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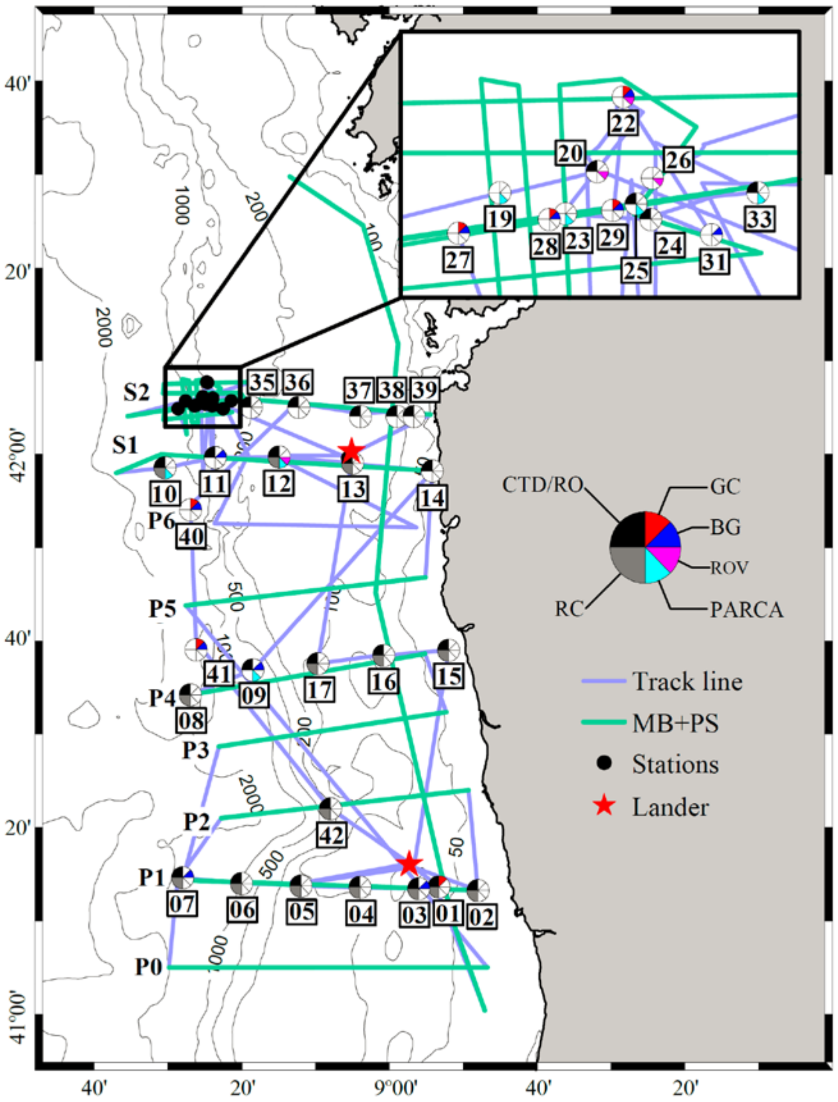
Short Cruise Report
RV METEOR – M110 GALIMOS

Vigo – Cadiz (Spain)
Sept. 15 – 30, 2014
Chief Scientist: Dr. Till J.J. Hanebuth
Captain: Rainer Hammacher



Objectives

The study area off the northwestern Iberian Peninsula is a representative example for the eastern Atlantic continental margin. The oceanographic and sedimentary shelf systems are generally dominated by the winterly storm regime. Seasonally, the wind fields control ocean-current directions, seabed-sediment mobilization, and upwelling/downwelling conditions. This cruise focused on the two areas of most distinct interaction between the hydrographic regime and the sedimentary system on the NW-Iberian continental margin, namely the mid-shelf mudbelt and the shelf edge/uppermost slope.

The mid-shelf mudbelt off Galicia.

A prominent example for a muddy sediment depocenter is the Galician mudbelt, which forms since about five thousand years in mid-shelf position all along the coast. Geometry, volume and age structure of this mudbelt are well understood as result of own previous studies.

The specific hydrographic conditions controlling mud settling, resuspension and final deposition were target of cruise M110 GALIMOS by monitoring the water-column structure and the formation and behavior of bottom nepheloid layers. In addition, water column, seabed, and subsurface were planned to be sampled. The data obtained will be hydrodynamically analyzed as well as integrated into a morphodynamic model to simulate the mudbelt formation with the aim to identify the major environmental forces.

The shelf edge/uppermost continental slope.

An outstanding example for probably coupled erosion-deposition activity under high-energy conditions is found just off the shelf edge off Galicia. Here, a pair of morphological terraces exists at 350–450 m water depth. These terraces appear in association with numerous downslope-running channels (“gullies”) which cut back into the shelf edge. The origin of these terraces is not obvious but data from a preceding cruise indicated that a particular internal layer in the ocean stratification seems to coincide with the vertical position of these terraces.

This shelf edge system, thus, offers potentially a unique opportunity to observe *in-situ* seabed shaping and material behavior, as the result of the exposure to internal waves. A geological origin of these terraces, i.e., relation to the underlying rock formation, can be excluded. Our basic hypothesis focused, thus, on a mechanistic linkage of horizontal boundaries in the internal water-column structure and the seabed characteristics. Aim of cruise M110 GALIMOS was to monitor the water column and intermediate suspension layers in concert with seabed investigations. The data obtained will allow for analyzing and simulating the wave/seafloor interaction, and developing a conceptual shelf-edge model.

Narrative

During the first week of the GALIMOS cruise, we focused on the mid-shelf mudbelt. As a first step, we ran a long N-S directed shelf profile (PARASOUND 18 kHz, SADCP 75 kHz, Multibeam echosounder EM122). We deployed the lander (equipped with an upward looking ADCP 300 kHz, a downward looking ADCP 1200 kHz, 3 current meters, 1 LISST) on the second day off the Douro river mouth at 72 m water depth with the intention for a 36-hour monitoring of bottom-near processes.

In the meantime, we ran profiles with the shipboard acoustic systems (PARASOUND 18 kHz and parametric 4 kHz, SADCP 75 kHz, Multibeam echosounder EM122) mainly perpendicular to the coast from 30 to 2.000 m water depths. We also took water and sediment samples at 20 stations on transects along three of these profiles (P1, P4, P6), and we had one dive with the ROV on the mudbelt off the Ría de Vigo to investigate the bedform inventory.

Much to our excitement, a strong storm deep passed over the region and led to the measurement of a 96-hour time series recording the increase and subsequent decrease of storm-related energy conditions at the seafloor (as analogue to regime dominating the winter season with prevailingly westerly and southwesterly winds). The recovery of the lander went well and one day later we deployed the lander already for a second time off the Ría de Vigo at 125 m water depth.

During the second week, main target of investigation was the region on the uppermost continental slope with its two prominent morphological ledges at 400-500 m water depths. The wind conditions turned towards northerly directions leading to southeasterly rolling wave and swell systems, thus, providing conditions contrasting those prevailing during the first week. We investigated the water column itself with the PARASOUND 18 kHz and the SADCP 75 kHz systems along E-W trending profiles as well as by stationary monitoring (time series) at selected stations. We collected valuable information about the density and type of the particles in the intermediate layers and “particle clouds” with the particle camera (ParCa) and the (yoyo-) CTD/water sampler. Intention was to find out which sort of material might be responsible for the obtained acoustic (18 kHz) reflections.

In a next step, we looked directly at the conditions of the seafloor in the ledges’ region by deploying the ROV three times along upslope profiles across the individual ledges. Grab samples and short gravity cores along inside a gully were taken to document which role downslope gravity-driven processes play in transporting sands from the outer shelf down into the deep ocean. We recovered the lander which we had placed on the center of the mid-shelf mudbelt five days after its deployment. The recovery maneuver was successful but turned out more difficult than expected because a bottom trawling fisher had relocated the lander by about 95 m. As a consequence of his intervention, all six buoys were lost and a mooring deployment on the shelf-edge terraces was, thus, no longer possible.

During the remaining two days, we finished our lateral profiling on the shelf, measured several additional stationary time series with PARASOUND and with (yoyo-) CTD/water sampler, and sampled sediments along upslope transects inside two further gullies for comparing differences in local downslope transport. A final ROV dive at the location of the first lander deployment (mid-shelf position off the Douro river mouth) served for measuring bedform dimensions (sand ripples) as an additional indicator for bottom flow intensities during the storm which had affected this region during the preceding week.

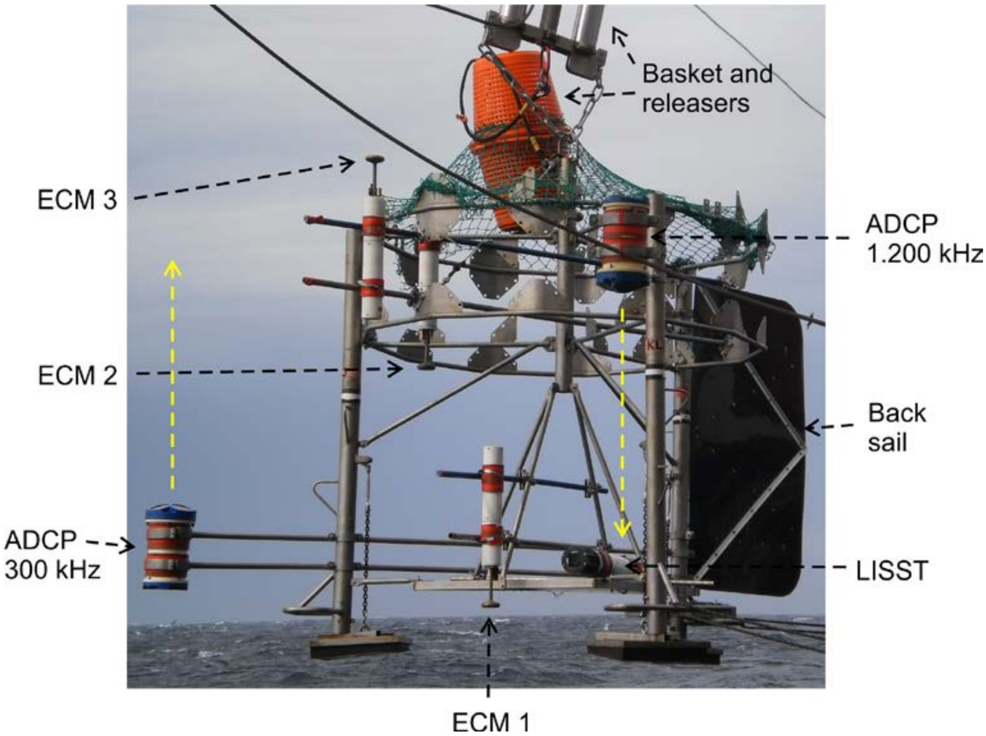


Fig. 1 Lander design and devices.

Acknowledgements

We would like to express our great gratitude to Captain Rainer Hammann and his team of RV METEOR. Their great interest, intense support, and high expertise made this cruise a successful voyage. We thank Guillermo Frances and Anxo Mena (both Departamento de Geociencias Marinas y Ordenación del Territorio, Universidade de Vigo, Spain) for their help prior to the cruise.

The following colleagues have greatly contributed with regard to the bottom-near measurement campaign and the lander design: Christian Winter, Eva Kwoll and Eberhard Kopiske (MARUM, Bremen); Frank Wenzhöfer, Axel Neuhausen and Fabian Schramm (MPI, Bremen); Joao Vitorino, Ines Marina Martins and Nuno Rufino Zacarias (Instituto Hidrográfico, Lisbon, Portugal); Brian Johnson (Coastal Carolina University, SC, USA). Martin Kölling kindly made the Rumohr corer, Karin Zonneveld and Nicole Kniebel the Rosetta/CDT available. Many thanks for this collaboration to all of these colleagues!

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List of Participants

1	Hanebuth	Till J.J.	Chief Scientist	MARUM, CMSS
2	Aepfler	Rebecca F.	CTD, water sampling	MARUM
3	Caínzos Díaz	Verónica	Sediment/water sampling	UVIGO
4	Cui	Yongsheng	ECM/OBS, ADCP	SYSU
5	Didenkulova	Ira	ECM/OBS, ADCP	MARUM
6	Dolan	Aundrea	Sediment/water sampling	CMSS
7	Gayes	Paul	Sediment/water sampling	CMSS
8	Groenewegen	Rudolf L.	ROV technician	NIOZ
9	Haberkern	Julia	Parasound, Multibeam	GeoB
10	Kockisch	Brit	CTD, Water, Geolab	GeoB
11	Lantzsch	Hendrik	Geolab, Deck	GeoB
12	Nowald	Nicolas	ROV, mooring	MARUM
13	Oberle	Ferdinand K.	Geolab, Deck	MARUM
14	Oliveira	Anabela	ADCP, LISST, sampling	MG-IH
15	Santos	Ana	ADCP, LISST, sampling	MG-IH
16	Steinborn	Bastian	Geolab, Deck	GeoB
17	T’Jampens	Michiel	ROV pilot	VLIZ
18	Versteeg	Willem H.	ROV technician	VLIZ
19	Zhang	Wenyan	ADCP, ECM/OBS	MARUM

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GeoB	*Faculty of Geosciences, University of Bremen, Germany*
MG-IH	*Marine Geology Division, Instituto Hidrográfico, Lisboa, Portugal*
UVIGO	*Dept. de Geociencias Marinas y Ordenación del Territorio, Univ. de Vigo, Spain*
CMSS	*School of Coastal and Marine Systems Science, Coastal Carolina Univ., SC, USA*
SYSU	*Sun Yat-Sen University, Guangzhou, P.R. China*

Station list

GeoB #	Ship site #	Gear	Date	Lat (N)	Long (W)	WD (m)	Rec (m)	Remarks
18901-1	ME1100/832-1	CTD+RO	16.09.	41°13.500´	8°53.600´	56		Malfunction
18901-2	ME1100/832-2	CTD+RO	16.09.	41°13.600´	8°53.500´	57		Malfunction
18901-3	ME1100/832-3	RC						Empty
18901-4	ME1100/832-4	RC					38	
18901-5	ME1100/832-5	GC					53	
18901-6	ME1100/832-6	Lander	16.09.	41°15.700´	8°56.600´	68		
18901-7	ME1100/854-2	CTD+RO	20.09.	41°15.735´	8°56.688´	68		
18902-1	ME1100/835-1	CTD+RO	17.09.	41°13.233´	8°48.017´	39.6		Malfunction
18902-2	ME1100/835-2	RC					31	Liner broke, sediment below 3 cm disturbed
18902-3	ME1100/835-3	CTD+RO	17.09.	41°13.235´	8°48.017´	39		
18903-1	ME1100/836-1	CTD+RO	17.09.	41°13.440´	8°56.040´	64.4		
18903-2	ME1100/836-2	RC						Empty
18903-3	ME1100/836-3	RC						Empty
18903-4	ME1100/836-4	GS					30	
18904-1	ME1100/837-1	CTD+RO	17.09.	41°13.592´	9° 3.996´	103		Malfunction
18904-2	ME1100/837-2	CTD+RO	17.09.	41°13.630´	9° 4.404´	103.2		Malfunction
18904-3	ME1100/837-3	RC					67	
18904-4	ME1100/837-4	CTD+RO	17.09.	41°13.555´	9° 3.958´	101.4		Malfunction
18904-5	ME1100/837-5	CTD+RO	17.09.	41°13.598´	9° 4.006´	101.9		
18905-1	ME1100/838-1	CTD+RO	17.09.	41°13.731´	9°11.975´	322.2		3 bottles (7, 8, 9) lost, 1 bottle damaged (6)
18905-2	ME1100/838-2	RC					23	
18906-1	ME1100/839-1	CTD+RO	17.09.	41°13.992´	9°20.020´	882.3		
18906-2	ME1100/839-2	RC					86	
18907-1	ME1100/840-1	CTD+RO	17.09.	41°14.620´	9°27.990´	2024		
18907-2	ME1100/810-2	RC						Empty
18907-3	ME1100/840-3	GS					1	
18908-1	ME1100/843-1	CTD+RO	18.09.	41°34.223´	9°26.962´	1648.7		
18908-2	ME1100/843-2	RC						Malfunction, plastic tube lost
18909-1	ME1100/844-1	CTD+RO	18.09.	41°36.903´	9°18.505´	1032.4		
18909-2	ME1100/844-2	ParKa	18.09.	41°36.902´	9°18.504´	1029.9		
18909-3	ME1100/844-3	GS					10	
18910-1	ME1100/846-1	CTD+RO	19.09.	41°58.571´	9°30.381´	1500.8		
18910-2	ME1100/846-2	RC						Malfunction, plastic tube lost
18910-3	ME1100/846-3	ParKa	19.09.	41°58.572´	9°30.380´	1502.7		
18911-1	ME1100/847-1	CTD+RO	19.09.	41°59.647´	9°23.585´	918.8		
18911-2	ME1100/847-2	GS					10	
18912-1	ME1100/848-1	CTD+RO	19.09.	41°59.719´	9°14.947´	148.7		
18912-2	ME1100/848-2	RC						Empty
18912-3	ME1100/848-3	RC						Empty
18912-4	ME1100/848-4	ROV	19.09.	41°59.689´	9°14.790´	146.7		
18913-1	ME1100/849-1	CTD+RO	19.09.	41°59.044´	9° 5.003´	121.6		One bottle not released (in 40 m)
18913-2	ME1100/849-2	RC					65	
18913-3	ME1100/849-3	CTD+RO	19.09.	41°59.003´	9° 4.998´	122.3		
18914-1	ME1100/850-1	CTD+RO	19.09.	41°58.210´	8°54.200´	30.5		
18915-1	ME1100/855-1	CTD+RO	20.09.	41°39.001´	8°51.984´	27.4		
18915-2	ME1100/855-2	RC						Empty, broken tube
18916-1	ME1100/856-1	CTD+RO	20.09.	41°38.427´	9° 0.777´	83.3		

18916-2	ME1100/856-2	RC						Empty, cracked tube
18917-1	ME1100/857-1	CTD+RO	21.09.	41°37.571´	9° 9.641´	80.9		
18917-2	ME1100/857-2	RC						Empty, tube broken
18918-1	ME1100/858-1	CTD+RO	21.09.	42° 0.002´	9° 4.997´	123.5		
18918-2	ME1100/858-2	RC					60	
18918-3	ME1100/858-3	RC					56	
18918-4	ME1100/858-4	ROV	21.09.	42° 0.000´	9° 4.990´	123.8		
18918-5	ME1100/858-5	RC					60	
18918-6	ME1100/858-6	Lander	21.09.	42° 0.032´	9° 5.147´	125.7		Lander got trawled by fishing boat
18918-7	ME1100/878-3	RC					60	
18918-8	ME1100/878-4	RC					55	
18919-1	ME1100/860-1	ParKa	21.09.	42° 5.722´	9°27.610´	1121		
18920-1	ME1100/861-1	CTD+RO	21.09.	42° 6.158´	9°25.267´	606		
18920-2	ME1100/861-2	CTD+RO	21.09.	42° 6.160´	9°25.251´	602		
18920-3	ME1100/861-3	CTD+RO	22.09.	42° 6.129´	9°25.274´	604		
18920-4	ME1100/861-4	CTD+RO	22.09.	42° 6.097´	9°25.284´	602		
18920-5	ME1100/861-5	CTD+RO	22.09.	42° 6.146´	9°25.277´	606		
18920-6	ME1100/861-6	CTD+RO	22.09.	42° 6.147´	9°25.277´	605		
18920-7	ME1100/861-7	CTD+RO	22.09.	42° 6.146´	9°25.277´	605		
18920-8	ME1100/861-8	CTD+RO	22.09.	42° 6.146´	9°25.276´	604.5		
18920-9	ME1100/861-9	CTD+RO	22.09.	42° 6.147´	9°25.278´	604.6		
18920-10	ME1100/861-10	CTD+RO	22.09.	42° 6.145´	9°25.275´	602.4		
18920-11	ME1100/861-11	CTD+RO	22.09.	42° 6.147´	9°25.277´	603.7		
18921-1	ME1100/862.1	ROV	22.09.	42° 6.150´	9°25.280´	603.5		
18922-1	ME1100/863-1	ROV	22.09.	42° 7.740´	9°24.740´	413.6		
18923-1	ME1100/864-1	ParKa	22.09.	42° 5.300´	9°26.100´	1062.1		
18924-1	ME1100/865-1	CTD+RO						
18924-2	ME1100/865-2	CTD+RO						
18924-3	ME1100/865-3	CTD+RO						
18924-4	ME1100/865-4	CTD+RO						
18924-5	ME1100/865-5	CTD+RO						
18924-6	ME1100/865-6	CTD+RO						
18924-7	ME1100/865-7	CTD+RO						
18924-8	ME1100/865-8	CTD+RO						
18924-9	ME1100/865-9	CTD+RO	23.09.	42° 5.250´	9°24.950´	606.8		
18924-10	ME1100/865-10	CTD+RO	23.09.	42° 5.247´	9°23.958´	603.9		
18924-11	ME1100/865-11	CTD+RO	23.09.	42° 5.248´	9°23.958´	606.2		
18924-12	ME1100/865-12	CTD+RO						
18924-13	ME1100/865-13	CTD+RO						
18924-14	ME1100/865-14	CTD+RO						
18924-15	ME1100/865-15	CTD+RO						
18925-1	ME1100/867-1	ParKa	23.09.	42° 5.520´	9°24.350´	746.1		
18925-2	ME1100/867-2	CTD+RO	23.09.	42° 5.515´	9°24.348´	745.7		
18926-1	ME1100/868-1	ROV	23.09.	42° 6.029´	9°23.924´	468.3		
18927-1	ME1100/870-1	GS					15	
18927-2	ME1100/870-2	GC					232	
18928-1	ME1100/871-1	GS					5	
18928-2	ME1100/871-2	GC						Empty

18929-1	ME1100/872-1	GS					13	
18929-2	ME1100/872-2	GC					5	Bag sample
18930-1	ME1100/873-1	GS					10	
18930-2	ME1100/873-2	GC						Empty
18931-1	ME1100/874-1	GS					1	
18932-1	ME1100/875-1	ParKa						
18932-2	ME1100/875-2	CTD+RO						
18933-1	ME1100/876-1	CTD+RO						
18933-2	ME1100/876-2	ParKa						
18934-1	ME1100/878-2	ROV	25.09.	42° 0.130´	9° 5.200´			Lander rescue operation
18935-1	ME1100/882-1	CTD+RO	26.09.	42° 5.878´	9°18.719´	196.9		
18936-1	ME1100/883-1	CTD+RO	26.09.	42° 5.507´	9°12.260´	152.6		
18936-2	ME1100/883-2	CTD+RO	26.09.	42° 5.476´	9°12.670´	154.8		
18936-3	ME1100/883-3	CTD+RO	26.09.	42° 5.477´	9°12.676´	154.5		
18937-1	ME1100/884-1	CTD+RO	26.09.	42° 4.368´	9° 3.976´	128.3		
18938-1	ME1100/885-1	CTD+RO	26.09.	42° 4.582´	8°58.968´	99.6		
18939-1	ME1100/886-1	CTD+RO	26.09.	42° 4.445´	8°56.703´	78.4		
18940-1	ME1100/888-1	GS					5	
18940-2	ME1100/888-2	GC					25	Banana
18941-1	ME1100/889-1	GS					10	
18941-2	ME1100/889-2	GC					98	
18942-1	ME1100/890-1	CTD+RO						
18942-2	ME1100/890-2	RC					14	