



Data quality control of the recent Argo floats in the Black Sea

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BLACK SEA ARGO ACTIVITIES

Black Sea Deployments per year

2002 : 3 (US/Turkey)

2005 : 2 (US/Turkey)

2006 : 2 (US/Turkey)

2009: 1 (France/Bulgaria)

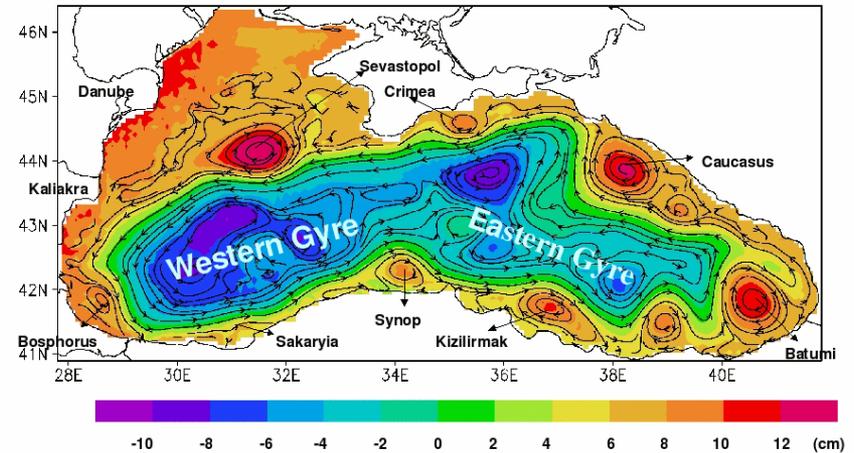
2010: 1 (France)

2011: 3 (Bulgaria)

2012: 4 (Italy)

2013: 1 (Bulgaria) + expected 1 (redeployed Italy), 2 (Turkey)

At the moment: 7 floats working





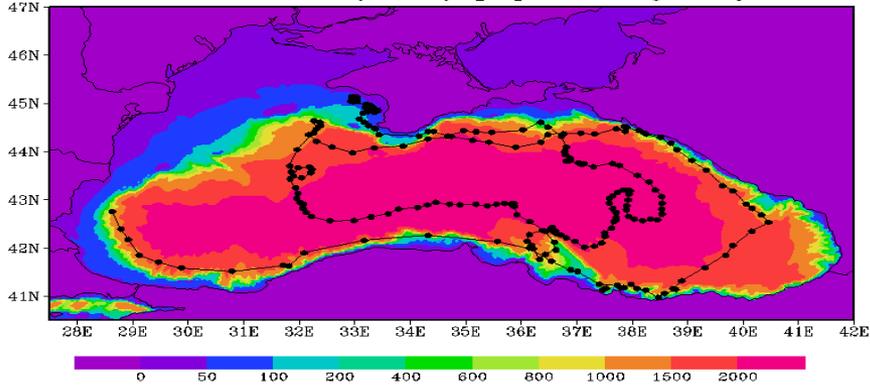
Performance of the recent Argo floats in the Black sea



Float N1901200 - Kaliakra

Deployed on 08/12/2009 - IFREMER
PROVOR CTS3
Parking depth – 200 m
Profile depth – 1550 m
Last cycle – 23/02/2013

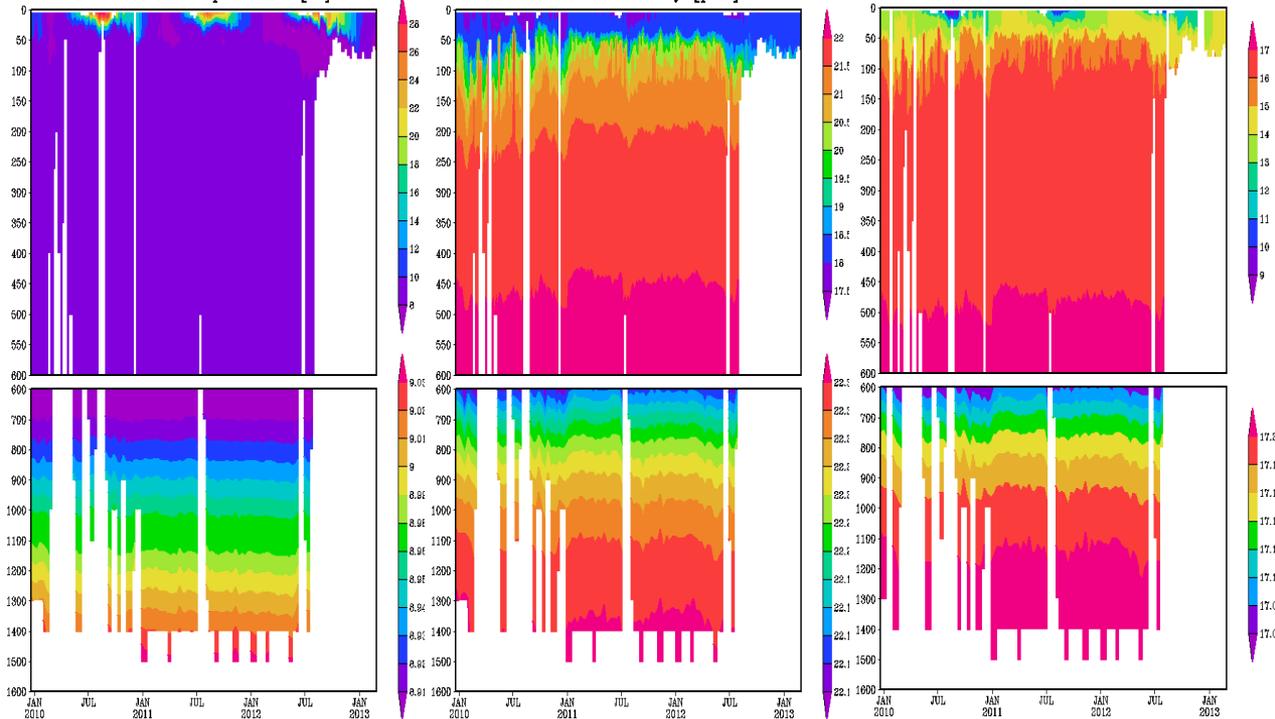
Kaliakra: Bathymetry [m] and Trajectory



Kaliakra : Temperature [°C]

Kaliakra : Salinity [psu]

Kaliakra : Rho



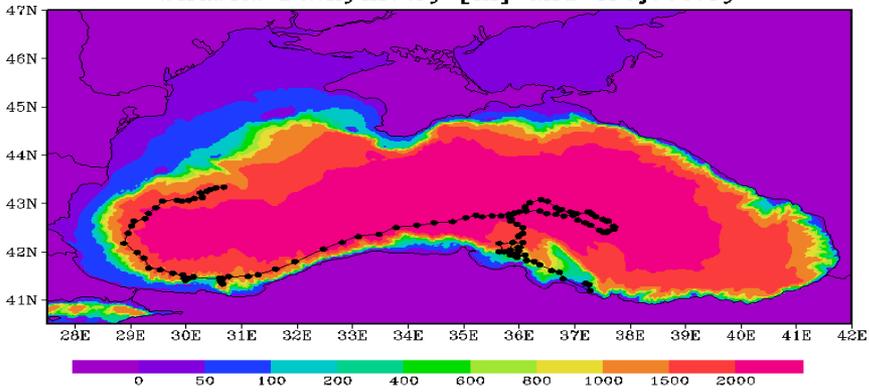
The cold intermediate layer (CIL) is completely lost during 2010 and 2011, but reappears in 2012, due to the very cold winter conditions.



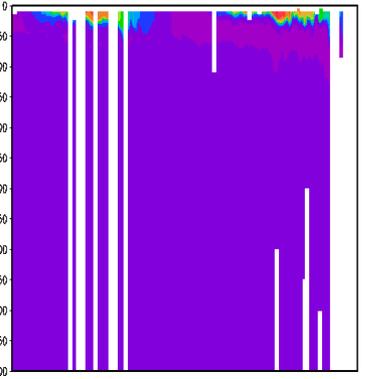
Float N6900803 – Shabla

*Deployed on 18/03/2011 - BulArgo
APEX
Parking depth– 750 m
Profile depth – 1500 m
Last cycle - 08/03/2013*

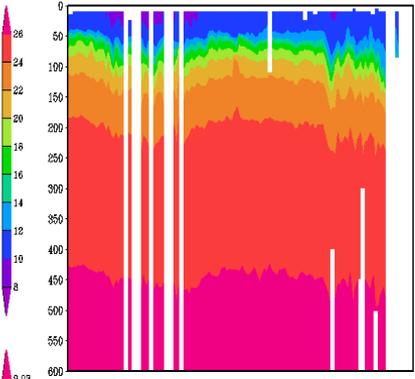
Shabla: Bathymetry [m] and Trajectory



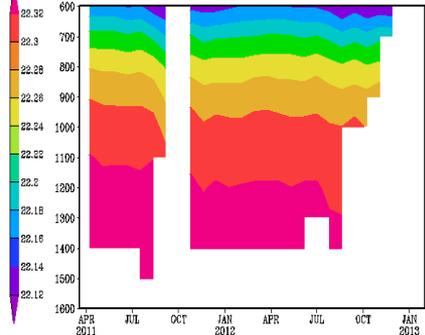
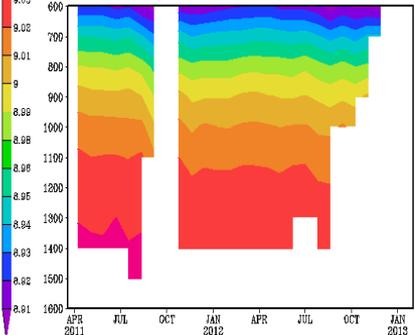
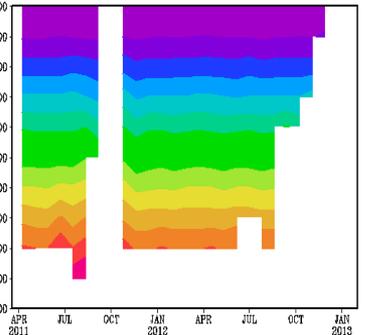
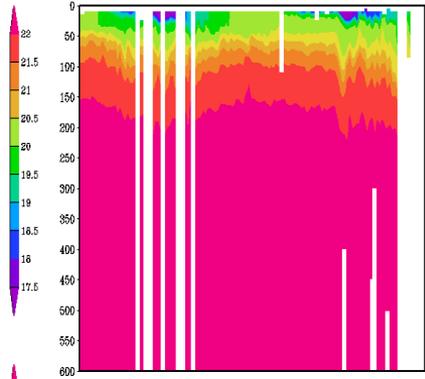
Shabla : Temperature [°C]



Shabla : Salinity [psu]



Shabla : Rho

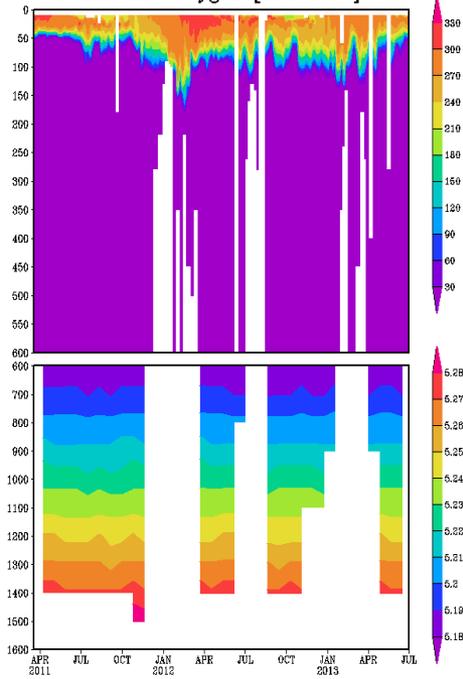


Recreation of the CIL in the winter of 2012. Unusually hot summer – high surface temperature. Shallowing of the isohalines and isopycnets – indicator for dominating cyclonic or anticyclonic circulation.

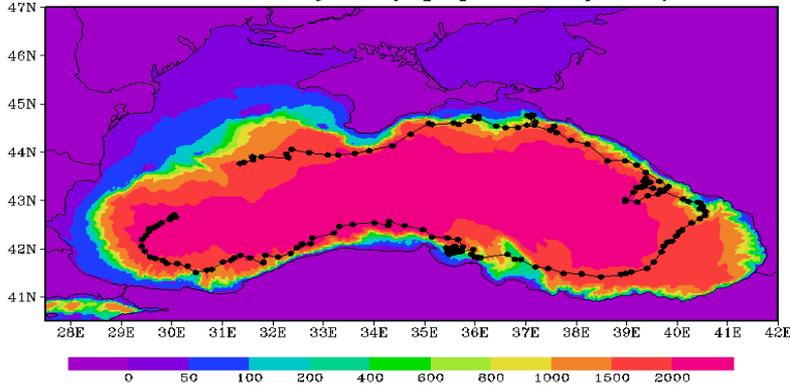


Float N6900804 – Emona

Emona : Oxygen [mmol.m^{-3}]

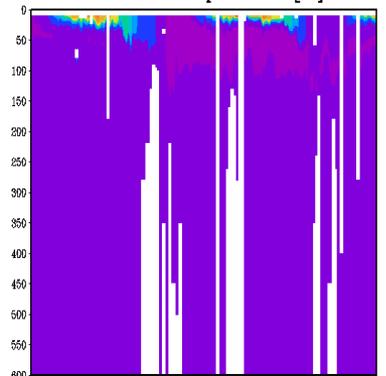


Emona: Bathymetry [m] and Trajectory

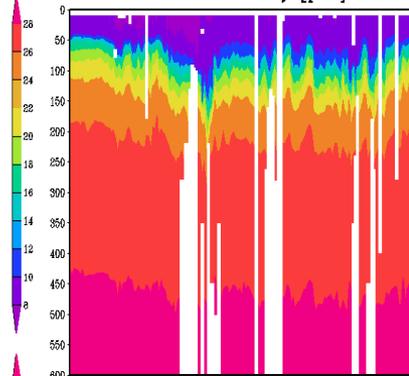


Deployed on 19/03/2011 -
BulArgo
APEX
Parking depth – 750 m
Profile depth – 1500 m
Oxygen sensor Aanderaa
Last cycle – 01/07/2013

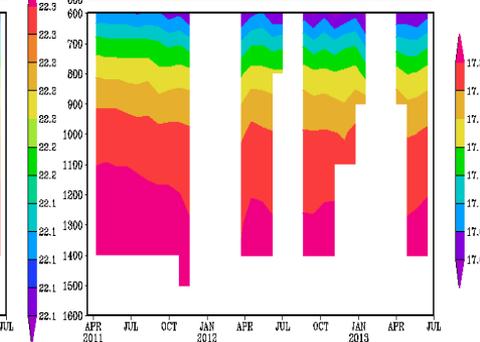
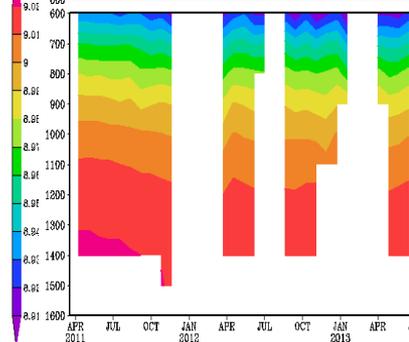
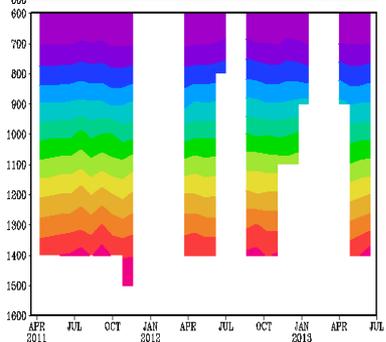
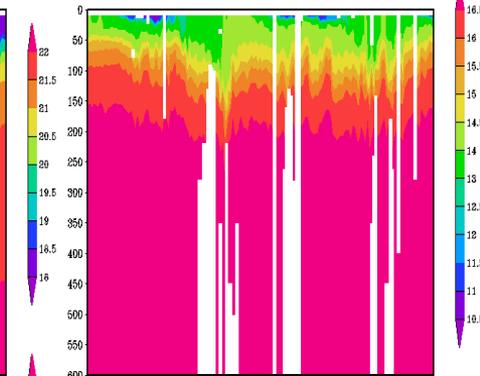
Emona : Temperature [°C]



Emona : Salinity [psu]



Emona : Rho



In October 2011 it was captured in the Sinop coastal eddy, which could be identified very well on the plots of the vertical profiles: the halocline , pycnocline and oxycline deepen substantially.

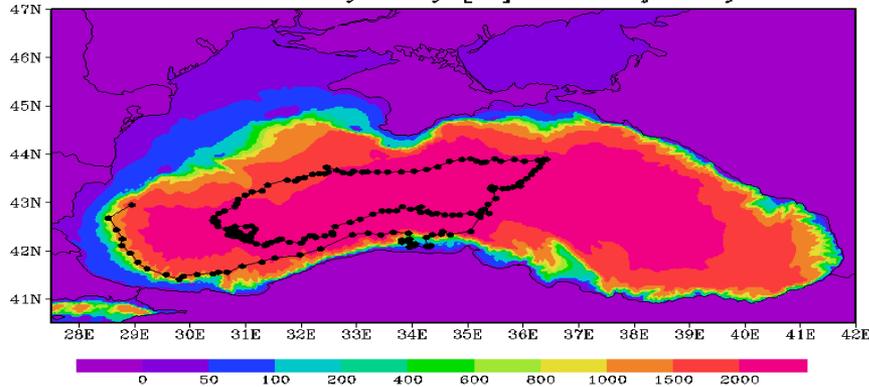


Float N6900805 – Galata

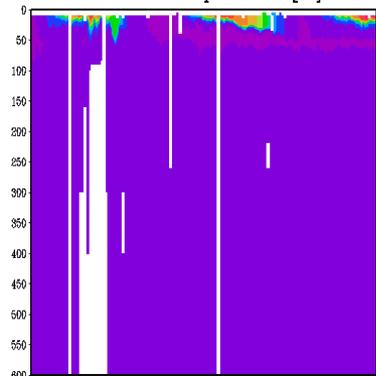
*Deployed on 19/03/2011 - BulArgo
APEX*

*Parking depth – 750 m
Profile depth – 1500 m*

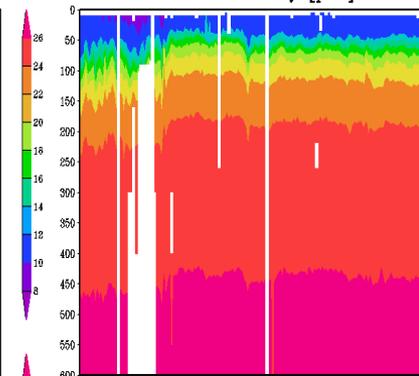
Galata: Bathymetry [m] and Trajectory



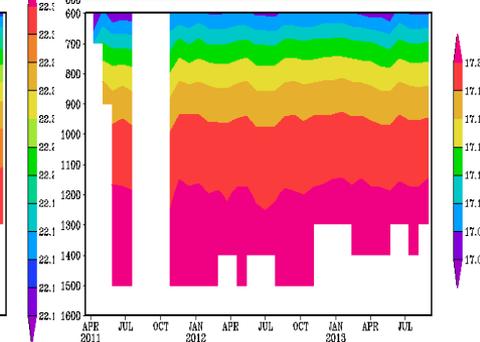
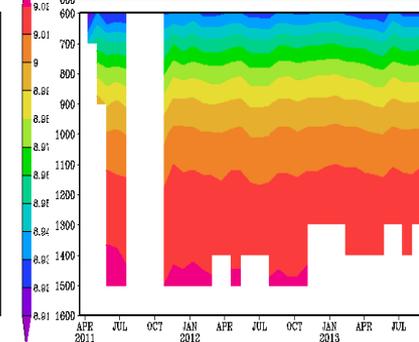
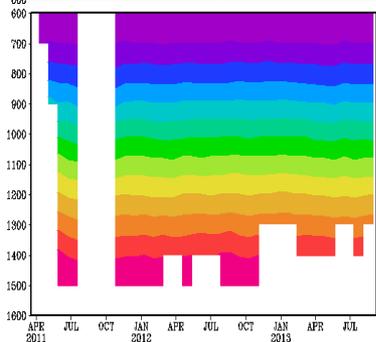
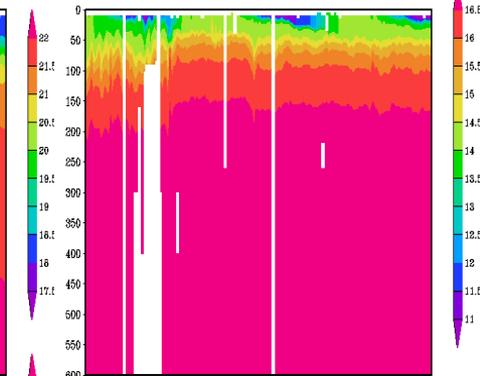
Galata : Temperature [°C]



Galata : Salinity [psu]



Galata : Rho



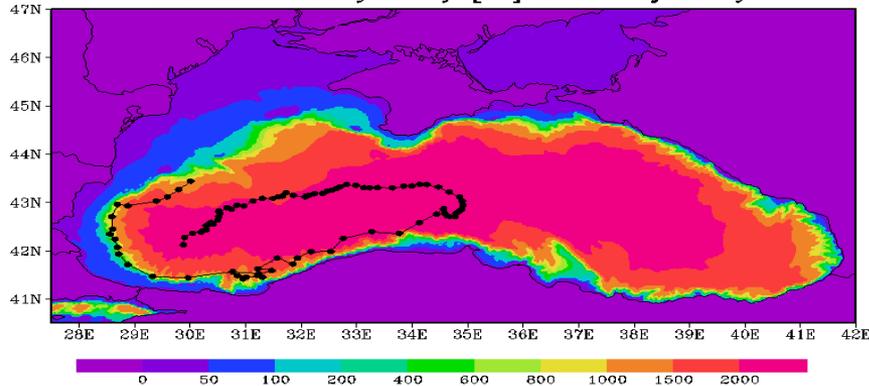
*The temperature profiles
show again the recreation
of the CIL in the winter of
2012 which means that
this have happened
almost simultaneously
basin-wide.*



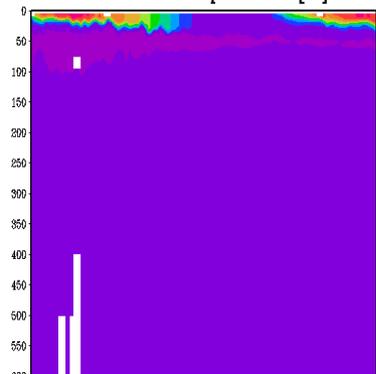
Float N6901959 – Rusalka

*Deployed on 08/06/2012 – ARGO - Italy
ARVOR
Parking depth – 200 m
Profile depth – 1500 m*

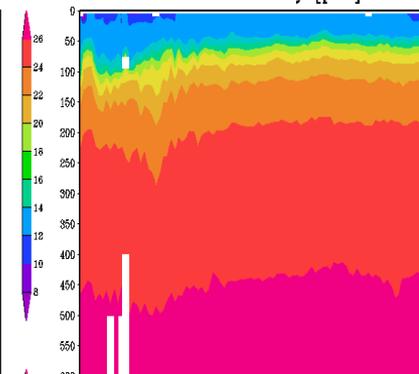
Rusalka: Bathymetry [m] and Trajectory



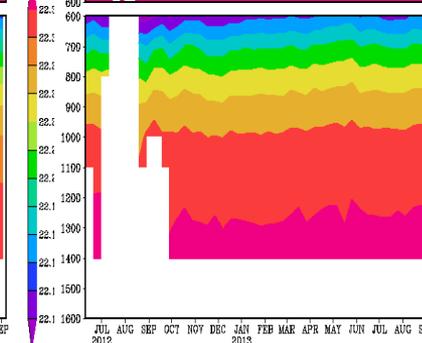
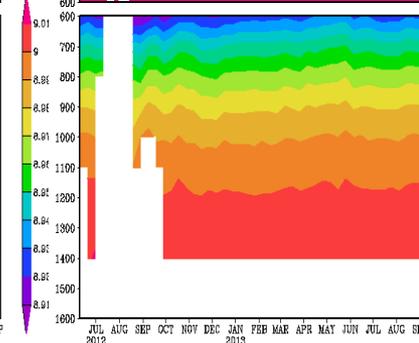
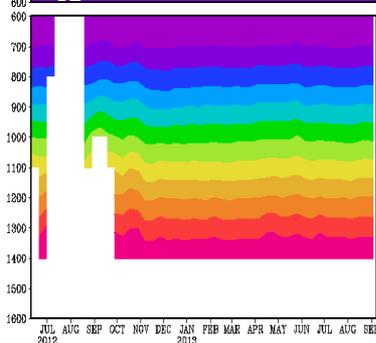
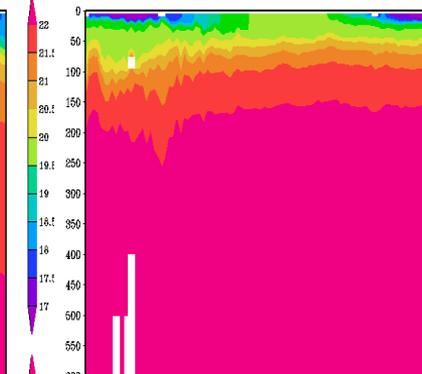
Rusalka : Temperature [°C]



Rusalka : Salinity [psu]



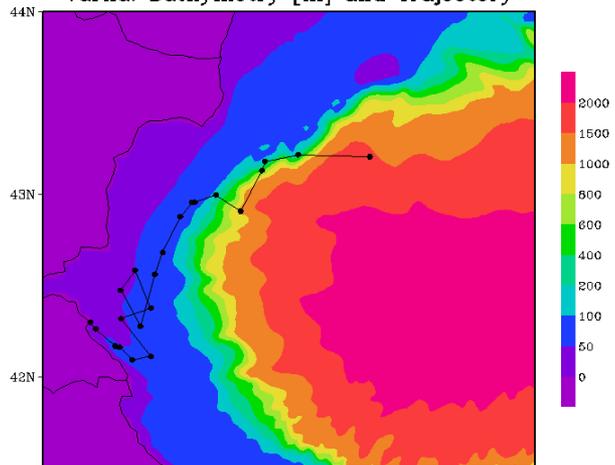
Rusalka : Rho



The temperature profiles show the thinning of the CIL after the hot summer in 2012. Very interesting feature could be noted on the salinity profile near Bosphorus Straits: an intrusion of saline water which probably is consequence of the Mediterranean water plume.



Varna: Bathymetry [m] and Trajectory



Float N6901960 – Varna

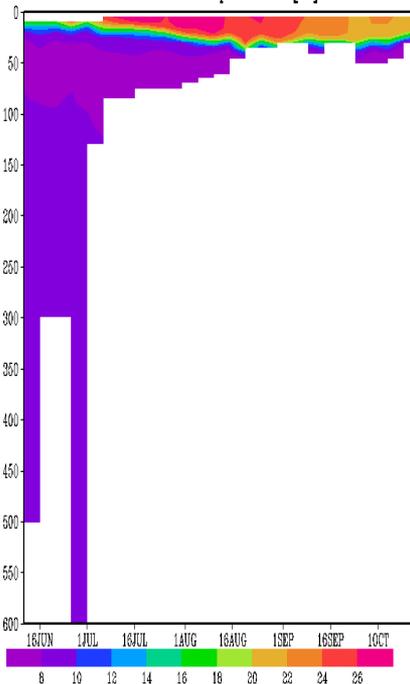
*Deployed on 08/06/2012 – ARGO – Italy
AVROR*

Parking depth – 350 m

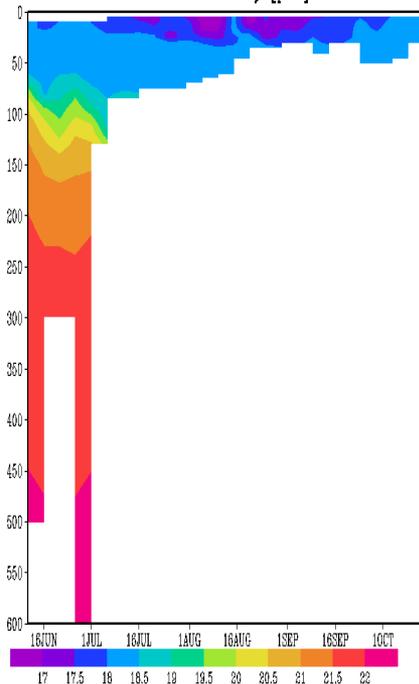
Profile depth – 1500 m

October 2012 – beached

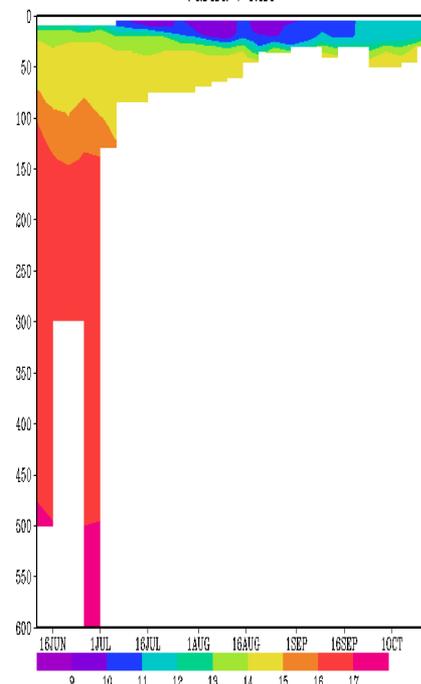
Varna : Temperature [°C]



Varna : Salinity [psu]



Varna : Rho



*Anticyclonic eddy in
the Burgas Bay*

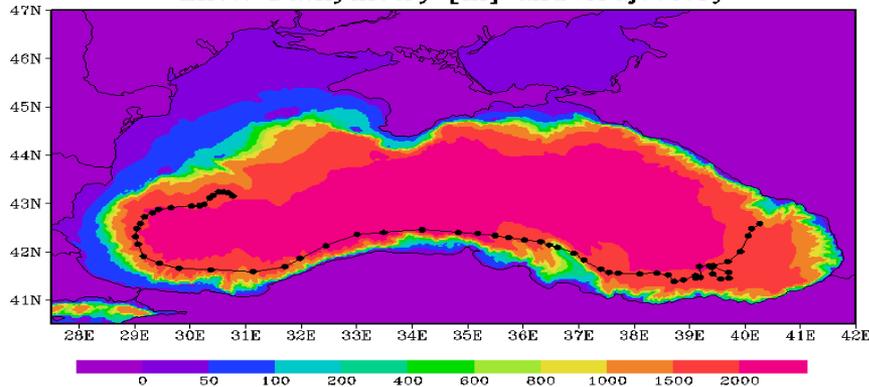


Float N6901961– Elito

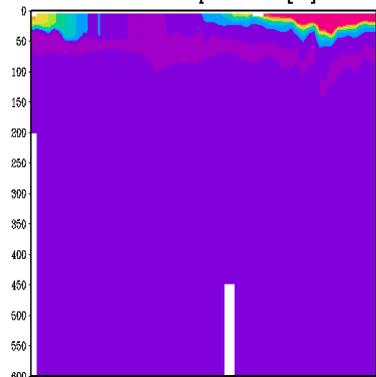
*Deployed on 07/11/2012 – ARGO - Italy
ARVOR*

*Parking depth – 200 m
Profile depth – 1500 m*

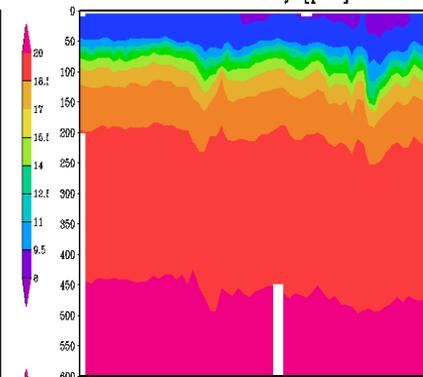
Elito: Bathymetry [m] and Trajectory



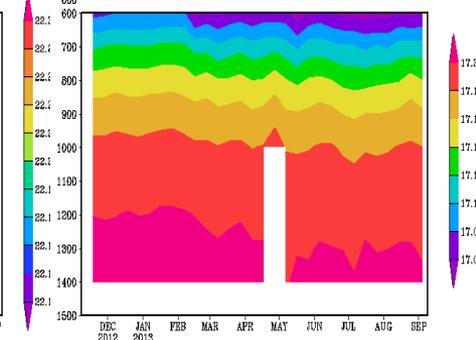
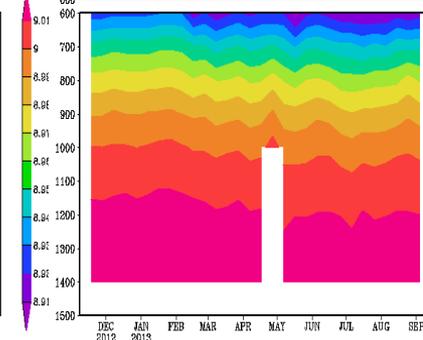
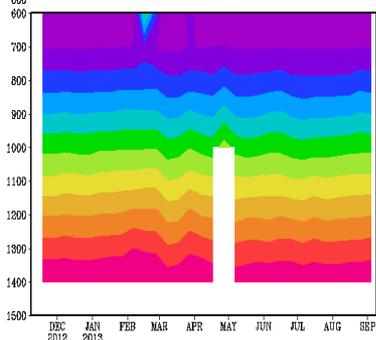
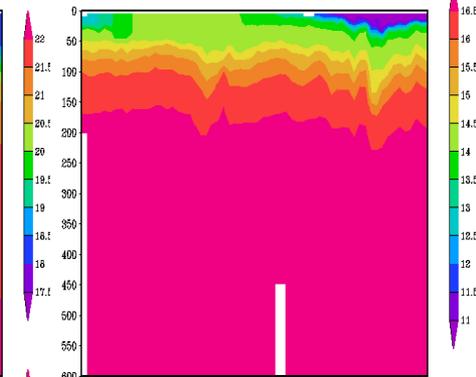
ELiTo : Temperature [°C]



ELiTo : Salinity [psu]



ELiTo: Rho

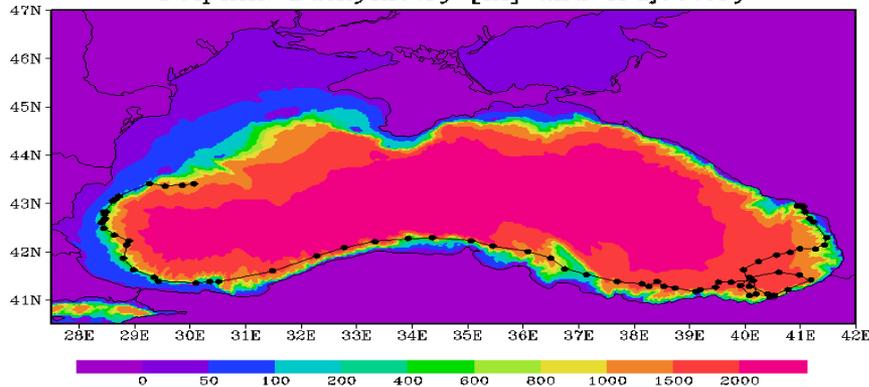


The isothermic conditions in the shallow 50-70 m layer on the temperature plot indicate that the winter convection starts around December and in February the Sea Surface Temperature (SST) is equal to the CIL one.



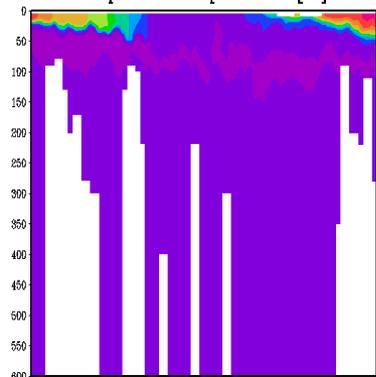
Float N6901962– Dolphin

Dolphin: Bathymetry [m] and Trajectory

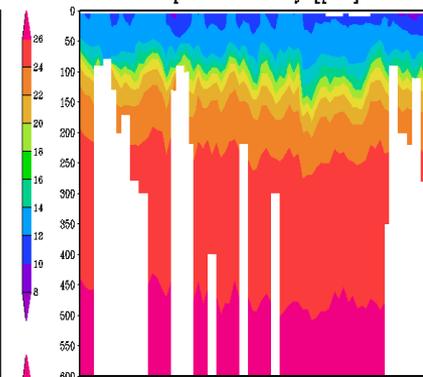


*Deployed on 15/08/2012 – ARGO - Italy
ARVOR
Parking depth – 200 m
Profile depth – 1500 m*

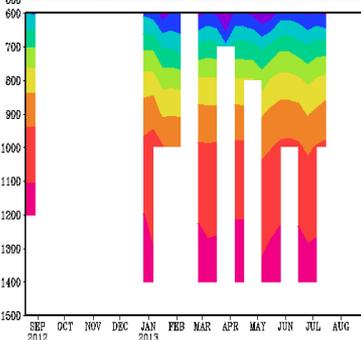
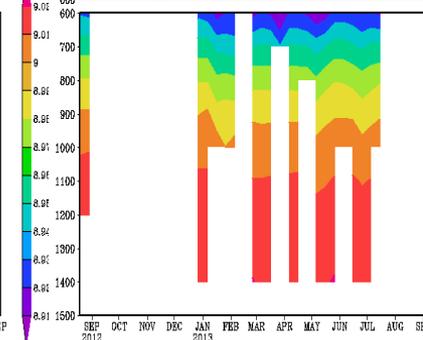
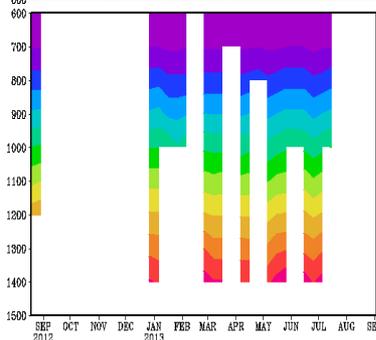
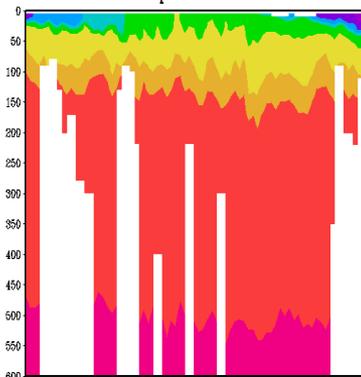
Dolphin : Temperature [°C]



Dolphin : Salinity [psu]



Dolphin : Rho



This float also follows the Rim current very strictly as Elito, but at a bit less deep parts. The CIL is tining in the end of 2012, but the SST does not reach the CIL temperature, because around the south Black Sea coast the temperature is generally higher that in the open sea.



Real-time quality control procedures



The data coming from each float are provided by the Ifremer database in netCDF format. A Fortran code program is prepared to read from the netCDF file and 9 QC procedures are applied.

- Missing cycle check
- Range for pressure, temperature and salinity
 - Pressure cannot be less than 0 dbars and greater than 2000dbars
 - Pressure is supposed to be monotonously increasing function with depth
 - Temperature cannot be less than 0° C and greater than 35° C
 - Salinity cannot be less than 2 PSU and greater than 25 PSU
 - Density has to enter within the range 0 – 18 sigma units
- Inverse stratification test test - the water column should be stable, which requires that the water density is increasing with depth.



The Argo data are interpolated to 13 levels in order to coincide with the levels of the climatological data of the Black Sea: 20, 50, 75, 100, 125, 150, 200, 300, 500, 750, 1000, 1250, 1500 m.

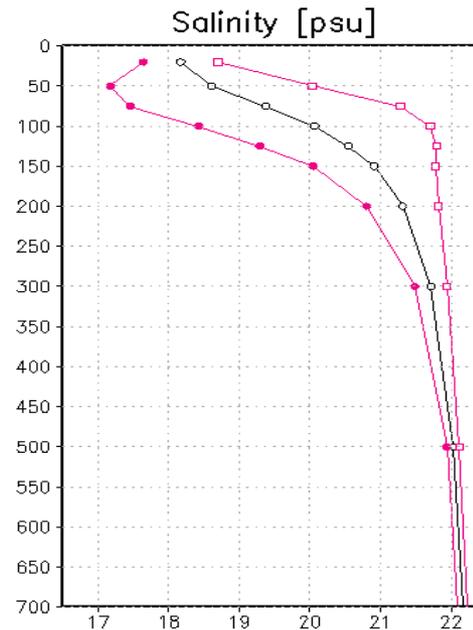
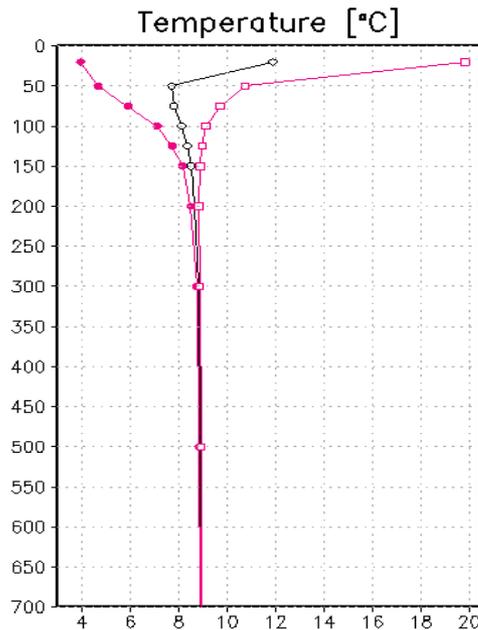
- *Regional range test – if a value fails the test it is flagged as bad data*

- *Inverse stratification*

- *Impossible date test*
 - *Year greater than 2002*
 - *Month in range 1 to 12*
 - *Day in range expected for month*
 - *Hour in range 0 to 23*
 - *Minute in range 0 to 59*



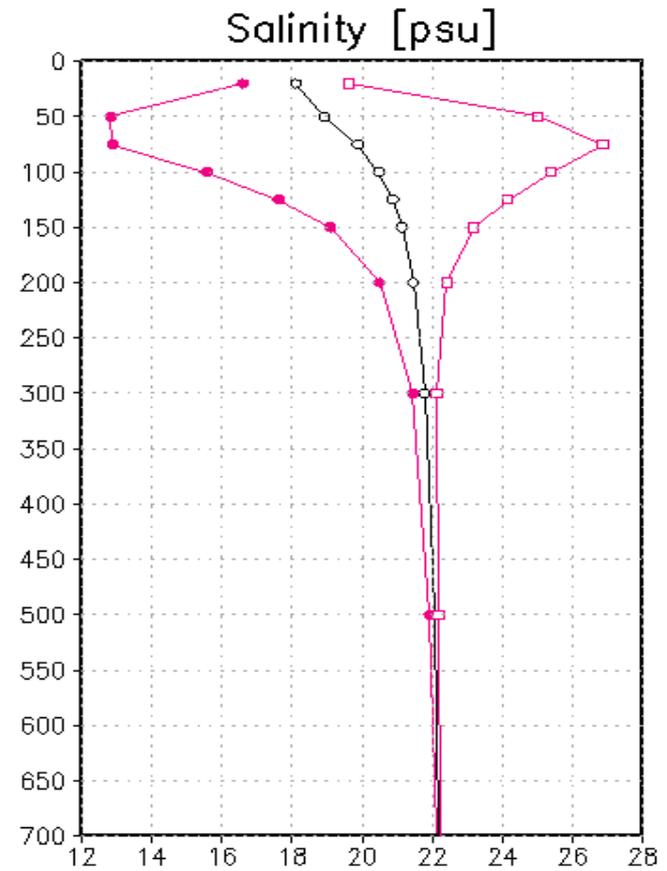
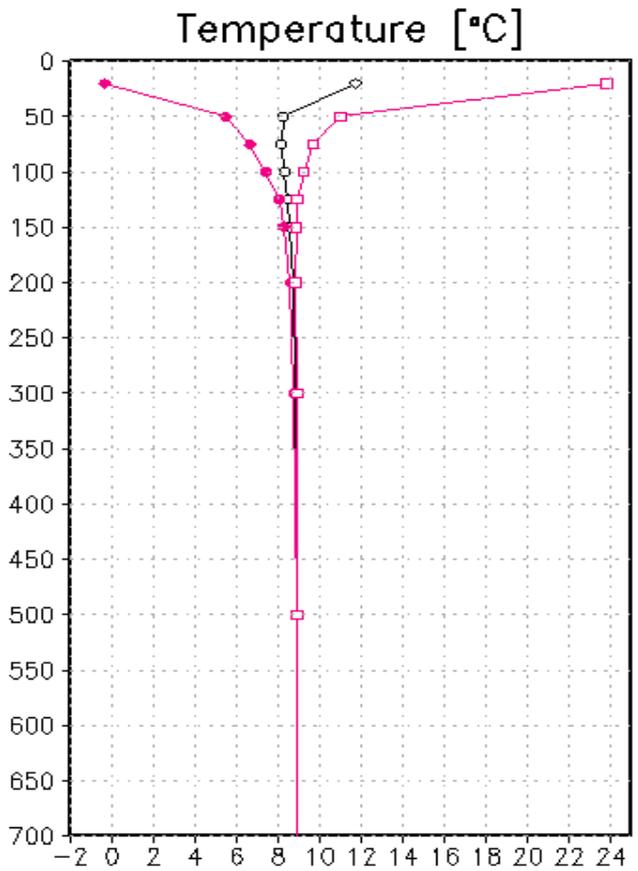
- *Comparison with climatology data – for every Argo profile, the closest point from the climatological data is found (interpolating in space and time). These are averaged for all float profiles and at the end the mean deviation and root mean square deviation are obtained for each level of the climatological data. Then the acceptable ranges profile is constructed.*



- *Impossible location test*
 - *Latitude in range –90 to 90*
 - *Longitude in range –180 to 180*

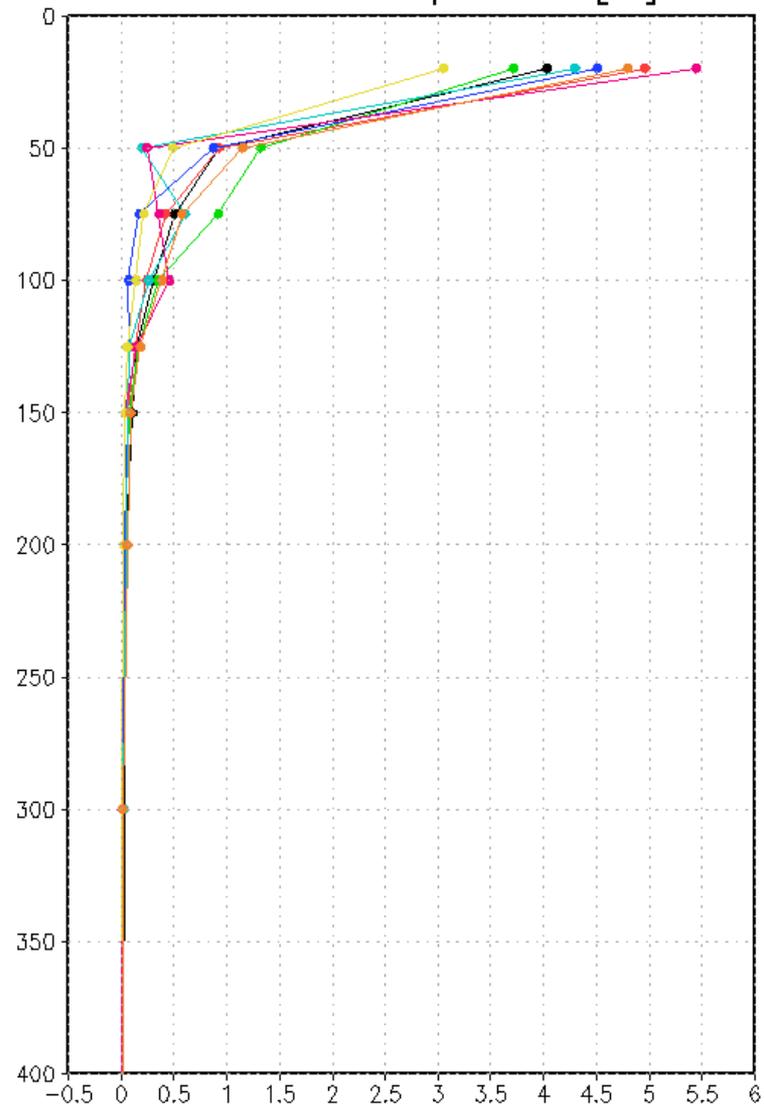


- Comparison with Argo data - The temperature and salinity data from all Argo profiles are averaged, the root mean square deviation is calculated and if the tested value is not in the range of the mean \pm RMS the value is flagged as suspicious.



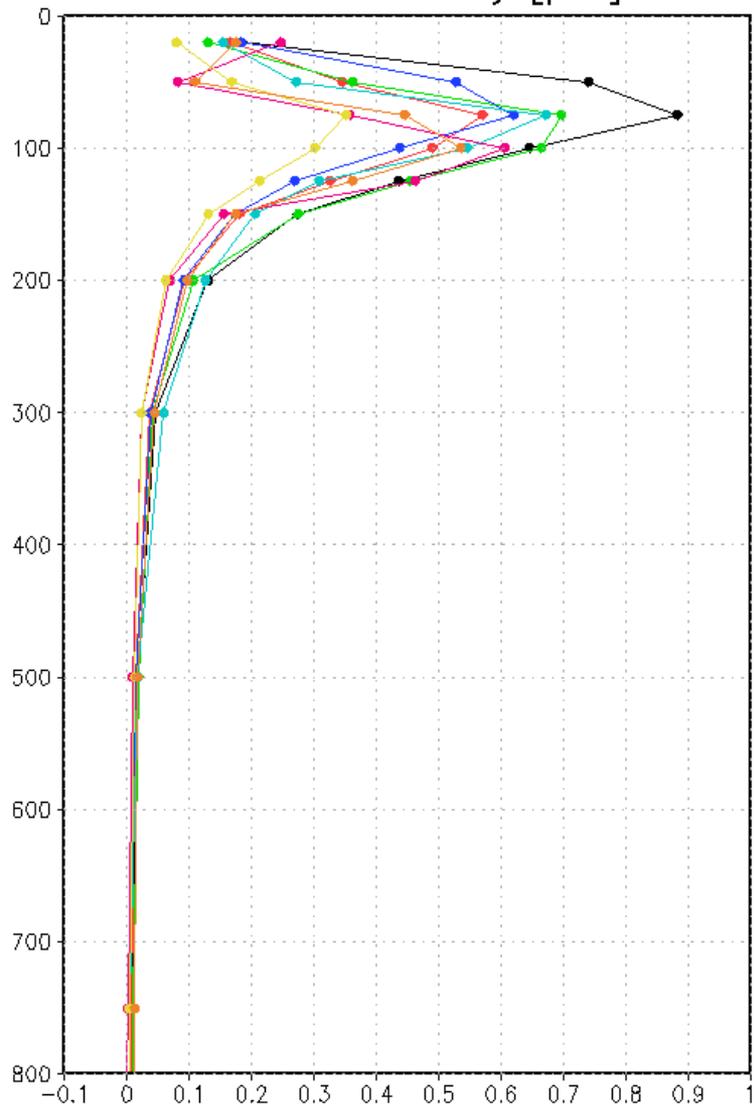


RMS error Temperature [$^{\circ}\text{C}$]



- Kaliakra
- Shabla
- Emona
- Galata
- Rusalka
- Varna
- Elito
- Dolphin

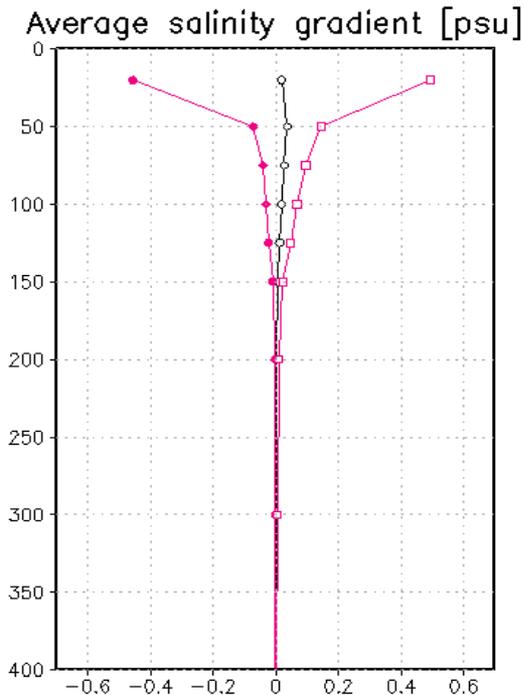
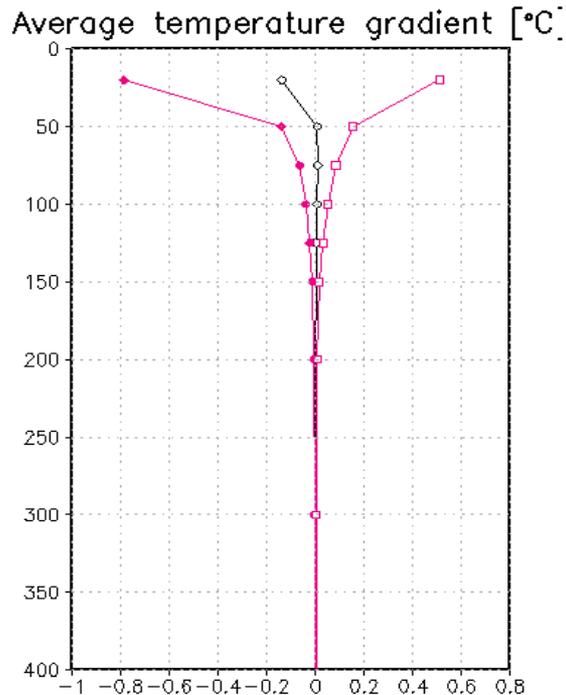
RMS error Salinity [psu]



- Kaliakra
- Shabla
- Emona
- Galata
- Rusalka
- Varna
- Elito
- Dolphin



- *Comparison with Argo gradient – for the purposes of this test we calculated the temperature and the salinity gradient for the data of each Argo float for the interpolated in 13 levels of climatological data. These gradients are then averaged and the root mean square deviation is calculated. If the tested value is not in the range of the mean value \pm RMS the value is flagged as suspicious.*



- *Visual quality control – each profile is also visually checked, which helped a lot to discover suspicious profiles which were then investigated in more details.*



- *Quality Flags*

n	Meaning
“ ”	No QC was performed
A	$N = 100\%$; All profile levels contain good data
B	$75\% \leq N < 100\%$
C	$50\% \leq N < 75\%$
D	$25\% \leq N < 50\%$
E	$0\% < N < 25\%$
F	$N = 0\%$; No profile levels have good data

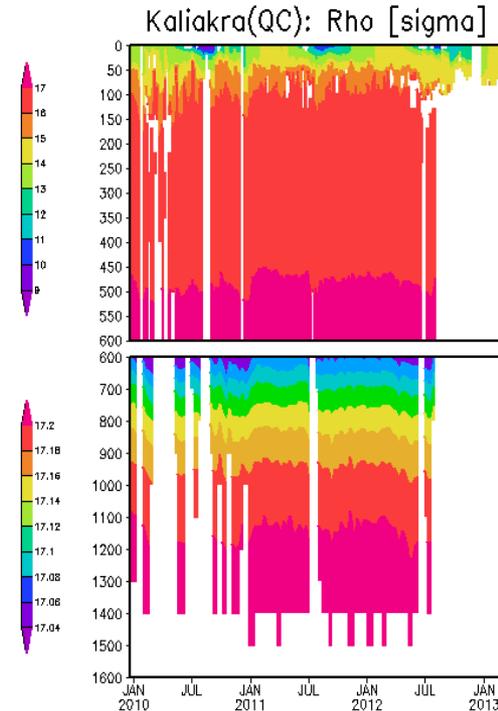
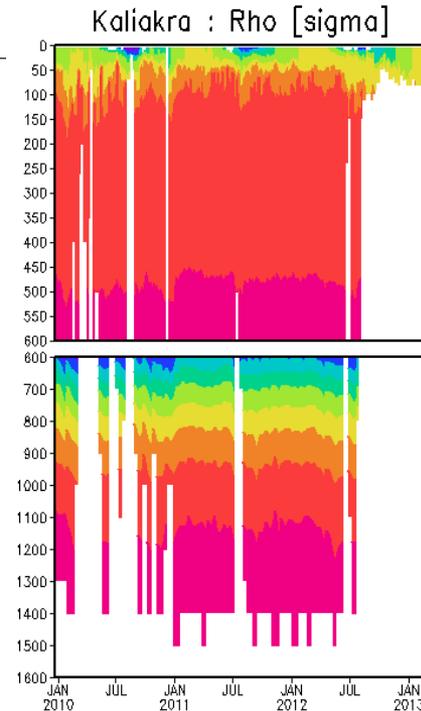


Results from the quality control

Kaliakra – 234 profiles:

Performed test	Number of bad values
Missing cycle	2
Pressure range test of original levels	1
Pressure increasing test of original levels	1
Temperature range test of original levels	0
Salinity range test of original levels	1
Comparison with Argo data	47
Comparison with climate data	12
Inverse stratification test	3
Comparison with Argo gradient	3

Profile flag	Percentage of the profiles
A	82,3%
B	14,6%
C	2,1%
D	1%
E	0
F	0

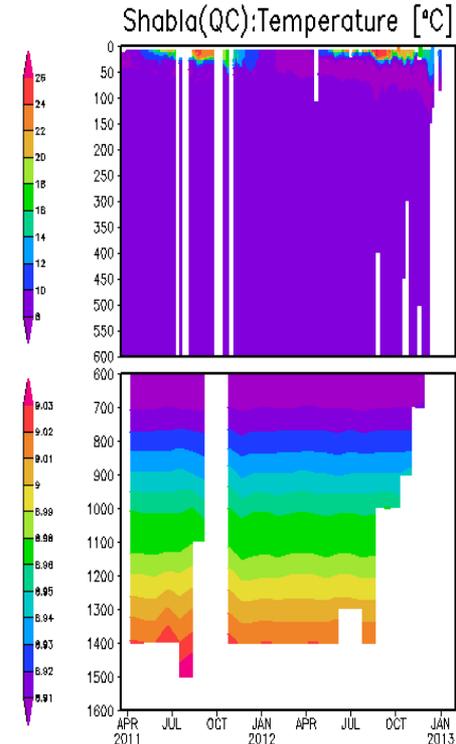
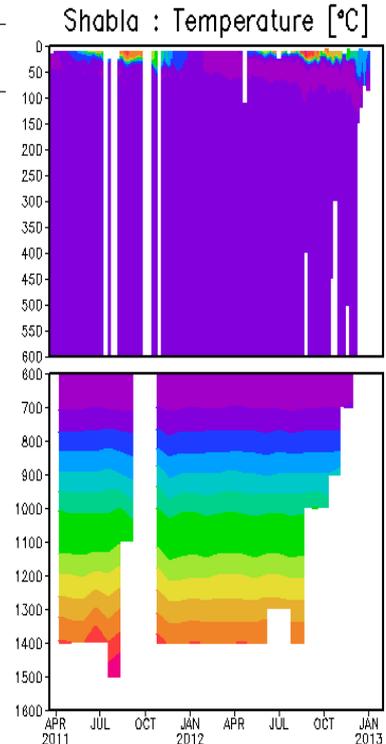




Shabla – 138 profiles:

Performed test	Number of bad values
Missing cycle	11
Pressure range test of original levels	26
Pressure increasing test of original levels	5
Temperature range test of original levels	21
Salinity range test of original levels	33
Comparison with Argo data	38
Comparison with climate data	18
Inverse stratification test	0
Comparison with Argo gradient	2

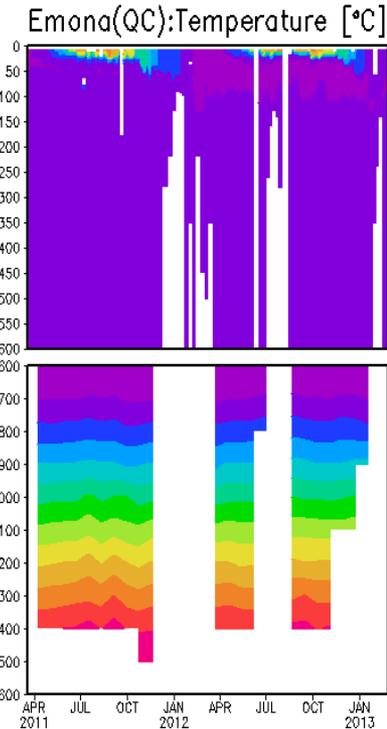
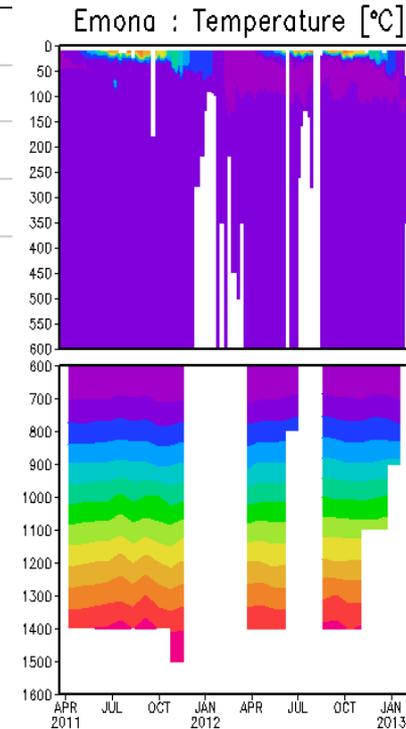
Profile flag	Percentage of the profiles
A	74,8%
B	21,2%
C	3,1%
D	0,9%
E	0
F	0





Emona - 146 profiles:

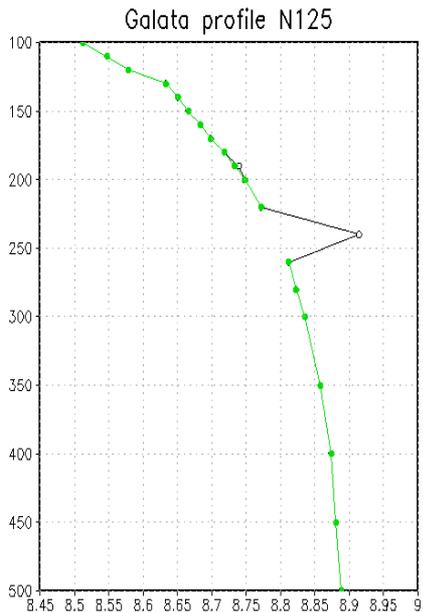
Performed test	Number of bad values	Profile flag	Percentage of the profiles
Missing cycle	2	A	81,2%
Pressure range test of original levels	107	B	13,9%
Pressure increasing test of original levels	11	C	4,2%
Temperature range test of original levels	104	D	0
Salinity range test of original levels	109	E	0
Oxygen temperature range	105	F	0,7%
Comparison with Argo data	24		
Comparison with climate data	17		
Inverse stratification test	0		
Comparison with Argo gradient	7		



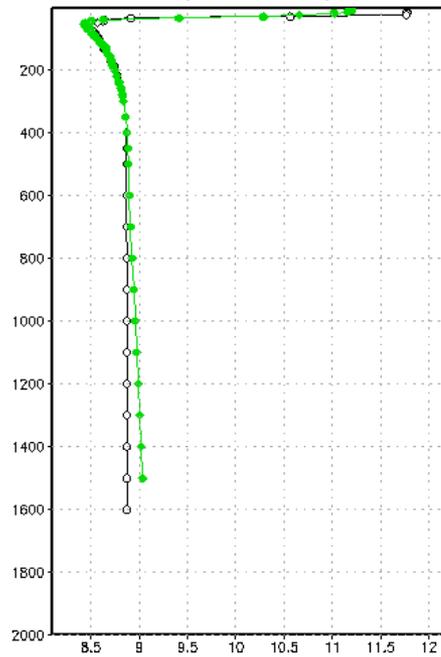


Galata – 146 profiles:

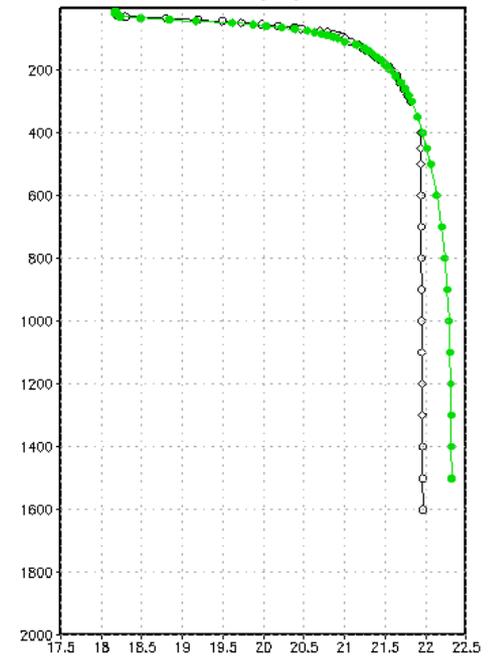
Performed test	Number of bad values	Profile flag	Percentage of the profiles
Missing cycle	3	A	91%
Pressure range test of original levels	53	B	7%
Pressure increasing test of original levels	12	C	1,3%
Temperature range test of original levels	48	D	0,7%
Salinity range test of original levels	49	E	0
Comparison with Argo data	14	F	0
Comparison with climate data	12		
Inverse stratification test	0		
Comparison with Argo gradient	5		



Galata temperature profile N49



Galata salinity profile N49





Rusalka – 59 profiles:

Performed test	Number of bad data	Profile flag	Percentage of the profiles
Missing cycle	0	A	89,8%
Pressure range test of original levels	0	B	8,5%
Pressure increasing test of original levels	0	C	1,7%
Temperature range test of original levels	0	D	0
Salinity range test of original levels	0	E	0
Comparison with Argo data	10	F	0
Comparison with climate data	0		
Inverse stratification test	0		
Comparison with Argo gradient	0		

Varna – 26 profiles:

Performed test	Number of bad data	Profile flag	Percentage of the profiles
Missing cycle	0	A	84,6%
Pressure range test of original levels	0	B	0
Pressure increasing test of original levels	0	C	0
Temperature range test of original levels	0	D	7,7%
Salinity range test of original levels	0	E	0
Comparison with Argo data	0	F	7,7%
Comparison with climate data	4		
Inverse stratification test	0		
Comparison with Argo gradient	0		



Dolphin – 46 profiles:

Performed test	Number of bad data	Profile flag	Percentage of the profiles
Missing cycle	0	A	77,8%
Pressure range test of original levels	0	B	17,8%
Pressure increasing test of original levels	0	C	4,4%
Temperature range test of original levels	0	D	0
Salinity range test of original levels	0	E	0
Comparison with Argo data	14	F	0
Comparison with climate data	6		
Inverse stratification test	0		
Comparison with Argo gradient	0		

Elito – 29 profiles:

Performed test	Number of bad data	Profile flag	Percentage of the profiles
Missing cycle	0	A	72,4%
Pressure range test of original levels	0	B	27,6%
Pressure increasing test of original levels	0	C	0
Temperature range test of original levels	0	D	0
Salinity range test of original levels	0	E	0
Comparison with Argo data	10	F	0
Comparison with climate data	5		
Inverse stratification test	0		



**Thank you for your
attention!!!**