Sea floor methane emissions in continental shelves and the role of anaerobic methane oxidation

IANA TSANDEV[1], PIERRE REGNIER[1,2], ANDREW DALE[3] AND ANDY RIDGWELL[4]

[1]Faculty of Geosciences, Utrecht University, Utrecht, the Netherlands
[2]Department of Earth and Environmental Sciences, Unversité Libre de Buxelles, Brussels, Belgium
[3]Leibniz-Institut für Meereswissenschaften (IFM-GEOMAR), Kiel, Germany
[4]School of Geographical Sciences, University of Bristol, Bristol, UK

Fluxes of methane from sea floor gas hydrates are a key forcing of Earth's climate. If this methane is oxidized aerobically, such as in a ventilated water column or the oxic part of the sediment, it results in loss of seawater dissolved inorganic carbon (DIC) and alkalinity (ALK) and $CaCO_3$ dissolution. The effect can be opposite if anaerobic oxidation of methane takes place, eg. throughout the reduced part of the sediment column, releasing alkalinity and inducing carbonate precipitation. In this study we identify shelf environments known for high methane hydrate concentrations and model the sediment column with a 1-D biogeochemical reaction network simulator (BRNS) of sedimentary dynamics. Upper boundary conditions on the sediment are extracted from an Earth system model of intermediate complexity – GENIE – through steady state fields of the relevant tracers (organic matter flux to the seafloor, bottom water oxygen content, etc.). We further impose bottom boundary upward advective fluxes of methane on the sediment column based on hydrate dissolution estimates. We identify the pathways of methane transformation – aerobic vs. anaerobic. We find that upon methane hydrate destabilization, anaerobic methane oxidation (AOM) can significantly reduce the efflux of methane to the overlying water and build up DIC and ALK inventories in the sediment porewaters, pushing the system toward carbonate precipitation. This results in increased effluxes of DIC and ALK to the overlying seawater. The magnitude of the AOM effect is, however very sensitive to the assumed rate of anaerobic methane oxidation in the sediment.

Biogeochemical impact of long-range transported dust over Northern South China Sea

S.-C. TSAY[1]*, S.-H. WANG[1,2] AND N.C. HSU[1]

[1]Goddard Space Flight Center, NASA, Greenbelt, Maryland, USA (*correspondence: si-chee.tsay@nasa.gov, christina.hsu@nasa.gov)
[2]Oak Ridge Associated Universities, Oak Ridge, Tennessee, USA (sheng-hsiang.wang-1@nasa.gov)

Transpacific transport and impact of Asian dust aerosols have been well documented (e.g. results from ACE-Asia and regional follow-on campaigns), but little is known about dust invasion to the South China Sea (SCS). On 19-21 March 2010, a fierce Asian dust storm affected large areas from the Gobi deserts to the West Pacific, including Taiwan and Hong Kong. As a pilot study of the 7-SEAS (Seven South East Asian Studies) in the northern SCS, detailed characteristics of long-range transported dust aerosols were first observed by a comprehensive set of ground-based instruments deployed at the Dongsha islands (20°42′52″ N, 116°43′51″ E). Aerosol measurements such as particle mass concentrations, size distribution, optical properties, hygroscopicity, and vertical profiles help illustrate the evolution of this dust outbreak. Our results indicate that these dust particles were mixed with anthropogenic and marine aerosols, and transported near the surface. Satellite assessment of biogeochemical impact of dust deposition into open oceans is hindered by our current inability in retrieving areal dust properties and ocean colors over an extensive period of time, particularly under the influence of cloudy conditions. In this paper, we analyze the changes of retrieved Chlorophyll-a (Chl-a) concentration over the northern SCS, considered as oligotophic waters in the spring, from long-term SeaWiFS measurements since 1997. Over the past decade, six long-range transported dust events are identified based on spatiotemporal evolutions of PM_{10} measurements from regional monitoring stations, with the aid of trajectory analysis. Multi-year composites of Chl-a imagery for dust event and non-dust background during March-April are applied to overcome insufficient retrievals of Chl-a due to cloudy environment. Due to anthropogenic modification within a shallow boundary layer off the densely populated and industrial southeast coast of China, the iron ion activation of deliquescent dust particles enhances the efficiency of fertilization for biological productivity. Compared to the West Pacific, the marine ecosystem in the northern SCS is much more susceptible to the biogeochemical impact of long-range transported Asian dust.