Performance of the recent Argo floats in the Black Sea. Data quality control procedures and lessons learned.

Elisaveta Peneva, Emil Stanev, Milena Milanova

Sofia University "St. Kliment Ohridski"


6900803
6900805
6900804
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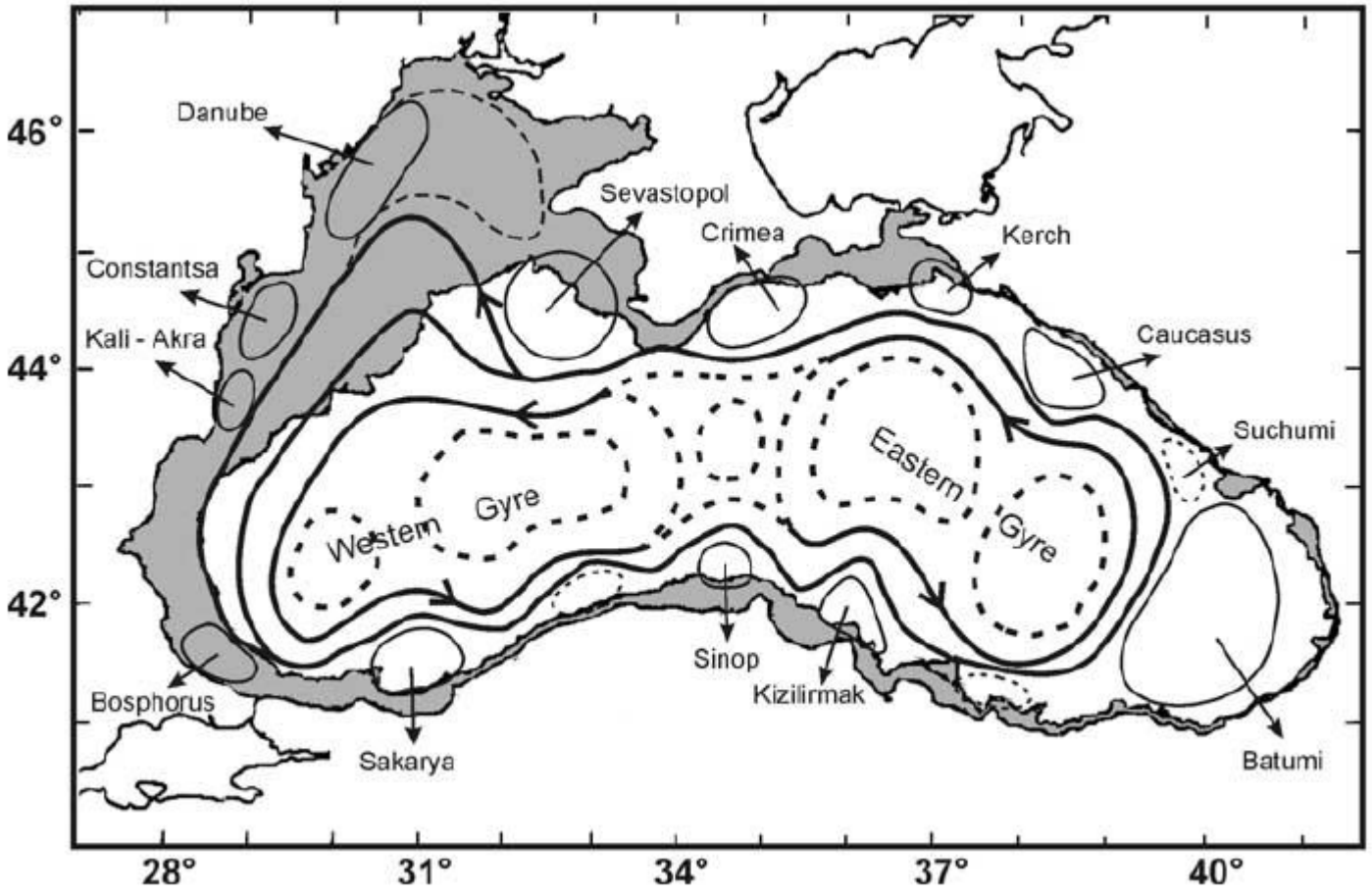
Danube
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Crimea
Kerch
Constantsa
Kali - Akra
Caucasus
Suchumi
Eastern Gyre
Western Gyre
Sinop
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Batumi
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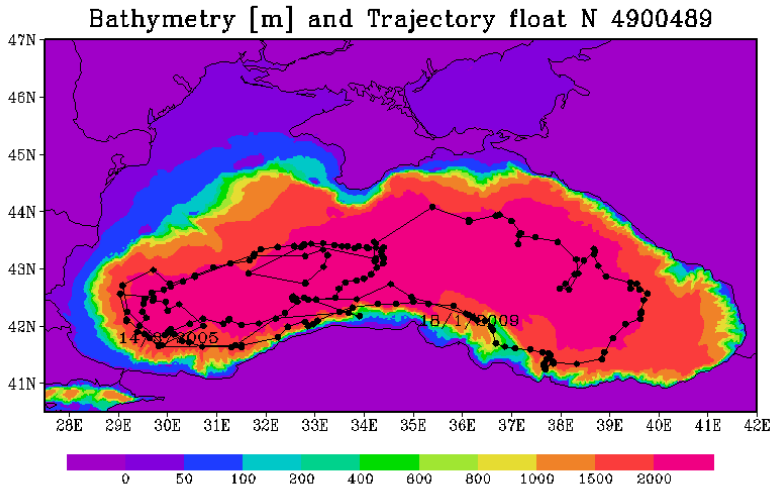
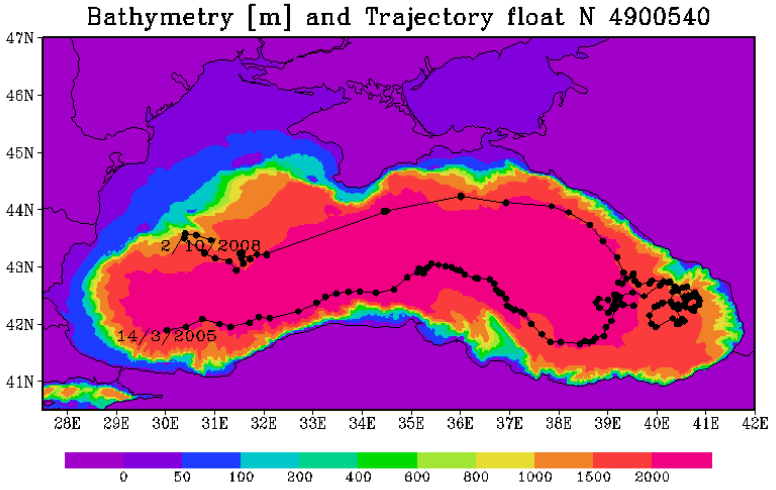

Bathymetry [m] and Trajectory float N 4900489
47N
46N
45N
44N
43N
42N
41N
28E 29E 30E 31E 32E 33E 34E 35E 36E 37E 38E 39E 40E 41E 42E
14/3/2005
0 50 100 200 400 600 800 1000 1500 2000


Bathymetry [m] and Trajectory float N 4900540
47N
46N
45N
44N
43N
42N
41N
28E 29E 30E 31E 32E 33E 34E 35E 36E 37E 38E 39E 40E 41E 42E
2/10/2008
14/3/2005
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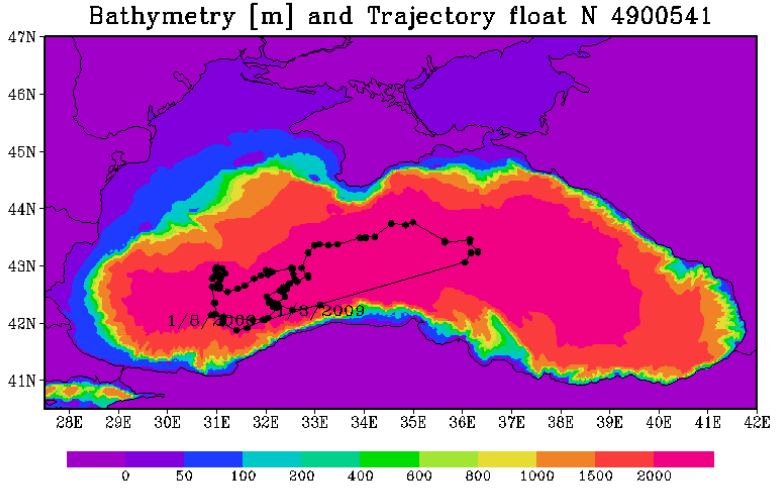
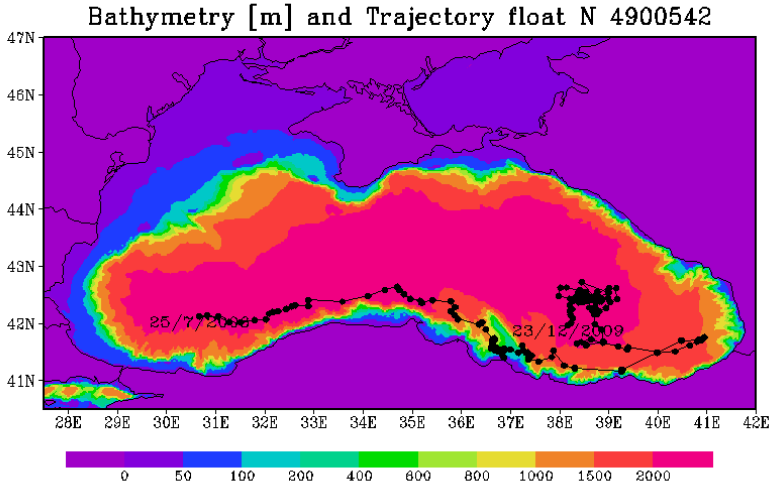

Bathymetry [m] and Trajectory float N 4900541
47N
46N
45N
44N
43N
42N
41N
28E 29E 30E 31E 32E 33E 34E 35E 36E 37E 38E 39E 40E 41E 42E
0 50 100 200 400 600 800 1000 1500 2000


Bathymetry [m] and Trajectory float N 4900542
47N
46N
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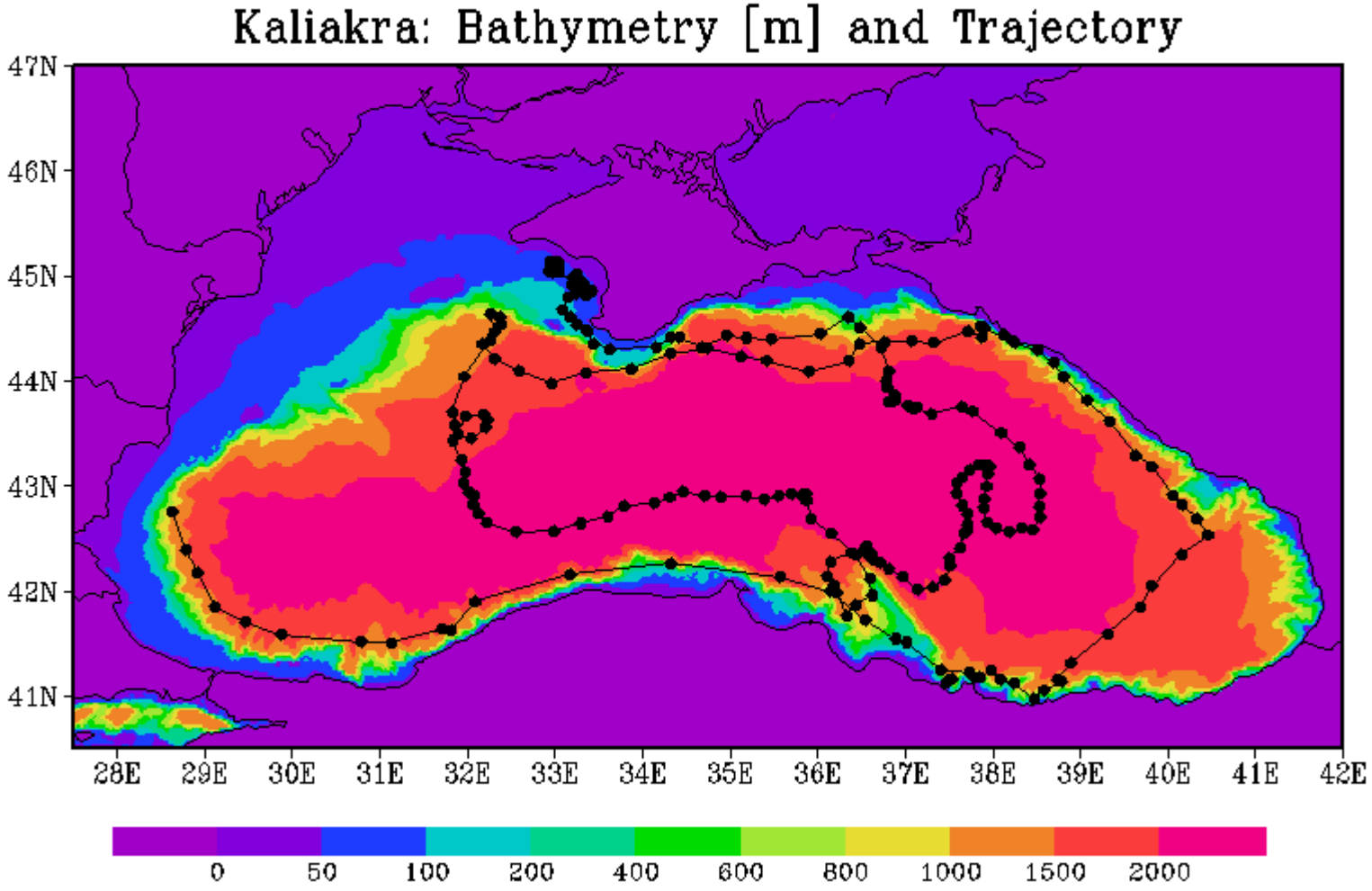
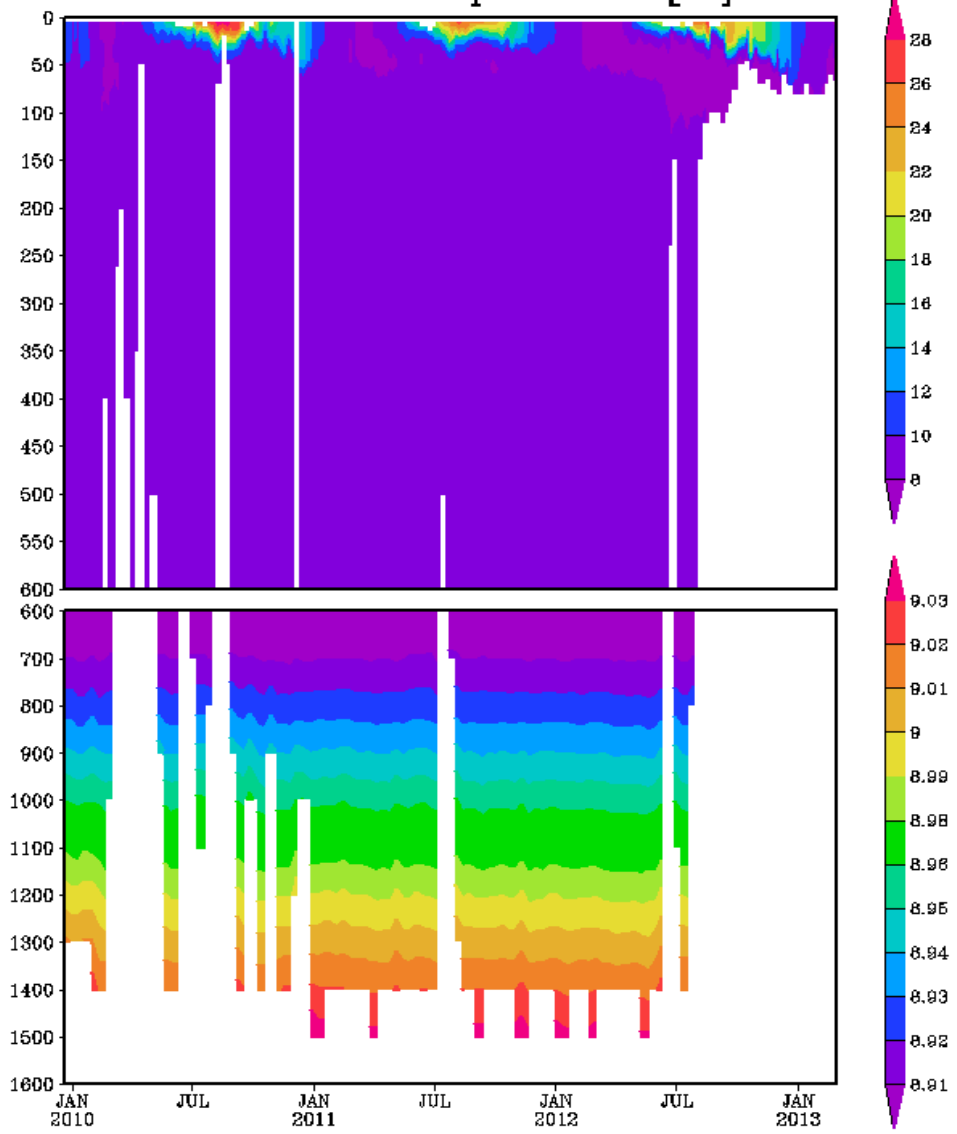
44N
43N
42N
41N
28E 29E 30E 31E 32E 33E 34E 35E 36E 37E 38E 39E 40E 41E 42E
25/7/2008
23/12/2009
0 50 100 200 400 600 800 1000 1500 2000

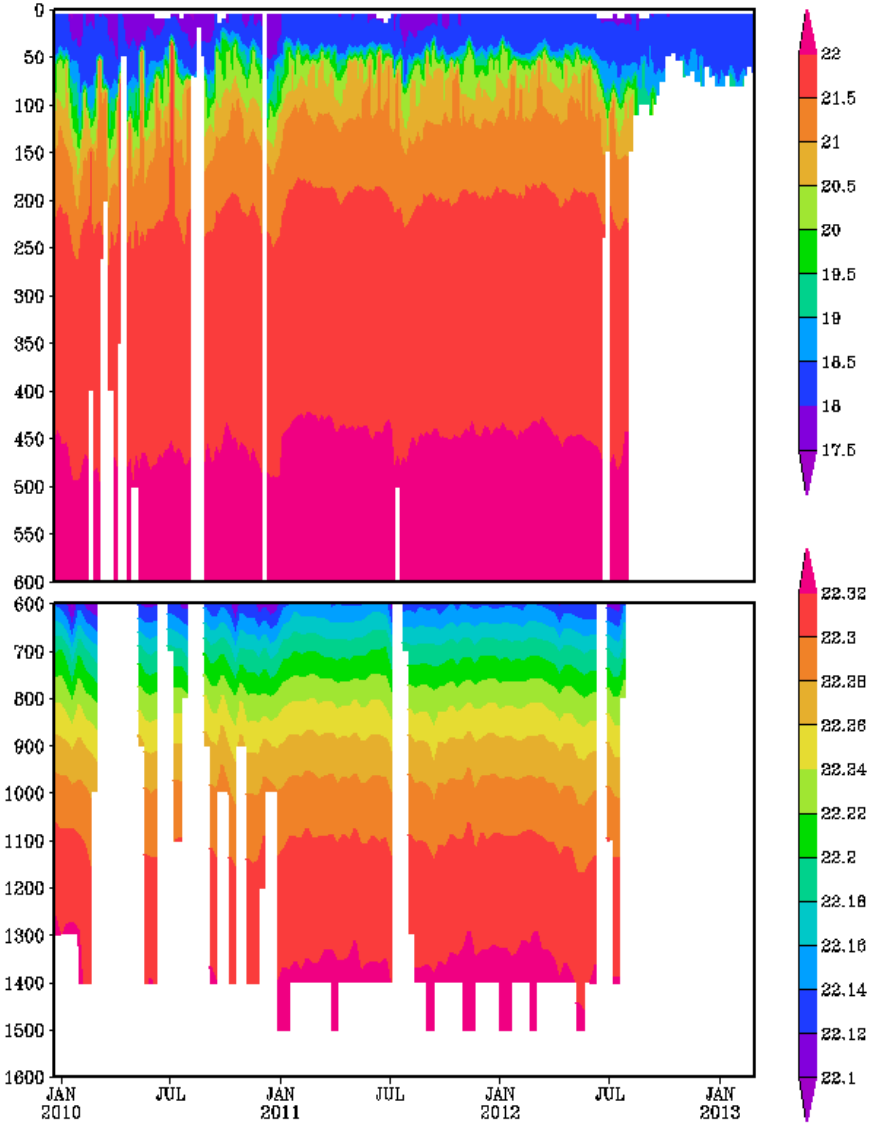
Kaliakra: N 1901200 –deployed December 2009



Kaliakra : Temperature [°C]



Kaliakra : Salinity [psu]



BULARGO

In 2010 the BulArgo project was initiated in Bulgaria, funded by the Bulgarian National Science Fund and the Ministry of Education, Youth and Science (~100 000 euro)

The Ministry of Education, Youth and Science supports the Argo program in the Black Sea. The project finishes in June 2013 and partners plan to apply for continuation on the next call for proposals .

BulArgo partners:

- **Institute of Oceanology – BAS, Varna**
- **National Institute of Meteorology and Hydrology – BAS**
- **Sofia University “St. Kliment Ohridski”**

Goals:

- **To develop national research infrastructure as a Bulgarian component of the Euro-Argo network.**
- **To increase sources of the Black Sea in-situ data and to improve quality of local in-situ products and forecasts**
- **To promote international collaboration towards establishment of a Black Sea Argo program**

BULARGO ACTIVITIES

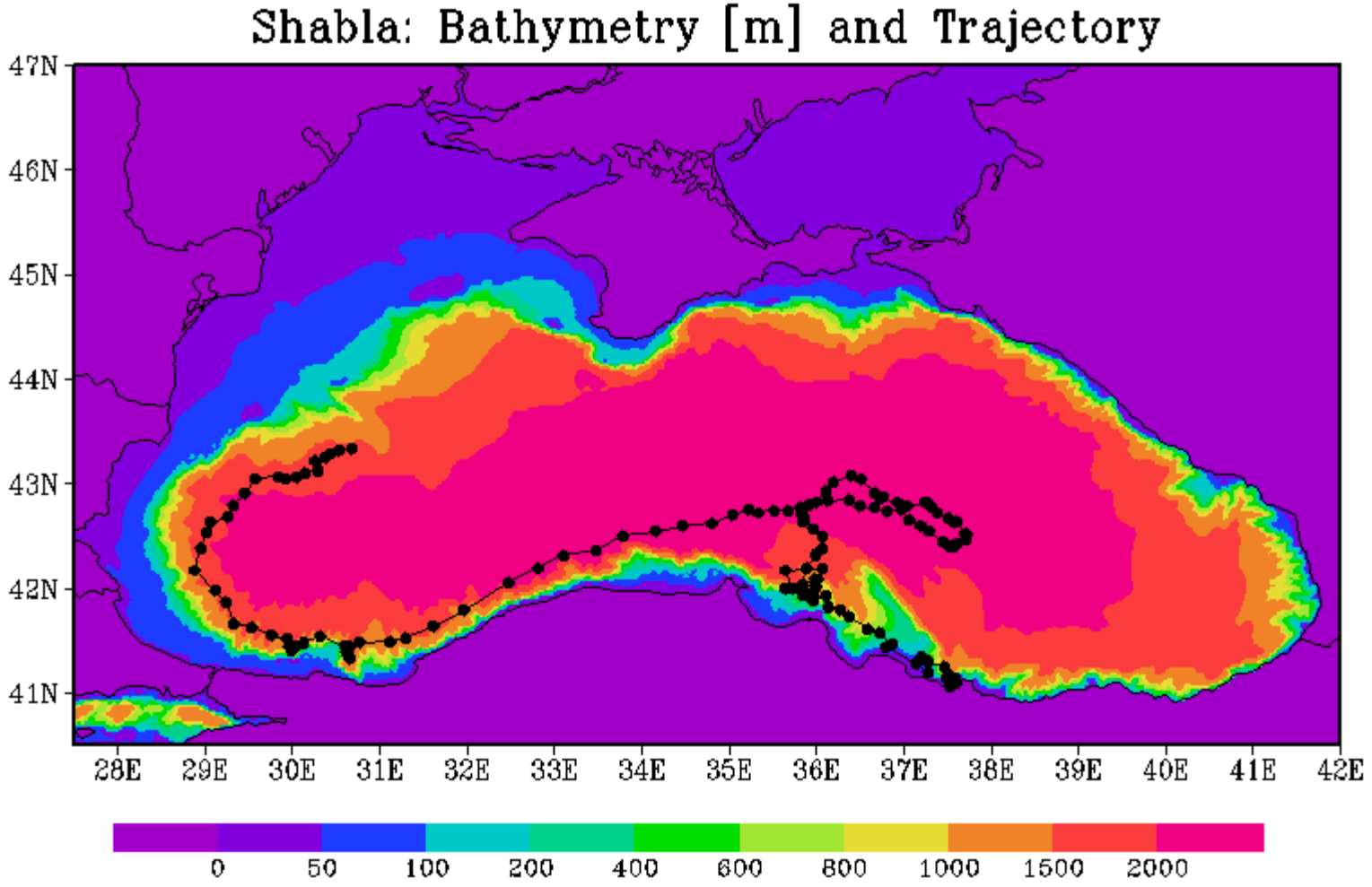
17 – 19 March 2011 3 floats were deployed during the R/V Akademik cruise

Two of the floats were deployed along the Black sea geostrophic current at depth 1000m and one, additionally equipped with oxygen sensor, was deployed at depth 2000m

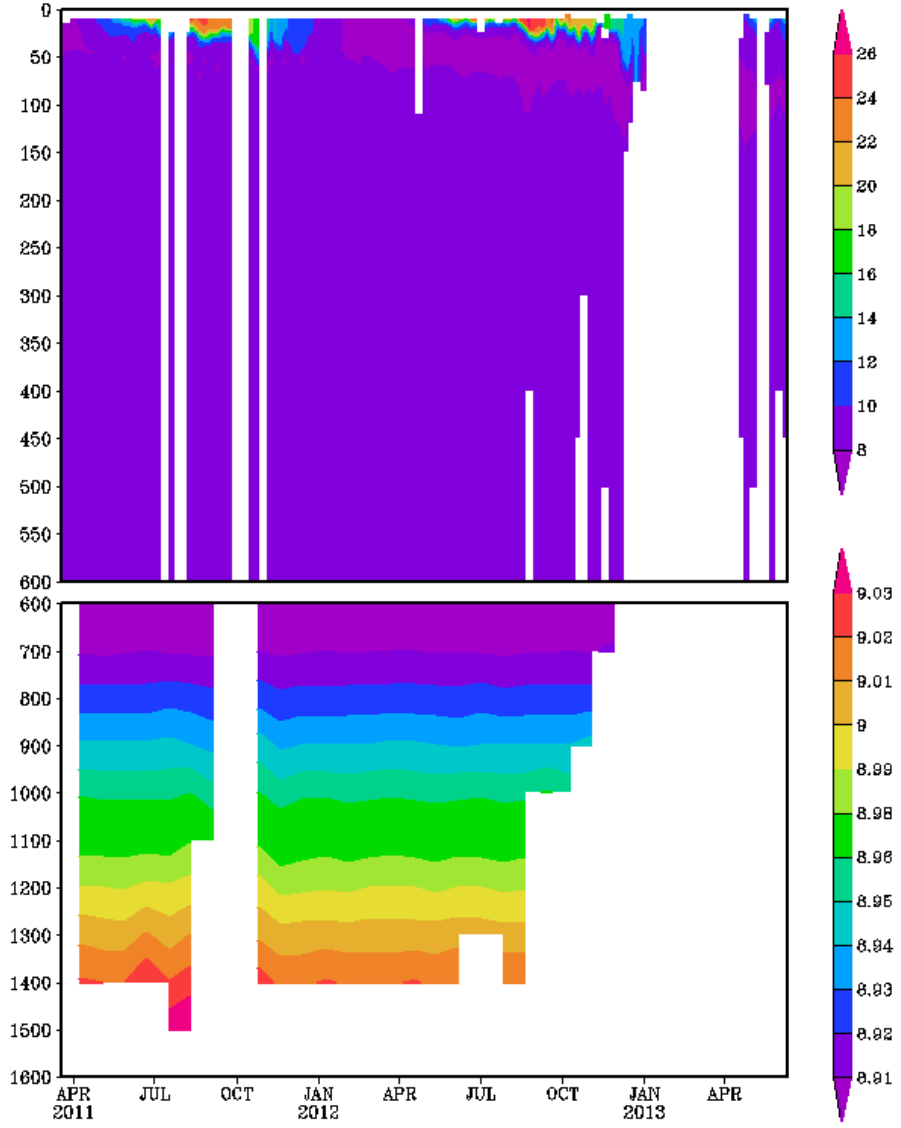
The floats are designed for a parking depth of 750 m, profiling depth of 1500 m and temporal cycle of 5 days


RESET

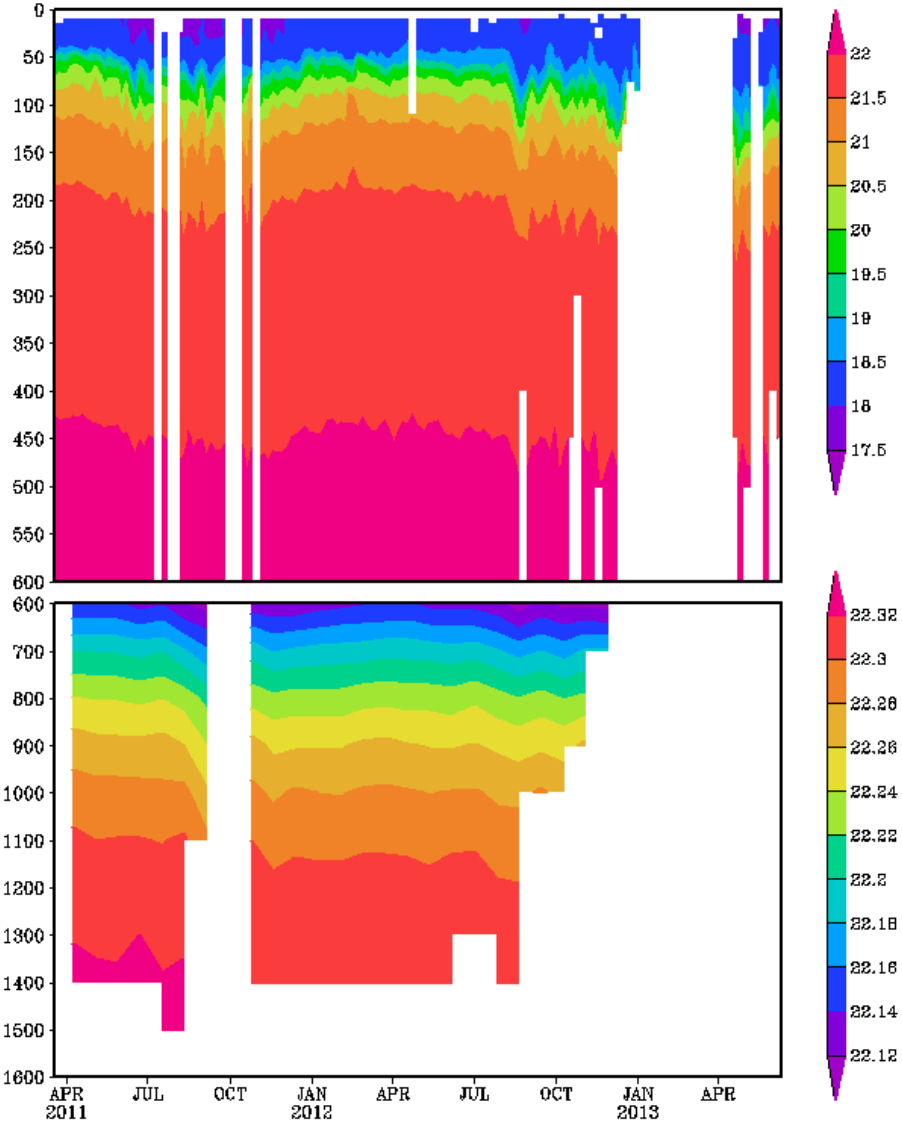
Shabla: N 6900803 –deployed March 2011



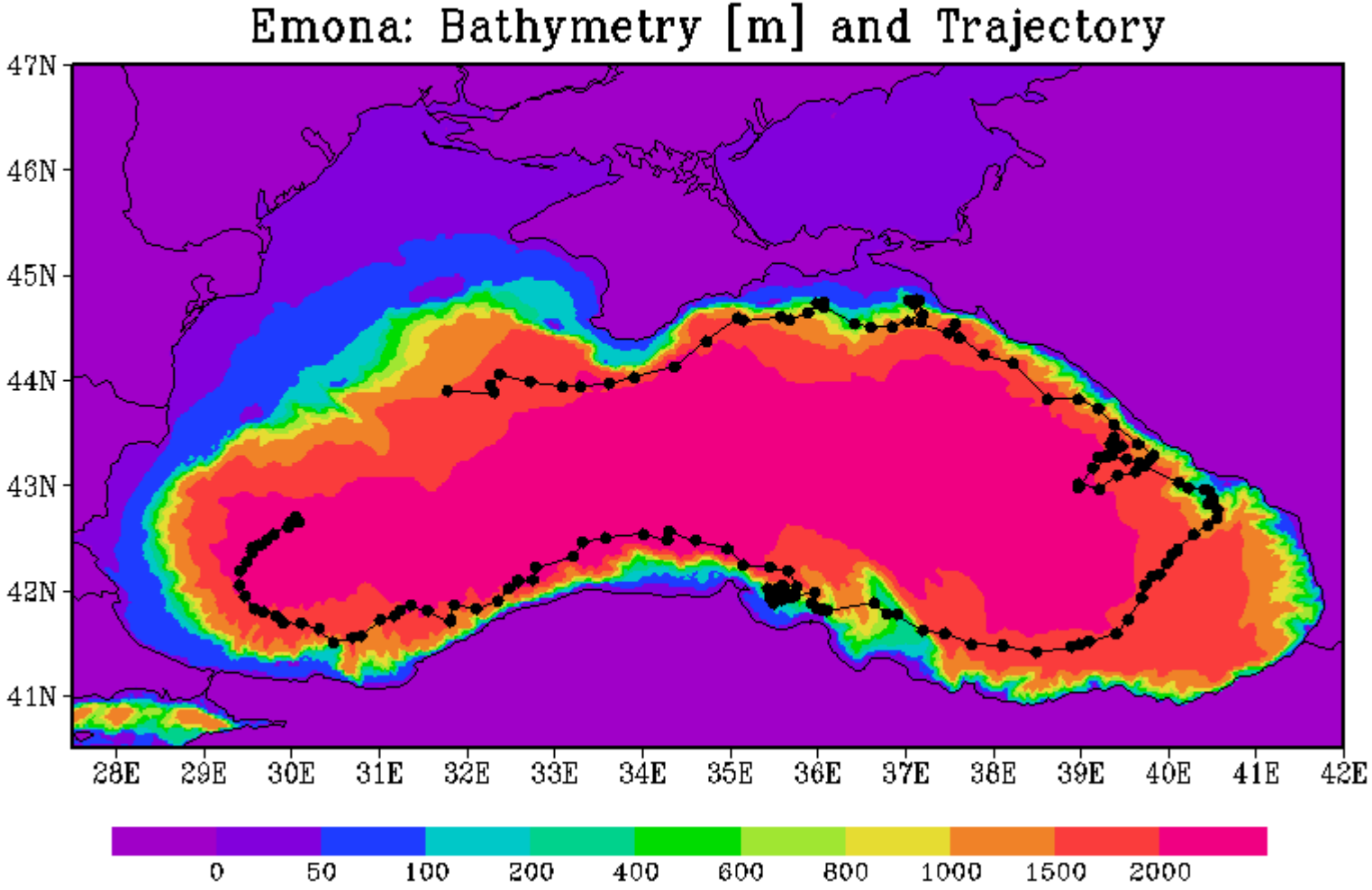
Shabla : Temperature [°C]



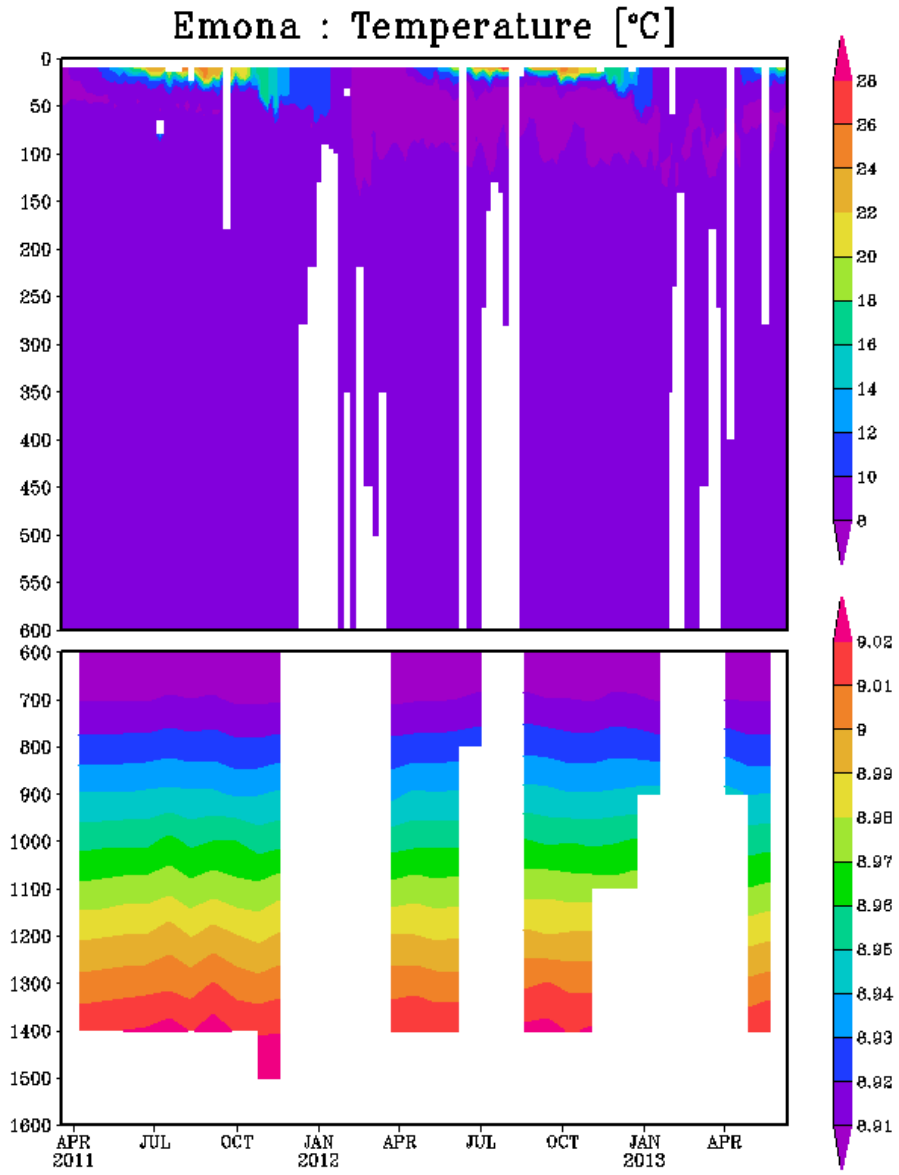
Shabla : Salinity [psu]



Emona: N 6900804 –deployed March 2011




Euro
Argo


Emona : Temperature [°C]
0
50
100
150
200
250
300
350
400
450
500
550
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
APR 2011
JUL
OCT
JAN 2012
APR
JUL
OCT
JAN 2013
APR
28
26
24
22
20
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16
14
12
10
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8.95
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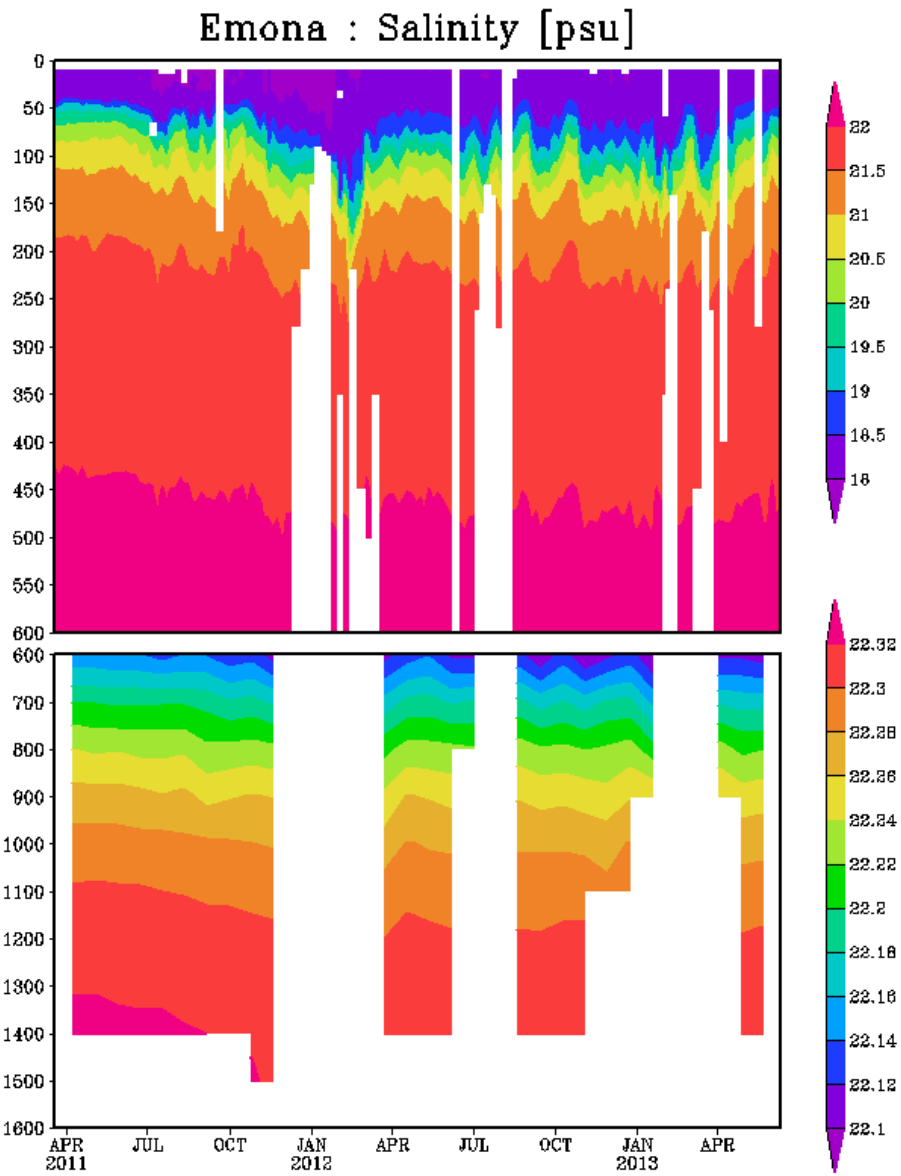
8.93
8.92
8.91


Emona : Salinity [psu]
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APR 2011
JUL
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JAN 2012
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JAN 2013
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20
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19
18.5
18
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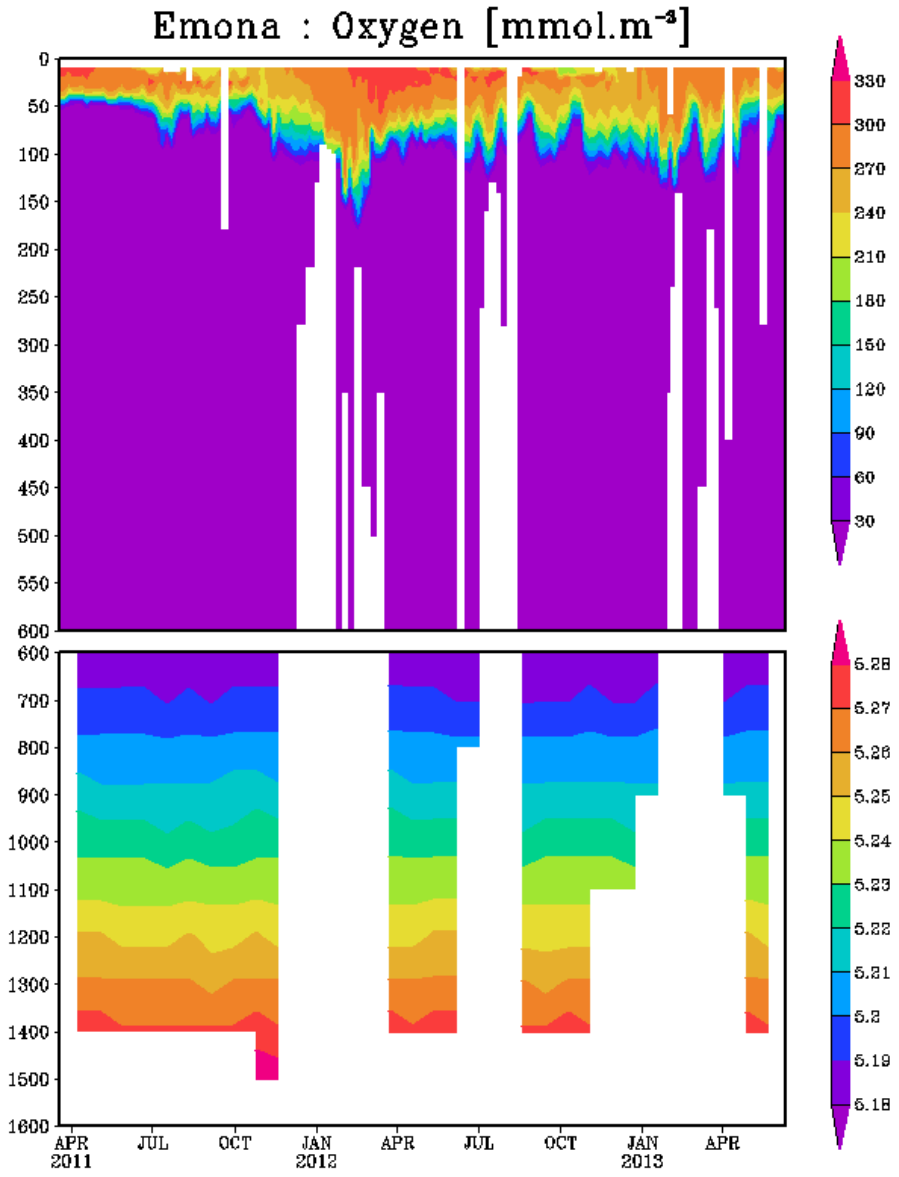
22.2
22.18
22.16
22.14
22.12
22.1


Emona : Oxygen [mmol.m⁻³]
0
50
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400
450
500
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330
300
270
240
210
180
150
120
90
60
30
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
5.28
5.27
5.26
5.25
5.24
5.23
5.22
5.21
5.2
5.19
5.18
APR
2011
JUL
OCT
JAN
2012
APR
JUL
OCT
JAN
2013
APR

!========================

! TOX=> SEA TEMPERATURE FROM DOXY SENSOR (degree C)

! BOX=> phase obtained with blue light excitation (BPhase)

! O2CONC => microM

!========================

!for Emona float N 6900804 coefficients are:

data PhaseCoef/-1.595962E+00,1.125157E+00,0.000000E+00,0.000000E+00/

data TempCoef/2.500892E+01,-3.106162E-02,2.915783E-06,-4.303529E-09/

data C0Coef/4.537931E+03,-1.625950E+02,3.295740E+00,-2.792849E-02/

data C1Coef/-2.509530E+02,8.023220E+00,-1.583980E-01,1.311410E-03/

data C2Coef/5.664169E+00,-1.596469E-01,3.079099E-03,-2.462650E-05/

data C3Coef/-5.994490E-02,1.483260E-03,-2.821099E-05,2.151560E-07/

data C4Coef/2.436140E-04,-5.267590E-06,1.000640E-07,-7.143200E-10/

! *coeficients for solubility, saturation and salinity compensation*

A0 = 2.00856

A1 = 3.22400

A2 = 3.99063

A3 = 4.80299

A4 = 9.78188e-1

A5 = 1.71069

B0 = -6.24097e-3

B1 = -6.93498e-3

B2 = -6.90358e-3

B3 = -4.29155e-3

CSAL = -3.11680e-7

SAL0= 0.

BPHASE=BOX !blu light exitation

RPHASE=0. !red light exitation =0

UPHASE=BPHASE-RPHASE !uncalibrated phase measurement

DPHASE - calibrated phase measurement

*DPHASE=PhaseCoef(1)+PhaseCoef(2)*UPHASE+PhaseCoef(3)*UPHASE**2+PhaseCoef(4)*UPHASE**3*

*TEM=TempCoef(1)+TempCoef(2)*UPHASE+TempCoef(3)*UPHASE**2+TempCoef(4)*UPHASE**3*

*C0= C0Coef(1)+C0Coef(2)*TOX+C0Coef(3)*TOX**2+C0Coef(4)*TOX**3*

*C1= C1Coef(1)+C1Coef(2)*TOX+C1Coef(3)*TOX**2+C1Coef(4)*TOX**3*

*C2= C2Coef(1)+C2Coef(2)*TOX+C2Coef(3)*TOX**2+C2Coef(4)*TOX**3*

*C3= C3Coef(1)+C3Coef(2)*TOX+C3Coef(3)*TOX**2+C3Coef(4)*TOX**3*

*C4= C4Coef(1)+C4Coef(2)*TOX+C4Coef(3)*TOX**2+C4Coef(4)*TOX**3*

*O2CONC=C0+(C1*DPHASE)+(C2*DPHASE**2)+(C3*DPHASE**3)+(C4*DPHASE**4)*

! salinity compensation

TSC=LOG((298.15-TOX)/(273.15+TOX))

SALCOMP=EXP((SAL-SAL0)(B0+B1*TSC+B2*TSC**2+B3*TSC**3)+CSAL*(SAL**2-SAL0**2))*

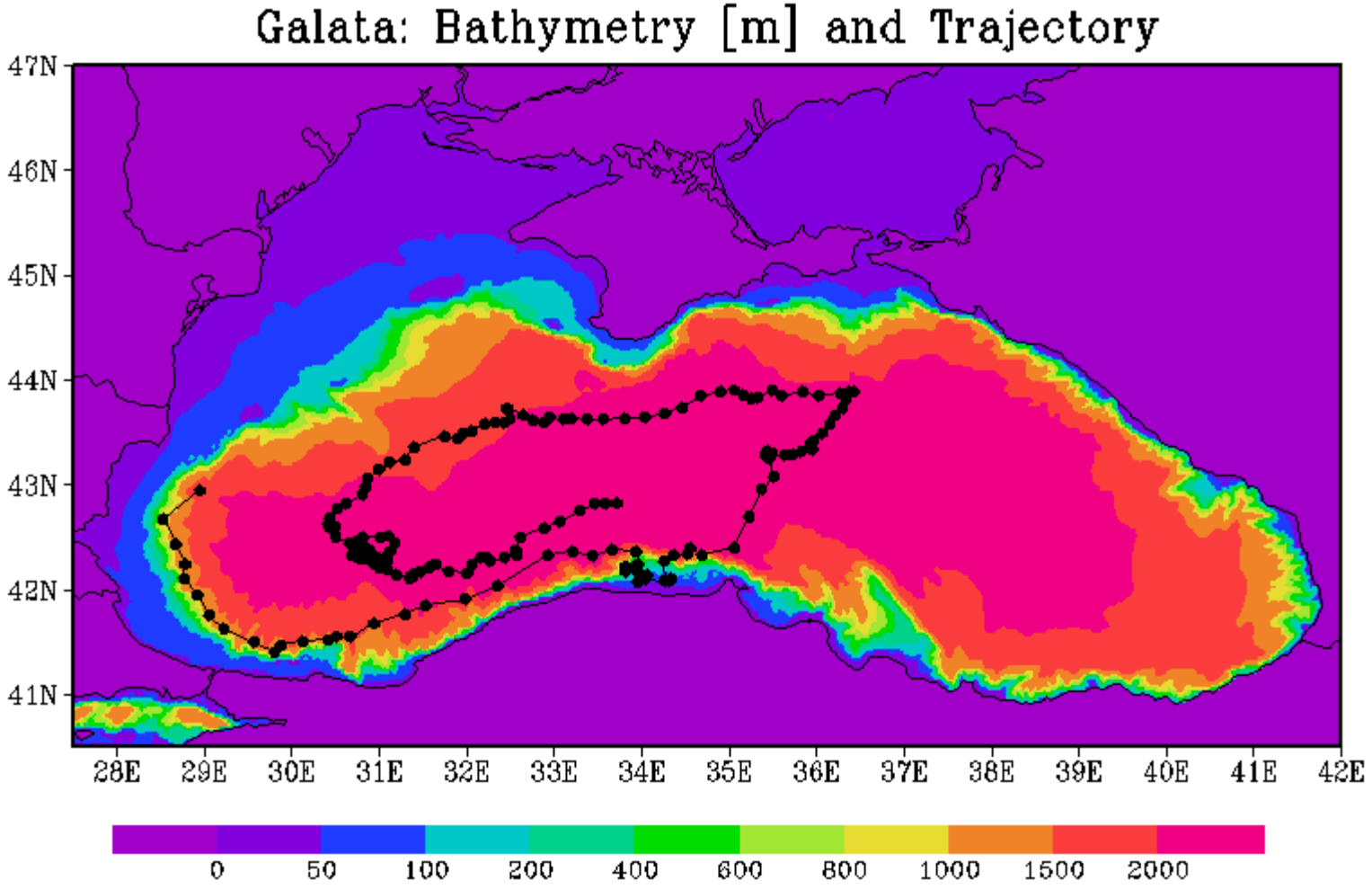
*O2CONC=O2CONC*SALCOMP*

!depth compensation

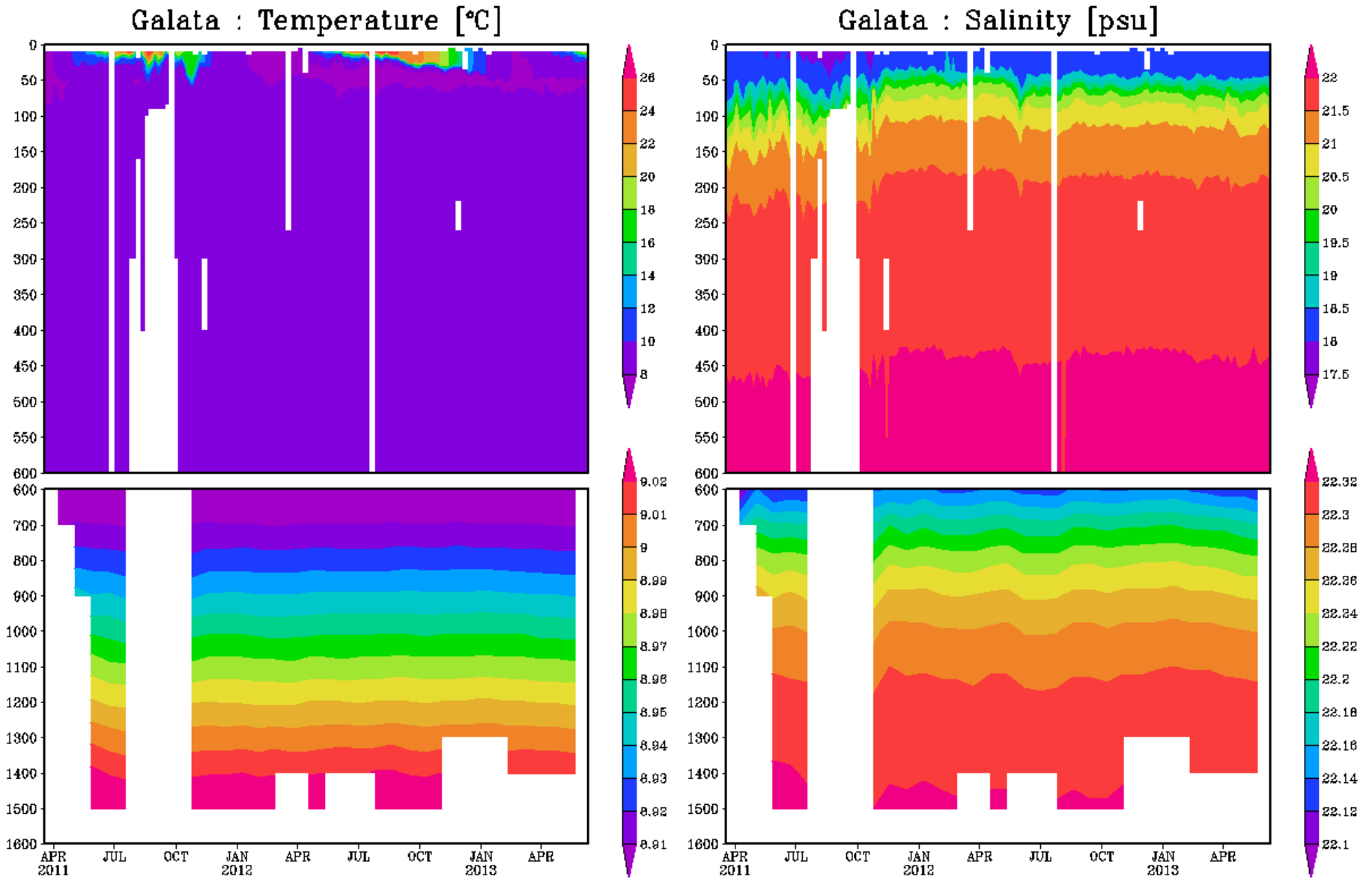
*DEPCOMP=1.+0.04*PR/1000.*

*O2CONC=O2CONC*DEPCOMP*

Galata: N 6900805 –deployed March 2011




Euro
Argo


Galata : Temperature [°C]
Galata : Salinity [psu]
0
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22.18
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22.1
APR
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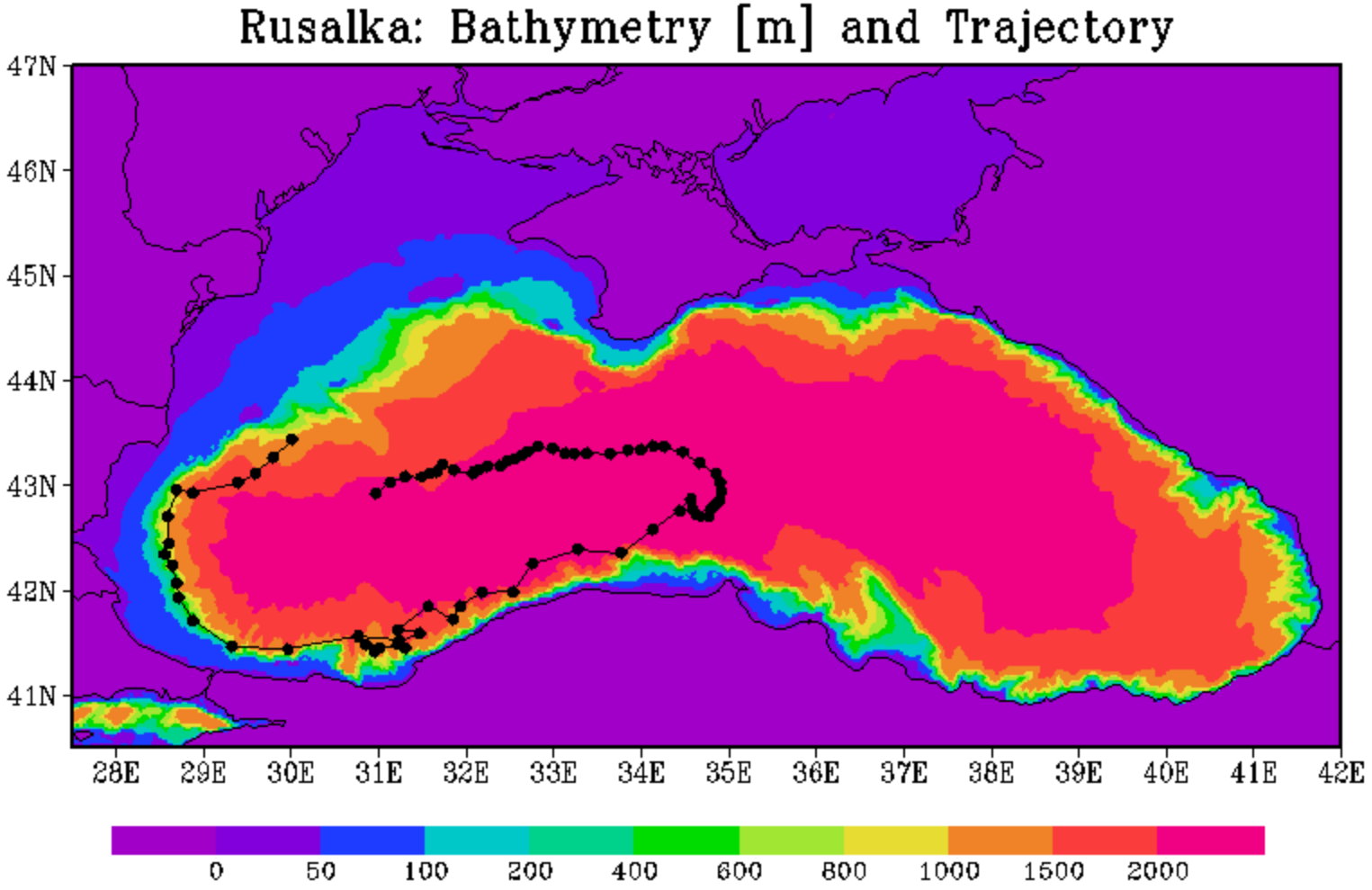
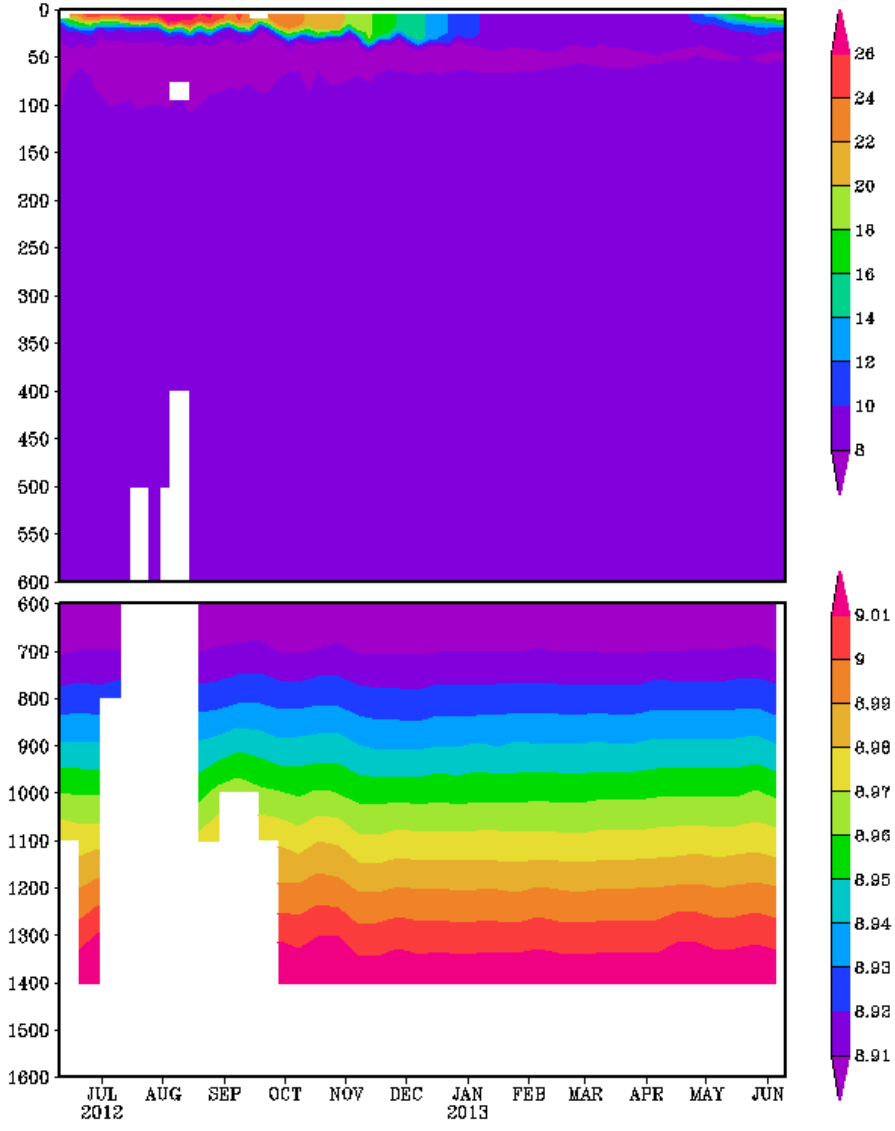
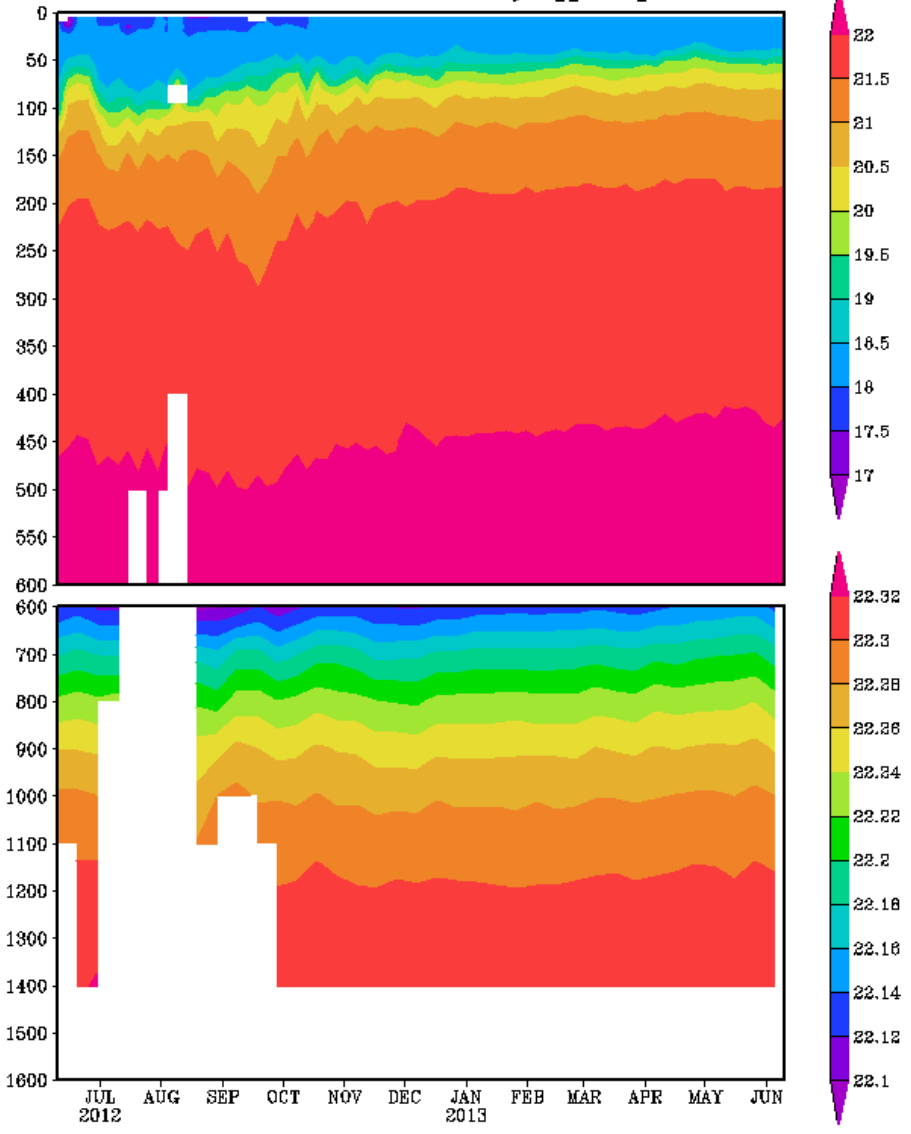
Rusalka: N 6901959 –deployed June 2012



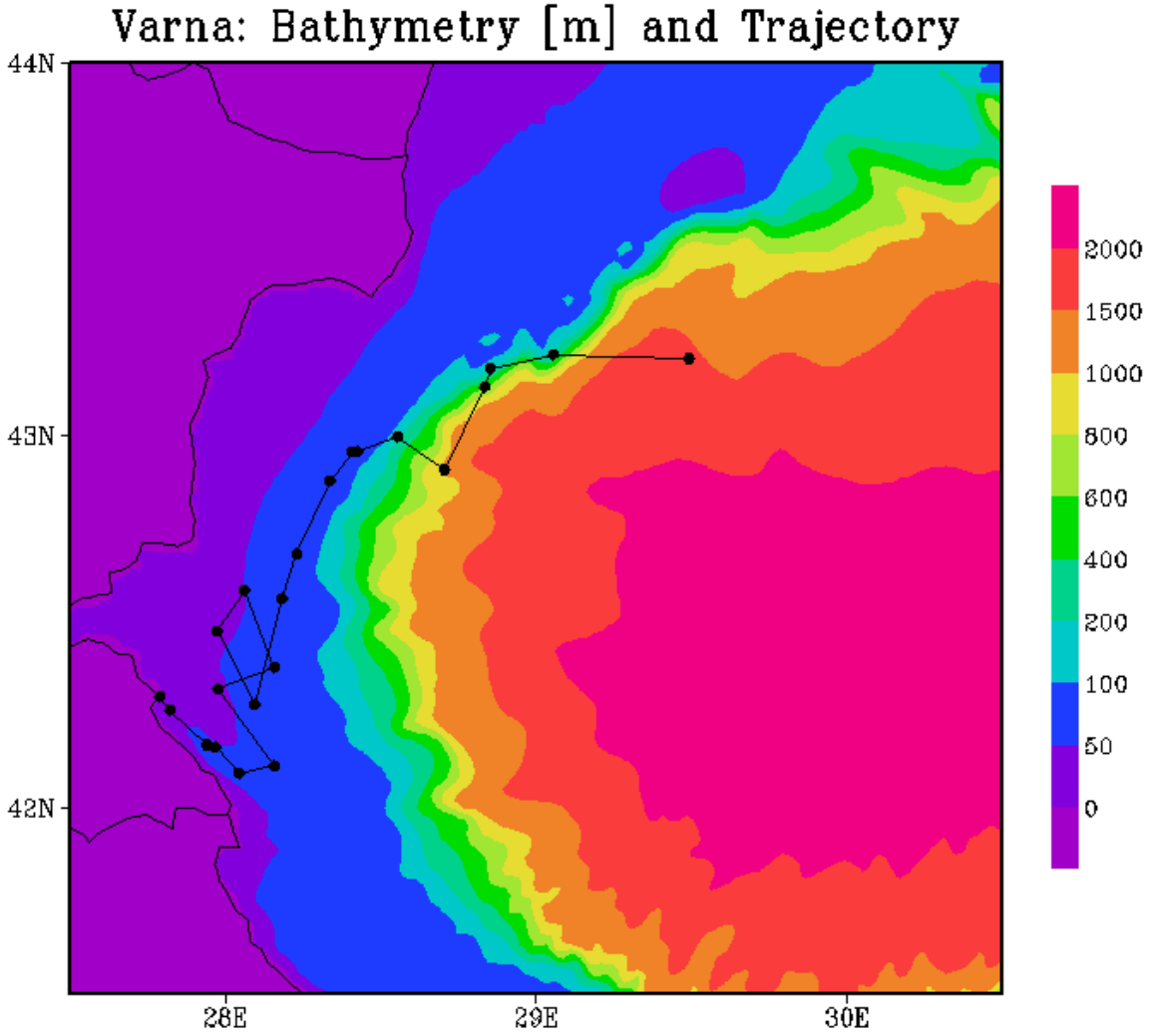
Rusalka : Temperature [°C]

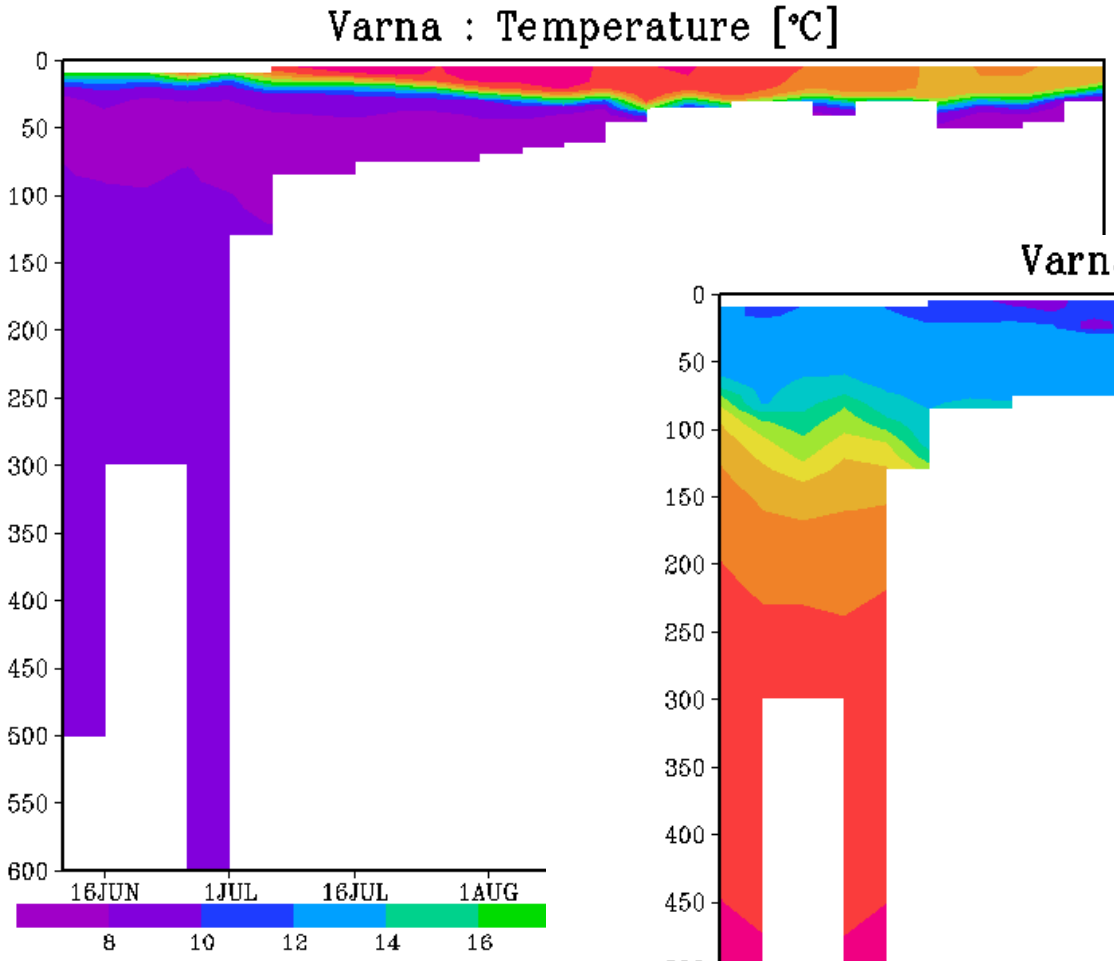


Rusalka : Salinity [psu]



Varna: N 6901960 –deployed June 2012




Varna : Temperature [°C]
0
50
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150
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600
16JUN
1JUL
16JUL
1AUG
8
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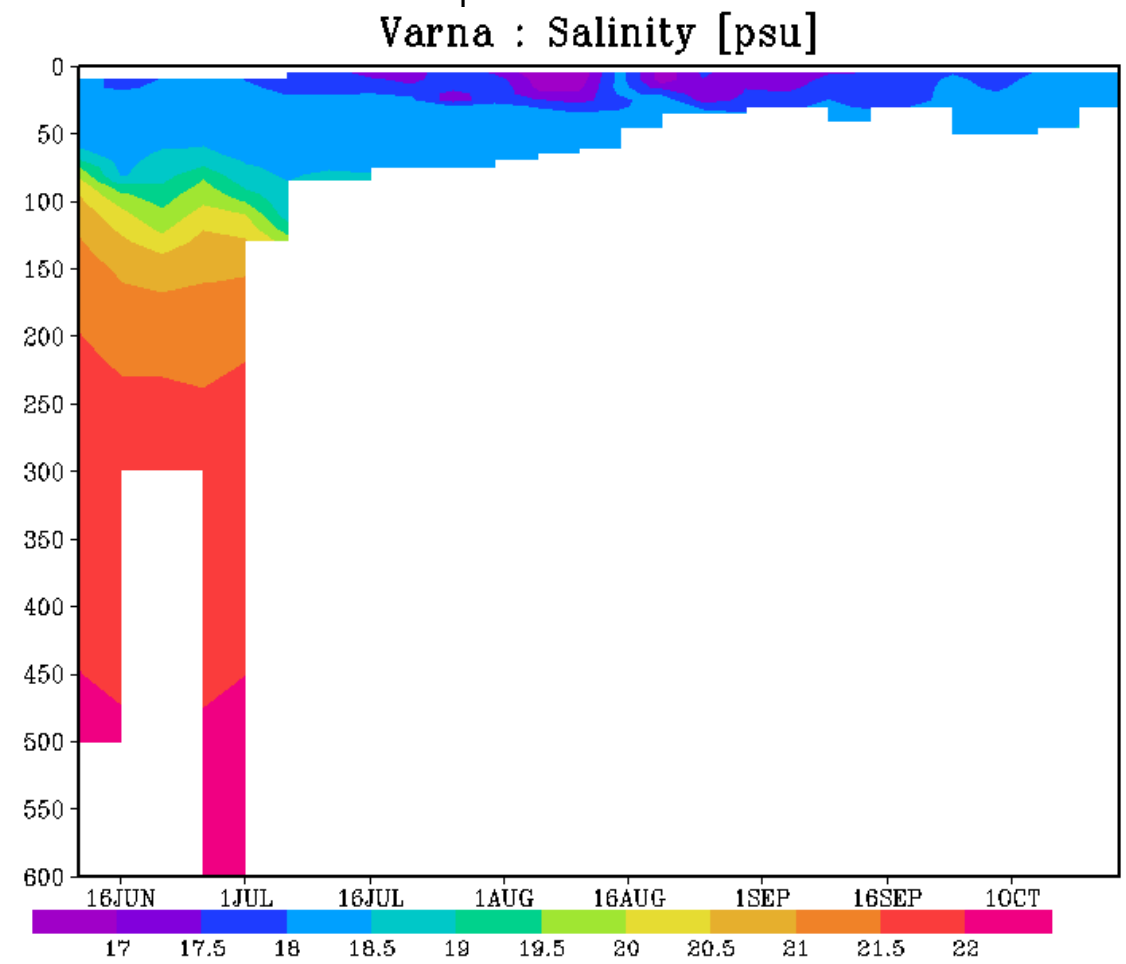
12
14
16


Varna : Salinity [psu]
0
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16JUN
1JUL
16JUL
1AUG
16AUG
1SEP
16SEP
1OCT
17
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18.5
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19.5
20
20.5
21
21.5
22


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UNITED NATIONS
WORLD CLIMATE
RESEARCH PROGRAM
ARGO FLOAT ID 9145EAD
DEPLOYED 09 06 2012
DO NOT OPEN this instrument.
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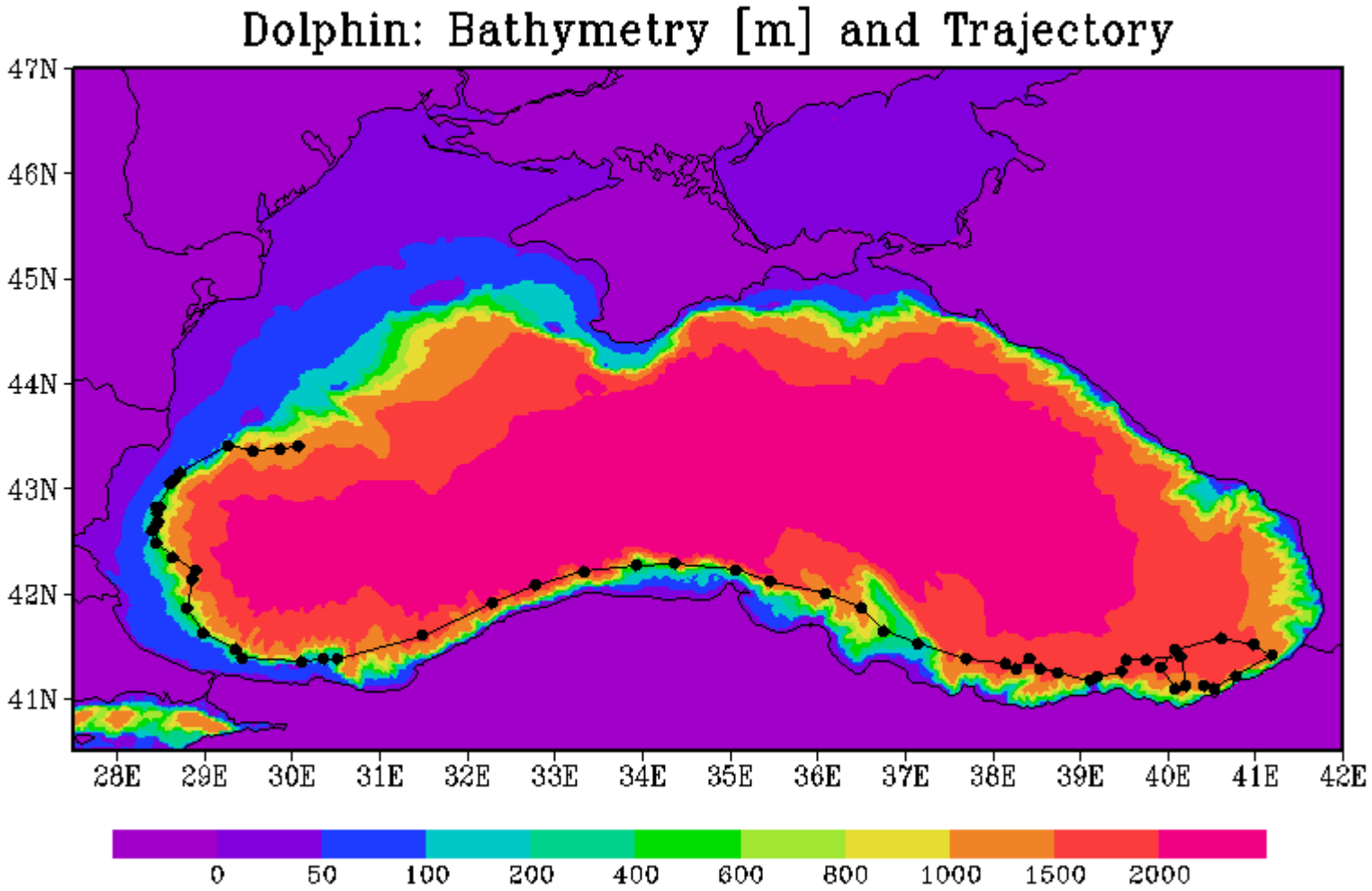
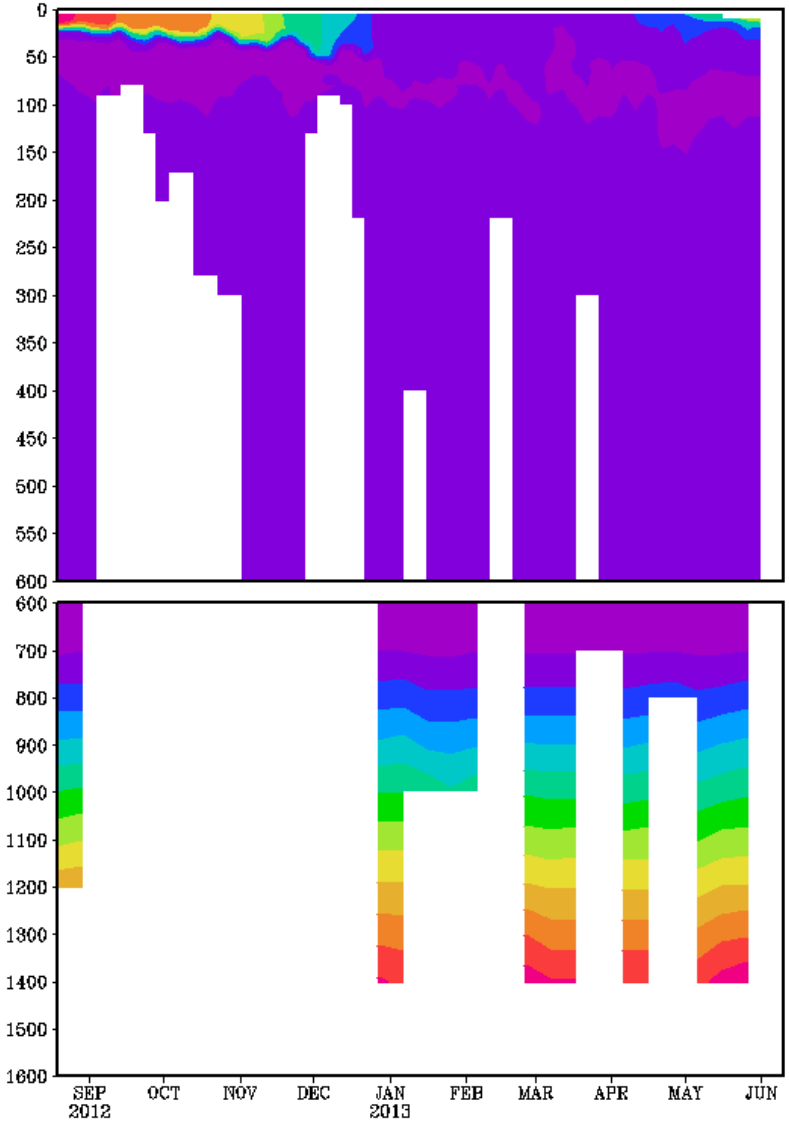
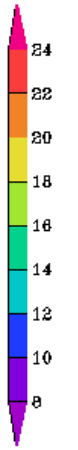
MENTATION

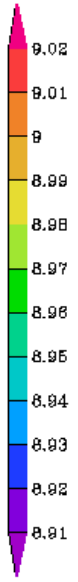
Delfin: N 6901962 –deployed August 2012



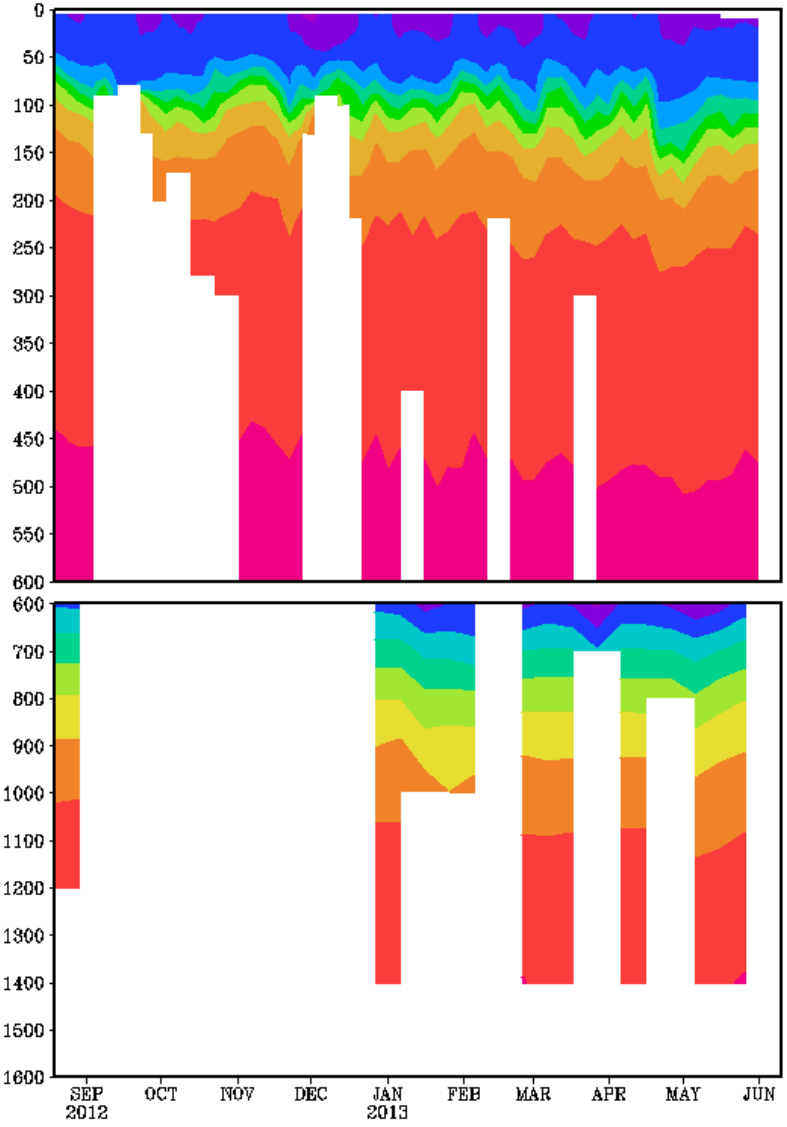
Dolphin : Temperature [°C]

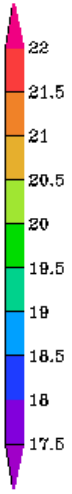


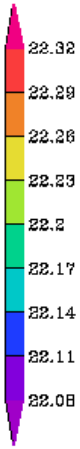




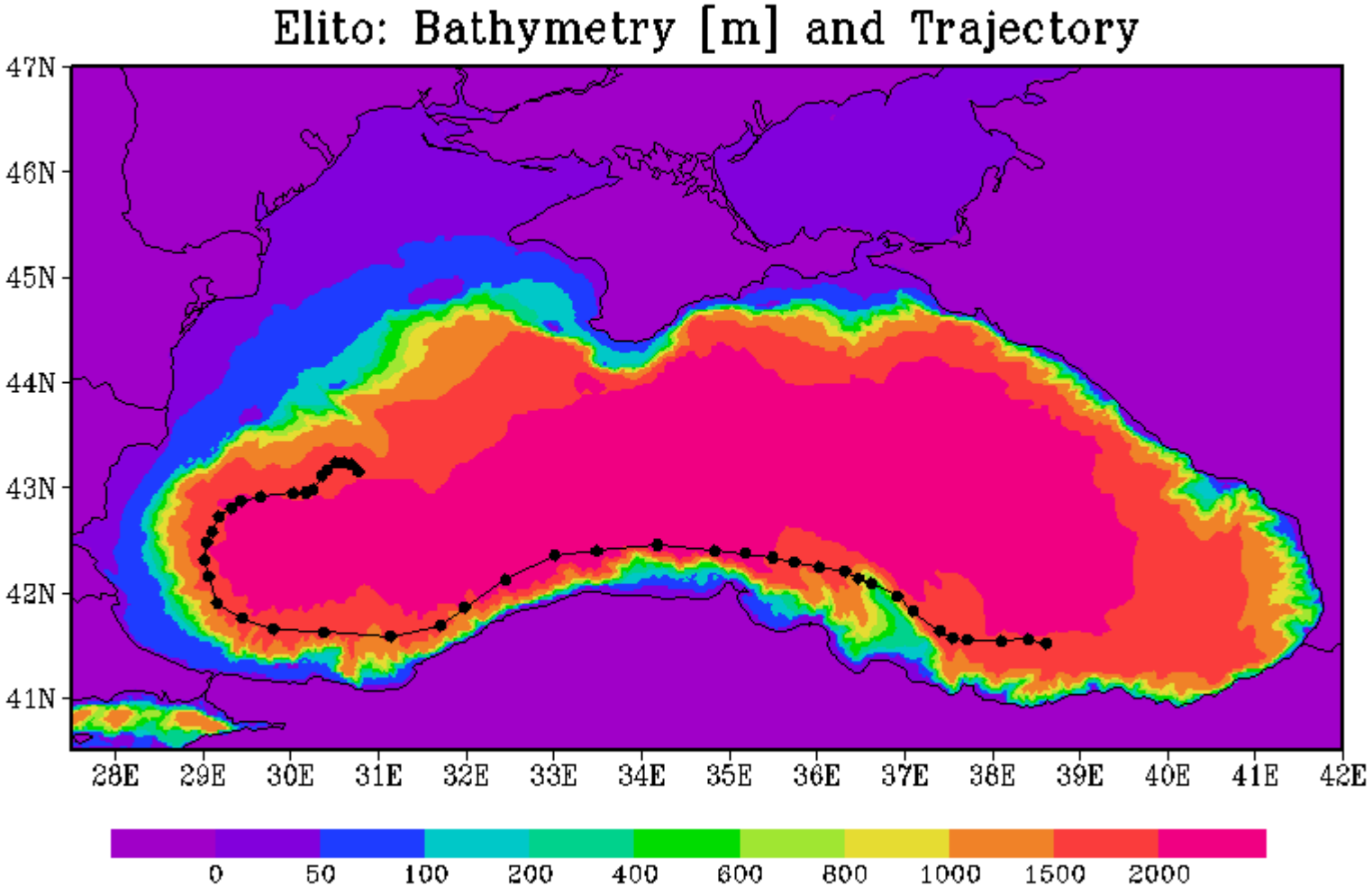
Dolphin : Salinity [psu]



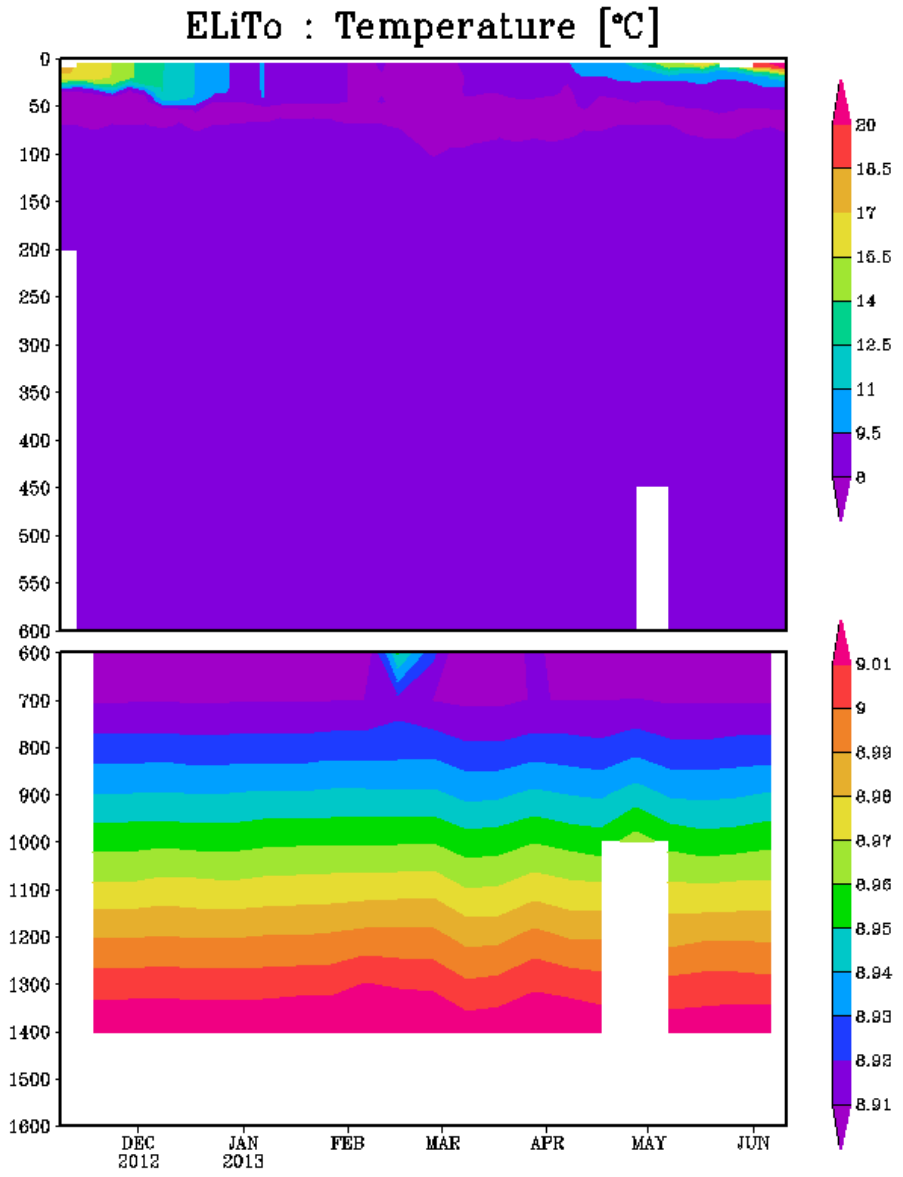




Elito: N 6901962 –deployed October 2012




Euro
Argo


ELiTo : Temperature [°C]
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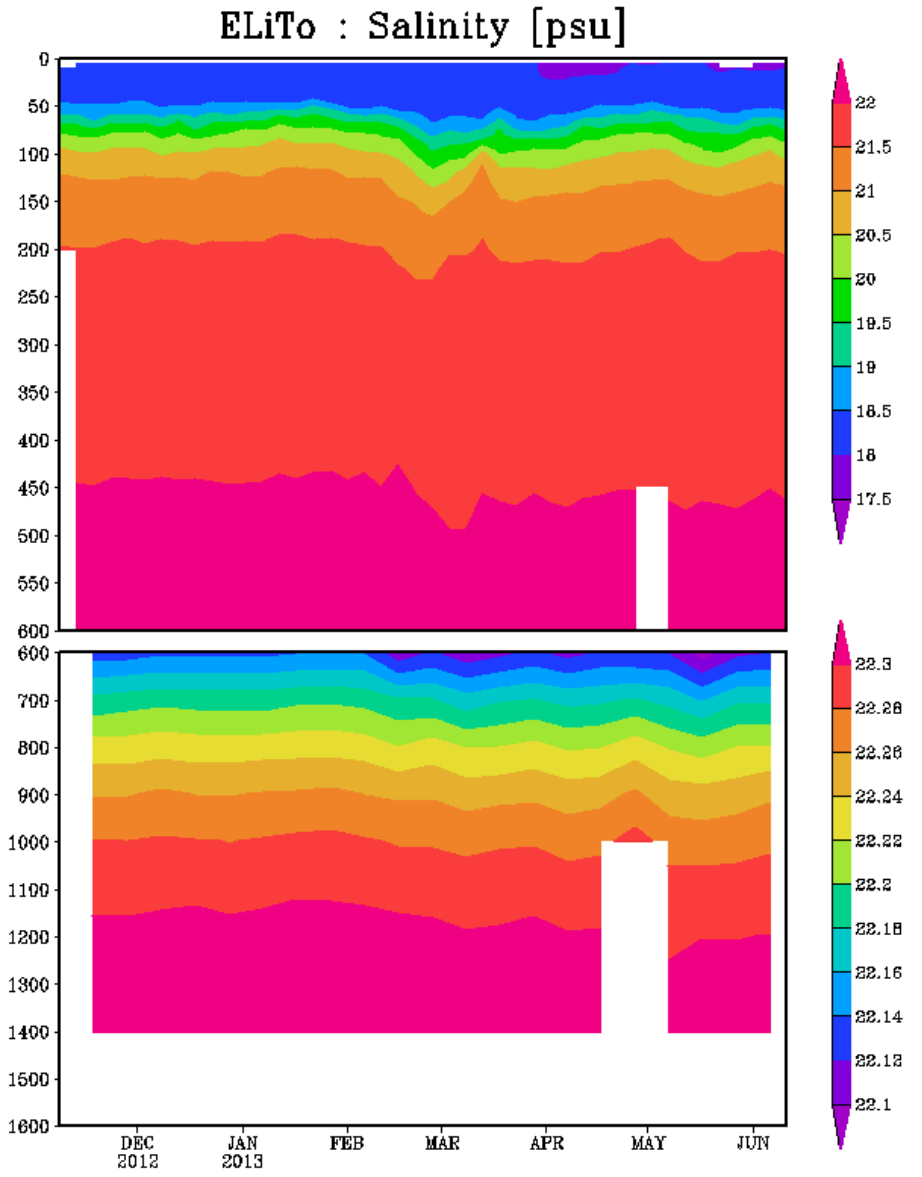
8.92
8.91
DEC
2012
JAN
2013
FEB
MAR
APR
MAY
JUN


ELiTo : Salinity [psu]
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1100
1200
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1600
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20
19.5
19
18.5
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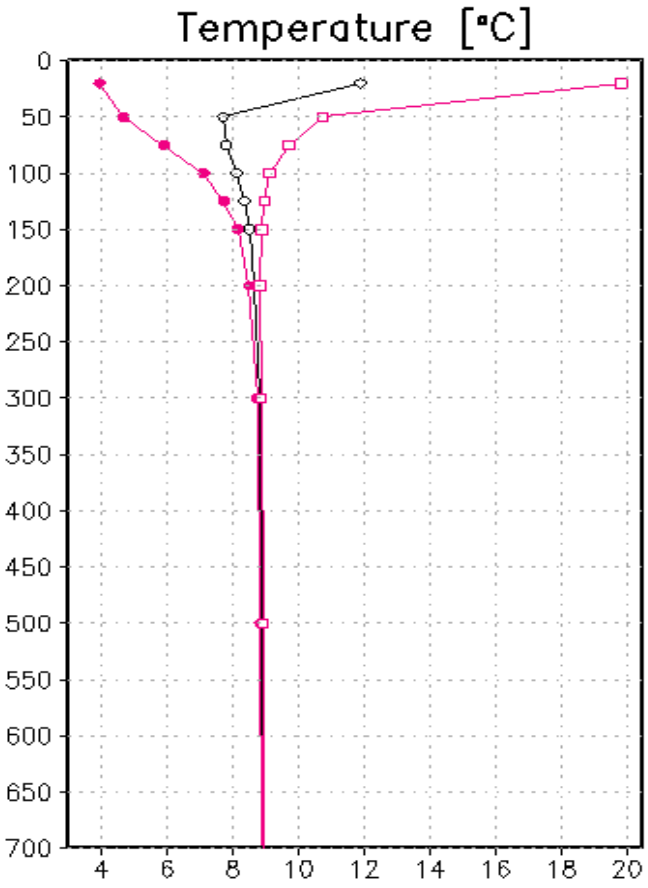
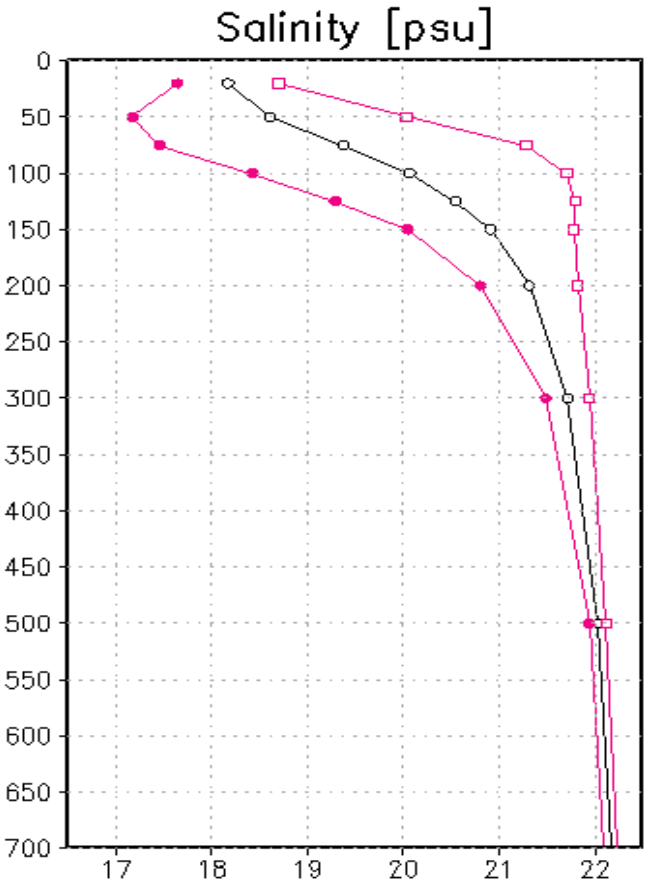
17.5
22.3
22.28
22.26
22.24
22.22
22.2
22.18
22.16
22.14
22.12
22.1
DEC
2012
JAN
2013
FEB
MAR
APR
MAY
JUN

Quality control procedures

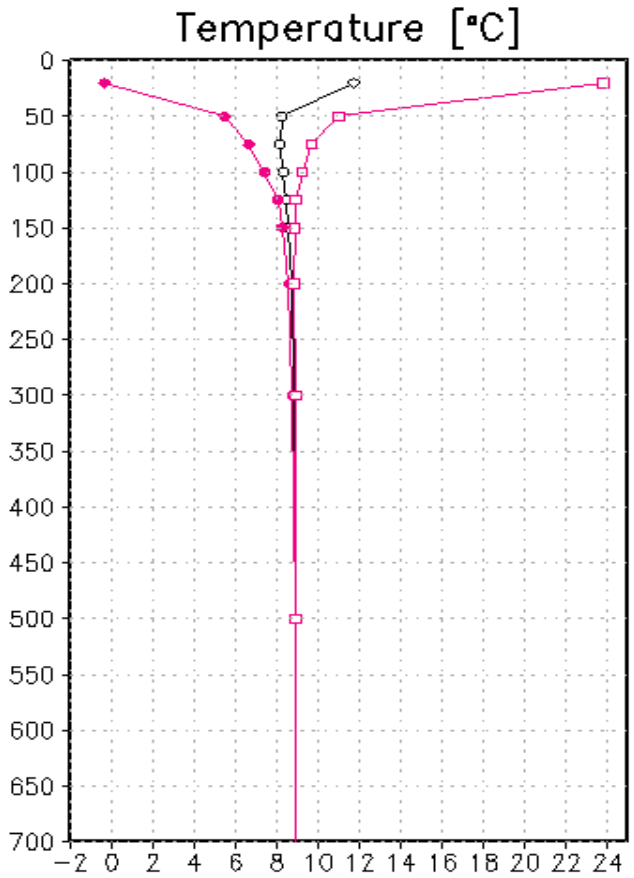
Range for pressure, temperature and salinity
Missing cycle check
Inverse stratification test
Comparison with climatology data
Comparison with Argo data
Comparison with Argo gradient
Impossible date test
Impossible location test
Visual quality control
Profile quality flags assigned

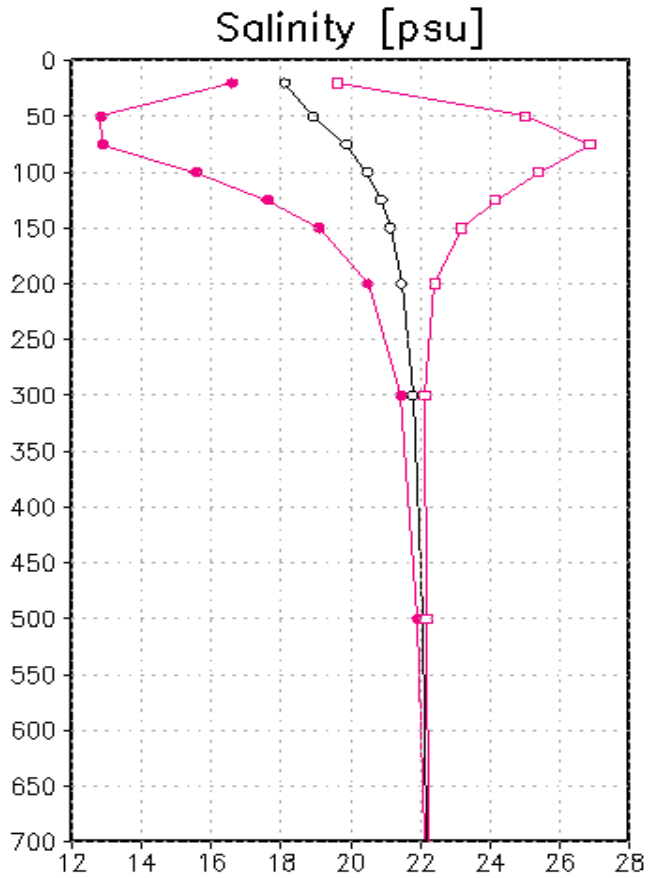
Comparison with climatology data

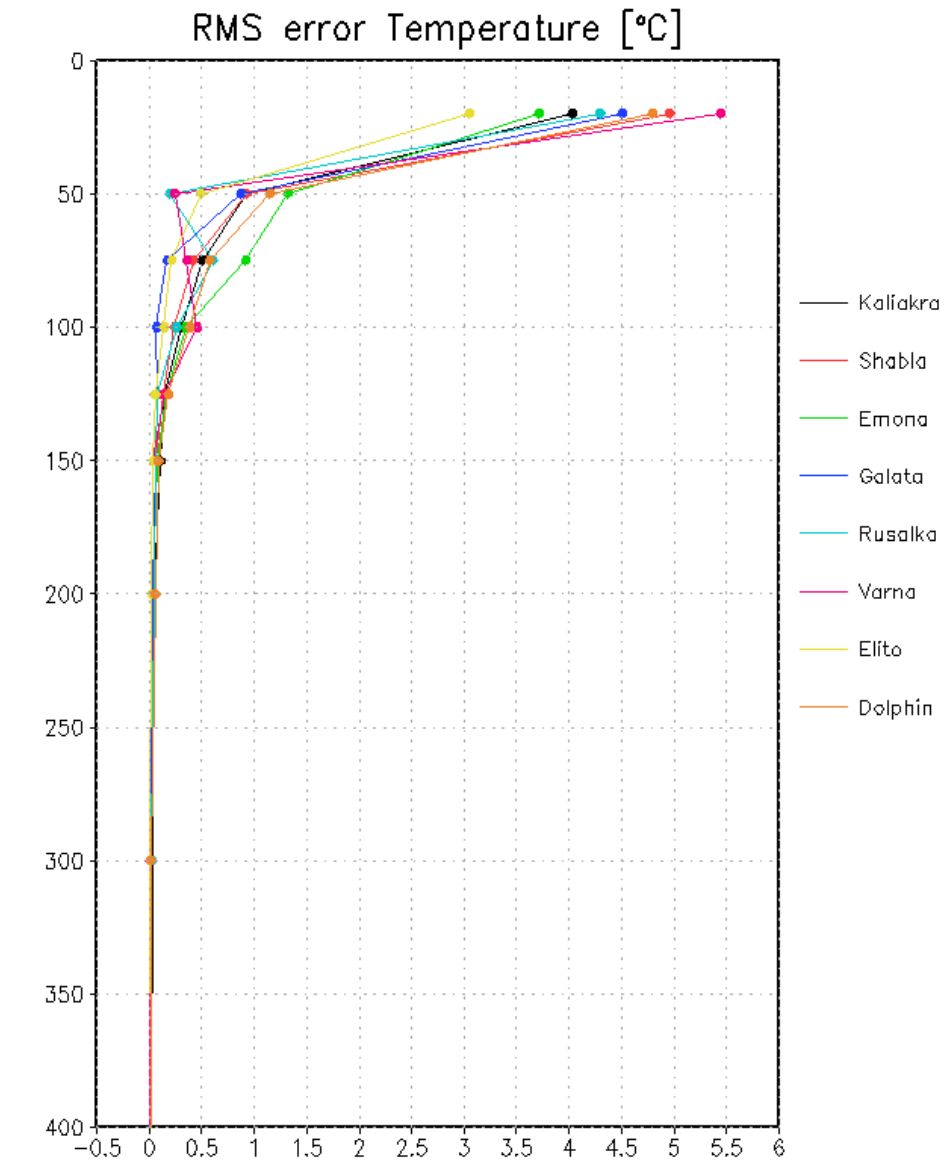


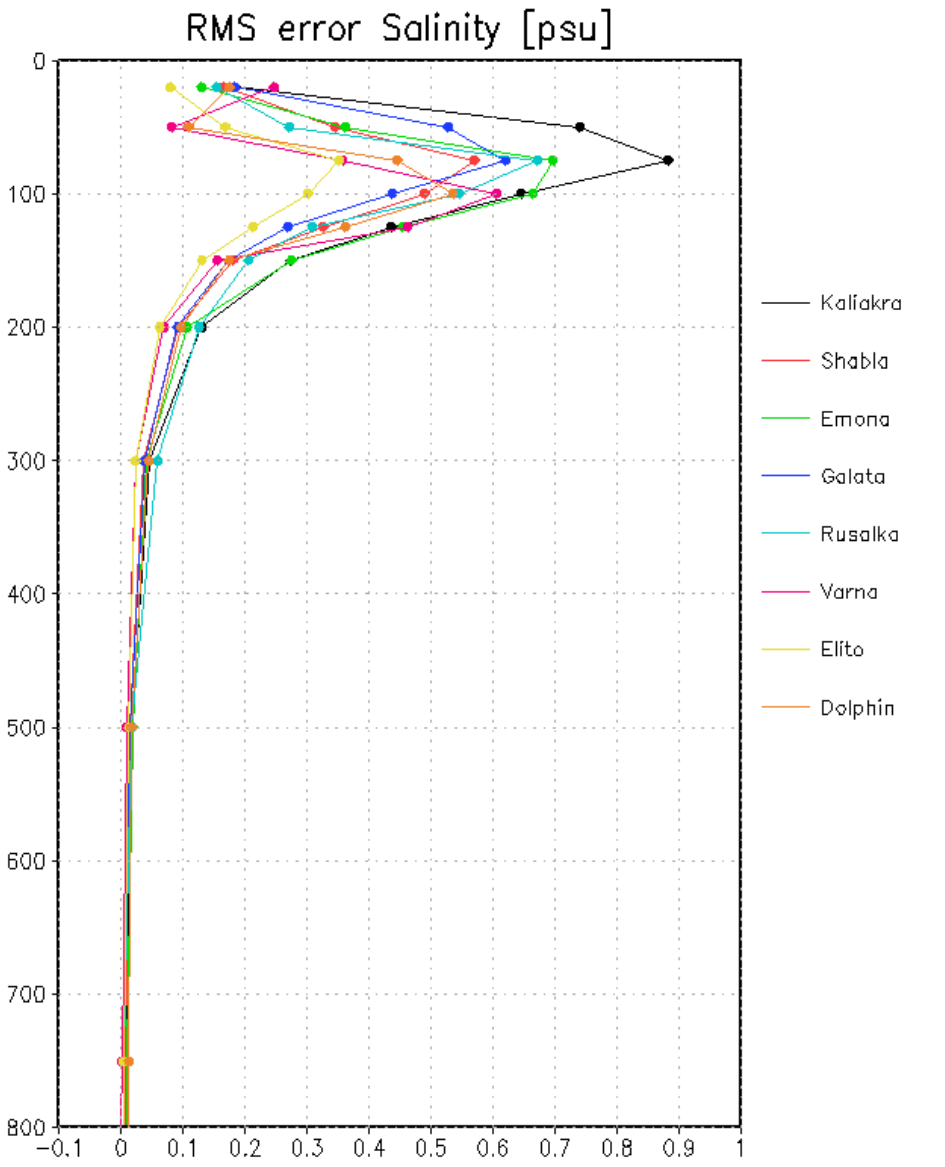


Comparison with Argo data

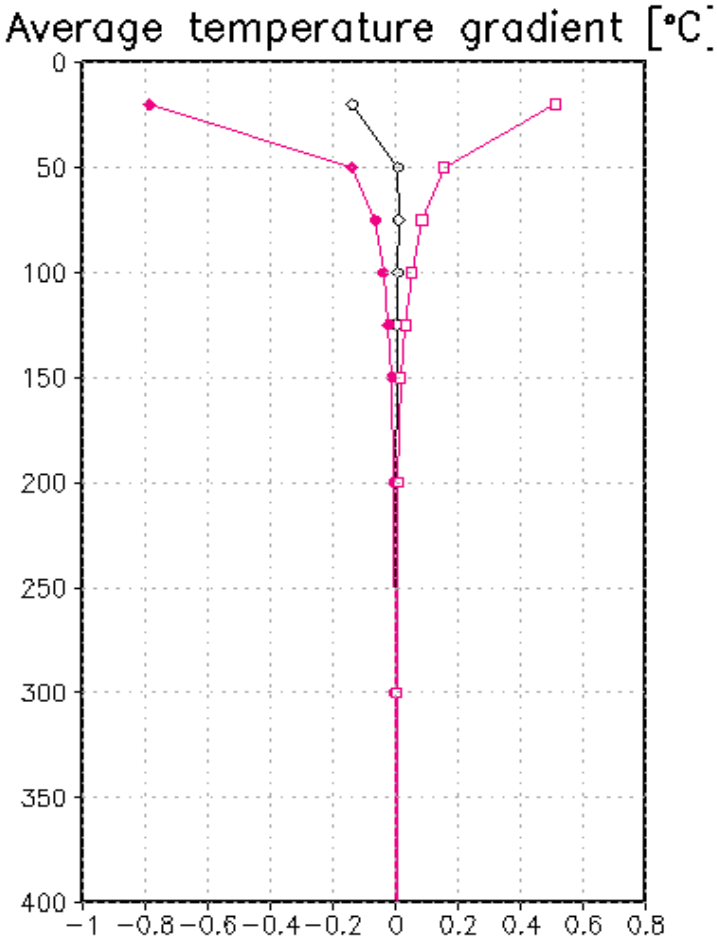


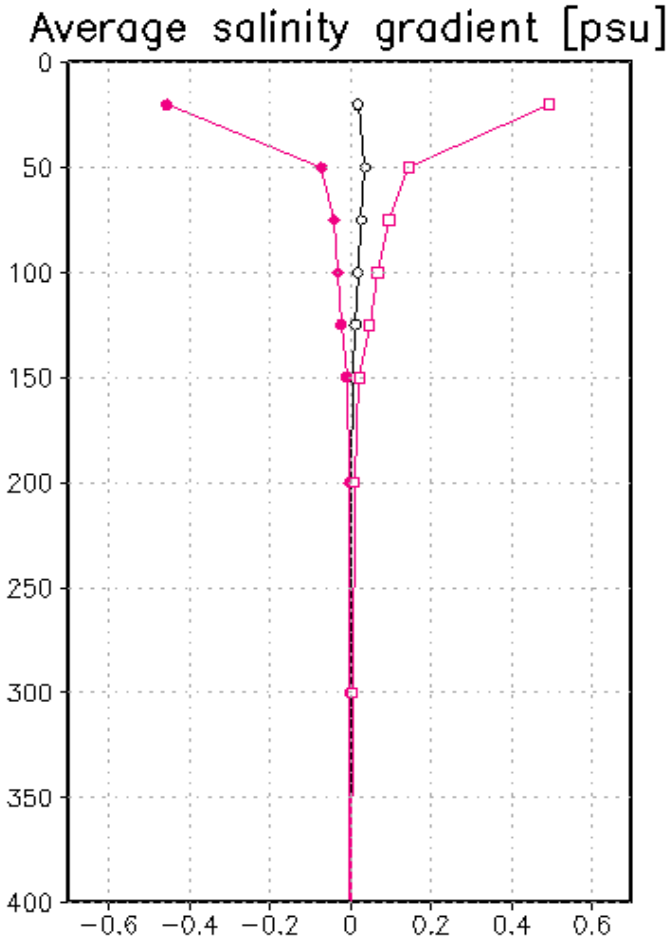



RMS error Temperature [°C]
0
50
100
150
200
250
300
350
400
−0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
5.5
6
Kaliakra
Shabla
Emona
Galata
Rusalka
Varna
Elito
Dolphin

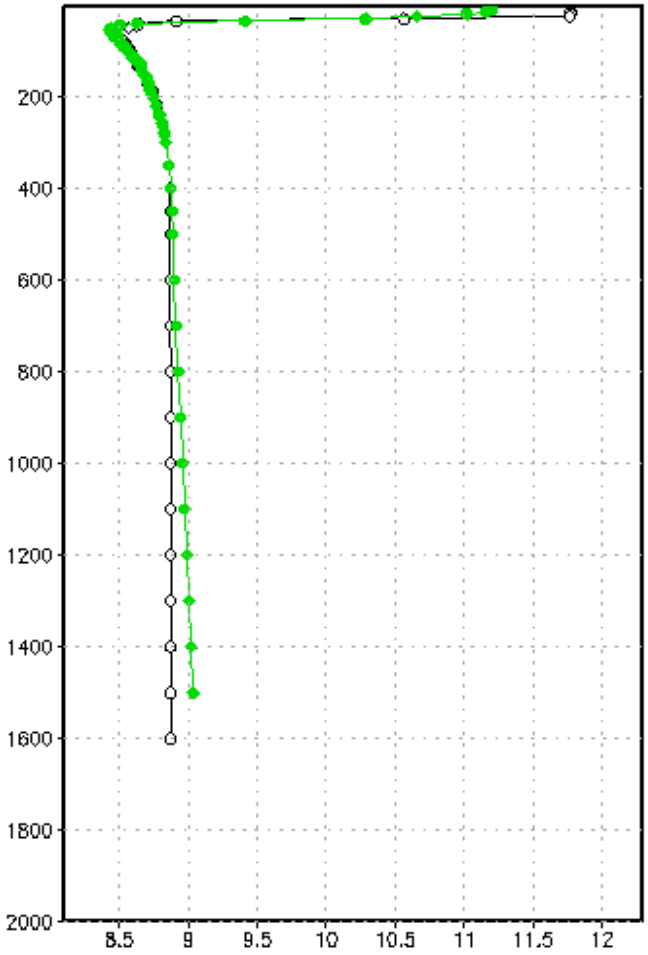

RMS error Salinity [psu]
0
100
200
300
400
500
600
700
800
−0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Kaliakra
Shabla
Emona
Galata
Rusalka
Varna
Elito
Dolphin

Comparison with Argo gradient

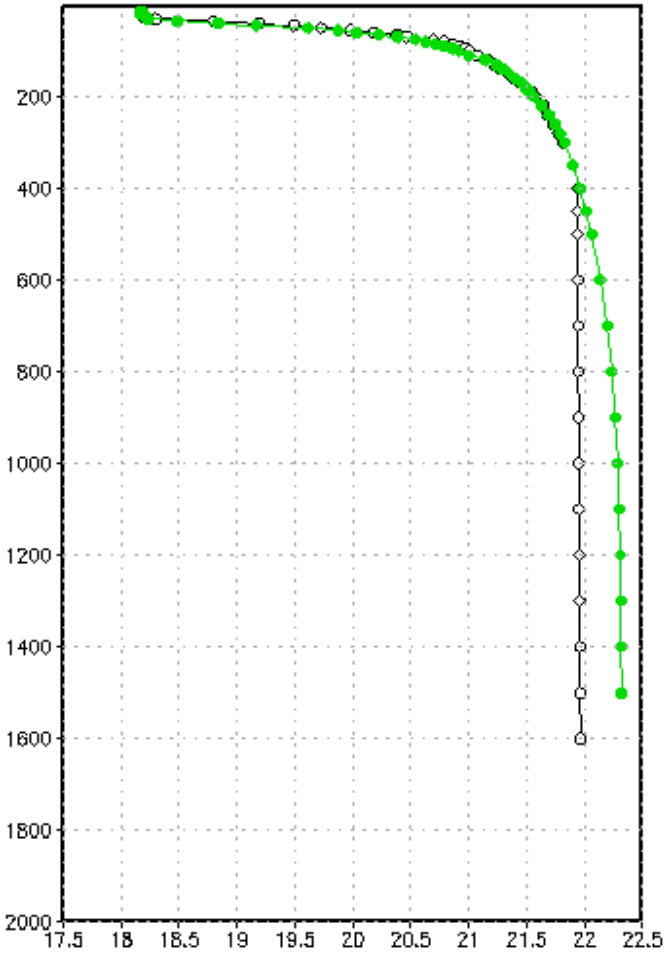




Galata temperature profile N49



Galata salinity profile N49



Quality Flags

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

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**

Adjust table row

Shabla – 138 profiles:

Performed test	Number of bad values	Profile flag	Percentage of the profiles
Missing cycle	**11**	**A**	**74,8%**
Pressure range test of original levels	**26**	**B**	**21,2%**
Pressure increasing test of original levels	**5**	**C**	**3,1%**
Temperature range test of original levels	**21**	**D**	**0,9%**
Salinity range test of original levels	**33**	**E**	**0**
Comparison with Argo data	**38**	**F**	**0**

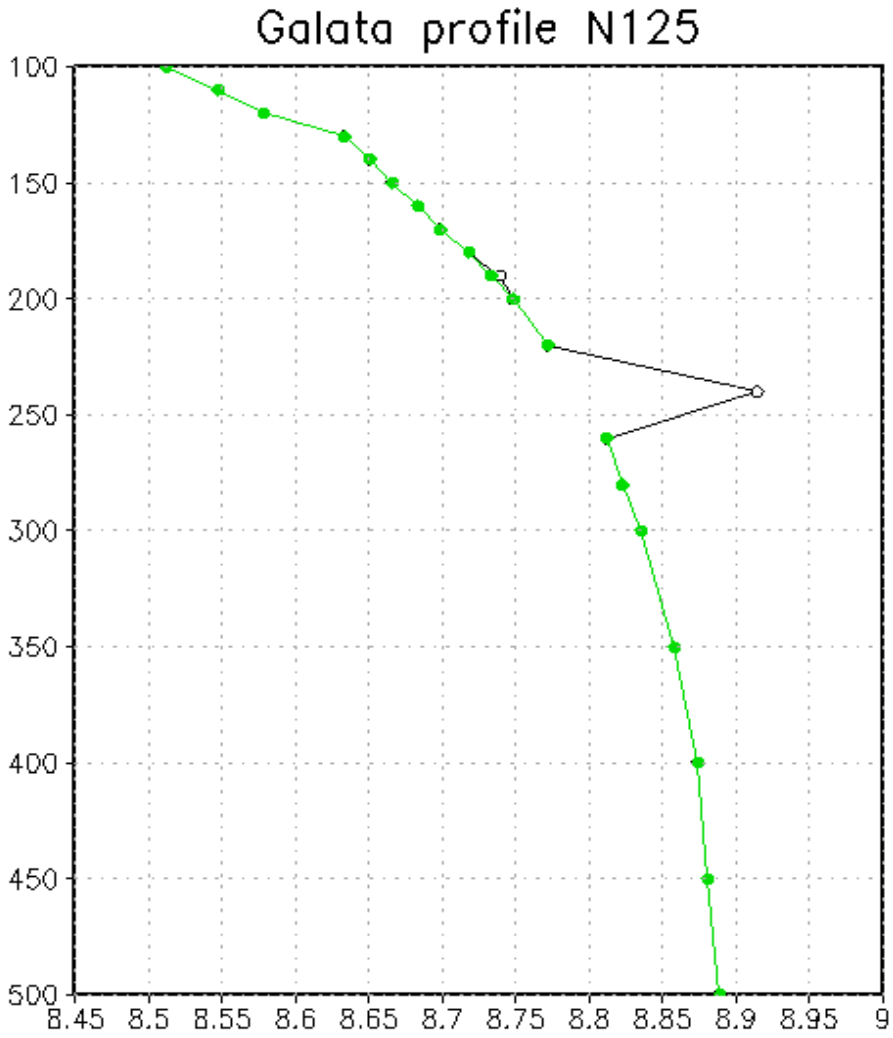
Emona - 146 profiles:

Performed test	Number of bad values
Missing cycle	2
Pressure range test of original levels	107
Pressure increasing test of original levels	11
Temperature range test of original levels	104
Salinity range test of original levels	109
Oxygen temperature range	105
Comparison with Argo data	24
Comparison with climate data	17
Inverse stratification test	0
Comparison with Argo gradient	7

Profile flag	Percentage of the profiles
A	81,2%
B	13,9%
C	4,2%
D	0
E	0
F	0,7%

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 profile N125
100
150
200
250
300
350
400
450
500
8.45
8.5
8.55
8.6
8.65
8.7
8.75
8.8
8.85
8.9
8.95
9

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
Missing cycle	0
Pressure range test of original levels	0
Pressure increasing test of original levels	0
Temperature range test of original levels	0
Salinity range test of original levels	0
Comparison with Argo data	0
Comparison with climate data	4
Inverse stratification test	0
Comparison with Argo gradient	0

Profile flag	Percentage of the profiles
A	84,6%
B	0
C	0
D	7,7%
E	0
F	7,7%

Dolfin – 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			

Lessons learned:

There is a real chance that the float is captured by a coastal eddy and stuck in the shallow area or grounded

To avoid this the parking depth should be not less than 700 m

Deployment in summer is more dangerous because of the weak Rim current

Future deployments:
Euro-Argo ERIC
EC projects E-AIMS and Pegaso

For more information:

Euro-Argo
http://www.euro-argo.eu

MedArgo
http://nettuno.ogs.trieste.it/sire/medargo/

BulArgo:
http://www.gisserver.io-bas.bg/Web_argo/