MERMEX: Marine Ecosystems Response in the Mediterranean Experiment (https://mermex.com.univ-mrs.fr/)

Response of the Med. Ecosystems to global change including temperature increase and anthropogenic pressure (contaminants). This project (2010-2020), belongs to the CNRS/INSU 'ECOMED Project' which comprises atmospheric chemistry (Charmex), hydrometeorology (HYMEX), Biodiversity (Biodivmex)…

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B. Charrière, J.L. Fuda, W. Ludwig, M. Mallet, A. Monaco, P. Raimbault as well as..

MerMex group in 2008

MERMEX currently includes more than 15 french laboratories and more than 500 scientists

MERMEX will be the main french oceanographic programme for 2010-2020

It will be supported by France (CNRS, INSU, IFREMER, IRD, Universities)

One MERMEX duty is to seek for collaborations in UE and country from southern Med. Sea

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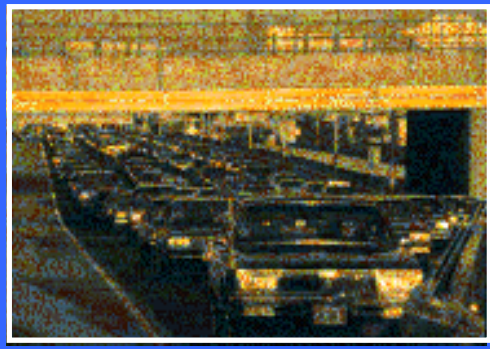
The modern anthropic pressure in the Mediterranean basin



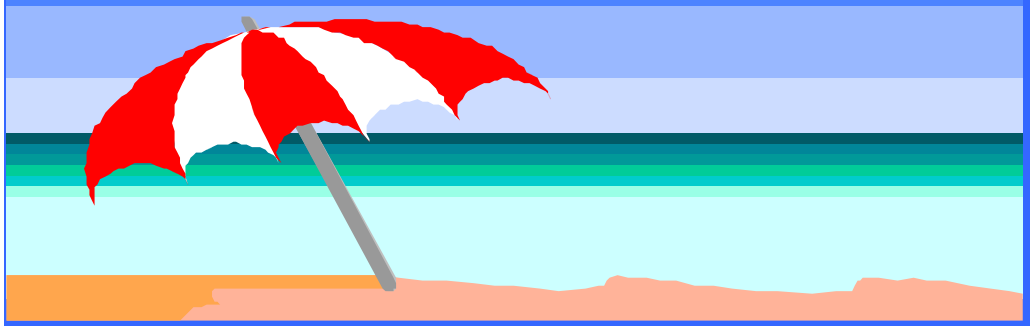
Citizens:

450 millions in 2000 -> 550 millions in 2025

Tourists:

158 millions in 1996 (1/4 of world' tourism!!)

----> 300 millions in 2025



==> **Eutrophication**

==> **River dams**

==> **Pollution :** metals, oil (1 million tons/year - i.e. 20% of the global oil pollution in the world' oceans)

Mediterranean Margins

Semi-enclosed basin (2.5 millions km^2), short residence time of water,
Averaged depth : 2200 m. Deep water temperature > 12°C

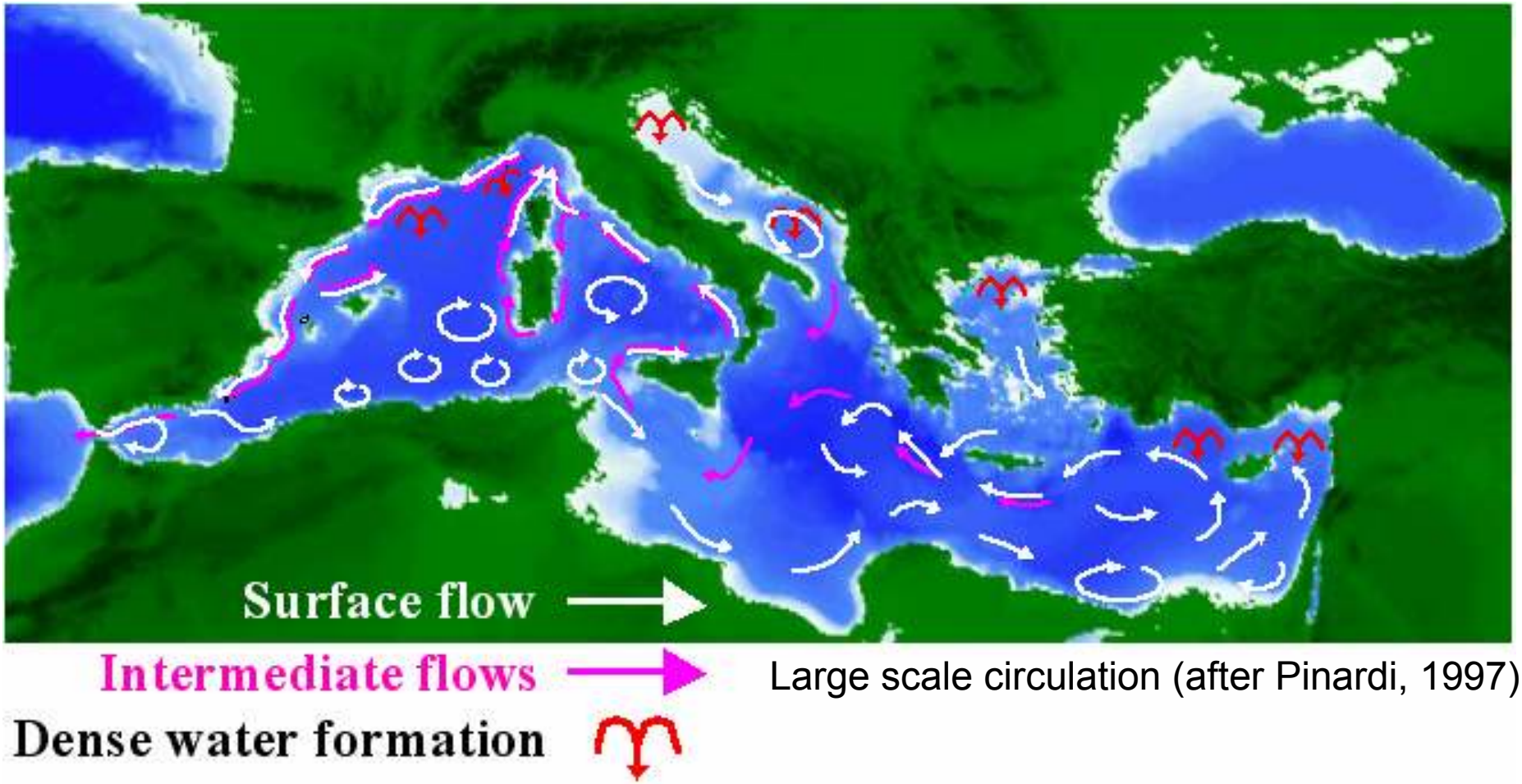
Surrounded by Major rivers and margins

Oceanic circulation

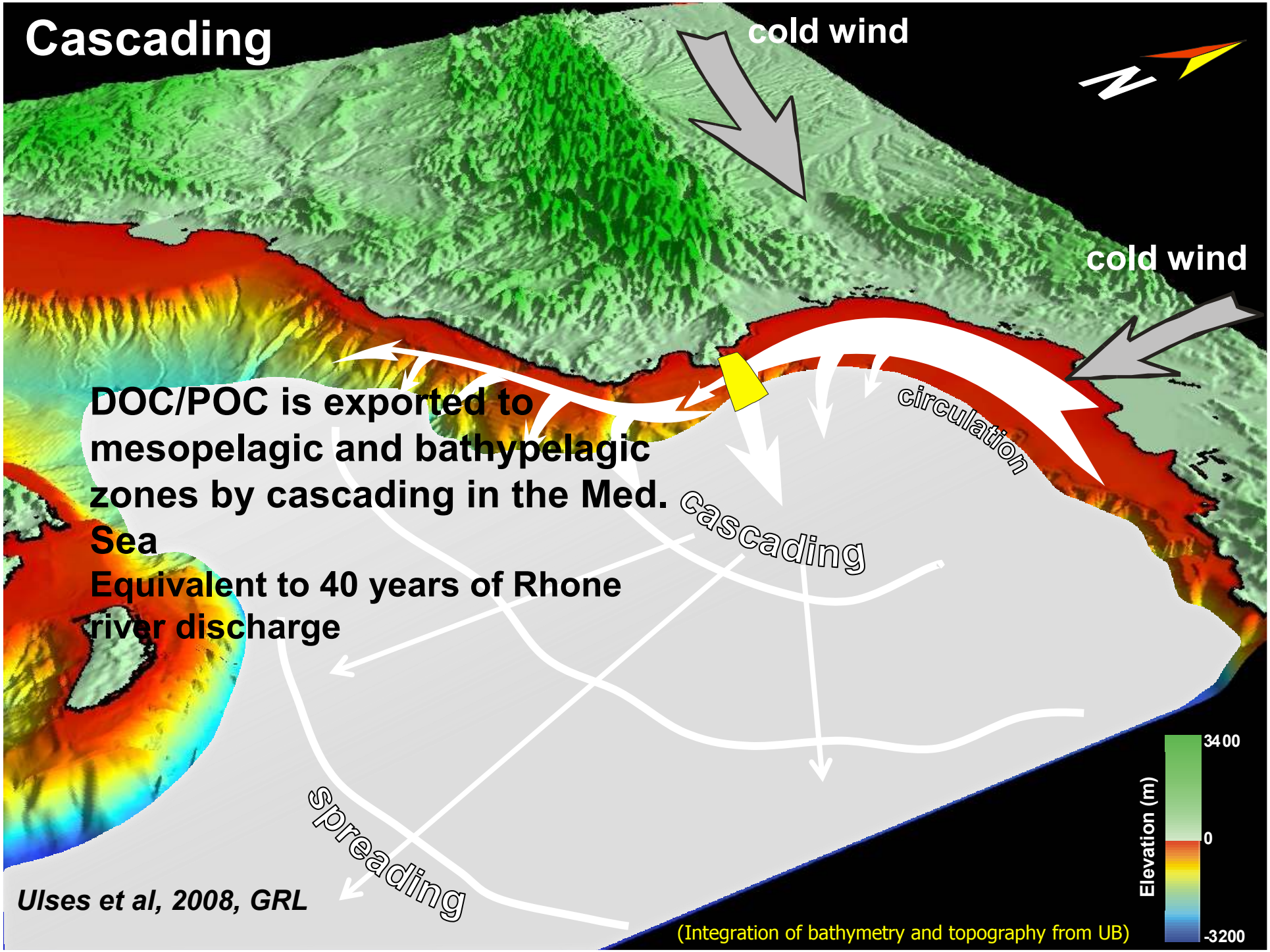
There is a system of "Conveyor Belt" similar to those of the global ocean. The drivers of the thermohaline circulation are

(1) the difference of density between Atlantic Ocean and the salty Med Sea

(2) the surface water convection (Gulf of Lion, Adriatic, Cretan basin)



Large scale circulation (after Pinardi, 1997)


Cascading
cold wind
cold wind
N
DOC/POC is exported to mesopelagic and bathypelagic zones by cascading in the Med. Sea
Equivalent to 40 years of Rhone river discharge
circulation
cascading
spreading
Ulses et al, 2008, GRL
(Integration of bathymetry and topography from UB)
Elevation (m)
3400
0
-3200

Possible change that may affect winter convection in open Mediterranean Sea

A climate change run with an atmosphere regional climate model was used to force a Mediterranean Sea high-resolution ocean model over the 1960–2099 period.

→ **IPCCA2-scenario : Surface T** (+3.1°C **) and S (**+ 0.48 psu**)** are simulated at the end of the 21st century and for the deeper layers (T : +1.5°C and S : + 0.23 psu, av.).

Possibility of decrease of surface density and winter deep-water formation.

At the end of the 21st century, **the Mediterranean thermohaline circulation (MTHC) weakening can be evaluated as −40% for the intermediate waters and −80% for the deep circulation with respect to present-climate conditions**

Change in DOM/POM export in the mesopelagic waters of the Med Sea? Less DOM in mesopelagic waters, less sequestration…

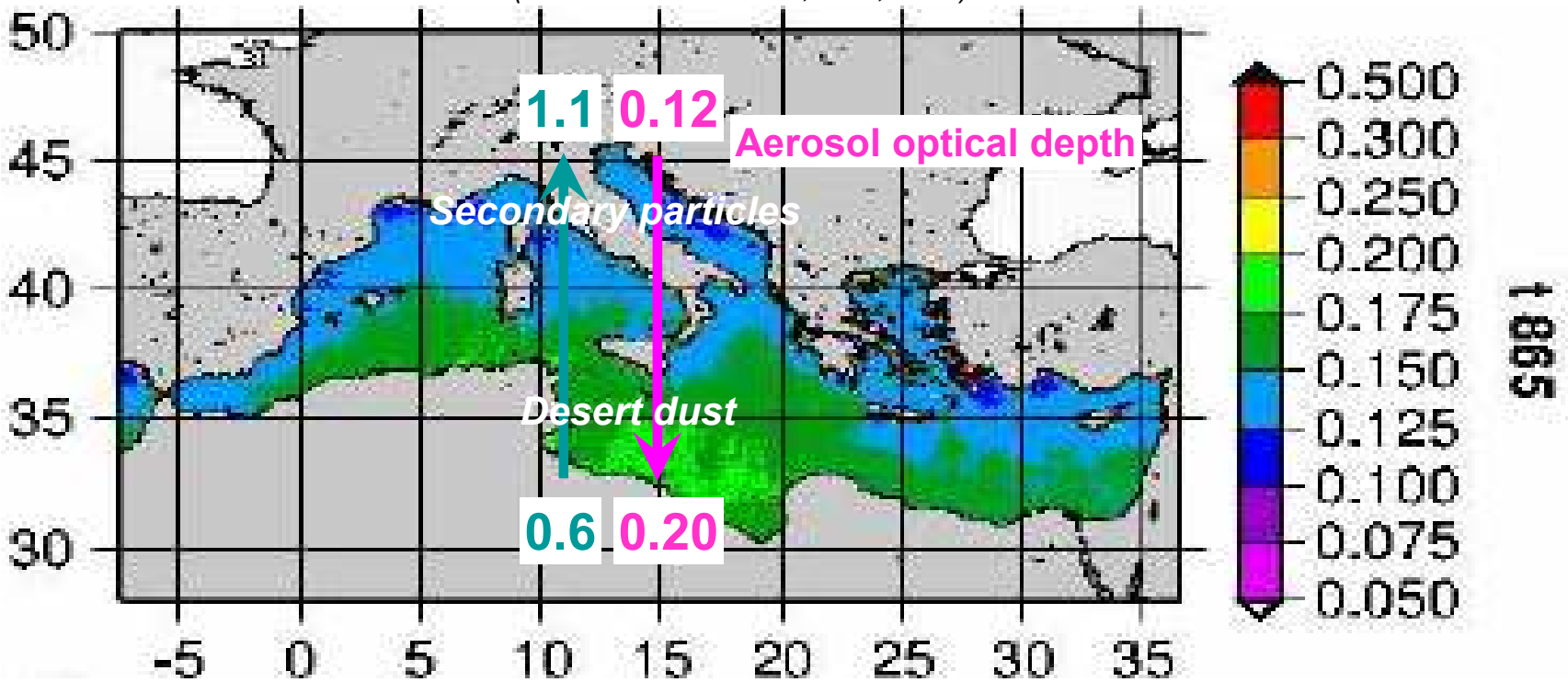
Somot et al.Clim. Dyn. (2006)

The Mediterranean atmosphere

- ⇨ Intense solar radiation
- ⇨ Aerosol climatologies at the basin scale from Meteorological satellites
  (Moulin et al., JGR, 1998)

1998-2003 average of SeaWiFS-derived aerosol optical depth at 865 nm

(Antoine and Nobileau, JGR, 2006)



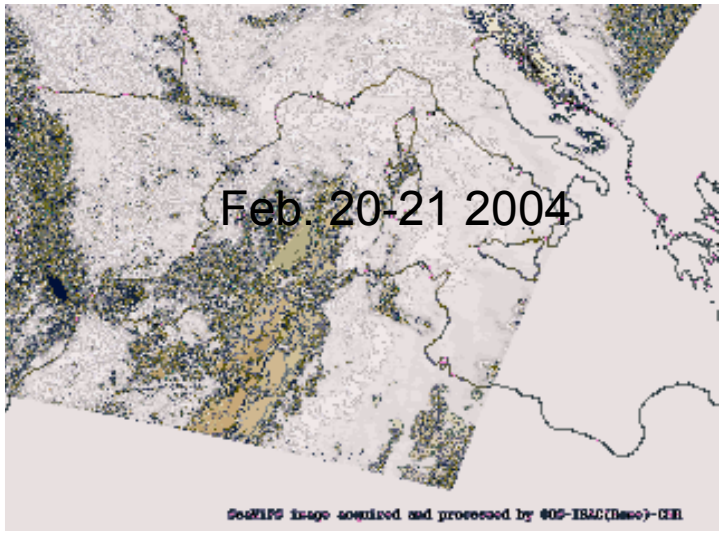
- ⇨ African dust is dominant

Occurrence of extremes atmospheric events in the Med Sea

2 examples

Saharan Dust event

ex. event in western Med.: dust input to the surface waters may reach **50 tons of dust km^{-2} within 2 days**



Biomass burning

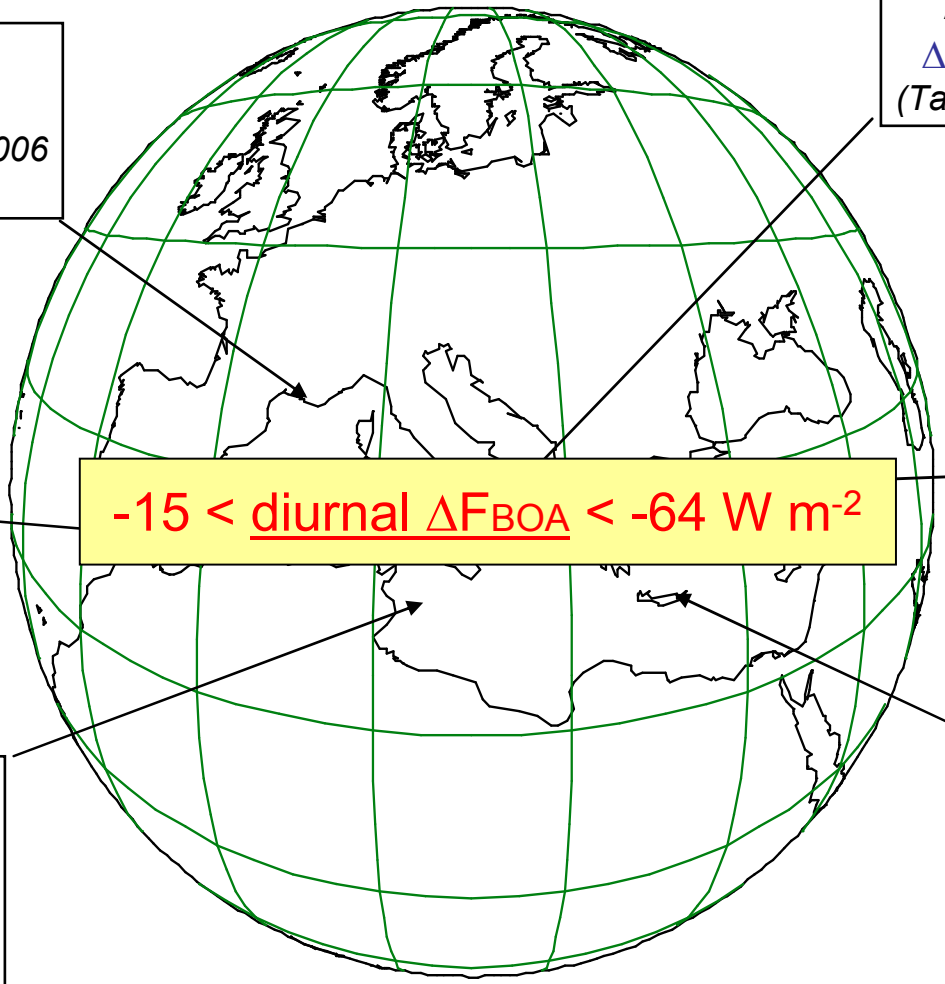
ex. in Greece in August 2007: several weeks of emissions and inputs to the surface waters

Due to increasing demographic pressure, these events are expected to increase: what will be the **impact on the biogeochemistry of the Med Sea?**

Recently, the occurrence of Saharan events with extremely strong fluxes (>20 t.km-2.event-1) was significantly higher than in the 90's: **how those high inputs of new phosphorus will impact New Production, in particular from diazotrophs?**

Aerosols may impact the solar radiation budget

Aerosol may significantly decrease the solar radiation at the Med. Sea surface



Aerosol pollution
ΔF_{BOA} ~ -34 W m^{-2}
(Mallet et al, Atmos. Env., 2006
Roger et al., JGR, 2006)

Aerosol pollution
ΔF_{BOA} ~ -15 W m^{-2}
(Tafuro et al., JGR, 2007)

Aerosol pollution
ΔF_{BOA} ~ -23 W m^{-2}
(Horvath et al., JGR, 2002)

-15 < diurnal ΔF_{BOA} < -64 W m^{-2}

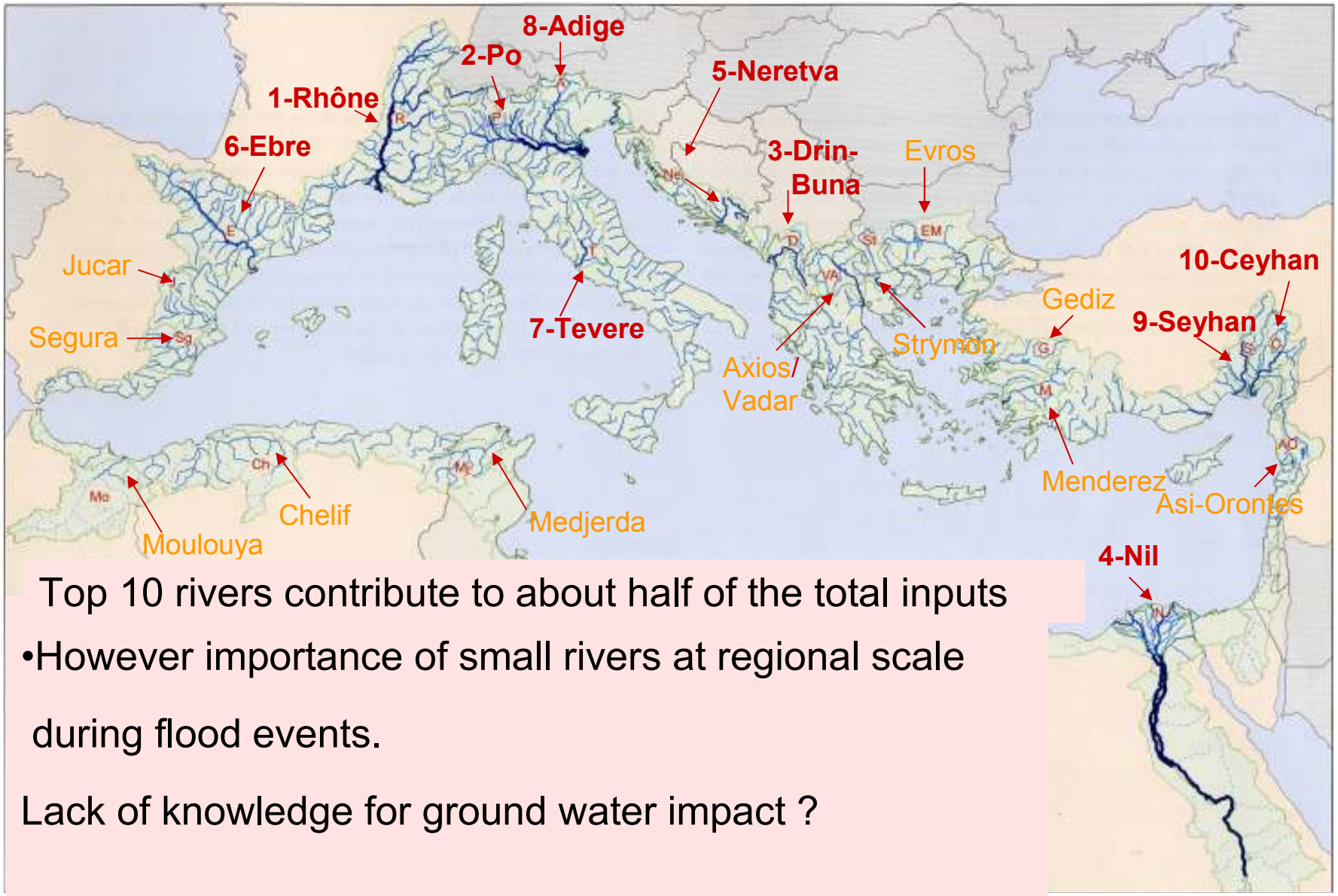
Aged biomass burning
ΔF_{BOA} ~ -64 W m^{-2}
(Formenti et al, JGR, 2002)

Desert dust
ΔF_{BOA} ~ -37 W m^{-2}
Pollution aerosol
ΔF_{BOA} ~ -20 W m^{-2}
(Meloni et al, JGR, 2003)

Anthropogenic
ΔF_{BOA} ~ -18 W m^{-2}
(Markowicz et al, GRL, 2002)

Mallet et al., Charmex workshop, 29-31 January 08

Major rivers of the Mediterranean



Top 10 rivers contribute to about half of the total inputs

- However importance of small rivers at regional scale during flood events.

Lack of knowledge for ground water impact ?

Source : Margat, 2004

Long term change of water discharges

Code bassin[1]	Fleuve	Pays	Station	Superficie (km^2)	Période		Moyenne Q		Changem. Q
					début	fin	(m^3/s)	Ref.	(%)
NWE	Rhône	France	Beaucaire	95590	1920	1999	1706	[3]	--[2]
NWE	Têt	France	Vinça	930	1935	2000	10	[4]	56.8
NWE	Ebre	Espagne	Tortosa	84230	1914	1999	459	[3]	-47.3
Mer Noire	Danube	Roumanie	Tulcea Ceatal Izmail	807000	1921	2000	6413	[3]	--
ADR	Adige	Italie	Boara Pisani	11954	1922	1980	226	[5]	-35.8
ADR	Pô	Italie	Pontelagoscuro	70091	1919	1996	1514	[3]	--
NWE	Arno	Italie	San Giovanni	8190	1924	1995	91	[3]	-39.2
ADR	Pescara	Italie	Santa Theresa	3130	1939	1999	50	[3]	-34.7
TYR	Tibre	Italie	Ripetta	16500	1921	1997	223	[3]	-21.6
ADR	Ofanto	Italie	S. Samuele di Cafiero	2720	1930	1999	13	[3]	-43.4
TYR	Medjerda	Tunisie	Ghardimaou	1490	1950	1995	5	[5]	-55.6
SLE	Nil	Egypte	Assouan		1871	1984	2744	[5]	-40.3

Decreasing fluxes (20-50%) for most rivers…

Source : Ludwig et al., 2003

Long term change of water discharges

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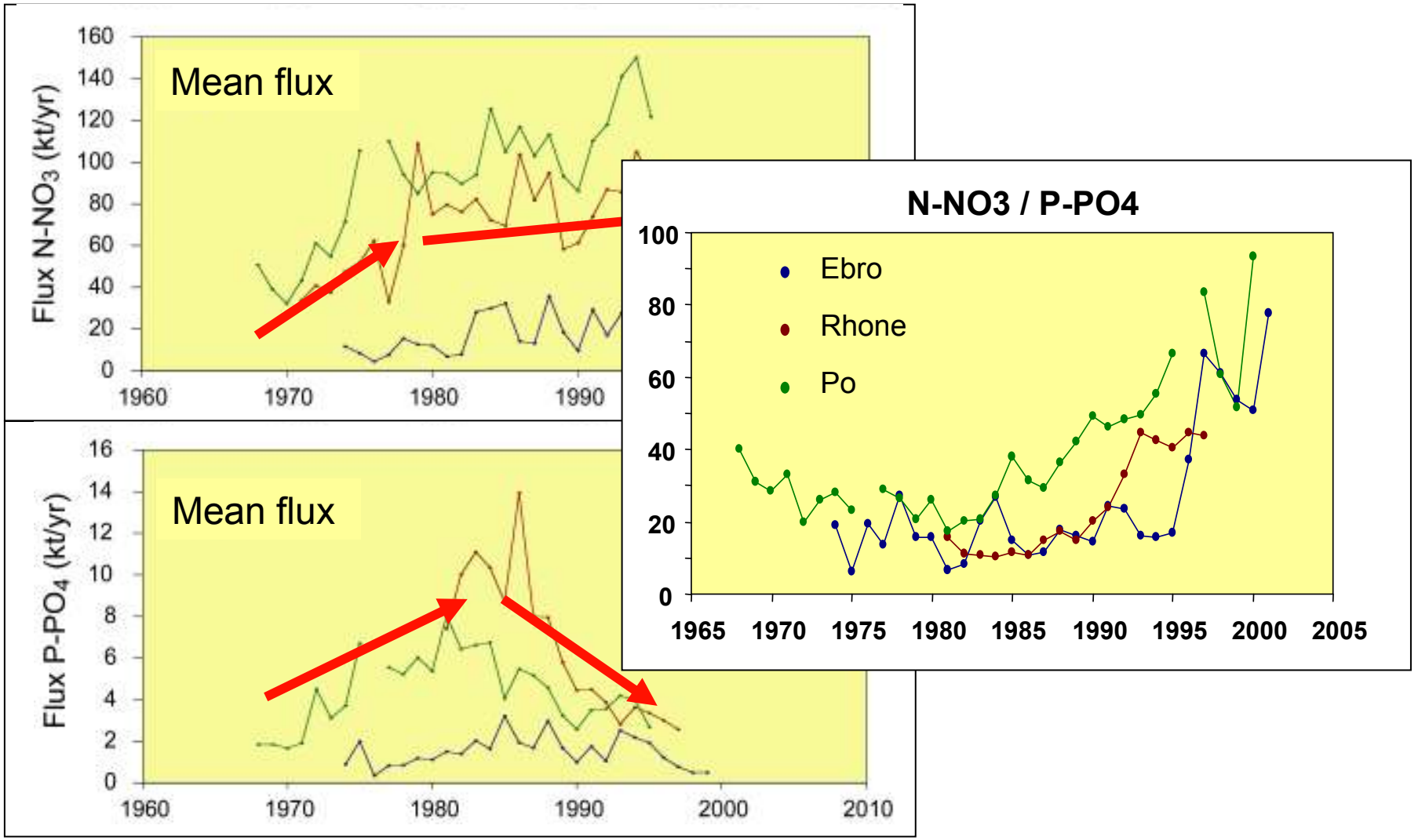
except for the largest ones

Source : Ludwig et al., 2003

Change in nutrient fluxes in large mediterranean rivers



Nutrients discharges directly linked to human activities; change of their fluxes and stochiometry likely to affect coastal ecosystems

Main scientific questions in MERMEX

→Redaction of a White book (article that will be submitted to a peer review journal)

Forcing

Physical

Chemical and socio-economic

What will be the marine Med ecosystem response to the changes of :

1. The hydrodynamic regime (winter convection, cascading, large cold wind episods)
2. The intensity of the extreme events (disastrous river floods, storms, dusts from sahara)
3. The température, acidification (calcification, mineralization, CO2 equilibrium)
4. The solar radiation (primary production, surface water photochemistry, degradation processes)
5. The stoechiometric ratios of bio reactive elements
6. The chemical contaminants
7. Overfishing, invasive species …

Budget

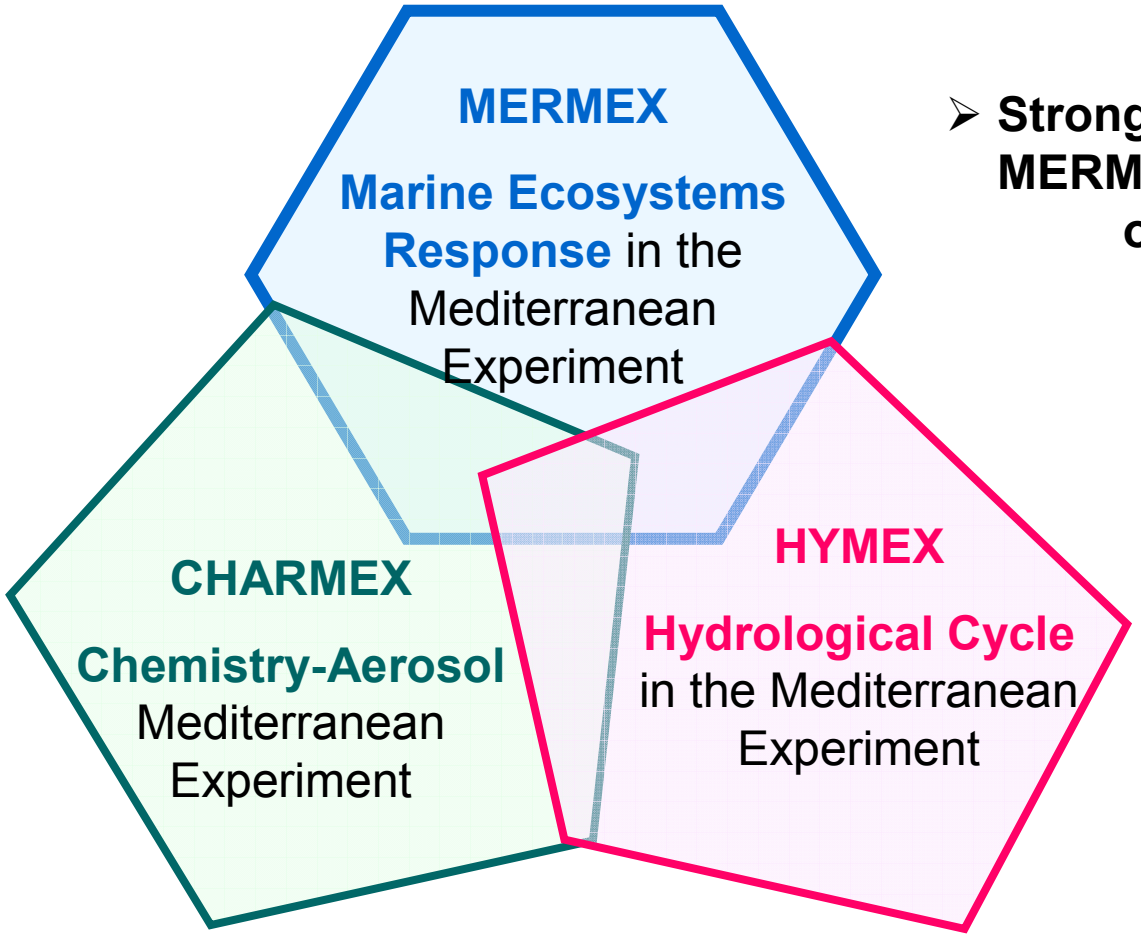
Functioning and structure of end to end ecosystems

?

Overlap with others programmes

10 years?...

Med Sea programme



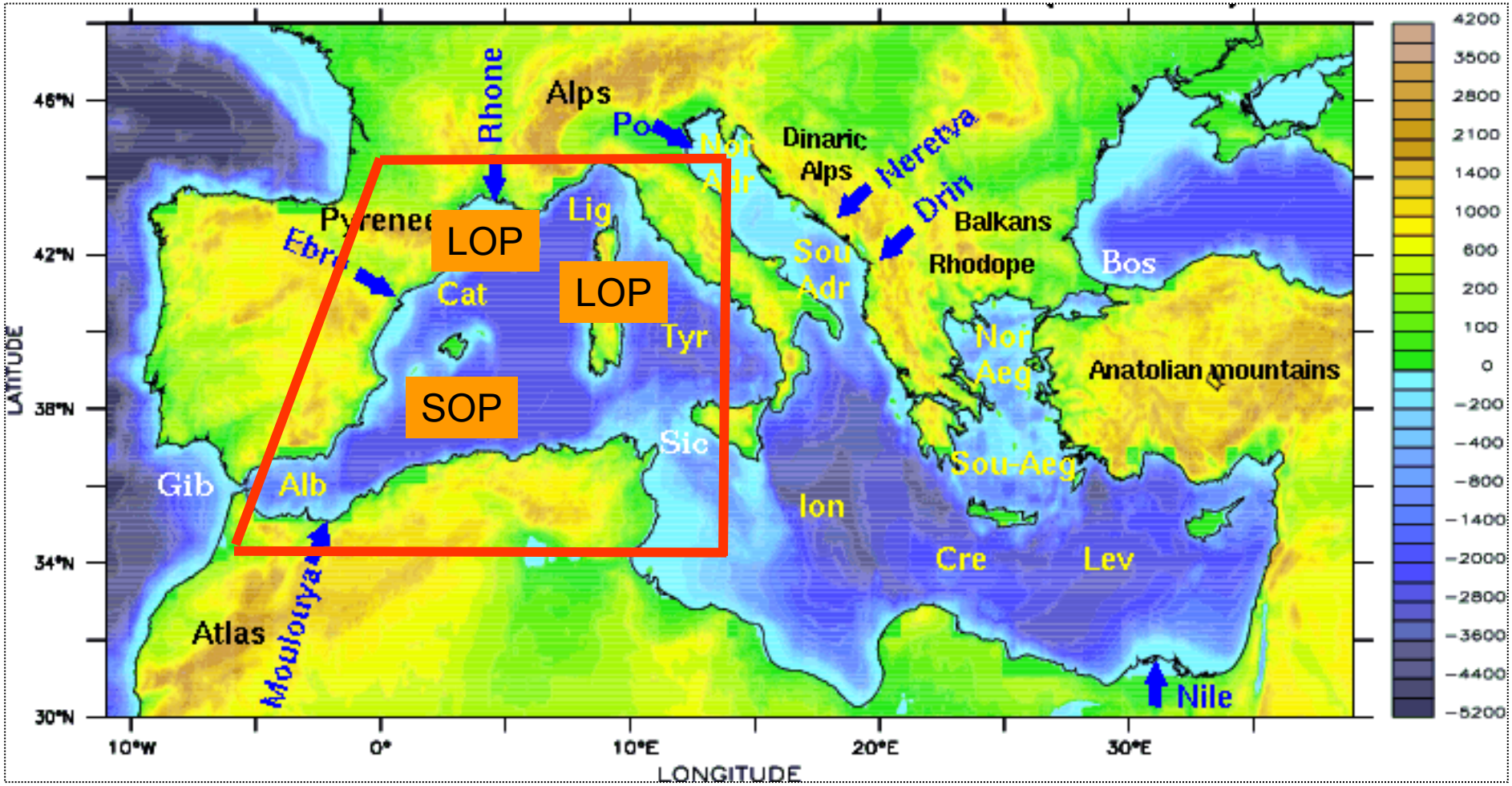
- Strong collaboration between MERMEX and the new French observation programme
- MOOSE

MOOSE

- Establish connexions with other european programmes to contribute to cover the whole Med Sea and to fuel global Med models

STRATEGY of MERMEX : OBSERVATION - EXPERIMENTATION AND MODELLING

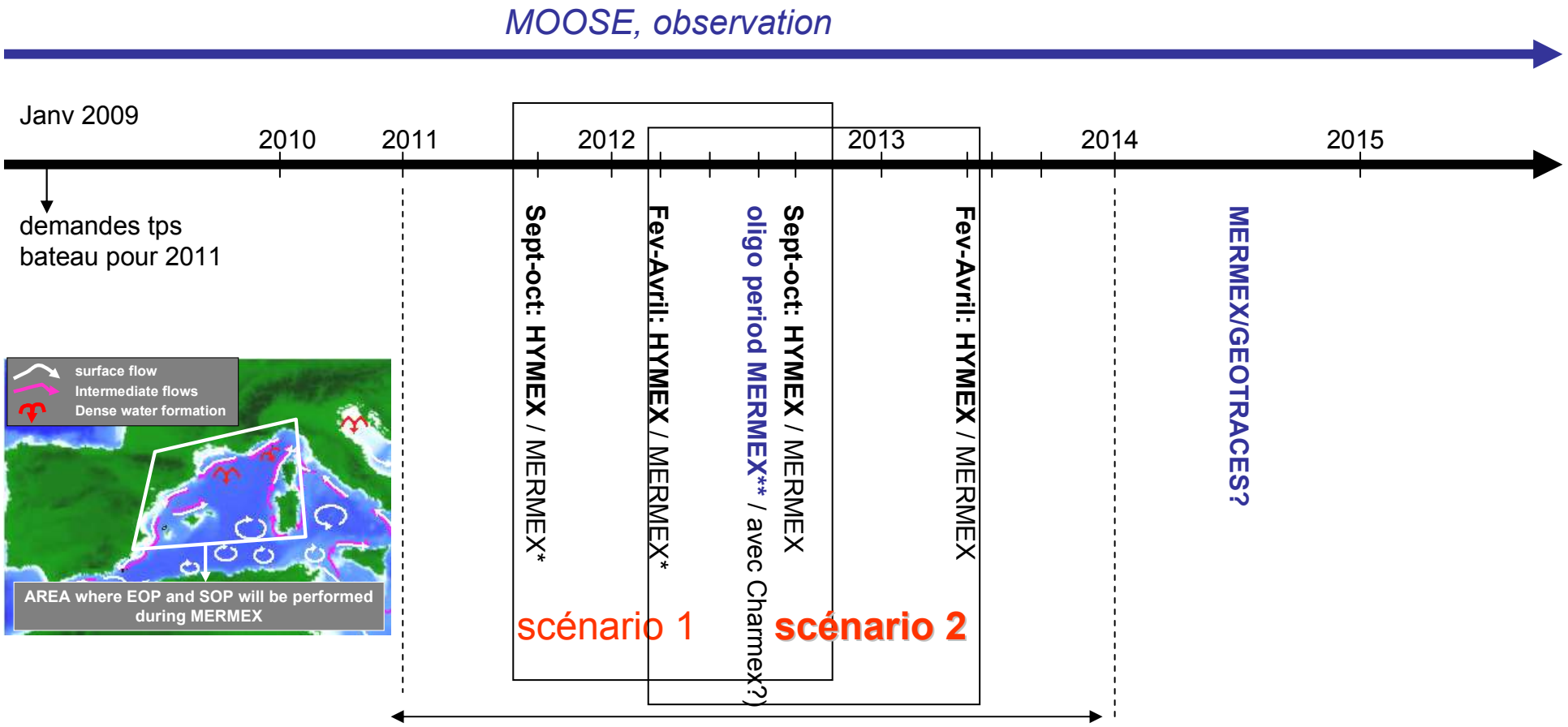
MERMEX will concentrate in W. Mediterranean including french coastal areas (Gulf of Lions) as well as in the central area of the western Med Sea. Collaborations need to be established with other Mediterranean partners for studying the entrance of the system.



Possible MerMEx experimental strategy

- **2009 : White book in progress**
- **2009: Establish relatioships with other Med countries**
- **2009 : Implementation plan**
- **2010: Preliminary studies**
  - modelling, time series data analyses, field sites evaluation, instrumental development and testing, laboratory experiments.
- **2010: set-up of continuous coastal stations (buoys) for observation**
  - Super-sites
    - LOP (long-term obs. with automated measurements):

    > 10 years
- **From 2011-2012: intensive summer field campaigns (SOP)**
  - Oceanographic cruises….

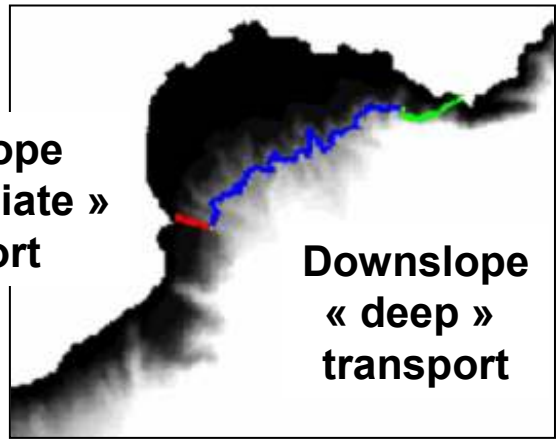


+ EOP (3 ans): atmosphérique (Charmex) + Fleuves + ground waters (Mermex + MOOSE)+ rejets urbains (Mermex + Hymex, SHS?...)

•campagnes prévues par HYMEX auxquelles pourraient être associé la biogéochimie (sans étude de processus)

•**campagnes typiquement MERMEX/ même zone d'étude: l'ensemble de la NW-Med

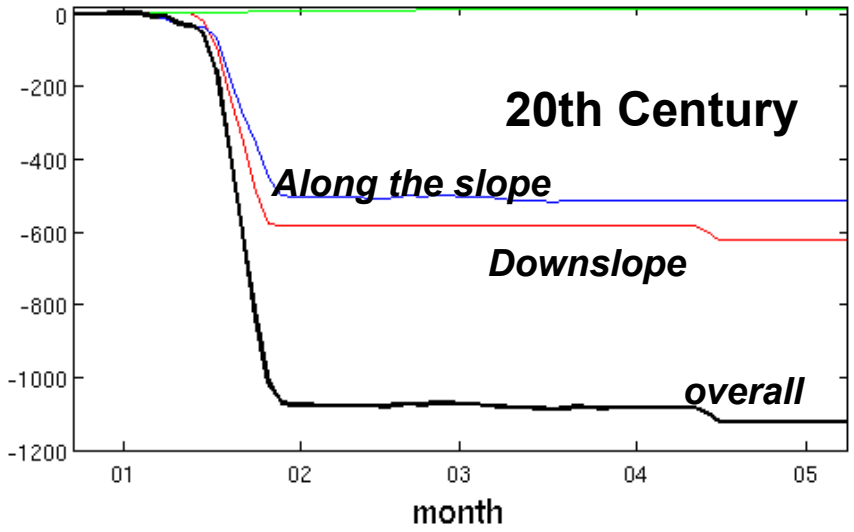
Impact of Climate Change (IPCC-A2 Scenario) on cascading and mesopelagic biogeochemistry

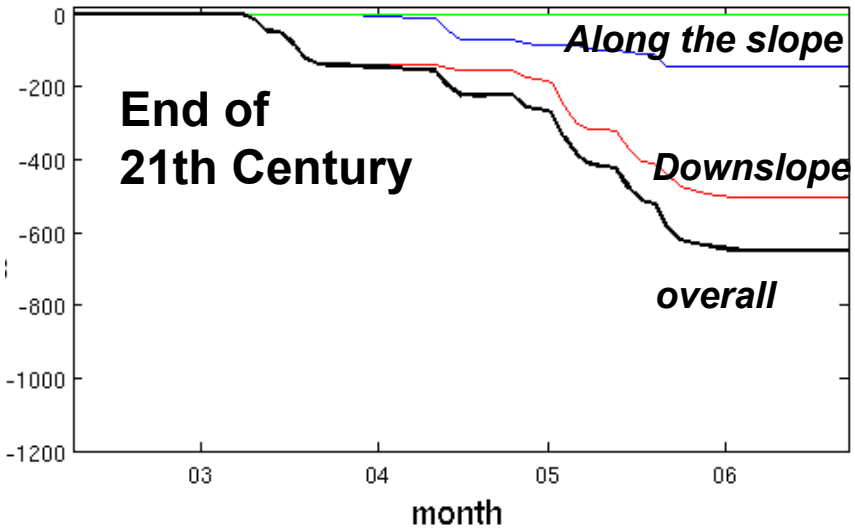


A2-warming gives rise to decrease of dense water formation rate and deep export

Consequences on mesopelagic Biogeochemistry ?

Export of shelf water (km^3)





Hermann et al, 2008, CSR