Mariners Weather Log

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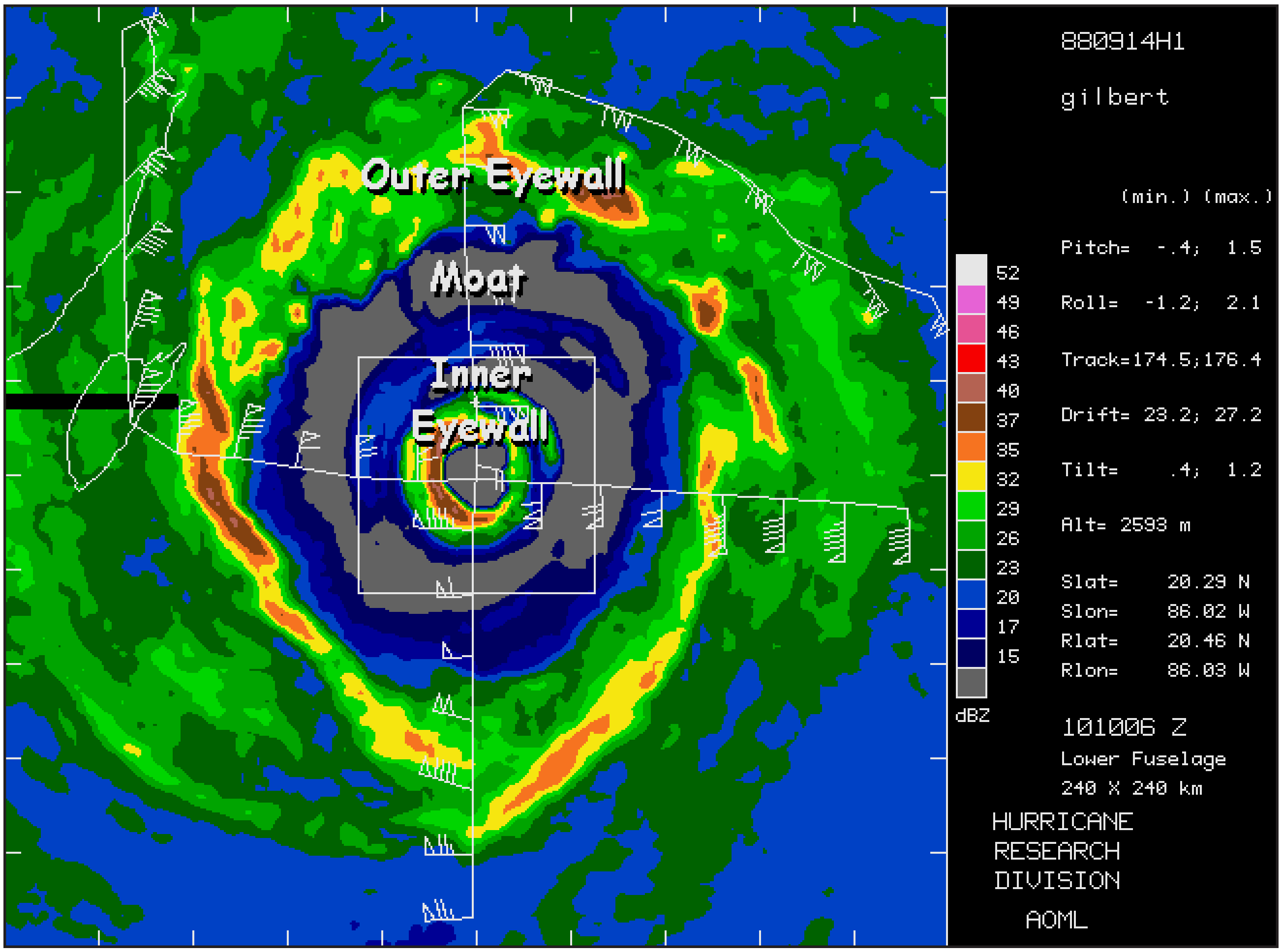

Double eyewall structure of hurricane Gilbert on September 14, 1988, near Cozumel Island, Yucatan. The devastating peak wind and rainfall occurs in the hurricane eyewalls. The moat is an area of lesser wind and rainfall between the two eyewalls. Superimposed on the radar picture is the aircraft's track and wind at about 2600 meters (8500 feet) (wind barbs and flags in knots). See article on page 4.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this department. Use of funds for printing this periodical has been approved by the director of the Office of Management and Budget through December 1999.

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Articles, photographs, and letters should be sent to:

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

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

From the Editorial Supervisor

This issue features a fascinating interview with Dr. Hugh Willoughby, head of the Hurricane Research Division of NOAA's Atlantic Oceanographic and Meteorological Laboratories, on concentric (double) hurricane eyewalls. Hurricane eyewalls are the nearly circular ring of thunder-storm-like cloud towers surrounding the often clear, nearly calm center or eye of the storm. The eyewalls contain the devastating peak wind and rainfall of the hurricane and can extend up to 10 miles high in the atmosphere. While most hurricanes have a single eyewall, many major category 3 or stronger hurricanes (50 % or more) develop the double eye wall structure.The double structure usually lasts a day or two, with the inner wall eventually dissipating as the outer wall contracts in to become the new single eyewall (going through an entire eyewall replacement). See the article for details.

This issue also contains the AMVER rescue report for 1999. Participation in the AMVER program was at an all time high with a record 4,813 vessels receiving AMVER participation awards for 1999 (the previous record was 4,095 vessels in 1998). To receive the participation award, a vessel must be on the AMVER Plot for at least 128 days. Nine vessels were nominated for special AMVER awards for their role in notable rescue efforts. Five vessels actually receive special awards, which are sponsored by Lloyds List (a UK trade newspaper), Safety at Sea Magazine (UK), the Association For Rescues at Sea (an organization of retired Navy and U.S. Coast Guard Admirals), KPN Station 12 (the Dutch signatory to COMSAT), and the New York Chapter of the Navy League of the United States (a lobbying organization for maritime services). Please contact Mr. Rick Kenney, the AMVER Maritime Relations Officer for more information (see contact information in the back of this publication).

Martin S. Baron⚓

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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Concentric Eyewalls of Hurricanes

An Interview with Dr. Hugh E. Willoughby

Debi Iacovelli
Tropical Weather Specialist
Coral Gables, Florida

Editor's Note: This interview was conducted in 1993. Dr. Willoughby is currently the director of the Hurricane Research Division of the Atlantic Oceanographic and Meteorological Laboratories in Miami, Florida.

The eye of a hurricane is a spectacular view from any satellite image. It is one of nature's most beautiful arrays, strikingly unique from the rest of the storm. While one eyewall is an expected feature of an intense cyclone, the subject of double eyewalls is sometimes shrouded in mystery, even among those of us who are familiar with the subject of tropical meteorology. But the second eyewall of the hurricane forms in a similar manner as the first. Let's examine this a bit closer.

While the eye of a hurricane contains a column of sinking air, the large convective spiral bands surrounding the center are comprised of air that is rising. Near the tropopause (the top of the troposphere, at about 50,000 feet, or 15,250 meters), as most of the rising air is forced to diverge away from the storm, the Coriolis force (deflection of air flow to the right in the northern hemisphere due to the rotation of the earth) gives it a clockwise twist outward. However, not all of this air moves away from the storm—some moves into the eye itself, and the inward clash of air causes sinking motion. As this air sinks, it warms by compression. This causes the air in the eye to dry out and explains why the eye is typically cloud-free.

As a hurricane becomes intense, the eyewall (the area of rising air and convection surrounding the eye) begins to contract and get smaller. It shrinks towards the center because latent heat (heat released due to the condensation of water vapor to form cloud droplets) released in the rings causes warmer air to enter the top of the hurricane's eye. The eye becomes warmer as a result.

The formation of a secondary eyewall around the original one occurs no differently than the formation of the original eyewall. In fact, it would not be wrong to think of a hurricane with concentric eyewalls as two hurricanes, with the smaller one within the eye of the larger one. Tropical cyclones with concentric eyewalls

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undergo cycles in which the inner eyewall is replaced by the outer one, which sometimes causes a decrease in the intensity of the system. It is thought that this weakening occurs because the dominating outer eyewall may bar the flow of saturated air into the center of the hurricane.

As the outer eyewall intensifies and contracts inward, this induces a secondary circulation with strong subsidence (downward movement of air) over the inner eyewall, disrupting the circulation of the inner eyewall, and causing the central pressure of the hurricane to rise and the wind to weaken. A concentric eyewall pattern can exist unimpeded if the system is out over open water, but many times this concentric eyewall arrangement will not survive if the hurricane is close to land (circulation over land robs the hurricane of its fuel: water vapor from the sea surface and latent heat released as a result of condensation).

Tropical cyclones which attain maximum wind speeds of greater than 164 feet per second (greater than 50 meters per second, 110 mph, or 97 knots) for 1 minute average mean wind speeds create a closed eyewall near the storm center, surrounded by spiral rain bands. Many times during rapid intensification the spiral rain bands form complete or partial rings around the original eyewall. This secondary eyewall usually contains well-defined maximum winds and heavy precipitation.

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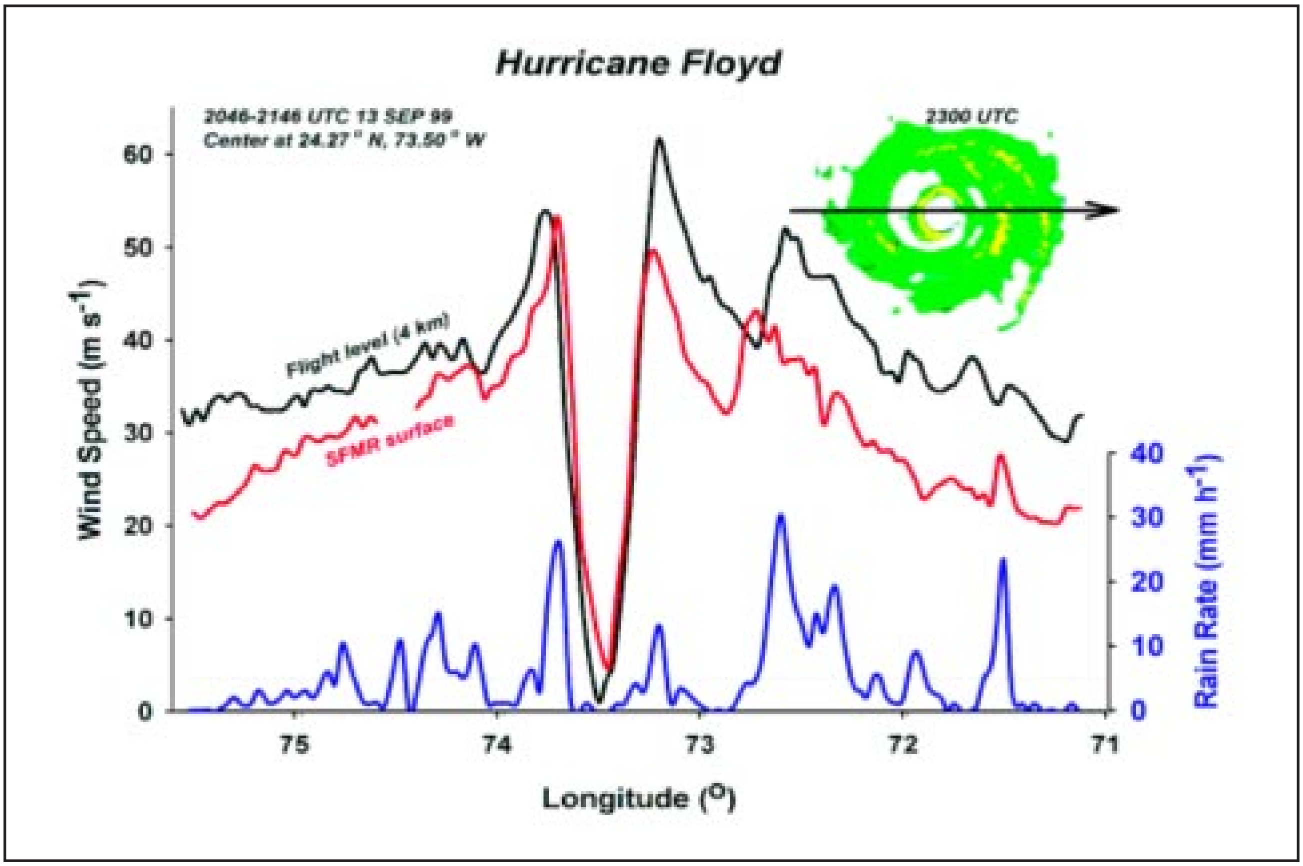

A west to east pass across Hurricane Floyd when it was a Category 4 hurricane east of Miami, heading west. This graph compares wind measured at 6 km with that sensed at the surface by the stepped frequency microwave radiometer. The radar reflectivity image at the upper right shows the concentric eye outlined by precipitation, and the wind profiles exhibit a clear double maximum.

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This arrangement of inner and outer eyewall regions are referred to as "concentric eyewalls."

Foremost in concentric eyewall research and investigation is Dr. Hugh E. Willoughby of the Hurricane Research Division (HRD) in Miami, Florida. Born at the end of World War II, Dr. Willoughby attended the University of Arizona and received a Bachelor's degree in Geophysics and Geochemistry. After serving in the Navy as a reconnaissance meteorologist on the island of Guam, Dr. Willoughby received his doctorate in Atmospheric Sciences from the University of Miami in 1977. Dr. Willoughby was kind enough to grant this interview for the Weather Watcher Review:

WWR: When was your first flight into a hurricane with the Navy?

HW: It was Typhoon Olga in 1970.

WWR: When did you first start working on concentric eyewalls in hurricanes?

HW: Well, it started on the last flight I made with the Navy, which was Typhoon Amy in 1971. I was literally coming back from the Philippines to pack my household goods and leave Guam. We made one fix on the way back, and I noticed as we were flying into the storm that the winds would pick up, and we'd fly through rain, and then the winds would drop off on the other side. I thought, "Gee, that's funny!" Because what I had always been taught is that the winds increased towards the center of a hurricane. That episode started me thinking. The first P3 Orion data set I looked at was Hurricane Anita in 1977. There was a concentric eyewall, but there was never a replacement. It went onshore before the replacement happened. Anita and Hurricane David both pointed towards the concentric eyewall idea, and then when Hurricane Allen came along, my mind was prepared, and I suddenly realized what was going on.

WWR: Can you tell us about the structure of the eyewall of a hurricane and how having an outer eyewall can influence the structure of the inner one?

HW: The eyewall, in all of our observations, is sort of cone-shaped. It's more narrow at the bottom than the top. The slope of the eyewall is typically about 45 degrees or less. Sometimes it's as much as 60 degrees off the vertical, and 30 degrees up from the horizontal. So, it's sort of a truncated cone. All our observations seem to show it. The one exception is when you're actually having a concentric eyewall replacement. The inflow into the inner eye from the outer eye tends to push the inner eye, and makes it more vertical. That happened in Hurricane Gilbert pretty clearly. The radar imagery showed that the inner eye became more vertical on the second day when it was full of clouds, and started to weaken.

WWR: So when the inner eyewall becomes more vertical, does this weaken the hurricane?

HW: Yes. The same thing that would cause it to become more vertical is also producing a sinking motion over the whole inner eye structure. This tends to keep the convection from perking along the way it did before the outer eyewall formed.

WWR: Tell us about the concentric eyewall pattern in Hurricane Gilbert.

HW: The sight at maximum intensity showed what looked like to be an outer eyewall forming, and then, right at landfall, there were very clear, very striking concentric eyewall patterns.

WWR: Was this concentric eyewall pattern noticeable on radar reflectivity?

HW: Oh yes, definitely. What happened with Gilbert was, of course, you couldn't really tell whether the cycle of an outer eyewall replacing the inner one had weakened it or whether the passage over the Yucatan did. Probably both things contributed. Then it went out over the Bay of Campeche on the West side of the Yucatan, and you could still see the old inner eyewall. It was a lot larger. The outer eyewall had managed to shrink just a little bit, and those features kind of hung on for the whole way across the Bay of Campeche until landfall on the Mexican mainland.

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A photograph of Hurricane Floyd's eyewall from a NOAA WP-3D reconnaissance airplane (model N43RF) on 13 September 1999 at 1942 UT when the storm was centered at 28 degrees 04 minutes north, 73 degrees 14 minutes west, with 924 mb central pressure.

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WWR: You published a paper about this in 1992. Has anything newer come out? And what are your current projects?

HW: We haven't seen any concentric eyewalls since then. I've been working a little bit more on hurricane motion lately. I feel that the observational side of concentric eyewall work is pretty much completed. We can't justify flying the P3-Orion airplane merely to watch concentric eyewalls, but we still pick up on the reports.

WWR: Were they closed eyewalls?

HW: They were predominantly closed eyewalls. The Air Force Reserve Unit was out there almost continuously, but the Orions flew only as the storm went by Cape Hatteras.

WWR: Were the Orions flying into this storm, too?

HW: We used the P3s. We were interested in comparisons in a number of fixed instrumented buoys off Hatteras, and we were also interested in what the surface winds would be in comparison to the flight-level winds. We had one flight and two fixes. The Air Force doesn't record radar, but their flight-level data was almost continuous and very, very good quality. They sent us an IBM floppy disk with their flight-level data on it. We found someone who could analyze it the same way we do ours. I could track wind maxima from one pass to the next, and I correlated them the way a geologist would correlate strata just connecting lines. It's a little ambiguous. Sometimes you have to ask yourself, "Is this the one I should be watching, or is it that

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one?" But looking at the general picture, there were seven or eight of these little things in Bob propagating inward, while the pressure just kept going down. When our airplanes were flying, the storm was also within the range of the radar off Cape Hatteras. I could identify features in their radar reflectivity that I was able to track from the flights. But these weren't real closed, donut-like eyewalls. Thinking back, I wonder if hurricanes don't form this sort of feature fairly regularly.

WWR: Aren't concentric eyewall features common in hurricanes when they attain an average central pressure of 926 mb (27.35 inches)?

HW: You see the eyewall replacements when the winds are more than about 50 meters per second (112 mph). But I think that features like concentric eyewalls, though not as vigorous, do form in weaker storms.

WWR: Would they be closed eyewalls, though?

HW: They're probably closed, or mostly closed, in terms of the dynamics. But the issue is not whether the convection, or the radar pictures, make a closed ring. It's whether there's a wind maximum. That's the crucial thing in terms of making it look differently from a spiral band, although some spiral bands have wind maxima in them too. The idea is that the concentric eyewall that makes the replacement, where you actually get a weakening of the storm, is a particularly energetic feature that's essentially able to beat out the rest of the competition. And it eventually goes into competition with the old eyewall. These concentric eyewalls can exist for a day or two as an eyewall replacement, but the storm doesn't really weaken. The notion is that when you're watching the central pressure, you get a pressure fall across the main eyewall where the wind's really strong. This is because of the relationship between the pressure gradient and the wind. And if an outer wind maximum forms, sometimes it'll get to be stronger than the main eyewall before the main eyewall has a chance to weaken.

WWR: Did the pressure fall when Hugo made a concentric eyewall?

HW: No. In fact, that was the thing that was peculiar about Hurricane Hugo—the inner eyewall did not weaken when the outer eyewall formed. It was north of Puerto Rico and it weakened because the environment was not very favorable. It was in westerly shear (there were sharp changes in wind speed vertically upward through the storm, with wind blowing from west to east), and had been weakened by passage over Puerto Rico. We don't have very good data, but we think that when it reintensified and actually made the eyewall that hit Charleston, that feature formed a long ways out on a fairly flat wind profile. It swept inward to become the main eyewall, so it actually strengthened during eyewall replacement, because the outer eyewall was so much stronger than the pre-existing eyewall.

WWR: Now, that wasn't the case with Hurricane Andrew, was it?

HW: No, in that case it was a clear classical eyewall replacement, and the pressure rose into the low 940s if I remember right. Then it just started back down and dropped like crazy.

WWR: And the pressure fell during landfall as well?

HW: It came ashore so fast that it probably didn't realize it was over land until it was in the Everglades. I remember talking to the meteorologist who was on board the Air Force airplane. They had made their penetration east of Miami about an hour before landfall. Of course, all the city lights were on. Off to the west of them it looked like a beautiful, tropical night in Miami. Then as they went from south to north, they got out of the storm over the Ft. Lauderdale-Boca Raton area. They looked around at each other in the cockpit and said, "This is an historical hurricane. We should go back in!" So they turned around and penetrated the storm again, essentially over west Homestead. And then they got down in the Keys, and decided that they'd go back and do it again! So we have multiple wind profiles across Andrew as it went ashore.

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Concentric Eyewalls

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WWR: That's rare. Reconnaissance is usually carried out over water.

HW: Yes, that's very rare. They were in severe turbulence a good part of the time. For an experienced hurricane meteorologist to say "severe turbulence," he means severe turbulence.

WWR: Even flying into a Florida thunderstorm is more dangerous than penetrating a hurricane that's over land.

HW: Yes, that's true. I've been in severe turbulence maybe three or four times in hurricanes or typhoons. Anyway, they probably had a very wild ride. They could see the transformers flickering out on the ground. There'd be a huge flash of light and the sub-station would destroy itself. They watched the city lights going out block by block. One of the guys I work with lives farther south of Miami than I do, and he and his family were huddled in their bathroom. It was either him or one of his neighbors who claimed that they could hear an airplane. The neighborhood wasn't ever in the eye, so it was actually kind of dubious as to whether they heard the airplane, but it did go right over them. The reconnaissance plane measured their strongest winds a mile east of Kendall Campus over Miami Dade Junior College, which was 75 meters per second (168 mph) at flight level.

WWR: What would 75 meters per second at flight level be extrapolated to in terms of surface wind speeds?

HW: That's a good question, because you can't really compute that. They were at the 700 mb level, or 3 kilometers in altitude (10,000 feet). Extrapolated to the surface, that's roughly 150 knots (173 mph). The National Hurricane Center's figure of 145 knots (167 mph), is, I suppose, the official maximum.

WWR: Are you in agreement with that?

HW: Yes, I am. Not simply because of the wind speeds, but more so because of the pressure readings. The best pressure reading that we could get was 922 mb (27.23 inches of mercury), which comes from a brave soul who huddled in the wreckage of his house under a mattress reading his barometer with a flashlight! There have been a lot of similar reports which have been consistent with one another. The 922 mb reading puts you at the low boundary of Category 5, and this correlates well, since the 150 knot speed would also put you into Category 5. But that's just speculation from flight level, and it would have to be something like 80% of that at most for sustained winds.

WWR: Have you flown into many tropical cyclones, Dr. Willoughby?

HW: Of the active research people in this lab (HRD) I have the most penetrations into the eye. I've got my book right here. Let's see, I'll give you the accurate statistics.

WWR: We'd be most interested in that.

HW: Three hundred and thirty-five penetrations. That includes some typhoons when I was in the Navy, but mostly hurricanes. We made two penetrations into Typhoon Robyn while I was in Guam during August 1993. We were interested in weak systems, but one of the systems managed to provide us with an excuse to investigate Typhoon Robyn. It was really a lot of fun, because the Air Force airplanes don't have as nice of a radar system as the P3-Orions do, so it was a lot of running things off of maps in the back of the airplane, and not being able to see. It was a lot more artistic than what we do with the P3s.

WWR: You sure have an interesting perspective on tropical meteorology.

HW: A lot of the way I think about meteorology is similar to the way a geologist thinks. My training in geology just gives me a different perspective. I get people complaining to me, "Why do you waste your time with these crummy observations?" on one side, and on the other it's, "Well, gee! You do great work if it didn't have all that mathematics in it." I feel that research in meteorology uses the language of mathematical physics, but it's still an observational natural science like geology, biology, or astronomy.⚓

Great Lakes Wrecks—The Wreck of the Aycliffe Hall

Skip Gillham
Vineland, Ontario, Canada

Aycliffe Hall was a small bulk carrier built at South Bank on Tees, England in 1928. Construction did not take long. The keel was laid January 15, the hull launched March 22, and on April 16 the 258.5 foot long freighter sailed for North America.

This was the first in a series of new vessels for the recently reorganized Hall fleet. It was also the first to use what was to become the company standard of having names end with "cliffe Hall."

Aycliffe Hall had six hatches and two cargo holds. On the first trip it loaded 2,200 tons of fluorspar at Middleborough, England, for Sault Ste. Marie, Ontario. It also took a 65 foot long tug, the **Vigilant**, as deck cargo as far as Sorel, Quebec.

Coal, grain, and pulpwood were the key cargoes and the vessel sailed on the Great Lakes, St. Lawrence, and east to Halifax, Nova Scotia, and Saint John, New Brunswick.

On June 11, 1936, **Aycliffe Hall** was upbound and in ballast trying to penetrate dense, late spring fog on Lake Erie. Near Long Point, the 612 foot long American ore carrier **Edward J. Berwind**, met **Aycliffe Hall** with devastating results. The port side of the smaller ship was ripped open at the after hold. The damage could not be contained. All nineteen crew members were rescued and the ship sank as early morning light filtered through the haze.

An attempt at salvage brought **Aycliffe Hall** to the surface in the fall, but the two months of work were wasted when the pontoons holding the bow were dislodged by a storm. The ship plunged to the bottom for good. In 1939 the vessel was relocated and all rigging was blown clear by explosives so as not to be a hazard to navigation.

Edward J. Berwind was repaired and later sailed as **Mathew Andrews**, **Blanche Hindman**, and **Lac Ste. Anne** before being scrapped at Port Colborne, Ontario, in 1986.

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

The *Aycliffe Hall* sank as a result of a collision with the *Edward J. Berwind* on June 11, 1936. This happened in dense fog on Lake Erie, near Long Point. All 19 crew members were rescued.

The NWS Coastal Marine Forecast

Richard May
National Weather Service
Silver Spring, Maryland

The coastal waters marine forecast (CWF) is a National Weather Service (NWS) product designed to serve the widest variety of maritime activities. The product is issued for mariners in small craft staying near the shore, and for the larger ocean-going vessels that transit the coastal waters. The CWF is subdivided into separate zones covering coastal marine areas, bays, harbors, and river entrances.

The CWF is issued four times daily by the coastal Weather Forecast Offices (WFO) and include a synopsis, headlines of significant weather (when necessary), forecast text, and a three-to-five day outlook. The forecast text goes out 36 to 48 hours and contains wind direction and speed (in knots), sea heights (in feet), and significant weather or visibility restrictions.

The product includes headlines whenever any of the following are issued:

- Small Craft Advisory
- Gale Warning
- Storm Warning
- Hurricane Warning
- Tropical Storm Warning

Separate Special Marine Warnings and Marine Weather Statements are issued for short term weather events such as gusty winds with thunderstorms. Marine Weather Statements are also issued for dense fog.

NWS Modernization and Restructuring

The National Weather Service has completed its modernization and restructuring program. For marine services, the number of coastal marine zones around the United States and its territories was more than doubled during the late 1990s. More WFOs issuing marine forecasts for smaller areas will produce greater forecast accuracy. The coastal marine forecast service transfers among the WFOs were completed by December 1, 1999. Table 1 shows all WFOs now issuing coastal marine forecasts and warnings.

Dissemination of Coastal Marine Forecasts

Mariners can obtain the CWF from weather broadcasts, telephone recordings, the Internet, and other sources. The most common NWS dissemination routes are described below:

NOAA Weather Radio (NWR): The NOAA Weather Radio network provides voice broadcasts

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Coastal Marine Forecast

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of coastal marine forecasts as part of a continuous cycle. NWR utilizes seven frequencies ranging from 162.400 to 162.550 mHz. The NWR network covers nearly all of the coastal U.S., Great Lakes, Hawaii, populated Alaska coastline, Guam and the northern Mariana Islands, and Puerto Rico and the Virgin Islands. Typical coverage is 25 nm offshore.

NOAA Telephone Recordings: Most NWS offices offer the latest coastal marine forecasts on telephone recordings. These telephone numbers are usually listed in the telephone directory white pages under "United States Government," "Commerce Department," "National Weather Service."

U.S. Coast Guard VHF Voice: U.S. Coast Guard broadcasts coastal marine forecasts and storm warnings of interest to the mariner on VHF channel 22A following an initial call on VHF channel 16. The USCG VHF network provides near-continuous coverage of coastal U.S., Great Lakes, Hawaii, and populated Alaska coastline. Typical coverage is 25 nm off-shore.

Internet: NWS coastal marine forecasts can be accessed from http://www.nws.noaa.gov/om/marine/forecast.htm

For marine product dissemination information, please visit: http://www.nws.noaa.gov/om/marine/home.htm

Great Lakes

The Great Lakes Near-Shore forecast (NSH) is the CWF equivalent for the Great Lakes. The NSH covers specific marine zones which extend from shore out five nautical miles. Great Lakes marine zones also include bays and connecting rivers. Open lake forecasts are issued for waters beyond five nautical miles from shore, during the NSH season and for the entire lakes during the colder months.

The Near-Shore forecast is issued four times daily, from spring through fall, by the ten Great Lakes WFOs (see Table 2). The forecast text goes out 36 to 48 hours and contains wind direction and speed (in knots), wave heights (in feet), and significant weather or visibility restrictions. Headlines are included in the Near-Shore forecast whenever small craft advisories, gale warnings, or storm warnings are issued.

Separate Special Marine Warnings and Marine Weather Statements are issued for short lived weather events such as thunderstorms with gusty winds crossing the lakes. Marine Weather Statements are also issued for visibility restrictions in dense fog or snow.

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Table 1

Weather Forecast Offices (WFO) Issuing the Coastal Marine Foreast (CWF)

WFO Caribou ME	WFO Miami FL	WFO Portland OR
WFO Portland ME	WFO San Juan PR	WFO Medford OR
WFO Boston MA	WFO Key West FL	WFO Eureka CA
WFO New York City	WFO Tampa Bay FL	WFO San Francisco CA
WFO Philadelphia PA	WFO Tallahassee FL	WFO Los Angeles CA
WFO Baltimore MD/Washington DC	WFO Mobile AL	WFO San Diego CA
WFO Wakefield VA	WFO New Orleans LA	WFO Juneau AK
WFO Newport NC	WFO Lake Charles LA	WFO Anchorage AK
WFO Wilmington NC	WFO Houston TX	WFO Fairbanks AK
WFO Charleston SC	WFO Corpus Christi TX	WFO Honolulu HI
WFO Jacksonville FL	WFO Brownsville TX	WFO Guam
WFO Melbourne FL	WFO Seattle WA	WSO Pago Pago, American Samoa

Coastal Marine Forecast

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Table 2

Weather Forecast Offices (WFO) Issuing the Near Shore Forecast (NSF)

WFO Duluth MN	WFO Milwaukee WI
WFU Marquette MI	WFO Chicago IL
WFO Gaylord MI	WFO Grand Rapids MI
WFO Detroit MI	WFO Cleveland OH
WFO Green Bay WI	WFO Buffalo NY

FZUS56 KLOX 151725
CWFLAX
COASTAL MARINE FORECAST
NATIONAL WEATHER SERVICE LOS ANGELES/OXNARD CA
830 AM PST WED MAR 15 2000

PZZ600-152230-
SYNOPSIS FOR SOUTHERN CALIFORNIA COAST AND SANTA BARBARA CHANNEL
830 AM PST WED MAR 15 2000

AT 18Z...10 AM LOCAL TIME...A 1027 MB HIGH WILL BE 600 NM WEST OF POINT CONCEPTION WITH A RIDGE EXTENDING TO A 1029 MB HIGH OVER NORTHERN IDAHO. STRONG NW FLOW WILL CONTINUE ACROSS THE OUTER WATERS OF CENTRAL AND SOUTHERN CALIFORNIA...WITH INCREASING ONSHORE FLOW ACROSS THE INNER

WATERS.

$$

PZZ670-152230-
POINT PIEDRAS BLANCAS TO POINT ARGUELLO AND OUT 60 NM
830 AM PST WED MAR 15 2000

...SMALL CRAFT ADVISORY...

.TODAY...WIND NW 20 TO 25 KT WITH WIND WAVES 4 FEET...INCREASING TO 25 TO 30 KT WITH LOCALLY STRONGER GUSTS AND WIND WAVES 5 FEET IN THE AFTERNOON. SWELL NW 8 FEET. PATCHY MORNING FOG. .TONIGHT...WIND NW 25 TO 30 KT. WIND WAVES 5 FEET. SWELL NW 8 FEET. PATCHY FOG. THU...WIND NW 20 TO 25 KT WITH WIND WAVES 4 FEET...INCREASING TO 25 TO 30 KT WITH LOCALLY STRONGER GUSTS AND WIND WAVES 5 FEET IN THE AFTERNOON. SWELL NW 9 FEET. PATCHY MORNING FOG.
$$

PZZ673-152230-
POINT ARGUELLO TO SANTA CRUZ ISLAND AND OUT 60 NM _830 AM PST WED MAR 15 2000

...GALE WARNING...

.TODAY...WIND NW 25 KT WITH WIND WAVES 4 FEET...INCREASING TO 30 TO 35

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Coastal Marine Forecast

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**KT WITH LOCALLY STRONGER GUSTS AND WIND WAVES 6 FEET IN THE AFTERNOON.
SWELL NW 8 FEET. PATCHY MORNING FOG. .TONIGHT...WIND NW 30 TO 35 KT WITH WIND WAVES 6 FEET...LOWERING TO 25 KT WITH WIND WAVES 4 FEET OVERNIGHT. SWELL NW 8 FEET. PATCHY FOG.
THU...WIND NW 25 KT WITH WIND WAVES 4 FEET...INCREASING TO 30 TO 35 KT WITH LOCALLY STRONGER GUSTS AND WIND WAVES 6 FEET IN THE AFTERNOON. SWELL NW 9 FEET. PATCHY MORNING FOG.**

$$

**PZZ676-152230-
OUTER WATERS SANTA CRUZ ISL TO MEXICAN BORDER
830 AM PST WED MAR 15 2000**

...SMALL CRAFT ADVISORY...

**.TODAY...WIND NW 15 TO 20 KT INCREASING TO 20 TO 25 KT WITH LOCALLY STRONGER GUSTS BY AFTERNOON. WIND WAVES 4 FEET. SWELL NW 9 FEET. PATCHY MORNING FOG.
.TONIGHT...WIND N TO NW 20 TO 25 KT WITH LOCALLY STRONGER GUSTS. WIND WAVES 4 FEET. SWELL NW 9 FEET. PATCHY FOG.
.THU...WIND NW 20 TO 25 KT WITH LOCALLY STRONGER GUSTS. WIND WAVES 4 FEET. SWELL NW 9 FEET. PATCHY MORNING FOG.
$$**

**PZZ650-152230-
EAST SANTA BARBARA CHANNEL
830 AM PST WED MAR 15 2000**

**.TODAY...WIND LIGHT...BECOMING W 10 TO 15 KT WITH WIND WAVES 2 FEET IN THE AFTERNOON. SWELL W 6 FEET. PATCHY MORNING FOG. TONIGHT...WIND W TO NW 15 KT WITH WIND WAVES 2 FEET...BECOMING VARIABLE 10 KT OR LESS OVERNIGHT...EXCEPT FOR LOCAL WIND N 15 TO 20 KT WITH WIND WAVES 3 FEET BELOW PASSES AND CANYONS. SWELL W 6 FEET. PATCHY FOG.
.THU...WIND LIGHT...BECOMING W TO NW 15 KT WITH WIND WAVES 2 FEET IN THE AFTERNOON. SWELL W 6 FEET. PATCHY MORNING FOG.
$$**

**PZZ655-152230-
INNER WATERS POINT MUGU TO SAN MATEO POINT
830 AM PST WED MAR 15 2000**

**.TODAY...WIND LIGHT...BECOMING W TO NW 10 TO 15 KT WITH WIND WAVES 2 FEET IN THE AFTERNOON. SWELL W 5 FEET. AREAS OF MORNING FOG.
TONIGHT...WIND W TO NW 10 TO 15 KT WITH WIND WAVES 2 FEET...BECOMING VARIABLE 10 KT OR LESS OVERNIGHT. SWELL W 4 FEET. PATCHY FOG.
.THU...WIND VARIABLE 10 KT OR LESS...BECOMING W TO NW 10 TO 15 KT WITH WIND WAVES 2 FEET IN THE AFTERNOON. SWELL W 5 FEET. PATCHY MORNING FOG.
$$**

**PZZ690-152230-
OUTLOOK FOR SOUTHERN CALIFORNIA OUTER WATERS
830 AM PST WED MAR 15 2000
.FRI THROUGH SUN...WIND NW 15 TO 25 KT. SEAS NEAR 10 FEET.
$$**

RORKE

1999 Amver Business Report—It Was Another Very Good Year!

NUMBER OF SURVIVORS RESCUED: 151
PROGRAM PARTICIPATION GROWTH: 2%

***RECORDS BROKEN*:**

NUMBER OF SHIPS ON AVERAGE DAILY PLOT:	2,832
SHIPS RECEIVING PARTICIPATION AWARDS:	4,813
DAILY PLOT ABOVE 2,800 MARK:	254 Days
DAILY PLOT ABOVE 2,900 MARK:	29 Days
HIGHEST DAILY NUMBER OF SHIPS ON PLOT:	**2,984**

RESPONSE: 167 SHIPS FROM 39 COUNTRIES DIVERTED TO ASSIST!

Top Five Nations: United States (35) Japan (26) Norway (20) Greece (10) Denmark/Germany (5)
(Number of ships diverted to assist in rescues)

***AWARDS*:** Norway (577) Greece (571) Japan (567) United States (563) United Kingdom (280) (Number of ships that earned awards for the year; these vessels were on the AMVER plot for at least 128 days during the year)

33 SHIPS FROM 16 COUNTRIES MADE RESCUES!

Owner Countries: Norway (6) United States (5) Japan (4) Germany (3) Singapore (3) Greece (2) Australia (1) Austria (1) Cayman Islands (1) Chile (1) Cyprus (1) India (1) Mexico (1) Malaysia (1) Russia (1) Switzerland (1) (Number of ships actually making rescues)

Ships: Jag Rekha (1), Winter Sun (6), National Progress (7), Iron Newcastle (16), Star Dieppe (1), Pacific Venus (1), Shinoussa (3), Las Sierras (16), C/S Mercury (4), Nordcloud (1), Mac Tide (2), Allegra (1), Team Merkur (3), Shohjin (3), Star Fraser (2), Asphalt Victory (2), Nuevo Leon (2), Jakov Sverdlov (11), Rio Haina (4), Alicahue (31), Gulf Eagle (3), Corona Challenge (2), Dorothea Rickmers (2), Endeavor (3), Crown Emerald (1), Laura (2), Nyon (2), CSAV Taipei (1), ITB Mobile (2), C/S Splendour of the Seas (11), Rubin Iris (3), Elektra (1), Terrier (1)
(Number of people rescued)

ALERTS:
406 MHZ EPIRB ALERTS INITIATED 30% OF AMVER CASES
121.5 MHZ EPIRB ALERTS INITIATED 17% OF AMVER CASES
DIGITAL SELECT CALL (DSC) / INMARSAT-C = 6% OF CASES

INCIDENTS:

VESSELS DISABLED OR ADRIFT:	23 Cases
VESSELS TAKING ON WATER:	10 Cases
MEDICAL EVACUATIONS:	14 Cases
VESSEL FIRES/SINKINGS:	8 Cases
PERSONS IN WATER:	6 Cases

NOMINATIONS: **9 VESSELS NOMINATED FOR SPECIAL AWARDS:**

M/V IRON NEWCASTLE - Austria (AS) flag)
M/V NATIONAL PROGRESS - Singapore(SN) flag
M/V NORDCLOUD - Cyprus (CY) flag
M/V MAC TIDE 63 - United States (US) flag
M/V ATLANTIC HORIZON - United States (US) flag
M/V JAKOV SVERDLOV - Russia (RS) flag
M/V ALICAHUE - Chile (CI) flag
M/V NYON - Switzerland (SZ) flag
C/S SPLENDOUR OF THE SEAS - Norway (NO) flag

Tides in Shallow Water

Bruce Parker
National Ocean Service

In our December 1998 column we answered the question "Why are the tides so predictable?" The question that we did not fully answer is why huge tidal ranges occur at places like the Bay of Fundy in Nova Scotia, Canada. In that column we did explain that the width and depth of an ocean basin determines its natural period of oscillation and the closer its natural period is to the principal tidal period (12.42 hours) the larger the tides in the ocean will be. However, the ocean basins are too wide (and thus their natural periods of oscillation are too far from the tidal period) for the tides in the ocean to be of any significant size. The largest tides occur in shallow waters, at the ends of certain bays, and along coasts with very wide continental shelves, and we didn't explain why that happens. Nor did we explain why the fastest tidal currents are found in the entrances to bays and in certain straits. We now come back to this subject to complete the story, and describe the many effects that shallow water can have on tides and tidal currents.

The increase in tidal range and tidal current speeds that one sees in the shallow waters of bays, rivers and straits can go to dramatic extremes if the circumstances are right. Tidal ranges reach 50 feet in Minas Basin in the Bay of Fundy. Tidal ranges greater than 40 feet occur at the northern end of Cook Inlet near Anchorage in Alaska, in the Magellan Strait in Chile, in the Gulf of Cambay in India, along the Gulf of St. Malo portion of the French coast bordering the English Channel, in the Severn River in England, and along the open coast of southern Argentina. In a few rivers a portion of the tide wave propagates up the river as a tumultuous wall of water, called a *tidal bore*. The largest tidal bores are found in the Tsientang River near Hanchow, China, and in the Amazon River, where at certain times they can be greater than 25 feet in height and travel up the river at a speed of 15 knots. Smaller bores occur in the Meghna River in India, in the Peticodiac River at the end of the Bay of Fundy, in Turnagain Arm near Anchorage, and in the Severn River in England.

Tidal current speeds greater than 15 knots occur in Seymour Narrows, between Vancouver

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Tides in Shallow Water

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Island and the mainland of British Columbia, Canada. Tidal currents of 10 knots are found in South Inian Pass in Southeast Alaska and in Kanmon Strait, Japan. In some narrow or shallow straits the tidal currents create dangerous whirlpools or *malströms*. Most famous is the whirlpool in the Strait of Messina (between Sicily and the southern tip of the Italian mainland) which Homer depicted in his *Odyssey* as the second of two monsters, Scylla and Charybdis, faced by Ulysses. The malström in the narrow strait between two of the southern Loften Islands off Norway was a dangerous tidal whirlpool written about by both Jules Verne and Edgar Allan Poe.

Why are there large tidal ranges in some bays but not in others? Why do only a few rivers have large tidal bores? And what circumstances cause large tidal current speeds and in some cases large whirlpools? While it is the astronomical forcing of the tide that is the basis for the tide's predictability, it is the hydrodynamics (i.e., the physics of the water movement) of the tide that is responsible for these differences in tidal effects. And, as we shall see, it is the dimensions of the bay or river (and of any adjoining waterways) that control the hydrodynamics. It is the length, width, and depth of the waterway that determines the tidal range, as well as the specific times when high and low waters occur. These dimensions also determine whether the tide will be semidiurnal, diurnal, or the in-between case referred to as a *mixed* tide. (A mixed tide has two high waters and two low waters a day, like a semidiurnal tide, but with one high water much higher than the other high water and/or one low water much lower than the other low water.)

The large tidal range that we see in bays and rivers is not directly generated there by the gravitational forces of the moon and sun. Such bodies of water are too small. Only the oceans are large enough for the relatively weak tide generating forces to produce an appreciable tide (see the December 1998 column). A very long wave with small amplitude is generated in the ocean which propagates toward a coast. When the tide wave reaches the shallower water of the continental shelf and the even shallower water of the bays and rivers, it is amplified by a number of hydrodynamic mechanisms.

The long tide wave from the ocean enters and propagates up a river as a *progressive wave*, that is, the crest of the wave (i.e., high water) moves progressively up the river, as does the trough of the wave (i.e., low water) [see Figure 1]. To someone on the shore, the tide doesn't look like a wave because its wavelength (the distance from one crest to the next crest) is hundreds of miles long and the change in water level is very slow, there being about 6¼ hours between the arrival of a crest (high water) and the arrival of the following trough (low water) and then another 6¼ hours until the arrival of the next crest. In such a progressive tide wave, the flood currents (i.e., the currents flowing up the river) are fastest at approximately the same time as high water, and the ebb currents (i.e., the currents flowing down the river) are fastest at approximately the same time as low water. Slack

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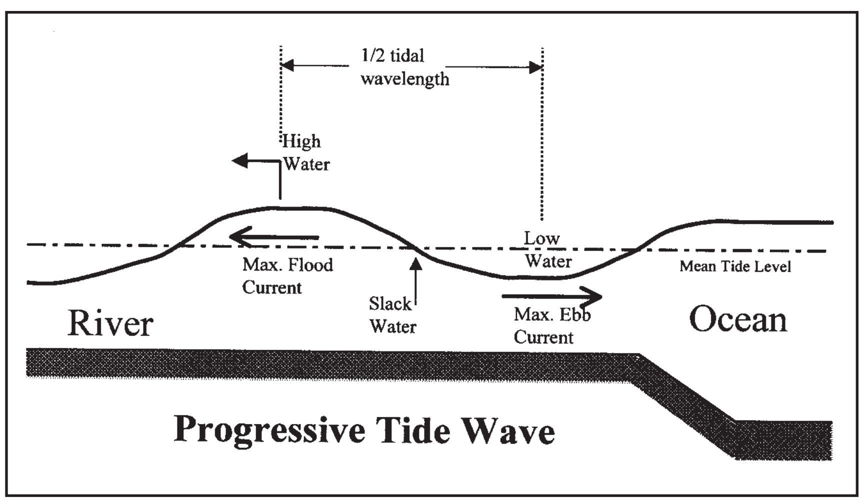

Figure 1. The tide propagating up a river as a progressive wave. High water occurs later as one moves upstream. The tidal wavelength is typically on the order of hundreds of miles.

Tides in Shallow Water

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water (i.e., when there is no current) occurs approximately halfway between the times of high water and low water. So as the progressive tide wave travels past an observer on the shore, the water flows upstream as the water level rises, reaching a peak flood current at high tide, then slows up, reverses direction, and flows downstream as the water level drops, reaching a peak ebb flow at low tide.

If there is nothing in a river to impede or stop the tide wave (like a dam or rapids or a sudden decrease in width), it will continue to travel up the river until friction wears it down. This decrease in tidal range as one goes up the river occurs because of the rubbing of the tidal currents on the bottom of the river, which dissipates energy from the tide wave. (The bottom resists the flow of the water over it and slows the water down right next to the bottom. This slower-moving water then slows the water just above it, which slows the water above it, and so on. The rougher the bottom the more energy that is lost from the wave.) However, if the width of the river decreases as the wave moves upriver, then the tidal range will be increased, because the same energy is being forced through a smaller opening. If the depth of the river decreases there is a similar but less dramatic amplifying effect. Decreasing depths will, however, also increase frictional energy loss and thus work to reduce the tidal range. (The frictional effect is stronger in shallower water because there is less water to slow down. In deep water the energy loss is spread over a larger water column, and so has less effect.)

The greatest amplification of a tide wave usually occurs in a bay (or in a river with a dam). In this case, the tide wave is reflected at the head of the bay (or at the dam) and travels back down the waterway toward the ocean. This *reflected* wave is not observable by someone on the shore because it is superimposed on the next incoming tide wave that is propagating up the bay, and it is the combination of the two waves that one observes. The resulting combined wave is called a *standing wave*, because the high and low waters do *not* progress up the

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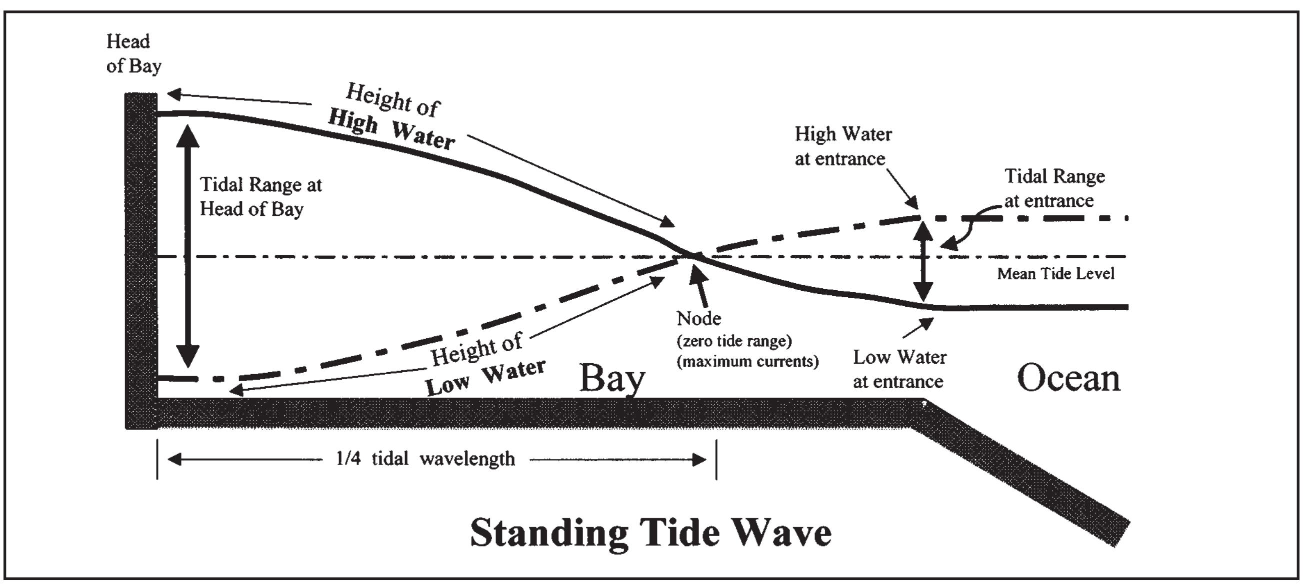

Figure 2. The tide as a standing wave in a bay. The water level merely moves up and down (the water level is shown for two extremes, high water and low water). High water occurs at approximately the same time everywhere, on one side of the node (which is the point of zero tidal range). This is an idealized case assuming there is no frictional effect. With friction the tidal range at the node is not zero and the times of high water do progress slightly up the bay.

Tides in Shallow Water

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bay or river. The water simply moves up and down everywhere at the same time (see Figure 2), with the greatest tidal range at the head of the bay. With a standing wave, the tidal range decreases as one moves from the head of the bay toward the ocean entrance, and, if the bay is long enough, reaches a minimum at one location (called a *node*) and then starts increasing again. This node occurs at ¼ of a tidal wavelength from the head of the bay (see Figure 2). (High water comes ½ a wavelength before low water, so if a high water travels a distance equal to ¼ of a tidal wavelength up the bay to the head and then ¼ of a wavelength back down the bay, it will have gone ½ a wavelength and so coincide with low water of the next incoming wave, and the two will cancel each other out at that location, producing a very small tidal range.) High waters occur at the same time everywhere on one side of the node, which is the same time as low waters occur on the other side of the node. For a standing wave the strongest tidal currents do not coincide with high water or low water, but occur when water level is near mean tide level, approximately halfway between the times of high water and low water. At the times of high water and low water there is no flow (slack water). The water flows into the bay, stopping the inward flow at high water, reverses direction, flows out of the bay until low water, at which time it reverses again and starts flowing into the bay again.

When length of a bay is exactly ¼ of a tidal wavelength, then a situation called *resonance* occurs, which creates the largest tides possible. To understand why resonance occurs we must look at this from the point of view of the ocean tide forcing the water inside the bay to oscillate. When the water in the bay is forced to move up and down by the tide at the entrance, it will freely oscillate (slosh up and down) with a natural period that depends directly on its length and inversely on (the square root of) its depth. If the basin has the right combination of length and depth so that the natural period is the same as to the tidal period, then the oscillation inside the bay will be synchronized with the oscillation at the entrance due to the ocean tide. In other words, the next ocean tide will be raising the water level in the bay at the same time that it would already be rising due to its natural oscillation (stimulated by the previous ocean tide wave), so that both are working together, thus making the tidal range inside higher.

Most bays actually fall in between the extremes of pure progressive wave and pure standing wave described above, because friction reduces the tide wave as it travels. Thus, the reflected wave will always be smaller than the incoming wave, especially near the bay entrance, and the combination of the two frictionally damped progressive waves will not be a pure standing wave. There will be no point of zero tidal range, but only an area of minimum tidal range. There will be some progression of high waters (and low waters) up the bay, and maximum flood or ebb currents will not occur exactly half way between high water and low water. A basin ¼ of a wavelength long will still produce the largest possible tidal range at the head of the bay, but friction keeps that tidal range much smaller than it would be without friction.

In some bays the very high tidal range at the head of the bay is due to a combination of both a narrowing width and a near resonant situation (due to the right length and depth). The highest tidal ranges may involve several amplifications, the bay being perhaps connected to a gulf with perhaps a wide continental shelf beyond that, with amplifications of the tide wave occurring in each basin. This is the case with the Bay of Fundy tides, the tide wave being already amplified by the Gulf of Maine and the continental shelf prior to entering the Bay of Fundy.

Huge tidal ranges are not restricted to bays. If the continental shelf is the right combination of depth and width, a near resonant situation can also result. This is the reason for the 40-foot tidal ranges along the coast of southern Argentina. The continental shelf there is over 600 miles wide, and includes the Falkland Islands near the edge of the shelf (where the tidal ranges only reach 6 feet). The distance from the Argentinean coast to the edge of the shelf is fairly close to ¼ of a tidal wave-

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length for that depth of water. Essentially, that wide shelf has a natural period of oscillation that is fairly close to the tidal period.

The largest tidal currents in bays tend to be near the entrances. Maximum tidal current speeds are zero right at the head of the bay (since there is no place for the water to flow). As one moves down the bay toward the ocean, the maximum flood and ebb tidal current speeds increase, with the greatest speeds occurring at the entrance, or, if the bay is long enough, at the area of smallest tidal range (the nodal area). However, if the width of the bay decreases at any point, the current speeds will be increased in that narrow region (since the same volume of water is being forced to flow through a smaller cross-section, it must flow faster). This can be especially dramatic if there is a sudden decrease in width and depth. The largest tidal currents are found in narrow straits in which the tides at either end have different ranges or times of high water.

Where a strait suddenly becomes very narrow and/or shallow, or where it bends or has irregularities in the bottom, eddies can be formed. Where the tidal currents are very strong, a much stronger and longer lasting whirlpool (strong enough to overturn small boats) can be formed. To envision one way in which such a whirlpool can be created look at Figure 3. When the tidal flow from the south moves through the strait, the current vectors follow the shoreline and converge to flow through the narrow opening. When the flow reverses, however, the flow from the narrow section enters the wider southern area like a jet, with the fast flows in the center. There is nothing to directly slow the flow that had been moving north close to the coast, and, even while the flow in the center is toward the south, that coastal flow's inertia keeps it going northward, until the land forces it to the west to join with the southerly flow, thus forming the circular flow of the whirlpool. It is this sheltering effect of the point of land that creates the whirlpool, but in other cases some well placed large rocks in the fast tidal flow could have a similar effect.

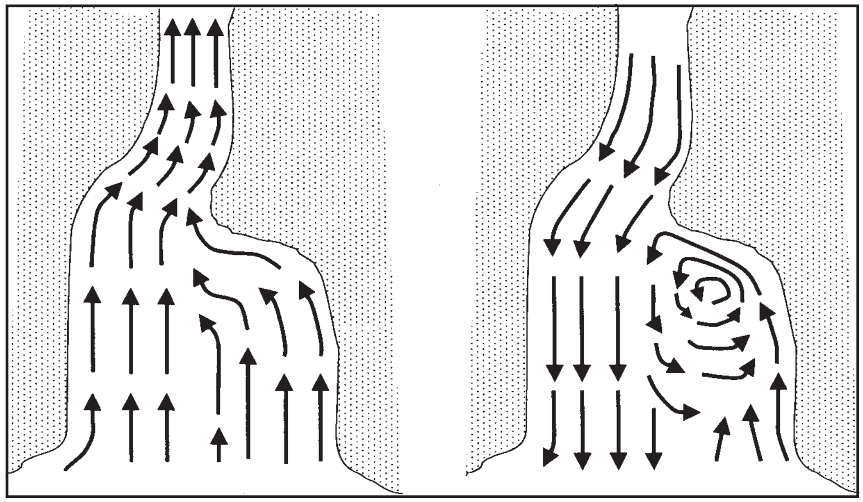

Figure 3. The spawning of a tidal whirlpool in a narrow strait. The whirlpool (in the right panel) forms due to the sheltering effect of land when the strong tidal flow is toward the south. On the east side of the strait, the coastal flow's inertia keeps it going northward, until the land forces it to the west to join with the southerly flow

In our December 1998 column we explained the origin of a diurnal tidal signal due to the declination of the moon, north or south of the equator. In a particular bay the size of this diurnal signal (compared with the usually dominant semidiurnal tidal signal) also depends on the dimensions of the basin. A particular bay could have a natural period of oscillation that is closer to the diurnal tidal period (approximately 24.84 hours) than to the semidiurnal period. Thus, the diurnal forcing at the entrance to the bay could be amplified more than the semidiurnal signal. Depending on the size of the diurnal signal at the entrance the result could be a mixed tide or a diurnal tide. At such locations (such as parts of the Gulf of Mexico) the tide will be diurnal near times of maximum lunar declination, but will be semidiurnal near times when the moon is over the equator.

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The wavelength of a tide wave in a bay depends on the depth of the water and on the tidal period. The shallower the bay the shorter the wavelength. The longer the tidal period the longer the wavelength. A diurnal tidal component has a wavelength twice as long as a semidiurnal tidal component since its period is twice as long. When a waterway is shallow enough and long enough so that more than ¼ of a semidiurnal wavelength fits in the waterway, there will be a nodal area with a very small semidiurnal tidal range. This will be an area where the diurnal tide could dominate (the diurnal tide would still be large at the semidiurnal nodal area, since the diurnal node will be twice as far from the head of the bay). Thus near the head of the waterway the tide could be semidiurnal, but near the semidiurnal nodal area the tide could be mixed or even diurnal. This is the case near Victoria, British Columbia, at the southeastern end of Vancouver Island (see Figure 4). At that location along the Strait of Georgia-Strait of Juan de Fuca waterway, the semidiurnal

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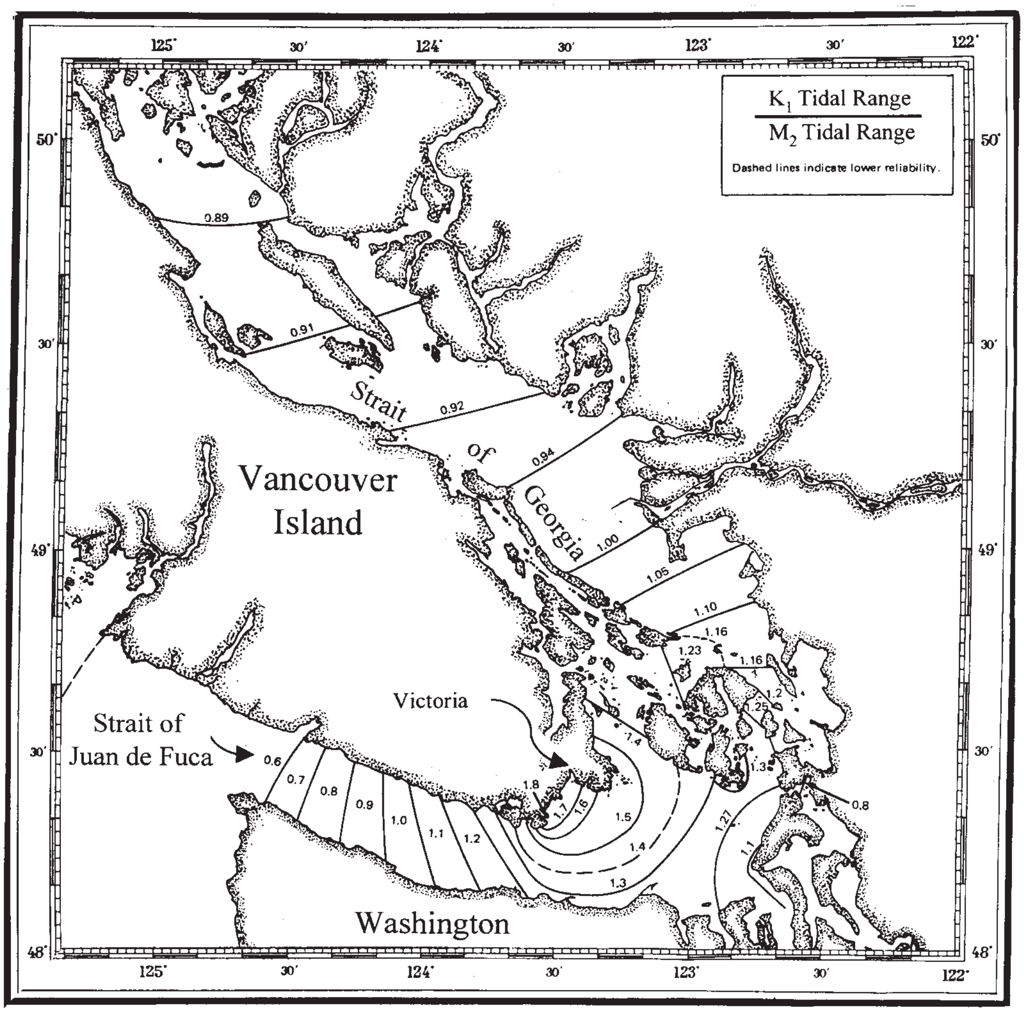

Figure 4. The ratio of the diurnal component of the tide (K_1) to the semidiurnal component of the tide (M_2) along the length of the Strait of Georgia-Strait of Juan de Fuca. The highest ratio of diurnal range to semidiurnal range occurs near Victoria, British Columbia, because that is the area of the semidiurnal node (minimum M_2 tidal range), which is ¼ of a semidiurnal tidal wavelength from the northern end of the Strait of Georgia.

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tidal component decreases to a minimum, but the diurnal component does not, and so the tide becomes diurnal (while at the northern end of the Strait of Georgia the tide is semidiurnal).

Whether due to a basin size conducive to amplifying the diurnal signal in the tide and/or due to the existence of a semidiurnal nodal area (leaving the diurnal signal as the dominant one), there are numerous areas around the world with strong diurnal tides—places like Norton Sound in Alaska near the Bering Strait and various (but not all) locations in the Philippines, New Guinea, and the islands of Indonesia. In southern China, at Beihai, and at Do Son, Vietnam, the diurnal signal is dominant, with tidal ranges that reach 15 feet and 10 feet respectively (near times of maximum southern declination of the moon); the tide even remains diurnal even nears times when the moon is over the equator.

The primary effect of shallow water on the tide that we have discussed so far is that it shortens the tidal wavelength down to the same order of magnitude as the lengths of bays and river basins, thus bringing the dynamic situation closer to resonance and increasing the tidal ranges. [Or, one can also look at it from the point of view of the shallower depths increasing the natural periods of these bays and rivers (which are very small basins compared to the ocean) to be closer to the tidal period.] However, very shallow water can have other effects on the tide, for example, distorting the shape of the tide wave, that is, making it very asymmetric, so that its rise and fall (and its flood and ebb) are no longer equal (see the second curve in Figure 5). The tide can then no longer be described by a simple cosine wave (the first curve in Figure 5). In some cases such distortion leads to double high waters or double low waters (see third curve in Figure 5). The extreme case of distortion is a tidal bore (the fourth curve in Figure 5).

How does shallow-water distort the tide? The speed at which a long wave (like the tide) travels depends on the depth of the water; it is directly proportional to (the square root of) the depth. When depth of the water is much greater than the tidal range, the speed of the crest of a tide wave and the speed of the trough are virtually the same, since the tide wave itself has only a very small effect on the total water depth. But in the shallow waters of bays and rivers where the depth is not much greater than the tidal range, the total water depth under the crest is larger than the total water depth under the trough. In this case, the crest of the wave (i.e., high water) travels faster than the trough of the wave (i.e., low water). If the tide wave travels far enough the crest begins to catch up with the trough ahead of it (which is falling behind the crest ahead of it). The shape of the tide wave begins to look like the second curve in Figure 5, with a more rapid rise to high water and a slower fall to low water. It can also modify the tidal current so that the flood current is stronger, but lasts a shorter time than the ebb current.

Another shallow water distorting mechanism depends on friction, which can have both asymmetric and symmetric effects. The asymmetric effect (similar to that just discussed and represented in Figure 5) results because friction has a greater effect in shallow water than in deep water, and so it slows down the trough more than the crest. A symmetric effect results because energy loss due to friction is proportional to the square of the current. This means that there will be much more energy loss during times of maximum flood and maximum ebb than near slacks. This effect, combined with the asymmetric effect, can lead to double high or low waters (see third curve in Figure 5).

Friction, of course, dissipates energy from the entire wave and slowly wears the entire wave down. However, if, as the wave propagates up the river, the river's width is decreasing significantly, this can keep the amplitude of the wave high in spite of the friction. Thus, the tide wave can continue to travel up a narrowing river, getting more and more distorted in shape.

In a river there will also be the river current itself (resulting from fresh water flowing downhill)

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Tides in Shallow Water

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added onto the tidal current. This will make the ebb current faster and last longer, while producing a shorter slower flood current phase. Far up a river where the river flow is faster than the strongest tidal current, the flow of water will always be downstream, but the speed of flow will oscillate, flowing the fastest downstream at the time of maximum ebb for the tidal current and flowing the slowest downstream at the time of maximum flood for the tidal current. This is a simple addition to the tide, but the river flow also interacts with the tide and distorts it; this interaction is caused by friction. As just mentioned, energy loss due to friction is proportional to the square of the total current. When the river current, flowing in the same direction as the ebb current, creates a larger combined ebb current, there is a greatly increased energy loss. Likewise, when the river current, flowing opposite to the flood current, reduces the total speed, the energy loss is greatly reduced. This not only has an asymmetric effect that distorts the tide (causing a faster rise to high water and delaying the time of low water), but it also further wears down the entire wave because the increased energy loss during ebb is out weighs the decreased energy loss during flood.

Oceanographers refer to these various shallow-water effects on the tide as *nonlinear* effects,

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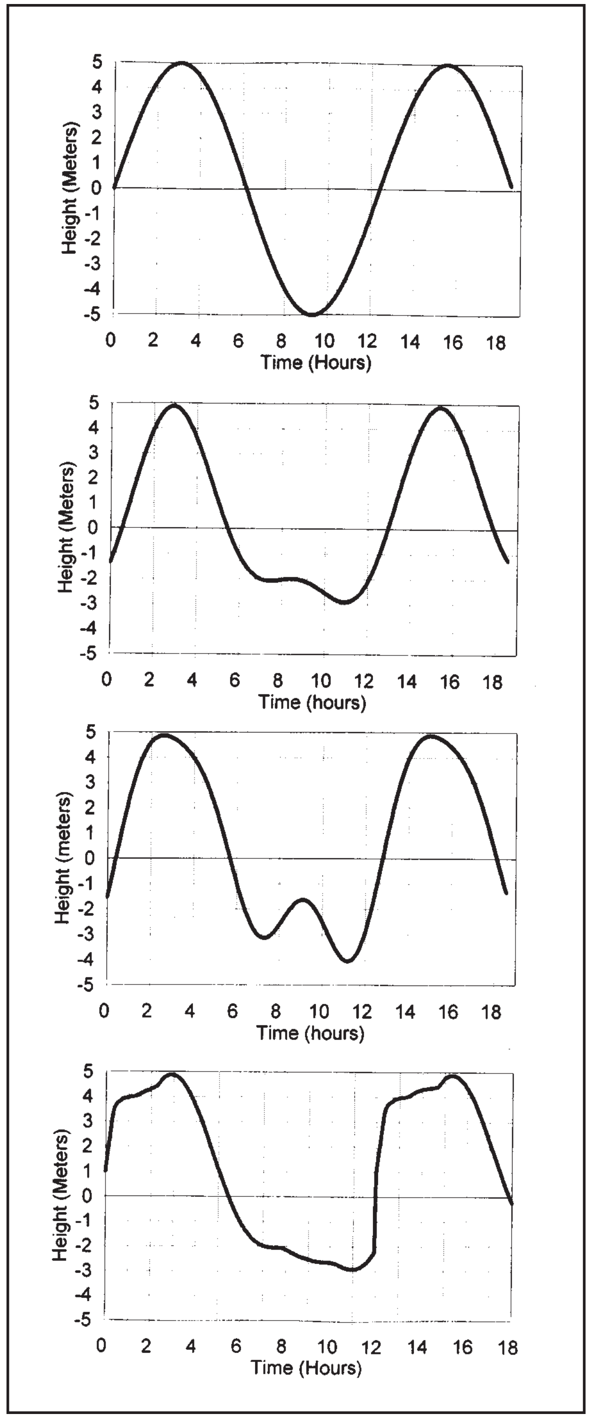

Figure 5. Typical tide curves (i.e., tidal height changing with time, over 1½ tidal cycles) for an area with no shallow-water effects (top panel) and three areas with different degrees of distortion caused by the shallow water. In the third panel a double low water occurs. The fourth panel shows the almost instantaneous rise in water level due to the passage of a tidal bore.

Tides in Shallow Water

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referring to the mathematical representation of the hydrodynamics. When one property depends directly on another property that is a *linear* relationship; for example, if energy (E) was directly proportional to the speed (u) of the current (e.g., E = ku, where k is some constant). In a nonlinear relationship energy might be directly proportional to the square of the speed (e.g., $E = k u^2$). When relationships are linear, different components or phenomena simply add together—they don't affect each other. But when relationships are nonlinear, various phenomena interact and change each other. The discussion above about the river current simply adding onto the tidal current to create faster ebb currents and slower flood currents was actually a linear approximation for what goes on. Frictional energy being proportional to u^2 causes the interaction of the river flow with the tide that distorts it and reduces its tidal range. Another type of nonlinear shallow-water effect causes interactions between storm surge (generated by the wind) and the tide. In this case, when the water level is raised by the wind, that increases the water depth and changes the tidal dynamics, usually increasing the tidal range.

As already mentioned, the extreme case of tidal distortion is the tidal bore, in which most of the above discussed nonlinear effects combine in a complex way (that is only recently starting to be understood). Tidal bores occur in rivers with dramatically decreasing widths and very large tidal ranges at the mouth. They have been written about throughout history. One of the most famous was the tidal bore that almost destroyed the army of Alexander the Great in the Indus River of India in 325 B.C. The oldest tide table (for which a copy still exists) was produced by the Chinese to predict the occurrence of the tidal bore in the Tsientang River. The table was carved in stone on the Zhejiang Ting pavilion on the bank of the Tsientang at Yanguan. A printed version was produced in 1056 A.D., 200 years before the earliest known printed European tide table, for London Bridge in England.

Ancient Chinese scientists appear to have understood that the bore was caused by the tide and that the tide was connected with the moon and sun (described as early as the first century by Wang Chung). However, the Chinese population had many legends to explain the bore, and religious significance was given to the times when the bore was largest and went the furthest up the river (such as at spring tides). Their imaginations were stimulated not just by the huge wall of water moving swiftly up the river (and capsizing any Chinese junks which had not managed to get to the safety of the specially built shelters along the shoreline), but also by the thunderous roar that could be heard while the bore was still miles away. The longest lasting legend in China about the bore was that around the 5th century a virtuous minister, named Wu Tzu-Hsu, was unjustly killed by his prince and then thrown into the river. The vengeful spirit of Wu Tzu-Hsu caused the bore, rousing the waves to the their periodic wrath and havoc. At the mid-autumn full moon ("the 18th day of the 8th month") when the bore was very great, people from hundreds of miles away would gather on the shore and watch boatmen and fishermen plunge against the wave and others swim in the river with flags in their hands to meet Tzu-Hsu . Since many people were often drowned during this festival, governors as early as the 11th century tried to ban the activity, but to no avail, and the festival continued into the 19th century.

Surprisingly, those 1056 A.D. tide tables still do a fairly good job of predicting the occurrence of the bore today, which is amazing since river conditions have probably changed many times since the 11th century. In other rivers around the world, changing river conditions have eliminated bores that used to exist. There is, for example, no longer a bore in the Indus River, nor in the Seine River in France (where a bore killed Victor Hugo's daughter), nor in the Colorado River in the U.S., nor in several other rivers where dams or dredging have changed the hydrodynamics.

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

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

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

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

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

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

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

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

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

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

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

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

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

Marine Weather Review
North Atlantic Area
April through August 1999

George Bancroft
Meteorologist
Marine Prediction Center

Like the North Pacific, the North Atlantic experienced its most active weather in April. An upper level low was persistent near or just east of Newfoundland, steering developing low pressure systems off the U.S. East Coast or Canadian Maritimes and then east or northeast toward Europe. Many of these lows developed storm force winds (52 knots or greater). A large storm system formed at 43N 44W on 2 April (first surface chart Figure 1). The absorption of three other lows to the west, each with its surge of arctic air, were factors in this development. Note the first surge of arctic air south of Newfoundland with a 50 kt ship report at 39N 55W. This is an area of heavy ship traffic; and the maximum seas generated were the highest in the North Atlantic during this period. The second surface chart in Figure 1 shows the system at maximum intensity on 3 April, and the third part of the figure is a sea state analysis 24 hours later showing up to 11 meter seas (36 ft) south of the center.

The low approaching the Great Lakes in the second analysis of Figure 1 moves southeast of Nova Scotia in Figure 2 with a strong surge of arctic air behind it, and good support aloft from the digging short wave troughs at 500 mb. The central pressure dropped to 976 mb by 0600 UTC 6 April, just southeast of Cape Race, but

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North Atlantic Area

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much of the intensification was in the 18 hour period ending at 0600 UTC 5 April. The highest wind report from a ship was a south wind of 50 kt near 43N 43W at 0000 UTC 6 April. The storm then moved northeast and slowly weakened. The cold air pouring south over relatively warm water behind this system had considerable effect on the sea surface, and seas were up to 9 meters (29 feet) west of the low in spite of limited fetch (see sea state analysis in Figure 2).

In mid April the upper low near Newfoundland moved northeast, allowing rapid movement of systems from off the U.S. East Coast across the Atlantic with intensification. Figure 3 shows the development of the most intense low of the five-month period, in terms of central pressure. This fast moving system strengthened rapidly as it approached the British Isles, with the central pressure dropping 25 mb in the 24-hour period ending at 0600 UTC 20 April. The third analysis in Figure 3 shows this system at peak intensity of 964 mb. This was the only storm in either ocean to drop below 970 mb during the period of this report. There were two ship reports with west winds of 50 kt along 50N south of the center, one at 1800 UTC 19 April and the other at 0600 UTC 20 April, and reported seas were up

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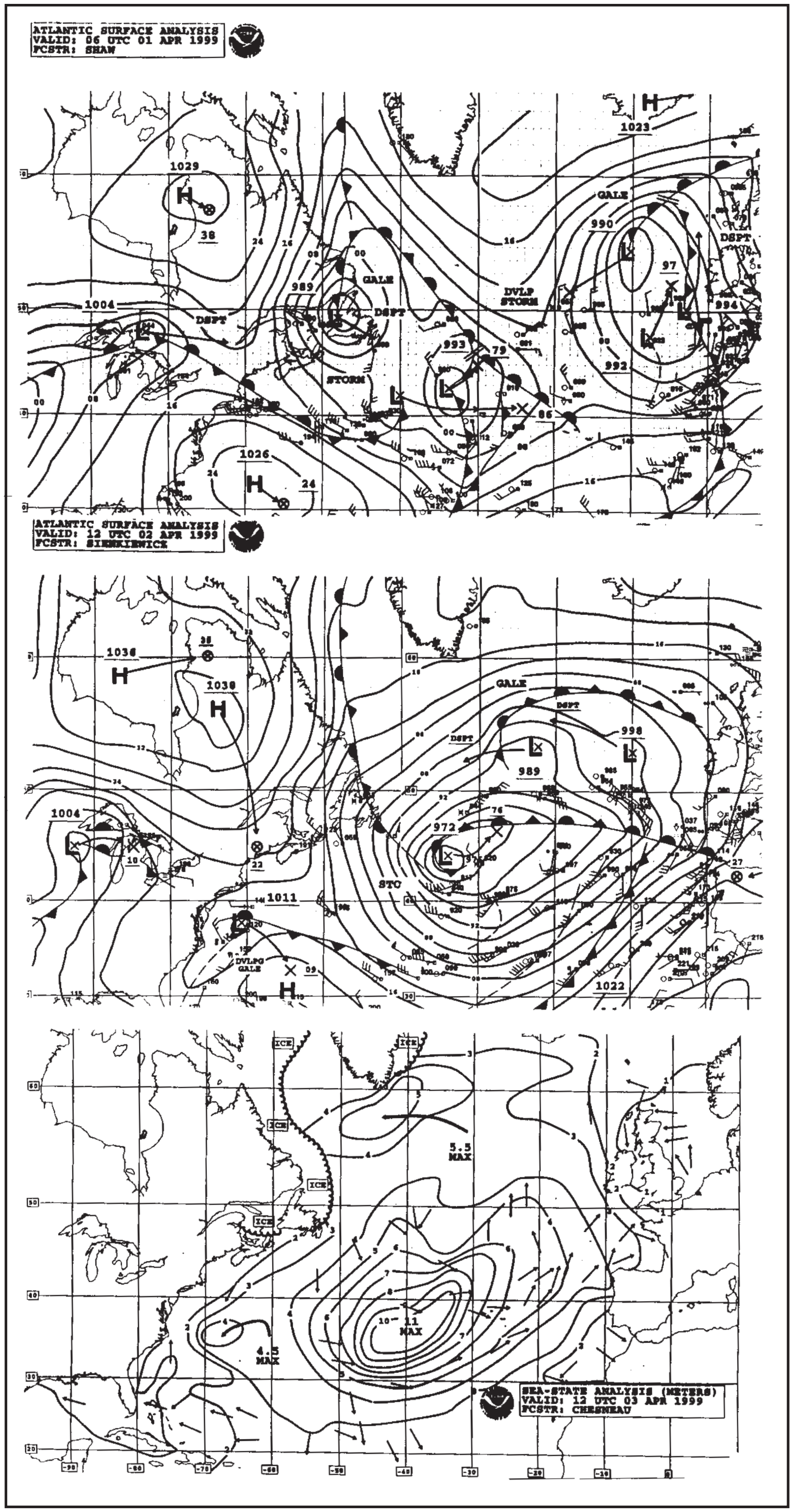

Figure 1. Series of two MPC North Atlantic surface analyses valid 0600 UTC 01 April and 1200 UTC 02 April 1999; plus a sea state analysis valid 1200 UTC 03 April 1999, or 24 hours after valid time of second surface analysis.

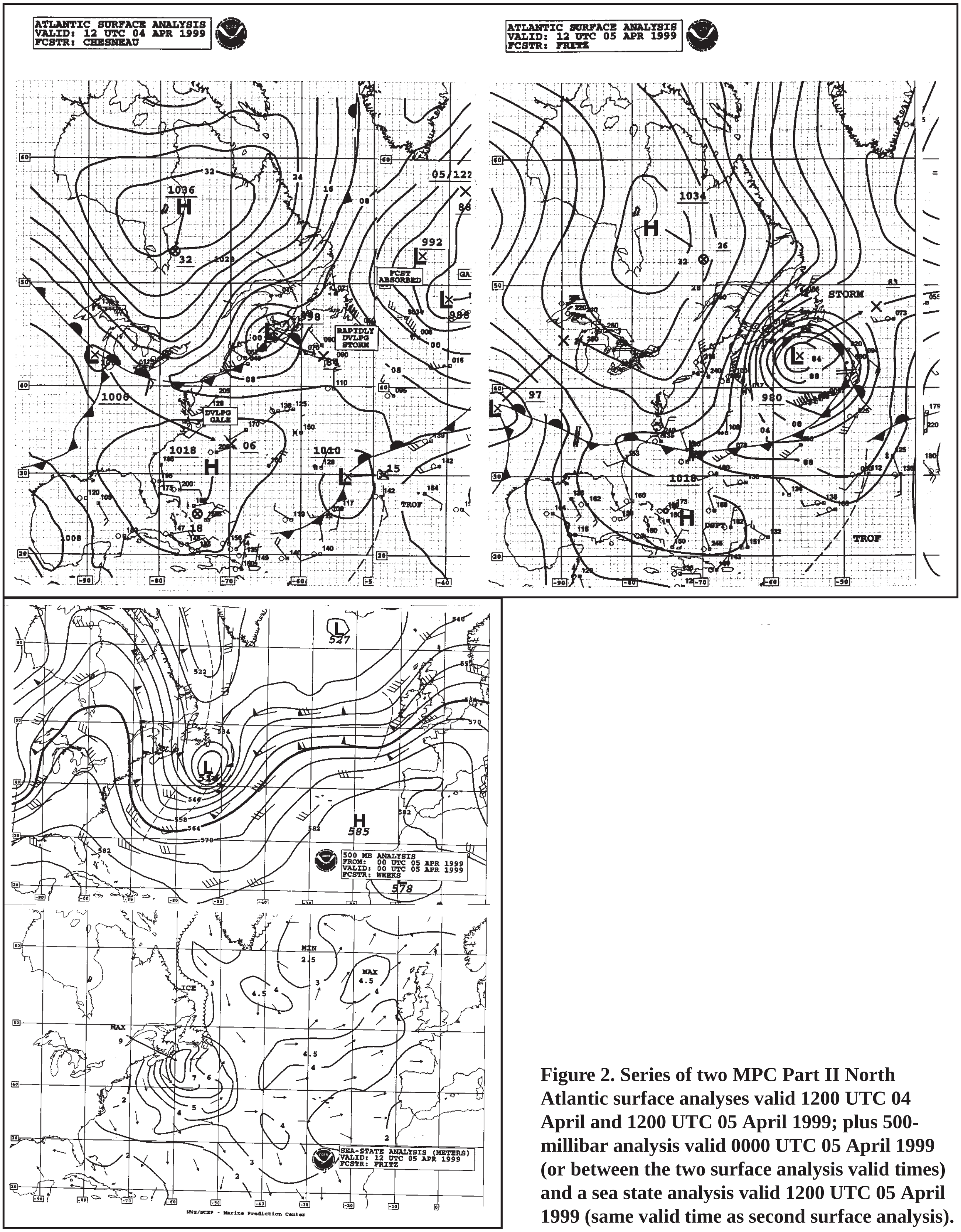

Figure 2. Series of two MPC Part II North Atlantic surface analyses valid 1200 UTC 04 April and 1200 UTC 05 April 1999; plus 500-millibar analysis valid 0000 UTC 05 April 1999 (or between the two surface analysis valid times) and a sea state analysis valid 1200 UTC 05 April 1999 (same valid time as second surface analysis).

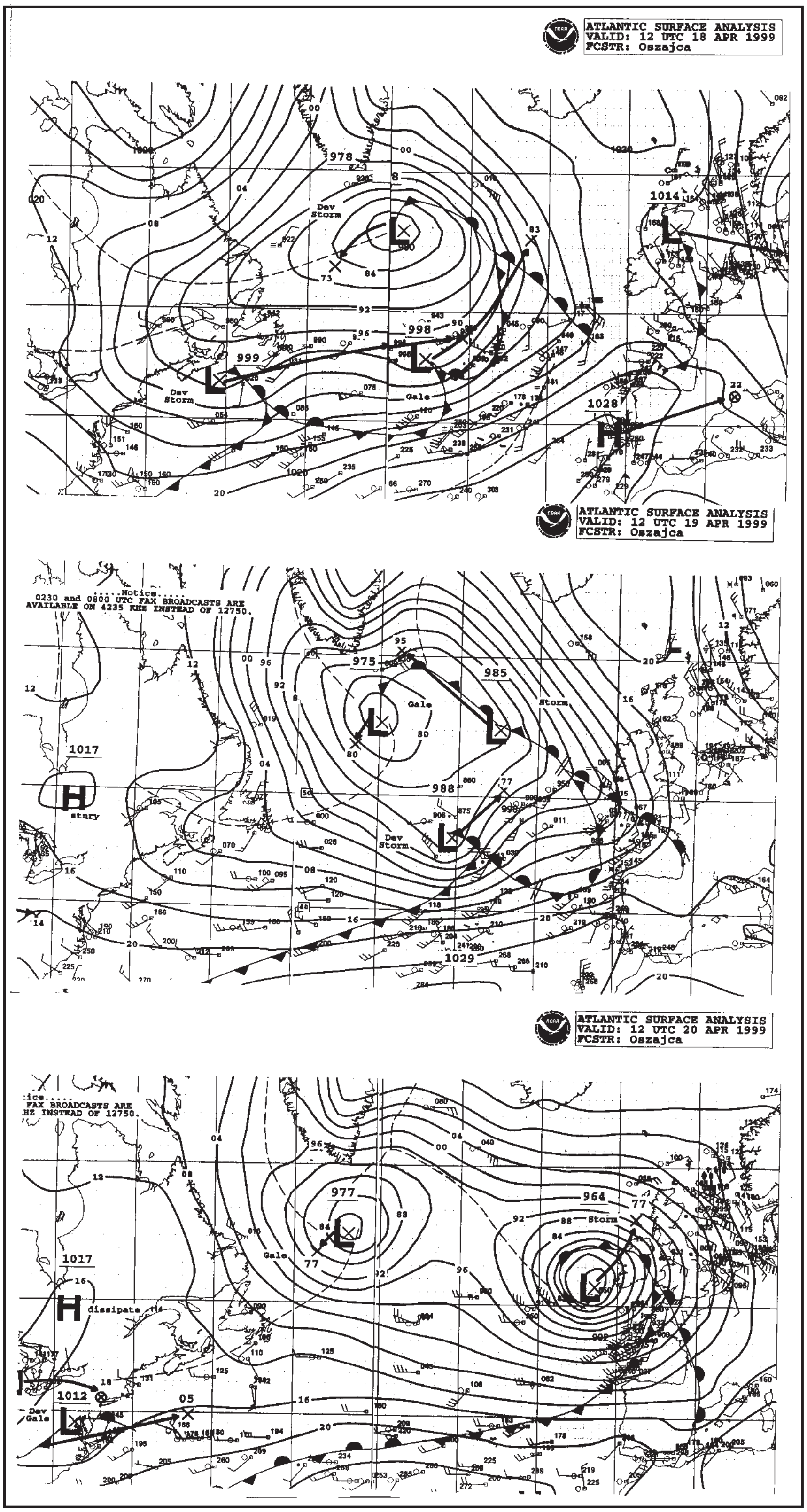

Figure 3. Series of three MPC North Atlantic surface analyses valid at 1200 UTC on each of the dates April 18, 19, and 20, 1999. Development of eastern North Atlantic storm is shown.

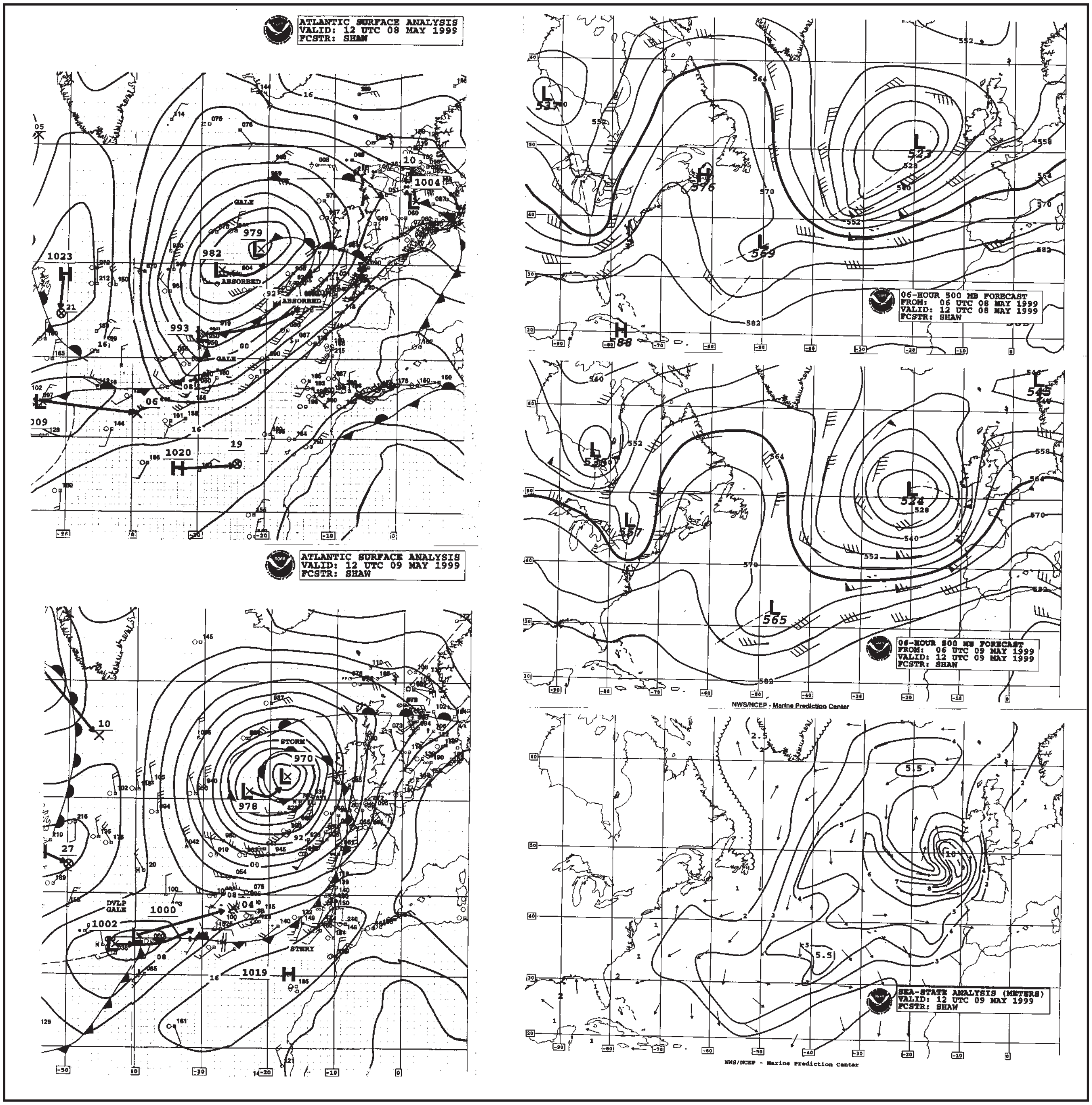

Figure 4. Series of two MPC Part I North Atlantic surface analyses valid at 1200 UTC on each of the dates May 8 and 9, 1999; plus series of two 500-millibar analyses (actually computer-generated 6-hour model forecasts with short wave troughs manually added) valid at 1200 UTC on each of the dates May 8 and 9, 1999, and a sea state analysis valid at 1200 UTC 9 May, 1999 (same valid time as second surface analysis).

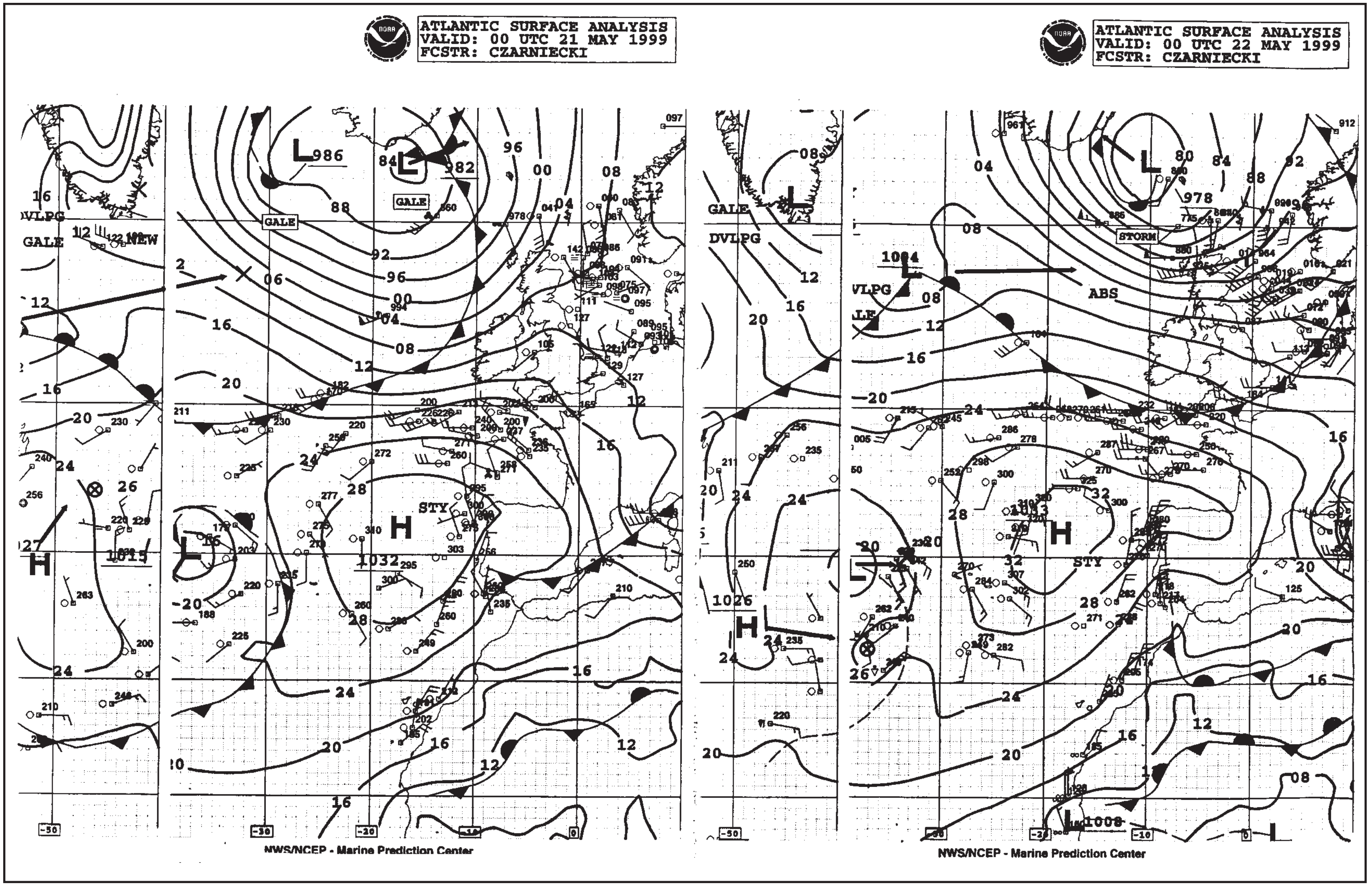

Figure 5. Series of two MPC Part I North Atlantic surface analyses valid at 0000 UTC on each of the dates May 21 and 22, 1999. Development of storm in far northeast Atlantic is shown.

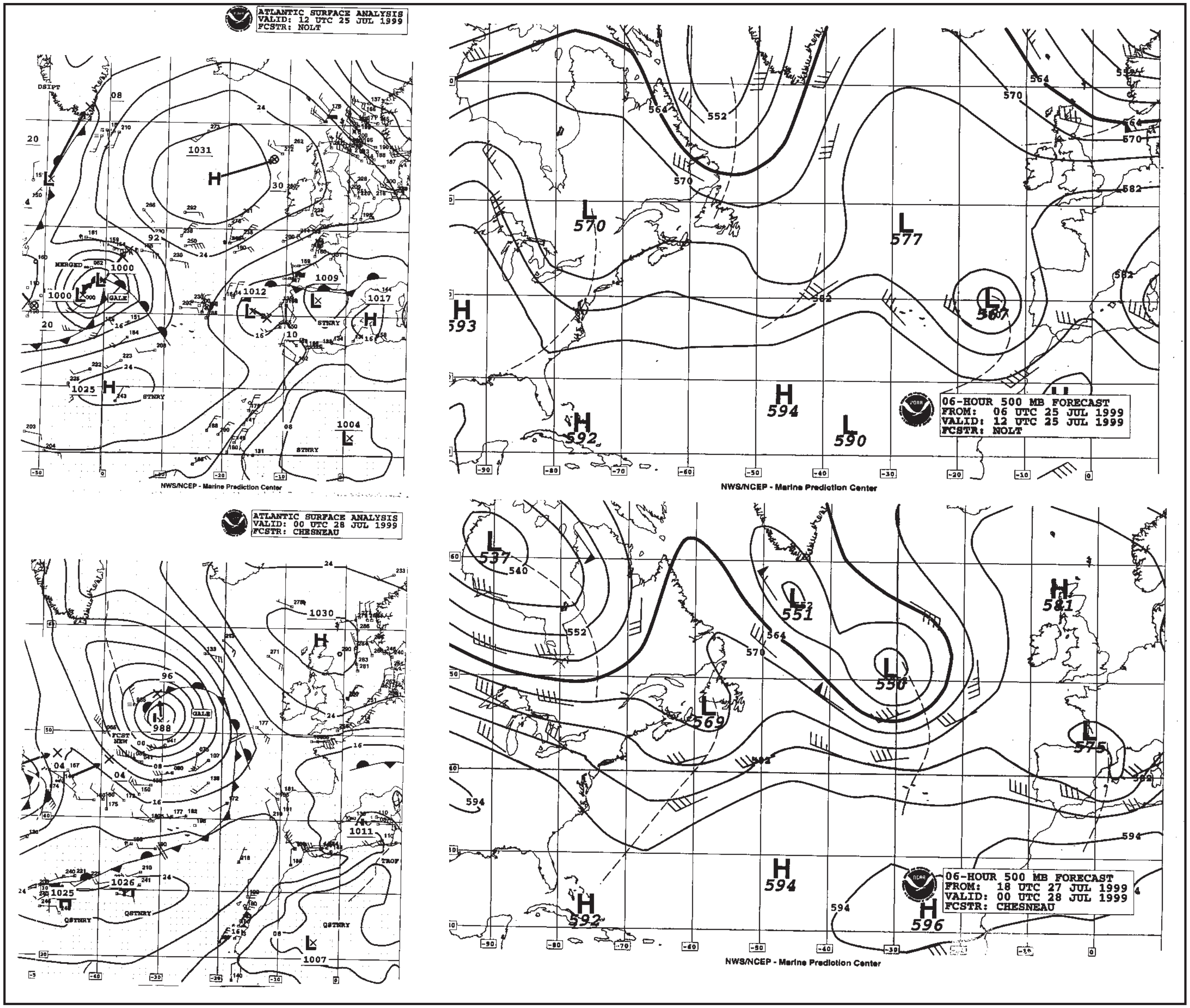

Figure 6. Series of two MPC Part I North Atlantic surface analyses and corresponding 500-millibar analyses (actually computer-generated 6-hour model forecasts with short wave troughs manually added) valid at 1200 UTC 25 July and 0000 UTC 28 July 1999. Development of a strong gale in central portion of North Atlantic is shown.

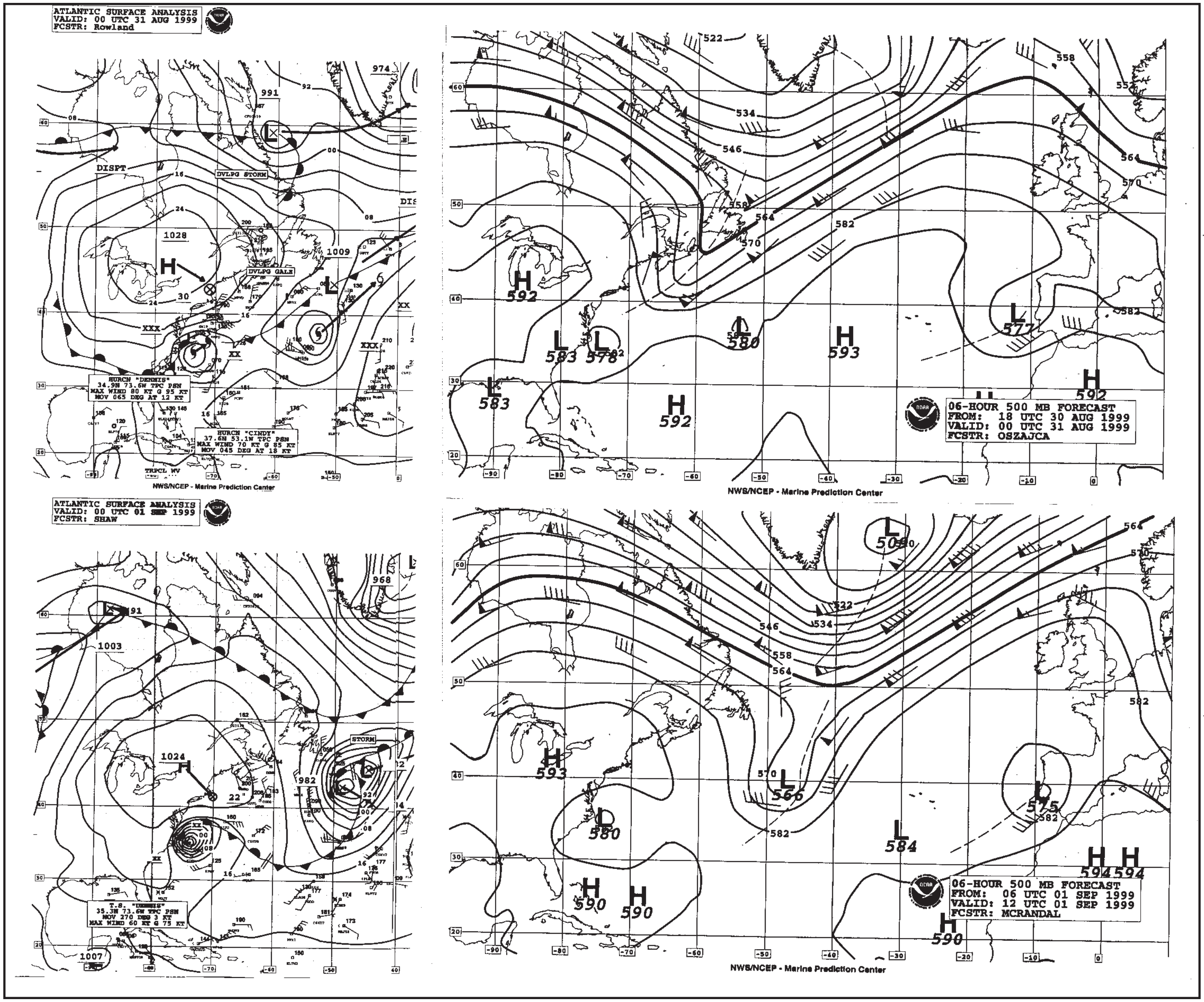

Figure 7. Series of two MPC Part II North Atlantic surface analyses valid at 0000 UTC 31 August and 0000 UTC 01 September, 1999, plus series of two 500-millibar analyses (6-hour model forecasts with short wave troughs manually added) valid at 0000 UTC 31 August and 1200 UTC 01 September 1999 (second 500-mb analysis valid 12 hours after second surface analysis).

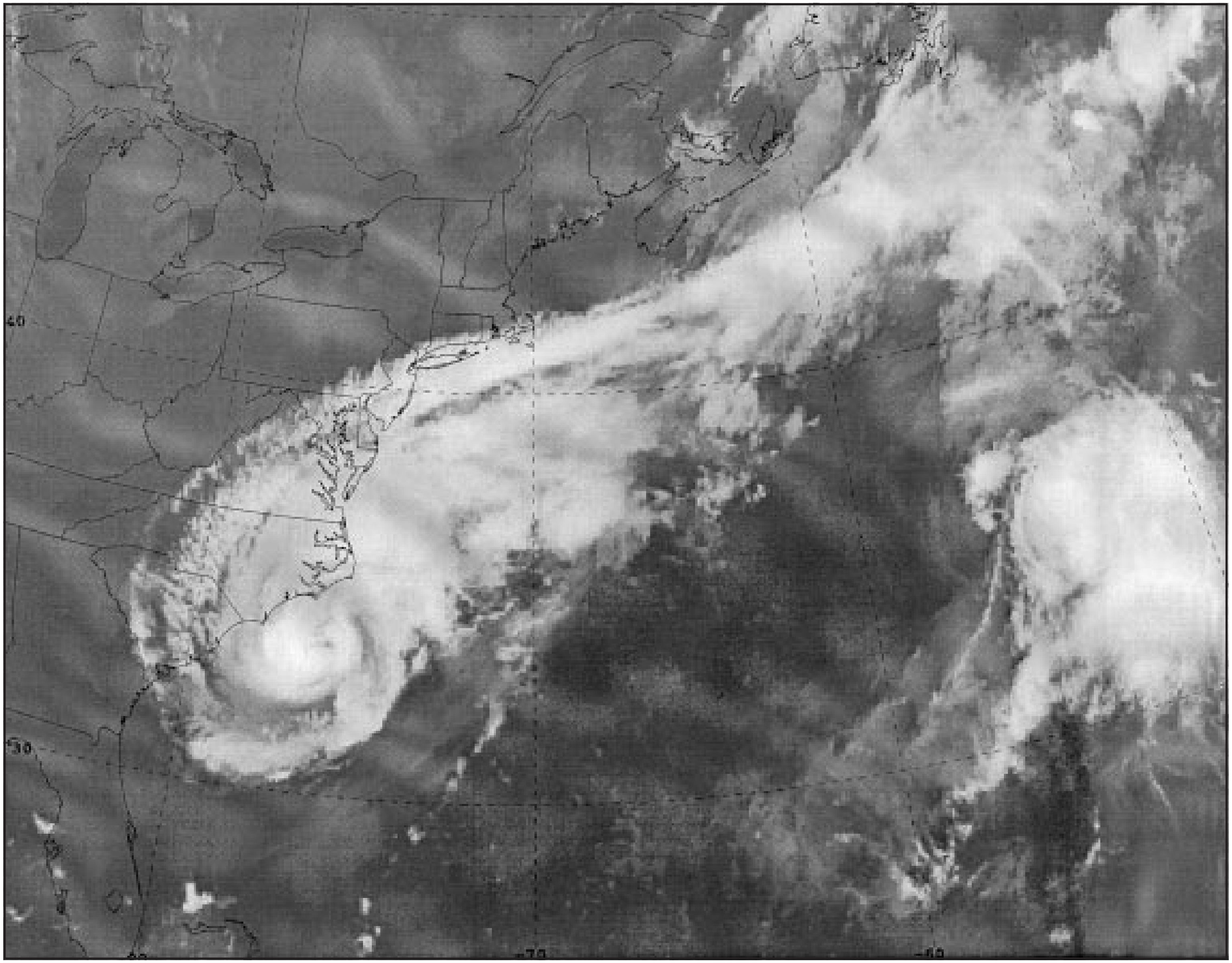

Figure 8. GOES-8 infrared satellite image valid at 1145 UTC 30 August 1999 (or about 12 hours prior to valid time of first surface analysis in Figure 7). Hurricanes Dennis (near North Carolina coast) and Cindy (near 35N 54W) are shown.

North Atlantic Area

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to 7 meters (24 ft) south of the center.

The upper air steering pattern underwent rapid changes late in April and into May as a strong upper level ridge developed over the middle of the Atlantic. It then retrogressed (shifted westward) to near the U.S. East Coast in early May. This shut off the flow of low pressure systems off the East Coast, except for the formation, at the end of April, of a cutoff low which lingered off the southeast U.S. coast for several days. The stronger activity shifted to the eastern Atlantic early in May where a large and complex low formed. The surface and 500 mb charts in Figure 4 show a gale center near 51N 21W which intensified even more as a 500 mb short wave trough triggered redevelopment on the cold front to the south of the main center. The new low is shown in the second surface analysis (1200 UTC 9 May), absorbing the old center. The central pressure dropped to 970 mb, the lowest pressure in the North Atlantic for May. The sea state analysis for 1200 UTC 9 May in Figure 4 shows maximum seas of 10 meters (33 ft) near the strong cold front associated with this system.

The westerly upper level flow 0600 UTC 27 July the ship **SFPM** (name not available) reported from 47N 32W with a pressure of 984.9 millibars. The same ship at 0000 UTC 28 July reported 8.5 meter seas (28 ft) south of the center near 46N 34W, the highest seas reported with this system.

Tropical Activity

The first tropical cyclone of the Atlantic hurricane season was Tropical Storm Arlene, which drifted slowly north from near 60W and 31N over a one week period in the middle of June. It dissipated northeast of Bermuda on June 18.

After Arlene, there was no tropical cyclone activity until late August, when Hurricanes Cindy and Dennis moved into the area at about the same time. Figure 7 shows Hurricane Cindy at 0000 UTC 31 August approaching a frontal zone to the north, and then becoming an extratropical storm 24 hours later. At 500 mb, Cindy appears as a weak 500 mb low at 38N 53W that is picked up by a strong short wave trough approaching from the northwest. The ship **Fidelio** (**WQVY**) reported a north wind 60 kt on the back side of the extratropical storm at 0000 UTC 1 September. Hurricane Dennis moved northeast just off the coast of the Carolinas on August 30 and 31, and then became “trapped” by a building high pressure ridge at the surface and aloft to the north and northeast. Dennis weakened to a tropical storm and stalled for several days off the North Carolina coast before moving inland over North Carolina by Labor Day weekend. Frying Pan Shoals near the southeast coast of North Carolina reported a north wind 80 kt with gusts to 97 kt at 1000 UTC 30 August with the passage of Dennis. Seas reached 9 meters (31 ft) at Frying Pan Shoals prior to this, at 0200 UTC 30 August. Buoy **41004** (32.5N 79W) reported northwest wind 51 kt with gusts of 72 kt at 0400 UTC 30 August. Seas reached 11 meters (37 ft) at buoy **41002** (32N 75W) at 1200 UTC on 30 August. The pressure dropped to as low as 976 mb at buoy **41001** (35N 73W) as Dennis moved just to the north at 0400 UTC 31 August. Seas were 10.5 meters (34 ft) at this buoy. The **Zim USA** (**4XFO)** reported from 32N 76W with a south wind 60 kt at 0600 UTC on 30 August.

Figure 8 is a GOES8 infrared satellite image of Hurricanes Cindy and Dennis valid 1145 UTC 30 August (about 12 hours prior to the map time in the first surface analysis of Figure 7). An eye is visible only in Dennis. As the descriptive tropical cyclone labels in Figure 7 indicate, Dennis was somewhat stronger than Cindy at 0000 UTC 31 August.

Reference

Sienkiewicz, J. and Chesneau, L., *Mariner’s Guide to the 500-Millibar Chart* (Mariners Weather Log, Winter 1995).⚓

Marine Weather Review
North Pacific Area
April through August 1999

George Bancroft
Meteorologist
Marine Prediction Center

The weather pattern over the North Pacific was quite active in April with marked northern and southern branches of the jet stream, more typical of late winter. There were two storm tracks: (1) east or northeast across the Bering Sea and into the Gulf of Alaska, and (2) a southern track, from near Japan toward the Gulf of Alaska. The storms then turned southeast or redeveloped over the western U.S. Many of these low pressure systems attained storm strength (wind speed 52 knots or greater, Beaufort force 10 or greater) in April. Figure 1 depicts what was perhaps the most active part of the April to August period in terms of storm developments. The storm that developed over the northern Kurile Islands early on 3 April and moved into the Bering Sea on 4 April was the strongest of the five-month period in terms of central pressure, winds, and seas. The 500 mb charts in Figure 1 show a strong short wave trough and jet stream winds of 100 kt or more which supported this development (an article with a complete description of the relationship of surface and 500 mb level features is mentioned in the References). The second surface analysis chart in Figure 1 shows the system at maximum intensity with ship reports of 50 to 65 kt wind on the south and southwest sides of the center. The **Margrethe Maersk** (**OYSN2**) reported a northwest wind of 65 kt and 15 meter (49 ft) seas near 49N 159E. To the southeast, the **Golden Gate Bridge** (**3FWM4**) reported a west wind of 55 kt and 9 meter seas (30 ft). Figure 2 is an infrared satellite image valid for 4 April with ship reports plotted. One can see that

Continued on Page 49

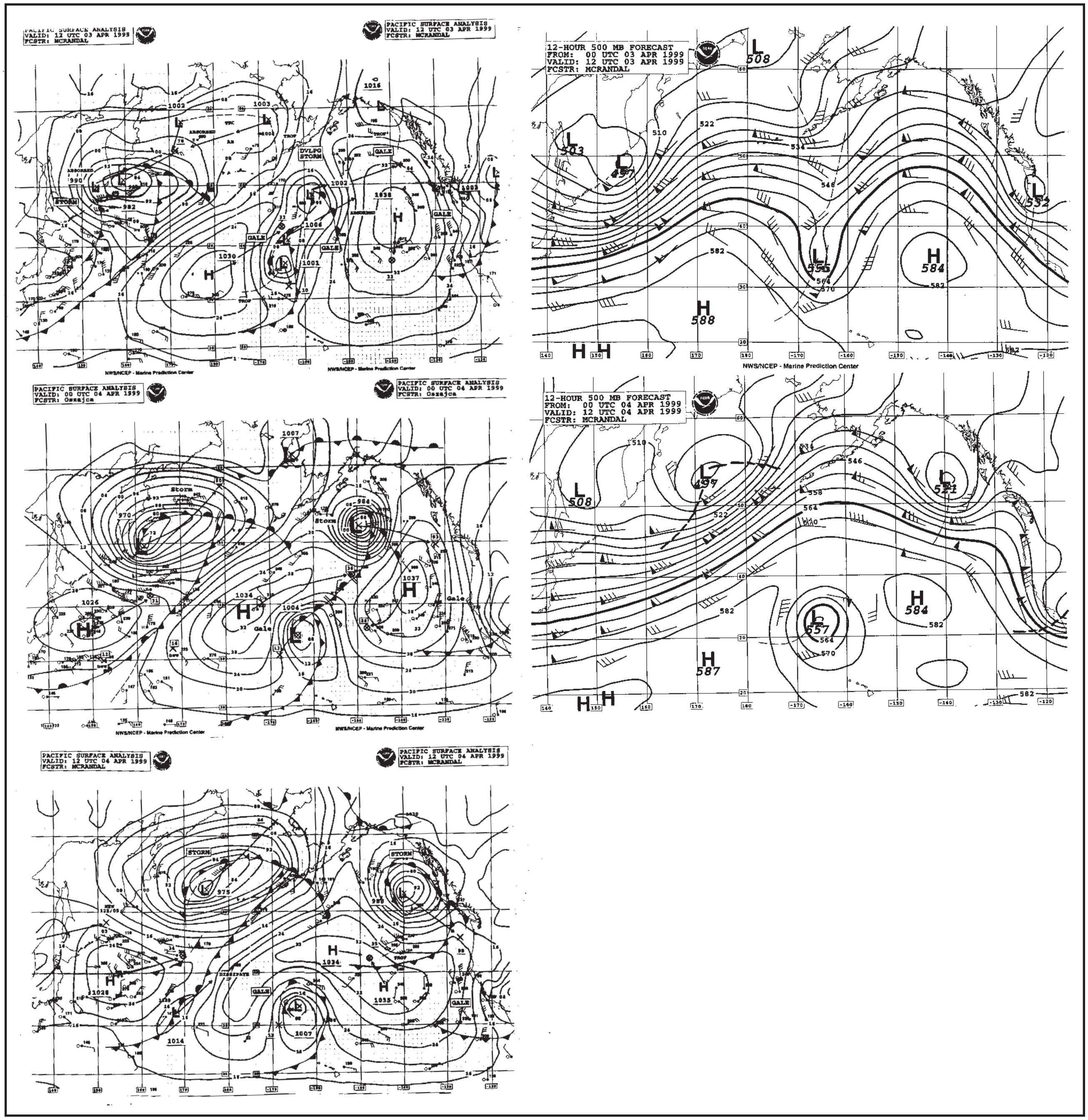

Figure 1. Series of three MPC Pacific surface analysis charts valid at 1200 UTC 03 April, 0000 UTC 04 April and 1200 UTC 04 April 1999. The 500-millibar charts (model-generated 12-hour forecasts with short wave troughs manually added) are valid 1200 UTC 03 April and 1200 UTC 04 April, matching the valid times of the first and third surface analyses.

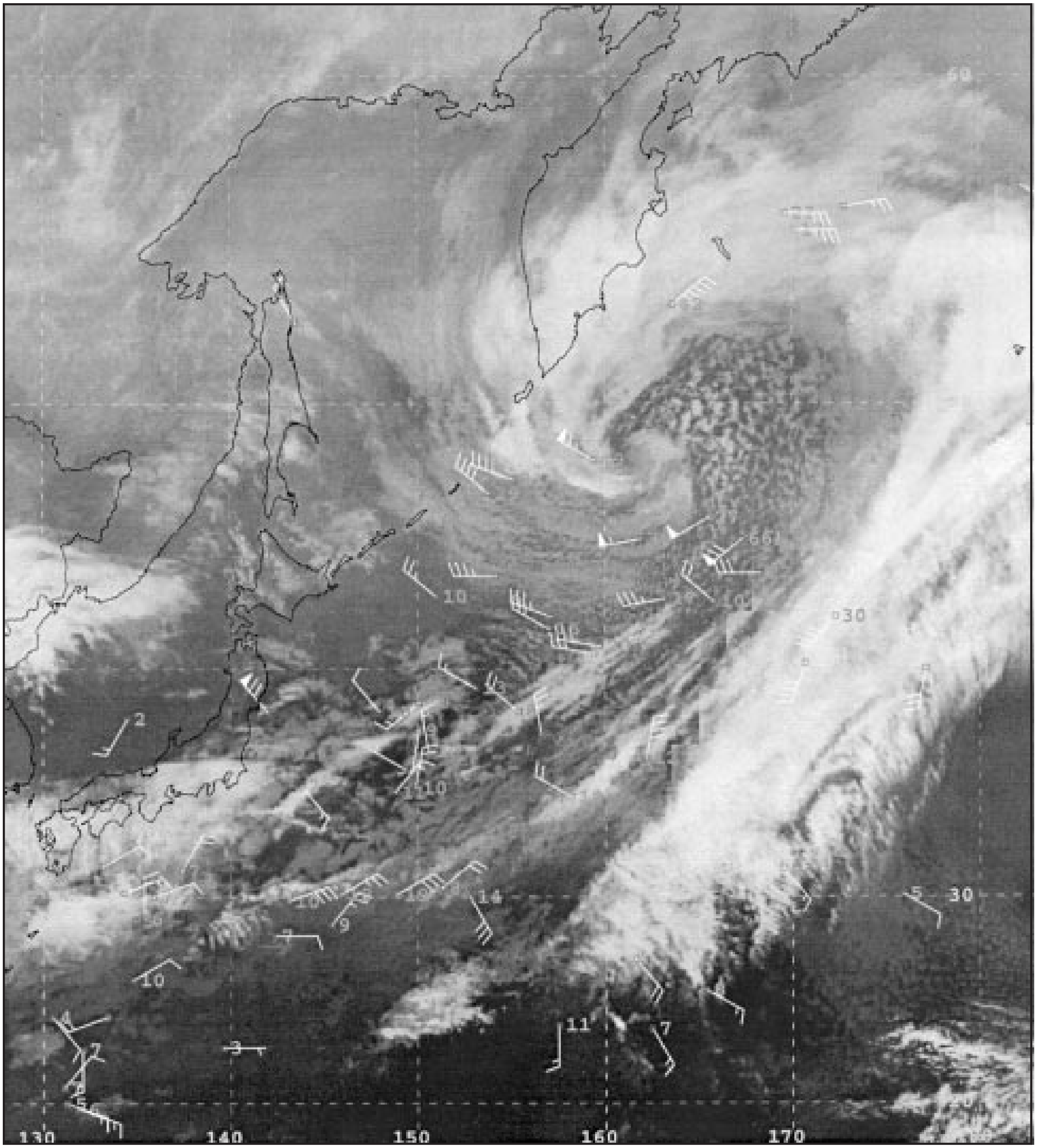

Figure 2. Composite GMS and GOES10 infrared satellite image of western Pacific storm with ship data plotted. Valid time is 0015 UTC 04 April 1999.

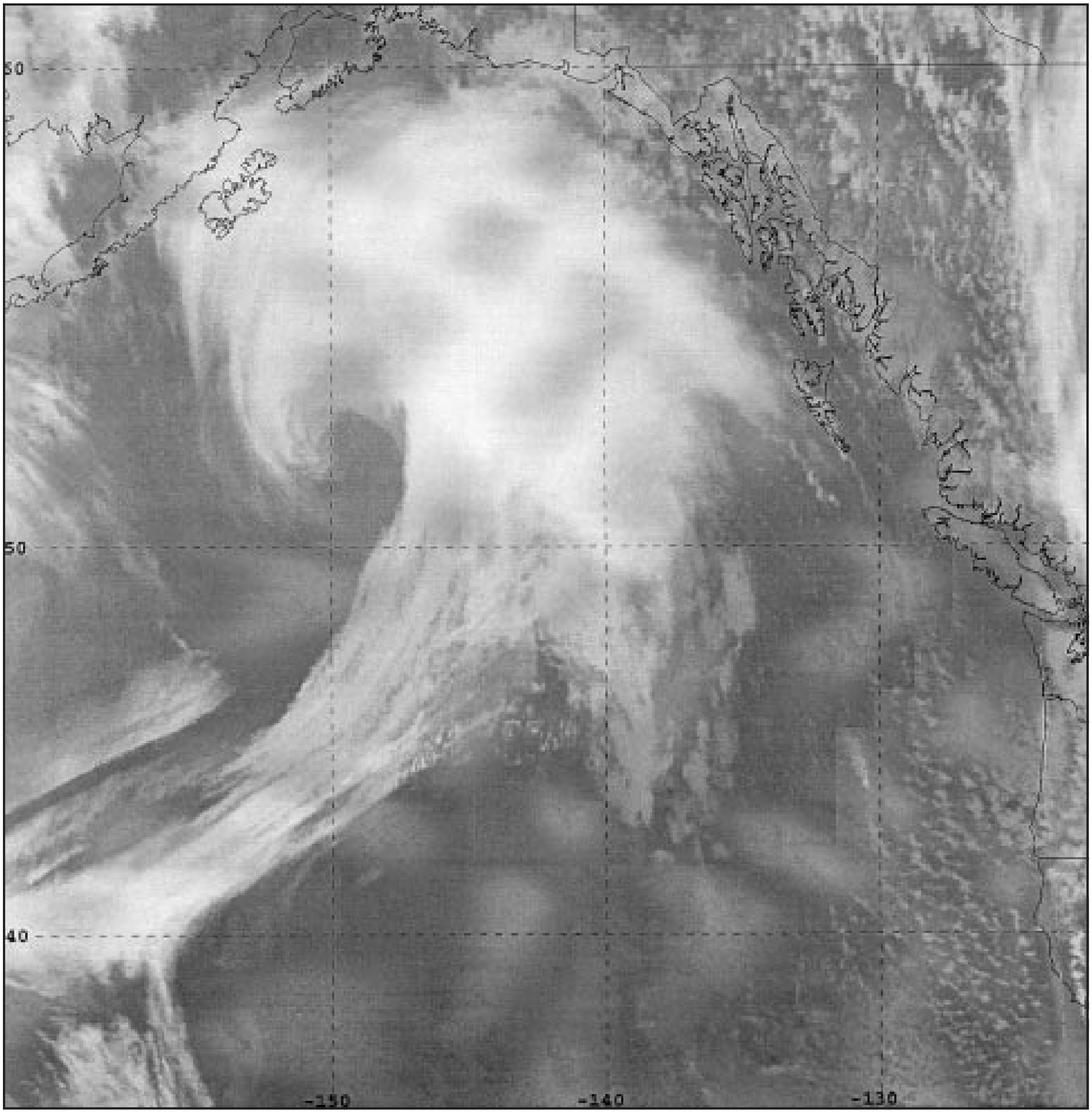

Figure 3. GOES-10 infrared satellite image of Gulf of Alaska storm valid at 0015 UTC 04 April 1999.

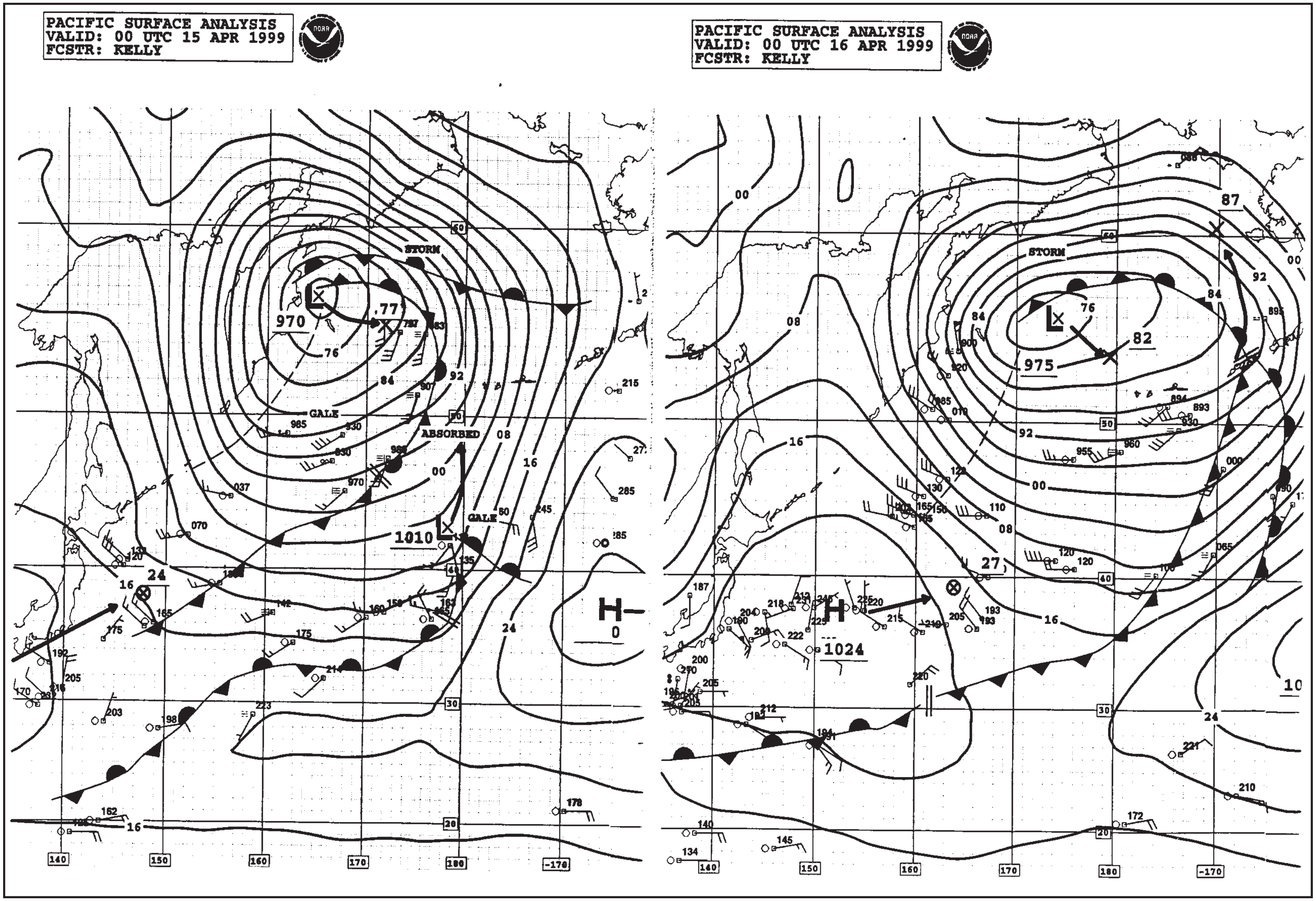

Figure 4. Series of two Part II MPC Pacific surface analyses valid at 0000 UTC April 15 and 0000 UTC April 16, 1999.

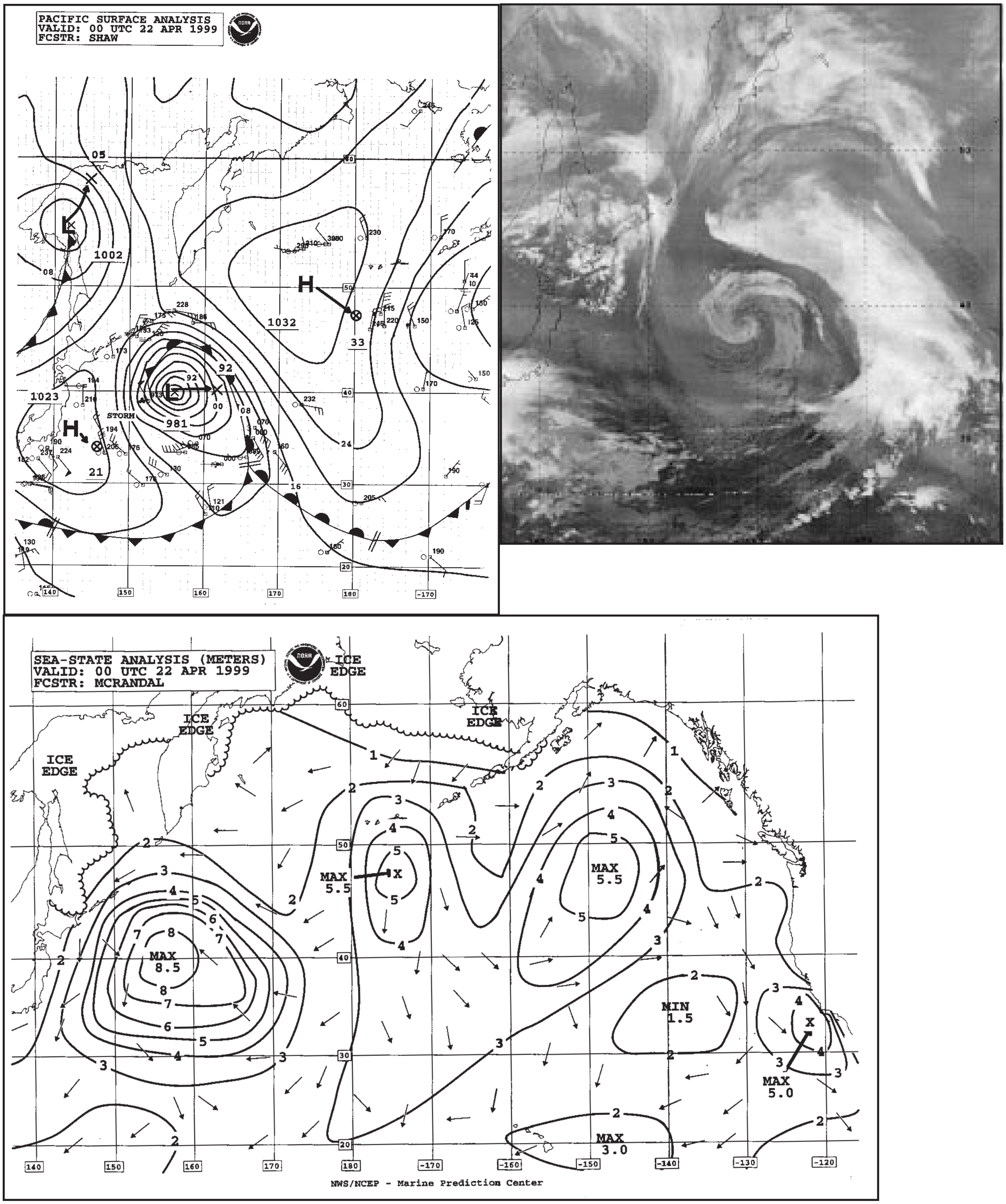

Figure 5. MPC Part II Pacific Surface Analysis and Sea State Analysis valid 0000 UTC 22 April 1999; plus a GMS infrared satellite image of western North Pacific storm valid 1145 UTC 22 April 1999.

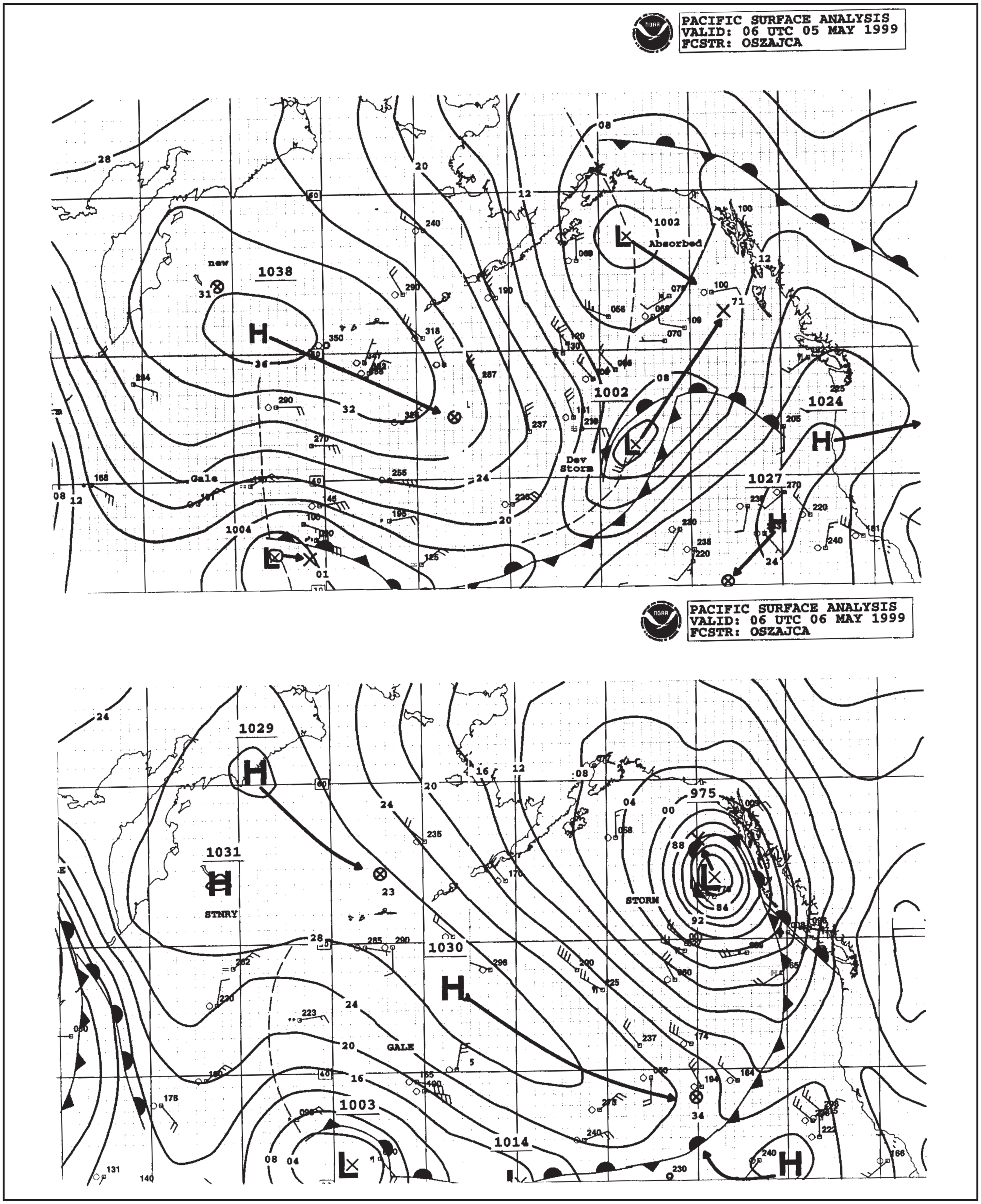

Figure 6. Series of two MPC Pacific surface analyses valid at 0600 UTC May 5 and 0600 UTC May 6, 1999.

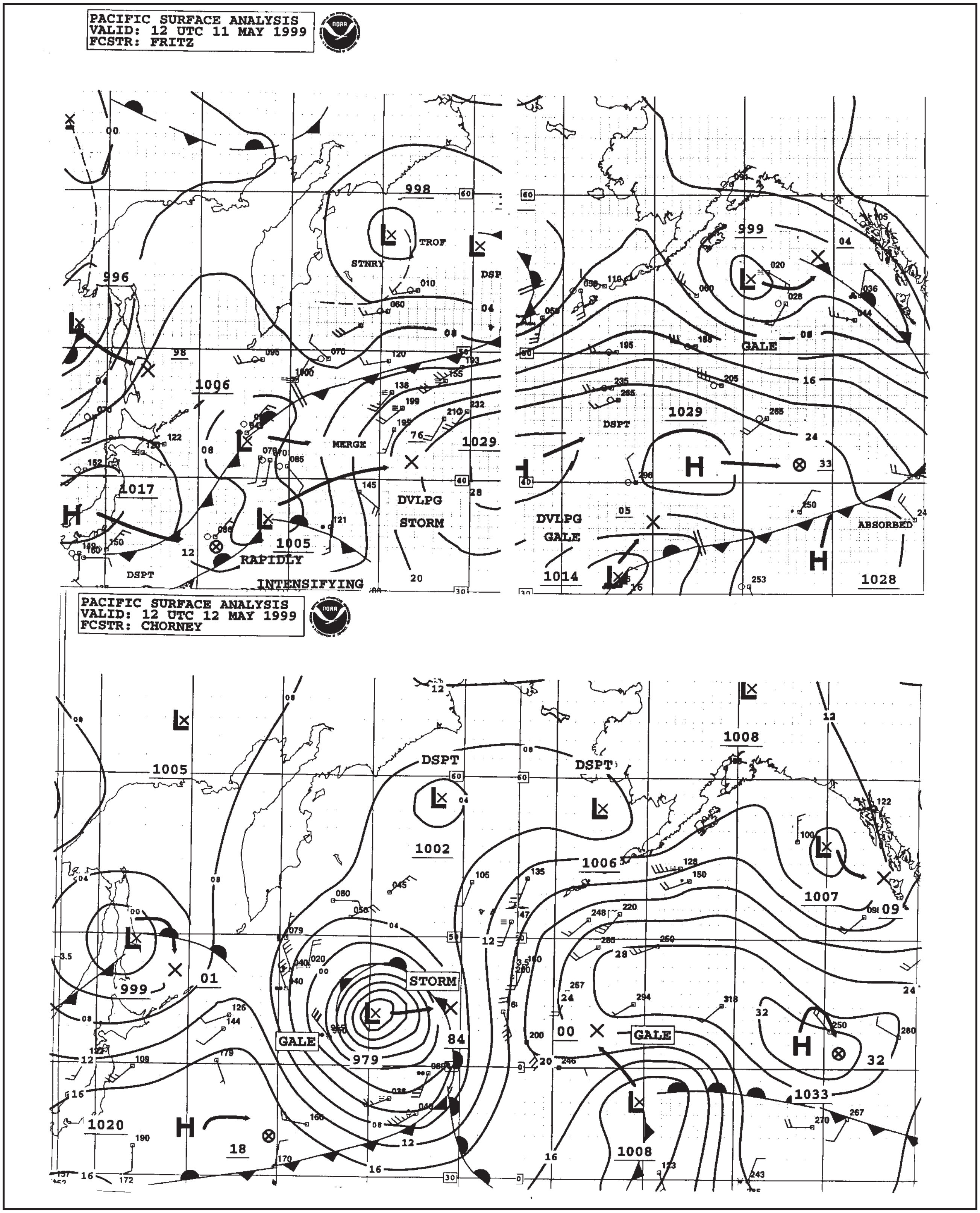

Figure 7. Series of two MPC Pacific surface analyses valid at 1200 UTC May 11 and 1200 UTC May 12, 1999.

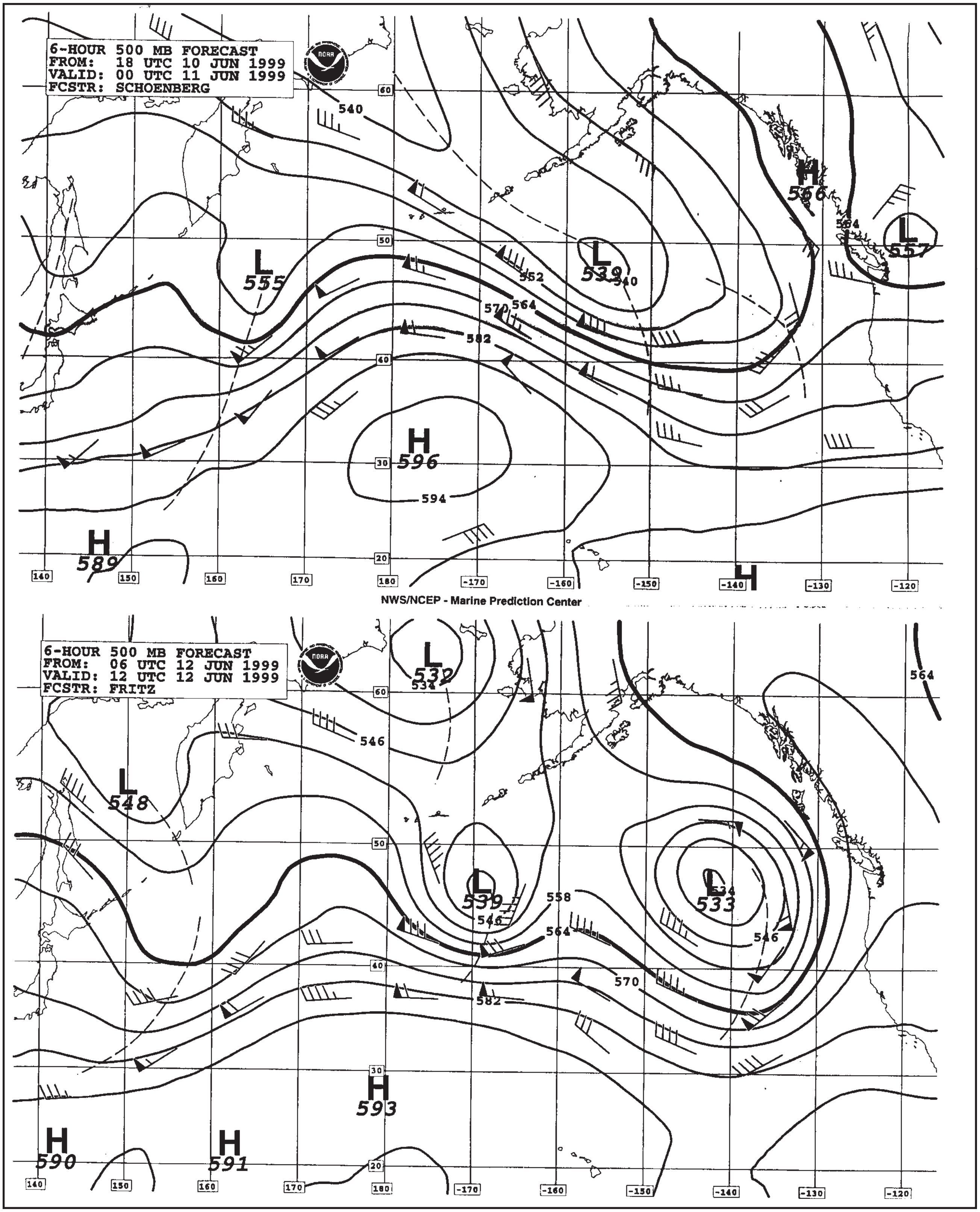

Figure 8. Series of 500-millibar analysis charts (actually model-generated 6-hour forecast with short wave troughs manually added) valid at 0000 UTC 11 June and 1200 UTC 12 June 1999. Also see Figure 9.

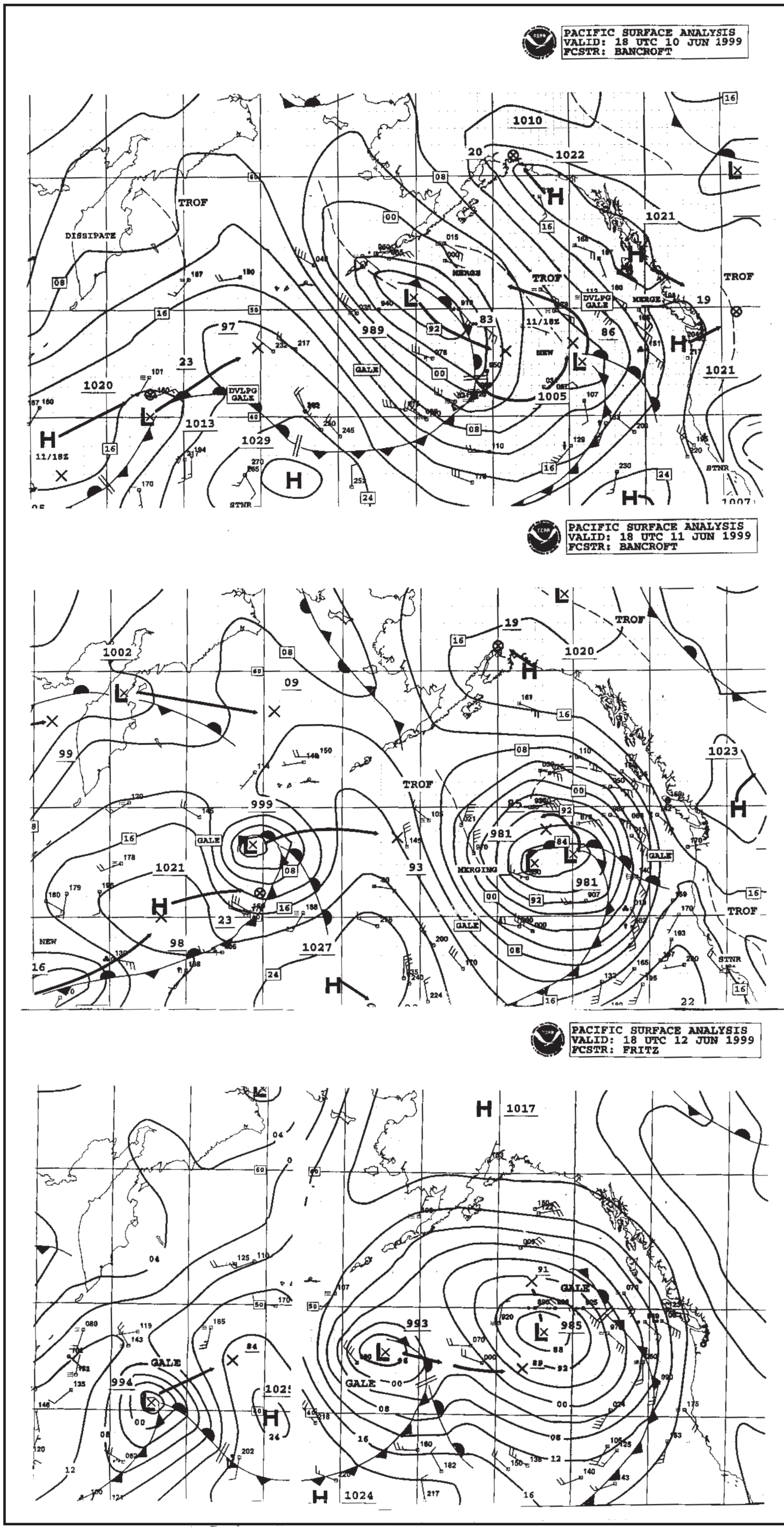

Figure 9. Series of three MPC Pacific surface analyses valid at 1800 UTC on each of the dates June 10, 11, and 12, 1999.

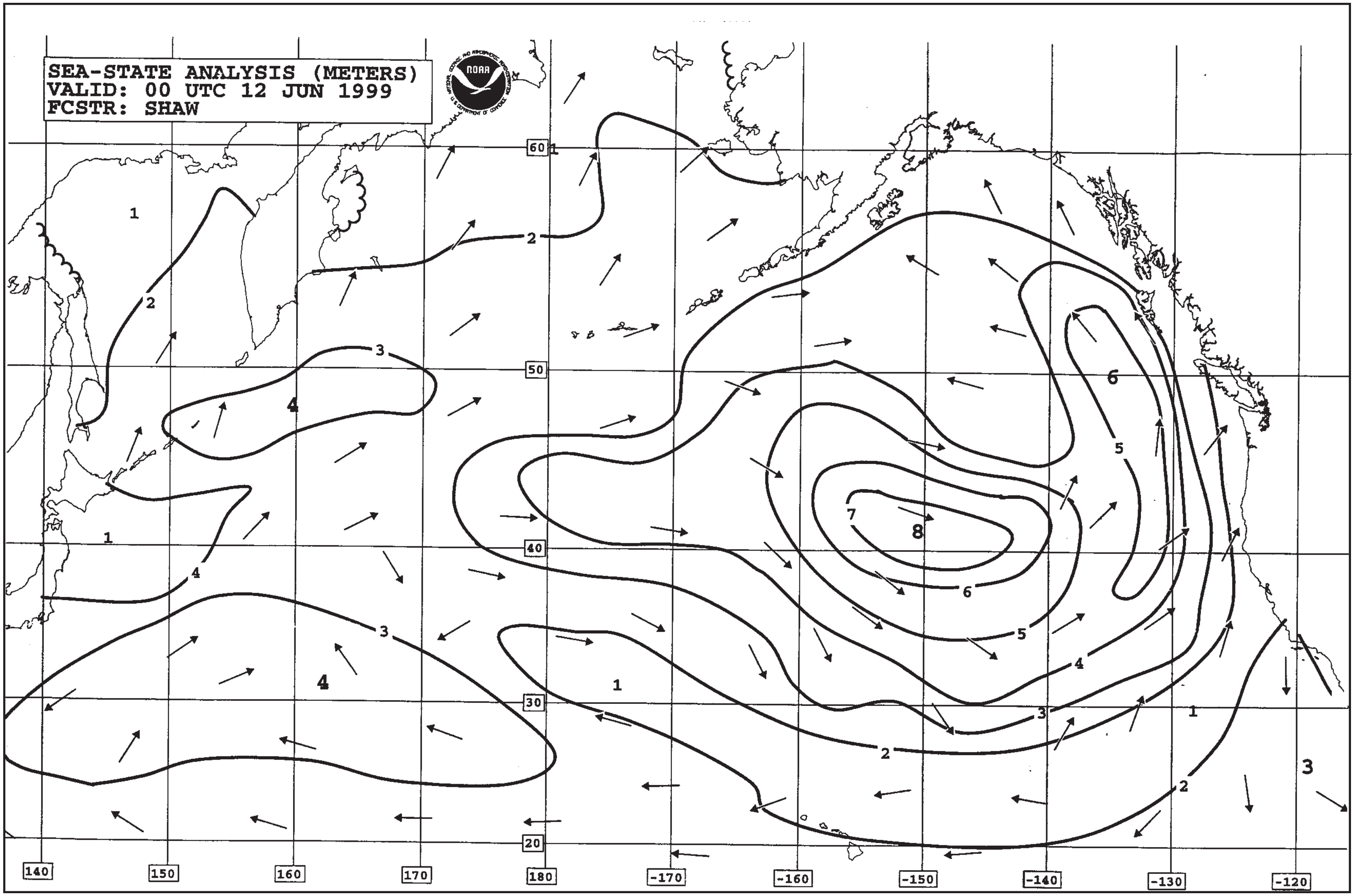

Figure 10. Pacific sea state analysis valid 0000 UTC 12 June 1999. Also see Figure 9.

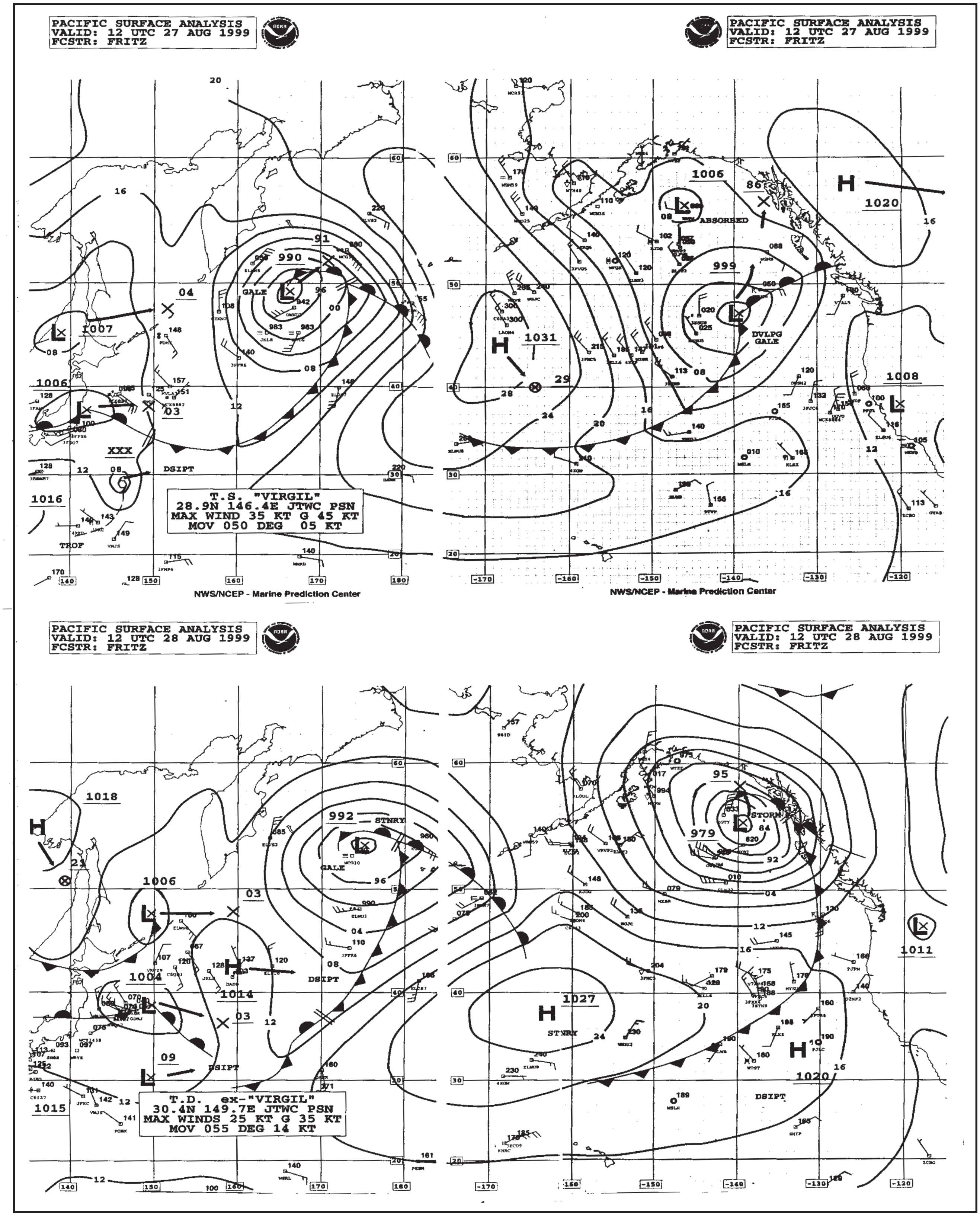

Figure 11. MPC North Pacific surface analyses valid 1200 UTC August 27 and 1200 UTC August 28, 1999.

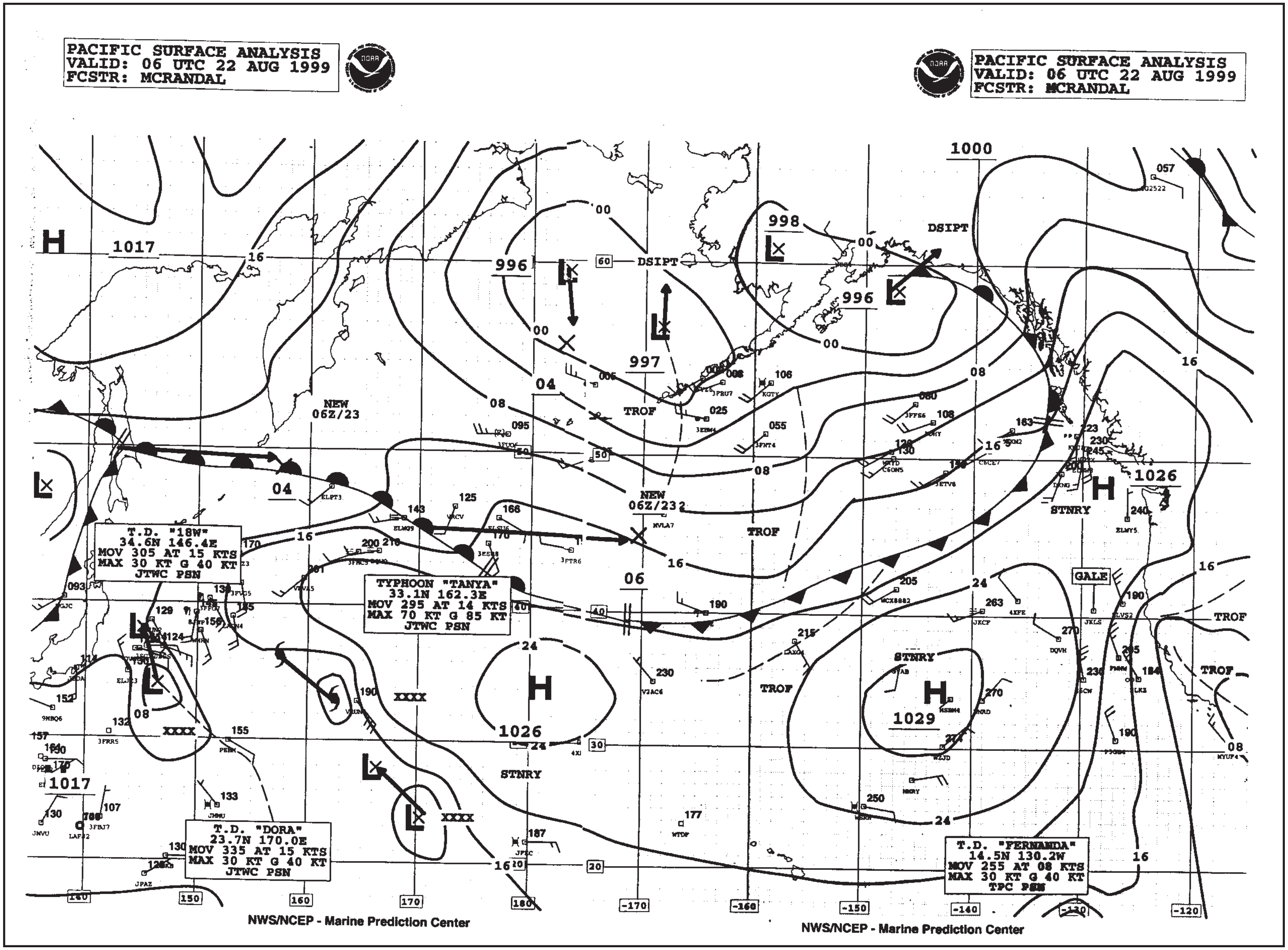

Figure 12. MPC North Pacific surface analysis valid at 0600 UTC 22 August 1999 depicting tropical cyclones.

North Pacific Area

Continued from Page 36

the stronger winds are associated with the frontal cloud band wrapping around the west side of the center and cold air entering the system to the south and southeast (marked by cumulus type clouds). The eastern storm shown in Figure 1 rapidly developed as two 500 mb short wave troughs shown in the first panel combined to form a closed low which moved through the upper ridge in the Gulf of Alaska. The surface analyses in Figure 1 show this developing storm breaking off from another system to the south near 37N 164W and moving into the Gulf of Alaska. The central pressure dropped 17 mb from 1001 mb to 984 mb in the six-hour period ending at 0000 UTC 4 April. Figure 3 is a GOES-10 satellite infrared image of this storm as it approached maximum intensity, with the time of the image the same as the second analysis in Figure 1. Whiter shades of color in the image denote colder (higher) clouds, which appear wrapping around the west side of this vigorous system. Also shown in Figure 1, northwest gales off the U.S. west coast were the result of the pressure gradient set up between strong inland low pressure and high pressure to the west. Note the 50 kt northwest wind off Point Conception at 0000 UTC 4 April from the **CSL Cabo (D5XH)**. Reported seas were 7 meters (24 ft). These conditions continued until 7 April as the Gulf of Alaska storm moved southeast and inland over California.

Another developing storm followed the northern storm track and moved east into the Bering Sea by 15 April and is depicted in Figure 4. The first surface analysis shows the storm at maximum intensity with 970 mb central pressure, as intense as the aforementioned 4 April western Pacific storm. Storm force winds were mainly in the cold air north and west of the center in an area of sparse ship data. The second analysis in Figure 4 shows the storm with a circulation covering much of the area north of 40N. There is one ship report of 55 kt wind west of the center. The storm weakened to a gale as it crossed the central Aleutians on the April 17.

The southern storm track off Japan became more active by mid April with low pressure systems tracking mainly east between 30N and 40N over the western Pacific, then northeast later in the month as blocking high pressure to the northeast weakened. The strongest of these is shown in Figure 5, attaining a central pressure of 981 mb at 0000 UTC 22 April. The ship **S6PD** (name not available) reported a northwest wind of 50 kt southwest of the center near 39N 153E, while another ship, the **Saga Ocean** (**LAON4**), reported a west wind of 45 kt and 7 meter seas (24 ft) near 34N 159E. Seas up to 8.5 meters (29 ft) were analyzed by the Marine Prediction Center MPC) closer to the center as shown in the second part of Figure 5, a sea state analysis. The third part of Figure 5 is an infrared satellite image showing a mature storm almost 12 hours later with a well defined circulation even in the higher clouds.

In May, the pattern remained active as in April, but with the stronger activity and occurrence of storm force winds north of 40N. The beginning of the month was more active than the end as the westerlies shifted north and became less amplified as would be expected with the approach of summer. The most noteworthy developments were early in the month on both sides of the ocean, producing storm force winds. Figure 6 depicts the development of the eastern system from a frontal low pressure wave which was originally cut off at southern latitudes south of a large high to the northwest, but rapidly intensified as it absorbed a cold low in the Gulf of Alaska. This development qualifies as a “bomb” as the central pressure is shown falling 27 mb in the 24-hour period covered by Figure 6. The **Sealand Anchorage** (**KGTX**) was just ahead of the front off Vancouver Island at 0600 UTC 6 May and reported a southeast wind of 50 kt and 10 meter seas (34 ft). Only 12

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North Pacific Area

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hours earlier this ship was at 52N 133W near the buoys **46208** (52.5N 132.7W) and **46147** (51.8N 131.2W) which were reporting 4 meter seas (14 ft). Much of this increase occurred in the first six hours. A western North Pacific developing storm is shown in Figure 7, the result of the merging of northern and southern lows. Much of the intensification occurred between analysis times in the figure, a drop of 26 mb in 24 hours. The system bottomed out at 972 mb 12 hours later at 0000 UTC 13 May near 45N 176E which made it the strongest of May. Late on 13 May, this storm absorbed a second low that was to the southeast near 37N 160W in Figure 7. A ship reported a 50 kt east wind at 1200 UTC 13 May near 47N 162W (not shown in fig. 7), in the tight pressure gradient between the second low and the strong ridge to the north.

The main track of low pressure systems continued to shift north and weaken in June and July as is normally the case, with the middle of June being the exception. By 10 June a blocking high pressure ridge developed over Alaska, forcing a shift south in the westerlies as shown in the 500 mb charts of Figure 8. An unusually strong upper low developed off the U.S. West Coast by 12 June. Figure 9 shows the evolving surface pattern with a large surface gale center forming under the upper low. Normally high pressure should be off the U.S. west coast at this time of year. During the following week this pattern persisted with a series of lows from the west which resulted in a strengthening of the large low to the east. The central pressure of the large eastern low bottomed out at 975 mb at 0600 UTC 12 June, which is between map times of the second and third parts of Figure 9. Widespread gales are evident from ship reports from the southern Gulf of Alaska southward. Maximum seas reached at least 8 meters (27 ft) south of the center as shown in the sea state analysis of Figure 10.

July is usually the least stormy month in the North Pacific, and July 1999 was no exception. August brought a pickup in cyclonic activity in northern latitudes, especially late in the month with the approach of fall. Figure 11 shows a development of the first extratropical low of the season classified by the Marine prediction Center (MPC) as a storm, with a track and intensity similar to the early May storm shown in Figure 6. The **Potomac Trader** (**WXBZ**), reported a west wind of 45 kt from south of the center near 53N 138W at 1800 UTC 28 August.

Tropical Activity

Figure 12 is a surface analysis from late August, the most active part of the April to August period. The area was dominated by high pressure south of 50N and the westerlies had retreated north, a more favorable situation for tropical cyclones. There are several such systems on the map. Among them, Tropical Storm Tanya formed at 30N near the dateline on 19 August and then drifted northwest, becoming a typhoon late on the 20 August and was the only tropical cyclone to directly affect the high seas area north of 30N and east of 160E during the five-month period of this report. Figure 12 shows Tanya at maximum intensity crossing the southwest corner of the area. Tanya later dissipated by the August 25 as it recurved back east of 160E. In Figure 12, tropical depression 18W near Japan, merged with a front to the north and moved into the high seas area as an extratropical gale on 26 August. The gale center shown in Figure 11 entering the Bering Sea was formerly tropical depression 18W.

Reference

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

Marine Weather Review
Tropical Atlantic And Tropical East Pacific Areas
May through August 1999

Dr. Jack Beven
National Hurricane Center

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

I. Transfer of Offshore Forecast Responsibility

At 1530 UTC Monday 3 April 2000, the Tropical Prediction Center (TPC) will assume responsibility for the Offshore Marine Forecasts and Warnings currently prepared by the Weather Forecast Offices in Miami, Florida, and New Orleans, Louisiana. The products affected include:

- Offshore Marine Forecast for the Southwest North Atlantic south of 31N and west of 65W and the Caribbean Sea.
- Offshore Marine Forecast for the Gulf of Mexico.

The only changes being implemented are the issuing office of the forecasts/warnings and associated changes in the World Meteorological Center (WMO) headers. No changes will be made to the areas covered by the forecasts/ warnings nor to the issuance times. The WMO header for the Southwest North Atlantic and Caribbean Forecast will change from FZUS62 KMFL to FZNT23 KNHC and the Gulf of Mexico Forecast from FZUS64 KLIX to FZNT24 KNHC.

Please direct any questions regarding the transfer to:

Christopher Burr
Chief, Tropical Analysis and Forecast Branch (TAFB)
Tropical Prediction Center
Phone: 305-229-4430
E-mail: burr@nhc.noaa.gov

or
Martin Nelson
Lead Forecaster, TAFB
Phone: 305-229-4435
E-mail: martin@nhc.noaa.gov

II. Introduction To Significant Weather

La Niña conditions continued, with some signs of weakening, through the period in the tropical Eastern Pacific. This allowed for a normal beginning of the Atlantic hurricane season with below normal activity in the eastern Pacific Ocean. As is normal for this period, tropical weather systems were the dominant weather features.

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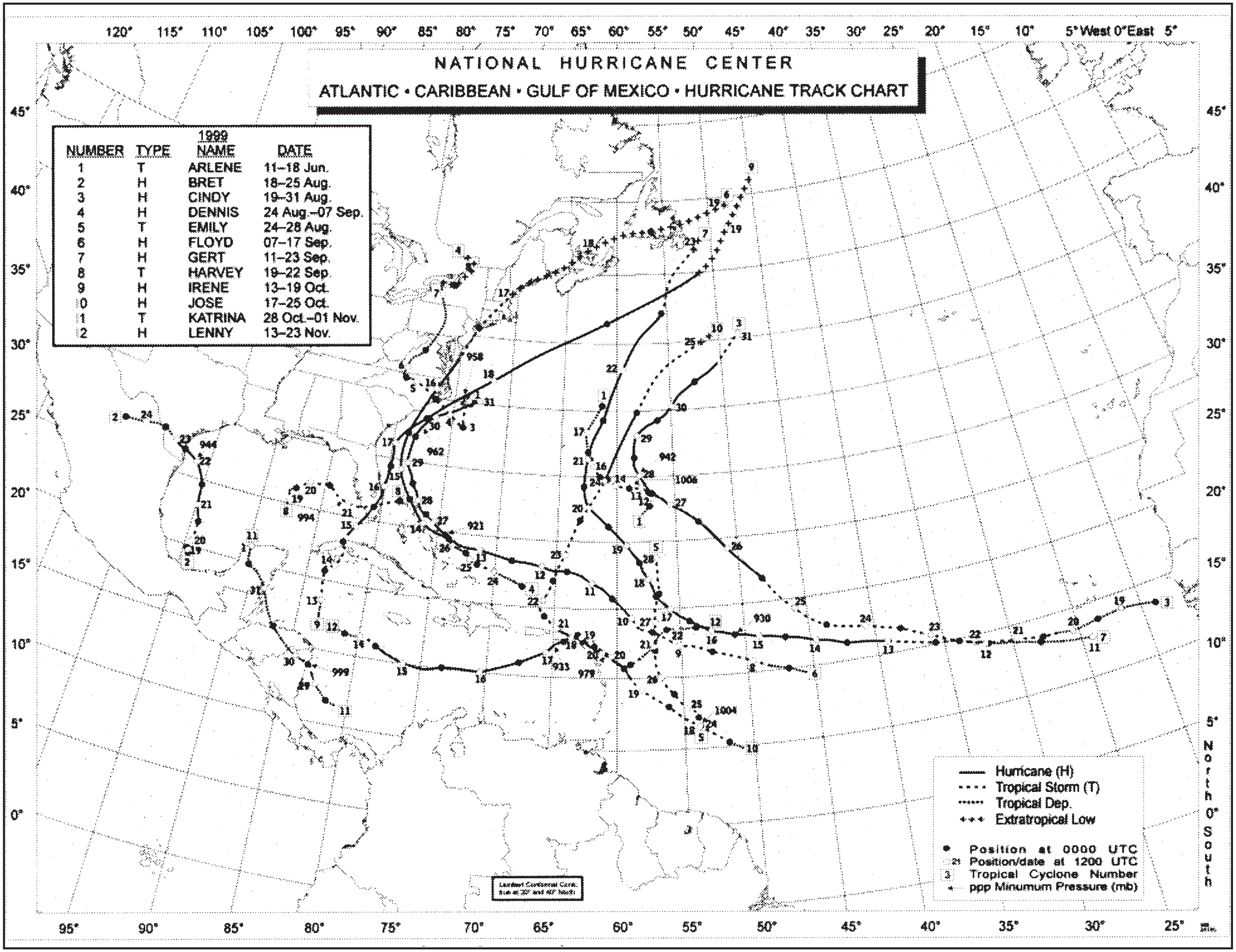

Figure 1. Atlantic hurricane and tropical storm tracks of 1999.

Tropical Prediction Center
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III. Significant Weather of the Period

A. Tropical Cyclones: Six tropical cyclones developed over the Atlantic during the period, including three hurricanes, two tropical storms, and a tropical depression. Eleven tropical cyclones formed over the eastern Pacific basin, including four hurricanes, two tropical storms, and five tropical depressions.

1. Atlantic

The first tropical depression was Arlene. She formed from a complex weather system that included a weak cold front, an upper level low, and part of a tropical wave about 465 nm southeast of Bermuda on 11 June (Figure 1), and became a tropical storm the next day as it moved toward the northeast. A westward turn occurred on 13 June as Arlene reached a peak intensity of 50 kt. The westward motion continued the next day, followed by a slow northwestward track on 15-16 June. Slow weakening also occurred during the time, and the cyclone weakened to a depression while moving northward about 100 nm east of Bermuda on 17 June. The depression turned northeastward before dissipating about 240 nm northeast of Bermuda on 18 June.

There are no known ship reports of tropical-storm force winds from Arlene and no reports of damage or casualties.

Tropical Depression Two: A westward-moving tropical wave organized into a tropical depression over the southwest Gulf of Mexico on 2 July. Moving westward, the 30 kt depression made landfall about 35 nm south-southeast of Tuxpan, Mexico, the next day. It quickly dissipated over land.

The **Nuernberg Express (9VBK)** reported northwest winds of 20-25 kt, which was instrumental in determining that the depression had formed. Rainfall totals over Mexico ranged from 4 to 13 inches. There were no reports of damage or casualties.

Hurricane Bret: A tropical wave moving westward from the Yucatan Peninsula organized into a tropical depression over the Bay of Campeche on 18 August (Figure 1). The system drifted erratically near 20N 95W for the next 24 hours as it became a tropical storm. Bret started a northward motion on 20 August, and this continued the next day as it became a hurricane. Rapid intensification followed, and Bret reached a peak intensity of 125 kt with an aircraft-measured minimum pressure of 944 mb on 22 August. A northwestward turn occurred on this day, which brought the eye of Bret to the coast of Kennedy County, Texas, near 0000 UTC 23 August. The cyclone moved northwestward to westward after landfall, eventually dissipating over northern Mexico on 25 August.

Bret's small but intense core made landfall over a sparsely inhabited area, and shipping avoided the storm. Thus, there are few surface reports of strong winds. Rincon del San Jose, Texas, reported 63 kt sustained winds, with the instrument there failing just before the eye passed nearby. NOAA buoy **42020** reported 58 kt sustained winds with gusts to 73 kt along with a 982.9 mb pressure at 1900 UTC 22 August.

Bret caused $60 million damage in the United States, a remarkably low total given that it was a Category 3 hurricane on the Saffir-Simpson scale at landfall. There were no reports of casualties.

Hurricane Cindy: A tropical wave moved off the African coast on 18 August and developed into a tropical depression about 250 nm east-southeast of the Cape Verde Islands early the next day (Figure 1). Upper-level wind shear slowed further development as the depression moved westward, and it was late on 20 August before it became Tropical Storm Cindy. Further strengthening occurred, and Cindy became a hurricane on 22 August. This was short-lived, though, as increased wind shear weakened Cindy back to a tropical storm later that day. The storm changed little in strength for the next several days as it turned west-northwestward on 23 August and northwestward on 25 August. Decreased shear on 26 August allowed Cindy to regain hurricane strength, and it further strength-

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ened to a peak intensity of 120 kt on 28 August (Figure 2). The hurricane turned northward at that point, passing about 325 nm east of Bermuda on 29 August. A northeastward turn occurred later that day. Cindy continued toward the northeast and weakened for the rest of its life. It dropped below hurricane strength on 31 August and was absorbed into a large extratropical low later that day about 850 nm west of the Azores.

A few ships were close enough to Cindy to experience tropical-storm force winds. The **Mineral Columbia** (call sign unknown) reported 62 kt winds and 9 meter (30 ft) seas at 0000 UTC 27 August, while the **Chickadee Elkeschland** (call sign unknown) reported 37 kt winds at 0600 UTC 26 August. There were no reports of damage or casualties.

Hurricane Dennis: A west-northwestward-moving tropical wave became better organized north of Puerto Rico on 23 August. The system developed into a tropical depression early the next day about 190 nm east of Turks Island (Figure 1) and became Tropical Storm Dennis later that day. Dennis slowed to an erratic west-northwestward drift on 25 August, followed by a steadier west-northwestward motion on 26 August as it reached hurricane strength. This track brought the hurricane near or just east of the eastern Bahamas, with the eye passing over the Abaco island group about 0700 UTC 28 August. Dennis reached a peak intensity of 90 kt later that day (Figure 2) and maintained it through 30 August. The lowest minimum central pressure measured by a Hurricane Hunter aircraft during this time was 962 mb on 30 August. The hurricane turned northward on 29 August and east-northeastward on 30 August, following a course parallel to the southeastern coast of the United States. At the end of August, Dennis was east-southeast of Cape Hatteras, North Carolina, and in the process of stalling.

Although Dennis did not make landfall in the United States during the period, the center passed close enough to the North Carolina coast to bring tropical storm force winds. The maximum reported sustained winds were 53 kt with gusts to 77 kt at Oregon Inlet, while Wrightsville Beach reported a gust to 96 kt. Amateur radio reports from the Abaco island group in the Bahamas indicated 50 to 55 kt sustained winds with gusts of 60 to 65 kt as the eye passed over.

The large circulation of Dennis affected many ships, with selected ship observations included in

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Table 1. Selected ship observations of tropical storm or greater winds associated with Hurricane Dennis, 24 August - 31 August 1999.

Ship	Date/Time (UTC)	Lat. (°N)	Lon. (°W)	Wind dir/speed (deg/kt)	Pressure (mb)
Sealand Crusader	24/0600	21.0	67.0	130/35	1011.5
Iver Express	24/1800	23.2	74.6	010/39	1012.0
Jo Sypress	26/1500	25.9	73.0	120/39	1012.5
Nomzi	27/0300	25.9	74.0	090/45	1010.0
Morelos	28/2100	26.2	74.4	170/34	1007.0
Nedlloyd Holland	29/0000	27.8	79.2	340/42	1002.0
Torm Freya	29/0600	29.5	74.8	150/48	1005.0
Star Hidra	29/0600	29.8	76.5	120/56	999.3
Star Hidra	29/0900	29.7	76.4	150/56	999.5
Zim U.S.A.	30/0600	31.8	75.5	180/65	999.0
Zim U.S.A.	30/0900	32.3	75.0	180/65	1000.0
OOCL Fair	30/0900	32.7	74.3	180/50	1002.0
SHIP	30/1200	36.9	75.0	040/40	1014.5
OOCL Fair	30/1500	32.1	74.6	210/50	1002.0
OOCL Fair	30/1800	32.0	75.0	260/55	1006.0
Inspiration	30/2100	35.6	72.6	090/55	1002.5
Barbet Arrow	31/1200	32.5	71.5	240/40	1009.2
Stonewall Jackson	31/1200	33.5	71.7	230/55	1003.5
Sealand Performance	31/1200	35.1	70.1	160/45	1005.0
Barbet Arrow	31/1800	32.4	72.3	250/40	1015.0
Edyth L.	31/1800	34.8	75.1	310/55	1005.7

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Table 1. The **Zim U.S.A. (4XFO)** reported 65 kt winds and a 999.0 mb pressure at 0600 UTC 30 August. Additionally, Dennis affected many of the NOAA buoys and Coastal Marine Automated Network (C-MAN) stations near the southeastern United States coast. The C-MAN station at Frying Pan Shoals, North Carolina, reported 81 kt sustained winds with gusts to 91 kt at 0945 UTC 30 August, with a minimum pressure of 977.2 mb at 0900 UTC.

The rest of the story about Dennis will appear in the next Mariners Weather Log.

Tropical Storm Emily: A westward-moving tropical wave developed a weak low-level circulation between 19-23 August. The system organized and became a tropical depression and tropical storm on 24 August about 360 nm east of the southern Windward Islands (Figure 1). Emily reached a peak intensity of 45 kt later that day with an aircraft-measured minimum central pressure of 1004 mb. The storm moved northwestward on 24-25 August with a slight weakening due to upper-level shear caused by Hurricane Cindy. Emily turned northward on 26 August and was eventually absorbed into Cindy's much larger and more powerful circulation on 28 August (Figure 2).

The circulation of Emily was small and far from land, so there were no reports of tropical-storm force winds, damage, or casualties.

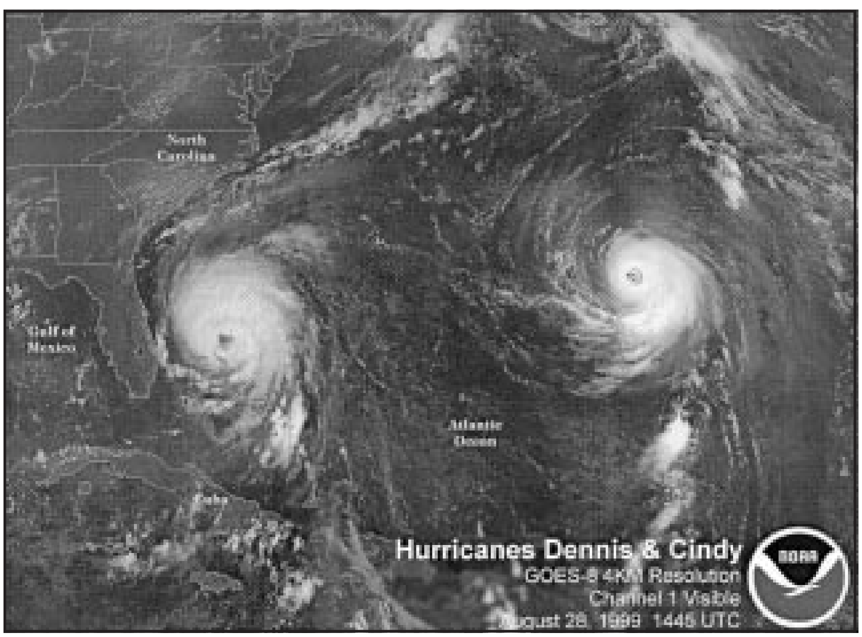

Figure 2. GOES-8 visible image of Hurricanes Cindy (right) and Dennis (left) at 1445 UTC 28 August 1999. Tropical Storm Emily is dissipating to the south of Cindy. Image courtesy of the National Climatic Data Center.

2. Eastern Pacific

Hurricane Adrian: Adrian formed as a tropical depression about 225 nm southeast of Acapulco, Mexico on 18 June (Figure 3). It moved west-northwestward and became a tropical storm later that day and an estimated 85-kt hurricane with a short-lived eye on 20 June. The cyclone passed near Socorro Island as a weakening tropical storm on 21 June and dissipated about 300 nm southwest of the southern tip of Baja California on the next day.

The **L'atalante** (call sign unknown) is the only ship known to have encountered Adrian, reporting 34 kt winds and a 998.6 mb pressure on 19 June. Socorro Island reported 40 kt winds and a 993 mb pressure at 1200 UTC 21 June.

Although Adrian did not make landfall, outer rainbands spread over western Mexico causing two deaths from flash flooding. Four other deaths were attributed to high surf.

Hurricane Beatriz: A tropical wave spawned Beatriz as a depression about 300 nm south of Lazaro Cardenas, Mexico on 9 July (Figure 3). It moved west-northwestward and became a tropical storm later that day. Beatriz moved westward on 11 July as it became a hurricane. This was followed by a west-northwestward motion and an estimated peak intensity of 105 kt on 13

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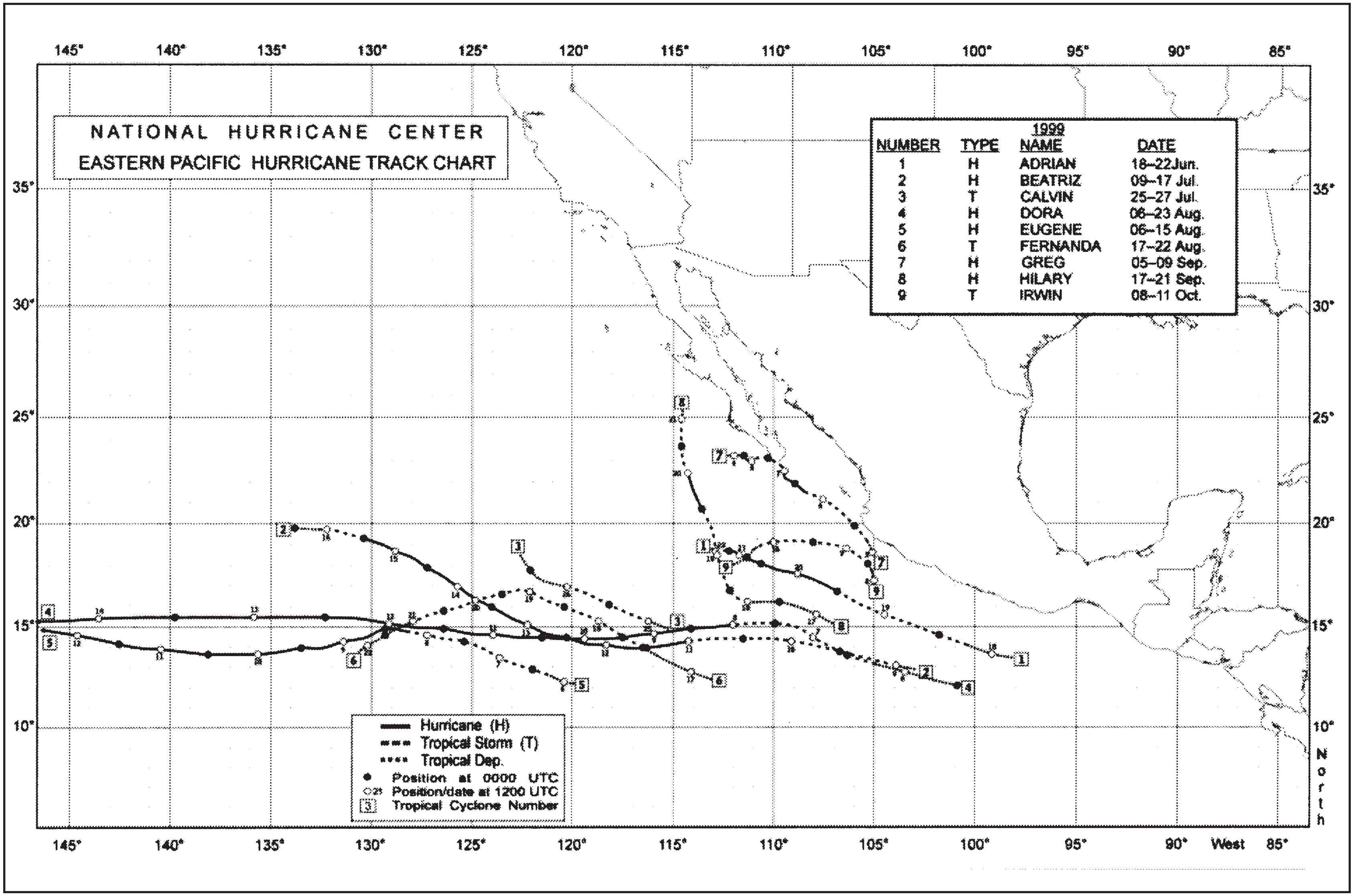

Figure 3. Eastern Pacific hurricane and tropical storm tracks of 1999.

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July. Steady weakening followed, and Beatriz eventually dissipated about 1100 nm east of the Hawaiian Islands on 17 July.

The only ship known to have encountered Beatriz was the ship **Belo Oriente** (call sign unknown), which reported 35 kt winds about 190 nm from the center at 1200 UTC 13 July. There were no reports of damage or casualties.

Tropical Depression Three-E: This cyclone formed from a tropical wave that caused significant weather over the Caribbean Sea (see Other Significant Events below). The wave entered the Eastern Pacific on 13 July and became a tropical depression about 250 nm west-southwest of Manzanillo, Mexico, on 14 July. The depression moved west-northwestward that day, then turned westward until dissipation about 400 nm southwest of Cabo San Lucas, Mexico, on 15 July. There were no reports of damage or casualties from this system.

Tropical Depression Four-E: A tropical wave that moved into the Eastern Pacific on 15 July produced this cyclone, which formed on 23 July about 1440 nm east-southeast of the Hawaiian Islands. The cyclone moved westward across 140W into the Central Pacific basin on 24 July and dissipated the next day about 710 nm east-southeast of the Hawaiian Islands. There were no reports of damage or casualties.

Tropical Storm Calvin: Calvin developed about 560 nm southwest of the southern tip of Baja California on 25 July (Figure 3) from a tropical wave that reached the Pacific on 20 July. It became a poorly-organized 35 kt tropical storm later that day as it moved toward the west-northwest. Strong wind shear prevented further strengthening, and Calvin turned northwestward and weakened to a depression on 26 July. It dissipated the next day about 750 nm west-southwest of the southern tip of Baja California.

Calvin was far from land and ships avoided the storm. Thus, there were no reports of tropical-storm force winds, damage, or casualties.

Tropical Depression Six-E: This system developed from a tropical wave on 26 July about 1000 nm west-southwest of the southern tip of Baja, California and about 360 nm southwest of Calvin. The system moved west-northwestward and dissipated on 28 July about 1250 nm west-southwest of the southern tip of Baja, California. There were no reports of damage or casualties.

Hurricane Dora: Dora was the longest-lived eastern Pacific tropical cyclone of 1999. A tropical wave that entered the Pacific on 3-4 August developed into a depression about 290 nm south of Acapulco, Mexico, on 6 August (Figure 3). The system moved west-northwestward through 8 August, then moved westward until crossing into the Central Pacific basin on 14 August. The cyclone became a tropical storm on 7 August and became a hurricane the next day (Figure 4). The hurricane twice reached an estimated peak intensity of 120 kt on 12-13 August and was a major hurricane for four days. Dora continued westward across the Central Pacific, passing south of Hawaii and crossing the International Date Line into the Western Pacific as a tropical storm on 20 August. It dissipated about 550 nm north-northwest of Wake Island on 23 August.

Despite Dora’s intensity and long track, there were no reports of tropical-storm force or greater winds, damage, or casualties in the area.

Hurricane Eugene: Eugene formed as a depression about 870 nm southwest of the southern tip of Baja, California on 6 August (Figure 3). The cyclone became a tropical storm later that day as it moved west-northwestward. Eugene turned toward the west and became a hurricane on 8 August. It reached an estimated peak intensity of 95 kt on 9 August (Figure 4). Eugene crossed into the Central Pacific basin on 11 August, and eventually dissipated about 500 nm southwest of Hawaii on 15 August.

There were no reports of tropical-storm force winds, damage, or casualties.

Tropical Depression Nine-E: A tropical wave that moved into the

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Eastern Pacific 6 August produced this depression, which formed on 13 August about 650 nm south-southwest of the southern tip of Baja, California. The cyclone moved west-northwestward through its life, which ended on 15 August about 750 nm southwest of the southern tip of Baja, California. There were no reports of damage or casualties.

Tropical Storm Fernanda: Fernanda first developed into a depression about 400 nm south-southwest of Socorro Island on 17 August (Figure 3). The cyclone moved west-northwestward, reaching tropical storm strength on 18 August and an estimated peak intensity of 55 kt the next day. It then turned toward the west-southwest and weakened, eventually dissipating about 1300 nm west-southwest of the southern tip of Baja, California on 22 August.

There were no reports of tropical-storm force winds, damage, or casualties.

Tropical Depression Eleven-E: A tropical wave that moved into the Eastern Pacific on 15 August spawned a broad low pressure area south of Baja, California on 19 August. Further development was slow, and it was on 23 August that the low organized into a tropical depression about 90 nm southwest of Cabo San Lucas, Mexico. The cyclone moved west-northwestward and dissipated the next day about 170 nm west of Cabo San Lucas. Although the depression and the precursor low produced a large area of rain and near-tropical storm force winds, there were no reports of damage or casualties.

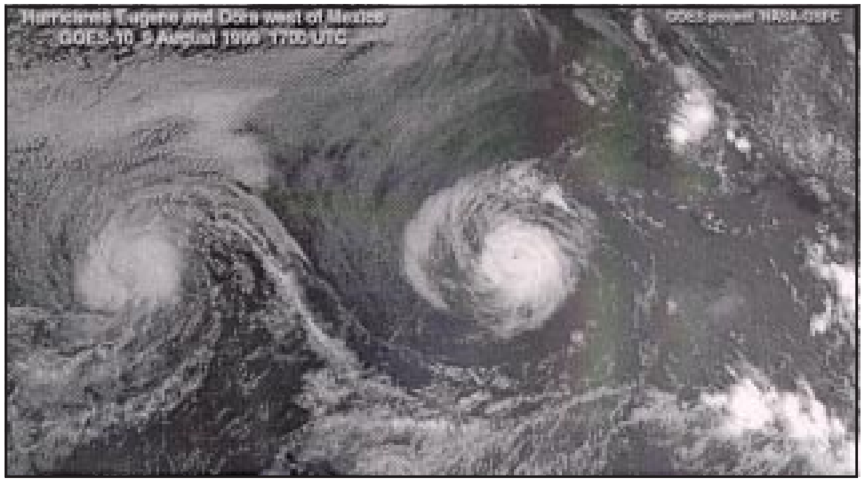

Figure 4. GOES-10 visible image of Hurricanes Dora (right) and Eugene (left) at 1700 UTC 9 August 1999. Image courtesy of NASA-Goddard Space Flight Center, data from NOAA GOES.

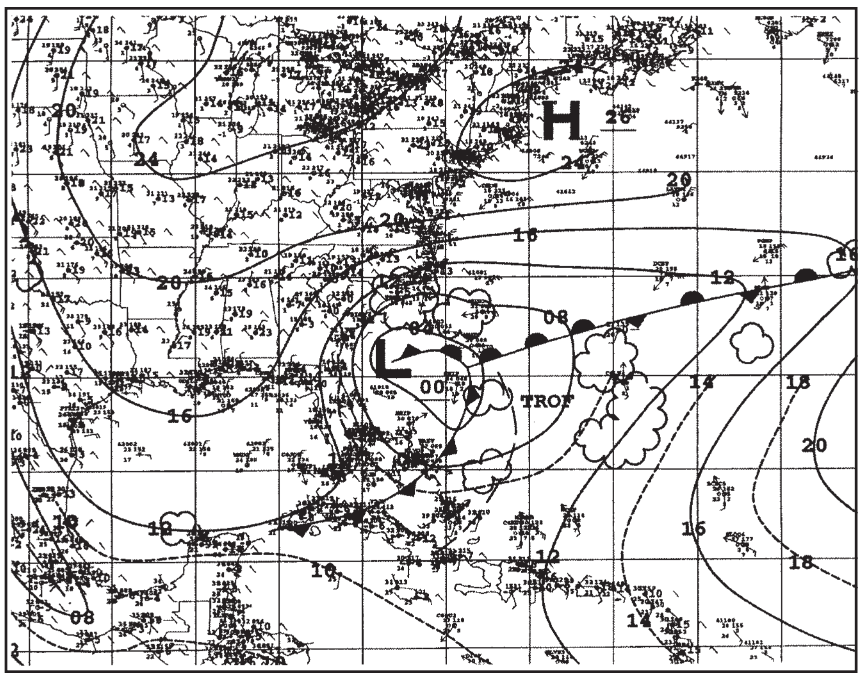

Figure 5. Tropical Analysis and Forecast Branch surface analysis at 1800 UTC 1 May 1999. Solid lines are isobars at 4 mb intervals with intermediate isobars as dashed lines.

B. Other Significant Events

1. Atlantic, Caribbean, and Gulf of Mexico

Storm of 30 April-3 May: At 1200 UTC 30 April, a 1003 mb low formed just off the Georgia and South Carolina coast near 32N

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79W. This was caused by a slow moving upper-level low pressure system, which was rather far south for that time of year. The low strengthened into a gale center by 0000 UTC 1 May and become a storm center near 31N 79W at 0600 UTC 1 May. Storm-force winds occurred only north of 31 degrees N. However, gale conditions occurred west of the center along and offshore of the coasts of Georgia and north Florida. Figure 5 shows a surface analysis at 1800 UTC 1 May with the 1000 mb storm centered east of Jacksonville, Florida. The storm center drifted slowly eastward on 2-3 May, with gale conditions moving north of 31 degrees N at 1800 UTC 2 May. Large swells affected the east coast of Florida through 3 May. Buoy **41010** east of Cape Canaveral reported seas of 4.5 meters (14 feet) at 0000 UTC 2 May and continued to indicate seas above 2.5 meters (8 feet) until 1200 UTC 3 May. The storm also brought unusually cool temperatures to the southeast United States, and several record lows were set in Florida on 1-2 May.

Strong Caribbean Tropical Wave of 8-11 July: A strong tropical wave moved quickly westward across the Caribbean Sea on 8-11 July. It first moved into the Caribbean early on 8 July, accompanied by a large area of showers and thunderstorms. By 1800 UTC that day the wave was along 64W. At this time a gale warning was issued for the area north of 15N within 180 nm west of the wave axis, including the waters near Puerto Rico and the U.S. Virgin Islands. Winds of 25 to 35 knots were predicted along and just ahead of the wave. Elsewhere along the wave axis winds of 20 to 25 knots were expected. A Hurricane Hunter aircraft investigating the wave near this time reported 50 kt winds at 1500 ft but could not close off a surface circulation (better developed tropical storms develop a closed or circular movement of air at the surface). The wave axis moved to along 72W by 1200 UTC 9 July and winds decreased below gale force. However, the system became a little better organized during the afternoon of 10 July, and a broad low pressure system formed just off the northeast coast of Honduras (Figure 6). The low moved westward and made landfall over southern Belize early on 11 July. Winds of 20 to 30 knots accompanied the system as it crossed the central and western Caribbean. The low continued westward across central American and later became Tropical Depression Three-E in the Eastern Pacific (see Tropical Cyclones above).

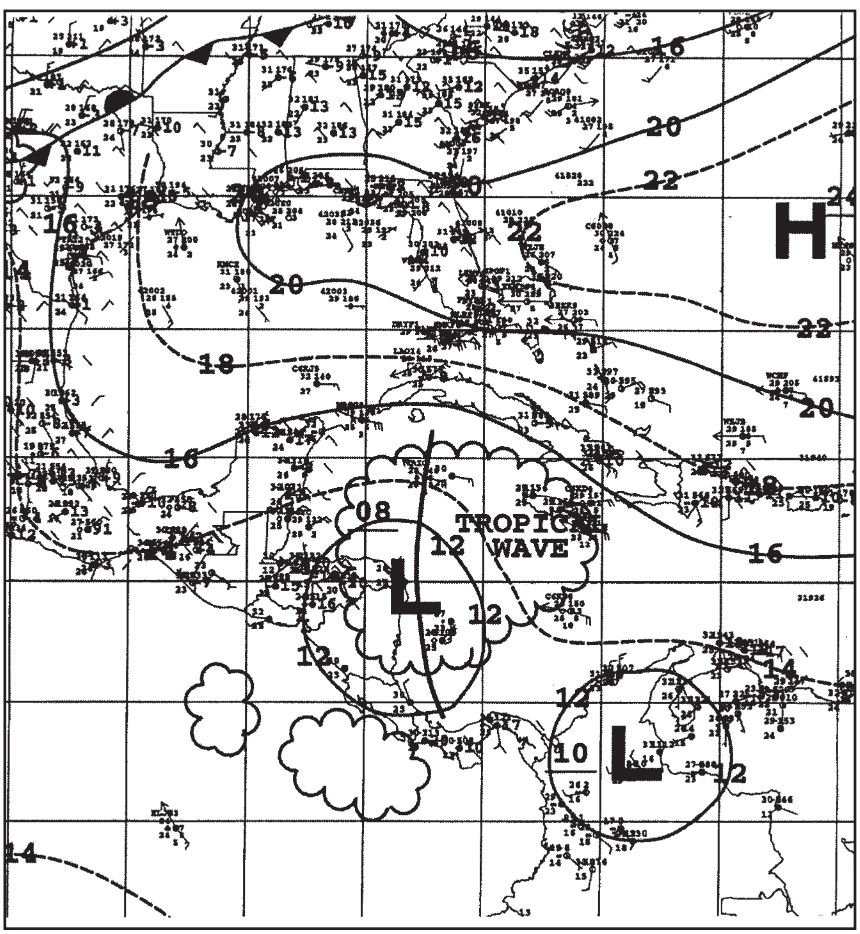


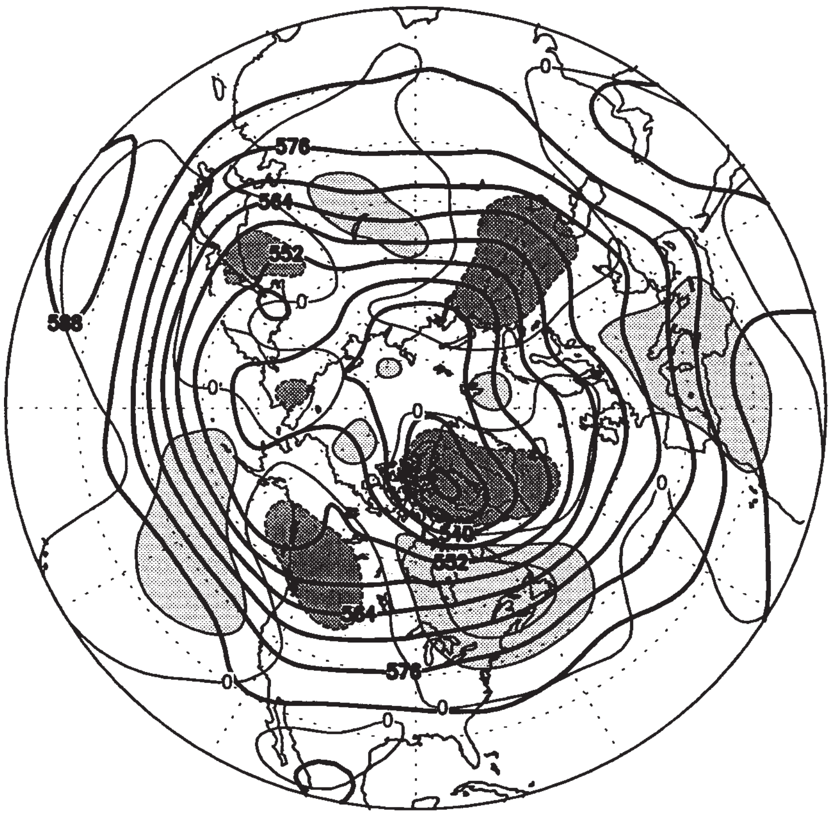
Figure 6. TAFB surface analysis at 1800 UTC 10 July 1999. Otherwise same as Fig. 5.

<u>2. Eastern Pacific</u>

None.⚓

May–June 1999

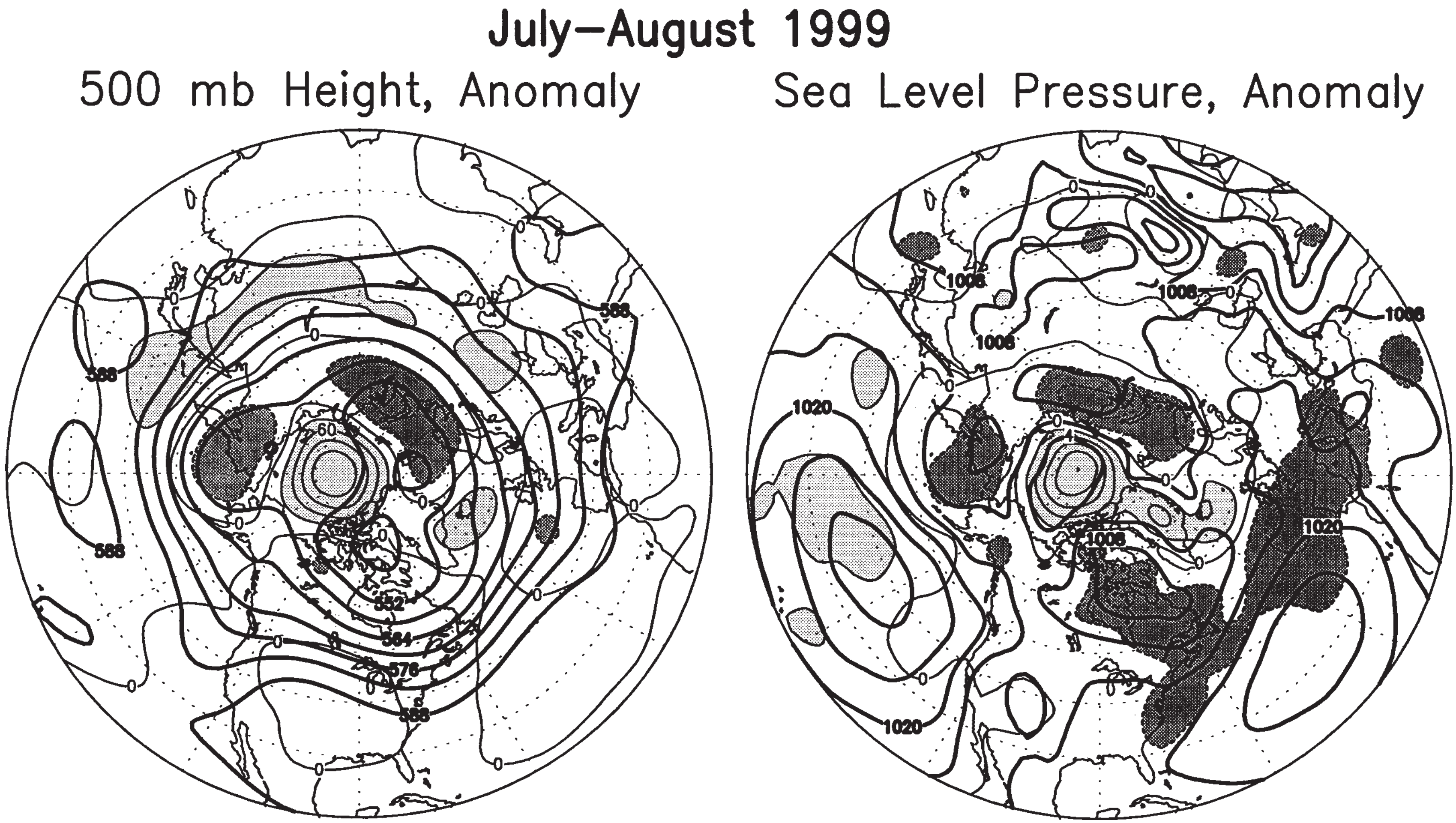
500 mb Height, Anomaly



Sea Level Pressure, 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

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



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

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

A Familiarization Float Aboard the M/V Sea-Land Kodiak
January 20 – February 1, 1998

George P. Bancroft and Joseph L. Czarniecki
Marine Prediction Center
Camp Springs, Maryland

Introduction

Taking a familiarization voyage aboard a commercial vessel gives a marine forecaster the opportunity to meet the "customer," provide a firsthand look at how HF radiofacsimile and Inmarsat satellite text products are used, gain an appreciation of how weather affects ship operations, and provide opportunity for exchange of ideas and feedback on National Weather Service products and the Voluntary Observing Ship (VOS) program.

In January 1998 we had the privilege of traveling as guests aboard the **MV Sea-Land Kodiak (KGTZ**) , which was scheduled to leave Anchorage on January 21 at 0000 Alaska Standard Time (AST) and make a round trip to Tacoma, Washington, with stops at Kodiak and Dutch Harbor, Alaska. A precursor to this trip was a ship visit we made a year earlier on another Sea-Land vessel docked in Anchorage. Greg Matzen, Marine Program Manager of the NWS Alaska Regional Headquarters, was our main point of contact in Anchorage. We allowed two or three days in Anchorage at either end of the trip in case the ship altered its schedule or ran late.

Choosing to travel in winter gave us the opportunity to experience aboard ship the more active weather that is prevalent in Alaskan waters and the Gulf of Alaska at that time of year.

The Ship

The **Kodiak**, like the other two Sea-Land ships operating between Tacoma and Alaska, is 710 feet long and 78 feet wide, which is small compared to newer container ships, and can carry up to 706 containers stored above deck and in the hold, of which 280 can be refrigerated. The ship cruises at between 19 and 20 knots using a seven cylinder marine diesel engine.

The ship's superstructure with six levels containing the bridge and living quarters is aft of where much of the cargo is stored. Above the bow and just forward of the cargo there is a foremast and a breakwater or steel shield which provides some protection to containers from seas that come over the bow. In the rear of the ship, aft of the superstructure, there is a poop deck where some containers are stored. A helipad is at the stern of the vessel, used for helicopter operations including taking a pilot aboard while the vessel is transiting Cook Inlet.

The bridge and radio room were on the top level (level 6). The bridge includes the wheelhouse in the forward section containing radar equipment and also instrumentation and controls connected with running the ship. Aft of the wheelhouse is the navigation desk with primary GPS equipment plus backup, a NAVTEX receiver and

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dial-type wind instruments mounted above the desk. On the back wall behind the desk there is a barograph and cloud chart. Above the desk there is an echograph sounding recorder for depth soundings, a PC with navigation, weather and tide-related software and another PC for monitoring engine operation, and a GMDSS workstation with Inmarsat-C, HF SSB and VHF radio. A curtain could be drawn around the navigation bridge area to block out any light from persons standing watch in the wheelhouse at night. The radiofacsimile equipment was in a port-side rear corner of the bridge and consisted of a PC with AEAFax software interconnected to an HF receiver. Flanking the bridge on either side there were two "bridge wings" or small deck overhangs which have bow-thruster controls allowing the operator to maneuver the ship in port while in view of the dock. The radio room was equipped with a PC used for e-mail, a fax machine, a backup Alden radio-facsimile recorder (the old paper-copy version), and a large radio/ communications console that included satellite telephone.

Sea-Land Kodiak in port at Dutch Harbor, Alaska.

The other five levels consisted of mainly living space, with the galley and mess rooms located on level 1. We lived in spare officer's quarters on level 5, with easy access to the bridge and the officers' lounge nearby. The rooms were spacious with double bed, reclining chair, combination desk/dresser, and bathroom with shower. Linens, towels, and soap were provided. Each room was equipped with a life jacket and survival suit. The laundry room was one level below, with detergent provided. Meal service was cafeteria style and, although this was not a cruise ship, the food was of high quality with good variety to choose from. In addition, there were snacks, fruit, sandwiches, ice cream, and coffee and tea available 24 hours a day in the officers' lounge. A TV and VCR were also in the lounge, although much of the trip was out of range of TV stations. Videotapes were available, including movies and videos dealing with company operations, and even a tape on the NWS VOS program.

The Crew

The ship was manned by a crew of 21 persons. We came into contact most often with the Captain or Master; the First, Second and Third Mates; and the Radio Officer on the bridge and in the officers' lounge and mess room. Also, one of five Able Bodied Seamen was usually in the wheelhouse steering the ship. During mealtimes we often encountered two engineers who worked in the engine room, including the Chief Engineer, who also gave us a tour of the engine room.

The Mates rotated on four-hour bridge watches with duties including the taking of weather observations. The Second Mate was also responsible for repair and maintenance of weather instruments. The Radio Officer was responsible for the repair and operation of communications equipment, and repair of electronic navigational equipment. On our trip, the Radio Officer would place personal calls via satellite and send and receive fax messages.

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Trip Diary

The **M/V Sea-Land Kodiak**, Voyage 350, departed Anchorage on the evening of January 20, 1998, on a 12-day itinerary with port stops in Kodiak, Dutch Harbor, and Tacoma. The vessel arrived back in Anchorage on the morning of February 1, 1998.

Anchorage to Kodiak

Prior to departure, Second Mate John Riggs met us upon our visit to the ship in the afternoon to direct us to our cabins and allow us to stow our luggage. We later met the Captain, George W. Schaberg, on the bridge as the ship was departing. Upper Cook Inlet near the Port of Anchorage has tidal ranges of around 9.5 meters (30 ft), tidal currents of up to 8 knots, shoals and winter ice which affect departures and arrivals. We were told that normally a tug may or may not be used for departure from the Port of Anchorage depending on sea ice, but are used for docking because of strong tidal currents and winter ice.

A pilot came aboard in Anchorage to guide the ship down Cook Inlet and accompanied the ship all the way to Kodiak. The ship plowed through considerable sea ice in upper Cook Inlet which is kept broken up by the tides. This cut 1 to 2 knots off the ship's speed. More important was the shifting glacial silt of the upper Inlet and a shallow area known as the Knik Arm Shoal marked on a navigational chart along with the route of the ship. The Captain called attention to the depth sounding recorder which showed that the ship cleared the shoal by 3.4 fathoms or about 20 feet. The minimum required clearance is 10 feet. Because of the shifting bottom, they update the depth of the shoal on the navigational chart as the ship passes over. The Second Mate who arrived for the 12-4 am watch remarked that expected winds to 30 knots off Kodiak could present problems in docking due to its easterly exposure. Twenty knot winds are considered a threshold above which problems occur.

Captain George W. Schaberg, Master of Sea-Land Kodiak (left), with Radio Officer in the radio room.

The Radio Officer, Tom Thielecke, showed us the radiofax system on the bridge, using a PC running AEAFax software. He could leave it set to receive charts, which after appearing on the screen would be downloaded and stored on the hard disk and could be uploaded on the screen later. He noted that he missed facsimile on the last 13-day trip, citing possible problems with stop tones. He showed the NAVTEX receiver used for receiving coastal and offshore forecasts and also other navigational safety messages transmitted by the U.S. Coast Guard. The Radio Officer also showed how observations are sent via Inmarsat on the GMDSS workstation. High Seas forecasts were received via the Inmarsat-C SafetyNET, using a printer attached to this workstation. Captain Schaberg demonstrated use of GPS, which showed a direct readout of the ship's course and speed over ground. The radars detected the Cook Inlet shoreline, fixed targets such as the oil and gas platforms on the west side of the Inlet, and sometimes even sea ice.

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The ship cruised down the Inlet overnight under clear skies. By 0700 AST the ship reached the Kennedy Entrance, where it started to roll due to 12 ft. swells from the Gulf of Alaska “on the beam,” and the weather changed abruptly to overcast with rain showers. We noticed that the Watch Officer logs observations in abbreviated form on the ship’s log about every two hours using Beaufort numbers. At 0600 AST and 0800 AST the log showed winds east to northeast at Force 7, or about 30 knots. The Alaskan waters were in a somewhat blocked pattern forcing a storm track along 40N and then either northeast into British Columbia or into the Gulf of Alaska where the lows weakened and turned west toward Kodiak Island or the Alaska Peninsula (Figure 1). Forecasts that we checked before the trip indicated improving conditions as we traveled west away from the storm track. It turned out that 30 knot wind and 4 meter (13 ft) seas near the Kennedy Entrance would be the highest conditions we would encounter for much of the first half of the trip. When we approached Kodiak winds dropped to around 20 kt and the weather improved offshore, but low clouds and rain showers obscured the mountains. Docking at Kodiak was at noon on January 21 and involved using a tug to slowly push the ship toward the dock while the stern thruster assisted in turning the ship to face south. The city and its more protected small boat harbor were visible to the north.

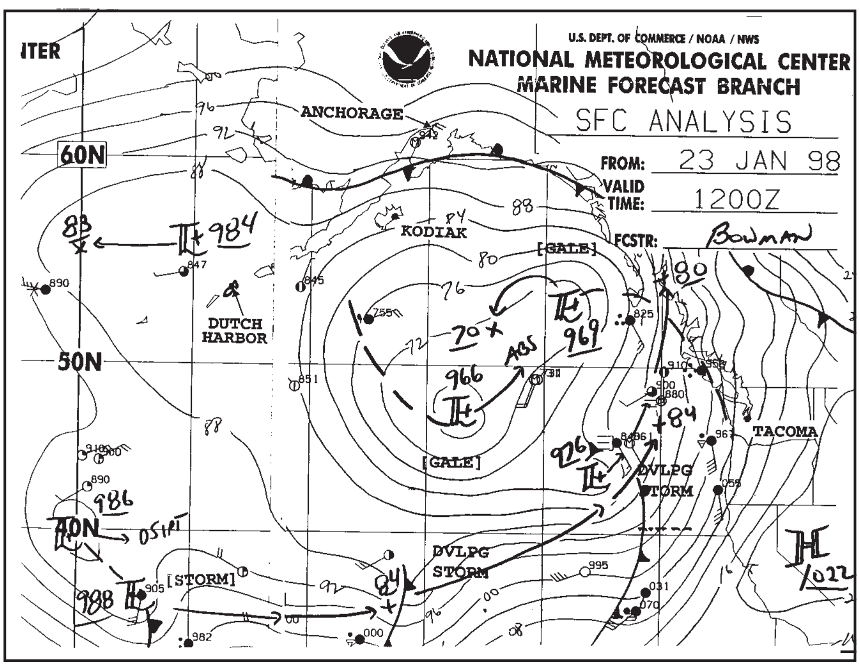

Figure 1. Surface analysis valid 12Z 23 January 1998. Sea-Land Kodiak was in port at Dutch Harbor, Alaska, at this time.

During a four-hour layover in Kodiak we met Peggy Dyson (who retired in November 1998 after providing more than 25 years of meteorological support). She showed us Kodiak and her home, where she collected observations via radio and made marine broadcasts (the broadcasts are now made by the National Weather Service Office in Kodiak). Peggy collected marine observations from vessels operating in Alaskan waters and provided these to the National Weather Service. She also transmitted weather forecasts and warnings out to the vessels.

Kodiak to Dutch Harbor

We returned to the ship just before 4 pm, at which time a loud bell sounded, which we learned is a warning that everyone must be aboard for departure one hour later. This leg of the trip began with Force 5 east to northeast winds while on a southwest heading overnight, giving way to light winds the next day (January 22). Third Mate Alan Fosmo took an 18Z observation that morning, recording the complete observation in a soft-cover book of forms, then copied the observation onto a smaller form for immediate transmission over Inmarsat-C at the GMDSS terminal. He reported calm winds and 1.5 meter (5 ft) seas mainly as a northeast swell. This was the first of 16 observations taken and transmitted by this ship during the trip.

We encountered nearly calm winds and seas for the remainder

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of the leg to Dutch Harbor, on a route which took us through Unimak Pass. The eastern Aleutians and Alaska Peninsula were under an upper low with weak surface low pressure (Figure 1) and the weather was basically good with variable cloudiness and scattered snow showers. Arrival was at night at 0130 AST on January 23.

The Captain's original schedule was for a layover of 12 hours at Dutch Harbor, but the arrival of another container vessel, APL's **President Kennedy**, and extra containers of fish and crab in refrigerated containers stretched our stay to more than 36 hours (while the President Kennedy was unloaded). We had time to explore the area. The weather in Dutch Harbor was described by the crew as the best that they ever experience, even in summer. Only one tug was needed on standby in this weather, but we were told that sometimes three are needed during high winds to hold the ship in port. On January 24, after frequent changes in departure time due to arrival of extra containers, the ship departed at 1500.

Dutch Harbor to Tacoma

This was the longest leg of the trip, with a scheduled transit time of three days and 21 hours, across the Gulf of Alaska then into the Strait of Juan de Fuca and Puget Sound enroute to Tacoma. This was when weather was to become more of a factor since we would be crossing the main storm track. They used Ocean Systems Inc. (OSI) ship routing software and made a movie loop of surface pressure and sea state forecasts, plus forecast winds and seas along the ship's track and a printout of various ship performance parameters along with winds and seas along the route. The Radio Officer ran the program prior to departure. It took about 45 minutes to download new model data.

View from the bridge as Sea-Land Kodiak plows through heavy seas 300 nm west of Vancouver Island in the North Pacific storm depicted in Figure 2.

The Captain chose to go through the Akutan Pass to the Pacific side to take advantage of a 7 knot ebb current forecast available from a tide and current program run on a PC. This boosted the ship's speed over ground to 25 knots in the pass, saving two hours, according to the Captain. He could obtain printouts of half-hourly tide and current data from the program for various locations, which he finds quite useful for planning purposes to save time and fuel.

The Chief Engineer gave us a tour of the engine room, for which ear protection was required. He showed us the three-story-tall engine, stern thrusters, and the sea water intake pipe where the sea water temperature is measured and then remoted to the bridge where it can be called up on a PC.

For the first two days of the transit the weather was good with variable cloudiness and scattered showers. The ship encountered slowly increasing northwest to west winds on the back side of northward moving lows passing well to the east but not exceeding Force 6, 22 to 27 kt, producing wind waves that increased to 5 to 7 ft on the afternoon of January 25. A gentle east to northeast swell developed on the morning of

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January 25 and was likely old swell coming from the low pressure systems to the east. The ship rode smoothly in these conditions. Following winds and seas boosted the ship's speed over ground by up to 0.4 knot during this part of the trip. On the bridge, the Captain was checking the weather more closely that day. We saw him plotting forecast positions of lows taken from the High Seas text forecast on the navigation chart where the ship's track is plotted, showing the lows passing south and east of the ship.

A storm center moved north to the Queen Charlottes early on January 26 then turned northwest and weakened while a weaker low approached the ship from near Kodiak Island, producing west winds of Force 6 and 5 ft chop plus a moderate east swell. On the evening of the 26th the wind shifted to south and diminished to 10 kt or less and the skies cleared as a ridge of high pressure passed over, but not for long. The next low was intensifying southwest of the ship and moving northeast, taking a track farther west than previous lows. The strong front with this system approached the ship the next morning (Figure 2). The weather quickly deteriorated later that night, with the ship's log showing southeast winds up to gale force (Force 8 as written in the log) by 0300 PST on January 27. Winds were up to 50 kt at 1000 PST, at which time the Third Mate prepared and sent an 18Z observation. The ship was riding reasonably smooth on reduced

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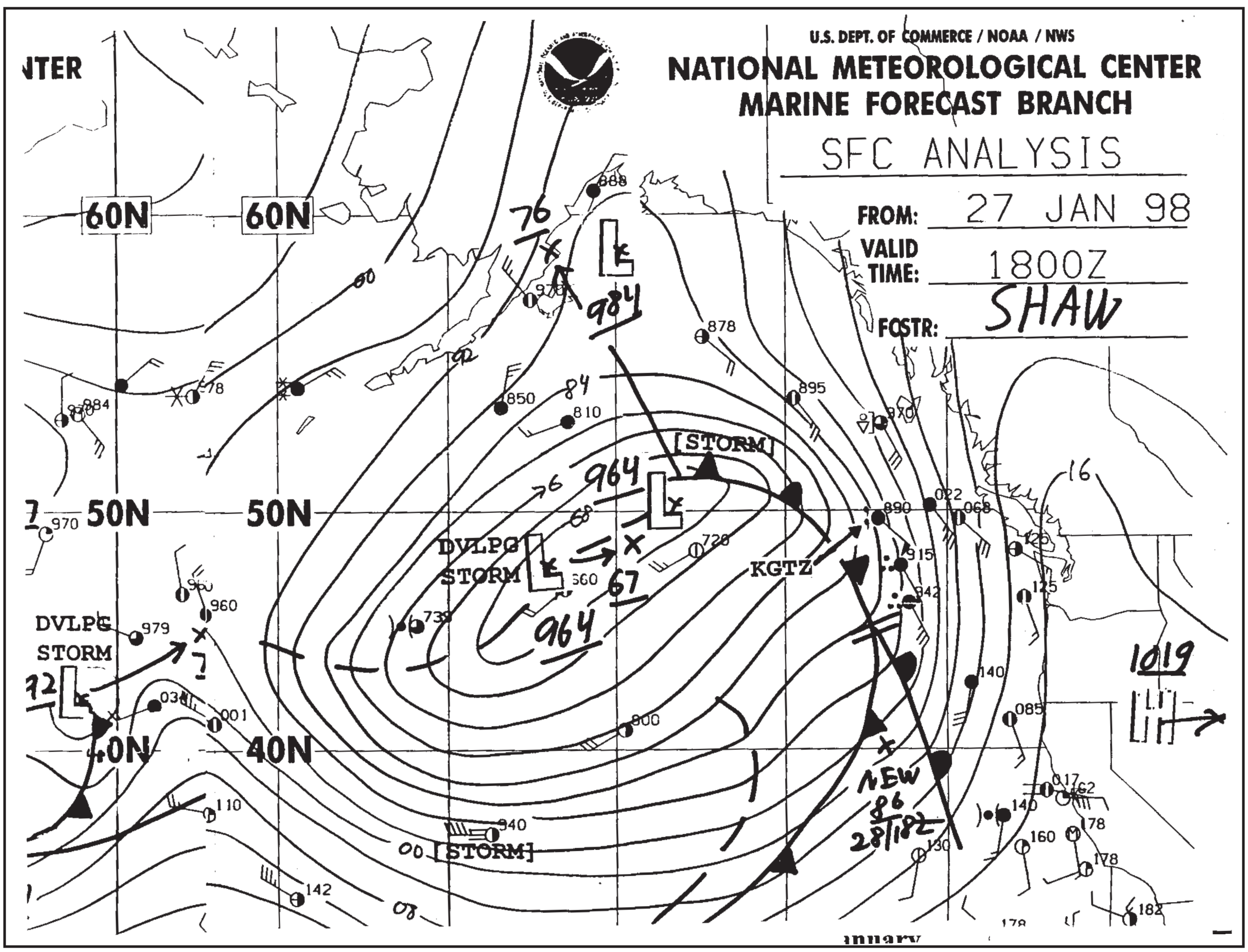

Figure 2.Surface analysis valid 18Z 27 January 1998 with arrow pointing to KGTZ observation.

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speed (down to 11 kt) and cutting into the southeast swells at about 40 degrees. The First Mate wrote this in the log and remarked that this was reducing the amount of roll and water over the deck. In the afternoon winds continued southeast 45 to 50 kt and combined seas rose to 11 meters (34 ft). Larger waves lifted the bow and then slammed it into the following wave. This slowed the ship and could be felt aboard as a lurching back and forth along with pitching. The motion of the front was slowed by a strong upper level ridge near the West Coast which, combined with the eastward motion of the ship, kept us in a prolonged period of strong gale to storm force conditions lasting through the night. Between midnight and 0200 PST January 28, the Second Mate wrote in the log that winds were gusting to 65 kt with much spray over the starboard bow and considerable lurching and pitching in seas up to 12 meters (38 ft). As a result speed was further reduced to 7.5 kt. This was the most uncomfortable part of the trip and sleeping was difficult.

Conditions improved by morning on January 28, with winds down to 35 to 40 knots, but swells on the beam caused the ship to roll. Winds continued south to southeast 30 to 35 knots with 5.5 meter (18 ft) swells to the entrance to Strait of Juan de Fuca and the ship's speed was increased. There was a gentle background southwest swell which did not become noticeable until the southeast swell was eliminated inside the strait. We arrived off Port Angeles 1800 PST with the Captain figuring that we lost nine hours due to weather, but arrival was considerably earlier than forecast by a later run of OSI, which called for arrival not until the next morning. A pilot came aboard, arriving by tug, to guide the ship to Tacoma. He was equipped with a cellular phone and a laptop computer with attached light, allowing him to work in a darkened wheelhouse. Arrival at Tacoma was at 2330 on January 28. Meanwhile radiofacsimile charts and ship routing guidance suggested following winds and seas on the final leg up to Anchorage. The Captain had to decide whether to remain in Tacoma longer and take on a full load (and be late into Anchorage) or have a fast turnaround and take a smaller load, then leave for Anchorage early the next morning. He decided on a quick turnaround and put five cranes to work loading 490 containers in Tacoma for an early 7 am departure. This, the Captain reasoned, would enable the ship to arrive in Cook Inlet on the incoming tide and make it across the shoals. He said that Sea-Land has competition on this leg, and stores in the Anchorage area expect their groceries and supplies by Monday morning.

Tacoma to Anchorage

The ship, leaving Tacoma at 0700 PST as Voyage 351, headed up Puget Sound as rain started to fall, but the rain stopped as the ship was approaching the Strait of Juan

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Sea-Land Kodiak docking in Kodiak, Alaska. View is to the north with the city and a small boat harbor in the background.

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de Fuca. This area is in the "rain shadow" of the Olympic Mountains, according to the pilot guiding the ship to his drop-off point off Port Angeles at noon.

Winds in the Strait were light and we passed Cape Flattery at 1530 PST. The Second Mate at the time, John Riggs, pointed out that southwest swell is often encountered near the entrance, which can be seen from a distance ahead of the ship by the appearance of spray from breaking waves on the southwest shore of Vancouver Island. We actually encountered 3.5 to 5 meter (12 to 15 ft) southwest swell just outside the strait, including a maximum 5.5 meter (18 ft) swell which slammed against the port bow, although winds were only southwest 15 kt or less. This was leftover swell from a storm which moved north past Vancouver Island early that morning. As the ship turned northwest coming out of the Strait, the seas on the beam caused the ship to roll, which gradually subsided during the night as the old swell dampened out overnight. Skies cleared during the night as a high pressure ridge passed.

The next morning on January 30 southeast winds were increasing ahead of the next storm and trailing front, which was centered at 49N 140W at 1200 UTC on January 30. This storm developed on a north-south oriented front and, instead of moving into British Columbia or turning west in the Gulf of Alaska and weakening like many of the systems that month, moved north northwest and slammed into the coast near Prince William Sound 24 hours later (Figure 3). The Third Mate took an 18Z observation, reporting southeast winds 30 kt and 5.5 meter (18 ft) combined seas including building southeast swell and decaying old westsouthwest swell. At 1300 PST we noticed that winds and seas were increasing rapidly and sent an e-mail to Greg Matzen at the National Weather Service Regional Headquarters in Anchorage through the Radio Officer and later that afternoon received confirmation from Greg that he had relayed this to Juneau Weather Forecast Office as well as to the Anchorage and Seattle Weather Forecast Offices. In the early afternoon the wind gauge was fluctuating wildly in direction with a strong southeast wind. The wind vane and anemometer are mounted atop the bridge in front of the stack. John Riggs, on watch at that time, said that the ship's stack can block the wind blowing on the stern, causing inaccurate readings. Wind observations were most accurate when blowing on the beam.

By 1600 PST winds were up to 60 knots as reported and transmitted at 00Z by the Second Mate, John Riggs. The sea changed from a choppy combination of wind waves and swell from different directions to a predominant southeast swell with wave lengths comparable to half the ship's length and a speed of 25 knots, which is a common swell speed according to the crew. The swell was actually overtaking the ship. The winds were gusting to hurricane force by late afternoon and seas were up to 8 to 11 meters (25 to 35 ft). This was logged by the Second Mate as Force 11 to 12 on the ship's log. The ship rode smoothly and comfortably in these conditions of following winds and

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A tanker in the Strait of Juan de Fuca.

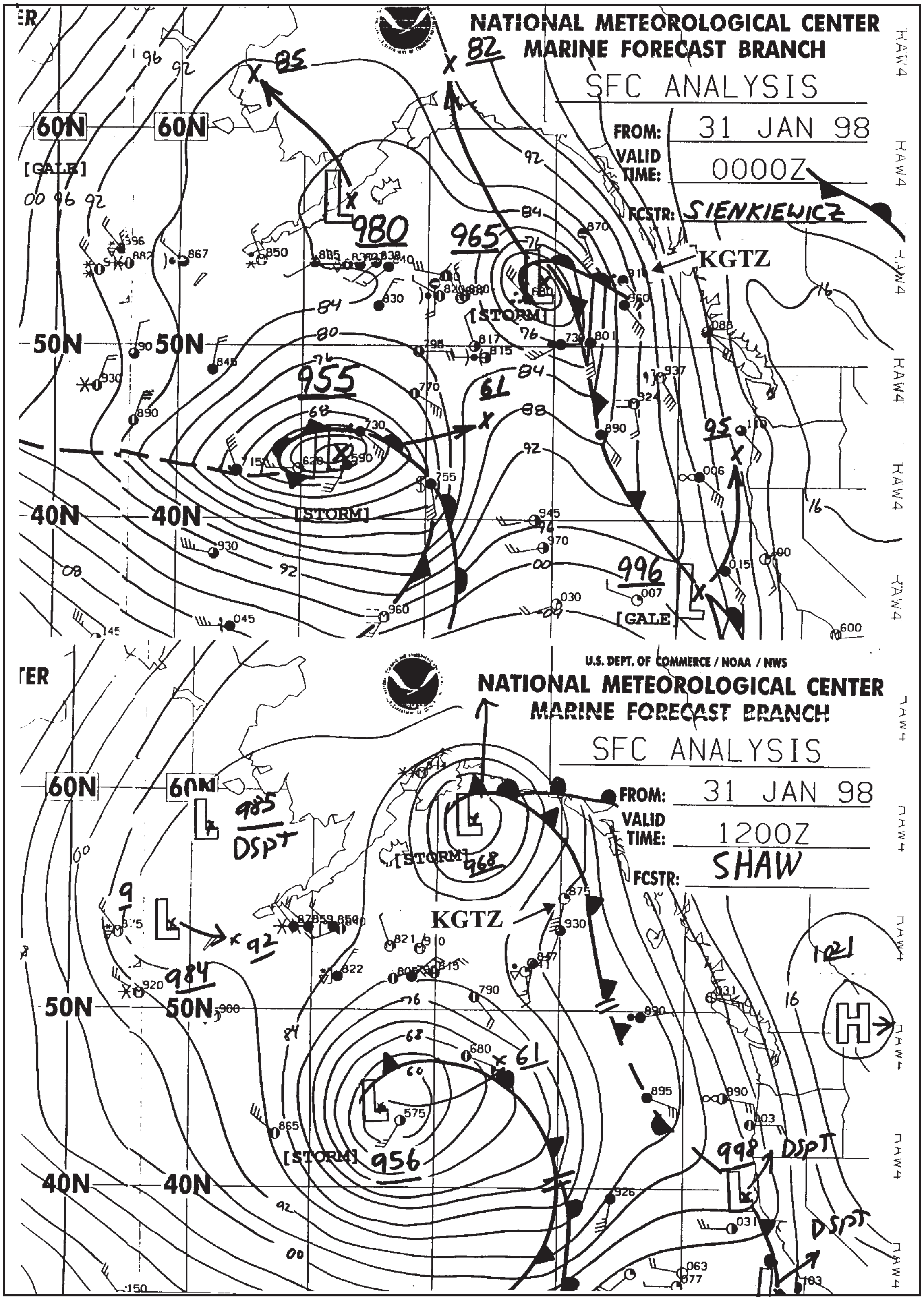

Figure 3. Surface analyses for 0000 UTC 31 January and 1200 UTC 31 January 1998 with arrows pointing to KGTZ observations.

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seas, with the ship doing 20 knots compared with the usual 19 knots. The Captain noted that even a two-tenths knot speed difference can make a large difference over a three-day trip in making it to upper Cook Inlet on the flood tide.

By 2000 AST the wind shifted to south and diminished to Force 8 or 35 to 40 kt as the storm's front passed. The ship rolled during the night as we picked up southwest swell on the beam behind the storm. By the morning of January 31 there was a confused sea with moderate to heavy crossing swells from the southeast and westsouthwest. These seas slowly subsided on Saturday January 31 as the storm center weakened and moved inland over south central Alaska. The weather that day was good with broken clouds and good visibility. On that day we heard from Coast Guard reports that a 77 ft fishing vessel, the **La Conte**, sank off the coast 80 miles southeast of Yakutat the previous night in the same storm that we encountered the previous day. Reported seas were 16 meters (50 ft), according to news reports.

Winds dropped off to light southeast by evening with swell down to 5 meters (16 ft) from 10.5 meters (33 ft) reported earlier in the day. The ship passed Kennedy Entrance around midnight and the wind switched to north in Cook Inlet, picking up to Force 6 to Force 8 off Anchor Point, then decreased toward 7 am off Kenai. There, we were to pick up a pilot by helicopter, but flights were grounded at the Kenai airport due to fog. There was a wait of almost an hour as the pilot rode an oil/gas platform service boat from Nikiski out to the ship. We arrived at the Anchorage dock by 1100 AST behind a another vessel, which could not complete docking since ice lodged between the ship and the dock had to be cleared. We debarked at noon.

Conclusion

Weather, oceanography, as well as cargo had a profound effect on Sea-Land's operation, especially in the last half of the trip. We observed how marine radiofax charts and text products are used along with the ship's navigation chart, plus guidance for ship routing from another source such as OSI. Of the radiofax charts, the Marine Prediction Center's (MPC) six-hourly surface analyses and the 48-hour forecasts of surface pressure and sea state were the most popular. The weather affects ship handling differently depending on track of the ship in relation to storm track. We had several cases of the ship rolling in beam seas. Winds and seas on the bow, such as in the storm encountered enroute from Dutch Harbor to Tacoma, resulted in the need for a decrease in speed, for greater safety of the ship and cargo and comfort of the crew. On the other hand, the ship seemed to take advantage of the other situation northbound off the Queen Charlottes in which the ship rode smoothly in following winds and seas, even though winds gusted to hurricane force and seas were 11 meters (35 ft). The Captain wanted to take advantage of following conditions plus additional oceanographical information such as currents and tides, which we plainly noticed in use often. Attention is paid to the special case of Cook Inlet, with its winter ice which slows the ship, strong currents and shifting shoals. We did not encounter any freezing spray on this trip, but when it occurs, the crew said it tends to be worst near Kennedy Entrance. Weather in port is important in that it affects the difficulty in docking and need for tug assistance. Also marine and aviation weather affects the arrival of or debarkation of a pilot who may travel by boat or helicopter to and from the ship, besides boarding or debarking when the ship is in port.

The storm of January 30-31 that affected the ship was interesting because of the abrupt change in the seas to primarily southeast swell building rapidly on the afternoon of January 30. At the MPC we see similar changes, by looping model data such as primary swell period and direction, with the appearance of swell fronts or sudden changes in period over a short distance.

A major issue was observations, including those in support of the VOS program. We watched how the Mates take and transmit observations. The observing of wind and sea state appear to present special challenges, and these are critical elements for a

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marine forecast. Wind was measured 100 ft above the water with a potential obstruction (the stack) nearby and the motion of the ship to take into account. We observed them using a wheel calculator in most cases and sometimes an electronic calculator to convert relative wind to actual wind. The graphical method in NWS Observing Handbook No. 1 (a copy of which was on the bridge) was not used. It is interesting to note that the ship's wind observation taken January 26 at 1800 UTC was logged as 2722 (270 degrees, 22 knots) but we later found that observation was flagged by MPC's quality control program as bad since it came in with 95 kt—not an obvious miscoding, but possibly a communications error. Sea state observing is a challenge because of the problem of discerning the various swell groups and height of the bridge above the water, which makes the waves look smaller than they actually are. We saw one observer throw an orange peel into the water to determine the wave period. Temperature and dew point were measured with a sling psychrometer, and from wet and dry bulb thermometers mounted in wooden instrument shelters on the outside wall of each side of the wheelhouse. It is conceivable that errors could be introduced through coding the observation and copying the observation from one form to another, and we see such errors in our quality control. The two bridge wings on either side of the bridge appeared good vantage points to observe the sky, weather, and obstructions to vision from 90 ft above the water.

Sea-Land Kodiak approaching Port of Anchorage (01 February 1998).

Of the 16 observations sent, only one was taken in the coastal waters. We informed them of the Alaska Region's need for more coastal observations, especially Cook Inlet. The Third mate told us they are busy watching for small boats. The shorter plain language observations that the Mates record on the ship log every two hours (every hour in gale or storm conditions) would be useful to supplement the VOS program in various ways, such as automation of the observation much like those of high altitude aircraft, with Global Positioning System supplying the location and ground speed of the ship. Another way is to have a shore station radio the ship for observations off the log. Ships can send plain language observations to National Weather Service Alaskan offices on 4125 KHZ.

We appreciate the opportunity to experience weather at sea, learn more about how weather and oceanography affect ship operations, observe VOS activities, and exchange ideas and feedback. We would like to express our thanks and appreciation to Sea-Land Service, Inc. and in particular, to Dave Burmeister of Sea-Land's Tacoma office and Greg Matzen, Marine Program Manager of National Weather Service's Alaska Region, for helping to arrange this trip. Our acknowledgment also goes to First Mate Bob Ramsey, who boarded the ship in Tacoma, for contribution of a large photograph of the ship, and to the crew of the ship.⚓

Voluntary Observing Ship Program

Martin S. Baron
National Weather Service
Silver Spring, Maryland

New AMVER/SEAS for Windows Under Development

As reported in this column in the August 1999 Mariners Weather Log, development of new AMVER/SEAS software is well underway. This new Windows™ version is extremely user-friendly, with features such as on-screen drop-down menus with code tables, sea state and cloud photographs, and help menus. We anticipate that the program will be available for distribution in late 2000 or early 2001. Future versions in planning include such features as real time inputs from Expendable Bathythermographs (XBTs) and meteorological sensor packages.

Prior to release of this new software, we highly recommend use of AMVER/SEAS version 4.52, available from U.S. Port Meteorological Officers or SEAS Field Representatives, or the SEAS webpage at: http://seas.nos.noaa.gov/seas/

Y2K Strikes VOS!!

It has been determined that the PKZIP.EXE and PKUNZIP.EXE version 2.03 files on many AMVER/SEAS program disks, used to archive VOS observation data, are not Y2K compliant. Performance is erratic, but will usually result in the loss of archived data. A repair disk, as well as a complete new set of AMVER/SEAS software, is available from your U.S. PMO or SEAS representative. The repair disk upgrades the PKWARE

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files on your hard disk to version 2.50, without loss of your Administrative and AMVER files or any previously collected VOS observations.

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

You can determine if you have the older version of PKWARE buy looking in the SEAS4 directory. The older versions of PKZIP and PKUNZIP are dated 1993.

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

VOS Program Publications to be Available on CD-ROM

We are planning to make VOS program publications available in CD-ROM format (in addition to our printed versions). Publications and forms such as National Weather Service Observing Handbook No. 1, the Ships Code Card, Ships Weather Observations Form B-81, the ships code card, etc. will be included.

The VOS publications will be combined on CD-ROM with the AMVER/SEAS for Windows™ software. Expect availability with completion of the AMVER/SEAS for windows software late in 2000 or early 2001.

New Recruits–May through August 1999

During the four month period May through August 1999, United States Port Meteorological Officers recruited 40 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 nm of the United States and Canadian coasts (at 0000Z, 0300Z, 0600Z, 0900Z, 1200Z, 1500Z, 1800Z), or within 300 nm of a named tropical storm or hurricane**. 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 $YYGGi_w$ $99L_aL_aL_a$ $Q_cL_oL_oL_oL_o$.

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- BBXX is the ship's weather report identifier and is always the first group of the weather message. It is the international identifier for a ship's weather report.

- D...D is your radio call sign of three to nine characters in length. Transmit your actual call sign characters only. Do not use slashes or periods to fill in space.

- YY and GG are the day and observation hour in Universal Time Coordinated (UTC), and are coded with two digits each — YY as 01, 02, 10 etc; GG as 06, 09, 12, etc. For GG, round off to the nearest whole hour UTC e.g. both 11:52 and 12:08 would be coded as 12.

- i_w is the wind measurement indicator, and is coded as 3 for estimated wind speed, and as 4 for anemometer measured wind speed.

- 99 is the ship's position groups indicator (position is defined by latitude, quadrant, and longitude) and always precedes the latitude, $L_aL_aL_a$.

- $L_aL_aL_a$ is your latitude and is indicated in whole degrees and tenths of a degree, with the decimal point left out i.e. 50.8 degrees is entered as 508; 25.0 degrees is entered as 250. For values less than 10 degrees, the first L_a is coded as zero i.e. 6.2 degrees is entered as 062. To convert minutes to tenths of a degree, divide the minutes by six and disregard the remainder i.e. 35 minutes is 5 tenths; 57 minutes is 9 tenths.

- Q_c is the quadrant of the globe, and is coded as either 1, 3, 5, or 7, according to your latitude and longitude. If your latitude/longitude are north/east, code Q_c as 1; if south/east, code Q_c as 3; if south/west, code Q_c as 5; if north/west, code Q_c as 7.

- $L_oL_oL_oL_o$ is your longitude, and like latitude, is reported in whole degrees and tenths of a degree. As for latitude, convert minutes to tenths by dividing minutes by six and disregarding the remainder. For values less than 10 degrees of longitude, code the first two L_oL_o as zero. For values less than 100 degrees of longitude, the first L_o is coded as zero. Examples: 2 degrees 27 minutes of longitude is coded as 0024; 25 degrees 47 minutes of longitude is coded as 0257; 163 degrees 56 minutes of longitude is coded as 1639.

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

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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 noticibly 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.

5. Always make sure your equipment is properly calibrated. A Port Meteorological Officer (PMO) should calibrate your barometer and barograph once every three months, and also check your psychrometer during every ship visit. Sea water thermometers (whether hull mounted or located in the condenser intake) should be calibrated annually and checked every time your vessel is in the yard for service. If your vessel has an anemometer, it should be calibrated once every six months. Make sure the anemometer is located where the ships superstructure will not interfere with the air motion. When recording dry and wet bulb temperatures, always take your psychrometer to the windward side of the ship. This allows contact with air fresh from the sea which has not passed over the deck prior to your measurement.

6. Transmit your observations without delay as soon as possible after you've observed the data. Your report is used as real-time data, indicative of current, up-to-date conditions at your vessel. Make your observation as close to the reporting hour as you can.

7. Transmission problems or difficulties with radio stations should be reported to your PMO and written down in the appropriate space on the back of the B-81 Ships Weather Observations form.

8. Keep a close, continuous watch on the sea at all times. This will make it easier to keep track of sea conditions and to observe and report your sea and swell data. Sea State/Wind Speed posters for use with the Beaufort Scale are available from PMOs.

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:

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1. Select appropriate Land Earth Station Identity (LES-ID). See table below.
2. Select routine priority.
3. Select duplex telex channel.
4. Initiate the call. Wait for the GA+ signal.
5. Select the dial code for meteorological reports, 41+.
6. Upon receipt of our answerback, NWS OBS MHTS, transmit the weather message starting with BBXX and the ship's call sign. The message must be ended with five periods. Do not send any preamble.
   GA+
   41+
   NWS OBS MHTS
   BBXX WLXX 29003 99131 70808 41998 60909 10250 2021/ 4011/ 52003 71611 85264 22234 00261 20201 31100 40803.....

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

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

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

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.

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Using The SEAS/AMVER Software

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

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

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

Telephone (Landline, Cellular, Satphone, etc.)

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

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

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

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Reporting Through United States Coast Guard Stations

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

U.S. Coast Guard High Seas Communication Stations

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

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Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
Guam	(NRV)	SITOR	1100		1212	12482.5	12585	Night
Guam	(NRV)	SITOR	1100		1612	16689	16812.5	24hr
Guam	(NRV)	SITOR	1100		2212	22290	22382	Day
Guam	(NRV)	Voice		003669994[1]	601	6200	6501	Night[5]
Guam	(NRV)	Voice		003669994[1]	1205	12242	13089	Day[5]

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

Voice frequencies are carrier (dial) frequencies. SITOR and DSC frequencies are assigned frequencies.

Note that some stations share common frequencies.

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

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

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

U.S. Coast Guard Group Communication Stations

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

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

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

Reporting Through Specified U.S. Commercial Radio Stations

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

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

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

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

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

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Globe Wireless

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

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

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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.

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

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Location	(CALL)	Mode	SEL CAL	MMSI #	ITU CH#	Ship Xmit Freq	Ship Rec Freq	Watch
	(WLO)	SITOR	1090	003660003	2272	22320	22412	24Hr
	(WLO)	SITOR	1090	003660003	2284	22326	22418	24Hr
	(WLO)	SITOR	1090	003660003	2510	25177.5	26105.5	24Hr
	(WLO)	SITOR	1090	003660003	2515	25180	26108	24Hr
	(WLO)	DSC		003660003		4208	4219	24Hr
	(WLO)	DSC		003660003		6312.5	6331.0	24Hr
	(WLO)	DSC		003660003		8415	8436.5	24Hr
	(WLO)	DSC		003660003		12577.5	12657	24Hr
	(WLO)	DSC		003660003		16805	16903	24Hr
	(WLO)	Voice		003660003	405	4077	4369	24Hr
	(WLO)	Voice			414	4104	4396	24Hr
	(WLO)	Voice			419	4119	4411	24Hr
	(WLO)	Voice		003660003	607	6218	6519	24Hr
	(WLO)	Voice		003660003	824	8264	8788	24Hr
	(WLO)	Voice			829	8279	8803	24Hr
	(WLO)	Voice			830	8282	8806	24Hr
	(WLO)	Voice		003660003	1212	12263	13110	24Hr
	(WLO)	Voice			1226	12305	13152	24Hr
	(WLO)	Voice			1607	16378	17260	24Hr
	(WLO)	Voice			1641	16480	17362	24Hr
	(WLO)	VHFVoice			CH 25,84			24Hr
	(WLO)	DSC Call		003660003	CH 70			24Hr
	(WLO)	DSC Work		003660003	CH 84			24Hr
Tuckerton,	(WSC)	SITOR	1108		419	4181.5	4219	24Hr
NJ	(WSC)	SITOR	1108		832	8392	8432	24Hr
	(WSC)	SITOR	1108		1283	12518	12620.5	24Hr
	(WSC)	SITOR	1108		1688	16727	16850	24Hr
	(WSC)	SITOR	1108		1805	18872.5	19683	24Hr
	(WSC)	SITOR	1108		2295	22331.5	22423.5	24Hr
Seattle, WA	(KLB)	SITOR	1113		408	4176	4214	24Hr
	(KLB)	SITOR	1113		608	6266.5	6318	24Hr
	(KLB)	SITOR	1113		818	8385	8425	24Hr
	(KLB)	SITOR	1113		1223	12488	12590.5	24Hr
	(KLB)	SITOR	1113		1604	16685	16808.5	24Hr
	(KLB)	SITOR	1113		2240	22304	22396	24Hr

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

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

Ship Station Response	Land Station Response
1) INITIATE ARQ CALL	
	2) RTTY CHANNEL
	3) "WHO ARE YOU" (Requests Ship's Answerback)
4) SHIP'S ANSWERBACK IDENTITY	
	5) GA+?
6) Send Command OBS+ (Weather Observations) OPR+ (Operator Assistance) HELP+ (Operator Procedure)	
	7) MOM
	8) MSG+?
9) SEND MESSAGE	
10) KKKK (End of Message Indicator, WAIT for System Response DO NOT DISCONNECT)	
	11) RTTY CHANNEL
12) SHIP'S ANSWERBACK	
	13) SYSTEM REFERENCE, INFORMATION, TIME, DURATION
	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 May 1 through August 31, 1999

NAME OF SHIP	CALL	AGENT NAME	RECRUITING PMO
ABLE DIRECTOR	9MCJ3	TAULADAN GIGIN SDN. BHD./NO. 89, LORONG TIONG.	NORFOLK, VA
AMERICA FEEDER	ELUZ8	NAVYLLOYD A.G. REEDERE	MIAMI, FL
ARCO JUNEAU	KSBG	SABINE TRANSPORTATION CO.	SEATTLE, WA
CHAPMAN	KUS1083	RESEARCH VESSEL CHAPMAN	NORFOLK, VA
CHEVRON COPENHAGEN	A8GL	JOHNSON MARINE SERVICES	SAN FRANCISCO, CA
COLUMBUS CANTERBURY	ELUB8	T. PARKER HOST, INC.	NORFOLK, VA
EDWARD E. GILLEN III	WTV5234	GILLEN MARINE CONSTRUCTION	CHICAGO, IL
FASCINATION	3FWK9	CARNIVAL CRUISE LINES	MIAMI, FL
FAUST	DWQS	RUDIGER FLEIG SCHIFFAHRTS-KG	MIAMI, FL
FEDERAL BASFIN	8PNO	ANGLO-EASTERN SHIP MANAGEMENT LTD.	NORFOLK, VA
HANJIN KEELUNG	P3UH7	PORT METEOROLOGICAL OFFICER	HOUSTON, TX
HERITAGE SERVICE	WBS4312	M/V HERITAGE, C/O CISPRI	ANCHORAGE, AK
JAN RITSCHER	DHRF	NORTON LILLY INTL INC.	NEW YORK CITY, NY
KAREN MAERSK	OZKN2	MAERSK PACIFIC LTD	SEATTLE, WA
KNUD MAERSK	OYBJ2	MAERSK PACIFIC LTD.	NEW YORK CITY, NY
KRISTEN D	WTK9856	PLAUNK TRANSPORTATION	CHICAGO, IL
MADELINE	WAP2920	MARITIME HERITAGE ALLIANCE	CHICAGO, IL
NYK SPRINGTIDE	S6CZ	SUNRISE SHIPPING AGENCY	SEATTLE, WA
PACTIMBER	YJQW3	LASCO SHIPPING CO.	SEATTLE, WA
PEARL ACE	VRUN4	STRACHAN SHIPPING CO.	SEATTLE, WA
REGAL PRINCESS	ELVK6	PRINCESS CRUISES	MIAMI, FL
SALLY MAERSK	OZHS2	MAERSK PACIFIC LTD	SEATTLE, WA
SC BREEZE	ELOC6	RUGGERIO AND OGLE	NEW YORK CITY, NY
SEVEN SEAS	3FBS9	MITSUI O.S.K., LINES, LTD	SEATTLE, WA
SOFIE MAERSK	OZUN2	MAERSK PACIFIC LTD.	SEATTLE, WA
SOROE MAERSK	OYKJ2	MAERSK PACIFIC LTD	SEATTLE, WA
STAR HOYANGER	LAXG4	WESTFAL - LARSEN MGT. AS	BALTIMORE, MD
STENA CLIPPER	C6MX4	CROWELY TRANSPORTATION	MIAMI, FL
STOLT LOYALTY	D5KX	INCHCAPE SHIPPING AGENCIES INC.	NEW YORK CITY, NY
SUN ACE	3EMJ6	M.O. SHIP MANAGEMENT CO., LTD	SEATTLE, WA
SUSAN MAERSK	OYIK2	MAERSK PACIFIC LTD	SEATTLE, WA
SVEND MAERSK	OYJS2	MAERSK PACIFIC LTD.	SEATTLE, WA
THE MONSEIGNEUR	KAQN	AMERICAN HEAVY LIFT	NEW YORK CITY, NY
USCGC ALEX HALEY	NZPO	USCGC ALEX HALEY (WMEC 39)	NORFOLK, VA
USCGC ANTHONY PETIT	NERW	USCGC ANTHONY PETIT	CHICAGO, IL
USNS DAHL	NZJB	MAERSK LINE LIMITED	NORFOLK, VA
USNS KISKA	NMFC	T-AE 35	LOS ANGELES, CA
USNS PERSISTENT	XXXX	MAERSK LINE LIMITED	NORFOLK, VA
VLADIVOSTOK	UBXP	FESCO AGENCIES N.A., INC	SEATTLE, WA
ZIM SEATTLE	ELWZ3	MERIT STEAMSHIP AGENCY INC.	SEATTLE, WA

VOS Program Awards and Presentations Gallery

*January 2000–Force 11 winds (Force 12 is maximum) with phenomenal seas near 35-30N 156-00E. Photo by Captain John E. Belcourt, **MV Green Lake**.*

*Crepuscular Rays, mid Pacific, February 2000. Photo by Captain John E. Belcourt, **MV Green Lake**.*

*PMO New York Tim Kenefick presented a 1997 VOS award to the **Oleander**. From left, Chief Mate Alain Aube, Second Engineer Ronnie Fernandez, Captain Jan Van de Westeringh, Chief Engineer Tsegay Habtemariam, and Chief Engineer Jan Swart.*

*View from the bridge of **M/V Star Trondanger** 13 November, 1998, at 0130 UTC under Force 12 conditions. Location 46.7 degrees north, 177.4 degree east. Wind was from 270 degrees at 80-90 knots.*

*PMO Miami Bob Drummond presenting a VOS outstanding performance award to Captain Leonardo Franpolla of the Carnival Cruise Ship **Destiny**. The other people in the photograph are ships officers.*

PMO New York Tim Kenefick presented a 1997 VOS award to the NOAA Ship ***Delaware II***. The three chief engineers are pictured. (No deck officers were aboard at the time.)

PMO New York Tim Kenefick presented a 1997 VOS award to the ***Sea Lion****. From left, Second Mate Fred Walley, Captain Gary deVries.*

PMO New York Tim Kenefick presented a 1997 VOS award to the ***Sea-Land Crusader****. From left, Chief Mate Bob Anderson, Chief Engineer Joe Blunt, Captain Bill Boyce, Radio Operator Lee Brown.*

PMO Miami Bob Drummond presented a 1998 VOS award to the ***Stephan J****. From left, Captain Fredic Nolting and Chief Make Lorenzo Chiong.*

Captain Jan Van der Westering and Johan Vrolik of the ***Oleander*** *receiving an outstanding VOS performance award from PMO Tim Kenefick.*

Captain Martin H. Birk and 2nd Officer Robert Jacobsen of the ***Majestic Maersk*** *receiving an outstanding VOS performance award from PMO NYC Tim Kenefick.*

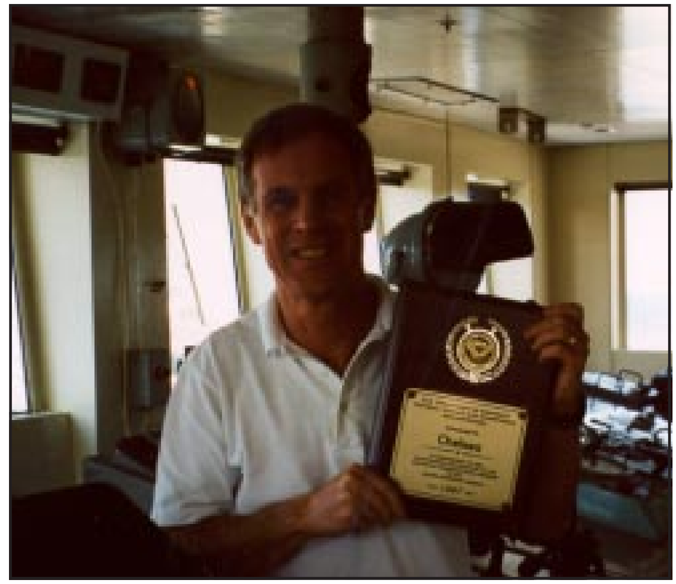
Captain Jeffrey A. Miller of the ***M/V Chelsea*** *received a 1998 outstanding VOS performance award from Miami PMO Bob Drummond.*

*PMO Miami Robert Drummond presented a VOS award to the **Tropic Tide**. From left, Chief Mate W. DeGannesk, Captain Kennady, Chief Mate N. Fariolan.*

*The **Tui Pacific** was one of the ships recognized in 1998 by the VOS program for the high quality of weather observations. Pictured left to right are Deck Cadet Maryse Gagnon, Chief Officer Enes Hodzic, Second Officer Ivo Batinic, Master Gajaba Sirimanne, Third Officer Sergey Bargman, and PMO Pat Brandow of Seattle.*

*PMO New York Tim Kenefick presented a VOS outstanding performance award to the **SC Horizon**. From left, Second Mate Sushil Mathur, Chief Mate Anil Nauni, Captain V. M. Suvarna, Principal Observer Sameer Sablok, Cadet Nikhil Gadgil.*

The NOAA ship **Miller Freeman** was one of the ships recognized in 1997 by the VOS program for the high quality of surface weather observations. Pictured from left to right are Chief Survey Tech Bill Floering, PMO Pat Brandow of Seattle, Commanding Officer CDR Gary Petrae, and Executive Office LCDR David Mattens.



Captain Jeffrey A. Miller of the ***M/V Chelsea*** *receiving a 1998 VOS award from Miami PMO Bob Drummond.*

PMO Norfolk Peter Gibino presented 1997 and 1998 VOS outstanding performance awards to crew members of the ***Mosel Ore****.*

PMO New Orleans Jack Warrelmann presented a 1998 VOS award to the ***S.S. Northern Lights****. From left, Chief Mate Mark Daly, Captain Jack Hearn, and Captain Bryan Belsito.*

VOS Coop Ship Reports — May through August 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	MAY	JUN	JUL	AUG	TOTAL
A. V. KASTNER	ZCAM9	Jacksonville	0	0	0	48	48
AALSMEERGRACHT	PCAM	Long Beach	31	39	12	32	114
ACT 7	GWAN	Newark	76	76	48	45	245
ADVANTAGE	WPPO	Norfolk	1	0	0	5	6
AGULHAS	3ELE9	Baltimore	6	38	24	32	100
AL AWDAH	9KWA	Houston	34	6	0	0	40
AL FUNTAS	9KKX	Miami	66	0	67	6	139
AL SAMIDOON	9KKF	Houston	4	41	24	0	69
ALBEMARLE ISLAND	C6LU3	Newark	48	47	35	25	155
ALBERNI DAWN	ELAC5	Houston	31	36	19	4	90
ALBLASGRACHT	PCIG	Houston	1	24	10	54	89
ALEXANDER VON HUMBOLD	Y3CW	Miami	647	646	0	505	1798
ALKMAN	C6OG4	Houston	39	30	28	22	119
ALLEGIANCE	WSKD	Norfolk	20	29	14	14	77
ALLIANCA AMERICA	DHGE	Baltimore	8	21	7	0	36
ALLIGATOR AMERICA	JPAL	Seattle	0	0	0	1	1
ALLIGATOR BRAVERY	3FXX4	Oakland	58	63	46	42	209
ALLIGATOR COLUMBUS	3ETV8	Seattle	13	9	14	34	70
ALLIGATOR FORTUNE	ELFK7	Seattle	10	5	23	17	55
ALLIGATOR GLORY	ELJP2	Seattle	21	14	15	19	69
ALLIGATOR HOPE	ELFN8	Seattle	25	31	28	31	115
ALLIGATOR LIBERTY	JFUG	Seattle	75	33	65	54	227
ALLIGATOR STRENGTH	3FAK5	Oakland	6	5	0	0	11
ALPENA	WAV4647	Cleveland	23	11	9	16	59
ALPHA HELIX	WSD7078	Seattle	0	0	0	3	3
ALTAIR	DBBI	Miami	518	487	661	348	2014
ALTAMONTE	3EIG4	Long Beach	0	0	9	3	12
AMAZON	S6BJ	Norfolk	18	40	25	0	83
AMBASSADOR BRIDGE	3ETH9	Oakland	51	55	55	36	197
AMERICA FEEDER	ELUZ8	Miami	0	13	18	2	33
AMERICA STAR	C6JZ2	Houston	61	85	89	35	270
AMERICAN MARINER	WQZ7791	Cleveland	13	21	36	6	76
AMERICAN MERLIN	WRGY	Norfolk	0	0	0	21	21
AMERICANA	C6QG4	New Orleans	0	0	4	20	24
ANASTASIS	9HOZ	Miami	1	1	0	2	4
ANATOLIY KOLESNICHENKO	UINM	Seattle	27	5	3	11	46
ANKERGRACHT	PCQL	Baltimore	4	22	0	6	32
APL CHINA	V7AL5	Seattle	25	26	58	40	149
APL GARNET	9VVN	Oakland	0	6	66	32	104
APL JAPAN	V7AL7	Seattle	29	56	40	33	158
APL KOREA	WCX8883	Seattle	43	31	65	67	206
APL PHILIPPINES	WCX8884	Seattle	35	23	45	36	139
APL SINGAPORE	WCX8812	Seattle	55	81	49	52	237
APL THAILAND	WCX8882	Seattle	26	29	38	67	160
APOLLOGRACHT	PCSV	Baltimore	12	33	34	33	112
AQUARIUS ACE	3FHB8	New York City	0	0	25	24	49
ARCO ALASKA	KSBK	Long Beach	17	0	0	12	29
ARCO CALIFORNIA	WMCV	Long Beach	13	13	10	9	45
ARCO FAIRBANKS	WGWB	Long Beach	0	0	16	37	53
ARCO INDEPENDENCE	KLHV	Long Beach	7	2	0	5	14

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
ARCO JUNEAU	KSBG	Seattle	0	0	14	94	108
ARCO SAG RIVER	WLDF	Long Beach	2	8	4	9	23
ARCO SPIRIT	KHLD	Long Beach	16	18	14	10	58
ARCO TEXAS	KNFD	Long Beach	15	9	13	11	48
ARGONAUT	KFDV	Newark	4	22	36	48	110
ARIES	KGBD	New York City	28	54	27	38	147
ARINA ARCTICA	OVYA2	Miami	91	49	78	90	308
ARKTIS FUTURE	OXUF2	Miami	53	70	72	44	239
ARMCO	WE6279	Cleveland	20	10	1	45	76
ARTHUR M. ANDERSON	WE4805	Chicago	84	88	112	55	339
ATLANTIC	3FYT	Miami	49	207	202	223	681
ATLANTIC CARTIER	C6MS4	Norfolk	0	1	11	13	25
ATLANTIC COMPANION	SKPE	Newark	25	19	25	30	99
ATLANTIC COMPASS	SKUN	Norfolk	15	32	32	35	114
ATLANTIC CONCERT	SKOZ	Norfolk	9	15	7	18	49
ATLANTIC CONVEYOR	C6NI3	Norfolk	34	28	34	15	111
ATLANTIC ERIE	VCQM	Baltimore	0	0	1	1	2
ATLANTIC NOVA	3FWT4	Seattle	36	45	40	29	150
ATLANTIC OCEAN	C6T2064	Newark	7	34	0	8	49
ATLANTIS	KAQP	New Orleans	11	2	15	28	56
AUCKLAND STAR	C6KV2	Baltimore	58	51	61	60	230
AUSTRAL RAINBOW	WEZP	New Orleans	5	0	0	0	5
AUTHOR	GBSA	Houston	0	0	5	1	6
B. T. ALASKA	WFQE	Long Beach	19	12	3	5	39
BARBARA ANDRIE	WTC9407	Chicago	22	29	23	31	105
BARRINGTON ISLAND	C6QK	Miami	36	50	52	55	193
BAY BRIDGE	ELES7	Seattle	14	13	14	10	51
BELLONA	3FEA4	Jacksonville	4	15	13	16	48
BERING SEA	C6YY	Miami	23	17	19	0	59
BERNARDO QUINTANA A	C6KJ5	New Orleans	3	4	7	11	25
BLUE GEMINI	3FPA6	Seattle	55	33	49	55	192
BLUE HAWK	D5HZ	Norfolk	4	0	0	0	4
BLUE NOVA	3FDV6	Seattle	22	34	26	26	108
BONN EXPRESS	DGNB	Houston	655	678	353	716	2402
BP ADMIRAL	ZCAK2	Houston	7	21	0	49	77
BRIGHT PHOENIX	DXNG	Seattle	43	41	52	32	168
BRIGHT STATE	DXAC	Seattle	0	0	29	36	65
BRISBANE STAR	C6LY4	Seattle	30	23	50	27	130
BRITISH ADVENTURE	ZCAK3	Seattle	55	61	48	36	200
BRITISH HAWK	ZCBK6	New Orleans	61	59	7	0	127
BRITISH RANGER	ZCAS6	Houston	43	61	23	22	149
BT NIMROD	ZCBL5	Long Beach	16	0	3	2	21
BUCKEYE	WAQ3520	Cleveland	11	3	1	5	20
BUFFALO	WXS6134	Cleveland	11	9	28	22	70
BUNGA ORKID DUA	9MBQ4	Seattle	27	0	31	14	72
BUNGA ORKID SATU	9MBQ3	Seattle	0	2	0	0	2
BURNS HARBOR	WQZ7049	Chicago	136	105	114	115	470
CALCITE II	WB4520	Chicago	8	3	16	3	30
CALIFORNIA HIGHWAY	3FHQ4	Seattle	8	0	0	0	8
CALIFORNIA JUPITER	ELKU8	Long Beach	12	2	18	5	37
CALIFORNIA MERCURY	JGPN	Seattle	19	23	16	0	58
CAPE JACOB	WJBA	New Orleans	0	0	1	0	1
CAPE MAY	JBCN	Norfolk	5	25	7	5	42
CAPT STEVEN L BENNETT	KAXO	New Orleans	19	66	0	0	85
CARIBBEAN MERCY	3FFU4	Miami	0	11	17	0	28
CARLA A. HILLS	ELBG9	Oakland	0	24	10	0	34
CARNIVAL DESTINY	3FKZ3	Miami	14	22	30	12	78
CARNIVAL PARADISE	3FOB5	Miami	23	19	13	23	78
CASON J. CALLAWAY	WE4879	Chicago	32	41	66	41	180
CEDRELA	C6JP9	Seattle	0	1	0	0	1
CELEBRATION	ELFT8	Miami	21	26	12	1	60
CENTURY HIGHWAY #2	3EJB9	Long Beach	0	19	19	17	55

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
CENTURY HIGHWAY NO. 1	3FFJ4	Houston	19	21	21	13	74
CENTURY LEADER NO. 1	3FBI6	Houston	1	28	42	35	106
CHARLES E. WILSON	WZE4539	Cleveland	0	1	0	0	1
CHARLES ISLAND	C6JT	Miami	58	59	57	65	239
CHARLES M. BEEGHLEY	WL3108	Cleveland	31	36	43	6	116
CHASTINE MAERSK	OWNJ2	New York City	0	28	0	0	28
CHC NO.1	3FSL2	Seattle	0	24	19	9	52
CHELSEA	KNCX	Miami	21	28	34	31	114
CHESAPEAKE BAY	DIOD	Long Beach	0	1	0	0	1
CHESAPEAKE BAY	WMLH	Houston	49	36	29	38	152
CHESAPEAKE TRADER	WGZK	Houston	15	0	55	10	80
CHEVRON ARIZONA	KGBE	Miami	24	23	10	18	75
CHEVRON ATLANTIC	C6KY3	New Orleans	0	0	0	4	4
CHEVRON COPENHAGEN	A8GL	Oakland	0	0	1	11	12
CHEVRON EDINBURGH	VSBZ5	Oakland	0	0	78	19	97
CHEVRON FELUY	ELIN	Houston	0	0	0	1	1
CHEVRON LOUISIANA	WHNG	Oakland	1	0	0	0	1
CHEVRON MISSISSIPPI	WXBR	Oakland	32	42	27	44	145
CHEVRON PERTH	C6KQ8	Oakland	0	0	3	20	23
CHEVRON SOUTH AMERICA	ZCAA2	New Orleans	17	59	36	0	112
CHIEF GADAO	WEZD	Oakland	29	19	14	14	76
CHIQUITA BELGIE	C6KD7	Baltimore	47	52	49	34	182
CHIQUITA BREMEN	ZCBC5	Miami	47	44	32	40	163
CHIQUITA BRENDA	ZCBE9	Miami	34	32	59	51	176
CHIQUITA DEUTSCHLAND	C6KD8	Baltimore	31	33	54	66	184
CHIQUITA ELKESCHLAND	ZCBB9	Miami	53	54	52	64	223
CHIQUITA FRANCES	ZCBD9	Miami	31	12	29	30	102
CHIQUITA ITALIA	C6KD5	Baltimore	59	50	49	60	218
CHIQUITA JEAN	ZCBB7	Jacksonville	45	47	48	29	169
CHIQUITA JOY	ZCBC2	Miami	52	51	49	44	196
CHIQUITA NEDERLAND	C6KD6	Baltimore	33	46	52	49	180
CHIQUITA ROSTOCK	ZCBD2	Miami	39	50	40	31	160
CHIQUITA SCANDINAVIA	C6KD4	Baltimore	54	56	58	70	238
CHIQUITA SCHWEIZ	C6KD9	Baltimore	31	11	12	13	67
CHO YANG ATLAS	DQVH	Seattle	29	43	16	40	128
CHOYANG PHOENIX	P3ZY6	Norfolk	16	12	19	20	67
CITY OF DURBAN	GXIC	Long Beach	54	34	46	62	196
CLEVELAND	KGXA	Houston	28	52	50	52	182
COASTAL MANATEE	KGXM	Jacksonville	4	17	16	0	37
COLORADO	KWFE	Miami	13	1	0	0	14
COLUMBIA STAR	WSB2018	Cleveland	9	17	13	11	50
COLUMBIA STAR	C6HL8	Long Beach	64	72	66	74	276
COLUMBUS AMERICA	ELSX2	Norfolk	89	36	0	0	125
COLUMBUS AUSTRALIA	ELSX3	Houston	71	25	0	0	96
COLUMBUS CALIFORNIA	ELUB7	Houston	32	37	0	0	69
COLUMBUS CANADA	ELQN3	Seattle	14	17	45	27	103
COLUMBUS CANTERBURY	ELUB8	Norfolk	38	39	23	55	155
COLUMBUS QUEENSLAND	ELUB9	Norfolk	2	0	27	17	46
COLUMBUS VICTORIA	ELUB6	Long Beach	14	29	37	41	121
CONDOLEEZZA RICE	C6OK	Baltimore	1	18	6	7	32
CONTSHIP ENDEAVOUR	ZCBE7	Houston	38	18	24	39	119
CONTSHIP SUCCESS	ZCBE3	Houston	76	95	58	117	346
COPACABANA	PPXI	Norfolk	21	0	0	11	32
CORAL SEA	C6YW	Miami	23	39	13	22	97
CORMORANT ARROW	C6IO9	Seattle	21	0	7	8	36
CORNUCOPIA	KPJC	Oakland	4	31	29	10	74
CORWITH CRAMER	WTF3319	Norfolk	16	6	11	2	35
COSMOWAY	3EVO3	Seattle	0	0	1	10	11
COURTNEY BURTON	WE6970	Cleveland	27	30	28	32	117
COURTNEY L	ZCAQ8	Baltimore	17	17	13	15	62
CROWN OF SCANDINAVIA	OXRA6	Miami	52	63	79	85	279
CSL CABO	D5XH	Seattle	51	40	39	26	156

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
CSS HUDSON	CGDG	Norfolk	9	38	5	47	99
DAGMAR MAERSK	DHAF	New York City	0	79	55	5	139
DAISHIN MARU	3FPS6	Seattle	70	64	83	68	285
DANIA PORTLAND	OXEH2	Miami	38	75	21	81	215
DAVID Z. NORTON	WZF9655	Cleveland	0	0	0	3	3
DAWN PRINCESS	ELTO4	Miami	9	3	2	3	17
DELAWARE BAY	WMLG	Houston	0	19	20	3	42
DENALI	WSVR	Long Beach	28	1	39	32	100
DIRECT CONDOR	ELWP7	Long Beach	0	0	0	63	63
DIRECT KEA	C6MP8	Long Beach	67	73	24	0	164
DIRECT KOOKABURRA	C6MQ2	Long Beach	56	37	0	0	93
DOCK EXPRESS 20	PJRF	Baltimore	38	91	22	0	151
DON QUIJOTE	SFQP	New York City	8	38	49	13	108
DORTHE OLDENDORFF	ELQJ6	Seattle	0	0	1	0	1
DRAGOER MAERSK	OXPW2	Long Beach	26	29	28	19	102
DUHALLOW	ZCBH9	Baltimore	70	64	73	87	294
DUNCAN ISLAND	C6JS	Miami	19	36	50	31	136
DUSSELDORF EXPRESS	S6IG	Long Beach	54	0	0	0	54
E.P. LE QUEBECOIS	CG3130	Norfolk	218	230	226	235	909
EARL W. OGLEBAY	WZE7718	Cleveland	0	0	1	0	1
EASTERN BRIDGE	C6JY9	Baltimore	67	77	79	62	285
ECSTASY	ELNC5	Miami	0	12	15	10	37
EDELWEISS	VRUM3	Seattle	42	21	27	10	100
EDGAR B. SPEER	WQZ9670	Chicago	113	92	106	100	411
EDWIN H. GOTT	WXQ4511	Chicago	47	37	40	22	146
EDYTH L	C6YC	Baltimore	14	13	11	18	56
EL MORRO	KCGH	Miami	3	5	13	18	39
EL YUNQUE	WGJT	Jacksonville	1	34	51	59	145
ELATION	3FOC5	Miami	12	15	7	9	43
EMERALD ISLE	WCX7834	Chicago	0	0	1	0	1
EMPIRE STATE	KKFW	New York City	18	59	32	0	109
ENDEAVOR	WAUW	New York City	26	52	24	21	123
ENDURANCE	WAUU	New York City	32	6	13	13	64
ENERGY ENTERPRISE	WBJF	Baltimore	0	19	0	0	19
ENGLISH STAR	C6KU7	Long Beach	77	79	85	74	315
ENIF	9VVI	Houston	0	0	0	12	12
ENTERPRISE	WAUY	New York City	33	40	47	19	139
EVER DELIGHT	3FCB8	New York City	17	0	9	14	40
EVER DEVOTE	3FIF8	New York City	0	0	0	2	2
EVER DIADEM	3FOF8	New York City	3	0	2	3	8
EVER GAINING	BKJO	Norfolk	0	0	3	0	3
EVER GIFTED	BKHF	Long Beach	7	7	8	5	27
EVER GLOWING	BKJZ	Long Beach	2	0	15	18	35
EVER GOING	3EZW2	Seattle	12	26	24	7	69
EVER GOODS	BKHZ	Newark	3	2	0	0	5
EVER GROUP	BKJI	Long Beach	0	4	2	15	21
EVER LAUREL	BKHH	Long Beach	0	0	14	10	24
EVER LEVEL	BKHJ	Miami	0	9	11	13	33
EVER RACER	3FJL4	Norfolk	7	0	16	2	25
EVER REACH	3FQO4	Newark	8	20	8	0	36
EVER RESULT	3FSA4	Norfolk	7	0	9	0	16
EVER REWARD	3FYB3	New York City	0	2	0	6	8
EVER RIGHT	3FML3	Long Beach	7	6	0	12	25
EVER ULTRA	3FEJ6	Seattle	6	12	10	11	39
EVER UNION	3FFG7	Seattle	21	26	23	31	101
EVER UNIQUE	3FXQ6	Seattle	8	7	25	19	59
EVER UNISON	3FTL6	Long Beach	4	11	8	11	34
EVER UNITED	3FMQ6	Seattle	4	10	20	10	44
FAIRLIFT	PEBM	Norfolk	0	81	65	44	190
FAIRMAST	PJLC	Norfolk	43	2	9	56	110
FANAL TRADER	VRUY4	Seattle	60	56	47	56	219
FANTASY	ELKI6	Miami	6	12	31	29	78

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
FARALLON ISLAND	FARIS	Oakland	107	98	97	139	441
FASCINATION	3EWK9	Miami	0	5	11	9	25
FAUST	WRYX	Jacksonville	0	35	33	27	95
FIDELIO	WQVY	Jacksonville	30	21	36	50	137
FLAMENGO	PPXU	Norfolk	0	0	14	0	14
FOREST CHAMPION	3FSH3	Seattle	0	12	25	0	37
FRANCES HAMMER	KRGC	Jacksonville	25	60	39	33	157
FRANCES L	C6YE	Baltimore	42	40	41	34	157
FRANK A. SHRONTZ	C6PZ3	Oakland	0	0	11	18	29
FRANKFURT EXPRESS	9VPP	New York City	18	5	9	12	44
FRED R. WHITE JR	WAR7324	Cleveland	1	0	0	8	9
G AND C PARANA	LADC2	Long Beach	13	3	13	0	29
GALAXY ACE	VRUI2	Jacksonville	0	24	90	78	192
GALVESTON BAY	WPKD	Houston	51	27	33	37	148
GANNET ARROW	C6QF5	Seattle	0	0	0	25	25
GEORGE A. SLOAN	WA5307	Chicago	26	27	31	27	111
GEORGE A. STINSON	WCX2417	Cleveland	36	25	23	9	93
GEORGE SCHULTZ	ELPG9	Baltimore	31	55	19	34	139
GEORGE WASHINGTON BRIDGE	JKCF	Long Beach	48	47	38	52	185
GEORGIA RAINBOW II	VRVS5	Jacksonville	30	80	84	49	243
GINGA MARU	JFKC	Long Beach	0	0	41	92	133
GLOBAL LINK	WWDY	Baltimore	0	0	7	0	7
GLOBAL NEXTAGE	XYLV	Seattle	0	0	0	11	11
GLORIOUS SUCCESS	DUHN	Seattle	0	8	3	0	11
GLORIOUS SUN	DVTR	Seattle	1	0	0	0	1
GOLDEN BEAR	NMRY	Oakland	59	53	58	55	225
GOLDEN BELL	3EBK9	Seattle	12	12	0	4	28
GOLDEN GATE	KIOH	Long Beach	44	68	17	62	191
GOLDEN GATE BRIDGE	3FWM4	Seattle	82	75	49	57	263
GRANDEUR OF THE SEAS	ELTQ9	Miami	9	12	6	6	33
GREAT LAND	WFDP	Seattle	32	22	36	49	139
GREEN BAY	KGTH	Long Beach	26	4	8	10	48
GREEN ISLAND	KIBK	New Orleans	0	2	0	0	2
GREEN LAKE	KGTI	Baltimore	29	13	2	10	54
GREEN POINT	WCY4148	New York City	2	4	14	1	21
GREEN RAINIER	3ENI3	Seattle	28	42	33	23	126
GRETE MAERSK	OZNF2	New York City	23	0	19	28	70
GROTON	KMJL	Newark	7	37	2	35	81
GUANAJUATO	ELMH8	Jacksonville	0	0	12	25	37
GUAYAMA	WZJG	Jacksonville	23	33	33	36	125
HADERA	ELBX4	Baltimore	64	57	50	59	230
HANJIN BARCELONA	3EXX9	Long Beach	0	0	1	0	1
HANJIN BOMBAY	DSDU5	Seattle	1	0	0	0	1
HANJIN COLOMBO	3FTF4	Oakland	6	0	0	6	12
HANJIN KAOHSIUNG	P3BN8	Seattle	5	9	15	9	38
HANJIN KEELUNG	P3VH7	Houston	35	10	41	9	95
HANJIN LOS ANGELES	3FPQ7	Newark	8	6	0	0	14
HEICON	P3TA4	Norfolk	5	10	0	10	25
HEIDELBERG EXPRESS	DEDI	Houston	621	679	383	502	2185
HENRY HUDSON BRIDGE	JKLS	Long Beach	52	57	32	75	216
HERBERT C. JACKSON	WL3972	Cleveland	15	16	9	9	49
HOEGH DENE	ELWO7	Norfolk	35	38	70	42	185
HOEGH MINERVA	LAGI5	Seattle	11	0	0	0	11
HOLIDAY	3FPN5	Long Beach	0	1	4	8	13
HONG KONG SENATOR	DEIP	Seattle	12	18	27	27	84
HONSHU SILVIA	3EST7	Seattle	58	53	64	6	181
HOOD ISLAND	C6LU4	Miami	48	47	41	28	164
HORIZON	ELNG6	Miami	0	0	0	24	24
HOUSTON	FNXB	Houston	29	71	8	0	108
HOUSTON EXPRESS	DLBB	Houston	36	53	0	0	89
HUMACAO	WZJB	Norfolk	36	36	35	32	139
HUMBERGRACHT	PEUQ	Houston	49	19	6	24	98

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
HUME HIGHWAY	3EJO6	Jacksonville	33	28	16	16	93
HYUNDAI DISCOVERY	3FFR6	Seattle	30	32	48	47	157
HYUNDAI EXPLORER	3FTG4	Seattle	37	51	31	35	154
HYUNDAI FORTUNE	3FLG6	Seattle	34	0	0	9	43
HYUNDAI FREEDOM	3FFS6	Seattle	8	6	7	17	38
HYUNDAI INDEPENDENCE	3FDY6	Seattle	0	5	4	0	9
HYUNDAI LIBERTY	3FFT6	Seattle	14	15	9	11	49
IMAGINATION	3EWJ9	Miami	27	20	22	11	80
INDEPENDENT LEADER	DHOU	New York City	59	24	0	0	83
INDIAN OCEAN	C6T2063	New York City	12	9	2	8	31
INDIANA HARBOR	WXN3191	Cleveland	16	16	24	22	78
INLAND SEAS	WCJ6214	Chicago	8	5	3	9	25
INSPIRATION	3FOA5	Miami	2	6	15	28	51
IRENA ARCTICA	OXTS2	Miami	76	60	51	63	250
ISLA DE CEDROS	3FOA6	Seattle	39	56	46	53	194
ISLAND BREEZE	C6KP	Miami	7	3	0	0	10
ITB BALTIMORE	WXKM	Baltimore	12	6	14	9	41
ITB MOBILE	KXDB	New York City	10	51	28	11	100
ITB NEW YORK	WVDG	Newark	13	47	13	3	76
IVARAN CONDOR	DGGD	Houston	34	27	36	24	121
IVARAN EAGLE	DNEN	Houston	19	20	40	31	110
IVARAN RAVEN	DIGF	Houston	25	25	26	14	90
IVER EXPRESS	PEXX	Houston	15	0	9	9	33
IWANUMA MARU	3ESU8	Seattle	48	86	77	60	271
J. DENNIS BONNEY	ELLE2	Baltimore	5	1	8	0	14
J.A.W. IGLEHART	WTP4966	Cleveland	0	3	2	0	5
JACKLYN M.	WCV7620	Chicago	9	7	0	6	22
JACKSONVILLE	WNDG	Baltimore	19	22	1	14	56
JADE ORIENT	ELRY6	Seattle	0	6	4	7	17
JADE PACIFIC	ELRY5	Seattle	1	0	15	7	23
JAMES	ELRR6	New Orleans	31	32	27	34	124
JAMES R. BARKER	WYP8657	Cleveland	5	1	0	0	6
JEB STUART	WRGQ	Oakland	61	64	29	22	176
JO CLIPPER	PFEZ	Baltimore	19	42	50	63	174
JOHN G. MUNSON	WE3806	Chicago	83	45	24	61	213
JOIDES RESOLUTION	D5BC	Norfolk	1	10	23	18	52
JOSEPH H. FRANTZ	WA6575	Cleveland	0	0	7	5	12
JOSEPH L. BLOCK	WXY6216	Chicago	32	0	3	22	57
JOSEPH LYKES	ELRZ8	Houston	2	19	0	19	40
JUBILEE	3FPM5	Long Beach	4	0	0	2	6
JULIUS HAMMER	KRGJ	Jacksonville	9	17	44	32	102
KAIJIN	3FWI3	Seattle	9	0	0	0	9
KANIN	ELEO2	New Orleans	0	0	33	0	33
KAPITAN BYANKIN	UAGK	Seattle	5	0	0	43	48
KAPITAN KONEV	UAHV	Seattle	32	56	44	39	171
KAPITAN MASLOV	UBRO	Seattle	46	56	57	46	205
KAREN ANDRIE	WBS5272	Chicago	33	29	14	15	91
KAREN MAERSK	OZKN2	Seattle	0	0	0	24	24
KATRINE MAERSK	OZLL2	New York City	6	3	0	5	14
KAUAI	WSRH	Long Beach	7	14	41	42	104
KAYE E. BARKER	WCF3012	Cleveland	12	10	14	16	52
KAZIMAH	9KKL	Houston	43	73	55	51	222
KEN SHIN	YJQS2	Seattle	19	18	37	26	100
KEN YO	3FIC5	Seattle	4	39	8	0	51
KENAI	WSNB	Houston	0	17	13	16	46
KENNETH E. HILL	C6FA6	Newark	0	29	30	19	78
KENNETH T. DERR	C6FA3	Newark	0	5	28	21	54
KINSMAN INDEPENDENT	WUZ7811	Cleveland	80	64	6	14	164
KIWI ARROW	C6HU6	Houston	0	52	11	39	102
KNOCK ALLAN	ELOI6	Houston	38	43	78	67	226
KOELN EXPRESS	9VBL	New York City	526	415	387	32	1360
KRISTEN MAERSK	OYDM2	Seattle	23	11	0	20	54
KURE	3FGN3	Seattle	0	11	33	23	67

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
LEE A. TREGURTHA	WUR8857	Cleveland	27	12	16	4	59
LEGEND OF THE SEAS	ELRR5	New Orleans	6	0	0	0	6
LEISE MAERSK	OXGR2	Oakland	27	0	0	0	27
LEOPARDI	V7AU8	Baltimore	1	0	0	0	1
LIBERTY SEA	KPZH	New Orleans	0	0	26	16	42
LIBERTY SPIRIT	WCPU	New Orleans	0	0	25	0	25
LIBERTY STAR	WCBP	New Orleans	16	47	0	54	117
LIBERTY SUN	WCOB	Houston	20	29	28	5	82
LIHUE	WTST	Seattle	5	16	13	25	59
LILAC ACE	3FDL4	Long Beach	0	10	13	0	23
LINDA OLDENDORF	ELRR2	Baltimore	4	0	0	0	4
LINDO MAERSK	OWEQ2	Long Beach	0	25	25	0	50
LNG AQUARIUS	WSKJ	Oakland	71	61	31	37	200
LNG CAPRICORN	KHLN	New York City	20	26	28	18	92
LNG LEO	WDZB	New York City	7	22	39	38	106
LNG LIBRA	WDZG	New York City	65	55	66	51	237
LNG TAURUS	WDZW	New York City	19	24	20	13	76
LNG VIRGO	WDZX	New York City	18	11	20	10	59
LOK PRAGATI	ATZS	Seattle	8	0	3	18	29
LONG BEACH	3FOU3	Seattle	7	10	4	18	39
LONG LINES	WATF	Baltimore	38	0	0	0	38
LOOTSGRACHT	PFPT	Houston	44	38	25	68	175
LOUIS MAERSK	OXMA2	Baltimore	19	18	3	1	41
LTC CALVIN P. TITUS	KAKG	Baltimore	0	0	0	18	18
LUISE OLDENDORFF	3FOW4	Seattle	0	0	0	18	18
LURLINE	WLVD	Oakland	45	44	8	19	116
LUTJENBURG	ELVF6	Long Beach	51	24	18	33	126
LYKES ADVENTURER	KNFG	Jacksonville	0	9	0	0	9
LYKES CHALLANGER	FNHV	Houston	21	21	26	43	111
LYKES COMMANDER	3ELF9	Baltimore	23	38	41	36	138
LYKES DISCOVERER	WGXO	Houston	54	60	60	3	177
LYKES EXPLORER	WGLA	Houston	20	18	35	42	115
LYKES HAWK	ELVB6	Houston	0	0	0	26	26
LYKES LIBERATOR	WGXN	Houston	36	39	35	50	160
LYKES NAVIGATOR	WGMJ	Houston	23	31	9	24	87
LYKES PATHFINDER	3EJT9	Baltimore	32	32	47	28	139
MAASDAM	PFRO	Miami	1	0	3	8	12
MACKINAC BRIDGE	JKES	Long Beach	89	45	50	83	267
MADISON MAERSK	OVJB2	Oakland	12	44	20	33	109
MAERSK CALIFORNIA	WCX5083	Miami	0	0	0	15	15
MAERSK COLORADO	WCX5081	Miami	10	1	11	4	26
MAERSK GANNET	GJLK	Miami	4	0	4	0	8
MAERSK GENOA	DGUC	New York City	17	0	0	0	17
MAERSK GIANT	OU2465	Miami	217	228	230	229	904
MAERSK MIAMI	DPCO	New York City	0	11	26	25	62
MAERSK SANTOS	ELRR4	Baltimore	0	12	15	0	27
MAERSK SCOTLAND	MXAR9	Houston	0	30	39	36	105
MAERSK SEA	S6CW	Seattle	31	53	51	60	195
MAERSK SHETLAND	MSQK3	Miami	0	15	0	0	15
MAERSK SOMERSET	MQVF8	New Orleans	26	23	3	65	117
MAERSK STAFFORD	MRSS9	New Orleans	16	50	27	37	130
MAERSK SUN	S6ES	Seattle	19	47	32	38	136
MAERSK SURREY	MRSG8	Houston	20	0	32	14	66
MAERSK TENNESSEE	WCX3486	Miami	0	0	11	31	42
MAERSK TEXAS	WCX3249	Miami	0	0	38	32	70
MAGLEBY MAERSK	OUSH2	Newark	28	28	17	46	119
MAHARASHTRA	VTSQ	Seattle	8	2	6	1	17
MAHIMAHI	WHRN	Oakland	51	25	33	57	166
MAIRANGI BAY	GXEW	Long Beach	12	54	61	44	171
MAJESTY OF THE SEAS	LAOI4	Miami	28	14	28	15	85
MANHATTAN BRIDGE	3FWL4	Long Beach	29	65	38	45	177
MANOA	KDBG	Oakland	3	52	44	57	156

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
MARCHEN MAERSK	OWDQ2	Long Beach	16	16	25	20	77
MAREN MAERSK	OWZU2	Long Beach	14	21	0	0	35
MARGRETHE MAERSK	OYSN2	Long Beach	21	16	17	15	69
MARIE MAERSK	OULL2	Newark	6	5	9	13	33
MARINE CHEMIST	KMCB	Houston	30	6	30	53	119
MARINE COLUMBIA	KLKZ	Oakland	58	54	55	66	233
MARINOR	C6KY9	Baltimore	0	0	1	0	1
MARIT MAERSK	OZFC2	Miami	29	15	12	11	67
MARK HANNAH	WYZ5243	Chicago	0	4	9	4	17
MARY E. HANNAH	WA3133	Chicago	0	0	4	0	4
MATHILDE MAERSK	OUUU2	Long Beach	23	18	22	16	79
MATSONIA	KHRC	Oakland	49	51	17	24	141
MAUI	WSLH	Long Beach	41	44	34	46	165
MAURICE EWING	WLDZ	Newark	0	13	35	37	85
MAYAGUEZ	WZJE	Jacksonville	31	31	32	32	126
MAYVIEW MAERSK	OWEB2	Oakland	16	6	17	0	39
MC-KINNEY MAERSK	OUZW2	Newark	6	7	7	4	24
MEDUSA CHALLENGER	WA4659	Cleveland	48	54	70	38	210
MEKHANIK KALYUZHNIY	UFLO	Seattle	0	5	49	41	95
MEKHANIK MOLDOVANOV	UIKI	Seattle	0	0	10	25	35
MELBOURNE STAR	C6JY6	Newark	59	63	44	29	195
MELVILLE	WECB	Long Beach	48	64	38	56	206
MERCHANT PREMIER	VROP	Houston	24	10	6	0	40
MERCHANT PRINCIPAL	VRIO	Miami	56	59	57	0	172
MERCURY ACE	JFMO	Norfolk	44	9	0	8	61
MERLION ACE	9VHJ	Long Beach	3	0	0	0	3
MESABI MINER	WYQ4356	Cleveland	23	6	2	0	31
METEOR	DBBH	Houston	188	205	202	178	773
METTE MAERSK	OXKT2	Long Beach	12	11	25	14	62
MICHIGAN	WRB4141	Chicago	12	15	20	8	55
MIDDLETOWN	WR3225	Cleveland	36	25	15	8	84
MING ASIA	BDEA	New York City	24	22	22	22	90
MOKIHANA	WNRD	Oakland	45	58	73	81	257
MOKU PAHU	WBWK	Oakland	53	63	66	51	233
MONCHEGORSK	P3NL5	Houston	16	27	0	0	43
MORELOS	PGBB	Houston	55	38	37	57	187
MORMACSKY	WMBQ	New York City	0	2	0	1	3
MORMACSTAR	KGDF	Houston	2	0	2	16	20
MORMACSUN	WMBK	Norfolk	26	39	26	16	107
MOSEL ORE	ELRE5	Norfolk	26	26	55	2	109
MSC BOSTON	9HGP4	New York City	37	25	10	11	83
MSC GINA	C4LV	New York City	0	0	7	48	55
MSC NEW YORK	9HIG4	New York City	25	8	9	26	68
MUNKEBO MAERSK	OUNI5	New York City	7	33	0	0	40
MV CONTSHIP ROME	ELVZ6	Norfolk	61	32	34	44	171
MV MIRANDA	3FRO4	Norfolk	104	30	0	0	134
MYRON C. TAYLOR	WA8463	Chicago	10	16	20	18	64
MYSTIC	PCCQ	Long Beach	0	0	34	82	116
NADA II	ELAV2	Seattle	6	22	24	2	54
NAJA ARCTICA	OXVH2	Miami	0	0	31	110	141
NATHANIEL B. PALMER	WBP3210	Seattle	7	5	5	39	56
NATIONAL DIGNITY	DZRG	Long Beach	5	12	12	17	46
NATIONAL HONOR	DZDI	Long Beach	0	11	9	5	25
NEDLLOYD DELFT	PGDD	Houston	0	0	0	2	2
NEDLLOYD HOLLAND	KRHX	Houston	51	72	57	63	243
NEDLLOYD MONTEVIDEO	PGAF	Long Beach	52	68	22	36	178
NEDLLOYD RALEIGH BAY	PHKG	Houston	0	0	2	47	49
NEGO LOMBOK	DXQC	Seattle	31	0	0	0	31
NELVANA	YJWZ7	Baltimore	0	6	8	2	16
NEPTUNE ACE	JFLX	Long Beach	27	0	0	14	41
NEPTUNE RHODONITE	ELJP4	Long Beach	8	14	0	7	29
NEW HORIZON	WKWB	Long Beach	4	29	23	36	92
NEW NIKKI	3FHG5	Seattle	29	0	5	52	86

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
NEWARK BAY	WPKS	Houston	70	67	68	48	253
NEWPORT BRIDGE	3FGH3	Oakland	11	0	0	0	11
NIEUW AMSTERDAM	PGGQ	Long Beach	31	0	0	0	31
NOAA DAVID STARR JORDAN	WTDK	Seattle	46	34	51	81	212
NOAA SHIP ALBATROSS IV	WMVF	Norfolk	38	105	82	33	258
NOAA SHIP DELAWARE II	KNBD	New York City	0	105	106	161	372
NOAA SHIP FERREL	WTEZ	Norfolk	18	11	0	18	47
NOAA SHIP KA'IMIMOANA	WTEU	Seattle	87	151	466	134	838
NOAA SHIP MCARTHUR	WTEJ	Seattle	0	16	45	178	239
NOAA SHIP MILLER FREEMAN	WTDM	Seattle	144	166	194	116	620
NOAA SHIP OREGON II	WTDO	New Orleans	157	85	105	146	493
NOAA SHIP RAINIER	WTEF	Seattle	76	65	55	77	273
NOAA SHIP RONALD H BROWN	WTEC	New Orleans	61	71	80	95	307
NOAA SHIP T. CROMWELL	WTDF	Seattle	92	71	63	81	307
NOAA SHIP WHITING	WTEW	Baltimore	61	56	1	48	166
NOBEL STAR	KRPP	Houston	0	1	27	18	46
NOBLE STAR	3FRU7	Seattle	0	13	0	53	66
NOL AMAZONITE	9VBX	Long Beach	15	3	0	0	18
NOL DIAMOND	9VYT	Long Beach	0	0	0	19	19
NOL STENO	ZCBD4	New York City	23	17	36	42	118
NOLIZWE	MQLN7	New York City	94	65	78	39	276
NOMZI	MTQU3	Baltimore	78	62	54	75	269
NOORDAM	PGHT	Miami	0	0	7	16	23
NORASIA SHANGHAI	DNHS	New York City	32	24	29	14	99
NORD JAHRE TRANSPORTER	LACF4	Baltimore	2	0	5	4	11
NORDMAX	P3YS5	Seattle	37	100	25	100	262
NORDMORITZ	P3YR5	Seattle	45	64	60	57	226
NORTHERN LIGHTS	WFJK	New Orleans	48	43	18	38	147
NORWAY	C6CM7	Miami	0	0	0	15	15
NTABENI	3EGR6	Houston	37	2	65	18	122
NUERNBERG EXPRESS	9VBK	Houston	425	693	724	732	2574
NYK SEABREEZE	ELNJ3	Seattle	0	2	12	0	14
NYK SPRINGTIDE	S6CZ	Seattle	0	12	8	3	23
NYK STARLIGHT	3FUX6	Long Beach	45	53	19	35	152
NYK SUNRISE	3FYZ6	Seattle	35	33	26	46	140
NYK SURFWIND	ELOT3	Seattle	31	32	42	6	111
OCEAN CAMELLIA	3FTR6	Seattle	0	0	0	43	43
OCEAN CITY	WCYR	Houston	0	27	33	42	102
OCEAN CLIPPER	3EXI7	New Orleans	6	3	29	14	52
OCEAN LAUREL	3FLX4	Seattle	8	5	12	0	25
OCEAN PALM	3FDO7	Seattle	72	77	55	66	270
OCEAN SERENE	DURY	Seattle	45	24	14	7	90
OCEAN SPIRIT	ELKI8	Seattle	0	5	2	1	8
OCEANBREEZE	ELLY4	Miami	0	1	62	61	124
OGLEBAY NORTON	WAQ3521	Cleveland	17	4	16	18	55
OLEANDER	PJJU	Newark	36	50	46	6	138
OLYMPIA	V7AZ4	Baltimore	77	31	40	0	148
OLYMPIAN HIGHWAY	3FSH4	Seattle	26	0	38	21	85
OOCL AMERICA	ELSM7	Oakland	49	36	44	44	173
OOCL CALIFORNIA	ELSA4	Seattle	30	41	31	38	140
OOCL CHINA	ELSU8	Long Beach	23	60	41	24	148
OOCL ENVOY	ELNV7	Seattle	23	22	23	2	70
OOCL FAIR	ELFV2	Long Beach	17	33	29	26	105
OOCL FAITH	ELFU9	Norfolk	23	53	22	21	119
OOCL FIDELITY	ELFV8	Long Beach	19	39	28	30	116
OOCL FORTUNE	ELFU8	Norfolk	19	21	6	39	85
OOCL FREEDOM	VRCV	Norfolk	60	28	60	66	214
OOCL FRIENDSHIP	ELFV3	Long Beach	46	34	48	39	167
OOCL HONG KONG	VRVA5	Oakland	0	6	19	34	59
OOCL INNOVATION	WPWH	Houston	42	45	37	35	159
OOCL INSPIRATION	KRPB	Houston	48	34	59	53	194
OOCL JAPAN	ELSU6	Long Beach	69	67	80	67	283

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
ORANGE BLOSSOM	ELEI6	Newark	27	0	0	0	27
ORIANA	GVSN	Miami	5	39	24	48	116
ORIENTAL ROAD	3FXT6	Houston	10	37	11	0	58
ORIENTE GRACE	3FHT4	Seattle	8	1	7	15	31
ORIENTE HOPE	3ETH4	Seattle	31	0	0	0	31
ORIENTE NOBLE	3FVF5	Seattle	27	28	5	38	98
ORIENTE PRIME	3FOU4	Seattle	0	0	1	4	5
ORIENTE VICTORIA	3FVG8	Seattle	0	0	19	8	27
OVERSEAS CHICAGO	KBCF	Oakland	4	1	0	0	5
OVERSEAS JOYCE	WUQL	Jacksonville	26	24	31	49	130
OVERSEAS MARILYN	WFQB	Houston	1	13	10	28	52
OVERSEAS NEW ORLEANS	WFKW	Houston	21	8	0	27	56
OVERSEAS NEW YORK	WMCK	Houston	3	1	4	13	21
OVERSEAS OHIO	WJBG	Oakland	6	9	0	14	29
OVERSEAS WASHINGTON	WFGV	Houston	0	6	0	0	6
P & O NEDLLOYD BUENOS AI	PGEC	Houston	12	12	7	17	48
P & O NEDLLOYD VERA CRUZ	PGFE	Houston	18	2	5	16	41
P&O NEDLLOYD CHILE	DVRA	New York City	4	0	3	4	11
P&O NEDLLOYD HOUSTON	PGEB	Houston	49	53	38	20	160
P&O NEDLLOYD LOS ANGELES	PGDW	Long Beach	49	54	45	7	155
P&O NEDLLOYD TEXAS	ZCBF6	Houston	66	73	54	48	241
PACDREAM	ELQO6	Seattle	19	20	12	21	72
PACDUKE	A8SL	Seattle	0	0	0	15	15
PACIFIC HIRO	3FOY5	Seattle	0	28	0	0	28
PACIFIC SENATOR	ELTY6	Long Beach	0	10	68	15	93
PACKING	ELBX3	Seattle	5	6	13	1	25
PACOCEAN	ELJE3	Seattle	6	14	23	25	68
PACPRINCE	ELED7	Seattle	9	4	11	6	30
PACROSE	YJQK2	Seattle	0	3	14	3	20
PATRIOT	KGBQ	Houston	2	10	7	17	36
PAUL BUCK	KDGR	Houston	6	1	5	0	12
PAUL R. TREGURTHA	WYR4481	Cleveland	32	10	36	35	113
PEARL ACE	VRUN4	Seattle	0	3	1	37	41
PEGASUS HIGHWAY	3FMA4	New York City	5	0	0	0	5
PEGGY DOW	PJOY	Long Beach	35	23	10	0	68
PHILIP R. CLARKE	WE3592	Chicago	42	52	44	35	173
PIERRE FORTIN	CG2678	Norfolk	171	204	231	231	837
PINO GLORIA	3EZW7	Seattle	10	18	9	9	46
PISCES EXPLORER	MWQD5	Long Beach	65	9	51	39	164
POLYNESIA	D5NZ	Long Beach	84	79	82	77	322
POTOMAC TRADER	WXBZ	Houston	12	33	49	65	159
PRESIDENT ADAMS	WRYW	Oakland	61	55	43	46	205
PRESIDENT GRANT	WCY2098	Long Beach	22	41	48	61	172
PRESIDENT HOOVER	WCY2883	Houston	21	24	21	19	85
PRESIDENT JACKSON	WRYC	Oakland	1	28	39	44	112
PRESIDENT KENNEDY	WRYE	Oakland	36	51	61	42	190
PRESIDENT POLK	WRYD	Oakland	50	52	56	67	225
PRESIDENT TRUMAN	WNDP	Oakland	48	64	55	52	219
PRESIDENT WILSON	WCY3438	Long Beach	0	21	31	19	71
PRESQUE ISLE	WZE4928	Chicago	37	24	0	34	95
PRIDE OF BALTIMORE II	WUW2120	Baltimore	10	28	35	31	104
PRINCE OF OCEAN	3ECO9	Seattle	56	84	85	91	316
PRINCE WILLIAM SOUND	WSDX	Long Beach	0	0	2	10	12
PRINCESS OF SCANDINAVIA	OWEN2	Miami	62	71	129	146	408
PROJECT ARABIA	PJKP	Miami	27	28	33	32	120
PROJECT ORIENT	PJAG	Baltimore	43	21	46	27	137
PUDONG SENATOR	DQVI	Seattle	78	59	62	26	225
PUSAN SENATOR	DQVG	Seattle	22	38	45	66	171
QUEEN ELIZABETH 2	GBTT	New York City	49	71	58	74	252
QUEEN OF SCANDINAVIA	OUSE6	Miami	20	33	32	41	126
QUEENSLAND STAR	C6JZ3	Houston	64	60	62	53	239
R.J. PFEIFFER	WRJP	Long Beach	13	26	17	17	73

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
RAINBOW BRIDGE	3EYX9	Long Beach	89	84	68	38	279
REBECCA LYNN	WCW7977	Chicago	0	17	5	2	24
REGINA MAERSK	OZIN2	New York City	4	5	0	0	9
REPULSE BAY	MQYA3	Houston	1	0	7	1	9
RESERVE	WE7207	Cleveland	0	0	7	0	7
RESOLUTE	KFDZ	Norfolk	45	13	42	37	137
RHAPSODY OF THE SEAS	LAZK4	Miami	1	1	0	0	2
RICHARD G MATTHIESEN	WLBV	Jacksonville	3	0	3	4	10
RICHARD REISS	WBF2376	Cleveland	15	10	11	9	45
RIO APURE	ELUG7	Miami	51	13	35	37	136
ROBERT E. LEE	KCRD	New Orleans	11	18	2	16	47
ROGER BLOUGH	WZP8164	Chicago	88	77	89	24	278
ROGER REVELLE	KAOU	New Orleans	37	20	28	0	85
ROYAL ETERNITY	DUXW	Norfolk	41	34	23	0	98
ROYAL PRINCESS	GBRP	Long Beach	23	11	45	43	122
RUBIN BONANZA	3FNV5	Seattle	70	4	39	0	113
RUBIN KOBE	DYZM	Seattle	20	36	57	59	172
RUBIN PEARL	YJQA8	Seattle	82	54	61	26	223
RYNDAM	PHFV	Miami	9	0	0	0	9
SAGA CREST	LATH4	Miami	0	0	1	35	36
SALLY MAERSK	OZHS2	Seattle	0	0	19	0	19
SALOME	S6CL	Newark	0	0	14	0	14
SAM HOUSTON	KDGA	Houston	6	0	26	5	37
SAMUEL GINN	C6OB	Oakland	2	0	0	0	2
SAMUEL H. ARMACOST	C6FA2	Oakland	0	13	27	4	44
SAMUEL RISLEY	CG2960	Norfolk	162	2	53	86	303
SAN ISIDRO	ELVG8	Norfolk	26	36	49	37	148
SAN MARCOS	ELND4	Jacksonville	51	41	1	34	127
SANTA CHRISTINA	3FAE6	Seattle	6	13	4	4	27
SC BREEZE	ELOC6	New York City	0	38	49	0	87
SC HORIZON	ELOC8	New York City	8	0	0	26	34
SCHACKENBORG	OYUY4	Houston	17	0	0	2	19
SEA FOX	KBGK	Jacksonville	24	17	0	0	41
SEA INITIATIVE	DEBB	Houston	0	0	40	29	69
SEA LION	KJLV	Jacksonville	0	84	2	0	86
SEA LYNX	DGOO	Jacksonville	68	67	70	37	242
SEA MARINER	J8FF9	Miami	65	48	68	0	181
SEA PRINCESS	KRCP	New Orleans	0	28	7	0	35
SEA RACER	ELQI8	Jacksonville	55	78	70	62	265
SEA WISDOM	3FUO6	Seattle	45	0	0	53	98
SEA-LAND CHARGER	V7AY2	Long Beach	6	52	11	17	86
SEA-LAND EAGLE	V7AZ8	Long Beach	34	14	38	26	112
SEA/LAND VICTORY	DIDY	New York City	31	25	42	39	137
SEABOARD FLORIDA	3FBW5	Miami	21	19	11	8	59
SEABOARD UNIVERSE	ELRU3	Miami	0	10	14	21	45
SEALAND ANCHORAGE	KGTX	Seattle	60	46	59	62	227
SEALAND ARGENTINA	DGVN	Jacksonville	6	8	5	7	26
SEALAND ATLANTIC	KRLZ	Norfolk	24	35	21	17	97
SEALAND CHALLENGER	WZJC	Newark	29	13	1	0	43
SEALAND CHAMPION	V7AM9	Oakland	2	37	22	26	87
SEALAND COMET	V7AP3	Oakland	16	50	10	15	91
SEALAND CONSUMER	WCHF	Houston	56	39	60	53	208
SEALAND CRUSADER	WZJF	Jacksonville	67	65	66	83	281
SEALAND DEFENDER	KGJB	Oakland	31	27	18	5	81
SEALAND DEVELOPER	KHRH	Long Beach	1	3	3	0	7
SEALAND DISCOVERY	WZJD	Jacksonville	47	53	54	64	218
SEALAND ENDURANCE	KGJX	Long Beach	21	19	32	32	104
SEALAND ENTERPRISE	KRGB	Oakland	74	74	55	73	276
SEALAND EXPEDITION	WPGJ	Jacksonville	49	55	58	51	213
SEALAND EXPLORER	WGJF	Long Beach	18	34	31	63	146
SEALAND EXPRESS	KGJD	Long Beach	7	26	12	10	55
SEALAND FREEDOM	V7AM3	Houston	32	11	13	43	99
SEALAND HAWAII	KIRF	Seattle	36	50	21	13	120

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
SEALAND HONDURAS	OUQP2	Miami	14	28	9	30	81
SEALAND INDEPENDENCE	WGJC	Long Beach	36	62	52	57	207
SEALAND INNOVATOR	WGKF	Oakland	21	21	33	23	98
SEALAND INTEGRITY	WPVD	Norfolk	60	16	93	127	296
SEALAND INTREPID	V7BA2	Norfolk	17	5	50	15	87
SEALAND KODIAK	KGTZ	Seattle	39	40	22	35	136
SEALAND LIBERATOR	KHRP	Oakland	9	10	17	2	38
SEALAND MARINER	V7AM5	Houston	22	22	28	15	87
SEALAND MERCURY	V7AP6	Oakland	0	0	0	23	23
SEALAND METEOR	V7AP7	Long Beach	3	2	0	19	24
SEALAND NAVIGATOR	WPGK	Long Beach	5	46	79	69	199
SEALAND PACIFIC	WSRL	Long Beach	27	50	52	47	176
SEALAND PATRIOT	KHRF	Oakland	22	11	35	2	70
SEALAND PERFORMANCE	KRPD	Houston	54	68	55	54	231
SEALAND PRODUCER	WJBJ	Long Beach	43	50	78	75	246
SEALAND QUALITY	KRNJ	Jacksonville	31	43	34	34	142
SEALAND RACER	V7AP8	Long Beach	0	0	27	28	55
SEALAND RELIANCE	WFLH	Long Beach	36	56	66	50	208
SEALAND SPIRIT	WFLG	Oakland	59	23	35	50	167
SEALAND TACOMA	KGTY	Seattle	7	15	20	23	65
SEALAND TRADER	KIRH	Oakland	59	50	54	43	206
SEALAND VOYAGER	KHRK	Long Beach	48	63	63	39	213
SEARIVER BATON ROUGE	WAFA	Oakland	2	0	0	0	2
SEARIVER BAYTOWN	KFPM	Oakland	0	0	0	19	19
SEARIVER LONG BEACH	WHCA	Long Beach	4	10	2	0	16
SEARIVER NORTH SLOPE	KHLQ	Oakland	2	8	1	16	27
SENSATION	3ESE9	Miami	1	6	1	0	8
SETO BRIDGE	JMQY	Oakland	35	39	61	49	184
SEVEN OCEAN	3EZB8	Seattle	0	0	22	15	37
SEVEN SEAS	3FBS9	Seattle	0	0	0	1	1
SEWARD JOHNSON	WST9756	Miami	0	24	40	27	91
SHIRAOI MARU	3ECM7	Seattle	53	46	54	94	247
SIDNEY FOSS	WYL5445	Seattle	0	0	0	1	1
SIDNEY STAR	C6JY7	Houston	47	55	65	78	245
SIERRA MADRE	WSDJ	Long Beach	0	0	0	1	1
SINCERE SUCCESS	VRUC5	Seattle	8	16	0	0	24
SINGA STAR	9VNF	Seattle	44	26	0	0	70
SKAUBRYN	LAJV4	Seattle	42	10	45	5	102
SKAUGRAN	LADB2	Seattle	19	0	3	2	24
SKOGAFOSS	V2QT	Norfolk	0	0	37	0	37
SNOW CRYSTAL	C6ID8	New York City	71	79	91	89	330
SOFIE MAERSK	OZUN2	Seattle	0	0	0	21	21
SOKOLICA	ELIG5	Baltimore	1	0	1	0	2
SOL DO BRASIL	ELQQ4	Baltimore	71	39	1	22	133
SOLAR WING	ELJS7	Jacksonville	79	91	77	83	330
SONORA	V7BQ9	Houston	11	9	1	0	21
SOROE MAERSK	OYKJ2	Seattle	0	0	9	0	9
SOUTH FORTUNE	3FJC6	Seattle	46	42	69	55	212
SOVEREIGN OF THE SEAS	LAEB2	Miami	0	0	2	4	6
ST BLAIZE	J8FO	Norfolk	28	46	37	12	123
STAR ALABAMA	LAVU4	Baltimore	9	20	8	22	59
STAR AMERICA	LAVV4	Jacksonville	7	1	30	25	63
STAR DOVER	LAEP4	Seattle	0	17	0	0	17
STAR EVVIVA	LAHE2	Jacksonville	0	4	0	0	4
STAR FUJI	LAVX4	Seattle	31	7	28	26	92
STAR GEIRANGER	LAKQ5	Norfolk	28	20	38	25	111
STAR GRAN	LADR4	Long Beach	18	0	9	4	31
STAR HANSA	LAXP4	Jacksonville	0	2	2	4	8
STAR HARDANGER	LAXD4	Baltimore	0	0	6	3	9
STAR HARMONIA	LAGB5	Baltimore	26	79	33	20	158
STAR HERDLA	LAVD4	Baltimore	29	31	33	4	97
STAR HOYANGER	LAXG4	Baltimore	0	0	0	63	63
STAR SKARVEN	LAJY2	Miami	19	20	13	15	67

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
STAR TRONDANGER	LAQQ2	Baltimore	0	2	6	4	12
STATENDAM	PHSG	Miami	15	0	0	0	15
STELLAR IMAGE	3FDO6	Seattle	32	0	43	11	86
STELLAR KOHINOOR	3FFG8	Seattle	0	18	0	18	36
STENA CLIPPER	C6MX4	Miami	0	0	24	73	97
STEPHAN J	V2JN	Miami	67	75	74	104	320
STEWART J. CORT	WYZ3931	Chicago	65	40	54	41	200
STONEWALL JACKSON	KDDW	New Orleans	9	5	0	16	30
STRONG CAJUN	KALK	Norfolk	23	14	32	18	87
SUGAR ISLANDER	KCKB	Houston	0	1	0	3	4
SUN ACE	3EMJ6	Seattle	0	1	0	23	24
SUN DANCE	3ETQ8	Seattle	9	0	0	16	25
SUNBELT DIXIE	D5BU	Baltimore	8	21	24	14	67
SUNDA	ELPB8	Houston	25	43	41	3	112
SUSAN MAERSK	OYIK2	Seattle	0	15	3	0	18
SUSAN W. HANNAH	WAH9146	Chicago	18	3	4	5	30
SVEN OLTMANN	V2JP	Miami	16	0	0	0	16
SVEND MAERSK	OYJS2	Seattle	0	0	21	0	21
SWAN ARROW	C6CN8	Baltimore	9	0	0	8	17
T/V STATE OF MAINE	NTNR	Norfolk	37	41	0	0	78
TAI CHUNG	3FMC5	Seattle	0	0	54	54	108
TAI HE	BOAB	Long Beach	62	65	38	47	212
TAIHO MARU	3FMP6	Seattle	77	110	88	61	336
TAIKO	LAQT4	New York City	21	19	8	0	48
TAMPA	LMWO3	Long Beach	0	25	0	0	25
TAMPERE	LAOP2	Norfolk	11	0	17	0	28
TAUSALA SAMOA	V2KS	Seattle	54	48	54	0	156
TECO TRADER	KSDF	New Orleans	5	10	16	12	43
TEQUI	3FDZ5	Seattle	13	36	19	36	104
TEXAS	LMWR3	Baltimore	1	0	0	0	1
TEXAS CLIPPER	KVWA	Houston	0	43	54	12	109
THORKIL MAERSK	MSJX8	Miami	38	36	43	13	130
TMM OAXACA	ELUA5	Houston	24	21	31	17	93
TOBIAS MAERSK	MSJY8	Long Beach	19	46	46	42	153
TORM FREYA	ELVY8	Norfolk	23	33	34	34	124
TOWER BRIDGE	ELJL3	Seattle	9	9	14	13	45
TRADE APOLLO	VRUN7	New York City	10	48	26	20	104
TRANSWORLD BRIDGE	ELJJ5	Seattle	12	11	5	2	30
TRITON	WTU2310	Chicago	65	36	6	41	148
TROJAN STAR	C6OD7	Baltimore	17	0	0	0	17
TROPIC JADE	J8NY	Miami	0	0	0	26	26
TROPIC LURE	J8PD	Miami	3	8	11	11	33
TROPIC SUN	3EZK9	New Orleans	27	24	19	17	87
TROPIC TIDE	3FGQ3	Miami	57	66	29	11	163
TUI PACIFIC	P3GB4	Seattle	55	70	60	84	269
TULSIDAS	ATUJ	Norfolk	6	1	0	0	7
TURMOIL	9VGL	New York City	12	6	6	1	25
TUSTUMENA	WNGW	Seattle	0	0	2	8	10
USCGC ACACIA (WLB406)	NODY	Chicago	0	0	0	2	2
USCGC ACTIVE WMEC 618	NRTF	Seattle	0	0	0	2	2
USCGC DURABLE (WMEC 628)	NRUN	Houston	1	0	0	0	1
USCGC EAGLE (WIX 327)	NRCB	Miami	1	0	0	1	2
USCGC KUKUI (WLB-203)	NKJU	Seattle	11	1	11	6	29
USCGC MACKINAW	NRKP	Chicago	5	0	22	2	29
USCGC MELLON (WHEC 717)	NMEL	Seattle	8	5	1	0	14
USCGC NORTHLAND WMEC 904	NLGF	Norfolk	7	2	0	29	38
USCGC POLAR SEA__(WAGB 1	NRUO	Seattle	34	0	0	0	34
USCGC STEADFAST (WMEC 62	NSTF	Seattle	0	1	0	0	1
USCGC SUNDEW (WLB 404)	NODW	Chicago	15	1	0	7	23
USCGC WOODRUSH (WLB 407)	NODZ	Seattle	1	3	0	0	4
USNS BOWDITCH	NWSW	New Orleans	3	0	0	0	3
USNS HENSON	NENB	New Orleans	16	3	19	11	49

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SHIP NAME	CALL	PORT	MAY	JUN	JUL	AUG	TOTAL
USNS NAVAJO_(TATF-169)	NOYK	Long Beach	0	0	14	2	16
USNS PERSISTENT	XXXX	Norfolk	0	0	1	0	1
USNS REGULUS	NLWA	New Orleans	0	1	14	5	20
USNS SATURN T-AFS-10	NADH	Norfolk	0	2	2	0	4
USNS SODERMAN	NANL	Norfolk	0	3	5	5	13
VALIANT	WXCA	New Orleans	0	0	1	13	14
VASILTY BURKHANOV	UZHC	Seattle	0	0	0	1	1
VEGA	9VJS	Houston	43	22	0	4	69
VICTORIA	GBBA	Miami	3	0	0	1	4
VIRGINIA	3EBW4	Seattle	34	58	20	37	149
VISION	LAKS5	Seattle	3	3	35	18	59
VLADIVOSTOK	UBXP	Seattle	0	0	0	11	11
WAARDRECHT	S6BR	Seattle	35	81	39	81	236
WASHINGTON HIGHWAY	JKHH	Seattle	0	51	45	4	100
WASHINGTON SENATOR	DEAZ	Long Beach	0	0	0	27	27
WECOMA	WSD7079	Seattle	48	61	6	0	115
WESTERN BRIDGE	C6JQ9	Baltimore	74	54	53	8	189
WESTWARD	WZL8190	Miami	0	0	7	8	15
WESTWARD VENTURE	KHJB	Seattle	38	36	13	48	135
WESTWOOD ANETTE	C6QO9	Seattle	0	0	0	53	53
WESTWOOD ANETTE	DVDM	Seattle	9	0	0	0	9
WESTWOOD BELINDA	C6CE7	Seattle	31	24	39	33	127
WESTWOOD BORG	LAON4	Seattle	41	58	49	76	224
WESTWOOD BREEZE	LAOT4	Seattle	49	12	11	4	76
WESTWOOD CLEO	C6OQ8	Seattle	4	41	39	38	122
WESTWOOD JAGO	C6CW9	Seattle	30	45	31	38	144
WESTWOOD MARIANNE	C6QD3	Seattle	49	0	58	47	154
WILFRED SYKES	WC5932	Chicago	3	11	11	10	35
WILLIAM E. CRAIN	ELOR2	Oakland	0	10	31	10	51
WILLIAM E. MUSSMAN	D5OE	Seattle	0	6	5	14	25
WILSON	WNPD	New Orleans	32	64	0	0	96
WOENSDRECHT	S6BP	Long Beach	7	0	0	0	7
WORLD ISLAND	3FDH4	Long Beach	37	0	0	0	37
WORLD SPIRIT	ELWG7	Seattle	1	0	42	42	85
YUCATAN	XCUY	Houston	4	0	0	0	4
YURIY OSTROVSKIY	UAGJ	Seattle	39	34	44	36	153
ZIM AMERICA	4XGR	Newark	0	18	24	49	91
ZIM ASIA	4XFB	New Orleans	23	20	34	16	93
ZIM ATLANTIC	4XFD	New York City	22	50	19	42	133
ZIM CANADA	4XGS	Norfolk	22	10	51	40	123
ZIM CHINA	4XFQ	New York City	15	28	32	24	99
ZIM EUROPA	4XFN	New York City	27	30	14	1	72
ZIM HONG KONG	4XGW	Houston	23	25	15	39	102
ZIM IBERIA	4XFP	New York City	72	45	25	49	191
ZIM ISRAEL	4XGX	New Orleans	0	14	16	42	72
ZIM ITALIA	4XGT	New Orleans	11	0	55	60	126
ZIM JAMAICA	4XFE	New York City	27	26	49	57	159
ZIM JAPAN	4XGV	Baltimore	28	25	33	10	96
ZIM KOREA	4XGU	Miami	3	1	1	0	5
ZIM MONTEVIDEO	V2AG7	Norfolk	31	47	56	69	203
ZIM PACIFIC	4XFC	New York City	41	36	9	20	106
ZIM SANTOS	ELRJ6	Baltimore	18	43	16	17	94
ZIM SEATTLE	ELWZ3	Seattle	0	28	46	54	128
ZIM U.S.A.	4XFO	New York City	6	27	23	26	82

Totals	May	23329
	Jun	24966
	Jul	24402
	Aug	24874
Period Total		97571

Buoy Climatological Data Summary —

May through August 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.

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)
May 1999													
41001	34.7N	072.6W	743	21.4	22.2	1.8	5.1	01/17	12.0	SW	29.5	01/23	1014.8
41002	32.3N	075.2W	743	22.2	22.8	1.5	4.9	01/03	10.3	SW	30.5	01/08	1015.4
41004	32.5N	079.1W	12	15.2	19.7	4.6	5.5	01/04	32.9	N	36.3	01/02	1004.8
41008	31.4N	080.9W	740	21.5	22.7	0.9	3.3	01/05	10.8	S	34.2	01/01	1016.1
41009	28.5N	080.2W	1397	23.9	25.1	1.1	3.5	01/15	10.5	E	26.8	01/14	1016.3
41010	28.9N	078.6W	1486	23.9	24.8	1.3	4.4	02/01	10.8	S	31.3	01/20	1016.6
42001	25.9N	089.6W	735	25.9	27.3	0.9	3.2	05/17	10.6	SE	32.8	09/00	1014.4
42002	25.9N	093.6W	743	25.6	26.0	1.1	2.6	06/02	12.9	SE	26.0	01/08	1013.3
42003	25.9N	085.9W	743	25.8	27.7	0.8	2.8	08/00	9.2	E	30.5	08/00	1015.1
42007	30.1N	088.8W	744	24.3	25.6	0.6	3.0	05/06	9.9	SE	27.6	05/00	1015.5
42019	27.9N	095.4W	741	25.1	25.4	1.2	2.9	06/14	11.9	SE	25.3	18/07	1012.3
42020	26.9N	096.7W	735	25.5	25.5				12.7	SE	24.7	15/12	1011.6
42035	29.2N	094.4W	743	24.6	25.4	0.9	2.0	04/13	11.2	SE	26.8	18/05	1014.2
42036	28.5N	084.5W	742	23.5	23.9	0.7	2.4	01/04	8.4	SW	32.4	08/00	1015.4
42039	28.8N	086.0W	742	23.8	24.4	0.7	3.2	05/14	8.8	E	34.6	07/21	1016.5
42040	29.2N	088.3W	740	24.3	25.1	0.8	3.7	05/08	9.1	SE	29.0	05/02	1015.0
44004	38.5N	070.7W	743	17.2	17.8	1.6	5.1	02/17	12.1	NE	30.3	14/10	1016.2
44005	42.9N	068.9W	743	9.9	8.6	1.0	2.6	25/17	8.2	S	22.3	21/11	1017.2
44007	43.5N	070.1W	742	10.7	9.8	0.7	2.5	25/04	7.1	S	26.0	25/02	1017.0
44008	40.5N	069.4W	743	10.6	9.3	1.2	3.6	03/08	9.1	NE	24.1	03/03	1016.9
44009	38.5N	074.7W	743	13.8	12.9	1.3	3.7	02/18	11.2	NE	26.6	02/17	1016.1
44011	41.1N	066.6W	643	11.4	9.2	1.4	3.8	03/18	9.4	NE	23.5	25/09	1017.7
44013	42.4N	070.7W	742	11.2	10.3	0.6	2.1	04/03	8.3	SE	20.6	25/17	1016.8
44014	36.6N	074.8W	743	14.0	11.8	1.5	4.8	02/13	10.5	S	30.1	02/12	1014.7
44025	40.3N	073.2W	734	12.8	11.9	1.1	3.3	03/08	9.3	NE	27.6	03/07	1016.3
45001	48.1N	087.8W	224	5.7	3.1	0.7	2.2	25/15	11.9	SW	25.3	25/11	1011.5
45002	45.3N	086.4W	741	7.9		0.5	3.1	07/16	9.9	S	31.9	06/21	1014.3
45003	45.4N	082.8W	743	6.9	4.2	0.4	2.4	25/21	9.7	E	25.5	25/20	1015.0
45004	47.6N	086.5W	744	5.5	3.0	0.6	2.5	25/10	11.2	SE	26.6	06/22	1014.4
45005	41.7N	082.4W	743	14.1	13.1	0.4	2.1	13/15	9.9	NE	29.3	24/23	1014.8
45006	47.3N	089.9W	743	5.4	2.5	0.6	2.5	10/23	10.4	NE	26.4	10/22	1013.4
45007	42.7N	087.0W	744	9.5	7.0	0.4	1.4	12/11	9.2	S	23.9	06/17	1014.2
45008	44.3N	082.4W	743	7.8	4.8	0.4	2.2	25/18	9.4	SE	26.6	25/17	1015.5
46001	56.3N	148.2W	744	4.6	5.3	2.4	7.2	10/03					1008.9
46003	51.8N	155.8W	386	4.3	4.2	2.1	4.8	29/02	11.9	W	27.4	28/18	1012.7
46005	46.1N	131.0W	742	8.2	8.7	2.4	4.8	07/13					1021.2

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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)
46006	40.8N	137.5W	691	10.7	11.4	2.1	4.2	07/08	13.0	NW	26.2	05/16	1026.0
46011	34.9N	120.9W	744	11.1	11.3	2.5	6.0	09/03	16.0	NW	30.7	09/00	1015.7
46012	37.4N	122.7W	334	9.7	9.6	2.6	5.5	08/23	17.0	NW	33.0	09/03	1017.6
46013	38.2N	123.3W	739	9.4	8.3	2.5	5.5	09/03	17.8	NW	35.6	08/21	1017.1
46014	39.2N	124.0W	744	10.1		2.5	4.8	08/22	16.9	NW	32.3	09/01	1018.8
46022	40.7N	124.5W	743	9.8	9.4	2.3	5.3	29/20	11.9	N	25.1	29/09	1019.6
46023	34.7N	121.0W	743	11.0	11.3	2.5	5.3	08/23	18.8	NW	34.4	09/00	1016.9
46025	33.8N	119.1W	741	14.3	15.8	1.3	3.3	04/03	6.4	W	28.8	03/18	1015.1
46026	37.8N	122.8W	743	9.5	9.3	2.2	4.7	09/04	15.4	NW	32.1	09/01	1017.1
46027	41.8N	124.4W	731	9.3	8.7	2.1	4.4	30/03	13.5	NW	38.3	30/01	1018.9
46028	35.7N	121.9W	744	10.6	11.2	2.7	6.5	08/23	19.0	NW	35.4	13/05	1016.4
46029	46.1N	124.5W	741	9.9	11.4	2.0	3.9	08/04	11.6	NW	23.1	07/03	1019.2
46030	40.4N	124.5W	720	9.3	8.6				13.1	N	27.0	08/11	1019.7
46035	56.9N	177.8W	731	1.9	3.0	1.7	5.3	14/21	13.3	NW	29.3	14/20	1014.9
46047	32.4N	119.5W	106	12.6	13.1	2.0	2.9	30/07	12.6	NW	20.4	29/12	1016.9
46050	44.6N	124.5W	743	10.2		2.1	3.8	08/04	12.6	N	25.8	29/03	1019.8
46053	34.2N	119.8W	742	13.1	13.9	1.4	2.7	15/07	9.7	W	27.4	03/23	1014.8
46054	34.3N	120.4W	740	11.4	12.4	2.3	5.1	09/04	21.2	NW	35.6	13/23	1014.7
46059	38.0N	130.0W	744		12.9	2.4	4.8	30/23	14.7	NW	25.6	30/13	
46060	60.6N	146.8W	1479	6.6	7.3	0.6	2.1	30/00	8.4	SE	27.0	29/22	1010.4
46061	60.2N	146.8W	1488	6.5	6.9	1.4	4.9	07/09	10.9	E	34.6	30/05	1009.7
46062	35.1N	121.0W	734	10.9	11.0	2.4	5.4	09/03	16.5	NW	30.7	09/03	1016.0
46063	34.2N	120.7W	744	11.3	11.9	2.6	5.3	09/05	18.4	NW	30.1	08/09	1015.1
51001	23.4N	162.3W	741	24.3	24.9	1.9	3.5	31/17	11.8	E	22.4	31/18	1017.3
51002	17.2N	157.8W	738	24.1	24.9	2.2	2.9	25/17	15.6	E	24.8	10/12	1016.6
51003	19.2N	160.7W	741	24.4	25.3	1.8	2.9	18/07	11.1	E	25.6	18/07	1016.0
51004	17.4N	152.5W	737		24.0	2.3	3.0	22/02					1016.8
51028	00.0N	153.9W	729	26.1	26.3	2.0	3.0	31/02	10.4	NE	18.8	29/15	1010.5
ABAN6	44.3N	075.9W	743	14.6	10.7				4.6	S	16.0	08/19	1016.2
ALSN6	40.4N	073.8W	739	14.6		0.9	3.1	03/11	13.0	E	31.4	03/12	1017.0
BLIA2	60.8N	146.9W	1488	6.5					6.7	N	20.3	18/18	1011.3
BURL1	28.9N	089.4W	728	24.3					10.4	SE	32.6	05/23	1013.9
BUZM3	41.4N	071.0W	742	12.5	11.3	0.7	2.3	25/08	12.0	SW	31.1	03/18	1017.0
CARO3	43.3N	124.4W	744	9.7					11.9	N	31.6	02/13	1021.1
CDRF1	29.1N	083.0W	744						8.4	SW	22.1	08/02	1016.1
CHLV2	36.9N	075.7W	743	16.8	15.3	0.8	3.5	01/00	16.1	NE	37.8	02/18	1015.8
CLKN7	34.6N	076.5W	743	19.4					11.9	SW	33.7	01/00	1017.3
CSBF1	29.7N	085.4W	744	23.1					7.6	SE	33.1	07/18	1015.6
DBLN6	42.5N	079.3W	743	14.3					9.9	SW	37.5	25/16	1016.3
DESW1	47.7N	124.5W	744	9.4					10.9	NW	33.2	06/19	1018.5
DISW3	47.1N	090.7W	743	9.2					11.6	NE	38.9	10/23	1012.7
DPIA1	30.2N	088.1W	744	23.9					9.6	SE	32.4	05/05	1015.9
DRYF1	24.6N	082.9W	743	25.8	26.7				7.0	E	19.0	01/06	1015.1
DSLN7	35.2N	075.3W	743	18.2		1.3	4.4	01/16	16.6	SW	41.0	15/10	
DUCN7	36.2N	075.8W	742	18.2					14.2	N	37.4	02/15	1017.6
FBIS1	32.7N	079.9W	736	21.0					9.0	SW	26.6	01/00	1016.6
FFIA2	57.3N	133.6W	743	7.0					9.2	SE	28.1	26/22	1012.6
FPSN7	33.5N	077.6W	743	20.9		1.2	3.0	02/13	15.8	N	58.1	01/05	1015.5
FWYF1	25.6N	080.1W	743	25.7	27.0				10.6	SE	31.6	13/00	1017.6
GDIL1	29.3N	089.9W	744	24.7	26.7				8.3	SE	26.2	29/15	1015.3
GLLN6	43.9N	076.4W	744	12.8					11.0	SE	29.0	08/20	1016.4
IOSN3	43.0N	070.6W	743	11.5					11.1	S	31.9	25/02	1016.6
KTNF1	29.8N	083.6W	720	22.6					8.8	SW	28.7	07/22	1015.5
LKWF1	26.6N	080.0W	744	24.5	26.5				9.3	SE	23.5	29/19	1016.0
LONF1	24.8N	080.9W	744	26.3	28.8				8.0	SE	25.1	10/00	1015.8
LPOI1	48.1N	116.5W	744	10.2	8.2				6.2	S	27.0	07/07	1016.2
MDRM1	44.0N	068.1W	743	9.3					11.9	S	30.7	25/06	1017.2
MISM1	43.8N	068.8W	743	9.6					11.8	S	32.4	25/06	1017.0
MLRF1	25.0N	080.4W	741	25.9	27.1				8.7	SE	24.5	21/08	1016.2
MRKA2	61.1N	146.7W	1486	6.6					7.6	NE	22.0	19/02	1010.6
NWPO3	44.6N	124.1W	744	9.7					10.7	N	29.0	06/20	1020.4
PILM4	48.2N	088.4W	743	6.6					12.6	E	37.5	07/12	1015.1
POTA2	61.1N	146.7W	1485	6.5					7.2	NE	22.4	18/18	1010.2
PTAC1	39.0N	123.7W	744	9.6					13.7	N	29.8	23/01	1017.8
PTAT2	27.8N	097.1W	724	25.4	26.6				14.3	SE	35.2	18/09	1012.2
PTGC1	34.6N	120.6W	744	10.8					17.9	N	33.6	15/10	1016.5
ROAM4	47.9N	089.3W	743	9.4									1013.2
SANF1	24.4N	081.9W	736	26.2	26.9				8.5	E	24.3	30/17	1016.0
SAUF1	29.8N	081.3W	743	22.6	23.5				9.9	SE	24.8	05/13	1016.7
SBIO1	41.6N	082.8W	743	15.8					10.8	E	32.3	24/21	1014.8
SGNW3	43.8N	087.7W	743	11.4					10.6	S	27.6	17/05	1013.6
SISW1	48.3N	122.8W	744	9.5					11.5	W	36.3	07/02	1018.5
SMKF1	24.6N	081.1W	743	26.5	28.0				8.7	E	21.9	05/04	1016.2
SPGF1	26.7N	079.0W	743	25.0					8.1	SE	25.0	01/15	1016.2
SRST2	29.7N	094.0W	257	23.0					13.6	SE	28.0	11/15	1012.6
STDM4	47.2N	087.2W	743	9.6					16.1	SE	32.1	07/02	1013.5
SUPN6	44.5N	075.8W	742	15.0	11.5				7.7	S	29.1	25/19	1015.9

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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)
THIN6	44.3N	076.0W	744	14.8									
TPLM2	38.9N	076.4W	742	17.7	17.0				9.7	NE	23.3	02/11	1017.4
TTIW1	48.4N	124.7W	743	8.6					10.8	W	31.2	17/15	1019.2
VENF1	27.1N	082.4W	743	23.6	27.4								

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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)
41001	34.7N	072.6W	720	24.1	24.5	1.4	3.0	12/02	11.3	SW	22.5	29/16	1018.3
41002	32.3N	075.2W	720	24.6	25.3	1.3	2.3	17/19	9.5	S	23.1	18/08	1018.3
41004	32.5N	079.1W	558	24.8	25.8	1.3	3.6	19/14	11.9	SW	27.0	19/06	1017.4
41008	31.4N	080.9W	720	24.9	25.6	1.0	2.5	18/18	11.7	NE	24.3	18/15	1017.6
41009	28.5N	080.2W	1427	26.1	26.7	1.0	2.4	07/16	9.1	S	27.8	30/23	1017.2
41010	28.9N	078.6W	1435	25.8	26.7	1.3	2.3	07/14	10.6	E	24.7	30/10	1018.0
42001	25.9N	089.6W	719	27.8	28.6	0.7	1.6	26/13	9.6	SE	23.3	26/08	1015.0
42002	25.9N	093.6W	717	27.9	28.4	1.0	2.4	24/20	12.0	SE	25.5	24/12	1014.3
42003	25.9N	085.9W	719	27.4	28.6	0.6	1.6	01/19	7.5	E	25.1	01/14	1015.4
42007	30.1N	088.8W	720	27.5	29.0	0.5	1.5	19/18	10.0	SW	20.8	19/15	1016.2
42019	27.9N	095.4W	719	27.6	28.1	1.1	2.2	25/02	11.3	SE	20.6	25/08	1013.2
42020	26.9N	096.7W	705	27.7	28.0	1.5	1.7	30/13	12.5	SE	21.0	05/14	1012.6
42035	29.2N	094.4W	720	27.7	28.5	0.9	1.8	25/13	11.3	S	20.6	25/11	1015.1
42036	28.5N	084.5W	720	26.7	27.4	0.5	2.2	19/09	7.4	E	28.6	05/05	1015.8
42039	28.8N	086.0W	719	27.2	28.2	0.6	2.4	19/11	8.2	E	22.2	19/15	1017.0
42040	29.2N	088.3W	719	27.7	29.0	0.7	2.0	20/00	8.9	SW	19.8	07/19	1015.6
44004	38.5N	070.7W	720	21.3	21.2	1.4	2.9	11/22	11.9	SW	23.3	11/18	1018.5
44005	42.9N	068.9W	719	15.6	14.1	1.0	2.3	29/01	9.4	S	22.7	28/22	1017.2
44007	43.5N	070.1W	719	15.9	14.2	0.8	1.8	09/12	7.6	S	21.2	09/08	1016.5
44008	40.5N	069.4W	720	15.9	14.7	1.2	2.7	11/05	10.2	S	22.7	18/05	1018.4
44009	38.5N	074.7W	720	19.5	19.4	1.2	2.6	12/13	11.2	NE	24.1	21/23	1018.1
44011	41.1N	066.6W	432	15.5	13.9	1.4	3.4	11/07	10.1	SW	29.1	18/08	1018.2
44013	42.4N	070.7W	714	17.1	15.5	0.6	2.0	09/19	7.9	S	18.7	20/20	1017.2
44014	36.6N	074.8W	720	20.9	20.2	1.3	2.9	12/05	11.3	S	21.8	19/22	1017.0
44025	40.3N	073.2W	720	18.6	18.5	1.0	2.1	29/21	10.7	SW	21.4	09/22	1017.7
45001	48.1N	087.8W	717	6.3	3.6	0.4	1.8	01/03	8.6	SE	22.2	05/15	1014.9
45002	45.3N	086.4W	719	13.4		0.4	1.8	14/14	9.1	S	28.4	29/02	1015.9
45003	45.4N	082.8W	720	13.3	11.9	0.4	2.7	29/12	8.8	SE	31.1	29/10	1015.9
45004	47.6N	086.5W	720	6.7	3.9	0.3	1.9	05/19	8.4	SE	30.3	05/16	1015.5
45005	41.7N	082.4W	720	20.1	20.1	0.2	1.3	29/12	8.1	NE	24.5	14/13	1016.1
45006	47.3N	089.9W	720	7.6	3.7	0.2	1.3	01/13	7.7	SW	17.9	11/19	1014.9
45007	42.7N	087.0W	625	16.7	15.9	0.3	2.9	29/07	7.2	SE	25.8	29/03	1015.8
45008	44.3N	082.4W	720	14.7	12.9	0.3	2.0	29/14	7.8	SE	24.9	29/07	1016.5
46001	56.3N	148.2W	720	7.1	7.1	2.1	4.8	27/22					1008.6
46003	51.8N	155.8W	656	6.6	6.5	2.1	3.7	11/16	12.2	W	26.8	27/17	1008.2
46005	46.1N	131.0W	720	10.4	10.3	2.2	5.8	12/05					1018.2
46006	40.8N	137.5W	628	13.3	13.9	2.2	6.2	13/04	13.7	W	26.4	11/11	1020.8
46011	34.9N	120.9W	720	11.7	12.4	2.1	4.0	14/17	13.0	NW	27.4	09/00	1014.0
46013	38.2N	123.3W	713	10.4	9.2	2.5	4.3	22/14	17.0	NW	30.1	27/00	1014.6
46014	39.2N	124.0W	719	11.3		2.4	4.2	27/02	15.3	NW	30.7	22/04	1016.4
46022	40.7N	124.5W	719	11.3	10.9	2.0	3.9	13/22	10.3	N	25.5	22/10	1017.7
46023	34.7N	121.0W	720	11.7	12.6	2.1	3.6	14/22	15.8	NW	31.1	09/00	1015.1
46025	33.8N	119.1W	720	14.6	16.6	1.2	2.5	04/02	6.3	W	21.2	04/11	1012.8
46026	37.8N	122.8W	715	10.6	10.5	2.1	3.6	22/14	13.1	NW	28.2	07/03	1014.6
46027	41.8N	124.4W	700	10.3	8.9	1.9	3.6	14/03	10.7	NW	32.4	23/00	1017.0
46028	35.7N	121.9W	717	11.5	12.0	2.3	3.8	14/08	16.5	NW	29.1	08/00	1014.3
46029	46.1N	124.5W	719	12.2	13.5	1.7	3.9	06/03	7.7	W	18.5	05/08	1017.8
46030	40.4N	124.5W	608	10.5	9.5				13.5	N	23.7	23/15	1017.7
46035	56.9N	177.8W	690	4.3	4.9	1.3	3.7	05/10	12.3	NE	28.4	07/16	1010.6
46041	47.3N	124.8W	172	12.2	13.3	1.7	2.6	30/02	6.8	NW	20.0	25/10	1017.2
46047	32.4N	119.5W	713	13.0	14.0	2.4	4.4	08/13	14.7	NW	25.1	14/05	1014.2
46050	44.6N	124.5W	643	12.9		1.8	4.0	14/00	8.9	NW	19.0	05/14	1018.1
46053	34.2N	119.8W	720	13.4	14.7	1.3	2.7	15/00	9.5	W	28.4	03/22	1013.2
46054	34.3N	120.4W	707	11.9	12.5	2.2	4.0	14/12	19.1	NW	35.4	14/04	1013.1
46059	38.0N	130.0W	718		15.0	2.1	4.7	13/16	13.8	N	26.2	12/05	
46060	60.6N	146.8W	1431	10.9	11.3	0.5	1.2	28/18	6.5	SW	18.5	01/11	1012.4
46061	60.2N	146.8W	1438	10.6	10.7	1.1	3.7	28/16	7.3	E	25.1	05/02	1011.9
46062	35.1N	121.0W	701	11.5	12.0	2.1	3.9	14/22	13.5	NW	27.4	07/23	1014.0
46063	34.2N	120.7W	720	11.9	12.3	2.3	4.1	14/13	16.5	NW	27.4	14/05	1013.7
51001	23.4N	162.3W	717	24.5	25.3	2.0	3.1	01/05	14.8	E	22.1	26/15	1019.4
51002	17.2N	157.8W	711	24.4	25.2	2.2	3.2	30/09	15.5	NE	22.5	17/22	1016.7
51003	19.2N	160.7W	718	24.7	25.5	1.8	2.5	07/22	10.3	E	19.7	22/10	1016.3
51004	17.4N	152.5W	702		24.4	2.2	3.0	07/21					1016.6
51028	00.0N	153.9W	708	26.1	26.4	1.8	2.7	04/16	11.0	E	18.8	10/16	1011.2
ABAN6	44.3N	075.9W	720	19.9	17.4				3.6	S	14.3	14/17	1016.6
ALSN6	40.4N	073.8W	715	20.0		0.9	2.3	10/00	14.5	S	32.0	28/20	1018.3
BLIA2	60.8N	146.9W	1437	10.8					5.8	NW	27.5	05/15	1013.2
BURL1	28.9N	089.4W	720	27.6					10.0	S	24.5	26/13	1015.0
BUZM3	41.4N	071.0W	720	17.8	16.3	0.7	1.9	28/23	12.4	SW	30.6	28/23	1018.1

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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)
CARO3	43.3N	124.4W	719	12.1					7.3	N	26.9	13/00	1019.2
CDRF1	29.1N	083.0W	718	26.2					7.9	NE	21.0	28/01	1016.7
CHLV2	36.9N	075.7W	720	20.9	20.4	0.9	2.0	12/05	14.7	NE	31.4	16/13	1018.0
CLKN7	34.6N	076.5W	621	23.7					11.1	SW	27.7	19/14	1018.4
CSBF1	29.7N	085.4W	718	26.2					6.3	NE	17.6	01/13	1016.2
DBLN6	42.5N	079.3W	719	19.9					7.3	SW	26.9	03/01	1017.5
DESW1	47.7N	124.5W	719	11.9					8.1	NW	25.6	05/11	1017.1
DISW3	47.1N	090.7W	718	14.1					8.2	SW	22.4	07/03	1014.4
DPIA1	30.2N	088.1W	720	27.0					9.1	SW	23.7	05/05	1016.6
DRYF1	24.6N	082.9W	719	27.5	28.8				7.3	E	19.6	01/03	1015.3
DSLN7	35.2N	075.3W	720	23.4		1.2	2.4	12/12	15.2	SW	31.9	30/07	
DUCN7	36.2N	075.8W	719	22.2					13.0	N	25.8	20/01	1019.8
FBIS1	32.7N	079.9W	718	24.6					10.1	SW	21.1	11/16	1018.2
FFIA2	57.3N	133.6W	719	10.5					6.6	S	23.2	12/14	1012.6
FPSN7	33.5N	077.6W	720	24.4		1.2	2.7	19/12	14.0	SW	35.1	19/09	1017.8
FWYF1	25.6N	080.1W	720	27.3	28.3				10.8	SE	33.2	02/03	1018.1
GDIL1	29.3N	089.9W	717	27.7	29.6				7.8	S	19.4	26/21	1016.2
GLLN6	43.9N	076.4W	720	18.3					10.5	SE	28.6	03/17	1016.9
IOSN3	43.0N	070.6W	720	17.9					11.9	S	25.9	07/00	1016.6
KTNF1	29.8N	083.6W	713	25.3					7.2	NE	20.4	30/09	1016.3
LKWF1	26.6N	080.0W	718	26.3	27.8				9.0	SE	26.7	29/08	1016.7
LONF1	24.8N	080.9W	720	27.5	29.3				8.3	E	23.9	18/17	1016.1
LPOI1	48.1N	116.5W	718	14.7	12.9				7.0	S	26.9	25/14	1013.8
MDRM1	44.0N	068.1W	718	13.4					12.5	S	30.9	06/22	1016.9
MISM1	43.8N	068.8W	720	14.3					12.6	S	28.1	08/20	1016.7
MLRF1	25.0N	080.4W	716	27.3	28.5				8.5	SE	23.6	29/05	1016.5
MRKA2	61.1N	146.7W	1438	11.0					8.7	SW	31.2	05/08	1012.5
NWPO3	44.6N	124.1W	720	12.0					6.3	NW	18.6	28/03	1018.8
PILM4	48.2N	088.4W	720	9.2					10.5	W	27.9	08/00	1015.7
POTA2	61.1N	146.7W	1424	11.1					6.3	SW	30.2	05/10	1012.2
PTAC1	39.0N	123.7W	719	10.6					12.4	N	23.8	27/10	1015.3
PTAT2	27.8N	097.1W	718	27.8	29.1				14.3	SE	26.9	26/08	1012.8
PTGC1	34.6N	120.6W	720	11.3					16.5	N	30.1	15/09	1014.7
ROAM4	47.9N	089.3W	719	12.1	6.1				12.6	W	33.8	05/16	1014.9
SANF1	24.4N	081.9W	712	27.6	28.3				8.3	E	25.5	16/23	1016.2
SAUF1	29.8N	081.3W	719	25.6	27.3				10.3	E	28.7	19/10	1017.6
SBIO1	41.6N	082.8W	718	21.3					8.2	E	31.8	14/12	1016.0
SGNW3	43.8N	087.7W	720	16.3					9.4	S	26.7	06/19	1015.7
SISW1	48.3N	122.8W	720	11.1					10.0	W	31.5	05/19	1017.0
SMKF1	24.6N	081.1W	720	28.2	28.9				8.8	E	21.6	06/18	1016.5
SPGF1	26.7N	079.0W	719	26.3					7.8	SE	23.0	07/23	1017.1
SRST2	29.7N	094.0W	390	27.5					12.5	S	24.7	25/12	1014.0
STDM4	47.2N	087.2W	717	13.4					16.9	S	28.2	26/17	1014.7
SUPN6	44.5N	075.8W	719	19.9	18.2				7.7	SW	22.4	25/16	1016.2
THIN6	44.3N	076.0W	717	19.5									
TPLM2	38.9N	076.4W	698	21.7	22.0				10.1	S	19.9	04/13	1019.3
TTIW1	48.4N	124.7W	719	10.7					9.2	SW	29.0	05/06	1017.7
VENF1	27.1N	082.4W	720	25.7	29.3								

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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)
41001	34.7N	072.6W	740	26.5	26.8	1.3	2.3	01/05	11.4	SW	24.3	26/15	1017.3
41002	32.3N	075.2W	740	27.2	27.5	1.1	2.3	01/00	10.2	SW	28.0	30/12	1018.3
41004	32.5N	079.1W	739	27.6	28.0	1.0	3.9	01/05	10.2	SW	29.3	01/03	1018.2
41008	31.4N	080.9W	741	27.8	28.3	0.7	2.1	01/06	10.4	S	24.1	13/04	1018.1
41009	28.5N	080.2W	1453	26.4	27.7	0.6	1.8	01/00	10.0	SE	23.7	02/19	1018.6
41010	28.9N	078.6W	1470	27.9	28.6	1.0	2.3	04/04	8.8	SE	17.5	02/05	1019.2
42001	25.9N	089.6W	739	28.4	29.2	0.6	1.8	02/16	8.2	E	20.0	19/04	1017.2
42002	25.9N	093.6W	743	28.4	29.5	0.9	3.3	03/10	10.2	SE	26.6	03/06	1017.0
42003	25.9N	085.9W	740	28.3	29.5	0.7	1.7	12/09	8.2	E	24.7	30/16	1017.3
42007	30.1N	088.8W	742	28.3	29.8	0.4	1.5	04/01	8.9	SE	22.0	12/21	1017.9
42019	27.9N	095.4W	741	28.0	29.0	0.9	2.6	03/09	9.0	SE	20.8	21/11	1016.0
42020	26.9N	096.7W	691	28.1	28.6	1.0	2.8	04/01	11.2	SE	27.8	17/12	1015.4
42035	29.2N	094.4W	740	28.4	29.8	0.7	1.8	01/07	9.3	S	22.2	09/12	1017.7
42036	28.5N	084.5W	738	28.2	29.1	0.6	1.7	03/12	7.5	E	23.7	04/00	1017.3
42039	28.8N	086.0W	453	28.0	29.3	0.7	1.7	03/22	7.8	E	18.7	04/11	1019.5
42040	29.2N	088.3W	740	28.4	29.5	0.6	1.8	04/05	8.4	W	19.2	15/18	1017.3
44004	38.5N	070.7W	742	24.3	24.6	1.2	2.8	13/18	11.5	SW	24.7	08/05	1015.5
44005	42.9N	068.9W	149	21.0	20.5	1.0	3.0	02/14	8.8	S	25.8	02/14	1009.9
44007	43.5N	070.1W	741	18.0	16.0	0.6	1.9	02/16	6.7	S	22.5	02/16	1012.0
44008	40.5N	069.4W	744	19.7	18.3	1.0	2.8	13/20	8.8	SW	26.2	13/19	1014.6
44009	38.5N	074.7W	741	23.6	23.3	0.9	3.0	13/12	10.2	S	27.6	13/08	1015.3
44011	41.1N	066.6W	658	18.4	16.9	1.1	2.4	03/09	8.5	SW	19.8	13/14	1014.1
44013	42.4N	070.7W	741	19.4	17.8	0.4	1.4	14/10	7.6	SW	20.6	02/16	1012.9
44014	36.6N	074.8W	737	25.1	24.7	1.0	2.4	12/23	9.8	SW	25.3	25/01	1015.1
44025	40.3N	073.2W	743	23.0	22.8	0.9	2.8	02/07	10.4	SW	24.9	13/09	1013.9

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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)
45001	48.1N	087.8W	737	10.9	7.9	0.4	1.8	06/17	8.5	SW	20.0	06/16	1011.7
45002	45.3N	086.4W	737	19.5		0.5	2.8	14/18	10.0	S	27.0	09/02	1013.1
45003	45.4N	082.8W	738	18.5	17.3	0.4	1.8	09/14	9.3	S	23.7	09/12	1013.0
45004	47.6N	086.5W	744	12.4	9.7	0.3	2.2	06/16	8.4	W	26.4	06/13	1012.4
45005	41.7N	082.4W	743	24.4	24.5	0.3	1.2	09/13	9.1	SW	23.5	09/12	1014.3
45006	47.3N	089.9W	744	13.9	11.0	0.3	1.7	06/12	7.8	SW	20.2	06/11	1012.0
45007	42.7N	087.0W	741	22.2	21.5	0.4	2.3	10/09	8.8	S	33.4	21/08	1014.3
45008	44.3N	082.4W	742	19.8	18.6	0.3	1.7	10/10	8.3	S	24.3	01/19	1014.0
46001	56.3N	148.2W	740	10.1	10.1	1.6	2.8	28/12					1017.7
46003	51.8N	155.8W	743	9.8	9.4	1.7	3.2	18/16	12.8	SW	22.3	21/13	1022.7
46005	46.1N	131.0W	741	11.6	12.2	1.7	3.3	14/23					1022.5
46006	40.8N	137.5W	642	14.0	15.4	1.9	2.8	14/05	13.9	N	21.6	31/09	1025.0
46011	34.9N	120.9W	735	13.8	14.5	1.7	3.5	07/08	11.2	NW	23.9	24/21	1014.7
46013	38.2N	123.3W	731	11.5	10.8	1.8	4.9	02/07	12.5	NW	32.6	02/07	1015.5
46014	39.2N	124.0W	742	11.8		1.9	4.4	02/03	11.0	NW	30.5	02/01	1016.9
46022	40.7N	124.5W	741	11.9	11.4	1.8	4.7	14/07	8.8	N	23.3	14/07	1017.2
46023	34.7N	121.0W	740	13.7	14.5	1.6	3.1	05/20	13.6	NW	28.6	24/23	1015.7
46025	33.8N	119.1W	742	16.9	18.5	1.1	1.8	25/01	5.7	W	14.6	27/01	1013.4
46026	37.8N	122.8W	741	12.0	12.6	1.6	4.2	02/11	11.3	NW	29.3	02/00	1015.5
46027	41.8N	124.4W	736	11.1	10.1	1.6	4.0	13/00	8.5	NW	33.8	15/00	1016.6
46028	35.7N	121.9W	742	12.9	13.4	2.0	4.3	07/07	13.4	NW	32.1	07/13	1015.2
46029	46.1N	124.5W	733	13.3	14.1	1.4	3.8	14/11	9.7	NW	22.2	05/22	1018.4
46035	56.9N	177.8W	712	6.8	7.0	1.5	3.6	25/02	13.8	SW	29.3	03/21	1012.3
46041	47.3N	124.8W	741	12.5	12.6	1.4	4.2	14/07	8.0	NW	21.4	14/09	1018.1
46047	32.4N	119.5W	723	14.8	16.0	2.0	3.4	24/14	13.2	NW	23.7	24/04	1014.8
46050	44.6N	124.5W	719	13.5		1.6	4.0	14/11	10.7	N	26.8	13/00	1018.4
46053	34.2N	119.8W	741	16.1	17.4	1.1	2.1	06/23	10.0	W	21.4	24/02	1014.0
46054	34.3N	120.4W	730	14.2	15.2	1.7	3.1	07/08	18.3	NW	29.7	07/01	1013.7
46059	38.0N	130.0W	732		16.3	1.9	4.7	13/13	13.2	N	27.6	13/09	
46060	60.6N	146.8W	1452	13.5	14.3	0.4	1.0	10/11	7.6	SW	22.5	10/10	1017.3
46061	60.2N	146.8W	1477	13.2	1								

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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)
41001	34.7N	072.6W	740	26.7	27.6	1.7	10.3	30/21	11.9	S	45.9	30/23	1013.2
41002	32.3N	075.2W	739	27.6	28.3	1.8	11.3	30/11	12.1	SW	41.2	30/13	1013.9
41004	32.5N	079.1W	742	28.2	29.1	1.2	5.4	29/16	12.1	SW	50.5	30/03	1013.6
41008	31.4N	080.9W	742	28.4	29.6	0.9	3.0	29/16	11.8	S	30.9	29/16	1013.6
41009	28.5N	080.2W	1461	27.6	28.4	0.9	5.0	29/07	9.3	S	29.0	29/10	1013.9
41010	28.9N	078.6W	1340	28.4	29.4	1.3	8.3	29/04	10.9	S	57.5	29/04	1014.8
42001	25.9N	089.6W	740	28.8	29.8	0.5	2.3	22/15	7.1	SE	20.4	15/16	1013.9
42002	25.9N	093.6W	739	29.1	30.0	0.7	4.3	22/03	8.5	SE	29.7	22/06	1014.1
42003	25.9N	085.9W	742	28.9	30.3	0.5	1.4	06/16	7.3	NW	28.4	15/11	1013.8
42007	30.1N	088.8W	721	29.6	30.7	0.3	1.4	09/19	8.4	W	25.5	09/18	1013.8
42019	27.9N	095.4W	743	28.8	29.5	0.7	4.8	22/16	7.8	S	24.7	22/15	1013.2
42020	26.9N	096.7W	738	28.2	29.1	0.9	8.2	22/16	9.5	SE	58.1	22/18	1012.7
42035	29.2N	094.4W	741	29.5	30.3				8.7	SW	20.6	29/20	1014.6
42036	28.5N	084.5W	735	29.0	29.9	0.7	1.5	11/21	7.9	SW	31.1	03/10	1013.2
42039	28.8N	086.0W	197	29.5	30.7	0.4	1.3	31/16	6.3	NW	19.4	26/13	1012.9
42040	29.2N	088.3W	198	30.2	31.3	0.4	0.9	08/20	6.7	SW	16.3	08/21	1013.4
44004	38.5N	070.7W	743	24.5	25.0	1.4	5.6	31/06	11.1	S	34.8	31/06	1014.1
44005	42.9N	068.9W	742	19.2	19.2	1.1	3.4	30/08	11.2	S	26.6	08/18	1013.1
44007	43.5N	070.1W	743	17.6	16.3	0.7	1.7	30/09	7.4	S	21.8	30/01	1012.7
44008	40.5N	069.4W	740	21.0	21.4	1.2	3.5	30/07	9.6	S	27.4	30/08	1013.9
44009	38.5N	074.7W	741	24.2	24.7	1.2	5.5	31/12	11.7	S	32.6	30/16	1013.6
44011	41.1N	066.6W	714	19.7	19.1	1.2	2.9	09/08	8.6	S	23.7	30/10	1014.0
44013	42.4N	070.7W	741	18.5	17.4	0.6	2.0	21/23	8.3	SE	23.3	22/07	1013.3
44014	36.6N	074.8W	740	25.7	26.3	1.3	7.9	31/21	11.2	S	42.7	30/20	1012.5
44025	40.3N	073.2W	743	22.7	23.4	1.1	3.1	31/05	11.2	S	26.4	20/23	1013.2
45001	48.1N	087.8W	733	16.0	15.7	0.5	1.9	13/10	9.5	S	26.6	16/01	1014.9
45002	45.3N	086.4W	739	19.3		0.6	2.8	16/15	10.7	S	28.8	16/14	1015.5
45003	45.4N	082.8W	740	18.5	19.3	0.5	2.3	29/02	10.3	NW	27.8	29/00	1014.9
45004	47.6N	086.5W	739	15.6	15.1	0.5	2.1	08/01	9.5	NW	27.6	08/01	1015.5
45005	41.7N	082.4W	742	21.7	23.5	0.5	1.8	30/14	10.3	N	26.8	10/13	1014.2
45006	47.3N	089.9W	741	16.6	16.4	0.4	2.9	13/01	8.5	W	30.5	13/02	1015.2
45007	42.7N	087.0W	738	20.8	22.1	0.6	3.5	14/02	10.7	N	28.0	14/03	1015.4
45008	44.3N	082.4W	741	19.4	20.0	0.6	2.4	14/05	10.5	N	27.0	29/03	1015.3
46001	56.3N	148.2W	741	12.0	12.4	1.7	3.9	05/01	14.6	W	21.8	30/17	1008.6
46003	51.8N	155.8W	262	11.3	11.1	2.1	3.8	03/13	11.2	SW	24.5	03/11	1013.7
46005	46.1N	131.0W	741	14.4	14.4	1.5	3.1	28/19					1018.1
46006	40.8N	137.5W	626	16.1	16.6	1.5	2.6	28/12	11.1	W	20.4	01/02	1020.5
46011	34.9N	120.9W	737	13.6	13.4	1.4	3.4	31/04	11.0	NW	26.0	31/00	1013.9
46012	37.4N	122.7W	100	13.8	13.1	1.9	3.5	31/04	12.2	NW	26.4	31/03	1014.6
46013	38.2N	123.3W	733	13.1	12.1	1.6	3.5	31/21	12.2	NW	28.8	21/01	1015.0
46014	39.2N	124.0W	737	14.4		1.5	3.2	22/01	11.9	NW	27.0	22/02	1016.6
46022	40.7N	124.5W	357	13.9	13.1	1.2	2.4	26/21	7.6	N	17.1	30/03	1016.5

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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)
46023	34.7N	121.0W	743	14.0	13.8	1.5	3.6	31/04	13.8	NW	29.3	31/03	1014.9
46025	33.8N	119.1W	742	16.5	18.3	1.0	1.6	31/03	6.0	W	15.9	07/00	1012.4
46026	37.8N	122.8W	739	13.2	13.2	1.3	2.8	31/03	10.0	NW	25.1	30/22	1014.9
46027	41.8N	124.4W	730	13.3	12.4	1.2	2.7	22/01	6.8	NW	29.3	22/00	1015.8
46028	35.7N	121.9W	374	14.5	14.7	1.5	2.7	04/08	15.2	NW	28.8	13/11	1015.4
46029	46.1N	124.5W	735	15.1	15.4	1.2	2.3	29/13	8.3	N	22.0	22/22	1016.6
46035	56.9N	177.8W	699	7.7	8.0	1.8	5.5	19/06	14.4	SW	32.3	04/01	1005.8
46041	47.3N	124.8W	740	14.5	14.7	1.2	2.5	11/14	7.5	NW	20.6	23/03	1016.3
46042	36.7N	122.4W	681	14.5	14.3	1.4	3.3	31/05	10.8	NW	23.3	04/00	1015.1
46047	32.4N	119.5W	730	15.6	16.8	1.9	3.2	31/12	15.9	NW	23.5	31/03	1013.8
46050	44.6N	124.5W	733	15.1		1.2	2.4	29/17	7.8	N	20.2	09/23	1016.8
46053	34.2N	119.8W	710	14.5	15.1	1.0	1.7	01/01	9.6	W	20.0	07/00	1013.1
46054	34.3N	120.4W	711	13.4	13.2	1.5	3.4	31/09	19.6	NW	32.1	04/03	1012.8
46059	38.0N	130.0W	732		18.6	1.4	2.7	23/09	10.5	NW	21.2	05/13	
46060	60.6N	146.8W	1448	13.6	14.2	0.4	1.5	13/03	8.5	E	28.2	23/02	1010.9
46061	60.2N	146.8W	1478	13.3	14.0	1.0	3.7	29/09	9.8	E	29.7	22/20	1010.3
46062	35.1N	121.0W	732	13.6	13.4	1.4	3.7	31/02	12.7	NW	31.5	31/02	1013.8
46063	34.2N	120.7W	727	13.8	13.2	1.7	4.0	31/06	15.7	NW	25.5	31/05	1013.2
51001	23.4N	162.3W	737	25.5	26.3	1.7	2.7	25/13	13.5	E	23.4	31/17	1019.0
51002	17.2N	157.8W	736	25.3	25.8	2.2	5.7	16/13	16.5	NE	29.5	16/16	1015.9
51003	19.2N	160.7W	734	25.9	26.7	1.9	3.6	17/03	12.3	E	22.5	16/16	1016.1
51004	17.4N	152.5W	733		25.3	2.1	5.4	15/18					1015.9
51028	00.0N	153.9W	571	25.3	25.4	1.7	2.2	19/16	12.5	E	18.7	07/01	1012.1
ABAN6	44.3N	075.9W	743	19.6	22.3				3.4	S	12.3	15/16	1014.5
ALSN6	40.4N	073.8W	736	22.8		0.9	2.6	21/05	14.2	S	47.9	05/20	1014.1
BLIA2	60.8N	146.9W	1484	12.7					6.9	NW	28.1	28/15	1011.8
BURL1	28.9N	089.4W	738	29.5					8.8	W	33.1	09/16	1013.5
BUZM3	41.4N	071.0W	739	20.8	20.3	0.8	1.8	14/11	12.4	SW	28.3	30/06	1013.9
CARO3	43.3N	124.4W	742	13.9					5.7	N	18.8	07/13	1017.6
CDRF1	29.1N	083.0W	737	28.4					7.3	W	23.2	03/05	1013.9
CHLV2	36.9N	075.7W	742	25.4	26.2	0.9	5.4	31/17	13.2	S	48.3	30/20	1013.6
CLKN7	34.6N	076.5W	743	26.8					11.2	SW	60.7	30/14	1013.4
CSBF1	29.7N	085.4W	737	28.9					7.4	W	27.0	02/17	1013.4
DBLN6	42.5N	079.3W	744	20.6					8.3	N	30.4	06/17	1015.2
DESW1	47.7N	124.5W	741	13.8					9.4	NW	26.2	23/03	1016.3
DISW3	47.1N	090.7W	743	17.5					9.2	SW	34.1	12/21	1015.6
DPIA1	30.2N	088.1W	731	29.3					7.3	SW	25.0	29/21	1014.1
DRYF1	24.6N	082.9W	740	28.9	30.3				7.4	E	22.8	14/11	1014.0
DSLN7	35.2N	075.3W	46	28.8		0.7	0.7	01/16	11.4	SW	18.6	01/17	
DUCN7	36.2N	075.8W	740	26.0					12.2	S	55.8	30/20	1015.4
FBIS1	32.7N	079.9W	732	28.3					9.5	SW	24.4	30/00	1013.8
FFIA2	57.3N	133.6W	741	12.4					7.7	SE	45.0	28/16	1012.9
FPSN7	33.5N	077.6W	743	27.5		1.4	9.5	30/02	14.9	S	80.4	30/10	1013.2
FWYF1	25.6N	080.1W	739	28.8	30.0				9.9	S	32.6	03/23	1014.3
GDIL1	29.3N	089.9W	684	29.5	31.2				7.1	W	22.7	09/18	1014.2
GLLN6	43.9N	076.4W	738	20.7					10.6	W	27.8	06/21	1014.5
IOSN3	43.0N	070.6W	743	18.9					11.4	S	26.4	09/18	1013.0
KTNF1	29.8N	083.6W	742	28.0					7.5	SW	23.9	09/12	1013.4
LKWF1	26.6N	080.0W	739	27.9	29.6				7.4	SW	25.7	22/17	1014.4
LONF1	24.8N	080.9W	740	28.9	30.5				8.1	S	21.2	22/18	1014.6
LPOI1	48.1N	116.5W	693	20.3	20.0				6.3	S	25.3	25/20	1014.5
MDRM1	44.0N	068.1W	741	16.0					12.3	S	28.7	08/18	1012.9
MISM1	43.8N	068.8W	743	16.3					12.1	S	26.6	14/00	1012.9
MLRF1	25.0N	080.4W	736	28.9	30.2				8.6	SW	24.3	17/18	1014.9
MRKA2	61.1N	146.7W	1473	12.1					8.4	NE	32.5	28/12	1011.2
NWPO3	44.6N	124.1W	741	14.0					6.7	N	23.4	23/01	1017.3
PILM4	48.2N	088.4W	741	19.2					10.7	W	30.4	15/23	1009.0
POTA2	61.1N	146.7W	1460	12.3					7.1	NE	26.3	28/17	1010.8
PTAC1	39.0N	123.7W	744	13.5					9.6	N	24.2	31/11	1015.0
PTAT2	27.8N	097.1W	742	28.4	30.1				11.0	SE	40.8	22/22	1012.9
PTGC1	34.6N	120.6W	739	13.1					17.6	N	27.6	25/05	1014.4
SANF1	24.4N	081.9W	742	28.7	30.0				8.0	S	38.1	05/21	1013.9
SAUF1	29.8N	081.3W	744	27.8	28.3				8.8	SW	27.3	03/02	1013.9
SBIO1	41.6N	082.8W	742	21.9					8.2	N	22.9	18/02	1014.5
SGNW3	43.8N	087.7W	740	19.8					10.0	S	26.8	14/01	1015.5
SISW1	48.3N	122.8W	737	12.7					8.6	W	26.2	31/02	1016.2
SMKF1	24.6N	081.1W	742	28.9	30.6				8.8	S	24.6	03/14	1015.6
SPGF1	26.7N	079.0W	742	28.5					8.2	S	32.6	28/22	1014.6
SRST2	29.7N	094.0W	741	29.0					9.2	S	27.1	31/16	1013.8
STDM4	47.2N	087.2W	742	17.0					12.3	S	31.3	07/12	1015.2
SUPN6	44.5N	075.8W	741	19.8	22.7				7.7	S	24.0	28/22	1014.1
THIN6	44.3N	076.0W	722	19.6									
TPLM2	38.9N	076.4W	742	24.8	26.2				10.7	S	30.0	30/08	1014.2
TTIW1	48.4N	124.7W	742	12.9					8.5	S	31.9	25/09	1017.0
VENF1	27.1N	082.4W	743	27.7	30.8								

Meteorological Services—Observations

U.S. Port Meteorological Officers

Headquarters

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

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

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

Mary Ann Burke, Editor
Mariners Weather Log
6959 Exeter Court, #101
Frederick, MD 21703
Tel and Fax: 715-663-7835
E-mail: wvrs@earthlink.net

Atlantic Ports

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

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

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

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

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

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

Great Lakes Ports

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

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

Gulf of Mexico Ports

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

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

Pacific Ports

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

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

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

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

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

Lynn Chrystal, OIC
National Weather Service, NOAA

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Meteorological Services

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

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

SEAS Field Representatives

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

Mr. Steven Cook
NOAA-AOML
United States GOOS Center
4301 Rickenbacker Causeway
Miami, FL 33149
Tel: 305-361-4501
Fax: 305-361-4366
E-mail: cook@aoml.noaa.gov

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

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

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

NIMA Fleet Liaison

Tom Hunter, Fleet Liaison Officer
ATTN: GIMM (MS D-44)
4600 Sangamore Road
Bethesda, MD 20816-5003
Tel: 301-227-3120
Fax: 301-227-4211
E-mail: huntert@nima.mil

U.S. Coast Guard AMVER Center

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

Other Port Meteorological Officers

Australia

Headquarters
Tony Baxter
Bureau of Meteorology
150 Lonsdale Street, 7th Floor
Melbourne, VIC 3000
Tel: +613 96694651
Fax: +613 96694168

Melbourne
Michael T. Hills, PMA
Victoria Regional Office
Bureau of Meteorology, 26th Floor
150 Lonsdale Street
Melbourne, VIC 3000
Tel: +613 66694982
Fax: +613 96632059

Fremantle
Captain Alan H. Pickles, PMA
WA Regional Office
1100 Hay Street, 5th Floor
West Perth WA 6005
Tel: +619 3356670
Fax: +619 2632297

Sydney
Captain E.E. (Taffy) Rowlands, PMA
NSW Regional Office
Bureau of Meteorology, Level 15
300 Elizabeth Street
Sydney NSW 2000
Tel:+612 92961547
Fax: +612 92961589
Telex: AA24640

Canada

Randy Sheppard, PMO
Environment Canada
1496 Bedford Highway, Bedford
(Halifax) Nova Scotia B4A 1E5
902-426-6703
E-mail: randy.sheppard@ec.gc.ca

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

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

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

China

YU Zhaoguo
Shanghai Meteorological Bureau
166 Puxi Road
Shanghai, China

Denmark

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

United Kingdom

Headquarters
Capt. E. J. O'Sullivan
Marine Observations Manager
Met. Office - Observations Voluntary (Marine)
Scott Building
Eastern Road
Bracknell, Berkshire RG12 2PW
Tel: +44-1344 855654
Fax: +44-1344 855921
Telex: 849801 WEABKA G

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Meteorological Services

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

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

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

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

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

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

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

France

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

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

Germany

Henning Hesse, PMO
Wetterwarte, An der neuen Schleuse
Bremerhaven
Tel: +49 47172220
Fax: +49 47176647

Jurgen Guhne, PMO
Deutscher Wetterdienst
Seewetteramt
Bernhard Nocht-Strasse 76
20359 Hamburg
Tel: 040 3190 8826

Greece

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

Hong Kong

C. F. Wong, PMO
Hong Kong Observatory
Unit 2613, 26/F, Miramar Tower
14/F Ocean Centre
1 Kimberly Road
Kowloon, Hong Kong
Tel: +852 2926 3100
Fax: +852 2375 7555

Israel

Hani Arbel, PMO
Haifa Port
Tel: 972 4 8664427

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

Japan

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

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

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

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

Kenya

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

Malaysia

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

Mauritius

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

Netherlands

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

New Zealand

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

Norway

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

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Meteorological Services

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Poland

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

Saudi Arabia

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

Singapore

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

South Africa

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

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

Sweden

Morgan Zinderland
SMHI
S-601 76 Norrköping, Sweden

Meteorological Services - Forecasts

Headquarters

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

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

U.S. NWS Offices

Atlantic & Eastern Pacific Offshore & High Seas

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

Tropics

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

Central Pacific High Seas

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

Alaska High Seas

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

Coastal Atlantic

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

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

Tom Fair/Frank Nocera
National Weather Service Forecast Office
445 Myles Standish Blvd.
Taunton, MA 02780
Tel: 508-823-1900
E-mail: thomas.fair@noaa.gov; frank.nocera@noaa.gov

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

Continued on Page 118

Meteorological Services

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

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

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

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

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

John F. Townsend
National Weather Service Office
5777 South Aviation Avenue
Charleston, SC 29406-6162
Tel: 803-744-0303 ext. 6 (forecaster)
803-744-0303 ext. 2 (marine weather recording)

Kevin Woodworth
National Weather Service Office
5777 S. Aviation Avenue
Charleston, SC 29406
Tel: 843-744-0211
Fax: 843-747-5405
E-mail: kevin.woodworth@noaa.gov

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

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

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

Great Lakes

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

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

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

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

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

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

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

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

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

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

Coastal Gulf of Mexico

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

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

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

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

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

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

Brian Kyle
National Weather Service Office
Houston
1620 Gill Road
Dickenson, TX 77539

Continued on Page 119

Meteorological Services

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Tel: 281-337-5074
Fax: 281-337-3798

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

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

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

Coastal Pacific

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

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

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

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

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

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

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

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

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

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

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

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
1315 East-West Highway
Distribution Unit
Silver Spring, MD 20910
Attn: Mariners Weather Log

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