WP1 Understanding and evaluating climatic changes and natural hazards

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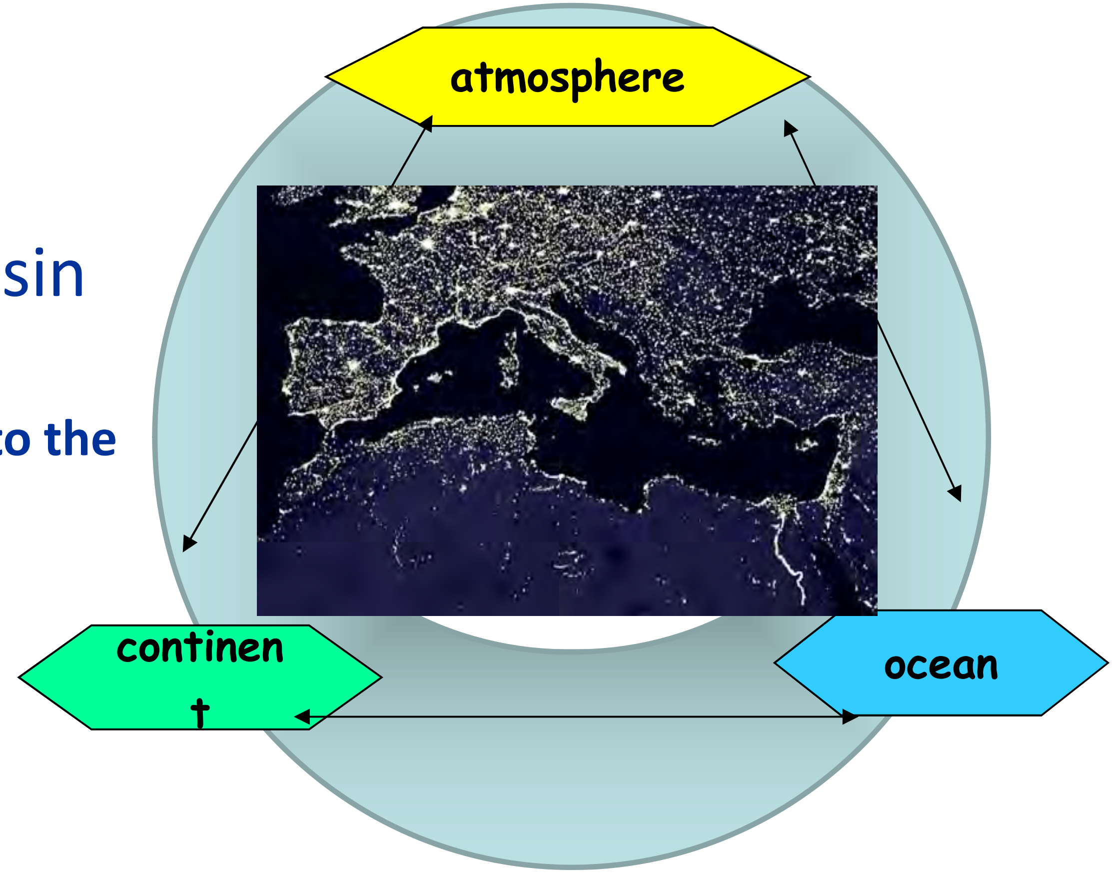
Objectives

- Climatic changes & natural hazard assessment:
  - **Observing**
  - **Evaluating and analysing variabilities at different time scales**
  - **Modelling**



- Context:
  Mediterranean basin

- integration from continent to the Sea

- amplification factors: urbanised area, high population densities, big cities, industries, contaminants

1) Natural hazard and risk

- Includes:
- **Seismic hazard: earthquakes including site and induced effects** (tsunamies, liquefaction, gravitational effects…)
- **Gravitational hazard from land to sea**: landslides, avalanches,
- **Costal changes**: erosion, extreme events…

- From short to long term scales of observation

- Appreciating risk – means also to assess « vulnerability » on economy and society…

example 1: to assess seismic hazards in relatively low seismicity area (active tectonics, paleoseismicity)

Understanding faulting behavior of slow slip fault in **low to moderate** seismicity area: Case studies of the western Mediterranean domain where moderate but destructive earthquakes occured

Aquila (Italia, 2009): M: 6.3, 308 deaths
Al Hoceima (Morocco, 2004): M 6.3, 629 deaths
Agadir (Morocco, 1960): M 5.8, 12.000-15.000 deaths
Monastir (Tunisia, Sd century): M 5.8- 6
Lambesc (Provence, France, 1909): M: 6, 46 deaths (today=> more than 1000 deaths)

Scientific challenge: seismic hazard assessment of this kind of domain

Lambesc earthquake (June 11th, 1909)

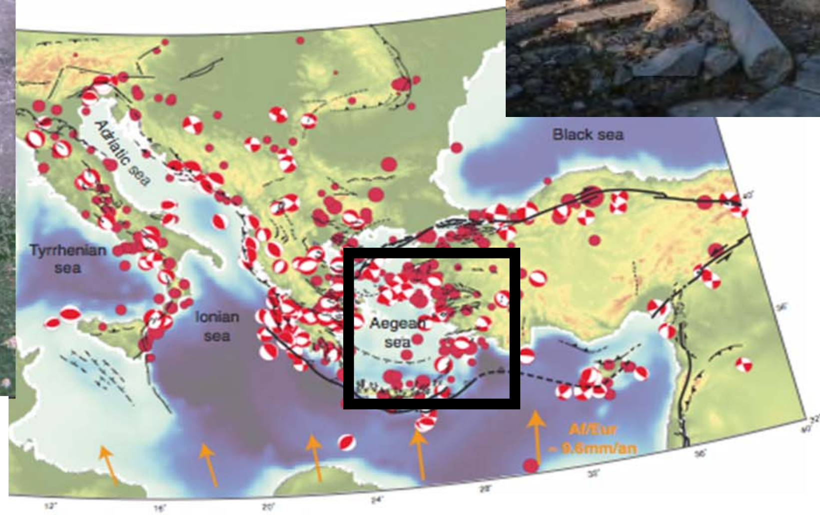
Bellier et al, CEREGE, IRSTEA, IRSN, CEA

example 2: to assess slip age and frequency of past strong earthquakes (active tectonics, paleoseismicity and archeoseismicity)

Paleoseismicity

bedrock fault scarp using cosmogenic nuclides: How many earthquakes incrementallly exhumed that scarp ?

Archeoseismicity



archeological observations

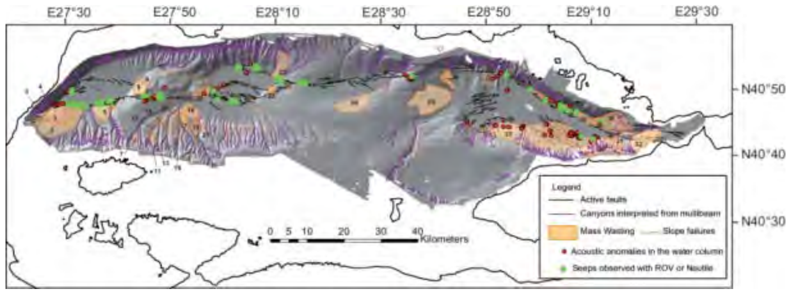
Aegean Region: potential for better seismic mitigation in a highly touristy area (Izmir, Bodrum)

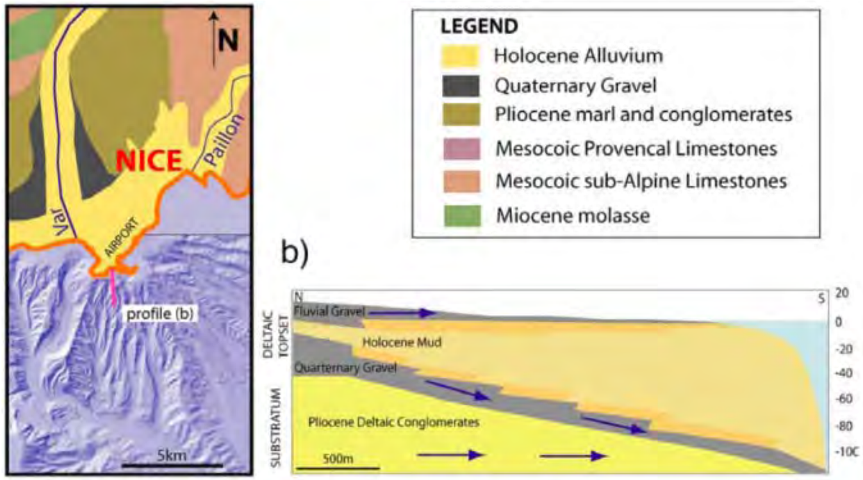
L Benedetti, CEREGE, program ENVI-MED SAFEAR

example 3: Can fresh water infiltration induce submarine slope instability?

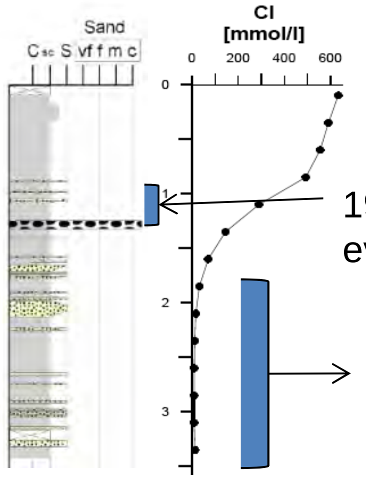
- Pore water freshening degrades clay mechanical properties
- Landslide triggering factors include
  - Earthquakes
  - Pressure transients in aquifers
  - Human activities
- Submarine landslides cause tsunamis
- Case studies
  - Var Delta
  - Sea of Marmara (Istanbul)

Sea of Marmara: Fluid emissions and landslides triggered by earthquakes *(Zitter et al., 2012)*





Var delta architecture and groundwater flow
(Dubar & Anthony, 1995; Anthony and Julian, 1997; Guglielmi & Prieur, 1997)



Kopf et al. (2010), Stegmann et al. (2011)

1979 event

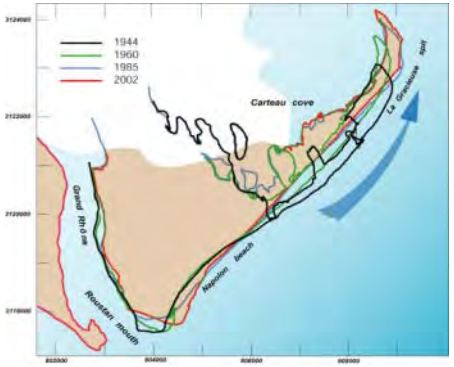
Fresh water in marine clays -> potential hazard !

EMSO European Sea Observatory Research infrastructure consortium

P Henry, Y Guglielmi, E Anthony… CEREGE

example 4: coastal hazard - shoreline erosion and extreme events

Observations and monitoring:
Long term shoreline changes (100 yrs) and extreme events (days)



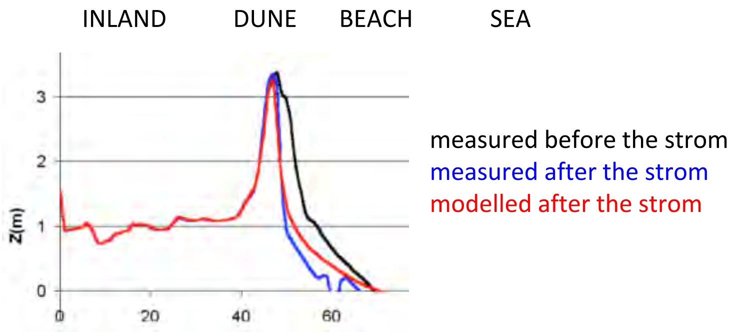
Rhone delta shoreline changes

Coastal flooding in Languedoc

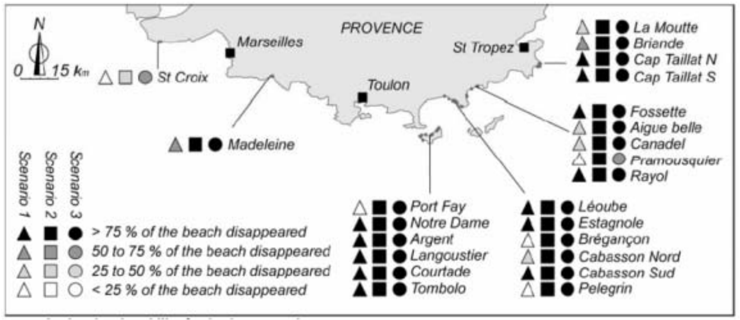
Coastal erosion in Hyeres Bay

Modelling:
Long term (100 yrs) shoreline changes and erosion

- Modelling dune erosion



- Predicting « pocket » beaches disappearing in case of sea level rise



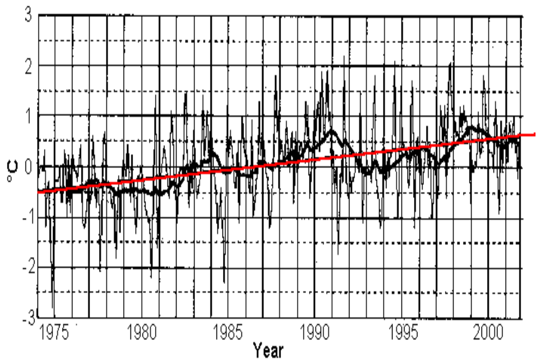
F Sabatier, CEREGE, OHM Littoral

2) Global change

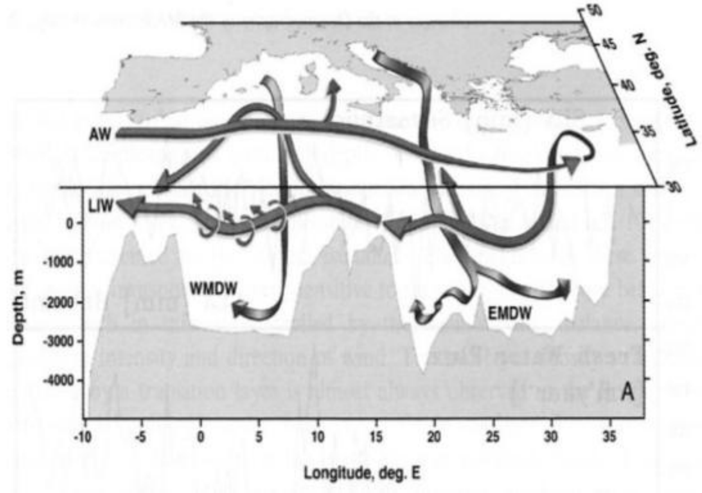
Time scale of observation : Long term trend

UV, Température, water ressource, acidification…

example 1 : Impact of warming on dense water formation and stratification ?



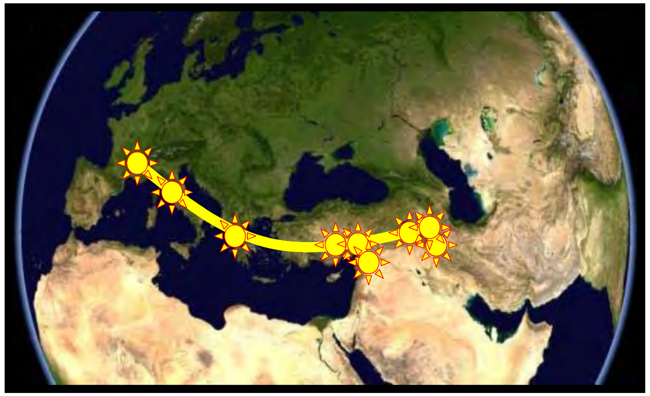
Surface Med Sea T°C : 1.1°C / 27 years



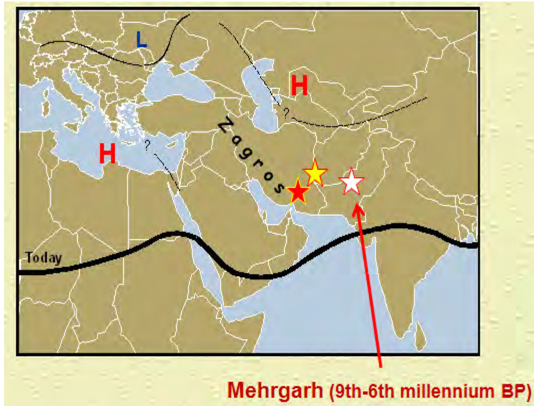
Different areas of dense water formation that play a role on the general circulation, transfer of carbon to deeper layers and availability of nutrients.

MISTRALS / Mermex program, MIO …

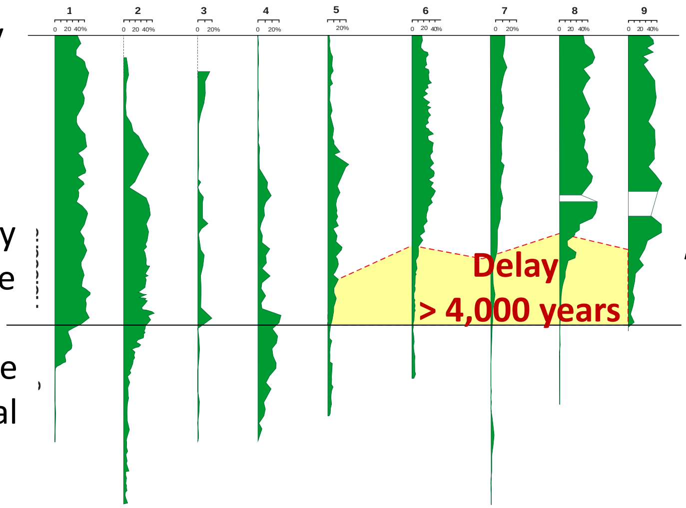
example 2 : impact of monsoon – holocene paleoclimatology (approx 10 000 years) in continental Middle East (Iran)

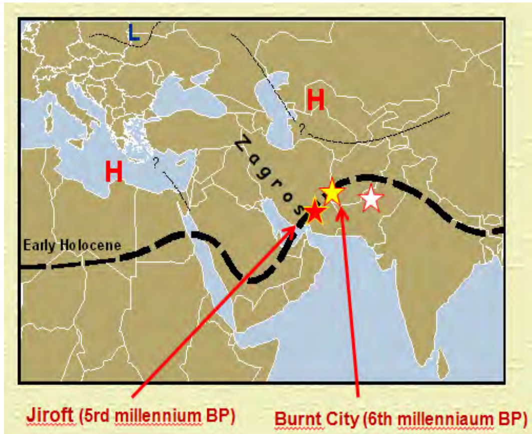


Retreat of the Indian Summer Monsoon and its possible impacts on the decline of mid-Holocene civilizations in southeastern Middle East



Chronology of the expansion of deciduous oak forest from Europe to Iranian Plateau

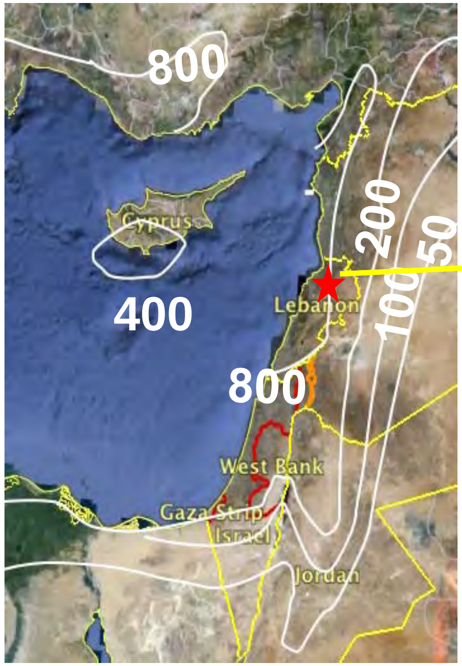




M Djamali V Andrieu-Ponel…IMBE

example 3 : paleohydrology – long-term paleoclimatology in Lebanon (approx 400 000 years)

Study area

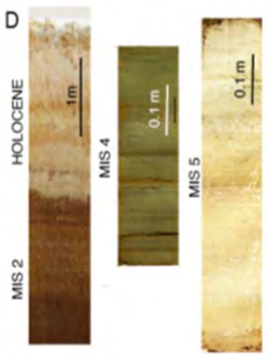


Mean annual precipitation (mm)

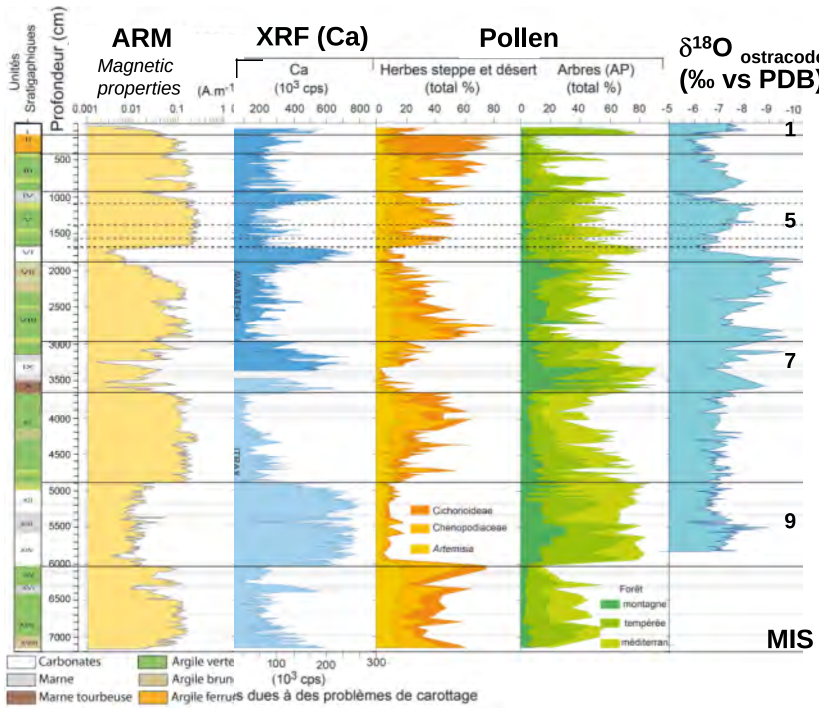
Steep N/S and E/W climatic gradients: an area sensitive to water resource

Climate archives

Yammouneh sediment core (73 m)



Multi-proxy results from the Yammouneh basin core



A paleoclimatic approach to obtain information about spatial and temporal variability of local hydrological cycle (wet vs dry climate, variability relation with glacial and interglacial periods)

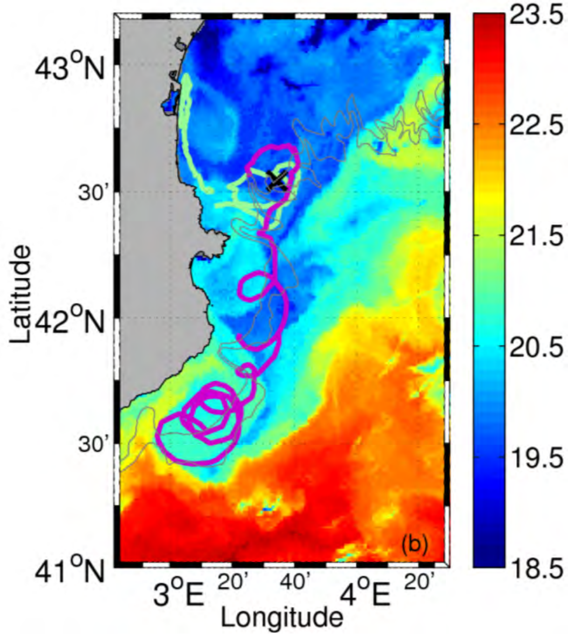
L Vidal, PI program Insu Paleoliban, CEREGE

Time scale of observation: short term variability, including extreme / episodic events

- ✓ heat waves,
- ✓ river floods,
- ✓ Forest fires
- ✓ extreme events of atmospheric deposition,
- ✓ NW Med sea (cascading, mescoscale circulation,

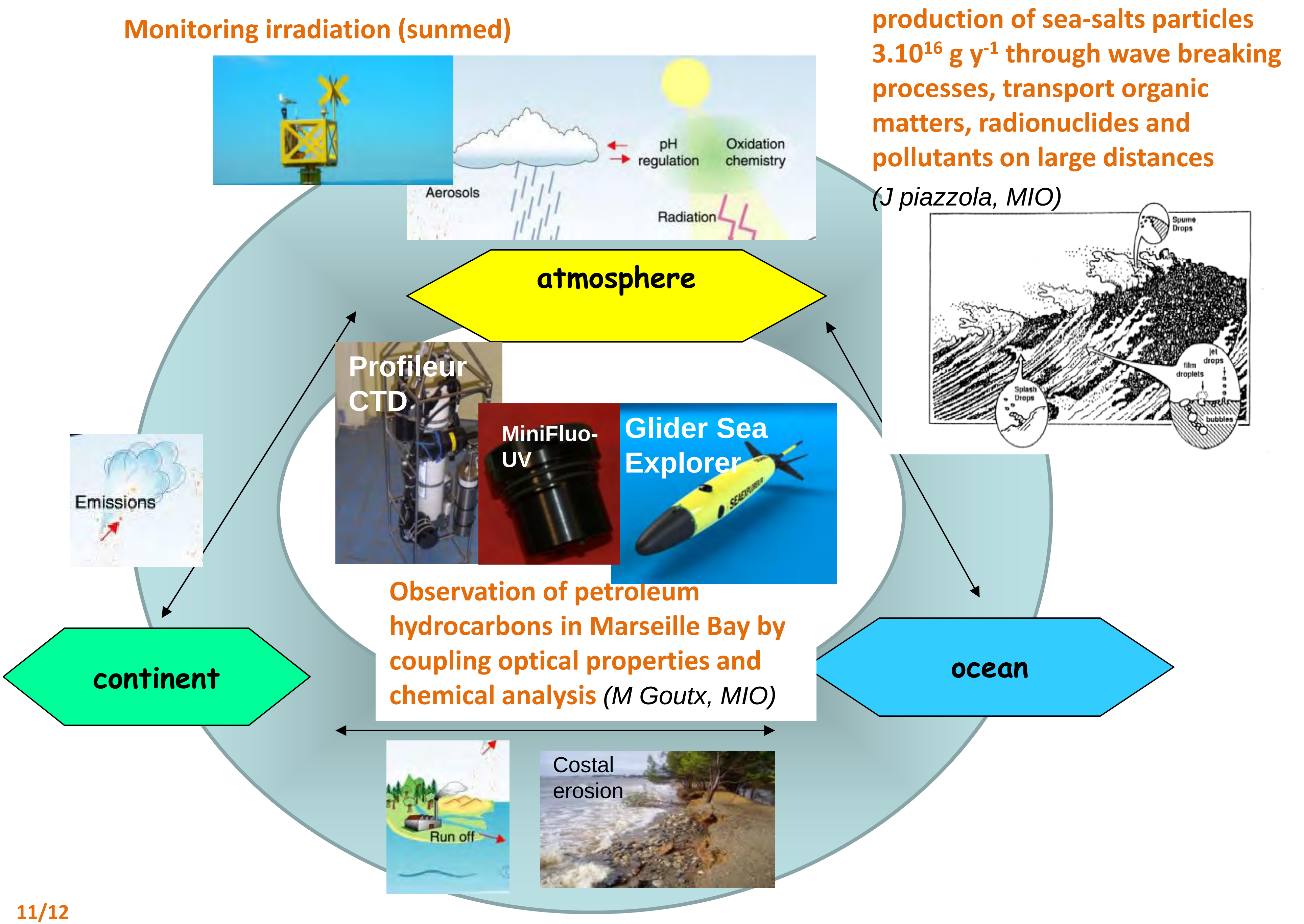
huge Greece forest fires in Aug 2007 impacting whole Ionian Sea, coincident with a Saharian dust event

exchanges between Gulf of Lion and Catalan shelf



Rhône river flood in Camargue, Dec 2005

Labs MIO, CEREGE, IRSTEA, IMBE…
programs MISTRALS (Mermex, Charmex), Latex…


Monitoring irradiation (sunmed)
pH regulation
Oxidation chemistry
Aerosols
Radiation
production of sea-salts particles 3.10^{16} g y^{-1} through wave breaking processes, transport organic matters, radionuclides and pollutants on large distances
(J piazzola, MIO)
Spume Drops
Splash Drops
film droplets
jet drops
bubbles
atmosphere
Profileur CTD
MiniFluo-UV
Glider Sea Explorer
Emissions
Observation of petroleum hydrocarbons in Marseille Bay by coupling optical properties and chemical analysis (M Goutx, MIO)
continent
ocean
Run off
Costal erosion

Laboratories involved

CEREGE (AMU, CNRS-INSU, IRD, Collège de Fr.), MIO (AMU, Univ-Toulon-Var CNRS-INSU, IRD), IRSTEA, DESMID, IMBE (AMU, CNRS-INEE, IRD), ECCOREV…

Programs & Partners

MISTRALS (Hymex, Charmex, Mermex, Termex), MOOSE, LATEX, FUME, Equipex ASTER, PALEOMEX, PALEOLIBAN

Collège de France, CEA, IRSN, BRGM, INERIS, IFREMER, Pole Mer, Pole Risque,

Univ Sfax, Univ Bizerte, Libanes National Centre of Geophysics, Iranian Nati. Inst. Ocean, Geological Survey of Iran, Teheran Univ., Univ Marrakech…