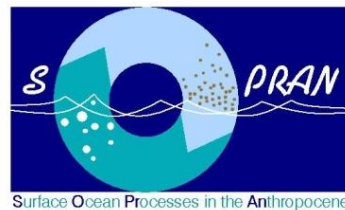
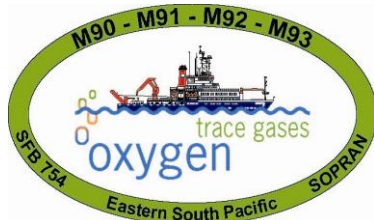


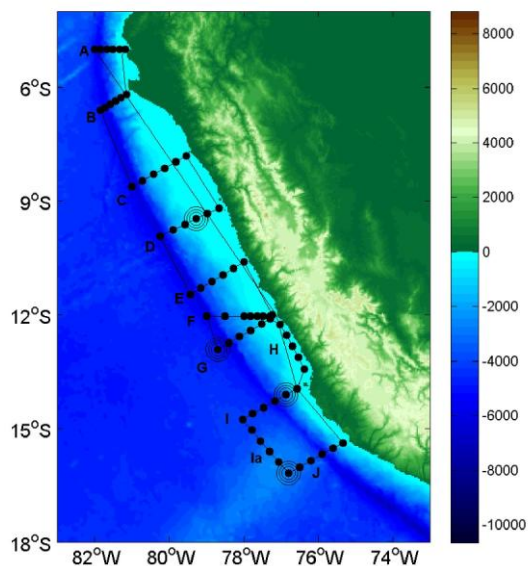
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Short Cruise Report
R/V METEOR M91
Callao – Callao (Peru)
01 Dec – 26 Dec 2012

Chief Scientist: PD Dr. Hermann W. Bange
Captain: Thomas Wunderlich



Objectives

The Meteor cruise M91 was conducted as part of the SOPRAN (Surface Ocean Processes in the Anthropocene) project. M91 was designed as an integrated biogeochemical study on the upwelling off Peru in order to assess its importance for the emissions of various climate-relevant atmospheric trace gases and tropospheric chemistry. The major objectives of M91 were

- (i) to estimate the emissions of trace gases such as nitrous oxide (N_2O), carbon dioxide (CO_2), halocarbons and other trace gases from and the deposition of aerosols to the Peruvian upwelling region,
- (ii) to investigate the role of the seasurface microlayer for the exchange of trace gases across the ocean/atmosphere interface and
- (iii) to investigate the role of the coastal upwelling and the underlying oxygen minimum zone off Peru as a source of trace gases.

Narrative

Meteor left the port of Callao on 01 Dec 2012. After steaming north for one day, a CTD/RO test station was performed at $09^{\circ} 3.61' S$, $79^{\circ} 58.82' W$ on 02 Dec. 2012. The first W/E transect at $5^{\circ}S$ was reached on 3 Dec 2012 where regular station work began. Each station usually consisted of one or two CTD/RO casts followed by a microstructure cast and sampling with the zodiac. A series of transects perpendicular to the coast were occupied while moving from north towards south. In total nine W/E transects (A-G, I, J) and two N/S transects (H and Ia), parallel to the coast, were occupied (see Figure 1 below). Additional to the regular sampling stations, five 24h-stations were performed during the transects D, G, I and J (see Figure 1 below). The work program of the 24h-stations in general included four CTD casts, four microstructure casts and several zodiac sampling trips. The anticyclonic eddy located off the coast and centered at about $16^{\circ}30'S$, $76^{\circ}30'W$, which was sampled by Lothar Stramma during Meteor cruise M90 as well, was sampled during the transects Ia and J from 20 to 23 Dec 2012. Station work was finished on 23 Dec in the evening. After the last station at $15^{\circ} 22.76' S$, $75^{\circ} 19.91' W$ Meteor headed towards Callao, where the cruise M91 was finished in the morning of 26 December 2012. In total 98 CTD/RO stations, 55 microstructure casts and 45 sampling trips with the zodiac were performed. Moreover, continuous underway atmospheric and surface ocean sampling and measurements were performed along the entire cruise track.

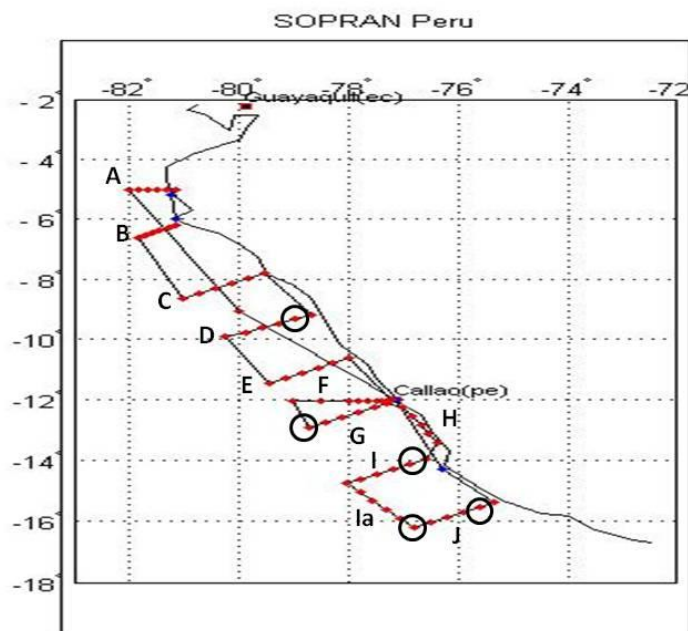


Figure 1: Cruise track with locations of stations (red dots) of Meteor M91. Transects A-J are indicated as well as the locations of the 24h station (circles)

Acknowledgements

We would like to thank Captain Th. Wunderlich, his officers and crew of R/V METEOR for their support of our measurement program and for creating a very friendly and professional work atmosphere on board. The ship time of METEOR was provided by the German Science Foundation (DFG) within the core program METEOR/MERIAN. Financial support for M91 was provided by the German BMBF joint project SOPRAN (Surface Ocean Processes in the Anthropocene: www.sopran.pangaea.de).

We also benefited from the participations of Avy Bernales, Georgina Flores, Violeta Leon from the Instituto del Mar del Peru (IMARPE), Callao, who performed own measurements and helped with the sampling. We gratefully acknowledge their support.

We thank the authorities of Peru for the permission to work in their territorial waters.

List of M91 participants

1. Hermann Bange	Chem. Oceanogr./ <i>Chief Scientist</i>	GEOMAR
2. Avy Bernales	Biol. Oceanogr. / Observer	IMARPE
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4. Violeta Leon	Chem. Oceanogr. / Observer	IMARPE
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18. Jon Roa	Biol. Oceanogr. / SML	GEOMAR
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20. Bettina Derstroff	Air Chemistry / VOC, OVOC	MPI CH
21. Wei Song	Chem. Oceanogr. / VOC	MPI CH
22. Patrick Veres	Air Chemistry / VOC	MPI CH
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24. Ingo Weinberg	Chem. Oceanogr. / Halocarb.	U Hamburg
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29. Annie Bourbonnais	Mar. Microbiol. / N isotope	U Mass
30. Bernd Frey	Meteorology	DWD

MSS, Microstructure of upper ocean

SML, surface microlayer

VOC, OVOC, volatile organic compounds, oxygenated volatile compounds

DMS, dimethylsulphide

List of PIs involved in M91

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IMARPE	Instituto del Mar del Peru, Callao, Peru
LDEO	Lamont-Doherty Earth Observatory, Palisades, NY, USA
MPI CH	Max-Planck-Institut für Chemie, Mainz, Germany
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TUB	TU Braunschweig, Germany
U Bremen	Universität Bremen, Germany
UEA	School of Environmental Sciences, Univ. East Anglia, Norwich, UK
U Hamburg	Universität Hamburg, Germany
U Heidelberg	Universität Heidelberg, Germany
U Kiel	Universität Kiel, Germany
U Mass	University of Massachusetts, Dartmouth, MA, USA

Overview of the measurement program

WP Nitrous oxide / short-lived N compounds / N processes

(PIs Hermann Bange, Carolin Löscher)

- Underway dissolved N₂O, CO and CO₂
- Depth profiles of diss. CH₄
- Depth profiles of N₂O, hydroxylamine (NH₂OH), hydrazine (N₂H₄)
- Depth profiles of DNA/RNA, flow cytometry
- N₂O and NH₂OH production rates
- N₂ fixation rates

WP Carbonate system

(PI Michelle Graco)

- pH, DIC, total alkalinity chlorophyll
- Ca, Si isotopes
- Utermöhl samples
- Chlorophyll
- Phytoplankton amount
- Coccolithophorid diversity

WP Microstructure

(PI Marcus Dengler)

- Microstructure profiling system
- Conductivity-temperature-depth (CTD) profiles (incl. fluorescence sensor)
- ADCP measurements

WP Upwelling velocity

(PI Reiner Steinfeldt)

- Helium isotope ratio (³He/⁴He)

WP – Halocarbons, Radio soundings, Pigments

(PIs Birgit Quack, Kirsten Krüger, Harald Biester, Elliot Atlas)

- Underway and depth profiles of diss. halocarbons
- Atmospheric halocarbons and other trace gases (canister sampling)
- Underway and depth profiles of diss. oxygenated/reduced inorganic and particulate organic halogens
- Phytoplankton pigments
- Flow cytometry
- DNA
- Rain rate, rain drop size, rain amount
- Radio soundings (humidity, air temp., wind speed)

WP Halocarbon isotopes and molecular biology

(PIs R. Seifert, Detlef Schulz-Bull, Klaus Jürgens, Falk Pollehne)

- Carbon isotopic composition of atm., diss. and particulate halocarbons
- Atmospheric and dissolved other trace gases (CFCs, alkanes, etc.)
- DNA

WP Surface Microlayer

(PI Anja Engel)

- Dissolved and total organic carbon (DOC and TOC)
- Total nitrogen and total dissolved nitrogen (TN and TDN)
- CDOM, fluorescent DOM
- Total and dissolved combined carbohydrates
- Total and dissolved hydrolysable amino acids
- Bacterial cells number, phytoplankton cells number
- Marine gels (TEP, CSP)

WP DMS

(PI Cathleen Zindler)

- Underway and depths profiles of diss. DMS, diss./partic. DMSP, diss./partic. DMSO

WP Volatile Organic Compounds (VOCs) and oxygenated VOCs

(PI Jonathan Williams)

- Continuous atmospheric VOCs and OVOCs (methanol, acetone, DMS, isoprene, terpenes etc.)
- Atmospheric O₃
- Depth profiles of diss. VOC and OVOCs (isoprene, DMS, etc.)

WP Reactive Halogen Species

(PI Ulrich Platt)

- Atmospheric IO, BrO, NO₂, O₃, O₄, formaldehyde, glyoxal
- Atmospheric O₃

WP Air-sea Exchange and CO₂ Fluxes

(PIs Bernd Jähne, Christopher Zappa)

- Local heat transfer velocities
- Sea surface roughness (mean square slope), wave heights, wave frequency spectra
- Measurements of 2D slope, height maps of the sea surface, wavenumber/frequency spectra of waves
- CO₂ eddy covariance fluxes

WP Aerosols

(PI Alex Baker)

- Aerosol bulk composition

WP Nitrogen Isotopes and N₂/Ar

(PI Mark Altabet)

- Dissolved inorganic N (DIN) isotopes: NO₃⁻ and NO₂⁻ δ¹⁵N and δ¹⁸O, NH₄⁺ δ¹⁵N and dissolved organic N (DON) δ¹⁵N
- N₂/Ar and δ¹⁵N₂
- N₂O: δ¹⁵N and δ¹⁸O, and ¹⁵N site preference
- Near-surface POM δ¹⁵N

Station List M91

Station List: CTD/RO, MSS, Zodiac

Stat#-Cast#	Transect	Date, UTC	Time, UTC	Position, Lat	Position Lon	Water depth, m	Gear	CTD/RO depth, m	Remarks
ME910/1712-1		02/12/2012	13:13	9° 3,61' S	79° 58,82' W	708.1	CTD/RO	404	test station
ME910/1712-2		02/12/2012	13:44	9° 3,62' S	79° 58,76' W	583.4	MSS		test station
ME910/1713-1	A	03/12/2012	12:23	5° 0,01' S	82° 0,01' W	5289.5	CTD/RO	2005	
ME910/1713-2	A	03/12/2012	13:51	5° 0,11' S	81° 59,98' W	5288.8	MSS		
ME910/1713-3	A	03/12/2012	15:44	4° 59,99' S	82° 0,02' W	5290	CTD/RO	199	
ME910/1713-4	A	03/12/2012	16:07	4° 59,98' S	82° 0,02' W	5289.2	ZODIAK		
ME910/1714-1	A	03/12/2012	18:34	5° 0,00' S	81° 49,81' W	4535.7	CTD/RO	2006	
ME910/1715-1	A	03/12/2012	21:44	5° 0,01' S	81° 40,23' W	2837.6	CTD/RO	2008	
ME910/1715-2	A	03/12/2012	23:11	5° 0,02' S	81° 40,21' W	2828.9	MSS		
ME910/1715-3	A	04/12/2012	01:03	5° 0,00' S	81° 40,22' W	2834.6	CTD/RO	217	
ME910/1716-1	A	04/12/2012	03:19	4° 59,98' S	81° 30,02' W	1494.6	CTD/RO	1157	
ME910/1717-1	A	04/12/2012	06:03	5° 0,01' S	81° 19,81' W	117.5	CTD/RO	107	
ME910/1717-2	A	04/12/2012	06:41	5° 0,03' S	81° 19,81' W	115.9	MSS		
ME910/1718-1	A	04/12/2012	09:02	5° 0,00' S	81° 10,19' W	27	CTD/RO	25	
ME910/1719-1	B	04/12/2012	16:13	6° 11,40' S	81° 8,41' W	313.6	CTD/RO	302	
ME910/1719-2	B	04/12/2012	16:43	6° 11,52' S	81° 8,44' W	333.5	MSS		
ME910/1719-3	B	04/12/2012	18:06	6° 13,72' S	81° 9,24' W	1201.7	ZODIAK		
ME910/1720-1	B	04/12/2012	20:17	6° 16,80' S	81° 17,41' W	1829.3	CTD/RO	1756	
ME910/1720-2	B	04/12/2012	21:31	6° 16,80' S	81° 17,41' W	1828.5	ZODIAK		
ME910/1721-1	B	04/12/2012	23:41	6° 21,92' S	81° 25,81' W	2644.1	CTD/RO	1988	
ME910/1721-2	B	05/12/2012	01:05	6° 22,02' S	81° 25,84' W	2652	MSS		
ME910/1721-3	B	05/12/2012	03:03	6° 21,93' S	81° 25,81' W	2643.2	CTD/RO	152	
ME910/1722-1	B	05/12/2012	05:10	6° 26,99' S	81° 34,20' W	3662.6	CTD/RO	2006	
ME910/1723-1	B	05/12/2012	08:27	6° 32,39' S	81° 42,59' W	5669	CTD/RO	2009	
ME910/1724-1	B	05/12/2012	11:11	6° 37,18' S	81° 49,79' W	5398	CTD/RO	2000	
ME910/1724-2	B	05/12/2012	12:35	6° 37,20' S	81° 49,80' W	5393.5	MSS		
ME910/1724-3	B	05/12/2012	14:30	6° 37,19' S	81° 49,81' W	5396.4	CTD/RO	152	
ME910/1724-4	B	05/12/2012	14:51	6° 37,19' S	81° 49,81' W	5396.7	ZODIAK		
ME910/1725-1	C	06/12/2012	02:18	8° 37,82' S	80° 59,97' W	5954.9	CTD/RO	2008	

ME910/1725-2	C	06/12/2012	03:43	8° 37,87' S	81° 0,02' W	5949.4	MSS	
ME910/1725-3	C	06/12/2012	05:46	8° 37,81' S	81° 0,02' W	5951.8	CTD/RO	150
ME910/1726-1	C	06/12/2012	09:50	8° 28,18' S	80° 42,61' W	2984	CTD/RO	2008
ME910/1727-1	C	06/12/2012	14:27	8° 18,61' S	80° 24,59' W	854.1	CTD/RO	843
ME910/1727-2	C	06/12/2012	15:18	8° 18,67' S	80° 24,62' W	856.3	MSS	
ME910/1727-3	C	06/12/2012	17:03	8° 18,61' S	80° 24,61' W	856.9	CTD/RO	150
ME910/1727-4	C	06/12/2012	17:31	8° 18,62' S	80° 24,61' W	854.7	ZODIAK	
ME910/1728-1	C	06/12/2012	21:33	8° 8,46' S	80° 7,20' W	171.9	ZODIAK	
ME910/1728-2	C	06/12/2012	22:14	8° 8,40' S	80° 7,19' W	171.7	CTD/RO	150
ME910/1729-1	C	07/12/2012	01:57	7° 58,79' S	79° 49,80' W	137.5	CTD/RO	131
ME910/1729-2	C	07/12/2012	02:24	7° 58,82' S	79° 49,82' W	138.2	MSS	
ME910/1730-1	C	07/12/2012	06:25	7° 49,66' S	79° 33,23' W	55.8	CTD/RO	35
ME910/1731-1	D	07/12/2012	15:20	9° 11,39' S	78° 40,21' W	66.3	CTD/RO	58
ME910/1732-1	D	07/12/2012	19:07	9° 19,79' S	78° 58,19' W	121.8	CTD/RO	110
ME910/1732-2	D	07/12/2012	19:31	9° 19,79' S	78° 58,19' W	121.8	ZODIAK	
ME910/1733-1	D	07/12/2012	23:27	9° 28,80' S	79° 16,80' W	156.1	CTD/RO	151
ME910/1733-2	D	07/12/2012	23:56	9° 28,81' S	79° 16,81' W	155.9	MSS	
ME910/1733-3	D	08/12/2012	03:58	9° 29,52' S	79° 17,07' W	156.5	MSS	
ME910/1733-4	D	08/12/2012	08:03	9° 30,24' S	79° 17,39' W	156.4	MSS	
ME910/1733-5	D	08/12/2012	10:49	9° 31,26' S	79° 17,89' W	154.2	ZODIAK	
ME910/1733-6	D	08/12/2012	11:33	9° 31,26' S	79° 17,89' W	156	CTD/RO	150
ME910/1733-7	D	08/12/2012	11:58	9° 31,27' S	79° 17,89' W	155.3	MSS	
ME910/1733-8	D	08/12/2012	16:00	9° 31,85' S	79° 18,16' W	153.8	MSS	
ME910/1733-9	D	08/12/2012	19:15	9° 32,75' S	79° 18,43' W	155.2	ZODIAK	
ME910/1733-10	D	08/12/2012	20:06	9° 32,81' S	79° 18,44' W	154.9	MSS	
ME910/1733-11	D	08/12/2012	20:45	9° 33,67' S	79° 18,77' W	153.7	ZODIAK	
ME910/1733-12	D	08/12/2012	22:30	9° 33,68' S	79° 18,78' W	153.8	MSS	
ME910/1733-13	D	08/12/2012	23:14	9° 34,15' S	79° 19,06' W	152.8	CTD/RO	150
ME910/1734-1	D	09/12/2012	02:23	9° 37,19' S	79° 34,80' W	393.2	CTD/RO	388
ME910/1735-1	D	09/12/2012	06:21	9° 46,18' S	79° 52,83' W	1638.2	CTD/RO	1606
ME910/1736-1	D	09/12/2012	11:25	9° 55,82' S	80° 13,79' W	6342.9	CTD/RO	2006
ME910/1736-2	D	09/12/2012	12:58	9° 55,82' S	80° 13,83' W	6342.9	MSS	
ME910/1736-3	D	09/12/2012	14:38	9° 57,28' S	80° 14,77' W	6338.1	CTD/RO	198
ME910/1736-4	D	09/12/2012	15:05	9° 57,28' S	80° 14,77' W	6337	ZODIAK	
ME910/1737-1	E	10/12/2012	01:26	11° 28,20' S	79° 25,80' W	5890	CTD/RO	2005
ME910/1737-2	E	10/12/2012	02:48	11° 28,24' S	79° 25,79' W	5891.2	MSS	
ME910/1737-3	E	10/12/2012	04:43	11° 29,88' S	79° 25,50' W	5878.9	CTD/RO	125

ME910/1738-1	E	10/12/2012	08:06	11° 17,39' S	79° 8,39' W	3950.4	CTD/RO	2008
ME910/1739-1	E	10/12/2012	12:45	11° 7,19' S	78° 51,00' W	2262.3	CTD/RO	2006
ME910/1739-2	E	10/12/2012	14:13	11° 7,25' S	78° 50,97' W	2260.8	MSS	
ME910/1739-3	E	10/12/2012	15:25	11° 8,18' S	78° 50,25' W	2245.9	CTD/RO	151
ME910/1739-4	E	10/12/2012	15:49	11° 8,18' S	78° 50,25' W	2246.5	ZODIAK	
ME910/1740-1	E	10/12/2012	19:45	10° 56,99' S	78° 33,59' W	1078.2	CTD/RO	1065
ME910/1740-2	E	10/12/2012	20:36	10° 56,99' S	78° 33,60' W	1079.3	ZODIAK	
ME910/1741-1	E	11/12/2012	00:33	10° 46,81' S	78° 16,20' W	310.4	CTD/RO	301
ME910/1741-2	E	11/12/2012	01:05	10° 46,82' S	78° 16,21' W	309.9	MSS	
ME910/1742-1	E	11/12/2012	05:20	10° 37,50' S	78° 0,29' W	107.8	CTD/RO	99
ME910/1743-1	F	11/12/2012	15:46	12° 0,49' S	77° 13,84' W	56.7	CTD/RO	52
ME910/1743-2	F	11/12/2012	16:04	12° 0,49' S	77° 13,84' W	55.5	ZODIAK	
ME910/1744-1	F	11/12/2012	17:43	12° 3,08' S	77° 18,21' W	100.7	CTD/RO	92
ME910/1744-2	F	11/12/2012	18:05	12° 3,08' S	77° 18,21' W	101.4	ZODIAK	
ME910/1745-1	F	11/12/2012	19:24	12° 2,39' S	77° 22,21' W	115.9	CTD/RO	109
ME910/1745-2	F	11/12/2012	19:46	12° 2,39' S	77° 22,21' W	116.6	ZODIAK	
ME910/1746-1	F	11/12/2012	21:29	12° 2,39' S	77° 29,41' W	142	CTD/RO	139
ME910/1746-2	F	11/12/2012	21:54	12° 2,42' S	77° 29,42' W	142.2	MSS	
ME910/1746-3	F	11/12/2012	22:30	12° 2,95' S	77° 29,65' W	143.8	ZODIAK	
ME910/1747-1	F	12/12/2012	00:30	12° 2,39' S	77° 39,00' W	180.3	CTD/RO	170
ME910/1748-1	F	12/12/2012	02:48	12° 2,37' S	77° 49,21' W	822.7	CTD/RO	822
ME910/1748-2	F	12/12/2012	03:37	12° 2,40' S	77° 49,19' W	809.7	MSS	
ME910/1749-1	F	12/12/2012	07:23	12° 2,39' S	77° 58,80' W	1708.1	CTD/RO	1695
ME910/1749-2	F	12/12/2012	08:44	12° 2,41' S	77° 58,80' W	1707.5	MSS	
ME910/1750-1	F	12/12/2012	14:44	12° 2,38' S	78° 30,02' W	3078.9	CTD/RO	2008
ME910/1750-2	F	12/12/2012	16:07	12° 2,44' S	78° 30,01' W	3078.3	MSS	
ME910/1750-3	F	12/12/2012	17:37	12° 3,79' S	78° 29,65' W	3069.4	ZODIAK	
ME910/1751-1	F	12/12/2012	23:01	12° 2,42' S	79° 0,05' W	6072.4	CTD/RO	2006
ME910/1751-2	F	13/12/2012	00:34	12° 2,41' S	79° 0,02' W	6080.4	MSS	
ME910/1751-3	F	13/12/2012	02:22	12° 4,13' S	79° 0,26' W	5977.1	CTD/RO	174
ME910/1752-1	G	13/12/2012	08:24	12° 55,21' S	78° 42,02' W	5044.4	CTD/RO	5012
ME910/1752-2	G	13/12/2012	11:34	12° 55,20' S	78° 42,00' W	5039.7	ZODIAK	
ME910/1752-3	G	13/12/2012	12:04	12° 55,23' S	78° 42,00' W	5039.2	MSS	
ME910/1752-4	G	13/12/2012	13:33	12° 56,94' S	78° 41,44' W	4949.6	CTD/RO	174
ME910/1752-5	G	13/12/2012	14:05	12° 56,96' S	78° 41,43' W	4950.4	ZODIAK	
ME910/1752-6	G	13/12/2012	18:38	12° 57,03' S	78° 41,43' W	4946.6	MSS	
ME910/1752-7	G	13/12/2012	20:08	12° 59,80' S	78° 40,98' W	4962.8	ZODIAK	

ME910/1752-8	G	13/12/2012	21:21	12° 55,20' S	78° 42,03' W	5035.6	CTD/RO	2006
ME910/1752-9	G	13/12/2012	22:41	12° 55,20' S	78° 42,03' W	5047.3	ZODIAK	
ME910/1752-10	G	14/12/2012	00:30	12° 55,23' S	78° 42,03' W	5036.7	MSS	
ME910/1752-12	G	14/12/2012	07:21	12° 57,73' S	78° 42,63' W	4960.2	CTD/RO	2005
ME910/1753-1	G	14/12/2012	12:00	12° 44,99' S	78° 24,01' W	5940	CTD/RO	2007
ME910/1753-2	G	14/12/2012	13:19	12° 45,00' S	78° 24,01' W	5943.6	ZODIAK	
ME910/1754-1	G	14/12/2012	17:21	12° 34,79' S	78° 6,61' W	3052	CTD/RO	2010
ME910/1754-2	G	14/12/2012	18:57	12° 34,79' S	78° 6,61' W	3046.9	ZODIAK	
ME910/1755-1	G	14/12/2012	22:56	12° 25,21' S	77° 48,62' W	1100.9	ZODIAK	
ME910/1755-2	G	14/12/2012	23:43	12° 25,21' S	77° 48,61' W	1102.2	CTD/RO	1088
ME910/1755-3	G	15/12/2012	00:42	12° 25,23' S	77° 48,60' W	1099.7	MSS	
ME910/1755-4	G	15/12/2012	02:24	12° 26,49' S	77° 49,03' W	1158.4	CTD/RO	181
ME910/1756-1	G	15/12/2012	06:28	12° 15,01' S	77° 31,21' W	202	CTD/RO	194
ME910/1756-2	G	15/12/2012	07:06	12° 15,03' S	77° 31,21' W	202.5	MSS	
ME910/1757-1	G	15/12/2012	10:02	12° 6,93' S	77° 17,50' W	96	CTD/RO	88
ME910/1758-1	H	15/12/2012	12:55	12° 16,31' S	77° 1,14' W	70.7	CTD/RO	67
ME910/1758-2	H	15/12/2012	13:13	12° 16,31' S	77° 1,14' W	70.2	ZODIAK	
ME910/1759-1	H	15/12/2012	17:26	12° 33,01' S	76° 50,39' W	104.3	CTD/RO	98
ME910/1759-2	H	15/12/2012	17:50	12° 33,04' S	76° 50,37' W	103.4	MSS	
ME910/1759-3	H	15/12/2012	18:28	12° 33,95' S	76° 50,25' W	104.5	ZODIAK	
ME910/1760-1	H	16/12/2012	12:47	12° 50,41' S	76° 40,80' W	101.9	CTD/RO	98
ME910/1760-2	H	16/12/2012	13:09	12° 50,44' S	76° 40,78' W	102	MSS	
ME910/1760-3	H	16/12/2012	13:48	12° 51,27' S	76° 40,66' W	108	ZODIAK	
ME910/1761-1	H	16/12/2012	17:36	13° 8,42' S	76° 31,81' W	98.4	CTD/RO	90
ME910/1761-2	H	16/12/2012	17:58	13° 8,40' S	76° 31,80' W	97.3	ZODIAK	
ME910/1761-3	H	16/12/2012	18:30	13° 8,40' S	76° 31,80' W	96.8	ZODIAK	
ME910/1762-1	H	16/12/2012	22:44	13° 25,78' S	76° 22,19' W	85.4	ZODIAK	
ME910/1762-2	H	16/12/2012	23:17	13° 25,79' S	76° 22,20' W	86	CTD/RO	81
ME910/1762-3	H	16/12/2012	23:38	13° 25,81' S	76° 22,24' W	86.3	MSS	
ME910/1763-1	I	17/12/2012	03:33	13° 56,96' S	76° 34,23' W	252.6	CTD/RO	245
ME910/1763-2	I	17/12/2012	04:02	13° 57,04' S	76° 34,22' W	254.9	MSS	
ME910/1764-1	I	17/12/2012	08:34	14° 7,23' S	76° 52,23' W	0	CTD/RO	2252
ME910/1764-2	I	17/12/2012	10:16	14° 7,27' S	76° 52,26' W	2270.9	MSS	
ME910/1764-3	I	17/12/2012	11:49	14° 8,77' S	76° 53,89' W	2622.4	CTD/RO	200
ME910/1764-4	I	17/12/2012	12:11	14° 8,77' S	76° 53,89' W	2624.1	ZODIAK	
ME910/1764-5	I	17/12/2012	16:02	14° 8,79' S	76° 53,93' W	2630.5	MSS	
ME910/1764-6	I	17/12/2012	17:38	14° 11,11' S	76° 55,95' W	3108	ZODIAK	

ME910/1764-7	I	17/12/2012	18:05	14° 11,10' S	76° 55,99' W	3112.1	ZODIAK		
ME910/1764-8	I	17/12/2012	20:33	14° 11,10' S	76° 55,99' W	3114.4	CTD/RO	2007	
ME910/1764-9	I	17/12/2012	22:00	14° 11,10' S	76° 55,99' W	3113.1	ZODIAK		
ME910/1764-10	I	17/12/2012	22:30	14° 11,11' S	76° 56,01' W	3120.1	MSS		
ME910/1764-11	I	18/12/2012	04:00	14° 12,57' S	76° 57,42' W	3415.1	MSS		
ME910/1764-12	I	18/12/2012	07:03	14° 14,36' S	76° 58,78' W	3677.5	CTD/RO	2009	
ME910/1765-1	I	18/12/2012	12:00	14° 16,79' S	77° 10,21' W	6545.8	CTD/RO	2007	
ME910/1765-2	I	18/12/2012	13:20	14° 16,79' S	77° 10,21' W	4707.6	ZODIAK		
ME910/1766-1	I	18/12/2012	17:27	14° 26,99' S	77° 28,23' W	4621.6	CTD/RO	2007	
ME910/1766-2	I	18/12/2012	18:58	14° 27,07' S	77° 28,33' W	4624.3	MSS		
ME910/1766-3	I	18/12/2012	20:31	14° 29,23' S	77° 29,95' W	4604.2	CTD/RO	175	
ME910/1766-4	I	18/12/2012	20:56	14° 29,23' S	77° 29,95' W	4596.7	ZODIAK		
ME910/1767-1	I	19/12/2012	00:23	14° 37,20' S	77° 45,60' W	4271.5	CTD/RO	2006	failure: bottles not closed
ME910/1767-2	I	19/12/2012	02:19	14° 37,20' S	77° 45,60' W	4276.7	CTD/RO	2007	
ME910/1768-1	I	19/12/2012	06:55	14° 46,20' S	78° 1,80' W	4177.5	CTD/RO	2007	
ME910/1768-2	I	19/12/2012	08:30	14° 46,40' S	78° 1,94' W	4175.1	MSS		
ME910/1768-3	I	19/12/2012	10:05	14° 48,04' S	78° 2,65' W	4142.7	CTD/RO	176	
ME910/1769-1	Ia	19/12/2012	13:53	15° 2,84' S	77° 47,38' W	3955.4	CTD/RO	1003	
ME910/1769-2	Ia	19/12/2012	14:46	15° 2,93' S	77° 47,39' W	3969.4	MSS		
ME910/1769-3	Ia	19/12/2012	16:17	15° 4,18' S	77° 46,72' W	3958.9	ZODIAK		
ME910/1770-1	Ia	19/12/2012	20:35	15° 19,67' S	77° 32,08' W	3576.6	ZODIAK		
ME910/1770-2	Ia	19/12/2012	21:07	15° 19,68' S	77° 32,02' W	3591.5	CTD/RO	1002	
ME910/1770-3	Ia	19/12/2012	22:11	15° 19,70' S	77° 32,03' W	3576.1	MSS		
ME910/1770-4	Ia	19/12/2012	23:41	15° 21,20' S	77° 32,78' W	3588.1	CTD/RO	200	
ME910/1771-1	Ia	20/12/2012	03:30	15° 36,53' S	77° 18,07' W	3012.4	CTD/RO	1003	
ME910/1771-2	Ia	20/12/2012	04:16	15° 36,58' S	77° 18,06' W	3009.8	MSS		
ME910/1772-1	Ia	20/12/2012	09:40	15° 53,48' S	77° 3,45' W	2669.7	CTD/RO	1004	
ME910/1772-2	Ia	20/12/2012	10:21	15° 53,52' S	77° 3,45' W	2670	MSS		failure
ME910/1772-3	Ia	20/12/2012	10:58	15° 54,15' S	77° 3,56' W	2642.1	ZODIAK		
ME910/1772-4	Ia	20/12/2012	11:32	15° 54,21' S	77° 3,62' W	2643.6	MSS		
ME910/1773-1	J	20/12/2012	16:19	16° 10,71' S	76° 48,25' W	2843	MSS		
ME910/1773-2	J	20/12/2012	17:56	16° 9,49' S	76° 48,27' W	2827	CTD/RO	2013	
ME910/1773-3	J	20/12/2012	20:32	16° 9,38' S	76° 49,28' W	2810.4	CTD/RO	181	
ME910/1773-4	J	20/12/2012	23:33	16° 9,36' S	76° 49,47' W	2770.9	MSS		
ME910/1773-5	J	21/12/2012	04:00	16° 10,48' S	76° 48,46' W	2823.6	CTD/RO	--	stat. cancelled: heavy swell
ME910/1774-1	J	21/12/2012	19:40	16° 1,15' S	76° 30,14' W	3213.8	CTD/RO	2010	

ME910/1774-2	J	21/12/2012	21:15	16° 1,14' S	76° 30,73' W	3223.9	MSS	
ME910/1774-3	J	21/12/2012	22:55	16° 3,29' S	76° 31,43' W	3205.9	CTD/RO	203
ME910/1775-1	J	22/12/2012	02:35	15° 50,96' S	76° 12,08' W	3564.9	CTD/RO	2011
ME910/1775-2	J	22/12/2012	04:06	15° 50,99' S	76° 12,15' W	3563.8	MSS	
ME910/1775-3	J	22/12/2012	05:54	15° 52,49' S	76° 12,17' W	3544.1	CTD/RO	176
ME910/1776-1	J	22/12/2012	09:30	15° 41,40' S	75° 54,02' W	5105.1	CTD/RO	2009
ME910/1776-2	J	22/12/2012	10:58	15° 41,46' S	75° 54,01' W	6692.6	MSS	
ME910/1776-3	J	22/12/2012	12:23	15° 42,79' S	75° 53,97' W	7204.8	ZODIAK	
ME910/1776-4	J	22/12/2012	12:54	15° 42,79' S	75° 53,97' W	5061.9	CTD/RO	199
ME910/1777-1	J	22/12/2012	16:40	15° 31,17' S	75° 36,02' W	2230.9	CTD/RO	2010
ME910/1777-2	J	22/12/2012	18:05	15° 31,17' S	75° 36,01' W	2229.8	ZODIAK	
ME910/1777-3	J	22/12/2012	18:34	15° 31,19' S	75° 36,03' W	2233.6	MSS	
ME910/1777-4	J	22/12/2012	20:05	15° 32,44' S	75° 36,84' W	2546.9	CTD/RO	200
ME910/1777-5	J	22/12/2012	20:31	15° 32,44' S	75° 36,84' W	2546.4	ZODIAK	
ME910/1777-6	J	23/12/2012	00:31	15° 32,46' S	75° 37,36' W	2607.9	MSS	
ME910/1777-7	J	23/12/2012	04:30	15° 33,57' S	75° 37,76' W	2791.3	CTD/RO	2009
ME910/1777-8	J	23/12/2012	06:34	15° 33,65' S	75° 37,77' W	2793.5	MSS	
ME910/1777-9	J	23/12/2012	12:34	15° 35,19' S	75° 38,24' W	3137.7	MSS	
ME910/1777-10	J	23/12/2012	13:56	15° 36,42' S	75° 38,60' W	3375.6	ZODIAK	
ME910/1777-11	J	23/12/2012	14:57	15° 36,42' S	75° 38,60' W	3376.1	CTD/RO	2011
ME910/1778-1	J	23/12/2012	20:01	15° 22,76' S	75° 19,91' W	276.3	CTD/RO	270
ME910/1778-2	J	23/12/2012	20:39	15° 22,83' S	75° 20,04' W	268.7	MSS	
ME910/1778-3	J	23/12/2012	21:33	15° 23,64' S	75° 21,20' W	164.3	ZODIAK	
ME910/1778-4	J	23/12/2012	22:54	15° 23,40' S	75° 21,58' W	138.1	CTD/RO	133

Station List: Sampled parameters

Table Legend:

Nut. stands for dissolved nutrients (nitrat, nitrite, ammonium, silicate and phosphate)

- (1) U, Utermöhl; C, S, Ca and Si isotopes; DIC (diss. inorganic carbon); TA (total Alkalinity) by IMARPE
- (2) pH measurements by IMARPE
- (3) Helium isotope by U Bremen
- (4) VOCs by MPI Mainz
- (5) DMS, DMSP, DMSO by GEOMAR
- (6) N₂O by GEOMAR
- (7) N₂ fixation, N₂O production, NH₂OH production by U Kiel
- (8) C, CH₄; O, NH₂OH; H, N₂H₄ by GEOMAR
- (9) DIN isotopes (¹⁵N, ¹⁸O), DO¹⁵N, N₂O isotopomers, PO¹⁵N, N₂/Ar by U Mass.
- (10) DOM from CTD by GEOMAR
- (11) DOM in surface microlayer by GEOMAR
- (12) Chl.a, flow Cytometry by GEOMAR, U Kiel
- (13) DNA/RNA filtration by GEOMAR, U Kiel
- (14) Halocarbons by GEOMAR
- (15) inorganic halogens, POBr and POI by GEOMAR/TU Braunschweig
- (16) Halocarbons isotopes by U Hamburg/IOW

Stat#-Cast#	Tran- sect	Gear	CTD/RO m	Nut., O ₂	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
ME910/1713-1	A	CTD/RO	2005	X		X		X	X	X	X		X	X		X				
ME910/1713-3	A	CTD/RO	199	X		X	X	X	X	X	X		X	X		X				
ME910/1713-4	A	ZODIAK													X					
ME910/1714-1	A	CTD/RO	2006	X		X	X													
ME910/1715-1	A	CTD/RO	2008	X		X		X		X			X							
ME910/1715-3	A	CTD/RO	217	X		X	X	X	X	X			X				X			
ME910/1716-1	A	CTD/RO	1157	X		X	X													
ME910/1717-1	A	CTD/RO	107	X		X	X			X			X							
ME910/1718-1	A	CTD/RO	25	X		X	X													
ME910/1719-1	B	CTD/RO	302	X		X	X	X	X	X	X		X							
ME910/1719-3	B	ZODIAK													X					
ME910/1720-1	B	CTD/RO	1756	X		X	X							X						
ME910/1720-2	B	ZODIAK													X					

ME910/1756-1	G	CTD/RO	194	X	U	X	X		X		X		X		X			
ME910/1757-1	G	CTD/RO	88	X	U	X	X				X							
ME910/1758-1	H	CTD/RO	67	X		X	X		X		X	X						
ME910/1758-2	H	ZODIAK											X					
ME910/1759-1	H	CTD/RO	98	X		X	X	X	X	X	O	X		X		X		X
ME910/1759-3	H	ZODIAK											X					
ME910/1760-1	H	CTD/RO	98	X		X	X	X	X	X		X	X		X			
ME910/1760-3	H	ZODIAK											X					
ME910/1761-1	H	CTD/RO	90	X		X	X	X	X			X						X
ME910/1761-2	H	ZODIAK											X					
ME910/1761-3	H	ZODIAK											X					
ME910/1762-1	H	ZODIAK											X					
ME910/1762-2	H	CTD/RO	81	X		X	X	X	X	X	O	X		X	X	X	X	X
ME910/1763-1	I	CTD/RO	245	X		X	X	X	X			X		X				
ME910/1764-1	I	CTD/RO	2252	X		X		X	X	X		X	X		X			X
ME910/1764-3	I	CTD/RO	200	X		X	X	X		X		X	X					
ME910/1764-4	I	ZODIAK												X				
ME910/1764-6	I	ZODIAK							X									
ME910/1764-7	I	ZODIAK												X				
ME910/1764-8	I	CTD/RO	2007	X		X		X		X		X	X					X
ME910/1764-9	I	ZODIAK												X				
ME910/1764-12	I	CTD/RO	2009	X		X						X	X					X
ME910/1765-1	I	CTD/RO	2007	X		X	X	X	X			X	X		X			
ME910/1765-2	I	ZODIAK												X				
ME910/1766-1	I	CTD/RO	2007	X		X		X	X			X		X		X		X
ME910/1766-3	I	CTD/RO	175	X		X	X	X	X			X		X	X	X	X	X
ME910/1766-4	I	ZODIAK												X				
ME910/1767-1	I	CTD/RO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ME910/1767-2	I	CTD/RO	2007	X		X	X					X						
ME910/1768-1	I	CTD/RO	2007	X		X		X	X			X		X		X		
ME910/1768-3	I	CTD/RO	176	X		X	X		X	X		X				X		
ME910/1769-1	la	CTD/RO	1003	X		X		X	X			X	X		X	X	X	
ME910/1769-3	la	ZODIAK												X				
ME910/1770-1	la	ZODIAK												X				
ME910/1770-2	la	CTD/RO	1002	X		X	X	X	X	O	X							
ME910/1770-4	la	CTD/RO	200	X		X			X	X	O	X			X			
ME910/1771-1	la	CTD/RO	1003	X		X	X	X						X		X		

ME910/1772-1	la	CTD/RO	1004	X		X	X	X		X			X						
ME910/1772-3	la	ZODIAK												X					
ME910/1773-2	J	CTD/RO	2013	X		X	X		X		X	X	X						X
ME910/1773-3	J	CTD/RO	181	X		X			X		X	X	X						
ME910/1773-5	J	CTD/RO	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
ME910/1774-1	J	CTD/RO	2010	X		X			X				X						
ME910/1774-3	J	CTD/RO	203	X		X	X						X		X	X	X	X	
ME910/1775-1	J	CTD/RO	2011	X		X			X				X		X		X		
ME910/1775-3	J	CTD/RO	176	X		X	X						X		X	X	X	X	X
ME910/1776-1	J	CTD/RO	2009	X		X		X		X			X						
ME910/1776-3	J	ZODIAK												X	X				
ME910/1776-4	J	CTD/RO	199	X		X	X		X				X				X		
ME910/1777-1	J	CTD/RO	2010	X		X		X	X	X	X	X	X	X	X	X	X	X	X
ME910/1777-2	J	ZODIAK												X					
ME910/1777-4	J	CTD/RO	200	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
ME910/1777-5	J	ZODIAK												X					
ME910/1777-7	J	CTD/RO	2009	X		X							X		X				X
ME910/1777-10	J	ZODIAK							X										
ME910/1777-11	J	CTD/RO	2011	X		X		X					X	X	X	X	X	X	X
ME910/1778-1	J	CTD/RO	270	X		X	X	X	X	X			X		X	X	X	X	
ME910/1778-3	J	ZODIAK												X					
ME910/1778-4	J	CTD/RO	133	X		X			X				X						

Data and Sample Storage and Availability

The data were collected for the BMBF Verbundprojekt SOPRAN (Surface Ocean Processes in the Anthropocene). The SOPRAN data management is run by the Kiel Datamanagement Team (KDMT) at GEOMAR which organizes and supervises the storage and publication of SOPRAN data with a web-based multi-user system (portal). In a first phase data are only available to the project (i.e. M91) user groups. After a three year proprietary time the KDMT will publish M91 data by releasing them to national and international data archives such as PANGAEA (www.pangaea.de). The M91 data set will be released by 01 February 2016 at the latest. Digital object identifiers (DOIs) are automatically assigned to data sets archived in the PANGAEA Open Access library making them publically retrievable, citeable and reusable for the future. All M91 metadata are immediately available via from the GEOMAR portal: <https://portal.geomar.de/metadata/leg/show/316029>. In addition the GEOMAR portal provides a single downloadable KML formatted file (<https://portal.geomar.de/metadata/leg/kmlexport/316029>) which retrieves and combines up-to-date M91 related information and links to restricted data as well as to published data for visualization e.g. in GoogleEarth.