Ocean Observing Co-Design

by The Global Ocean Observing System

2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Tropical Cyclone Exemplar

Scott Glenn
Rutgers University, Center for Ocean Observing Leadership

Cheyenne Stienbarger
NOAA Global Ocean Monitoring and Observing Program

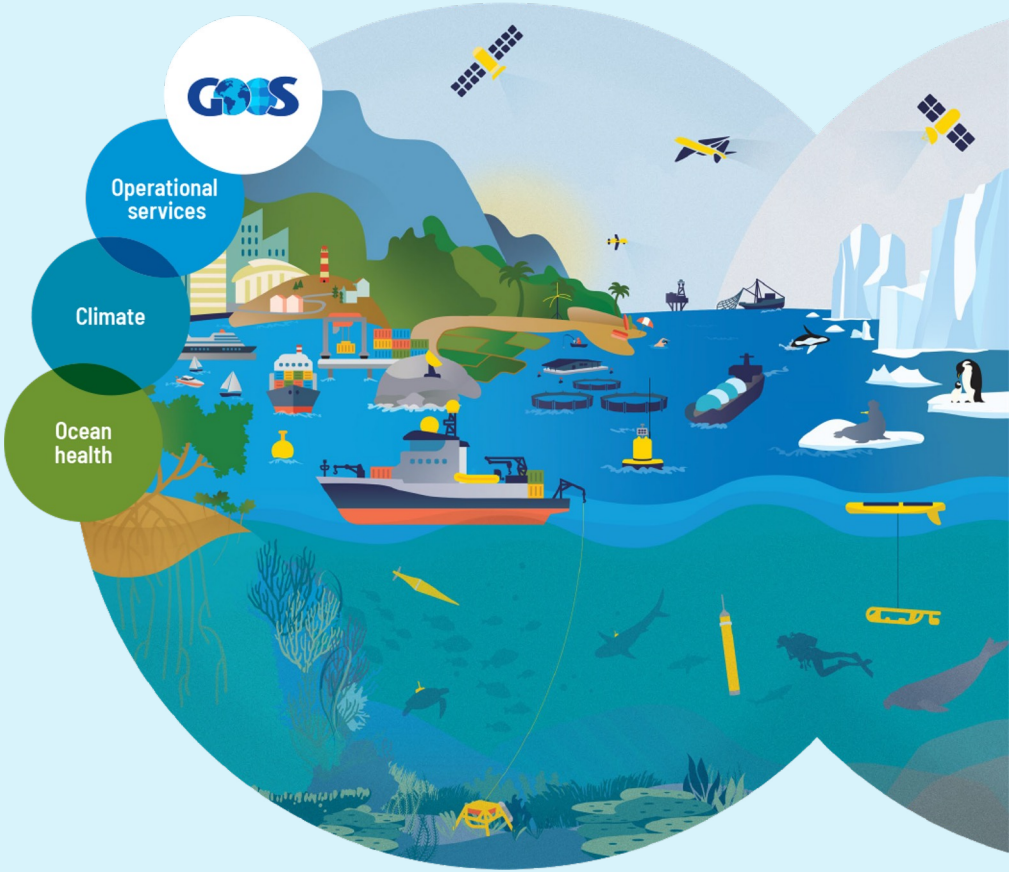
Expert Team:

Olivier Bousquet (France/South Africa), Shoude Guan (China), Kosuke Ito (Japan), Sok Kuh Kang (Korea), Hyun-Sook Kim (USA), Matthieu Le Henaff (USA), I-I Lin (Taiwan), Travis Miles (USA), Pattabhi Rama Rao (India)

At the heart of the Ocean Decade

GOOS Ocean Observing Co-Design Programme

David Legler, NOAA; **Sabrina Speich**, IPSL; Emma Heslop, IOC/UNESCO; Ann-Christine Zinkann, NOAA; Mairéad O'Donovan, GOOS; Andrea McCurdy, UCAR



2021 2030 United Nations Decade of Ocean Science for Sustainable Development

Ocean Observing Co-Design Objectives

1.

- Provide national government funders the **information needed to target investment globally, regionally and locally**.

2.

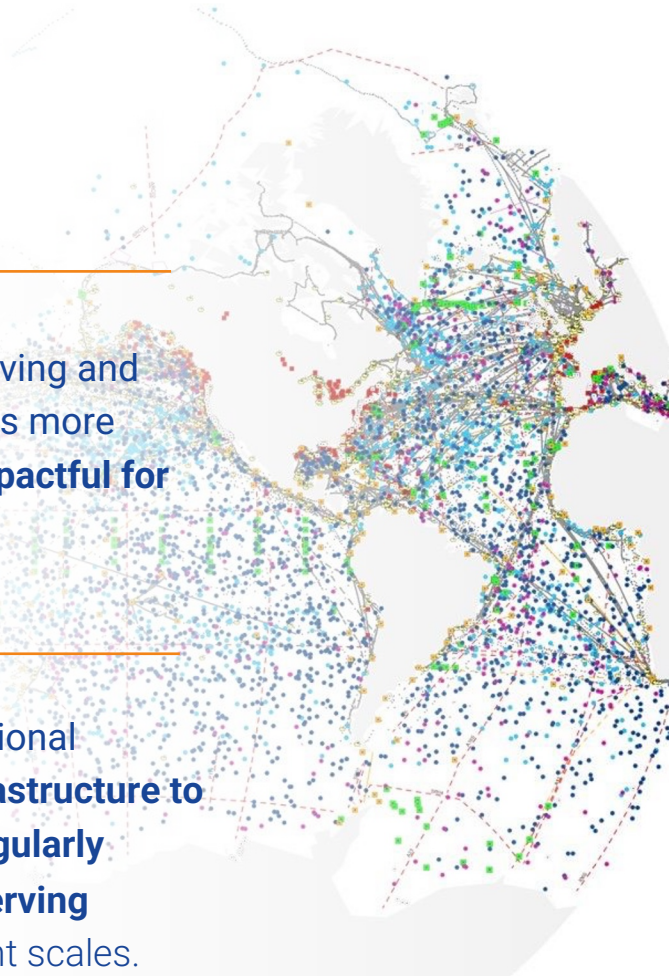
- Make ocean observing and forecasting outputs more **accessible and impactful for end-users**.

3.

- **Develop system diagnostics, tools and reporting capability** to better assess fitness-for-purpose across evolving requirements and use-inspired needs.

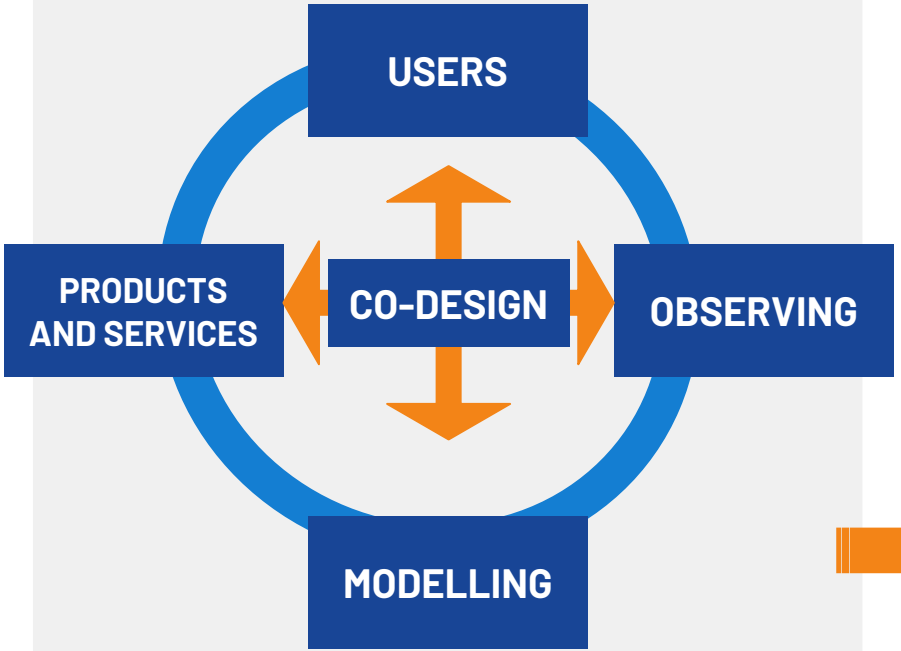
4.

- Establish international **capacity and infrastructure to co-design and regularly evaluate the observing system** at different scales.



Exemplar Projects: Key to a Co-Designed System

Co-design: an iterative process



Initial Exemplar Projects

- Carbon Cycle
- Tropical Cyclones
- Marine Life 2030
- Storm Surge
- Marine Heatwaves
- Boundary Currents

Develop best practices
Communicate co-design blueprint and ROI
Track, evaluate, and report on implementation
Embed co-design as part of GOOS

CONVERGENCE OF INTERESTS, CAPABILITIES & NEED

2021 2030

Challenge 6

Increase community resilience to ocean hazards

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.

Tropical Cyclone Statistics

1,945
disasters have been attributed to tropical cyclones over the past 50 years.

779,324+
people have been killed by tropical cyclones in the last 50 years.

USD 1.4 trillion
Economic losses caused by tropical cyclones during the 50-year period since 1970.

43 deaths
and USD 78M in damages caused by tropical cyclones and related hazards every day in the 50-year period since 1970.

200-500 km
The diameter of a tropical cyclone is typically around 200 to 500 km, but can reach up to 1000 km.

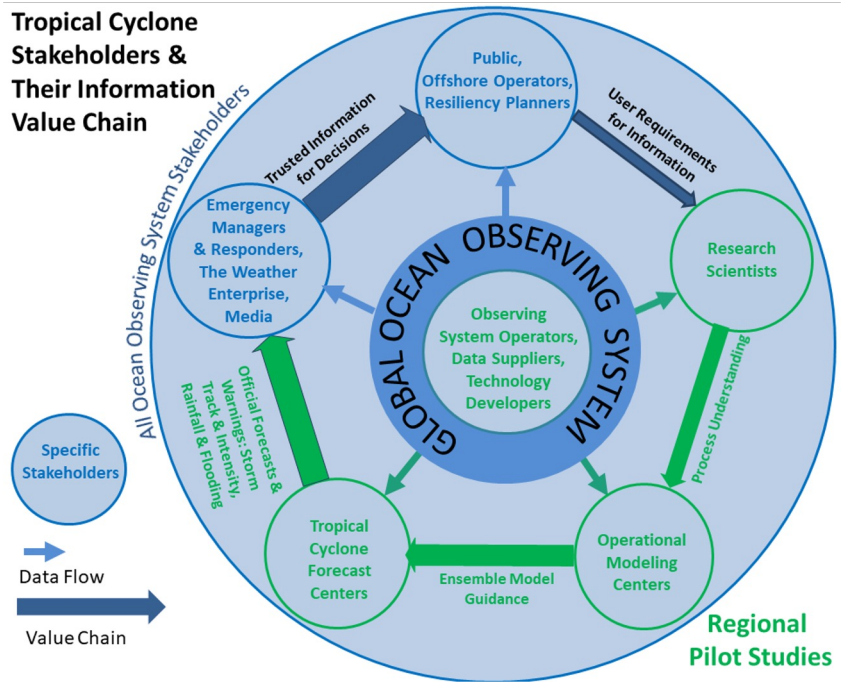
200%
Percentage of which the population of tropical cyclone-prone regions has increased.

WMO

GOOS

- United Nations Decade of Ocean Science for Sustainable Development - **The Ocean Decade** (2021-2030) - Challenge 6 of 10
- World Meteorological Organization (WMO) Early Warnings for All - **EW4All** (2022-2027)
- **Earth System Science** approaches for coupled observations, modeling, data assimilation and forecasting are accelerating
- **Autonomous / uncrewed observing systems** for remote & extreme environments are increasingly accessible technologies
- **Tropical Cyclones** are increasingly destructive globally

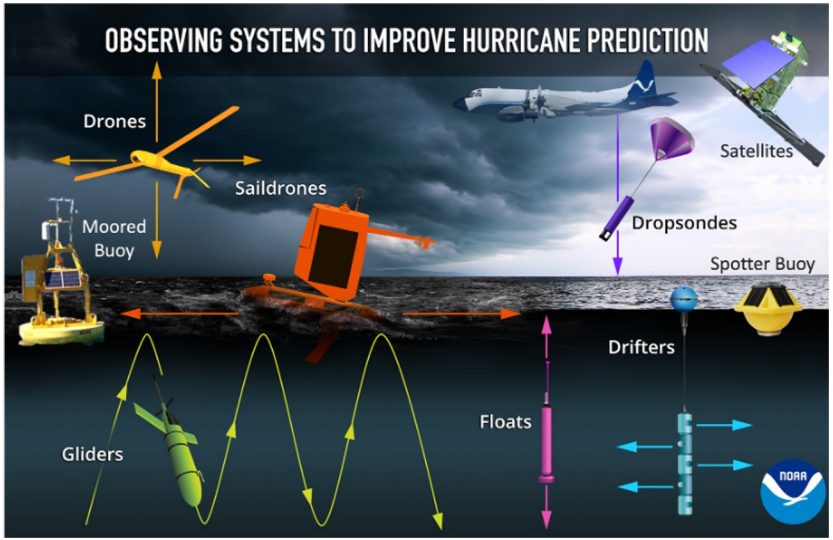
CO-DESIGN VALUE CHAIN - INFORMATION FLOW



The Tropical Cyclone co-design process places particular emphasis on these nodes of the value chain:

- **Research scientists** that improve understanding
- **Operational modeling centers** that produce the ensemble of model guidance products
- **Tropical Cyclone forecast centers** that produce the official forecasts and warnings

CO-DESIGN VALUE CHAIN – REQUIREMENTS FEEDBACK

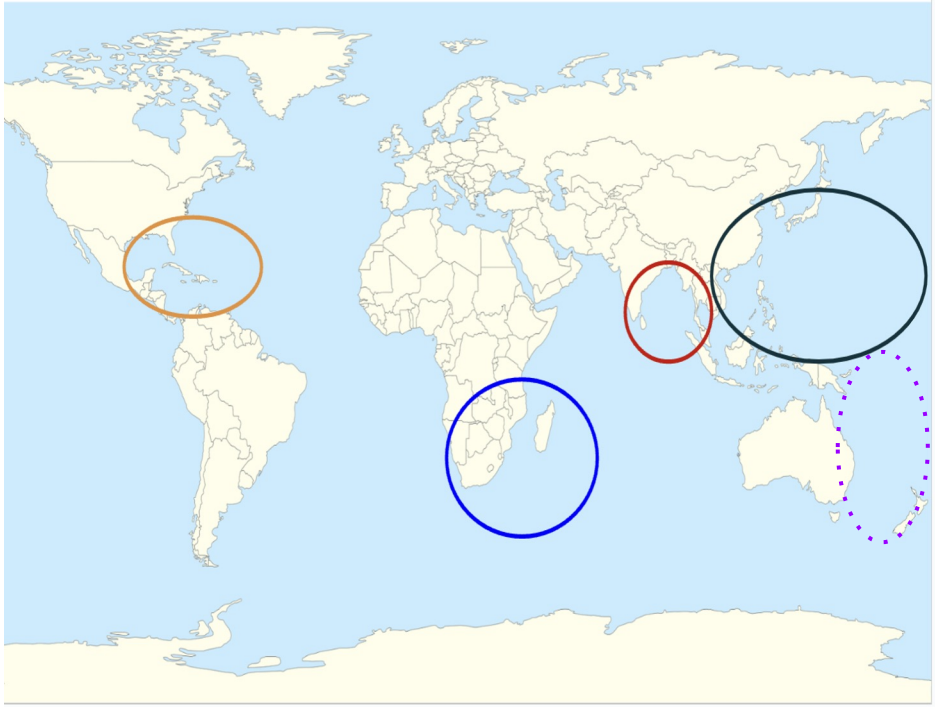


NOAA PMEL

Requirements are fed back through the value chain starting with public needs:

- **Emergency Managers** require forecasts and warnings with sufficient accuracy and lead time to make important decisions
- **Forecast Centers** require improved improved numerical model guidance products to make better forecasts
- **Modeling Centers** require more and better ocean observations to improve Earth System model guidance
- **Observing System Operators** can/should prioritize deployment of the most critical observing systems to improve models

FIVE PILOT STUDY REGIONS DEFINED



Tropical Americas and Caribbean (TAC)
Capacity building for the most damaging TCs

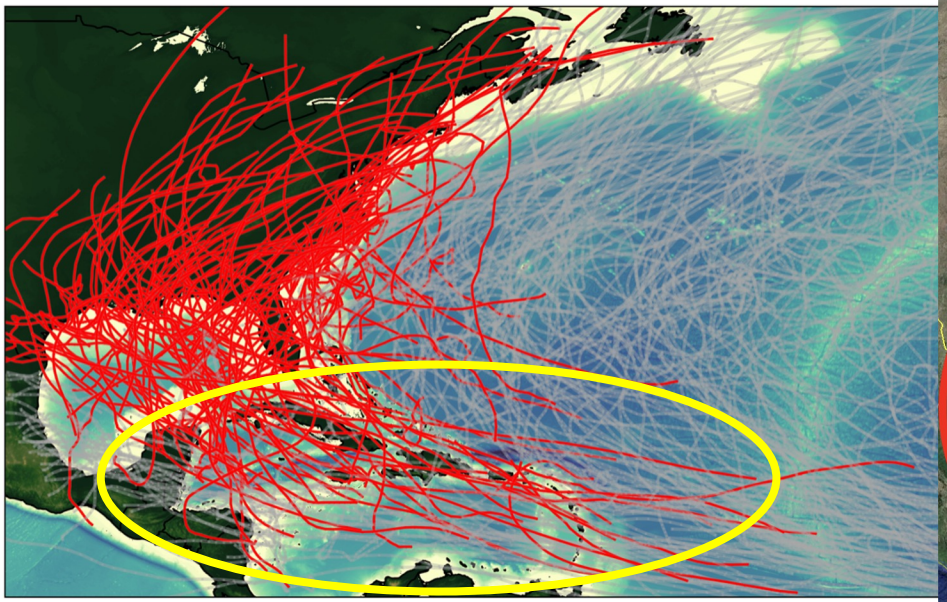
North Pacific Ocean and Marginal Seas (NPOMS)
Coupled air-sea science in the most intense TCs

Southwest Indian Ocean (SWIO)
Co-designing the response to the triple threat of changing boundary currents, MHWs, & TCs

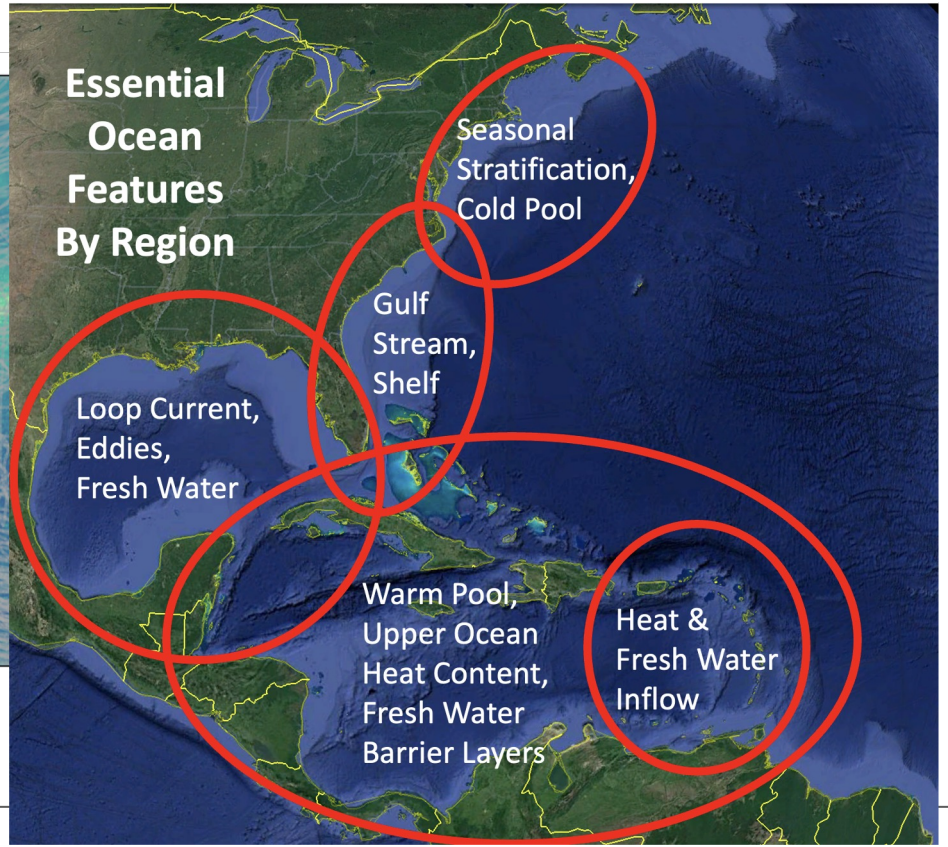
Bay of Bengal, Indian Ocean
Fostering national networks for the most deadly TCs

Pacific Islands – *New Start!*
Initial co-development of regional stakeholder needs along the value chain

TAC HURRICANE TRACKS & ESSENTIAL OCEAN FEATURES



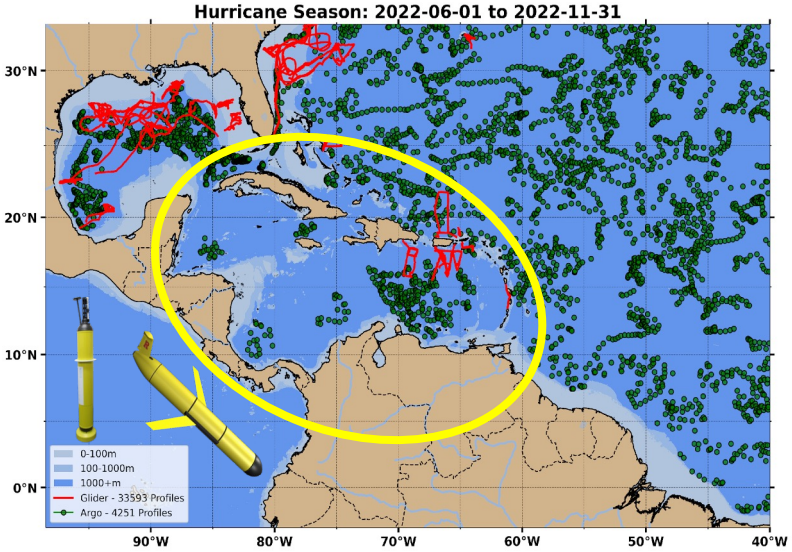
Gray - All Hurricane tracks since 2000
Red - 5 days before US landfall



TAC PILOT COLLABORATIONS

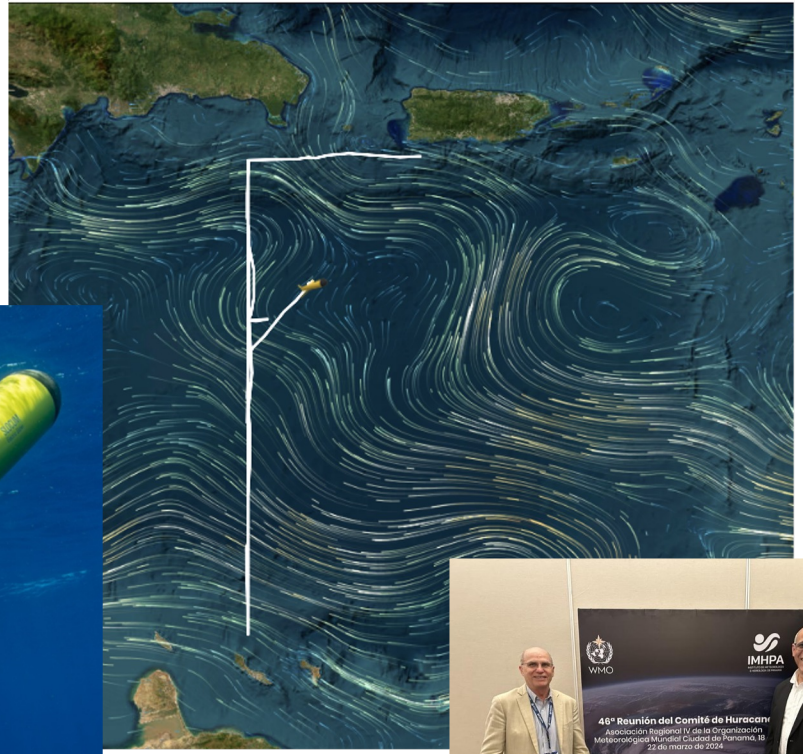
- Building and enhancing region connections via **IOCARIBE-GOOS** & **WMO RA-IV**

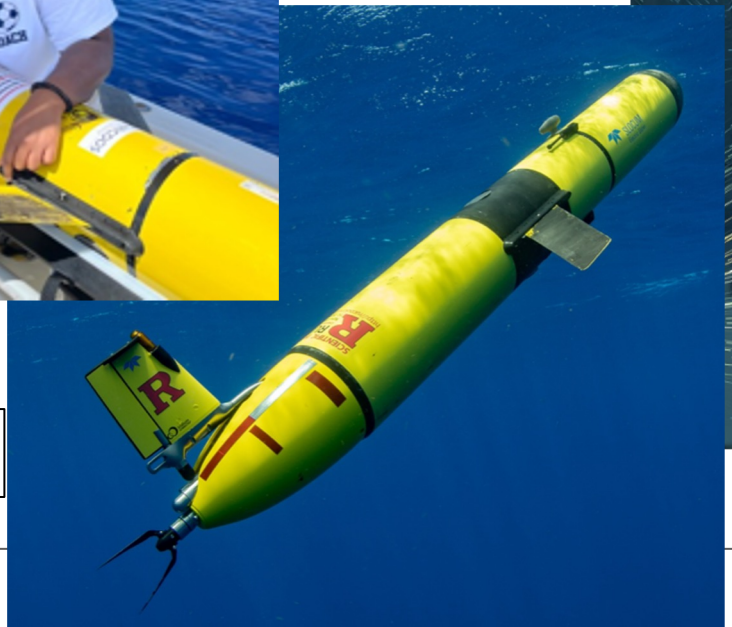
- Collaborating with local partners (e.g., Caribbean Institute for Meteorology & Hydrology) and having discussions around:
  - *Advancing our international partnerships in the context of **expanding EEZ permissions*** for uncrewed systems to roam across an initial set of National Jurisdictions
  - *Exploring the vision for a **co-designed TAC observing system***



CARIBBEAN THROUGHFLOW GLIDER MISSION

Repeat Transect From Puerto Rico to Dominican Republic to Curacao



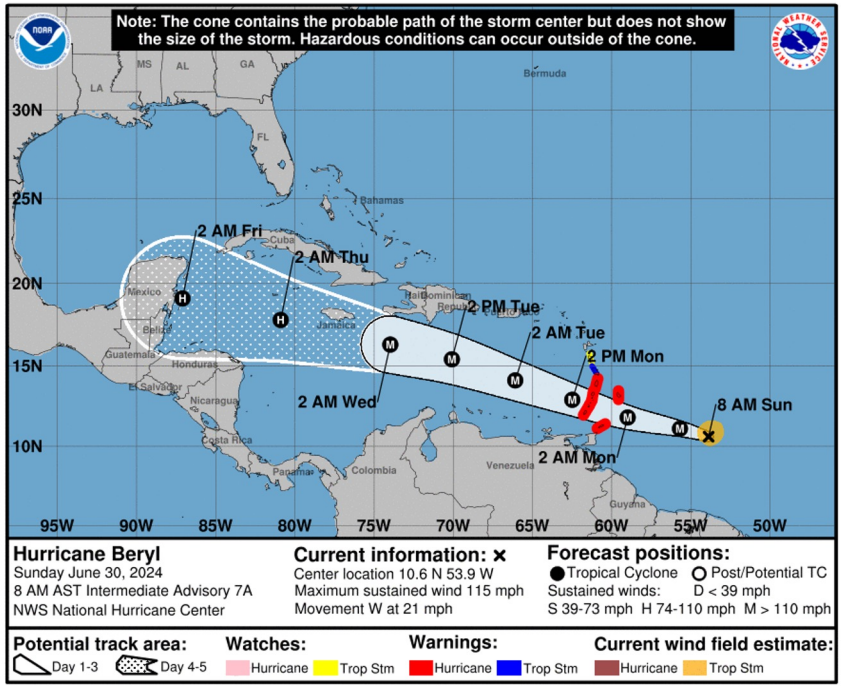


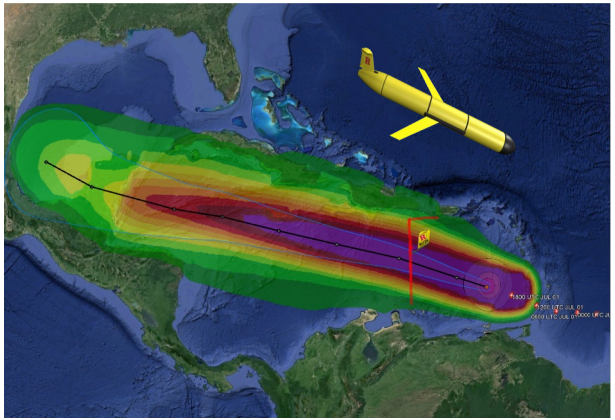
WMO Region IV Coordination

Funded by:

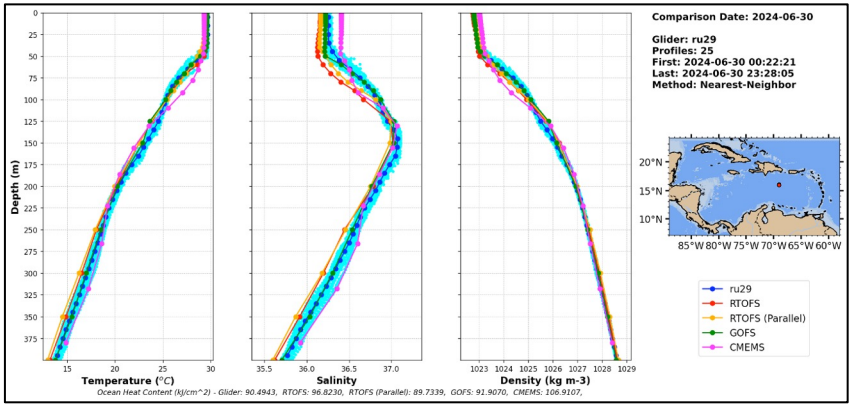
THE
G. UNGER VETLESEN
FOUNDATION

RECORD BREAKING CAT 5 HURRICANE BERYL



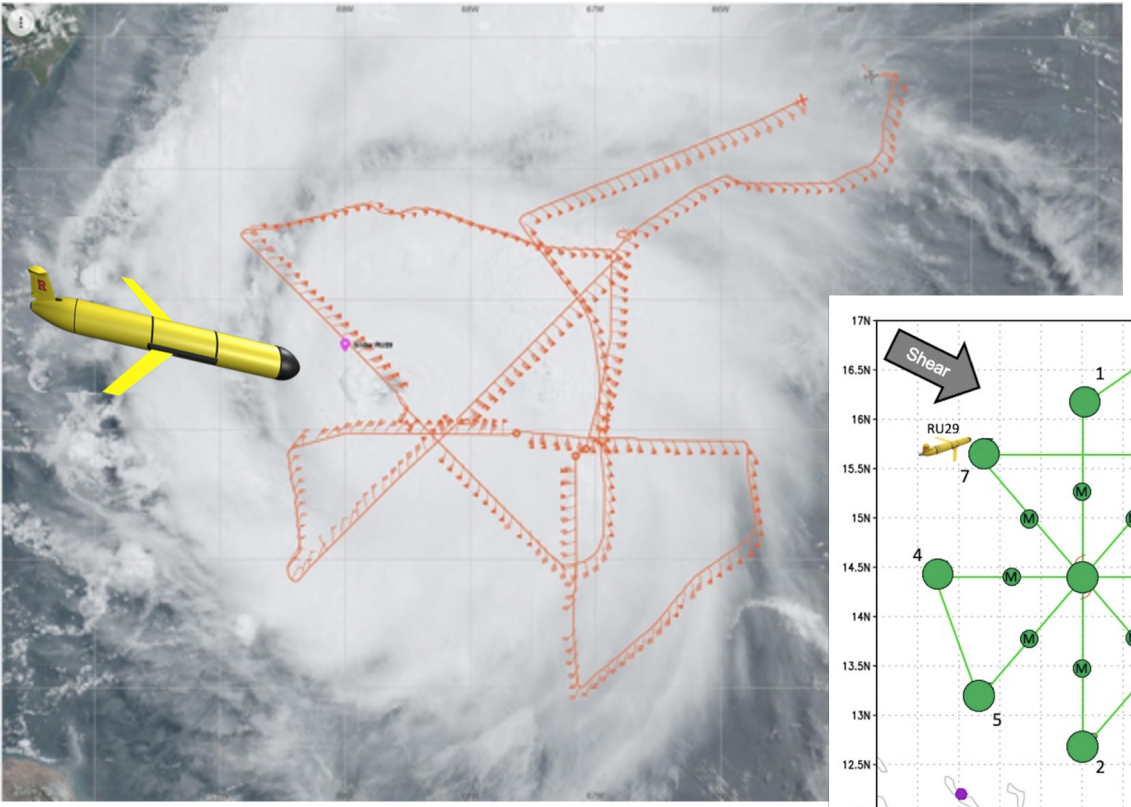


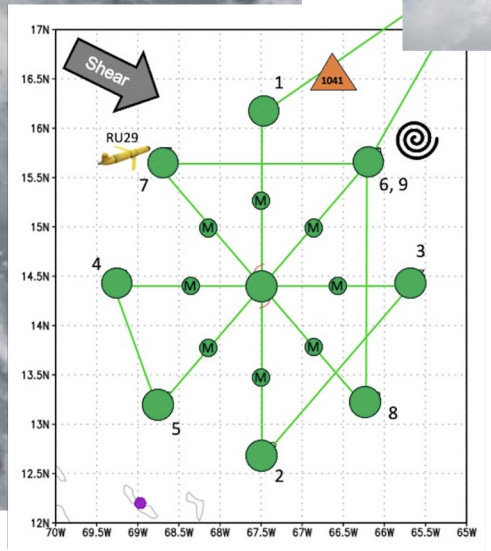
Glider data is shared on the GTS in real time and assimilated in operational ocean models used for hurricane forecasts



Daily Operational Ocean Model/Data Comparison Products

HURRICANE HUNTER AIRCRAFT COORDINATION

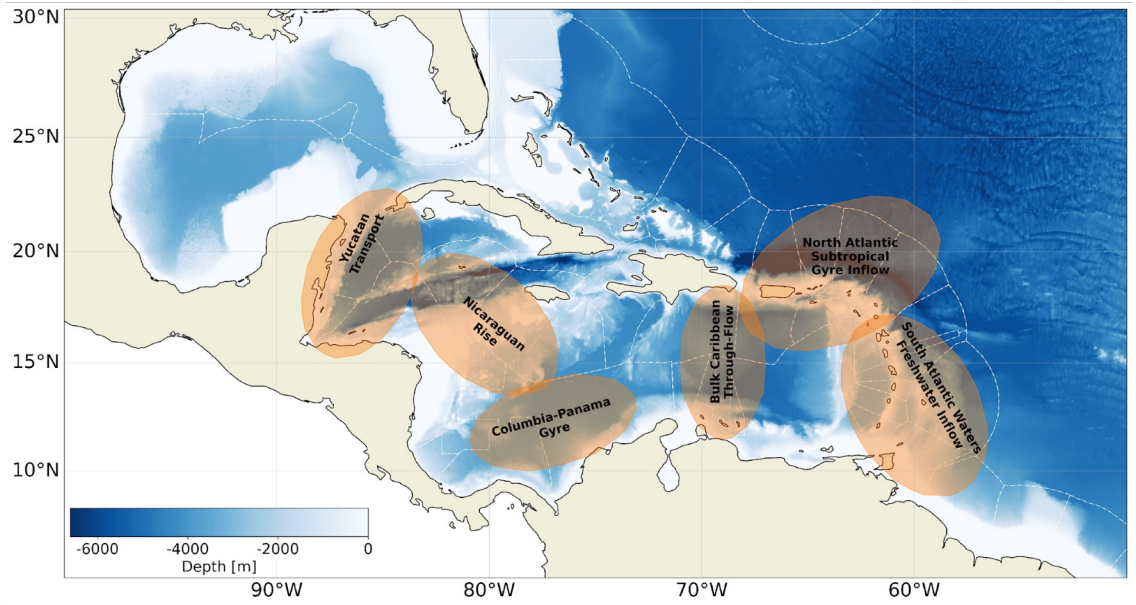




NOAA P3 Hurricane Hunter dropsonde deployments coordinated with underwater glider location in Cat 5 Hurricane Beryl

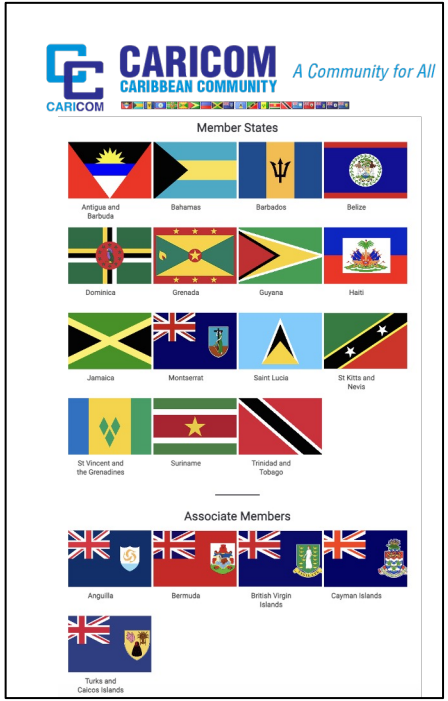
TAC PILOT IMPLEMENTATION

Co-Design of targeted, gap-filling observation areas based on island interest and the need to observe Essential Ocean Features that improve forecast models



Ocean Observing in areas under National Jurisdictions (OONJ) *Report No.: GOOS-246*

Intergovernmental agreements as a pathway forward

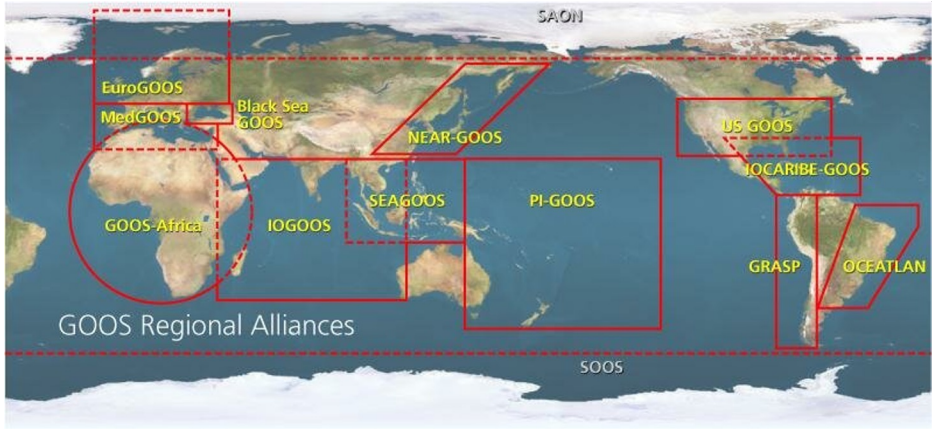


REGIONAL ENGAGEMENTS & COLLABORATIONS

Prioritizing regional engagements, collaborations, and partnerships across the pilot regions

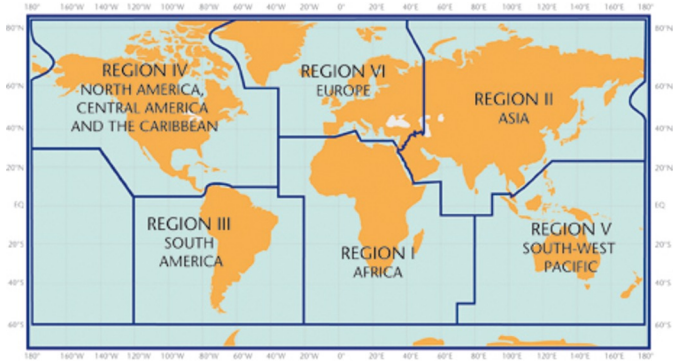
- **North Pacific Ocean and Marginal Seas (NPOMS)**
  - Collaborations with Korea Institute of Ocean Science and Technology, Korea Meteorological Administration, etc. through the U.S. – Korea Joint Project Agreement
- **Southwest Indian Ocean**
  - Agulhas Current Observing System Design Workshop - Cape Town
  - Alignment of Tropical Cyclone, Marine Heatwave, and Boundary Current Exemplars
- **Intergovernmental Meetings**
  - 8th WMO Workshop on the Impact of Various Observing Systems on Numerical Weather Prediction and Earth System Prediction
  - 2024 WMO Technical Conference on Meteorological and Environmental Instruments and Methods of Observation

INITIAL PACIFIC ISLAND ENGAGEMENT



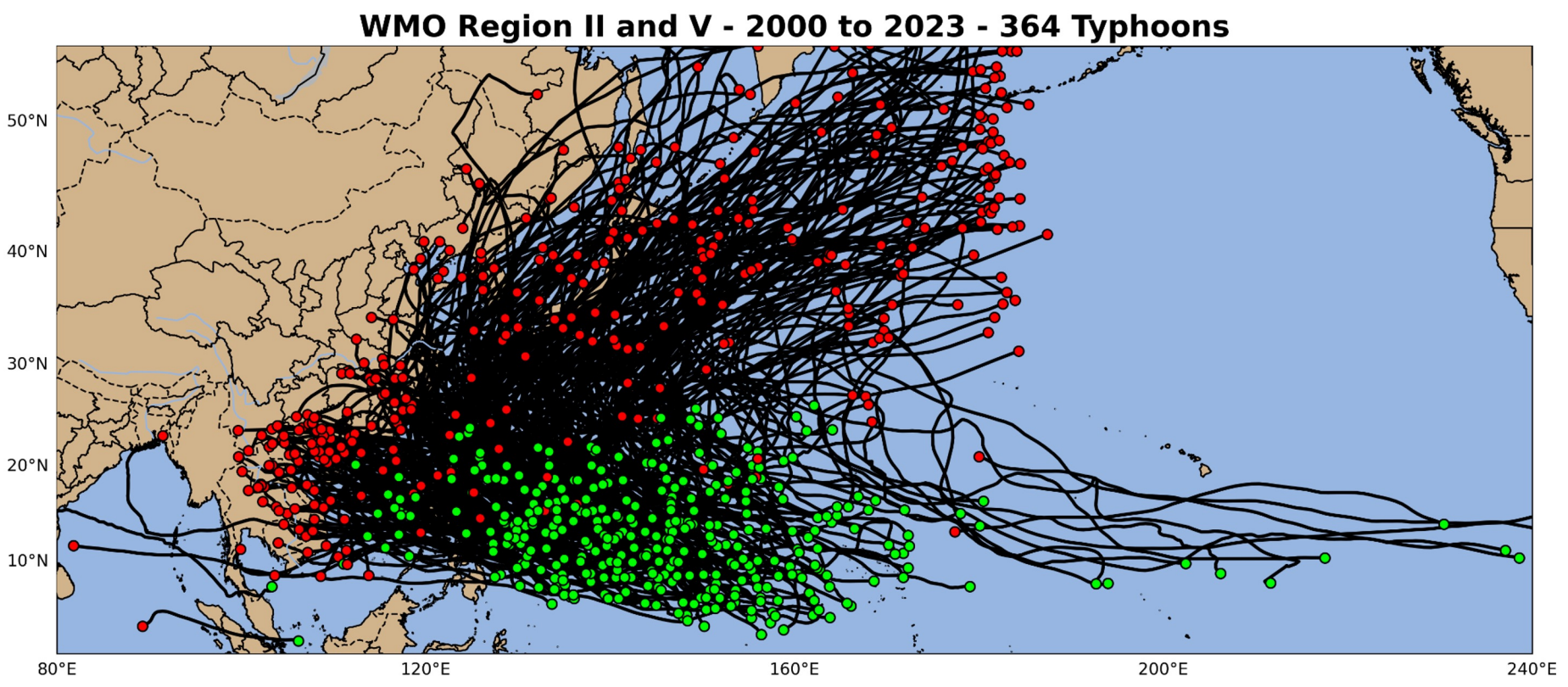
WMO

Regional Associations

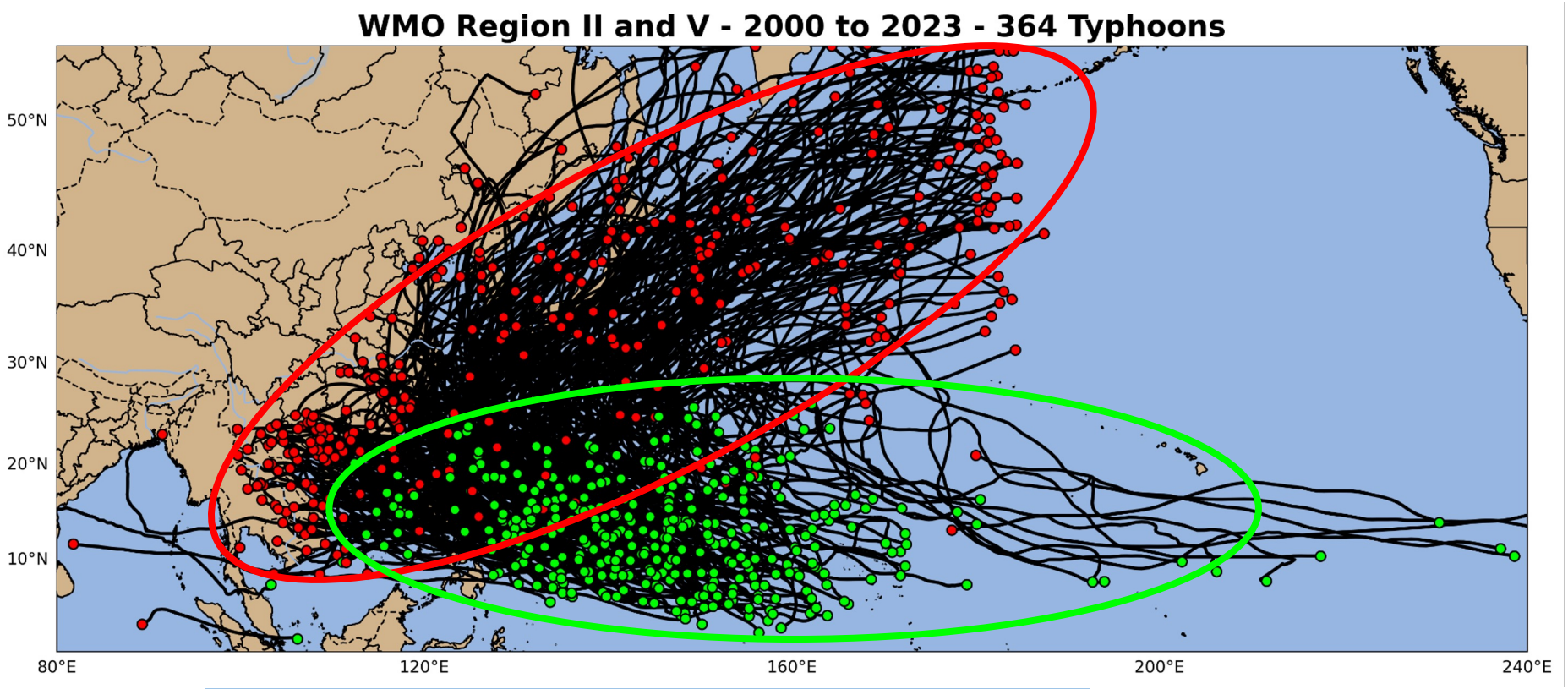


Existing **Regional Organizations** provide opportunities for collaborative international Co-Design

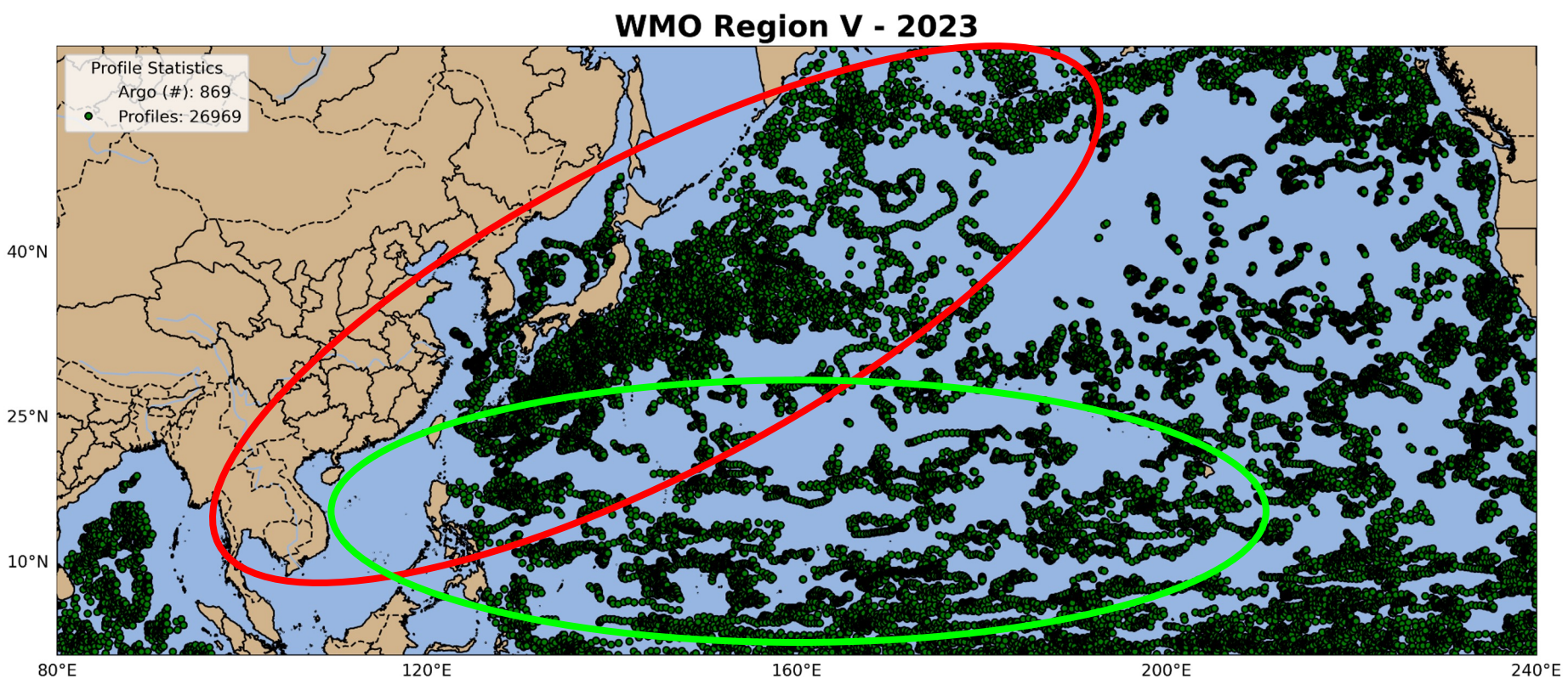
- **GOOS Regional Alliance:**
  - PI-GOOS -
  - **2 May 2024**
- **WMO Regional Association:**
  - Region V: South West Pacific
  - **31 July 2024**
- **DBCP Training Workshop 2024:**
  - Indonesia
  - **7 August 2024**
- Regional Specialized Meteorological Centers (**RSMC**)
  - Nadi, Fiji



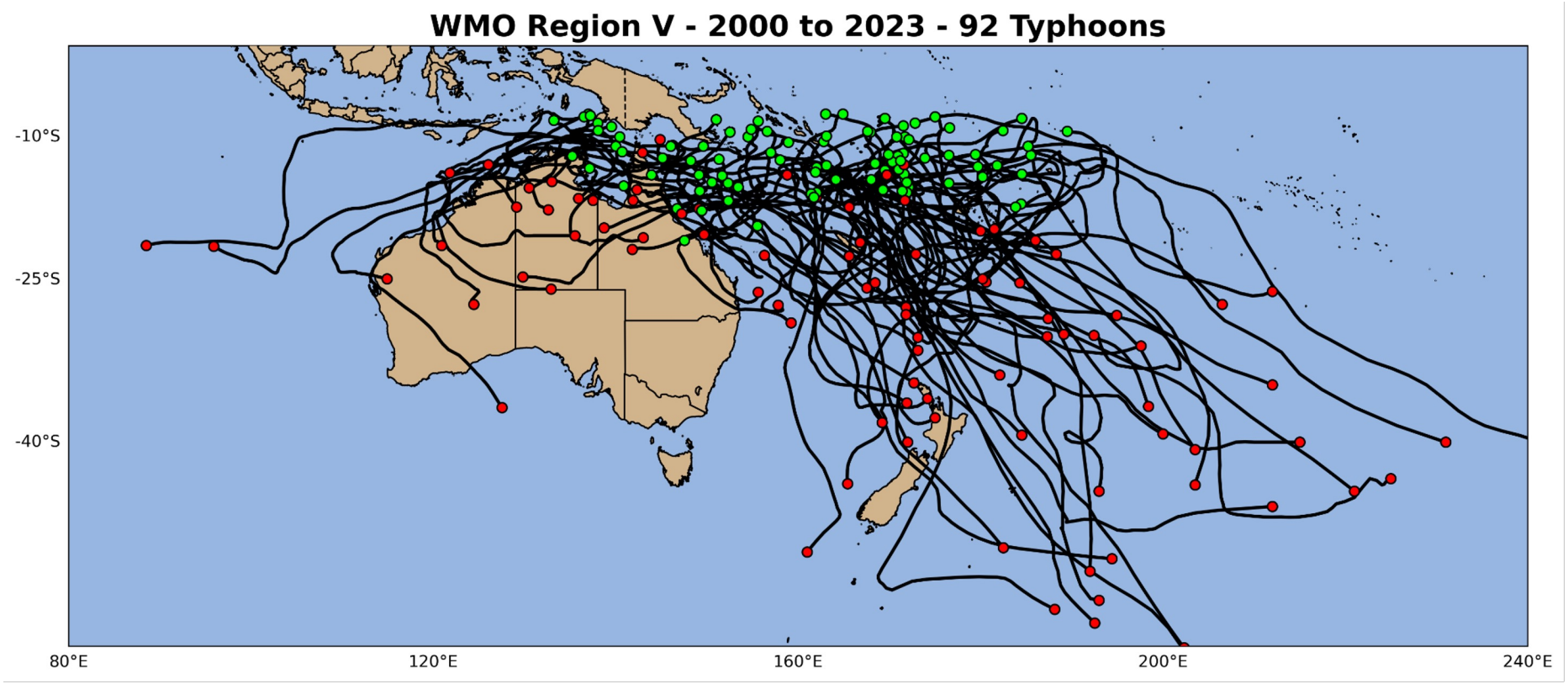
North Pacific Typhoon Tracks (Green Start, Red End)



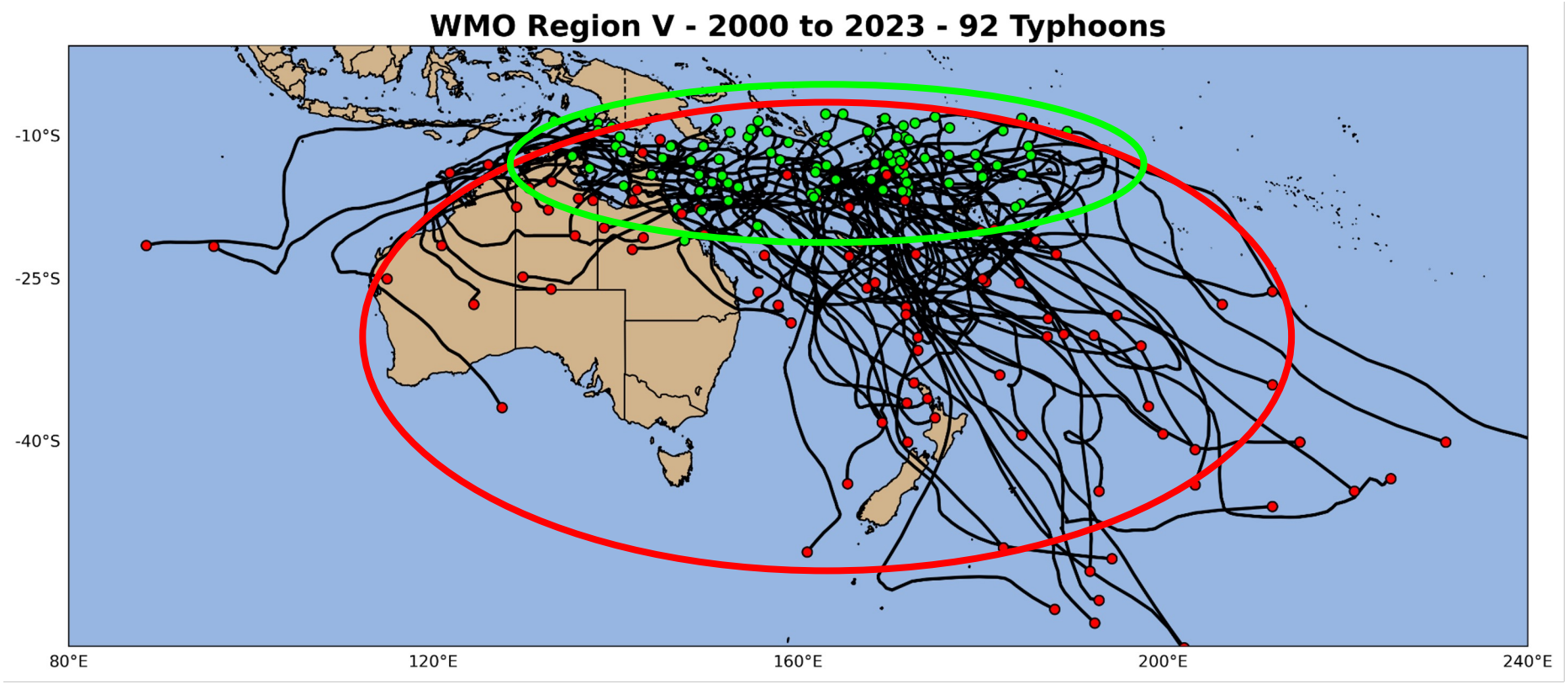
North Pacific Typhoon Tracks (Green Start, Red End)



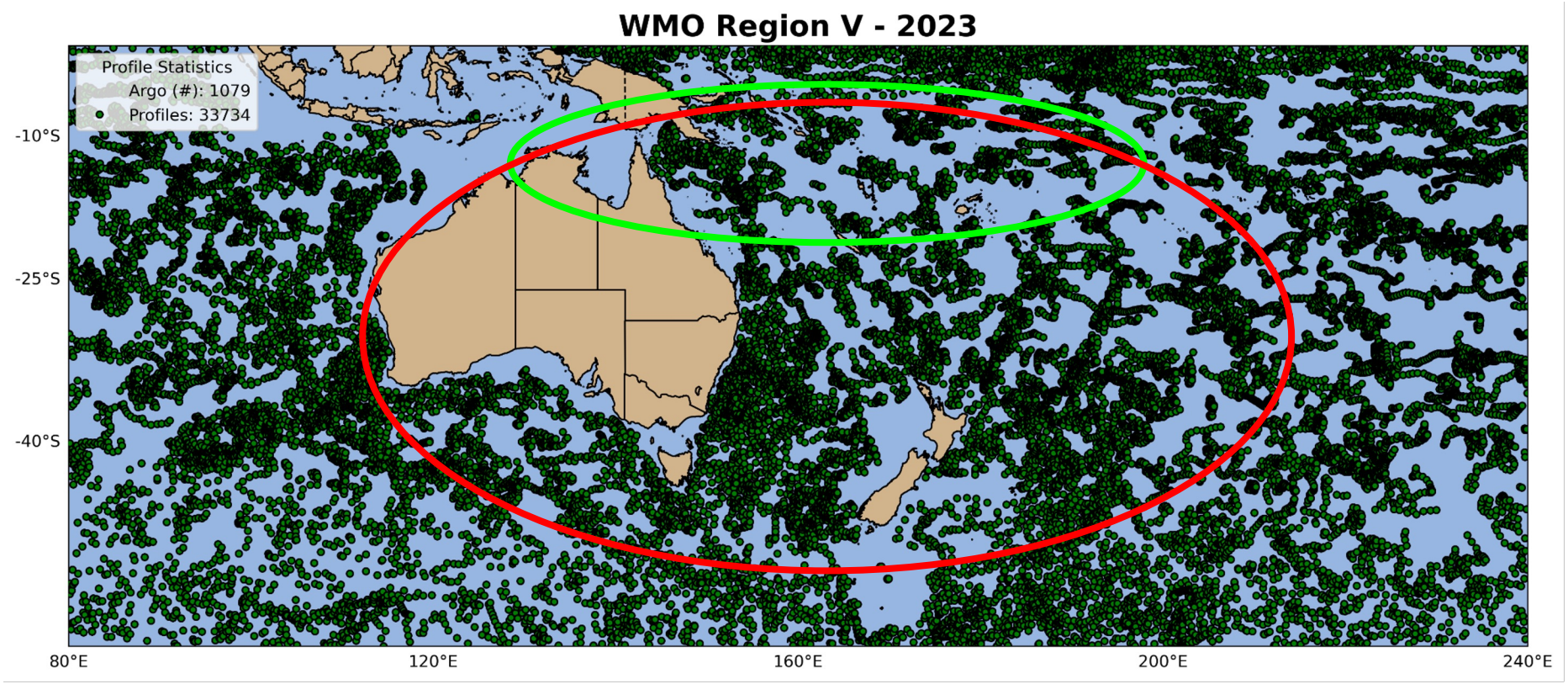
North Pacific 2023 Argo Float Surfacings (Dark Green)



South Pacific Typhoon Tracks (Green Start, Red End)



South Pacific Typhoon Tracks (Green Start, Red End)

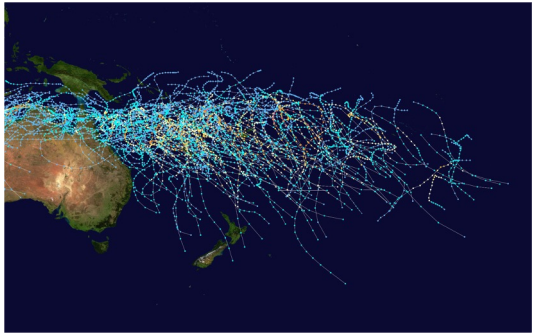


South Pacific 2023 Argo Float Surfacings (Dark Green)

PACIFIC ISLANDS & TROPICAL CYCLONES

- "Pacific island tropical cyclones are more frequent and globally relevant, yet less studied" [Marler 2014]
- For a Pacific Island Pilot Study within the Tropical Cyclone Exemplar (*co-design from the beginning*):
  - TC Exemplar information sharing with PI-GOOS, WMO Region V, DBCP 2023, …..
  - Is there other regional expertise we should engage?
  - Are there high priority regions or needs we should be aware of?
  - Can we engage the proper stakeholders? Can stakeholders help us define regional requirements?
  - What Essential Ocean Features are required in coupled models?
  - Share existing observing, modeling and capacity building capabilities; can we identify implementing partners for next steps?
  - Pursue funding opportunities at the foundation & government levels

Pacific Tropical Cyclones



Ocean Observing Co-Design
by The Global Ocean Observing System

THANK YOU!

CONTACT:

cheyenne.stienbarger@noaa.gov
glenn@marine.rutgers.edu

2021 2030 United Nations Decade of Ocean Science for Sustainable Development