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Inventory and burial fluxes of Black Carbon in the Swedish continental shelf sediments

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Highly condensed black carbon (BC) particles, mainly derived from incomplete combustion of biomass and fossil fuel, are involved in several important processes in the biogeosphere [1], including sedimentary carbon burial, sequestration of organic pollutants in soils and sediments, affecting Earth's radiative heat balance and even human respiratory health. BC is commonly found to constitute several to 20% of total sedimentary carbon, and thus plays an important but poorly constrained role in the global biogeospheric carbon cycle. Sequestration of biogenic carbon as BC is a direct sink of the element from the rapidly cycling atmosphere-biosphere reservoirs, whereas burial of petrogenic/fossil BC is simply a conversion of one form of geological carbon to another [2].

Considerable emphasis has been made on the relevant role this recalcitrant form of organic matter (OM) may play on the global C cycle and yet large uncertainty exists around BC detection and quantification. This work seeks to provide a large-scale estimate of the reservoir and burial sink flux of BC in sediments from the extensive Swedish continental shelf (SCS), as a first approach to global inventories. To this end, a total of 120 sediment samples were collected from the Exclusive Economic Zone (EEZ) along the ≈2000 km SCS stretch. The most recalcitrant fraction of the sedimentary OM was isolated and determined by means of a commonly applied method in biogeochemical studies of soils and sediments: chemo-thermal oxidation at 375˚C in air (CTO-375). The obtained BC concentration was used to estimate the inventory and burial flux of BC in the SCS surface sediments, following [3], which takes into account key geophysical and geochemical properties of the nine distinct sedimentary regimes of the SCS that was separately assessed. Globally representative values of the sediment properties (e.g. density of dried sediments, bioturbated mixing depth, sedimentation rate or porosity over the mixed depth) were employed for the calculations of the BC inventory and, in turn, the burial flux.

BC ranged 0.6 - 17.7 mg/gdw (mean 2.4±2.2 mg/gdw), representing 2 - 47% of TOC (mean 5±4%). The southern regions presenting the highest populations, most important industrial activity and traffic density, registered richer content of BC (2.9±2.4 mg/gdw). In contrast, sediments from Northern Baltic Sea, with less anthropogenic activity and influence of continental Europe, showed lower concentration of BC (1.3±0.4 mg/gdw). The spatial distribution of the carbonaceous compound was statistically correlated with certain molecular combustion markers such as PAHs, which displayed highly significant correlation with BC (r_s= 0.54, $p<0.01$) but not with bulk TOC, suggesting both that the CTO-375 isolated BC was not significantly affected by TOC charring and that it is a significant portion of the combustion-derived BC in such coastal sediments. The BC inventory estimate in the EEZ sediments of the SCS ranged from 4 to 123 mg/cm^2 (mean of 17±15 mg/cm^2). The national burial flux was evaluated to be on the order of 0.17-4 mg/yr cm^2 (mean of 0.7±0.6 mg/yr cm^2), with the Southern regions constituting a more significant removal sink of the recalcitrant combustion residue in this Northern European area.

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[3] Jönsson et al., 2003. Environ. Sci. Technol. 37, 245-255.