Appendix A
Regional Weather

1 The following are descriptions of typical weather patterns in major boating regions of the United States.

New England, Mid-Atlantic

2 This area is frequently a meeting place for cP and mT air masses. When cP prevails, the weather is dry. When mT prevails, temperature and humidity are comparatively high. Storms pass along the boundary between the two air masses and are frequent, especially from autumn through spring.

3 Most warm fronts move into an area between south and west; most cold fronts between west and north. East of the Appalachians, however, a cold front sometimes moves down from the northeast. This is known as a back-door front. It may create a considerable period of adverse weather for boating, although severe storms are not common.

4 **Temperature & Humidity.** Temperatures vary widely. In the north, ice, snow, and winter lay-ups of several months are common. Humidity varies widely, depending on the overlying air mass.

5 **Barometric Pressure.** The pressure changes almost continuously. It may vary from 30.65 inches during clear, dry weather to 28.70 inches in stormy conditions. Pressure and tendency are valuable in forecasting when combined with other data.

6 **Local Storms.** The most intense thunderstorms occur in connection with fronts and squall lines from early spring to early summer. Local air-mass thunderstorms, rare and usually less severe, are almost entirely a summertime phenomenon. Tornadoes are also rare and occur more often in the spring season.

7 **Gales.** Gale force winds may occur in any season but are most frequent in winter. Nor' easters are common and sometimes are of near hurricane force in winter. They are rare in summer.

8 **Hurricanes.** West Indies hurricanes are a potential threat until they either move over land well to the south (when they may still re-curve and bring flooding rainfall as they move back out to sea) or until they re-curve at sea and pass south and east of 40° N, 70° W. While the official Atlantic Hurricane season is 1 June to 30 November the season is very peaked with most tropical storms and hurricanes occurring from August through October.

9 **Visibility.** There is a great deal of advection fog along the Atlantic coast in spring and summer, from Cape Cod eastward, because of relatively cold water inshore. Warm, humid air blows in from the Gulf Stream offshore. Fog produced over the cold coastal water is blown onshore by easterly or southerly breezes. Fog often occurs at the mouths of rivers or over partially enclosed harbors along the coast of the northeastern states in the fall. This fog usually burns off by midmorning.

10 **Water Conditions.** Waves on shallow bays and sounds, such as Long Island Sound, build up rapidly when the wind increases. These enclosed bodies of water have little wave system when air is light, so rising winds have an unruffled surface on which to work. Significant waves can develop in a few minutes.

11 Over open sea, existing wave and swell systems, including cross swells, are almost always present; These are not easily altered by sudden squalls. The size of the ocean waves increase if the squall wind comes from the same direction as the waves.

12 Large changes in coastal and harbor water levels are common during hurricanes and onshore gales. Beaches, structures, and moored boats may be heavily damaged, especially when hurricanes come ashore. Seiches do not occur in this area.

13 **Wind Conditions.** Prevailing winds in Spring and Summer are typically from the Southwest across most of New England. In winter, these winds come more predominantly from the west. A characteristic of New England is a high degree of thermally-driven winds also most likely from the Southwest. In spring and early summer, these thermals may bring warmer, moist air over colder water leading to advection fog.

The Great Lakes

14 This is an area of frequent movement of major weather systems from the northwest, west, or southwest. Squally conditions and large changes in temperature occur as such systems move through, especially in winter and early spring.

15 In the absence of any general weather system, lake breezes develop close to the shore during the day, but the center of a large lake remains calm.

16 **Temperature.** Seasonal and daily temperatures are variable. Winter cold, ice, snow, and frequent strong winds encourage wintertime lay-up during the coldest months. Although the humidity is generally lower than in most coastal areas, humid weather occurs when mT air approaches from the Gulf of Mexico.

17 **Barometric Pressure.** The barometer shows wide changes: from high to less than 29.00 inches, in the deepest storm systems. Barometric pressure and tendency are useful in predicting the approach of major weather systems.

18 **Local Storms.** Thunderstorms are largely the result of moving fronts or squall lines and can be severe. Summer air-mass thunderstorms are not as frequent as in more southern latitudes. These storms are not usually severe but may be hazardous to small boats. Tornadoes and waterspouts occur most frequently from February through August. The tornadoes are generally associated with frontal or prefrontal squall lines.

19 **Squalls.** Appearance of a line of cumulonimbus clouds on the horizon is commonly a result of cooler air under running warmer air. This can produce high winds and heavy rainfall. A 180° wind shift often occurs. Brassy skies in the west or northwest, usually in the late afternoon, may foretell a severe squall bringing rain within an hour.

20 **Visibility.** Visibility is affected by atmospheric stability. If distant objects can be seen at 1100, the atmosphere is unstable and the weather could worsen in the afternoon. If visibility is only 1 to 2 miles, the air is stable. Haze and smoke are stratified near the surface. The weather is likely to be good during the day as far as wind and rain are concerned. A pale yellow sky at sunset may be an indication of rain within 12 hours. A bright yellow sky indicates a likelihood of good sailing winds. Steam fog is rare, but in early fall it may appear in enclosed harbors until an hour or two after sunrise. Advection fog is common during the spring and early summer.

21 **Water Conditions.** On a shallow body of water with no swells or wave trains like those that appear on the open ocean, waves build up rapidly with an increase in wind. If a wave system already exists and the increasing wind is coming from the same direction as the waves, they will grow larger. In a sudden squall, this can happen quickly.

22 A wind of 15 knots or more, blowing over a lake with a fetch of some hundreds of miles, will cause the water to rise along the lee shore. On rare occasions this rise may be as much as 10 feet.

23 **Seiches,** usually due to atmospheric forces, are rapid changes in the level of water along the lakeshore. The change may amount to as much as 4 feet. Generally the water level falls, but it may oscillate slowly. Sometimes a series of waves 4 feet high or more accompanies the changing water level.

South Atlantic, Florida, Gulf—General Area

24 Weather over these states is dominated much of the time by the semi-permanent Bermuda high. The circulation around this high affects not only

inland and coastal areas but also areas well offshore.

25 The area has more atmospheric moisture than the north. Annual precipitation is heavy, ranging from 45 to 65 inches. Amounts are less over the extreme western Gulf. Winter cyclones produce extensive rainfall over the Gulf States, and summer thundershowers are frequent throughout the region.

26 **Temperature & Humidity.** Comparatively mild temperatures prevail most of the time. However, several times each winter, the westerlies of the mid-latitudes are displaced southward enough to bring extra-tropical cyclones and cP air to all of these states. During severe cold waves, freezing temperatures sometimes reach into southern Florida and extreme southern Texas. However, boating is a year-round activity. Hot, humid summers make spring and fall popular boating seasons.

27 **Barometric Pressure.** The barometer is a helpful forecast tool, but it is not used as much as in more northerly latitudes. The diurnal pressure change is pronounced, especially in the southernmost portions of this region, and tends to obscure pressure changes associated with weak migratory systems. It is often more important to note the 24-hour change than the change during the past few hours. Pressures substantially above or below normal for the season warrant investigation. Unusually high readings indicate strong anticyclones, which produce above-normal winds and seas over extensive areas surrounding the benign center of the high. In general, a pressure of 1010 millibars (29.8 inches) or less is cause for concern and may indicate that some kind of weather disturbance is near.

28 **Local Storms.** Thunderstorms occur frequently over land on summer afternoons, usually in a spotty pattern, owing to the abundant supply of moist, conditionally unstable air. Upper winds may carry these storms offshore in late afternoon or evening. Nocturnal thunderstorms often occur over the warm waters of the Gulf Stream and the Gulf of Mexico.

29 Tornadoes are seen in all seasons, but the most destructive ones usually occur in late winter or spring, with severe thunderstorms along squall lines ahead of cold fronts. Tornadoes are more common in the Gulf States than elsewhere in the region.

30 **Hurricanes.** Hurricanes are a threat to all parts of the region. While the official Atlantic Hurricane season is 1 June to 30 November the season is very peaked with most tropical storms and hurricanes occurring from August through October.

31 **Visibility.** All land areas are subject to radiation fog. Advection fog is common in winter when warm, moist air flows inland from the Gulf. The waters of the northern Gulf are sometimes affected, and these sea fogs tend to be quite persistent.

32 **Land & Sea Breezes.** During the warmer months, with a weak pressure gradient, coastal areas experience a sea breeze from the middle of the morning to shortly after sunset. A weaker offshore or land breeze usually prevails at night.

Florida

33 **Movement of Weather.** Weather systems usually move from west to east over middle and higher latitudes. In the latitude of Florida, however, movement may be from east to west, as easterly winds often extend to high altitudes. An example is the "easterly waves" that appear over the Caribbean. These sometimes affect the lower Florida peninsula and the Keys.

34 **Fronts.** Nearly all frontal action comes from early October to mid-May. Most cold fronts that reach Florida extend from cyclones far to the north. The typical weather sequence described in texts is rarely experienced. Many cold fronts produce no rain at all. Often the rain that does occur is associated with a prefrontal squall line. The front is then dry but can be distinguished from the squall line by lower dew points and a more persistent veering of the wind.

35 After passage of a relatively strong cold front, the weather usually turns clear and cool for a few days, and then gradually warms up until the next front arrives. Many fronts dissipate south of Florida. Those that do return as warm fronts are usually quite weak, and the typical pre-warm front cloud sequence is rarely observed. Occluded fronts rarely if ever occur over the peninsula of Florida.

36 **Upper Troughs & Convergence Lines.** Troughs in the upper air, not indicated by the surface

pressure pattern, may cause areas of cloudy, showery weather with possible thunderstorms. These are best located by satellite photos. Recent satellite pictures are shown on nearly all TV weather programs.

37 Showers and thunderstorms also form along lines where two wind streams are converging at an angle that may be much less than 45°. These are difficult to forecast. Be alert to their development by watching for lines of convective cloud development and by monitoring NOAA Weather Radio broadcasts of radar reports.

38 **Local Storms.** Florida has more thunderstorms per unit area than any other state. The vast majority of these are afternoon storms over land, from mid-May to November. Winter thunderstorms are usually associated with fronts and squall lines. Nocturnal thunderstorms develop over the Gulf Stream and, in perhaps half the cases along the southeast coast, drift inland during the early morning hours (0500-0900). Morning thundershowers are less frequent from Palm Beach northward. The most frequent months are August and September. Morning storms tend to be less severe than the afternoon variety.

39 A number of tornadoes are reported annually, however, these are usually small and less severe than those of the Mississippi Valley and Plains states.

40 Waterspouts are numerous in the Florida Keys- requiring constant vigilance. Many appear in relatively benign weather—that is, light wind along a shower-free portion of a line of building cumulus clouds with no thunderstorms in the area. Fortunately, most waterspouts are small, and the alert skipper can take evasive action by steering a course at right angles to, and away from, the forward movement of the vortex.

41 **Visibility.** Fog, the main restriction to visibility, occurs mainly during winter and early spring. Fog is quite prevalent along the northeast coast and on the west coast from Cedar Key to Pensacola during this time. Occasionally it may last all day. Fog is rare in south Florida except for local ground fog that is of little danger to boating.

42 **Small-Craft Advisories.** Advisories in summer are nearly always brief unless a tropical storm is involved. A prolonged windy period is usually due to a large anticyclone that is centered well north of Florida and is either stationary or slow-moving. The result can be several days of small-craft advisories, especially along the east coast of Florida. The most likely months for these windy periods are October, March, and April. October nor' easters can cause considerable beach erosion.

Gulf States

43 Boating is a year-round sport. Winter lay-up is a rarity. Sailors often find better winds for racing or cruising in the cooler part of the year than in mid-summer.

44 **Fronts.** Cold fronts moving down the Mississippi Valley may go as far as extreme southeast Texas. Owing to the Bermuda high, cold fronts sometimes tend to stall and move slowly into the Gulf of Mexico to become stationary, returning over land as a warm front when a developing low progresses eastward and northward from the central Gulf states.

45 **Local Storms.** The Gulf Coast has severe thunderstorms that occasionally spawn tornadoes, although they are not so frequent or as severe as those in "Tornado Alley" (Northwest Texas, Oklahoma, and Kansas). Watches and warnings are issued as needed, usually for a period of one to a few hours. Monitor severe thunderstorm warnings and keep a visual watch for threatening convective activity. Such storms can pose severe hazards for small boats.

46 **Squall Lines.** Squall lines frequently cause severe thunderstorms and tornadoes. Occurring usually in late winter or early spring, these storms are brought about by the clash between warm, moist Gulf air and colder air from the north. Houston, Texas, is one popular boating area over which these storms are notable.

47 During the unstable periods when squall lines are in the area, cumulonimbus clouds and waterspouts often appear. If you sight such phenomena, be prudent and take shelter.

48 The temperature difference between North Houston and Galveston Island is normally 5 to 10 degrees; such a temperature difference does not necessarily imply a difference of air masses.

49 **Hurricanes.** While the official Atlantic Hurricane season is 1 June to 30 November the season

is very peaked with most tropical storms and hurricanes occurring from August through October.

50 **Visibility.** The chief restriction to visibility is fog. Most fogs occur during the winter and early spring months. From Pensacola west to Port O' Conner, fog during these seasons are sometimes severe, forcing shipping, boating, and aircraft activities to halt.

The West Coast—General Area

51 West Coast weather is strongly influenced not only by normal meteorological patterns but also by topography, the Pacific high (also called the Hawaiian high), and the cold California Current.

52 **Topography.** The entire West Coast is mountainous, rising abruptly from the sea in most places. Storms moving in from the Pacific deposit most of the precipitation between the coast and the inland mountain ranges. These ranges protect the coastal areas from most of the severely cold air that sweeps over the rest of the country from Canada in the winter months.

53 **Pacific High.** The vast North Pacific is dominated by a huge high-pressure system—the Pacific high. It intensifies during the summer months and weakens during the winter. In summer, the Pacific high is centered approximately 1,200 to 1,500 miles west of Los Angeles and is so dominant that it forces most lows well to the north of Washington. This high weakens rapidly through October and November, allowing a progression of low centers to affect the weather in Washington and Oregon. Continuing to lose strength during December, the Pacific high weakens enough by January to allow lows to penetrate into northern California and, occasionally, as far south as southern California. By March and April, the trend reverses; the pressure rises gradually and the Pacific high resumes its blocking effect.

54 **California Current.** The prevailing westerly winds are relatively warm and moist. The cooling effect of the California Current encourages advection fog as the wind crosses the colder water.

55 **Storms.** Storms are most frequent on the Washington coast in the winter months. Extratropical cyclones are less common toward the south and are infrequent in southern California in any season. Severe storms are rare anywhere on the West Coast during the summer months.

56 Because of the protection afforded by the mountains, major storms from the east or northeast are rare. Most storms move in from the northwest, with south to southwest winds preceding the front and west to northwest winds following it.

57 Because the air is abruptly lifted as it is forced over the coastal mountains and the pressure gradients steepen as the storm system approaches the coast, the south to southwesterly wind flow can be strong, with gale-force winds and heavy precipitation.

58 Thunderstorms and squall lines, typical of cold front passage on the East Coast, are relatively rare on the West Coast.

59 **Local Winds.** The coastal mountains normally act as a barrier to winds from the continental interior. However, the pressure pattern occasionally creates a strong gradient between the interior and the ocean, with strong easterly (offshore) winds developing. These winds, which follow the valleys to the ocean, exhibit regular patterns and are given special names by local residents. The air flow is downslope to the sea so compression heating occurs.

60 These winds are characterized by low relative humidity and clear skies (except for the dust stirred up). The most prominent local winds are those that flow through the Strait of Juan de Fuca, between Washington and British Columbia, and down the Santa Ana River Valley in southern California, including the Los Angeles area.

61 **Fog.** The large temperature difference between warm offshore water and cold inshore water sets the stage for advection fog. It develops when the moist, relatively warm air lying over the offshore water is gently transported across the cold water near shore—provided there is no cloud system overhead. The air is cooled to its dew point and fog results.

62 There are two reasons why the water is much colder near the coast. One is the California Current. The other is the northwesterly winds, which cause upwelling of cooler water from the ocean depths close to the coastline.

63 Advection fog is most common in late summer and early autumn. This is the suggested procedure for forecasting this type of fog:

1. If the wind is predicted to come from west or southwest with high relative humidity, fog is probable.
2. If the wind is from the northwest and the relative humidity is high, fog is unlikely, but possible.
3. If the wind is north or northwest with low relative humidity, the likelihood of fog is remote.

64 Most West Coast harbors are located in bays formed by the mouths of major river systems that drain the interior. Nocturnal radiational cooling sends a flow of cold air down these valleys. A shallow layer of radiation fog forms in the early morning hours, and generally dissipates before noon when the sea breeze returns. Occasionally, the nighttime radiation fog is supplanted by advection fog carried in on the daily sea breeze, and fog persists for several days.

65 **Boating Weather.** West Coast boating centers are strongly influenced by local peculiarities. Study the topography, ocean currents, air drainage, and historical weather patterns for the area in which you intend to operate your boat.

Washington, Oregon

66 The stretch of coast from Canada to Cape Mendocino is closely bordered by a high north-south mountain range, which causes strong orographic lifting and wrings rain out of almost any appreciable air flow from the south-southwest to north-northwest.

67 The prevailing pressure gradient between the Aleutian low and the Pacific high keeps an almost continuous westerly flow going and sends a succession of cold and occluded fronts beating into the coastal mountains.

68 These fronts vary seasonally in severity and timing, from almost daily gale-force winds in the winter months to a summertime two- to four-day cycle of cloudiness. This is followed by light rain, clearing for a day or two, and then repeating.

Northern and Central California

69 The stretch of coast from Cape Mendocino to Pt. Arguello is bordered by a lesser mountain range not as close to the coastline, running northwest-southeast. A large desert, the California Central Valley lies inland. Farther inland, along the California-Nevada border, is the Sierra Nevada mountain range.

70 The Sierra Nevada range generally blocks the flow of intensely cold Canadian cP air, preventing it from overflowing from the central and northwestern United States into the California coast zone. The northwest-southeast orientation of the coastal range, and the fact that this area is more frequently under the domination of the Pacific high, create conditions similar to the Washington-Oregon coast but much less severe.

Southern California

71 The stretch of coast from Point Conception to the Mexican border runs predominantly west-east, trending more southeast below Los Angeles, and backed by a high west-east mountain range a few miles inland. The area is protected by the mountains and is also shielded from frontal activity by the blocking effect of the Pacific high, so much so that true frontal passages are restricted to occasional winter storms. Rain is infrequent and requires a strong air flow from the south or southwest to be moderate or heavy in amount. This happens only when the Pacific high is weak or far to the west.

72 The area inland (Southern California, Nevada, Arizona, North-Mexico) is a large desert—hot, dry, and usually dominated by a thermally induced low-pressure trough.

73 The southward flowing California Current, combined with upwelling from the ocean depths a short distance offshore, brings cold water close to the coastline. A light wind from southwest to west carries moist air across this cold surface and causes fairly frequent fog and low stratus clouds in the coastal zone. This is a time to expect fog since the southwest-to-south breezes are most common at night and in the early morning hours. They are burned off by the sun or dissipated as the sea breeze develops.

74 The inland desert heats up rapidly each day,

establishing the thermal low that draws in air from the ocean. The sea breeze generally starts as a light flow of 4 to 8 knots but increases rapidly to 15 to 25 knots from 1200 to 1400. It diminishes rapidly after sunset. This sea breeze develops a considerable chop over coastal water, creating hazardous conditions for outboard boats and some discomfort to small cruisers.

75 A dominating mountain range lies west-to-east from Pt. Arguello past Los Angeles, then curves toward the southeast. This explains why many storms appear to change characteristics when entering the southern California zone. For example, a west wind sweeps upslope and causes clouds and rain all the way from the Canadian border to Pt. Arguello. But below Pt. Arguello, storms coming from the northwest or west bring considerably less precipitation and cloudiness.

76 The Pacific high generally blocks the advance of cold and unstable mP air into Southern California. This high must be weak or far to the west or southwest to permit a really vigorous frontal passage in Southern California.

77 **Forecasting Hints.** Strong winds can arise without much visual warning or any advance indication by the barometer. The main cause is the steep pressure gradient that develops when any firm circulation (whether a low or a high) presses in from seaward against the coastal mountain range. In such a situation, the wind direction varies from northwest to south-southwest and the speed varies from 20 to as high as 60 knots. Lows generally have extensive cloud systems, and several times each year produce conditions unstable enough to cause heavy rain.

78 When highs advance on the southern California coast from inland, they obliterate the usual thermal low over the desert area. This occasionally happens when a mass of cold air surges down from Canada into the Great Basin. This cold air spills though the mountain passes and rushes down the valleys toward the ocean at speeds of 30 to 50 knots or more. The air is heated by compression as it descends and thus does not appear to be the same cold air that overlies the inland areas. The major channel for this flow is through Cajon Pass and down the Santa Ana River Valley, whence Santa Ana winds get their name.

79 These Santa Ana winds generally arise in the afternoon (after the sun's thermal effect over the desert areas begin to diminish) and blow most strongly during the late afternoon, evening, and nighttime hours.

80 Santa Ana winds can be accurately forecast by watching for higher pressures and lower temperatures in the desert areas. The zones affected are those below the mountain valleys.

81 You may get a warning of half an hour to an hour by observing the advancing wall of dust and dirt that outlines the leading edge of the Santa Ana coming from inland. The main dangers to boaters from these winds are their sudden onslaught and the fact that they blow offshore.

82 Storms are almost unheard of in southern California waters from June through September. They are most frequent during January, February, and March, and even then they are unusual. For a storm to be severe the Pacific high must usually retreat and a strong flow of unstable, moist air must advance from the north. Since this phenomenon is well reported as it progresses down the coast, the main problem is to decide whether the storm will "turn the corner" at Pt. Arguello and head into this area. A prior strong flow from south to southwest increases the probability of a storm.

83 Tropical storms or hurricanes that move in a northwest direction from the Mexican coast develop the largest swells affecting the southern California coastline. This is because the generating area is from the quadrant to the right of the storm's path.

84 Therefore, the swells form and move in a direction parallel to the storm. This becomes a continuous generating region of strong winds. The huge swells from these tropical storms often result in breakers 6 to 8 feet high.