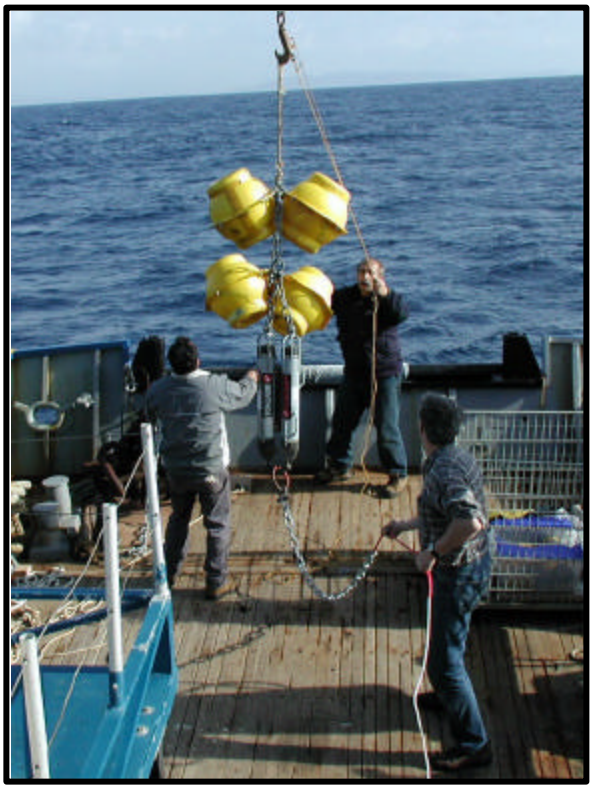
ARG Mooring Deployment



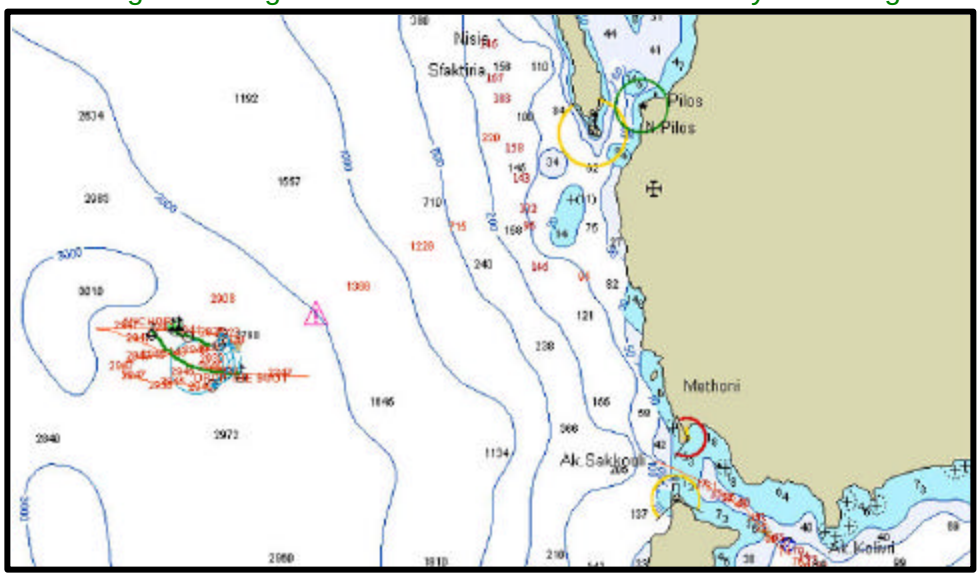
The acoustic releases are lifted over the stern during the mooring deployment.

The mooring deployment was scheduled for early November as the rainy season in southwestern Greece usually goes from November to March. Unfortunately the shipping company in Seattle failed to apply for the correct customs form, something known as an ATA carnet, and when the mooring gear arrived in Greece in October, we were informed by Greek Customs that in lieu of the ATA carnets, somebody would need to post a bond for 48,800 Euros. Nobody had this amount of money. It took over a month, and a costly trip to Greece, before the mooring gear was able to clear Customs and arrive in Pylos. By then, the deployment ship, the R/V Philia, had gone into dry dock for annual maintenance, and then the Christmas holidays and New Year's Day happened. The Principal Investigator for the mooring, Dr. Jeff Nystuen, had to attend an essential meeting from 4-8 January 2004, so it wasn't until January 10th, 2004 that Nystuen and APL Field Engineer, Eric Boget, could head for Greece to deploy the mooring.

The R/V Philia, from Heraklio, Crete, was waiting at dockside in Pylos when we arrived on Sunday night.

There had been another unexpected crisis prior to the Customs disaster. The company that owned the ship that we had expected to charter in Pylos had gone out of business. NESTOR had worked to arrange a new ship, but didn't provide an estimated cost of the charter until late September. The estimate, nearly $25,000 for just the deployment, was way too high for our budget. We had to scramble to find another ship. The Director of the National Center for Marine Research (NCMR), Dr. Georgio Chronis, offered to let us use the R/V Philia, from Heraklio, Crete, for about $3500 per day for the deployment cruise. This

was an excellent deal for us, as the R/V Philia is a small, but well equipped and crewed research vessel. The Philia was waiting for us in Pylos when we arrived on Sunday night, January 11th. We introduced ourselves to Captain Manolis Kokos and the rest of crew before retiring for the night. The weather forecast for Tuesday was marginal.



An overview of the bathymetry near Pylos (Pilos) and Methoni. The blue circle under the survey location in the left part of the diagram has a diameter of 1 nautical mile (1.7 km).

On Monday, we unpacked our gear at NESTOR and loaded it onto the ship. Two of the shipping crates had been bashed in during shipping, but all of the equipment checked out ok. We spent all day and well into the evening finishing the mooring rigging and getting everything ready for the deployment. The original plan was to put the mooring on the 2000 m isobath. But the Acoustic Rain Gauges (ARGs) needed to be at very specific depths for the scientific objectives. This required a very precise mooring placement and the 2000 m isobath is on a very steep underwater slope. After examining the bathymetric (depth) charts for the region, we had decided to put the mooring on a shelf a couple of kilometers further offshore in water about 2900 m deep. But we would need to do a survey before choosing the exact location for the mooring.

Spooling the mooring line onto the ship's winch on Monday afternoon.

There are two ways to deploy moorings: anchor-first and anchor-last. The anchor first deployment allows for a more

precise mooring location, but the heave of the ship in the waves and the heavy anchor on the end of the line as it is lowered into place puts a lot of stress on the mooring line and may break it. With such a long mooring line, 2960 m, this is risky, especially if there are significant ocean waves present. The safer method is anchor last. This method has the top of the mooring, a float, placed in the water first. The mooring is then spooled out onto the sea surface, for 2960 m. The anchor is dropped last, and sinks down, pulling the mooring underwater. However, the mooring line also pulls the anchor to the side, and so the anchor lands some distance from the drop location. With such a long mooring line, a fairly large region of relatively flat ocean bottom is needed to insure that the correct depth is achieved. We rigged the winches for an anchor-first deployment, but knew that we might have go anchor-last.

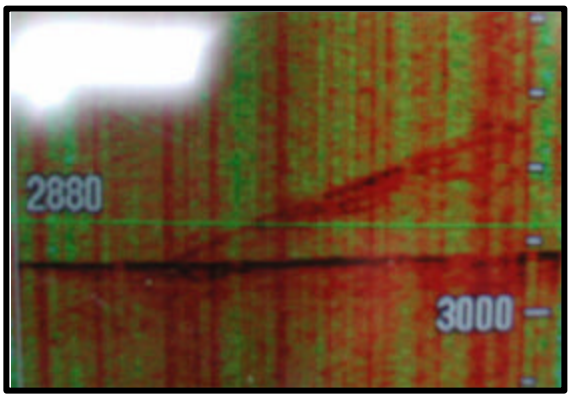
Crewmember Kikos Matsos and Eric Boget enjoying a break at sunset on Monday. Kikos is fishing from the dockship. He caught a few small fish for dinner.

The weather forecast for Tuesday had not changed. It is fairly windy in the Ionian Sea in the winter and the winds were blowing from the west, allowing the waves to build up. On Tuesday morning the Captain decided to go out anyway to check on proposed deployment location. It was too rough for an anchor-first deployment and even too rough for an anchor-last deployment. The P.I. got slightly seasick and the cook wasn't seen all day. The proposed deployment location was fairly flat, although 2940 m deep, rather than 2960 m. Fortunately, Eric had inserted a separate section of line, exactly 20 m long, into the mooring line and could easily remove it to shorten the mooring line to 2940 m.

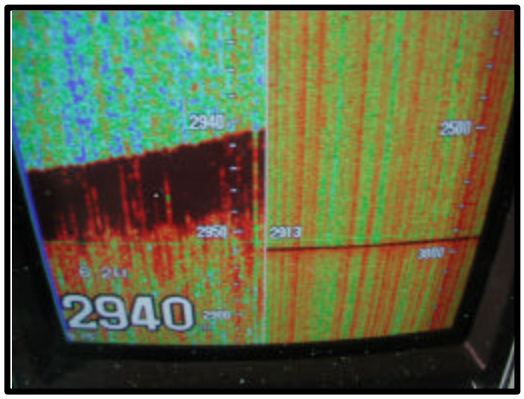
Steaming back into Pylos on Tuesday afternoon. It was too rough to deploy the mooring on Tuesday. The seas were 2 m high and the wind over 10 m/s.

The Survey

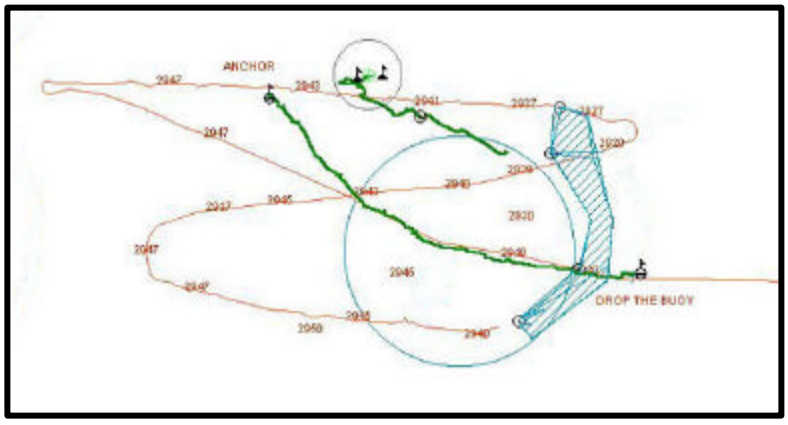
The winds were down a bit on Wednesday morning, but the waves were still too high and so we decided to go anchor-last. The first task was to do the detailed survey of the mooring area to be sure that the bottom was flat. The Philia has a depth sounder using a low frequency that can reach the bottom nearly 3 km beneath the ship. Depth sounders work by sending a sound pulse downward. The time of the return echo determines the depth. If the bottom is flat, then there is only one strong return. However, if there is a nearby cliff, then two echos are returned: one from the bottom, and one from the top of the cliff even though the cliff isn't directly below the ship. As we zigzagged over the area, the Captain identified a cliff on the eastern edge of the area. We had to make sure that the anchor would clear the cliff when we dropped it.



The sonar screen showing an underwater cliff. The main return (horizontal dark line) is from the bottom at 2880 m, but the diagonal dark line is from a cliff. The signal from the top of the cliff arrives sooner than the signal from the bottom, although the cliff is not directly below the ship.



The sonar screen showing a flat bottom with a depth of 2940 m. This is what we wanted to see.



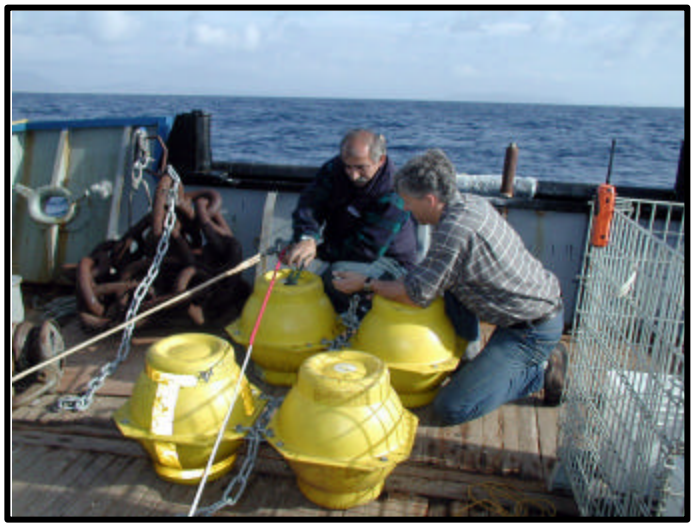
The completed survey. The red line (with depths) shows the ship track. The large blue circle is the target area, 1 nm in diameter. The blue cross-hashed area is the location of the cliff. The lower green line shows where the mooring line was laid out on the ocean surface starting with the float at the point marked "drop the buoy" and ending at the point where we dropped the anchor "anchor". The anchor landed in the small circle at the top, nearly 1 km to the east of the drop point. The ocean current must have been going to the north on this day.

Into the Water

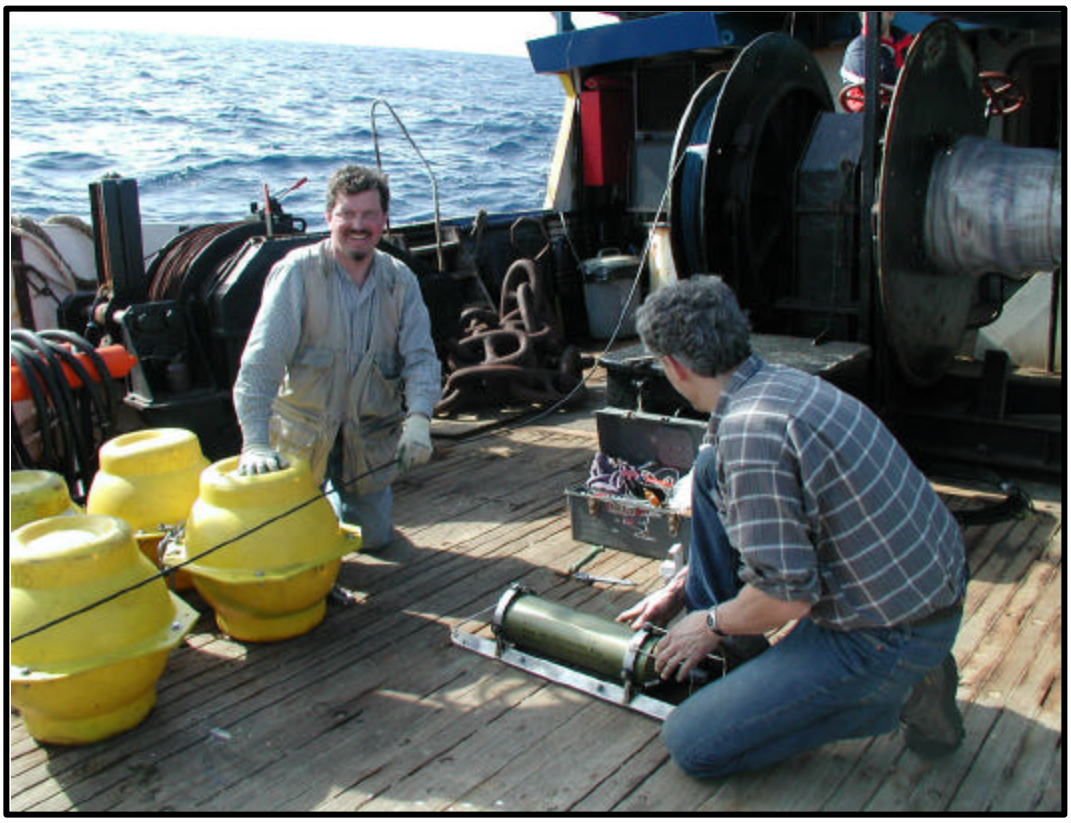
The Captain giving final instructions to the crew for the mooring deployment. He ordered that a 200-m line be tied to the top of the float so that we could find the final landing position of the mooring, and that we could "lift it up" to verify the depth. This line would be cut as the final action of the deployment.

The waves were still too high for an anchor-first deployment. We would do anchor-last, but this required "flipping" the mooring line on the winches. It had been spooled onto the winch with the topside end of the rigging spooled on first. It took about an hour to "flip" nearly 3 km of line. Once that was done, the top float, designed to be 30 m underwater was hoisted over the stern. And then the Captain slowly steamed away as the line was reeled out. At each spot in the mooring line where an instrument is placed the winch is stopped while the instrument is attached to the line, and then the spooling continues. Ultimately nearly 3 km of line was stretched across the ocean surface. Fortunately, no other ships were present, as they might have steamed across the line and cut it.

"Flipping" the mooring line. The mooring line is being reversed onto a second winch to allow for an anchor-last deployment.



Attaching four floats to the mooring line. A glass ball inside each yellow case provides 25 kg of buoyancy. The anchor is the pile of huge chain links next to the stern. It weighs 600 kg in air (522 kg in water).

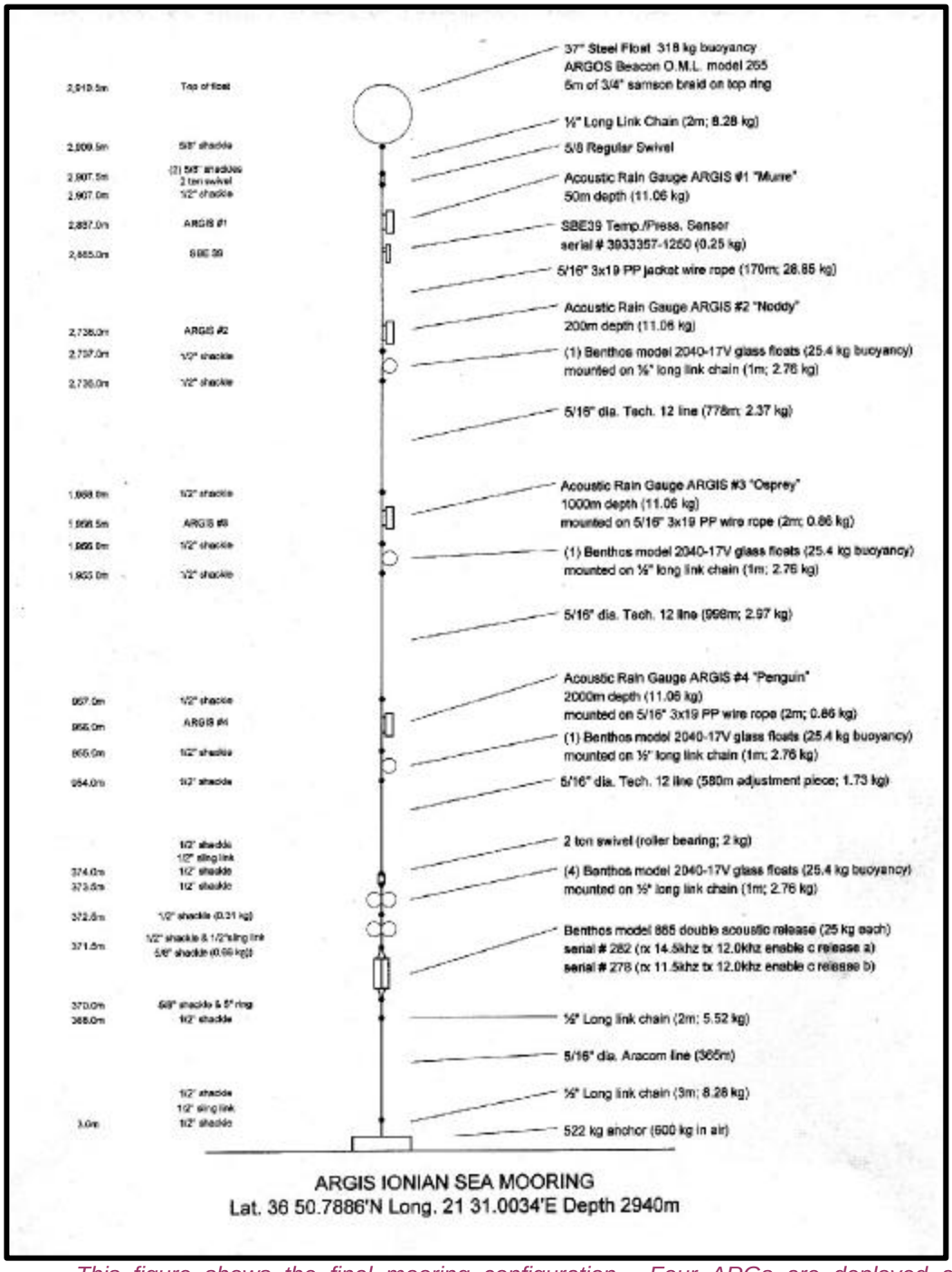


Jeff Nystuen and Eric Boget attaching an Acoustic Rain Gauge (ARG) to the mooring line.

Once the entire mooring line was laid out on the ocean surface, the Captain slowly moved the ship to the spot that he thought was the best drop point. As soon as we released the anchor, he turned the ship and began to steam towards the top float deployment position. It takes about 30 minutes for the anchor to reach the bottom. As the anchor drags the mooring line down, the top float begins to "surf" across the ocean surface. We scanned the ocean for the float, spotted it, and then chased it as it led us to the final landing location for the anchor. The upper green line on the final survey figure shows the chase. The eastern end (right) shows where we spotted the float and the upper circle shows where the float disappeared underwater. The Captain had ordered that an extra 200 m of line (with floats) be added to the top, so that we could verify the exact location of the mooring and so that we could lift it up to verify the exact depth of the top float. To my surprise, this extra line disappeared underwater, and stayed underwater for about 10 minutes before resurfacing. We grabbed it, pulled on it, and decided that the mooring was within 5 m of the correct depth (2940 m). Satisfied, we cut the line and headed home.

The top float surfing through the waves as it is being dragged down by the anchor falling to the bottom. We chased it, until it disappeared underwater, hopefully not to be seen again until the mooring is recovered in April 2004.

Mooring Configuration



This figure shows the final mooring configuration. Four ARGs are deployed at 50m, 200m, 1000m and 2000 m. A top float provides 375 kg of buoyancy. The exact depth of the top ARG is determined by a pressure sensor located next to that ARG. A dual acoustic release system is located below the lowest ARG. When the mooring is to be recovered, an acoustic signal is sent to this release allowing the mooring to rise to the surface. The anchor stays on the bottom. An emergency satellite beacon is located on the top float. If the mooring releases prematurely, this beacon will notify us that it is on the surface. No news is good news!

P.I. Jeffrey Nystuen and Captain Manolis Kokos

Crewmembers Manolis Paraschakis and Costas Parascevas operating the winch and crane during the deployment.

Crewmember Michalis Soulvas surveying Pylos harbor

Eric Boget enjoying the ride home after a successful deployment

The R/V Philia heading back to Crete on Thursday after the deployment

Sunset at the mouth of Narvarino Bay, Pylos, Greece