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Biogeochemistry of coastal seas and continental shelves – Including biogeochemistry during the International Polar Year

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During the General Assembly of the European Geosciences Union in Vienna, May 2010, a session was held within the Biogeosciences division entitled "Biogeochemistry of coastal seas and continental shelves – including Biogeochemistry during the International Polar Year (IPY)". The session hosted 36 presentations, 11 of which were presented orally. The session was co-sponsored by the International Geosphere-Biosphere Programme/International Human Dimensions Programme (IGBP/IHDP) core project Land-Ocean Interactions in the Coastal Zone (LOICZ), as well as by the Canadian IPY programs Circumpolar Flaw lead study and GEOTRACES (An International Study of the Marine Biogeochemical Cycles of Trace Elements and Their Isotopes). The session aimed at fostering the understanding of the biogeochemistry of continental shelves, coastal seas and estuarine systems and offered early outcomes of the 2007/2008 IPY to be presented. This special issue comprises six contributions to the above session, showcasing examples for recent advancements in the field of coastal biogeochemistry.

Coastal seas and continental shelves constitute the interface between land and open ocean, and, broadly spoken, become the more similar to open ocean the larger the distance to the coast is. Conversely, terrestrial, in particular riverine, impacts on the marine biogeochemistry of coastal seas and continental shelves gain accentuation with proximity to the coast. While the gradient between land and open ocean, often called land-ocean continuum, is one particular characteristic of coastal seas and continental margins, these systems exhibit a further crucial difference to the open oceans: the proximity of sediments to the sea surface, hence close coupling in space and time of the pelagic and the benthic environments. In other words, the shallow water column in coastal seas and continental shelves constitutes a close link between surface sediments and the atmosphere, which permits relatively direct interactions between both the sedimentary and atmospheric compartments, often at permanent or seasonal times scales (e.g. Borges et al., 2005; Thomas et al., 2009). In contrast in open oceans the sediment and atmospheric compartments are strictly separated at long time scales ($\cong$1000yr). One consequence is that the high primary productivity in the shallow waters fuels immediately sedimentary processes, while in open oceans much of the primary productivity

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(>90%) is decomposed in the water column before reaching the sea floor. The high export of organic matter in shallow waters stimulate anaerobic processes in surface sediments, which in return exchange products such as Mn (Kowalski et al., 2012) or total alkalinity (A_T) with the overlaying waters. Such a return flux of A_T, for example, is thought to enhance the absorption of atmospheric CO_2 by shallow waters (Thomas et al., 2009). Crucial for the understanding and eventual prediction of the role of shallow sediments in controlling CO_2 air-sea fluxes, and element concentrations in overlaying waters is the understanding and quantification of exchange processes between the shallow sediments and the overlaying water column. Three contributions to this special issue address this aspect employing observational (Kowalski et al., 2012; Klaassen and Spilmont, 2012) and theoretical (Lettmann et al., 2012) approaches, respectively.

A further characteristic of coastal seas and continental shelves is the high temporal and spatial variability of CO_2 fluxes (e.g. Thomas and Schneider, 1999; Frankignoulle and Borges, 2001; Thomas et al., 2004; Borges et al., 2005, 2008; Chen and Borges, 2009; Shadwick et al., 2010, 2011). The driving factors often vary within the system at seasonal time scales, and the deduction of general patterns remains difficult, which in turn requires detailed case studies. Two further contributions to these issues shed light on the variability and controls of CO_2 fluxes in estuaries, and coastal and shelf regions (Bozec et al., 2012; Lorkowski et al., 2012), again using observational and theoretical approaches. The Bozec et al. (2012) study contributes to better evaluate air-sea CO_2 fluxes in river plumes that usually act as sinks of CO_2 for large stratified systems, and as CO_2 sources for smaller well-mixed systems (Borges, 2005). The Lorkowski et al. (2012) modelling work addresses the decadal variability of air-sea CO_2 fluxes and carbonate chemistry that are difficult to address from a purely observational approach due to lack of long time-series of CO_2 variables in coastal areas. Lorkowski et al. (2012) explore the impact of eutrophication on carbonate chemistry in North Sea that has been recently shown to be important in near-shore systems (Borges and Gypens, 2010).

Factors controlling air-sea CO_2 fluxes in coastal environments comprise bottom topography (Thomas et al., 2004), seasonality in temperature or riverine inputs for example (Chen and Borges, 2009). Biological processes exert a further major control on the CO_2 fluxes in coastal seas and continental shelves. Such regions are usually biologically rich and characterized by high metabolic activity (Wollast, 1998; Gattuso et al., 1998), which in turn complicates the accurate understanding of the biological control of CO_2 air-sea fluxes. The paper by Moreno et al. (2012) is devoted to this question and provides detailed insight in phytoplankton community structure in the Argentinean continental shelf, giving a particular emphasis on the controls of the different size fractions of phytoplankton community, that will to a large extent determine the rates of organic carbon export and ultimately the CO_2 air-sea fluxes.

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