BY ORDER OF THE COMMANDER 1ST WEATHER GROUP	**1ST WEATHER GROUP TACTICS, TECHNIQUES, AND PROCEDURES 3-3.1800.AFWWS.OWS**
	25 Jan 2018
	Tactical Doctrine
	Threat Assessment

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PURPOSE: The 1st Weather Group Tactics, Techniques, and Procedures (1 WXG TTP) 3-3 series of publications is the primary Air Force Weather Weapon System reference document for 1 WXG operations. This series provides considerations to be used in the planning and execution for effective mission accomplishment consisting of recognized best practices forming the foundation for employing and standardizing operations of the Air Force Weather Weapon System. This document describes how 1 WXG units implement Air Force policy.

APPLICATION: This publication applies to all regular, Air Force Reserve, and Air National Guard personnel assigned to permanent or temporary duty in a 1 WXG unit. IAW AFI 33-360, "Complying with publications in this category is expected, but not mandatory." The tactics, techniques, and procedures in this document are authoritative; deviations require sound judgment and careful consideration; in order to maintain continuity of operations and standardize operations to the highest degree, 1 WXG/DO is the authorized agent to approve deviations from 1 WXG TTP 3-3 series publications.

The following Joint Publication 1-02 definitions apply:

Tactics--The employment and ordered arrangement of forces in relation to each other.

Techniques--Non-prescriptive ways or methods used to perform missions, functions, or tasks.

Procedures--Standard, detailed steps that prescribe how to perform specific tasks.

SCOPE: This publication addresses meteorologically-based basic weapon system tasks and implements threat based operations concepts discussed in 1 WXG TTP 3-1.1. *Threat Based Operations*. This TTP provides information on basic tactics and techniques used for standardization, and present a solid foundation on which standing operating procedures are formulated.

Contents

CHAPTER 1

1. INTRODUCTION/OVERVIEW

1.1. General Description. The Threat Tracking Database (TTDB) is a common platform designed for logging and maintaining continuity of assessed weather threats across each OWS's assigned region of operations. The product consists of four time-phased maps (00-24hr/24-48hr/48-72hr/72-96hr) of the assigned region of operations with an overlay of forecast threat areas. The TTDB may be extended to weather challenges as deemed necessary by OWS operations leadership and employed as a coordination and collaboration tool with serviced units. Figure 1.1. below outlines the threat criteria along with associated colors.

1.1.1. Threat Assessment Completion. At a minimum, operations or flight leadership will accomplish the Threat Assessment Mon-Fri, and the Day shift SDO will accomplish it on weekends, holidays, and base down days. The Threat Assessment and associated e-mails will be completed and sent daily.

1.2.1.2. Identify the following threats affecting the squadron's AOI. **This means any threat affecting the AOI will be identified, regardless of whether or not it affects a TAF/PWW site.**

Color	Color HEX	Criteria	Criteria HEX
	#0000FF	Tornado	#4E6FDA
	#FF0000	Convective Winds >= 50 knots/Hail >= 3/4"	#F9583D
	#9933FF	Freezing Precipitation	#CA5EE0
	#09C3F5	Blizzard and or Heavy Snow	#8AC9DA
	#66FF00	Heavy Rain	#7CDC66
	#000000	Non-Convective Winds >= 50 knots	#909090
	#FFFF00	Unsuitable Alternate - CIG/VIS (<1000/2)	#FFFF99
	#FF9900	Significant Tropical	#F8A15A

Figure 1.1. Threat Assessment legend and color palette

Note: Squadrons may include additional criteria and associated colors with prior 1 WXG/DO coordination and approval. See Figure 1.2. below for currently coordinated additional criteria.

	#347940	Convective Winds >= 35 knots but < 50 knots/Hail < 3/4"	#009A46
	#ED0AE4	Non-Convective Winds >= 35 knots	#E8AAE1
	#996633	Dust or Sandstorm	#BBB287

Figure 1.2. Additional approved criteria and associated colors

1.2. General Guidance.

1.2.1. The Senior Duty Officer (SDO). The SDO is responsible for the accuracy and currency of the TTDB for the squadron's assigned region of operations with primary emphasis on hours 25-96. Time critical decision making for the current day's threats is handled by the WWA and TAF product set and may not always be horizontally consistent with threats logged in the TTDB.

1.2.2. Daily Threat Discussion. 1 WXG units will conduct a daily threat discussion with affected units. These are formal teleconferences employing Defense Collaboration Services (DCS) conducted by senior operations leaders (DO, Ops Superintendent, production flight OIC, or a designated civilian trainer or technical expert) which amplifies on the data contained in the TTDB and included in the daily e-mail (below) to the supported units.

1.2.4.1. Maintain daily attendance of WF participation in DCS collaborations.

1.2.4.2. After identifying threat areas, ensure to coordinate with adjacent OWSs for any areas that may encroach on their regional Area of Interest.

1.2.3. Daily e-mail summary. 1 WXG units will provide a daily e-mail summary of assessed threats for non-collocated Total Force and primary Active Duty locations not later than 1200L Mon-Fri. The threat assessment will include all assessed threats for day 2-4 (25-96 hrs) and will include a PSI for all assessed threats. Send these daily e-mails to the weather representatives for the affected installations (OSS weather flight, Army weather squadron detachment) for installations with indigenous weather support and to the designated point of contact at non-collocated Total Force units in accordance with the installation data page.

CHAPTER 2

2. CHARACTERIZATION TACTICS

2.1. General

2.1.1. General Characterizations (GC). Base Threat Determinations on the GCs discussed in TTP 3-1.1 Threat Based Operations (also found in Attachment 1 of this TTP). The GCs are SEVERE THUNDERSTORMS (includes Tornadoes, Damaging Winds and/or Hail), DAMAGING OR STRONG WINDS (Non-Convective), HEAVY RAIN, HEAVY SNOW, and FREEZING PRECIPITATION.

2.1.2. Threat and Probability of Severity Index (PSI) Determination. 1 WXG units will assign a PSI to assessed threats throughout the operational 96-hour battle rhythm.

2.1.2.1. Threats need to be identified before determining the PSI. The forecaster must have an understanding of the big picture before determining the PSI. This process can be done via several different methods. Look to squadron SOPs for specific guidelines in each unit's regional Area of Interest.

2.1.2.1. Assign a PSI to weather threats using the decision aids in Attachment 3 of TTP 3-1.1. Threat Based Operations.

2.1.2.2. **Confidence Level**:

2.1.2.2.1. **LOW:** The scale and severity of the hazard poses a measurable, but low risk to the installation. The period of exposure to the hazard can be mitigated and the hazard poses minimal injury and little to no impact to Mission and/or Unit Readiness (DISRUPTIVE). The hazard may only be represented in RoT or single model deterministic with or without local amplification. The weather features associated with the hazard may be pulse-like or poorly organized synoptically forced system. There will be little or no correlation in the SCOF or the Ensembles. Direct threat to an aerodrome complex is possible, but unlikely to persist for significant duration.

2.1.2.2.2. **MEDIUM:** The scale and severity of the hazard is sufficiently organization to present a quantifiable risk to the installation. The period and scope of the hazard is of sufficient duration to require advance preparation for protective actions and poses risk for minor injury or damage to unprotected resources with some degradation to Mission and/or Unit Readiness (MODERATE). Synoptically forced weather events associated with the hazard will be poorly organized, or in the early stages of development with some modification of the hazard by local

amplification or dampening effects. There will be little correlation in the SCOF or higher uncertainties in the ensemble based characterizations. Convective threats are likely to be associated with strong pulse type thunderstorms in a Hi/Lo environment and may occur several times within or in the near vicinity to the warned location, usually associated with clusters or scattered coverage lines. Non-convective, synoptically forced events may occur multiple times over a defined threat period but will not be the predominant condition during the threat period.

2.1.2.2.3. **HIGH:** The scale or severity of the event will be highly organized and persistent presenting a notable danger to lives and property at a warned location. The period and scope of the hazard will be conducive to severe injury to personnel or damage to structures with a significant degradation to Mission and/or Unit Readiness (CRITICAL). Personnel and material risk reduction is best affected by sheltering or evacuation in advance of the event; real property may be buttressed to mitigate risks from these weather events. The synoptic system will be organized with moderate matching SCOF and measurable agreement (high probabilities persisting run-to-run) in ensemble based characterizations. Convective hazards are usually associated with organized convective lines, frontal boundaries, or mesoscale convective systems that can clearly be identified by sensing systems and produce damaging winds or hail over wide swaths. Non-convective hazards are normally associated with readily identifiable synoptic weather features and may persist for extended timeframes.

2.1.2.3. **Weather Threat Probability**:

2.1.2.3.1. **Isolated** (Improbable, but possible to occur): May only be represented in RoTs or single model deterministic without correlation in SCOFs/Ensembles. Also, pulse type thunderstorms in Hi/Lo environment triggered by insolation/local heating.

2.1.2.3.2. **Scattered** (Unlikely, can be expected to occur): Local amplification of a poorly organized synoptically forced system or local dampening of an organized synoptically forced system. Poor correlation in SCOFs and may not be represented in ensembles. Also, locally enhanced pulse type thunderstorms in Hi/Lo environment.

2.1.2.3.3. **Numerous** (Will occur several times): Local amplification of a poorly organized synoptically forced system; SCOFs and Ensemble signaling is not strong. Conditions are likely to occur many times over multiple hours but not predominant.

2.1.2.3.4. **Frequent** (Will occur frequently): Organized, synoptically forced system with moderate pattern matching in SCOFs and measureable ensemble agreement. Conditions are temporary or predominant for short periods.

2.1.2.3.5. **Persistent** (Continually experienced): Persistent or widespread synoptically forced system with strong pattern matching in SCOFs and strong ensemble agreement.

2.1.2.4. **Weather Threat Severity:** Defined as the effect impact on a supported installation or operations. Split into four categories as follows:

2.1.2.4.1. **DISRUPTIVE:** Minimal injury or damage, little or no impact to mission and/or unit readiness. Non-Weather watch/warning category events presenting an impact to ops.

2.1.2.4.2. **MODERATE:** Minor injury or damage, some degradation to mission and/or unit readiness. Moderate Thunderstorms, Strong Winds, Heavy Rain/Snow, Freezing Precipitation of light intensity with an intermittent characteristic.

2.1.2.4.3. **CRITICAL:** Severe injury or damage, significant degradation to mission capability and/or unit readiness. Severe Thunderstorms, Damaging Winds (LT 64kts), Heavy Rain/Snow (GT Min Criteria), and Freezing Precipitation (Light – Moderate).

2.1.2.4.4. **CATASTROPHIC:** Death, loss of asset, severe degradation to mission and/or unit readiness. Damaging winds GTE 64kts, Hail GTE 1.5 inch, Blizzard, Sandstorm, Freezing Precipitation (persistent or GTE moderate intensity).

RISK ASSESSMENT MATRIX				PROBABILITY							
				FREQUENCY OF OCCURRENCE OVER TIME							
				A Persistent	B Frequent	C Numerous	D Scattered	E Isolated	AFMAN 15-129 V 1 Table 4.1 Associations		
SEV ERITY	Effect of Hazard	Catastrophic (Death, Loss of Asset, Mission Capability or Unit Readiness)	I	H	H	H	M	M	I	Tornado, Damaging winds GTE 64kts, Hail GTE 1.5 inch, Blizzard, Sandstorm, Freezing Rain (persistent or GTE Mdt intensity)	Catastrophic (Death, Loss of Asset, Mission Capability or Unit Readiness)
		Critical (Severe Injury or Damage Significantly Degraded Mission Capability or Unit Readiness)	II	H	H	M	M	L	II	Severe TS, Damaging wind LT 64kts, Heavy snow (GT Min Criteria), Heavy Rain (GT Min Criteria), Freezing Rain (lgt-mdt)	Critical (Severe Injury or Damage Significantly Degraded Mission Capability or Unit Readiness)
		Moderate (Minor Injury or Damage, Degraded Mission Capability or Unit Readiness)	III	H	M	M	L	L	III	Moderate Thunderstorm, Strong Winds , Heavy Rain (meeting threshold), Heavy Snow (meeting threshold), Freezing precip of light intensity or intermittent characteristic	Moderate (Minor Injury or Damage, Degraded Mission Capability or Unit Readiness)
		Disruptive (Minimal Injury or Damage, Little or No Impact to Mission Readiness or Unit Readiness)	IV	M	M	L	L	L	IV	Non-Weather Watch/Warning category events presenting an impact to operations	Disruptive (Minimal Injury or Damage, Little or No Impact to Mission Readiness or Unit Readiness)
				Risk Assessment Levels							
				H=High M = Medium L=Low							
				Characterization based on Environmental Threat Indicator Diagram							
				Persistent or widespread synoptically forced system with strong pattern matching in SCOFs and strong ensemble agreement	Organized, synoptically forced system with moderate pattern matching in SCOFs and measurable ensemble agreement. Conditions temporary or predominant for short periods.	Local amplification of a poorly organized synoptically forced system or local dampening of an organized synoptically forced system; SCOFs and Ensemble signalling is not strong. Condition likely to occur many times over multiple hours but not predominant	Local amplification of a poorly organized synoptically forced system or local dampening of an organized synoptically forced system. Poor correlation in SCOFS and may not be represented in ensembles. Also, locally enhanced pulse type thunderstorms in Hi/Lo environment	May only be represented in RoTs or Single Model Deterministic without correlation in SCOFs / Ensembles. Also, pulse type thunderstorms in hi/lo environment triggered by insolation/local heating			
				A	B	C	D	E			

Weather Threat

Fig. 1.1. Merger of AF Risk Assessment Matrix with weather threats and output from 1 WXG PSI determination

2.1.2.5. Threats need to be identified prior to determining the PSI. An understanding of the big picture is necessary before determining the PSI. To accomplish this, the Threat Summary located on the AFW-WEBS Ensemble page is quite useful for the CONUS

(AFW-WEBS -> Ensembles -> 4km MEPS -> Severe Plots -> Threat Summary). For overseas areas the

2.2. Decision Time Line

2.2.1. T-96 hours to T-48 hours. Identify threat associated with major features and/or patterns. Threats will be discussed with the Sub-Region Supervisors (SS) and Flight Leadership. Most threats will be of Low or Medium Risk.

2.2.2. T-72 hours to T-48 hours. Threat Assessment Leader (TAL), Sub-Region Supervisors (SS) and Flight Leadership (FL) will accomplish a reassessment of threats for each Threat Assessment product. The SDO will ensure graphics charts are horizontally consistent with forecast threats (i.e. tropical storm route graphic, SIG WX, TSTMs).

2.2.3. T-36 hours to T-30 hours. Sub-Region Supervisors conduct collaboration with EU's in order to simplify communications for future WWA issuance. Forecasters may begin to reflect Threat in their TAF product and their worksheets.

2.2.4. T-30 hours to T-10 hours. Continue collaboration between Sub-Region Supervisors/TAL and EU's. The SDO will begin to conduct Threat Drilldown briefing(s) for affected Region(s) at the T-10 hr point. Forecasters will address the Threats within the body of their TAF and worksheets by using accepted TTPs and Meteorological reasoning/forecasting.

2.2.5. T-10 hours to end of threat potential. SS will identify and characterize threats based on the General Characteristic listed in TTP 3-1.1, Threat Based Operations. SSs/Forecasters will maintain contact with affected EUs during the period to ensure communication lines remain open and prompt forecasters to issue corresponding WWAs if threat is still warranted. If potential no longer exists, Forecasters do not issue WWAs or cancel issued WWAs, and SS provide updated inputs for potential amendment to the Threat Assessment product. Points Forecaster will issue products as required to supported sites.

REFERENCES

First Weather Group, United States Air Force, 2014: Threat based operations. TTP 3-1.1. 48 pp.

United States Air Force, 2011: Air and space weather operations – characterization. AFMAN 15-129, Vol. 1, 75 pp.

Attachment 1. Listing of Generalized Characterizations

THREAT: **Severe Thunderstorm**

GC1: High Buoyancy - Highly Sheared and Synoptically Forced

Threat Discussion: Threat consists of highly organized lines, quasi-linear structures, and organized clusters of thunderstorms, many of which are displaying supercellular characteristics with well-defined segregation of up and downdraft cores and significant storm tilt. Damaging wind events are organized and persistent, extending 20-50 NM in advance of the main line of thunderstorms. Be alert for the increased risk of rear flank downdrafts meeting or exceeding damaging wind thresholds. Damaging hail is persistent and recurring throughout the lifecycle of the individual thunderstorms. Most favored environment for tornadoes/funnel clouds.

GC2: Moderate/Low Buoyancy - Highly Sheared and Synoptically Forced

Threat Discussion: Threat consists of organized lines or clusters of splitting thunderstorm cells. Primary damaging wind and hail threats associated with favored right or left moving thunderstorms. Thunderstorms in this environment present a difficult forecast challenge given that many of these events occur post FROPA with higher storm bases than in more buoyant environments.

GC3: High Buoyancy - Weakly Sheared and Synoptically Forced

Threat Discussion: Threat consists of loosely organized lines or clusters of pulse type thunderstorms. The primary threat consists of damaging winds and hail in close proximity to individual storm cells with the majority of damaging wind events occurring directly under the thunderstorm downdraft in the mature phase (heavy precipitation) with a lesser threat of damaging winds in the rear flank of downstream thunderstorms.

GC4: High Buoyancy - Weakly Sheared and Locally Forced

Threat Discussion: Threat consists of discretely organized pulse type thunderstorms focused on converging thunderstorm outflow boundaries, local forcing events such as sea or lake breeze discontinuities. Rapid development of pulse storms is possible with storm lifecycle reaching significant thresholds in timescales impossible to provide desired lead time for damaging wind or hail warnings. Wind and hail threats are proximate to the geographic location of the thunderstorm downdraft in the mature phase with propagation of effect decreasing rapidly with distance from the epicenter of the event. Thunderstorm wind events can be either of the dry or wet microburst type triggered wind events with the most difficult characterization being the “virga bomb” type.

THREAT: **Moderate Thunderstorm**

GC1: Moderate/Low Buoyancy - Highly Sheared and Synoptically Forced

Threat Discussion: Threat consists of loosely organized clusters or individual splitting thunderstorm cells. Primary damaging wind and hail threats associated with favored right or left moving thunderstorms; many damaging hail events occur as hail is ejected from the leading edge of advancing storms falling to the ground as the only precipitation type. Moderate level storms

are difficult to characterize given that many of these events occur post FROPA and are associated with elevated storm bases.

GC2: High Buoyancy - Weakly Sheared and Synoptically Forced

Threat Discussion: Threat consists of disorganized clusters or singular pulse type thunderstorms. The primary threat consists of isolated instances of strong winds and hail in close proximity to individual storm cells with the majority of wind events occurring directly under the thunderstorm downdraft in the mature phase during heavy precipitation. Thunderstorm bases may be elevated with the greatest threat being instances when environmental flow patterns accentuate thunderstorm downrushes.

GC3: High Buoyancy - Weakly Sheared and Locally Forced

Threat Discussion: Threat consists of discretely organized pulse type thunderstorms focused on converging thunderstorm outflow boundaries, local forcing events such as sea or lake breeze discontinuities. Rapid development of pulse storms is possible with storm lifecycle reaching significant thresholds in timescales impossible to provide desired lead time for damaging wind or hail warnings. Wind and hail threats are proximate to the geographic location of the thunderstorm downdraft in the mature phase with propagation of effect decreasing rapidly with distance from the epicenter of the event.

Notes:

1. Buoyancy/Shear values associated with high/low determinations are generally described in this TTP for purpose of overview. Specific values may vary by region or season and will be more thoroughly described in 1 WXG TTP 3-3.6 *Characterizing Thunderstorm Threats*.
2. Proximity to the event may be the sole determining factor between strong and damaging wind events associated with these three general characterizations.

THREAT: **Damaging or Strong Wind**

GC1: Synoptically Forced - Cold Air Advection

Threat Discussion: Threat consists of periods of strong to damaging winds following passage of surface cold fronts. Damaging winds may be enhanced or suppressed by local terrain and may be sub-threshold in urban terrain due to interference and disruption of wind flow around structures. Intensity and duration of these events are highly dependent on the vertical organization of the atmosphere with the most intense surface winds occurring with the alignment of mid-tropospheric temperature gradients, downward vertical motions and unstable conditions in the lower tropopause. Sustained damaging wind events are most prevalent in the immediate vicinity of surface cold fronts and persist through the period of greatest cold air advection.

GC1: Synoptically Forced - Warm Air Advection

Threat Discussion: Threat consists primarily of isolated periods of strong to damaging winds following passage of the surface warm front and associated with a deepening low pressure system. Strongest winds are coupled with the area of greatest surface pressure falls accompanied by dry (or drier) air intrusion into the flow pattern and may be enhanced or suppressed by local terrain. These events may be accompanied by a well-developed low level jet stream, but can occur within broad regions of enhanced low level windflow in the absence of a well-defined low level jet.

GC2: Local Effect - Inversion Break

Threat Discussion: Threat consists primarily of a brief period or single wind gust meeting or exceeding the strong or damaging threshold. Damaging winds occur in deep layers of strong vertical temperature/density discontinuity above a surface based temperature inversion. The highest recorded wind speeds are associated with the inversion breaking; while most events of this general characterization occur singularly or for a brief period, persistent events are associated with strong synoptic features accounting for synoptically forced - warm air advection general characterizations.

GC3: Local Effect - Terrain Induced

Threat Discussion: Threat consists primarily of brief periods meeting or exceeding strong or damaging wind thresholds due to local terrain forcing. These events are most common in rough or mountainous terrain due to funneling or katabatic wind effects with the terrain introducing additional variability in wind direction and enhancing wind speeds and gusts in the most favorable directions. Katabatic winds may be persistent and largely unsupported by synoptic and mesoscale isobaric gradients, often occurring in the hours preceding local sunrise. Similar enhancement of wind speeds may be experienced at the sub-mesoscale in urban terrain due to Bernoulli effects induced by structures. These events may register on airfield wind sensors or tactical sensing systems and should be accounted for in decision aids that execute the 1 WXG 3-3 series TTPs.

NOTE: Favorable wind directions for terrain induced winds, or local enhancement/suppression can normally be deduced from wind rose diagrams; seasonal variations apply and will be included in decision aids executing 1 WXG TTP 3-3.10.

THREAT: **Heavy Rain**

GC1: Synoptically Forced - Tropical Moisture Plume

Threat Discussion: Threat consists of extended period of widespread heavy rain with potential for imbedded rain showers/thunderstorms. Greatest precipitation accumulations occur at the intersection of the tropical moisture plume with surface fronts or troughs in coastal or subtropical regions. In addition, significant/record rainfall amounts have occurred at the northernmost extension of the tropical moisture plume, a great distance poleward of the source region, as the leading edge of the moisture plume interacts with polar front jet stream cores or streaks or is entrained into the warm sector of an advancing polar front.

GC2: Synoptically Forced - Quasi-stationary Precipitation Field

Threat Discussion: Threat consists of extended period of light to moderate rain with potential for imbedded rain showers or thunderstorms depending on the vertical temperature profile of the in situ airmass over the warned location. Quasi-stationary precipitation fields form under three basic synoptic situations: 1) Heavy rain occurs in the deformation zone of mature low pressure systems and may persist for extended periods if the low pressure system is barred from progression such as during a cutoff low or presence of a downstream blocking ridge pattern 2) Heavy rain occurs along stationary or extremely slow moving frontal boundaries with the heaviest rain occurring due to isentropic lift into the cold dome; flow is generally orthogonal to the isentropes in the most severe of cases.
3) Heavy rain or persistent regenerative rain showers/thunderstorms occur as result of interaction of tropical and polar jet stream cores and streaks, or due to splits in the polar jet stream flow. Convective cells and elements form in the region with the greatest upper level divergence and propagate parallel to the mid-tropospheric steering flow with the “trailing edge” of the precipitation field anchored to the source region beneath the splitting jet streams.

GC3: Local Effect - HP Supercells

Threat Discussion: Threat consists of extended periods of rainshower/thunderstorms punctuated by periods of squalls and heavy precipitation. Supercellular storms arrayed along synoptic or mesoscale boundaries may “train” over an installation or region and produce significant precipitation totals in a four to six hour period. Heaviest rainfall rates occur in the rain cooled, downdraft dominated rearward flank of supercellular thunderstorm complexes and may deposit warning-level accumulations in as little as an hour depending on precipitable water content and storm motion.

GC4: Local Effect - Terrain Forced Precipitation Event

Threat Discussion: Threat consists of extended periods of light to moderate rain with potential for periods of heavier rainshowers or thunderstorms depending on the vertical temperature profile over the affected installation. Terrain forced heavy precipitation events may result from the following conditions: 1) Orographically induced rainshowers/thunderstorms may anchor on significant terrain features and consistently regenerate to produce warning-level precipitation accumulations. 2) Persistent upslope conditions may yield continuous rain/drizzle lasting for many days. Warning category precipitation accumulations are most likely in tropical and sub-tropical regions. 3) Extended periods of light to moderate rainfall occur in deep marine layers trapped against higher terrain as result of persistent onshore flow.

THREAT: **Heavy Snow**

GC1: Synoptically Forced - Deformation Zone

Threat Discussion: Threat consists of highly organized snow field possibly with imbedded snow showers with the heaviest snow accumulation on the equatorward side of the synoptically bounded deformation zone. Anticipate extended periods of moderate to heavy snow in the exit region of the supporting polar jet stream feature with the individual weather elements moving southwest to northeast parallel to the flow along the leading edge of the feature.

GC2: Synoptically Forced - Quasi-stationary Precipitation Field

Threat Discussion: Threat consists of bands of light to moderate snow with the potential for imbedded snow showers normally associated with mid-tropospheric shortwave troughs passing over a surface boundary. Greatest precipitation accumulations occur due to isentropic lift into the cold dome with the heaviest precipitation occurring where the flow is orthogonal to the isentropes.

GC3: Local Effect - Upslope Conditions

Threat Discussion: Threat primarily consists of persistent light snow for an extended time period, generally associated with terrain amplification of weak atmospheric dynamics due to persistent flow in favorable upslope fetches transporting moisture to the affected region.

NOTE: Upslope effects may locally enhance existing snowfall events and should be characterized as local amplification of a synoptically forced event (GC-1 or GC-2)

GC4: Local Effect - Lake Effect Snow

Threat Discussion: Threat primarily consists of extended periods of moderate snow/snow showers on the lee side of open bodies of water. Lake effect snow is most common in post frontal environments and may persist for extended periods. Local snow accumulations exceeding 12 inches are possible depending on water temperatures and the stability of the atmosphere in the post frontal environment. Snow fall areas may propagate hundreds of miles downstream from the source region should favorable conditions persist for extended time frames.

NOTE: Lake effects may locally enhance synoptically forced snow events and should be characterized as a local amplification of general characterizations 1 or 2.

THREAT: **Freezing Precipitation**

GC1: Synoptically Forced Cold under Warm (Polar Airmass)

Threat Discussion: Threat consists of periods of freezing precipitation gradually changing over to snow or ice pellets as cold air intrudes beneath an in situ warm airmass. Vertical velocities and the decreasing depth of the warm layer aloft determine the intensity and duration of the freezing precipitation event.

GC2: Synoptically Forced Warm over Cold (Polar Airmass)

Threat Discussion: Threat consists mainly of freezing drizzle gradually transistioning to liquid precipitation. Surface temperatures may be well below zero degrees Celsius at onset and gradually warm to the termination of the event. This synoptically forced event is most commonly associated with passage of a warm front or warm frontal wave on a stationary frontal boundary with the onset and intensity of the event primarily determined by the depth of the moisture pool and depth of the cold layer at the surface at onset.

GC3: Retreating Arctic Airmass

Threat Discussion: Threat consists of brief periods of light freezing drizzle sometimes mixed with snow; the precipitation intensity could be extremely light and not rapidly detected by human observers until rime begins to accumulate on fixed objects. Although synoptically forced, the atmospheric dynamics are weaker than with advancing Polar systems and well-defined surface features may not be readily discernible.

GC4: Local Effect - Upslope Conditions

Threat Discussion: Threat consists of extended periods of light freezing drizzle resulting from the transport of moisture into an established or terrain trapped surface cold pool. Precipitation intensities are generally light with the drizzle falling from stratiform cloud decks into the surface based cold layer, Although intensities may be light, this event may persist for several days resulting in significant ice accumulation on untreated surfaces.

GC5: Homogeneous Nucleation

Threat Discussion: Threat consists of intermittent or patchy light freezing drizzle in atmospheric thermal profiles entirely below freezing. Cloud top temperatures within geographically and seasonally optimal ranges are prime determining factors for onset, intensity, and duration of these events. In many cases, aircraft icing on climb and descent significantly exceeds the rate of ice accumulation at the surface.