DYNAMO Surface Mooring Data

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1. Data Set Overview:

During DYNAMO, three surface/subsurface pairs of moorings were deployed by the R/V *Roger Revelle* during cruise leg 1 in mid-September 2011. The mooring sites are denoted D1, D2, and D3.

Time period: 3 September 2011 – 1 January 2012.

Physical location: The mooring locations and data periods were as follows:

D1	0°N, 78.9°E	11 Sep. 2011 – 20 Nov. 2011
D2	1.5°S, 78.8°E	11 Sep. 2011 – 21 Jan. 2012
D3	9.7°S, 78.5°E	11 Sep. 2011 – 6 Jan. 2012

Data source: Meteorological instrumentation on a surface moored buoy. SST was measured at ~1 m depth.

2. Instrument Description

The surface moorings were equipped with a Weatherpak® weather station. Specifications are provided below and in the attachment.

Measurement	Sensor type	Manufacturer: Model #	Resolution	Range	Accuracy
Wind speed	Gill Ultrasonic	Gill WindSonic™ Ultrasonic Wind Sensor	0.01 m/s (0.02 knots)	0 - 60 m/s (116 knots)	±2% @12 m/s
Wind direction	Gill Ultrasonic	Gill WindSonic™ Ultrasonic Wind Sensor	1°	0 - 359° (No dead band)	±3° @12 m/
	Navico Fluxgate	Navico		0-359°	
Air temperature	Resistance	Vaisala INTERCAP Humidity and Temperature Probe HMP60		-40 ~+60 °C	±0.6 °C
Relative humidity	Capacitance	INTERCAP Humidity and Temperature Probe HMP60		0~100% RH	0~90% RH ±3 % RH 90~100% RH ±5 %RH
Rainfall	Capacitance	R. M. Young: 50202		0-50 mm	±1 mm
Downwelling shortwave radiation	Pyranometer	LI-COR LI-200		90 micrA per 1000 W /m^2	±5%
Downwelling longwave radiation	Pyrgeometer	Eppley Laboratory: PIR-TAO, Delrin case, 3-output (1)	0.1 W m-2 0.03°C	200 W m-2 @ 20°C (thermopile only)	±1%

Barometric pressure	Pressure transducer	RM Young Barometric Pressure sensor Model 61302	Analog 0.025% of scale Serial 0.01 hPa	500-1100 hPa	0.2hPa (25°C) 0.3 hPa (-40 to +60°C) -40 to +60°C
Sea surface and subsurface temperature	Thermistor	Sea Bird Electronics: SBE37	0.001°C	1-31°C (-5-35°C)	±0.003°C

3. Data Collection and Processing

Surface Meteorology (P, T, wind, humidity, rain, shortwave, longwave radiations) was recorded every ten minutes. The data were transmitted in real time using an Iridium data transmission system. The data were averaged to hourly and daily resolution. The original Matlab format data were provided by Barry Ma at UW/APL. These data were converted in to CF Complient NetCDF. Brandon Kerns combined the meteorological data (original files like: D1_daily.mat, D1_met_hrly.mat) and the 1 m SST data (original file: sea_temp_1m_hrgrid_dynamo.mat). No additional quality control was done.

4. Data Format

There is one data file for each surface mooring. The data are in CF compliant NetCDF format.

```
dimensions:
        time = 1539 ;
        time_daily = 65 ;
        time_sst = 3085 ;
        site = 1 ;
variables:
        double site_lat(site) ;
                site_lat:units = "degrees_latitude" ;
                site_lat:long_name = "Site Latitude" ;
        double site_lon(site) ;
                site_lon:units = "degrees_longitude" ;
                site_lon:long_name = "Site Longitude" ;
        double time(time) ;
                time:units = "seconds since 1970-1-1 0:00:00 0:00" ;
                time:notes = "Time for hourly time resolution data." ;
        double time_daily(time_daily) ;
                time_daily:units = "seconds since 1970-1-1 0:00:00 0:00" ;
                time_daily:notes = "Time for daily time resolution data." ;
        double time_sst(time_sst) ;
                time_sst:units = "seconds since 1970-1-1 0:00:00 0:00" ;
                time_sst:notes = "Time for hourly SST data." ;
        float sea_surface_temperature(time_sst) ;
                sea_surface_temperature:units = "Kelvin" ;
                sea_surface_temperature:standard_name = "sea_surface_temperature" ;
                sea_surface_temperature:long_name = "Sea surface temperature (~1m
depth)" ;
                sea_surface_temperature:comment = "SST measurement depth is ~1m." ;
        float air_temperature(time) ;
                air_temperature:units = "degree_Celsius" ;
                air_temperature:standard_name = "air_temperature" ;
        float air_temperature_daily(time_daily) ;
                air_temperature_daily:units = "degree_Celsius" ;
                air_temperature_daily:standard_name = "air_temperature" ;
```

```
        float relative_humidity(time) ;
                relative_humidity:units = "percent" ;
                relative_humidity:standard_name = "relative_humidity" ;
        float relative_humidity_daily(time_daily) ;
                relative_humidity_daily:units = "percent" ;
                relative_humidity_daily:standard_name = "relative_humidity" ;
        float air_pressure(time) ;
                air_pressure:units = "Pa" ;
                air_pressure:standard_name = "air_pressure" ;
        float air_pressure_daily(time_daily) ;
                air_pressure_daily:units = "Pa" ;
                air_pressure_daily:standard_name = "air_pressure" ;
        float wind_speed(time) ;
                wind_speed:units = "m s-1" ;
                wind_speed:standard_name = "wind_speed" ;
        float wind_speed_daily(time_daily) ;
                wind_speed_daily:units = "m s-1" ;
                wind_speed_daily:standard_name = "wind_speed" ;
        float u(time) ;
                u:units = "m s-1" ;
                u:standard_name = "eastward_wind" ;
        float u_daily(time_daily) ;
                u_daily:units = "m s-1" ;
                u_daily:standard_name = "eastward_wind" ;
        float v(time) ;
                v:units = "m s-1" ;
                v:standard_name = "northward_wind" ;
        float v_daily(time_daily) ;
                v_daily:units = "m s-1" ;
                v_daily:standard_name = "northward_wind" ;
        float solar_down(time) ;
                solar_down:units = "W m-2" ;
                solar_down:standard_name = "downwelling_shortwave_flux_in_air" ;
        float solar_down_daily(time_daily) ;
                solar_down_daily:units = "W m-2" ;
                solar_down_daily:standard_name = "downwelling_shortwave_flux_in_air" ;
        float ir_down(time) ;
                ir_down:units = "W m-2" ;
                ir_down:standard_name = "downwelling_longwave_flux_in_air" ;
        float ir_down_daily(time_daily) ;
                ir_down_daily:units = "W m-2" ;
                ir_down_daily:standard_name = "downwelling_longwave_flux_in_air" ;
        float rain_rate(time) ;
                rain_rate:units = "mm h-1" ;
                rain_rate:standard_name = "rainfall_rate" ;
                rain_rate:long_name = "Rain Rate (Hourly)" ;
        float rain_rate_daily(time_daily) ;
                rain_rate_daily:units = "mm h-1" ;
                rain_rate_daily:standard_name = "rainfall_rate" ;
                rain_rate_daily:long_name = "Rain Rate (Daily)" ;

// global attributes:
                :Conventions = "CF-1.7" ;
                :title = "DYNAMO Surface Mooring \"D1\" Data: Dynamo Legacy
Collection" ;
                :institution = "University of Washington Applied Physics Laboratory" ;
                :contact = "Ren-Chieh Lien (rcl@uw.edu), Brandon Kerns
(bkerns@uw.edu)" ;
                :source = "Moored buoy surface observations" ;
                :history = "Brandon Kerns obtained the data from Ren-Chieh Lien in
January 2018 and converted from Matlab format to netcdf format." ;
                :references = "" ;
```

```
                     :comment = "DYNAMO moorings were deployed by the R/V Revelle during
mid September 2011. This file contains the surface meteorological measurements and the
SST. Surface meteorological measurements are provided at hourly and daily resolution.
Surface meteorological mesaurements are at ~4 meters above the sea surface. SST is
provided at hourly resolution. SST was measured at ~1 meter depth. Meteorological
instrumentation on mooring D1 was vandalized on 20 November 2011." ;
}
```

5. Data Remarks

The data can be accessed using the myriad of software that is able to interact with NetCDF format files, including ncdump, ncview, Matlab, Python, IDL, and NCL.

Hourly and daily mean data are provided.

Mooring D1 was vandalized on 20 November. Mooring D3 broke from its chain on 6 January 2012.

6. References

Chi, Nan-Hsun, Ren-Chieh Lien, Eric A. D'Asaro, and Barry B. Ma, 2014: The surface mixed layer heat budget from mooring observations in the central Indian Ocean during Madden–Julian Oscillation events. *J. Geophys. Res. Oceans,* **119,** 4638-4652. https://doi.org/10.1002/2014JC010192.

Attachment: DYNAMO Mooring instrument assignment.

DYNAMO Surface Mooring Instrument Depths (updated:10/11/2012 11:21 AM)

Instrument	Note	Depth /High(m) from sea surface	D1 (0S)	D2 (1.5S)	D3 (8S)
Weatherpak			3031	3081	3080
WindSonic	Wind	3.1m	10460042	10510042	10510039
EPLAB PIR	Longwave	2.7m	36813F3	36798F3	36799F3
LiCor	Shortwave	2.7m	PY70254	PY71186	PY71184
RMY Raingauge	Rain	2.8m	01762	08858	01859
RMY BP	Pressure	3.0m	BPA2033	BPA3024	BPA3036
SIM			8988169224000588286	8988169224000735267	8988169224000825944
IMEI			300025010108860	300025010216420	300025010216400
Phone # MSISDN			+ 8816 224 67604	+ 8816 924 84602	+ 8816 924 84603
SABLE			6860	2920	5560
CABO/WABO			0230	2190	1630
SBE37 shallow	S1	Bridle(1.5m)	8444	8445	5754
DVS (ID#01)	D1	3m	12351	12754	15877
SBE37 (ID#03)	S2	5m	7005	7017/p	7028
DVS (ID#02)	D2	8m	15970	15969	15878
Chipod	C1	10m(9m)	516	522	528
SBE37 (ID#04)	S3	10m	7007	7018	7029
SBE37 (ID#05)	S4	15m	7008	7019/p	7030
1200kHz ADCP		19m	10683	10644	1420
SBE37 (ID#06)	S5	20m	7009	7020	7031
Chipod	C2	25m(24m)	517	523	529
HOBO	H1	25m	772	779	786
SBE37 (ID#07)	S6	30m	7010	7021	7032
HOBO	H2	35m	773	780	512
Chipod	C3	37m	519	525	531
SBE37 (ID#08)	S7	40m	7011	7022	7033
Chipod	C4	43m	518	524	530
HOBO	H3	45m	774	781	513
SBE37 (ID#09)	S8	50m	7012	7023	7034
HOBO	H4	55m	775	782	514
Chipod	C5	60m(59m)	520	526	532
SBE37 (ID#10)	S9	60m	7013	7024/p	8456
HOBO	H5	65m	776	783	515
SBE37 (ID#11)	S10	70m	7014	7025	8457
HOBO	H6	75m	777	784	516
Chipod	C6	80m(79m)	521	527	533
SBE37 (ID#12)	S11	80m	7015	7026	8458
SBE37 (ID#13)	S12	90m	7016	7027	8459
300kHz ADCP		100m	16253	16254	10525
SBE37SMP	S13	101m	5742/p	5743/p	5744/p
HOBO	H7	125m	778	785	xxx
SBE37SMP	S14	150m	5757	5755	5756
SBE37SMP	S15	200m	5751	5752	5753
SBE37SMP	S16	300m	5745	5746	5747
SBE37SMP	S17	500m	5748	5749	5750
Release			31361/ 31362 (55)	31848 / 31851 (57)	33637 / 33640 (59)

** Fairings in between 20m and 250m **DYNAMO Subsurface mooring instrument assignment**

	SD1 (0S)	SD2 (1.5S)	SD3 (8S)
75kHz ADCP	11681	12891	12859
Flasher	U04-064	U04-065	------
SABLE	1920	5830	8830
Release	33635/ 33636 (58)	33639 (60)	31363 / 31364 (56)

Note:

- D3 buoy instrument started 09/09/2011 120000
- SD2 only use one release. The banana link on 33638/33639 set needs to be replaced.
- D2 5m,15m,60m and 101m have pressure plug removed.
- D1, D2, D3 @ 101m will have pressure measurement .
- DVSs at D2 & D1 sampling at 5 min interval w/ 28 pings per ensemble.
- Need to check SBE37- 5748 & 5751 pump might not working??

Mooring locations

Name	Fixs	Fixs	Depth	Deployed (UTC)
D1	78.90703°E, 0.02926°S	78°54.4218'E, 0°01.7556'S	4755m	09/17/2011 0945
SD1	78.96513°E, 0.04888°S	78°57.9078E, 0°02.9328'S	4761m	09/17/2011 1337
D2	78.71423°E, 1.51754°S	78°42.8556'E, 1°31.0524'S	4950m	09/15/2011 1005
SD2	78.83005°E, 1.55964°S	78°49.8030'E, 1°33.578'S	4932m	09/14/2011 1210
D3	78.46702 °E, 9.6930°S	78°28.021'E, 9°41.58'S	5357m	09/11/2011 0940
SD3	78.49307°E, 9.67504°S	78°29.584'E, 9°40.50'S	5360m	09/12/2011 0550

Mooring lines

D3 mooring line: nylon 4627m + 140m (below release)

SD3 mooring line: kevlar 4500m +295m

D2 mooring line: nylon 4191m +160m (below release)

SD2 mooring line: kevlar 4389m (108m removed from 4500m original spool)

D1 mooring line: nylon 4029m + 130m (below release)

SD1 mooring line: kevlar 4188m (312m removed from 4500m original spool)
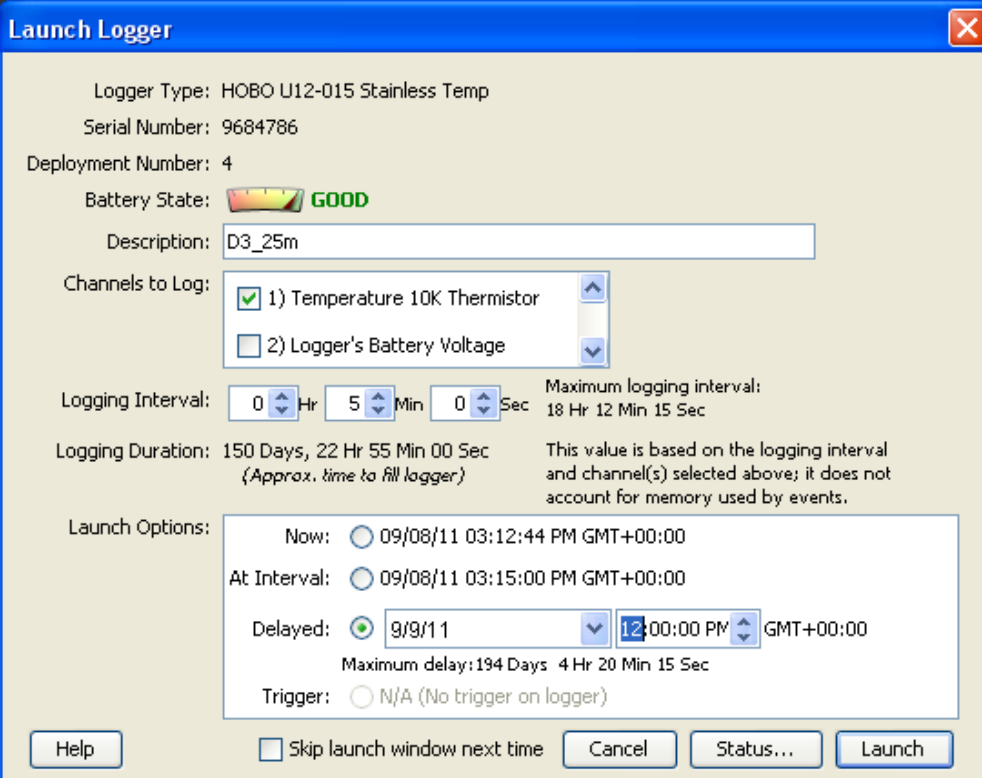
Weatherpak setting:

10 min data interval.
Iridium modem turned on 30min for every 2hrs, started on the even hour UTC.

ADCP Setting

	Δt	pings	Δz	Last cell range	max range	δu	card installed	Memory needed	period	battery pack needed
1200kHz ADCP	120s	20 (burst one per sec)	0.5 m	19.0m	12.3m	1.55 cm/s	256 MB	125 MB	150 days	1 pack
300kHz	4s	1	2 m	100.2m	92.6m	6.9 cm/s	4 GB	2.8GB	150 days	2.6 packs
75kHz	300s	10 (burst one per sec)	8 m	584mm	550m	4.73 cm/s	512 MB	61 MB	140 days	4.0 packs ambiguity vel 1.2 m/s
DVS	240s (D3) 300s (D1,D2)	28 (burst one per sec)	0.5m	2.83m	3.08m	0.6cm/s		8.6 MB	150 days	

MicroCATs	Sampling interval: 2min	Battery Endurance Calculator 1.1 Model = SBE 37 IMP Firmware 3.0 or higher Pressure Sensor = Strain gauge Sample Interval = 120 Sampling Type = Autonomous Number to Query = 0 Communication per Hour = 1 Battery Type is: AA Lithium Battery Capacity = 8.8 Amp-Hours Battery Endurance is: 144 Days	Battery Endurance Calculator 1.1 Model = SBE 37 SMP RS-232 Firmware = 3.0 or higher Pressure Sensor = Strain gauge Sample Interval = 120 Sampling Type = Autonomous Transmit Real Time Not Enabled Battery Type is: AA Lithium Battery Capacity = 8.8 Amp-Hours Battery Endurance is: 149 Days
HOBO	5 min interval.		

DVS	D3 mooring: 4 min interval. Burst mode: 28 pings, one per second. Started: 1min, 30sec before the hour. **D1 & D2 mooring:** 5 min interval. Burst mode: 28 pings, one per second. Started: 1min, 30sec before the hour.	
75kHz ADCP	5min interval. 10 pings per ensemble (burst mode, 1 /sec) 8 m depth cell. Ambiguity velocity 1.2m/s	

300kHz ADCP	4 sec interval. 1 ping per ensemble 2 m depth cell	
1200kHz ADCP	2 min interval. Burst mode: 20 pings per ensemble. one ping per second.	

300kHz ADCP screen:

PlanADCP (Advanced) : [C:\barry\DYNAMO_ADCP\DYNAMO_300k.txt]

File   Settings   View   Help

CAUTION: Not enough battery packs for the deployment.

Basic   Advanced   Expert

Environmental Setup:
Transducer Depth: 0 m
Salinity: 35 ppt
Magnetic Variation: 0 °
Temperature: 5 °C

Deployment Timing Setup:
Duration: 150 days
Ensemble Interval: 00:00:04.00
Ping Int.(☑ Auto): 00:00:04.00
Min TP

☐ Ping Immediately After Deployment
First Ping Date and Time:
09-Sep-2011   12:00:00

Profiling Setup:
Pings Per Ensemble: 1
Number of Depth Cells: 49
Depth Cell Size: 2 m
Mode: 1

Deployment Consequences:
First Cell Range: 4.20 m
Last Cell Range: 100.20 m
Max Range: 92.62 m
Standard Deviation: 6.94 cm/s
Ensemble Size: 1134 bytes
Storage Required: 3503.95 MB
Power Usage: 1455.17 Wh
Battery Pack Usage: 3.2

Notes

Workhorse Sentinel: 300 kHz/ High Res./ 3 Battery Packs/ Memory: 2000 MB

1200kHz ADCP screen:

PlanADCP (Advanced) : [C:\barry\DYNAMO_ADCP\DYNAMO_1200k_SN1420.txt]

File   Settings   View   Help

Basic   Advanced   Expert

Environmental Setup:
Transducer Depth: 0 m
Salinity: 35 ppt
Magnetic Variation: 0 °
Temperature: 5 °C

Deployment Timing Setup:
Duration: 150 days
Ensemble Interval: 00:02:00.00
Ping Int.(☐ Auto): 00:00:01.00
Min TP

☐ Ping Immediately After Deployment
First Ping Date and Time:
09-Sep-2011   12:00:00

Profiling Setup:
Pings Per Ensemble: 20
Number of Depth Cells: 37
Depth Cell Size: 0.5 m
Mode: 1

Deployment Consequences:
First Cell Range: 1.05 m
Last Cell Range: 19.05 m
Max Range: 12.36 m
Standard Deviation: 1.55 cm/s
Ensemble Size: 894 bytes
Storage Required: 92.08 MB
Power Usage: 434.43 Wh
Battery Pack Usage: 1.0

Notes

Workhorse Sentinel: 1200 kHz/ High Res./ 1 Battery Pack/ Memory: 256 MB