The Microbial Response to Atmospheric Dust

Ebling, A.M.; Wyatt, N.J.; Landing, W.M. (FSU, Earth, Ocean, and Atmospheric Science)

Introduction

Natural and anthropogenic aerosols are a significant source of bioactive trace elements to ocean surface waters, often influencing the growth of marine microbial communities[1,2]. Opportunistic, heterotrophic bacteria have been shown to experience an initial, rapid growth during atmospheric dust deposition events[3,4,5] that may influence trace element availability for other microorganisms[6]. There is, however, limited knowledge on the components of dust that stimulate this bacterial response. The principle objectives of this study are therefore to determine which dust constituents stimulate the heterotrophic bacteria and how the activity of such bacteria affect the availability of dust-derived trace elements to marine autotrophs.

Experimental

Dissolved trace element concentrations were monitored during an incubation experiment of natural marine waters. Six different treatments were conducted: control incubations in light and dark systems; iron salt (FeCl) addition incubations in light and dark systems; and atmospheric dust addition incubations in light and dark systems. Seawater was sampled from the incubation containers at times 0, 6, 24, 48, 72, and 96 hours and analyzed for dissolved trace elements (Al, Mn, Fe, Co, Ni, Cu, Zn, Cd, and Pb) by pre-concentration onto a cation exchange column prior to analysis by high-resolution inductively-coupled plasma mass spectroscopy (HR-ICP-MS). A detailed description of the method can be found in Milne et al. (2010)[7]. The samples were analyzed using the Thermo Scientific Element 2 (E2) HR-ICP-MS located in the Geochemistry Program of the NHMFL.

Results and Discussion

Iron was the initial focus of our experiment and will therefore be discussed in this report. The dissolved iron concentrations for each incubation experiment over time are shown in Fig. 1 (top panel). There was no significant difference between the light and dark incubations for each treatment (p value = 0.371 for control, 0.899 for FeCl, and 0.501 for dust) and the data were therefore combined. Linear regression was performed on each treatment over time (Fig. 1 bottom panel) to determine the rate of loss of iron. The rate of loss in the FeCl and dust treatments was 5 ± 0.8 pmol L^{-1} h^{-1} and 4 ± 0.8 pmol L^{-1} h^{-1}, respectively. The rate of loss in the control treatment was 2 ± 1 pmol L^{-1} h^{-1}. Until the data on bacterial and phytoplankton growth in the spiked samples is available, we can only speculate on what caused the increase in the rate of dissolved Fe loss in the FeCl and dust treatments. If we assume all incubations lost dissolved iron at the same rate due abiotic factors, then an additional 2-3 pmol L^{-1} h^{-1} could have been removed by biological uptake.

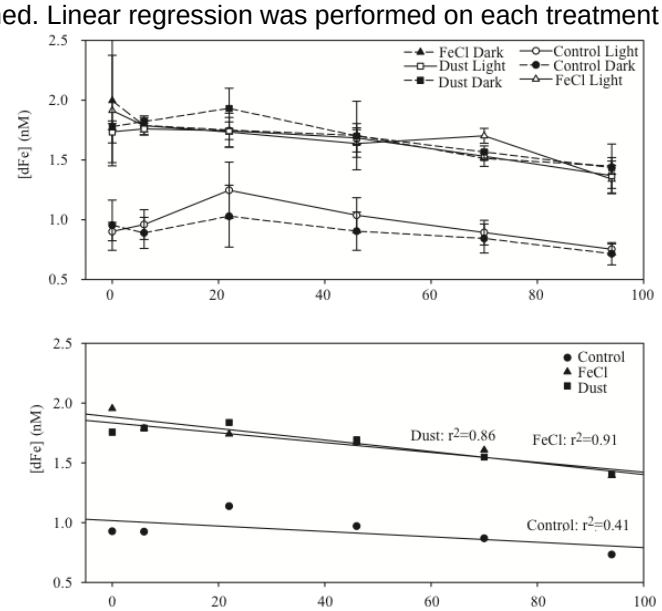

Fig. 1: (top panel) The average dissolved Fe concentrations in the six different incubation experiments over time. Error bars indicate standard deviation (n = 3). (bottom panel) The dissolved Fe concentrations in the three treatments over time. The solid lines indicate the linear regression of each treatment.

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