2021 2030 United Nations Decade of Ocean Science for Sustainable Development

OASIS Observing Air-Sea Interactions Strategy

Observing Air-Sea Interactions Strategy (OASIS)

Face-to-Face Meeting Summary Report

November 2024

Contents

Overview

The Observing Air-Sea Interactions Strategy (OASIS) was initiated as a SCOR working group #162 in November 2020 and became an endorsed UN Decade of Ocean Sciences for Sustainable Development programme in 2021. While OASIS has hosted many virtual meetings large and small, the OASIS Face-to-Face (F2F) Meeting in February 2024 was the first and last face-to-face meeting of the SCOR working group and marks a midpoint for the UN Decade programme.

Meeting Goals

The OASIS F2F Meeting took place on February 17-18, 2024 in New Orleans, Louisiana (USA), on the weekend prior to the Ocean Sciences 2024 meeting. There were 58 in-person and 15 virtual participants. The meeting aimed to achieve the following outcomes:

- Review, clarify, and share OASIS mission, and vision for 2030
- Review, vet, and help promote current OASIS activities and endorsed projects
- Highlight gaps and emerging areas for the OASIS
- Reorganize the OASIS governance under Grand Ideas (see Figure 1, next page)
- Ensure everyone knows how to Get Involved

Attendees at the OASIS Face-to-Face Meeting, February 2024.

Figure 1: *Graphic showing the OceanObs'19 white papers that went into creating the OASIS Grand Ideas (shown on the right).*

Workshop Summary

The F2F meeting covered various discussions and presentations aimed at advancing and unifying strategies for observing air-sea interactions. Day 1 began with welcome remarks and emphasized the importance of collaboration and mentorship in expanding global data availability. Key themes included optimizing observation networks, satellite utilization, and enhancing earth system models. Lightning talks highlighted UN Ocean Decade projects linked to OASIS, including Ocean Observations Initiative (OOI), uncrewed surface vehicles (USVs) for the Global Ocean Observing System (GOOS), and Southern Ocean Fluxes (SOFLUX), addressing data sustainability, model development, and community engagement. Discussions revolved around data management, best practices, and capacity building, with a focus on fostering partnerships and supporting small island developing states. Breakout sessions delved into topics like data standards, stakeholder communication, and satellite data utilization, emphasizing the need for coordinated efforts and capacity development, particularly in coastal regions.

At the opening of the meeting, participants in person and online were queried through live polls asking "What are your air-sea interaction topics of interest/research?" There were 158 responses. The summarized word mapping results are presented in Figure 2. The larger text represents answers submitted more frequently - i.e. where there is more critical mass of interest. The results also indicate the level of diversity in flux-type research, expanding over several disciplines, methods and regions of the global ocean.

Participants were also asked a series of questions related to their interest in conducting research and/or education mobility between institutions and countries. There were 31 responses, with 24 participants answering "Yes" to "Would you consider mobility between the north-south / south-south?" When asked how long they would stay, 11 participants said <1 month, 12 said <3 months, and 6 said 3-12 months. Lastly, participants were asked about what mobility collaboration activities would they undertake on such research visits. These included: workshops, summer schools and training, joint proposal writing, research planning for joint experiments and fieldwork, and network building.

Day 2 of the OASIS workshop focused on refining the organization's vision, establishing five-year goals, and enhancing interdisciplinary collaboration. Key discussions included the development of a value proposition, the importance of industry participation, and the need for a clear communication strategy. Participants explored satellite air-sea fluxes, process studies, and the integration of new technologies and methods for improving data collection and model forecasts. Breakout groups addressed observational gaps, the importance of co-designing field campaigns, and leveraging existing opportunities in the Southern Ocean. The day concluded with a consensus on creating an OASIS Steering Committee, establishing term limits for leadership, and identifying actionable steps to achieve OASIS's four overarching goals, which are outlined in this report. Overall, the meeting aimed to align community efforts, address challenges in observing air-sea fluxes, and outline strategies for advancing global air-sea interaction observations within the OASIS community and beyond. Mission and vision statements were proposed and refined throughout the workshop.

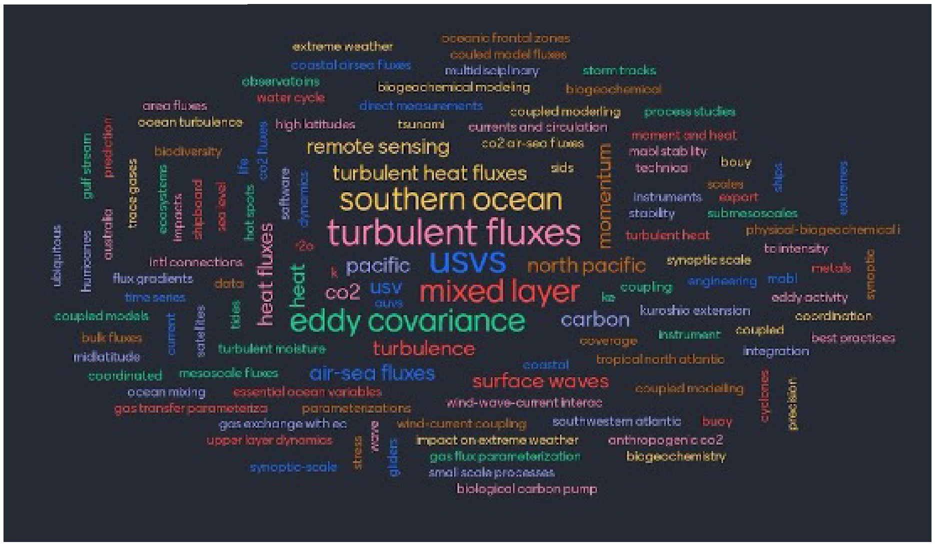

Figure 2: *A word cloud showing participant responses to "What are your air-sea interaction topics of interest/research?" Larger text indicates multiple submissions.*

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OASIS Mission & Vision

Observing Air-Sea Interactions Strategy

Mission: To develop a practical, integrated approach for observing air-sea exchanges associated with the Energy, Water, Carbon and Life Cycles.

Vision: To have a pathway to Get Involved in Ocean-Atmosphere Interaction Science for Sustainable Development.

OASIS is focused on establishing a strategic vision with clear near-, mid-, and long-term goals to guide our efforts from 2024 to 2030. OASIS aims to develop proposals and requirements, ensuring that our objectives align with the evolving needs of our stakeholders. Current efforts include uncrewed surface vehicles; best practices and findable, accessible, interoperable, and reusable (FAIR) data principles; strengthening partnerships and small island developing states (SIDS) capacity development; and international global ocean observing system efforts. The top priority action from this workshop is establishing our five-year goals and achieving consensus on the top 3-6 funding priorities and their implementation strategies.

Our strategic vision plan includes:

- Developing specific five-year goals to implement our Grand Ideas.
- Building strong partnerships around the world, including in the global south and in SIDS. Our goal is that these air-sea interaction observations are made globally and used globally.
- Establish a scientific steering committee that can shape and implement the OASIS vision.
- Expanding the diversity of voices within OASIS beyond observationalists to include modelers, end users, and industry representatives.
- Mentoring the next generation of leaders through leadership ladders that empower and connect early career ocean professionals (ECOPs) on the global stage.
- Serving as a bridge between different communities across our Grand Ideas and enhancing interdisciplinary collaboration.
- Crafting a value chain and clear value propositions.
- Integrating air-sea experts with new and existing working groups, such as the Intergovernmental Panel on Climate Change, US Climate Variability and Predictability Program, World Climate Research Program, and others.
- Communicating and clarifying air-sea interaction information to ensure effective outreach, including language translation support for organizations like the United Nations Educational, Scientific and Cultural Organization (UNESCO).

OASIS Restructuring

OASIS is in need of restructuring following the conclusion of the SCOR working group. The transition will involve establishing a Scientific Steering Committee with senior mentors and ECOP leads, and term limits to ensure dynamic and diverse leadership. This restructuring is essential for effective governance until 2030 and beyond, aligning with the goals of the UN Ocean Decade. The steering committee will oversee task teams within each of OASIS's grand ideas, including:

- **The Grandest Idea of All** – The OASIS Theory of Change (encompassing capacity strengthening and partnership building, developing recommended practices, and creating FAIR data and OASIS products),
- **Grand Idea 1:** An Expanded Global Network of In Situ Air-Sea Interaction Observations,
- **Grand Idea 2:** Satellites Optimized for Air-Sea Fluxes, and
- **Grand Idea 3:** Improved Models and Understanding of Air-Sea Interaction Processes.

Each theme team will have at least two leads, including a representative from ECOP community, ensuring diverse and innovative leadership. To maintain continuity and fresh perspectives, team leadership will have overlapping term limits. The OASIS program office will schedule regular meetings to facilitate ongoing collaboration and strategic planning, including establishing terms of reference to guide the teams' objectives and responsibilities. This restructuring aims to enhance the effectiveness, leadership, and impact of OASIS in the air-sea observation community.

Next Steps

Action Items

- Establish an OASIS Steering Committee
- Finalize task teams and leadership, with leadership ladder and term limits
- Set actionable steps to achieve OASIS's overarching goals

Implementing Actions

The UN Decade OASIS programme (Action #97) seeks scalable contributions to support:

1.	ECOP participation in OASIS activities, including for honorariums, travel, publications relevant to OASIS activities. These funds would be administered by the OASIS project office	**$100K/year**
2.	Creation of a website and data portal for the "USV network for GOOS" project (Endorsed Action # 35.3) linked to OASIS. This website and data portal would form a centralized home for the international USV for GOOS Community of Practice	**$200K/year**
3.	OASIS project office at UCAR Center for Ocean Leadership, including 1 FTE with professional communication skills	**$150K/year**
4.	Face-to-face community workshops for OASIS programme and its individual theme teams and task teams (i.e., OASIS, Best Practices, FAIR data, Partnership & Capacity Strengthening, USV for GOOS, Fluxes from Space, SOFLUX, Tech Development Dream Team...)	**$30K each**
5.	Data buys for air-sea interaction observations (e.g. from Saildrone, Inc., Sofar, Inc) delivered to public "Open Data" repositories and modeling & data centers around the world, with support of mission management and scientific analyses	**$1M each**
6.	a. "Scientist in Residence" scientific extended visits (2 weeks or longer) to SIDS & the Global South and b. Short (2 - 6 months) paid internships to foster institutional collaboration	**$5-15K**
7.	OASIS Graduate Research Fellowship with Academic and Research Advisors and OASIS community mentors from multiple institutions	**$90K**

The USV Network for GOOS Project (Action #35.3) linked to the OASIS programme seeks scalable contributions to support:

1.	Creation of a website and data portal for the "Uncrewed Surface Vehicle (USV) network for GOOS" project (Endorsed Action # 35.3) linked to OASIS. This website and data portal would form a centralized home for the international USV for GOOS Community of Practice	**$200K/year**
2.	Face-to-face community workshops	**$30K each**
3.	Data buys for air-sea interaction observations (e.g. from Saildrone, Inc., Sofar, Inc) delivered to public "Open Data" repositories and modeling & data centers around the world, with support of mission management and scientific analyses	**$1M each**
4.	OASIS Graduate Research Fellowship with Academic and Research Advisors and OASIS community mentors from multiple institutions	**$90K**
5.	Early Career Ocean Professionals (ECOP) participation in the USV Network for GOOS project, including for Honorariums, travel, publications	**$30K**

Acknowledgements

We acknowledge funding provided by national committees of the Scientific Committee on Oceanic Research (SCOR) and from a grant to SCOR from the U.S. National Science Foundation (OCE-2140395) to support SCOR Working Group #162 (OASIS) activities, including covering some of the OASIS F2F Workshop hosting costs and additional travel support, which helped make this event a success.

Additionally, this workshop would not have been possible without the support from NOAA's Global Ocean Monitoring and Observing Program (GOMO) for funding early career ocean professionals' travel and participation and the NOAA Climate Variability and Predictability (CVP) program for funding some of the workshop hosting costs. Lastly, we are grateful to the UCAR Center for Ocean Leadership (COL) for serving as the OASIS program office and organizing the workshop.

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Appendices

Appendix 1: Meeting Agenda

DAY 1	DAY 2
Welcome	*Welcome*
Overview of OASIS	**Grand Idea 2:** Satellite Air-Sea Fluxes: New Views from Space
Grandest Idea of All: Theory of Change	**Breakout Groups:** Grand Idea 2
Breakout Groups: Theory of Change	**Report Out:** Desired Outcomes for Grand Idea 2
Report out: Desired Outcomes for Theory of Change, Desired Outcomes for OASIS	OASIS Restructuring – OASIS Projects, Theme Teams and Task Teams, OASIS Leaders and Communication
Lunch & Poster Session	*Lunch & Poster Session*
Grand Idea 1: Global In Situ Array: Connecting the Parts	**Grand Idea 3:** Process Studies that Feed ESMs
Breakout Groups: Grand Idea 1	**Breakout Groups:** Grand Idea 3
Report Out: Desired Outcomes for Grand Idea 1	**Report Out:** Desired Outcomes for Grand Idea 3
Working Session – OASIS Community of Practise Papers in Preparation	OASIS Going Forward
Closing Remarks, Agenda for Day 2	Day 2 Closing Remarks
Evening Social Gathering	*Workshop Adjourn*

Appendix 2: Sessions in Detail: OASIS Goals

GRAND IDEA 1: An Expanded Global Network of In Situ Air-Sea Interaction Observations

Guiding Questions

- What are the gaps?
- What emerging tech development is needed?
- How can OASIS coordinate existing and emerging observing efforts to expand capability of the Global Ocean Observing System?
- Do any of the Tech Development or Network Design activities need funding?
- What is the Pitch?
- What is the “Value proposition” for stakeholders or potential funders?
- Vision for OASIS: What do you hope OASIS accomplishes in the next 1 year, 3-5, 10 years?

Key Takeaways

GAPS IN OBSERVATIONS & PROCESS UNDERSTANDING

- Critical gaps in making observations in undersampled, remote, and extreme environments (e.g., Southern Ocean, polar regions, high wind conditions).
- Need for better process studies to improve and constrain flux parameterizations, with particular attention to coastal and extreme environments.
- Gaps in geographic coverage and lack of subsurface data. Enhanced observations are needed for both short-term weather and long-term climate modeling.

TECHNOLOGICAL CHALLENGES & OPPORTUNITIES

- Development of low-cost, miniaturized instruments for remote and extreme conditions (e.g., autonomous vehicles, drones, and small-scale devices).
- Issues with power, communication, and instrumentation failures in harsh environments, particularly for unmanned platforms.
- Better standardization of data validation and quality control is essential for different platforms (e.g., satellites, USVs).
- Emerging technologies (e.g., microplastic flux monitoring) and mass-produced instruments could lower costs and increase accessibility for developing nations.

DATA MANAGEMENT & STANDARDIZATION

- Improve interoperability and harmonization of data, especially for essential ocean variables (EOVs) and flux measurements.
- Need for centralized data repositories to facilitate intercomparison studies and model validation.
- Apply FAIR principles to improve data accessibility and reduce barriers like paywalls, ensuring data is available to the broader community, including the Global South.

CAPACITY BUILDING & GLOBAL COLLABORATION

- OASIS can play a key role in promoting collaboration, especially between Global South and established institutions, through training programs, workshops, and internships.
- Focus on co-developing solutions and enhancing capacity in data-sparse regions (e.g., polar, coastal, and Southern Ocean).
- Engage local communities and industries by addressing region-specific needs and aligning with global research objectives.

FUNDING & SUSTAINABILITY

- Sustained funding is necessary for long-term observation networks and process studies. OASIS should advocate for more stable, long-term investment in these areas.
- Leverage public-private partnerships and philanthropic funding to support the development of new technologies and observation networks.
- Promote OASIS as a key player in coordinating funding efforts and connecting stakeholders to facilitate global research and operationalization.

VISION FOR OASIS

- In the short term, focus on improving strategic goals related to climate and weather models and increasing visibility.
- In the longer term, build a large-scale observation network, operationalize research, and enhance public communication strategies to highlight OASIS's societal relevance.
- Position OASIS as an educator and leader in setting data standards and advancing the use of emerging technologies in air-sea flux observations.

GRAND IDEA 2: Satellites Optimized for Air-Sea Fluxes

Guiding Questions

- What is needed from the in situ network to construct & validate sat-flux products?
- Is it possible to create ocean-based WMO fiduciary reference stations? Supersites?
- What intensive field programs are needed for each OASIS-relevant satellite proposal?
- How can these OASIS-relevant satellite proposals be complementary?
- What is needed from a System of satellites for OASIS goals? How can OASIS help?
- Do any of these activities need funding? What is the Pitch? What is the "Value proposition" for stakeholders or potential funders?
- Vision for OASIS: What do you hope OASIS accomplishes in the next 1 year, 3-5, 10 years?

Key Takeaways

GAPS IN OBSERVATIONS

- Limited observations in extreme and remote environments (e.g., high latitudes, tropical, polar, and storm regions).
- Need for more accurate, high-resolution flux measurements to improve parameterizations, especially in coastal and extreme environments.

- Mismatch between satellite and in-situ data due to spatial and temporal differences, creating validation challenges.
- Geographic gaps in the observation network, requiring more coverage, including long-term and mobile platforms like USVs Uncrewed Surface Vehicles.

TECHNOLOGICAL NEEDS & SOLUTIONS

- Development of low-cost, high-resolution instruments (e.g., pCO2 sensors, autonomous vehicles) for use in difficult conditions.
- Co-hosted science packages on commercial satellites and collaboration with industry to leverage existing infrastructure.
- Continued focus on developing and maintaining long-term observation networks and "super sites" for calibration and validation.
- Expansion of satellite missions to ensure continuity and overlapping data for cross-validation.

DATA MANAGEMENT & INTEGRATION

- Importance of building centralized data repositories and improving data harmonization between in-situ and satellite observations.
- Need for comprehensive uncertainty assessments in flux measurements to improve trust in model and data outputs.
- Promotion of open-source satellite data processing routines to enable community access and collaboration.

CAPACITY BUILDING & GLOBAL COLLABORATION

- Strengthen partnerships between the in-situ and satellite communities, focusing on transparency and collaboration.
- Engage the Global South and coastal nations in developing and maintaining observation systems for societal benefits, such as climate adaptation and weather prediction.
- Increase training programs, especially in underrepresented regions, to build local capacity and improve data collection and analysis skills.

OASIS'S ROLE & VISION

- Facilitate collaboration and knowledge-sharing among diverse stakeholders, ensuring sustained funding and engagement across the air-sea interaction community.
- Advocate for broader, long-term observation networks that support global climate models and societal applications (e.g., greenhouse gas monitoring, disaster preparedness).
- In the short term, focus on workforce development, improving flux parameterizations, and connecting communities. Long-term goals include enhanced climate models and influencing policy through accurate data.

FUNDING & OUTREACH

- OASIS should unify its pitch to funders, emphasizing societal impacts, such as climate policy and environmental protection.
- Engage young scientists and early-career researchers (ECOPs) by promoting involvement in proposal writing and project leadership.
- Advocate for long-term funding to support both process studies and observation networks.
- Explore partnerships with commercial industries and philanthropic organizations to secure sustained investments.

GRAND IDEA 3: Improved Models and Understanding of Air-Sea Interaction Processes

Guiding Questions

- What are our gaps in process understanding limiting Earth System Model Forecasts?
- What are the gaps in observations that constrain the Earth System Model Forecasts?
- What parameterisations need improvement & scaling up? What is the strategy?
- How can OASIS help other groups working on these (e.g., SOLAS, CLIVAR, UN Decade Programmes…)?
- Do any of these activities need funding?
- What is the Pitch?
- What is the “Value proposition” for stakeholders or potential funders?
- Vision for OASIS: What do you hope OASIS accomplishes in the next 1 year, 3-5, 10 years?

Key Takeaways

GAPS IN PROCESS UNDERSTANDING & OBSERVATIONS

- Missing or poor microphysics and flux parameterizations, particularly in extreme conditions and fine-scale processes.
- Lack of observations for meso- and submesoscale ocean currents, subsurface coupling, and diurnal air-sea interactions.
- Critical gaps in high-wavenumber processes, surface waves, gas exchange, and latent heat transfer at high winds.
- Limited data from coastal, polar, and underrepresented regions, such as the Southern Ocean.
- Need for long-term sustained observations to capture interannual variability and support process studies.

PARAMETERIZATION & MODEL IMPROVEMENTS

- Parameterizations are often adequate or “good enough” globally but regionally inappropriate (e.g., in polar and coastal areas).
- Importance of using observations to reveal biases in models, avoiding “tuning” without justification.
- Hierarchical approach needed to connect observations with model testing and improvement, ensuring statistical constraints rather than direct data-driving.

TECHNOLOGY & METHODS

- Need for scalable, miniaturized, low-cost technologies, such as drones or citizen science initiatives, to expand data collection.
- Developing new platforms like mobile "supersites" to improve data collection and upscale flux measurements.
- Improving collaborations with field campaigns to combine observations with data assimilation and modeling components.

OASIS'S ROLE & VALUE PROPOSITION

- OASIS as a key connector for global collaboration, helping to integrate air-sea interaction projects and provide international networking.
- Promoting engagement through outreach, bridging language barriers, and making the scientific community more accessible.
- Providing resources for process studies, particularly through funding efficiencies, field campaign networking, and capacity building.
- Positioning OASIS as an advocate for securing funding by demonstrating its importance to model development and Earth system forecasting.

FUTURE VISION FOR OASIS

- Short-term (1 year): Improve outreach, connect community members, and expand visibility of OASIS.
- Medium-term (3-5 years): Establish structured collaboration networks and enhance international participation.
- Long-term (10 years): Achieve systematic improvements in model accuracy by filling observational gaps and influencing global ocean observation networks.

GRANDEST IDEA OF ALL: Theory of Change

Guiding Questions

- Who are your partners & stakeholders? What partnerships could OASIS help foster?
- How can OASIS help make data more FAIR? What toolboxes? Products are needed?
- What are emerging best practices needed? How can they be more equitable?
- Do any of the Theory of Change activities need funding? What is the Pitch? What is the "Value proposition" for stakeholders or potential funders?
- Vision for OASIS: What do you hope OASIS accomplishes in the next 1 year, 3-5, 10 years?

Key Takeaways

COLLABORATION & COMMUNITY BUILDING

- OASIS can unify a diverse community, promoting best practices and international collaboration.
- Enhance outreach, especially in the Global South, by improving accessibility to data and engaging local scientists.

- Build partnerships across sectors (policy, private, public), ensuring a balance between scientific and societal needs.

DATA STANDARDS & FAIR PRINCIPLES

- Emphasize the need for FAIR (Findable, Accessible, Interoperable, and Reusable) principles for data sharing.
- Standardize data collection and reporting, especially for new technologies (e.g., USVs), and harmonize global data standards.
- Improve metadata quality and reduce barriers like paywalls, making data more accessible for regional resilience efforts.

CAPACITY BUILDING & TRAINING

- Prioritize capacity building, especially through training programs, workshops, and summer schools that include Global South scientists.
- Co-develop satellite-based training modules and integrate with existing educational programs to enhance skill development in underrepresented regions.
- Build stronger connections between modeling and observational communities through joint efforts and toolboxes for flux analysis.

FUNDING & RESOURCE MOBILIZATION

- OASIS should advocate for long-term funding solutions and engage larger funders (philanthropic, international agencies) to sustain global efforts.
- Focus on mobility programs (e.g., internships, visiting scientists) to encourage knowledge exchange and reduce brain drain.
- Provide a central hub for collaborative funding opportunities to avoid duplicative efforts and ensure efficient use of resources.

TECHNOLOGICAL ADVANCEMENTS

- Leverage technological innovations like drones, low-cost sensors, and open-source tools to scale up data collection and improve flux measurements.
- Encourage digital twinning and centralized data dashboards, although these may require significant funding and support.

CHALLENGES IN OBSERVATIONS & MODELING

- Address gaps in observations, particularly in meso- and submesoscale ocean currents, surface waves, and polar regions.
- Improve flux parameterizations and integrate satellite and field data for more accurate Earth System Models.
- Balance timescales of studies to capture interannual variability, and link process studies to societal impacts.

OASIS VISION & VALUE PROPOSITION

- OASIS should position itself as a connector between scientific, policy, and stakeholder communities, facilitating the adoption of air-sea interaction observations for societal benefits.
- Promote the value of air-sea interaction data to diverse sectors like fisheries, shipping, and climate modeling to drive investment.
- In the short term, increase visibility, standardize practices, and enhance capacity. In the long term, contribute to improving global climate and ocean forecasting models.

OASIS and the UN Decade

Guiding Questions

- How to Get Involved in UN Decade Projects?
- How can OASIS help the Projects linked to OASIS?
- How can UN Decade Projects (partners) help OASIS achieve its goals?

Key Takeaways

- Key strategies to better advance OASIS as a UN Decade Program:
- Data Management for USVs and centralized data vs. PI data
- Data Accessibility:
  - The Ocean Observatories Initiative (OOI) uses a glider Data Assembly Center (DAC), suggesting a similar setup could be beneficial for Uncrewed Surface Vehicles (USVs).
  - Using Digital Object Identifiers (DOIs) for data can facilitate easy availability and sharing.
- Standardization and Best Practices:
  - Standardization across the board is necessary, especially as various startups and businesses need to adopt best practices.
  - The Integrated Ocean Observing System (IOOS) serves as a U.S. data hub and could provide a model for implementing OASIS's goals for ensuring FAIR data.

Appendix 3: Detailed Notes

Notes document
Breakout group notes

Appendix 4: Meeting Organizers

OASIS CO-CHAIRS

Seb Swart — University of Gothenburg, Sweden

Meghan Cronin — NOAA, USA

Christa Marandino — GEOMAR, Germany

Cassie Wilson — Center for Ocean Leadership, USA

Masha Edmondson — Center for Ocean Leadership, USA

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Sarah Gille — UCSD, USA

Charles Addy — PhD Student at University of Hawai'i, USA (ECOP)

Marcel du Plessis — University of Gothenburg, Sweden (ECOP)

Clarissa Anderson — Southern California Coastal Ocean Observing System, USA

Appendix 5: Participant List

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Christine Gommenginger
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