

# Building Robust and Sustainable Capacity for the Western Indian Ocean

On the Auspicious Occasion of CLIVAR Western Indian Ocean Workshop

**Dr. Sidney Thurston**

National Oceanic and Atmospheric Administration (NOAA)  
Global Ocean Monitoring and Observing Program (GOMO)

Chair, Indian Ocean Observing System (IndOOS) Resource Forum (IRF)

Vice-Chair World Meteorological Organization (WMO)

Standing Committee on Earth Observing Systems and Monitoring Networks

9 June, 2022



# International Dimensions of Sustained WIO Observations

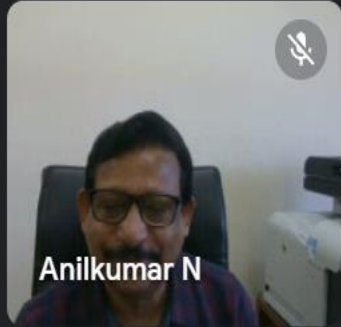
(Thoughts While Flying 2.5M miles across the Indo-Pacific Region Over 25 Years)

- Empowering Western Indian Ocean States to Adjust to A Changing Environment Takes Time and an In-Region Presence,
- *Helicopter Science* is not sustainable and is not mutually beneficial
- Building Long-term Partnerships is Required to Proliferate Earth System Observations for Improving Forecasts and Predictions to Save Lives and Protect Livelihoods,
- Building Personal Relations, Trust and Technical Capacity is Essential to Train the Next Generation of Researchers, Operational Forecasters and Informed Decision Makers.



**Co-Design>>Co-Create!**

**Thank You!**



Anilkumar N



Kiran Kumar N



Aneesh Lotliker



Nagaraja Kumar Ma...



E Pattabhi Rama R...



Sidney Thurston - ...



Nick Dadamo



Juliet Hermes



Meredith Kurz - N...



Joseph Naughton ...



Jim Costopulos



Marie Sicre



Jenny Huggett



Motoki Nagura



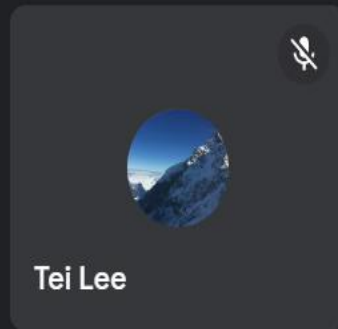
Gilbert Siko



Nelly Florida



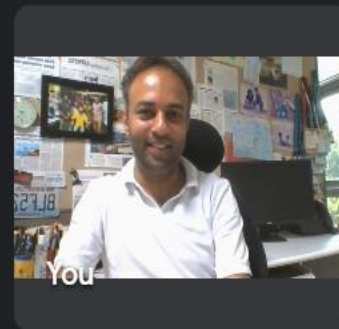
Amit Tandon



Tei Lee



Shuhei Masuda



You

**IRF-14 Colleagues**



# Capacity Development is Essential for Training the Next Generation of Researchers and Operational Forecasters



NOAA co-sponsored training of ocean data to large and diverse groups of regional participants and fostering partnerships between developed and developing countries to realize the social-economic benefits of ocean observing systems.

Deliver technical expertise in South Asia, Western Indian Ocean/East Africa,

Empower developing States on the applications of ocean observation data for understanding and predicting regional weather, ocean and climate and their impact on fisheries, coastal zone management, natural disasters, water resource management, human health and others.

To date over thirty capacity development workshops have been held across the Indo-Pacific Region

# NOAA Co-sponsored Western Indian Ocean Capacity Building Workshops



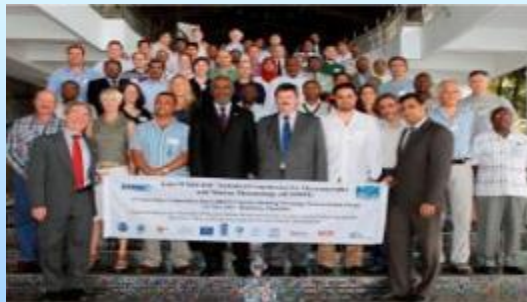
Cape town April 2010



Port Elizabeth May 2014



Mombasa Kenya May 2012



Mauritius May 2011



Zanzibar Tanzania April 2013



WHAT WILL THE  
WEATHER BE  
TOMORROW?











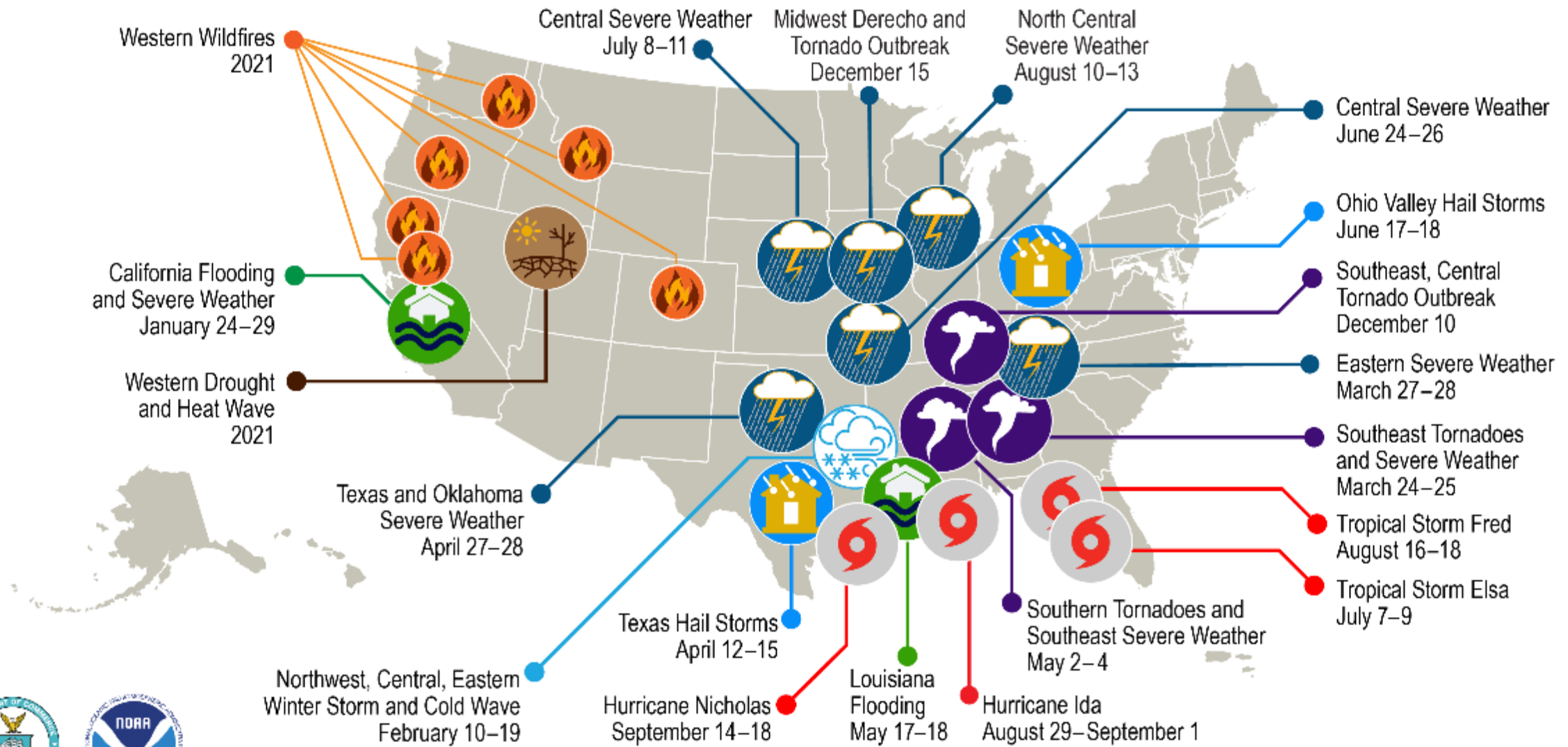
# Role of the Indian Ocean in the Asian Monsoon



- One third of the world's population is affected by the Asian Monsoons.
- Accurate prediction of seasonal monsoon rainfall would be of tremendous socio-economic value.
- Forecasts are improving as transitioning from statistical to dynamical and by assimilating in-situ data such as from RAMA

# U.S. 2021 Billion-Dollar Weather and Climate Disasters

-  Drought/Heat Wave
-  Flooding
-  Hail
-  Hurricane
-  Tornado Outbreak
-  Severe Weather
-  Wildfire
-  Winter Storm/Cold Wave

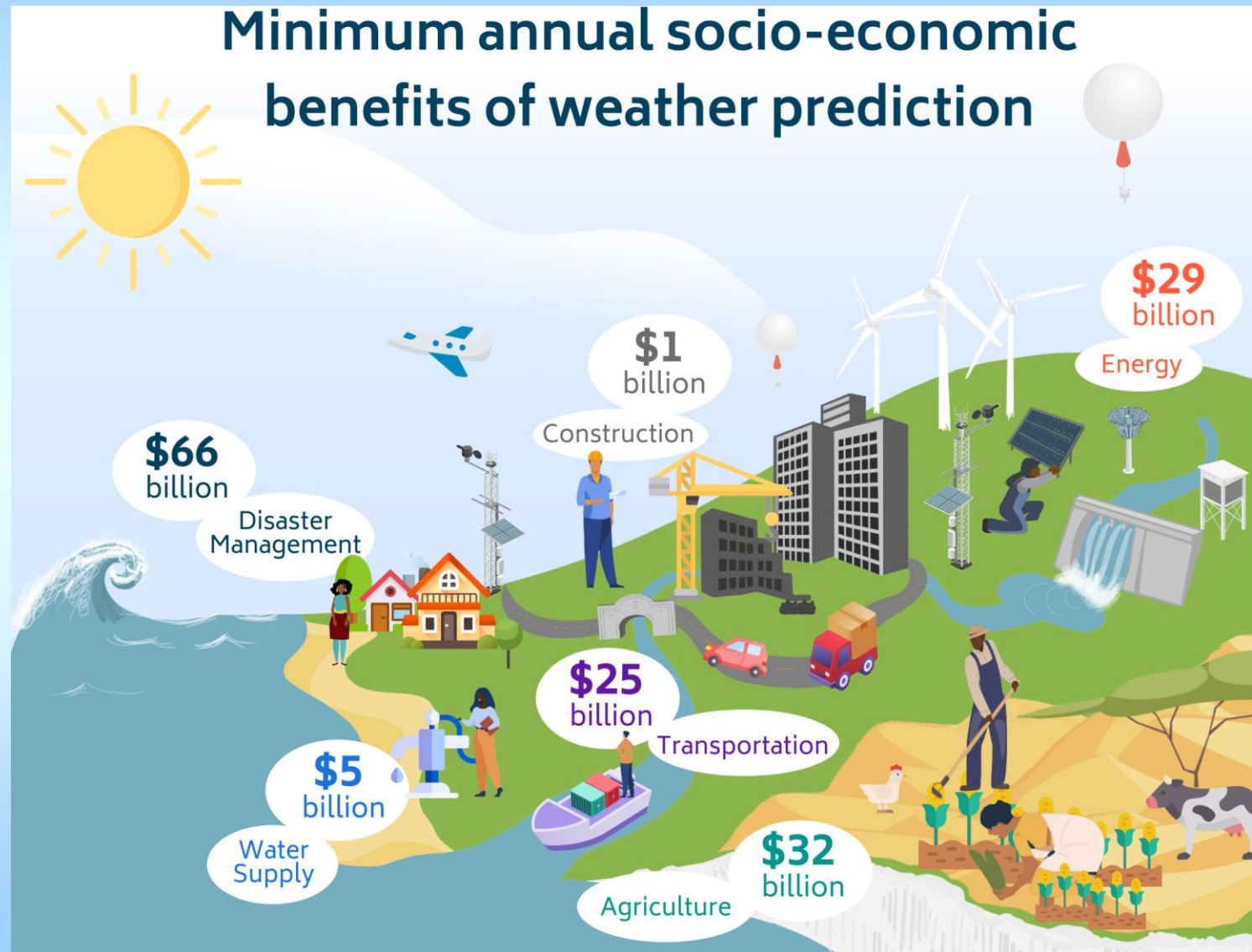


This map denotes the approximate location for each of the **20 separate billion-dollar weather and climate disasters that impacted the United States in 2021**



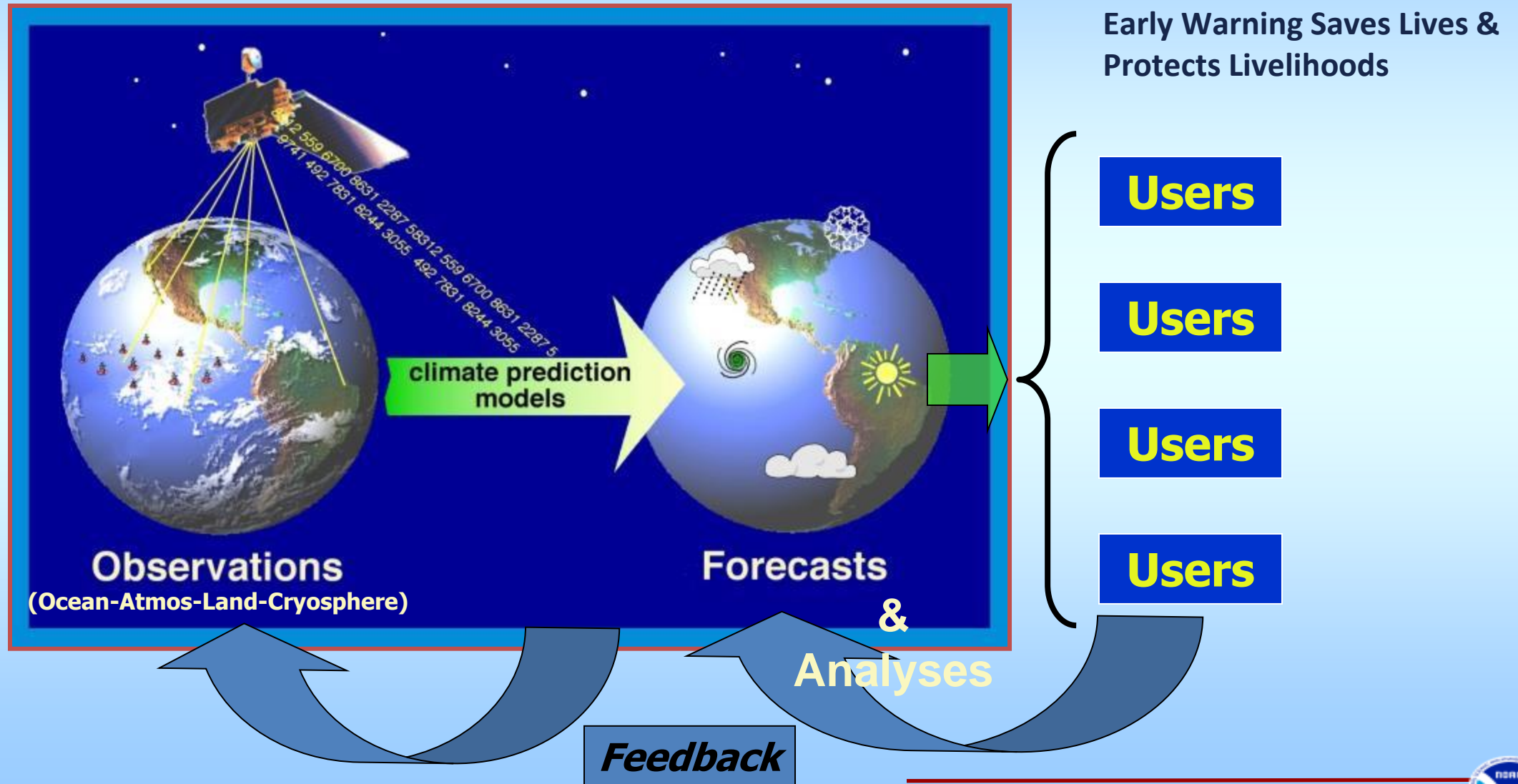


# Infographic Representing the Minimum Annual socio-economic Benefits of Weather Prediction to Several Economic Sectors



WMO Information Brief 2021

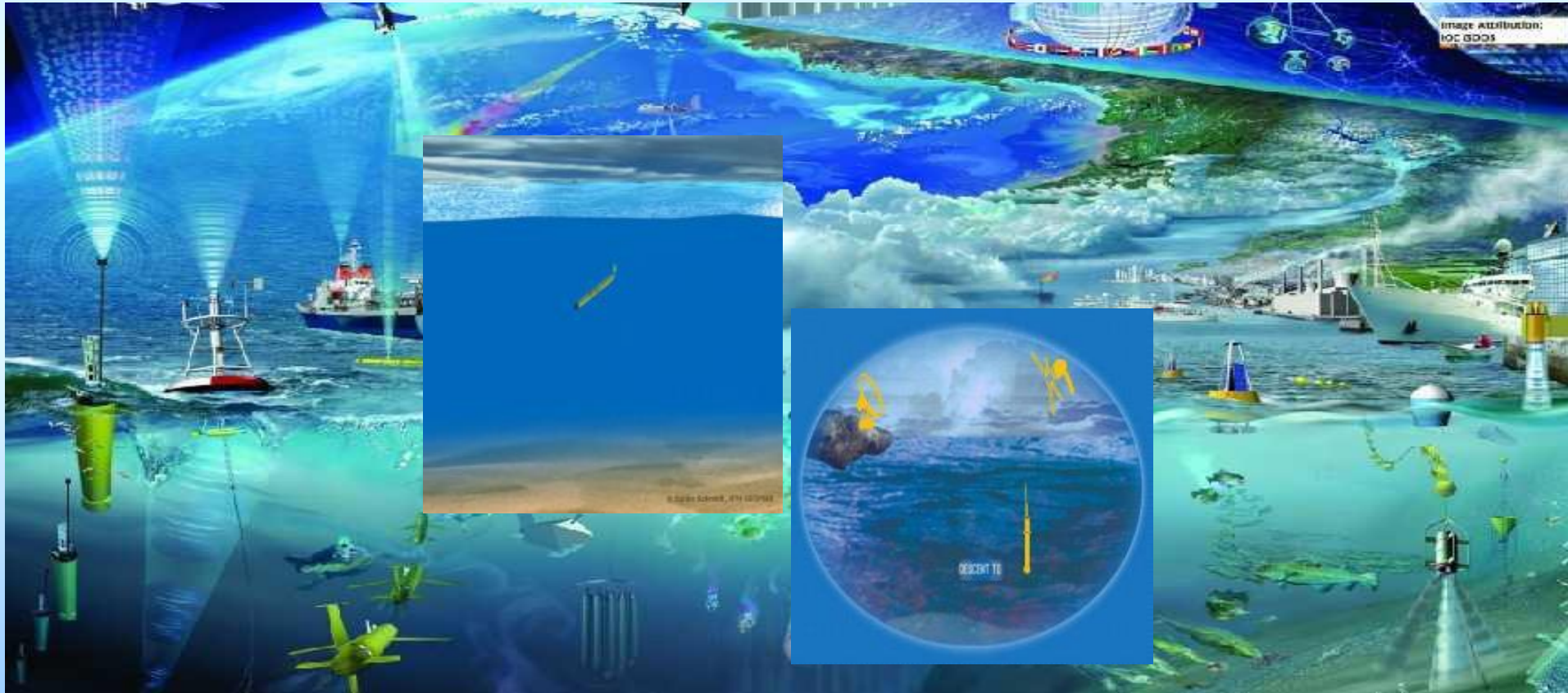
# Sustainability Requires Provision of Climate Products and Services to Society



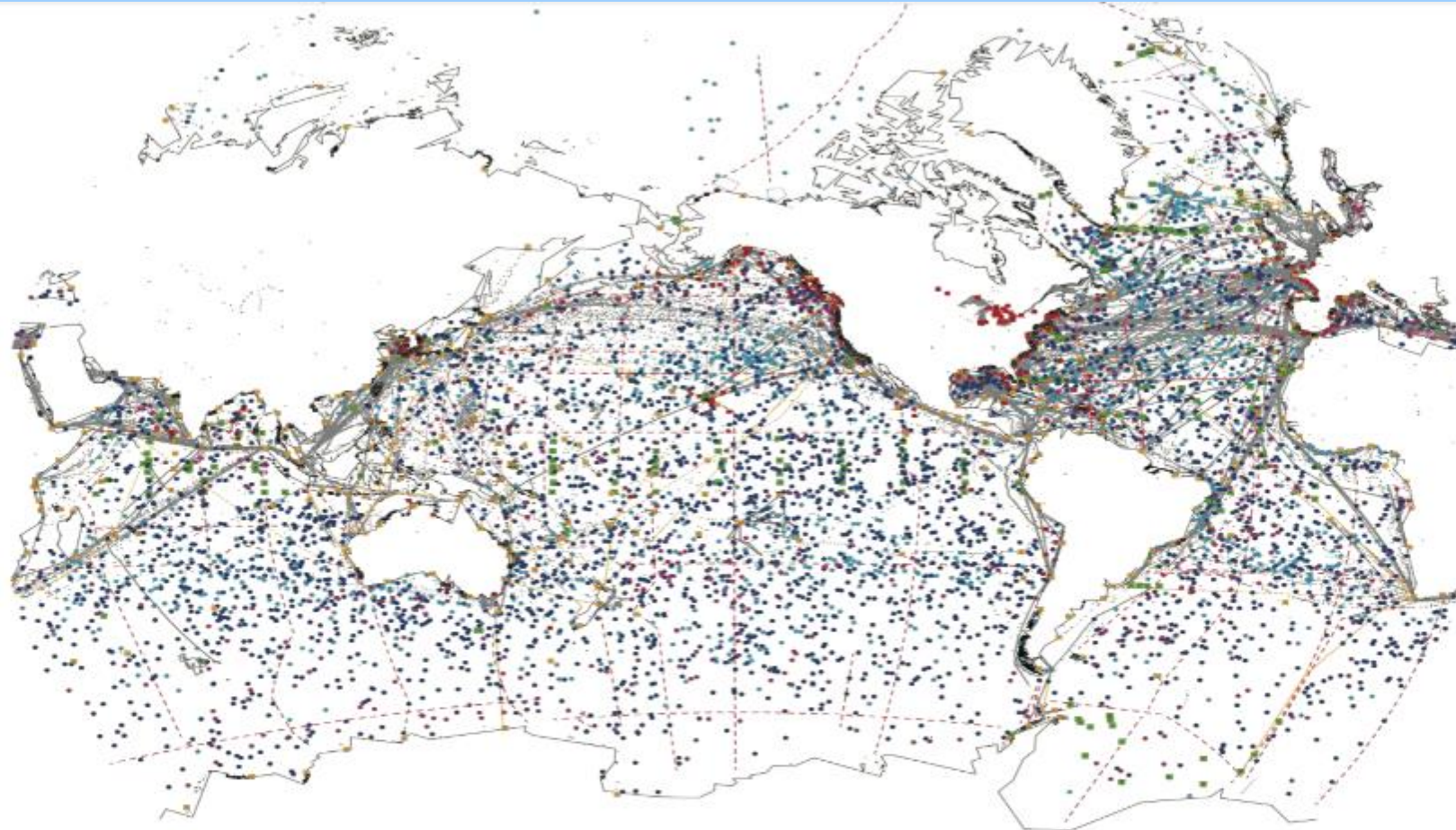
# A 'new world' in Observational Technology

Contemporary techniques/technology, infrastructure give us an improved capacity to measure and characterize (processes)








Direct and robotically – gear, humans and animals –  
above, at and below the sea surface



# The Global Ocean Observing System (GOOS)



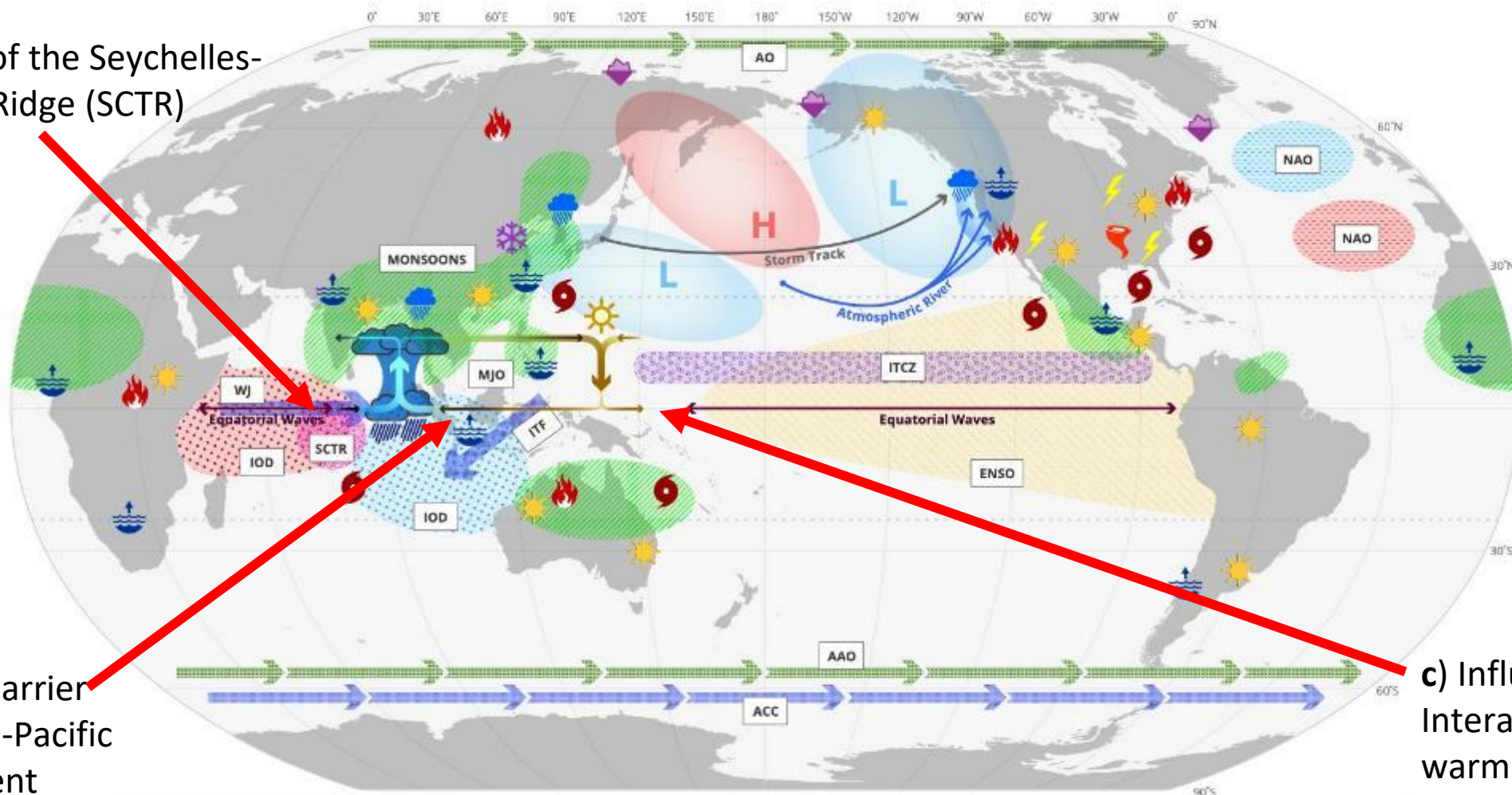
See *in situ* networks table for map legend. OceanOPS data source as of June 2021: operational platforms latest location (Argo, DBCP, AniBOS, VOS, ASAP); fixed platforms location (GLOSS, HF radars, OceanSITES); reference lines (GO-SHIP, SOOP); sampled sites (OceanGliders). Dashed lines for GO-SHIP and SOOP have not been sampled after Covid-19 Impact; dots for VOS and ASAP show May 2021 observations. Symbols size is not to scale, in the map they are exaggerated to an order of hundreds kilometers for readability.

-  Ship based meteorological measurements - SOT/VOS
-  Ship based aerological measurements - SOT/ASAP
-  Ship based oceanographic measurements - SOT/SOOP-XBT
-  Sea level gauges - GLOSS
-  Drifting and polar buoys - DBCP
-  Moored buoys - DBCP
-  Long-term time series sites - OceanSITES

-  Profiling floats - Argo
-  Repeated transects - GO-SHIP
-  OceanGliders
-  HF radars
-  Biogeochemistry & Deep floats - Argo
-  Animal borne ocean sensors - AniBOS

# MADDEN-JULIAN OSCILLATION (MJO): GLOBAL IMPACTS

a) Genesis: Role of the Seychelles-Chagos Thermal Ridge (SCTR)



b) Propagation: Barrier effect of the Indo-Pacific Maritime Continent

c) Influence on ENSO: Interaction with the warm pool

**MJO**

upward motion → stormy and wet

downward motion → sunny and dry

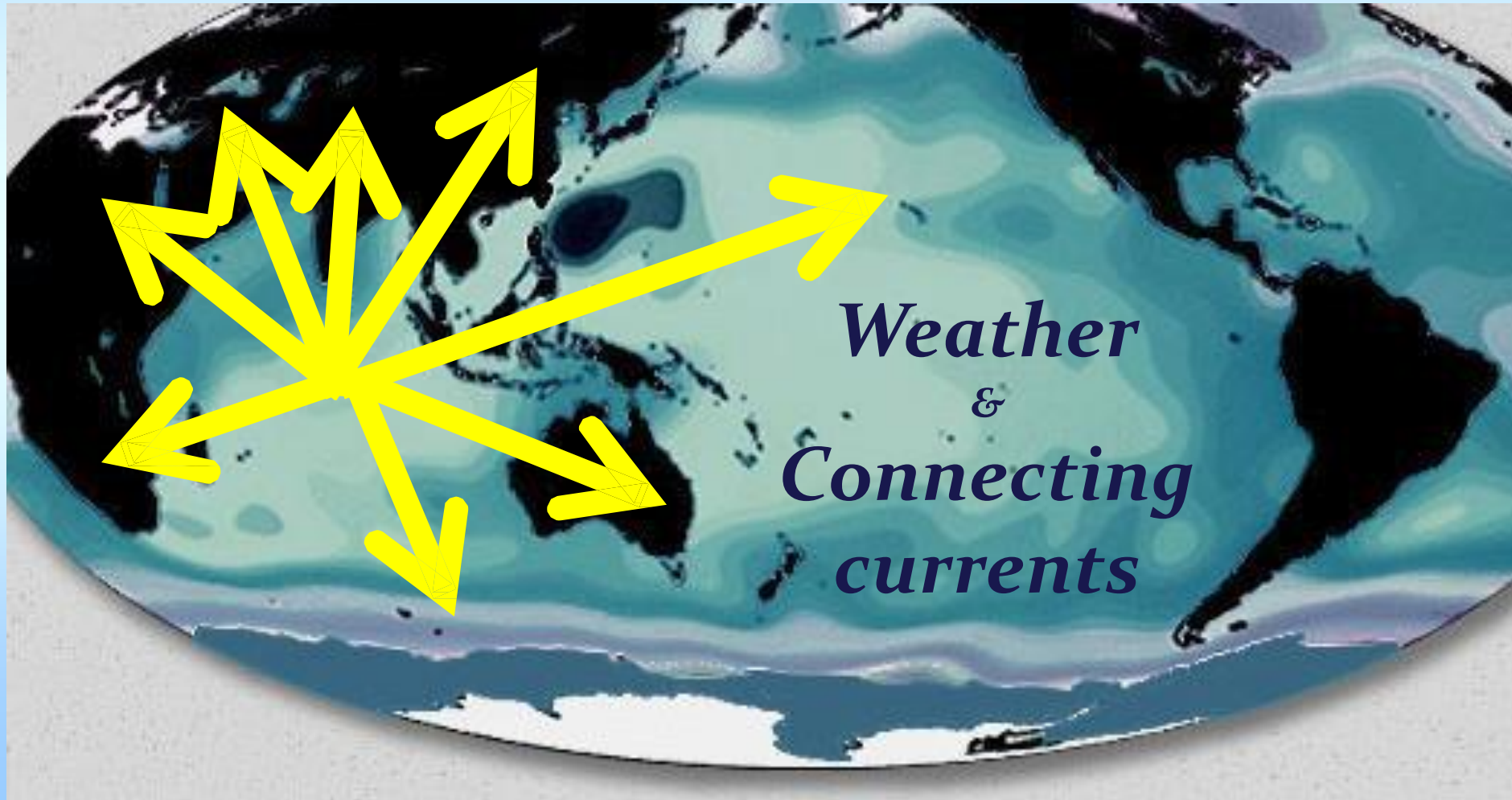
→ Atmospheric River	☀ Heat Waves
❄ Cold Surges	⚡ Lightning
→ Equatorial Waves	❄ Sea Ice
☁ Extreme Rainfall	→ Storm Track
🔥 Fires	🌪 Tornadoes
🌊 Flood	🌀 Tropical Cyclones

🌐 Atmospheric Circulation (AO, AAO)	🌿 Monsoons
🌊 El Niño-Southern Oscillation (ENSO)	🌊 North Atlantic Oscillation (NAO)
🌊 Indian Ocean Dipole (IOD)	🌊 Oceanic Circulation (ITF, WJ, ACC)
🌊 InterTropical Convergence Zone (ITCZ)	🌊 Seychelle-Chagos Thermocline Ridge (SCTR)

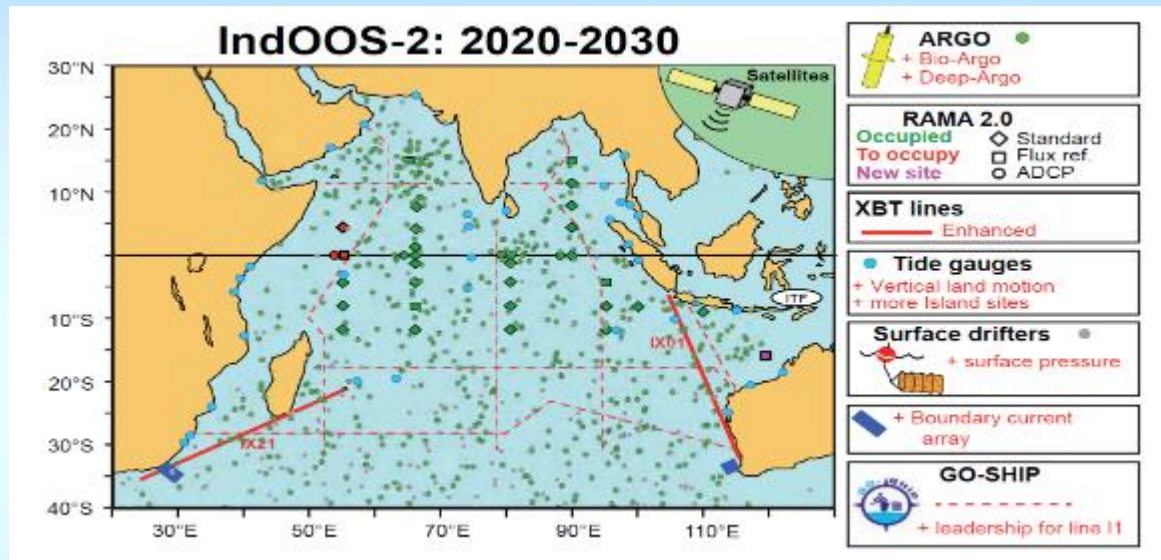
*Not represented on map: Aerosol, Carbon Dioxide, Earth's Annular Momentum, Electromagnetic Field (Schumann Resonance), Length of the day, Ocean Chlorophyll, Ozone*

# The Point Is

The Indian Ocean has a profound environmental influence on its own rim & oceanic environs and on neighboring land masses far away from its own domain, including North America



# NOAA Contributes Significantly to the Multinational Indian Ocean Observing System (IndOOS)



Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA);

To encourage scientific and technological initiatives, in the participating countries, to meet the objectives of IndOOS;

To enhance and facilitate data and information sharing with regard to IndOOS.

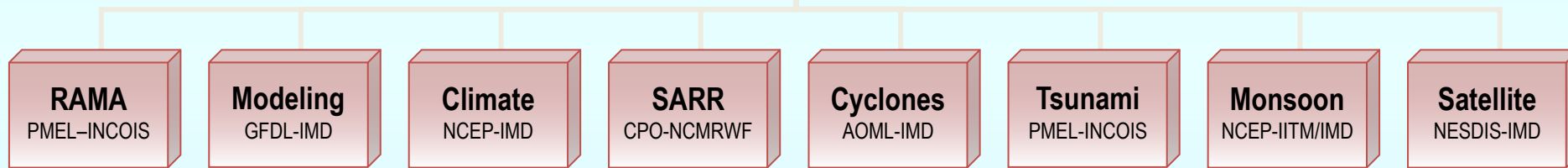




# Robust NOAA - India Ministry of Earth Sciences Partnership for Economic and Societal Benefits

**NOAA-MoES**  
Memorandum of Understanding

**Established 2008**



**10<sup>th</sup> Anniversary Celebration**  
**U.S.-India Colloquium: Earth**  
**Observations and Science for Society**  
**and Economy**  
**Goa**  
**June 14-16, 2018**

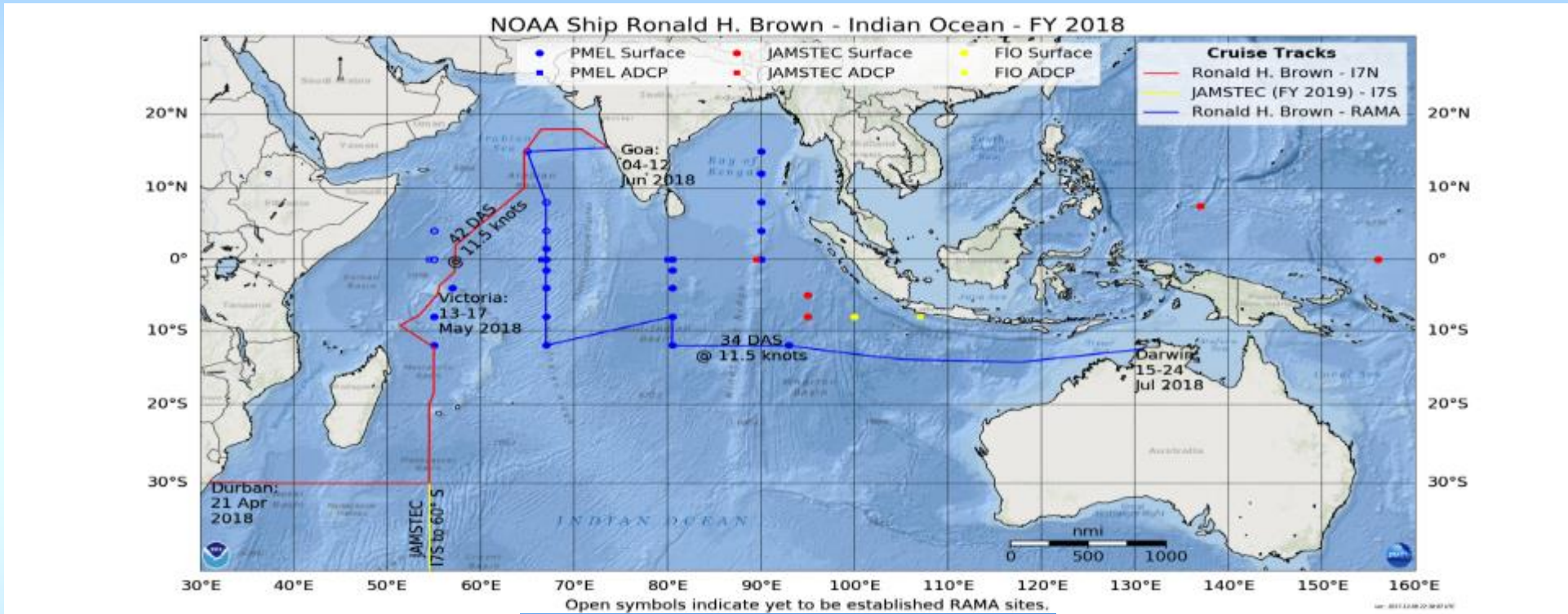


**MoES Secretary Rajeevan & NOAA**  
**Assistant Administrator Craig Mclean**





# 2018 NOAA Ship *Ronald H. Brown* Multidisciplinary Indian Ocean Expedition



## Port Calls:

1. Durbin, South Africa
2. Mauritius
3. Goa, India
4. Darwin, Australia

# Formal NOAA-MoES Agreements



India Ambassador Taranjit Singh Sandhu and NOAA Administrator (Acting) Dr. Neil Jacobs signing the MOU to enhance U.S.-India scientific cooperation for Ten Years.



India MoES Dr. Ramadass and Craig McLean Signing the RAMA *Resource-Sharing* Implementing Arrangement and Launching Joint Indian Ocean Data Portal August 2021





# NOAA's Long-Term RAMA Partnership with Indonesia BMKG



13<sup>th</sup> Annual Workshop  
Bogor - August 2019

15<sup>th</sup> Annual Workshop  
Virtual – September 2021



Synergy between BMKG and NOAA, for Delivery of Information for Climate Decision Support Services,

Ph.D. Opportunities in US,

Training Opportunities at NOAA's Climate Prediction Center (CPC) International Climate Desk,

Eastern Indian Ocean RAMA Shiptime

Latest Agreement Signed January 2016



Established 2005





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### New RAMA partnership between PMEL and the Korea Institute of Ocean Science and Technology

July 06, 2017



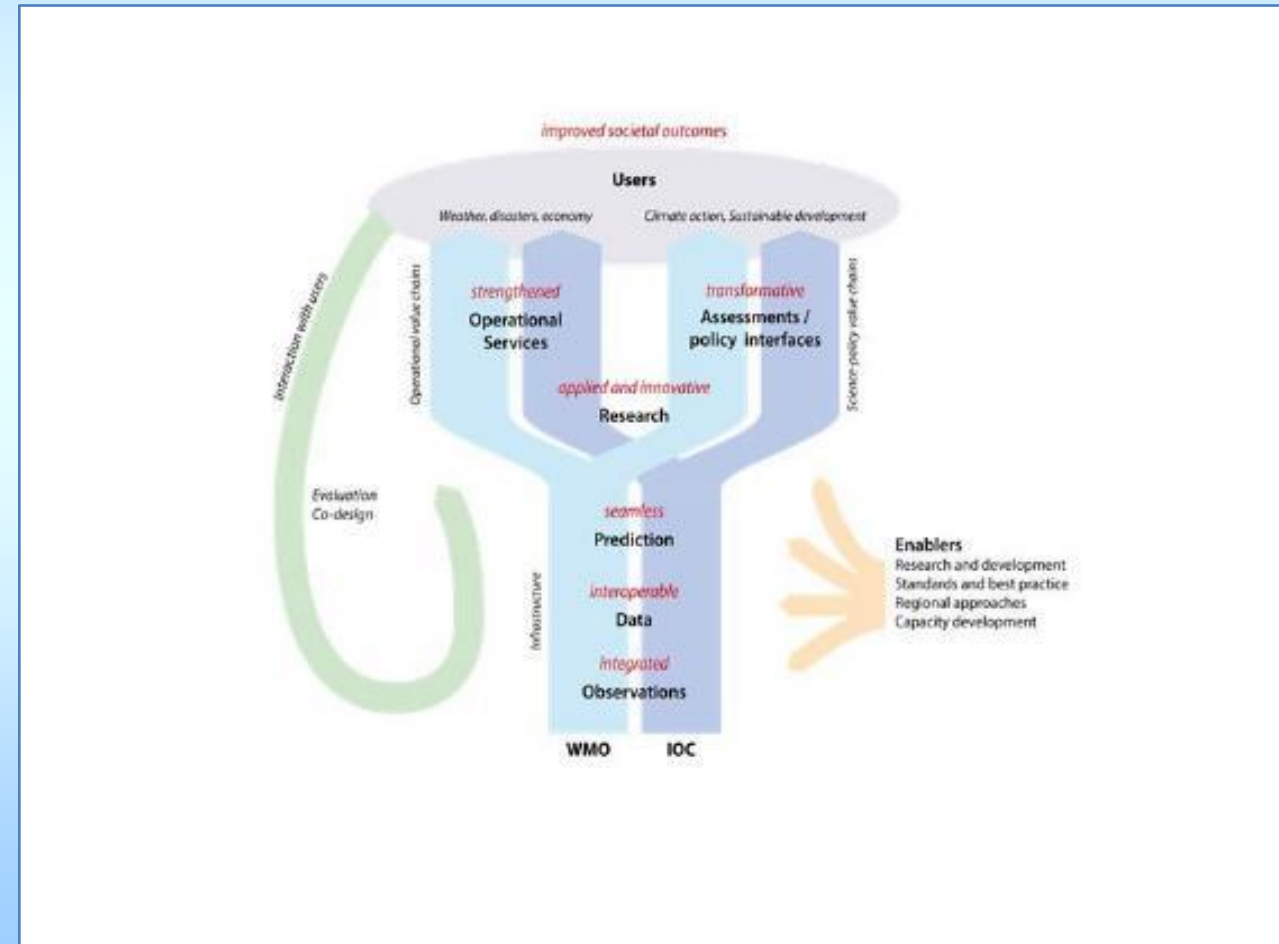
ROK Research Vessel *Isabu*  
NOAA-KIOST Cruise  
January 2022



# Indian Ocean Test Bed Concept

The IOGOOS Community is Well-Positioned to Demonstrate the *Co-Design* Concept to the World Ocean-Met-Climate Community for *Exemplars* such as Improving Forecasts of:

- Monsoon,
- Extreme Events (TC),
- Subseasonal-to-Seasonal (S2S),
- Storm Surge,
- Droughts,
- Floods,
- Other Disaster Risk Reductions.



Thank You!



**NOAA Global Ocean Monitoring and Observing Program**  
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