NORTHERN ARIZONA PLANETARY SCIENCE ALLIANCE (NAPSA): YEAR 3 PROGRESS AND INITIATIVES. J. J. Hagerty1, N. Barlow2, W. Grundy3, J. Heynssens4, R. Porter5, and T. N. Titus1,1 USGS, Astrogeology Science Center, Flagstaff, AZ; 2 Department of Physics and Astronomy, Northern Arizona University, Flagstaff, AZ; 3 Lowell Observatory, Flagstaff, AZ; 4 Northern Arizona University, Electrical Engineering and Computer Science Department, Flagstaff, AZ; 5 Northern Arizona University, School of Earth Science and Environmental Sustainability, Flagstaff, AZ; Email: jhagerty@usgs.gov.

**Introduction:** Research institutions in Northern Arizona, and Flagstaff in particular, have a long history of conducting high-level planetary science and astronomical research. Scientists and educators at the Lowell Observatory, Northern Arizona University (NAU), the US Geological Survey (USGS), and the US Naval Observatory (USNO), have made key contributions to understanding the origin and evolution of the Solar System; however, collaborations among these institutions have been rare even though their experience and capabilities are complementary. Recognizing the potential benefit of a formalized framework for promoting research and education collaboration, in 2014 representatives from each of these institutions established the Northern Arizona Planetary Science Alliance (NAPSA), which has been reported on at LPSC [1,2]. This alliance consists of the following specific entities: NAU (Department of Physics and Astronomy, School of Earth Science and Environmental Sustainability, Department of Electrical Engineering and Computer Science, Department of Mechanical Engineering, Center for Science Teaching and Learning, and Department of Mathematics and Statistics), Lowell Observatory, USGS (Astrogeology Science Center, Western Geographic Science Center, Arizona Water Science Center, and Geology, Minerals, Energy, and Geophysics Science Center), and the US Naval Observatory.

One of the main objectives of this initiative is to provide a singular portal for members of the planetary science community, the regional school systems, and the general public to access information and resources associated with the cutting-edge planetary research being conducted in Northern Arizona. As such, NAPSA has recently created a public webpage (https://napsaconsortium.wordpress.com/) for posting updates on NAPSA activities and initiatives. We have also developed an email list serve for updating interested parties on NAPSA efforts. Please contact the lead author if you wish to be added to the list serve.

**Rationale and Goals:** Northern Arizona has many unique characteristics that have created a nexus of planetary science research. From the abundance of terrestrial analog sites (e.g., Meteor Crater, the Grand Canyon, the San Francisco Volcanic Field, the Colorado Plateau, and the Verde Valley) to the designation of Flagstaff as the first “International Dark Sky City” ideal for telescopic observations, to Flagstaff being named America’s first STEM community, it is clear that Northern Arizona has much to offer the planetary science community. However, the NAPSA initiative seeks to further increase the reach and impact of Northern Arizona’s planetary research efforts by combining experience, knowledge, and facilities to create a one-stop research and educational resource for anyone interested in planetary science. The establishment of a new Ph.D. program in Astronomy and Planetary Science through NAU’s Department of Physics and Astronomy will only further planetary science opportunities in Northern Arizona.

**Workshops and Seminars:** One of the major objectives of NAPSA is to increase communication between each institution via workshops and seminars. A kickoff workshop was held in May 2014 that was focused on educating scientists, staff, and students about the research being conducted, and the resources that are available at each institution. The first half of the workshop was focused on identifying roadblocks that hamper collaboration and the second half of the workshop was focused on breakout discussion sessions addressing student training, research collaborations, and community outreach. A follow-up poster session was held in September 2014 at the USGS that allowed individual scientists to present research projects that could benefit from collaborations with students at NAU, as well as researchers at other institutions.

In February 2015, NAPSA hosted a workshop on the mapping of small and irregular bodies in the Solar System. The morning session was dedicated to defining the current state-of-the-art, major issues that need to be addressed, and tools and methods useful to the investigation of small bodies. The afternoon discussion session focused on mission ideas, student involvement, and opportunities for collaboration. For the first time, NAPSA began to work with entities beyond Northern Arizona, including Arizona State University and the Johns Hopkins University Applied Physics Laboratory. As a result of these efforts, NAPSA representatives began working in January 2016 with the USGS on an effort to provide an initial assessment of the mineral resources within asteroids [3].

In March 2016, NAPSA held a workshop on “Exoplanets and Habitability: Connecting the Very Large to the Very Small.” The focus of this half day workshop
was to discuss research in all areas related to exoplanets and the potential habitability of planetary surfaces beyond the Earth. Invited presentations by Dr. Jill Tarter and Dr. Penny Boston highlighted the agenda, which also included presenters from all NAPSA institutions.

In September 2015 and 2016, NAPSA hosted poster sessions on the NAU campus (Figure 1). These poster sessions were designed to engage a broader range of students and to involve more scientists and staff. The poster sessions were covered by local media and gained the attention of local, regional, and state government representatives.

**Student Involvement and Training:** Working with the NAU Center for Science Teaching and Learning (CSTL), NAPSA is developing new opportunities for students of all ages to become involved in the planetary sciences. Curriculum support and development is a major component of the NAPSA initiative, with one potential benefit being a degree program in planetary photogrammetry and cartography. Until then, we will strive to involve NAU undergraduate and graduate students in the cutting-edge planetary science projects at Lowell, USGS, and USNO through grant funding and programs such as the NAU/NASA Space Grant Internship program, while also creating opportunities for scientists and research staff to contribute to classes and seminars at NAU. The ultimate goal is to help train the next generation of planetary scientists in a variety of fields. Researchers from USGS and Lowell have been giving presentations in engineering, computer science, and physical science classes to inform students about careers that are available in the field of planetary science.

The collaborative efforts discussed above have resulted in a competitively selected education and public outreach grant from NASA. The grant titled “Planetary Learning that Advances the Nexus of Engineering, Technology, and Science (PLANETS)” is an innovative, collaborative partnership to develop and disseminate out-of-school time (OST) curricular and teacher professional development (PD) modules that integrate planetary science, technology, engineering, and mathematics. The PLANETS team (Center for Science Teaching and Learning (CSTL) and the Department of Physics and Astronomy at NAU; the USGS Astrogeology Science Center; and the Museum of Science (MOS) Boston) will provide students and educators with current, relevant, and engaging planetary science content delivered through OST science, technology, engineering, and mathematics activities [4,5].

**Future Efforts:** In February 2017 NAPSA will host another community workshop. The focus of this workshop is to discuss relevant research in all areas related to “Volatiles Across the Solar System”. This is an opportunity to gain an understanding of current research efforts within northern Arizona and to look for new opportunities to expand that research. The topics include, but are not limited to:

- The origin of volatiles
- The inventory of volatiles
- The role that volatiles play in shaping planetary evolution
- Comparative planetology
- In-situ resource utilization of volatile species

NAPSA will also hold its annual poster session in the fall of 2017 at NAU that will focus on student education and employment opportunities in the planetary sciences. Throughout 2017, the NAPSA steering committee will continue to reach out to other planetary science institutions within and beyond Arizona to further expand the impact and reach of these community efforts.


**Acknowledgements:** The members of the NAPSA Steering Committee would like to thank their host institutions for their continued input and support.

![Figure 1. NAPSA poster session at the DuBois Center on the South Campus of Northern Arizona University, September 2015. Scientists and students from each NAPSA institution presented current and future research affiliated with planetary science.](image-url)