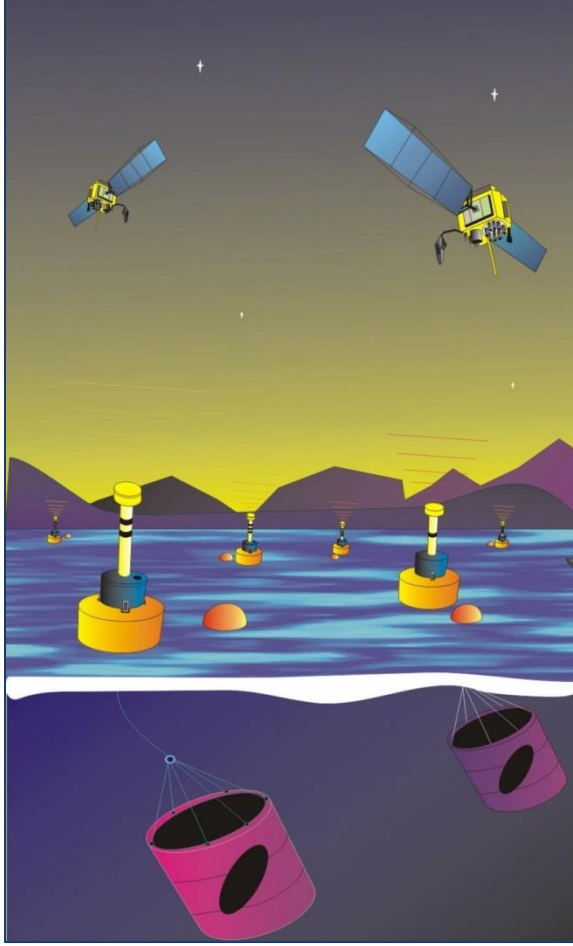
Towards improved drifter SST

A collaboration between the satellite community and the Data Buoy Co-operation Panel

David Meldrum



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GHRSST

Group for High Resolution Sea Surface Temperature

EUMETSAT

esa

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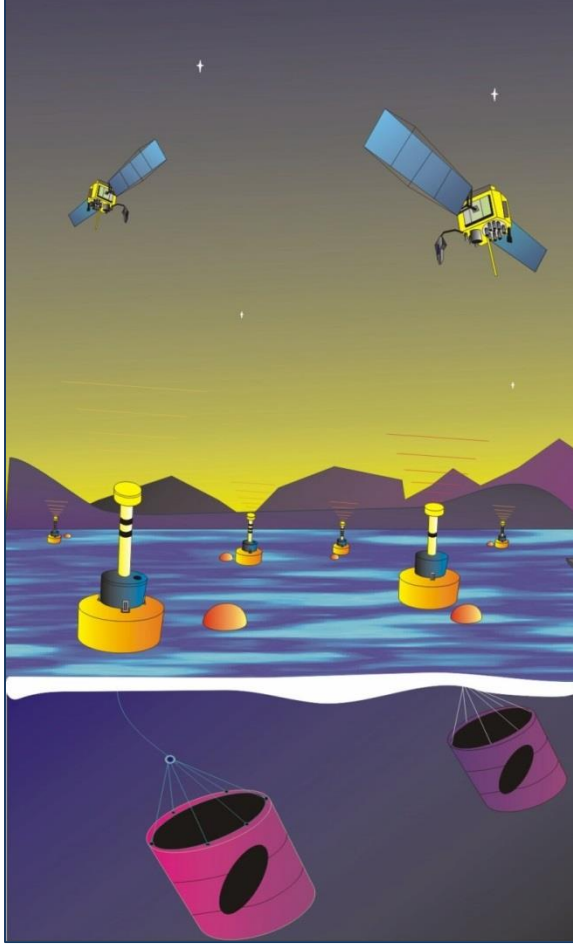

Who are the Data Buoy Co-operation Panel?

- Formed by the WMO and IOC of UNESCO in 1983
  - Open membership, voluntary subscriptions to support activities and employment of a technical co-ordinator
- Aims
  - To improve quality, quantity and timeliness of buoy data
  - To encourage the research community to insert their buoy data onto the GTS
  - To evaluate and pilot new technologies for data buoys
  - To engage with other ocean observing communities through JCOMM, GOOS and the space agencies

DBCP sessions: Oban 2010 and La Jolla 2016

- Annual budget ~USD 250k
- Technical co-ordinator based at JCOMMOPS in Brest

The traditional drifting buoy

Traditionally

- Satcomms: Argos
- SST accuracy: 0.2K
- SST resolution: 0.1K

More recently

- Satcomms: Iridium
- SST accuracy: 0.2K
- SST resolution: 0.01K
- Majority carry barometer

In future

- SST accuracy: 0.05K
- ONLY if valuable to do so

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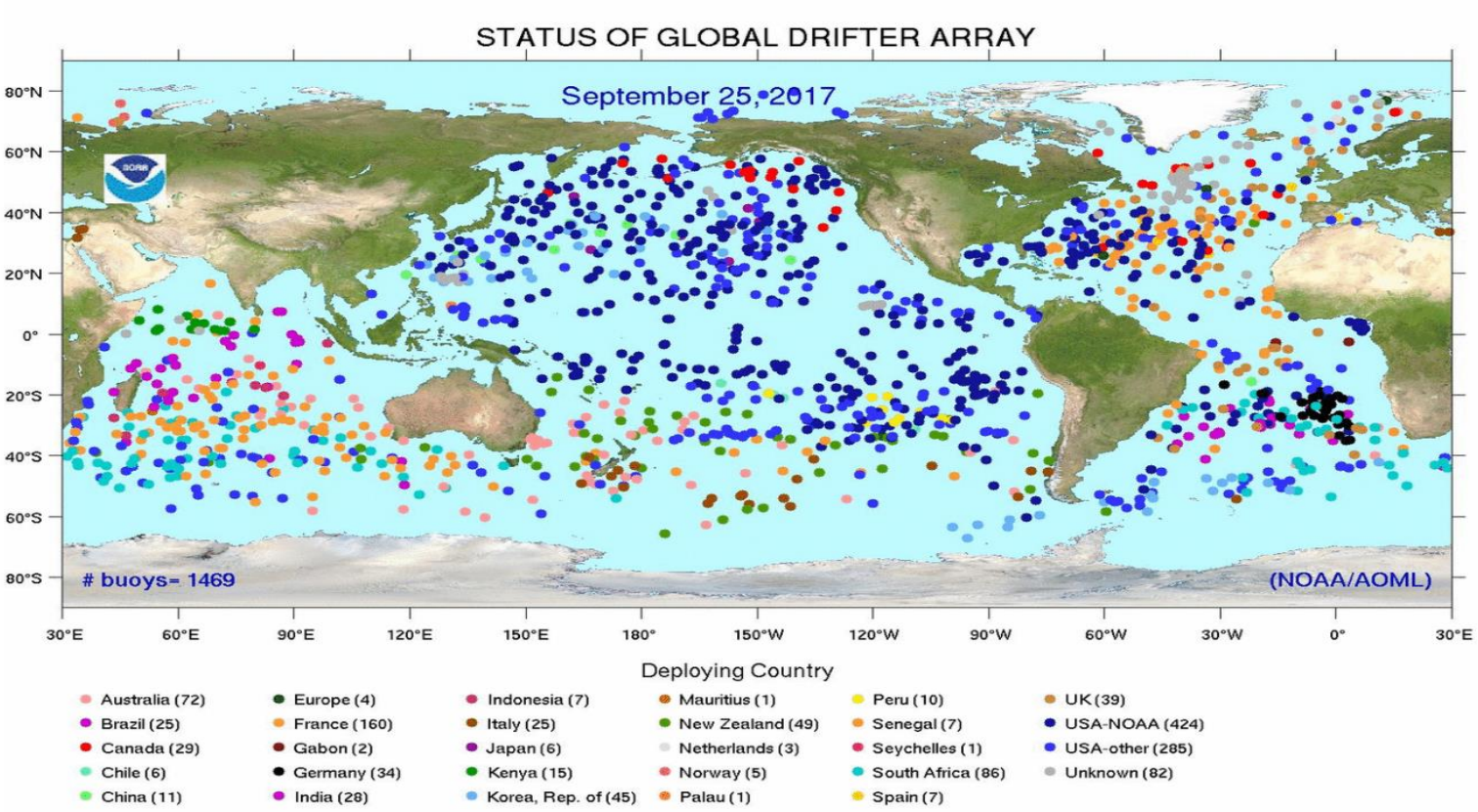
How many drifters are out there right now?



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DBCP dialogue with the satellite community

- Group for High Resolution SST (GHRSST) and DBCP started a dialogue (2008)
  - DBCP made aware of importance of drifter SST for satellite validation
    - Issues with poor resolution, unknown accuracy, little metadata
    - Not just for T but also for (x,y,z,t)
  - Agree a set of requirements for drifter HRSST

Result of a dialogue: the GHRSST ‘standard’

- Hourly measurements
- Report design depth in calm water to ± 5 cm
- Report geographical location to ± 0.5 km or better
- SST accuracy to ± 0.05K or better, resolution 0.01K
- Report time of SST measurements to ± 5 minutes

Result of a dialogue: the GHRSST 'standard'

- Hourly measurements
- Report design depth in calm water to ± 5 cm
- Report geographical location to ± 0.5 km or better
- SST total standard uncertainty to ± 0.05K or better, resolution 0.01K
- Report time of SST measurements to ± 5 minutes

Activities since 2008

- Establishment of DBCP-GHRSST Pilot Project
- Initial deployments by ESURFMAR, Met Office and DBCP
  - Preliminary analyses by satellite community do not demonstrate expected improvements
  - Value of HRSST yet to be demonstrated
- Need to understand uncertainties in the measurements
- Need to establish traceability
- Both of above lead to recent initiatives by the space sector

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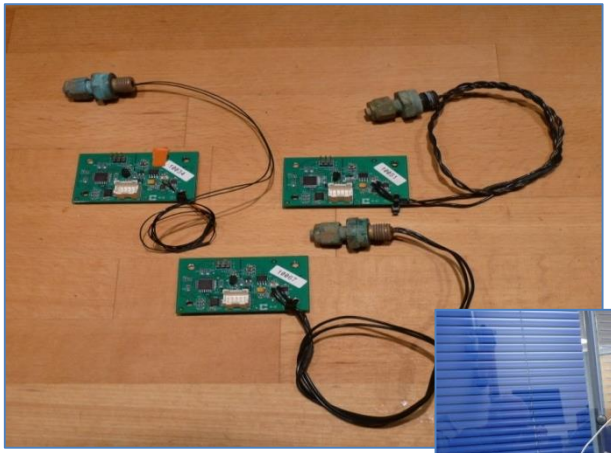
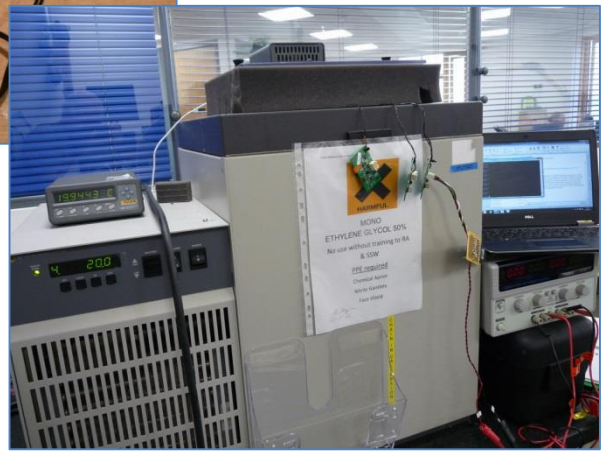
HRSST drifter deployments

- About 1200 total
- Most are HRSST-1
  - Traditional sensor
  - Report to 0.01C via Iridium
  - BUFR essential for coding
  - Becoming default standard
- About 70 HRSST-2
  - Dedicated sensor module
  - Digital output
  - Calibration certificate
  - Not yet demountable for post calibration
  - Incremental cost approx $1000 initially
  - Accuracy better than 0.05C (Blouch)





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More recent developments

- With the move to Iridium and BUFR, HRSST is becoming the default standard
- ESA finally commission work into the traceability of *in situ* SST
  - Mostly related to radiometric measurements
  - Subset of work on drifter SST and IST
- EUMETSAT release ITT for the procurement and deployment of 100 HRSST-2 drifters
  - Objective is to prove or disprove the usefulness of HRSST-2
  - Will also study the dynamics of the drifter within the water column

FRM4STS – option 1

Ref	Short name	Deliverable title and description	Date due
OP-10	LIB	Web-based library (LIB) of relevant calibration and validation documentation for non-recoverable SST instruments.	KO+21
OP-20	TR-4	Technical Report (TR-4): "Towards SI Traceability for non-recoverable SST FRM Instruments"	KO+21
OP-30	STM	Scientific and Technical Meeting Report: "Towards SI Traceability for non-recoverable SST FRM Instruments"	KO+22

OP-10/LIB - metadata database

- Source material
  - Manufacturers' job files
    - Some manufacturers no longer exist, files unavailable
    - Backup archive of Global Drifter Program (GDP) job files
  - Global Drifter Program deployment records
    - Contain WMO ID and drogue loss data
    - Drogue status (ON/OFF) determines drifter dynamics
  - Météo France / ESURFMAR database
  - JCOMMOPS WMO ID database
- >20,000 drifters deployed!
- Source material being parsed by PERL script into searchable CSV file
  - Software nearing completion
- This database will be maintained in the future by JCOMMOPS (DBCP commitment)

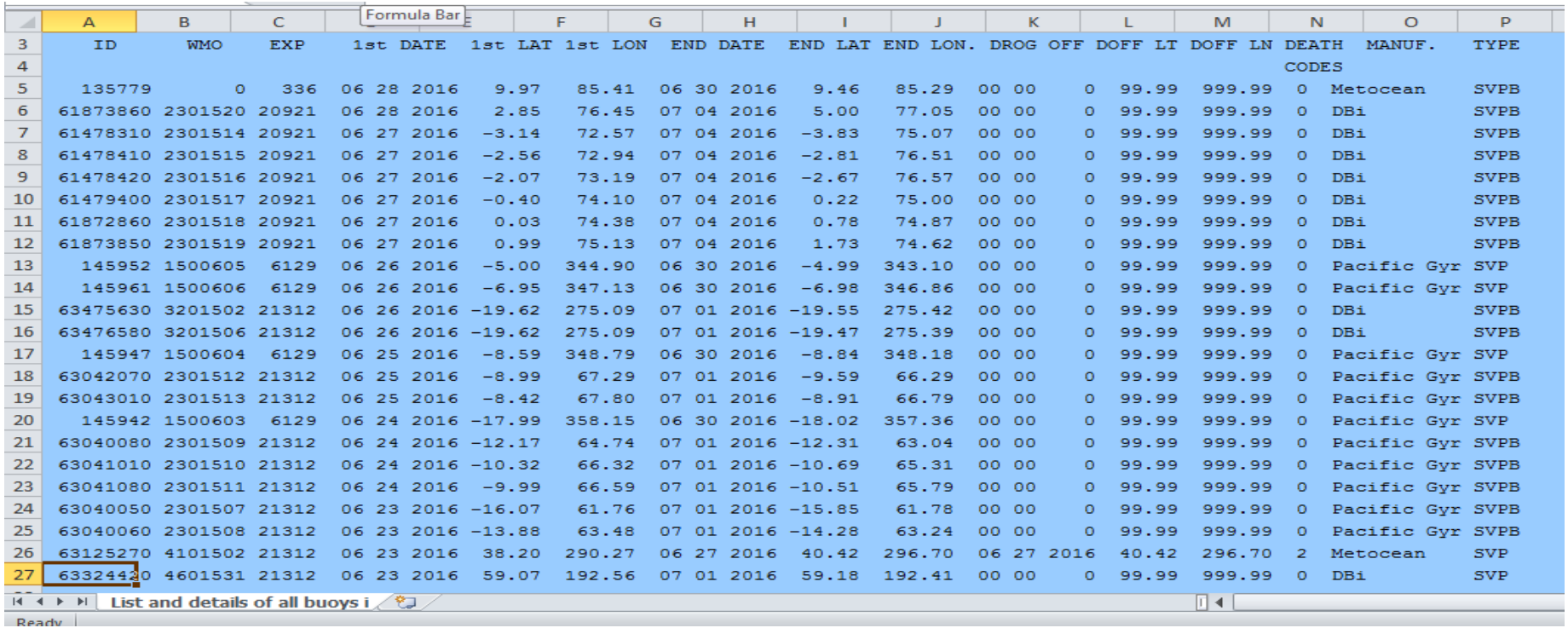
OP-10/LIB – manufacturer's job file

Job_813B - Notepad

File Edit Format View Help

```
ARGOS IDs                       26910, 26914, 27353, 27356, 27952, 27954, 27955, 27956.

Manufacturer                    METOCEAN Data Systems Ltd.  (Job 813B)
                                (SCN 1016 V2.66, FID 2088, SID 2022)

Purchaser                       Oregon State University

Sensor Array                    Sea Surface Temperature, Battery Voltage, Optical Colour Monitor

Surface Float                   35.5 cm diameter, fiberglass surface float.  Construction; 1.5 oz
                                per sq. ft (500g/m^2)fiberglass mat; outer gel coat for UV
                                protection and prevent water absorption.

Message Length                  256 bits

Message Format:                 8 bits          Checksum
                                12 bits         Radiance channel 1 (Lu683)
                                 8 bits         Std Deviation channel 1
                                12 bits         Radiance channel 2 (Lu670)
                                 8 bits         Std Deviation channel 2
                                12 bits         Radiance channel 3 (Lu555)
                                 8 bits         Std Deviation channel 3
                                12 bits         Radiance channel 4 (Lu510)
                                 8 bits         Std Deviation channel 4
                                12 bits         Radiance channel 5 (Lu490)
                                 8 bits         Std Deviation channel 5
                                12 bits         Radiance channel 6 (Lu443)
                                 8 bits         Std Deviation channel 6
                                12 bits         Radiance channel 7 (Lu412)
                                 8 bits         Std Deviation channel 7
                                12 bits         Irradiance channel (Ed490)
                                 8 bits         Std Deviation irradiance channel
                                 6 bits         Data Age
                                 4 bits         Number of averages in OCM data
                                 2 bits         Message ID      (Always zero for this product)
                                 4 bits         Blank, set to zero
                                 6 bits         Battery Voltage
                                10 bits         Sea Surface Temperature
                                 8 bits         Percentage Time On Surface during surface check
                                                function
                                 8 bits         Average Surface Time
                                 8 bits         Average submerged wait
                                 8 bits         Average pressure sensor volts
                                 8 bits         Surface Voltage
                                 8 bits         Maximum depth voltage
                                 8 bits         Last night length

Temperature Sensor Type         0.1 degree C interchangable thermistor, model YSI 44032 in a
                                capped 316ss Swagelock through-hull fitting at base of surface
                                float.
Temperature Equation            Temp (C) = n * 0.05 - 2
```

OP-10/LIB – GDP deployment file



ID	WMO	EXP	1st DATE	1st LAT	1st LON	END DATE	END LAT	END LON.	DROG	OFF	DOFF LT	DOFF LN	DEATH CODES	MANUF.	TYPE
135779	0	336	06 28 2016	9.97	85.41	06 30 2016	9.46	85.29	00 00	0	99.99	999.99	0	Metocean	SVPB
61873860	2301520	20921	06 28 2016	2.85	76.45	07 04 2016	5.00	77.05	00 00	0	99.99	999.99	0	DBi	SVPB
61478310	2301514	20921	06 27 2016	-3.14	72.57	07 04 2016	-3.83	75.07	00 00	0	99.99	999.99	0	DBi	SVPB
61478410	2301515	20921	06 27 2016	-2.56	72.94	07 04 2016	-2.81	76.51	00 00	0	99.99	999.99	0	DBi	SVPB
61478420	2301516	20921	06 27 2016	-2.07	73.19	07 04 2016	-2.67	76.57	00 00	0	99.99	999.99	0	DBi	SVPB
61479400	2301517	20921	06 27 2016	-0.40	74.10	07 04 2016	0.22	75.00	00 00	0	99.99	999.99	0	DBi	SVPB
61872860	2301518	20921	06 27 2016	0.03	74.38	07 04 2016	0.78	74.87	00 00	0	99.99	999.99	0	DBi	SVPB
61873850	2301519	20921	06 27 2016	0.99	75.13	07 04 2016	1.73	74.62	00 00	0	99.99	999.99	0	DBi	SVPB
145952	1500605	6129	06 26 2016	-5.00	344.90	06 30 2016	-4.99	343.10	00 00	0	99.99	999.99	0	Pacific Gyr	SVP
145961	1500606	6129	06 26 2016	-6.95	347.13	06 30 2016	-6.98	346.86	00 00	0	99.99	999.99	0	Pacific Gyr	SVP
63475630	3201502	21312	06 26 2016	-19.62	275.09	07 01 2016	-19.55	275.42	00 00	0	99.99	999.99	0	DBi	SVPB
63476580	3201506	21312	06 26 2016	-19.62	275.09	07 01 2016	-19.47	275.39	00 00	0	99.99	999.99	0	DBi	SVPB
145947	1500604	6129	06 25 2016	-8.59	348.79	06 30 2016	-8.84	348.18	00 00	0	99.99	999.99	0	Pacific Gyr	SVP
63042070	2301512	21312	06 25 2016	-8.99	67.29	07 01 2016	-9.59	66.29	00 00	0	99.99	999.99	0	Pacific Gyr	SVPB
63043010	2301513	21312	06 25 2016	-8.42	67.80	07 01 2016	-8.91	66.79	00 00	0	99.99	999.99	0	Pacific Gyr	SVPB
145942	1500603	6129	06 24 2016	-17.99	358.15	06 30 2016	-18.02	357.36	00 00	0	99.99	999.99	0	Pacific Gyr	SVP
63040080	2301509	21312	06 24 2016	-12.17	64.74	07 01 2016	-12.31	63.04	00 00	0	99.99	999.99	0	Pacific Gyr	SVPB
63041010	2301510	21312	06 24 2016	-10.32	66.32	07 01 2016	-10.69	65.31	00 00	0	99.99	999.99	0	Pacific Gyr	SVPB
63041080	2301511	21312	06 24 2016	-9.99	66.59	07 01 2016	-10.51	65.79	00 00	0	99.99	999.99	0	Pacific Gyr	SVPB
63040050	2301507	21312	06 23 2016	-16.07	61.76	07 01 2016	-15.85	61.78	00 00	0	99.99	999.99	0	Pacific Gyr	SVPB
63040060	2301508	21312	06 23 2016	-13.88	63.48	07 01 2016	-14.28	63.24	00 00	0	99.99	999.99	0	Pacific Gyr	SVPB
63125270	4101502	21312	06 23 2016	38.20	290.27	06 27 2016	40.42	296.70	06 27 2016		40.42	296.70	2	Metocean	SVP
6332442[illegible]0	4601531	21312	06 23 2016	59.07	192.56	07 01 2016	59.18	192.41	00 00	0	99.99	999.99	0	DBi	SVP

OP-10/LIB - Météo France database

WMO	Iridium IMEI	Dep. Lat	Dep. Lon	Region	Ship name	From	SST probe type & S/N	SST depth (m)	End
6400520	300034012486100	60.0	-30.8	North Atlantic	Reykjafoss	Halifax	YSI 46000	0.15	1
6400521	300034012874080	61.0	-30.0	North Atlantic	Reykjafoss	Halifax	YSI 46000	0.15	1
1400536	300234010302890	-15.0	65.0	Indian Ocean	Tamarin	La Reunion	YSI 46000	0.15	2
1400537	300234010409000	-11.4	70.0	Indian Ocean	Tamarin	La Reunion	YSI 46000	0.15	2
1400538	300234010303890	-8.4	75.0	Indian Ocean	Tamarin	La Reunion	YSI 46000	0.15	2
1400539	300234010300940	-4.8	80.0	Indian Ocean	Tamarin	La Reunion	YSI 46000	0.15	0
3300700	300224010428080	-45.0	-49.2	South Atlantic	Hartland Point	Southampton			1
3300698	300234010425180	-40.1	-43.4	South Atlantic	Hartland Point	Southampton			2
6200597	300234010301840	50.0	-35.9	North Atlantic	OOCL Belgium	Le Havre	YSI 46000	0.15	0
4400614	300234010305940	50.0	-37.0	North Atlantic	OOCL Belgium	Le Havre	YSI 46000	0.15	1
4400615	300234011023600	50.0	-44.0	North Atlantic	OOCL Belgium	Le Havre	YSI 46000	0.15	3
4400616	300234011813550	50.5	-47.9	North Atlantic	OOCL Belgium	Le Havre	YSI 46000	0.15	0
4400617	300234011023160	51.3	-52.0	North Atlantic	OOCL Belgium	Le Havre	YSI 46000	0.15	1
6200696	300234011917510	45.5	-35.0	North Atlantic	OOCL Norfolk	Southampton	YSI 46000	0.15	3
	300234011918170	45.8	-30.0	North Atlantic	OOCL Norfolk	Southampton	YSI 46000	0.15	2
4400768	300234011912520	45.2	-44.0	North Atlantic	OOCL Norfolk	Southampton	YSI 46000	0.15	2
4400609	300234010821540	44.9	-52.0	North Atlantic	OOCL Norfolk	Southampton	YSI 46000	0.15	0
4400767	300234011919510	45.1	-48.0	North Atlantic	OOCL Norfolk	Southampton	YSI 46000	0.15	
6200697	300234011020160	40.0	-31.0	North Atlantic	Milan Express	Fos-sur-Mer	YSI 46000	0.15	2
4400625	300234011502100	53.0	-44.0	North Atlantic	Reykjafoss	Halifax	YSI 46000	0.15	2
4400549	300234011025170	58.8	-36.0	North Atlantic	Reykjafoss	Halifax	YSI 46000	0.15	
4400551	300234011027150	41.6	-43.0	North Atlantic	Milan Express	Fos-sur-Mer	YSI 46000	0.15	2
4400610	300234011028150	57.3	-39.0	North Atlantic	Reykjafoss	Halifax	YSI 46000	0.15	0
4400747	300234011029160	40.7	-40.5	North Atlantic	Milan Express	Fos-sur-Mer	YSI 46000	0.15	1
4400620	300234011022170	-38.0	-32.0	North Atlantic	Milan Express	Fos-sur-Mer	YSI 46000	0.15	1
6400522	300234011029150	60.1	-32.7	North Atlantic	Reykjafoss	Halifax	YSI 46000	0.15	
6200519	300034013114260	45.0	-29.0	North Atlantic	OOCL Nagoya	Southampton	YSI 46000	0.15	1
6200520	300034013611180	44.6	-32.0	North Atlantic	OOCL Nagoya	Southampton	YSI 46000	0.15	
6200518	300234011024270	41.0	-25.0	North Atlantic	Lisbon Express	Brest	YSI 46000	0.15	1

SVP Log | SVP-B Log | SVP-BS Log | SVP-BTC Log | Versions

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OP-10/LIB – JCOMMOPS database

WMO	TELECOM ID	TELECOM	PTFM NAME	PTFM FAMILY	PTFM TYPE	CONTACT NAME	EMAIL	PROGRAM
5300949	4873	ARGOS	SVP_METOCEAN	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
5300550	4877	ARGOS	SVP_METOCEAN	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
4800731	5300	ARGOS	ICEX	ICE_BUOYS	ICEBUOY	Chris Marshall	chris.marshall@ec.gc.c	EC-IABP
4800507	5315	ARGOS	ICEX	ICE_BUOYS	ICEBUOY	Chris Marshall	chris.marshall@ec.gc.c	EC-IABP
4800508	5318	ARGOS	ICEX	ICE_BUOYS	ICEBUOY	Chris Marshall	chris.marshall@ec.gc.c	EC-IABP
5600523	8098	UNKNOW	DB_METOCEAN	DB	DB			DBCP
5300555	8098	ARGOS	SVP_METOCEAN	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
5300552	8099	ARGOS	SVP_METOCEAN	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
4800505	16791	UNKNOW	DB	DB	DB	Chris Marshall	chris.marshall@ec.gc.c	EC DB
4100725	30171	ARGOS	DB	DB	DB			DBCP
5100809	34127	ARGOS	SVP_MARLIN-YUG	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
5100735	34129	ARGOS	SVP_MARLIN-YUG	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
5600522	34134	UNKNOW	DB_METOCEAN	DB	DB			DBCP
5100867	34134	ARGOS	SVP_MARLIN-YUG	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
5100902	34135	ARGOS	SVP_MARLIN-YUG	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
1500917	34138	ARGOS	SVP_MARLIN-YUG	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
600512	34148	ARGOS	SVP_MARLIN-YUG	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
5300947	34149	ARGOS	SVP_MARLIN-YUG	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
5600506	34150	ARGOS	SVP_MARLIN-YUG	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
5600938	34164	ARGOS	SVP_TECHNOCEAN	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB
5600940	34166	ARGOS	SVP_TECHNOCEAN	DB	SVP	Joel Cabrie	j.cabrie@bom.gov.au	BOM DB

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OP-20/TR-4 – Technical Report

- Review of past and present practice for drifter SST
- Workshop outcomes: consensus on future best practice
- Journal article
- Recommendations for further work
  - Other platforms
  - Other EOVs

OP-30/STM - Workshop at Scripps

Measurement uncertainty and traceability: issues to consider

- Sensor accuracy
  - Calibrated or batch-qualified?
    - Before or after integration into drifter?
    - What errors are introduced in signal processing and message formatting?
  - Traceability to national standards
  - Sensor drift
  - Post-calibration seldom possible
- Positional and temporal accuracy
  - Errors in the above look like sensor errors to the analyst
- Depth uncertainty
  - 'SST' is a function of depth
  - How does the depth of the sensor vary?
  - How is the sensor output sampled/averaged?
- What errors are introduced in downstream processing and archival?

Workshop outcomes

- Acceptance in principle of the GHRSST Standard for drifter SST implementation and reporting, subject to its eventual validation as a useful standard;
- Acceptance in principle of the requirement for SI traceability of drifter SST;
- Endorsement of the efforts to harmonize and publish the available drifter metadata dataset;
- Agreement that mechanisms must be found to maintain the harmonized dataset in the future;
- Request to the satellite community to facilitate access to satellite SST data by the drifter community;
- Agreement that a working group be established to take forward the above and to further develop standards and best practice;
- Agreement to reconvene just ahead of the next DBCP session (Brest, November 2017)

Next steps

- Evaluate usefulness of ESA study
- Implement EUMETSAT 100-drifter proposal
- Consider extension to other EOVs
  - Wave spectral data

- Questions, comments?

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