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*Appendix II: Science Programme Details*

**Moisture Transport by Water Isotope Analyses**

*PIs & Scientific Institutes*

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*Rationale*

Fresh snow samples will be repeatedly collected in the locale, over the period of the encampment, whenever snow accumulates from blowing / drifting / snowfall (i.e at least daily basis). In addition, a large number of small volume snow samples will be collected in a small area to establish experimental reproducibility. After the mission, the snow samples will be analyzed in the laboratory for 18O/16O and 2H/1H water isotope ratios. By sampling the snow that is being re-mobilized, we will learn about water chemistry and moisture transport around the encampment during the winter months. In addition, the data will act as a proxy for Antarctic surface temperature around the encampment.

The Team will also create a photographic record of how wind shapes the surface, height and spacing of drift features (sastrugi, ridges, etc) of undisturbed snow. Together, such data can provide information about Antarctic atmospheric dynamics in terms of wind action & moisture transport.

*Expedition Methodology*

Snow samples will be collected daily, at least 15 m upwind of the vehicles and campsite.A small pit is dug out (50x50x50 cm) using a shovel, and a stainless steel snow sampler is used to repeatedly collect snow ‘steps’ into a 1 liter ‘whirlpak’ sample bag from surface down 50 cm depth. Snow sample bags are stored in the caboose until uplift.

Repeated photos will be taken of undisturbed snow features (e.g. measure one particular sastrugi in each frame), over the encampment period, using a measuring device (TBD) to provide a reference scale.

*Post-Expedition Analyses*

Snow samples will be returned to scientific laboratories to perform highly sensitive analyses of water isotope ratios in snow. Photographs will be analyzed to track effects of wind on undisturbed snow.**Psychrophilic Bacteria profiling:**

*PIs & Scientific Institutes*

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*Rationale*

The objectives of the project are to determine the potential diversity of extreme psychrophilic (‘cold-loving’) bacteria in Antarctica, and to establish a map on the distribution of bacteria across the Antarctic. The research forms the basis of creating a collection of Antarctic bacteria for conservation and research purposes, bearing in mind that such extremes environments such as Antarctica could be under threat from climate change. Potentially the documentation of such psychrophilic bacteria may have technological and economic significance.

*Expedition Methodology*

Obtain snow (or other) samples in the locale of the encampment. A strategy will be devised for repeated sampling to establish experimental reproducibility. The sampling site must be at least 15 m upwind of vehicle and campsite. avoiding sites contaminated by human activities (urine, footprints etc.). For each sample site, obtain 3 samples (as replicates for statistical analysis), collected within 1 meter radius of each other. Use the 50ml specimen sample bottle to scoop sample (ice, snow, melt-water, soil) into container to fill up. Avoid touching the sample with bare hands. Screw on lid and store specimen sample bottles in box in caboose (unheated), or whenever possible keep the samples frozen in the outdoors. Samples should be kept as cold as possible at all times.

*Post-Expedition Analyses*

Samples will be returned to scientific laboratories to perform Denaturing Gradient Gel Electrophoresis (DGGE) pyro-sequencing to obtain a catalog of the diversity of the bacteria in each sample. Metabolic activities of any cultivable bacteria will be determined using the Biolog system. ***Measurement of the dynamics of coastal Antarctic Ice Sheet drift*:**

*PIs & Scientific Institutes*

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Other PIs TBD

*Rationale*

The naturally slow coastal-bound progress of the AIS (ultimately sloughing off as coastal glaciers into the Antarctic ocean) over the main Antarctic land mass may be affected by current warming trends (for example warmer seas causing increased underside melting of coastal glaciers). The objective of this proposal is to use GPS equipment to map the coastal progress of the Antarctic Ice Sheet, using geodetic (the measurement and representation of the Earth) quality GPS receiver, combined with extensive measures using hand held GPS.

*Expedition Methodology*

The Geodetic GPS system is activated at the beginning of the traverse. The explorer team do not need to carry out any specific daily actions as the GPS is set up to automatically record and store data over the traverse. Handheld GPS systems will be deployed by the Team throughout the encampment period (protocols TBD).

*Post-Expedition Analyses*

Data is downloaded from the geodetic & handheld GPS systems and processed. The aim is to integrate all the GPS data in order to measure the velocity (speed & direction) of movement of the coastal-bound ice sheets.**Weather Observations:**

*PIs & Scientific Institutes*

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*Rationale*

The objective of this proposalis to track weather conditions at the encampment, as an important adjunct to the scientific data collected. In addition, it will regularly return data to the state-of-the-art educational tool ‘Weather Observation Website -WOW’ (http://wow.metoffice.gov.uk), a cloud-based system available in over 40 countries worldwide, which aims to encourage school children & enthusiasts to take an active interest in the weather and how it may be different because of climate change.

*Expedition Methodology*

Equipment: precision aneroid barometer, digital temperature sensor & hand anemometer. The team will perform observations (TBD) from the three manual instruments and e-mail them for entry on the WOW system back in the UK.

*Post-Expedition Analyses*

In addition to data for research & education, another deliverable is to help validate models in Antarctica, depending on the number of observations possible to make each day at the encampment.

**Physiological and Psychological effects - The ‘White Mars’ studies:**

*PIs & Scientific Institutes*

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*Rationale*

Undertaking a polar expedition can be seen as an excellent analogue for space research and although space related studies have been undertaken on fixed polar bases, this type of work has not been performed on a small travelling group who are truly isolated. The work will therefore examine both the physical and psychological effects of the expedition’s extreme nature in a linked series of studies called the ‘White Mars’ project. The conditions of particular interest include:

*The prolonged period of complete isolation -* the traverse team will be alone on the ice from at least March to October 2013 and the isolation experienced will be truly “real” since there would be no opportunity for medical evacuation during the Antarctic winter.

*The altered day-night cycle -* the team will experience three to four months of complete darkness enabling research on changes in circadian rhythm.

*Chronic hypobaric hypoxia -* The expedition will encounter altitudes up to 3,200 meters and furthermore, the extremely low temperatures and the lower gravitational field at high latitudes will further decrease atmospheric pressure, creating low oxygen levels equivalent to about 3,800-meters altitude.

*Exposure to extreme environments -* The Antarctic Plateau is the world’s largest desert exposing the team to both extreme cold and low humidity.

*Periods of unusually limited visual stimuli coupled with potential hypoxic changes to the eyes –* some members of the team will spend many hours on most days looking into darkness and all members will be subject to a degree of chronic hypoxia. This is expected to have effects on vision and visual processing.

*Expedition Methodology*

The Team will undergo full physiological characterization in the UK in terms of body weight, physical fitness and muscle function and structure before and after the journey. They will then undergo a repeating 28 day cycle of diary recording and testing to evaluate the following:

1. Appetite, food intake, activity levels and consequent changes in fitness, strength, body weight and body composition.
2. Reflex speeds and cognitive function using computer based testing
3. Blood and urinary hormones related to stress and circadian rhythms.
4. The retina and visual function.
5. Vitamin D levels and their relationship to immune function.
6. The bacteria being carried by the men on and in their bodies
7. Sleep duration and quality using EEG
8. Psychological status and determination of small group dynamics
9. Haemostatic function (the ability of the blood to clot)
10. Kidney function
11. Performance and mood before and after taking caffeine tablets
12. Responses to hand cooling

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*Post-Expedition Analyses*

The data returned on the physical and psychological effects of the Coldest Journey will be analyzed by a variety of UK and international groups and should prove to be of great interest within the research community.