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Weather Operations Planning, Execution, and Assessment

WEATHER OPERATIONS INTRODUCTION

Last Reviewed: 27 May 2015

Air Force weather operations provide direct support to conventional and special operations forces (SOF) of the Air Force and Army.[1] When designated, Air Force weather forces also provide direct support to joint, multinational, and other national agency operations.[2] Weather operations provide a critical piece of situational awareness when a commander is building battlespace awareness of the assigned operational area. Though information about environmental conditions and the effects these conditions have (referred to throughout this Annex as weather and weather effects information) can be applied throughout a theater and across the range of military operations (ROMO), such information should always be tailored by weather forces to the military operation being executed, whether at the strategic, operational, or tactical level.

[1] Direct weather support to the Army was established via inter-service support agreement based on the National Security Act of 1947.
[2] Joint Publication (JP) 3-59, *Meteorological and Oceanographic Operations*

WEATHER FUNDAMENTALS

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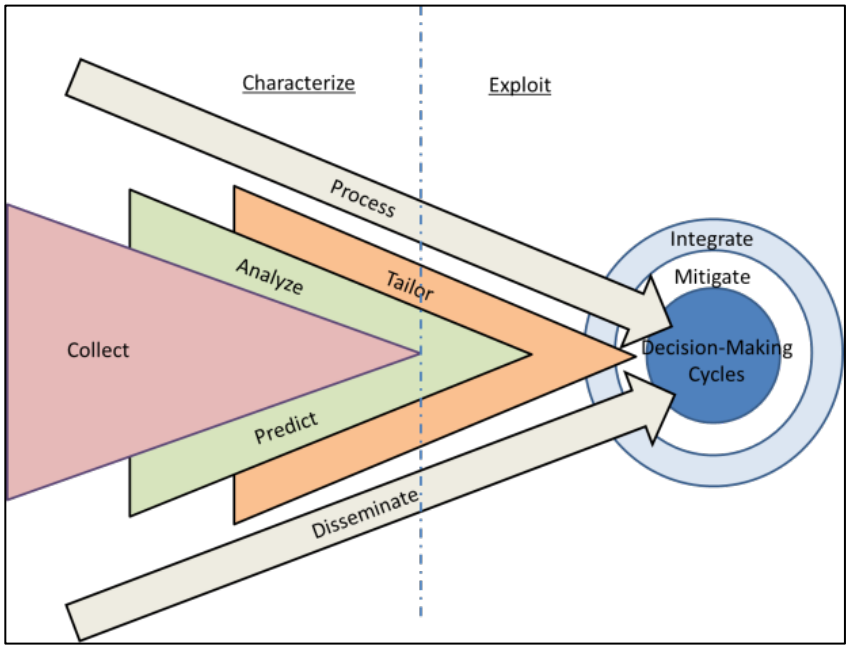
For the purposes of Air Force doctrine, weather is defined as **all meteorological and space environmental factors as provided by Services, support agencies, and other sources. These factors include the whole range of atmospheric phenomena, from Earth's surface up to and including the space environment.**[1]

Effective weather operations are executed through the overarching principles, functions, and processes depicted on the Conceptual Model of Air Force Weather Operations graphic below. The left half of the figure shows how weather forces **characterize** the environment through the **collection, analysis, prediction,** and **tailoring** of atmospheric and space weather data from both Department of Defense (DOD) and non-DOD sources. This weather data and information, used to predict the future state of the environment, are stored in a net-centric data repository that is accessible through end-user systems and web-based interfaces.



Conceptual Model of Air Force Weather Operations

The right half of the graphic depicts how the weather community **exploits** the information from the net-centric data repository to **tailor** and **integrate** weather

[1] Adapted from meteorological and oceanographic definition in JP 3-59, *Meteorological and Oceanographic Operations*.

information for use in decision-making processes at the strategic, operational, and tactical levels. Weather personnel, either through reachback or embedded with operational units, command and control facilities, and intelligence centers, use tailored weather information to advise decision-makers, enabling them to **mitigate** and **exploit** the effects of weather. Throughout the characterization and exploitation functions, weather data and information undergoes processing and dissemination. All of these processes culminate in decision-making cycles, allowing leaders to make effective decisions to exploit the effects of weather.

The enduring principles of weather operations are **accuracy**, **consistency**, **timeliness**, and **relevance**.

WEATHER PRINCIPLES

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Accuracy

Air Force weather operations provide weather information to the commander, Air Force forces (COMAFFOR), to allow commanders to exploit environmental factors and mitigate weather effects from planning through mission execution. Gaps in weather sensor coverage, limitations on the accuracy of weather observing systems and prediction models, and the complexity of atmospheric processes can all reduce accuracy. The Air Force weather community constantly strives to overcome or mitigate these impediments. The supported community, including operators, should assist weather personnel by actively providing feedback and first-hand observations regarding the latest mission area weather conditions. For instance, post-strike inflight reports and post-mission debriefing should include target area and other relevant weather information. Pilot reports, imagery, and ground observations allow the weather community to improve the accuracy of weather and weather effects information for follow-on missions.

Consistency

Air Force weather operations should provide consistent weather and weather effects information to forces at all levels/echelons, resulting in “one operation, one forecast.” To achieve this result, weather personnel should derive products from the same basic data from designated characterization sources to ensure consistent weather exploitation products. Weather information provided to decision-makers and other end users should, therefore, be spatially and temporally consistent across the operational environment as appropriate and provide a common operating environmental picture. The coordination and collaboration on an integrated, predictive weather product is required when multiple military units are operating in the same geographic area (e.g., the same airfield, air refueling routes, military operating areas, or drop zones). Coordinated weather operations ensure commanders at every level receive consistent weather information.

Timeliness

Weather information is perishable; therefore, it should be derived from the latest available data, disseminated quickly, and integrated at the appropriate time into the planning and execution of military operations. Air Force weather operations should also be vigilant and responsive, informing commanders of potential weather effects on proposed and ongoing military operations in a timely manner.

A significant aspect of timeliness is how weather information is disseminated to the warfighter. A net-centric data repository, using machine-to-machine dissemination,

improves the chances that critical weather information and its impact on operations will reach decision-makers in time to capitalize on time-sensitive opportunities. For instance, real-time information sent to an aircraft (such as images of targets affected by the weather and accounting for particular targeting sensors) enhances situational awareness for newly received time-sensitive targets. Similarly, space situational awareness[1] (SSA) requires timely integration of accurate and relevant space weather information into military space operations to help protect friendly forces, characterize space system anomalies, differentiate between intentional and unintentional interference, and exploit adversary vulnerabilities. Weather entities and decision-makers should maintain communication with one another to support and sustain the timely dissemination of weather information.

Relevancy

Weather information should be relevant for it to provide benefit to military operations. Air Force weather personnel ensure decision-makers receive information on weather parameters that have the potential to degrade or enhance any mission prior to mission execution. Commanders, in turn, should assess the expected performance of their assets in light of weather effects to determine the proper combination of delivery systems, munitions, platforms, and other resources to attain desired effects. Air Force weather operations are most relevant when integrated from the beginning of the operational planning process. Weather information applies directly to planning, executing, assessing, and sustaining operations.

Air Force weather personnel should cultivate a two-way flow of information, in which operators provide relevant mission data that can be used to enhance the applicability of weather information to operations. Weather personnel should consider the strengths, limitations, and time factors associated with specific air, space, maritime, land, and special operations missions they are supporting and tailor weather products accordingly, based on the mission requirements. For instance, weather that could negatively affect air refueling operations, such as excessive turbulence and cloud cover above 18,000 feet, may not appear to be relevant to Army helicopters operating below 500 feet, but could affect other platforms supporting the same mission objective. Thus, weather personnel processing a detailed understanding of operations and mission profiles can ensure that weather information is relevant.

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[1] SSA is defined as “cognizance of the requisite current and predictive knowledge of the space environment and the operational environment upon which space operations depend” (JP 3-14 *Space Operations*).

WEATHER FUNCTIONS

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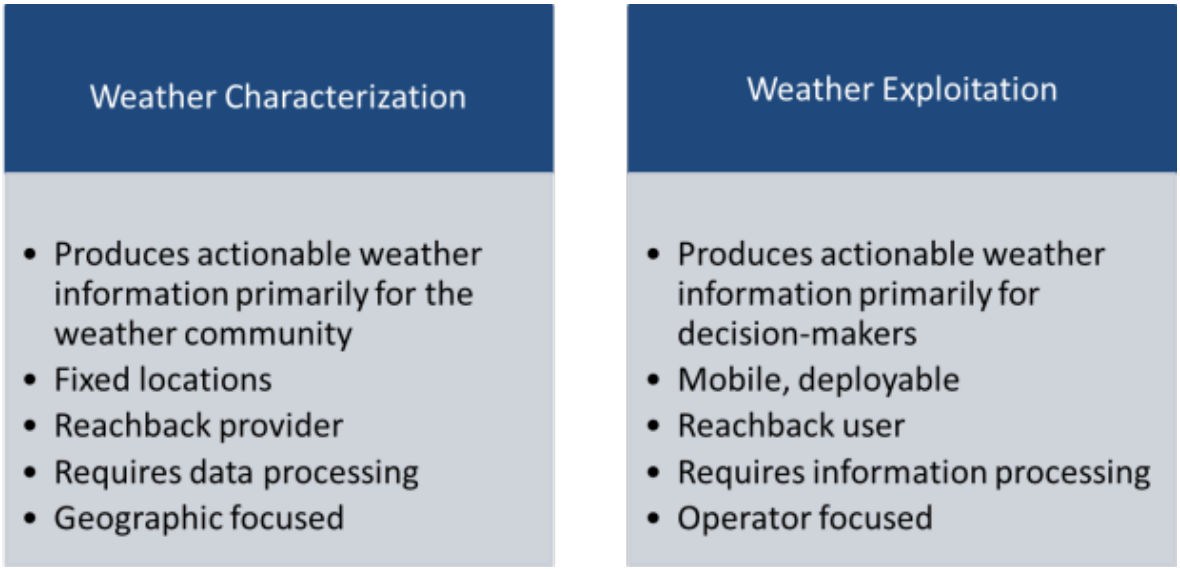
The two functions of weather operations are **characterization** and **exploitation.** Characterization describes past, present, and future weather conditions. Exploitation enables decision-makers to adjust and maximize operations based on weather and weather effects information. The figure, "Comparison between the Weather Functions," compares the main features of characterization and exploitation as used by weather forces.



Comparison between the Weather Functions

Characterization

Characterization is the ability to collect accurate data and process this data into usable information in order to "analyze that data, and to use the results to produce a coherent picture of the past, present and/or future state of the air and space environment."[1] Characterization encompasses the weather process of *collection*, as well as elements of the processes of *analysis, prediction, and tailoring*. Air Force weather operations provide actionable situational awareness to commanders covering past, present, and future states of the atmosphere and space environment in order to improve operational outcomes. Air Force weather operations collect and

[1] Air Force Manual (AFMAN) 15-129, Volume 1, *Air and Space Weather Operations - Characterization*.

analyze data on the state of the atmosphere through the use of polar orbiting and geostationary satellites, and through the employment of a complex network of ground-based, airborne, and maritime sensors. The data is processed to predict the future state of the atmosphere by applying the art and science of meteorology and by using complex atmospheric computer models.

Exploitation

Weather exploitation is "the ability to minimize the impact of weather threats to friendly forces while simultaneously capitalizing on weather conditions that maximize the operational advantage over enemy forces."[2] It requires weather personnel to *analyze*, *tailor, integrate, and mitigate* weather data and effects. Knowledge of the weather and how it affects both friendly and adversary operations is a key component of battlespace awareness. Accurate, consistent, and relevant characterization of the weather, integrated into operational planning in a timely manner, can provide friendly forces with the meteorological knowledge necessary to anticipate and exploit the best window of opportunity to plan, execute, support, and sustain specific operations.

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[2] AFMAN 15-129, Volume 2, *Air and Space Weather Operations—Exploitation*.

WEATHER OPERATIONS PROCESSES

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Air Force weather personnel execute eight processes—**collection**, **processing**, **analysis**, **prediction**, **tailoring**, **dissemination**, **integration, and mitigation**—to characterize weather and exploit weather effects information.

Collection

Weather collection is described as the process of gathering and storing raw weather data in databases from which weather products are later derived. This data includes surface, air, and space-based observations, including meteorological satellite imagery and weather radar data from worldwide military, civilian, government, and commercial sources. Since each collection capability has limitations, Air Force weather operations seek an optimal blend of measurements from ground, sea, air, and space-based sensors. Although the Department of Defense owns many of these sensors, most international data are obtained via data-sharing agreements with other countries, to include freely shared data under the auspices of international organizations such as the World Meteorological Organization and International Civil Aviation Organization.

Commanders should include non-traditional weather collection efforts throughout planning and operations to ensure receipt of adequate weather information in a timely manner. Inadequate sources or availability of weather data may be a problem in regions where military operations occur. The Air Force maintains the capability to deploy in close coordination with joint and coalition forces to establish weather support for military operations. In addition, non-traditional weather data sources, such as intelligence, surveillance, and reconnaissance (ISR) platforms and remotely piloted aircraft, can significantly enhance the quality and quantity of theater weather data collection.

A single piece of accurate weather information, regardless of the source, may provide the critical piece of information pivotal to mission success. Therefore, continuous collection of weather information and cooperation with outside sources are needed to ensure the optimal accuracy of weather products.

Processing

Weather processing is described as the act of converting raw data into useable weather information. Collected weather data flows into a net-centric repository where much of this data is processed into usable information primarily for weather personnel.

Observed conditions are input into predictive weather models. High-speed computer processors run physics-based simulations of the environment and develop output representing the spatial and temporal evolution of the environment. This processed data serves as the basis for the other processes in the exploitation function: analysis, prediction, tailoring, integration and mitigation. Data and information may be further processed and repeatedly refined to support military operations, for example, historical data is processed to produce climatic summaries.

Analysis

Weather analysis is described as the process of transforming collected weather data into useful weather information and enables production of accurate weather forecasts. It entails building a coherent, integrated depiction of the past and current state of the weather over a specified region. An effective analysis of collected weather data helps ensure the accuracy of the weather forecast provided to decision-makers. It enables identification of weather features and conditions requiring subsequent study and monitoring. The analyzed data is processed and disseminated to net-centric databases to provide inputs which weather personnel use in building forecast products for decision making.

Prediction

Weather prediction is described as the process of creating a forecast from analyzed weather information which anticipates future weather conditions. Weather operations leverage environmental data and analyzed weather information to predict how future weather conditions (such as temperature, cloud cover, and ionospheric scintillation[1]) may affect operations. Weather personnel employ computer models and analyze other information to produce detailed forecasts, which include temporal and spatial assessments of atmospheric and space weather features and their associated weather elements. Prediction accuracy is highly dependent on the timeliness, accuracy, and quality of the initial input. Weather personnel rely on constant feedback from updated weather collections of actual conditions and continually adjust and assess prediction information to improve their forecasts.

Tailoring

Weather tailoring is described as the process of transforming relevant weather information into actionable information by aligning it with operationally significant weather parameters. Weather information should be tailored to unique operational requirements. Weather personnel match products against mission, system, and platform requirements. Weather products should be customized based on known, specific environmental sensitivities of, and effects on, operations and systems. Some examples of tailored weather products include decision aids, weather effects matrices, terminal aerodrome forecasts, drop zone forecasts, and target-area depictions. Like the analysis and prediction processes, the process of tailoring is a function of both characterization and exploitation.

[1] Scintillation is “the rapid, random variation in signal amplitude, phase, and/or polarization caused by small-scale irregularities in the electron density along a signals path. Ionospheric scintillation can cause degradation of satellite communications signals.” (AU-18, *Space Primer*, Air University Press, September 2009).

Dissemination

Weather dissemination is described as the process of delivering weather data and information to users in a suitable form. Dissemination occurs across the other weather processes and ensures that products created through the collection, analysis, prediction, and tailoring processes is received by the appropriate end-user. These users may be weather personnel or decision-makers, depending on which output product is being used. Processed weather data may be disseminated to weather personnel for use in analysis or prediction products. Tailored forecasts may be disseminated to operators for use in the decision-making cycle so that leaders can take action based upon this information. Because of its importance to the other weather processes, dissemination should occur in a timely, reliable manner. Interruption of the process of dissemination at any stage can disrupt the flow of accurate, relevant data to the decision-maker, significantly impacting their ability to exploit weather information.

Integration

Weather integration is described as the process of infusing tailored decision-grade weather and weather effects information into planning and decision-making cycles. Effective integration enables decision-makers to maintain battlespace awareness. Informed with timely, relevant, and accurate information, decision-makers can anticipate the weather's effects on planned operations, then exploit those conditions which facilitate achievement of the commander's objectives. Timeliness is critical to effective integration; therefore, commanders should ensure weather and weather effects information is fully integrated into decision-making processes and command and control (C2) systems in time to inform the appropriate decision points. Likewise, weather personnel should be pro-active and place great importance in reaching out to supported units to ensure integration occurs early in decision-making cycles. Air Force weather operations use a net-centric repository of weather and operational effects information to facilitate such integration. The net-centric repository also allows weather personnel to fuse relevant weather effects information with other operational information into an operational picture tailored to the mission.

Some C2 systems allow decision-makers to extract mission-specific weather information from the net-centric weather data repository through machine-to-machine interfaces without consulting weather personnel and without knowing if the specific weather information was tailored by weather personnel. Because decision-makers or other end-users may lack a thorough understanding of the strengths and weaknesses of the available weather information, it is critical that weather personnel remain integrated in all phases of the planning and execution process.

Mitigation

Weather mitigation is described as the process of providing decision-makers with options and courses of action, based on tailored and integrated weather information, so that they can adjust operational plans and exploit weather effects to operations. Large scale weather events can cause strategic impacts that can be devastating to military operations. Weather personnel provide this information to commanders, enabling them to determine the best employment packages and courses of action for those weather conditions. When weather information is used by leaders to

effectively mitigate, plans can be adjusted and optimal mission effectiveness achieved. The process of mitigation gives decision-makers options on beddown of forces, operational capabilities desired, and resource protection actions to take. Weather personnel should articulate their level of confidence in their predictions to decision-makers to be of value when leaders assess and manage risk in an operation. Weather personnel who are properly integrated, and have established a relationship of trust and relevancy with their supported decision-makers have greater influence in the mitigation process than others.

THE AIRMAN'S PERSPECTIVE

Last Reviewed: 27 May 2015

Weather information, exploited at every decision point during the planning, execution, assessment, and sustainment of military operations, is a key enabler of airpower. Airmen should be aware of how the effects of weather can impact operations in the air domain and space domains.

AIR DOMAIN (WX)

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Weather has a profound effect on flight operations. Even on a clear day, the impact of something as simple as the speed and direction of the wind can significantly impact operations. Severe weather such as large hail, high winds, and heavy rains can halt flying operations and damage unprotected aircraft on the ground.

Weather support to air operations focuses on three broad areas: protecting air assets, personnel, and base infrastructure from hazardous weather; maximizing aircraft performance and the effectiveness of the aircraft's weapons systems; and assisting commander, Air Force forces (COMAFFOR) during mission planning and execution.

Protecting Air Assets/Personnel/Base Infrastructure

Protecting air assets, personnel, and base infrastructure from hazardous weather is a continuous responsibility shared between a regionally focused operational weather squadron and an installation's local weather entity (whether a squadron, flight, detachment, or operating location). Weather personnel and systems monitor weather conditions and alert the installation's personnel when hazardous weather is forecast or occurring. Depending on the type and intensity of conditions and the installation's mission assets, a series of actions to mitigate risk ranging from moving, tying-down, or sheltering aircraft to a full scale evacuation of aircraft and personnel may be implemented.

Aircraft in flight are also susceptible to hazardous weather. For example, the sudden onset of a thunderstorm could require aircraft to change their route of flight or divert to an alternate base. Weather personnel routinely monitor weather along planned flight routes, alerting decision-makers to the onset of hazardous weather conditions such as turbulence, icing, and thunderstorms.

Maximizing Aircraft/Weapon System Performance

During short-term mission planning (1 to 3 days) and execution, weather personnel play a vital role in helping maximize aircraft and weapons system performance based on observed and forecast weather. Airborne intelligence collection platforms, for example, are uploaded with appropriate sensor packages and plan their flight routes based on cloud cover and flight-level wind forecasts. Weather personnel use sophisticated computer models that help fighter and bomber pilots choose the best approach to their targets or provide a simulated picture of what a target might look like through a specific targeting pod based on environmental factors. For example, terminal aerodrome

forecasts assist in determining take-off and landing conditions and choosing suitable alternate recovery locations. Flight-level wind forecasts help air planners determine the range of their aircraft, potentially saving precious time and fuel by exploiting favorable winds. Drop zone forecasts help enable airdropped cargo and personnel to land safely on the target area. These weather products, as well as many others, help decision-makers exploit environmental conditions to maximize aircraft and weapons system performance, giving aviators a relative advantage over their adversaries.

Assisting in Planning and Execution

Weather information, exploited at every decision point during the planning, execution, assessment, and sustainment of military operations, is a key enabler of airpower. Weather forces directly support air planning and execution at the strategic, operational, and tactical levels. Well before hostilities begin, they provide weather effects analyses, forecasts, long-range outlooks, and climatological assessments that help shape future operations. Weather information such as historical crosswind trends and low ceiling information can impact decisions regarding aircraft deployment and staging operations. Persistent heavy cloud cover can hamper intelligence collection efforts, possibly driving major changes to a proposed campaign plan. A perfect example of the effectiveness of integration during planning is the contributions of the air operations center's weather personnel. These personnel can provide target area weather forecasts, predictions of weather effects on precision-guided munitions effectiveness, and assessments of weather effects on intelligence, surveillance, and reconnaissance (ISR) sensors. In addition, it provides weather-effect decision aids, including electro-optical and space weather effects guidance, to planners during master air attack plan and air tasking order development. These products are vital in determining the timing of operations and to selection of the appropriate weapons system to meet the joint force commander's objectives.

SPACE DOMAIN (WX)

Last Updated: 27 May 2015

Just as weather affects air operations, atmospheric and space weather can directly impact space systems and the intelligence, surveillance, and reconnaissance (ISR); navigation; and communication services these space systems are expected to provide.

Weather Effects on Space Operations

Weather affects space support operations (launch, recovery, ground sites). For example, a hurricane approaching the Eastern Range launch sites at Cape Canaveral Air Force Station can delay a satellite's launch or damage the rocket on the launch pad. Global space mission operations and space control can also be affected. For example, rain may cause signal attenuation (due to absorption of the radio signals by water vapor), hindering satellite communication (SATCOM) in the higher frequency ranges (C-band and above).[1]

Space Weather

Space weather is defined as "the conditions and phenomena in space and specifically in the near-Earth environment that may affect space assets or space operations."[2] The Air Force is responsible for conducting space environmental (space weather) operations in support of all elements of the Department of Defense.[3]

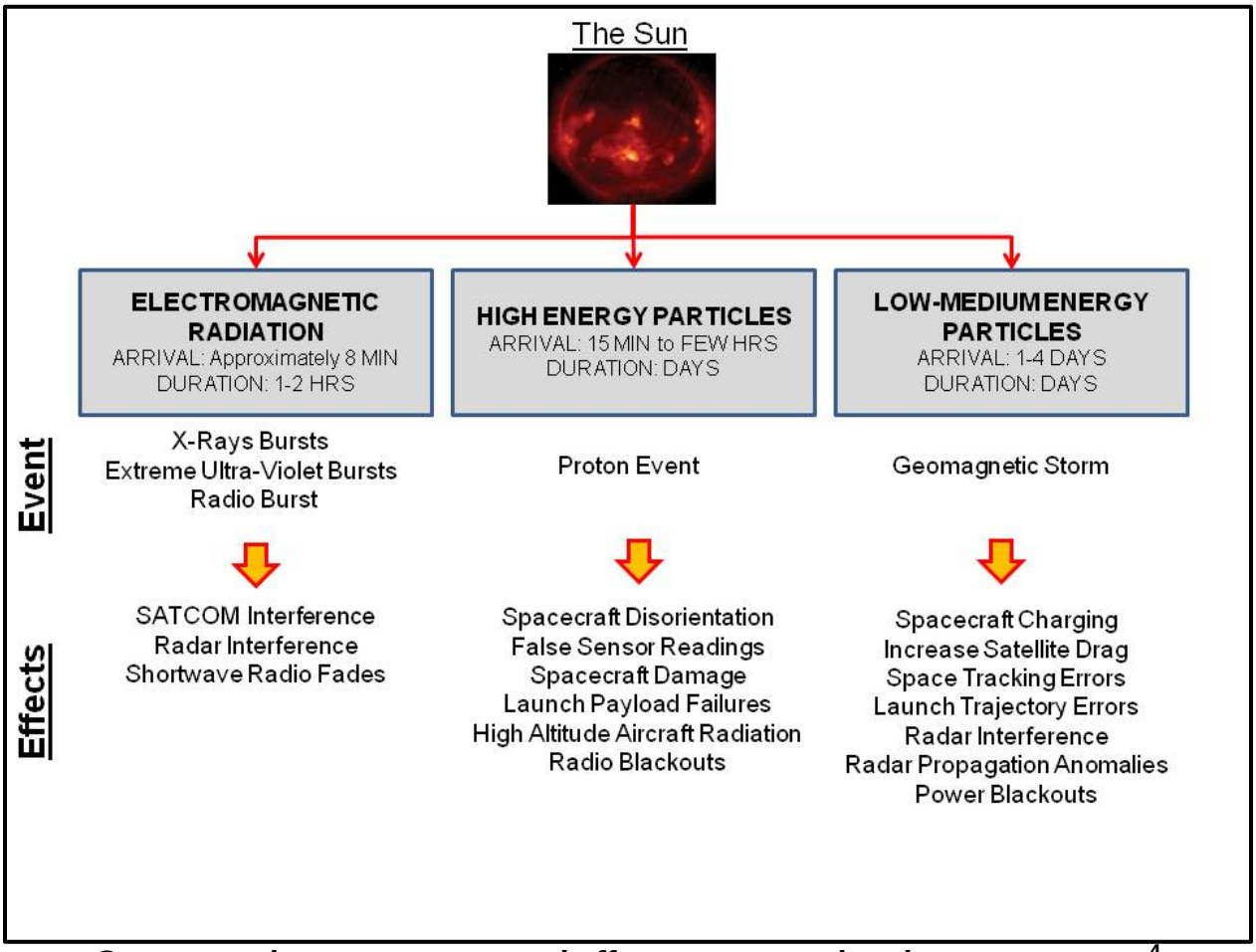
Specially trained Air Force weather personnel monitor the sun's solar activity. They pay particular attention to sunspots, which are good indicators of periods of increased solar activity and help with solar forecasting. These space weather forecasts can be of critical importance during the planning and execution of military operations. Space-based satellites and ground-based systems that observe the sun and space environment assist forecasters in their characterization and exploitation of solar activity. When an event such as solar flare or coronal mass ejection (CME) occurs, weather personnel and systems provide notifications via alert messages to commanders.

Space Weather Effects on Air and Ground Operations

Having the proper understanding of space weather is critical when planning and conducting military operations. It also helps contribute to good space situational

[1] For more information, see Annex 3-14, *Space Operations*.
[2] JP 3-59.
[3] Chairman of the Joint Chiefs of Staff Instruction (CJCSI) 3810.01D *Meteorological and Oceanographic Operations*.

awareness (SSA), which is crucial when air and ground operators experience interference and degradation to radio signals, SATCOM, Global Positioning System (GPS) signals, or radar operations. Knowledge of the space environment can help personnel mitigate the effects of space weather, and help differentiate between equipment malfunctions, natural interference, and man-made interference (purposeful and non-purposeful). Being able to distinguish between purposeful interference and natural sources of interference on space systems (whether on the ground or in space) enables the COMAFFOR or the functional air operations center (AOC) for space to identify threat trends to better protect the United States and its allies' space center of gravity.



Space weather event types and effects on ground and space systems[4]

Space Weather Effects on Space and Cyberspace Operations

Space weather has a direct impact on space operations. Space weather such as a proton event (high-energy charged particles released from the sun) can disable satellite subsystems or even an entire spacecraft (temporarily or permanently). By extension, space weather interference on space systems also affects operations in the cyberspace domain since a great deal of cyberspace mission data transits the space domain.

[4] For more detail on space weather effects see the space weather tutorials on the Air Force Weather Web Services site https://weather.af.mil/confluence/display/AFWWEBSTBT/Space+Weather+Main+Page

Increased solar activity can also cause an expansion of Earth's atmosphere, increasing atmospheric drag, which can shorten the operational life of low-orbiting satellites by causing their orbits to decay more rapidly. It can also hamper the tracking of space-based objects by the space surveillance network, since the spacecraft may be in a different position than expected due to the increase in atmospheric drag. A positive effect of an increase in atmospheric drag is a reduction in the amount of space debris (man-made and natural) due to the speeding-up of atmospheric re-entry of objects in low Earth orbit.

PRESENTATION OF WEATHER FORCES

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Air Force weather forces supporting Air Force and conventional Army operations deploy under the air expeditionary task force (AETF) construct. Special operations weather forces deploy as special operations force (SOF) enablers as directed by United States Special Operations Command. Air Force weather personnel provide support through a combination of on-site and reachback[1] operations. Support is provided to: Air Force components, AETFs, air operations centers (AOC), Air Force expeditionary flying units, Army conventional modular force echelons, Air Force SOF and Army SOF.

[1] Reachback is the process of obtaining products, services, applications, forces, equipment or material from organizations that are not forward deployed. (JP 3-30 *Command and Control of Joint Operations*).

STRATEGIC AND OPERATIONAL WEATHER ORGANIZATIONS

Last Updated: 27 May 2015

Air Force Weather Wing

Air Force weather delivers worldwide weather information to joint warfighters, unified combatant commands, and national programs through a specialized mission wing (referred to hereafter as the Air Force weather wing), and subordinate weather groups, which act as the primary production centers for the weather characterization function of Air Force weather operations. Due to the extensive processing systems, data storage capacity, and communications requirements needed, the weather characterization function is generally performed by these fixed reachback organizations. The Air Force weather wing is responsible for collecting, compiling, processing, and formatting atmospheric and space weather data and information from commercial, civil, and military sources into a four-dimensional representation of the natural environment. Within subordinate weather groups, combatant command-aligned operational weather squadrons (OWSs) provide characterization weather support to all Air Force and Army installations and activities within their associated combatant commander's area of responsibility. Other weather squadrons provide specialized weather support to include space and climatological weather support. Air Force weather climate support is the authoritative source for Department of Defense (DOD) and other US government agencies and produces specialized climate studies and assessments which are used to optimize military and intelligence operations and planning. Scientific services ensure continuous improvement of weather support provided to the end-user. Deployed forces can request reachback support to take advantage of these mission areas.

Integrated life cycle management functions for Air Force weather systems are conducted by supporting program execution offices within Air Force Material Command and Air Force Space Command. This includes all Research, Development, Test & Evaluation (RDT&E), acquisition and sustainment activities.

The OWSs form the backbone of regionally focused reachback weather operations, providing a variety of weather forecast products (such as terminal aerodrome forecasts, weather watches, warnings, and advisories) and support to Air Force, Army, Air National Guard, Air Force Reserve forces, and other users as directed in their respective operational areas. OWS areas of responsibility are aligned with the Unified Command Plan's geographic combatant commands. OWS products generally focus on characterizing the atmosphere for use by an air operations center, weather squadrons, weather flights, detachments, operating locations, and other units.

Space Weather Support

Space weather support to DOD is provided through a specialized, strategic-level weather squadron and several solar observatory detachments. This weather squadron uses space weather data collected from ground and space-based sensors to provide mission-tailored analyses, forecasts, warnings and strategic level products. Their products are used for mission planning and environmental situational awareness by national agencies, DOD operators, warfighters, the commander, Air Force forces (COMAFFOR); and other military decision-makers.

Weather Flight/Detachment/Operating Location

At the installation level, Air Force weather operations provide direct support to Air Force units, Army units, and Air Force special operations forces (SOF). On Air Force installations, weather forces are normally organized as a weather flight in an operations support squadron. On Army installations, weather personnel are typically assigned to weather squadrons, with subordinate detachments and operating locations. These weather personnel provide the function of exploitation by producing mission-tailored products and integrating into operational units' planning and decision-making processes, thus enabling operators to exploit weather factors for mission execution. Installation weather operations contribute to weather characterization by collecting and disseminating near-real-time weather observations and other local-scale weather data.

AIR FORCE COMPONENT SUPPORT TO JOINT AND MULTINATIONAL OPERATIONS (WX)

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Joint and Multinational Organizations

Air Force weather capabilities should be integrated with those of other Services and nations to provide coherent and structured weather operations to joint and multinational forces. To this end, Air Force weather personnel may be tasked to fill joint weather positions on a combatant commander (CCDR), joint force commander (JFC), joint force air component commander (JFACC), joint force land component commander (JFLCC), or joint force special operations component commander (JFSOCC) staff, or within a joint or combined air operations center (AOC).[1]

Air Force Component Staff Level

In a joint or multinational operational environment, the commander, Air Force forces (COMAFFOR) exercises operational control (OPCON) and administrative control (ADCON) of all assigned and attached conventional Air Force weather personnel deployed to a theater.[2]

The CCDR's senior meteorological and oceanographic (METOC) officer (SMO) coordinates the weather capability needed to support the joint task force (JTF). In addition, the COMAFFOR should have weather personnel on the operations (A-3) staff and in the AOC. These personnel are involved in contingency planning and ensure the COMAFFOR's weather requirements are met.

The senior Air Force weather representative to the COMAFFOR is designated the COMAFFOR staff weather officer (SWO). The COMAFFOR SWO monitors and coordinates Air Force weather resources in theater, including those supporting conventional land forces and special operations forces (SOF), and advises the COMAFFOR A-staff on all matters related to employing Air Force weather resources. The COMAFFOR SWO also coordinates Air Force and Army requirements with the appropriate joint and coalition meteorological and oceanographic entities.[3]

[1] See JP 3-59, *Meteorological and Oceanographic Operations*, for details on joint weather operations.
[2] For a detailed discussion on command relationship and authorities see Annex 3-30, *Command and Control*
[3] See JP 3-59 for further discussion on SWO support to joint weather operations.

The COMAFFOR SWO should also coordinate closely with counterparts on other JTF and component staffs. If the COMAFFOR is not dual-hatted as the JFACC, the COMAFFOR SWO should coordinate with the senior weather personnel supporting the JFACC's staff. Similar to the COMAFFOR SWO, staff weather officers of other components have functional support responsibilities and should coordinate their respective component requirements directly with their joint counterparts to deconflict responsibilities and ensure unity of effort.

AIR EXPEDITIONARY TASK FORCE (WX)

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Weather personnel should deploy with their supported air expeditionary wing, group, squadron, aligned strike mission design series flying squadron(s), or agile combat support (ACS) team or other supported Army unit as part of an air expeditionary task force (AETF). The commander, Air Force forces (COMAFFOR) retains operational control (OPCON) of weather personnel supporting conventional Army units at all echelons. Tactical control (TACON) may be delegated to the supported Army commander as appropriate. Weather personnel and equipment from other units, including National Guard or Reserve forces, may be tasked to augment AETF weather.

Air Force weather capabilities supporting air expeditionary wing--level operations are normally organized, commanded, and employed as a weather flight in an expeditionary operations support squadron. In some instances, it may be best for weather personnel to be directly attached to a flying squadron in order to provide more tailored, specific environmental information in support of operations.

Air Force weather personnel assigned or attached to an AETF normally obtain weather characterization information from reachback organizations such as operational weather squadrons. Reachback operations provide the ability to reliably access weather information and resources for exploitation while minimizing the in-theater footprint.

AIR OPERATIONS CENTER (WX)

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Air Force weather personnel supporting geographic and functional air operations centers (AOC) are typically aligned under the combat operations division but integrate weather throughout all AOC divisions and operations.

The size of the weather support element is flexible and responsive to the changing requirements of the operation. For example, at a geographic AOC, weather personnel support other specialty teams, such as the battlefield coordination detachment and the joint personnel recovery center. As another example, in a functional space AOC, the weather personnel also support the Unified Space Vault Division.

The AOC's weather element normally reaches back to a supporting operational weather squadron for a significant portion of weather information needed to support AOC operations.

CONVENTIONAL ARMY WEATHER SUPPORT

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Air Force weather operations support Army commanders by effectively integrating and exploiting weather information and knowledge within mission command, the Army operations process, warfighting functions, and operational framework to enable successful prosecution of the Army's Unified Land Operations doctrine. Air Force weather personnel provide Army commanders and their staffs an estimate of the confidence level for all weather analytical assessments and weather knowledge exploited within the Army's operational structure. Air Force weather personnel supporting the U.S. Army ensure weather effects knowledge across the six warfighting function capabilities enables commanders to integrate and synchronize the force at the decisive time and place on the battlefield to achieve the desired effects and win decisively. The capability of commanders and their staffs to anticipate, exploit, and mitigate weather effects on the employment of friendly and adversary combat power is important to achieving asymmetric advantages and decisively defeating the adversary. Weather effects information and knowledge is critical to commanders' situational understanding and decision making and is exploited within the military decision-making process[1], including intelligence preparation of the operational environment, fires and targeting protection, risk management, and information collection.

Conventional Army weather support is provided through habitually-aligned weather squadrons (WSs), typically positioned under an air support operations group, which may belong to an air-ground operations wing under a numbered Air Force or with an Air Force component commander. A WS is comprised of personnel, trained in basic soldier skills,[2] who deploy with and provide direct support to Army force echelons. Weather support should be seamlessly integrated within the Army corps, division, aviation brigade/battalion, and brigade combat team battle rhythms. In addition, weather personnel coordinate, establish and/or maintain weather reporting networks within their respective operational areas for use during operational planning and execution. Weather personnel are trained and equipped to operate for extended periods in austere conditions that are removed from traditional airbase logistics support. Additionally, select airmen receive special training and equipment to support forcible entry operations (e.g., airborne and air assault) as part of a brigade, division, or corps assault command post.

[1] Also see Army Doctrine Publication 3-0, *The Operations Process*.
[2] "Basic soldier skills" refers to training mandated and provided by the Army for weather personnel embedded in Army units IAW US Army STP 21-1-SMCT, *Soldier Manual of Common Tasks* (http://armypubs.army.mil/doctrine/STP_1.html).

Because of its diverse mission, a conventional Army support weather squadron is organized to maximize training efficiencies in functional skills, combat survival and tactical equipment operations and maintenance. Each WS is aligned with specific Army force echelons and provides Air Force command and control of subordinate detachments and operating locations that are co-located with that supported Army unit.

When deployed to support conventional Army operations, Air Force weather personnel are typically assigned to an expeditionary weather squadron (EWXS) comprised of mission-ready weather personnel sourced from WSs located on Army installations throughout the world. The EWXS is normally a subordinate unit within an expeditionary air support operations group. The EWXS may be augmented by theater-level weather systems support cadre (WSSC) personnel when necessary to maintain Air Force weather sensors within the EWXS area of interest. The WSSC is a theater asset that uses personnel from the communications maintenance career field and is responsible for set-up, maintenance, and theater logistics of Air Force weather sensors in accordance with the theater sensing strategy.

When appropriate, the EWXS commander tailors conventional Army weather support to forward deploy in support of Army modular force echelons. These forward-deployed weather personnel leverage characterization information from centralized weather organizations via a combination of reachback and distributed operations to provide tailored weather and weather effects information essential to planning and executing operations. The commander, Air Force forces (COMAFFOR) retains operational control (OPCON) and administrative control (ADCON) of conventional Army weather support units and provides those units in direct support of Army operations. As an alternative, the Joint Force Commander may specify tactical control (TACON) of both the EWXS and/or its subordinate units to the commander, Army forces (COMARFOR).

SPECIAL OPERATIONS WEATHER SUPPORT

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Air Force Special Operations Weather Support

Air Force special operations forces (SOF) weather support is provided by assigned weather flights at the base/installation level. These flights leverage operational weather squadrons and special operations weather squadron for reachback support. In instances where Army or Air Force SOF act as the senior airfield authority, Air Force SOF provides airfield services (i.e. base operating support) and mission services. In this context, mission services include aircrew briefings and integration into mission planning and execution.

Army Special Operations Weather Support

The special operations weather team (SOWT) is the primary Air Force Special Operations Command (AFSOC) force provider for weather operations in support of Army SOF. SOWTs provide SOF commanders and their staffs with weather effects information for Army air and ground SOF capabilities. SOWTs ensure this information and knowledge is integrated within the Army's military decision-making process, fires, information collection, risk management, and other activities to enable successful execution of special operations. SOWTs reach back to AFSOC's SOWS and leverage weather products and information which they tailor in support of specific SOF missions. SOWTs also maintain the capability to train US SOF, allied forces, and indigenous personnel in taking and disseminating limited weather observations. These teams also conduct environmental special reconnaissance to include avalanche and snow pack assessments and littoral and riverine assessments. SOWTs are capable of infiltrating joint operations areas via sea, air, or land and operating both independently and with other SOF in permissive, uncertain, and hostile areas. SOWTs are the only forces in the US Special Operations Command organized, trained, and equipped to perform environmental reconnaissance operations in support of environmental requirements for the joint force commander.[1] Selected SOWTs maintain small unmanned aircraft systems, military free fall, demolition, and diver qualifications or certifications.

[1] Annex 3-05, *Special Operations*.

WEATHER OPERATIONS PLANNING, EXECUTION, AND ASSESSMENT

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Since weather operations affect planning and execution across the joint forces, JP 3-59 and the *Joint Meteorological and Oceanographic (METOC) Handbook* are excellent references when planning, executing, and assessing weather operations. Weather and weather effects information should be incorporated into the planning, execution and assessment of military operations. A sound and comprehensive weather sensing strategy is essential to prevent a commander from having an incomplete or inaccurate understanding of their operational areas.

Weather Operational Planning

In any planning process, weather should be considered at the earliest possible stage of the plan. A combatant commander's planning staff should take into account weather effects and weather force lay-down during deliberate and crisis action planning. Weather forces should be collocated with key command and control elements to inject weather and weather effects information throughout the planning process. In addition to the guidance provided in the weather annex of the *Air Force War Mobilization Plan, Volume One*, planners should balance operational impacts with the benefits of reachback weather support to minimize the logistics footprint. When planning operations with the Army, weather requirements should be identified and passed to the Air Force for validation.

During plan development, the Army provides the Air Force with the Army's requirements for weather support and services in accordance with the joint force commander's operational objectives. In coordination with the Air Force, the Army includes and synchronizes Army-provided equipment used to support Air Force weather capabilities in the time-phased force deployment database (TPFDD).[1]

Weather Operations Execution

Air Force weather operations help predict when weather could affect friendly and enemy air, space, and surface operations, possibly offering friendly force commanders an exploitable asymmetric advantage. Air Force weather operators persistently monitor, assess, and report weather conditions.[2]

[1] Army Regulation 115-10, *Weather Support for the Army*.
[2] Annex 3-0, *Operations and Planning*.

Weather Operations Assessment

To assess operational effectiveness and technical performance, Air Force weather personnel assess their ability to accurately predict the weather (technical performance) and its impact on operations (operational effectiveness). In general, operational weather squadrons focus on evaluating characterization products for their technical assessment while Army support weather squadrons (WSs) and lower echelon Air Force weather entities evaluate the exploitation products on their operational effectiveness. Assessments are used to modify or create new techniques, procedures, products, and services.

Operation EAGLE CLAW: A Hard Lesson to Learn

Top-secret planning for what would be one of the most complicated and ambitious raids in American history, the Iranian hostage rescue attempt of 1980, lasted over five months but it fell short of fully considering an incorrigible foe: the weather.

Historical records pointed to winter as the optimal time for a mission of this type, as limited moonlight and suitable temperatures and densities represented favorable conditions for night RH-53D operations. Nevertheless, the mission was set for late April, introducing additional weather challenges such as suspended dust, which proved to be a factor in the subsequent mishap. This mission-impacting information was never briefed to JTF planners and decision makers.

Recommendations to use a WC-130 weather reconnaissance aircraft as a scout in advance of the RH-53Ds were discounted based on assumed favorable weather conditions and for security reasons. Additionally, it was determined that pilot reports from accompanying C-130s, flying the same route, could provide advance notice of unfavorable weather as needed. However, the C-130s ended up arriving at the destination, Desert One, well ahead of the helicopters and were unable to relay up-to-the-minute weather data to the RH-53D crews.

Weather operations personnel were excluded from planning and rehearsal exercises at the JTF training areas, eliminating their ability to work with the aircrews….

Furthermore, mission execution weather briefings, developed by weather operations personnel, were presented by J-2 intelligence officers who had little, if any, formal weather training or experience. Aircrew feedback was provided in the same indirect way. Pilots were thus unaware of the possibility of encountering suspended dust and were unprepared to handle it. Integration of weather information, a vital contributor to mission success, never occurred.

—Paul B. Ryan
The Iranian Rescue Mission: Why It Failed

Additionally, weather personnel reference Joint Lessons Learned Information System (JLLIS) during the planning process, archive weather planning and execution data, and document weather lessons learned in accordance with the joint lessons learned program (JLLP).