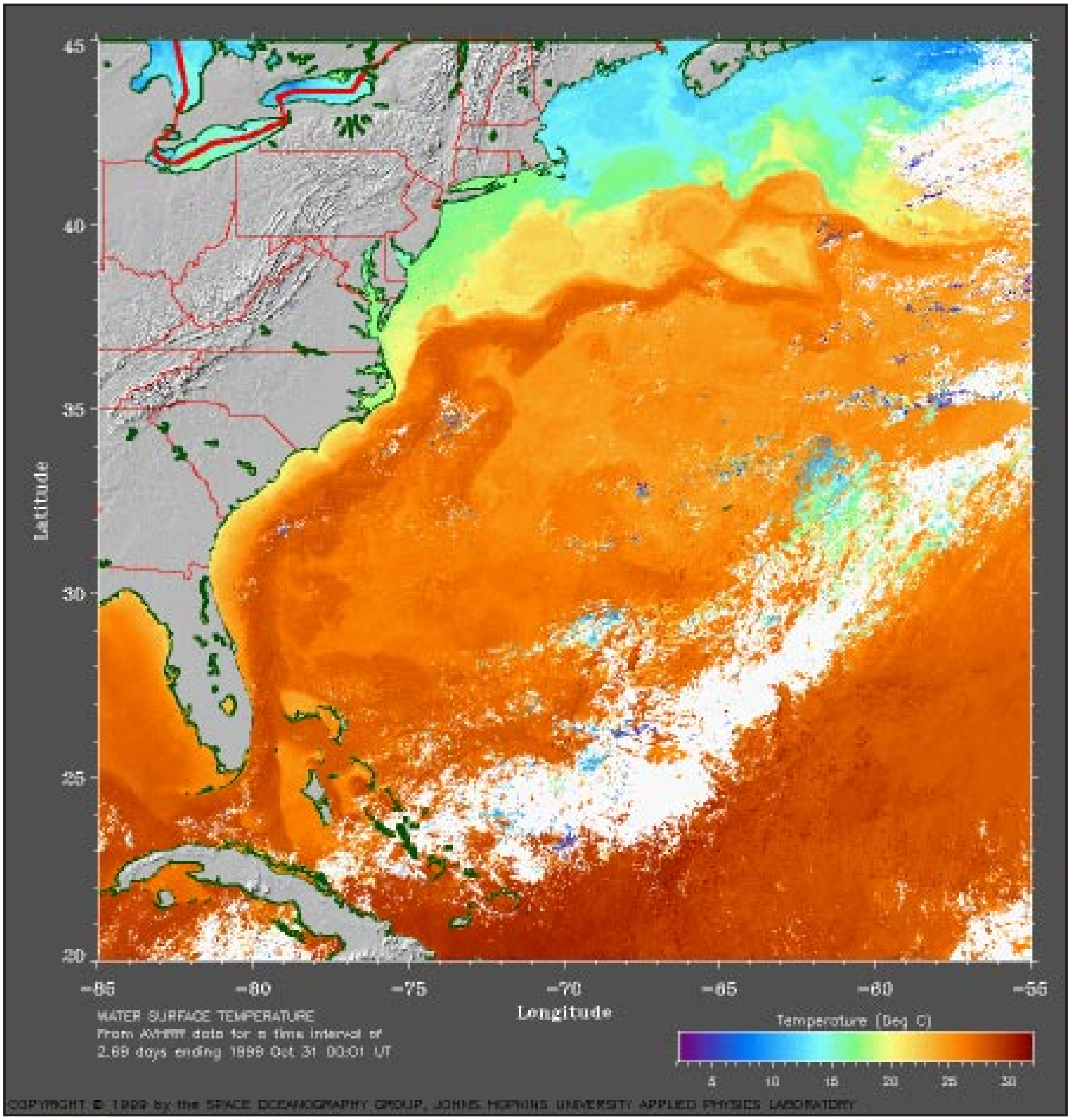
Mariners Weather Log

Vol. 43, No. 2 August 1999



Sea Surface Temperature image of the North Atlantic Ocean showing the Gulf Stream System (intense currents on the western side of the North Atlantic Ocean). For centuries, the only information on ocean surface currents came from mariners. With the introduction of satellites, a view of ocean currents can be seen on a daily basis.

Mariners Weather Log

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From the Editorial Supervisor

As the 20th century ends and we enter the new millennium, now, as never before, the topics of weather and climate are at the forefront of speculation and study. In the past, predictions about humanity's future did not take account of changing climate, disappearing forests, spreading deserts, rising sea levels, and the like. Now, as we are all aware, changes like these are likely to affect our future profoundly. In light of this, the cover of this issue was chosen to recognize the impact that ocean currents such as the Gulf Stream have on weather and climate.

The Gulf Stream impacts weather both in the United States and Europe. Along the United States east coast, a class of storms, referred to as "Nor'Easters" can form in winter near or over the Gulf Stream as cold air from the North American continent meets the Gulf Stream warm air. Development of these storms can sometimes be explosive, with central pressures dropping 18 mb (0.5 inches) or more in less than 24 hours (called "bombs" in our North Atlantic Marine Weather Reviews). Further east, the Gulf Stream has a major moderating impact on the weather of Iceland, Western Europe, the Azores, and the Canary Islands.

It is widely believed that ocean currents, along with phenomena such as El Niño and La Niña are key to understanding and predicting weather and climate change. They will be at the forefront of climate research throughout the 21st century. We will continue to run articles on these subjects as they become available.⚓

Some Important Webpage Addresses

NOAA	http://www.noaa.gov
National Weather Service	http://www.nws.noaa.gov
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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George Burkley
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The Maritime Institute of Technology and Graduate Studies (MITAGS) offers both two- and five-day Coast Guard approved weather courses which meet International Maritime Organization Standards of Training and Conduct for Watchkeepers (STCW) requirements.

It is no secret that a hurricane (or typhoon) is a very powerful and dangerous weather system. A fully developed category 5 hurricane (on the Saffir-Simpson Hurricane Scale), the highest classification a hurricane can attain, will have winds in excess of 135 knots and will control over one million cubic miles of atmosphere.

Hurricanes can also create waves over 50 feet high in the open ocean. Further, the low pressure at the center of one of these hurricanes can cause the ocean’s surface to rise and produce a coastal surge that can be 20 feet or more above the normal high water mark. While it is hard to grasp the power of a typical hurricane, if the energy from one were converted to electricity, it could supply the United States power demand for six months.

Although the subject of how hurricanes form is complex there are some general constants. All hurricanes originate near the equator and sustain themselves by capturing and condensing the warm moist air that is present at these latitudes. A hurricane begins to form when there is a buildup of equatorial heat and this heat is unable to move away to the earth’s polar regions quickly enough to keep the earth’s atmosphere in balance.

Because a hurricane expedites removal of heat from equatorial regions to cooler polar areas it is similar to a circuit breaker in an electrical system or a relief valve on a radiator. It quickly transfers heat from hot equatorial regions to cool polar areas. Hurricanes are so good at removing heat that water temperatures behind a hurricane are often reduced several degrees.

Avoidance is an essential ship routing tactic in dealing with hurricanes and, though recognized limits do exist in both hurricane track and intensity forecasting, there are two reliable rules that should be used by mariners. These are the “34-knot wind radius” and the “1-2-3” rules.

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Hurricane Avoidance

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Thirty-Four-Knot Wind Radius Rule

The 34-knot wind radius rule states that ships should stay outside the area of a hurricane where winds of 34 knots or greater are analyzed or predicted. Often this area is not symmetrical around a hurricane, varying within semi-circles or quadrants.

Thirty-four knots is chosen as the critical wind speed because as wind speed doubles its generated force increases by a factor of four (see side bar on wind force), and when 34 knots is reached, sea state development significantly limits ship maneuverability. When ship maneuverability is limited, then course options are also significantly reduced.

Hurricane advisory messages produced by the National Weather Service, National Hurricane Center provide 34-knot wind radius analysis and forecast. For example; advisory #30 for Hurricane Bonnie, produced on August 26, 1998, provided the following information on location of 34-knot winds:

0900Z Wed 26 Aug 1999:
34 knot winds……….200NE 150SE 125SW 150NW
(Thirty-four knot winds found out to 200 miles from center in NE quadrant, 150 miles of center in SE quadrant, 125 miles of center in SW quadrant, and 150 miles of center in NW quadrant.)

Forecast for 27 Aug 1999:
34 knot winds……….200NE 150SE 50SW 75NW

Using this information, a chart can be constructed showing the area to be avoided, and this area should be compared with National Weather Service, Marine prediction Center sea-state and wind-wave analysis and forecasts. Subsequent forecasts should be used to validate and update conditions, which are then used to update a ship's route.

The 1-2-3 Rule: Constructing an Area to be Avoided Around a Tropical Cyclone's Track

The 1-2-3 rule states that track error forecasting for a hurricane is 100 miles either side of a predicted track for each 24-hour forecast period. Thus, for a 24-hour period, an error of 100 miles (1 day x 100 miles) to the left or right of an official predicted track is applicable. For 48 hours the error is 200 miles (2 x 100), and for 72 hours the error is 300 miles (3 x 100).

Averaging errors in track deviation from predicted path for the period 1988-1997 substantiates this rule of thumb:

Forecast Interval (Hours)	Avg. Error (nm) (left & right of track) Atlantic Ocean	Avg. Error (nm) (left & right of track) Pacific Ocean
24	88	71
48	166	137
72	248	195

Therefore, when a hurricane's track is plotted, a 100-mile error for each 24-hour period must be applied and a vessel within this adjusted area must take action as if a hurricane were bearing directly toward them, which may become the case.

Combining both the "34-knot wind radius" and "1-2-3" rules allows calculation of the **area to avoid** when a hurricane- or a hurricane-force mid-latitude low

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Wind Force

Force per square foot experienced when wind is blowing perpendicular to a surface is calculated using this formula:

F = 0.004V(squared)

F = wind force measured in pounds per square inch
V = wind velocity in knots

Wind Speed	Force (lbs./square foot)
10	0.4
15	0.9
20	1.6
25	2.5
30	3.6
34	4.6

Source: U.S. Navy Sailors Handbook

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pressure system is detected. An example of this technique is diagramed in Figure 1. Mariners transiting hurricane- and typhoon-prone regions who make use of these two well-proven techniques will reduce risk to life, cargo, and vessel damage.

Author Biographies

Michael Carr is a graduate of the U.S. Coast Guard Academy and a U.S. Navy Ship Salvage Diving Officer (SSDO). He holds a 1600-ton all oceans license and is an instructor at the Maritime Institute of Technology and Graduate Studies (MITAGS) in Linthicum Heights, Maryland. Michael authored the recently released book "*Weather Simplified: How to Read Weather Charts and Satellite Images*" published by International Marine/McGraw Hill.

George Burkley is a 1989 graduate of the California Maritime Academy and has served as a merchant ships officer and an aviator in the U.S. Naval reserve. He currently is the Marine Science Department Head at MITAGS, instructing in radar/ARPA, electronic navigation, and heavy Weather Avoidance.

Lee Chesneau is a senior marine forecaster with the NWS's Marine Prediction Center, Camp Springs, Maryland. He is the Outreach Coordinator and liaison to the Maritime Institute of Technology Conference and Training Center in Linthicum Heights, Maryland, commonly known in the maritime industry as MITAGS. He co-instructs two-day marine Weather Safety Seminars jointly with Navigator Publishing and MITAGS, as well as the five-day Heavy Weather Avoidance courses at MITAGS.⚓

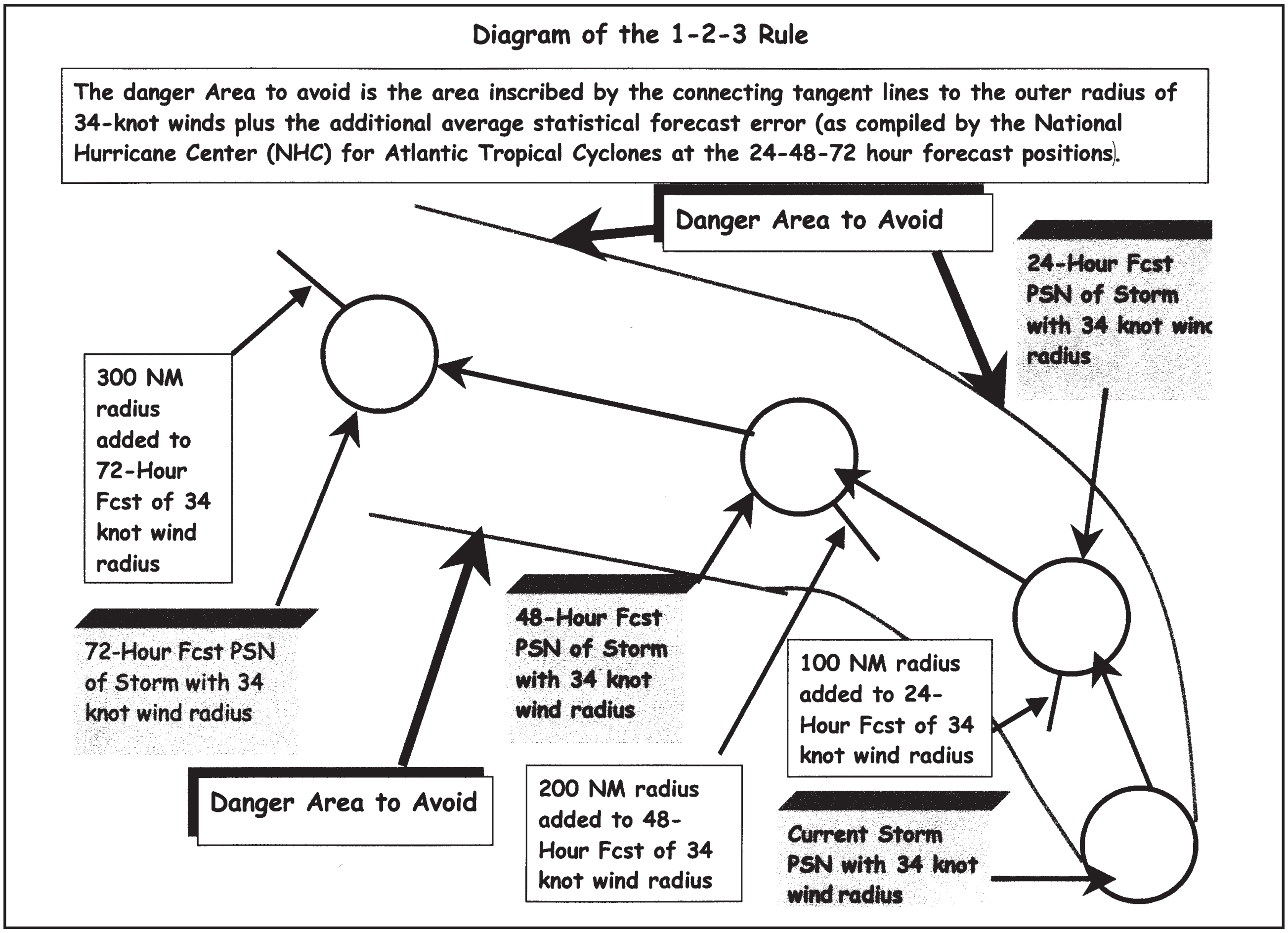
Diagram of the 1-2-3 Rule

The danger Area to avoid is the area inscribed by the connecting tangent lines to the outer radius of 34-knot winds plus the additional average statistical forecast error (as compiled by the National Hurricane Center (NHC) for Atlantic Tropical Cyclones at the 24-48-72 hour forecast positions).

Figure 1. Diagram of the 1-2-3 rule.

Obtaining National Weather Service Hurricane Advisories Using E-Mail

Note: The following provided information does not imply any endorsement by the National Weather Service as to function or suitability for your purpose or environment.

Using the University of Illinois Listserver for Marine Applications

These Lists provide an automated means to receive NWS hurricane forecast products via e-mail. However, performance may vary and receipt cannot be guaranteed by either UIUC or the National Weather Service.

The University of Illinois at Urbana-Champaign (UIUC) operates an e-mail Listserver, of which two Lists, WX-ATLAN, and WX-TROPL, are of special interest to mariners who do not have direct access to the World Wide Web but who are equipped with an e-mail system. These lists provide an automated means to receive hurricane information via e-mail. Information on this system may be found at: **http://ralph.centerone.com/wxlist/**.

Users should be aware of the costs for operating their particular e-mail system before attempting to use this Listserver, especially when using satellite communication systems. Although the service is free, the user is responsible for any charges associated with the communication system(s) used by their e-mail system. As this Listserver will send requested data on a continuous basis until service is successfully terminated, potential charges might be significant.

As a general guide, National Weather Service hurricane products average 1 Kbyte each in length. The tropical weather OUTLOOK is transmitted on a six-hour cycle during the hurricane season. Other products are

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Hurricane Advisories

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transmitted when active systems exist, on a six-hour cycle (one series of products for each storm). Products may be transmitted more often as the systems approach landfall, to make corrections, etc. The lists may contain products in addition to those produced by the National Weather Service.

This Listserver is not operated or maintained by the National Weather Service. Please direct all questions to Chris Novy at: chris@siu.edu.

National Weather Service hurricane products may also be found on the World Wide Web at links including:

http://www.nws.noaa.gov
http://weather.gov
http://www.nhc.noaa.gov
http://www.nws.noaa.gov/om/marine/forecast.htm

Below are an abbreviated set of instructions for the WX-ATLAN and WX-TROPL lists on the UIUC Listserver.

WX-ATLAN Information

This list contains topical weather outlooks, hurricane position reports, etc. It is most active from June through December. Portions of the products on this list may be in abbreviated (coded) format.

To subscribe to WX-ATLAN send e-mail to listserv@po.uiuc.edu and include the following message:

```
sub wx-atlan YourFirstName YourLastName
```

To signoff WX-ATLAN send e-mail to listserv@po.uiuc.edu and include the following message:

```
signoff wx-atlan
```

WX-ATLAN mailings are subdivided based on product category. There is presently no way to restrict mailings to a specific storm. By default, when you first subscribe, you will receive ONLY the brief outlook (OUTLOOK) The available sub-topics are:

OUTLOOK = Brief discussions concerning development trends [ABNT20]

TROPDISC = Detailed discussions concerning development trends [AXNT20]

FORECAST = Storm forecasts (wind and sea height estimates) [WTNT2x]

ADVISORY = Storm status reports (movement, wind speeds, etc) [WTNT3x]

STRMDISC = Discussion reports concerning a specific storm [WTNT4x]

POSITION = Position reports [WTNT5x]

UPDATE = Storm updates (they often cites recon reports) [WTNT6x]

STRIKE = Strike probabilities (landfall probabilities) [WTNT7x]

ALL = All sub-topics

RECON = URNT12 FOS header Vortex messages

To receive bulletins from just one specific product, say the strike probabilities, send e-mail to listserv@po.uiuc.edu with the following:

```
set wx-atlan topics: strike
```

You can also use combinations of the keywords for multiple products. For example:

```
set wx-atlan topics: strike,position,tropdisc
```

Notes: If you have previously specified a list of sub-topics and now you want to add or delete specific sub-topics, prefix them with a (+) or (-) respectively. For example, to add ADVISORY and delete TROPDISC (while leaving any other sub-topics alone) you would send the command:

```
set wx-atlan topics: +advisory -tropdisc
```

You must already be subscribed to WX-ATLAN in order to use the sub-topic commands.

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WX-TROPL Tropical Information

This list contains topical weather outlooks, hurricane position reports, etc. Portions of the products on this list may be in abbreviated (coded) format.

Note: For Atlantic and Gulf of Mexico information see the WX-ATLAN list.

To subscribe to WX-TROPL send e-mail to listserv@po.uiuc.edu and include the following message:

```
sub wx-tropl YourFirstName YourLastName
```

To signoff WX-TROPL send e-mail to listserv@po.uiuc.edu and include the following message:

```
signoff wx-tropl
```

WX-TROPL mailings are subdivided into geographic regions. By default, new subscribers will receive all bulletins. We have set up sub-topic areas for a number of geographically related regions:

PACIFIC-EN = Pacific Ocean Eastern Northern region (90W to 140W)

PACIFIC-NC = Pacific Ocean North Central region (140W to 180W)

PACIFIC-NW = Pacific Ocean Northwest region (100E to 180E)

PACIFIC-SW = Pacific Ocean Southwest (120E to 180E south of Equator)

INDIAN-N = Indian Ocean (North) (100E to 40E north of Equator)

INDIAN-S = Indian Ocean (South) (120E to 40E south of Equator)

PACIFIC-SE = Pacific Ocean Southeast Region

To receive bulletins from just one specific region, say the northwest Pacific Ocean, send e-mail to listserv@po.uiuc.edu with the following:

```
set wx-tropl topics: pacific-nw
```

You can also use combinations of the keywords for multiple areas. For example:

```
set wx-tropl topics: pacific-en, pacific-nw
```

Notes: If you have previously specified a list of sub-topics and now you want to add or delete specific sub-topics, prefix them with a (+) or (-) respectively. For example, to add PACIFIC-NW and delete INDIAN-N (while leaving any other sub-topics alone) you would send the command:

```
set wx-tropl topics: +pacific-nw -indian-n
```

You must already be subscribed to WX-TROPL in order to use the sub-topic commands.

If you wish to receive National Weather Service hurricane products via e-mail only upon individual request , the NWS FTPMAIL server may be more appropriate for your needs.

Using the NWS FTPMAIL Server

National Weather Service radiofax charts broadcast by U.S. Coast Guard from Boston, New Orleans, and Pt. Reyes, California are available via e-mail. Marine text products are also available. The FTPMAIL server is intended to allow Internet access for mariners and other users who do not have direct access to the World Wide Web but who are equipped with an e-mail system. Turnaround is generally in under three hours, however, performance may vary widely and receipt cannot be guaranteed. To get started in using the NWS FTPMAIL service, follow these simple directions to obtain the FTPMAIL “help” file (6 Kbytes).

Send an e-mail to:
ftpmail@weather.noaa.gov

Subject line: Put anything you like.

Body: help

Also available at: **http://weather.noaa.gov/pub/fax/ftpmail.txt**

Great Lakes Wrecks — The Roy A. Jodrey

Skip Gillham
Vineland, Ontario, Canada

It has been twenty-five years since the **Roy A. Jodrey** went to the bottom of the St. Lawrence River. The ship was lost off Wellesley Island on November 21, 1974.

This was a modern member of the Algoma Central Marine fleet. It was barely nine years old, having been launched at Collingwood, Ontario, on September 9, l965. The ship sailed to load the first cargo, a shipment of limestone, on November 11, l965.

The 640-foot, 6-inch long bulk carrier was constructed with on-board systems and a 250-foot self-unloading boom that allowed the discharge of a wide variety of cargoes without the need for shore-based personnel or equipment.

Roy A. Jodrey operated throughout the Great Lakes and St. Lawrence Seaway and was carrying 20,450 tons of taconite ore pellets from Sept Iles, Quebec, to Detroit when it went down.

The upbound vessel struck Pullman Shoal in the American Narrows section of the St. Lawrence east of the entrance to Lake Ontario. There were three bumps and the ship sheered to port and took on a starboard list.

The vessel was intentionally grounded adjacent to the Coast Guard station near Alexandria Bay, New York, some 1600 feet upstream from Pullman Shoal.

The forward area was badly holed and a quick investigation revealed the seriousness of the damage. The crew abandoned ship via lifeboat and around midnight the Captain and Chief Engineer were removed.

Shortly afterwards the hull slipped off the precarious perch on the ledge, rolled on its side and sank.

Due to the depth and location, salvage of the ship or cargo proved unfeasible. The **Roy A. Jodrey** remains on the bottom as proof that even the most modern ships are not exempt from disaster.

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

The *Roy A. Jodrey* above Lock 1 of the Welland Canal on February 25, 197l. (Skip Gillham photo.)

Waves *Beneath* the Sea

Bruce Parker
National Ocean Service

On August 29, 1893, two months into its voyage to the North Pole, the Norwegian ship **Fram** was steaming in calm weather through open waters north of Taimur Island, Siberia, when it came almost to a dead stop. The ship's engine had been going at full pressure, moving her at 5 knots, when the speed suddenly dropped to1 knot, and stayed that way. The ship's progress was greatly slowed, and Dr. Fridtjof Nansen, the leader of the expedition, wrote in his journal, "It was such slow work that I thought I would row ahead to shoot seal."

The **Fram** had encountered what Norwegian seaman called "dödvand" or "*dead water*". This strange phenomenon caused a ship to lose her speed and to refuse to answer her helm. The only clue to its cause was that dead water always occurred at locations where the sea was covered with fresh or brackish water. And this was indeed the case in the sound north of Taimur Island, where the ice cover had been melting rapidly. August 30th brought more slow going. Nansen wrote: "We could hardly get on at all for the dead water, and we swept the whole sea along with us." "We made loops in our course, turned sometimes right round, tried all sorts of antics to get clear of it, but to little purpose. The moment the engine stopped, it seemed as if the ship was sucked back."

The **Fram** encountered dead water on several other occasions during its voyage. In November 1898, two years after his expedition's end, Nansen sent a letter to Professor Vilhelm Bjerknes, an old classmate, asking for his opinion as to the cause of this phenomenon. Bjerknes hypothesized correctly that, when there is a layer of fresh water on top of saltwater, a moving ship will not only generate visible waves at the boundary between water and air, but will also generate invisible waves beneath the sea along the boundary between the freshwater layer and the saltwater layer below it. The energy that normally would have propelled the ship forward was instead going into generating these "*internal waves*," with the result that the ship hardly moved at all (see Figure 1).

Bjerknes then turned the problem over to his student Vagn Walfrid Ekman, who proceeded to confirm Bjerknes' theory with mathematics and with experiments. In these experiments he used a glass tank containing a freshwater layer on top of a salt-water layer that had been dyed a dark color to make the interface clearer. Ekman pulled a model boat along the surface and was able to generate clearly observable internal waves propagating along the interface between the two water layers.

This was the first demonstration and explanation of internal waves in the ocean. Internal waves, however, had been observed earlier in a totally different setting. Benjamin Franklin may have been the first to write about them, in a letter dated December 1, 1762, while he was in Madeira, Spain. He had made what he referred to as an Italian lamp, by filling the bottom third of a glass tumbler

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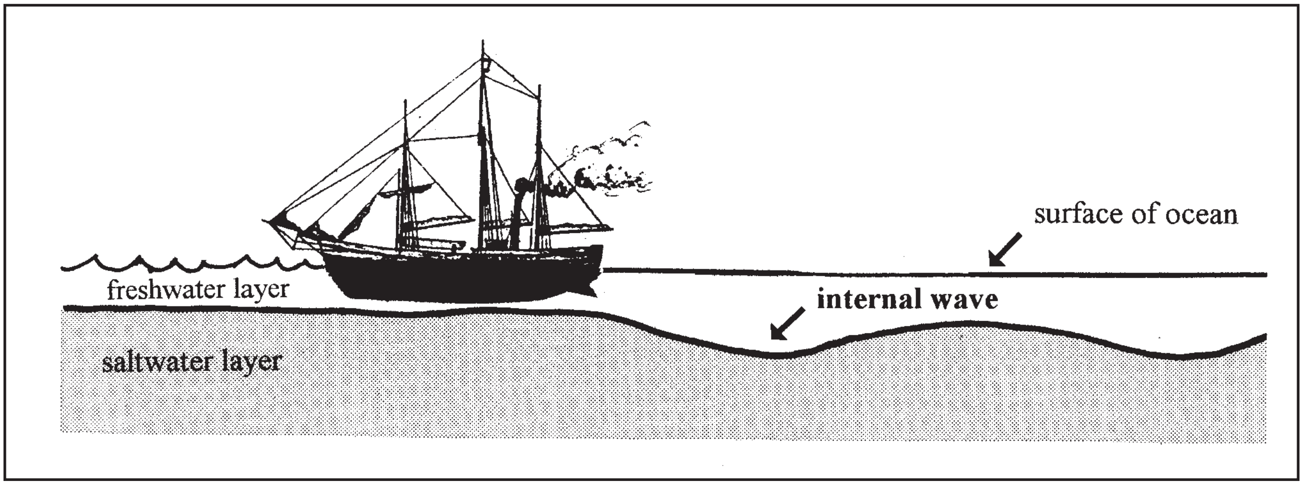

Figure 1. A model of the Norwegian ship *Fram* generating an internal wave at the interface between an upper layer of freshwater and a lower layer of saltwater.

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with water, and the next third with oil. He noticed times when the surface of the oil (with air above it) was motionless, but the surface of the water under the oil could be "in great commotion, rising and falling in irregular waves". He repeated this experiment many times when he returned to America. Today one often sees toys where a layer of blue-dyed water is covered with a layer of clear oil to make the waves along the interface look like waves at sea. These waves, however, look like they're moving in slow motion, and they become larger and break more easily than would water waves covered with a layer of air. (As we shall see, this is due the small difference in the densities of water and oil, which is much smaller than the difference in the densities of water and air).

When one looks at the details of the wave motion along the interface between two liquids (whether water and oil or saltwater and freshwater) there are many similarities with the wave motion along the surface of the ocean (described in our last Physical Oceanography column). When the two layers are motionless, with the lighter fluid resting on the heavier one, and the interface is a horizontal straight line, the entire system is in equilibrium. At every point the weight of the fluid is exactly balanced by the pressure exerted on it by neighboring fluid. If something disturbs the interface, for example by pushing the interface up at some point, heavier water from the lower layer will be moved higher up in the water column into a layer of lighter water. Gravity will then pull the heavier water back down. Without any appreciable friction to stop this downward movement the inertia of the heavier water will keep it moving downward, overshooting its original at-rest equilibrium position and moving deeper than it originally was. The lighter water in the top layer follows after, flowing down into the depression. This lighter water moves downward in the water column into a layer of heavier water. The buoyancy of the lighter water (being surrounded now by heavier water) eventually starts it moving upward again. This oscillation of the interface between the two layers also moves horizontally, because the individual water particles do not just move up and down; they also move to the left and right. In fact, water particles in both layers trace out circular orbits (rotating in opposite directions on opposite sides of the interface). Energy is transferred horizontally to surrounding water particles, and so the wave (i.e., the shape of the distorted interface) propagates along the interface (see Figure 2).

Due to the small density difference between the two water

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layers, the gravitational restoring force is reduced, and is much smaller than the restoring force for waves on the ocean's surface. The heavier water particles raised up in the crest of an internal wave are not that much heavier than the surrounding water, so it takes longer for these water particles to slow up and start falling again. Likewise, lighter water particles lowered into the trough of an internal wave are not that much lighter than surrounding water. They are, therefore, only slightly buoyant and so they also take longer to slow up and then to starting moving upward. This makes for larger wave heights (they move farther up or down before slowing down) and for slower propagating wave forms (it takes longer for the restoring force to return water particles to their average position). Internal wave periods vary from 10 minutes to several hours, compared with several seconds to minutes for surface waves. Internal waves can reach heights of several hundred feet in the ocean, much larger than their surface wave counterparts.

For a ship to be caught in dead water, first, its draft must be close to the thickness of the fresh water surface layer, so it can generate an internal wave, and second, it must be traveling at the same speed (or slower) than the speed of propagation of the internal wave created. The speed of the internal wave is determined by the density difference between the two layers, and by the thickness of the layers. The drag on the ship reaches a maximum when the ship's speed is very close to the internal wave speed. If the ship has enough power to go faster than the speed of the internal wave (usually speeds greater than 5 knots will be enough), it can break away from the dead water. Dead water is thus less of a problem today with the power of modern ships. However, there have been cases where a ship has slowed down and then suddenly come to a dead stop (sometimes with extreme vibrations). In such cases, the initial reaction is usually that the ship has run aground. In some instances ships have even been dry-docked to assess the damage from the "grounding," only to find that there was none.

Back when ships had less power than today, incidents of dead water were reported at many locations around the world where there was a fresh or brackish water layer on top of a saltwater layer. Dead water was especially common in the fjords of Scandinavia. A fjord is a hollowed-out glacial valley with a sill at the ocean end. Cold dense saltwater fills the bottom of the fjord to the depth of the sill. The surface water is lighter due to the freshwater from streams running into the fjord. The sill at the entrance tends to act like a filter, keeping a major portion of the energy in the ocean from getting into the fjord, so that there is little vertical mixing and the two layers are maintained. Thus, a fjord is an ideal location for the generation of internal waves. Dead water was less common in rivers because, even with strong runoff, the water column can be well mixed from top to bottom if the currents are strong enough (espe-

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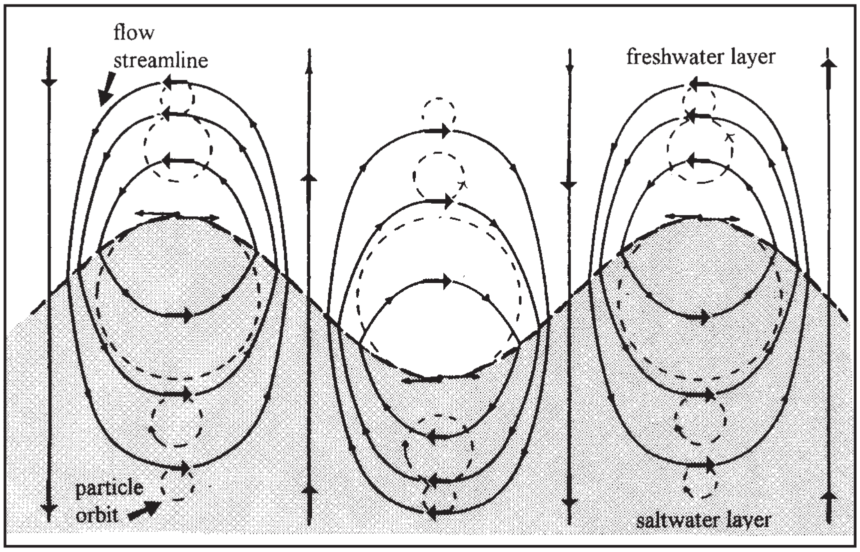

Figure 2. An idealized internal wave propagating along the interface between an upper layer of freshwater and a lower layer of saltwater. The streamlines show the direction of flow for a particular moment in time. The particle orbits are the motion of specific water particles over one complete cycle of the internal wave as it propagates from left to right.

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cially if there are strong tidal currents). When dead water was reported in rivers (with slow currents), it occurred at different locations at different times of the year because of differing amounts of runoff, since the thickness of the upper layer had to be comparable to the ship draft. Dead water occurred upriver during dry seasons, and outside the river entrance in the sea during periods of heavy runoff. Dead water also tended to be more prevalent during sea breezes and flood tides (which helped maintain the thickness of the freshwater surface layer).

Internal waves are not limited to rivers and fjords where fresh water flows out over saltwater. Most internal waves, in fact, occur offshore and in the open ocean, but there the density differences are primarily due to differences in water temperature. The upper layer is lighter because the water is warmer than in the lower layer. Heat from the sun warms the surface waters of the ocean, and that heat slowly propagates downward into the ocean depths. The action of surface waves often mixes the water to a particular depth, so that the entire upper layer is the same warmer temperature. In this case there is a sudden change in temperature as one crosses the interface between this warm upper layer and the cooler layer below. This interface is called a *thermocline* (the interface between fresher water and saltier water is called a *halocline*). It is along the thermocline that internal waves in the ocean propagate. When water density increases with depth (due to decreasing temperature or to increasing salinity) the water is said to be “stratified”. Wherever water is stratified, internal waves are possible.

Because the density difference between an upper warm layer and a lower cool layer in the ocean is smaller than that between freshwater and saltwater layers, and because the thickness of these layers is larger, the amplitudes of the internal waves in the ocean can be much larger than those in fjords and rivers. Ocean internal waves are often 160 feet high, but have been measured at heights of 600 feet. These internal waves also produce currents (see below) that can reach speeds of 6 knots. The largest internal waves tend to occur where the thermocline is deep and where the local generation mechanisms are energetic enough (places like the Strait of Gibralter, where current speeds are increased by the sudden narrow width of the strait).

When two fluid layers are close in density it does not take much of a disturbance to move water vertically and to generate an internal wave. As we have seen, this disturbance can be a moving ship, but it can also be a change in wind stress or pressure at the ocean surface. When stratified water flows over a bump in the river bottom (or over an ocean ridge or shelf break, or over any irregular underwater topography) the fluid particles will be displaced vertically upward. Being heavier than their surroundings, those water particles are acted upon by gravity to move them downward again, thus starting the internal wave (see Figure 3). The internal waves that result can vary significantly, having periods from a few minutes

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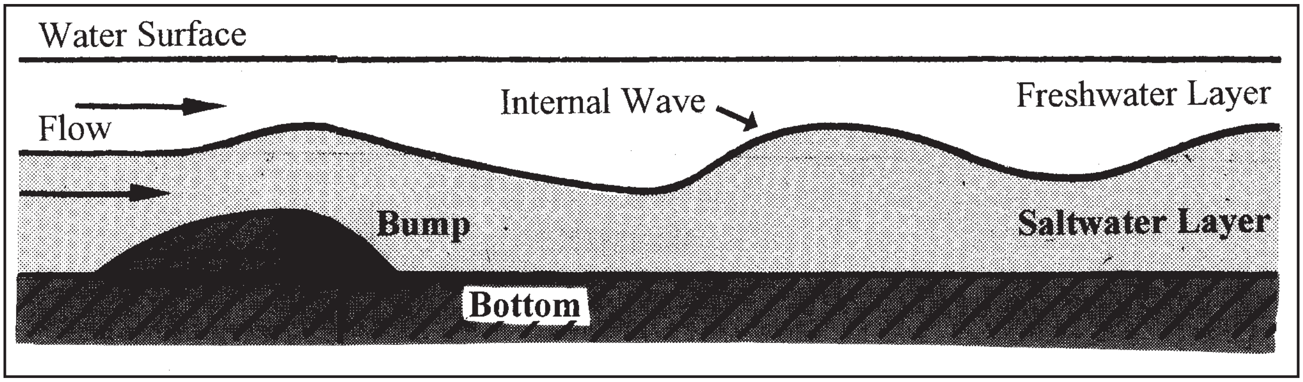

Figure 3. Internal wave generated by two-layered flow over a topographic feature on the bottom.

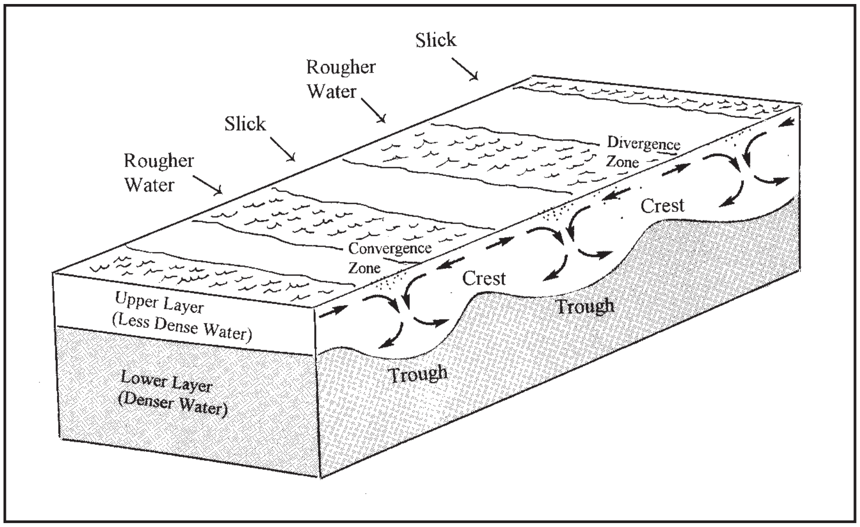

Figure 4. The circulation pattern produced by a propagating internal wave. At the water's surface, long slicks of smooth water alternate with bands of rougher water. Surface debris tends to collect in the convergence zones over the troughs of the internal wave, as does plankton.

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to many days. *Internal tidal waves*, with the thermocline or halocline moving up and down at tidal frequencies, are probably the most common variety. An earthquake can produce *internal tsunamis* at the same time that it is producing the much faster and more destructive tsunami on the ocean's surface.

Sudden disturbances can generate *"solitary" internal waves*. A solitary wave (also called a *soliton*) is a single peak or trough that moves along the thermocline. Such waves can maintain their shape as they travel for hundreds of miles. Disturbances at a shelf break or in a strait can produce packets of solitons, which always travel with the tallest soliton at the front of the packet. A typical situation is that strong tidal currents oscillate stratified water over continental shelf topography or through a strait, which generates long internal tidal waves, which become unstable as they propagate onto the sloping shelf (much like a wave breaking on a beach). This breaking of the internal tidal wave generates packets of solitons with even larger heights and stronger currents. For example, packets of internal solitons have been observed in oil fields in the northern South China Sea that were generated 350 miles to the east, and two to four days earlier, by tidal forcing at the shallow sill in the Luzon Strait (halfway between Taiwan and the Philippines). These waves had traveled at speeds of 4 to 8 knots and had been refracted around an island creating a complex interference pattern of wave fronts. Packets of solitons are very common in this area, observable throughout the year. During some months these packets arrive every 12 hours. These waves can be 165 feet high and accompanied by currents on the order of 3 knots or higher.

Although internal waves beneath the surface of the water are not directly visible, they do have an effect on the water's surface that is clearly observable. Figure 4 illustrates the circulation pattern produced by propagating internal waves. Water in the upper layer moves down toward the trough of the internal wave as the interface moves deeper, and water in the upper layer over the crest is pushed aside as the crest of the internal wave moves upward. At the ocean's surface, therefore, the motion of the surface water is away from the crests and toward the troughs; the water tends to converge over the troughs and diverge over the crests. This causes any floating surface debris to collect over the troughs. This debris dampens the small surface ripples, making the surface smooth and glassy. The result is long parallel *slicks* of smooth water on the ocean surface, alternating with long rows of rougher water.

Such surface patterns were observable by Nansen and many others who described the surface waters during incidents of dead water. Nansen's comment that "we swept the whole sea along with us" was a typical description of dead water and was a reference to the smooth slick area (over the unseen trough of the internal wave

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just behind and below the stern of the ship) that moved with the ship. His comment that "The moment the engine stopped, it seemed as if the ship was sucked back," was a reaction to the slick area (and succeeding surface pattern) moving past the ship as the internal wave below propagated forward leaving the ship behind. For the larger internal waves offshore and in the open ocean, the parallel rows of smooth slicks and rougher water can each be 60 miles long. The difference in the surface roughness can be seen from satellites with Synthetic Aperture Radar (SAR) or with ordinary photography (if the sun is at the right angle). With packets of internal solitons, each soliton is preceded by a very long band of rough water (called "rips") and followed by an equally long band of calm water.

Most of the interest in internal waves today is not because of dead water, but because of the damage that the large internal waves in the ocean can do, especially to oil drilling operations. Large amplitude internal waves (especially packets of internal solitons), with their associated strong currents, can create enormous bending moments in offshore structures, and have been reported to displace oil platforms hundreds of feet in the horizontal as well as tens of feet in the vertical direction. Drillships appear to be especially susceptible to the effect of internal waves. Self-propelled and designed to drill for oil in water over 7000 feet deep, they use dynamic positioning and propulsion to maintain a constant position while drilling. Studies in the Andaman Sea (west of Burma) have shown increases in mooring line tensions that correlate directly with independently measured packets of 200-foot high internal solitons propagating past the drillship. Internal waves are capable of causing large integrated forces on vertical elements such as risers and tethers. Because of the real possibility of riser failure or other problems, internal soliton prediction systems have been developed.

Internal waves have also been cited as the possible cause for a few unexplained submarine losses. Perhaps the most famous was the loss of the **USS Thresher** on April 10, 1963, in the Gulf of Maine. The most probable cause of the tragedy was determined by the Navy to be a leak in an engine room seawater system which shorted electrical circuits causing a loss of propulsion power. At some point she sank below her crush depth and then plunged to the bottom. Two days before, however, a large storm crossed the Gulf of Maine creating a subsurface eddy and (it was speculated) possibly a 300-foot-high internal wave. A submarine traveling through an internal wave could very quickly cross from dense to less dense water and suddenly become heavier and start to sink. Without prompt pumping of ballast overboard and enough propulsion power to propel it toward the surface, the submarine could continue to head deeper. Whether an internal wave played a role in the **Thresher** tragedy will never be known, but internal waves are certainly important in submarine operations. They can affect sound transmission and a submarine can trim its buoyancy so that it can "rest" on a density layer, move slowly, and remain undetected by surface craft. Internal waves observed with satellite Synthetic Aperture Radar (SAR) may also be used to locate moving ships, by analyzing patterns at the surface produced by the internal waves generated by the ship.

Internal waves also have a variety of other as yet not fully appreciated effects. The slicks above the troughs have been shown to be associated with higher concentrations of plankton. This has been seen not just at the surface, but throughout the water column over the troughs. Porpoises have been observed feeding in these surface slicks. The porpoises also ride internal waves, much as a surfer rides a wave on the surface of the ocean. Porpoises learn to tilt themselves at a slope that matches the slope of the internal waves, so that in effect they're on a perpetual downhill ride.

We have only talked about internal waves traveling horizontally along an interface between two layers of water, such as a thermocline. However, water temperature can become cooler with depth in a smooth and continuous manner, rather than in a sudden change

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when crossing a thermocline. In such cases, internal waves are no longer restricted to traveling horizontally. Although the largest still travel horizontally, some also travel vertically. Thus, internal waves can travel to all depths of the ocean if the stratification is right. They are, therefore, an important mechanism for transporting energy from the ocean's surface to the ocean bottom. If vertical propagation is impeded by the bottom or by a sudden change in stratification at some depth, these internal waves can also be reflected.

Internal waves also occur in the atmosphere, traveling on the interface between warm and cold air. They can produce patterns of clouds organized into bands, with the clouds over the crests of the internal wave. They are often found downwind of mountain ranges, the so-called lee waves in which sailplane pilots soar to great heights.

In the report that Ekman wrote describing his experiments and his mathematical treatment of internal waves, he also provided a section of collected historical anecdotes about the occurrences of dead water recorded as far back as the Roman Empire. Since dead water would very suddenly hold back a ship, as if by a mysterious force, it was attributed to a whole host of causes. Seamen blamed it on the gods or other supernatural forces, on magnetic rocks, and on molluscs that suddenly grew on the ship's hull. They also imagined very large remora fish (the normal size remora attach themselves to sharks and other fish) that could attach onto the hull of a ship and hold it in place even during a strong wind. The slick that follows a ship in dead water led some mariners to believe that something had made the water stick to the vessel and the ship had to drag it along it, thus greatly reducing its speed.

Over the years mariners have tried a variety of ways to escape dead water, including shearing off course, running the whole crew forward and aft on the deck, scooping up quantities of water on deck, pouring oil on the water ahead of the ship, working the rudder rapidly, firing guns into the water, and hitting the water with oars. Tugboats with a vessel in tow were usually more successful in escaping. Typically the vessel they towed had a deeper draft and was the vessel actually caught in the dead water. When this happened one course of action was to shorten the rope between the tugboat and the towed vessel as much as possible. Unknowing to the tug captain, this allowed the tug's propeller to mix the water around the vessel being pulled, destroying the interface on which the internal wave traveled.

Of all the stories collected by Ekman, to which he attributed a role to internal waves, the most famous was the Battle of Actium, the naval battle on September 2, 31 BC, where the fleets of Marc Antony and Cleopatra were defeated by Octavian. Ekman cites an account by Pliny the Naturalist, who said that during that sea battle a remora fish grabbed onto Antony's ship and held it so fast that he was obliged to board another vessel. Although it will never be known for sure, Ekman's guess that an internal wave was involved may be correct. The Battle of Actium took place on the Adriatic Sea along the coast of Dalmatia (near where Croatia is today). The Adriatic Sea receives large amounts of freshwater river runoff. Antony's fleet was trapped close to shore by Octavian's fleet. Octavian had lighter shallower-draft vessels, whereas Antony's vessels were heavy deeper-draft Roman warships equipped with stone throwing catapults. Historians have mentioned how the lighter ships of Octavian were more maneuverable. But if on that day there was a layer of brackish water on the surface, Antony's deeper draft vessels would have been more likely to be captured by dead water, and Pliny's description of Antony's vessel being held fast may have been accurate. The battle ultimately ended when Cleopatra decided to flee with her 60 ships and Antony abandoned his legions and chased after her. It was a sea battle that changed history, and it is possible that internal waves may have played a role in Octavian's victory, which led to his subsequent crowning as Rome's first emperor, Augustus.

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

Hands Across the Water!
Ship Reporting Systems Save Lives at Sea

Richard T. Kenney
United States Coast Guard
Maritime Relations Officer

As part of a visit to U.S. Coast Guard facilities around the United States, a delegation of officials from the People's Republic of China visited the AMVER Maritime Relations Office in New York City. There, they were met by Captain Gabriel Kinney, Chief of the Office of Search and Rescue at U.S. Coast Guard (USCG) Headquarters in Washington, D.C., and Mr. Rick Kenney, the AMVER Maritime Relations Officer. At Mr. Kenney's invitation, Captain Shen Jugen, former Master of the AMVER rescue ship **Gao He**, and Mr. Lachun Liu, Chief of Ship Operations, from the offices of COSCO North America in Secaucus, New Jersey, were invited to participate as technical interpreters.

The Chinese group was headed by Mr. Wang Zhi Yi, Director of the Shanghai Maritime Safety Agency (SMSA). It included Mr. Zhai Jiugang, Director of the Navigation Safety Division of the Maritime Safety Agency (MSA) of China; Mr. Chang Fu Zhi, Director of the Navigation Safety Division of SMSA; Mr. Chen Zhen Wei, Director of the Aids To Navigation District of SMSA; Mr. Gao Hui, an Engineer from the Ministry of Communication; and Mr. Hu Ming, an Investments Engineer from the Shipping Bureau of the Ministry of Communication.

The group had previously visited the USCG's Pacific Area Headquarters in Alameda, California; Vessel Traffic Service facilities San Francisco; and a USCG small boat Group and Air Station in Los Angeles. In a meeting with Vice Admiral Collins, the U.S. Coast Guard's Pacific Area Commander, discussions centered on developing a "partnership" between the MSA and USCG on such matters as search and rescue, port state control, and oil pollution response programs.

The purpose of their New York visit was to brief AMVER officials on the establishment of a new China Ship Reporting System (CHISREP) for any vessels, foreign and domestic, that enter the Chinese sea area (9 degrees N northward, 130 degrees E, westward, excluding other countries'

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territorial seas). Participation in CHISREP is mandatory for all Chinese-registered ships over 300 GT engaged in international routes, and 1600 GT engaged in domestic coastal routes. All ships not registered in China must report when they arrive or depart from Chinese harbors. The reporting scheme follows the IMO-prescribed format.

The main functions of CHISREP are to provide assistance for search and rescue, marine safety and pollution prevention, utilizing information from the system. CHISREP is an active system, which means once a ship joins CHISREP and begins sending daily position reports, if a report is missed, the CHISREP Center will perform a pre-alarm and consult the ship's company, operator or related departments to ensure that the ship is in no distress. Reports fall into two categories: General Reports (Sail Plan, Position Report, Deviation Report, and Final Report), and Special Reports (Dangerous Goods, Harmful Substances, and Marine Pollutant Reports). Reports can be sent via NBDP, Morse, wireless phone, or Inmarsat. Coast Radio Stations in Shanghai, Guangzhou, and Dalian are prescribed report-receiving stations. The CHISREP computer center is located in the Shanghai Maritime Safety Administration.

Officials of the China Ship Reporting System (CHISREP) and U.S. Coast Guard AMVER Safety Network exchange information on the similarities and differences between the two computerized lifesaving systems. From right, Richard Kenney (U.S. Coast Guard AMVER Maritime Relations Officer), Wang Zhi Yi (Director General, Shanghai Maritime Safety Agency), and Gabriel Kinney (Chief, U.S. Coast Guard, Office of Search and Rescue). An interpreter is seated on the far right.

There was an exchange of information on the operation of both systems. By comparison to the worldwide AMVER system, CHISREP is a smaller, regional system. In contrast to the Chinese system, AMVER is used only for search and rescue. It is a "passive" system that does not initiate action unless a ship is unreported or overdue. The only reports required are the Sail Plan, Position Reports, Deviation Report, and Arrival Report. The Coast Guard representatives took advantage of the opportunity to promote increased AMVER participation by the COSCO fleet. Captain Shen was called upon to relate his experience in carrying out an AMVER rescue of a yachtsman in a remote area of the Pacific Ocean during a storm to illustrate the value of AMVER reporting.

Discussions also centered around other search and rescue issues of mutual interest, such as GMDSS implementation, and the planned COSPAS-SARSAT termination of 121.5 MHz beacon processing. A bilateral agreement between the two nations, signed in 1987, was seen as a good blueprint for future close cooperation in training, communications, and even joint search and rescue exercises. Both sides considered this dialogue valuable to understanding the role of both the AMVER and CHISREP systems, and the benefits of maximum participation by ships in both. It was agreed that discussions would continue on broader issues of search and rescue so that, by joint cooperation, the two nations could enhance safety of life at sea.⚓

Some Frequently Asked Questions About NDBC Buoys

David B. Gilhousen
National Data Buoy Center
Bay St. Louis, Mississippi

Are weather buoys relatively new?

Actually, no. The U.S. Navy first developed experimental buoys to acquire weather data in the 1950s. Approximately 50 individual data buoy programs were conducted by many agencies and research laboratories in the 1960s. The National Data Buoy Center (NDBC) was founded in 1970 as a joint National Weather Service (NWS)–U.S. Coast Guard (USCG) project, and deployed its first experimental buoy southeast of Norfolk, Virginia, in 1972. By 1979, NDBC had moored 26 buoys in the Pacific, Atlantic, and Gulf of Mexico. There are presently 67 buoy stations supported by NWS and other agencies. What is relatively new are the web sites that help to disseminate the observations. NDBC's web site, **http://www.ndbc.noaa.gov/** receives approximately 2 million hits each month, and the NWS's Interactive Marine Observation page, **http://www.nws.fsu.edu/buoy/**, which also contains Canadian and British buoys,

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Questions About NDBC Buoys

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receives approximately 3.5 million hits each month.

Why aren't waves measured at more stations?

Sea state is not an easy measurement to make. Between the two major types of NDBC stations (floating moored buoys and fixed platforms), it is more difficult to measure waves from a platform.

If the station identifier is alphanumeric instead of numeric, the station is a fixed platform in the Coastal-Marine Automated Network (C-MAN). For example;

- CSBF1 identifies the C-MAN station at Cape San Blas, Florida
- 42036 identifies a moored buoy in the northeastern Gulf of Mexico.

A C-MAN automatic weather station is usually located on a lighthouse, pier, jetty, piling, beach, or offshore platform. Only on offshore platforms, where NDBC uses a downward-pointing laser sensor, can waves be easily measured. Even if waves could be measured at all C-MAN stations, the wave measurements would be severely affected at many of these sites by shallow water and would not be representative of nearby deeper water.

Who determines where buoys and C-MAN stations are located?

No one person or agency determines the locations. The number of buoy locations grew and evolved in response to the changing needs of the NWS, other government agencies, and non-federal reimbursable customers.

The first group of buoys was placed 200 to 300 miles offshore for NWS support in the 1970s. The NWS chose these locations because they wanted advance indication of storms and wave conditions before they affected the coastal areas. Then, after 1979, eight buoys were deployed in the Great Lakes in response to the sinking of the **Edmund Fitzgerald**. When the USCG announced plans to automate lighthouses, Congress funded the NWS for the C-MAN program in the 1980s. Although the C-MAN program did include several offshore platforms and (originally) a few coastal buoys, most coastal buoys were funded through reimbursable agreements with government agencies other than NWS. Some of these agencies support data collection for experiments that could last from a few months to several years. Once the experiment is complete, the station is no longer continued unless Congress supplies funding. Several years ago, Congress supplied permanent funding for 36 buoy and C-MAN stations that had been funded originally by other government agencies.

Can cameras that relay "live" photos be added to NDBC buoys?

Yes, but several significant problems would have to be solved. First, a method of keeping salt spray off the lenses would have to be developed. NDBC tries to operate stations one to two years without servicing them. Second, the communications capability of the Geostationary Operational Environmental Satellite (GOES) system that NDBC uses is far too limited to relay photos. Other satellites could be used, but they would be very expensive to operate.

For answers to other frequently asked questions, visit: **http://www.ndbc.noaa.gov/faq.shtml/**

Marine Debris: Sources and Sinks in the Ocean Environment

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What is it?

Marine debris comes from a myriad of sources, land-based activities and ship-based activities alike. Whatever the source, however, the effects of this disposal are the same. Trash in our oceans and coastal waters diminishes aesthetics, harms natural resources, and costs everyone in clean up expenses. It's often difficult to pinpoint the sources of most debris, as the nature of the oceans transport these materials sometimes thousands of miles from their origin, and trash usually doesn't come with an identification tag. Likewise the vast nature of the oceans makes it easy to forget or overlook the tonnage of debris that enters the waters. Once out to sea, our interaction or exposure to the problem is minimal to nonexistent. And what we don't see, we tend less to worry over. Through the ages, dumping of trash into the oceans seemed only natural, as the waters appeared able to accommodate our debris indefinitely. Once the trash disappeared from sight as it settled beneath the surface, problems seemed nonexistent, effects appeared nil, and any concerns drifted away with the ocean currents. Only relatively recently did we begin to notice the results of the years of misuse. Animals entangled in nets, shipboard wastes spread across the shores, miscellaneous debris afloat in the waters we use more and more for recreation. With our growing dependence upon the coasts and coastal waters for sport as well as economic gain, our awareness of these impacts has heightened. We are finally understanding the effects of our early mistakes. It's now our job to take steps to stop ongoing impacts and clean up the effects from past wrongs. This article discusses the impacts, sources, and solutions to marine debris.

What are the impacts?

Once debris enters the marine environment, its biological effects may be considered in three primary areas: entanglement, consumption, or habitat degradation. These produce immediate to residual impacts, from loss of forage space to tragic deaths. Marine mammals, seabirds, and sea turtles all are at significant risk to entanglement. Studies estimate that at least 135 species of vertebrates and eight invertebrates have been reported through surveys as entangled in marine debris. These animals often seem to "play" with items they encounter, inadvertently exposing themselves to greater risk of becoming ensnared. The effects of entanglement can be quite severe. The most likely result is death due to drowning, often over an extended period, as animals respond to the stressor by twisting and worsening the clutch of the debris. Some impacts may extend even longer, such as low-grade suffocation from plastic bands that restrict airways as the animals grow.

The global biological effects of debris tend to vary with the health of a particular species' population. When entanglement occurs within strong populations such as sea lions, herring gulls, or northern elephant seals, losses may have limited effects on the population.

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While individual animals are lost, the populations are able to sustain themselves. For other populations that are no longer at sustainable levels, risk to entanglement may have a significant effect on the population's continued existence. Hawaiian monk seals, green sea turtles, and northern right whales are examples of such species. Losses of even limited numbers of these individuals may drastically reduce that group's ability to continue existence.

How much of an effect this impact has on a population depends on the level of interaction between the stressor and the species. For example, birds tend to use plastics in nest building, picking up odds and ends throughout their daily excursions. Bits of net, bags, or line may stand out as a valuable commodity to an efficient builder. The dangers in collecting this debris include risk of entanglement as fishing nets are hauled on board or lines are shuttled off back decks. Birds may attempt to land on cast off net that is afloat on the surface, then become entangled, and eventually drown. Curiosity of young animals results in increased entanglements of juvenile seals and other mammals. Turtles and sea lions may swim through netting or ringed bands, resulting in the plastic encircling a neck or fin. Over time, this debris may constrict growth, ultimately strangle, promote infection in an open wound, or amputate a limb. Yet another risk comes from future entanglement, as a piece of rope or filament may drag behind an ensnared animal, eventually snagging on rocks, kelps, or corals, or even tethering an animal from swimming free. These and many other methods are indicative of the devastating effects marine debris may have on many marine animals.

In the marine environment, animals generally rely less on vision in determining food sources. Dark waters and continuous wave action tend to make man-made items indistinguishable from food. Plastic pellets often resemble prey items for seabirds seeking a young crab afloat in surface waters. The adverse effects of plastics ingestion may even be passed through a colony by simple rearing characteristics. For example, adult birds may pass plastic pellets to their young as they feed by regurgitation. Juvenile fledglings may accumulate sufficient materials that their food becomes toxic. Jellyfish are a favorite meal for many species, however its appearance underwater is quite similar to a discarded plastic bag. Ingested by a sea turtle, whale or other animal, the effects are devastating. Plastics may obstruct airways and digestive tracts. A pygmy whale made international news when bags upon bags were removed from her gut. The plastics, twisted with air pockets throughout, inhibited her ability to dive, keeping her buoyant above critical food sources. Starving and unable to navigate, she was near death when luck came her way and she was rescued. To her good fortune, veterinarians were able to remove the debris and nurse her to health before returning her to her natural environment. These effects are examples with potentially lethal results. Sublethal effects have been found as well, including reduced growth and feeding desire.

Impacts to the biological environment such as these touch our emotions. We hate to think of sad sea lions succumbing to a slow and tragic end. Other emotions are rallied at the thought of our beaches being littered with medical waste or toxic materials, our human environment likewise succumbing to tragic impacts. Our lives are affected, in terms of ability to enjoy recreation, fish for our livelihoods, or move freely across the marine environment. We expect our shorelines to be clear of trash, so that we can enjoy the outdoors with our families, without worry of exposure to empty bottles or used syringes. Increasingly, however, visits to the beaches bring us face to face with the problem. Plastics wash ashore from distant cargo vessels, medical and industrial wastes float from trash barges or sewer overflows, and the disinterested neighbors up the beach leave leftover picnic utensils for the next recreationer to pick that spot in the sun. By any path it takes, marine debris on the shoreline is an alarm to us. It's visually unappealing, as well as a potential health risk. And while the aesthetics may have a significant connection to our economy, the greater

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disturbance is to the delicate balance that keeps the coastal environment running in check. When this balance slides one way or the other, tourism dollars may likewise wane from the coastal communities so closely tied to the environment. Without picturesque estuaries, healthy tidal pools and clean sandy shores, the draw to the beach is not as strong. Vacation dollars that previously supported coastal enterprises may be redirected to support a timberline lodge or non-coastal adventure.

These impacts affect the shoreward side of the coastal environment, yet the problems with marine debris don't stop there. Out at sea, boaters and commercial fishers also feel the effects of trash in the waters. Fishermen may feel economic impacts as their target catches are caught by other means. For example, lost gear from one fishery may entrap species of another fishery. When a fishery is large, the effects may be minimal. Yet when a fishery consists of a handful of captains, any lost catch is a factor in the sustainability of the resource and the associated income. Economic impacts also come to those fishers that lose their gear. Nets, lines, and traps can cost tens of thousands of dollars to a fisherman each year. Gear lost at sea not only costs the fishery in terms of environmental costs, but in replacement costs as well. Yet another aspect involves the effects of marine debris on the boats themselves. Propellors may become entangled in drifting net or lines, floating trash may damage props, and large scale objects may even impart damage to hulls. Typically these impacts are the result of another boat's carelessness with trash. The responsibility is on each vessel so that it's trash doesn't adversely affect the livelihood or recreational enjoyment of others.

Where does it come from?

Marine debris can take several forms and evolve from many sources. The most common debris is plastics, in a myriad of forms. Other debris include contaminants such as oil spillage and toxic discharge, as well as point source pollution from sewage outfalls. Some debris is just plain random, such as tires, crates, or galley wastes, all of which affect the marine environment. The effects vary between degrading to debilitating, depending on where in the ocean environment the debris resides. For example, food wastes discharged from a ship may be consumed by marine species, yet the plastic bag in which it was contained may suffocate a sea turtle. Ice bags and bait boxes may entrap other organisms or suffocate important fauna once they settle on the sea floor.

Vessel debris is a visible focus in the discussion of marine debris. Ships have sailed the seas for hundreds of years, and only recently (such as the 1970s) has the practice of overboard disposal become a globally recognized concern. In beginning to remedy the problem, many of the solutions are wrapped with issues more difficult than simply ordering ships to return all wastes to port. The costs involved in retaining wastes can be significant, as can costs for dockside disposal. Determining who pays for disposal also is a factor. These are just some of the issues that limit developing countries from ratifying MARPOL Annex V*.

A final source of debris comes from land-based sources. Urban areas inland of waterways are culprits in the degradation of our coastal zone as a result of sewer overflows or industrial wastes. Not only are these sources for threats to the coastal resources, but threats to human health as well. Visibility was high when surgical wastes began to appear on public beaches in the 1980s. In an instant, public concern was raised sufficient to noticeably reduce beach visitors for some time. When rains cause waste treatment plants to operate above capacity, human waste and other debris may be diverted directly to adjacent rivers or coastal waters. Storm water also washes debris from roadways into storm drains, which eventually reach the same waters. Flowing underground, these types of pollution travel out of the public's sight and often mind. Nevertheless, the impacts occur, thus education is necessary to reduce the impacts from their start.

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What's the Answer?

Studies show there is a significant value placed on clean beaches, even by the public that does not necessarily visit a beach. Just knowing that our coastal zone is clean is of value to many. Given this value, how do we reduce the debris and impacts on the resources? This requires actions at several stages, from product development to public education. A good example of improvement comes from our beverages. A sizable source of impact and risk to marine resources came from plastic six-pack rings. Thousands of animals become entangled when these rings find their way to oceans and beaches and thousands of rings are retrieved in annual beach clean ups. One manufacturer recognized the problems this product caused and sought a remedy. With the assistance of design teams, plastic rings were improved in production to increase degradation rates of the plastic in sunlight and to include pull tabs to break individual rings apart after use.

The U.S. ratified Annex V more than ten years ago, yet implementation is still a challenge. By 1993, 69 nations had ratified Annex V. Difficulties include the magnitude of coverage (the world's oceans) and limited resources for surveillance, lack of prosecution for foreign fleets by flag states, and economic disincentives. Despite these hurdles, there have been remarkable gains made in some areas. Annual numbers of vessels off-loading garbage has increased significantly and steadily, a reflection of increasing compliance. Beach clean ups of plastics, which may be an indicator for Annex V compliance, are reporting decreasing percentages of such wastes among the trash removed from the shoreline. Education is a strong step in influencing change, particularly among the public that uses its beaches, for fishing, diving, and general enjoyment of the coastal environment. Where do we go from here? A few strategies for improved implementation may include:

- Work with recreational boaters to fully comply with zero-discharge of debris. Because this group generally remains close to shore and trips are short, storage of all trash for disposal portside should be a reasonable mandate. Reduction in disposable materials will reduce the amount of trash to be stored. Educating boaters will also assist in reaching full compliance.

- Commercial fishing vessels operating shorter trips should also reach full compliance. Initiatives to recycle fishing gear would reduce that left at sea and new technology may be available to reduce the amounts of gear lost. Annex V enforcement must also be increased, perhaps via labeling gear as well as reporting of lost gear for accountability.

- Shipping vessels should implement improved onboard garbage handling methodologies and ports should provide adequate trash reception facilities.

A clean ocean is integral to healthy resources. The public desires a clean coastal environment and our marine resources depend on clean waters to exist. Given these fundamental requirements, it is clear that we all must work together to support the resources. By keeping our beaches clean, returning all trash from vessels to the dockside, and stopping discharge of pollutants and debris from stormwater flows, we will all contribute to a healthy marine environment.

Footnote

* The 1973 International Convention for the Prevention of Pollution from Ships is known as MARPOL. It went into effect in 1983 with the intent to end the "deliberate, negligent, or accidental release of harmful substances from ships" and to work toward the elimination of international pollution of the marine environment. It focuses on the wastes generated during the normal operations of vessels. MARPOL falls under the umbrella of the International Maritime Organization. Within the United States, the Coast Guard has the implementing authority. MARPOL includes several annexes. Annex V addressed ship-generated garbage, including a prohibition on disposal of plastics in the ocean. Annex V took effect December 31, 1988.⚓

Marine Weather Review
North Atlantic Area
December 1998 through March 1999

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Meteorologist
Marine Prediction Center

December began with a strong upper level ridge of high pressure over the eastern Atlantic which forced developing lows exiting the U.S. East Coast or the Canadian Maritimes northward toward Greenland and Iceland. Later in December the ridge broke down, leading to more unstable zonal (westerly) flow across the Atlantic steering the cyclones more east into the Great Britain area. This was the most active part of the winter in the North Atlantic, which lasted through January. The strong ridge re-appeared in the eastern Atlantic by February which led to a series of slow moving lows developing off the southeast U.S. coast, making late winter the most active period off the entire East Coast.

Hurricane Nicole

The tropical cyclone season normally runs through November in the North Atlantic. However, December 1998 began with Hurricane Nicole moving north along 35W in the high seas waters and becoming an extratropical storm by 00Z 02 December (Figure 1). The two 500 mb analysis charts in Figure 1 (corresponding to the first and third panels of the surface analysis) show a weak 500 mb low near 34N 40W associated with Nicole which re-intensified as an extratropical storm. Note the 60 kt ship report west of the center at 00Z 02 December. This system later merged with the storm center moving off the Labrador coast leading to a 964 mb storm over the Labrador Sea by 00Z 04 December (not shown).

Storm of December 22-24, 1998

This system strengthened explosively while still over land, from 989 mb at 12Z 22 December to 949 mb at 12Z 23 December when the center was just off the Labrador coast, a drop of 40 mb in 24 hours. The 24 hour track of the developing storm in the first surface panel of Figure 2 shows this strengthening. At 500 mb the development is supported by a strong short wave trough and jet of more than 100 kt (Figure 2). The storm, southeast of Cape Farewell at 12Z 24 December, reached maximum intensity by that time and was the second most intense North Atlantic storm of the winter, second only to the 926 mb storm described below. Surface data was sparse, but there was a ship report that reported 951.3 mb pressure, southwest wind of 35 kt, and 9 meter seas (30 ft), just southeast of the center shown in the second surface analysis of Figure 2. Gale to storm force winds occurred as far south as 45N south of the center. This system then drifted east and weakened.

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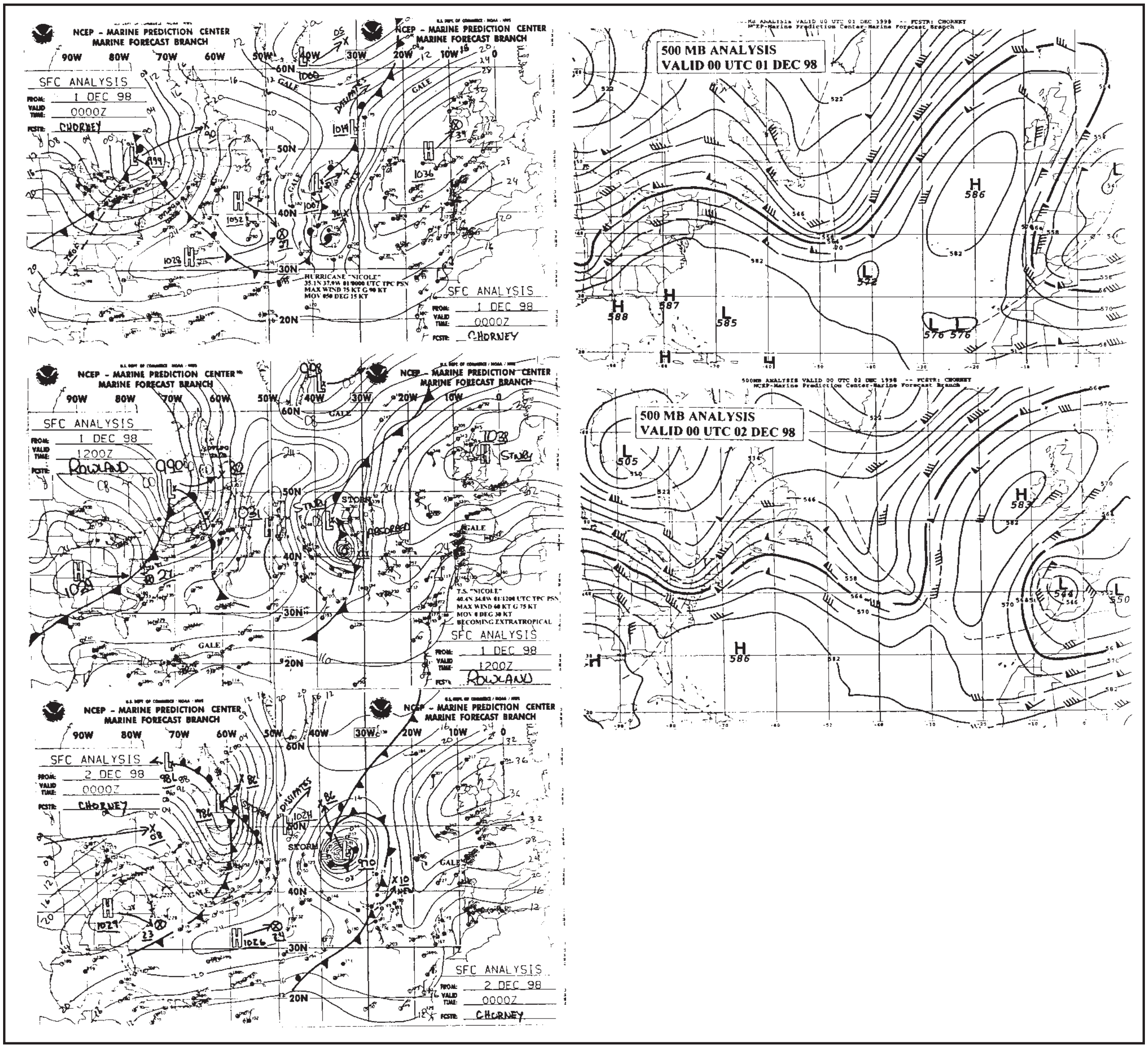

Figure 1. Series of three surface analysis charts for the period 00Z 01 December 1998 to 00Z 02 December 1998 and two 500 millibar analysis charts valid 00Z 01 December 1998 and 00Z 02 December 1998 showing transformation of Hurricane Nicole into an extratropical storm.

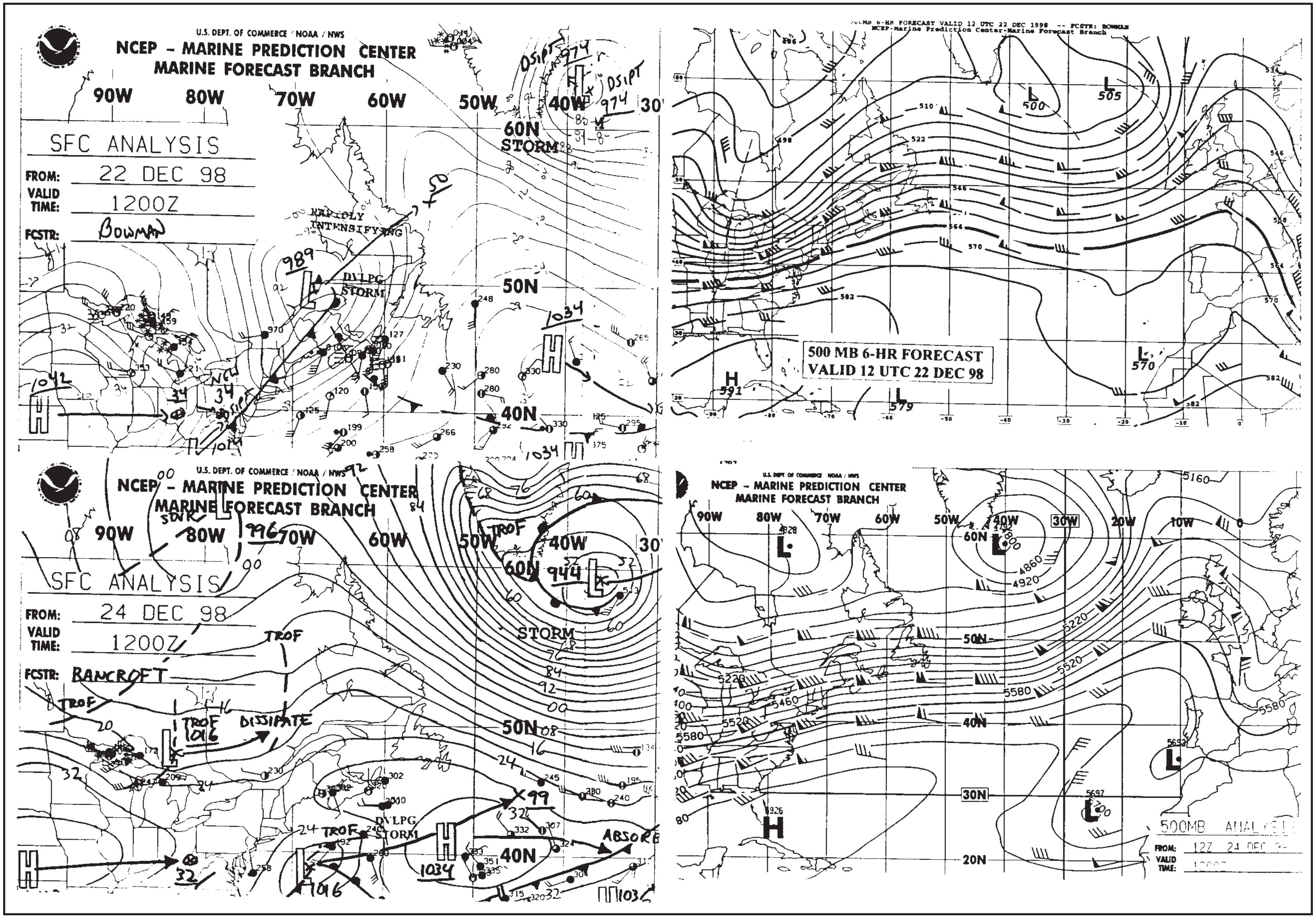

Figure 2. Two-panel display of surface analyses and corresponding 500-millibar analysis charts valid 12Z 22 December 1998 and 12Z 24 December 1998 showing development of the storm of December 22-24, 1998.

North Atlantic Area

Continued from Page 26

British Isles Storm December 26-27, 1998

This system developed off the South Carolina coast late on December 23 and became a storm south of Newfoundland near 42N by 00Z December 25. It was picked up by a strong short wave trough and underwent explosive strengthening shown in Figure 3. Much of the intensification shown in Figure 3 occurred in the 6 hour period from 06Z to 12Z December 26 when the central pressure dropped 22 mb. The 500 mb analysis in Figure 3 is valid between the two surface analysis times and shows a short wave trough with negative tilt approaching Ireland (a trough which tilts to the left northward along its axis), supported by a very strong 120 kt jet. These conditions were favorable for rapid strengthening. The second surface panel of Figure 3 shows the storm at maximum intensity slamming into the British Isles. A wind of 50 kt was reported by a ship near the coast of Ireland. At 12Z 26 December, between the valid times of the two surface analyses in Figure 3, buoy 62081 just southwest of Ireland near 51N 13W reported 11 meter seas (36 ft). To the southwest of the buoy, ship **PJRN** (name not known) near 50N 15W reported a west wind of 55 kt. Seas were 6 meters (20 ft) or higher south of the storm center down to 40N and west to 30W at that time. Figure 4 is a METEOSAT7 infrared satellite image of the storm near maximum intensity. The center is clearly evident and marked by a “ring cloud”, a signature of a very intense cyclone.

December 27-28 Storm

This system formed off the southeast U.S. coast like its predecessor, but moved east along 47-48N before turning more north upon approaching 20W. It was moving at more than 50 kt while passing east of Newfoundland and rapidly intensifying. Figure 5 shows this system absorbing an arctic front moving off the Canadian Maritimes. It would appear that the arctic air drawn into the circulation and the fast eastward motion could account for the reported winds. In Figure 5, ship the **MSC Sicily (DDPH)** reported a northwest wind of 90 kt at 18Z 28 December. Twelve hours prior to this, the **Galveston Bay (WPKD)** reported northwest winds 75 kt. These reports were the highest reported winds in either oceanic area during the four-month period. At 18Z 28 December the cluster of ships (on the analysis in Figure 5) southwest of the center, between 36N and 40N, reported northwest winds 50 to 55 kt and seas 8 to 13 meters (26 to 43 ft). The ships with south to southwest winds 45 to 55 kt southeast of the center at that time reported seas 9 to 10 meters (30 to 33 ft).

926 mb Storm Near Iceland January 15-16

Like the December 27-28 storm, this system was moving more than 50 kt as it rapidly intensified near Newfoundland at 00Z 14 January (Figure 6). The central pressure dropped 50 mb in the 24-hour period ending at 00Z 15 January and another 35 mb in the following 24 hours, leading to a large 926 mb storm just south of Iceland at 00Z 16 January. This was the most intense storm of the season in either ocean. Figure 7 is a METEOSAT7 infrared satellite image showing the storm near maximum intensity just southeast of Iceland. The appearance of a ring of cold-topped clouds around the center along with the dry slot wrapping around the center are characteristic of a very deep, intense low (see Figure 7). A study done for mid-latitude storms showed a relationship between cloud patterns, stages of storm development, and central pressures. Storms that undergo an intensification below 960 mb develop “ring cloud” features. (Reference: Frank J. Smigielski and H. Michael Mogil, Use of Satellite Information For Improved Oceanic Surface Analysis, First International Winter Storm Symposium American. Meteorological. Society, New Orleans, LA –January 1991).

At 21Z 15 January ship **Dettifos (P3BK4)** reported a south wind of 60 kt and a 928 mb pressure. The highest reported wind was from the ship **V2XO** (name not available) which reported from 60N 10W at 21Z 15 January with a southwest wind of 68 kt. Gale- to storm-force winds and seas of 6 to 9 meters (20 to 30 ft) or more covered much of the area east of 50W and north 40N at this time.

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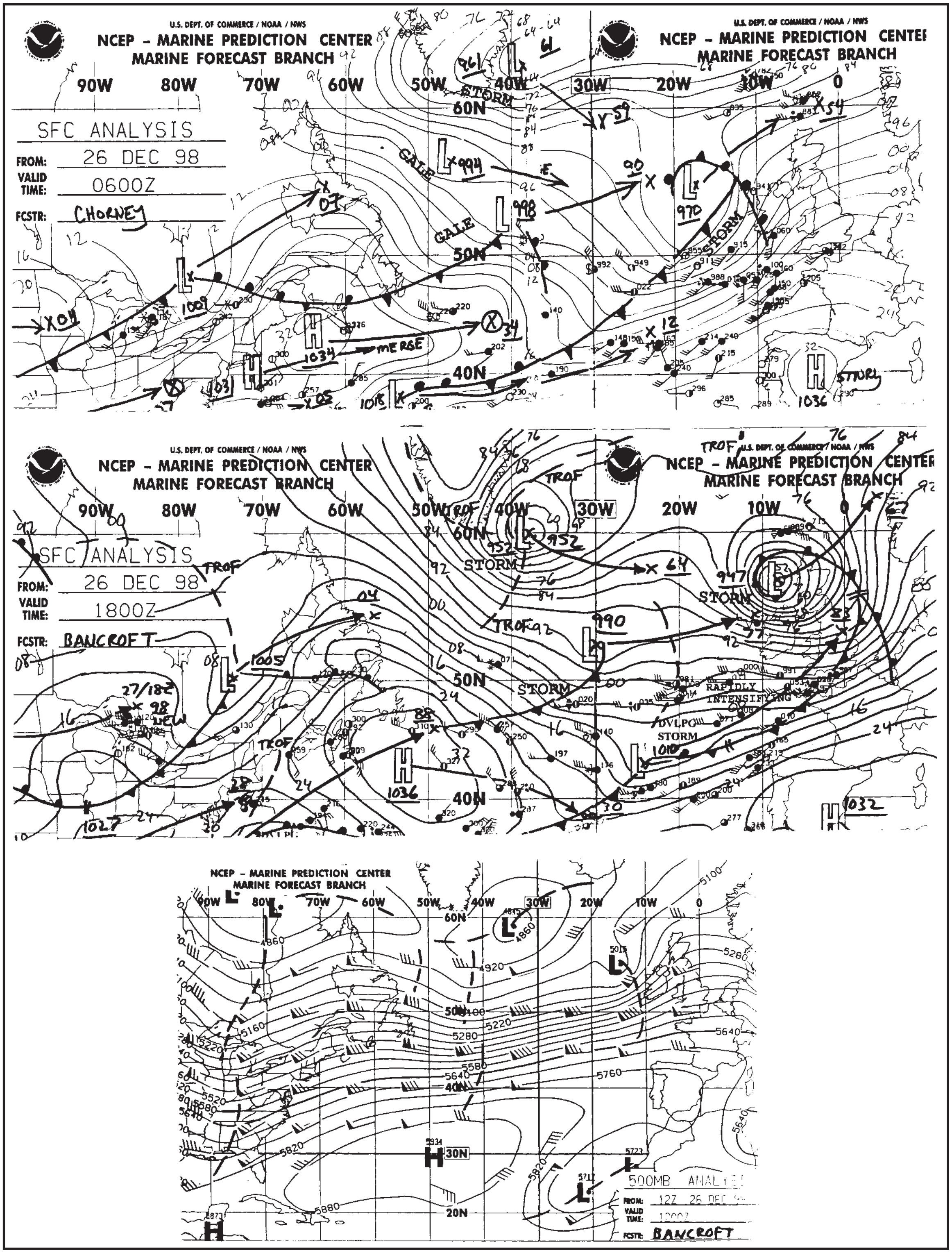

Figure 3. Two-panel display of surface analyses for 06Z 26 December and 18Z 26 December 1998 showing rapid intensification of the British Isles storm. A 500 mb analysis is included, valid 12Z 26 December 1998, which is between the two surface analysis times.

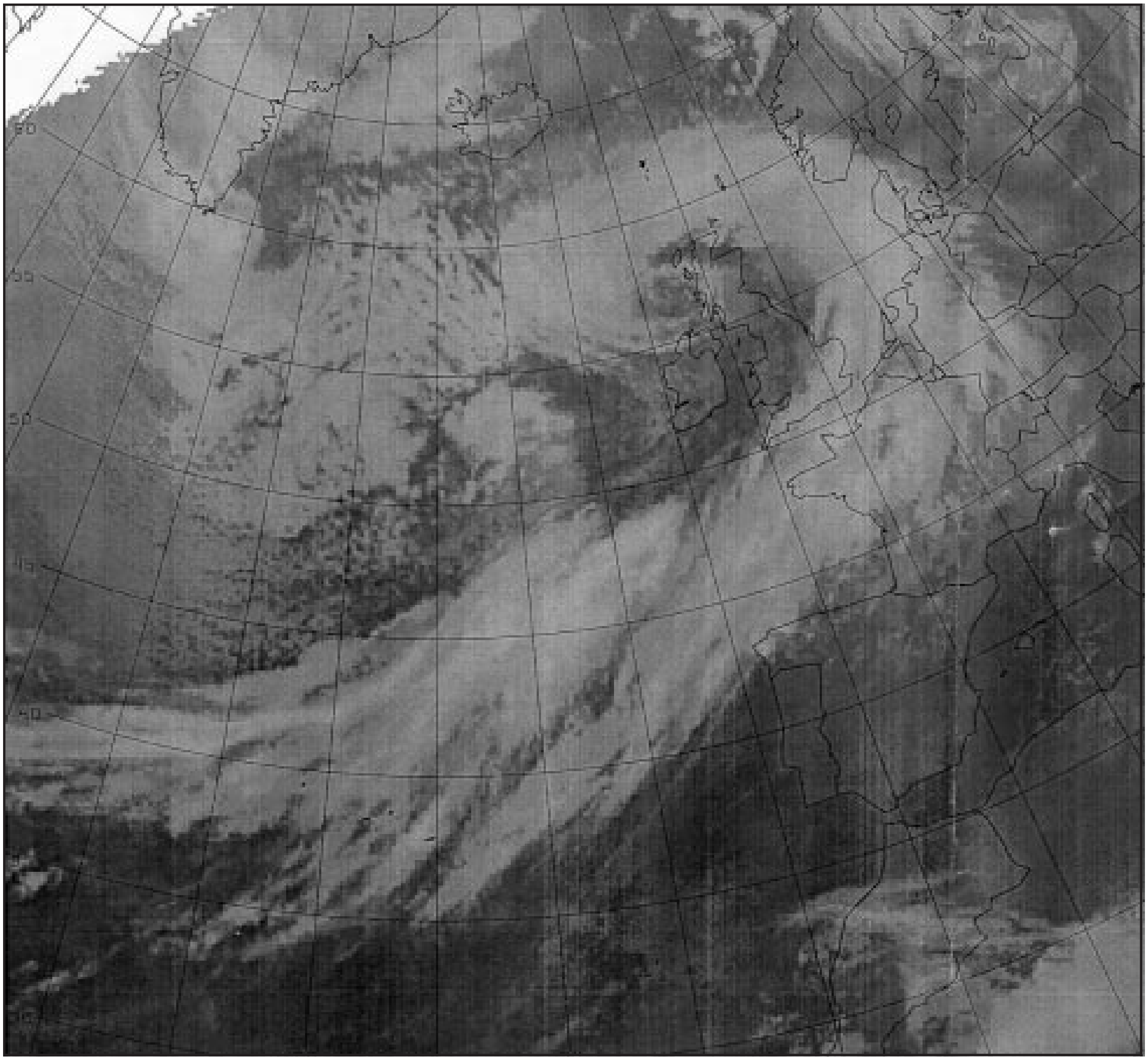

Figure 4. METEOSAT7 infrared satellite image valid 18Z 26 December 1998.

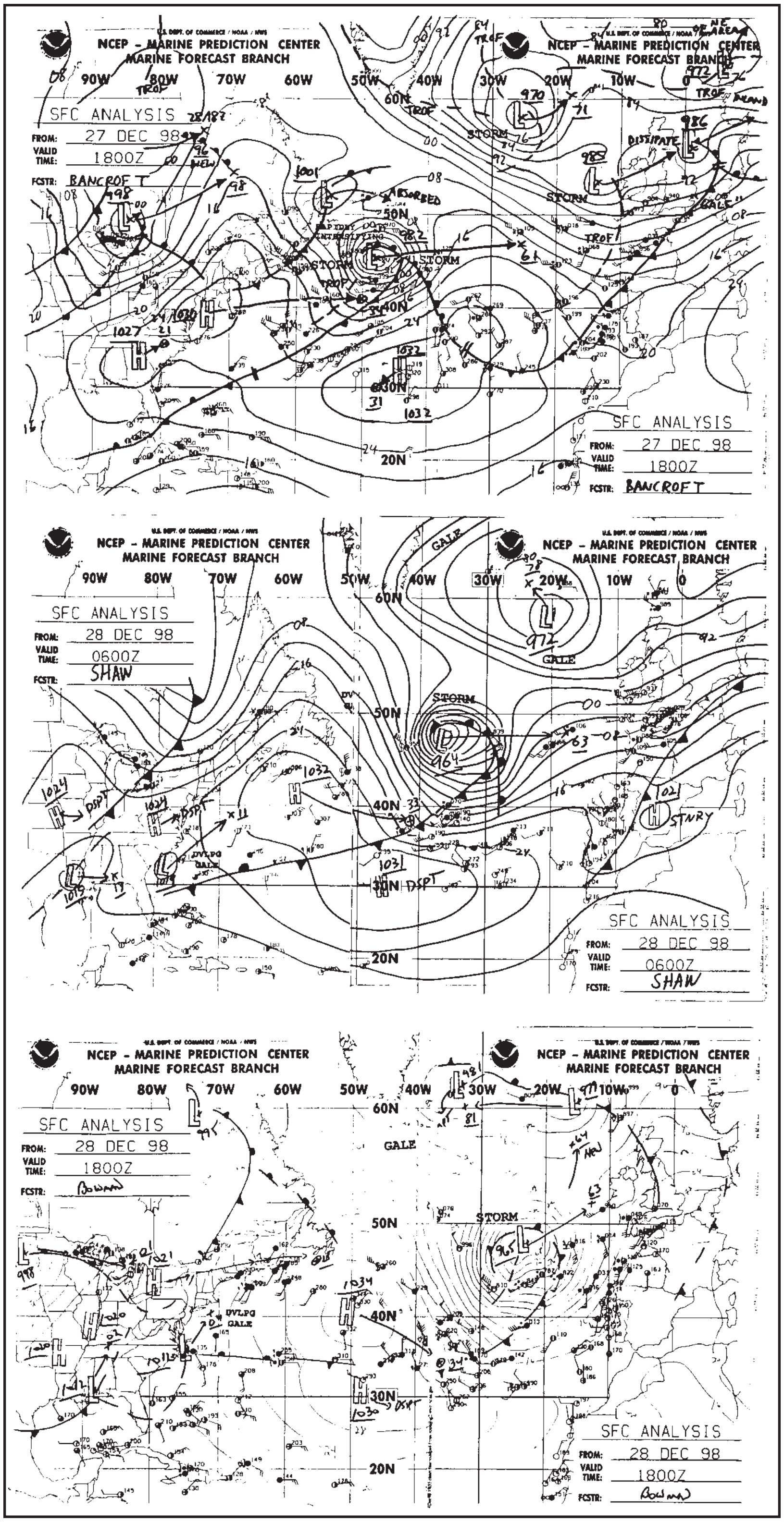

Figure 5. Three-panel series of surface analysis charts for the period 18Z 27 December to 18Z 28 December 1998, depicting the storm of December 27-28 with winds up to 90 kt.

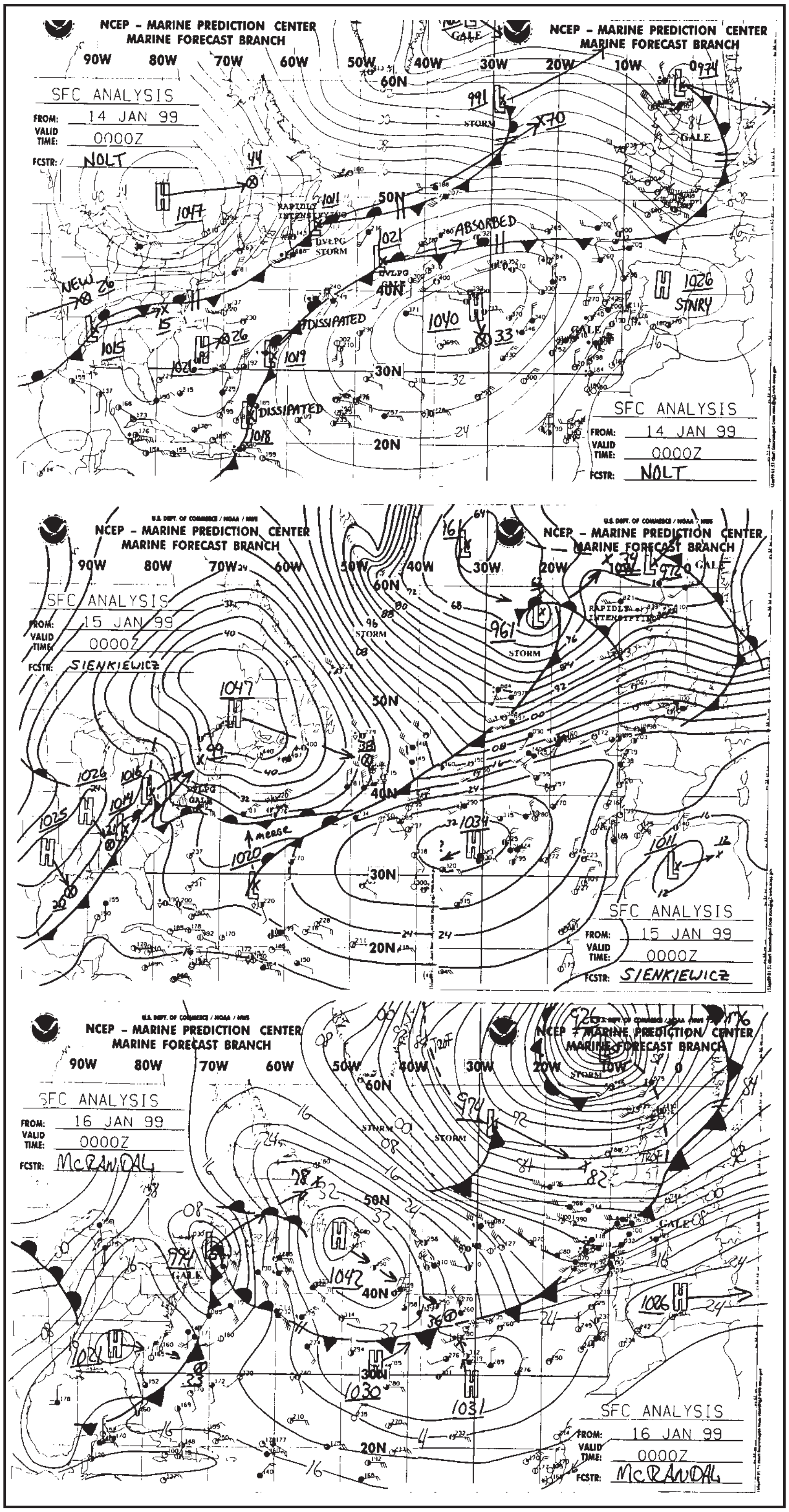

Figure 6. Three-panel series of surface analyses for the period 00Z 14 January to 00Z 16 January, 1999, depicting development of the 926 mb Iceland storm.

North Atlantic Area

Continued from Page 29

At 00Z 17 January, 24 hours after the third analysis in Figure 6, buoy 62108 west of Ireland reported seas of 9.5 meters (31 ft). To the south, ship **Maersk Colorado (WCX5081)** reported from 47N 21W with a northwest wind 55 kt and 9 meter seas (30 ft).

Storm off East Coast February 4-6

A persistent upper level trough near the U.S. East Coast in February and March led to frequent cyclogenesis (storm development). Unlike storms that formed earlier in the winter and moved out rapidly, these were slower-moving and developed gale- and sometimes storm-force winds. One of the strongest of these East Coast lows strengthened 32 mb after moving off the southeast Virginia coast at 18Z 04 February, to become a 976 mb storm 39N 63W 24 hours later (Figure 8). North to northwest winds of 45 to 60 kt were on the back side of the storm west to 73W over the northern mid-Atlantic offshore waters. Seas were up to 11 to 13 meters (32 to 43 ft). The system then slowed and began to weaken and turn more north as it encountered a building ridge of high pressure over the central Atlantic.

Storm March 11

Several storms formed during the period over the south central waters and off the coast of Portugal. The strongest of these is depicted in Figure 9 near 41N 18W with winds of 50 to 60 kt reported west of the center. Reported seas were 5 to 9 meters (16 to 30 ft) in this area. The storm, near maximum intensity at this time, subsequently drifted southeast and weakened.

Reference

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

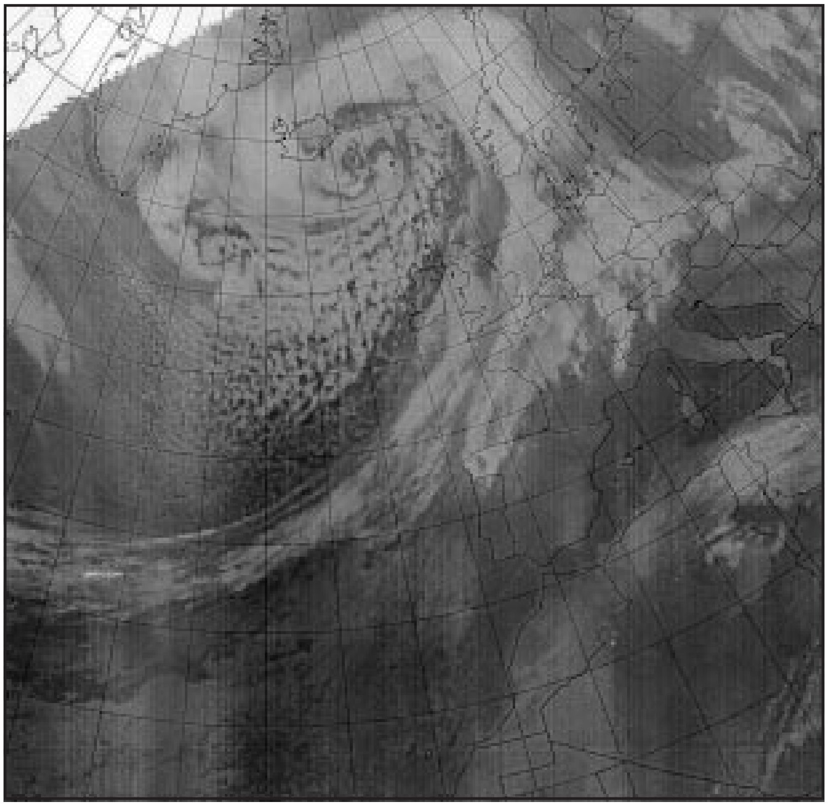

Figure 7. METEOSAT7 infrared satellite image of the storm in Figure 6 near maximum intensity. Valid time is 00Z 16 January 1999.

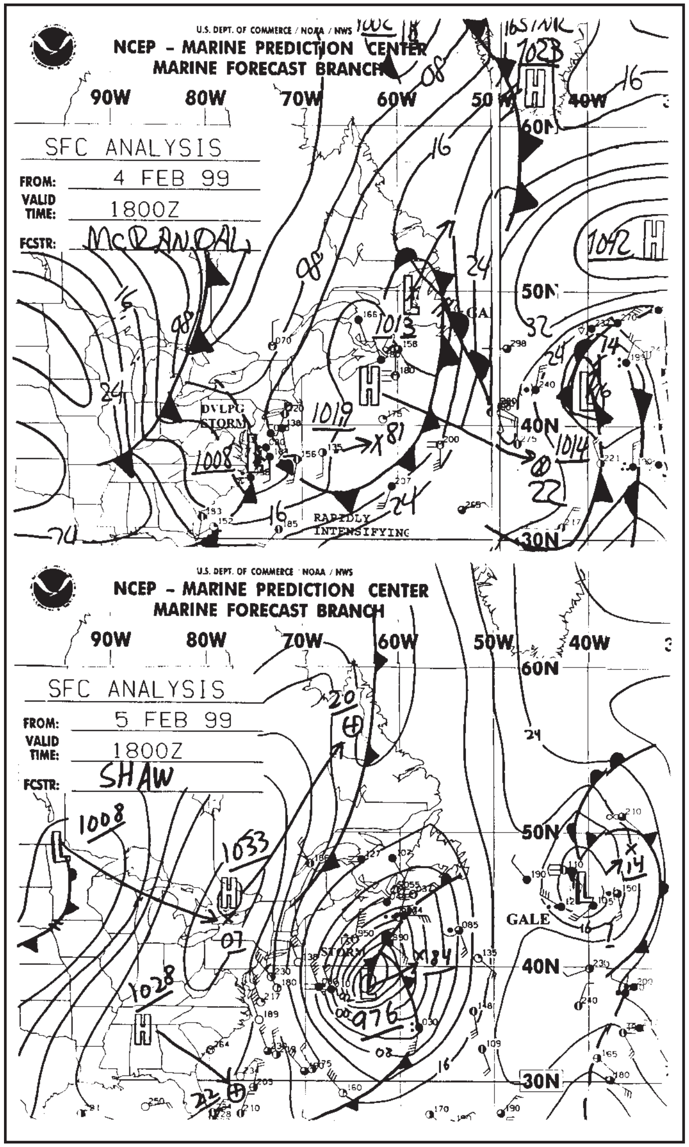

Figure 8. Two- panel display of surface analyses valid 18Z 04 February and 18Z 05 February 1999, depicting development of the East Coast storm of February 4-5, 1999.

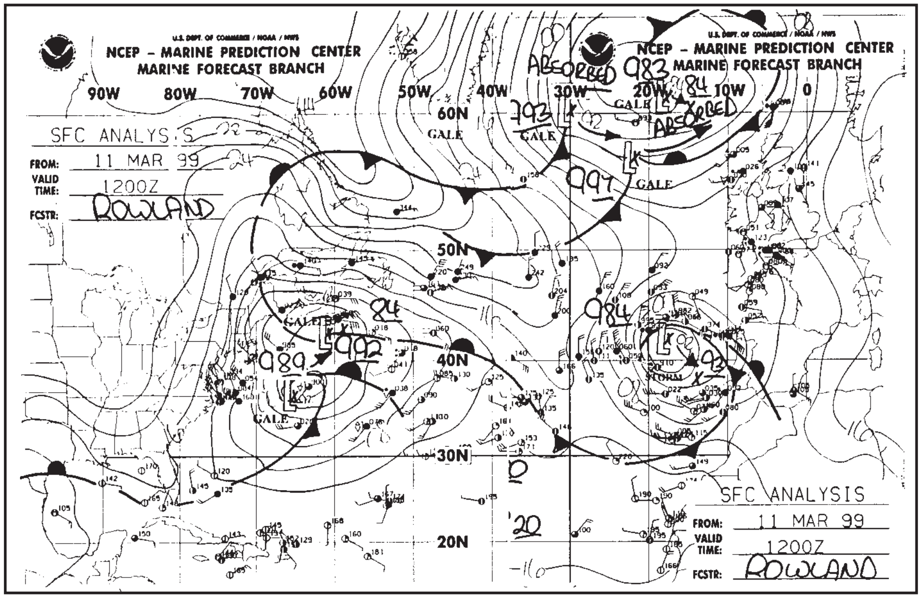

Figure 9. Surface analysis valid 12Z 11 March 1999 showing a cutoff storm off coast of Portugal.

Marine Weather Review
North Pacific Area
December 1998 through March 1999

George P. Bancroft
Meteorologist Marine Prediction Center

The winter of 1998/1999 was dominated by La Niña, with a strong jet stream extending from near Japan east northeast toward the Gulf of Alaska. Also a series of strong upper lows moving east from Siberia to the Kamchatka Peninsula area helped fuel significant developments. This led to frequent storm development east of Japan, with the lows then tracking east northeast to the Gulf of Alaska, with some of the lows moving more north into the Aleutians and Bering Sea and redeveloping in the Gulf of Alaska or looping back toward the Kamchatka Peninsula to be "captured" by the upper low in that area. Beginning late in January 1999, an upper low developed over Alaska and the Gulf of Alaska. This forced the jet stream south into the U.S. Pacific Northwest and Vancouver Island area and led to more storminess in that area. This set the stage for the major storm in early March off the Washington and Oregon coasts that is covered in this article.

Storm Near Dateline January 4-8

The two panels of Figure 1 show the storm developing east of Japan and strengthening 33 mb during the 24-hour period between surface analyses. This development would therefore qualify as a meteorological "bomb" labeled on the analysis as "RAPIDLY INTENSIFYING." The first 500 mb chart in the Figure shows a 105 kt jet, an upper low near the Kamchatka Peninsula and a pair of short wave troughs (troughs of shorter wavelength and amplitude embedded in large upper lows) supporting this development. In the cold unstable air behind the surface cold front, winds are stronger than the pressure gradient indicates. (Note the two 50 kt ship reports in the first surface panel.)

The second surface analysis in Figure 1 shows the storm near maximum intensity at 955 mb crossing the dateline, unusually intense for that far south. There were ship reports with 55 to 60 kt east and southeast of the center at 12Z 05 January (between surface analysis times). Also note the 35 kt report with 958 mb pressure near the center.

The system then drifted northeast and began to weaken by 7 January. The second 500 mb chart for 00Z 08 January (two days later) shows that the Kamchatka upper low has reformed to the southeast over the storm center. The storm was slowly weakening and drifting east at that time.

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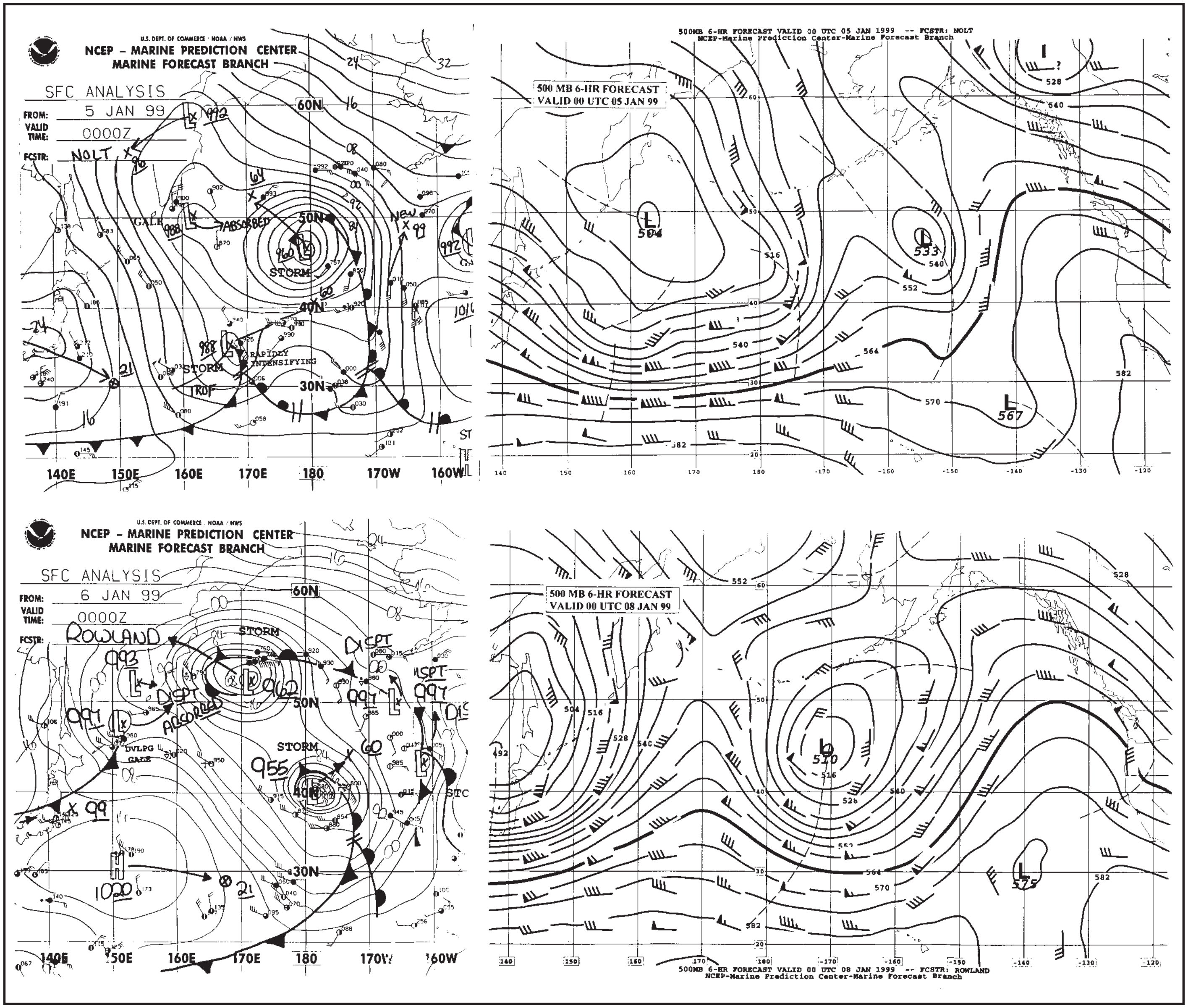

Figure 1. Two-panel display of surface analysis and 500-mb charts showing the development of the early January 1999 storm east of Japan. The second 500-mb chart is valid 48 hours after the second surface analysis.

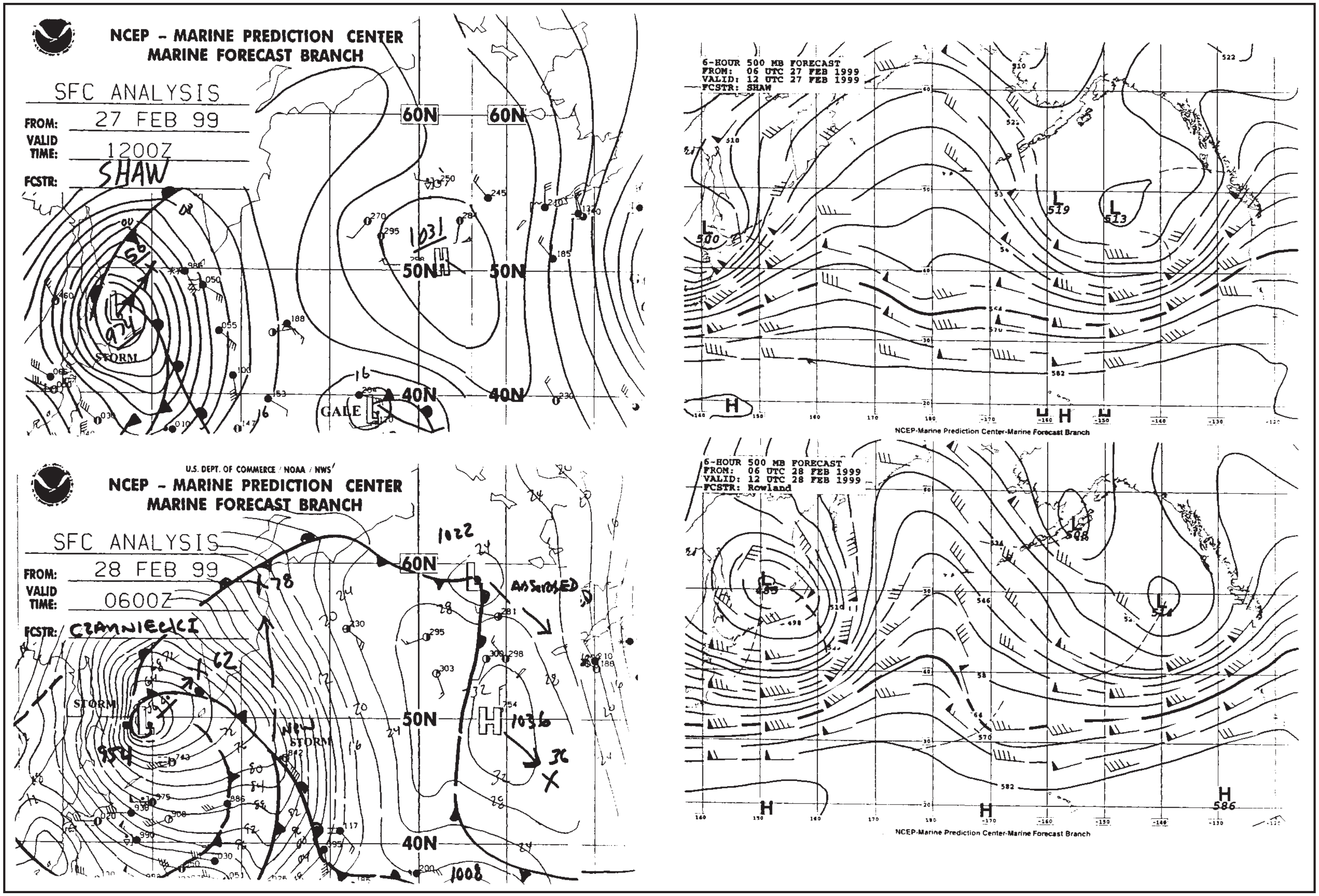

Figure 2. Two-panel display of surface analysis and 500-mb charts for the storm of February 27-28, 1999 near the Kurile Islands.

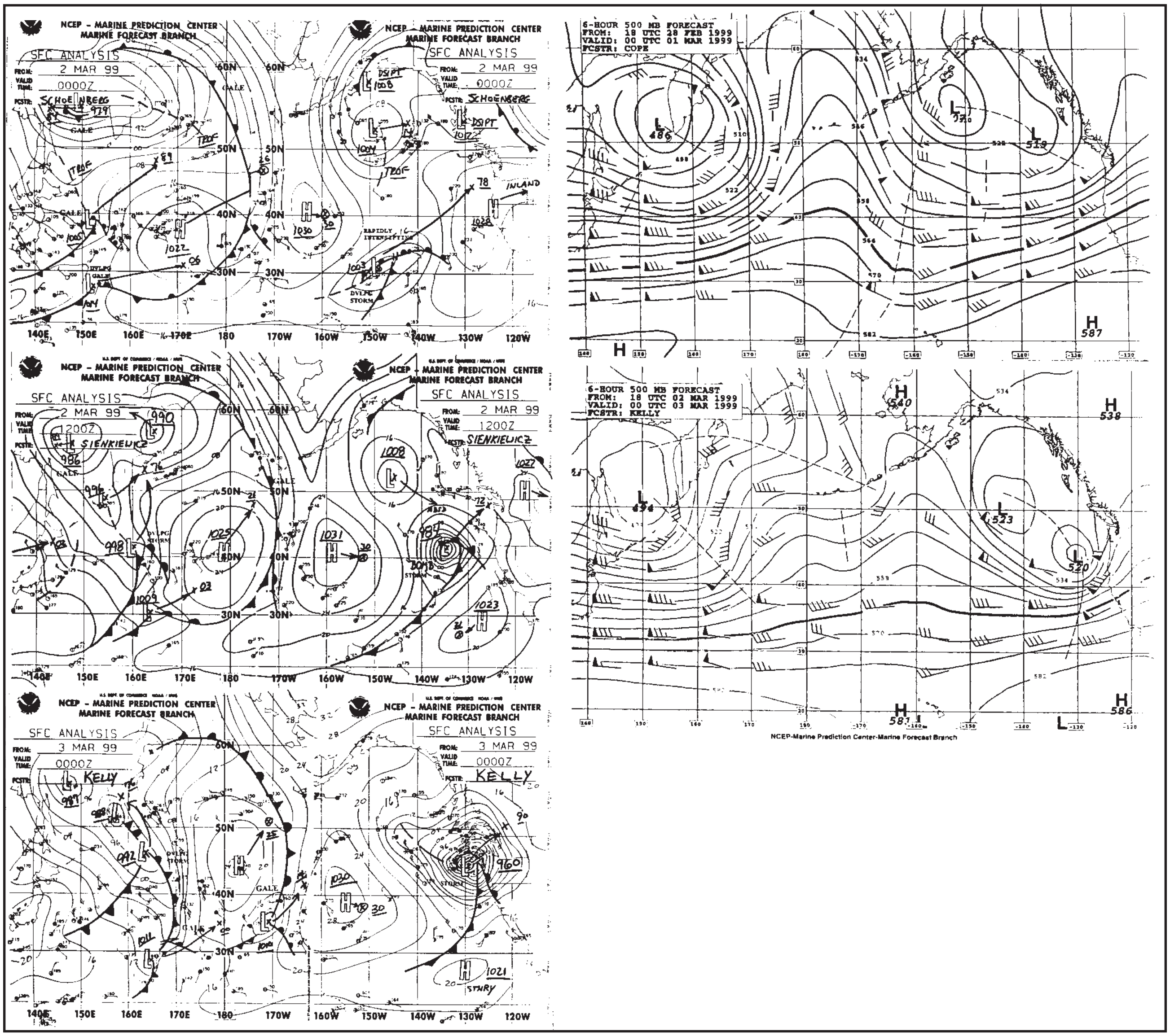

Figure 3. Series of three surface analysis charts for the period 02 March 00Z to 03 March 00Z, 1999 and two 500 mb charts valid 01 March 00Z and 03 March 00Z, 1999, depicting the development of the March 2-3 Pacific Northwest storm.

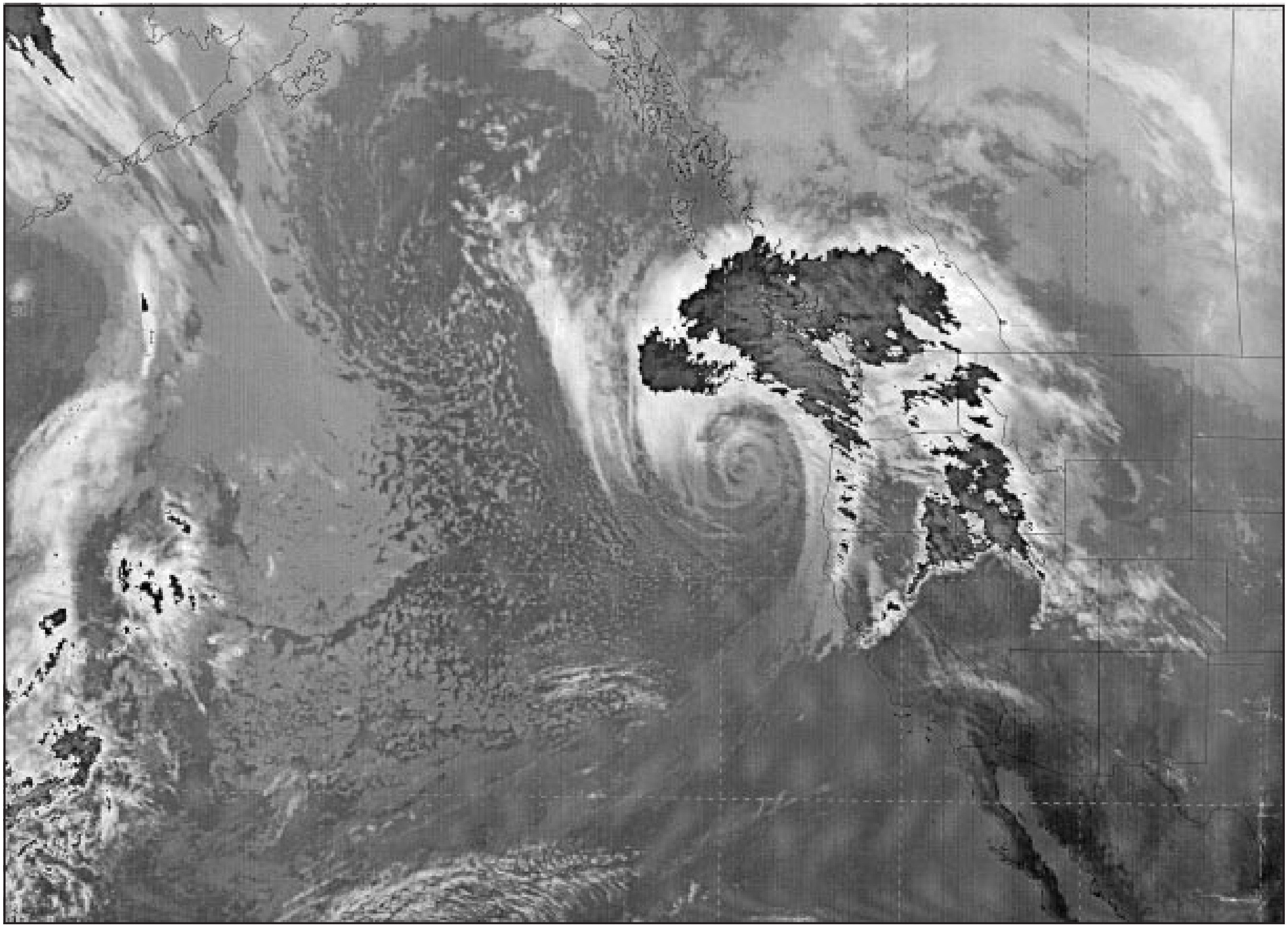

Figure 4. GOES infrared image of the storm in Figure 3 near maximum intensity. Valid time is 0015Z 03 March 1999. Colder cloud tops are computer-enhanced.

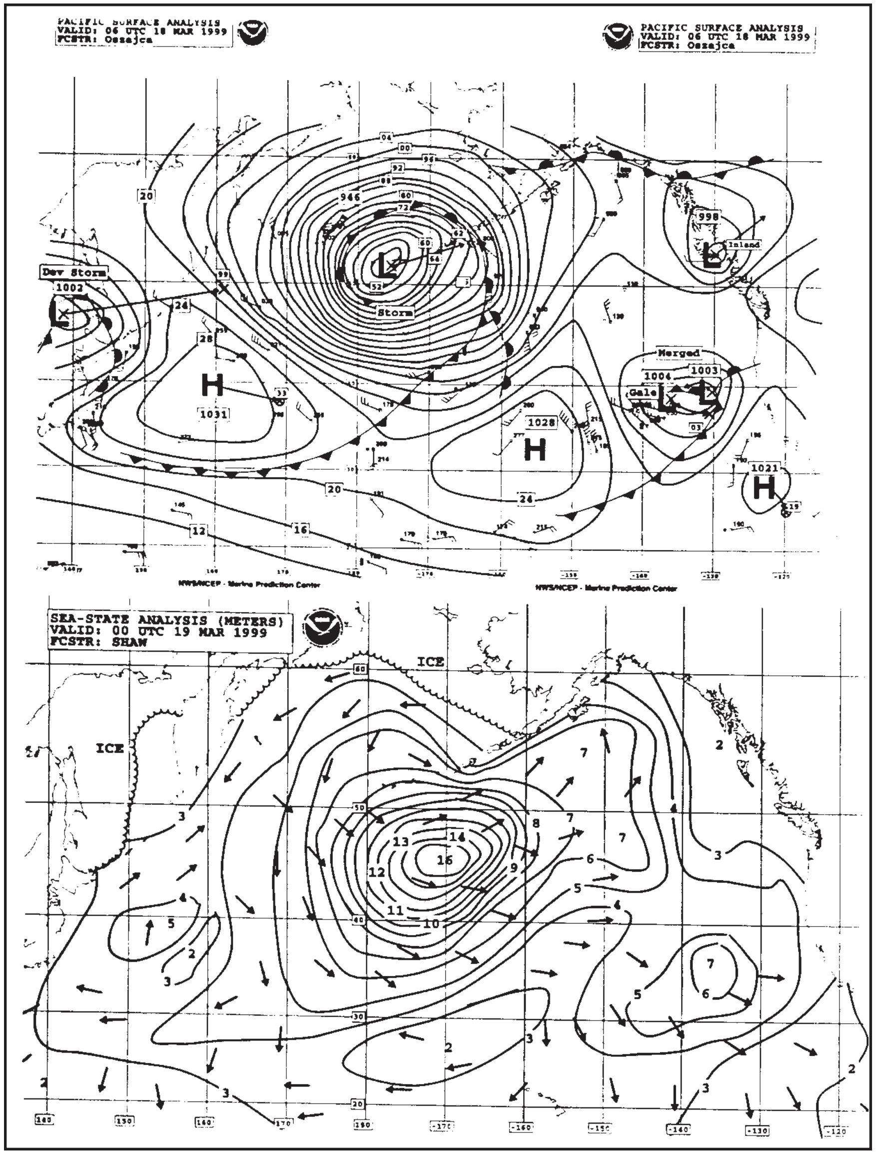

Figure 5. Surface analysis valid 06Z 18 March 1999 showing the first of two “twin super-storms.” The second part is a sea state analysis valid 00Z 19 March 1999.

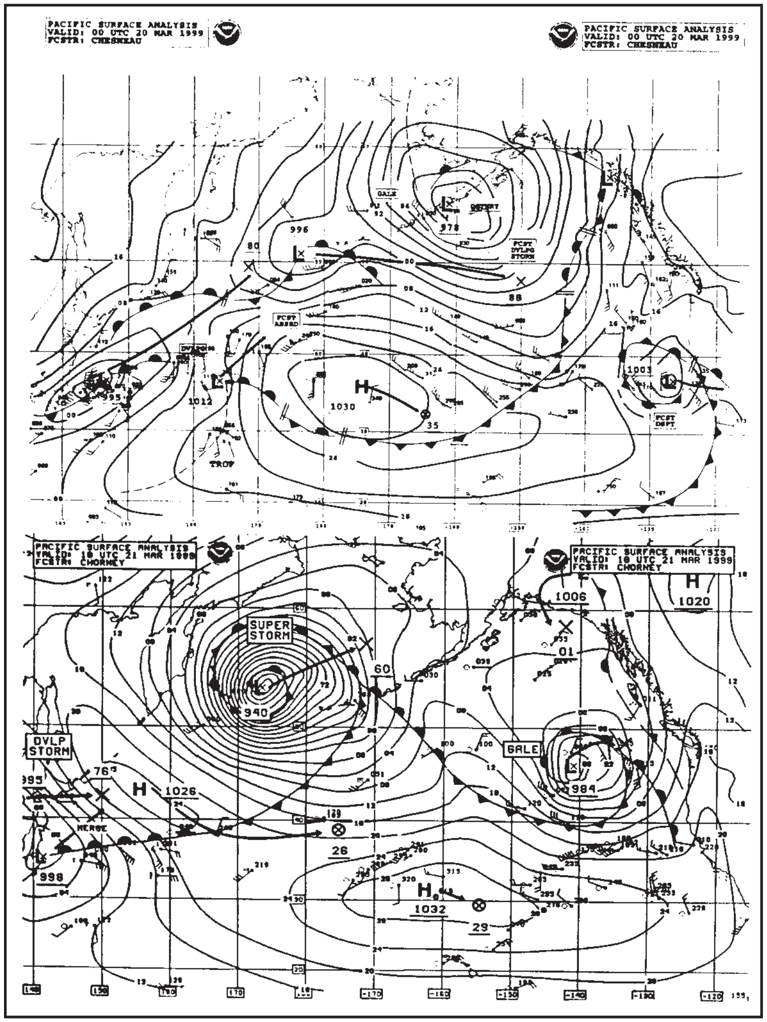

Figure 6. Two-panel display of surface analyses valid 00Z 20 March and 18Z 21 March 1999 showing the development of the second “super-storm” of late March.

North Pacific Area

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Storm Near Kurile Islands February 27-28

This storm resulted from the explosive strengthening of a low as it moved into the northern Sea of Japan and then to the southern Sea of Okhotsk. The system slowed with the lowest pressure at 954 mb near 50N 150E at 06Z 28 February as shown in the second surface analysis in Figure 2. The most rapid strengthening was the drop from 1000 mb at 18Z 26 February (when the center was moving off the coast) to 962 mb at 18Z 27 February. The accompanying 500 mb charts show that the development is supported by a disturbance (strong short wave trough) and 100 kt jet moving northeast from Japan (first panel). Then in the second panel the system has strengthened into an intense upper low nearly vertically stacked (from lower to higher levels in the atmosphere).

As the system reached maximum intensity, gale- to storm-force winds appear behind the front down to 35N. The maximum reported wind was a west wind of 60 kt from a ship (name and call sign not available) at 46N 152E at 12Z 28 February (six hours later). Maximum seas were around 9 meters (30 ft) near 43N 149E.

Pacific Northwest Storm of March 2-3

This storm was a classic “bomb,” forming out of a low near 30N which strengthened by 43 mb in 24 hours after it was picked up by a short wave disturbance coming from the northwest. Figure 3 illustrates this development. The southern disturbances (short wave troughs) consolidate and begin to close off (intensify to develop a detached revolving circulation) at 500 mb by 00Z 03 March. Figure 4 is an enhanced infrared satellite photo of the storm at 00Z 03 March showing the meteorologist a classic signature of a mature intense cyclone. The center is quite evident. The bands of relatively dry air spiraling around to the north and west sides of the center are indicative that the system is near maximum intensity.

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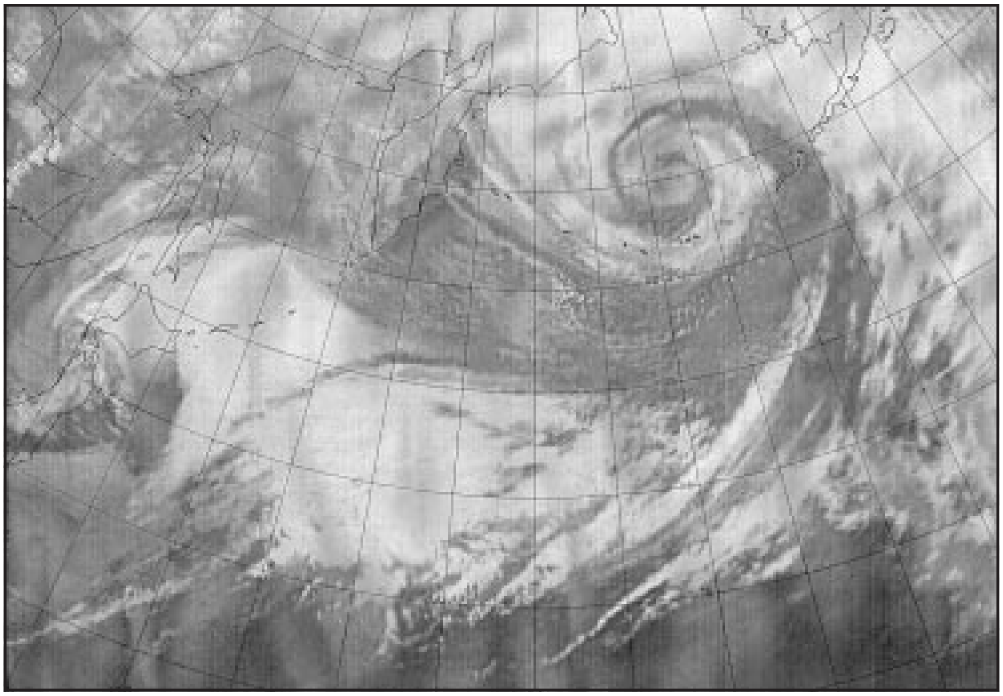

Figure 7. GMS infrared satellite image of the storm in Figure 6 near maximum intensity, valid 0332Z 22 March 1999.

North Pacific Area

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This storm packed hurricane force winds as it reached its peak off the north Oregon coast. The highest winds from any of the coastal buoys were a gust of 62 kt at buoy 46050 moored 15 miles west of Newport, Oregon. The CMAN station at Destruction Island a few miles off the northwest tip of the Olymic Peninsula reported gusts to 69 kt at 10Z on 3 March, and Tatoosh Island (15 miles south of destruction island) later had gusts to 77 kt from the west at 16Z on 3 March after the storm center had passed. Farther offshore a ship, the **Veracruz (ELFO9)** reported a northwest wind of 60 kt at 00Z 03 March (Figure 3). Other reports around the center of the storm were in the 40 to 50 kt range.

Perhaps the most notable feature of this storm was the phenomenal seas it generated in the coastal waters and also the rapid building of the seas as the storm approached. Maximum seas exceeded 40 ft just off the northwest Oregon and southwest Washington coasts. The highest reported sea was 14 meters (46 ft) at buoy 46050 at 07Z 03 March. This was more than double the 6.5 meter sea (21 ft) reported six hours prior to this at 01Z 03 March.

From a historical perspective, the NWS Portland, Oregon, office noted that the central pressure of this storm was likely equal to that of the 1962 Columbus Day storm. Also, seas at the buoy 46050 were the highest in memory at that location.

Twin Super-Storms, Aleutians Area, March 15-22

Besides the storminess associated with the upper level trough off the West Coast, there was an active track of cyclones from Japan to the Aleutians and southern Bering Sea and then east. This made March perhaps the most active period of the winter. The strongest of these developed in mid to late March with central pressures below 950 mb. Figure 5 shows the first of these two storms with similar tracks and intensities. It is shown near maximum intensity at 946 mb in the central Aleutians at 06Z 18 March in the upper panel of Figure 5, while the lower panel is a sea state analysis valid 18 hours later when seas were fully developed. Note the 16 meter (50 feet) maximum analyzed south of the center, which was the highest of all the daily sea state analyses done by the National Weather Service, Marine Prediction Center (MPC) for either ocean in this four-month period. There was a 60 kt ship report (vessel name unknown) in the Bering Sea northwest of the center (Figure 5), but winds were likely hurricane force south of the center where there were no ship reports.

The second storm formed near Japan at 00Z 20 March and reached a maximum intensity of 940 mb near the western Aleutians at 18Z 21 March (Figure 6). Much of the intensification occurred in the 24-hour period from 12Z 20 March to 12Z 21 March when the central pressure dropped 50 mb, from 992 mb to 942 mb. The **Sealand Liberator (KHRP)** at 12Z 21 March reported 20 knot southeast wind, pressure 943.5 mb and seas 6 meters (20 ft) near the center of the storm. After passage of the center six hours later, the pressure jumped to 968 mb; wind increased to northwest 68 kt and seas built to 9.5 meters (31 ft). The **Polar Eagle (ELPT3)** reported from near 54N 180W at 12Z 21 March with a southeast wind of 60 kt and seas 7 meters (23 ft). In the central Bering Sea, Buoy 46035 reported a peak wind of 43 knots with gusts to 52 knots (maximum 60 kt) ahead of the front at 21Z 21 March. Sea state at this buoy increased from 2 meters (7 ft) at 12Z 21 March to 9 meters (30 ft) 10 hours later. This storm, like its predecessor, then slowed and turned east and began to weaken. Figure 7 is an infrared satellite image of the fully mature storm, still with pressure around 940 mb, with the cold, dry air wrapping completely around a center which is clearly evident near 55N 178W in this picture.

Both storms reached maximum intensity in a relatively data-sparse area and there were no ship reports where maximum winds and seas are likely to have occurred, south of the centers. However, remote sensing through radar altimetry indicated maximum seas in the 18 to 20 meter (59 to 65 ft) range (Sienkiewicz, MPC, personal communication).⚓

Marine Weather Review
Tropical Atlantic and Tropical East Pacific Areas
January through April 1999

Dr. Jack Beven
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I. Introduction

La Niña conditions continued through the period in the tropical Eastern Pacific. This contributed to different weather patterns compared with this time in 1998, which in turn led to considerably calmer conditions in the Tropical Prediction Center (TPC) forecast areas compared with this time last year.

II. La Niña and Weather Events

The El Niño phenomenon is an abnormal warming of ocean temperatures in the tropical Pacific west of South America. As seen in 1998, it causes major changes in world weather patterns. The reverse phenomenon, La Niña, occurs when these waters become colder than normal.

Figure 1 shows the Eastern Pacific sea surface temperature (SST) anomalies for the week of 24-30 January 1999. Notice the dark stripe along the Equator west of 110W. This is an area of below normal SSTs associated with La Niña, with some temperatures greater than 2.5^{o}C below normal.

While strong El Niño events produce significant and somewhat predictable changes in weather patterns, changes associated with La Niña are less clear. Generally, strong La Niña events see above normal numbers of Atlantic hurricanes and normal to below normal numbers of Eastern Pacific hurricanes. However, there are exceptions, such as in 1973. While Eastern Pacific SSTs were below normal that year, only eight tropical storms and hurricanes occurred in the Atlantic compared with the long term average of ten.

La Niña also affects winter weather patterns. Normally, the Gulf of Mexico and adjacent Atlantic are less stormy during La Niña events than during El Niño events, with smaller numbers of strong low pressure areas. This results from differences in the jet stream patterns between the two types of events. However, strong winter storms can occur in these areas during La Niña events, as shown by the Florida coastal storm of 10-12 March 1996.

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Tropical Prediction Center

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As of this writing, the La Niña might be weakening, as the cold SST anomalies are slowly warmimg and the associated tropical air pressure patterns are weakening. Is another El Niño on the horizon? Only time will tell.

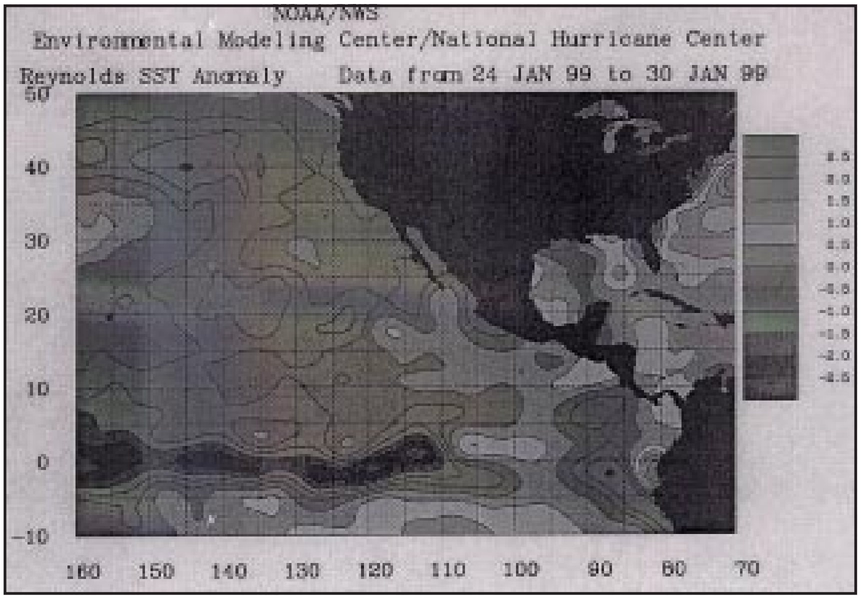

Figure 1. Eastern Pacific sea surface temperature anomalies for the week of 24-30 January 1999.

III. Start of the 1999 Hurricane Season

May 15 marked the start of the Eastern Pacific hurricane season while June 1 is the start of the Atlantic hurricane season.

IV. Significant Weather

<u>A. Tropical Cyclones:</u> No tropical cyclones occurred in the Tropical Atlantic or Tropical Eastern Pacific during the January - April period. This is normal, as only four tropical or subtropical cyclones are known to have occurred during this time of year in these areas since 1886.

<u>B. Other Significant Events:</u> As mentioned earlier, the first four months of 1999 were calmer compared with the El Niño winter and early spring of 1998. Most gale events were associated with strong cold fronts trailing from gale or storm centers located in more northerly latitudes. However, two significant gale centers did develop. The first was in the far eastern portion of the tropical Atlantic area in late January. The second developed along the Gulf of Mexico coast in mid-March and produced gale conditions in the Gulf and Western Atlantic.

1. Atlantic, Caribbean and Gulf of Mexico

Central Atlantic Gale of 24-27 January: A gale center developed on 24 January in the central Atlantic. By 0000 UTC 25 January, the center was analyzed near 31N 34W with a central pressure of 1012 mb. Although the central pressure was rather high, a 1034 mb high pressure system located northwest of the gale center combined with it to create a strong pressure gradient and a large area of gale force winds. The first ship report of gale force winds was at 0000 UTC 25 January from the **Chiquita Bremen**,which reported 40 kt north winds near 30N 43W. By 1200 UTC 25 January the gale had drifted to near 29N 35W (Figure 2). At that time, the **Robert E. Lee**, located near 31N 45W, reported 39 kt northeast winds and 18 ft combined seas.

The system continued to strengthen slowly while moving southwest. By 0000 UTC 26 January (Figure 3) it was located near 27N 38W with a 1006 mb central pressure. Because the area of strong winds remained nearly stationary for about 36 hours,large swells were propagated. The ship **V2HL** (name not available) reported 20 foot swells at both 0000 UTC and 1200 UTC 26 January, as did the **Chiquita Rostock** near 31N 46W at 1200 UTC. Late on 26 January the high pressure system began to weaken. The central pressure dropped to 1004 MB by 0600 UTC 27 January. Although gales ended about that time, large swells which had been generated by the gale

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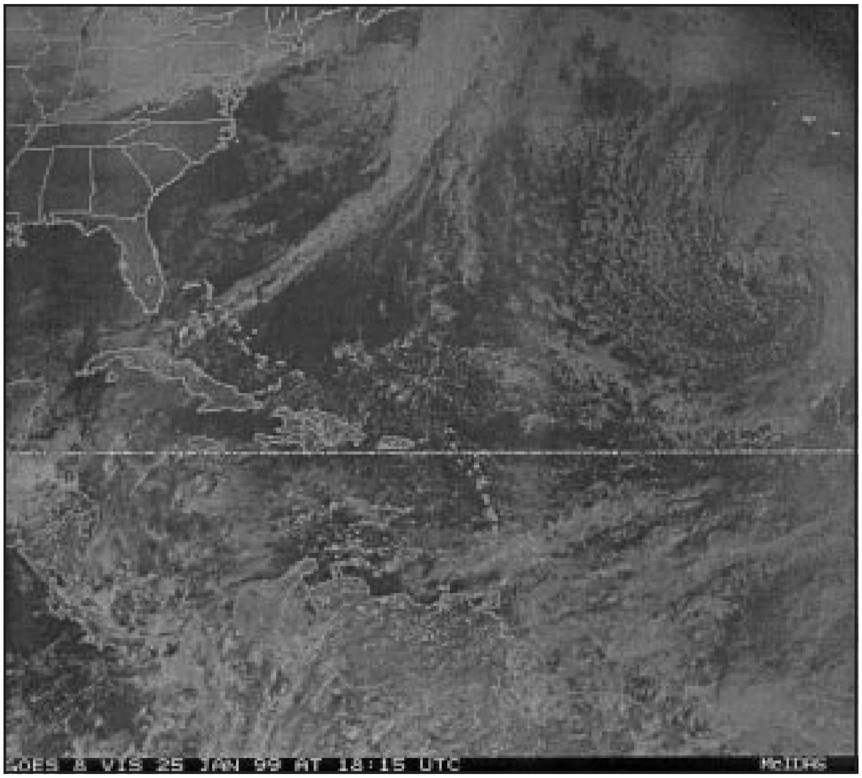

Figure 2. GOES-8 visible image at 1815 UTC 25 January 1999. Image courtesy of the National Climatic Data Center.

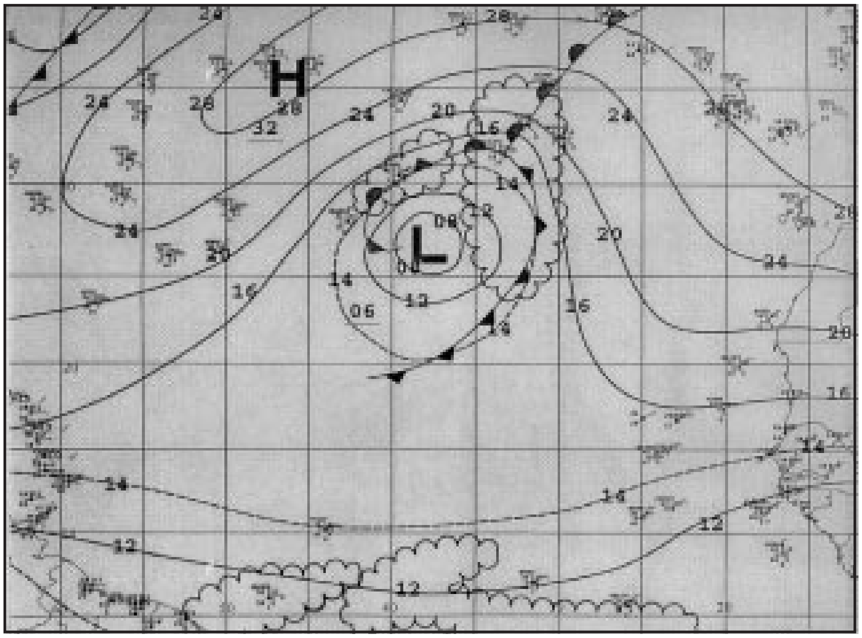

Figure 3. Subset of TAFB surface analysis at 0000 UTC 26 January 1999. Solid isobars are at 4 mb intervals with intermediate dashed isobars at 2 mb intervals.

Tropical Prediction Center

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affected the area for the next few days.

Atlantic Gale of 31 January - 2 February: On 31 January a low formed near 34N 61W. As the system developed, a strong high pressure center located over the northeast United States combined with it to produce strong northeast winds over a large area of the western Atlantic. At 0000 UTC 1 February the 1000 mb gale was centered near 33N 57W. At that time, the ship **C6JS** (name not available) reported 40 kt northwest winds while the **Nolizwe** reported 34 kt winds. Both ships were near 30N 63W. The **Primo (V7AV6)**, located closer to the gale center, reported 41 kt winds. At 1200 UTC 1 February, the **C6JS** near 32N 60W reported 40 kt winds with 26 ft combined seas. **Primo** near 29N 36W reported 36 kt. By 1800 UTC 1 February there was a 996 mb low located near 33N 50W. After 1800 UTC the gale center turned northeast and rapidly moved away from the area.

Cold Front and Gale of 16-18 February: Starting at 0000 UTC 16 February, gale conditions developed north of 29N between 57W and 67W. This occurred along and to the west of a cold front trailing from a mid-latitude gale center. The area of gales spread east and by 1200 UTC 16 February were north of 28N between 50W and 61W. At 0000 UTC 17 February the ship **C6JS**

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Tropical Prediction Center

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reported 38 kt southwest winds near 31N 49W. Several ships reported 10 to 16 ft seas on 17 February. Gale conditions continued spreading east and by 0000 UTC 18 February were north of 29N between 45W and 60W. The Gale Force winds ended in this area by 0600 UTC 18 February. However, large swells affected the area through the remainder of the day.

Cold Front and Gale of 8-10 March: A strong cold front and associated 20-30 kt winds moved across the U.S. east coast and the western Atlantic on 7-8 March, reaching a 31N 62W to central Cuba line by 1800 UTC 8 March. At that time, a developing storm center produced an area of gales north of 28N within 300 nm west of the cold front. The front continued to move rapidly southeast and by 1800 UTC 9 March was analyzed from 31N 50W to near Puerto Rico. At that time the ship **ELTN6** (name not available) reported 34 kt west winds near 28N 54W. The **Hood Island** reported 34 kt westerly winds at 0000 UTC 10 March west of the cold front. Gales had moved further north by 0600 UTC 10 March, although 20-30 kt winds continued for another 12 hours.

Gulf of Mexico-Atlantic Gale of 12-16 March: A low pressure center developed over southeast Texas on 12 March and moved northeast into southern Louisiana on 13 March. By 0000 UTC 14 March, the 1000 MB low pressure was centered just north of New Orleans moving slowly east. An associated cold front extended southwest across the Gulf to near Veracruz, Mexico. The C-MAN site at Southwest Pass, Louisiana, reported 40 kt south winds just ahead of the cold front. Six hours later, the **Chevron Arizona** near 29N 87W reported 38 kt westerly winds just west of the cold front. By 1800 UTC 14 March, the low was centered over north Georgia. The cold front trailed southward into north Florida and extended across the Gulf of Mexico from Cedar Key to the northeast tip of the Yucatan Peninsula (Figure 4). Winds in the Gulf of Mexico had decreased below gale force. However, several buoys still reported 10 to 12 ft seas.

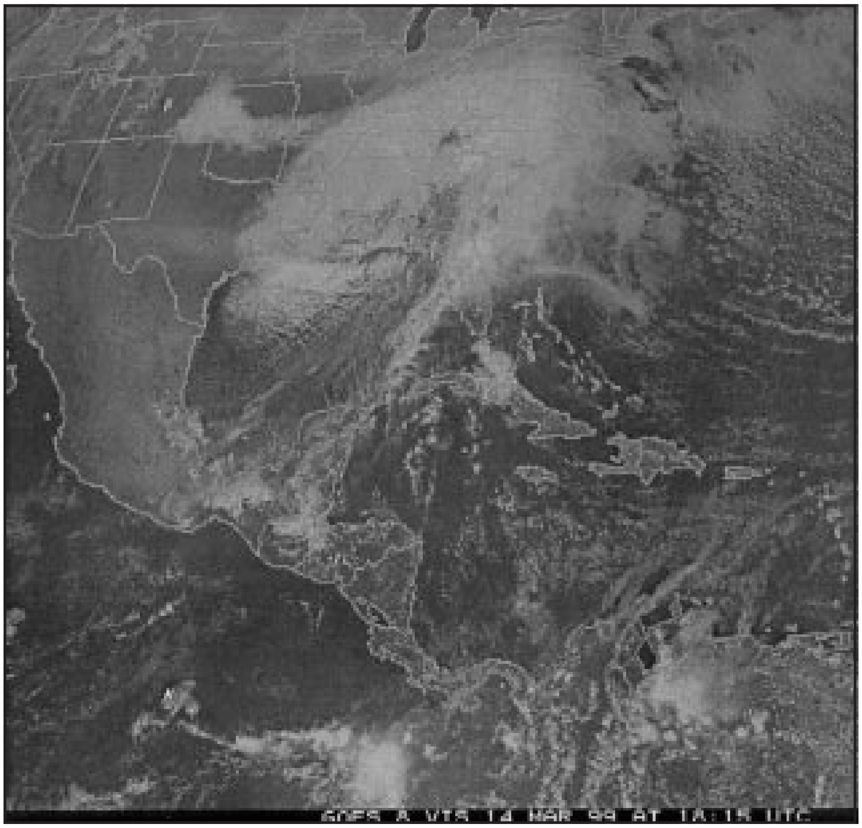

Figure 4. GOES-8 visible image at 1815 UTC 14 March 1999. Image courtesy of the National Climatic Data Center.

As the front approached the western Atlantic, the winds again increased. Ship **YJWZ7** (name not available) reported 40 kt southwest winds at 0000 UTC 15 March near 32N 80W. At 0600 UTC 15 March, the low pressure system moved off the North Carolina coast and rapidly developed into a storm center. The cold front extended south across the southern tip of Florida into western Cuba. Buoy 41002 near 32N 75W reported 40 kt south-southeast winds with 15 ft seas at this time. Later on 15 March the

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storm center moved rapidly northeast.

Caribbean Wind Surge of 17-19 April: From 17-19 April, low surface pressures over northern South America, in combination with a strong high pressure ridge across the Atlantic, created a strong pressure gradient across the central and eastern Caribbean. A strong easterly wind surge developed over the southern Caribbean along and just north of the coast of Colombia. At 1800 UTC 17 April the **Lincoln Universal** near 17N 76W and the **Caribic** near 13N 75W reported 34 kt and 36 kt easterly winds respectively. At nearly the same time, a satellite scatterometer overpass (Figure 5) indicated an area 30 to 35 kt winds over the south-central Caribbean, confirming the ship observations.

This was a difficult forecast situation, as numerical model guidance underestimated the pressure gradient and wind speeds. The surge continued on 18 April, with the **Caribic** reporting 34 kt easterly winds near 14N 77W at 0600 UTC and 33 kt near 11N 79W six hours later. By 0600 UTC 19 April, the pressure gradient decreased slightly across the Caribbean and the winds decreased below gale force. However, 20-25 kt easterly winds continued across the area for several more days. During this event, ship observations and scatterometer satellite wind estimates were a very valuable forecast tool, as they helped pinpoint the strength and area of the strongest winds.

2. Eastern Pacific

The East Pacific area was affected by six gale events in the Gulf of Tehuantepec (and surrounding waters) and one gale center that moved rapidly eastward across the northern boundary of the forecast area in early March.

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 rapidly eastward across the Gulf of Mexico. The gale events were verified by satellite Special Sensor Micro-

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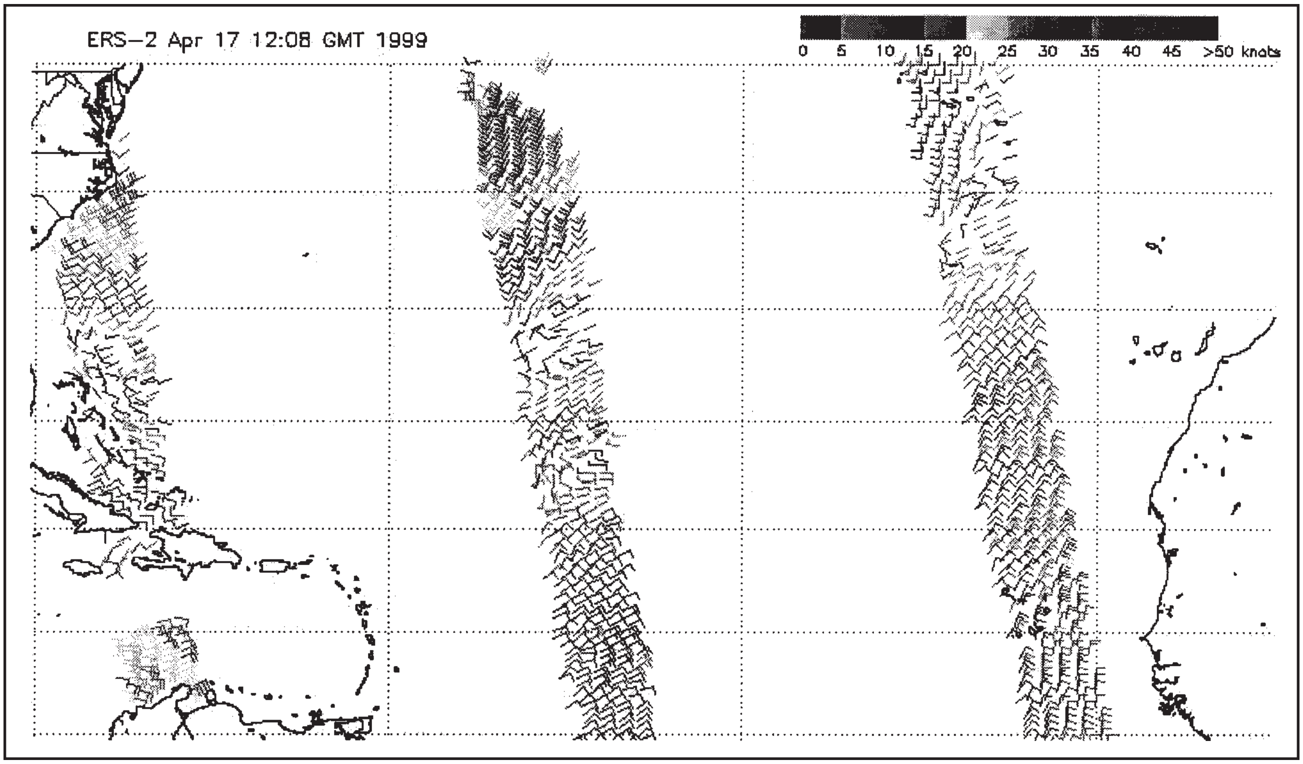

Figure 5. ERS-2 Scatterometer data for 17 April 1999. Image courtesy of the Naval Research Laboratory.

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wave/Imager (SSM/I) data and occasionally by ship reports. Each event lasted for two to four days with the gale conditions confined to within 240 nautical miles of the coast although SSM/I data in some cases indicated wind speeds in the 20 to 30 kt range extending southward and southwestward to 9N (approximately 420 nautical miles from the coast).

The fourth (12-14 February) and fifth (15-16 March) events were the strongest of the six. The fourth event was marked by a strong pressure gradient between a cold front and a 1037 mb high that moved eastward across Texas and the southeast United States. Gale conditions began approximately 1800 UTC 12 February and continued until 1800 UTC 14 February. The **Century Highway No. 3** reported 45 kt northeast winds and 18 ft combined seas near 12N 96W at 1200 UTC 14 February. Figure 6 depicts the daily average SSM/I wind speeds on 14 February.

The fifth event began approximately 0000 UTC 15 March and was marked by an elongated ridge of high pressure that extended across the central United States through east Texas and into the western Gulf of Mexico (the cold front at this time was along a line extending from the Georgia coast across the west tip of Cuba into the Gulf of Honduras). This front/ridge pattern progressed eastward 20 to 25 kt and gale conditions ended at approximately 1200 UTC 16 March. A ship (name or call sign not available) reported 39 kt north winds and 11 ft combined seas near 15N 94W at 1200 UTC

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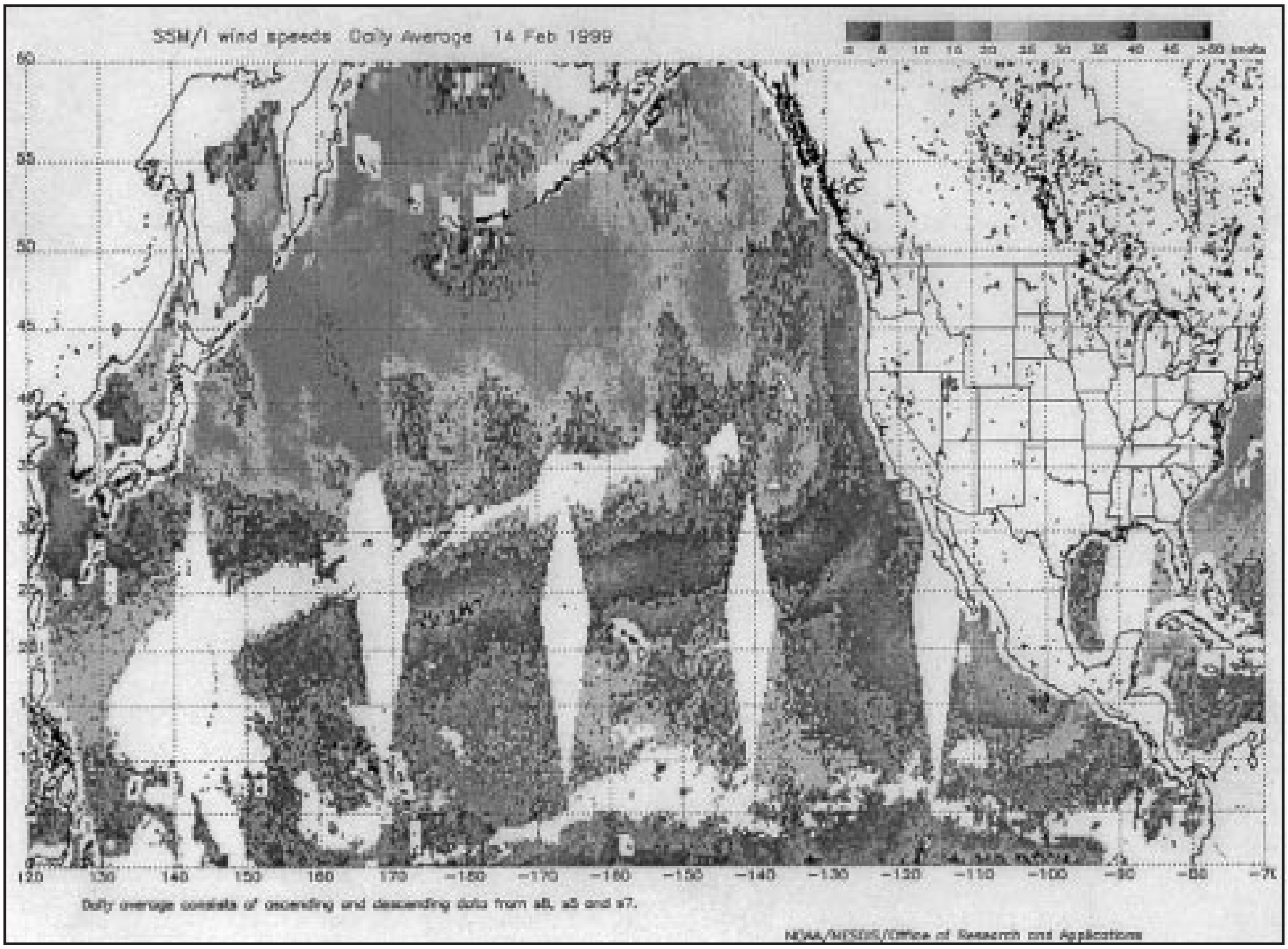

Figure 6. SSM/I average surface winds for 14 February 1999. Image courtesy of the NOAA/NESDIS Office of Research and Applications.

Tropical Prediction Center

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15 March. The same ship reported 34 kt northeast winds (seas not reported) six hours earlier. Figure 8 depicts the daily average SSM/I wind speeds on 15 March.

Cold Front and Gale of 6-7 March: A strong cold front entered the forecast area from the north between 1200 UTC 6 March and 1800 UTC 6 March. By 0000 UTC 7 March the cold front extended southwest from 30N 126W through 24N 140W. Gale conditions were confined to the area west of the cold front with the ship **DXQC** (name not available) reporting 33 kt north winds and 10 ft combined seas near 30N 132W. Six hours later the ship **VRUY4** (name not available) reported 33 kt north winds and 12 ft combined seas near 24N 131W. By 1200 UTC 7 March, the gale center associated with the cold front moved southeast near 30N 121W with a central pressure of 1010 mb (the gale strengthened only slightly over the preceding 24 to 36 hours). The ship **DXQC** (moving southeast about 15 kt) encountered 34 kt north winds and 17 ft combined seas near 29N 129W. The gale center then tracked eastward (Figure 9) and weakened as it crossed the northern Baja peninsula and into northwest Mexico between 0000 UTC and 0600 UTC 8 March. The cold front continued to move southeast and gradually weakened. The **DXQC** encountered 33 kt north winds and 14 ft combined seas near 28N 127W at 1800 UTC 8 March.⚓

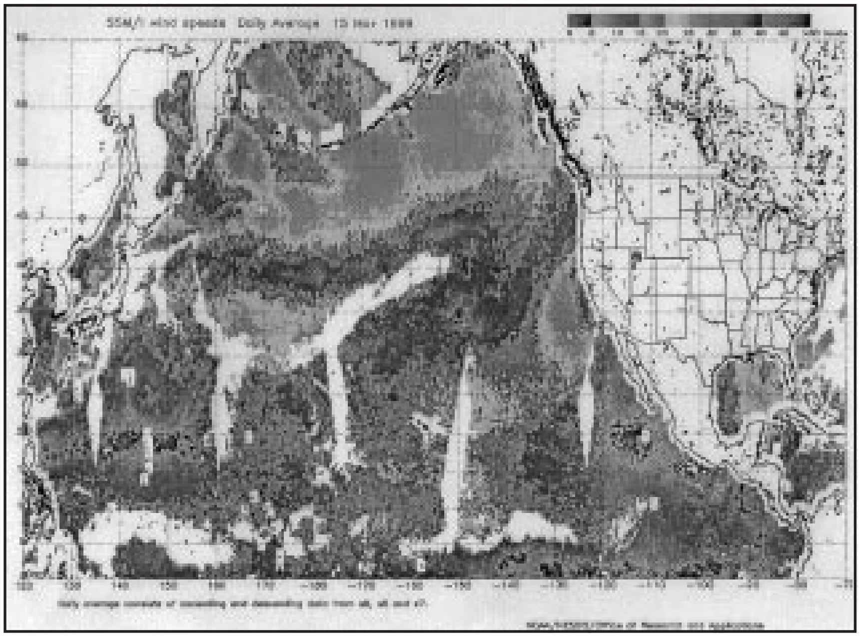


Figure 8. SSM/I average surface winds for 15 March 1999. Image courtesy of the NOAA/NESDIS Office of Research and Applications.

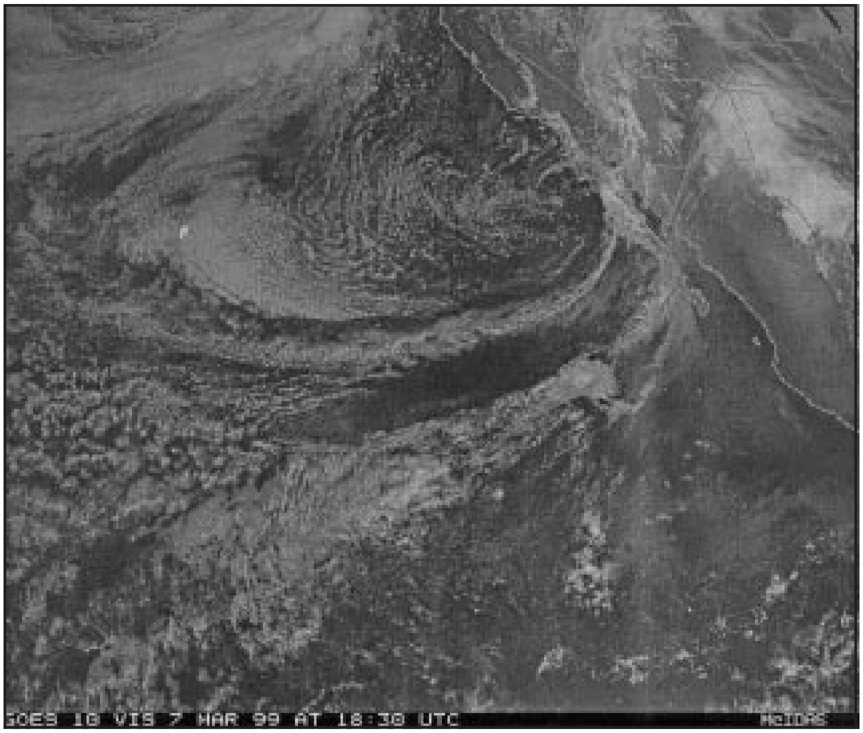
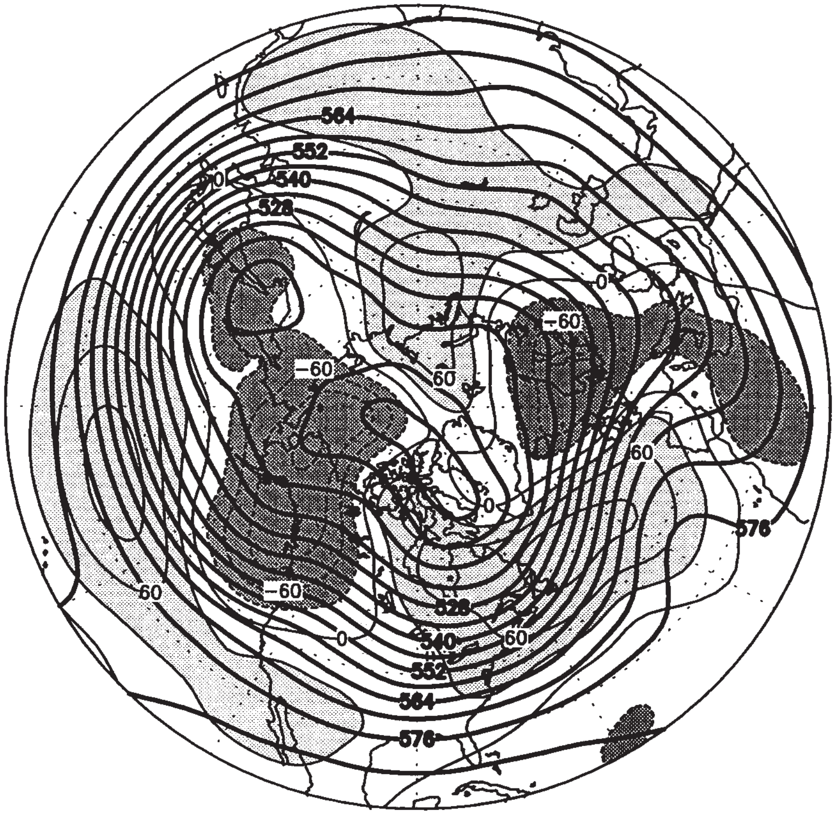


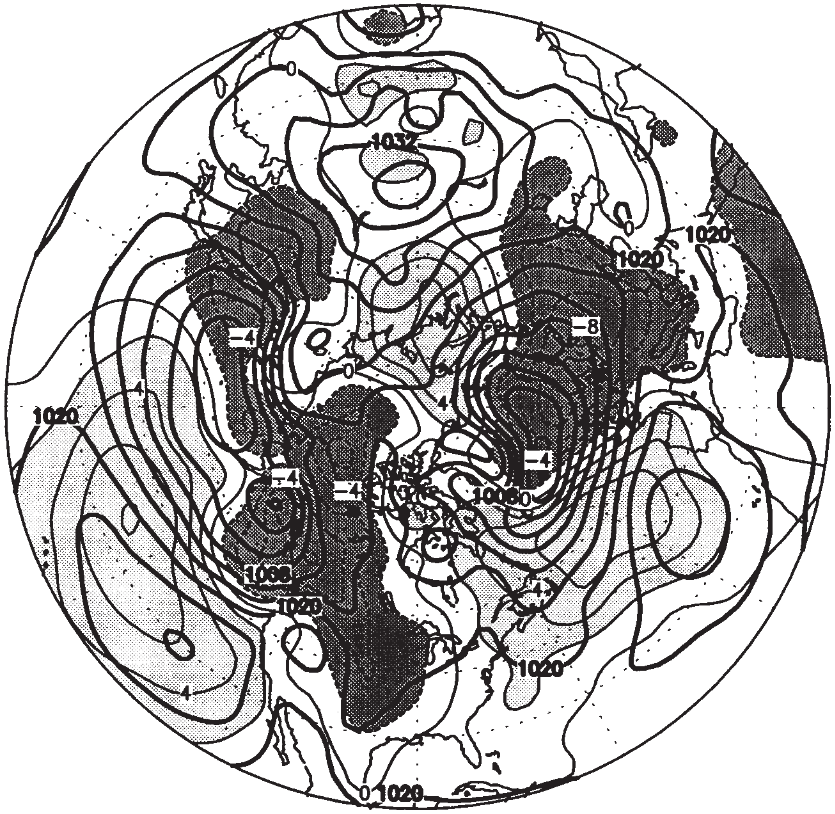
Figure 9. GOES-10 visible image at 1830 UTD 7 March 1999. Image courtesy of the National Climatic Data Center.

January–February 1999



500 mb Height, Anomaly

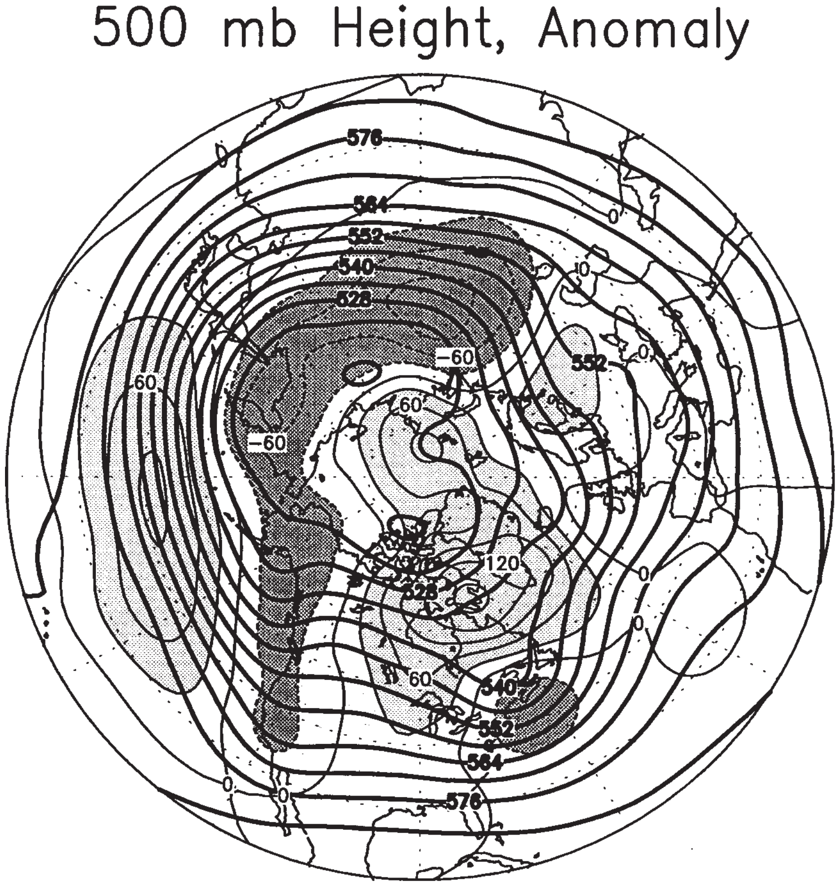
The chart on the left shows the two-month mean 500-mb height contours at 60 m intervals in solid lines, with alternate contours labeled in decameters (dm). Height anomalies are contoured in dashed lines at 30 m intervals. Areas where the mean height anomaly was greater than 30 m above normal have light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

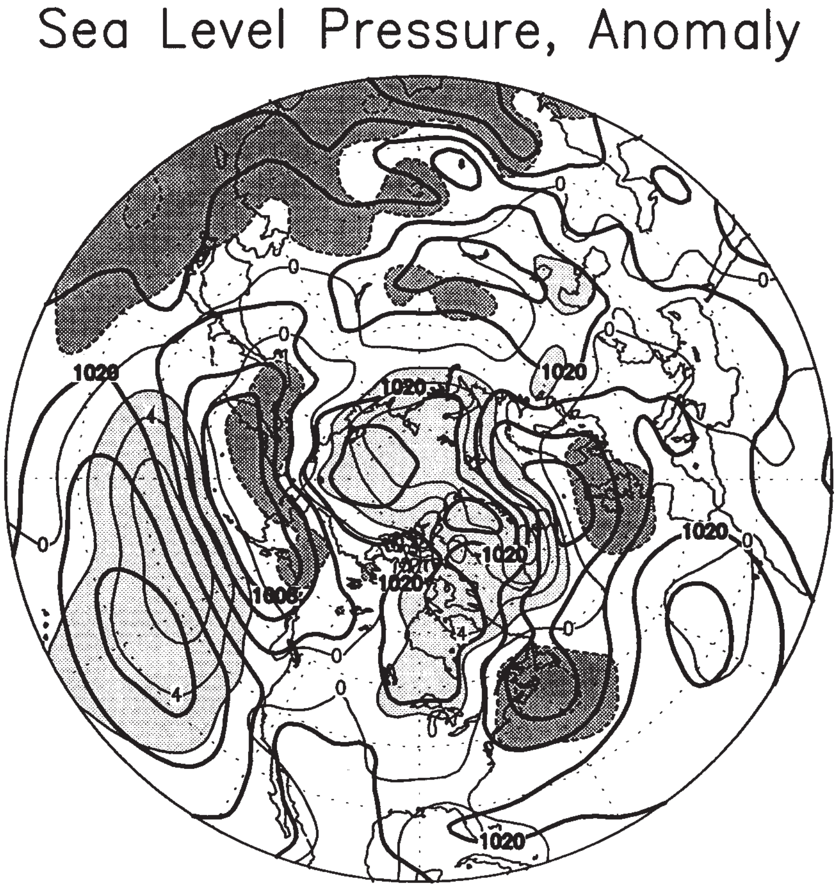


Sea Level Pressure, Anomaly

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.

March–April 1999





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.

Familiarization Float Aboard the Charles M. Beeghly
May 6-7, 1999

Eric Stevens
National Weather Service
Marquette, Michigan

The 800-foot **Charles M. Beeghly** reached the Sault Ste Marie locks on the evening of May 6 as it headed for Superior, Wisconsin, with a load of limestone. John Machowski and I, both meteorologists with the National Weather Service in Marquette, Michigan, rode the comparatively tiny motor launch, **Ojibway**, from the "Soo Store" warehouse out to meet the Beeghly. John and I were guests of the Interlake Steamship Company and the crew of the Beeghly for just over 24 hours as the Beeghly completed its journey to Superior. Our goal was to observe the operations aboard a Great Lakes ore carrier and to learn what impact the weather has on the Great Lakes' largest ships.

Upon leaving Sault Ste Marie, the wind blew from the southeast at 10 to 20 knots and waves were only 2 to 3 feet (.5 to 1 meter) while we were still in Whitefish Bay. By the time we had reached the western half of Lake Superior, the wind had picked up to northeast 20 to 30 knots, and waves had built to 4 to 6 feet (1 to 2 meters). The Beeghly hardly seemed to notice such waves. The last time I had been on Lake Superior was in September 1998, when I took the **Royale Queen III** to Isle Royale. Waves reached 6 feet that day, and the Queen was soon filled with seasick passengers. This contrast illustrates how different boats handle similar conditions differently, such as wave height, structural icing, or fog, to name a few weather elements. Captain Russ Brohl of the Beeghly mentioned that 8- to 12-foot (2.5- to 4-meter) waves are more noticeable and sometimes break over the deck, but the ship and cargo can handle these conditions. Waves begin to be more of an issue when they reach the 13 to 15 foot (4 to 4.5 meter) range, as they will then frequently break over the deck and all the hatches must be secured. The wind in the immediate Duluth/Superior area was quite gusty. The topography at the western tip of Lake Superior can sometimes focus the wind and produce significant differences between the weather on the open lake and the weather right along shore at Duluth/Superior.

While many smaller boats rely exclusively on radio broadcasts for their weather information, the Beeghly's communications equipment allows the wheelhouse crew to read copies of the National Weather Service open lake, Coded Marine Forecast (MAFOR), and nearshore forecasts themselves. They also download graphical forecasts via DMAWDS (Digital MArine Weather Dissemination System). These graphical forecasts depict the positions of high and low pressure centers and fronts on the Great Lakes and help the crew interpret the weather forecast.

Captain Bruhl and the crew of the Beeghly showed John and I the warmest hospitality throughout the trip. John and I truly appreciated the opportunity to sail aboard the Beeghly, and we are already using the knowledge gained during the voyage to assist in forecasting the weather for Lake Superior.⚓

Coastal Forecast Office News—North Carolina Area

Laura Furgione
Warning Coordination Meteorologist
National Weather Service Office
Newport, North Carolina

The first four months of 1999 were quite active along the North Carolina coast. Although there were no major storms, numerous cold frontal passages produced many gale force wind episodes. The main storm track this winter ran from the southern plains northeast toward the Ohio Valley region. Coastal North Carolina was to the south of most of the low pressure systems, and this produced several events where strong south to southeast winds developed.

Gale force south to southeast wind events occurred during the following periods: January 3rd and 24th, February 12th and 28th, and March 13th. Sustained winds of 30 to 40 knots produced seas of 10 to 15 feet along the coast, with the worst conditions mainly from Cape Hatteras south. These strong winds and large seas produced significant beach erosion along the south coast, mainly from Emerald Isle to North Topsail Beach.

A low pressure system that developed off the South Carolina coast during late April, moved very slowly northeast and produced a prolonged period of strong northeast winds along the coast. Winds of 35 to 45 knots with gusts to 50 knots were common the 29th and 30th. These strong winds produced very rough seas of 4 to 5 meters (12 to 16 feet), with the worst conditions from Cape Hatteras south. Beach erosion was reported along the Outer Banks, with some flooding along the southern Pamlico sound.

The National Weather service in Newport anticipated all the above events and issued Marine Weather Statements well in advance to give mariners a heads-up of the hazardous conditions. In addition to the Coastal Waters Forecast, statements were issued during each event to give additional information to mariners and coastal residents.

The National Weather Service in Newport transmits numerous products for the marine user. One of our most popular forecast products is the Coastal Marine Forecast, which covers South of Currituck Beach Light to Surf City and out to 20 nm. For those interested in forecasts beyond 48 hours, an extended three- to five-day forecast is also compiled. Included in the extended forecast is wind speed, wind direction, and wave height. Special Marine Warnings are issued on an as-needed basis. These include severe thunderstorms, waterspouts, and wind speeds that are forecast to exceed 35 knots.

All the forecasts can be obtained via the NOAA Weather Radio. The transmitter in New Bern is 162.40 Mhz, while the Hatteras transmission can be heard over 162.475 Mhz. An Offshore Forecast from Baltimore Canyon to Hatteras Canyon then southward to Blake Ridge can be found on either channel. During hurricane season, June 1 through November 30, Tropical Marine Advisories are also broadcast. Additional sources include our recorded forecast telephone line (252) 223-5737 and our web site **http://www.nws.noaa.gov/er/mhx**

Coastal Forecast Office News—North Carolina Area (Continued)

Carl Morgan
Meteorologist
National Weather Service Forecast Office
Wilmington, North Carolina

An unusually-intense low pressure system began to take shape off the South Carolina coast on Thursday April 29, 1999, and lingered nearly stationary until Sunday, May 2nd. As a result of the tight pressure gradient between the strengthening low pressure offshore and a ridge of high pressure east of the Appalachian Mountains, the Carolina coastal waters from Surf City, North Carolina, to South Santee River, South Carolina, were pounded with gale- to storm-force winds for nearly four days.

The meteorological conditions which lead to the development of this system more typically occur during the winter season. A cold front pushed southward through the Carolinas during the late night and early morning hours of April 27 and 28 and stalled off the South Carolina coast. Weak low pressure (1010 mb) developed along the front Thursday morning as a 500 mb trough swung into the Mid-Atlantic region (500 mb troughs observed on the 500 mb analyses frequently result in the formation of surface low pressure areas). The 500 mb trough evolved into a closed low Thursday evening before moving off the South Carolina coast early Friday. The surface low deepened to 1004 mb by Saturday morning as the surface and upper-level systems became vertically stacked.

A Gale Warning was issued by the National Weather Service in Wilmington, North Carolina, at 4:08 am EDT Thursday, April 29 for the coastal waters between Surf City and South Santee River. The Gale Warning was upgraded to a Storm Warning at 8:18 am EDT Friday, April 30, for the waters between Surf City and Murrells Inlet. The Storm Warning remained in effect for nearly 44 continuous hours.

The storm coincided with a full moon on Friday, causing higher than normal high tides. Beach erosion was reported along the shores of Pender and New Hanover counties, including Topsail and Wrightsville beaches. Because winds remained generally out of the northeast, the south-facing beaches of Brunswick county were spared significant damage.

Heavy rain, which began falling on Tuesday, continued into Sunday. More than 13 inches fell across portions of New Hanover county, leaving up to a foot of water standing on flood prone roads. By Saturday afternoon, numerous roads across New Hanover, Pender, and Brunswick counties were blocked by flood waters. The New Hanover County town of Carolina Beach was hit particularly hard, as several feet of water blocked roads in the northern part of town. US 421, the main artery between Carolina Beach and the rest of New Hanover County, was severed.

The Oak Island Coast Guard Station recorded a wind gust of 70 knots on Friday afternoon. The tower at Frying Pan Shoals, North Carolina, approximately 30 nm southeast of Cape Fear, recorded sustained winds to 61 knots and seas of 5 meters (17 feet) at the peak of the storm. Wind gauges in the coastal communities of Surf City, Kure Beach, and Southport recorded gusts up to 43 knots on Saturday.

One mariner lost his life when a shrimp boat capsized near the mouth of the Cape Fear River Thursday morning.

Storm Warnings were lowered to Gale Warnings at 4:00 am EDT on Sunday, May 2nd. Winds and seas subsided throughout the afternoon as the low pressure system weakened and moved northeast of the area. Gale Warnings were lowered at 4:00 pm Sunday.⚓

Voluntary Observing Ship Program

Martin S. Baron
National Weather Service
Silver Spring, Maryland

New SEAS/AMVER Software (Windows version) Under Development

Development of new SEAS/AMVER software is underway. This new Windows® version features on-screen drop-down windows with code tables, sea state and cloud photographs, and help menus. The entire ships code card is available as a tutorial on-screen. To create your coded weather message, you either click on code values drawn directly from the on-screen tables, or you type-in the value from your computer keyboard.

Like earlier SEAS/AMVER software, this software is "paperless." Your completed weather observations are stored in the computer and transferred to Archive Diskettes for mailing to your PMO (special postage paid diskette mailers are now available, see below). Recording of observations on Ships Weather Observations Form B-81 is still appropriate for ships not using this software or incapable of using this software due to equipment limitations.

SEAS 2000 will also support AMVER position reporting requirements when the report is transmitted through COMSAT affiliated stations.

We expect this new software to be available in late 2000. A version to operate with shipboard Expendible Bathythermographs (XBTs) is also being developed. Prior to release of this new software, we recommend use of SEAS version 4.52 (available from Port Meteorological Officers (PMOs), SEAS Field Representatives, or the SEAS webpage at **http://seas.nos.noaa.gov/seas/**

Three NOAA line offices are collaborating in the SEAS 2000 development effort. It's being lead by the Office of Atmospheric Research, Global Ocean Observing System (GOOS) Operations Center, with the office of NOAA Corps Operations writing the software in cooperation with the National Weather Service (NWS).

System requirements for new SEAS/AMVER software will be Pentium 133 MHz or greater, VGA monitor, Windows 95, 98, or NT, 3.5 inch floppy drive, and a compact disk reader (CD).

New SEAS Archive Diskette Mailers

Special SEAS Archive Diskette mailers are now available from PMOs. These are for mailing your SEAS formatted weather observation records to your PMO. (If you are using Form B-81 Ships Weather Observations, use the large mail envelopes available from your PMO.) After reviewing the observations, the PMO sends

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VOS Program

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the SEAS diskettes (or Form B-81) to the National Climatic Data Center for archiving. Like the envelopes, the diskette mailers are pre-printed with PMO mailing addresses and are postage paid when mailed in any United States port.

The backs of the mailers are pre-printed with a checklist of weather observing and reporting supplies to order from your PMO. There is also space for you to enter your vessel mailing address.

Updated Observing Handbook Now Available

The revised edition of NWS Observing Handbook No.1 is now in print. (The cover of the revised edition is the same as the old edition; the April 1999 revision date appears on the title page next to the inside front cover.) This new edition replaces the August 1995 edition. Copies were mailed to all NWS Voluntary Observing Ships. Additional copies are available from PMOs. The most notable change has been a complete rewrite of Chapter 3, Transmitting the Observation.

New Recruits—January through April 1999

During the four-month period January through April 1999, PMOs recruited 42 vessels into the Voluntary Observing Ship Program. Thank you for joining the program.

Please remember that the weather reporting schedule for Voluntary Observing Ships is four times daily, at 0000Z, 0600Z, 1200Z, and 1800Z. Three hourly observations are also requested from vessels operating within 200 miles of the United States and Canadian coasts (at 0000Z, 0300Z, 0600Z, 0900Z, 1200Z, 1500Z, 1800Z). Please make every effort to follow the weather reporting schedules. Your observations are very important to the weather forecasting effort, and to your safety and well being at sea.

Some Reminders

1. Complete the transmission of your INMARSAT weather report in 30 seconds or less. This helps reduce communications costs paid by the NWS.

2. Take special care to accurately code your day, time, and position information (section 0 of the Ships Synoptic Code). Meteorological reports received with section 0 coding errors can seldom be used, and are usually discarded. Section 0 consists of the first five groups of the weather message — BBXX D....D $YYGGi_w$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$.

3. Remember the relationship between i_x in group i_ri_xhVV and group $7wwW_1W_2$. I_x must be coded as 1 when group $7wwW_1W_2$ is included in your weather message (most of the time). If not reporting any significant weather, i_x is coded as 2 and group $7wwW_1W_2$ is omitted from the weather message.

4. Many sea states are composed of a mixture of sea and swell which can be difficult to unravel. Swell waves are due to the action of strong winds in some distant area and may travel thousands of miles from their origin before dissipating. Swell waves have longer wavelengths in comparison to sea waves and also have longer periods.

To help distinguish sea from swell, use (1) your observed wind speed, and (2) wave direction of movement. A succession of waves with long wavelength with height of 3 meters or more, when the wind has not exceeded 10 knots, would have to be classified as swell because the local wind is not strong enough to be responsible. Waves not moving with the local wind must be described as swell.

With stronger winds, when there is a considerable sea, distinguishing between sea and swell can be difficult if there is not much difference between their direction of motion. In such cases, waves with noticeably longer periods are swell. If period differences cannot be distinguished, and the waves are moving in the same direction, it is best to regard the combined motion as being due to sea waves.

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VOS Program

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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

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VOS Program

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Operator	Service	Station ID			
		AOR-W	AOR-E	IOR	POR
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

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.

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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

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]

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Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
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
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.

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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 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

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STATION		MMSI #
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.

Globe Wireless

Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
Slidell,	(WNU)	SITOR			401	4172.5	4210.5	24Hr
Louisina	(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

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Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
San Francisco,	(KPH)	SITOR			413	4178.5	4216	24Hr
California	(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,	(WCC)	SITOR				6297	6334	24Hr
USA	(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
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

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Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
Cape Town,	(ZSC)	SITOR			408	4176	4214	24Hr
South Africa	(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,	(A9M)	SITOR			419	4181.5	4219	24Hr
Arabian Gulf	(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,	(SAB)	SITOR			228	2155.5	1620.5	24Hr
Sweden	(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,	(ZLA)	SITOR			402	4173	4211	24Hr
New Zealand	(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,	(VIP)	SITOR			406	4175	4213	24Hr
Western	(VIP)	SITOR			806	8379	8419	24Hr
Austrailia	(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

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Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
	(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
	(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, NJ	(WSC)	SITOR	1108		419	4181.5	4219	24Hr
	(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	

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VOS Program

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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

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.

National Weather Service Voluntary Observing Ship Program

New Recruits from January 1 through April 30, 1999

NAME OF SHIP	CALL	AGENT NAME	RECRUITING PMO
ALMA	ELPN5	OMI CORPORATION	NEW YORK CITY, NY
ANASTASIS	9HOZ	MERCY SHIPS	MIAMI, FL
APL GARNET	9VVN	AMERICAN SHIP MANAGEMENT	SAN FRANCISCO, CA
ARABIAN SEA	C6QS	ECUADORIAN LINE, INC.	MIAMI, FL
BARBICAN SPIRIT	DVFS	PMO	MIAMI, FL
CANBERRA	GBVC	PRINCESS CRUISES	MIAMI, FL
CHOYANG PHOENIX	P3ZY6	INCHAPE SHIPPING SERVICES	NORFOLK, VA
CMS ISLAND EXPRESS	J8NX	TROPICAL SHIPPING AND CONSTRUCTION CO	MIAMI, FL
CORAL SEA	C6YW	ECUADORIAN LINE....TRIREME VESSEL MANAGEMENT	MIAMI, FL
CRYSTAL HARMONY	C6IP2	CRYSTAL CRUISE LINE	MIAMI, FL
DOCELAKE	ELUI6	INCHAPE SHIPPING SERVICES	NORFOLK, VA
DONAU	LXDO	% TECTO N.V.	HOUSTON, TX
EMERALD ISLE	WCX7834	BEAVER ISLAND BOAT COMPANY	CHICAGO, IL
EVER DIAMOND	3FQS8	EVERGREEN AMERICA CORP	NORFOLK, VA
EVER DIVINE	3FSA8	EVERGREEN AMERICA CORPORATION	NORFOLK, VA
FRANK A. SHRONTZ	C6PZ3	CEVRON SHIPPING	SAN FRANCISCO, CA
GOLDENSARI INDAH	9VVB	MANHATTAN SHIPPING (CANADA) LTD	SEATTLE, WA
GREEN POINT	WCY4148	CENTRAL GULF LINES	NEW YORK CITY, NY
GREEN SAIKAI	3EVS5	INTERNATIONAL SHIPPING CO INC	SEATTLE, WA
HMI PETROCHEM	KNJL	HVIDE MARINE INC.	MIAMI, FL
HOEGH DENE	ELWO7	KERR NORTON MARINE	NORFOLK, VA
IMAN	TCTC	PMO	MIAMI, FL
KATRINE MAERSK	OZLL2	MAERSK PACIFIC LTD.	NEW YORK CITY, NY
KIRSTEN MAERSK	OYDM2	MAERSK PACIFIC LTD	SEATTLE, WA
MAERSK SEA	S6CW	A.P.MOLLER SINGAPORE PTE LTD	SEATTLE, WA
MARINE CHEMIST	KMCB	PORT METEOROLOGICAL OFFICER	HOUSTON, TX
MERCEDES	9HHE5	POLEMBROS MARITIME	NORFOLK, VA
MSC ORINOCO	3EFY7	TRANS-AMERICA SS AGENCY	LOS ANGELES, CA
MV CONTSHIP ROME	ELVZ6	LYKES LINES, FIRST VIRGINIA TOWER	NORFOLK, VA
ORIENTE VICTORIA	3FVG8	INTERNATIONAL SHIPPING CO.	SEATTLE, WA
ORTA	DXAY	T. PARKER HOST	NEW YORK CITY, NY
PACDREAM	ELQO6	LASCO SHIPPING CO.	SEATTLE, WA
REGAL PRINCESS	ELVK6	PRINCESS CRUISES	MIAMI, FL
SANTA BARBARA	ELOT3	NYK LINE (NORTH AMERICA) INC.	SEATTLE, WA
SULU WARRIOR	DZEO	INCHCAPE SHIPPING SERVICES	NORFOLK, VA
TAUSALA SAMOA	V2KS	SUNRISE SHIPPING AGENCY	SEATTLE, WA
TECO TRADER	KSDF	GULFCOAST TRANSIT CO	NEW ORLEANS, LA
THORKIL MAERSK	MSJX8	UNIVERSAL MARITIME	MIAMI, FL
TROPICAL LIGHT	ELTP3	INCHCAPE SHIPPING SERVICES	BALTIMORE, MD
USNS SAN JOSE	NIBV	MASTER	SAN FRANCISCO, CA
WESTWOOD BORG	LAON4	OCEAN AGENCIES INC., SUITE 202	SEATTLE, WA
WESTWOOD BREEZE	LAOT4	OCEAN AGENCIES INC., SUITE 202	SEATTLE, WA

VOS Program Awards and Presentations Gallery

The ***Sealand Integrity*** *received 1997 and 1998 outstanding VOS awards. From left, Chief Mate Bruce Myrdek, Captain Wes Winters, New York PMO Tim Kenefik, Captain Alan Hinshaw, and Chief Mate Bob Sargent.*

A VOS outstanding performance award for 1998 is presented to the Carnival Cruise ship ***Destiny****. From left, 3rd Officer Vasta Rosario, 2nd Officer Barrile Pierluiai, Miami PMO Bob Drummond,and 2nd Officer Longhin Gianluca.*

Derek LeeLoy, NWS Pacific Region Ocean Services Program Coordinator, performs ship visitations on behalf of the VOS program in the Honolulu area.

PMO Miami Robert Drummond presented a VOS award to Captain James V. Seiler of the ***R/V Stewart Johnson****.*

The ***Chevron South America*** *received a 1999 outstanding VOS performance award from Norfolk PMO Pete Gibino. She is one of the 15 largest vessels in the world, at 1200 feet long with a beam of 229 feet. The vessel can carry 3,162,635 barrels of oil (about 407,000 tons) at 98% full. Draft at full load is 75 feet. With a 42,000 HP steam engine, she has a service speed of about 15.3 knots loaded and 17 knots in ballast.*

PMO Miami Bob Drummond presented a 1998 VOS award to the ***T/S State of Maine*** *(shown dockside in Castine, Maine).*

PMO Baltimore Jim Saunders presenting a 1997 VOS award to Alastair McDonald of the ***Gypsum King****.*

The ***APL Singapore*** *was one of the ships recognized in 1998 by the VOS program. Standing left to right are PMO Pat Brandow, Captain Harrison, and Second Mate Mark Schiedemayer.*

PMO Baltimore Jim Saunders presenting a 1998 VOS award to Chief Mate Albert Zykov of the ***Agulhas****.*

PMO Chicago Amy Seeley presenting a 1998 VOS award to 2nd Mate Edward T. Gaynor of the ***M/V Burns Harbor****.*

The ***Edwin H. Goott*** *is presented a 1998 VOS award. From left are First Mate Cass Kane, Captain Elden W. Brege, and Second Mate Richard Robertson. Courtesy PMO Chiago Amy Seeley.*

Aboard the ***Chevron South America*** *are, from left, C/O Emil Smeraldo, 3rd Officer Brigitta Johansen, and 2nd Officer Philip Nottingham.*

The ***Sea-Land Anchorage*** *comes through in 1998 with one of the top honors of the VOS awards program. Pictured from left to right are Second Mate Philip Kelly, Chief Mate James Kitterman, and PMO Pat Brandow of Seattle.*

Waterspout spotted by the ***Argonaut*** *on May 30, 1999, at 1400Z, 38.2N 63.3W. Photo courtesy of Master R. Bowden.*

VOS Coop Ship Reports — January through April 1999

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
AALSMEERGRACHT	PCAM	Long Beach	20	52	38	48	158
ACT 7	GWAN	Newark	40	62	2	0	104
ADVANTAGE	WPPO	Norfolk	0	0	0	2	2
AGDLEK	OUGV	Miami	18	2	1	22	43
AGULHAS	3ELE9	Baltimore	55	26	37	35	153
AL AWDAH	9KWA	Houston	24	74	44	71	213
AL FUNTAS	9KKX	Miami	27	2	0	0	29
AL SAMIDOON	9KKF	Houston	33	10	6	33	82
ALBEMARLE ISLAND	C6LU3	Newark	61	47	51	54	213
ALBERNI DAWN	ELAC5	Houston	46	6	0	31	83
ALBLASGRACHT	PCIG	Houston	0	0	22	17	39
ALEXANDER VON HUMBOLD	Y3CW	Miami	728	139	692	703	2262
ALKMAN	C6OG4	Houston	36	18	45	67	166
ALLEGIANCE	WSKD	Norfolk	4	17	15	20	56
ALLIANCA AMERICA	DHGE	Baltimore	16	0	0	0	16
ALLIGATOR AMERICA	JPAL	Seattle	0	0	6	11	17
ALLIGATOR BRAVERY	3FXX4	Oakland	33	49	44	42	168
ALLIGATOR COLUMBUS	3ETV8	Seattle	13	9	15	12	49
ALLIGATOR FORTUNE	ELFK7	Seattle	16	16	13	16	61
ALLIGATOR GLORY	ELJP2	Seattle	23	15	16	16	70
ALLIGATOR HOPE	ELFN8	Seattle	9	17	32	28	86
ALLIGATOR LIBERTY	JFUG	Seattle	72	24	67	33	196
ALLIGATOR STRENGTH	3FAK5	Oakland	15	19	11	8	53
ALPENA	WAV4647	Cleveland	0	0	0	11	11
ALTAIR	DBBI	Miami	502	615	684	494	2295
AMAZON	S6BJ	Norfolk	22	35	0	51	108
AMBASSADOR BRIDGE	3ETH9	Oakland	68	58	120	45	291
AMERICA STAR	C6JZ2	Houston	63	82	83	85	313
AMERICAN CORMORANT	KGOP	Jacksonville	2	3	0	0	5
AMERICAN MERLIN	WRGY	Norfolk	5	0	0	0	5
AMERIGO VESPUCCI	ICBA	Norfolk	5	6	6	15	32
ANASTASIS	9HOZ	Miami	0	2	3	33	38
ANATOLIY KOLESNICHENKO	UINM	Seattle	13	32	33	15	93
ANKERGRACHT	PCQL	Baltimore	0	39	55	70	164
APL CHINA	V7AL5	Seattle	36	25	43	15	119
APL GARNET	9VVN	Oakland	42	32	71	0	145
APL JAPAN	V7AL7	Seattle	10	24	19	24	77
APL KOREA	WCX8883	Seattle	46	54	38	40	178
APL PHILIPPINES	WCX8884	Seattle	34	30	32	61	157
APL SINGAPORE	WCX8812	Seattle	46	44	57	53	200
APL THAILAND	WCX8882	Seattle	52	39	36	49	176
APOLLOGRACHT	PCSV	Baltimore	61	29	22	38	150
ARCO ALASKA	KSBK	Long Beach	0	5	14	6	25
ARCO CALIFORNIA	WMCV	Long Beach	1	0	0	2	3
ARCO INDEPENDENCE	KLHV	Long Beach	16	15	9	14	54
ARCO PRUDHOE BAY	KPFD	Long Beach	0	0	0	1	1
ARCO SAG RIVER	WLDF	Long Beach	5	7	14	7	33
ARCO SPIRIT	KHLD	Long Beach	14	9	7	18	48
ARCO TEXAS	KNFD	Long Beach	10	12	13	14	49
ARGONAUT	KFDV	Newark	14	32	11	7	64
ARIES	KGBD	New York City	5	2	3	7	17
ARINA ARCTICA	OVYA2	Miami	116	97	129	90	432
ARKTIS FUTURE	OXUF2	Miami	0	11	71	63	145
ARMCO	WE6279	Cleveland	0	0	5	15	20
ARTHUR M. ANDERSON	WE4805	Chicago	0	0	16	16	32
ATLANTIC	3FYT	Miami	203	207	176	161	747
ATLANTIC BULKER	3FSQ4	Miami	0	7	0	0	7
ATLANTIC CARTIER	C6MS4	Norfolk	25	9	3	0	37

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
ATLANTIC COMPANION	SKPE	Newark	16	14	31	30	91
ATLANTIC COMPASS	SKUN	Norfolk	32	13	32	32	109
ATLANTIC CONCERT	SKOZ	Norfolk	21	13	12	17	63
ATLANTIC CONVEYOR	C6NI3	Norfolk	26	36	25	25	112
ATLANTIC NOVA	3FWT4	Seattle	1	12	44	49	106
ATLANTIC OCEAN	C6T2064	Newark	36	19	20	0	75
ATLANTIS	KAQP	New Orleans	0	0	14	21	35
AUCKLAND STAR	C6KV2	Baltimore	86	66	66	59	277
AUSTRAL RAINBOW	WEZP	New Orleans	0	0	26	25	51
AUTHOR	GBSA	Houston	51	23	28	17	119
B. T. ALASKA	WFQE	Long Beach	9	9	23	16	57
BARBARA ANDRIE	WTC9407	Chicago	0	0	9	25	34
BARRINGTON ISLAND	C6QK	Miami	30	30	62	82	204
BAY BRIDGE	ELES7	Seattle	14	6	5	2	27
BELLONA	3FEA4	Jacksonville	6	17	18	14	55
BERING SEA	C6YY	Miami	20	22	42	33	117
BERNARDO QUINTANA A	C6KJ5	New Orleans	30	25	25	15	95
BLUE GEMINI	3FPA6	Seattle	82	43	44	47	216
BLUE HAWK	D5HZ	Norfolk	26	15	30	22	93
BLUE NOVA	3FDV6	Seattle	33	26	35	26	120
BONN EXPRESS	DGNB	Houston	450	525	674	314	1963
BP ADMIRAL	ZCAK2	Houston	40	58	47	21	166
BREMEN EXPRESS	9VUM	Norfolk	11	12	0	0	23
BRIGHT PHOENIX	DXNG	Seattle	41	40	61	31	173
BRISBANE STAR	C6LY4	Seattle	4	45	32	22	103
BRITISH ADVENTURE	ZCAK3	Seattle	40	56	52	37	185
BRITISH HAWK	ZCBK6	New Orleans	60	63	67	16	206
BRITISH RANGER	ZCAS6	Houston	48	55	71	74	248
BT NIMROD	ZCBL5	Long Beach	16	4	10	23	53
BUCKEYE	WAQ3520	Cleveland	0	0	0	12	12
BUFFALO	WXS6134	Cleveland	0	0	0	15	15
BUNGA ORKID DUA	9MBQ4	Seattle	32	30	1	8	71
BURNS HARBOR	WQZ7049	Chicago	31	0	24	132	187
C.S. IRIS	GVIA	Seattle	14	5	0	0	19
CALCITE II	WB4520	Chicago	0	0	0	26	26
CALIFORNIA HIGHWAY	3FHQ4	Seattle	0	6	7	8	21
CALIFORNIA JUPITER	ELKU8	Long Beach	11	7	10	11	39
CALIFORNIA LUNA	3EYX5	Seattle	9	2	17	4	32
CALIFORNIA MERCURY	JGPN	Seattle	13	19	4	8	44
CAPE CHARLES	3EFX5	Seattle	5	11	4	11	31
CAPE MAY	JBCN	Norfolk	10	9	14	5	38
CAPE TRINITY	KAFD	Houston	6	8	45	1	60
CAPT STEVEN L BENNETT	KAXO	New Orleans	15	7	41	6	69
CARDIGAN BAY	ZCBF5	New York City	42	0	0	0	42
CARIBBEAN MERCY	3FFU4	Miami	16	0	0	25	41
CARLA A. HILLS	ELBG9	Oakland	86	83	70	10	249
CARNIVAL DESTINY	3FKZ3	Miami	43	29	37	17	126
CARNIVAL PARADISE	3FOB5	Miami	17	26	27	28	98
CAROLINA	WYBI	Jacksonville	6	26	19	0	51
CASON J. CALLAWAY	WE4879	Chicago	0	0	0	37	37
CELEBRATION	ELFT8	Miami	9	12	16	5	42
CENTURY HIGHWAY #2	3EJB9	Long Beach	19	24	9	22	74
CENTURY HIGHWAY NO. 1	3FFJ4	Houston	20	21	27	20	88
CENTURY HIGHWAY_NO. 3	8JNP	Houston	6	40	36	0	82
CENTURY LEADER NO. 1	3FBI6	Houston	30	8	21	54	113
CHARLES ISLAND	C6JT	Miami	55	67	56	38	216
CHARLES M. BEEGHLEY	WL3108	Cleveland	0	0	0	32	32
CHASTINE MAERSK	OWNJ2	New York City	6	13	0	0	19
CHELSEA	KNCX	Miami	25	8	28	35	96
CHESAPEAKE BAY	DIOD	Long Beach	0	1	0	0	1
CHESAPEAKE BAY	WMLH	Houston	19	48	5	67	139
CHESAPEAKE TRADER	WGZK	Houston	49	10	17	20	96
CHEVRON ARIZONA	KGBE	Miami	0	0	85	106	191
CHEVRON ATLANTIC	C6KY3	New Orleans	32	21	23	2	78
CHEVRON EDINBURGH	VSBZ5	Oakland	7	0	0	14	21
CHEVRON LOUISIANA	WHNG	Oakland	1	0	0	16	17
CHEVRON MISSISSIPPI	WXBR	Oakland	42	46	42	38	168
CHEVRON NAGASAKI	A8BK	Oakland	19	4	11	0	34
CHEVRON SOUTH AMERICA	ZCAA2	New Orleans	11	0	43	54	108
CHEVRON WASHINGTON	KFDB	Oakland	0	0	0	23	23
CHIEF GADAO	WEZD	Oakland	19	28	19	27	93
CHIQUITA BELGIE	C6KD7	Baltimore	38	48	47	30	163
CHIQUITA BREMEN	ZCBC5	Miami	40	40	50	47	177

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
CHIQUITA BRENDA	ZCBE9	Miami	51	40	49	37	177
CHIQUITA DEUTSCHLAND	C6KD8	Baltimore	60	29	42	45	176
CHIQUITA ELKESCHLAND	ZCBB9	Miami	30	44	48	48	170
CHIQUITA FRANCES	ZCBD9	Miami	29	33	29	39	130
CHIQUITA ITALIA	C6KD5	Baltimore	52	42	56	66	216
CHIQUITA JEAN	ZCBB7	Jacksonville	45	44	30	49	168
CHIQUITA JOY	ZCBC2	Miami	21	49	52	41	163
CHIQUITA NEDERLAND	C6KD6	Baltimore	34	46	54	54	188
CHIQUITA ROSTOCK	ZCBD2	Miami	20	53	47	50	170
CHIQUITA SCANDINAVIA	C6KD4	Baltimore	61	53	44	40	198
CHIQUITA SCHWEIZ	C6KD9	Baltimore	17	9	2	8	36
CHO YANG ATLAS	DQVH	Seattle	43	50	62	30	185
CHOYANG PHOENIX	P3ZY6	Norfolk	0	0	0	5	5
CITY OF DURBAN	GXIC	Long Beach	51	57	52	68	228
CLEVELAND	KGXA	Houston	0	0	0	4	4
COLORADO	KWFE	Miami	0	1	0	14	15
COLUMBIA BAY	WRB4008	Houston	1	8	0	0	9
COLUMBIA STAR	WSB2018	Cleveland	0	0	0	18	18
COLUMBIA STAR	C6HL8	Long Beach	76	57	86	77	296
COLUMBINE	3ELQ9	Baltimore	1	16	83	3	103
COLUMBUS AMERICA	ELSX2	Norfolk	40	49	68	7	164
COLUMBUS AUSTRALIA	ELSX3	Houston	37	17	25	41	120
COLUMBUS CALIFORNIA	ELUB7	Houston	20	42	0	56	118
COLUMBUS CANADA	ELQN3	Seattle	55	63	14	19	151
COLUMBUS CANTERBURY	ELUB8	Norfolk	0	0	0	52	52
COLUMBUS QUEENSLAND	ELUB9	Norfolk	31	12	3	0	46
COLUMBUS VICTORIA	ELUB6	Long Beach	42	0	29	19	90
CONDOLEEZZA RICE	C6OK	Baltimore	0	0	3	7	10
CONTSHIP ENDEAVOUR	ZCBE7	Houston	0	0	28	26	54
CONTSHIP SUCCESS	ZCBE3	Houston	84	43	94	58	279
COPACABANA	PPXI	Norfolk	3	15	0	0	18
CORAL SEA	C6YW	Miami	0	0	0	44	44
CORDELIA	3ESJ3	Long Beach	0	6	4	7	17
CORMORANT ARROW	C6IO9	Seattle	0	65	61	0	126
CORNUCOPIA	KPJC	Oakland	48	53	19	12	132
CORWITH CRAMER	WTF3319	Norfolk	1	19	35	45	100
COSMOWAY	3EVO3	Seattle	3	10	22	8	43
COURTNEY BURTON	WE6970	Cleveland	0	0	2	23	25
COURTNEY L	ZCAQ8	Baltimore	21	16	19	21	77
CRISTOFORO COLOMBO	ICYS	Norfolk	18	17	13	12	60
CROWN OF SCANDINAVIA	OXRA6	Miami	43	43	42	63	191
CSL CABO	D5XH	Seattle	31	35	34	52	152
CSS HUDSON	CGDG	Norfolk	0	0	0	51	51
DAGMAR MAERSK	DHAF	New York City	18	4	1	0	23
DAISHIN MARU	3FPS6	Seattle	69	75	77	56	277
DANIA PORTLAND	OXEH2	Miami	39	66	31	17	153
DAVID Z. NORTON	WZF9655	Cleveland	0	0	0	1	1
DAWN PRINCESS	ELTO4	Miami	28	28	25	28	109
DELAWARE BAY	WMLG	Houston	0	0	18	14	32
DELAWARE TRADER	WXWL	Long Beach	40	86	116	40	282
DENALI	WSVR	Long Beach	32	21	31	15	99
DIRECT FALCON	C6MP7	Long Beach	69	63	92	18	242
DIRECT KEA	C6MP8	Long Beach	61	67	92	70	290
DIRECT KOOKABURRA	C6MQ2	Long Beach	26	73	46	59	204
DOCK EXPRESS 20	PJRF	Baltimore	31	10	38	5	84
DON QUIJOTE	SFQP	New York City	0	0	26	0	26
DONAU	LXDO	Houston	20	23	0	0	43
DORTHE MAERSK	DHPD	New York City	26	2	0	0	28
DORTHE OLDENDORFF	ELQJ6	Seattle	6	2	10	20	38
DRAGOER MAERSK	OXPW2	Long Beach	42	3	24	35	104
DUHALLOW	ZCBH9	Baltimore	68	64	74	47	253
DUNCAN ISLAND	C6JS	Miami	23	43	51	45	162
DUSSELDORF EXPRESS	S6IG	Long Beach	701	363	714	676	2454
E.P. LE QUEBECOIS	CG3130	Norfolk	0	0	0	191	191
EAGLE BEAUMONT	S6JO	New York City	2	0	0	0	2
EASTERN BRIDGE	C6JY9	Baltimore	89	85	79	80	333
ECSTASY	ELNC5	Miami	6	1	0	0	7
EDELWEISS	VRUM3	Seattle	35	48	35	37	155
EDGAR B. SPEER	WQZ9670	Chicago	45	0	30	136	211
EDWIN H. GOTT	WXQ4511	Chicago	7	0	0	28	35
EDYTH L	C6YC	Baltimore	8	10	14	18	50
EL MORRO	KCGH	Miami	0	0	5	14	19
EL YUNQUE	WGJT	Jacksonville	2	25	25	0	52

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
ELATION	3FOC5	Miami	6	4	8	5	23
EMPIRE STATE	KKFW	New York City	29	38	0	0	67
ENCHANTMENT OF THE SEAS	LAXA4	Miami	2	1	3	0	6
ENDEAVOR	WAUW	New York City	21	29	56	23	129
ENDURANCE	WAUU	New York City	23	17	38	30	108
ENERGY ENTERPRISE	WBJF	Baltimore	9	0	0	0	9
ENGLISH STAR	C6KU7	Long Beach	64	63	63	77	267
ENIF	9VVI	Houston	0	15	0	0	15
ENTERPRISE	WAUY	New York City	31	26	64	35	156
EVER DELIGHT	3FCB8	New York City	0	4	7	4	15
EVER DELUXE	3FBE8	Norfolk	0	10	12	0	22
EVER DEVOTE	3FIF8	New York City	0	0	0	1	1
EVER GAINING	BKJO	Norfolk	0	9	0	0	9
EVER GALLANT	BKJN	Norfolk	0	0	2	0	2
EVER GARLAND	3EOB8	Long Beach	4	0	0	4	8
EVER GENERAL	BKHY	Baltimore	0	0	21	0	21
EVER GENTLE	BKHE	Newark	0	16	15	0	31
EVER GLOWING	BKJZ	Long Beach	5	0	0	7	12
EVER GRACE	3FWR2	Seattle	0	12	13	0	25
EVER GROUP	BKJI	Long Beach	0	0	4	0	4
EVER GUEST	BKJH	Norfolk	0	0	18	15	33
EVER LAUREL	BKHH	Long Beach	11	22	0	0	33
EVER LEVEL	BKHJ	Miami	10	22	9	3	44
EVER RACER	3FJL4	Norfolk	2	17	3	14	36
EVER REACH	3FQO4	Newark	0	0	0	15	15
EVER RENOWN	3FFR4	Long Beach	9	0	0	0	9
EVER RESULT	3FSA4	Norfolk	0	0	7	0	7
EVER RIGHT	3FML3	Long Beach	2	0	12	5	19
EVER ROUND	3FQN3	Long Beach	0	11	0	0	11
EVER ULTRA	3FEJ6	Seattle	6	10	7	7	30
EVER UNION	3FFG7	Seattle	0	0	0	23	23
EVER UNIQUE	3FXQ6	Seattle	6	4	10	11	31
EVER UNISON	3FTL6	Long Beach	13	10	16	15	54
EVER UNITED	3FMQ6	Seattle	9	4	5	4	22
FAIRLIFT	PEBM	Norfolk	36	20	56	0	112
FAIRMAST	PJLC	Norfolk	0	42	24	19	85
FANAL TRADER	VRUY4	Seattle	57	35	71	46	209
FANTASY	ELKI6	Miami	0	1	0	4	5
FARALLON ISLAND	FARIS	Oakland	146	135	126	102	509
FASCINATION	3EWK9	Miami	10	11	9	11	41
FAUST	WRYX	Jacksonville	27	29	16	2	74
FIDELIO	WQVY	Jacksonville	45	43	44	29	161
FLAMENGO	PPXU	Norfolk	0	26	0	0	26
FLORAL LAKE	3FFA5	Seattle	0	0	0	2	2
FOREST CHAMPION	3FSH3	Seattle	65	2	0	0	67
FRANCES HAMMER	KRGC	Jacksonville	19	12	17	18	66
FRANCES L	C6YE	Baltimore	55	40	41	35	171
FRANKFURT EXPRESS	9VPP	New York City	52	40	33	47	172
G AND C PARANA	LADC2	Long Beach	14	9	29	14	66
GALVESTON BAY	WPKD	Houston	26	42	45	56	169
GANNET ARROW	C6QF5	Seattle	5	5	15	5	30
GEORGE A. SLOAN	WA5307	Chicago	1	0	0	21	22
GEORGE A. STINSON	WCX2417	Cleveland	5	0	7	6	18
GEORGE SCHULTZ	ELPG9	Baltimore	36	15	30	25	106
GEORGE WASHINGTON BRIDGE	JKCF	Long Beach	55	45	49	51	200
GEORGIA RAINBOW II	VRVS5	Jacksonville	0	0	15	68	83
GLOBAL LINK	WWDY	Baltimore	42	76	7	0	125
GLOBAL MARINER	WWXA	Baltimore	31	19	0	0	50
GLOBAL SENTINEL	WRZU	Baltimore	8	0	0	0	8
GLORIOUS SUCCESS	DUHN	Seattle	0	13	0	20	33
GLORIOUS SUN	DVTR	Seattle	0	0	8	2	10
GOLDEN BEAR	NMRY	Oakland	0	0	0	7	7
GOLDEN BELL	3EBK9	Seattle	12	9	5	10	36
GOLDEN GATE	KIOH	Long Beach	0	0	12	75	87
GOLDEN GATE BRIDGE	3FWM4	Seattle	67	76	59	83	285
GRANDEUR OF THE SEAS	ELTQ9	Miami	4	12	9	9	34
GREAT LAND	WFDP	Seattle	21	0	0	47	68
GREEN BAY	KGTH	Long Beach	26	13	17	5	61
GREEN ISLAND	KIBK	New Orleans	0	29	0	4	33
GREEN LAKE	KGTI	Baltimore	31	49	66	71	217
GREEN POINT	WCY4148	New York City	0	3	17	16	36
GREEN RAINIER	3ENI3	Seattle	24	35	27	41	127
GREEN RIDGE	WRYL	Seattle	5	0	0	0	5

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
GRETE MAERSK	OZNF2	New York City	18	16	8	9	51
GROTON	KMJL	Newark	12	7	10	26	55
GUANAJUATO	ELMH8	Jacksonville	22	11	14	1	48
GUAYAMA	WZJG	Jacksonville	3	13	21	21	58
HADERA	ELBX4	Baltimore	34	40	39	14	127
HANDY LOGGER	DZBH	Seattle	1	1	0	0	2
HANJIN BARCELONA	3EXX9	Long Beach	8	0	1	0	9
HANJIN COLOMBO	3FTF4	Oakland	0	6	8	0	14
HANJIN KAOHSIUNG	P3BN8	Seattle	5	6	17	9	37
HANJIN KEELUNG	P3VH7	Houston	64	43	59	28	194
HANJIN LOS ANGELES	3FPQ7	Newark	0	9	8	15	32
HANJIN PORTLAND	3FSB3	Newark	0	14	3	0	17
HANJIN TOKYO	3FZJ3	New York City	8	0	0	0	8
HANSA CALADONIA	DHFN	Norfolk	3	7	0	0	10
HARBOUR BRIDGE	ELJH9	Seattle	2	0	0	0	2
HEIDELBERG EXPRESS	DEDI	Houston	288	0	526	182	996
HEKABE	C6OU2	New Orleans	38	0	0	0	38
HENRY HUDSON BRIDGE	JKLS	Long Beach	84	50	42	85	261
HERBERT C. JACKSON	WL3972	Cleveland	0	0	0	8	8
HOEGH DENE	ELWO7	Norfolk	0	0	0	14	14
HOEGH DYKE	LAGM5	Norfolk	7	0	0	0	7
HOEGH MINERVA	LAGI5	Seattle	13	14	0	0	27
HOEGH MIRANDA	LAGJ5	Norfolk	0	0	15	11	26
HOLIDAY	3FPN5	Long Beach	1	1	0	3	5
HONG KONG SENATOR	DEIP	Seattle	33	42	40	36	151
HONSHU SILVIA	3EST7	Seattle	65	58	65	70	258
HOOD ISLAND	C6LU4	Miami	25	44	38	31	138
HORIZON	ELNG6	Miami	0	1	0	0	1
HOUSTON	FNXB	Houston	54	10	7	24	95
HOUSTON EXPRESS	DLBB	Houston	0	16	58	63	137
HUMACAO	WZJB	Norfolk	28	32	36	38	134
HUMBERGRACHT	PEUQ	Houston	14	0	34	53	101
HUME HIGHWAY	3EJO6	Jacksonville	0	3	47	37	87
HYUNDAI CONTINENTAL	D9RV	Norfolk	0	0	5	1	6
HYUNDAI DISCOVERY	3FFR6	Seattle	18	20	35	40	113
HYUNDAI EXPLORER	3FTG4	Seattle	4	50	38	44	136
HYUNDAI FORTUNE	3FLG6	Seattle	1	15	32	18	66
HYUNDAI FREEDOM	3FFS6	Seattle	7	12	9	14	42
HYUNDAI INDEPENDENCE	3FDY6	Seattle	0	0	1	0	1
HYUNDAI LIBERTY	3FFT6	Seattle	11	7	8	15	41
IMAGINATION	3EWJ9	Miami	0	4	1	12	17
INDEPENDENT LEADER	DHOU	New York City	0	11	70	71	152
INDIAN OCEAN	C6T2063	New York City	14	23	13	18	68
INSPIRATION	3FOA5	Miami	2	2	4	2	10
IRENA ARCTICA	OXTS2	Miami	115	107	127	80	429
ISLA DE CEDROS	3FOA6	Seattle	0	16	25	43	84
ISLAND PRINCESS	GBBM	Long Beach	2	7	0	0	9
ITB BALTIMORE	WXKM	Baltimore	5	0	0	3	8
ITB MOBILE	KXDB	New York City	1	2	0	13	16
ITB NEW YORK	WVDG	Newark	15	28	15	17	75
IVARAN CONDOR	DGGD	Houston	19	12	13	20	64
IVARAN EAGLE	DNEN	Houston	18	41	23	11	93
IVARAN RAVEN	DIGF	Houston	34	24	36	34	128
IVER EXPLORER	PEXV	Houston	13	0	0	0	13
IVER EXPRESS	PEXX	Houston	53	39	51	44	187
IWANUMA MARU	3ESU8	Seattle	16	21	12	16	65
J. DENNIS BONNEY	ELLE2	Baltimore	0	0	0	16	16
J.A.W. IGLEHART	WTP4966	Cleveland	0	0	0	4	4
JACKLYN M.	WCV7620	Chicago	0	0	16	8	24
JACKSONVILLE	WNDG	Baltimore	30	39	36	21	126
JADE ORIENT	ELRY6	Seattle	20	1	4	2	27
JADE PACIFIC	ELRY5	Seattle	0	17	6	11	34
JAHRE SPIRIT	LAWS2	Houston	7	2	1	0	10
JAMES	ELRR6	New Orleans	40	49	48	56	193
JAMES N. SULLIVAN	ELPG8	Baltimore	5	0	0	0	5
JEB STUART	WRGQ	Oakland	0	2	2	66	70
JO CLIPPER	PFEZ	Baltimore	34	8	27	36	105
JOHN G. MUNSON	WE3806	Chicago	0	0	0	83	83
JOIDES RESOLUTION	D5BC	Norfolk	69	22	48	7	146
JOSEPH L. BLOCK	WXY6216	Chicago	1	0	9	16	26
JOSEPH LYKES	ELRZ8	Houston	25	26	32	37	120
JUBILEE	3FPM5	Long Beach	48	36	10	2	96
JULIUS HAMMER	KRGJ	Jacksonville	11	3	9	9	32

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
JUPITER DIAMOND	9VNA	Baltimore	0	43	0	0	43
KAIJIN	3FWI3	Seattle	0	0	0	5	5
KANIN	ELEO2	New Orleans	64	13	14	37	128
KAPITAN BYANKIN	UAGK	Seattle	9	21	26	24	80
KAPITAN KONEV	UAHV	Seattle	22	20	41	59	142
KAPITAN MASLOV	UBRO	Seattle	15	9	24	37	85
KAREN ANDRIE	WBS5272	Chicago	0	0	2	31	33
KATRINE MAERSK	OZLL2	New York City	0	0	0	4	4
KAUAI	WSRH	Long Beach	0	1	8	13	22
KAYE E. BARKER	WCF3012	Cleveland	11	0	2	25	38
KAZIMAH	9KKL	Houston	39	45	0	88	172
KEE LUNG	BHFN	Seattle	0	14	0	7	21
KEN KOKU	3FMN6	Seattle	10	14	1	6	31
KEN SHIN	YJQS2	Seattle	5	4	15	18	42
KENAI	WSNB	Houston	2	6	8	0	16
KENNETH E. HILL	C6FA6	Newark	43	51	44	4	142
KENNETH T. DERR	C6FA3	Newark	63	27	40	0	130
KENNICOTT	WCY2920	Seattle	2	13	0	0	15
KINSMAN INDEPENDENT	WUZ7811	Cleveland	0	0	0	13	13
KNOCK ALLAN	ELOI6	Houston	36	33	24	0	93
KOELN EXPRESS	9VBL	New York City	271	615	447	682	2015
KRISTEN MAERSK	OYDM2	Seattle	0	34	6	14	54
KURE	3FGN3	Seattle	14	23	28	8	73
LEE A. TREGURTHA	WUR8857	Cleveland	7	0	0	19	26
LEGEND OF THE SEAS	ELRR5	New Orleans	5	17	20	15	57
LEISE MAERSK	OXGR2	Oakland	0	11	1	27	39
LEOPARDI	V7AU8	Baltimore	0	0	5	22	27
LIBERTY SPIRIT	WCPU	New Orleans	6	0	3	0	9
LIBERTY STAR	WCBP	New Orleans	44	39	40	8	131
LIBERTY SUN	WCOB	Houston	54	38	4	30	126
LILAC ACE	3FDL4	Long Beach	11	12	76	57	156
LINDA OLDENDORF	ELRR2	Baltimore	24	48	38	50	160
LINDO MAERSK	OWEQ2	Long Beach	0	0	0	49	49
LNG AQUARIUS	WSKJ	Oakland	64	47	56	66	233
LNG CAPRICORN	KHLN	New York City	26	24	12	2	64
LNG LEO	WDZB	New York City	29	49	69	64	211
LNG LIBRA	WDZG	New York City	3	20	8	24	55
LNG TAURUS	WDZW	New York City	21	31	17	2	71
LNG VIRGO	WDZX	New York City	23	62	49	20	154
LOK PRAGATI	ATZS	Seattle	42	0	2	10	54
LONG BEACH	3FOU3	Seattle	0	5	0	10	15
LONG LINES	WATF	Baltimore	28	19	85	21	153
LOOTSGRACHT	PFPT	Houston	20	21	39	40	120
LOUIS MAERSK	OXMA2	Baltimore	0	39	4	31	74
LUCY OLDENDORFF	ELPA2	Long Beach	0	19	34	8	61
LUISE OLDENDORFF	3FOW4	Seattle	16	4	0	0	20
LURLINE	WLVD	Oakland	12	34	45	43	134
LUTJENBURG	ELVF6	Long Beach	48	56	68	41	213
LYKES ADVENTURER	KNFG	Jacksonville	6	4	0	0	10
LYKES CHALLANGER	FNHV	Houston	39	14	21	9	83
LYKES COMMANDER	3ELF9	Baltimore	22	17	12	31	82
LYKES DISCOVERER	WGXO	Houston	29	29	19	57	134
LYKES EXPLORER	WGLA	Houston	62	34	40	7	143
LYKES LIBERATOR	WGXN	Houston	35	21	28	44	128
LYKES NAVIGATOR	WGMJ	Houston	27	16	26	17	86
LYKES PATHFINDER	3EJT9	Baltimore	2	47	20	5	74
M. P. GRACE	ELBG	New Orleans	0	0	3	0	3
M/V FRANCOIS L.D.	FNEQ	Norfolk	6	54	57	8	125
MAASDAM	PFRO	Miami	0	0	2	2	4
MACKINAC BRIDGE	JKES	Long Beach	82	57	71	59	269
MADISON MAERSK	OVJB2	Oakland	13	11	19	24	67
MAERSK BROOKLYN	C6OE8	New York City	65	43	0	0	108
MAERSK CALIFORNIA	WCX5083	Miami	29	0	0	0	29
MAERSK COLORADO	WCX5081	Miami	30	10	2	8	50
MAERSK GANNET	GJLK	Miami	69	6	72	41	188
MAERSK GENOA	DGUC	New York City	24	41	35	34	134
MAERSK GIANT	OU2465	Miami	233	214	222	228	897
MAERSK SANTOS	ELRR4	Baltimore	6	2	0	6	14
MAERSK SEA	S6CW	Seattle	0	0	12	49	61
MAERSK SHETLAND	MSQK3	Miami	6	45	6	0	57
MAERSK SOMERSET	MQVF8	New Orleans	64	27	27	6	124
MAERSK STAFFORD	MRSS9	New Orleans	47	52	58	48	205
MAERSK SUN	S6ES	Seattle	75	39	0	0	114

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
MAERSK SURREY	MRSG8	Houston	56	82	73	48	259
MAERSK TAIKI	9VIG	Baltimore	2	68	0	1	71
MAERSK TENNESSEE	WCX3486	Miami	22	44	0	0	66
MAERSK TEXAS	WCX3249	Miami	0	16	1	0	17
MAGLEBY MAERSK	OUSH2	Newark	3	9	24	5	41
MAHARASHTRA	VTSQ	Seattle	1	3	0	2	6
MAHIMAHI	WHRN	Oakland	60	25	54	51	190
MAIRANGI BAY	GXEW	Long Beach	67	43	68	72	250
MAJESTIC MAERSK	OUJH2	Newark	26	0	35	0	61
MAJESTY OF THE SEAS	LAOI4	Miami	45	36	48	30	159
MANHATTAN BRIDGE	3FWL4	Long Beach	21	62	51	34	168
MANOA	KDBG	Oakland	46	26	23	1	96
MANUKAI	KNLO	Oakland	0	0	1	36	37
MARCHEN MAERSK	OWDQ2	Long Beach	19	9	15	0	43
MAREN MAERSK	OWZU2	Long Beach	16	7	18	12	53
MARGRETHE MAERSK	OYSN2	Long Beach	17	23	20	46	106
MARIE MAERSK	OULL2	Newark	18	17	21	10	66
MARINE CHEMIST	KMCB	Houston	0	0	44	40	84
MARINE COLUMBIA	KLKZ	Oakland	40	24	56	54	174
MARIT MAERSK	OZFC2	Miami	9	19	21	17	66
MATHILDE MAERSK	OUUU2	Long Beach	27	33	25	20	105
MATSONIA	KHRC	Oakland	49	27	49	20	145
MAUI	WSLH	Long Beach	37	40	54	44	175
MAURICE EWING	WLDZ	Newark	3	61	50	22	136
MAYAGUEZ	WZJE	Jacksonville	33	32	33	25	123
MAYVIEW MAERSK	OWEB2	Oakland	17	17	24	14	72
MC-KINNEY MAERSK	OUZW2	Newark	7	12	9	17	45
MEDUSA CHALLENGER	WA4659	Cleveland	5	0	0	34	39
MEKHANIK KALYUZHNIY	UFLO	Seattle	53	45	1	0	99
MEKHANIK MOLDOVANOV	UIKI	Seattle	69	0	1	0	70
MELBOURNE STAR	C6JY6	Newark	41	53	28	36	158
MELVILLE	WECB	Long Beach	38	66	66	48	218
MERCHANT PREMIER	VROP	Houston	25	39	47	29	140
MERCHANT PRINCIPAL	VRIO	Miami	12	6	41	16	75
MERCURY	3FFC7	Miami	0	0	2	0	2
MERCURY ACE	JFMO	Norfolk	0	12	14	35	61
MERLION ACE	9VHJ	Long Beach	3	10	9	7	29
MESABI MINER	WYQ4356	Cleveland	8	0	10	17	35
METEOR	DBBH	Houston	167	168	178	185	698
METTE MAERSK	OXKT2	Long Beach	8	18	13	13	52
MICHIGAN	WRB4141	Chicago	4	5	5	9	23
MIDDLETOWN	WR3225	Cleveland	0	0	3	38	41
MING ASIA	BDEA	New York City	0	7	15	21	43
MING PEACE	ELVR9	Long Beach	6	4	0	0	10
MOKIHANA	WNRD	Oakland	63	36	50	45	194
MOKU PAHU	WBWK	Oakland	80	58	63	26	227
MORELOS	PGBB	Houston	37	40	58	31	166
MORMACSKY	WMBQ	New York City	26	11	19	0	56
MORMACSTAR	KGDF	Houston	36	51	24	22	133
MORMACSUN	WMBK	Norfolk	10	31	16	5	62
MOSEL ORE	ELRE5	Norfolk	25	34	36	0	95
MSC BOSTON	9HGP4	New York City	27	31	38	45	141
MSC NEW YORK	9HIG4	New York City	45	43	55	0	143
MUNKEBO MAERSK	OUNI5	New York City	0	0	0	15	15
MV CONTSHIP ROME	ELVZ6	Norfolk	0	0	0	7	7
MV MIRANDA	3FRO4	Norfolk	0	31	27	0	58
MYRON C. TAYLOR	WA8463	Chicago	0	0	0	6	6
NADA II	ELAV2	Seattle	25	22	32	1	80
NAJA ARCTICA	OXVH2	Miami	2	18	1	0	21
NATHANIEL B. PALMER	WBP3210	Seattle	60	60	46	21	187
NATIONAL DIGNITY	DZRG	Long Beach	11	12	13	6	42
NATIONAL HONOR	DZDI	Long Beach	1	17	4	6	28
NEDLLOYD HOLLAND	KRHX	Houston	47	65	68	38	218
NEDLLOYD MONTEVIDEO	PGAF	Long Beach	21	47	0	30	98
NEDLLOYD RALEIGH BAY	PHKG	Houston	0	3	2	0	5
NEGO LOMBOK	DXQC	Seattle	0	24	30	14	68
NELVANA	YJWZ7	Baltimore	26	47	11	0	84
NEPTUNE ACE	JFLX	Long Beach	0	0	0	23	23
NEPTUNE RHODONITE	ELJP4	Long Beach	23	15	12	26	76
NEW CARISSA	3ELY7	Seattle	71	12	0	0	83
NEW HORIZON	WKWB	Long Beach	10	14	48	0	72
NEW NIKKI	3FHG5	Seattle	36	43	53	61	193
NEWARK BAY	WPKS	Houston	51	49	49	61	210

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
NEWPORT BRIDGE	3FGH3	Oakland	22	7	14	14	57
NIEUW AMSTERDAM	PGGQ	Long Beach	0	0	0	12	12
NOAA SHIP ALBATROSS IV	WMVF	Norfolk	28	33	101	92	254
NOAA SHIP DELAWARE II	KNBD	New York City	12	68	93	101	274
NOAA SHIP FERREL	WTEZ	Norfolk	6	0	12	23	41
NOAA SHIP KA'IMIMOANA	WTEU	Seattle	29	51	0	15	95
NOAA SHIP MCARTHUR	WTEJ	Seattle	0	28	0	13	41
NOAA SHIP MILLER FREEMAN	WTDM	Seattle	0	0	0	127	127
NOAA SHIP OREGON II	WTDO	New Orleans	64	72	75	46	257
NOAA SHIP RAINIER	WTEF	Seattle	0	0	0	27	27
NOAA SHIP RONALD H BROWN	WTEC	New Orleans	40	64	74	37	215
NOAA SHIP T. CROMWELL	WTDF	Seattle	13	82	86	97	278
NOAA SHIP WHITING	WTEW	Baltimore	0	8	0	30	38
NOBEL STAR	KRPP	Houston	12	11	12	0	35
NOL STENO	ZCBD4	New York City	3	6	14	36	59
NOLIZWE	MQLN7	New York City	113	18	105	91	327
NOMZI	MTQU3	Baltimore	58	81	58	90	287
NOORDAM	PGHT	Miami	4	0	0	0	4
NORASIA SHANGHAI	DNHS	New York City	0	0	21	10	31
NORD JAHRE TRANSPORTER	LACF4	Baltimore	8	3	5	6	22
NORDMAX	P3YS5	Seattle	66	50	72	84	272
NORDMORITZ	P3YR5	Seattle	34	77	72	15	198
NORTHERN LIGHTS	WFJK	New Orleans	0	0	0	11	11
NORWAY	C6CM7	Miami	0	0	0	36	36
NORWEGIAN WIND	C6LG6	Miami	19	23	5	11	58
NTABENI	3EGR6	Houston	0	40	38	14	92
NUERNBERG EXPRESS	9VBK	Houston	713	649	704	711	2777
NUEVO LEON	XCKX	Houston	17	15	17	11	60
NYK SPRINGTIDE	S6CZ	Seattle	6	0	0	0	6
NYK STARLIGHT	3FUX6	Long Beach	39	59	31	40	169
NYK SUNRISE	3FYZ6	Seattle	49	31	33	46	159
NYK SURFWIND	ELOT3	Seattle	0	0	0	23	23
OCEAN BELUGA	3FEI6	Jacksonville	16	15	2	5	38
OCEAN CITY	WCYR	Houston	50	32	55	35	172
OCEAN HARMONY	3FRX6	Seattle	7	3	1	0	11
OCEAN LAUREL	3FLX4	Seattle	2	0	0	0	2
OCEAN PALM	3FDO7	Seattle	7	35	45	69	156
OCEAN SERENE	DURY	Seattle	38	0	47	0	85
OGLEBAY NORTON	WAQ3521	Cleveland	10	0	10	32	52
OLEANDER	PJJU	Newark	23	14	18	25	80
OLIVEBANK	3ETQ5	Baltimore	1	0	0	0	1
OLYMPIA	V7AZ4	Baltimore	71	80	78	57	286
OLYMPIAN HIGHWAY	3FSH4	Seattle	0	0	10	14	24
OOCL AMERICA	ELSM7	Oakland	30	31	42	36	139
OOCL CALIFORNIA	ELSA4	Seattle	41	29	37	51	158
OOCL CHINA	ELSU8	Long Beach	58	53	61	58	230
OOCL ENVOY	ELNV7	Seattle	29	23	35	40	127
OOCL FAIR	ELFV2	Long Beach	17	17	31	38	103
OOCL FAITH	ELFU9	Norfolk	44	38	70	42	194
OOCL FIDELITY	ELFV8	Long Beach	13	18	37	11	79
OOCL FORTUNE	ELFU8	Norfolk	16	37	28	13	94
OOCL FREEDOM	VRCV	Norfolk	47	65	46	56	214
OOCL FRIENDSHIP	ELFV3	Long Beach	18	28	16	32	94
OOCL HONG KONG	VRVA5	Oakland	34	26	16	13	89
OOCL INNOVATION	WPWH	Houston	35	43	53	50	181
OOCL INSPIRATION	KRPB	Houston	52	31	55	55	193
OOCL JAPAN	ELSU6	Long Beach	72	61	83	56	272
ORANGE BLOSSOM	ELEI6	Newark	0	0	23	22	45
ORIANA	GVSN	Miami	73	4	43	25	145
ORIENTAL ROAD	3FXT6	Houston	25	74	23	16	138
ORIENTE GRACE	3FHT4	Seattle	28	15	27	5	75
ORIENTE HOPE	3ETH4	Seattle	23	19	33	5	80
ORIENTE NOBLE	3FVF5	Seattle	35	11	0	0	46
ORIENTE PRIME	3FOU4	Seattle	11	0	0	0	11
OURO DO BRASIL	ELPP9	Baltimore	0	6	0	0	6
OVERSEAS CHICAGO	KBCF	Oakland	2	2	4	0	8
OVERSEAS HARRIET	WRFJ	Houston	0	2	5	0	7
OVERSEAS JOYCE	WUQL	Jacksonville	64	64	59	29	216
OVERSEAS MARILYN	WFQB	Houston	3	4	1	6	14
OVERSEAS NEW ORLEANS	WFKW	Houston	4	14	32	43	93
OVERSEAS NEW YORK	WMCK	Houston	28	30	19	0	77
OVERSEAS OHIO	WJBG	Oakland	15	15	0	1	31
P & O NEDLLOYD BUENOS AIRES	PGEC	Houston	14	22	15	20	71

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
P & O NEDLLOYD VERA CRUZ	PGFE	Houston	20	5	17	8	50
P&O NEDLLOYD CHILE	DVRA	New York City	13	7	3	0	23
P&O NEDLLOYD HOUSTON	PGEB	Houston	0	0	31	49	80
P&O NEDLLOYD LOS ANGELES	PGDW	Long Beach	49	55	64	38	206
P&O NEDLLOYD TEXAS	ZCBF6	Houston	54	57	71	72	254
PACDREAM	ELQO6	Seattle	0	15	27	3	45
PACDUKE	A8SL	Seattle	14	3	0	0	17
PACIFIC ARIES	ELJQ2	Seattle	0	44	0	0	44
PACIFIC HIRO	3FOY5	Seattle	39	0	0	0	39
PACIFIC PRINCESS	GBCF	New York City	1	16	8	1	26
PACIFIC SELESA	DVCK	Seattle	16	27	53	1	97
PACIFIC SENATOR	ELTY6	Long Beach	53	2	2	62	119
PACKING	ELBX3	Seattle	5	8	14	0	27
PACOCEAN	ELJE3	Seattle	10	34	48	10	102
PACPRINCE	ELED7	Seattle	11	8	1	15	35
PACPRINCESS	ELED8	Houston	6	14	0	0	20
PACROSE	YJQK2	Seattle	0	7	2	0	9
PAUL BUCK	KDGR	Houston	13	8	0	0	21
PAUL R. TREGURTHA	WYR4481	Cleveland	0	0	10	28	38
PEGASUS HIGHWAY	3FMA4	New York City	16	0	17	7	40
PEGGY DOW	PJOY	Long Beach	51	36	54	28	169
PHILIP R. CLARKE	WE3592	Chicago	0	0	11	79	90
PIERRE FORTIN	CG2678	Norfolk	0	0	0	8	8
PINO GLORIA	3EZW7	Seattle	6	0	0	12	18
PISCES EXPLORER	MWQD5	Long Beach	13	26	6	59	104
POLYNESIA	D5NZ	Long Beach	55	66	92	95	308
POTOMAC TRADER	WXBZ	Houston	27	23	17	30	97
PRESIDENT ADAMS	WRYW	Oakland	54	60	61	58	233
PRESIDENT GRANT	WCY2098	Long Beach	24	43	30	15	112
PRESIDENT HOOVER	WCY2883	Houston	21	42	34	35	132
PRESIDENT JACKSON	WRYC	Oakland	49	34	48	14	145
PRESIDENT KENNEDY	WRYE	Oakland	38	32	25	29	124
PRESIDENT POLK	WRYD	Oakland	0	0	2	67	69
PRESIDENT TRUMAN	WNDP	Oakland	60	62	55	40	217
PRESIDENT WILSON	WCY3438	Long Beach	21	5	17	13	56
PRESQUE ISLE	WZE4928	Chicago	3	0	0	68	71
PRINCE OF OCEAN	3ECO9	Seattle	0	0	0	24	24
PRINCE WILLIAM SOUND	WSDX	Long Beach	1	2	1	0	4
PRINCESS OF SCANDINAVIA	OWEN2	Miami	90	81	129	110	410
PROJECT ARABIA	PJKP	Miami	25	46	20	54	145
PROJECT ORIENT	PJAG	Baltimore	52	38	46	32	168
PUDONG SENATOR	DQVI	Seattle	25	61	65	68	219
PUSAN SENATOR	DQVG	Seattle	22	11	7	16	56
QUEEN ELIZABETH 2	GBTT	New York City	64	11	43	47	165
QUEEN OF SCANDINAVIA	OUSE6	Miami	38	32	36	45	151
QUEENSLAND STAR	C6JZ3	Houston	67	56	53	61	237
R.J. PFEIFFER	WRJP	Long Beach	18	24	22	11	75
RAINBOW BRIDGE	3EYX9	Long Beach	50	98	79	70	297
RAYMOND E. GALVIN	ELCO5	Oakland	1	0	0	0	1
REGINA MAERSK	OZIN2	New York City	5	16	3	20	44
REPULSE BAY	MQYA3	Houston	9	3	0	3	15
RESOLUTE	KFDZ	Norfolk	25	15	0	24	64
RHAPSODY OF THE SEAS	LAZK4	Miami	14	7	4	0	25
RICHARD G MATTHIESEN	WLBV	Jacksonville	0	0	0	2	2
RICHARD REISS	WBF2376	Cleveland	0	0	0	32	32
RIO APURE	ELUG7	Miami	35	52	55	62	204
ROBERT E. LEE	KCRD	New Orleans	20	0	7	13	40
ROGER BLOUGH	WZP8164	Chicago	0	0	2	36	38
ROGER REVELLE	KAOU	New Orleans	31	24	0	5	60
ROSINA TOPIC	ELAJ6	Seattle	0	35	45	0	80
ROYAL ETERNITY	DUXW	Norfolk	30	9	48	28	115
ROYAL PRINCESS	GBRP	Long Beach	32	34	52	49	167
RUBIN BONANZA	3FNV5	Seattle	0	54	49	4	107
RUBIN KOBE	DYZM	Seattle	11	14	44	31	100
RUBIN PEARL	YJQA8	Seattle	51	46	57	73	227
RUBIN STELLA	3FAP5	Seattle	0	0	1	53	54
RYNDAM	PHFV	Miami	0	21	44	19	84
SAM HOUSTON	KDGA	Houston	0	22	0	28	50
SAMUEL GINN	C6OB	Oakland	42	34	33	0	109
SAMUEL H. ARMACOST	C6FA2	Oakland	0	7	15	7	29
SAMUEL RISLEY	CG2960	Norfolk	192	156	140	150	638
SAN ISIDRO	ELVG8	Norfolk	24	18	27	9	78
SAN MARCOS	ELND4	Jacksonville	0	26	29	1	56

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
SAN PEDRO	DHHO	Norfolk	63	28	6	40	137
SANKO LAUREL	3EXQ3	Seattle	0	4	0	0	4
SANTA CHRISTINA	3FAE6	Seattle	10	10	1	7	28
SANTORIN 2	P3ZL4	Seattle	52	46	55	0	153
SARAMATI	9VIW	Baltimore	0	37	0	0	37
SC HORIZON	ELOC8	New York City	15	0	32	5	52
SCHACKENBORG	OYUY4	Houston	0	0	0	37	37
SEA FOX	KBGK	Jacksonville	53	7	0	0	60
SEA INITIATIVE	DEBB	Houston	58	51	22	46	177
SEA LION	KJLV	Jacksonville	33	17	30	3	83
SEA LYNX	DGOO	Jacksonville	40	57	75	62	234
SEA MARINER	J8FF9	Miami	67	7	1	23	98
SEA PRINCESS	KRCP	New Orleans	0	29	0	0	29
SEA RACER	ELQI8	Jacksonville	39	35	66	53	193
SEA WISDOM	3FUO6	Seattle	23	49	63	44	179
SEA-LAND CHARGER	V7AY2	Long Beach	34	43	29	37	143
SEA-LAND EAGLE	V7AZ8	Long Beach	10	21	34	28	93
SEA/LAND VICTORY	DIDY	New York City	0	0	0	26	26
SEABOARD FLORIDA	3FBW5	Miami	13	12	23	25	73
SEABOARD UNIVERSE	ELRU3	Miami	15	16	18	2	51
SEABOURN PRIDE	LALT2	Miami	6	3	0	0	9
SEABREEZE I	3FGV2	Miami	0	0	1	1	2
SEALAND ANCHORAGE	KGTX	Seattle	48	59	59	64	230
SEALAND ARGENTINA	DGVN	Jacksonville	37	30	6	8	81
SEALAND ATLANTIC	KRLZ	Norfolk	52	28	29	24	133
SEALAND CHALLENGER	WZJC	Newark	57	16	0	19	92
SEALAND CHAMPION	V7AM9	Oakland	37	17	24	67	145
SEALAND COMET	V7AP3	Oakland	2	22	48	14	86
SEALAND CONSUMER	WCHF	Houston	28	25	42	50	145
SEALAND CRUSADER	WZJF	Jacksonville	33	22	31	50	136
SEALAND DEFENDER	KGJB	Oakland	0	0	28	33	61
SEALAND DEVELOPER	KHRH	Long Beach	0	0	0	3	3
SEALAND DISCOVERY	WZJD	Jacksonville	0	37	45	38	120
SEALAND ENDURANCE	KGJX	Long Beach	5	33	31	20	89
SEALAND ENTERPRISE	KRGB	Oakland	71	69	57	72	269
SEALAND EXPEDITION	WPGJ	Jacksonville	41	42	49	61	193
SEALAND EXPLORER	WGJF	Long Beach	17	43	0	25	85
SEALAND FREEDOM	V7AM3	Houston	42	13	31	26	112
SEALAND HAWAII	KIRF	Seattle	34	7	48	45	134
SEALAND INDEPENDENCE	WGJC	Long Beach	38	38	23	44	143
SEALAND INNOVATOR	WGKF	Oakland	27	14	17	18	76
SEALAND INTEGRITY	WPVD	Norfolk	103	12	24	79	218
SEALAND INTREPID	V7BA2	Norfolk	8	16	24	26	74
SEALAND KODIAK	KGTZ	Seattle	44	32	47	21	144
SEALAND LIBERATOR	KHRP	Oakland	51	6	56	17	130
SEALAND MARINER	V7AM5	Houston	24	31	24	21	100
SEALAND MERCURY	V7AP6	Oakland	6	30	14	10	60
SEALAND METEOR	V7AP7	Long Beach	37	7	1	8	53
SEALAND NAVIGATOR	WPGK	Long Beach	57	54	66	30	207
SEALAND PACIFIC	WSRL	Long Beach	45	47	51	66	209
SEALAND PATRIOT	KHRF	Oakland	40	39	39	46	164
SEALAND PERFORMANCE	KRPD	Houston	31	33	53	56	173
SEALAND PRODUCER	WJBJ	Long Beach	18	55	66	51	190
SEALAND QUALITY	KRNJ	Jacksonville	23	30	37	34	124
SEALAND RACER	V7AP8	Long Beach	9	0	0	0	9
SEALAND RELIANCE	WFLH	Long Beach	76	62	52	41	231
SEALAND SPIRIT	WFLG	Oakland	30	43	51	20	144
SEALAND TACOMA	KGTY	Seattle	30	29	14	11	84
SEALAND TRADER	KIRH	Oakland	59	38	54	63	214
SEALAND VOYAGER	KHRK	Long Beach	32	47	72	47	198
SEARIVER BATON ROUGE	WAFA	Oakland	4	8	13	9	34
SEARIVER BENICIA	KPKL	Long Beach	2	0	0	0	2
SEARIVER LONG BEACH	WHCA	Long Beach	8	8	1	0	17
SEARIVER NORTH SLOPE	KHLQ	Oakland	11	14	18	11	54
SENATOR	V7AY7	Miami	0	1	24	0	25
SENSATION	3ESE9	Miami	0	11	11	4	26
SETO BRIDGE	JMQY	Oakland	34	53	63	60	210
SEVEN OCEAN	3EZB8	Seattle	28	12	0	0	40
SEWARD JOHNSON	WST9756	Miami	0	57	34	39	130
SHIRAOI MARU	3ECM7	Seattle	50	34	24	6	114
SIDNEY STAR	C6JY7	Houston	54	36	70	80	240
SINCERE SUCCESS	VRUC5	Seattle	0	1	0	0	1
SINGA STAR	9VNF	Seattle	0	0	43	39	82

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
SKAUBRYN	LAJV4	Seattle	76	27	39	10	152
SKAUGRAN	LADB2	Seattle	7	0	8	6	21
SKOGAFOSS	V2QT	Norfolk	0	0	0	2	2
SKS TANA	LAZI4	Norfolk	1	0	0	0	1
SNOW CRYSTAL	C6ID8	New York City	49	62	69	78	258
SOKOLICA	ELIG5	Baltimore	8	18	6	7	39
SOL DO BRASIL	ELQQ4	Baltimore	0	0	36	41	77
SOLAR WING	ELJS7	Jacksonville	77	27	82	86	272
SONG OF AMERICA	LENA3	Miami	12	11	3	0	26
SONORA	XCTJ	Houston	29	9	35	32	105
SOUTH FORTUNE	3FJC6	Seattle	16	0	41	41	98
SOVEREIGN OF THE SEAS	LAEB2	Miami	35	20	3	0	58
ST BLAIZE	J8FO	Norfolk	52	22	49	20	143
STAR ALABAMA	LAVU4	Baltimore	25	22	31	23	101
STAR AMERICA	LAVV4	Jacksonville	6	0	0	9	15
STAR DOVER	LAEP4	Seattle	27	0	8	15	50
STAR EVVIVA	LAHE2	Jacksonville	3	14	1	2	20
STAR FUJI	LAVX4	Seattle	21	22	31	22	96
STAR GEIRANGER	LAKQ5	Norfolk	0	0	0	19	19
STAR GRAN	LADR4	Long Beach	5	16	17	25	63
STAR HARDANGER	LAXD4	Baltimore	0	4	0	0	4
STAR HARMONIA	LAGB5	Baltimore	8	57	39	26	130
STAR HERDLA	LAVD4	Baltimore	12	19	32	1	64
STAR SKARVEN	LAJY2	Miami	41	25	37	21	124
STAR TRONDANGER	LAQQ2	Baltimore	7	7	4	5	23
STATENDAM	PHSG	Miami	1	7	8	27	43
STELLAR KOHINOOR	3FFG8	Seattle	10	19	15	8	52
STEPHAN J	V2JN	Miami	102	87	100	106	395
STEWART J. CORT	WYZ3931	Chicago	7	0	6	80	93
STONEWALL JACKSON	KDDW	New Orleans	10	4	41	0	55
STRONG CAJUN	KALK	Norfolk	10	23	31	15	79
SUGAR ISLANDER	KCKB	Houston	11	5	22	0	38
SUN DANCE	3ETQ8	Seattle	0	0	0	11	11
SUNBELT DIXIE	D5BU	Baltimore	9	15	12	22	58
SUNDA	ELPB8	Houston	8	3	68	50	129
SUSAN W. HANNAH	WAH9146	Chicago	0	2	24	2	28
SVEN OLTMANN	V2JP	Miami	13	24	19	24	80
SWAN ARROW	C6CN8	Baltimore	13	0	0	0	13
TAI HE	BOAB	Long Beach	43	40	39	53	175
TAIHO MARU	3FMP6	Seattle	72	80	49	38	239
TAIKO	LAQT4	New York City	1	4	0	0	5
TAKASAGO	LACR5	Jacksonville	7	5	0	0	12
TAMPA	LMWO3	Long Beach	1	0	0	0	1
TAMPERE	LAOP2	Norfolk	38	18	39	25	120
TANABATA	LAZO4	Baltimore	28	2	0	0	30
TAPIOLA	LAOQ2	Norfolk	32	0	0	0	32
TAUSALA SAMOA	V2KS	Seattle	0	0	0	2	2
TECO TRADER	KSDF	New Orleans	0	0	33	5	38
TEQUI	3FDZ5	Seattle	22	23	33	12	90
TEXAS	LMWR3	Baltimore	0	0	30	3	33
THORKIL MAERSK	MSJX8	Miami	55	50	38	55	198
THORNHILL	YJZU9	New Orleans	4	6	0	0	10
TMM MEXICO	XCMG	Houston	46	50	50	17	163
TMM OAXACA	ELUA5	Houston	34	44	32	60	170
TOBIAS MAERSK	MSJY8	Long Beach	28	31	17	0	76
TOKIO EXPRESS	9VUY	Long Beach	14	1	0	0	15
TORM FREYA	ELVY8	Norfolk	46	10	25	29	110
TOWER BRIDGE	ELJL3	Seattle	17	13	13	13	56
TRADE APOLLO	VRUN7	New York City	16	28	44	22	110
TRADE COSMOS	VRUQ2	Miami	5	0	0	0	5
TRANSWORLD BRIDGE	ELJJ5	Seattle	56	53	37	17	163
TRENT	ELSM2	New York City	1	0	0	0	1
TRINITY	WRGL	Houston	13	2	0	0	15
TRITON	WTU2310	Chicago	0	0	39	55	94
TROJAN STAR	C6OD7	Baltimore	60	30	32	32	154
TROPIC LURE	J8PD	Miami	0	2	1	0	3
TROPIC SUN	3EZK9	New Orleans	14	15	17	21	67
TROPIC TIDE	3FGQ3	Miami	54	51	47	54	206
TROPICAL DAWN	ELTK9	Baltimore	17	0	0	0	17
TROPICALE	ELBM9	New Orleans	1	4	2	1	8
TUI PACIFIC	P3GB4	Seattle	40	38	42	71	191
TULSIDAS	ATUJ	Norfolk	5	1	3	3	12
TURMOIL	9VGL	New York City	0	0	0	9	9

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SHIP NAME	CALL	PORT	JAN	FEB	MAR	APR	TOTAL
USCGC ACACIA (WLB406)	NODY	Chicago	20	1	1	0	22
USCGC ACTIVE WMEC 618	NRTF	Seattle	0	1	0	0	1
USCGC ALERT (WMEC 630)	NZVE	Seattle	0	1	0	3	4
USCGC BRAMBLE (WLB 392)	NODK	Cleveland	0	0	0	1	1
USCGC DEPENDABLE	NOWK	Baltimore	3	0	0	0	3
USCGC DURABLE (WMEC 628)	NRUN	Houston	3	1	1	11	16
USCGC MACKINAW	NRKP	Chicago	4	1	14	14	33
USCGC MELLON (WHEC 717)	NMEL	Seattle	20	34	16	0	70
USCGC MIDGETT (WHEC 726)	NHWR	Seattle	3	0	0	0	3
USCGC MOHAWK WMEC 913	NRUF	Jacksonville	0	1	0	0	1
USCGC MORGENTHAU	NDWA	Oakland	1	0	0	0	1
USCGC PLANETREE	NRPY	Seattle	0	9	0	0	9
USCGC POLAR SEA__(WAGB 1	NRUO	Seattle	36	96	115	132	379
USCGC POLAR STAR (WAGB 1	NBTM	Seattle	1	0	0	0	1
USCGC RELIANCE WMEC 615	NJPJ	Miami	1	0	0	0	1
USCGC STORIS (WMEC 38)	NRUC	Seattle	1	0	0	0	1
USCGC SUNDEW (WLB 404)	NODW	Chicago	0	0	5	3	8
USNS BELLATRIX	NHLL	Houston	0	4	13	0	17
USNS BOWDITCH	NWSW	New Orleans	5	0	0	4	9
USNS GUS W. DARNELL	KCDK	Houston	19	6	0	0	25
USNS HENSON	NENB	New Orleans	7	0	3	29	39
USNS SATURN T-AFS-10	NADH	Norfolk	0	0	13	1	14
USNS SIOUX	NJOV	Oakland	47	22	0	0	69
USNS SUMNER	NZAU	New Orleans	0	1	1	0	2
VALIANT	WXCA	New Orleans	0	0	1	26	27
VEGA	9VJS	Houston	27	23	41	18	109
VICTORIA	GBBA	Miami	0	0	0	1	1
VIRGINIA	3EBW4	Seattle	18	32	33	24	107
VISION	LAKS5	Seattle	31	16	0	0	47
WAARDRECHT	S6BR	Seattle	50	17	31	37	135
WECOMA	WSD7079	Seattle	11	0	1	20	32
WESTERN BRIDGE	C6JQ9	Baltimore	92	37	75	51	255
WESTWARD	WZL8190	Miami	3	2	12	36	53
WESTWARD VENTURE	KHJB	Seattle	35	0	8	47	90
WESTWOOD ANETTE	DVDM	Seattle	44	56	46	72	218
WESTWOOD BELINDA	C6CE7	Seattle	33	41	40	41	155
WESTWOOD BORG	LAON4	Seattle	62	51	53	61	227
WESTWOOD BREEZE	LAOT4	Seattle	0	16	69	39	124
WESTWOOD CLEO	C6OQ8	Seattle	35	38	41	65	179
WESTWOOD JAGO	C6CW9	Seattle	37	47	48	51	183
WESTWOOD MARIANNE	C6QD3	Seattle	63	44	66	45	218
WIELDRECHT	S6BO	Seattle	9	52	5	0	66
WILFRED SYKES	WC5932	Chicago	4	0	7	13	24
WILLIAM E. CRAIN	ELOR2	Oakland	0	0	12	4	16
WILLIAM E. MUSSMAN	D5OE	Seattle	36	9	0	0	45
WILSON	WNPD	New Orleans	7	4	22	40	73
WOENSDRECHT	S6BP	Long Beach	9	18	23	26	76
WORLD ISLAND	3FDH4	Long Beach	0	30	0	34	64
WORLD SPIRIT	ELWG7	Seattle	0	0	34	0	34
YUCATAN	XCUY	Houston	35	25	24	44	128
YURIY OSTROVSKIY	UAGJ	Seattle	87	33	36	48	204
ZIM AMERICA	4XGR	Newark	53	27	24	21	125
ZIM ASIA	4XFB	New Orleans	10	11	36	27	84
ZIM ATLANTIC	4XFD	New York City	35	37	17	48	137
ZIM CANADA	4XGS	Norfolk	26	29	43	44	142
ZIM CHINA	4XFQ	New York City	30	35	58	17	140
ZIM EUROPA	4XFN	New York City	30	76	61	28	195
ZIM HONG KONG	4XGW	Houston	0	0	25	17	42
ZIM IBERIA	4XFP	New York City	49	14	25	68	156
ZIM ISRAEL	4XGX	New Orleans	32	33	29	0	94
ZIM ITALIA	4XGT	New Orleans	56	14	13	1	84
ZIM JAMAICA	4XFE	New York City	68	27	20	27	142
ZIM JAPAN	4XGV	Baltimore	12	18	47	21	98
ZIM KOREA	4XGU	Miami	5	3	11	10	29
ZIM MONTEVIDEO	V2AG7	Norfolk	6	8	6	63	83
ZIM PACIFIC	4XFC	New York City	24	40	43	13	120
ZIM SANTOS	ELRJ6	Baltimore	54	22	33	35	144
ZIM U.S.A.	4XFO	New York City	26	31	25	15	97

Totals	Jan	22864
	Feb	21512
	Mar	25419
	Apr	24703
Period Total		94498

Buoy Climatological Data Summary —

January through April 1999

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.

January 1999

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)
41001	34.7N	072.6W	743	16.8	21.2	2.3	5.5	03/16	15.5	W	35.9	24/22	1021.7
41002	32.3N	075.2W	741	18.9	22.6	2.0	5.0	24/20	13.1	SE	31.1	03/14	1022.0
41004	32.5N	079.1W	742	16.5	20.6	1.5	5.2	03/05	12.9	SW	30.3	03/01	1021.2
41008	31.4N	080.9W	742	13.6		1.0	3.0	31/12	9.2	NW	27.6	04/07	1021.7
41009	28.5N	080.2W	1485	21.0	23.4	1.5	4.5	31/23	12.5	SE	40.6	03/07	1021.3
41010	28.9N	078.6W	1483	21.4	24.2	1.8	4.4	31/19	12.8	SE	31.3	03/09	1021.6
42001	25.9N	089.6W	741			1.4	3.9	02/22	12.9	SE	34.6	02/20	1019.0
42003	25.9N	085.9W	742	21.9	25.0	1.6	3.9	03/05	14.7	E	35.0	03/00	1019.0
42007	30.1N	088.8W	743	14.1	16.1	0.7	2.7	23/04	10.1	SE	28.8	23/03	1020.5
42020	26.9N	096.7W	744	19.3	21.6				14.6	SE	31.9	23/01	1017.2
42035	29.2N	094.4W	744	14.8	15.7	1.0	2.6	22/10	11.2	SE	30.9	02/17	1019.2
42036	28.5N	084.5W	743	18.0	20.7	1.1	2.6	10/08	12.7	E	28.6	03/00	1020.4
42039	28.8N	086.0W	743	18.5	21.5	1.3	3.6	23/07	13.8	SE	31.3	31/07	1021.1
42040	29.2N	088.2W	740	17.9	21.5	1.3	4.1	23/05	12.3	SE	26.8	23/02	1020.1
44004	38.5N	070.7W	743	10.4	15.2	2.5	6.9	03/22	16.2	W	31.5	03/18	1021.7
44005	42.9N	068.9W	733	0.8	5.3	2.2	5.8	04/01	17.6	W	35.2	03/22	1019.8
44007	43.5N	070.1W	742	-2.1		1.3	5.4	15/21	14.4	SW	32.8	19/03	1020.3
44008	40.5N	069.4W	700	4.9	7.3	2.4	5.9	04/00	16.4	W	32.8	03/22	1020.0
44009	38.5N	074.7W	743	5.3	7.6	1.5	4.7	03/16	14.4	S	30.9	10/00	1021.4
44011	41.1N	066.6W	743	4.2	6.0	2.6	6.1	04/06	16.3	W	36.1	04/02	1021.0
44013	42.4N	070.7W	740	0.3	4.0	1.1	4.0	03/21	14.6	W	35.8	03/20	1019.5
44014	36.6N	074.8W	739	9.1	10.6	1.6	5.5	03/15	12.9	SW	26.8	03/14	1021.1
44025	40.3N	073.2W	98	1.1	6.6	1.1	2.3	31/06	13.0	N	26.2	31/03	1028.5
46001	56.3N	148.2W	740	2.0	4.3	3.6	7.7	12/22					1001.7
46005	46.1N	131.0W	743	8.1	9.0	3.7	8.9	16/12	16.0	SW	39.6	25/23	1014.8
46006	40.8N	137.5W	665	11.1	12.0	3.7	10.6	17/23	17.5	W	39.4	17/22	1019.6
46011	34.9N	120.9W	743	12.3	13.2	2.6	6.7	27/02	9.9	NW	27.2	31/05	1019.7
46012	37.4N	122.7W	738	10.7	10.9	2.5	5.8	26/17					1019.9
46013	38.2N	123.3W	740	10.1	10.8	2.6	6.5	26/17	10.9	NW	28.0	31/17	1020.7
46014	39.2N	124.0W	744	10.0		2.9	7.0	26/16	10.8	SE	28.8	31/14	1020.5
46022	40.7N	124.5W	743	9.9	10.4	3.1	7.9	27/02	13.4	N	36.7	22/18	1019.7
46023	34.7N	121.0W	740	12.1	13.0	2.5	6.3	27/17	12.4	NW	28.2	12/23	1020.3
46025	33.8N	119.1W	741	13.8	14.3	1.3	2.5	20/02	7.1	W	25.3	21/16	1019.5
46026	37.8N	122.8W	456	10.2	10.1	1.9	5.6	19/00	9.5	NW	20.6	09/06	1021.6
46027	41.8N	124.4W	582	9.6	9.8	3.4	7.1	26/21	13.9	S	33.2	17/23	1017.8
46028	35.7N	121.9W	743	11.4	11.8	2.8	7.7	27/01	11.4	NW	27.4	01/00	1019.7
46029	46.1N	124.5W	679	8.4	9.3	3.4	9.2	29/14	14.8	S	38.3	29/17	1014.5
46030	40.4N	124.5W	732	9.9	10.3	1.8	3.0	01/01	15.3	N	35.4	22/18	1019.9

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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)
46035	56.9N	177.8W	727	-1.0	2.4	3.7	9.9	31/17					1003.2
46042	36.7N	122.4W	743	11.1	11.7	2.8	7.7	26/21	11.3	NW	26.4	30/18	1020.3
46045	33.8N	118.5W	742	13.4	14.0	1.0	2.1	19/23	4.6	E	16.5	26/16	1018.8
46050	44.6N	124.5W	743	8.8	9.6	3.3	9.0	29/18	13.8	S	40.6	29/17	1017.8
46053	34.2N	119.8W	738	13.2	13.7	1.5	3.0	27/04	8.0	W	25.5	16/17	1019.2
46054	34.3N	120.4W	735	12.6	12.9	2.4	6.1	19/07	13.2	NW	29.7	01/02	1018.9
46059	38.0N	130.0W	742		13.3	3.4	9.6	26/14	14.4	NW	35.6	26/08	
46060	60.6N	146.8W	1457	0.4	5.4				12.0	NW	34.2	13/09	1002.8
46061	60.2N	146.8W	1482	0.8	5.5	1.9	7.1	13/20	16.6	N	36.9	13/12	1002.0
46062	35.1N	121.0W	734	12.1	12.7	2.6	6.8	27/01	10.9	NW	29.7	31/08	1019.3
46063	34.2N	120.7W	741	12.4	12.9	2.7	7.0	27/03	12.6	NW	26.8	01/03	1018.8
51001	23.4N	162.3W	733	22.7	23.6	3.2	8.4	01/02	12.6	E	29.9	22/07	1018.0
51002	17.2N	157.8W	741	24.2	25.2	2.7	4.7	01/16	14.7	NE	25.3	23/13	1015.8
51003	19.2N	160.7W	742	24.1	25.2	2.6	6.1	01/09	12.0	NE	23.8	25/16	1016.3
51004	17.4N	152.5W	741	23.8	24.6	2.7	5.0	26/09	14.0	E	26.2	25/05	1016.5
51028	00.0N	153.9W	725	23.9	23.7	2.1	3.3	03/22	13.0	NE	19.8	20/04	1010.1
ABAN6	44.3N	075.9W	744	-7.1	0.9				6.3	SW	21.9	28/09	1020.8
ALSN6	40.4N	073.8W	708	1.8		1.1	4.4	03/15	18.1	W	44.6	03/14	1021.3
BLIA2	60.8N	146.9W	1459	-1.3					19.7	N	46.0	29/13	1004.0
BURL1	28.9N	089.4W	743	14.9					14.6	SE	42.1	02/15	1019.8
BUZM3	41.4N	071.0W	744	1.3					18.6	W	50.0	03/20	1021.9
CARO3	43.3N	124.4W	741	8.4					13.3	S	44.6	20/20	1019.4
CDRF1	29.1N	083.0W	742	10.1					6.7	NE	21.6	31/23	1021.6
CHLV2	36.9N	075.7W	741	7.7	8.4	1.0	3.8	03/12	14.4	S	31.9	15/13	1022.0
CLKN7	34.6N	076.5W	740	11.1					11.4	SW	36.7	03/12	1024.2
CSBF1	29.7N	085.4W	737	14.0					6.5	E	25.0	02/22	1021.0
DBLN6	42.5N	079.3W	744	-3.0					15.4	SW	40.8	01/10	1019.4
DESW1	47.7N	124.5W	742	6.9					15.3	SE	55.2	29/13	1015.1
DISW3	47.1N	090.7W	742	-8.2					15.9	SW	39.0	27/17	1018.2
DPIA1	30.2N	088.1W	743	13.6					11.2	SE	32.2	02/17	1021.1
DRYF1	24.6N	082.9W	744	21.6	22.5				11.9	NE	27.0	10/05	1019.0
DSLN7	35.2N	075.3W	743	13.3		1.4	5.1	24/17	18.8	W	51.1	03/15	1024.9
DUCN7	36.2N	075.8W	463	11.4		0.6	1.3	15/08	11.5	S	29.3	24/12	1023.7
FBIS1	32.7N	079.9W	740	11.5					8.3	SW	33.0	31/22	1022.6
FFIA2	57.3N	133.6W	742	1.2					16.9	SE	39.4	22/11	1007.5
FPSN7	33.5N	077.6W	743	16.6		1.6	6.1	03/07	15.6	SW	44.0	03/04	1020.8
FWYF1	25.6N	080.1W	741	22.2	24.1				16.7	E	31.3	24/07	1021.8
GDIL1	29.3N	089.9W	743	15.0	15.4				9.7	SE	29.4	09/16	1019.9
GLLN6	43.9N	076.4W	740	-4.7					18.0	NE	40.3	04/14	1020.0
IOSN3	43.0N	070.6W	741	-1.6									1019.8
KTNF1	29.8N	083.6W	744	13.1					7.4	E	24.7	02/17	1021.3
LKWF1	26.6N	080.0W	742	21.4	23.6				12.2	SE	27.9	03/06	1021.1
LONF1	24.8N	080.9W	740	21.3	21.1				11.7	E	24.5	05/00	1020.0
LPOI1	48.1N	116.5W	490	3.2	4.3				7.5	S	29.6	14/21	1018.9
MDRM1	44.0N	068.1W	742	-1.6					20.5	W	49.9	04/02	1019.2
MISM1	43.8N	068.8W	742	-1.5					20.3	W	47.7	03/23	1019.1
MLRF1	25.0N	080.4W	742	22.3	24.4				15.4	SE	27.6	11/23	1020.2
MRKA2	61.1N	146.7W	1476	-4.1					13.1	NE	37.7	29/04	1005.2
NWPO3	44.6N	124.1W	743	7.7					12.2	S	40.7	29/22	1018.6
PILM4	48.2N	088.4W	744	-9.7					16.5	NW	35.3	26/06	1019.0
POTA2	61.1N	146.7W	1483	-3.9					24.3	NE	46.9	30/19	1003.7
PTAC1	39.0N	123.7W	739	9.7					9.3	N	29.4	30/22	1020.0
PTAT2	27.8N	097.1W	739	15.2	15.4				11.2	SE	31.4	02/14	1017.9
PTGC1	34.6N	120.6W	740	12.4					11.7	N	32.2	01/03	1020.0
ROAM4	47.9N	089.3W	717	-9.7					19.4	N	41.0	04/01	1017.9
SANF1	24.4N	081.9W	743	22.2	23.6				16.0	NE	31.1	04/18	1019.7
SAUF1	29.8N	081.3W	741	15.7	17.2				8.3	NW	28.3	31/14	1022.3
SBIO1	41.6N	082.8W	742	-4.0					15.3	SW	37.9	04/06	1018.8
SGNW3	43.8N	087.7W	742	-6.7	0.0				13.3	W	41.3	02/15	1017.8
SISW1	48.3N	122.8W	743	6.4					13.2	SE	41.9	29/15	1016.1
SMKF1	24.6N	081.1W	741	22.3	24.4				16.2	E	27.6	04/18	1020.2
SPGF1	26.7N	079.0W	742	21.6					10.5	E	22.6	11/20	1020.8
SRST2	29.7N	094.0W	740	13.6					10.5	SE	25.7	02/17	1020.4
STDM4	47.2N	087.2W	741	-6.7					18.2	NW	41.4	19/04	1016.3
SUPN6	44.5N	075.8W	743	-7.3	1.0				11.4	SW	31.0	19/16	1019.4
THIN6	44.3N	076.0W	740	-6.8									
TPLM2	38.9N	076.4W	744	3.1	3.1				10.9	S	34.1	03/11	1022.7
TTIW1	48.4N	124.7W	744	6.4					15.1	E	58.7	29/08	1015.3
VENF1	27.1N	082.4W	743	17.3	18.4				7.8	E	24.9	03/05	1022.1

February 1999

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)
41001	34.7N	072.6W	667	15.1	20.0	2.9	6.7	22/22	16.9	NW	35.8	05/02	1017.0
41002	32.3N	075.2W	672	17.3	21.5	2.4	4.8	28/22	14.7	NW	35.9	28/23	1018.5
41004	32.5N	079.1W	665	15.2	19.7	1.4	4.2	02/05	13.3	SW	30.7	28/17	1018.5
41008	31.4N	080.9W	671	14.2	16.2	1.0	2.9	01/01	9.9	S	27.6	13/04	1019.3
41009	28.5N	080.2W	1343	20.0	22.8	1.4	4.9	01/02	12.4	SW	28.8	01/02	1019.6
41010	28.9N	078.6W	1342	20.5	23.7	1.9	4.9	01/03	13.6	S	29.7	28/22	1019.5
42001	25.9N	089.6W	656	21.1		0.9	4.2	12/22	9.9	E	29.9	12/20	1019.4
42003	25.9N	085.9W	671	22.1	26.2	1.0	3.3	13/14	10.4	E	31.5	13/06	1019.0
42007	30.1N	088.8W	672	15.7	17.4	0.5	1.7	12/12	10.5	SE	30.9	12/12	1020.3
42019	27.9N	095.4W	603	18.9	19.8	1.2	3.9	12/09	10.7	SE	34.2	21/04	1018.5

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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)
42020	26.9N	096.7W	671	20.1	20.9				12.0	SE	36.5	12/04	1017.9
42035	29.2N	094.4W	671	17.0	17.7	0.8	2.1	12/07	10.3	SE	29.9	12/06	1020.0
42036	28.5N	084.5W	671	18.2	20.7	0.9	3.5	13/07	10.2	E	28.2	18/03	1019.6
42039	28.8N	086.0W	670	18.5	21.7	1.0	3.0	13/12	10.6	S	26.8	13/07	1020.6
42040	29.2N	088.2W	672	18.0	21.6	0.9	2.9	12/16	10.6	N	29.0	12/13	1019.6
44004	38.5N	070.7W	672	8.8	13.8	2.7	6.5	05/13	16.6	NW	40.6	05/07	1016.6
44005	42.9N	068.9W	670	1.7	4.5	2.1	7.6	26/03	16.7	NW	37.3	25/23	1015.3
44007	43.5N	070.1W	672	0.3		1.2	5.1	26/07	12.9	N	30.5	03/03	1016.5
44008	40.5N	069.4W	664	4.1	6.0	2.5	8.0	25/15	16.7	N	37.9	25/12	1015.0
44009	38.5N	074.7W	670	4.8	6.5	1.5	3.4	25/01	14.0	NW	28.8	05/11	1018.0
44011	41.1N	066.6W	670	4.6	6.5	2.8	9.2	25/17	17.7	NW	43.3	05/11	1013.9
44013	42.4N	070.7W	672	1.5	2.9	1.3	4.8	25/21	12.9	NW	31.1	25/18	1015.5
44014	36.6N	074.8W	669	8.0	9.5	1.8	3.9	25/05	12.7	NW	27.6	05/11	1017.3
44025	40.3N	073.2W	672	3.4	5.9	1.3	3.2	25/17	13.7	NW	29.7	05/09	1017.0
46001	56.3N	148.2W	669	-.1	3.2	3.8	7.9	07/20					991.7
46005	46.1N	131.0W	672	7.4	8.0	5.4	13.0	16/08	22.2	SW	40.0	11/18	1004.0
46006	40.8N	137.5W	504	10.0	10.5	5.5	12.8	16/00	23.9	SW	40.2	11/07	1009.4
46011	34.9N	120.9W	671	11.6	12.2	3.0	7.1	17/08	11.7	NW	27.0	09/19	1021.6
46012	37.4N	122.7W	670	10.4	10.9	3.2	5.6	07/04					1021.7
46013	38.2N	123.3W	672	9.9	10.4	3.4	6.7	16/22	11.6	NW	29.5	09/14	1022.1
46014	39.2N	124.0W	672	9.5		3.7	6.7	06/20	12.4	SE	30.9	09/13	1021.5
46022	40.7N	124.5W	671	9.4	9.8	4.2	8.0	16/22	15.5	SE	41.8	06/14	1019.0
46023	34.7N	121.0W	672	11.4	12.1	3.1	5.7	26/09	14.3	NW	29.9	10/03	1022.1
46025	33.8N	119.1W	672	13.1	13.5	1.6	2.9	10/09	8.4	NW	33.0	10/03	1020.7
46027	41.8N	124.4W	671	9.0	9.5	4.2	9.0	16/18	15.8	SE	38.5	06/12	1017.7
46028	35.7N	121.9W	670	10.8	11.4	3.3	5.7	26/05	12.1	NW	25.8	09/17	1021.9
46029	46.1N	124.5W	672	8.1	8.9	4.9	9.8	16/17	20.3	S	42.6	05/21	1009.4
46030	40.4N	124.5W	650	9.4	10.1				16.6	SE	41.8	06/12	1019.7
46035	56.9N	177.8W	660	-1.1	1.5	3.5	9.1	01/00					994.3
46042	36.7N	122.4W	671	10.6	11.4	3.4	6.3	17/04	11.3	NW	26.2	09/15	1022.3
46045	33.8N	118.5W	672	12.7	13.5	0.4	3.2	10/04	3.9	W	18.5	10/19	1019.9
46050	44.6N	124.5W	671	8.8	9.3	5.0	10.1	06/00	20.6	S	42.2	05/22	1012.9
46053	34.2N	119.8W	669	12.5	12.9	1.8	2.9	22/02	10.0	W	29.1	10/02	1020.4
46054	34.3N	120.4W	666	11.7	11.8	2.9	7.1	17/09	15.5	NW	33.2	22/21	1020.4
46059	38.0N	130.0W	672		12.3	4.6	9.9	16/15	17.2	W	31.3	12/07	
46060	60.6N	146.8W	1208	-.6	4.7	1.0	3.0	15/18	12.4	N	32.1	15/05	993.5
46061	60.2N	146.8W	1342	-.9	4.2	2.0	7.0	15/22	16.2	NW	39.6	15/16	992.3
46062	35.1N	121.0W	657	11.4	11.9	3.0	6.3	26/04	12.2	NW	28.6	10/01	1021.3
46063	34.2N	120.7W	672	11.7	11.9	3.0	5.7	17/06	14.5	NW	27.8	10/04	1020.4
51001	23.4N	162.3W	671	22.6	23.7	2.9	6.6	27/03	13.7	E	26.9	03/17	1020.9
51002	17.2N	157.8W	672	23.7	24.5	3.1	5.6	04/19	18.0	NE	27.1	03/23	1017.9
51003	19.2N	160.7W	672	23.8	24.7	2.8	6.4	27/08	13.5	E	24.5	13/04	1018.6
51004	17.4N	152.5W	672	23.4	24.1	3.3	5.6	28/00	16.9	E	26.9	04/08	1018.5
51028	00.0N	153.9W	655	24.1	23.9	2.1	3.1	15/20	11.5	E	20.2	09/21	1010.9
ABAN6	44.3N	075.9W	672	-2.9					5.4	N	16.0	28/14	1019.1
ALSN6	40.4N	073.8W	651	2.7									

March 1999

41001	34.7N	072.6W	741	14.9	19.0	2.9	6.5	15/12	17.3	NW	37.9	15/11	1015.3
41002	32.3N	075.2W	742	17.6	22.3	2.3	6.1	01/08	15.3	NW	40.8	15/05	1016.7
41004	32.5N	079.1W	728	15.3	19.1	1.3	4.1	14/23	14.5	W	31.9	03/20	1016.7
41008	31.4N	080.9W	736	14.6		0.9	3.0	14/20	11.2	NE	27.2	14/18	1017.4
41009	28.5N	080.2W	1484	20.1	22.4	1.2	3.4	14/20	11.8	N	27.2	14/19	1017.9
41010	28.9N	078.6W	1485	20.5	23.7	1.6	4.1	15/03	12.0	NW	29.0	14/22	1018.1
42001	25.9N	089.6W	743	21.7		1.3	4.0	14/19	12.7	SE	32.6	15/08	1016.4
42002	25.9N	093.6W	701	21.5	23.1	1.6	4.7	14/01	15.5	SE	34.4	28/18	1015.8
42003	25.9N	085.9W	743	22.0	25.2	1.2	4.2	15/12	12.5	E	30.9	14/08	1016.6
42007	30.1N	088.8W	744	16.5	17.9	0.8	2.7	08/14	12.3	SE	27.6	08/13	1017.6
42019	27.9N	095.4W	742	19.3	19.9	1.5	3.5	14/06	12.0	SE	29.0	03/10	1014.9
42020	26.9N	096.7W	742	20.2	20.7				12.8	E	30.1	13/13	1014.3
42035	29.2N	094.4W	741	17.7	18.5	1.0	2.2	07/16	11.9	SE	28.4	13/18	1016.7
42036	28.5N	084.5W	737	18.2	19.8	1.0	4.3	15/05	11.3	E	28.6	03/23	1017.3
42039	28.8N	086.0W	742	18.8	21.0	1.2	4.7	14/23	12.4	SE	31.5	09/07	1018.1
42040	29.2N	088.2W	454	18.6	19.8	1.3	3.7	08/22	12.6	SE	30.3	03/12	1017.1
44004	38.5N	070.7W	741	9.2	12.4	2.8	7.6	15/17	17.7	NW	33.2	22/10	1014.1
44005	42.9N	068.9W	741	2.8	3.8	2.3	5.5	07/23	17.5	NW	37.3	16/00	1010.9
44007	43.5N	070.1W	739	2.2		1.3	5.6	22/16	14.4	NW	35.8	22/13	1011.6
44008	40.5N	069.4W	739	4.7	5.2	2.5	7.3	04/21	16.7	NW	33.6	16/12	1012.0
44009	38.5N	074.7W	739	5.0	5.6	1.6	5.6	28/07	16.1	NW	35.0	07/10	1015.1
44011	41.1N	066.6W	734	5.0	5.0	2.9	7.6	16/16	15.8	NW	36.5	16/12	1011.2
44013	42.4N	070.7W	734	3.0	2.7	1.3	4.2	07/11	14.6	NW	32.6	07/07	1010.9
44014	36.6N	074.8W	742	7.9	9.4	1.8	4.7	27/15					1015.0
44025	40.3N	073.2W	738	4.3	5.2	1.5	5.3	04/12	16.5	W	33.6	04/10	1013.3
45002	45.3N	086.4W	350	2.5	2.9	1.0	2.7	21/17	15.1	S	31.3	21/16	1018.0
45006	47.3N	089.9W	33	4.4	1.3	0.6	1.1	31/00	10.7	E	19.4	30/23	1006.9
45007	42.7N	087.0W	506	2.7	3.4	0.8	2.5	22/05	12.1	N	27.2	18/01	1020.8
46001	56.3N	148.2W	738	1.3	3.1	3.1	7.5	19/04					998.2
46005	46.1N	131.0W	740	6.4	7.6	4.4	10.0	17/12					1009.5
46006	40.8N	137.5W	379	8.5	10.2	4.1	9.1	29/00	18.1	W	34.6	02/17	1016.6
46011	34.9N	120.9W	744	10.8	11.4	3.1	6.6	30/13	13.4	NW	27.4	04/23	1016.7
46012	37.4N	122.7W	735	10.0	10.7	2.9	5.0	04/02	15.7	NW	30.5	27/05	1016.8
46013	38.2N	123.3W	738	9.7	10.5	3.3	6.9	30/04	13.1	NW	30.3	27/02	1017.4

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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)
46014	39.2N	124.0W	744	9.1		3.6	7.3	30/01	12.1	NW	32.1	24/13	1017.4
46022	40.7N	124.5W	744	8.9	9.9	3.7	7.6	30/01	13.1	SE	36.5	02/23	1016.1
46023	34.7N	121.0W	741	10.7	11.7	3.0	6.1	30/16	15.9	NW	34.8	19/13	1017.6
46025	33.8N	119.1W	743	12.4	13.7	1.5	3.1	31/10	8.2	W	28.6	31/22	1016.7
46027	41.8N	124.4W	735	8.6	9.7	3.7	8.2	30/00	12.5	S	35.6	30/18	1015.5
46028	35.7N	121.9W	744	10.4	11.7	3.3	6.7	30/14	14.6	NW	31.9	27/03	1016.9
46029	46.1N	124.5W	744	7.6	8.9	3.8	12.8	03/07	15.5	S	46.2	03/04	1011.3
46030	40.4N	124.5W	697	9.0	10.0				14.4	SE	35.9	02/23	1016.8
46035	56.9N	177.8W	715	-2.0	1.5	3.8	8.9	22/09	19.9	SE	47.0	18/00	999.8
46042	36.7N	122.4W	744	10.2	11.3	3.3	6.3	30/07	13.4	NW	30.1	27/06	1017.3
46050	44.6N	124.5W	744	8.1	9.4	3.9	14.1	03/06	15.8	S	44.9	03/03	1013.4
46053	34.2N	119.8W	743	11.7	12.2	1.7	3.1	01/20	11.0	W	30.3	31/02	1016.1
46054	34.3N	120.4W	731	10.9	11.5	2.9	5.0	30/15	16.8	NW	36.7	26/23	1016.1
46059	38.0N	130.0W	739		11.9	4.1	7.7	29/17	15.6	NW	31.3	02/16	
46060	60.6N	146.8W	1450	1.0	4.0	0.9	2.5	19/08	12.3	E	32.6	20/22	1001.5
46061	60.2N	146.8W	1487	1.3	4.0	1.9	6.1	19/16	14.9	E	40.2	19/13	1000.1
46062	35.1N	121.0W	729	10.6	11.2	3.1	6.4	30/13	13.8	NW	29.1	27/01	1016.6
46063	34.2N	120.7W	740	10.9	11.3	3.1	5.6	26/07	14.9	NW	29.1	04/13	1016.1
51001	23.4N	162.3W	744	22.6	24.0	2.9	6.2	21/08	16.2	E	25.7	20/07	1020.2
51002	17.2N	157.8W	741	23.5	24.4	2.8	4.3	21/21	17.7	NE	24.4	21/22	1016.9
51003	19.2N	160.7W	742	23.8	24.8	2.7	4.8	21/09	14.5	E	25.2	21/00	1017.4
51004	17.4N	152.5W	710	23.2									

April 1999

41001	34.7N	072.6W	720	18.5	20.6	2.3	5.6	16/12	16.5	SW	33.2	12/05	1015.0
41002	32.3N	075.2W	720	20.6	21.8	2.0	5.4	30/14	14.6	SW	29.7	30/00	1016.0
41004	32.5N	079.1W	720	20.1	21.3	1.4	5.1	30/23	14.4	SW	38.9	30/23	1014.9
41008	31.4N	080.9W	720	19.5		0.9	2.3	25/14	11.4	S	29.1	30/23	1015.7
41009	28.5N	080.2W	1440	22.8	23.6	1.0	2.7	01/06	10.5	S	24.9	17/15	1017.0
41010	28.9N	078.6W	1440	23.0	24.5	1.3	3.1	01/01	11.2	S	25.3	17/18	1017.5
42001	25.9N	089.6W	626	23.6		1.0	3.0	17/18	11.5	SE	26.8	16/14	1015.9
42002	25.9N	093.6W	719	23.4	24.0	1.4	2.7	16/00	15.1	SE	27.0	16/09	1014.1
42003	25.9N	085.9W	720	24.4	26.5	1.0	3.0	17/11	11.1	E	35.8	17/10	1016.0
42007	30.1N	088.8W	719	21.7	22.4	0.6	1.7	15/07	11.5	S	24.1	15/06	1016.3
42019	27.9N	095.4W	705	22.5	22.5	1.4	2.9	22/03	12.4	SE	29.3	03/18	1012.9
42020	26.9N	096.7W	705	22.7	22.7				12.7	SE	29.7	15/13	1012.0
42035	29.2N	094.4W	720	21.7	22.1	1.0	2.2	03/20	11.5	SE	30.5	03/20	1014.7
42036	28.5N	084.5W	720	21.4	22.0	0.8	2.2	01/00	8.5	SE	28.6	28/19	1016.5
42039	28.8N	086.0W	720	21.9	22.7	0.9	3.2	01/00	9.1	SE	24.1	30/22	1017.5
42040	29.2N	088.3W	720	22.1	23.0	0.9	2.3	15/23	10.4	SE	24.3	16/11	1016.0
44004	38.5N	070.7W	720	11.9	13.4	2.0	4.3	10/08	14.4	W	29.9	21/03	1014.1
44005	42.9N	068.9W	720	5.6	4.8	1.3	3.5	05/03	11.3	NW	29.1	05/02	1011.5
44007	43.5N	070.1W	720	6.4		0.6	1.7	07/04	10.0	NW	25.6	04/12	1012.2
44008	40.5N	069.4W	707	6.7	6.0	1.6	3.7	05/13	12.2	N	26.2	10/13	1012.6
44009	38.5N	074.7W	720	9.3	8.5	1.1	2.7	10/04	10.5	SW	28.0	10/01	1014.6
44011	41.1N	066.6W	716	5.7	5.1	2.0	5.4	05/05	13.1	SW	29.9	12/17	1011.0
44013	42.4N	070.7W	720	7.2	5.6	0.7	2.2	05/10	9.9	NW	24.9	05/03	1011.5
44014	36.6N	074.8W	717	11.1	9.4	1.4	3.9	30/15	12.1	SW	29.5	30/13	1014.3
44025	40.3N	073.2W	705	8.2	7.6	1.0	2.1	16/21	11.0	SW	23.3	24/06	1013.5
45002	45.3N	086.4W	720	4.3	3.2	0.6	2.4	01/03	10.7	NE	26.4	04/05	1016.4
45003	45.4N	082.8W	541	3.9	2.8	0.4	2.5	11/16	9.4	NE	28.4	11/15	1017.2
45004	47.6N	086.5W	720	3.0	2.3	0.6	3.1	04/04	9.9	N	29.9	04/04	1018.0
45005	41.7N	082.4W	97	8.3	7.8	1.0	2.1	28/11	15.2	NE	23.5	28/01	1020.6
45006	47.3N	089.9W	719	2.7	1.6	0.7	3.6	04/04	10.5	NE	29.9	03/23	1018.0
45007	42.7N	087.0W	720	5.3	4.0	0.6	3.0	23/14	9.7	NE	29.7	23/12	1014.5
45008	44.3N	082.4W	271	4.1	2.6	0.4	2.7	23/13	9.6	NE	25.8	23/11	1021.3
46001	56.3N	148.2W	719	3.1	4.2	3.2	9.0	02/15					1008.4
46005	46.1N	131.0W	719	7.2	7.8	2.6	10.0	05/07					1022.2
46006	40.8N	137.5W	589	9.4	10.2	2.2	5.5	08/21	14.0	NW	28.8	07/16	1026.3
46011	34.9N	120.9W	720	11.1	11.6	2.6	6.6	04/02	13.6	NW	35.8	04/02	1016.3
46012	37.4N	122.7W	714	9.9	10.0	2.3	5.0	03/16	13.3	NW	37.5	03/23	1016.7
46013	38.2N	123.3W	717	9.7	9.7	2.8	6.4	06/07	16.8	NW	37.5	03/23	1017.2
46014	39.2N	124.0W	719	9.4		2.7	7.3	06/02	15.2	NW	36.1	04/01	1018.5
46022	40.7N	124.5W	718	9.2	9.7	2.7	7.7	06/02	14.3	N	33.4	23/03	1019.1
46023	34.7N	121.0W	719	10.9	11.8	2.6	6.6	04/06	16.0	NW	40.6	04/02	1017.3
46025	33.8N	119.1W	719	12.3	13.4	1.4	3.7	28/23	9.7	W	36.5	04/03	1015.9
46026	37.8N	122.8W	437	10.1	9.9	2.0	4.2	29/02	14.5	NW	32.8	22/12	1017.5
46027	41.8N	124.4W	704	9.0	9.1	2.4	6.7	05/23	14.2	NW	33.6	29/23	1019.0
46028	35.7N	121.9W	720	10.6	11.7	2.9	7.7	04/02	15.7	NW	35.2	04/01	1016.5
46029	46.1N	124.5W	720	8.4	9.6	2.3	7.0	05/16	12.5	NW	32.4	10/06	1019.9
46030	40.4N	124.5W	292	9.1	8.7				16.0	N	33.8	22/10	1019.0
46035	56.9N	177.8W	696	-.9	1.4	2.5	6.4	05/06	17.4	W	38.9	04/08	1010.4
46042	36.7N	122.4W	72	9.9	11.0	3.0	6.2	03/23	17.5	NW	35.8	03/22	1014.4
46050	44.6N	124.5W	711	8.9		2.4	7.9	03/23	13.4	N	34.2	10/09	1020.4
46053	34.2N	119.8W	720	11.5	12.1	1.5	3.1	28/21	12.3	W	32.4	28/21	1015.5
46054	34.3N	120.4W	693	10.9	11.2	2.4	5.8	04/04	16.6	NW	38.1	04/03	1015.7
46059	38.0N	130.0W	720		11.9	2.7	9.1	05/23	15.2	N	31.1	08/23	
46060	60.6N	146.8W	1374	3.4	4.6	0.7	2.2	01/05	10.2	E	32.4	01/05	1010.7
46061	60.2N	146.8W	1429	3.5	4.6	1.6	5.4	01/10	13.2	E	34.0	01/05	1009.6
46062	35.1N	121.0W	702	10.8									

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