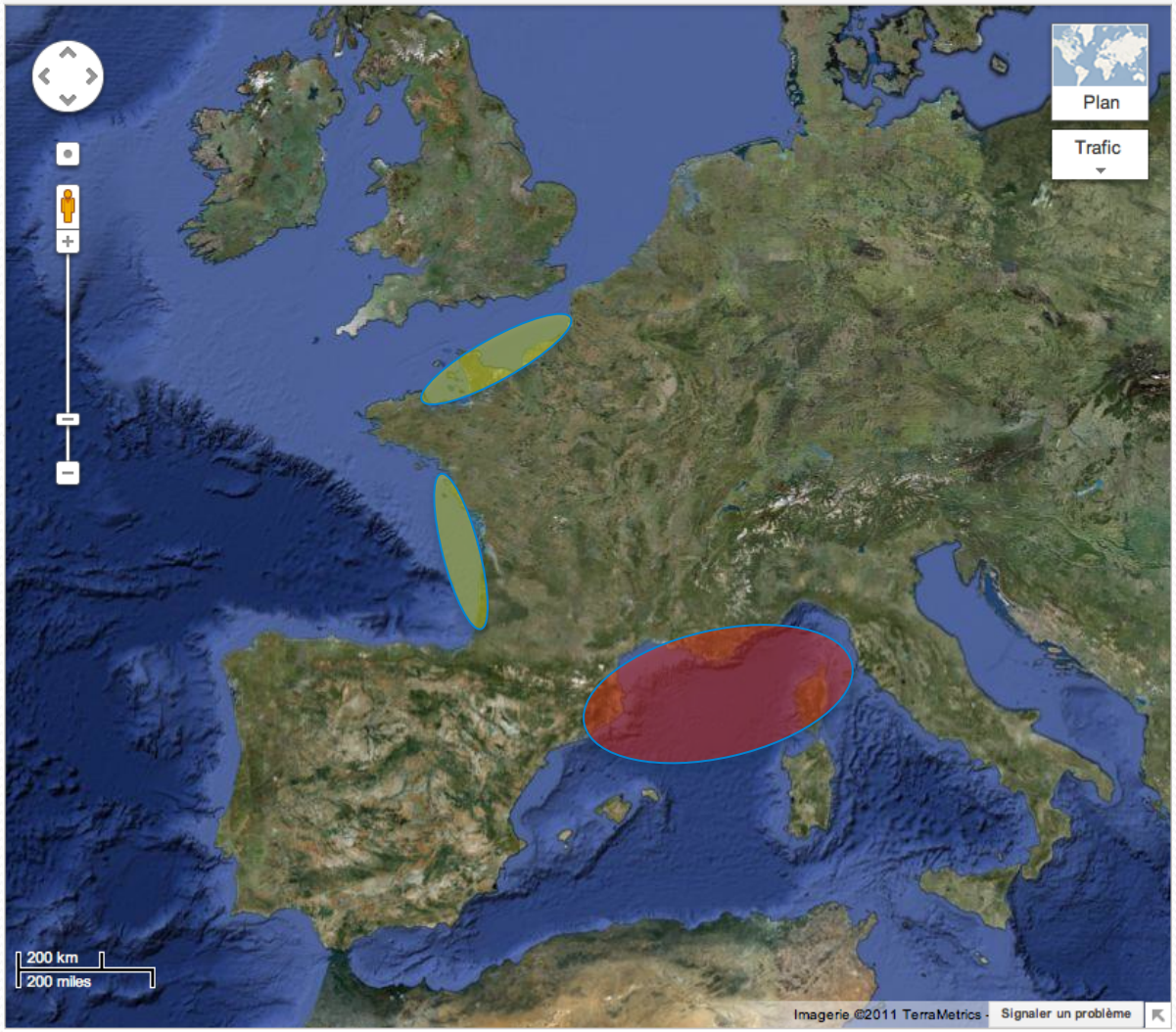
Context



Atlantic and Channel: coastal moorings only (CNRS, IFREMER)

Mediterranean Sea: open ocean moorings (MOOSE network)

Strong focus on Med Sea evolution (water mass, biogeochemical cycles)

Strong links with Med countries and EU

A context of a changing sea

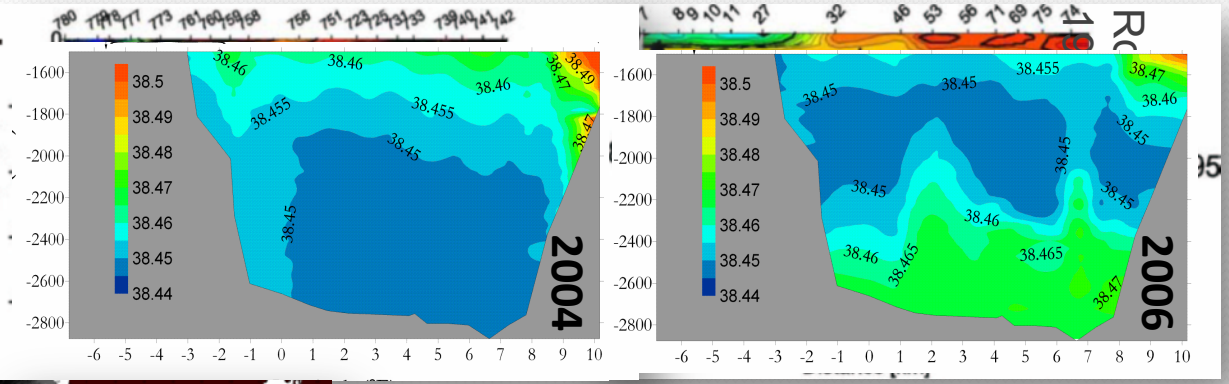
Since when oceanographic measurements are available, and mainly during the past 30 years, significant changes in the properties and the circulation of the Mediterranean have been observed:

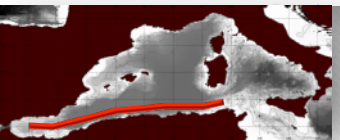
- *"Gradual"* tendency towards higher heat and salt contents
- *"Sudden"* basin-scale events

WMDW: 1985-2000
θ $5.5 \cdot 10^{-3}$ °C yr^{-1}
S $1.2 \cdot 10^{-3}$ yr^{-1}

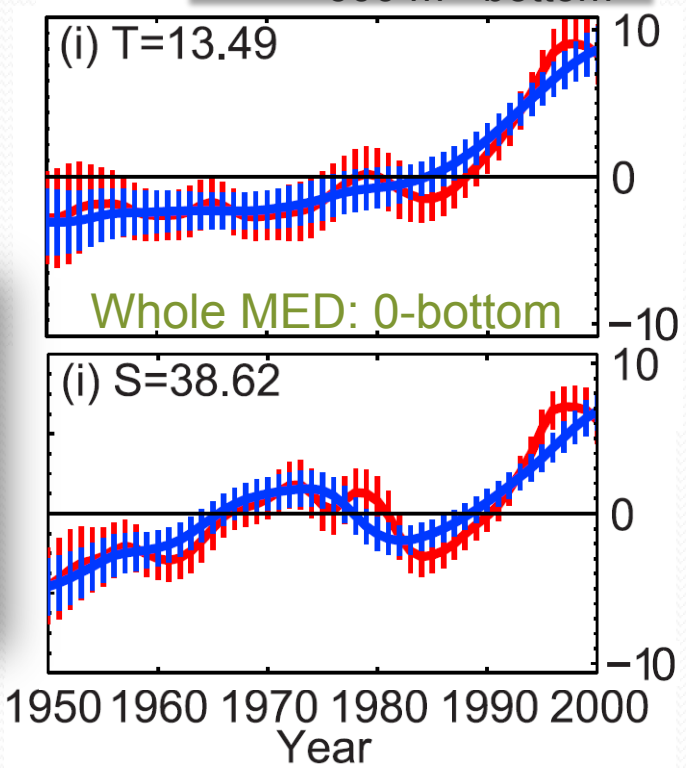
Western Mediterranean Transition (since 2005)

Schroeder et al., 2008

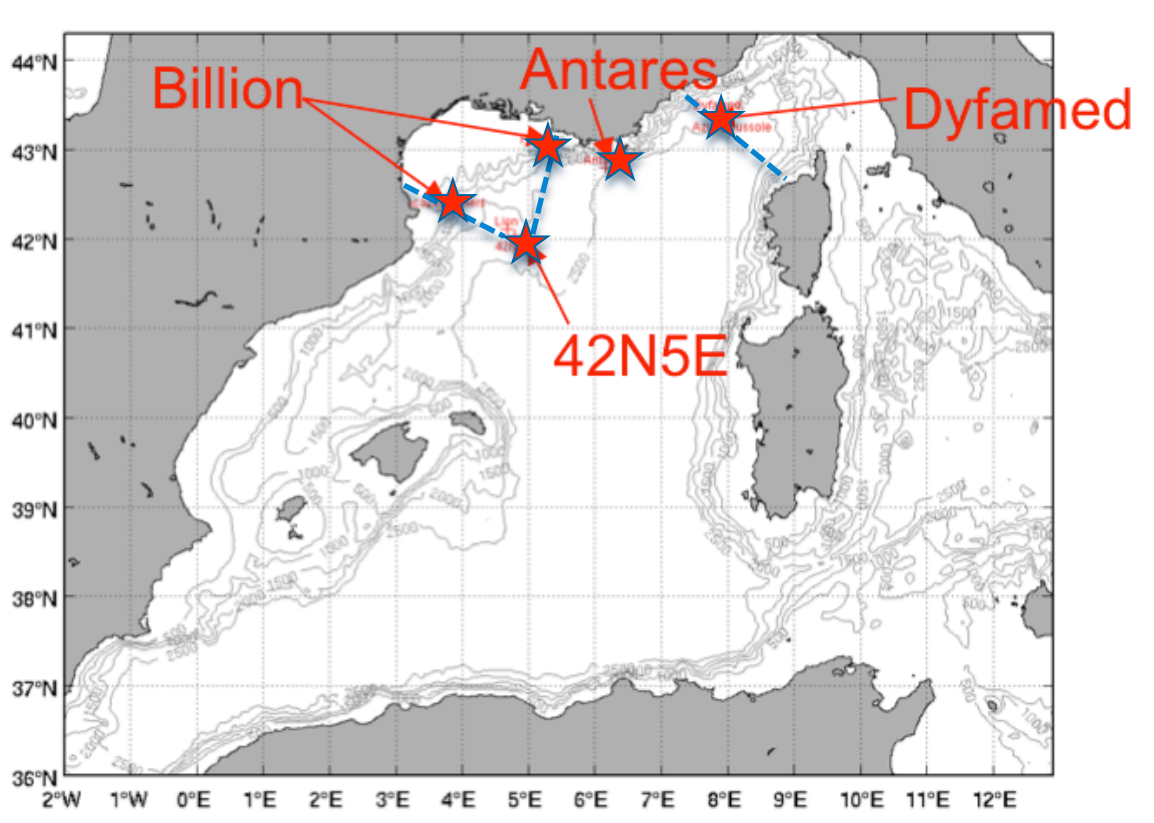




Abrupt deep T and S increases



MOOSE: Long observation periods for intermediate and deep variabilities with core parameters (T, S, currents, O2, turbidity, particle fluxes)

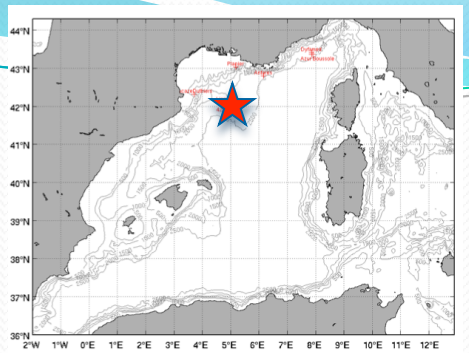


Billion: canyons shelf water formation, cascading, bottom resuspension

Antares: seafloor infrastructure with realtime transmission. Deep circulation and O2 variability

Dyfamed: Ligurian Sea water column**:** convection/mixed layer and export

42N5E: Deep convection water column



42N5E (« LION ») 2007-present

P.Testor (LOCEAN), L.Mortier (ENSTA), X.Durrieu de Madron (CEFREM)

Site : Central Gulf of Lions, 2400m depth, 135 km from Marseille. Link with canyons observations

Characteristics: open ocean, full convection site, water mass formation in the NW Med Sea

Data: T, S, currents, deep O2 (CTD to Coriolis)

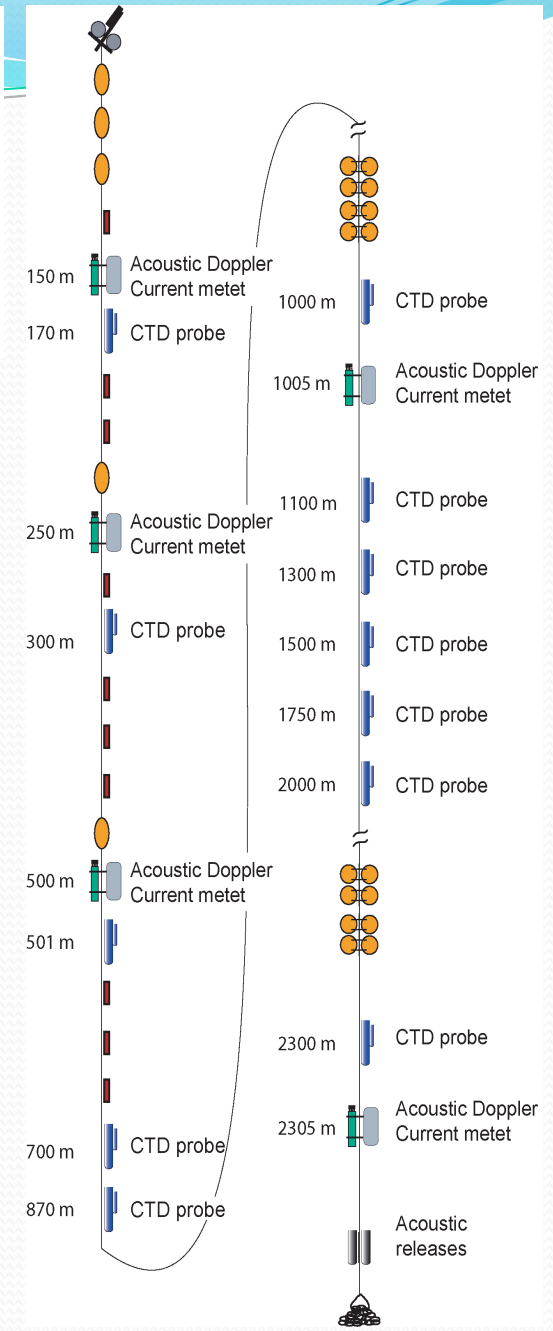
Platforms:

•One standalone mooring with CTD, currents and O2 sensors (150-2400m). One standalone deep mooring with CTD, currents

•Since 2011 one sediment trap in bottom

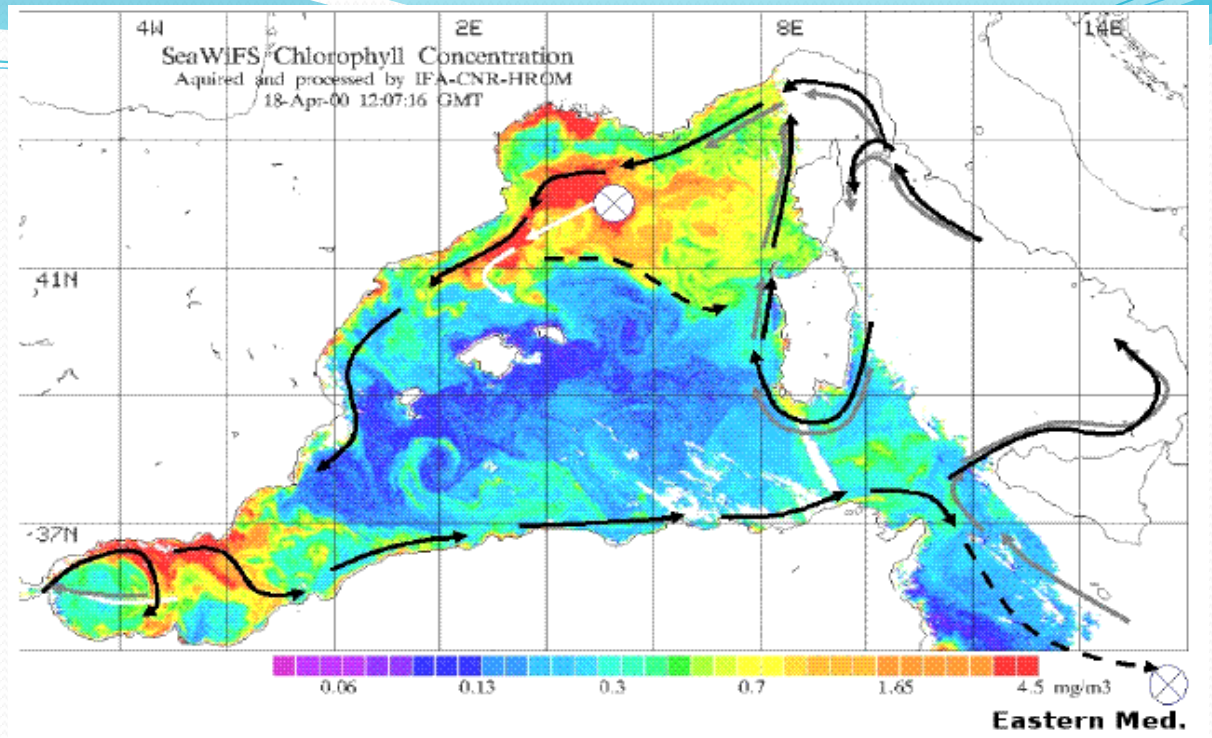
•Meteo France ODAS buoy with surface CTD and T sensors

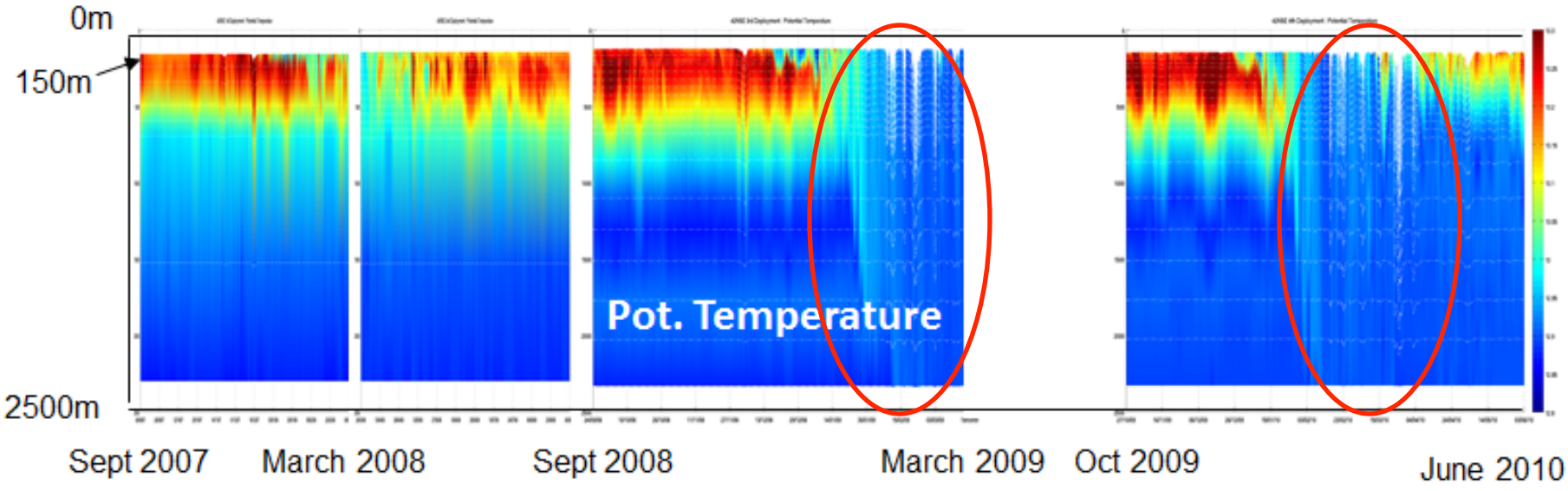
•Glider section (Banyuls-42N5E-Marseille)

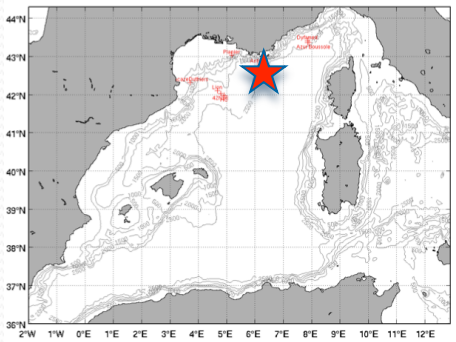


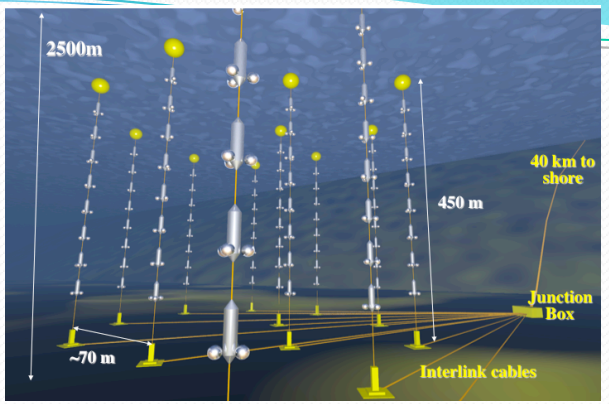
Convection affects the entire water column for two winters 2008/2009 and 2009/2010

« Deep » winter convection events









ANTARES (42°48N, 6°10E) 2004-present

PI: D.Lefevre, C.Tamburini (LMGEM)

Site : Ligurian Sea/Gulf of Lions, 2400m depth, 20km from Toulon

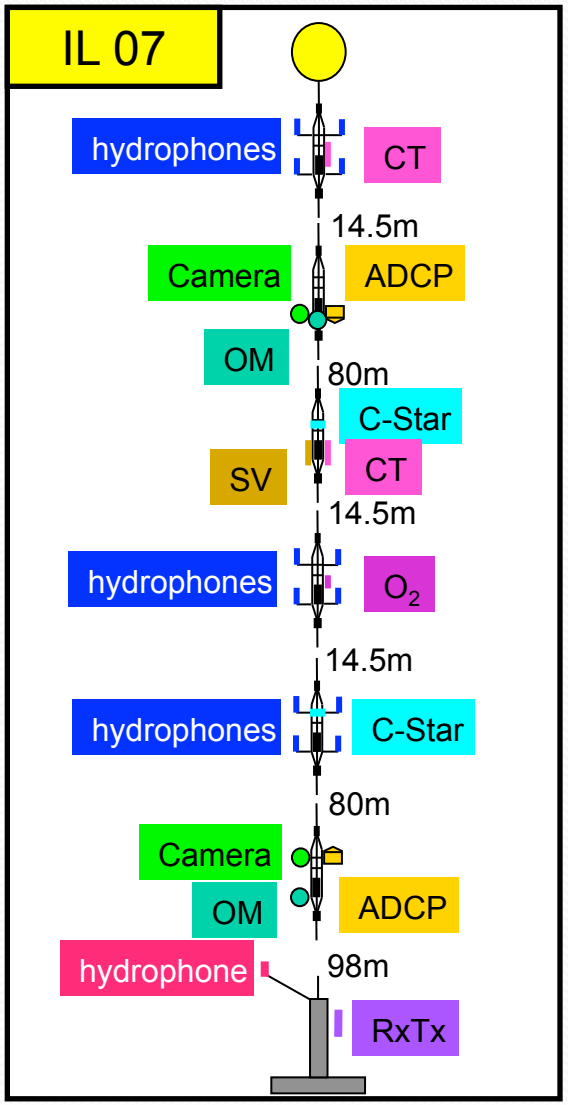
Characteristics: bottom of slope, boundary of North Current, deep waters circulation, bioluminescence

Data: T, S, currents, O2 (Coriolis)

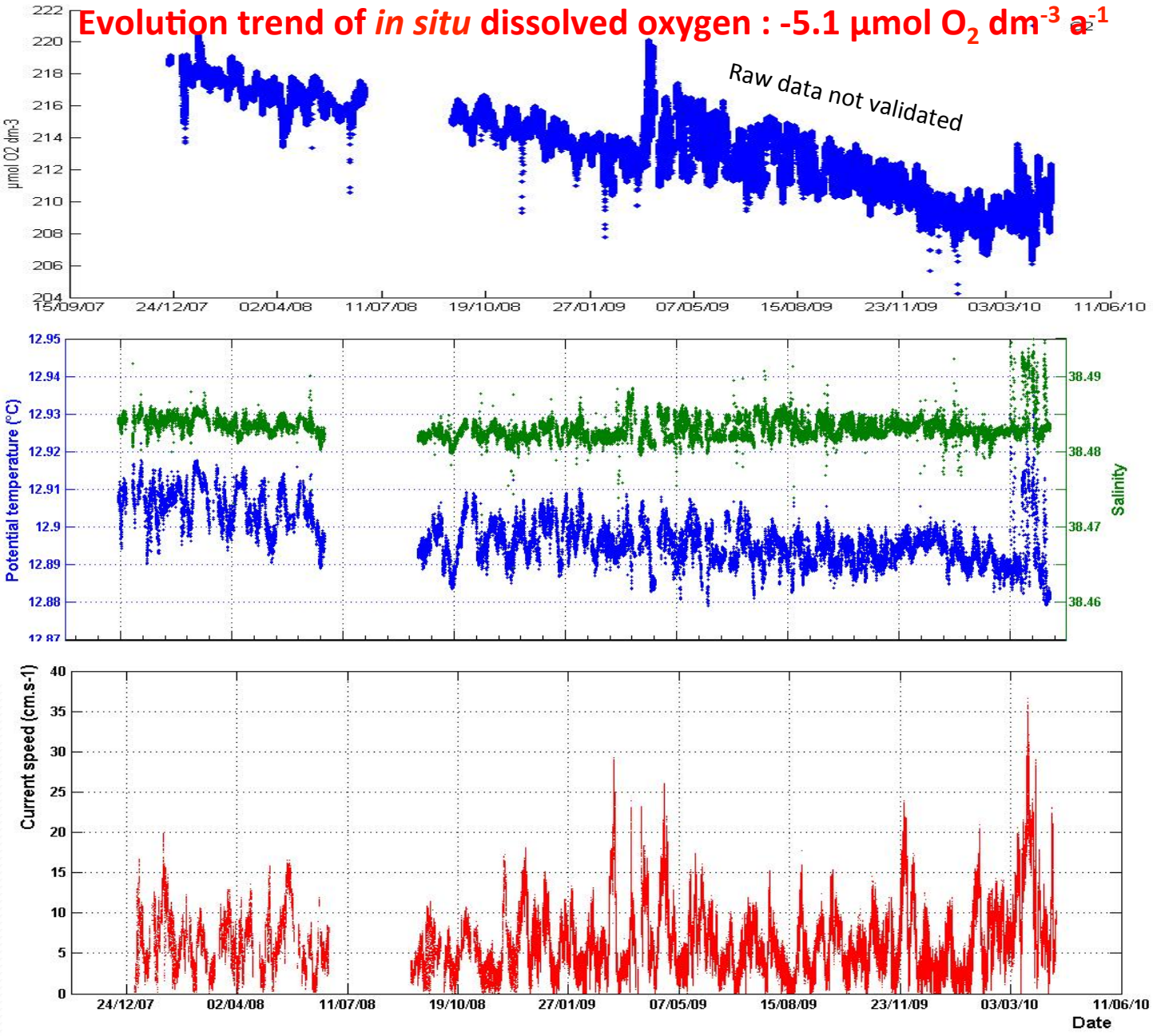
Platforms:

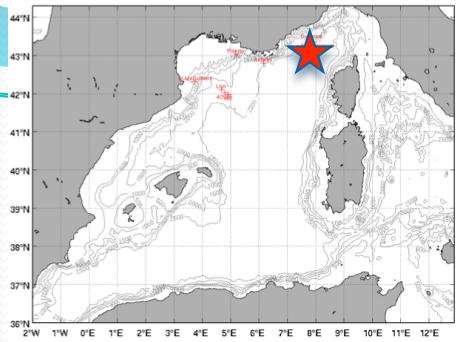
•2 real-time moorings linked to the neutrino telescope cable with CTD, currents, O2 and ΔO2 data

•1 standalone mooring with CTD, currents and IODA (2000-2400m): maintenance every 3 months. Sensor development and realtime data calibration



Temperature, Salinity, currents, O_2 time-series (IL07)





DYFAMED (43°25N, 7°52E) 1988-present

PI: L.Coppola (OOV)

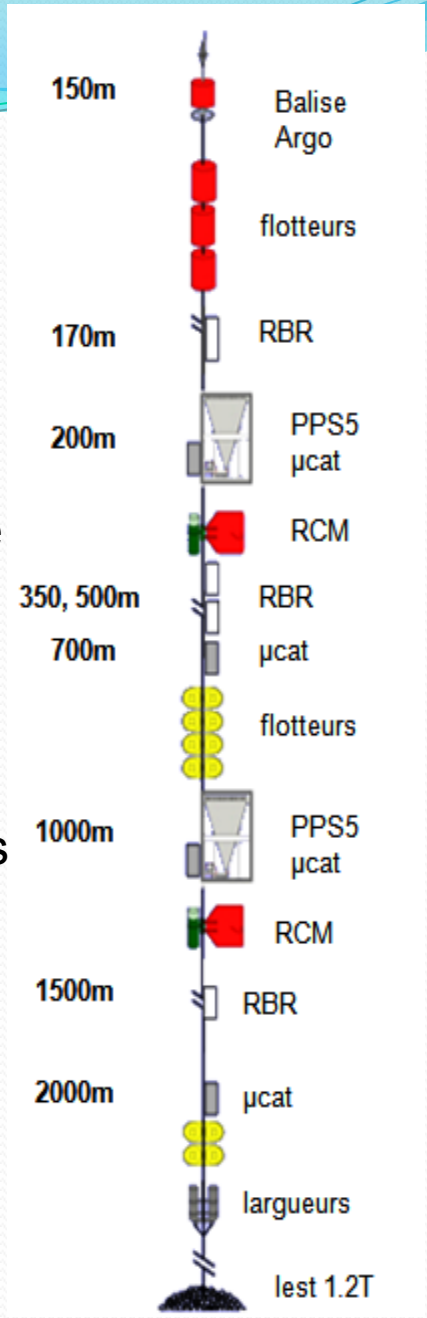
Site : Centrale Ligurian Sea, 2350m depth, 50km from Nice

Characteristics: open ocean, presence of front, atmospheric inputs, semi-convection, mesotrophic to oligotrophic, 20 years time series

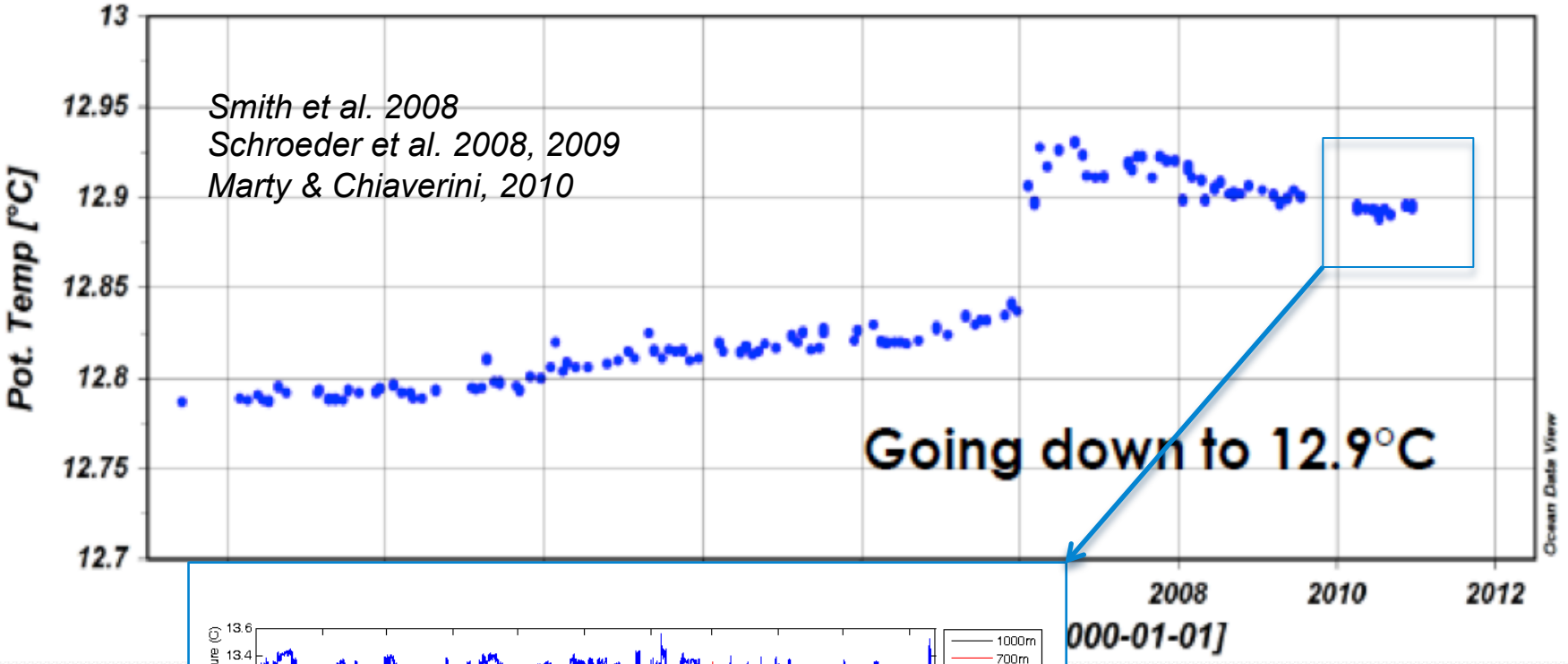
Data: T, S, currents, particle fluxes (CTD to Coriolis)

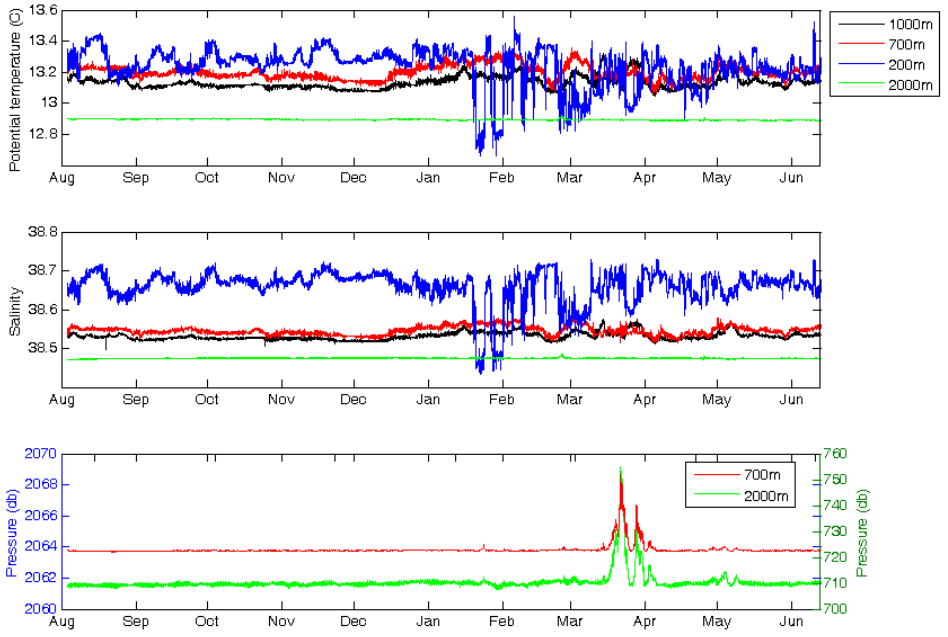
Platforms:

- 1 standalone mooring line with sediments traps and CTD, currents sensors from 150 to 2300m
- Optical buoy for ocean color satellite calibration and marine optics studies
- Meteo France ODAS buoy with CTD and T sensors
- Monthly cruise for seawater sampling (DO, nutrients, DIC-pH)
- Bio-gliders section (Nice-Calvi) and bio-Argo floats deployments



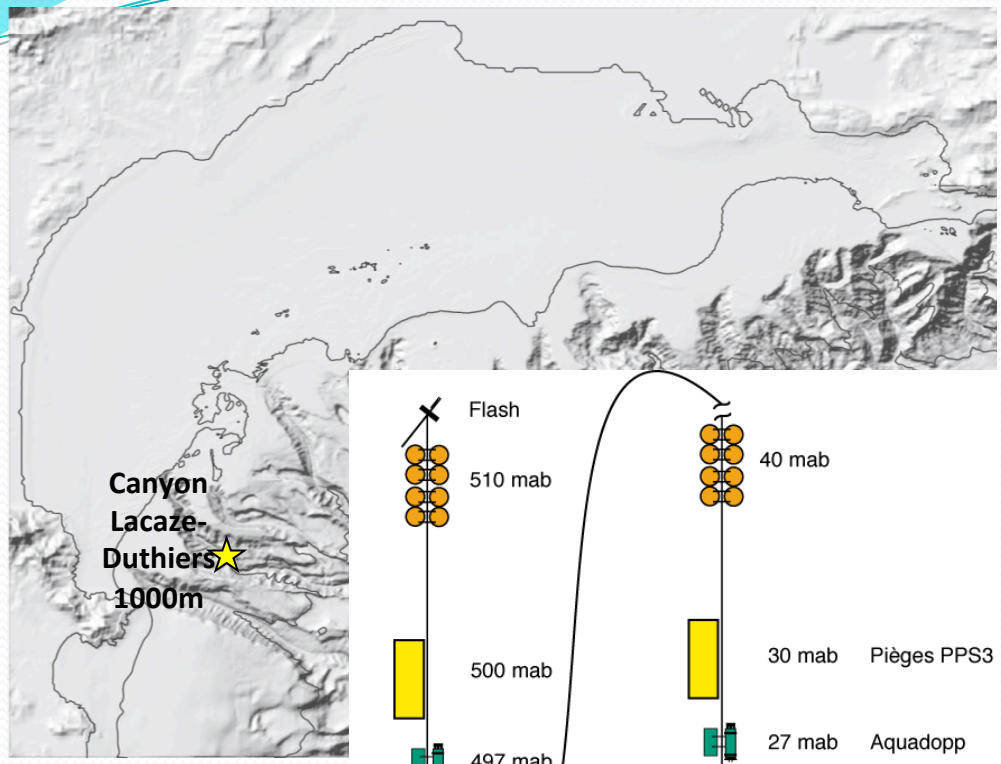
Data and Results: Deep water temperature change (WMT)

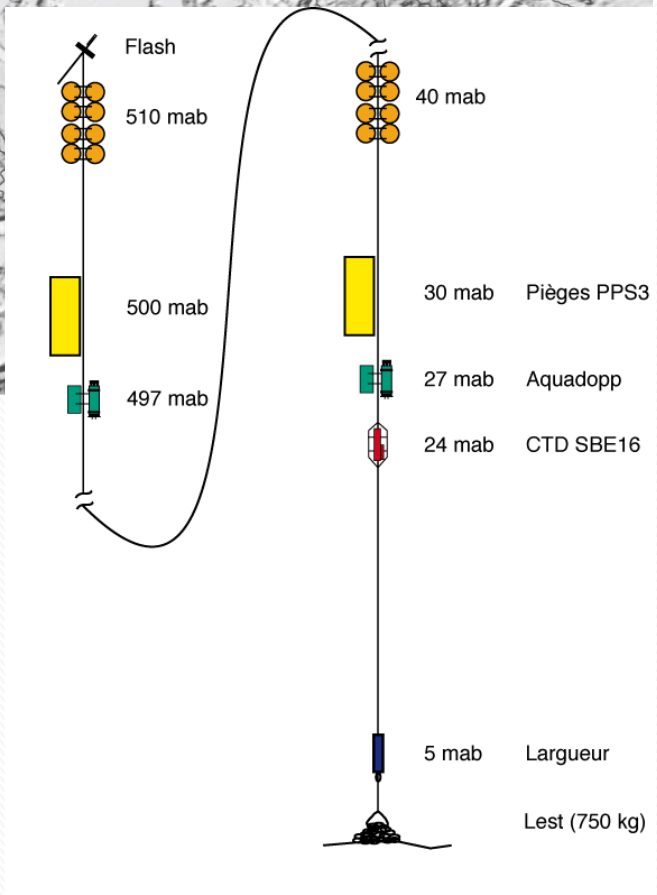




(from Coppola et al.)

BILLION: Suivi des conditions hydrodynamiques et flux particulaires





Sediment traps deployed in canyons areas

Cascading on the continental slope (since 1993)

Traps PPS3 @ 500m & 25-50m above seafloor

Maintenance every 6 months

2x2x6 samples per deployment

Data: T, S, currents, particle fluxes (CTD to Coriolis)

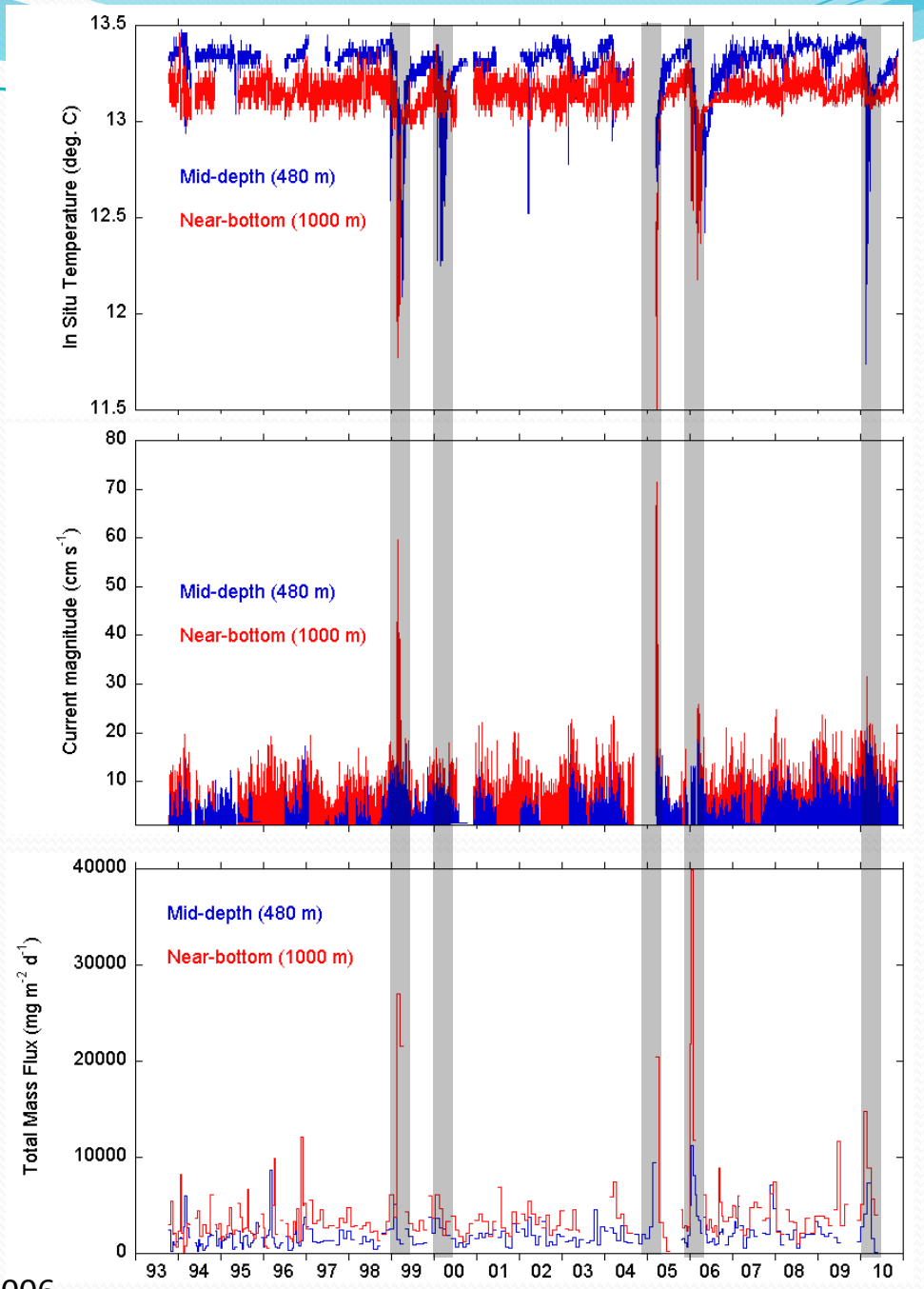
Cascading in Lacaze-Duthiers canyon

Intense events in 1999/2000, 2005/2006 and 2010

Temperature decrease (>0.5°C)

Bottom currents > 30 cm s^{-1}

Daily particle fluxes > 10 g m^{-2}



Heussner et al., 2006

International actions

EU projects:

HERMIONE, EURO-STRATAFORM (Billion)

EUROSITES Collaborative (Antares, Dyfamed)

ESONET NE (Antares)

PERSEUS (Lion, Dyfamed, Billion)

FixO3 (submitted) I3 infrastructure (Antares, Lion, Dyfamed)

ESFRI: EMSO (Antares, Dyfamed)

CIESM: HydroChanges (Lion, Antares, Dyfamed)

International: OceanSites (Dyfamed)

Perspectives

- Implement biogeochemical sensors (PERSEUS): O2 and nitrate
- pH-pCO2 strong interest but no plans so far
- Real-time transmission: Dyfamed and Lion in the loop. Potential funds for Dyfamed through EMSO (to be confirmed)
- Cross-validation with Argo and gliders equipped with bio-sensors (GROOM, FIXO3)