WG4: Intense sea-atmosphere interactions

Plenary Session

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Outlines

I. Discussions on the scientific issues that will be addressed in the HyMex project

I. Observational and modelling strategies for addressing the scientific key questions

Scientific questions

WG4-SQ1: How Mediterranean cyclogenesis, local topography and land-sea distribution interact to produce strong winds?

The main objectives are:

(i) to improve our understanding of the processes leading to the Mediterranean **cyclogenesis**,

(ii) to study **local winds** in the Mediterranean, modulated by local topography (e.g. acceleration between mountain gaps, channeling between land surfaces, etc), and

(iii) to assess the evolution of the Mediterranean cyclogenesis process under **future climate conditions** along the 21st century, using climate scenarios for the Mediterranean region.

All objectives will make use of in-situ as well as remote observations, plus meteorological and climate modeling.

Scientific questions

WG4-SQ2: How air-sea fluxes are modulated?

The main objectives are:

(i) to improve the **parameterization** of air-sea fluxes,

(ii) to investigate the **role of the THC** (thermal heat content) as an energy tank for the atmosphere and

(iii) to study the role of the **air-sea fluxes** on the intensity of cyclogenesis and associated winds.

All objectives will make use of in-situ as well as remote observations, plus meteorological and ocean modeling.

Scientific questions

WG4-SQ3: How the Mediterranean Sea responses to the atmosphere?

The main objectives are:

(i) to improve our knowledge of the **oceanic convection** and the coastal dense water formation,

(ii) to understand the role of mesoscale processes on the formation of **dense water**,

(iii) to study the processes participating to the **slow branch** of the water cycle, especially the dispersion of dense water at the basin scale and

(iv) to assess the evolution of **dense water formation** and of the thermohaline circulation under future climate conditions.

All objectives will make use of in-situ as well as remote observations, plus oceanic modeling.

SQ1: How Med. cyclogenesis, local topography and land-sea distribution interact to produce strong winds ?

*(a) Development of a **database** of multi-scale space-time series of near-surface winds, temperature and humidity*: Elaboration of an dataset of surface winds, temperature and humidity over land and sea. These observations should cover the Mediterranean, plus selected coastal areas, where in-situ observations and high-resolution meteorological modeling will provide information for severe local winds.

*(b) Creation of a high-resolution **reanalysis** of Mediterranean cyclones*: Use of high-resolution meteorological models over the Mediterranean to build a reanalysis dataset (covering at least a 10 year period).

*(c) Assessment of the relation between strong surface winds and large/meso-scale **predictors***: Derivation of predictors (large/meso-scale circulations, local topography, coastline shape, etc) of the regional strong winds.

*(d) Derivation of scenarios of the evolution of the Mediterranean cyclogeneses under future **climate** conditions*: Use of climate models at high resolution for the study of possible changes in cyclones intensity and track, under the future climate conditions.

SQ2: How air-sea fluxes are modulated ?

(a) *Development of a **database** of*: meteorological parameters, momentum and surface heat fluxes, precipitation, sea state, SST, SSS, aerosols.

*(b) Investigation and improvement of existing **parameterizations**:* there is need to check existing parameterizations and/or modify them.

(c) Improvement of the understanding of: time and space scales that the air-sea interactions modulate the wind, the oceanic mixing and the THC of the upper ocean.

*(d) Comparison of non coupled and coupled **simulations***: investigation of the frequency needed of forcing / coupling as well as of the impact of their spatial resolution. Optimal configuration of atmospheric and ocean modeling.

(e) Investigation of the role of aerosols: quantification of the correlation between heat fluxes with aerosol concentration and properties.

SQ3: How the Mediterranean sea responses to the atmosphere?

(a) *Development of space-time series of oceanic hydrological characteristics*: Elaboration of a database of temperature and salinity profiles at moorings deployed at selected key points in conjunction with measurements of air parameters and surface heat fluxes.

(b) High resolution modeling of convection and dense water formation :to investigate the effect of earth rotation, non hydrostatic processes, intermittent forcing and provide improved parameterization of mixing.

(c) Better characterization of the large scale circulation: investigate the variability in the DWF regions , characterization of (sub) mesoscale processes involved in restratification and dispersion of dense water.

SQ3: How the Mediterranean sea responses to the atmosphere?

(d) *Exploration of new potential sites of DWF:* hypothesis of a DWF area in the southeast of Corsica, around Sardinia, in the Ionian Sea.

(e) *Derivation of scenarios of the evolution of the DWF under future climate conditions*: Use of climate models at high resolution for the study of possible changes in convection and coastal dense water formation (frequency and intensity of events) .

SUMMARY

	IN-SITU OBS	REMOTE SENSING	MODELING
SQ1: winds and cyclones	Buoys, weather stations, ships	QuikSCAT, SAR, lidars, wind profilers	High resolution weather modeling (areas?)
SQ1: high resolution reanalysis			High resolution weather modeling (whole Med)
SQ1: future scenarios			High resolution climate modeling (whole Med, period?)
SQ2: Air-sea fluxes	Buoys, weather stations, ships, aerosol measurements	QuikSCAT, AVHRR, MODIS/MERIS, aerosol measur., PBL measurements	
SQ2: coupled simulations			High res. weather/ocean modeling (areas?)

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SUMMARY

	IN-SITU OBS	REMOTE SENSING	MODELLING
SQ3: oceanic characteristics	Buoys, ships, gliders		
SQ3: modeling of ocean convection			High resolution ocean modeling
SQ3: large scale circulations	Drifters, gliders	Satellite measurements	High resolution ocean modeling
SQ4: evolution of DWF in the future			Climate modeling

Three scientific questions:

WG4-SQ1: How Mediterranean cyclogenesis, local topography and land-sea distribution interact to produce strong winds?

Cyclogenesis – the observations will cover the whole Mediterranean Sea

Strong local winds – local experimental areas

WG4-SQ3:

How the Mediterranean Sea responses to the atmosphere?

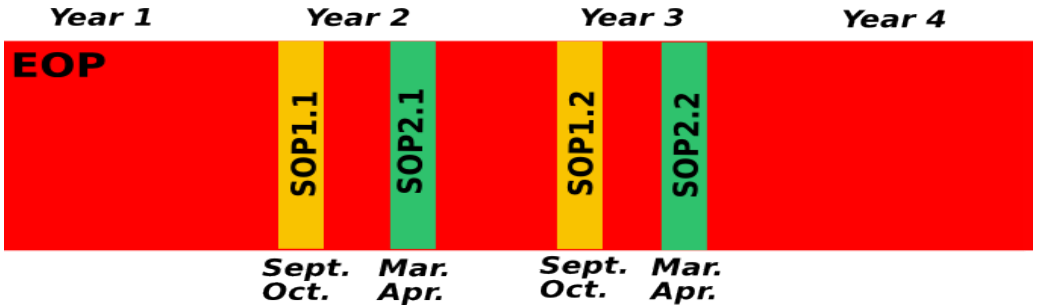
The deep water formation needs to be explored at different time scales to allow the documentation of the interannual variations and the long-term evolution in the hot spots of the Mediterranean

WG4-SQ2:

How air-sea fluxes are modulated?

Simultaneous high space-time measurements of atmospheric and oceanic parameters to deduce the heat, water and momentum fluxes between them in particular during autumn and winter

Programme strategy

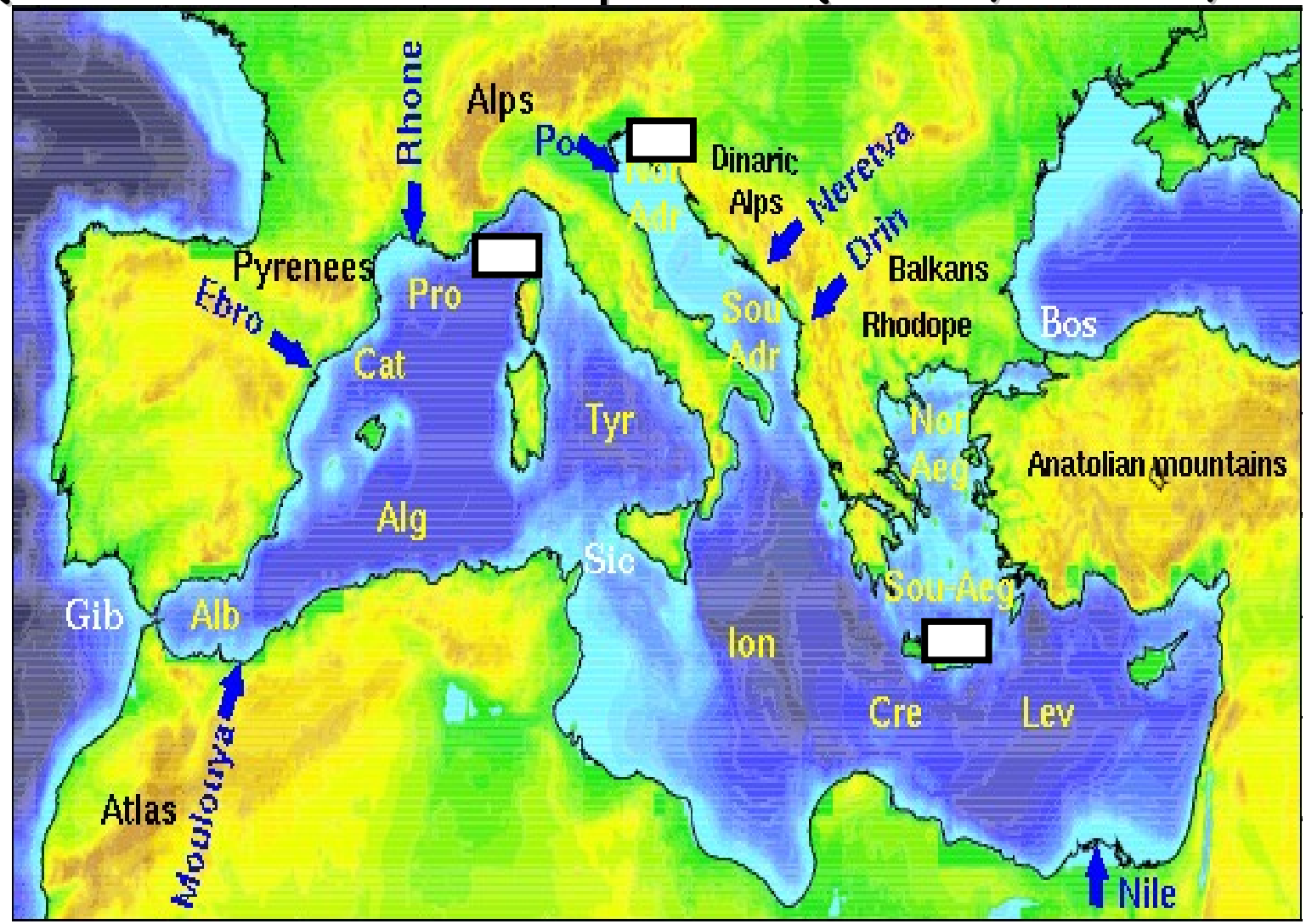


I Observational Strategy: mostly dedicated to EOP & SOP

II Modelling and Data Assimilation Strategy

III Satellites (not really discussed)

SQ1. STRONG WINDS: 3 super sites (Corsica, Adriatic, Cretan)



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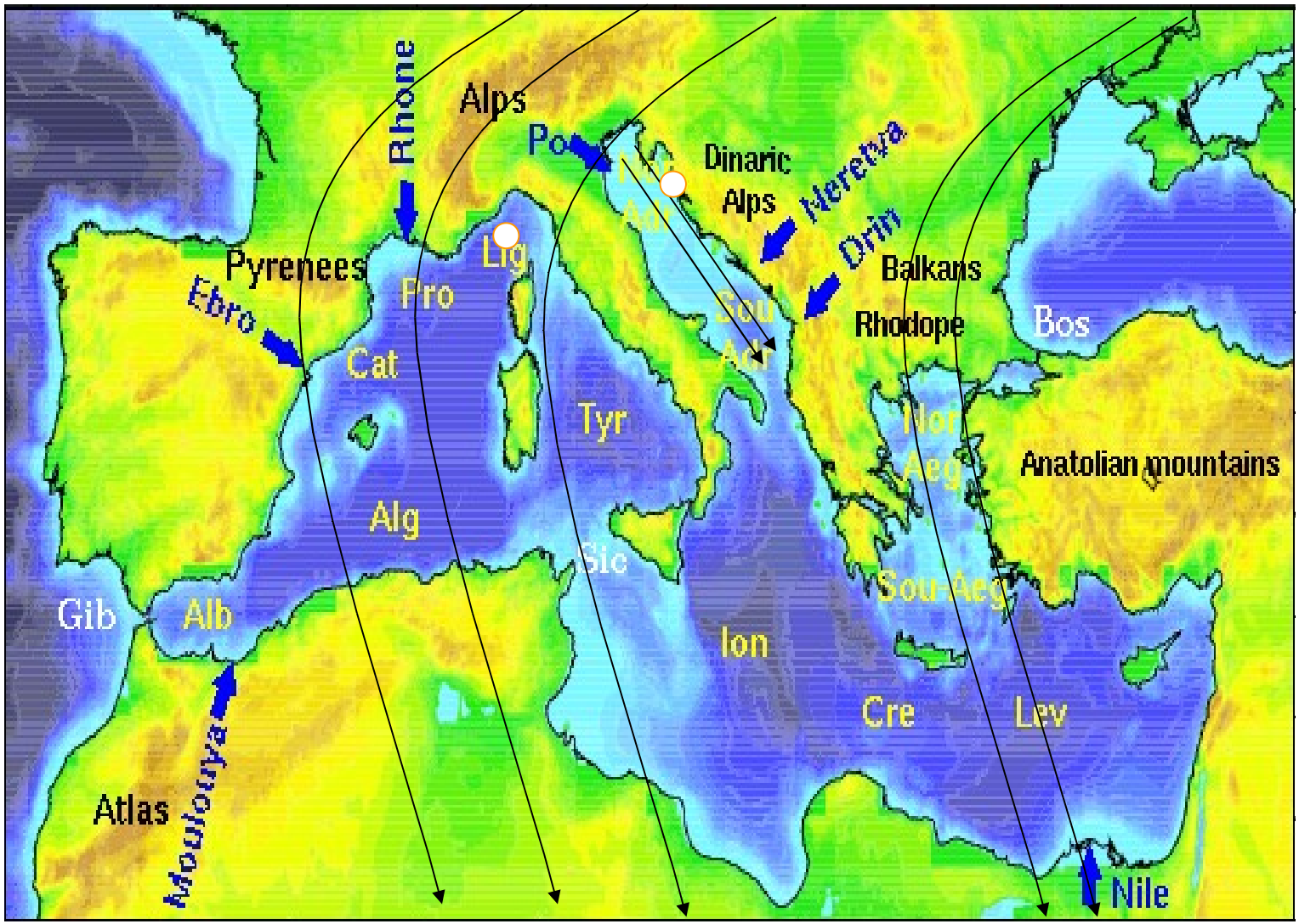
SQ1. CYCLOGENESIS: aircrafts, 3 buoys



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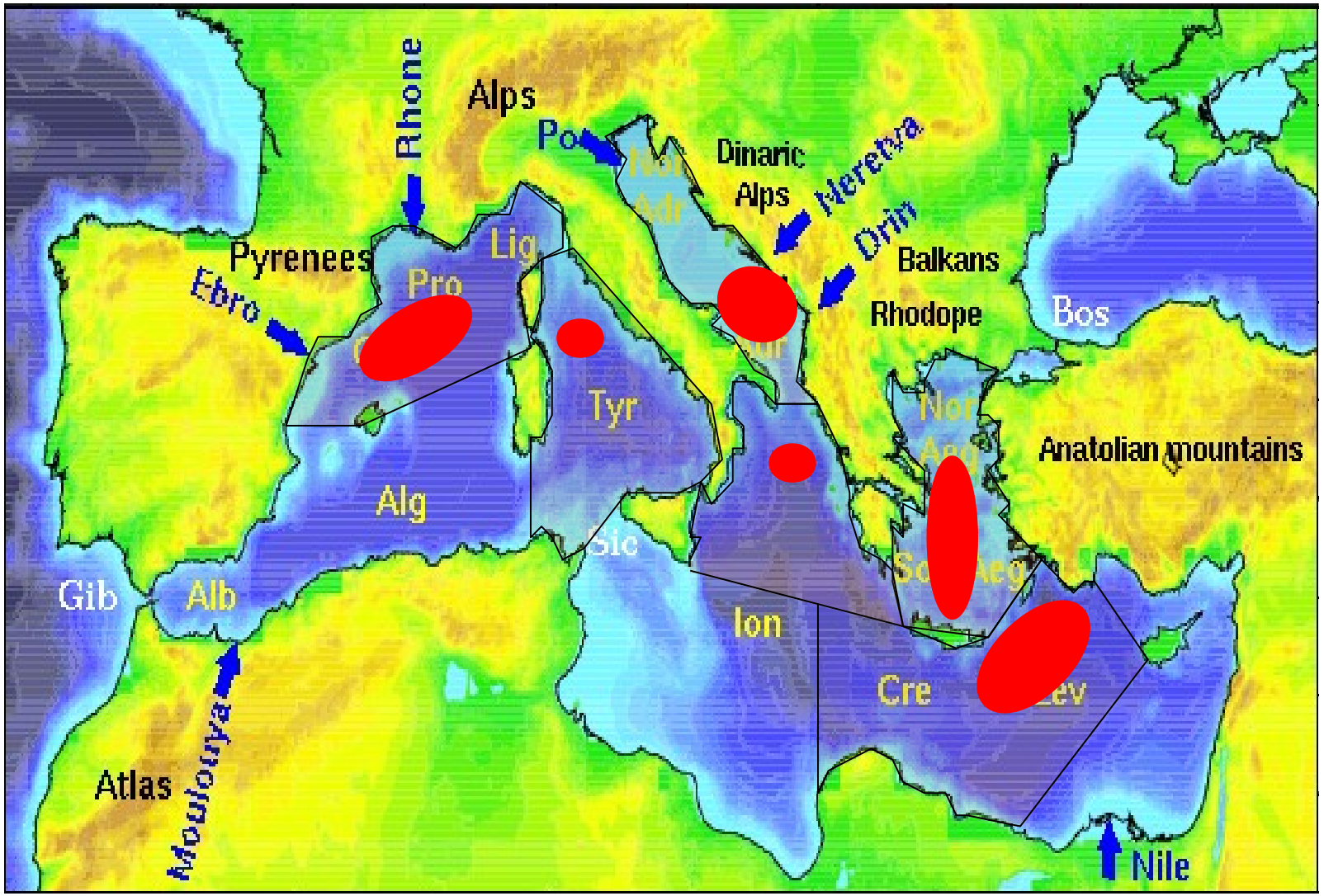
SQ3 & SQ2: DEEP WATER FORMATION & AIR-SEA INTERACTIONS



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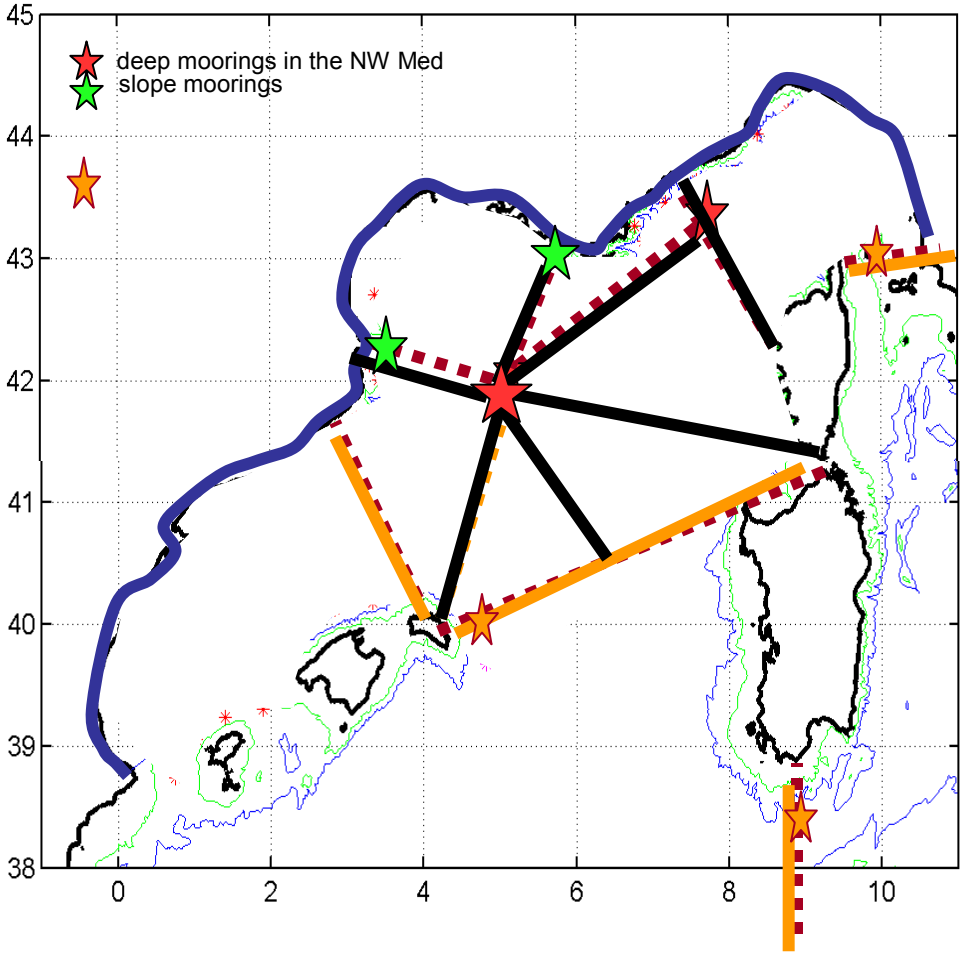
I Observational Strategy

EOP & SOP
presented by areas of interest

North-western Mediterranean EOP



DW formation and spreading:

- Glider star-transects all the year (6 gliders) in the MEDOC zone
- Monthly(?) CTD+O2 deep transects in the straits of Corsica, Sardinia and Gibraltar
- Monthly(?) CTD deep transects between Minorca and Sardinia, between Corsica and Dyfamed, and Minorca and Spain (CTD or 2 gliders?)

Coastal water cascading:

- high frequency observations with deep moorings
- CTD deep transects between Minorca and Spain

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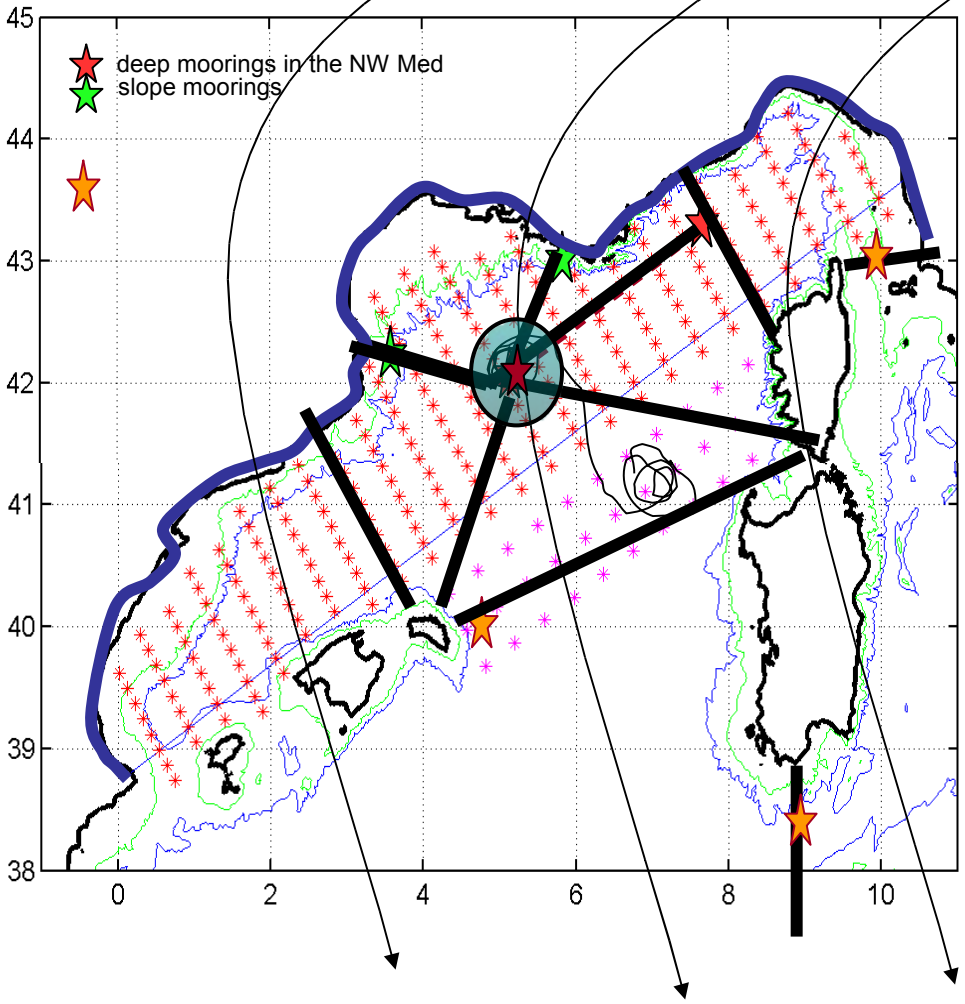
North-western Mediterranean SOP



Air-sea interactions:

Adaptative atmospheric network (Balloons, etc)

- Continuous transects with one ship equiped with an atmospheric mast
- Aircrafts
- *River runoff monitoring*
- CTD along the transects (MLD)

Modulation of the Deep Water Formation & Spreading (process oriented studies):

- A second ship (MerMex, eddies)
- Glider and CTD,XBT,O2 at almost the same place from bottom to surface in winter (convection, mixing, internal waves)
- Surface drifters (SCVs)

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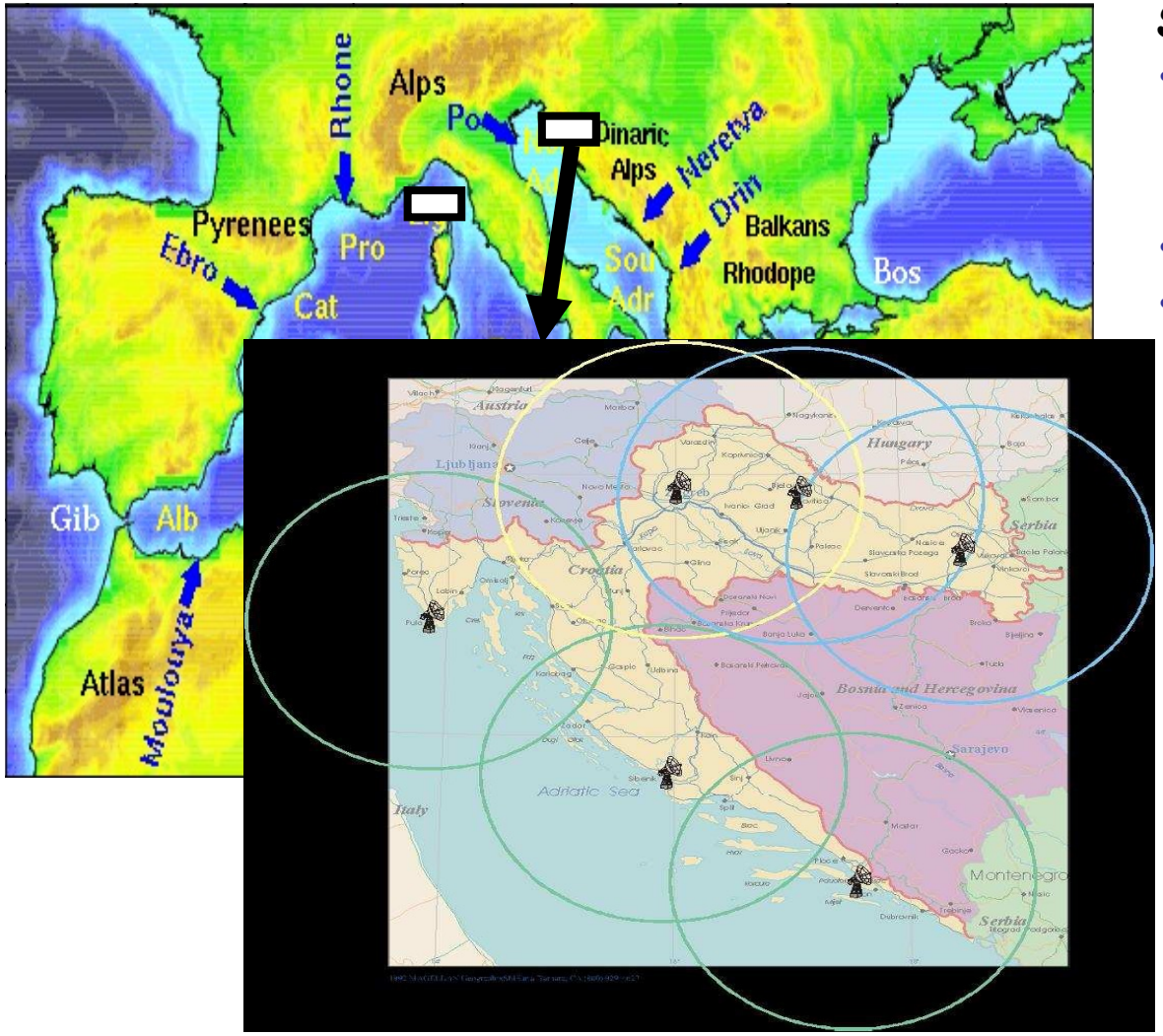
Adriatic Sea EOP



Strong winds & evaporation:

- Radar data (15 minutes, reflectivity and velocity data)
- Wind profilers
- Scintillometer

Radar network in Croatia (three radars on the coast are not installed yet)

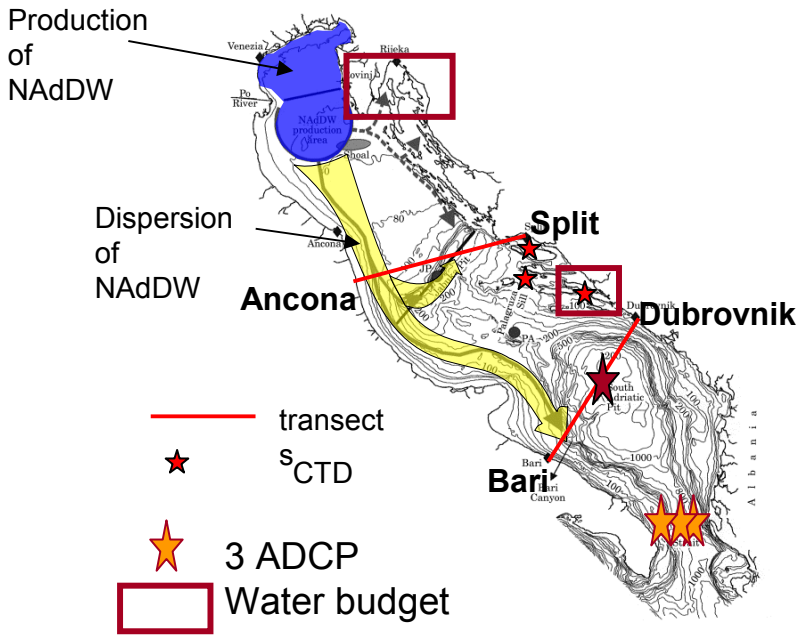
Adriatic Sea EOP

Research ship BIOS-II, Institute of Oceanography and Fishering

Database of transects:
40 years giving the opportunity to detect long-term trends and regime shifts

Air-sea interactions:

- Ship (atmospheric mast, CTD, XBT)
- Buoys (atmospheric parameters, aerosols)
- Local water budgets
- boundary layer processes
- CTD mooring (MLD, DWF)
- ADCP in Otranto Strait



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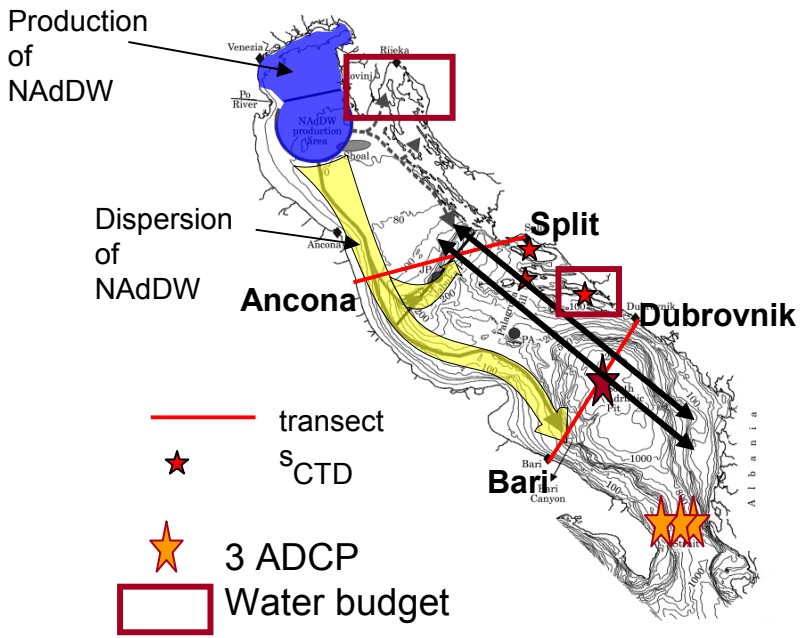
Adriatic Sea SOP

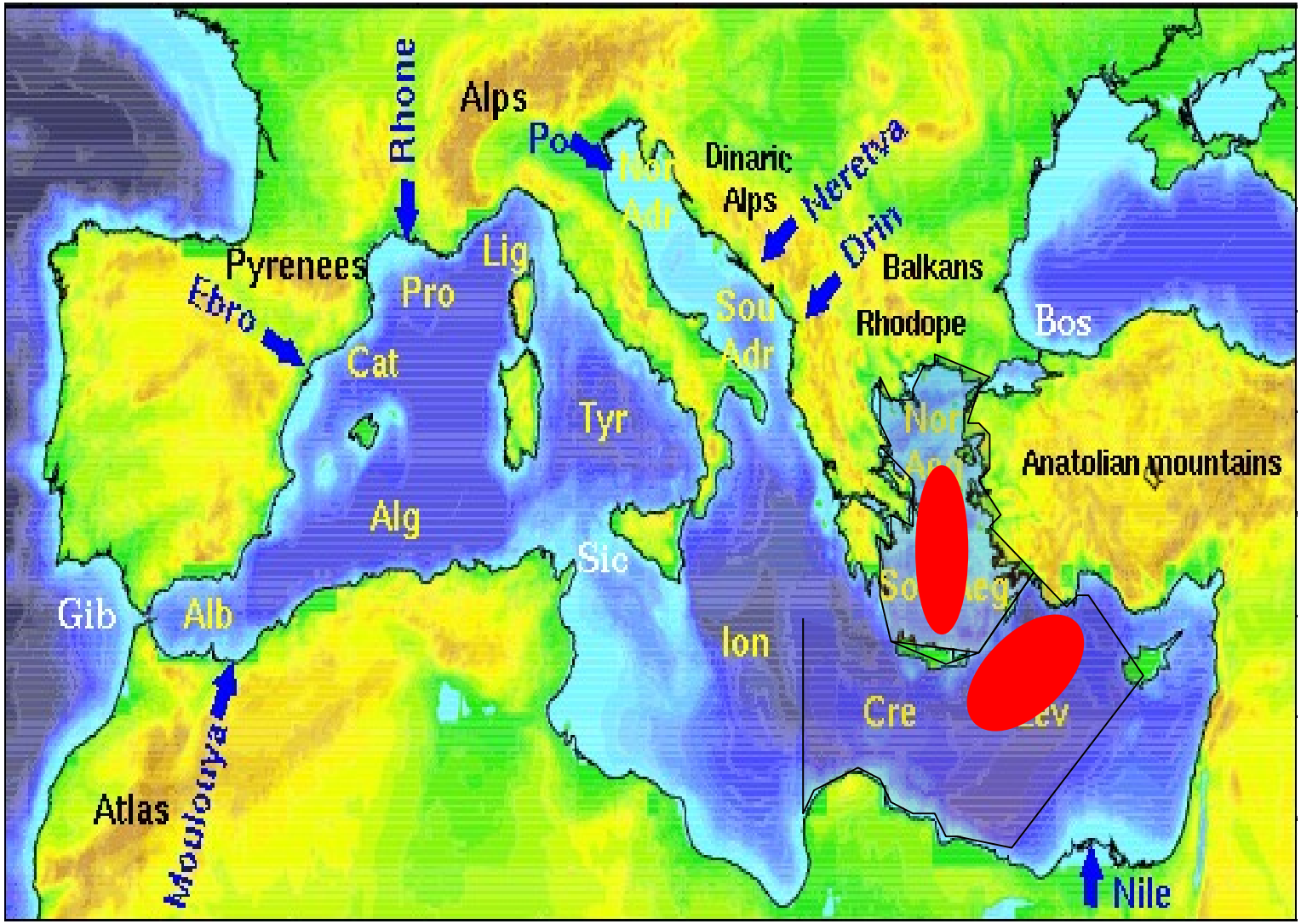
Air-sea interactions & water budget:

- Same as EOP
- Aircraft in the southern Adriatic

The Bora research to date has been mainly focused on the dynamics and structure of severe Bora in the northern Adriatic. Examined to a significantly lesser degree is a less predictable counterpart in the southern Adriatic, where the Dinaric Alps are higher, broader, and steeper, and where the upwind Bora layer is generally less well defined. (Horvath at all, 2009, Weather and Forecasting)



Aegean-Cretan Sea and Levantine basin EOP



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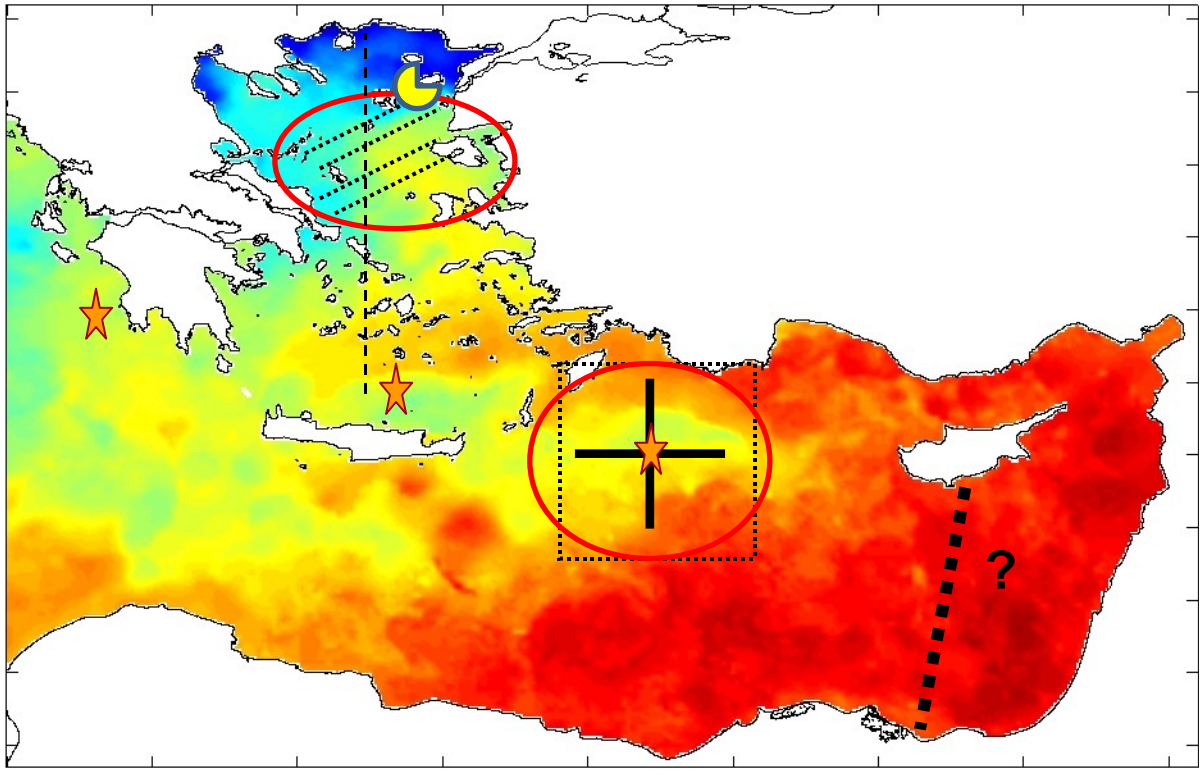
Aegean-Cretan Sea and Levantine basin EOP

Gliders*——
CTD Surveys* ·····
Buoys** ★
HF Radar *** ◔
} with 0_2 measurements



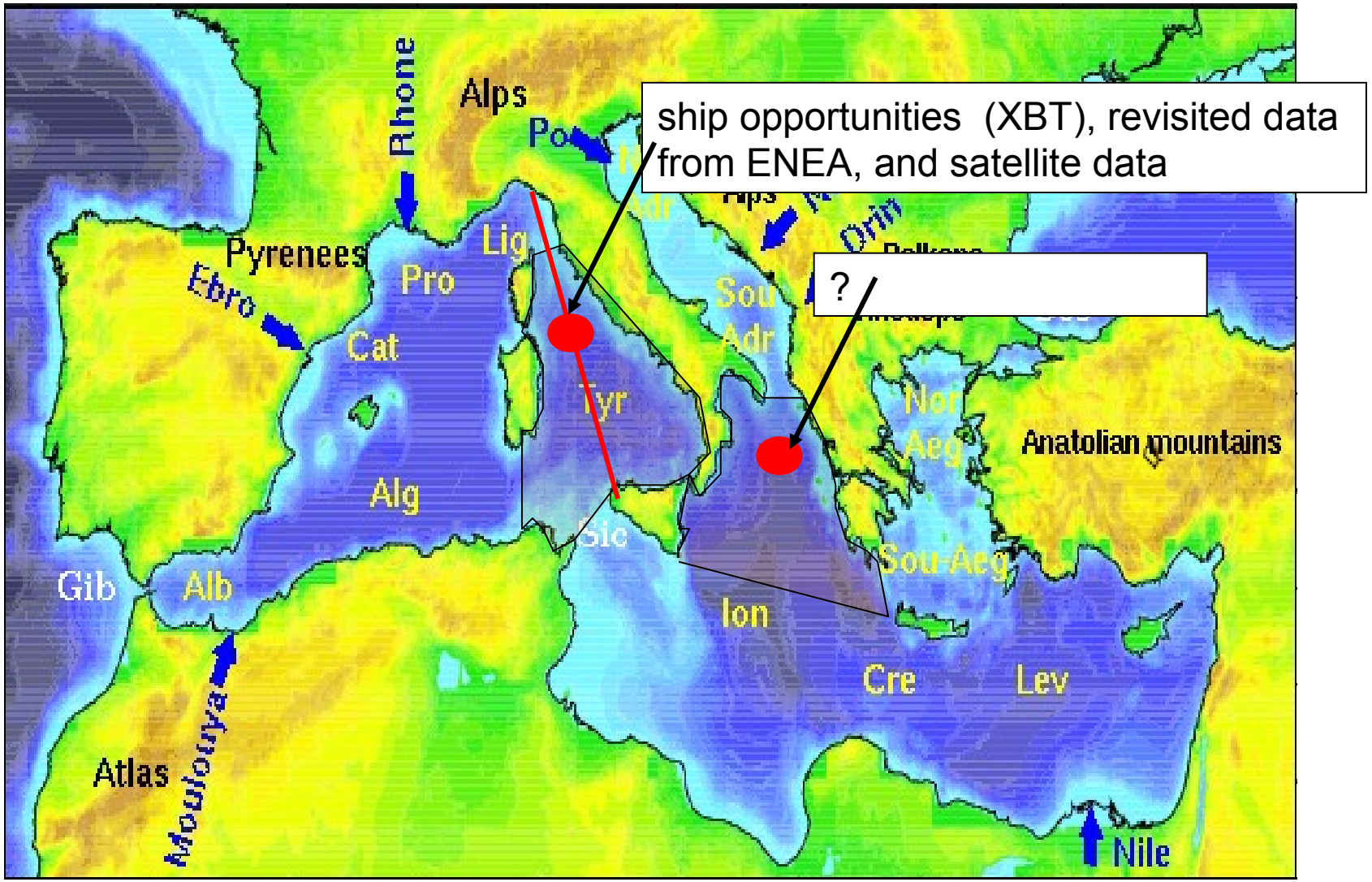
Deep water formation:

*instrumentation/strategy (HCMR-Univ. Athens)

** Two existing and a new proposed at Rhodes Gyre (HCMR)

***Monitor BSW outflow (Univ. Aegean)

Tyrrhenian Sea and Ionian Sea: new sites of DWF ?



II Modeling and Data Assimilation Strategy

General needs

Coupled and non-coupled models of high resolution need to be developed in order:

- to study the cyclogenetic processes in the Mediterranean
- to study strong local winds, influenced by topography
- to ameliorate the parameterization of the air-sea interactions
- to make sensitivity experiments (new parameterizations, etc)
- to evaluate forecasts
- Tools to assist the SOP and EOP

To be discussed in roundtable modelling

Which models could be sheared with other WGs

- New ECMWF analyses at 15km in 2010
- New models have to be developed in Forecast or Research mode?

- WG3: high precipitation?
  - 10km basin-wide model or1km regional model?
  - Non hydrostatic hypothesis?

- WG1: atmospheric reanalysis at 10km in a forced mode?

- During the cruise?

- Need to new high space-time resolution of data to be assimilated

Proposals

Numerical basin-scale models

- ECMWF atmospheric model
- Coupled MED12-WRF global model
- Real-time operational ORCA12 Mercator
- Ensemble forecast
- MEDMIP_O model comparisons (WG1)

Atmospheric Adaptative Observation and regional weather modelling

Numerical mesoscale models

Adriatic Sea area

- ALADIN/HR mesoscale model – 8 km horizontal resolution; DADA dynamical adaptation of surface wind field at 2 km 10-year (1991 – 2000) dynamical downscaling the global data (ERA-40) with ALADIN/HR/DADA are available
- WRF model – 1 km horizontal resolution
- COAMPS model (Coupled Ocean – Atmosphere Mesoscale Prediction System) – multiple nested grid domains, the finest grid having 333-m horizontal spacing.

·NO OCEAN MODEL

Aegean-Cretan Sea and Levantine basin

- BOLAM mesoscale model operating at 15-km resolution over S. Europe and 7 km over Greece. Seven year BOLAM winds at 7 km resolution over Greece are stored in database.
- WRF model – 1 km horizontal resolution. WRF is already operational and it will be used as the primary tool for very-high resolution modelling over the Aegean Sea and especially Crete

·ALERMO-ARPERA Aegean-Cretan Sea and Levantine basin area (3km/50km)

Northwestern Mediterranean

- WRF mesoscale model operating at 21-km resolution over the Mediterranean area and 7 km over the Gulf of Lions, not in operational mode.
- AROME 2km Météo-France, forecast.

·SYMPHONIE oceanic model of the canyons in the Gulf of Lions