Geotraces in the Mediterranean
Workshop 4-6 October 2010, Villefranche-sur-Mer (France)

Revisiting the Mercury Cycle in the Mediterranean Waters coupling Speciation and Stable Isotopic Composition Approaches

D. Cossa[1], L.-E. Heimbürger[2], J. E. Sonke[2], C. Lamborg[3] and N. Pirrone[4]
[1] IFREMER, F-83507 La Seyne-sur-Mer, France
[2] LMTG-OMP, F-31400 Toulouse, France
[3] WHOI, Woods Hole, MA 02543, USA
[4] CNR-IIA, I-87036 Rende, Italy

Mercury (Hg) is a globally distributed, redox active and highly toxic element because of the stability of naturally occurring bioaccumulating methylated species. The Mediterranean Sea is especially affected by Hg deposition, high recycling between atmosphere and sea-surface, and high methylation rates , which favours Hg hyperbiomagnification in marine food webs. Recent analytical developments in ultra-trace performances allow to perform high resolution vertical profiles of major Hg species speciation (HgT, HgR, DGM, Hg^0, MMHg, DMHg). Moreover, recent discovery of both mass-dependent (MDF) and mass-independent fractionation (MIF) provide new insights into the Hg biogeochemical cycle. In addition, the MIF provides information about specific chemical pathways, such as photoreduction. However, no data has yet been reported for Hg isotope geochemistry in natural marine waters. We propose to revisit the Hg cycle in the major Mediterranean basins using these ultra-trace and stable isotope techniques.

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***important GEOTRACES key parameter**

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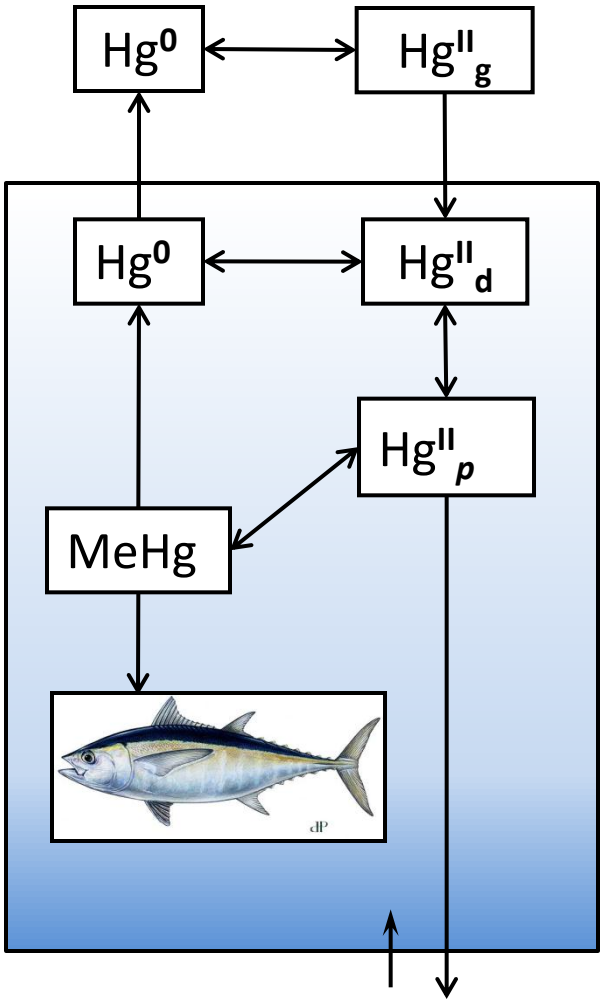
Why study Hg in the Mediterranean?

- MeHg is a potent neurotoxin
- MeHg accumulates to potential harmful concentrations in the marine food web!
- Short water residence time
- Natural + anthropogenic sources (2:3)
- LRT -> global impact

Marine Hg cycle



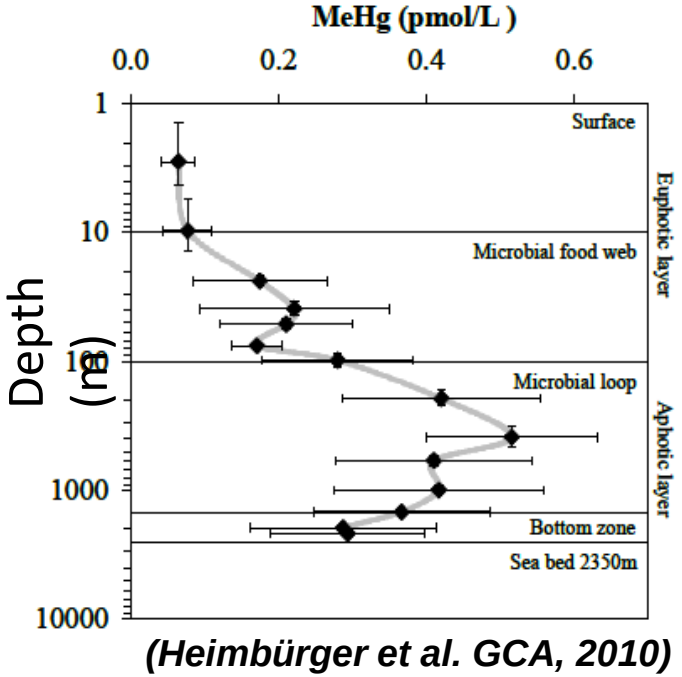
Atmosphere

Water column

Sediment

Bioamplification factor > 1.000.000

1mg in 1000000 L accumulates in 1 kg of fish (top predator)



(Heimbürger et al. GCA, 2010)

C_{org} flux fuels Hg methylation at depth ***(Cossa et al., L&O 2009; Sunderland et al. GBC, 2009)***

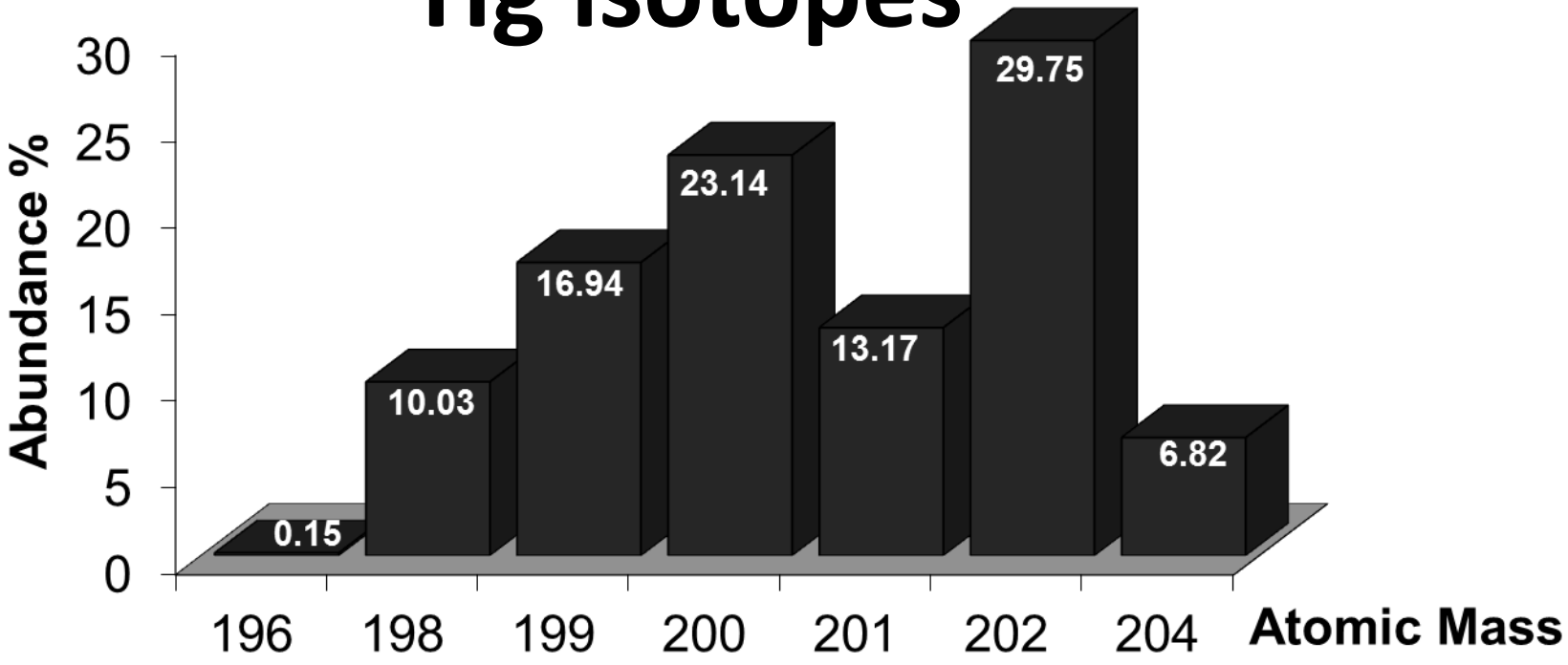
Key questions

- What controls Hg trends and variability in the Mediterranean Sea?
- What are the mecanisms altering the dynamic balance between sinks and sources?
- What are the causes for the alarming concentrations of (Me)Hg levels in biota?
- What changes of the Hg cycle are induced due to changing climate and enhanced anthropogenic emissions?

<u>New:</u>

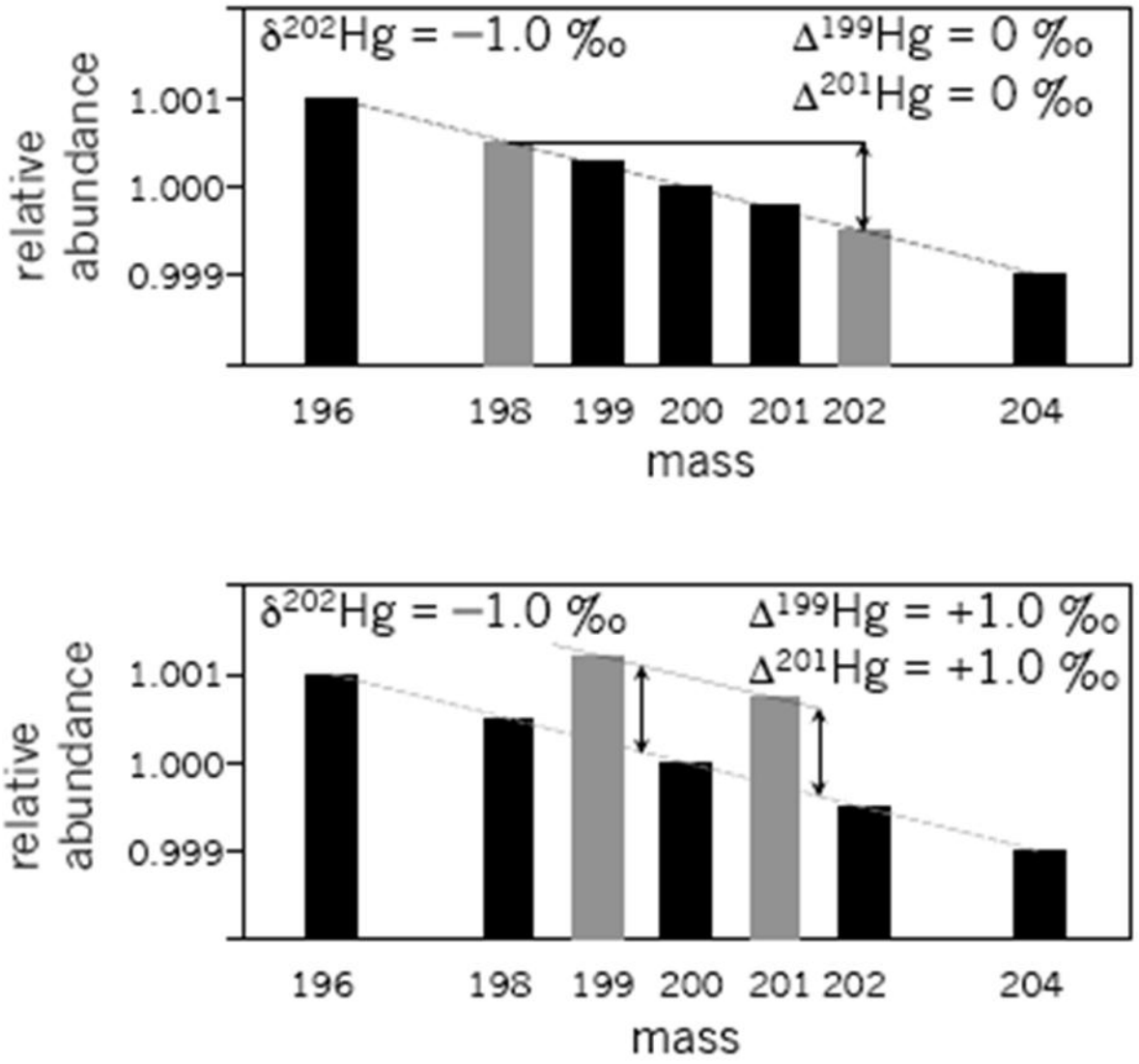
- Can isotopes trace Hg emissions and cycling?

Hg isotopes



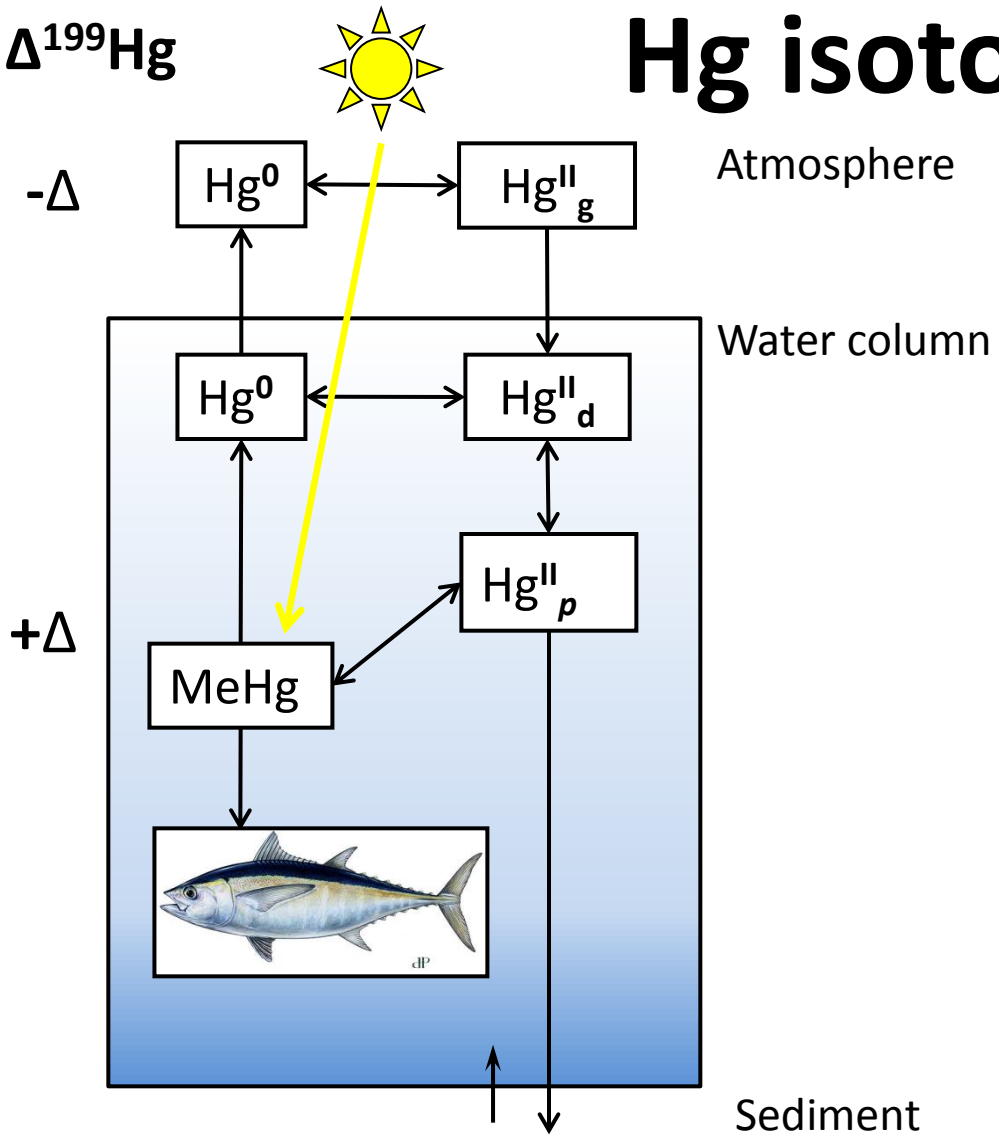
Isotopic signature can be used to trace emission sources, e.g. anthropogenic Hg

Hg isotopes



Large variations in MDF and MIF are observed in fish and provide new insights into the sources and bioaccumulation of Hg in food webs. MIF in fish can also be used to estimate the loss of methylmercury via photoreduction in aquatic ecosytems ***(Bergquist and Blum SCIENCE, 2007)***.

Hg isotopes



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Thank you!

Further reading:

- Bergquist, B. A. and Blum, J. D. (2007). "Mass-Dependent and -Independent Fractionation of Hg Isotopes by Photoreduction in Aquatic Systems." Science **318**(5849): 417-420.
- Cossa, D., B. Averty and N. Pirrone (2009). "The origin of methylmercury in open Mediterranean waters." Limnol. Oceanogr.
- Heimbürger, L.-E., Cossa, D., Marty, J.-C., Migon, C., Averty, B., Dufour, A. and Ras, J. (2010). "Methyl mercury distributions in relation to the presence of nano- and picophytoplankton in an oceanic water column (Ligurian Sea, North-western Mediterranean)." Geochimica Et Cosmochimica Acta **74**(19): 5549-5559.
- Sunderland, E. M., D. P. Krabbenhoft, J. W. Moreau, S. A. Strode and W. M. Landing (2009). "Mercury sources, distribution, and bioavailability in the North Pacific Ocean: Insights from data and models." Global Biogeochemical Cycles **23**: 14.