

PROJECT TITLE: Microplastic pathways in the Southern Ocean
Lead Institution: University of Exeter
Lead Supervisor: Dr. Katy Sheen, University of Exeter, Department of Geography
Co-Supervisor: Dr Sally Thorpe, British Antarctic Survey, Ecosystems
Co-Supervisor: Prof Tamara Galloway, University of Exeter, Biosciences
Co-Supervisor: Dr. Emma Young, British Antarctic Survey, Polar Oceans

Project Enquiries: k.i.sheen@exeter.ac.uk



Microplastics collection on the RRS James Clark Ross, in the western Antarctic Peninsula.



Antarctic sea ice and seal.

Project Background

The Southern Ocean and Antarctic marine environment are often considered pristine and largely beyond the reach of human impact. However, of increasing concern is the presence of tiny floating plastic fragments (microplastics) found in Antarctic and sub-Antarctic waters and sediments [Waller et al., 2017]. Microplastics can be ingested by keystone filter feeder species such as Antarctic krill, with toxicological effects that can in turn accumulate through the food chain and impact larger predators such as seabirds, seals and whales [Cole et al., 2013; Kaposi et al., 2014; Lusher et al. 2015.]. The deposition of microplastics on the seabed will also likely impact benthic communities. Crucially, however, the extent, quantity, sources and impacts of marine plastics in Antarctica are largely unknown. Recent studies indicate that local sources such as shipping and scientific research stations do not account for recorded concentrations of microplastics indicating an influx of plastic from more remote regions [Waller et al., 2017]. This project will use models and field observations to better understand the sources, dispersal routes and timescales of microplastics that have reached Antarctic waters. Ultimately, this project will help to inform the future governance of polar marine pollution.

Project Aims and Methods

The primary aim of this project is to better quantify the sources, pathways and distribution of marine microplastics in Antarctica and the surrounding Southern Ocean. The Southern Ocean acts as a confluence and upwelling zone for water masses from across the globe, and hence likely collects microplastics from far reaching sources. However, the strong circumpolar currents associated with the Southern Ocean can also act as barriers to the southward flux of particles into the Antarctic waters. The difficulty of collecting sufficient temporal and spatially distributed concentrations of microplastics across the Southern Ocean means that ocean models are an essential tool to 'fill in the gaps'. This project will use Lagrangian (i.e. particle tracking) models to map the pathways of microplastics that have reached Antarctic waters from both local and remote sources [e.g. Van Sebille et al. 2015]. In particular, model data will help to assess the role of smaller scale processes such as storms and eddies in facilitating the southward transfer of microplastic across the frontal barriers that encircle the Antarctic continent [Tamzitt et al., 2017; Fraser et al. 2018]. Model data will be initialised and validated by observations of marine microplastic distribution and concentrations collected by the British Antarctic Survey (BAS). Although largely theoretically based, there may be the opportunity for the student to participate in a BAS research cruise to the Southern Ocean to gain experience of fieldwork and microplastic data collection.

The student will benefit from interaction and collaboration with the newly-formed Scientific Committee on Antarctic Research (SCAR) action group Plastics in Polar Environment.

There will be some flexibility to adjust this PhD project to allow the successful applicant to direct their own research and cater for any specific interests – it will have to stay broadly within the current remit, be aligned with available data and remain within the expertise of project supervisors.

Candidate Requirements

This project would suit a candidate with a background in Earth sciences, oceanography, physical geography, mathematics, computer science or physics. Candidates should be able to demonstrate high academic achievement, good numerical skills and academic research experience.

CASE or Collaborative Partner

CASE partner still to be confirmed, but potentially the World Wide Fund for Nature polar group.

Training

The project will provide training in physical oceanographic data analysis and modelling, and potentially marine microplastic field data collection. There will be extensive opportunities for students to expand their academic outlook, for example by attendance at international conferences. Specific training will include:

- Gaining knowledge of physical ocean processes
- Computer coding and oceanographic modelling
- An understanding of marine microplastics pollution in polar regions, its impact and governance
- Processing of large data sets
- Presentation of research at national and international conferences and workshops
- Attendance at a relevant summer school where possible
- Training in writing of scientific papers
- Opportunity to spend time at the British Antarctic Survey

References / Background reading list

Cole et al., (2013) Microplastic ingestion by zooplankton. *Environ. Sci. Technol.* 47, 6646-6655.
Fraser et al. (2018) Antarctica's ecological isolation will be broken by storm-driven dispersal and warming *Nature Climate Change*, 8, 704-708
Kaposi et al. (2014) Ingestion of microplastic has limited impact on a marine larva, *Environ. Sci. Technol.* 48(3), 1638-1645.

Lusher et al., (2015). Microplastic and macroplastic ingestion by a deep diving cetacean: the True's beaked whale *Mesoplodon mirus*. *Environ. Pollut.* 199, 185-191.

Tamsitt et al, (2017), Spiraling up: pathways of global deep waters to the surface of the Southern Ocean, *Nature*, 8, 172

Van Sebille et al. (2015), A Global Inventory of Small Floating Plastic Debris. *Environmental Research Letters*, 10.

Waller et al. (2017), Micorplastics in the Antarctic marine system: An emerging area of research, *Sci. of. Total Environ.* 598, 220-227.

Useful links

The application deadline is 1600 hours GMT Monday 7 January 2019 and interviews will take place between 4 and 15 February 2019. For more information about the NERC GW4+ DTP, please visit <https://nercgw4plus.ac.uk>.