The Anthropocene's fingerprint as reflected by the occurrence and fluxes of organic pollutants in the global oceans

JORDI DACHS[1], BELÉN GONZÁLEZ-GAYA[1,2], JAVIER CASTRO-JIMÉNEZ[1,3], MARIA-CARMEN FERNÁNDEZ-PINOS[1], PAULO CASAL[1], CRISTINA PIZARRO[1], LAURA MORALES[1], MARIANA PIZARRO[1], MARIA VILA-COSTA[1], ESTEBAN ABAD[1], BENJAMÍ PIÑA[1], LAURENCE MÉJANELLE[4], BEGOÑA JIMÉNEZ[2]

[1]IDAEA-CSIC. Barcelona 08034, Catalonia, Spain. Email: jordi.dachs@idaea.csic.es
[2]IQOG-CSIC, Madrid 28006, Spain.
[3]MIO, AMU/UT/CNRS/IRD, Marseille, France.
[4]LECOB. UPMC/CNRS, Banyuls sur mer, France.

The human civilization is currently using more than 200,000 synthetic organic compounds in a myriad of industrial proceses, consumer products, and agricultural applications. Even though, many of these chemicals reach the environment, including the remote oceanic regions, their ecological relevance is unknown. In addition, the use of fossil fuels further contributes to the introduction of hydrocarbons to the atmosphere and ultimately to the ocean. In this work, we show the results from the 7-month long Malaspina Circumnavigation cruise that took place in 2011. Gas, aerosol, dissolved, particulate and planktonic phases were analyzed for semivolatile polycyclic aromatic hydrocarbons (PAHs), perfluoroalkyl substances (PFASs), polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p- dioxins and furans (PCDD/Fs), and organophosphate esters (OPEs), among other chemicals. Organic pollutants were found to be ubiquitous in the atmosphere and seawater from the tropical and subtropical Atlantic, Pacific, and Indian oceans. The spatial distribution showed higher concentrations in seawater close to the continents. However, the concentrations of PAHs, OPEs, PCBs, and PCDD/Fs in plankton were higher in the regions with lower biomass, consistent with the coupling of air-water exchange, settling of particulate bound chemicals, and degradation. Atmospheric inputs were dominated by diffusive air-water exchange, and accounted for an important input of PAHs and other organic pollutants to the global oceans. In addition,we found evidence of adverse biological effects due to these complex mixtures of organic pollutants in the remote ocean. The atmospheric inputs of the semivolatile aromatic-like hydrocarbons to the global oceans was estimated to be of 400 Tg C y^{-1}, about 15 % of the carbon oceanic inputs due to CO_2.