

# Developing a NASA Astrobiology Research Coordination Network for Ocean Worlds

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## Abstract

As the number of confirmed and suspected ocean-bearing worlds in our solar system has continued to expand, we have the opportunity and the challenge of comparing and exploring these worlds – including the original ocean world, Earth – to further our understanding of their formation, evolution, behavior, and habitability. NASA’s Astrobiology Program has recently identified Ocean Worlds as a core area of study that is critical to advancing astrobiology research. To support NASA’s investment in this area of research and new programmatic infrastructure, we are developing a Research Coordination Network for Ocean Worlds (*NOW*). We will discuss the structure and purpose of *NOW*, as well as key goals, deliverables, and upcoming activities that will open to the entire science community.

## 1. Introducing *NOW*

The concept for *NOW* originated as an SMD research coordination network to promote intellectual exchange amongst NASA-funded researchers, as well as the broader scientific community, in the interdisciplinary field of Astrobiology. In response to NASA’s interest in reaching across Divisions, *NOW* also plans to establish new links between scientists supported in the Planetary Sciences and Earth Science Divisions where synergies in observational platforms, and technologies for understanding habitability and biosignature detection, may lead to new developments in both scientific understanding and technology development. The following points emphasize the rationale behind our network and speak to NASA’s RCN goals:

- *NOW* will accelerate ocean worlds research by facilitating communication among active research teams funded across NASA divisions and expanding community-wide engagement.
- *NOW* team members will investigate the diversity of physical and chemical conditions on ocean worlds and how their evolution may support

conditions suitable to sustaining life.

- *NOW* will embrace the ocean worlds exploration program goal as defined by Roadmap to Ocean Worlds (ROW) to “identify ocean worlds, characterize their oceans, evaluate their habitability, search for life, and ultimately understand any life we find” [1].
- *NOW* will enhance the development of future NASA missions to Ocean Worlds, beginning with *Europa Clipper*.
- The *NOW* research coordination network (RCN) will create a network of scientists and technologists that will catalyze NASA’s Ocean Worlds program, making it extremely timely.

Our overarching goal is to advance comparative studies that characterize Earth and other ocean worlds across their interiors, oceans, and cryospheres, investigate their habitability, search for biosignatures, and understand life in relevant ocean world analogues and beyond. This goal will be achieved by communication and collaboration across a virtual network of scientists who have obtained NASA support to conduct diverse research ranging from outer solar system ocean worlds to the oceans and cryosphere of Earth, with implications for astrobiology. *NOW* will advance the goals and objectives of NASA’s Planetary Science and Earth Science divisions by addressing the potential for life elsewhere and studying planet Earth from space to advance scientific understanding of life in remote environments and to meet societal needs.

*NOW* is led by an interdisciplinary team to foster intellectual development across these fields of inquiry and advance technical concepts for assessment of habitability and biosignature detection in remotely sensed and in situ studies. The *NOW* RCN includes all investigators on selected proposals that are relevant to ocean worlds science and who choose to participate. In addition to facilitating communication within the RCN, *NOW* will host activities that are open to the entire scientific community, regardless of funding status.

## 2. Key Areas of Interest

Ocean Worlds research is at the forefront of Astrobiology, guiding the search for life beyond Earth, particularly in three key areas supported by NASA's Planetary and Earth Science Divisions:

- **Geophysics:** The ice-covered ocean worlds of the outer solar system are geophysically distinct from the terrestrial planets. Exploring their geophysical evolution, and processes occurring at their ice-ocean and ocean-rock interfaces, provides unique opportunities for comparative studies throughout the solar system, including with Earth's cryosphere, especially in the arctic and Antarctic.
- **Ocean Systems:** Ocean worlds provide a first opportunity for comparative oceanography between Earth and other planets, including ice-ocean interactions. Such studies are not only important in terms of understanding habitability beyond Earth but also to better understand Earth's ability to sustain life through time.
- **Life:** Ocean worlds provide the nearest planetary opportunities to search for extant Earth-like life. They are predicted to host the essential ingredients for habitability (water, energy and essential elements). Analog and theoretical studies of resource exchange, the generation of life-supporting energy, especially at rock-water and ice-ocean interfaces, and detecting signs of life in Earth's cryosphere and ocean will further understanding of life, both on Earth and on other ocean worlds.

Importantly, *NOW* creates a bridge between NASA Planetary Sciences and Earth Sciences division programs by which we can **“advance space exploration by helping scientists recognize the basic markers for life across the universe”** (NASA Earth Sciences Division). *NOW* is creating communication channels that don't typically exist between the disciplines required for interrogation of ocean worlds in the next generation of missions focused on exploration of the outer solar system and beyond. **We anticipate multidisciplinary advances in understanding habitability and development of new technologies in support of the search for life.**

## 3. *NOW* Implementation

The following objectives will be met through collaborative, cross- and interdisciplinary activities.

### Objectives:

1. Identify and stimulate novel directions of inquiry through enhanced communication within NASA's ocean worlds PI community.
2. Pursue activities that both reveal and help address critical knowledge gaps in ocean worlds research.
3. Stimulate and facilitate new ocean worlds collaborations to undertake high-impact interdisciplinary research.
4. Identify and integrate research on Earth and other ocean worlds (e.g. oceans, their interiors, and the cryosphere) to catalyze synergistic studies that identify the conditions and potential for life.
5. Cultivate and augment the training of a new generation of interdisciplinary ocean worlds researchers.

### *NOW* Activity concepts:

The *NOW* RCN will collectively decide on the set of activities that will most efficiently advance ocean worlds science, which may include:

- Cross-training boot camps for planetary and ocean scientists
- Workshop series *NOW* Earth, *NOW* Europa, *NOW* Titan, *NOW* Enceladus, etc. that would also include public-engagement aspects
- Field-based activities involving cross disciplinary teams working together to address ocean worlds-relevant science.
- Infusing Ocean Worlds sessions into national and international meetings
- NASA mission planning training seminars

*NOW* will provide a forum for exchange of ideas and learning across the interdisciplinary spectrum of backgrounds, perspectives, and diversity represented within the network of NASA-funded ocean worlds investigators and work to increase inclusion among future funded researchers.

## Acknowledgements

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## References

- [1] Hendrix, A., T. Hurford, and 26 colleagues (2019). The NASA Roadmap to Ocean Worlds. *Astrobiology* 19(1): 1-27.