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## **REDUCING THE RISKS OF LONG-TERM HUMAN SPACE EXPLORATION BY SIMULATING MISSIONS IN AN ANALOG ENVIRONMENT ON MAUNA LOA**

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### **BACKGROUND**

We are establishing a research program using a realistic space habitat, in an analog environment on Mauna Loa, under operational conditions similar to those of a planetary exploration mission, to understand and address the risks of long-term human space exploration.

Although some risks of long-term space exploration identified by the HRP are related to radiation or microgravity, many are common to isolated, confined or extreme environments here on Earth. These so-called analog environments share a significant subset of the conditions astronauts will face in long-term space exploration. Hawaii's geography provides numerous natural analog environments suitable for simulated missions under geological, operational and psychological conditions relevant to those astronauts will experience as they explore the solar system. Of course, no analog is perfect; it is therefore important to ensure that the conditions most relevant to a particular study are high fidelity.

Our habitat will be at about 8000 feet on the saddle slope of Mauna Loa, in a very low vegetation area on a quarried cinder cone. There is very little life visible from the site, human or otherwise, aside from the Mauna Kea telescopes which can be seen in the distance. The habitat will be low-impact and off-the-grid, constructed primarily from repurposed shipping containers. It is designed to allow resupply and maintenance without contact with the crewmembers, who will remain in isolation. The habitat is being constructed for the purposes of the food study (described below), but it is intended for continued use.

### **THE FIRST STUDY**

The first long-term study at this site is focused on the food the astronauts will eat during long-term planetary exploration missions<sup>1</sup>. The current NASA food system, which uses individual pre-prepared meals, is suitable for short-duration low earth orbit missions and stays on the ISS. However, longer-term missions must consider packaging waste, energy efficiency, scheduling, menu fatigue and the effect of sharing food and food preparation duties on the social cohesion of the crew. Our study will examine the trade-offs (energy, effort, food intake, food satisfaction, waste) between pre-prepared meals and meals that require some preparation, over the long term. To be valid, this study must be set in a realistic operational analog, with the kind of workload, communications issues, psychological stresses, and so on, that an astronaut crew would face. We are now recruiting a crew of six to occupy the habitat for four months in early 2013. They will live and work under strict analog conditions, only venturing outside in simulated space suits, and communicating with 'Earth' via channels disrupted by latencies and drop-outs.

### **OPPORTUNISTIC RESEARCH**

This long-term analog mission is also an excellent opportunity for other researchers, and we invite them to participate. We will select a compatible set of opportunistic research studies to test their ideas in this unique environment. Possible topics include remote medicine, crew dynamics, communication technologies, psychological support strategies, and so on. Because there are a large number of identified risks that can only be studied under long-term controlled analog conditions, we plan to repeat this four-month simulated mission scenario annually (with the rest of the year set aside for repairs, upgrades, training, student research, and public outreach), so that all the necessary countermeasures can be explored, developed and thoroughly tested.

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<sup>1</sup> This study is described in more detail in the abstract entitled "Fluid Shift To The Upper Body Reduces Nasal Cavity Dimension And Airflow In Head-Down Bed Rest Subjects" by Caldwell, Halpern and Hunter, also to be presented at this meeting.