PACIFIC REGION TECHNICAL NOTES

82-012
August 18, 1982

The Canadian Drifting Buoy Program in the Pacific Ocean - An Overview

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INTRODUCTION

In August 1979, the Atmospheric Environment Service (AES) decided to replace the Ocean Weather Station PAPA (at 50°N, 145°W) with a more cost-effective meteorological observing system designated PADS (Pacific Area Data System). This alternate system currently consists of four main programs. These programs are: the Pacific Weather Centre's (PWC) Geostationary Meteorological Satellite Data Reception and Analysis Station, the B.C. Coastal Automatic Weather Stations, the upper air soundings provided by the Automated Shipboard Aerological Program (ASAP), and the Drifting Buoy Program.

The objective of this note is to present a synopsis and several provisional recommendations regarding the drifting buoys deployed in the northeast Pacific by the AES.

BACKGROUND

Initially considered was the mooring of two fully instrumented discus buoys near the PAPA site. However this was judged too costly considering maintenance and the high risk of losing a buoy. Instead, the decision was made to deploy the relatively simple satellite-tracked expendable drifting buoys which showed promise in the First GARP Global Experiment (FGGE). A number of these buoys were obtained from Hermes Electronics Ltd.

Figure 1 illustrates a typical FGGE type buoy. All present buoys deployed by the AES measure the atmospheric pressure and the sea surface temperature. Additional sensors (wind, waveheight, etc.) may be installed, however the high cost of these sensors may make it prohibitive. A wide variety of drogues are often attached to retard the buoy drift.

COMMUNICATIONS, PROCESSING, AND DISPLAY

Once a buoy is launched, the transmissions are received by the near-polar orbiting satellites (NOAA-6, TIROS-N). The direct satellite receiving station in Edmonton, Local Users Terminal (LUT), obtains the transmissions and after processing, forwards the message to

Sub System Control (SSC) in Toronto. The SSC disseminates the messages to the Regional Weather Centres via the AES teletype communications network. The average elapsed time between the buoy transmission and its arrival at a Weather Centre is roughly 30 minutes (practically real-time) via the LUT-SSC route.

It should be noted that due to the geometry of the satellite orbits, the transmissions are not received regularly. Approximately 8 reports per day are received at different times each day.

At Edmonton the transmissions are transformed into the international DRIBU Code and also into a pseudo-ship synoptic code format. At all Weather Centres the synoptic surface charts are machine plotted. For a report to be automatically plotted, it must be able to pass through the AES Synoptic Decode Program. Currently the Decode Program does not recognize the DRIBU Code, and hence, the need for a pseudo-ship code format which is recognized by the general Decode Program.

Whenever possible the pressure tendency is also estimated. A special algorithm is used if three or more pressure reports are received at specified intervals.

Since September 1981 all buoy reports have been automatically plotted at the PWC on the surface charts if the reports are received within ±1 hour of the valid times of the charts. Also, all reports, whether plotted on charts or not, are retained for 12 hours and may easily be retrieved by the meteorologists for examination.

POSITION AND PRESSURE ACCURACY

The Doppler frequency shift caused by the relative motion between the buoys and satellites is used to determine the buoy positions. The mean position error is approximately 5 km.

The pressure reports are generally fairly accurate, probably within 1 mb or less. A comparison of the actual pressure tendency and the calculated tendency (using the aforesaid algorithm) yielded a mean difference of 0.2 mb. The calculated pressure tendency characteristic curve code was found to be 97% of the time similar or identical to the code obtained by using the actual pressure curve.

DATA TIMELINESS

In order to itemize the usefulness of the data, the reports should be received near the valid times of the four surface charts prepared each day at the PWC. The data may then be plotted on the charts to facilitate the prognostications. To obtain a rough estimate of the number of buoy reports plotted, two buoys were selected and the charts examined over several months. The results are displayed in Figure 2. Generally each buoy is plotted 2 or 3 times per day, however, the calculated pressure tendency (and code) appears less frequently, about once or twice a day.

BUOY OPERATIONS

Since 1980, four groups of FGGE type buoys (16 in total) have been deployed in the Pacific.

The first experimental group (4 buoys) was launched near PAPA in January 1980. The second group (6 buoys), deployed again in the vicinity of PAPA in October 1980, formed part of the Storm Transfer and Response Experiment (STREX). This experiment confirmed the feasibility of satellite-tracked drifting buoys and the arrival of the data in real-time at the PWC. As a follow up, a third group (3 buoys) was deployed further west (along longitude 156°W and between latitudes 40 and 48°N) in September 1981. The most recent group (3 buoys) was launched even further west (along longitude 177°W and between the same latitudes as group 3) in June 1982. Most of the buoys were drogued.

The buoy and drogue lifespans are summarized in Figure 3. From Figure 3, it may be noted that the buoy lifespans vary considerably and the drogues do not appear to remain attached for any significant length of time.

TRAJECTORIES

The mean buoy trajectories do show general agreement with the traditional and ordinary concept of general surface circulation over the northern Pacific Ocean. However, a detailed look will reveal a variety of meso- or microscale fluctuations, likely wind and current induced. The mean paths for the group 3 buoys are portrayed in Figure 4. Comparing the buoy paths to the mean ocean surface currents, Figure 5, one may note that a favourable comparison exists. A preliminary estimate of the un-drogued buoy speeds confirmed our initial suspicion that the drift and surface current speeds are of the same order of magnitude.

While a buoy is drogued its forward displacement is significantly retarded. This may be observed by the weekly positions of the two northern buoys in Figure 4. These two buoys were drogued for the first 50 days or less and during this period the weekly intervals were compressed relative to the subsequent intervals. It has been noted that a drogued buoy travels roughly one-fourth the distance over a non-drogued buoy.

DEPLOYMENT AREA

The operational meteorologists at the PWC favour an area bounded by latitudes 35 to 50°N and longitudes 140 to 160°W, for buoy deployment. This region is relatively data sparse and of interest since a large percentage of cyclones (affecting the B.C. Coast) originate from, or track across, the area. Figure 4 shows that the buoys remained within the above specified area for approximately 7 months.

RECOMMENDATIONS

From the preceeding synopsis several recommendations or conclusions are readily brought forward.

1. An obvious fault is the premature demise of the drogues. In the most recent deployment, the drogues appeared to have failed after only 50 days (this was deduced from a chart of the weekly plotted positions). An effort should be made to rectify this as a drogue would significantly extend the residence time of a buoy within a given area.

2. Another significant improvement could perhaps be made by using the GOES-West satellite as a receiver for the buoy transmissions. Regular reports would then be available and at the most useful times (for example at 12 GMT when ship reports are particularly scarce). Furthermore, it would ensure pressure tendency reports for each surface chart.

3. In reference to the pressure tendency, it may also be quite feasible to have the buoy microprocessor store hourly observations which may then be transmitted when the satellite comes into view. This would ensure that pressure tendencies would always be available.

4. At least several buoys should always be present within the area preferred by the PWC meteorologists (latitude 35 to 50°N, longitude 140 to 160°W). The results of the buoys in group 3 would suggest that approximately every 6 months a new set of buoys should be launched (unless the buoys remain drogued).

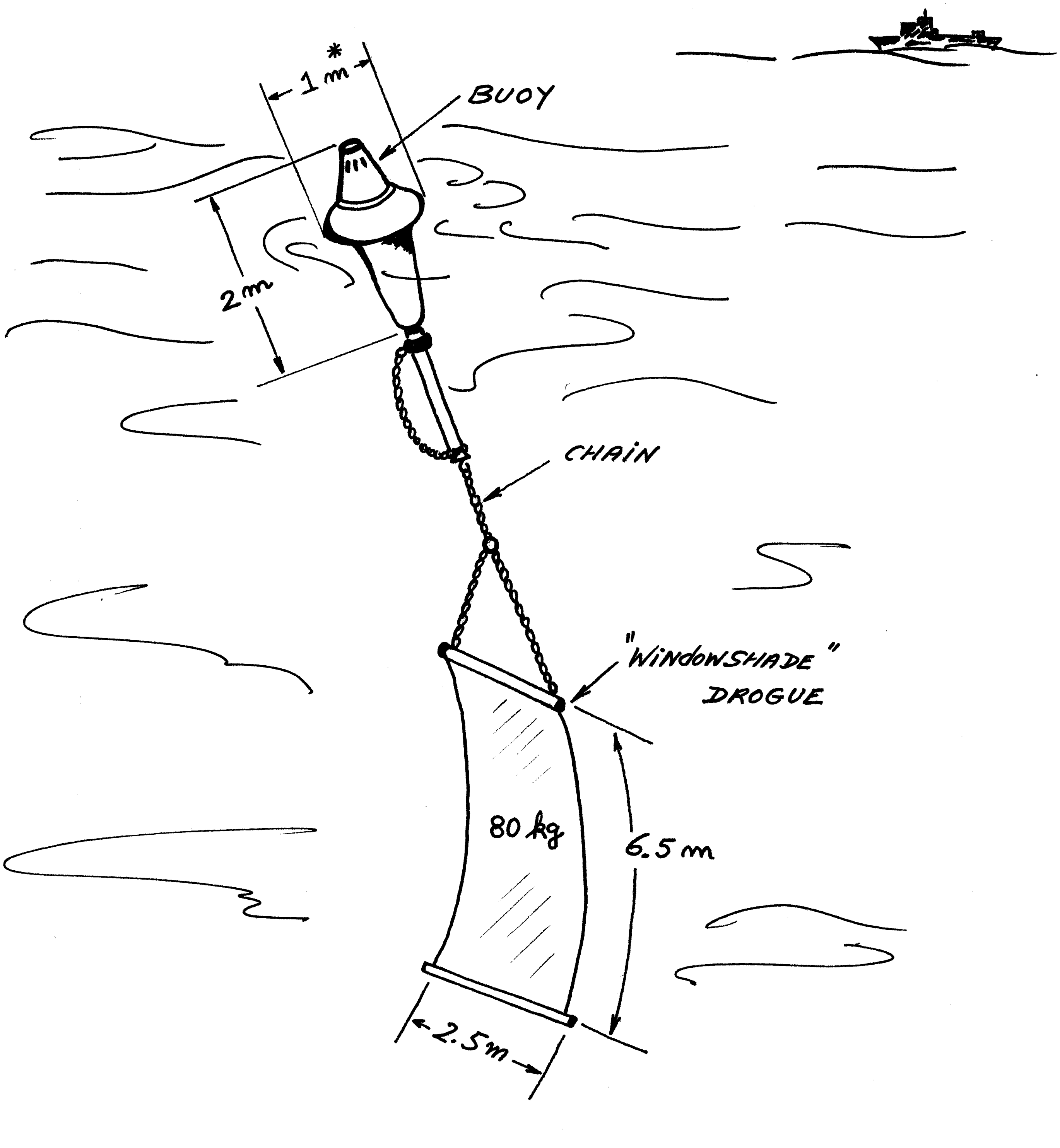
ACKNOWLEDGMENTS

The authors would like to thank Mr. Dan Petrunik of the PWC for his assistance in compiling data for this report.

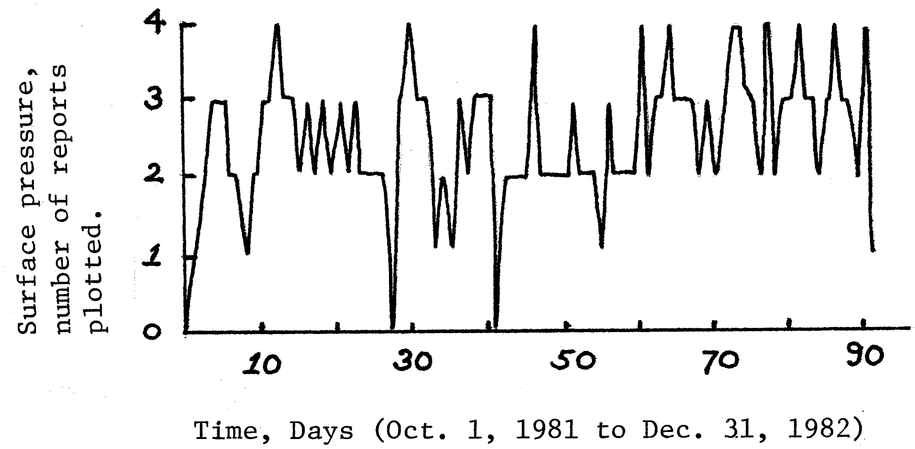
Gratefully acknowledged are Mr. R.E. Vockeroth, Director of PADS, and Mr. C.S. diCenzo, Coordinator of PADS, as their reports and correspondence were used extensively for this summary.

FIG. 1.

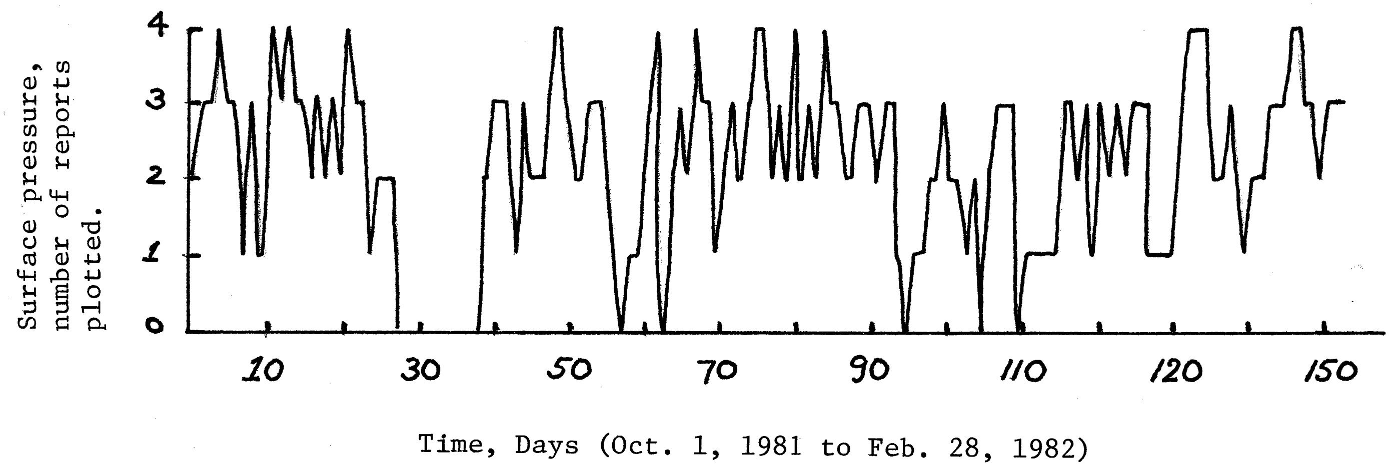
DRIFTING BUOY



*ALL MEASUREMENTS APPROXIMATE.



Buoy 46639 (WMO)
Average number of surface pressure reports per day is 2.46.
Average number of pressure tendency reports per day is 2.04.



Buoy 46640 (WMO)
Average number of surface pressure reports per day is 2.27
Average number of pressure tendency reports per day is 0.91.

Fig. 2 . Graphs illustrating the number of times per day that the buoy reports were plotted on the surface weather charts of the Pacific Weather Centre. The Centre prepares 4 charts a day.

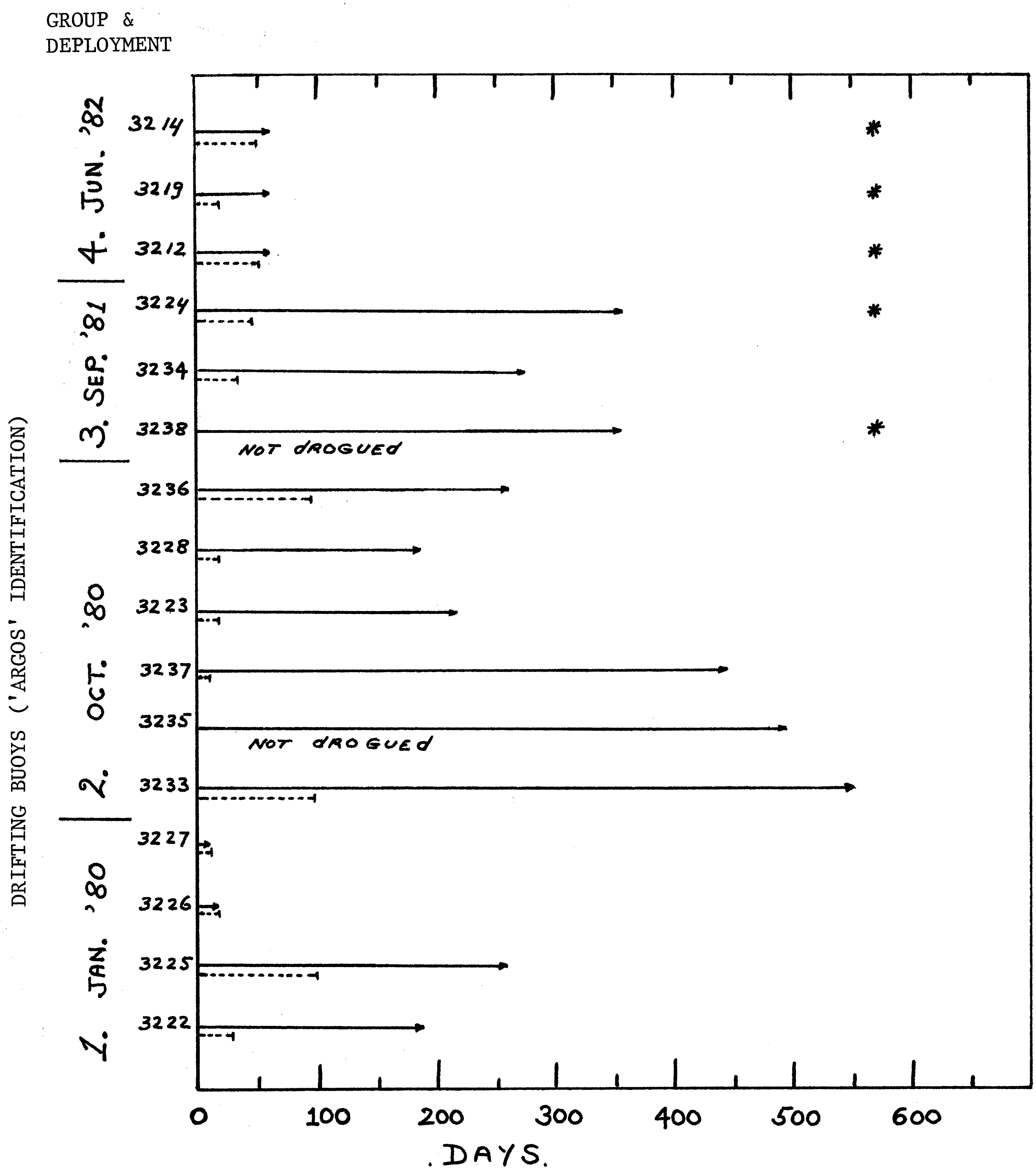


Fig. 3. The number of days (solid lines) that each buoy remained fully operational after deployment in the Pacific Ocean.
Buoys that are still fully operational as of Aug. 9, 1982 are flagged by an *.
The dashed lines represent the number of days (roughly) that the drogue remained attached to the buoy.

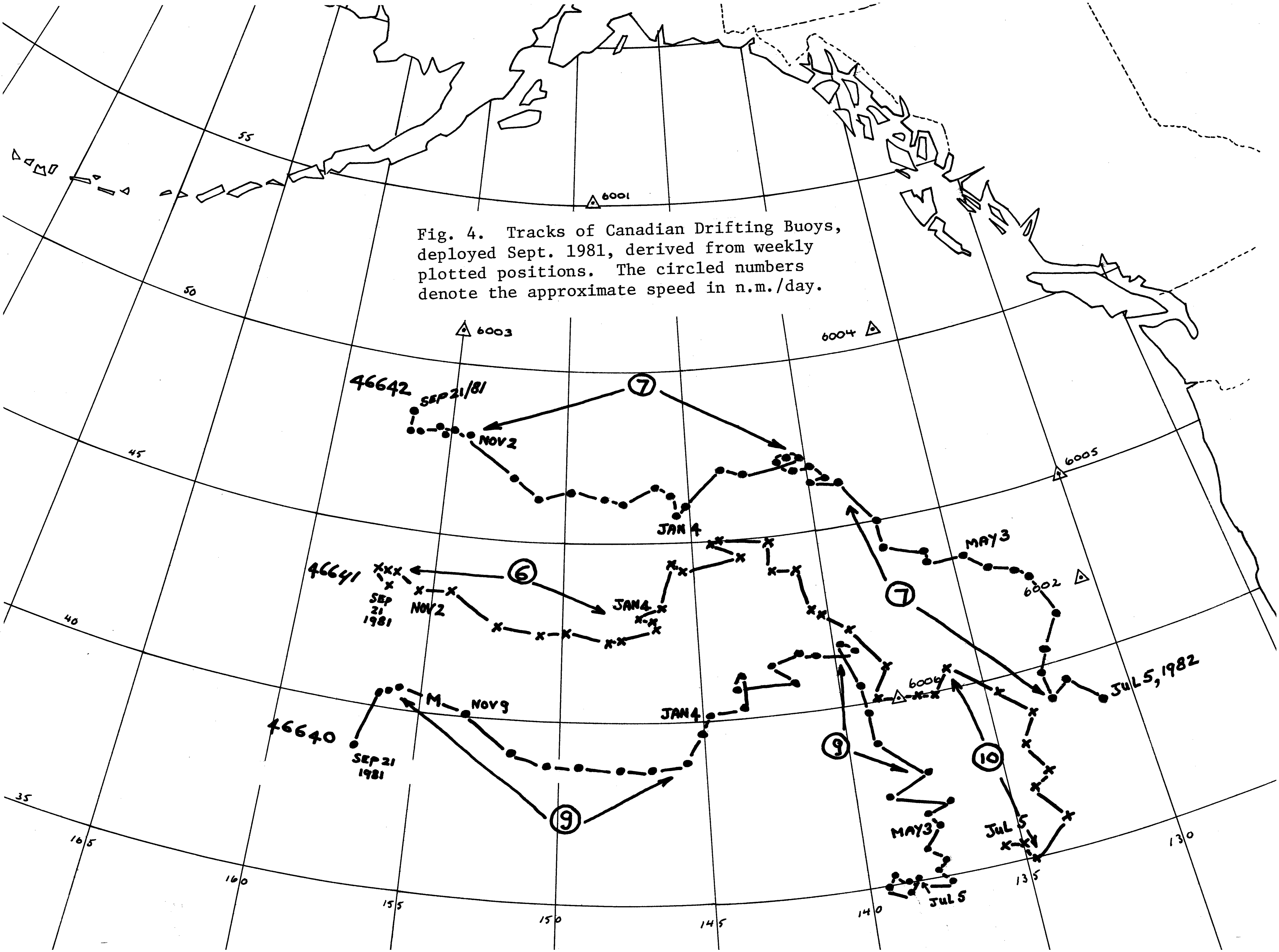


Fig. 4. Tracks of Canadian Drifting Buoys, deployed Sept. 1981, derived from weekly plotted positions. The circled numbers denote the approximate speed in n.m./day.

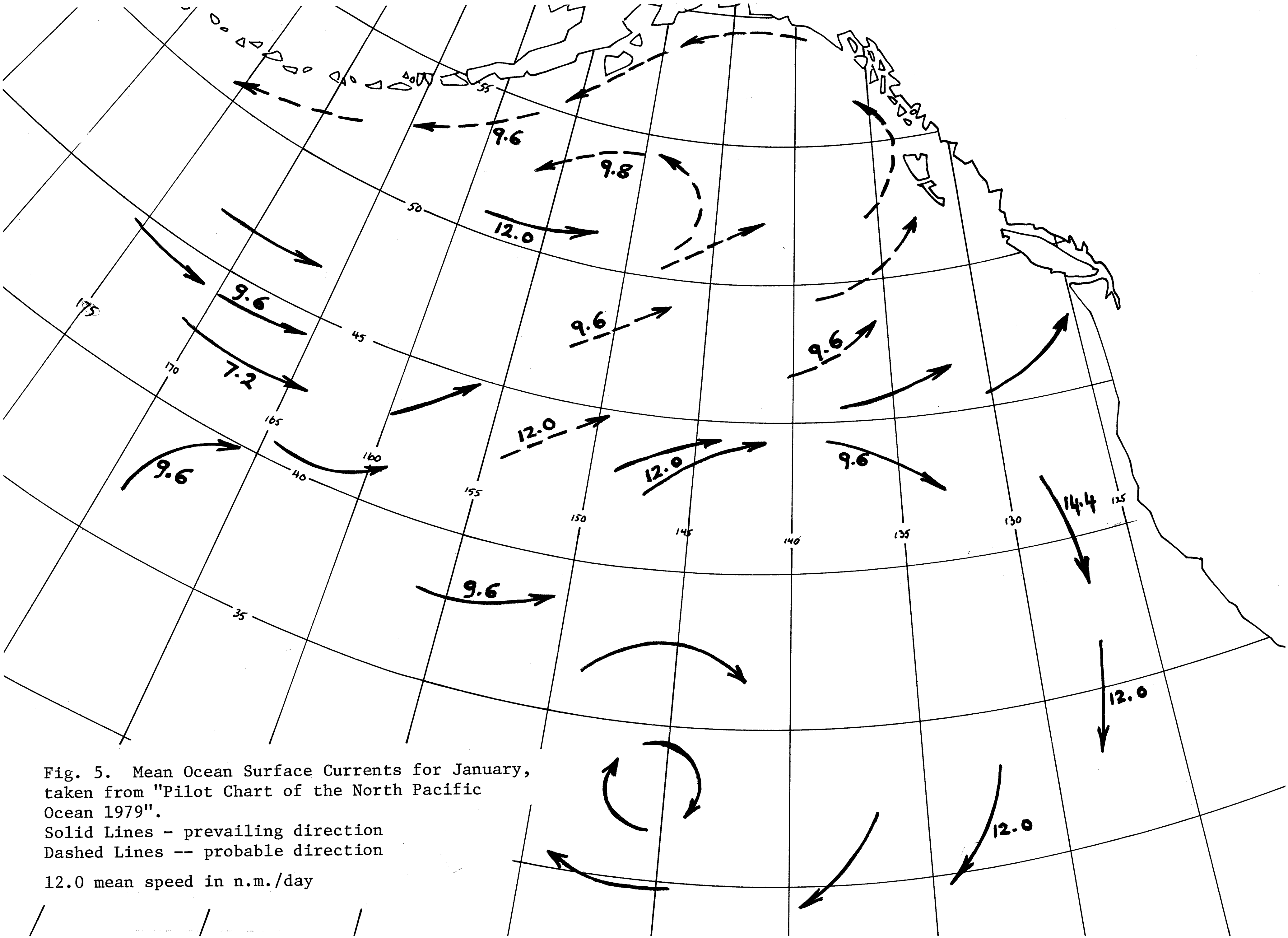


Fig. 5. Mean Ocean Surface Currents for January, taken from "Pilot Chart of the North Pacific Ocean 1979".
Solid Lines - prevailing direction
Dashed Lines -- probable direction
12.0 mean speed in n.m./day