Glaciers: A window into anthropogenic perturbation of the global carbon cycle

ARON STUBBINS[1†], E. HOOD[2], P.A. RAYMOND[3], G.R. AIKEN[4], R.L. SLEIGHTER[1], P.J. HERNES[5], D. BUTMAN[3], P.G. HATCHER[1], R.G. STRIEGL[4], P. SCHUSTER[4], H.A.N. ABDULLA[1] AND R.G.M. SPENCER[6]

[†] Skidaway Institute of Oceanography, Savannah, GA, USA
[1]Old Dominion University, Norfolk, VA, USA
[2]University of Alaska Southeast, Juneau, AK, USA
[3]Yale University, New Haven, CT, USA
[4]USGS, 3215 Marine Street, Boulder, CO, USA
[5]University of California, Davis, CA, USA
[6]Woods Hole Research Center, Falmouth, MA, USA

Glacier-derived dissolved organic matter (DOM) provides a significant source of ancient, yet highly bioavailable C to downstream ecosystems. The remnants of ancient peatlands and forests since overrun by glaciers have been invoked as a source of this ancient, labile DOM. Here we challenge this hypothesis, demonstrating that DOM exported from glaciers is predominantly anthropogenic and enters glaciers in a pre-aged form. C-containing aerosols, mainly from biomass and fossil fuel burning, are the original source of this aged-glacier DOM. Once deposited on glacier surfaces, aerosol DOM is exported downstream, providing an energy subsidy to aquatic ecosystems. As deposition of combustion products is a global phenomenon, we propose that all ecosystems are receiving this ancient, labile C subsidy. In vibrant ecosystems, the labile DOM windfall is presumably rapidly processed, its signal lost and impact masked. In frigid glacier environments, these inputs stand out, making glaciers sentinel ecosystems for the study of perturbation to global biogeochemical cycles through anthropogenic deposition. This deposition is predicted to increase in the future as emissions of combustion derived aerosols accelerates along with industrial growth.

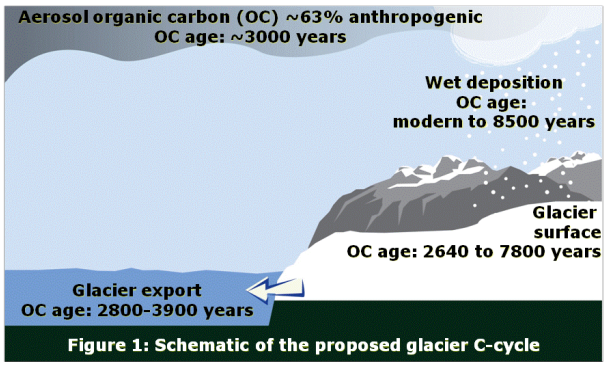

Figure 1: Schematic of the proposed glacier C-cycle

Climatically driven changes in sediment supply on the SW Iberian shelf since the Last Glacial Maximum

R. STUMPF[1]*, M. FRANK[1], J. SCHÖNFELD[1] AND B.A. HALEY[1,2]

[1]Leibniz Institute of Marine Sciences (IFM-GEOMAR), Wischhofstraße 1-3, 24148 Kiel, Germany (*correspondence: rstumpf@ifm-geomar.de)
[2]College of Oceanic & Atmospheric Sciences, 104 Ocean Admin. Bldg., Corvallis, OR 97331-5503, USA

The assemblage of marine sediments on the SW Iberian shelf reflects various ambient particle sources that have undergone significant changes as a function of prevailing weathering and transport regimes since the Last Glacial Maximum (LGM). The relatively rapid, decadal scale Mediterranean overturning circulation permits mixing of suspended particles from the entire Mediterranean Sea. They are entrained into the suspended particulate matter (SPM) carried by Mediterranean Outflow Water (MOW), which enters the Eastern North Atlantic through the Strait of Gibraltar and spreads at intermediate water depth in the Gulf of Cadiz and along the Portuguese continental margin. Further major sediment sources that have potentially contributed to the budget of SPM along the flow path of MOW on the SW Iberian shelf are North African dust and river transported particles from the Iberian Peninsula. In order to reconstruct climate and circulation driven changes in the supply of sediments from these sources over the past ~23 000 years, radiogenic Nd, Sr, and Pb isotope records of the clay-size sediment fraction were produced from three gravity cores in the Gulf of Cadiz (577 m) and on the Portuguese shelf (1745 m, 1974 m). These records were supplemented by time series of clay mineral abundances and clay mineral ratios from the same set of samples. Contrary to expectations, the transition from the LGM to the Holocene was not marked by very strong changes of the source areas of the sediments deposited on the SW Iberian shelf. However, the Heinrich stadial 1 and the African Humid Period are marked by significantly different isotopic records. The data also suggest that the continental chemical weathering regime changed with prevailing climate conditions and supplied the SW Iberian shelf with variable clay mineral abundances from essentially the same source rocks.