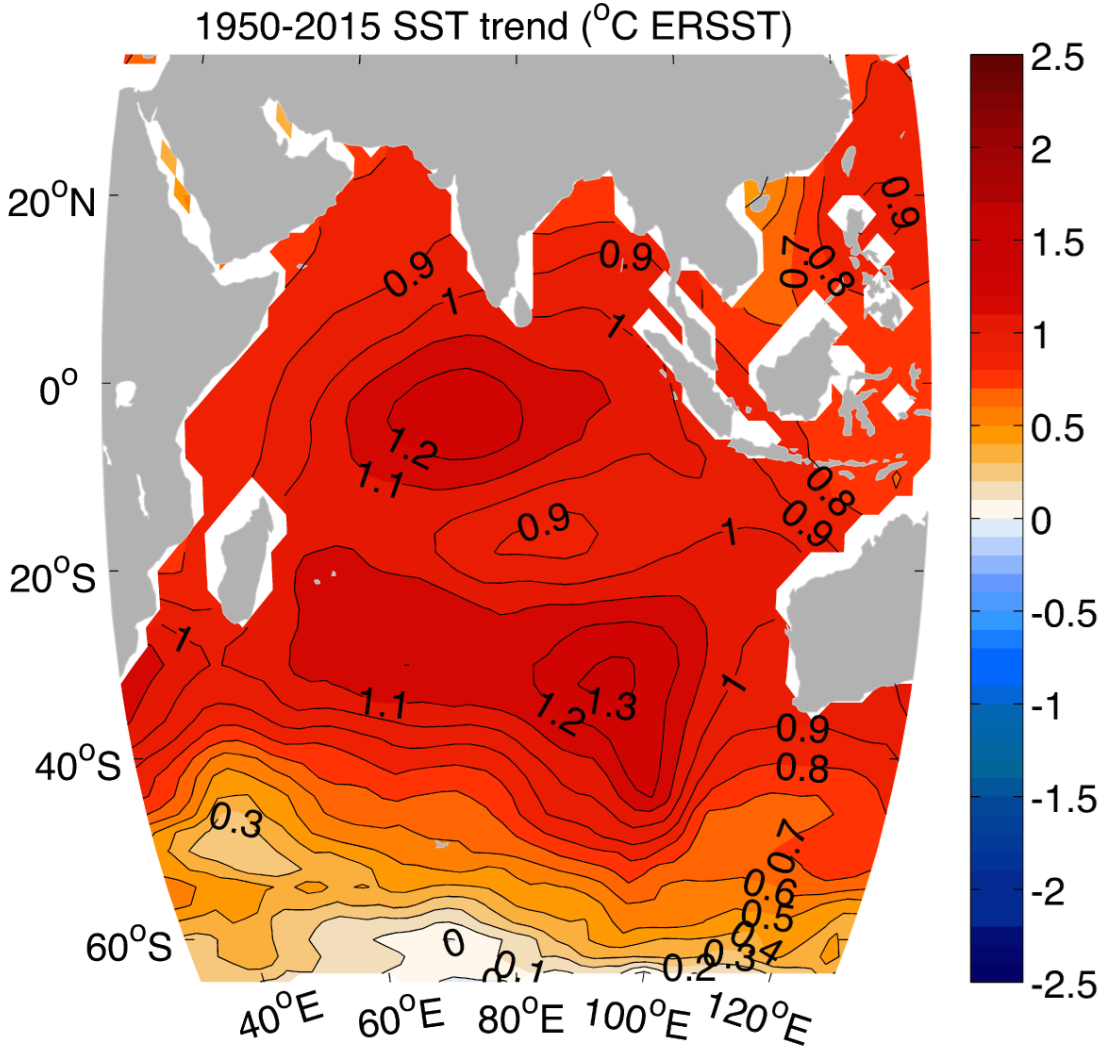
Indian Ocean observing system for addressing the challenges and priorities of the next decade

1. **The Indian Ocean is warming at a rapid pace, presenting new weather and climate challenges to South Asia**

2. **A redesign of the observing systems are required to address these challenges**

3. **Improved observations and forecasts require regional partnerships and data sharing**



Roxy Mathew Koll[1,2], Aditi Modi[1,3]

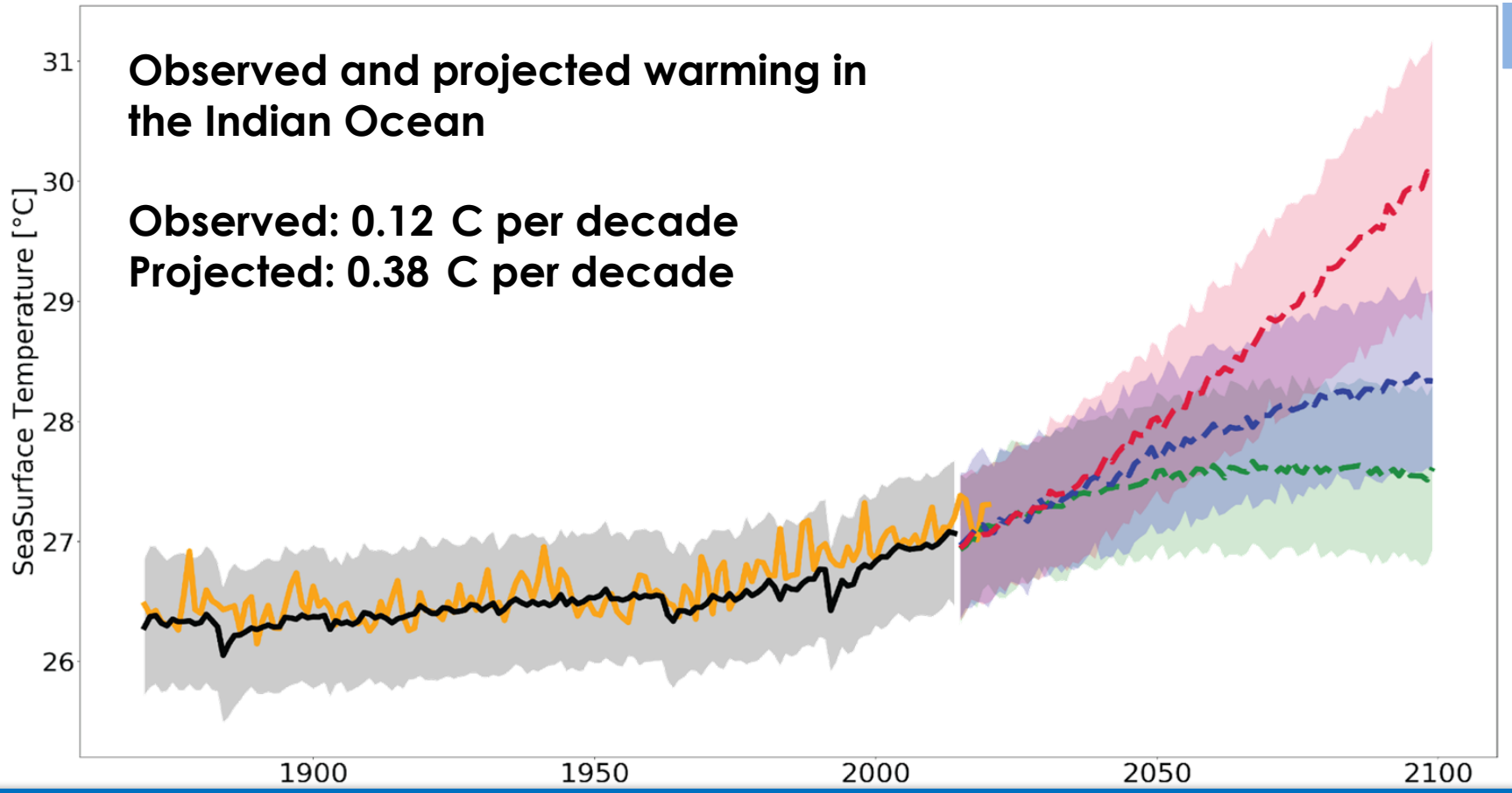
[1] Indian Institute of Tropical Meteorology | [2] Indian Ocean Region Panel | [3] IIOE2-ECSN

Indian Ocean is warming at a rapid pace

IPCC AR6

At the ocean surface, temperature has on average increased by 0.88 [0.68–1.01] °C from 1850-1900 to 2011-2020, with 0.60 [0.44–0.74] °C of this warming having occurred since 1980. The ocean surface temperature is projected to increase from 1995–2014 to 2081–2100 on average by 0.86 [0.43–1.47, *likely* range] °C in SSP1-2.6 and by 2.89 [2.01–4.07, *likely* range] °C in SSP5-8.5. Since the 1950s, the fastest surface warming has occurred in the Indian Ocean and in Western Boundary Currents, while ocean

CMIP6

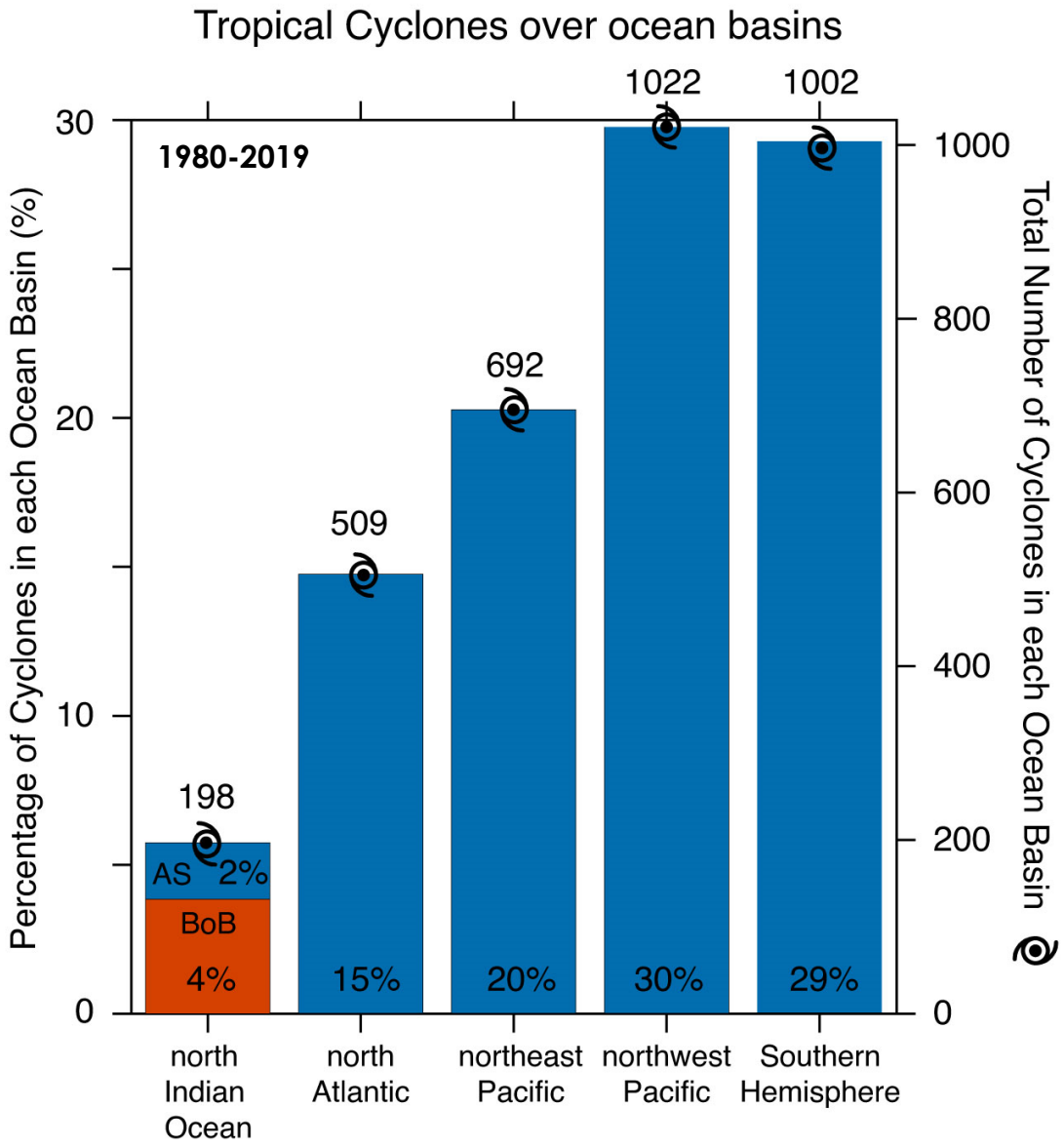


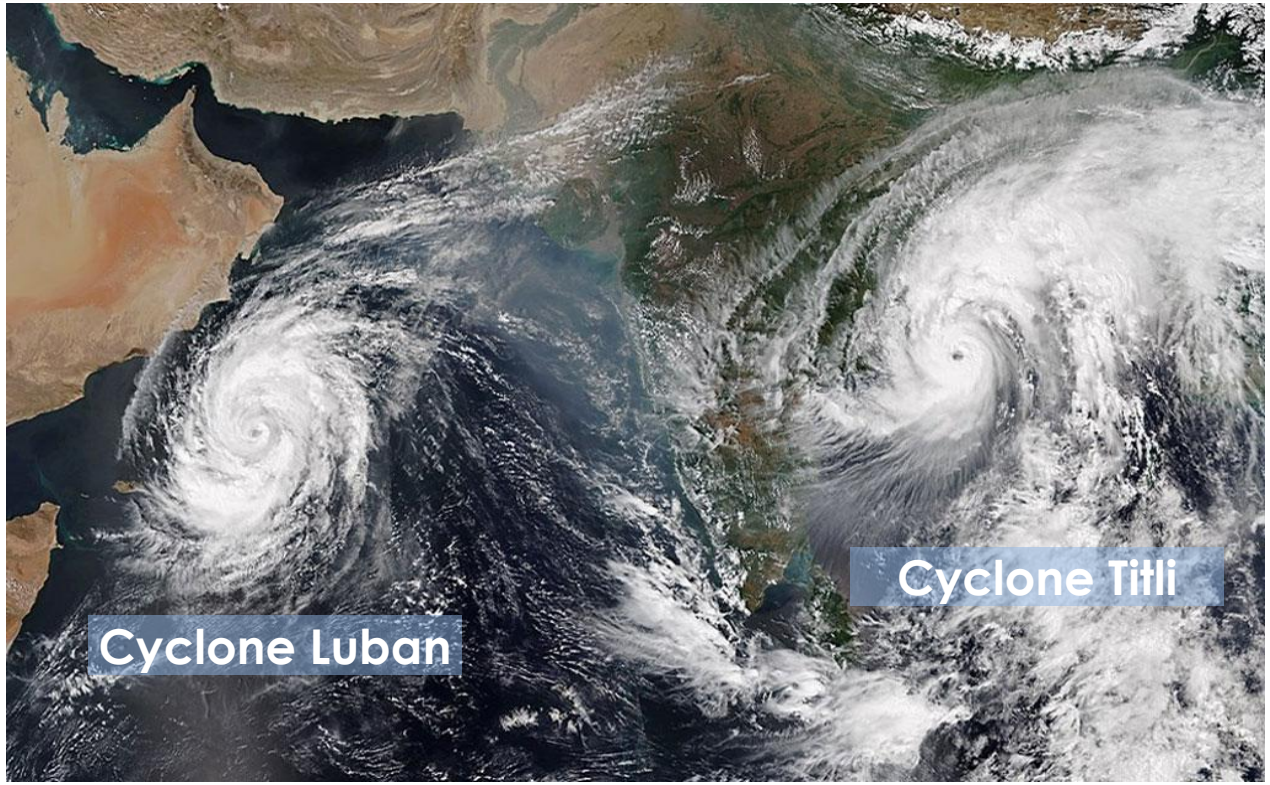
IPCC *Sixth Assessment Report* 2021; CMIP6/Roxy et al. 2022

Indian Ocean warming — impacts on South Asia

IndOOS Review 2019; Beal et al. *BAMS* 2020; Krishnan et al. *India Climate Change Report* 2020

Changing status of cyclones due to Indian Ocean warming





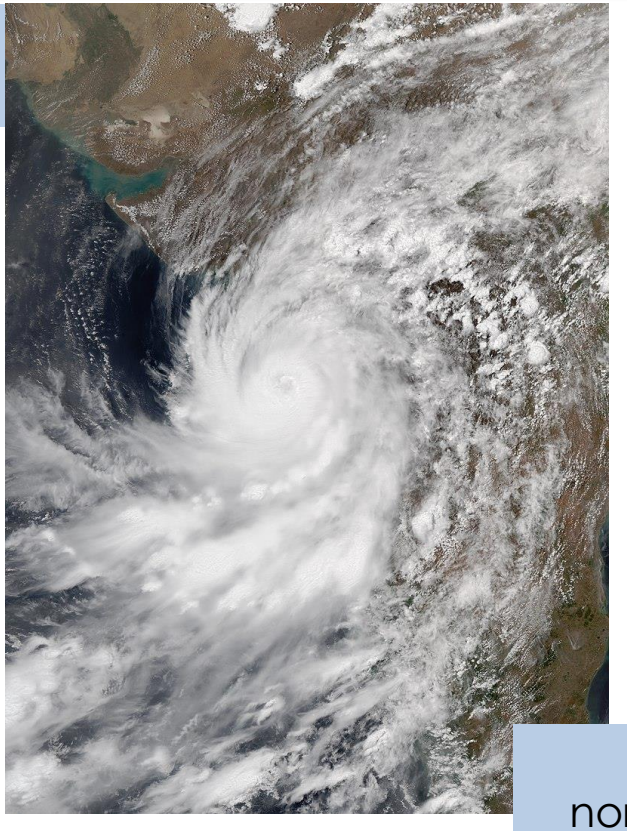
Arabian Sea and Bay of Bengal together contributes to only **6% of global cyclones, but 80% of fatalities**.

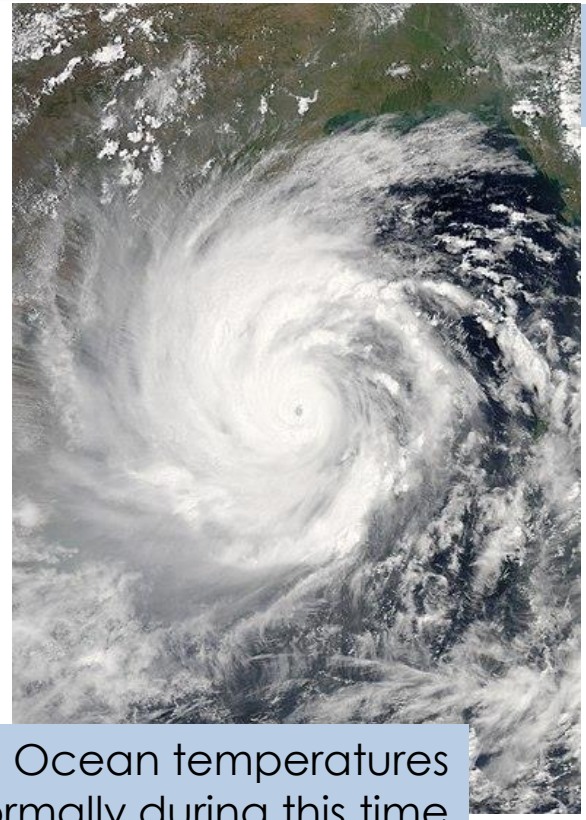
Skill of cyclone forecasts have improved, but still the damage is high as **the frequency, intensity, and duration of cyclones have increased.**

Singh and Roxy *Earth Science Reviews* 2022; Deshpande et al. *Climate Dynamics* 2021

Rapid intensification of cyclones due to Indian Ocean warming

Cyclone Nisarga





Cyclone Amphan

Cyclones are intensifying rapidly now. Cyclone Amphan intensified from Cat1 to Cat 5 cyclone in 18 hours.

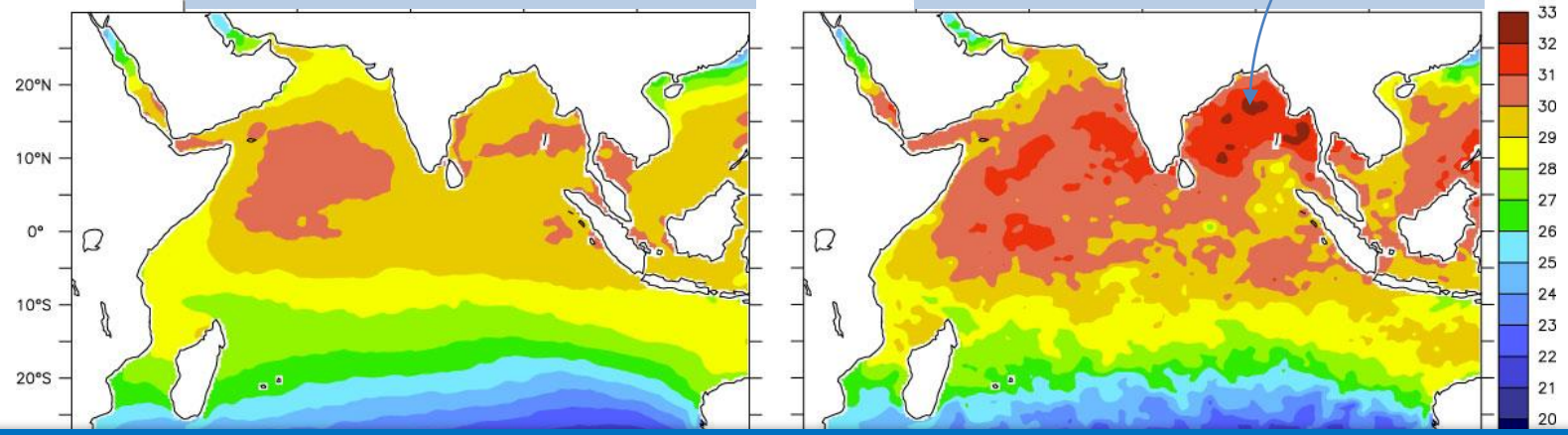
Extremely high temperatures, characteristic of a **marine heat wave**, supercharged these cyclones

Data requirements for improved forecast:

1. Ocean subsurface data
2. Improved wind coverage

Ocean temperatures normally during this time

Ocean temperatures during Coral Bleaching



Singh et al. *Scientific Reports* 2021; Saranya et al. *JGR Oceans* 2021

Marine heatwaves lead to extensive coral bleaching

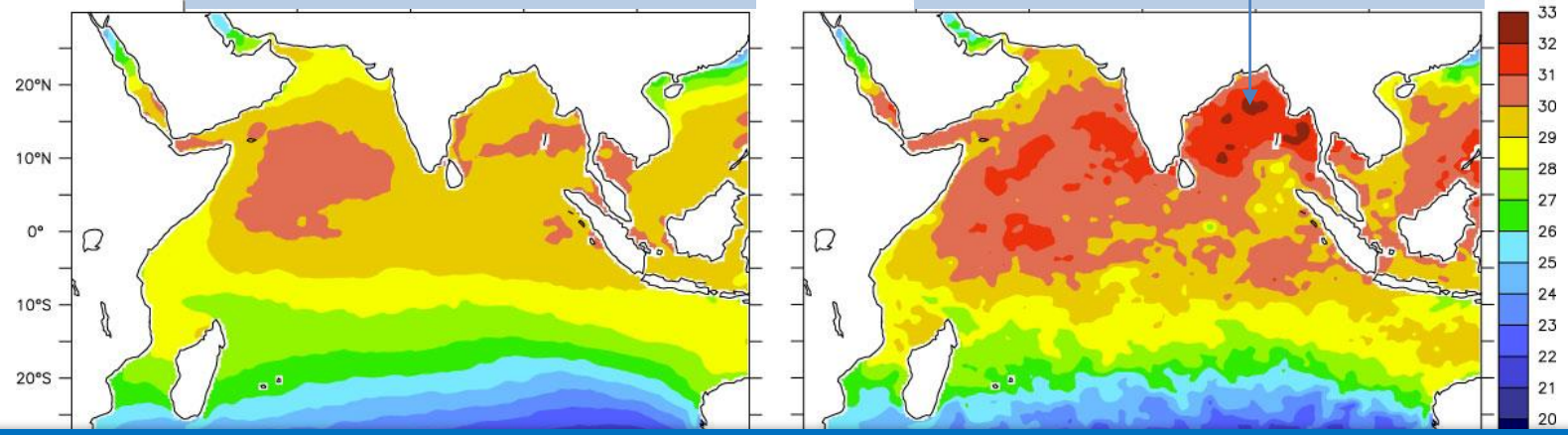
Corals have a mucus membrane — known as **zooxanthellae** — which acts as their shield and gives the color.
Warm temperatures bleach it away.

The same **marine heat waves** that intensified cyclone Amphan, led to coral bleaching in Gulf of Mannar (Bay of Bengal) also.

Data requirements:
Need to start monitoring marine heatwaves!

Ocean temperatures normally during this time

Ocean temperatures during Coral Bleaching



Singh et al. *Scientific Reports* 2021; Saranya et al. *JGR Oceans* 2021

Compound events

Sea level rise, storm surge, heavy rains, and a flooded river can overlap and damage a city and its outlying regions

Data/forecast requirements: We need to have a quantified understanding of compound events in the South Asian region.

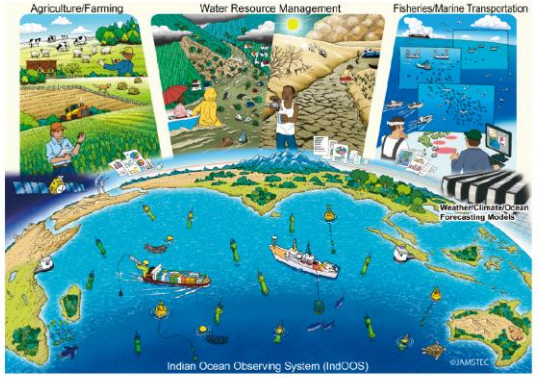
Collins et al. *IPCC SROCC* 2019;AGU/Eos

How do we monitor and forecast these changes?

Full Report

IndOOS-2

A roadmap to sustained observations of the Indian Ocean for 2020-2030



Coordinating lead authors

Lisa M. Beal, Jérôme Vialard, Mathew K. Roxy

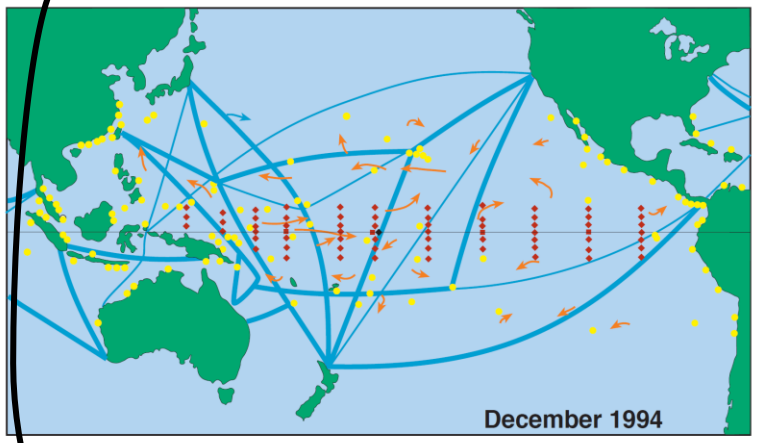
December 2019

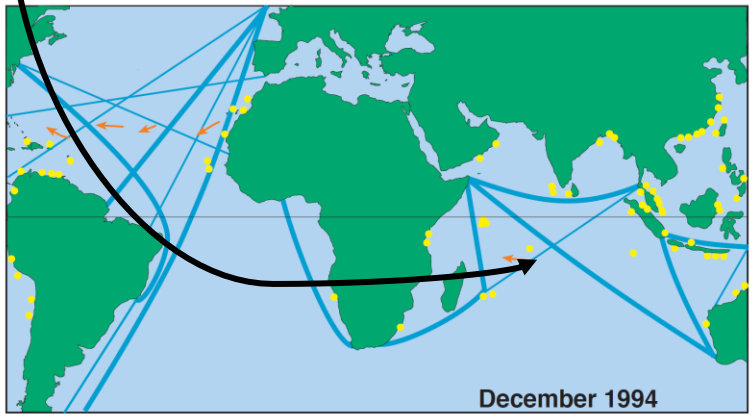
Sponsored by

Beal et al. *BAMS* 2020; Hermes et al. *Frontiers in Marine Science* 2019

Indian Ocean Observing System (IndOOS-2)

1990s

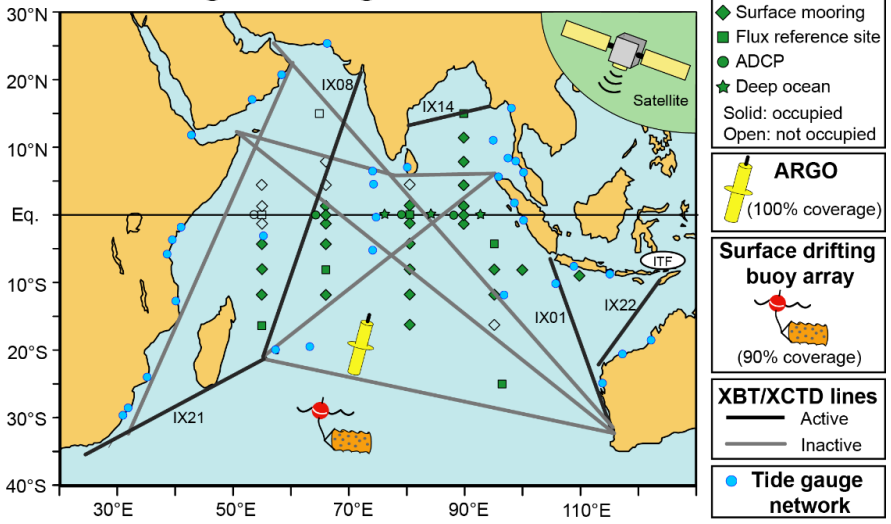




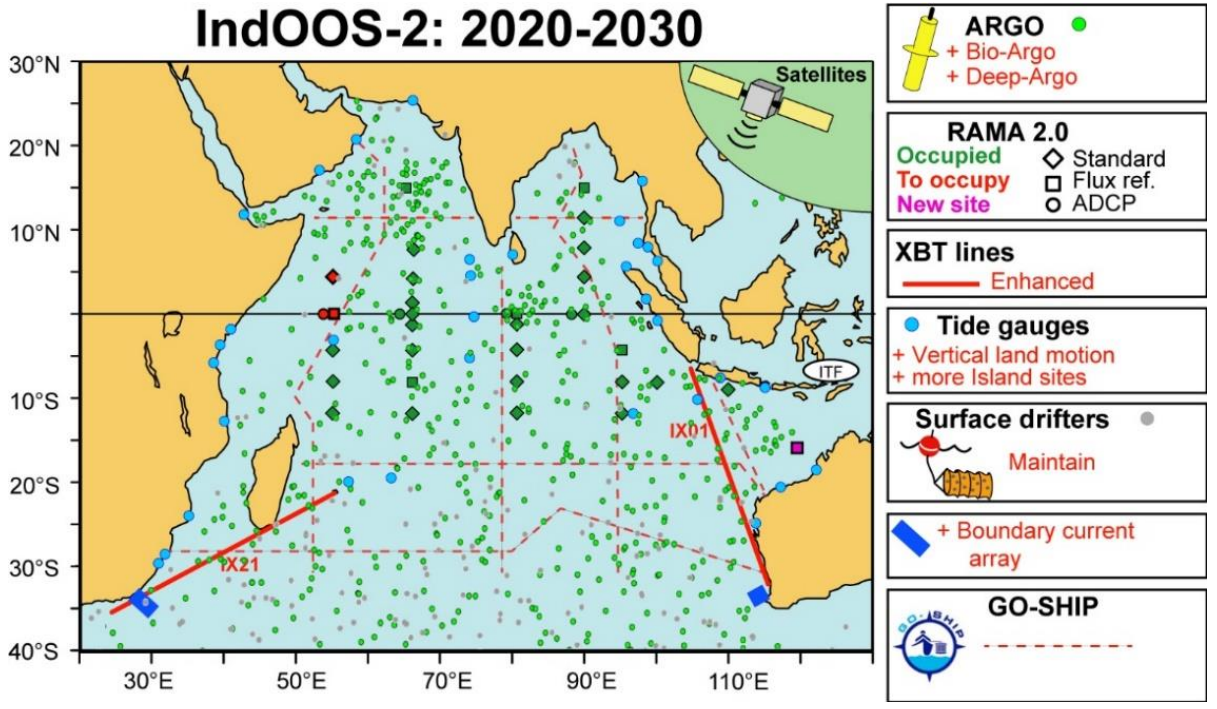
moored buoys · tide gage stations · satellite data relay · drifting buoys · volunteer observing ships

2000-2020

IndOOS: original design and current status



IndOOS-2: 2020-2030



Regional partnership is required

There is a need for increased investment and stronger partnerships with Indian Ocean rim countries and end-users, along with improved data sharing and commitments to best practices.

India–US partnership (MoES–NOAA)

Beal et al. *BAMS* 2020; Hermes et al. *Frontiers in Marine Science* 2019

Examples of regional partnership

THE TIMES OF INDIA

India's buoy network to provide ocean data to global researchers

TNN | Jun 12, 2018, 02.26 PM IST

DONA PAULA: Making a break from its earlier policy, the Union ministry of earth sciences had decided to share data obtained from the Ocean Moored Buoy Network in the Indian Ocean (OMNI) with the international research community and nations. The OMNI network along with the Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA) network will provide global researchers a trove of data from the 46 buoys moored in the Indian Ocean.

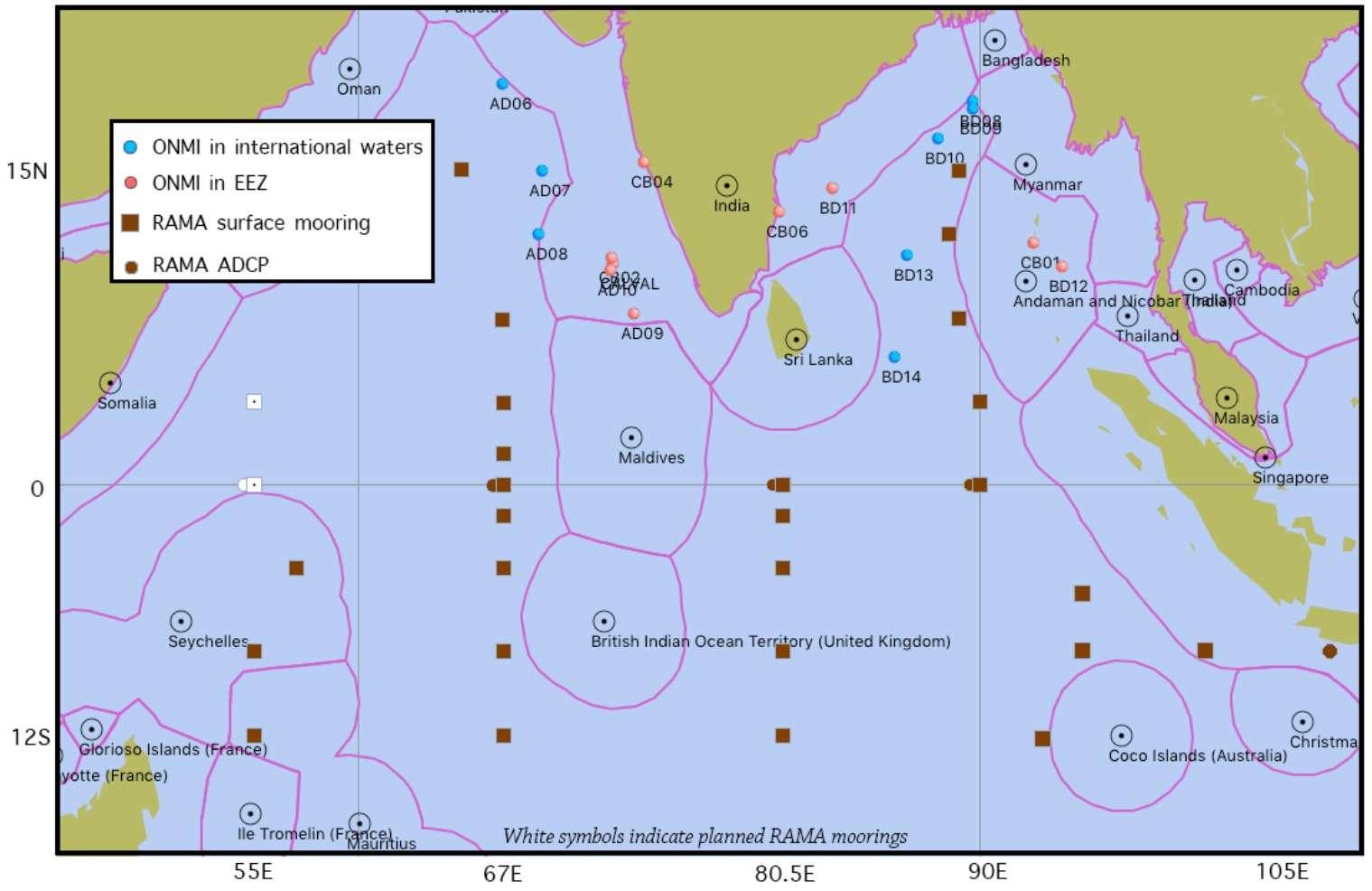
"Data from eight OMNI-buoys will be made available to all users. From now onwards, everyone will be able to assess the OMNI-buoy data freely which will be an important contribution to the international scientific community," union earth sciences secretary M Rajeevan said.

Addressing the Indo-US colloquium on Earth Observations and Sciences for Society and Economy, which got under way in Dona Paula on Monday, Rajeevan said that better data gathering had helped generate accurate weather forecasting and people had started believing in the Indian weather forecasts. The eight OMNI buoys are equipped with sensors, which record

Way forward:

Access to hydrographic data in Exclusive Economic Zones (EEZ)

RAMA-OMNI Mooring Array

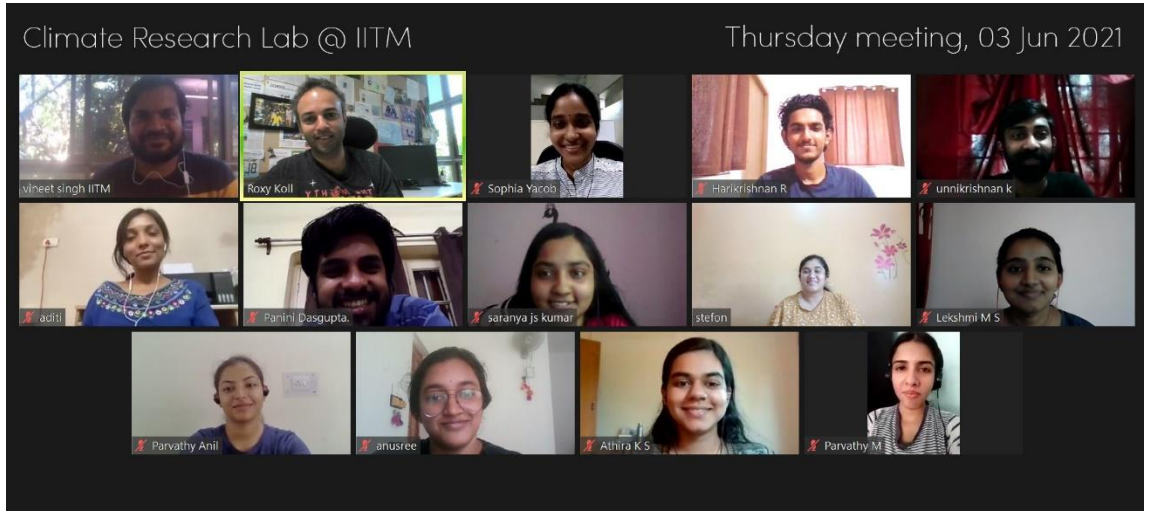


India–US partnership (MoES–NOAA)

Beal et al. *BAMS* 2020; Hermes et al. *Frontiers in Marine Science* 2019

Some of the collaborators in this work

Climate Research Lab @ IITM



Indian Ocean Network

IPCC Team

UN Decade of Ocean

Thank You