

# **SHORT CRUISE REPORT**

## **RV METEOR: cruise M-66/1**

**by : Prof. Dr. Monika Rhein, chief scientist**

*Institut für Umweltphysik  
Abt. Ozeanographie, Universität Bremen*

from Las Palmas, Spain to Willemstad, Netherlands Antilles

August 13 to September 19, 2005

**With contributions from K. Bulsiewicz, C.Mertens, R.Steinfeldt, M.Walter**

**Prof. Dr. Monika Rhein  
Institut für Umweltphysik, Abt. Ozeanographie  
Universität Bremen  
28334 Bremen, Germany  
Phon: ++49 421 218 2408  
Fax : ++49 421 218 7018  
Email : [mrhein@physik.uni-bremen.de](mailto:mrhein@physik.uni-bremen.de)**

## Research Program

The objectives of the M66/1 measurements are:

### Upper ocean circulation:

- to obtain a 2 year time series of the transport of southern hemispheric water through the passages into the Caribbean.
- to determine the variability of the fraction of South Atlantic water east and north of the islands.
- to estimate the transport of southern hemispheric water east of the islands across 16°N.

### Deep Circulation:

- to study the circulation and variability of the flow in the deep western boundary current and in the interior of the basin
- to calculate time scales of deep water spreading from the Labrador Sea to 16°N

The methods are:

- CTDO sensors to determine the distribution of water mass characteristics (pressure, temperature, salinity, oxygen) and analyse water samples from 10L bottles for chlorofluorocarbon components CFC-11 and CFC-12.
- measurement of the velocity field with ADCPs (Acoustic Doppler Current Profilers) attached to the CTDO system and with the vessel mounted ADCPs (75kHz and 38.5kHz)
- recover the CARIBA mooring array instruments, i.e. acoustic current meters, T/S sensors and Inverted Echo Sounders (PIES) east of the Caribbean.

## Cruise Narrative

The RV METEOR departed on August 13, 9 UTC from Las Palmas and headed towards the Henry Seamount at 27°18.5'N, 17°47.0'W. Dredging began at August 14, 1 UTC, and ended at August 15, 1 UTC. The weather was favourable for dredging in the southern section of the seamount. The METEOR reached Hierro at August 15, 6:30 UTC, and the three geologists and one technician departed while METEOR stayed near Puerto de la Estaca.

At August 15, 7:30 UTC, the METEOR headed towards the easternmost CTD station (51°W) of the 16°N section. With the trade winds from the back the speed of the METEOR was around 12 kn most of the time. During the transit of about 2000nm, a CTD test station was carried out successfully at August 17, 15:30 UTC. The CTD was lowered to 2000m depth. At August 20, 16 UTC, the 22 Niskin bottles were tested for CFC contamination by closing them all in the CFC minimum zone at 2500m depth. In the eastern Atlantic, very small concentrations are expected at this depth level. The test was successful, all bottles closed and no contamination could be found. This result was supported by the oxygen analysis. A second test was done on August 21, 17 UTC.

The 16°N section began at August 22, 15 UTC at the flank of the Midatlantic Ridge (CTD 4, 15°15'N, 51°20'W) at a water depth of 4000m. In order to resolve the flow-field of the Antarctic Bottom Water (AABW) at the bottom of the flank, the station spacing was at first 10nm, and then increasing to 20nm. The chosen spatial distance allows the resolution of the

flow field with the LADCP profiles measured parallel to the CTD casts. The LADCP profiles had good quality throughout the water column, but the expected northward flow of the AABW was not observed. The subsequent stations also showed the tidal velocities in the order of 3-4cm/s. The weather and sea remained calm and provided excellent working conditions. In the early morning (5UTC) of August, 25 the METEOR reached the longitude of 55°W, which on former cruises was the boundary between a net southward flow of North Atlantic Deep Water west of 55°W and a more sluggish and uncoordinated flow east of that longitude. Between 55°30'W and 57°40'W (Aug 25, 11UTC – Aug 26, 20UTC) we encountered an eddy. These eddies are called NBC rings, because of their creation at the retroflection of the North Brasil Current (NBC) into the North Equatorial Counter Current off the coast of Brazil. These rings are crucial for the transport of water from the South Atlantic across 16°N. The ring was subsurface intensified with highest velocities of 25-35cm/s between 400m and 600m depth, the fraction of South Atlantic water (SAW) was higher than 70% in the intermediate and central water masses. The signal at the surface was weak, so that most likely the ring cannot be seen by remote sensing.

During CTD 27 on August 27, one of the LADCP workhorses from RD Instruments (San Diego) failed, so that unfortunately we were unable to measure the deep velocity distribution in the western boundary region, where we expected the strongest signals. This instrument was sent to RD Instruments (RDI, San Diego) for refurbishment in February 2005. It failed after 20 profiles in June 2005 during our cruise with N/O Thalassa . The instrument was then sent back to RDI at July, 12 and after repair was delivered to RV METEOR to Las Palmas. Presumably, the instrument was not properly repaired. Due to the many parallel research cruises we were unable to take a backup instrument with us. For the remaining work in the deep western boundary current no deep velocity measurements could be carried out. With one instrument remaining, only velocity profiles to water depths shallower than 3000m are possible.

The 16°N section was finished with CTD 38 at August, 29, 4:30UTC. The METEOR headed south to carry out CTD stations every 9nm on the way to the mooring position B10 east of Saint Lucia and then to B8 north of Tobago. B10 was reached at August 30, 12 UTC (CTD 54), and B8 at September 1, 2UTC. Near that position, the surface water was murky and down to about 5m very fresh with salinities of about 27.0. Both features indicated the presence of river outflow from the Amazon and/or Orinoco. Although low salinities are frequently observed in that area especially a few months after the maximum of the river outflow, they are usually not below 32.

The METEOR turned towards Barbados, i.e. to the position of mooring B9 on the western side of Barbados. After finishing the CTD section, the remaining time was used to repeat the northern part of the section from Tobago to Barbados down to 12°35'N, 60°0'W with the two vessel mounted ADCPs. In the early morning of September, 2 (9:40UTC), CARIBA mooring B9 was released. 7 minutes after release the top float was seen and at 11 UTC the mooring was completely recovered. The top element, moored in 70m depth, showed severe signs of fishing activities but fortunately was not lost.

The CTD section from Barbados to St. Lucia began at September 2, 11:50 UTC, the station spacing was like on the last section about 9nm. When finished, a transport section to 13°40.0'N, 60°30.0'W was carried out. At September 3, 8:34 UTC the PIES at 13°47.50'N, 60°41.82'W was released. The instrument didn't respond. The release-code was repeatedly sent, but no acoustic nor radio or visual (flashlight) signals were received, although the flashlight should be easily seen in the darkness. Most likely, the PIES was not released. The

search was interrupted at 10:25 UTC. CARIBA mooring B10 at 13°48.00'N, 60°41.50'W was released. Both releasers responded immediately, and the mooring was sighted 7 minutes later. The complete mooring was on board about at 11:30 UTC. This mooring showed also signs of fishing activities. The construction of the top float was damaged and the mooring contained several pieces of fishing gear. It turned out that a few months after deployment, the mooring had been hauled several 100m nearer to the shore, where the bottom was 30m shallower. The top float was then located in 35m depth instead of 70m.

Afterwards the search for the PIES was continued. Several items were found, but not the PIES. The search was abandoned at 12:20 UTC, and the METEOR headed towards Tobago. Early at September 4, 7:15 UTC the PIES was contacted and after several attempts the releaser worked at 8:45 and the PIES surfaced. It was dark, the flashlight of the PIES made it very easy to find the instrument at 9:20. After the PIES was brought on board (9:30), CARIBA mooring B8 was released at 9:35, detected at 9:40 and recovered completely. The releasers were on deck at 10:50. At the former mooring position B8 a CTD (CTD 91) was carried out at 11:30 UTC .

This (CTD 91) was the first station on the way to St. Vincent, the station spacing was 10.5nm. The section was finished with CTD 102 at September 5, 12 UTC. After 11nm, the work in the passage between St. Vincent and St. Lucia began. The CTD section (CTD 103-108) was complemented by several ADCP transects to study the influence of the tides on the velocity distribution. The vessel mounted ADCP reached down to the bottom so that we received velocity data in the passage with full continuous coverage. After finishing the passage work, the METEOR was on her way to 13°47.50'N 60°41.80'W, the PIES position off St. Lucia. The METEOR drifted towards the PIES, and the instrument was acoustically released. It took about an hour from September 6, 6 UTC to 7 UTC before the PIES responded, and the instrument surfaced 30minutes later. The PIES was brought on deck at 7:54 UTC. Both PIES carried out the measurements successfully.

The METEOR continued her track to the passage between St. Lucia and Martinique. After 5 CTD stations (CTD 109-113), the 12nm wide passage was also studied with several shipboard ADCP transects. The METEOR left the passage at September 6, 20 UTC and sailed leewards of Martinique to the passage between Martinique and Dominica. Unfortunately Dominica refused the research within the 3nm zone, so that we could not achieve full coverage of the passage. The work in the passage was finished at September 7, 15 UTC. In order to reach deeper well mixed water needed to calibrate the moored MicroCats with the CTD, a CTD station was carried out in the Caribbean at 15°N, 61°23'W with a water depth of 2356m at 17UTC. Only 4 10L bottles were attached at the carousel, the others were replaced by the MicroCats.

Work continued when the passage between Dominica and Guadeloupe was reached at Sep. 7, 23 UTC with CTD stations (CTD 121-125) followed by ADCP transects. The 3nm zone of Dominica has been left out. At September 8, 13 UTC the METEOR stopped near Pointe a Pitre (Guadeloupe) to obtain the replacement for the leaking ADCP workhorse. The Leibniz Institute for Marine Research in Kiel, Germany was able to provide us with an instrument with short notice. The instrument was brought at 11:30 UTC and the METEOR set course to the 16°N section to repeat the stations in the Deep Western Boundary Current with 2 ADCP workhorses attached to the CTD/carousel. The station work started at 19 UTC and was finished at September 9, 13 UTC. In order to study deep mixing in the western boundary current, a CTD/LADCP YoYo station was carried out at 16°17'N, 60°35'W which lasted for 12 hours and 6 complete profiles (CTD 132-137) could be taken in that time period. The

results will be compared to microstructure measurements of K. Polzin, Woods Hole, USA, taken at about the same position.

Whether water from the South Atlantic also flows through the passages north of Guadeloupe was studied with CTD stations and ADCP transects in the passage between Guadeloupe and Antigua as well as between Anguilla and Anegada (Sombrero Passage) The latter is more than 2000m deep. The measurements in the Guadeloupe-Antigua passage (CTD 138-145) were finished at September 10, 21 UTC. The water between the two passages is very shallow, so that only ADCP sections were carried out. The work in the Sombrero Passage lasted from September 11, 9 UTC to September 12, 17:30 UTC (CTD 146 – 162). No CFC data have been taken in the Sombrero Passage. Several valves of the analysis system failed and through the unusual high failure rate the CFC sampling was stopped to be able to cover the following deep western boundary section. The velocity field in the passage was strongly influenced by tides. The detided total transport through the relatively large Sombrero Passage was small with 0.9 Sv inflow.

At September 12, 19 UTC, the CTD 163 marked the beginning of the meridional boundary section from Anegada across the Puerto Rico Trench to 23°N, 64°W. The measurements stopped at 5700m depth, although the trench is much deeper. The station spacing was at the slope 2.5 – 5nm, and further offshore the distance increased to 22nm. The deep water was devoid of scatterers leaving not enough signals for the LADCPs. The two instruments were removed after reaching water deeper than 5200m.

The last station of the boundary section at 23°36'N 64°06'W (CTD 181) was finished on September 16, 11:30 UTC, Shortly before the CTD was back on board, the CFC analysis system had to be shut down because of problems in the gas supply line, and the CFC samples were taken 'offline'. The glass ampoules were flame sealed and will be analysed in our lab in Bremen.

The METEOR set course to Curacao, where we arrived at September 19, 11 UTC. During the entire cruise, the METEOR always experienced calm winds and seas.

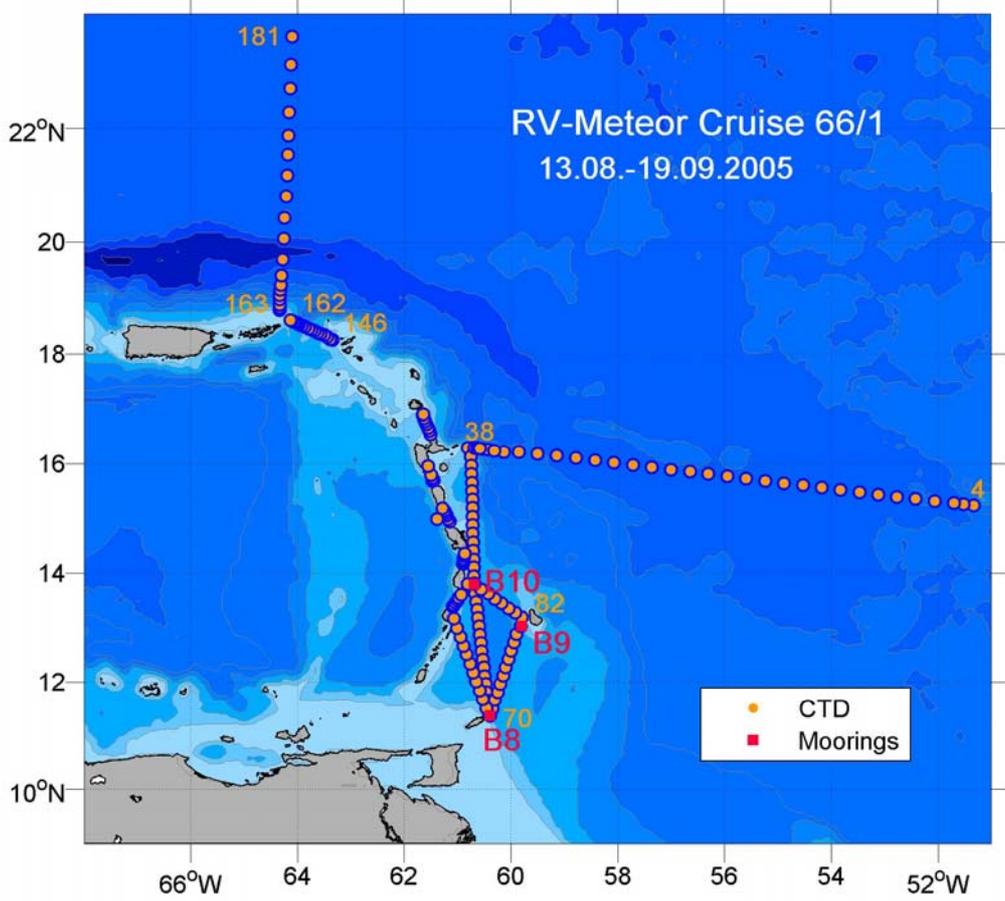


Figure 1 Station map METEOR cruise M66/1, August 13 – September 19, 2005 (Las Palmas – Willemstad)

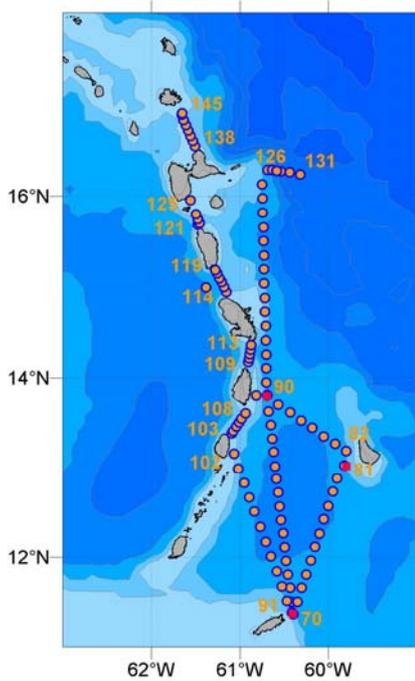


Figure 2 Stations between Tobago and Antigua, METEOR cruise M66/1

## **Technical Aspects**

### **CTD-O<sub>2</sub> Measurements (R. Steinfeldt)**

Measurements of conductivity, temperature, pressure and dissolved oxygen were performed with a Sea-Bird 911 plus system. The CTD was operated on a water sampler carousel together with 22 10 l Niskin bottles and 2 LADCPs. CTD data quality was good throughout the whole cruise. Some of the Niskin bottles, however, showed leakages at the bottom or the outlet. CTD data were calibrated by minimizing the difference between CTD values and salinity and oxygen samples from the Niskin bottles measured on board. The number of direct measurements was 1047 for oxygen and 498 for salinity, i.e about 6 and 3 samples per profile.

Oxygen measurements were carried out by the Winkler titration method. The standard did not show a remarkable drift, and the mean standard deviation between double samples was 0.020 ml/l. The difference between the directly measured and calibrated CTD oxygen data is 0.048 ml/l (0.046 ml/l) for all (below 1000 dbar) samples. At the beginning, the CTD oxygen sensor showed temporal fluctuations, but from profile 13 on identical calibration coefficients were used.

Salinities of the water samples were determined by means of a Guildline Autosal salinometer of type 8400A. The rms differences between the measured and calibrated CTD values amounted to 0.0029 (0.0024) for all (below 1000 dbar) samples. The mean deviation between measurements of substandard was in the range of 0.001.

IAPSO Standard Seawater of batch 145 was used for calibrating the salinometer. The salinities in the Antarctic Bottom Water (AABW) are in good agreement with former cruises if an offset of 0.003 is subtracted as was also done for salinity calibrations with batch 141. The oxygen values in the deep water are low compared with older data (differences between 0.05 and 0.1 ml/l). The surface oxygen saturation, on the other hand, is about 104 % and thereby in the same range as was measured the years before. An anomal large amount of samples (about one third) could not be used for the calibration routine both for oxygen and salinity, as the difference against the CTD values was too large. One reason could be the leakage of some of the Niskin bottles and/or problems at the oxygen sampling.

### **Analysis of Chlorofluorocarbons (K. Bulsiewicz)**

During the cruise M66/1 water samples have been collected from 10l Niskin bottles for the analysis of the chlorofluorocarbons CFC-11 and CFC-12. Measurements of the CFC concentration in the water samples have been performed on board using a gas chromatographic system with capillary column and Electron Capture Detector (ECD). CFC sampling has been performed on 125 stations. A total of 1300 CFC data have been obtained. On the last station, CFC samples were sealed in glass ampoules for later measurements on land, as the remaining amount of pure nitrogen was not sufficient to run the automatic extraction system.

The sampling blank for CFC-11 and CFC-12 was estimated at a test station where all bottles were tripped at the same depth. This water is 'old', exhibiting zero CFC-concentrations. For CFC-11 and CFC-12 the resulting sampling blank was 0.005 pmol/kg. Accuracy was checked

by analysing 33 water samples at least twice. It was found to be 0.6% for CFC-11 and 0.4% for CFC-12. The CFC concentration of the gas standard used to calibrate the water samples are reported on the SIO98 scale.

### **Lowered Acoustic Doppler Current Profiler LADCP (M.Walter)**

Most of the hydrographic stations were accompanied by current measurements with a lowered acoustic Doppler current profiler (LADCP) system attached to the CTD and water sampling carousel. Throughout the cruise, three instruments (RDI 300 kHz Workhorse Monitor) were used, partly two together or one as a single instrument.

Two instruments were used in a synchronized Master-and-Slave mode, with the upward looking as Slave and the downward looking as Master. When only one instrument was used, it was mounted downward looking. The instruments were powered by an external battery supply, consisting of 35 commercial quality 1.5V batteries assembled in a pressure resistant Aanderaa housing. The system was set to a ping rate of 1 ping/s and a bin length (= vertical resolution) of 10 m with a nominal range of 200 m for both operating modes, Master-and-Slave as well as single.

In total, 160 LADCP profiles were obtained during the 181 CTD stations of the cruise. The profiles from 132 to 137 were taken at the same position as a time series station.

During profile 26 on the 16° N transect, a water leakage (probably through the transducers) occurred in the upward looking instrument. Two of the transducers were damaged and severe corrosion was evident on one of the electronic boards of the unit. Unfortunately, there was no backup instrument on the ship at the time. With a water depth greater than 5000 m and very clear water (= few backscatterer), the data from a single instrument were not sufficient for a good-quality profile. Thus, the ensuing profiles up to CTD cast 33 were done without an ADCP. From cast 34 onwards, in the shallower and more productive waters close to the Antilles, a single instrument was used for profiling. A backup instrument shipped to Guadeloupe from the IfM-GEOMAR was available from profile 126 onwards, and was used for the rest of the cruise as a Slave.

From profile 114 onwards, beam 1 of the downward looking instrument started switching on and off. When the beam was working, it worked fine (normal range etc, no signs of any problem), but it stopped working for large stretches of time (several minutes) during profiles. The problem occurred mainly in shallow water, and we suspect an electronic connection problem related to outside pressure. After profile 117, the instrument was dismantled and checked for leakage, but everything was fine (except the occasional beam failure), therefore the instrument was remounted for profile 119 and used for the rest of the cruise. 3-beam solutions were used for the velocity calculation for the periods where beam 1 failed.

The stations from 169 up to the end of the cruise (a transect across the Puerto Rico Trench) were again deeper than 5000 m and extremely scarce in backscatterers for depth greater than 2000 m, so that even the range of the combined instruments was too small to obtain velocity profiles.

The different types of environments lead to large differences in instrument range during the cruise. For the shallower (up to 2500 m water depth) stations close to the Antilles and in the passages, there was a vast amount of backscatterers, and the range of the instrument (Master only) was up to the nominal 200 m in the upper 1000 m, and scarcely falling below 60 m

(again for the single instrument). With lowering and heaving velocities between 0.8 and 1.2 m/s of the instrument package this resulted in at least 200 shear estimates per depth bin and very good quality profiles.

In the deep stations of the 16°N and the Puerto Rico Trench sections, there were virtually no backscatterers below 2000 m, and the range was reduced to 2 bins (20 -30 m) for each instrument (50 m total for the package) in those parts of the profiles. With less than 100 shear estimates per depth bin no reliable velocity profile was obtained.

Post processing of the raw data was done using an inverse method which incorporates the measured velocity shear, the surface drift of the ship during the cast, and the bottom track velocities measured by the downward looking instrument to produce profiles of velocity and shear. This resulted in high quality velocity profiles, even for profiles with very weak current velocities (<0.05 m/s) and zero mean. Larger errors occur in the profiles deeper than 4000 m with few backscatterers and weak velocities, where not enough information is available for a good inversion.

### **Shipboard Acoustic Doppler Current Profiler SADCP (C. Mertens)**

Simultaneous single-ping data were recorded from two RD Instruments Acoustic Dopplers current profilers: A 75 kHz and a 38 kHz Ocean Surveyor (OS) model, both with flat phased-array transducers. The 75 kHz OS was mounted into the hull of the ship in July 2004, and the 38 kHz instrument was lowered in the ship's well at the beginning of the cruise.

Both instruments were configured to collect narrow bandwidth water-profile data throughout the cruise. The data from the 75 kHz OS was recorded in 8 m bins to get high vertical resolution data in the upper water column. To achieve maximum range the 38 kHz OS data were collected in 32 m bins. Both systems operated flawless throughout the cruise. The ship's 78 kHz Doppler log is known to cause strong interference with the 75 kHz Ocean Surveyor which results in a reduced range of about 250 m and a deterioration of the data quality. During station work the Doppler log was needed for navigational purposes, but it was switched off when the ship was underway.

Navigation and heading information were recorded together with the velocities. Both ADCPs used the synchro version of the Fiber Optic Compass (FOG) heading connected directly to the chassis of the ADCP to transform the measured velocities into earth coordinates although it has been found on an earlier cruise (M47/1) that the FOG has a heading dependent error. Because of this error the data were corrected by substituting the synchro-FOG heading values of each single ping with heading values from the Ashtech receiver. The Ashtech receiver operated continuously throughout the cruise, delivering reliable heading data.

A water-track calibration of the angle between the transducers and the Ashtech antenna system has been carried out for both instruments. For the 38 kHz OS a misalignment angle of  $-1.03^\circ$  and an amplitude factor of 1.004 were determined. For the 75 kHz OS the calibration resulted in a misalignment angle of  $-1.27^\circ$  and an amplitude factor of 1.008, which is very close to the calibration carried out during Meteor cruise M62/1.

The range of the 75 kHz OS was of about 700 m, and the 38 kHz OS achieved ranges of 1200 to 1400 m. The sea state was generally calm throughout the cruise and most of the time the ship didn't had to steam against the waves which resulted in a very good quality of shipboard ADCP data for this cruise.

## Dredge at Henry Seamount, cruise M66/1

Number	Time Start	Time Ende	Latitude	Longitude	Depth
1	Aug. 14, 1:02	4:10	27°18.5'N	17°47.0'W	3553m
2	Aug.14, 4:22	7:29	27°19.0'N	17°46.5'W	3362m
3	Aug.14, 8:04	11:22	27°18.0'N	17°45.0'W	3688m
4	Aug.14, 12:05	15:48	27°18.5'N	17°45.0'W	3935m
5	Aug.14, 16:32	20:31	27°20.0'N	17°48.0'W	3534m
6	Aug.15, 21:24	1:00	27°20.0'N	17°46.0'W	3880m

## CARIBA Moorings on cruise M66/1

Name	Latitude	Longitude	Depth	Deployment Date	Retrieval
B8	11°21.70'N	60°24.00'W	1130m	17.7.2004, 14:48	<b>4.9.2005</b>
PIES75	11°21.70'N	60°23.60'W	1123m	17.7.2004, 15:15	<b>4.9.2005</b>
B9	13°01.60'N	59°47.60'W	1007m	21.7.2004, 18:57	<b>2.9.2005 9:56</b>
B10	13°48.00'N	60°41.50'W	1002m	22.7.2004, 11:00	<b>3.9.2005 10:25</b>
PIES56	13°47.50'N	60°41.80'W	993m	22.7.2004, 13:50	<b>6.9.2005 6:00</b>

PIES: Inverted Echo Sounder with Pressure sensor

Time in UTC

**Bold dates: work done during M66/1 cruise**

### Recovered CARIBA Mooring B8/Tobago

Instrument	Number	Depth	Comments
Releaser	AR517	1055m	
Releaser	AR798	1055m	
MicroCat C,T	2476	953m	
MicroCat C,T	2454	753m	
MicroCat C,T	2438	552m	
RCM11	93	350m	
MicroCat C,T	2377	352m	
MicroCat C,T	2277	195m	
RCM11	91	93m	
MicroCat C,T	2051	78m	

Sampling rate for all instruments : 30min.

RCM: Aanderaa Acoustic Current Meter, +P: with pressure sensor

MicroCat C,T : SBE, measurement of temperature and conductivity

no radio transmitter, no flashlight

**Recovered CARIBA Mooring B9/Barbados**

Instrument	Number	Depth	Comments
Releaser	RT520	985m	
Releaser	RT521	985m	
MicroCat C,T	2050	952m	
MicroCat C,T	1943	751m	
MicroCat C,T	1931	550m	
RCM11	89	449m	
MicroCat C,T	1933	342m	
MicroCat C,T	1915	193m	
RCM11	94	90m	no data
MicroCat C,T	1888	73m	

RCM: Anderaa Acoustic Current Meter, +P: with pressure sensor  
MicroCat C,T : SBE, measurement of temperature and conductivity  
no radio transmitter, no flashlight

**Recovered CARIBA Mooring B10 / St. Lucia**

Instrument	Number	Depth	Comments
Releaser	RT531	955m	
Releaser	AR810	955m	
MicroCat C,T	3199	949m	
MicroCat C,T	3198	748m	
MicroCat C,T	3197	547m	
MicroCat C,T	1936	346m	
RCM11	92	344m	
MicroCat C,T	1934	189m	
RCM11	95	87m	
MicroCat C,T	1932	71m	

Sampling rate for all instruments : 30min.  
RCM: Anderaa Acoustic Current Meter, +P: with pressure sensor  
MicroCat C,T : SBE, measurement of temperature and conductivity  
**Radio frequency: 160.785 MHz**

## List of Participants M66/1

1 . Rhein, Monika, Prof. Dr.	Chief scientist	IUPHB
2 . Bulsiewicz, Klaus	CFC-analysis	IUPHB
3 . Fraas, Gerhard	Moorings	IUPHB
4 . Fraas, Karin	CTD/ADCP watch	IUPHB
5 . Voehrs, Gesa	CTD/ADCP watch, dust sampling	IUPHB
6 . Erdmann, Sandra	CFC-watch	IUPHB
7 . Bislich, Oliver	CTD/ADCP watch	IUPHB
8 . Kirchner, Kerstin	CTD/ADCP	IUPHB
9 . Krisponeit, Jon-Olaf	CTD/ADCP watch	IUPHB
10. Aschmann, Jan	CTD/ADCP watch	IUPHB
11. Kreuzmann, Christian	Meteorology	DWD
12. Mertens, Christian, Dr.	vm-ACPs, moorings	IUPHB
13. Drews, Reinhard	CFC watch	IUPHB
14. Oschmann, Michael	oxygen analysis, dust sampling	IUPHB
15. Grahlmann, Jann	CTD/ADCP watch, dust sampl.	IUPHB
16. Steinfeldt, Reiner, Dr.	CTD/Salinometer	IUPHB
17. Walter, Maren, Dr.	LADCP	IUPHB
18. Li, Xin	CTD/ADCP watch	IUPHB
19. Brentführer, Ramon	LADCP	IFM-GEOMAR
20. Söber, Uwe	CTD/ADCP watch	IUPHB
20. Torsten Truscheit	Meteorology	DWD
*21. Klügel, Andreas, Dr.	Geology	IFM-GEOMAR
*22. Ksienzyk, Anna	Geology	IFM-GEOMAR
*23. Hansteen, Thor, Dr.	Geology	IFM-GEOMAR

\*:participants from August, 12. to August, 15 2005.

### **DWD**

Deutscher Wetterdienst, Geschäftsfeld Seeschifffahrt, Bernhard-Nocht-Str. 76, 20359  
Hamburg, Germany

### **IUPHB**

Universität Bremen, Institut für Umweltphysik, Abt. Ozeanographie, Otto-Hahn-Allee, NW1,  
28359 Bremen, Germany

### **IFM-GEOMAR**

Leibniz Institut für Meeresforschung, Wischhofstrasse, 24105 Kiel, Germany

Meteor M66/1		CTD Stations					Page 1			
Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements		Comment
								CFCs	LADCP	
1	398	2005/08/17	16:30	23° 36.78' N	28° 59.49' W	5601	2001			x
2	399	2005/08/20	15:01	18° 27.59' N	42° 53.82' W	4748	2503	x		x
3	400	2005/08/21	16:03	16° 45.80' N	47° 22.65' W	4081	2472	x		x
4	401	2005/08/22	15:11	15° 14.49' N	51° 20.04' W	3998	3961	x		x
5	402	2005/08/22	19:12	15° 16.01' N	51° 31.09' W	5251	5270	x		x
6	403	2005/08/23	00:01	15° 17.04' N	51° 41.96' W	5421	5427	x		x
7	404	2005/08/23	05:49	15° 19.00' N	52° 4.04' W	4960	4961	x		x
8	405	2005/08/23	11:03	15° 21.98' N	52° 25.10' W	5150	5161	x		x
9	406	2005/08/23	16:07	15° 23.99' N	52° 46.01' W	5150	5148	x		x
10	407	2005/08/23	20:59	15° 26.46' N	53° 7.14' W	5310	5303	x		x
11	408	2005/08/24	02:07	15° 29.03' N	53° 28.04' W	5413	5420	x		x
12	409	2005/08/24	07:29	15° 31.51' N	53° 50.02' W	5475	5477	x		x
13	410	2005/08/24	12:37	15° 33.97' N	54° 11.01' W	5452	5462	x		x
14	412	2005/08/24	18:26	15° 36.51' N	54° 31.87' W	5496	5499	x		x
15	413	2005/08/24	23:42	15° 38.84' N	54° 53.02' W	5489	5500	x		x
16	414	2005/08/25	05:08	15° 41.51' N	55° 14.47' W	5487	5496	x		x
17	415	2005/08/25	10:20	15° 43.91' N	55° 36.09' W	5484	5497	x		x
18	416	2005/08/25	15:41	15° 46.47' N	55° 57.05' W	5591	5466	x		x
19	418	2005/08/25	21:03	15° 48.98' N	56° 18.50' W	5333	5335	x		x
20	419	2005/08/26	02:12	15° 51.48' N	56° 39.03' W	5287	5290	x		x
21	420	2005/08/26	07:34	15° 53.95' N	57° 0.54' W	5184	5177	x		x
22	421	2005/08/26	12:37	15° 56.51' N	57° 22.03' W	5286	5304			x
23	423	2005/08/26	18:15	15° 59.08' N	57° 43.00' W	5379	5414	x		x
24	424	2005/08/26	23:23	16° 1.53' N	58° 4.56' W	5364	5379	x		x
25	425	2005/08/27	04:36	16° 4.05' N	58° 25.55' W	5590	5606	x		x
26	426	2005/08/27	09:54	16° 6.48' N	58° 47.07' W	5760	5780	x		x
27	427	2005/08/27	15:24	16° 9.03' N	59° 8.54' W	5328	5353	x		x
28	428	2005/08/27	20:23	16° 11.46' N	59° 30.07' W	4995	4992	x		x
29	429	2005/08/28	01:14	16° 12.95' N	59° 51.51' W	5031	5018	x		x
30	430	2005/08/28	05:53	16° 13.01' N	60° 8.45' W	4844	4836			x
31	431	2005/08/28	09:50	16° 14.43' N	60° 18.97' W	4460	4449	x		x
32	432	2005/08/28	13:24	16° 15.88' N	60° 25.97' W	4778	4769			x
33	433	2005/08/28	17:08	16° 16.51' N	60° 31.97' W	4359	4363	x		x
34	434	2005/08/28	20:15	16° 16.95' N	60° 35.02' W	3060	3068			x
35	435	2005/08/28	22:52	16° 17.45' N	60° 37.99' W	2540	2482	x		x
36	436	2005/08/29	01:00	16° 17.53' N	60° 40.98' W	1742	1520	x		x

Meteor M66/1			CTD Stations			Page 2				
Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements CFCs	LADCP	Comment
37	437	2005/08/29	02:49	16° 17.55' N	60° 44.98' W	1100	780	x	x	
38	438	2005/08/29	04:16	16° 17.45' N	60° 49.00' W	549	539	x	x	
39	439	2005/08/29	05:59	16° 7.97' N	60° 45.03' W	1019	1049		x	
40	440	2005/08/29	07:51	15° 58.56' N	60° 44.55' W	995	985		x	
41	441	2005/08/29	09:37	15° 48.99' N	60° 44.55' W	1652	1634	x	x	
42	442	2005/08/29	11:48	15° 39.57' N	60° 43.99' W	2227	2201	x	x	
43	443	2005/08/29	14:20	15° 30.47' N	60° 44.09' W	2519	2491		x	
44	444	2005/08/29	17:15	15° 20.95' N	60° 43.56' W	2012	1992		x	
45	445	2005/08/29	19:37	15° 11.89' N	60° 43.55' W	1770	1758		x	
46	446	2005/08/29	21:49	15° 2.47' N	60° 43.54' W	917	920		x	
47	447	2005/08/29	23:33	14° 53.03' N	60° 43.04' W	537	532		x	
48	448	2005/08/30	01:02	14° 43.98' N	60° 43.01' W	527	522		x	
49	449	2005/08/30	02:30	14° 34.46' N	60° 42.52' W	631	635	x	x	
50	450	2005/08/30	04:18	14° 25.01' N	60° 42.49' W	1250	1234	x	x	
51	451	2005/08/30	06:23	14° 15.47' N	60° 42.00' W	1435	1415	x	x	
52	452	2005/08/30	08:22	14° 6.52' N	60° 42.04' W	1033	1021	x	x	
53	453	2005/08/30	10:11	13° 57.02' N	60° 42.01' W	974	957	x	x	
54	454	2005/08/30	11:54	13° 49.05' N	60° 41.48' W	986	973	x	x	
55	455	2005/08/30	13:50	13° 38.04' N	60° 40.55' W	1247	1227	x	x	
56	456	2005/08/30	15:50	13° 28.94' N	60° 38.96' W	1658	1635	x	x	
57	457	2005/08/30	18:03	13° 19.95' N	60° 38.03' W	1899	1872	x	x	
58	458	2005/08/30	20:19	13° 10.99' N	60° 37.00' W	2106	2078	x	x	
59	459	2005/08/30	22:49	13° 1.52' N	60° 36.04' W	2241	2217	x	x	
60	460	2005/08/31	01:27	12° 52.69' N	60° 35.11' W	2360	2335	x	x	
61	461	2005/08/31	04:13	12° 43.56' N	60° 34.06' W	2461	2432	x	x	
62	462	2005/08/31	06:51	12° 34.05' N	60° 33.07' W	2460	2434	x	x	
63	463	2005/08/31	09:30	12° 24.98' N	60° 32.05' W	2437	2411	x	x	
64	464	2005/08/31	12:11	12° 16.02' N	60° 30.59' W	2383	2355		x	
65	465	2005/08/31	14:52	12° 6.53' N	60° 29.59' W	2402	2373	x	x	
66	466	2005/08/31	17:29	11° 57.51' N	60° 28.60' W	2029	2007		x	
67	467	2005/08/31	19:52	11° 48.48' N	60° 27.52' W	1477	1453	x	x	
68	468	2005/08/31	22:03	11° 39.46' N	60° 26.01' W	1214	1193	x	x	
69	469	2005/09/01	00:03	11° 30.02' N	60° 25.06' W	1113	1088	x	x	
70	470	2005/09/01	01:51	11° 23.01' N	60° 24.57' W	1191	1171	x	x	
71	471	2005/09/01	03:37	11° 30.10' N	60° 21.04' W	1415	1388		x	
72	472	2005/09/01	05:44	11° 39.51' N	60° 18.09' W	1457	1392	x	x	

Meteor M66/1		CTD Stations					Page 3			
Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements		Comment
								CFCs	LADCP	
73	473	2005/09/01	07:49	11° 48.48' N	60° 15.06' W	1596	1571	x	x	
74	474	2005/09/01	10:03	11° 57.98' N	60° 12.03' W	1823	1800	x	x	
75	475	2005/09/01	12:24	12° 6.96' N	60° 9.10' W	2010	1985	x	x	
76	476	2005/09/01	14:48	12° 15.92' N	60° 6.06' W	2205	2183	x	x	
77	477	2005/09/01	17:17	12° 25.55' N	60° 3.03' W	2301	2270	x	x	
78	478	2005/09/01	19:47	12° 34.47' N	60° 0.01' W	2100	2135	x	x	
79	479	2005/09/01	22:19	12° 43.99' N	59° 57.02' W	1930	1901	x	x	
80	480	2005/09/02	00:39	12° 52.96' N	59° 54.07' W	1706	1683	x	x	
81	481	2005/09/02	02:53	13° 1.98' N	59° 49.04' W	1242	1218	x	x	
82	485	2005/09/02	11:50	13° 11.54' N	59° 48.02' W	1087	1064	x	x	
83	486	2005/09/02	13:31	13° 16.49' N	59° 55.53' W	1659	1634	x	x	
84	487	2005/09/02	15:41	13° 21.50' N	60° 3.01' W	1888	1863	x	x	
85	488	2005/09/02	17:56	13° 27.10' N	60° 11.04' W	2088	2064	x	x	
86	489	2005/09/02	20:10	13° 32.07' N	60° 18.52' W	2000	1973	x	x	
87	490	2005/09/02	22:30	13° 37.52' N	60° 26.04' W	1850	1818	x	x	
88	491	2005/09/03	00:46	13° 42.51' N	60° 34.08' W	1396	1377	x	x	
89	492	2005/09/03	02:45	13° 48.53' N	60° 41.54' W	991	980	x	x	
90	493	2005/09/03	04:21	13° 48.50' N	60° 48.97' W	582	469		x	
91	504	2005/09/04	11:33	11° 21.70' N	60° 23.78' W	1112	1101		x	
92	505	2005/09/04	13:20	11° 30.60' N	60° 27.98' W	925	910		x	
93	506	2005/09/04	15:11	11° 40.54' N	60° 31.51' W	1162	1138		x	
94	507	2005/09/04	17:15	11° 50.50' N	60° 35.07' W	1663	1636		x	
95	508	2005/09/04	19:29	12° 0.47' N	60° 39.04' W	2300	2262		x	
96	509	2005/09/04	22:15	12° 10.47' N	60° 42.52' W	2300	2228	x	x	
97	510	2005/09/05	00:58	12° 20.33' N	60° 46.05' W	2311	2283	x	x	
98	511	2005/09/05	03:36	12° 30.56' N	60° 50.06' W	2110	2086	x	x	
99	512	2005/09/05	06:09	12° 40.05' N	60° 53.49' W	1548	1529	x	x	
100	513	2005/09/05	08:20	12° 49.99' N	60° 57.02' W	1300	1219	x	x	
101	514	2005/09/05	10:20	12° 59.99' N	61° 1.00' W	600	588	x	x	
102	515	2005/09/05	11:50	13° 9.98' N	61° 4.03' W	437	438		x	
103	517	2005/09/05	13:37	13° 23.41' N	61° 5.60' W	483	498	x	x	
104	518	2005/09/05	14:30	13° 25.14' N	61° 4.43' W	1005	994	x	x	
105	519	2005/09/05	15:50	13° 28.04' N	61° 2.36' W	869	852	x	x	
106	520	2005/09/05	17:07	13° 30.78' N	61° 0.38' W	351	348	x	x	
107	521	2005/09/05	18:00	13° 33.06' N	60° 58.84' W	333	324	x	x	
108	522	2005/09/05	19:11	13° 36.75' N	60° 56.02' W	373	360		x	

Meteor M66/1		CTD Stations				Page 4				
Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements CFCs	LADCP	Comment
109	531	2005/09/06	12:26	14° 10.81' N	60° 54.14' W	415	419		x	
110	532	2005/09/06	13:16	14° 13.08' N	60° 53.77' W	780	777	x	x	
111	533	2005/09/06	14:18	14° 15.70' N	60° 53.30' W	902	897	x	x	
112	534	2005/09/06	15:31	14° 18.99' N	60° 52.75' W	878	840	x	x	
113	535	2005/09/06	16:42	14° 21.71' N	60° 52.35' W	329	330	x	x	
114	544	2005/09/07	07:24	14° 56.76' N	61° 9.07' W	413	420		x	
115	545	2005/09/07	08:22	14° 59.97' N	61° 10.68' W	631	594	x	x	
116	546	2005/09/07	09:28	15° 3.39' N	61° 12.42' W	1460	1422	x	x	
117	547	2005/09/07	11:07	15° 5.91' N	61° 13.71' W	2057	2043	x	x	
118	548	2005/09/07	13:05	15° 9.06' N	61° 15.26' W	1464	1456	x		
119	549	2005/09/07	14:33	15° 11.13' N	61° 16.77' W	856	844	x	x	
120	551	2005/09/07	16:34	14° 59.94' N	61° 22.98' W	2369	2354		x	
121	552	2005/09/07	23:04	15° 41.32' N	61° 28.43' W	788	866	x	x	
122	553	2005/09/08	00:14	15° 42.08' N	61° 27.39' W	1084	1071	x	x	
123	554	2005/09/08	01:40	15° 44.77' N	61° 28.43' W	707	631	x	x	
124	555	2005/09/08	02:45	15° 48.03' N	61° 29.85' W	470	467	x	x	
125	556	2005/09/08	04:42	15° 57.30' N	61° 33.41' W	513	250		x	
126	560	2005/09/08	19:11	16° 17.51' N	60° 41.03' W	1737	1704	x	x	
127	563	2005/09/08	20:55	16° 17.51' N	60° 38.03' W	2480	2504		x	
128	562	2005/09/08	23:18	16° 17.01' N	60° 35.11' W	3165	3120	x	x	
129	563	2005/09/09	02:00	16° 16.53' N	60° 32.09' W	4305	4334		x	
130	564	2005/09/09	05:50	16° 16.00' N	60° 26.07' W	4771	4765	x	x	
131	565	2005/09/09	10:03	16° 14.49' N	60° 19.02' W	4459	4449		x	
132	566	2005/09/09	14:56	16° 17.00' N	60° 35.09' W	3152	3101		x	Yo-Yo
133	566	2005/09/09	16:55	16° 16.98' N	60° 34.98' W	3358	3093		x	Yo-Yo
134	566	2005/09/09	18:48	16° 16.98' N	60° 34.98' W	3124	3073		x	Yo-Yo
135	566	2005/09/09	20:59	16° 16.99' N	60° 35.02' W	3134	3075		x	Yo-Yo
136	566	2005/09/09	23:07	16° 16.99' N	60° 35.01' W	3138	3088		x	Yo-Yo
137	566	2005/09/10	01:12	16° 17.00' N	60° 34.98' W	3138	3097		x	Yo-Yo
138	567	2005/09/10	08:22	16° 32.94' N	61° 30.50' W	458	453	x	x	
139	569	2005/09/10	09:24	16° 36.48' N	61° 32.02' W	433	431		x	
140	570	2005/09/10	10:22	16° 39.98' N	61° 33.53' W	417	411	x	x	
141	571	2005/09/10	11:50	16° 43.33' N	61° 35.06' W	190	674	x	x	
142	572	2005/09/10	12:54	16° 46.90' N	61° 36.54' W	853	844	x	x	
143	573	2005/09/10	14:03	16° 50.43' N	61° 38.09' W	427	421		x	
144	574	2005/09/10	14:58	16° 53.92' N	61° 39.54' W	478	466		x	

Meteor M66/1			CTD Stations				Page 5			
Prof.	Sta.	Date	Time	Latitude	Longitude	Water Depth	Prof. Depth	Measurements CFCs	LADCP	Comment
145	575	2005/09/10	15:48	16° 54.91' N	61° 39.02' W	418	412			x
146	582	2005/09/11	08:56	18° 15.00' N	63° 21.04' W	438	433			x
147	583	2005/09/11	09:50	18° 16.02' N	63° 23.51' W	852	844			x
148	584	2005/09/11	11:05	18° 18.53' N	63° 27.03' W	901	891			x
149	585	2005/09/11	12:18	18° 20.11' N	63° 30.48' W	1001	987			x
150	586	2005/09/11	13:35	18° 21.56' N	63° 34.00' W	1064	1052			x
151	587	2005/09/11	14:50	18° 23.01' N	63° 37.51' W	1136	1124			x
152	588	2005/09/11	16:19	18° 24.52' N	63° 40.97' W	863	857			x
153	589	2005/09/11	17:33	18° 26.05' N	63° 44.57' W	709	617			x
154	590	2005/09/11	18:41	18° 27.43' N	63° 47.97' W	995	1390			x
155	591	2005/09/11	20:12	18° 28.98' N	63° 51.56' W	1436	1420			x
156	592	2005/09/11	21:47	18° 30.45' N	63° 55.04' W	1559	1563	x		x
157	593	2005/09/11	23:26	18° 31.95' N	63° 58.49' W	2191	2173	x		x
158	594	2005/09/12	01:21	18° 32.88' N	64° 0.01' W	2072	2072			x
159	595	2005/09/12	03:16	18° 34.03' N	64° 2.07' W	1458	1492	x		x
160	596	2005/09/12	04:57	18° 34.44' N	64° 3.99' W	1921	1916			x
161	597	2005/09/12	07:00	18° 35.47' N	64° 6.52' W	1168	1157	x		x
162	598	2005/09/12	08:16	18° 36.50' N	64° 8.04' W	416	412			x
163	601	2005/09/12	19:04	18° 47.49' N	64° 20.02' W	622	607			x
164	602	2005/09/12	20:03	18° 50.00' N	64° 20.02' W	1312	1292	x		x
165	603	2005/09/12	21:29	18° 52.98' N	64° 20.03' W	1858	1841	x		x
166	604	2005/09/12	23:26	18° 58.40' N	64° 20.04' W	2926	2905	x		x
167	605	2005/09/13	02:10	19° 3.42' N	64° 20.04' W	3832	3812	x		x
168	606	2005/09/13	05:39	19° 8.94' N	64° 19.54' W	4851	4865	x		x
169	607	2005/09/13	09:46	19° 13.95' N	64° 19.02' W	5256	5280	x		x
170	608	2005/09/13	14:07	19° 23.93' N	64° 18.02' W	5390	5473	x		
171	609	2005/09/13	19:36	19° 41.46' N	64° 17.02' W	6938	5700	x		
172	610	2005/09/14	01:45	20° 3.92' N	64° 15.52' W	5998	5701	x		
173	611	2005/09/14	08:03	20° 26.01' N	64° 14.53' W	4960	4967	x		
174	612	2005/09/14	13:16	20° 48.49' N	64° 13.06' W	5146	5155	x		
175	613	2005/09/14	18:51	21° 10.62' N	64° 11.43' W	5339	5355	x		
176	614	2005/09/15	00:23	21° 32.47' N	64° 10.51' W	5574	5602	x		
177	615	2005/09/15	06:11	21° 52.52' N	64° 10.06' W	5741	5691	x		
178	616	2005/09/15	12:13	22° 16.90' N	64° 9.09' W	5791	5701	x		
179	617	2005/09/15	18:23	22° 42.04' N	64° 8.02' W	5806	5686	x		
180	618	2005/09/16	00:25	23° 6.92' N	64° 7.01' W	5803	5695	x		
181	619	2005/09/16	07:20	23° 36.48' N	64° 6.09' W	5805	5688	x		