Periodic Report for the DISCOSAT project PCIG12-GA-2012-333143

1. Publishable summary

Trace elements (e.g. iron, manganese, cobalt, lead) in the ocean can play important roles either sustaining phytoplankton (algae) growth as vital nutrients or by reducing growth when they exceed toxic concentrations. A major route for trace elements to enter the ocean is via natural and man-made atmospheric particles (aerosols) that 'rain out' or settle into the ocean surface, the zone most populated by marine plants and organisms. The DISCOSAT project aims to assess whether the predicted changing climate and ocean chemistry over the next century (e.g. changes to acidity, oxygen, temperature, organic molecules) will affect the amount of these trace metals dissolving into the ocean. This is important as major changes of this kind could lead to ecosystem changes in vast regions of the ocean, favouring the survival of certain marine plants and animals.

The work of the Fellow has focussed on regular seasonal sampling of aerosols at sites in the North Atlantic Ocean (Bermuda, Ireland and South West England). Simulation experiments have been conducted mimicking aerosol trace metals dissolving into seawater at different acidity, oxygen concentrations and temperature extremes. Results so far show that for all elements studied (Fe, Mn, Pb, Cu, Co) the impacts under future changing seawater conditions are not predicted to be devastating to the ecology of the ocean. Regardless of the variable studied, the dissolving time of metals was generally low (i.e. less than 10 minutes) and no significant changes to the quantities of the metals dissolving under these different extremes have been observed that would affect marine phytoplankton. However, major changes are evident depending on: whether the origins of aerosols are man-made (e.g. soot, ash) or natural (e.g. fine weathered dust), the global weather patterns (e.g. wind directions, pressure systems) and whether there are organic molecules (strong chelates or ligands) in the ocean that stabilise the dissolved metals in seawater.

This project involves state-of-the-art sampling, processing and analytical techniques. Highlights include the development and use of mass spectrometry techniques that allows the separation of trace metals from seawater leaches prior to analysis. This allows very sensitive detection of concentrations down to parts per trillion concentrations (i.e. 1 g in 1,000,000 tonnes of seawater). The Fellow Dr Ussher has benefitted from the project by establishing his research agenda at the University of Plymouth and inheriting clean room laboratory space as well as continuation and establishing of collaborative links with the Bermuda Institute of Ocean Sciences and National University of Ireland, Galway. Thus far, the Fellow has seized the opportunity to train and supervise three PhD students (UK and EC funded). He is now the main supervisor for three PhD students, one of which was made possible by part funding from the Career Integration Grant. The grant has also allowed attendance of the fellow and his students at 8 scientific conferences and meetings and facilitated visits to Bermuda, Ireland and local sampling sites for fieldwork. One major scientific paper on the topic of marine trace elements has already been published by the fellow (as corresponding author) with two more as a co-author and a further two are in preparation.

The prospects of the research career development and re-integration of the fellow are good as demonstrated by completion of probationary period as a lecturer and now being ready to apply for Reader (Assistant Professor) at Plymouth University, which is a major mid-career threshold in UK system.