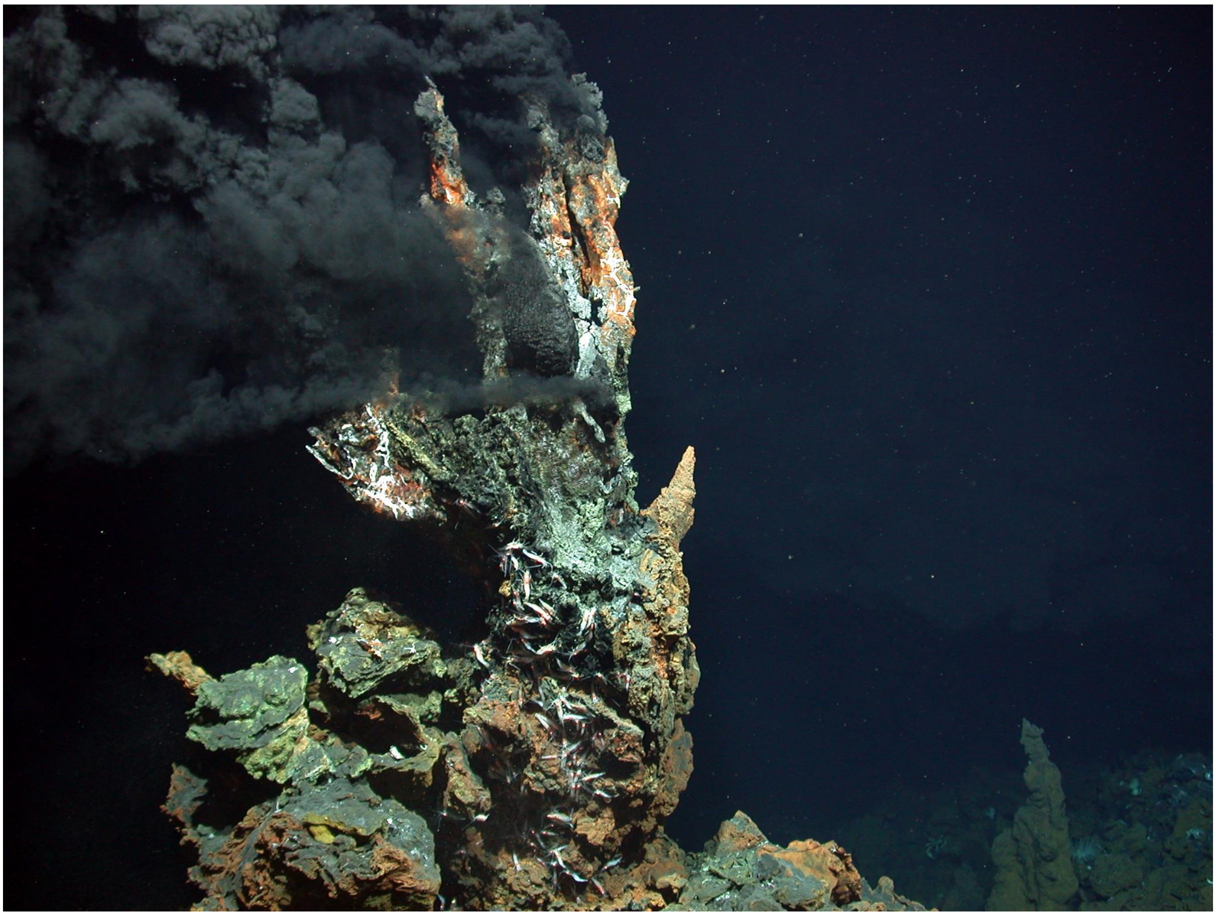
Driving Convergence in Space and Deep-Sea Science Exploration Programs

Space and ocean science share a common interest in investigating the conditions under which life can develop and proliferate. Our best chance of finding life on other planets is by exploring ocean worlds *(Peter Willis, JPL/NASA[1])*, necessitating the use of similar methods and observing strategies as in deep-sea science. This has been the common thread of the ROBEX[2] Sensor Workshop organized alongside the EGU General Assembly on April 27, 2017.



Finding environments on Earth that do not sustain life presents a real challenge. Astrobiologists, on the other hand, are still intensely focused on prospecting for life supporting conditions and finding indicators of biological activity. The concept of **Planetary Habitability (PH)** is the measure of a planet's or a natural satellite's potential to develop and sustain life, extrapolating from favorable conditions for life on earth. Most life forms

[1] https://solarsystem.nasa.gov/news/2017/01/26/a-new-test-for-life-on-other-planets last access May 9,2017

[2] http://www.robex-allianz.de/en/ last access May 18, 2017

relevant to studying PH can be found in extreme earth environments, for instance in the deep sea (e.g. hot vent systems). The seafloor surface sediment is of particular interest because both pelagic and sediment species aggregate here. Comparable to observations made in space, hostile and hard to access ocean environments present a multitude of technical challenges to in-situ observations.

The synergy between space and ocean initiatives was derived from the common need to operate systems in extreme environments. However, the ability for repeated access to marine sites makes it an effective 'test bed' for space systems (e.g., NEEMO[3]). While there were elements of the original intention to profit from reciprocal seeding across both fields, contributions to technological feasibility, accuracy and endurance were provided, to a large degree, by the space community. The 'one shot' nature of most space exploration initiatives dictates this, leaving little room for iterative workflows, which are a traditional component of ocean technological developments. We believe that a strong focus on the study and exploration of life and life supporting/seeding conditions will drive the desired convergence.

From a technical perspective, space and terrestrial observations are curtailed by similar challenges in the temporal and spatial access and discovery. We recommend a of focus on ideas targeting the following points:

- Innovative sensing methods for targeted acquisition of environmental parameters
- In-situ sample processing and analysis to enable long term and adaptive sampling
- Integrated, multidisciplinary sampling systems, including interoperability of data formats and access mechanisms
- Reusable systems to extend the spatial and temporal scale of sampling
- Methods and instruments allowing for the return of samples to earth
- Space and terrestrial science to converge towards a more iterative technical design process to achieve higher reliability
- Best practice framework for promoting interoperability across disciplines and fields or research and exploration

Taking a phased approach, the organization of dedicated workshops and demonstration campaigns will help develop a healthy framework for future collaboration. Joint project acquisitions along basic technology solicitations appear most promising, though the true potential of this collaboration is gaining wider appreciation.

[3] https://www.nasa.gov/mission_pages/NEEMO/index.html