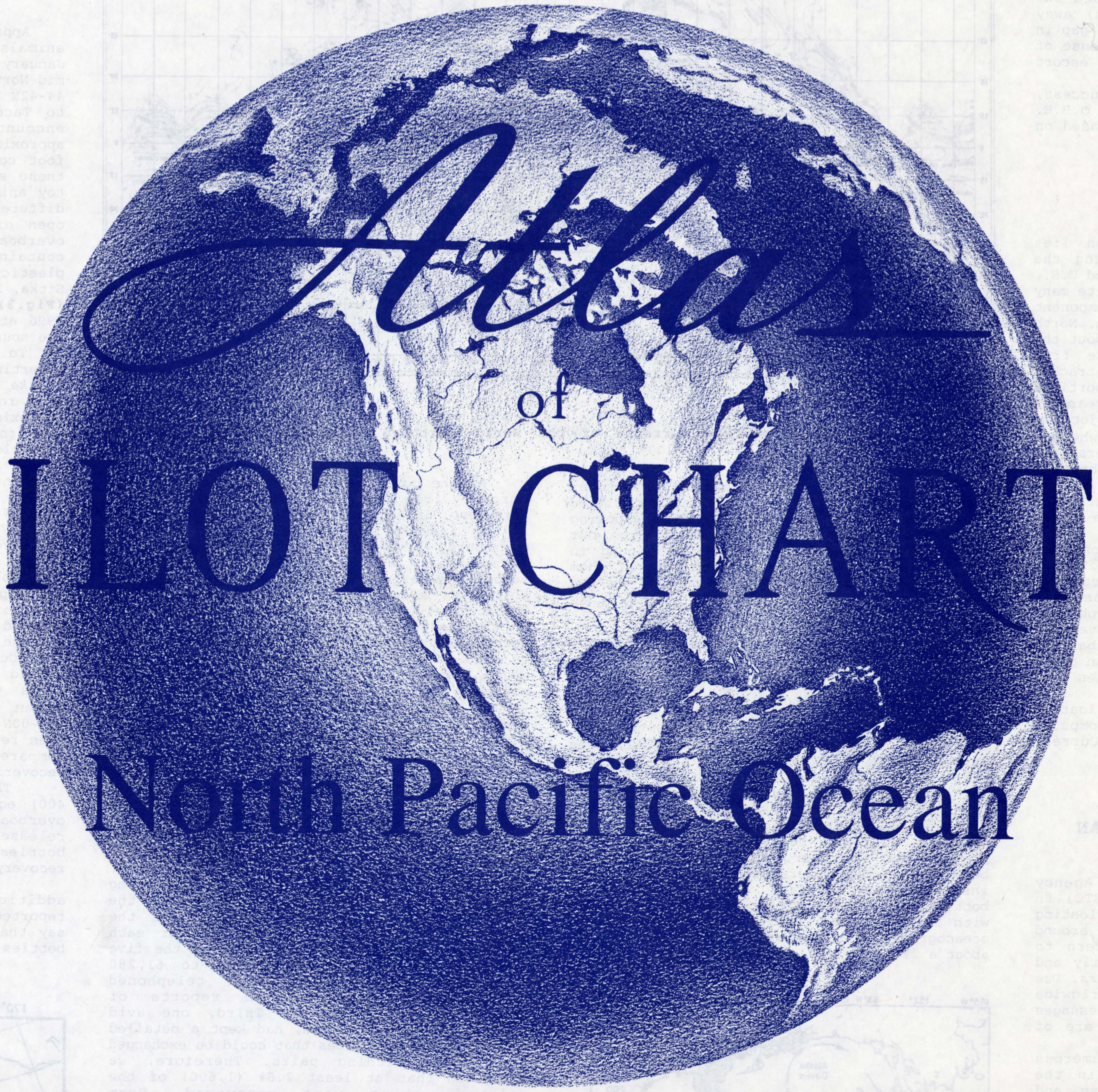

Atlas of PILOT CHARTS

North Pacific Ocean

NVPUB108

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DRIFTING OBJECTS ON THE OCEAN

DRIFTING OBJECTS

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1. INTRODUCTION

Objects floating on the sea surface come from many human activities. Some have had significant impact on human history, yet little is known concerning the origin, drift and fate of many objects found on the sea shore. Edwin Arlington Robinson (1923) stated in *Roman Bartholow:*

> *"An ocean is forever asking questions*
> *And writing them aloud along the shore."*

We ask your help in reporting recoveries of drifting objects, particularly ones that might be traceable to their origin, so that reports similar to these might be published in scientific journals. Information as to how and where your reports may be directed is provided at the end of this article.

To begin, we tell two brief stories about drifting objects, one concerning the influence of a drifting derelict Japanese vessel on Perry's expedition to Japan, and a second of the influence of a drifting corpse on the outcome of World War II. Following these are two detailed stories about spills from container vessels, i.e., the shoe spill and the toy spill.

2. IMPACT OF DRIFTING OBJECTS ON HUMAN HISTORY

Among the many examples that might be cited, two serve to illustrate the continuing impact of drifting objects on human history.

Perry's Expedition to Japan

Derelict vessels disabled by storms off Japan probably have been transported to the Americas by prevailing winds and ocean currents since at least 5,000 years ago, based on the comparison of ceramic pottery in Ecuador and Kyushu, Japan. After whaling begun off Japan in the early 1800's, many derelict vessels were reported throughout the North Pacific Ocean. Approximately 20% of the vessels landed in North America, a few with survivors of the typical 15 month drift. Survivors from one such drift vessel initiated a chain of events that significantly influenced the outcome of the Perry Expedition to Japan.

In October 1832, the *Hojun Maru* with a crew of 14 was disabled off Japan during a severe storm. After drifting 15 months, the vessel grounded in January 1834 near Cape Flattery. Three survivors were captured by local natives, and after a few months were rescued and brought to Fort Vancouver on the Columbia River. While at the fort, a young Chinook Indian, Ranald MacDonald, heard of the incident and theorized that by shipwrecking himself in Japan he might aid in the opening of Japan, which had been closed to foreigners for the previous two centuries.

Fourteen years later in June 1848, he carried out his plan. Because of his likable personality, he was not immediately executed for entering Japan but was held in prison for nine months until being deported in April 1849. While in prison, MacDonald instructed a number of Japanese scholars, thus becoming the first teacher of English in Japan. When Commodore Perry arrived five years later in 1854, knowledgeable interpreters were available to assist with the delicate negotiations associated with the formal opening of Japan.

WORLD WAR II: Invasion of Sicily

During the early morning hours on 30 April 1943, a British submarine surfaced a mile off Spain and discharged one of the strangest counterespionage devices destined to have a major effect on the outcome of World War II. It was a corpse released so as to drift to the shore with the wind and the tide so it would be found and reported to the German Intelligence Service. In the attaché case chained to the corpse were personal papers of the highest ranking Allied commanders, forged convincingly so that Adolf Hitler and his highest officials would believe their authenticity. The corpse was recovered a little offshore by a Spanish fisherman. Spanish officials reported the matter to the German Intelligence Service and the papers eventually reached Hitler.

Summarizing the results of this operation code named Mincemeat, based on files of the German Intelligence Service recovered after the war, Montagu reported: "As regards the eastern Mediterranean, we caused immense (German) effort to be put into the defense of Greece (the decoy target), with the creation of mine fields, shore batteries, et.; we caused a concentration of (German) troops in Greece which justified the appointment by Hitler of Rommel to command them; these troops included a Panzer Division which had to be sent across Europe; all this was completely wasted effort from the German point of view and diminished the potential defense of Sicily and of Italy."

"As regards the Western Mediterranean: we caused an increase in the fortification and reinforcement of Corsica and Sardinia (decoy targets) at the expense of that of Sicily: we caused the defensive preparations in Sicily to be largely diverted from those coasts of the island where the Allies in fact landed, to the coasts where they did not land; we caused the Germans to send R-boats (torpedo boats) away from Sicily to the Aegean, thus opening a gap in their defenses which 'prejudiced the defense of Sicily' as well as creating a shortage of escort vessels."

As a result of the operation's success, Ewen Montagu was awarded the Military O.B.E. The movie "*The Man Who Never Was*" was based on Montagu's book about the operation.

3. NORTH PACIFIC GYRE

Most of the North Pacific Ocean lies within a great gyre, **(Fig.1)** connecting the coastal waters off Japan, Canada, mainland U.S., Hawaii, and the Philippine Islands. Despite many oceanographic studies of the gyre's component currents (Kuroshio, Subarctic, California, North Equatorial), much is yet to be learned about the circulation of water within the gyre from drifting objects. For example, satellite-tracked drifters have been monitored only along portions of the gyre's circumference because 4-6 years is required for a hypothetical drifting object to be transported once around the gyre, whereas batteries within satellite-tracked drifters last only 2 or 3 years. Reports of drift bottles released near Hawaii and found in North America are particularly valuable because they will have transited around three-quarters of the great gyre.

In this brief article, we focus on this gyre's sub-current flowing from Japan to North America because: 1) many drifting objects are released to the gyre along coastal Japan as a result of frequent natural disasters (typhoons, earthquakes, tsunamis); 2) debris from vessels damaged by storms is spilled into the Subarctic Current because shipping routes from Asian ports to North America follow great circle routes that intersect the intercontinental current.

To simulate the drift of various floating objects around the gyre, we used the computer program known as the Ocean Surface Current Simulations (OSCURS) numerical model.

4. SOURCE REGION: OBJECTS FLOATING OFF JAPAN

At the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) in Bethesda, Maryland, reports of objects floating on the sea surface are received from all around the world. Particular objects of concern to international shipping are broadcast daily and published in the weekly *Notice to Mariners.* Due to its international obligations to worldwide shipping, DMAHTC does not release radio messages on many smaller drifting objects that are of interest to oceanographers.

Because beachcombers report numerous objects that are traceable upstream in the Subarctic Current to the vicinity of Japan, and because the Japanese are meticulous in reporting materials adrift, the reports obtained over an interval of time were examined. In the Defense Mapping Agency's watch room where messages are received and reviewed for dangerous floating objects, we transcribed the objects reported for a four month period (15 July - 14 November 1993) in the Japanese reporting area that might have been transported to North America. The 101 reports included: a number of different derelict vessels (25 reports), logs (60 reports), cargo containers (4 reports), a collapsed house, pontoon, fishing net, steel buoy, and a crewman overboard. While we could not eliminate duplicate sightings, this sample indicates that a considerable number of floating objects originate from Japanese coastal waters.

As floating objects are transported eastward, they are sorted by winds, currents, flotation, and biological processes. The time required to drift directly from Japan to North America varies from eleven months to 2-3 years, depending on windage, but many objects sink as they become water-logged and as biological growth decreases their buoyancy. For example, the vessel *Ryo Yei Maru,* disabled on 11 December

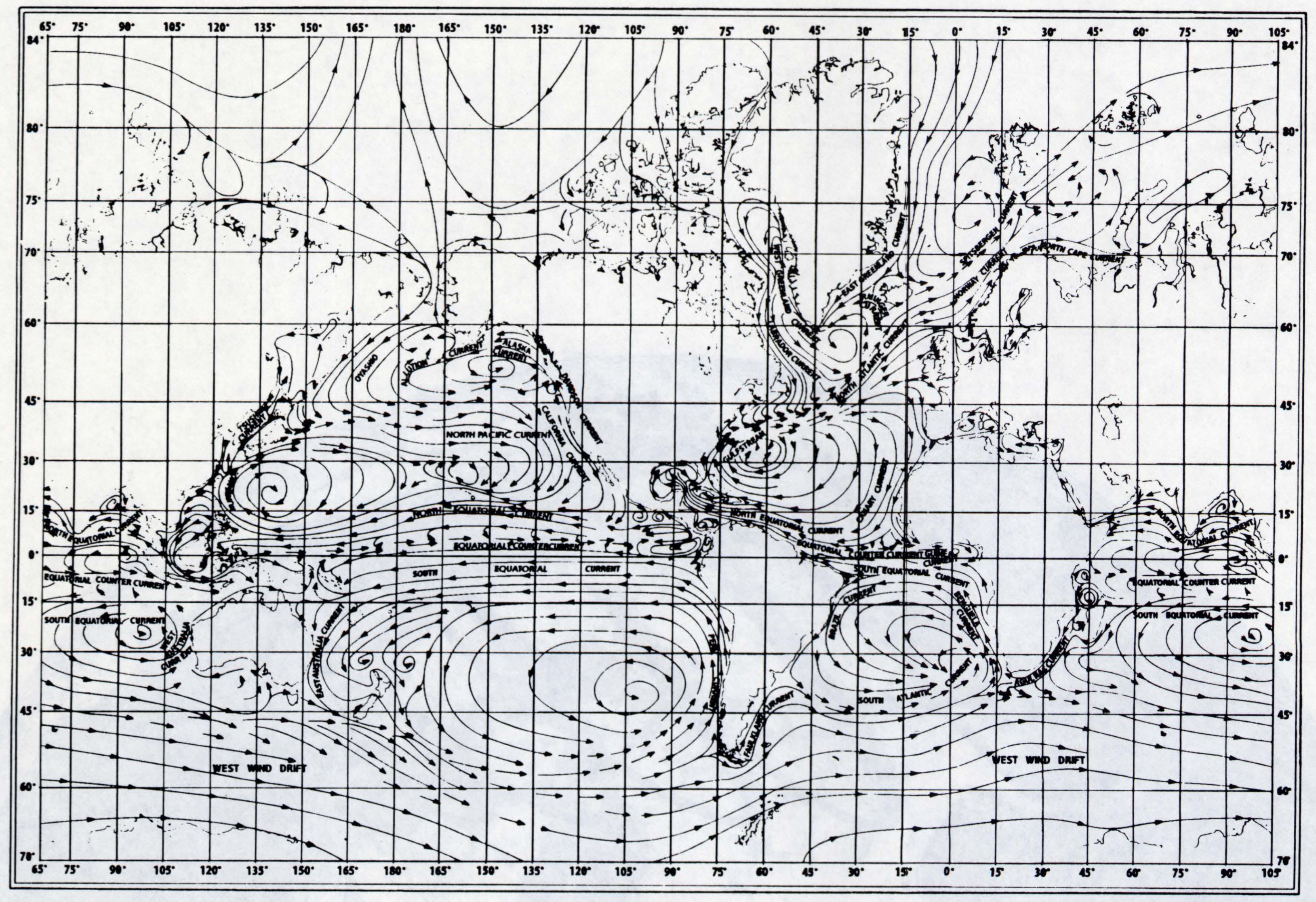


Fig.1. Major surface currents of the world (northern hemisphere winter).

1926 off Japan, was discovered on 31 October 1927 off the coast of Washington, having drifted for 11 months without capsizing, thus exposing the vessel to considerable windage. From our collection of twenty or so messages found in drift bottles, with less windage most of them required 2-3 years to follow the path of the *Ryo Yei Maru.*

5. THE NORTH PACIFIC SHOE SPILL

Approximately 80,000 athletic shoes were lost overboard on 27 May, 1990 in the North Pacific Ocean in the vicinity of 48-00N 161-00W. Six months to a year later, thousands of shoes washed ashore in North America from southern Oregon to the Queen Charlotte Islands. We gathered beachcomber reports and compared the inferred shoe drift with OSCURS and historical drift bottle returns **(Fig.2)**. This spill, like that of children's toys described later, may provide new data for ocean current pathways because both spills were far larger than typical instantaneous releases of 500-1000 drift bottles. The drift pattern here is documented with a much larger sample than in the typical oceanographic drift experiment that usually has about a 2% drift bottle recovery rate.

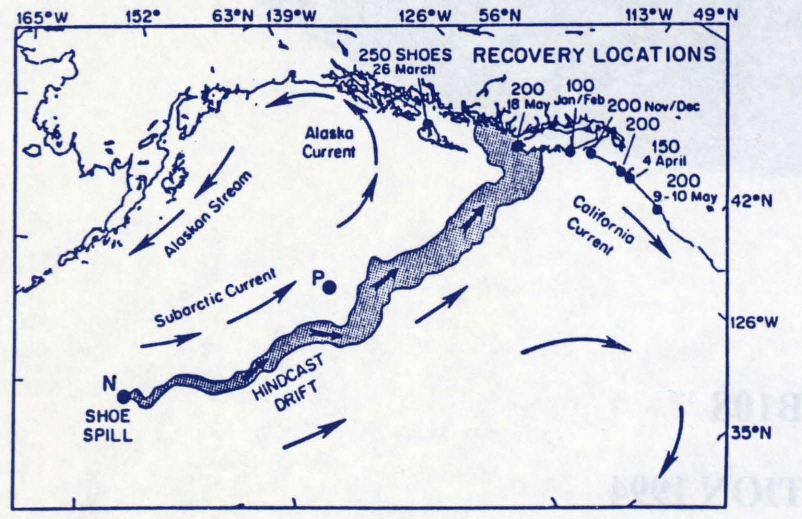


Fig.2. Chart showing where 80,000 athletic shoes washed overboard on 27, May 1990 (N; shoe spill), and dates and locations where 1300 shoes were discovered by beachcombers (dots along coast). Drift of the shoes (in tint) simulated with a computer model, is thought to have passed close to Ocean Station Papa (P), where 33,869 drift bottles were released. (Reprinted from Transactions of the American Geophysical Union, EOS; Ebbesmeyer and Ingraham, 1992)

As the container vessel *Hansa Carrier* was enroute from Korea to the U.S. Pacific Northwest, it encountered a severe storm causing 21 of its 40-foot containers to be lost overboard. Five of the lost containers held approximately 80,000 shoes. From beachcomber reports, a variety of shoes were spilled, from children's sizes to men's large hiking shoes. Unfortunately, the shoes were not tied together, so that matching pairs did not come ashore; however, beachcombers held swapmeets in Oregon to find matching shoes. Despite a year in the ocean, many of the shoes were wearable after cleaning.

It was clear from preliminary reports that thousands of shoes had washed ashore. Later, after an Oregon newspaper reported our oceanographic interest in the shoes' drift, the Associated Press picked up the story and national media focused on our project. The media were quite helpful by relaying our interest in having the public write to us describing additional finds of shoes.

To obtain quantitative information, three lines of inquiry were pursued. First, examination of container load plans detailing the contents of each container enabled the comparison of serial numbers of many of the recovered shoes with those listed for each container. This revealed that four of the five containers opened, releasing up to 61,280 individual shoes. Second, we telephoned beachcombers, resulting in reports of approximately 1300 shoes. Third, one avid beachcomber, Steve McLeod, had kept a detailed list totaling 1600 shoes that could be exchanged to obtain matching pairs. Therefore, we estimated that at least 2.6% (1,600) of the released shoes were recovered. From beachcombers' stories it became evident that other beachcombers had found large numbers of shoes, but we were unable to contact some of them. Considering that some sank to the sea floor, and that many shoes washed ashore went unreported, the actual percentage of shoes reaching shore is underestimated, perhaps by a substantial amount.

OSCURS was used to hindcast the shoes' oceanic drift. The first sizable reports documented about two hundred shoes found during Thanksgiving to Christmas, 1990, and about a hundred shoes found on Vancouver Island during January and February, 1991. These recovery dates were 174-211 days after the spill (in Washington) and 218-278 days after the spill (on Vancouver Island). This gave the shoes an average recovery time of 220 days. The simulation of the shoes' trajectories indicated first landing on Vancouver Island 249 days after the spill, in approximate agreement with the first reports of shoe beachings. Therefore, after the spill it appears that the shoes drifted approximately due east.

Reports of shoe recoveries in large quantities were from as far north as the Queen Charlotte Islands and as far south as southern Oregon. Assuming that the shoes were released at one location, considerable dispersion occurred in the latitudinal direction.

At the present time, OSCURS does not resolve the coastal currents close to the shores in the eastern Pacific Ocean. As the shoes first reached the near shore waters in winter, the northward flowing Davidson Current may explain the shoes found in the Queen Charlotte Islands. Many shoes were found along the Oregon coast through June when the local coastal currents are southerly. Apparently, during winter and spring, coastal currents dispersed the shoes over a distance greater than estimated from available observations of oceanic dispersion.

At the northern end of the Big Island of Hawaii three shoes were found from January to March, 1992. These shoes appear to have followed the California Current southward, and then traveled westward. Additional computer runs indicate that some of the shoes should arrive in Japan during 1994.

6. THE NORTH PACIFIC TOY SPILL

Approximately 29,000 floatable bathtub toy animals (6-12 cm) were lost overboard on 10 January 1992 from a container vessel in the mid-North Pacific Ocean in the vicinity of 44-42N 178-06E. During its voyage from Hong Kong to Tacoma, Washington, the container vessel encountered severe storm conditions. In approximately 44-42N 178-06E, twelve of its 40-foot containers were washed overboard. One of these steel containers held 7,200 packages of toy animals, with each package containing four different toy animals. The container was torn open either by the ship's stays as it went overboard or by collisions with the other containers. Ten months later, some of the plastic toys began showing up on beaches near Sitka, Alaska. According to computer simulations **(Fig.3)**, the toys' drift proceeded past the 1990 athletic shoe spill site on their way to the southeast Alaska coast.

To obtain reports of toys found on beaches, advertisements were placed in a local newspaper (*Sitka Sentinel*) near the toys' first landfall. From responding beachcombers, we learned that approximately 400 toys fitting our descriptions were found between November, 1992 and August, 1993 along approximately 800 km of shore between Kayak and Coronation Islands bordering the eastern Gulf of Alaska. The first known landfall of the toys was reported by two beachcombers near 57-06N 135-42W on 16 November (6 toys) and near 57-48N 136-24W during 28-29 November 1992 (20 toys).

To account for the windage of these floatable toys, during numerous runs of OSCURS, the empirical functions for current speed and angle of deflection were systematically adjusted to find a match between the model's trajectories and the toys' first landfall.

Our best estimate for the toys' trajectory passed close to the site where the athletic shoes were previously spilled in May, 1990 (about 48-00N 161-00W) and Ocean Station Papa (50-00N 145-00W), where many drift bottles have been released. Therefore, it is interesting to compare the number of toys recovered with recoveries of shoes and bottles.

The total number of toys reported (about 400) equals approximately 1.4% of those lost overboard (29,000). Historical drift bottle releases made near the toy spill totaled 16 bottles recovered from 663 releases for a recovery rate of 2.4%.

Anecdotal evidence suggests that many additional toys were recovered, but not reported. Therefore, it is not unreasonable to say that the recovery rate of toys, shoes and bottles is approximately the same.

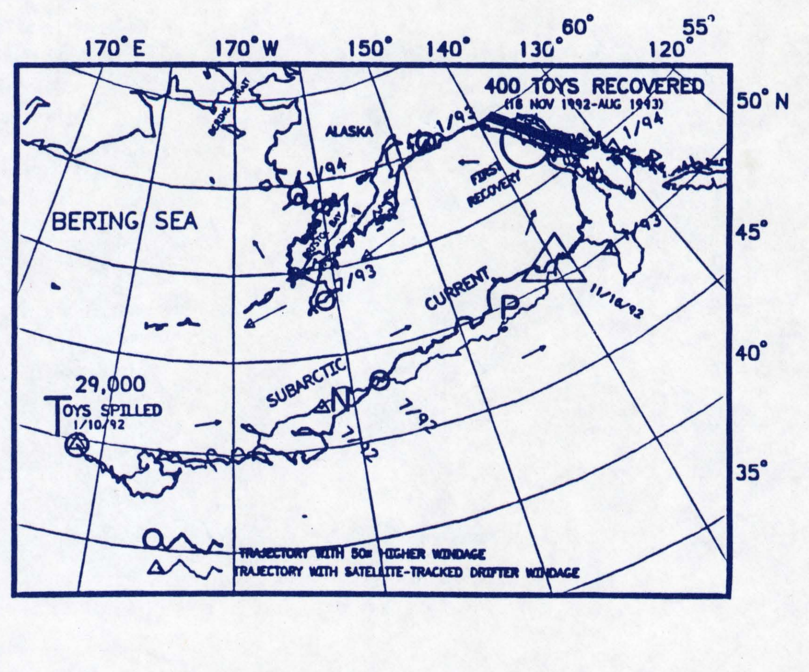


Fig.3. Chart showing where 29,000 bathtub toys washed overboard on 10 January 1992 (T; toy spill), and dates and locations where about 400 toys were discovered by beachcombers. Drift of the toys, simulated with OSCURS computer model, passed near the site (N), where athletic shoes were spilled, and near Ocean Station Papa (P), where 33,869 drift bottles were released.

To determine the long-term fate of the toys, the computer simulation was continued beyond first landfall, showing that the toys traveled counterclockwise around the Gulf of Alaska, and then through passes west of the Alaska Peninsula into the Bering Sea. By January, 1994 the toys had arrived in Bristol Bay and were presumably trapped in the seasonal sea ice. The following spring during breakup, given the prevailing currents, it is reasonable that the toys eventually will have been transported through the Bering Strait into the Arctic Ocean in the vicinity of Point Barrow, and from there will have been carried with Arctic pack ice north of Siberia, eventually reaching the North Atlantic Ocean.

Previously, drifts starting north of the Bering Strait have arrived at several different locations in the North Atlantic: (1) wreckage from the *Jeannette* frozen in the pack ice in the Chuchchi Sea (near Hearld Island) in November 1879 was found five years later on the southwestern coast of Greenland; (2) a barrel containing a message released near Point Barrow in September 1899 was recovered on the north coast of Iceland, about six years later; (3) several bottles released in the vicinity of Nome, Alaska were found approximately ten years later in Iceland, Ireland, and Norway; and (4) a drift bottle, released 26 June, 1979 in the Bering Strait, was found in western Scotland seven years later on 6 July, 1986. Given the release of 29,000 toy animals, we anticipate that by 1999-2003 a few will have been transported to similar locations in the North Atlantic Ocean.

7. SUMMARY

This brief history of some objects drifting in the ocean indicates that some have had significant impact on human history, and have contributed to the scientific understanding of ocean currents. We continue to learn from drifting objects about the variability of the great ocean currents, and believe that ocean debris will continue to influence human history.

The size of some container spills dwarfs comparable oceanographic studies. For a perspective on the relative size of spilled drifting objects, consider the drift bottles released during three major oceanographic programs: (1) 33,869 bottles in the northeast Pacific Ocean during 1956-1959 for Project NORPAC; (2) 21,615 bottles released off Oregon by Oregon State University during 1961-1970; and (3) 148,384 bottles off California and Mexico by Scripps Institution of Oceanography during 1955-1971 as part of the California Cooperative Oceanic Fisheries Investigation. Spills of 61,000 shoes and 29,000 toys released instantaneously are thus relatively large numbers.

Many types of man-made objects drift on the surface of the North Pacific Ocean. Frequently, they have organisms attached to them. Depending on the associated windage, the objects and organisms will be transported to various locations in the north Pacific Ocean and adjoining water bodies. Some animals, such as Velella Velella, have adapted wind-sailing life strategies and are profoundly effected by winds. Early spring of some years leaves great numbers stranded in windrows along the beaches of the northwest Pacific Coast. Our calculations suggest that the fate of long-term drifting objects is not only sensitive to the great interannual variations, but also that this variation increases with the amount of their surface area subject to windage.

In our correspondence with beachcombers of North American shores, we learned that a number of bottles containing Asian notes have been uncovered. Unfortunately, most are never translated.

We are aware that many bottles containing messages are thrown from vessels all over the world. For example, Captain Basil S. Biggs released at least 500 message bottles during the 1960's and 1970's and received replies to approximately 5% of his short messages. He collected a number of the more interesting drifts into a scrapbook entitled "*Epic Voyages of Messages in Bottles*". A number of the drifts span the North and South Atlantic, as well as the North Pacific Ocean, and provide valuable scientific information. We hope other mariners will follow Captain Biggs' example and carefully record the release times and locations, as well as the recovery dates and locations.

Regarding containers, detailed accounts on the sea state conditions that occur at the time of spills and how the contents escape from the containers soon after a spill are lacking. Letters detailing any incident observed by a mariner would be appreciated. Information regarding containers, spills, drift bottles, and other interesting drifting objects should be sent to:

Dr. Curtis C. Ebbesmeyer
6306 21st Ave. NE
Seattle, Washington 98115
USA

Letters of acknowledgment and interesting accounts will be returned. Stories providing new scientific insight will be developed into scientific accounts.

PILOT CHART OF THE NORTH PACIFIC OCEAN

AVERAGE CONDITIONS OF WIND AND WEATHER OVER THE NORTH PACIFIC OCEAN DURING CURRENT MONTH

WINDS: South of 25°N, the prevailing trade winds are from the east or northeast at an average Beaufort force of 3 to 5. Between 25°N and 50°N, the prevailing winds are from the northwest through southwest and average force 4 to 6. Winds north of 50°N, are predominantly out of the southeast across the Gulf of Alaska, east across the Bering Sea and north across the Sea of Okhotsk. At these higher latitudes the winds average force 4 to 6.

PRESSURE: During January, the Aleutian Low dominates the North Pacific extending from northeastern Asia to western Canada. Its central position lies east of the southern tip of the Kamchatka Peninsula on the 170°E meridian with a central pressure of just over 997 millibars, tying with February for the lowest value of the year. The Pacific Subtropical High extends from the California coast to the Hawaiian Islands with a mean central pressure of just over 1020 millibars. The Siberian High which covers most of the Asian Continent extends out over the East China Sea and southern Japan, thus completing the band of high pressure across the lower latitudes of the North Pacific.

VISIBILITY: South of 40°N, the only areas where visibilities of less than 2 miles occur more than 10 percent of the time, are in the Sea of Japan and a small area from Los Angeles to San Diego. North of 40°N, visibilities of less than 2 miles are reported 5 percent or more of the time with most areas north of 45°N, reporting frequencies of 10 percent or more. Frequencies of 20 percent extend over the Sea of Okhotsk and Bering Sea with frequencies of 30 percent occurring along the eastern side of the Kamchatka Peninsula.

AIR TEMPERATURE: The mean air temperature in January ranges from less than −24°C in the Chukchi Sea to more than 28°C near the equator. North of 30°N, going from west to east on a given latitude, the temperature increases except along the California coast where the cold ocean current reduces the air temperature. Along latitude 40°N, the mean air temperature ranges from just under −2°C off the Korean coast to over 12°C at 130°W. At this same latitude 98 percent of the observations fall from just below −12°C to just over 16°C. Extreme temperatures range from below −40°C in the Chukchi Sea to just over 32°C near the equator.

WAVE HEIGHTS: The red lines on the main body of the chart indicate the percentage of frequency of wave heights greater than or equal to 12 feet. In analysis, when both sea and swell are reported, the higher value is used in summarization. Except for the protected coastal sea, most areas between Hawaii and the Bering Sea, experience wave heights of 12 feet or higher 10 percent or more of the time. Ten percent frequencies are also observed in the South China Sea, East China Sea, and the Philippine Sea. Frequencies reach a high of 40 percent between the southern tip of the Kamchatka Peninsula and the Aleutians.

GALES: Winds of Beaufort force 8 and higher are confined mainly between 30°N and 65°N and east of Japan and the Kamchatka Peninsula. A region with gale frequencies of 10 percent or more extends from southeastern Japan north to northern Alaska and east to 148°W. Most regions along the Aleutian chain report frequencies of less than 10 percent except for areas that extend east of Dutch Harbor and west of 177°W. The eastern half of the Gulf of Alaska also observes frequencies of 10 percent or more with the exception of the coastal areas.

EXTRATROPICAL CYCLONES: The principal area of cyclogenesis stretches from the Sea of Japan to 145°W along the 40°N parallel. Primary storm tracks run from the Sea of Japan across to the Aleutians from some 600 to 800 miles east. In this region one major track runs north into the Bering Sea while a second one runs northeast into the Gulf of Alaska. From the Gulf, storms move north into Alaska or west into Canada. Secondary storm tracks move out of Siberia into the Sea of Okhotsk where they join the major track to the Bering Sea.

TROPICAL CYCLONES: For the period in which we have fairly complete records (1949–1977) there has not been a reported tropical cyclone in the eastern North Pacific during January. The frequency, however, is greater in the western North Pacific, where for an average 10 year period, four storms should reach tropical storm strength (≥ 34 kts) and of these, three should reach typhoon strength (≥ 64 kts).

AVERAGE ICE LIMITS: Types and limits of ice are shown in red as follows:
- Minimum extent of sea ice of ⅛ or greater concentration.
- Mean extent of sea ice of ⅛ or greater concentration.
- Maximum extent of sea ice of ⅛ or greater concentration.
- Glaciers.

FREQUENCY OF WAVE HEIGHTS: The red lines on the main body of the chart indicate the percent frequency of wave height equal to or greater than 12 feet. In the analysis, when both sea and swell are reported, the higher value is used in the summarization.

EXPLANATION OF WIND ROSES: The wind roses in blue color are located in the center of each 5° square. Each rose shows the distribution of the winds that have prevailed in the area over a considerable period of time. The wind percentages are summarized for calm and for the Cardinal and Intercardinal compass points. The arrows fly with the wind, indicating the direction from which the wind blew. The length of the shaft, measured from the outside of the circle to the end of the visible shaft (not necessarily to the end of the last feather), using the appropriate scale below, gives the percentage of the total number of observations in which the wind has blown from that direction. The number of feathers shows the average force of the wind on the Beaufort scale. The figure in the center of the circle gives the percentage of calms. When the arrow is too long (over 29 percent) to fit conveniently in the 5° square, the percentage is indicated numerically on the shaft.

FOR EXAMPLE: The sample wind rose should be read thus: In the reported observations the wind has averaged as follows: From N. 32 percent, force 5; from N.E. 11 percent, force 4; from E. 8 percent, force 4; from S.E. 4 percent, force 4; from S. 3 percent, force 4; from S.W. 5 percent, force 4; from W. 10 percent, force 4; from N.W. 25 percent, force 4; calms 2 percent.

SCALE OF WIND PERCENTAGES

SURFACE CURRENTS

The monthly stream and drift currents shown on this chart by green arrows indicate in general the currents that may be expected.

Generally, sufficient data are available to delineate the prevailing current pattern and to determine the mean speed. However, the user is cautioned that changes in wind direction, speed, and duration can change local currents both in direction and speed.

- Prevailing direction
- Probable direction
- 1.2 Mean current speed in knots.
- Approximate limits of Equatorial Countercurrent.

USE OF CHART

This chart is not intended to be used alone but in conjunction with other navigational aids. The chart presents, in graphic form, averages obtained from data gathered over many years in meteorology and oceanography to aid the navigator in selecting the quickest and safest routes. Included are explanations of how to use each type of information depicted on this chart.

Small icebergs and bergy bits calved from glaciers are usually confined to coastal waters.

LOCAL WEATHER

For extended remarks on the marine climate along foreign coasts, see the appropriate Sailing Directions (Enroute and Planning Guides) prepared and published by the Defense Mapping Agency Hydrographic/Topographic Center. For the coasts of the United States and its possessions, see the appropriate Coast Pilot prepared and published by the National Ocean Service. The quarterly publication "Mariners Weather Log", prepared and published by the National Oceanic and Atmospheric Administration, Environmental Data and Information Service, carries informative articles on marine climatic conditions.

MAGNETIC VARIATION: The lines of equal magnetic variation for the epoch 1990 are shown by gray lines on the main body of the chart. The annual rate of change is shown by gray lines on the uppermost inset chart.

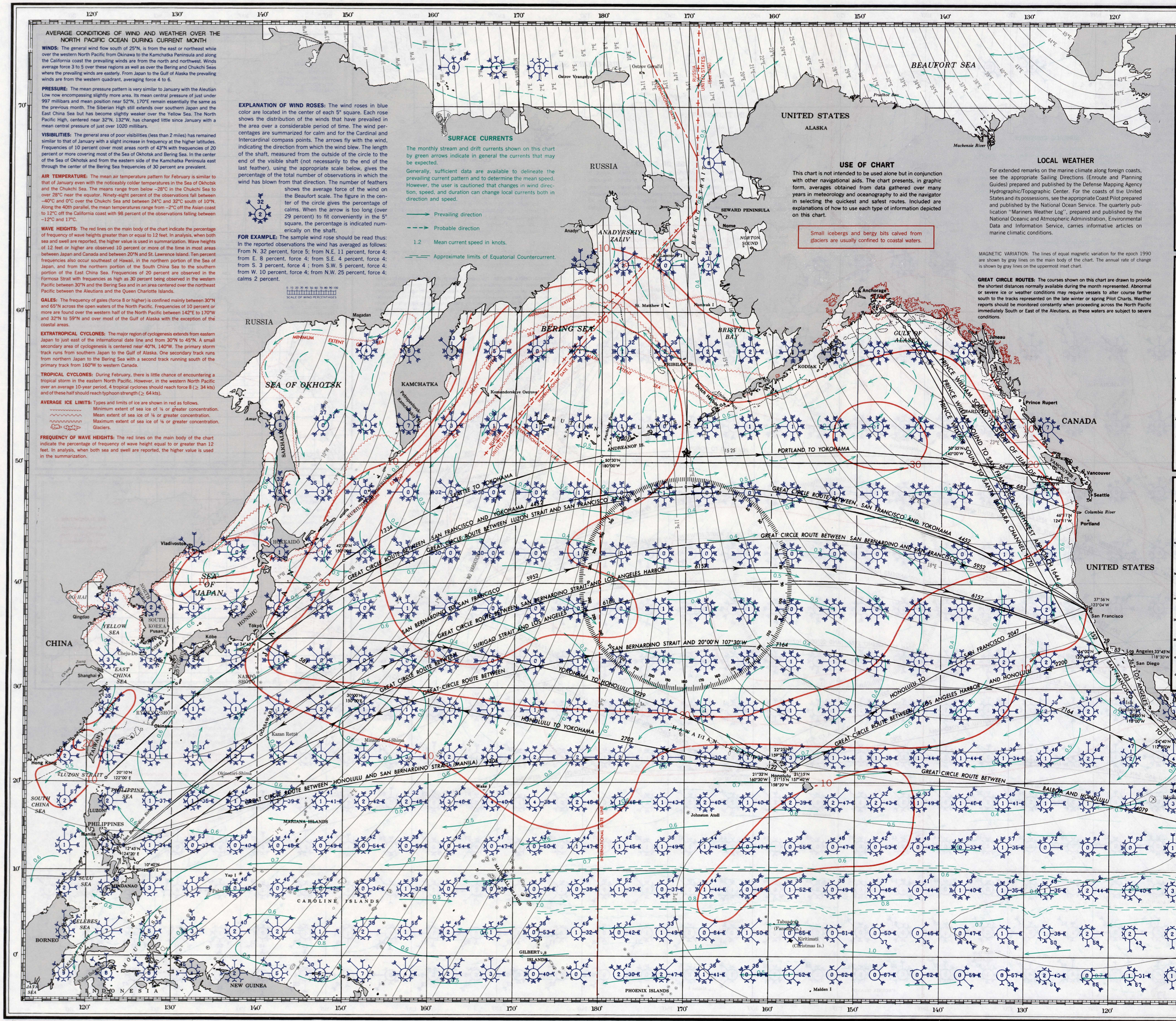
GREAT CIRCLE ROUTES: The courses shown on this chart are drawn to provide the shortest distances normally available during the month represented. Abnormal or severe ice or weather conditions may require vessels to alter course farther south to the tracks represented on the late winter or spring Pilot Charts. Weather reports should be monitored constantly when proceeding across the North Pacific immediately South or East of the Aleutians, as these waters are subject to severe conditions.

NOTE: It should be kept in mind that most ships tend to avoid areas of inclement weather. The frequency of gales and high waves is generally greater than that which is actually reported due to climatological observations being biased toward favorable weather conditions.

NOTE: Maritime boundary provisionally applied pending formal exchange of instruments of ratification.

NOTE: Depiction of maritime boundary has been changed since the last edition.

PILOT CHART OF THE NORTH PACIFIC OCEAN



AVERAGE CONDITIONS OF WIND AND WEATHER OVER THE NORTH PACIFIC OCEAN DURING CURRENT MONTH

WINDS: The general wind flow south of 25°N, is from the east or northeast while over the western North Pacific from Okinawa to the Kamchatka Peninsula and along the California coast the prevailing winds are from the north and northwest. Winds average force 3 to 5 over these regions as well as over the Bering and Chukchi Seas where the prevailing winds are easterly. From Japan to the Gulf of Alaska the prevailing winds are from the western quadrant, averaging force 4 to 6.

PRESSURE: The mean pressure pattern is very similar to January with the Aleutian Low now encompassing slightly more area. Its mean central pressure of just under 997 millibars and mean position near 52°N, 170°E remain essentially the same as the previous month. The Siberian High still extends over southern Japan and the East China Sea but has become slightly weaker over the Yellow Sea. The North Pacific High, centered near 32°N, 132°W, has changed little since January with a mean central pressure of just over 1020 millibars.

VISIBILITIES: The general area of poor visibilities (less than 2 miles) has remained similar to that of January with a slight increase in frequency at the higher latitudes. Frequencies of 10 percent cover most areas north of 43°N with frequencies of 20 percent or more covering most of the Sea of Okhotsk and Bering Sea. In the center of the Sea of Okhotsk and from the eastern side of the Kamchatka Peninsula east through the center of the Bering Sea frequencies of 30 percent are prevalent.

AIR TEMPERATURE: The mean air temperature pattern for February is similar to that of January even with the noticeably colder temperatures in the Sea of Okhotsk and the Chukchi Sea. The means range from below −28°C in the Chukchi Sea to over 28°C near the equator. Ninety-eight percent of the observations fall between −40°C and 0°C over the Chukchi Sea and between 24°C and 32°C south of 10°N. Along the 40th parallel, the mean temperatures range from −2°C off the Asian coast to 12°C off the California coast with 98 percent of the observations falling between −12°C and 17°C.

WAVE HEIGHTS: The red lines on the main body of the chart indicate the percentage of frequency of wave heights greater than or equal to 12 feet. In analysis, when both sea and swell are reported, the higher value is used in summarization. Wave heights of 12 feet or higher are observed 10 percent or more of the time in most areas between Japan and Canada and between 20°N and St. Lawrence Island. Ten percent frequencies also occur southeast of Hawaii, in the northern portion of the Sea of Japan, and from the northern portion of the South China Sea to the southern portion of the East China Sea. Frequencies of 20 percent are observed in the Formosa Strait with frequencies as high as 30 percent being observed in the western Pacific between 30°N and the Bering Sea and in an area centered over the northeast Pacific between the Aleutians and the Queen Charlotte Islands.

GALES: The frequency of gales (force 8 or higher) is confined mainly between 30°N and 65°N across the open waters of the North Pacific. Frequencies of 10 percent or more are found over the western half of the North Pacific between 142°E to 170°W and 32°N to 59°N and over most of the Gulf of Alaska with the exception of the coastal areas.

EXTRATROPICAL CYCLONES: The major region of cyclogenesis extends from eastern Japan to just east of the international date line and from 30°N to 45°N. A small secondary area of cyclogenesis is centered near 40°N, 140°W. The primary storm track runs from southern Japan to the Gulf of Alaska. One secondary track runs from northern Japan to the Bering Sea with a second track running south of the primary track from 160°W to western Canada.

TROPICAL CYCLONES: During February, there is little chance of encountering a tropical storm in the eastern North Pacific. However, in the western North Pacific over an average 10-year period, 4 tropical cyclones should reach force 8 (≥ 34 kts) and of these half should reach typhoon strength (≥ 64 kts).

AVERAGE ICE LIMITS: Types and limits of ice are shown in red as follows.
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Mean extent of sea ice of ⅛ or greater concentration.
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Glaciers.

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0 10 20 30 40 50 60 70 80 90 100
SCALE OF WIND PERCENTAGES

SURFACE CURRENTS

The monthly stream and drift currents shown on this chart by green arrows indicate in general the currents that may be expected.

Generally, sufficient data are available to delineate the prevailing current pattern and to determine the mean speed. However, the user is cautioned that changes in wind direction, speed, and duration can change local currents both in direction and speed.

Prevailing direction
Probable direction
1.2 Mean current speed in knots.
Approximate limits of Equatorial Countercurrent.

USE OF CHART

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Small icebergs and bergy bits calved from glaciers are usually confined to coastal waters.

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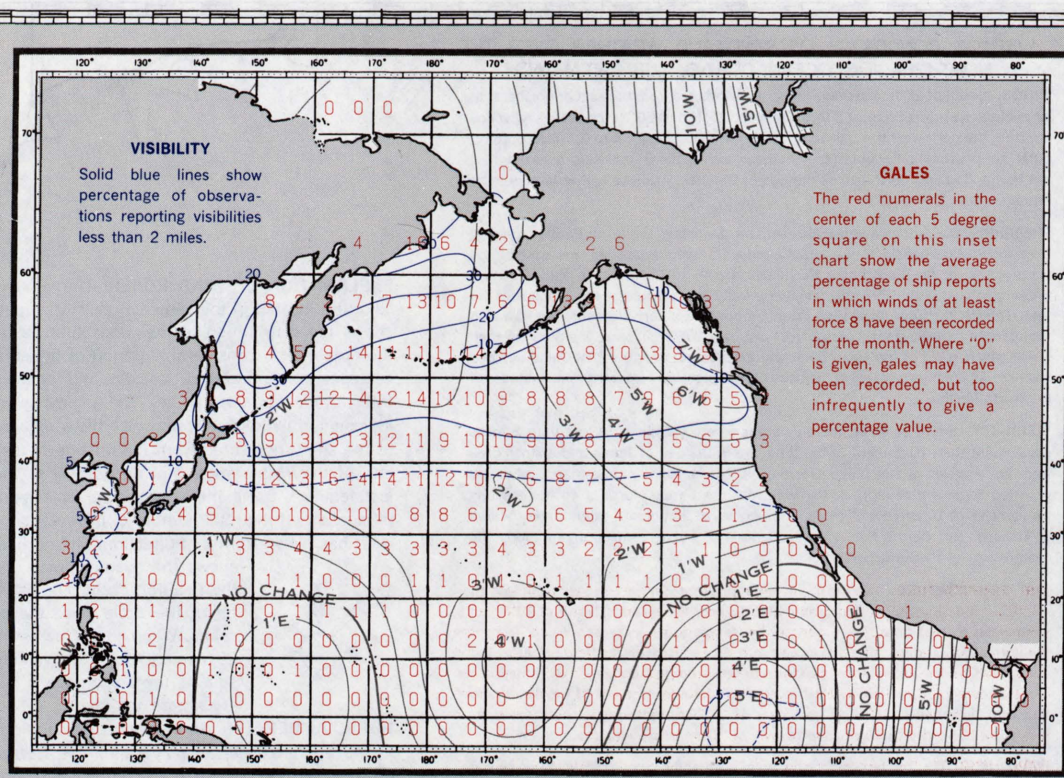
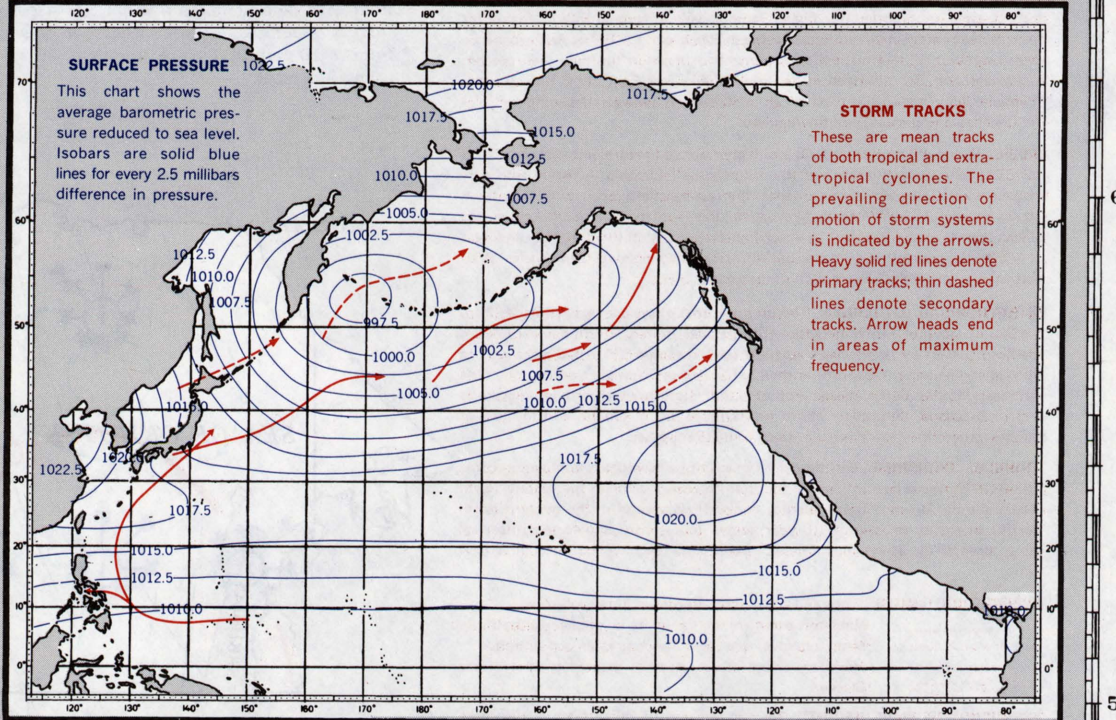


VISIBILITY

Solid blue lines show percentage of observations reporting visibilities less than 2 miles.

GALES

The red numerals in the center of each 5 degree square on this inset chart show the average percentage of ship reports in which winds of at least force 8 have been recorded for the month. Where "0" is given, gales may have been recorded, but too infrequently to give a percentage value.

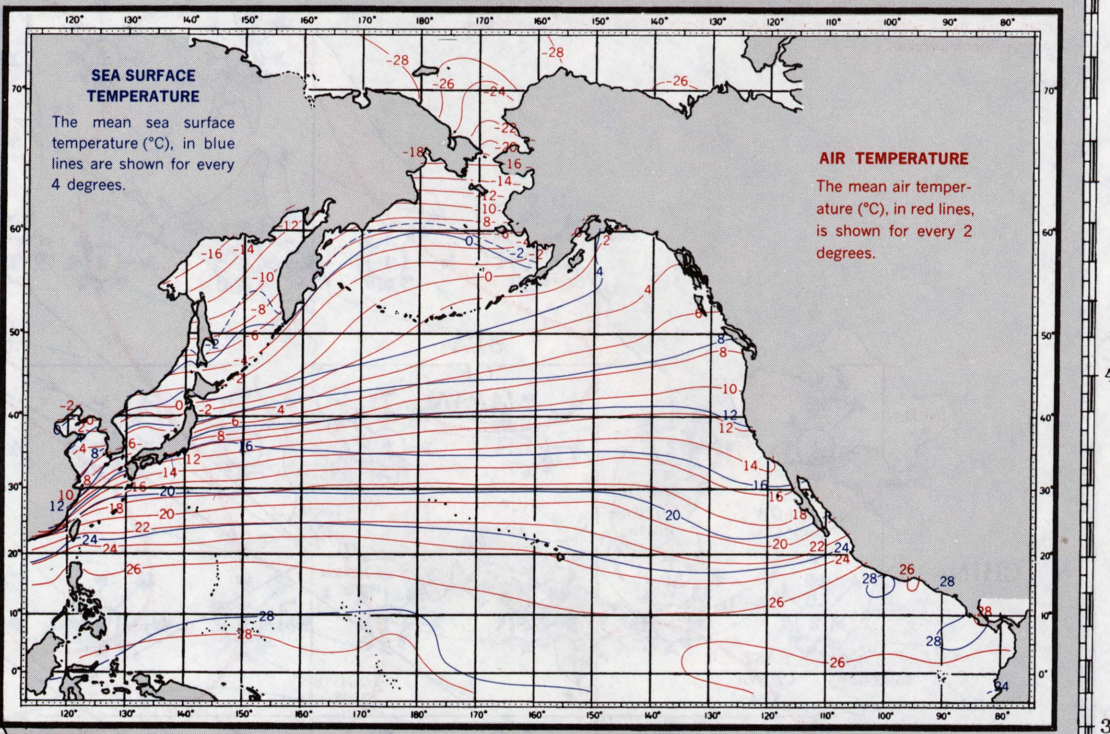


SURFACE PRESSURE

This chart shows the average barometric pressure reduced to sea level. Isobars are solid blue lines for every 2.5 millibars difference in pressure.

STORM TRACKS

These are mean tracks of both tropical and extratropical cyclones. The prevailing direction of motion of storm systems is indicated by the arrows. Heavy solid red lines denote primary tracks; thin dashed lines denote secondary tracks. Arrow heads end in areas of maximum frequency.



SEA SURFACE TEMPERATURE

The mean sea surface temperature (°C), in blue lines are shown for every 4 degrees.

AIR TEMPERATURE

The mean air temperature (°C), in red lines, is shown for every 2 degrees.

NOTE: It should be kept in mind that most ships tend to avoid areas of inclement weather. The frequency of gales and high waves is generally greater than that which is actually reported due to climatological observations being biased toward favorable weather conditions.

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PILOT CHART OF THE NORTH PACIFIC OCEAN

AVERAGE CONDITIONS OF WIND AND WEATHER OVER THE NORTH PACIFIC OCEAN DURING CURRENT MONTH

WINDS: From Japan to northern California and southern Alaska, the prevailing winds are from the west to southwest averaging force 4 to 6. The remaining regions of the Pacific maintain average force winds of 3 to 5. Northeasterly winds prevail south of 25°N and north of 60°N with north to northwesterly winds occurring over the Sea of Okhotsk, the Sea of Japan, the Yellow Sea, and off the coast of California.

PRESSURE: The transition month shows the Aleutian Low filling to 1004 millibars, compared to 997 millibars in February. It is still centrally positioned at 53°N, 170°E. A secondary low of 1007 millibars has formed in the Gulf of Alaska. A noticeable lessening of the pressure gradient across the North Pacific has also occurred since the previous month. The Siberian High has retreated significantly, affecting little of the Pacific Ocean except in the vicinity of the Yellow Sea. The Pacific Subtropical High has greatly increased its influence by extending from the western United States to 165°E. Its central pressure has increased to over 1023 millibars and is now centered near 30°N, 138°W.

VISIBILITIES: During March, increased frequencies of visibilities less than 2 miles occur over the East China Sea with frequencies reaching 20 percent off the China coast near Shanghai. Most regions north of 40°N, show frequencies of at least 5 to 10 percent with frequencies exceeding 20 percent along most of the coastal areas of the Sea of Okhotsk and across most of the Bering Sea. The highest occurrences appear in the Bering Sea where frequencies of 30 percent are observed in several areas.

AIR TEMPERATURE: With the approach of spring the mean air temperature increases slightly over the North Pacific. Ninety percent of the temperature observations in the Sea of Okhotsk and Bering Sea are still below 0°C. The mean temperatures range from below −24°C in the Chukchi Sea to over 28°C near the equator. Ninety-eight percent of the temperatures in the Chukchi Sea fall between −40°C and 0°C and between 24°C and 32°C below 10°N. Eastward along the 40th parallel, 98 percent of the temperatures fall between −6°C and 17°C with the means ranging from 3°C to 11°C.

WAVE HEIGHTS: The red lines on the main body of the chart indicate the percentage of frequency of wave heights greater than or equal to 12 feet. In analysis, when both sea and swell are reported, the higher value is used in summarization. Wave heights of at least 12 feet are observed more than 10 percent of the time in most areas between Japan and North America and between the Bering Sea and Hawaii. Frequencies increase to 30 percent over the western Pacific between the Kuril Islands and the Pribilof Islands and between 155°E and 178°W near the 40th parallel. Wave heights of this magnitude are also observed 10 percent of the time between the Marshall and Hawaiian Islands and in the waters surrounding Taiwan.

GALES: Most gale force winds over the North Pacific Ocean occur (5 percent or greater) from east-central Japan to as far north as the Bering Sea and the Gulf of Alaska and as far east as Canada and the northwestern United States. Frequencies of 10 percent or more are mainly confined to the western North Pacific from 32°N to 57°N and lie north of the Aleutians in the north and between Japan and the international date line in the south.

EXTRATROPICAL CYCLONES: During March, the major area of cyclogenesis spans some 600 miles in width and extends in length from Japan to near 45°N, 170°E. The primary storm track crosses southern Japan passing through the center of the major area of cyclogenesis. On the northeast edge of this area of cyclogenesis, the primary track branches with the lows either heading north towards the Aleutians or east towards Canada. A second primary track branches from the northwestern edge of the area of cyclogenesis into the southern region of the Bering Sea. Secondary tracks move southeast out of Asia across northern Japan, north across the central region of the Gulf of Alaska, and southeast into the northwestern United States.

TROPICAL CYCLONES: For the period of record only one tropical storm has been observed during March in the western North Pacific. However, on the average in the western North Pacific, a tropical storm (≥ 34 kts) will be observed once every 2 years and a typhoon (≥ 64 kts) once every 5 years.

AVERAGE ICE LIMITS: Types and limits of ice are shown in red as follows.
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SCALE OF WIND ROSES

SURFACE CURRENTS

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Prevailing direction

Probable direction

1.2 Mean current speed in knots.

Approximate limits of Equatorial Countercurrent.

USE OF CHART

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PILOT CHART OF THE NORTH PACIFIC OCEAN

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AVERAGE CONDITIONS OF WIND AND WEATHER OVER THE NORTH PACIFIC OCEAN DURING CURRENT MONTH

WINDS: The mean wind speeds have continued to decrease from the winter months. The strongest average winds, force 4, prevail from southern Japan to the Gulf of Alaska, off the California coast, and in the areas associated with the persistent northeasterly and easterly trades. The remainder of the Pacific averages force 2 to 3. Northeasterly winds prevail south of 30°N and over the northern portion of the Bering Sea and Chukchi Sea. Southwesterly and westerly winds prevail over the remainder of the Pacific except along the west coast of the U.S. where they are northwesterly and over the Asian waters where they are southerly.

PRESSURE: With summer nearing, the Aleutian Low becomes rather ill-defined even though the pressure over the Bering Sea remains relatively low. The dominate feature is the Pacific Subtropical High which extends from the North American to the Asian Continent with ridging as far north as Alaska. Its mean central pressure still remains just over 1023 millibars which is now centered near 35°N, 140°W.

VISIBILITIES: Increased occurrences of visibilities of less than 2 miles have appeared over the northwest Pacific. Frequencies of 10 percent or more lie north of a line that extends from the southern edge of the East China Sea across central Japan into the Gulf of Alaska and along the western coast of Alaska. An area of twenty percent frequenceis lies off the southwest tip of Korea in the Yellow Sea and runs from northern Japan into the Sea of Okhotsk and the Bering Sea. The highest frequencies, 30 percent, occur over the central portion of the Sea of Okhotsk and Kuril Islands and along the northeast side of the Kamchatka Peninsula.

AIR TEMPERATURE: As the sun moves north the temperature range decreases substantially between the equator and the pole. Temperatures south of 20°N increase little, but north of 60°N they increase by 6° to 12° Celsius. Mean temperatures range from −6°C in the Chukchi Sea to over 28°C near the equator. Approximately ninety-eight percent of the observations in the Chukchi Sea fall between −20°C and 4°C, at 40°N between 4°C and 20°C, and south of 20°N between 20°C and 32°C. Mean temperatures along the 40th parallel are nearly isothermal with only a one degree range from 12°C in the western Pacific to 13°C in the eastern Pacific.

WAVE HEIGHTS: The red lines on the main body of the chart indicate the percentage of frequency of wave heights greater than or equal to 12 feet. In analysis, when both sea and swell are reported, the higher value is used in summarization. By May, wave heights of 12 feet or higher have decreased significantly from the winter months. Frequencies of just more than 10 percent are the highest observed. Regions where these frequencies occur are off the northern coast of California, west of the Pribilof Islands, and between the Kuril Islands and the Gulf of Alaska.

GALES: During May there are few reports of gale force winds (≥ 34 kts). Three small areas report frequencies of 5 percent. One area is located south of the western portion of the Aleutian chain centered near 49°N, 178°E, another is centered near 48°N, 167°W, and a third along the Oregon and northern California coasts.

EXTRATROPICAL CYCLONES: By May, the principal area of cyclogenesis has shifted slightly west extending from the Sea of Japan to near 45°N, 163°E. A smaller second area appears south of the western edge of the Aleutian chain, centered near 45°N, 175°W. The primary tracks run from southeastern Japan to western Canada with a track near 42°N, 162°E branching into the southwestern Bering Sea and one near 52°N, 155°W branching into southern Alaska. A secondary track moves northeast across northern Japan and the southern edge of the Kuril Islands.

TROPICAL CYCLONES: By May, temperatures are beginning to increase enough in the eastern North Pacific to produce some infrequent tropical cyclone activity. During an average 10-year period in the eastern North Pacific one can expect 3 tropical cyclones of force 8 or greater, with most obtaining hurricane strength (≥ 64 kts). On the average for a comparable time in the western North Pacific, one can expect 13 tropical cyclones to reach force 8 with 9 of these reaching typhoon strength (≥ 64 kts).

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SCALE OF WIND PERCENTAGES

SURFACE CURRENTS

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- Prevailing direction
- Probable direction
- 1.2 Mean current speed in knots.
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VISIBILITY Solid blue lines show percentage of observations reporting visibilities less than 2 miles.

GALES The red numerals in the center of each 5 degree square on this inset chart show the average percentage of ship reports in which winds of at least force 8 have been recorded for the month. Where "0" is given, gales may have been recorded, but too infrequently to give a percentage value.

SURFACE PRESSURE This chart shows the average barometric pressure reduced to sea level. Isobars are solid blue lines shown for every 2.5 millibars difference in pressure.

STORM TRACKS These are mean tracks of both tropical and extratropical cyclones. The prevailing direction of motion of storm systems is indicated by the arrows. Heavy solid red lines denote primary tracks; thin dashed lines denote secondary tracks. Arrow heads end in areas of maximum frequency.

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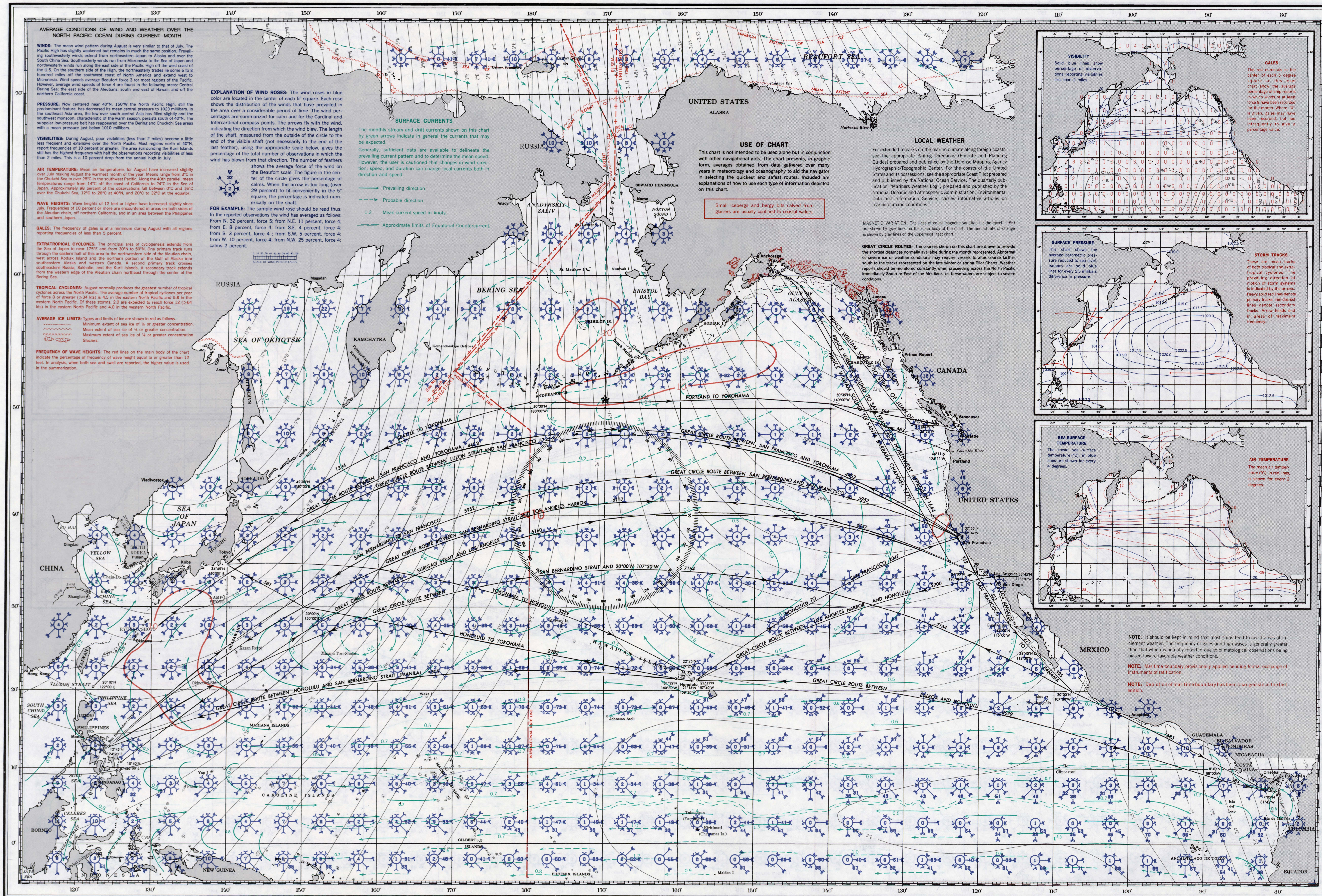
AUGUST

PILOT CHART OF THE NORTH PACIFIC OCEAN



AVERAGE CONDITIONS OF WIND AND WEATHER OVER THE NORTH PACIFIC OCEAN DURING CURRENT MONTH

WINDS: The mean wind pattern during August is very similar to that of July. The Pacific High has slightly weakened but remains in much the same position. Prevailing southwesterly winds extend from northeastern Japan to Alaska and over the South China Sea. Southeasterly winds run from Micronesia to the Sea of Japan and northwesterly winds run along the east side of the Pacific High off the west coast of the U.S. On the southern side of the High, the northeasterly trades lie some 6 to 8 hundred miles off the southwest coast of North America and extend west to Micronesia. Wind speeds average Beaufort force 3 for most regions of the Pacific. However, average wind speeds of force 4 are found in the following areas: Central Bering Sea; the east side of the Aleutians; south and east of Hawaii; and off the northern California coast.

PRESSURE: Now centered near 40°N, 150°W the North Pacific High, still the predominant feature, has decreased its mean central pressure to 1023 millibars. In the southeast Asia area, the low over south central Asia has filled slightly and the southwest monsoon, characteristic of the warm season, persists south of 40°N. The subpolar low-pressure belt has reappeared over the Bering and Chuckchi Sea areas with a mean pressure just below 1010 millibars.

VISIBILITIES: During August, poor visibilities (less than 2 miles) become a little less frequent and extensive over the North Pacific. Most regions north of 40°N, report frequencies of 10 percent or greater. The area surrounding the Kuril Islands still has the highest frequency with half the observations reporting visibilities of less than 2 miles. This is a 10 percent drop from the annual high in July.

AIR TEMPERATURE: Mean air temperatures for August have increased slightly over July making August the warmest month of the year. Means range from 3°C in the Chukchi Sea to over 28°C in the southwest Pacific. Along the 40th parallel, mean temperatures range from 14°C off the coast of California to 24°C in the Sea of Japan. Approximately 98 percent of the observations fall between 0°C and 16°C over the Chukchi Sea, 12°C to 28°C at 40°N, and 20°C to 32°C at the equator.

WAVE HEIGHTS: Wave heights of 12 feet or higher have increased slightly since July. Frequencies of 10 percent or more are encountered in areas on both sides of the Aleutian chain, off northern California, and in an area between the Philippines and southern Japan.

GALES: The frequency of gales is at a minimum during August with all regions reporting frequencies of less than 5 percent.

EXTRATROPICAL CYCLONES: The principal area of cyclogenesis extends from the Sea of Japan to near 175°E and from 30°N to 50°N. One primary track runs through the eastern half of this area to the northwestern side of the Aleutian chain, west across Kodiak Island and the northern portion of the Gulf of Alaska into southeastern Alaska and western Canada. A second primary track crosses southeastern Russia, Sakhalin, and the Kuril Islands. A secondary track extends from the western edge of the Aleutian chain northeast through the center of the Bering Sea.

TROPICAL CYCLONES: August normally produces the greatest number of tropical cyclones across the North Pacific. The average number of tropical cyclones per year of force 8 or greater (≥34 kts) is 4.5 in the eastern North Pacific and 5.8 in the western North Pacific. Of these storms, 2.0 are expected to reach force 12 (≥64 kts) in the eastern North Pacific and 4.0 in the western North Pacific.

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SCALE OF WIND PERCENTAGES

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Solid blue lines show percentage of observations reporting visibilities less than 2 miles.

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This chart shows the average barometric pressure reduced to sea level. Isobars are solid blue lines for every 2.5 millibars difference in pressure.

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These are mean tracks of both tropical and extra-tropical cyclones. The prevailing direction of motion of storm systems is indicated by the arrows. Heavy solid red lines denote primary tracks; the dashed lines denote secondary tracks. Arrow heads end in areas of maximum frequency.

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PILOT CHART OF THE NORTH PACIFIC OCEAN

AVERAGE CONDITIONS OF WIND AND WEATHER OVER THE NORTH PACIFIC OCEAN DURING CURRENT MONTH

WINDS: The circulation pattern has begun to take on winter characteristics as the Aleutian Low becomes well-established again. Mean wind speeds have increased since August, with winds north of 40°N, averaging force 3 to 5 and south of 40°N, force 2 to 4. Mean northerly winds are observed over the Yellow Sea, Sea of Japan, Bering Sea, and off the western coast of the U.S. and Mexico. South of 35°N, between 130°W and 130°E, prevailing winds are from the eastern quadrant while southwesterly winds prevail across the South China Sea and westerlies in a relatively large region that extends from northern Japan to western Canada and southern Alaska.

PRESSURE: With the beginning of autumn the Aleutian Low reappears over the Gulf of Alaska and the Bering Sea, with a central pressure of just under 1007 millibars. The North Pacific anticyclone shows signs of the changing seasons as it moves southeast and decreases its extent. Its mean central pressure has decreased to just over 1020 millibars, centered near 35°N, 145°W. Near the China coast and the Sea of Japan the pressures have risen somewhat since August as the low over southern Asia fills and the southwest monsoon disappears.

VISIBILITIES: A noted improvement in visibilities occurs over the North Pacific from the previous month. Poor visibilities (less than 2 miles) appear 20 percent less of the time in many regions north of 40°N. Frequencies of 10 percent or more are mainly confined between 40°N to 60°N and 150°E to 135°W. Frequencies of 10 percent also occur along the California coast and in the northeast Sea of Okhotsk. The highest occurrences, 20 to 30 percent, occur over the Kuril Islands and along the southwest side of the Kamchatka Peninsula.

AIR TEMPERATURE: Mean temperatures across the North Pacific have begun to cool off from the previous month with the most noticeable changes occuring north of 30°N. Means range from just under 0°C at 70°N to over 28°C in the southwest Pacific between the equator and 25°N. At 40°N, the means range from 15°C off the California coast to 20°C off the Asian coast. Approximately 98 percent of the temperatures fall between –4°C and 8°C in the Chukchi Sea, between 12°C and 28°C at 40°N, and between 20°C and 32°C at the equator.

GALES: The frequency of gales increases slightly in September, particularly along the southern coast of Alaska. Frequencies of 5 percent cover the northern end of the Gulf of Alaska, Bristol Bay and the Bering Sea to as far west as 175°E, and along the southeastern region of the Aleutian chain from the Fox Islands to the Rat Islands.

EXTRATROPICAL CYCLONES: During September, the principal area of cyclogenesis has decreased in size as compared to the three previous summer months. It now extends from southern Japan to near 50°N, 170°E. One primary track runs from central Japan to the Gulf of Alaska with a second one paralleling the first, running from near 42°N, 178°E to near 52°N, 155°W. One secondary storm track branches off the primary storm track across the western Aleutians. Other secondary tracks extend across southern Sakhalin to east of the Commander Islands and across the northern portion of the Sea of Okhotsk.

TROPICAL CYCLONES: The frequency of tropical cyclone activity across the North Pacific in September nearly equals the peak in August. On the average 4.1 storms per year reach force 8 or greater (≥34 kts) in the eastern North Pacific and 5.6 in the western North Pacific. Of these storms 1.8 will reach force 12 (≥64 kts) in the eastern North Pacific and 4.1 in the western North Pacific.

WAVE HEIGHTS: The number of areas where wave heights of at least 12 feet are observed 10 percent or more of the time continue to increase. Frequencies of 10 percent are observed in most areas between 40°N and 60°N and between the Kuril Islands and the Queen Charlotte Islands. Similar wave regimes are also observed off northern California and from the East China Sea to the Philippine Sea.

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SCALE OF WIND PERCENTAGES

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PILOT CHART OF THE NORTH PACIFIC OCEAN

AVERAGE CONDITIONS OF WIND AND WEATHER OVER THE NORTH PACIFIC OCEAN DURING CURRENT MONTH

WINDS: By October, the Aleutian Low has become as dominant a feature as the Pacific Subtropical High. Westerly winds prevail between 35°N and 60°N with the exception of the northerly winds along Japan. At these latitudes the winds average force 4 to 6. North of 60°N, prevailing northerly winds average force 3 to 4 while over the East China Sea and South China Sea, northerly winds average force 3 to 6. From California to the Philippines, wind speeds average force 2 to 4. In this region the prevailing winds are easterly with the exception of northerly winds off California.

PRESSURE: The Aleutian Low has deepened about 8 millibars since last month bringing the mean central pressure to under 1000 millibars with a clearly defined center over Kodiak Island in the Gulf of Alaska. Two centers appear in the Pacific High as it elongates and becomes less influential, each with a pressure of just over 1020 millibars centered near 35°N, 178°E and 35°N, 138°W. Pressures have increased over eastern Asia and the western Pacific as the Siberian High increases in strength and pushes over the Yellow Sea and the Sea of Japan.

VISIBILITIES: During October, visibilities of less than 2 miles are less frequent and widespread than at any time of the year. Most regions north of 40°N have observed frequencies of 5 percent or more. The highest frequencies, of just over 10 percent, occur northwest of St. Lawrence Island, along the coastal region of North America from central California to southeastern Alaska, and in midocean along the 45th parallel from the Kuril Islands to 160°W and from 145°W to 135°W.

TEMPERATURE: With the onset of winter the mean zero isotherm has moved south from its September position in the Chukchi Sea to across St. Lawrence Island in the Bering Sea. Mean temperatures range from −8°C at 70°N to over 28°C in the southwest Pacific south of 22°N. Along the 40th parallel, the mean temperature is near 14°C off both the California and Asian coast and near 18°C at 145°W. Most temperatures (approximately 98 percent) fall beteen −20°C and 4°C over the Chukchi Sea, between 8°C and 24°C at 40°N, and between 20°C and 32°C at the equator.

GALES: The frequency of winds of force 8 or greater have increased significantly from the previously warmer months. During October, most gales are confined primarily to the latitude band between 40°N and 60°N. Areas with the highest frequencies (10 percent or higher) are located to the east of the Kamchatka Peninsula, centered near 50°N, 163°E, and the region running from the south coast of Alaska to 45°N and between 138°W to 179°E.

EXTRATROPICAL CYCLONES: The principal area of cyclogenesis lies more east-west during October, extending from the Sea of Japan to near 170°E. The north-south extent of the area is from 30°N to 45°N. The primary storm tracks run from southwest to northeast with one extending from southeastern Japan to near 52°N, 158°W where it divides into a northerly track to Alaska and an easterly one to Canada. A second track runs from southern Sakhalin across the Komandorskiye Islands into the western Bering Sea with a third track running from west to east just south of the western edge of the Aleutian Chain.

TROPICAL CYCLONES: The frequency of tropical cyclones begins to decrease in October. An average of 2.2 tropical cyclones per year of force 8 or greater (≥ 34 kts) occur in the eastern North Pacific and 4.3 in the western North Pacific. Of these, an average of 1.0 will reach hurricane strength (≥ 64 kts) in the eastern North Pacific and 3.3 in the western North Pacific.

WAVE HEIGHTS: In general, most areas between 25°N and the Bering Sea and between Japan and North America experience wave heights of at least 12 feet, 10 percent or more of the time. Ten percent frequencies are also encountered from the northern Philippines to the East China Sea and over the east central Philippine Sea Frequencies increase over the North Pacific to a maximum of 30 percent south of Kodiak Island between 140°W and the Aleutians.

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SCALE OF WIND PERCENTAGES

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WINDS: The intensification of the Aleutian Low since October has had little effect on the general circulation pattern. The mean wind flow between 35°N and 60°N is west to southwest while south of 35°N, it is east to northeast. The exceptions are the prevailing northerly winds that are observed off California and in an area that extends from Japan to the South China Sea. Winds average force 4 to 6 over the South China Sea and in most regions North of 30°N. The remaining areas of the North Pacific average force 3 to 5.

PRESSURE: Although mean temperatures are lower, only a slight southerly movement of the Aleutian Low is noted as it becomes centered near 57°N, 150°W with its mean central pressure remaining just under 1000 millibars. Along the 30th parallel, the Pacific High extends from California to 150°E. Its mean central pressure of just over 1020 millibars is centered near 32°N, 140°W. Pressures continue to rise near Japan and Korea as the Asiatic High continues to build.

VISIBILITIES: The percent of observations reporting visibilities of less than 2 miles has increased slightly since October. Most regions north of 40°N, report frequencies of at least 5 percent with frequencies of at least 10 percent running northwest of a line from northern Japan to southwestern Alaska. Frequencies of 10 percent are also observed off the California coast near San Francisco, between Vancouver Island and the mainland, and in an area with a radius of approximately 300 miles centered near 50°N, 150°W. Frequencies of 20 percent are reported in the north-central Sea of Okhotsk and in a narrow area that extends from the Komandorskiye Islands to the Bering Strait.

TEMPERATURE: A marked decrease in the mean air temperature is noted from the previous month as temperatures continue to drop. Means range from a −16°C over the Chukchi Sea to over 28°C in the southwest Pacific between the equator and 20°N. Along the 40th parallel, means range from 8°C off Asia to 15°C in the eastern Pacific. Less than 2 percent of the observations fall outside the range of −32°C to 0°C in the Chukchi Sea, −2°C to 20°C at 40°N, and 20°C to 32°C at the equator.

GALES: The frequency of gales (≥ 34 kts) has increased from the previous month with most unprotected areas between 30°N and 65°N reporting frequencies of at least 5 percent. The areas of highest frequency (10 percent or greater) are located from the Gulf of Alaska to the Kuril Islands and from 40°N to the Bering Sea.

EXTRATROPICAL CYCLONES: The principal area of cyclogenesis over the North Pacific extends from the Sea of Japan to near 175°W and from 30°N to 47°N. The migration of lows across the Pacific move primarily from southwest through northeast following three primary tracks. The western most track extends from southeastern Russia across the Kuril Islands into the western portion of the Bering Sea. The central storm track extends from a region to the east of central Japan to Bristol Bay and the easternmost track extends from near 43°N, 175°W to near 47°N, 160°W where it branches northeast into Alaska and east into the northwestern United States.

TROPICAL CYCLONES: Tropical cyclone activity continues to decrease across the North Pacific with the most significant decreases occurring in the eastern North Pacific. During an average time span of 10 years one can expect only 3 storms of force 8 or greater in the eastern North Pacific. Of these, it is unlikely that any will reach hurricane strength (force 12). In the western North Pacific for an equivalent period, 29 are expected to reach force 8 or greater; of these, 21 are expected to reach force 12.

WAVE HEIGHTS: Wave heights of 12 feet or higher are encountered 10 percent or more of the time in most areas between the Hawaiian Islands and St. Lawrence Island and between Japan and North America. Ten percent frequencies are also encountered east of the Hawaiian Islands and from Vietnam to Okinawa. Frequencies increase to 20 percent over the South China Sea and 30 percent along the 50th parallel between 135°W and 160°E.

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