Effects of very harsh 2012 winter conditions on the deep layer of the Southern Adriatic Sea

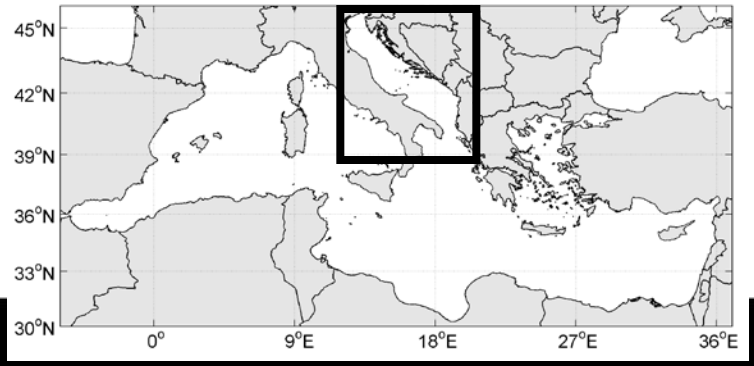
Bensi M.*[1], Cardin V.[1], Rubino A.[2], Notarstefano G.[1], Poulain P.M.[1]

[1] **Istituto Nazionale di Oceanografia e di Geofisica Sperimentale, Trieste, Italy, *mbensi@ogs.trieste.it**

[2] **Università Cà Foscari di Venezia, Venice, Italy.**

Sailor-E2M3A

Southern **A**driatic **I**nterdisciplinary Laboratory for **O**ceanographic **R**esearch

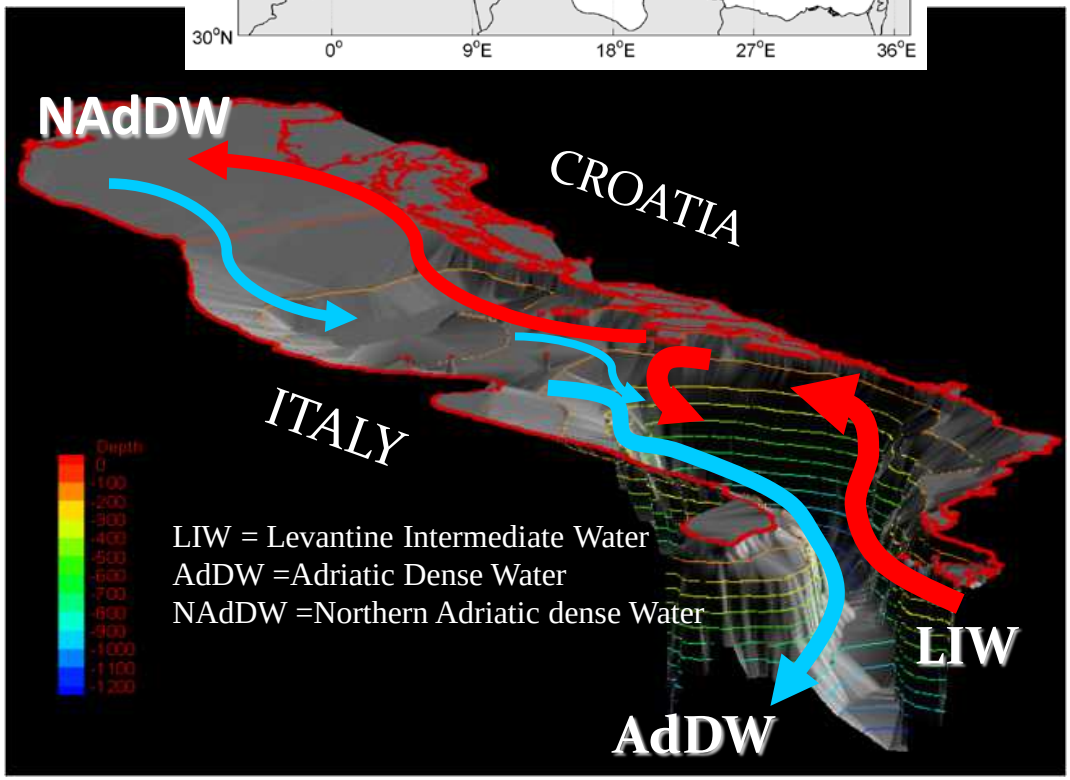


Main features:

- Complex bathymetry and circulation
- Strong influence of atmospheric forcing
- Strong influence with Ionian Sea

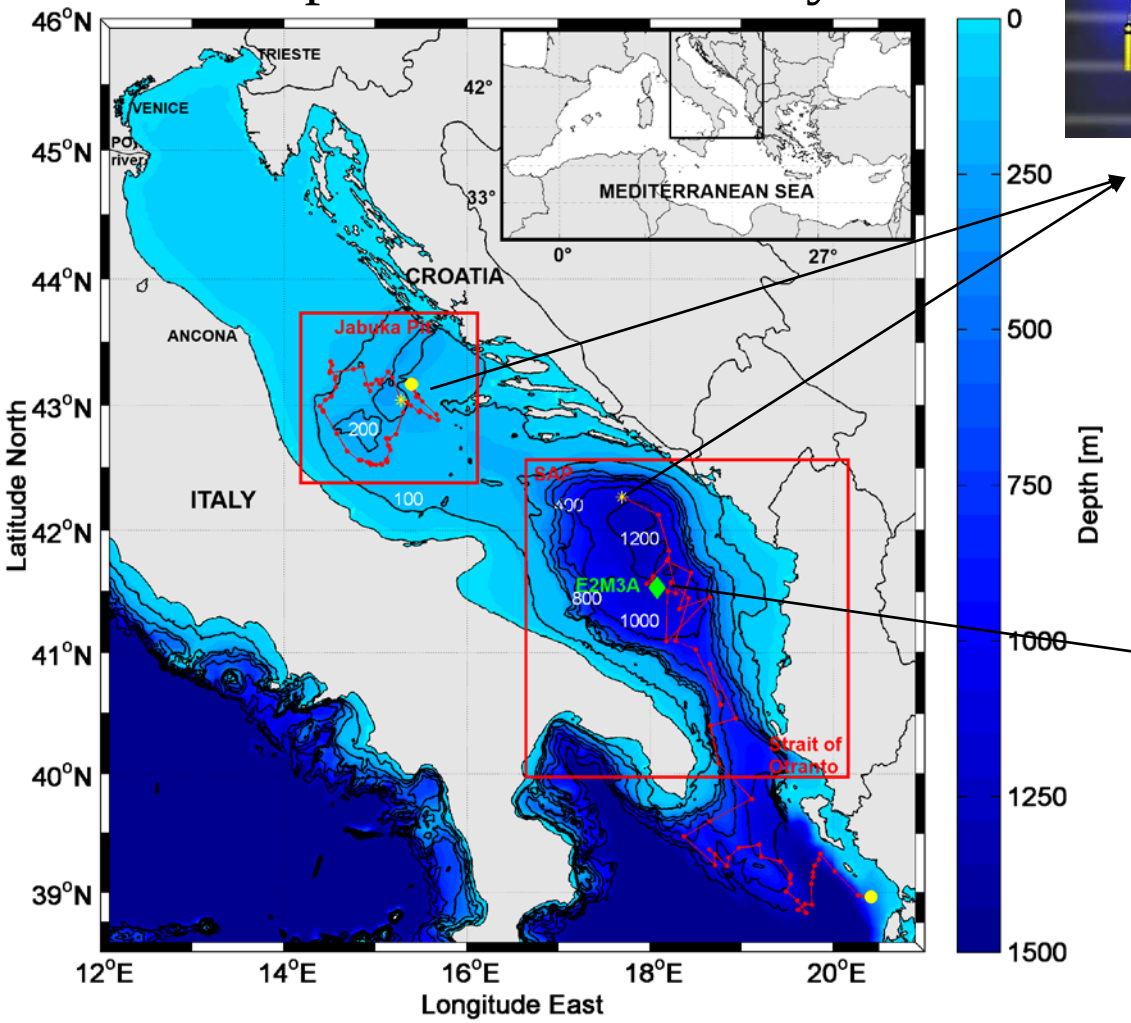
Principal processes to study:

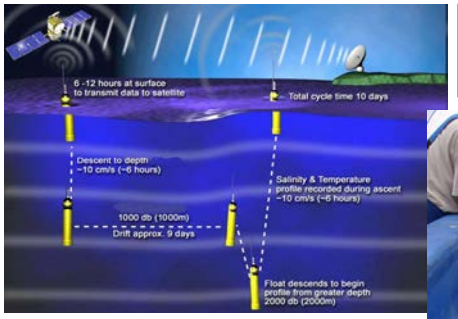
- Deep water formation both in the Northern and Southern basins
- Cascading
- Circulation



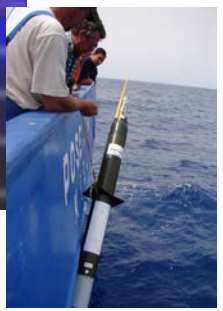
Data and Methods

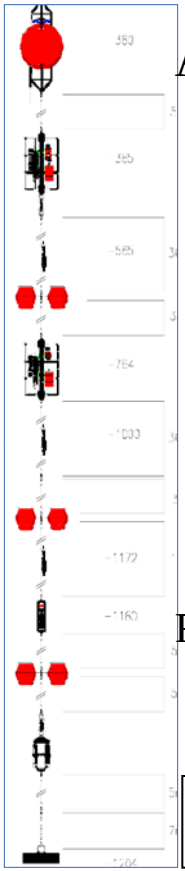
Temperature and Salinity





2010-present





ADCP ~300m

CTD ~350m

CT ~550m

CTD ~750m

CT ~ 1000m

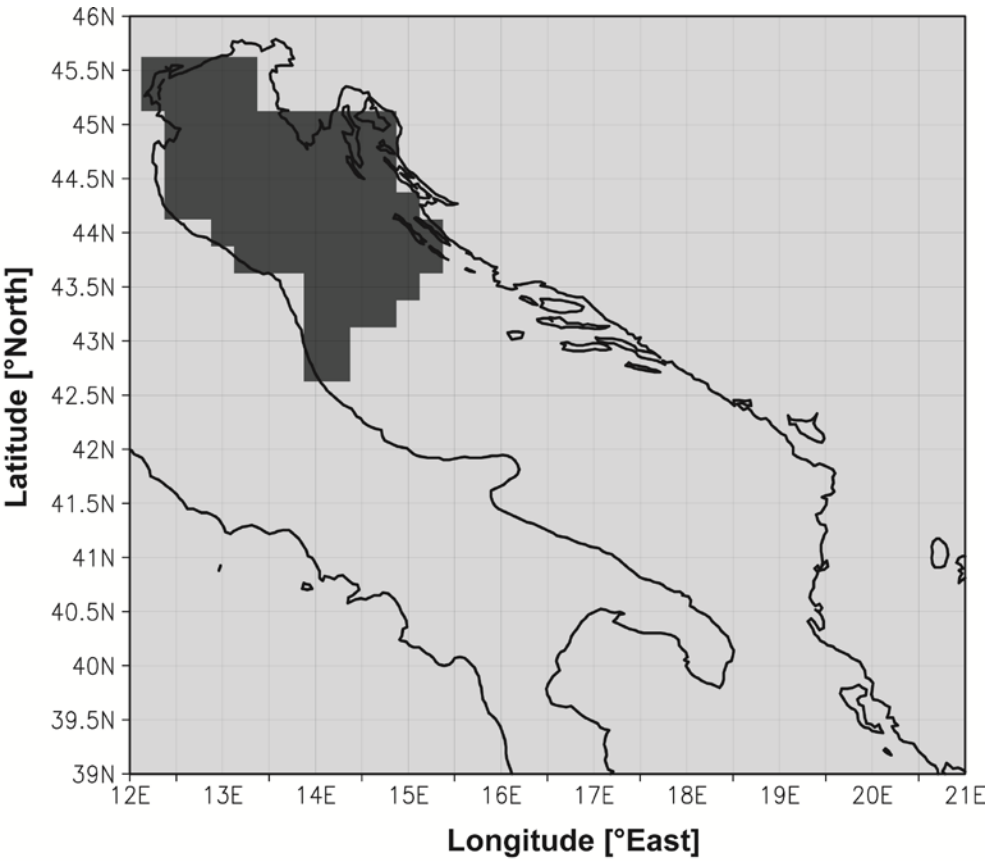
CT ~1200m

RCM11 ~1200m

2006-present

Data and Methods

Wind, Air–sea heat fluxes (Qnet)



Calculated **every 6 h** (00, 06, 12, 18 UTC) from the European Center for Medium Range Weather Forecast (ECMWF) using a Gaussian grid (83 points), 0.25°.

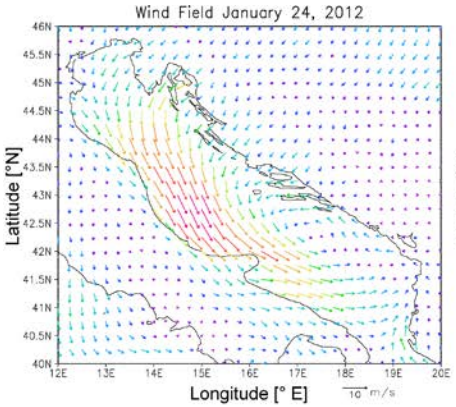
[*Cardin and Gacic*, 2003]

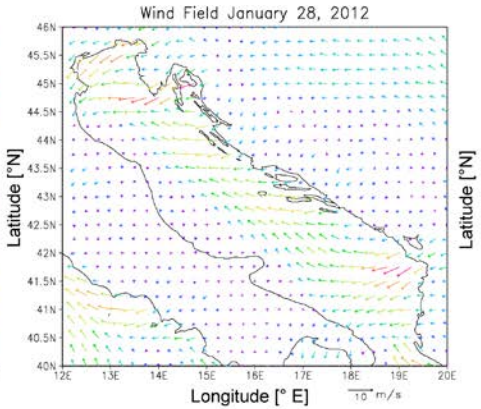
RESULTS: long-lasting Bora event in winter 2012

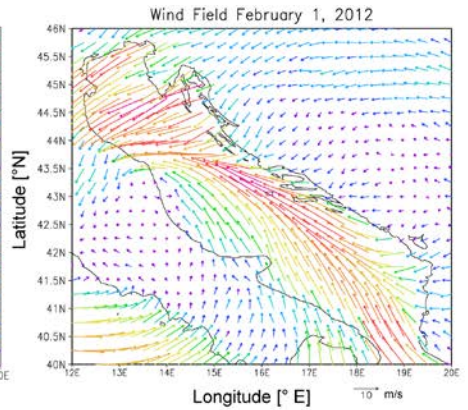
1-Exceptionally long (≈ 20 days, from 24 January until 14 February 2012, usually the duration is 3-5 days)

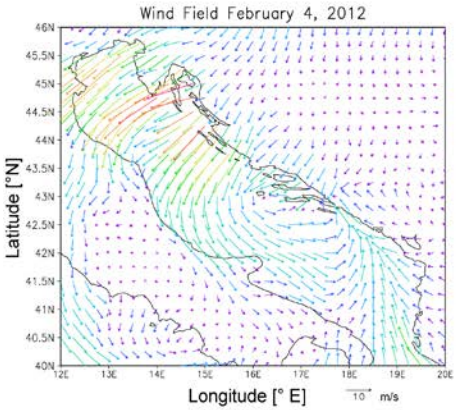
2-Exceptionally strong (wind gusts > 42 m s^{-1}, maximum daily mean value ≈ 21 m s^{-1})

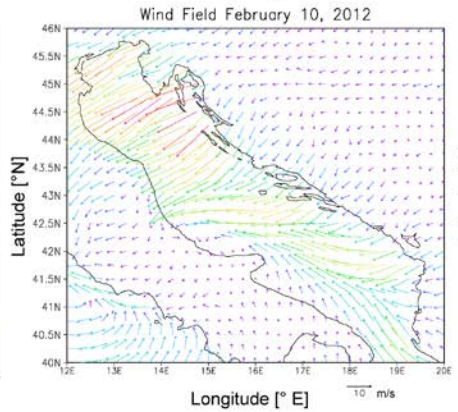
3-Exceptional sea cooling: in the N. Adriatic T reached 4°C (usually is ≈ 7-8°C)

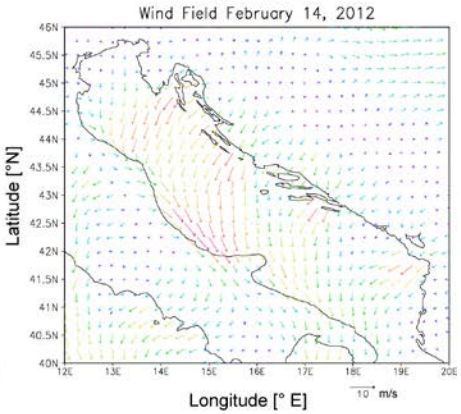




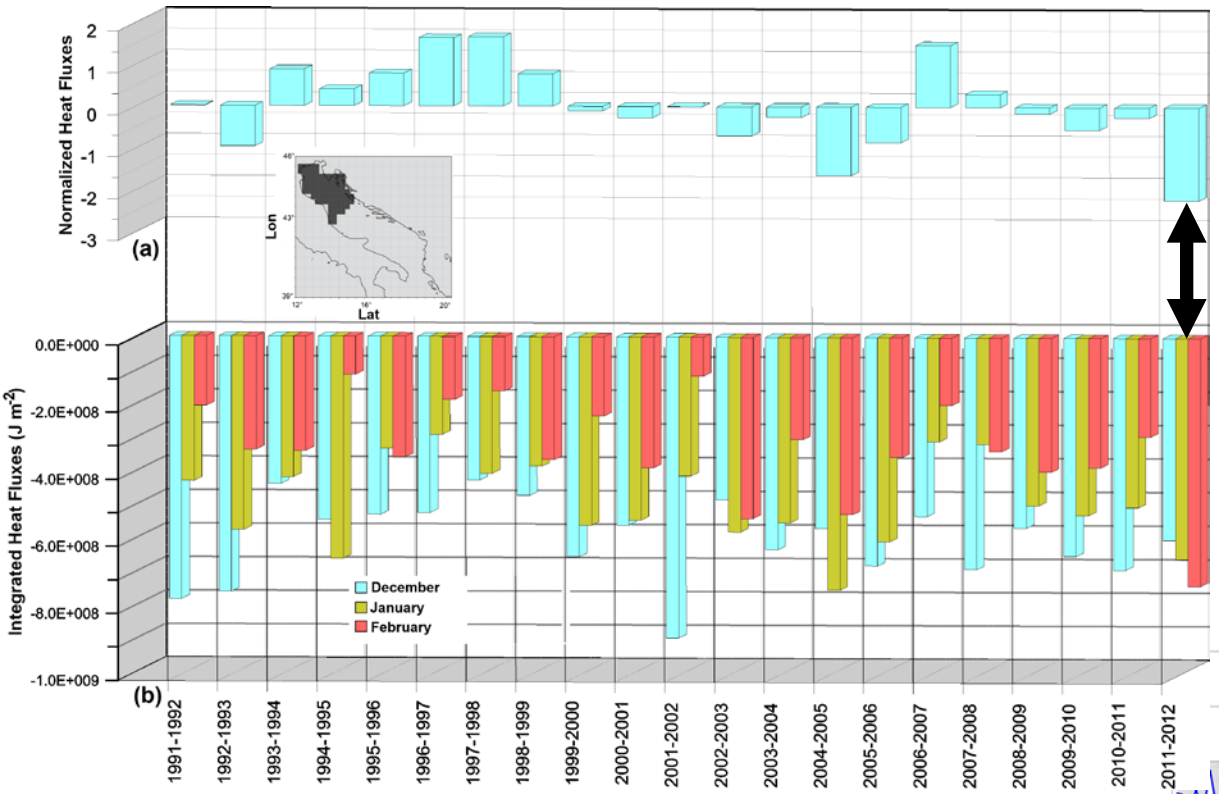




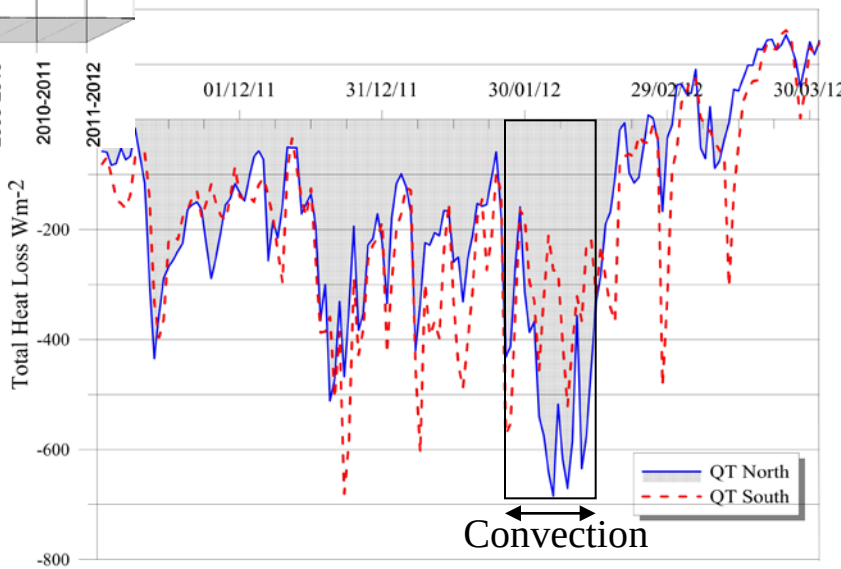




RESULTS: winter heat fluxes variability



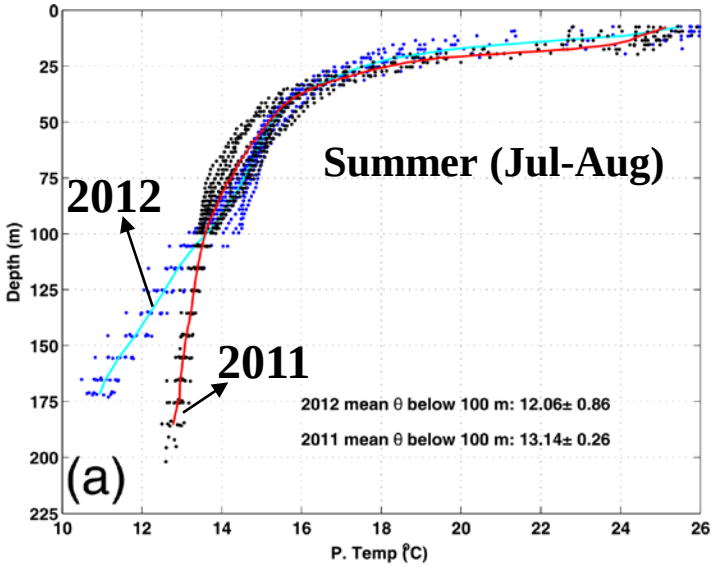
N. Adriatic: 1991-2012

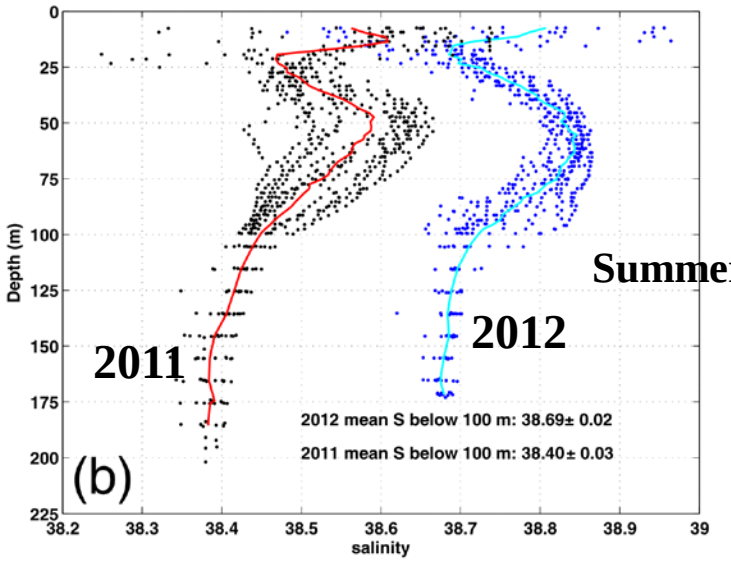


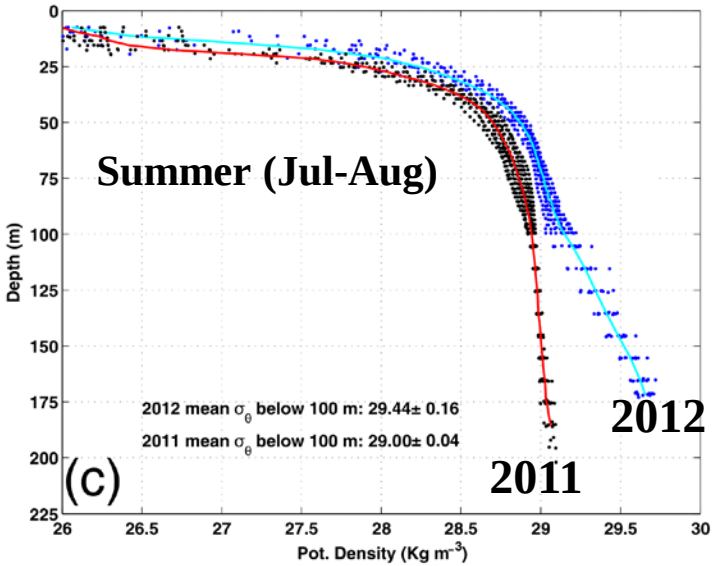
Winter 2011-2012:
Northern Adriatic vs Southern Adriatic

[Bensi et al., under review]

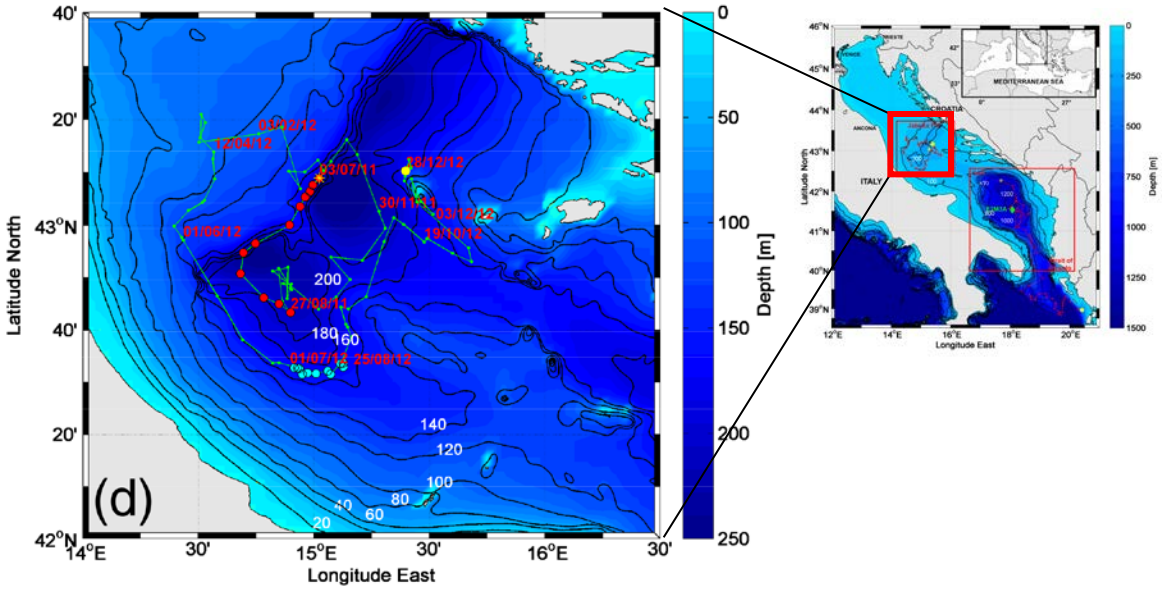
RESULTS: effects of the harsh winter in the Middle Adriatic (float data)



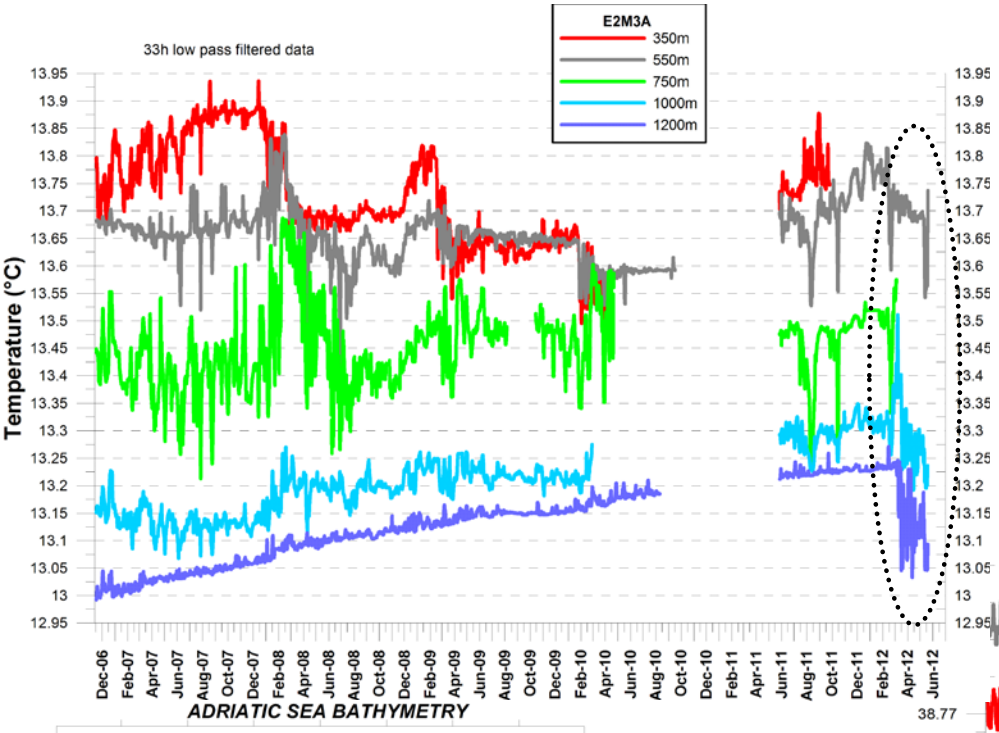


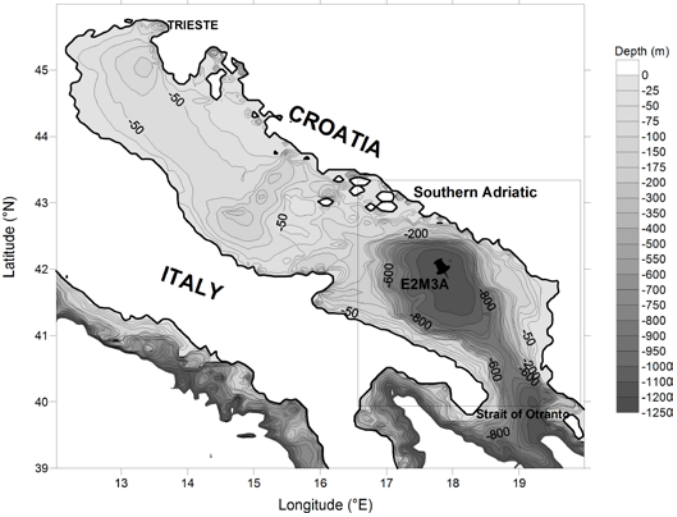


Float data



RESULTS: long-term monitoring at the E2M3A, main features (mooring data)





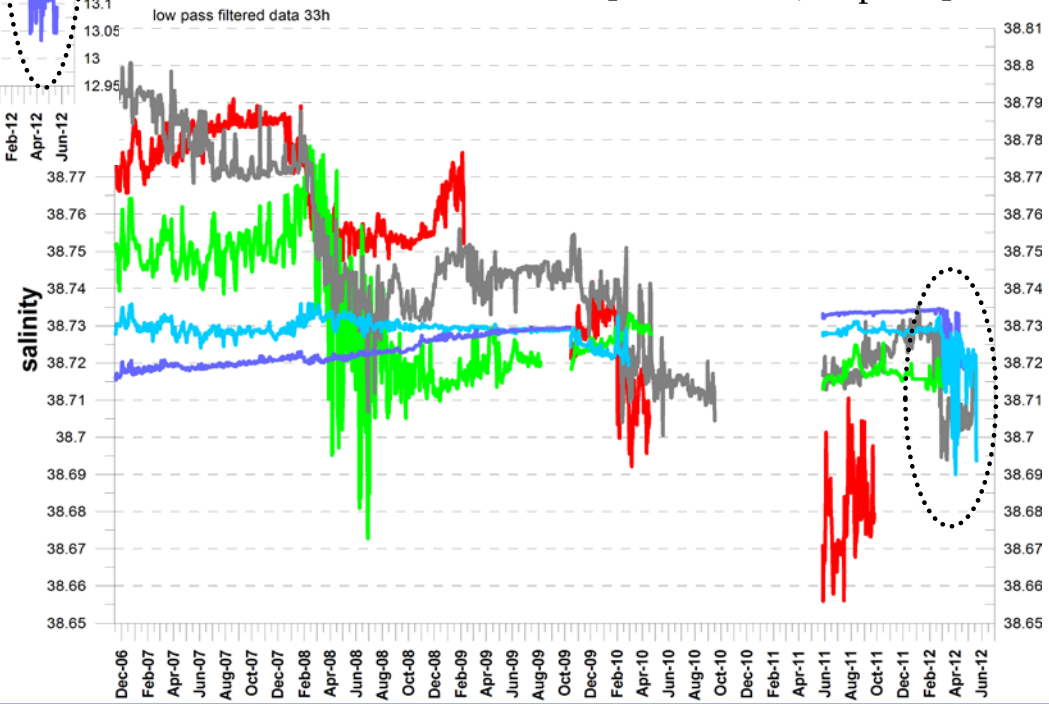
Intermediate layer:

- Abrupt decrease in T and S after winter convection phases.
- Reduced LIW signal

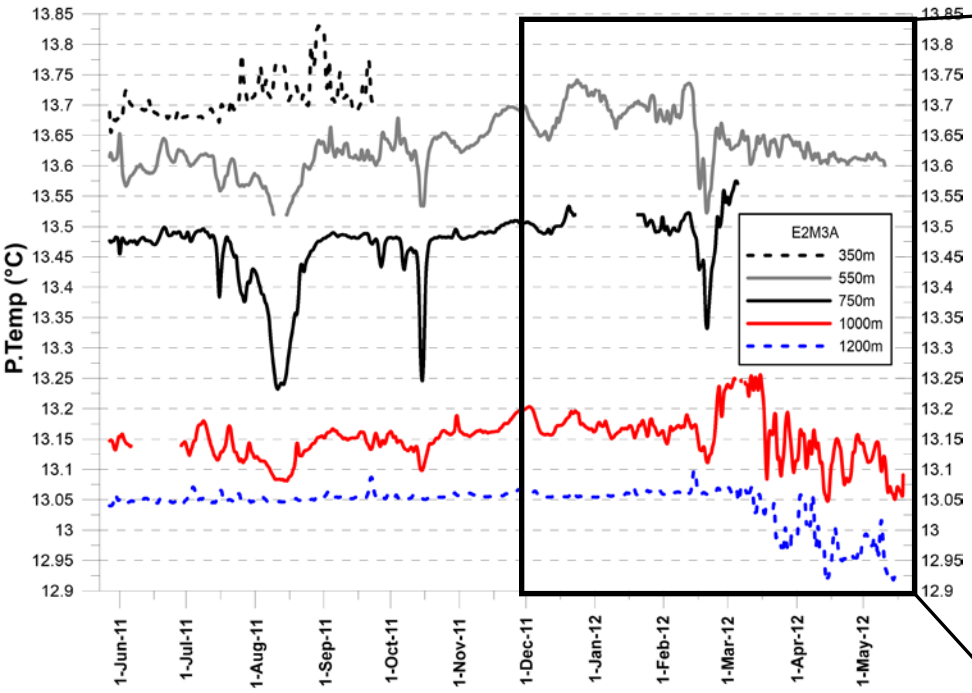
Deep layer:

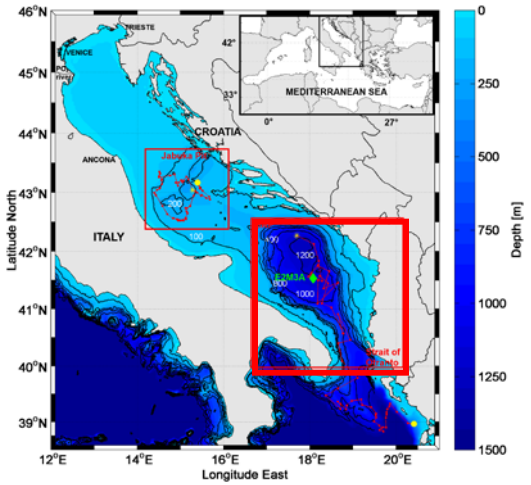
- Positive T and S trend (~0.05 °C y^{-1} and ~0.004 y^{-1}).

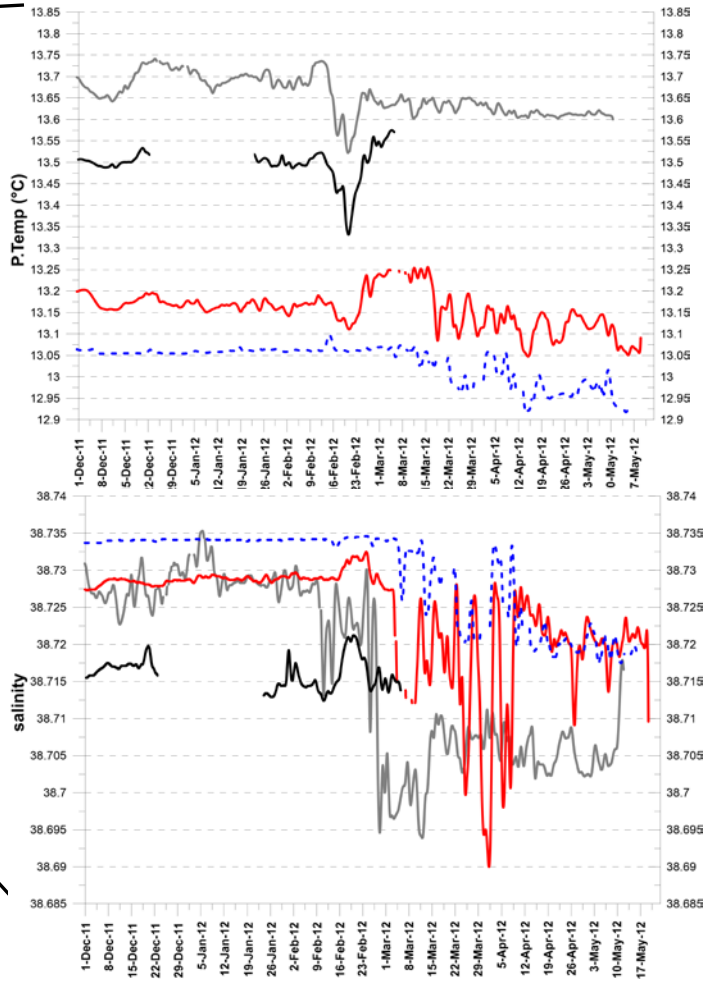
[Bensi et al., in press]



RESULTS: effects of the harsh winter in the Southern Adriatic (mooring data)

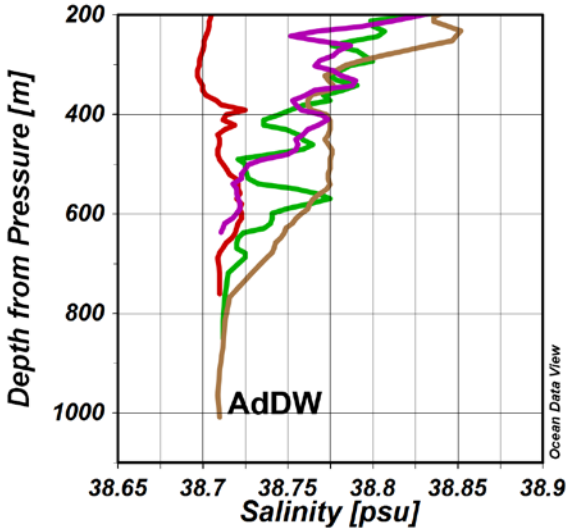


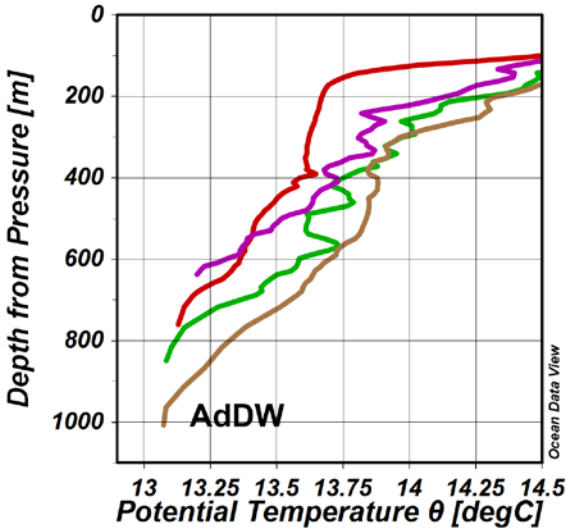


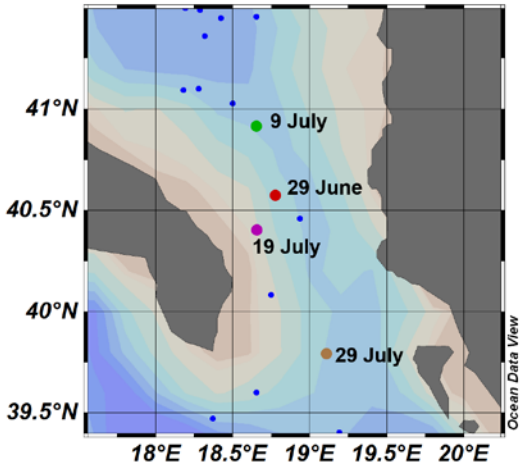


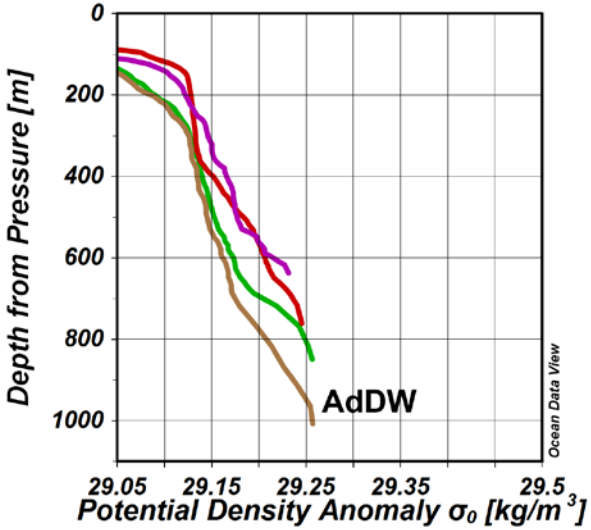
Winter 2011-2012

RESULTS: effects of the harsh winter in the Strait of Otranto (float data)









July 2012 [Float]:

Θ ~ 13.08°C

S ~ 38.71

σ_θ ~ 29.25 kg m-3

June 2011 [cruise Pos414]:

Θ ~ 13.27°C

S ~ 38.72-38.73

σ_θ ~ 29.22/29.23 kg m-3

July 2010 [cruiseMSM154] :

Θ ~ 13.29/13.42°C

S ~ 38.72

σ_θ ~ 29.19/29.22 kg m-3

Conclusion:

1. Exceptional meteorological and oceanographic conditions in winter 2012:
   - First occurence in historical records of harsh and long-lasting events of Bora wind
   - Most intense winter heat loss over the last 20 years
   - Exceptional low discharge of Rivers (mainly Po)
   - Low rain rates

2. Vigorous convective activity; extreme dense (> 30 kg m^{-3}) NAdDW production

3. NAdDW spreaded very quickly to the south and caused profound variations in the deep waters of the Middle and South Adriatic

4. SAP: T and S decrease in the bottom layers → interrupt the positive trends of the last 5 years

5. AdDW characteristics of 2012 profoundly differ from those of 2010 and 2011 → density increase of 0.02 kg m^{-3}

6. Exceptional event detected and followed using two different observing systems (floats and mooring)

References:

1. Bensi M., Cardin V, Rubino A., Notarstefano G., Poulain P.M. **Effects of winter convection on the deep layer of the Southern Adriatic in 2012, Under review on JGR-OCEANS.**
2. Bensi M., Cardin V., Rubino A, Thermohaline variability and mesoscale dynamics observed at the E2M3A deep-site in the Southern Adriatic Sea. AGU BOOKS programs, special issue 'The Mediterranean Sea: Temporal Variability and Spatial Patterns', Editors: Borzelli G.L.E., Gačić M., Malanotte-Rizzoli P. and Lionello P. [accepted on 7 December 2012].
3. Cardin V., Gacic M., (2003), Long-term heat flux variability and winter convection in the Adriatic Sea. Journal of Geophysical Research, Vol. 108, no. C9, 8103,doi:10.1029/2002JC001645.
4. Gacic, M., Civitarese G., Borzelli G. L. E., Kovačević V., Poulain P.-M., Theocharis A., Menna M., Catucci A., and Zarokanellos N. (2011), On the relationship between the decadal oscillations of the northern Ionian Sea and the salinity distributions in the eastern Mediterranean, J. Geophys. Res., 116, 9 PP., doi:201110.1029/2011JC007280.

Thanks for your Attention!