U.S. NAVY
MARINE CLIMATIC ATLAS OF THE WORLD
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MEDITERRANEAN

The first section provides a seasonal overview of weather hazards to navigation along the major shipping routes in the Mediterranean Sea. The second section provides a general summary of the Mediterranean climate, including local wind terminology.

Weather along the Mediterranean routes is controlled by complex interactions of Asiatic, European, African and Atlantic air masses. The sea itself cools hot air masses from Africa in summer and warms cold air masses from Europe in winter. Added to this are the local influences on winds, waves, and weather of a complex topography, including numerous islands. While weather along the Mediterranean routes is often fair, hazardous conditions can arise quickly, particularly from fall through spring.

Strait of Gibraltar -- Passage through the Strait and Alboran Channel can be complicated by high winds, rough seas, strong currents, and poor visibilities. The surrounding topography intensifies these conditions. Winter winds (November-April) out of the northeast through southeast over Iberia are channeled into strengthening easterlies through the Strait. Known as levantes (or levanters), these winds, while less frequent than in summer, are strongest in winter. They usually blow at 15 to 25 knots and occasionally a narrow band (about 2 miles wide) will reach gale force and extend up to 60 miles west of the Strait, north of 36-degrees N. A long fetch allows a build up of very high seas; waves greater than 13 feet occur on about 2 percent of the ship observations. Levantes are triggered by several weather situations. From fall through spring they are often generated by approaching cold fronts from the west, when a lee depression forms near the Balearic Islands. They are accompanied by low clouds and visibility-reducing rains. In general, the levantes occur with high pressure over western Europe and low pressure across the western Mediterranean. When navigating a levante, easterlies at Tarifa and Taza usually give a close approximation to speeds in the Strait, while windspeeds on Alboran Island are indicative of those in the Alboran Channel.

Westerlies can also create problems when navigating the Strait and Alboran Channel. They blow with low pressure to the north or a high building into the western Mediterranean from the west or southwest. It is common to differentiate between westerlies associated with two different type air masses. Strong south-westerlies ahead of cold fronts are called vendavales while northwesterlies behind cold fronts are known as ponientes. Since the poniente is often associated with high pressure building in from the Atlantic it can be expected at any time of the year, especially in the Strait. The weather is usually good; outside of scattered showers, skies are usually clear to partly cloudy with good visibilities. If an upper air trough moves east of the area gales may blow in the Alboran Channel. A rule of thumb is, if Rota's pressure is 4 mb. higher than Malaga's you can expect strong westerlies in the Strait. Strong westerlies often blow over the southern passage.

The Vendaval is often associated with storminess and is accompanied by precipitation. It occurs mainly in late fall and early spring and is triggered by lows moving eastward into the Mediterranean, across Spain or southern France. The winds sometimes reach gale force but seldom maintain it. Its onset, however, is sometimes accompanied by squalls, thunderstorms, or even waterspouts. Vendavales tend to blow stronger in the Strait than in the Alboran Channel due to funneling.

Sometimes an approaching cold front will trigger the formation of a low in the Gulf of Cadiz, which in turn creates rough weather along the routes through the Strait. Also, a cutoff low pressure system produces major weather problems in the area as it can remain stationary for up to 7-10 days. When storms approach from the west, about 30 percent move into the Alboran Channel while others head southeastward over North Africa or northeastward into Spain.

These winter weather producers are responsible for the gales that occur 2 to 4 percent of the time and the wave heights of 8 feet or more that are encountered about 10 to 20 percent of the time. Swell waves usually arrive from the northwest and are funneled through the Strait; they exceed 12 feet about 4 percent of the time. Steep seas, 12 feet or more in height, with wavelengths of 128 feet (5-second period) or less are encountered about 1 to 2 percent of the time in the Alboran Channel in winter.

From May through September the Azores High builds northeastward toward the Alps bringing frequent levante winds through the Strait and Alboran Channel. Windspeeds range from about 10 to 20 knots. Levantes generate a warm

flow of air across the relatively cool waters of the Strait frequently causing fog and low stratus. At the eastern end you may encounter heavy dew, mist, or occasional drizzle. Foggiest conditions are usually found in the Alboran Channel, south of 36-degrees N. When these easterlies are prolonged they move warm surface water into the Strait which causes the eastern edge of the fog area to recede slowly westward. July and August are the foggiest months along these routes; visibilities drop below 2 miles on about 6 to 8 percent of the observations.

The poniente, associated with high pressure building in from the Atlantic, blows westerly through the Strait. Gales are infrequent, particularly in summer, and good weather usually accompanies this wind.

The transitional seasons are of different length and character. During spring (March-May) weather alternates between winter storminess and the more summer type weather. Autumn, in contrast, usually lasts the month of October and is notable for a rather abrupt change to stormy winter weather.

Alboran Channel (Barcelona, Marseille, Genova, and Livorno) -- Between the Alboran Channel and Barcelona and over the southern portions of the routes between the Channel and Marseille, Genova, and Livorno the weather is usually good. Gales blow under 5 percent of the time and visibilities below 2 miles are observed less than 2 percent of the time.

During winter (November-February), north and northeast of Mallorca, over the Marseille, Genova, and Livorno routes gales and seas of 8 feet or more can be expected about 10 to 20 percent of the time. Conditions ease in the Golfo di Genova but intensify in the Golfe du Lion. This weather is often the result of a cold northwesterly to northerly flow known as the mistral. So well defined is the mistral that its western boundary forms a shear line that divides the weather conditions encountered along these routes. The line runs approximately from Perpignan through Mahon to Bougie; it tends to oscillate between southwest Mallorca and northwest Menorca. This boundary, which can vary from 2 to 20 miles in width, is sometimes marked by a line of convective clouds but otherwise is only noticeable by the marked change in wind and sea. Typically, to the west of the boundary, winds run 8 to 16 knots in 3 to 5 foot seas. To the east wave heights climb to 14 to 20 feet in 35 to 45 knot winds. Along the coastal area from Marseille to Toulon winds often exceed 40 knots and occasionally reach 100 knots in gusts. At buoy TOQD (42-deg.13'N, 5-deg 34'E), along the Genova route, windspeeds exceed 40 knots about 8 percent of the time. Blowing spray in storm force mistrals can reduce visibilities.

Seas increase rapidly with the onset of the mistral. Significant wave heights up to 24 feet have been observed during storm force mistrals in the Golfo du Lion while 30-foot seas have been encountered even farther from the coast. Small vessels are often forced to seek the shelter of the Balearic Islands. Usually a low pressure system will develop in the Golfo di Genova when a mistral begins in the Gulf du Lion. There are often a few indicators to warn of an approaching mistral. Wave clouds are observed over the Massif Central of southern France approximately 6 hours in advance of a mistral. The station at Orange gives a good 3 to 4 hour warning of gale force mistrals when winds there increase to 25 knots from the northwest. Mistrals are most severe during winter and spring and occasionally extend to the southern portion of these routes. During late fall and early winter mistrals may occur if the water temperatures are 10-deg. F or more warmer than the air.

Most other winter weather problems along these routes are created by low pressure systems. Some come from the Atlantic across France, Spain, or through the Strait of Gibraltar; others form in the Mediterranean, especially in the Golfe du Lion, the Balearic Sea, and the Genova Gulf. Lows that form in the Golfo di Genova tend to move southeastward across the Tyrrhenian Sea while Balearic Sea storms usually move northeastward toward the Golfo di Genova.

A strong northeast wind that blows from Cape de Gata to the Golfe du Lion and known as a levante is generated by a low south of the Balearic Islands with a high to the north of the Mediterranean Sea. Levantes are most likely in fall and spring along the routes through the Balearic Sea. Gales can be expected about eight or nine times per year compared to once or twice south of Ibiza. Levantes are often accompanied by rain, below normal temperatures, and heavy seas. The Balearic Sea storms often form when a weakening low or cold front moves eastward across the Iberian Peninsula. Sometimes southerly winds can reach 30 to 40 knots with gusts to 60 knots in the warm sector of a developing low. Sea conditions along these routes can be quite rough, especially after the passage of the low when south through southwest swells meet northwest through north-induced seas.

The vendaval is another wind associated with cyclonic activity along these routes; it sometimes reaches gale force but seldom for very long. The onset of this southwest wind is, however, associated with violent squalls, thunderstorms, and sometimes waterspouts. Vendaval weather is most likely on the portions of the routes south of the Balearic Islands in late fall and early spring. Routes running close to the Balearic Islands are occasionally besieged by a north-westerly gale known as a poniente. It occurs when a lee trough develops along the coast between Barcelona and Valencia. Winds are generally light westerlies out to about 50 miles offshore with stronger winds to the east. Important exceptions occur at Alicante and Valencia where strong local westerly and west-

northwesterly winds funnel through the mountain valleys. Poniente weather is usually good outside of scattered showers.

On the portions of the routes south of Cape de la Nao a dry, scorching, sand and dust laden wind is occasionally encountered ahead of a cyclone. Known as a leveche, it is a continuation of the sirocco of North Africa, and while it is not particularly strong, its effects can be debilitating. The leveche usually blows in a succession of scorching puffs. Its onset is preceded by light, variable winds while a streak of brownish cloud, stretching from west to east, is observed to the south.

While dense fog is infrequent along these routes, visibilities drop below 2 miles about 1 to 3 percent of the time in the summer. Sirocco fogs occur when hot air picks up moisture and then moves across relatively cooler waters to the north. Foggy conditions are most likely between Cape de San Sebastian and Marseille; they also occur in the Gulfs of Lion and Genova. Poor visibilities, due to rain and blowing spray, occurring in winter and spring, are likely in the Balearic Sea and southward.

While wind and sea conditions are often good in the Golfe di Genova, they can on occasion be troublesome. Strong sirocco conditions to the south may generate heavy swells in the gulf. The gulf region is also a major area for the formation of extratropical cyclones. Cyclogenesis can occur in all seasons although the maximum region is located farther south in winter than in summer. Many of these systems remain stationary, while the others either move northeastward or southeastward. These cyclones are needed for an extensive mistral to occur. In the Golfo di Genova they generate showers, low clouds, and poor visibilities. Strongest winds occur from the northeast after a storm moves southeastward.

Alboran Channel (Straits of Messina, Sicilia, and Napoli) -- Rough seas and gales cause occasional problems, mainly from November through April, while poor visibilities are more likely in summer.

During winter, between Oran and Sicilia, gales occur 3 to 5 percent of the time while seas of 8 feet or more are encountered 10 to more than 20 percent of the time. These conditions are most likely between Bejaia and Bizerte; they are less likely in the Tyrrhenian Sea. Extratropical cyclones are responsible for most of the troublesome weather from fall through spring. Although they usually do not directly cross the western portions of the routes, their circulations may extend into the region and associated cold fronts sweep as far south as 30-deg. N. A few lows enter the Mediterranean through the Strait of Gibraltar while others come from North Africa.

The North African cyclones usually form south of the Atlas Mountains and move eastward then northeastward; occasionally they will move northward. When this occurs they generate a strong easterly wind (levante) through the Alboran Channel. Infrequently, secondary lows will form over the Mediterranean north of the Atlas Mountains; these can be quite intense and either move eastward with the parent low or dissipate. They are small scale features but can generate strong winds and thunderstorms along the Algerian and Tunisian coasts. Sometimes they will develop into major systems, particularly if a cold front blows in from the north.

Another wind-weather related feature generated by North African cyclones is the sirocco (also called chili). These southeast through southwest winds, occurring in the warm sector of the storm, originate over the desert and bring hot, dry air to portions of the routes between the Alboran Channel and Bizerte. They blow about four to five times per month in late spring and early summer. They are usually light, but often gusty with occasional gales. Weather may include blowing dust and sand near the coast with visibilities sometimes reduced to a few yards in dense dust clouds. This, combined with the high temperatures they bring, makes sirocco weather very uncomfortable at times.

The westerly portions of these routes are also subject to strong southwest to west winds (vendavales) occurring most often in late autumn and early spring. They are associated with lows moving eastward into the Mediterranean, across Spain or southern France. While they seldom reach gale force vendavales are often associated with violent squalls, thunderstorms, and sometimes even waterspouts. When a lee trough develops along the south coast of Spain it often generates southwesterly gales along the Algerian coast. Thunderstorms often cause locally turbulent sea conditions between Bejaija and Bizerte. From late October to April prevailing west to northwest winds cause heavy seas at times between Oran and the Strait of Sicilia.

Sirocco weather often takes on a different character in the Strait of Sicilia and over the Tyrrhenian Sea. Southeast winds with a long overwater trajectory bring fog and stratus with drizzle except on the east coast of Sardegna. Along the north coast of Sicilia a local foehn effect (downslope wind) results in high temperatures and low humidities. These routes along this coast, including the Strait of Messina, are occasionally subject to strong northwest winds that create heavy seas. The east coast is subjected to heavy seas during a gregale (strong northeast wind) which may be expected on about seven occasions between November and April. Along the Napoli route, off southern Sardegna, south through southwest winds (libeccio) generate rough sea conditions in winter as do winds from the northwest through northeast.

Mistral conditions can sometimes reach these routes. They are worst east of Bejaia; only in extreme cases do they extend to Algeria but more frequently they reach Sicilia. On satellite photographs wave clouds extending from Sardegna to Tunisia are generally associated with gale force mistrals. Mistral conditions rarely reach the west coast of Italy. Weather along this coast, however, is often affected by Genova cyclones; most of these rather weak systems remain stationary. The few that do move southeastward, intensify and sometimes stall off the southern coast of Italy. They bring showers, poor visibilities, and strong northeasterlies to the Napoli route. These winds occasionally reach gale force after the low moves through. Upon reaching the boot of Italy the lows usually dissipate. Fog affects mostly the waters off southeast Sardegna, the Sicilian Narrows, and the coast of Sicilia. Sirocco winds pick up moisture after a long fetch over water; they bring mist or fog and stratus clouds. These conditions may persist for a day or two south and east of Sicilia in late winter when sea temperatures are lowest. Summer fog is sometimes observed between Sardegna and the North African coast and along the west coast of Italy. Poor visibilities can also occur with blowing dust or sand carried on the southerly winds of the sirocco. Occasionally these conditions are widespread but many sandstorms are local and short-lived. Visibilities of less than 5 miles, caused by dust or haze, are most common from April through September; sometimes near the African coasts visibilities may be reduced to 1/2 mile or less.

Marseille (Straits of Sicilia) -- Between Marseille and the Bonifacio Strait waves of 8 feet or more are encountered from 15 to more than 20 percent of the time from October through April; they are less likely during the rest of the year. Gales reach a peak in winter when they blow 10 to 15 percent of the time. Mistrals, which account for much of the rough weather, are prevalent year 'round but strongest from February through April. This cold northwesterly flow causes visibility-reducing, blowing spray but usually little in the way of clouds and rain. Sometimes the leading edge of a mistral will act as a cold front and trigger convective clouds and a few showers. Extratropical storms and their associated fronts are the other weather producers along this portion of the route. Occasionally a storm will drift into the Golfe du Lion from the east coast of Spain or one may form south of the Alps; these bring precipitation and sometimes 30- to 40-knot southwesterlies in winter. Strong southeasterlies, known as marins, are extensions of the Sirocco and are most likely in autumn and spring; they are often accompanied by low stratus and fog. Visibilities are generally good, dropping below 2 miles only on 1 to 2 percent of the observations; summer is the most likely season for fog.

In the Strait of Bonifacio mistrals are funneled into strong westerly winds that often reach 50 knots and extend eastward for considerable distance. This effect creates a "V" shaped pattern of strong winds; 20-foot seas have been encountered as wave heights are often doubled on the eastern side of the Strait. Strong winds with an easterly component often have a similar effect in reverse. Along the Tyrrhenian Sea portion of the route, waves of 8 feet or higher roll in 10 to 15 percent of the time from December through February. Gales, infrequent in all seasons, are most likely in winter. The Genova cyclone moving southeastward brings precipitation followed by strong northeasterly winds. Sometimes mistrals extend into this area when a stationary low forms in the Golfo di Genova; however, windspeeds are somewhat reduced by the influence of the Alps. The sirocco occasionally affects these waters; it usually occurs in the warm sector of passing cyclones. When the winds are out of the southeast with a long overwater trajectory, sirocco weather is low stratus and fog while south-westerlies bring hot and dry weather and visibility-reducing dust. These winds may reach gale force on several occasions from fall through spring.

In the Strait of Messina, winds with either a northerly or southerly component are funneled through the Strait, fanning out in a "V" shape. Rough seas can occur on each side of the "V". Sometimes opposing winds within a short distance can cause choppy conditions. On the east side of the Strait, squally northeastlies, descending from the snow-covered mountains of Clabria, are frequent. Thunderstorms may develop at the northern entrance to the Strait when the winds are out of the northwest.

Along the Barcelona-Sicilia Strait route, waves of 8 feet or more occur 10 to 20 percent of the time east of Menorca from October through April. To the west they are encountered less than 10 percent of the time except in December. Gales are less common, blowing 5 percent of the time in winter, southeast of Sardegna. Mistrals can reach the eastern two thirds of this route when a low is present in the Golfo di Genova, which is most likely in winter and spring. The western boundary, some 2 to 20 miles wide, fluctuates from Menorca northwestward. To the southeast mistrals can bring 14 to 20 foot seas and 35 to 45 knot winds. Even when the mistral is confined to the Golfe du Lion, the swells it generates may reach this route. Rough weather along this route is also generated by lows that form off the east coast of Spain, then move southeastward, and by North African lows. These North African systems bring the sirocco, which is often accompanied by fog, as well as strong winds and rough seas. When it forms south of the Atlas Mountains it may generate strong easterly to southeasterly winds along this route and seas can get rough in the Strait of Sicilia. In a related development, a secondary low may form over the Strait and actually become dominant.

Visibilities along this route are occasionally hampered by precipitation, dust, and fog; they are worst in summer, south of Sardegna, and in winter around the Balearic Islands. Dust haze is often sufficient to reduce visibilities below 5 miles especially from April through September. Mist or fog and low stratus come with a southeasterly sirocco. Visibilities less than 2 miles occur about 1 percent of the time in winter over the Sicilia Strait and near Barcelona. In summer they occur 1 to 2 percent of the time along the entire route.

Adriatic Sea Routes -- Summer (June-September) is the best season to sail the Adriatic Sea; usually the weather is warm and dry while winds are light. Winter (November-February) is the worst season as routes are plagued by cold, bora winds and unsettled weather from passing storms. During the long spring season weather is changeable as periods of stormy weather alternate with the more settled, summer-like conditions. The fall transition season is short and there is usually an abrupt change to winter-type weather during October.

Boras occur mainly from November through March; they are strong, cold, northerly or northeasterly winds that can extend the entire length of the Adriatic Sea to some 60 miles south of the Strait of Otranto. These winds result from the accumulation of cold air over the Balkan Peninsula, especially over Yugoslavia. They are triggered by either a strong high pressure system over central Europe or by a low pressure system in the southern Adriatic or Ionian Sea. They are most extensive with the low to the south. With high pressure, strong winds are often local, extending only a few miles seaward from the Yugoslavian coast. Strongest bora winds usually occur along the eastern shore of the Adriatic, from Trieste to the Albanian border, where the direction and speed are often influenced by the orientation of the mountains, gaps, and valleys. At Trieste, where topographic conditions are most favorable, hourly winds speeds have been measured at 70 knots with gusts to 110 knots. Along the major open water route, although the bora is less intense, gales are common. They are more likely with low pressure to the south, particularly over the southern portion of the route. The average duration of a bora that reaches gale force is 12 hours, but it could last 2 days. Unlike the eastern shore, winds at coastal locations along the east coast of Italy are representative of winds over the western Adriatic. There are diurnal variations along both shores as the sea breeze either reinforces or counteracts the bora. The weather associated with the bora is usually clear and dry; however, when it is triggered by a low to the south, low clouds, fog, and rain may be present from the southern Adriatic through the Strait of Otranto.

The sirocco is a southeast through southwest wind that originates over North Africa. It normally occurs, over the Adriatic Sea, within the warm sectors of cyclones passing either north or west of the region. These lows develop either in the Golfo di Genova area (including the northern Adriatic) or over North Africa. The onset of the sirocco is gradual and the wind is not as strong as the bora; however, gales are likely, particularly in winter and spring. The average duration of continuous gales is 10 to 12 hours and they can last for as much as 36 hours. Maximum speeds have reached 55 knots. They are most frequent over the southern portion of the route. These winds pick up moisture over the Ionian Sea so that low clouds, fog, and rain are often associated with them. These conditions tend to be worst along the routes north of Palagruza Island, especially from October through January. In addition, the long fetch makes heavy seas most likely near the Golfo di Venezia.

The Genova cyclones are lows that develop south of the Alps, over the Golfo di Genova, Ligurian Sea, Po Valley, Golfo di Venezia, and northern Adriatic. While they can form in any season, their area of development is farthest south in winter. A majority of these systems remain stationary; however, some move in a northeasterly direction while others track southeastward. West or north of the Adriatic, if their circulation extends far enough south, they can generate siroccos, and if they make it to the Ionian Sea they may trigger a bora. The North African cyclones form south of the Atlas Mountains and may move eastward to Tunisia before recurving northeastward. This situation is most likely from late fall through spring. If they pass west of the Adriatic, sirocco conditions are likely.

Straits of Sicilia, Messina, Otranto (Eastern Mediterranean Ports) -- The routes between these straits and eastern destinations, include such ports as Tarabulus, Alexandria, Tel Aviv, Bayrut, Iskenderun and Port Said. The weather along these routes is mainly controlled by the monsoon nature of surrounding lands and the low pressure systems that pass over these waters.

During the winter, high pressures lie over Eurasia and the Sahara Desert while lows move between these systems over the relatively warm eastern Mediterranean waters. Weather along the shipping routes is often unsettled as the storms generate siroccos, boras, mistrals, and gregales. During the summer, with Eurasia warm and the Sahara hot, high pressure lies across the cooler waters of the eastern Mediterranean with heat lows over land. Weather along the shipping routes is often warm, dry, and settled with light winds except for the etesian, which blows down the Aegean Sea and out into eastern waters. The spring and fall transitional seasons are a battle between winter and summer weather. Spring's battle lasts from March through May, while in autumn October brings a quick end to summer.

Several types of extratropical systems influence the weather along these routes. North African cyclones usually develop south of the Atlas Mountains; they are most likely in spring and uncommon in summer. The cyclones usually intensify upon reaching the Gulf of Gabes. Most move northeastward across the east central Mediterranean and Ionian Sea. The ones that continue eastward remain weak, however a northeastward movement toward Crete or Cyprus often results in rapid strengthening. The systems that move over open waters usually generate sirocco conditions along the routes through the Ionian Sea and central Mediterranean. They can generate mistrals, boras, gregales, and siroccos. If the low stalls just west of southern Italy, a new center may develop over the Ionian Sea, and if there is a strong bora in the Adriatic, a low may strengthen when entering the east central Mediterranean. Ionian Sea cyclones may also develop with a cold air outbreak from the Adriatic Sea. They tend to move southward or southeastward then eastward toward Crete. The associated weather is similar to that of the Genova cyclone. If either an Ionian Sea or Golfo di of Genova cyclone stalls to the west of Greece during the fall or winter, a secondary

system may develop in the southern Aegean. This is even more likely if cold air has invaded the Aegean Sea. Storms tend to form along the cold air edge then head southward and later eastward toward Cyprus. If their circulation extends to North Africa, sirocco conditions may be expected ahead of the storm. Gales are often likely north and west of the center, while heavy showers and poor visibilities are likely along and behind the associated cold front.

Sometimes a low, known as a Cyprus depression, will develop in the lee of the Taurus Mountains of Turkey, from the Gulf of Antalya to Cyprus. This can occur in any season but they are most intense from November through April. Weather to the west of Cyprus depressions is typical for cold air moving over relatively warm waters-strong, squally winds and heavy showers. If desert air from the south or southeast is drawn into the circulation, sirocco conditions may occur ahead of the front. Between the Strait of Sicilia and Tarabulus the sirocco brings gales from the south through southeast. While siroccos can occur in any season they are most likely along this route from March through June. Along the coast of Libya dust conditions can be so severe that ships may be prevented from entering port.

Along the United Arab Republic, Israel, and Lebanon the air is also dry with poor visibilities in blowing sand or dust. Dust clouds tend to be deep along the North African coasts but shallow along the coasts of Israel and Lebanon. Because of a strong surface inversion produced over water, especially in spring, anomalous radar and radio propagation are likely. Along the open sea routes, sirocco conditions are most likely from November through April. The weather is variable, depending upon modifications that have occurred over relatively cool waters. Dust can still reduce visibilities as far north as Malta, but along most central and eastern Mediterranean routes low stratus, fog, rain, and drizzle are likely. Winds are usually out of the southeast through southwest but gales blow less than 5 percent of the time. Easterlies are sometimes observed at the extreme eastern end of the Mediterranean, where the Arabian desert is the source.

The bora emerges through the Strait of Otranto in a narrow band of strong winds directed toward the northwest coast of Libya. Its maximum extent is about 60 miles south of the strait; however, if it occurs in conjunction with a low in the south central Mediterranean it becomes a northeasterly wind known as gregale, which extends to Malta. The gregale is accompanied by low clouds, heavy rain, and poor visibilities. It reaches 20 to 30 knots for extended periods, generating seas in excess of 12 feet; 20-foot seas have been reported near Malta and anchorages at Valletta offer little protection. The bora can also occur over the Aegean Sea and extend into the eastern Mediterranean. The extent depends upon the depth of the cold air outbreak. If it is shallow, bora conditions rarely extend south of Crete while a deep air mass can push the bora well out to sea, affecting the routes to and from Tel Aviv and Port Said. They may even reach gale force. The direction of the bora is generally northerly near Crete, becoming west-northwesterly in the eastern Mediterranean. Convective cloudiness and showers may occur in the east. On the south side of Crete, at Timbakion, a channeling effect increases northerly windspeeds to more than twice that of the wind entering on the north.

While summer weather is usually good along most routes, a northerly wind from the Aegean Sea, known as the etesian can cause problems. The prevailing period for the etesian (meltem in Turkish) is May through October; maximum frequency and strength occur in July and August. In general, the wind passes southeastward between Rhodes and Crete and then turns eastward with reduced strength to the south of Cyprus. Northwesterlies east of Crete become westerlies south of Cyprus. Gale force etesians are most likely in the seas east of Crete and off the south coast of Crete. The channeling effect is readily apparent in the channel between the Dodecanese Islands and mainland Turkey and in the region between Paros and Naxos as far south as Thira. Gale force winds occur up to 10 percent of the time over the southern Aegean Sea. Gales are infrequent in other areas except where channeling or sea breeze effects combine with the etesian to increase windspeeds. A secondary etesian extends from the Strait of Otranto southeastward into the Mediterranean; it is neither as frequent nor as strong as the main wind. Etesian weather along the eastern Mediterranean routes is generally dry with good visibilities and, because of its long overwater trajectory, some cumulus clouds are likely.

In addition to the dust-reducing visibility at Tarabulus and the exposure problem at Valletta, other ports in the region have some local conditions that should be noted. At Sigonella, from late autumn through spring, poor visibilities can be expected in advance of any low that causes air to flow into the Catania Valley from the east or southeast. In summer and fall an easterly flow could bring showers and thunderstorms. Taranto, Italy offers one of the few Mediterranean anchorages where weather is not greatly affected by surrounding terrain. In Argostolian Bay, the anchorage is one of the most hazardous in the Mediterranean; while seas do not build, extremely variable winds of 40 to 50 knots can come up without warning due to local topography. At Akrotiri, the sea breeze has climbed to 35 knots, on occasion, during the summer.

Aegean Sea Routes -- In this region, which includes such ports and destinations as Thessaloniki, Piraievs, Izmir, and the Dardanelles, weather and winds are altered by the numerous islands, particularly in the south. In addition, the Aegean is surrounded on three sides by land featuring complex topography. Along these routes cyclonic activity and unsettled weather are common in winter and, because of the proximity of the cold Eurasian land mass to the north, cold outbreaks are frequent winter events. Summer weather is usually settled and dry, but is frequently interrupted by a strong northerly to northwesterly flow called the etesian. A long spring, from March through May, features a battle

between winter and summer regimes; however, in autumn the battle is abrupt, with winter conditions taking control sometime during October.

The etesian (meltem in Turkish) is a northerly wind that can develop in all seasons, but is most likely from May through October. Its maximum frequency and strength occur in July and August. This general flow results from the circulation between a high over the water and a low pressure trough over Turkey. These winds are intensified when cold air builds over the Balkans, following a frontal passage, and in regions where air is channeled between islands. This effect is most apparent in the Doro Channel between Euboea and Andros Islands, from the Dodecanese Islands to mainland Turkey, and in the area between Paros and Naxos as far south as Thira. In the southern Aegean, during July and August, gales may occur up to 10 percent of the time. Winds of 22 knots or more blow 15 to 25 percent of the time from July through September in the waters around the Cyclades Islands. In these channels gale conditions may occur, on the average, about 13 days per month in the heart of the season and on about 4 to 6 days per month in spring and fall; during July and August they may last for 4 days at a time.

There is a diurnal variation, particularly near the coasts, due to the sea breeze effect. Along the west coast of Turkey the sea breeze supports the etesian so windspeeds often reach a maximum about 1700 LST. At Athens, on the other hand, the sea breeze opposes the etesian. Northerly winds are at a minimum around noon and there are days when the sea breeze dominates. In the northern Aegean and near the Macedonian and Thracean coasts, the sea breeze also opposes the etesian. In the southern Aegean, where the etesian is strongest, winds peak between 1400 and 1700 LST at Naxos.

Etesian weather is generally dry with clear skies and good visibilities; however, when this wind is triggered by a cold front, thunderstorms often occur over the northern portions of the routes both ahead and behind the front. This is most likely in spring and fall. During July and August scattered altocumulus clouds often precede the onset of a strong etesian.

The bora affects conditions over the Aegean Sea mainly during winter. It is most common along the Yugoslavian coast. The bora is a strong northerly to the northeasterly wind that blows over the Aegean Sea through the Dardanelles and Vardar gaps. If the pressure pattern favors a northeasterly wind the main entrance is through the Dardanelles while northerlies blow mainly through the Vardar gap. Northeasterlies generate high seas over the northern Aegean. By the time the bora reaches the Dodecanese Islands its direction is northwesterly. Large variations in speed and direction are likely due to the channels and obstructions. The weather associated with the bora depends upon the depth of the northerly or northeasterly flow. When it is shallow, or a low is located to the south, low clouds, rain, and poor visibilities are common. If the bora is associated with a deep northerly or northeasterly flow, skies are generally clear.

Cyclades, at Euboea, Crete, and in the Gulf of Thermaikos -- Strong northerlies create squalls over islands with high mountains as well as in the Gulfs of Patrai and Corinth. Even though the sirocco originates in North Africa it is sometimes found in the Aegean Sea east of storms moving eastward or northeastward toward Turkey or the Black Sea. It is most likely from November through April over the southern and western Aegean Sea, the Cretan Sea, and the Mirtoan Sea. While windspeeds are usually less than gale force, gales can occur in the channels between the Dodecanese Islands and the Turkish mainland. Low stratus, fog, and drizzle usually accompany the sirocco in these waters.

From autumn through spring extratropical cyclones may develop over or pass through the Aegean Sea. In the southern Aegean and Cretan Seas cold air outbreaks may trigger the formation of low pressure systems. They usually move southeastward then eastward. Heavy rains with poor visibilities are usually associated with these storms while gales are likely near and to the north of their centers. Ionian Sea storms or former Genova cyclones sometimes move through the area from the southwest and, if cold air is present, they are usually forced eastward across the southern Aegean. With the lack of a blocking system, these storms will often head northeastward across Greece toward the Black Sea. Occasionally a northeastward moving North African cyclone will affect the Aegean Sea routes and, when this occurs, gales are likely. Sirocco winds will occur ahead of the storm and even stronger winds are likely to the west of a low that tracks northeastward.

MEDITERRANEAN CLIMATE

The influence of the sea results in mild winters and warm summers in the Mediterranean. In the northern gulfs, where winds are mainly of land origin, continental extremes of temperature are more likely during both seasons. Winter is the stormiest season. The Golfe du Lion, the Golfe di Genova, and the Adriatic Sea are the principal areas of cyclogenesis during this season. Storms generally follow an easterly track along the north side of the Mediterranean. In general gales are more likely in the north, particularly in the Golfe du Lion, Adriatic, and Aegean Seas.

Spring and autumn show a decrease in the number of storms although cyclogenesis occurs in the Golfo di Genova and the northern Adriatic Sea. The storm tracks are similar to those of winter, although the frequency of gale force winds is about one-half that of winter.

Summer is characterized by fair weather. Storms and strong winds are uncommon throughout most of the area.

Poor visibility in the form of fog or precipitation is much more likely to occur during the winter months than any other season, particularly in the north. Dust or dry haze blowing from North Africa can also greatly reduce visibility. Summer is characterized by exceptional visibility over the entire area, except near large cities where there is often an early morning fog.

Pressure:
During the winter months the pressure is low over the Mediterranean and high over the surrounding land, which is colder than the water. Extensions of the semipermanent Azores High reach into Spain and North Africa, and extensions of the Asiatic High influence the Balkan Peninsula and the eastern shores of the Black Sea. A low pressure center is located over Corse (Corsica) and Sardegna (Sardinia). During this season the relatively warm temperatures over the Mediterranean acts as a source region for cyclones and reinforces storms that move eastward from the Atlantic.

In spring the Asiatic High deteriorates and a low pressure area is established over Asia Minor. The Azores High still extends into the Mediterranean, but it lies slightly northward of its winter position. Storms continue to move eastward over the Mediterranean, but they become less frequent and less severe as the season advances.

In summer the pressure distribution is rather stable, with the Azores High to the north and the low pressure center over Asia Minor. Migrating storms are very rare at this time of the year.

Autumn is characterized by a rather uniform pressure distribution. The low pressure area in Asia Minor is still active, although considerably weaker than in summer. There is an increase in number and intensity of lows during this season, and the paths of these storms are similar to those of winter months.

Winds:
In the Mediterranean there is no general wind current dominating the whole region at any time of the year, although the overall wind pattern remains fairly constant in all seasons.

During the winter season winds are often westerly to northwesterly with average speeds of 12-17 knots. Between the Strait of Gibraltar and Sardegna (Sardinia) both easterly and westerly winds predominate, and in the Adriatic southwesterly winds are common. The west coast of Italy shows no prevailing wind direction. Cyprus and the northeastern Mediterranean have a high percentage of northerly and northeasterly winds. The Aegean shows the greatest departure from the general pattern, with northerlies in all seasons, although in winter both northerly and southerly winds are frequent.

Spring brings little change to the above pattern except in the northeastern Mediterranean where southwesterly winds now predominate. The average wind speeds drop to 9 to 13 knots in spring.

In the summer months the average wind speeds are 5 to 9 knots over the area. The general pattern remains the same except in the Aegean, where southerly winds are rare.

Fall brings little change in the general pattern except for the southeastern Mediterranean, where winds are variable. The average wind speeds increase to 7 to 10 knots in this season.

Land-Sea Breezes:
The diurnal alternation of land and sea breezes caused by the differential heating of land and sea is pronounced in the warm season and sometimes noticeable in the cool season. During daylight hours the land warms up much more

rapidly than the sea causing air near the surface to rise. Air flowing in from seaward to replace this rising air forms the sea breeze. At night the reverse action takes place.

Regular sea breezes prevail from April to October, beginning at 0700 or 0800 (LST), reaching a maximum about 1300 or 1400, and continuing until about 1800 or 1900. In the spring and autumn the sea breeze begins later in the morning, and in the winter, when it occurs, its onset may be delayed until noon. The extent of land-sea breezes is about 10 to 20 miles from the coast. The sea breezes usually reach 11 to 16 knots, while the land breezes are weaker, averaging 5 to 9 knots.

Gales:
Gales are most likely in the Golfe du Lion, the Adriatic Sea, and the Aegean Sea. There is a general decrease toward the south and east, but gale frequency increases in the main straits, such as the Strait of Gibraltar and Alboran Sea, due to funneling.

Winter is the primary season for strong winds. The highest frequency of gales is the Golfe du Lion, where they occur greater than 20% of the time near the head, decreasing to 10% frequency in the open seas. Both the Adriatic and Aegean Seas show a 10% frequency of gales in this season. The extreme winds are most likely from September through March in Mediterranean. The maximum recorded wind was 65 knots, at Iskenderun in March. Izmir has recorded 61 knots in that month and has a summer record of 50 knots (June). Split has recorded a 58-knot north-northeasterly gale during the month of December. Very few stations have recorded winds greater than 30 knots during June, July, and August.

Regional Winds:
The complex topography of the Mediterranean area, with mountains to the north, desert to the south, numerous islands and indented coastlines, results in a variety of regional winds. Most of these winds have names. They are briefly described and shown below.

Bora: A fall wind whose source is so cold that when the air reaches the lowlands or coast the dynamic warming is insufficient to raise the air temperature to the normal level for the region; hence it appears as a cold wind. The terms borino and boraccia denote a weak bora and strong bora, respectively. The term is applied (along with karstbora) to the cold northeast wind on the Dalmatian coast of Yugoslavia in winter when cold air from Russia crosses the mountains and descends to the relatively warm shores of the Adriatic. It is very stormy and squally; the squalls sometimes reach 90 knots or more. The cyclonic bora (bora scura), with clouds and rain, covers the whole Adriatic and occurs with a low pressure system to the south. The dry anticyclonic bora is generated by a powerful anticyclone over central Europe. It is very violent over the land but extends only a short distance out to sea. A local bora also occurs on the east shore of the Adriatic with an anticyclone over the Balkans. Boras may last for several days, although advancing cold fronts may be preceded by a relative lull. Each cold front is accompanied by a violent squall and followed by an increase in winds which are strongest and most frequent in the cool season. Bora gales occur about 10 16349n the northern Adriatic during the month of January.

Borasca: (or borasco; also called bourrasque.) Literally, "Little bora". A thunderstorm or violent squall, especially in the Mediterranean.

Cers: A name for the mistral in Catalonia, Narbonne, and parts of Provence (southern France and northeastern Spain). It is very violent and turbulent in the Aude Valley below Carcassone with gusts often reaching 45 to 50 knots. It is cold in the winter, hot in the summer, and always dry and clear. A similar northerly wind in Spain is the cierzo.

Chergui: An east or southeast desert wind in Morocco (North Africa), especially in the north. It is persistent, very dry and dusty, hot in the summer, and cold in the winter. It blows with high pressure in the Mediterranean and the isobars running nearly parallel with the coast. It is said to be most frequent in the forty days following July 11th or 12th, a period which is known as the Smaim (compare simoom).

Chili: A warm, dry, descending wind in Tunisia resembling the sirocco. In southern Algeria it is called chichili.

Cierzo: Spanish term for the mistral in the lower valleys of the Ebro. It occurs mainly in the autumn and early winter.

Dusenwind: (literally "jet wind" or "blast wind.") The mountain-gap wind of the Dardanelles; a strong east-northeast wind which blows out of the Dardanelles into the Aegean Sea, penetrating as far as the island of Lemnos. It is caused by a ridge of high pressure over the Black Sea.

Etesians: The prevailing northerly winds in summer in the eastern Mediterranean and especially the Aegean Sea; basically similar to monsoon and equivalent to maestro of the Adriatic Sea. According to the ancient Greeks, the etesians blow for forty days beginning with the heliacal rising of Sirius. They are associated (along with the seistan and shamal) with the deep low pressure area which forms in summer over northwest India. They bring clear skies and dry, relatively cool weather. In Greece the etesian wind is locally named the sleeper. In Turkey it is the meltem. The Romans used the word also for the southwest monsoon of the Arabian Sea. During the summer these northwesterly through northeasterly winds are very persistent and in some places have almost the character of trade winds. They are dry and, moving over a relatively cool sea, they bring good visibility and clear skies; only after traveling some distance over the sea do they generate cumulus clouds. Their windspeeds may be greatly increased by funneling in many of the narrow channels of the Aegean.

Ghibli: (Also called chibli, gebli, gibleh, gibli, kibli.) A hot dust-bearing desert wind in Tripolitania similar to the foehn. In Morocco, the analogous gibla is a hot dry wind from between the southeast and south. It means "the direction in which one turns," i.e., the traditional direction of Mecca.

Gregale: The Maltese and best known variant of a term for a strong northeast wind in the central and western Mediterranean. It occurs either with high pressure over central Europe or the Balkans and low pressure over Libya, when it may continue for up to five days, or with the passage of a low to south or southeast, when it lasts only a day or two. It is most frequent in winter. The weather varies with the type of pressure distribution and the onshore or offshore direction of the wind. At Malta the gregale raises dangerous seas in the harbor.

Khamsin: (Also spelled camsin, chamsin, kansin, khamasseen, khemsin.) A dry, dusty, and generally hot desert wind in Egypt and over the Red Sea. It is generally southerly or southeasterly, occurring in front of depressions moving eastward across North Africa or the southeastern Mediterranean.

Leste: Spanish nautical term for east wind. The name is given to a hot, dry, dusty, easterly or southeasterly wind which blows from the Atlantic coast of Morocco out to Madeira and the Canary Islands. It is a form of sirocco and occurs ahead of depressions advancing eastward.

Levante: The Spanish and most widely used term for an east or northeast wind occurring along the coast and inland from southern France to the Strait of Gibraltar. It is moderate or fresh (not as strong as the gregale), mild, very humid, overcast and rainy; it occurs with a depression over the western Mediterranean Sea. In summer it is rare and weak; in January it is inhibited by the Iberian anticyclone. It is most frequent from February to May and October to December.

Evanter: An English name for the levante, more specifically applied to winds in the Strait of Gibraltar and on the east coast of Spain. It blows from east or northeast with high pressure over central Europe and a depression over the southwest Mediterranean. It is most frequent and strongest from October to December and February to May, and persists for two or three days.

Levantera: A persistent east wind in the Adriatic, usually bringing cloudy weather.

Leveche: (Also spelled laveche.) A name for the sirocco in Spain. It is a hot, sand- and dust-laden wind from between southeast and southwest, that blows in front of a depression on the southeast coast of Spain, but extends only a few miles inland.

Lebeccio: Italian name for a southwest wind; used especially in northern Corsica for the west or southwest wind which blows throughout the year, and especially in winter when it is often stormy. On windward slopes it brings rain, with thunderstorms in summer and autumn; after crossing the mountains it is warm and dry, but may be very turbulent.

Liberator: A name sometimes given the west wind through the Strait of Gibraltar.

Lips: The ancient Greek name for the southwest wind; it is the sea breeze in Athens. On the Tower of the Winds it is represented by a barelegged young man carrying a piece of a trireme (ancient galley). This may indicate either that the wind favored homecoming ships or that, when stormy, it caused wrecks. Today the name is applied to any hot wind, usually the sirocco.

Maestro: A northwesterly wind with fine weather which blows, especially in summer, in the Adriatic; it is most frequent on the western shore, and is equivalent to the etesians of the eastern Mediterranean. It is also found on the coast of Corsica and Sardinia.

Mamatele: (Also called mamaliti, mamatili.) A light northwest wind of Sicily; a form of mistral.

Marin: A warm, moist, southeast wind from the sea on the French Mediterranean coast and in the Maritime Alps, especially frequent in spring and autumn. In the Rhone delta it blows also from the south.

Meltem: 1. (Also spelled meltemi.) A strong wind from the northeast or east which oftens sets in suddenly and blows during the day in summer on the Bulgarian coast and in the Bosporus. 2. Turkish name for the etesians.

Mistral: A north wind which blows down the Rhone valley south of Valence, France and into the Golfe du Lion. It is strong, squally, cold, and dry; the combined result of the basic circulation, a fall wind, and jet-effect wind. It blows from the north or northwest in the Rhone Delta, where it is strongest, from the northwest in Provence, and from the northeast in the valley of the Durance, below Sisteron.

A general mistral usually begins with the development of a depression over the Tyrrhenian Sea or Golfo di Genova with an anticyclone advancing from the Azores to central France. It often exceeds 50 knots and reaches 75 knots in the lower Rhone Valley and 45 knots at Marseilles, decreasing both to the east and west. In the absence of a strong pressure gradient, a weaker katabatic local mistral develops in the Rhone Valley. A general mistral usually lasts for several days, sometimes with short lulls. It is most violent in winter and spring, and may do considerable damage.

The mistral has a variety of local names; mangofango in Provence; secaire, maistrau, maistre or magistral in the Cevennes; dramundan in Perpignan; cierzo in Spain, cers in the Pyrennes, etc. South of Mont Ventoux a similar wind is named bise. A local west wind of mistral type which descends from Mt. Canigou to the plains of Roussillon is called canigonenc.

Orsure: A stormy north to northeast wind in the Golfe du Lion.

Ponente: A west wind on the Cote d'Azur (French Mediterranean coast), the northern Roussillon region, and Corsica. On the Cote d'Azur it is a weakened mistral and brings clear skies. In northern Roussillon it is the land breeze of early morning, changing to southeast during the day, and generally preceding the tramontana.

Raffiche: (Also called refoli.) In the Mediterranean region, gusts from the mountains; violent gusts of the bora.

Riefne: An intense storm of Malta in the Mediterranean.

Simoom: (Many variant spellings.) A strong, dry, dust-laden desert wind which blows in the Sahara, Palestine, Syria and the desert of Arabia. Its temperature may exceed 130øF and the humidity may fall below 10 per cent. The name means "poison wind" and is given because the sudden onset of a simoom may cause heatstroke. This is attributed to the fact that the hot wind brings more heat to the body than can be disposed of by the evaporation of perspiration.

Siffanto: A southwest wind of the Adriatic Sea; it is often violent.

Sirocco: (Also spelled scirocco.) A warm south or southeast wind in advance of a depression moving eastward across the southern Mediterranean Sea or North Africa. The air comes from the Sahara (as a desert wind) and is dry and dusty, but the term is not used in North Africa, where the natives call it chom (hot) or arifi (thirsty). In crossing the Mediterranean the sirocco picks up much moisture because of its high temperature, and reaches Malta, Sicily, and southern Italy as a very enervating, hot, humid wind. As it travels northward it causes fog and rain. In some parts of the Mediterranean region the word may be used for any southerly wind. In the extreme southwest of Greece a warm foehn wind crossing the coastal mountains is named sirocco di levante. There are a number of local variants of the spelling such as xaroco (Portuguese), jaloque or xaloque (Spanish), and xaloc or xalock (Catalonian). In the Rhone Delta the warm rainy southeast sirocco is called eissero. On Zakynthos Island it is called lampadista.

Solano: A southeasterly or easterly wind on the southeast coast of Spain in summer, usually an extension of the sirocco. It is hot and humid and sometimes brings rain; when dry it is dusty.

Tarantata: A strong breeze from the northwest in the Mediterranean region.

Tramontana: A cold wind from the northeast or north, particularly on the west coast of Italy and northern Corsica, but also in the Balearic Islands and the Ebro Valley in Catalonia. Like the mistral, it is associated with the advance of an anticyclone from the west following a depression over the Mediterranean. Weather is fine with occasional showers.

Traversier: In the Mediterranean, dangerous winds blowing directly into port.

Vardar: (Also called vardarac.) A cold fall wind blowing from the northwest down the Vardar valley in Greece to the Gulf of Salonica. It occurs when atmospheric pressure over eastern Europe is higher than over the Aegean Sea, as is often the case in winter. It persists for two or three days with a mean velocity of 10 to 15 knots, rising to 30 knots in squalls. It is strongest where the Vardar River leaves the mountains, but it extends for some distance out to sea.

Vendaval: A stormy southwest wind on the southern Mediterranean coast of Spain and in the Strait of Gibraltar. It occurs with a low advancing from the west in late autumn, winter, or early spring, and is often accompanied by thunderstorms and violent squalls.

TEMPERATURE

The regional climate of the Mediterranean is generally one of mild winters and hot summers. In the summer months the average daily temperatures increase toward the east and south. The average daily highs in summer are usually in the mid to high 60's or low 70's (degrees F). Hot temperatures are not unusual along the North African coast when a hot dry breeze blowing off the desert (sirocco) encroaches on the marine environment. The highest temperature recorded in the Mediterranean region is 118-degrees F, which was measured in Banzart in August and in Tunis in July. High temperatures also occur in a number of other places in the Mediterranean due to adiabatic heating of air as it flows down the lee side of a mountain range (foehn effect), especially near the Corsican Mountains, the north coast of Sicilia (Sicily), and southern Italy when the sirocco blows in summer. Palermo has recorded a high of 114-degrees F in August.

In general the average winter temperatures increase toward the south, and they are slightly higher in the eastern region than in the western Mediterranean. January and February are usually the coldest months. The lowest temperatures occur in the cold continental air streams on the shores of the Golfe du Lion, the north Adriatic, and in the north Aegean Sea. In these areas the minimum temperature may be as low as 15-degrees to 20-degrees F. The extreme minimum in the area is 6-degrees F, which was recorded in Trieste in February. Changes in wind direction can bring about marked changes in temperature. In summer months if the onset of the (cool) sea breeze is delayed till afternoon, a drop of 15-degrees to 20-degrees F may occur when the sea breeze does arrive. Large changes occur when the sirocco winds are suddenly followed by a cold front. The west coast of Greece can experience large summer changes when hot, dry winds from the mountains are followed by a cold front. Detailed tables of temperature for the major ports can be found in the climatic tables.

RELATIVE HUMIDITY

The relative humidity over most of the Mediterranean Sea is highest in the winter months, decreasing to a minimum during July or August. In general the relative humidity is highest during the night; this variation is brought about more by diurnal temperature variations than changes in actual water content. The seasonal variation is highest in the northern area and very small along the North African coast. Winds often determine the short period range in humidity. Offshore winds are generally dry in all seasons, especially on the North African coast where the sirocco is often desiccative, while the sea breeze is generally quite moist. An extreme example of wind effect has been noted at Al Iskandariyah where relative humidity as low as 8% has risen to 90% within 2 hours after the arrival of northwest winds in the rear of a low.

In the winter months the relative humidity is generally highest in the western part of the region, although the January minimum occurs at Genova, which has a 56% daytime average in this month. In the summer months the relative humidity is highest in the southern Mediterranean.

The diurnal variation depends, to a great extent, on the local winds and, therefore, has a large range over the Mediterranean area. Average diurnal changes can be nearly 0% (Hefa in October) and as high as 24% (Banzart in July). The diurnal range is smallest along the eastern shore of the Mediterranean and at Genova, which does not have a diurnal average greater than 9% in any month during the year. For detailed figures on relative humidity see the climatic tables.

PRECIPITATION-RAINFALL

Rainfall in the Mediterranean area generally occurs in association with low pressure systems. Heaviest rains occur ahead of cold fronts, particularly when the air is warm and humid. In autumn, when the sea is still very warm, showers caused by instability and thunderstorms are often associated with warm fronts. Thunderstorms also occur in siroccos when they are orographically lifted in the northern parts of the Mediterranean area.

The average annual precipitation is generally highest in the northern sector, decreasing to a minimum along the eastern North African coast. Rijeka has an annual average of 62 inches, the highest in the area, with 111 days

showing measurable precipitation (0.04 inch or greater), while the minimum of 3 inches is reported at Bur Said, which has an average of only 19 days with measurable precipitation. Most of the northwestern area reports an annual average close to 30 inches.

Most of the Mediterranean experiences a dry season in the summer when there is an almost constant flow of surface air onto North Africa and a very stable lapse rate in the atmosphere. A change in either of these conditions, such as exceptionally cold air moving in from Europe or warm air blowing out of Africa, could cause a break in the dry season. The southeastern Mediterranean experiences almost complete aridity during the summer months; no station on the North African coast reports more than a 1 inch total for the summer months (June, July, August). The northeast is also dry with Piraievs averaging 0.6 inches and Izmir 1.0 inch for the summer months. To the northeast, Genova has an average of 6.8 inches total and 13 days showing measurable precipitation.

The Mediterranean rainy season usually occurs from late fall to early spring. December, a representative month in the rainy season, shows Genova and Napoli with an average of 5.4 inches and 9 and 13 days respectively with measurable precipitation. Some cities to the south are still quite dry; Bur Said has an average of only 0.6 inches and 4 rainy days in December. For additional data on rainfall see the climatic tables.

PRECIPITATION-SNOW
Snow is relatively rare at sea level in the Mediterranean Sea. The most affected areas are the northeast Adriatic and the northern parts of the Aegean Sea, where snow falls on an average of six days each year. Snow seldom lies on the ground for more than 1-2 days in this area.

PRECIPITATION-HAIL
Hail may occur in the northern Mediterranean at any time of the year, but in general it is most frequent in spring and winter. In the southern areas hail is practically confined to these seasons. In regions where the rainfall consists mainly of heavy showers, the highest frequencies of hail occur in the seasons of maximum rainfall, and not necessary of maximum thunderstorm activity. Hail in this region occurs mainly along cold fronts, in showers caused by instability in cold air masses, and in thunderstorms.

THUNDERSTORMS
The frequency of Mediterranean thunderstorms is highest in the northern waters, with a maximum in the North Adriatic, decreasing to a minimum along the north coast of Africa, from Libya to Egypt. The annual average of thunderstorm days ranges from 37 at Split to 3 at Bur Said. In the North Adriatic, the frequency of thunderstorms is highest in the summer months, with many of these being air mass thunderstorms. Rijeka has an average of 6 thunderstorm days during the month of July. In other parts of the Mediterranean autumn and winter are the main season for thunderstorms. Autumn thunderstorms are most common in the western and central Mediterranean, southern Adriatic, and the western Aegean; Tunis and Piraevs average 4 thunderstorm days in October. In the eastern Aegean and eastern Mediterranean thunderstorms are most common in winter.

CLOUDINESS
In general, the Mediterranean is not a cloudy area. The seas west of Sicilia (Sicily) and the northern Adriatic experience a slightly greater percentage of cloud cover than the rest of the area. Most of the stations in western Mediterranean report an annual average of near 4 oktas (eights) cloud cover, while most cities in the eastern region report to 2 to 3 oktas average cloud cover.

The cloud cover is heaviest during the winter months. In December Napoli has an average of 13 cloudy days (ø=> .8 cloud cover), while Alger averages 11 and Bayrut has a mean of 7 cloudy days. The area is seldom overcast during the summer months, and few stations report more than 2 to 3 cloudy days each month during this season. In many places along the coast the diurnal variation of cloud cover during the winter often gives a maximum each morning due to low stratus. This cover normally dissipates after sunrise, and there is a second maximum in the afternoon due to the development of cumulus. Most of the area only experiences the afternoon maximum in summer. The clearest time of the day is in the evening. The diurnal cloud changes usually only affect the offshore waters to a distance of 10-15 miles from the coast. For additional data on cloudiness see the climatic tables.

VISIBILITIES
The more important causes of poor visibility in the Mediterranean are fog, dust, haze, and precipitation. Mist or fog is common near large cities in the early morning, when the smoky air is especially favorable for condensation of moisture. Dense sea fogs are relatively scarce in the Mediterranean, but when they do occur, they are more frequent in the relatively cool waters of the northern gulfs than in the warmer water to the south. On the coast radiation fog sometimes develops in early morning when winds are very light, but this usually decreases soon after sunrise.

The northward movement of moist sirocco air over the relatively cool sea is a major cause of fog in the Mediterranean. Thick sirocco fogs occur in the northern Adriatic, along the west coast of Italy, and in the Golfo di Genova and the Golfe du Lion. Fog at Venezia has been known to continue for as long as five days.

The haze caused by African dust can affect the visibility just as intensely and abruptly as a dense fog. This dust is carried northward from the desert area by storms moving eastward along the North African coast and is associated with the hot sirocco or other southerly winds. Duststorms are most intense in the strong winds ahead of a cold front. A duststorm seldom lasts for more than 12 hours at any one place, although a low may cause duststorms for three or more days as it moves along its track. Generally the dust clears after the passage of the cold front. Duststorms are most common in May, but they can occur at any time of the year. Such dust may travel great distances northward, but generally the extent of reduced visibility is limited to a belt 20 to 50 miles wide along the African coast.

Poor visibility is generally most common in winter and spring. Venezia has an average of 12 days a month with visibilities less than 2 miles in both February and December, while Napoli averages 10 days in April. The southern and eastern Mediterranean ports seldom show more than 3 days per month with poor visibility (less than 2 miles) during this period.

EXCESSIVE REFRACTION AND MIRAGE

Abnormal atmospheric conditions inducing refraction and mirage are fairly common in many parts of the Mediterranean. Refraction may blur, distort, raise, or depress a horizon and confuse position reckonings onboard ship. When cool air is blowing over a relatively warm sea, the surface air may be warmed, causing it to be less dense than the air directly above it. These conditions bring about "inferior" refraction and the horizon is depressed; distant low-lying objects are not seen at all. The objects which are seen appear to be nearer and clearer. This mirage occurs in the morning in shoal areas, shallow water, and along flat coasts.

A "superior" mirage occurs when the surface layers of a relatively warm current are cooled by the water mass. The horizon is elevated and objects over the normal horizon may be visible. Visibility is falsely judged to be exceptionally good. This mirage occurs in light, hot, offshore winds.

Mirages are most likely along the coast of North Africa, in the Golfe du Lion, Stretto di Messina, the Ionian and Aegean Seas, on the French Riviera, and in the eastern Mediterranean, especially near the coasts. The most complex mirages ever witnessed are those in Stretto di Messina known as "Fata Morgana," which are characterized by multiple distortions of images generally in the vertical, so that objects such as cliffs and cottages are distorted and magnified into fantastic castles.