Mariners Weather Log

Vol. 44, No. 2 August 2000

The *Jay Gould* sank on June 17, 1918, near Southeast Shoal, Lake Erie, while towing the barge Commodore. All on board the two ships were rescued by passing steamboats. (See article on page 13.)

Photo: Milwaukee Public Library.

Mariners Weather Log

U.S. Department of Commerce
Norman Y. Mineta, Secretary

National Oceanic and
Atmospheric Administration
Dr. D. James Baker, Administrator

National Weather Service
John J. Kelly, Jr.,
Assistant Administrator for Weather Services

Editorial Supervisor
Martin S. Baron

Editor
Mary Ann Burke

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Articles, photographs, and letters should be sent to:

Mr. Martin S. Baron, Editorial Supervisor
Mariners Weather Log
National Weather Service, NOAA
1325 East-West Highway, Room 14108
Silver Spring, MD 20910

Phone: (301) 713-1677 Ext. 134
Fax: (301) 713-1598
E-mail: martin.baron@noaa.gov

From the Editorial Supervisor

This issue features an article on storm surge, which is the term used to describe the rise in still-water sea level that accompanies the landfall of a tropical storm or hurricane. Recognized as the single most destructive aspect of a hurricane, the coastal storm surge can cause much damage and loss of life (nine out of ten hurricane deaths result from drowning in storm surge). The low pressure in the eye literally sucks the ocean surface upward, like liquid through a straw, and vast tracts of low-lying coastal terrain can be inundated with water as the eye of the hurricane makes landfall. In the northern hemisphere, the area just to the right of the storm track experiences the greatest rise in water level due to the added effect of the wind pushing the water. During the infamous hurricane Camille in 1969, a 25-foot storm surge inundated Pass Christian, Mississippi. Lesser heights are more usual, but still extremely dangerous.

Directly linked to a tropical storm's central barometric pressure, storm surges typically range from 4 to 5 feet for a category 1 hurricane, to 9 to 12 feet for a category 3 hurricane, to 18 feet and above for a category 5 hurricane. See the article for more details.

This issue also contains updated and newly revised information on communication methods for ships to transmit AMVER sail plan/position/deviation/arrival reports. The AMVER record speaks for itself. Over the last five years, AMVER has rescued over 1,500 people, most of whom would have perished if AMVER assistance had not been available. Safeguard your safety and that of fellow mariners by participating in AMVER.

Martin S. Baron⚓

Some Important Webpage Addresses

NOAA	http://www.noaa.gov
National Weather Service	http://www.nws.noaa.gov
AMVER Program	http://www.amver.com
VOS Program	http://www.vos.noaa.gov
SEAS Program	http://seas.nos.noaa.gov/seas/
Mariners Weather Log	http://www.nws.noaa.gov/om/mwl/mwl.htm
Marine Dissemination	http://www.nws.noaa.gov/om/marine/home.htm

See these webpages for further links.

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Bruce Parker
National Ocean Service

Over the centuries, the deadliest and most destructive element of a hurricane has been the *storm surge*, the huge mass of water, often tens of miles wide and many feet high, that is driven onto the land by the high winds and low pressure of the storm. Combined with the astronomical tide, the resulting *storm tide* has time and time again throughout history caused massive flooding, inundating coastal areas for miles inland, destroying buildings, and drowning people. With today's satellite- and model-based warning systems, evacuations have greatly diminished casualties, at least in the developed countries. The building of sea walls and dikes has also reduced the likelihood of extensive damage in some populated areas, although there is always the possibility of a storm more powerful than those structures were designed for. Storm surge, however, still remains the most serious threat to all low-lying coastal areas where hurricanes or extratropical storms can threaten.

Although storm surge was not the main cause of death or damage in the last two major hurricanes in North America, Andrew in August 1991 (high winds caused billions of dollars in damage in southern Florida) and Mitch on 26 October through 4 November 1998 (torrential rains caused flooding and mudslides that killed 11,000 in Honduras and Nicaragua), the deadliest hurricanes in history have wreaked their havoc through storm surges.

The deadliest hurricane in U.S. history was the hurricane that wiped out half the city of Galveston, Texas, in September 1900, killing at least 6,000 and perhaps even thousands more than that because so many people were never found (remains were unearthed for years following that storm). In this case a 6 meter (20 ft) storm surge had come in like a bulldozer that literally scoured

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whole city blocks out of existence. With its deep harbor, Galveston had been a thriving port and one of the largest cities in the U.S. After the hurricane, the primary port moved upstream to Houston. The move to Houston required the dredging of a deep-water ship channel, but at least it was in a safer location than Galveston. After the hurricane a 3 m (10 ft) sea wall was built to protect Galveston, but in August 1915 another violent hurricane produced 3.6 m (12 ft) storm tides which flooded the business district to a depth of 1.8 m (6 ft) and killed 275 people. Four years later, down the coast from Galveston, another great hurricane storm surge almost destroyed the city of Corpus Christi.

The deadliest hurricane (or *cyclone* as it is called in the Indian Ocean) in this century was in Bangladesh in November 1970 when, in a horrifying episode of human loss, more than 300,000 people were killed in the low-lying deltas of the Ganges River by a huge storm surge estimated to be over 9 m (30 ft) high. Sadly again in May 1991, 138,000 more people died there from a hurricane with a 6 m (20 ft) storm surge. Year after year other cyclones producing other storm surges have taken lives in the northern Bay of Bengal in both Bangladesh and India, on a scale lower than the 1970 and 1991 incidents, but still higher than anything we have seen in the U.S. Even with today's warning systems, the cyclone of 29 October 1999, that hit Orissa, India, in the northern Bay of Bengal, with a 6 m (20 ft) storm surge that swept nine miles inland, killed approximately 10,000 people and made a million people homeless. For reasons we will see below, out of 23 cases of major hurricane disasters around the world (with human death tolls of 10,000 or more), 20 have occurred along the coast of the Bay of Bengal. The worst of the worst may have been the storm surge in 1876 produced by the Bakerganj Cyclone of Bangladesh, which was estimated to have killed approximately 2 million people. The aftermath of such storm surges—shattered buildings and trees and bodies everywhere—can only be compared to the destruction of war.

How exactly do the low pressure and high winds of a hurricane, or of an extratropical storm, produce a storm surge and what other factors are involved? The effect of

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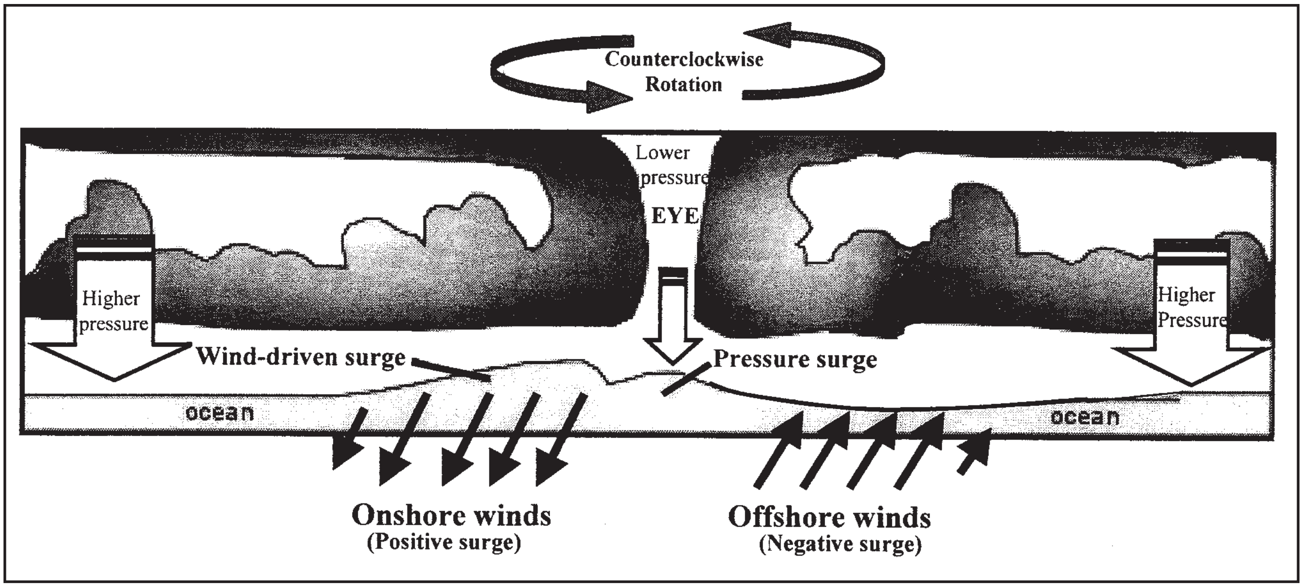

Figure 1. Simplified depiction of the storm surge produce by a hurricane making landfall on a coast in the Northern Hemisphere, looking out toward the ocean from the land. The parts of the surge due to pressure and wind are not really separated as shown in the diagram. See text for explanation.

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pressure on water level is usually referred to as the *inverted barometer effect*. Water level is higher under low atmospheric pressure and lower under high atmospheric pressure (see Figure 1). The greatest pressure effect on water level is in the eye of a hurricane, where the pressure is the lowest. One can initially think of this as being like a vacuum or plunger sucking the water up and raising the water level. More accurately, one should realize that the atmosphere is pressing down on the water surface everywhere, but that if it is pressuring down harder in one place (for example, in the area outside the edges of the hurricane) and pressing down with less force in another place (for example, in the eye of the hurricane), then the water will be pushed from the higher pressure area to the lower pressure area, where the water surface will be raised. So it is the pressure difference between outside the hurricane and the eye that determines how much the water level will rise in the eye. (This will only take place, however, in the ocean or coastal ocean where there is enough water to be pulled in from the outside. A hurricane directly over a small bay would not have the same pressure effect.) The general rule is that one millibar in pressure difference translates into a centimeter of water level elevation change. Similarly, a pressure drop of one inch of mercury translates into 13.8 inches of water elevation rise. For the strongest hurricanes, with barometric pressure in the eye on the order of 900 mb or less, the pressure difference translates into a 1.2 m (4 ft) rise in water level in the eye. Since storm surges produced by large hurricanes can reach 6 m (20 ft) or more in height, it is apparent that the pressure effect is not the main cause of storm surge.

There is one way, however, in which the pressure effect can be enhanced. If the hurricane happens to be moving forward at the same speed as would a long water wave (i.e., the surge) produced by the pressure effect, then resonance will occur and the water level will become higher. This is more likely to happen with fast moving hurricanes in shallower water (where the wave speed is slower). Typical average speeds of hurricanes in the Gulf of Mexico range from 4-13 kts but can reach up to 35-43 kts. The speed of a long water wave is, for example, 35 kts in water that is 8 m (27 ft) deep. So if a hurricane is moving ashore at a speed of 35 kts and the water is 8 m (27 ft) deep, then one would expect the water level in the eye to increase in height, perhaps doubling or more.

The most important cause of storm surge is the wind. There are two ways in which the wind can generate a storm surge. In shallower water the *onshore component of the wind* directly pushes the water up against the coast, raising the water level. This is the frictional effect of the wind rubbing on the water surface and moving it forward. The top layers of water then rub on the lower layers which move them forward. The coast stops the total water movement causing the water to pile up higher against it until the surge tops over the coast causing flooding (or perhaps propagates up a river or a bay). The slope of the water surface tilted up against the shore increases directly with increased wind speed and with decreased water depth. The same amount of wind stress will raise the water higher in shallower water than in deep water, because in deep water the wind's transferred momentum is spread over the greater depth giving less movement to each parcel of water.

In deeper water it is the *alongshore component of the wind*, blowing parallel to the coast, that causes the water level to rise or fall. This is due to the Coriolis effect resulting from the Earth's rotation (see the Physical Oceanography column in the August 1998 issue of the *Mariners Weather Log*). In the Northern Hemisphere, the wind-induced surface current is deflected a little bit to the right by the Coriolis force, and each layer of water below is further deflected to the right, producing what is called an Ekman spiral. However, on average over the entire depth of the current, the transport of water is perpendicular to (i.e., 90^{o} to the right of) the wind. Thus, for example, if the coast runs north and south, a wind toward the south will pile water up against the coast, while a wind toward the north will lower the water level along the coast.

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Both wind components may play a role in storm surge generation, but the onshore component tends to dominate in water depths less than 90 m (300 ft), and the alongshore component tends to dominate in depths greater than 90 m (300 ft). Thus, one would expect the onshore winds to be critical with a hurricane nearing landfall. Because of the circular wind patterns (counterclockwise in the Northern Hemisphere), the strongest onshore winds in a hurricane will be to the right of the eye as it hits the coast head on. To the left of the eye the winds will be blowing offshore and the water level will actually be lowered (see Figure 1). For extratropical storms, which are much larger in geographical extent than hurricanes, the alongshore wind component over the continental shelf is often the dominant effect. The storm surge tends to rise or fall more slowly (over a period of days), and often looks quite similar over long stretches of the coast.

No matter what the generating mechanism, the resulting storm surge is in the form of a very long wave, which, as it propagates toward the coast encounters shallower water, decreasing its speed and therefore increasing its height (in order to conserve its energy). Thus, shallow water will always increase storm surge heights, and the faster the depths decrease the greater the amplification of the storm surge will be. Similarly, and even more dramatically, if a storm surge wave travels into a gulf or bay that has a decreasing width, the funneling effect will also amplify the size of the storm surge. A combination of converging coastlines and shallow depths is part of the explanation for the large storm surges often seen in the Gulf of Mexico and especially in the Bay of Bengal.

If a storm surge wave is moving in the right direction along a coast, for example, southward along a continental east coast (in the Northern Hemisphere), the Coriolis force causes the water surface to slope up against the coast, trapping the wave along the coast and preserving its form over long distances. In areas with these coastally trapped storm surge waves, such as along the east coast of the United Kingdom, storm surge elevations can be accurately predicted in the southern region based on the surge already experienced in the northern region.

In some cases, when looking at records of the nontidal water level records over the period of a storm event, one sees oscillations (called *forerunners*) appearing at a location before the storm arrives, and other times one can see oscillations (called *resurgence*) after the storm has left or died out. It is not always clear why this happens, and it may be different for each case. For hurricanes the forerunners may be long waves created by the storm that have a propagation speed that is faster than the storm's speed and so arrive sooner than the storm (or the storm itself may not arrive at all, if it does not make landfall in that location). For extratropical storms the rising water level can temporarily change the tidal regime in shallow-water areas. The tide may then have a modified range or its times of high and low water may be changed, so that the normal tidal constants used to predict the tide do not apply as accurately to this changed situation. Thus, when the astronomical tide prediction is subtracted from the total measured water level data record to produce the nontidal/storm-surge data record, a tidal signal is left that looks like oscillations on top of the storm surge (and might be interpreted as coastally trapped waves perhaps). For extratropical storms the same mechanism could produce what look like resurgence oscillations after the main surge. However, for hurricanes that leave the area quickly, such resurgence oscillations may simply be natural free oscillations in the basin (like in a bath tub that has been disturbed, with the oscillations slowly dying out). They could also be trailing waves behind a fast moving hurricane because of slower propagation speeds.

Although direct forcing by the wind is the main cause of storm surges, with low pressure also playing a role, there are some other mechanisms which also contribute. Any mechanism other than the astronomical tide can contribute, since by definition the storm surge is the total measured water level minus the astronomical tide. Storms always produce

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very large *wind waves*, which are much shorter in wavelength (on the order of tens to hundreds of feet) than the surge (on the order of miles) and essentially ride on the water level surface of the storm tide. Besides doing damage on their own, and being transported further inshore because of the storm surge, such waves when they break also contribute water on top of that already brought in by the surge. Even in situations where they do not break, waves may transport water shoreward that contributes to the total raised water level. Waves topping over barrier reefs and barrier islands can significantly contribute water to the flooding inside the reefs or islands.

Rainfall, of course, also adds a volume of water onto the storm tide, either directly or as increased discharge coming down any rivers or streams in the area of the storm. The winds of the storm will tend to keep those fresh waters from escaping to the sea as quickly as they might otherwise. During a cyclone, the additional discharge of the Ganges River coming into the northern Bay of Bengal makes a contribution to the storm surge and flooding.

The total height of the storm tide, of course, is also affected by the stage of the tide, being higher (and more likely to cause damage) if the storm surge arrives at the time of high water. Likewise, the greatest destruction can result when a storm hits the coast at times when the highest tides occur, such at spring tides (near full or new moon, when the effects of the moon and sun are working together) or even worse at perigean spring tides (when the moon is also closest to the Earth). In some respects, however, a large tidal range may, on average over many storms, help reduce the damage of storm surges for a particular region, since there will be times when the surges will arrive at low tide or mid-tide, thereby decreasing the storm tide (by the difference between the stage of tide and the high water line); since it is water elevation above the high water line that causes flooding. Areas with little tidal range, like much of the Gulf of Mexico, will have flooding from storm surge no matter what part of the tidal cycle the surge arrives at.

Thus we see that there are a number of factors affecting the height of a storm surge hitting a particular location, including: the strength of the storm (its wind speed and low pressure); the location of the center of storm in relation to shore (whether it comes ashore, and if so, where and how quickly, and if it is a hurricane, whether a particular location is to the right of the eye); the shallowness of the water; and the coastline configuration (whether there is a gulf or bay with decreasing widths).

Whether a location becomes flooded will depend on how high the shore and adjoining land is and what stage of tide coincides with the storm's landfall. The loss of life and the amount of destruction, of course, depend more on how populated the location is, and what kind of precautions have been taken, such as instituting warning systems and evacuations plans and building sea walls and dikes where needed. New Orleans, much of it below sea level, has been improving its levees, but a Category 3 (964-945 mb; 97-113 knot winds) or higher storm could still cause serious flooding. With no high ground in southwest Florida and a growing population, even a Category 2 storm (979-965 mb; 84-96 knot winds) could cause serious problems there. New York City worries many experts the most, because of the way that the north-south Jersey coast and the east-west coast of Long Island create a corner that could help funnel a storm surge to produce higher elevations. Some have calculated that if Hurricane Hugo has made landfall in New York City instead of near Charleston, South Carolina, the resulting storm surge would have covered the tip of Manhattan and JFK airport with 3 m (10 ft) of water.

Not all storm surges have to be in the ocean. In September 1928 a hurricane moved across Florida from the Atlantic to the Gulf of Mexico, crossing Lake Okeechobee's northern shore. The result in this very shallow and confined basin was a storm surge that propagated southward to the opposite shore, flooding the low area south of the lake and killing almost 2,000 migrant workers (the

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second deadliest U.S. hurricane on record). In response to this storm dikes were built around the lake.

We have so far concentrated on the adverse effects of high water levels due to storm surge. However, storm surges can just as often cause much lower than normal water levels, in the extreme leaving waterways dry. For commercial shippers, worried about underkeel clearance under their deep-draft oil tankers and cargo ships, this can be a very serious problem. Running aground because of lower than expected water levels can result in spills of hazardous materials, or, perhaps the closing of a port long enough to cause economic losses. Such decreases in water level (and thus under keel clearance) do not have to be large to have such adverse effects. Every inch of a ship's draft can mean many thousands of dollars worth of cargo, so ships ride fully loaded and thus as close to the bottom as safety allows. Knowing the effect of wind and pressure on the water level is critical. It is for this reason that real-time physical observation oceanographic systems have been installed in many ports to provide more accurate water level information than just astronomical tide predictions, and that coastal oceanographic forecast models are now being implemented not just for predicting flooding due to high storm surge but also to predict low water conditions as well.

In the foreword to his best seller, *The Perfect Storm*, Sebastian

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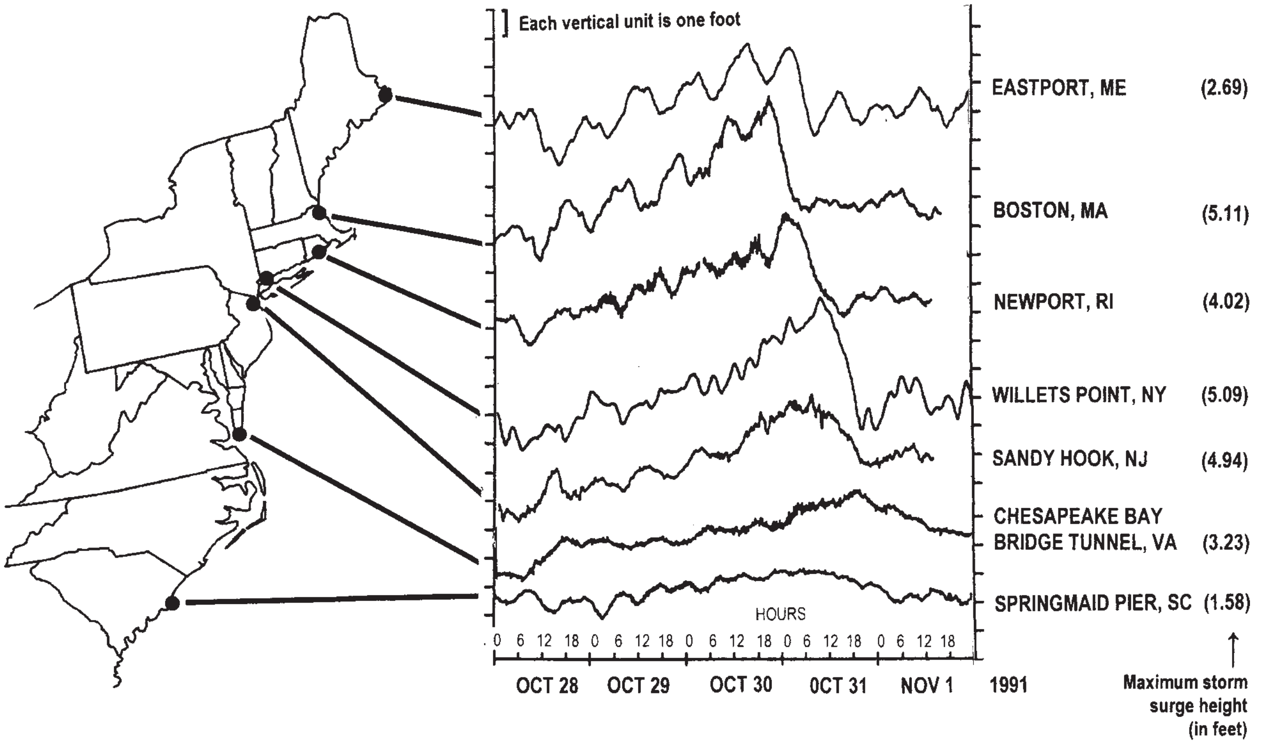

Figure 2. The storm surge (i.e., total water level minus the predicted astronomical tide) during the Halloween Storm of 1991 measured at various tide stations along the Atlantic Coast of the U.S. The lefthand end of each curve starts at zero ft (above the astronomical tide), with the exception of the curve for Chesapeake Bay Bridge Tunnel, which starts a little below zero.

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Junger says that he used "*perfect* in the meteorological sense: a storm that could not possibly have been worse." In the title of the present Physical Oceanography column we use the word "*perfect*" in a similar way but in the oceanographic sense: what are the combination of conditions that has produced (or will someday produce) the worst possible storm surge. The title of this column could have been interpreted as being about the storm surge that accompanied "*The Perfect Storm*" described by Junger. That storm, also referred to as the Halloween Storm of 1991 (not to be confused with the 1993 Storm of The Century, ed.), was a *hybrid storm*, namely, a storm with features of both tropical and extra tropical storms. In this case it was produced by a rare combination of a weakening hurricane (Grace), an unusually strong Canadian High, and a developing low pressure in the North Atlantic. And the storm did indeed produce significant storm surge, over a very large geographic area., i.e., the entire East Coast of the U.S. (see Figure 2). The size of the surge is not comparable to that produced by the largest hurricanes making landfall in other parts of the U.S., but, combined with the astronomical tide, the total storm tide produced elevations close to the largest ever seen in the northeastern U.S. The largest measured surges during the Halloween Storm occurred at Boston (1.56 m, 5.11 ft) and at Willets Point (1.55 m, 5.09 ft) at the western end of Long Island Sound (with surge measurements at other tide gauges in Long Island Sound falling just below 1.5 m (5 ft). Combined with the tide, the corresponding highest observed elevation (above Mean Lower Low Water [MLLW]) was 4.4 m (14.29 ft) for Boston and 3.8 m (12.39 ft) for Willets Point. There was moderate to severe coastal flooding along most of the East Coast and especially in New England. At locations not having tide gauges, the storm surge might have been even higher, especially up rivers and at the ends of shallow bays. The 3 to 9 m (10 to 30 ft) wind waves riding on top of the storm tide also contributed to the flooding, but it is difficult (without a tide gauge) to measure the actual storm surge separated from the added wave effects. Debris lines often used to determine high water elevations are typically the result of both storm tide plus the wind waves.

There have been other documented hybrid storms that have also produced comparable storm tides. An unusual one that again illustrated the circumstances that can allow a tropical storm to re-intensify, and to gain energy by combining with a continental extra tropical weather system, was the so-called Saxby Gale in October 1869. The storm actually went up the Gulf of Maine and Bay of Fundy with the eye making landfall in the area of Passamaquoddy Bay. It produced a 1.8 m (6 ft) storm surge to the right of the eye, but it also arrived at almost the worst possible time, near the time of perigean spring tides in an area with the world's largest tide range. The waters rose to 16.5 m (54 ft) at the Burncoat Head Lighthouse, which is recorded in the Guinness Book of Records as the site of the highest tides ever officially recorded in the world. Most of the Acadian dikes in Minas Basin and Chignecto Bay, which had been built a century before to reclaim the extensive salt marshes, were overtopped by the storm tide, flooding the lowlands. The water remained trapped behind the dikes for several days after the storm. The storm surge itself may have been increased by the storm moving up the bay at the same speed as the traveling long wave; i.e., at about the resonant frequency of the Bay of Fundy-Gulf of Maine system. What gave this storm its name, however, was the fact that some believed it had been correctly predicted ten months earlier by a Lt. Steven Saxby in a letter he wrote to *The Standard of London* in England on 25 December 1868. In fact, Saxby wrongly believed that the weather was controlled by the phases of the moon, and his letter was part of his active campaign to promote his ideas. He did not predict a storm in the Bay of Fundy specifically, but he predicted that perigean spring tides would be accompanied by equinoctal gales at 0500 local time on 5 October 1869 – somewhere in the world. He got lucky in the Bay of Fundy.

Returning to the title of this column—has there been "the

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perfect storm surge”? Was it the one responsible for the 6 m (20 ft) storm tide that wiped out Galveston (and is described in Erik Larson’s recent best seller, *Isaac’s Storm*) or the even larger ones that have repeatedly brought horror to Bangladesh? Like Junger, we do not use the word *perfect* in the sense of destruction or human death toll. Our only criteria for the perfect storm surge is the height of the surge. Which has been the largest (and why), and are larger ones possible?

The largest recorded storm surge in the U.S., which occurred during Hurricane Camille in August 1969, was a 7.6 m (25 ft) high surge that inundated Pass Christian, Mississippi. In addition, surges of at least .9 m (3 ft) hit locations all along the coast as far away as 125 miles to the east and 31 miles to the west of Pass Christian. Camille was a Category 5 (<920 mb and >135 knot winds) hurricane with a low central pressure of 905 mb and wind gusts of almost 174 kts that approached the coastline Mississippi over shallow Gulf waters. More than 18,000 homes and 700 businesses were destroyed. About half of the 256 lives lost were from this storm surge. But it could have been much worse. Luckily storm surge warnings were heeded by local emergency management officials and thousands of people were evacuated just prior to the arrival of the hurricane.

The strongest hurricane to hit the U.S. this century did not produce the highest storm surge. The “Labor Day” hurricane of 1935 with the lowest central pressure (892 mb) ever measured in the U.S. and wind gusts over 174 kts, produced a storm surge of about 5.4 m (18 ft). A rescue train sent to remove World War I veterans and residents from the Florida Keys was swept from the tracks of the Flagler Railroad on Long Key at an elevation of 9 m (30 ft) above mean low water, but this was due to the huge wind waves that were superimposed on the storm surge. A total of 423 people were killed in the Florida Keys. The fact that Camille’s storm surge was higher than the one for the 1935 Labor Day hurricane was due to the more favorable coastline and depths of the Mississippi coast versus that of the Florida Keys.

Although Hurricane Andrew did most of its damage through its high winds, it did produce storm surges, which varied considerably in size and provide examples of how the direction of the hurricane and the coastline can affect the size of the surge. As Andrew approached the Atlantic coast of southern Florida from the east it caused a maximum storm surge at the tide gauge at Haulover Pier, Miami, of only .8 m (2.6 ft), with a maximum observed storm tide elevation of 1.6 m (5.2 ft). However, the maximum elevations were much larger further south on the western shore of shallow Biscayne Bay where the storm tide was estimated at 5 m (17 ft). When Andrew crossed southern Florida and entered the Gulf of Mexico, the same wind direction that had pushed water onto the land on the Atlantic side now pushed water away from the shore on the Gulf side and there were thus negative storm surges, the lowest being 1.3 m (4 ft) below the tide at Naples.

The northern Bay of Bengal is certainly unique in the world in its ability to produce large (and devastating) storm surges. With its funneling coastal configuration, shallow coastal waters bordering on low flat terrain with countless river channels up which the storm surge can propagate and grow, and the added river discharge from the Ganges River, it is not surprising that storm surges of over 9 m (30 ft) have been reported. In 1876 the storm surge associated with the Bakerganj Cyclone of Bangladesh was estimated to be an incredible 12.5 m (41 ft) high.

However, the largest storm surge ever recorded, 13 m (43 ft) high, appears to have occurred in March 1899 when a major hurricane made landfall near Bathurst Bay, North Queensland, on the northeast coast of Australia. In 1958 H.E. Whittingham tried to reconstruct the details of the hurricane and accompanying storm surge from barometer data and the extensive of eyewitness accounts that had been recorded. A Constable Kenny, who was in charge of the Eight-mile Police Station at Cooktown, and some troopers were camped on a ridge 12 m (40

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ft) above sea level, about a half mile from the beach and directly in the path of the hurricane. The wind had been blowing lightly from the southeast, but around 11:30 on the night of 4 March it picked up speed; around 2 am on 5 March it veered a couple of points and blew with hurricane force, probably reaching over 100 knots. At 5 am it shifted direction and blew even harder from the northeast. And not long after the wind shift an immense storm tide wave swept inshore and reached waist deep on the ridge with Constable Kenny's camp on it. From there the storm surge stretched 2 to 3 miles inland. At that time the astronomical tide was at neaps and had a range of less than .6 m (2 ft) and the stage of tide was probably a couple of hours after high water, almost to mean tide level, when the surge hit. Although the estimated storm surge seems reliable, it is difficult to determine exactly why it became so large. The storm surge resulting from the winds (estimated to be greater than 100 knots) would have been amplified by the very shallow water between the coast and the Great Barrier Reef, which is only 12 miles from the coast at that point, its closest point anywhere along the coastline. The coastline and barrier reef lie approximately northwest to southeast, perpendicular to the hurricane path (which came from the northeast), but they then bend a little to the west just north of Bathurst Bay. As the front edge of the cyclone approached (rotating clockwise, since this is in the Southern Hemisphere), the winds from the southeast (in the front edge of the storm) would have first pushed water into the Bathurst Bay area from the shallow waters between the Barrier Reef and the coast southeast of the area of landfall. Then, as the hurricane went onto land, the wind from the northeast would have pushed that water up onto the shore. Waves topping over the Barrier Reef would have added a lot more water for the wind to push onshore. Whether this all adds up to a 13 m (43 ft) storm surge is difficult to tell a hundred years after the fact (and without detailed modeling using accurate bathymetry and geography), but most of the elements needed for producing a huge storm surge seem to be there.

Whether there has ever been a larger storm surge than the one in Bathurst Bay or the ones in Bangladesh we can only speculate. There is, of course, one famous flooding event in history that one might be tempted to consider. There has been much conjecture about the possibility of a massive flood that could have served as the basis for the Bible's story of Noah's ark, a story which in varying forms also appears in the Koran, as well as in the writings of a number of other peoples of the Middle East. A few scientists have suggested that, if such a colossal flood did in fact take place, its most likely location was at the northern end of the Persian Gulf near the mouth of the Euphrates. One wouldn't need to explain 40 days and 40 nights of storm (the Koran and other writings say 6 days and nights) nor the 150 days that the Bible's flood was said to have lasted, since such tales tend to grow with each retelling. But it is interesting that the Bible and many other accounts speak of the flood coming *from* the sea. Some authors have suggested a tsunami caused by an earthquake, but that would not have lasted long enough. We commonly speak of (and insurance companies sometimes plan for) the so-called "hundred-year storm"—the really big one that happens once every hundred years. But has anyone ever speculated on the size of a "thousand-year storm"? And if such a truly uncommonly large storm happened a few thousand years ago near the mouth of Euphrates, would the combination of the heavy rain, river runoff, and a tremendous storm surge created in the (then much shallower) northern end of the Persian Gulf produce a flood that would in the following centuries grow in legend to become a flood that covered the world, except for a mountain top on which an ark could land? If the Bible's great flood did involve a storm surge, then that might give a whole new meaning to the phrase "*perfect* storm surge."

Bruce Parker is Chief of the Coast Survey Development Laboratory, National Ocean Service, NOAA.⚓

Great Lakes Wrecks: The Jay Gould

Skip Gillham
Vineland, Ontario, Canada

Jay Gould had a longer than average career for a wooden hulled steamer. She managed fifty seasons of Great Lakes trading before sinking on Lake Erie.

The ship was built for the package freight trade and completed at Buffalo by the Union Drydock Company in 1869. The 71 m (235 ft) long by 10 m (33 ft) wide freighter was Hull 2 from the shipyard and was powered by a Steeple compound engine.

Various package freight cargoes were transported west for the developing communities while raw materials and bulk cargoes, often packed in barrels, were consigned for the eastbound journey.

On May 9, 1884, **Jay Gould** was heralded as the first ship of the season into the port of Duluth. Today, modern steel bulkers, usually with assistance from icebreakers, arrive as many as six weeks earlier.

A first mishap caught **Jay Gould** during a storm in October 1893, and the vessel arrived at Bay Mills, Michigan, with five feet of water in the hold. The First Mate had been washed overboard and, in a streak of good fortune, he was washed back on deck! He suffered only bruises.

Jay Gould's profile was changed when she was rebuilt as a bulk carrier at Detroit in 1916. The vessel was owned by the Rochester Sand and Gravel Co.

Disaster struck on June 17, 1918, when the aging carrier, towing the barge **Commodore**, was headed from Cleveland, Ohio, to Sandwich, Ontario, with a cargo of coal. The tired hull of the steamer began leaking near Southeast Shoal on Lake Erie and succumbed. The trailing barge was caught in the trough of the seas and rolled over. Fortunately, all on board the two ships were rescued by passing steamers.

In time the submerged hull of **Jay Gould**, resting in forty feet of water, had to be dynamited as a hazard to navigation. Today it has become an attraction to novice and intermediate divers.

Skip Gillham is the author of 18 books, most related to Great Lakes ships and shipping.⚓

Harvesting the Sea—Aquaculture Offers a Supplement to Traditional Fisheries

Ramona Schreiber
Marine Biologist
National Oceanic and Atmospheric Administration
Office of Policy and Strategic Planning

Seafood has been a part of the nation’s diet throughout history, and in the mind of the public, the source most naturally thought of is the open ocean. When we think of salmon, shrimp or oysters, the images that come to mind are likely a trolling fisherman with lines following his boat, billowing nets dropping into the sea behind a shrimper, or man-sized tongs grappling over the side of a skiff. Over time, however, these products have come from other sources less recognized but increasingly more important. The production of seafood through aquaculture takes the concepts of agriculture to the ocean waters. Aquaculture is a rising star in the nation’s seafood production.

Aquaculture involves the propagation, cultivation and marketing of aquatic animals and plants in controlled or selected aquatic environments for any commercial, recreational, or public purpose. While production of trout and bait fish date back to the late 19th century, the more familiar product, catfish, didn’t gain ground until the late 1950s. From that point the industry has expanded not only in freshwater or land-based production, but into species grown in the coastal environment such as shrimp, oysters, and salmon.

Many terms are used in the industry, primarily representing specialties to the general concept. Fish farming means the raising of a fish in controlled conditions for consumptive or ornamental trade. Shellfish culture refers to the production of clams, oysters, or related mollusks. Ornamental aquaculture describes the raising of organisms for the ornamental trade and can include freshwater, saltwater, fish, invertebrates, and plants. Crustacean aquaculture might be used to describe production of lobster, crayfish, or shrimp. Mariculture is the specific term for aquaculture of saltwater organisms as opposed to freshwater.

Aquaculture may involve a number of methods depending on the species and location of the system. Traditional practice began with the use of ponds on land. Fish are allowed to swim freely until harvest is facilitated by partial draining and seining to remove the stock. New technologies have resulted in a number of additional systems available such as cages, raceways, and recirculating systems. Facilities may be “intensive,” that is involving high amounts of labor, feed, materials or equipment, or “extensive” in terms of the addition of few inputs. Natural lakes and farm ponds are examples of the latter. Cage culture uses an existing water body (pond or coastal environment), however fish are enclosed in a cage or basket, allowing water to pass freely but retaining fish in a contained unit. Harvest is simple and labor intensive seining is avoided. Raceways are more often used for active fish such as trout, and involve large quantities of high quality water. Water moves

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through a system of sloping terrain, either recirculating after fish and feed waste is removed or discharged and replaced with fresh water. While these facilities are land based, a move into the coastal environment has resulted in new methods as well as modified approaches from land. Net pens are used to contain fish stock in a closed area while hanging racks are used to grow out oysters and non-motile species. A major area of expansion, however is in the open ocean. Pen culture of salmon has been in existence for some time. Used primarily in protected environments near shore. A move offshore may reduce current impediments such as social and environmental concerns existing near shore. Out of site, less resistance might be felt and impacts may be reduced with greater depths and flushing rates of a more active environment.

Production includes similar steps regardless of the form of aquaculture involved. Spawning or broodstock is necessary as a source of the “seed” to initiate production. Eggs are hatched generally in laboratory facilities and allowed to develop and produce fingerlings. From this point the stock may be released in open systems or kept in closed systems, allowing the fingerlings to grow out to marketable size.

Globally and nationally, consumers are looking to seafood as a protein source at an increasing rate. This increase is likely due to both improved availability (fresh fish can be delivered to interior states in days where in the past only frozen product could be marketed) and trends toward healthy eating and the healthful quality of seafood. With a global population that could reach 8.6 billion by 2030, the demand for fresh seafood is expected to rise. This, in light of decreasing abundances of wild stocks means that a gap could spread between product and demand. Experts anticipate aquaculture production may need to more than double in the next 25 years to meet global seafood demands.

Raising seafood product rather than harvesting wild stocks raises public interest in a wide range of areas. For many, the opportunity offers a revolutionizing approach and conservation of natural stocks. The potential to provide high quality seafood at a time when wild fisheries are harvested at a maximum level may relieve some pressure and afford those to recover to sustainable levels. Where anthropogenic factors have affected native stocks, aquaculture may enhance commercial and recreational species. Rearing of threatened protected species for stock recovery is a similar benefit. Ecological benefits may result from the natural filtration systems some species provide. Shellfish, particularly oysters, filter impressive amounts of phytoplankton and concentrate nutrients from the water column. Their use could be an important tool in mitigating eutrophication in coastal waters. New job opportunities exist in aquaculture; ventures in this area may reduce the impacts of closures in traditional fisheries. Further, increasing production may support additional export of U.S. product and help reduce foreign trade deficits. Export of environmental technology likewise benefits the national economy.

Net pens hold red drum in coastal Louisiana waters. Photo by Jimmy L. Avery, Louisiana Cooperative Extension Service.

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Harvesting the Sea

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Other aquaculture concerns include competition for resources, environmental risks, and genetic implications. On land, ownership of the resource is fairly clear; property is owned or leased and crops are assets to be traded by the owner. At sea, however, the resources are public domain; rights to their harvest as well as responsibility for their impact is less clear and management can be difficult. In the coastal zone where most marine aquaculture activities locate, competing use by recreational and commercial interests as well as land development all come to a head. States facing these conflicts are developing policies that will balance the needs of all users as well as the risks to the environment. Concerns over environmental risk include impacts on water quality, adjacent benthic habitat, disease, and chemical contamination. Ecological risks are of concern as well, particularly with respect to genetic impacts on wild stocks as a result of escapees and spread of non-native species into the natural environment. The latter may result in initial displacement of native fish, eventually leading to disruption of the ecological balance within a system.

In order to meet the rapidly rising demand for seafood, new technologies will be essential. The National Marine Fisheries Service has long been involved, promoting aquaculture that is environmentally sound through its scientific research and technology development. The National Sea Grant College Program's research and outreach activities support study in offshore and recirculating marine systems, hormonal controls, growout technology, disease control, marketing and environmental technologies to manage water quality. Through the Coastal Zone Management Act, the National Ocean Service has responsibilities in the wise use of land and water resources of the coastal zone. Coastal management programs have the task of balancing competing demands of development and protection. Aquaculture facilities and their management must be addressed in the comprehensive planning for the coastal zone.

The expansion of aquaculture to meet the nation's and the world's demand for seafood products boasts a range of issues and technologies to be addressed. Done well, however, the opportunity exists to contribute to the world's food security, lift pressure off over-harvested fisheries, and provide new resources to the economy. With good science teamed with national and international coordination, this growing technology should provide a valuable piece of the national fisheries portfolio.

References

Creswell, L. 2000. The emergence of aquaculture: Bridging the gap. Marine Technology Society Journal 34 (1): 3-4.

DeVoe, M.R. 2000. Marine aquaculture in the United States: A review of current and future policy and management challenges. Marine Technology Journal 34 (1): 5-17.

NOAA's Aquaculture Policy. 1999. http://swr.ucsd.edu/fmd/bill/aquapol.htm

Swann, L. 1992. A basic overview of aquaculture. Illinois-Indiana Sea Grant Program Technical Bulletin Series #102.⚓

Atlantic salmon are raised in circle pens just offshore. Photo by Atlantic Salmon of Maine.

Communication Methods for Filing AMVER Reports

Richard T. Kenney
United States Coast Guard
Maritime Relations Officer

Revised: 1 June 2000

AMVER, the Automated Mutual-Assistance Vessel Rescue System, sponsored by the U.S. Coast Guard, is a unique, computer-based, and voluntary global ship reporting system used world-wide by search and rescue authorities to arrange for assistance to persons in distress at sea. AMVER's success is tied directly to the number of merchant vessels regularly reporting their sail plans and positions. Ships incur no additional obligation to respond to distress alerts than already exists under international law of the sea. Since AMVER identifies the best ship or ships to respond, it releases other vessels to continue their voyage, thus saving fuel, time, and payroll costs. Information sent to AMVER is protected and used only in a bonafide maritime or aviation emergency.

The following methods are recommended for ships to transmit AMVER sail plan/position/deviation/arrival reports:

1. Electronic mail via the Internet. **AMVER's address is:** amvermsg@amver.com

If a ship already has an inexpensive means of sending electronic mail to an Internet address, this is a preferred method. Electronic mail may be sent via satellite or via HF radio, depending on the ship's equipment and arrangements with communications providers ashore. Ships must be equipped with a personal computer, an interface between the computer and the ship's communications equipment, and the appropriate software. <u>*Please note*</u>*: The e-mail path on shore to the AMVER center is essentially free,* <u>*but*</u> *the communications service provider may still charge from ship-to-shore.*

2. AMVER/SEAS "compressed message" via INMARSAT-C via COMSAT. **AMVER address: (For information, please see the AMVER/SEAS program documentation.)**

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AMVER

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Ships equipped with INMARSAT Standard C transceiver with floppy drive and capability to transmit a binary file (ship's GMDSS INMARSAT C transceiver can be used); an IBM-compatible computer (not part of the ship's GMDSS system) with hard drive, 286 or better PC, VGA graphics; an interface between them; and the AMVER/SEAS software (available free of charge from the U.S. National Oceanic and Atmospheric Administration, NOAA), may send combined AMVER/weather observation messages free of charge via COMSAT land earth stations at: *001 Atlantic Ocean Region – West (AORW) – (Southbury); 101 Atlantic Ocean Region – East (AORE) – (Southbury); 201 Pacific Ocean Region (POR) – (Santa Paula); 321 Indian Ocean Region (IOR) – (Aussaguel).*

AMVER/SEAS software can be downloaded from the INTERNET at: http://seas.nos.noaa.gov/seas/ Or requested from: COMSAT Mobile Communications, 6560 Rock Spring Drive, Bethesda, MD 20817, phone: +1 301 214 3100 (option 1).
INTERNET e-mail:
cmcsales@comsat.com

3. Hf Radiotelex service of U.S. Coast Guard communications stations:

Full information on how to send AMVER messages this way can be found at: http://www.navcen.uscg.mil/marcomms/cgcomms/call.htm

4. Hf radio at no cost via U.S. Coast Guard contractual Agreements with the following companies:

Globe Wireless Super Station Network
Mobile Marine Radio (WLO)

5. Telex. AMVER address: 127594 AMVERNYK

AMVER reports may be filed via telex using either satellite (code 43) or HF radio. Ships must pay the tariffs for satellite communications. Radio TELEX reports, if filed via a coast station participating in the AMVER program, may be sent free of charge. Participating coast stations are listed in the AMVER bulletin magazine. TELEX is a preferred method when less costly methods are not available.

6. Telefax. Telefacsimile phone number to the U.S. Coast Guard operations systems center in Martinsburg, West Virginia: +1 304 264 2505

In the event other communications media are unavailable or inaccessible, AMVER reports may be faxed directly to the AMVER computer center. However, this is the least desirable method of communications, since it involves manual input of information to the computer vice electronic processing. *Please note: Do not fax reports to the AMVER Maritime Relations Office in New York, since it is not staffed 24 x 7, and relay and processing of reports is delayed pending normal Monday-Friday business hours.*

The following method is discouraged:

CW (Morse Code) **AMVER address: AMVER**

Due to the decline in its usage, the number of coast stations supporting it, its high cost, potential for error, and the mandatory carriage of upgraded GMDSS communications capabilities, ships are discouraged from using this medium.

Ship operators are requested to pass this information to their vessels as soon as possible.

For more information regarding AMVER, please contact Mr. Rick Kenney at AMVER New York at telephone number (212) 668-7762, fax (212) 668-7684, or via e-mail: rkenney@batteryny.uscg.mil or visit the new AMVER web site at: www.amver.com

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AMVER Maritime Relations Office
United States Coast Guard
USCG Battery Park Building
New York, NY 10004 USA
Phone: (212) 668-7762
Fax: (212) 668-7684⚓

Some Technical Terms Used in This Month's Marine Weather Reviews

Isobars: Lines drawn on a surface weather map which connect points of equal atmospheric pressure.

Trough: An area of low pressure in which the isobars are elongated instead of circular. Inclement weather often occurs in a trough.

Short Wave Trough: Specifies a moving low or front as seen in upper air (constant pressure) weather charts. They are recog-nized by characteristic short wavelength (hence short wave) and wavelike bends or kinks in the constant pressure lines of the upper air chart.

Digging Short Wave: Upper air short waves and waves of longer wavelength (long waves) interact with one another and have a major impact on weather systems. Short waves tend to move more rapidly than longer waves. A digging short wave is one that is moving into a slower moving long wave. This often results in a develop-ing or strengthening low pressure or storm system.

Closed Low: A low which has developed a closed circulation with one or more isobars encircling the low. This is a sign that the low is strengthening.

Cutoff Low: A closed low or trough which has become detached from the prevailing flow it had previously been connected to (becoming cutoff from it).

Blocking High Pressure: A usually well developed, stationary or slow moving area of high pressure which can act to deflect or obstruct other weather systems. The motion of other weather systems can be impeded, stopped completely, or forced to split around the blocking High Pressure Area.

Frontal Low Pressure Wave: refers to an area of low pressure which has formed along a front.

Tropical Wave or Depression: An area of low pressure that originates over the tropical ocean and may be the early stage of a hurricane. Often marked by thunderstorm or convective cloud activity. Winds up to 33 knots.

Wind Shear: Refers to sharp changes in wind speed and/or direction over short distances, either vertically or horizontally. It is a major hazard to aviation. Wind shear above Tropical depressions or storms will impede their development into hurricanes.

Closed off Surface Circulation: Similar to a closed low. Refers to a surface low with one or more closed isobars. When there are falling pressures, the low is considered to be strengthening.

Marine Weather Review
North Atlantic Area—January through April 2000

George P. Bancroft
Meteorologist
Marine Prediction Center

Editors note: Unless otherwise noted, sea heights given in this article are significant wave heights: the average height of the highest one-third of the waves.

A large storm was slowly weakening between Greenland and Iceland as January 2000 began. This storm attained peak intensity below 930 mb at the end of December 1999 and is described in the April 2000 issue of Mariners Weather Log. It left a strong vertically-stacked low. Meanwhile, low pressure systems continued to track east-northeast off New England and the Canadian Maritimes early in January. One of these moved off the New England coast (see Figure 1), and during the 24-hour period ending 0600 UTC 03 January it deepened 37 mb (1.09 in.). This storm easily qualified as a meteorological "bomb" (rapid pressure decrease of at least 18 mb in a 24-hour period). The second surface analysis in Figure 1 shows the storm at maximum intensity (958 mb) with a 67 kt southwest wind reported by buoy **63118** (60.3N 4W) southeast of the center at 0600 UTC 03 January. Winds increased to 71 kts from the west six hours later at buoy **63118** as the storm passed to the north. This was the highest wind report from this storm. Seas more than doubled from 4.5 m (15 ft) to 10 m (32 ft) at this buoy during the six-hour period. At 1200 UTC 03 January the ship **ELXC7** (name unknown) encountered southwest winds of 62 kts near 54N 1E. Maximum reported seas were 12.5 m (41 ft), from buoy **62105** (55.6N 13W) at 0000 UTC 03 January. Figure 2 is a METEOSAT7 infrared satellite image of the storm, showing a well-defined center near 61N 7W and extensive cold unstable air over the North Atlantic west of the center, revealed by cumulus-type clouds (broken cloud areas). The comma-like cloud southeast of Greenland is the 985 mb storm in Figure 1 (at 56N 38W).

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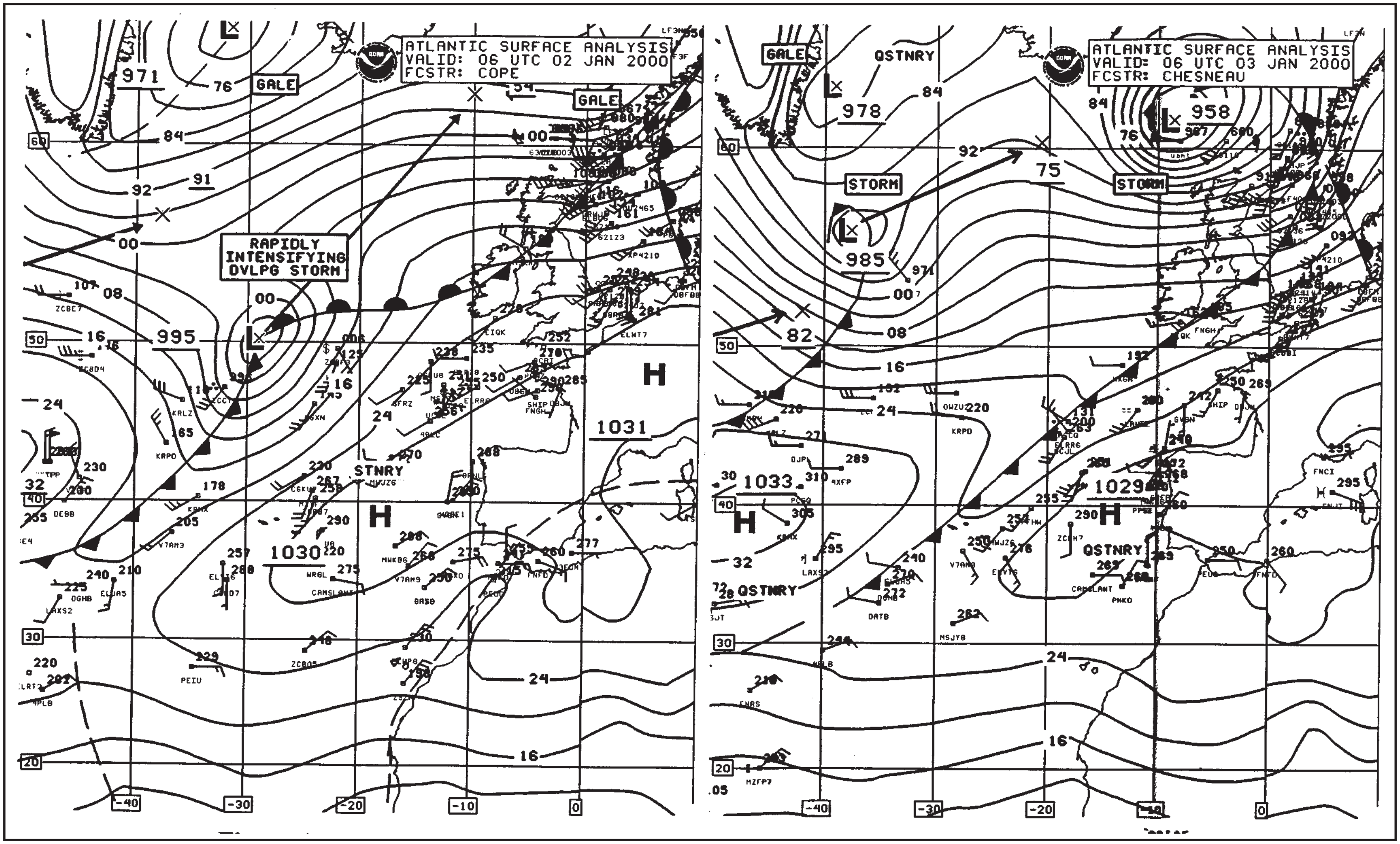

Figure 1. MPC North Atlantic surface analysis charts (Part 1) valid 0600 UTC 02 and 03 January 2000.

North Atlantic Area

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The storm that followed, noted above in the satellite image and in Figures 1 and 3, was not as intense, developing a central pressure of 970 mb as it passed north of Great Britain on 04 January (Figure 3). It did develop 60 kt winds, as indicated by a report from the **Kapitan Kudlai** (**P3NH5**) southwest of the center near 54N 31W at 1800 UTC 03 January (first part of Figure 3). A third storm, with pressure dropping 34 mb while it moved from Newfoundland to 52N 32W in the 24 hour period ending at 1800 UTC 04 January, is also shown in Figure 3. There are several ships with 50 kt winds southwest of the center (52N 32W, 965 mb) in Figure 3. The **Ironbridge** (**ZCCY9**) reported a west wind of 55 kts near 45N 39W at 1200 UTC 04 January. The maximum wind reported was a southwest wind of 70 kts from ship **C6NI3** (name unknown) near 50N 21W at 0600 UTC 05 January as the center passed to the north. There were several reports of seas above 12 m (40 ft), with the highest being 14.5 m (47 ft) from the **Eagle Malaysia** (**VRCV**) near

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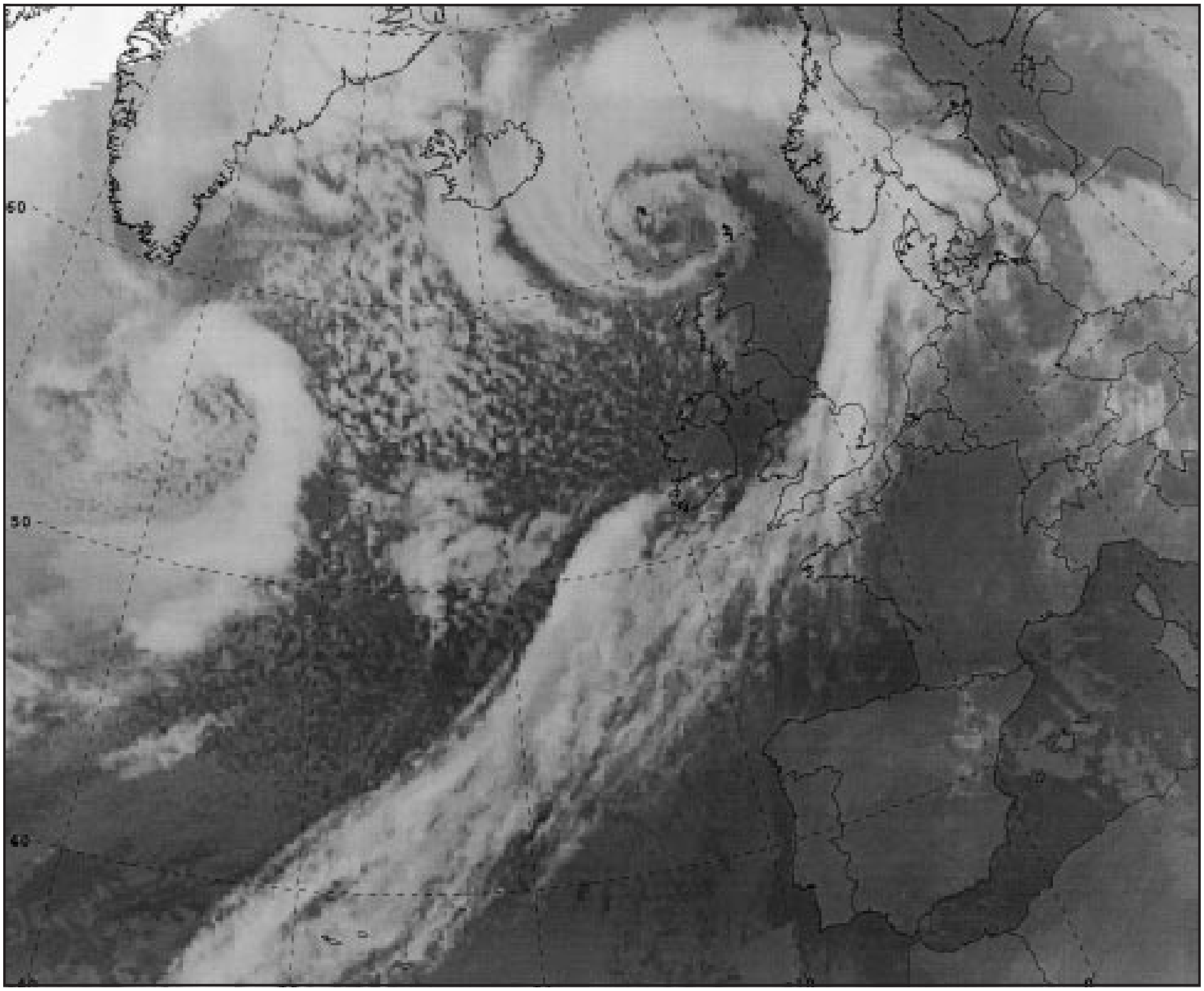

Figure 2. METEOSAT7 infrared satellite image of the eastern North Atlantic and western Europe valid 0633 UTC 03 January 2000. Valid time approximates valid time of second analysis in Figure 1.

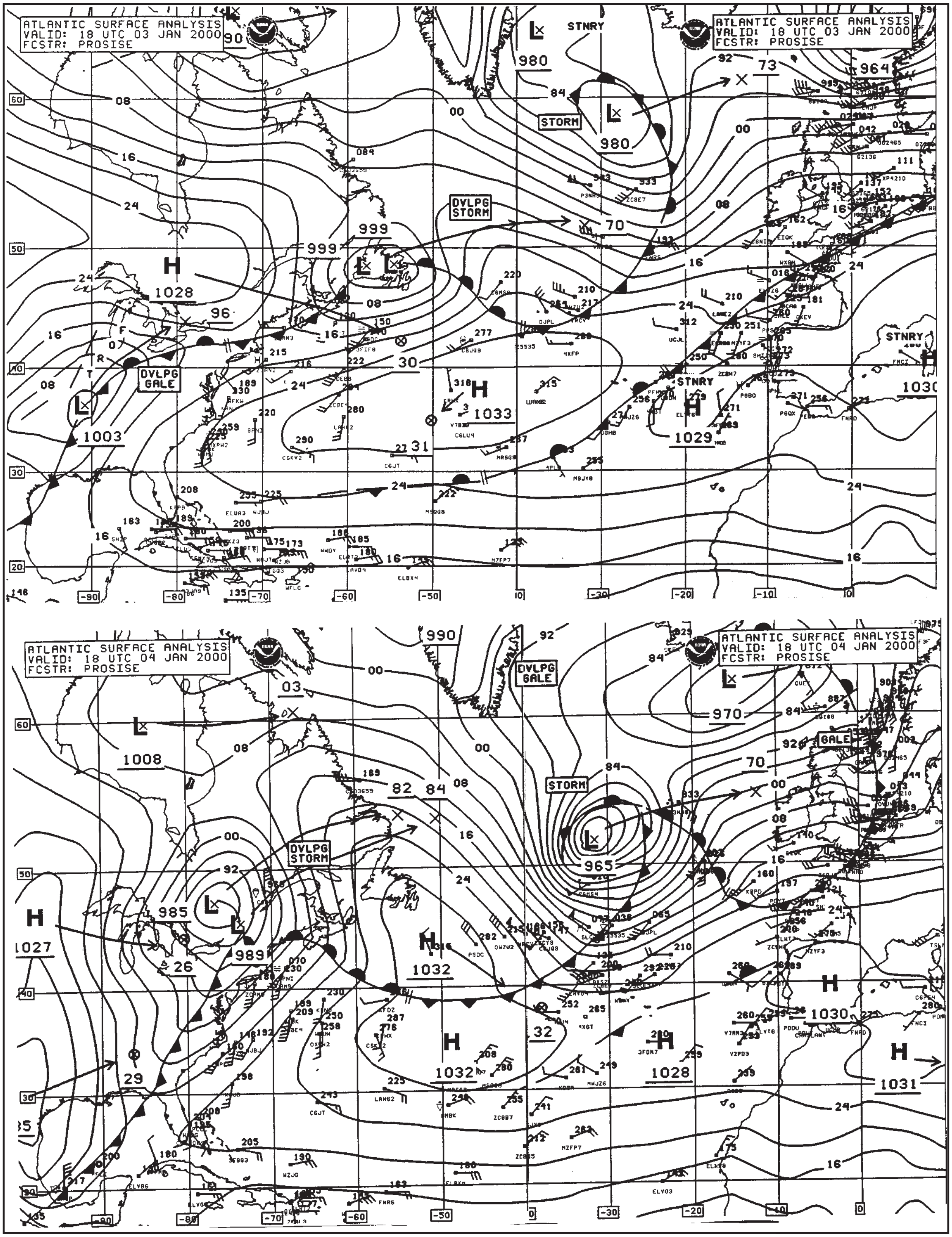

Figure 3. MPC North Atlantic surface analysis charts valid 1800 UTC 03 and 04 January 2000.

North Atlantic Area

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45N 39W at 1200 UTC 04 January.

High pressure built northward at the surface and aloft as the month progressed, forcing low pressure systems farther north. One of these, shown over southern Quebec in the second part of Figure 3, moved northeast and passed east of Cape Farewell with a 946 mb center 48 hours later, and east of Iceland by 0000 UTC 08 January. It passed through an area of sparse reports. Another storm followed a similar track three days later, developing a 949 mb center near 58N 36W at 1200 UTC 09 January before weakening.

The western North Atlantic was experiencing a stormy period late in January. Figure 4 shows a pattern of lows which rapidly intensified as they moved off the East Coast, then lifted north through the Canadian Maritimes to the Davis Strait, blocked by high pressure to the east. The gale center, shown over the Labrador Sea in the first part of Figure 4, had moved off the New England coast at 0000 UTC 17 January and became a storm south of Newfoundland near 42N 58W. It had a 987 mb center at 1200 UTC 18 January before turning north. Ship **WAUU** (at 39N 67W, name unknown) reported a northwest wind of 50 kts and seas 11.5 m (38 ft) at 1800 UTC 17 January. The **Sea-Land Performance** (**KRPD**) reported a northwest wind of 60 kts near 36N 61W at 1200 UTC 18 January. The system that followed was even stronger, shown off the U.S. East Coast in the first part of Figure 4, and then approaching Newfoundland 24 hours later with 965 mb pressure in the second part. At 0600 UTC 20 January the ship **3FDN7** (name unknown) at 42N 54W reported southeast winds of 45 kts and 10.5 m (35 ft) seas. At 1200 UTC 20 **8POG** (name unknown) encountered a 65 kt northwest wind just west of the center near 43N 56W. Twelve hours later the **British Steel** (**ZCCV5**) near 45N 53W reported a west wind of 65 kts and 8 m (27 ft) seas. The highest wind from a buoy was west 50 kts at **44141** (42N 56W) at 1200 UTC 20 January. The next developing storm is shown in Figure 4 near Cape Hatteras. Fueled by the warm Gulf Stream, its pressure dropped 37 mb in the 24 hour period ending at 1800 UTC 21 January, to become a 949 mb storm near 43N 63W. This was a track farther west than the previous storm, producing stronger winds in the U.S. offshore waters. Buoy **44004** (38.5N 70.7W) reported a northwest wind 49 kts with gusts to 66 kts at 0300 UTC 21 January, highest among buoys, and maximum seas 8.5 m (29 ft) 12 hours later. Buoy **44011** (41N 66.6W) reported winds almost as strong and maximum seas 9 m (30 ft) around 1800 UTC 21 January. The highest wind was 64 kts, reported by two ships, a southwest wind from **3FSN8 (**43N 60W) at 2100 UTC 21 January and a northwest wind from **LAKR5** (41N 65W) at 1800 UTC 21 January. The ship **ELRE5** encountered 12 m (39 ft) seas near 37N 58W at 1200 UTC 21 January, along with 48 kt southwest winds. Buoy **44142 (**42.5N 64W) reported a lowest pressure of 948.1 mb at 1700 UTC 21 January. Figure 5 shows the storm at 1815 UTC 21 January in a GOES8 infrared satellite image, fully developed and near maximum intensity.

By late January the eastern Atlantic high-pressure ridge began to flatten, allowing low-pressure systems to move east of Greenland toward Norway. One of these, shown in Figure 6, approached Iceland with a 960 mb center at 1800 UTC 28 January, and strengthened to 940 mb 18 hours later, before reaching the coast of Norway at 1800 UTC 29 January. This was the second most intense storm of the January to April period in both oceans. There were numerous reports from buoys and ships of winds in the 45 to 65 kt range in the North Sea. At 1800 UTC 29 January the **Arina Arctica** (**OVYA2**) encountered west winds of 65 kts and 7.5 m (25 ft) seas near 58N 5E, and the ship **MWYG6** (60N 4W, name unknown) reported 10.5 m (35 ft) seas.

The pattern changed to a more southwest flow aloft in early February 2000, steering developing lows from the Canadian Maritimes or northeast U.S. coast toward Iceland or north of Great Britain, some deepening to central

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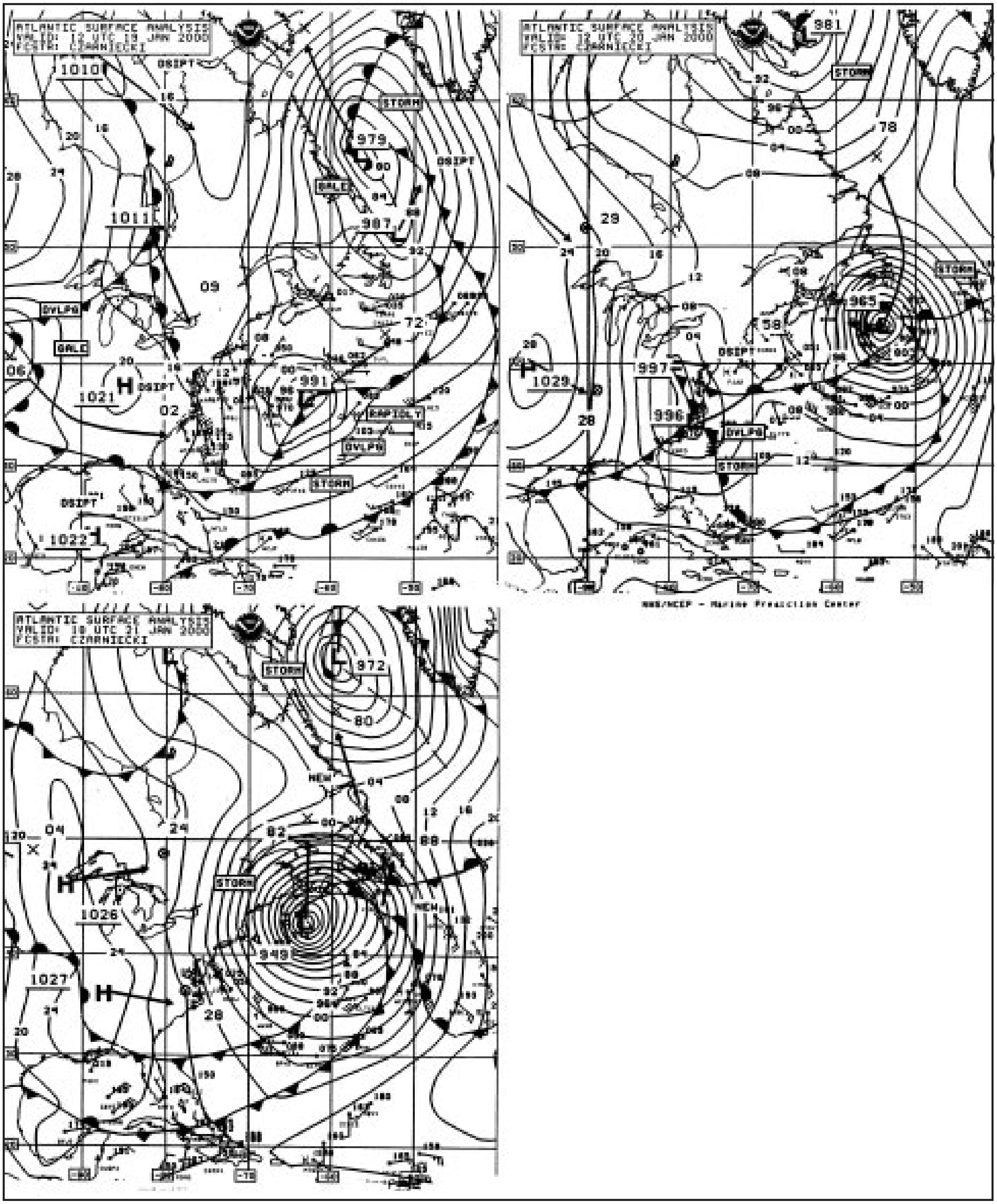

Figure 4. MPC North Atlantic surface analysis charts (Part 2) valid 1200 UTC 19 and 20 January and 1800 UTC 21 January 2000.

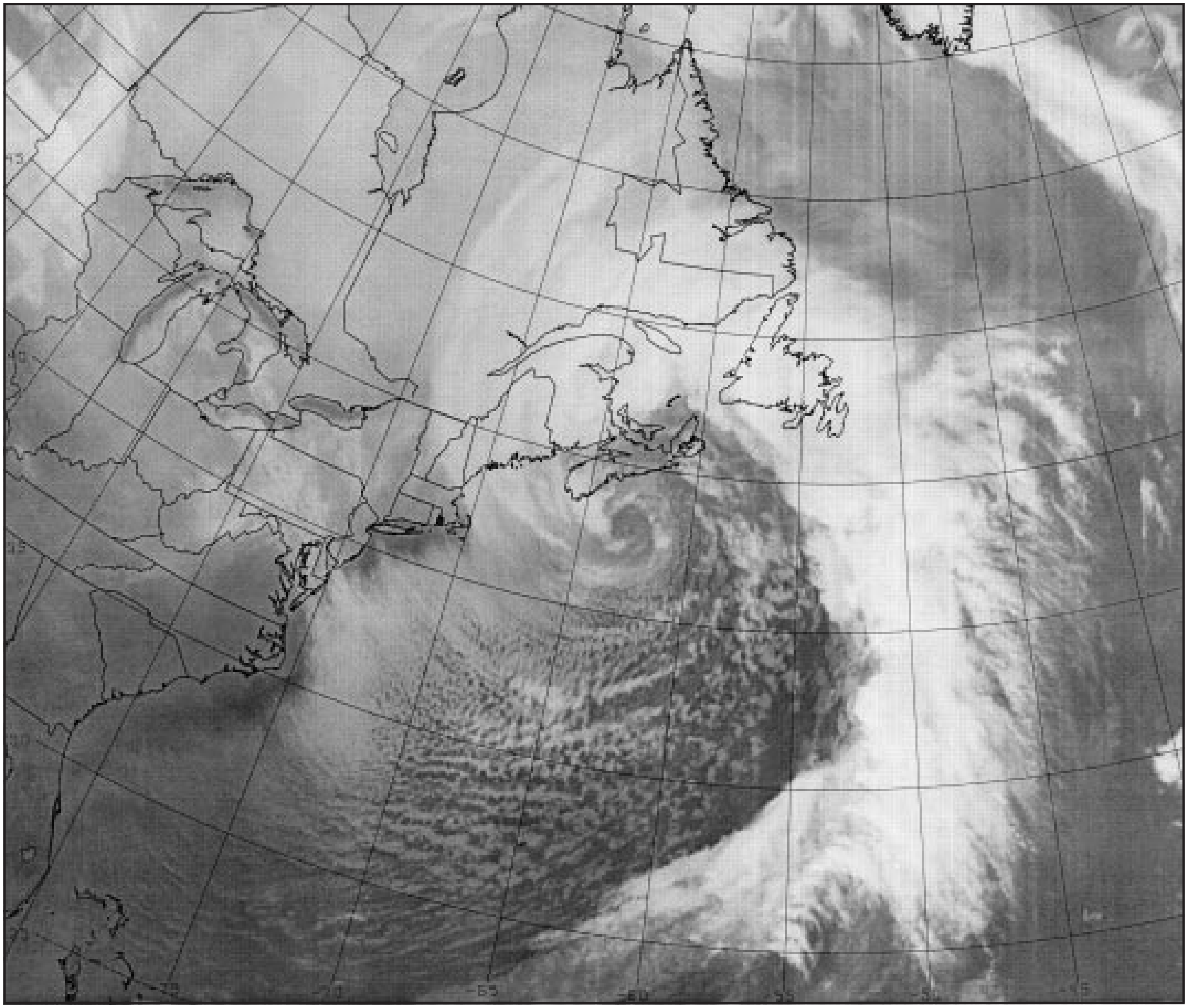

Figure 5. GOES8 infrared satellite image valid 1815 UTC 21 January 2000. Valid time approximates valid time of third surface analysis in Figure 4.

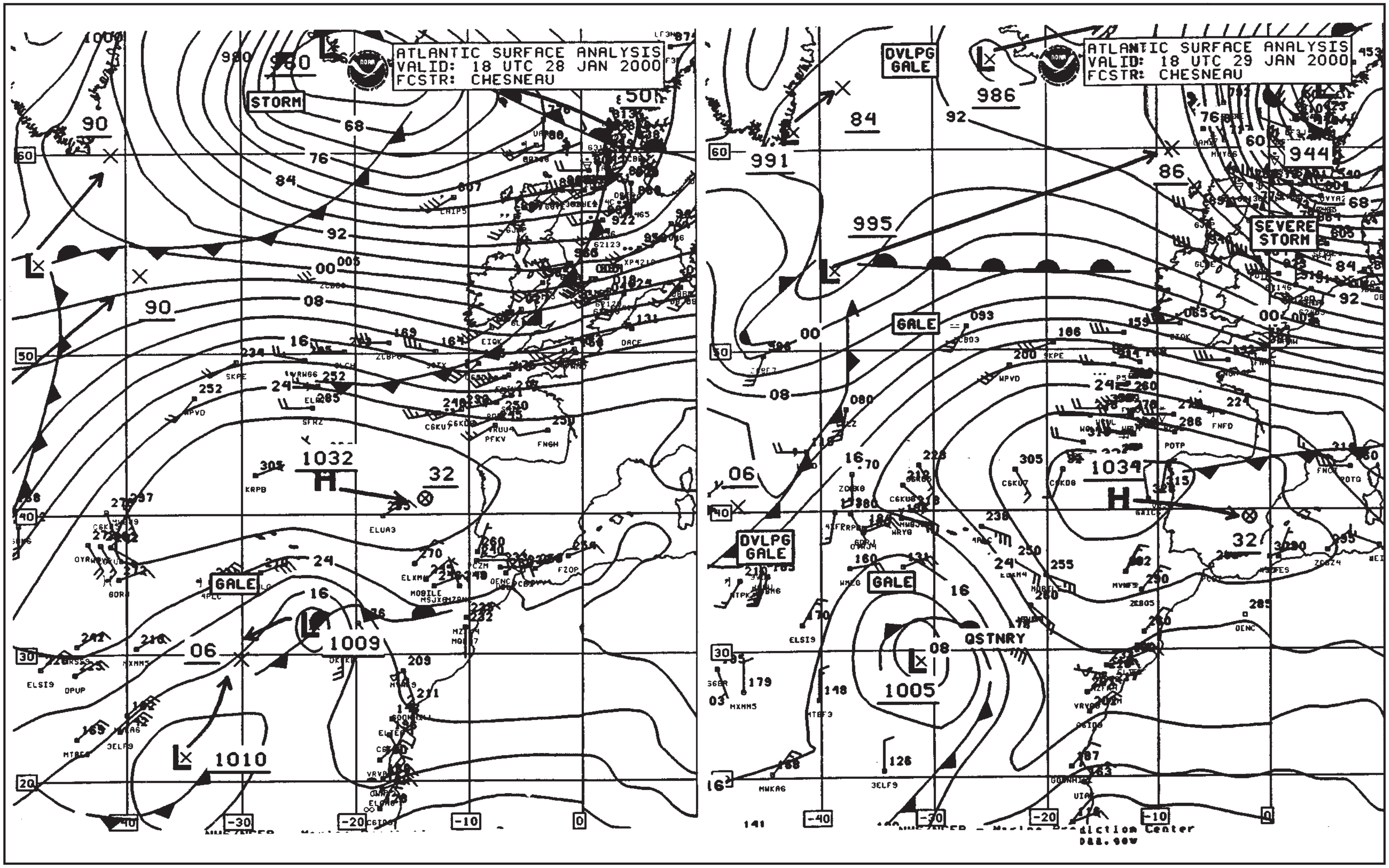

Figure 6. MPC North Atlantic surface analysis charts (Part 1) valid 1800 UTC 28 and 29 January 2000.

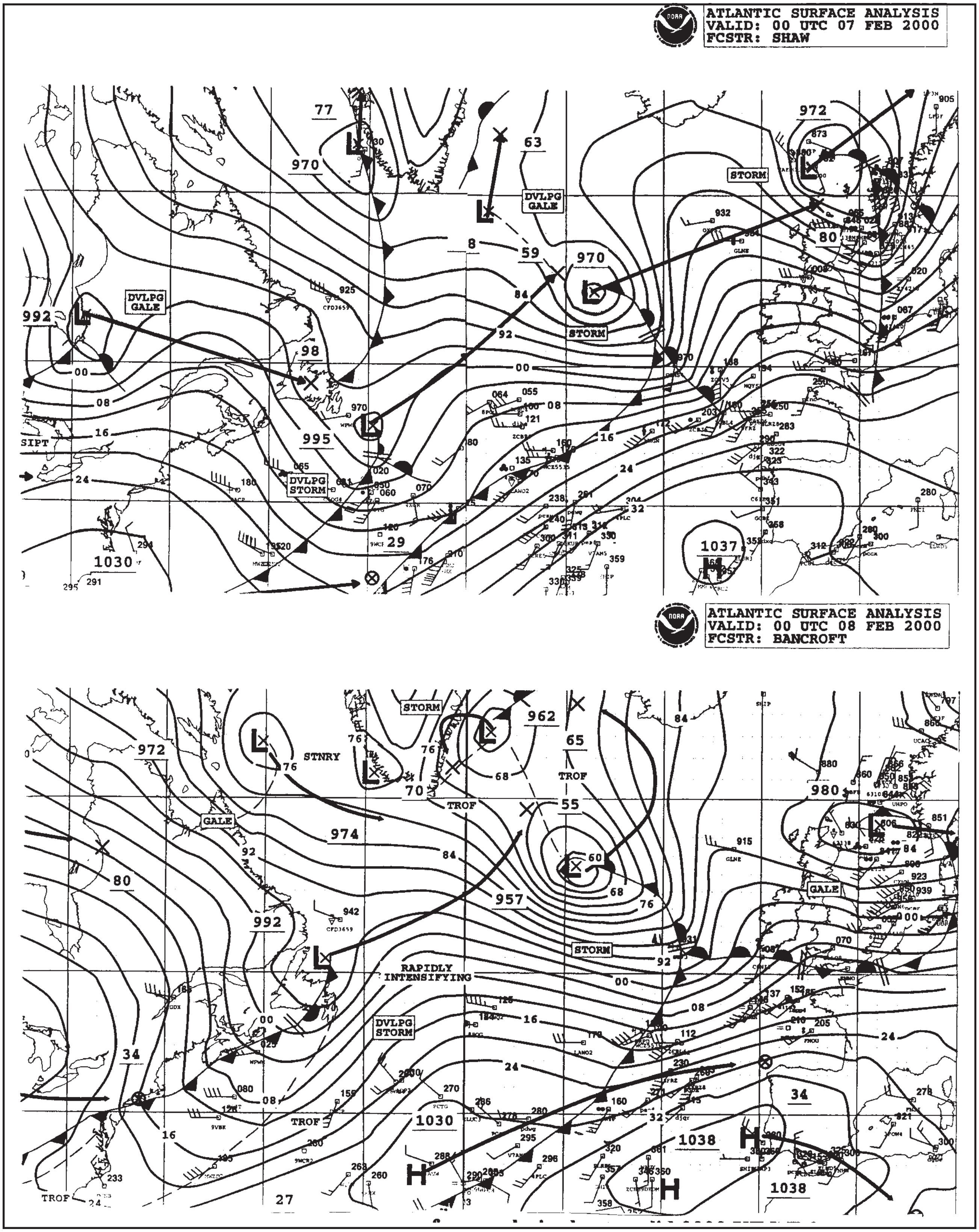

Figure 7. MPC North Atlantic surface analysis charts valid 0000 UTC 07 and 08 February 2000.

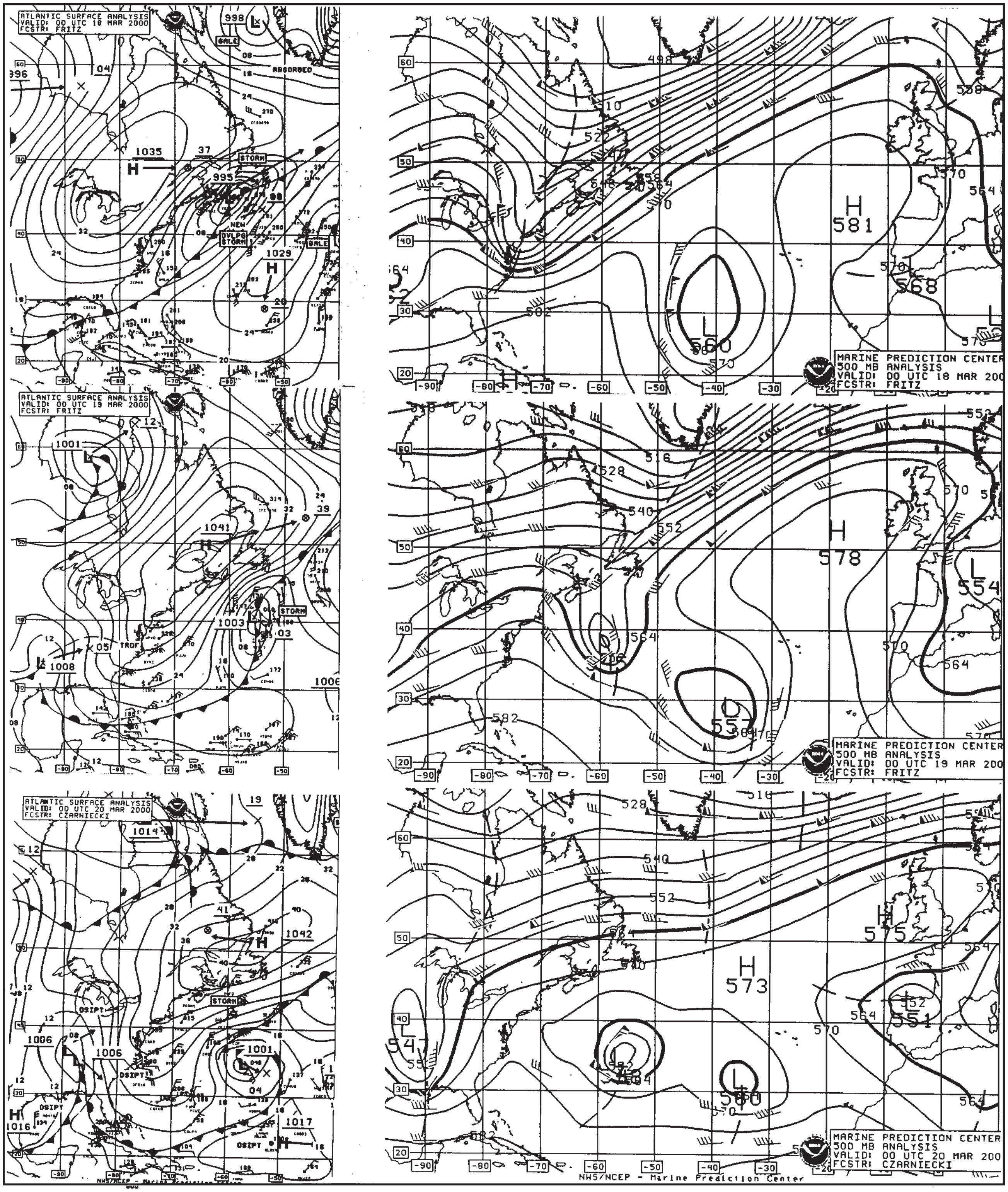

Figure 8. MPC North Atlantic surface analysis charts (Part 2) and corresponding North Atlantic 500-Mb charts valid 0000 UTC 18, 19, and 20 March 2000.

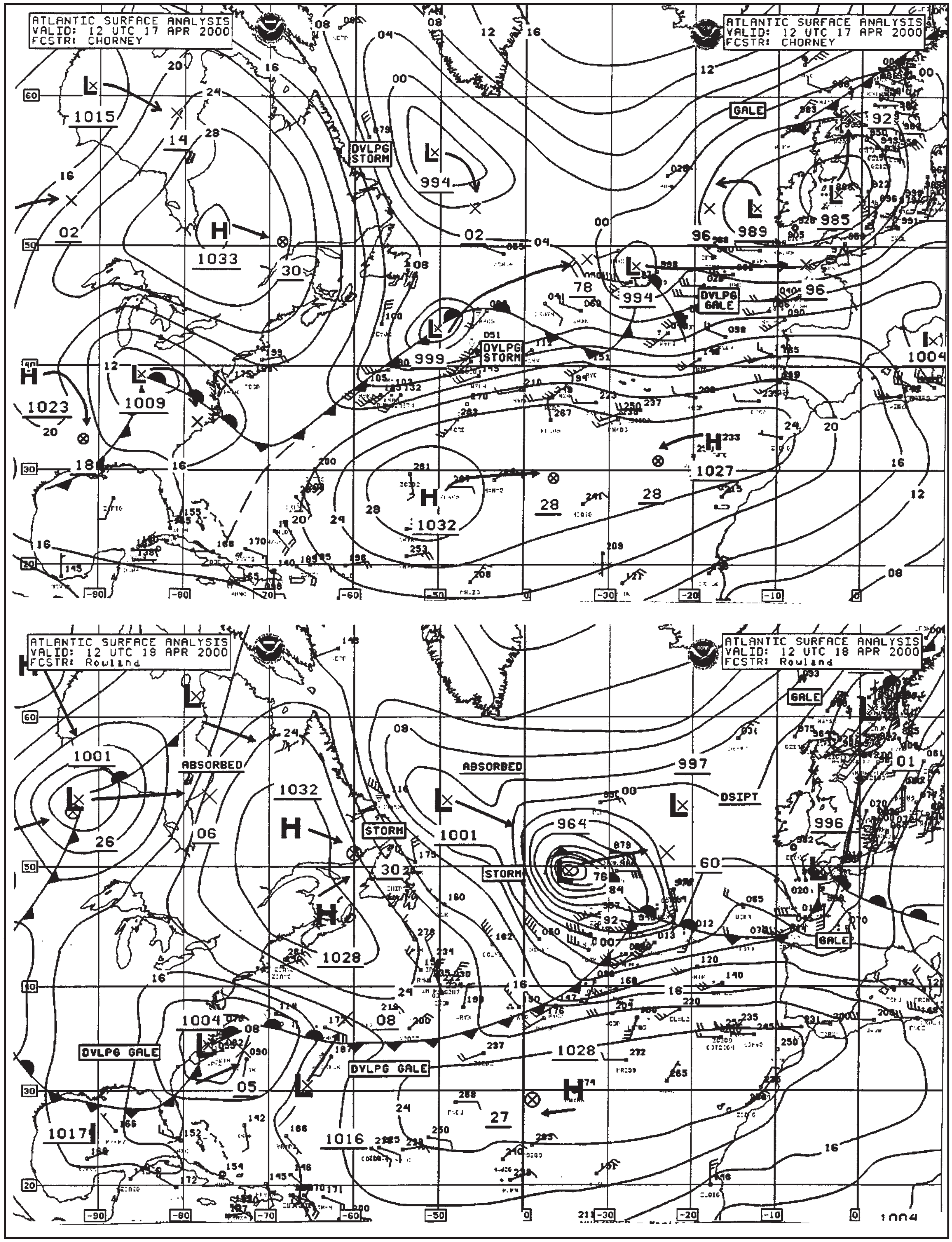

Figure 9. MPC North Atlantic surface analysis charts valid 1200 UTC 17 and 18 April 2000.

North Atlantic Area

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pressures near 950 mb. Figure 7 shows the most active part of the period from February to April, with four systems that produced storm force winds over the North Atlantic. Southwest of the departing storm north of Great Britain in the first part of Figure 7, the **Discovery** (**GLNE**) at 58N 12W reported a northwest wind of 60 kts at 1800 UTC 06 February. The **Atlantic Cartier** (**C6MS4)** is shown with a south wind of 55 kts near 50N 19W ahead of the 970 mb central Atlantic storm at 0000 UTC 07 February. Twenty-four hours later this storm was replaced by the one coming from southeast of Newfoundland, to become the 957 mb storm shown in the second part of Figure 7. The ship **C6NI3** (name unknown) reported west winds 60 kts near 51N 12W at 0600 UTC 08 February. Satellite data showed winds to 70 kts at this time south of the center, in an area of sparse ship reports.

By the second week in March high pressure began to build over the eastern North Atlantic, forcing low-pressure systems to move north toward Greenland and the Davis Strait. Later in March an unusual event occurred in which a low-pressure center moved northeast to the Canadian Maritimes on 17 March. Then, instead of turning north toward Greenland, it turned southeast and became “cut off” from the westerlies. Figure 8 shows this occurring over a 48-hour period from 0000 UTC 18 March to 0000 UTC 20 March. The 500-mb charts corresponding with the surface analyses show a short wave trough over New England “digging” southeast toward a cutoff low south of Newfoundland, with which it merged. The low-pressure center became trapped by strong high pressure to the north and east. This led to a large area of gale to storm force winds between the low and the high over the Canadian Maritimes. The **Saga Horizon** (**VRUZ9)**, at 41N 60W, reported north winds of 60 kts and 12 m (39 ft) seas at 1200 UTC 19 March. The **Nosac Ranger** (**WRYG**) encountered north winds of 50 kts and 15.5 m (51 ft) seas at 38N 62W at this time, and again near 40N 61W at 1800 UTC 19 March. The lowest central pressure for this low was only 997 mb. The pressure difference between the low and high to the north actually mattered more in this case to account for the storm winds and huge waves. The low drifted southeast and weakened to a gale on the 20 March, and did not finally lift northeast until the blocking high moved east and weakened on 24 March.

In early April a ridge built northward over the central North Atlantic toward Greenland. Low-pressure systems developing near the East Coast moved north through the Labrador Sea. The high pressure which had lingered near Great Britain during much of March was replaced by a series of southward-moving low pressure systems, one of which stalled over the Bay of Biscay by 02 April before moving inland on 04 April. Gale to locally storm force north winds accompanied these systems, and actually extended from the Norwegian Sea to northwest Africa during 02-03 April.

The central Atlantic blocking high weakened by 16 April, allowing southwest to northeast movement of low-pressure systems to resume. The most significant of these lows was a storm that developed rapidly over a 24-hour period ending at 1200 UTC 18 April. Figure 9 shows the most rapid phase of this development. The central pressure dropped 37 mb (1.09 in.) in this 24-hour period. The storm is shown at maximum intensity (964 mb) in the second part of Figure 9. The **Ironbridge** (**ZCCY9**) encountered west winds of 65 kts near 46N 30W at 0000 UTC 19 April, the highest wind report from this storm. The **Mette Maersk** (**OXKT2**) reported northwest winds of 45 kts and 10.5 m (35 ft) seas near 45N 38W at 1200 UTC 18 April. The storm began to weaken slowly on 19 April and drifted east along 50N. The circulation expanded to cover much of the western North Atlantic as the center approached Great Britain and stalled on 20 April.

References

Joe Sienkiewicz and Lee Chesneau, *Mariner's Guide to the 500-Millibar Chart* (Mariners Weather Log, Winter 1995).

George Bancroft, *Marine Weather Review, North Atlantic Area, September through December 1999* (Mariners Weather Log, April 2000).⚓

Marine Weather Review
North Pacific Area—January through April 2000

George P. Bancroft
Meteorologist
Marine Prediction Center

Editors note: Unless otherwise noted, sea heights given in this article are significant wave heights: the average height of the highest one-third of the waves.

The period began with blocking high pressure at the surface and aloft extending from the Bering Sea southeastward, which had the effect of turning northward moving low pressure systems toward the west as they approached the Aleutians. This is contrary to the normal eastward or northeastward movement of low-pressure areas at these latitudes. By 12 January, the high pressure ridge developed a more north to south orientation near the dateline and strengthened in response to developing strong low pressure west of the area. To the east, a large area of low pressure persisted in the Gulf of Alaska. Weather systems were slow moving with this type of pattern. Although some of the lows developed storm force winds (48 kts or greater), none developed into intense storms. This began to change by the middle of January, as the Bering Sea ridge began to weaken and shift east, allowing developing lows to track northeast from near Japan toward the Bering Sea. By the end of January the ridge was replaced by low pressure at the surface and aloft, and a more active pattern that lasted into March.

The first major storm of the period formed from a merger of two lows, one east of Japan and the other coming north from the subtropics. Figure 1 shows this development over a 48-hour period, leading to an intense low at 964 mb in the southwest Bering Sea at 1200 UTC 20 January. As the two lows consolidated into a 970 mb storm at 1200 UTC 19 January, the **B.T. Alaska** (**WFQE**) reported a west wind of 60 kts near 44N 160E. Eighteen hours later there was a report of 65 kt northwest winds from the **Saga Ocean** (**LAON4**) at 52N 165E, the highest wind reported. The highest seas were south of the center. The third surface analysis in Figure 1 shows the **Westwood Marianne** (**C6QD3**), south of the storm center at 52N 173E with a west wind of 40 kts and seas of 9 m (30 ft). Three hours later, seas built to 16.5 m (54 ft), while the west wind picked up to 60 kts. North of the storm center at 0600

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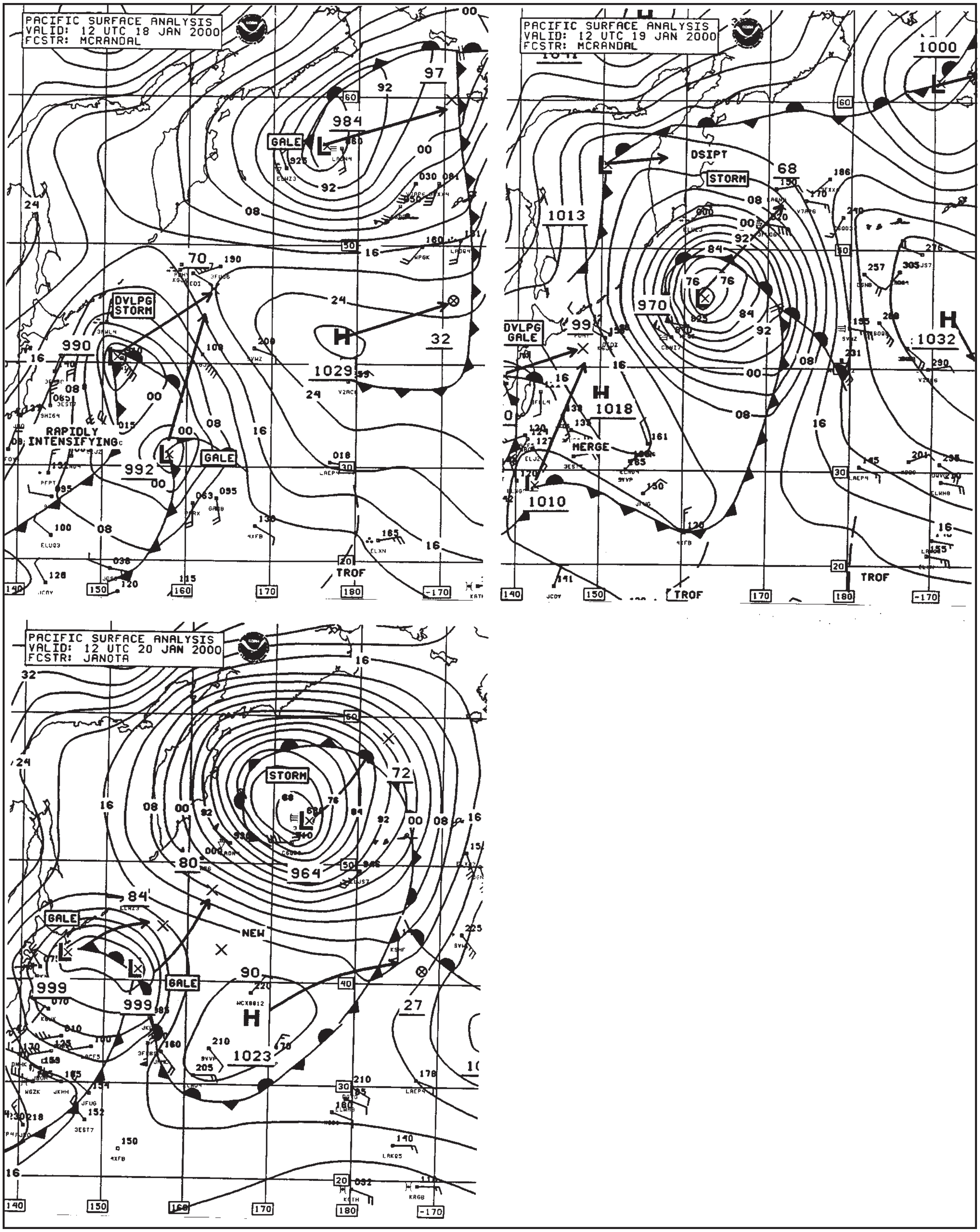

Figure 1. MPC North Pacific surface analyses (Part 2) valid at 1200 UTC 18, 19, and 20 January 2000.

North Pacific Area

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UTC 20 January the ship **UHJD** (name unknown) encountered a northeast wind of 50 kts. As this system weakened in the Bering Sea, a second storm followed a similar track toward the Bering Sea two days later, with reported winds to 60 kts and a central pressure deepening to 955 mb near the western Aleutians (not shown).

As these storms weakened in the Bering Sea, several developing lows passed to the south, along or just south of the Aleutians. One of these, shown in Figure 2, developed hurricane force winds and possible extreme wave heights south of the center as it passed south of the eastern Aleutians on 26 January. The **Denali** (**WSVR**) reported a west wind of 70 kts at this time, plotted in Figure 2 near 48N 170W. The author has determined the wind to be accurate, but is uncertain about the reported seas of 21.5 m (71 ft), with no nearby reports for comparison. This storm strengthened to 951 mb near the Alaska Peninsula six hours later before weakening inland on 27 January.

The storm in Figure 2 left a trailing front east of Japan. A series of low-pressure systems formed along this front late in January, as depicted in Figure 3. The low near the dateline at 1200 UTC 28 January was a meteorological “bomb,” dropping 41 mb (1.21 inches) in central pressure in the 24-hour period ending at 1200 UTC 29 January (third part of Figure 3). Even more remarkable, much of this drop occurred in the first six hours (29 mb or 0.86 in.)! This storm was also noted for dangerous winds and seas. There were several ship reports with winds in the 60 to 75 kt range south and southwest of the center on 29 January. The ship **4XFO** (name unknown) reported a southwest wind of 75 kts near 39N 145W at 1200 UTC 29 January, followed by a west wind of 75 kts six hours later near 39N 143W. At 1800 UTC 29 January the ship **VRWE8** (name unknown) reported northwest winds of 60 kts and 24.5 m seas (81 ft) near 42N 148W. The author is uncertain about the reported seas being this high. Six hours later, the same ship sent a report of 50 kt northwest winds and 18.5 m (60 ft) seas, comparable to the 17 m (55 ft) seas reported by the ship **WCX8883** (name unknown) to the southeast near 37N 143W at that time. Figure 4 shows the flow patterns at 500 mb valid at the times of the first and third parts of Figure 3. It shows a 105 kt jet stream and intensifying short wave trough crossing the dateline at 1200 UTC 28 January, supporting this development (see references, article by Sienkiewicz and Chesneau for more information on use of the 500-mb chart). Figure 5 is an infrared satellite picture of the North Pacific showing three low-pressure systems in various stages of development. One is weakening near the Alaskan coast. Another, the major storm that is the subject of this paragraph, is near maturity and maximum intensity near 42N 147W. A third forms near the dateline and is labeled “developing storm” in the third part of Figure 3. Later, as the storm moved onshore on the central Gulf coast of Alaska late on 31 January, the **Sea-Land Kodiak** (**KGTZ**) and the **Chesapeake Trader** (**WGZK**) just south of the Kenai Peninsula reported west winds of 60 kts.

The most intense storm of the four-month period in both oceans formed near Japan at 0600 UTC 30 January and took a northeast track over the following two days while deepening rapidly. The central pressure dropped 42 mb (1.24 in.) in the first 24 hours ending at 1200 UTC 31 January, and then fell another 24 mb in the second 24-hour period ending at 1200 UTC 01 February. The storm strengthened to 934 mb (27.58 in.) central pressure in the southern Bering Sea near the dateline (Figure 6, third part). The ship **DYZM** reported from 39N 175E with a south wind of 60 kts ahead of the cold front at 1800 UTC 31 January. While the storm was near maximum intensity, various ships around the eastern and central Aleutians reported winds in the 45 to 60 kt range, with a maximum wind of 65 kts from the southeast, reported by the **European Express** (**PEDS**), just north of Adak at 0000 UTC 01 February. The ship **WFQF** (name unknown) reported a south wind 55 kts ahead of the cold front near 50N 161W at 1200 UTC 01 February. Just to the west, **LAXG4** (name unknown) experienced 13.5 m (45 ft) seas near 51N 165W, the highest reported with this storm. South of

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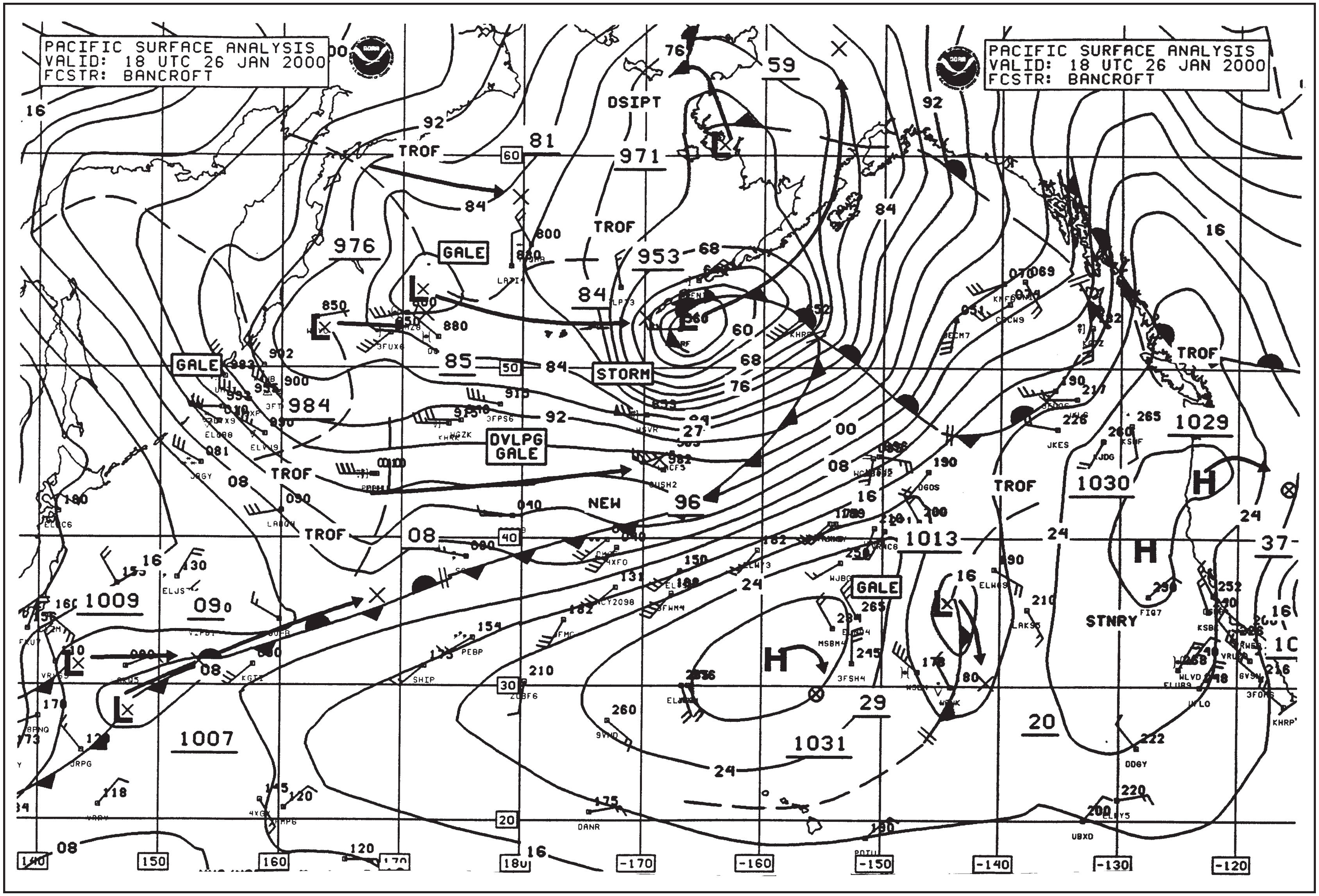

Figure 2. MPC North Pacific surface analysis for 1800 UTC 26 January 2000.

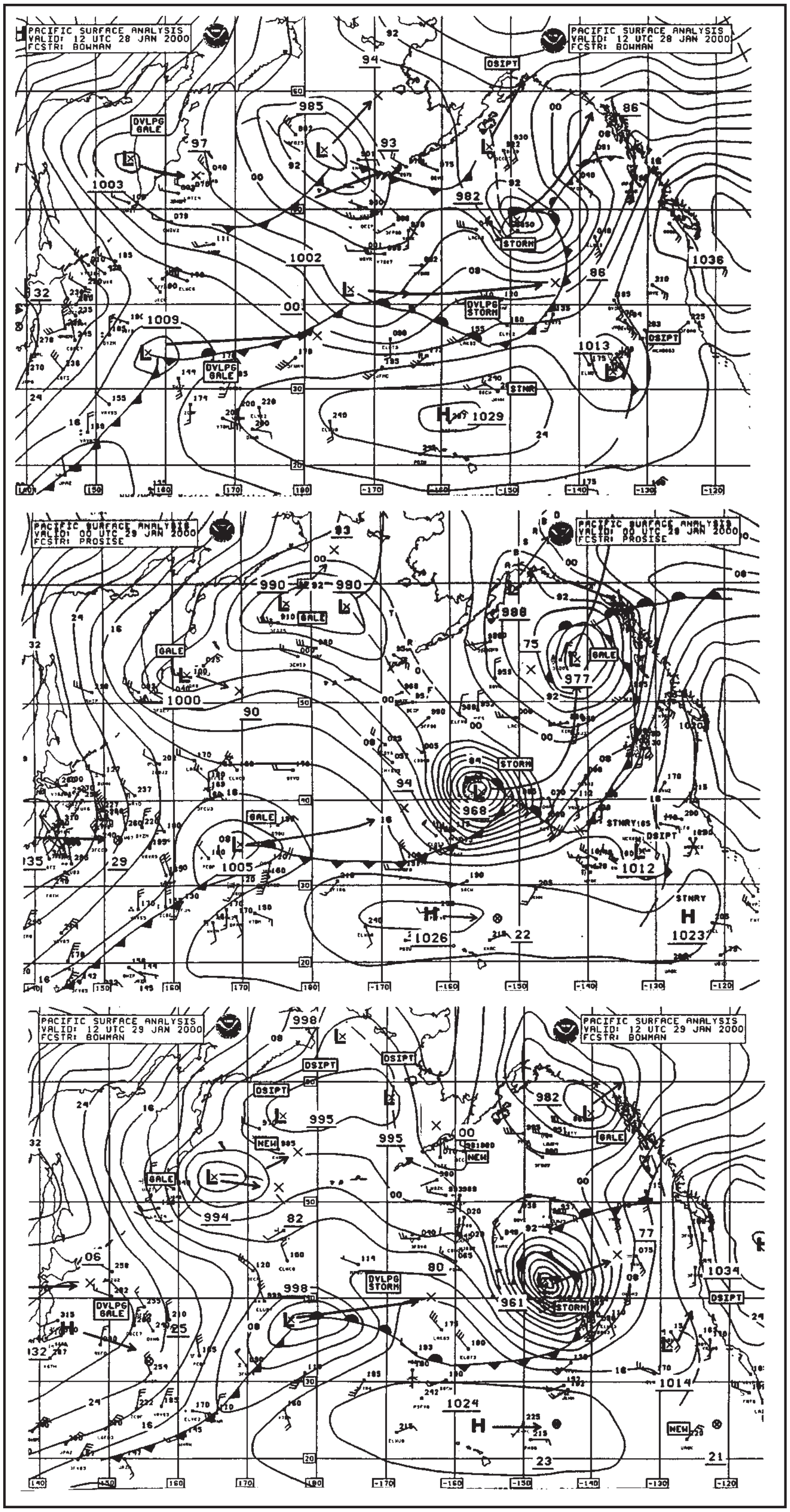

Figure 3. MPC North Pacific surface analyses valid 1200 UTC 28 January, and 0000 UTC and 1200 UTC 29 January 2000.

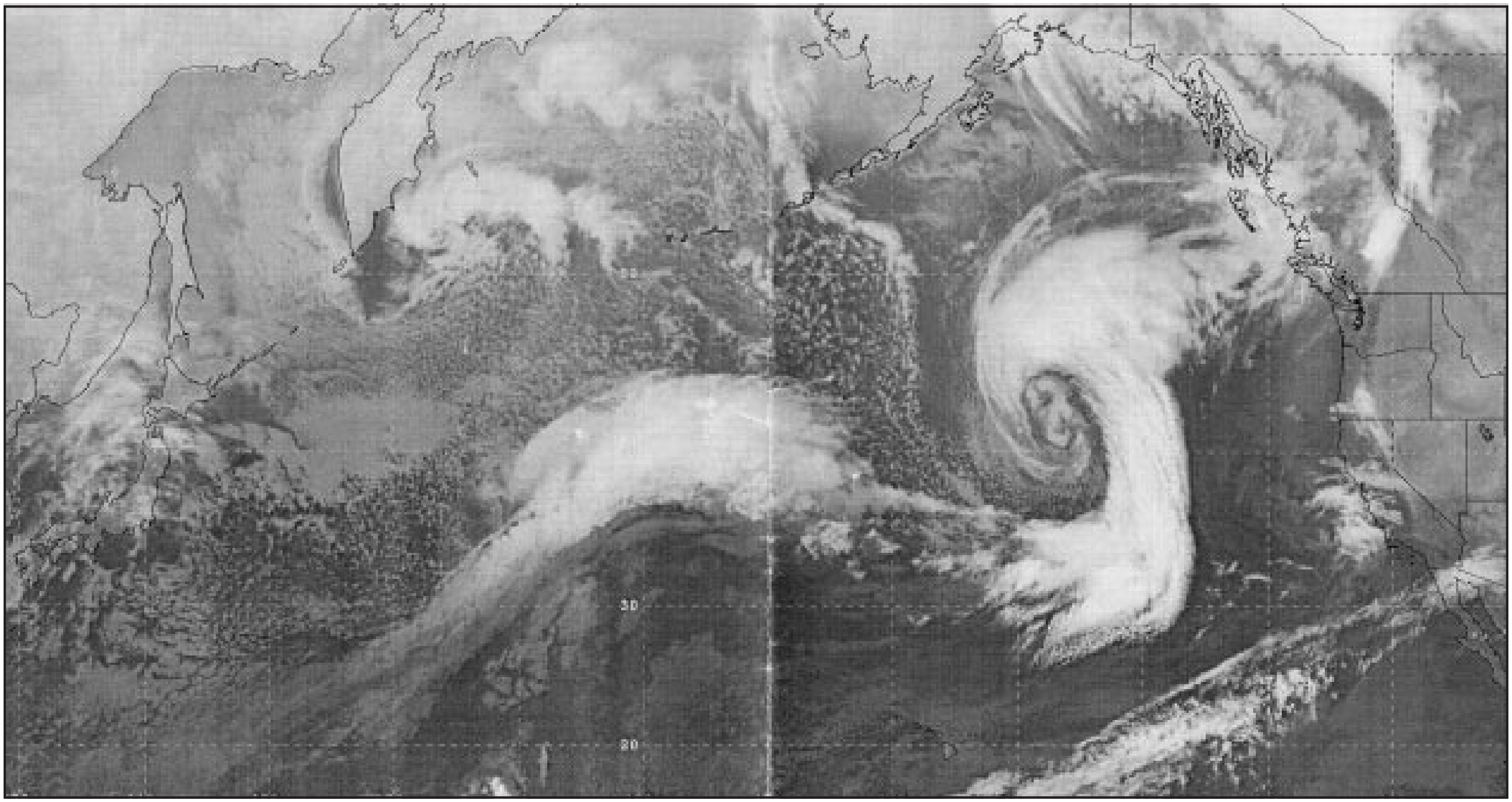

Figure 4. Infrared satellite image of North Pacific (composite of GOES and GMS) valid at 1145 UTC 29 January 2000. Infrared imagery displays temperature in various shades of gray, ranging from white (coldest) to black (warmest), allowing clouds to be seen at night.

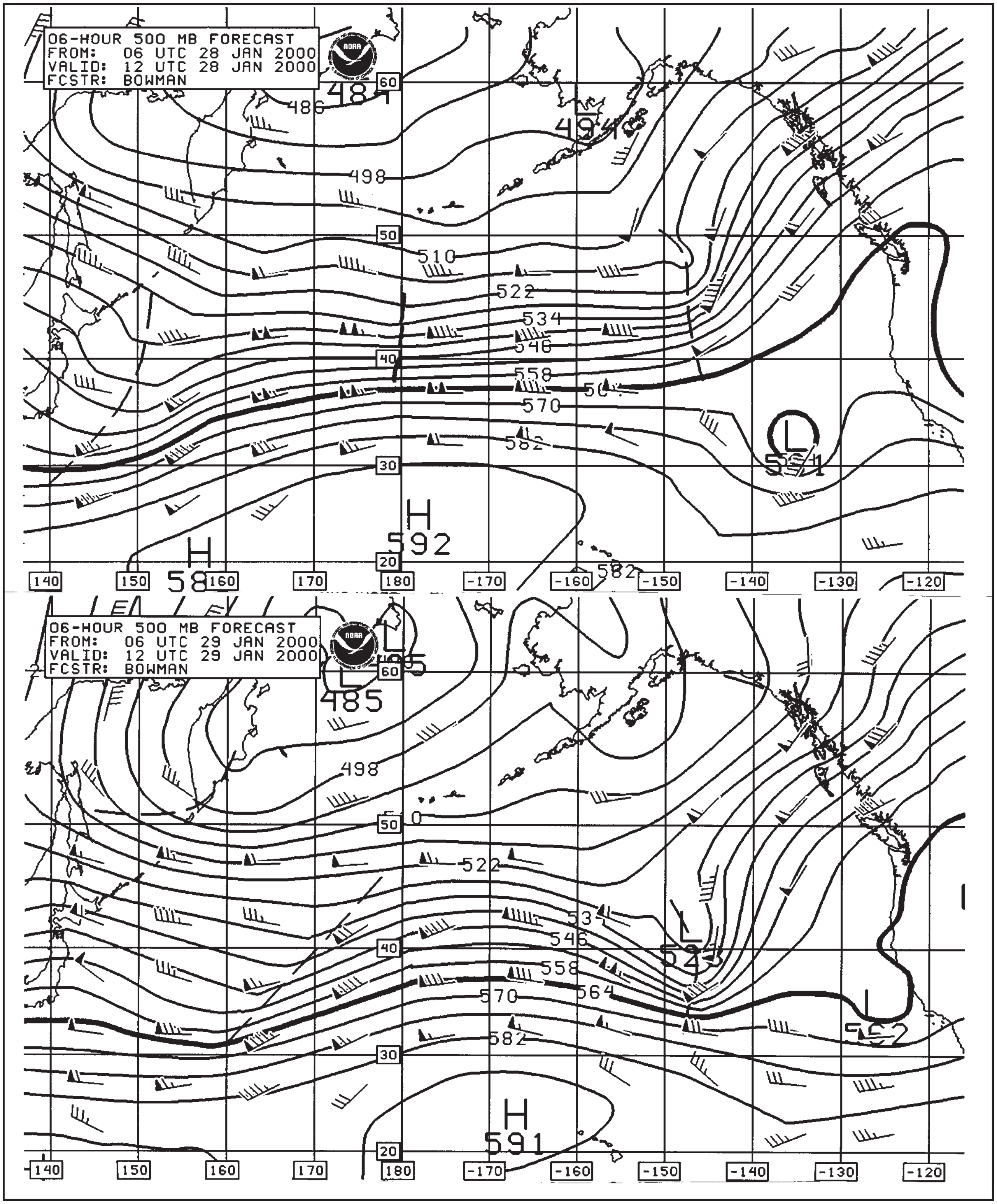

Figure 5. 500-Mb charts valid at 1200 UTC 28 and 29 January 2000. Valid times correspond to first and third surface charts of Figure 3.

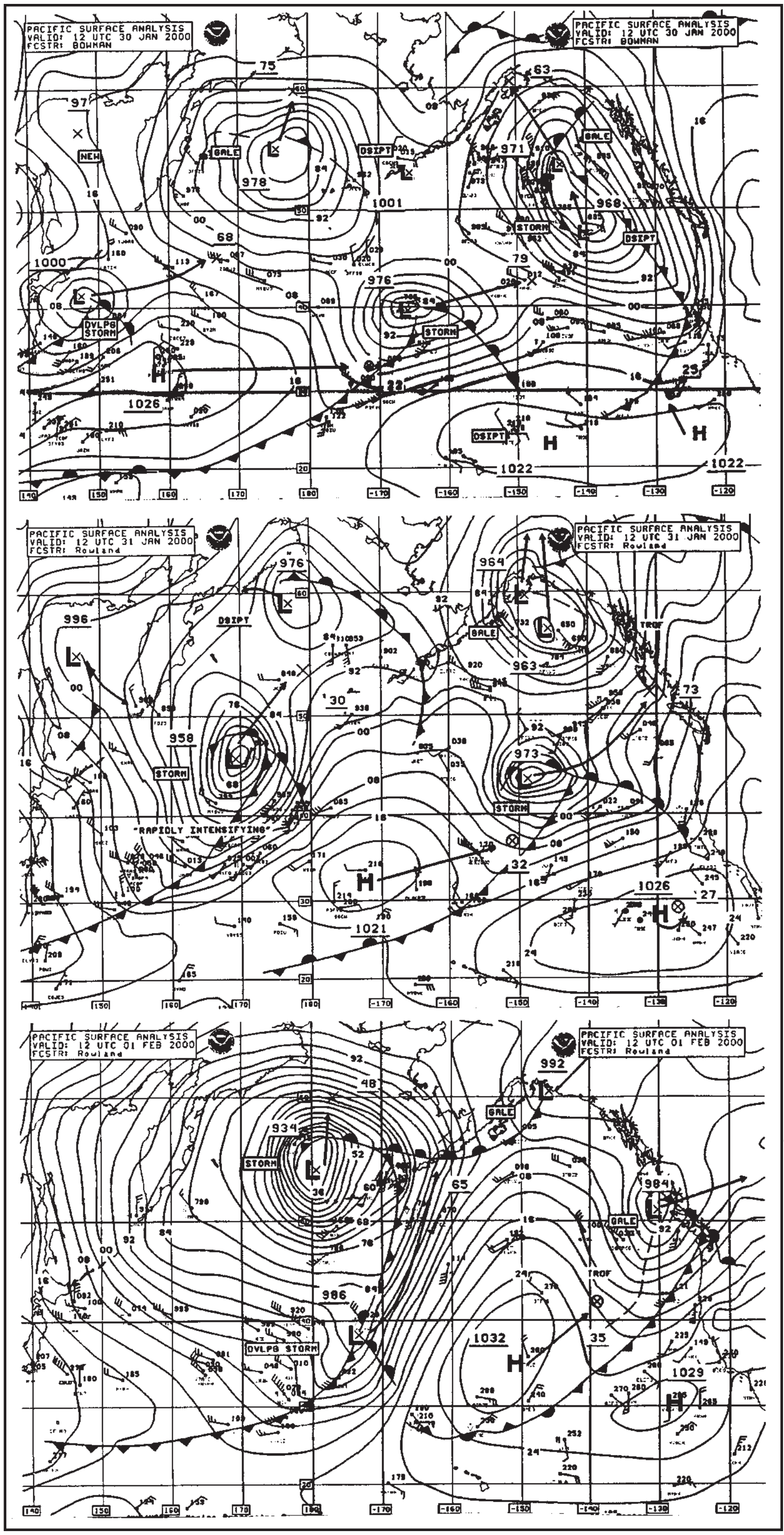

Figure 6. MPC North Pacific surface analyses valid at 1200 UTC 30 and 31 January and 1200 UTC 01 February 2000.

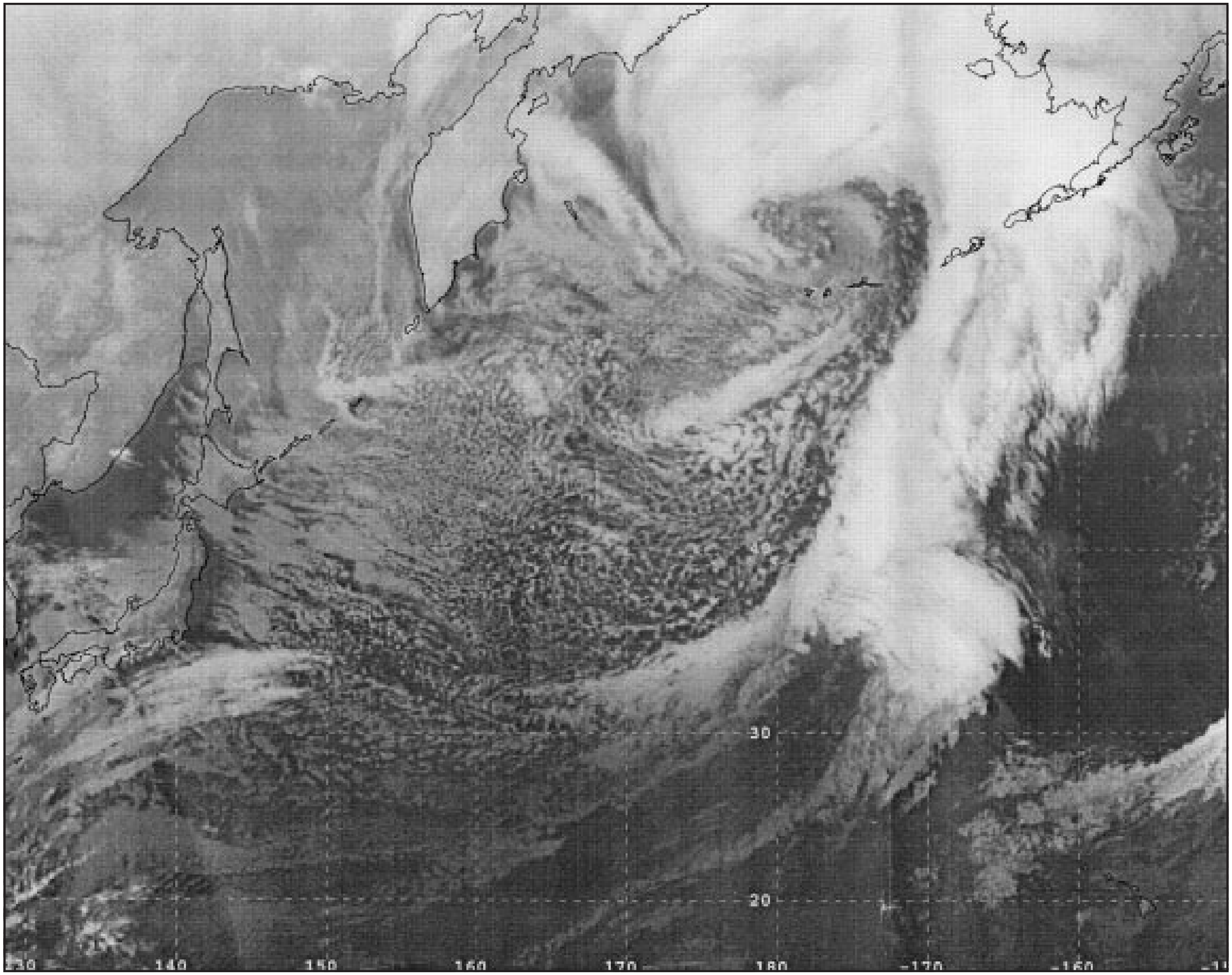

Figure 7. Infrared satellite image of North Pacific (composite of GOES and GMS) valid 1145 UTC 01 February 2000. Valid time corresponds to third analysis chart of Figure 6.

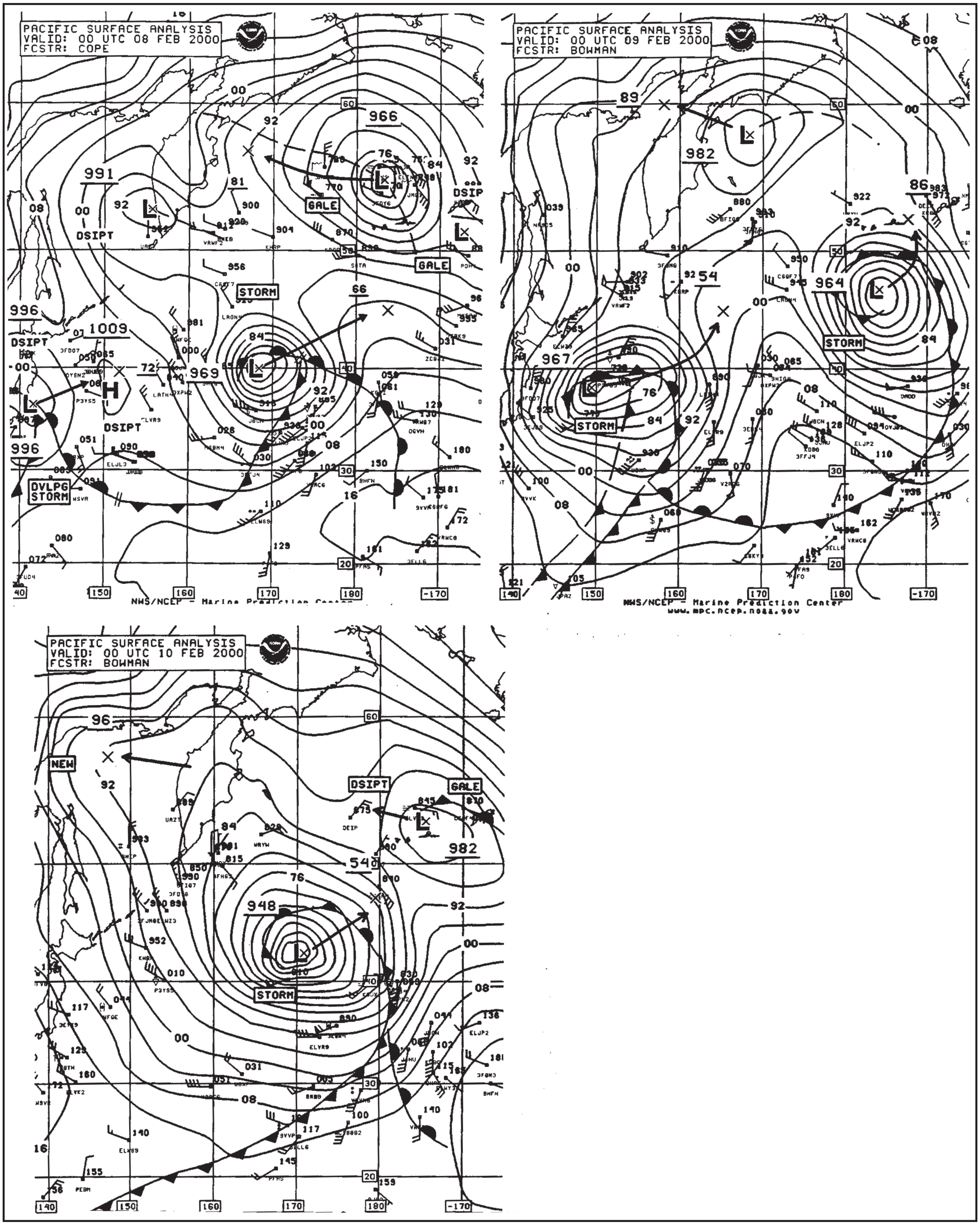

Figure 8. MPC North Pacific surface analyses (Part 2) valid at 0000 UTC 08, 09, and 10 February 2000.

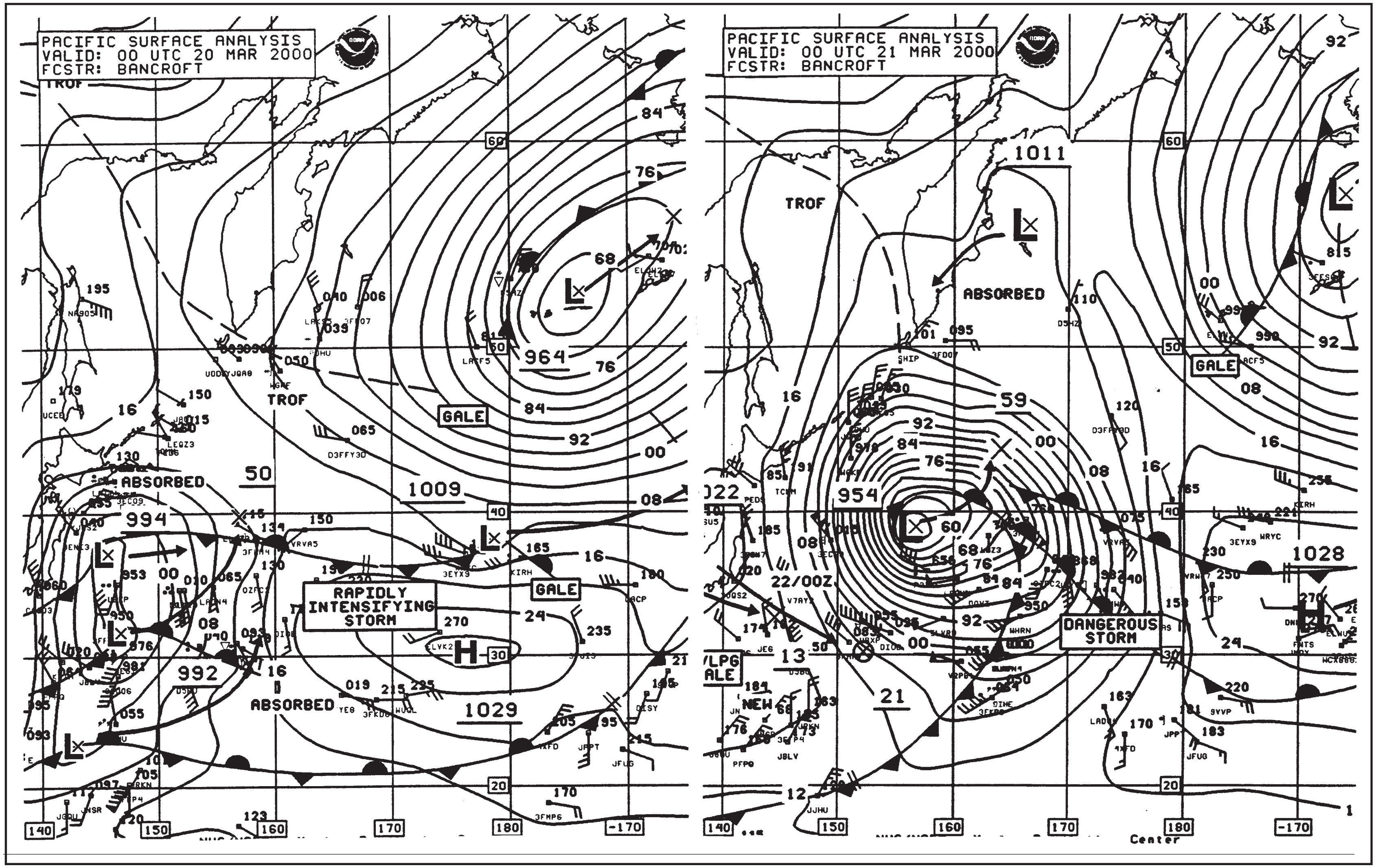

Figure 9. MPC North Pacific surface analyses (Part 2) valid at 0000 UTC 20 and 21 March 2000.

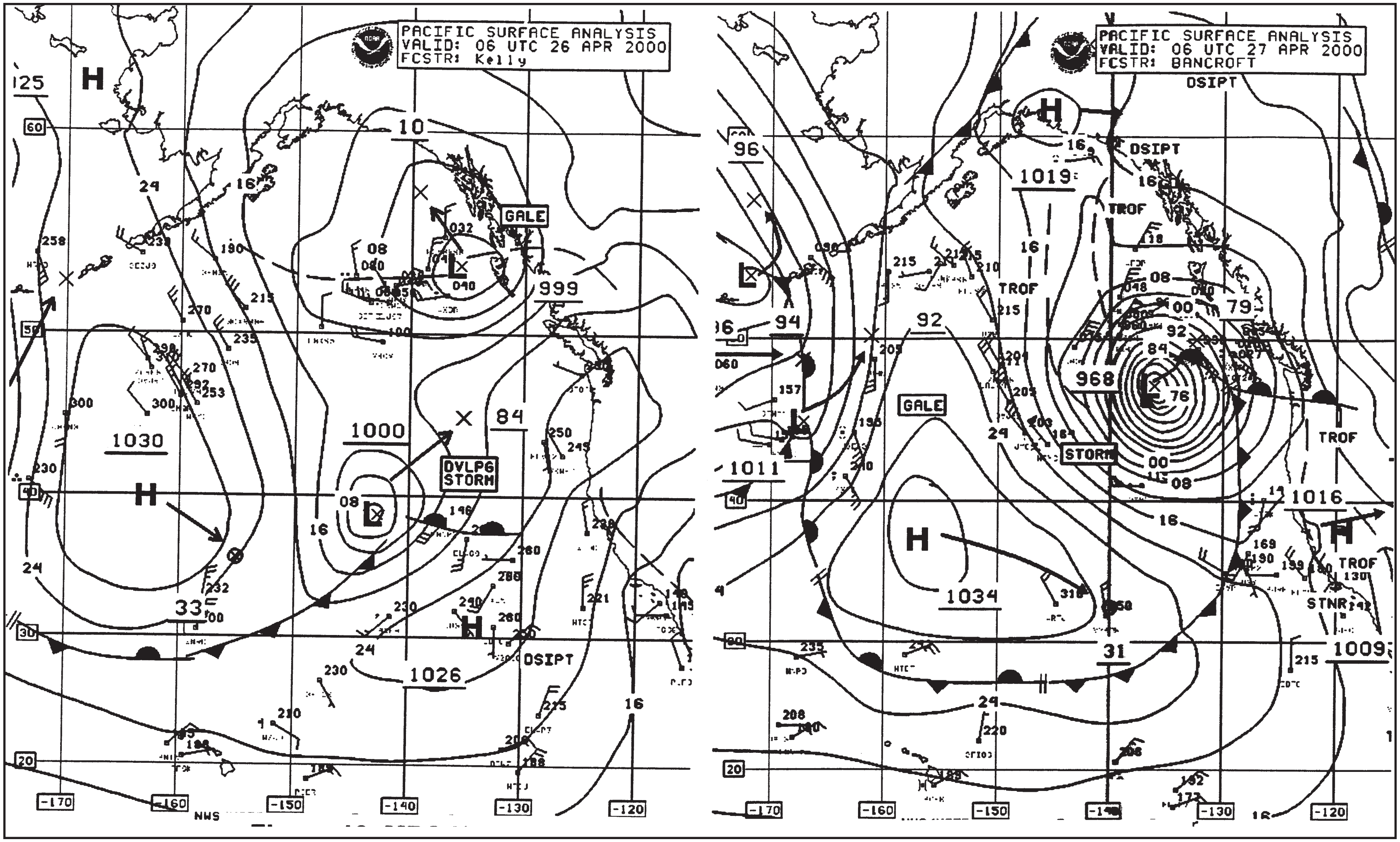

Figure 10. MPC North Pacific surface analyses (Part 1) valid at 0600 UTC 26 and 27 April 2000.

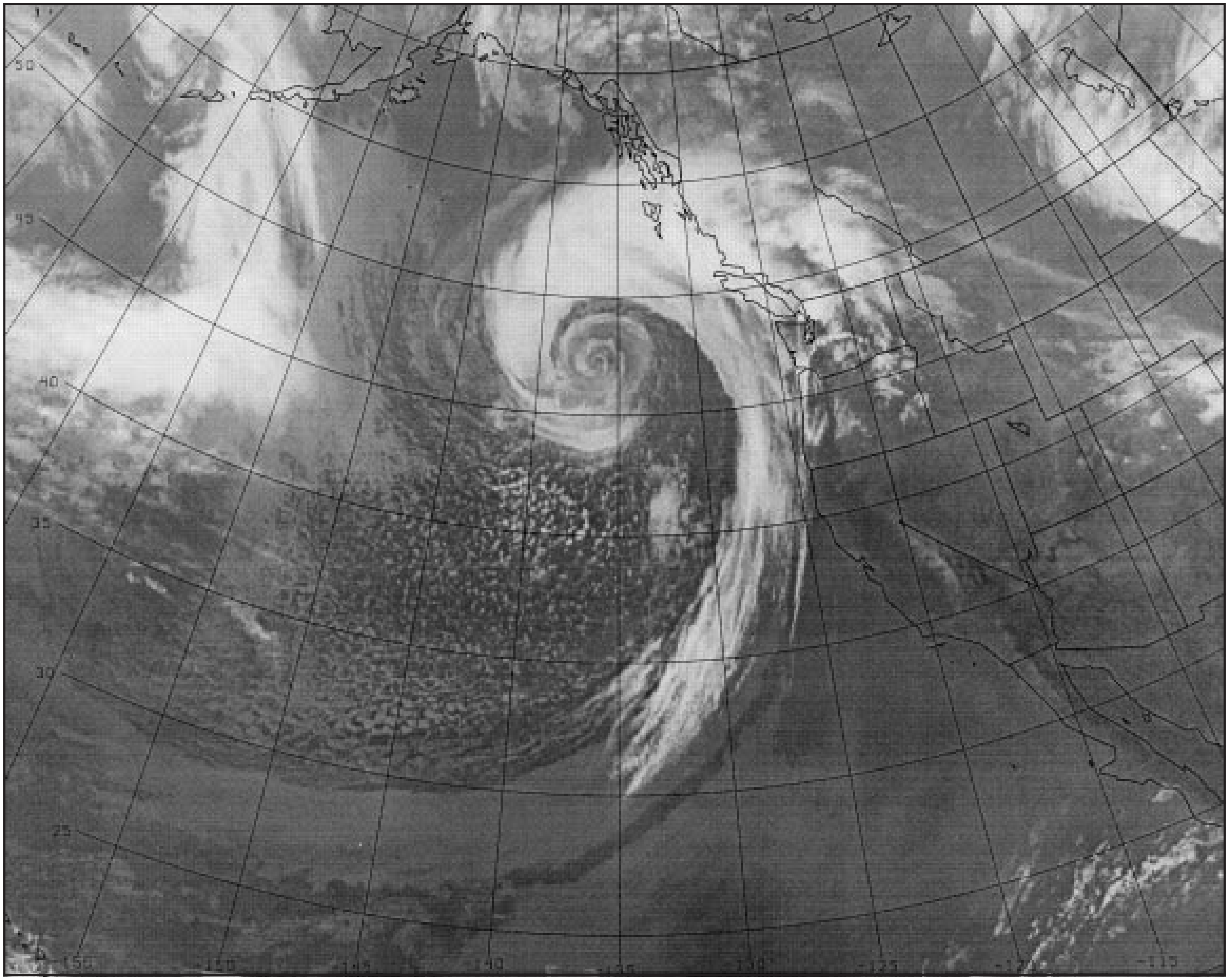

Figure 11. GOES10 infrared satellite image valid at 0600 UTC 27 April. Valid time corresponds to second surface chart in Figure 10.

North Pacific Area

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the center near 48N 177W the **Cotswold** (**ZCBJ2**) reported west winds of 35 kts and 10.5 m (34 ft) seas. Figure 7 is an infrared satellite image of the storm near maximum intensity, showing the massive "comma cloud" and large area of cold unstable air (cumulus-type clouds) south of the center.

The remainder of February and through much of March was quite active with frequent low-pressure systems developing east of Japan and moving northeast toward the Gulf of Alaska or southeast Bering Sea. Many developed storm force winds. The strongest is displayed in Figure 8. After initially dropping 29 mb in central pressure in the first 24 hours after leaving the coast of Japan, the storm strengthened to 948 mb at 0000 UTC 10 February. This is unusually intense for this latitude, and the second lowest pressure in the North Pacific during this four-month period. Key observations came from the **Saga Crest** (**LATH4**), which reported west winds of 65 kts near 40N 169E at both 0000 and 0600 UTC 10 February. Reported seas were 17 m (56 ft) at 0000 UTC and 20.5 m (67 ft) at 0600 UTC 10 February. To the southeast, the **Virginia** (**3EBW4**) near 36N 175E reported a southwest wind of 60 kts at 0000 UTC 10 February. The storm then moved northeast and began to weaken, reaching the central Aleutians by 12 February.

A pair of storms formed off Japan in the middle of March which, like the February storm above, reached maximum intensity east of Japan before turning northeast and weakening. Both reached a similar intensity, about 954 mb, and developed maximum winds of at least 60 kts and maximum seas of 15 m (50 ft) or more. The first storm, at 981 mb on the coast of Japan at 1200 UTC 16 March, underwent much of its intensification in the first 12 hours, dropping 21 mb to 960 mb at 0000 UTC 17 March (the warm Kuroshio Current helps fuel rapid intensification of low-pressure centers moving off Japan, especially in winter). The highest wind report was northwest 60 kts from the **B.T. Alaska** (**WFQE**) near 40N 149E, west of the center at 0600 UTC 17 March. The **Rainbow Bridge** (**3EYX9**) reported a northwest wind of 35 kts and 16.5 m (54 ft) seas southwest of the center near 34N 159E at 0000 UTC 18 March. The second storm formed from the merging of three low-pressure centers off Japan over a 24-hour period as depicted in Figure 9, with a pressure drop of 38 mb (1.12 in). The second part of Figure 9 shows the storm at maximum intensity of 954 mb at 0000 UTC 21 March. The highest wind reported was 61 kts from the southeast by **Golden Gate Bridge** (**3FWM4**) near 39N 165E at 1800 UTC 20 March. The **Saga Ocean** (**LAON4**) encountered west winds of 55 kts and 17.5 m (58 ft) seas southwest of the center near 37N 167E at 0600 UTC 22 March (the highest reported seas with this storm).

Late in March the pattern changed, leading to a more northward movement of developing lows from near Japan toward the Sea of Okhotsk or western Bering Sea, some of which developed storm force winds. With the arrival of spring, the low-pressure systems were not as strong as in March or earlier. By mid-April the flow pattern aloft became more west to east, and low-pressure systems that formed were mainly below storm strength. Late in April a deep low-pressure trough aloft formed over the eastern Pacific. Figure 10 shows a storm that developed in this trough and moved northeast toward the Queen Charlotte Islands, the strongest system to develop in April. The storm is shown at maximum intensity, 968 mb, off the Washington coast in the second part of Figure 10. During development, the maximum 24-hour pressure fall in the center was 34 mb (1.00 in.) from 0000 UTC 26 April to 0000 UTC 27 April. At 0600 UTC 27 April, the ship **WCX8884** (name unknown) at 51N 139W reported north winds of 50 kts and 11.5 m (37 ft) seas. The **Sea-Land Trader** (**KIRH**) nearby at 50N 139W encountered 55 kt north winds. Figure 11 is a GOES10 infrared satellite image of the storm at maximum intensity, with cloud bands spiraling in around a well-defined center.

Reference

Joe Sienkiewicz and Lee Chesneau, *Mariner's Guide to the 500-Mb Chart* (Mariners Weather Log, Winter 1995).⚓

Marine Weather Review
Tropical Atlantic and Tropical East Pacific Areas—January through April 2000

Dr. Jack Beven
National Hurricane Center

Daniel Brown
Christopher Burr
Tropical Analysis and Forecast Branch
Tropical Prediction Center
Miami, Florida

I. Importance of Ship Observations

Most marine forecasts are prepared for areas several times larger than most National Weather Service public or aviation forecasts. However these marine areas contain far less data than found in any public or aviation forecast area. In many instances the lack of data makes marine forecasting much more difficult. Since observations are more sparse over marine areas, the quality of these observations are extremely important. At the Tropical Prediction Center (TPC), buoy observations along the southeast United States coast and in the Gulf of Mexico are a very valuable data source, but over the vast open ocean ship observations are an extremely important forecast tool. Accurate, timely, ship observations are extremely important, as a single observation can become a very valuable piece of information.

When the marine forecaster at the TPC prepares a forecast, the first thing he or she examines is a surface map containing all observations within the forecast area. The wind and pressure, along with the wind wave and swell heights are carefully analyzed. If the ship's observation appears to be in error, the last few observations from the ship or additional ships or buoys nearby will be examined. (Editors Note: Errors may be the result of faulty instrument calibration, inadequate observer training, human error, or communications errors. To ensure accurate data, ships should have their instruments calibrated regularly, and measurements should be taken from the appropriate location aboard ship. Anemometers should be located as far forward as possible to reduce interference from the moving vessel. Obtain temperature readings from the windward side of the ship. Code your data very carefully, especially vessel location and position information in section 1 of the ships synoptic code. Contact a Port Meteorological Officer for assistance or refer to NWS

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Observing Handbook No. 1 for more information).

If the ship's observations constantly seems to be in error then the ship's observation will most likely be disregarded. If the ship is very reliable but one observation seems incorrect, the ship's observation will be examined more closely. For example, if a ship reports very high winds compared to ships or buoys nearby, the reported weather may be studied for thunderstorms or other weather occurrences which may explain the stronger winds. The forecaster may check the ship's observations for a 24-hour period or compare it with other nearby ships that have reported. Additional satellite data sources such as Special Sensor Microwave/Imager ([SSM/I], an instrument on Defense Meteorological Satellites program [DMSP] satellites which measures surface wind speed), Earth Remote Sensing (ERS-2) satellite Scatterometer data (measuring wind speed and direction), or Quikscat (a National Aeronautical and Space Administration satellite equipped with scatterometers), may be used to check the questionable observation. A gale event in October showed a great example of how an ERS Scatterometer pass aided in determining the reliability of a questionable, but accurate, ship report. At 0000 UTC 21 October the **President Arthur** reported 48 kt winds in the southwest Bay of Campeche. At the time the observation seemed a little on the high side, but an ERS scatterometer pass from 1646 UTC October 20, verified the presence of 40-45 kt winds in the extreme southwestern Gulf of Mexico. The combination of the ship observation and the scatterometer data helped forecasters to verify and continue the gale warning.

When a ship observation appears inaccurate, forecasters will not discredit a ship's observation unless they are completely sure that the observation is clearly in error. An example of a ship observation which appears to be reporting too high winds and seas was recently noted in the eastern Gulf of Mexico (Figure 1). In this situation it is rather obvious that the ship near 27N 86W (east winds of 25 kt and 5 meter (16 ft) seas was clearly in error. Several ships and buoys nearby reported winds of 10 to 15 kts and seas of 1 to 2 m (2 to 6 ft). In this situation it was clear that the ship observation could be eliminated when completing a wind and seas analysis.

An example of when it is difficult to determine the accuracy of ship observations is shown in Figure 2. In this situation three ship observations within 120 nm of each other reported wind speeds of 10 kt, 25 kt, and 35 kt at the same time. The three ships also reported sea heights of 2.5 to 6 m (8 to 19 ft). In this case, satellite derived wind data such as ERS Scatterometer or Quikscat can help to determine the accuracy of the observations. But if satellite derived data is not available the forecaster would likely smooth or "average" the observations to make an "educated guess" about the current wind speeds and sea heights. Situations like this make marine forecasting even more difficult, because it makes it very hard for forecasters to determine current conditions which are needed to make more accurate marine forecasts.

In certain situations, one or two ship observations may significantly impact a future forecast or warning situation. During tropical cyclone events, forecasters request three-hourly ship reports within 300 nm of the center, as forecasters value such timely ship observations near developing gales or tropical cyclones. In some instances a single ship observation may influence a forecaster to issue a gale or storm warning or to warn of a tropical cyclone. An example of this occurred last year during development of Hurricane Greg in the eastern Pacific Ocean. On 5 September 1999 cloud patterns indicated that an area of disturbed weather just off the coast of Manzanillo, Mexico, had become better organized and a tropical depression formed at 1200 UTC (Avila, 1999). At 1800 UTC 5 September the ship **Hume Highway** reported southwest winds of 42 kts and a pressure of 1006.5 mb. Based on this observation, the tropical depression was upgraded to Tropical Storm Greg (Avila). Greg later became a hurricane on 6 September and then weakened to a tropical storm as it passed over Cabo San Lucas on 7 September.

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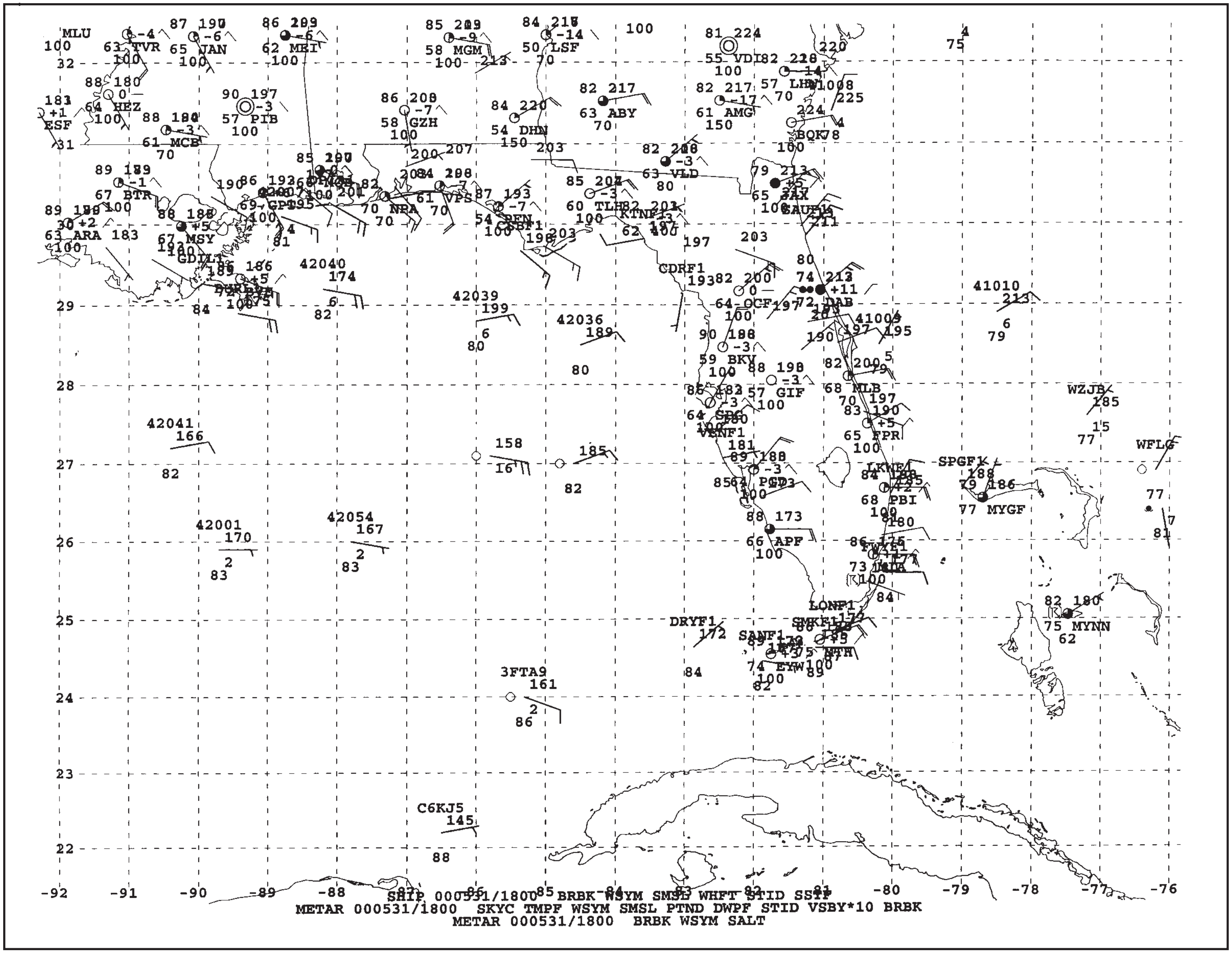

Figure 1. Example of a ship observation clearly in error in the central Gulf of Mexico.

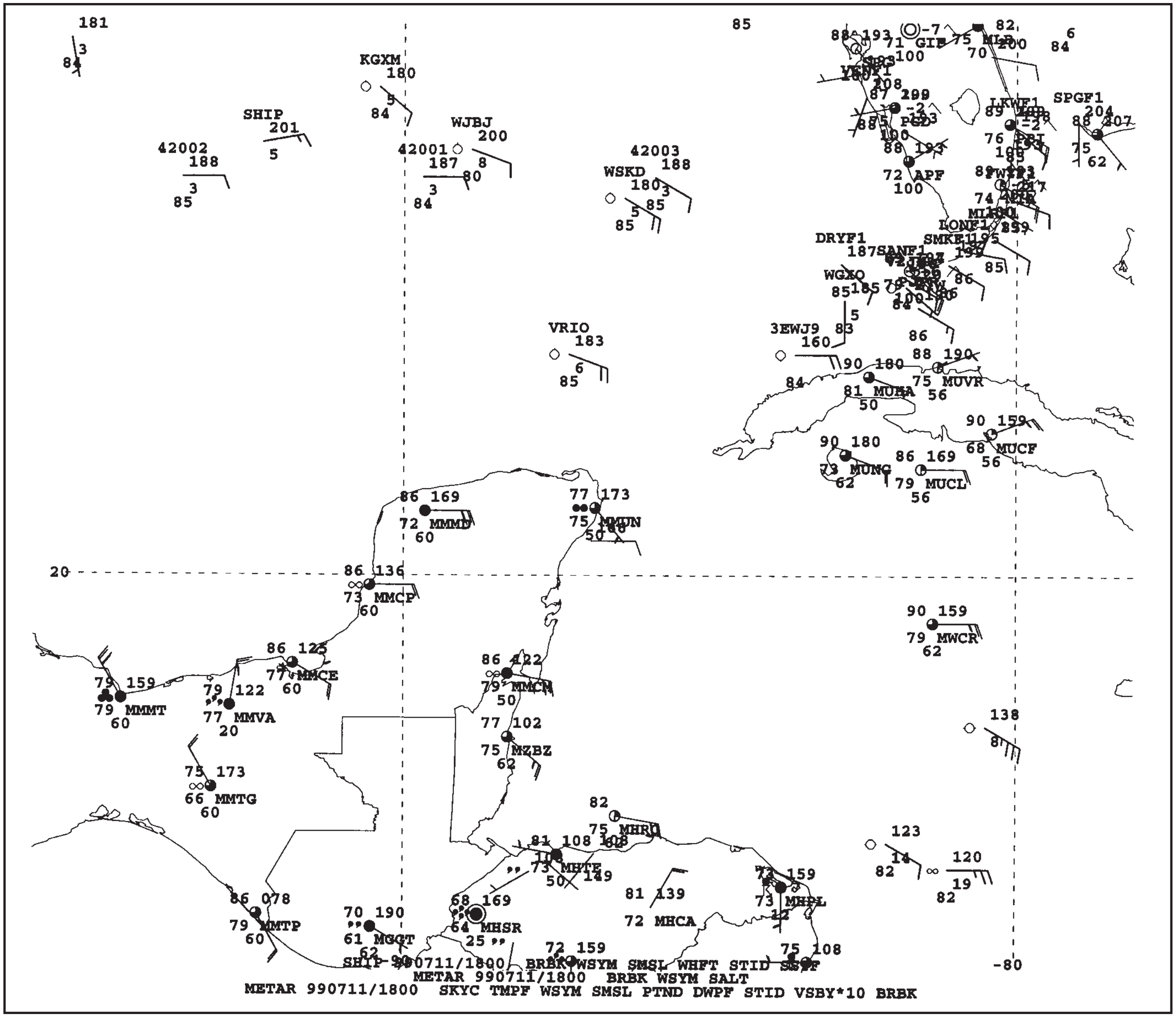

Figure 2. Example of three questionable ship observations in the northwest Caribbean Sea.

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In this case the observation from the **Hume Highway** was very valuable because it indicated a tropical storm had formed. The value and reliability of this single observation aided the forecaster in determining the strength and location of the tropical cyclone.

Sometimes ship observations are cleary in error and can be discounted immediately. In other instances ship observations must be examined closely by the forecaster to determine if they are accurate. However, the majority of ship observations are very reliable and are used to determine the strength and location of gale, storm, or tropical cyclone circulation centers. Many times ship observations are also used to determine the radius of gale or storm force winds. While marine and tropical cyclone forecasting is intended to keep mariners well away from gales, storms, or tropical cyclones, sometimes rapidly developing or moving systems do not allow time for ships to get out of a storms path. When a ship takes a weather observation, the data is valuable and important, because at some point their observation could be the most significant piece of information a forecaster attains.

II. Significant Weather of the Period

A. Tropical Cyclones: None.

B. Other Significant Events:

1. Atlantic, Caribbean and Gulf of Mexico

The winter months of 2000 were quite active in terms of non-tropical gale warnings. In early January a strong cold front and high pressure center produced gales in the Gulf of Mexico and storm conditions in the Gulf of Tehuantepec. Later in January a series of cold fronts moved off the east coast of the United States producing gale conditions over the western Atlantic. In February and March, a few gale centers developed in the central and eastern Atlantic. The most significant gale and brief storm event of the period occurred over the central Atlantic on 25-28 February.

Strong Gulf of Mexico Cold Front 4-5 January: On the afternoon of 3 January, 2000, a cold front moved off the Texas coast into the northwest Gulf of Mexico. As the cold front continued southeast on 4 January a strong high pressure ridge built over the western Gulf of Mexico. By 1200 UTC 4 January the cold front extended from the Florida Panhandle to near Veracruz Mexico. Northwest to north winds of 25 to 30 kts covered the Gulf northwest of the front. Over the extreme southwest Gulf of Mexico winds were expected to become northerly at 30 to 40 kts for about an 18 hour period beginning at 1200 UTC. At 1800 UTC 4 January the high pressure center moved into central Texas and the cold front extended from the northeast Gulf into the Bay of Campeche. Veracruz along the immediate coast of Mexico reported gale force sustained winds with gusts well over storm force during the afternoon of 4 January. A ship (name unknown) at 1800 UTC 4 January near 20N 95W encountered northerly winds of 40 kts. At 0600 UTC 5 January winds over the southwest Gulf of Mexico decreased to below gale force, however 20-25 kt winds continued for another 12 to 24 hours.

Strong Atlantic and Caribbean Cold Front 15-17 January: A strong fast-moving cold front moved off the southeast United States coast on the afternoon of 13 January. The front moved rapidly southeast as a strong high pressure center built over the eastern United States. At 0000 UTC 15 January the front extended from 31N 62W across central Cuba to the Yucatan Peninsula. Gale conditions were forecast within 240 nm west of the cold front. An area of gale force winds was also expected in the Caribbean Sea north of 16N from near Jamaica and the Windward Passage east to the Mona Passage. The front was very impressive in visible satellite imagery (Figure 3) as cold air stratocumulus clouds covered the western Atlantic and northwest Caribbean Sea. Quikscat data from 2313 UTC 15 January (Figure 4) indicated winds of 35 to 40 kts from the Windward Passage south to between eastern Jamaica and western Haiti. By 1200 UTC 16 January the cold front extended from 31N 48W through the Leeward Islands into the extreme

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eastern Caribbean. At that time the ship **Green Island** near 30N 56W reported northwest winds of 40 kts and the **Geeta** encountered northwest winds of 33 kts near 29N 55W.

At 1200 UTC 17 January the front extended from 31N 41W to just east of the Leeward Islands. By that time the high pressure center weakened and gale conditions ended. However, several ships in the Atlantic, including the **Mormacstar** and the **Humbergracht**, reported northerly swell heights of 13 to 16 ft between the cold front and 65W. In the eastern Caribbean the ships **Baltic Universal** and **ZCBJ6** (name not available) reported 4 m swells (13 ft). Swell heights across the west-central Atlantic remained around 3 m (8 to 10 ft) for the next several days.

Series of Atlantic Gales and Cold Fronts 18-27 January: During a ten day period in mid to late January a longwave trough became established along the East Coast of the United States. During the period several gale centers developed off the southeast United States coast and moved northeast. The trailing cold fronts produced very wintry conditions across the Eastern United States and several areas of gale force wind south of 31N. Five separate cold fronts produced gale conditions as they swept off the southeast U.S. coast. The gale conditions generally

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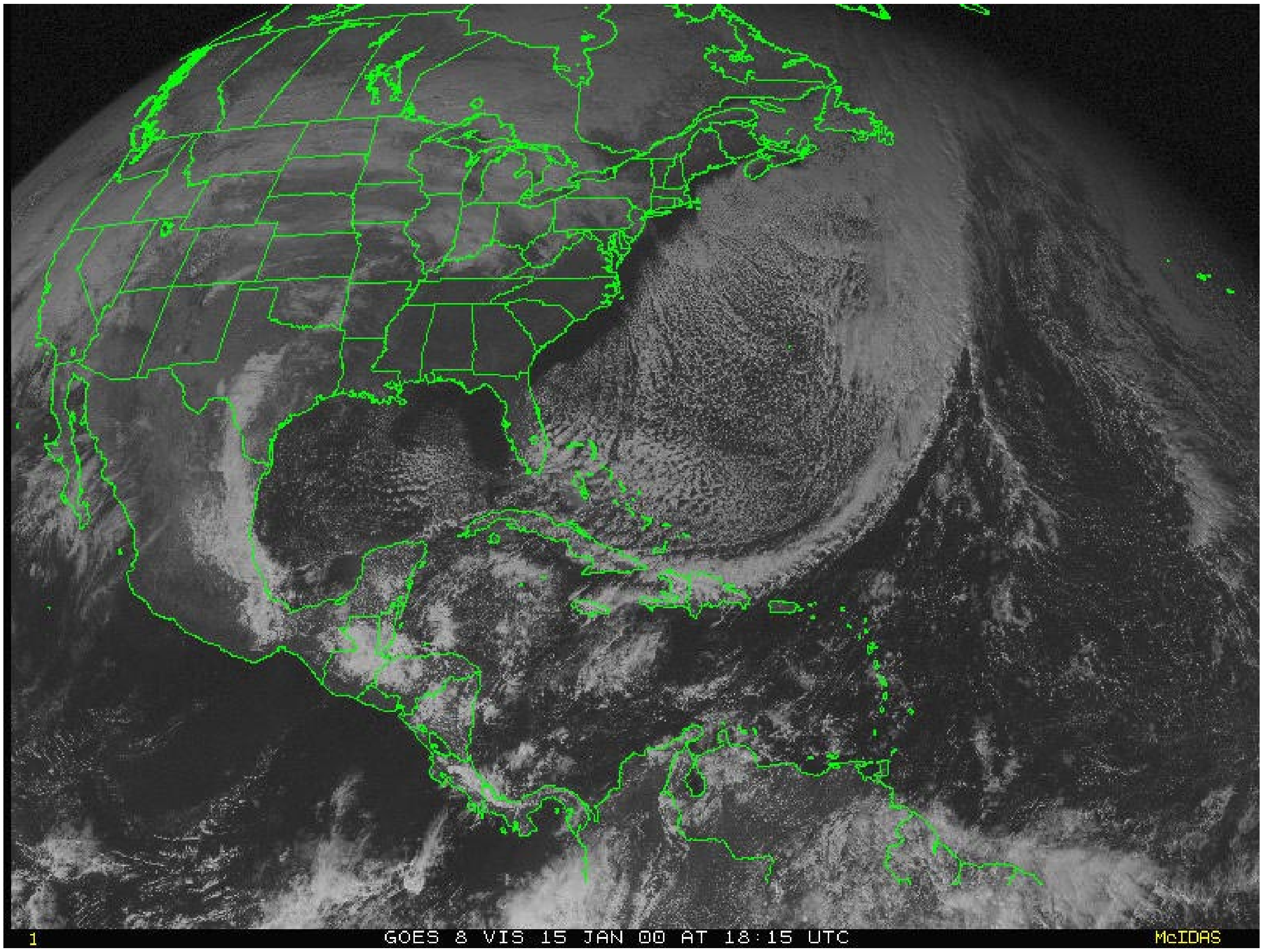

Figure 3. GOES-8 visible image of strong Atlantic and Caribbean cold front at 1815 UTC 15 January 2000. Image courtesy of the National Climatic Data Center.

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remained north of 28N and west of 60W with the duration of the gale events ranging from 18 to 42 hours. The first event occurred from 1200 UTC 17 January to 1200 UTC 18 January. During this event the ship **Fidelio** reported northwest winds of 34 kts and combined seas of 6 m (20 ft) at 0600 UTC 18 January. The second event begin at 0600 UTC 19 January and ended at 1200 UTC 20 January. The third event lasted 36 hours from 1200 UTC 24 January to 0600 UTC 26 January.

The fourth event began as a low pressure system developed along the northern Gulf Coast early on 24 January. The low tracked quickly towards the east and became a gale center at 1200 UTC 24 January. At 1800 UTC January 24 the 1002 mb gale center was centered near 32N 78W with a cold front trailing across south

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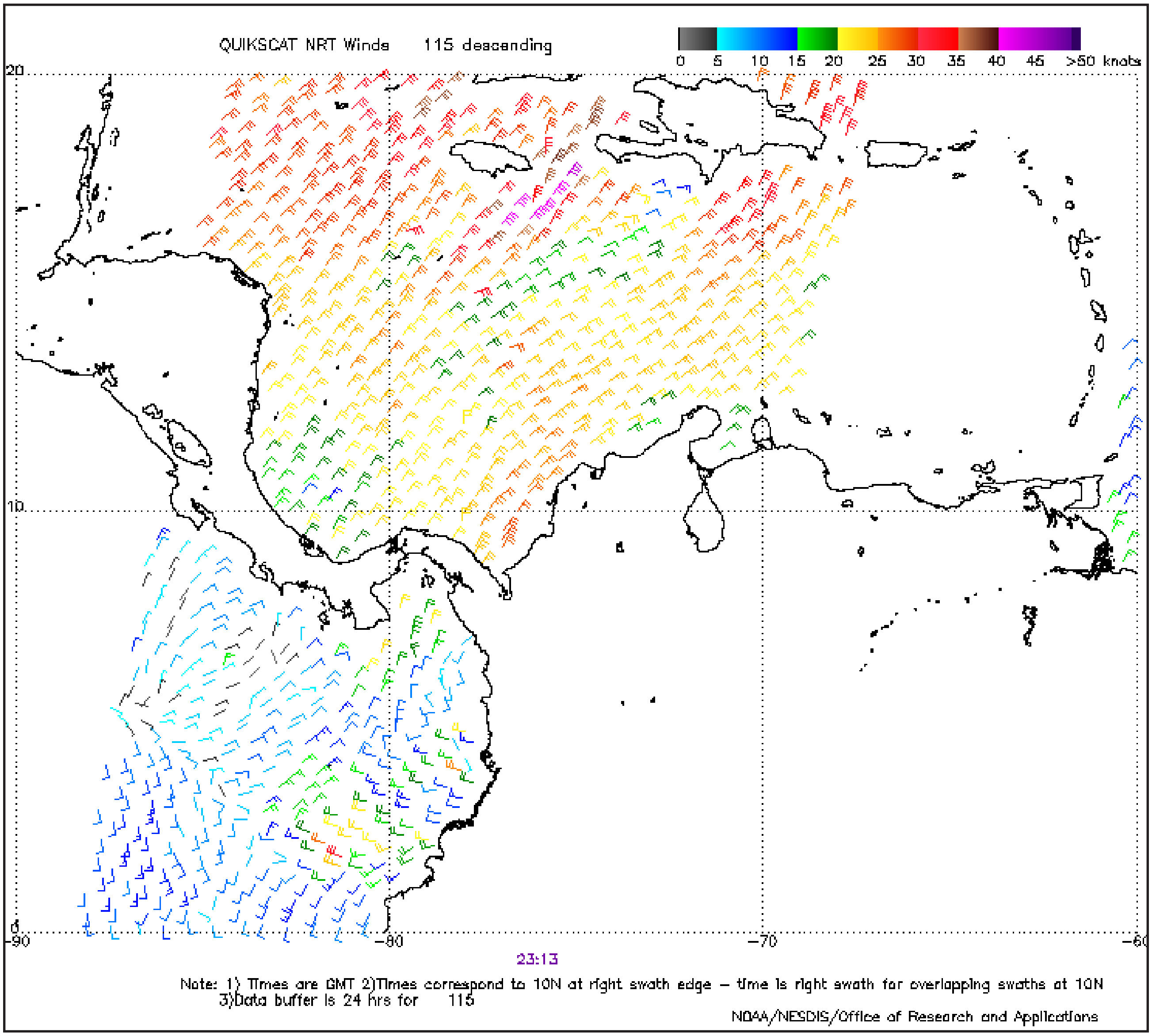

Note: 1) Times are GMT 2)Times correspond to 10N at right swath edge – time is right swath for overlapping swaths at 10N
3)Data buffer is 24 hrs for 115

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Figure 4. Quikscat data for 15 January 2000. Image courtesy of National Environmental Satellite, Data, and Information Service.

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Florida. Gale warnings were in effect north of 26N west of 65W. At 0600 UTC 25 January the ship **Vega** just east of the cold front observed south winds of 34 kt near 29N 73W. The gale center moved northeast and rapidly strengthened into a 981 mb storm center just off the North Carolina Coast by 1200 UTC 25 January. At that time the ship **Rani Padmini** near 31N 70W reported south winds of 34 kts just east of the cold front. Gale conditions continued along the cold front until 0600 UTC 26 January. Several ships in the western Atlantic reported combined seas of 3 to 4.5 m (10 to15 ft) including the ship **8PNK** (name unknown) which observed combined seas of 5 m (17 ft) at 1200 UTC 25 January.

The final event occurred as a cold front moved into the western Atlantic on 26 January. Gale conditions occurred from 1200 UTC 26 January to 1200 UTC 27 January. At 1800 UTC 26 January several ships in the western Atlantic reported gale force winds. The **Edyth L.** encountered 38 kt winds at 28N 73W and the ship **Fantasy** near 26N 78.5W observed 34 kt winds. The drifting buoy 41651 near 31N 78.5W reported 33 kt wind at 1800 UTC 26 January and 0000 UTC 27 January.

East Atlantic Gale 31 January - 02 February: At 1200 UTC 31 January a gale center was located near 37N 45W. The gale center was forecast to move east-southeast and remain north of 31N. However, gale conditions were expected well southwest of the center. Late on 31 January a gale warning was issued north of 29N between 35W and 45W. At 0600 UTC 1 February the 999 mb gale center was centered near 36N 36W. The ship **Sugar Islander** encountered 40 kt winds and 5 m (16 ft) combined seas near 29N 39W at 0600 UTC. A Quikscat pass at 0839 UTC 1 February detected a large area of 30 to 35 kt winds over the western semicircle of the gale center. At 1800 UTC 1 February the ship **Lykes Challenger** observed 34 kt winds near 32N 45W. The gale center then moved east-southeast and at 0600 UTC 2 February gale warnings were discontinued south of 31N. Large northerly swells of 3.5 m (9 to 12 ft) continued over the east-central Atlantic until 4 February.

Atlantic Gale and Storm 25-28 February: The longest and perhaps most significant gale event during winter months of 2000 developed in the west-central Atlantic in late February. At 1200 UTC 24 February, a 1017 mb low pressure system developed near 27N 60W along the remnants of an old stationary front. The developing low was expected to move slowly northeast and intensify into a gale center. At 1200 UTC 25 February the low pressure center became a 1008 mb gale center near 29N 56W. By 1800 UTC several ships in the area from 25N to 30N between 50W and 60W observed winds of 25 to 35 kts with the ship **Nedlloyd Clement** observing northerly winds of 36 kts just northwest of the gale center. It became apparent that a strong high pressure ridge would build over the western Atlantic creating a strong pressure gradient across the northwest quadrant of the gale.

At 1200 UTC 26 February the gale become a 1005 mb storm center near 30N 52W. The area of storm force winds were forecast to occur along and north of 31N. As the ship **Nedlloyd Clement** continued to move north, it observed winds of 49 kts at 1800 UTC February 26 and 47 kt at 0000 UTC 27 February. Southeast of the storm center the ship **MRSS8** (name not available) reported winds of 40 kts near 28N 46W and the ship **Douce France** observed winds of 34 kts near 25N 47W between 0000 UTC and 0600 UTC 27 February. By 1200 UTC 27 February with the lack of storm force observations the storm center was reclassified as a 1005 mb gale center near 31N 46W. A Quikscat pass at 2148 UTC 27 February (Figure 5) clearly detected the center of the gale near 33N 46W. The Quikscat pass was a tremendous forecast aid as the pass clearly detected the circulation center and an area of 35 to 45 kt winds within about 300 NM of the center over the northwest semicircle. This data indicated that most of the area of gale force winds were north of the 31N and at 0600 UTC 28 February gale warnings were discontinued. Large northerly swells of 3 to 4.5 m (10 to 15 ft) were observed north of 20N between 45W and

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62W on the 27 February and slowly subsided around 3 m (10 ft) by 29 February.

Additional Gale Events: Several short-term gale events occurred during the period. A very brief Gulf of Mexico gale event occurred when a 1015 mb low pressure center developed late on 27 January along the coast of Texas, then tracked across the northern Gulf Coast on 28 January. Brief gale conditions occurred on 28 January over the extreme northern Gulf of Mexico along the coast of southeast Louisiana, Mississippi, and Alabama.

Also on 27-28 January a gale center moved southeast and gale conditions were expected from 26N to 31N between 35W and 42W. At 1200 UTC 27 January the ship **Horncloud** observed northerly winds of 40 kts and combined seas of 4.5 m (15 ft) near 31N 41W. At 1800 UTC 28 January the gale center had moved far enough northeast that gale conditions had ended south of 31N.

In February a short-lived gale event occurred in the west Atlantic as a low pressure system developed off the north Florida Coast. Early on 10 February the low moved slowly northeast and developed into a 1004 mb gale center off the coast of South Carolina. Gale conditions were briefly experienced north of 29N between 72W and 78W. The gale center continued to move slowly north and gale conditions ended south of 31N by late on 10 February.

On 4 March a low pressure system moved east-northeast across the southeast United States. The low pressure system exited the coast of South Carolina at 1800 UTC 4 March. At 0600 UTC 5 March the low center developed into a 1002 mb gale center near 33N 71W with a cold front trailing to southeast Florida. Gale conditions were forecast north of 29N within 360 nm east of the cold front. At 1800 UTC 5 March the gale center was located near 34N 61W with the cold front trailing into the Straits of Florida. At 0000 UTC 6 March the ship 3FRY9 (name not available) just east of the cold front encountered southwest winds of 36 kts near 29N 54W. At 0600 UTC 6 March as the gale center moved well north of 31N gale conditions ended.

In late March a strong cold front produced gale conditions over the extreme western Atlantic. As a storm center developed off the coast of the northeast United States, a trailing cold front moved off the southeast United States coast early on 28 March. Ahead of the cold front, an area of gale force wind was located north of 28N west of 72W for a twelve-hour period from 0600 UTC to 1800 UTC 28 March.

2. Eastern Pacific

This area was affected by three storm events and three gale events in the Gulf of Tehuantepec (and surrounding waters), and three cold fronts that moved rapidly eastward across 30N.

Gulf of Tehuantepec: All the Gulf of Tehuantepec events resulted from north to northeast winds passing through the Isthmus of Tehuantepec behind strong cold fronts that moved east and southeast across the Gulf of Mexico. These events were verified by SSMI and Quikscat data and occasionally by reliable ship reports. Each event lasted two to three days except the five-day event from 14-18 January.

The first (05-06 January), second (14-18 January), and fifth (04-06 April) events were the strongest of the six. All of these produced storm force winds. The first event was marked by a strong pressure gradient between a cold front and a 1036 mb high that moved northeast across Texas into the south central United States. Gale force winds first began at approximately 0000 UTC 05 January (after being forecast for 30 hours) and then intensified to storm force winds for six hours beginning 0600 UTC 05 January and then weakened to gale force winds until 0000 UTC 06 January. The ship **Heidelberg Express** reported 40 kt north winds near 14N 96W at 0600 UTC 05 January.

The second event began approximately on 14 January and was marked by a strong pressure gradient extending from the south central United States (1044 mb High over Missouri, Illinois, and

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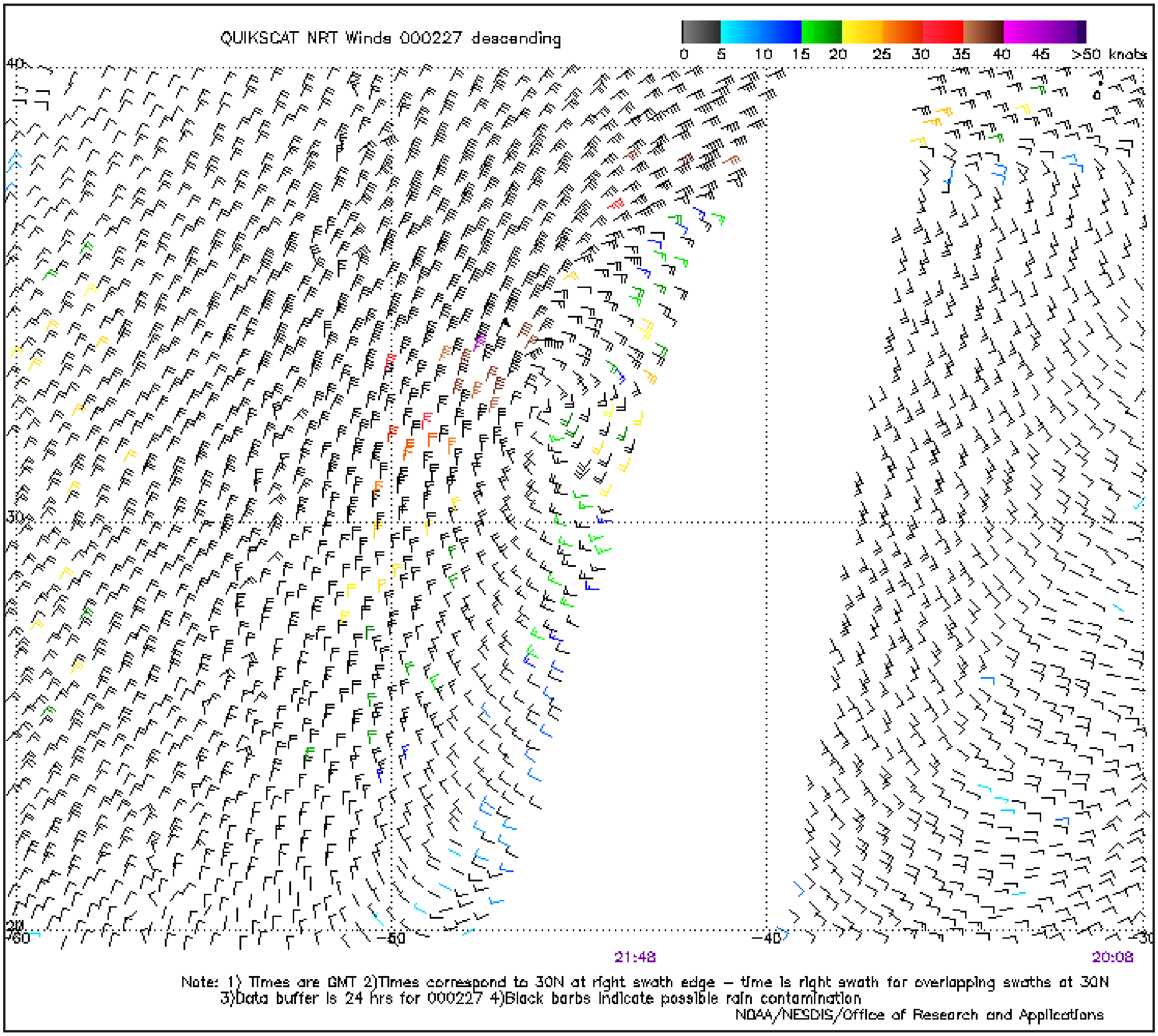

Note: 1) Times are GMT 2)Times correspond to 30N at right swath edge – time is right swath for overlapping swaths at 30N
3)Data buffer is 24 hrs for 000227 4)Black barbs indicate possible rain contamination
NOAA/NESDIS/Office of Research and Applications

Figure 5. Quikscat data for 27 February 2000. Image courtesy of National Environmental Satellite, Data, and Information Service.

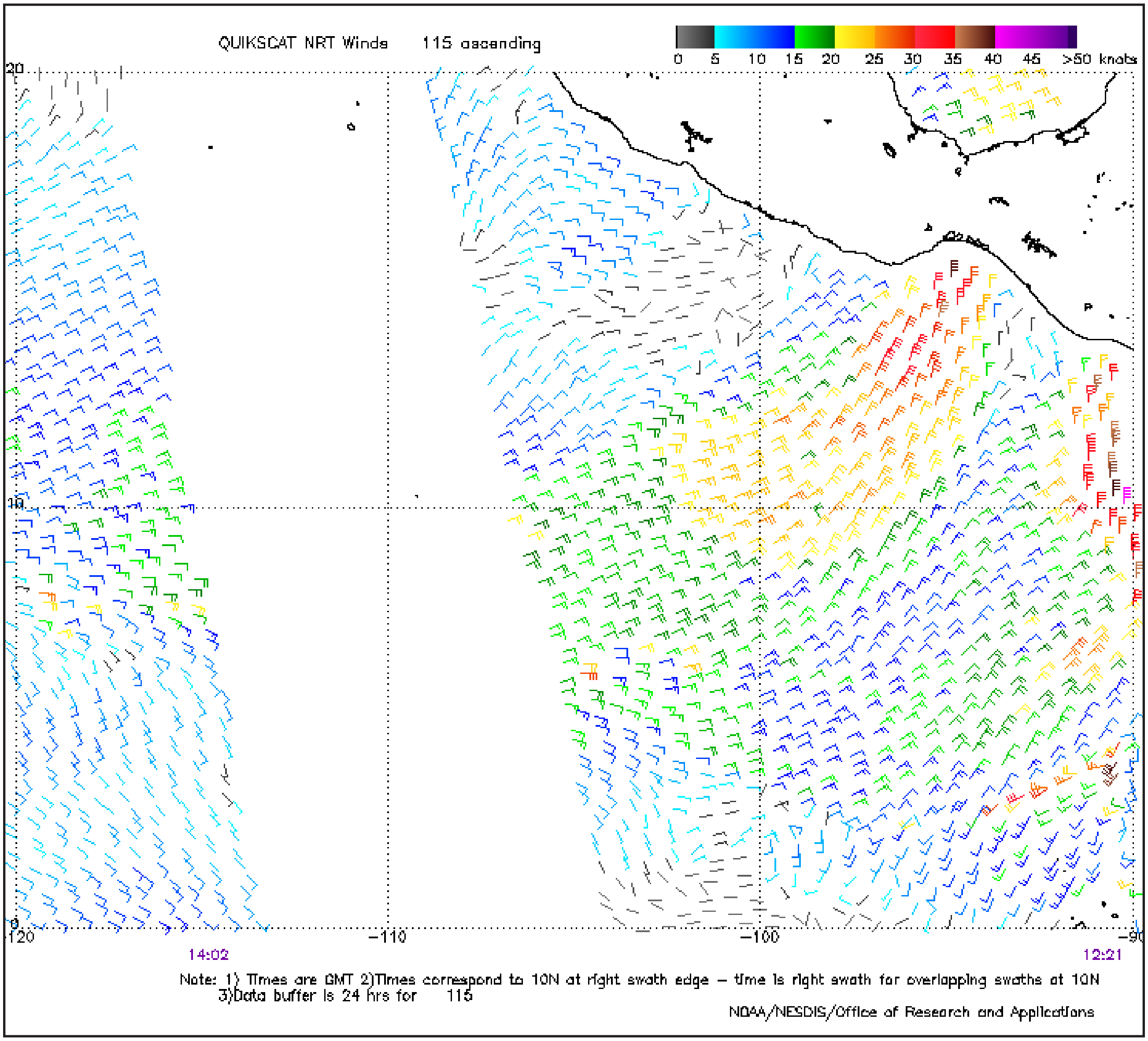

Figure 6. Quikscat data for 15 January 2000. Note that wind data along the eastern edge of the Quikscat pass (90W-92W) are unreliable. Image courtesy of National Environmental Satellite, Data, and Information Service.

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Kentucky) southward across the Gulf of Mexico and continuing south of Mexico and Central America. The accompanying cold front moved rapidly southeast across the Gulf of Mexico into the northwest and central Caribbean (this cold front moved as far south as the northern tip of South America!). Gale force winds first began at 1200 UTC 14 January (after being forecast for 36 hours) and storm force winds began at 0000 UTC 15 January and continued for 18 hours. Gale force winds continued beyond this time until 0600 UTC 18 January. It should be noted that gale and near gale conditions were experienced from south of Central America and Mexico to 10N east of 105W including the Gulf of Papagayo (up to 400- 500 nautical miles). The ship **Queen Elizabeth 2** reported 49 kt north northeast winds and 5 m (16 ft) combined seas near 14.6N 96.1W at 0000 UTC 15 January. Figure 6 shows the strong winds over the Gulf of Tehuantepec from a Quikscat pass at approximately 1200 UTC 15 January.

The fifth event began 04 April and was marked by a pair of cold fronts that moved rapidly southeast across the Gulf of Mexico into the northwest Caribbean. A 1030 mb high was located west of the frontal boundaries at 1800 UTC 04 April (that eventually merged) over east Texas, then moved east into the central Gulf of Mexico and east northeast across central Florida. Gale force winds first began at 1800 UTC 04 April (after being forecast for 30 hours) and then storm force winds nine hours later (after being forecast for 15 hours). Storm conditions continued until 1200 UTC 05 April and then gale conditions until 0000 UTC 06 April.

Cold Fronts and Gale Conditions of 03-04 February, 05-07 February, and 20-21 February: A strong cold front entered the forecast area from the northwest on 0000 UTC 04 February and continued rapidly eastward until 0000 UTC 06 February and then gradually dissipated. Gale force winds covered the forecast area for 30 hours (beginning 1800 UTC 03 February) within 420 nautical miles (later reduced to 180 nautical miles) east of the cold front from 27N to 30N (near gale force winds were encountered by several ships west of the cold front). Several ships reported gale force winds with the strongest report from the ship **Takamine** which encountered 39 kt southwest winds near 28.4N135.8W at 0000 UTC 04 February.

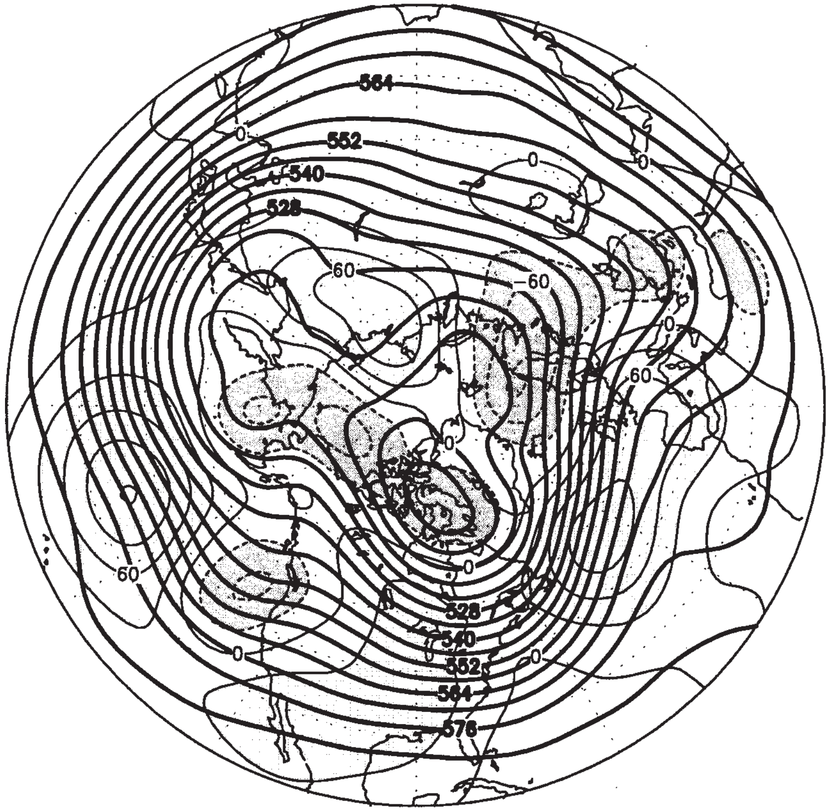
The second cold front entered the forecast area on 1800 UTC 05 February and continued eastward for the next two and a half days and then gradually dissipated. Gale force winds within 240 nautical miles east of the cold front north of 27N first began on 1800 UTC 05 February and continued until 0600 UTC 07 February. In addition, gale force winds within 240 nautical miles west of the cold front north of 28N first began on 1800 UTC 06 February and continued for 12 hours. The ship **Sealand Discovery** encountered several gale and near gale force winds and combined seas to 5 m (17 ft) west of the cold front. The ship **Sealand Hawaii** encountered several minimal gale force winds and combined seas to 5m (17 ft) east of the cold front. The ship **APL Thailand** encountered 32 kt south winds and 3 m (10 ft) combined seas near 29.9N 138.5W at 1800 UTC 05 February.

The third cold front entered the forecast area on 0000 UTC February 20 and moved rapidly eastward entering northern Baja, California, on 1800 UTC 21 February (associated storm center was located north of the area). Gale force winds were located within 300 to 480 nautical miles west of the cold front from 28N to 30N for 18 hours beginning 1800 UTC 20 February. The ship **Advantage** encountered 33 kt north winds and combined seas 4 m (13 ft) near 29.6N 138.4W at 1800 UTC 20 February. The ship **Pearl Ace** encountered 33 kt northwest winds (seas not available) near 28.6N 133.3W at 0600 UTC 21 February and 33 kt west winds and 2 m (7 ft) combined seas near 27.0N 129.9W at 1800 UTC 21 February.

III. References

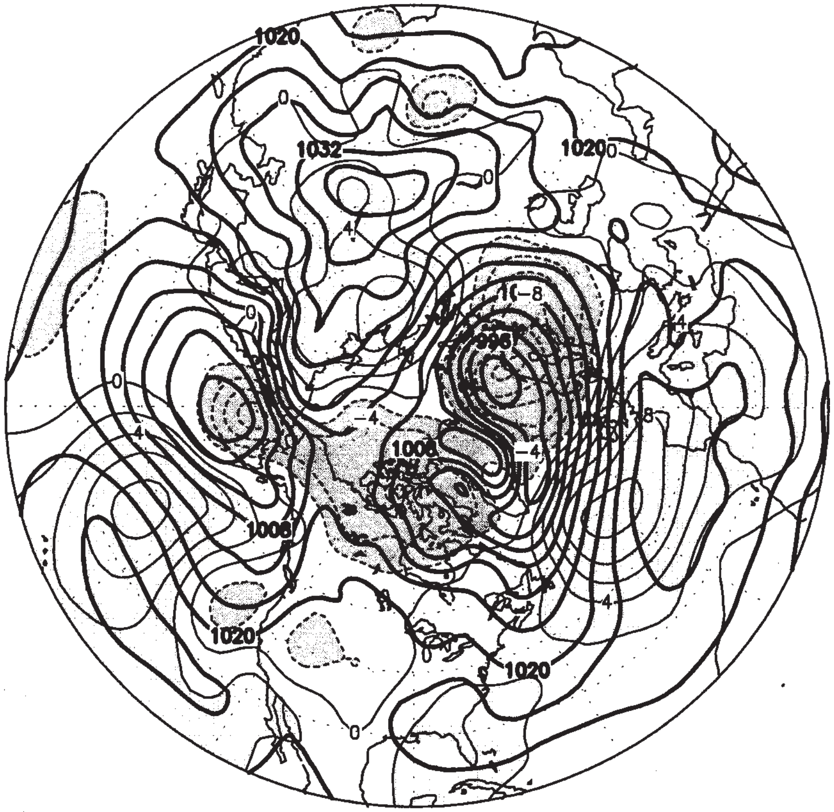
Avila, L.A.,1999. Preliminary Report: Hurricane Greg 5-9 September 1999. NOAA/NWS/ National Hurricane Center.⚓

January–February 2000



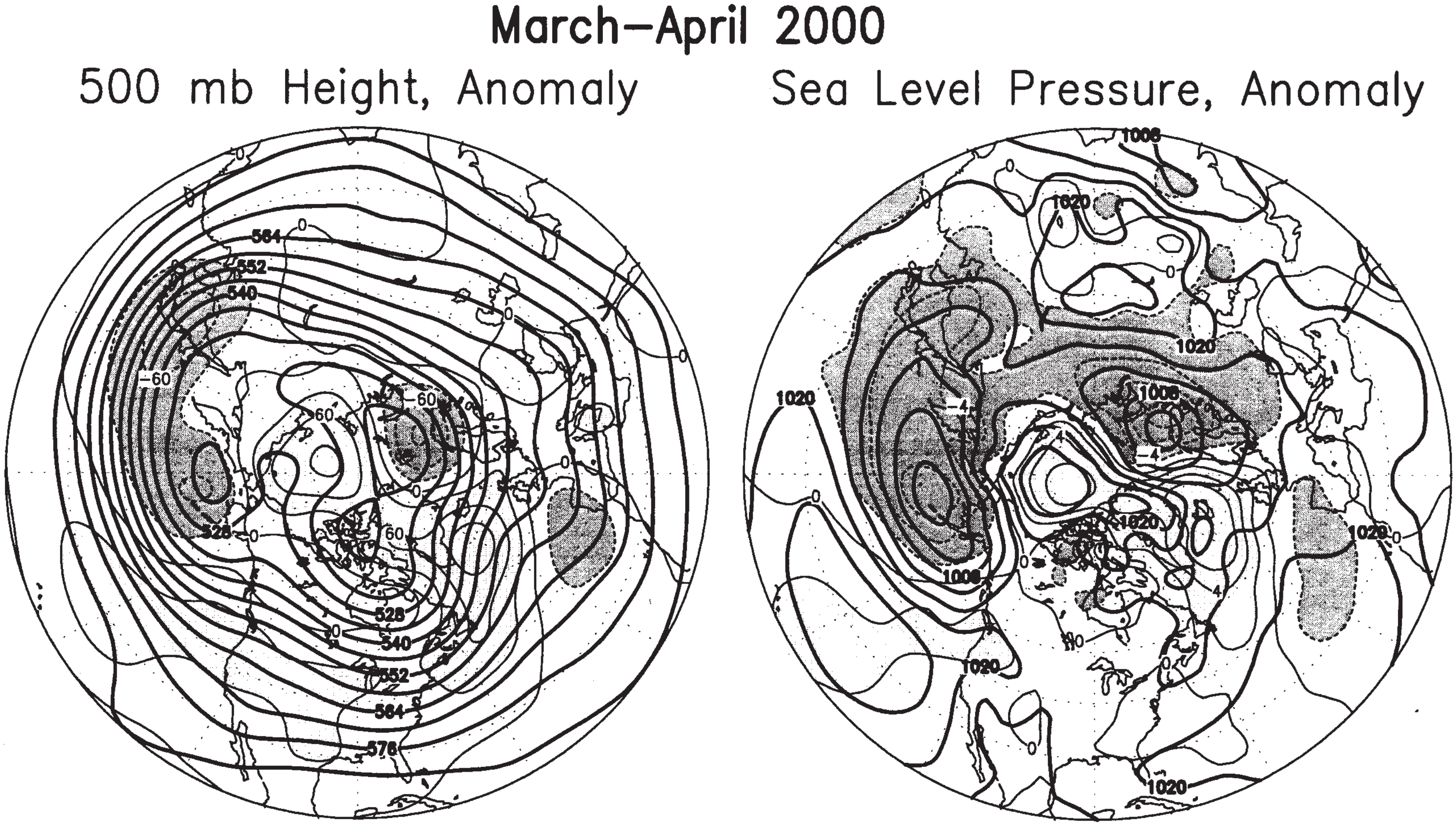
500 mb Height, Anomaly

The chart on the left shows the two-month mean 500-mb height contours at 60 m intervals in solid lines, with alternate contours labeled in decameters (dm). Height anomalies are contoured in dashed lines at 30 m intervals. Areas where the mean height anomaly was greater than 30 m above normal have light shading, and areas where the mean height anomaly was more than 30 m below normal have heavy shading



Sea Level Pressure, Anomaly

The chart on the right shows the two-month mean sea level pressure at 4-mb intervals in solid lines, labeled in mb. Anomalies of SLP are contoured in dashed lines and labeled at 2-mb intervals, with light shading in areas more than 2 mb above normal, and heavy shading in areas in excess of 2 mb below normal.



The chart on the left shows the two-month mean 500-mb height contours at 60 m intervals in solid lines, with alternate contours labeled in decameters (dm). Height anomalies are contoured in dashed lines at 30 m intervals. Areas where the mean height anomaly was greater than 30 m above normal have light shading, and areas where the mean height anomaly was more than 30 m below normal have heavy shading

The chart on the right shows the two-month mean sea level pressure at 4-mb intervals in solid lines, labeled in mb. Anomalies of SLP are contoured in dashed lines and labeled at 2-mb intervals, with light shading in areas more than 2 mb above normal, and heavy shading in areas in excess of 2 mb below normal.

Improved Estimates of Swell from Moored Buoys

David Gilhousen
National Data Buoy Center
Stennis Space Center, Mississippi

Rex Hervey
National Data Buoy Center Technical Services Contractor
Stennis Space Center, Mississippi

The National Data Buoy Center (NDBC) improved the estimates of swell and wind-driven sea heights and periods given on its web site, **http://www.ndbc.noaa. gov**, beginning in June 2000. These estimates will appear in the World Meteorological Organization's FM-13 code just like a ship report and plot on weather maps starting in approximately November 2000.

NDBC began posting buoy estimates of swell height and period in 1997 because of numerous requests from mariners. Until then, only significant wave height, dominant period, and spectral wave data were posted on its web site. Knowledge of swell and wind-driven sea are important for a wide variety of commercial and recreational marine interests, such as design of offshore moorings and structures, beach erosion studies, and surf forecasting. Though this knowledge can be gleaned from spectral wave data, many mariners do not have the time or experience to do so.

The best methods to estimate the swell and wind-driven sea could not be used since they required wave direction, a quantity that many NDBC buoys do not measure. As a result, NDBC developed a method based on wave steepness which requires only nondirectional wave data. This method determines a period to separate the wind-driven seas from the swell based on the knowledge that wind seas are steeper than swell and that maximum steepness occurs near the peak period of the wind-waves. The method had been used to estimate wind-driven sea and swell on the NDBC web site since 1997. However, it underestimates the swell when winds are light or abating.

To improve performance, the steepness method was modified to limit the maximum allowable separation period based on the observed wind speed. This is

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Improved Estimates of Swell

Continued from Page 60

possible because sustained winds can build waves with ever increasing heights and periods only up to a certain point. If the winds are sustained long enough, a point will be reached where wind and wave propagation speeds are approximately equal. The wind can exert no further force on the waves, and wind-seas are said to have become fully-developed. Since peak frequencies of fully-developed seas generated by a given wind speed are well known, this relationship can be used to set an upper limit on the separation period.

Positive results were obtained in tests of the modified method using measurements from directional buoys where swell and wind-seas can be easily identified by differences in propagation direction. Improved results were also obtained when the modified method was compared with wind-driven sea and swell estimates from the Navy's operational wave model (WAM), shown in Figure 1. While the modification presents a slight disadvantage in that it requires wind speed information, satisfactory results are obtained without knowledge of wave direction. ⚓

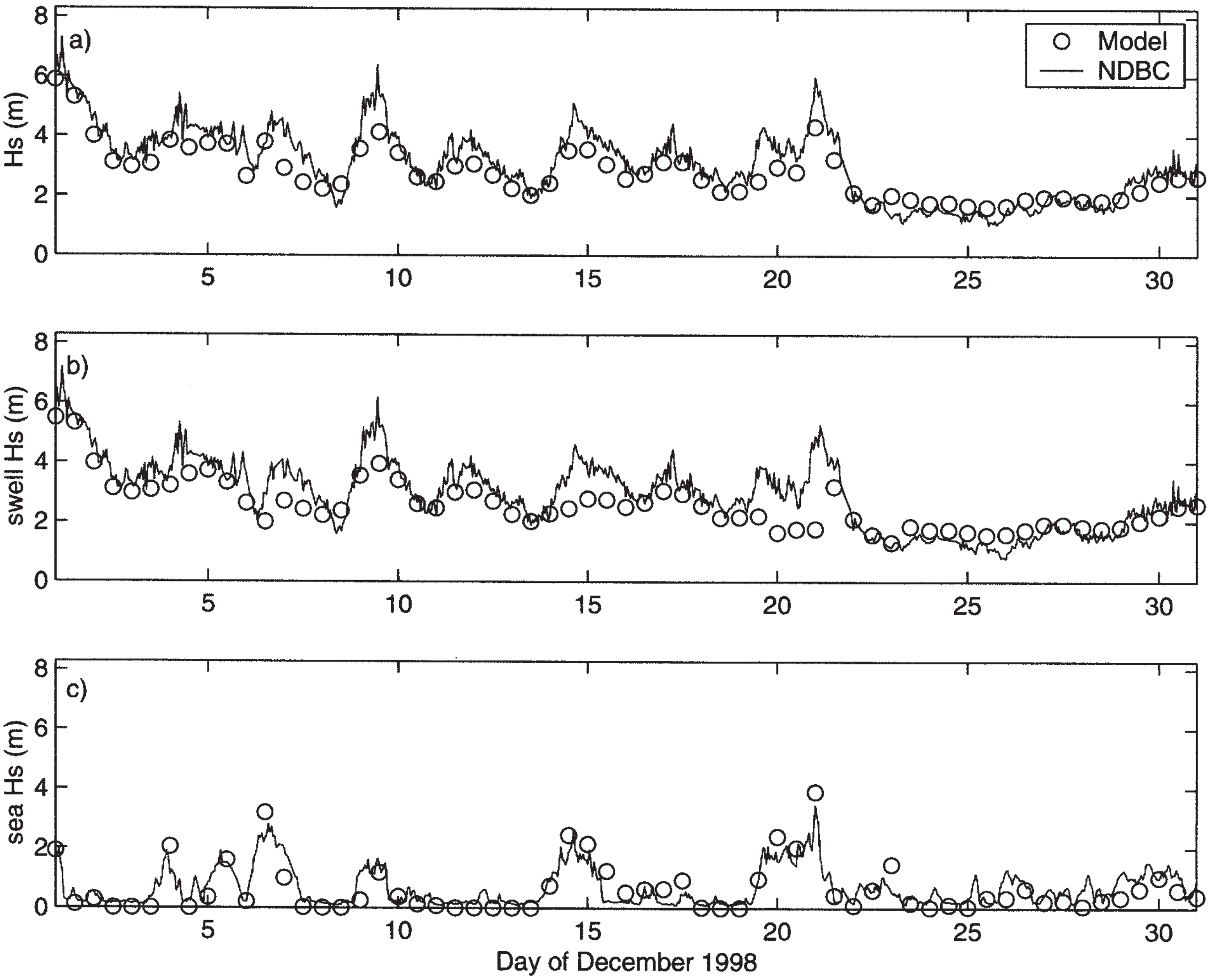

Figure 1. Comparison of NDBC's modified steepness method with the estimates from the Navy's wave model: a) combined wind-driven seas and swell significant wave height (Hs), b) swell Hs, and c) wind-driven seas Hs.

Coastal Forecast Office News

Great Lakes Area Experiences Milder than Normal Winter of 1999/2000

Diane Moravek
Meteorologist
National Weather Service Forecast Office
Cleveland, Ohio

The winter of 1999-2000 was warmer than normal throughout the Great Lakes area.

Temperatures in December were mild with readings that averaged 3 to 5 degrees F above normal for the month. In January, Buffalo was near normal while most other areas were 1 to 2 degrees F above normal. The exceptions were Duluth, Milwaukee, and Chicago, where the average was 4 to 5 degrees F above normal. February was very mild with averages of 5 to 9 degrees F above normal for the month.

Because of the milder winter, freezing degree days* were mostly below normal. For the southern waters, freezing degree days were close to normal, or slightly above, through the end of February. The remainder of the lakes were 200 to 400 degree days below normal, with the exception of Duluth, which was 600 degree days below normal.

As of the first of March, ice cover over the lakes was well below normal for that point in the season as a result of the mild winter weather. Aside from extensive coverage over Lake Erie, Saginaw Bay, the Straits, Green Bay and Whitefish Bay, most of the lakes were ice free except Lake Superior, which had mainly fast shore ice coverage.

Where ice existed, thicknesses were lower than normal since frigid cold weather had not been consistent enough over the winter months to build ice cover.

* Editors note: Freezing Degree Days (FDD) are used by forecasters on the Great Lakes as a measure of winter severity. Very cold winters have more FDD, while mild winters have fewer FDD. They are based on the mean daily temperature (F), and the departure of this mean from 32F, i.e. a daily mean of 20F produces 12 FDD. Daily mean temperature is computed by adding the daily high and low temperatures and dividing by 2. For example, for a high of 30F and low of 20F, the mean is 25F, producing 7 FDD.

Marine Effects of the 25 January 2000 Storm in Virginia and the Northern Outer Banks of North Carolina

Neil A. Stuart
Meteorologist
National Weather Service Office
Wakefield, Virginia

On 24 January 2000 a very intense nor’easter developed off the coast of North and South Carolina, reaching Cape Hatteras during the early morning hours of 25 January.

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The storm was a result of a strengthening upper-level low that tracked across the Gulf Coast states late on 23 January, reaching the Gulf Stream off the Carolinas on 24 January, where the rapid intensification of the surface and upper low took place. The storm center tracked northeast, well offshore Virginia Beach, by early afternoon on 25 January. The intense nor'easter produced a wide range of effects along the coast of Virginia and the northern Outer Banks of North Carolina, including tidal flooding, high seas, and storm-force winds, gusting to near hurricane force.

Tides across southeastern Virginia and the northern Outer Banks of North Carolina peaked between 4.73 ft MLLW at Gloucester, Virginia, to 6.99 ft MLLW at Watchapreague, Virginia. Flood stage in Hampton Roads (5 ft MLLW) was exceeded twice, with tides at Sewell's Point and the Chesapeake Bay Bridge Tunnel peaking at 5.86 ft MLLW and 6.27 ft MLLW, respectively (Figure 1). Wave heights observed at Chesapeake Light Tower, Virginia Beach Buoy (False Cape), and Duck Corps of Engineers (COE) Pier (C-MAN DUCN7), peaked at 16.54 ft, 18.83 ft and 11.19 ft respectively (Figure 2).

Winds associated with the storm were unusually strong. Maximum 10-minute average winds each

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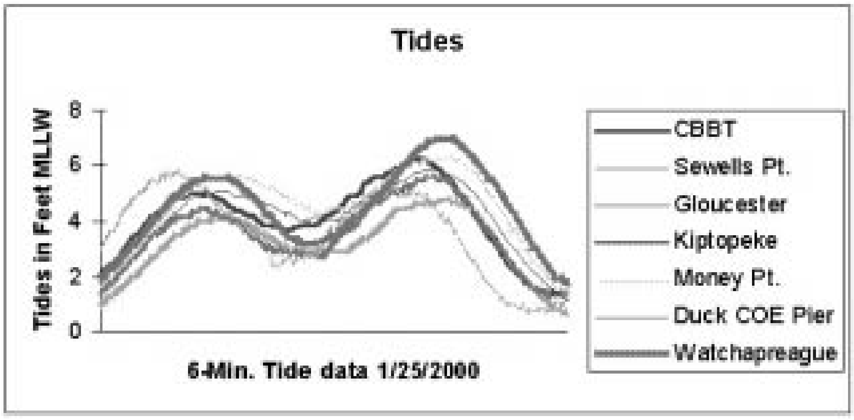

Figure 1.

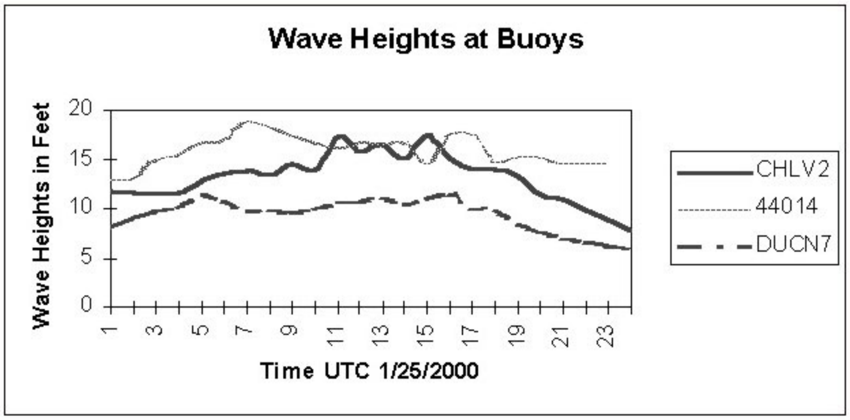

Figure 2.

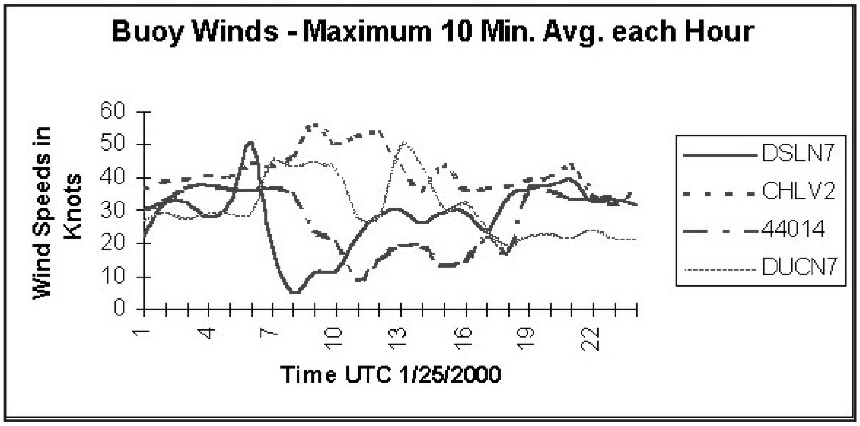

Figure 3.

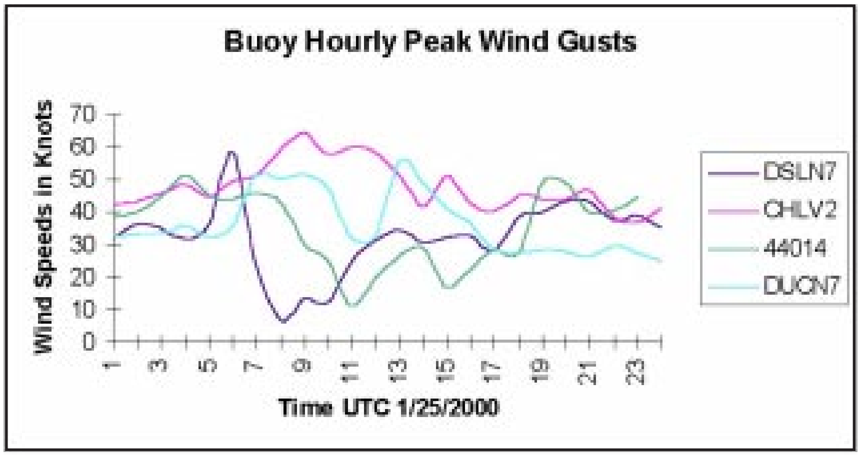

Figure 4.

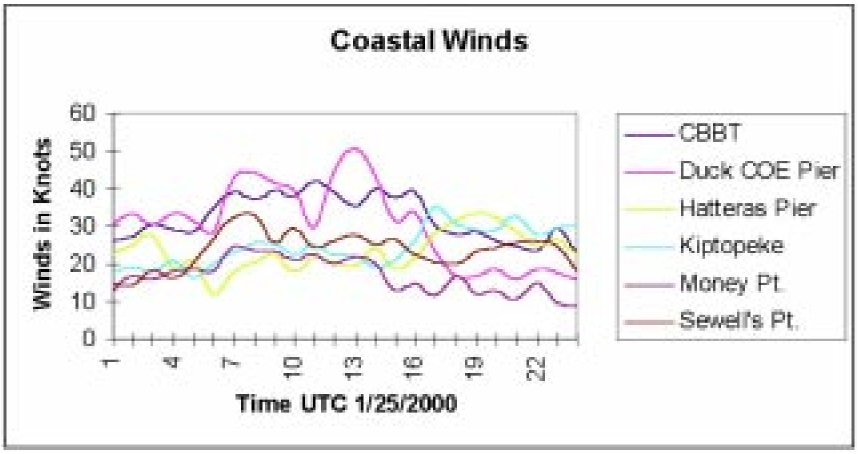

Figure 5.

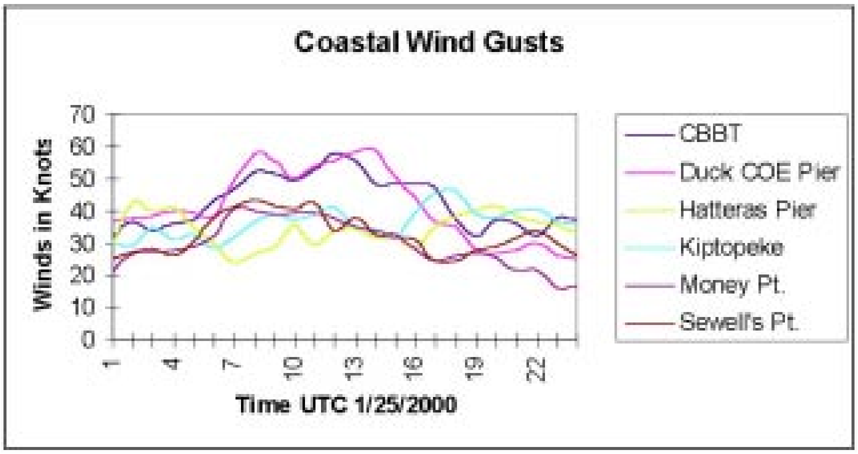

Figure 6.

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hour at Chesapeake Light Tower, Diamond Shoals Light Tower, Virginia Beach Buoy (False Cape) and Duck COE Pier (C-MAN DUCN7), peaked at 56 kts, 51 kts, 38 kts and 50 kts, respectively (Figure 3). Storm-force winds (48 kts) were observed at Chesapeake Light Tower for at least five consecutive hours. Peak gusts at Chesapeake Light Tower, Diamond Shoals Light Tower, Virginia Beach Buoy (False Cape), and Duck COE Pier (C-MAN DUCN7) were 65 kts, 56 kts, 44kts, and 51 kts, respectively (Figure 4). Sustained winds along the coast ranged from 24 kts at Money Point to 51 kts at Duck COE Pier (NOS CO-OPS), with Chesapeake Bay Bridge Tunnel, Sewell's Point, and Kiptopeke reporting sustained winds 25-40 kts during much of 25 January (Figure 5). Peak wind gusts at coastal locations were over 40 kts, with Duck COE Pier (NOS CO-OPS) and Chesapeake Bay Bridge Tunnel reporting gusts near 60 kts (Figure. 6).

The center of the storm tracked closest to Diamond Shoals Light Tower and the Virginia Beach Buoy (False Cape), hence, the lowest sea level pressures were observed at these two buoys (Figs. 7 and 8). Minimum sea level pressures at Chesapeake Light Tower, Diamond Shoals Light Tower, Virginia Beach Buoy (False Cape), and both Duck COE

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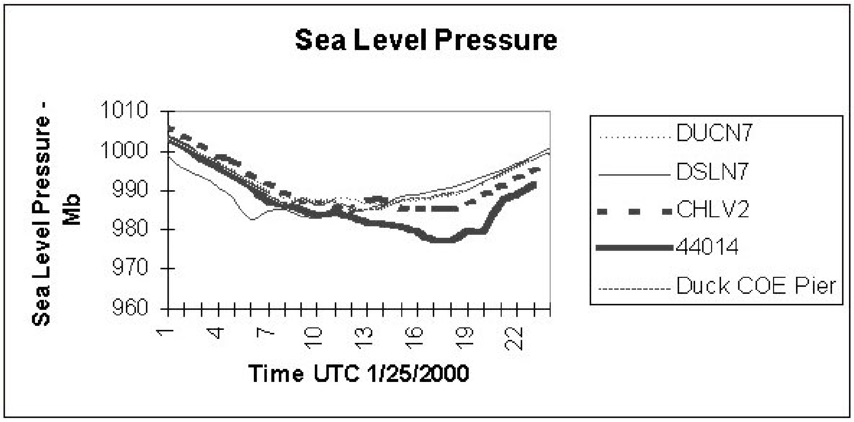

Figure 7.

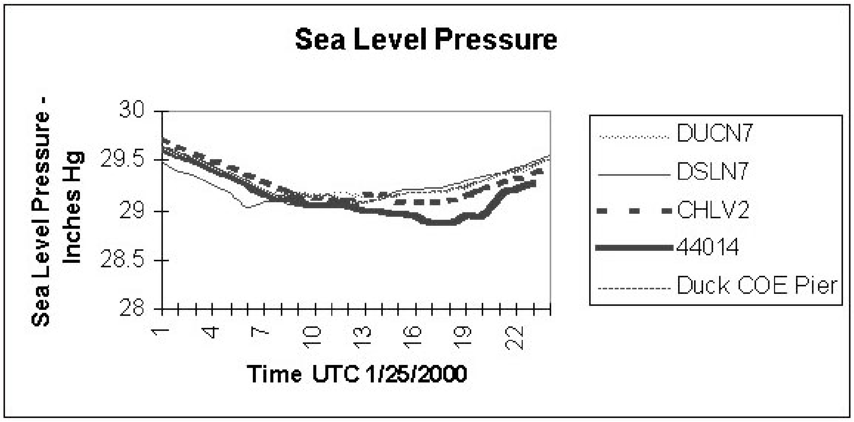

Figure 8.

Coastal Forecast Office News

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Pier stations (C-MAN DUCN7 and NOS CO-OPS) were 985.0 Mb (29.09 In.), 982.7 Mb (29.02 In.), 977.2 Mb (28.86 In.), 986.7 Mb (29.14 In.), and 985.0 Mb (29.09 In.) respectively.

Marine Verification

Richard May
Assistant Marine Weather Services Program Manager
National Weather Service
Silver Spring, Maryland

How does the National Weather Service (NWS) measure improvement of its marine forecasts? While ongoing feedback from mariners is an important tool, warning and forecast verification is currently the quantitative method used to measure NWS marine warning and forecast improvement.

The NWS Marine Prediction Center (MPC) and Weather Forecast Offices (WFO) issue marine forecasts of wind speed, wind direction, and significant wave height up to four times daily. Gale and storm warnings, as well as small craft advisories, are issued when needed. These forecast and warning parameters are compared against the NWS buoy and Coastal Marine Automated Network (C-MAN) observations.

The NWS Environmental Modeling Center (EMC) archives the marine forecast, warning, and observation data at the central computer facility in Suitland, Maryland, and computes quarterly (three months) verification scores which are posted on the National Marine Verification Program (NMVP) home page at: **http://polar.wwb.noaa.gov/omb/papers/nmvp/**

These scores are computed for warning category (storm warnings, gale warnings, and small craft advisories), wind direction, wind speed, and significant wave height. The webpage also provides a detailed explanation of the statistical measures used in the NMVP.

The NMVP statistics are used to measure the accuracy, skill, and timeliness of marine warnings and forecasts. The data also provides feedback to NWS marine forecasters and assists NWS managers in setting goals for improvements to products and services.⚓

Voluntary Observing Ship Program

Martin S. Baron
National Weather Service
Silver Spring, Maryland

Observations From Moving Ships Are Very Important

As mentioned in the Marine Weather Review, Tropical Atlantic and Tropical East Pacific Areas (page 46 of this issue), accurate, timely, ship observations are very important to marine forecast operations. Without ship observations, marine weather forecasting would be severely hampered.

Forecasting for marine areas is much more difficult than forecasting over land, because of the severe data scarcity over the oceans. On average, for every 100 surface observations on land, there is only 1 observation at sea. Also, there are no upper air or radar observations at sea to support the surface data.

The marine data shortage makes it especially important to have accurate marine observations. One bad marine report can be very misleading to the forecaster, because there may be no other observations nearby for a comparison, and to help serve as a data quality check.

When the marine forecaster prepares a forecast, the first step is to examine a surface map containing all observations from the forecast area. The data is carefully analyzed, to obtain an understanding of the prevailing weather conditions and any possible changes that might occur. **For vast marine areas, the only data available comes from ship reports**.

The National Weather Service thanks ships officers for participating in the Voluntary Observing Ship (VOS) Program, and for taking the time to observe the data, format it into the Ships Synoptic Code, and transmit it as a real-time message.

All vessels are encouraged to follow the weather reporting schedule as best they can -- **REPORT WEATHER AT 0000, 0600, 1200, and 1800 UTC When Underway.** This is a worldwide schedule for all marine areas. Also remember the 3-hourly reporting schedule for vessels operating within 300 miles of named tropical storms or hurricanes (also in effect worldwide). Additionally, the United States and Canada request 3-hourly reports from within 200 miles of their coastlines, and from anywhere on the Great Lakes.

Report Accurate Data

Great care must be taken at all times to ensure the accuracy of your data. Make sure your equipment is properly calibrated. Sea water thermometers should be calibrated annually, and checked at every opportunity. If your vessel has an anemometer, the recommended interval for calibration is once every 6 months. Make sure the anemometer is located where the ships superstructure will not interfere with air motion. A PMO should calibrate your barometer and barograph once every 3 months and check

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your psychrometer during every ship visit. When recording dry and wet bulb temperatures, take your psychrometer to the windward side of the ship (to ensure that your measurements are for air fresh from the sea).

Reminder about Y2K Problem with AMVER/SEAS Software

The PKZIP.EXE and PKUNZIP.EXE version 2.03 files on many AMVER/SEAS program disks, used to archive VOS observation data, are not Y2K compliant. Performance is erratic but will usually result in the loss of archived data. A repair disk as well as a complete new set of AMVER/SEAS software is available from your U.S. PMO or SEAS representative. The repair disk upgrades the PKWARE files on your hard disk to version 2.50 without loss of your Administrative and AMVER files as well as any previously collected VOS observations.

Until such time that your AMVER/SEAS software has been upgraded to include the version 2.50 of PKWARE, we request that you not attempt to archive any VOS observation data to floppy disk as this will likely result in the unrecoverable loss of data.

You can determine if you have the older version of PKWARE by looking in the SEAS4 directory.

The older versions of PKZIP and PKUNZIP are dated 1993.

NOTE: This Y2K bug does not affect the real-time transmit function of the AMVER/SEAS program. Please continue to take observations and participate in the AMVER and VOS programs.

New Recruits— January through April 2000

During the four month period January - April, 2000, United States Port Meteorological Officers recruited 30 vessels into the Voluntary Observing Ship Program. Thank you for joining the program. Please make every effort to follow the weather reporting schedule. Your observations are not only important to the weather forecasting effort, but also to your safety and well being at sea.

The following ships were presented VOS awards in recognition of their outstanding contibutions to the Voluntary Observing Ship Program of theUnited States of America for 1999:

Ambassador Bridge
Isla De cedros
Northern Lights
Sea-Land integrity
APL Korea
James
Ocean Palm
Sea-land Performance
Barrington Island
Kapitan Konev
Oleander
Seto Bridge
Cason J. Callaway
Liberty Star
OOCL Freedom
Sol Do Brasil
Charles Island
Lykes Discoverer
OOCL Inspiration
Stephan J
Chesapeake Bay
Lykes Commander
Overseas Joyce
Str. Southdown Challenger
CSX Sealand Trader
M/V Mesabi Miner
Polynesia
Str. Kinsman
Independent
CSX Sealand Enterprise
Majesty of the Seas
Rebecca Lynn
Taiho Maru
Dagmar Maersk
Marie Maersk
Rio Apure
Thorkill Maersk
Duncan Island
Melville
Rubin Kobe
Westwood Jago
Endurance
Moku Pahu
Sea Racer
Wilfred Sykes
Frances L
Nedlloyd Holland
Sea-Land Crusader
Zim USA
Galveston Bay
NOAA Ship Albatross IV
Sea-Land Consumer
Zim Montevideo
Golden Gate
NOAA Ship Oregon II
Sea-Land Navigator

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Summary of Weather Report Transmission Procedures

Weather observations sent by ships participating in the VOS program are sent at no cost to the ship except as noted.

The stations listed accept weather observations which enter an automated system at National Weather Service headquarters. This system is not intended for other types of messages. To communicate with NWS personnel, see phone numbers and e-mail addresses at the beginning of this manual.

INMARSAT

Follow the instructions with your INMARSAT terminal for sending a telex message. Use the special dialing code 41 (except when using the SEAS/AMVER software in compressed binary format with INMARSAT C), and do not request a confirmation. Here is a typical procedure for using an INMARSAT A transceiver:

1. Select appropriate Land Earth Station Identity (LES-ID). See table below.
2. Select routine priority.
3. Select duplex telex channel.
4. Initiate the call. Wait for the GA+ signal.
5. Select the dial code for meteorological reports, 41+.
6. Upon receipt of our answerback, NWS OBS MHTS, transmit the weather message starting with BBXX and the ship's call sign. The message must be ended with five periods. Do not send any preamble.

```
GA+
41+
NWS OBS MHTS
BBXX WLXX 29003 99131 70808 41998 60909 10250 2021/ 4011/ 52003 71611 85264 22234
00261 20201 31100 40803.....
```

The five periods indicate the end of the message and must be included after each report. Do not request a confirmation.

Land-Earth Station Identity (LES-ID) of U.S. Inmarsat Stations Accepting Ships Weather (BBXX) and Oceanographic (JJYY) Reports

Operator	Service	Station ID			
		AOR-W	AOR-E	IOR	POR
COMSAT	A	01	01	01	01
COMSAT	B	01	01	01	01
COMSAT	C	001	101	321	201
COMSAT	C (AMVER/SEAS)	001	101	321	201
STRATOS/IDB	A (octal ID)	13-1	13-1	13-1	13-1
STRATOS/IDB	A (decimal ID)	11-1	11-1	11-1	11-1
STRATOS/IDB	B	013	013	013	013

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Use abbreviated dialing code 41.
Do not request a confirmation

If your ship's Inmarsat terminal does not contain a provision for using abbreviated dialing code 41, TELEX address **0023089406** may be used via COMSAT. Please note that the ship will incur telecommunication charges for any messages sent to TELEX address 0023089406 using any Inmarsat earth station other than COMSAT.

Some common mistakes include: (1) failure to end the message with five periods when using INMARSAT A, (2) failure to include BBXX in the message preamble, (3) incorrectly coding the date, time, latitude, longitude, or quadrant of the globe, (4) requesting a confirmation.

Using The SEAS/AMVER Software

The National Oceanic and Atmospheric Administration (NOAA), in cooperation with the U.S. Coast Guard Automated Mutual-assistance VEssel Rescue program (AMVER) and COMSAT, has developed a PC software package known as AMVER/SEAS which simplifies the creation of AMVER and meteorological (BBXX) reports. The U.S. Coast Guard is able to accept, at no cost to the ship, AMVER reports transmitted via Inmarsat-C in a compressed binary format, created using the AMVER/SEAS program. Typically, in the past, the cost of transmission for AMVER messages has been assumed by the vessel. When ships participate in both the SEAS and AMVER programs, the position of ship provided in the meteorological report is forwarded to the Coast Guard as a supplementary AMVER position report to maintain a more accurate plot. To obtain the AMVER/SEAS program contact your U.S. PMO or AMVER/SEAS representative listed at the back of this publication.

If using the NOAA AMVER/SEAS software, follow the instructions outlined in the AMVER/SEAS User's Manual. When using Inmarsat-C, use the compressed binary format and 8-bit X.25 (PSDN) addressing (31102030798481), rather than TELEX if possible when reporting weather.

Common errors when using the AMVER/SEAS include sending the compressed binary message via the code 41 or a plain text message via the X.25 address. Only COMSAT can accept messages in the compressed binary format. Text editors should normally not be utilized in sending the data in the compressed binary format as this may corrupt the message.

Telephone (Landline, Cellular, Satphone, etc.)

The following stations will accept VOS weather observations via telephone. **Please note that the ship will be responsible for the cost of the call in this case.**

GLOBE WIRELESS	650-726-6588
MARITEL	228-897-7700
WLO	334-666-5110

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The National Weather Service is developing a dial-in bulletin board to accept weather observations using a simple PC program and modem. **The ship will be responsible for the cost of the call when using this system.** For details contact:

Tim Rulon, NOAA
W/OM12 SSMC2 Room 14114
1325 East-West Highway
Silver Spring, MD 20910 USA
301-713-1677 Ext. 128
301-713-1598 (Fax)
timothy.rulon@noaa.gov
marine.weather@noaa.gov

Reporting Through United States Coast Guard Stations

U.S. Coast Guard stations accept SITOR (preferred) or voice radiotelephone weather reports. Begin with the BBXX indicator, followed by the ships call sign and the weather message**.**

U.S. Coast Guard High Seas Communication Stations

Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
Boston	(NMF)	Voice		003669991	424	4134	4426	Night[3]
Boston	(NMF)	Voice		003669991	601	6200	6501	24Hr
Boston	(NMF)	Voice		003669991	816	8240	8764	24Hr
Boston	(NMF)	Voice		003669991	1205	12242	13089	Day[3]
Chesapeake	(NMN)	SITOR	1097		604	6264.5	6316	Night[2]
Chesapeake	(NMN)	SITOR	1097		824	8388	8428	24Hr
Chesapeake	(NMN)	SITOR	1097		1227	12490	12592.5	24hr
Chesapeake	(NMN)	SITOR	1097		1627	16696.5	16819.5	24Hr
Chesapeake	(NMN)	SITOR	1097		2227	22297.5	22389.5	Day[2]
Chesapeake	(NMN)	Voice		003669995	424	4134	4426	Night[2]
Chesapeake	(NMN)	Voice		003669995	601	6200	6501	24Hr
Chesapeake	(NMN)	Voice		003669995	816	8240	8764	24Hr
Chesapeake	(NMN)	Voice		003669995	1205	12242	13089	Day[2]
Miami	(NMA)	Voice		003669997	601	6200	6501	24Hr
Miami	(NMA)	Voice		003669997	1205	12242	13089	24Hr
Miami	(NMA)	Voice		003669997	1625	16432	17314	24Hr
New Orleans	(NMG)	Voice		003669998	424	4134	4426	24Hr
New Orleans	(NMG)	Voice		003669998	601	6200	6501	24Hr
New Orleans	(NMG)	Voice		003669998	816	8240	8764	24Hr
New Orleans	(NMG)	Voice		003669998	1205	12242	13089	24Hr
Kodiak	(NOJ)	SITOR	1106		407	4175.5	4213.5	Night
Kodiak	(NOJ)	SITOR	1106		607	6266	6317.5	24Hr
Kodiak	(NOJ)	SITOR	1106		807	8379.5	8419.5	Day
Kodiak	(NOJ)	Voice		003669899[1]	***	4125	4125	24Hr
Kodiak	(NOJ)	Voice		003669899[1]	601	6200	6501	24Hr
Pt. Reyes	(NMC)	SITOR	1096		620	6272.5	6323.5	Night
Pt. Reyes	(NMC)	SITOR	1096		820	8386	8426	24Hr

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Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
Pt. Reyes	(NMC)	SITOR	1096		1620	16693	16816.5	Day
Pt. Reyes	(NMC)	Voice		003669990	424	4134	4426	24Hr
Pt. Reyes	(NMC)	Voice		003669990	601	6200	6501	24Hr
Pt. Reyes	(NMC)	Voice		003669990	816	8240	8764	24Hr
Pt. Reyes	(NMC)	Voice		003669990	1205	12242	13089	24Hr
Honolulu	(NMO)	SITOR	1099		827	8389.5	8429.5	24hr
Honolulu	(NMO)	SITOR	1099		1220	12486.5	12589	24hr
Honolulu	(NMO)	SITOR	1099		2227	22297.5	22389.5	Day
Honolulu	(NMO)	Voice		003669993[1]	424	4134	4426	Night[4]
Honolulu	(NMO)	Voice		003669993[1]	601	6200	6501	24Hr
Honolulu	(NMO)	Voice		003669993[1]	816	8240	8764	24Hr
Honolulu	(NMO)	Voice		003669993[1]	1205	12242	13089	Day[4]
Guam	(NRV)	SITOR	1100		812	8382	8422	24hr
Guam	(NRV)	SITOR	1100		1212	12482.5	12585	Night
Guam	(NRV)	SITOR	1100		1612	16689	16812.5	24hr
Guam	(NRV)	SITOR	1100		2212	22290	22382	Day
Guam	(NRV)	Voice		003669994[1]	601	6200	6501	Night[5]
Guam	(NRV)	Voice		003669994[1]	1205	12242	13089	Day[5]

Stations also maintain an MF/HF DSC watch on the following frequencies: 2187.5 kHz, 4207.5 kHz, 6312 kHz, 8414.5 kHz, 12577 kHz, and 16804.5 kHz.

Voice frequencies are carrier (dial) frequencies. SITOR and DSC frequencies are assigned frequencies. Note that some stations share common frequencies.

An automated watch is kept on SITOR. Type "HELP+" for the of instructions or "OBS+" to send the weather report.

For the latest information on Coast Guard frequencies, visit their webpage at: http://www.navcen.uscg.mil/marcomms.

[1] MF/HF DSC has not yet been implemented at these stations.
[2] 2300-1100 UTC Nights, 1100-2300 UTC Days
[3] 2230-1030 UTC Nights, 1030-2230 UTC Days
[4] 0600-1800 UTC Nights, 1800-0600 UTC Days
[5] 0900-2100 UTC Nights, 2100-0900 UTC Days

U.S. Coast Guard Group Communication Stations

U.S. Coast Guard Group communication stations monitor VHF marine channels 16 and 22A and/or MF radiotelephone frequency 2182 kHz (USB). Great Lakes stations do not have MF installations.

The following stations have MF DSC installations and also monitor 2187.5 kHz DSC. Additional stations are planned. Note that although a station may be listed as having DSC installed, that installation may not have yet

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been declared operational. The U.S. Coast Guard is not expected to have the MF DSC network installed and declared operational until 2003 or thereafter.

The U.S. Coast Guard is not expected to have an VHF DSC network installed and declared operational until 2005 or thereafter.

STATION			MMSI #
CAMSLANT Chesapeake VA	MF/HF	—	003669995
COMMSTA Boston MA	MF/HF	Remoted to CAMSLANT	003669991
COMMSTA Miami FL	MF/HF	Remoted to CAMSLANT	003669997
COMMSTA New Orleans LA	MF/HF	Remoted to CAMSLANT	003669998
CAMSPAC Pt Reyes CA	MF/HF	—	003669990
COMMSTA Honolulu HI	MF/HF	Remoted to CAMSPAC	003669993
COMMSTA Kodiak AK	MF/HF	—	003669899
Group Atlantic City NJ	MF		003669903
Group Cape Hatteras NC	MF		003669906
Group Southwest Harbor	MF		003669921
Group Eastern Shore VA	MF		003669932
Group Mayport FL	MF		003669925
Group Long Island Snd	MF		003669931
Act New York NY	MF		003669929
Group Ft Macon GA	MF		003669920
Group Astoria OR	MF		003669910

Reporting Through Specified U.S. Commercial Radio Stations

If a U.S. Coast Guard station cannot be communicated with, and your ship is not INMARSAT equipped, U.S. commercial radio stations can be used to relay your weather observations to the NWS. When using SITOR, use the command “OBS +”, followed by the BBXX indicator and the weather message. **Example:**

```
OBS +          BBXX WLXX 29003 99131 70808 41998 60909 10250 2021/
               40110 52003 71611 85264 22234 00261 20201 31100 40803
```

Commercial stations affiliated with Globe Wireless (KFS, KPH, WNU, WCC, etc.) accept weather messages via SITOR or morse code (not available at all times).

Commercial Stations affiliated with Mobile Marine Radio, Inc. (WLO, KLB, WSC) accept weather messages via SITOR, with Radiotelephone and Morse Code (weekdays from 1300-2100 UTC only) also available as backups.

MARITEL Marine Communication System accepts weather messages via VHF marine radiotelephone from near shore (out 50-60 miles), and from the Great Lakes.

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Globe Wireless

Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
Slidell, Louisina	(WNU)	SITOR			401	4172.5	4210.5	24Hr
	(WNU)	SITOR				4200.5	4336.4	24Hr
	(WNU)	SITOR			627	6281	6327	24Hr
	(WNU)	SITOR			819	8385.5	8425.5	24Hr
	(WNU)	SITOR			1257	12505	12607.5	24Hr
	(WNU)	SITOR			1657	16711.5	16834.5	24Hr
Barbados	(8PO)	SITOR			409	4176.5	4214.5	24Hr
	(8PO)	SITOR			634	6284.5	6330.5	24Hr
	(8PO)	SITOR			834	8393	8433	24Hr
	(8PO)	SITOR			1273	12513	12615.5	24Hr
	(8PO)	SITOR			1671	16718.5	16841.5	24Hr
San Francisco, California	(KPH)	SITOR			413	4178.5	4216	24Hr
	(KPH)	SITOR			613	6269	6320	24Hr
	(KPH)	SITOR			813	8382.5	8422.5	24Hr
	(KPH)	SITOR			822	8387	8427	24Hr
	(KPH)	SITOR			1213	12483	12585.5	24Hr
	(KPH)	SITOR			1222	12487.5	12590	24Hr
	(KPH)	SITOR			1242	12497.5	12600	24Hr
	(KPH)	SITOR			1622	16694	16817.5	24Hr
	(KPH)	SITOR			2238	22303	22395	24Hr
	(KFS)	SITOR			403	4173.5	4211.5	24Hr
	(KFS)	SITOR				6253.5	6436.4	24Hr
	(KFS)	SITOR			603	6264	6315.5	24Hr
	(KFS)	SITOR				8323.5	8526.4	24Hr
	(KFS)	SITOR			803	8377.5	8417.5	24Hr
	(KFS)	SITOR			1203	12478	12580.5	24Hr
	(KFS)	SITOR			1247	12500	12602.5	24Hr
	(KFS)	SITOR				16608.5	17211.4	24Hr
	(KFS)	SITOR			1647	16706.5	16829.5	24Hr
	(KFS)	SITOR			2203	22285.5	22377.5	24Hr
Hawaii	(KEJ)	SITOR				4154.5	4300.4	24Hr
	(KEJ)	SITOR			625	6275	6326	24Hr
	(KEJ)	SITOR			830	8391	8431	24Hr
	(KEJ)	SITOR			1265	12509	12611.5	24Hr
	(KEJ)	SITOR			1673	16719.5	16842.5	24Hr
Delaware, USA	(WCC)	SITOR				6297	6334	24Hr
	(WCC)	SITOR			816	8384	8424	24Hr
	(WCC)	SITOR			1221	12487	12589.5	24Hr
	(WCC)	SITOR			1238	12495.5	12598	24Hr
	(WCC)	SITOR			1621	16693.5	16817	24Hr
Argentina	(LSD836)	SITOR				4160.5	4326	24Hr
	(LSD836)	SITOR				8311.5	8459	24Hr
	(LSD836)	SITOR				12379.5	12736	24Hr
	(LSD836)	SITOR				16560.5	16976	24Hr
	(LSD836)	SITOR				18850.5	19706	24Hr
Guam	(KHF)	SITOR			605	6265	6316.5	24Hr
	(KHF)	SITOR			808	8380	8420	24Hr
	(KHF)	SITOR			1301	12527	12629	24Hr
	(KHF)	SITOR			1726	16751	16869	24Hr
	(KHF)	SITOR			1813	18876.5	19687	24Hr
	(KHF)	SITOR			2298	22333	22425	24Hr
Newfoundland	(VCT)	SITOR			414	4179	4216.5	24Hr

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Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
Canada	(VCT)	SITOR			416	4180	4217.5	24Hr
	(VCT)	SITOR			621	6273	6324	24Hr
	(VCT)	SITOR			632	6283.5	6329.5	24Hr
	(VCT)	SITOR			821	8386.5	8426.5	24Hr
	(VCT)	SITOR			838	8395	8435	24Hr
	(VCT)	SITOR			1263	12508	12610.5	24Hr
	(VCT)	SITOR			1638	16702	16825	24Hr
Cape Town, South Africa	(ZSC)	SITOR			408	4176	4214	24Hr
	(ZSC)	SITOR			617	6271	6322	24Hr
	(ZSC)	SITOR			831	8391.5	8431.5	24Hr
	(ZSC)	SITOR			1244	12498.5	12601	24Hr
	(ZSC)	SITOR			1619	16692.5	16816	24Hr
	(ZSC)	SITOR			1824	18882	19692.5	24Hr
Bahrain, Arabian Gulf	(A9M)	SITOR			419	4181.5	4219	24Hr
	(A9M)	SITOR				8302.5	8541	24Hr
	(A9M)	SITOR				12373.5	12668	24Hr
	(A9M)	SITOR				16557.5	17066.5	24Hr
	(A9M)	SITOR				18853.5	19726	24Hr
Gothenburg, Sweden	(SAB)	SITOR			228	2155.5	1620.5	24Hr
	(SAB)	SITOR				4166.5	4259	24Hr
	(SAB)	SITOR			626	6275.5	6326.5	24Hr
	(SAB)	SITOR			837	8394.5	8434.5	24Hr
	(SAB)	SITOR			1291	12522	12624	24Hr
	(SAB)	SITOR			1691	16728.5	16851.5	24Hr
Norway,	(LFI)	SITOR				2653	1930	24Hr
	(LFI)	SITOR				4154.5	4339	24Hr
	(LFI)	SITOR				6250.5	6467	24Hr
	(LFI)	SITOR				8326.5	8683.5	24Hr
	(LFI)	SITOR				12415.5	12678	24Hr
	(LFI)	SITOR				16566.5	17204	24Hr
Awanui, New Zealand	(ZLA)	SITOR			402	4173	4211	24Hr
	(ZLA)	SITOR			602	6263.5	6315	24Hr
	(ZLA)	SITOR			802	8377	8417	24Hr
	(ZLA)	SITOR			1202	12477.5	12580	24Hr
	(ZLA)	SITOR			1602	16684	16807.5	24Hr
	(ZLA)	SITOR				18859.5	19736.4	24Hr
Perth, Western Austrailia	(VIP)	SITOR			406	4175	4213	24Hr
	(VIP)	SITOR			806	8379	8419	24Hr
	(VIP)	SITOR			1206	12479.5	12582	24Hr
	(VIP)	SITOR			1210	12481.5	12584	24Hr
	(VIP)	SITOR			1606	16686	16809.5	24Hr

The frequencies listed are used by the stations in the Global Radio network for both SITOR and GlobeEmail. Stations listed as being 24hr may not be operational during periods of poor propagation.

For the latest information on Globe Wireless frequencies, visit their webpage at:
http://www.globewireless.com

Stations and channels are added regularly. Contact any Globe Wireless station/channel or visit the website for an updated list.

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Mobile Marine Radio Inc.

Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
Mobile, AL	(WLO)	SITOR	1090	003660003	406	4175	4213	24Hr
	(WLO)	SITOR	1090	003660003	410	4177	4215	24Hr
	(WLO)	SITOR	1090	003660003	417	4180.5	4218	24Hr
	(WLO)	SITOR	1090	003660003	606	6265.5	6317	24Hr
	(WLO)	SITOR	1090	003660003	610	6267.5	6319	24Hr
	(WLO)	SITOR	1090	003660003	615	6270	6321	24Hr
	(WLO)	SITOR	1090	003660003	624	6274.5	6325.5	24Hr
	(WLO)	SITOR	1090	003660003	806	8379	8419	24Hr
	(WLO)	SITOR	1090	003660003	810	8381	8421	24Hr
	(WLO)	SITOR	1090	003660003	815	8383.5	8423.5	24Hr
	(WLO)	SITOR	1090	003660003	829	8390.5	8430.5	24Hr
	(WLO)	SITOR	1090	003660003	832	8392	8432	24Hr
	(WLO)	SITOR	1090	003660003	836	8394	8434	24Hr
	(WLO)	SITOR	1090	003660003	1205	12479	12581.5	24Hr
	(WLO)	SITOR	1090	003660003	1211	12482	12584.5	24Hr
	(WLO)	SITOR	1090	003660003	1215	12484	12586.5	24Hr
	(WLO)	SITOR	1090	003660003	1234	12493.5	12596	24Hr
	(WLO)	SITOR	1090	003660003	1240	12496.5	12599	24Hr
	(WLO)	SITOR	1090	003660003	1251	12502	12604.5	24Hr
	(WLO)	SITOR	1090	003660003	1254	12503.5	12606	24Hr
	(WLO)	SITOR	1090	003660003	1261	12507	12609.5	24Hr
	(WLO)	SITOR	1090	003660003	1605	16685.5	16809	24Hr
	(WLO)	SITOR	1090	003660003	1611	16688.5	16812	24Hr
	(WLO)	SITOR	1090	003660003	1615	16690.5	16814	24Hr
	(WLO)	SITOR	1090	003660003	1625	16695.5	16818.5	24Hr
	(WLO)	SITOR	1090	003660003	1640	16703	16826	24Hr
	(WLO)	SITOR	1090	003660003	1644	16705	16828	24Hr
	(WLO)	SITOR	1090	003660003	1661	16713.5	16836.5	24Hr
	(WLO)	SITOR	1090	003660003	1810	18875	19685.5	24Hr
	(WLO)	SITOR	1090	003660003	2210	22289	22381	24Hr
	(WLO)	SITOR	1090	003660003	2215	22291.5	22383.5	24Hr
	(WLO)	SITOR	1090	003660003	2254	22311	22403	24Hr
	(WLO)	SITOR	1090	003660003	2256	22312	22404	24Hr
	(WLO)	SITOR	1090	003660003	2260	22314	22406	24Hr
	(WLO)	SITOR	1090	003660003	2262	22315	22407	24Hr
	(WLO)	SITOR	1090	003660003	2272	22320	22412	24Hr
	(WLO)	SITOR	1090	003660003	2284	22326	22418	24Hr
	(WLO)	SITOR	1090	003660003	2510	25177.5	26105.5	24Hr
	(WLO)	SITOR	1090	003660003	2515	25180	26108	24Hr
	(WLO)	DSC		003660003		4208	4219	24Hr
	(WLO)	DSC		003660003		6312.5	6331.0	24Hr
	(WLO)	DSC		003660003		8415	8436.5	24Hr
	(WLO)	DSC		003660003		12577.5	12657	24Hr
	(WLO)	DSC		003660003		16805	16903	24Hr
	(WLO)	Voice		003660003	405	4077	4369	24Hr
	(WLO)	Voice			414	4104	4396	24Hr
	(WLO)	Voice			419	4119	4411	24Hr
	(WLO)	Voice		003660003	607	6218	6519	24Hr
	(WLO)	Voice		003660003	824	8264	8788	24Hr
	(WLO)	Voice			829	8279	8803	24Hr
	(WLO)	Voice			830	8282	8806	24Hr

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VOS Program

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Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
	(WLO)	Voice		003660003	1212	12263	13110	24Hr
	(WLO)	Voice			1226	12305	13152	24Hr
	(WLO)	Voice			1607	16378	17260	24Hr
	(WLO)	Voice			1641	16480	17362	24Hr
	(WLO)	VHFVoice			CH 25,84			24Hr
	(WLO)	DSC Call		003660003	CH 70			24Hr
	(WLO)	DSC Work		003660003	CH 84			24Hr
Tuckerton,	(WSC)	SITOR	1108		419	4181.5	4219	24Hr
NJ	(WSC)	SITOR	1108		832	8392	8432	24Hr
	(WSC)	SITOR	1108		1283	12518	12620.5	24Hr
	(WSC)	SITOR	1108		1688	16727	16850	24Hr
	(WSC)	SITOR	1108		1805	18872.5	19683	24Hr
	(WSC)	SITOR	1108		2295	22331.5	22423.5	24Hr
Seattle, WA	(KLB)	SITOR	1113		408	4176	4214	24Hr
	(KLB)	SITOR	1113		608	6266.5	6318	24Hr
	(KLB)	SITOR	1113		818	8385	8425	24Hr
	(KLB)	SITOR	1113		1223	12488	12590.5	24Hr
	(KLB)	SITOR	1113		1604	16685	16808.5	24Hr
	(KLB)	SITOR	1113		2240	22304	22396	24Hr

WLO Radio is equipped with an operational Thrane & Thrane TT-6200A DSC system for VHF and MF/HF general purpose digital selective calling communications.

Ship Telex Automatic System Computer Commands and Guidelines for Contacting Mobile Marine Radio stations.

Ship Station Response	Land Station Response
1) INITIATE ARQ CALL	
	2) RTTY CHANNEL
	3) "WHO ARE YOU" (Requests Ship's Answerback)
4) SHIP'S ANSWERBACK IDENTITY	
	5) GA+?
6) Send Command OBS+ (Weather Observations) OPR+ (Operator Assistance) HELP+ (Operator Procedure)	
	7) MOM
	8) MSG+?
9) SEND MESSAGE	
10) KKKK (End of Message Indicator, WAIT for System Response DO NOT DISCONNECT)	
	11) RTTY CHANNEL
12) SHIP'S ANSWERBACK	
	13) SYSTEM REFERENCE, INFORMATION, TIME, DURATION

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14) GA+?

15) GO TO STEP 6, or

16) BRK+? Clear Radio Circuit)

Stations listed as being 24Hr may not be operational during periods of poor propogation.

For the latest information on Mobile Marine Radio frequencies, visit their webpage at: http://www.wloradio.com.

MARITEL Stations

Instructions for MARITEL

Key the mike for five seconds on the working channel for that station. You should then get a recording telling you that you have reached the MARITEL system, and if you wish to place a call, key your mike for an additional five seconds. A MARITEL operator will then come on frequency. Tell them that you want to pass a marine weather observation.

Stations	VHF Channel(s)
WEST COAST	
Bellingham, WA	28,85
Port Angeles, WA	25
Camano Island, WA	24
Seattle, WA	26
Tumwater, WA	85
Astoria, OR	24,26
Portland, OR	26
Newport, OR	28
Coos Bay, OR	25
Santa Cruz, CA	27
Santa Barbara, CA	86
Redondo Bch, CA	27,85,87
HAWAII	
Haleakala,HI (Maui)	26
GREAT LAKES	
Duluth, MN (Superior)	84
Ontonagon, MI (Superior)	86
Copper Harbor (Superior)	87
Grand Marias (Superior)	84
Sault Ste Marie (Superior)	86
Port Washington, WI (Mich)	85
Charlevoix (Michican)	84
Roger City (Huron)	28
Alpena, MI (Huron)	84
Tawas City, MI (Huron)	87
Detroit, MI (Erie)	28
Cleveland, OH (Erie)	86
Buffalo, NY (Erie)	28
NORTH EAST COAST	
Portland, ME	87
Southwest Harbor, ME	28
Rockport, ME	26,84
Gloucester, MA	25
Boston, MA	26,27
Hyannisport, MA	28
Nantucket, MA	85
New Bedford, MA	24,26
Narragansett, RI	84
New London, CT	26,86
Bridgeport, CT	27
Staten Island, NY	28
Sandy Hook, NJ	24
Toms River, NJ	27
Ship Bottom, NJ	28
Beach Haven, NJ	25
Atlantic City, NJ	26
Philadelphia, PA	26
Delaware WW Lewes, DE	27
Dover, DE	84
Ocean City, MD	26
Virginia Bch, VA	26,27
CHESAPEAKE BAY	
Baltimore, MD	25,26
Cambridge, MD	28
Point Lookout, MD	26
Belle Haven, VA	25
SOUTH EAST COAST	
Morehead City, NC	28
Wilmington, NC	26
Georgetown, SC	24
Charleston, SC	26
Savannah, GA	27
Jacksonville, FL	26
Daytona Beach, FL	28
Cocoa Bch, FL	26
Vero Bch, FL	27
St Lucie, FL	26
W Palm Bch,	28
Ft Lauderdale, FL	84
Miami, FL	24,25
Key Largo, FL	28
Marathon, FL	27
Key West, FL	26,84
GULF COAST	
Port Mansfield, TX	25
Corpus Christi, TX	26
Port O'Conner, TX	24
Matagorda, TX	84
Freeport, TX	27
Galveston, TX	24

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Arcadia, TX	87
Houston, TX	26
Port Arthur, TX	27
Lake Charles, LA	28,84
Erath, LA	87
Morgan City, LA	24,26
Houma, LA	86
Venice, LA	27,28,86
New Orleans, LA	24,26,87
Hammond, LA	85
Hopedale, LA	85
Gulfport, MS	28
Pascagoula, MS	27
Pensacola, FL	26
Ft Walton Bch, FL	28
Panama City, FL	26
Apalachicola, FL	28
Crystal River, FL	28
Clearwater, FL	26
Tampa Bay, FL	24
Venice, FL	27
Ft Myers, FL	26
Naples, FL	25

For the latest information on MARITEL frequencies, visit their webpage at: http://www.maritelinc.com.

Military Communications Circuits

Navy, Naval, and U.S. Coast Guard ships wishing to participate in the VOS program may do so by sending unclassified weather observations in synoptic code (BBXX format) to the following Plain Language ADdress (PLAD):

SHIP OBS NWS SILVER SPRING MD

As weather observations received by NWS are public data, vessels should check with their local command before participating in the VOS Program.

Very Important: Please keep us informed about changes to your mailing address. Voluntary Observing Ships may contact any United States Port Meteorological Officer (PMO) to update or change an address.

National Weather Service Voluntary Observing Ship Program

New Recruits from January 1 through April 30, 2000

NAME OF SHIP	CALL	AGENT NAME	RECRUITING PMO
ALFAMAR	TCYB	KERR STEAMSHIP CO., 1403 GREENBRIER PKWY, #550	NORFOLK, VA
ANNA	LAGU4	BARBER SHIP MANAGEMENT LTD.	JACKSONVILLE, FL
APL TOURMALINE	9VVP	AMERICAN SHIPMANAGEMENT	SAN FRANCISCO, CA
CHARLES B. RENFREW	C6JP	CHEVRON SHIPPING CO	NEW ORLEANS, LA
CHEMICAL PIONEER	KAFO	% BIEHL & CO.	HOUSTON, TX
COASTAL MERCHANT	WCV8696	COASTAL TRANSPORTATION INC.	SEATTLE, WA
COASTAL SEA	WCA7944	COASTAL TRANSPORTATION, INC	SEATTLE, WA
COLUMBUS CANADA	P3RD8	T. PARKER HOST, SUITE 820, WORLD TRADE CTR.	NORFOLK, VA
CROWN PRINCESS	ELVK5	ELLER AND COMPANY//C/O GEORGE PARRA	MIAMI, FL
GRAND PACE	3FGJ9	INCHCAPE SHIPPING SERVICES	NEW YORK CITY, NY
GREAT JADE	VRVL7	PORT METEOROLOGICAL OFFICE	SEATTLE, WA
HUAL ASIA	C6QX7	HOEGH FLEET SERVICES AS	NEW YORK CITY, NY
ISPAT TARANG	ELSR7	CAPES SHIPPING AGENCIES, INC	NORFOLK, VA
JOHN W. BROWN	KHJL		BALTIMORE, MD
MAERSK VALENCIA	ELXK7	STRACHAN SHIPPING AGENCY	NORFOLK, VA
MANAGER OF COMMUNICATIONS	TAMPA1	BILLY MORERO	HOUSTON, TX
MARINE MANAGER	MARINE	MAERSK SEALAND	HOUSTON, TX
MSC XINGANG	3EHR6	MEDITERRANEAN SHIPPING CO INC	NORFOLK, VA
ORANGE STAR	ELFS7	LAVINO SHIPPING AGENCY INC	NEWARK, NJ
P&O NEDLLOYD MARSEILLE	MYSU5	MERIT STEAMSHIP AGENCY INC	SEATTLE, WA
RUBIN ARTEMIS	3FAH7	NAVIX LINE, LTD	SEATTLE, WA
SABINE PHILADELPHIA	WNFJ	SABINE TRANSPORTATION	NEW ORLEANS, LA
SAUDI MAKKAH	HZQZ	BIEHL & CO.	HOUSTON, TX
SS OCEANIC	C6IF7	CAPT. GEORGE ANTONELLOS PREMIER CRUISE LINE	MIAMI, FL
TANABATA	LAZO4		BALTIMORE, MD
TRACER	PJFB	INCHAPE SHIPPING SERVICES	NORFOLK, VA
USNS BRUCE C. HEEZEN	NBID	COMMANDING OFFICER	NEW ORLEANS, LA
USNS JOHN LENTHALL	NJLN	MILTARY SEALIFT COMMAND	NORFOLK, VA
USNS SEAY	NZIN	COMMANDING OFFICER	NEW ORLEANS, LA
USNS VINDICATOR	NTOR	USNS VINDICATOR (TAGOS-3)	NORFOLK, VA

VOS Program Awards and Presentations Gallery

The ***APL Korea*** *was chosen by Pat Brandow (PMO Seattle) as one of the top performers of 1999. A VOS plaque was presented to the crew. Pictured from left to right is off-going Second Mate William Morgan, Captain James Londagin, and on-coming Second Mate Ian Allen.*

The ***Isla De Cedros*** *received a 1999 VOS performance award from Seattle PMO Pat Brandow. From left, Third Mate Divya Bharati, Second Mate M. N. Asghar, Captain NB. K. Dayaram, and Seattle PMO Pat Brandow.*

The ***Westwood Jago*** *received a 1999 VOS performance award from Seattle PMO Pat Brandow. From left, Third Mate Perfecto Sandoval, Jr., and Captain Harry Simonsen.*

Captain A. C. Dunnings of the ***Rio Apure*** *received a 1999 VOS performance award from Fort Lauderdale PMO Bob Drummond.*

Outgoing Chief mate Lorenzo Chiong (left), and incoming Chief mate Jonathon Villafldr of the ***MS Stephen J.*** *receiving a 1999 VOS performance award from Fort Lauderdale PMO Bob Drummond.*

Captain Lefteris Konstantinides of the Celebrity Cruise Ship ***Horizon*** *received a 1999 VOS performance award from Fort Lauderdale PMO Bob Drummond.*

The ***OOCL Inspiration*** *was presented with a VOS award. From left to right are 2 Mate Steve Wardman, Capt. Eric Franzen, and Bosn Mark Trepp. This was the top ship from Houston PMO Jim Nelson.*

Captain Olav Soevdsnes (left), and Second Officer Tommy Sivertsen of the Royal Caribbean Cruise Line ship ***Majesty of The Seas*** *received a 1999 VOS performance award from Fort Lauderdale PMO Bob Drummond.*

PMO Romeoville (Chicago) Amy Seeley presented a 1998 VOS award to the ***Edgar B. Speer****. From left, Captain L. G. Stolz, and mate Richard Robertson.*

Larry Hubble (a marine forecaster in Anchorage, Alaska) presented a VOS award to the ***Guardian****. Pictured left to right is Master Jim Faria and mate Steve Illiage.*

The ***Guardian*** *was presented a VOS award by Harry Hubble (a marine forecaster in Anchorage, Alaska).*

PMO Miami Bob Drummond presented a 1999 VOS award to Captain Patrick Van Deuran of the ***Charles Island.***

VOS Coop Ship Reports — January through April 2000

The National Climatic Data Center compiles the tables for the VOS Cooperative Ship Report from radio messages. The values under the monthly columns represent the number of weather reports received. Port Meteorological Officers supply ship names to the NCDC. Comments or questions regarding this report should be directed to NCDC, Operations Support Division, 151 Patton Avenue, Asheville, NC 28801, Attention: Dimitri Chappas (828-271-4060 or dchappas@ncdc.noaa.gov).

SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
1ST LT JACK LUMMUS	WJLV	New York City	0	0	0	13	13
A. V. KASTNER	ZCAM9	Jacksonville	0	27	75	34	136
AALSMEERGRACHT	PCAM	Long Beach	2	31	27	19	79
ADVANTAGE	WPPO	Norfolk	28	66	35	19	148
AGDLEK	OUGV	Miami	1	1	5	1	8
AGNES FOSS	WYZ3112	Seattle	24	11	33	8	76
AGULHAS	3ELE9	Baltimore	44	27	30	48	149
AL FUNTAS	9KKX	Miami	0	5	4	8	17
ALBEMARLE ISLAND	C6LU3	Newark	17	46	19	21	103
ALBERNI DAWN	ELAC5	Houston	16	24	47	47	134
ALBLASGRACHT	PCIG	Houston	22	28	8	40	98
ALEXANDER VON HUMBOLD	Y3CW	Miami	652	656	716	669	2693
ALFAMAR	TCYB	Norfolk	0	0	2	18	20
ALKMAN	C6OG4	Houston	32	37	59	38	166
ALLEGIANCE	WSKD	Norfolk	4	11	6	8	29
ALLIANCA AMERICA	DHGE	Baltimore	0	0	13	15	28
ALLIGATOR BRAVERY	3FXX4	Oakland	47	55	53	39	194
ALLIGATOR COLUMBUS	3ETV8	Seattle	36	38	12	19	105
ALLIGATOR FORTUNE	ELFK7	Seattle	12	16	12	12	52
ALLIGATOR GLORY	ELJP2	Seattle	43	45	13	40	141
ALLIGATOR HOPE	ELFN8	Seattle	6	3	3	6	18
ALLIGATOR LIBERTY	JFUG	Seattle	80	61	72	52	265
ALTAIR	DBBI	Miami	498	587	578	203	1866
AMBASSADOR BRIDGE	3ETH9	Oakland	54	59	79	61	253
AMERICA FEEDER	ELUZ8	Miami	0	0	1	0	1
AMERICA STAR	GZKA	Houston	71	79	77	96	323
AMERICAN MARINER	WQZ7791	Cleveland	2	0	0	11	13
AMERICAN MERLIN	WRGY	Norfolk	0	5	13	0	18
AMERICANA	C6QG4	New Orleans	5	7	0	0	12
ANASTASIS	9HOZ	Miami	11	1	2	0	14
ANATOLIY KOLESNICHENKO	UINM	Seattle	2	24	0	22	48
ANKERGRACHT	PCQL	Baltimore	37	80	39	82	238
APL CHINA	S6TA	Seattle	20	54	23	40	137
APL GARNET	9VVN	Oakland	22	25	10	4	61
APL JAPAN	S6TS	Seattle	62	32	28	17	139
APL KOREA	WCX8883	Seattle	49	44	15	19	127
APL PHILIPPINES	WCX8884	Seattle	13	16	41	33	103
APL SINGAPORE	WCX8812	Seattle	64	48	54	36	202
APL THAILAND	WCX8882	Seattle	38	47	57	27	169
APL TOURMALINE	9VVP	Oakland	54	58	73	54	239
APOLLOGRACHT	PCSV	Baltimore	14	60	39	32	145
AQUARIUS ACE	3FHB8	New York City	9	10	15	25	59
ARCO ALASKA	KSBK	Long Beach	14	7	13	9	43
ARCO CALIFORNIA	WMCV	Long Beach	0	1	5	0	6
ARCO FAIRBANKS	WGWB	Long Beach	62	41	0	6	109
ARCO INDEPENDENCE	KLHV	Long Beach	11	12	18	18	59
ARCO SPIRIT	KHLD	Long Beach	9	15	13	14	51
ARCO TEXAS	KNFD	Long Beach	9	8	4	3	24
ARCTIC OCEAN	C6T2062	Newark	13	9	4	0	26
ARGONAUT	KFDV	Newark	37	27	32	0	96
ARINA ARCTICA	OVYA2	Miami	66	102	91	51	310
ARTHUR M. ANDERSON	WE4805	Chicago	38	0	22	98	158
ASTORIA BRIDGE	ELJJ5	Long Beach	34	40	60	54	188
ATLANTIC	3FYT	Miami	199	196	164	233	792
ATLANTIC CARTIER	C6MS4	Norfolk	17	14	17	28	76
ATLANTIC COMPANION	SKPE	Newark	36	21	32	39	128

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
ATLANTIC COMPASS	SKUN	Norfolk	16	25	33	36	110
ATLANTIC CONCERT	SKOZ	Norfolk	8	5	0	1	14
ATLANTIC CONVEYOR	C6NI3	Norfolk	39	40	30	32	141
ATLANTIC ERIE	VCQM	Baltimore	1	1	0	0	2
ATLANTIC OCEAN	C6T2064	Newark	10	15	37	16	78
ATLANTIS	KAQP	New Orleans	0	0	0	13	13
AUCKLAND STAR	C6KV2	Baltimore	63	60	77	80	280
AUSTRAL RAINBOW	WEZP	New Orleans	19	0	0	0	19
B. T. ALASKA	WFQE	Long Beach	57	46	56	48	207
BARBARA ANDRIE	WTC9407	Chicago	0	0	0	18	18
BARRINGTON ISLAND	C6QK	Miami	54	40	36	34	164
BAY BRIDGE	ELES7	Long Beach	11	0	8	17	36
BERING SEA	C6YY	Miami	0	1	30	3	34
BERNARDO QUINTANA A	C6KJ5	New Orleans	10	18	31	26	85
BLACKHAWK	WBN2081	Seattle	5	2	2	11	20
BLUE GEMINI	3FPA6	Seattle	9	0	0	0	9
BLUE HAWK	D5HZ	Norfolk	21	16	19	9	65
BLUE NOVA	3FDV6	Seattle	20	28	45	31	124
BOHEME	SIVY	New York City	37	0	13	36	86
BONN EXPRESS	DGNB	Houston	488	591	694	457	2230
BP ADMIRAL	ZCAK2	Houston	2	1	0	0	3
BRIGHT PHOENIX	DXNG	Seattle	32	31	49	55	167
BRIGHT STATE	DXAC	Seattle	2	30	21	34	87
BRITISH ADVENTURE	ZCAK3	Seattle	19	45	69	29	162
BRITISH RANGER	ZCAS6	Houston	69	59	46	23	197
BROOKLYN BRIDGE	3EZJ9	Oakland	0	7	7	39	53
BT NESTOR	ZCBL4	New York City	15	52	0	0	67
BUCKEYE	WAQ3520	Cleveland	0	0	5	2	7
BUNGA ORKID DUA	9MBQ4	Seattle	23	0	0	0	23
BURNS HARBOR	WQZ7049	Chicago	0	0	22	109	131
CALCITE II	WB4520	Chicago	0	0	0	8	8
CALIFORNIA HIGHWAY	3FHQ4	Seattle	5	8	7	0	20
CALIFORNIA JUPITER	ELKU8	Long Beach	57	52	55	11	175
CALIFORNIA LUNA	S6CM	Seattle	0	0	1	1	2
CALIFORNIA MERCURY	JGPN	Seattle	27	13	0	10	50
CAPE MAY	JBCN	Norfolk	40	14	10	15	79
CAPT STEVEN L BENNETT	KAXO	New Orleans	7	4	6	0	17
CARIBBEAN MERCY	3FFU4	Miami	0	23	0	0	23
CARNIVAL DESTINY	3FKZ3	Miami	29	21	0	0	50
CARNIVAL PARADISE	3FOB5	Miami	58	44	56	40	198
CARNIVAL TRIUMPH	3FFM8	Miami	24	21	0	0	45
CAROLINA	WYBI	Jacksonville	0	0	6	33	39
CASON J. CALLAWAY	WE4879	Chicago	23	0	11	33	67
CELEBRATION	ELFT8	Miami	0	3	4	5	12
CENTURY HIGHWAY #2	3EJB9	Long Beach	23	21	23	19	86
CENTURY HIGHWAY NO. 1	3FFJ4	Houston	40	39	41	37	157
CENTURY HIGHWAY_NO. 3	8JNP	Houston	0	15	45	10	70
CENTURY LEADER NO. 1	3FBI6	Houston	43	38	37	29	147
CHARLES E. WILSON	WZE4539	Cleveland	0	0	0	18	18
CHARLES ISLAND	C6JT	Miami	62	71	70	70	273
CHARLES M. BEEGHLEY	WL3108	Cleveland	12	0	0	0	12
CHASTINE MAERSK	OWNJ2	New York City	6	0	0	0	6
CHELSEA	KNCX	Miami	16	6	0	0	22
CHEMICAL PIONEER	KAFO	Houston	23	41	17	11	92
CHEMICAL TRADER	KRGJ	Jacksonville	27	34	8	33	102
CHESAPEAKE BAY	WMLH	Houston	2	11	60	33	106
CHESAPEAKE TRADER	WGZK	Houston	79	65	81	58	283
CHEVRON ARIZONA	KGBE	Miami	0	0	4	16	20
CHEVRON ATLANTIC	C6KY3	New Orleans	26	4	0	0	30
CHEVRON COLORADO	KLHZ	Oakland	7	25	13	0	45
CHEVRON EMPLOYEE PRIDE	C6MC5	Baltimore	0	0	7	2	9
CHEVRON FELUY	C6FH5	Houston	23	28	88	77	216
CHEVRON MISSISSIPPI	WXBR	Oakland	43	46	44	29	162
CHEVRON PERTH	C6KQ8	Oakland	30	0	40	31	101
CHEVRON SOUTH AMERICA	ZCAA2	New Orleans	29	74	40	59	202
CHEVRON WASHINGTON	KFDB	Oakland	33	7	0	15	55
CHIEF GADAO	WEZD	Oakland	22	13	0	0	35
CHIQUITA BARU	ZCAY7	Jacksonville	0	2	0	7	9
CHIQUITA BELGIE	C6KD7	Baltimore	34	47	35	45	161
CHIQUITA BREMEN	ZCBC5	Miami	46	36	43	55	180
CHIQUITA BRENDA	ZCBE9	Miami	52	37	62	66	217
CHIQUITA DEUTSCHLAND	C6KD8	Baltimore	76	47	65	66	254
CHIQUITA ELKESCHLAND	ZCBB9	Miami	41	50	40	55	186

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
CHIQUITA FRANCES	ZCBD9	Miami	9	25	32	38	104
CHIQUITA ITALIA	C6KD5	Baltimore	44	17	36	49	146
CHIQUITA JEAN	ZCBB7	Jacksonville	44	26	40	26	136
CHIQUITA JOY	ZCBC2	Miami	26	44	45	31	146
CHIQUITA NEDERLAND	C6KD6	Baltimore	33	46	51	31	161
CHIQUITA ROSTOCK	ZCBD2	Miami	35	38	81	57	211
CHIQUITA SCANDINAVIA	C6KD4	Baltimore	45	42	39	52	178
CHIQUITA SCHWEIZ	C6KD9	Baltimore	25	51	54	50	180
CHO YANG ATLAS	DQVH	Seattle	42	53	34	40	169
CHOYANG PHOENIX	P3ZY6	Norfolk	0	46	59	15	120
CITY OF DURBAN	GXIC	Long Beach	68	70	73	63	274
CLEVELAND	KGXA	Houston	10	0	22	0	32
CMA CGM MONET	ELRR6	New Orleans	0	0	9	38	47
CMS ISLAND EXPRESS	J8NX	Miami	7	6	0	0	13
COASTAL MERCHANT	WCV8696	Seattle	8	0	18	39	65
COASTAL SEA	WCA7944	Seattle	0	0	1	1	2
COLORADO	KWFE	Miami	0	0	9	34	43
COLUMBIA STAR	C6HL8	Long Beach	71	0	0	0	71
COLUMBINE	3ELQ9	Baltimore	32	33	28	4	97
COLUMBUS CALIFORNIA	ELUB7	Houston	82	77	62	60	281
COLUMBUS CANADA	ELQN3	Seattle	9	2	21	0	32
COLUMBUS CANTERBURY	ELUB8	Norfolk	52	43	28	34	157
COLUMBUS QUEENSLAND	ELUB9	Norfolk	45	51	37	0	133
COLUMBUS VICTORIA	ELUB6	Long Beach	13	0	0	0	13
CONDOLEEZZA RICE	C6OK	Baltimore	0	8	81	0	89
CONTSHIP AMERICA	V7BZ3	Miami	45	31	32	53	161
CONTSHIP ENDEAVOUR	ZCBE7	Houston	32	36	41	33	142
CONTSHIP SUCCESS	ZCBE3	Houston	107	57	88	107	359
CORAL HIGHWAY	3FEB5	Jacksonville	0	0	0	5	5
CORAL SEA	C6YW	Miami	0	10	35	27	72
CORMORANT ARROW	C6IO9	Seattle	20	9	17	6	52
CORWITH CRAMER	WTF3319	Norfolk	8	23	5	20	56
COURTNEY BURTON	WE6970	Cleveland	10	0	0	8	18
COURTNEY L	ZCAQ8	Baltimore	16	10	13	17	56
CROWLEY UNIVERSE	ELRU3	Miami	24	14	20	15	73
CROWN OF SCANDINAVIA	OXRA6	Miami	70	66	51	47	234
CROWN PRINCESS	ELVK5	Miami	0	0	0	6	6
CSL CABO	D5XH	Seattle	21	47	71	60	199
DAGMAR MAERSK	DHAF	New York City	33	45	43	13	134
DAISHIN MARU	3FPS6	Seattle	96	72	101	77	346
DANIA PORTLAND	OXEH2	Miami	100	115	64	113	392
DARYA PREETH	VRUX8	Long Beach	1	0	0	0	1
DAWN PRINCESS	ELTO4	Miami	8	17	4	0	29
DELAWARE BAY	WMLG	Houston	22	24	15	12	73
DENALI	WSVR	Long Beach	66	59	25	12	162
DIRECT CONDOR	ELWP7	Long Beach	79	46	49	70	244
DIRECT EAGLE	ELWY5	Long Beach	73	38	56	43	210
DIRECT FALCON	ELWQ5	Long Beach	0	0	0	33	33
DIRECT KEA	ELWN7	Long Beach	0	0	2	0	2
DIRECT KOOKABURRA	ELWB8	Long Beach	9	12	20	2	43
DOCK EXPRESS 20	PJRF	Baltimore	0	0	55	74	129
DON QUIJOTE	SFQP	New York City	9	0	0	25	34
DORTHE OLDENDORFF	ELXC4	Seattle	0	37	23	20	80
DRAGOER MAERSK	OXPW2	Long Beach	22	50	8	22	102
DUHALLOW	ZCBH9	Baltimore	122	81	35	53	291
DUNCAN ISLAND	C6JS	Miami	44	19	28	23	114
EAGLE BEAUMONT	S6JO	New York City	0	2	0	0	2
EASTERN BRIDGE	C6JY9	Baltimore	0	29	70	91	190
ECSTASY	ELNC5	Miami	24	15	12	15	66
EDELWEISS	VRUM3	Seattle	21	2	1	0	24
EDGAR B. SPEER	WQZ9670	Chicago	54	1	37	110	202
EDWIN H. GOTT	WXQ4511	Chicago	23	0	8	41	72
EDYTH L	C6YC	Baltimore	63	28	82	44	217
EL MORRO	KCGH	Miami	3	4	3	19	29
EL YUNQUE	WGJT	Jacksonville	55	34	39	60	188
ELATION	3FOC5	Miami	1	2	9	0	12
EMPIRE STATE	KKFW	New York City	45	46	0	0	91
ENCHANTMENT OF THE SEAS	LAXA4	Miami	22	10	3	0	35
ENDEAVOR	WAUW	New York City	15	37	23	26	101
ENDURANCE	WAUU	New York City	47	4	31	45	127
ENGLISH STAR	C6KU7	Long Beach	83	70	77	75	305
ENIF	9VVI	Houston	0	4	26	26	56
ENTERPRISE	WAUY	New York City	6	45	25	31	107

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
EVER DAINTY	3FMZ7	Norfolk	0	0	5	0	5
EVER DELIGHT	3FCB8	New York City	0	2	0	0	2
EVER DELUXE	3FBE8	Norfolk	0	0	0	3	3
EVER DEVELOP	3FLF8	New York City	1	0	0	0	1
EVER DEVOTE	3FIF8	New York City	15	0	8	19	42
EVER DIADEM	3FOF8	New York City	5	5	6	0	16
EVER GAINING	BKJO	Norfolk	12	6	8	0	26
EVER GIFTED	BKHF	Long Beach	2	7	0	0	9
EVER GUIDE	3EVJ2	Seattle	12	0	9	18	39
EVER LEVEL	BKHJ	Miami	8	0	2	4	14
EVER REFINE	3FSB4	New York City	9	0	13	0	22
EVER RESULT	3FSA4	Norfolk	5	9	8	10	32
EVER RIGHT	3FML3	Long Beach	4	3	15	0	22
EVER ROUND	3FQN3	Long Beach	0	13	5	7	25
EVER ROYAL	3FGI3	Long Beach	3	3	0	0	6
EVER ULTRA	3FEJ6	Seattle	13	3	3	8	27
EVER UNION	3FFG7	Seattle	19	17	6	2	44
EVER UNISON	3FTL6	Long Beach	5	0	0	4	9
FAIRLIFT	PEBM	Norfolk	19	8	0	8	35
FAIRMAST	PJLC	Norfolk	7	4	7	38	56
FANTASY	ELKI6	Miami	8	7	9	9	33
FASCINATION	3EWK9	Miami	0	1	1	0	2
FAUST	WRYX	Jacksonville	45	43	47	36	171
FEDERAL BASFIN	8PNO	Norfolk	3	0	0	0	3
FIDELIO	WQVY	Jacksonville	57	59	52	38	206
FIGARO	S6PI	Newark	30	21	46	23	120
FINAL TRADER	VRUY4	Seattle	2	39	24	29	94
FRANCES HAMMER	KRGC	Jacksonville	0	0	22	25	47
FRANCES L	C6YE	Baltimore	7	15	12	29	63
FRANK A. SHRONTZ	C6PZ3	Oakland	10	0	0	12	22
FRANKFURT EXPRESS	9VPP	New York City	7	1	1	10	19
G AND C PARANA	LADC2	Long Beach	5	3	1	0	9
GALVESTON BAY	WPKD	Houston	51	54	60	36	201
GANNET ARROW	C6QF5	Seattle	0	0	0	7	7
GEETA	VRUL7	New Orleans	11	5	4	0	20
GEMINI	KHCF	New York City	24	26	17	0	67
GEORGE A. SLOAN	WA5307	Chicago	0	0	0	6	6
GEORGE A. STINSON	WCX2417	Cleveland	0	0	0	3	3
GEORGE SCHULTZ	C6FD4	Baltimore	17	17	19	12	65
GEORGE WASHINGTON BRIDGE	JKCF	Seattle	63	36	53	53	205
GEORGIA RAINBOW II	VRVS5	Jacksonville	22	79	31	67	199
GLOBAL LINK	WWDY	Baltimore	33	0	0	0	33
GLOBAL MARINER	WWXA	Baltimore	22	0	18	9	49
GLOBAL SENTINEL	WRZU	Baltimore	0	3	29	0	32
GLORIOUS SUCCESS	DUHN	Seattle	41	4	39	51	135
GOLDEN BEAR	NMRY	Oakland	0	0	0	15	15
GOLDEN BELL	3EBK9	Seattle	19	23	1	0	43
GOLDEN GATE	KIOH	Long Beach	53	61	60	29	203
GOLDEN GATE BRIDGE	3FWM4	Long Beach	108	85	102	82	377
GRANDEUR OF THE SEAS	ELTQ9	Miami	0	1	1	7	9
GREAT LAND	WFDP	Seattle	0	11	35	32	78
GREEN BAY	KGTH	Long Beach	56	21	43	67	187
GREEN ISLAND	KIBK	New Orleans	0	0	3	0	3
GREEN LAKE	KGTI	Baltimore	80	56	42	36	214
GREEN POINT	WCY4148	New York City	0	7	31	11	49
GREEN RAINIER	3ENI3	Seattle	35	29	23	38	125
GRETE MAERSK	OZNF2	New York City	26	3	8	17	54
GROTON	KMJL	Newark	6	2	6	1	15
GUANAJUATO	ELMH8	Jacksonville	12	0	0	0	12
GUAYAMA	WZJG	Jacksonville	33	39	31	20	123
GYPSUM BARON	ZCAN3	Norfolk	0	0	0	28	28
HADERA	ELBX4	Baltimore	76	76	72	45	269
HANJIN HONG KONG	P3UX7	Long Beach	3	0	0	0	3
HANJIN KEELUNG	P3VH7	Houston	11	3	7	5	26
HANJIN NAGOYA	3FJW8	New York City	14	3	0	0	17
HANJIN OSAKA	3EQD9	New York City	7	0	0	6	13
HEAVEN RIVER	ELVF6	Long Beach	8	3	0	5	16
HEIDELBERG EXPRESS	DEDI	Houston	450	570	335	649	2004
HENRY HUDSON BRIDGE	JKLS	Seattle	69	70	59	55	253
HERBERT C. JACKSON	WL3972	Cleveland	0	0	2	15	17
HOEGH DENE	ELWO7	Norfolk	3	17	0	0	20
HOEGH DUKE	ELWP2	Norfolk	0	0	24	0	24
HOLIDAY	3FPN5	Long Beach	0	5	0	0	5

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
HONG KONG SENATOR	DEIP	Seattle	55	38	48	58	199
HONSHU SILVIA	3EST7	Seattle	38	45	22	37	142
HOOD ISLAND	C6LU4	Miami	30	32	35	42	139
HORIZON	ELNG6	Miami	0	0	1	0	1
HOUSTON EXPRESS	3FQT9	Houston	36	27	45	15	123
HUAL ASIA	C6QX7	New York City	0	0	1	0	1
HUMACAO	WZJB	Norfolk	40	33	35	0	108
HUMBERGRACHT	PEUQ	Houston	60	54	9	22	145
HUME HIGHWAY	3EJO6	Jacksonville	12	19	30	5	66
HYUNDAI DISCOVERY	3FFR6	Seattle	37	23	56	38	154
HYUNDAI EXPLORER	3FTG4	Seattle	72	24	43	28	167
HYUNDAI FORTUNE	3FLG6	Seattle	1	15	5	10	31
HYUNDAI FREEDOM	3FFS6	Seattle	19	18	25	12	74
HYUNDAI INDEPENDENCE	3FDY6	Seattle	0	20	6	11	37
HYUNDAI LIBERTY	3FFT6	Seattle	11	12	11	15	49
IMAGINATION	3EWJ9	Miami	7	6	0	0	13
INDAMEX NEW YORK	C6W2034	New Orleans	0	0	0	3	3
INDIAN OCEAN	C6T2063	New York City	21	12	14	21	68
INDIANA HARBOR	WXN3191	Cleveland	0	0	0	73	73
IRENA ARCTICA	OXTS2	Miami	112	118	104	61	395
ISLA DE CEDROS	3FOA6	Seattle	46	36	56	42	180
ITB BALTIMORE	WXKM	Baltimore	1	1	20	0	22
ITB MOBILE	KXDB	New York City	0	5	6	0	11
ITB NEW YORK	WVDG	Newark	0	0	4	5	9
IWANUMA MARU	3ESU8	Seattle	87	79	101	61	328
J. BENNETT JOHNSTON	C6QE3	Oakland	0	2	3	0	5
J.A.W. IGLEHART	WTP4966	Cleveland	0	0	0	4	4
JACKLYN M.	WCV7620	Chicago	6	1	11	10	28
JACKSONVILLE	WNDG	Baltimore	19	3	1	5	28
JADE PACIFIC	ELRY5	Seattle	12	22	21	7	62
JEB STUART	WRGQ	Oakland	7	6	6	2	21
JO CLIPPER	PFEZ	Baltimore	31	76	42	3	152
JOHN G. MUNSON	WE3806	Chicago	19	0	7	31	57
JOHN J. BOLAND	WF2560	Cleveland	0	0	0	5	5
JOIDES RESOLUTION	D5BC	Norfolk	45	76	34	49	204
JOSEPH	ELRZ8	Houston	42	43	43	30	158
JOSEPH L. BLOCK	WXY6216	Chicago	9	0	0	0	9
JUBILEE	3FPM5	Long Beach	29	7	0	0	36
JUDY LITRICO	KCKB	Houston	9	4	5	0	18
JUSTINE FOSS	WYL4978	Seattle	1	0	0	0	1
KANIN	ELEO2	New Orleans	31	11	50	35	127
KAPITAN BYANKIN	UAGK	Seattle	63	49	51	19	182
KAPITAN KONEV	UAHV	Seattle	53	49	61	23	186
KAPITAN MASLOV	UBRO	Seattle	2	10	0	0	12
KAREN ANDRIE	WBS5272	Chicago	14	0	1	10	25
KAREN MAERSK	OZKN2	Seattle	0	39	0	0	39
KATRINE MAERSK	OZLL2	New York City	0	9	6	0	15
KAUAI	WSRH	Long Beach	3	3	32	9	47
KAYE E. BARKER	WCF3012	Cleveland	0	0	2	0	2
KAZIMAH	9KKL	Houston	93	0	94	75	262
KEE LUNG	BHFN	Seattle	0	0	0	2	2
KEN KOKU	3FMN6	Seattle	0	0	1	0	1
KEN SHIN	YJQS2	Seattle	30	10	16	23	79
KEN SHO	3FMS5	Seattle	0	23	0	0	23
KENAI	WSNB	Houston	16	5	1	3	25
KENNETH E. HILL	C6FA6	Newark	19	10	12	19	60
KENNETH T. DERR	C6FA3	Newark	11	11	0	0	22
KENNICOTT	WCY2920	Seattle	0	0	1	0	1
KENTUCKY HIGHWAY	JKPP	Norfolk	5	0	14	11	30
KIRSTEN MAERSK	OYDM2	Seattle	0	29	17	0	46
KIWI ARROW	C6HU6	Houston	37	25	32	17	111
KNOCK ALLAN	ELOI6	Houston	109	65	100	80	354
KNUD MAERSK	OYBJ2	New York City	0	0	8	0	8
KOELN EXPRESS	9VBL	New York City	320	576	502	683	2081
KURE	3FGN3	Seattle	27	10	22	19	78
LAKE GUARDIAN	WAO9082	Chicago	0	0	3	0	3
LEE A. TREGURTHA	WUR8857	Cleveland	0	0	2	0	2
LEONARD J. COWLEY	CG2959	Norfolk	5	53	91	38	187
LIBERTY SEA	KPZH	New Orleans	0	0	0	14	14
LIBERTY SPIRIT	WCPU	New Orleans	0	32	46	49	127
LIBERTY STAR	WCBP	New Orleans	0	24	28	27	79
LIBERTY SUN	WCOB	Houston	39	29	0	0	68
LIHUE	WTST	Oakland	55	46	36	39	176

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
LILAC ACE	3FDL4	Long Beach	4	14	13	8	39
LNG AQUARIUS	WSKJ	Oakland	35	22	28	22	107
LNG ARIES	KGBD	New York City	0	16	52	35	103
LNG CAPRICORN	KHLN	New York City	19	22	17	1	59
LNG LEO	WDZB	New York City	42	23	7	20	92
LNG LIBRA	WDZG	New York City	53	49	44	18	164
LNG TAURUS	WDZW	New York City	19	16	11	11	57
LNG VIRGO	WDZX	New York City	16	9	7	21	53
LOK PRAGATI	ATZS	Seattle	1	10	9	0	20
LOOTSGRACHT	PFPT	Houston	40	34	43	48	165
LUISE OLDENDORFF	3FOW4	Seattle	46	28	58	49	181
LURLINE	WLVD	Oakland	72	53	27	35	187
LYKES CHALLANGER	FNHV	Houston	78	65	88	74	305
LYKES CHALLENGER	ELXM4	Houston	42	47	6	1	96
LYKES COMMANDER	3ELF9	Baltimore	29	58	35	65	187
LYKES CONDOR	DGGD	Houston	32	37	50	29	148
LYKES DISCOVERER	WGXO	Houston	55	46	49	81	231
LYKES EAGLE	DNEN	Houston	33	33	55	55	176
LYKES EXPLORER	WGLA	Houston	38	25	38	17	118
LYKES HAWK	ELVB6	Houston	58	29	13	13	113
LYKES LIBERATOR	WGXN	Houston	18	16	43	43	120
LYKES NAVIGATOR	WGMJ	Houston	35	47	36	47	165
LYKES PATHFINDER	3EJT9	Baltimore	0	1	0	0	1
LYKES RAVEN	DIGF	Houston	59	33	31	29	152
M/V SP5. ERIC G. GIBSON	KAKF	Baltimore	0	0	0	11	11
MAASDAM	PFRO	Miami	0	5	44	40	89
MACKINAC BRIDGE	JKES	Seattle	62	61	84	76	283
MADISON MAERSK	OVJB2	Oakland	12	12	10	31	65
MAERSK ARIZONA	KAKG	Baltimore	10	5	1	0	16
MAERSK CALIFORNIA	WCX5083	Miami	18	29	18	3	68
MAERSK GANNET	GJLK	Miami	0	3	0	0	3
MAERSK GIANT	OU2465	Miami	238	228	245	237	948
MAERSK SCOTLAND	MXAR9	Houston	33	12	0	27	72
MAERSK SEA	S6CW	Seattle	62	45	65	44	216
MAERSK SHETLAND	MSQK3	Miami	76	45	71	31	223
MAERSK SOMERSET	MQVF8	New Orleans	64	19	48	32	163
MAERSK STAFFORD	MRSS9	New Orleans	32	9	0	28	69
MAERSK SURREY	MRSG8	Houston	4	48	9	14	75
MAERSK TAIKI	9VIG	Baltimore	47	62	0	0	109
MAERSK TENNESSEE	WCX3486	Miami	43	35	71	51	200
MAERSK TEXAS	WCX3249	Miami	22	41	39	25	127
MAERSK VALENCIA	ELXK7	Norfolk	4	46	41	54	145
MAGLEBY MAERSK	OUSH2	Newark	34	15	16	16	81
MAHARASHTRA	VTSQ	Seattle	0	1	14	5	20
MAHIMAHI	WHRN	Oakland	35	72	69	35	211
MAIRANGI BAY	GXEW	Long Beach	44	76	72	39	231
MAJESTY OF THE SEAS	LAOI4	Miami	6	0	0	0	6
MANHATTAN BRIDGE	3FWL4	Seattle	54	67	66	43	230
MANOA	KDBG	Oakland	53	66	56	50	225
MANUKAI	KNLO	Oakland	43	0	0	0	43
MARCHEN MAERSK	OWDQ2	Long Beach	18	30	38	7	93
MAREN MAERSK	OWZU2	Long Beach	14	13	13	23	63
MARGRETHE MAERSK	OYSN2	Long Beach	4	37	15	8	64
MARIE MAERSK	OULL2	Newark	28	18	0	8	54
MARINE CHEMIST	KMCB	Houston	5	16	39	39	99
MARINE COLUMBIA	KLKZ	Oakland	4	9	28	25	66
MARIT MAERSK	OZFC2	Miami	7	13	33	28	81
MARK HANNAH	WYZ5243	Chicago	5	1	13	18	37
MATHILDE MAERSK	OUUU2	Long Beach	21	15	0	14	50
MATSONIA	KHRC	Oakland	61	50	43	48	202
MAUI	WSLH	Long Beach	14	18	15	21	68
MAURICE EWING	WLDZ	Newark	54	75	78	78	285
MAYAGUEZ	WZJE	Jacksonville	18	33	36	32	119
MAYVIEW MAERSK	OWEB2	Oakland	23	20	11	22	76
MC-KINNEY MAERSK	OUZW2	Newark	15	17	8	14	54
MEKHANIK KALYUZHNIY	UFLO	Seattle	39	27	35	31	132
MEKHANIK MOLDOVANOV	UIKI	Seattle	62	69	57	52	240
MELBOURNE STAR	GOVL	Newark	34	65	67	80	246
MELVILLE	WECB	Long Beach	0	37	77	93	207
MERCURY	3FFC7	Miami	0	0	0	4	4
MESABI MINER	WYQ4356	Cleveland	23	0	21	60	104
METEOR	DBBH	Houston	579	536	612	712	2439
METTE MAERSK	OXKT2	Long Beach	11	47	39	10	107

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
MICHIGAN	WRB4141	Chicago	11	5	7	5	28
MIDDLETOWN	WR3225	Cleveland	0	0	0	1	1
MING ASIA	BDEA	New York City	22	24	23	28	97
MOKIHANA	WNRD	Oakland	42	54	67	51	214
MOKU PAHU	WBWK	Oakland	41	0	0	0	41
MONCHEGORSK	P3NL5	Houston	32	1	0	0	33
MORELOS	PGBB	Houston	46	43	21	53	163
MORMACSKY	WMBQ	New York City	12	8	0	0	20
MORMACSTAR	KGDF	Houston	36	25	20	22	103
MORMACSUN	WMBK	Norfolk	34	67	21	19	141
MOSEL ORE	ELRE5	Norfolk	39	62	67	65	233
MSC BOSTON	9HGP4	New York City	48	72	36	0	156
MSC CALIFORNIA	LAKS5	Seattle	68	37	64	49	218
MSC FEDERICA	C4LV	New York City	27	36	43	44	150
MSC NEW YORK	9HIG4	New York City	48	66	2	0	116
MSC PATAGONIA	P3TA4	Norfolk	1	0	0	0	1
MSC XINGANG	3EHR6	Norfolk	0	0	0	12	12
MV CONTSHIP ROME	ELVZ6	Norfolk	65	36	43	69	213
MYRON C. TAYLOR	WA8463	Chicago	0	0	0	15	15
MYSTIC	PCCQ	Long Beach	49	58	14	0	121
NATHANIEL B. PALMER	WBP3210	Seattle	38	10	6	0	54
NATIONAL HONOR	DZDI	Long Beach	0	1	0	0	1
NEDLLOYD HOLLAND	KRHX	Houston	51	48	49	39	187
NEDLLOYD RALEIGH BAY	PHKG	Houston	13	15	37	45	110
NELVANA	YJWZ7	Baltimore	7	0	0	7	14
NEPTUNE RHODONITE	ELJP4	Long Beach	12	3	18	4	37
NEW HORIZON	WKWB	Long Beach	14	0	0	0	14
NEW NIKKI	3FHG5	Seattle	57	44	0	84	185
NEWARK BAY	WPKS	Houston	76	61	49	67	253
NIEUW AMSTERDAM	PGGQ	Long Beach	2	0	1	15	18
NOAA DAVID STARR JORDAN	WTDK	Seattle	0	0	0	47	47
NOAA SHIP ALBATROSS IV	WMVF	Norfolk	0	0	40	58	98
NOAA SHIP DELAWARE II	KNBD	New York City	0	39	51	32	122
NOAA SHIP KA'IMIMOANA	WTEU	Seattle	0	87	10	45	142
NOAA SHIP MCARTHUR	WTEJ	Seattle	11	26	0	0	37
NOAA SHIP MILLER FREEMAN	WTDM	Seattle	1	109	154	33	297
NOAA SHIP OREGON II	WTDO	New Orleans	131	148	44	0	323
NOAA SHIP RONALD H BROWN	WTEC	New Orleans	0	15	65	17	97
NOAA SHIP T. CROMWELL	WTDF	Seattle	0	11	77	70	158
NOAA SHIP WHITING	WTEW	Baltimore	0	0	3	45	48
NOAAS GORDON GUNTER	WTEO	New Orleans	0	100	164	54	318
NOBEL STAR	KRPP	Houston	26	30	23	0	79
NOBLE STAR	3FRU7	Seattle	35	88	0	0	123
NOL STENO	ZCBD4	New York City	42	40	38	29	149
NOLIZWE	MQLN7	New York City	14	45	66	50	175
NOMZI	MTQU3	Baltimore	81	67	47	51	246
NOORDAM	PGHT	Miami	7	1	1	4	13
NORASIA SHANGHAI	DNHS	New York City	11	30	37	62	140
NORD JAHRE TRANSPORTER	LACF4	Baltimore	6	10	3	4	23
NORDMAX	P3YS5	Seattle	71	60	88	64	283
NORDMORITZ	P3YR5	Seattle	34	76	70	76	256
NORTHERN LIGHTS	WFJK	New Orleans	42	18	27	49	136
NORWAY	C6CM7	Miami	3	0	0	0	3
NORWEGIAN MAJESTY	C6OY4	Miami	0	1	0	0	1
NTABENI	3EGR6	Houston	66	69	22	50	207
NUERNBERG EXPRESS	9VBK	Houston	725	669	723	704	2821
NYK SPRINGTIDE	S6CZ	Seattle	11	15	10	18	54
NYK STARLIGHT	3FUX6	Long Beach	60	32	48	20	160
OCEAN CAMELLIA	3FTR6	Seattle	10	37	70	59	176
OCEAN CITY	WCYR	Houston	0	0	0	53	53
OCEAN CLIPPER	3EXI7	New Orleans	0	7	1	45	53
OCEAN PALM	3FDO7	Seattle	69	76	59	55	259
OCEAN SERENE	DURY	Seattle	15	7	15	0	37
OCEANBREEZE	ELLY4	Miami	22	17	33	23	95
OGLEBAY NORTON	WAQ3521	Cleveland	1	0	6	4	11
OLEANDER	PJJU	Newark	29	56	50	37	172
OLYMPIAN HIGHWAY	3FSH4	Seattle	22	9	10	17	58
OOCL FAIR	VRWB8	Long Beach	24	41	63	27	155
OOCL FIDELITY	VRWG5	Long Beach	50	58	16	35	159
OOCL FORTUNE	VRWF2	Norfolk	10	48	20	29	107
OOCL FREEDOM	VRCV	Norfolk	34	34	17	27	112
OOCL FRIENDSHIP	VRWD3	Long Beach	0	0	37	41	78
OOCL HONG KONG	VRVA5	Oakland	34	27	29	36	126

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
OOCL INNOVATION	WPWH	Houston	43	43	50	31	167
OOCL INSPIRATION	KRPB	Houston	55	54	75	46	230
ORIANA	GVSN	Miami	51	52	63	48	214
ORIENTAL ROAD	3FXT6	Houston	0	0	58	73	131
ORIENTE HOPE	3ETH4	Seattle	0	0	51	9	60
ORIENTE VICTORIA	3FVG8	Seattle	7	0	16	20	43
OURO DO BRASIL	ELPP9	Baltimore	0	0	2	4	6
OVERSEAS HARRIETT	WRFJ	Houston	0	17	6	28	51
OVERSEAS JOYCE	WUQL	Jacksonville	42	32	48	31	153
OVERSEAS MARILYN	WFQB	Houston	4	26	6	2	38
OVERSEAS NEW ORLEANS	WFKW	Houston	20	38	27	22	107
OVERSEAS NEW YORK	WMCK	Houston	19	12	19	2	52
OVERSEAS OHIO	WJBG	Oakland	18	23	19	7	67
OVERSEAS PHILADELPHIA	WGDB	Houston	13	9	3	0	25
OVERSEAS WASHINGTON	WFGV	Houston	18	13	15	13	59
P & O NEDLLOYD BUENOS AI	PGEC	Houston	25	32	12	44	113
P & O NEDLLOYD VERA CRUZ	PGFE	Houston	16	30	22	16	84
P&O NEDLLOYD HOUSTON	PGEB	Houston	55	34	37	21	147
P&O NEDLLOYD LOS ANGELES	PGDW	Long Beach	17	27	69	91	204
P&O NEDLLOYD MARSEILLE	MYSU5	Seattle	59	54	64	58	235
P&O NEDLLOYD SYDNEY	PDHY	Seattle	45	57	53	42	197
P&O NEDLLOYD TEXAS	ZCBF6	Houston	61	46	53	79	239
PACDREAM	ELQO6	Seattle	17	10	18	20	65
PACIFIC HIRO	3FOY5	Seattle	0	24	23	0	47
PACIFIC PRINCESS	GBCF	New York City	15	65	56	12	148
PACIFIC SENATOR	ELTY6	Long Beach	39	0	0	54	93
PACKING	ELBX3	Seattle	6	7	20	0	33
PACOCEAN	ELJE3	Seattle	30	31	19	28	108
PACPRINCE	ELED7	Seattle	17	4	11	10	42
PACPRINCESS	ELED8	Houston	31	19	24	45	119
PAUL BUCK	KDGR	Houston	22	4	17	1	44
PAUL R. TREGURTHA	WYR4481	Cleveland	1	0	10	25	36
PEARL ACE	VRUN4	Seattle	58	68	62	48	236
PEGASUS HIGHWAY	3FMA4	New York City	0	0	6	12	18
PELAGIA	PGRQ	Houston	20	4	64	46	134
PFC EUGENE A. OBREGON	WHAQ	Norfolk	0	0	4	15	19
PHILIP R. CLARKE	WE3592	Chicago	28	0	3	7	38
PISCES EXPLORER	MWQD5	Long Beach	10	56	53	38	157
POLYNESIA	D5NZ	Long Beach	72	78	91	89	330
POTOMAC TRADER	WXBZ	Houston	52	77	32	64	225
PRESIDENT ADAMS	WRYW	Oakland	71	57	37	52	217
PRESIDENT GRANT	WCY2098	Long Beach	33	27	11	6	77
PRESIDENT JACKSON	WRYC	Oakland	63	48	64	69	244
PRESIDENT KENNEDY	WRYE	Oakland	76	58	59	46	239
PRESIDENT POLK	WRYD	Oakland	78	56	74	72	280
PRESIDENT TRUMAN	WNDP	Oakland	60	51	44	45	200
PRESQUE ISLE	WZE4928	Chicago	19	0	10	26	55
PRIDE OF BALTIMORE II	WUW2120	Baltimore	0	0	0	6	6
PRINCE WILLIAM SOUND	WSDX	Long Beach	1	0	0	0	1
PRINCES HIGHWAY	3ERU8	Jacksonville	0	75	64	66	205
PROJECT ARABIA	PJKP	Miami	0	24	12	4	40
PROJECT ORIENT	PJAG	Baltimore	3	0	22	46	71
PUDONG SENATOR	DQVI	Seattle	89	58	80	86	313
PUSAN SENATOR	DQVG	Seattle	83	50	38	64	235
QUEEN ELIZABETH 2	GBTT	New York City	61	39	36	55	191
QUEEN OF SCANDINAVIA	OUSE6	Miami	1	10	15	22	48
QUEENSLAND STAR	MZBM7	Houston	0	13	69	69	151
R.J. PFEIFFER	WRJP	Long Beach	22	28	25	24	99
RAINBOW BRIDGE	3EYX9	Seattle	85	66	68	38	257
RAYMOND E. GALVIN	C6FD6	Oakland	11	6	16	11	44
REGAL EMPRESS	C6LW2	New York City	0	0	5	8	13
RENEGADE	ZCMF9	Miami	0	0	0	15	15
REPULSE BAY	MQYA3	Houston	9	0	8	1	18
RESOLUTE	KFDZ	Norfolk	58	29	23	0	110
RHAPSODY OF THE SEAS	LAZK4	Miami	2	8	0	0	10
RHINE FOREST	ELFO3	New Orleans	0	1	0	0	1
RICHARD G MATTHIESEN	WLBV	Jacksonville	32	12	0	0	44
RICHARD H MATZKE	C6FE5	Oakland	12	11	0	3	26
RICHARD REISS	WBF2376	Cleveland	0	0	0	2	2
RIO APURE	ELUG7	Miami	20	34	23	30	107
ROBERT E. LEE	KCRD	New Orleans	27	9	0	12	48
ROGER BLOUGH	WZP8164	Chicago	25	0	9	23	57
ROGER REVELLE	KAOU	New Orleans	44	9	41	45	139

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
ROTTERDAM EXPRESS	S6IG	Long Beach	0	0	0	573	573
ROYAL PRINCESS	GBRP	Long Beach	34	35	28	48	145
RUBIN ARTEMIS	3FAH7	Seattle	0	0	1	0	1
RUBIN BONANZA	3FNV5	Seattle	28	16	0	43	87
RUBIN KOBE	DYZM	Seattle	33	71	32	91	227
RUBIN PEARL	YJQA8	Seattle	96	48	62	60	266
SAGA CREST	LATH4	Miami	1	51	28	11	91
SALLY MAERSK	OZHS2	Seattle	11	0	29	31	71
SALOME	S6CL	Newark	26	11	7	3	47
SAM HOUSTON	KDGA	Houston	36	5	27	11	79
SAMUEL L. COBB	KCDJ	Oakland	0	0	1	1	2
SAMUEL RISLEY	CG2960	Norfolk	176	184	173	101	634
SAN ISIDRO	ELVG8	Norfolk	19	3	1	0	23
SAN MARCOS	ELND4	Jacksonville	9	29	13	38	89
SANTA BARBARA	ELOT3	Seattle	3	1	4	2	10
SANTA CHRISTINA	3FAE6	Seattle	12	5	0	0	17
SANTA MONICA	ELNJ3	Seattle	47	44	27	55	173
SAUDI MAKKAH	HZQZ	Houston	0	0	0	4	4
SC BREEZE	ELOC6	New York City	0	28	26	14	68
SCL INFANTA	GBSA	Houston	41	37	54	56	188
SEA FOX	KBGK	Jacksonville	44	0	0	0	44
SEA INITIATIVE	DEBB	Houston	23	18	18	24	83
SEA MARINER	J8FF9	Miami	40	57	34	83	214
SEA PRINCESS	KRCP	New Orleans	1	29	0	69	99
SEA RACER	ELQI8	Jacksonville	57	43	34	47	181
SEA VALOR	WBN9212	Seattle	0	0	0	5	5
SEA WISDOM	3FUO6	Seattle	42	31	0	0	73
SEA-LAND CHARGER	V7AY2	Long Beach	6	42	34	34	116
SEA-LAND DISCOVERY	WZJD	Jacksonville	72	56	63	70	261
SEA-LAND EAGLE	V7AZ8	Long Beach	57	1	39	31	128
SEA/LAND VICTORY	DIDY	New York City	26	11	9	24	70
SEABOARD FLORIDA	3FBW5	Miami	0	4	0	0	4
SEABOARD SUN	ELRV6	Jacksonville	0	1	0	0	1
SEALAND ANCHORAGE	KGTX	Seattle	59	59	35	56	209
SEALAND ATLANTIC	KRLZ	Norfolk	53	28	58	31	170
SEALAND CHALLENGER	WZJC	Oakland	20	23	19	2	64
SEALAND CHAMPION	V7AM9	Oakland	11	62	20	27	120
SEALAND COMET	V7AP3	Oakland	29	45	24	35	133
SEALAND CONSUMER	WCHF	Houston	45	41	20	31	137
SEALAND CRUSADER	WZJF	Jacksonville	61	78	75	44	258
SEALAND DEFENDER	KGJB	Oakland	48	49	35	30	162
SEALAND DEVELOPER	KHRH	Long Beach	68	54	39	36	197
SEALAND ENDURANCE	KGJX	Long Beach	39	37	39	13	128
SEALAND ENTERPRISE	KRGB	Oakland	47	66	75	76	264
SEALAND EXPEDITION	WPGJ	Jacksonville	60	63	55	41	219
SEALAND EXPLORER	WGJF	Long Beach	22	21	54	52	149
SEALAND EXPRESS	KGJD	Long Beach	20	7	37	30	94
SEALAND FREEDOM	V7AM3	Houston	56	40	22	8	126
SEALAND HAWAII	KIRF	Seattle	48	28	5	39	120
SEALAND HONDURAS	OUQP2	Miami	51	42	29	31	153
SEALAND INDEPENDENCE	WGJC	Long Beach	63	36	10	4	113
SEALAND INNOVATOR	WGKF	Oakland	42	56	29	21	148
SEALAND INTEGRITY	WPVD	Norfolk	48	78	131	90	347
SEALAND INTREPID	9VWZ	Norfolk	0	0	49	27	76
SEALAND KODIAK	KGTZ	Seattle	55	44	50	40	189
SEALAND LIBERATOR	KHRP	Oakland	52	24	35	26	137
SEALAND MARINER	V7AM5	Houston	8	17	20	16	61
SEALAND MERCURY	V7AP6	Oakland	61	15	15	57	148
SEALAND METEOR	V7AP7	Long Beach	33	45	23	39	140
SEALAND NAVIGATOR	WPGK	Long Beach	68	71	79	53	271
SEALAND PACIFIC	WSRL	Long Beach	55	49	64	38	206
SEALAND PATRIOT	KHRF	Oakland	32	33	24	28	117
SEALAND PERFORMANCE	KRPD	Houston	63	70	66	49	248
SEALAND PRODUCER	WJBJ	Long Beach	77	64	66	67	274
SEALAND QUALITY	KRNJ	Jacksonville	51	42	47	44	184
SEALAND RACER	V7AP8	Long Beach	22	17	43	11	93
SEALAND RELIANCE	WFLH	Long Beach	0	42	65	75	182
SEALAND SPIRIT	WFLG	Oakland	51	57	56	33	197
SEALAND TACOMA	KGTY	Seattle	50	40	53	52	195
SEALAND TRADER	KIRH	Oakland	30	51	54	56	191
SEALAND VOYAGER	KHRK	Long Beach	57	47	38	40	182
SEARIVER BAYTOWN	KFPM	Oakland	7	1	13	13	34
SEARIVER NORTH SLOPE	KHLQ	Oakland	6	9	9	14	38

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
SENSATION	3ESE9	Miami	0	16	0	0	16
SETO BRIDGE	JMQY	Oakland	39	31	72	40	182
SEVEN OCEAN	3EZB8	Seattle	15	0	0	0	15
SEWARD JOHNSON	WST9756	Miami	27	10	0	0	37
SHIRAOI MARU	3ECM7	Seattle	141	131	104	166	542
SIDNEY FOSS	WYL5445	Seattle	10	14	15	13	52
SINE MAERSK	OZOK2	Seattle	0	0	6	1	7
SINGA STAR	9VNF	Seattle	0	58	76	0	134
SKAGEN MAERSK	OYOS2	Seattle	13	12	0	6	31
SKAUBRYN	LAJV4	Seattle	16	32	51	84	183
SKAUGRAN	LADB2	Seattle	0	1	26	34	61
SKODSBORG	OYRJ4	Houston	24	4	0	0	28
SNOW CRYSTAL	C6ID8	New York City	81	66	91	85	323
SOFIE MAERSK	OZUN2	Seattle	0	21	0	1	22
SOL DO BRASIL	ELQQ4	Baltimore	57	54	17	34	162
SOLAR WING	ELJS7	Jacksonville	78	79	78	84	319
SOROE MAERSK	OYKJ2	Seattle	3	0	0	33	36
SOUTH FORTUNE	3FJC6	Seattle	13	0	0	35	48
SOUTHDOWN CHALLENGER	WA4659	Cleveland	14	0	0	29	43
SOVEREIGN MAERSK	OYGA2	Seattle	6	0	0	0	6
SOVEREIGN OF THE SEAS	LAEB2	Miami	1	3	2	0	6
SPLENDOUR OF THE SEAS	LAUS4	Miami	23	20	18	8	69
ST BLAIZE	J8FO	Norfolk	16	11	0	5	32
STAR ALABAMA	LAVU4	Baltimore	19	0	29	0	48
STAR AMERICA	LAVV4	Jacksonville	20	36	0	0	56
STAR DOVER	LAEP4	Seattle	51	38	55	62	206
STAR EVVIVA	LAHE2	Jacksonville	32	40	30	17	119
STAR FRASER	LAVY4	Norfolk	23	30	38	26	117
STAR GEIRANGER	LAKQ5	Norfolk	63	8	70	33	174
STAR GRAN	LADR4	Long Beach	0	51	18	0	69
STAR GRINDANGER	LAKR5	Norfolk	16	23	32	0	71
STAR HANSA	LAXP4	Jacksonville	55	12	9	48	124
STAR HARDANGER	LAXD4	Baltimore	3	6	3	8	20
STAR HARMONIA	LAGB5	Baltimore	2	36	21	0	59
STAR HERDLA	LAVD4	Baltimore	8	30	21	1	60
STAR HIDRA	LAVX4	Seattle	0	0	0	22	22
STAR HOYANGER	LAXG4	Baltimore	15	6	18	10	49
STAR SKARVEN	LAJY2	Miami	0	37	26	18	81
STAR TRONDANGER	LAQQ2	Baltimore	19	9	11	3	42
STATENDAM	PHSG	Miami	27	5	25	33	90
STELLAR IMAGE	3FDO6	Seattle	25	8	29	53	115
STELLAR KOHINOOR	3FFG8	Seattle	27	9	27	35	98
STENA CLIPPER	C6MX4	Miami	24	21	24	57	126
STEPHAN J	V2JN	Miami	85	118	131	118	452
STEWART J. CORT	WYZ3931	Chicago	27	0	6	57	90
STONEWALL JACKSON	KDDW	New Orleans	0	22	4	0	26
STRONG CAJUN	KALK	Norfolk	1	0	0	0	1
SUN DANCE	3ETQ8	Seattle	8	0	17	0	25
SUNBELT DIXIE	D5BU	Baltimore	25	14	24	17	80
SUNDA	ELPB8	Houston	8	0	0	0	8
SUSAN MAERSK	OYIK2	Seattle	0	0	44	5	49
SUSAN W. HANNAH	WAH9146	Chicago	0	6	1	4	11
SVEND MAERSK	OYJS2	Seattle	19	0	0	8	27
SVENDBORG MAERSK	OZSK2	Seattle	0	0	41	0	41
TAGUS	LAZA2	Long Beach	0	0	27	1	28
TAI HE	BOAB	Long Beach	37	13	55	44	149
TAIHO MARU	3FMP6	Seattle	94	82	111	0	287
TAIKO	LAQT4	New York City	0	26	14	10	50
TAKAMINE	LACT5	Jacksonville	16	2	0	0	18
TAKASAGO	LACR5	Jacksonville	1	16	9	12	38
TANABATA	WCZ5535	Baltimore	46	61	32	20	159
TAUSALA SAMOA	V2KS	Seattle	70	72	66	46	254
TECO TRADER	KSDF	New Orleans	11	27	35	23	96
TEQUI	3FDZ5	Seattle	27	18	24	18	87
THORKIL MAERSK	MSJX8	Miami	47	44	59	10	160
TMM MEXICO	3FRY9	Houston	50	30	60	26	166
TMM OAXACA	ELUA5	Houston	14	0	0	0	14
TOBIAS MAERSK	MSJY8	Long Beach	38	49	25	31	143
TORM FREYA	ELVY8	Norfolk	38	9	31	51	129
TOWER BRIDGE	ELJL3	Long Beach	9	17	16	12	54
TREIN MAERSK	MSQQ8	Baltimore	63	41	51	43	198
TRINITY	WRGL	Houston	1	28	10	0	39
TROJAN STAR	C6OD7	Baltimore	1	0	0	0	1

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
TROPIC FLYER	J8NV	Miami	0	0	0	18	18
TROPIC LURE	J8PD	Miami	13	15	26	22	76
TROPIC SUN	3EZK9	New Orleans	22	13	8	3	46
TROPIC TIDE	3FGQ3	Miami	12	6	9	3	30
TROPICALE	ELBM9	New Orleans	0	8	1	0	9
TUI PACIFIC	P3GB4	Seattle	88	56	2	0	146
TUSTUMENA	WNGW	Seattle	5	11	0	11	27
USCGC ACTIVE WMEC 618	NRTF	Seattle	1	1	0	0	2
USCGC COURAGEOUS	NCRG	Norfolk	12	1	0	0	13
USCGC DURABLE (WMEC 628)	NRUN	Houston	5	0	0	0	5
USCGC HARRIET LANE	NHNC	Norfolk	0	0	2	0	2
USCGC HEALY WAGB-20	NEPP	Seattle	2	49	71	112	234
USCGC KUKUI (WLB-203)	NKJU	Seattle	0	0	16	38	54
USCGC MACKINAW	NRKP	Chicago	32	0	24	21	77
USCGC MELLON (WHEC 717)	NMEL	Seattle	1	23	8	0	32
USCGC NORTHLAND WMEC 904	NLGF	Norfolk	0	11	2	0	13
USCGC POLAR STAR (WAGB 1	NBTM	Seattle	6	44	15	63	128
USCGC STORIS (WMEC 38)	NRUC	Seattle	0	0	0	2	2
USCGC SUNDEW (WLB 404)	NODW	Chicago	0	0	1	2	3
USNS BRUCE C. HEEZEN	NBID	New Orleans	0	0	0	31	31
USNS GILLILAND	NAMJ	Norfolk	14	0	1	0	15
USNS GUS W. DARNELL	KCDK	Houston	3	0	24	28	55
USNS NAVAJO_(TATF-169)	NOYK	Long Beach	0	0	22	22	44
USNS PERSISTENT	XXXX	Norfolk	0	4	20	11	35
USNS SUMNER	NZAU	New Orleans	1	4	3	0	8
VALIANT	WXCA	New Orleans	1	0	0	0	1
VASILTY BURKHANOV	UZHC	Seattle	1	0	0	0	1
VEGA	9VJS	Houston	40	28	0	25	93
VIRGINIA	3EBW4	Seattle	18	28	21	18	85
VLADIVOSTOK	UBXP	Seattle	71	62	62	31	226
VOYAGER OF THE SEAS	ELWU7	Miami	1	3	0	0	4
WAARDRECHT	S6BR	Seattle	59	31	48	80	218
WASHINGTON HIGHWAY	JKHH	Seattle	60	47	108	114	329
WEATHERBIRD II	WCT6653	Seattle	13	13	21	11	58
WESTERN BRIDGE	C6JQ9	Baltimore	77	91	97	79	344
WESTWARD	WZL8190	Miami	6	13	12	15	46
WESTWARD VENTURE	KHJB	Seattle	29	19	0	15	63
WESTWOOD ANETTE	C6QO9	Seattle	65	39	64	49	217
WESTWOOD BELINDA	C6CE7	Seattle	48	62	50	65	225
WESTWOOD BORG	LAON4	Seattle	65	67	60	42	234
WESTWOOD BREEZE	LAOT4	Seattle	33	6	4	8	51
WESTWOOD CLEO	C6OQ8	Seattle	37	28	28	31	124
WESTWOOD JAGO	C6CW9	Seattle	49	31	55	35	170
WESTWOOD MARIANNE	C6QD3	Seattle	45	0	14	48	107
WIELDRECHT	S6BO	Seattle	0	0	9	0	9
WILFRED SYKES	WC5932	Chicago	7	0	6	24	37
WILLIAM E. CRAIN	ELOR2	Oakland	11	17	0	4	32
WILSON	WNPD	New Orleans	4	31	57	17	109
WORLD SPIRIT	ELWG7	Seattle	24	23	25	28	100
YUCATAN	3FTA9	Houston	0	0	31	51	82
YURIY OSTROVSKIY	UAGJ	Seattle	117	69	97	72	355
ZIM AMERICA	4XGR	Newark	21	21	47	23	112
ZIM ASIA	4XFB	New Orleans	59	55	19	79	212
ZIM ATLANTIC	4XFD	New York City	26	28	70	58	182
ZIM CANADA	4XGS	Norfolk	21	32	40	17	110
ZIM CHINA	4XFQ	New York City	34	20	28	44	126
ZIM EUROPA	4XFN	New York City	0	0	0	33	33
ZIM HONG KONG	4XGW	Houston	44	21	58	46	169
ZIM IBERIA	4XFP	New York City	48	41	49	21	159
ZIM ISRAEL	4XGX	New Orleans	18	14	18	15	65
ZIM ITALIA	4XGT	New Orleans	40	53	30	21	144
ZIM JAMAICA	4XFE	New York City	17	41	46	14	118
ZIM JAPAN	4XGV	Baltimore	22	32	18	16	88
ZIM KOREA	4XGU	Miami	4	23	14	12	53
ZIM MONTEVIDEO	V2AG7	Norfolk	60	74	70	24	228
ZIM PACIFIC	4XFC	New York City	62	19	14	52	147
ZIM SEATTLE	ELWZ3	Seattle	51	71	40	42	204
ZIM U.S.A.	4XFO	New York City	61	11	31	49	152

Totals	Jan	23896
	Feb	23842
	Mar	25074
	Apr	24936
Period Total		97748

Buoy Climatological Data Summary —

January through April 2000

Weather observations are taken each hour during a 20-minute averaging period, with a sample taken every 0.67 seconds. The significant wave height is defined as the average height of the highest one-third of the waves during the average period each hour. The maximum significant wave height is the highest of those values for that month. At most stations, air temperature, water temperature, wind speed and direction are sampled once per second during an 8.0-minute averaging period each hour (moored buoys) and a 2.0-minute averaging period for fixed stations (C-MAN). Contact NDBC Data Systems Division, Bldg. 1100, SSC, Mississippi 39529 or phone (601) 688-1720 for more details.

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
January 2000													
41002	32.3N	075.2W	740	16.2	20.7	2.5	7.2	20/18	15.1	S	36.7	20/11	1020.0
41004	32.5N	079.1W	740	14.0	20.0	1.6	4.2	24/22	15.4	N	34.2	20/09	1020.7
41008	31.4N	080.9W	741	12.0	13.7	1.1	2.6	25/02	12.2	N	31.3	25/03	1021.7
41009	28.5N	080.2W	1475	18.7	22.2	1.4	4.1	15/01	13.1	NW	34.0	24/21	1020.9
41010	28.9N	078.5W	1475	20.1	23.8	2.1	5.3	25/06	15.0	S	33.8	25/00	1022.4
42001	25.9N	089.7W	739	21.4	24.0	1.3	3.9	14/21	13.5	SE	29.0	24/13	1020.6
42002	25.9N	093.6W	734	21.3	22.9	1.5	4.9	04/19	15.0	S	32.4	04/14	1020.5
42003	25.9N	085.9W	733	21.7	25.5	1.3	5.0	14/23	13.7	SE	36.1	24/13	1020.5
42007	30.1N	088.8W	733	13.2	15.2	0.8	3.1	28/13	11.9	N	31.9	28/13	1022.2
42020	26.9N	096.7W	735	19.9		1.6	3.6	27/18	14.5	S	30.3	04/09	1019.2
42035	29.2N	094.4W	728	13.9	15.1	1.0	2.8	27/15	11.7	E	28.6	28/00	1021.3
42036	28.5N	084.5W	731	16.7	19.6				12.5	SE	29.5	14/11	1021.3
42039	28.8N	086.0W	739	17.5	21.2	1.3	4.3	24/17	13.6	SE	30.5	14/08	1022.0
42040	29.2N	088.2W	734	17.2	21.1	1.3	4.6	28/19	14.2	S	36.5	28/18	1021.3
42041	27.2N	090.4W	738	20.0	23.2	1.5	4.5	14/14	13.4	NE	27.0	14/11	1020.3
44004	38.5N	070.7W	649	9.2	16.9	3.4	9.5	26/02	20.4	NW	47.8	21/02	1015.6
44005	42.9N	068.9W	730	0.5	7.2	2.4	6.8	17/17	19.5	NW	40.4	26/10	1013.2
44007	43.5N	070.1W	733	-2.9	4.8	1.1	5.0	11/02	14.6	NW	36.3	17/06	1013.9
44008	40.5N	069.4W	728	2.8	6.6	2.8	9.7	26/05	18.0	NW	40.8	21/07	1015.1
44009	38.5N	074.7W	737	3.2	7.6	1.6	7.4	25/14	17.4	NW	39.8	25/13	1018.7
44011	41.1N	066.6W	499	4.8	7.7	3.1	9.2	21/17	18.6	NW	47.4	21/12	1013.7
44013	42.4N	070.7W	742	-1.6	4.7	1.2	5.3	25/19	17.0	NW	38.5	17/08	1014.8
44014	36.6N	074.8W	665	7.9	15.6	1.8	5.7	25/06	16.1	NW	39.4	20/21	1018.8
44025	40.3N	073.2W	740	1.7	7.4				17.9	NW	37.7	22/00	1016.5
46001	56.3N	148.2W	731	1.4	4.2	3.8	10.2	27/18	18.9	SW	37.3	27/09	1001.8
46005	46.1N	131.0W	484	7.7	9.2	3.2	8.9	30/19	15.8	W	35.2	16/11	1014.5
46012	37.4N	122.7W	720	11.4	11.5	2.2	6.4	31/11					1021.0
46013	38.2N	123.3W	708	11.1	11.4	2.4	7.8	31/12	12.0	NW	27.0	05/09	1021.2
46014	39.2N	124.0W	724	10.4	10.7	2.5	7.5	31/09	11.1	SE	31.9	30/10	1020.3
46022	40.7N	124.5W	548	10.6	10.9	2.6	5.5	16/21	13.6	S	37.1	13/19	1020.3
46023	34.7N	121.0W	724	12.3	12.9	2.1	6.5	31/21	13.4	NW	28.2	02/12	1021.7
46025	33.8N	119.1W	720	13.6	14.1	1.1	3.3	31/22	6.6	W	24.7	02/07	1019.6

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BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
46026	37.8N	122.8W	732	10.9	11.0	2.1	5.9	31/16	10.2	NW	30.3	30/14	1021.3
46027	41.8N	124.4W	703	9.8	10.0	2.7	7.0	31/09	12.4	SE	36.9	16/10	1018.8
46029	46.1N	124.5W	331	7.7	9.3	3.5	10.1	16/19	16.1	S	44.5	16/18	1014.9
46030	40.4N	124.5W	709	10.5	10.6	2.7	8.6	31/10	14.7	SE	37.3	16/11	1020.3
46035	56.9N	177.8W	492	-3.1	1.5	3.2	8.1	21/12	19.4	N	39.6	30/10	1008.7
46041	47.3N	124.8W	579	7.0	9.0	2.7	9.6	16/21	14.5	SE	42.4	16/19	1015.3
46042	36.7N	122.4W	697	11.6	11.5	2.1	6.7	31/12	10.5	NW	29.7	30/16	1021.7
46047	32.4N	119.5W	668	13.4	14.0	2.2	6.9	31/20	11.4	NW	29.0	05/13	1020.3
46050	44.6N	124.5W	727	8.3	9.6	3.2	12.1	16/18	14.6	S	44.5	16/15	1017.5
46053	34.2N	119.8W	679	13.4	13.6	1.3	4.5	31/21	8.7	W	26.4	02/13	1020.4
46054	34.3N	120.4W	709	12.7	12.7	2.0	6.0	31/23	13.6	NW	31.3	05/21	1020.1
46059	38.0N	130.0W	728	11.8	12.7	2.9	9.5	31/02	13.2	SW	34.6	16/06	1018.9
46060	60.6N	146.8W	1381	-.3	4.7	0.9	3.6	31/23	12.2	N	42.7	31/23	1003.6
46061	60.2N	146.8W	1466		4.3	1.9	5.7	27/07	17.1	E	48.8	31/22	1001.9
46062	35.1N	121.0W	722	12.3	12.7	2.1	6.6	31/16	11.3	NW	26.6	02/04	1020.8
46063	34.2N	120.7W	733	12.4	12.5	2.2	6.5	31/22	13.0	NW	27.0	05/20	1020.3
51001	23.4N	162.3W	327	22.5	23.7	2.6	4.7	15/14	14.4	E	27.1	15/05	1020.1
51002	17.2N	157.8W	731	23.7	24.6	2.7	4.5	08/14	17.3	NE	25.9	08/08	1016.1
51003	19.2N	160.7W	737	23.6	24.6	2.6	4.2	27/19	14.2	E	24.1	27/17	
51004	17.4N	152.5W	716	23.2	24.2	2.9	4.5	09/07	15.9	E	24.9	28/09	1015.8
51028	00.0N	153.8W	711	23.9	23.9	2.1	3.1	26/03	15.5	E	22.9	25/15	1009.9
ABAN6	44.3N	075.9W	740	-6.9	1.4				5.4	S	21.7	04/16	1018.6
ALSN6	40.4N	073.8W	738	0.3	6.8	1.2	3.5	25/16	19.6	NW	44.8	17/02	1018.0
AUGA2	59.4N	153.4W	1430	-7.8									

February 2000

41002	32.3N	075.2W	686	17.4	20.3	2.0	4.5	15/04	13.5	N	30.5	10/03	1021.9
41004	32.5N	079.1W	693	15.2	18.6	1.4	3.7	17/22	13.8	NE	31.5	05/02	1022.4
41008	31.4N	080.9W	692	12.1	11.9	0.9	2.1	17/23	9.8	N	26.8	14/17	1023.3
41009	28.5N	080.2W	1379	19.1	21.8	1.3	2.9	10/07	12.0	N	26.0	09/21	1022.2
41010	28.9N	078.5W	1368	20.2	23.0	1.7	5.6	10/04	11.8	NW	33.2	10/02	1023.8
42001	25.9N	089.7W	689	21.3	22.7	1.2	3.8	02/03	12.7	NE	29.9	02/02	1020.9
42002	25.9N	093.6W	678	21.7	23.0	1.4	3.8	02/09	14.9	SE	28.4	25/14	1020.4
42003	25.9N	085.9W	685	21.8	24.9	1.1	2.6	23/15	12.7	E	26.0	01/21	1021.1
42007	30.1N	088.8W	690	14.8	15.2	0.6	1.5	23/21	9.2	SE	27.2	05/02	1023.0
42020	26.9N	096.7W	582	20.3	48.6	1.6	4.6	02/13	14.1	SE	32.3	02/12	1018.9
42035	29.2N	094.4W	688	15.8	15.6	0.9	1.7	23/07	9.4	SE	21.0	19/10	1021.1
42036	28.5N	084.5W	680	17.0	18.8				10.0	NE	23.3	23/04	1022.4
42039	28.8N	086.0W	688	18.3	21.3	0.9	2.3	05/08	11.4	E	24.7	23/07	1023.0
42040	29.2N	088.2W	689	17.9	20.4	1.0	2.4	23/19	11.6	SE	26.2	05/04	1022.2
42041	27.2N	090.4W	691	19.9	21.6	1.2	3.4	02/00	11.1	SE	25.8	02/01	1020.9
44005	42.9N	068.9W	687	1.9	5.8	1.9	4.3	01/04	17.2	W	35.4	07/10	1017.8
44007	43.5N	070.1W	686	-.6	3.5	1.0	2.7	09/10	12.4	SW	29.9	09/11	1017.8
44008	40.5N	069.4W	690	3.5	4.4	2.0	4.7	03/04	16.2	W	28.8	02/11	1019.5
44009	38.5N	074.7W	692	4.0	4.6	1.1	2.9	14/14	12.6	NW	30.7	14/13	1021.6
44013	42.4N	070.7W	692	0.7	2.5	0.9	3.1	19/11	13.5	W	32.4	12/04	1018.7
44014	36.6N	074.8W	643	9.6	14.2	1.4	3.2	14/12	13.3	N	27.0	03/22	1021.4
44025	40.3N	073.2W	690	2.9	4.1				13.2	W	29.7	02/06	1019.8
46001	56.3N	148.2W	687	2.6	3.7	3.7	10.1	03/01	12.9	SE	29.7	01/01	1002.8
46005	46.1N	131.0W	535	7.8	8.7	3.6	8.8	01/21	15.0	E	30.3	21/21	1009.8
46012	37.4N	122.7W	685	11.9	12.2	2.9	5.7	27/21					1016.1
46013	38.2N	123.3W	674	11.5	11.9	3.4	7.0	14/21	12.2	SE	29.0	22/21	1016.2
46014	39.2N	124.0W	689	11.1	11.4	3.3	7.4	27/22	12.1	SE	32.8	22/16	1014.7
46023	34.7N	121.0W	690	12.4	13.1	3.0	6.8	21/20	12.0	SE	31.3	20/22	1018.8
46025	33.8N	119.1W	688	13.1	13.7	1.8	4.8	21/21	8.7	W	24.3	24/04	1018.4
46026	37.8N	122.8W	689	11.5	12.2	2.8	5.7	27/21	12.6	S	31.5	13/12	1016.4
46027	41.8N	124.4W	673	10.7	10.9	3.1	7.4	14/17	12.4	SE	43.3	14/16	1013.0
46030	40.4N	124.5W	684	11.2	11.5	3.3	8.3	14/17	16.3	SE	38.5	22/12	1014.2
46035	56.9N	177.8W	512	-.7	1.3	3.5	8.0	25/04	20.7	E	41.4	01/06	981.8
46041	47.3N	124.8W	573	7.9	8.7	2.9	7.5	02/09	11.4	SE	35.6	22/12	1012.0
46042	36.7N	122.4W	668	12.0	12.1	3.2	6.3	27/22	12.1	SE	29.3	20/16	1017.1
46047	32.4N	119.5W	673	13.6	14.3	3.0	6.5	01/01	9.8	NW	23.1	20/03	1018.8
46050	44.6N	124.5W	689	9.2	10.0	3.2	7.0	22/13	12.8	S	37.7	29/06	1012.7
46053	34.2N	119.8W	652	13.0	13.6	2.0	4.6	21/22	10.2	W	27.6	20/17	1018.7
46054	34.3N	120.4W	669	12.8	13.2	3.0	6.2	21/18	11.5	NW	28.0	20/23	1018.1
46059	38.0N	130.0W	681	11.3	11.5	3.9	8.8	27/10	15.6	SW	38.3	14/06	1011.5
46060	60.6N	146.8W	1336	2.2	4.2	0.8	3.7	01/00	10.3	E	42.2	01/00	1006.7

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BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
46061	60.2N	146.8W	1373	3.3	4.5	1.9	6.4	19/05	14.4	E	41.6	19/14	1005.6
46062	35.1N	121.0W	671	12.5	12.9	3.0	6.2	21/17	10.7	S	31.7	23/10	1017.6
46063	34.2N	120.7W	691	12.7	13.1	3.1	6.6	21/18	10.7	NW	27.0	12/06	1017.9
51001	23.4N	162.3W	692	23.0	23.7	2.6	5.8	19/21	11.1	E	25.5	01/09	1019.4
51002	17.2N	157.8W	691	23.6	24.2	2.5	4.1	20/20	15.6	NE	26.4	21/19	1017.9
51003	19.2N	160.7W	690	23.7	24.3	2.5	4.5	20/04	10.6	E	18.1	23/23	
51004	17.4N	152.5W	680	23.1	24.0	2.6	3.9	20/21	15.5	E	25.3	21/16	1017.8
51028	00.0N	153.8W	684	24.2	24.0	2.1	3.2	21/23	13.5	E	18.8	05/15	1010.6
ABAN6	44.3N	075.9W	693	-4.2	0.2				5.7	SW	18.1	14/16	1019.5
ALSN6	40.4N	073.8W	692	2.4	4.1	0.8	2.3	14/20	15.4	W	38.7	14/15	1021.0
AUGA2	59.4N	153.4W	1320	-.2					17.6	NE	48.9	01/03	1003.3
BLIA2	60.8N	146.9W	1383	1.2					10.6	N	51.6	02/21	1008.0
BURL1	28.9N	089.4W	690	16.9					13.0	NE	29.8	05/05	1022.3
BUZM3	41.4N	071.0W	692	1.6		1.2	4.2	14/21	16.8	W	39.0	14/17	1019.1
CARO3	43.3N	124.4W	692	9.3									

March 2000

BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
41002	32.3N	075.2W	717	19.5	21.7	2.2	4.5	28/15	14.1	SW	28.2	18/03	1016.9
41004	32.5N	079.1W	734	17.8	20.1	1.5	4.6	20/14	14.0	NE	30.5	20/12	1017.2
41008	31.4N	080.9W	740	16.5	16.1	1.0	3.1	18/13	10.6	NE	27.6	18/12	1017.7
41009	28.5N	080.2W	1468	21.6	23.2	1.4	4.2	19/06	12.3	E	24.9	11/22	1017.2
41010	28.9N	078.5W	1481	21.8	23.3	1.8	4.0	18/22	13.1	S	31.9	28/05	1019.1
42001	25.9N	089.7W	737	23.1	23.5	1.0	2.4	12/15	11.1	E	29.1	16/00	1015.6
42002	25.9N	093.6W	735	22.7	23.3	1.3	3.1	12/04	13.7	SE	29.1	19/16	1014.9
42003	25.9N	085.9W	738	23.5	25.7	1.1	2.8	16/01	11.9	NE	27.2	17/10	1016.3
42007	30.1N	088.8W	737	18.7	19.9	0.6	2.3	16/07	10.6	S	24.1	04/07	1017.0
42035	29.2N	094.4W	736	18.9	19.6	0.9	2.6	15/06	10.6	SE	34.0	15/05	1015.5
42036	28.5N	084.5W	738	20.0	21.2				10.3	E	24.1	19/14	1016.9
42039	28.8N	086.0W	740	20.8	22.8	1.0	2.9	15/18	11.4	E	24.5	15/15	1017.5
42040	29.2N	088.2W	740	20.1	21.3	0.9	3.0	16/00	10.8	SE	25.6	12/03	1016.4
42041	27.2N	090.4W	741	21.7	22.7	1.0	2.7	15/15	10.5	E	25.1	19/09	1015.5
44005	42.9N	068.9W	740	4.4	5.6	2.0	6.0	17/20	15.4	S	36.9	17/11	1014.7
44007	43.5N	070.1W	740	3.3	3.6	1.2	3.8	28/18	11.4	N	31.3	17/12	1014.7
44008	40.5N	069.4W	737	5.7	5.5	2.2	6.9	18/04	13.9	NE	33.2	17/17	1015.5
44009	38.5N	074.7W	737	7.3	6.4	1.4	4.4	22/07	12.8	S	35.8	22/08	1016.6
44011	41.1N	066.6W	575	6.2	6.0	2.6	7.7	18/06	14.9	NE	33.0	18/02	1017.9
44013	42.4N	070.7W	742	4.2	3.8	1.2	4.7	17/21	12.1	NW	34.4	17/13	1015.2
44014	36.6N	074.8W	721	9.6	12.1	1.6	4.1	21/03	11.8	N	27.6	18/01	1016.3
44025	40.3N	073.2W	578	5.8	5.6	1.6	3.8	22/07	13.6	S	32.1	18/00	1016.7
45002	45.3N	086.4W	577	1.6	2.8	0.7	2.9	09/16	11.7	S	28.0	27/03	1016.6
45007	42.7N	087.0W	407	4.2	4.3	0.7	3.2	16/05	11.3	S	28.8	16/02	1017.0
46001	56.3N	148.2W	743	3.0	3.8	4.0	7.9	15/15	16.2	E	36.1	15/05	997.9
46005	46.1N	131.0W	723	7.6	8.1	4.0	9.8	11/01	16.4	SW	32.3	15/16	1016.7
46012	37.4N	122.7W	112	11.3	12.4	3.3	6.6	05/16					1016.1
46013	38.2N	123.3W	706	10.6	10.8	3.4	6.8	03/12	16.4	NW	35.4	05/12	1018.4
46014	39.2N	124.0W	737	9.9	10.3	3.4	7.5	03/13	13.9	NW	34.2	05/12	1018.7
46023	34.7N	121.0W	736	11.8	12.1	3.1	5.8	04/07	16.4	NW	34.6	20/03	1017.8
46025	33.8N	119.1W	742	13.1	14.1	1.4	3.2	05/23	7.0	W	25.8	05/22	1015.4
46026	37.8N	122.8W	728	10.6	11.3	2.9	5.9	05/16	13.5	NW	34.2	17/03	1018.4
46027	41.8N	124.4W	682	9.4	10.1	3.2	6.4	03/08	13.9	NW	30.9	04/23	1019.4
46030	40.4N	124.5W	736	9.8	10.0	3.3	7.4	06/02	16.8	N	38.9	05/12	1020.4
46035	56.9N	177.8W	617	-2.0	1.4	2.6	7.6	19/22	16.7	NE	34.6	11/07	995.0
46041	47.3N	124.8W	673	7.9	9.3	3.3	6.3	03/05	13.2	SE	29.5	02/01	1018.8
46042	36.7N	122.4W	674	11.4	11.6	3.2	7.0	05/20	13.4	NW	31.1	05/16	1018.6
46047	32.4N	119.5W	715	13.2	14.4	3.3	6.3	20/18	13.5	NW	30.9	20/09	1016.2
46050	44.6N	124.5W	737	8.8	9.9	3.4	6.6	20/06	12.5	S	29.0	14/01	1020.7
46053	34.2N	119.8W	734	12.6	13.0	1.9	3.6	05/22	8.6	W	28.2	20/02	1016.0
46054	34.3N	120.4W	732	12.1	12.3	3.0	5.1	06/15	17.2	NW	37.1	20/03	1015.8
46059	38.0N	130.0W	734	10.3	11.0	3.4	7.0	03/11	13.0	NW	29.5	10/10	1022.8
46060	60.6N	146.8W	1434	2.5	3.8	0.9	2.7	29/18	10.8	E	33.2	03/21	1003.0
46061	60.2N	146.8W	1470		4.6	2.3	6.7	16/04	15.1	E	38.9	29/16	1007.3
46062	35.1N	121.0W	718	11.7	11.9	3.2	6.4	03/23	14.0	NW	34.8	17/03	1016.9
46063	34.2N	120.7W	741	12.0	12.1	3.3	5.9	04/05	16.1	NW	31.9	20/03	1016.2
51001	23.4N	162.3W	736	23.3	24.2	2.7	5.3	15/23	12.2	E	26.6	31/15	1019.9
51002	17.2N	157.8W	730	23.8	24.5	2.8	4.9	20/05	16.8	E	28.1	18/13	1017.7
51003	19.2N	160.7W	729	23.7	24.5	2.4	4.3	24/16	12.6	E	24.9	31/23	
51004	17.4N	152.5W	734	22.9	23.6	2.7	4.3	19/18	16.3	E	24.5	19/09	1017.5

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BUOY	LAT	LONG	OBS	MEAN AIR TP (C)	MEAN SEA TP (C)	MEAN SIG WAVE HT (M)	MAX SIG WAVE HT (M)	MAX SIG WAVE HT (DA/HR)	SCALAR MEAN WIND SPEED (KNOTS)	PREV WIND (DIR)	MAX WIND (KTS)	MAX WIND (DA/HR)	MEAN PRESS (MB)
51028	00.0N	153.8W	722	24.8	24.7	2.0	3.0	26/03	11.1	E	17.3	18/13	1010.4
ABAN6	44.3N	075.9W	740	2.5	1.4				5.2	S	23.1	17/09	1016.0
ALSN6	40.4N	073.8W	738	6.5	5.1	1.2	3.5	22/00	16.3	S	34.9	03/05	1016.6
AUGA2	59.4N	153.4W	1465	1.1					22.3	NE	56.8	27/10	999.3
BLIA2	60.8N	146.9W	1470	1.9					11.2	N	32.3	15/09	1004.0
BURL1	28.9N	089.4W	740	19.1									

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41002	32.3N	075.2W	352	19.3	21.7	1.8	5.4	09/12	14.1	S	29.7	09/06	1020.7
41004	32.5N	079.1W	704	18.5	20.3	1.4	3.9	14/01	14.1	SW	34.2	08/22	1015.7
41008	31.4N	080.9W	713	18.1	18.9	1.0	3.5	13/20	11.8	S	30.7	09/03	1016.6
41009	28.5N	080.2W	1418	21.5	23.2	1.2	3.2	09/09	12.1	S	28.8	05/06	1016.6
41010	28.9N	078.5W	1420	21.8	23.3	1.7	4.2	09/11	12.9	S	28.0	09/05	1018.6
42001	25.9N	089.7W	712	23.3	24.3	1.0	3.1	09/04	10.5	SE	28.4	03/10	1016.3
42002	25.9N	093.6W	709	23.2	24.2	1.2	3.7	09/00	13.1	SE	33.6	23/15	1015.9
42003	25.9N	085.9W	710	23.6	26.2	1.1	3.5	24/18	11.4	E	27.2	09/05	1016.5
42007	30.1N	088.8W	701	20.2	21.4	0.6	1.6	03/17	12.0	SE	28.8	03/21	1017.1
42035	29.2N	094.4W	708	21.0	22.1	0.9	1.9	04/03	11.1	SE	27.4	04/02	1016.3
42036	28.5N	084.5W	704	20.4	21.6				10.7	NW	27.0	09/02	1016.6
42039	28.8N	086.0W	712	20.9	22.4	1.0	3.8	09/07	12.0	SE	27.0	08/23	1017.5
42040	29.2N	088.2W	716	21.3	22.8	1.0	3.1	04/13	12.5	SE	28.4	04/12	1016.4
42041	27.2N	090.4W	711	22.3	23.5	1.0	3.2	04/14	10.1	SE	25.1	04/11	1016.2
44005	42.9N	068.9W	714	6.0	5.9	2.0	4.8	09/22	15.4	SW	32.4	09/18	1013.5
44007	43.5N	070.1W	716	5.7	5.6	1.3	4.0	09/14	12.3	S	30.3	09/14	1013.1
44008	40.5N	069.4W	708	7.8	7.1	2.2	6.3	10/00	14.0	S	33.6	09/17	1014.2
44009	38.5N	074.7W	711	9.6	9.0	1.6	4.5	19/01	13.6	S	32.8	09/09	1014.3
44011	41.1N	066.6W	715	7.9	6.9	2.5	7.1	10/07	14.9	S	33.4	09/15	1015.0
44013	42.4N	070.7W	710	6.3	5.4	1.2	3.8	26/18	13.3	W	29.9	22/09	1013.7
44014	36.6N	074.8W	691	12.5	15.4	1.7	4.5	26/07	13.2	S	32.6	09/07	1013.9
44025	40.3N	073.2W	711	7.5	7.2	1.6	4.1	18/17	13.4	S	32.3	09/13	1013.6
45001	48.1N	087.8W	599	1.5	2.8	0.8	3.5	09/19	11.9	NE	34.0	09/17	1019.2
45002	45.3N	086.4W	709	3.2	3.2	0.7	2.7	20/18	11.9	N	31.9	20/22	1016.6
45003	45.4N	082.8W	602	3.0	2.9	0.7	3.7	10/10	11.4	NW	31.1	10/07	1017.1
45004	47.6N	086.5W	578	1.5	2.5	0.7	5.1	09/20	10.9	N	31.9	09/20	1020.3
45005	41.7N	082.4W	464	6.8	6.4	0.4	2.5	17/17	8.5	NE	24.7	17/14	1016.1
45006	47.3N	089.9W	579	2.0	2.2	0.7	3.0	20/15	10.1	NE	29.7	09/12	1021.0
45007	42.7N	087.0W	710	5.2	4.7	0.8	5.2	08/08	11.1	N	33.8	08/06	1015.6
45008	44.3N	082.4W	598	3.2	2.5	0.8	4.1	08/09	11.8	N	32.6	08/08	1016.9
46001	56.3N	148.2W	705	3.4	4.0	2.3	4.4	30/15	12.9	E	30.5	01/21	1005.5
46002	42.5N	130.3W	284	10.5	10.5	3.4	7.3	28/09	15.4	W	29.3	26/20	1017.9
46005	46.1N	131.0W	703	8.1	8.8	2.7	9.2	25/06	13.6	W	33.8	24/17	1016.4
46011	34.9N	120.9W	594	11.9	11.6	2.2	5.0	29/02	14.2	NW	29.9	24/01	1017.5
46013	38.2N	123.3W	683	11.3	10.9	2.1	4.6	29/05	11.8	NW	28.2	23/21	1018.2
46014	39.2N	124.0W	689	11.0	11.1	2.0	5.1	29/03	9.0	NW	27.0	16/15	1018.3
46023	34.7N	121.0W	692	12.1	11.9	2.2	4.9	29/03	15.2	NW	34.6	17/05	1018.0
46025	33.8N	119.1W	689	14.2	15.1	1.3	2.8	18/20	7.0	W	23.3	17/16	1015.6
46026	37.8N	122.8W	702	11.3	11.5	1.8	4.0	17/03	11.2	NW	28.4	16/22	1018.3
46027	41.8N	124.4W	628	10.3	10.4	1.9	5.5	26/00	8.8	SE	28.4	02/00	1018.6
46028	35.7N	121.9W	569	11.9	12.1	2.2	4.7	29/14	15.9	NW	31.1	17/02	1017.3
46030	40.4N	124.5W	707	10.7	10.7	2.0	5.0	28/08	11.4	N	23.9	16/12	1019.2
46035	56.9N	177.8W	567	0.2	1.5	2.5	6.7	21/02	16.1	N	36.9	20/23	1007.4
46041	47.3N	124.8W	646	9.2	9.7	1.9	5.1	28/07	9.8	NW	20.0	25/09	1018.0
46042	36.7N	122.4W	654	12.1	11.9	2.0	4.6	28/22	12.4	NW	32.8	17/03	1018.4
46047	32.4N	119.5W	645	13.8	14.7	2.4	5.4	29/12	15.5	NW	27.4	28/16	1016.6
46050	44.6N	124.5W	661	10.0	10.6	2.2	5.4	28/22	10.9	N	27.0	25/07	1019.2
46053	34.2N	119.8W	676	13.2	13.2	1.3	3.1	29/01	9.3	W	27.2	28/23	1015.7
46054	34.3N	120.4W	692	12.2	12.2	2.1	4.9	29/06	18.4	NW	35.2	24/02	1016.0
46059	38.0N	130.0W	698	11.3	11.8	2.3	5.5	28/05	11.0	W	25.3	18/02	1018.9
46060	60.6N	146.8W	1373	4.1	5.2	0.6	2.7	21/04	8.7	E	35.9	21/04	1010.4
46061	60.2N	146.8W	1405		5.4	1.7	6.6	20/23	12.5	E	40.4	21/01	
46062	35.1N	121.0W	687	12.1	12.2	2.0	4.7	29/03	13.6	NW	30.5	28/23	1017.1
46063	34.2N	120.7W	699	12.1	11.8	2.2	4.9	29/05	15.6	NW	30.5	24/00	1016.5
51001	23.4N	162.3W	703	22.5	23.8	2.6	5.6	04/19	16.2	E	28.6	04/03	1021.5
51002	17.2N	157.8W	704	23.8									

Meteorological Services—Observations

U.S. Port Meteorological Officers

Headquarters

Vincent Zegowitz
Voluntary Observing Ships Program Leader
National Weather Service, NOAA
1325 East-West Hwy., Room 14112
Silver Spring, MD 20910
Tel: 301-713-1677 Ext. 129
Fax: 301-713-1598
E-mail: vincent.zegowitz@noaa.gov

Martin S. Baron
VOS Assistant Program Leader
National Weather Service, NOAA
1325 East-West Hwy., Room 14108
Silver Spring, MD 20910
Tel: 301-713-1677 Ext. 134
Fax: 301-713-1598
E-mail: martin.baron@noaa.gov

Tim Rulon
Communications Program Manager
National Weather Service, NOAA
1325 East-West Hwy., Room 14114
Silver Spring, MD 20910
Tel: 301-713-1677 Ext. 128
Fax: 301-713-1598
E-mail: timothy.rulon@noaa.gov
marine.weather@noaa.gov

Mary Ann Burke, Editor
Mariners Weather Log
6959 Exeter Court, #101
Frederick, MD 21703
Tel and Fax: 301-663-7835
E-mail: wvrs@earthlink.net

Atlantic Ports

Robert Drummond, PMO
National Weather Service, NOAA
2550 Eisenhower Blvd, No. 312
P.O. Box 165504
Port Everglades, FL 33316
Tel: 954-463-4271
Fax: 954-462-8963
E-mail: robert.drummond@noaa.gov

Lawrence Cain, PMO
National Weather Service, NOAA
13701 Fang Rd.
Jacksonville, FL 32218
Tel: 904-741-5186
E-mail: larry.cain@noaa.gov

Peter Gibino, PMO, Norfolk
NWS-NOAA
200 World Trade Center
Norfolk, VA 23510
Tel: 757-441-3415
Fax: 757-441-6051
E-mail: peter.gibino@noaa.gov

James Saunders, PMO
National Weather Service, NOAA
Maritime Center I, Suite 287
2200 Broening Hwy.
Baltimore, MD 21224-6623
Tel: 410-633-4709
Fax: 410-633-4713
E-mail: james.saunders@noaa.gov

PMO, New Jersey
National Weather Service, NOAA
110 Lower Main Street, Suite 201
South Amboy, NJ 08879-1367
Tel: 732-316-5409
Fax: 732-316-6543

Tim Kenefick, PMO, New York
National Weather Service, NOAA
110 Lower Main Street, Suite 201
South Amboy, NJ 08879-1367
Tel: 732-316-5409
Fax: 732-316-7643
E-mail: timothy.kenefick@noaa.gov

Great Lakes Ports

Amy Seeley, PMO
National Weather Service, NOAA
333 West University Dr.
Romeoville, IL 60441
Tel: 815-834-0600 Ext. 269
Fax: 815-834-0645
E-mail: amy.seeley@noaa.gov

George Smith, PMO
National Weather Service, NOAA
Hopkins International Airport
Federal Facilities Bldg.
Cleveland, OH 44135
Tel: 216-265-2374
Fax: 216-265-2371
E-mail: George.E.Smith@noaa.gov

Gulf of Mexico Ports

John Warrelmann, PMO
National Weather Service, NOAA
Int’l Airport, Moisant Field
Box 20026
New Orleans, LA 70141
Tel: 504-589-4839
E-mail: john.warrelmann@noaa.gov

James Nelson, PMO
National Weather Service, NOAA
Houston Area Weather Office
1620 Gill Road
Dickinson, TX 77539
Tel: 281-534-2640 x.277
Fax: 281-337-3798
E-mail: jim.nelson@noaa.gov

Pacific Ports

Derek Lee Loy
Ocean Services Program Coordinator
NWS Pacific Region HQ
Grosvenor Center, Mauka Tower
737 Bishop Street, Suite 2200
Honolulu, HI 96813-3213
Tel: 808-532-6439
Fax: 808-532-5569
E-mail: derek.leeloy@noaa.gov

Robert Webster, PMO
National Weather Service, NOAA
501 West Ocean Blvd., Room 4480
Long Beach, CA 90802-4213
Tel: 562-980-4090
Fax: 562-980-4089
Telex: 7402731/BOBW UC
E-mail: bob.webster@noaa.gov

Robert Novak, PMO
National Weather Service, NOAA
1301 Clay St., Suite 1190N
Oakland, CA 94612-5217
Tel: 510-637-2960
Fax: 510-637-2961
Telex: 7402795/WPMO UC
E-mail: bob.novak@noaa.gov

Patrick Brandow, PMO
National Weather Service, NOAA
7600 Sand Point Way, N.E.
Seattle, WA 98115-0070
Tel: 206-526-6100
Fax: 206-526-4571 or 6094
Telex: 7608403/SEA UC
E-mail: pat.brandow@noaa.gov

Gary Ennen
National Weather Service, NOAA
600 Sandy Hook St., Suite 1
Kodiak, AK 99615
Tel: 907-487-2102
Fax: 907-487-9730
E-mail: w-ar-adq@noaa.gov

Lynn Chrystal, OIC
National Weather Service, NOAA

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Meteorological Services

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Box 427
Valdez, AK 99686
Tel: 907-835-4505
Fax: 907-835-4598
E-mail: w-ar-adz@noaa.gov

Greg Matzen, Marine Program Mgr.
W/AR1x2 Alaska Region
National Weather Service
222 West 7th Avenue #23
Anchorage, AK 99513-7575
Tel: 907-271-3507
E-mail: greg.matzen@noaa.gov

SEAS Field Representatives

Mr. Robert Decker
Seas Logistics
7600 Sand Point Way N.E.
Seattle, WA 98115
Tel: 206-526-4280
Fax: 206-525-4281
E-mail: bob.decker@noaa.gov

Mr. Gregg Thomas
NOAA-AOML
GOOS Center
4301 Rickenbacker Causeway
Miami, FL 33149
Tel: 305-361-4348
Fax: 305-361-4366
E-mail: thomas@aoml.noaa.gov

Mr. Robert Benway
National Marine Fisheries Service
28 Tarzwell Dr.
Narragansett, RI 02882
Tel: 401-782-3295
Fax: 401-782-3201
E-mail: rbenway@whsun1.wh.whoi.edu

Mr. Jim Farrington
SEAS Logistics/ A.M.C.
439 WestWork St.
Norfolk, VA 23510
Tel: 757-441-3062
Fax: 757-441-6495
E-mail: farrington@aoml.noaa.gov

Mr. Craig Engler
Atlantic Oceanographic & Met. Lab.
4301 Rickenbacker Causeway
Miami, FL 33149
Tel: 305-361-4439
Fax: 305-361-4366
Telex: 744 7600 MCI
E-mail: engler@aoml.noaa.gov

NIMA Fleet Liaisons

Joe Schruender, East Coast Fleet Liaison

Chris Janus, West Coast Fleet Liaison
ATTN: GIMM (MS D-44)
4600 Sangamore Road
Bethesda, MD 20816-5003
Tel: 301-227-3120
Fax: 301-227-4211
E-mail: schruender@nima.mil, janus@nima.mil

U.S. Coast Guard AMVER Center

Richard T. Kenney
AMVER Maritime Relations Officer
United States Coast Guard
Battery Park Building
New York, NY 10004
Tel: 212-668-7764
Fax: 212-668-7684
Telex: 127594 AMVERNYK
E-mail: rkenney@batteryny.uscg.mil

Other Port Meteorological Officers

Australia

Head Office
Marine Observations Unit
Bureau of Meteorology
150 Lonsdale Street, 7th Floor
Melbourne, VIC 3000
Tel: +613 9669 4651
Fax: +613 9669 4168
E-mail: marine_obs@bom.gov.au

Melbourne
Michael J. Hills, Port Meteorological Agent
Victoria Regional Office
Bureau of Meteorology, 26th Floor
150 Lonsdale Street
Melbourne, VIC 3000
Tel: +613 6669 4982
Fax: +613 9663 4957
E-mail: m.hills@bom.gov.au

Fremantle
Malcolm Young, Port Meteorological Agent
MalMet Services Pty Ltd
Unit 3/76 Gardner Street
COMO WA 6152
Tel: +618 9474 1974
Fax: +618 9260 8475
E-mail: malyoung@mail.iinet.net.au

Sydney
Captain Einion E. (Taffy) Rowlands, PMA
NSW Regional Office
Bureau of Meteorology, Level 15
300 Elizabeth Street
Sydney NSW 2000
Tel:+612 9296 1547
Fax: +612 9296 1648
E-mail: e.rowlands@bom.gov.au

Canada

Randy Sheppard, PMO
Environment Canada
45 Alderney Drive, 16th Floor
Dartmouth, Nova Scotia B2Y 2N6
902-426-6703
E-mail: randy.sheppard@ec.gc.ca

Jack Cossar, PMO
Environment Canada
Bldg. 303, Pleasantville
P.O. Box 21130, Postal Station “B”
St. John’s, Newfoundland A1A 5B2
Tel: 709-772-4798
E-mail: jack.cossar@ec.gc.ca

Michael Riley, PMO
Environment Canada
Pacific and Yukon Region
Suite 700, 1200 W. 73rd Avenue
Vancouver, British Columbia V6P 6H9
Tel: 604-664-9136
Fax: 604-664-9195
E-mail: Mike.Riley@ec.gc.ca

Ron Fordyce, Supt. Marine Data Unit
Rick Shukster, PMO
Roland Kleer, PMO
Environment Canada
Port Meteorological Office
100 East Port Blvd.
Hamilton, Ontario L8H 7S4
Tel: 905-312-0900
Fax: 905-312-0730
E-mail: ron.fordyce@ec.gc.ca

China

YU Zhaoguo
Shanghai Meteorological Bureau
166 Puxi Road
Shanghai, China

Denmark

Commander Lutz O. R. Niegsch
PMO, Danish Meteorological Inst.
Lyngbyvej 100, DK-2100
Copenhagen, Denmark
Tel: +45 39157500
Fax: +45 39157300

United Kingdom

Headquarters
Capt. E. J. O’Sullivan
Marine Observations Manager
Met. Office - Observations Voluntary (Marine)
Scott Building
Eastern Road

Continued on Page 100

Meteorological Services

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Bracknell, Berkshire RG12 2PW
Tel: +44-1344 855654
Fax: +44-1344 855921
Telex: 849801 WEABKA G

Bristol Channel
Captain Austin P. Maytham, PMO
P.O. Box 278, Companies House
CrownWay, Cardiff CF14 3UZ
Tel: + 44 029 2202 142223
Fax: +44 029 2022 5295

East England
Captain John Steel, PMO
Customs Building, Albert Dock
Hull HU1 2DP
Tel: +44 01482 320158
Fax: +44 01482 328957

Northeast England
Captain Gordon Young, PMO
Able House, Billingham Reach Ind. Estate
Billingham, Cleveland TS23 lPX
Tel: +44 0642 560993
Fax:+44 0642 562170

Northwest England
Colin B. Attfield, PMO
Room 331, Royal Liver Building
Liverpool L3 1JH
Tel:+44 0151 236 6565
Fax: +44 0151 227 4762

Scotland and Northern Ireland
Captain Peter J. Barratt, PMO
Navy Buildings, Eldon Street
Greenock, Strathclyde PA16 7SL
Tel: +44 01475 724700
Fax: +44 01475 892879

Southeast England
Captain Harry H. Gale, PMO
Trident House, 21 Berth, Tilbury Dock
Tilbury, Essex RM18 7HL
Tel: +44 01385 859970
Fax: +44 01375 859972

Southwest England
Captain James M. Roe, PMO
8 Viceroy House, Mountbatten Business Centre
Millbrook Road East
Southampton SO15 lHY
Tel: +44 023 8022 0632
Fax: +44 023 8033 7341

France

Yann Prigent, PMO
Station Mét., Noveau Semaphore
Quai des Abeilles, Le Havre
Tel: +33 35422106
Fax: +33 35413119

P. Coulon
Station Météorologique
de Marseille-Port
12 rue Sainte Cassien
13002 Marseille
Tel: +33 91914651 Ext. 336

Germany

Volker Weidner, PMO
Deutscher Wetterdienst
Met. Hafendienst
Postfach 70 04 21
22004 Hamburg
Tel: 040 3190 8826

Volker Weidner, PMO
Peter Gollnow, PMO
Horst von Bargen, PMO
Deutscher Wetterdienst
Jenfelder Allee 70a
22043 Hamburg
Tel: +49 40 66901411
Fax: +49 40 66901496
E-mail: pmo@dwd.de

Henning Hesse, PMO
Deutscher Wetterdienst
An de Neuen Schleuse
27570 Bremerhaven
Tel: +49 471 7004018
Fax: +49 471 7004017
E-mail: pmo@dwd.de

Ulrich Ranke, PMO
Deutscher Wetterdienst
Flughafendamm 45
28199 Bremen
Tel: +49 421 5372163
Fax: +49 421 5372166
E-mail: pmo@dwd.de

Christel Heidner, OMP
Christine Bergs, PMO
Deutscher Wetterdienst
Seestr. 15a
18119 Rostock
Tel: +49 381 5438830
Fax: +49 381 5438863
E-mail: pmo@dwd.de

Greece

George E. Kassimidis, PMO
Port Office, Piraeus
Tel: +301 921116
Fax: +3019628952

Hong Kong

C. F. Wong, PMO
Hong Kong Observatory
134A Nathan Road
Kowloon
Hong Kong
Tel: +852 2926 3113
Fax: +852 2311 9448

Israel

Hani Arbel, PMO
Haifa Port
Tel: 972 4 8664427

Aharon Ofir, PMO
Marine Department
Ashdod Port
Tel: 972 8 8524956

Japan

Headquarters
Marine Met. Div., Marine Dept.
Japan Meteorological Agency
1-34 Otemachi, Chiyoda-ku
Tokyo, 100 Japan
Fax: 03-3211-6908

Port Meteorological Officer
Kobe Marine Observatory
14-1, Nakayamatedori-7-chome
Chuo-ku, Kobe, 650 Japan
Fax: 078-361-4472

Port Meteorological Officer
Nagoya Local Meteorological Obs.
2-18, Hiyori-cho, Chikusa-ku
Nagoya, 464 Japan
Fax: 052-762-1242

Port Meteorological Officer
Yokohama Local Met. Observatory
99 Yamate-cho, Naka-ku,
Yokohama, 231 Japan
Fax: 045-622-3520

Kenya

Ali J. Mafimbo, PMO
PO Box 98512
Mombasa, Kenya
Tel: +254 1125685
Fax: +254 11433440

Malaysia

NG Kim Lai
Assistant Meteorological Officer
Malaysian Meteorological Service
Jalan Sultan, 46667 Petaling
Selangor, Malaysia

Mauritius

Mr. S Ragoonaden
Meteorological Services
St. Paul Road, Vacoas, Mauritius
Tel: +230 6861031
Fax: +230 6861033

Continued on Page 101

Meteorological Services

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Netherlands

John W. Schaap, PMO
KNMI/PMO-Office
Wilhelminalaan 10, PO Box 201
3730 AE De Bilt, Netherlands
Tel: +3130 2206391
Fax: +3130 210849
E-mail: schaap@knmi.nl

New Zealand

Julie Fletcher, MMO
MetService New Zealand Ltd.
P.O. Box 722
Wellington, New Zealand
Tel: +644 4700789
Fax: +644 4700772

Norway

Tor Inge Mathiesen, PMO
Norwegian Meteorological Institute
Allegaten 70, N-5007
Bergen, Norway
Tel: +475 55236600
Fax: +475 55236703

Poland

Jozef Kowalewski,PMO
Institute of Meteorology and Water Mgt.
Maritime Branch
ul.Waszyngtona 42, 81-342 Gdynia Poland
Tel: +4858 6205221
Fax: +4858 6207101
E-mail: kowalews@stratus/imgw.gdynia.pl

Saudi Arabia

Mahmud Rajkhan, PMO
National Met. Environment Centre
Eddah
Tel:+ 9662 6834444 Ext. 325

Singapore

Edmund Lee Mun San, PMO
Meteorological Service, PO Box 8
Singapore Changi Airport
Singapore 9181
Tel: +65 5457198
Fax: +65 5457192

South Africa

C. Sydney Marais, PMO
c/o Weather Office
Capt Town International Airport 7525
Tel: + 27219340450 Ext. 213
Fax: +27219343296

Gus McKay, PMO
Meteorological Office
Durban International Airpot 4029
Tel: +2731422960
Fax: +2731426830

Sweden

Morgan Zinderland
SMHI
S-601 76 Norrköping, Sweden

Meteorological Services - Forecasts

Headquarters

Marine Weather Services Program Manager
National Weather Service
1325 East-West Highway, Room 14126
Silver Spring, MD 20910
Tel: 301-713-1677 x. 126
Fax: 301-713-1598
E-mail: laura.cook@noaa.gov

Richard May
Assistant Marine Weather Services
Program Manager
National Weather Service
1325 East-West Highway, Room 14124
Silver Spring, MD 20910
Tel: 301-713-1677 x. 127
Fax: 301-713-1598
E-mail: richard.may@noaa.gov

U.S. NWS Offices

Atlantic & Eastern Pacific Offshore & High Seas

David Feit
National Centers for Environmental
Prediction
Marine Prediction Center
Washington, DC 20233
Tel: 301-763-8442
Fax: 301-763-8085

Tropics

Chris Burr
National Centers for Environmental
Prediction
Tropical Prediction Center
11691 Southwest 17th Street
Miami, FL 33165
Tel: 305-229-4433
Fax: 305-553-1264
E-mail: burr@nhc.noaa.gov

Central Pacific High Seas

Tim Craig
National Weather Service Forecast Office
2525 Correa Road, Suite 250
Honolulu, HI 96822-2219
Tel: 808-973-5280
Fax: 808-973-5281
E-mail: timothy.craig@noaa.gov

Alaska High Seas

Dave Percy
National Weather Service
6930 Sand Lake Road
Anchorage, AK 99502-1845
Tel: 907-266-5106
Fax: 907-266-5188

Coastal Atlantic

John W. Cannon
National Weather Service Forecast Office
P.O. Box 1208
Gray, ME 04039
Tel: 207-688-3216
E-mail: john.w.cannon@noaa.gov

Mike Fitzsimmons
National Weather Service Office
810 Maine Street
Caribou, ME 04736
Tel: 207-498-2869
Fax: 207-498-6378
E-mail: mikefitzsimmons@noaa.gov

Tom Fair/Frank Nocera
National Weather Service Forecast Office

Continued on Page 102

Meteorological Services

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445 Myles Standish Blvd.
Taunton, MA 02780
Tel: 508-823-1900
E-mail: thomas.fair@noaa.gov;
frank.nocera@noaa.gov

Ingrid Amberger
National Weather Service Forecast Office
175 Brookhaven Avenue
Building NWS #1
Upton, NY 11973
Tel: 516-924-0499 (0227)
E-mail: ingrid.amberger@noaa.gov

James A. Eberwine
National Weather Service Forecast Office
Philadelphia
732 Woodlane Road
Mount Holly, NJ 08060
Tel: 609-261-6600 ext. 238
E-mail: james.eberwine@noaa.gov

Dewey Walston
National Weather Service Forecast Office
44087 Weather Service Road
Sterling, VA 20166
Tel: 703-260-0107
E-mail: dewey.walston@noaa.gov

Brian Cullen
National Weather Service Office
10009 General Mahone Hwy.
Wakefield, VA 23888-2742
Tel: 804-899-4200 ext. 231
E-mail: brian.cullen@noaa.gov

Robert Frederick
National Weather Service Office
53 Roberts Road
Newport, NC 28570
Tel: 919-223-5737
E-mail: robert.frederick@noaa.gov

Doug Hoehler
National Weather Service Forecast Office
2015 Gardner Road
Wilmington, NC 28405
Tel: 910-762-4289
E-mail: douglas.hoehler@noaa.gov

Stephanie Fauver
National Weather Service Office
5777 South Aviation Avenue
Charleston, SC 29406-6162
Tel: 843-744-0303 ext. 6
E-mail: stephanie.fauver@noaa.gov

Andrew Shashy
National Weather Service Forecast Office
13701 Fang Road
Jacksonville, FL 32218
Tel: 904-741-5186

Randy Lascody
National Weather Service Office
421 Croton Road
Melbourne, FL 32935
Tel: 407-254-6083

Michael O'Brien
National Weather Service Forecast Office
11691 Southwest 17 Street
Miami, FL 33165-2149
Tel: 305-229-4525

Great Lakes

Daron Boyce, Senior Marine Forecaster
National Weather Service Forecast Office
Hopkins International Airport
Cleveland, OH 44135
Tel: 216-265-2370
Fax: 216-265-2371

Tom Paone
National Weather Service Forecast Office
587 Aero Drive
Buffalo, NY 14225
Tel: 716-565-0204 (M-F 7am-5pm)

Tracy Packingham
National Weather Service Office
5027 Miller Trunk Hwy.
Duluth, MN 55811-1442
Tel: 218-729-0651
E-mail: tracy.packingham@noaa.gov

Dave Guenther
National Weather Service Office
112 Airport Drive S.
Negaunee, MI 49866
Tel: 906-475-5782 ext. 676
E-mail: dave.gunther@noaa.gov

Terry Egger
National Weather Service Office
2485 S. Pointe Road
Green Bay, WI 54313-5522
Tel: 920-494-5845
E-mail: teriegger@noaa.gov

Robert McMahon
National Weather Service Forecast Office
Milwaukee
N3533 Hardscrabble Road
Dousman, WI 53118-9409
Tel: 414-297-3243
Fax: 414-965-4296
E-mail: robert.mcmahon@noaa.gov

Tim Seeley
National Weather Service Forecast Office
333 West University Drive
Romeoville, IL 60446
Tel: 815-834-0673 ext. 269
E-mail: tim.seeley@noaa.gov

Bob Dukesherer
National Weather Service Office
4899 S. Complex Drive, S.E.
Grand Rapids, MI 49512-4034
Tel: 616-956-7180 or 949-0643
E-mail: bob.dukesherer@noaa.gov

John Boris
National Weather Service Office
8800 Passenheim Hill Road
Gaylord, MI 49735-9454
Tel: 517-731-3384
E-mail: john.boris@noaa.gov

Bill Hosman
National Weather Service Forecast Office 9200
White Lake Road
White Lake, MI 48386-1126
Tel: 248-625-3309
Fax: 248-625-4834
E-mail: jeff.boyne@noaa.gov

Coastal Gulf of Mexico

Constantine Pashos
National Weather Service Forecast Office
2090 Airport Road
New Braunfels, TX 78130
Tel: 210-606-3600

Len Bucklin
National Weather Service Forecast Office
62300 Airport Road
Slidell, LA 70460-5243
Tel: 504-522-7330

Steve Pfaff, Marine Focal Point
National Weather Service Forecast Office
300 Pinson Drive
Corpus Christi, TX 78406
Tel: 512-289-0959
Fax: 512-289-7823

Rick Gravitt
National Weather Service Office
500 Airport Blvd., #115
Lake Charles, LA 70607
Tel: 318-477-3422
Fax: 318-474-8705
E-mail: richard.gravitt@noaa.gov

Eric Esbensen
National Weather Service Office
8400 Airport Blvd., Building 11
Mobile, AL 36608
Tel: 334-633-6443
Fax: 334-607-9773

Paul Yura
National Weather Service Office
20 South Vermillion
Brownsville, TX 78521

Brian Kyle
National Weather Service Office

Continued on Page 103

Meteorological Services

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Houston
1620 Gill Road
Dickenson, TX 77539
Tel: 281-337-5074
Fax: 281-337-3798

Greg Mollere, Marine Focal Point
National Weather Service Forecast Office
3300 Capital Circle SW, Suite 227
Tallahassee, FL 32310
Tel: 904-942-8999
Fax: 904-942-9396

Dan Sobien
National Weather Service Office
Tampa Bay
2525 14th Avenue SE
Ruskin, FL 33570
Tel: 813-645-2323
Fax: 813-641-2619

Scott Stripling, Marine Focal Point
National Weather Service Office
Carr. 190 #4000
Carolina, Puerto Rico 00979
Tel: 787-253-4586
Fax: 787-253-7802
E-mail: scott.stripling@noaa.gov

Coastal Pacific

William D. Burton
National Weather Service Forecast Office
Bin C15700
7600 Sand Point Way NE
Seattle, WA 98115
Tel: 206-526-6095 ext. 231
Fax: 206-526-6094

Stephen R. Starmer
National Weather Service Forecast Office
5241 NE 122nd Avenue
Portland, OR 97230-1089
Tel: 503-326 2340 ext. 231
Fax: 503-326-2598

Rick Holtz
National Weather Service Office
4003 Cirrus Drive
Medford, OR 97504
Tel: 503-776-4303
Fax: 503-776-4344
E-mail: rick.holtz@noaa.gov

Jeff Osiensky
National Weather Service Office
300 Startare Drive
Eureka, CA 95501
Tel: 707-443-5610
Fax: 707-443-6195

Jeff Kopps
National Weather Service Forecast Office
21 Grace Hopper Avenue, Stop 5
Monterey, CA 93943-5505
Tel: 408-656-1717
Fax: 408-656-1747

Chris Jacobsen
National Weather Service Forecast Office
520 North Elevar Street
Oxnard, CA 93030
Tel: 805-988-6615
Fax: 805-988-6613

Don Whitlow
National Weather Service Office
11440 West Bernardo Ct., Suite 230
San Diego, CA 92127-1643
Tel: 619-675-8700
Fax: 619-675-8712

Andrew Brewington
National Weather Service Forecast Office
6930 Sand Lake Road
Anchorage, AK 95502-1845
Tel: 907-266-5105

Dave Hefner
National Weather Service Forecast Office
Intl. Arctic Research Ctr. Bldg./UAF
P.O. Box 757345
Fairbanks, AK 99701-6266
Tel: 907-458-3700
Fax: 907-450-3737

Robert Kanan
National Weather Service Forecast Office
8500 Mendenhall Loop Road
Juneau, AK 99801
Tel and Fax: 907-790-6827

Tom Tarlton
Guam
Tel: 011-671-632-1010
E-mail: thomas.tarlton@noaa.gov⚓

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