Thirty-eighth Session of the DBCP

World Meteorological Organization 1 November 2022.

DBCP S&T Workshop

Theme *Delivering Global Ocean Surface Data for Research, Operations and User Impact*

Observing Air-Sea Interaction for a predicted, safe, clean, healthy, resilient, and productive ocean

R Venkatesan, *National Centre for Coastal Research, India & Adjunct Professor, University of Massachusetts- Dartmouth, USA*

Meghan Cronin (*NOAA Pacific Marine Environmental Laboratory, USA)*

Christa Marandino (*GEOMAR, Germany)*

Sebastiaan Swart *(University of Gothenburg, Sweden)*

OASIS Working Group #162 (SCOR)

airseaobs.org

Launching for Tropical Pacific Observing System (TPOS) 2021 Mission. Credit: Saildrone, Inc.

Observing Air-Sea Interactions Strategy (OASIS)

Meghan Cronin (NOAA PMEL, co-chair of SCOR Working Group #162)

OASIS is an endorsed UN Ocean Decade Programme developed by SCOR Working Group #162

Taking a "system-as-a-whole" approach for making surface and boundary layer observations relevant to the Earth's energy, water, and carbon cycles, including their physical, biological, and geological components

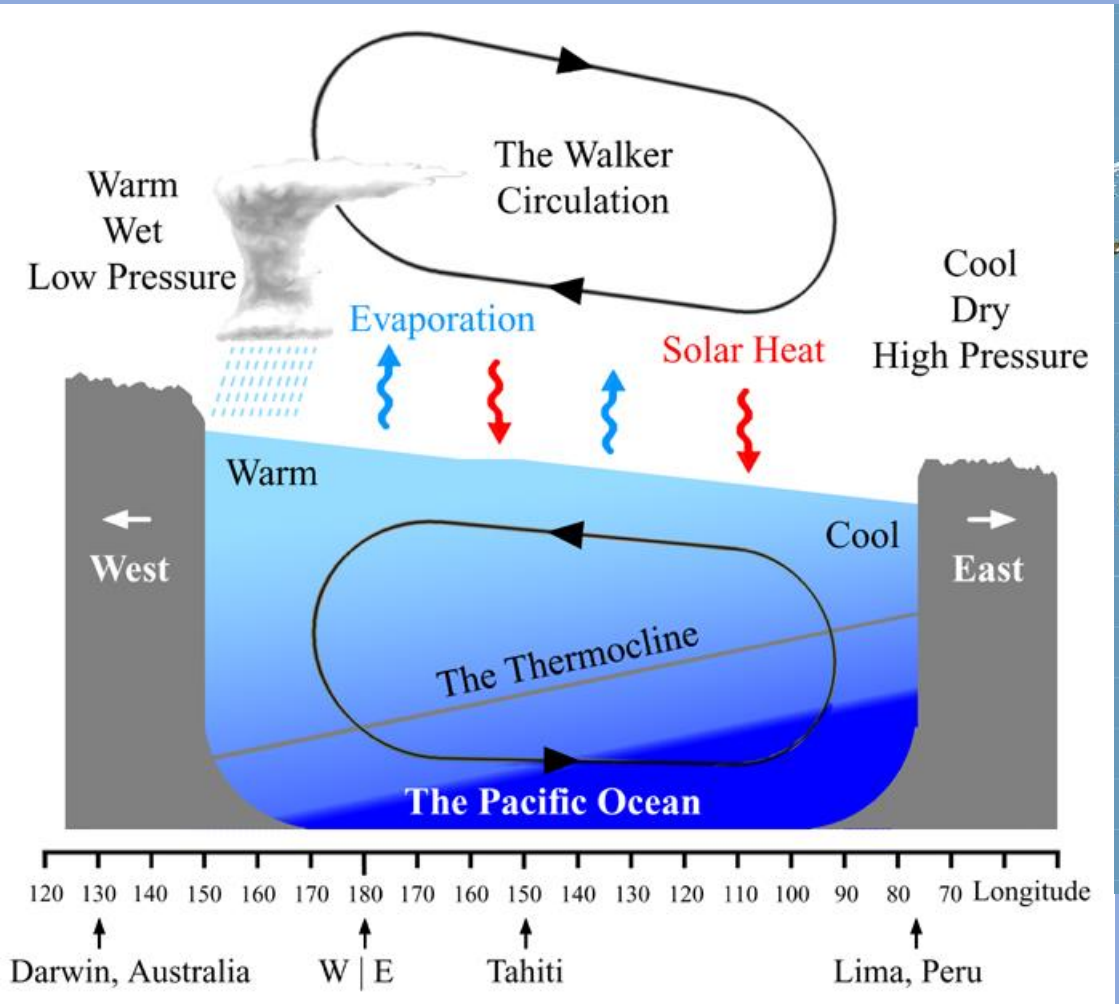
OASIS is a community working to harmonize observational strategies and develop a practical, integrated approach to observing air-sea interactions…

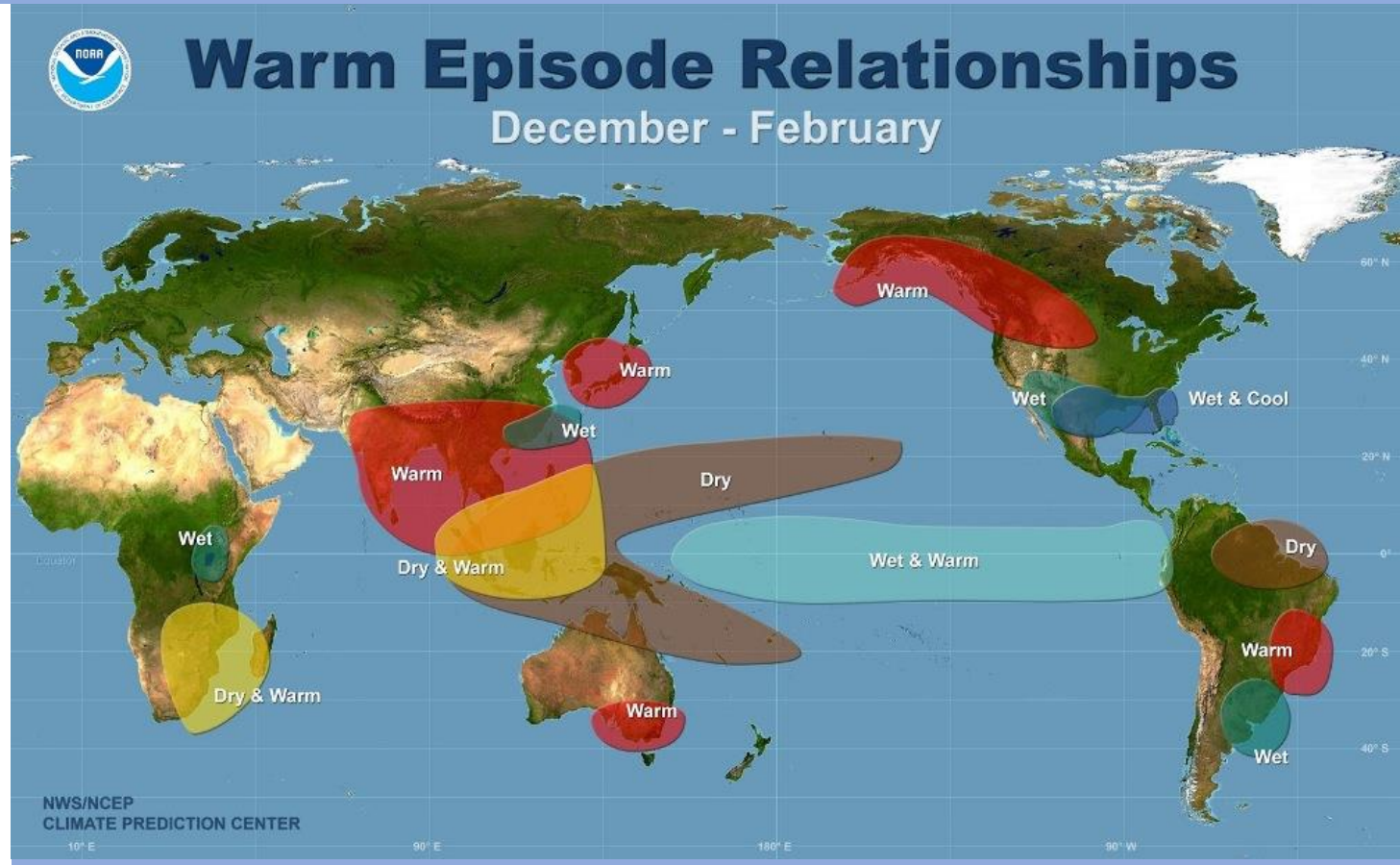
…through capacity development, leveraging of multi-disciplinary activities, and advancement of understanding.

Photo of Earth taken by Apollo 17 crew enroute to Moon on December 7, 1972

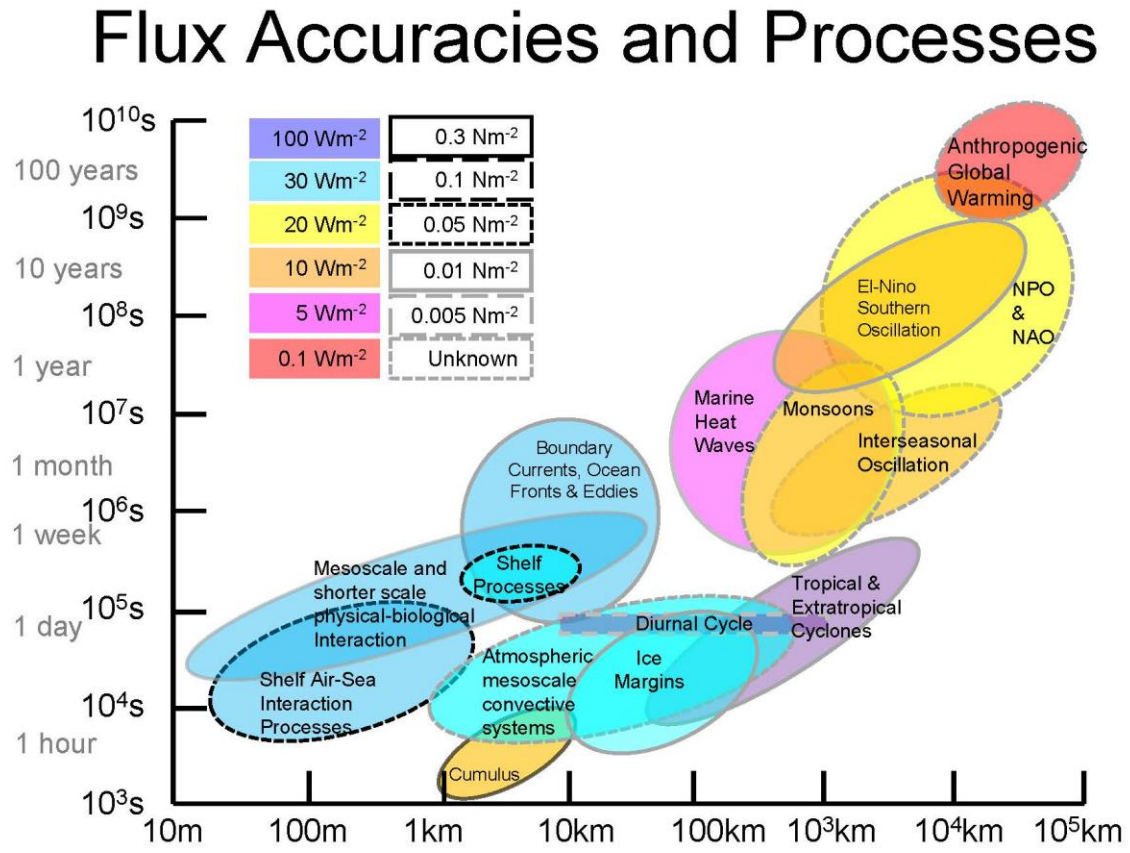
Credit: NASA

Oceans influence weather and climate by warming (and cooling) the lower atmosphere





To predict weather and climate influenced by the ocean, we must accurately resolve air-sea heat fluxes



Goals for 2030:

Gridded Air-Sea fluxes with 1-day random uncertainties of:

15 W m^{-2} (5%) & 0.01 N m^{-2} (5%)

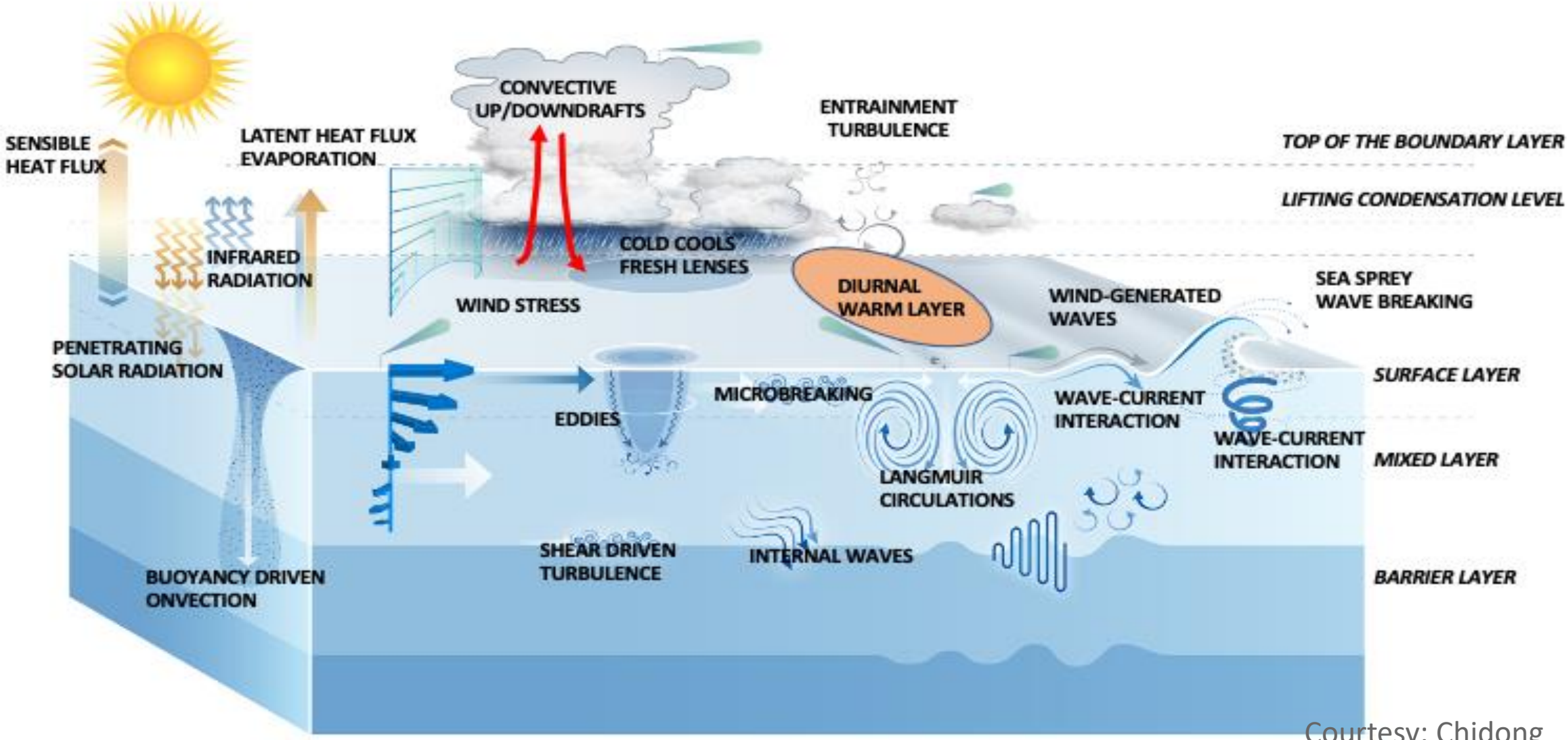
And Biases less than:

5 W m^{-2} & 0.005 N m^{-2}

For: 3-hourly at 25 km

Aspirational goal: 1-hrly at 10km

Air-Sea Transition Zone & Associated Processes



Courtesy: Chidong Zhang

OASIS Theory of Change

Observing Air-Sea Interactions Strategy (OASIS) is harmonizing community recommendations from OceanObs'19 and UN Decade Laboratories…

…into a practical, integrated approach designed to promote partnerships, capacity strengthening and multidisciplinary actions

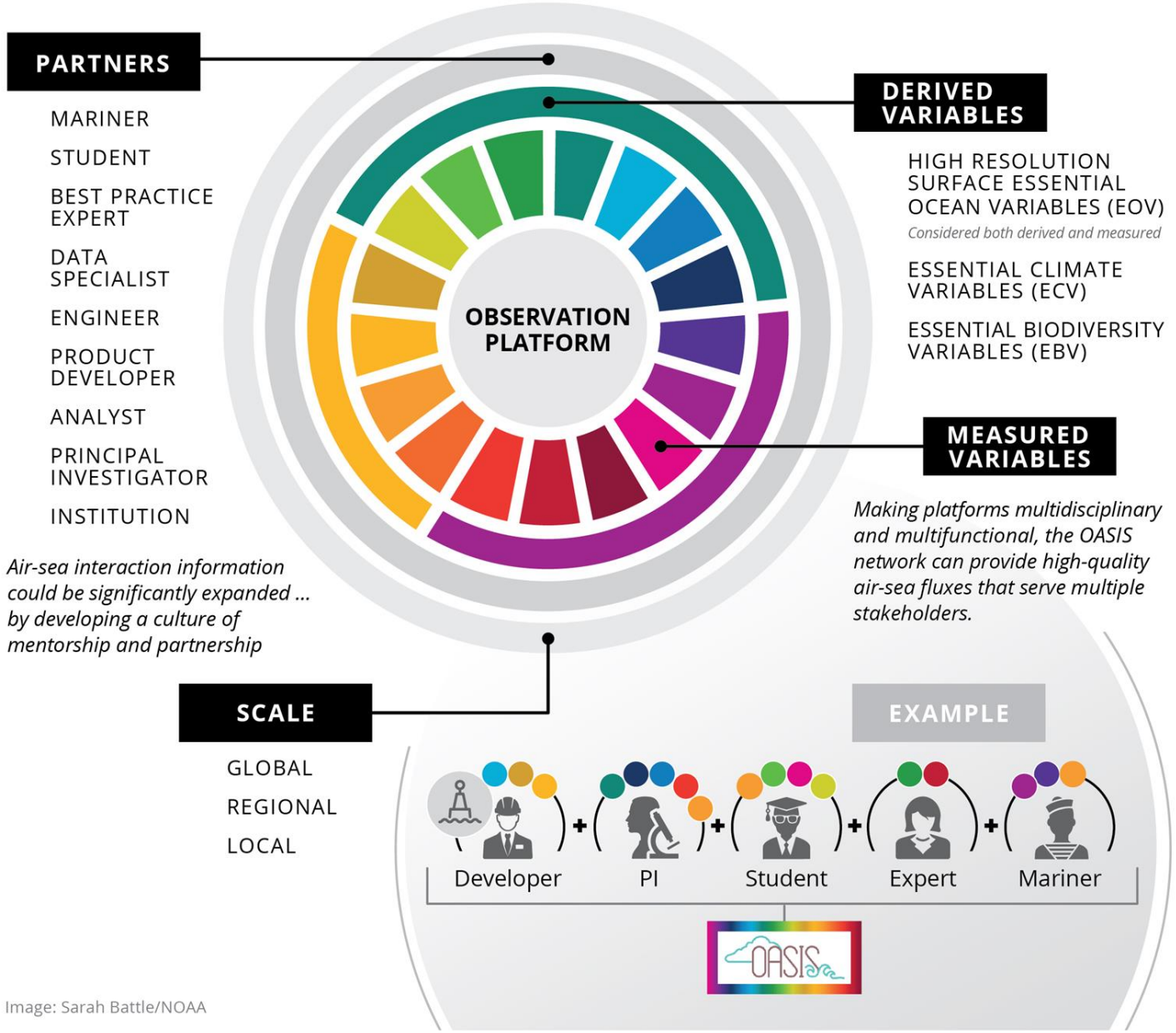


Image: Sarah Battle/NOAA

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Observing Air-Sea Interactions Strategy (OASIS) is harmonizing community recommendations from OceanObs'19 and UN Decade Laboratories…

…into three "Big Asks"

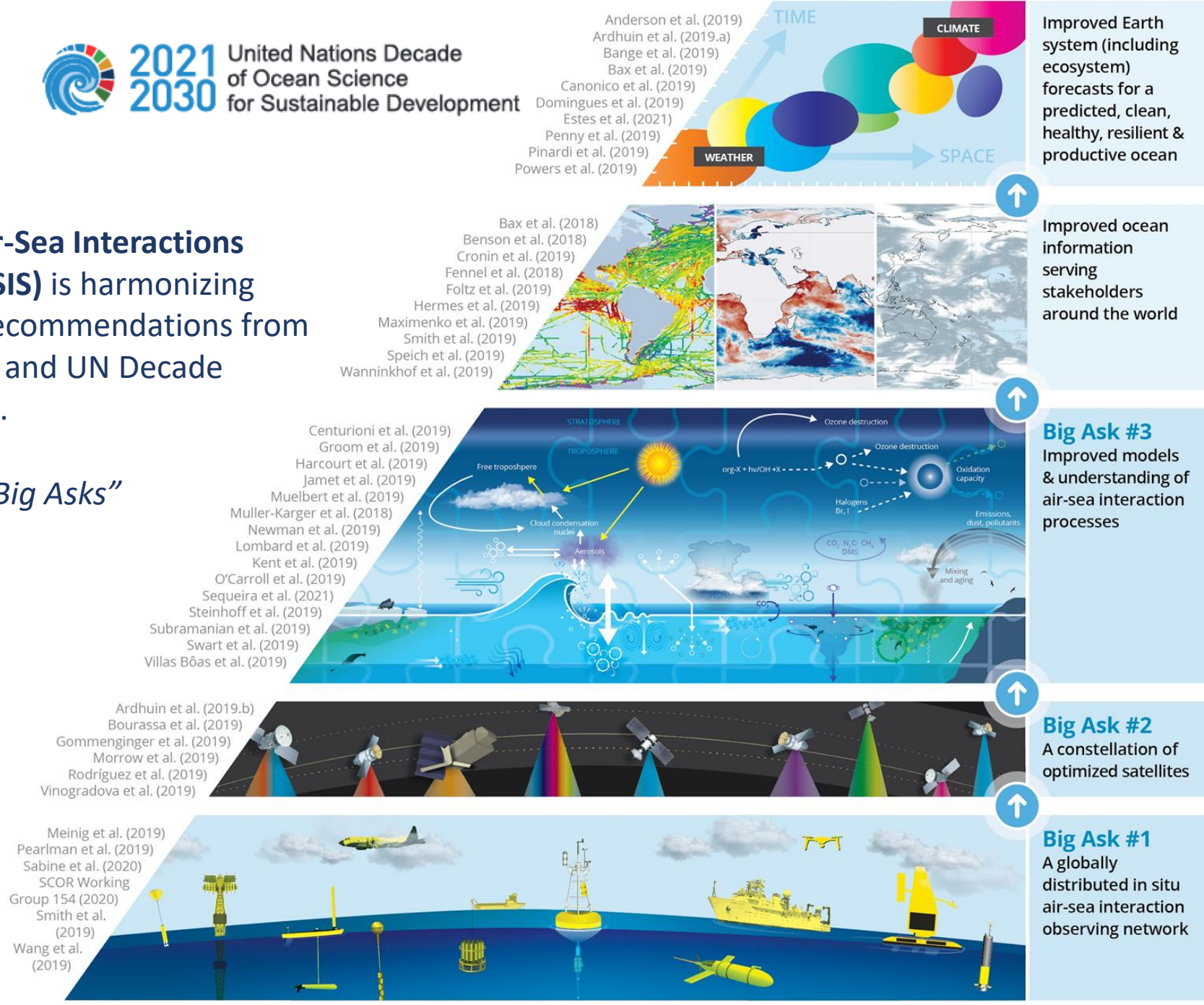
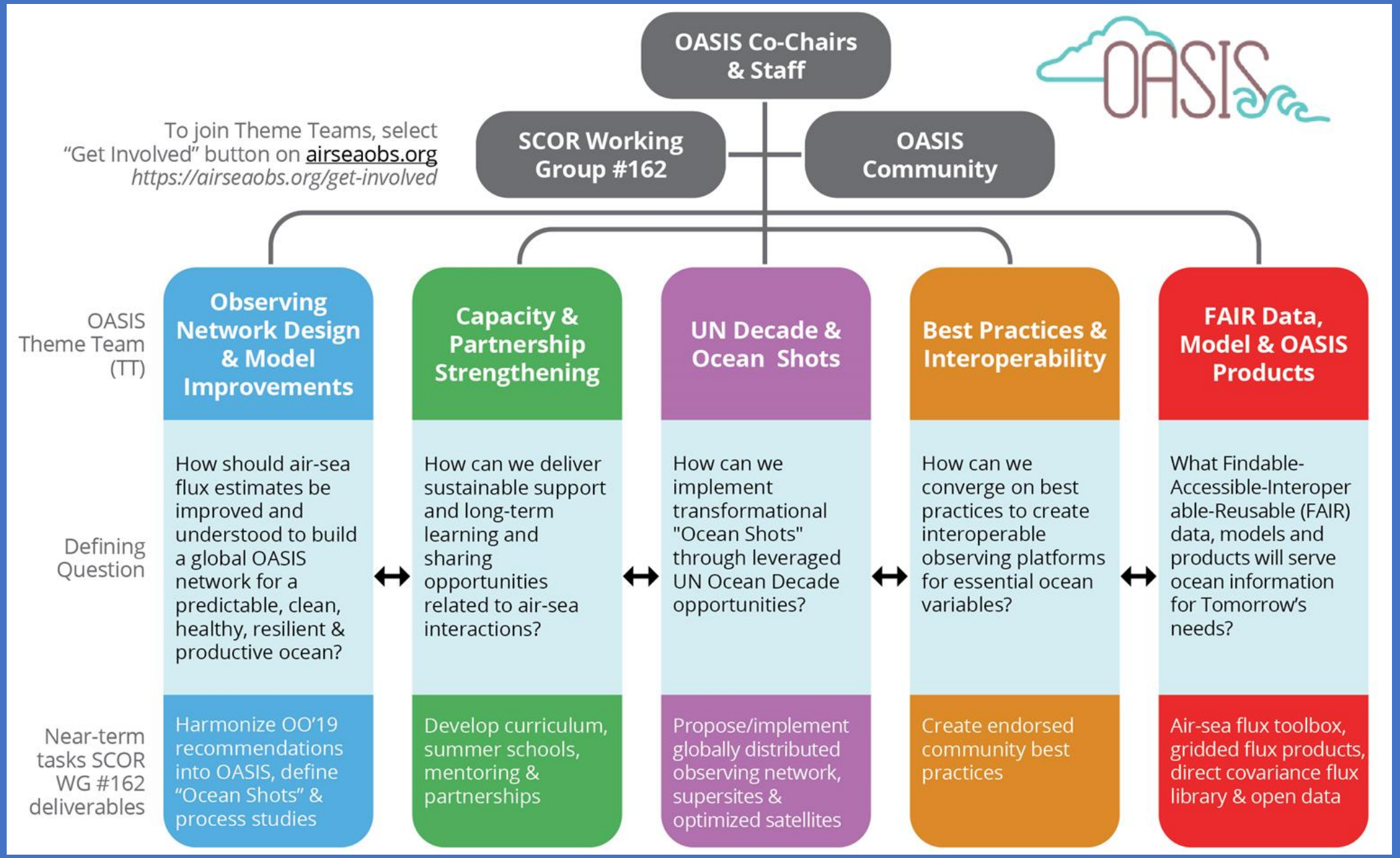
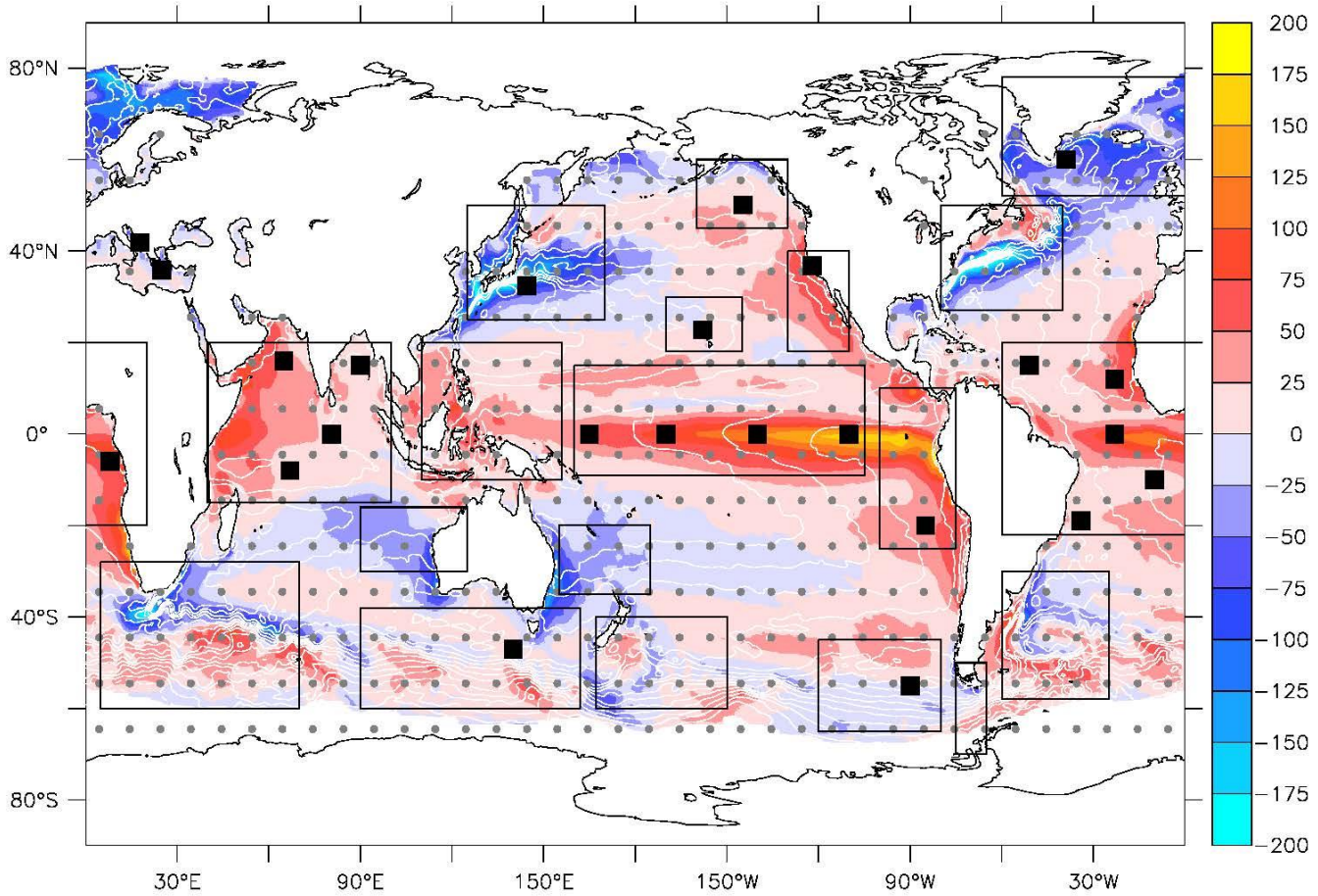


Image: Sarah Battle/NOAA

Three "Big Asks" are the foundation of OASIS and support efforts to achieve our goal of improved Earth system forecasts for a clean, healthy, resilient & productive ocean

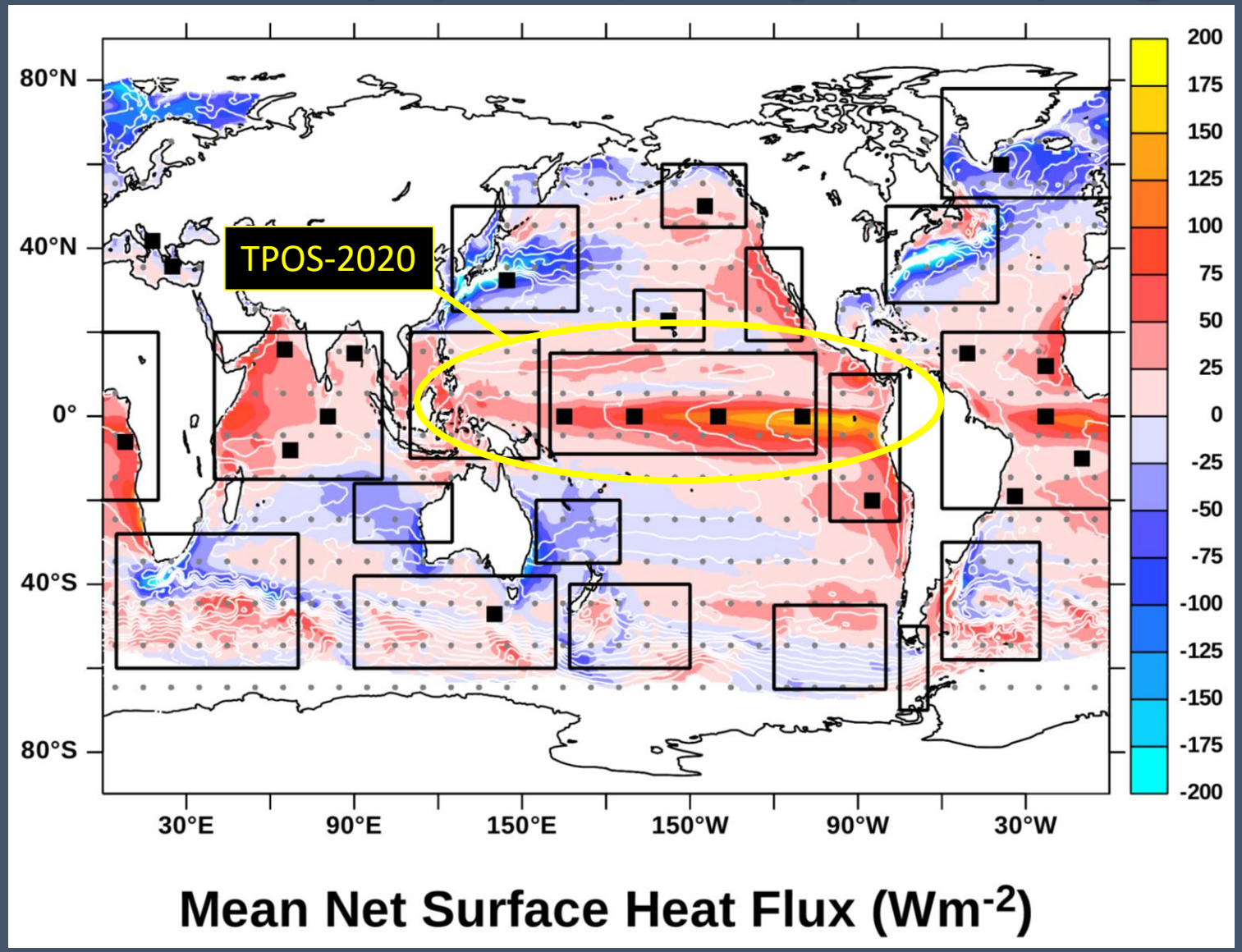

OASIS Co-Chairs & Staff
SCOR Working Group #162
OASIS Community
To join Theme Teams, select "Get Involved" button on airseaobs.org
https://airseaobs.org/get-involved
OASIS
OASIS Theme Team (TT)
Observing Network Design & Model Improvements
Capacity & Partnership Strengthening
UN Decade & Ocean Shots
Best Practices & Interoperability
FAIR Data, Model & OASIS Products
Defining Question
How should air-sea flux estimates be improved and understood to build a global OASIS network for a predictable, clean, healthy, resilient & productive ocean?
How can we deliver sustainable support and long-term learning and sharing opportunities related to air-sea interactions?
How can we implement transformational "Ocean Shots" through leveraged UN Ocean Decade opportunities?
How can we converge on best practices to create interoperable observing platforms for essential ocean variables?
What Findable-Accessible-Interoperable-Reusable (FAIR) data, models and products will serve ocean information for Tomorrow's needs?
Near-term tasks SCOR WG #162 deliverables
Harmonize OO'19 recommendations into OASIS, define "Ocean Shots" & process studies
Develop curriculum, summer schools, mentoring & partnerships
Propose/implement globally distributed observing network, supersites & optimized satellites
Create endorsed community best practices
Air-sea flux toolbox, gridded flux products, direct covariance flux library & open data

Global *in situ* flux array, built around an expanded OceanSITES network of reference stations in 22 key (boxed) regions



Global network: 500-1000 drifting or mobile platforms and more reference stations (squares) in key (boxed) regions

Drifting and Mobile Flux Platforms (examples)

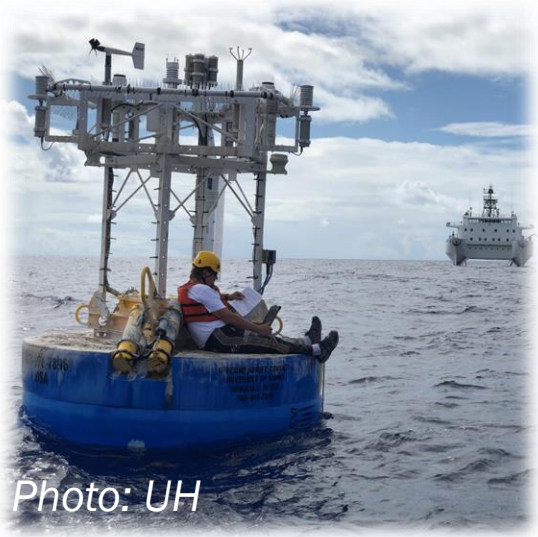


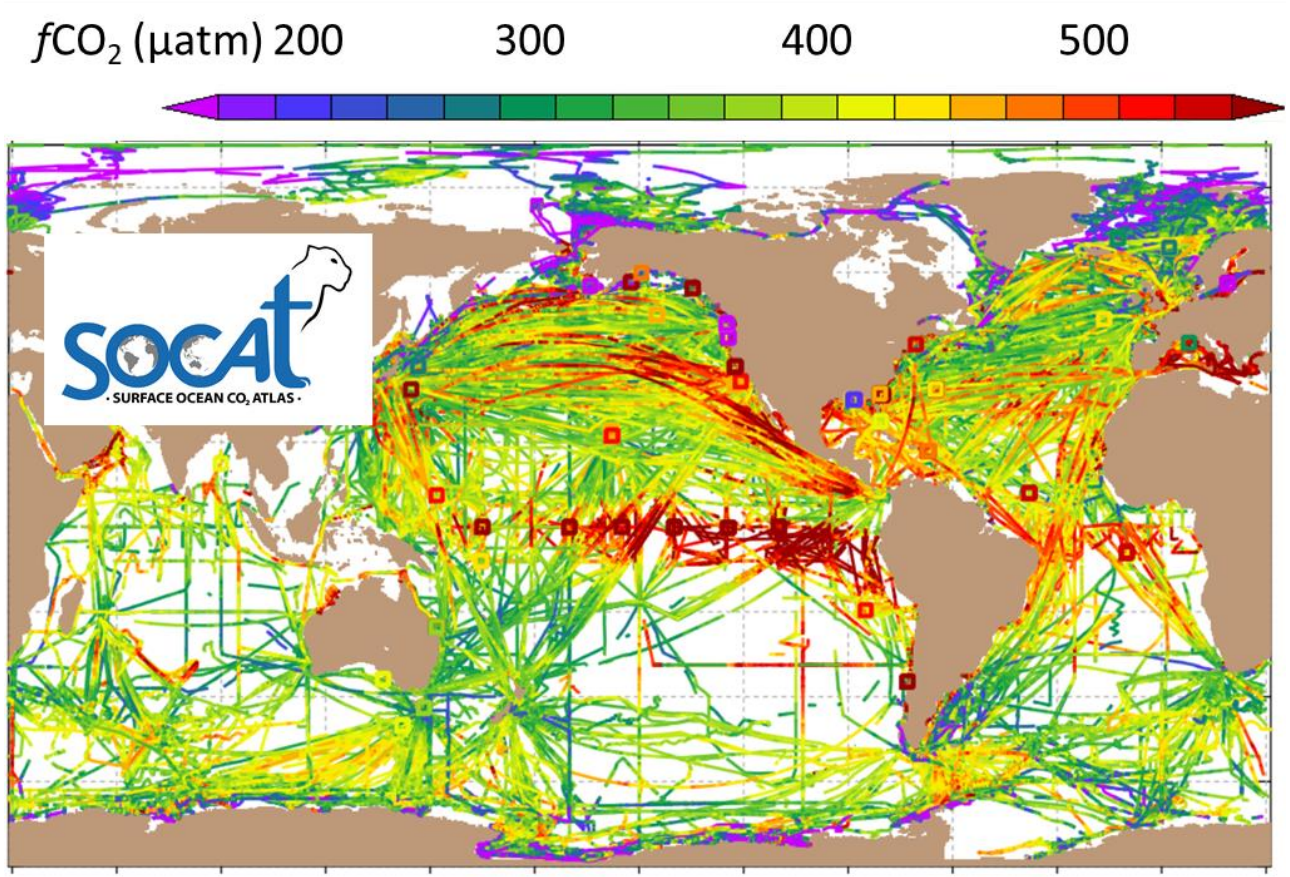
Cronin et al. (2019) **"Air-sea fluxes with a focus on heat and momentum"**

Reference Stations (examples)

Surface ocean CO_2 flux: all seawater pCO_2 measurements collected since 1957

SOCONET
• SURFACE OCEAN CO_2 OBSERVING NETWORK •





Virtual Workshop: Air-Sea Observations for a Safe Ocean

April 7, 2022 midnight to 0200 AM CEST

For more information: https://airseaobs.org/oasis-for-a-safe-ocean


R Venkatesan


Meghan Cronin


Jérome Aucan

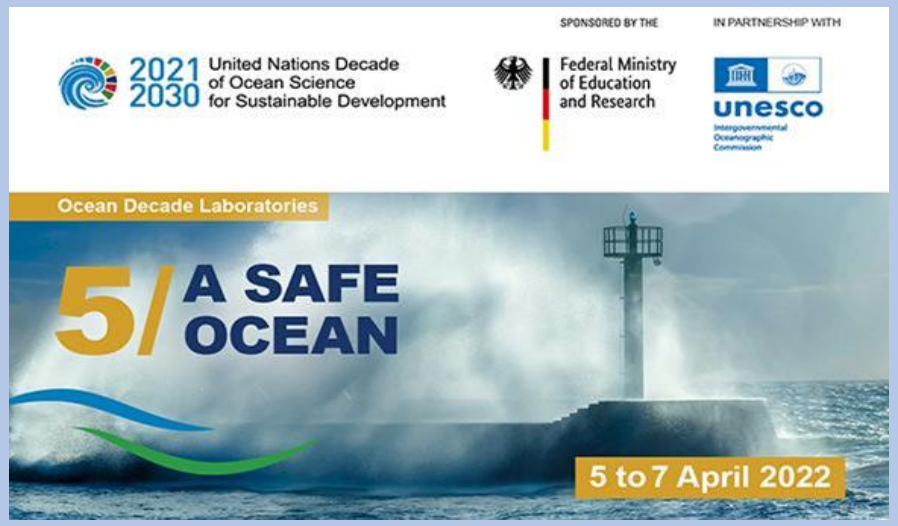

Samantha Wills*


Evan Jones*


Sebastien Boulay


Marcus Landon Aydlett


Patricia Chardón Maldonado*



Organizers:

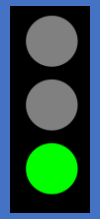
- *R. Venkatesan, Member WMO NIOT India*
- *Meghan Cronin, NOAA PMEL USA; co-chair of OASIS SCOR Working Group #162,*
- *Christa Marandino, GEOMAR, Germany; co-chair of OASIS SCOR Working Group #162,*
- *Clarissa Anderson, Executive Director, (SCCOOS), Scripps Institution of Oceanography,*
- *Randi Rotjan, Boston University, Phoenix Islands Protected Area,*
- *Samantha Wills University of Washington CICOES*

- ***Three sessions***
- ***Posters and Networking in OASIS Gather. Town***

Island Nations to Regional to Global needs for early warning systems	**Moderator:** R. Venkatesan (NIOT, India); **Presenter:** Evan Jones (FSU, USA); Marcus Landon Aydlett (Guam Weather Forecast Office)
Techniques	**Moderator:** Jérome Aucan (SPC, New Caledonia); **Presenter:** Sebastien Boulay (Sofar Ocean USA; New Zealand)
Strategies	**Moderator:** Meghan Cronin (NOAA PMEL, USA) **Presenter:** Patricia Chardón-Maldonado (CARICOOS, Puerto Rico)

- *Can observing systems be integrated to serve all?*
- *How can traditional knowledge of air-sea interaction be incorporated?*
- *How can recent advances reduce marine hazards?*
- *What new cost-effective technologies may be appropriate for SIDS?*
- *How can this technology be maintained and used effectively by local SIDS citizens?*
- *What can OASIS do to promote a Safe Ocean?*

Observes one or more EOVs or ECVs - Contributes to meeting requirements through observing one or more of the GOOS Essential Ocean Variables or GCOS[1] Essential Climate Variables.



Multidisciplinary AIR and SEA instrument-based observations

Physics	Biochemistry	Biology and Ecosystems
✓ Sea state	✓ Oxygen	• Phytoplankton biomass and diversity
✓ Ocean surface stress	✓ Nutrients	• Zooplankton biomass and diversity
• Sea ice	• Inorganic carbon	✓ Fish abundance and distribution
✓ Sea surface height	• Transient tracers	✓ Marine turtles, birds, mammals abundance and distribution
✓ Sea surface temperature	✓ Particulate matter	✓ Hard coral cover and composition
✓ Subsurface temperature	• Nitrus oxide	✓ Seagrass cover and composition
✓ Surface currents	• Stable carbon isotopes	• Macroalgal canopy cover and composition
✓ Subsurface currents	• Dissolved organic carbon	• Mangrove cover and composition
✓ Sea surface salinity		• Microbe biomass and diversity (*emerging)
✓ Subsurface salinity		• Invertebrate abundance and distribution (*emerging)
✓ Ocean surface heat flux		

Cross-disciplinary (including human impact)	
✓ Ocean colour	✓ Ocean sound
• Marine debris (*emerging)	

goosocean.org/eov

Essential Climate Variables

For graphical version click here
What are Essential Climate Variables (ECVs)?

Atmosphere

Surface
- ✓ Precipitation
- ✓ Pressure
- ✓ Radiation budget
- ✓ Temperature
- ✓ Water vapour
- ✓ Wind speed and direction

Upper-air
- Earth radiation budget
- Lightning
- Temperature
- Water vapor
- Wind speed and direction

Atmospheric Composition
- Aerosols
- Carbon dioxide, methane and other greenhouse gases
- Clouds
- Ozone
- Precursors for aerosols and ozone

Land

Hydrosphere
- Groundwater
- Lakes
- River discharge

Cryosphere
- Glaciers
- Ice sheets and ice shelves
- Permafrost
- Snow

Biosphere
- Above-ground biomass
- Albedo
- Evaporation from land
- Fire
- Fraction of absorbed photosynthetically active radiation (FAPAR)
- Land cover
- Land surface temperature
- Leaf area index
- Soil carbon
- Soil moisture

Anthroposphere
- Anthropogenic Greenhouse gas fluxes
- Anthropogenic water use

Ocean

Physical
- ✓ Ocean surface heat flux
- • Sea ice
- ✓ Sea level
- ✓ Sea state
- ✓ Sea surface currents
- ✓ Sea surface salinity
- ✓ Sea surface stress
- ✓ Sea surface temperature
- ✓ Subsurface currents
- ✓ Subsurface salinity
- ✓ Subsurface temperature

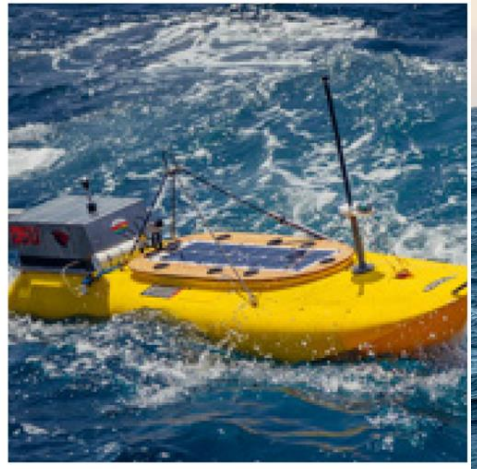
Biogeochemical
- ✓ Inorganic carbon
- ✓ Nitrous oxide
- ✓ Nutrients
- ✓ Ocean colour
- ✓ Oxygen
- ✓ Transient tracers

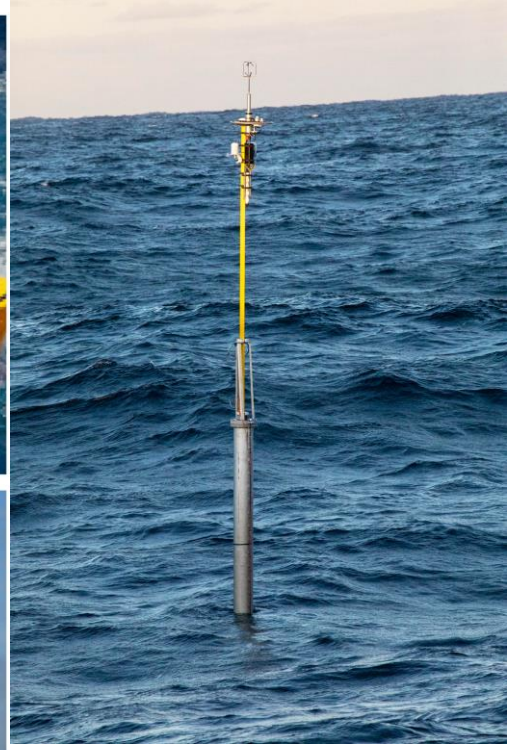
Biological/ecosystems
- ✓ Marine habitats
- ✓ Plankton

https://gcos.wmo.int/en/essential-climate-variables/table

Various platforms for measuring air-sea interaction

Want to make these more capable of observing air-sea interactions





For global coverage of air-sea heat fluxes, we must:

Flux EOV/ECV	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Bulk SST	Partially met												Adequate
Skin Temperature	Partially met												Adequate
Wind Speed and Direction	Partially met												Adequate
Air Temperature	Not met												Adequate
Humidity	Not met												Adequate
Bulk Surface Currents	Partially met												Adequate
Skin Surface Currents	Not met												Adequate
Surface Solar Radiation	Partially met												Adequate
Surface Longwave Radiation	Partially met												Adequate
Albedo	Partially met												Met
Sea State	Requirement Unknown												Requirement Known

	Requirement not met / inadequate
	Requirement partially met / threshold
	Requirement adequately met / breakthrough
	Requirement fully met / ideal goal

) "Air-sea fluxes with a focus on heat and

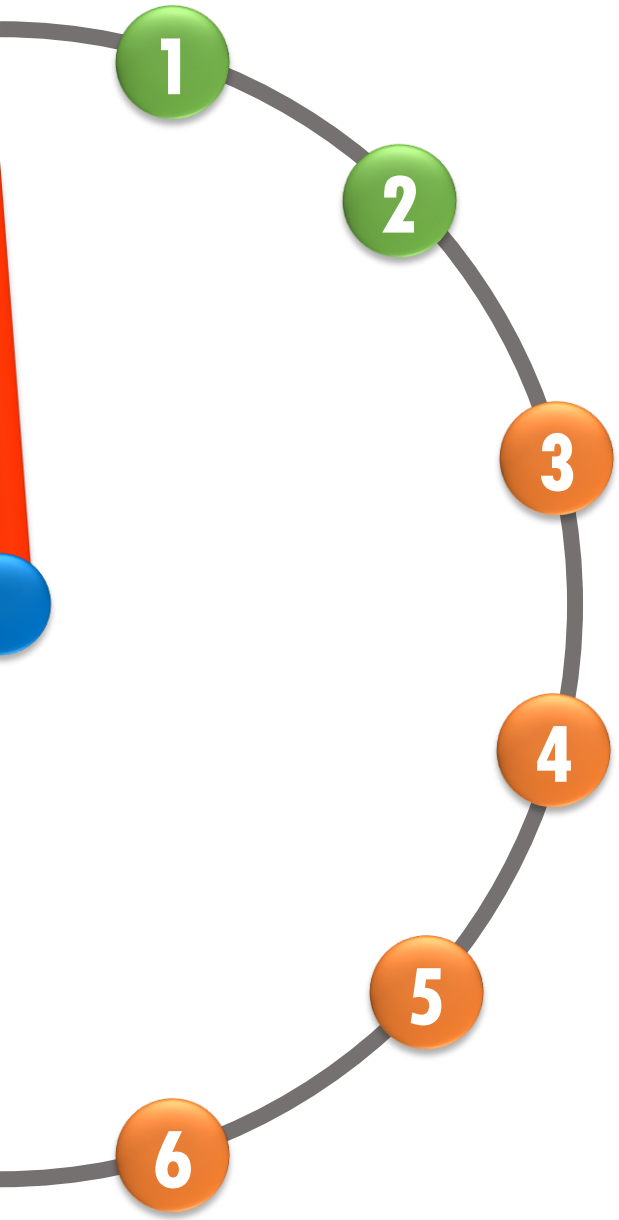
(1) Optimize satellite-based boundary layer obs for near-surface air temperature & humidity, …

(2) Expand the global network of *in situ* air-sea interaction observations

(3) For improving coupling physics in models.
OASIS 3 big asks are for improved in situ, improved satellites, and improved models

OASIS 2030 observing system Vision

Our basic strategy is to use an in situ network of flux platforms to tune and validate satellite observations and numerical weather prediction model



Expand Obs Network , Co-Design approach

Earth System Modeling must include ocean

eg. Air-Sea-Land Interaction Process Oriented Studies…

Technology Development

e.g. direct covariance flux, radiometers, profilers,etc…

Best Practices, calibrations

interoperability experiments

FAIR Data & OASIS products

Capacity & Partnership Strengthening

eg SIDS

Outcomes of the 2030 Air-Sea Flux Observing System

- Better prediction of **longterm weather & climate** influenced by the oceans
- Better **wind stress** driving ocean circulation
- Better quantification of **rain** originating over the oceans
- Better tracking of ocean **uptake of anthropogenic carbon dioxide** and resulting **ocean acidification.**

SCOR WG #162 members

SCOR WG Member	Institution
Meghan Cronin*	NOAA Pacific Marine Environmental Laboratory, **US** (co-chair)
Sebastiaan Swart*	University of Gothenburg, **Sweden** (co-chair)
Christa Marandino*	Geomar, **Germany**
R. Venkatesan	National Centre for Coastal Research, **India**
Phil Browne ^	ECMWF, **UK**
Warren Joubert ^	South African Weather Service, **South Africa**
Ute Schuster	University of Exeter, **UK**
Nadia Pinardi	University of Bologna, **Italy**
Shuangling CHEN ^&	Second Institute of Oceanography, **China**
Clarissa Anderson	Scripps Institution of Oceanography, **US**
Jim Edson	Woods Hole Oceanographic Institution, **US**
Zhaohui CHEN	Ocean University of China, **China**
Juliet Hermes	South African Environmental Observation Network, **South Africa**
Fabrice Ardhuin	University Brest, CNRS, IRD, Ifremer, LOPS, IUEM, **France**
Oscar Alves	Bureau of Meteorology, **Australia**
Hiroyuki Tomita	Graduate School of Environmental Science, Hokkaido University, **Japan**

THANK YOU FOR LISTENING

OASIS

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