Manganese in an ocean general circulation model

M. M. P. VAN HULTEN[1]*, J.-C. DUTAY[1], M. ROY-BARMAN[1], A. TAGLIABUE[2], A. STERL[3], R. MIDDAG[45] AND H. J. W. DE BAAR[56]

[1]Laboratoire des Sciences du Climat et de l'Environnement (LSCE), LSCE-Orme, point courrier 129, CEA-Orme des Merisiers, 91191 Gif-sur-Yvette Cedex, France (*correspondence: mvhulten@lsce.ipsl.fr)

[2]University of Liverpool, 4 Brownlow Street, Liverpool L69 3GP, UK

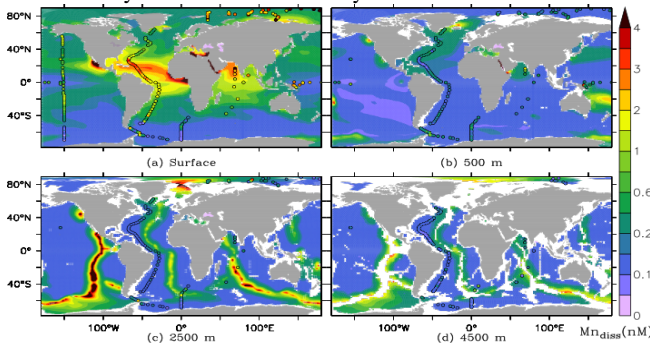
[3]KNMI, Utrechtseweg 297, 3731 GA De Bilt, the Netherlands

[4]UCSC, 1156 High Street, Santa Cruz, CA 95064, USA

[5]NIOZ, Landsdiep 4, 1797 SZ 't Horntje, Texel, the Netherlands

[6]RUG, Postbus 72, 9700 AB Groningen, the Netherlands

Dissolved manganese (Mn) is a bioessential element and its oxidised form is involved in the removal of trace elements in the ocean. Recently, a large number of Mn measurements have been obtained in the Atlantic ocean as part of the GEOTRACES programme. While these measurements give new insights into the main sources of Mn, the processes that redistribute Mn throughout the ocean are less clear. We added the first manganese module to the biogeochemical model PISCES (as part of a global general circulation model) to examine the cycling of Mn at the global scale. Mn sources include atmospheric dust deposition, rivers, low oxygen sediments and hydrothermal vents. Redox and adsorption processes in the water column are included in the model via a first-order equilibration equation between dissolved and oxidised Mn that depends on irradiance. The aggregation and settling of oxidised Mn is also included. While biological uptake probably plays an important role in the removal of Mn, this is not yet taken into account by the model.



The modelled Mn distribution is compared with a global dataset of measurements, with a focus on the Atlantic Ocean. Important features that are present in the dataset are reproduced by the model (figure): (1) the relatively homogeneous distribution in the deep ocean, (2) the high Mn concentration in the ocean surface waters due to a combination of dissolution of Mn from deposited dust and photoreduction, and (3) the strong, locally enhanced Mn concentrations near the Mid-Atlantic Ridge that arise from hydrothermal sources of reactive Mn.