Biogeosciences Discuss.,
doi:10.5194/bg-2015-517-RC2, 2016

Interactive comment on "Diatoms Si Uptake Capacity Drives Carbon Export In Coastal Upwelling Systems" *by* F. Abrantes et al.

Anonymous Referee #1

Received and published: 21 March 2016

General Comments: This study synthesizes is a significant number of total organic carbon and sedimentary diatom abundance (SDA) samples from surface sediments in five important coastal upwelling regions around the globe. The authors attempt to use these data to determine whether a global generalization regarding the most important factor regulating SDA. This is a creative synthesis of data which is not only spatially and temporally expansive, but time consuming to produce (e.g. quantification of diatom valves in sediments).

Specific Comments: In its present form, I have concerns; but if addressed, could see this being an interesting contribution which supports the recent synthesis by Tréguer and De La Rocha (2013). In that synthesis, Tréguer and De La Rocha (2013) observed that the burial of diatoms is mainly driven by the magnitude of water-column biogenic silica production, due to the fate of nearly all produced diatom silica is dissolution in the

water column or sediments. Tréguer and De La Rocha (2013)'s data is based on silicon biogeochemical measurements; however, this study gets to a similar result using just sediment diatom valve abundance and annual mean nutrient data (i.e. more production, more SDA). The overall presentation is confusing in some areas and will need some refinement (e.g. full of undefined abbreviations, lack of calculation transparency and detail, important details in the supplementary material).

The idea of SDA in the sediments also assumes that these diatoms have a significant amount of carbon to drive at least a portion of TOC trends; however, iron limitation (see below) of diatom production produces cells with high Si and low organic matter diatoms. It has been known for 15 years that iron and macronutrients play a significant role in regulating diatom production in upwelling regions (e.g. Bruland et al. 2001, Limnology and Oceanography 46(7)). And because diatoms Si per cell is plastic, driven by both the rate of uptake (substrate dependent) and the duration of a cell cycle (growth-rate dependent), iron limitation can have a substantial effect on ballasting diatoms (i.e. high silicic acid means diatoms take up Si at high rates, low Fe means diatoms grow slower and decouple Si and C or N quotas). While the records for dissolved iron in the water column are not available, for thoroughness, it would be good to at least discuss iron as it affects both the Si quota for a diatom and also reduces the organic matter per cell.

Technical Corrections: General: the author order on citations is odd (e.g. sometimes by year, other times listed alphabetically by first author, other times no obvious pattern, Page 5, line 27). Page 2, Lines 9 – 10: Field et al. (1998) showed that highly productive regions (e.g. Coastal upwelling zones with satellite Chlorophyll a > 1 mg/m3) was only ∼18% of total ocean net primary production, not 80-90% as stated here. Page 3, Line 26: change μML-1 to μM Section 3.1.2: the main points of this section could be clearer Page 4, Line 26: perform vs. preform Page 4, Line 42: please change [Si(OH)4-] to [Si(OH)4] (at seawater pH Si is not ionic), please make this correction elsewhere in the manuscript Page 4, Line 44: this sentence is basically what Tréguer and De La Rocha (2013) have shown among all oceanic systems. Considering so much dissolution occurs in the water column and sediments (e.g. >95%), the burial of diatoms in sediments is largely predicted by the magnitude of their production in the surface waters. See General Comments. Page 5, Line 23-24: While this is certainly the conclusion of this analysis, such a statement is rather grandiose given the record is a 47-year average, and later it is discussed that the temporal scale of inference for the Silicon-related discussion is tens to hundreds of years (Page 6, line 32). Perhaps be more conservative? Page 5, Line 37: contrarily vs. contrary Page 6, Line 7: silicic acid "can be" a limiting nutrient for diatom growth, most kinetic data demonstrate it is unlikely for growth to be limited by silicic acid (also Brzezinski and Nelson 1996 reference was in the North Atlantic gyre, not an upwelling system, see below for upwelling systems references). Page 6, Line 9: the Dugdale and Wilkerson (1998) model was driven by silicic acid nutrient profiles, not direct data, plus this was in the equatorial Pacific not a coastal upwelling system. Additionally, in this same system, Brzezinski et al. (2008, Limnology & Oceanography) showed it was unlikely that silicic acid was limiting diatom growth based on the degree of kinetic limitation observed. Page 6, Line 29: This assumption may be reasonable (see comment on Page 4, Line 44 regarding Tréguer and De La Rocha 2013 study and perhaps cite this as justification) but completely ignores diatom frustules in the sediments which have been authigenically transformed via reverse weathering (e.g. Michalopoulos et al. 2000, Geology 28) and are likely to not be quantified (i.e. not recognizable). Additionally, the SDA proxy may be more representative of large and/or heavily silicified diatoms only. Perhaps the potential bias could be discussed in the methods. Page 6, Line 34: Dugdale et al. (2011) reference is from equatorial Pacific, not a coastal upwelling system (e.g. see Goering et al. 1973 DSR for Peru or Nelson et al. 1981 Consumption and Regeneration of Silicic Acid in Three Coastal Upwelling Systems for Baja California and Northwest Africa). Page 6, Line 37: Goering et al. 1973 actually showed Michaelis-Menten uptake fit Si uptake responses in an upwelling system, the Dugdale paper did not focus on silicate. Page 6, Line 42: expand [S] to be [Si(OH)4] Page 7, Line 2: use of SisurfMAX is unclear until you mine through supplementary tables Page 7, line 18: I disagree, if iron is

the limiting nutrient in the upwelling system (e.g. Bruland et al. 2001, Limnology and Oceanography) then it isn't Silicon uptake which affects C sequestration, it is iron which leads to excess Si ballast (see also Brzezinski et al. 2015, JGR Oceans).

Interactive comment on Biogeosciences Discuss., doi:10.5194/bg-2015-517, 2016.