we deployed 2 CODE-GPS drifters along the second transect crossing the plume on 6 June 2003. More information about the deployment and recoveries of these drifters are provided in Table 7.

DOLCEVITA 2- PLUME DEPLOYMENTS

Number	Type	Status	Switched On	Deploy date/time	Longitude	Latitude	SST	SSS
37682	CODE/GPS	New		6/06/2003 18:57	12 41.68	44 55.43	22.9	36.9
37685	CODE/GPS	New		6/06/2003 19:54	12 43.42	44 48.47	22.8	34.8

Table 7. Deployment information for the drifters deployed near Po River plume .

3. Preliminary Results and Interpretation

3.1 Drifter tracks

Five-day long drifter trajectory segments in the northern and middle Adriatic basins are shown in Figure 11 for four consecutive periods spanning most of the cruise. Plus symbols represent

deployment locations, stars and open circles correspond to the first and last locations during the time period considered, respectively. Black solid symbols represent recovery locations. Note that the trajectory segment may be shorter than 5 days if the drifter was deployed or if it was recovered during the period considered. Only the positions provided by the Argos Doppler system and the positions of deployment/recovery are plotted.

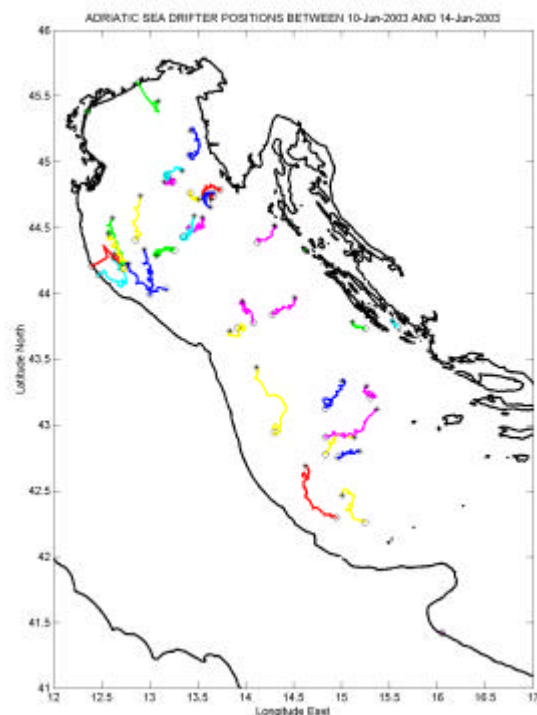
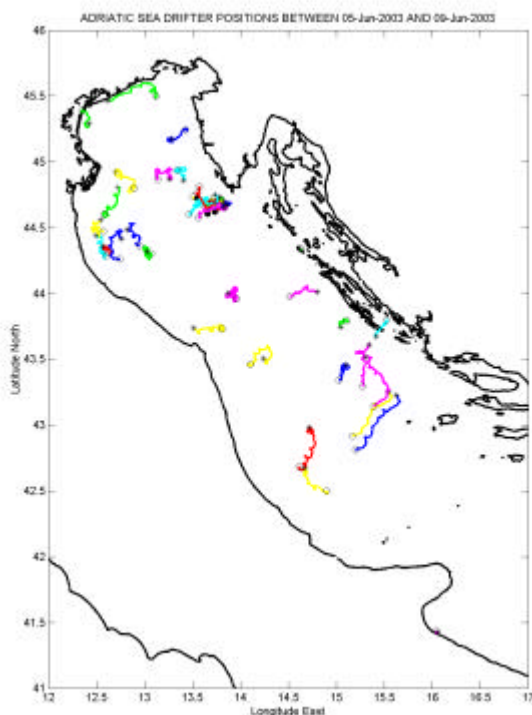
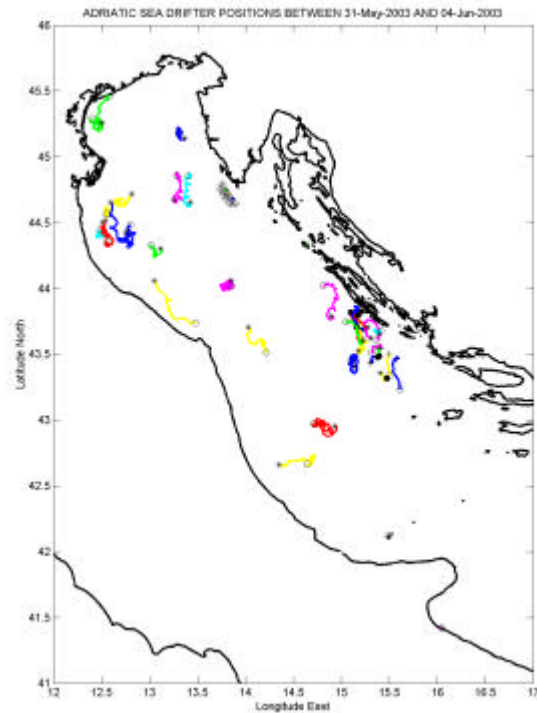
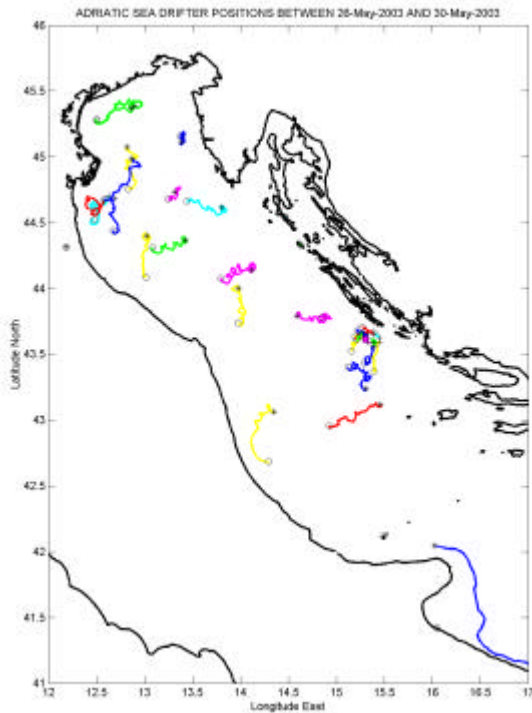


Figure 11. Five-day long trajectory segments of the drifters in the northern and middle Adriatic Sea for consecutive periods ending on 30 May (top left), on 4 June (top right), on 9 June (bottom left) and on 14 June 2003 (bottom right). See text for details.

3.2 Drifter Thermistor Data

Two CODE/Tz drifters with thermistor chains down to 50 or 30 m were operated on 29 May - 4 June and on 4-6 June 2003, during the MAF and NAF small-scale surveys. Examples of the processed and edited data are illustrated in Figures 12 and 13 for drifter 33354. The mean motion of the drifter was to the southwest and then to the northwest. Significant high-frequency (mostly inertial) motions are superimposed on these mean patterns. They are well resolved in the GPS positions sampled at half-hour intervals (see Figure 12)

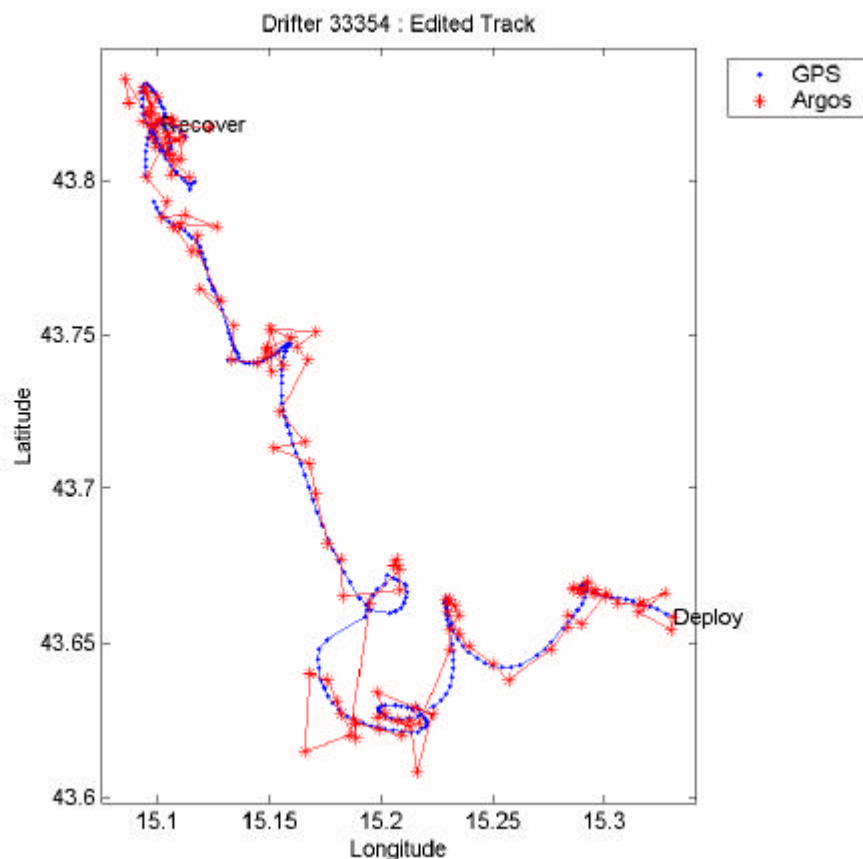


Figure 12. GPS (blue dot) and Argos (red star) locations of the CODE/Tz drifter 33354 launched during the MAF small-scale survey between 29 May and 4 June 2003. The GPS positions were sampled at half-hour intervals.

The thermal stratification of the water column above 50 m depth was well sampled by the 11 thermistors (10 units on the chain and one in the drifter body at about 30 cm below the surface;

see Figure 13). An increase of temperature from ~19 C to ~22 C is evident above 10 m during the period of observations. This trend is modulated by a diurnal signal.

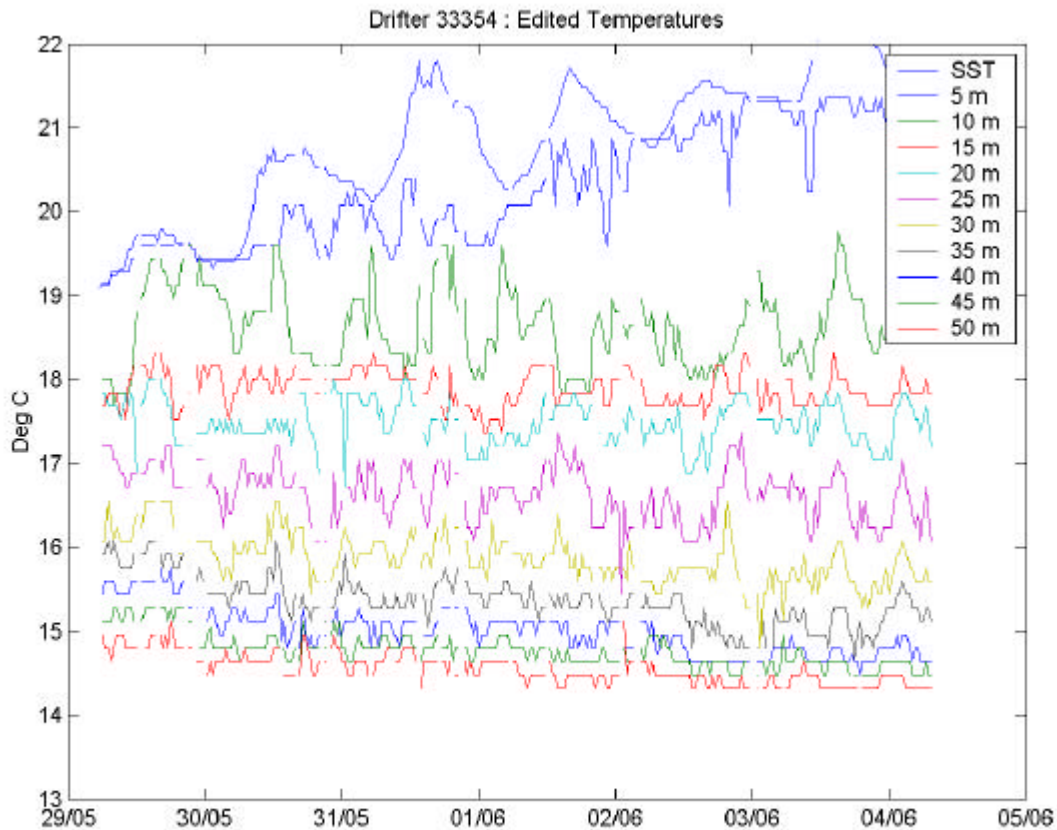


Figure 13. Temperatures versus time for drifter 33354 between 29 May and 4 June 2003 spanning the top water column between the surface (SST) and 50 m depth.

3.4 Drifter Optical Data

Two optical drifters (SVP/OCM) were operated on 29 May – 4 June and on 4-6 June 2003 during the MAF and NAF small-scale surveys. Examples of the processed and edited data are illustrated for drifter 33356 in Figures 14 to 17. This drifter moved to northwest with evident inertial oscillations (Figure 14). The time series of downwelling irradiance (at 490 nm) and upwelling radiances (at 7 visible wavelengths) for the period 29 May – 4 June 2003 are depicted in Figures 15 and 16. The diurnal variability is obviously striking. Spectra of the upwelling radiances are typical of oligotrophic waters (Figure 17). When scaled by the downwelling irradiance, the spread of the lines due to the different hours of the day is much reduced as

expected. The irradiances were calculated from the measured value at 490 nm (see an example of their daily variation in Figure 15) and the ratio computed from optical data measured by a MicroSAS instrument installed on the ship's bow (courtesy of B. Jones).

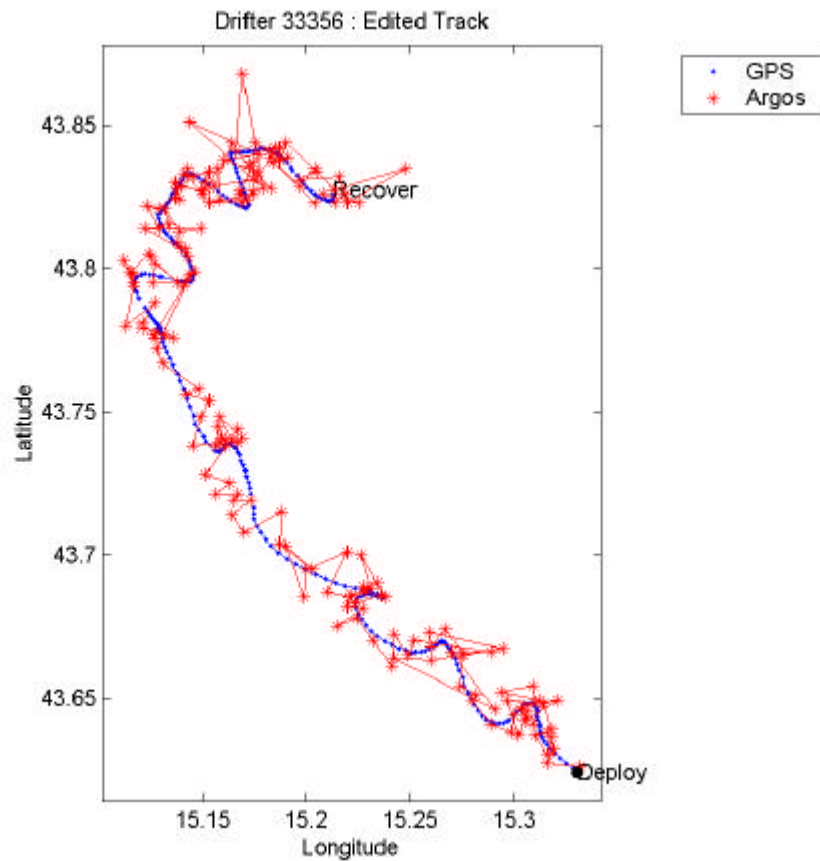


Figure 14. GPS (blue dot) and Argos (red star) locations of SVP/OCM drifter 33356 launched during the MAF survey between 29 May and 4 June 2003. GPS positions were sampled every half-hour.

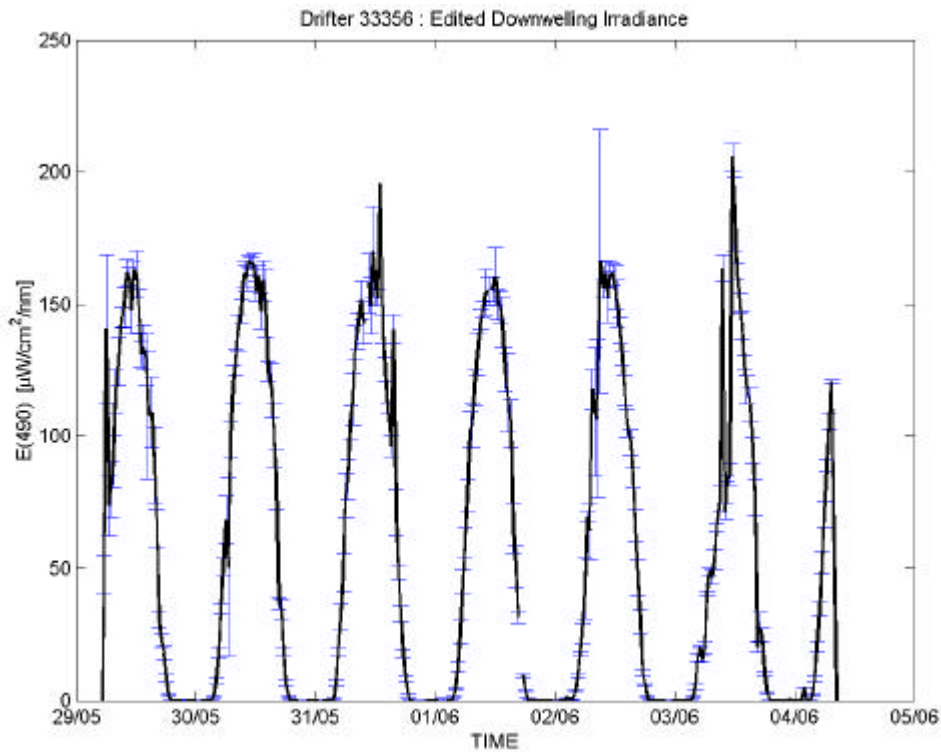


Figure 15. Downwelling irradiance at 490 nm ($\mu\text{W}/\text{cm}^2/\text{nm}$) data for drifter 33356 between 28 May and 2 June 2003.

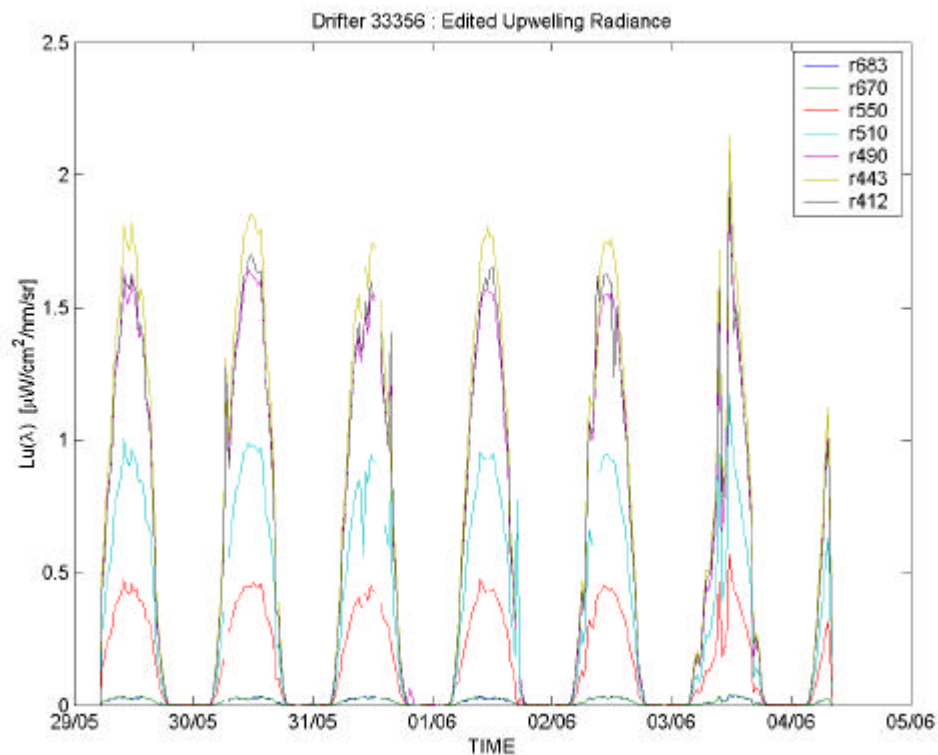


Figure 16. Upwelling radiance at 7 visible wavelengths ($\mu\text{W}/\text{cm}^2/\text{nm}/\text{sr}$) data for drifter 33356 between 28 May and 2 June 2003.

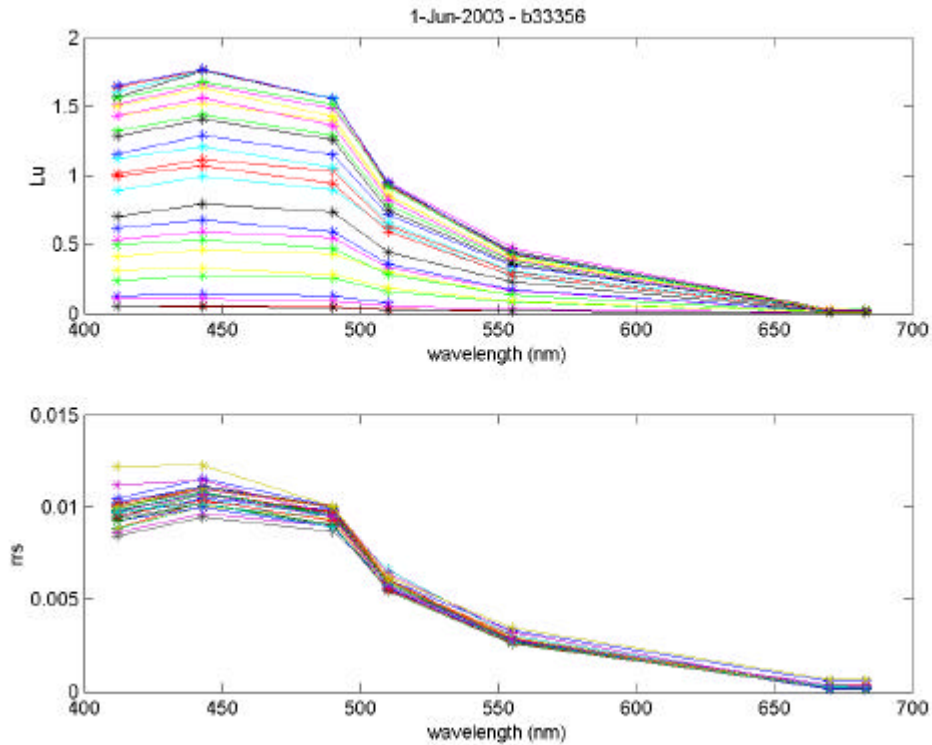


Figure 17. Upwelling radiance ($\text{mW}/\text{cm}^2/\text{nm}/\text{sr}$) data for drifter PTT ID 33356 on 1 June 2003 between 4:00 and 18:00 GMT for 7 channels in the visible band (top). Corresponding spectra of remote sensing reflectance (bottom).

3. Conclusions

In general, drifter operations during the DOLCEVITA-2 cruise were successful. Drifter deployment and recovery operations were very efficient, mostly because of the good sea conditions. A total of 34 deployment and 13 recovery operations were conducted. Eighteen drifters were left in the water.

The refurbished SVP/OCM and CODE/Tz drifters manufactured by Metocean worked satisfactorily according to the requested specifications, providing continuous times series of temperatures and optical properties at half-hour intervals.