Table 1

Recommendations/ Chapters	Argo/BGC-Argo/Deep Argo	RAMA / surface buoy	XBT Network / SOOP	Drifters	Tide and river Gauges	Satellite Measures	GO-SHIP	ITF	Boundaries / Currents / Coastal Upwelling	Pilot studies	Validation / improvement of data products
1: Argo	a) Maintain core Argo: 450 floats north of 40°S. b) Double # floats in the equatorial Indian Ocean to capture intraseasonal variabilities important to MJO and MISO. c) Deploy deep Argo floats to map circulation, heat, and salt content below 2000 m. d) Deploy more BGC-Argo floats to address six major scientific questions: Carbon uptake, OMZs, Nitrate cycling, acidification, the biological carbon pump, and phytoplankton communities.										
2: RAMA		a) Reduce RAMA sites from 46 to 30, based on pragmatics of piracy, vandalism, ship time, and costs: RAMA2.0. b) New Flux Reference Site in Timor Sea (14°S, 115°E), region of highest tropical SST variability. c) Add O2 sensors on Arabian Sea and Bay of Bengal moorings to measure OMZs. d) Add BGC sensors in regions of high productivity variability and change.									
3: XBT Network			a) Continue >30 year record of IX01, IX22, and PX02 XBT lines, providing geostrophic volume and heat transports of the ITF. Better target the 200 m isobaths to improve monitoring of swift currents along the shelf. b) Enhance Argo deployment density along IX01 XBT line to better resolve salinity variability related to the ITF. c) Maintain the High Resolution IX21 XBT line to capture long term changes of the Agulhas Current system. d) Reactivate IX12 XBT line to detect long term changes in the tropical thermocline ridge as well as the boundary current system in the Arabian Sea. e) Maintain the IX08 and IX14 XBT lines in the Bay of Bengal and AS7, important for ENSO, IOD, and monsoon variability and prediction. Encourage the public release of these data by India. f) Implement automatic XBT launchers on SOOP vessels (Chapter 8), providing higher resolution data and improved data return with minimal crew labour. g) Installation of hull-mounted ADCPs on SOOP vessels to provide absolute upper ocean heat transport.					b) Enhance Argo deployment density along IX01 XBT line to better resolve salinity variability related to the ITF. these data by India. f) Implement automatic XBT launchers on SOOP vessels (Chapter 8), providing higher resolution data and improved data return with minimal crew labour.	c) Maintain the High Resolution IX21 XBT line to capture long term changes of the Agulhas Current system. d) Reactivate IX12 XBT line to detect long term changes in the tropical thermocline ridge as well as the boundary current system in the Arabian Sea.		
4: Surface Drifter				a) More drifters in undersampled regions such as the Somali Current, Great Whirl, SCTR, and in the inflowing ITF between Australia and Indonesia. b) Sustain the array via international partnerships coordinated through the Data Buoy Cooperation Panel. c) Re-evaluate the GOOS/GCOS sampling requirements, for example, 5°x5° bins are very coarse compared to equatorial and boundary flows. d) Evaluate the value of barometric pressure observations for numerical weather forecasting. Should all drifters collect these observations?							
5: Tide Gauge Network					a) Enhance network along coasts of Thailand and Africa, at equator (Chapter 10) and SCTR (Chapter 14). Improve network of island stations, which are highly effective for comparisons to satellite data and for combined 'reconstructions' of long-term regional sea level change. b) Enhance and consolidate existing networks in the Southern Ocean and around Antarctica through cooperation of their countries (namely Australia, France, Japan, Russia, South Africa and the UK). c) Sustain the core tide gauge network for GLOSS and for tsunami monitoring (IOC, 2015). d) Digitization of historical sea level data. e) More colocated tide gauge and GNSS stations.							d) Digitization of historical sea level data.
6: Satellite Missions						a) Ensure three satellite scatterometers in coordinated orbits to sample diurnal winds, with near real-time public data access. b) Sustain passive microwave radiometer all-weather SST mission(s). c) Continue satellite SSS and improve their accuracy and spatial resolution. d) Enhance space-based capability to monitor sub-mesoscale variability (e.g., for sea level and ocean surface currents). e) Sustain in situ measurements for satellite calibration and validation, particularly from high-frequency moorings.					
7: GO-SHIP							a) Review the GO-SHIP Indian Ocean plan, with specific consideration of whether I03 or I05 may be considered a full GO-SHIP reference section in future. b) Identify national or multi-national support for the occupation of I01E and I01W sections. c) Increase national participation in the GO-SHIP program, with focus on increased participation of Indian Ocean rim countries. d) Recommend regions where specific Level 2 and 3 measurements are desirable and of highest priority.				
8: New Technologies		Continued integration of χ-pods on RAMA moorings to examine seasonal transitions within the equatorial wave guide and the accompanying atmospheric and oceanic variability.	Auto-launchers to enable doubling of XBT sampling on some key lines like IX01, that monitors exchanges between the Pacific and Indian Oceans.				DRONES??	Auto-launchers to enable doubling of XBT sampling on some key lines like IX01, that monitors exchanges between the Pacific and Indian Oceans.	a) Monitoring boundary currents with arrays comprising CPIES, gliders, and moorings, possibly with Articulating Profilers or LAMPs in the future, in regions like the Somali, Leeuwin, and Agulhas Currents.	Investigating the remote Indian Ocean interior with autonomous or expendable platforms that incorporate traditional and new sensor technologies including DWS drifters (with SST and GPS sensors), χ-SOLO floats, X-Spar floats, Saildrones, Wave Gliders, and Minimets.	
9: S2S		a) Increase vertical resolution of upper ocean sensors on RAMA buoys to resolve shallow diurnal warm layer and night time mixed layer deepening. T/S sensors at: 0.5 m, 1 m, 2 m, 3 m, 5 m, 7 m, 10 m, and every 5 m down to 50 m . b) New RAMA site in the eastern Indian Ocean, with upper ocean T/S sensors and a meteorological station. c) Add surface flux reference sites in the western Indian Ocean (equatorial and Arabian Sea). d) Enhance some of the existing upper ocean measurements at RAMA sites with concurrent, high frequency meteorological measurements. e) Increase observations in coastal regions, especially near the Maritime Continent.									
10: Surface Flux Products		a) Implement unoccupied flux reference sites in Arabian Sea and western Indian Ocean and maintain established flux reference sites in the revised RAMA-2.0 design (Chapter 2). b) Enhance a subset of the flux reference sites for direct flux measurements to validate bulk algorithm flux computations.				c) Engage with the satellite surface radiation producers to help diagnose and validate surface radiative products.					c) Engage with the atmospheric reanalysis community to help evaluate and guide future improvement of tropical convective parameterizations.
11: Ocean Data Assimilation Products	a) Augment deep ocean measurements such as deep Argo							b) Develop a comprehensive monitoring system for the Indonesian Throughflow.	c) Enhance capabilities to monitor subtropical fluxes, in particular the dominant Agulhas Current, at the southern boundary of the basin.		d) Continue development of coupled ocean-atmosphere data assimilation systems. e) Strengthen collaborations among data assimilators, modelers, and observationalists to improve capabilities for reanalysis, prediction, and observing system evaluation.
12: Extreme Events	b) Maintain the Argo network in TC-prone regions	c) Sustain RAMA-2.0 and enhance air-sea flux measurements at sites in the BoB (meridional section at 90°E from 5°N) and southwestern IO (between 55°E and 80°E from 5°S). f) Establish a RAMA flux mooring site in the northwestern Australian basin (~15°S; 120°E) to capture TC and MHW signals.		g) Enhance barometric measurements from surface drifters and encourage pilot study in BoB using drifters that make more measurements: atmospheric pressure, wind speed and direction, air and sea temperature, salinity, humidity and waves.	d) Maintain coastal tide-gauge measurements, particularly around the BoB and along the west coast of Australia.	a) New (and sustained) satellite technology and intercalibration-work to (i) develop continuous, basin-scale wind and SST records reliable in rainy/cloudy regions, (ii) increase resolution of altimetry for oceanic currents and surge response to TCs.			e) Enhance glider observations along the west coast of Australia and across the Leeuwin Current.	h) Enhance glider observations of oceanic response to TCs in the BoB.	

Recommendations/ Chapters	Argo/BGC-Argo/Deep Argo	RAMA / surface buoy	XBT Network / SOOP	Drifters	Tide and river Gauges	Satellite Measures	GO-SHIP	ITF	Boundaries / Currents / Coastal Upwelling	Pilot studies	Validation / improvement of data products
13: MJO / MISO		a) Given the importance of monitoring the diurnal cycle, increasing the vertical resolution in the upper 10 m at RAMA sites is desirable. Suggested depths of T/S sensors are: 0.5 m, 1.0 m, 2.0 m, 3 m, 5 m, 7 m, 10 m. The enhancement of vertical resolution would be particularly useful at flux reference sites (Chapter 10) and in the key regions listed below. b) New RAMA site off northwestern Australia in the Timor Sea at 14°S, 115°E, as (Chapter 12, Chapter 14). c) Continuation of surface buoy measurements at 18°N, 90°E in the northern Bay of Bengal. d) ADCP measurements in SCTR on RAMA mooring at 4°S, 65°E. e) Additional buoy measurements in the southern part of the Banda Sea to capture the largest intra-seasonal SST anomalies of the Indo Seas.									
14: Monsoons	a) Argo floats equipped with auxiliary surface temperature and salinity (STS) sensors in the Bay of Bengal, Arabian Sea warm pool, and SCTR to capture fine-scale upper-ocean thermohaline stratification.	b) Surface buoys in the BoB (poleward of 14°N) and Arabian Sea that measure meteorological parameters as well as high-resolution upper-ocean (~150m) temperature and salinity. c) Enhance RAMA sites with ADCPs in the central basin (65°-85°E) and with high resolution (~10 cm) temperature and salinity measurements in the eastern (100°E and 110°E) and western (45°E, 50°E, 55°E, 60°E and 65°E) regions. d) Additional RAMA sites within the SCTR, along 65°E and 75°E and between 12°S and the equator.									
15: Hydroclimate, freshwater budget	a) Increase Argo coverage in under-sampled regions like the northern Bay of Bengal and central equatorial Indian Ocean.	a) Complete and maintain RAMA-2.0, especially for 90°E in the Bay of Bengal, 55°E and 67°E in the SCTR, and 95–107°E in the eastern equatorial Indian Ocean. b) Establish a RAMA surface mooring and flux reference site off northwestern Australia.	a) Maintain surface meteorological measurements and ocean observations from commercial shipping, as part of the VOS programme. b) Maintain XBT lines IX01 and IX22, more regularly sample IX08 and IX14, and reactivate IX12.	a) Enhance surface drifter network with more surface barometric pressure sensors and increased coverage in eastern equatorial Indian Ocean and off northwestern Australia.	c) Enhance river gauge network to observe runoff and riverine input from Indian Ocean rim countries.	a) Maintain existing satellite observations for relevant variables at the air-sea interface, with basin-scale coverage over the Indo-Pacific region. b) Improve SSS-sensing satellite capabilities over marginal seas and coastal regions (cf. SMAP, Aquarius, SMOS).					
16: Primary productivity	b) Consult with the global BGC-Argo community, to plan observations of nutrients, bio-optics, and oxygen on Argo floats in regions of high primary productivity variability (NW Arabian Sea, tip Indian, SCTR), as well as OMZs and areas important for the marine nitrogen cycle.					e) Sustain satellite ocean color missions.	c) Maintain nutrient measurements on GO-SHIP lines and add observations of phytoplankton community structure. Make similar measurements on RAMA maintenance voyages.				a) Analyze existing observations and model outputs to better determine the locations of largest productivity variability. These areas should be prioritized for biogeochemical observations. d) Compare in situ chlorophyll and productivity observations to collocated satellite ocean color to quantify the accuracy of satellite algorithms from SeaWiFS and develop regionally tuned algorithms, if necessary.
17: Boundary Currents and ITF			a) Maintain the frequently repeated IX01 XBT section across the ITF, and enhance with an auto launcher for increased resolution (also of the South Java Current at the northern end) and with Argo float deployments for salinity measurements. b) Maintain the repeated IX12 XBT section, which crosses the Somali Current and Leeuwin Current systems at its northern and southern ends, respectively, and enhance resolution with an auto launcher.		c) Maintain the existing network of island and coastal sea level stations and ensure open accessibility of these data so that boundary current transports can be estimated using sea level proxies.	d) Maintain satellite altimeter missions to characterize long term variations of mesoscale eddy energetics in ocean boundary currents.		a) Maintain the frequently repeated IX01 XBT section across the ITF, and enhance with an auto launcher for increased resolution (also of the South Java Current at the northern end) and with Argo float deployments for salinity measurements. e) Establish an international alliance to measure ITF volume and heat transports, as well as biogeochemical fluxes, in different passages in order to contextualize and constrain the sustained upper-ocean geostrophic estimates from the IX01 XBT section.	f) Re-establish the ASCA mooring array for the Agulhas Current system through regional alliances, combining mooring observations with periodic glider and ship surveys. g) Enhance the Leeuwin Current array to monitor full-depth volume and heat transports through combined mooring and glider observations. h) Monitor the Somali Current and the South Java Current using ocean gliders. i) Sustain observations of the monsoon currents off the Indian subcontinent through regional alliances.		
18: Upwelling systems	d) Extend the IndOOS into the Sumatra/Java upwelling region, by enhancing deployment of Argo and BGC-Argo floats or adding glider sections.	a) Maintain RAMA sites along 8°S within the Seychelles-Chagos thermocline ridge and in the equatorial region.			b) Since the satellite based SSH data near the coast is affected by land, tide gauges must also be maintained.	b) Maintain satellite observations of SST, sea level, surface momentum and heat fluxes, and ocean color. Since the satellite based SSH data near the coast is affected by land, tide gauges must also be maintained.	f) Biogeochemical and ecological parameters at least seasonally — nutrients, chlorophyll, oxygen, pH, CO2, and plankton community structures — in upwelling systems.		c) Extend the IndOOS into the Sumatra/Java upwelling region, by enhancing deployment of Argo and BGC-Argo floats or adding glider sections. d) A pilot study of new observing platforms within the Oman/Somalia upwelling region, potentially a RAMA site, BGC-Argo deployment, and/or glider sections. An intensive study is needed with a capacity development component. e) A process study of ship observations across the upwelling regions (Sumatra/Java and/or the Seychelles-Chagos thermocline ridge) during upwelling and non-upwelling seasons to conduct microstructure measurements for evaluation of vertical mixing processes and to obtain water samples for nutrients, chlorophyll, oxygen, pH, CO2, and plankton community structure analyses.	d) A pilot study of new observing platforms within the Oman/Somalia upwelling region, potentially a RAMA site, BGC-Argo deployment, and/or glider sections. An intensive study is needed with a capacity development component.	
19: Interannual modes	a) Maintain the existing elements of IndOOS, in particular satellite missions and the Argo network.	b) Complete and maintain the RAMA-2.0 buoy network. Tropical sites within the western and eastern poles of the IOD are essential.	d) Maintain the IX01 XBT line with a fortnightly resolution to monitor the Pacific influence on Ningaloo Niño/Niña.			a) Maintain the existing elements of IndOOS, in particular satellite missions and the Argo network.		d) Maintain the IX01 XBT line with a fortnightly resolution to monitor the Pacific influence on Ningaloo Niño/ Niña.	c) Enhance near-coastal observations to a horizontal resolution of 0.25° or higher at the tropical eastern boundary.		
20: OMZs	a) A suite of 200 BGC-Argo floats as part of the global implementation plan of 1000 BGC-Argo floats (Chapter 1). In situ air calibrations to refine DO measurement precision should be adopted (Bushinsky et al., 2016). Floats targeted to regions with the strongest deoxygenation trends.						c) Leveraging of ship-based sampling opportunities (GO-SHIP, GEOTRACES) to obtain the full suite of geochemical EOVs (NO2, NH4, PO4, and δ15N) and perform onboard rate experiments within OMZs.		b) A fleet of gliders or AUVs outfitted to measure dissolved oxygen and core nutrients to sample coastal regions where societal implications are greatest (Indian subcontinent).	b) A fleet of gliders or AUVs outfitted to measure dissolved oxygen and core nutrients to sample coastal regions where societal implications are greatest (Indian subcontinent).	
21: Sea level	b) Maintain the Argo network to obtain basin-wide estimation of thermosteric and halosteric sea level contributions. c) Enhance deep ocean observations using deep ocean moorings and deep Argo to assess the effect of deep ocean variability on sea level change.	d) Maintain RAMA-2.0, particularly the meridional sections at 67°E and 80°E where sea level variability is large over the thermocline ridge (Figures 21.1 and 21.2), and the zonal sections at the equator, 2°N and 2°S that capture IOD signals, and all moorings in the eastern equatorial Indian Ocean for temperature and velocity measurements.	e) Maintain the IX01 XBT line to monitor the ITF.		a) Maintain the existing network of tide gauge stations, including the recently added tide gauge in the Seychelles-Chagos thermocline ridge (Bradshaw et al., 2015). Enhance engagement and cooperation of all coastal and island states in the Indian Ocean, with a focus on new tide gauges around the SCTR (Mauritius, French "Iles éparses"). Add GNSS stations co-located with tide gauges to measure land movement (Chapter 5).	g) Maintain satellite altimetry missions, satellite missions measuring vector winds at the ocean surface, and Earth gravity satellite missions such as GRACE and GOCE that capture changes of mass distribution in the ocean. Enhance resolution and coastal retrieval of sea surface height from satellite, such as the upcoming SWOT mission.	f) Maintain the trans-Indian Ocean GO-SHIP line at ~32°S, including crossings of the Leeuwin and Agulhas currents at the boundaries, for decadal basin-wide heat budget.	e) Maintain the IX01 XBT line to monitor the ITF.			
22: Decadal variability	c) Maintain the IndOOS Argo network.	b) Complete and maintain RAMA-2.0 in order to observe and diagnose surface and upper ocean variability in key regions, such as the equatorial band and SCTR, and for calibration of satellite SST and wind retrievals.	a) Maintain the IX01 XBT line with at least fortnightly resolution to monitor geostrophic mass and heat transport of the ITF. Increase salinity measurements with enhancement of regional Argo floats or a pilot glider program along IX01.		e) Maintain the existing network of island and coastal tide gauge stations, and ensure open accessibility to these data. Upgrade stations in the western Arabian Sea and on the horn of Africa with GNSS stations to monitor vertical land movements.	d) Maintain satellite observations and intercalibration-work that can provide basin-scale wind, sea level, and SST records that span several decades, including in rainy/cloudy regions.			SHOULD ADD SOMETHING HERE??		f) Develop collaborations with the paleo-proxy community to provide long records of SST variability in the IOD eastern pole and of sea level variability near the west coast of Australia (Zinke et al., 2015), in the Chagos archipelago, and Mascarene Islands.
23: Heat budget	d) Maintain the Argo program throughout the Indian Ocean to map interior heat content change.		c) Enhance XBT line IX01 with automated launchers and more regional Argo float deployments (for salinity) to monitor the geostrophic volume and heat fluxes of the Indonesian Throughflow.			e) Maintain satellite observations of SST, SSH, and surface winds	f) Maintain decadal repeats of GO-SHIP line I5 at ~32°S.	c) Enhance XBT line IX01 with automated launchers and more regional Argo float deployments (for salinity) to monitor the geostrophic volume and heat fluxes of the Indonesian Throughflow.	a) Re-establish and maintain an Agulhas System volume, heat, and freshwater array at the western boundary near 34°S, including an "end-point" mooring to measure interior geostrophic overturning down to ~2000 m. b) Enhance and maintain a Leeuwin Current array to measure volume, heat, and freshwater flux at the eastern boundary near 34°S, including an "end-point" mooring down to ~2000 m.		
24: Carbon cycle	c) Determine whether BGC-Argo measurements can be used to determine carbon system parameters. Critical considerations are the specific BGC measurements needed and whether alkalinity can be estimated accurately enough in the highly variable salinity regimes of the northern and equatorial Indian Ocean. If successful then additional BGC-Argo float deployments should be motivated, particularly in the Arabian Sea and the Bay of Bengal.	a) Deploy MAPCO2 systems at RAMA Flux Reference Sites. The central Arabian Sea site should be a top priority because of large seasonal variability in air-sea CO2 flux and acidic, low oxygen waters. Additional deployments should target regions with high temporal variability in CO2 fluxes and/or rapidly increasing pH.	b) Increase the number of SOOP-CO2 measurements, particularly in the southern central Indian Ocean and also in the northern Arabian Sea and Bay of Bengal.								
25: Anthro Change	b) Maintain and enhance Argo coverage near the ITF to capture freshening of water masses. Two hundred BGC-Argo floats for oxygen, bio-optics, and core nutrients. Deep Argo floats to constrain estimates of total heat content and sea level change.	a) Maintain and complete the RAMA-2.0 array and expand with a site in the Arabian Sea (10°N, 60°E) where air-sea flux uncertainties are large. Add MAPCO2 systems at RAMA Flux Reference Sites for pH and air-sea flux of CO2.	e) Maintain the IX01 XBT line to monitor the geostrophic volume and heat transport of the ITF. Pilot a glider program along IX01 line for salinity.		h) Maintain and augment the tide-gauge network, in particular in the islands of the southwestern tropical Indian Ocean, ensure open distribution and common processing of the data, and add colocated GNSS stations to measure land motion.	f) Maintain satellite observations of SST, SSS, sea level and winds which are inter-calibrated between missions for climate-quality data. Acknowledge ongoing satellite missions and their measurements as being a vital part of the IndOOS and convey to the agencies responsible for maintaining and renewing these satellite missions.	d) Sustain the GO-SHIP repeat hydrographic sections in the Indian Ocean (Chapter 7) to quantify long-term change and provide calibrations for Argo. Add observations of phytoplankton community structure on GO-SHIP lines.	e) Maintain the IX01 XBT line to monitor the geostrophic volume and heat transport of the ITF. Pilot a glider program along IX01 line for salinity.	c) Monitor boundary fluxes of volume, heat, and freshwater in Agulhas and Leeuwin Currents. Explore the technical feasibility of a long-distance glider line along 32°S.	e) Pilot a glider program along IX01 line for salinity.	g) Model experiments that go hand-in-hand with observations to separate the role of climate change, internal variability, and ENSO forcing on regional SST.