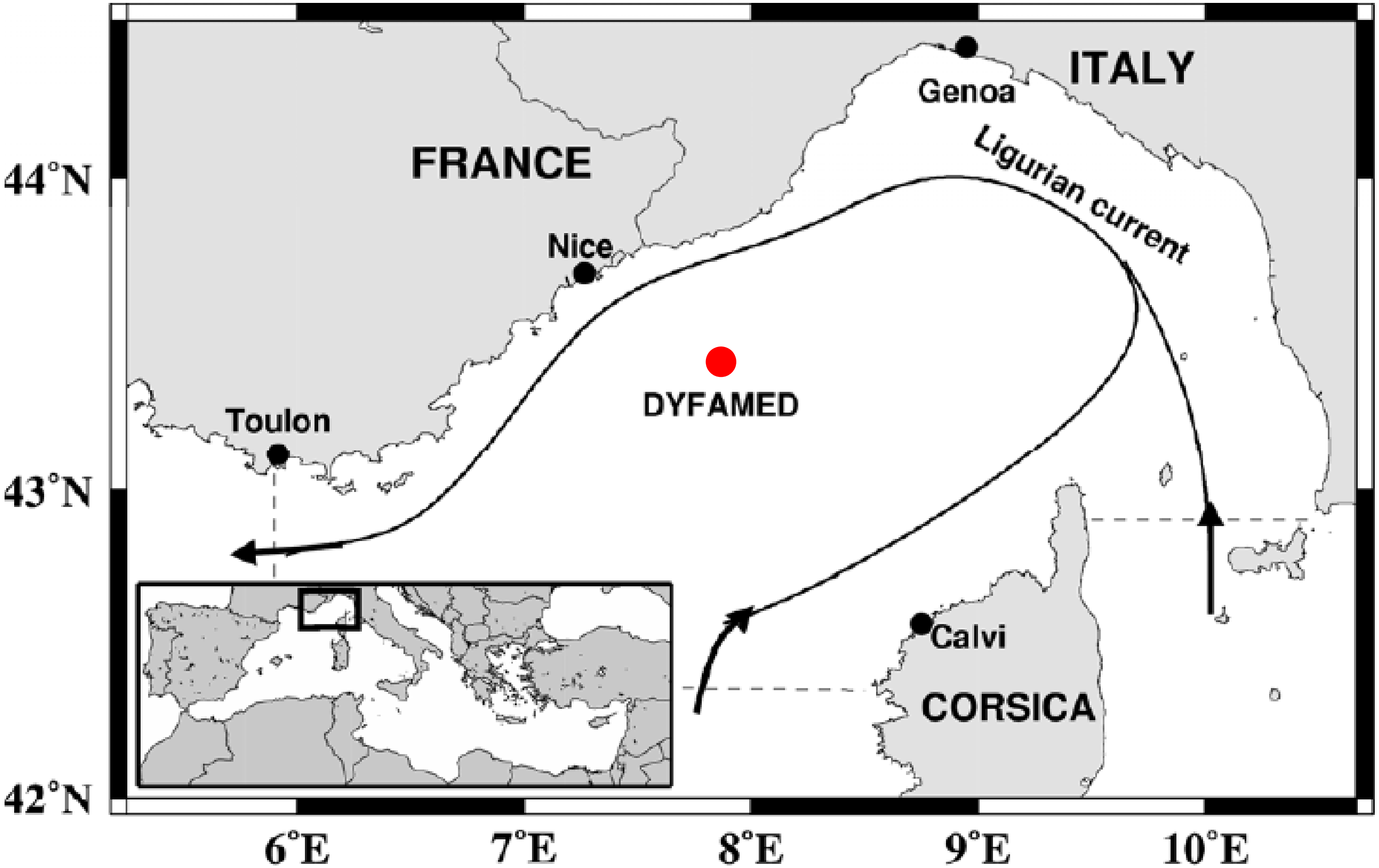
# Seasonal and interannual patterns of 1000m depth trace metal fluxes at the DYFAMED time-series station (Ligurian Sea)

**Christophe MIGON**, Lars-Eric HEIMBÜRGER, Rémi LOSNO and Juan-Carlos MIQUEL

migon@obs-vlfr.fr

COMET = COnstructing MEditerranean Time-series (*LEFE - INSU*)

CIESM 2010




The DYFAMED site is assumed 1D: Apart from exceptional conditions (extreme hydrodynamics and/or coastal emissions), the DYFAMED site is sheltered from lateral inputs (*Béthoux et al., 1988; Lévy et al., 1998*).

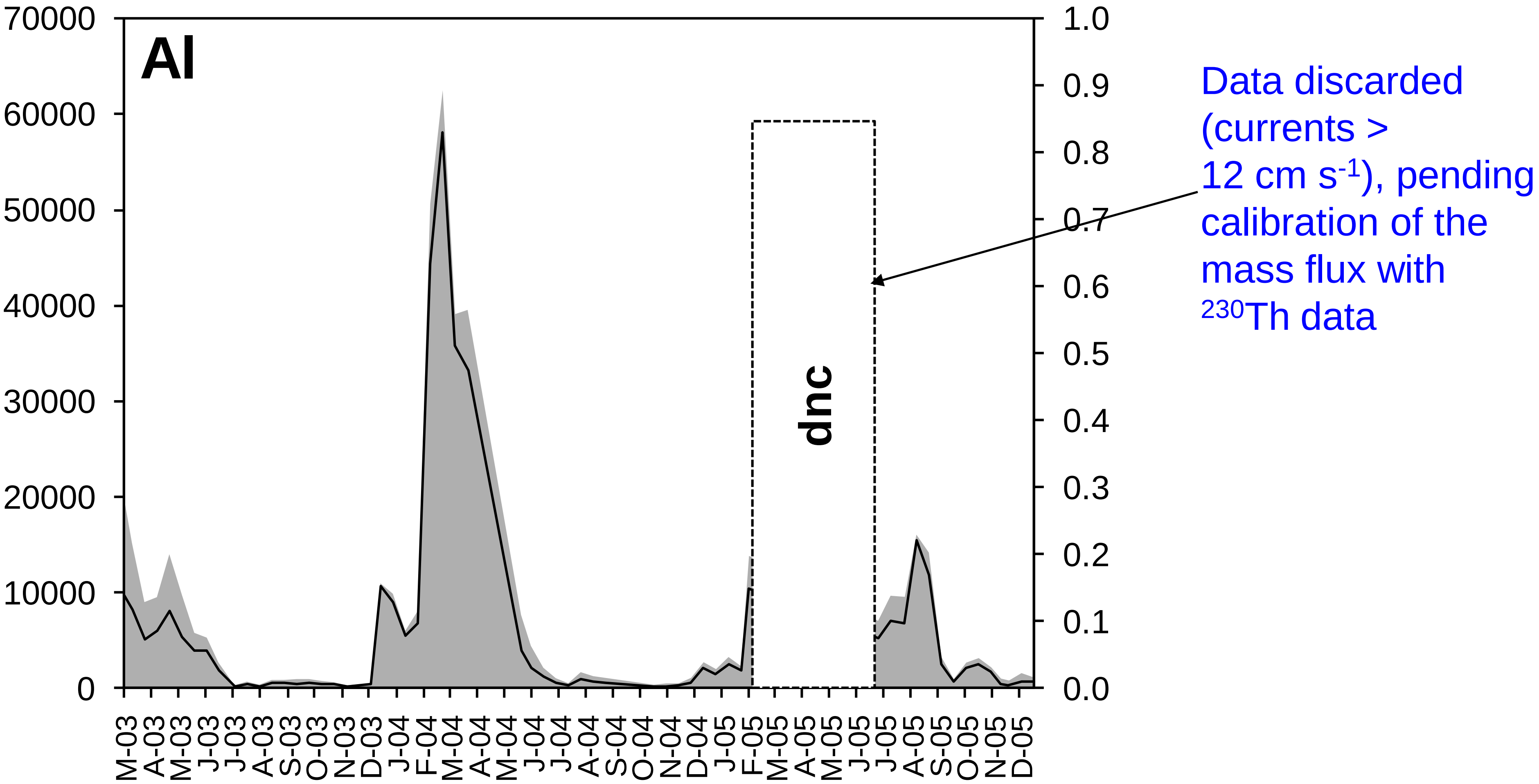
➔ The atmosphere is believed the only significant source of TMs to the open Ligurian Sea.

CIESM 2010

Automated time-series sediment traps were moored at the DYFAMED site. Conical sediment traps (Technicap PPS 5, height 2.3 m, collection area 1 $m^2$) were equipped with a programmable 24-cup collector.

CIESM 2010

## TM flux (black line, µg $m^{-2}$ $d^{-1}$) and Mass flux (grey, g $m^{-2}$ $d^{-1}$)



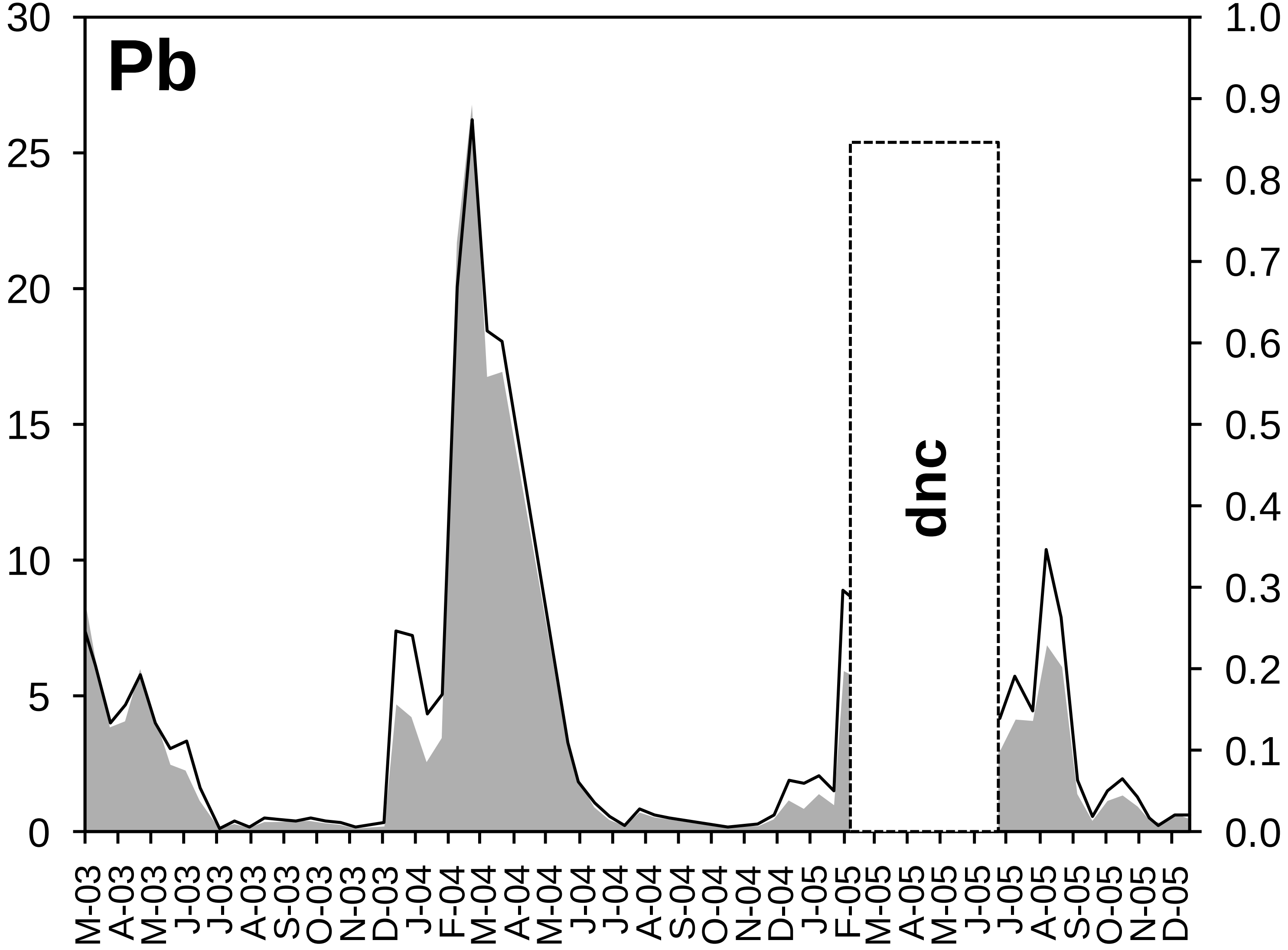

January-February: dense water formation ➔ convection. Vertical mixing driven by cooling and/or increase of salinity of surface waters (wind) carries dissolved and particulate matter, including TMs, to depths (“flush down” effect)

March to June: Spring phytoplankton bloom drives the vertical transfer of TMs

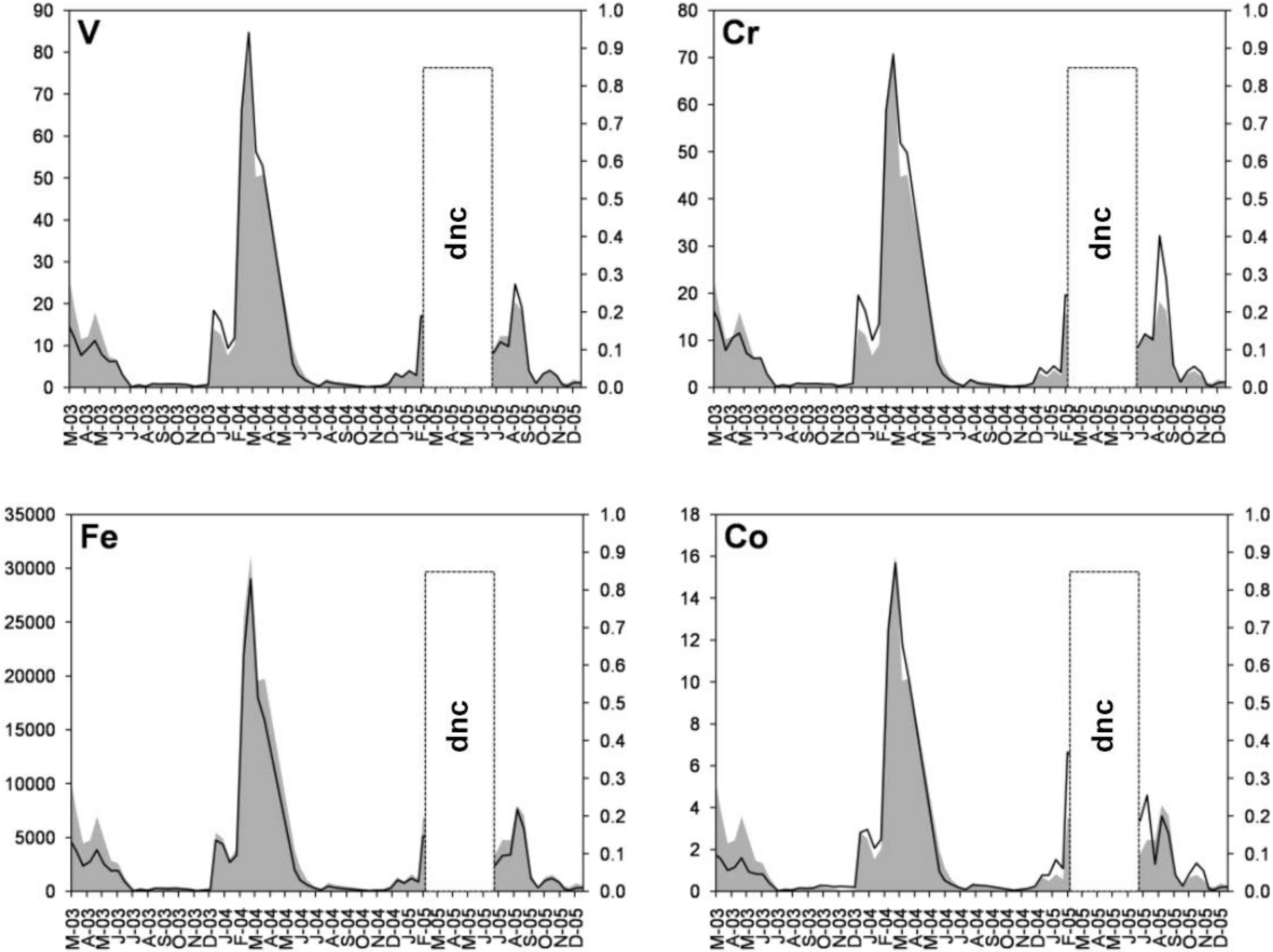
Oligotrophic season: Very low transfer, due to lower biological activity

CIESM 2010

**Outstanding feature: the strong covariance observed between the mass flux and the TM flux, whatever the nature of the TM**




**Pb: Exactly the same seasonal pattern as Al**


V
dnc
Cr
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Fe
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Co
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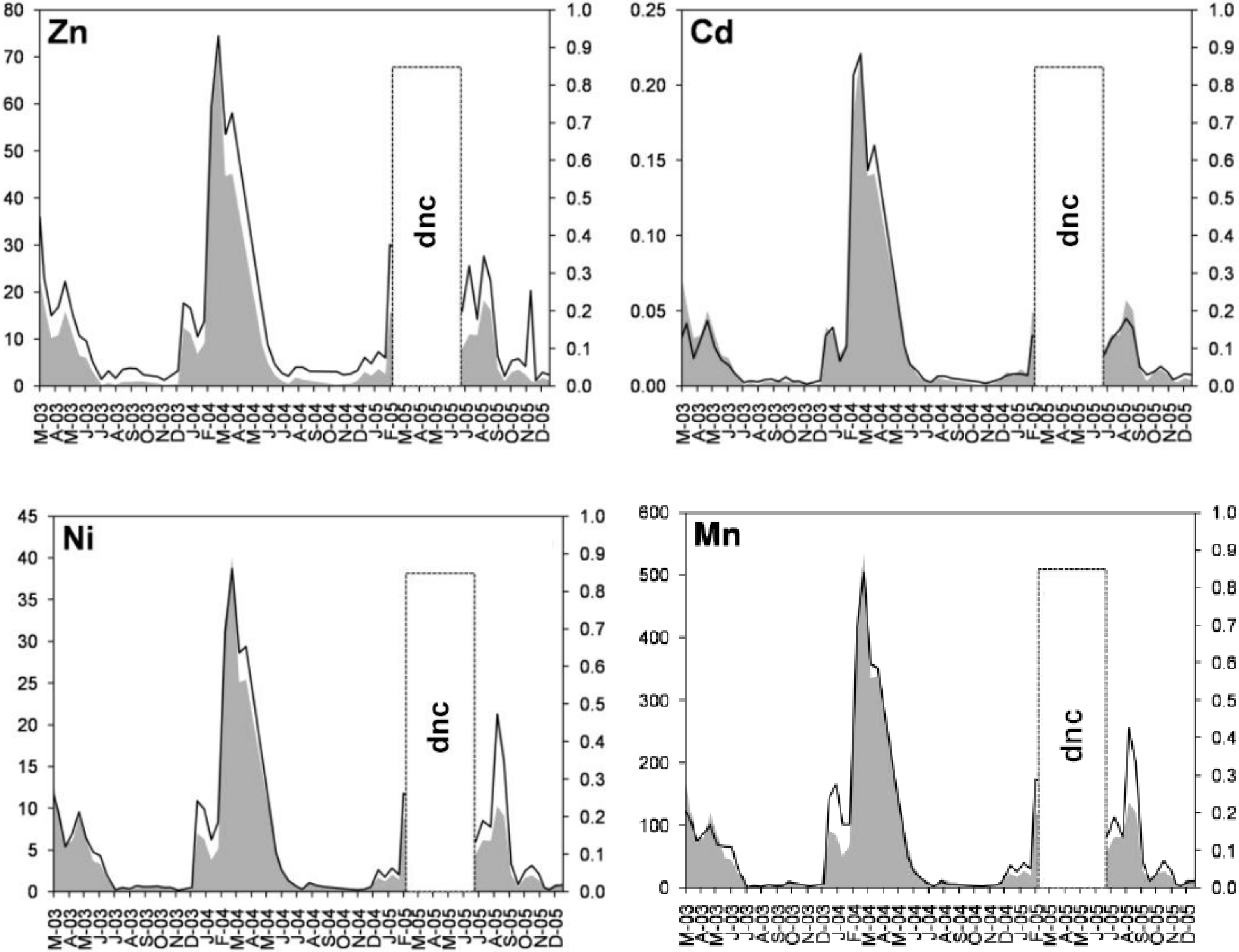
Zn
Cd
Ni
Mn
dnc
dnc
dnc
dnc
0 10 20 30 40 50 60 70 80
0.00 0.05 0.10 0.15 0.20 0.25
0 5 10 15 20 25 30 35 40 45
0 100 200 300 400 500 600
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0
M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03 J-04 F-04 M-04 A-04 M-04 J-04 J-04 A-04 S-04 O-04 N-04 D-04 J-05 F-05 M-05 A-05 M-05 J-05 J-05 A-05 S-05 O-05 N-05 D-05

CIESM 2010

● Fluxes of a wide variety of TMs (e.g., anthropogenic such as Zn, Cd, Pb, … or crustal such as Al, Fe, Co, … i.e. TMs of which atmospheric deposition to the sea surface varies with different seasonal patterns) exhibit in every case the same temporal variability.

● All TMs, whether of crustal or anthropogenic origin, are strongly and significantly ($p < 0.0001$) intercorrelated, which suggests that all TMs are driven to depths at the same time and, therefore, gathered into the mass flux.

● Saharan dust episodes that were observed apart from periods of winter convection or spring bloom did not yield any significant vertical fluxes: dust particles supposedly accumulated above the thermocline.
The same applies to strong anthropogenic episodes.

➔ We conclude the temporal variability of atmospherically derived TM fluxes is an effect, instead of a cause, of mass vertical transfer.
*(This is not inconsistent with mineral ballasting)*
As a result, mass fluxes control the temporal variability of TM removal from surface waters.

# Tentative summary

- Hydrodynamical features of Mediterranean regions of dense water formation (e.g., the Ligurian Sea) are strongly constrained by climatic and meteorological conditions (winter temperature, wind events, rain events). As a consequence, the Ligurian spring bloom and subsequent marine fluxes below the euphotic layer are strongly dependent on climatic and meteorological conditions.

- The variability of mass flux is successively driven by winter convection ("flush down" effect) and biogenic carbon production.

- Therefore, the TM downward transfer is controlled by the seasonal variability of mass flux, and not by the variability of atmospheric fluxes.

***Thank you***