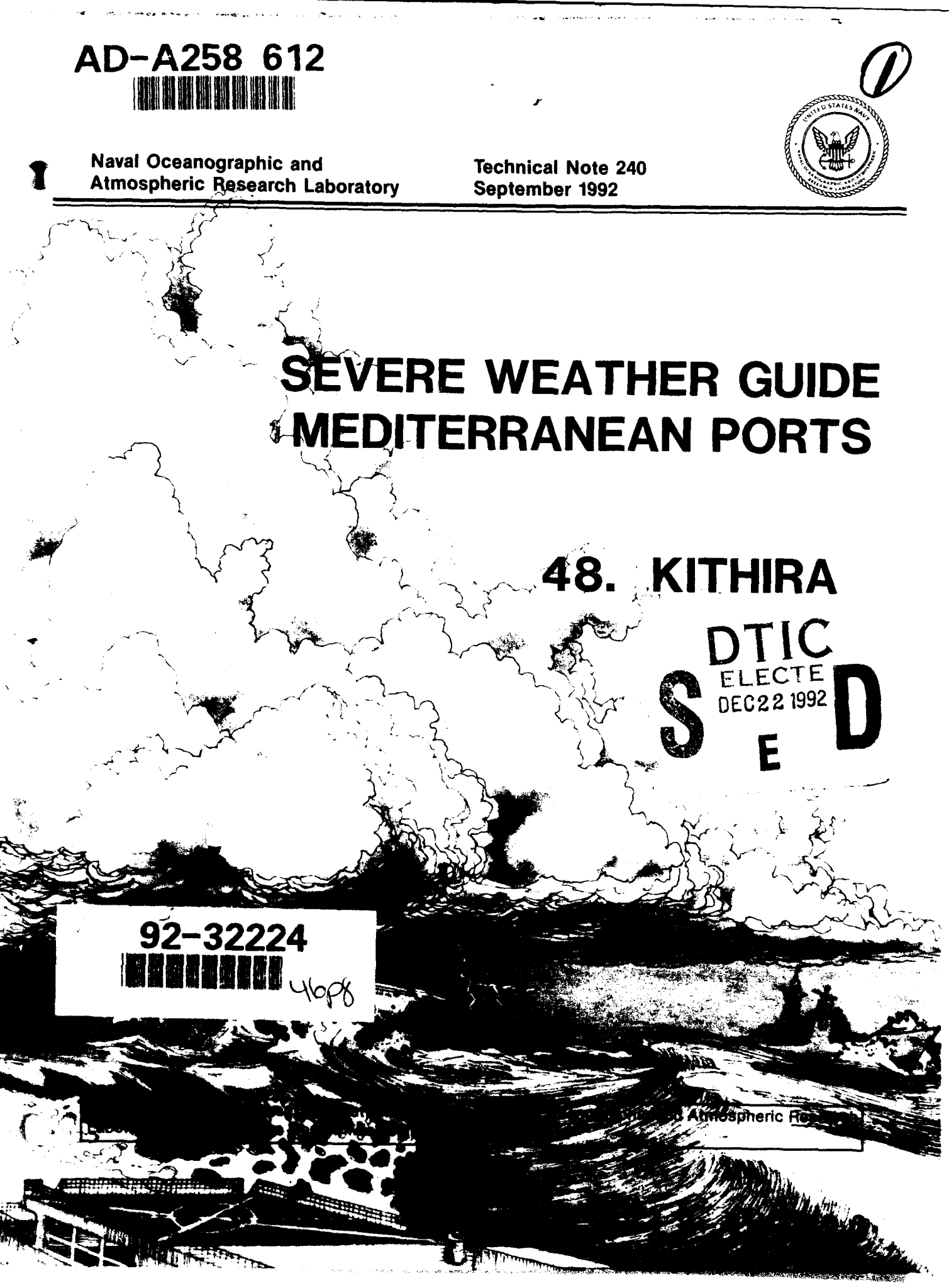
Naval Oceanographic and
Atmospheric Research Laboratory

Technical Note 240
September 1992

SEVERE WEATHER GUIDE MEDITERRANEAN PORTS

48. KITHIRA



These working papers were prepared for the timely dissemination of information; this document does not represent the official position of NOARL.

ABSTRACT

This handbook for the port of Kithira, one in a series of severe weather guides for Mediterranean ports, provides decision-making guidance for ship captains whose vessels are threatened by actual or forecast strong winds, high seas, restricted visibility or thunderstorms in the port vicinity. Causes and effects of such hazardous conditions are discussed. Precautionary or evasive actions are suggested for various vessel situations. The handbook is organized in four sections for ready reference: general guidance on handbook content and use; a quick-look captain's summary; a more detailed review of general information on environmental conditions; and an appendix that provides oceanographic information.

ACKNOWLEDGMENTS

The support of the sponsor, Naval Oceanography Command, Stennis Space Center, MS, LCDR E. Steiner, USN, Program Element O&M,N-1, is gratefully acknowledged.

CONTENTS

FOREWORD

This handbook on Mediterranean Ports was developed as part of an ongoing effort at the Meteorology Division, Naval Research Laboratory (NRL), Monterey, to create products for direct application to Fleet Operations. The research was conducted in response to Commander Naval Oceanography Command (COMNAVOCEANCOM) requirements validated by the Chief of Naval Operations (OP-096).

As mentioned in the preface, the Mediterranean region is unique in that several areas exist where local winds can cause dangerous operating conditions. This handbook will provide the ship's captain with assistance in making decisions regarding the disposition of his ship when heavy winds and seas are encountered or forecast at various port locations.

Readers are urged to submit comments, suggestions for changes, deletions and/or additions to Naval Oceanography Command Center (NAVOCEANCOMCEN), Rota with a copy to the oceanographer, COMSIXTHFLT. They will then be passed on to NRL Monterey for review and incorporation as appropriate. This document will be a dynamic one, changing and improving as more and better information is obtained.

PORT INDEX

The following is a list of Mediterranean Ports that have been evaluated since 1988, with future ports and probable year of distribution also included. Computerized versions of these port guides are currently available for those ports with an asterisk (*). Those without the asterisk will be computerized in the near future. Contact the Naval Research Laboratory (NRL), Monterey or NOCC Rota for IBM compatible floppy disk copies.

NO.	PORT
*1	GAETA, ITALY
*2	NAPLES, ITALY
*3	CATANIA, ITALY
*4	AUGUSTA BAY, ITALY
*5	CAGLIARI, ITALY
*6	LA MADDALENA, ITALY
7	MARSEILLE, FRANCE
8	TOULON, FRANCE
9	VILLEFRANCHE, FRANCE
10	MALAGA, SPAIN
11	NICE, FRANCE
12	CANNES, FRANCE
13	MONACO
14	ASHDOD, ISRAEL
15	HAIFA, ISRAEL
16	BARCELONA, SPAIN
17	PALMA, SPAIN
18	IBIZA, SPAIN
19	POLLENSA BAY, SPAIN
20	LIVORNO, ITALY
21	LA SPEZIA, ITALY
22	VENICE, ITALY
23	TRIESTE, ITALY
*24	CARTAGENA, SPAIN
*25	VALENCIA, SPAIN
*26	SAN REMO, ITALY
*27	GENOA, ITALY
*28	PORTO TORRES, ITALY
*29	PALERMO, ITALY
*30	MESSINA, ITALY
*31	TAORMINA, ITALY
*32	TARANTO, ITALY
*33	TANGIER, MOROCCO
*34	BENIDORM, SPAIN
*35	ROTA, SPAIN
*36	LIMASSOL, CYPRUS
*37	LARNACA, CYPRUS
*38	ALEXANDRIA, EGYPT
*39	PORT SAID, EGYPT
*40	BIZERTE, TUNISIA
*41	TUNIS, TUNISIA
*42	SOUSSE, TUNISIA
*43	SFAX, TUNISIA
*44	SOUDA BAY, CRETE
*45	PIRAEUS, GREECE
*46	KALAMATA, GREECE
*47	KERKIRA (CORFU), GREECE
*48	KITHIRA, GREECE
*49	THESSALONIKI, GREECE

1993	PORT
	VALLETTA, MALTA
	ISKENDERUN, TURKEY
	IZMIR, TURKEY
	ISTANBUL, TURKEY
	ANTALYA, TURKEY

PREFACE

Environmental phenomena such as strong winds, high waves, restrictions to visibility and thunderstorms can be hazardous to critical Fleet operations. The cause and effect of several of these phenomena are unique to the Mediterranean region and some prior knowledge of their characteristics would be helpful to ship's captains. The intent of this publication is to provide guidance to the captains for assistance in decision making.

The Mediterranean Sea region is an area where complicated topographical features influence weather patterns. Katabatic winds will flow through restricted mountain gaps or valleys and, as a result of the venturi effect, strengthen to storm intensity in a short period of time. As these winds exit and flow over port regions and coastal areas, anchored ships with large 'sail areas' may be blown aground. Also, hazardous sea state conditions are created, posing a danger for small boats ferrying personnel to and from port. At the same time, adjacent areas may be relatively calm. A glance at current weather charts may not always reveal the causes for these local effects which vary drastically from point to point.

Because of the irregular coast line and numerous islands in the Mediterranean, swell can be refracted around such barriers and come from directions which vary greatly with the wind. Anchored ships may experience winds and seas from one direction and swell from a different direction. These conditions can be extremely hazardous for tendered vessels. Moderate to heavy swell may also propagate outward in advance of a storm resulting in uncomfortable and sometimes dangerous conditions, especially during tending, refueling and boating operations.

This handbook addresses the various weather conditions, their local cause and effect and suggests some evasive action to be taken if necessary. Most of the major ports in the Mediterranean will be covered in this series of handbooks. A priority list, established by the Sixth Fleet, exists for the port studies conducted and this list will be followed as closely as possible in terms of scheduling publications.

RECORD OF CHANGES

CHANGE NUMBER	DATE OF CHANGE	DATE ENTERED	PAGE NUMBER	ENTERED BY

1. GENERAL GUIDANCE

1.1 DESIGN

This handbook is designed to provide ship captains with a ready reference on hazardous weather and wave conditions in selected Mediterranean harbors. Section 2, the captain's summary, is an abbreviated version of section 3, the general information section intended for staff planners and meteorologists. Once section 3 has been read, it is not necessary to read section 2.

1.1.1 Objectives

The basic objective is to provide ship captains with a concise reference of hazards to ship activities that are caused by environmental conditions in various Mediterranean harbors, and to offer suggestions for precautionary and/or evasive actions. A secondary objective is to provide adequate background information on such hazards so that operational forecasters, or other interested parties, can quickly gain the local knowledge that is necessary to ensure high quality forecasts.

1.1.2 Approach

Information on harbor conditions and hazards was accumulated in the following manner:

A. A literature search for reference material was performed.
B. Cruise reports were reviewed.
C. Navy personnel with current or previous area experience were interviewed.
D. A preliminary report was developed which included questions on variou local conditions in specific harbors.
E. Port/harbor visits were made by NOARL personnel; considerable information was obtained through interviews with local pilots, tug masters, etc; and local reference material was obtained.
F. The cumulative information was reviewed, combined, and condensed for harbor studies.

1.1.3 Organization

The handbook contains two sections for each harbor. The first section summarizes harbor conditions and is intended for use as a quick reference by ship captains, navigators, inport/at sea OOD's, and other interested personnel. This section contains:

A. a brief narrative summary of environmental hazards,
B. a table display of vessel location/situation, potential environmental hazard, effect-precautionary/evasion actions, and advance indicators of potential environmental hazards,
C. local wind wave conditions, and
D. tables depicting the wave conditions resulting from propagation of deep water swell into the harbor.

The swell propagation information includes percent occurrence, average duration, and the period of maximum wave energy within height ranges of greater than 3.3 feet and greater than 6.6 feet. The details on the generation of sea and swell information are provided in Appendix A.

The second section contains additional details and background information on seasonal hazardous conditions. This section is directed to personnel who have a need for additional insights on environmental hazards and related weather events.

1.2 CONTENTS OF SPECIFIC HARBOR STUDIES

This handbook specifically addresses potential wind and wave related hazards to ships operating in various Mediterranean ports utilized by the U.S. Navy. It does not contain general purpose climatology and/or comprehensive forecast rules for weather conditions of a more benign nature.

The contents are intended for use in both pre-visit planning and in situ problem solving by either mariners or environmentalists. Potential haz-

ards related to both weather and waves are addressed. The oceanographic information includes some rather unique information relating to deep water swell propagating into harbor shallow water areas.

Emphasis is placed on the hazards related to wind, wind waves, and the propagation of deep water swell into the harbor areas. Various vessel locations/situations are considered, including moored, nesting, anchored, arriving/departing, and small boat operations. The potential problems and suggested precautionary/evasive actions for various combinations of environmental threats and vessel location/situation are provided. Local indicators of environmental hazards and possible evasion techniques are summarized for various scenarios.

CAUTIONARY NOTE: In September 1985 Hurricane Gloria raked the Norfolk, VA area while several US Navy ships were anchored on the muddy bottom of Chesapeake Bay. One important fact was revealed during this incident: Most all ships frigate size and larger dragged anchor, some more than others, in winds of over 50 knots. As winds and waves increased, ships 'fell into' the wave troughs, BROADSIDE TO THE WIND and became difficult or impossible to control.

This was a rare instance in which several ships of recent design were exposed to the same storm and much effort was put into the documentation of lessons learned. Chief among these was the suggestion to evade at sea rather than remain anchored at port whenever winds of such intensity are forecast.

2. CAPTAIN'S SUMMARY

The Port of Kithira is located on the southern part of the Island of Kithira near 36°08' N, 23°00' E in the south central Aegean Sea (Hydrographer of the Navy, 1968). The island is situated between the southernmost part of Greece and the western end of the island of Crete (Figure 2-1).

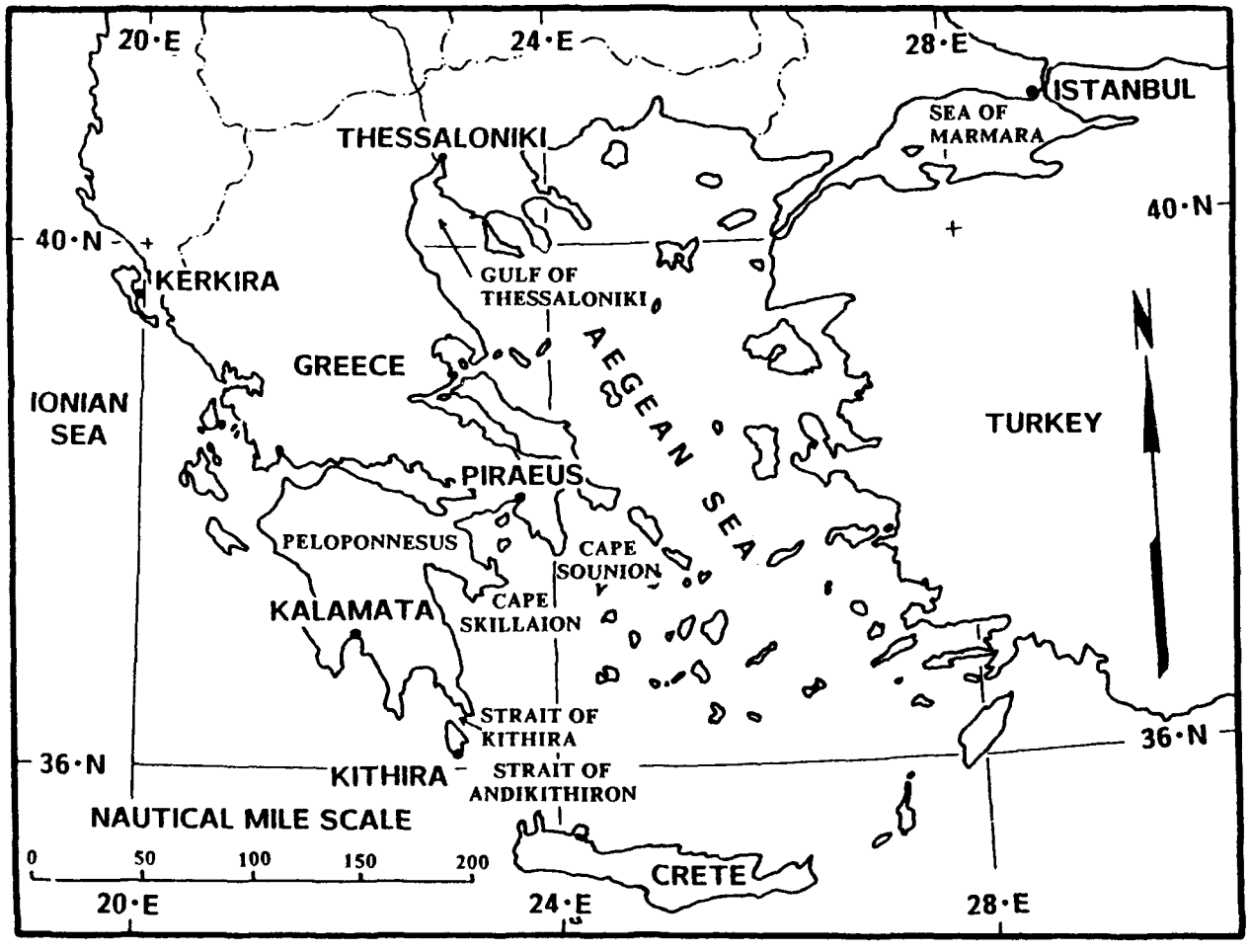


Figure 2-1. Ports of Greece and Surrounding Waters.

The Port is on the southern end of Kithira Island (Figure 2-2). Both the island and the town of Kithira are relatively small in size and population. The island dimensions are approximately 15 n mi long in the north-south direction and 10 n mi wide at the widest point. The town is only a few city blocks in size. The terrain is hilly with maximum elevation about 1756 ft (532 m). The Port is located at the head of the small Bay of Kapsaliou. The Bay extends northward about 3/4 n mi inland with fairly high terrain ringing the northern and western sides. The Bay opens to the southeastward. A second anchorage area and even smaller harbor is located off the northeast part of the Island in the Bay of Ayias Pelayias.

The Strait of Elafonison, about 5 n mi wide, separates the Island from the mainland to the north. The Passage of Kithiron and Strait of Andikithiron separate the Island from Crete about 50 n mi to the south-southeast. The Bay of Kapsaliou is open to the south with only two small offshore islands. One (name not known) is located about one n mi to the southwest of the harbor and the other, Avgo, is located about 2½ n mi to the south. These two islands are the only features blocking the open sea approach.

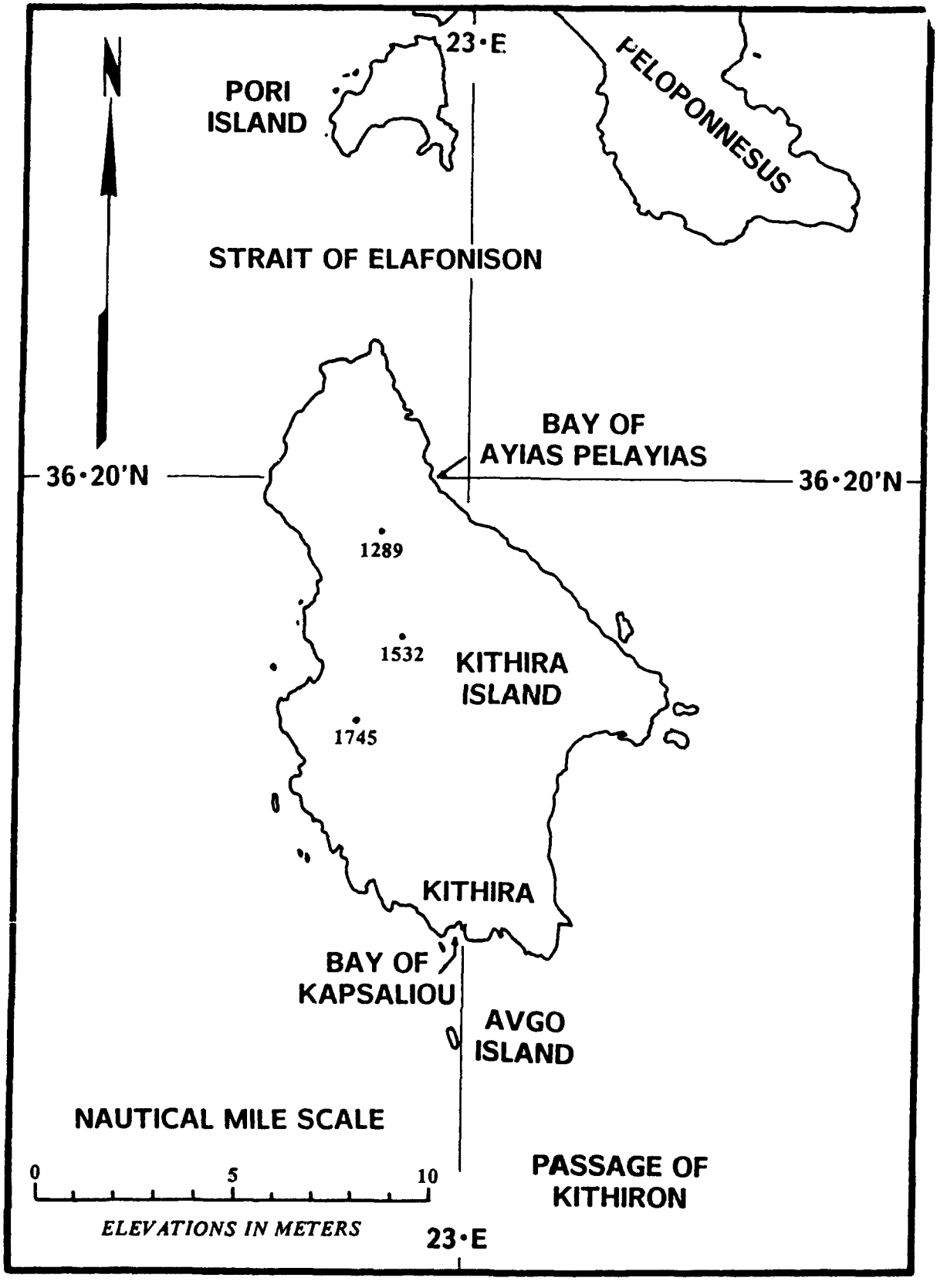


Figure 2-2. Approaches to the Ports of Kithira Island, Greece.

The harbor is very small with extremely limited facilities. The pier facilities, located on the northwest side of the mushroom shaped peninsula that extends into the central Bay, are well protected (Figure 2-3). A lighthouse is located on the western portion of the peninsula.

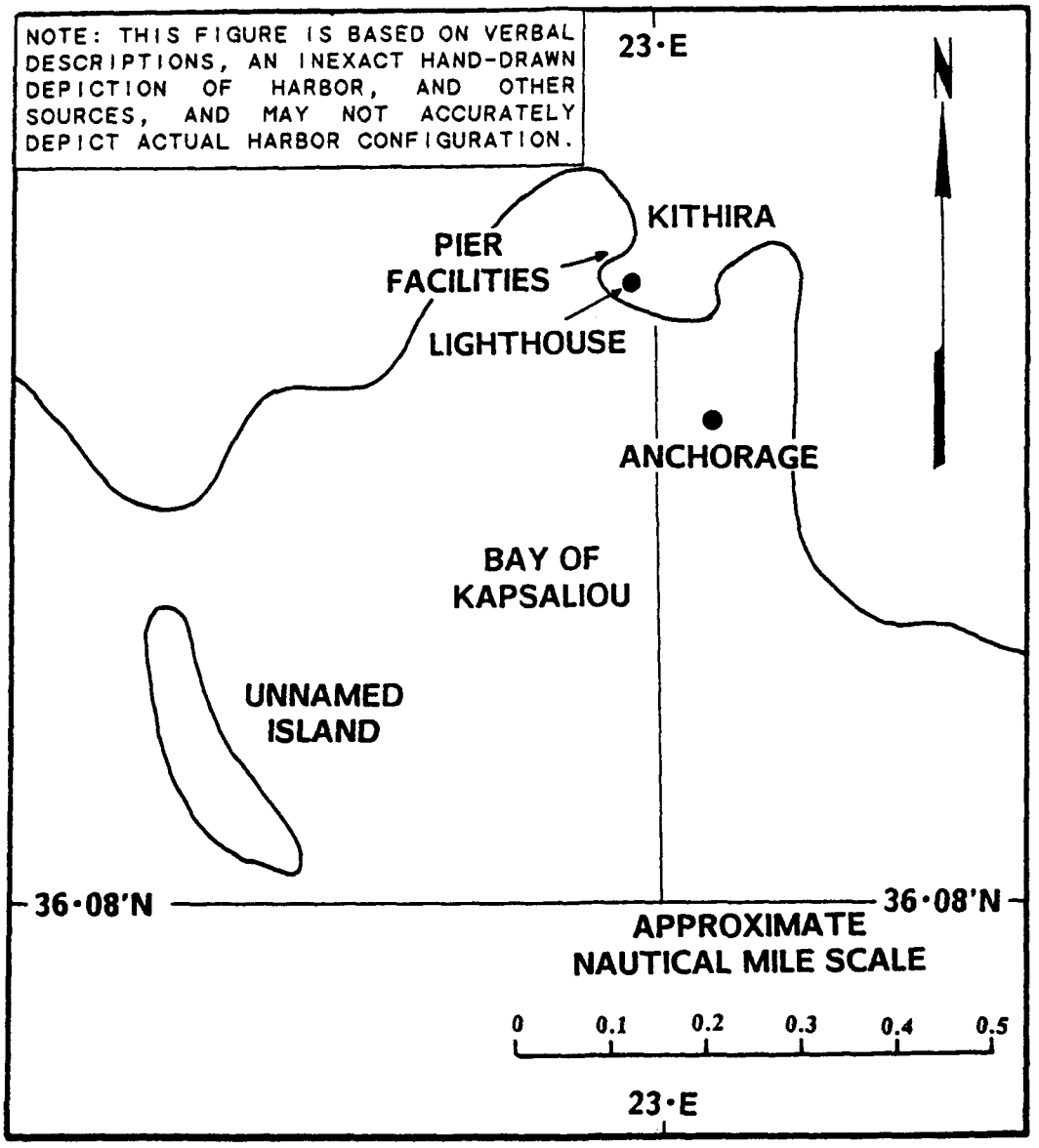


Figure 2-3. The Port of Kithira, Greece.

The Port has no berthing for large ships. Depths at the pier are limited to 13 to 15 ft (4-4½ m). Anchorage can be made about 1/4 n mi southeast of the lighthouse in 45 to 50 ft (14-15 m) depths. Holding is good in a rocky bottom (Port Visit, 1990). Moving westward from this anchorage to a location southwest of the lighthouse will provide protection from southwesterly winds but more exposure to southeasterly winds. Depths increase to near 95 ft (29 m). Anchor dragging may occur in this area during heavy southeasterly swell and winds (Hydrographer of the Navy, 1968) due to the soft mud and sand bottom.

The Bay is protected from the prevailing year-around north-to-northeast winds. During winter 17 to 27 kt (Force 5-6) northerly winds are associated with regional Bora events, known locally as Meltemi. During summer northerly winds of similar strength are associated with Etesian events. The warm season southerly sea breeze of this area tends to counteract the prevailing northerly wind resulting in lower wind speed during the afternoon. During both seasons northerly winds over the exposed open sea areas may reach 34 to 47 kt (Force 8-9) while the winds over the protected harbor are much lower.

The most hazardous conditions are caused by southeasterly winds. Migratory low pressure systems approaching from the west or southwest result in these conditions. On average four or five cyclones per winter are experienced. Winds may reach 34 to 47 kt (Force 8-9) and waves 10-13 ft (3-4 m). Waves will be composed of both short period wind waves (<6 second) and longer period swell (10-12 seconds). Swell and wind waves directions may vary by 90° or more. Small boat operations are typically canceled during strong southerly wind events. The local steep terrain contributes to squally unsettled weather during strong wind conditions regardless of wind direction.

Visibility is generally good with only moderate reductions due to summer haze or winter low clouds and precipitation. No other significant weather conditions have been reported.

Specific hazardous environmental conditions, vessel situations, and suggested precautionary/evasive action scenarios for the Port of Kithira are summarized in Table 2-1.

Table 2.1. Summary of Hazardous Environ

HAZARDOUS CONDITIONS	INDICATORS OF POTENTIAL HAZARD	S
1. Strong SE'ly winds/waves - Caused by migratory cyclones. * Most hazardous conditions, occurs winter, spring and autumn. * Winds 34 to 47 kt, waves 10 to 13 ft. * Rapid shift from easterly to southerly. * Local wind waves may be out of phase with swell.	1. Advance Warning * Low approaching from west, pressure falling, increasing low clouds, wind shifting out of north to easterly, rapid shift to southerly. Duration * Generally a day, seldom more than 2.	
2. S'ly winds/waves - Sciroccos out of North Africa * Most likely late winter into spring. * Winds gale force or less. * Brings low clouds, rain, reduced visibility.	2. Advance Warning * Altocumulus cloud deck approaching from south day before onset. * Southerly swell increasing. * Prevailing northerly winds decrease. * Increasing low clouds. Duration * Normally last about 3 days.	
3. N'ly winds - Winter Boras, Summer Etesians * Rapid onset. * Gusty, squally weather. * Near freezing temperatures in winter.	3. Advance Warning Winter Boras * Rising pressure over Balkans, weak cyclone over eastern Mediterranean. * Rapid local onset Duration * One to five days Summer Etesians * Increasing cloudiness over Balkans day before onset. Duration * Generally one to five days, but can last for weeks.	

ıs Environmental Conditions for the Port of Kithira, Greece.

VESSEL LOCATION/ SITUATION AFFECTED	EFFECT-PRECAUTIONARY/EVASIVE ACTIONS
(1) Anchorage	a. The anchorages are exposed to wind and waves. * Anchorage southeast of lighthouse most protected from SE'lys. * Moving to anchorage southwest of lighthouse more protected from SW'ly winds, but anchor dragging may occur under strong SE'ly. * Anchorage northeast of Island protected.
(2) Small Boats	a. The harbor affords good protection from waves, but limited protection from winds. * Small craft runs to/from anchorage likely curtailed.
(1) Anchorage	a. The anchorages are exposed to wind and waves. * Anchorage southwest of lighthouse most protected from SW'lys, anchor dragging may occur during strong SE'lys. * Anchorage northeast of Island protected.
(2) Small Boats	a. The harbor affords good protection from waves, but limited protection from winds. * Small boat operations outside harbor hazardous, use due caution.
(1) Anchorage	a. Terrain provides protection for harbor and anchorages. * Close-in anchoring maximizes terrain protection. * Best holding southeast of lighthouse. * Anchor dragging possible, will be towards deeper water. * Near freezing temperatures during winter, use foul weather procedures and gear.
(2) Small Boats	a. Gusty, squally weather. * Boat runs outside harbor may be curtailed during strongest events. * Near freezing temperatures during winter, use foul weather procedures and gear.

SEASONAL SUMMARY OF HAZARDOUS CONDITIONS

WINTER (November through February)

* S'ly winds (migratory cyclones) 34 to 47 kt, SE'ly most hazardous
  - abrupt wind shift, E to SE to SW as storm approaches/grows
  - gusty winds due to terrain influences
  - waves 10 to 13 ft
  - duration usually less than a day
* N'ly winds (Boras) 17 to 27 kt prevail, extremes 41 to 47 kt
  - offshore flow, no significant waves
  - onset abrupt, gusty and squally weather
  - duration 1 to 5 days for stronger events

SPRING (March through May)

* S'ly winds (Scirocco) 22 to 33 kt
  - waves 4 to 7 ft
  - duration several days, gradual onset

SUMMER (June through September)

* N'ly winds (Etesian) 17 to 27 kt prevail, extreme 41 to 47 kt
  - offshore flow, no significant waves
  - duration 1 to 5 days for strong events, onset abrupt

AUTUMN (October)

* Rapid transition to winter weather
  - expect first winter-type cyclone by end of month

Note: For more detailed information on hazardous weather conditions, see previous Table 2-1 in this section and Hazardous Weather Summary in Section 3.

References

Hydrographer of the Navy, 1968: Mediterranean Pilot. Volume IV. Hydrographer of the Navy, London, England.

Port Visit Information

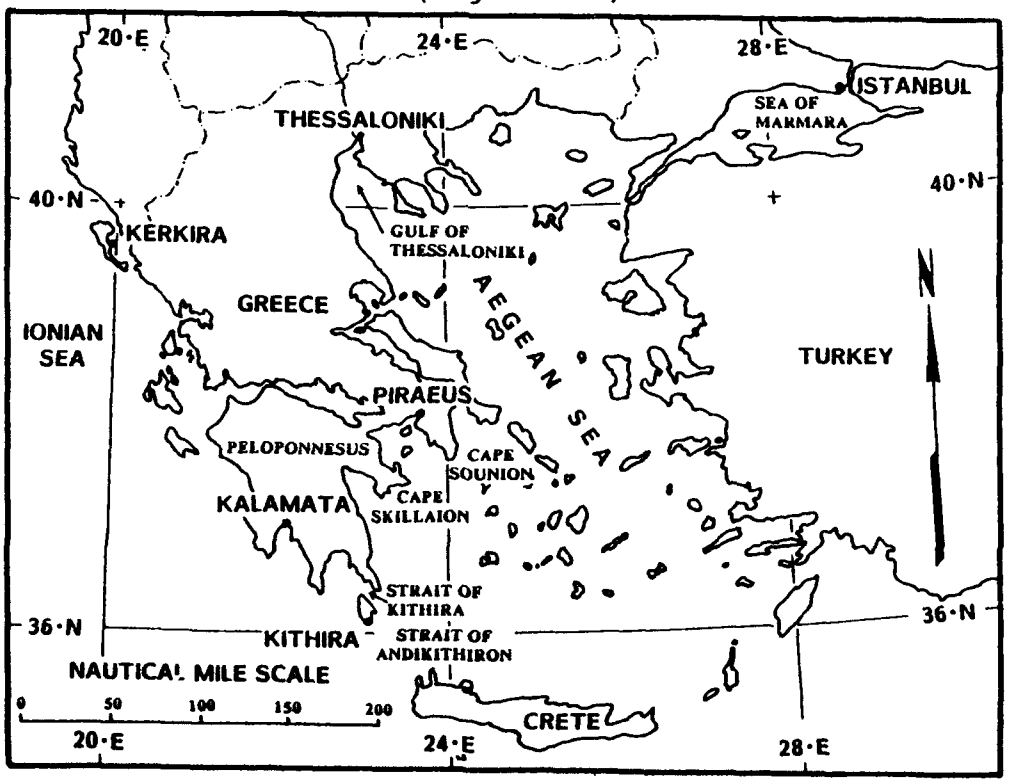
May 1990. NOARL Meteorologists R. Fett and R. Miller met with Harbor Master Samias to obtain some of the information included in this port evaluation.

3. GENERAL INFORMATION

This section is intended for fleet meteorologists/oceanographers and staff planners. Section 3.5 includes a general discussion of hazards and Table 3-1 provides a summary of vessel locations/situations, potential hazards, effect-precautionary/evasive actions, and advance indicators and other information by season.

3.1 Geographic Location

The Port of Kithira is located on the southern part of the Island of Kithira near 36°08' N, 23°00' E in the south central Aegean Sea (Hydrographer of the Navy, 1968). The island is situated between the southernmost part of Greece and the western end of the island of Crete (Figure 3-1).



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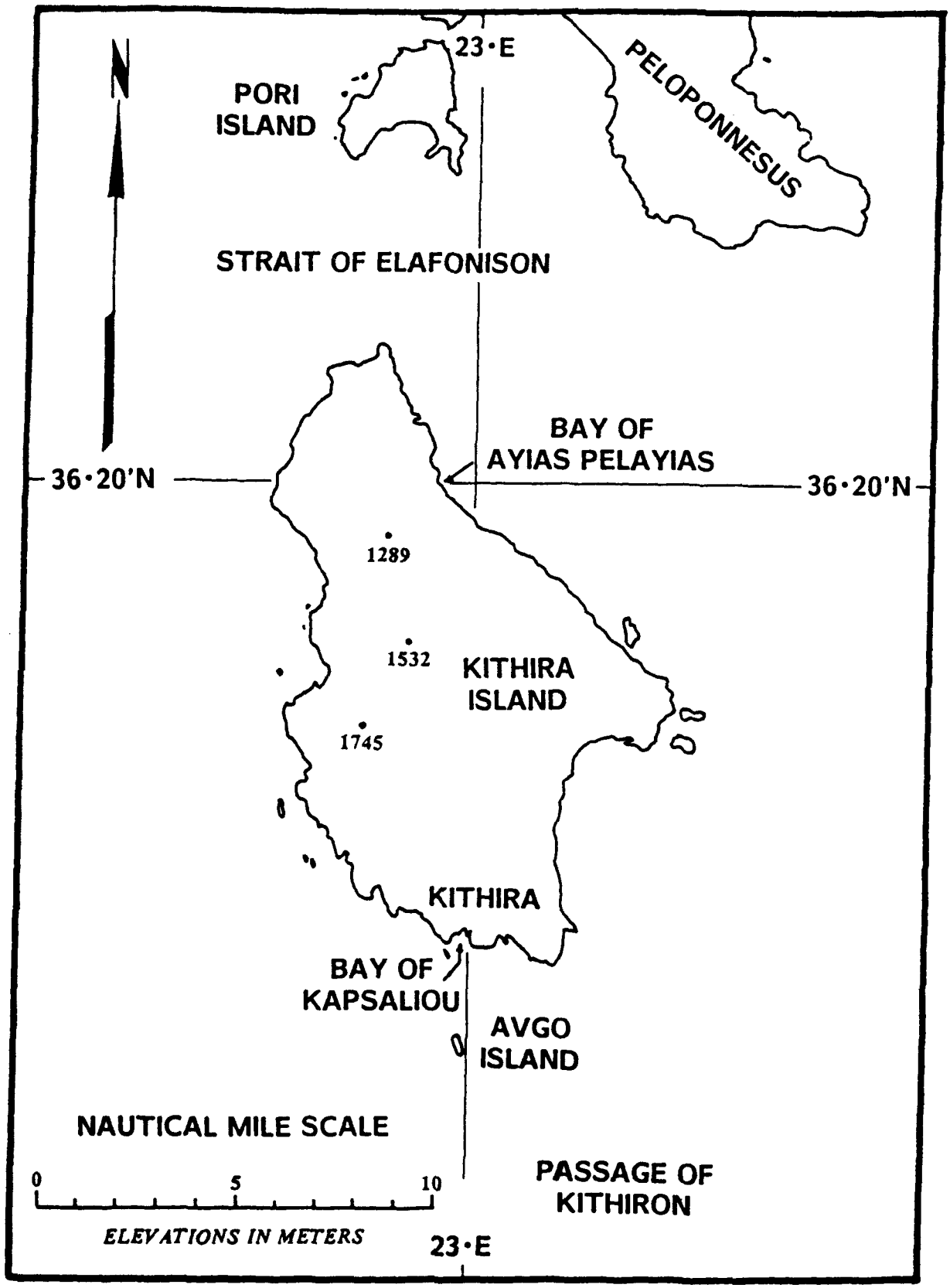

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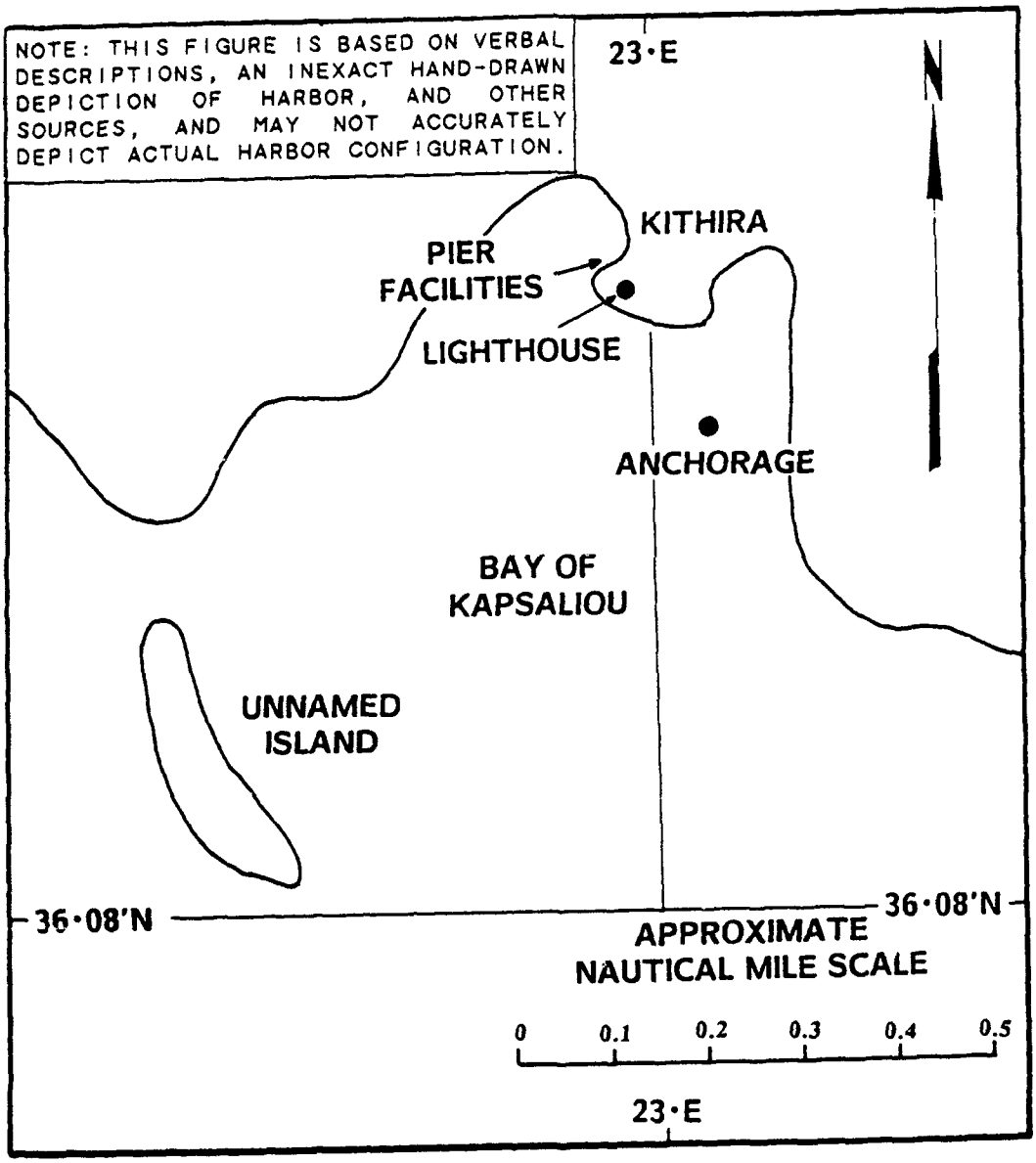

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3.2 Qualitative Evaluation of the Port of Kithira

Kithira is a small coastal port with very limited facilities. U.S. Navy ship usage is limited to the anchorages. The harbor and anchorages are well protected from the regions prevailing northerly winds. However, the harbor and anchorages are exposed to southerly wind and waves. Protection from southerly winds and waves can be found north of the island.

Holding is considered good at the anchorage southeast of the harbor. Anchorage dragging may occur at the anchorage area southwest of the lighthouse.

3.3 Currents and Tides

Tides are limited to a foot or less, currents are negligible.

3.4 Visibility

Visibility is generally good with only moderate reductions due to summer haze or winter low clouds and precipitation.

3.5 Hazardous Conditions

The Port of Kithira and anchorages are exposed to southerly wind and waves. These conditions are typically associated with migratory cyclones. The worst conditions typically start with easterly winds that veer abruptly to southeasterly with increasing speed and then to southwesterly. During winter the cyclones generally approach from the west, typically starting as Genoa lows or lows forming over the central Mediterranean. During spring most southerly high wind events are the result of Sciroccos that move out of North Africa and approach the Port from the southwest. Scirocco events may last several days while winter cyclonic events, although stronger, generally last only a day or so.

Although extremely rare, storms having topical cyclone characteristics including apparent "eye" cloud configuration have been observed on at least three occasions in the Mediterranean Basin. During an event in September 1983 the storm moved from the Gulf of Gabes, through the Straits of Sicily, along the east coast of Sardinia and into the Gulf of Genoa. Winds of 60 kt were reported at Cagliari, Sardinia while winds near the storm's eye were 100 kt.

A seasonal summary of various known environmental hazards that may be encountered in the Port of Kerkira follows.

A. WINTER (November through February)

The prevailing winds of the region are northerly. During Bora events the local winds may reach 41 to 47 kt (force 9) but the Port is protected by the terrain to the north. During strong Bora events early morning temperatures may be near zero with only limited warming during the day. See NTAG Vol. III (1980) for case study description of Bora events.

The worst conditions at the Port occur when migratory cyclones approach from the west, resulting in southerly flow over the region. Winds reach 34 to 47 kt (force 8-9) and waves 10 to 13 ft (3-4 m). While the harbor is protected, the anchorages are fully exposed. Anchorages north of the Island provide some protection from southerly winds.

A second cause of southerly winds are Sciroccos that approach from the south or southwest after forming over North Africa. Due to the dust carried by these systems "Red Rain" may be experienced. Sciroccos tend to persist for several days; intensity and duration increase from late winter into early spring.

Occasional thunderstorms are experienced with passing frontal systems which are generally associated with migratory lows. Restrictions to visibility are limited to precipitation and low cloud effects.

B. SPRING (March through May)

The spring transition is prolonged with alternating periods of winter- and summer-like conditions. Migratory winter-like cyclones can be experienced well into May. The prevailing winds during non-storm periods remain northerly.

The frequency, intensity, and extent of Scirocco conditions are at a maximum during spring. Sciroccos tend to develop slowly over a day or two, but then may persist for several days. Over Greece, Sciroccos generally bring cloudy conditions and light rain mixed with dust (Red Rains). Local conditions of 22 to 33 kt winds and waves of 4 to 7 ft (1-2 m) are typical for Scirocco events.

C. SUMMER (June through September)

Typical mediterranean climate conditions, nearly cloud and precipitation free with mild temperatures (daily highs in upper 80's, nightly lows in mid 60's), dominate. There are no truly hazardous weather conditions during summer. The prevailing winds remain northerly in response to the development of the thermal low over southwestern Asia with relatively high pressure over the Mediterranean. A thermal low pressure trough extends westward along the southern coast of Turkey from the thermal low.

The intensity and position of the thermal trough determines the regional wind/weather conditions. Enhanced northerly flow of 17 to 27 kt (force 5-6) develops over the local area when the thermal trough is most intense and/or shifted to its western most position off southwest Turkey. These events are called Meltemi in Greece and are part of the regional Etesian wind pattern which influences the Aegean Sea, Balkan Peninsula, and Asia Minor during summer. The Etesian is, in turn, a regional aspect of the continental scale monsoonal flow of Asia. Etesian events, and

therefore Meltemi events, tend to persist for several days. During these events the southerly local sea breeze along southward-facing coasts will counter the northerly gradient flow resulting in deceased wind speeds during the afternoon.

While no local indicators were identified during the 1990 Port visit to Kithira, the tendency for an increase in clouds the day before and first day of Etesian events was noted in Reiter (1971), as a well-known fact by Aegean Sea fishermen. Thunderstorm activity tends to occur over Greece on the day before and the first day of an Etesian during May-June and September-October periods. During July and August the clouds are typically limited to scattered altocumulus on the day preceding the onset of strong Etesian conditions.

D. AUTUMN (October)

The most hazardous aspect of weather in autumn, as elsewhere in the Mediterranean, is the rapidity with which the winter-type pattern is established. On average, over the northern Mediterranean, the winter pattern is established around the end of the third week of October. While the first storms are not likely to be as intense as some later in the winter, the marked change from the summer mediterranean weather can catch people unaware and unprepared. A migratory cyclone approaching from the west is the most likely early season event. Conditions for migratory lows are addressed in the Winter Section and described in detail in Brody and Nestor (1980).

3.6 Harbor Protection

The harbor and anchorages are protected by terrain from the prevailing regional northerly winds. The anchorages are exposed to southerly winds and waves. Under strong southeasterly wind

conditions anchor dragging may occur in areas south and southwest of the lighthouse.

3.6.1 Wind and Weather

The most hazardous conditions are caused by migratory cyclones passing through the area. Winds may shift from the prevailing northerly to easterly, then abruptly to southeasterly with increasing speeds and finally southwesterly as a cyclone approaches and passes the area. Wind speeds are likely to be increasing throughout this shifting sequence. Low clouds, rain and reduced visibility normally accompany the strong southerly wind events.

While strong northerly winds occur over this region throughout the year, the terrain of the Island provides protection to the harbor and anchorage areas. During strong wind conditions gusty, squally weather is likely over the Bay due to the turbulent flow caused by the surrounding steep terrain. Along south-facing coastlines, such as at the Port of Kithira, the summer sea breeze may offset the prevailing northerly winds resulting in light wind conditions during afternoon and evening periods.

3.6.2 Waves

The harbor is protected from all wave action. The anchorages are exposed to southerly waves. Winter migratory cyclonic storms result in waves of 10-13 ft (3-4 m) with both short period (<6 sec) wind waves and longer period swell (10-12 sec) occurring over the Bay and in the anchorage areas.

3.7 Protective and Mitigating Measures

3.7.1 Moving to a New Anchorage

According to the Port Visit (1990) comments the conditions are never so bad as to require departing the area. However, the anchorage in the Bay of Ayias Pelayias off the northeast coast of Kithira Island is protected from southerly and westerly winds and to a lesser extent from southeasterlies. The anchorage southeast of the lighthouse offers some protection from southeasterly winds while the anchorage southwest of the lighthouse is less exposed to southwesterly flow.

3.7.2 Scheduling

During summer the southerly sea breeze may cancel out the regional northerly gradient winds. Lightest wind conditions will then occur during the afternoon and early evening. No other local forcings of synoptic scale conditions were noted in the references.

3.7.3 Small Boat Operations

Small boat operations outside of the harbor are likely to be curtailed during strong southerly wind events. The general squally, gusty nature of the winds for this area will require extra precautions. During strong southerly winds the non-alignment of local wind and waves, due to squalls, with the southerly swell will result in additional hazards to alongside operations.

3.8 Local Indicators of Hazardous Weather Conditions

No local indicators were noted during the Port Visit of 1990. Reiter (1971) reported that increasing cloudiness over the Balkan Peninsula and Aegean Sea on the day preceding the estab-

lishment of an Etesian wind period was a well known fact by local fishermen. During the periods of May-June and September-October thunderstorms and lightning frequently occur on the day preceding the outbreak of the Etesian as well as on the first day of the Etesian. During July and August, when the most stable atmospheric conditions exist over the Mediterranean, altocumulus are typically noted on the day preceding the onset of the Etesian.

Another regional indicator is a deck of altocumulus approaching from the southwest in advance of a Scirocco. Brody and Nestor (1980) summarize various regional indicators for the Aegean Sea area.

3.9 Summary of Problems, Actions, and Indicators

Table 3-1 is intended to provide easy-to-use seasonal references for forecasters on ships using the Port of Kithira. Table 2-1 (Section 2) summarizes Table 3-1 and is intended primarily for use by ship captains.

Table 3.1. Potential Problem Situation

VESSEL LOCATION/ SITUATION AFFECTED	POTENTIAL HAZARD	EFFECT - PRECAUTI
1. Anchored Most common in winter - occurs in autumn and spring	a. SE'rly winds/waves - Most hazardous conditions caused by migratory cyclones approaching from the west. Winds 34 to 47 kt, waves 10 to 13 ft. Rapid wind shift from east to southeast with abrupt increase in speed. Squalls over Bay, local wind waves out of phase with swell.	a. The anchorage southea protected from SE'rly wi southwest of lighthouse SW'rly winds/waves, but during strong SE'rlies. Island provides protecti waves.
Occur late winter into spring	b. S'rly winds/waves - Caused by Scirocco. Winds 22 to 33 kt, waves 4 to 7 ft. Dust and or "Red Rain" may occur.	b. The anchorage southea protected from SE'rly wi southwest of lighthouse SW'rly winds/waves, but during strong SE'rlies. Island provides protecti waves.
Occur all seasons	c. N'rly winds - Caused by Bora in winter, Etesian in summer. Winter: strongest events, 41-47 kt. Gusty, squally weather, abrupt onset. Near freezing temperatures. Summer: winds 17 to 27 kt, extreme events 41 to 47 kt, may last several days.	c. Gusty, squally condit at anchor. Close in anc protection. Anchor drag er water. Significant i ages north of Island and

m Situations at the Port of Kithira, Greece -- All Seasons

PRECAUTIONARY/EVASIVE ACTION	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARDS
ıge southeast of the lighthouse most n SE'rly winds/waves. Anchorage l.ghthouse more protected from waves, but anchor dragging may occur SE'rlies. Anchorage northeast of es protection from S'rly winds and	a. Strong southerly winds are most often caused by cyclones and fronts approaching from the west, generally follow Genoa low development with intensification or secondary development in the Ionian Sea. Most rapid onset and strongest events will occur when systems approaching from the west intensify over the Ionian Sea. When they are associated with a strong Bora over the Adriatic Sea, systems over the Ionian Sea become most intense. If a cold surge dominates the area to the north, Ionian Sea cyclones will travel astward, if not cyclones will move northeastard.
ıge southeast of the lighthouse most n SE'rly winds/waves. Anchorage l.ghthouse more protected from waves, but anchor dragging may occur SE'rlies. Anchorage northeast of es protection from S'rly winds and	b. Sciroccos occur when North African depressions move northeastward over the Mediterranean Sea. To reach the Aegean Sea area a well developed 500 mb trough that extends from southern Europe across the Mediterranean into North Africa is necessary. Sciroccos bring low stratus, fog and drizzle, reduced visibility and occasional heavy rain. Gale force wind speeds are likely over exposed marine areas.
...y conditions may cause swinging ...e in anchorage maximizes terrain ...nor dragging will be toward deep- ...nificant improvement over anchor- ...sland and open sea areas.	c. Boras and Etesians are caused by steep gradients between high pressure over southeastern Europe and low pressure over the eastern Mediterranean. A cold air outbreak typically accompanies Boras and spring/autumn Etesians. The basic synoptic pattern at 500 mb is a migratory ridge and deepening trough in advance of the ridge moving eastward from western Europe. During autumn and winter the primary surface feature is a strong high moving southeastward from near Scotland, two days before onset over the Aegean, to over the Balkans on day of onset. A weak low over the Mediterranean moves eastward in advance of the onset. During the spring an intense low is located over Greece two days before the onset with ridging building behind the low. Summer Etesians develop when the thermal trough extending westward from Asia Minor along the southern coast of Turkey becomes most intense. Increasing cloudiness develops over the Balkan Peninsula the day before onset, generally altocumulus during July and August and thunderstorms during May-June and September-October.

Table 3.1. (cont

VESSEL LOCATION/ SITUATION AFFECTED	POTENTIAL HAZARD	EFFECT - PRECAUTIC
2. Small Boat Operations Most common in winter - occurs in Autumn and spring.	a. SE'rly winds/waves - Most hazardous conditions caused by migratory cyclones approaching from the west. Winds 34 to 47 kt, waves 10 to 13 ft. Rapid wind shift from east to southeast with abrupt increase in speed. Squalls over Bay, local wind waves out of phase with swell.	a. Small boat runs to/fr Alongside and well deck hazardous due to variati and deep water swell dir Operations inside harbor
Occur late winter into spring	b. S'rly winds/waves - Caused by Scirocco. Winds 22 to 33 kt, waves 4 to 7 ft. Dust and or "Red Rain" may occur.	b. Small boat operations ous, use due caution.
Occur all seasons	c. N'rly winds - Caused by Bora in winter, Etesian in summer. *Winter: strongest events,* 41-47 kt. Gusty, squally weather, abrupt onset. Near freezing temperatures. Summer: winds 17 to 27 kt, extreme events 41 to 47 kt, may last several days.	c. Small boat operations due to gusty, squally we *wind speeds and directio* problems. Large vessels anchor.

1. (continued)

CAUTIONARY/EVASIVE ACTION	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARDS
ns to/from anchorages curtailed. l deck operations additionally variations of local wind wave well directions and periods. harbor may be hazardous.	a. Strong southerly winds are most often caused by cyclones and fronts approaching from the west, generally follow Genoa low development with intensification or secondary development in the Ionian Sea. Most rapid onset and strongest events will occur when systems approaching from the west intensify over the Ionian Sea. When they are associated with a strong Bora over the Adriatic Sea, systems over the Ionian Sea become most intense. If a cold surge dominates the area to the north, Ionian Sea cyclones will travel eastward, if not cyclones will move northeastward.
rations outside harbor hazardich.	b. Sciroccos occur when North African depressions move northeastward over the Mediterranean Sea. To reach the Aegean Sea area a well developed 500 mb trough that extends from southern Europe across the Mediterranean into North Africa is necessary. Sciroccos bring low stratus, fog and drizzle, reduced visibility and occasional heavy rain. Gale force wind speeds are likely over exposed marine areas.
rations outside harbor hazardous ally weather. Rapidly changing irections will cause handling vessels likely to be swinging at	c. Boras and Etesians are caused by steep gradients between high pressure over southeastern Europe and low pressure over the eastern Mediterranean. A cold air outbreak typically accompanies Boras and spring/autumn Etesians. The basic synoptic pattern at 500 mb is a migratory ridge and deepening trough in advance of the ridge moving eastward from western Europe. During autumn and winter the primary surface feature is a strong high moving southeastward from near Scotland, two days before onset over the Aegean, to over the Balkans on day of onset. A weak low over the Mediterranean moves eastward in advance of the onset. During the spring an intense low is located over Greece two days before the onset with ridging building behind the low. Summer Etesians develop when the thermal trough extending westward from Asia Minor along the southern coast of Turkey becomes most intense. Increasing cloudiness develops over the Balkan Peninsula the day before onset, generally altocumulus during July and August and thunderstorms during May-June and September-October.

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Port Visit Information

May 1990. NOARL Meteorologists R. Fett and R. Miller met with Harbor Master Samias to obtain some of the information included in this port evaluation.

APPENDIX A

General Purpose Oceanographic Information

This section provides some general definitions regarding waves and is extracted from H.O. Pub. No. 603, Practical Methods for Observing and Forecasting Ocean Waves (Pierson, Neumann, and James, 1955).

Definitions

Waves that are being generated by local winds are called "SEA". WAVES that have traveled out of the generating area are known as "SWELL". Seas are chaotic in period, height and direction while swell approaches a simple sine wave pattern as its distance from the generating area increases. An in-between state exists for a few hundred miles outside the generating area and is a condition that reflects parts of both of the above definitions. In the Mediterranean area, because its fetches and open sea expanses are limited, SEA or IN-BETWEEN conditions will prevail. The "SIGNIFICANT WAVE HEIGHT" is defined as the average value of the heights of the one-third highest waves. PERIOD and WAVE LENGTH refer to the time between passage of, and distances between, two successive crests on the sea surface. The FREQUENCY is the reciprocal of the period ($f = 1/T$); therefore as the period increases the frequency decreases. Waves result from the transfer of energy from the wind to the sea surface. The area over which the wind blows is known as the FETCH, and the length of time that the wind has blown is the DURATION. The characteristics of waves (height, length, and period) depend on the duration, fetch, and velocity of the wind. There is a continuous generation of small short waves from the time the wind starts until it stops. With continual transfer of energy from the wind to the sea surface the waves grow with the older waves leading the growth and spreading the energy over a greater range of frequencies. Throughout the growth cycle a SPECTRUM of ocean waves is being developed.

A Beaufort Scale table with related wave effects is shown on the following page.

BEAUFORT SCALE

Beaufort Number	Wind Speed Knots	Wind Speed MPH	Seaman's term	Effects observed at sea	Term and height of Waves in meters
0	Under 1	Under 1	Calm	Sea like mirror.	Calm, glassy, 0
1	1-3	1-3	Light air	Ripples with appearance of scales; no foam crests.	
2	4-6	4-7	Light breeze	Small wavelets; crests of glassy appearance, not breaking	Rippled, less than 0.5
3	7-10	8-12	Gentle breeze	Large wavelets; crests begin to break; scattered whitecaps.	Smooth, 0.5
4	11-16	13-18	Moderate breeze	Small waves, becoming longer; numerous whitecaps.	Slight, 1.0
5	17-21	19-24	Fresh breeze	Moderate waves, taking longer form; many whitecaps; some spray.	Moderate, 1.0-2.5
6	22-27	25-31	Strong breeze	Larger waves forming; whitecaps everywhere; more spray.	Rough, 2.5-4.0
7	28-33	32-38	Moderate gale	Sea heaps up; white foam from breaking waves begins to be blown up in streaks.	
8	34-40	39-46	Fresh gale	Moderate high waves; edges of crests begin to break; foam is blown in steaks.	Very rough, 4.0-6.0
9	41-47	47-54	Strong gale	High waves; sea begins to roll; dense streaks of foam; spray may reduce visibility.	
10	48-55	55-63	Whole gale	Very high waves with overhanging crests; sea takes white appearance as foam is blown in very dense streaks; rolling is heavy and visibility reduced.	High, 6.0-9.0
11	56-63	64-72	Storm	Exceptionally high waves; sea covered with white foam patches; visibility still more reduced.	Very high, 9.0-13.5
12 13 14 15 16 17	64-71 72-80 81-89 90-99 100-108 109-118	73-82 83-92 93-103 104-114 115-125 126-136	Hurricane	Air filled with foam; sea completely white with driving spray; visibility greatly reduced. Winds of force 12 and above very rarely experienced on land; usually accompanied by widespread damage.	Phenomenal, greater than 13.5

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