Physical data report by station

Station n°145

LMD / UMR 8539 / Paris / France
LPO / UMR 6523 / Brest / France
IBENS / INSERM 1024 stations/ CNRS 8197 / Paris / France

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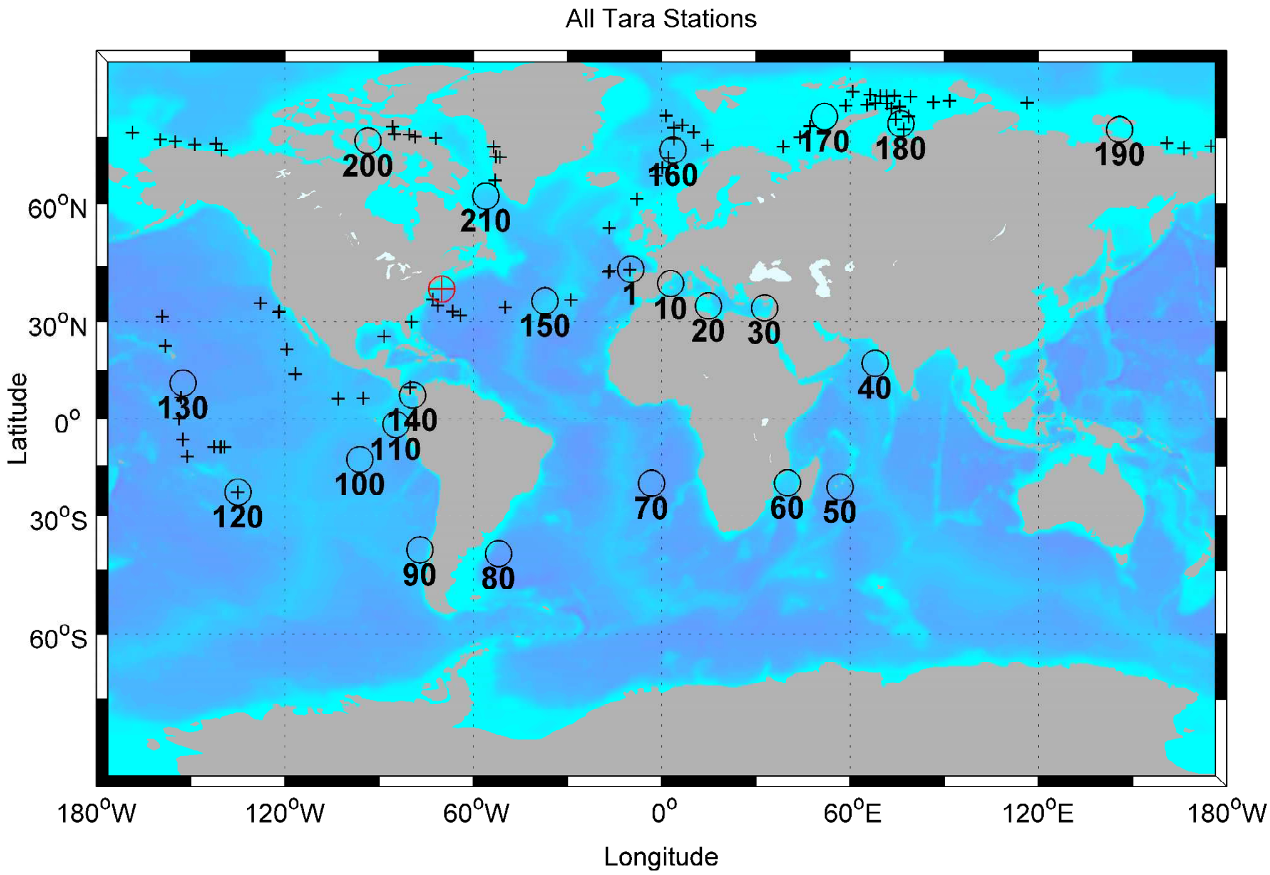

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Station overview

We present here the geographical situation of the station and a quick overview of the physical data available. For more information please see the next sections. About availability in the table below, 1 means "available" and 0 "not available".

Station n°	145
Location	North Pacific Ocean
Date	2/2/2012
Mean Longitude	-70.0565°
Mean Latitude	39.1839°
CTDs profiles	7

Availability:	
UV Satellite fields	1
SST Satellite fields	1
SSS Satellite fields	1
SSH Satellite fields	1
CHL1 Satellite fields	1
Argo floats	1

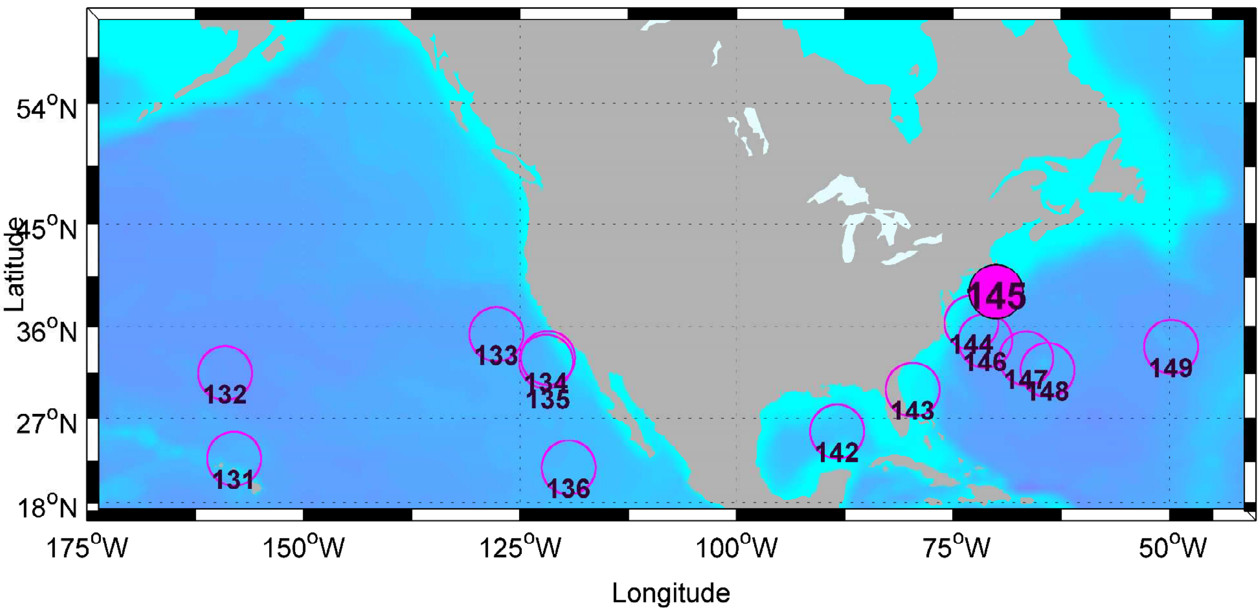

Figure 1: Filled magenta black circle indicate the station of this study.

1 Sea surface temperature, height and chlorophyll

1.1 Introduction

We present here several sea surface properties at the station position using satellite data (SSH $[m]$ in Fig.2 and Fig.3, the SST $[°C]$ in Fig.4 and Fig.5 and the CHL1 $[mg/m^3]$ in Fig.6 and Fig.7). We give definitions and information about these quantities below:

- Sea Surface Height (SSH): Maps of Absolute Dynamic Topography (MADT) from the global 1/4° (approx. $27km$) Daily Delayed Time Archiving Validation and Interpretation of Satellite Data in Oceanography (AVISO) field (Rio and Hernandez, 2004; Capet et al., 2014). The altimeter products were produced by Ssalto/Duacs and distributed by Aviso, with support from Cnes (`http://www.aviso.oceanobs.com/duacs/`).
- Sea Surface Temperature (SST): OSTIA uses satellite data provided by the GHRSST project, together with in-situ observations to determine the sea surface temperature. The analysis is performed using a variant of optimal interpolation (OI) described by Martin et al. (2007). The National Centre for Ocean Forecasting produces the analysis at a resolution of 1/20° (approx. $5km$). OSTIA data is provided in GHRSST netCDF format every day.
- Chlorophyll (CHL1): Weekly 1/10°Chlorophyll maps processed and distributed by ACRI-ST GlobColour service, supported by EU FP7 MyOcean & ESA GlobColour Projects, using ESA ENVISAT MERIS data, NASA MODIS and SeaWiFS data.

Legend In order to relieve figures we describe here their general legend:

- ● indicate the casts of Tara stations identified by their respective numbers.
- ○ are used to locate other Tara's stations around.
- □ refer to CTD profiles. When filled, each colour corresponds to a reference used in profiles plots (see CTD section) to make distinction between them.
- We indicate bathymetry by grey contours, horizontal geostrophic surface velocity field by dark arrows proportional to the current intensity, and SSH field by white contours.
- The ▼ is the nearest coast point (zlevel=0) of each ctd profile from etopo2 database
- When shown, $\bigtriangledown$ represent Argo's data available around the mean longitude and latitude position of CTDs. We defined a box around the mean position with $\Delta X \pm 4°$ $lat - lon$ and $\Delta t \pm 15$ $julian\ days$. Argo's numbers are only an index.
- Date refers to the day when SST, SSH or Chlorophyll maps are available.

1.2 SSH maps

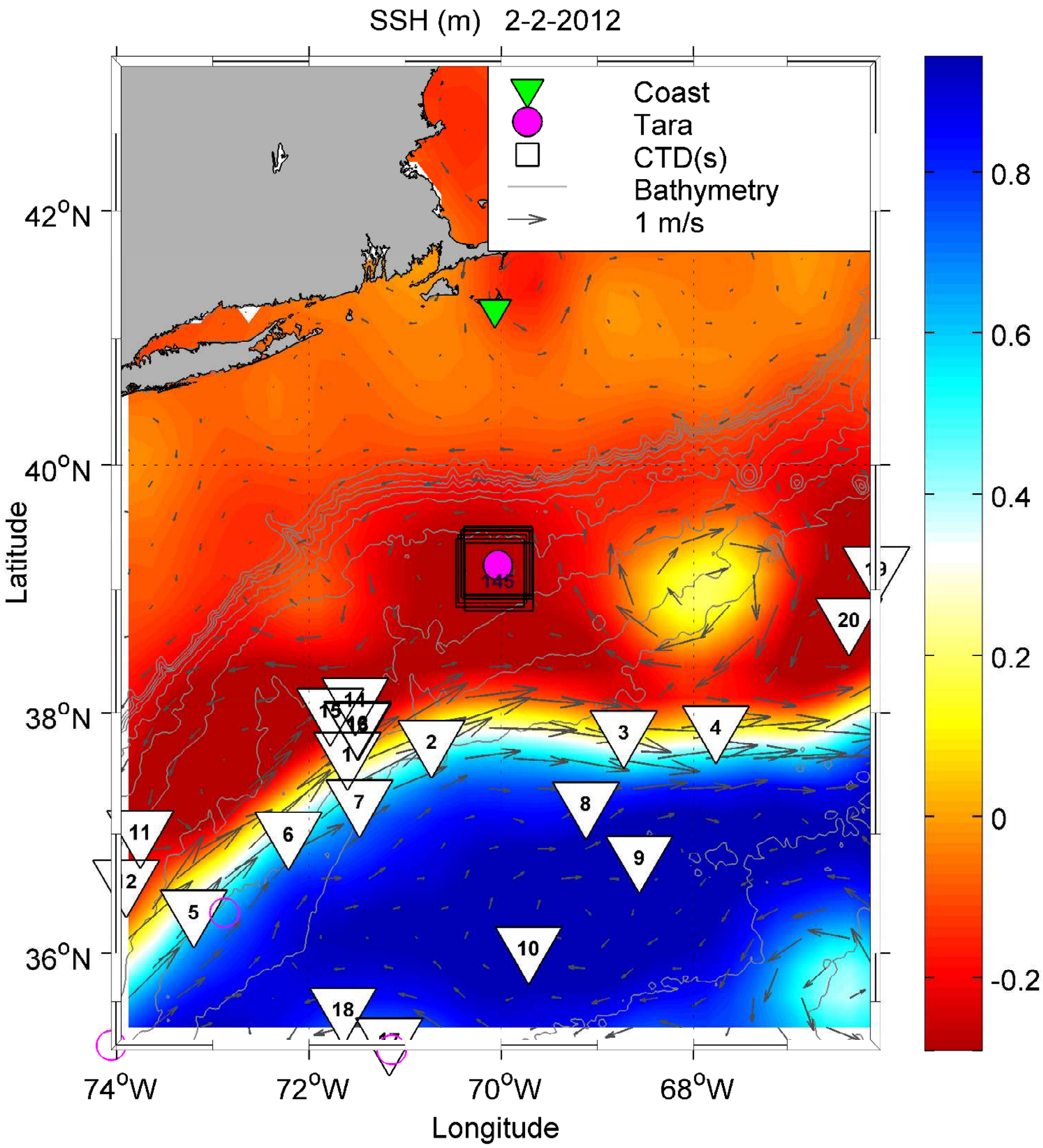

Figure 2: Description: see legend p. 14

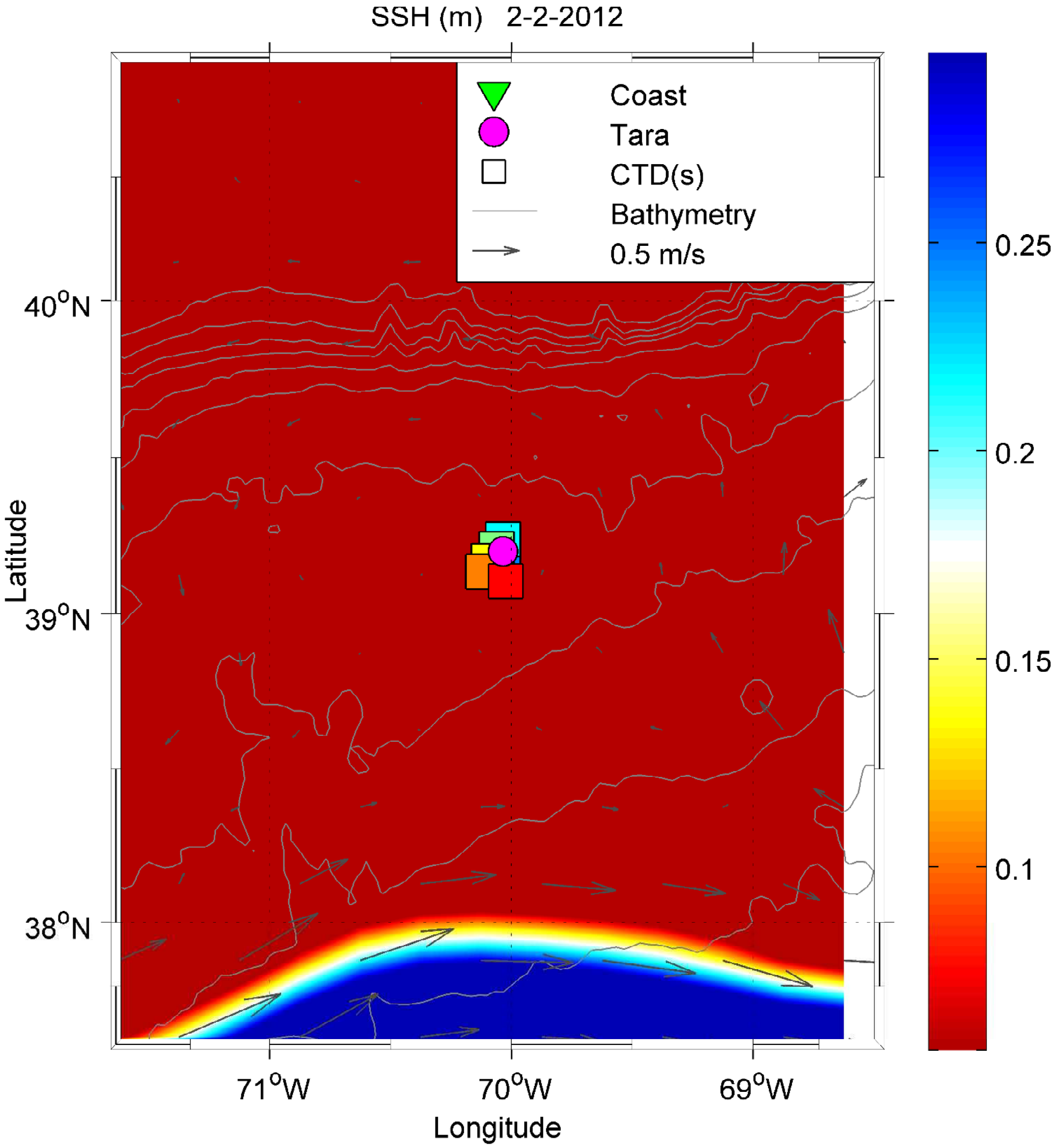

Figure 3: Description: see legend p. 14

1.3 SST maps

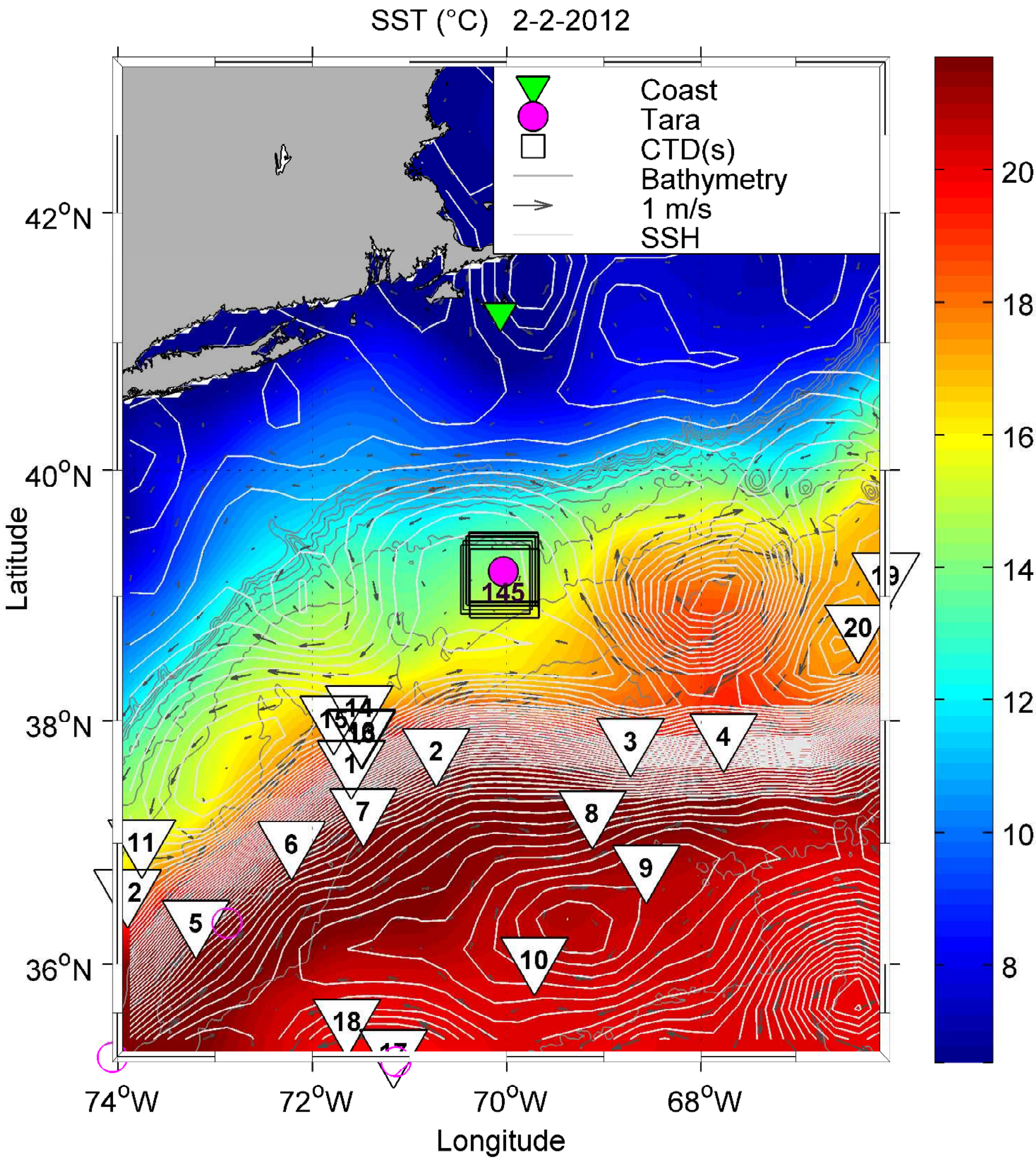

Figure 4: Description: see legend p. 14

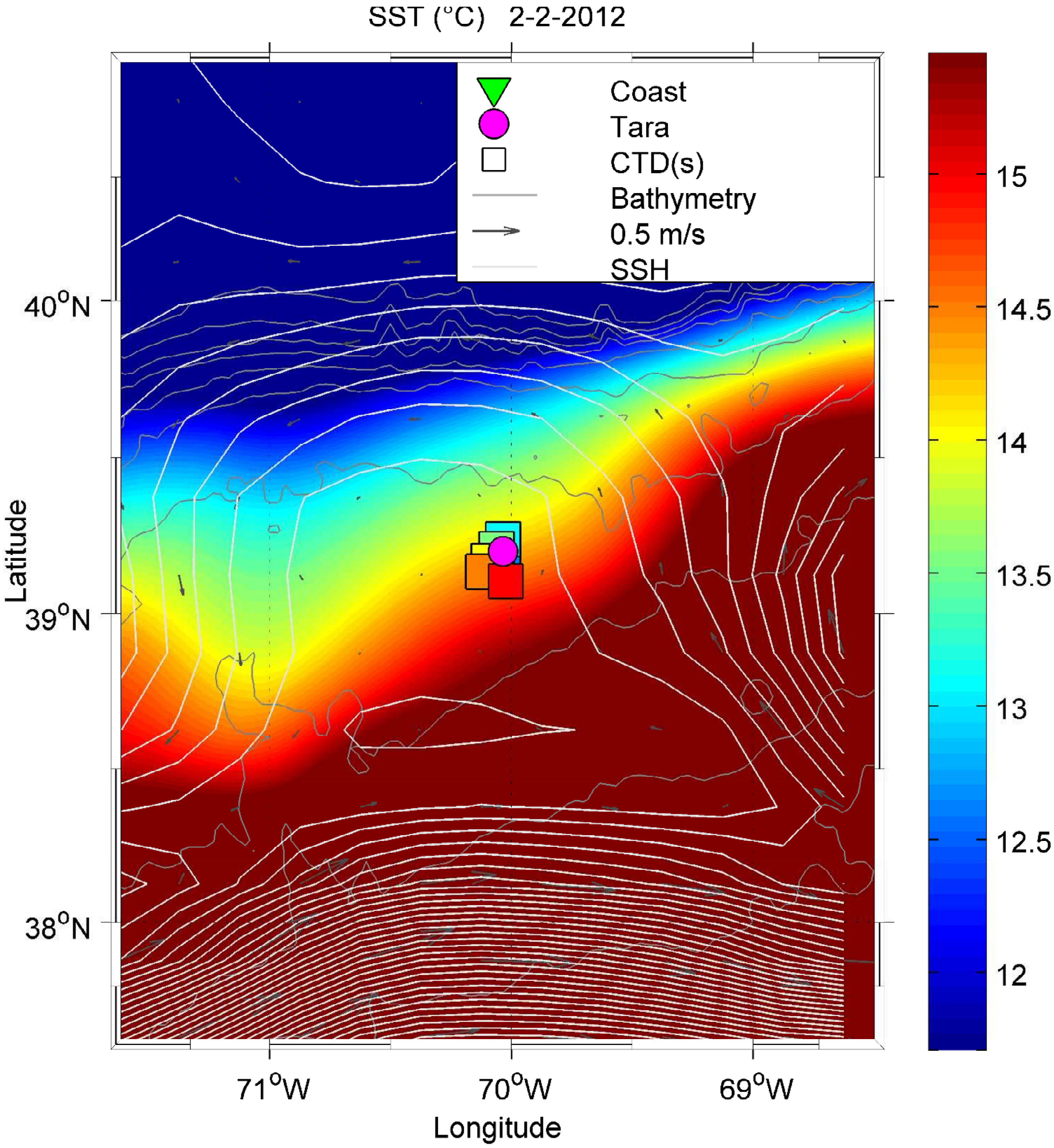

Figure 5: Description: see legend p. 14

1.4 Chlorophyl maps

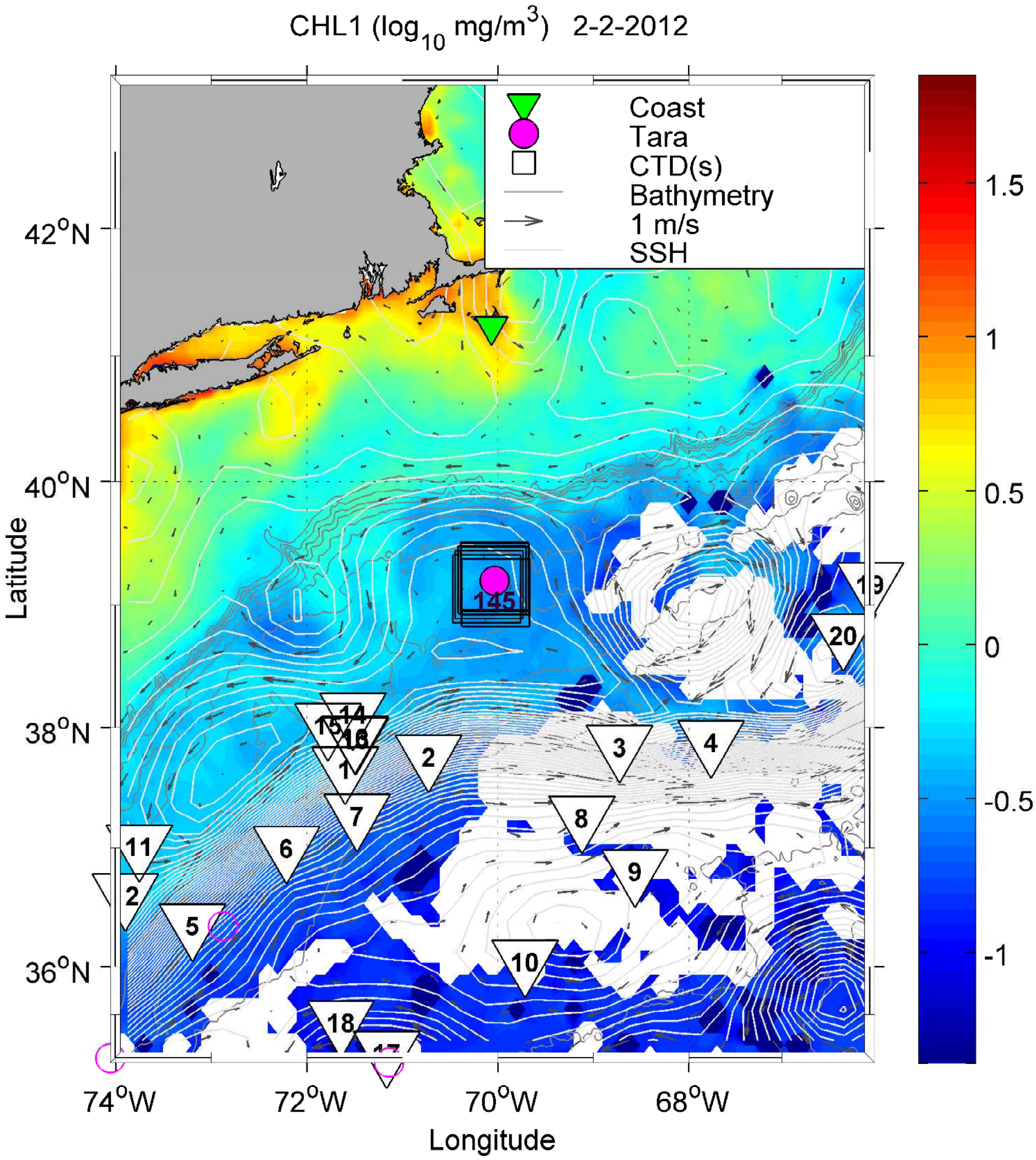

Figure 6: Description: see legend p. 14

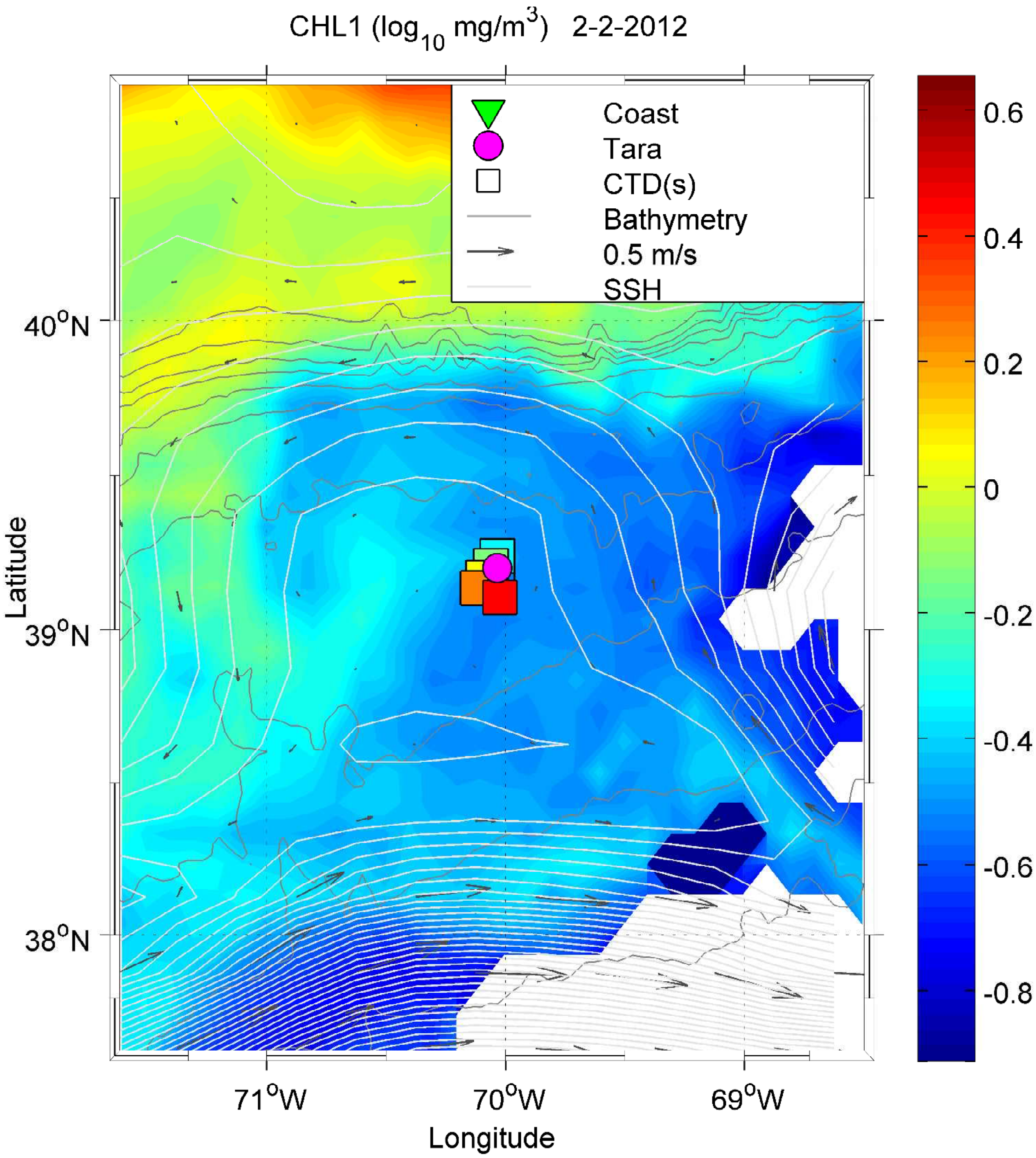

Figure 7: Description: see legend p. 14

2 TSG

2.1 Introduction

To complete the hydrological surface study, we use ThermoSalinoGraph (TSG) data measured by the Tara around the stations. Thermosalinographs are used to collect information about the sea surface, typically in flow-through systems operating continuously throughout a cruise.

We looked for the nearest TSG data available at $\Delta t \pm 15$ *julian days* around Tara stations. TSG data from the TARA OCEAN project (station 1 to 151) are validated but this is not the case of TSG data recorded during the TARA Porlar Cicle project that might present errors.23575 records satisfy these conditions. It is important to emphasize that TSG data are measure along the boat path whereas satellite data are snapshots.

TSG surface temperature is plotted over the Sea Surface Temperature measured by satellite and provided by OSTIA in figure 8.

TSG absolute salinity is plotted over the weekly Sea Surface Salinity data measured by Soil Moisture and Ocean Salinity (SMOS) mission in figure 9. The L3 SMOS data are available on the LOCEAN website (via a request form) but they still experience large biases and noise on various time and space scales. Nicolas KOLODZIEJCZYK work with a team at the LOCEAN to reduce these errors (see Hernandez et al. (2014), Kolodziejczyk et al. (2015b) and Kolodziejczyk et al. (2015a) for more information). These products are not perfect and large biases still exist but they are very promising. He gracefully gave us two types of corrected data for the context of this study:

- The most accurate set of data is composed of weekly map over the Atlantic (between 42N and 42S) with a resolution of 75 km for the period spanning from 2011 to 2013. Corrections are applied to reduce costal, large scale and seasonal orbit biases. An Optimal Interpolation using ISAS Argo interpolated products is performed.
- The other product is the 1/4 2days L3 SMOS data spanning from 30-Jun-2010 to 30-Aug-2014 on which a monthly filter and a systematic coastal bias correction are applied.

The Optimal interpolation product is not available for this station so the L3 band + coastal biais correction is ploted.

2.2 TSG Temperature maps

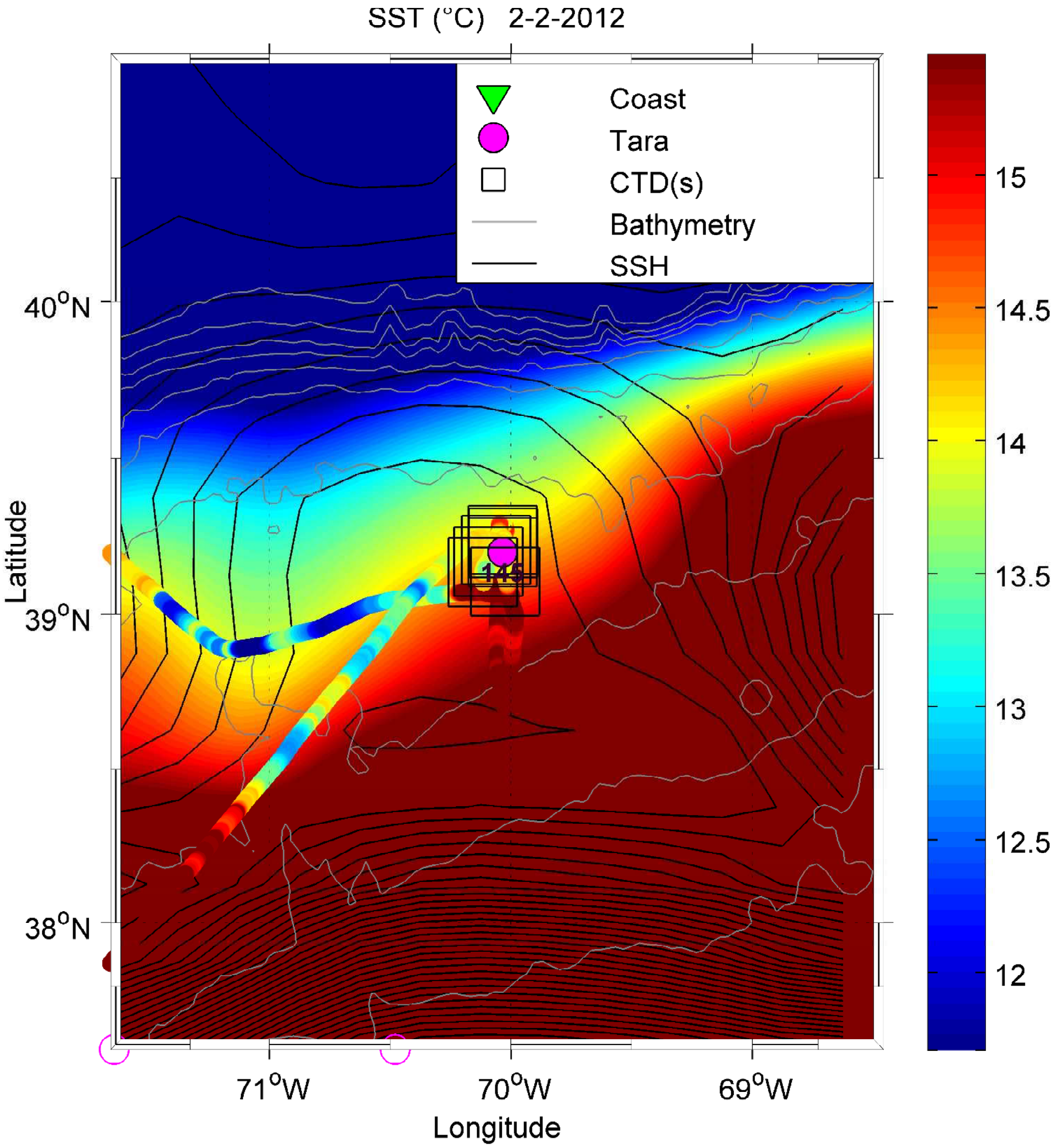

Figure 8: Description: see legend p. 14

2.3 TSG Salinity maps

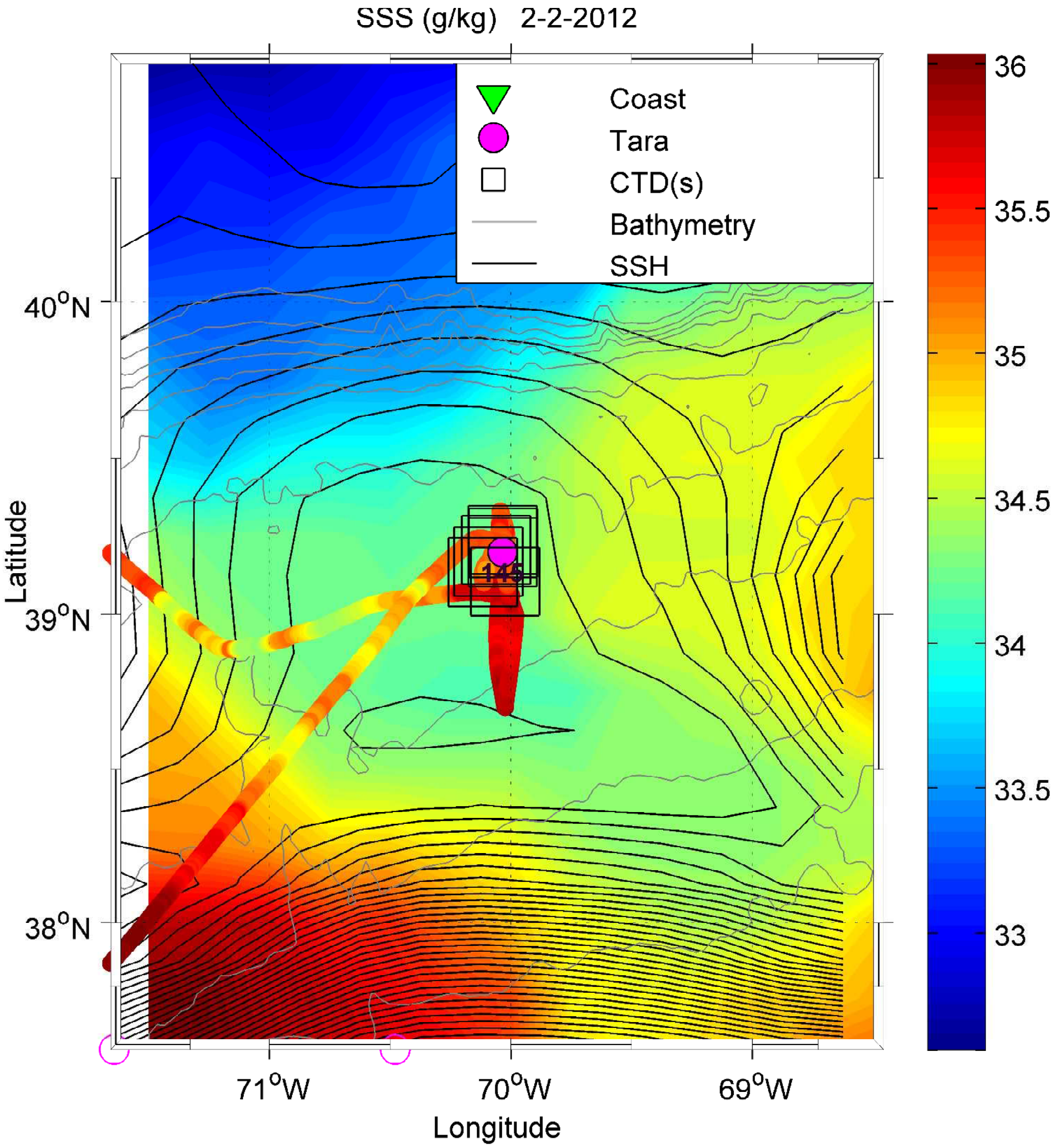

Figure 9: Description: see legend p. 14

3 Conductivity, Temperature and Depth (CTD) measurements

3.1 Introduction

In this study, CTD's measurements have been realized by a `Seabird vertical profiler`. The CTD profiles shown here are provided by the Villefranche Oceanographic Laboratory (LOV), Villefranche-Sur-Mer, France (http://www.obs-vlfr.fr/LOV/ZooPart/Portal/). Moreover, vertical profiles of Nitrate and Oxygen are provided. Additional quantities like salinity or density are then inferred using the Gibbs SeaWater (GSW) Oceanographic Toolbox (`http://www.teos-10.org/pubs/gsw/html/gsw_contents.html`).

For the Tara station n145, 7 CTD profiles are available. We calculate the potential density σ_0 referred to surface and the Brunt-Vaisala frequency (N^2). This one is a pulsation known as the "Brunt-Vaisala frequency" (s^{-2}), and given by:

$$N^2(z) = -\frac{g}{\rho_*}\frac{d\sigma}{dz} \tag{1}$$

where g is the vertical component of gravity, ρ_* a constant density value, d/dz the vertical derivative operator and σ the potential density (we use here σ_0). For more information please refer to Gerkema and Zimmerman (2008) (Eq. 3.18, p. 48 in the book). For each profile, $N^2(z)$ is calculated with a finite differences numerical scheme using $dz = 1m$. When calculated, $N^2(z)$ is averaged with a running median window on $30dbar$ ($\pm 5\ dbar$, centred) to filter noise at small vertical scales ($\sim 1\ m$).

We calculate the depth of mixed layer using two definitions given by De Boyer Montégut et al. (2004) to determine the MLD (m). Given a potential temperature profile $\theta(z)$ or a potential density profile $\sigma(z)$, we calculate z for which:

$$|\theta(z) - \theta(10m)| \leq 0.2\ °C \tag{2}$$

$$|\sigma(z) - \sigma(10m)| \leq 0.03\ kg/m^3 \tag{3}$$

Profiles and $\theta - S$ diagrams are presented on Fig. 10 and 11. Colors are used to distinct each CTD profile (dark blue for the first to red for the last one, "jet colorbar-like": dark blue, blue, light blue, cyan, green, yellow, orange, dark orange, red, dark red). Filled circles represent the bottle depths. We give bottles depths, and we calculate the N^2 and fluorescence maximum depths. We give the values of N^2 at all these different depths. Results are given in the Tab. 1

Several indices were computed to describe the context of CTD sampling. A season flag and a position in the season are given for each ctd sample. 4 "submesoscale" structures indices were computed at each ctd location from Satellite data. The intensity of the STT gradient and the intensity of the geostrophic currents are directly understandable. Strain rate is linked to the derivative of geostrophic current [see Waugh et al. (2006)] and Lyapunov exponent (computed by F.D'Ovidio [see d'Ovidio et al. (2004)])is a measure of the presence of a transport front where values in excess of 0.1 day-1 are typically fronts.

Legend In order to relieve figures we describe here their general legend:

- For each CTD we give the Tara's cast's number, CTD number, the bottom depth inferred from `eTopo2` bathymetry product, the distance, azimuth and position of nearest coast point (also inferred from etopo).
- Time information are then presented by giving the date in classic and julian format. Two season indices are presented: the season and the position in this season
- We give the fluo value at Max_{Fluo} depth, and a simple sum of fluo along vertical profile (from 1 to 200m, when possible).
- "Submesoscale" indices computed from satellite data are then presented.

- Ctd properties are then computed at precise depths: MLD_θ, MLD_σ, Max_{Fluo}, Max_{N^2} and each bottle depth.

3.2 CTD profiles

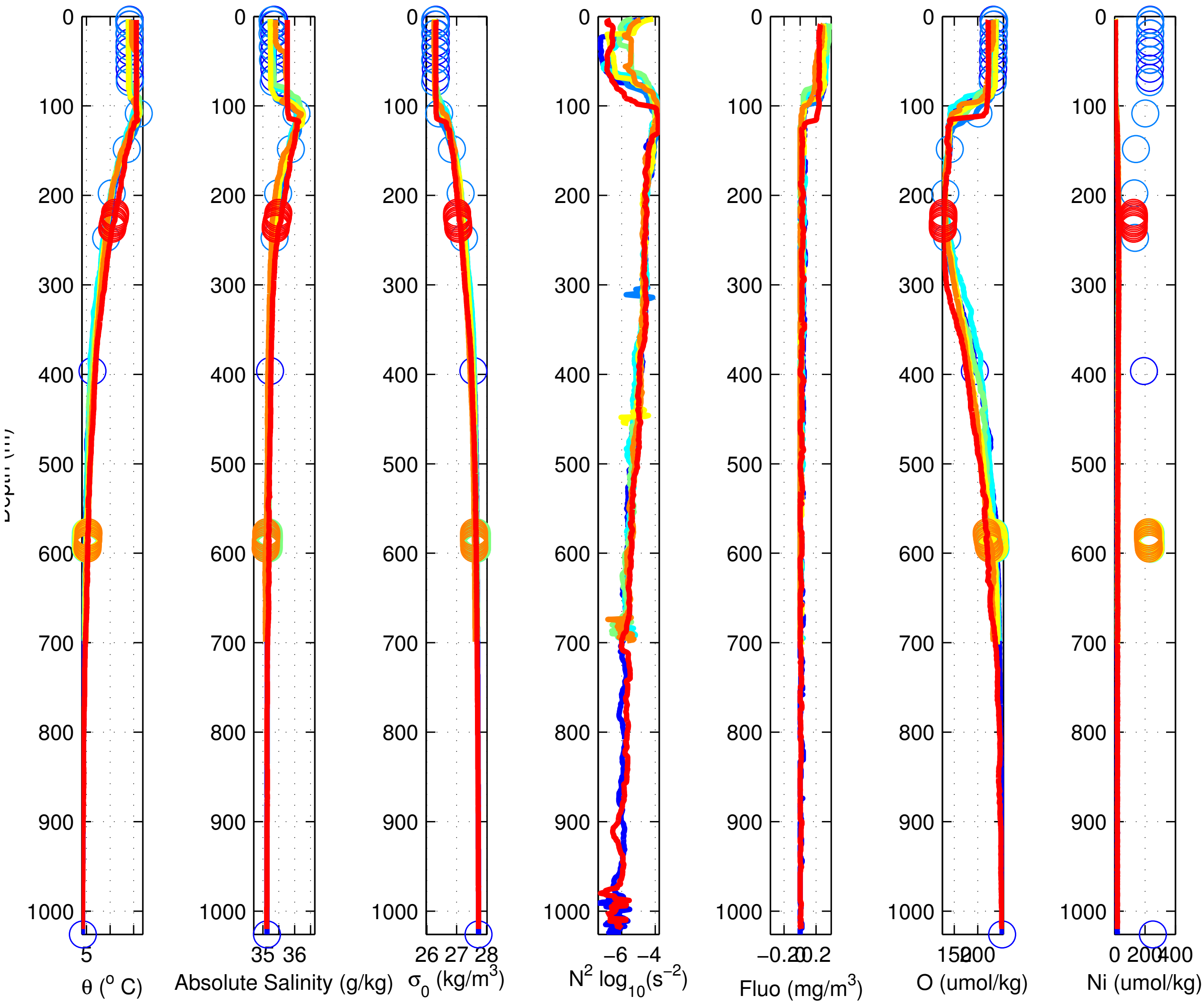

Figure 10: Description: see paragraph p. 14

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3.3 CTD $\theta - S$ diagrams

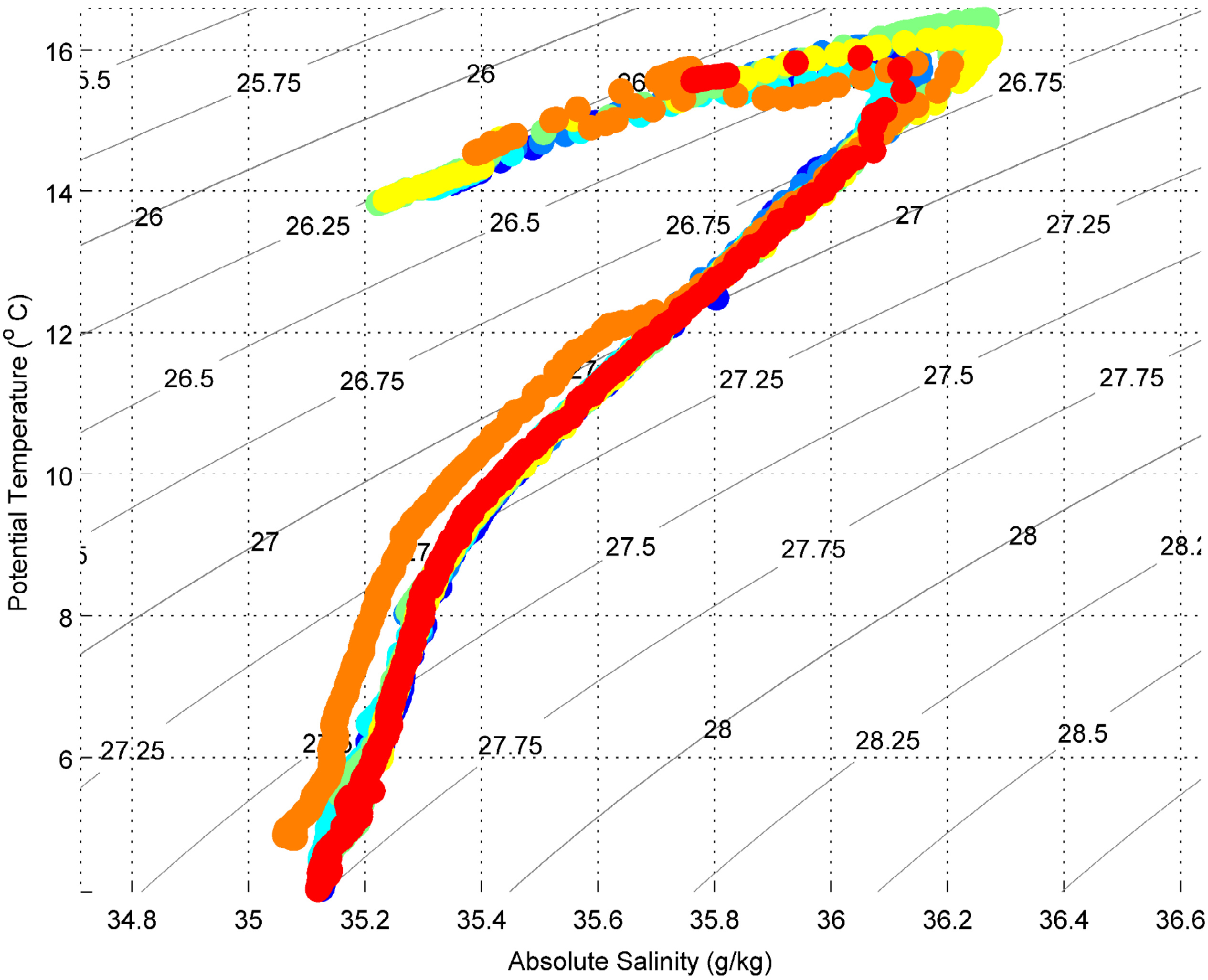

Figure 11: Description: see paragraph p. 14

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3.4 Water column characterization from CTD measurements

Profil	CTD	Lon	Lat	CTD Depth max (m)	Bathy (m)	Dist[km]/azimuth[°] coast	Lon coast	Lat coast
145	1	-70.0325	39.2302	1026	-2649	223/359	-70.0667	41.2333

Day	Month	Year	Julian day	Core biology Flag	Season	Season part (early-middle-late)
2	2	2012	2455960	1	Winter	Middle

$Max_{Fluo}(mg/m^3)$	Depth (m)	Sum $Fluo$ $1-200m(mg/m^3)$
0.31747	55	57.841

Intensity SST Gradient $(°/100km)$	Intensity Geostrophic current (m/s)	Strain $rate$ (s^{-2})	Lyapunov exponent $(1/days)$
2.6965	0.052165	1.0279e-05	0.047635

	Depth (m)	T $(°C)$	AS (g/kg)	σ_0 (kg/m^3)	N^2 (s^{-2})	$Fluo$ (mg/m^3)	O $(\mu mol/kg)$	Ni $(\mu mol/kg)$
$10m$	10	14.124	35.3501	26.3073	5.5265e-08	0.30767	234.202	2.9212
Max	1026	4.2238	35.1254	27.74	NaN	0	252.4319	17.9306
MLD_σ	91	14.9803	35.595	26.313	NaN	0.22807	192.1179	3.1002
MLD_θ	128	14.0167	35.9504	26.7953	0.00023132	0.04654	138.0038	13.4262
Max_{N2}	100	15.8048	36.0612	26.4863	0.00023584	0.066985	164.283	6.929
Max_{Fluo}	55	14.1332	35.3504	26.307	6.4547e-08	0.31747	233.5868	3.137
Max_O	1026	4.2238	35.1254	27.74	NaN	0	252.4319	17.9306
Min_O	212	10.373	35.4996	27.1538	5.0039e-05	0.040949	130.0597	20.655
$Depth\ Nitro$	105	15.5536	36.1291	26.5955	NaN	0.055437	150.5436	8.6942
B i1	1036	NaN	NaN	NaN	NaN	NaN	NaN	NaN
B i2	400	6.1081	35.2252	27.5913	4.0054e-05	0.052977	200.5002	19.6967
B i3	70	14.1358	35.3506	26.3071	2.1109e-07	0.31559	233.1489	5.1617
B i4	60	14.1329	35.3503	26.3071	7.089e-08	0.31817	233.3448	3.3413
B i5	50	14.1326	35.3505	26.307	5.4373e-08	0.31482	233.5837	3.0738
B i6	40	14.1288	35.35	26.3072	4.8192e-08	0.30929	234.0272	2.9457
B i7	30	14.1295	35.3502	26.3069	1.3293e-08	0.30929	233.5153	2.4451
B i8	20	14.1263	35.3497	26.3069	8.6849e-08	0.30929	233.531	1.8833
B i9	10	14.124	35.3501	26.3073	5.5265e-08	0.30767	234.202	2.9212
B i10	5	14.1156	35.35	26.3089	9.7647e-06	NaN	233.8541	3.7066

Table 1:

Profil	CTD	Lon	Lat	CTD Depth max (m)	Bathy (m)	Dist[km]/azimuth[°] coast	Lon coast	Lat coast
145	2	-70.0343	39.2003	317	-2663	226/359	-70.0667	41.2333

Day	Month	Year	Julian day	Core biology Flag	Season	Season part (early-middle-late)
2	2	2012	2455960	1	Winter	Middle

$Max_{Fluo}(mg/m^3)$	Depth (m)	Sum $Fluo$ $1-200m(mg/m^3)$
0.30814	13	57.841

Intensity SST Gradient $(°/100km)$	Intensity Geostrophic current (m/s)	Strain $rate$ (s^{-2})	Lyapunov exponent $(1/days)$
2.7923	0.050494	9.234e-06	0.047635

	Depth (m)	T $(°C)$	AS (g/kg)	σ_0 (kg/m^3)	N^2 (s^{-2})	$Fluo$ (mg/m^3)	O $(\mu mol/kg)$	Ni $(\mu mol/kg)$
$10m$	10	14.0782	35.3129	26.2884	5.188e-07	0.32296	234.8638	6.7681
Max	317	7.7289	35.2837	27.4129	NaN	0	157.3569	24.694
MLD_σ	97	15.0909	35.6305	26.3162	0.00011489	0.18183	212.1006	4.466
MLD_θ	143	13.9515	35.9447	26.8051	0.00013215	0.035386	140.5446	18.264
Max_{N2}	123	15.7316	36.1535	26.5745	0.00025909	0.012847	149.9756	10.2005
Max_{Fluo}	13	14.089	35.3138	26.2869	NaN	0.30814	234.6729	4.5008
Max_O	14	14.0885	35.3136	26.2869	6.4656e-07	0.30814	234.718	4.6118
Min_O	210	10.1792	35.4663	27.1616	1.3177e-05	0	130.3224	23.6683
$Depth\ Nitro$	125	15.5771	36.1439	26.6023	8.5405e-05	0.0098432	146.4125	11.3116
B i1	250	9.1869	35.3686	27.2528	1.2906e-05	0.012725	134.3861	26.643
B i2	200	10.5238	35.5162	27.14	3.3231e-05	0.011553	130.6171	24.3458
B i3	150	13.5264	35.8862	26.849	8.4923e-05	0.0063115	140.1626	17.555
B i4	110	16.0364	36.0498	26.4248	1.108e-05	0.040949	194.9924	6.6385
B i5	75	14.1148	35.3194	26.2877	1.1901e-06	0.27198	233.7189	5.6508
B i6	50	14.1179	35.3199	26.2866	9.0588e-08	0.27908	233.9232	5.6554
B i7	35	14.1153	35.3186	26.2857	1.7738e-08	0.29645	233.8625	5.3893
B i8	20	14.0889	35.3134	26.2869	4.9388e-07	0.30859	235.1057	4.6303
B i9	10	14.0782	35.3129	26.2884	5.188e-07	0.32296	234.8638	6.7681
B i10	5	14.079	35.3134	26.2885	1.0652e-05	NaN	235.2285	4.8104

Table 2:

$Profil$	CTD	Lon	Lat	CTD Depth max (m)	Bathy (m)	Dist[km]/azimuth[°] coast	Lon coast	Lat coast
145	3	-70.0343	39.2392	698	-2645	222/359	-70.0667	41.2333

Day	Month	Year	Julian day	Core biology Flag	Season	Season part (early-middle-late)
2	2	2012	2455960	1	Winter	Middle

$Max_{Fluo}(mg/m^3)$	Depth (m)	Sum $Fluo$ $1-200m(mg/m^3)$
0.36074	14	57.841

Intensity SST Gradient $(°/100km)$	Intensity Geostrophic current (m/s)	Strain $rate$ (s^{-2})	Lyapunov exponent $(1/days)$
2.6475	0.052477	1.0635e-05	0.047635

	Depth (m)	T $(°C)$	AS (g/kg)	σ_0 (kg/m^3)	N^2 (s^{-2})	$Fluo$ (mg/m^3)	O $(\mu mol/kg)$	Ni $(\mu mol/kg)$
$10m$	10	14.0583	35.3199	26.298	2.9161e-06	0.34894	235.9124	7.1327
Max	698	4.5824	35.1245	27.6974	NaN	0.040949	245.9207	18.3089
MLD_σ	82	14.8629	35.5701	26.3195	0.00021912	0.22617	215.3624	5.8658
MLD_θ	125	13.9141	35.9522	26.8183	4.3598e-05	0.040949	137.369	17.7954
Max_{N^2}	100	15.6053	36.0725	26.5402	NaN	0.050182	150.8325	13.4124
Max_{Fluo}	14	14.0603	35.3203	26.298	1.2037e-06	0.36074	236.1528	4.6719
Max_O	696	4.5831	35.1243	27.6972	1.3185e-06	0.025182	245.9599	19.3767
Min_O	176	11.1689	35.5839	27.0759	8.9396e-05	0.035492	130.5363	23.0998
$Depth\ Nitro$	92	15.4275	35.8798	26.4324	0.00015334	0.066985	171.8998	7.6204
B i1	600	4.8287	35.1334	27.676	3.5384e-06	0	238.0654	19.8256
B i2	598	4.8349	35.1333	27.6751	2.6257e-06	0	237.9573	18.4299
B i3	596	4.8389	35.1334	27.6748	1.4224e-06	0	237.7719	19.4702
B i4	594	4.8463	35.1338	27.6742	1.9148e-06	0	237.4495	18.8623
B i5	592	4.8516	35.1342	27.6739	3.1651e-06	0	237.3509	19.8955
B i6	590	4.8577	35.1343	27.6732	1.6923e-06	0	237.1775	20.3129
B i7	588	4.8639	35.1348	27.673	2.7661e-06	0	236.8776	20.6624
B i8	586	4.8678	35.1348	27.6725	2.6195e-06	0.010449	236.4349	22.3978
B i9	584	4.8705	35.1343	27.6717	2.8609e-06	0.012055	236.1857	18.2455
B i10	582	4.8734	35.1344	27.6715	1.9904e-06	0.026672	236.5932	18.6463

Table 3:

$Profil$	CTD	Lon	Lat	CTD Depth max (m)	Bathy (m)	Dist[km]/azimuth[°] coast	Lon coast	Lat coast
145	4	-70.0612	39.2075	696	-2661	226/360	-70.0667	41.2333

Day	Month	Year	Julian day	Core biology Flag	Season	Season part (early-middle-late)
2	2	2012	2455960	1	Winter	Middle

$Max_{Fluo}(mg/m^3)$	Depth (m)	Sum $Fluo$ $1-200m(mg/m^3)$
0.36981	13	57.841

Intensity SST Gradient $(°/100km)$	Intensity Geostrophic current (m/s)	Strain $rate$ (s^{-2})	Lyapunov exponent $(1/days)$
2.7564	0.045804	9.9516e-06	0.047635

	Depth (m)	T $(°C)$	AS (g/kg)	σ_0 (kg/m^3)	N^2 (s^{-2})	$Fluo$ (mg/m^3)	O $(\mu mol/kg)$	Ni $(\mu mol/kg)$
$10m$	10	13.8408	35.2246	26.2704	5.3133e-08	0.37179	240.2218	5.4585
Max	696	4.6346	35.1359	27.7006	NaN	0	244.3191	20.4345
MLD_σ	78	14.8475	35.5067	26.2741	0.00014349	0.19094	221.8951	7.6198
MLD_θ	140	13.7163	35.9323	26.8449	0.0001189	0	136.5505	18.5526
Max_{N^2}	113	15.9444	36.2154	26.5729	0.00029608	0.040949	147.283	12.4625
Max_{Fluo}	13	13.8462	35.2266	26.2709	4.5117e-07	0.36981	240.0851	5.693
Max_O	696	4.6346	35.1359	27.7006	NaN	0	244.3191	20.4345
Min_O	192	10.5744	35.511	27.1268	NaN	0	130.7571	24.5893
$Depth\ Nitro$	695	4.6379	35.1364	27.7006	1.4267e-06	0	244.1121	18.1393
B i1	600	5.009	35.1712	27.6852	1.1157e-06	0	231.4614	21.5063
B i2	598	5.041	35.1754	27.6847	8.042e-07	0	230.1474	20.9691
B i3	596	5.0478	35.1761	27.6845	8.4215e-07	0	229.5659	19.1992
B i4	594	5.0627	35.1793	27.6853	1.2705e-06	0	229.2226	21.7084
B i5	592	5.0692	35.1793	27.6845	1.1983e-06	0	228.5304	19.3706
B i6	590	5.0539	35.1761	27.6837	1.1738e-06	0	228.932	21.5211
B i7	588	5.0446	35.1754	27.6842	1.0869e-06	0	229.5084	19.3519
B i8	586	5.0787	35.1819	27.6853	1.647e-06	0	229.5913	20.7551
B i9	584	5.1422	35.1883	27.683	8.6144e-06	0	227.205	19.3701
B i10	582	5.1369	35.1861	27.6819	1.4177e-06	0	226.0094	20.6161

Table 4:

$Profil$	CTD	Lon	Lat	CTD Depth max (m)	Bathy (m)	Dist[km]/azimuth[°] coast	Lon coast	Lat coast
145	5	-70.0933	39.1694	702	-2693	230/1	-70.0667	41.2333

Day	Month	Year	Julian day	Core biology Flag	Season	Season part (early-middle-late)
2	2	2012	2455960	1	Winter	Middle

$Max_{Fluo}(mg/m^3)$	Depth (m)	Sum $Fluo$ $1-200m(mg/m^3)$
0.3129	25	57.841

Intensity SST Gradient $(°/100km)$	Intensity Geostrophic current (m/s)	Strain $rate$ (s^{-2})	Lyapunov exponent $(1/days)$
2.8411	0.040254	9.1282e-06	0.047635

	Depth (m)	T $(°C)$	AS (g/kg)	σ_0 (kg/m^3)	N^2 (s^{-2})	$Fluo$ (mg/m^3)	O $(\mu mol/kg)$	Ni $(\mu mol/kg)$
$10m$	10	13.8834	35.2363	26.2705	1.5808e-07	0.30014	238.4432	4.8491
Max	702	4.7351	NaN	NaN	NaN	0.025033	242.127	19.009
MLD_σ	93	15.0341	35.5576	26.2728	0.00027476	0.16312	216.0686	5.9861
MLD_θ	142	13.7733	35.9543	26.8499	8.3566e-05	0.028797	138.808	19.8685
Max_{N^2}	103	16.1088	36.1262	26.4663	0.00020639	0.05461	174.9427	9.7937
Max_{Fluo}	25	13.8881	35.2368	26.2703	1.0629e-07	0.3129	238.0182	5.7028
Max_O	701	4.7361	NaN	NaN	NaN	0.025033	242.2237	18.602
Min_O	182	10.9448	35.5586	27.0973	5.4191e-05	0.025033	129.6753	23.6557
$Depth\ Nitro$	102	16.0518	36.082	26.4456	0.00013295	0.05461	177.4512	8.5796
B i1	600	4.946	NaN	NaN	NaN	0.013692	236.1457	20.3215
B i2	598	4.9468	NaN	NaN	NaN	0.013692	235.9719	18.7018
B i3	596	4.9504	NaN	NaN	NaN	0.011254	235.7509	20.2354
B i4	594	4.9607	NaN	NaN	NaN	0.013692	235.795	19.4069
B i5	592	4.9743	NaN	NaN	NaN	0.010273	234.7686	20.3767
B i6	590	4.9629	NaN	NaN	NaN	0.007137	234.7117	20.2708
B i7	588	4.9672	NaN	NaN	NaN	0.007137	235.6805	20.2433
B i8	586	4.9745	NaN	NaN	NaN	0.0077598	235.3344	19.4734
B i9	584	4.9742	NaN	NaN	NaN	0.0067834	235.449	19.4762
B i10	582	4.9884	NaN	NaN	NaN	0.0059067	234.7395	18.6712

Table 5:

$Profil$	CTD	Lon	Lat	CTD Depth max (m)	Bathy (m)	Dist[km]/azimuth[°] coast	Lon coast	Lat coast
145	6	-70.1163	39.1358	699	-2720	234/1	-70.0667	41.2333

Day	Month	Year	Julian day	Core biology Flag	Season	Season part (early-middle-late)
2	2	2012	2455960	1	Winter	Middle

$Max_{Fluo}(mg/m^3)$	Depth (m)	Sum $Fluo$ $1-200m(mg/m^3)$
0.28338	14	57.841

Intensity SST Gradient $(°/100km)$	Intensity Geostrophic current (m/s)	Strain $rate$ (s^{-2})	Lyapunov exponent $(1/days)$
2.9682	0.039287	8.3085e-06	0.047635

	Depth (m)	T $(°C)$	AS (g/kg)	σ_0 (kg/m^3)	N^2 (s^{-2})	$Fluo$ (mg/m^3)	O $(\mu mol/kg)$	Ni $(\mu mol/kg)$
$10m$	10	14.5424	35.3922	26.2503	4.318e-06	0.28347	233.5643	6.4758
Max	699	4.9215	35.0793	27.6237	NaN	0	233.6182	19.0594
MLD_σ	89	15.6133	35.7353	26.2797	2.8576e-05	0.15438	212.8921	5.7995
MLD_θ	126	14.3681	36.0198	26.7737	8.5181e-05	0	139.4909	16.2658
Max_{N^2}	102	15.3567	35.9475	26.5005	0.00011632	0.040949	160.5272	11.8983
Max_{Fluo}	14	14.5809	35.4032	26.2506	1.6852e-06	0.28338	232.7941	4.5331
Max_O	623	4.9647	35.0628	27.6049	2.6937e-06	0	234.5046	19.6659
Min_O	203	10.1499	35.3741	27.0949	1.0604e-05	0.026785	129.1692	25.7503
$Depth\ Nitro$	99	15.3704	35.8364	26.4121	0.00051304	0.091086	163.6524	8.9893
B i1	600	5.026	35.066	27.6001	8.8937e-07	0	232.2058	19.9989
B i2	598	5.0347	35.0673	27.6002	9.3829e-07	0	231.8556	19.7842
B i3	596	5.0601	35.0734	27.602	2.8162e-06	0	231.6945	19.8798
B i4	594	5.1025	35.0763	27.5994	4.7871e-07	0	229.9268	20.4398
B i5	592	5.1325	35.0793	27.5982	6.8352e-07	0	228.6032	20.0305
B i6	590	5.1605	35.0833	27.5981	2.7704e-06	0	227.9764	19.4374
B i7	588	5.2007	35.0909	27.5994	1.7415e-06	0	227.0757	20.9945
B i8	586	5.2397	35.0965	27.5991	2.8502e-06	0	225.4354	21.9439
B i9	584	5.2695	35.0954	27.5947	4.2522e-06	0	223.825	20.9019
B i10	582	5.3156	35.1058	27.5974	1.1465e-05	0	223.1212	19.837

Table 6:

$Profil$	CTD	Lon	Lat	CTD Depth max (m)	Bathy (m)	Dist[km]/azimuth[°] coast	Lon coast	Lat coast
145	7	-70.0234	39.1049	1020	-2687	237/359	-70.0667	41.2333

Day	Month	Year	Julian day	Core biology Flag	Season	Season part (early-middle-late)
4	2	2012	2455962	1	Winter	Middle

$Max_{Fluo}(mg/m^3)$	Depth (m)	Sum $Fluo$ $1-200m(mg/m^3)$
0.2343	71	57.841

Intensity SST Gradient $(°/100km)$	Intensity Geostrophic current (m/s)	Strain $rate$ (s^{-2})	Lyapunov exponent $(1/days)$
3.3696	0.061433	1.0927e-05	0.047635

	Depth (m)	T $(°C)$	AS (g/kg)	σ_0 (kg/m^3)	N^2 (s^{-2})	$Fluo$ (mg/m^3)	O $(\mu mol/kg)$	Ni $(\mu mol/kg)$
$10m$	10	15.5731	35.7664	26.3098	7.6704e-08	0.25113	222.0029	5.7135
Max	1020	4.2196	35.119	27.7353	NaN	0.013268	251.8722	19.1112
MLD_σ	114	15.6553	35.822	26.3375	0.00025705	0.20955	159.3422	6.4166
MLD_θ	118	15.4351	36.124	26.6187	0.00053502	0.09546	141.2099	12.6588
Max_{N^2}	118	15.4351	36.124	26.6187	0.00053502	0.09546	141.2099	12.6588
Max_{Fluo}	71	15.5766	35.7664	26.3112	1.9042e-07	0.2343	222.6317	5.7382
Max_O	1020	4.2196	35.119	27.7353	NaN	0.013268	251.8722	19.1112
Min_O	239	10.3624	35.477	27.1387	1.588e-05	0.046588	125.7815	26.6022
$Depth$ $Nitro$	116	15.9052	36.0502	26.4555	0.00077711	0.19751	139.8181	8.7562
B i1	240	10.3224	35.4722	27.142	1.8712e-05	0.046588	125.8964	28.7146
B i2	238	10.4071	35.4887	27.14	1.8101e-05	0.046588	125.6489	26.3409
B i3	236	10.4998	35.4974	27.1304	2.9854e-05	0.031939	125.6816	25.9332
B i4	234	10.5844	35.5111	27.1261	NaN	0.031939	125.5502	23.8159
B i5	232	10.7075	35.5247	27.1147	7.2849e-06	0.027291	126.1124	25.2943
B i6	230	10.8443	35.5537	27.1126	7.7675e-05	0.025033	126.5738	23.3297
B i7	228	11.036	35.5662	27.0877	0.00012226	0.024696	126.2155	24.493
B i8	226	11.0619	35.5695	27.0855	5.9318e-06	0.025033	126.9064	24.0328
B i9	224	11.0951	35.5725	27.0817	1.226e-05	0.025033	127.2065	24.0055
B i10	222	11.1363	35.5806	27.0804	6.5324e-06	0.025033	127.7671	24.1102

Table 7:

4 ARGO

4.1 Introduction

To complete the CTD study, we use ARGO data available around Tara's stations. ARGO is a global array of autonomous profiling floats that observe pressure, temperature and salinity in the upper $2000m$ of the ocean. These data were collected and made freely available by the International Argo Program and the national programs that contribute to it (http://www.argo.ucsd.edu, http://argo.jcommops.org).

The Argo Program is part of the Global Ocean Observing System. The ARGO profiles were downloaded on the Aviso ftp web site where only pressure (P), temperature (T), and salinity (S) data. However, some of these profiles were still suspicious so applied another analysis in the same way that Chaigneau et al. (2011) using the following conditions:

- Data flagged as good and probably good (Argo quality flag 1 and 2)
- The shallowest data above 15 dbar and the deepest data below 300m
- A difference of pressure level inferior than 25 dbar between 0-100dbar and inferior than 50 dbar between 100-300dbar

We looked for the nearest ARGO floats available in box defined by $\Delta X \pm 4^\circ$ $lat - lon$ and $\Delta t \pm 15$ $julian\ days$ around Tara stations. For each CTD profile we search for the best matching ARGO profile. We computed distance dx, delay time dt, and radius $r = \sqrt{dx^2 + dt^2}$ between each ARGO and CTD profiles. We add correlations calculations between CTD-ARGO salinity and temperature. Correlations are calculated using the `corrcoef` function in `Matlab`. To make correlations calculation possible we interpolate ARGO profiles (defined on the 152 levels vertical grid) on a CTD-compatible 1 decibar vertical grid. We present the results in Tab. 10 with the ARGO profiles we kept after tests. We show the CTD and **all** ARGO profiles on Fig. 12, and a $\theta - S$ diagram on Fig. 13.

4.2 Correlations with CTD profiles

CTD	Argo	*Radius*	*dt* (*jul*)	*dx* (*km*)	θ correl.	S correl.	Lon Argo	Lat Argo
1	1	220.7836	13	220.4006	0.98682	0.77112	-71.599	37.676
1	2	172.9834	9	172.7491	0.96058	0.69517	-70.725	37.776
1	3	190.5379	1	190.5353	0.98981	0.82993	-68.726	37.857
1	4	246.8033	-3	246.785	0.96494	0.6625	-67.768	37.896
1	5	423.4496	15	423.1838	0.82562	0.65094	-73.197	36.366
1	6	311.9091	11	311.7151	0.81897	0.63718	-72.212	37.016
1	7	250.5179	7	250.4201	0.81381	0.61874	-71.474	37.286
1	8	232.3561	-1	232.354	0.74584	0.49323	-69.119	37.27
1	9	297.5299	-5	297.4879	0.72505	0.48815	-68.564	36.821
1	10	354.2835	-14	354.0067	0.70171	0.47124	-69.715	36.06
1	11	407.7571	14	407.5167	0.97943	0.8884	-73.753	37.03
1	12	446.9727	10	446.8608	0.9949	0.95232	-73.9	36.62
1	13	193.2914	-2	193.281	0.99828	0.91914	-71.49	37.92
1	14	178.3455	-6	178.2445	0.96559	0.59944	-71.518	38.126
1	15	201.9231	-10	201.6754	0.97175	0.62353	-71.779	38.038
1	16	192.8121	-14	192.3032	0.9969	0.92088	-71.495	37.935
1	17	450.5359	13	450.3483	0.76633	0.59486	-71.164	35.286
1	18	434.238	-2	434.2334	0.73762	0.51999	-71.643	35.545
1	19	339.3614	13	339.1123	0.99356	0.9322	-66.101	39.19
1	20	319.6785	3	319.6644	0.99364	0.89936	-66.384	38.774
2	1	218.1103	13	217.7225	0.92047	0.25502	-71.599	37.676
2	2	169.8273	9	169.5887	0.7759	-0.15681	-70.725	37.776
2	3	187.9912	1	187.9885	0.95737	0.40558	-68.726	37.857
2	4	244.9765	-3	244.9581	0.84382	-0.18961	-67.768	37.896
2	5	420.888	15	420.6206	0.93486	0.57122	-73.197	36.366
2	6	309.2183	11	309.0226	0.92962	0.42486	-72.212	37.016
2	7	247.5871	7	247.4881	0.87178	0.44274	-71.474	37.286
2	8	229.2987	-1	229.2965	0.87708	-0.10044	-69.119	37.27
2	9	294.6184	-5	294.576	0.97183	0.075549	-68.564	36.821
2	10	350.9867	-14	350.7074	0.84857	-0.39423	-69.715	36.06
2	11	405.6993	14	405.4577	0.89454	0.61457	-73.753	37.03
2	12	444.7544	10	444.642	0.96366	0.83528	-73.9	36.62
2	13	190.7112	-2	190.7007	0.98053	0.73647	-71.49	37.92
2	14	175.9782	-6	175.8759	0.85454	-0.01375	-71.518	38.126
2	15	199.6614	-10	199.4108	0.84972	0.010546	-71.779	38.038
2	16	190.2544	-14	189.7386	0.96539	0.75026	-71.495	37.935
2	17	447.2675	13	447.0785	0.97095	-0.28456	-71.164	35.286
2	18	431.0579	-2	431.0532	0.89518	-0.30884	-71.643	35.545
2	19	339.5596	13	339.3107	0.97205	0.8445	-66.101	39.19
2	20	319.3862	3	319.3721	0.98322	0.81899	-66.384	38.774
3	1	221.4705	13	221.0886	0.98455	0.75332	-71.599	37.676
3	2	173.8692	9	173.6361	0.94737	0.60815	-70.725	37.776
3	3	191.4344	1	191.4318	0.98683	0.80979	-68.726	37.857
3	4	247.5245	-3	247.5063	0.94786	0.52164	-67.768	37.896
3	5	424.092	15	423.8266	0.89605	0.59546	-73.197	36.366
3	6	312.6009	11	312.4073	0.8888	0.57004	-72.212	37.016
3	7	251.3043	7	251.2068	0.89096	0.55229	-71.474	37.286
3	8	233.3529	-1	233.3507	0.9099	0.36096	-69.119	37.27
3	9	298.5012	-5	298.4593	0.92836	0.40494	-68.564	36.821
3	10	355.2975	-14	355.0216	0.882	0.34896	-69.715	36.06
3	11	408.2198	14	407.9797	0.98203	0.93154	-73.753	37.03
3	12	447.491	10	447.3793	0.99427	0.95887	-73.9	36.62
3	13	193.9436	-2	193.9333	0.99688	0.91862	-71.49	37.92
3	14	178.9213	-6	178.8207	0.97136	0.58763	-71.518	38.126
3	15	202.4609	-10	202.2138	0.97144	0.59244	-71.779	38.038
3	16	193.4569	-14	192.9497	0.99589	0.92698	-71.495	37.935
3	17	451.4792	13	451.292	0.84609	0.511	-71.164	35.286
3	18	435.1332	-2	435.1286	0.86924	0.40302	-71.643	35.545
3	19	339.5094	13	339.2604	0.99004	0.89998	-66.101	39.19
3	20	319.9734	3	319.9593	0.98739	0.83222	-66.384	38.774

Table 8: Description: see paragraph p. 21

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CTD	Argo	*Radius*	*dt* (*jul*)	*dx* (*km*)	θ correl.	*S* correl.	Lon Argo	Lat Argo
4	1	217.2761	13	216.8869	0.98143	0.68392	-71.599	37.676
4	2	169.7627	9	169.5239	0.93497	0.50983	-70.725	37.776
4	3	190.0487	1	190.0461	0.98494	0.7434	-68.726	37.857
4	4	247.3291	-3	247.3109	0.94333	0.41906	-67.768	37.896
4	5	419.9236	15	419.6556	0.90091	0.56483	-73.197	36.366
4	6	308.3998	11	308.2035	0.89328	0.53261	-72.212	37.016
4	7	247.0912	7	246.992	0.89099	0.52087	-71.474	37.286
4	8	230.8765	-1	230.8744	0.91066	0.34169	-69.119	37.27
4	9	296.3729	-5	296.3308	0.93353	0.37958	-68.564	36.821
4	10	351.9823	-14	351.7038	0.8886	0.32007	-69.715	36.06
4	11	404.2797	14	404.0372	0.97696	0.92187	-73.753	37.03
4	12	443.4632	10	443.3505	0.99266	0.94484	-73.9	36.62
4	13	189.7652	-2	189.7546	0.99379	0.87115	-71.49	37.92
4	14	174.8195	-6	174.7165	0.9594	0.51822	-71.518	38.126
4	15	198.4097	-10	198.1575	0.95761	0.51853	-71.779	38.038
4	16	189.2939	-14	188.7755	0.99311	0.88973	-71.495	37.935
4	17	447.5216	13	447.3327	0.85662	0.46246	-71.164	35.286
4	18	431.0351	-2	431.0304	0.87684	0.36706	-71.643	35.545
4	19	341.8628	13	341.6155	0.98981	0.89417	-66.101	39.19
4	20	321.7893	3	321.7753	0.98676	0.78203	-66.384	38.774
5	1	212.2426	13	211.8441	0.98022	0.43777	-71.599	37.676
5	2	164.8384	9	164.5925	0.94084	0.20151	-70.725	37.776
5	3	188.4891	1	188.4865	0.98635	0.53118	-68.726	37.857
5	4	247.1819	-3	247.1637	0.95121	0.14912	-67.768	37.896
5	5	414.9217	15	414.6504	0.90897	0.63722	-73.197	36.366
5	6	303.3574	11	303.1579	0.90268	0.52889	-72.212	37.016
5	7	242.033	7	241.9318	0.90244	0.50968	-71.474	37.286
5	8	227.9649	-1	227.9627	0.91695	-0.066632	-69.119	37.27
5	9	293.8708	-5	293.8283	0.93883	0.1146	-68.564	36.821
5	10	348.0233	-14	347.7416	0.89379	-0.27354	-69.715	36.06
5	11	399.5596	14	399.3143	0.97112	0.7484	-73.753	37.03
5	12	438.6347	10	438.5207	0.99085	0.85293	-73.9	36.62
5	13	184.7522	-2	184.7414	0.99287	0.74822	-71.49	37.92
5	14	169.9045	-6	169.7985	0.9506	0.20127	-71.518	38.126
5	15	193.5576	-10	193.2992	0.95368	0.21398	-71.779	38.038
5	16	184.3005	-14	183.768	0.99035	0.7724	-71.495	37.935
5	17	442.774	13	442.5831	0.86914	0.15978	-71.164	35.286
5	18	426.1164	-2	426.1117	0.88529	-0.17078	-71.643	35.545
5	19	344.729	13	344.4838	0.99075	0.85359	-66.101	39.19
5	20	324.0217	3	324.0079	0.9898	0.75932	-66.384	38.774
6	1	208.0915	13	207.685	0.99313	0.89769	-71.599	37.676
6	2	160.6524	9	160.4001	0.95764	0.74778	-70.725	37.776
6	3	186.9106	1	186.9079	0.99201	0.92184	-68.726	37.857
6	4	246.7488	-3	246.7306	0.94831	0.5314	-67.768	37.896
6	5	410.8193	15	410.5454	0.91421	0.58273	-73.197	36.366
6	6	299.1956	11	298.9933	0.90658	0.5587	-72.212	37.016
6	7	237.8022	7	237.6991	0.90974	0.56965	-71.474	37.286
6	8	225.2744	-1	225.2722	0.91702	0.33472	-69.119	37.27
6	9	291.4956	-5	291.4527	0.93477	0.372	-68.564	36.821
6	10	344.5026	-14	344.218	0.88609	0.3606	-69.715	36.06
6	11	395.7791	14	395.5314	0.99131	0.90982	-73.753	37.03
6	12	434.7377	10	434.6226	0.99545	0.95215	-73.9	36.62
6	13	180.6391	-2	180.628	0.99142	0.9458	-71.49	37.92
6	14	165.9164	-6	165.8078	0.98007	0.79124	-71.518	38.126
6	15	189.6404	-10	189.3766	0.98062	0.80471	-71.779	38.038
6	16	180.2073	-14	179.6627	0.9949	0.97885	-71.495	37.935
6	17	438.6889	13	438.4962	0.86235	0.53266	-71.164	35.286
6	18	421.9287	-2	421.9239	0.87761	0.4107	-71.643	35.545
6	19	346.8366	13	346.5929	0.98883	0.86398	-66.101	39.19
6	20	325.5826	3	325.5688	0.98695	0.80417	-66.384	38.774

Table 9: Description: see paragraph p. 21

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CTD	Argo	*Radius*	dt (jul)	dx (km)	θ correl.	S correl.	Lon Argo	Lat Argo
7	1	210.766	15	210.2315	0.99281	0.93984	-71.599	37.676
7	2	160.4596	11	160.0821	0.97793	0.91209	-70.725	37.776
7	3	179.1345	3	179.1094	0.99669	0.97293	-68.726	37.857
7	4	238.15	-1	238.1479	0.98009	0.82837	-67.768	37.896
7	5	413.8352	17	413.4859	0.86192	0.72602	-73.197	36.366
7	6	301.7056	13	301.4254	0.85609	0.71953	-72.212	37.016
7	7	239.1247	9	238.9553	0.85164	0.7044	-71.474	37.286
7	8	219.0563	1	219.054	0.78752	0.57705	-69.119	37.27
7	9	284.6937	-3	284.6779	0.76577	0.57458	-68.564	36.821
7	10	340.2618	-12	340.0502	0.74484	0.56656	-69.715	36.06
7	11	400.4959	16	400.1762	0.98496	0.85859	-73.753	37.03
7	12	438.9376	12	438.7736	0.9981	0.92948	-73.9	36.62
7	13	183.6178	0	183.6178	0.99598	0.98123	-71.49	37.92
7	14	169.6723	-4	169.6251	0.96772	0.82035	-71.518	38.126
7	15	193.6822	-8	193.5169	0.97731	0.85566	-71.779	38.038
7	16	183.1115	-12	182.7179	0.99772	0.97117	-71.495	37.935
7	17	437.2321	15	436.9747	0.80586	0.69681	-71.164	35.286
7	18	421.4036	0	421.4036	0.77913	0.61589	-71.643	35.545
7	19	339.0667	15	338.7347	0.99718	0.87584	-66.101	39.19
7	20	317.2866	5	317.2472	0.9978	0.93463	-66.384	38.774

Table 10: Description: see paragraph p. 21

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4.3 ARGO and CTD profiles

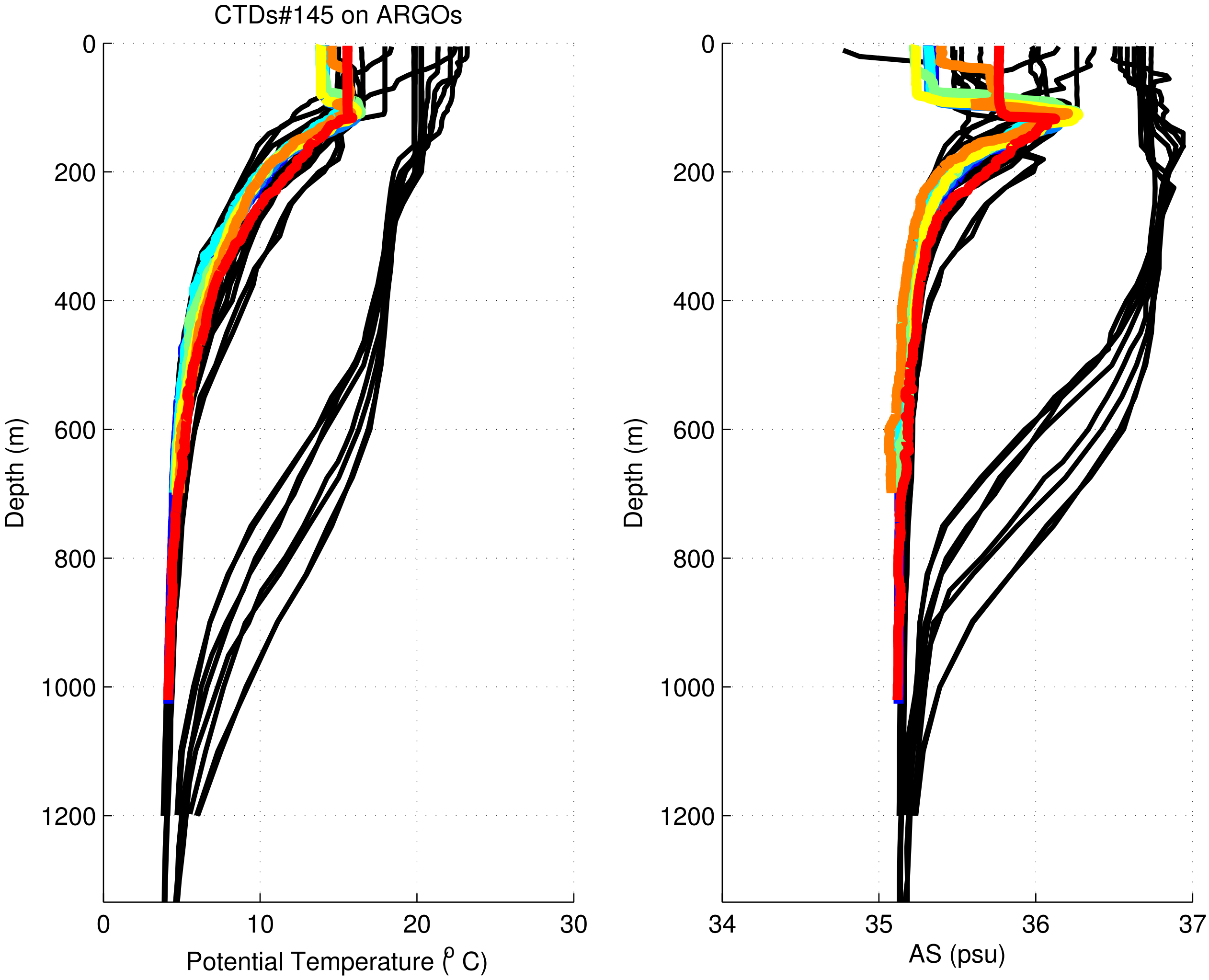

Figure 12: Description: see paragraph p. 21

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4.4 ARGO and CTD $\theta - S$ diagrams

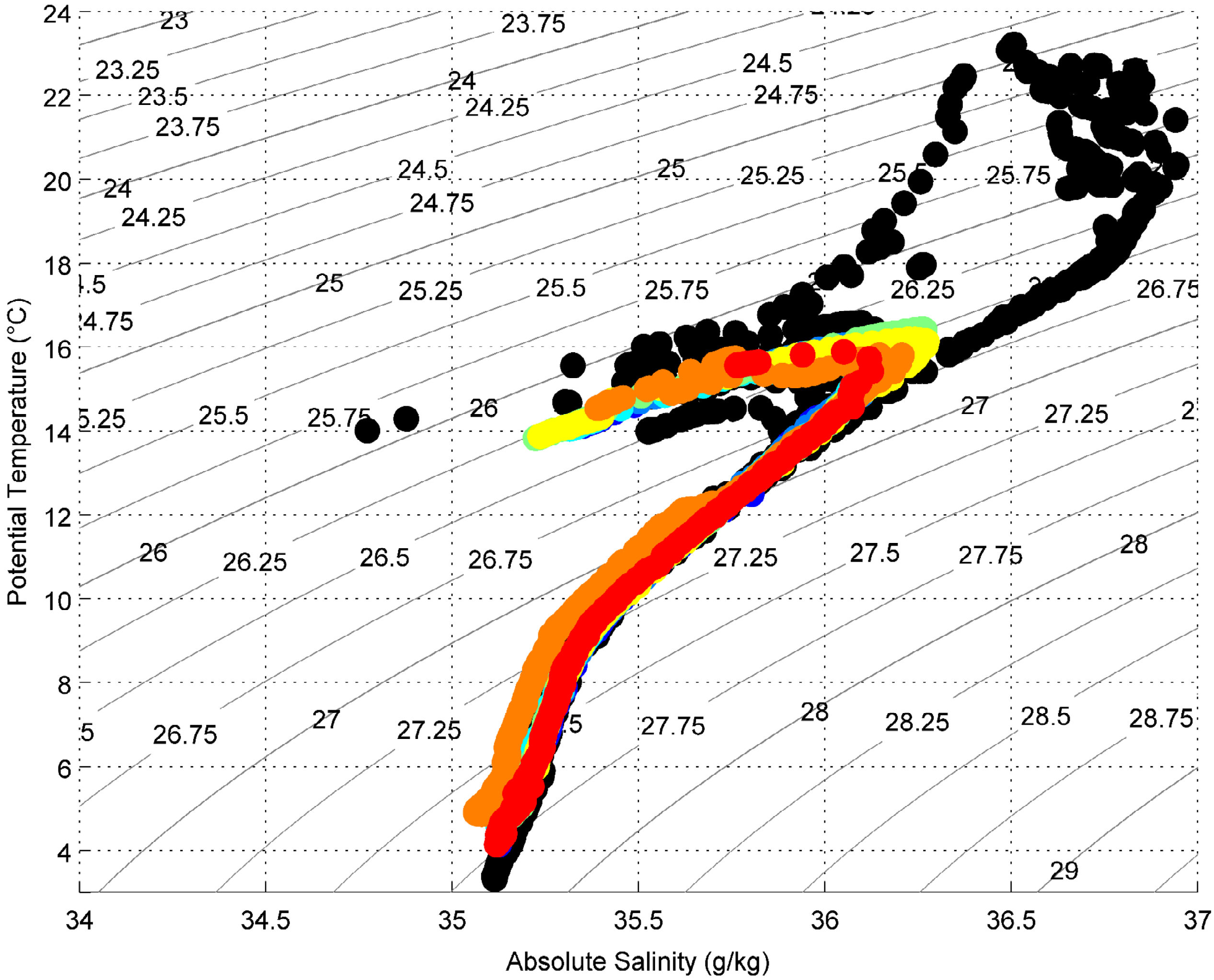

Figure 13: Description: see paragraph p. 21

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