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FOREWORD

1. PURPOSE AND SCOPE

Marine Corps Warfighting Publication (MCWP) 3-35.7, *MAGTF Meteorological and Oceanographic Support*, provides the information needed by Marines to understand, plan, and conduct Marine air-ground task force (MAGTF) meteorological and oceanographic (METOC) operations. The focus of MCWP 3-35.7 is METOC effects on operations and missions. It addresses METOC planning requirements, command relationships, METOC support capabilities, and external support requirements. Detailed information is provided on:

- METOC support organization and structure
- Sample METOC support products
- Weather and oceanographic effects on MAGTF operations
- Meteorological critical values
- Sample Annex H (METOC Services) for operation orders and plans.

2. SUPERSESSION

MCWP 3-35.7 is a new publication.

3. CERTIFICATION

Reviewed and approved this date.

BY DIRECTION OF THE COMMANDANT OF THE MARINE CORPS

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To Our Readers

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Unless otherwise stated, whenever the masculine or feminine gender is used, both men and women are included.

MAGTF Meteorological and Oceanographic Support

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Chapter 1

Introduction

"Know the enemy, know yourself;
Your victory will never be endangered.
Know the ground, know the weather;
Your victory will then be total."
— Sun Tzu, *The Art of War*

1001. General

Weather and oceanographic conditions are factors over which commanders have no control but that have the potential to affect every combatant, piece of equipment, and operation. Weather becomes more significant to success in the modern battlespace as advanced technological weapons and support systems are fielded because of their vulnerability to adverse weather. Effective oceanographic information and support is especially critical to Marine expeditionary forces (MEFs) as they seek broader and bolder operational opportunities to project combat power from the sea. Many battles and campaigns have been won or lost as a result of the impact of weather. Although commanders have no control over these factors, they can take advantage of weather and oceanographic conditions or minimize their effects through planning and training. To do so, commanders and planners need support from meteorological and oceanographic (METOC) elements operating from the tactical to the national and international levels.

1002. Mission

The mission of the Marine Corps METOC Service is to provide meteorological, oceanographic, and space environmental information, products, and services that are required to support Marine Corps operations and other military operations as may be directed.

1003. Historical Perspective

Weather and oceanographic support is critical to tactical operations and operational-level planning. History is replete with examples of the weather's and oceanography's effects on the timing, as well as the success or failure, of military operations on a variety of battlefields. Some examples are the Spanish Armada, the Battle of Trenton, Hitler's attempt to take Moscow, the Battle of Stalingrad, Tarawa, Operation Overlord, the Battle of the Bulge, the Chosin Reservoir, and the Inchon Landing. The battlespace of tomorrow will provide examples of victories and defeats that are attributable to the skillful integration, or lack of integration, of weather in military planning and the execution of combat operations.

1004. General Principles

The following principles comprise the cornerstone of METOC support in all operations. By applying these principles, METOC support is better prepared to enhance and sustain operations. These principles include:

- Accuracy of data and information
- Timeliness of data and information
- Relevance to the operational user
- Unity of effort
- Readiness
- Evaluation of effectiveness.

a. Accuracy of Data and Information

Commanders depend on accurate weather and oceanographic information to plan and direct their operations. Inaccurate information can cost lives, undermine the successful execution of an operation or mission, waste resources, and impair readiness. This is true anytime—whether at peace or at war. The complexity of the mission and amount of detail required; the capability to collect data and model and forecast the weather, sea, and coast conditions; the perishable nature of such data; and human error all affect accuracy. Therefore, METOC information will never be totally free of inaccuracies. These factors must be explained and quantified to decisionmakers so that they may place an appropriate weight and level of confidence on them when making decisions.

b. Timeliness of Data and Information

Marine air-ground task force (MAGTF) METOC support is effective when a commander receives accurate weather and oceanographic information in time to consider its impact on the decision to be made. METOC information that could influence an operation is worthless when the commander receives it after an opportunity has passed, an irreversible decision has been made, or an operation is complete. Communication links are vital to support and sustain the timely dissemination of METOC information and are key to the overall capability and success of MAGTF METOC operations.

c. Relevance to the Operational User

METOC support provides commanders and planners with an understanding of the weather, sea, and coastal situations and the impact of these on threat operations. It bears on each echelon's current, planned, and alternate courses of action (COAs). METOC personnel and those supporting METOC operations must tailor the information for specific applications and missions so that the user can quickly identify and apply relevant information without additional analysis or manipulation. Attaining this goal requires METOC personnel to understand operational user needs and implies a user's responsibility to identify specific METOC information requirements for content, form, medium, presentation, timeliness, and frequency of delivery.

d. Unity of Effort

Weather information that influences a commander's decision usually cannot be derived from data obtained from a single source. Instead, METOC data from many sources must be assembled into a database. That database contains a complete and integrated summary of weather and oceanographic conditions over an extended region and time that affect the area that is of interest to the commander. To accomplish this task, METOC organizations at all levels must have clearly defined functions that eliminate duplication, maximize sharing of information, and are mutually supportive of the overall METOC support concept. The responsibilities of each organization must be clear, explicit, and understood by all.

e. Readiness

METOC units, databases, products, and equipment must be responsive to the requirements of commanders and their forces. All METOC resources must be maintained in a degree of readiness that ensures employment capability commensurate with the unit's mission.

f. Evaluation of Effectiveness

The overall effectiveness of METOC support is based on the successful and effective accomplishment of specific military missions. Each METOC or supporting unit must evaluate effectiveness on the basis of the principles stated above. This requires METOC organizations at all levels to be fully integrated into all unit planning and operations. Such interaction leads to mutual understanding and trust throughout the warfighting team.

g. Methods of Providing Weather Support

(1) Direct Support. Direct weather support occurs when a MAGTF METOC unit is organized under the operational control of the supported commander. Traditionally, most MAGTF METOC support has been located within the aviation combat element (ACE) and focused on providing meteorological support. Other MAGTF units requiring METOC support for tactical operations would request support through the chain of command to the MAGTF command element (CE). If directed, METOC forces would be provided on the basis of mission priorities, or other support arrangements would be established.

(2) General Support. At units without organic or direct support METOC elements, METOC support is provided via general support. Units will verify and relay METOC information requirements to higher headquarters (HQ). Some organic support may still come from observations that may be taken by the unit intelligence officer, ground reconnaissance units, or artillery regimental HQ meteorological personnel. However, the preponderance of METOC information to such units will be provided via general support by external organizations. Communications capabilities are improvements on the usefulness of METOC general support. The current capability of using message text formats to satisfy weather customer needs will evolve to include graphics exchange. Editable graphics are constructed from file transfers of the databases. When this capability matures, commanders and planners will be able to query the METOC database when desired, construct graphics from the query, and tailor the results for their planning and decisionmaking needs.

1005. Planning Considerations

METOC information is as much a part of intelligence as enemy and terrain data. It is often as significant as enemy intentions and trafficability. It affects enemy actions and the decisions of both forces. Adverse weather and oceanographic conditions affect mobility; decrease the ability to see and attack deep; degrade electro-optical systems; increase the requirement for thoroughly integrated air, ground, logistic, and command and control operations; and slow the movement of supplies and reinforcements. Therefore, commanders must be aware of and prepare for general and specific effects of the weather and oceanographic conditions on enemy and friendly major weapons systems and operations. This includes evaluating plans to minimize adverse METOC effects on friendly forces and to maximize the effects on the enemy. Timely and accurate METOC estimates enable commanders to effectively plan and execute the operations.

a. Combat Power

Combat power is the total destructive force that we can bring to bear on our enemy at a given time. It is made up of many components, each with its own unique weather and oceanographic sensitivities. To employ these component forces for maximal effect in the battlespace, commanders must be knowledgeable of weather and oceanographic conditions and their effects on the different aspects of combat power.

b. Concentration and Speed

If commanders are knowledgeable of METOC effects on the enemy and friendly forces, then timely and accurate METOC estimates and support will enable them to consolidate their forces and respond more rapidly than the enemy.

c. Surprise and Boldness

Changing METOC conditions provide both sides with windows of opportunity and vulnerability. Defenders use these windows to set the terms of battle, defeat the enemy attack, and seize the initiative. Attackers use these windows to enhance the attack and carry the battle to the enemy through bold but calculated offensive operations.

d. Exploiting Vulnerability and Opportunity

Vulnerability is often uncertain, and opportunity is fleeting. As the depth of the battlefield is extended in space and time, it becomes more likely that

weather and oceanographic conditions will vary, opening and closing windows of opportunity and vulnerability.

1006. Conclusions

The weather and oceanographic conditions affect military operations. Each has different effects on various types of forces and, in some cases, dictates the types of forces that can be employed effectively. METOC data is part of the intelligence required by MAGTF commanders and staffs to plan and execute operations. That intelligence results from analyzing weather data, identifying weather effects, and assessing the impact of weather on Marine Corps systems, tactics, and operations to provide vital information for commanders to optimally employ their forces. As such, the requirement for on-scene dedicated METOC support cannot be overstated. Weather and changing oceanographic processes can affect all types of Marine Corps operations, including operational maneuver across the range of military operations. Each element of a MAGTF, as well as each echelon of command, has a wide range of functions and responsibilities with many unique METOC information and support requirements. MAGTF METOC operations, products, and services must support them all.

Chapter 2

METOC Support Systems and Functions

2001. METOC Support Network

The global crisis response capability of the MAGTF requires an extensive network of weather observers, analysts, and forecasters. The network consists of the weather and oceanographic services of each friendly country, the U.S. Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), and Department of Defense (DOD) METOC units within the Army, Navy, Air Force, and Marine Corps.

2002. Capabilities and Limitations

METOC services provide observation network and related facilities. Peacetime cooperation among nations for weather services provides global and hemispheric analyses in support of military operations anywhere in the world. During wartime, METOC control and other security restrictions may drastically limit the availability of other national and indigenous METOC information. U.S. military METOC services and units are specialized organizations with worldwide capabilities that are structured to satisfy unique military requirements. They exchange METOC data with national weather services and have access to national and international weather and oceanographic databases. Characteristics of the military METOC services are mobility, responsiveness to command, and combat readiness.

2003. Naval METOC Support System

The Naval METOC Support System includes all Navy and Marine Corps units that contribute oceanographic, meteorological, and hydrographic observations or services; the activities assigned to the Naval METOC Command (NAVMETOCCOM); and a very limited number of other meteorology- or oceanography-oriented activities, such as the Naval Oceanographic and Atmospheric Research Laboratory and its atmospheric directorate.

a. Naval METOC Command

The NAVMETOCCOM, located at Stennis Space Center, Mississippi, is organized to collectively provide global METOC support to the fleet through its regional centers, which include:

- The Naval Atlantic METOC Center (NAVLANTMETOCCEN), which is located in Norfolk, Virginia
- The Naval Pacific METOC Center (NAVPACMETOCCEN), which is located at Pearl Harbor, Hawaii
- The Naval Pacific METOC Center West (NAVPACMETOCCENWEST), which is located in Guam
- The Naval European METOC Center (NAVEURMETOCCEN), which is located in Rota, Spain.

These regional centers have subordinate facilities and detachments throughout their geographical areas of responsibility. The regional centers are the primary sources of METOC support for forces afloat.

b. Fleet Numerical METOC Center

The Fleet Numerical METOC Center (FNMOC), located in Monterey, California, is the master computer center for the Naval METOC Support System and the hub of the Naval Environmental Data Network. It is linked with the data collection and distribution networks of the Air Force, NOAA, and the World Meteorological

Organization (WMO). It is responsible for generating and distributing basic and applied numerical (computer) METOC products for use by regional centers and other users throughout the fleet and the DOD. The Navy Oceanographic Data Distribution Expansion System (NODDES) is the primary means of distributing the center's products.

c. Naval Oceanographic Office

The Naval Oceanographic Office (NAVOCEANO), located at Stennis Space Center, plans, organizes, and executes multidisciplinary ocean surveys and geospatial information and services (GI&S) programs in support of DOD and Department of the Navy (DON) operational requirements and other assigned technical programs by using assigned ships, aircraft, and other platforms, including spacecraft. It is the primary oceanographic production center for the Navy and is responsible for receiving and processing satellite data in support of fleet operations. The NAVOCEANO also provides near-real-time oceanographic products, including detailed front and eddy analysis, and guidance to naval regional METOC centers and command centers worldwide in support of fleet operations.

2004. Marine Corps METOC Support System

The Marine Corps METOC Support System is designed to readily deploy and operate in an austere expeditionary environment. It is intended to provide comprehensive METOC support to all elements of a MAGTF, as well as to the bases and stations of the supporting establishment. This system is designed to interconnect and maximize the support available from naval, joint, and other METOC sources. The system will be augmented by data that is observed, collected, modeled, and reported by organic Marine Corps METOC assets and other Marine Corps assets, such as the topographic platoons, MAGTF all-source fusion center (MAFC), and ground and aviation reconnaissance units. The primary function of the Marine Corps METOC Support System is to provide accurate, timely, and comprehensive METOC support that enhances MAGTF mission accomplishment through tactical exploitation of the environment.

2005. Marine Corps Staff METOC Personnel

a. Commandant of the Marine Corps, Deputy Chief of Staff, Aviation, Aviation Logistics Support Branch

This position is staffed by the senior weather service officer in the Marine Corps. This special staff officer acts as the 6800 occupation field specialist and action officer. This is the cognizant officer for Marine Corps METOC support requirements.

b. Space and Naval Warfare Systems Command

This external billet is responsible for ensuring that validated U.S. Marine Corps (USMC) METOC requirements are satisfied. This officer also provides technical assistance regarding USMC operations to other METOC project officers within and external to the METOC Systems Office. The METOC Systems Office plans and manages the design, development, procurement, and life-cycle support of hardware and software systems that measure, transmit, distribute, and process METOC data.

c. Marine Liaison, Commander, Naval METOC Command

This special staff officer acts as the liaison for METOC programs and policies between the Navy and the Marine Corps. This officer is responsible for advising the commander on issues that affect littoral and expeditionary warfare operations; the Marine Corps' METOC support requirements for the CE, ACE, ground combat element (GCE), and combat service support element (CSSE); and interaction with joint command staffs. This billet is located within the joint operations division of the operations directorate (N-3).

d. Marine Liaison, Naval Oceanographic Office

The responsibilities of the Marine staffing this billet include the development, management, and maintenance of Commander, Naval METOC Command (CNMOC) METOC equipment support programs; assistance in identifying and developing training materials; participation in matters concerning the Office of the Federal Coordinator of Meteorology (OFCM); evaluation and testing of new hardware and software; participation as a member of mobile training teams for newly procured CNMOC-provided METOC equipment; and performance of other Marine Corps-associated duties as may be assigned.

2006. MAGTF METOC Personnel

MAGTF METOC personnel provide information on the past, present, and future states of the METOC environment within which aircraft, weapons systems, and Marines operate. Resident within the MEF CE's intelligence section and Marine wing support squadrons (MWSSs), they are an integral part of the MAGTF. The Marine Corps weather organization consists of two operational chains of command—one for the Fleet Marine Force (FMF) and the other for the Marine Corps air station (MCAS) and Marine Corps air facility (MCAF). (See Appendix C.)

a. Marine Forces Pacific/Marine Forces Atlantic METOC Officer

The Marine Corps Forces, Pacific (MARFORPAC) and Marine Corps Forces, Atlantic (MARFORLANT) METOC officer billet is currently an additional duty for the senior weather service officer closest to these HQ. The MARFORPAC/MARFORLANT METOC officer performs the following functions:

(1) Advises and assists the commanding general in the execution and management of METOC resources by planning, coordinating, and validating the collection, evaluation, interpretation, and dissemination of METOC data.

(2) Maintains liaison with other-Service counterparts and represents the commanding general at joint Service METOC meetings.

(3) Maintains staff cognizance and management coordination for weather-related matters.

(4) Serves as the Marine Corps senior METOC officer when the HQ deploys.

(5) Conducts staff studies directly related to improving MAGTF warfighting capabilities.

(6) Prepares and presents staff- and command-level briefings.

(7) Provides staff support in planning for the employment and utilization of organic METOC assets, equipment, and capabilities.

(8) Provides climatological, meteorological, tidal, astronomical, and other METOC data for planning.

(9) Develops and prepares the METOC annex (Annex H) for operation plans/orders and provides input into the communications and information systems annex (Annex K), the intelligence annex (Annex B), and other annexes, as necessary, regarding METOC issues.

b. MEF METOC Officer

The staff weather officer (SWO) serves within the G-2 section under the cognizance of the intelligence operations officer. As such, he serves as a technical expert for the MEF commander on all METOC-related matters. The MEF METOC officer performs the following functions:

(1) Advises and assists the commanding general in the execution and management of METOC resources by planning, coordinating, and validating the collection, evaluation, interpretation, and dissemination of METOC data.

(2) Coordinates with the MARFORPAC/MARFORLANT METOC officer on METOC-related matters.

(3) Maintains liaison with other-Service counterparts and represents the commanding general at joint Service METOC meetings.

(4) Maintains staff cognizance and management coordination for METOC-related matters.

(5) Provides METOC support to intelligence and staff studies directly related to improving MAGTF warfighting capabilities.

(6) Provides staff support in planning for the employment and utilization of organic METOC assets, equipment, and capabilities.

(7) Provides climatological, meteorological, tidal, astronomical, and other METOC data for planning.

(8) Develops, prepares, and updates the METOC annex (Annex H) for operation plans/orders and provides input into the communications and information systems annex (Annex K), the intelligence annex (Annex B), and other annexes, as necessary, regarding METOC issues.

(9) Serves as the joint METOC officer (JMO) during joint operations/exercises when the MEF CE is assigned the role and responsibilities of joint task force (JTF) HQ.

c. Marine Wing Support Group METOC Officer

The Marine wing support group (MWSG) METOC officer:

(1) Coordinates all METOC assets that reside in the ACE.

(2) Provides METOC briefings to ACE commanders and their staffs to support current and future operations.

(3) Provides METOC effects information with particular attention to critical weather threshold values that limit systems, operations, or tactics.

(4) Advises commanders of METOC support capabilities and limitations and coordinates effective methods of providing support to plan and carry out MAGTF operations.

(5) Prepares METOC annexes to operation plans and orders and reviews METOC annexes of senior and subordinate commands to ensure that stated responsibilities are coordinated and met.

(6) Prepares climatological studies and analyses in support of planned exercises, operations, and commitments.

(7) Provides METOC support to elements of the MAGTF other than the ACE as directed.

(8) Assists in determining METOC support data requirements.

(9) Coordinates METOC training.

d. Marine Wing Support Squadron METOC Officer

This officer is responsible for training and carrying out the plans and missions as prepared by higher HQ. Responsibilities include:

(1) Receiving, monitoring, and analyzing METOC data to produce tailored, value-added information for supported units.

(2) Operating all METOC equipment, including satellite receivers, radar, or other available weather display equipment used as the basis for weather forecasting and observing.

(3) Preparing and disseminating forecasts. Forecast services include providing:

- Forecasts focused on specific missions, locations, and weather parameters critical to current operations and for future planning
- Forecasts of upper-air winds
- Forecasts of temperature and precipitation amounts to support terrain team hydrographic and trafficability predictions
- Data for chemical downwind messages
- Tailored forecasts for dissemination to supported MEF weather support teams
- Forecasts and observations to air traffic control (ATC)
- Weather products for intelligence preparation of the battlespace (IPB)
- Weather warnings for mission areas and deployed locations
- Aviation flight weather briefings in support of ACE missions.

(4) Ensuring the combat readiness and mission capability of METOC personnel and equipment.

e. MEF Weather Support Team METOC Officer

MEF weather support teams are sourced from the MWSS. When a MEF weather support team is attached to or placed in direct support of another MAGTF element, its officer in charge is responsible for weather support, including:

(1) Advising and assisting the CE, GCE, CSSE, or Marine expeditionary unit (MEU) commander and staff on METOC matters relative to their operations.

(2) Establishing and implementing policies governing METOC support services provided by the MEF weather support team.

(3) Coordinating with higher METOC echelons as appropriate to meet operational requirements of the supported MAGTF element.

Chapter 3

METOC Support to the MAGTF

3001. MAGTF METOC Support Concept of Operations

Upon the employment of a MAGTF, tactical METOC support will transition from garrison-based to on-scene METOC support. Naval METOC centers will retain responsibility for the provision of weather facsimile support; METOC gridded field data; wind, sea, and tropical cyclone warnings and advisories; and area oceanographic support. Tailored on-scene METOC support is available from METOC assets organic to the MAGTF CE and ACE. MEF weather support teams from the MWSSs are task organized to provide direct support to commanders and staffs of MAGTF elements other than the ACE, that is, the CE, the GCE, the MEU, and the CSSE. MAGTF elements should forward unique tactical METOC requirements via the chain of command to the ACE instead of requesting personnel and equipment directly. The MWSS, equipped with a meteorological mobile facility (METMF) complex, is normally deployed to a forward operating base (FOB) in direct support of that airfield.

3002. METOC Support Principles

METOC support for MAGTF tactical operations is based on the following principles:

- Weather and oceanographic effects must be considered by commanders and planners during all operational phases to determine the best COA to accomplish the mission and METOC effects on estimated threat operations.
- Accuracy of weather forecasts depends on the density and timeliness of weather observations. Because of continuously changing atmospheric conditions, weather information is highly perishable. Weather forecasts must be monitored and updated continually. All weather observations, surface and aloft, particularly those taken beyond forward units, must have high priority and be rapidly disseminated to all MAGTF elements.
- The accuracy of oceanographic, particularly surf zone, estimates must be confirmed shortly before any surface assault (e.g., by ground reconnaissance, sea-air-land (SEAL) teams, or unmanned aerial vehicle (UAV) forces).
- Timely, reliable communication is critical to effective METOC support.
- During joint and combined operations, warfighters must be presented with a common tactical picture of the environment and its effects on operations. Close coordination between METOC support providers throughout and supporting the JTF is required.

3003. METOC Support Requirements

Requirements for METOC support vary between the operational and tactical level and between the CE, GCE, ACE, and CSSE.

a. The Command Element

The MEF HQ requires forecasts of critical METOC elements (such as flying and surf conditions, current and tide conditions, and warnings of extreme and dangerous weather conditions) at least 72 - 96 hours before an operation, as well as periodic updates throughout execution.

b. The Ground Combat Element

The GCE requires METOC support in the form of estimates and graphic products that can be used for planning and decisionmaking. There is also a requirement for general weather forecasts that cover the following 24 - 48 hours and are focused on ground combat-related weather elements and coastal and sea data such as:

- Tidal, current, and surf data
- Beach slope, water depth, surf zone, and surf breaker description
- Severe weather warnings
- Horizontal visibility and obstructions to vision
- Astronomical data (sunrise, sunset, beginning of morning nautical twilight (BMNT), end of evening nautical twilight (EENT), moonrise, moonset, lunar illumination)
- Precipitation rate and type
- Ambient air temperature and humidity
- Extreme heat or cold
- Surface wind speed and direction
- Cloud cover
- Freeze/thaw depth
- Ice/snow depth
- Wet bulb globe temperature index (WBGTI)—an index used to determine heat stress conditions
- Windchill index
- Barometric tendencies
- Upper-air refractivity indices (used in providing tactical decision aids (TDAs) for detection ranges and radars)
- Upper-air temperatures, winds, and heights.

c. The Aviation Combat Element

The ACE requires precise current weather information for every aircraft flight and forecasts for the following 72 - 96 hours for the entire area of operations. Aviation units are concerned with weather conditions at widely dispersed departure airfields, weather conditions en route to destinations and targets, and conditions at the arrival airfield or over the target areas. In addition to the weather elements required by the GCE, the ACE requires precise aviation-related weather elements such as:

- Altimeter settings
- Ceiling height
- Pressure altitude (PA) and density altitude (DA)
- Cloud base/cloud top height
- Upper-air temperatures, winds, and heights
- In-flight icing and turbulence conditions
- Severe weather briefings.

d. The Combat Service Support Element

The CSSE's operations are heavily influenced by extreme weather conditions. Both extreme heat and cold can put added stress and strain on MAGTF equipment and create additional requirements for maintenance and spare parts. Heavy precipitation can make outside storage difficult. Severe weather can degrade the existing road system, thereby affecting trafficability, mobility, and construction efforts and, in the case of heavy icing or snow buildup, making it impassable. Unfavorable sea state conditions can make landing support and logistics over the shore operations much more difficult. Generally, the CSSE's specific weather and oceanographic information requirements are the same as those of the GCE.

3004. Tasks and Responsibilities

a. The Command Element

The CE has no organic METOC data collection assets or forecasting capability. It depends on the ACE or external units for operational METOC support. Such support will be coordinated and obtained by the SWO within the MEF intelligence section. The MAGTF commander's responsibilities are to:

- Coordinate with the ACE commander to ensure that the ACE's METOC support requirements are met

- Provide logistical and communications support to the attached MEF weather support team
- Integrate weather analysis into future planning and current operations
- Provide critical or threshold values for determining and assessing the weather effects on threat weapons systems, tactics, capabilities, and estimated COAs
- Integrate climatological, meteorological, and oceanographic estimates into IPB and analyze resulting intelligence products.

Marine ground reconnaissance forces may conduct special missions to gather meteorological, geographic, and hydrographic reconnaissance in support of specific aerospace, land, or maritime operations (beach gradients, obstacles (natural and manmade), tide and surf, depths of water, contour of the sea bottom, routes of exit from the beaches, and soil trafficability).

b. The Ground Combat Element

The GCE provides limited but vital METOC support in the form of upper-air data from its artillery forces and surface weather observations from all GCE forces (particularly ground reconnaissance and combat engineer forces). However, it depends on the ACE for specialized METOC support. The GCE commander's responsibilities are to:

- Identify METOC requirements to the MAGTF CE and coordinate with the ACE to ensure that tactical METOC support requirements are known and satisfied
- Provide logistical and communications support to the attached MEF weather support team
- Provide surface observations and all upper-air observations beyond forward troops and relay the data to the ACE and MAGTF CE
- Provide critical or threshold values for determining the weather effects on GCE weapons systems, tactics, and operations
- Assess the impact of weather effects on GCE weapons systems, tactics, and operations
- Integrate weather and oceanographic analysis into future planning
- Provide trafficability and hydrographic forecasts.

c. The Aviation Combat Element

The ACE provides the majority of METOC support required by the MAGTF. To do so effectively, it requires numerical products from the FNMOC, regional center support, satellite data, and access to both surface and upper-air data from the Air Force, Navy, and allied meteorological services, as well as data furnished by MAGTF sources. The ACE commander's responsibilities are to:

- Plan and coordinate tactical METOC support requirements for the ACE and, as directed, elements of the MAGTF in accordance with the MAGTF commander's priorities
- Provide MEF weather support teams to support each element, as required
- Provide METOC personnel with the technical training and skills necessary to support MAGTF operations
- Integrate weather analysis and estimates into future planning and current operations
- Assess the general effect of weather on weapons systems, tactics, and operations on the basis of critical values identified by each element
- Provide weather and oceanographic observations, forecasts, staff support, and timely advisories or warnings of expected weather that may adversely affect MAGTF operations or that could be a hazard to personnel or materiel

- Ensure rapid dissemination of METOC products and services
- Provide weather support products for use in soil trafficability and hydrographical predictions
- Provide climatological support for tactical missions, IPB, and tactical decisionmaking aids
- Provide light and tidal data
- Provide atmospheric and astronomical information affecting radar, communications, and electro-optical weapons systems
- Conduct liaison with naval METOC centers and other external METOC elements for special tactical support requirements beyond inherent capabilities
- Collect and disseminate METOC data obtained from mission reports and in-flight reports by using the target weather information (TARWI) code.

d. The Combat Service Support Element

The CSSE provides limited but vital METOC support in the form of surface weather and trafficability reports. However, it depends on external units for most METOC support. The CSSE commander's responsibilities are to:

- Coordinate with the MAGTF CE and ACE to ensure that its METOC support requirements are identified and satisfied
- Provide logistical and communications support to the attached MEF weather support team
- Integrate METOC analysis and estimates into future planning and current operations
- Provide critical or threshold values for determining the weather effects on CSSE systems and operations
- Assess the impact of weather effects on CSSE systems and operations and MAGTF-wide combat service support (CSS).

3005. METOC Support Capabilities

The METOC section within the MEF intelligence section and the MWSS weather section in the ACE are organized and structured to support a variety of MAGTF- and ACE-specific operations/deployments. These organizations are manned and equipped to be used in a variety of ways, contingent on the size, scope, and mission of the MAGTF. Dedicated METOC support is available for all MAGTF elements from within the ACE. However, a greater level of METOC support is normally required by, and therefore dedicated to, ACE operations.

a. Meteorological Mobile Facility

The highest level of METOC support to the MAGTF is the deployment of the METMF. The METMF provides a METOC support capability similar to that found in garrison METOC facilities, is normally deployed as part of an entire MWSS, and is the only realistic option for large-scale MAGTF operations. Once established ashore, the MWSS may use a MEF weather support team to forward base personnel and equipment in support of ACE units that are separated from the main airbase. This redeployment also provides the METMF with a forward data collection capability that significantly enhances overall support efforts to the entire MAGTF.

b. MEF Weather Support Team

Part of the MWSS table of organization (T/O) is dedicated to the formation of MEF weather support teams. These MEF weather support teams are task organized to provide a limited level of METOC support. Consisting of a weather officer, two forecasters, and two observers, these teams are directly attached to the elements that they are tasked to support and rely on those elements for logistical and communications support. MEF weather support teams do not have a standalone

METOC capability. Instead, during operations they get METOC products from the nearest deployed METMF or other METOC support organizations to satisfy the supported units' METOC information requirements.

3006. METOC Communications and Information Systems Requirements

An area of METOC operations that is currently undergoing substantial change is METOC communications and information systems architectures. The efforts of METOC personnel depend heavily on a secure, reliable, and fast communications and information systems architecture to exchange METOC information with the joint METOC forecast unit (JMFU), other component METOC units, METOC regional and production centers, and MAGTF elements. Integration of METOC communications and information systems requirements into MAGTF communications planning will provide the conduit for reliable exchange of situational and forecast information and ensure that time-perishable METOC information may be obtained, processed, and disseminated when needed. Each mission and situation is unique and, therefore, requires some modifications to the supporting communications and information systems architecture. Detailed planning and close coordination between the SWO, the MAGTF G-2/S-2, and the G-6/S-6 are critical for establishing a reliable and effective METOC communications and information systems architecture. Specific systems and technical architectures (equipment, frequencies, communications nets, local area networks/wide area networks, and systems) are addressed in Marine Corps Warfighting Publication (MCWP) 6-22, *Communications and Information Systems*.

Appendix A

Glossary

Section I. Acronyms

Note: Acronyms change over time in response to new operational concepts, capabilities, doctrinal changes, and other similar developments. The following publications are the sole authoritative sources for official military acronyms:

1. Joint Pub 1-02, *DOD Dictionary of Military and Associated Terms*.

2. Fleet Marine Force Reference Publication (FMFRP) 0-14, *Marine Corps Supplement to the DOD Dictionary of Military and Associated Terms*. (This publication is being updated and will be published during fiscal year 1998 with the new designator of Marine Corps Reference Publication (MCRP) 5-2C.)

55SXS ..... 55th Space Weather Squadron

AAV ..... assault amphibious vehicle
AAVC ..... AAV, command model
AAVP ..... AAV, personnel model
AAVR ..... AAV, recovery model
ACCI ..... Air Combat Command instruction
ACCM ..... Air Combat Command manual
ACE ..... aviation combat element
AFCAT ..... Air Force catalog
AFCCC ..... Air Force Combat Climatology Center
AFDIGS ..... Air Force Digital Graphics System
AFDIS ..... Air Force Global Weather Central Dial-In Subsystem
AFI ..... Air Force instruction
AFJI ..... Air Force joint instruction
AFP ..... Air Force publication
AFTTP ... Air Force tactical training publication
AFWA ..... Air Force Weather Agency
AMCI ..... Air Mobility Command instruction
AOAFCST .. amphibious objective area forecast
AR ..... Army regulation
ARTYMET ..... artillery meteorological
ASLTFCST ..... assault forecast
ATC ..... air traffic control
AUTODIN ..... Automatic Digital Network
AVWX ..... aviation route weather forecast
AWDS ..... Automated Weather Distribution System
AWN ..... Automated Weather Network
AWS ..... Air Weather Service

BDA ..... battle damage assessment
BKN ..... broken
BMCT ..... beginning of morning civil twilight
BMNT ... beginning of morning nautical twilight
BSSG ..... brigade service support group

CAT ..... clear air turbulence
CE ..... command element
CJCSI ..... Chairman of the Joint Chiefs of Staff instruction
CJCSM .... Chairman of the Joint Chiefs of Staff manual
CLF ..... commander, landing force
CLR ..... clear
CNMOC ..... Commander, Naval METOC Command
COA ..... course of action
COMNAVSURFLANT ..... Commander, Naval Surface Force Atlantic
COMNAVSURFPAC ..... Commander, Naval Surface Force Pacific
CONOPS ..... concept of operations
COVER ..... IREPS coverage diagram
CRRC ..... combat rubber reconnaissance craft
CSS ..... combat service support

CSSE ..... combat service support element

DA ..... density altitude
DAS ..... direct air support
DEFCON ..... defense readiness condition
DMS ..... Defense Message System
DMSP ..... Defense Meteorological Satellite Program
DOD ..... Department of Defense
DON ..... Department of the Navy
DSN ..... Defense Switched Network

EECT ..... end of evening civil twilight
EENT ..... end of evening nautical twilight
EM ..... electromagnetic
EMCON ..... emission control
EMP ..... electromagnetic pulse
EOTDA .. Electro-Optical Tactical Decision Aid
ES ..... electronic warfare support
ESM ..... electronic support measure
ESP ..... environmental support packet

FAA ..... Federal Aviation Administration
FALOP ..... Forward Area Limited Observing Program
FARP ..... forward arming and refueling point
FLIR ..... forward looking infrared
FLTNUMMETOCCENINST ... Fleet Numerical METOC Center instruction
FLTNUMMETOC DET ..... Fleet Numerical METOC Detachment
FM ..... U.S. Army field manual
FMF ..... Fleet Marine Force
FMFRP ..... Fleet Marine Force reference publication
FNMOC ..... Fleet Numerical METOC Center
FOB ..... forward operating base
FTS ..... Federal Telephone System

GCE ..... ground combat element
GI&S ..... geospatial information and services

HMH ..... Marine heavy helicopter squadron
HMLA ..... Marine light attack helicopter squadron
HMM ..... Marine medium helicopter squadron
HQ ..... headquarters

IFR ..... instrument flight rules
IPB ..... intelligence preparation of the battlespace
IREPS ..... Integrated Refractive Effects Prediction System

JMFU ..... joint METOC forecast unit
JMO ..... joint METOC officer
JOTS ..... Joint Operational Tactical System
JTF ..... joint task force

LCAC ..... landing craft air cushion
LCM ..... landing craft, mechanized
LCU ..... landing craft, utility
LCVP ..... landing craft, vehicle, personnel

MACG ..... Marine air control group
MAFC ..... MAGTF all-source fusion center
MAG ..... Marine aircraft group
MAGTF ..... Marine air-ground task force
MARFORLANT ..... Marine Corps Forces, Atlantic
MARFORPAC ..... Marine Corps Forces, Pacific
MCAF ..... Marine Corps air facility
MCAS ..... Marine Corps air station
MCRP ..... Marine Corps reference publication
MCWP ... Marine Corps warfighting publication
MEF ..... Marine expeditionary force
MEF(FWD) ..... MEF (forward)
METMF ..... meteorological mobile facility
METOC ..... meteorological and oceanographic
METSAT ..... meteorological satellite
MEU ..... Marine expeditionary unit
MOPP ..... mission-oriented protective posture
MRS ..... Mini-Rawinsonde System
MSI ..... modified surf index
MST ..... Mountain Standard Time
MWSG ..... Marine wing support group
MWSS ..... Marine wing support squadron

NAI ..... named area of interest
NATO ..... North Atlantic Treaty Organization
NAVEURMETOCCEN ..... Naval European METOC Center
NAVLANTMETOCCEN ..... Naval Atlantic METOC Center
NAVMETOCCOM .. Naval METOC Command
NAVMETOCCOMINST ..... Naval METOC Command instruction
NAVOCEANO .... Naval Oceanographic Office
NAVPACMETOCCEN ..... Naval Pacific METOC Center
NAVPACMETOCCENWEST .... Naval Pacific METOC Center West
NBC ..... nuclear, biological, and chemical
NESDIS ..... National Environmental Satellite Data and Information Service
NFOV ..... narrow focus of vision
NOAA ..... National Oceanic and Atmospheric Administration
NODDES ..... Navy Oceanographic Data Distribution Expansion System
NODDS ..... Navy Oceanographic Data Distribution System
NOGAPS ..... Navy Operational Global Atmospheric Prediction System
NORAPS ..... Navy Operational Regional Atmospheric Prediction System
NOSC TD ..... Naval Oceanography Systems Command technical document
NWS ..... National Weather Service

OAAW ..... offensive antiair warfare
OFCM .... Office of the Federal Coordinator of Meteorology
OPORD ..... operation order
OPTASK ..... operational task
OVC ..... overcast

PA ..... pressure altitude
PCS ..... propagation conditions summary
PSYOP ..... psychological operation
PV ..... Platform Vulnerability
RGR ..... rapid ground refueling
RP ..... reference publication

SAM ..... surface-to-air missile
SCT ..... scattered
SEAD ..... suppression of enemy air defenses
SEAL ..... sea-air-land
SPOT ... *satellite pour l'observation de la terre*
STRKFCST ..... strike forecast
STU-III ..... secure telephone unit III
SWO ..... staff weather officer

T/O ..... table of organization
TAF ..... terminal aerodrome forecast
TAMPS .... Tactical Aviation Mission Planning System
TARWI ..... target weather information
TAS ..... tactical atmospheric summary
TC ..... technical catalog
TDA ..... tactical decision aid
TN ..... technical note
TOW ..... tube launched, optically tracked, wire command link guided missile

UAV ..... unmanned aerial vehicle
UGDF ..... uniform gridded data field
USAFETAC ..... U.S. Air Force Environmental Technical Applications Center
USMC ..... U.S. Marine Corps
UTC ..... Coordinated Universal Time

VFR ..... visual flight rules
VMA ..... Marine attack squadron
VMAQ ..... Marine tactical electronic warfare squadron
VMFA ..... Marine fighter attack squadron
VMGR ..... Marine aerial refueler transport squadron

WBGTI ..... wet bulb globe temperature index
WEAX ..... daily weather forecast (USMC)
WFOV ..... wide focus of vision
WMO ..... World Meteorological Organization
WSR ..... Weather Service regulation

Section II. Definitions

Note: Definitions of military terms change over time in response to new operational concepts, capabilities, doctrinal changes, and other similar developments. The majority of METOC terms are not defined in Joint Pub 1-02. Accordingly, the following publications are the authoritative sources for official definitions of METOC terms used within this publication:

1. Joint Pub 3-59, *Joint Doctrine for Meteorological and Oceanographic Support.*

2. COMNAVSURFPAC/COMNAVSURFLANT 3840.1B, *Joint Surf Manual*.

A

absolute humidity—The mass of water vapor in a given volume of air. It represents the density of water vapor in the air.

aerosols—Tiny suspended solid particles (dust, smoke, etc.) or liquid droplets that enter the atmosphere from either natural or human (anthropogenic) sources, such as the burning of fossil fuels.

air pressure (atmospheric pressure)—The pressure exerted by the weight of air above a given point, usually expressed in millibars or inches of mercury.

atmosphere—The air surrounding the Earth. (Joint Pub 1-02)

B

bar—A submerged or emerged embankment of sand, gravel, or mud built on the sea floor in shallow water by waves and current. May also be composed of mollusk shells. (*Joint Surf Manual*)

berm—The nearly horizontal portion of a beach or backshore having an abrupt fall and formed by deposition of material by wave action. Marks the limit of ordinary high tides. (*Joint Surf Manual*)

breaker—A wave tripped by shoaling water. Categorized as spilling, plunging, or surging. (*Joint Surf Manual*)

breaker angle—The angle at which a breaker makes the beach. (*Joint Surf Manual*)

C

ceiling—The height of the lowest layer of clouds when the weather reports describe the sky as broken or overcast.

clear air turbulence (CAT)—Turbulence encountered by aircraft flying through cloudless skies. Thermals, wind shear, and jet streams can be factors in producing CAT.

climatological forecast—A weather forecast, usually a month or more in the future, that is based on the climate of a region rather than on current weather conditions.

contrail (condensation trail)—A cloud-like streamer frequently seen forming behind aircraft flying in clear, cold, humid air.

D

deep water—Where water depth is greater than one-half the length of the wave. Deep water conditions are said to exist when the surface waves are not affected by bottom topography. (*Joint Surf Manual*)

density—The ratio of the mass of a substance to the volume occupied by it.

dew—Water that has condensed onto objects near the ground when their temperatures have fallen below the dewpoint of the surface air.

dewpoint temperature—The temperature to which air must be cooled (at constant pressure and constant water vapor content) for saturation to occur.

diffraction—The bending of light around objects, such as a cloud of fog droplets, producing fringes of light and dark or colored bands.

E

environmental services—The various combi- nations of scientific, technical, and advisory activities (including modification processes, i.e., the influence of manmade and natural factors) required to acquire, produce, and supply information on the past, present, and future states of space, atmospheric, oceanographic, and terrestrial surroundings for use in military planning and decisionmaking processes, or to modify those surroundings to enhance military operations. (Joint Pub 1-02)

F

fetch—The area over which ocean waves are generated by a wind with a constant direction and speed. (*Joint Surf Manual*)

G

gradient—The rate of inclination to horizontal expressed as a ratio, such as 1:25 indicating one unit of rise to 25 units of horizontal distance. Used to describe beach slope. (*Joint Surf Manual*)

I

infrared radiation—Electromagnetic radiation with wavelengths between about 0.7 and 1,000 mm. This radiation is longer than visible radiation but shorter than microwave radiation.

inversion—An increase in air temperature with height.

isobar—A line connecting points of equal pressure.

isotach—A line connecting points of equal wind speed.

isotherm—A line connecting points of equal temperature.
.

J

joint meteorological and oceanographic forecast unit—A flexible, transportable, jointly supported collective of METOC personnel and equipment formed to provide the JTF and joint force METOC officer with full METOC services. Also called JMFU. (*Joint Surf Manual*)

joint meteorological and oceanographic officer—Officer designated to provide direct METOC support to the JTF commander. Also called JMO. (*Joint Surf Manual*)

K

knot—A unit of speed equal to one nautical mile per hour. One knot equals 1.15 miles per hour.

L

littoral current—Current moving generally parallel to and adjacent to the shoreline. (*Joint Surf Manual*)

longshore bar—A ridge that runs generally parallel to the shore and is submerged by high tides. (*Joint Surf Manual*)

M

meteorological and oceanographic forecast center—Shore-based METOC production activity. (*Joint Surf Manual*)

meteorological data—Meteorological facts pertaining to the atmosphere, such as wind, temperature, air density, and other phenomena, that affect military operations. (*Joint Surf Manual*)

modified surf index (MSI)—A single dimensionless number that provides a relative measure of the conditions likely to be encountered in the surf zone. The MSI is a calculated value based on breaker type, period and height, speed of any littoral current, relative wind speed, and secondary wave height. (*Joint Surf Manual*)

modified surf limit—The maximum modified surf index at which routine operations should be attempted. Exceeding the limit is not feasible without increasing the casualty rate. (*Joint Surf Manual*)

O

offshore bar—A bar built principally by wave action on sand or gravel at a distance from shore and separated by a lagoon. Also known as a barrier bar. (*Joint Surf Manual*)

P

plunging breaker—A breaking wave that expends its energy suddenly. Characterized by a wave peaking into an advancing vertical wall of water. The crest curls far over and descends violently into the preceding trough. Easily identified by its explosive sound. (*Joint Surf Manual*)

precipitation—Any form of water particle, liquid or solid, that falls from the atmosphere and reaches the ground.

R

refraction—The deflection of a wave moving in shallow water at an angle to the depth contours that causes the advancing wave to bend toward alignment with the depth contours (as opposed to facing the shoreline directly). (*Joint Surf Manual*)

rip current—Narrow rips of water that flow out from the shore through the breaker line. Consists of feeder currents that flow parallel to the shore inside the breaker; a “neck,” which is the narrow stream that flows outward; and a head, where the current widens and dissipates. Speeds of up to two knots occur within the rip current. (*Joint Surf Manual*)

S

space environment—The region beginning at the lower boundary of the Earth’s ionosphere (approximately 50 km) and extending outward that contains solid particles (asteroids and meteoroids), energetic charged particles (ions, protons, electrons, etc.), and electromagnetic and ionizing radiation. (*Joint Surf Manual*)

space weather—Describes the environment and other natural phenomena above a 50-km altitude. (*Joint Surf Manual*)

swash—The rush of water up onto the beach following the breaking of a wave. Also known as uprush. (*Joint Surf Manual*)

swell—Ocean waves that have traveled out of their fetch. Swell characteristically exhibits a more regular and longer period with flatter crests than sea waves. (*Joint Surf Manual*)

W

wave crest—The highest part of a wave. (*Joint Surf Manual*)

wave height—The vertical distance between a wave trough and a wave crest. (*Joint Surf Manual*)

wavelength—The horizontal distance between successive wave crests measured perpendicular to the wave crests. (*Joint Surf Manual*)

wave period—The time required for a wave crest to traverse a distance equal to one wavelength. (*Joint Surf Manual*)

wave steepness—The ratio of wave height to wave length. (*Joint Surf Manual*)

wave trough—The lowest part of a wave between successive wave crests. (*Joint Surf Manual*)

wave velocity—The speed at which a wave form advances, usually expressed in knots. (*Joint Surf Manual*)

weather—The condition of the atmosphere at any particular time and place.

weather elements—The elements of air temperature, air pressure, humidity, clouds, precipitation, visibility, and wind that determine the present state of the atmosphere (the weather).

wind wave—A wave resulting from the action of wind on a water surface. While the wind is acting on it, it is a sea wave; thereafter, it is a swell. (*Joint Surf Manual*)

Appendix B

References and Related Publications

Joint Publications

Joint Pub 3-0	*Doctrine for Joint Operations*
Joint Pub 3-59	*Joint Doctrine for Meteorological and Oceanographic Support*
Joint Pub 5-03.1	*Joint Operation Planning and Execution System Vol. I, Planning Policies and Procedures*
Joint Pub 6-05.3	*Employment of Joint Tactical Communications Systems* (draft)
	Joint Meteorology and Oceanography (METOC) Training Handbook

Chairman of the Joint Chiefs of Staff Instruction (CJCSI)

CJCSI 3810.01	*Meteorological and Oceanographic Operations*

Chairman of the Joint Chiefs of Staff Manual (CJCSM)

CJCSM 3122.03	*Joint Operation Planning and Execution System Vol. II, Planning Formats and Guidance*

Marine Corps Publications

Marine Corps Warfighting Publications (MCWPs)

MCWP 2-1	*Intelligence Operations*
MCWP 3-1	*Ground Combat Operations*
MCWP 3-2	*Aviation Operations* (draft)
MCWP 4-1	*Logistic Operations* (draft)
MCWP 5-1	*Marine Corps Planning*

Navy Publications

CNMOC METOC Concept of Operations (CONOPS)

CNMOC METOC CONOPS	Naval Meteorology and Oceanography Command ltr 3140 ser 3/255 of 22 Oct 96

NAVMETOCCOM Instructions (NAVMETOCCOMINSTs)

NAVMETOCCOMINST 3140.1K	*United States Navy Meteorological & Oceanographic Support System Manual*
NAVMETOCCOMINST 3140.17A	*Policies Concerning the Provision of Meteorology and Oceanography Products and Services*

Fleet Numerical METOC Center Instruction (FLTNUMMETOCCENINST)

FLTNUMMETOCCENINST 3147.1	*Navy Oceanographic Data Distribution System Products Manual*

Fleet Numerical METOC Detachment (FLTNUMMETOC DET) Asheville Notice

FLTNUMMETOC DET Asheville Notice 3146	*Guide to Naval Meteorology and Oceanography Command Atmospheric Climatic Summaries, Products, and Services*

Commander, Naval Surface Force Pacific (COMNAVSURFPAC)/Commander, Naval Surface Force Atlantic (COMNAVSURFLANT) Manual

COMNAVSURFPAC/ COMNAVSURFLANT 3840.1B	*Joint Surf Manual*

Reference Publications (RPs)

RP 1	*Environmental Effects on Naval Weapons Systems and Naval Warfare* (Unclassified)
RP 33	*Fleet Oceanographic and Acoustic Reference Manual*
RP 50	*Catalog of Classified Naval Oceanographic Office Publications*
RP 51	*Catalog of Naval Oceanographic Office Unclassified Publications*

Naval Oceanographic Office Catalog

NAVOCEANO N03140	*METOC Products Available from Warfighting Support Center Classified Services Branch*

Army Publications

U.S. Army Field Manuals (FMs)

FM 1-230	*Meteorology for Army Aviators*
FM 6-15	*Tactics, Techniques and Procedures for Field Artillery Meteorology*
FM 34-81	*Weather Support for Army Tactical Operations*
FM 34-81-1	*Battlefield Weather Effects*
FM 34-130	*Intelligence Preparation of the Battlefield*

FM 100-5	*Operations*

Army Regulation (AR)/Air Force Joint Instruction (AFJI)

AR 115-10/AFJI 15-157	*Meteorological Support for the U.S. Army*

Air Force Publications

Air Force Instruction (AFI)

AFI 15-118	*Requesting Specialized Weather Support*

Air Force Catalog (AFCAT)

AFCAT 15-152	*Space Environmental Products*

Air Force Publication (AFP)

AFP 105-34	*JFACC*

U.S. Air Force Environmental Technical Applications Center (USAFETAC) Technical Catalog (TC)

USAFETAC/TC-95/001	*Catalogue of Air Force Weather Technical Publications (1992 - 1995)*

Air Weather Service (AWS) Technical Catalog

AWS/TC-91/001	*Catalogue of AWS Technical Documents (1941-1991)*

Air Force Combat Climatology Center (AFCCC) Technical Note (TN)

AFCCC/TN-95/005	*Capabilities, Products and Services of Air Force Combat Climatology Command*

Air Combat Command Instruction (ACCI)

ACCI 15-150	*Air Combat Command Weather Operations*

Air Combat Command Manual (ACCM)

ACCM 15-151	*Air Combat Command Weather Readiness*

Air Mobility Command Instructions (AMCIs)

AMCI 10-404	*Air Mobility Element/Tanker Task Force/Tanker Airlift Control Element*
AMCI 10-406	*Tanker Task Force/Tanker Airlift Control Element*

Weather Service Regulations (WSRs)

617 WSR 16-1	*Weather Support*
617 WSR 16-X	*Weather Communications*

Appendix C

METOC Support Organization and Structure

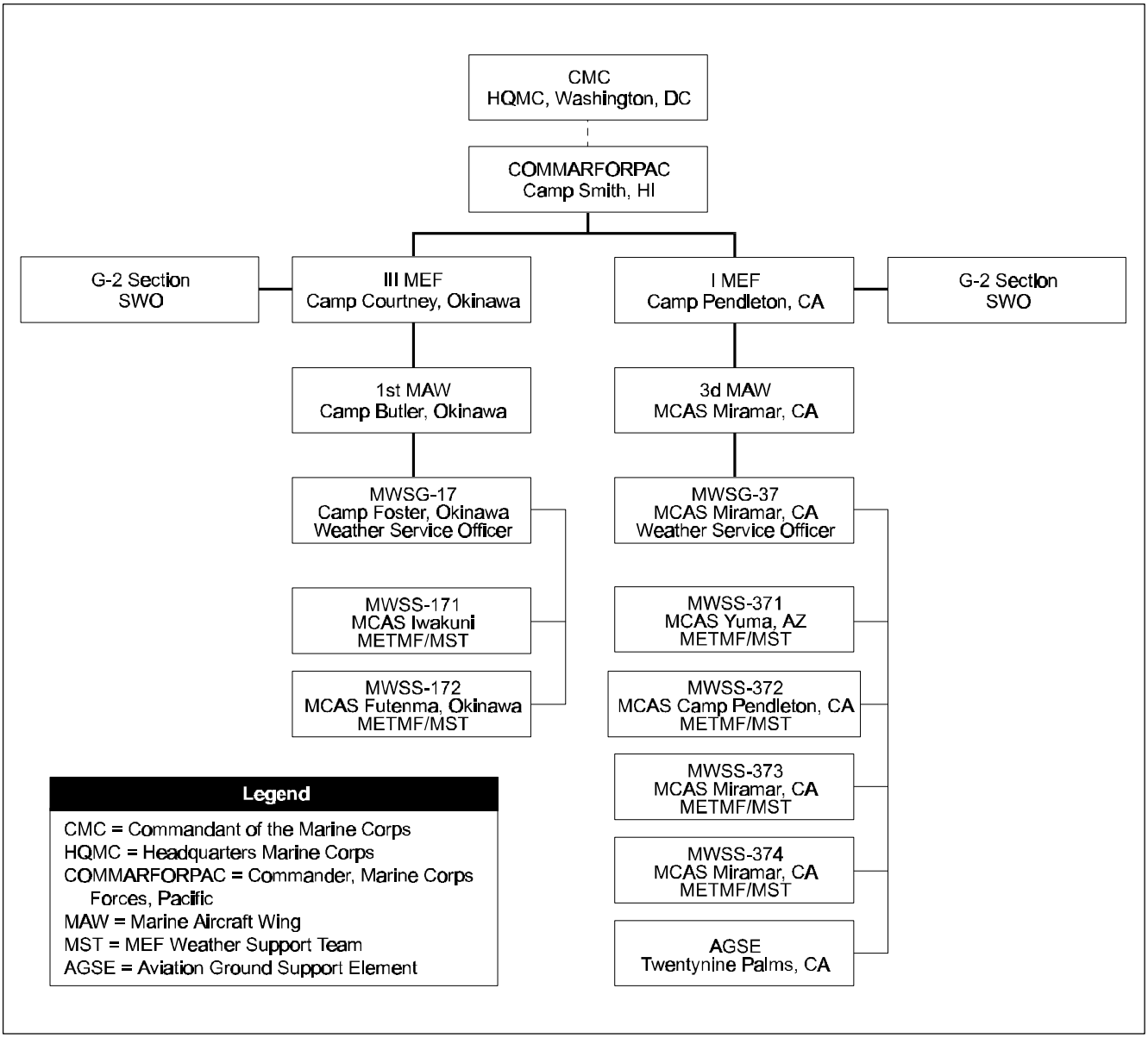


Figure C-1. MARFORPAC METOC Organization.

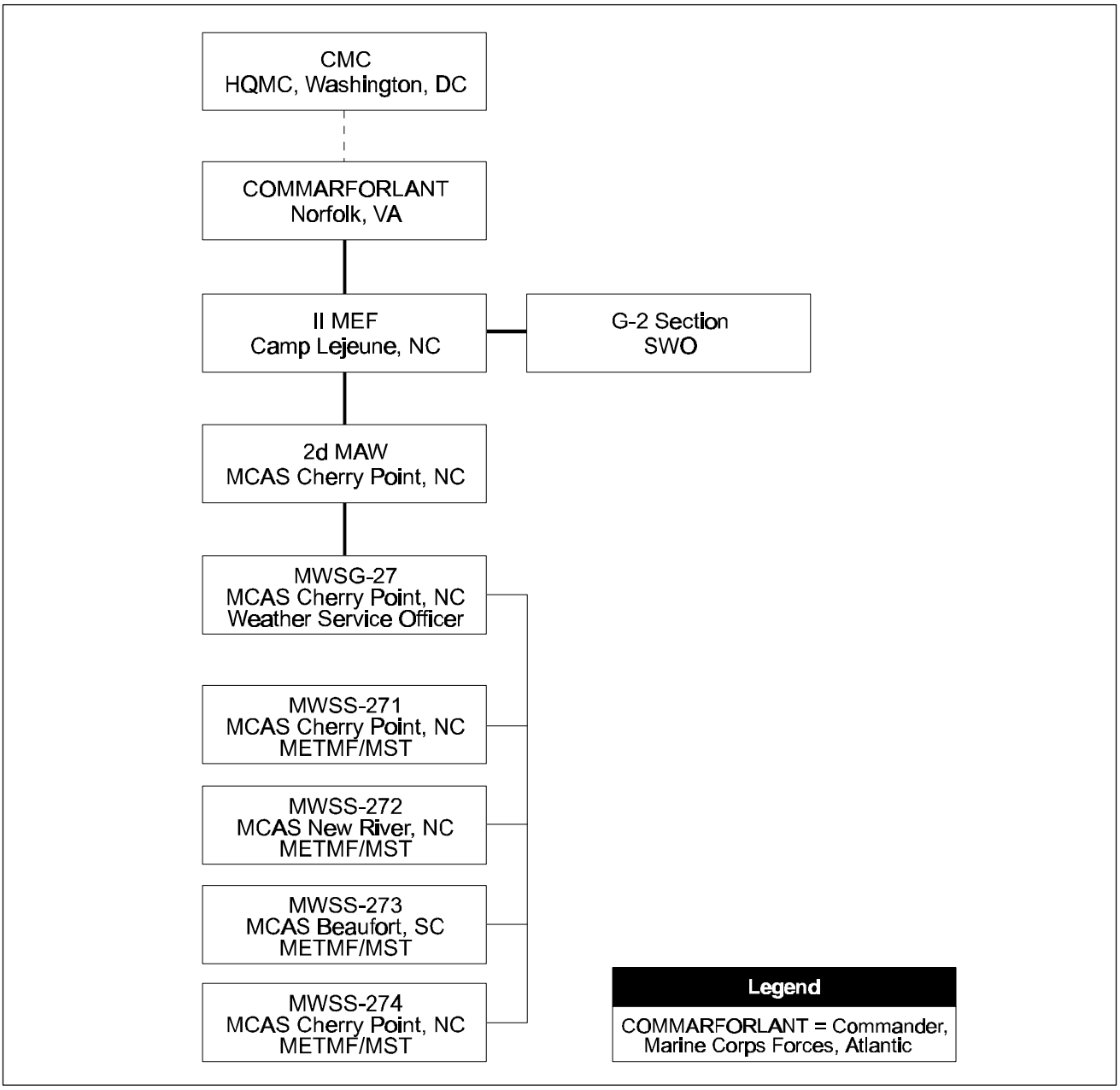


Figure C-2. MARFORLANT METOC Organization.

Appendix D

Support Products and Services

Section I: Sample METOC Support Products and Services

Several METOC products and services are available to aid MAGTF commanders and planners. Tailored products can be provided upon request to accommodate many missions and situations. A brief discussion of some of the more common products and services follows.

Solar/Lunar Almanac

This almanac provides monthly or daily summaries of ephemeral data for the sun and moon for locations worldwide. These summaries include times for sunrise/sunset and moonrise/moonset, beginning/ending times of nautical and civil twilight, total daylight in percent illumination, phases of the moon in percent illumination, time and altitude of sun/moon meridian passage, night vision goggle illumination data, and 24-hour solar/lunar positions (altitude and azimuth). This can be produced in tabular or graphical format.

Weather Effects Matrix

Weather elements and their associated impact on operations are the primary focus of the weather effects matrix. It is part of the IPB process and will assist commanders and planners in making go/no go and other tactical decisions. The impact of weather on specific mission areas will be defined as favorable, marginal, or unfavorable. This product can be tailored or adapted to meet specific operational criteria or mission parameters. A weather effects matrix is developed by intelligence personnel by using meteorological parameters provided by METOC personnel. See figure D-1 (page D-2) for an example of the weather effects matrix.

MAGTF Standard Tactical METOC Support Plan

This plan provides a common baseline of standardized products and services to be provided at a minimum during MAGTF operations. These tactical support products are tailored or modified as necessary by on-scene METOC forces to meet specific operational requirements and tactical situations. The METOC support plan is based on the Navy's Operational Task (OPTASK) METOC, which uses North Atlantic Treaty Organization (NATO) APP-4 standards to provide a standard for the coordination of tactical METOC services and reporting responsibilities within a MAGTF. Support consists of the following three areas:

OPTASK METOC

This involves operational tasks and uses NATO APP-4 standards to provide a standard message for the coordination of tactical METOC services and reporting responsibilities within a MAGTF. This is the Navy's equivalent to the MAGTF Annex H.

Standard Tactical Summaries

These summaries are designed to provide METOC information and support to MAGTF elements during routine operations. They include the MAGTF daily weather forecast (WEAX) and tactical atmospheric summary (TAS). These support products are normally transmitted daily or as required.

Daily Weather Forecast. The WEAX provides a plain-language meteorological situation, a

Weather Impact: Friendly Forces

Operation	Valid as of:			
	24 h	48 h	72 h	96 h
Deep Air Support				
Close Air Support				
Assault Support				
AAW/SEAD				
Ground Operations				
Airborne Operations				
Communications				
NBC/Smoke				
UAVs				

Weather Impact: Enemy Forces

Operation	Valid as of:			
	24 h	48 h	72 h	96 h
Deep Air Support				
Close Air Support				
Assault Support				
AAW/SEAD				
Ground Operations				
Airborne Operations				
Communications				
NBC/Smoke				
Special Forces				

Legend

Unfavorable
Marginal
Favorable

AAW = Antiair Warfare
SEAD = Suppression of Enemy Air Defenses
NBC = Nuclear, Biological, and Chemical

Figure D-1. Weather Effects Matrix.

24-hour forecast, and a 48-hour outlook for each METOC or operational zone of interest. Astronomical data is included, and a radiological forecast is appended as required. See Appendix G for an example of a WEAX.

Tactical Atmospheric Summary. This summary provides an atmospheric refractive summary, a tactical assessment, electromagnetic (EM) sensor performance predictions, infrared sensor detection range predictions, and communication range predictions. See Appendix G for an example of a TAS.

Special Tactical Summaries

These summaries are designed to provide METOC information and support for specific MAGTF operations and/or functions. They

include the amphibious objective area forecast (AOAFCST), strike forecast (STRKFCST), and assault forecast (ASLTFCST).

Amphibious Objective Area Forecast. The AOAFCST is designed to provide support for amphibious rehearsals and landings. It includes a plain-language meteorological situation, a 24-hour forecast for the amphibious objective/ landing area, surf forecasts for target beaches, a tactical assessment, an abbreviated atmospheric summary, and astronomical data. A radiological and chemical fallout forecast is appended as the tactical situation dictates.

Strike Forecast. The STRKFCST is designed to provide a coordinated forecast whenever multiple ACE strike (offensive antiair warfare (OAAW)/suppression of enemy air defenses (SEAD)/direct air support (DAS)) platforms (Marine attack squadron (VMA)/Marine fighter attack squadron (VMFA)/Marine tactical electronic warfare squadron (VMAQ)) are operating as an integrated force under one tactical commander. It includes a plain-language meteorological situation, a 24-hour forecast of en route and target weather, an outlook to 48 hours, a tactical assessment, and electro-optical sensor performance predictions. See Appendix G for an example of a STRKFCST.

Assault Forecast. The ASLTFCST is designed to provide a coordinated forecast whenever multiple assault support platforms (Marine aerial refueler transport squadron (VMGR)/Marine heavy helicopter squadron (HMH)/Marine medium helicopter squadron (HMM)/ Marine light attack helicopter squadron (HMLA)) are operating as an integrated force under one tactical commander. It includes a plain-language meteorological situation, a 24-hour forecast of en route forward arming and refueling point (FARP)/rapid ground refueling (RGR) and landing zone weather, an outlook to 48 hours, a tactical assessment, and electro-optical sensor performance predictions. See Appendix G for an example of an ASLTFCST.

Electro-Optical Tactical Decision Aid

The effects of weather on the sensor performance of various weapons systems and platforms are complex. Although new technology continues to offer advantages that increase performance of “smart” weapons, an unavoidable and intangible factor is the weather and its impact on them. Electro-Optical Tactical Decision Aid (EOTDA) is a software model that predicts the performance of air-to-ground weapons systems and direct-view optics on the basis of environmental and tactical information. Performance is expressed primarily in terms of maximum detection or lock-on range. EOTDA supports three regions of the spectrum: infrared, visible, and laser. Most MAGTF aviation platforms, weapons, and systems are supported by the database contained in the program. Systems not supported can be defined by the user to work with the EOTDA program. Figure D-2 (page D-4) provides examples of EOTDA products.

Integrated Refractive Effects Prediction System

The Integrated Refractive Effects Prediction System (IREPS) software was developed to provide a rapid-response, on-scene environmental data processing, prediction, and display capability for the comprehensive assessment of refractive effects on surveillance, communications, electronic warfare, and weapon guidance systems. Locally collected meteorological information is used to prepare analyses of present atmospheric and EM propagation conditions. Common applications/products include the following.

The IREPS Coverage Diagram

The IREPS coverage diagram (COVER) has many tactical uses. The most important task of air defense is to develop an air picture through surface-based and airborne surveillance platforms. COVER provides a display of radar detection or communication in the vertical plane. The output

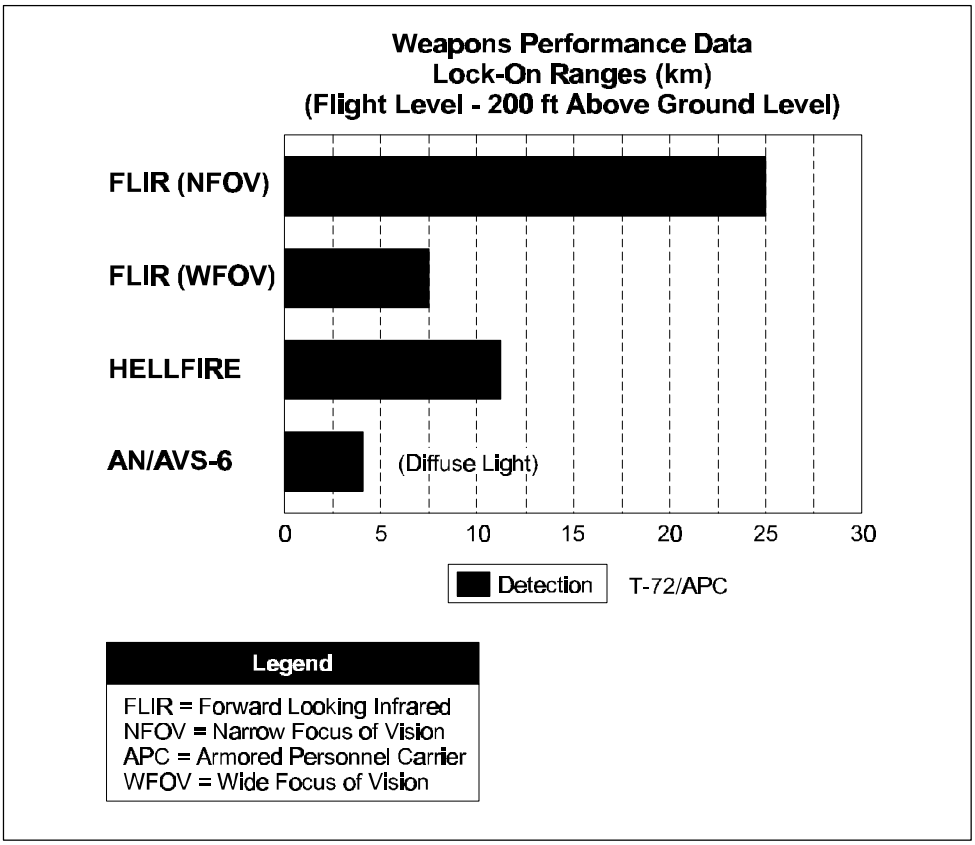


Figure D-2. Sample EOTDA Products.

diagram will alert units to potential "shadow zones" in their radar coverage against attacking aircraft or missiles. When used for threat surface-to-air missiles (SAMs), the COVER diagram will show the threat radar's area of coverage on a curved earth and will plot range versus height. COVER incorporates the effects of the atmosphere on a threat system and therefore compliments the Tactical Aviation Mission Planning System (TAMPS) data. Figure D-3 provides a sample COVER display.

Another tactical use of COVER is for attack aircraft positioning. Knowledge of the existence and the height of a surface-based duct would enable the mission planner to select the optimum altitude for penetration. By flying below a duct, attack aircraft can maximize the element of surprise and remain undetected by enemy radar. In a similar situation, electronic attack aircraft can adjust their position to maximize the effectiveness of onboard jammers by using the coverage display. Figure D-4 (page D-6) provides examples of tactical uses/applications of the COVER diagram.

Path Loss

This IREPS product shows one-way path loss in decibels versus range due to spreading, diffraction, scattering, and anomalous propagation. It can be used for long-range air-search radar (surface based or airborne), for surface search radar when employed against low-flying targets, and to determine the intercept range of radar or communications systems by an electronic warfare support (ES) receiver. In fact, once an altitude is specified for the path-loss curve, it is simply a slice of the COVER display at the specified altitude. Figure D-5 (page D-7) provides a sample path-loss display.

Platform Vulnerability

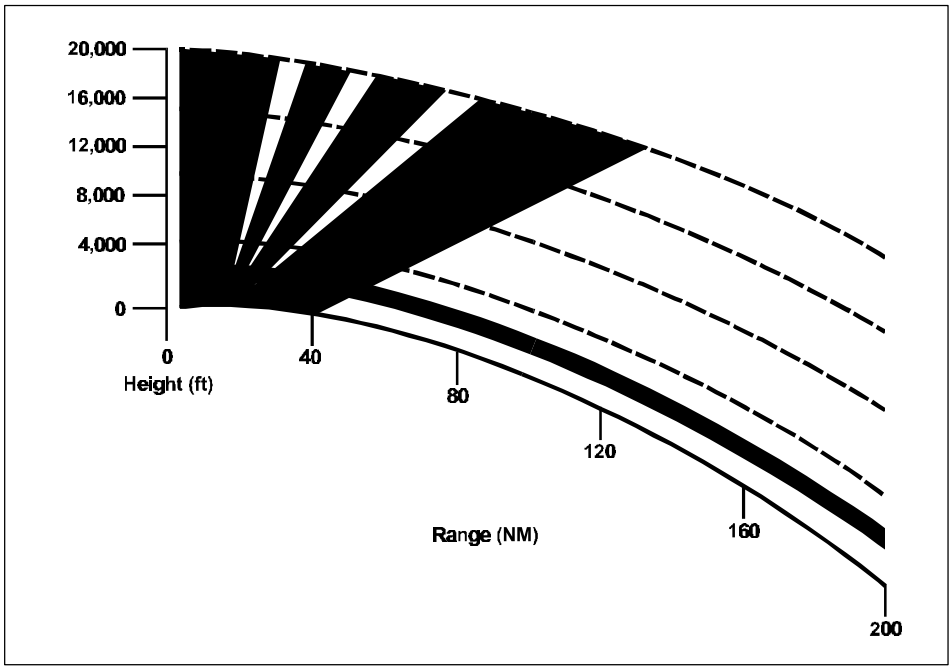


Figure D-3. Sample COVER Diagram.

Platform Vulnerability (PV) is useful in evaluating electronic emission control posture. This IREPS product assesses the relative vulnerability of various emitters within the Marine air control group (MACG) versus their value in surveillance or communication. A bar graph shows the maximum range at which a specified receiver can detect these emitters under given atmospheric conditions. From this display, it is immediately obvious which emitter within the MACG is most vulnerable to interception. By selectively silencing various emitters, the command, control, and communications mission planner can customize an emission control (EMCON) plan to a particular mission. PV is normally employed against aircraft flying at altitudes higher than 10,000 feet. Figure D-6 (page D-7) provides a sample PV display.

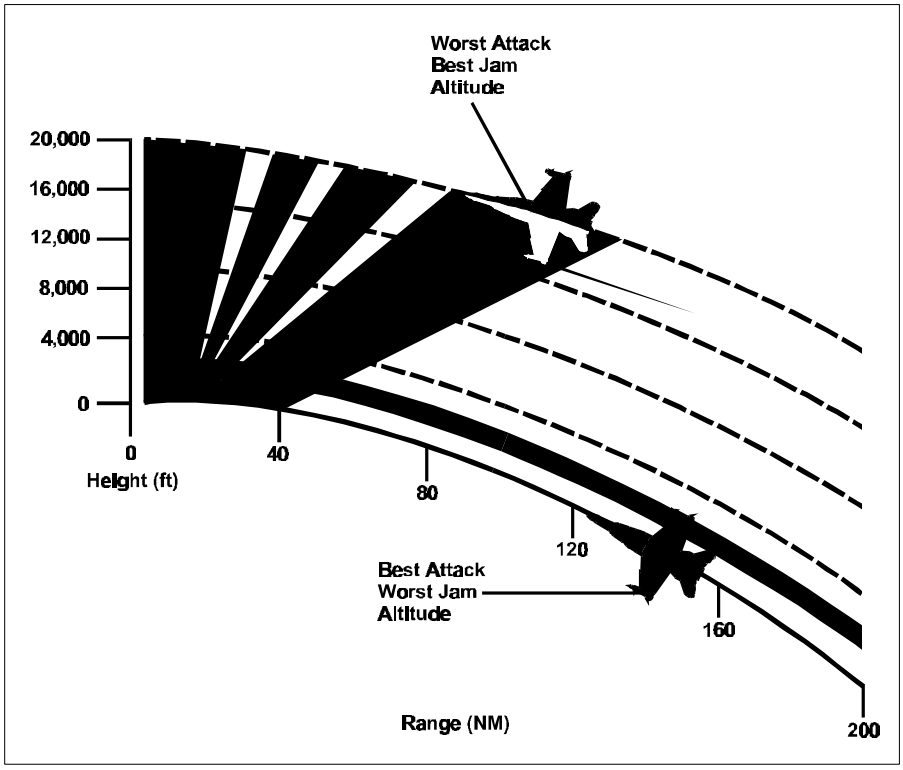
METOC Briefings

A number of METOC briefings can be conducted to support MAGTF requirements. A variety of media can be used in preparing these briefs, ranging from overhead transparencies to computer/ electronic presentations. Prior planning and coordination with the G-2/S-2 and G-3/S-3 are recommended to ensure consistency, continuity, and appropriateness of the type of brief to be conducted. Two common METOC briefings are discussed below.

Climatology Briefs

These briefs can be conducted for any geographical area or location of interest for any time of year. They are normally conducted as part of predeployment workups to normal operations, exercises, or actual contingencies. Climatological briefs should be requested before initial planning sessions to allow all planners time to consider the historical environmental effects.

Historical and statistical METOC information/ data are used exclusively and should not be confused with actual or real-time METOC events. There are several elements that are normally covered, but the brief is not limited to them; they include general geography and terrain, oceanography, general climate, historical EM



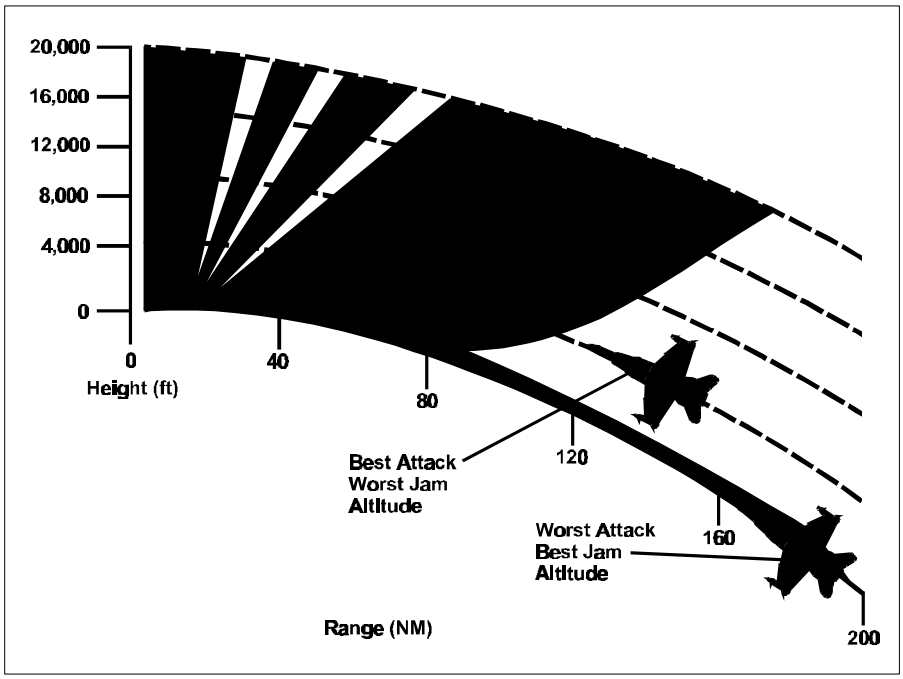


Figure D-4. Tactical Uses of the COVER Diagram.

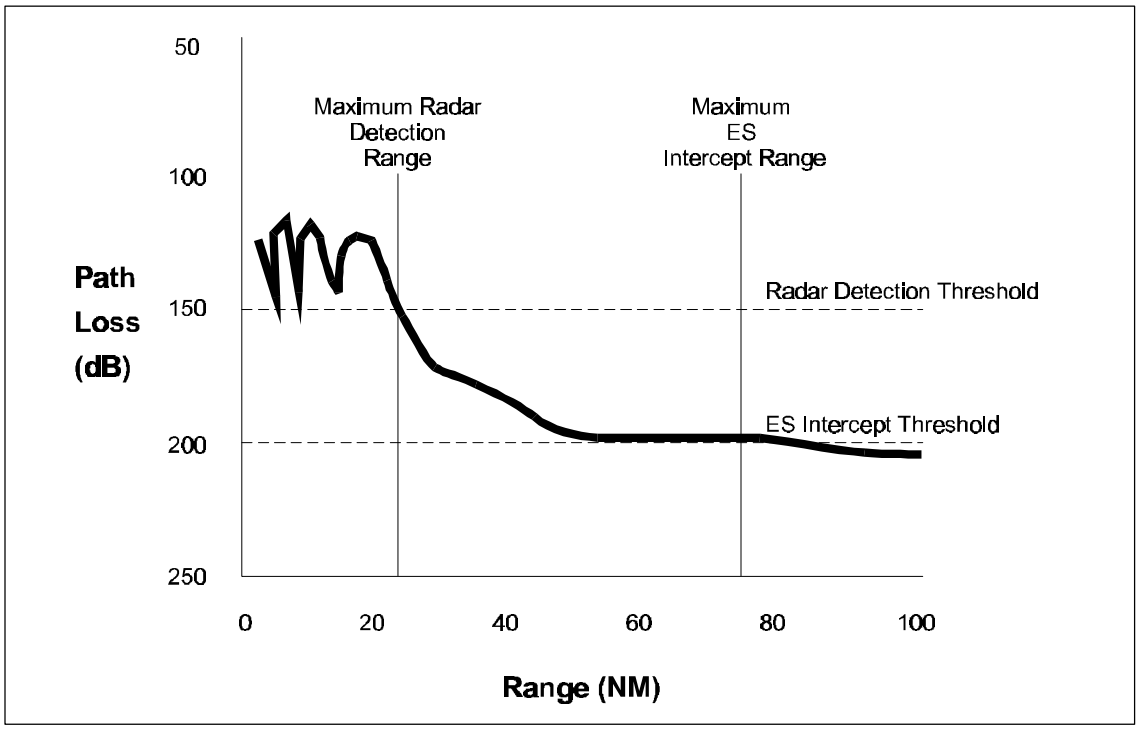


Figure D-5. Sample Path-Loss Display.

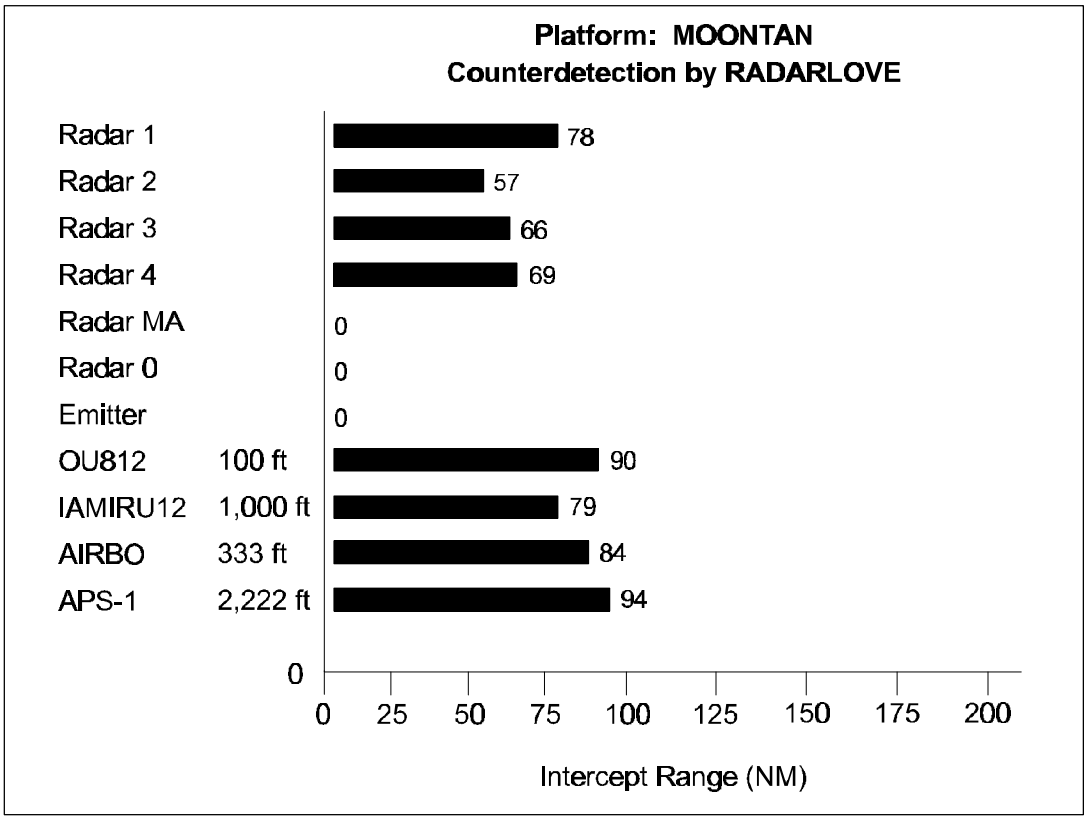


Figure D-6. Sample PV Display.

propagation, electro-optical climatology (infrared band only), astronomical information, specific weather elements, and assessment/impact on planned operations. A sample brief is provided as figure D-7 on pages D-9 through D-17.

METOC Operational Briefs

This type of brief is normally conducted twice daily (morning/evening) or as necessary to support actual combat operations and exercises. METOC support objectives and information requirements are established for this type of brief based on the combat element being supported, the level of command, and the mission to be accomplished. This brief will normally cover, but is not limited to, an analysis of the current METOC situation, forecast conditions out to 96 hours, astronomical data, and an impact assessment of planned COAs/operations. Figure D-8 on pages D-18 through D-23 gives an example of a typical brief that may be provided to the ACE commander and staff planners during a MEF-sized operation.

Radiological Fallout

Forecast patterns of radiological fallout may be used to determine unit maneuvering in the event of a nuclear burst. The output diagram reflects variable levels of radiation during a user-defined time period. The levels of radiation may also be set by the user.

Vapor Liquid Substance Tracking Program

This program assists in forecasting patterns of chemical fallout, which may be used to determine unit maneuvering in the event of chemical warfare.

Tactical Decision Aids

TDAs are software programs run on communications and information systems that use critical-value information. TDAs allow the operator to enter system information, terrain data, and weather conditions, either manually or automatically. TDAs describe the exact impacts expected and the resulting estimated performance degradation. When such an analysis is done for both friendly and threat systems, the commander can determine the tactical advantage. TDAs have the potential to give the commander another tactical advantage by comparing systems before a battle, thus allowing additional reaction time to make adjustments before the enemy is engaged in battle. Application steps include:

- The specific weather and environmental elements causing a potential impact on the system platform, its subsystems, operations, and logistics
- The critical values or ranges of each of these weather elements
- The resultant effects of correlating each of these critical values or ranges with the observed or forecasted weather conditions that are occurring, or expected to occur, in the area of operations
- The critical values or ranges that cause a marginal or unsatisfactory capability
- The impact of weather, the exact cause, and the duration that the event is forecasted to continue
- The effects of weather on threat systems (using the same process)
- The tactical advantages presented to both sides by weather conditions.

In addition to tactical tailoring, the commander can simulate outcomes by using a range of optimistic and pessimistic forecast values to show the tactical advantages of each set of conditions.

Operation Sugar Cane

Climatology and Weather

Overview

- Geography
- Terrain
- Operational Interests
- General Climate
- Specific Weather Elements
- Assessment and Recommendations

Figure D-7. Sample Climatology Brief.

Geography

El Sonora is:

- Rectangular
- 160 mi West to East
- 60 mi North to South
- Smallest Nation in Central America
- Same Approximate Size as Massachusetts
- Most Densely Populated Nation in South America.

Terrain

- 4 Major Regions (Lengthwise)
  - Pacific Lowlands
  - Southern Mountains
  - Plateau
  - Northern Mountains
- 20 Active Volcanoes
- Rich Soils (Provided by Ash/ Lava)
- Flood Prone

Figure D-7. Sample Climatology Brief (Continued).

Oceanography (General)

- Port Information
- Tide Range Average: 6.16 ft
- Currents: From ESE at .5 - 1.0 kt
- Bottom Materials: Sand and Shell
- Shoreline: Varied (All Rock to Sand and Cobble Beaches)
- Average Water Temperature: 80 °F

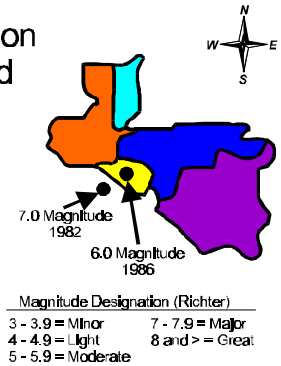
Astronomical Information (General)

- Average Daylight: 12 h 35 min
- Average From Sunset to Civil Twilight: 22 min
- Average From Sunset to Nautical Twilight: 48 min
- Shortest Day: 21 December

Figure D-7. Sample Climatology Brief (Continued).

Seismic Activity (General)

- Earthquakes Fairly Common
- Greatest Threat to Life and Property
- Can Induce Landslides That Block Roads and Mountain Passes
- Increased Frequency of Occurrence Predicted by Seismologists



Historical EM Propagation Conditions

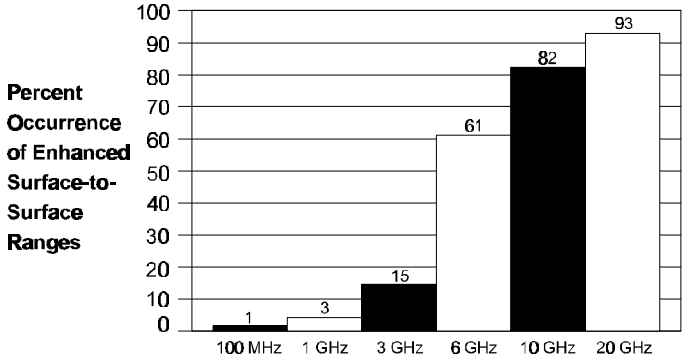
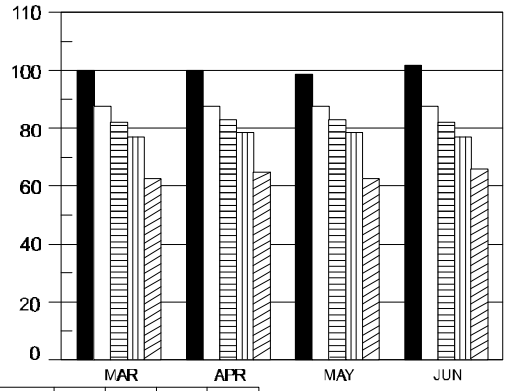


Figure D-7. Sample Climatology Brief (Continued).

General Climate

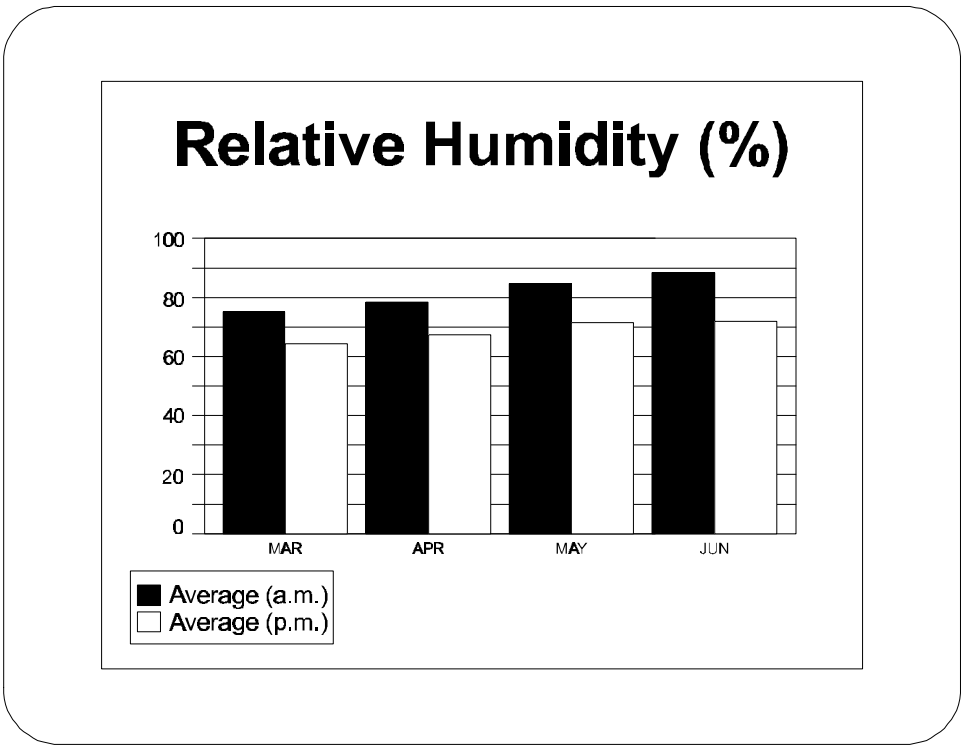
- Beginning of Wet Season
- Hot With Afternoon Thunderstorms
- Mostly Cloudy Skies Prevail
- Flying Weather Generally Good
- Tropical Cyclones Rare

Temperature (°F)



	OCT	NOV	DEC	JAN
Absolute Maximum	100.1	100.1	99.1	99.2
Average Maximum	88.1	88.1	88.1	88.1
Average	82.0	82.0	82.0	81.0
Average Minimum	76.0	75.0	75.0	75.0
Absolute Minimum	58.1	66.0	63.0	64.0

Figure D-7. Sample Climatology Brief (Continued).



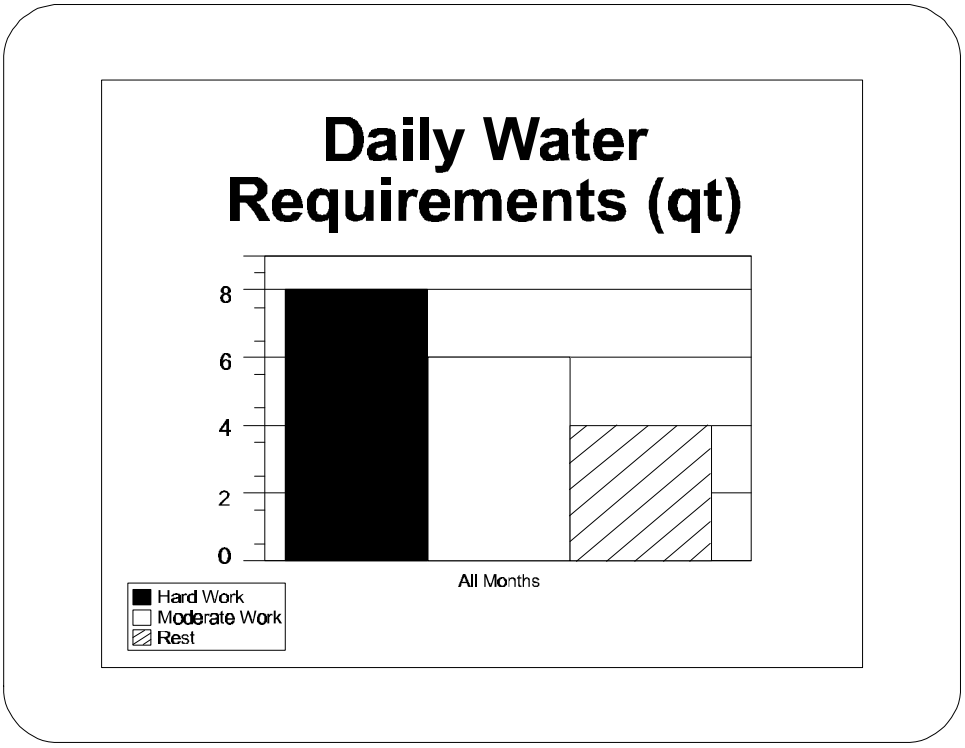
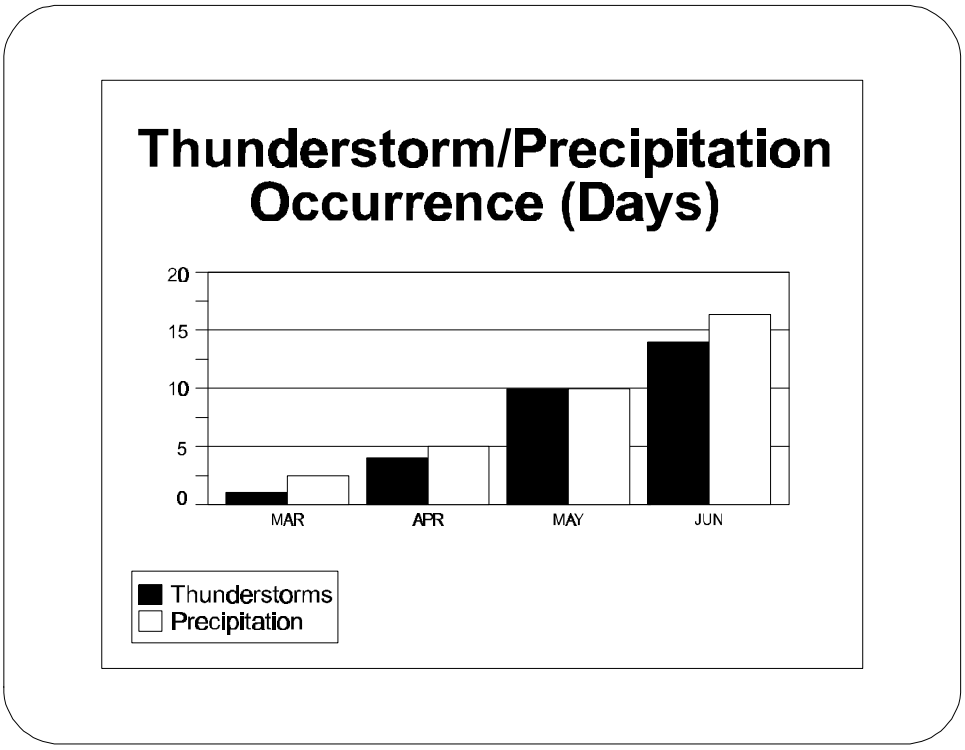


Figure D-7. Sample Climatology Brief (Continued).



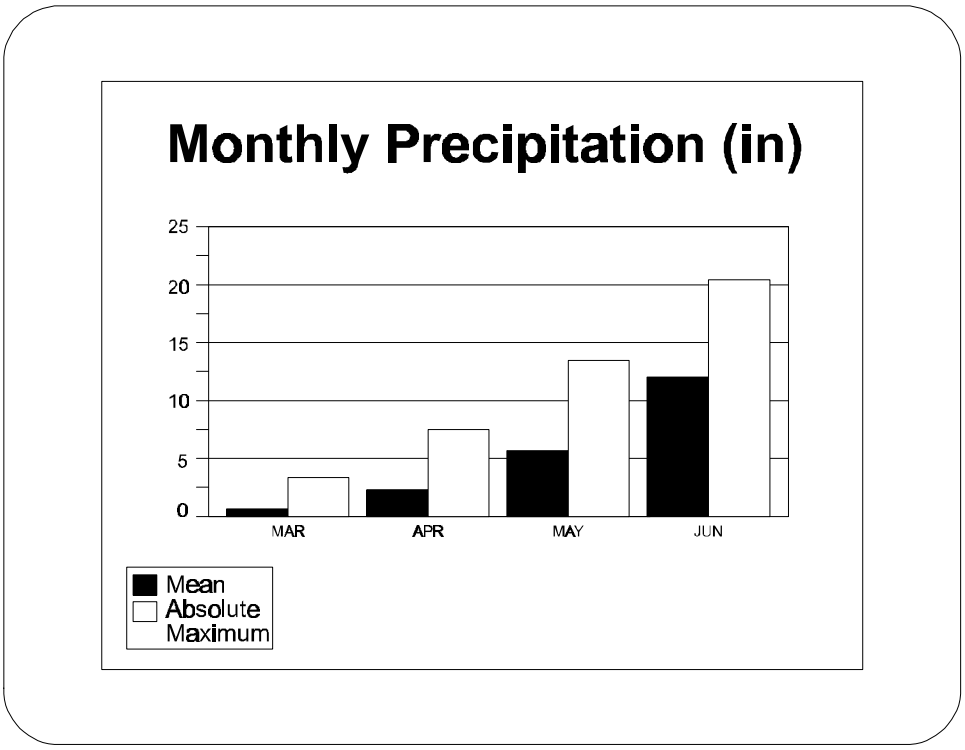
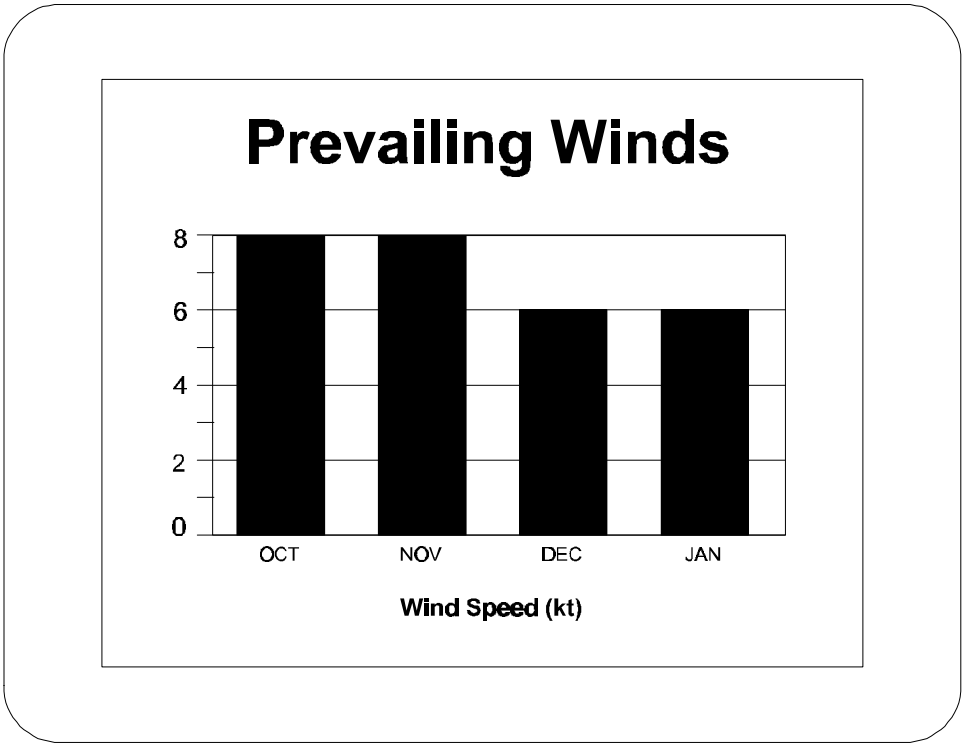


Figure D-7. Sample Climatology Brief (Continued).



Assessment and Recommendations

- Major Impact for Extended Operations (Wet Season: April Through October)
- Natural Disaster Plan
  - Earthquake
  - Flash Flooding
    - Further G-2/S-2 and Topographic Study
    - Trafficability Versus Logistic/Supply Issue
- Severe Weather Plan (Hurricanes, Thunderstorms, etc.)
- Acclimation Period Due to Extreme Temperatures and High Relative Humidity (Water Versus Activity Level)

Figure D-7. Sample Climatology Brief (Continued).

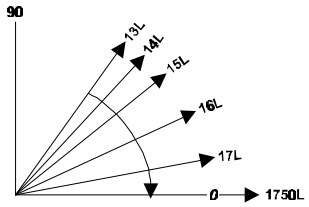
Figure D-7. Sample Climatology Brief (Continued).

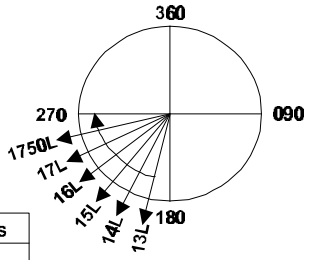
Meteorology and Oceanography Support Package

Solar Data

East Ranges/Growler Wash

Valid Time: 24 Oct 97/1300L - 2100L





Time	Elevation	Azimuth	Remarks
1300	44	195	
1400	39	213	
1500	31	228	EENT 1844
1600	21	240	No Moon
1700	9	249	
1750	0	258	

Figure D-8. Sample METOC Operational Brief.

Departure/Recovery Forecast

Valid Time: 24 Oct 97/1345L - 2100L

Sky Condition: Few 200
Visibility: 7+
Significant Weather: None
Surface Winds: 300 12 - 14 kt G26kt Becoming
300 12-14 kt G26kt by 17L
Departure Outside Air Temperature: 79°F/26°C
Departure Altimeter Setting: 29.68 in
Recovery Altimeter Setting: 29.67 in
Recovery Outside Air Temperature: 74°F/23°C
PA: +310 ft DA: +1,630 ft
PA: +320 ft DA: +1,280 ft

Flight Level Data

Valid Time: 24 Oct 97/1345L - 2100L

Contrails: Possible 31,067 ft Probable 36,149 ft

Minimum Freezing Level: 8,000 ft

Icing: None

Turbulence: Light Occasional Moderate:
Surface - 10,000 ft and 15,000 ft - 30,000 ft

Significant Weather: None

Figure D-8. Sample METOC Operational Brief (Continued).

Flight Level Winds/Temperature

Valid Time: 24 Oct 97/1345L - 2100L

Flight Level	Winds	Temperature
010	33010 kt	+24 °C
020	33012 kt	+22 °C
030	33015 kt	+20 °C
040	33018 kt	+17 °C
050	33020 kt	+06 °C
100	30030 kt	-04 °C
150	29055 kt	-08 °C
200	28065 kt	-19 °C
250	27080 kt	-29 °C
300	27090 kt	-44 °C
350	270100 kt	-49 °C
400	270120 kt	-53 °C

East Ranges/Growler Wash Forecast

Valid Time: 24 Oct 97/1345L - 2100L

Sky Condition:	Few 200
Visibility:	7+
Significant Weather:	None
Surface Winds:	300 12 - 14 kt G26kt Becoming 300 12 - 14 kt G26kt by 17L
Maximum Outside Air Temperature:	78 °F/25 °C
Minimum Altimeter Setting:	29.65 in
Maximum PA:	+330 ft Maximum DA: +1,530 ft

Figure D-8. Sample METOC Operational Brief (Continued).

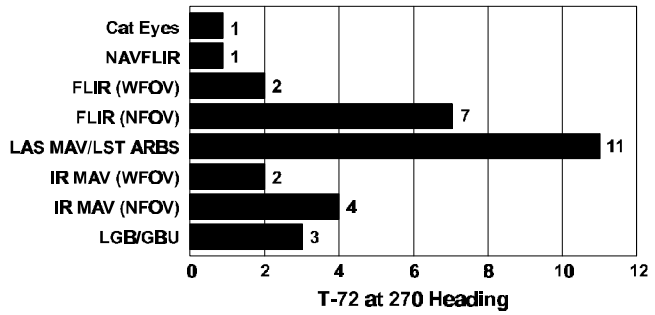
Aerial Refueling/Direct Air Support Center (Airborne) Forecast

(Copper-Rakish/Rakish-Slide Dome)
Valid Time: 24 Oct 97/1400L - 2030L

Sky Condition:	Few 200
Icing:	None
Significant Weather:	None
13K Winds/Temperature:	29,040 kt/-06°C
21K Winds/Temperature:	28,065 kt/-29°C
Turbulence:	Light to Occasional Moderate: Surface - 8,000 ft and 15,000 ft - 30,000 ft

Electro-Optical Tactical Decision Aid

Average Detection/Lock-On Ranges (NM) at FL 200



Latch/Vault
24 Oct 97/1345L - 2100L

View Direction: 090
Thermal Crossover: 1630L and 1930L

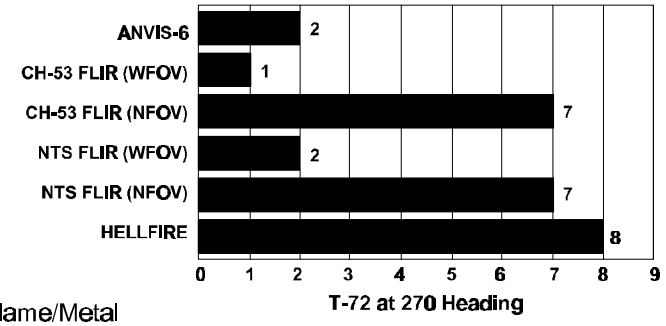
Legend

NAVFLIR = Navigation Forward Looking Infrared
LAS MAV = Laser MAVERICK
LST ARBS = Laser Spot Tracker Angle Rate Bombing System
IR MAV = Infrared MAVERICK
LGB = Laser Guided Bomb
GBU = Guided Bomb Unit

Figure D-8. Sample METOC Operational Brief (Continued).

Electro-Optical Tactical Decision Aid

Average Detection/Lock-On Ranges (km) at FL 001



Flame/Metal
24 Oct 97/1345L - 2100L

View Direction: 090
Thermal Crossover: 1545L

Legend

ANVIS = Aviator's Night Vision Imaging System
NTS = Night Targeting System

Tactical Atmospheric Summary

Valid Time: 24 Oct 97/1345L - 2100L

Surface-Based Ducts: None
Elevated Ducts: None

Tactical Assessment:

Surface-to-Surface: Normal Ranges for All Frequencies

Surface-to-Air: Normal Ranges at All Altitudes

Air-to-Air: Normal Ranges at All Altitudes

Figure D-8. Sample METOC Operational Brief (Continued).

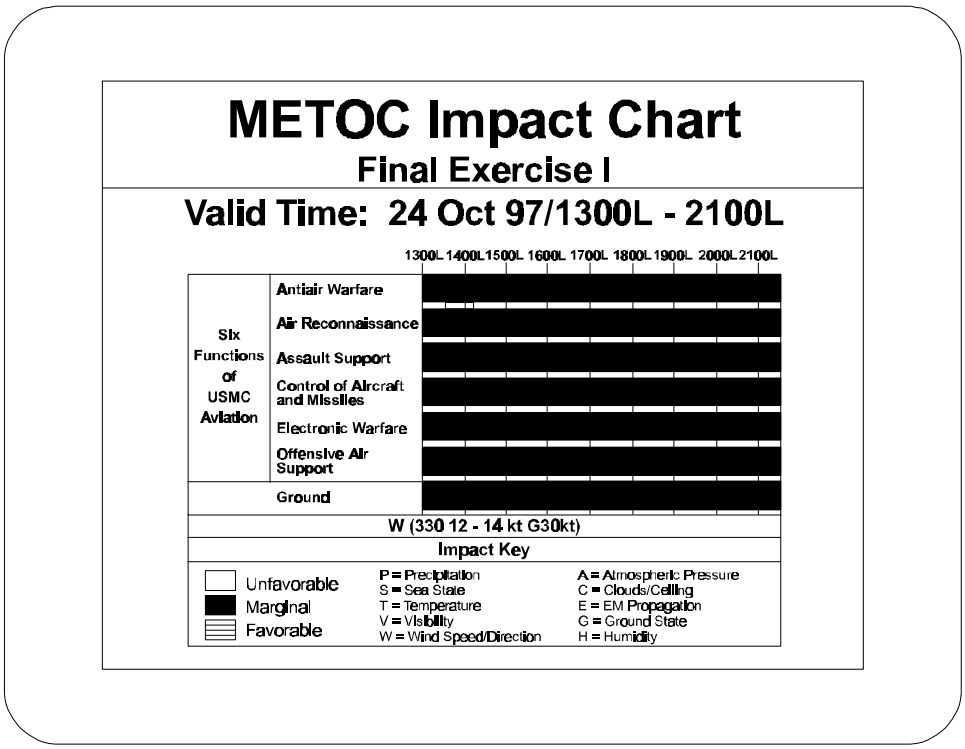


Figure D-8. Sample METOC Operational Brief (Continued).

Section II: Oceanographic Products

Several oceanographic products and services are available to aid MAGTF commanders and planners. Tailored products can be provided on request to accommodate many missions and situations. Some of the more common products and services are listed below.

Tides

This product provides a summary of tidal range, heights, and times of high and low tides. Exact site location is required for accurate output. Output is available in tabular or graphical format.

Annotated Imagery of Littoral Areas

Images obtained from land satellite, the French *satellite pour l'observation de la terre* (SPOT), or other national technical means are analyzed to extract oceanographic parameters. Detected obstructions, reefs, shoals, nearshore currents, water clarity, and sea surface temperatures are typically annotated.

Special Tactical Oceanographic Information Chart

This is a 1:25,000-scale special-purpose chart depicting nearshore hydrographic conditions, with data appropriate for mine warfare, amphibious operations, or special operations displayed along the chart border. These products are produced by the NAVOCEANO Warfighting Support Center. Requests will be coordinated by the MAGTF SWO to avoid duplication of requirements.

Environmental Support Packet

The environmental support packet (ESP) describes nearshore oceanographic conditions by providing evaluated data on nearshore hydrography, tides, currents, marine life, water clarity, and so on. It normally includes an oceanographic executive summary to highlight significant features.

Sea Surface Conditions

Surface conditions in the operating area can affect both divers and other reconnaissance personnel. These conditions are influenced by time of year, wind, waves, tides, current, cloud cover, temperature, visibility, and the presence of other ships.

A significant factor is the sea state. Wave action can affect everything from the stability of the moor to the vulnerability of the crew to seasickness or injury. Unless properly moored, a ship or boat drifts or swings around an anchor, fouling lines and dragging divers. In addition, surface waves may become a problem when the diver enters or leaves the water and during decompression stops near the surface. Table D-1 provides a sample sea state chart.

Hydrographic Survey

The purpose of a hydrographic survey is to systematically collect information about the foreshore and nearshore sea approaches to a designated landing beach. This information will be transferred to a hydrographic sketch, which may be used by the commander, landing force (CLF), to plan landing(s). The survey normally encompasses the nearshore area from the three-fathom line to the water's edge; the foreshore, backshore, and hinterland for about 100 yards; and the length of the beach as designated by CLF. The hydrographic survey and beach survey overlap in that they both cover the foreshore.

Table D-1. Sea State Chart.

Sea State	Description	Wind Force (Beaufort)	Wind Description	Wind Range (kt)	Wind Velocity (kt)	Average Wave Height (ft)
0	The sea is like a mirror.	0	Calm	< 1	0	0
	Ripples with the appearance of scales are formed, but without foam crests.	1	Light air	1 - 3	2	0.05
1	Small wavelets, still short but more pronounced, form; crests have a glassy appearance but do not break.	2	Light breeze	4 - 6	5	0.18
2	Large wavelets form; crests begin to break. Foam of a glassy appearance forms; there may be scattered whitecaps.	3	Gentle breeze	7 - 10	8.5 10	0.6 0.88
3	Small waves form, becoming longer; whitecaps are fairly frequent.	4	Moderate breeze	11 - 16	12 13.5 14 16	1.4 1.8 2.0 2.9
4	Moderate waves appear, taking a more pronounced form; there are many whitecaps and a chance of some spray.	5	Fresh breeze	17 - 21	18 19 20	3.8 4.3 5.0
5	Large waves begin to form; white foam crests are more extensive everywhere. There is some spray.	6	Strong breeze	22 - 27	22 24 24.5 26	6.4 7.9 8.2 9.6
6	The sea heaps up and white foam from breaking waves begins to be blown in streaks along the direction of the wind. Spindrift begins.	7	Moderate gale	28 - 33	28 30 30.5 32	11 14 14 16
7	Moderately high waves of greater length form; edges of crests break into spindrift. The foam is blown in well-marked streaks along the direction of the wind. Spray affects visibility.	8	Fresh gale	34 - 40	34 36 37 38 40	19 21 23 25 28
8	High waves form. Dense streaks of foam appear along the direction of the wind. The sea begins to roll. Visibility is affected.	9	Strong gale	41 - 47	42 44 46	31 36 40

Table D-1. Sea State Chart (Continued).

Sea State	Description	Wind Force (Beaufort)	Wind Description	Wind Range (kt)	Wind Velocity (kt)	Average Wave Height (ft)
9	Very high waves with long overhanging crests form. Foam is in great patches and is blown in dense white streaks along the direction of the wind. The surface of the sea takes on a white appearance. The rolling of the sea becomes heavy and shock-like. Visibility is affected.	10	Whole gale	48 - 55	48 50 51.5 52 54	44 49 52 54 59
	Exceptionally high waves appear. The sea is completely covered with long white patches of foam along the direction of the wind. Everywhere the edges of the wave crests are blown into froth. Visibility is seriously affected.	11	Storm	56 - 63	56 59.5	64 73
	The air is filled with foam and spray. The sea is completely white with driving spray. Visibility is very seriously affected.	12	Hurricane	64 - 71	> 64	> 80

Appendix E

Weather Effects on MAGTF Operations

This appendix describes common weather elements and weather effects on specific types of units and selected operations.

Common Effects

Although environmental elements tend to have different effects on different types of units and operations, many can be identified as having similar effects on a majority of combat elements and operations.

Many of the common effects can be derived for planning purposes from the climate of the theater of operations. Special attention must be given to those elements of weather that may limit operations or preclude them altogether. For instance, operations in the tropics must be planned to consider the recurring cycle of the monsoon season. In continental Europe, strategies must consider severe winters and the annual autumn freezes and spring thaws, which affect trafficability and cross-country movement.

Very early in the planning process, planners must relate the possible COAs to weather expectancies derived from climatological studies. There must be an acceptable likelihood that the weather conditions required for any proposed COA will occur. It is imperative for an operation to be meteorologically feasible at the operational level of warfare and for planning for seasonal weather changes to be considered early in the planning process.

When considering the effects of environmental conditions, the impact that weather and terrain have on each other must be considered. Weather and terrain are so interrelated that they must be considered together when planning ground and air operations. Weather elements can drastically alter terrain features and trafficability. Conversely, terrain features may exert considerable influence on local weather. The relationship between weather and terrain must be carefully correlated in terrain studies to produce accurate terrain intelligence. This planning is an integral part of the IPB process.

Weather Elements

Terrain features affect weather, climate, and weather elements such as:

- Visibility
- Temperature
- Humidity
- Precipitation
- Wind
- Clouds.

Specific elements vary with the geographical area, time, and season. A description of the climate of a large area considers terrain influences only in general terms, whereas a description of a small area such as a single valley can be specific. It is important that commanders and staffs understand and consider weather in their tactical planning. They must recognize the tactical significance of weather effects on intended operations and the risks or opportunities that they present. The effects of weather are integrated with enemy and terrain analysis through IPB. Factors that must be considered include:

- Visibility
- Wind
- Precipitation
- Clouds
- Temperature and humidity

- Severe weather
- Illumination and obstructions to vision.

Visibility

Low visibility is beneficial to offensive and retrograde operations and detrimental to defensive operations. In the offense, it conceals the concentration of maneuver of friendly forces, thus enhancing the possibility of achieving surprise. Low visibility hinders the defense because cohesion and control become difficult to maintain, reconnaissance and surveillance are impeded, and target acquisition is less accurate.

These disadvantages may be offset partially by extensive use of illuminants, radar, sound detection, and thermal and infrared devices; however, infrared devices are degraded in range by any moisture source, precipitation, or moisture-absorbing smoke. Smoke and obscurant aerosols can be expected on medium-intensity to high-intensity battlefields and may be used locally to reduce visibility. In all operations, obscurants limit the use of aircraft and aerial optical and infrared surveillance devices.

Wind

Wind speed and direction, both on the surface and aloft, usually favor the upwind force in the use of nuclear, biological, and chemical (NBC) weapons. Winds of sufficient speed can reduce the combat effectiveness of a force downwind by blowing dust, smoke, sand, rain, or snow on personnel and equipment. The force located upwind has better visibility and can, therefore, advance and maneuver faster. Strong winds limit airborne, air assault, and aviation operations.

Strong surface winds and gusts can:

- Injure personnel
- Damage material and structures
- Give anomalous radar returns
- Restrict visibility by blowing sand, dust, and other material.

Generally, winds above 20 nautical miles per hour create such effects. Smoke operations are usually ineffective at wind speeds greater than seven nautical miles per hour. As surface wind speed increases, either naturally or enhanced by vehicle movement, the windchill becomes a critical factor. The windchill factor adversely affects improperly clothed personnel and impedes activity in unsheltered areas. Wind speed also affects the distance that sound will travel. Wind may prove beneficial by aiding in drying soil. A windchill index chart developed by the U.S. Army Research Institute of Environmental Medicine is shown as figure E-1. Trench foot and immersion foot may occur at any point on the chart.

Precipitation

The primary significance of precipitation is its effect on soil; visibility; personnel effectiveness; and the functioning of ground maneuver units, aviation, CSS operations, and electro-optical and infrared systems. The state of the ground affects trafficability; heavy rain can make some unsurfaced roads and off-road areas impassable. Rain and snow can greatly reduce:

- Personnel effectiveness by limiting visibility, increasing fatigue, and causing discomfort and other physical and psychological problems
- The persistence of chemical agents (or can create NBC hot spots)
- The range of lasers, night vision devices, and thermal tank sights
- The effectiveness of aircraft.

Precipitation also degrades the quality of supplies in storage. Snow accumulation of greater than one inch degrades trafficability and reduces the impact of mines and the blast effects of point munitions. Generally, precipitation in excess of 0.10 inches per hour or two inches in a 12-hour period is considered critical for tactical operations. Snowfall exceeding 18 inches reduces tracked vehicle speed; movement on foot is very difficult without snowshoes or skis.

Wind Speed (kt)	Actual Temperature Reading (°F)											
	50	**40**	**30**	**20**	**10**	**0**	**-10**	**-20**	**-30**	**-40**	**-50**	**-60**
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-82	-98	-113	-129	-145
35	27	11	-4	-20	-35	-51	-67	-85	-100	-116	-132	-148
40	26	10	-6	-21	-37	-53	-69	-87	-103	-119	-135	-151
	Little Danger				**Increasing Danger**			**Great Danger**				
	Exposure for less than 1 h with dry skin is considered safe. Maximum danger of false sense of security exists.				Exposed flesh may freeze within 1 minute.			Flesh may freeze within thirty seconds.				

Clouds

The type and amount of cloud cover, as well as the height of cloud bases and tops, influence friendly and enemy aviation operations. Extensive cloud cover reduces the effectiveness of air support. This effect becomes more pronounced as cloud cover increases, cloud bases lower, and conditions associated with clouds (such as icing, turbulence, and poor visibility aloft) increase. In a relatively unstable air mass, clouds are associated with strong vertical currents, turbulence, and restricted visibility aloft. Generally, close air support missions and aerial resupply missions require a ceiling of at least 1,000 feet.

Clouds affect ground operations by limiting illumination and the solar heating of targets for infrared systems. Clouds limit the use of infrared-guided artillery by decreasing the envelope in which it can seek and lock on to laser-designated targets. Cloud-free line of sight is required for delivery of precision-guided munitions from aircraft.

Temperature and Humidity

Temperature and humidity affect air density. Air density decreases as the temperature or humidity increases; thus, the efficiency of aircraft propulsion is reduced in areas of high temperature or high humidity. Although temperature and humidity may not directly affect a particular tactical operation, extremes will reduce personnel and equipment capabilities and may necessitate a reduction of aircraft payloads (for example, fuel, weapons, and personnel).

Tactics that are effective in one climate may be ineffective when applied in another. The high temperatures and humidity in the tropics are conducive to the growth of dense foliage, which greatly affects tactical operations. Desert climates can range from extremely hot in the daytime to very cold at night, requiring added protective measures. In arctic climates, cold weather periods create an almost constant need for heated shelters; cause difficulty in constructing fortifications; increase the dependence on logistical support; and

necessitate special clothing, equipment, and survival training.

Windchill factors are produced by a combination of temperature and wind speed. A windchill factor of -26 °F (-32 °C) is considered to be the critical value for equipment and personnel operating in cold weather. The opposite extreme, 120 °F (49 °C), is the critical value for personnel operating in hot weather. The critical WBGTI value for personnel operating in hot weather is 90 °F. Similar restrictions occur in desert terrain, where the temperature from day to night may vary as much as 100 °F (37 °C). Personnel operating in warm temperatures are more susceptible to becoming heat casualties when in mission-oriented protective posture (MOPP) gear.

Temperatures of targets and objects on the battlefield at night are important for the use of thermal sights and forward looking infrared (FLIR) devices. A difference in temperature or thermal contrast is required for these devices to see a target. Normally, the target and background heat and cool at different rates. Twice a day, in the morning and evening, targets without internal heating come to relatively the same temperature as the background. At this point, thermal crossover occurs and the thermal device does not have the capability to see the target. The duration of thermal crossover may be only a few seconds when the morning sun strikes a target or several minutes on cloudy, adverse-weather days; this depends on the threshold temperature contrast required by the thermal device. TDAs can be used to predict these temperature differences for planners and to estimate lengths of thermal crossover periods.

Severe Weather

Severe weather affects most operations by presenting a threat of injury to personnel, damaging equipment and structures, limiting ground and air mobility and air operations, and threatening troop morale. Electrical storms often accompany severe weather conditions and add the hazard of lightning strikes at munitions storage areas and fueling points. Lightning may also interrupt land- line communications and both communication and noncommunication use of the EM spectrum.

Illumination and Obstructions to Vision

Illumination and obstructions to vision affect the visibility required for various operations and affect the overall planning for security, concealment, and target acquisition by visual, electronic, or electro-optical means.

Meteorological Products

Meteorological products are categorized as either primary products or tactical weather products. Primary products are used by the weather service officer in preparing tactical weather products. They are usually received in the form of weather observations, forecasts, gridded data, and climatological studies. Primary products are received from indigenous sources, other Marine Corps weather units, the Navy, the Air Force, and in-flight aircraft in wartime and from the National Weather Service (NWS) and Federal Aviation Administration (FAA) in peacetime. Although some primary weather products are passed directly to MAGTF users, many need to be modified or updated to reflect local observation, local terrain, and mission requirements.

Weather observations contain information on existing weather conditions and specific weather elements at specific locations and times. The basic types of observations are surface and upper air.

Surface Observations

Surface observations are taken hourly or as required by the Marine Corps Weather Service. Observations include:

- Surface winds
- Precipitation type and intensity
- Prevailing visibility
- Obstructions to vision
- Clouds/ceiling
- Temperature

- Dewpoint temperature
- Surface atmospheric pressure
- Remarks
- Altimeter setting
- Humidity.

Additional elements may include:

- Snow depth
- Precipitation amounts
- State of the ground
- Maximum and minimum temperatures.

Other information such as windchill, PA, and DA can be derived from the surface observation. The wet bulb globe temperature is obtained from weather units and provides information on heat casualty potential. Freeze-thaw depth, ice thickness, current water depth, river stages, and trafficability are obtained from engineer units.

Upper-Air Observations

Upper-air observations are taken by METMFs and artillery meteorological (ARTYMET) sections at established time intervals. They measure temperature, pressure, relative humidity, and wind speed and direction. From these observations, fallout wind estimates, ballistics information, and computer meteorological messages are prepared.

Weather Planning Factors

This paragraph describes weather planning factors that are unique to specific units or selected operations.

Effects of Weather on Amphibious Operations

Weather effects on amphibious operations may be beneficial or detrimental. Certain weather conditions may help to conceal landing operations. Other conditions may hinder beaching and unloading, task force movement, and essential air support operations. Figure E-2 (pages E-7 and E-8) shows effects of weather on amphibious operations. Table E-1 (page E-8) shows 50% survival rate times for personnel in water of various temperatures.

Effects of Weather on Ground Maneuver Operations

Armor and infantry operations are influenced primarily by those weather elements that degrade trafficability and visibility. Figure E-3 (page E-9) shows the effects of weather on armor in infantry operations.

Effects of Weather on Artillery Operations

Artillery operations are heavily weather dependent. Artillery not only must contend with those weather effects that are common to all units, but also may compensate for a number of special effects pertinent to their operations. Figure E-4 (page E-10) shows the effects of weather on artillery operations.

Effects of Weather on Aviation Operations

Marine aviation is involved in multifaceted operations over the length and breadth of the battlefield. These operations include aerial weapons, reconnaissance and surveillance, and routine logistic support. Missions are varied and require the operation of both fixed-wing and rotary-wing aviation assets in a variety of flight modes and altitudes. Figure E-5 (pages E-11 and E-12) shows the effects of weather on aviation operations.

Effects of Weather on Communications and Information Systems Operations

Communications and information systems operations are affected by a number of weather elements. Virtually all of the special weather conditions that apply to communications and information systems operations affect EM propagation. Figure E-6 (page E-13) shows the effects of weather on communications and information systems operations.

Effects of Weather on Air Defense Operations

Air defense operations require environmental information for both deployment and employment. Deployment requires climatological data, trafficability, and severe weather forecasts. Environmental elements affecting employment vary according to the type of weapons systems used. When missile systems require radar surveillance, elements such as refractive index and precipitation must be known. Other systems require visual target acquisition. Figure E-7 (page E-14) shows the effects of weather on air defense operations.

Effects of Weather on Engineer Operations

Engineer operations are influenced by current environmental conditions, forecasted conditions, and climatology. Figure E-8 (page E-15) shows the effects of weather on engineer operations.

Effects of Weather on Intelligence Operations

Many intelligence operations such as collection and dissemination may be hindered by certain weather conditions. All-source intelligence processing requires evaluation of all weather conditions, current and forecasted, as they affect enemy and friendly operations. Figure E-9 (page E-16) shows the effects of weather on intelligence operations.

Effects of Weather on Logistic Operations

Logistical operations include the supply, maintenance, and transportation required to support the MAGTF. Numerous weather factors affect the planning and activities required for each operation. Those weather factors that influence logistic operations subsequently affect the supported combat force. If logistic units are prevented from supporting forward combat elements, the success of the combat mission may be jeopardized. Figure E-10 (page E-17) shows the effects of weather on logistical operations.

Effects of Weather on Medical Support Operations

Air medical evacuation requires the same weather support as other aviation elements. Besides aviation operations, weather influences are considered in establishing field hospitals and anticipating prestockage and workloads. The requirements for weather support for ground evacuation of casualties are the same as for land transportation, including considering patient comfort under extreme weather conditions. Figure E-11 (page E-18) shows the effects of weather on medical support operations.

Effects of Weather on Military Police Operations

Military police are involved in weather-sensitive operations such as:

- Route and area reconnaissance
- Security
- Traffic and movement control
- Rear area protection
- Refugee control
- Enemy prisoner of war control
- Civil disturbance control operations.

Acoustical propagation can significantly affect the use of loudspeakers in civil disturbance control operations. Acoustical propagation is a function of attenuation and refraction, which in turn are influenced by temperature gradient, density, wind, and sky cover. Figure E-12 (page E-18) shows the effects of weather on military police operations.

Effects of Weather on NBC Operations

NBC operations are extremely sensitive to environmental conditions that affect the movement and diffusion of chemical or biological fallout. Figure E-13 (page E-19) shows the effects of weather on NBC operations.

Effects of Weather on Psychological Operations

Tactical psychological operations (PSYOPs) are influenced primarily by those weather elements

that degrade the audibility of loudspeaker broadcasts and affect the distribution of leaflets. Figure E-14 (page E-20) shows the effects of weather on PSYOPs.

Severe Weather

Severe weather hampers debarkation and landing craft operations, creates unacceptable surf conditions, may preclude landing, and interferes with construction support.

Wind (Surface)

Surface wind may cause postponement of landings. It affects the state of the sea and handling of landing craft.

Windchill

Windchill may cause a requirement for special equipment and rigging for landing and for special supplies and equipment to support operations afloat and ashore.

Temperature (Surface)

Extreme surface temperatures may cause a requirement for special equipment and rigging for landing and for special supplies and equipment to support operations afloat and ashore.

Tide

Tide conditions may cause postponement of landings and may conceal beach obstacles.

Ceiling—Cloud and Sky Cover

Cloud and sky cover may hamper air support operations and landing craft navigation and may offer concealment from air reconnaissance.

Fog

Fog reduces visibility and increases landing craft navigation problems and water and terrain hazards. It may provide concealment.

Illumination

Illumination may dictate the time of landing and support operations.

Lunar Phase

The lunar phase affects tidal conditions.

Figure E-2. Effects of Weather on Amphibious Operations.

Freeze or Thaw Depth

Freeze or thaw depth may hamper movement over the beach and construction support.

State of the Sea

State of the sea may preclude landing or resupply of landing forces and may cause debarkation to be canceled. It may endanger the use of landing craft. Severe conditions can degrade naval gunfire support.

Temperature (Water)

Cold temperatures decrease survivability of personnel in the water. Survival in sea water temperatures in excess of 70 °F depends more on fatigue factors than on hypothermia.

Figure E-2. Effects of Weather on Amphibious Operations (Continued).

Table E-1. 50% Survival Rate Times (hours).

Sea Water Temperature (°F)	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**
Without Immersion Suit	1.2	1.3	1.4	1.4	1.5	1.6	1.7	1.8	1.8	1.9
With Immersion Suit	1.5	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.3
Sea Water Temperature (°F)	**40**	**41**	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**
Without Immersion Suit	2	2.2	2.3	2.5	2.6	2.8	2.9	3	3.2	3.3
With Immersion Suit	3.5	4	4.4	4.8	5.3	5.8	6.2	6.7	7.1	7.6
Sea Water Temperature (°F)	**50**	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**	**59**
Without Immersion Suit	3.5	4.3	5.2	6.1	6.9	7.8	8.6	9.4	10.3	11.1
With Immersion Suit	8	9.2	10.4	11.6	12.8	14	15.2	16.4	17.6	18.8
Sea Water Temperature (°F)	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**	**68**	**69**
Without Immersion Suit	12	12.9	13.7	14.6	15.4	16.3	17.1	18	18.8	19.6
With Immersion Suit	20	21.2	22.4	23.6	24.8	26	27.2	28.4	29.6	30.8

Visibility

Visibility may affect visual acquisition and may degrade laser range finding and target designation. Poor visibility increases the survivability of light infantry.

Precipitation

Precipitation degrades trafficability and the effectiveness of target acquisition and weapon control systems and limits visibility.

Wind (Surface)

High crosswinds cause degradation of trajectory data and first-round hit capability and cause smoke to disperse quickly.

Windchill

Windchill influences the type of lubricants to be used, determines engine warm-up periods, and affects the sustained rate of fire for weapons as well as personnel effectiveness and safety.

Temperature (Surface)

Extreme temperatures decrease the habitability of vehicles and reduce personnel effectiveness. Low temperatures degrade the ballistics of main guns and require frequent starting of vehicles.

Humidity

When coupled with high temperatures, humidity decreases the effectiveness of crews in closed vehicles and the stamina of unmounted Marines.

Barometric Pressure

Barometric pressure affects M1 gunnery computations.

Figure E-3. Effects of Weather on Ground Maneuver Operations.

Ceiling—Cloud and Sky Cover

Cloud and sky cover affect target acquisition and terminally guided munitions.

Visibility

Visibility affects target acquisition and fire adjustment as well as electro-optical target designation.

Electrical Storms and Thunder

Electrical storms and thunder restrict munitions handling.

Refractive Index

Refraction affects radar, laser, and infrared distance measuring techniques.

Wind (Surface)

Surface wind affects the accuracy of rocket fires.

Wind (Aloft)

Wind profiles are used to calculate ballistic wind correction.

Altimeter Setting and Atmospheric Pressure

Altimeter setting and atmospheric pressure are important factors in ensuring altitude accuracy, in barofuzing, and in making fire control calculations.

Density Profile

The density profile affects fire control computations.

Pressure Profile

The pressure profile is used for baroarming and barofuzing techniques and for calculating densities.

Temperature (Surface)

Surface temperature information is used in making fire control surface density determinations and in estimating ballistic atmosphere pressure and densities aloft.

Temperature Profile

The temperature profile is used to calculate ballistic temperature and air density.

Moisture Profile

The moisture profile is used to determine virtual temperature and atmosphere ducting conditions. It affects electro-optical target designation.

Figure E-4. Effects of Weather on Artillery Operations.

Ceiling—Cloud and Sky Cover

Cloud and sky cover limit operations in which aircraft are required to operate clear of clouds, may preclude landings or increase danger in takeoffs, and may preclude close air support missions.

Visibility

Visibility affects landing and takeoff capabilities, reconnaissance and target acquisition, electro-optical target designation, and terminally guided munitions. Low visibility increases flight hazards.

Electrical Storms and Thunder

Electrical storms are hazardous to in-flight operations, refueling operations, and rearming operations.

Precipitation

Precipitation affects visibility, flight safety, and density altitude. Powdery snow may preclude hover operations.

Snow Depth

Snow affects ground handling.

Refractive Index

Refraction affects optical, radar, laser, and infrared range finding techniques.

State of the Ground

The state of the ground influences the effectiveness of air-delivered munitions.

Turbulence

Turbulence affects reconnaissance and surveillance; shear affects systems performance. Turbulence may cause aircraft structural damage and affect aircraft control. Severe turbulence may cause cancellation of operations.

Wind (Surface)

Surface wind affects aircraft control near the ground. It affects landing and takeoff as well as ground speed for low-level flights.

Blowing Dust and Sand

Blowing dust and sand may affect hydraulic systems and windscreens.

Wind (Aloft)

Wind aloft affects navigation and ground speed at higher flight altitudes.

Figure E-5. Effects of Weather on Aviation Operations.

Density Altitude

DA affects lift capabilities and reciprocating engine performance. It also limits fuel and weapons load.

Pressure Altitude

PA affects reciprocating engine performance.

Pressure Profile

Pressure affects terrain avoidance.

Temperature (Surface)

High temperatures reduce lift capabilities. Cold temperatures increase maintenance requirements and time to perform. Temperature extremes can also reduce the number of personnel carried because of weight and bulk of protection gear.

Dewpoint

Dewpoint affects engine efficiency calculations and serves as a warning of possible fog formation or icing conditions.

Illumination

Illumination affects operations using night vision devices.

Figure E-5. Effects of Weather on Aviation Operations (Continued).

Dust

Dust affects EM propagation.

Electrical Storms and Thunder

Electrical storms interfere with radio and wire communications and may disrupt synchronization for data communications.

Fog

Fog affects EM propagation.

Precipitation

Precipitation affects EM propagation.

Blowing Snow

Blowing snow builds static discharge, which may affect EM propagation.

Ionospheric Disturbance

Ionospheric disturbance affects the reliability of radio communications systems.

Refractive Index

Refraction affects EM propagation characteristics of the atmosphere.

Icing

Icing may damage cable lines and antennas; it decreases the efficiency of microwave systems.

Wind (Surface)

Surface wind may damage antennas and transmission lines, may cause cable blowdown, and interferes with antenna installation.

Temperature (Surface)

High temperatures adversely affect electronic circuits and may increase maintenance requirements. Extreme cold may snap cable lines. Cold decreases the life of battery-operated equipment.

Humidity

Humidity may cause fungal growth within circuits; this can result in premature system failure.

Figure E-6. Effects of Weather on Communications and Information Systems Operations.

Refractive Index

Refraction degrades target acquisition and radar tracking performance, especially during superrefraction.

Fog

Fog degrades visual acquisition and tracking.

Cloud Cover and Ceiling

Cloud cover may degrade visual acquisition and tracking.

Precipitation

Precipitation degrades or prevents visual acquisition and tracking and infrared homing. It may weaken radar signals.

Surface Pressure

Surface pressure affects calibration of equipment.

Electrical Storms

Electrical storms degrade the effectiveness of electronic systems.

Light Data

Light affects visual acquisition and tracking.

Temperature

High temperatures degrade the effectiveness of electronic systems. Very low temperatures may affect mechanical devices. Extreme cold can produce detectable ice-fog exhaust trails from certain weapons systems and vehicles.

Humidity

Humidity affects refraction and may degrade radar effectiveness.

Figure E-7. Effects of Weather on Air Defense Operations.

Visibility

Visibility affects survey operations.

Precipitation

Precipitation influences river current, water depth, and bridge construction; complicates construction and maintenance operations; and affects flooding, river crossing operations, and soil bearing strength.

Snow Depth

Snow depth affects site selection and construction, flood prediction, and mobility and countermobility operations.

Freeze or Thaw Depth

Freeze or thaw depth affects site selection and construction and complicates excavation.

Temperature (Water)

Water temperature affects the survivability of troops in the water during port construction, river crossings, and beach operations.

Tide

The tide affects site selection and port and beach operations, including the timing of beach operations.

Wind (Surface)

Surface wind affects river crossings, port and watercraft operations, smoke operations, and structural strength requirements. It also hinders certain construction operations.

Humidity

Humidity affects the handling, storage, and use of building materials.

Temperature (Surface)

Surface temperature affects trafficability, flood potential, ice thickness, and river crossing capabilities. It may affect the use of certain construction materials.

Figure E-8. Effects of Weather on Engineer Operations.

Ceiling—Cloud and Sky Cover

Cloud and sky cover may affect aerial infrared and photographic collections systems, restrict use of UAVs, and increase the effectiveness of illumination devices.

Visibility

Visibility may affect visual, photographic, infrared, and electronic data collection systems.

Electrical Storms and Thunder

Electrical storms affect the efficiency of electronic systems and dissemination through radio and wire communications systems.

Precipitation

Precipitation obstructs vision, degrades photographic and infrared collection systems, and may degrade radar collection systems.

Severe Weather

Severe weather may prevent employment of aerial collection systems and may damage or prevent installation of collection system antennas.

Ionospheric Disturbances

Ionospheric disturbances may degrade electronic collection and communications and radar collection systems.

Light Data

Light data is required for planning collection operations and for long-range planning.

Icing

Ice may degrade the performance of aerial collection systems if permitted to coat antennas.

Wind (Surface)

Surface wind may affect the employment of aerial collection systems and may damage or prevent the installation of electronic collection system antennas.

Temperature (Surface)

Surface temperature may affect collection system reliability.

Inversion

Inversion may provide false indications to certain electronic collection systems.

Figure E-9. Effects of Weather on Intelligence Operations.

Visibility

Reduced visibility may slow ground movement of munitions and supplies forward, may preclude aerial re-supply operations, and may conceal ground transportation operations.

Electrical Storms and Thunder

Electrical storms endanger storage, handling, and transportation of munitions and fuels; may interrupt computerized inventory operations; and can damage storage facilities and stored material.

Precipitation

Precipitation may affect storage of munitions and supplies and may preclude ground transportation over unpaved surfaces.

Snow Depth

Snow depth affects the ability to move supplies forward and affects the forward deployment of maintenance teams.

Freezing Precipitation

Freezing precipitation has a severe impact on logistical and maintenance support (air and surface).

Surf and Tide Conditions

Surf and tide conditions affect the movement of supplies ashore and amphibious operations.

Temperature (Surface)

Cold may affect vehicle starting and warm-up periods and may increase maintenance requirements (as a result of temperature-induced failures). It creates ice, which may preclude the use of waterways for transportation. Temperature affects the storage of perishable supplies; affects snow melting, which can cause flooding, reduce trafficability, and hinder ground transportation; and affects freeze or thaw depth, which may determine the use of supply routes. Temperature information is required for calibration of artillery systems.

Humidity

Humidity affects the storage of munitions and other supplies and may increase equipment failure rates and affect maintenance operations.

Figure E-10. Effects of Weather on Logistic Operations.

Precipitation

Precipitation affects available water supply, influences hospital site selection, and may damage unprotected supplies.

Severe Weather

Severe weather may produce an increased nonbattle casualty load.

Temperature (Surface)

Extreme temperatures may require special protection of medical supplies, increase patient load because of heat and cold injuries, and affect seasonal diseases.

Humidity

Humidity may affect storage of medical supplies.

Figure E-11. Effects of Weather on Medical Support Operations.

Precipitation

Precipitation may require additional protection for enemy prisoners of war.

Severe Weather

Severe weather may affect security operations and refugee control.

Wind (Surface)

Wind affects the use of riot control agents.

Inversion

Inversion may affect the use of riot control agents.

Figure E-12. Effects of Weather on Military Police Operations.

Ceiling—Cloud and Sky Cover

Information on cloud and ground albedo, sky cover, and visibility are required to estimate thermal levels resulting from nuclear bursts.

Precipitation

Precipitation affects the persistence of chemical agents. Snow may cover and render ineffective certain liquid agents. Precipitation may produce radioactive rainout and hot spots.

Sunlight

Sunlight shortens the life span of biological agents.

State of the Ground

The state of the ground influences the effectiveness of chemical agents and affects fallout concentration levels. Wet soil degrades the effectiveness of smoke munitions.

Turbulence

Turbulence affects the length of time that chemical agents and smoke will remain in the target area.

Wind (Surface)

Wind measurements from the surface to 98,424 ft (50,000 m) or higher are needed for fallout pattern prediction (nuclear weapons). Wind affects chemical/biological agent dispersion and may decrease chemical agent persistence.

Wind (Aloft)

Wind aloft affects the aerial delivery of chemical/biological agents and may degrade the effectiveness of smoke operations.

Humidity

A high level of humidity increases the effectiveness of smoke and some chemical agents. Combined with high temperatures, it reduces the time in which troops in protective gear are effective. High humidity levels destroy some chemical agents. Humidity affects biological agents; the effect varies depending on humidity level and the type of agent.

Inversion

Inversion affects aerosol dispersion and the persistence of chemical/biological agents.

Figure E-13. Effects of Weather on NBC Operations.

Ceiling—Cloud and Sky Cover

Cloud and sky cover may affect aerial loudspeakers and leaflet delivery by restricting visibility and access to the target.

Visibility

The delivery of leaflets by aircraft may be hampered when the pilot cannot see the target.

Electrical Storms and Thunder

Electrical storms and thunder reduce the audibility of loudspeakers and interfere with radio broadcasts.

Precipitation

Precipitation may force the target audience under cover, where they are not receptive to leaflet drops or loudspeaker broadcasts. It reduces the audibility of loudspeakers and destroys leaflets.

Snow

Snow reduces the effectiveness of leaflet dissemination and durability.

Wind (Surface)

High winds will reduce the audibility of loudspeakers. Wind speed and direction will affect the distribution of leaflets by air or artillery.

Humidity

Humidity affects the distance that sound will travel.

Figure E-14. Effects of Weather on PSYOPs.

Appendix F

Meteorological Critical Values

Meteorological critical values are those values that significantly reduce the effectiveness of operations, equipment, and weapons systems. Significant variations above or below critical values can prevent the successful completion of a mission. Therefore, the MAGTF SWO must be included in the planning stages of all operations. Commanders must be aware of meteorological critical values and consider them in all planning.

This appendix provides tables of critical values for specific operations. It does not, however, provide absolute values for every operation or weapons system in the battlespace. Critical values must be weighed against the tactical situation and the mission. Although weather personnel forecast and call attention to critical factors, only commanders decide which values are critical for each operation. Additional input from NAVOCEANO, terrain analysis teams, and other sources and the criticality of the mission are weighed by the commander in reaching a decision. Tables within this appendix show some meteorological critical values for specific and branch operations.

Weather information is frequently color coded to help the decisionmaker quickly assess the impact of weather on impending operations and decisions. This person normally is the tactical unit commander to whom the weather service personnel provide support. The following color code is suggested for consistency within the operational commands:

- Green (favorable)—there are no weather restrictions.
- Amber (marginal)—weather degrades or limits.
- Red (unfavorable)—weather significantly affects or prohibits.

The following tables provide meteorological critical values for a variety of military operations and functions.

Table F-1. Amphibious Operations.

Amphibious Operations		
Element	**Critical Value**	**Impact**
Ceiling—cloud and sky cover	≤ 1,000 ft	Concealment; close air support planning
Visibility (surface)	≤ 1 mi	Target acquisition
Wind (surface)	≥ 7 kt ≥ 35 kt	Personnel landing and smoke operations Wave and surf limits
Temperature (surface)	> 90 °F < 32 °F	Personnel and equipment support Planning and logistic support, fuels, and expendable supplies
Windchill	≤ -25 °F 1-min exposure ≤ -74 °F 1-sec exposure	Troop safety
Precipitation	> 0.1 in/h liquid	Shore trafficability
Effective illumination	< 0.0011 lux (lx)	Planning for night landing operations and concealment
Littoral current	Any underlying current or riptide > 3 kt	Mission planning
Tides	Variable threshold of watercraft	Type of watercraft required; timing of mission
Temperature (water)	> 86 °F	Personnel safety
State of the sea	> 3-ft waves	Mission planning
Surf breaker description	Surging surf > 4-ft breakers	Mission planning
Surf zone	Area covered by surf	Mission planning

Table F-2. Intelligence Operations.

Intelligence Operations		
Element	**Critical Value**	**Impact**
Ceiling—cloud and sky cover	≤ 200 ft ≤ 1,000 ft	Engagement range Aerial observation
Surface visibility at the following wavelengths: 1.06 m, 3 - 5 m, 8 - 12 m	< 1 mi	Determination of enemy's ability to conceal actions; location and identification of targets
Wind (surface)	> 60 kt	Equipment damage
Precipitation	> 0.1 in/h liquid > 0.5 in/h liquid > 2 in within a 12-h period	Audio sensors and radar effectiveness Speed of personnel and equipment movement Speed of personnel and equipment movement; trafficability and storage of equipment
Snow depth and cover	> 6 in	Trafficability
Thunderstorms and lightning	Any occurrence within 3 mi	Troop and equipment safety; false alarms and false readings
Temperature (surface)	>122 °F < -58 °F	Emplacement site selection
Temperature (ground)	< 32 °F	Trafficability assessment
Wet bulb globe temperature	> 85 °F	Troop safety
EM propagation	Subrefraction and superrefraction	Ducting of radar transmission and returns
Effective illumination	< 0.0011 lx	Target acquisition
River stage and current strength	> 6-ft depth	Enemy's ability to cross rivers or streams

Table F-3. Ground Maneuver Operations.

Ground Maneuver Operations		
Element	**Critical Value**	**Impact**
Ceiling—cloud and sky cover	≤ 1,000 ft	Concealment and cover from threat surveillance; tactical air and aerial supply support; background contact for target acquisition or using thermal devices
Surface visibility at the following wavelengths: 1.06 m, 3 - 5 m, 8 - 12 m	Dragon < 800 ft Tube launched, optically tracked, wire command link guided missile (TOW) < 1,600 m	Target acquisition; system selection
Wind (surface)	> 7 kt	Smoke operations; background radar noise
	> 20 kt	Visibility restriction in blowing sand and snow; soil drying speed; aerial resupply; windchill effect on equipment and personnel
	> 30 kt	Accuracy of antitank missiles
	> 75 kt	Antenna failure
	> 125 kt	Equipment (van) failure
Precipitation	> 0.1 in/h liquid > 2 in within a 12-h period	Soil type (affected by temperature and moisture); vehicle movement; site location; river levels; runoff; flooding; delays in resupply; demolitions; river crossing; visibility; target acquisition; radar effectiveness
Snow depth and cover	> 2 in within a 12-h period > 6 in > 24 in	Effectiveness of mines; choice of construction materials; trafficability
Freeze and thaw depth	< 6 in	Off-road employment of wheeled and tracked vehicles
Thunderstorms and lightning	Any occurrence within 3 mi	Munitions safety; personnel communications equipment safety
Temperature (surface)	≥ 122 °F	Thermal sights
	> 90 °F	Lubricants, personnel, and infrared sensors
	> 32 °F	River crossing sites and off-road movements (affected by melting snow and ice)
	< 32 °F	Drying of soil; freeze or thaw depth
	Any change of 50 °F	Munitions trajectories
Windchill	≤ -25 °F 1-min exposure ≤ -75 °F 1-sec exposure	Time before exposed flesh will suffer frostbite

Table F-3. Ground Maneuver Operations (Continued).

Ground Maneuver Operations		
Element	**Critical Value**	**Impact**
Effective illumination	< 0.0011 lx	Use of night vision devices
Sea/shore conditions	Current and tide > 5 kt	Beach and port sea-to-shore loading and offloading operations
	Waves > 3 ft Swell > 3 ft Surf > 5 - 6 ft	Landing operations

Table F-4. Field Artillery Operations.

Field Artillery Operations		
Element	**Critical Value**	**Impact**
Ceiling—cloud and sky cover	≤ 600 ft	Target acquisition; Copperhead performance
Visibility—slant range at the following wavelengths: 1.06 m, 3 - 5 m, 8 - 12 m	≤ 1 mi	Target acquisition
Wind—vertical profile	> 5-kt change/3,280 ft	UAV operations; nuclear fallout prediction
Thunderstorms and lightning	Any occurrence within 3 mi	Safety and storage of munitions
Effective illumination	< 0.0011 lx	Mission planning for night artillery operations

Table F-5. Aviation and Air Assault Operations.

Aviation and Air Assault Operations		
Element	**Critical Value**	**Impact**
Ceiling—cloud and sky cover	≤ 300 ft (90 m)	Nap-of-the-earth planning and acquisition—rotary wing
	≤ 300 ft (90 m) flat terrain	Daylight target acquisition—fixed wing
	≤ 500 ft (150 m) mountain terrain	Daylight target acquisition—fixed wing
	≤ 500 ft (150 m) flat terrain	Night target acquisition—fixed wing
	≤ 1,000 ft mountain terrain	Night target acquisition—fixed wing
Visibility (surface)	≤ 0.25 mi (400 m)	Navigation and target acquisition—rotary wing
	≤ 1 mi (1,600 m)	Landing and takeoff minimums for mission planning
	≤ 3 mi (4,800 m)	Landing and takeoff minimums for mission planning
Visibility (slant range)	≤ 0.25 mi (400 m)	Navigation and target acquisition—rotary wing
	≤ 3 mi (4,800 m) mountain terrain	Navigation and target acquisition—rotary wing
Wind (surface)	> 30 kt > 15-kt gust spread	Mission planning; aircraft safety
Wind (aloft)	> 30 kt	Mission planning—duration
Precipitation	Any freezing	Rotorblade icing; aircraft survivability and damage
	> 0.5 in/h liquid	Target acquisition
Hail	≥ 0.25-in diameter	Aircraft damage
Snow depth and cover	> l in (2.54 cm) powder	Location of landing zone and drop zone; vertigo
Icing	≥ Light (clear/rime)	Mission planning and safety; ordnance delivery restrictions—rotary wing
Turbulence	Moderate	Mission planning; aircraft survivability
Thunderstorms and lightning	Any occurrence within 3 mi of site	Refueling and rearming operations
DA: variable with aircraft, weight, power, and temperature	> 6,900 ft	Flight control, runway limits, takeoff, and landing
Effective illumination	< 0.0011 lx	Mission planning for night operations

Table F-6. Air Defense Operations.

Air Defense Operations		
Element	**Critical Value**	**Impact**
Ceiling—cloud and sky cover	≤ 500 ft	Selection of weapons systems and positioning for convoy
	≤ 5,000 ft	Aircraft detection and identification
Visibility (surface)	< 2 mi	Aircraft detection and identification for short-range air defense systems
	< 3 mi	Weapons system selection and placement for the Stinger system
Wind (surface)	> 30 kt	Communications and radar antenna
	> 50 kt > 57-kt gusts	Weapons system selection and planning
Wind (aloft)	> 50 kt	Aiming and tracking
Precipitation	> 0.5 in/h liquid	All radar ≥ 10 GHz (degraded); all infrared sensors
Thunderstorms and lightning	Any occurrence within 2 mi of site	Communications, radar, and storage and protection of missile systems
Temperature (surface)	> 120 °F < -45 °F	Mission planning for use of a man-portable air defense system
Windchill	≤ -25 °F 1-min exposure	Personnel protection; planning gear and equipment needs
	≤ -74 °F 1-sec exposure	Personnel protection; planning gear and equipment needs
Effective illumination	< 0.0011 lx	Target acquisition of aircraft

Table F-7. Engineer Operations.

Engineer Operations		
Element	**Critical Value**	**Impact**
Ceiling—cloud and sky cover	≤ 500 ft	Area of operations and location of facilities; personnel safety; aerial reconnaissance; camouflage needs
Visibility (surface)	≤ 0.25 mi	Mission planning; concealment and cover
Wind (surface)	≥ 13 kt	Construction and stability of bridges and structures
Precipitation	> 0.5 in/h liquid	Need for mines (reduced); loading and offloading operations
Snow depth and cover	> 2 in within a 12-h period	Some areas of operations and locations of facilities; stability of bridge structures; types of demolitions to be used and size and charge; blast from trigger mechanisms (may render mines ineffective)
Freeze and thaw depth	< 6 in	Trafficability determination
Thunderstorms and lightning	Any occurrence within 1 mi of site	Equipment and personnel safety; munitions protection
Temperature (ground)	< -32 °F	Freeze or thaw depth determination; construction material; operations, personnel, and structures (threatened as a result of precipitation at or below 32 °F)
Humidity	> 35%	Comfort, equipment operations, and site selection planning

Table F-8. Airborne Operations.

Airborne Operations		
Element	**Critical Value**	**Impact**
Ceiling—cloud and sky cover	≤ 300 ft (90 m) flat terrain	Mission planning (day)—jump altitude, aircraft penetration
	≤ 500 ft (150 m) flat terrain	Mission planning (night)—jump altitude, aircraft penetration
	≤ 500 ft (150 m) mountain terrain	Target acquisition (day)
	≤ 1,000 ft (300 m) mountain terrain	Target acquisition (night)
	≤ 10,000 ft mountain terrain	Mission planning for landing zone or drop zone
Surface visibility at the following visible wavelengths: 1.06 m, 3 - 5 m, 8 - 12 m	≤ 0.25 mi (400 m)	Mission planning—infrared sensors; navigation and target acquisition—rotary wing
	≤ 1 mi (1,600 m)	Day mission planning—minimum takeoff or landing, minimum fixed wing
	≤ 3 mi (4,800 m)	Night mission planning—minimum takeoff or landing, minimum fixed wing
Wind (surface)	≥ 13 kt	Troop safety for paradrop operations; limiting value for operations during training
	≥ 15 kt (≥ 21 kt for C-12 and U-21)	Mission planning and aircraft safety and recovery
	≥ 25 kt (OV-1) ≥ 30 kt and/or gust speeds	Mission planning and aircraft safety and recovery
Wind (aloft)	≥ 40 kt	Jump point; planning for flight route and duration
Precipitation	Any intensity or type	Rate of troop fall and target acquisition
Thunderstorms and lightning	Any occurrence	Aircraft performance; aircraft refueling; reliability of communications systems; predetonation of certain munitions
Temperature (surface)	≤ 32 °F (0 °C)	Ground conditions
PA	< 100 ft	Parachute opening altitude
DA: variable with aircraft, weight, power, and temperature	> 6,900 ft	Planning; cargo limits
	> 4,000 ft	Weight limits for attack and OH-58s
	> 2,000 ft	OH-58 troop configuration (limited)
Effective illumination	< 0.0011 lx	Planning of night missions; navigation safety

Table F-9. Nuclear, Biological, and Chemical Operations.

NBC Operations		
Element	**Critical Value**	**Impact**
Ceiling—cloud and sky cover	≤ 5,000 ft	Aerial deployment agents; thermal effects (enhanced if burst is below clouds); thermal and electromagnetic pulse (EMP) effects (reduced if burst is above clouds)
Wind	> 3 kt but < 7 kt	NBC operations (favorable)
	> 10 kt	NBC operations (unfavorable)
	> 15 kt	First-round munitions accuracy
Precipitation	Any intensity or type	Washing of agents and smoke out of the atmosphere; nuclear hot spot creation
Thunderstorms and lightning	Any occurrence within 3 mi	Troop and munitions storage safety
Temperature (surface)	> 95 °F	Rate of evaporation of liquid chemical agents; dispersion of aerosols (high risk of injury in MOPP IV)
	> 68 °F	Risk of heat illness in persons in MOPP IV (moderate)
	< 32 °F	Type of shelter (determined by climate extremes); troop vulnerability to nuclear radiation (indirectly affected); thermal radiation effect (indirect) due to type of troop clothing
Temperature (vertical gradient profile)	Reversal from stable to unstable	Time agents or smoke will remain in an area (reduced)
	Reversal from unstable to stable	Time agents or smoke will remain in an area (increased)
Humidity	> 60%	Agent effectiveness and dispersion for blister agents (very effective in hot, humid weather)
Effective illumination	< 0.0011 lx	Night operation of NBC equipment

Table F-10. Logistic Operations.

Logistic Operations		
Element	**Critical Value**	**Impact**
Snow depth and cover	> 2 in	Trafficability
Freeze and thaw depth	< 6 in	Site and equipment selection; mobility
Thunderstorms and lightning	Any occurrence within 3 mi	Equipment, personnel, and munitions safety
Temperature (surface)	> 122 °F < -25 °F	Storage and required temperature control for movement of medicines; munitions storage
Humidity	> 70%	Storage of selected supplies and munitions

Table F-11. Communications and Information Systems Operations.

Communications and Information Systems Operations		
Element	**Critical Value**	**Impact**
Wind (surface)	> 7 kt	Radar background noise
	> 25 kt	Safety and stability for installing line of sight and troposcatter antennas
	> 69 kt	Wind damage to main communications antenna—linear pole
	> 78 kt	Safety and stability of single channel radio and short-range, wideband radio antennas
Precipitation	Any occurrence of freezing	Damage to equipment and antennas; wind tolerances of antennas; troop safety
	> 0.5 in/h liquid	Blocking of troposcatter transmission; radar range (decreased); signal for single channel radio, short-range wideband radio, and line of sight communications (attenuated by precipitation)
Thunderstorms and lightning	Any occurrence within 3 mi	Damage to equipment; interference with radio signals, especially high frequency signals
Temperature (vertical gradient or profile)	All significant inversions	Fading during use of troposcatter equipment
Ionospheric disturbances	Not applicable	Dictation of most usable frequencies for communications

Table F-12. Waterborne Surface Assault (General) Critical Values.

Element: Sea State (As Defined in Appendix A)			
Platform	**Favorable**	**Marginal**	**Unfavorable**
Combat rubber reconnaissance craft (CRRC)	1	2	> 2
Landing craft, mechanized (LCM)8	2	3	> 3
Landing craft, utility (LCU)	2	3	> 3
Landing craft air cushion (LCAC)	3	4	> 4
Element: Maximum Surf			
Platform	**Favorable**	**Marginal**	**Unfavorable**
CRRC	< 2 ft	2 - 3 ft	> 3 ft
LCM8	< 6 ft	6 - 7 ft	> 7 ft
LCU	< 6 ft	6 - 7 ft	> 7 ft
LCAC	< 7 ft	7 - 8 ft	> 8 ft
Element: MSI			
Platform	**Favorable**	**Marginal**	**Unfavorable**
LCM8	< 7	7 - 8	> 8
LCU	< 11	11 - 12	> 12
Landing craft, vehicle, personnel (LCVP)	< 4	4 - 5	> 5
Element: Littoral Current			
Platform	**Favorable**	**Marginal**	**Unfavorable**
LCU	< 1 kt	1 - 2 kt	> 2 kt
Element: Miscellaneous			
Platform	**Favorable**	**Marginal**	**Unfavorable**
LCAC			
- Significant breaker height	0 - 4 ft	4 - 8 ft	8 - 12 ft
- Significant breaker type	Spilling	Surging	Plunging (steep)
- Allowable load size	75 tons	60 tons	45 tons

Table F-13. Critical Values for the Assault Amphibious Vehicle (AAV).

Load	Maximum Surf Height	Wave Interval (Not Less Than)
100% Plunging Surf:		
Combat load	6 ft	9 sec
Troop load	6 ft	9 sec
Combat equipped	6 ft	13 sec
50% Plunging Surf, 50% Spilling Surf:		
Combat load	6 ft	8 sec
Troop load	6 ft	8 sec
Combat equipped	6 ft	10 sec
100% Spilling Surf:		
Combat load	6 ft	5 sec
Troop load	6 ft	5 sec
Combat equipped	6 ft	7 sec

Note: Criteria are applicable to the AAV, personnel model (AAVP)-7A1; AAV, command model (AAVC)-7A1; and AAV, recovery model (AAVR)-7A1**.** Criteria are based on the following three load conditions: combat load—10,000 lb; troop load—5,600 lb; combat equipped—no load.

Planning for combat operations should be predicated on the AAVP-7A1's demonstrated capability of negotiating 10-ft plunging waves in combat-load and troop-load conditions and 8-foot plunging waves in combat-equipped conditions.

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Appendix G

Sample Annex H (METOC Services)

I MARINE EXPEDITIONARY FORCE
CAMP PENDLETON BLUELAND
012200T MAR 98

Annex H (METOC Services) to I MEF Operation Order 2-98 (Operation Backup) (U)

REFERENCES:

(a) (U) CJCSI 3810.01, *Meteorological and Oceanographic Operations*

(b) (U) Joint Pub 3-59, *Joint Doctrine for Meteorological and Oceanographic Support*

(c) (U) Joint Pub 3-59.1, *JTTP for Meteorological and Oceanographic Support*

(d) (U) NAVMETOCCOMINST 3140.1K, *United States Navy Meteorological & Oceanographic Support System Manual*

(e) (U) MCWP 3-35.7, *MAGTF Meteorological and Oceanographic Support*

(f) (U) JTF X Operation Order (OPORD), Annex H

Time Zone: T

1. (U) SITUATION

a. (U) Concept of METOC Support. METOC support under this annex includes collection, processing, derivation, and dissemination of information describing past, present, and future atmospheric, oceanographic, and terrestrial conditions. USMC METOC personnel who are organic to the ACE will provide METOC support to forward-deployed elements/units of I MEF/Blue Force. A JMFU, composed of USMC and Blue Force METOC personnel, will be established to support the JTF HQ, I MEF, Marine Aircraft Group (MAG)-39, 1st Marine Division, and Brigade Service Support Group (BSSG)-5. The JMFU will be under the direction of the JMO.

b. (U) Assumptions

(1) (U) Indigenous weather facilities and services are available.

(2) (U) Meteorological satellites will be available to provide imagery and data to forces in and out of the theater of operations.

(3) (U) METOC observations from all areas under military and political control of the enemy will be denied.

(4) (U) METOC data of all types may continue to be made available by friendly and neutral countries under WMO agreements.

c. (U) Planning Factors. In March, the Pacific Ridge begins to move northward and gradually intensify as a thermal trough (heat low) begins to form over northwestern Mexico, western Arizona, and southeastern California. Due to the influx of warm air, resulting from the migration and development of these pressure systems, the high-pressure center located over the northwestern U.S. has weakened and almost disappeared, allowing Nevada low-pressure systems to affect the local area. A "Nevada low" is a local name given to the surface reflection of an upper-level closed low or deep trough over Nevada. The Nevada low is typically a "cold" low that develops during the February-to-April period, producing strong pressure gradients over western Arizona, Nevada, Utah, and southern California. The primary concern with a Nevada low is the strong winds associated with the pressure system. With a well-developed Nevada low over southern Nevada, Yuma can expect southwesterly winds in advance of the associated cold front and westerly to northwesterly winds sustained at 15 - 20 knots with gusts of 30 - 40 knots following frontal passage. As with any lower desert region, blowing sand and dust can be a significant problem for flight operations. The sand dunes, located west-northwest of Yuma, become a factor with a sustained surface wind of 22 knots or greater from the west through northwest. Reduced visibility to less than 3 miles in blowing dust or sand will result. (See Appendix 1.)

2. (U) MISSION. Provide METOC services for I MEF and other designated units supporting/participating in operations under all situations of the basic order.

3. (U) EXECUTION

a. (U) Concept of Operations. The METOC support organization will be directed by the JTF commander, with recommendations and advice from the JMO. The HQ Air Force Weather Agency (AFWA) and the FNMOC, which comprise the two primary METOC production centers, will provide routine centralized METOC support as required or special METOC support as tasked for the area of operations. In addition, the AFWA and FNMOC will provide initial METOC support until METOC communications are established and the JMFU is operational. Once established, the JMFU will be the primary METOC forecast agency for military forces in BLUELAND and will provide tailored theater-level products for the area of operations. (See Appendix 2.) METOC personnel at all echelons will further tailor these products, as necessary, to support their customers.

b. (U) Tasks and Responsibilities

(1) (U) The I MEF SWO is responsible for providing/arranging METOC support to HQ, I MEF (Forward) (MEF(FWD)), and for coordinating and directing overall METOC support for operations in BLUELAND.

(2) (U) The SWO is responsible for providing METOC support to all forces in theater, as outlined by references (a) - (d). The JMO will develop the MEF METOC plan and will coordinate METOC support during implementation of the OPORD.

(3) (U) When directed by the commanding general of I MEF, MWSS 372 and Blue Force METOC personnel will combine to form the JMFU.

(a) (U) The JMFU will be established at Yuma, BLUELAND.

(b) (U) MWSS 372's METMF, forward deployed to Auxiliary II, BLUELAND, will be the alternate JMFU. The alternate JMFU is responsible for producing and disseminating JMFU products:

(1) When directed by the JMO.

(2) If connectivity with the primary JMFU is lost for a period of six hours.

(4) (U) MWSS 372 will provide METOC support to all forward-deployed units located in the vicinity of Auxiliary II, BLUELAND.

(5) (U) When directed by the JMO, MWSS 372 will provide a fully equipped MEF weather support team, capable of rapid redeployment, to accompany operational commanders and to provide on-scene METOC services.

(6) (U) The HQ AFWA and the NAVMETOCCOM will, through their centralized facilities, provide centralized products.

(7) (U) The 55th Space Weather Squadron (55SXS) will provide specialized space METOC products.

(8) (U) Units at all echelons will follow the steps below to determine and fill METOC support requirements. Higher echelon units receiving shortfalls will look within their resources for the required capability.

(a) (U) Determine METOC service support requirements.

(b) (U) To the extent possible, provide resources from organic organizations to satisfy their requirements.

(c) (U) When unable to satisfy their requirements, notify the next highest echelon of the shortfall.

(9) (U) Intelligence units at all echelons of command will ensure that all TARWI and Forward Area Limited Observing Program (FALOP) inputs are passed to the JMFU in a timely manner.

(10) (U) Pilot reports received by METOC/ATC personnel will be forwarded to the JMFU in a timely manner.

(11) (U) METOC reports include the following.

(a) (U) All METOC units with forecast requirements will issue a METOC terminal aerodrome forecast (TAF) every six hours or as directed by the JMFU.

(b) (U) All METOC units will take and disseminate surface observations every hour and upper-air soundings every 12 hours or as directed by the JMFU.

c. (U) Coordinating Instructions

(1) Direct coordination is authorized and encouraged between all echelon SWOs. SWOs will coordinate special METOC support requirements with the JMO.

(2) The I MEF(FWD) WEAX is the official forecast for the area of operations. (See Appendix 2, Tab A.) METOC units may tailor the I MEF(FWD) WEAX to meet specific operational requirements. Coordinate significant deviations from the I MEF(FWD) WEAX with the JMFU officer in charge, except to satisfy an immediate operational need or under conditions affecting the safety of personnel or equipment. In these cases, coordinate with the JMFU officer in charge after the fact.

4. (U) ADMINISTRATION AND LOGISTICS. Logistics of METOC equipment and supplies will be conducted as outlined in unit standing operating procedures and Annex D. METOC units are expected to deploy with enough materials to last until resupply can be reasonably expected. Report problems with logistic support for METOC units through the operational chain of command.

5. (U) COMMAND AND CONTROL. Use theater and tactical nets in addition to established METOC circuits to pass data and forecast guidance. (See Annex K.)

a. (U) METOC command and control includes normal METOC services augmented with tailored forecasts to support the operational and tactical commanders. Regional METOC data streams provide observations, general forecasts, and special products as requested. Exploit all other data sources, including U.S. and foreign satellite, teletype, and facsimile broadcasts.

b. (U) Loss of METOC communications circuits will critically degrade the control of METOC services. Copy joint Service, allied, or other nations' data sources to continue accurate and consistent support. Supplement data with local observations taken by tactical units in theater.

c. (U) METOC services are available to echelons where special circuits are not available. Commercial telephone lines, unclassified weather broadcasts sent in the blind, and computer bulletin boards will be used to provide information. MEF weather support teams are available to accompany operational commanders to provide on-scene METOC support.

d. (U) Dissemination of METOC data will be in accordance with applicable operations security instructions. (See Annex C.)

G. GLAD
BGen, U.S. Marine Corps
Commanding

Appendices:

1 - Astronomical and Climatological Data

2 - MAGTF Standard Tactical METOC Support Plan

OFFICIAL:

D. L. WHO
COL USMC

I MARINE EXPEDITIONARY FORCE
CAMP PENDLETON BLUELAND
012200T MAR 98

Appendix 1 (Astronomical and Climatological Data) to Annex H (METOC Services) to I MEF Operation Order 2-98 (Operation Backup) (U)
Astronomical and Climatological Data (U)

1. All times are listed as local times or Mountain Standard Time (MST). Local time (Tango) is -7 hours from Coordinated Universal Time (UTC) (Zulu). BLUELAND remains in MST throughout the year. Terms and definitions include:

a. Sunrise/Moonrise. The instant when the upper edge of the sun/moon appears on the sea-level horizon.

b. Sunset/Moonset. The instant when the upper edge of the sun/moon disappears below the sea-level horizon.

c. Nautical Twilight. When the center of the sun's disk is 12 degrees below the sea-level horizon. BMNT = beginning of morning nautical twilight. EENT = end of evening nautical twilight.

d. Civil Twilight. When the center of the sun's disk is 6 degrees below the sea-level horizon. BMCT = beginning of morning civil twilight. EECT = end of evening civil twilight.

e. Lunar Illumination (% LUM). Given in percentage of the "actual" lunar disk visible at midnight of each given day.

2. Astronomical data for Yuma, BLUELAND, (32°39'N, 114°37'W) is as follows:

a. Astronomical Data for March 19xx:

			Sun				Moon		%
Date	BMNT	BMCT	Rise	Set	EECT	EENT	Rise	Set	LUM
Mar 1	0612	0641	0706	1836	1901	1929	1536	0435	89
Mar 2	0611	0640	0704	1837	1902	1930	1630	0513	94
Mar 3	0610	0639	0703	1838	1902	1931	1725	0550	98
Mar 4	0609	0637	0702	1838	1903	1932	1820	0625	98
Mar 5	0608	0636	0701	1839	1904	1932	1916	0700	100
Mar 6	0606	0635	0700	1840	1905	1933	2013	0734	99
Mar 7	0605	0634	0658	1841	1905	1934	2112	0810	97
Mar 8	0604	0632	0657	1842	1906	1935	2211	0848	92
Mar 9	0603	0631	0656	1842	1907	1935	2312	0929	85
Mar 10	0601	0630	0655	1843	1908	1936	——	1014	75
Mar 11	0600	0629	0653	1844	1908	1937	0012	1103	66
Mar 12	0559	0627	0652	1845	1909	1938	0112	1158	55

Mar 13	0558	0626	0651	1845	1910	1938	0211	1257	43
Mar 14	0556	0625	0649	1846	1911	1939	0305	1400	32
Mar 15	0555	0624	0648	1847	1911	1940	0356	1506	21
Mar 16	0554	0622	0647	1847	1912	1941	0443	1612	12
Mar 17	0552	0621	0646	1848	1913	1941	0526	1718	05
Mar 18	0551	0620	0644	1849	1913	1942	0607	1822	01
Mar 19	0550	0618	0643	1850	1914	1943	0647	1926	00
Mar 20	0548	0617	0642	1850	1915	1944	0726	2028	02
Mar 21	0547	0616	0640	1851	1916	1944	0805	2128	06
Mar 22	0546	0614	0639	1852	1916	1945	0846	2226	12
Mar 23	0544	0613	0638	1852	1917	1946	0928	2321	19
Mar 24	0543	0612	0636	1853	1918	1947	1012	——	26
Mar 25	0542	0610	0635	1854	1919	1947	1058	0013	37
Mar 26	0540	0609	0634	1855	1919	1948	1146	0102	47
Mar 27	0539	0608	0632	1855	1920	1949	1236	0148	57
Mar 28	0538	0607	0631	1856	1921	1950	1328	0230	66
Mar 29	0536	0605	0630	1857	1921	1950	1421	0310	75
Mar 30	0535	0604	0629	1857	1922	1951	1514	0347	83
Mar 31	0534	0603	0627	1858	1923	1952	1609	0423	90

b. Astronomical Data for April 19xx:

			Sun				Moon		%
Date	BMNT	BMCT	Rise	Set	EECT	EENT	Rise	Set	LUM
Apr 1	0532	0601	0626	1859	1924	1953	1706	0458	95
Apr 2	0531	0600	0625	1900	1924	1954	1803	0533	99
Apr 3	0529	0559	0623	1900	1925	1954	1902	0609	99
Apr 4	0528	0557	0622	1901	1926	1955	2002	0646	100
Apr 5	0527	0556	0621	1902	1927	1956	2104	0727	99
Apr 6	0525	0555	0620	1902	1927	1957	2206	0811	95
Apr 7	0524	0553	0618	1903	1928	1958	2307	0900	88
Apr 8	0523	0552	0617	1904	1929	1958	——	0954	78
Apr 9	0521	0551	0616	1904	1930	1959	0006	1051	70
Apr 10	0520	0550	0615	1905	1930	2000	0101	1153	58
Apr 11	0519	0548	0613	1906	1931	2001	0152	1256	46
Apr 12	0517	0547	0612	1907	1932	2002	0239	1400	35
Apr 13	0516	0546	0611	1907	1933	2002	0322	1504	24
Apr 14	0515	0544	0610	1908	1933	2003	0403	1608	15
Apr 15	0513	0543	0609	1909	1934	2004	0442	1710	07
Apr 16	0512	0542	0607	1909	1935	2005	0520	1812	03
Apr 17	0511	0541	0606	1910	1936	2006	0559	1912	00

Apr 18	0509	0540	0605	1911	1936	2007	0639	2011	00
Apr 19	0508	0538	0604	1912	1937	2008	0720	2108	03
Apr 20	0507	0537	0603	1912	1938	2008	0804	2203	08
Apr 21	0506	0536	0602	1913	1939	2009	0850	2254	14
Apr 22	0504	0535	0601	1914	1940	2010	0938	2341	22
Apr 23	0503	0534	0559	1915	1940	2011	1028	——	28
Apr 24	0502	0533	0558	1915	1941	2012	1119	0025	39
Apr 25	0501	0531	0557	1916	1942	2013	1211	0106	49
Apr 26	0459	0530	0556	1917	1943	2014	1304	0144	59
Apr 27	0458	0529	0555	1917	1943	2015	1357	0220	68
Apr 28	0457	0528	0554	1918	1944	2015	1452	0255	78
Apr 29	0456	0527	0553	1919	1945	2016	1549	0329	86
Apr 30	0455	0526	0552	1920	1946	2017	1647	0404	92

3. All climatological data is based on observations from 1948 through 1994. Terms and definitions include:

a. Temperatures. Listed in degrees Fahrenheit for conversion to Celsius: (°F - 32)/1.8 = °C.

b. Sky Condition. CLR = clear (absence of clouds or obscuring phenomena). SCT = scattered (1/10 - 5/10 sky coverage). BKN = broken (6/10 - 9/10 sky coverage). OVC = overcast (10/10 sky coverage).

c. Field Condition. VFR = visual flight rules (ceiling 1,000 ft or greater and/or visibility 3 mi or greater). IFR = instrument flight rules (ceiling below 1,000 ft and visibility below 3 mi).

d. Visibility. The greatest visibility equaled or exceeded throughout at least one-half of the horizon circle (not necessarily continuous).

e. Ceiling. The height ascribed to the lowest broken or overcast layer aloft that is predominately opaque or the vertical visibility into an obscuring phenomena.

4. Climatological data for March is as follows. (See figure G-1.)

Temperature		Humidity		Precipitation	
Average maximum	79 °F	0500L	48%	Absolute maximum	1.8 in
Average minimum	51 °F	1400L	28%	Absolute minimum	0.0 in
Absolute maximum	100 °F	1700L	19%	Average	0.2 in
Absolute minimum	32 °F	Average	34%		
Average	65 °F				

Sky Condition		Field Condition		Ceiling/Visibility		
CLR	50%	VFR	99.0%	< 3,000 ft and 3 mi		1.0%
SCT	21%	IFR	1.0%	< 1,500 ft and 3 mi	<	0.5%

BKN		16%	< 1,000 ft and 3 mi	<	0.5%
OVC		13%			

Surface Winds

0800L	NNE	6.0 kt
1400L	W	9.5 kt
2000L	W	7.8 kt
All hours	W	8.4 kt
Maximum	NW	2.0 kt

Thunderstorms

Average number of days 0.7

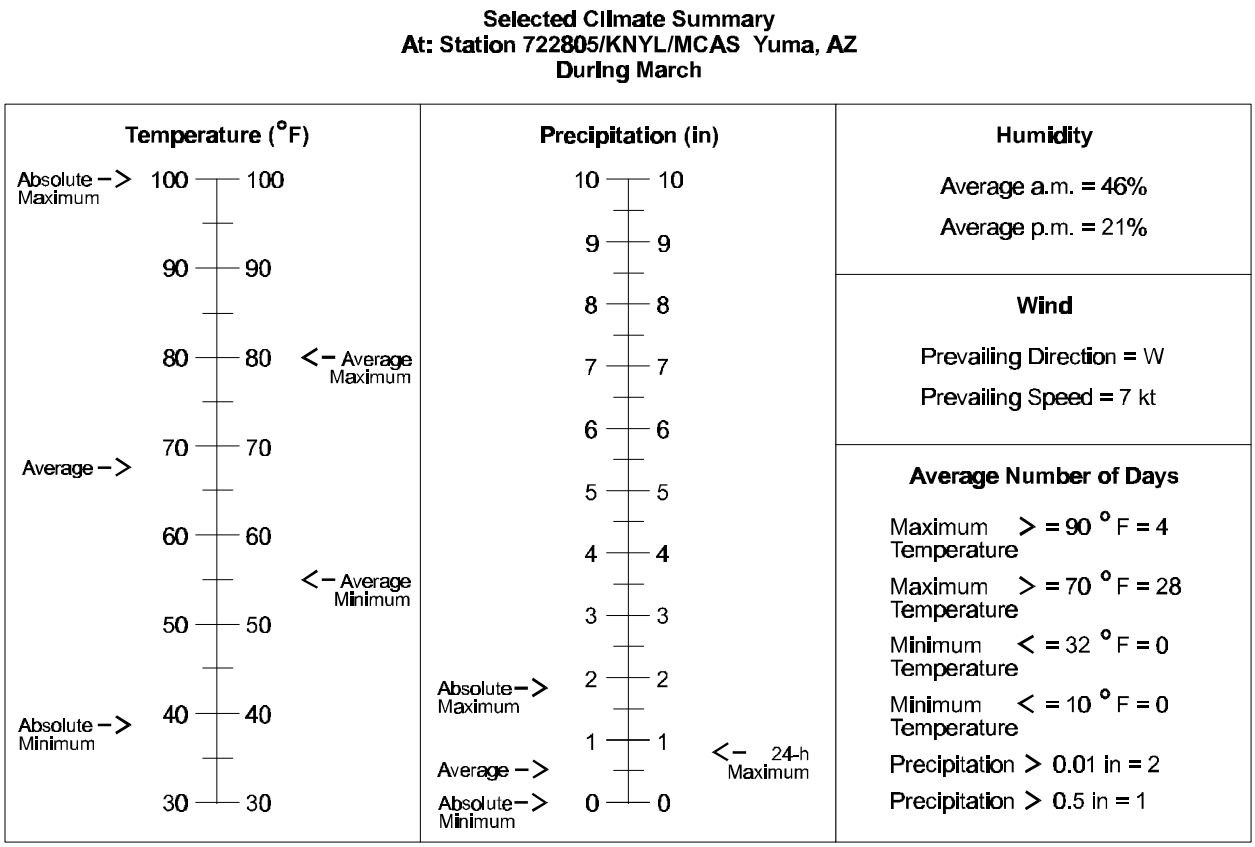

Figure G-1. Sample Climate Summary for March.

5. Climatological data for April is as follows. (See figure G-2.)

Temperature		Humidity		Precipitation		
Average maximum	87 °F	0500L	44%	Absolute maximum		1.2 in
Average minimum	57 °F	1400L	17%	Absolute minimum		0.0 in
Absolute maximum	109 °F	1700L	16%	Average		0.1 in
Absolute minimum	41 °F	Average	29%			
Average	72 °F					
Sky Condition		**Field Condition**		**Ceiling/Visibility**		
CLR	58%	VFR	99.0%	< 3,000 ft and 3 mi		1.0%
SCT	20%	IFR	1.0%	< 1,500 ft and 3 mi	<	0.5%

BKN	14%	< 1,000 ft and 3 mi	< 0.5%
OVC	8%		

Surface Winds

0800L	N	6.4 kt
1400L	W	9.6 kt
2000L	W	8.1 kt
All hours	W	8.7 kt
Maximum	N	52.0 kt

Thunderstorms

Average number of days 0.7

Selected Climate Summary
At: Station 722805/KNYL/MCAS Yuma, AZ
During April

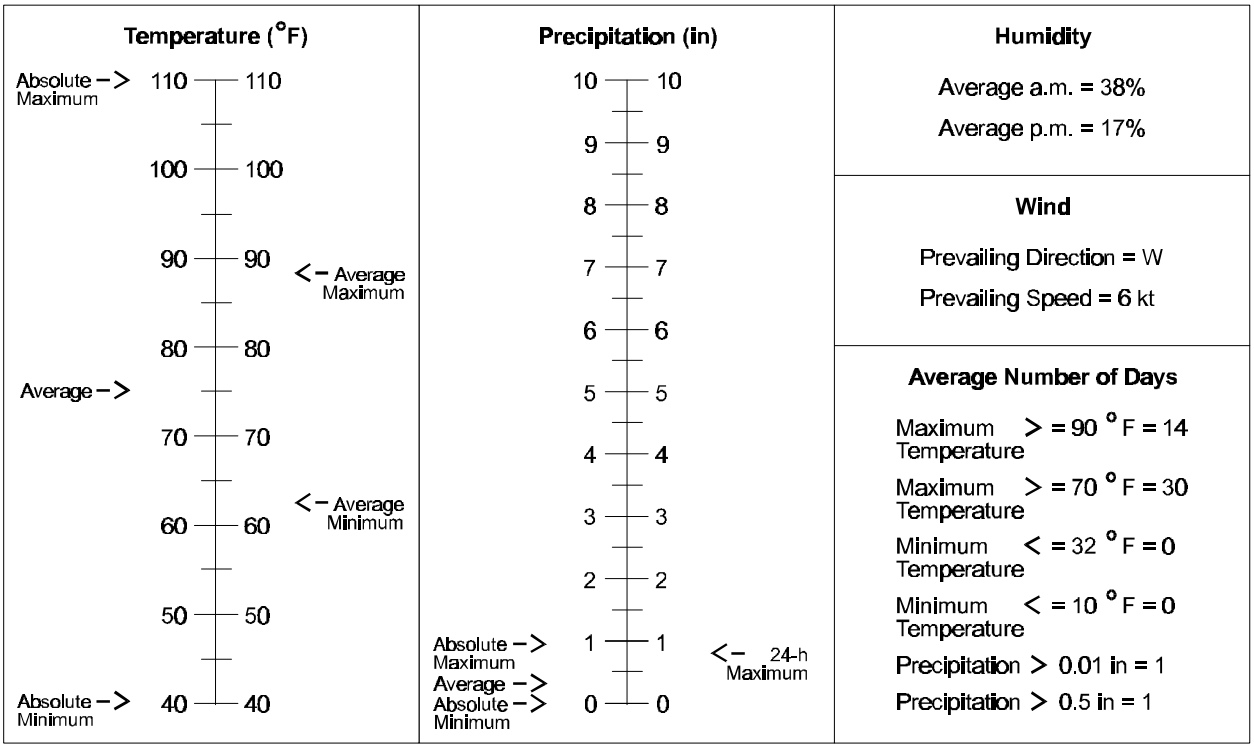

Figure G-2. Sample Climate Summary for April.

I MARINE EXPEDITIONARY FORCE
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Appendix 2 (MAGTF Standard Tactical METOC Support Plan) to Annex H (METOC Services) to I MEF Operation Order 2-98 (Operation Backup) (U)
MAGTF Standard Tactical METOC Support Plan (U)

1. Upon the employment of a MAGTF (MEU/MEF(FWD)/MEF) as part of a larger naval, joint, or combined force, responsibility for the provision of tactical METOC support will transition from garrison-based to on-scene METOC support assets under the direction and control of the ACE commander. Naval METOC centers will retain responsibility for the provision of weather facsimile support; METOC field data; wind, sea, and tropical cyclone warnings/advisories; area oceanographic support; and detailed local forecasts/tactical support products for naval units operating independently.

2. Tailored on-scene METOC support is available from METOC assets organic to the ACE. The MWSSs, equipped with a METMF complex, are normally deployed to a FOB in direct support of that airfield. MEF weather support teams from the MWSSs are assigned to provide direct support to commanders/staffs of MAGTF elements other than the ACE, that is, the CE, GCE, and CSSE. MAGTF elements should forward unique tactical METOC support requirements via the chain of command to the ACE instead of requesting personnel and equipment directly.

3. The MAGTF ACE commander shall coordinate all tactical METOC support requirements for each element; designate MWSSs to provide MEF weather support teams; provide for the timely dissemination of local warnings/advisories, observations/forecasts, and tactical support summaries/products; and maintain liaison with naval METOC centers for special tactical support requirements. To provide a common baseline within each MAGTF, tailored tactical METOC support should be developed in accordance with this appendix.

4. The MAGTF Standard Tactical METOC Support Plan consists of the following:

a. OPTASK METOC (Meteorology/Oceanography). OPTASKs are developed by using NATO APP-4 standards to provide a standard message for coordination of tactical METOC services and reporting responsibilities within a MAGTF. A standing Marine Corps-wide OPTASK METOC has yet to be promulgated by the FMF Pacific/Atlantic commanders. Once published, MAGTF commanders will issue serialized OPTASK METOC supplements detailing specific requirements for all operations and exercises.

b. Standard Tactical Summaries. These summaries are designed to provide minimum levels of tactical METOC support to MAGTF elements during routine operations. They include the WEAX and TAS. These support products are normally transmitted daily or as required.

(1) The I MEF WEAX is based on the standard NAVMETOCCOM WEAX/aviation route weather forecast (AVWX) format and shall include a meteorological situation, 24-hour forecast, and outlook to 48 hours for each METOC zone of interest. Astronomical data and a radiological fallout forecast should be appended as required. (See Enclosure (1) to Tab A of this appendix for METOC zones.)

(2) The TAS shall include an atmospheric refractive summary, a tactical assessment, EM sensor performance predictions, infrared sensor detection range predictions, communication range predictions, and an M-unit summary. Radiosonde calibration data should be appended when air-capable units are operating in proximity.

c. Special Tactical Summaries. These summaries are designed to provide minimum levels of tactical METOC support for specific operations and/or functions of Marine aviation. They include the AOAFCST, STRKFCST, and ASLTFCST.

(1) The AOAFCST is designed to provide support for exercise/real-world amphibious landings and rehearsals. It shall include a meteorological situation, a 24-hour forecast for the amphibious objective area/landing area, a surf forecast for target beaches, a tactical assessment, an abbreviated atmospheric summary, and astronomical data. A radiological and chemical fallout forecast should be appended as the tactical situation dictates. The initial forecast should be issued at least 24 hours before the beginning of amphibious operations.

(2) The STRKFCST is designed to provide a coordinated forecast whenever multiple strike (OAAW/SEAD/DAS) platforms (VMFA/VMA/VMAQ) are operating as an integrated force under one tactical commander. It shall include a meteorological situation, a 24-hour forecast of en route and target weather, an outlook to 48 hours, a tactical assessment, and electro-optical sensor performance predictions.

(3) The ASLTFCST is designed to provide a coordinated forecast whenever multiple assault support platforms (VMGR/HMH/HMM/HMLA) are operating as an integrated force under one tactical commander. It shall include a meteorological situation, a 24-hour forecast of en route FARP/RGR and landing zone weather, an outlook to 48 hours, a tactical assessment, and electro-optical sensor performance predictions.

5. Tabs A through E of this appendix include drafting guides for each of the tactical summaries discussed in this plan. They provide METOC forecasters with a baseline for development of tailored tactical support summaries that meet minimum support requirements. On-scene tactical support products should be modified as required to meet specific operational requirements and tactical situations. Additionally, METOC forecasters should strive to maintain a balance between full-spectrum support to MAGTF elements and communications efficiency. Under normal conditions, tactical summaries should not exceed 2 - 3 pages in length.

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Tab A (WEAX) to Appendix 2 (MAGTF Standard Tactical METOC Support Plan) to Annex H (METOC Services) to I MEF Operation Order 2-98 (Operation Backup) (U)
I MEF WEAX (U)

(PASS TO (CE/ACE/GCE/CSSE))
MSGID/GENADMIN/UNIT/SERIAL/MON/YR//
SUBJ/I MEF WEAX//
RMKS/

1. ( ) METEOROLOGICAL SITUATION AT Z (Note: Include the location/movement/development of synoptic high- and low-pressure centers and associated fronts referenced to common geographical points, areas, or established METOC zones. When in doubt, use latitude/longitude.)

2. ( ) 24-HOUR FORECAST COMMENCING Z (ALONG TRACK FROM N(S)/ E(W) TO N(S)/ E(W)) OR VICINITY OF N(S)/ E(W) (Note: Area of operations should be omitted if the Marine Forces commander prefers an unclassified forecast.

a. Sky/Weather (Plain-Language Format)

b. Visibility (NM)

c. Surface Winds (kt)

d. Maximum/Minimum Temperatures (°F/°C)

e. Relative Humidity (%)

f. Absolute Humidity (g/m³)

g. WBGTI/Flag Condition

h. Aviation Parameters

(1) Cloud/Ceilings (ft) (Note: TAF format is recommended.)

(2) Winds/Temperatures Aloft (Flight Level/Direction/Speed (kt)/Temperatures (°C))

(3) Turbulence (Note: Include discussion of all known CAT.)

(4) Minimum Freezing Level (ft)

(5) Icing

(6) Contrails (ft)

(7) Minimum Altimeter Setting (inches of Mercury)

(8) Maximum PA/DA

3. ( ) OUTLOOK TO 48 HOURS

4. ( ) ASTRONOMICAL DATA (UTC OR LOCAL)

a. Sunrise/Sunset/Sunrise

b. BMNT/BMCT/EECT/EENT

c. Moonrise/Moonset/Illumination (%)

5. ( ) 24-HOUR RADIOLOGICAL FALLOUT FORECAST FOR (AIR BURST/SURFACE BURST)

	Weapon Yield (Kilotons)		
a. Effective Downwind Direction (True (T))/Speed (kt)	__ /__	__/__	__/__
b. Sector Angle/Distance to Zone 1 (NM)	__/__	__/__	__/__

(Note: Radiological fallout forecast should be included for actual/exercise defense readiness condition (DEFCON) 3 or MOPP level 2; otherwise at senior forecaster's discretion.)

6. ( ) RELEASED BY (Note: Include when MINIMIZE imposed.)//
DECL/ // (As required.)

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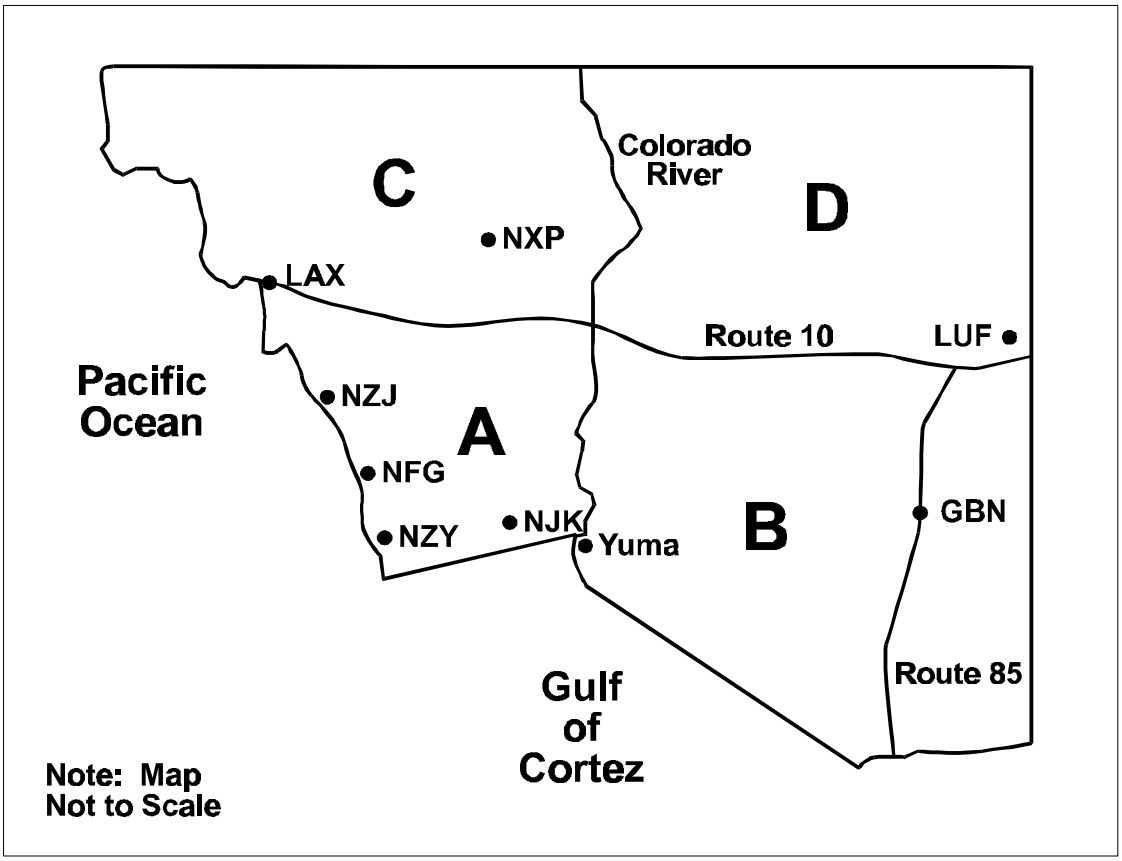
Enclosure 1 (METOC Zones) to Tab A (WEAX) to Appendix 2 (MAGTF Standard Tactical METOC Support Plan) to Annex H (METOC Services) to I MEF Operation Order 2-98 (Operation Backup) (U)

METOC Zones (U)



Legend
LAX = Los Angeles NZJ = MCAS El Toro NFG = MCAS Camp Pendleton NZY = North Island Naval Air Station, San Diego NJK = El Centro Naval Air Station, El Centro NXP = Twentynine Palms Expeditionary Airfield, Twentynine Palms LUF = Luke Air Force Base, Phoenix GBN = Gila Bend Auxiliary Air Force Base, Gila Bend

Figure G-3. METOC Zones.

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Tab B (Tactical Atmospheric Summary) to Appendix 2 (MAGTF Standard Tactical METOC Support Plan) to Annex H (METOC Services) to I MEF Operation Order 2-98 (Operation Backup) (U)

Tactical Atmospheric Summary (U)

(PASS TO (MAG/TACC/DASC/MATC/TAOC/SAAWC))
MSGID/GENADMIN/UNIT/SERIAL/MON/YR//
SUBJ/TACTICAL ATMOSPHERIC SUMMARY//
RMKS/

1. ( ) ATMOSPHERIC REFRACTIVE SUMMARY: BASED ON Z UPPER-AIR SOUNDING TAKEN AT N/ W

a. Surface-Based Duct Height (ft)

b. Elevated Ducts (Bottom-Top) (ft)

2. ( ) TACTICAL ASSESSMENT (Note: 1. Expand on the guidance contained in the propagation conditions summary (PCS) module. Specifically, discuss the atmospheric impact on MAGTF EM systems with respect to sensor-target-duct geometry (i.e., aircraft positioning; optimum altitudes for jamming, attack, EM surveillance, etc.). Highlight those sensors that are significantly degraded/enhanced. Focus on tactical guidance that will enable the tactical air coordinator, sector antiair warfare coordinator, and combat mission planners to effectively exploit a given atmospheric environment. 2. As feasible, include an analysis/forecast of atmospheric refractivity conditions in the projected operating area.)

3. ( ) EM SENSOR PERFORMANCE PREDICTIONS

a. Air Search Radar Ranges (NM) for (Missile)/(Fighter Bomber) Square Meter Targets at Various Altitudes, Based on 90% Probability of Detection

Altitude (100 ft^2)	(005)	(010)	(050)	(100)	(200)	(300)
Radar						
AN/TPS-59	__/__	__/__	__/__	__/__	__/__	__/__
AN/TPS-63	__/__	__/__	__/__	__/__	__/__	__/__
AN/TPS-73	__/__	__/__	__/__	__/__	__/__	__/__
AN/MPQ-50	__/__	__/__	__/__	__/__	__/__	__/__
AN/MPQ-62	__/__	__/__	__/__	__/__	__/__	__/__
AN/UPS-3	__/__	__/__	__/__	__/__	__/__	__/__
AN/MPQ-53	__/__	__/__	__/__	__/__	__/__	__/__
AN/APS-138	__/__	__/__	__/__	__/__	__/__	__/__
AN/APY-1/2	__/__	__/__	__/__	__/__	__/__	__/__

(Note: Radar cross sections should be tailored to the expected threat. Naval Oceanography Systems Command Technical Document (NOSC TD) 1195, *Selected Electromagnetic System Parameters for Use in the Tactical Environmental Support System*/Air Force Tactical Training Publication (AFTTP) 3-1, *Threat Manual*, provide representative values of typical U.S./threat platforms. Include all air-search radars organic to or in support of the MAGTF.

b. Electronic Support Measure (ESM) Intercept Ranges (NM) for Various Emitters

Emitter	ESM Receiver (AN/ALQ-99 - ft)
_____ (surface)	_____
_____ (airborne)	_____
_____ (missile)	_____

(Note: A representative set of emitters tailored to the expected threat is preferable to listing *every* emitter available.)

c. ES Counterdetection Ranges (NM) for Various Threat ES Receivers:

U.S. Emitter	ES Receiver (Surface)	ES Receiver (Airborne)
_____	_____	_____
_____	_____	_____

(Note: A representative list of U.S. emitters and threat ES receivers is recommended.)

4. ( ) FLIR DETECTION RANGE PREDICTIONS WIDE FOCUS OF VISION (WFOV)/NARROW FOCUS OF VISION (NFOV) (NM) FOR TARGET AT VARIOUS ALTITUDES, BASED ON 50% PROBABILITY OF DETECTION, VISIBILITY NM, WIND SPEED kt, ABSOLUTE HUMIDITY g/m³

Altitude (100 ft[2]) Sensor	(005)	(010)	(050)	(100)	(200)	(300)
AN/AAR-51	__/NA	__/NA	__/NA	NA/NA	NA/NA	NA/NA
AN/AAS-38A	__/__	__/__	__/__	__/__	__/__	__/__
AN/AWS-1	__/__	__/__	NA/NA	NA/NA	NA/NA	NA/__

(Note: Include FLIR sensors available within the MAGTF. Target types should be tailored to expected threat. Flight levels should be consistent with platforms supported.)

5. ( ) COMMUNICATION RANGE PREDICTIONS

a. Ultrahigh Frequency Communication Range (Normal/Extended/Greatly Extended)

b. High Frequency Radio Propagation Condition/Forecast

(1) High Frequency Propagation Condition/Forecast

(2) 10.7-cm Flux

6. ( ) M-UNIT SUMMARY (PROVIDED FOR INPUT INTO IREPS)

Height (ft)	M-Unit	Type (Subrefractive/Normal/Superrefractive/Trapping)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

(Note: Include enough significant levels to enable MEF weather support teams to generate representative coverage diagrams using IREPS.)

7. ( ) MINI-RAWINSONDE SYSTEM (MRS) CALIBRATION DATA (Note: Include this section only if MRS-capable units are operating in proximity.)

8. ( ) RELEASED BY (Note: Include when MINIMIZE imposed.)//
DECL/ //

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Tab C (Strike Forecast) to Appendix 2 (MAGTF Standard Tactical METOC Support Plan) to Annex H (METOC Services) to I MEF Operation Order 2-98 (Operation Backup) (U)
Strike Forecast (U)

(PASS TO (MAG/TACC/DASC/FSCC/MATC/TAOC/SAAWC))
MSGID/GENADMIN/UNIT/SERIAL/MON/YR//
SUBJ/STRIKE FORECAST (STRKFCST)//
RMKS/

1. ( ) METEOROLOGICAL SITUATION AT Z

2. ( ) 24-HOUR FORECAST COMMENCING Z

a. En Route Weather to to

(1) Sky/Weather

(2) Visibility/Slant Range Visibility (NM)

(3) Sea Surface Temperature (°F)/In-Water Survival Time

(4) Cloud Tops/Ceilings (ft)

(5) En-route Winds/Temperatures Aloft (Location/Flight Level/Direction/Speed (kt)/ Temperatures (°C))

(6) Turbulence

(7) Minimum Freezing Level (ft)

(8) Icing

(9) Minimum Altimeter Setting (inches of Mercury)

(10) Contrail Formation

(11) Ditch Headings (Degrees T)

b. Target Area Weather (Note: Repeat for each target area.)

(1) Sky/Weather

(2) Visibility/Slant Range Visibility (NM)

(3) Surface Winds (kt)

(4) Maximum/Minimum Temperatures (°F)

(5) Cloud Tops/Ceilings (ft)

(6) Winds/Temperatures Aloft (Flight Level/Direction/Speed (kt)/Temperatures (°C))

(7) Turbulence

(8) Freezing Level (ft)

(9) Icing

(10) Minimum Altimeter Setting (inches of Mercury)

(11) D-Values

(12) Contrail Formation

(13) Astronomical Data (UTC) at Z:
Sunrise/Sunset/Sun Angles (Elevation/Azimuth):
BMNT/BMCT/EECT/EENT:
Moonrise/Moonset/Percent Illumination/Moon Angles (Elevation/Azimuth)/Lux Values:

3. ( ) OUTLOOK TO 48 HOURS

4. ( ) TACTICAL ASSESSMENT (Note: Correlate the current/forecasted weather to major concerns such as aerial refueling track cloud layers and ceilings, severe weather, target ceilings and visibilities, battle damage assessment (BDA), impact on electro-optical systems/weapons, IFR conditions, etc.)

5. ( ) ELECTRO-OPTICAL SENSOR PERFORMANCE PREDICTIONS (Note: Include representative electro-optical sensor performance predictions for strike sensors/weapons systems and key METOC assumptions.)

6. ( ) RELEASED BY (Note: Include when MINIMIZE imposed.)//
DECL/ //

I MARINE EXPEDITIONARY FORCE
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Tab D (Assault Forecast) to Appendix 2 (MAGTF Standard Tactical METOC Support Plan) to Annex H (METOC Services) to I MEF Operation Order 2-98 (Operation Backup) (U)
Assault Forecast (U)

(PASS TO (MAG/TACC/DASC/FSCC/MATC/TAOC/SAAWC))
MSGID/GENADMIN/UNIT/SERIAL/MON/YR//
SUBJ/ASSAULT FORECAST (ASLTFCST)//
RMKS/

1. ( ) METEOROLOGICAL SITUATION AT Z

2. ( ) 24-HOUR FORECAST COMMENCING Z

a. En Route Weather to to

(1) Sky/Weather

(2) Visibility/Slant Range Visibility (NM)

(3) Sea Surface Temperature (°F)/In-Water Survival Time

(4) Cloud Tops/Ceilings (ft)

(5) En-route Winds/Temperatures Aloft (Location/Flight Level/Direction/Speed (kt)/ Temperatures (°C))

(6) Turbulence

(7) Minimum Freezing Level (ft)

(8) Icing

(9) Minimum Altimeter Setting (inches of Mercury)

(10) Contrail Formation

(11) Ditch Headings (Degrees T)

b. FARP/RGR Weather (As required, include for return leg if necessary.)

(1) Sky/Weather

(2) Visibility/Slant Range Visibility (NM)

(3) Surface Winds (kt)

(4) Cloud Tops/Ceilings (ft)

(5) Maximum/Minimum Temperatures (°F)

(6) Minimum Altimeter Setting (inches of Mercury)

(7) Maximum PA/DA

c. Assault Landing Zone Weather (Note: Repeat for each assault landing zone.)

(1) Sky/Weather

(2) Visibility/Slant Range Visibility (NM)

(3) Surface Winds (kt)

(4) Maximum/Minimum Temperatures (°F)

(5) Maximum PA/DA

(6) Cloud Tops/Ceilings (ft)

(7) Winds/Temperatures Aloft (Flight Level/Direction/Speed (kt)/Temperatures (°C))

(8) Turbulence

(9) Freezing Level (ft)

(10) Icing

(11) Minimum Altimeter Setting (inches of Mercury)

(12) D-Values

(13) Contrail Formation

(14) Astronomical Data (UTC) at Z:
Sunrise/Sunset/Sun Angles (Elevation/Azimuth):
BMNT/BMCT/EECT/EENT:
Moonrise/Moonset/Percent Illumination/Moon Angles (Elevation/Azimuth)/Lux Values:

3. ( ) OUTLOOK TO 48 HOURS

4. ( ) TACTICAL ASSESSMENT (Note: Correlate the current/forecasted weather to major concerns such as FARP/RGR ceilings and visibilities, severe weather, landing zone ceilings and visibilities, BDA, impact on electro-optical systems/weapons, IFR conditions, etc.)

5. ( ) ELECTRO-OPTICAL SENSOR PERFORMANCE PREDICTIONS (Note: Include representative electro-optical sensor performance predictions for associated assault platforms and key METOC assumptions.)

6. ( ) RELEASED BY (Note: Include when MINIMIZE imposed.)//
DECL/ //

I MARINE EXPEDITIONARY FORCE
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Tab E (Amphibious Objective Area Forecast) to Appendix 2 (MAGTF Standard Tactical METOC Support Plan) to Annex H (METOC Services) to I MEF Operation Order 2-98 (Operation Backup) (U)
Amphibious Objective Area Forecast (U)

(PASS TO (CATF/CLF/MEF WEATHER SUPPORT TEAM/ACE))
MSGID/GENADMIN/UNIT/SERIAL/MON/YR//
SUBJ/AMPHIBIOUS OBJECTIVE AREA FORECAST (AOAFCST)//
RMKS/

1. ( ) METEOROLOGICAL SITUATION AT Z

2. ( ) 24-HOUR FORECAST COMMENCING Z FOR AMPHIBIOUS OBJECTIVE AREA (Note: Include separate forecast for landing area if significantly different from amphibious objective area weather.)

a. Sky/Weather

b. Visibility (NM)

c. Surface Winds (kt)

d. Maximum/Minimum Temperatures (°F) (Note: include windchill factor if applicable.)

e. Sea Surface Temperature (°F)

f. Combined Seas (ft)

g. In-Water Survival Time (h)

h. Aviation Parameters

(1) Clouds/Ceilings (ft)

(2) Winds/Temperatures Aloft (Flight Level/Direction/Speed (kt)/Temperatures (°C))

(3) Turbulence

(4) Freezing Level (ft)

(5) Icing

(6) Minimum Altimeter Setting (inches of Mercury)

(7) Maximum PA/DA

(8) Contrail Formation

(9) Slant Range Visibility (NM)

3. ( ) SURF FORECAST FOR (RED)/(BLUE) BEACH (Note: Output format included in Mobile Oceanography Support System surf module.)

a. ALPHA. Significant Breaker Height (ft).

b. BRAVO. Maximum Breaker Height (ft).

c. CHARLIE. Dominant Breaker Period(s).

d. DELTA. Dominant Breaker Type (% Spilling, Plunging, Surging).

e. ECHO. Breaker Angle (°).

f. FOXTROT. Littoral Current (kt).

g. GOLF1. Number of Surf Lines.
GOLF2. Surf Zone Width (ft).

h. MSI

i. High/Low Tides (UTC or Local)

j. Beach Conditions (Note: Provide summary of hydrographic reconnaissance data, including bottom type, beach slope/type/trafficability, and significant obstacles (locations) ashore and in shallows. Marine METOC personnel will be unable to provide without external assistance from reconnaissance units or NAVOCEANO.)

4. ( ) TACTICAL ASSESSMENT (Note: See COMNAVSURFPAC/COMNAVSURFLANT 3840.1B for a discussion of modified surf limits for various landing craft types. Discuss no-go criteria, LCAC limitations, etc.)

5. ( ) ATMOSPHERIC REFRACTIVE SUMMARY

a. Evaporative Duct Height (ft)

b. Surface-Based Duct Height (ft)

c. Elevated Duct Heights (Bottom-Top) (ft)

d. Radar PCS

(1) Surface-to-Surface Radar Ranges (Note: Expand on the guidance contained in EM PCS module.)

(2) Surface-to-Air Radar Ranges

(3) Air-to-Air Radar Ranges

(4) Air-to-Surface Radar Ranges

e. Communication Range Predictions

(1) Ultrahigh Frequency Communication Range (Normal/Extended/Greatly Extended)

(2) High Frequency Radio Propagation Summary

6. ( ) ASTRONOMICAL DATA (UTC OR LOCAL)

a. Sunrise/Sunset

b. BMNT/BMCT/EECT/EENT

c. Moonrise/Moonset/Percent Illumination

d. Night Vision Effectiveness (Lumens)

7. ( ) 24-HOUR RADIOLOGICAL FALLOUT/CHEMICAL FALLOUT FORECAST (Note: Include as tactical situation dictates.)

a. Effective Downwind Direction (T)/Speed (kt)

b. Distance (NM)

8. ( ) RELEASED BY (Note: Include when MINIMIZE imposed.)//
DECL/ //

Appendix H

METOC Centers

Introduction

METOC centers are Air Force and Navy centralized production sites and climatology centers. METOC centers are broken down into two categories—strategic forecast and climatology centers and theater, regional, and component forecast centers. See Joint Pub 3-59 for more information.

Strategic Forecast and Climatology Centers

Headquarters, Air Force Weather Agency

The HQ AFWA is located at Offutt Air Force Base, Nebraska.

Primary Mission. The primary mission of the HQ AFWA is to focus on weather support worldwide to theater JTF land and air operations. To do this, the AFWA ingests atmospheric and satellite observations to build an accurate, worldwide weather database to produce gridded analysis and forecast fields of parameters that feed specific application programs for the warfighter. The AFWA also provides tailored support products. See AFI 15-118, *Requesting Specialized Weather Support*, for procedures to request support and AFCAT 15-152, *Space Environmental Products*, Volumes 1, 2, and 3, for a detailed product and station listing.

Capabilities. Weather reports from meteorological sources throughout the world are gathered and relayed to the HQ AFWA. These reports are combined with information that is available from military and civilian meteorological satellites (METSATs) to construct a near-real-time integrated environmental database. The AFWA is the DOD center for defense METSAT data processing and the only U.S. agency that provides automated worldwide cloud depictions and forecasts. Computer programs model the resident atmospheric database and project changes. These models form building blocks for worldwide tailored weather support to warfighters.

Communications Connectivity. Access to numerical weather prediction METOC fields is gained through landline connectivity with the FNMOC. The AFWA data acquisition is chiefly through the Automated Weather Network (AWN); observations, forecasts, and advisories are relayed through high-speed circuitry. Satellite data from the Defense Meteorological Satellite Program (DMSP) and the National Environmental Satellite Data and Information Service (NESDIS) polar orbiting and geostationary satellites is relayed to the HQ AFWA through communications satellite or direct readout. Foreign geostationary satellite imagery is relayed over landlines.

Worldwide data and product dissemination is through the Air Force Digital Graphics System (AFDIGS) for facsimile graphics, through the AWN for alphanumeric data, and through the Automated Weather Distribution System (AWDS) for both graphics and alphanumerics. The automated Defense Switched Network (DSN) delivers HQ AFWA computer flight plans, mission-tailored products, and other alphanumeric products to users in the field. The Air Force Global Weather Central Dial-In Subsystem (AFDIS) provides worldwide access to the AFWA products through phone lines. The AFWA graphics products to which the AFDIS provides access, through computer modem link, include high-resolution analysis and forecast fields, observations, bulletins, and satellite imagery.

General Product Types. Cloud depiction, forecast products, and military operation support products (electro-optical TDA and soil moisture) are generated at the HQ AFWA. The basic output is data in the format of the uniform gridded data field (UGDF). This format provides the basis for AFWA support to JTF operations. This support product achieves consistency through the use of common numerical weather prediction data fields from the FNMOC.

55th Space Weather Squadron

The 55SXS is located at Falcon Air Force Base, Colorado.

Primary Mission. The primary mission of the 55SXS is to collect, maintain, analyze, and forecast space environmental conditions that can affect any location worldwide in support of DOD forces.

Capabilities. 55SXS support includes event notifications and warnings; routine observations; analyses; and forecasts for the ionosphere, the Earth's geomagnetic field, the magnetosphere, and the sun. Additionally, the Air Force Space Forecast Center provides assessments of space environmental conditions with respect to satellite, communications, and radar anomalies. See AFI 15-118 on procedures to request support and AFCAT 15-152, Volume 5, for a detailed product listing. General product types include:

- Alert notification of events (solar flares, radio bursts, geomagnetic storms, and proton events)
- Tailored support to exercises and contingencies, as required (radio propagation forecasts, solar and geomagnetic forecasts, and corrections for ionospheric refraction)
- Routine observation, analysis, and prediction of the space environment (planetary geomagnetic indices, solar flux, and radio propagation)
- Anomaly assessments (communications and satellite operations).

Fleet Numerical METOC Center

The FNMOC is located in Monterey, California.

Primary Mission. The primary mission of the FNMOC is to provide numerical weather prediction METOC data fields to other production centers and operating forces worldwide. The data fields include global and higher resolution regional atmospheric and oceanographic analyses and forecasts. The FNMOC is the DOD's center for worldwide numerical weather prediction and is the center of expertise for microwave satellite data. Consistency among all DOD forecast products is provided through the common baseline numerical weather prediction dataset generated by the FNMOC. Submit requests for support in accordance with NAVMETOCCOMINST 3140.1K. For the latest Navy Oceanographic Data Distribution System (NODDS) product listings, see FLTNUMMETOCCENINST 3147.1, *Navy Oceanographic Data Distribution System Products Manual*.

Capabilities. The FNMOC's primary numerical forecast model is the Navy Operational Global Atmospheric Prediction System (NOGAPS), an 82-km-resolution spectral wave model. The high-resolution regional numerical forecast model is the Navy Operational Regional Atmospheric Prediction System (NORAPS), which provides atmospheric data at 45-km resolution. Higher resolution nested regions can be located to cover contingency regions worldwide on short notice.

The NODDS provides worldwide dial-in access to FNMOC products through various computer modem links. Products available from the FNMOC include unclassified analysis and numerical forecast fields of the Earth's geomagnetic field, the magnetosphere, and the sun. Additionally, the 55SXS provides assessments of space environmental conditions with respect to satellite, communications, and radar anomalies. See AFI 15-118 on procedures to request support and

AFCAT 15-152, Volume 5, for a detailed product listing. General product types include:

- Alert notification of events (solar flares, radio bursts, geomagnetic storms, and proton events)
- Tailored support to exercises and contingencies, as required (radio propagation forecasts, solar and geomagnetic forecasts, and corrections for ionospheric refraction)
- Routine observation, analysis, and prediction of the space environment (planetary geomagnetic indices, solar flux, and radio propagation)
- Anomaly assessments (communications and satellite operations).

Communications Connectivity. Access to the worldwide METOC database is gained through connectivity to the FNMOC. Data and product dissemination are provided through a landline to the FNMOC; Automatic Digital Network (AUTODIN) to users, as required; standard Navy command, control, communications, computers, and intelligence (C4I) systems; the Joint Operational Tactical System (JOTS); and dial-in computer access through modem. Database summaries are available on CD-ROM.

General Product Types. General product types include:

- Three-dimensional oceanographic analyses
- Ocean front and eddy analyses
- Bathymetric profiles and databases
- Enclosed ocean basin circulation analyses and forecasts
- Mine drift predictions
- Oil spill dispersion predictions
- Tactical oceanographic summaries
- Specialized exercises and mission support
- Specialized oceanographic publications.

Air Force Combat Climatology Center

The AFCCC is located at Scott Air Force Base, Illinois.

Primary Mission. The primary mission of the AFCCC is to collect and store global environmental observations in its climatic database. It analyzes and applies information from the database, the HQ AFWA technical library, and other sources to prepare tailored environmental studies and analyses for DOD forces worldwide.

Capabilities. The AFCCC can prepare tailored environmental studies on almost any facet of meteorology affecting military operations from the Earth's surface through 400,000 feet above mean sea level. All studies and analyses are tailored to user requests. See AFI 15-118 to request support. Special product request procedures are provided in Chapter 2 and Appendix A of USAFETAC/TC-95/001, *Catalogue of Air Force Weather Technical Publications (1992 - 1995)*. Contingency support needed before JMFU activation should be requested from the AFCCC director of operations. After normal duty hours, contact the command post. Air Force and Army requests for Navy METOC support will be coordinated between the AFCCC and the FLTNUMMETOC DET. Responses are provided through the AFCCC in accordance with the AWS and the CNMOC memorandum of agreement. See AFCAT 15-152, Volume 4, for a detailed product listing. Additionally, a complete listing is published periodically as an AFCCC technical catalog.

Communications Connectivity. Communications connectivity includes DSN and commercial phone (both secure telephone unit III (STU-III) and nonsecure), nonsecure and secure facsimile, and the Defense Message System (DMS) through Scott Air Force Base.

General Product Types. General product types include:

- Airfield summary packages
- Surface observation climatic summaries
- Climatic briefs
- Specialized precipitation and temperature studies

- Descriptive (narrative) climatology studies
- Engineering design and construction studies
- Environmental simulation studies
- Low-level route climatologies
- Mission success indicators
- Wind duration studies.

Fleet Numerical METOC Detachment

The FLTNUMMETOC DET is located in Asheville, North Carolina.

Primary Mission. The primary mission of the FLTNUMMETOC DET is to provide METOC climatological services. To request support, see NAVMETOCCOMINST 3140.1K or FLTNUMMETOC DET Asheville Notice 3146, *Guide to Naval Meteorology and Oceanography Command Atmospheric Climatic Summaries, Products, and Services*, or coordinate directly by phone. Support requests requiring AFCCC climatological input will be coordinated. See FLTNUMMETOC DET Asheville Notice 3146 for a detailed product listing.

Communications Connectivity. Communications connectivity is through commercial phone lines and the Federal Telephone System (FTS). Real-time DMS message receipt and transmission is through a personal computer-based GATEGUARD system.

Operational, Theater, and Regional Component Forecast Centers

Operational, theater, and regional component forecast centers, shown below, include Air Force theater METOC centers and Navy METOC centers.

- Combined METOC Operations Center, Yongsan Army Installation, Seoul, Republic of Korea
- Alaskan Weather Operations Center, Elemendorf Air Force Base, Alaska
- European Command Forecast Unit, Traben-Trarbach, Germany
- Latin American Weather Operations Center, Howard Air Force Base, Panama
- Tanker Airlift Control Center, Scott Air Force Base, Illinois
- United States Naval Atlantic Meteorology Station Norfolk, Virginia
- United States Naval European Meteorology and Oceanography Center, Rota, Spain
- United States Naval Pacific Meteorology and Oceanography Center, Pearl Harbor, Hawaii
- United States Naval Pacific Meteorology and Oceanography Center West/Joint Typhoon Warning Center, Guam
- U.S. Air Forces, U.S. Central Command Weather Support Center, Shaw Air Force Base, South Carolina
- Air Combat Command Weather Support Unit, Langley Air Force Base, Virginia.

Air Force Theater METOC Centers

Primary Mission. The primary mission of Air Force theater METOC centers is to function as the Air Force, Army, and special operations forces component hubs for disseminating tailored METOC information to Air Force and Army component forces within their areas of responsibility. The mission also includes joint forces upon request or tasking from the commander in chief's senior METOC officer or JMO supporting the JTF.

Capabilities. Air Force component METOC centers produce tailored analysis and forecast guidance products that focus on the individual component's air-land areas. Products are based on numerical weather prediction guidance from HQ AFWA and other agencies. These centers routinely produce:

- Weather advisories and warnings
- Analyses and forecasts for particular operations and other tailored METOC data
- Products and services to support peacetime training

- Support to exercise and contingency operations.

Information on how to obtain specific support and detailed product descriptions can be obtained by calling the individual center directly.

Product Descriptions. These centers produce alphanumeric and graphic products such as cloud and visibility forecasts; drop zone forecasts; hazard forecasts; air refueling forecasts; and various other tailored METOC data, products, and services. These centers are the Army point of contact for Army weather support requirements, including sea state information.

Navy Theater METOC Centers

Primary Mission. The primary mission of Navy theater METOC centers is to function as the Navy theater component hub for dissemination of METOC data and to provide full support services to naval component forces and joint forces on request. These METOC centers administer Navy METOC operations within their assigned area of responsibility.

Capabilities. Theater METOC centers provide tailored analyses and forecast guidance products focused on an individual component's maritime and littoral areas of responsibility. These centers routinely produce:

- Significant weather and sea advisories and warnings and individual ship route forecasts
- Aviation weather forecasts
- Optimum track ship routing
- Weather across your track services.

Navy METOC centers provide deployable mobile environmental team services; ocean frontal position analyses; acoustic prediction services; and tailored METOC data, products, and services to support exercise and contingency operations. Theater METOC centers function as the primary communications node for transmitting data to fleet users through Navy C4I systems. Support may be requested in accordance with NAVMETOCCOMINST 3140.1K or by contacting the supporting theater center directly to request services.

Primary METOC Production Center Integration

The two primary METOC production centers supporting joint operations are the FNMOC and HQ AFWA. In combination, these two centers provide most of the central site data and products needed to support in-theater requirements. Operationally, they produce an integrated product set for the theater and are available for transmission to supported components through existing component communications and information systems. Consistency within the integrated product set is achieved through use of common numerical weather prediction data fields from the FNMOC in the generation of all application products.

Appendix I

Intelligence Preparation of the Battlespace

Introduction

The commander uses IPB to understand the battlespace and to integrate information on the enemy, weather, and terrain as well as the options presented to friendly and threat forces. IPB is the primary responsibility of the J-2, G-2, and S-2; however, the IPB process is not limited to the intelligence section and units. All commanders and staff officers participate in the IPB process and use its products for planning and decisionmaking. (See FM 34-130, *Intelligence Preparation of the Battlefield*, for a complete discussion of IPB.)

What Is IPB?

IPB is a systematic, continuous process of analyzing the threat and environment in a specific geographic area. It is designed to support staff estimates and military decisionmaking. Applying the IPB process helps the commander to selectively apply and maximize his combat power at critical points in time and space on the battlefield by:

- Determining the threat's likely COAs
- Describing the environment within which the unit is operating and the effects of the environment on the unit's operations.

IPB consists of four steps:

- Define the battlespace environment.
- Describe the battlespace's effects.
- Evaluate the threat.
- Determine the threat's COAs.

The IPB process is continuous. IPB is not just conducted before and during the command's initial planning for an operation, but is continued and further refined during the conduct of the operation. Each function in the process is performed continually to ensure that:

- The products of the IPB remain complete and valid
- The support provided to the commander remains relevant to direct the intelligence system throughout the current mission and into preparation for the next.

An overview of each function is presented below.

Step 1: Define the Battlespace Environment

In step 1 of the IPB process, the G-2/S-2:

- Establishes the limits of the area of interest in four dimensions: depth, width, height, and EM spectrum
- Identifies characteristics of the battlespace that will influence friendly and threat operations
- Identifies gaps in current intelligence holdings.

This focuses the command's initial intelligence operation efforts and the remaining steps of the IPB process. To further focus the remainder of the IPB process, the G-2/S-2 identifies characteristics of the battlespace that require in-depth evaluation of their effects on friendly and threat operations, such as terrain, weather, logistical infrastructure, and demographics. Generally, these are analyzed in more detail for areas within the command's area of operations and battlespace than for other areas in the area of interest. By convention, intelligence collection includes sensing or obtaining data other than weather. Weather data collection is not considered to be a part of the intelligence collection process. IPB uses

climatology and oceanographic information to determine maneuver and trafficability estimates and other effects on MAGTF and threat operations.

The G-2/S-2 establishes the limits of the area of interest to focus intelligence collection efforts on the geographic areas of significance to the command's specific mission. The limits of the area of interest are based on the amount of time estimated to complete the unit's mission and the location and nature of the characteristics of the battlespace that will influence the operation. If the command has not been assigned an area of operations, the G-2/S-2 coordinates with the G-3/S-3 to develop a joint recommendation on its limits for the commander's approval. Similarly, the G-2/S-2 confers with the G-3/S-3 on recommendations for the command's battlespace during the development of friendly COAs. The area requiring monitoring by the MAGTF METOC units is considerably larger than the area defined by the G-2/S-2. Weather systems and their associated effects will continue to influence and cross the battlespace regardless of the military situation. Weather systems that are perhaps thousands of miles upstream of the area of interest may affect the area of interest in time.

Defining the significant characteristics of the battlespace environment also aids in identifying gaps in current intelligence holdings and the specific intelligence required to fill them. The MAGTF SWO's inputs on METOC information requirements and resulting shortfalls in meteorological sensing strategy are part of this definition and identification process. Similarly, the G-2/S-2 identifies gaps in the command's knowledge of the threat and the current threat situation.

Once approved by the commander, the specific intelligence that is required to fill gaps in the command's knowledge of the battlespace environment and threat situation becomes the command's initial intelligence requirement.

Step 2: Describe the Battlespace's Effects

Step 2 evaluates the effects of the environment on friendly and threat operations. The G-2/S-2 identifies the limitations and opportunities that the environment offers for the potential operations of friendly and threat forces. This evaluation focuses on the general capabilities of each force until COAs are developed in later steps of the IPB process.

This assessment of the environment always includes an examination of terrain, including oceanographic conditions and weather. This part of the IPB process provides the basis on which concepts of operations are built and plans are made. Discussions of the characteristics of geography and infrastructure and their effects on friendly and threat operations may also be included.

The characteristics of geography include general characteristics of the terrain and weather such as climate, elevation, soil, vegetation, wind, moisture, and temperature. An area's infrastructure consists of the facilities, equipment, and framework needed for the functioning of systems, cities, or regions. Products developed in this step might include, but are not limited to:

- Population status overlay
- Overlays that depict the military aspects and effects of terrain
- Weather analysis
- Hydrographic and beach studies
- Integrated products such as modified combined obstacle overlays.

The weather analysis may include weather analysis overlays of specific parameters or meteorological conditions as well as graphic displays correlating weather events. In addition, weather effects matrices are provided based on climatology and expected conditions. These may include TDAs for electro-optical systems affecting the performance of threat and friendly forces. The SWO plays a key role in recommending what products are to be included depending on the mission, geographical region, climate, and influence

that the potential weather conditions could have on the planning and execution of the mission. Regardless of the subject or means of presentation, the G-2/S-2 ensures that these products focus on the effects of the battlespace environment.

Step 3: Evaluate the Threat

In step 3, the G-2/S-2 and staff analyze the command's intelligence holdings to determine how the threat normally organizes for combat and conducts operations under similar circumstances. When facing a well-known threat, the G-2/S-2 can rely on historical databases and well-developed threat models. When operating against a new or less well-known threat, the G-2/S-2 may need to develop the intelligence databases and threat models concurrently.

The G-2/S-2's evaluation is portrayed in a threat model that includes doctrinal templates that depict how the threat operates when unconstrained by the effects of the battlespace environment. Although these usually emphasize graphic depictions (doctrinal templates), threat models sometimes emphasize matrices or simple narratives. The SWO provides the expected range of METOC parameters to allow the G-2/S-2 staff to evaluate limitations of threat capabilities and potential threat actions. It is important for the SWO to be an integral part of the G-2/S-2 staff and know as much as possible about threat and friendly forces, capabilities, and systems and how weather and oceanographic conditions affect these systems.

Step 4: Determine Threat COAs

Step 4 integrates the results of steps 1 through 3 into intelligence estimates and supporting products. Given what the threat normally prefers to do and the effects of the specific operating environment, the threat's likely objectives and available COAs are analyzed. In step 4, the G-2/S-2 develops COA models that depict these threat COAs and prepares event templates and matrices in an effort to identify or estimate indicators that will reveal the threat COA being executed. This permits focusing intelligence collection and production efforts on those areas/events defined as named areas of interest (NAIs). Weather events, both actual and anticipated, are critical in determining the location of these NAIs and in estimating their effectiveness and reliability.

The enemy COA models developed in step 4 are the products that the staff uses in the planning and decisionmaking processes to enhance effectiveness. The G-2/S-2 cannot produce these models and accurately predict the threat COAs without having:

- Adequately defined and analyzed the friendly mission throughout the estimated duration of the operation; clearly identified the physical limits of the area of operations and the area of interest; and identified every characteristic of the battlespace environment that might affect the operation (These characteristics are also quantified by objective means, when possible, or by subjective means if qualitative assessments are not available (step 2).)
- Identified the opportunities and constraints that the battlespace environment offers to adversaries and friendly forces (Again, such information is also quantified by objective means, when possible, or by subjective means if qualitative assessments are not available (step 2).)
- Thoroughly considered what the threat is capable of and prefers to do in similar situations if unconstrained by the battlespace environment (step 3).

In short, the enemy COA models that drive the decisionmaking process are valid only if the G-2/S-2 establishes a good foundation during the first three steps of the IPB process.

IPB identifies facts and assumptions about the battlespace environment and the threat. It is imperative that these facts and assumptions are presented as separate entities. This permits objective decisions to be made regarding facts and identifies where subjective decisions need to be made regarding assumptions. The SWO helps the G-2/S-2

define weather conditions and uses TDAs, either manual or electronic, to show potential effects of the weather and oceanographic conditions and how these could affect the COAs of both threat and friendly forces. IPB is the basis for synchronization. Weather and oceanographic conditions affect the timing of operations and are an essential part of the overall battle synchronization. The G-2/S-2 completes the initial intelligence estimate, and other staff members build their estimates based on this information. Weather information integrated into the intelligence estimate is provided to other staff users, either in the same format or in another format designed for more effective use by that functional area. The information provided for the initial intelligence estimate is only the starting point and may require extensive efforts for application to other users.

The intelligence estimate includes five standard paragraphs defining the mission, areas of operation, enemy situation, enemy capabilities, and conclusions. The results and products of IPB, conveyed in the intelligence estimate, are essential elements of the Marine Corps Planning Process. Accordingly, the major IPB effort occurs before and during the six steps of the planning process. The steps are:

- Mission analysis
- COA development
- COA analysis
- COA comparison/decision
- Orders development
- Transition.

Consideration of weather is part of each of the above steps and requires SWO support. The information that is necessary to execute operations is provided to users via a number of means. The SWO must know this process completely, including each type of unit's or staff section's unique METOC information requirements, and must work to integrate METOC support into all supporting and follow-on steps and procedures throughout the command. For example, the fire support and communications and information systems plans can be greatly affected by METOC conditions. The SWO should ensure that weather products in the IPB process meet all of the command's requirements.

Although a standard analysis process is used to conduct a METOC analysis for the step describing battlespace effects, it is adapted to the specific tactical situation. Weather and oceanographic condition analysis cannot be viewed as a single step within the IPB process; rather, it is included at many steps throughout this iterative process. The SWO must understand the IPB process to provide effective support to the command's METOC information requirements. The initial METOC analysis plays a large part in describing effects anticipated in the battlespace. The terrain influences on the battlespace also help to shape the forecast. Weather and terrain must be considered when analyzing the battlespace because they complement each other and enhance the IPB process.