Lifetime and distribution of perfluorooctanoic sulfonate (PFOS) in the global oceans

C. C. WAGNER[1]*, C. P. THACKRAY[1], H. PICKARD[1], X. ZHANG[1] AND E.M. SUNDERLAND[1]

[1]Harvard John A. Paulson School of Applied Sciences and Engineering, Oxford Street, Cambridge, MA 02138, United States (*correspondence: cwagner@g.harvard.edu)

The ubiquitous presence of perfluorooctane sulfonate (PFOS) in seawater and wildlife of remote ocean locations has prompted major concern over the entire substance class, and led to the inclusion of PFOS in the Stockholm Convention in 2009. PFOS does not appreciably degrade under environmental conditions, and the ocean is thought to be the terminal sink for most PFOS releases, where it bioaccumulates in food webs and poses health risks to exposed wildlife and humans.

The dramatic reduction in PFOS releases after phase-out of the parent compound POSF (perfluorooctanesulfonyl fluoride) and its precursors is well documented in Europe and North America. By contrast, some studies have suggested a potential increase in releases from Asia and South America. The resulting shift in source regions is likely to affect residence times in the ocean and may drive continued exposure in marine food webs.

In our previous work, we developed a PFOS ocean simulation for the North Atlantic. Here, we extend this work to a global PFOS ocean simulation by including discharges from Japan, China and Brazil. Per-capita PFOS emission factors were derived from waste-water treatment plant and river measurements. The global ocean model is forced by historic PFOS releases from 1958-2015 and simulates realistic ocean physics and biogeochemistry. We find that 3400 Mg of PFOS have entered the ocean through rivers between 1958-2015. Based on vertical and lateral ocean circulation and particle associated removal we estimate that the shift in source regions has slowed the removal efficiency of PFOS. This work provides insights into future risks associated with shifting source regions and climate driven changes in ocean biogeochemistry.