RAMA The Research Moored Array for African–Asian–Australian Monsoon Analysis and Prediction

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TABLE S1A. (top) Autonomous Temperature Line Acquisition System (ATLAS) mooring meteorological and (bottom) oceanographic sensor specifications. Accuracies listed are based on predeployment and postrecovery calibrations for groups of sensors, and are supplied by the manufacturer (indicated by *), or, in the case of the SonTek current meter, are based on intercomparisons of acoustic Doppler current profiler data of known accuracy. Except for the SonTek current meter, ranges listed are ranges over which instruments are calibrated (tuned for the tropics) rather than over the full range of possible measurements. Data quality control procedures are described in full at www.pmel.noaa.gov/tao/proj_over/qc.html. Adapted from a table published online at www.pmel.noaa.gov/tao/proj_over/sensors.shtml.

Measurement	Model	Range	Resolution	Accuracy
Wind speed	R. M. Young 05103	1–20 m s^{-1}	0.2 m s^{-1}	±0.3 m s^{-1} or 3%
Wind direction	R. M. Young 05103	0°–355°	1.4°	5°
	E. G. and G. 63764 or KVH LP101-5	0°–359°	1.4°	
Air temperature	Rotronic Instrument Corp.: MP-100	14°–32°C	0.01°C	±0.2°C
Relative humidity		55%–95%	0.4% real time 0.02% delayed mode	±2.7%
Rainfall	R. M. Young 50203-34	0–50 mm	0.2 mm h^{-1}	±0.4 mm h^{-1} on 10 min filtered data
Downwelling shortwave radiation	Eppley PSP-TAO, Delrin case	200–1000 W m^{-2}	0.4 W m^{-2}	±2%
Downwelling longwave radiation	Eppley PIR-TAO, Delrin case, 3-output	200 W m^{-2} @ 20°C (thermopile only)	0.1 W m^{-2} 0.03°C	±1% (*)
Barometric pressure	Paroscientific MET1-2	800–1100 hPa	0.1 hPa	±0.01% of reading (*)

Measurement	Model	Range	Resolution	Accuracy
Sea surface and subsurface temperature	Yellow Springs Instruments (YSI) thermistor 46006	6°–32°C	0.001°C	±0.02°C
Sea surface and subsurface conductivity	Sea-Bird Electronics SBE37	3–6 S m^{-1}	0.0001 S m^{-1}	±0.02 psu (equivalent salinity)
	Sea-Bird cell with PMEL electronics	Same as above	0.002 S m^{-1}	Same as above
Water pressure	Paine 211-30-660-01	400–800 psi	0.03 psi	±1.4 psi
Current	SonTek Argonaut	0–600 cm s^{-1}	0.1 cm s^{-1} 0.1°	±5 cm s^{-1} ±5°

Table S1B. (top) M-Triangle Trans-Ocean Buoy Network (TRITON) meteorological and (bottom) oceanographic sensor specifications. Accuracies listed are based on predeployment and postrecovery calibrations for groups of sensors or are supplied by the manufacturer (indicated by *). Sensors are interfaced to the datalogger via a Japan Agency for Marine–Earth Science and Technology (JAMSTEC) developed A/D converter and signal processing module.

Measurement	Model	Range	Resolution	Accuracy
Wind speed	R. M. Young 85000	0–70 m s^{-1}	0.1 m s^{-1}	±2% or 0.1 m s^{-1} for 0–30 m s^{-1} ±3% for 30–70 m s^{-1} (*)
	R. M. Young 50106	0–60 m s^{-1}	0.1 m s^{-1}	1.1 m s^{-1} (*)
Wind direction	R. M. Young 85000	0°–360°	1°	±1° (*)
	R. M. Young 50106	0°–360°	0.1°	±1°–2°(*)
Air temperature	Rotronics MI01A	0–32.5°C	0.01°C	±0.05°C (*)
Relative humidity	Rotronics MI01A	0–100% RH	0.01% RH	±0.3% (*)
Precipitation	R. M. Young 50202	0–50 mm	1 mm	±1 mm (*)
Downwelling shortwave radiation	Eppley PSP	0–1400 W m^{-2}	0.01 W m^{-2}	±1–3% (*)

Measurement	Model	Range	Resolution	Accuracy
Conductivity	Sea-Bird Electronics SBE37-IM	0–7 S m^{-1}	0.0001 S m^{-1}	0.02–0.03 in salinity equivalent
Temperature		−5°–35°C	0.0001°C	0.005°C
Pressure		0–1450 psia	0.002% full scale	3–5 dbar
Temperature	Sea-Bird Electronics SBE39-IM	−5°–35°C	0.0001°C	0.005°C
Pressure		0–1450 psia	0.002% full scale	3–5 dbar
Current	Teledyne RD Instrument Doppler volume sampler	±6 m s^{-1}	0.1 cm s^{-1}	0.1%–0.5 cm s^{-1}, whichever is greater (*)

Table S1C. TRITON (top) meteorological and (bottom) oceanographic sensor specifications. Accuracies listed are either based on predeployment and postrecovery calibrations for groups of sensors or are supplied by the manufacture (indicated by *). The accuracy of Argonaut is based on the results of an intercomparison of daily means with an ADCP at the same location. Sensors are interfaced to the datalogger via an A/D converter and signal processing module developed by Woods Hole Oceanographic Institution.

Measurement	Model	Range	Resolution	Accuracy
Wind speed	R. M. Young 05103	0–60 m s^{-1}	0.1 m s^{-1}	0.3 m s^{-1} (*)
Wind direction	R. M. Young 05103	0–360°	1°	±2° (*)
Air temperature	Rotronics MI01A	0–32.5°C	0.01°C	±0.05°C
Relative humidity	Rotronics MI01A	0–100% RH	0.1% RH	1.1%
Precipitation	R. M. Young 50202	0–50 mm	1 mm	±2 mm (*)
Downwelling shortwave radiation	Eppley PSP	0–1400 W m^{-2}	0.1 W m^{-2}	±6% full scale
Measurement	**Model**	**Range**	**Resolution**	**Accuracy**
Conductivity	Sea-Bird Electronics SBE37-IM	0–7 S m^{-1}	0.0001 S m^{-1}	0.02–0.03 in salinity equivalent
Temperature		−5°–35°C	0.0001°C	0.005°C
Pressure		0–1450 psia	0.002% full scale	3–5 dbar
Current	SonTek Argonaut	0–1000 cm s^{-1} 0°–360°	0.1 cm s^{-1} 0.1°	3.3 cm s^{-1} 3.1°

Table S1D. Specifications for acoustic Doppler current profilers deployed JAMSTEC, Pacific Marine Environmental Laboratory (PMEL), and National Institute of Oceanography (NIO). Accuracies listed are based on data postprocessing procedures or on manufacturer supplied specifications (indicated by *). NIO introduced 76.8 kHz ADCPs over the period 2006–08 at its 77°, 83°, and 93°E equatorial mooring sites. Prior to that, between 2003 and 2008, 307 kHz ADCPs were used (see Table S1E).

Measurement	Model	Range	Resolution	Accuracy
Current profile	RD Instruments 76.8 kHz Workhorse Long Ranger	±500 cm s^{-1}	0.1 cm s^{-1}	±1% or ±0.5 cm s^{-1}, whichever is greater (*)
		0°–360°	0.01°	±2° (*)
		25–430 m	8 m	2–4 m

Table S1E. Specifications for acoustic Doppler current profilers deployed by NIO on current meter moorings at 0°, 77°E; 0°, 83°E; and 0°, 93°E during 2003–08. All accuracies listed are based on manufacturer supplied specifications.

Measurement	Model	Range	Resolution	Accuracy
Current profile	RD Instruments 307 kHz Workhorse Sentinel	±500 cm s^{-1}	0.2 cm s^{-1}	±0.5% or ±0.5 cm s^{-1}, whichever is greater
		0°–360°	0.01°	±5°
		10–100 m	4 m	2–4 m

Table S1F. Specifications for Aanderaa recording current meters (RCMs) on NIO deep ocean current meter moorings. Accuracies listed are supplied by the manufacture. A Sea-Bird SBE37-IM conductivity/temperature sensor (see Table S1B) was also deployed on early moorings 1–2 m below the 4000-m RCM and on later moorings 1–2 m below the 100-m RCM.

Measurement	Model	Range	Resolution	Accuracy
Current temperature conductivity	RCM 7	0–300 cm s^{-1}	0.3 cm s^{-1}	±2% reading
	Speed	0°–360°	0.35°	±7.5°
	Direction	0–7.4 S m^{-1}	0.007 S m^{-1}	±0.007 S m^{-1}
	Conductivity	−1°–32°C	0.03°C	±0.05°C
	Temperature	0–20 MPa	0.1% of range	±0.25% of range
	Depth			
Current temperature conductivity	RCM 8	2–295 cm s^{-1}	0.4 cm s^{-1}	±2% reading
	Speed	0°–360°	0.35°	±7.5°
	Direction	0–7.4 S m^{-1}	0.007 S m^{-1}	±0.007 S m^{-1}
	Conductivity	−1°–32°C	0.03°C	±0.05°C
	Temperature	0–8702 psi	8.7 psi	±27.85 psi
	Depth		or	or
			0.1% of range	±0.25% of range
Current temperature conductivity	RCM 11	0–300 cm s^{-1}	0.3 cm s^{-1}	±1% reading
	Speed	0°–360°	0.35°	±7.5°
	Direction	0–7.4 S m^{-1}	0.0074 S m^{-1}	±0.015 S m^{-1}
	Conductivity	−1°–33°C	0.03°C	±0.05°C
	Temperature	0–8702 psi	8.7 psi	±27.85 psi
	Depth		or	or
			0.1% of range	±0.25% of range

Table S2A. (top) Nominal heights of meteorological sensors and (bottom) depths of ATLAS mooring sensors. Acronyms are defined as wind speed and direction (wind); longwave radiation (LWR); shortwave radiation (SWR); rain gauge (rain); air/relative humidity (ATRH); barometric pressure (BP); subsurface temperature (T); subsurface temperature and conductivity (TC); subsurface temperature and pressure (TP); and subsurface temperature and horizontal velocity (TV). For TV sensors, the velocity measurement made at 10-m depth by a SonTek acoustic Doppler current meter cabled to a temperature sensor at 13-m depth, which relays both velocity and temperature data to the surface buoy. The 1-m TC sensor provides a measurement representative of sea surface temperature and conductivity. LWR and BP are installed only on Flux Reference Site ATLAS moorings. These moorings may also have additional instrumentation in the upper 140 m for temperature, salinity, and velocity measurements.

Meteorological sensor	Wind	ATRH	Rain	SWR	LWR	BP
Height (m)	4	3	3.5	3.5	3.5	3

Ocean sensor	TC	TC	TV	TC	TC	TC	T	TC	T	T	T	TP	TP
Depth (m)	1	10	10/13	20	40	60	80	100	120	140	180	300	500

Table S2B. (top) Nominal heights of meteorological sensors and (bottom) depths of m-TRITON mooring sensors. Wind, SWR, rain, ATRH, and TP represent the same parameters as in Table S2A. Temperature, conductivity and pressure is TCP; and horizontal velocity is V. The 1-m TCP sensor provides a measurement of sea surface temperature and conductivity. For the TCP&V sensor, V is measured at 10 m and TCP at 11 m.

Meteorological sensor	Wind	ATRH	Rain	SWR
Height (m)	3.1	2.3	2.8	2.8

Ocean sensor	TCP	TCP&V	TCP	TCP	TP	TP	TCP	TP	TP	TP	TP	TP
Depth (m)	1	10/11	20	40	60	80	100	120	140	200	300	500

Table S2C. (top) Nominal heights of meteorological sensors and (bottom) depths of TRITON mooring sensors. Wind, SWR, Rain, ATRH, BP, TC, TCP, and V represent the same parameters as in Table S2A. The 1.5-m TC sensor provides a measurement of sea surface temperature and conductivity.

Meteorological sensor	Wind	ATRH	Rain	SWR	BP
Height (m)	3.5	2.2	3.0	3.0	2.0

Ocean sensor	TC	V	TC	TC	TC	TC	TC	TC	TC	TC	TCP	TC	TCP
Depth (m)	1.5	10	25	50	75	100	125	150	200	250	300	500	750

Table S2D. Nominal depths of RCMs placed on the NIO deep sea current-meter moorings. The float depth for these moorings is nominally 100 m below the surface on which an upward-looking ADCP is mounted.

Ocean sensor	RCM-7	RCM-7	RCM-7	RCM-7	RCM-8	RCM-8/RCM-11
Depth (m)	100	300	500	1000	2000	4000