The Ocean Worlds Working Group

Linking ocean world science to technology development

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Agenda

What are Ocean Words from an OWWG perspective?

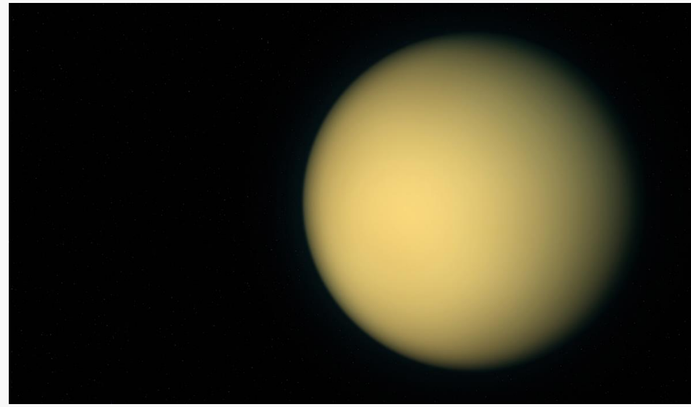
What is the OWWG, and what is its goal?

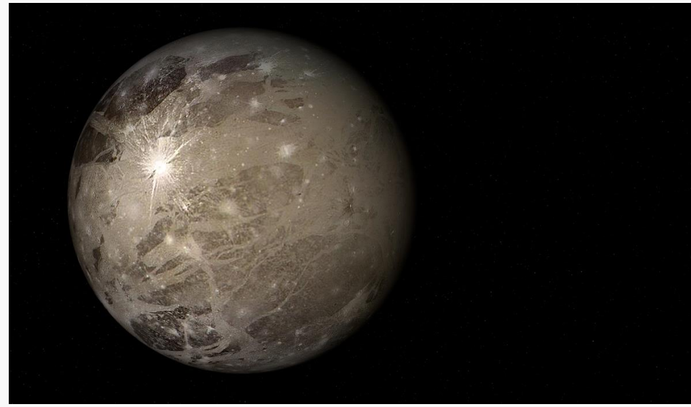
How are you accomplishing that goal?

What is the current status?

What are Ocean Worlds from an OWWG perspective?

- OPAG/SBAG/NOW fall under PSD, and we, therefore, are focused on Oceans beyond Earth.
- The OWWG is focused on **missions** that explore ocean worlds, and we, therefore, focus on our Solar System (where we can **visit!**).
- We include bodies that **currently** either **have or may have** substantial **subsurface liquid water** reservoirs.
  - Europa, Ganymede, Callisto, Mimas, Enceladus, Dione, Titan, Uranian Satellites, Triton, Ceres, Pluto, large KBOs.
- We explicitly do not include Mars and Venus (ancient oceans) and Io (magma oceans).





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What is the OWWG and what is its goal?

- The OWWG is a cross-AG working group chartered by OPAG, SBAG, and NOW to “create an actionable Ocean Worlds exploration strategy”.

- From *Origins, Worlds, and Life* (p. 568):
  - “Recommendation: NASA should develop scientific exploration strategies, as it has for Mars, in areas of broad scientific importance, for example, Venus and ocean worlds that have an increasing number of U.S. missions and international collaboration opportunities.”
- From *NASA’s 90-Day Response to the 2023-2033 Decadal Survey* (p. 20):
  - “Response: NASA does not concur with this recommendation and asserts that specific scientific exploration strategies should be community-generated by bodies such as the Analysis Groups, advisory committees, and NASEM’s standing boards and commissioned studies.”

Goal:

Create an actionable Ocean Worlds Exploration Strategy

- Specific, prioritized science goals
- Identify needed technology development
- Multi-decadal timescale
- Fit within NASA’s existing framework

Why do we need the OWWG? How is it different from OPAG/SBAG/NOW?

The OWWG is a response to the 2023 Decadal Survey's call for an Ocean Worlds Program.

OPAG and SBAG have diverse contituents with different priorities.

- OPAG includes both the giant planets and the OW community
- SBAG includes everything from dust to KBOs

The OWWG is specifically "cross-AG" and open to **the entire OW community**.

Objective: Create a document that describes a strategy for exploring Ocean Worlds in our Solar System

Approach:

Community driven.

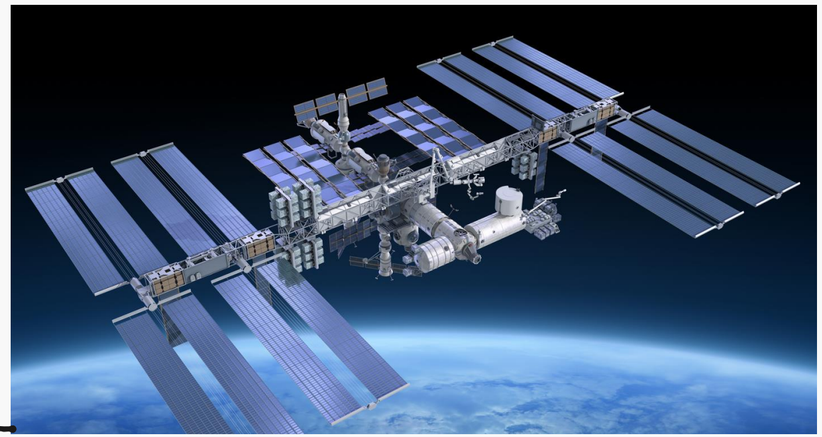
Survey existing **literature** to identify relevant material.

Identify **gaps** in scientific understanding and technology development.

Prioritize science goals to inform the most urgent **technology** needs.

Identify innovative **technology** solutions that can enable new scientific investigations.

Two Subgroups:



Science Goals

Tasked with identifying and prioritizing specific science goals that drive future exploration of Ocean Worlds.

Technology Roadmap

Tasked with identifying the technology development needed to explore Ocean Worlds. Includes instruments and architectural needs.

Outcome: A prioritized strategy that combines science goals, technology development needs, and future mission opportunities over the next 3-5 decades.

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The OWWG Approach

Utilize previous community efforts to define prioritized science questions and identify the technology development necessary to answer them.

Activities:

- Community **review** of relevant literature (Decadals, White papers, peer-reviewed literature)
- Organization and prioritization of key **science questions**
- Identification of required measurements and **critical technology**

Actions:

- Community Q&As and presentations
- **Working meetings** of subgroups working on science-technology traceability
- Joint meetings

Expected Outcomes:

- A limited set of prioritized **science questions** that link directly to necessary **technology development**.
- A limited set of **missions** that address these prioritized questions, fit within NASA's existing structures, and are prioritized for additional study.
- A strong, diverse, and welcoming Ocean Worlds **community**.

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Our Journey

OWWG timeline so far

October 2023

Group was formed and started strategizing its way forward

Jan - June 2024

First round of community engagement

July - October 2024

Working on lessons learned, strategizing next round of community engagement

Moving Forward

Second round of community engagement

Driving Science Questions* for Ocean Worlds Exploration:

**Preliminary wording*

1. Which outer solar system bodies contain **liquid water** in their interior?

2. How do Ocean Worlds **form and evolve** over time?

3. Do Ocean Worlds have past or present environments suitable for life? Which Ocean Worlds are **habitable**?

4. Does past or present **life** exist on Ocean Worlds?

Linking Science and Technology Development

Example traceability working draft for question 4 (Does past or present life exist on Ocean Worlds?):

							Mission Architecture							Ocean Worlds											
Science Question	Science Goal	Investigation	Measurements	Instrument	Instrument Tech Gap	Potential strategic approach to address instrument tech gap	Flyby	Orbit	Lander	Rover	Melt Probe	Submarine	Sample Return	Europa	Enceladus	Titan	Triton	Ceres	Pluto	Uranian Satellites	Mid-sized Saturnian Sats	Ganymede & Callisto	Other KBOs	Mission Tech Gap	Potential Strategic Approach to Address Mission Tech Gap
4.Does past or present life exist on ocean worlds	Determine whether biosignatures are found in plume material	amino acid type and abundance	mass spectrometry on samples directly during the flyby process	mass spectrometer operated during fast flyby (3-7km/s): Impact Ionization Mass Spec (SUDA-like)	relevant limit of detection not demonstrated yet		X							X	X		X							sterile collection of milligram quantities of material from plumes, pre-processing and transfer to instruments	

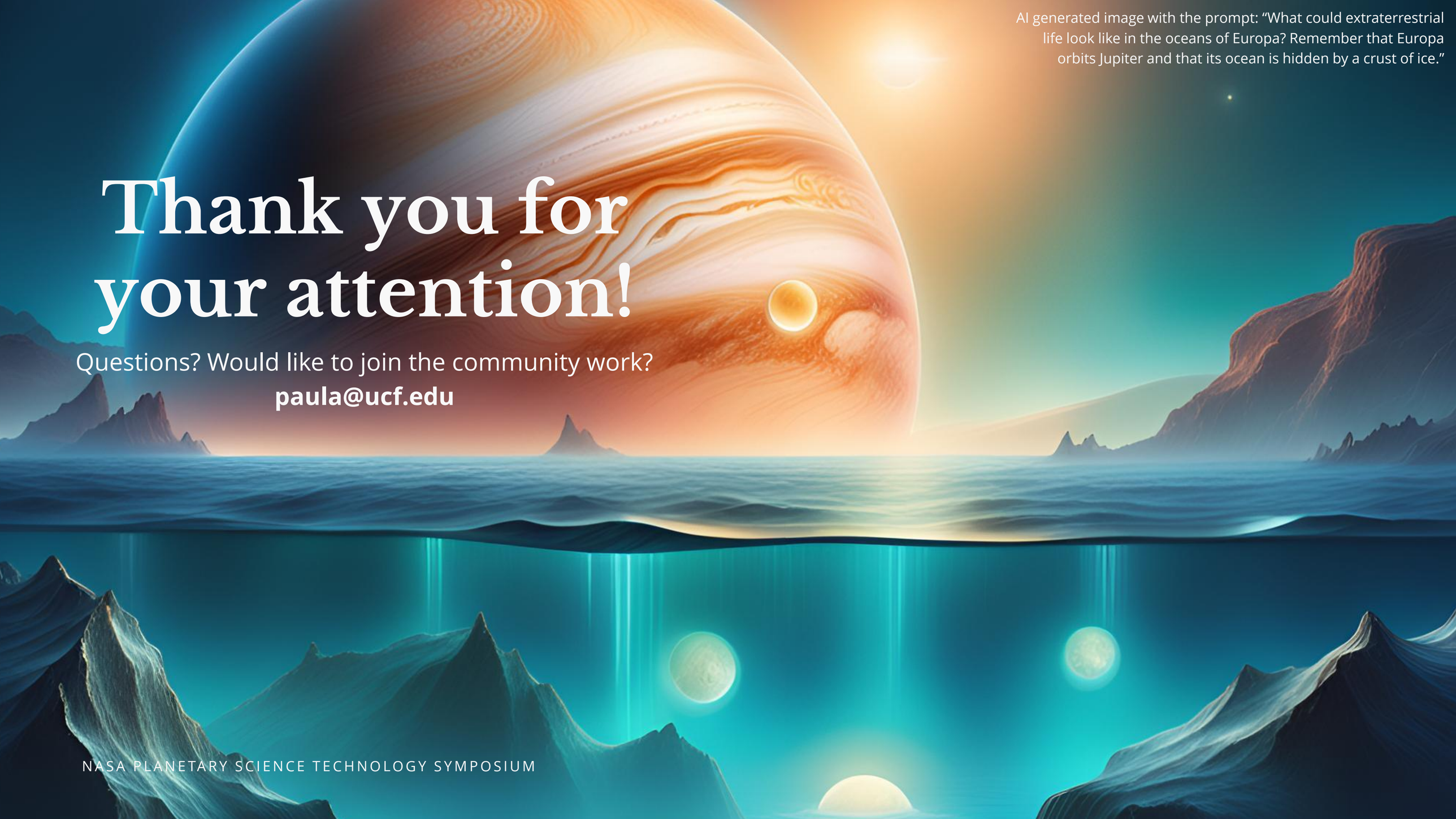
Linking Science and Technology Development

Example traceability working draft for question 2 (How do Ocean Worlds form and evolve over time?):

							Mission Architecture							Ocean Worlds											
Science Question	Science Goal	Investigation	Measurements	Instrument	Instrument Tech Gap	Potential strategic approach to address instrument tech gap	Flyby	Orbit	Lander	Rover	Melt Probe	Submarine	Sample Return	Europa	Enceladus	Titan	Triton	Comes	Pluto	Uranian Satellites	Mid-sized Saturnian Sats	Ganymede/Callisto	Other KBOs	Mission Tech Gap	Potential Strategic Approach to Address Mission Tech Gap
2. How do ocean worlds form and evolve	Determine the sources and magnitude of heat and energy within ocean worlds, and how Heat/energy is transport through ocean worlds (geophysics)	Measure the current surface heat flux of known ocean worlds	Remote Sensing heat flow measurements via Microwave radiometry	Microwave radiometer	TRL level? Improvements relative to Juno		X	X						X	X	X	X	X	X	X	X	X	X	Power and accommodation of MWR	

Moving Forward

- OWWG Leads are finalizing the draft traceability
- OWWG Leads are reaching out to community members for specific input
  - Utilizing the groups formed in the spring
- Preliminary draft traceability released to the community for comment
  - Form the “meat” of the strategy document



AI generated image with the prompt: “What could extraterrestrial life look like in the oceans of Europa? Remember that Europa orbits Jupiter and that its ocean is hidden by a crust of ice.”

Thank you for your attention!

Questions? Would like to join the community work?

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NASA PLANETARY SCIENCE TECHNOLOGY SYMPOSIUM