



A short history of Ocean Station Papa and Line P

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Abstract

This short article summarises the origins of observations at Ocean Station Papa, the evolution into Line P and the subsequent history of observations along that line.

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1. The origins of Line P

The Line P workshop in July 2006 was conceived to salute 50 years of oceanographic observations along Line P, but when did the time series begin exactly? I suggest that any really great endeavour has many starting points and Line P/Station P is no exception. The observing system along Line P was a direct outgrowth from the observations at Ocean Station Papa which itself has a long history, so it is worthwhile to ask how this all came about and when did “Line P” actually begin and why did it begin?

The seeds that grew into Line P were sown during the Second World War. In the Pacific Ocean the role of weather observations and forecasts during the Battle of the Coral Sea, in May 1942, and the increasing volume of trans-Pacific flights resulted in stations being established to monitor marine weather systems, and in 1943 the US Navy established two stations, one north of Hawaii and another in the Gulf of Alaska at 50°N and 145°W. The latter was manned by the 73 m Coast Guard Cutter *Haida*, which continued to occupy this station on and off for the remainder of the war. This was followed shortly afterwards by three plane-guard stations on a line between Hawaii and San Francisco. As the Pacific war moved westward additional stations were set up under air routes and in areas of special meteorological interest. Throughout the war, stations were established and directed by Navy commands and initially were occupied by Naval patrol vessels and auxiliary craft but as Coast Guard manned frigates arrived in 1944 most were assigned to weather station duty.

At first the personnel assigned to the Pacific Weather Ships restricted their activities to the observation and reporting of weather, but eventually an oceanographic program was added. At Ocean Station Peter (it later became Papa and will be referred to as OSP) daily observations of water column structure using mechanical

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bathythermographs began on 19th December 1949 and continued until the US vacated the site in June 1951 (Leipper, 1954). It is not clear why the US Navy withdrew from OSP though it is evident that there were budget problems.

At this point the US Weathership was promptly replaced by a Canadian vessel, but the personnel on board did not immediately view oceanographic observations as part of their mandate. Eventually, in July 1952, twice-daily mechanical bathythermograph observations began, so perhaps we could celebrate either December 1949 or July 1952 as the starting date of the oceanographic time series. In July 1956, hydrographic stations were started. The water column was usually sampled only to 1200 dbars, but occasionally samples (reversing thermometers and bottles sampled for salinity, oxygen and macronutrients) were gathered to the bottom. So perhaps July 1956 represents the start of the really useful oceanographic program. At this time the oceanographic sampling was managed by personnel at the Pacific Oceanographic Group of the Fisheries Research Board of Canada based in Nanaimo, British Columbia. Fig. 1 shows the Group in 1962.

In April 1959 hydrographic casts were started at seven stations along a line leading to Station Papa. This represents the start of the Line P program. During 1959 there were five surveys that took observations at the locations we now know as P7, P12, P15, P18, P21, P24 and P26. Sampling expanded slowly with eight stations typically sampled in 1960, nine in 1962, 11 in 1963 and 13 stations in 1965. By this time the sampling was stable and the original 13 stations were well established. Electronic measurements began in April 1969 when a Bissett-Berman STD was used for the first time.

The 13-station configuration was the standard set of observations from 1965 to 1981 and in Table 1 we list the stations occupied.

Many ships have occupied Station Papa throughout its history, but most notable were the contributions from the purpose-built weather ships, the *Quadra* and the *Vancouver*, the latter is shown in Fig. 2. These vessels were operated by the Canadian Department of Transport and each operated on a 6-week rotation sampling along Line P on the way out to the weather station. In August 1981 the Canadian Weathership program was terminated as a contribution to government austerity. The value of the oceanographic program was well recognised, so the Line P oceanographic program was maintained purely for its value as a research program using vessels operated by the Institute of Ocean Sciences (now, but not originally, with the Department of Fisheries and Oceans) which had itself come into existence only a few years earlier. At that time the number of stations comprising Line P was increased to 26, and then a little later to 27 where it rests today. That tran-



Fig. 1. Personnel of the Pacific Oceanographic Group in 1962. Front row, left to right: Al Dodimead, Noel Boston, Tim Parsons and John P. Tully. Second row: Fred Barber, Harry Hollister, Larry Giovando and John Strickland. Top row: Bob Lake and Nick Fofonoff.

Table 1

A list of the 13 stations comprising Line P from 1965 to 1981

Original name	Modern name	Latitude (N)	Longitude (W)
P01	P01	48° 34.5'	125° 30.0'
P02	P02	48° 36.0'	126° 00.0'
P03	P04	48° 39.0'	126° 40.0'
P04	P06	48° 44.6'	127° 40.0'
P05	P08	48° 49.0'	128° 40.0'
P06	P12	48° 58.2'	130° 40.0'
P07	P14	49° 07.4'	132° 40.0'
P08	P16	49° 17.0'	134° 40.0'
P09	P18	49° 26.0'	136° 40.0'
P10	P20	49° 34.0'	138° 40.0'
P11	P22	49° 42.0'	140° 40.0'
P12	P24	49° 50.2'	142° 40.0'
P13	P26	50° 00.0'	145° 00.0'

Fig. 2. The *CGS Vancouver* in 1966.

sition in sampling is easily visible in the time/longitude plot of station occupations from 1956 to the present time shown in Fig. 3.

In 2007, sampling along Line P usually comprises three surveys per year, in February, May and August/September. This strategy is aimed at supplying the minimal resolution needed to observe seasonal variability in the ocean. This is rather a far cry from the nine surveys completed in 1980, for example, but Line P remains a critical set of ocean observations that benefits from the long history available. Occasionally the vagaries of ship availability resulted in sampling gaps that are evident in Fig. 3, but also it was occasionally possible to increase the frequency of observations, for example during the 1997/1998 El Niño event when IOS scientists initiated an intense El Niño watch program. The vessel that today is used almost exclusively for observations along Line P is the *CCGS John P. Tully*, named after the long-time director of the Pacific Oceanographic Group shown in Fig. 1. The *CCGS J.P. Tully* is shown in Fig. 4 as it left the dock at the Institute of Ocean Sciences for a Line P trip in May 2003. Perhaps the most striking feature of this photograph is the contrast with Fig. 1, the evident change in gender balance in oceanography between the 1950s and the present day.

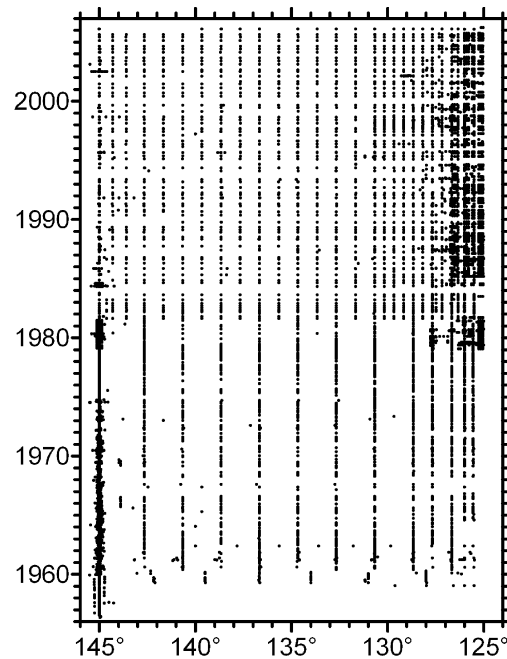


Fig. 3. The distribution of stations occupied in longitude and time along Line P from 1956 to the present time.



Fig. 4. The *CCGS John P. Tully* in May 2003 embarking on a trip to Ocean Station Papa. Standing to the right of the rosette is Michelle Li, continuing to her right around the rosette are Wendy Richardson, Chief Scientist Marie Robert, Nina Nemcek, Magnus Eek, and Bridget Watts (in front of the rosette).

As the inventory of data acquired along Line P grew so did the demand for time to perform experiments at OSP. Notable among the special programs at OSP were MILE (the Mixed-Layer experiment) in 1977, SUPER (Subarctic Pacific Ecosystem Research) in 1984, STREX (the Storm Response Experiment) in 1980, Ocean Storms in the fall of 1987, the El Niño watch program of 1997/1998 and the SOLAS/SERIES iron enrichment experiment in July 2003. However, the larger surveys along Line-P itself became a focus of activities in support of JGOFS (Joint Global Ocean Flux Study) and WOCE (the World Ocean Circulation Experiment) during

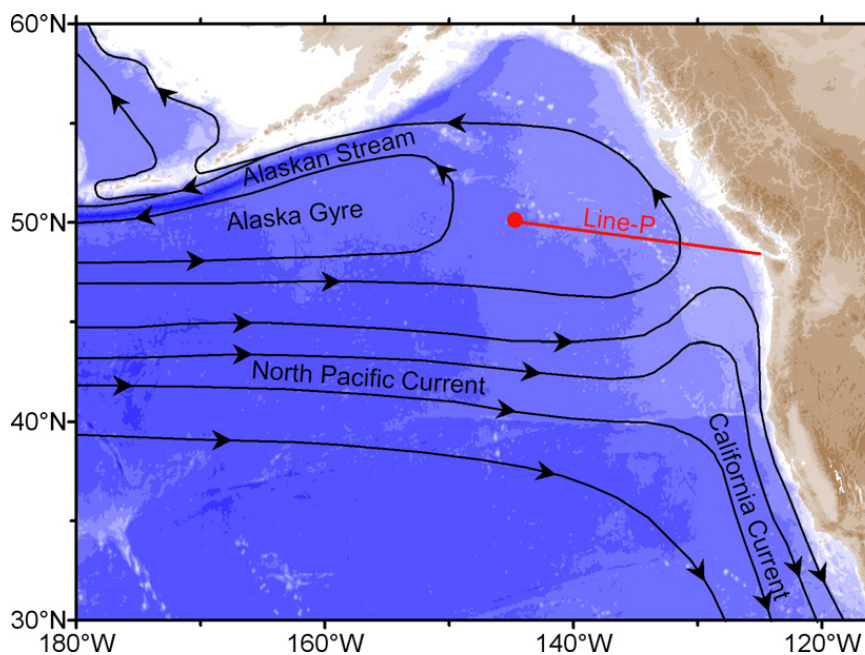


Fig. 5. The relationship of Line P to the dominant ocean current systems, based on Dodimead et al., 1963.

the 1990s. (In WOCE reports Line P is listed as line PR6, i.e. Pacific Repeat survey 6.) Early in the 21st century Fisheries and Oceans Canada began issuing annual “State of the Ocean Reports” and Line P observations quickly became an integral part of this report because of the long history available.

The ocean as seen along Line P is an area of weak currents. Fig. 5 shows the relationship of Line P to the major current systems following a sketch by Dodimead et al. (1963). Since that time we have refined our view of the circulation systems but though the maps produced by Argo (Freeland, 2006, for example), show considerable variability in the mean state they do not differ qualitatively from this view of the N.E. Pacific Ocean. Usually OSP lies within the Alaska Gyre, whereas the landward section is in the area that Dodimead called the “transition zone”. The North Pacific Current flows towards the coasts of the Americas and bifurcates near Vancouver Island with a northward branch forming the Alaska Current and a southern branch forming the California Current. This naturally produces a stagnation zone with weak currents and this is usually where the inshore section finds itself. This placement of the line has led to endless debates about whether or not Line P is in the right place, might it be better farther north or farther south? My conclusion is that yes, this may be a very quiet area of the ocean, but notwithstanding that observation Line P is in exactly the right place, specifically, it is where it has always been as the continuity of observations is critically important.

With the Mid-Ocean Dynamics Experiment (MODE) in the Atlantic Ocean oceanography began to learn one awkward lesson, and this is that the ocean is dominated by variability and the quiet northeast Pacific is no exception. Fig. 6 shows the enormous anomalies observed in the temperature field during two major El Niño events, the first beginning almost immediately after the demise of the old weather ship program and its reincarnation as a research program. The 1982/1983 El Niño showed clearly that massive changes taking place in the Gulf of Alaska and the concept of a static ocean, even in this quiet location, was forever lost. The 1982/1983 event remained “the El Niño of the century” until the event of 1997/1998. With the experience gained in 1982/1983 an intensive El Niño Watch program was initiated before any impact had occurred in the Gulf of Alaska. Superficially there are great similarities between the events, both being intense close to the coast, but the differences are quite as interesting. The 1997/1998 event showed larger deviations from normal, much closer onshore than the 1982/1983 event and did not penetrate as deeply as the early event. Nobody has yet offered an explanation for the differences.

To understand the role of variability one first needs to determine a mean state so that deviations from that state can be defined. In that sense this is what the five decades of observations along Line P have given us, a good representation of the mean state. The first commonly-used mean state for the ocean along Line P was

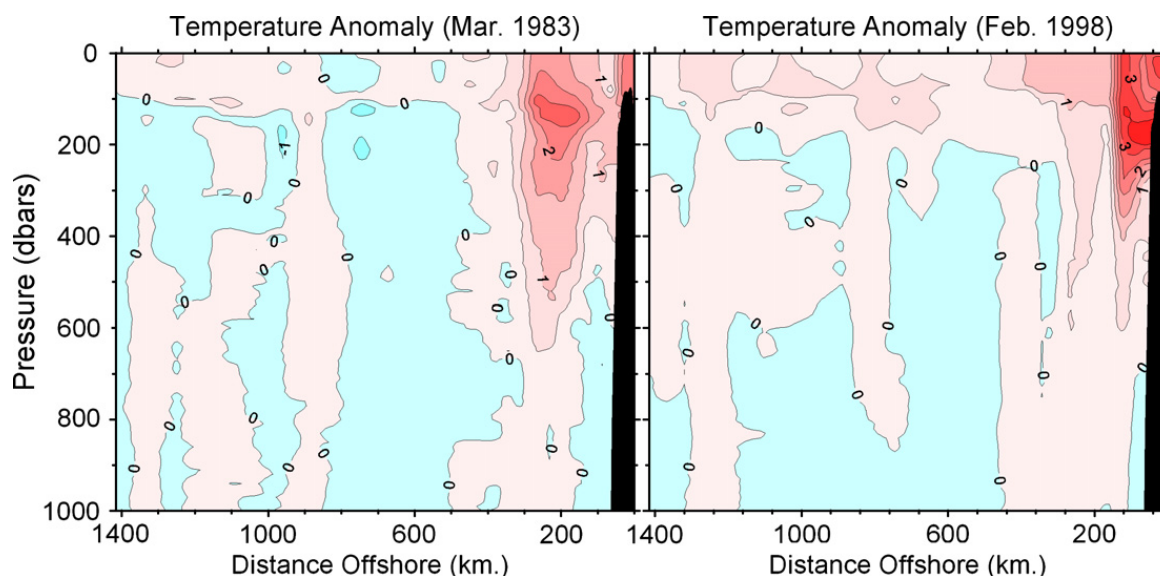


Fig. 6. The deviations from mean temperature along Line P, during the two largest El Niño events of the century.

published by Tabata and Weichselbaumer (1992a,b), which needs to be studied alongside Tabata and Peart (1985). These summaries were updated by Marie Robert (unpublished data set) who extended the database slightly to 1991 and took great care to make unbiased estimates of the mean states. It is this mean state that is most commonly used and allows the creation of spectacular images, as exemplified by Fig. 3, showing the large variability that can occur along Line P. But such diagrams are possible only because of the foresight of individuals that started the observations in 1942, 1949, 1952, 1956 or 1959 and maintained the program in 1981 against heavy odds.

2. Summary

The Line P archive provides a unique picture of the mean state of the ocean in the Gulf of Alaska, and also allows description of variability about the mean state. Line P is a core program with a considerable body of knowledge supporting it and as such it is a natural location for value-added expeditions that explore basic processes taking place in the ocean.

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