EGU21-13052, updated on 26 May 2022
https://doi.org/10.5194/egusphere-egu21-13052
EGU General Assembly 2021

Concepts to utilize planetary analogue studies for icy moon exploration missions

Marc S. Boxberg[1,2], Fabian Baader[3], Leonardo Boledi[1], Qian Chen[1], Bernd Dachwald[3], Gero Francke[4], Johanna Kerch[2], Ana-Catalina Plesa[5], Anna Simson[1], and Julia Kowalski[2,1]

[1]AICES and Faculty of Georesources and Materials Engineering, RWTH Aachen University, Aachen, Germany
[2]Computational Geoscience, Geowissenschaftliches Zentrum, Georg-August-Universität Göttingen, Göttingen, Germany
[3]Faculty of Aerospace Engineering, FH Aachen University of Applied Sciences, Aachen, Germany
[4]Gesellschaft für Systementwicklung und Instrumentierung mbH, Aachen, Germany
[5]Institut für Planetenforschung, Deutsches Zentrum für Luft- und Raumfahrt (DLR), Berlin, Germany

The icy moons of our Solar System, such as the Saturnian moon Enceladus and the Jovian moon Europa, are scientifically highly interesting targets for future space missions, since they are potentially hosting extraterrestrial life in their oceans below an icy crust. Moreover, the exploration of these icy moons will enhance our understanding of the evolution of the Solar System. For their eventual in-situ exploration, novel technological solutions and simulations are necessary. This also includes model-based mission support to assist the development of future melting probes which comprise one option to access the subglacial water.

Since 2012, several national projects under the lead of the DLR Explorer Initiatives develop key technologies to enhance our capability for the in-situ exploration of ice and to sample englacial or subglacial water. In 2020, the DLR Space Administration started the TRIPLE project (Technologies for Rapid Ice Penetration and subglacial Lake Exploration). This project develops an integrated concept for a melting probe that launches an autonomous underwater vehicle (nanoAUV) into a water reservoir and an AstroBioLab for in-situ analysis. All components are developed for terrestrial use while always having a future space mission with its challenges in mind. As part of a second project stage, it is envisioned to build the TRIPLE system and to access a subglacial lake in Antarctica in 2026.

To deliver key parameters such as transit time and overall energy requirement, a virtual test bed for strategic mission planning is currently under development. This consists of the Ice Data Hub that combines available data from Earth and other planetary bodies – measured or taken from the literature – and allows the visualization, interpretation and export of data, as well as trajectory models for the melting probe. We develop high-fidelity thermal contact models for the phase change as well as macroscopic trajectory models that consider the thermodynamic melting process and the convective loss of heat via the melt-water flow.

In this contribution, we present previous field test data obtained with the melting probe “EnEx-IceMole” from field deployments on temperate glaciers in the Alps and on Taylor Glacier in

Antarctica together with the thermal contact models. We explore the validity and accuracy of the models for different terrestrial environments and use the findings to predict the melting probe behaviour in extraterrestrial locations of future space missions.