UNITED STATES MARINE CORPS
MCAS Futenma Okinawa
Weather Service Section
Unit 35202
FPO AP 96372-5202

LOCAL AREA FORECASTER'S HANDBOOK

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4 Jun 1997

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FORWARD

This Forecaster's Handbook has been written in compliance with the requirements of NAVOCEANCOMINST 3140.2D of April 1992.

This handbook contains local climatology, special features, and forecasting rules and aids used by MCAS Futenma forecasters. Services provided and forecasting techniques are included for guidance to inexperienced and newly assigned forecasters.

This handbook is a revision of the MCAS Futenma Forecasting Handbook dated 4 April 1996, which should be destroyed. Constructive comments concerning format or contents are hereby solicited. Addition copies may be obtained upon request from the Weather Service Officer, MCAS Futenma Okinawa, FPO AP 96372-5202.

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FORECASTERS HANDBOOK
CHAPTER ONE
BASIC DESCRIPTION

101. Introduction and Topography. MCAS Futenma Weather Service office spaces and location of equipment are illustrated in figure I - 1. The office is located in the center of building 5 1 0, Airfield Operations. The building is surrounded by concrete and asphalt taxiways and parking lots. The Air Station is located 26 degrees, 16 minutes north latitude and 127 degrees, 45 minutes east longitude on the western side of south central Okinawa. The airfield is situated on a relatively flat, coral based plateau with an established field elevation of 247 feet above sea level. This location offers a commanding view of the East China Sea, 1 and 1/2 miles west-northwest, but no view of the Pacific Ocean 4 miles east. Inside the confines of the perimeter fence, the few remaining undeveloped areas are covered with dense vegetation. The terrain east of the single runway (06/24) continues to rise to a mean elevation of 300 feet above sea level. The area outside the perimeter is densely populated and well developed both commercially and domestically. A series of ridges, at varying distances and elevations extend from the north through east and continue on southward of the Air Station. The mean elevation is 330 feet with a peak elevation of 490 feet above sea level 3 3/4 miles northeast (045 degrees) of the Air Station. The northern portion of Okinawa has a mountainous ridge oriented northeast to southwest with a maximum elevation of 1634 feet at Mt.Yonaha. The south central portion of the island consists mainly of low hills and plains. The southern portion is a plateau with steep cliffs dropping off to the sea (see figure 1-2 for map of surrounding area). The local flying area is defined as a I 00 nautical mile radius of the Kadena Air Force Base TACAN, and the local area is defined as a 25 nautical mile radius of MCAS Futenma's airfield.

102. Meteorological Equipment. Remote sites for the equipment are annotated on figure 1-3 All meteorological equipment located at MCAS Futenma comes under the cognizance of MOETLO Yokosuka, Japan. Meteorological equipment maintained by station electronic technicians, include the following:

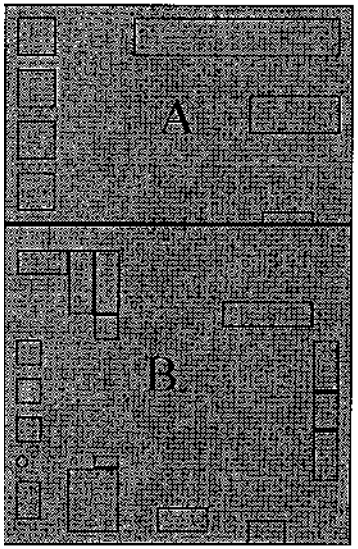
AN/GMQ-29B Automatic Meteorological Station
AN/UMQ-5 Wind measuring set. Indicators are also located in the tower and the pilot and forecasters briefing area.
AN/GMQ-13 Cloud height set- 400 foot base line.
AN/GMQ-32 Transmissometer. 500 foot base line.
REMOTE RADAR DROP Screen, located in forecasters area.
WSR-88D Doppler Weather Radar.

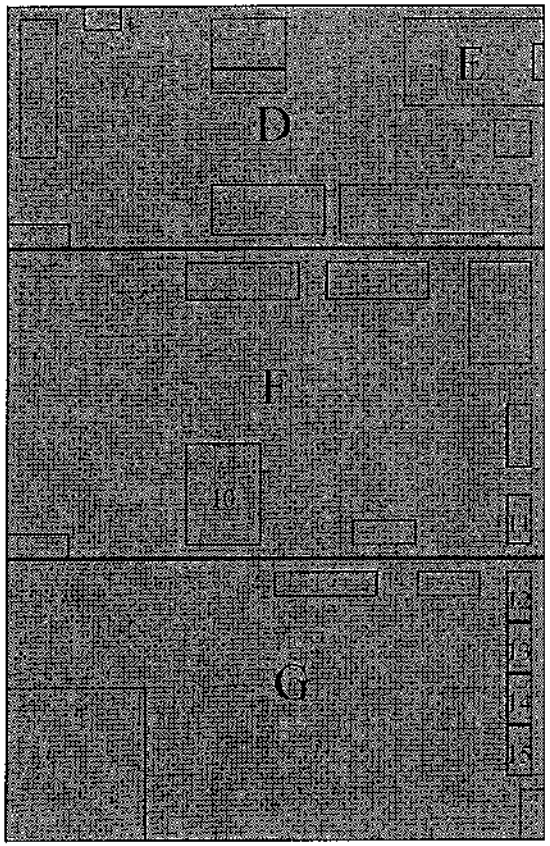
FUNCTIONAL AREA LEGEND

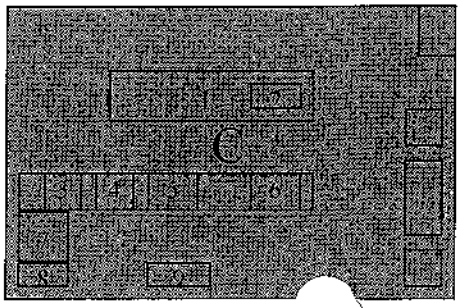
A - WEATHER SERVICE OIC'S OFFICE
B - WEATHER SERVICE CHIEF/TRAINING NCO/ADMIN CLERK
C - FORECASTER/PILOT BRIEFING AREA
D - SUPPLY AREA
E - OUTSIDE STORAGE AREA
F - PLOTTING AREA
G - OBSERVER AREA
H - WSR-88D DOPPLER WEATHER RADAR ROOM/LIBRARY

EQUIPMENT LEGEND

1 - MIDDS WALL OF THUNDER
2 - PILOT TO FORECASTER RADIO (METRO)
3 - MIDDS CPU
4- FAX MACHINE
5 - FORECASTER'S MIDDS COMPUTER
6 - CONTEL METEOROLOGICAL WORKSTATION (CMW)
7 - LOCAL AREA NETWORK COMPUTER
8 - SAFE
9 - UYK-83 COMPUTER SYSTEM (MOSS)
10-WSR-88D RADAR PRODUCT GENERATOR (RPG)
11-WSR-88D LASER PRINTER
12-OBSERVER'S CMW (MASTER)
13-OBSERVER'S MIDDS COMPUTER
14-GMQ-29B AUTOMATIC WEATHER STATION, RD-108 WIND RECORDER, AND THE R2368 HF RECEIVER
15-GMQ-13 CLOUD HEIGHT INDICATOR AND THE GMQ-32 TRANSMISSOMETER
16-WSR-88D PRINCIPAL USER PROCESSOR (PUP)
17-COMPUTER BASED TRAINING SYSTEM







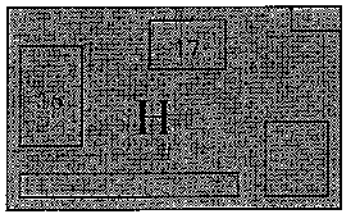


FIGURE 1-1.
MCAS FUTENMA WEATHER SERVICE OFFICE SPACES AND LOCATION OF EQUIPMENT.

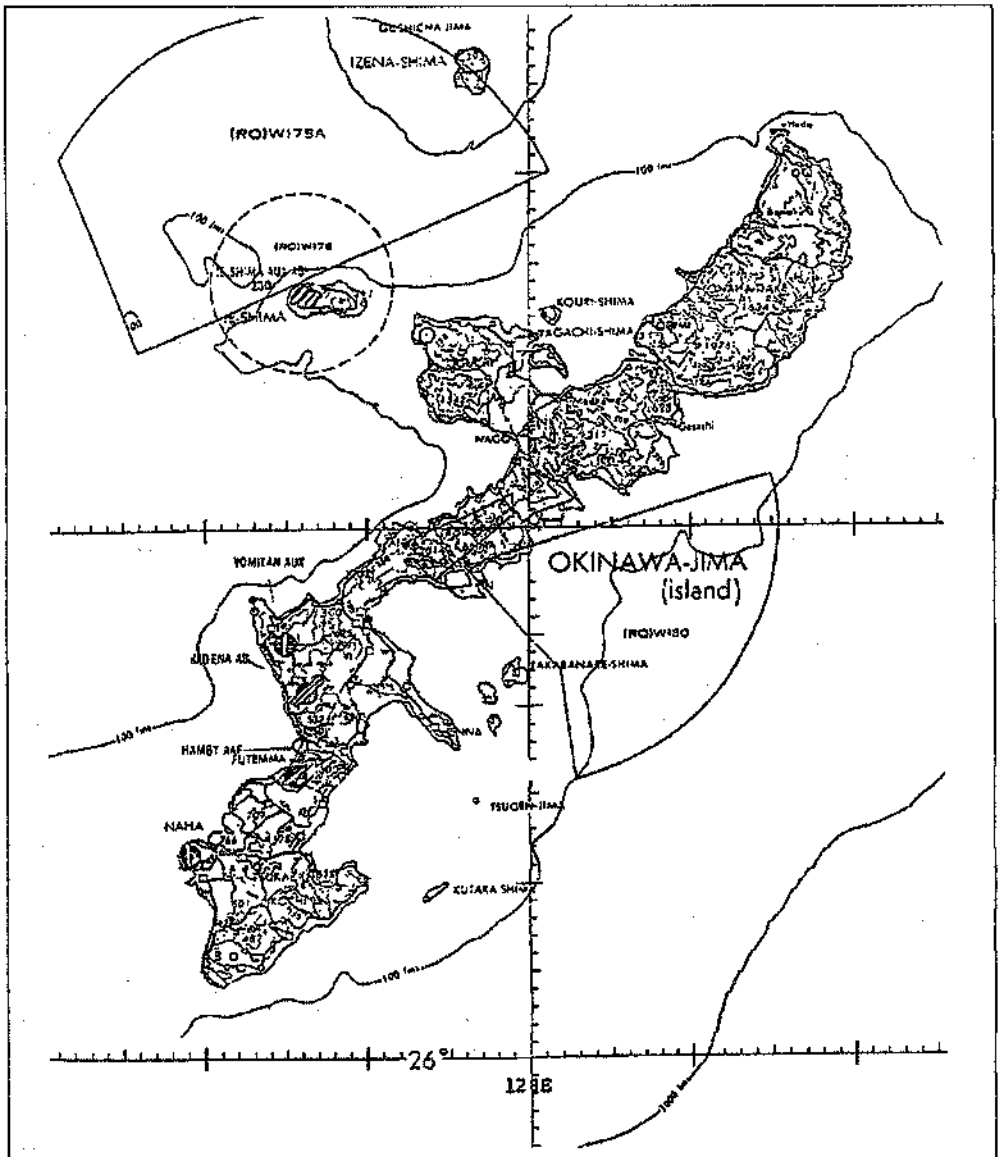


Figure I-3 Island of Okinawa

5

Figure 1-2. Surrounding Area Map.

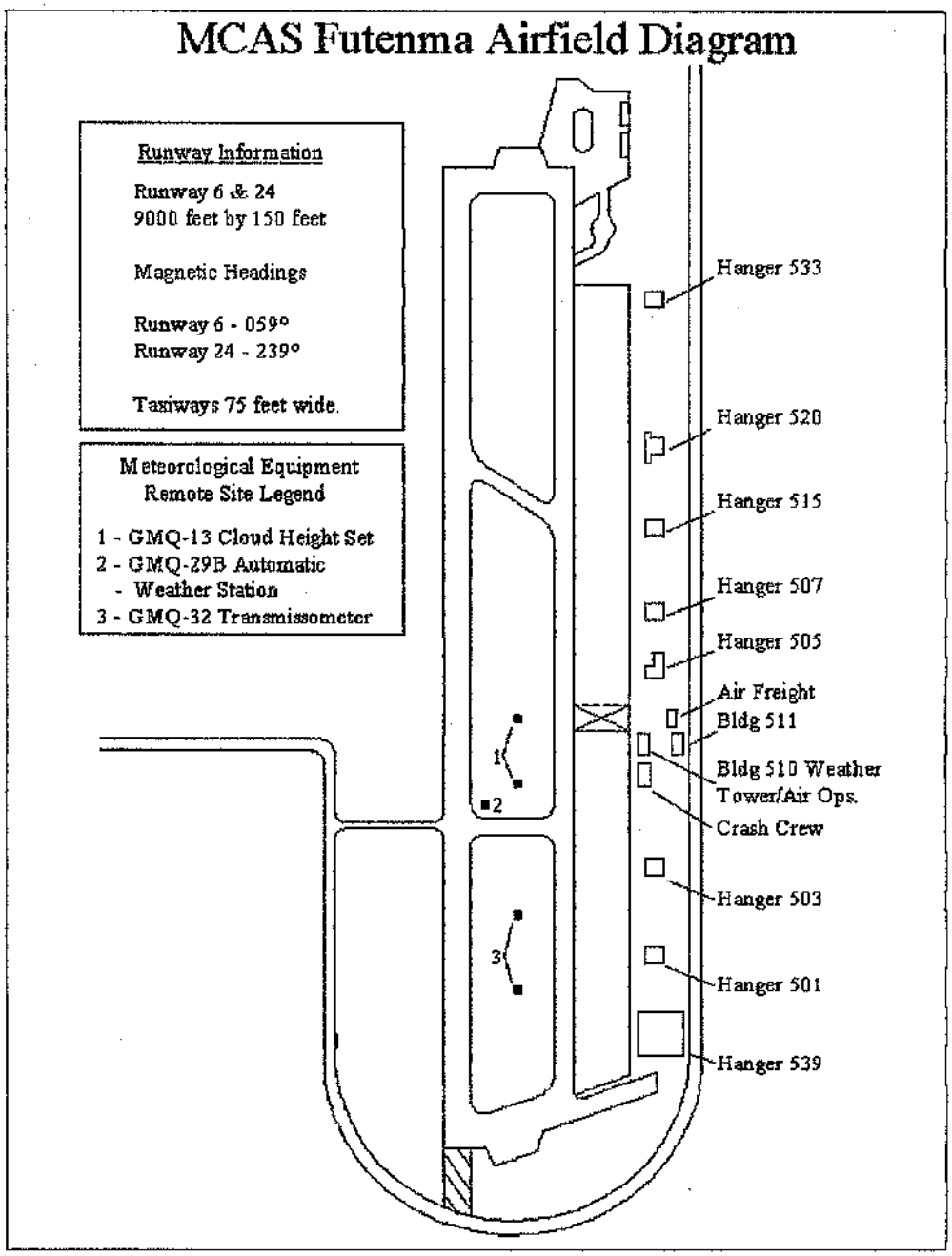


Figure 1-3. Airfield Diagram and Remote Site Locations.

Other meteorological equipment include the following:

ML-488/UM Aneroid barometer. Located on the east wall of the observer's lab at a height of 5' 1 " above ground level.
ML-41 Thermoscreen. Located 65 feet northwest of building 510.
ML-217 Four inch plastic rain gauge. Located west of building 510.
AN/PMQ-3 Hand Held Anemometer.
ML-3D Marine Barograph. Located in observer's room.

103. Communication Circuit and Equipment.

a. MIDDS - (Meteorology and Oceanography Integrated Data Display System). The wall of thunder for the MIDDS is located in the forecaster/pilot briefing area. MIDDS incorporates the PCGRAFAX, GSIDS, and the OPARS/NODDS computer systems. It also has Internet access. There are two terminals for the system. One i the forecaster/pilot briefing area and the other in the observers area. The PCGRAFAX receives Japanese Meteorological Agency (JMH) products utilizing a Harris R-2368 HF receiver. GSIDS receives satellite imagery directly from a geostationary satellite. OPARS/NODDS (Optimum Path Aircraft Routing System/Naval Oceanographic Data Display System) allows acquisition of products from FNMOD, Monterey, Ca.

b. CMW - (Contel Meteorological Workstation) These two workstations, one located in the forecaster/pilot briefing area and the other in the observers area, are the main source of meteorological information. The Air Force Automated Weather Network (AWN) HICKAM AFB manages this high-speed system. Local data requirements are evaluated and updated annually as governed by this office and applicable regulations.

c. METRO - A pilot to forecaster radio, located on the wall of thunder, allows direct communication between the forecaster and the airborne pilot. MCAS Futenma's METRO transmits and receives on 290.6 MHz's. The forecaster has the ability to transmit and receive on 344.6 MHz's (Kadena METRO) and MHz's (MCAS Futenma's Tower).

d. Telephone Service - This office possesses the following telephone access:

Weather OIC/NCOIC/Training NCO/Admin. Clerk	-636-3628
Forecast and Observation Services	-(636-3071/3177)

e. Tower Hotline - This dedicated telephone line, located in the observer's lab, is used to disseminate and solicit weather information to and from the tower.

Destructive Weather Network Phone - This dedicated conference style telephone line, located in the observers area, is used to disseminate all destructive weather warnings and advisories to agencies aboard the Air Station.

104. Support.

a. Commands Supported.

1. MCAS Futenma. Support to the Station includes:

· Flight forecasting for the VIP logistics aircraft (C-12andT-39).
· Monthly climatological and astronomical data.
· Special climatological studies.
· Weather Warnings and readiness notification.

2. CG I" MAW. Support to the Wing includes:

· CG daily weather brief for Okinawa. Includes plain language and aviation forecasts out to 96 hours.
Flight forecasting for the tenant squadrons.
· Weather warnings and readiness notification.
Special climatology and astronomical data for operations, exercises, and evaluations.
Personnel and meteorological mobile facilities support of exercises and/or operations.

3. CG MCB Butler. Support of Camp Butler includes:

· Daily forecasts for Base Ranges.
· Special climatology and astronomical data for operations, exercises, and evaluations.

- Other support as requested.

4. MACG 18. Support of MACG I8

- Daily forecasts for Base Ranges.

- Special climatology and astronomical data for operations, exercises, and evaluations.

- Other support as requested.

5. Transient Aircraft. Primary support would be flight forecasting for military and government aircraft for training and contingency purposes.

6. Other. Due to close working relations with the Naval Oceanography Command Detachment and with Detachment 8, 20th Weather Squadron, 1st Weather Wing, both located

aboard Kadena AB, the weather offices on Okinawa provide mutual supporting services. These include transmission of observations and forecasts during equipment outages and other assistance as requested by observers, forecasters, and administrative personnel.

b. Other Support-

1. Operations, Exercises, Evaluations, Training. Frequently, support is requested for the various needs of the Air Station and tenant organizations. This support could entail squadron briefings, NATOPS classes, seasonal transition safety classes, climotalogical studies, as well as many other possibilities. Support is provided as local assets can accommodate. All such requests are forwarded to the Weather Service Officer or NCOIC for validation.

2. Specialized Forecasts. Specialized forecasts and support are contained in Chapter 4.

c. Aircraft. The primary aircraft briefed by this office include CH-46, CH-53, C-130, H-1, AH-1, C-12, and T-39 flights. It is imperative that the forecaster fully understand these aircraft and their specific characteristics and limitations.

d. Meteorological Mobile Facilities. MWSS 172 maintains custody of a complete van complex - a primary, secondary, and integration unit. The Mark IV satellite van receiving terminal is positioned separately.

CHAPTER TWO

CLIMATE

201. Introduction. In order to be a proficient forecaster aboard MCAS Futenma, an in-depth understanding of air/sea interaction, atmospheric dynamics, climatology, and current trends is required.

202. Local Climatology.

a. Temperature. The average seasonal temperatures and relative humidity for MCAS Futenma are; spring (March, April, and May) 69.8 Deg F and 78.8%; summer (June, July, and August) 81.6 Deg F and 8 1. 7% -1 fall (September, October, and November) 76. 0 Deg F and 77.8%; winter (December, January, and February) 61-9 Deg F and 74.9%. The absolute maximum temperature recorded for the station is 98 Deg F (June and September 1967). The absolute minimum temperature for the station **is** 42 Deg F (1963). July is normally the hottest month of the year.

b. Precipitation. In August of 1969, MCAS Futenma recorded it's maximum amount of precipitation for a 24 hour period- 13-95 inches- Historically, May and June are the wettest months with an average monthly rainfall of 10.31 and 10.62 inches respectively- February is the driest month with 3.76 inches of mean monthly rainfall. The mean annual rainfall is 8 1. II inches.

c. Winds. The prevailing surface wind direction from November through March is of a northerly component, with an average speed of 7-4 knots. April through September's winds prevail from the east at 7.6 knots. The peak wind observed at MCAS Futenma (I 00 knots), was recorded during a tropical cyclone in October of 1961.

d. Weather Conditions. Annually, VFR conditions are experienced 94.7% of the time. IFR conditions are experienced 5.3% of the time. Below minimum conditions are experienced 0.2% of the time (The below minimums percentage is included in the IFR percentage.) The majority of the thunderstorm activity occurring around Futenma is in June, July, August, and September, with June having the most occurrences.

e. Diurnal Pressure Tendencies. See figure 2-7 below for the diurnal pressure changes for MCAS Futenma. All times are local and all pressures are in inches of mercury.

	00	03	06	09	12	15	18	21
JAN	009	007	006	010	009	004	005	009
FEB	007	005	004	007	007	999	003	006
MAR	004	002	002	005	004	999	000	003
APR	996	992	992	996	995	991	991	995
MAY	985	982	982	984	984	981	990	984
JUN	976	973	973	976	976	973	973	976
JUL	976	974	974	976	976	974	972	975
AUG	972	969	969	971	971	969	968	978
SEP	982	980	980	983	982	979	979	982
OCT	993	991	991	994	994	989	991	994
NOV	003	001	001	005	003	999	001	004
DEC	010	008	008	012	010	005	007	011

Figure 2-7. Diurnal Pressure Tendencies

f. Sea surface Temperature. Dependent upon the seasonal insulation cycle, sea surface temperatures exhibit a time lag of about one month due to the thermal properties of seawater. While maximum insulation occurs during July and August, the maximum water temperatures occur during August and September. Sea surface temperatures are also very much dependent upon current movement and strength.

g. Major Ocean Currents - General. The northwest Pacific Ocean has perhaps the most complex and variable system of ocean currents in the world. It is part of the North Pacific Subtropical Gym, a system of currents that dominate the flow in the North Pacific. At tropical latitudes, the gyre contains the North Equatorial Current, better known as the Kuroshio Current. This current moves westward from the central Pacific, curves to the northeast of the main Philippine island of Luzon, and then continues its northward flow toward the main Japanese islands. As it nears the island of Kyushu it splits into three branches, two primaries and one secondary. The larger of the two branches, known as the Kurosifio Extension flows along the eastern coast of Japan. The other enters the Sea of Japan through the Tsushima Strait, from the Tsushima Current. The secondary branch from the Yellow Sea Current and accounts for the movement of warmer water into the Yellow Sea basin.

1. Kuroshio Current/Kuroshio Extension. Analogous to the Gulf Stream in the North Atlantic, the Kuroshio Current is the northeastward flowing, warm western boundary current of the north Pacific. The name "Kuroshio" means "black stream" and refers to the dark cobalt blue color of the current waters. This color is an indication of the absence of marine life within the swiftly moving current. The primary current between 2ON and 3ON latitude, is

roughly 150 to 180 nautical miles wide; around 30N, it decreases to 80-100 nautical miles in width as it branches into the Kuroshio Extension. Speeds within the current system are seasonal and reflect the strength of the monsoonal flow. During the spring and summer, primary current speeds average approximately 1. 5 to 2.0 knots, while speeds in the Extension average 2.5 to 3.5 knots.

Lower speeds prevail in the winter; the main current moves at approximately 1.0 to 1.5 knots, while the waters of the Extension move at 2.0 to 2.5 knots. The massive volume of warm water transported by this current system into the western pacific region exerts a strong influence upon regional weather. Okinawa, for example, experiences neither extremely cold nor extremely warm temperatures as a direct result of the Kuroshio's moderating influence.

2. Tsushima Current. Branching northwestward from the Kuroshio current just south of Kyushu is the Tsushima Current. 'Ibis current enters the Sea of Japan through the Tsushima Strait dominating the entire Strait and continues its northward flow to wash the western coast of Hokkaido. Because of its origin In the Kuroshio System this current is also deep, swift and warm. It is the primary reason for the year-round ice-free characteristic of the southern Sea of Japan. Speeds of the current as it moves through the Tsushima Strait vary between 1.0 to 1.5 knots during the spring and summer to 0.5 to 1.0 knots during the winter. In the relatively open waters of the Sea of Japan, the current speeds decrease to 0.8 to 1 5 knots during and summer and 0.4 to 0.6 knots during the winter.

3. Yellow Sea Current. During the southwest monsoon season, this secondary branch of the Kurosino system forms and flows into the Yellow Sea basin. It exerts only a minimal influence on the Yellow Sea, as the water circulation within the basin is determined by tidal flow. However, the formation and presence of this current help to generate a cold counter-current that flows southward during the northwest monsoon season. This colder water is a major cause of fog formation in the Yellow Sea.

4. Liman Current. A cold, northerly current in the Western Sea of Japan, the Liman is the cold counterpart of the Kuroshio Extension. It is strongest during the winter, or northeast monsoon season, when it carries extremely cold water flowing at speeds of up to 1.0 knot. Advection fog generated by passage of warmer air over the much colder water is common in the current's area of influence. During the summer, when warmer waters dominate the Sea of Japan, current speeds drop to approximately 0.5 knots.

5. Kuroshio Countercurrent. A cold, northerly current, this countercurrent is the return-flow counterpart of the main Kuroshio Current. It is a shallow, fairly diffuse current that flow southward along the southern and eastern boundaries of the Kuroshio and extends to the south of Okinawa. It is variable in both speed and aerial extent. During the winter (Northeast monsoon), it reaches maximum length. Heating and surface mixing during the spring and summer month’s cause it to lose its identity made it extremely difficult to locate.

203. Monthlv Climatological Synopsis and Summary.

a. January. In January, the Polar Jet is divided into two distinct cores. The northernmost core extends from central China southeastward across the Shantung peninsula and over western Japan. The southernmost core extends from the Himalaya Mountains eastward over southeast China, then northeastward across Shanghai where it merges with the northern core. After merging, they pass east just south of Tokyo. Moderate Clear Air Turbulence (CAT) associated with the jet can be expected between 25, 000 and 50, 000 feet.

The mean position of the polar front lies southeastward from North Vietnam to Luzon, then northeastward over the Aleutian Islands. The southern portion of the polar front is quasi-stationary, ill defined, and relatively inactive. Occasionally a wave will form on the front in the vicinity of the Philippine Straits and deepen into a low, which will move northwestward along the front passing south of Okinawa.

The Siberian High, centered over outer Mongolia, dominates the low level circulation pattern north of the Polar Front. This produces northeasterly winds over the Ryukyu Islands, which brings good flying conditions.

Periodically, cold air outbreaks from the Siberian High push south of Okinawa. This re-establishment of the Polar Front can be analyzed on subsequent surface charts. The Polar Front is characterized by scattered rainshowers, isolated thunderstorms up to 30,000 feet, and broken mid-level clouds layered between 8,000 and 18,000 feet. Moderate rime icing, in cloud, can be expected at altitudes between 9, 000 and 20, 000 feet. Widespread broken to overcast stratocumulus, with bases at 4,000 feet and tops at 8,000 feet and gusty surface winds from the north at 30 knots or more follow these outbreaks for periods of 18-36 hours.

Typhoon season approaches a minimum with an average of one every ten years. C)f those reported, half dissipated before getting within 300 NM of Okinawa, 25% crossed over the Philippines, and 25% recovered northeastward between Okinawa and Iwo Jima.

The Freezing level averages 9000 feet and the Sea Surface Temperature average 68-70 Deg F.

JANUARY CLIMATOLOGICAL OUTLOOK

TEMPERATURE DEG. F

MEAN	60.2
MEAN MAXIMUM	64.8
MEAN MINIMUM	55.5
ABSOLUTE MAXIMUM (1969)	80
ABSOLUTE MINIMUM (1963)	42
MEAN RELATIVE HUMIDITY	73.3

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MEASURABLE)		50.9
MEAN AMOUNT OF PRECIP		4.74
MAXIMUM AMOUNT OF PRECIP		12.15
MAXIMUM AMOUNT IN 24 HOURS (1966)	4.55	
MINIMUM AMOUNT OF PRECIP		1.07

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	7.8
CONDITIONS GREATER THAN OR = TO 3000 FT & 3 MI	80.0%
CONDITIONS GREATER THAN OR = TO 1000 FT & 3 MI	98.0%
CONDITIONS GREATER TIIAN OR = TO 600 FT & 1 MI	99.0%
CONDITIONS GREATER THAN OR = TO 200 FT & 1/2 MI	95.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH:

FOG		15.4
THRUNDERSTORMS		1.0
SMOKE/HAZE		6.0
RAIN AND/OR DRIZZLE	70.1	

PRESSURE

MEAN STATION PRESSURE	29.850ins
MEAN SEA LEVEL PRESSURE	1020.5mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	NNE/7kts
NEXT FREQUENT DIRECTION WITH SPEED	N/10kts
ABSOLUTE PEAK GUST (1964)	WNW/47kts

DATA CURRENT 'THRU DEC 1993

b. February. During most of the month the jet stream is essentially in the same location as during January. The northern core flows southwestward over central China, across Cheju-Do Island and merges with the southern core over Kyushu. The southern core flows eastward from the Himalayas turning northeastward across Shanghai and merges with the northern core. The path is then similar to January's, passing east, just south of Tokyo. CAT can be expected between 25,000 and 50,000 feet.

The Polar Front remains quasi-stationary and ill-defined from North Vietnam across Luzon and northeastward into the Aleutian Islands. The occasional waves/lows that develop east of Taiwan

move northeastward along the frontal boundary. The lows are characterized by layered nimbostratus from 1,000 to 25,000 feet, with embedded rainshowers and thunderstorms with tops to 30,000 feet.

The low-level circulation is almost identical with that in January, and the Siberian High is still the dominant feature. Occasional outbreaks of cold air occur, with lows developing in the vicinity of Shanghai. These lows move eastward with the cold front, passing north of Okinawa and producing similar, but slightly better conditions as January cold frontal passages.

Typhoons are extremely rare. Records indicate an average of one every ten years, with approximately 75% recurving to the northeast and dissipating. The remainder continues towards the west, passing well south of Okinawa as they move towards the Philippine islands.

The Freezing Level averages 9000 feet and the Sea Surface Temperature averages 68-70 Deg F.

FEBRUARY CLIMATOLOGICAL OUTLOOK

TEMPERATURE DEG. F

MEAN	61.2
MEAN MAXIMUM	66.0
MEAN MINIMUM	56.4
ABSOLUTE MAXIMUM	82(1970)
ABSOLUTE MINIMUM	43(1981)
MEAN RELATIVE HUMIDITY	74.7

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MEASURABLE)	51.7
MEAN AMOUNT OF PRECIP	4.2
MAXIMUM AMOUNT OF PRECIP	10.45
MAXIMUM AMOUNT IN 24 IIOURS (1972)	3.68
MINIMUM AMOUNT OF PRECIP	1.23

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	7.7
CONDITIONS GREATER THAN OR = TO 3000 FT & 3 MI	78.0%
CONDITIONS GREATER THAN OR = TO 1000 FT & 3 MI	97.0%
CONDITIONS GREATER THAN OR = TO 600 FT & I MI	99.0%
CONDITIONS GREATER THAN OR = TO 200 FT & 1/2 MI	100%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH:

FOG	21.2
THUNDERSTORMS	1.6

SMOKE/HAZE	8.4
RAIN AND/OR DRIZZLE	66.4

PRESSURE

MEAN STATION PRESSURE	29.827ins
MEAN SEA LEVEL PRESSURE	1019.5mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	NNE/7kts
NEXT FREQUENT DIRECTION WITH SPEED	N/10kts
ABSOLUTE PEAK GUST (1969)	WNW/40kts

DATA CURRENT THRU 1993

c. March. The Polar Jet begins to migrate northward and increase in altitude. The northern core extends southeastward from central China, across Kyushu, and eastward south of Tokyo. The southern core stretches northeastward from the Himalayas to join the northern core just over Kyushu. Light to moderate CAT associated with the jet may be encountered at altitudes between 33,000 and 48,000 feet.

In March, the mean position of the Polar Front is from southern China just south of Hong Kong, eastward across the Bashi Channel south of Taiwan, and northeastward, passing south of Iwo Jima. As lows form on the front in the vicinity of Taiwan, tropical air overruns the front and produces continuous rain and thunderstorms embedded in nimbostratus layered from 1,000 to 20,000 feet over Okinawa. Light rime icing can be expected in cloud. Otherwise the Polar Front remains ill defined

The Siberian High frequently shows signs of receding slightly in March. This feature continues to control the low-level circulation north of the front with east-northeasterly winds.

This month, the frequency of typhoons starts to increase slightly, over February's seasonal minimum. An average of one typhoon every three years has been recorded. Of these, 40% moved northward out of the area, 200/o recurved between Guam and the Philippines, and the other 40% continued across Luzon, recurving across southern Taiwan and the Ryukyu Islands.

The Freezing Level averages 10000 feet and the Sea Surface Temperature average 68-70 Deg F.

MARCH CLIMATOLOGICAL OUTLOOK

TEMPERATURE DEG. F

MEAN	64.3

MEAN MAXIMUM	69.3
MEAN MINIMUM	59.4
ABSOLUTE MAXIMUM	83(1981)
ABSOLUTE MINMUM	42(1963)
MEAN RELATIVE HUMIDITY	76.4

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MEASURABLE)	52.0
MEAN AMOUNT OF PRECIP	6.16
MAXIMUM AMOUNT OF PRECIP	14.46*
MAXIMUM AMOUNT IN 24 HOURS (1981)*	4.97*
MINIMUM AMOUNT OF PRECIP	.80*

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	7.8
CONDITIONS GREATER THAN OR =TO 3000 FT & 3 MI	74.0%
CONDITIONS GREATER THAN OR =TO 1000 FT & 3 MI	95.0%
CONDITIONS GREATER THAN OR =TO 600 FT & I MI	98.0%
CONDITIONS GREATER THAN OR = TO 200 FT & 1/2 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH

FOG	29.6
THUNDERSTORMS	5.1
SMOKE/HAZE	18.7
RAIN AND/OR DRIZZLE	67.0

PRESSURE

MEAN STATION PRESSURE	29.769ins
MEAN SEA LEVEL PRESSURE	1017.6mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	N/10kts
NEXT FREQUENT DIRECTION	NNE/7kts
ABSOLUTE PEAK GUST (1986)	SW/64kts

DATA CURRENT THRU DEC 1993

d. April. The Jet Stream continues to migrate northward with average wind speeds decreasing during the month. Two cores are still apparent. The northern core reaches from North Korea to northern Honshu. The southern core stretches from near Shanghai, across Tokyo, and

merges with the northern core well east of Japan. CAT, associated with the Jet, may be encountered over Japan at altitudes of 35,000 to 40,000 feet.

During April, the mean position of the Polar Front lies from southeastern China, across central Taiwan, south of Okinawa, and northeastward towards the Aleutian Islands. Lows form along the front, in the vicinity of Taiwan, more frequently than in March. As these systems pass Okinawa, numerous rainshowers and thunderstorms can be expected. Light to moderate rime icing occurs in cloud from 14,000 to 25,000 feet.

The Siberian High continues to recede northward during April, and the Pacific High begins to build westward towards the Ryukyus. Low level circulation is still easterly, usually from the southeast.

The Inter Tropical Convergence Zone (ITCZ) begins to migrate to the north this month, although it does remain south of our area of prime concern.

In April, an average of one typhoon every two years has been recorded. Of those that formed, half came within 150 NM of Okinawa, 20% recurved after threatening the island, and 30% recurved northeastward posing no threat to Okinawa.

The Freezing level averages 12,500 feet and the Sea Surface Temperature averages 72-74 Degrees F.

APRIL CLIMATOLOGICAL OUTLOOK

TEMPERATURE DEG. F

MEAN	69.8
MEAN MAXIMUM	74.7
MEAN MINIMUM	65.0
ABSOLUTE MAXIMUM	88(1975)
ABSOLUTE MINIMUM	52(1972)
MEAN RELATIVE HUMIDITY	78.4

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MEASURABLE)	43.1
MEAN AMOUNT OF PRECIP	6.71
MAXIMUM AMOUNT OF PRECIP	18.13
MAXIMUM AMOUNT IN 24 HOURS (1975)	3.83
MINIMUM AMOUNT OF PRECIP	.83

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	7.8
CONDITIONS GREATER THAN OR = TO 3000 FT & 3 MI	71.0%
CONDITIONS GREATER THAN OR = TO 1000 FT & 3 MI	93.0%
CONDITIONS GREATER THAN OR = TO 600 FT & 1 MI	97.0%
CONDITIONS GREATER THAN OR = TO 200 FT & 1/2 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH:

FOG	32.1
THUNDERSTORMS	8.0
SMOKE/HAZE	22.5
RAIN AND/OR DRIZZLE,	56.7

PRESSURE

MEAN STATION PRESSURE	29.706ins
MEAN SEA LEVEL PRESSURE	1015.2mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	ESE/9kts
NEXT FREQUENT DIRECTION WITH SPEED	E/8kts
ABSOLUTE PEAK GUST (1984)	NW/41kts

DATA CURRENT THRU DEC 1993

e. May. During May, the Jet Stream splits into two separate distinct cores. Both migrate further north and higher in altitude than during April, with the average wind speeds decreasing. The northern core extends from Vladivostok southeast across the extreme northern portion of Honshu. The southern core extends across the southern portion of South Korea eastward over Tokyo. Moderate CAT associated with the Jet may be encountered at altitudes of 38,000 to 45,000 feet.

The Siberian High has weakened and receded out of our area of operations. A ridge from the Pacific High has moved over the Ryukyus bringing southeasterly winds at 10 to 15 knots to Okinawa, Taiwan, and Luzon.

The mean position of the *Polar* Front lies from central Taiwan, east-northeast across Okinawa, passing south of Japan into the Aleutian Islands. During this transition period, when the Polar Front is migrating northward towards it's mean summertime position, minor waves along the front frequently bring extended periods of copious precipitation. Tropical **air** over the front brings extensive low cloudiness over an area up to 500 miles north of the front. It is during this month that MCAS Futenma experiences the highest percentage of IFR conditions for the year.

The ITCZ reappears, stretching over the southern Philippines, across the South China Sea into Southeast Asia. Areas of increased convective activity may be expected with thunderstorm intensity reaching it's maximum between midnight and sunrise.

In May, an average of one typhoon has occurred every two years. Of these, half recurved in the vicinity of Luzon and pass within I 00 NM of Okinawa.

The Freezing Level averages 14,500 feet and the Sea Surface Temperature averages 76 Deg F.

MAY CLIMATOLOGICAL OUTLOOK

TEMPERAURE DEG F

MEAN	75.0
MEAN MAXIMUM	79.7
MEAN MINIMUM	70.3
ABSOLUTE MAXIMUM	90(1980)
ABSOLUTE MINIMUM	56(1981)
MEAN RELATIVE HUMIDITY	81.7

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MEASURABLE)	51.2
MEAN AMOUNT OF PRECIP	10.31
MAXIMUM AMOUNT OF PRECIP	27.19
MAXIMUM AMOUNT IN 24 HOURS (1972)	4.95
MINIMUM AMOUNT OF PRECIP	.71

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	8.2
CONDITIONS GREATER THAN OR = TO 3000 FT & 3 MI	65.0%
CONDITIONS GREATER THAN OR = TO 1000 FT &, 3 MI	89.0%
CONDITIONS GREATER TI-FAN OR = TO 600 FT &, I MI	96.0%
CONDITIONS GREATER THAN OR = TO 200 FT & 1/2 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH

FOG	31.9
THUNDERSTORMS	9.0
SMOKE/HAZE	14.8
RAIN AND/OR DRIZZLE	67.6

PRESSURE

MEAN STATION PRESSURE	29-595ins
MEAN SEA LEVEL PRESSURE	1011.4mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	ESE/9kts
NEXT FREQUENT DIRECTION WITH SPEED	E/9kts
ABSOLUTE PEAK GUST (1969)	SW/40kts

DATA CURRENT THRU DEC 1993

f. June. The Polar Jet continues to slowly drift northward. The two distinct cores are higher and have lighter winds than during May. The northern core reaches from Manchuna across North Korea, east-northeastward across northern Honshu. The southern core begins over southern China, curves eastward across South Korea, and continues east-northeastward over central Honshu. Light to moderate CAT, associated with the Jet may be encountered at altitudes of 35,000 to 45,000 feet.

Early in June, the Polar Front passes Okinawa on annual northern migration with the average position approximately halfway between Okinawa and Japan. Waves form on the front east of Shanghai and deepen into lows as they pass eastward, south of mainland Japan. Squall lines develop over the East China Sea ahead of the cold front and move rapidly across Okinawa. Heavy rainshowers with thunderstorms occur along these squall lines.

In June, the Mid-Pacific ridge line extends cast-west along the 20 degrees north parallel. A thermal low develops in the Burma area with troughs, extending northeastward into a low located over Manchuria. This pattern sets up a southerly low level wind flow across the Polar Front extensive Bai-IJ drizzle and rain to Japan.

The ITCZ becomes established along the 10 degrees north parallel causing extensive areas of towering cumulus and lines of thunderstorms developing from late afternoon throughout the hours of darkness. These thunderstorms can be severe, with tops extending above 50,000 feet.

By June, summer is in full bloom. The Pacific High transports warm, humid air into the local area from the south, making the days oppressive and bringing very little relief during the night.

The month of June is the start of "Typhoon Season". The western Pacific is well recognized for experiencing more tropical cyclones than any other area on the globe. Okinawa is the very heart of "Typhoon Alley", i.e. along the western periphery of the Pacific High. During June, an average of one typhoon develops every year. Eighteen percent of those pass within 100 NM of Okinawa.

The Freezing Level averages 15,000 feet and the Sea Surface Temperature averages 79 Deg F.

JUNE CLIMATOLOGICAL OUTLOOK

TEMPERATURE DEG F

MEAN	79.4
MEAN MAXIMUM	83.8
MEAN MINIMUM	75.0
ABSOLUTE MAXIMUM	98(1967)
ABSOLUTE MINIMUM	62(1968)
MEAN RELATTVE HUMIDITY	84.3

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MEASURABLE)	48.6
MEAN AMOUNT OF PRECIP	10.62
MAXIMUM AMOUNTT OF PRECIP	22.42
MAXIMUM AMOUNT IN 24 HOURS (1972)	7.29
MINIMUM AMOUNT OF PRECIP	.86

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVFR	8.3
CONDITIONS GREATER THAN OR=TO 3000 FT & 3 MI	62.0%
CONDITIONS GREATER THAN OR =TO 1000 FT & 3 MI	91.0%
CONDITIONS GREATER TIIAN OR=TO 600 FT & 1 MI	97.0%
CONDITIONS GREATER THAN OR=TO 200 FT'& 1/2 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH

FOG	29.0
THUNDERSTORMS	11.8
SMOKE/HAZE	12.7
RAIN AND/OR DRIZZLE	68.5

PRESSURE

MEAN STATION PRESSTJRE	29.521ins
MEAN SEA LEVEL PRESSURE	1008.7mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	SSW/10kts
NEXT FREQIJEN-JF DIRECTION WITH SPEED	S/8kts
ABSOLUTE PEAK GUST (1982)	SW/47kts

DATA CURRENT THRU 1993

g. July. The Polar Jet becomes of little significance to our operations during July. The northern core extends across the extreme northern portion of Hokkaido, and the southern core lies across North Korea and the northern most portion of Honshu.

The predominant feature in the low level circulation is the Pacific Ridge. This feature, combined with the Bay of Bengal low, sustains the southwest monsoon over southeast Asia. The Pacific Ridge is responsible for the south-southeasterly wind flow across the Ryukyu Islands. "Air mass" type thunderstorms frequently form over and around Okinawa, Taiwan, and the Philippines. These thunderstorms often develop rapidly and can produce sudden bouts of IFR conditions for short periods, of time.

The Polar Front has weakened significantly. Its mean position extends from between Cheju-Do Island and South Korea along the northern shore of Honshu. Generally, multi-layered nimbostratus is the rule north of the front.

The ITCZ continues to be well established this month, with it's mean position lying northwestward from the south of Guam, across northern Taiwan, and into southern China.

The area between Guam and Taiwan is a spawning ground for tropical cyclones. An average of 3 typhoons develop every year in July. Of these, 40 percent move northwestward to affect the Ryukyu Islands, with 16 percent passing within 100 NM of Okinawa.

The Freezing level averages 16,000 feet and the Sea Surface Temperature averages 80-85 Degrees F.

JULY CLIMATOLOGICAL OUTLOOK

TEMPERATURE DEG. F

MEAN	83.4
MEAN MAXIMUM	87.9
MEAN MINIMUM	78.8
ABSOLUTE MAXIMUM	94(1979)
ABSOLUTE MINIMUM	70(1977)
MEAN RELATIVE HUMIDITY	80.7

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MEASURABLE)	40.2
MEAN AMOUNT OF PRECIP	7.22
MAXIMUM AMOUNT OF PRECIP	21.64
MAXIMUM AMOUNT IN 24 HOURS (1964)	8.68
MINIMUM AMOUNT OF PRECIP	.59

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	7.2
CONDITIONS GREATER THAN OR = TO 3000 FT & 3 MI	75.0%
CONDITIONS GREATER THAN OR = TO 1000 FT & 3 MI	97.0%
CONDITIONS GREATER THAN OR = TO 600 FT & 1 MI	99.0%
CONDITIONS GREATER THAN OR = TO 200 FT & 1/2 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH

FOG	12.5
THUNDERSTORMS	8.4
SMOKE/HAZE	7.8
RAIN AND/OR DRIZZLE	61.2

PRESSURE

MEAN STATION PRESSURE	29.507ins
MEAN SEA LEVEL PRESSURE	1008.3mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	SE/8kts
NEXT FREQUENT DIRECTION WITH SPEED	SSE/7kts
ABSOLUTE PEAK GUST (1972)	SSW/68kts

DATA CURRENT THRU 1993

h. August. The Polar Jet cores have merged into one core of moderate intensity and has reached its northernmost seasonal limit. During this month the Jet is of little significance to flight operations in our area.

The Pacific Ridge now covers the entire Western Pacific Ocean. The ridge line generally lies east-west along the 30 degree north parallel.

Okinawa and Taiwan experience scattered "air mass" type showers in the early morning and afternoon with thunderstorms usually occurring late afternoon to early evening. Most of this month's rainfall is a result of activity associated with tropical cyclones passing near.

The ITCZ has migrated northward into the southern Ryukyu Islands. Its mean position lies from Guam to just north of Taiwan and westward into southern China. This broad band of activity usually contains numerous rainshowers from towering cumulus clouds with tops to 25,000 feet and scattered thunderstorms with tops from 35,000 to 60,000 feet. Usually, the thunderstorm activity is most severe during the hours of darkness and in areas of tropical cyclone activity.

This is the height of the typhoon season in the Far East with the intensity of individual stores building rapidly and affecting large areas. This month we can expect an average of four storms to develop. Of those, each has a 48% chance of affecting Okinawa, with 20% passing within 150 NM.

The Freezing level averages 16,000 feet and the Sea Surface Temperature averages 80-85 Deg F.

AUGUST CLIMATOLOGY OUTLOOK

TEMPERATURE DEG. F

MEAN	82.7
MEAN MAXIMUM	87.1
MEAN MINIMUM	78.4
ABSOLUTE MAXIMUM	95(1967)
ABSOLUTE MINIMUM	69(1969)
MEAN RELATIVE HUMIDITY	81.9

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MFASURABI.E)	53.5
MEAN AMOUNT OF PRECIP	9.71
MAXUMUM AMOUNT OF PRECIP	25.62
MAXIMUM AMOUNT IN 24 HOURS (1969)	13.95
MANIMUM AMOUNT OF PRECIP	2.65

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	7.4
CONDITIONS GREATER THAN OR = TO 3000 FT & 3MI	69.0%
CONDITIONS GREATER THAN OR = TO 1000 FT& 3 MI	95.0%
CONDITIONS GREATER THAN OR=TO 600 FT& I MI	99.0%
CONDITIONS GREATER THAN OR=TO 200 FT & 1/2 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH

FOG	16.3
THUNDRESTORMS	11.5
SMOKE	15.4
RAIN AND/OR DRIZZLE	64.8

PRESSURE

MEAN STATION PRESSURE	29.459ins
MEAN SEA LEVEL PRESSURE	1006.5mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED ESE/10kts

NEXT FREQUENT DIRECTION WITH SPEED E/10kts

ABSOLUTE PEAK GUST (1987) SE/98kts

DATA CURRENT THRU DEC 1993

i. September. During September, the Jet Stream begins to return southward and split into two distinct cores. The northern core stretches southeastward across Manchuria to Vladivostock and eastward across the southern tip of Hokkaido. The southern core stretches east-southeastward across the Shantung Peninsula across central South Korea, and eastward across central Honshu over Tokyo. Moderate to severe CAT associated with the Jet may be expected above 30,000 feet.

By the first of the month, the Polar Front has begun to migrate to the south. During the first ten days of the month, the front's mean position is from Shanghai eastward across Itazuke and Kushimoto and south of Tokyo. By the middle of September, the front has moved completely south of Japan to lie generally along the 30 degrees north parallel. During the last week of the month the front lies from Taiwan eastward across Miyako, and south of Okinawa. From there it extends northeastward into the Aleutian Islands.

As the Polar Front progresses to the south, we can expect low-pressure centers with accompanying waves to develop along it. These centers will travel along the front at speeds averaging 10 to 15 knots. Moderate frontal weather can be expected with squall lines developing well in advance.

The Pacific Ridge continues to recede to the east, allowing the Siberian high to push southeastward towards central China. The low-level flow will prevail from the southeast until the Polar Front passes to the south of Okinawa.

During September, the ICTZ is situated from central Burma, across Vietnam and eastward to a position just northeast of Luzon. From there it stretches southeastward, just south of Guam. Conditions throughout the lCTZ are much like those experienced in August.

September is still the height of typhoon season in the western Pacific with typhoons reaching their most severe intensity during the month. Four typhoons can be expected to during this month. One can be anticipated to pass within 100 NM of Okinawa and continue into Korea or western Japan, one should pass over a point just south of Taiwan, and two will receive well east of Okinawa and pass over, or just south of, eastern Japan.

The Freezing Level averages 15,000 feet and the Sea Surface Temperature average 82-84 Deg F.

SEPTEMBER CLIMATOLOGICAL OUTLOOK

TEMPERATURE DEG. F

MEAN	81.2
MEAN MAXIMUM	85.9
MEAN MINIMUM	76.6
ABSOLUTE MAXIMUM	98(1967)
ABSOLUTE MAXIMUM	65(1966)
MEAN RELATIVE HUMIDITY	79.6

PRECIPITATION

PERCENTAGE OF DAYS WITHPRECIP (MEASUREABLE)	48.2
MEAN AMOUNT OF PRECIP	6.62
MAXIMUM AMOUNT OF PRECIP	13.63
MAXIMUM AMOUNT IN 24 HOURS (1982)	7.94
MINIMUM AMOUNT OF PRECIP	1.72

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	6.9

CONDITIONS GREATER THAN OR=TO 3000 FT & 3 MI 76.0%

CONDITIONS GREATER THAN OR=TO 1000 FT& 3 MI	98.0%
CONDITIONS GREATER THAN OR=TO 600 FT& 1 MI	99.0%
CONDITIONS GREATER THAN OR=TO 200 FT & 1/2 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH

FOG	12.9
THUNDERSTORMS	9.7
SMOKE/HAZE	14.1
RAIN AND/OR DRIZZLE	65.5

PRESSURE

MEAN STATION PRESSURE	29.558ins
MEAN SEA LEVEL PRESSURE	1010.mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	E/8kts
NEXT FREQUENT DIRECTION WITH SPEED	ESE/8kt
ABSOLUTE PEAK GUST (1983)	SE/87kts

DATA CURRENT THRU 1993

j. October. The Jet Stream continues it's southerly trek. The northern core stretches southeastward from Mongolia across Peiping, eastward across North Korea, then northeastward across southern Hokkaido. The southern core stretches east-southeastward from central China across Kyushu, over the southern coast of Honshu, and over Tokyo. Moderate to severe CA'l' can be expected at altitudes between 35,000 and 48,000 feet.

The Pacific Ridge has moved well into the central north Pacific by October as the cold Siberian High has started to ridge eastward towards Korea and Japan. The first indications of surging appear towards the end of the month. These surges will bring outbreaks of cold Arctic air into Mongolia, where it begins to modify, and then eastward across North Korea and northern Japan. Low level winds over Taiwan, Okinawa, and southern Japan prevail from the northeast under the influence of the Siberian High.

By October, the Polar Front is south of Okinawa, with its southward progression showing a marked slowing trend. The mean position of the front during October is across Hong Kong, southern Taiwan, and northeastward, south of Okinawa and just north of Iwo Jima. Low-pressure centers continue to develop along the front, mostly to the west of Okinawa. Those developing in the vicinity of Taiwan are usually what are referred to as "Taiwan Lows". They're particularly significant in bringing poor flying weather to Okinawa. Taiwan lows will be discussed later in this chapter. Thunderstorm and rainshower activity decreases in the vicinity of Okinawa this month, while thunderstorms with tops to 35,000 feet can be expected in the vicinity of the front. Light to moderate rime icing can occur at altitudes between 15,000 and 21,000 feet.

During October the ITCZ moves south to a position near the equator, and is usually not a weather factor in the western Pacific.

With the ITCZ moving south, the frequency of tropical cyclone activity decreases in the western Pacific. However, typhoons which do develop and approach our area of operations are usually more intense than those earlier in the season. Of three typhoons expected this month, one should pass across the central or southern portion of the Philippines and move into the South China Sea. One will approach Okinawa with a 35% chance of passing within 100 NM of the island, and one will skirt Guam and recurve to the northeast well cast of Okinawa.

The Freezing Level averages 14000 feet and the Sea Surface Temperature averages 76-78 Deg F.

OCTOBER CLIMATOLIGICAL OUTLOOK

TEMPERATURE DEG. F

MEAN	76.0
MEAN MAXUMUM	71.0
MEAN MINIMUM	71.0
ABSOLUTE MAXIMUM	91(1984)
ABSOLUTE MINIMUM	58(1960)
MEAN RELATIVE HUMIDITY	75.0

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MEASUREBLE)	36.3
MEAN AMOUNT OF PRECIP	5.84
MAXIMUM AMOUNT OF PRECIP	13.28
MAXUMUM AMOUNT IN 24 IIOURS (1961)	7.69
MINIMUM AMOUNT OF PRECIP	.16

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	7.1
CONDITIONS GREATER THAN OR=TO 3,000 FT & 3MI	81.0%
CONDITIONS GREATER THAN OR=TO I,000 FT & 3 MI	97.0%
CONDITIONS GREATER THAN OR=TO 600 FT & 3 MI	99.0%
CONDITIONS GREATER THAN OR=TO 200 FT&1/2 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH

FOG	11.0
THUNDERSTORMS	5.0
SMOKE/HAZE	12.9
RAIN AND/OR DRRIZZE	61.3

PRESSURE

MEAN STATION PRESSURE	29.684ins
MEAN SEA LEVEL PRESSURE	1014.4mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	NE/7kts
NEXT FREQUENT DIRECTION WITH SPEED	NNE/8kts
ABSOLUTE PEAK GUST (1961)	N/100kts

k. November. The Polar Jet continues to slowly migrate south this month with two cores converging near Tokyo. The northern core leaves the Manchurian plateau and passes east-southeastward across North Korea to Tokyo, where it merges with the southern core, and combined moves east. The southern core stretches from the Himalayan Mountains eastward over southern China, the northeastward to merge with the northern core over Tokyo. Moderate to severe CAT associated with the Jet may be encountered at altitudes between 25,000 and 35,000 feet.

The Siberian High has become well established over Mongolia. This is the predominate feature influencing low level circulation and weather in the Far East. The low level wind flow prevails from the north over Japan and Korea, becoming northeasterly over the Ryukyu Islands and Taiwan.

During November, the mean position of the Polar Front lies from Laos, across Hainan, eastward just north of Luzon, then northeastward over Iwo Jitna and into the Aleutians. It is relatively weak and stable with little wave action. It is also usually very difficult to find its exact position accurately. Okinawa can expect two to four frontal passages this month as a result of outbreaks from the Siberian High. Moderate rainshowers and isolated thunderstorms are usually associated with these passages. Strong northerly winds for periods of 24 to 36 hours after passage can occur.

The frequency of typhoons in the western Pacific continues to decrease this month as the season nears its end. Two typhoons can be expected to influence our theater of operations in November. The few that do develop can be expected to grow rapidly into intense storms. Any particular storm that does form will have approximately a 36% chance of passing within 100 NM of Okinawa, a 43% chance of crossing the Philippines, and a 21 % chance of recurring northeastward well east of Okinawa.

The Freezing Level averages 13,000 feet and the Sea Surface Temperature average 74-76 Deg F.

NOVEMBER CLIMATALOGICAL OUTLOOK

TEMPERATURE DEG. F

MEAN	70.5
MEAN MAXUMUM	75.2
MEAN MINIMUM	65.9
ABSOLUTE MAXUMUM	88(1984)
ABSOLUTE MINIMUM	54(1988)
MEAN RELATIVE HUMIDITY	73.5

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIP (MEASURABLE)	39.5
MEAN AMOUNT OF PRECIP	4.18
MAXIMUM AMOUNT OF PRECEP	9.47
MAXIMUM AMOUNT IN 24 IIOURS (1971)	7.10
MIIMUM AMOUNT OF PRECIP	.22

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	7.4
CONDITIONS GREATER THAN OR=TO 3000 FT & 3 MI	82.0%
CONDITIONS GREATER THAN OR=TO 1000 FT & 3 MI	98.0%
CONDITIONS GREATER THAN OR=TO 600 FT & 1 MI	99.0%
CONDITIONS GREATER THAN OR=TO 200 FT & 1/2 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH

FOG	11.6
THUNDERSTORMS	.6
SMOKE/HAZE	6.3
RAIN AND/OR DRIZZLE	61.8

PRESSURE

MEAN STATION PRESSURE	29.800ins
MEAN SEA LEVEL PRESSURE	1018.5mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	NNE/8kts
NEXT FREQUENT DIRECTION WITH SPEED	NE/7kts
ABSOLUTE PEAK GUST (1971)	N/62kts

DATA CURRENT THRU 1993

1. December. The mean position of the Polar Jet reaches the limits of its annual migration south during December. The northern core parallels the southern border of Outer Mongolia, extending southeastward across the Shantung Peninsula and South Korea, then eastward across southern Japan, just south of Tokyo. The southern core extends from the Himalayan mountains east northeastward across Shanghai to merge with the northern core over western Japan. Moderate to severe CAT associated with the Jet may be encountered frequently north of the 30 degrees north parallel at altitudes above 30,000 feet.

The cold Siberian high-pressure cell continues to be a well established feature over Outer Mongolia and is the dominant influence on low level circulation in the Far East. Northerly low-level winds prevail over Korea and Japan, becoming northeasterly over Okinawa and Taiwan. Periodically, cold outbreaks from the Siberian High move southeastward across Japan bringing fight to moderate snowfall over Korea and Japan. Occasionally these outbreaks will reach as far south as Okinawa. Light to moderate clear and/or rime icing may be expected between 4,000 and 18,000 feet over mainland Japan when this happens.

The Polar Front has reached the southern limits of its seasonal migration this month. During December, the mean position extends from Burma, across Laos and North Vietnam, southeastward across northern Luzon, then northeastward towards the Aleutian Islands.

The ITCZ remains south of our area of operations and is not considered a weather factor this month.

As the typhoon season draws to a close, we can expect no more than one typhoon to develop this month. Any typhoons that do develop in December have a 17% chance of passing within 100 NM of Okinawa, a 23% chance of hitting Taiwan and a 60% chance of passing over the Philippines.

The Freezing level averages 11,000 feet and the Sea Surface Temperature average 70-72 Deg F.

DECEMBER CLIMATOLOGICAL OUTLOOK

TEMPERATURE DEG. F

MEAN	64.4
MEAN MAXIMUM	68.7
MEAN MIMIMUM	59.3
ABSOLUTE MAXINIUM	81(1978)
ABSOLUTE MINIMUM	47 (1960)
MEAN RELATIVE HUMIDITY	72.0

PRECIPITATION

PERCENTAGE OF DAYS WITH PRECIIP (MEASUABLE)	40.8
MEAN AMOUNT OF PRECUP	4.28
MAXIMUM AMOUNT OF PRECIP	9.92
MAXIMUM AMOUNT IN 24 HOURS (1971)	3.96
MINIMUM AMOUNT OF PRECIP	.21

CLOUDS AND CEILINGS

MEAN TENTHS OF SKY COVER	7.5
CONDITIONS GREATER THAN OR=TO 3000 FT & 3 MI	82.0%
CONDITIONS GREATER THAN OR=TO 1000 FT & 3 MI	98.0%
CONDITIONS GREATER THAN OR=TO 600 FT & 1 MI	99.0%
CONDITIONS GREATER THAN OR=TO 200 FT& 1 MI	>99.5%

WEATHER CONDITIONS, PERCENTAGE OF DAYS WITH

FOG	13.4
THUNDERSTORMS	.8
SMOKE/HAZE	5.0
RAIN AND/OR DRIZZLE	62.8

PRESSURE

MEAN STATION PRESSURE	29.856ins
MEAN SEA LEVEL PRESSURE	1020.5mbs

SURFACE WINDS

MOST FREQUENT DIRECTION WITH SPEED	NNE/7ts
NEXT FREQUENT DIRECTION WITH SPEED	NE/6ts
ABSOLUTE PEAK GUST (1971)	NNW/48kts

DATA CURRENT THRU 1993

204. Monsoons and the Seasons.

a. General. A significant portion of eastern Asian weather is controlled by the Asiatic monsoon. The term "monsoon" originated with the Arabic "mausim", a season, and was originally applied to the wind regimes of the Arabian Sea where winds blow for six months from the northeast (winter monsoon) and six months from the southwest (summer monsoon). Monsoon and monsoonal areas have been defined in many ways, but most have a central theme -- seasonality-- surface winds which blow persistently from one general direction during one season and just as persistently from a markedly different direction during another season.

1. In winter, the Siberian High, a large, shallow high-pressure cell, dominates eastern Russia. The cold, snow covered surface absorbs little solar radiation because of a high albedo, and subsequent cooling and light surface winds allow a massive pool of shallow but intensely cold air to develop. Surface pressures of 1050 millibars are not uncommon, and pressures of 1082 millibars were analyzed on surface charts over Siberia during 1974 and 1975 (FWC/JTWC, 1978). The high-pressure cell creates the winter monsoon, also called the

Northeast Monsoon resulting in a strong north or northeasterly flow predominating over eastern Asia and adjacent waters.

2. In summer, the warming landmass causes a large thermal low to form over Asia, creating the summer monsoon, also known as the Southwest Monsoon. It transports warm, moist air northward along the coastal area of eastern Asia. The summer monsoon of the western North Pacific is relatively weak compared to the summer monsoon of India. Gale force winds seldom occur, and then only when they are associated with strong inflow near a large tropical cyclone of with channeling (Venturi effect) through restricted waters such as the Taiwan Strait between mainland China and Taiwan. The summer monsoon of Asia is less intense than that of India due to:

(a) less intense heating at higher latitudes and periodic invasions of cool air from the north.

(b) a wider range of sea surface temperatures.

(c) clouds associated with the periodic formation of an extra-tropical or tropical cyclone reduces the incoming solar radiation that reaches the surface and eliminates the heat low.

(d) the more northerly position of the Polar Front.

3. In the mid-latitude coastal areas, the seasonal advance and retreat of the Polar Front (the boundary between continental polar (cP) and maritime tropical (mT) airmasses control the local meteorological conditions). The autumn transition from the summer to winter monsoon occurs rapidly. It involves a shift from light and variable southerly, winds to stronger, steadier northerly winds, as the mean position of the Polar Front migrates rapidly from near 4ON southward to 20-25N (Figure 2-13 and 2-14).

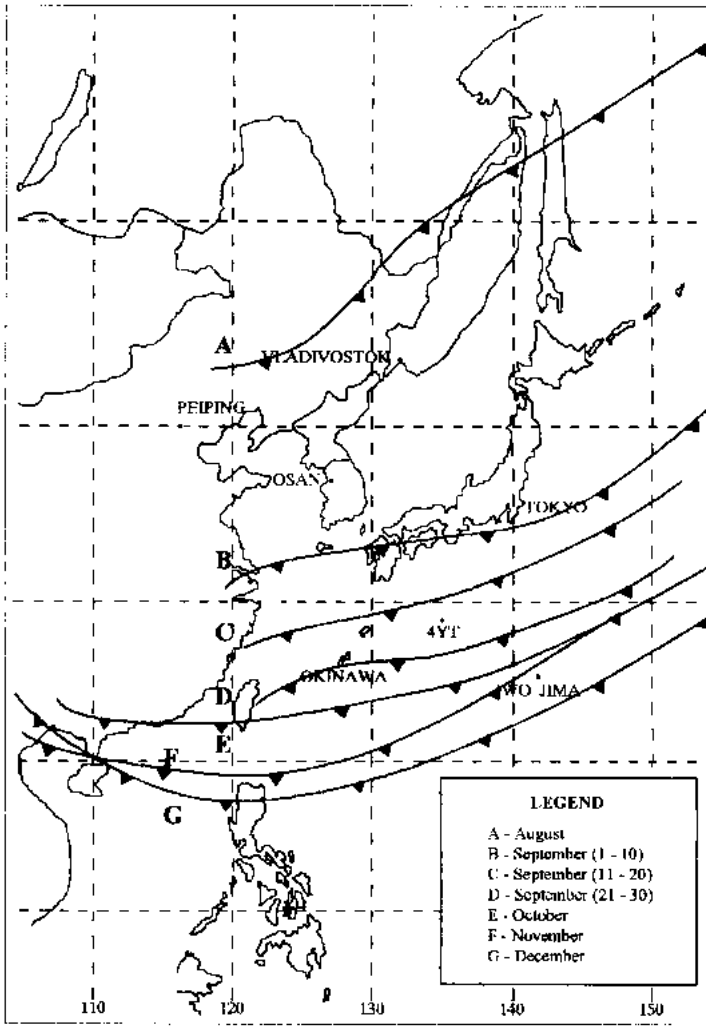


Figure 2-13. Seasonal Migration of the Primary Polar Front/Polar Trough System - Sum mid-Winter Seaward Advance.

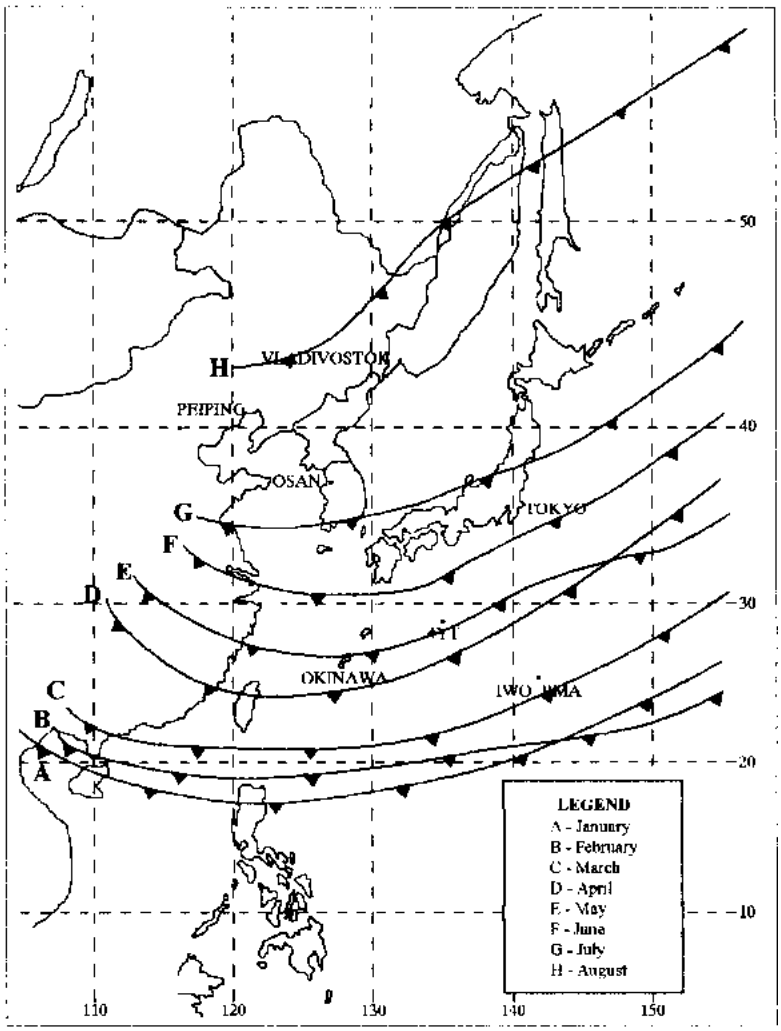


Figure 2-14. Seasonal Migration of the Primary Polar Front/Polar Trough System - Spring to Summer Landward Retreat.

The winter monsoon season dissipates as the Siberian High weakens during the spring, resulting in a northward migration of the Polar Font to its summer position and the establishment of the summer monsoon over the coastal waters of eastern Asia. This spring transition usually results in many vacillations between northeast and southwest flow in the mid-latitudes before, the thermal low becomes established over central Asia.

b. Seasons. The transitions from one monsoon regime to the other occur during the traditional late spring, summer, and early autumn months and, in some areas, cause such pronounced changes in the climate that the transition periods are treated as separate seasons. For example, the southern half of Japan experiences six distinct seasons plus a typhoon season that overlaps three of the other seasons. These seven seasons are:

1. Winter ……December to mid-March
2. Spring ……mid March to mid-June
3 Bai-U (wet season) also called Mei-Yu
Plum Rain in China……mid-June to mid-July
4. Summer ……mid-July to mid-September
5. Typhoon…… July, August, September
6. Autumn Bai-IJ (Shurin) ……mid-September to mid-October
7. Autumn ……mid-October through November

Korea, however, a country close to southern Japan, has four "traditional" seasons, but experiences a shortened autumn season and a longer winter season.

1. Winter.....November through February
2. Spring.....March through May
3. Summer.....June through August
4. Autumn.....September and October

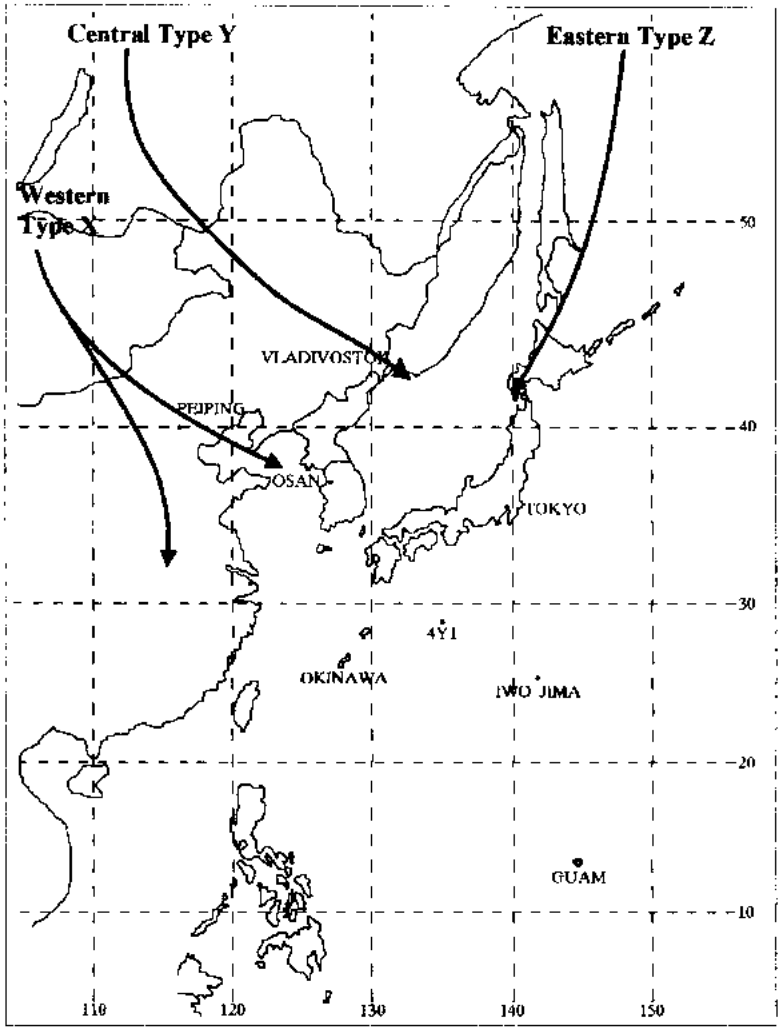


Figure 2-15. Tracks of Cold Fronts over Asia as categorized by Sjan-Zsi Li, adapted from Fleet Weather Central, Guam (1969).

205. Frontal Systems.

a. Cold Fronts

1. General. The majority of cold fronts approaching the eastern coast of Asia are the result of old, occluded fronts coming from Europe. Circumventing the Tibetan Plateau, they follow **a** southeastward and eastward track toward Korea and Japan, causing invasions of intensely cold air. The flow pattern at 500 through 200 millibars influences the direction the cold air will follow, and the availability of moisture determines weather in terms of precipitation and

clouds. It is theorized that in the Far East there are basically three types of cold fronts with respect to origin and movement (Figure 2-15). It also found that anticyclones will follow the same trajectories as the cold fronts. The vertical extent of cold fronts is not believed to extend much above 6,500 feet (1,981 meters). However, A. Lee in his study, The Cold Waves of China, found that they may reach 10,000 feet (3,048 meters) during a severe, cold outbreak.

2. Classifications.

(a) Western Cold Front - Type X. Western cold fronts occur most frequently of the three types hypothesized, originating on the shores of the Arctic Ocean in western Russia between 30E and 90E. They occur throughout the year and usually follow one of two trajectories. After leaving their source region most Western fronts travel into north China, reaching the coast about 40N. The other, less frequent trajectory has the cold front moving southward as far as Indo-China. Western fronts are quite shallow and only in intermediate latitudes do **they** cause severe drops in temperature. Frontal precipitation is associated with them. Cyclogenesis along these fronts over the Shandong Peninsula in the western Yellow Sea will also cause widespread frontal weather. Western cold fronts are produced by relatively strong meridional flow at 500 millibars with a long wave trough position over Korea.

(b) Central Cold Front - Type Y. Eastern cold fronts occur frequently and are especially severe in northern and central China, Manchuria Mongolia, Korea, and Japan. Originating in eastern Siberia between I OOF, and 140F, at 55N to 70N, they have more vertical extent than the Western type, and are associated with very dry and cold air, resulting in pronounced drops in temperature. Central fronts are most often observed during mid-Winter and are produced by strong meridional flow, or a block north of Mongolia and a long wave trough over Japan.

(c) Eastern Cold Front - Type Z. Eastern cold fronts are formed from 140E eastward between 55N and 7ON and travel toward the south-southwest along the east coast of Siberia and into Korea. They do not occur as frequently as Western and Central cold fronts are primarily spring and summer phenomena, with a secondary frequency maximum in November.

b. Mei-Yu/Bai-IJ Spring Front of the Far East.

1. General. The spring rainy season is a unique climatological feature. The circulation feature is known as the Mei-Yu front (plum rain) over China and Taiwan and as the Bai-U front in Japan. The front has a near stationary nature and occurs during the transition period between the Northeast Monsoon in winter and the Southwest Monsoon the summer. The front initially develops in mid to late May over southern China and Taiwan in response to the westward extension of the subtropical Pacific High (Mid Pacific High). The duration of the rainy season is about one month over the southern areas and increases to about two months over central China and southern Japan. The nature of the precipitation is continuous or intermittent light rain mixed with frequent heavier rainshowers or thunderstorms. The entire cloud-band and rainy area moves slowly northward throughout June and July and may influence areas of northern China and Japan

well into August. However, the front tends to move back and forth, thus creating a difficult short-term forecasting problem.

2. Characteristics. The Mei-Yu/Bai-U Front is a subtropical front and therefore has different characteristics than a Polar Front. A narrow steady precipitation zone, strong gradient of equivalent potential temperature, thick moist neutral layer, and a steady generation of convective instability characterize the Mei-YwBai-IJ front. However, model studies (Kuo and Anthes, 1982) as well as empirical studies by various far-east investigators indicate that the eastern section of the front (east of about 13 5E) is similar to a mid-latitude cold front while the western section (west of about 130E) resembles a semi-tropical system. The Mei-Yu/Bai-LT Front is a relatively shallow feature and develops in the lower troposphere, unlike the mid-latitude front which typically has a supporting trough that extends to the upper troposphere.

3. Structure. The Mei-Yu/Bai-U Front is marked by a significant low level jet (I,I,J) which exhibits ageostrophic flow near the surface to the 600 millibar layer. The winds are generally 20% to 50% stronger than the indicated geostrophic winds. The LLJ maximums are located near the 700 millibar level and are typically found about 1 80 nautical miles southeast of the areas of most active convection.

4. Circulation. The circulation pattern of the frontal structure is composed of weak mesoscale cyclones with embedded clusters of convective cells. In the vicinity of Taiwan, the mesoscale disturbances have a periodicity on the order of 17 to 20 hours, a wavelength of about 180 nautical miles, and a phase speed of 10 knots. The embedded convective clusters have periods of about 3 to 7 hours, wavelengths of 35 to I 00 nautical miles, and speeds of 12 to 15 knots. In the vicinity of southern Japan, the wavelengths of the mesoscale features are on the order of 600 nautical miles or less, while the phase speeds increase to 30 to 40 knots. The periodicity of the mesoscale remains near 20 hours, while the mesoscale disturbances are characterized by cyclonic circulation that show little tendency to deepen as they move eastward. Deepening is likely to occur if the Mei-Yu/Bai--U front is interacting with a mid latitude upper level trough east of about 135E.

5. The Mei-Yu/Bai-U cloud band has different characteristics in its northern and southern portions. In the northern portion, low and/or middle clouds generally prevail while in the southern portion well organized cumulonimbus clusters are found, especially to the west of 130E. The northern portion of the frontal zone is marked by a dry, area with light winds in the mid troposphere (500 mb) and above.

206. <u>Cyclones and Anticyclones</u>.

a. Cyclones.

1. General. Seasonal meteorological conditions affect the likelihood of cyclogenesis and cyclone trajectory cycles. Most discussions of migratory lows in the Far East identify six basic types, based on the location of their formation and/or track. Figure 2-16 depicts the tracks

of these systems designated as Types A thru F. Of the six types of cyclones, the "southern lows" (Types D thru F) generally are the three greatest weather producers that affect this station. They are the Shanghai Low (Type D), the Yellow Sea Low (Type E), and the Taiwan Low (Type F). The Forecaster however, should become proficient in the meteorological parameters associated with the "northern lows" (Types A thru C) due to the many flights that originate from this station and terminate or route through the areas affected by these systems. Tropical Cyclones will be discussed in a later section of this handbook.

2. The "northern lows" (Types A, B, and C) generally form in northern China or southern Russia and move from their source region into the Sea of Okhotsk or into the northern Pacific. They are all formed by movement of short-wave troughs through the low pressure source region, and all are enhanced by downslope adiabatic warming as the systems traverse from their mountainous source regions to the Sea of Japan. Northern lows include:

(a) Type A - Manchurian Low. Maximum occurrence is during the autumn and spring, The system generally tracks over Sakhalin Island and into the Sea of Okhotsk.

(b) Type B - Lake Baikal Low. Maximum occurrence is during spring, but may occur throughout the year. The track is somewhat south of the Manchurian Low, moving instead over the Sea of Japan and northern Japan. Average speed of movement is 22 knots.

(c) Type C - South Mongolia Low. South Mongolia lows can occur during any season. The track is more southerly than the two previously discussed, and may generate a Yellow Sea Low (Type E) as it passes through that re,-Ion. Its trajectory is normally over the Yellow Sea, Korea, the Sea of Japan, northern Japan, and into the southern Sea of Okhotsk with a mean speed of about 20 knots.

3. The "southern lows" (Types D, E, and F) generally form over central and southern China, then track over the Yellow Sea, Sea of Japan, and northern Japan, or track over the East China Sea and remain south of Japan. They occur year-round and produce widespread precipitation, low ceilings, poor visibility and occasional thunderstorms or high winds. There are three major systems in the southern group.

(a) Type D - Shanghai Low. So named for its source region, this type forms near the port city of Shanghai on the south coast of China, also called Hwang Ho Low. This system occurs most frequently during spring when a shallow Siberian High is centered over southern Siberia and Mongolia and a surface trough with little or no history takes on an identity

of the Kuroshio Current, but may take two to three days to initially develop. Moving from its source region, it tracks east to northeast at a mean speed of about 20 knots, and then eastward between the Japanese islands of Kyushu and Okinawa. These systems can accelerate to 40 knots, once past 130E. A deepening of the China thermal low also generates these lows. If the thermal low is deepened b), a short-wave trough moving north of the Himalaya Mountains, a central pressure of less than 1012 millibars will generate a Shanghai Low. If the low is deepened by

short-wave trough from the south of the Himalayas, a central pressure of less than 1000 millibars will generate a Shanghai Low. An empirical rule states that when a low is generated over China and passes .1 20 degrees east and south of 30 degrees north, it will be a Shanghai Low, and should pass south of the Japanese island of Honshu.

(b) Type E - Yellow Sea Low. Sometimes referred to as a Central Basin Low. Primarily a summer and autumn phenomena. These lows develop near the Yellow Sea in the area between Shanghai and Osan, getting their strength from the polar front or trough, they track through Korea, over the Sea of Japan, and through northern Japan. Commonly associated with these lows is the formation of a secondary low system, leading to a "double eye low" or "split low". This secondary development forms south of Kyushu or Shikoku roughly twelve to eighteen hours after the primary low center enters the Yellow Sea. It is this secondary low which influences Okinawan weather, bringing widespread unfavorable condition. Speed of movement of the primary system is erratic being completed dependent on upper level features. It is very similar to the Shanghai low; a basic distinction between the two is that when the low center passes 120E, longitude, if it tracks north of 30N, it Will be a Yellow Sea Low; if it tracks south, it will be a Shanghai low.

(c) Type F - Taiwan Low. During the period of December to May, an average of seven cyclones develop in the southern part of the East China Sea. Most of these develop during January to March. These cyclones develop rapidly in comparison to the Type D or Type E cyclones that form in China and move eastward across the northern part of the East China Sea. "Taiwan Lows", with their associated low ceilings, poor visibility, and continuous precipitation move rapidly northeastward and cause a considerable amount of IFR and below minimum flying weather at terminals on Okinawa. Taiwan lows move at an average speed of 25 knots, and cause precipitation over Okinawa 3 to 6 hours after cyclogenesis. Several conditions have been documented as favorable for the generation of these systems:

(1) 'I'hese lows develop when the Polar Front lies south of Okinawa, and a moderate upper level trough is moving eastward across Asia. A good indicator for development is when the northeast monsoon becomes weak and the upper level trough is located over northeast China or western Manchuria, causing warm and moist southwesterly now aloft over Taiwan. Local forecasters should be most watchful when the gradient winds veer south to east. Once the winds veer, cloudiness normally, increases and gives the appearance of an approaching warm front. Divergence and a weak temperature gradient are characteristic at the 500mb level over the area of cyclogenesis. Once formed, the waves should be moved with the speed of the 850mb flow over the wave center.

(2) Double Eye Type. This situation occurs during the late winter and when the surface ridge extends southeastward from the Siberian High over Japan andthe northwest Pacific. The principal feature is a low or wave forming on the Polar Front over the East China Sea and moving northeastward towards Japan. As it approaches the southern coast of Japan, a dynamical induced low forms over the Sea of Japan on the northern side of the mountain barrier. The original low maintains itself as the primary center while the induced low over the Sea of

Japan fills after passing northern Japan. A Taiwan Low study by Detachment 1, lst Weather Wing, shows poor flying weather associated with these double-eye lows. This weather usually affects all of Okinawa, Japan, Korea, and their surrounding ocean areas. The weather shield associated with a double-eye low, covers much more of an area than the single eye type, although the weather on Okinawa will usually break by the time the original low comes abeam of Kyushu.

(3) A migratory high-pressure system moves east from mainland China over Japan behind the polar front. As the front stagnates south of Japan, a wave forms on the front-behind the receding high.

(4) A ridge of high-pressure ex-tending southeastward from Siberia into Japan has formed. Behind this overextended ridge, a break forms near Taiwan. As a result, cylogenesis occurs and the new storm system moves northeast. This low does not necessarily form on the polar front and does not normally generate a family of waves since the over extended ridge is usually broken by the initial cyclonic formation, allowing the strong upper ridge to reestablish itself.

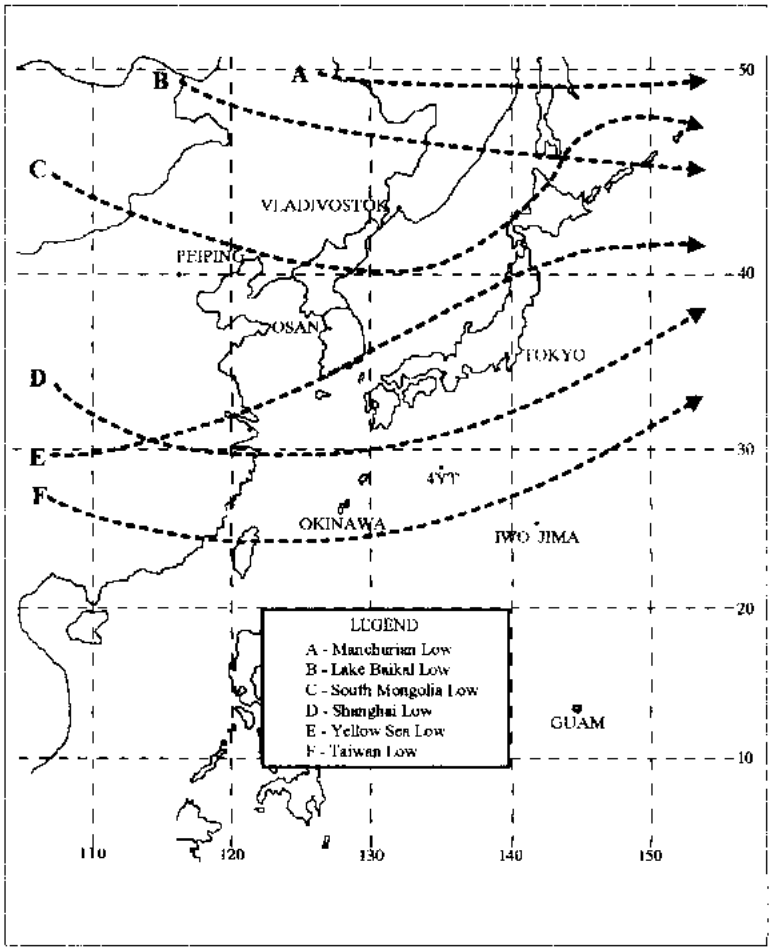


Figure 2-16. Migratory Cyclone Tracks

b. Anticyclones.

1. General.

(a) The two classes of anticyclones discussed in this section are the Siberian High, and the subtropical high which 'LS also referred to as the "Mid Pacific High". The Siberian High can be broken down into five sub-types (Types A thru E) categorized as migratory. Type F is a maritime polar (mP) airmass as its source region is in the northern Sea of Okhotsk. The Mid Pacific High can only be viewed as migratory in nature with respect to the seasonal north-south movement of the highs center.

(b) The spinning area for migratory high pressure centers affecting the Far

East are located over central Siberia near the Lake Baikal region. These migratory highs generally follow a definite pattern or track according to the season of the year. Figure 2-17 depicts the mean tracks of the high-pressure cells moving from their source regions. Most highs, in all seasons, follow a general southeastward, eastward then northeastward track across the islands of Japan. Migrating highs can be classified with regard to the area in which they form and the tracks that they follow after learn their source region.

2. Classifications - Migratory Anticyclones.

(a) Type A - West Lake Baikal Too. This high forms west of Lake Baikal and is a semi-permanent feature. The West Lake Baikal High has the highest central pressure of any high-pressure cell in the northern hemisphere with pressures as high as 1088 millibars bringing very cold Pointers. Surges of cold air move southeastward to the Shanghai area then eastward across southern Japan, bringing unusually cold periods to these regions. This high is most prevalent during the winter and early spring.

(b) Type B - East Lake Baikal High. Originating east of Lake Baikal, this high will move southeastward over northern Korea and then eastward over northern Honshu and Hokkaido. The East Lake Biikal High occurs primarily in the summer and autumn.

(c) Type C - Lake Baikal South Track. Forms over the Lake Baikal Region and moves south and then south-southwestward into Southeast Asia.

(d) Type D - Northeast Lake Baikal High - This high will move directly southeastward into the Hokkaido region and can be expected to occur at any time during the year. Its presence normally indicates a blocking situation in the northern tracks.

(e) Type E - East Siberian High. Forms in eastern Siberia and moves eastward into the Sea of Okhotsk and can occur year round.

(f) Type F - Sea of Okhotsk High. This, high forms in the northern Sea of Okhotsk and moves south-southwest into Sakhalin and Hokkaido and is common only during the summer months.

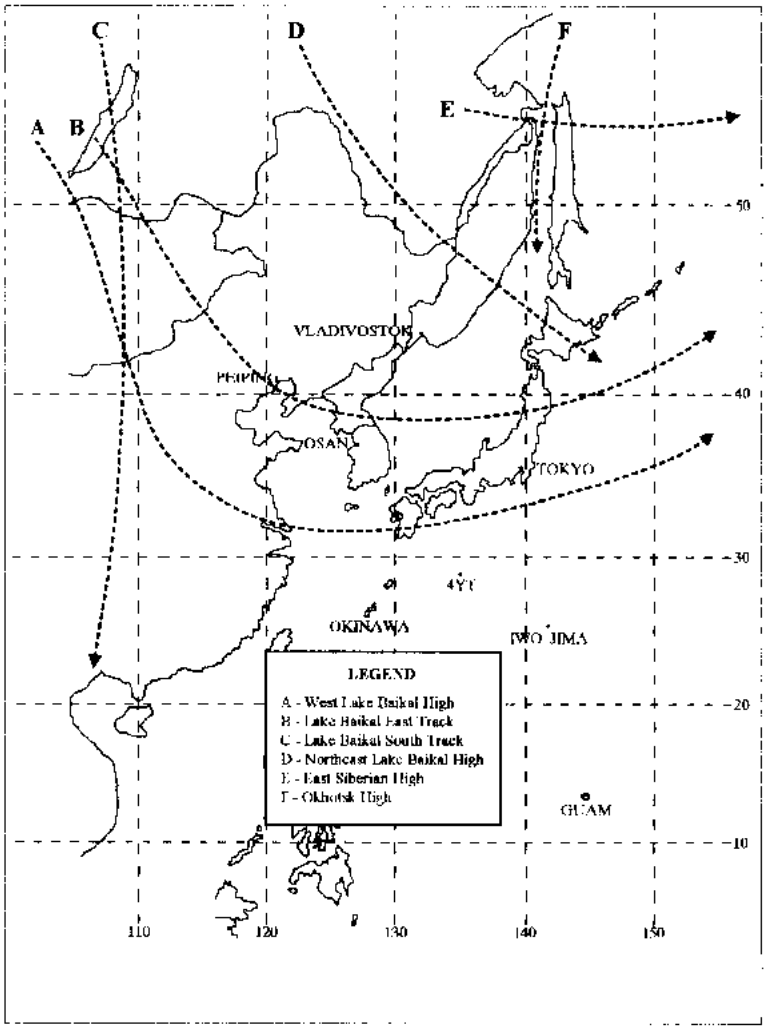


Figure 2-17. Migratory Anticyclone Tracks.

3. The Siberian High - is a continental polar- (cP) airmass originating over Siberia. At its source, cP air is usually characterized by a strong, low-level temperature inversion with temperatures ranging from 15 to -40 degrees Fahrenheit at the surface. As migratory mid tropospheric disturbances cause high pressure cells be break off, this, air is adiabatically warmed as much as 25 degrees Fahrenheit in its primarily southeastward downslope trajectory toward the coastal waters. It continues to warm and take on moisture in the lower layers as ii tracks over water. The effects of the warm Kuroshio and Tsushima currents further intensities the warming and contributes to the saturation of the airmass. Okinawan forecasters are interested mainly in those anticyclones that move eastward across the Yellow Sea-/Fast China Sea, and are or through the Sea of Japan into the Japanese mainland. If the axis of the high pressure cell is located south

of 35N, then weather conditions throughout the Ryukyu Islands are generally good with only scattered cumulus activity. If the track is north of 35N, unfavorable weather conditions occur because of the return circulation on the southwest side of the high. This results in overcast skies and rainshowers throughout the Ryukyu Islands, while aviation weather conditions in mainland Japan remain excellent.

(a) Siberian High - winter (mid-December to mid-March). At the surface, Eastern Asia is under the influence of the Siberian High pressure cell which resident in the Lake Baikal region of Russia. This high-pressure cell is at its maximum intensity in January and February. The Siberian High fluctuates in position and intensity in response to migratory mid-troposphic disturbances and sends cold surges eastward from the Asian mainland.

(b) Siberian High - spring (mid-March to mid-June). The Siberian High weakens considerably and gradually shifts from the lake Baikal position to near 45-N and 95E during spring. As the high weakens, occasional "bubble highs" break off from the main high-pressure cell and moves eastward across the Sea of Japan. As the small high moves rapidly eastward it is usually followed by cyclogenesis and bad weather in the coastal Asian waters.

(c) Siberian High - summer (mid-June to mid-September). The Siberian High is weak, and usually fractured into small high-pressure cells. Usually, only a reflection of the Siberian High is seen as a ridge through western Mongolia and the Lake Baikal region.

(d) Siberian High - autumn (mid-September to mid-December). As the Siberian High pressure cell becomes the dominant weather feature over Asia. Cool, dry air invades the offshore waters as northerly flow predominates at the surface. The ridge axis shifts to the southeast through western Mongolia and extending into southern Japan reaching as far south a-, Taiwan. High-pressure cells routinely break off from the Siberian High and move across the Sea of Japan and not-them Honshu.

4. The Mid Pacific High is a maritime tropical (mT) airmass originating in the warm southern portions of the Pacific. This warm damp air reaches Okinawa from a variety of directions ranging from the southeast through southwest. Air flowing clockwise around the southern portion of the high generally turns north between Guam and the Philippines, bringing warm moist air towards Okinawa. This air is markedly unstable due to the warmer surface temperatures over which it has traveled and to the lesser effects of subsidence on the western side of high-pressure areas. This airmass is convectively unstable and produces numerous showers and thunderstorm and is conducive to the development and maintenance of tropical cyclones.

(a) Mid Pacific High - winter (mid-December to mid-March). The Mid Pacific High is at its weakest and has receded southeastward. The westward extension of this oceanic high has also weakened and shifted southeastward.

(b) Mid Pacific High - spring (mid-March to mid-June). The Mid Pacific High stalls to build northward influencing the southwestern coast of mainland Japan and the

Ryukyu island chain. With the polar front transitioning over Okinawa the warm moist air being transported northward by the Mid Pacific High caused warm frontal-type over running and usually results in extensive precipitation over Okinawa and southern Honshu.

(c) Mid Pacific High - summer (mid-June to mid-September). The Mid Pacific High is at its um intensity. At the beginning of the traditional summer season the Mid Pacific High has pushed the polar front north of Okinawa to an east-west orientation along southern Honshu. As the warm moist air continues to over run the polar front, extensive periods of precipitation for most of mainland Japan. This condition usually persists until mid-July when the polar front shifts, northward and establishes its summer position northwest of the Sea of Japan.

(d) Mid Pacific High - autumn (Mid-September to mid-December). The transition from summer season to autumn occurs rapidly. The polar front moves rapidly from a position north of Korea to a position south of Japan is the Mid Pacific High significantly weakens and retreats to the southeast. Once again the warm tropical air over running the colder polar air brings rain and cloud weather to Okinawa and the southern half of Honshu. The duration of inclement weather is shorter during the autumn due to the rapid southward movement of the polar front and a decrease of tropical air being transported northward by the Mid Pacific High.

207. Tropical Cyclones.

a. Genesis

1. Tropical Type. According to Gray (1970), the vast majority of tropical cyclones that occur in the Western North Pacific during the summer half of the year begin intensifying two to four degrees of latitude on the poleward side of the doldrum equatorial trough (or inter-tropical convergence zone) in the maximum cyclonic shear zone. This tropical type forms within a deep tropospheric easterly current where vertical wind shear from the surface to 200 millibar flow above a genesis point is typically from the east. Figure 2-22 is a schematic, vertical distribution of the zonal wind flow to the north, to the south, and at the center of the tropical type disturbance. Intensifying disturbances will also initially show upper tropospheric warming of one to three degrees celsius between 500 and 300 millibars.

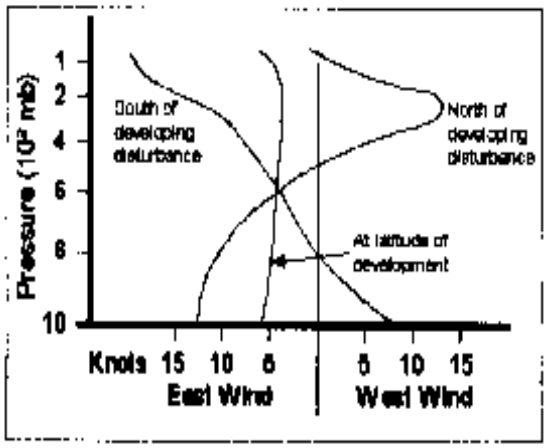


Figure 2-22. Vertical Distribution of the Zonal Winds.

2. Subtropical Type. The "subtropical" dissturbance accounts for only 18 percent of the yearly total. Formation occurs well within the trade winds, only during the late summer and early autumn and is not associated with the equatorial trough. This type development occurs in a climatological environment normally considered unfavorable for genesis (i.e., Deep Easterlies). It is typical associated with a sharp upper troposheric trough or shear line located two to three degrees to the west of the disturbance center. The characteristic wind flow associated with the type of development is depicted in figure 2-23.

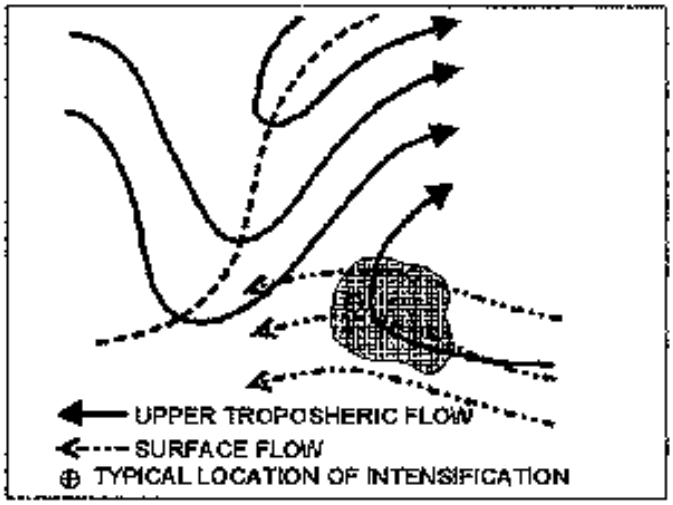


Figure 2-23. Synoptic Wind Flow Pattern for Subtropical Type.

3. Genesis - There is a hybrid type of warm core system that accounts for only one percent of the tropical cyclone cases. It usually occurs between 25N and 35N developing along stagnant frontal zones. Like other tropical cyclones. Its strongest winds are often in the lowest levels; but its other flow features differ from the other types. This hybrid type does not generally have intense cumulus convective cores. The maximum winds are located at large distances from the centers and are often less than 46 knots. These storms tend to occur both at the beginning and end of summer.

a. Tropical Cyclone Transformation. A tropical cyclone is identified as becoming "extra-tropical" when it loses its tropical characteristics. The term implies both northward displacement from the tropics and the conversion of the cyclone's primary energy source from latent-heat release to baroclinic processes; it does not carry and implication regarding the storm's strength or size. There are three cases of the extra tropical evolution:

1. Complex- The tropical cyclone merges with a front. A new extra-tropical Cyclone is embedded on the front and becomes the dominant system. The complex transition may or may not be favorable for extra tropical cyclogenesis.

2. Compound- A tropical cyclone merges with an extra-tropical cyclone. The compound transition generally has favorable tropospheric support for extra tropical cyclone. The resulting extra-tropical cyclone often undergoes further deepening, which is probably a response to the increased baroclinicity afforded by the convective latent heat associated with the tropical cyclone.

3. Dissipation - the tropical cyclone decays and dissipates over water without becoming extra-tropical.

4. The Following are characteristics of tropical cyclones as they are evolving into extra-tropical cyclones:

(a) Winds observed are in excess of the values that central pressures would indicate. The maximum wind area does not always relate to direction of storm movement.

(b) There is a loss of cloud organization. The central area of the storm fills with clouds, with tops 6,000 - 12,000 feet. Clouds below 700 millibars become stratiform. Remnants of the wall cloud observed by radar appear to rotate rapidly and, at times, the wall cloud completely disappears.

(c) There is a lack of torrential precipitation and, many times, there is no precipitation.

(d) Light to moderate clear air turbulence (CAT) occur,-, over a broad area surrounding the storm.

c. Tropical Cyclone Guide lines - General. The following guide lines are applicable to all seasons in the Far East since tropical cyclone activity has been observed in an months of the year.

1. No storm will recurve until it reaches a region where south or southwest winds prevail aloft. The steering level may range from 500 to 200 millibars depending on the strength of the storm. The steering level may be found by streamline analysis of various level.

2. Tropical cyclones approaching Japan on a northerly heading will form a secondary low in the Sea of Japan

3. In situations where a tropical cyclone moves west from its breeding ground south of Guam, a high cell over the Bonin Islands is not likely to weaken.. As a result, fair weather persists within the area of influence of the Bonin high.

4. Typhoons are more prevalent during June through October, as the subtropical ridge builds up to 23N-27N. The area near Guam is a natural breeding ground for these storms.

5. As the typhoon approaches, light to moderate showers are the rule. Towering cumulus and isolated cumulonimbus clouds with their associated cirrostratus shields are common. Nearer the center, the weather changes to moderate to heavy intermittent rain and showers. Ceilings of 200 feet and visibility's of 111"2 to 5 miles are common. Near the eye, rain and blowing spray are mixed by winds so that complete obstruction is common. Visibility is usually around 5 miles when 30 knots of wind are experienced, 1 mile or less in heavy showers, and obscured when finds exceed 65 knots.

d. Tropical Cyclone Tracks. While it must be realized that tropical storms and tropical cyclones deviate from the mean tracks presented in figures 2-24 through 2-28. These tracks should be a great benefit in long range forecasting. The application of the average tracks to specific short-range situations should be avoided. Warnings issued by FWC/JTWC Guam are the immediate source of information on predicted movement.

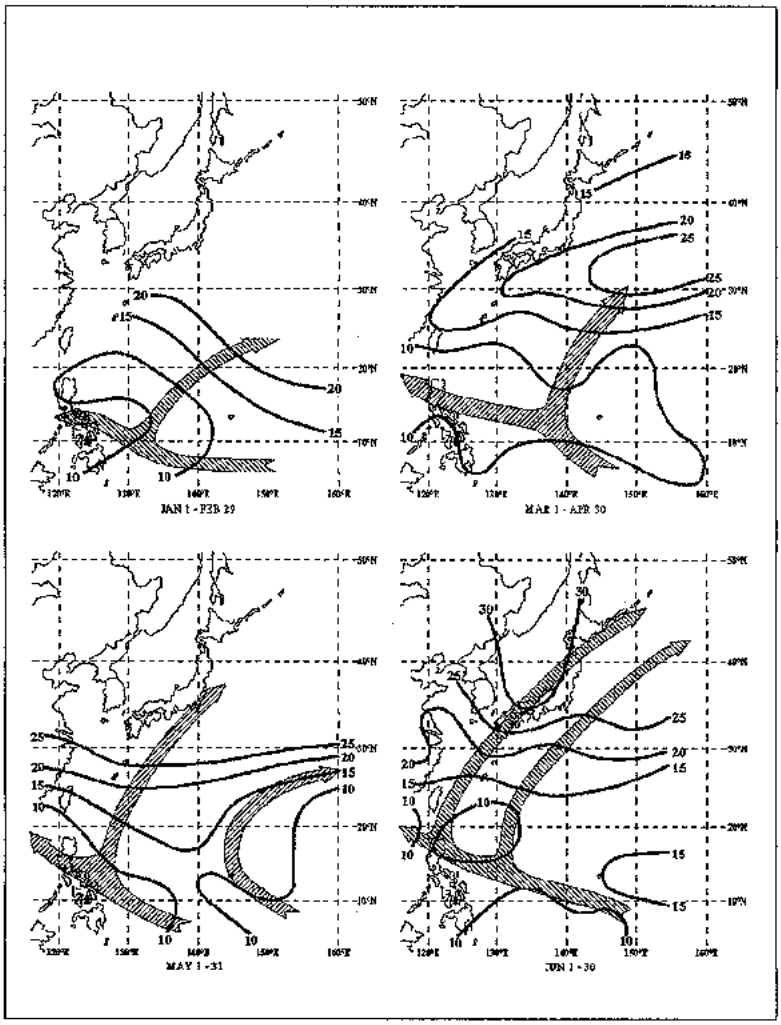


Figure 2-24. Preferred Western North Pacific Tropical Storm and Typhoon Tracks - January through June. Isolines show the average storm speed of movement in knots.

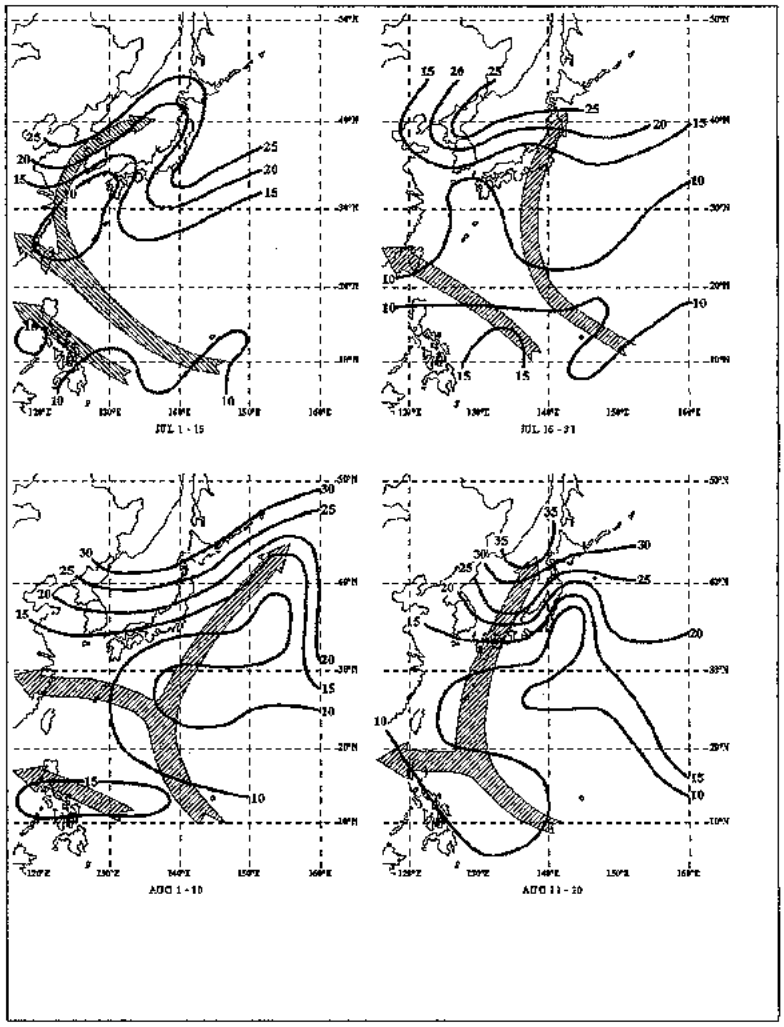


Figure 2-25. Preferred Western North Pacific Tropical Storm and Typhoon Tracks - July through 20 August. Isolines show the average storm speed of movement in knots.

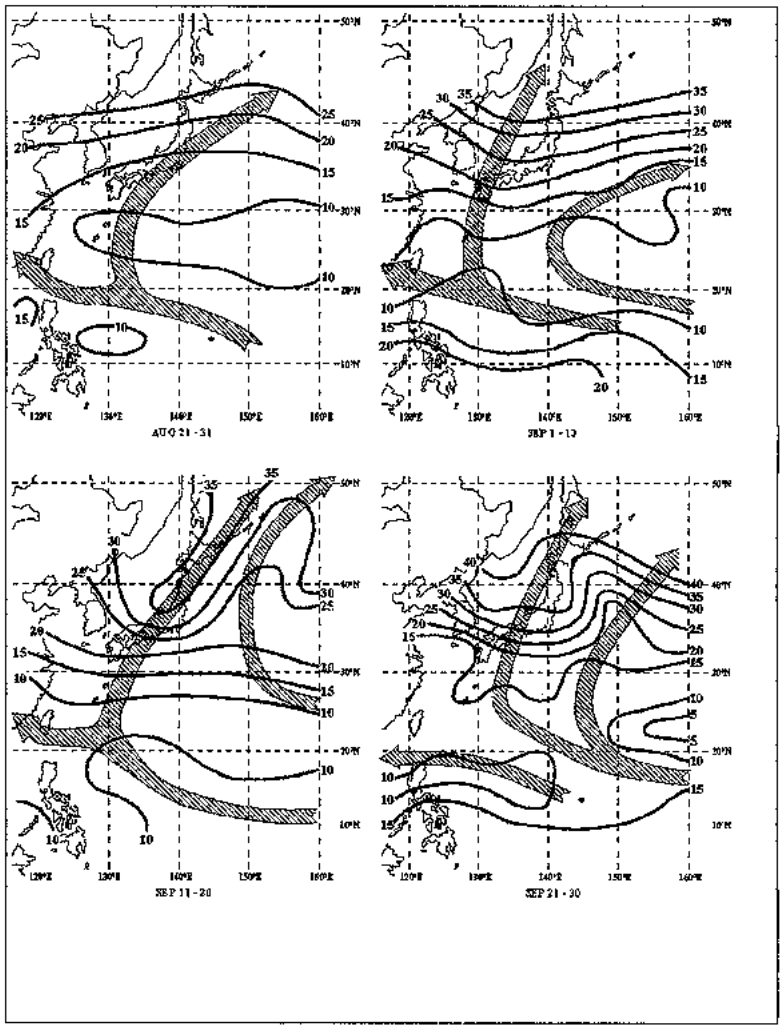


Figure 2-26. Preferred Western North Pacific Tropical Storm and Typhoon Tracks - 21 August through September. Isolines show the average storm speed of movement in knots.

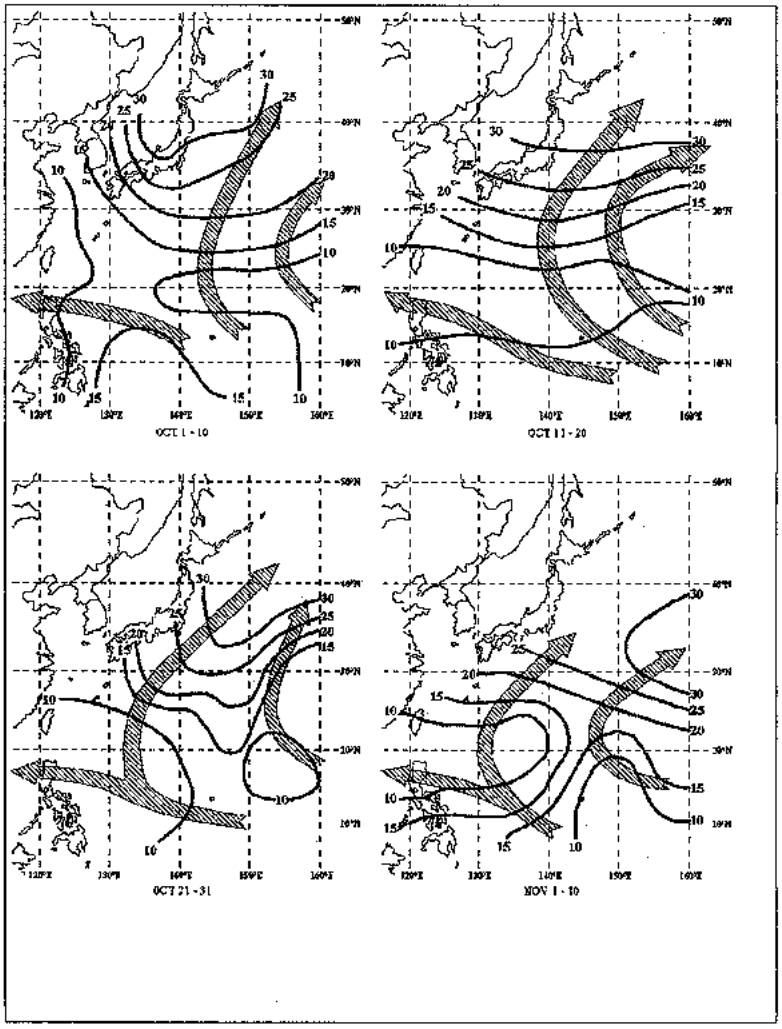


Figure 2-27. Preferred Western North Pacific Tropical Storm and Typhoon Tracks - October through 10 November. Isolines show the average storm speed of movement in knots.

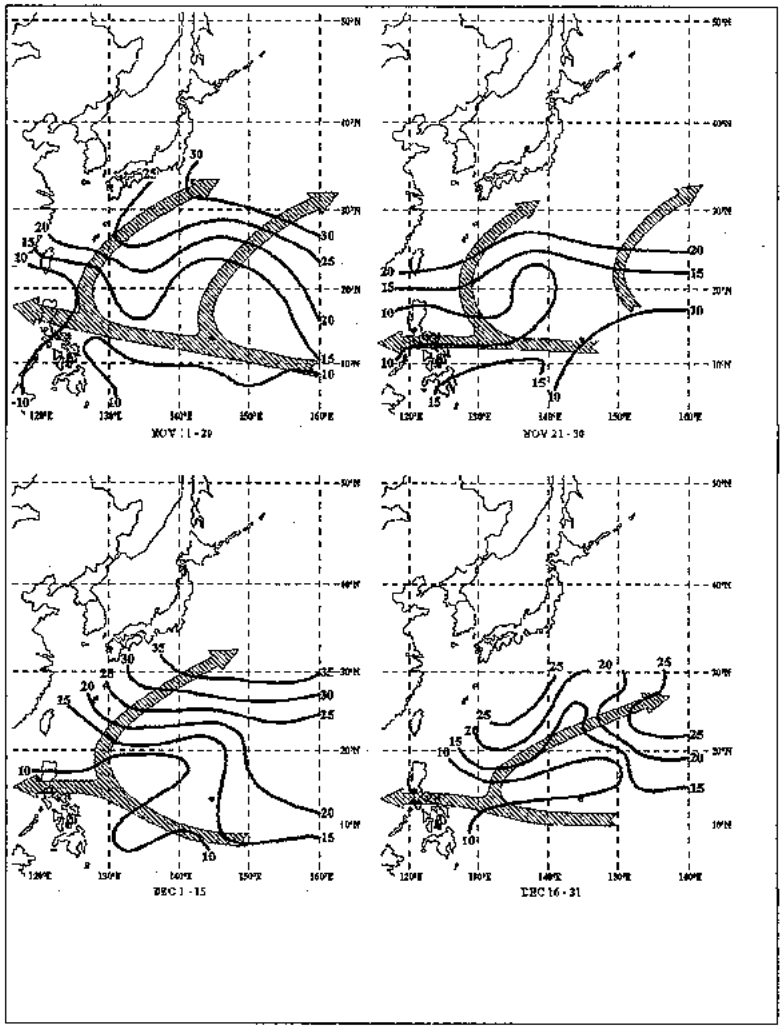


Figure 2-28. Preferred Western North Pacific Tropical Storm and Typhoon Tracks - 11 November through December. Isolines show the average storm speed of movement in knots.

CHAPTER THREE

FORECASTING

30 1. Introduction- it is important that all newly arriving Forecasters realize that the following discussions, examples, and forecasting rules of thumb are merely guidelines to be used as a starting point. Since Okinawa's weather is influenced by both mid-latitude and tropical systems, large deviations from the norm can be expected from time to time. With a little patience and desire, the new forecaster will become quite proficient at forecasting the ever changing weather patterns of Okinawa. The discussion on cyclogenesis is aimed at not only those systems that directly affect Okinawan terminals, but it is also aimed at preparing the forecaster to better understand the meteorological situations that could present hazardous conditions for flights enroute to terminals in Korea and mainland Japan.

302. Cyclogenesis.

a. General. The east coast of Asia and the south coast of Japan provide a naturally favorable climate for recurring cyclogenesis. It is one in which continental polar air masses are either in close proximity to warm maritime air masses or the continental air masses are undergoing rapid modification as they move out over the comparatively, warmer waters of the East China Sea and Yellow Sea. Synoptic patterns that aid in the formation of cyclogenesis or frontogenesis are described in the following paragraphs. Forecasters must be aware of these patterns so that they may forecast the development of fronts and lows that will eventually affect the areas of interest.

b. Bubble High Cyclogenesis.

1. General. The most reliable indicator for cyclogenesis in the cool seasons is the off-shore movement of cold, migratory high pressure cell from Asia. This is usually referred to as a "Bubble High". Cyclogenesis normally occurs 24 to 48 hours after the bubble high moves off the coast and the latitude of the cyclogenesis roughly correlates with the latitude of the bubble high. Generally, highs that move off-shore north of 35N will generate lows that move, into the Sea of Japan. Highs that move off-shore south of 30N will generate lows that move south of Japan. Cyclogeneis under these conditions normally occur in the Yellow Sea or the East China Sea and are referred to as Shanghai or Yellow Sea Lows. The lows that are produced by a high moving off-shore between 30N and 35N move in relation to its position to the jet stream. Lows developing north of the jet stream tend to move southeast toward the jet and then along the jet's southern boundary deepening rapidly, as they pass under the jet core. The location of a favorable 850 mb advection pattern also gives a good indication of the location of cyclogenesis.The above described synoptic pattern has been found so reliable in the past that a verification of nearly 100 percent will result with a forecast of cyclogenesis after a bubble high has moved off the Asia coast. While this is primarily a wintertime situation, the method is also applicable to clear-cut spring or summer situations. The delay between the off-shore movement of the high and the formation of the low is 24 to 36 hours during the winter and 36 to 48 hours in the spring and summer. Figure 3-1 depicts the normal surface pattern of the bubble high which

has broken off from the main high pressure cell over Asia with figure 3-2 indicating the critical area where cyclogenesis can occur in the Yellow Sea, East China Sea, and off the coast of southern Japan.

2. Associated Upper Air Pattern.

(a) 500 mb Flow - The flow at 500 millibars shows a pattern of minor short-wave ridges and troughs in connection with shallow, cold bubble highs, breaking off the semi-permanent Asian high. The short-wave ridge with its northwest flow moves eastward with time coincident with the surface bubble high.

(b) 300 mb Flow - The upper flow at 300 millibars off the east coast of Asia in the cool season exhibits a remarkable steadiness in direction. Figure 3-3 indicates the typical 300 millibar flow off the coast and over the bubble high. This is an idealized situation; however, the presence of a jet maximum near the cyclogenic area will ensure cyclogenesis if all other criteria have been met.

3. Types of Cyclogenesis Associated with Bubble Highs.

(a) Pre-existing Low to the Northwest - This type is characterized by a low pressure cell to the west or northwest of the critical area during the day that the bubble high moves off-shore. It is followed most frequently by the development of two cyclones or one elongated north-south cyclone, resulting in widespread cloudiness and poor weather. This type is typical of winter and has a tag time of about 24 hours. Figure 3-4 depicts the resultant developed cyclone in the East China Sea. If form frequently in the central China coastal area and moves east or northeastward along the south coast of Japan. This low is commonly referred to as a Shanghai Low.

(b) Pre-existing Cold Front - Characterized by a cold front northwest of critical area on the prediction day but no marked pressure cell is present. It is followed in about 65 percent of the cases by cyclogenesis in the western part of the critical area. In the other 35 percent of the time, poor weather is normally restricted to a band along the cold front and is not nearly as widespread. Under normal condition, no active warm front forms with this situation as the low moves northeastward or east-northeastward through the Sea of Japan. This type is typical of early through late winter and the time lag is from 24 to 36 hour. This low is referred to as the Yellow Sea Low, figure3-5. Positions are 24 hours apart with the time of the chart for the time of cyclogenesis.

(c) No Pre-existing Low or Cold Front - This type is marked by the formation of a wave cyclone west of the bubble high. The associated weather is the warm-frontal type in the critical area and moves up from the south. The northern part of the critical area is less affected than with the pre-existing low to the north. Lows forming in this fashion usually take 2 to 3 days to clear the area while those of other types move through the area much more rapidly. Typical of spring and autumn, the time lag is normally about 36 hours. These lows normally

form in the central of southern coastal regions of China and move along the south coast of Japan and are commonly called Taiwan Lows. Figure 3-6 depicts the surface synoptic pattern three days after the formation of the cyclone. The 24 hour positions cover the four day period from the time the bubble high broke from the semi-permanent high until the formation of an open wave or closed low.

(d) Validating Criteria - This forecasting procedure verifies in 80 percent of all cases, bur four important conditions must be considered:

(1) The bubble high must be located in the critical area.

(2) The bubble high must be a break-off cell of the Asian High and not a major cell itself.

(3) Tropical Cyclones in the immediate vicinity breakdown the forecasting procedure negating its value.

(4) This method is not valid during the summer as most coastal highs are merely reflections of diurnal pressure variations.

4. Deepening of lows - Once these lows form, they deepen rapidly with an average drop of 15 millibars. After leaving the formation area, it might be noted that any cyclonic circulation at the surface during the winter should be forecast to deepen. This is due, in part to the generally favorable upper air currents in some cases, but more to the land-water thermal contrast at the surface.

5. Deepening of lows due to the Kuroshio Current - The Kuroshio Current can exert a considerable influence upon the deepening of "Shanghai Lows". These lows initially form and propagate eastward along the Polar Front parallel to the southern coast of Japan and over the Kuroshio. As the low deepens on its eastward track, it pulls in increasing, amounts of maritime polar and maritime tropical air and also entrains large amounts of energy from the Kuroshio into its circulation. Additionally, the Kuroshio North Wall, which is the boundary between main axis of the warm Kuroshio current and that of the cold coastal waters of eastern Japan can become an area of intense atmospheric mixing and instability. The cold, dry, unstable northerly air associated with the low, interacting with the Kuroshio, can rapidly generate near gale force to gale force winds.

6. Refinement of the Location for Cyclogenesis - A refinement of the location for cyclogenesis can be done by a study of the 850 mb chart. First by location of the cool air and second by an estimate of when the warm air advection will begin. Also, an upstream jet maximum moving toward the area may aid in refinement of the time lag through an estimate of when the jet maximum will be in a favorable position for cyclogenesis. The 850 mb chart may

also indicate movement of the bubble high by checking the advection at that level. Warm advection beginning at the 850 millibar level with cold air advection ahead of the bubble high would signify that the high is beginning to move and will continue to move as long as the advection pattern persists.

c. Cyclogenesis in a Weak Pressure Trough Cool Seasons - Figure 3-7 shows an ideal example of the synoptic situation for this type of cyclogenesis to occur. In this figure a Yellow Sea low as depicted by cyclogenesis in its source region, which developed as it moved into the central Sea of Japan. The cyclogenesis off the east coast of Japan is by local meteorologist called an "Oshima Low", since it develops in the vicinity of Oshima Island near the main island of Shikoku. However, for the purpose of this handbook it is more commonly understood indicate the formation of the "double-eye low" associated at times with the passage of a Yellow Sea Low. This situation is created by the movement of the mid-tropospheric short-wave troughs in the following areas:

1. Cyclogenesis occurs along the southern coast of Japan when troughing is evident over the Kuroshio Current south of Japan and the gradient in the area is weak. This occurs most readily when the short-wave trough is not fast moving and there is a strong air-sea temperature difference (-7 degrees Celsius or more).

2. Cyclogenesis occurs when there is a marked onshore flow over southern China so that cold, continental air and the warmer, maritime air (or well modified cP air) are present in close proximity, there is a possibly of cyclogenesis occurring in the southern China region. The key to this situation is a surge of cold air at the 850 mb level brought about by a short-wave trough moving into the area.

3. When these is a weak, warm and contrasting cold advection pattern at the 850 millibar level over the Kuroshio Current the possibility exists for cyclogenesis.

d. Warm Season Cyclogenesis in a Cool 850 mb Tongue. During the warmer months, most cyclogenesis accompanies a short-wave trough moving into a cool tongue of air. Any cool pool or tongue of cool air that is well defined at the 850 millibar level in the warmer months is a possible cyclogenic area, particularly in the Sea of Japan or Yellow Sea. If a short-wave trough moves into one of these areas, cyclogenesis usually occurs. If the cool air moves eastward, rainshower and thunderstorms may be triggered. Cyclogenesis will usually occur when the short-wave, trough approaches within 5 to 10 degrees longitude of the centerline of the cool tongue of air.

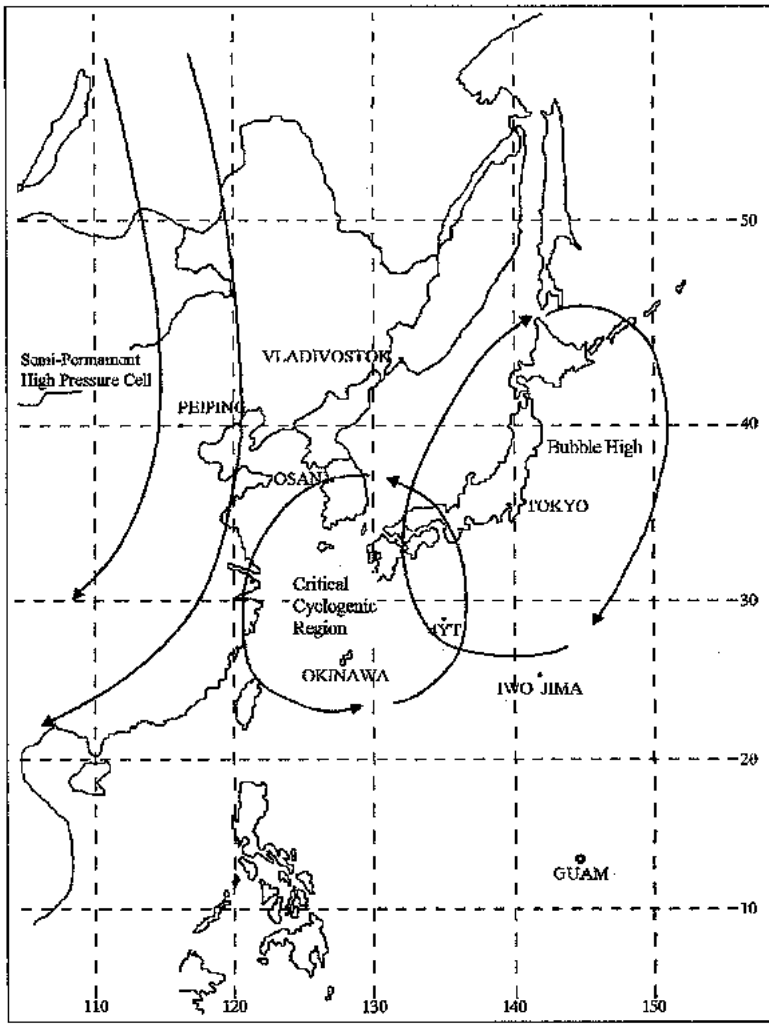


Figure 3-1. Critical Area of Cyclogenesis Associated with Bubble High.

FORECASTER'S HANDBOOK

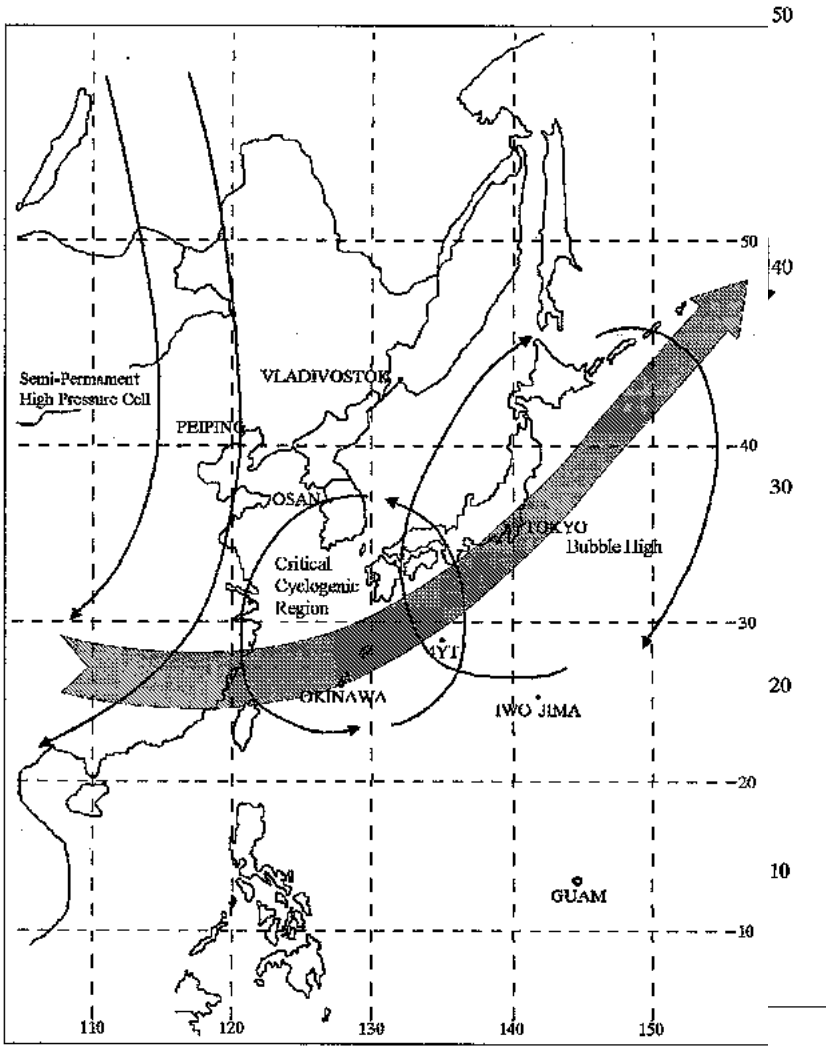


Figure 3-3. Typical 300 Millibar Flow Associated with Bubble Highs and Incipient Cyclonic Circulation.

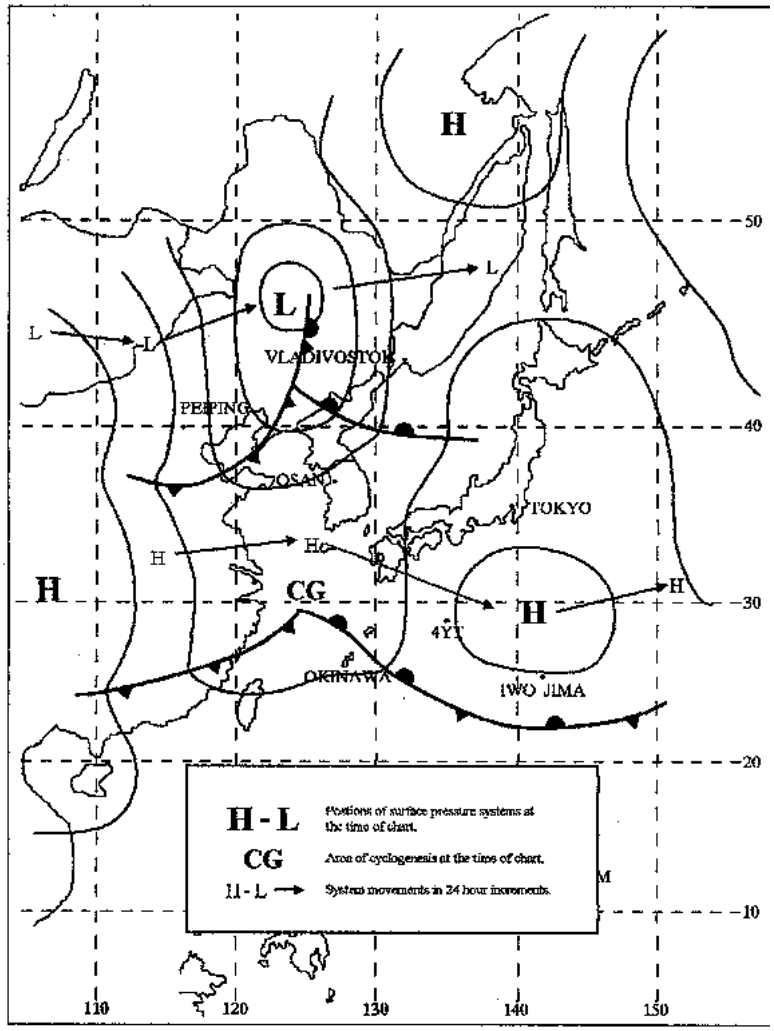


Figure 3-4. Cyclogenesis Associated with a Pre-existing Low to the Northwest of Bubble High. (Chart time: January)

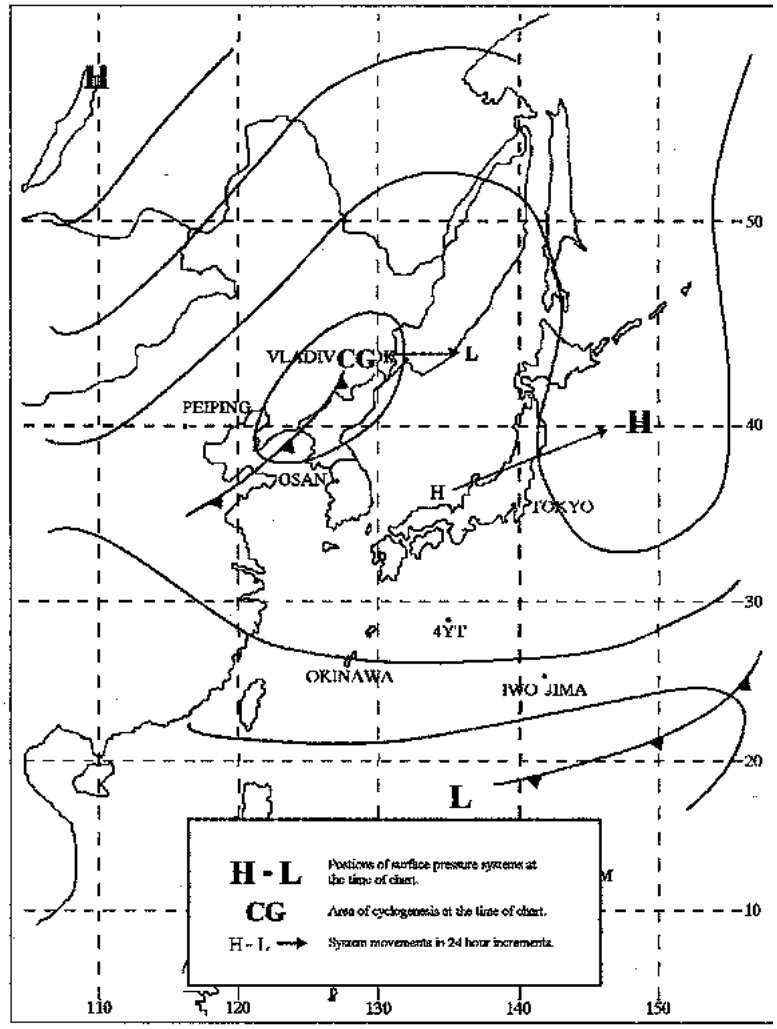


Figure 3-5. Cyclogenesis Associated with Pre-existing Cold Front. (Chart time: October).

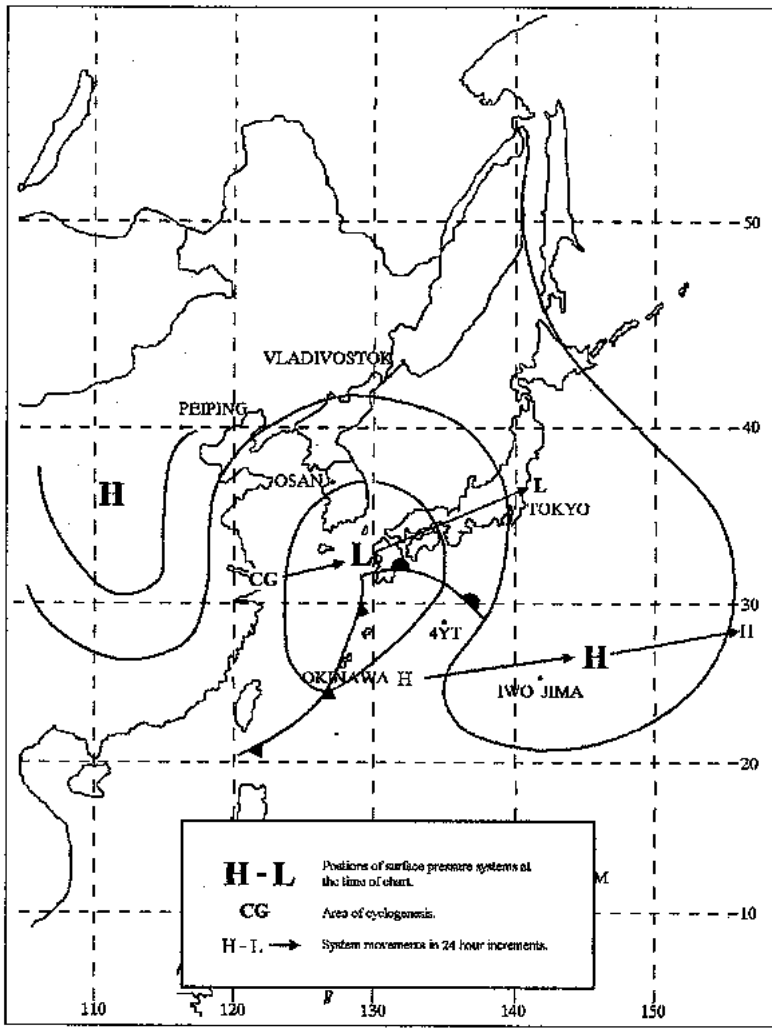


Figure 3-6. Cyclogenesis Associated with no Existing Low or Cold Front. (Chart time: March).

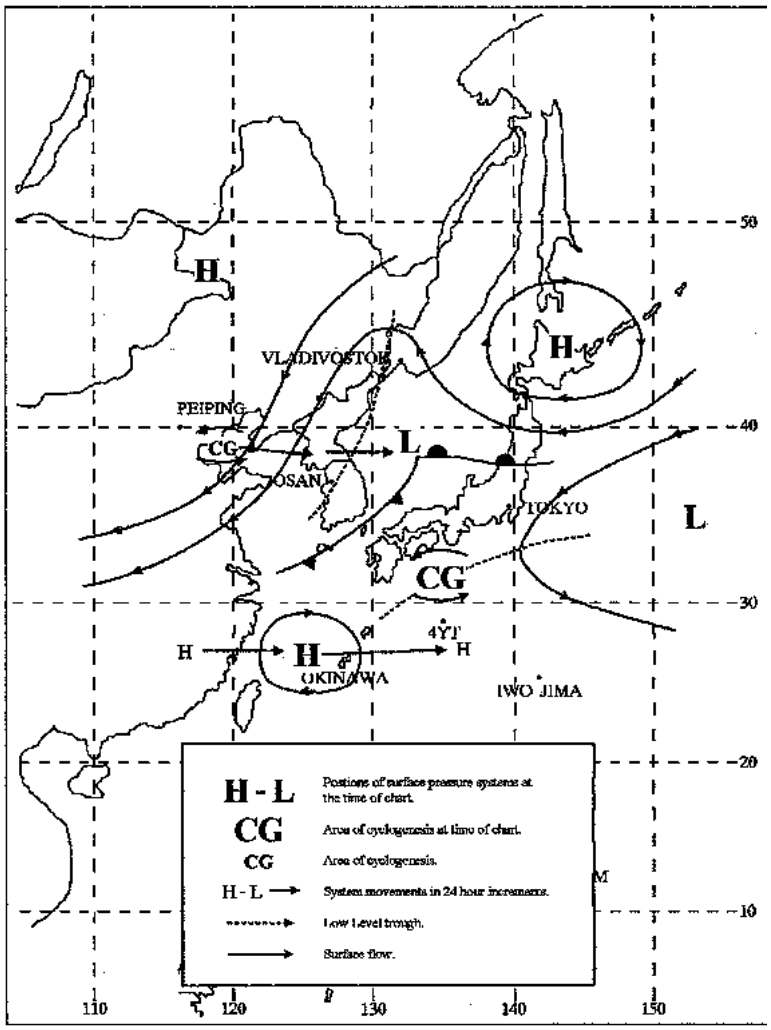


Figure 3-7. Cyclogenesis during Cool Season in a Weak Pressure Trough.

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303. Seasonal Forecasting Rules of Thumb

1. Winter. Arctic fronts reach their southern most position during this period. The main front extends from south and cast of Okinawa into the Philippine straits.

a. The most significant phenomena is the gusty post frontal surface winds. When a Siberian high outbreak is obvious, forecast surface winds of 20 gusting to 35 knots at frontal

passage. There may also be a second surge of gusty winds which reach 40 to 45 knots occurring I - 2 hours after frontal passage.

b. Surface wind speeds. At frontal passage, vary directly with the width of frontal bands. Narrow, rapid bands normally have gusts to 40 knots, while wide slower moving bands; usually gust to 25 to 30 knots.

c. When Futenma's surface winds, are gusting to 25 knots, forecast light to moderate low level turbulence during take off and landing.

d. Expect strong gusty surface winds with 1-3 days of intermittent light rain. and drizzle from overcast stratocumulus layers after frontal passage from a strong Siberia high outbreak. The layers are usually 3,000 to 6,000 feet thick with bases from 2,000 to 4,000 feet AGI. This precipitation usually, ends when the winds decrease and shift to the north or northeast.

e. Arctic, frontal passages at Futenma can be expected within 16 hours after passing Cheju-Do, if the 700 MB wind speed at Naha was 25 knots or greater at the time of frontal passage at Cheju-Do.

f. When a low pressure system travels through the Korean Straits towards the Sea of Japan, with a cold front extended towards the southwest frontal passage at Okinawa can be expected to occur as the center of the low pressure system crosses the Note peninsula (37 degrees N, 137 degrees E).

g. Eighty percent of the cold fronts approaching Okinawa from the northwest are inactive and move at about 25 knots, Some have been observed to move at speeds close to 50 knots.

h. Frequently, scattered convective showers occur over water during post frontal northerly flow as a result of strong surface heating of the relatively warm water surrounding Okinawa.

i. When minor troughs aloft are located well behind the surface trough, most of the rain and low ceilings experienced will be post frontal.

j . When the trough aloft is almost vertically located over the surface front most of the rain and low ceilings experienced will be pre-frontal with rapid improvement occurring a few hours after frontal passage.

k. For enroute weather briefings during November through February, the following points should be emphasized:

(1) With strong winds over Japan, flowing in a direction perpendicular to the mountains, severe to extreme turbulence is experienced over the Kanto Plain of central Japan.

(2) Icing becomes a problem for propeller type aircraft over routes extending northward to Korea and mainland Japan.

(3) Reports of moderate to severe turbulence above 20,000 feet is common. Wind speeds aloft can double in 12 hours and increase to over 200 knots near the jet core, creating tremendous horizontal and vertical wind shear.

2. Winter/Spring. During the period of December to May, and average of seven cyclones develop in the southern part of the East China Sea, These Taiwan lows frequently cause widespread IFR conditions lasting for several days.

a. Taiwan lows tend to develop in areas where there's convergence and a steep temperature gradient at the surface and divergence with a weak temperature gradient at 500 MB.

b. When a southerly component in the gradient winds at Okinawa persist for 6-12 hours, cyclone development is indicated.

c. When the normal westerlies aloft back to the southwest or South-southwest over Taiwan and areas further west along the China coast, precipitation can be expected over Okinawa in 24 to 36 hours, as a result of a Taiwan Low.

d. About 24 hours after the wind becomes east-southeast at Miyako and Ishigaki, the cold front associated with a Taiwan low moves east across Okinawa.

e. Most waves forming southwest of Okinawa move northeast at 12 to 15 knots, in isolated cases they move as fast as 25 knots.

f Taiwan lows usually deepen I millibars every 3 hours after they form. The low pressure deepens at a rate of 1 millibar per hour after reaching the southern coast of Kyushu.

g. When a Taiwan low moves northeast, cold frontal passage usually occurs within 24 hours after warm frontal passage. A squall line with thunderstorms usually precedes the cold front.

h. As a Taiwan low moves towards Okinawa, when Futenma experiences warm frontal type weather. Expect the cold front to pass within 5-6 hours after it passes Miyako.

i. In some cases Taiwan lows develop, deepen and move through the Okinawan area in less than 24 hours. This rapidly moving type system usually develops during the night and will be through the area by sunset the following day.

j. Lows forming near Taiwan cause rain at Okinawa within 3-6 hours after a closed circulation is evident.

k. Dust - During winter and spring, visibility may be reduced to as low as three miles in dust. Visibility's lowest during the day and improves at night, when the dust appears to settle. Quite often it will be mistaken for haze. The source region for the dust is the Gobi Desert, located throughout southern Mongolia. Occasionally during the winter and spring, a deep low pressure cell, extending through the 500 millibar level, is observed over the Gobi region. This low coupled with a strong outbreak of cold air from the Siberian high and the influence of the polar jet, carries the dust to the Ryukyu Islands- This dust often affects visibility to a height of 20,000 feet over Okinawa, and may persist for one to three days,

3. Spring. Frontal passages from Manchuria with Arctic out breaks, Shanghai lows, and Taiwan lows are the major weather producers during this period. In some cases tropical cyclones develop and move into the area, but dissipate rapidly when they reach the cool water and air temperatures north of 20 degrees North.

a. Shanghai lows move 20 - 40 knots north-northeast and then east-northeast, roughly paralleling, and adjacent to, the Kuroshio Current

b. Waves forming east of Shanghai will cause low ceilings and visibility throughout south and central Japan. When the associated cold front passes Ishigaki and Miyako, the front will pass through Okinawa 6 to 8 hours later.

c. Patchy ground fog can be expected in moist low lying areas on nights with good radiational cooling. During periods of heavy prolonged precipitation, fog forms due to the complete saturation of the ground and lower layers of the atmosphere.

d. During pre-warm frontal weather, a fog bank can form to the south-southwest, obscuring Naha. The bank lifts slightly over Futenma, and reduces visibility to one mile or less.

e. During Spring, stratus is a common occurrence. The following rules apply:

(1) Stratus is caused by the cooling of moist southerly air over the cooler shallow water.

(2) Fog over water will lift as it is advected over the islands and prevails as stratus until dissipation 2-3 hours after sunrise. This situation is intensified when the southerly flow is at 10-20 knots, causing rapid cooling of the air and the lowering of the mixing condensation level.

(3) Stratus is usually less than 1,000 feet thick with bases from 500 to 1,000 feet AGL.

(4) With strong south to southeasterly winds in the lower levels, stratus will be scattered to broken over most of the island one to two hours after sunset, and broken to overcast over Buckner Bay. Under these conditions, the stratus is variable and burns off rapidly after sunrise, forming a scattered to broken deck of the stratocumulus with bases 1,500 to 2,000 feet AGL.

(5) With light low level winds, stratus remains as a scattered deck with bases at 600 to 800 feet AGL. At sunrise this deck will become broken for 2-4 hours at 1,800 feet AGL. In this case the wind direction has no bearing on the cloud cover which makes it difficult to forecast the amount of cloud cover and the timing of the ceiling. When low stratus decks exist over the airfield, the approach end of runway 24 usually has ceilings 200 to 400 feet lower.

4. Summer. Summer weather on Okinawa consists of partly cloudy skies, southerly winds, and afternoon rainshowers with isolated thunderstorms in the vicinity. This begins normally during the third week of June and lasts until the first frontal passage in September.

a. The Pacific high builds into the area from the east, usually ridging along the 25 to 30 degrees north latitude line, extends westward to mainland China.

b. Temperatures show a definite rise during this period with afternoon highs averaging 89-91 degrees F and morning lows around 79-81 degrees F.

c. Winds prevail from the south-southeast to the south-southwest at 10-20 knots from early morning till sunset. After sunset they usually become light and variable.

d. A thunderstorm or two can be expected in the local flying area on any summer afternoon. They are difficult to forecast on station very far in advance. Usually thunderstorms on Okinawa result from cumulus building over the island with a light and variable wind aloft to 18,000 feet. This allows them to maintain their position over the island as they mature to thunderstorms,

e. Funnel clouds and water spouts are common during this period. Water spouts have been reported over Buckner Bay from TCU with tops below 20,000 feet.

5 . Fall. During this season, forecasting for the local area can become frustrating for the new forecaster. The polar front is now in transition from its mean summer time position to its mean winter time position. The southern edge of the quasi-stationary polar front is distinct with no gradual decrease in weather. If the forecaster misses the forecasted position for the front by as little as 10 miles or less, it can make the difference between partly cloudy skies and low overcast decks with continuous rain.

a. Early frontal passages are weak and disorganized south of Miyako Jima. Usually embedded thunderstorms can be expected.

b. Frontal passages are usually brief with 4-6 hours of light rain.

c, After cold frontal passage, showers will usually occur again 3-4 hours later in the rising pressure as the mid level trough approaches.

d. Early fall frontal passages occur on a 4-6 day cycle. In late fall the cycle shortens to 2-4 days.

e. When a Siberian high moving towards central China crosses 10 degrees east longitude and reaches the mouths of the Yangtze and Yellow rivers, the trough ahead of the high will cross the Ryukyu islands.

f. Expect cold frontal passage in 24 hours when the temperature advection below 500 MB changes from cold to warm and southerly winds appear in the 4,000 to 7,000 foot layer.

g. During the fall, mid level clouds usually constitute a ceiling. They are usually around 2,000 feet thick with bases from 8,000 and I 0,000 feet. These layers usually become scattered in the afternoon. The indicator is a thin moist layer on the 120OZ sounding with a very dry air above.

304. Warnings and Conditions of Readiness. Storms and the potential of destructive weather accompanying them, are a threat to aircraft, installations, personnel and equipment. Adequate and timely warnings or advisories, coupled with prompt and effective action, will minimize loss and damage from destructive weather.

1. Thunderstorm Advisory. This is published when thunderstorms are occurring or expected to occur in the local flying area (100 NM), but not the local area (25 NM) during the time specified.

2. Thunderstorm Warning Condition 2. Condition 2 is published when thunderstorms are occurring or expected to occur in the local area (25 NM) within the next 6 hours.

3. Thunderstorm Warning Condition I - Condition I is published when thunderstorms are imminent, within 5 NM or on station.

4. Wind Warnings. Wind warnings are published when the wind speed is forecast to meet the criteria below:

a. Local Wind - sustained 17 to 33 knots or gust to 23 knots or greater.

b. Gale - sustained winds of 34 to 47 knots.

c. Storm - sustained wind of 48 knots or greater.

5. Cross Wind Advisory- This is published when the cross wind component along the duty runway exceeds 15 knots, including gusts.

305. Tropical Cyclone Conditions of Readiness. The CG of KAB with the advice of the Commander of Detachment 8, 20th Weather Squadron, Kadena Air Base sets the Tropical cyclone conditions for all military installation on Okinawa. Each base commander- however, has the authority to upgrade the condition for his installation. It is important that each forecaster be prepared at all times to offer assistance to the commanders through the Weather Service Officer so these decisions can be made.

1. Tropical Cyclone Condition 4. Condition 4 is destructive winds of 50 knots or greater are possible within 72 hours. This condition remains in effect for the period of I July to 30 November each year.

2. Tropical Cyclone Condition 3. Destructive winds of 50 knots or greater are possible within 48 hours.

3. Tropical Cyclone Condition 2. Destructive winds of 50 knots or greater are anticipated within 24 hours.

4. Tropical Cyclone Condition 1. Destructive winds of 50 knots or greater are anticipated within 12 hours.

5. Tropical Cyclone Condition I Caution- Destructive winds of 50 knots or greater are anticipated within 12 hours with actual winds including gusts currently 34-49 knots.

6. Tropical Cyclone Condition I Emergency Destructive winds of 50 knots or greater including gusts, are now occurring.

7. Tropical Cyclone Condition Storm Watch Destructive winds of 50 knots are no longer being experienced, however, winds of 34-49 knots including gusts are still being experienced.

8. Tropical Cyclone Condition All Clear. All Tropical Cyclone danger has passed.

306. Routine Forecasts

1. Terminal Aerodrome Forecast (TAF). A 24 hour forecast prepared four times a day OOOOL, 0600L, 1200L, and 1800L. These must be transmitted over the CMW by H+20.

2. DD 175- 1. These are prepared for all flights except local VFR flights listed on flight schedules (Avg. 105 per month).

3. Flight Weather Package. Prepared on request, to include; HWD, Flight level winds, altimeter settings, ditch headings, sea surface temperature and any other data requested. All C-12 and T.39 flights will receive a complete Flight Weather Package. All flight weather packages will be prepared in accordance with NAVOCEANCOM instructions (Avg. 40 per month).

4. Daily Forecast Products. There are currently two different daily forecasts prepared in the morning. The CG Weather Brief which consists of forecasted data for several stations in the Far East. The G-2 forecast is a detailed forecast for MCAS Futenma and the surrounding area covering a period of 72 hours.

CHAPTER FOUR

SPECIALIZED FORECASTS

401. Introduction. Although requests for specialized forecasts are quite rare, we as forecaster's must be prepared to respond to one, should the occasion arise. The most probable types that could be requested are discussed below.

402. Radiological Fallout (RADFO). This forecast (not routinely prepared) may be required at some point in time. It is essential that the forecaster and observer are familiar with the procedures and references. The pattern of deposit of contaminated particles varies greatly with the upper winds and is also influenced by vertical currents, clouds, and precipitation. Predictions of fallout areas depend upon many assumptions about such things as weapons yield, burst type, nature of the surface, and meteorological factors. These predictions are not precise. However, it is important that planners and commanders have at least an approximate warning of the areas of serious contamination. Specific guidance and procedures are contained in OPNAVFNST 3441.1_, and FUPA 30 KGWC, listed in the AWSP 105-52 Vol III.

403. Aircraft Routing. Several routing forecasts are available. The most used are discussed below.

a. Air Force Global Weather Central Flight Level Winds Forecasts. Flight level winds are available as required via CMW (FXPN and FXPA series).

b. Optimum Path Aircraft Routing System (OPARS). The primary purpose of OPARS is to provide a flight planning service to the Naval Aviation community. By using state of the art computer power to combine the latest forecast environmental data with the most fuel efficient flight profile for specific aircraft, a recommended customized flight plan is provided. The forecast winds are determined by computer at the Fleet Numerical Oceanography Center (F'NOC) located in Monterey, California. When airborne, expected winds and fuel usage are then verified with actual conditions. OPARS can be requested and received either through the computer terminal in the weather office or via DOD message system (AUTODIN) (Avg 70 per month).

404. Electro-Optical (E-0) and Electromagnetic Conditions (EM).

a. General - Electro-Optical (E-0) systems are playing an increasing role in U.S. Marine Corps operational activities. Forecasters have a growing requirement to support E-0 systems and therefore a need to understand the interactions between E-0 systems and the atmosphere. This section also provides some basic background material on electromagnetic (EM) radiation, its interaction with atmospheric constituents, and general types of E-0 systems of concern to meteorologists.

b. E-O/IEM and the Atmosphere as a Medium.

1. E-0 and EM systems respond to electromagnetic radiation as a sensed stimulus. The atmosphere interferes to various degrees with these systems because it interacts with both the source and propagation of radiation. The interaction depends on the atmospheric constituents and the radiation wavelength. This handbook addresses portions of the magnetic spectrum from visible through microwave wavelengths (0.74 micrometers through 10.0 centimeters). Figure 4-1 provides categories of sensor wavelengths, general types of systems, and significance of adverse weather elements.

	Microwave		FLIR			Vidicon TV	
Systems	Communications	Radar	Laser				Eye/T.V
Wavelength	Microwave	Millimeter	Infrared				Visible
			Far Far	Far	Middle	Near	
Wavelength/ Frequencies	10cm-1cm 36Hz-30GHz	1cm-0.1mm	0.1mm-15μm	15μm-6μm	6μm-2μm	2μm-0.74μm	0.74μm-0.4μm
Weather Sensitivity	Generally increases with decreasing wavelength (To the right in this table)						
Clouds/Fog	Significant			Extremely Significant			
Dry Aerosols	Insignificant			Significant		Extremely Significant	
Precipitation	Significant		Extremely Significant				
Absorption	Significant		Can be Extremely Significant			Extremely Significant	
Scattering	Significant			Extremely Significant			

Figure 4-1. Electro-Optical and Electromagnetic Systems and Significance of Adverse Weather Elements as a Function of Sensor Wavelength Categories.

3. There are four atmospheric physical processes which affect electromagnetic (EM) radiation; reflection, scattering, absorption, and emission. The type and size of the atmospheric constituents, gaseous molecules and particulates (dust, haze, smokes, fogs, other aerosols, cloud droplets, and precipitation) affect the propagation of radiation. The influence on various wavelengths is determined by the relationship between the size of the atmospheric constituents and the wavelength of the radiation. This relationship, referred to as the size parameter, is stated as:

$$size\ parameter = \frac{2\pi r}{radiation\ wavelength}$$

where r is the particle radius.

(a) Reflection - Takes place when the size parameter is greater than approximately 10, that is, when the wavelength is much smaller than the particle radius.

(b) Scattering - Aerosol scattering is a function of the size and shape of the particle with respect to the wavelength of interest. If the particle is much larger than the wavelength of the radiation, the scattering effect is called optical scattering. Optical scattering is not a function of the wavelength. When the wavelength is approximately the size of the particle or longer, then the radiation diffracts among the object. This type of scattering is called Rayleigh scattering. Rayleigh scattering is wavelength dependent. The longer the wavelength (with respect to the particle) the less the loss due to scattering. A special case of Rayleigh scattering for spherical particles (rain drops, mist particles) is called Mie scattering. Mie scattering represents the transition between optical scattering and Rayleigh scattering. In general terms, molecular scattering does not have an impact on radiation losses except the ultraviolet (UV) regions where the wavelengths start to approximate the size of the molecules. The sky is blue because of the Rayleigh scattering of sun light by the molecules in the air.

(c) Absorption - Takes place on the molecular scale and occurs selectively with respect to wavelengths. Each absorbing constituent of the atmosphere (mainly water vapor, carbon dioxide, ozone, and oxygen) absorbs in specific wave length intervals, which are referred to as absorption bands. Radiation at other wavelengths is not significantly affected by that constituent.

(d) Emission - Is the emitting of electromagnetic radiation (for example, a flashlight beam or the heat from a household radiator). The process operates on the molecular scale, and every constituent of the atmosphere to include the earth emits radiation. However, emission occurs selectively with respect to wavelength, therefore the amount of energy emitted at a given wavelength may not be significant-

4. The bulk or fundamental atmospheric parameters of concern in E-O/EM forecasting are temperature, pressure, humidity, and wind. These elements determine the refractive index, absorption in the infrared, and the size and contribution to refractive index of atmospheric aerosols. Low-level profiles determine the atmospheric stability, which influences turbulence. Weather elements such as drizzle, rain, and snow can severely limit the performance of all E-O/EM systems.

c. E-O/EM Systems and Atmospheric Iterations.

I - This section addresses some general E-O/EM systems and atmospheric iterations of concern to the forecaster.

2. Visual Systems (E-0) - Cameras and human eyeballs are visual systems that require cloud-free line-of-sight between the sensor and target. Furthermore, reduced visibility due to scattering and absorption by haze, fog, and precipitation limit capabilities of visual systems. Also, each visible system requires a minimum level of illumination.

3. Infrared Systems (E-0) - Lasers and Forward Looking Infrared Radar (FLIR) are active and passive systems, respectively, that operate in the infrared wavelength and require cloud-free line-of-sight to the target. Some lasers can penetrate thin cloudiness, and passive infrared system may detect hot targets through thin clouds, Haze, fog, and precipitation degrade the transmission of energy at near infrared wavelengths. Systems operating at longer infrared wavelengths are degraded by absorption of energy by atmospheric water vapor.

4. Millimeter/Microwave Systems (EM) - Radar and microwave systems performance is degraded by two main atmospheric factors: Heavy cloudiness (thick cloudiness with large droplet distributions of near-precipitation-sized particles), and precipitation.

d. Specific Categories of E-O/EM Systems

1. High Energy Laser.

(a) Atmospheric conditions degrade High Energy Laser (HEL) system performance by reducing fluence (energy density per unit time deposited on the target) on the target in a variety of ways: aerosols and water vapor absorb energy, atmospheric turbulence spreads the beam fluence, and atmospheric turbulence also causes the beam to wander off its intended target.

(b) Environmental conditions such as heavy rainfall and fog-induced low visibility can reduce the effectiveness of (HEL) systems to a point that precludes operation of such systems.

2. Forward Looking Infrared.

(a) The basic concept of thermal sensing, such as FLIR, is the detection of a target by a thermal detector which senses or perceives a temperature difference (contrast) between the target and its background. The temperature differences result from solar heating (insolation) or cooling by the ambient wind. The sensed or perceived contrast by the detector is diminished by the atmosphere between the source target and its background) and the receiver (the infrared detector). The loss of contrast is termed the transmittance. The strongest reduction in contrast occurs during fog or precipitation. When visibility is less than 1 km, FLIR ranges can be considered the same as the visibility-

(b) These absorption characteristics give FLIR ranges a close relationship to the general atmospheric circulation patterns. In general there is a latitude to FLIR range correlation (increasing range with increasing latitude) reflecting a change from the warm moist stable equatorial area, to the cooler drier but variable mid-latitudes, and finally the cold dry polar regions. Effects such as continental outbreaks, stratus and fog regimes, upwelling, and oceanic currents and associated areas of cyclogenesis result in extreme variability of FLIR ranges over near coastal waters.

(c) In the infrared wavelengths (3.4 to 5 micrometers and 8 to 12 micrometers) the absorption by water vapor is generally the primary effect. Absorption by aerosol particles is normally of secondary importance. However, under conditions of atmospheric low water vapor content (low temperature and/or relative humidity) the aerosol absorption becomes dominant.

3. Radar and Microwave.

(a) The problems associated with atmospheric refraction and anomalous propagation of radar and radio waves have long been recognized by Marine and Naval units. The development of the computer based IREPS (Integrated Refraction Effects Prediction System), has significantly enhanced refraction index forecasting. General discussion of refraction and related conditions will be addressed below.

(b) The refractive index N is defined as the ratio of the speed of propagation of an electromagnetic (EM) wave in a vacuum to that in the actual atmosphere. Refraction is the bending of waves due to a change in density of the medium through which they are passing, the atmosphere for our purposes. Under standard, or "normal", conditions the density of the atmosphere decreases at a gradual but continuous rate with altitude. This density change is a function of decreasing temperature, humidity, and pressure and results in a rate-of-change of N of 12 units/1000 feet. When non-standard temperature and humidity vertical distributions occur the rate-of-change of N becomes non-standard too.

(c) The speed of propagation of an EM wave in a vacuum is greater than in air. Therefore, under normal conditions with decreasing density with height, EM waves travel faster at higher levels in the atmosphere than at lower. The result is that as a wave front, with some vertical extent, moves through the atmosphere the upper portion moves fastest and results in a downward bending or refraction of the wave front. The standard refraction rate however, is less than the curvature rate of the earth's surface. The end result is that under standard atmospheric conditions the wave front gradually moves away from (to higher altitudes) the earth's surface but at a lesser rate than a line tangent to the earth's surface.

(d) In the real world the atmosphere is seldom, if ever, standard. The actual refraction is typically slightly greater (super refraction) or less (subrefraction) than standard. Certain conditions occur which disrupt the standard temperature and humidity distributions to the extent that a significant degree of EM wave bending occurs and the wave becomes trapped within the layer of the atmosphere. This occurs under conditions of increasing temperature or sharply decreasing humidity with increasing altitude (as with an inversion). Anomalous propagation (AP) of the radar or microwave energy will then take place. The energy trapped within the layer will provide extended ranges in the layer or duct, but reduced ranges will result in the region which the waves were refracted away from.

c. There are three general types of ducts:

1. Elevated Ducts - Primarily affect airborne operations. They are the result of moisture layers and/or elevated temperature inversions. They may be found anywhere from surface to 20,000 feet or more, but are most common below 10,000 feet,

2. Surface Based Ducts - Can result in extended detection, intercept, and communication ranges for all frequencies above 100 MHz (Petit and Hamilton, 1984). These extended ranges presuppose that both the transmitter and receiver are in or near the duct. Surface ducts typically are found under the southeast quadrant (northern hemisphere), northeast quadrant (southern hemisphere), and near the center of high pressure systems.

Evaporation Ducts - Created by strong negative vertical water vapor gradients (i.e., water vapor rapidly decreases with height). Evaporation ducts most often occur over ocean areas and for the most part do not pose a problem for land stations. However, short periods of an evaporation duct existing over inland areas would be associated with rapid clearing after extensive amounts of precipitation has fallen over a large area. Normally evaporation ducts occur within 100 feet of the surface and tend to extend ranges for surface-to-surface systems operating above 3 GHz.

(a) Meteorological factors affecting evaporation duct height climatology for 10 Atlantic ocean weather stations was studied by Sweet (1980). Some general observations from this study are considered applicable to the general problem.

(1) Evaporation duct heights are normally within 100 feet of the sea surface.

(2) Evaporation duct heights increase as latitude decreases.
Median annual duct heights (the height exceeded half the time during the year) ranged from about 50 feet at 35 degrees north to about 20 feet at 55 degrees north and remained nearly constant to 62 degrees north, the northernmost station in the study.

(3) Increased air and sea surface temperatures result in higher duct heights.

(4) In mid-latitude, maximum duct heights occur during late fall and early winter. Minimum duct heights occur in late spring and early summer.

(5) Strong winds result in higher duct heights.

(6) Sea surface temperatures greater than air temperatures result in higher duct heights.

(b) Helvey and Rosenthal (1983) conducted a study to define ways of inferring refraction conditions from synoptic parameters. Considerable scatter or variation in duct conditions was found when attempting to correlate synoptic conditions with refractive conditions, resulting in an acknowledgment in the report that the procedures developed should be considered tentative interim guidance.

f. Forecast Aids for Elevated and/or Surface Based Ducts. The following synoptic features and inferred elevated trapping layer (ETL) indicators are provided for assistance in forecasting ETL conditions for the current time at remote sites. When coupled with forecasting of synoptic or climatological patterns, these inferences can also be helpful in forecasting future ETL conditions.

1. The strongest and most persistent inversions and associated refractive layers occur in the equatorward half of subtropical oceanic highs, particularly the southeast quadrant in the northern herm'sphere and northeast quadrant in the southern hemisphere.

2. Tracking westward under the equatorward half of the subtropical highs, convection related to warmer SST results in a progressively higher and weaker inversion (and refractive layer) with a correspondingly deeper marine layer.

3. Changes from fog through low stratus areas to higher stratocumulus and cumulus areas infer a higher and weaker inversion-

4. Ocean currents influence the thickness of the marine layer. Warm currents, such as the Kuroshio in the western north Pacific weaken and increase the thickness of the marine layer while the cold currents of the northwestern and eastern portion of the north Pacific intensify and reduce the thickness of the marine layer.

5. Because inversions and ducting are associated with subsidence and stable layers, therefore highs rather than lows, the frequency of ducting shows a strong correlation with SLP. When the SLP is below 1000 millibars, the probability of ducting is very low (< 10%) while with SLP >1020 millibars the probability approaches 50%.

6. Duct frequency versus surface wind direction is at a minimum for south through west-northwest winds and a maximum for north-northwest through southeast winds.

7. Duct frequency increases as the temperature difference between the surface and 700 millibar decreases. Small differences indicate a stable atmosphere (high frequency of inversion and ducts) and large differences indicate an unstable atmosphere and convective activity (low frequency of inversion and ducts).

g. Forecast Aids for Prediction of Standard Refractive Conditions

1. Area of concern is located within the northwest quadrant of subtropical highs or northern half of migratory highs.
2. Under or immediately following an active front.

3. Area of cyclonically curved isobars.
4. Close to a low pressure center.

5. Surface pressure less than 1000 millibars.
6. Cold air aloft, 700 millibar temperature less than -10 degrees celsius.
7. Presence of cumulus and deep convective clouds.
8. Unstable, windy conditions.
9. Open celled clouds behind frontal systems.

h. Forecast Aids for Duct Height,

1. The maximum frequency of oceanic ducts occurs in the 4,000 to 6,000 feet layer.

2. A secondary frequency maximum occurs between the surface and 2,000 feet when the SLP is > 1018 millibars and surface winds are <6 knots. (near centers of highs)

3. When a migratory upper-level trough replaces a anticyclone, strong low-level ducts are likely to become weak ducts near 10,000 feet within a 48 hour period.

4, Within oceanic anticyclones, duct heights vary by about 3,000 feet from the lowest level in the southeast quadrant to the highest in the northwest quadrant.

5. In addition to synoptic variations there are general latitude variations. On the average ducts are higher in lower latitude (over warm water) and lower towards the poles (over colder water).

6. There is a tendency for the mean elevated duct heights to increase with increasing SST. Figure 4-2 provides approximate mean duct heights for areas within 300 nautical miles of the center of highs for SST intervals,

Sea Surface Temperature (SST)		Height MSL	
(C)	(F)	(m)	(ft)
5 - 7	41 - 45	1000	3300
8 - 10	46 - 50	1200	3900
11 - 12	51 - 55	1300	4300
13 - 15	56 - 60	1400	4600
16 - 18	61 - 65	1500	4900
19 - 21	66 - 70	1600	5200
22 - 24	71 - 75	1700	5600
25 - 27	76 - 80	1800	6200
>27	>80	2000	6600

Figure 4-2. Approximate Mean Elevated Duct Heights for areas within 300 nautical miles of highs for Specified Sea Surface Temperature Intervals (Helvey and Rosenthal, 1983).

405. Radar Propagation (Refractive Index). This forecast (HFUS KGWC series) describes the effects the environment will have on refraction of radar waves in the atmosphere and may be

used to correct and account for abnormal refraction of weather radar and possible combat air patrolling radar -

a. Integrated Refractive Effects Prediction System (IREPS). The AN/TJYK-83 computer and GFEMPL software will compute and graph atmospheric effects to radar propagation.

406. Electro-Optical Decision Aids (EOTDA). An EOTDA is a software model that predicts the performance of air-to-ground weapon systems and direct view optics based on environmental and tactical information. Performance is expressed primarily in terms of maximum detection or lock-on range. Results are displayed in alphanumeric and graphic formats. The EOTDA can be used to determine the type of munition to be used as well as predicting the optimum time for a strike. The EOTDA supports systems in three regions of the spectrum-. Infrared (8 - 12μm)- Visible (0.4 - 0.9μm)- and Laser (1.06μm). The TV (Visible) includes low-light devices and direct view optics (e.g., Night Vision Goggles [NVG]).

407. Chemical Downwind Message (CDM). Hazards from chermical attacks are not confined to areas directly attacked. The vapor or aerosol will travel with the wind and may produce casualties among unprotected personnel downwind. Speedy identification of likely hazard areas and dissemination of area computations contains simple techniques for use by environmental forecasters in estimating the downwind hazard areas resulting from chemical attack.

CHAPTER FIVE

ENVIRONMENTAL EFFECTS

501. Introduction. The effects of natural phenomena on personnel, as well as aircraft, are a primary concern when planning any event. Alerting commanders, in a timely manner, of the occurrence or probability of occurrence of the phenomena is paramount for the forecaster to successfully accomplish his or her mission.

502. Environmental Effects on Planning for Various Aircraft Currently at MCAS Futenma.

a. CH-53.

1. Flights into known icing conditions should be avoided.

2. Restricted from flying into icing conditions greater than light.

3. Engine inlet icing may occur in temperatures up to +4 degrees celsius due to the cooling effect associated with reduced pressures in the engine inlet.

4. Severe to extreme turbulence should be avoided-

5. All thunderstorm activity should be avoided. All ordnance activity should cease within 5 miles of thunderstorms.

6. Rotors should not be engaged in winds from any direction in excess of 45 knots.

b. CH-46.

1. Flight into known icing conditions is prohibited. Every reasonable effort must be made to depart inadvertent icing as soon as possible.

2. Severe to extreme turbulence should be avoided.

3. All thunderstorms should be avoided. All ordnance activity should cease within 5 miles of thunderstorms.

4. Wind limits for rotor engage/disengage are as follows:

WIND AZIMUTH RELATIVE TO HELICOPTER	MAXIMLJM WIND SPEED

360 - 030	20 KTS
031 - 040	3O KTS
041 340	45 KTS
341 359	30 KTS

c. H-I/AH-l/AH-1W

1. Flights into known icing conditions should be avoided. Restricted from flying into areas of icing greater than a trace.

2. Continuous flight in trace icing conditions is not recommended.

3. Severe to extreme turbulence should be avoided.

4. Thunderstorms should be avoided. All ordnance activity should cease within 5 miles of thunderstorm activity.

5. Launch and recovery should be made into a relative wind of less than 45 knots. In an emergency, the helicopter may be launched in a 60 knot wind.

d. C-130.

l. Has anti-icing capability but no de-icing equipment.

2. Areas of moderate to extreme turbulence should be avoided.

3. Thunderstorms should be avoided.

4. Maximum cross wind component for takeoff/landings is 35 knots.

e. T-39.

1. Has anti-icing capability, but no deicing equipment. Areas of known icing should be avoided.

2. Moderate to extreme turbulence should be avoided.

3. Thunderstorms should be avoided.

4. Maximum cross wind component for takeoff/landing is 25 knots.

f. C- 12.

1. Prolonged flight in icing conditions is not recommended.

2. Moderate to extreme turbulence should be avoided.

3. Thunderstorms should be avoided.

4. Maximum crosswind component for takeoff/landing is 25 knots.

503. Takeoff Minimums.

a. Special Instrument Rating. No takeoff ceiling or visibility minimum apply. Takeoff shall depend on the judgment of the pilot and the urgency of the flight.

b. Standard Instrument Rating. Published minimums for the available non-precision approach, but not less than 300 foot ceiling and 1 statute mile visibility. When a precision approach compatible with installed and operable aircraft equipment is available, with published minimums less than 300/1, takeoff is authorized provided the weather is at least equal to the precision approach minimums for the landing runway in use, but in no case when the weather is less than 200 foot ceiling and 1/2 statute mile visibility or 2400 foot runway visual range (RVR).

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