Silicon stable isotope constraints on the pathways of thermocline nutrient replenishment

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The continued action of the ocean's biological carbon pump, driven by photosynthetic productivity at its sunlit surface, is contingent upon the supply of nutrients from the nutrient-rich abyss to the permanent thermocline. Increasingly compelling evidence implicates the Southern Ocean in this replenishment of thermocline nutrients, via the wind-driven upwelling of deep waters and the subduction of Subantarctic Mode Water (SAMW) to the base of the permanent thermocline [1].

The recent modelling study of Palter *et al.*. [2] estimated that SAMW supports between 33% and 75% of photosynthetic productivity at low latitudes, a range that hinges upon uncertainties in the pathways of the meridional overturning circulation (MOC). A novel opportunity to reduce this uncertainty is presented by the oceanic distribution of the stable isotope composition of silicic acid in seawater, δ^{30}Si. It has been argued by de Souza *et al.*. [3,4] that the oceanic δ^{30}Si distribution, and particularly the meridional gradient in Atlantic deep water δ^{30}Si values, provides strong support for a dominant Southern Ocean supply of silicic acid to the thermocline. Here, we combine these novel data constraints with a suite of ocean general circulation models in order to provide improved quantitative estimates of the importance of the SAMW contribution to the thermocline nutrient inventory.

Model variants that upwell a greater proportion of deep water within the Southern Ocean produce a more pronounced Atlantic deep water δ^{30}Si gradient, a result that provides further support for the importance of nutrients supplied by the Southern Ocean in maintaining low-latitude productivity. More broadly, these results pertain to the role of the Southern Ocean in the closure of the MOC, and ultimately to the driving mechanisms thereof [5].

[1] Sarmiento *et al.*. (2004) *Nature* **427**, 56-60. [2] Palter *et al.*. (2010) *Biogeosci*. **7**, 3549-2568. [3] de Souza *et al.*. (2012) *Glob. Biogeochem. Cyc*. **26**, GB2035, doi: 10.1029/2011GB004141. [4] de Souza *et al.*. (2012) *Biogeosci*. **9**, 4119-4213. [5] Kuhlbrodt *et al.*. (2007) *Rev. Geophys*. **45**, RG2001, doi: 10.1029/2004RG000166.

Dynamic of organic carbon in small volcanic mountainous tropical watersheds (Guadeloupe, FWI)

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In the tropical zone, small mountainous watersheds are affected by intense meteorological events. If the increase of the frequency and/or intensity of these extreme meteorological events (storms, cyclones) is confirmed [1, 2], it could lead to an increase of the export of dissolved and suspended material derived from soils.

We studied the geochemistry of three small watersheds around the Basse-Terre volcanic Island (FWI) during a four years period, by measuring dissolved organic carbon (DOC) and particulate organic carbon (POC) concentrations [3]. The mean annual yields range between 1.9-8.6 tC km^{-2} yr^{-1} and 8.1-25.5 tC km^{-2} yr^{-1} for DOC and POC, respectively. Floods and extreme floods account for 43% of the yearly water flux and represent 55% of the annual DOC flux, and more than 85% of the annual POC flux. These results show that organic carbon fluxes are largely underestimated if high temporal resolution sampling is not performed.

The important carbon export in Guadeloupe is induced by high intensity of precipitation leading to high runoff, high slopes, and high organic matter contents in Andosols and ferralitic soils. Even if the surface of volcanic and mountainous tropical islands is low compared to continental area, organic carbon yields in this specific context are so important that this surface can represent a significant proportion of the global annual carbon export. This total export is estimated to 2.4 ±0.6 MtC yr^{-1} for DOC and at 5.9 ±2.4 MtC yr^{-1} for POC. In addition, the quality of terrestrial organic matter (POC/DOC and C/N ; slightly degraded) arriving to the ocean is different from the one of large tropical river origin.

Our results show that tropical volcanic islands are significant pools of organic carbon for oceans and the effect on global carbon budget is still a matter of debate.

[1] Emmanuel (2005) *Nature*, **436**. [2] Trenberth (2005) *Science* **308**. [3] Lloret *et al.*. (2011) *Chem. Geol.*, **280**.

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