The state of the eastern North Pacific in the first half of 1997

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Dr. Howard Freeland is Head of the Ocean Science and Productivity Division at the Institute of Ocean Sciences (Department Fisheries and Oceans, Canada) and a member of PICES' Physical Oceanography and Climate Committee. His research interests include the climatic state of the ocean and low frequency variability. Dr. Freeland was the scientist primarily responsible for Canadian contribution to the WOCE lines P15 and P1. Presently he is accountable for maintenance of Line P, a line of CTD stations that has been monitored for over 40 years between the mouth of the Juan de Fuca Strait and Ocean Station Papa at 50˚N and 145˚W (also known as WOCE Repeat Hydrography Line P6). At the present time Howard is coordinating Canadian projects to monitor the 1997/98 El Niño and its impact on the west coast of British Columbia.

Figure 1 shows the monthly mean sea-surface temperature (SST) anomalies in the eastern North Pacific from January through June 1997. The year so far has been dominated overwhelmingly by the surprising events developing in the equatorial Pacific. The development of the 1997/98 El Niño was a surprise by itself, but the development so very early in the year was nothing short of astonishing.

Within the SST anomaly pictures of *Figure 1*, we see that conditions were close to normal at the beginning of the year. In the Gulf of Alaska SSTs were even marginally below normal from January through April. In March the first indications of an incipient El Niño became apparent to anyone who was watching sea level evolving on the equator. The event developed with great rapidity, and by May 1997, as we can see in *Figure 1*, extreme warm anomalies appearing in the map off California, meanwhile SSTs remained near normal in the Gulf of Alaska. By June the anomalies have penetrated through the entire northeastern Pacific and are heading towards the dateline along the Aleutian Islands. The pattern of anomalies displayed in June 1997, positive SST anomalies around the coast of N. America, and negative anomalies in the central Pacific, is the classic pattern of response of the eastern North Pacific to El Niño forcing. This pattern is observed in response to all El Niño events.

If this El Niño continued to develop according to the book, then we would expect the largest SST anomalies to appear during the period January through March 1998. However, the rapid and very early rise of this event does make it unique in our experience and any attempt to forecast the future evolution of a unique event is probably a fool's game. I make no attempt to forecast the evolution. One thing is certain, by summer 1997 a large amount of extra heat had been injected into the surface layers of the eastern North Pacific. There is no easy way for the ocean to dispose of this extra heat, and so we must expect the entire region to be dominated by positive SST anomalies for the rest of the year.

As it became evident that a large El Niño was developing, the Canadian oceanographic community launched a substantial effort to monitor the development and evolution of oceanographic conditions off the west coast of Canada. It is our hope that we will thereby develop a thorough picture of the effects that this event has on the Pacific Coast of Canada. The writer encourages all oceanographers in the countries that make up the PICES family to

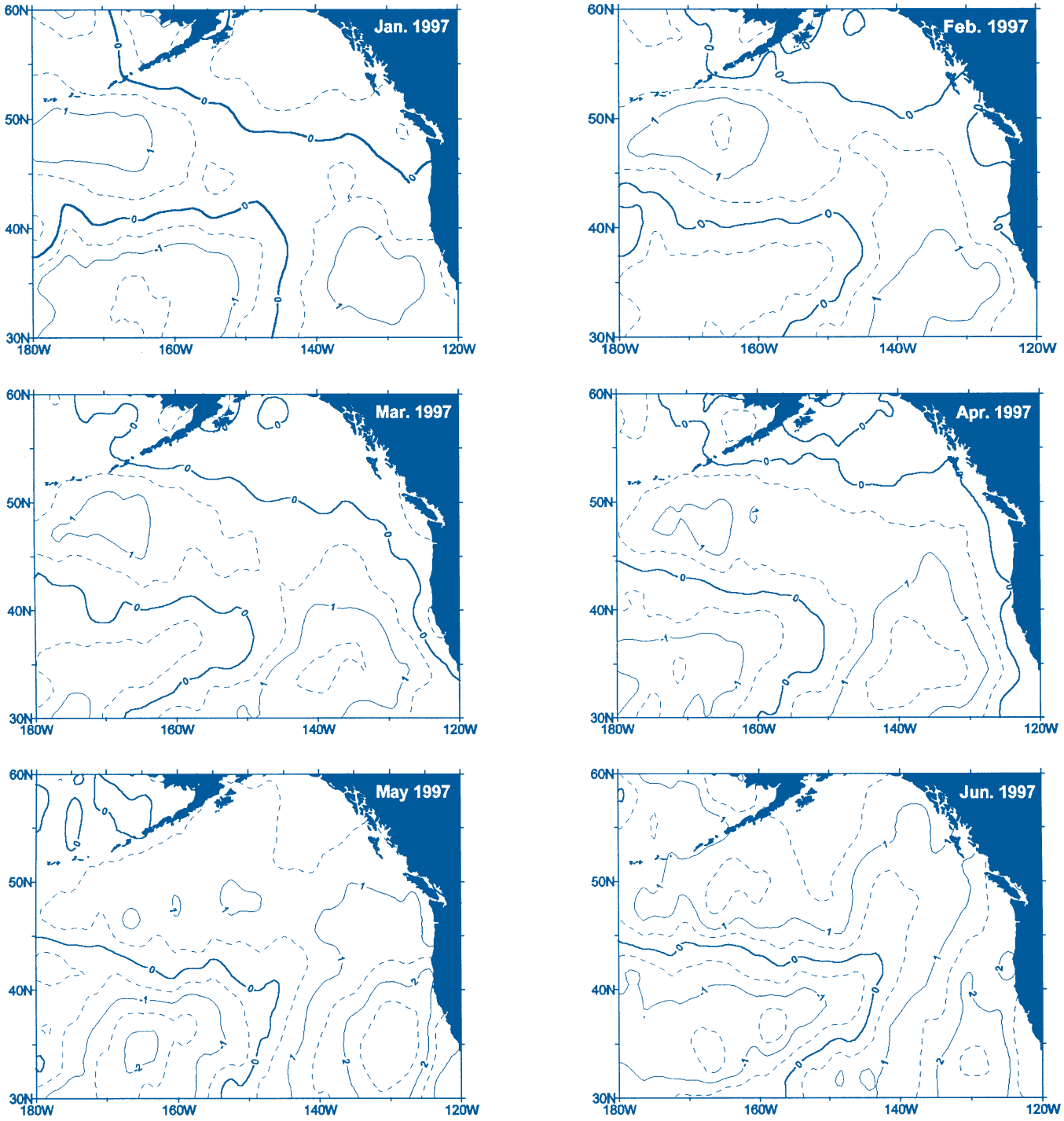

Fig. 1 Monthly mean sea-surface temperature anomalies for the eastern North Pacific Ocean, from January through June 1997. The solid contours are at intervals of 1ºC, and dashed contours at intervals of 0.5ºC. The bold contour indicates 0 anomaly.

develop similar monitoring programs. Even at this late date the evolution of the 1997/98 El Niño is not over and with co-operation we can develop a detailed description of the event.

Through the late summer of 1997, sea-surface temperatures continued to rise in the Gulf of Alaska. This is shown clearly in the diagrams in *Figure 2*. However, by October 1997, evidence suggests that sea-surface temperatures are beginning to decline. The highest temperatures were observed off the coast of British Columbia in September and were quite remarkably high. We have been sampling ocean

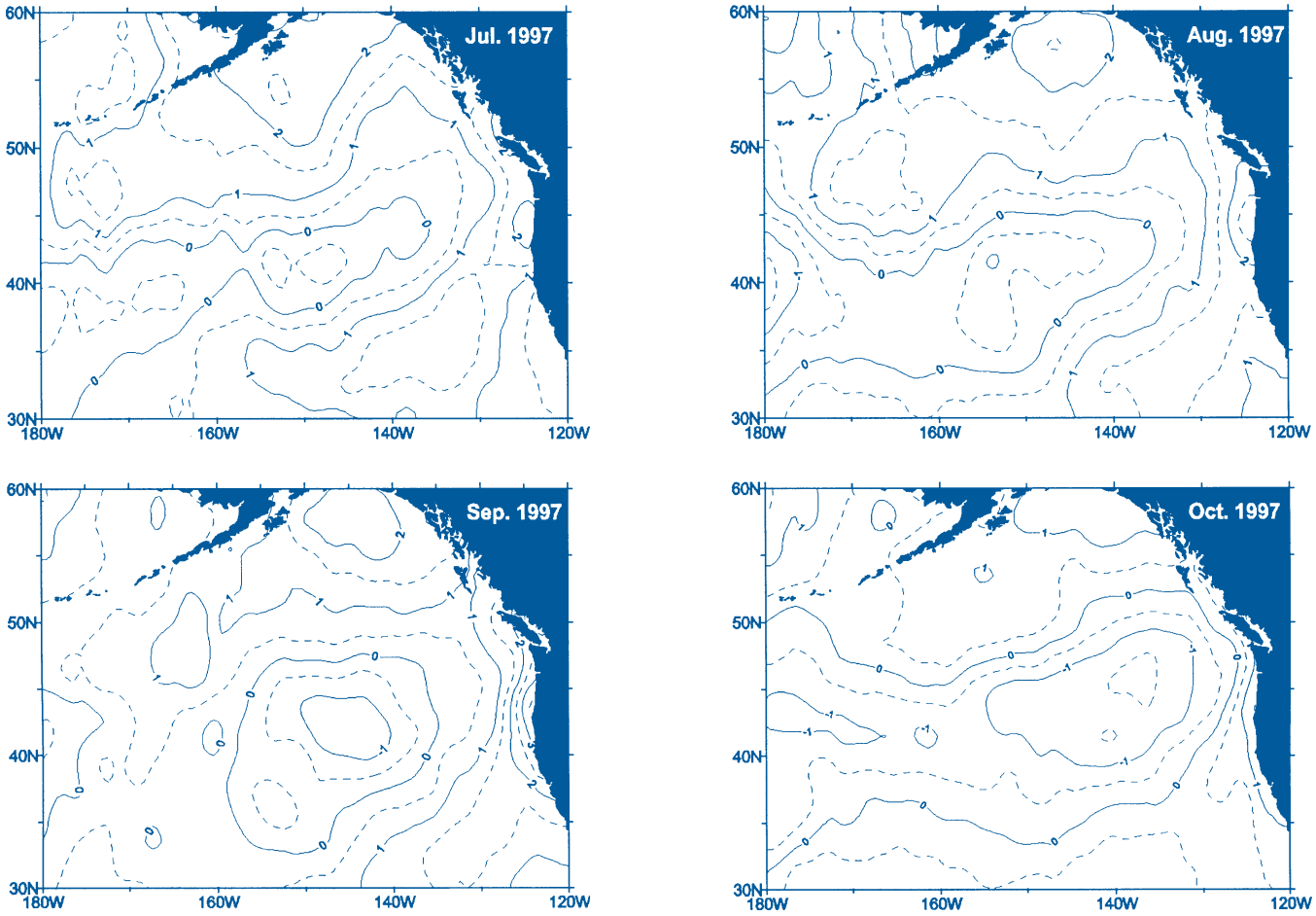

Fig. 2 Monthly mean sea-surface temperature anomalies for the eastern North Pacific Ocean, from July through October 1997. The solid contours are at intervals of 1ºC, and dashed contours at intervals of 0.5ºC. The bold contour indicates 0 anomaly.

temperatures daily at lighthouse stations around the coast of British Columbia since 1935, and saw the highest temperatures ever recorded in September 1997. For example, the monthly averaged temperature at Kains Island (northwestern coast of Vancouver Island) in September 1997 beat the previous record by 1.2ºC, a very large margin. Other records were less impressive, but records were set from Amphitrite Point on the southwest coast of Vancouver Island to Langara Island on the northwest tip of the Queen Charlotte Islands.

The El Niño develops on the equator, as we all know, and affects higher latitudes. So to look at the future evolution we must look south. During September and early October the southern oscillation index showed a steady decline towards more normal conditions. Then towards the end of October a new westerly wind burst developed. This can be seen and followed quite easily on an Australian web site that lists the southern oscillation index daily, and computes and displays 30-day running means. This site can be found at:- http://www.dnr.qld.gov.au/longpdk/. Anyone who accesses this site should note that Australians define the southern oscillation index in the same way that the rest of the world does, except that they multiply the result by 10, thus during the Oct./Nov. burst peak values of the SOI were reported near -60. The burst appeared to have lasted for several weeks and now (November 10th 1997) appears to have subsided.

It is possible that the El Niño forcing on the equator is now over and the ocean is steadily returning to normal. However, the Oct./Nov. burst must serve as a warning that we do not really know what the tropical Pacific has in store for us. El Niño events are supposed to develop during the period November to December, forecasting models appear to have failed, so all we can do is wait and watch.