

Technical Report
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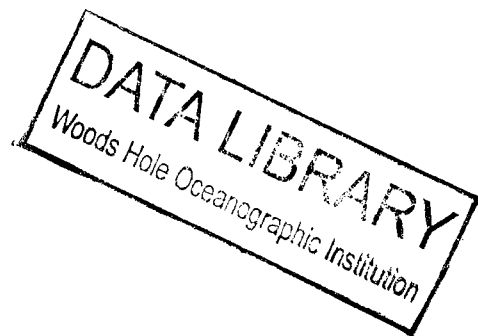


Pan American Climate Study (PACS) Data Report

by

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March 2000



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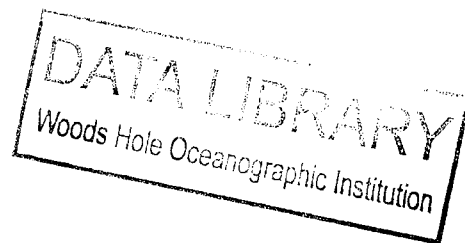
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Abstract

The surface mooring component of the NOAA Pan American Climate Study (PACS) took place from April 1997 to September 1998 in the eastern tropical Pacific. PACS was a NOAA funded study with the goal of investigating links between sea surface temperature variability in the tropical oceans near the Americas and climate over the American continents. Two air-sea interaction surface moorings were deployed along 125°W, spanning a strong meridional sea-surface temperature gradient. One mooring site was located in the cold tongue south of the equator, and the other site was in the region of warm ocean found north of the equator, near the northernmost summer location of the Intertropical Convergence Zone. The moorings were deployed to improve our understanding of air-sea fluxes and the processes that control the evolution of the sea surface temperature field in the region.

Four air-sea interaction buoys were deployed to occupy two sites for a period of 17 months. The sites were along 125°W near 3°S and 10°N. The Upper Ocean Processes Group at WHOI deployed the first two moorings in April 1997. These moorings were replaced with a second pair of moorings in December 1997. The final recovery occurred in September 1998. Each of these buoys on these moorings were equipped with meteorological instrumentation, including a Vector Averaging Wind Recorder (VAWR) and an Improved METeorological (IMET) system. The moorings also carried Vector Measuring Current Meters (VMCMS), single point temperature recorders and a few conductivity sensors on the mooring line to monitor the upper 200m of the ocean. In addition to the traditional instruments, several other experimental instruments were deployed with limited success on the mooring line including acoustic current meters, acoustic rain gauges and bio-optical instrument packages

This report describes the instrumentation deployed on the PACS surface moorings, along with information on the processing and quality control of the returned data. It presents a detailed overview of the meteorological and physical oceanographic data including time series plots, statistics and spectra of key parameters. It also presents analysis of the estimated air-sea heat, moisture and momentum fluxes.

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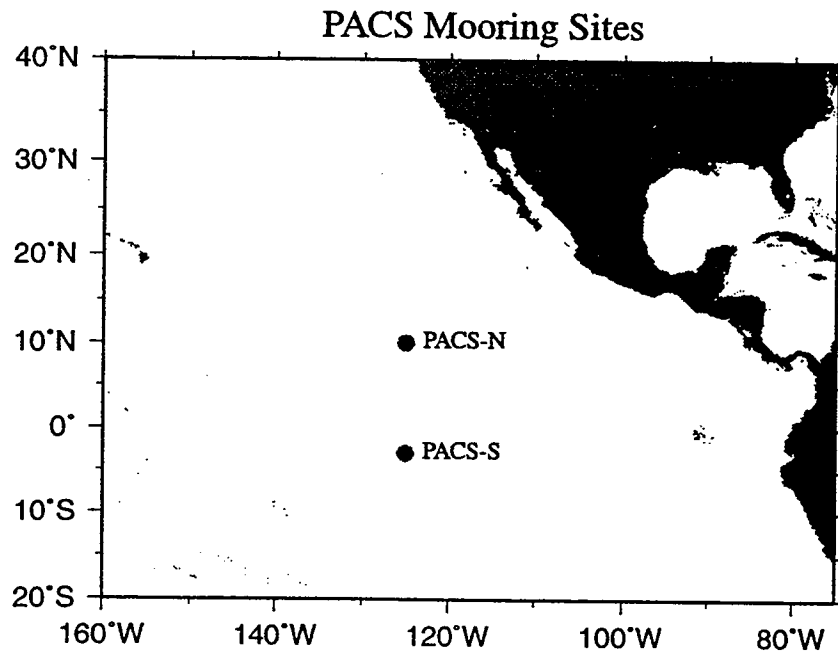
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Section 1: Introduction

The sea surface temperature field in the eastern tropical Pacific, with its strong asymmetry about the equator, annual and interannual variability, and links to climate are of great interest to the NOAA Pan American Climate Study (PACS) Program. The sea surface temperature field is believed to control the strength and location of the Inter-Tropical Convergence Zone (ITCZ); and this variability in the ITCZ may in turn influence the location of the jet stream and precipitation over North America. However, our understanding of the processes that control sea surface temperature in this region is lacking and uncertainties in existing climatologies of the surface heat flux, wind stress, and precipitation are large. The ITCZ and the warm water north of the equator both move north and south annually, but the details of the coupling between the two are unknown.

From April 1997 through September 1998, in a study for PACS, sites at 3°S and 10°N along 125°W were occupied with air-sea interaction surface moorings equipped to collect accurate time series of surface meteorology and upper ocean temperature, velocity, and salinity structure (Figure 1-1). The two sites span strong gradients in ocean temperature, from the cold tongue just south of the equator to the warm waters north of the equator, and gradients in cloud cover and precipitation associated with the location of the ITCZ.

Figure 1-1. PACS Equatorial Pacific Mooring Locations



Each mooring carried two complete sets of meteorological sensors (wind speed and direction, air and sea temperature, incoming short-wave radiation and incoming long-wave radiation, humidity, barometric pressure, precipitation). Both the Vector Averaging Wind Recorder (VAWR; Weller *et al.*, 1990) and Improved Meteorological (IMET; Hosom *et al.*, 1995) systems were used in redundancy to ensure that a complete and accurate time series of all meteorological variables would be collected. The moorings also carried oceanographic sensors (temperature, conductivity and current) placed in the top 200 m of the ocean to monitor the upper ocean variability.

The meteorological data permit the accurate calculation of the heat, freshwater, and momentum fluxes across the air-sea interface via the bulk formulae using techniques perfected in the Tropical Ocean-Global Atmosphere Coupled Ocean Atmosphere Response Experiment (TOGA COARE; Fairall *et al.*, 1996a). Data from the moorings will improve our understanding of the air-sea fluxes in the eastern tropical Pacific and the processes that control sea surface temperature.

The moorings were deployed in April 1997 from the R/V *Roger Revelle*, serviced in December 1997 from the R/V *Thomas Thompson* and recovered in September 1998 from the R/V *Melville*. A detailed description of the field work can be found in the cruise reports (Way, *et al.*, 1998, Trask *et al.*, 1998 and Ostrom *et al.*, 1999). Meteorological and hydrographic data were collected during all three of these cruises to complement the moored time series data. These new observations were made along an existing north-south line of the TOGA Tropical Atmosphere and Ocean (TAO) mooring array, which provides a larger time and space context for the work and a means to examine the effects of remote forcing.

This report documents the meteorological and oceanographic data returned from the PACS surface moorings. Section 2 describes the instrumentation used on the moorings. Section 3 describes the data processes and quality control. Time series plots, statistics and spectra of key parameters in Section 4 for the northern site and Section 5 for the southern site.

Note that the first buoy deployments covering the time period from April-December 1997 will be noted as PACS1 and the second deployments covering the time period from December 1997 to September 1998 as PACS2. The buoys deployed near 10°N are noted as NORTH (N) and those near 3°S as SOUTH (S). The specific times and locations are given in Table 1-1, 1-2.

Table 1-1 PACS 1 mooring deployment/recovery information

Mooring	Deployment Date and Time	Recovery Date	Anchor Position
WHOI PACS - South Discus Buoy WHOI Mooring Reference No. 1014	21 April 1997 @0002 UTC	7 December 1997 @1548 UTC	2°46.78'S 124°39.38'W
WHOI PACS - North Discus Buoy WHOI Mooring Reference No. 1015	29 April 1997 @2135 UTC	17 December 1997 @ 1533 UTC	9°58.99'N 125°23.39'W

Table 1-2 PACS 2 mooring deployment/recovery information

Mooring	Deployment Date and Time	Recovery Date	Anchor Position
WHOI PACS South Discus Buoy WHOI Mooring Reference No. 1020	9 December 1997 @ 0036 UTC	20 September 1998 @1429 UTC	2° 46.231'S 124° 39.733'W
WHOI PACS North Discus Buoy WHOI Mooring Reference No. 1021	19 December 1997 @ 0119 UTC	14 September 1998 @1429 UTC	9° 55.787' N 125° 24.772'W

Section 2: Instrumentation

Details about each type of instrument on the PACS moorings are provided below beginning with the meteorological instrumentation and then followed by the subsurface instrumentation. Specific information about the instrumentation deployed during PACS1 can be found in Way *et al.*, 1998 and for PACS2 in Trask *et al.*, 1998.

The instrumented buoy is shown in Figure 2-1-1 and the tower top plan view layout for PACS1 and PACS2 is provided in Figure 2-1-2. PACS1 and PACS2 North mooring schematics are shown in Figure 2-1-3 and 2-1-4. PACS1 and PACS2 South mooring schematics are shown in Figures 2-1-5 and 2-1-6. Blow-ups of the buoy tower and bridle for all four moorings are shown in Figures 2-1-7, 2-1-8, 2-1-9, and 2-1-10.

2-1. Meteorological Instrumentation

The WHOI discus buoys were outfitted with two separate meteorological packages. One system was a VAWR which logged and telemetered data from eight meteorological sensors. The second meteorological data recording system called IMET logged data from nine meteorological sensors and this data was also telemetered. On the PACS1 deployment both buoys had a stand-alone, internally recording instrument that measured relative humidity and air temperature. In addition to the VAWR and IMET systems deployed on the PACS2 buoys, there was also a stand-alone, internally recording instrument that measured precipitation as well as another that measured both relative humidity and air temperature. The relative humidity instrument deployed on PACS2 is an improved version of the IMET relative humidity module in that it was self-powered and recorded its data internally. It was part of a family of instruments called ASIMET which have been in use on Volunteer Observing Ships (VOS).

Figure 2-1-2 show a plan view layout of the meteorological instrumentation mounted on the PACS1 and PACS2 WHOI discus buoys. Tables 2-1-1 and 2-1-2 list the buoy-mounted instrumentation on the PACS1 and PACS2 North. Tables 2-1-3 and 2-1-4 list the buoy-mounted instrumentation on PACS1 and PACS2 South, respectively. The information listed includes sensor identification and sensor height with respect to the water line. The height of all buoy-mounted instrumentation is referenced to the buoy deck and the water line.

Figure 2-1-1. Photo of PACS South Instrumented Buoy

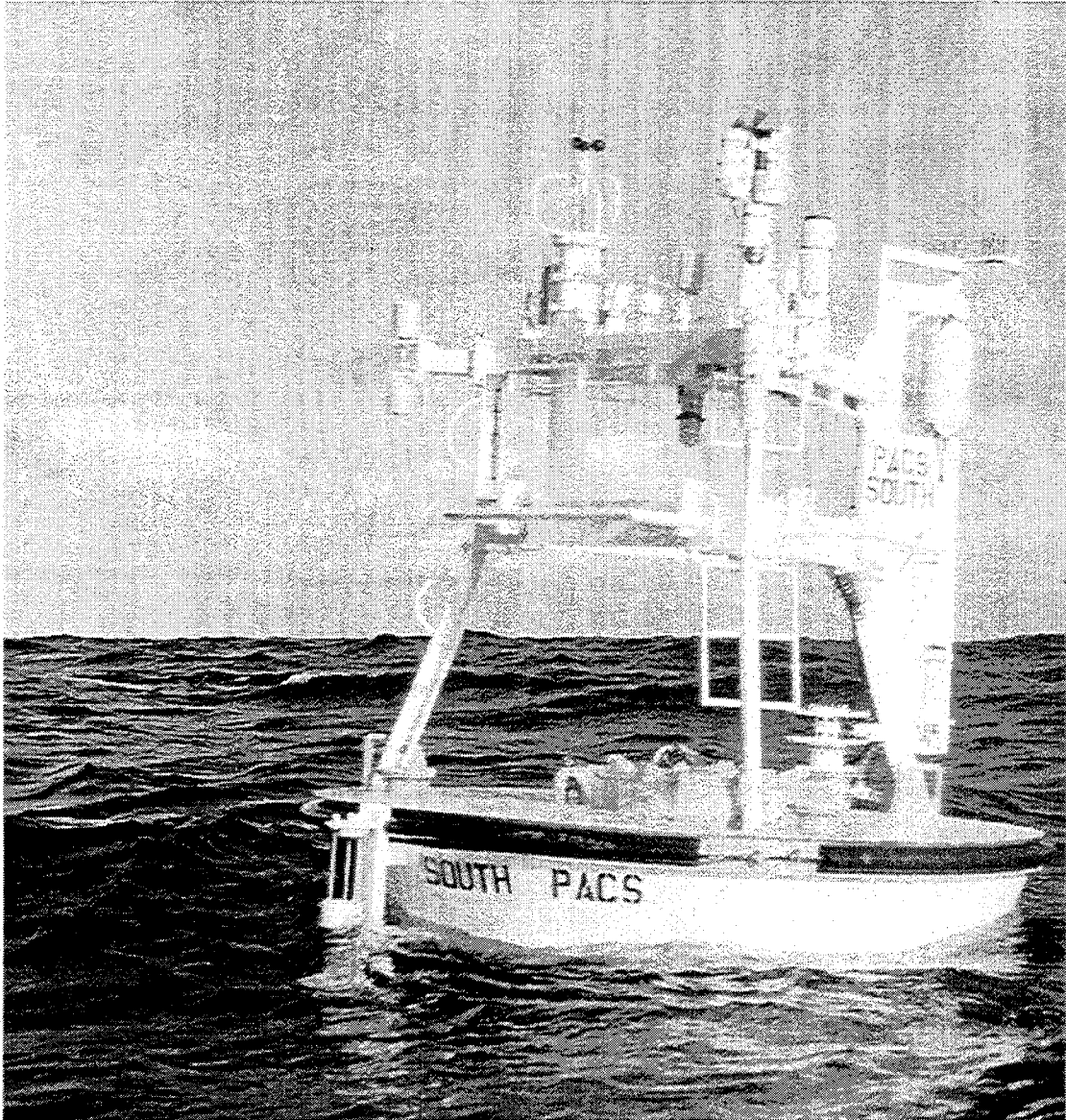
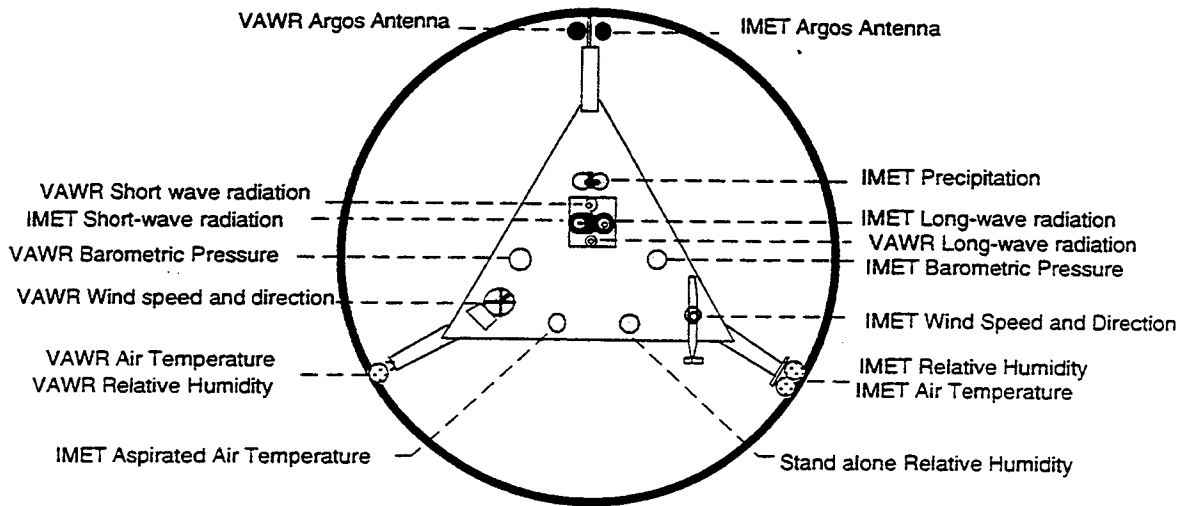
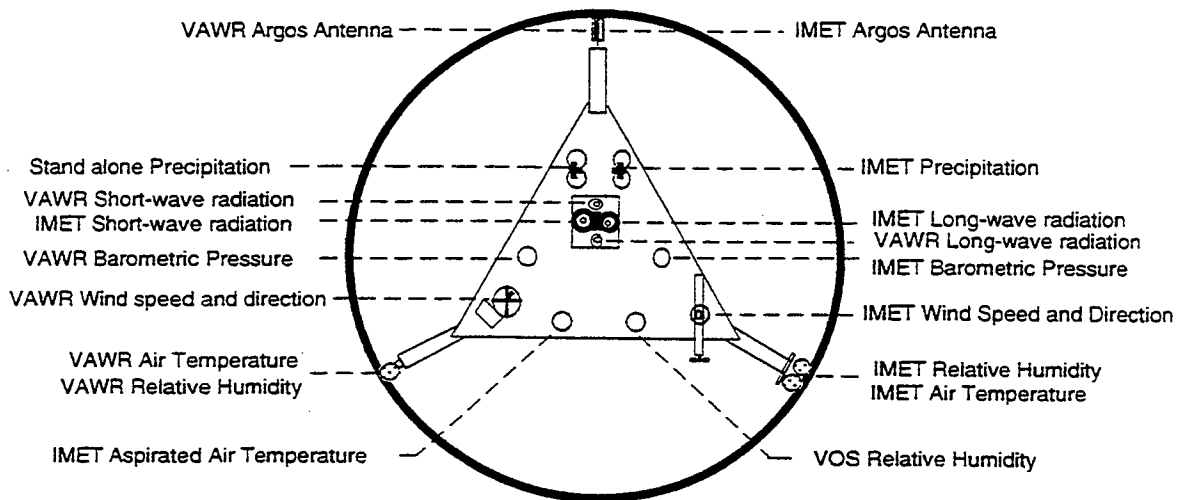


Figure 2-1-2. PACS Tower Top Layout



PACS 1 Discus Buoy Tower Layout



PACS 2 Discus Buoy Tower Layout

Figure 2-1-3. Schematic of PACS1 North Mooring.

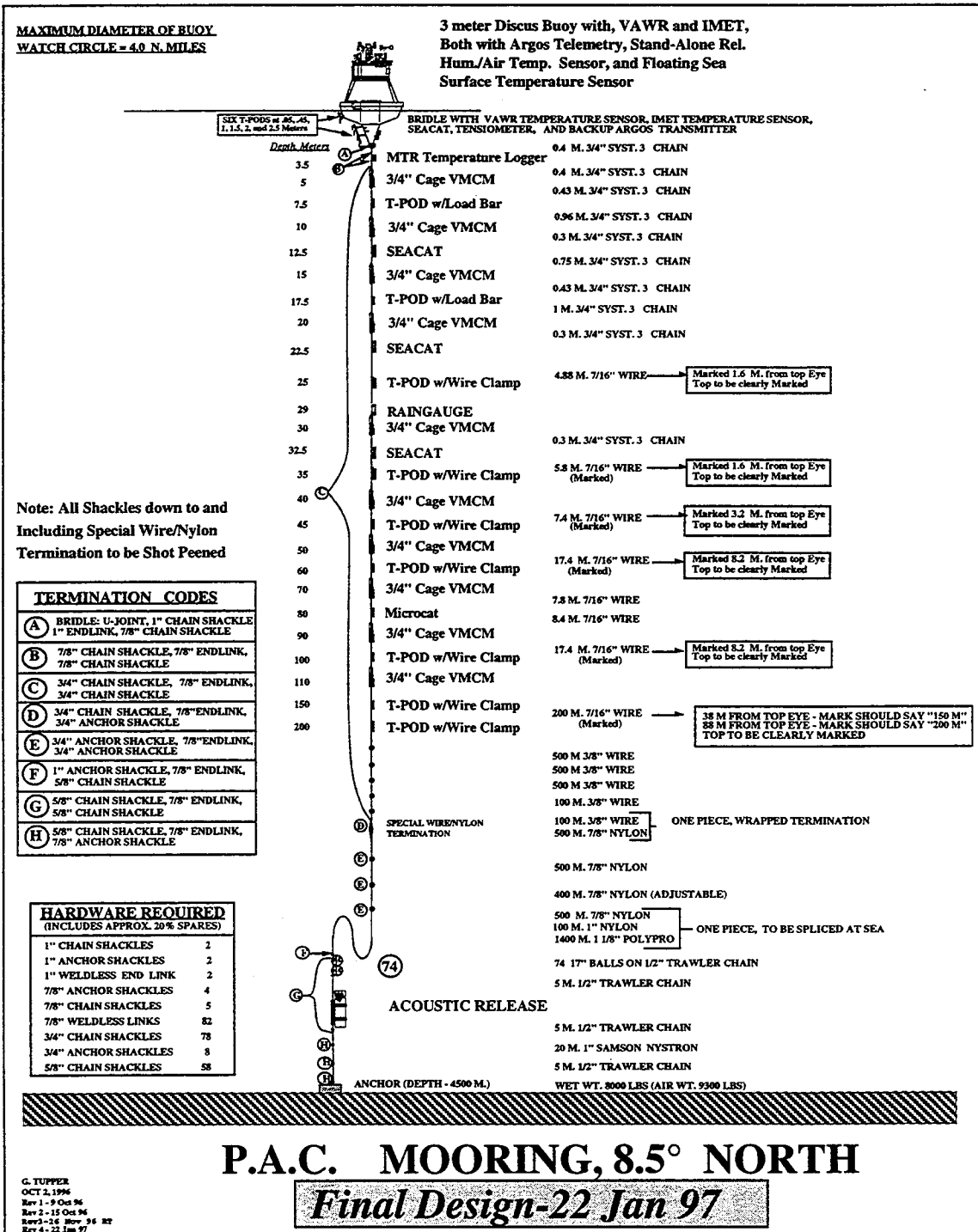


Figure 2-1-4. Schematic of PACS2 North Mooring.

