2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Ocean Decade: Call for Actions 01/2020

Thank you for your interest in submitting a proposed Decade Action for endorsement!

Via this Call for Decade Actions, partners are invited to request endorsement under the Ocean Decade for transformative Decade Actions that contribute to the Ocean Decade vision of 'the science we need for the ocean we want'. This Call for Decade Actions, which is the first of series to be launched as part of the Ocean Decade, focuses specifically on:

1. Large-scale, multi-country, transformative Decade programmes; and
2. Large-scale contributions of in-kind or financial resources for Decade Actions, or support to the coordination functions of the Ocean Decade through provision of in-kind and/or financial resources, and/or hosting of a Decade Collaborative Centre / Coordination Office.

Programmes or contributions that will enhance the sustainability of ocean science, including infrastructure or individual or institutional capacity, in light of the COVID-19 pandemic are welcome in response to this call.

Interested parties should complete and submit the Request for Endorsement for before 15 January 2021. Decisions on endorsement under this Call will be made in the first quarter of 2021. Further information on the call can be obtained by contacting oceandecade@unesco.org

Please note that initiatives proposed by United Nations entities are subject to a separate process that involves registration of their Decade Actions. Further details on that process can be obtained by contacting the IOC Secretariat.

Before starting we strongly encourage you to read the materials in the Resources page dedicated to the Call for Decade Actions.

 Ocean Decade: Call for Actions 01/2020

*A preliminary question identifies if you are ready now to submit the proposed action.

* 1. If you are ready to get started, please select if your proposed Decade Action is a: ☐ A Decade Programme - go to p. 2 --- YES

☐ A Decade In-Kind or Financial Contribution - go to p. 7 --- NO

REQUEST FOR ENDORSEMENT OF DECADE ACTION:

DECADE PROGRAMMES

Please only use this section of the questionnaire if your proposed Decade Action is a Decade Programme.

1. Overview of Proponent and Proposed Decade Programme

* 1. Lead Institution

SCOR Working Group #162 -- Developing an Observing Air-Sea Interactions Strategy (OASIS)

* 2. Lead Institution Type

International intergovernmental organisation
Regional intergovernmental organisation
Other regional organisation
National government
Sub-national government
University
Research institute
Private sector enterprise
Philanthropic Foundation
Corporate Foundation
Multilateral or bilateral funding agency
NGO / civil society organization
Working group / expert group / taskforce
Community group
Other (please specify)

Working group / expert group / taskforce

* 3. Lead institution physical address:

SCOR Secretariat; College of Earth, Ocean, and Environment; Robinson Hall; University of Delaware; Newark, DE 19716 USA

* 4. Contact person: Meghan Cronin (OASIS SCOR WG #162 co-chair)

* 5. Contact details

Address, City/Town, Country, Email Address, Phone Number

NOAA PMEL; 7600 Sandpoint Way NE; Seattle WA 98115 USA; Meghan.F.Cronin@noaa.gov; 1-206-526-6449

6. Partner details if relevant (for each partner please list Institution name, contact details including address & email and role of partner)

OASIS SCOR WG #162 Members (*ECOP)	**Institute**	**Country**	**Contact Info**
Meghan Cronin (co-chair)	NOAA Pacific Marine Environmental Laboratory	US	meghan.f.cronin@noaa.gov
Sebastiaan Swart (co-chair)	University of Gothenburg	Sweden	sebastiaan.swart@marine.gu.se
Nadia Pinardi	University of Bologna	Italy	nadia.pinardi@unibo.it
R. Venkatesan	National Institute of Ocean Technology	India	dr.r.venkatesan@gmail.com

Phil Browne*	ECMWF	UK, Italy	Philip.Browne@ecmwf.int
Warren Joubert*	South African Weather Service	South Africa	warren.joubert@weathersa.co.za
Ute Schuster	University of Exeter	UK	U.Schuster@exeter.ac.uk
Christa Marandino	Geomar	Germany	cmarandino@geomar.de
Shuangling CHEN*	Second Institute of Oceanography, Ministry of Natural Resources	China	slchen19@126.com
Clarissa Anderson	Scripps Institution of Oceanography	US	cra002@ucsd.edu
Jim Edson	Woods Hole Oceanographic Institution	US	jedson@whoi.edu
Zhaohui CHEN	Ocean University of China	China	chenzhaohui@ouc.edu.cn
Juliet Hermes	South African Environmental Observation Network, University of Cape Town, and Nelson Mandela University	South Africa	juliet@saeon.ac.za
Fabrice Ardhuin	University Brest Laboratoire d'Océanographie Physique et Spatiale (LOPS), CNRS, IRD, Ifremer	France	Fabrice.Ardhuin@ifremer.fr
Oscar Alves	Bureau of Meteorology	Australia	oscar.alves@bom.gov.au
Hiroyuki Tomita	Institute for Space-Earth Environmental Research (ISEE), Nagoya University	Japan	tomita@isee.nagoya-u.ac.jp

Partner Organization	**Role of Partner in OASIS Programme**	**Point of Contact**	**Contact Info**
GOOS Ocean Observations Physics and Climate (OOPC) panel	Help coordinate & integrate air-sea interaction observations within the GOOS for physics and climate	Sabrina Speich & Weidong Yu (co-chairs)	sabrina.speich@lmd.ipsl.fr, yuwd@mail.sysu.edu.cn
GOOS BGC panel / International Ocean Carbon Coordination Project (IOCCP)	Help coordinate & integrate biogeochemical air-sea interaction and carbon flux observations within the GOOS	Kim Currie (co-Chair), Véronique Garçon (co-chair), Rik Wanninkhof (former member)	Kim.Currie@niwa.co.nz, veronique.garcon.legos@gmail.com, Rik.Wanninkhof@noaa.gov

GOOS Biology-Ecosystem panel	Help coordinate & integrate OASIS biological and ecosystem observations within the GOOS	Frank Muller-Karger (member), Lavenia Ratnarajah (international project officer)	carib@usf.edu, l.ratnarajah@unesco.org
OceanPractices for the Decade	Help formalize ocean best practices needed for high-quality observations and interoperability within the OASIS network	Jay Pearlman (co-chair)	jay.pearlman@fourbridges.org
CoastalPredict	Help bridge open ocean and coastal OASIS observations with stakeholders	Nadia Pinardi (co-chair)	nadia.pinardi@unibo.it
Marine Life 2030	Help design and integrate biological and ecosystem observations within the OASIS network	Emmett Duffy (lead), Frank Muller-Karger (co-lead)	DuffyE@si.edu; carib@usf.edu
Deep Ocean Observing Strategy (DOOS)	Help connect surface OASIS observations with deep ocean observations and processes to inform interaction of the surface and deep ocean (e.g. GHG and elemental fluxes, animal migrations, etc.)	Lisa Levin (co-chair)	llevin@ucsd.edu
Ocean Corps	Help develop OASIS knowledge partners and users in developing countries	Brian Arbic (co-chair)	arbic@umich.edu
EquiSea	Help secure resources and build capacity for OASIS activities in developing countries	Alexis Valauri-Orton (co-chair)	avalauriorton@oceanfdn.org
Consortium for Ocean Leadership	Provides administration and communication support (see airseaobs.org)	Sheri Schwarz (Program Associate)	sschwartz@oceanleadership.org
NSF Regional Coordination Network	Help connect to OceanObs19 community recommendations for ocean observing in 2030	Jay Pearlman (co-chair)	jay.pearlman@fourbridges.org

* 7. Name of proposed Decade Programme

An Observing Air-Sea Interactions Strategy (OASIS)

8. Short title / acronym of proposed Decade Programme for communications purposes (if any)

OASIS

* 9. Summary description of proposed Decade Programme

(100 words or less to be used on website and in communications – please use lay terms that can be understood by a wide audience)

[100 words]
Air-sea exchanges of energy, moisture, and gases drive and modulate the Earth's weather and climate, influencing life, including our own. These air-sea interactions fuel the hydrological cycle and affect precipitation across the globe. Air-sea interactions affect the distribution of carbon dioxide between the atmosphere and ocean, how seawater flows and

winds blow, and how pollutants floating on the ocean surface move – information critical to policymakers, industry, and civil society. The Observing Air-Sea Interactions Strategy (OASIS) PROGRAMME will provide observational-based knowledge to fundamentally improve weather, climate and ocean prediction, promote healthy oceans, the blue economy, and sustainable food and energy.

* 10. Start & end date of proposed Decade Programme

Start: November 2021
End: December 2030

* 11. Estimated total budget of proposed Decade Programme

OASIS is built upon existing satellite, in situ, and operational modeling infrastructure, all of which have "secured" sustained funding. In particular...

Existing OASIS in situ observations with secured funding totalling more than $198M+ per year include:

DBCP network of drifting weather buoys
DBCP moored weather buoys (not including GTMBA)
OceanSITES (including GTMBA)
Moored Carbon Flux Systems
Uncrewed Surface Vehicles & drones (e.g., UxS)
NSF Ocean Observatories Initiative (OOI) surface moorings
VOS/SOOP + underway flux & boundary layer sensors
Argo
Regional Coastal Networks (e.g. IOOS)
Technology innovation
Data management

Existing Subseasonal-Seasonal Weather Forecast Services include:

Bureau of Meteorology (Australia)
China Meteorology Administration (China)
Istituto di Scienze dell'Atmosfera e del Clima - Consiglio Nazionale Delle Ricerche (Italy)
Meteo-France (France)
Environment and Climate Change Canada (Canada)
European Centre for Medium-Range Weather Forecasts (International)
Korea Meteorological Administration (Korea)
National Centers for Environmental Prediction (USA)
UK Met Office (UK)
Copernicus Marine, Atmosphere, Security, Emergency, and Climate Change Services (European Commision)

OASIS' objective is a minimum doubling in the air-sea interactions observing capabilities and Subseasonal-to-Seasonal Forecasts Services. Some of this expansion already has secured or partially secured funding, including:

Biogeochemical-Argo
Decadal Survey Satellite innovations

A minimum $200M per year investment over a five year period in new OASIS in situ observations should include:

Expansion of the drifter network to include new innovative drifting platforms and expanded sensor suite
Development of a new global multidisciplinary uncrewed surface vehicle (i.e. piloted drones, UxS) network
SuperSites / Process Studies / Intercomparison Studies (intensive field studies)
Expansion of OceanSITES reference stations through enhanced sensor suites and as legacy of completed SuperSites
Expansion of the VOS/SOOP network and capability for planetary boundary layer observations
Expansion of air-sea CO_2 flux enhancements to the above networks (e.g. SOCONET)
Integration of Marine Biodiversity Ocean Network (MBON) strategies and activities
Technology innovation -- *The OASIS PROGRAMME will tap into the creativity and ingenuity of a wide range of co-developers. We do not at this point know all the possible observing solutions that will form the OASIS backbone.*
Data management to ensure FAIR data
Interoperabililty across systems (including the use of best practices) so that there is a global integration of the data and data quality from existing and planned systems.
Training and capacity building to enable regional partnerships to operate and maintain the observing system in all corners of the world's ocean.

Other New Infrastructure -- *New discoveries typically lead to new questions and new infrastructure. It is important to plan at least 10% of the infrastructure growth to this as yet unknown technological solution.*

And a minimum $100M investment in OASIS Modeling and Forecasting activities would include:

Model development and model intercomparison experiments
OSSES to optimize observing array
Knowledge to information studies
Expansion of ocean and climate services utilizing this air-sea interaction information, including for longterm weather, subseasonal-to-seasonal (S2S) and climate services, and ecosystem modeling and forecasts
Training and capacity building to expand the stakeholder user-base. *Air-sea interaction information and services (e.g. S2S forecasts, ecosystem forecasts) should be provided to and by regional groups across the world, including least developed nations and island nations.*

12. Percentage of estimated budget that is secured

Roughly 50% of the funding is secured as described above.

13. Secured funding sources (donor name and approximate amount secured)

Secured funding for “existing OASIS in situ sustained observations” described above are estimated to total at least $198M per year:
NOAA/OAR/GOMO support for above listed networks ~ $44M / year
NOAA/NWS/NDBC supports ~$11M /year for current TPOS
NOAA/OMAO supports ~$15M / year for UxS
NSF/OOI ~ $7M / year (assuming annual budget is divided equally between 6 topics, one of which is air-sea exchange)
NOAA/IOOS support for regional coastal networks ~$39 M / year
Other US support for regional coastal networks ~$39 M / year
Other international agencies contributing to the sustained global ocean observing system ~ $44 M / year

Innovation within the satellite constellation as outlined by the Decadal Survey can be considered secured funding.

* 14. Do you require support to find additional resources for your Decade Programme?

Yes. Additional resources are needed.

To help find new sources of funding, our website (airseaobs.org) could have links for connecting NGO and philanthropic funders with organizations that can help implement the OASIS PROGRAMME. Guidance on this would be appreciated.

* 15. Would you like to be put in touch with partners working on similar issues or proposing Decade Actions that could have synergies with your proposed Action?

Yes

* 16. Countries in which the proposed Decade Programme will be implemented

It is hoped that all nations, including land-locked nations and least developed nations would benefit from and participate in some form, either through generating this ocean-atmosphere interaction information and/or using it.

* 17. Ocean basins in which the proposed Decade Programme will be implemented

Indian Ocean
North Pacific Ocean
South Pacific Ocean
North Atlantic Ocean
South Atlantic Ocean
Arctic Ocean
Antarctic Ocean

All of the above.

2. Description of the proposed Decade Programme

* 18. What is the high-level objective(s) of your proposed Decade Programme?

1) Improved scientific knowledge of ocean-atmosphere interactions, including critical physical and biogeochemical

processes at the air-sea interface, needed to create ocean information for decision makers.

2) A step change in the observational capacity to monitor the atmospheric and oceanic boundary layers and air-sea exchange processes at all scales, with global coverage via satellites and basin-wide in situ networks connected to coastal sites.

3) A transformation in our ability to accurately predict weather, climate, and ocean environments, including ecological components, and to quantify the air-sea exchange of carbon dioxide based upon the step increase in ocean information.

***** 19. What are the key expected outcomes of your proposed Decade Programme?

The OASIS PROGRAMME will enhance our ability to:

(1) **Monitor and predict surface ocean conditions and the ocean's influence on global weather and climate on timescales of days-seasons-years.** Better prediction of weather phenomena influenced by oceans, such as El Niño-Southern Oscillation (ENSO), Madden-Julian Oscillations, atmospheric rivers, and tropical cyclones, will enable improved predictions of extreme weather, droughts, and rainfall over land. Improved information and prediction of marine weather and physical conditions, such as surface waves, currents, sea surface temperature, and upper ocean heat content, would lead to improved understanding and forecasts of marine heatwaves, hurricane intensity, coastal flooding,...; and would enhance tracking of fish larvae, biodiversity, and debris (e.g., microplastics); enhance tracking for search and recovery; and would aid in the forecast of ecological conditions spanning the open ocean to the watershed. [*Decade* outcomes: "a predictable ocean," "a safe ocean"].

(2) **Track surface ocean carbon dioxide, ocean acidification, oceanic deoxygenation, nutrient concentrations, and measures of biodiversity** needed for verification of national emissions reporting, and to understand the multiple stressors impacting ecosystems and the ocean biogeochemical-climate feedbacks. ["A healthy & resilient ocean", "a sustainable productive ocean"].

(3) **Characterize oceanic and atmospheric processes and feedbacks that modulate surface fluxes of energy, moisture and carbon dioxide, and interact with the ecosystem.** Embracing this complexity is required for sound management of human activities, growing a robust blue economy, protecting life and property, and securing food, water, and energy. ["A healthy & resilient ocean", "a sustainable productive ocean", "a predictable ocean"]

***** 20. Please describe the activities that will be implemented as part of the proposed Decade Programme
(514 words out of 600 words or less)

OASIS is an end-to-end PROGRAMME, with activities that range from engaging stakeholders in co-developing the strategy, to developing and integrating sensor systems and networks for observing air-sea interactions, to using ocean observations to generate knowledge and predictions to aid decision-makers. The OASIS PROGRAMME will tap into the creativity and ingenuity of a wide range of co-developers to create new observing solutions that build upon the existing OASIS backbone within the global ocean observing system (e.g. moored and drifting buoys, research vessels and volunteer observing ships) and expand into new capabilities. OASIS will develop a new global ocean observing network based upon uncrewed surface vehicles that can be deployed from shore or near-shore and travel thousands of kilometers using naturally sourced energy (e.g. wind, solar, wave, currents). By reducing the carbon footprint of ocean measurements, including measurements of the ocean uptake of anthropogenic CO_2, OASIS will help transition oceanography over the next decade to a carbon-neutral world.

OASIS will help develop satellite observing capabilities based upon and tuned and validated against a globally distributed in situ network comprising fixed and mobile platforms. A "System as a Whole" approach would be taken, with the integrated global OASIS network designed to observe physical and biogeochemical processes that couple the oceanic and atmospheric boundary layers, as well as the marine ecosystem and biodiversity beneath the surface of the ocean. Interoperability amongst different platforms and networks will be achieved through development of best practices and ongoing interoperability experiments. Gaps in understanding, parameterizations, and model physics will be addressed through process studies and use of limited-life super sites in different regimes of the global oceans that may lead to long term sustained OceanSITES flux reference stations. These intensive field studies are particularly

important for optimizing satellite-based atmospheric profiles for surface boundary conditions needed for making satellite-based air-sea flux estimates.

The improved understanding of air-sea interaction and the coupled boundary layer response would be marshalled to improve forecasts of severe weather, ecosystem health, and the carbon budget, all needed to guide societal decision making. OASIS will support model studies for improving model physics and treatment of observations with a goal to improve prediction skill. Finally, OASIS will have a robust capacity-building arm and will work towards connecting stakeholders to service delivery of data and model products for societal benefit. OASIS will be a global observing network, operated by global data providers, producing ocean information used in all corners of the world.

OASIS will collaborate with integration efforts of the GOOS, bridging to coastal activities in collaboration with CoastPredict.org. In coastal regions, the deep ocean meets the surface and OASIS will bridge this divide by working with the sister Ocean Decade Programme for Marine Life 2030 and Seabed2030. OASIS will have a robust emphasis on capacity building, support and capacity sharing with and among developing and island nations, working in collaboration with efforts such as EquiSea Fund and Ocean Corps. OASIS recognizes the priority for developing best practices to ensure interoperability and to further expand air-sea interaction observations globally. OASIS will collaborate with “OceanPractices for the Decade” to further creation, prioritization, and adoption of best practices.

* 21. Please describe the theory of change that underpins your proposed Decade Programme i.e. how will the activities being carried out achieve the outcomes and objectives that you envisage

(363 out of 400 words or less)

The physics, chemistry, and biology at the interface between the air and the sea are critical for our success as a species. This fundamental fact is not something civil society thinks about on a daily basis, or that we necessarily consider even as we plan for sustainable development. OASIS provides the framework for capacity exchange and building collective knowledge of the critical processes upon which our life depends. OASIS will engage the general public in learning about how these Earth surface processes are fundamental in planning for sustainable development and conservation.

Air-sea exchanges are challenging to compute as they rely upon many co-located and synchronous, high resolution, high quality surface essential ocean variables (EOV) and climate variables (ECV). Air-sea heat flux estimates, as an example, require more than eight EOV/ECV, many of which are also needed to measure carbon flux. This challenge provides a transformative opportunity. By making observing platforms be multidisciplinary and multifunctional, the OASIS network can provide high-quality air-sea fluxes that serve multiple stakeholders. In addition, the co-location of multiple EOVs and ECVs, including essential biodiversity variables (EBVs), will revolutionize our ability to quantify air-sea exchanges and interrogate climate and multi-stressor impacts on ecosystem response, from biogeochemical parameters to components of the food web.

The need for co-located variables means that partnerships are essential for making the requisite observations, with one partner being responsible for the platform and a subset of EOV/ECV/EBV measurements, and other partners being responsible for other variables, analyses, data management, and product development. This provides a leveraging opportunity for new partners within the Programme. New partners may join an observing team to help with a single objective without needing to be responsible for engineering and operating the entire platform. New sensors must be carefully tested and integrated into platforms to ensure interoperability and non-interference with other measurements. By developing best practices and technical readiness level advancement procedures, and by developing a culture of mentorship and partnership, the capacity of the observing system could be significantly expanded. The result of this cultural shift would be a broader base of users, operators, technological solutions, and education and outreach opportunities that inspire the next generation of scientists.

* 22. Will your proposed Decade Programme enhance the sustainability of ocean science initiatives, including infrastructure or individual / institutional capacity, in light of the current Covid-19 pandemic?

Yes.

23. If yes, how will your proposed Decade Programme enhance the sustainability of ocean science initiatives, including infrastructure or individual / institutional capacity, in light of the current Covid-19 pandemic ?
(98 words out of 200 words or less)

The OASIS PROGRAMME will provide weather, climate, ocean, and marine life information that will make populations less vulnerable to water, food, and energy insecurities, which are compounded by COVID-19.

The OASIS global in situ ocean observing network will be expanded in part using uncrewed surface vehicles, including some that can be deployed from shore and travel thousands of kilometers using

naturally sourced energy (e.g. wind, solar, wave, currents). This not only reduces the need for experts to travel to distant locations closed for travel due to COVID19, but also helps transition ocean observations to a carbon-neutral world.

* 24. Please describe the coordination / management structure for the proposed Decade Programme
(171 out of 400 words or less)

The OASIS Programme is organized by SCOR Working Group #162. This Working Group (WG) was formed to harmonize recommendations from over 30 community strategy papers from the once-per-decade OceanObs19 conference. Over the next 2-3 years, the WG will help develop a governance structure that can oversee the PROGRAMME through the decade.

The OASIS SCOR WG #162 comprises members from diverse disciplines (physical/chemical/biological oceanography, atmospheric sciences), using different methodologies (satellite and in situ observations, modeling, theoretical), focused on data, knowledge, and information. Several members have extensive experience with capacity building efforts, which is a key component of the PROGRAMME. The WG is diverse in terms of gender, age, experience, and national origin. As the OASIS governance transitions from the SCOR WG organization, this diversity will be preserved.

Communication and administration of SCOR WG #162 is facilitated through the Consortium for Ocean Leadership as a post-OceanObs19 contribution consistent with outcomes of the NSF Regional Coordination Network. The SCOR WG #162 has several members that are also members of GOOS panels. OASIS will help interdisciplinary integration across GOOS and GCOS.

3. Contribution of Proposed Decade Programme to the UN Decade of Ocean Science for Sustainable Development (refer to the Ocean Decade Implementation Plan for details)

* 25. To which Sustainable Development Goal(s) (SDG) will your proposed Decade Programme contribute? Please select a maximum of three SDGs

GOAL 1: No Poverty.
GOAL 2: Zero Hunger
GOAL 3: Good Health and Well-being
GOAL 4: Quality Education
GOAL 5: Gender Equality
GOAL 6: Clean Water and Sanitation
GOAL 7: Affordable and Clean Energy
GOAL 8: Decent Work and Economic Growth
GOAL 9: Industry, Innovation and Infrastructure
GOAL 10: Reduced Inequality
GOAL 11: Sustainable Cities and Communities
GOAL 12: Responsible Consumption and Production
GOAL 13: Climate Action
GOAL 14: Life Below Water
GOAL 15: Life on Land
GOAL 16: Peace and Justice Strong Institutions
GOAL 17: Partnerships to achieve the Goal

* 26. How will your proposed Decade programme will contribute to the SDGs selected? Please Explain
(187 out of 200 words)

GOAL 13: Climate Action -- OASIS includes expansion of the in situ observing network for global monitoring of the ocean uptake of anthropogenic CO_2 and ocean acidification. These observations will address the socio-economic needs of carbon accounting and tracking of the state of ocean ecosystems. While absorption of anthropogenic CO_2 can reduce global warming, it comes at a cost of making the waters more acidic. A sustained effort to measure surface water CO_2 is thus warranted to provide data critical for assessments, policy and informational products. In addition, through OASIS, a new network of uncrewed surface vehicles will be developed, which will lower the carbon footprint of the oceanographic enterprise, while providing critical high resolution information on a global scale.

GOAL 14: Life Below Water. Data generated will allow the assessment and proposal of solutions for ecosystem problems such as warming, ocean acidification, deoxygenation, and pollutant loading.

GOAL 15: Life on Land. Ocean information will lead to improved forecasts of rainfall and droughts over land for medium to long timescales. These subseasonal-to-seasonal climate forecasts are critical for proper management of water and energy resources needed for sustainable development.

* 27. How will your proposed Decade Programme contribute to the vision and mission of the Decade (388 words out of 400 words)?

A sea-change increase of surface and boundary layer data would lead to revolutionary improvement in understanding of air-sea interactions and its representations in forecast models and would be used to constrain these improved numerical models for ocean, weather, and climate prediction. OASIS provides science we need to support the policies we want for a healthy ocean on which society can develop in a sustainable manner.

The OASIS PROGRAMME will build from the vision and recommendations of more than 30 Community Strategy Papers addressing surface ocean observing, written as part of the once-per-decade OceanObs'19 Conference. While the community strategy papers were largely siloed by discipline, region, network, EOVs of interest, or stakeholder need, the SCOR OASIS WG #162 has brought representatives from these communities together to create a unified vision for a multifunctional, multidiscipline, integrated observing system that allows near-realtime quantification of the air-sea exchanges and interactions, with breakthrough accuracy, throughout the global ice-free ocean.

The surface of the ocean is the portion of the ocean felt by the atmosphere, viewed from space, and experienced most directly by people and most other life on Earth. The ocean modulates the Earth's weather and climate through exchanges of heat, moisture, momentum, greenhouse gasses, aerosol precursor gases, and aerosols at the air-sea interface. The influence of air-sea fluxes on the Earth's water cycle, carbon cycle, and energy cycle is a critical element of the support of life on Earth. It is therefore imperative that the air-sea exchanges of heat, moisture, momentum, important greenhouse gasses, and biogenic trace gasses be monitored globally. Furthermore, because air-sea fluxes can depend upon feedbacks and interactions across disciplines and scales, to understand these air-sea exchanges and how they couple the atmosphere, ocean and biosphere, it is vital to also observe the oceanic and atmospheric boundary layer's chemical, biological, physical and geological components. These do not need to have independent observational networks. Because these different types of air-sea fluxes depend upon many of the same variables (e.g. winds, sea surface temperature,...), and upon similar turbulent and radiative processes, there is potential for considerable leveraging of observations through integration of the observing system.

To realize the value of this "Big Data", the OASIS will also build the community for making and using these data via new techniques, such as machine learning or community-based data processing software packages. The OASIS PROGRAMME thus will also include strategies for training data providers and data users, promoting standardized methods, and ensuring Findable-Accessible-Interoperable-and-Reusable (FAIR) observational best practices.

* 28. To which Decade outcome(s) will your proposed Decade Programme contribute ?

Outcome 1: A clean ocean where sources of pollution are identified and reduced or removed.
Outcome 2: A healthy and resilient ocean where marine ecosystems are understood, protected, restored and managed.
Outcome 3: A productive ocean supporting sustainable food supply and a sustainable ocean economy.
Outcome 4: A predicted ocean where society understands and can respond to changing ocean conditions.
Outcome 5: A safe ocean where life and livelihoods are protected from ocean-related hazards.
Outcome 6: An accessible ocean with open and equitable access to data, information and technology and innovation.
Outcome 7: An inspiring and engaging ocean where society understands and values the ocean in relation to human wellbeing and sustainable development.

All.

* 29. How will your proposed Decade Programme contribute to the Decade outcomes selected *(160 out of 200 words)*?

See answer to question 19.

The OASIS PROGRAMME will take a "systems as a whole" approach. By working collaboratively and co-designing the observing system, we believe that the end result will have added dimensions leading to more scientific discoveries and a deeper understanding of the feedbacks and interactions within the coupled atmosphere, ocean and biosphere.

In the 1980's and 1990's the Tropical Ocean-Global Atmosphere (TOGA) programme led to a transformation in oceanography, resulting in sustained ENSO observations that continue to this day and operational ENSO predictions that have enormous socio-economic benefits. For the Ocean Decade, OASIS will reach beyond TOGA, targeting not only air-sea interactions within the tropics, but also other air-sea interaction phenomena throughout the global oceans. OASIS will likewise consider not only the physical processes within these air-sea interactions, but also the interactions between physical and biogeochemical processes and their effects on marine life. We expect this will lead to a transformation in how we view the oceans.

* 30. To which Ocean Decade Challenge(s) will your proposed Decade Programme contribute?

Challenge 1: Understand and map land and sea-based sources of pollutants and contaminants and their potential impacts on human health and ocean ecosystems, and develop solutions to remove or mitigate them.

Challenge 2: Understand the effects of multiple stressors on ocean ecosystems, and develop solutions to monitor, protect, manage and restore ecosystems and their biodiversity under changing environmental, social and climate conditions.

Challenge 3: Generate knowledge, support innovation, and develop solutions to optimise the role of the ocean in sustainably feeding the world's population under changing environmental, social and climate conditions.

Challenge 4: Generate knowledge, support innovation, and develop solutions for equitable and sustainable development of the ocean economy under changing environmental, social and climate conditions.

Challenge 5: Enhance understanding of the ocean-climate nexus and generate knowledge and solutions to mitigate, adapt and build resilience to the effects of climate change across all geographies and at all scales, and to improve services including predictions for the ocean, climate and weather.

Challenge 6: Enhance multi-hazard early warning services for all geophysical, ecological, biological, weather, climate and anthropogenic related ocean and coastal hazards, and mainstream community preparedness and resilience.

Challenge 7: Ensure a sustainable ocean observing system across all ocean basins that delivers accessible, timely, and actionable data and information to all users.

Challenge 8: Through multi-stakeholder collaboration, develop a comprehensive digital representation of the ocean, including a dynamic ocean map, which provides free and open access for exploring, discovering, and visualizing past, current, and future ocean conditions in a manner relevant to diverse stakeholders.

Challenge 9: Ensure comprehensive capacity development and equitable access to data, information, knowledge and technology across all aspects of ocean science and for all stakeholders.

Challenge 10: Ensure that the multiple values and services of the ocean for human wellbeing, culture, and sustainable development are widely understood, and identify and overcome barriers to behaviour change required for a step change in humanity's relationship with the ocean.

* 31. How will your proposed Decade Programme contribute to the Decade Challenges selected *(188 out of 200 words)*?

Challenge 5 (ocean-climate nexus): The ocean influences weather and climate through air-sea interactions, placing OASIS directly within the ocean-climate nexus. OASIS will build knowledge for how the ocean influences weather and climate, how air-sea interaction data can translate into subseasonal-to-seasonal predictions of extreme weather, drought and rainfall over land. Global warming and climate change affect the patterns of air-sea fluxes forcing the ocean circulation and heat distribution within the ocean. The ocean-climate nexus is in fact at the air-sea interface, the focus of the OASIS PROGRAMME.

Challenge 6 (Enhance multi-hazard early warning services): In addition to enhancing subseasonal-to-seasonal weather forecasts, a service that directly depends upon air-sea interaction ocean information, the OASIS PROGRAMME will help create a network for carbon accounting and tracking of ocean acidification. These sustained observations are needed for national and international assessments, policy, and informational products.

Challenge 7: (Sustainable observing system with FAIR data): OASIS will expand air-sea interaction observations globally, optimizing the array design, and adding capability by making the observing systems multi-functional. By collaborating, cooperating, and forming partnerships, these observing systems will become more sustainable. OASIS will also develop new observing networks, such as the plans for a global uncrewed surface vehicle network, that have reduced carbon footprints. OASIS data will be FAIR.

* 32. To which Decade Objective(s) will your proposed Decade Programme contribute?

Objective 1: Identify required knowledge for sustainable development, and increase the capacity of ocean science to deliver needed ocean data and information

Objective 2: Build capacity and generate comprehensive knowledge and understanding of the ocean including human interactions, and interactions with the atmosphere, cryosphere and the land sea interface.

Objective 3: Increase the use of ocean knowledge and understanding, and develop capacity to contribute to sustainable development solutions.

* 33. How will your proposed Decade Programme contribute to the Decade Objective(s) selected *(197 out of 200 words)*?

The OASIS is an end-to-end observing PROGRAMME, encompassing all three Decade Objectives.

As with the Decade Objective 1, the PROGRAMME Objective 1 involves improving scientific understanding of physical

and biogeochemical processes at the air-sea interface. Gaps in the existing networks have been identified in nearly three-dozen OceanObs19 community strategy papers. Process studies and intensive field programs, embedded within a globally distributed network will be used for advancing atmospheric and oceanic boundary layer understanding, tuning and validating satellite retrievals, and for improving model physics.

The PROGRAMME Objective 2 calls for a step change in the observational capacity to monitor the atmosphere and ocean boundary layers and exchange processes, at all scales -- from frontal scales (important in coastal regions) to basin scale. This increase in comprehensive knowledge and understanding of the ocean will lead to a step change in ocean information. Thus,

The PROGRAMME Objective 3 is to deliver actionable ocean information that will lead to decade outcomes. In particular, with the improved knowledge and improved coupled models, constrained by a step increase in satellite and in situ air-sea interaction data, will lead to improved prediction of the ocean and forecasts of weather and climate influenced by the ocean.

* 34. With respect to the Decade Objectives selected above, to which Decade Sub-Objective(s) will your proposed Decade Programme contribute?

1.1: Provide the scientific basis for regular integrated assessments of the state of the ocean and identify priority gaps at different scales and in different geographies to frame efforts in exploration, observations and experimentation.

1.2: Promote new technology development and enhance access to technology to generate ocean data, information and knowledge.

1.3: Enhance and expand existing ocean observing systems across all ocean basins to deliver information on standardized essential ocean variables including social and economic, geological, physical, chemical, bathymetric, biological, ecological parameters, and observations on human interactions with the ocean.

1.4: Develop mechanisms that support community-led science initiatives and the recognition and inclusion of local and indigenous knowledge as a fundamental source of knowledge.

1.5: Undertake regular assessments of the state of ocean science capacity to identify and overcome barriers to generational, gender and geographic diversity, and promote sufficient and sustainable investment.

2.1: Generate a comprehensive inventory, mapping, and understanding of the role and function of ocean components including their human interactions and interactions with the atmosphere, cryosphere and the land sea interface.

2.2: Generate a comprehensive understanding of thresholds and tipping points for ocean components, including human interactions.

2.3: Innovate and expand the use of historical ocean knowledge to support sustainable development solutions.

2.4: Improve existing, and develop new generation ocean models for improved understanding of the past, current and future states of the ocean, including human interactions.

2.4: Improve prediction services and increase predictive capability for oceanic hazards or events including extreme weather and climate.

2.5: Expand cooperation in ocean-related education, training, capacity development and transfer of marine technology.

3.1: Broadly communicate and promote the role of ocean science for sustainable development across diverse stakeholder groups including through formal and information education and an expansion of ocean literacy approaches across stakeholder groups.

3.2: Develop interoperable, open access platforms and applications to share data, information and knowledge in a format that connects knowledge generators and users.

3.3: Undertake interdisciplinary, multi-stakeholder co-design and co-delivery of ocean solutions including policy, decision making, integrated ocean management frameworks, applications and services, and technology and innovation.

3.4: Expand and enhance spatial planning processes to contribute to sustainable development across regions and scales.

3.5: Expand and enhance inclusive and integrated management frameworks and tools, including nature-based solutions, to maintain ecosystem functioning, provide for adaptive processes under changing ocean conditions, and incorporate community values and needs.

3.6: Expand and enhance services, applications and management tools for building and mainstreaming preparedness and adaptive responses to multiple stressors and hazards.

3.7: Expand and enhance tools, applications and services that integrate and facilitate use of data, information, and knowledge on ocean-related natural capital including the social, cultural, environmental, and economic characteristics of the ocean.

* 35. How will your proposed Decade Programme contribute to the Decade sub-objectives selected (199 out of 200 words)?

The OASIS is an end-to-end PROGRAMME, encompassing all three Decade Objectives and multiple sub-objectives (see attached OASIS prospectus).

The OASIS PROGRAMME will have several approaches towards generating knowledge -- from developing innovative technological solutions for the observing system, and developing best practices to ensure interoperability, to expanding air-sea interaction observations globally, and using process studies to fill gaps in understanding. For example, understanding how the bottom retrieval of a satellite-based atmospheric profile relates to near-surface meteorological conditions will require intensive observations in different regimes throughout the global oceans and new technologies.

Satellite-based air-sea fluxes and boundary observations are needed for global coverage. To meet the required accuracy needs, high quality, global in situ calibration and validation observations are needed. To meet the resolution needs, these in situ and satellite observations must be used to constrain numerical models. This is particularly important with biogeochemical variables that cannot be measured from space. Thus the OASIS PROGRAMME will obtain a step change in ocean data through satellite innovations, increased in situ observations through expansion of sensor suites and platforms carrying these, and through improvements to numerical models.

Through modeling centers that transform ocean data into information, the OASIS PROGRAMME will serve diverse stakeholders.

* 36. Please check which of the following criteria are relevant to your proposed Decade Programme as far as they are relevant to your proposal:

Accelerate the generation or use of knowledge and understanding of the ocean, with a specific focus on knowledge that will contribute to the achievement of the SDGs and complementary policy frameworks and initiatives.

Is co-designed or co-delivered by knowledge generators and users, and does it facilitate the uptake of science and ocean knowledge for policy, decision making, management and/or innovation.

Will provide all data and resulting knowledge in an open access, shared, discoverable manner and appropriately deposited in recognized data repositories consistent with the IOC Oceanographic Data Exchange Policy[1] or the relevant UN subordinate body data policy.

If you check this criteria, please provide in the question below details of where data will be deposited and where it exists, attach a data management plan.

Strengthen existing or create new partnerships across nations and/or between diverse ocean actors, including users of ocean science.

Contribute toward capacity development, including, but not limited to, beneficiaries in Small Island Developing States, Least Developed Countries and Land-locked Developing Countries.

Overcome barriers to diversity and equity, including gender, generational, and geographic diversity.

Collaborate with and engage local and indigenous knowledge holders.

* 37. How will your proposed Decade Programme contribute to the Decade criteria selected *(no word limit)*?

Criteria 1 (accelerate generation and use of knowledge): The OceanObs19 papers listed in Question 41 Attached Supplement laid out gaps in understanding in air-sea interaction and surface ocean processes, and recommendations for generating this knowledge, understanding, and information. OASIS will follow these roadmaps for making progress within the Ocean Decade.

Criteria 2 (co-designed / co-delivered): While the OceanObs19 strategy papers were written by siloed communities, OASIS is bringing these plans together to create a “systems as a whole” approach. OASIS will also co-design with industry through Public-Private-Partnerships to find creative engineering and data solutions, and innovative information delivery schemes.

Criteria 3 (FAIR data): Data will be made available in near-realtime through the global telecommunications system (GTS) to modeling and data services as well as to open access, international repositories such as SOCAT, PANGAEA, GLODAP, and others.

Criteria 4 (Partnerships): A core principle of OASIS is that the air-sea interactions observing network can be substantially expanded through development of a culture of mentorship and partnership.

Criteria 5 (Capacity Development): OASIS will have a robust capacity development. Global data, generated by global knowledge providers for global ocean information users.

Criteria 6 (Diversity and equity): OASIS is being developed by a SCOR WG team that is diverse on a range of metrics: gender, nation, age, discipline, scientific approach. It is through this diversity that OASIS gains dimension.

Criteria 7 (Local and indigenous knowledge): OASIS will build upon local and regional efforts to gain global coverage. Indigenous knowledge from island nations will be particularly important for air-sea interaction observations and information.

4. Communications

* 38. Please describe how you plan to communicate about your proposed Decade Programme including the main target audiences and methods of communications *(69 words of 400 words or less)*.

To help with communication and engage with the larger community of air-sea interaction researchers and stakeholders, OASIS is developing a website: airseaobs.org. The co-chair of the SCOR WG #162 was formerly part of the Southern Ocean Observing System (SOOS) panel, and thus many of the communication tools used within the http://www.soos.aq/ website will be adopted by the airseaobs.org website, including the "Get Involve" buttons.

* 39. Have you developed a communications strategy or plan as part of your proposed Decade Programme? If so, please attach it as part of the supporting documentation.

Yes, our SCOR WG Prospectus included a communication plan. A more complete communication document is under development.

40. If yes, please attach the communications documents requested.

Attach OASIS SCOR WG #162 Prospectus

5. Supporting Documentation

41. Please attach any relevant supporting documents to your submission that will aid in its evaluation e.g. project log frame, research proposal, high-level budget, data management plan, communications strategy, or letters of support. Please note that none of these documents are obligatory, but can be provided at the discretion of the proponent if they feel it will help in the understanding of their request.

KEY REFERENCES from the OceanObs19 Frontiers in Marine Science Collection

Centurioni, et al. (2019) "Multidisciplinary Global In-Situ Observations of Essential Climate and Ocean Variables at the Air-Sea Interface in Support of Climate Variability and Change Studies and to Improve Weather Forecasting, Pollution, Hazard and Maritime Safety Assessments", *Front. Mar. Sci.* 6:419, doi: 10.3389/fmars.2019.00419

Cronin et al. (2019) "Air-Sea Fluxes with focus on Heat and Momentum", *Front. Mar. Sci. 6:430,* doi: 10.3389/fmars.2019.00430

Muller-Karger, et al. "Advancing marine biological observations and data requirements of the complementary essential ocean variables (EOVs) and essential biodiversity variables (EBVs) frameworks.", *Front. Mar. Sci*. 5:211, doi: 10.3389/fmars.2018.00211

Wanninkhof et al. (2019) “A surface ocean CO_2 reference network, SOCONET and associated marine boundary layer CO_2 measurements”, *Front. Mar. Sci.* 6:400, doi: 10.3389/fmars.2019.00400

For full list of relevant OceanObs19 papers, see pages 15-18 of the OASIS SCOR WG #162 Prospectus

* 42. Please confirm that you have completed your form submission:

I have completed my form submission.

We look forward to considering your inputs and/or further discussion with you about your submission!

Please note that the due diligence processes set out in UNESCO's Comprehensive Partnership Strategy will apply.

For queries, please contact oceandecade@unesco.org
For further information, please visit www.oceandecade.org