MCAS IWAKUNI, JAPAN

FORECASTER HANDBOOK

1999

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UNITED STATES MARINE CORPS
AIRFIELD AND HARBOR OPERATIONS
Weather Service Division
PSC 561 BOX 1876
FPO AP 96310-1876

3140
3WSD
01 Apr 99

From: Weather Services Officer, MCAS Iwakuni, Japan
To: Distribution

Subj: **FORECASTER HANDBOOK 1999 EDITION, MCAS IWAKUNI, JAPAN**

Ref: (a) NAVMETOCCOMINST 3140.2D

1. In accordance with the reference, the updated and revised forecaster handbook for this facility is submitted.

2. The forecaster’s handbook is a valuable forecasting aid utilized by weather division to assist permanent and newly assigned forecasters. I greatly appreciate the input and hard work on the part of all who sacrificed their time and effort in the complete revision of this manual.

3. If you desire additional copies, please do not hesitate to contact us at DSN (315) 253-4435/4387 or email at scottw@iwakuni.usmc.mil.

D. L. BOHANNON

I BASIC DESCRIPTION

101. TOPOGRAPHY AND EXPOSURE.

A. General:

Marine Corps Air Station Iwakuni is located at 34' 09'N latitude and 132' 14'E longitude, in the Yamaguchi Prefecture in the southwestern section of the main island of Honshu, Japan. The Air Station is approximately 23 miles south southwest of the city of Hiroshima. See *Figure 1-1*. The local time zone is India, -9 hours from Zulu. Iwakuni's ICAO identifier is RJOI, and the WMO Index Number is 47764.

The Air Station property is located on a delta giving the runway a mean elevation of 7 feet above MSL and a magnetic variation of 7' west. The splitting of the Nishiki River that flows from the west in the nearby mountain ranges to the sea forms this delta. The Nishiki River splits 2 miles west-northwest of the station into two tributaries that serve as boundaries for the air station. The first tributary is the Imazu River, which serves as the northern boundary. The second is the Monzen River that runs along the west through southwest side of the air station.

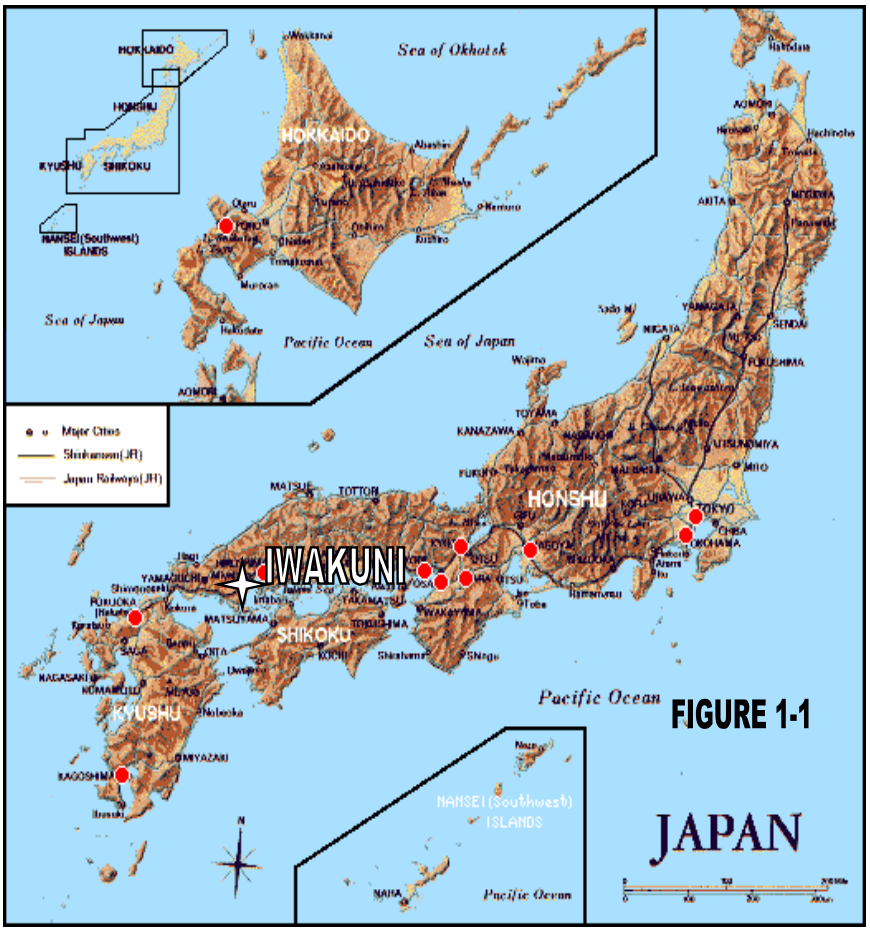


FIGURE 1-1

To the east lies Hiroshima Bay which continues eastward forming the inter-coastal region between the main island of Honshu and the smallest of Japan's four Main Islands; Shikoku.

There are several small mountainous islands in the bay. The largest is Oshima Island, located at the south end of the bay.

B. Terrain:

The local terrain is varied from just above sea level on the coastal delta plain to 4,500' mountain peaks within 25 miles to the northwest. The Chugoku Sanchi Mountain Range spans the entire length of the southwestern portion of Honshu. The primary orientation of the mountain chain is the same as the island itself southwest through northeast, running up the center of the island like a spine. Peaks along the Chugoku Sanchi vary from 1,000', 4 miles west of the station to 4,500' 25 miles northwest of the station. Ridgelines are varied but average 3,200' 20 miles west through north of the air station.

C. Terrain Affects on Weather Elements:

The wide ranges of extremes in terrain have a significant influence on weather not only on the micro-scale, but the synoptic scale as well.

The varied mountainous terrain affects the winds at the Air Station. A land breeze is felt throughout the year. This wind is more of a katabatic effect as the wind drains down from the mountains into the Nishiki River Valley to the Air Station delta causing an almost unwavering nightly surface wind from the northwest at 3-5 knots. At times, the sea breeze which is most noticeable in the late spring through early fall, and the mountain drainage wind have counteracted each other.

When this occurs, winds at opposite ends of the runway flow toward one another causing the winds to increase at the center of the field. These winds have been observed as high as 10 knots. The nearby mountains also serve as a protector from the severe Arctic and polar outbreaks. The adiabatic warming of the air as it descends the mountain causes much of the low unstable cloudiness to dissipate. Although snow showers do occur at the Air Station, this affect helps to greatly reduce the possibility. Most of the snowfall that does occur at the station appears to be coming, from clear skies, the falling snow is actually being blown from the clouds over the nearby mountains vice the norm of precipitating from clouds overhead.

The combination of the ridgeline northwest through southwest and the mountainous island from the northeast through southeast resembles a bowl like feature. This can trap a warm front over the station causing IFR conditions
with low stratus ceilings and thick fog for long, periods of time. Oshima Island and the numerous other smaller islands in the bay serve as effective barriers to high winds and seas from the south. As a result, there is almost negligible surge and

only moderate seas in the bay. Most importantly, they greatly reduce the possibility of potentially damaging, typhoon winds.

102. <u>LOCATION OF THE WEATHER OFFICE</u>:
The weather office is located on the first floor of the Airfield and Harbor Operations Building (757). Weather spaces are divided into areas consisting of a Forecasters area, Observers area and a combined Training; Administration, Supply and Logs area, The Weather Officer and NCOIC have offices adjacent to the Administration area. See *Figure 1-2* below.

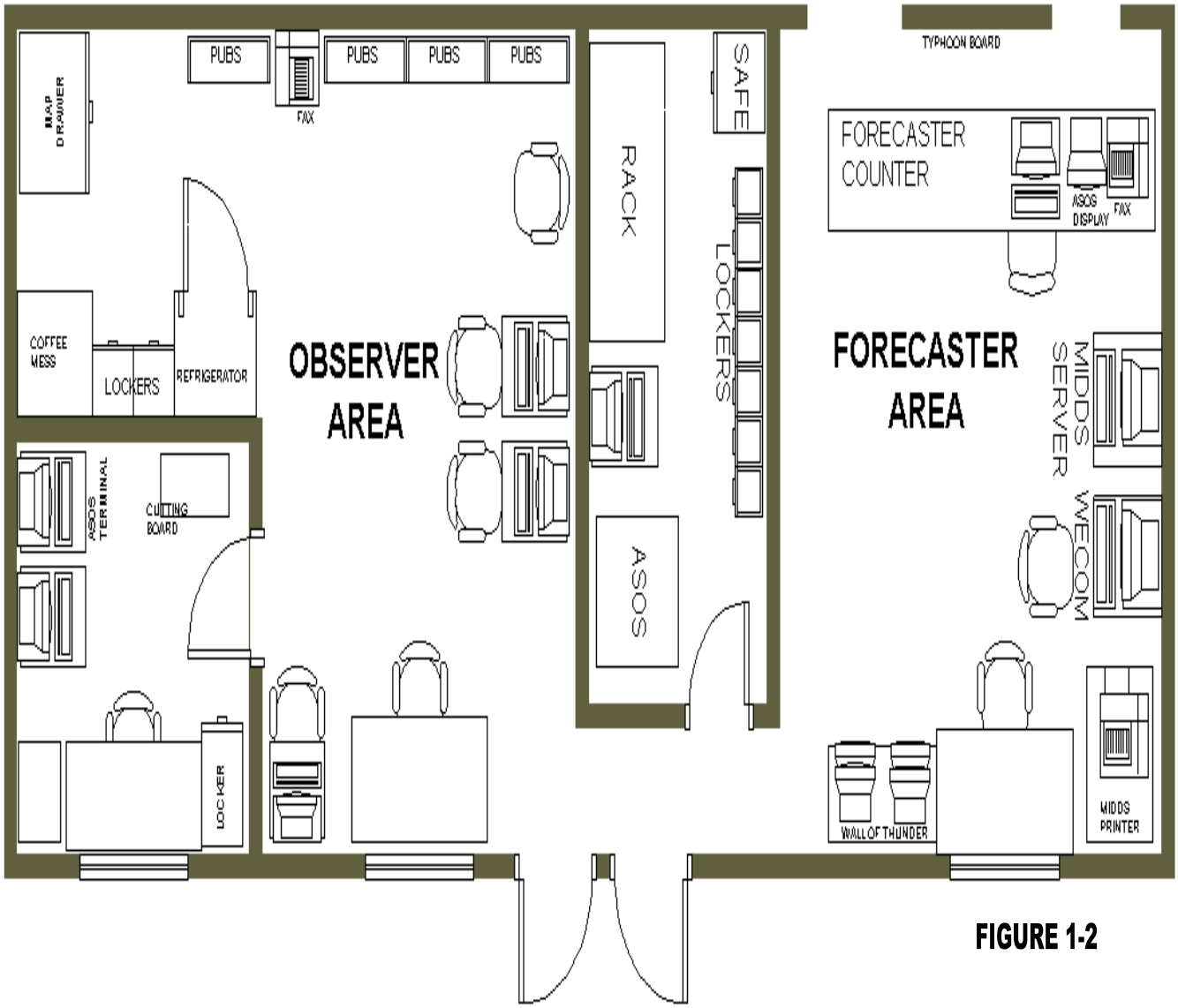


FIGURE 1-2

103. WEATHER EQUIPMENT AND LOCATION:
(See *figure 1-3* for sensor locations)

A. Automated Surface Observing System (ASOS):
Meteorological elements are measured by the ASOS system. The ASOS automatically measures winds, temperature and dew-point, sea level pressure, station pressure, etc. The ASOS combined sensor group is located at the approach end of Runway 02. The ACU or automatic control unit for this system is located in room 120 of the weather facility. There are visual display monitors located in the forecaster area and the Japanese observing area. There is an additional VDU located at the Air Traffic control tower. The observational spaces of the Weather Office.

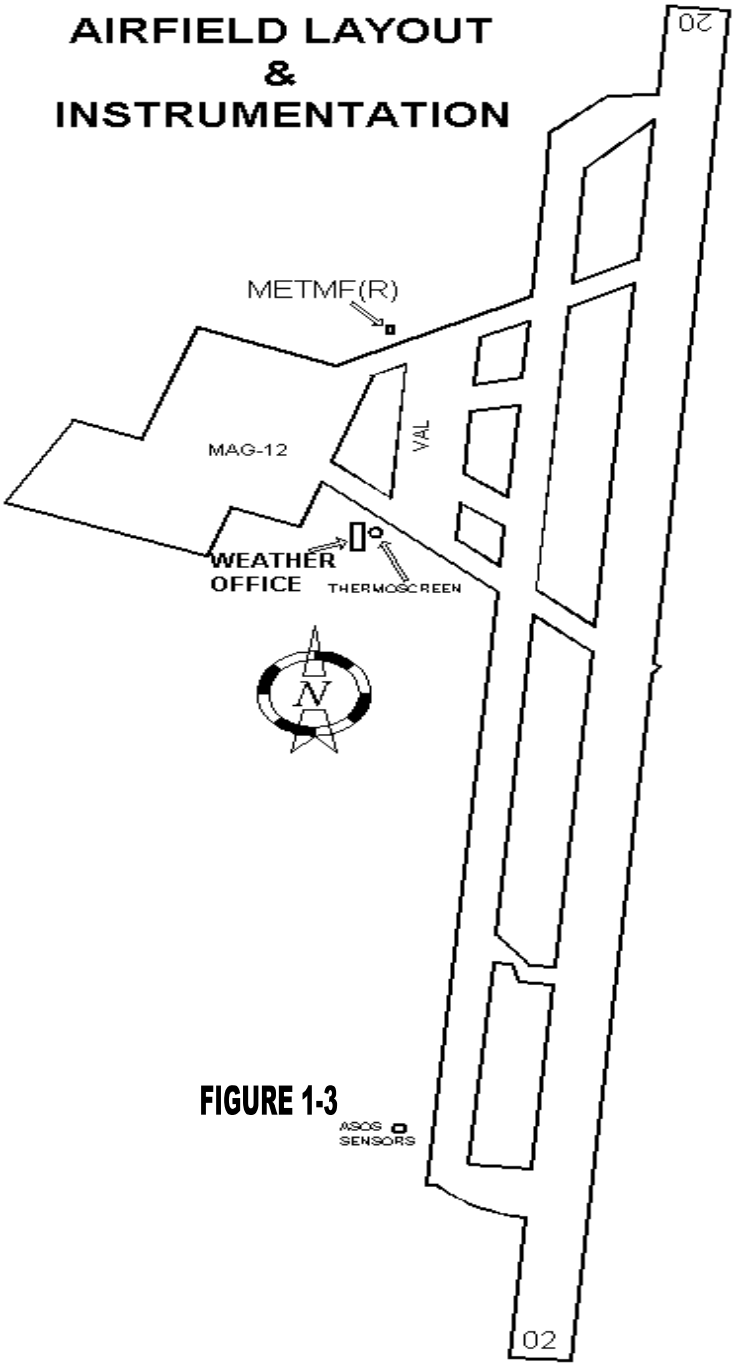


FIGURE 1-3

B. METOC Integrated Data Display System (MIDDS):
The Weather Office is equipped with a MIDDS terminal that includes workstations. The MIDDS system provides METOC data using a variety of sources. This allows for ease of METOC data flow to the customer. The main MIDDS terminal is located in the forecaster area. An additional workstation is located in the observer area. Future upgrades to this include a software build and two additional workstations.

C. Station Weather Radar (SWR):
This system will be a new upgrade for the weather service division. This system is due to be installed in late 99. The SWR will track weather systems up to 300 nautical miles away as in close as 5 miles. The system will include a 70-foot tower, Radome assembly, Radio/Transceiver unit, and A CPU unit that will be housed in the forecaster work area.

D. METeorological Mobile Facility Replacement METMF(R):
The METMF(R) is the new upgrade to the tactical weather suite. This is a significant upgrade that will increase this division's tactical capabilities. This system provides increased capability in just about every category. The unit is located via the van pad near bldg. 750.

E. Thermoscreen (ML-41):
A Cotton Region Type Thermoscreen with standard wet and dry bulb thermometers is located 50 feet east of the Airfield & Harbor Operations Building.

F. Wet Bulb Globe Thermometer (WBGT):
The WBGTI instrumentation is located adjacent to the Thermoscreen.

G. Aneroid Barometer (ML-448):
Station pressure is obtained from a wall mounted precision aneroid barometer located on the south wall of the observational area.

H. Marine Microbarograph:
A Marine Microbarograph is located on the west wall in the observational area and acts as a backup to the Aneroid Barometer.

I. Rain Gauge:
A standard 4" rain gauge is used as the primary instrument for measuring precipitation and is located 6 feet east of the Thermoscreen.

J. Weather Radar (TPS-76):
The Air Station Weather Office does not have its own weather radar. That system will be installed later this year. However, the Meteorological Mobile Facility, located near bldg. 750, does, and is currently awaiting frequency approval for use.

104. WEATHER COMMUNICATIONS EOTTIPMENT AND LOCATION:

A. Telephones: (DSN)

Weather Officer/NCOIC	253-4435/4387
Forecaster/Observer	253-3005/6931
Meteorological Mobile Facility	253-4674
FAX	253-3344/4810

B. Facsimile Machine:

A fax machine, located in the forecaster area, is used instead of a Weather Vision. It is the primary means of communicating with resident squadrons when it comes to DD175-1 briefings, weather warnings and daily forecasts. A second fax machine, with a dedicated line to the JMSDF, is also located in the forecaster area.

C. Metro Radio Freq. - 344.6 MHz Pilot to Forecaster:

The pilot to metro radio is located in the forecaster area.

D. NODDS Workstation:

An Everex PC equipped with a Motorola 9600 BPS Modem is the primary means of obtaining NODDS products and OPARS output. It is located in the forecaster area. Information received on this workstation is printed on a Kyocera 8010 Laser Printer.

E. Network Workstation:

A Unisys PC with modem and Network Interface Card, in service in the administrative area, is the primary means of communication on the Local Area Network as well as the Wide Area Network.

F. WECOM Workstation:

A PC, with a VGA Display, provides data reception of located on the Japanese Weather Service Division. All products are provided via JMA. It is located in the forecaster area.

105. AIRDROME AND LOCAL FLYING AREA:

MCAS Iwakuni has a unique situation in regard to runway configuration. Aside from it's own 8000'runway, oriented 020/200, it also has a sea lane airdrome located adjacent to the Air Station in Hiroshima Bay. The three marked sea-lanes are oriented: 040/220, 100/280, 160/340. Each sea-lane is approximately 8,000' long. *Figure 1-4*. The local flying area is best described as all of Mainland Japan west of the Central Western Japan ADIZ. It encompasses all of Kyushu, the western quarter of Honshu and the western three-quarters of Shikoku. *Figures 1-4 & 1-5.*

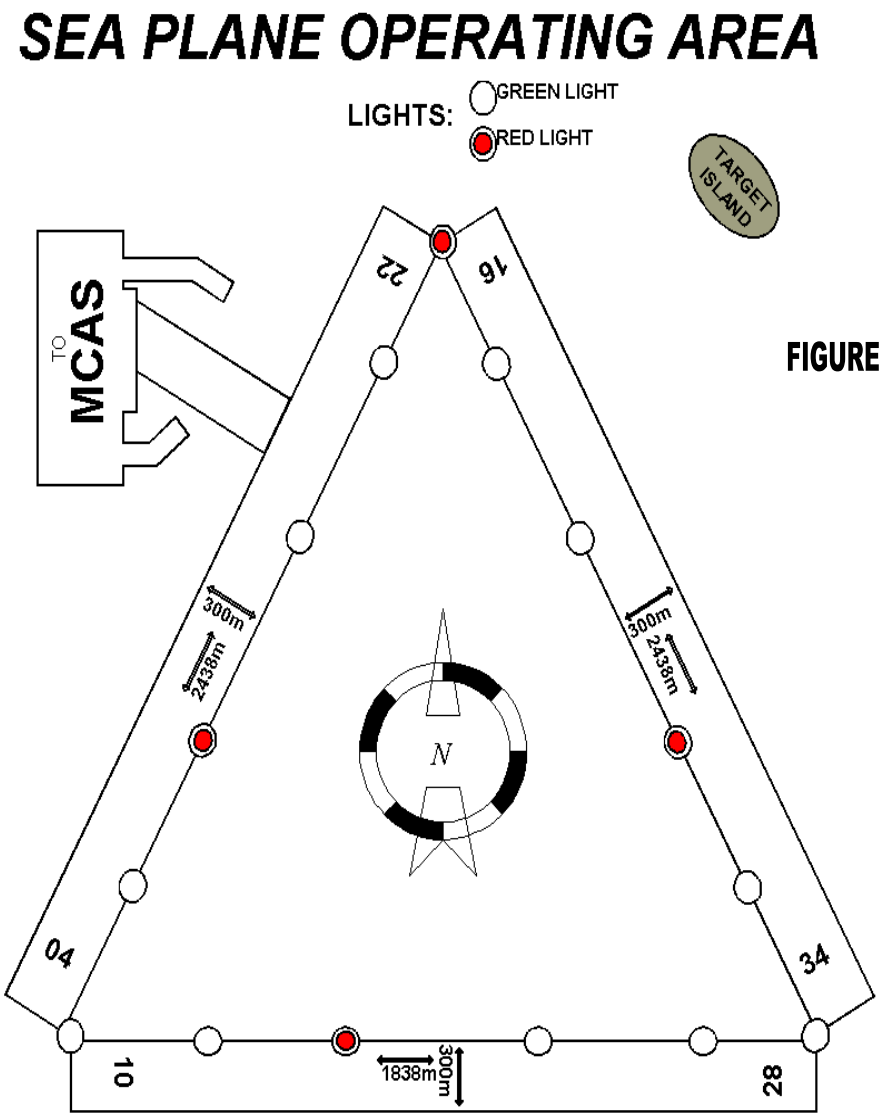


FIGURE 1-4

A. Weather Minimums:

	Ceiling	Visibility
VFR	1,000 Ft	3’miles
Special VFR(FCLP)*	800 Ft	2'miles
Special VFR(HELO)	500 Ft	1 mile
CTCA Minimums	300 Ft	3/4mile

* FCLP - Field Carrier Landing Practice

Departure and destination airports are identified by the standard ICAO location Identifiers. However, routine, and pilot reports use two and three letter NAVAID Identifiers.

106. <u>UNITS SUPPORTED</u>:
MCAS Iwakuni is home to the fixed wing arm of the 1st Marine Aircraft Wing. It is collocated with the Japanese Maritime Self-Defense Force (AISDF) who shares the 8,000' north south oriented runway. The Marine side of the Air Station has only one permanent Squadron, Station Operations Maintenance Squadron (SOMS). The squadron maintains two UC 12F aircraft and three CH46 Sea Knight Search and Rescue Helicopters. Iwakuni is also the home of Marine Aircraft Group 12, which supports the Unit Deployment Program (UDP) with squadrons rotating on a six-month basis.

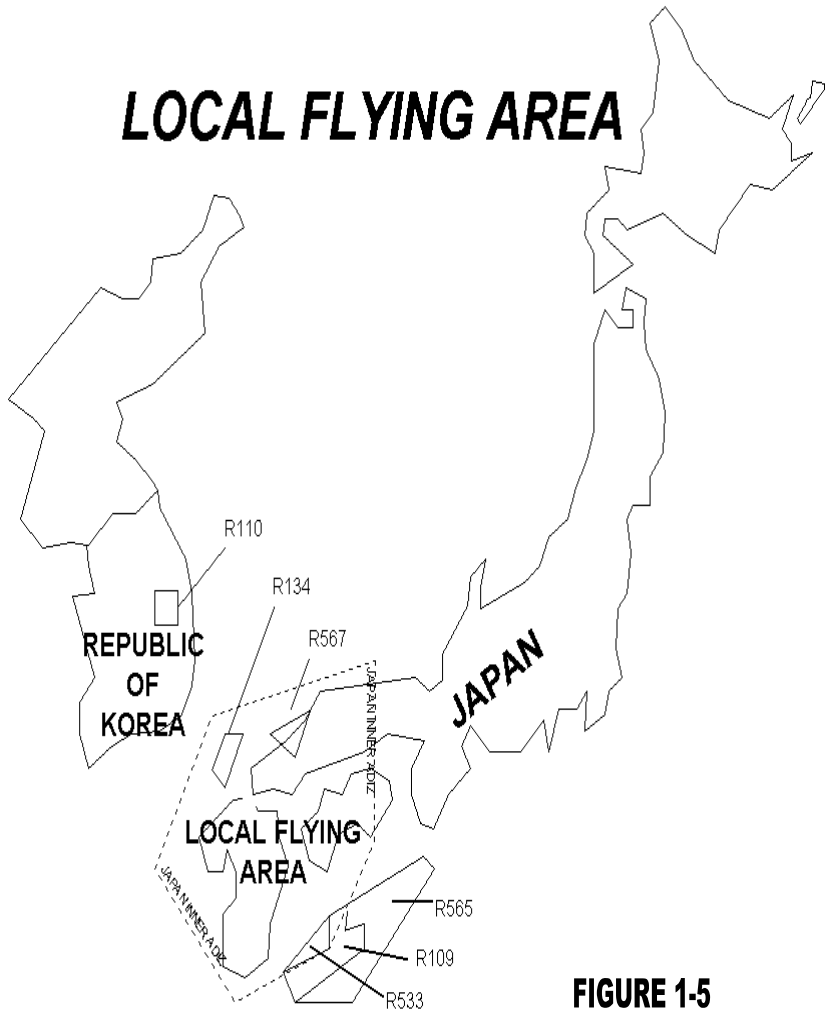


FIGURE 1-5

A. <u>Fleet Air Wing 31 (JMSDF)</u>:
Fleet Air Wing 31 consists of 2 P-3 Squadrons, 1 Squadron of US-1 Aircraft, (flying boats), 1 Squadron 0f CH-53 Helicopters and a couple of Lear Jets.

B. <u>Headquarters and Headquarters Squadron</u> (SOMS):
Two UC-12F aircraft, and three CH-46 Helicopters (SAR).

C. <u>MAG-12</u>:
All MAG-12 Squadrons based at Iwakuni participate in the UDP and consist of three F-18(A,B,C or D)squadrons, one AV8B squadron and one EA6-B squadron.

D. <u>FMF Units</u>:
1. Marine Aviation Logistics Squadron 12.
2. Combat Service Support Detachment 36
3. Marine Wing Support Squadron 171.

4. The air Station Community is provided with plain language weather forecasts via Armed Forces Radio and Television Network.

E. U. S. Army Ammunition Depot, Akizuki, Japan:
Environmental support is provided to the ammunition depot during Typhoon Season.

107. PRODUCTS AND SERVICES PROVIDED:
Services provided in support of the above commands include Flight Weather Briefs, Command and Staff briefings, Weather Observations and forecasts, destructive weather warnings, climatology, astronomical and tidal data, and strike briefings. Forecasts generated using the Geophysics Fleet mission Program Library are provided upon request.

CLIMATOLOGY

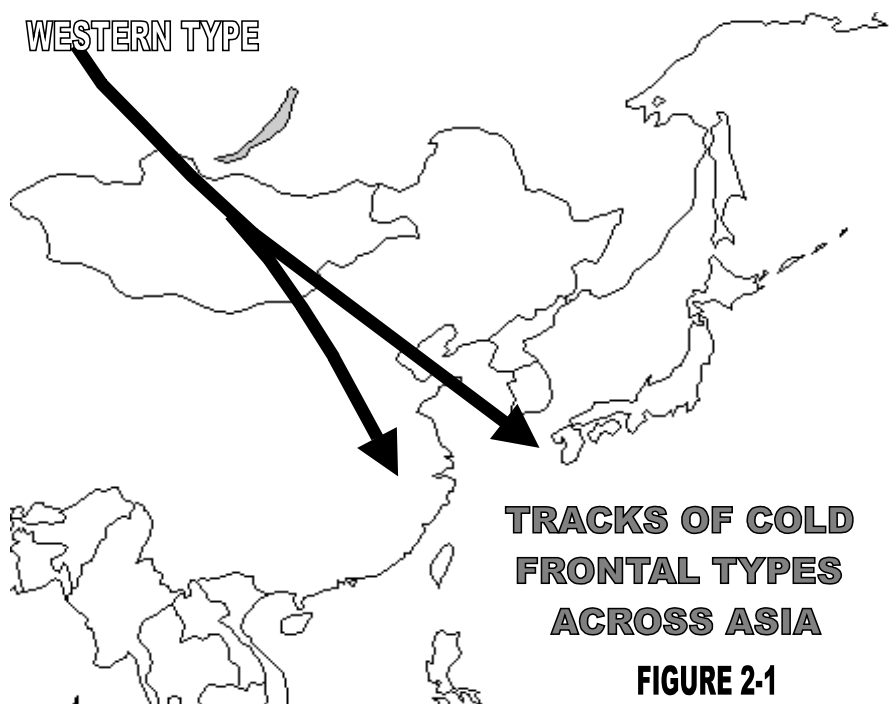
201. SYNOPTIC CLIMATOLOGY.

The source of the following descriptions is *The Environment of the South Korea and Adjacent Sea Areas, NA*VENVPPEDRSCHFAC TR77-O3 by LCDR Nestor. This publication has a detailed description of the climate and weather systems that effect Korea; therefore, most of the material could equally apply to Western Japan. Since the publication is available to all duty stations, only a brief description of systems will appear here.

202. COLD FRONT TYPES.

A. WESTERN.

Originates on the shores of the Arctic Ocean in western Siberia. It occurs throughout the year and often branches in northern Mongolia at about 47' N and 105' E. One portion travels toward the east-southeast into northern China, reaching the coast at about 40' N. The other portion, which occurs less frequently, travels south-southeast as far south as Southeast Asia. Cold fronts of this type are quite shallow and rarely cause severe falls in temperature. This type may cover the greater part of East Asia during January to February, at which time the high pressures located behind the fronts will often reach a center pressure of 1065 Mb. Relatively strong meridional flow at 500 Mb, with a long wave over the Korean peninsula, indicates Western type outbreaks. See *Figure 2-1*.



TRACKS OF COLD FRONTAL TYPES ACROSS ASIA

FIGURE 2-1

B. CENTRAL

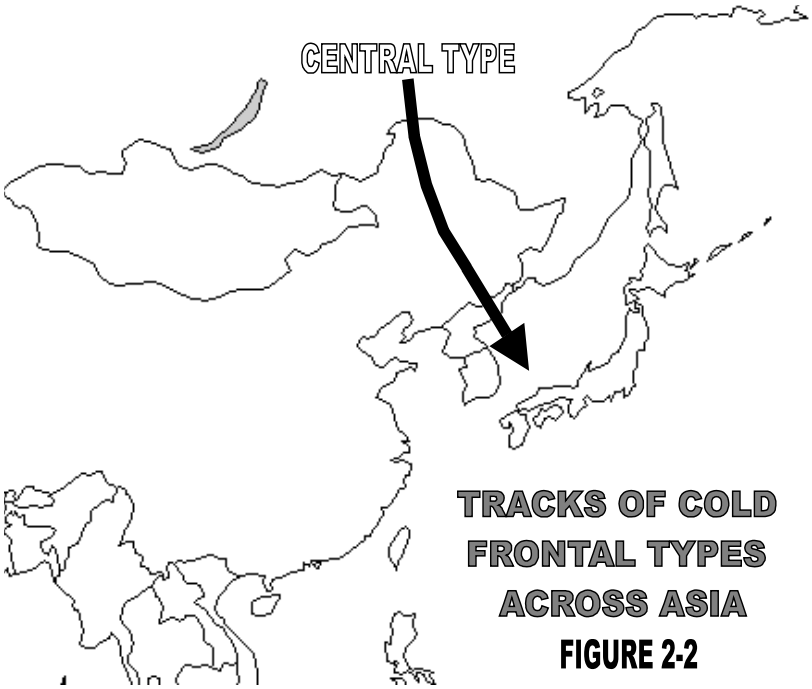


FIGURE 2-2

Originates in eastern Siberia between ’55 and ’70 N and 100 and 140 E longitude. This type also occurs frequently and is especially severe in northern and central China, Mongolia, and the Korean Peninsula. and Japan. It is considerably deeper than the Western type, and very dry, cold (significant reductions in temperature may be observed) air is associated with the system, This type is most frequently observed in mid-winter. A very strong meridional flow, or a block north of Mongolia, and a 500-Mb long wave over Japan are indicative of Central type development. (See *Figure 2-2*).

C. EASTERN.

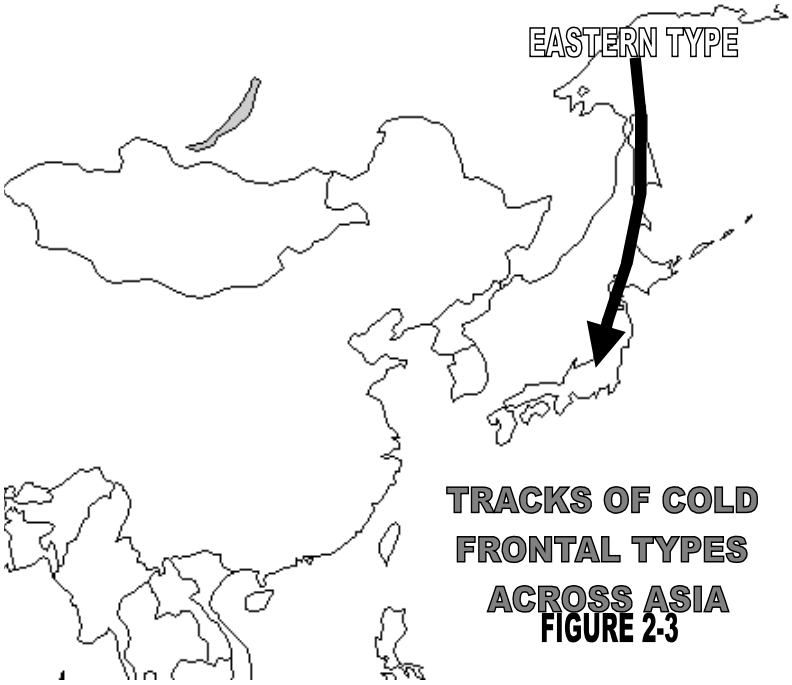


FIGURE 2-3

Forms near 60' N latitude and 150' E longitude. It travels south southwesterly, along the Siberian Maritime Provinces' eastern coast towards the Korean peninsula. This type, although not occurring as frequently as the Western and Central types, produces considerably more weather due to its maritime trajectory. Heavy rain, snow, and low overcast ceilings occur, particularly along the East Coast of Korea and along the northwestern coastline of Japan. Low centers along this front may develop very rapidly, occurring, at any time of the year, and cause

extremely high winds. This type of front occurs most frequently during spring and early summer, although eastern type outbreaks are also frequently observed in November. A well established, quasi-stationary low at 500 Mb over, or just east of the Kamchatka Peninsula, together with a high centered northeast of the Asian mainland are signs of Eastern type outbreaks. *Figure 2-3* represent the track of this cold frontal type. The first series of significant cold fronts, usually the western or eastern type, occur with threat regularity between the latter part of October and the early part of November. The second, more severe series occur around early December; and the third series, a very severe cold wave outbreak, in the latter part of January or early February.

204. WARM FRONTS.

Warm fronts can have adverse effects on the Japanese islands. Many lives are lost each year due to flooding, and landslides associated with heavy, warm frontal rains. The low ceilings and poor visibility affect aviation and boating activities as well. Warm fronts that affect the Iwakuni area occur primarily during-the autumn, winter, and spring, months. These warm fronts are associated with cyclones that generate over the East China Sea or Yellow Sea, and move eastward along the southern coast of Kyushu and Honshu. The passage of a cyclone and associated warm front cause widespread rain throughout southern Japan. The spring and autumn migrations of the polar front mark the period of maximum precipitation and cloudiness over southern Japan.

205. EXTRATROPICAL CYCLONE TYPES.

A. LAKE BIAKAL LOW (Type I).

These cyclones occur throughout the year with a maximum frequency in the spring. Their path is parabolic and they travel from the Lake Baikal region over Mongolia and Manchuria, then recurve over the Sea of Japan. With an average speed of 23 knots, they can very often be traced from lows that have originated in central Europe or Scandinavia and have migrated eastward in association with occluded frontal systems moving across the central Asian plateau. Generally, the occlusion breaks off at the triple point and a new, independent, low forms.

B. SOUTH MONGOLIA LOW (Type II).

These are the most common cyclones, occurring in all seasons and moving at an average speed of 20 knots. They follow a path over the northern most part of China, across the Korean Peninsula, and over southern Hokkaido or extreme northern Honshu.

C. HWANG HO OR SHANGHAI LOW (Type III).

These occur primarily during the spring. Originating in the upper reaches of the Hwang Ho (Yellow River) these lows travel southeastward passing over the Shanghai area before curving Northeastward, passing over the northern Ryukyu's and moving parallel to the eastern Japanese coast. These systems move at an average of 18 knots.

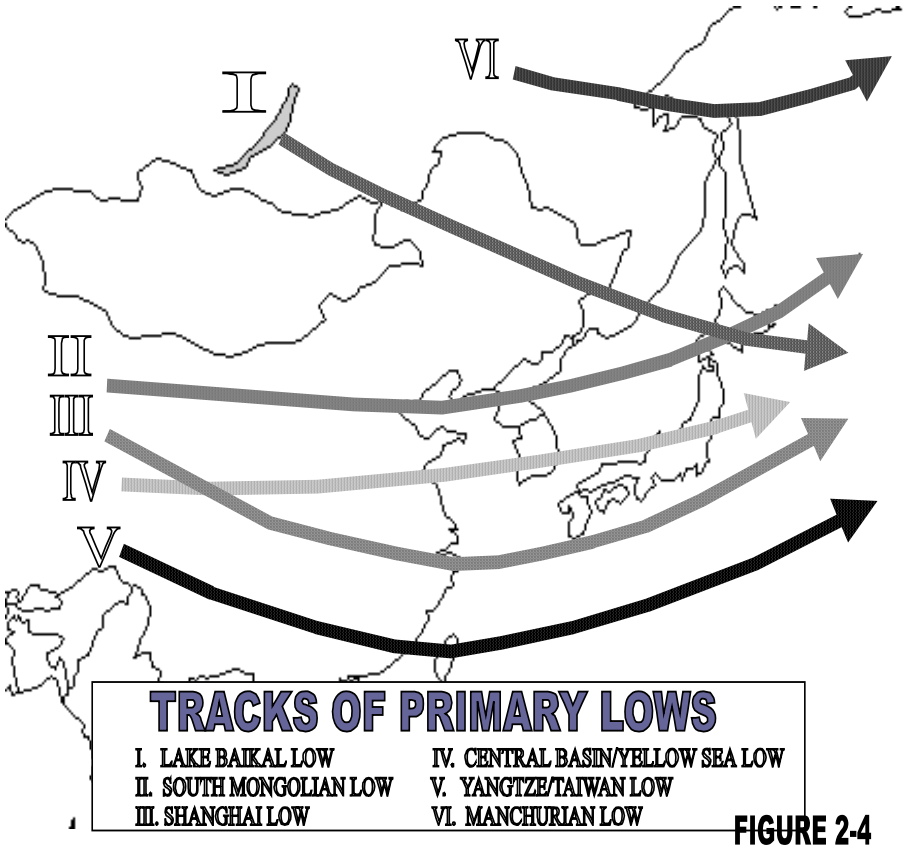


FIGURE 2-4

D. <u>CENTRAL BASIN OR YELLOW SEA LOW (Type IV)</u>.

These cyclones occur primarily in the summer and fall. Forming in the central plateau of China, these lows track in an east-northeasterly fashion, moving across the southern portions of the Yellow Sea, over South Korea and into the Sea of Japan tracking along the west coast of Honshu. These lows normally move at an average speed of 21 knots.

E. <u>YANGTZE OR TAIWAN LOWS (Type V)</u>.

These are the most rapid moving cyclones averaging 24 knots. They occur most frequently in the winter and spring months originating over the Yangtze River delta or the ocean areas near Taiwan. They move over the southern Ryukyu Islands and curve northeast, following the Kuroshio Current off the southern coast of Japan.

F. MANCHURIA LOW (Type VI).

These systems develop primarily during the fall and spring in the Manchuria area. They move over northern Sakhalin, over the Sea of Okhotsk, and over the Kamchatka Peninsula. *Figure 2-4* represents the tracks of these migratory lows.

206. UPPER AIR WINDS AND THE JET STREAM.

Japan lies within a belt of prevailing westerly upper level winds. At around 30,000 feet, strong westerly winds occur as a part of the global high level wind system in a band of strong winds known as the jet stream.

IN WINTER

In January, the axis of the jet stream blows west to east across the southern part of South Korea at average speeds of 150 knots and elevations of 30,000 to 35,000 feet. The location of the northern edge of this wind belt varies considerably, but it is usually south of Taejon, South Korea during January. In February, the jet stream is located slightly further south over southern Japan and is even stronger wit h winds close to 200 knots. In March, although the mean position of the main axis of the stream remains the same, the jet band widens, bringing, it closer to South Korea. The center of the jet is above Cheju-do with winds of 140 knots at 40,000 feet.

SPRING AND SUMMER

In April, the jet stream divides with one axis located across North Korea and Northern Honshu (the polar jet) and the other from Shanghai to Tokyo (the subtropical jet). The velocity associated with both branches decreases as spring chances to summer. By July, the southern branch has moved northward to lie over South Korea, it's speed weakened to 90 knots or even lower on occasions. This branch remains over South Korea through August and September, extending from Seoul to Tokyo at a hei2ht of 40,000 feet. As fall progresses, the. southern branch moves away to central China while the northern branch moves southward, first over North Korea and then further south with speeds increasing to 150 knots at 35,000 feet. By December, both branches converge to form one main core over the Korean Strait.

EFFECTS ON SYPNOPTIC SYSTEMS

The jet stream is at its lowest altitude and greatest ' velocity during the winter months. Its direction and flow in this region, as well as in other areas of the middle latitudes, governs the movement of low level pressure systems from west to east. Winter weather will generally originate on the west coast and move southeast. This steering effect of the jet, coupled with the funneling effect on the surface winds as they pass between the Chiri Massif in southwest Korea and Mount Halia on Cheju-do, produces high winds over the north coast of Cheju Island and surface wind velocities that average 17 to 19 knots. Good correlation between the mean jet axis and trajectories of prevailing storms exist over the Korean Peninsula in summer. Irregular or anomalous jet stream behavior may be observed during any month, but it occurs most frequently durina spring and fall.

207. CLOUD COVER.

On a yearly average most of Japan, including Iwakuni, has 6/8 (averaged over 24 hours day/365 days) of cloud cover. The exceptions are the northwest coast area with 7/8. The southeast coast of Kyushu and the Kanto Plains area with 5/8 coverage. Like Iwakuni, the southern half of South
Korea has 6/8 coverage and the rest of South and North Korea have 5/8. The winter cloud pattern sets up during November and continues though February. The most cloud cover (8/8) occurs on the northwest coast of Japan. Cloudiness diminishes toward the leeward side (south and east) of Japan with minimums occurring in southeast Kyushu and the Kanto Plains. The summer cloud pattern sets up beginning in April and continues through September. During this period, a large area of 6/8 to 7/8 cloudiness covers Korea, China, and Japan. Maximum cloudiness during, this period occurs in the south and east portions of Japan. This is a reversal of the winter situation.

208. SYNOPTIC CHARTS.

Figure 2-8 Is a calendar for major systems discussed in the Climatology section. Figures 2-9 through 2-20 show the mean wind flow, the jet stream, and the equatorial zone of convergence for each month. The mean low level wind flow is represented by continuous streamlines without respect to speed.

<table>
<tr><th colspan="6">MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB</th></tr>
<tr><th colspan="2">SPRING</th><th colspan="2">SUMMER</th><th colspan="2">FALL</th><th colspan="2">WINTER</th></tr>
<tr><td colspan="2">MIGRATORY HIGH TRANSITION PERIOD</td><td colspan="2">PACIFIC HIGH SOUTHERLY MONSOON</td><td colspan="2">TRANSITION PERIOD</td><td colspan="2">SIBERIAN BUILDS NORTWEST MONSOON</td></tr>
<tr><td colspan="2">POLAR FRONT SOUTH OF TAIWAN MOVING NORTH</td><td colspan="2">POLAR FRONT OVER KYUSHU MOVING TO NORTH KOREA</td><td colspan="2">POLAR FRONT OVER KYUSHU MOVING SOUTH</td><td colspan="2">POLAR FRONT SOUTH OF TAIWAN</td></tr>
<tr><td colspan="2">WEAKENING JET OVERHEAD MOVING NORTH</td><td colspan="2">WEAK JET CENTRAL MOST NORTHERLY POSITION IN JULY</td><td colspan="2">ORGANIZING JET CENTRAL MOVING SOUTH</td><td colspan="2">STRONG JET OVERHEAD MOVING SOUTH, MOST SOUTHERLY POSITION IN FEB</td></tr>
<tr><td colspan="2">THIRD SERIES OF OUTBREAKS CONTINUES</td><td colspan="4">TYPHOON THREAT</td><td>FIRST ARCTIC OUTBREAKS BEGIN</td><td>SECOND MORE INTENSE SERIES</td><td>THIRD SERIES SEVERE OUTBREAKS BEGIN</td></tr>
<tr><td colspan="2" rowspan="2">MAX FREQUENCY FOR LAKE BAIKAL LOWS,SHANGHAI LOWS, TAIWAN LOWS, AND MANCHURIA LOWS</td><td colspan="4">MAX FREQUENCY FOR YELLOW SEA LOWS</td><td colspan="3">MAX FREQUENCY FOR TAIWAN LOWS</td></tr>
<tr><td colspan="2">AIRMASS THUNDERSTORM MAXIMUM</td><td colspan="2">SECOND MAX MANCHURIAN LOWS</td><td colspan="3">BREAKOFF BUBBLE HIGH CYCLOGENESIS BEGINS</td></tr>
<tr><td colspan="8"></td></tr>
<tr><th colspan="8">HAZE AND SMOKE</th></tr>
<tr><td colspan="2">MINIMUM</td><td colspan="4">MAXIMUM</td><td colspan="3">MINIMUM</td></tr>
<tr><th colspan="8">PREVAILING SURFACE WIND DIRECTION</th></tr>
<tr><td colspan="3">WEST-NORTHWEST</td><td colspan="2">SOUTH</td><td colspan="3">WEST-NORTHWEST</td></tr>
</table>

Figure 2-8

JANUARY

An intense cold high-pressure cell is located over the Steppes of Siberia with a low-pressure cell over the Aleutian Islands. Cold, dry air flows from the Arctic southward along the east coast of Asia. The northerly flow of cold, dry air being transported from the interior of Asia has little opportunity to acquire moisture before reaching Korea. While moving across the

Sea of Japan, it is modified considerably. It acquires enough moisture to create extensive cloudiness, precipitation, and milder temperatures alone, the West Coast of Japan. Along the slopes of western Japan the majority of the clouds are convective. Therefore, low level turbulence is frequently encountered while flying in this region. To the east of the mountain range, weather conditions improve appreciably. Here most of the locations enjoy their best weather. Although passing cold fronts cause some low cloudiness, more often, only middle or high clouds are observed. (See Figure 2-10).

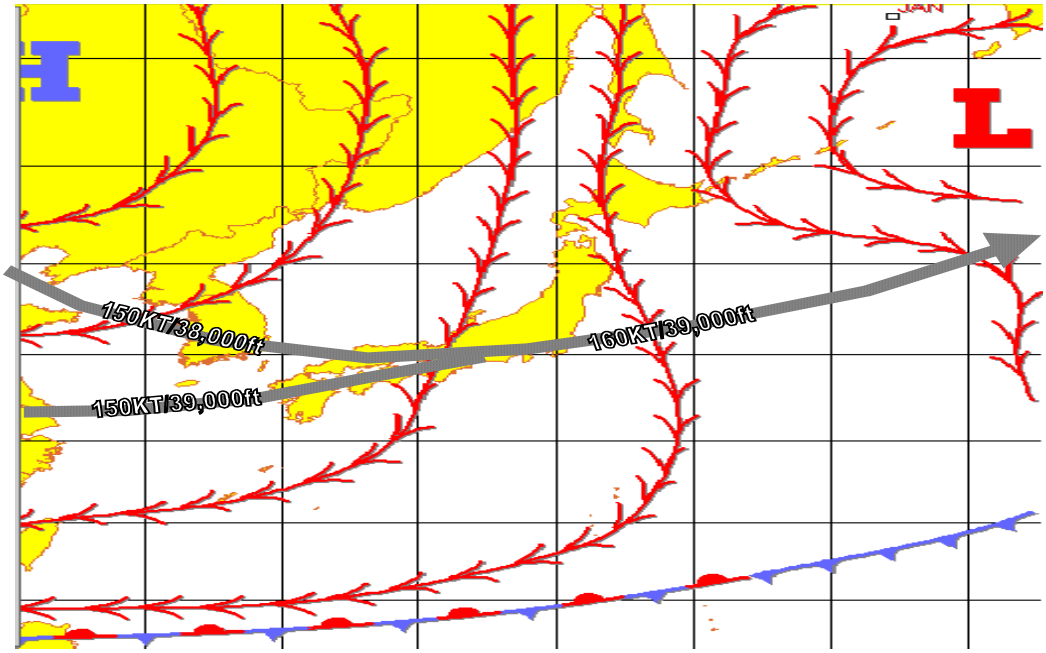


Figure 2-10

FEBRUARY

The Siberian High still maintains control over the weather. From Asia's vast reservoir of frigid wintry blasts still surge over Korea, Japan, and Taiwan. Japan, with her alpine backbone liberally sprinkled with snow, has a divided weather personality. The western and northern portions are cold and overcast with frequent snows. Cumulus buildups are common in this area, particularly in the mountain regions. Southern and eastern Japan are relatively warm with much less cloudiness. Here, however, widespread cloudiness and precipitation occur several times during, the month as storms which originate in the East China Sea move eastward to the south of Japan. Cold fronts which cross the Sea of Japan temporarily aggravate the generally inclement weather over western Japan. These same fronts often produce sunny weather on the east of the mountain divide.

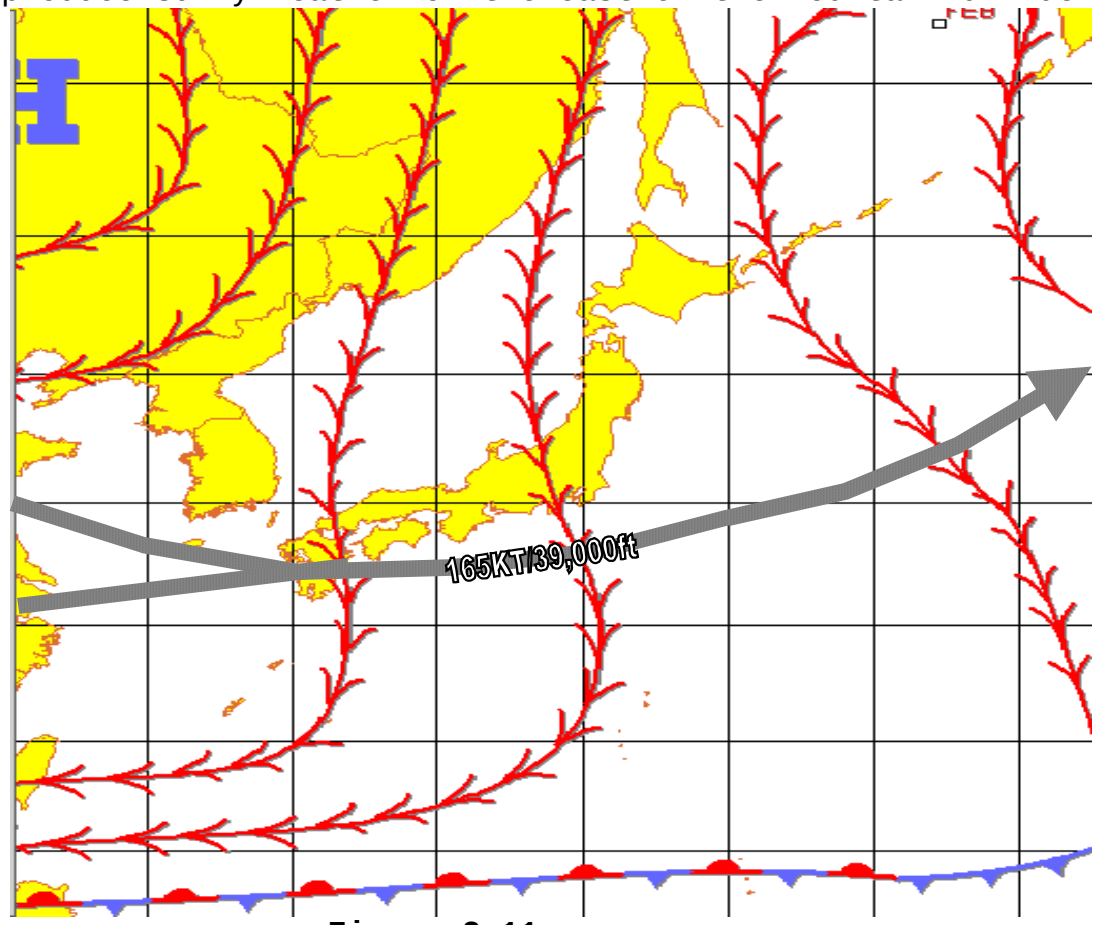


Figure 2-11

MARCH

Even though the Siberian High is in the weakening stages it still dominates the Far East. Northern Japan will continue receiving snow and maximum temperatures and will remain just above freezing. About four to six times during March, lows develop between Taiwan and the area of Shanghai. They move eastward, intensifying rapidly as they progress. The westerly and southerly flow, which briefly precedes these storms, brings warm air as far north as southern Korea and northern Honshu. These short periods of warmer weather are a promise of better things to come. However, as the cold front associated with the storm passes, wintry weather returns. Frontal weather becomes most hazardous during the latter part of the month. Thunderstorms, turbulence, icing, and intense rain occur throughout cold frontal areas. Warm fronts are spotted with occasional thunderstorms, which are often embedded in surrounding stratus clouds and rain.

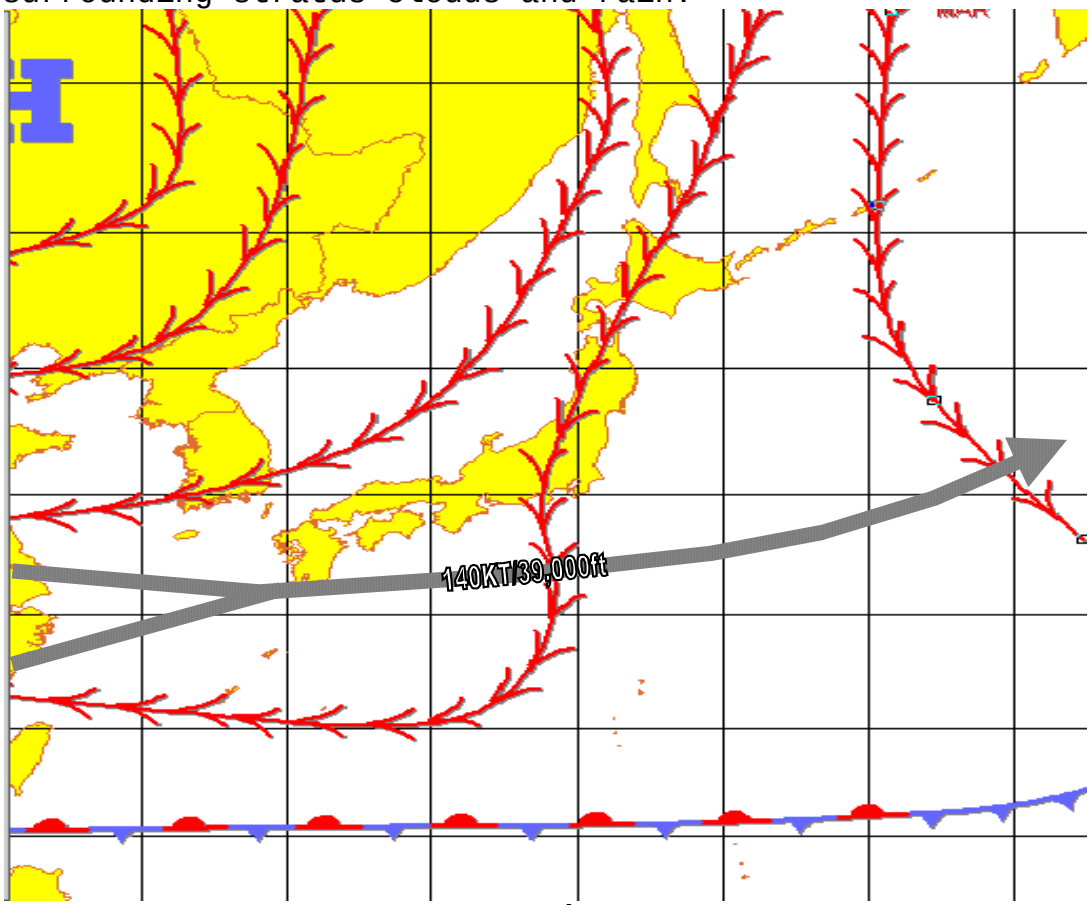


Figure 2-12

APRIL

The Siberian High continues to loosen its grip on the Far East. The western coastal areas of Korea and Japan gradually lose the high's cloud cover during April. Tile polar front retreats slowly northward and the number of waves increase along the front bringing in more cloudiness and precipitation to southern Japan and the areas east of Japan's central mountain divide. Throughout Japan and Korea, temperatures are 10 degrees warmer than during March even though cold temperatures do occur on occasion. In the past, snow has been reported in southern Japan during April, but it is rare. Northern Honshu and Hokkaido can still expect some snowfall during the first part of the month.

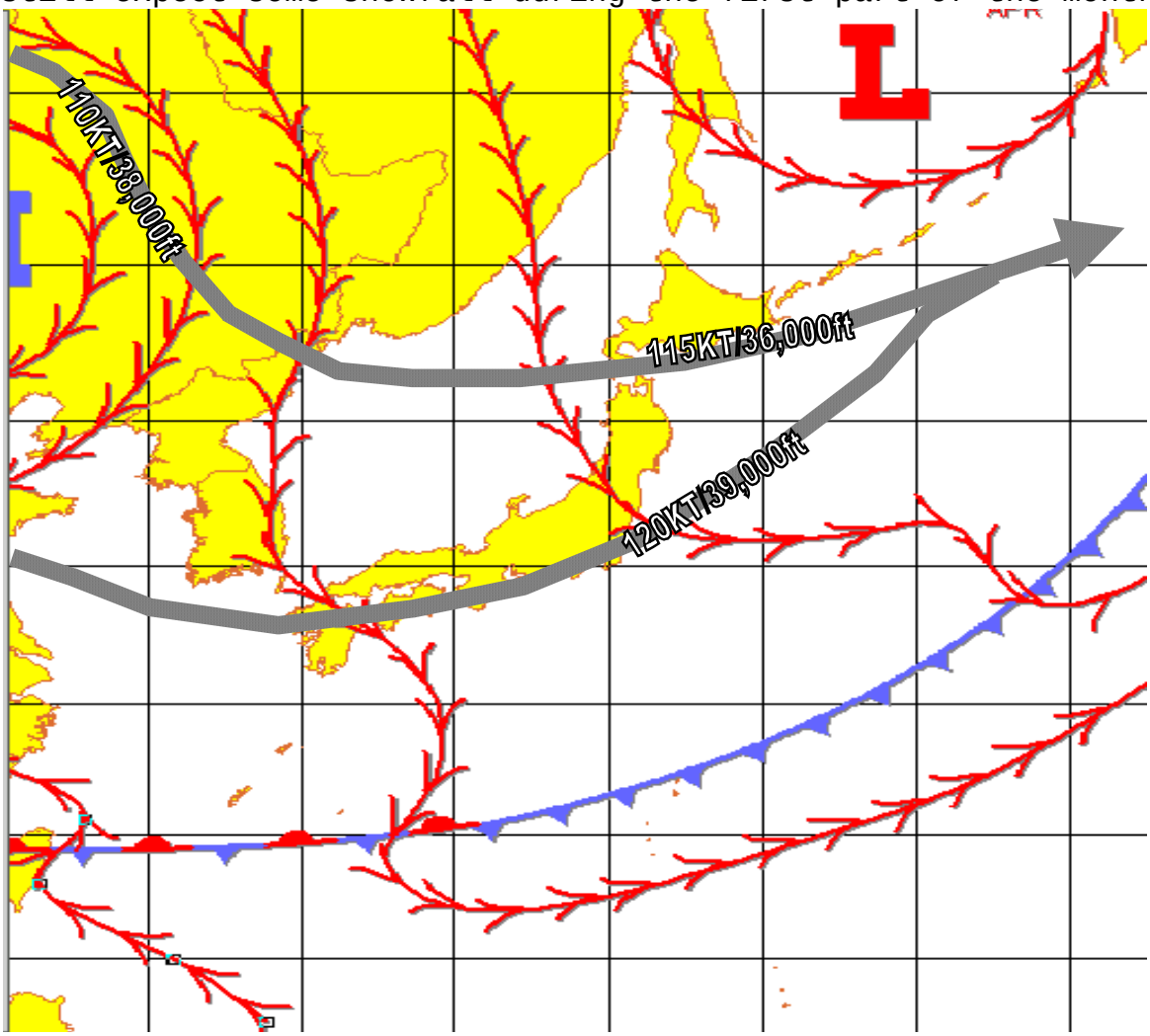


Figure 2-13

MAY

No large-scale pressure system dominates Japan during May. The cold Siberian High is weak and has retreated far to the north and west of its winter position. A westward extension of the

Kamchatka Low has deepened to form a large, but not intense, low-pressure center, near the Manchuria-Russian border. A broad trough of low pressure lies over the Yellow Sea and Southeastern China. Migratory storms tend to Form in the area where this trough and the polar front intersect. The western extremity of the warm Pacific High pushes slightly over southern Japan, but it is not a dominating influence. Storms form on the polar front more frequently than during preceding months and generally affect the southern coasts of Japan.

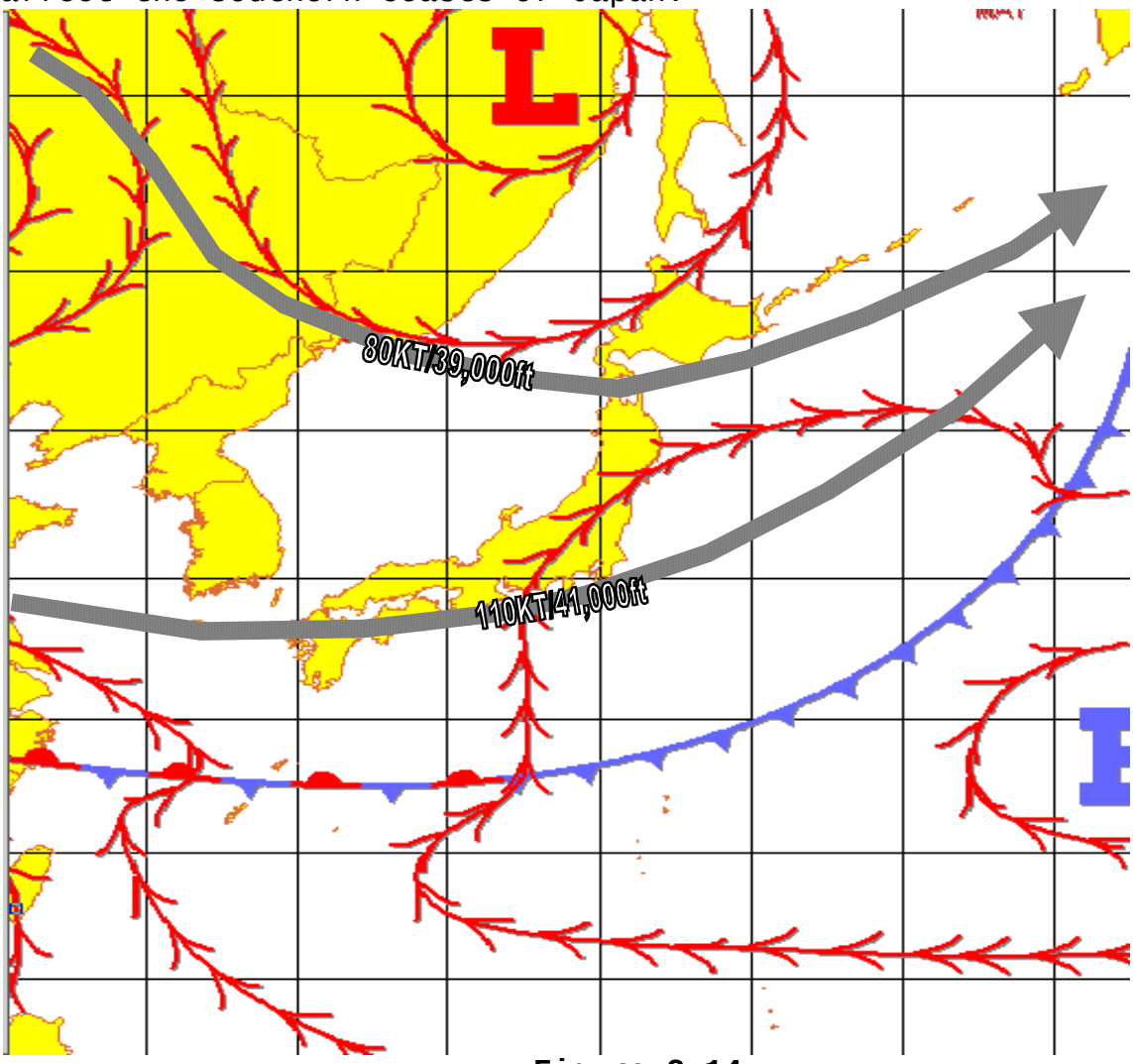


Figure 2-14

JUNE

This is the month that signals a major change in weather patterns. The polar front is the dominant force behind most of these meteorological changes. From Shanghai eastward to the southern tip of Kyushu, then northeastward parallel to the

southern Japan coast, the front acts as a buffer zone between the cool northern air mass and the warm southern air. As long as the cool air persists over Japan, the tropical air is forced aloft to form vast, deep layers of clouds from which falls persistent, light rain. This is the BAI-U season (literally, it means "Plum-Rain") which prevails over Japan. It has been known to begin as early as the middle of May. Once established, it tends to persist, producing a period of perpetual cloudiness, continuous drizzle and constant dampness. The only relief from the monotony of the BAI-U is the occasional passage of a cyclonic storm. If the storm cell is large, a day or so of fair weather may follow, but the BAI-U is quick to reassert itself.

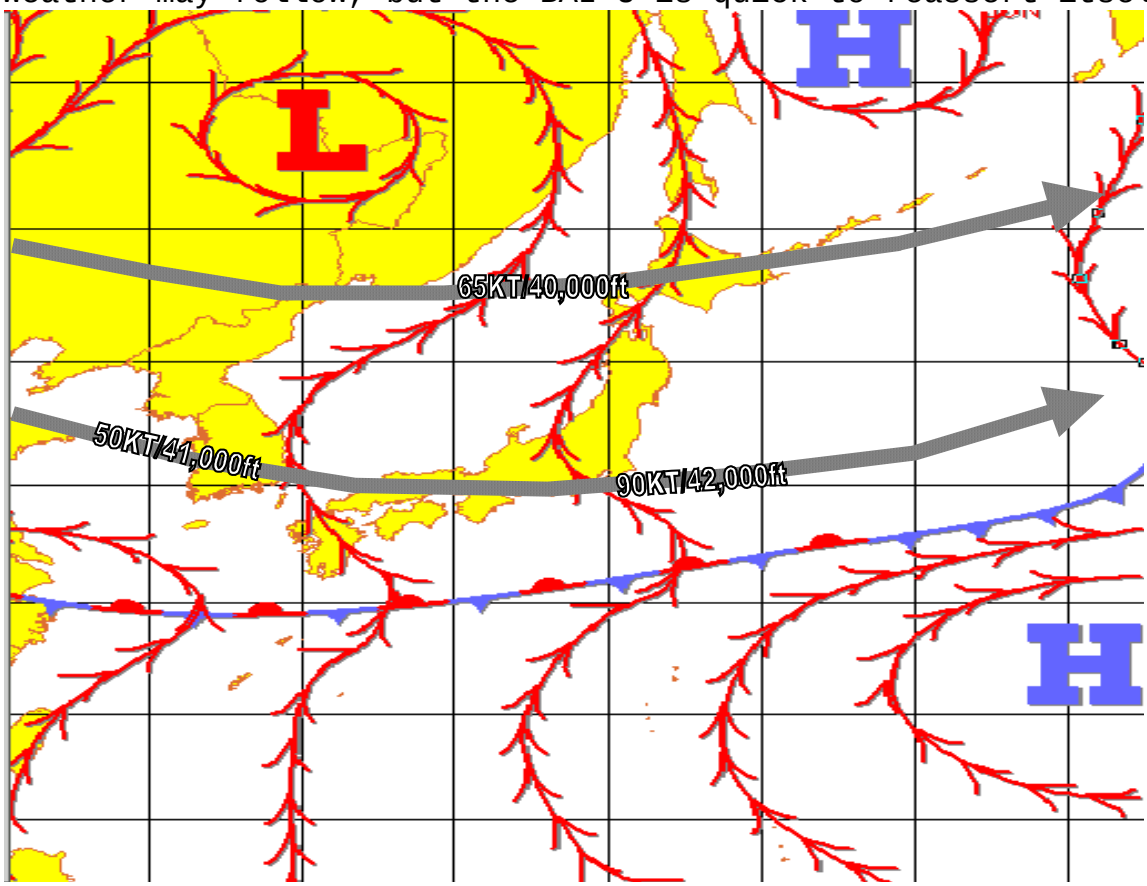


Figure 2-15

JULY

The BAI-U ends in southern Japan about the middle of July and in Korea, northern Honshu, and Hokkaido about the end of July. The Pacific High expands westward into the East China Sea while large continental low settles over northern China. The polar front extends southeastward from the plains north of Shanghai to Cheju-do, then northeast along the west coast of Honshu and from

there curves gently northeast into the northern Pacific Ocean. Throughout Japan rainfall decreases during July, especially after the end of the BAI-U. Instead of the steady rain of the BAI-U season, precipitation tends to fall as showers or is associated with thunderstorms. In northern Japan, dense fog, is a frequent occurrence. In fact, northern Honshu and the east coast of Hokkaido are plagued with fog throughout the remainder of July and August even though the polar front will have moved well to the north of that area. Shallow cold fronts push across Korea and the Sea of Japan three or four times during July. These fronts often appear to stall for several days in the Korean Straits and against the mountainous west coast of Honshu. These "hesitant" fronts bring the wettest month of the year to Korea.

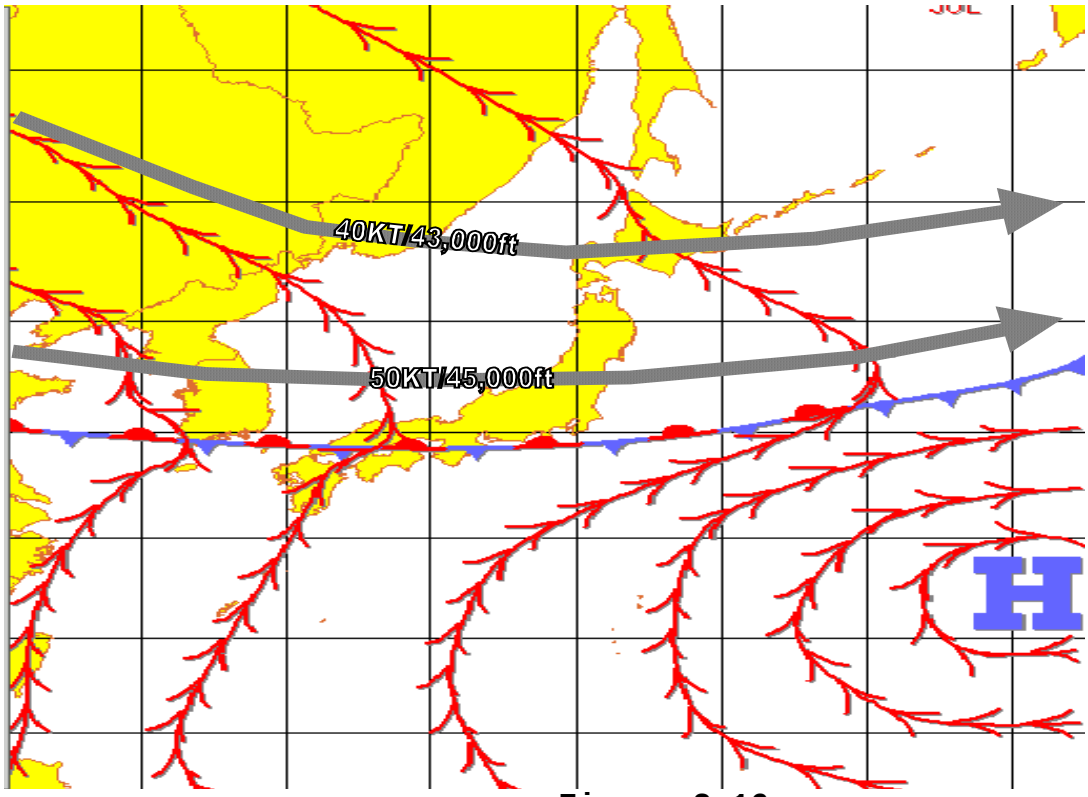


Figure 2-16

AUGUST

August is normally a "hot July" and the most typical summer month of the year. Nature unleashes her most discomforting tricks of high humidity and higher temperatures during this month. The polar front remains well north of Hokkaido and North Korea. Cyclonic lows that develop along the front bring some of the heaviest rains of the year to central and northern Korea. Over Japan, the only break in the heat and humidity comes in the

form of typhoons. August is the month most likely to have a typhoon hit Japan. Fog and low stratus, which affect the northeast coast of Honshu and the southeast coast of Hokkaido, show a small decrease from the July maximum. Elsewhere, weather may be classified a "typical tropical." A typical pattern will show cumulus clouds developing by midmorning and the amount increasing until late afternoon. By late afternoon many of the clouds will have built up to where they produce showers or even thunderstorms. Clouds, showers and thunderstorms dissipate rapidly during evening hours.

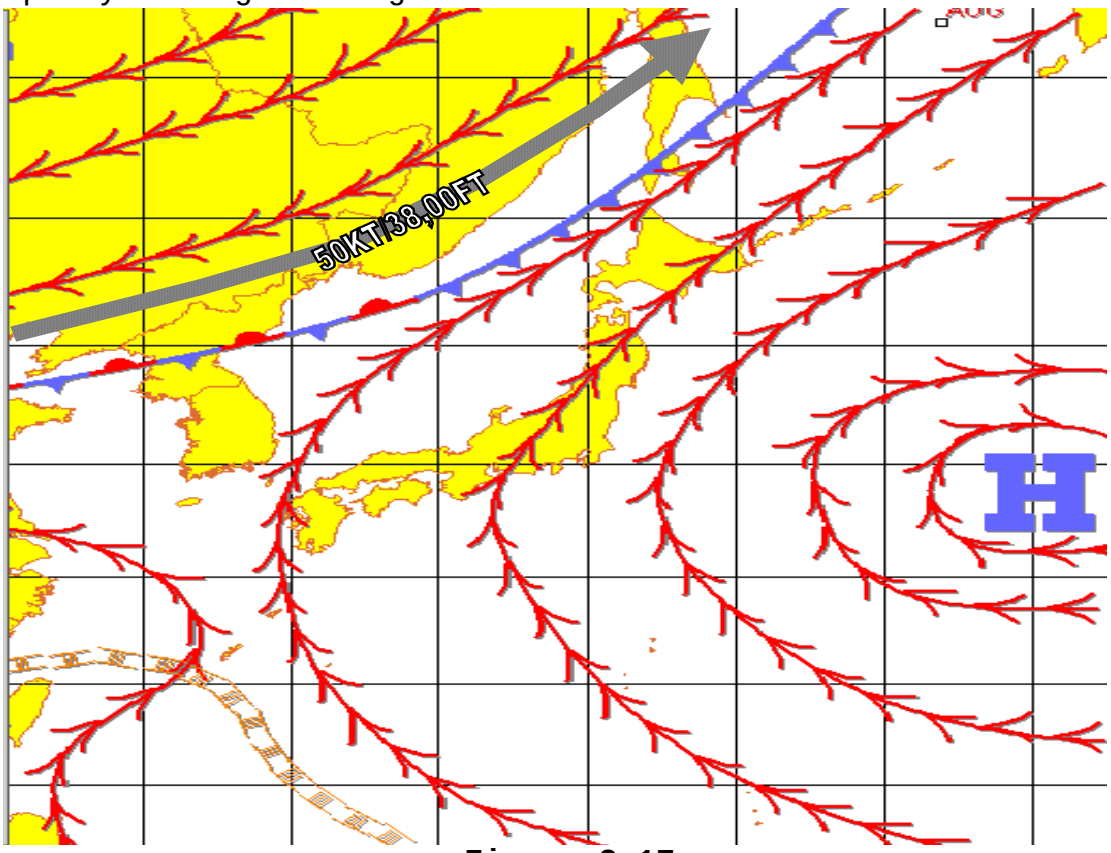


Figure 2-17

SEPTEMBER

In early September, the polar front begins moving rapidly towards the south from a position over northern Hokkaido. The movement of the front as it heads south can be traced by a wide band of rain, low ceilings and poor visibility in the area along and behind the front. The overall result is the replacement of the southerly flow of warm, moist tropical air of the summer monsoon with a cooler, drier northerly flow of air emanating from the Siberian High Pressure Cell. With continued

strengthening of the Siberian High, the polar front moves south of Okinawa by the end of the month. Along the front a wide band of low stratus and rain occurs. This is especially true along the east coasts of Japan and Korea where poor weather conditions prevail westward to the mountain ranges. During this month Japan's temperatures drop from "hot summer" to "cool autumn". The cooling trend is broken at times by the passage of typhoons.

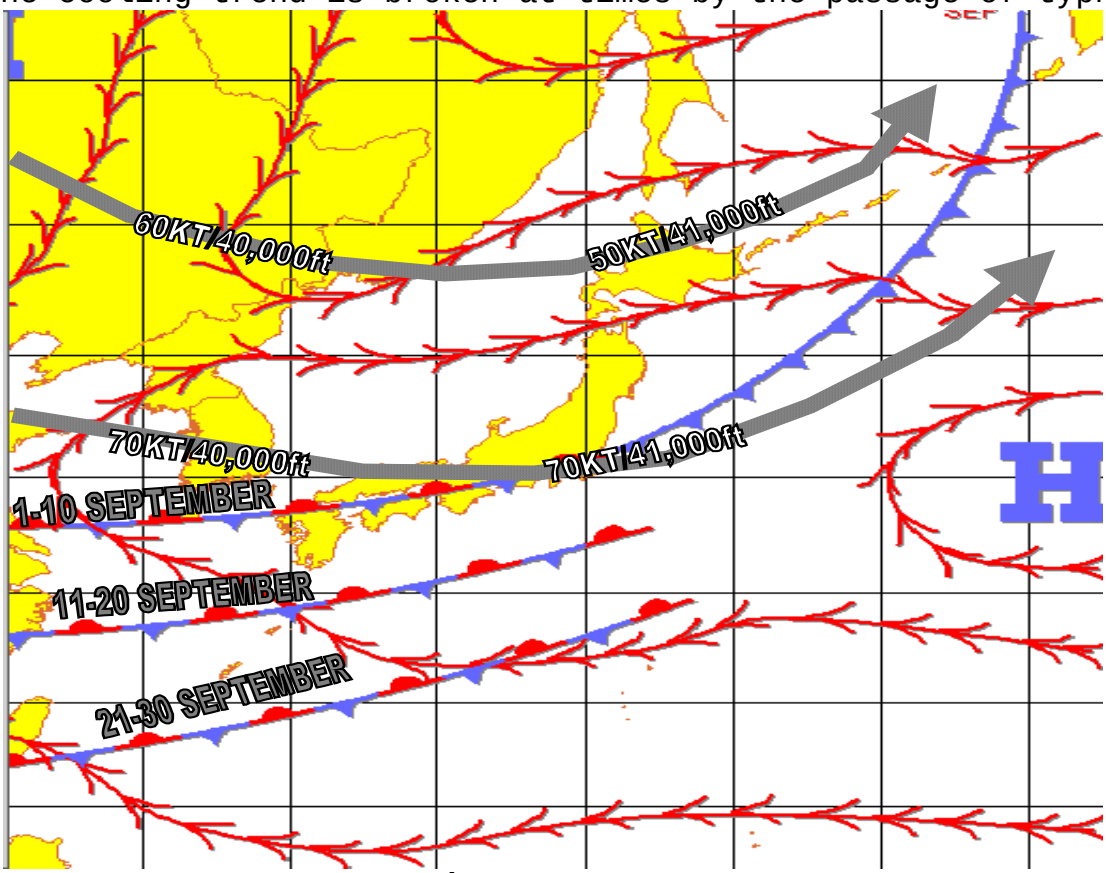


Figure 2-18

OCTOBER

The building of the Siberian High, which became noticeable in September, continues during October. Most of the Western Pacific notices the effects of this large-scale change when polar air masses, breaking away from the Siberian High, are carried southward. By October, these surges of polar air become stronger and more frequent. As a result, the mean position of the polar front extends from near Hong Kong to the south of Taiwan and then northeastward to the vicinity of Iwo Jima. North of the Ryukyu Islands the weather cools and becomes less humid. Korea, now under the influence of cool, dry air

experiences an increase in the frequency of sunny days. This same polar air, passing over the warm waters of the Sea of Japan, gains sufficient moisture to produce cumulus and stratocumulus clouds over the sea and along the western shores of Japan. Weather conditions are much better south and east of the Central Mountains of Japan. Fog near Misawa and Hokkaido becomes a rare phenomena. Most of the cloudiness that occurs over eastern Japan is associated with migratory lows, which develop on the polar front near the China coast. Despite a relatively large number of such storms. Many days with fair weather are found sandwiched between the passing lows.

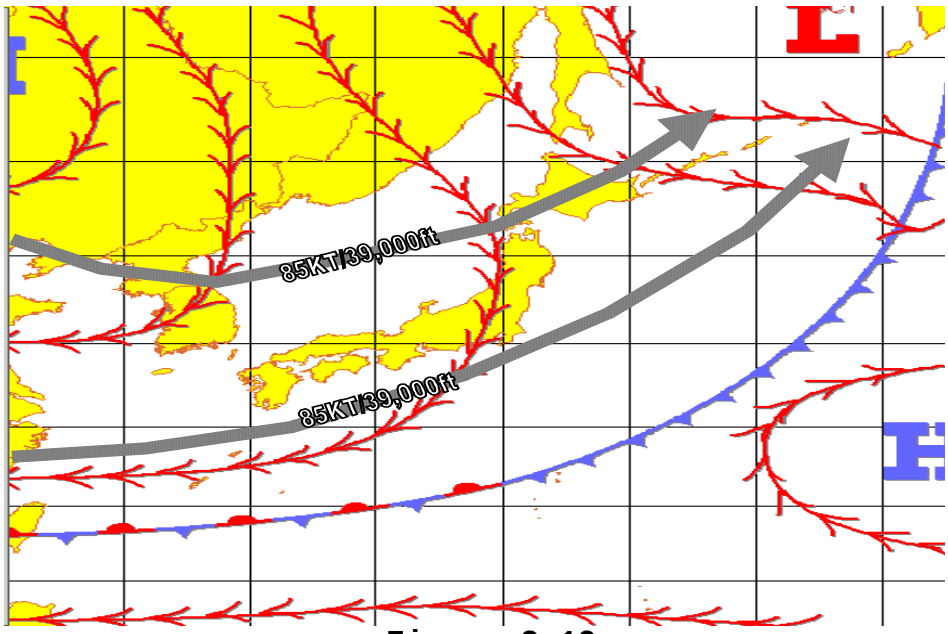


Figure 2-19

NOVEMBER

The Siberian High has now become the dominant weather feature over the Western Pacific and the Far East. The leading edge of the cold polar air has pushed as far south as the Philippines. With the exception of the western Japanese coastal areas, conditions during November are quite similar to October. The northerly flow of dry air over Korea results in excellent weather there, but this same air, as it travels over the warm sea between Korea and Japan, picks up sufficient moisture to cause extensive clouds along the west coast of Japan. These clouds pile up against the mountains and cause overcast skies and precipitation. East of the mountain chain, clear skies are frequent although smoke and haze mar the otherwise excellent

weather. Poor weather is associated with frontal passages or developing low-pressure centers. Freezing temperatures and snow showers can be expected in Hokkaido, the northern part of Honshu and Korea. Freezing temperatures and snow, although they do occur occasionally, are rare in the rest of Japan.

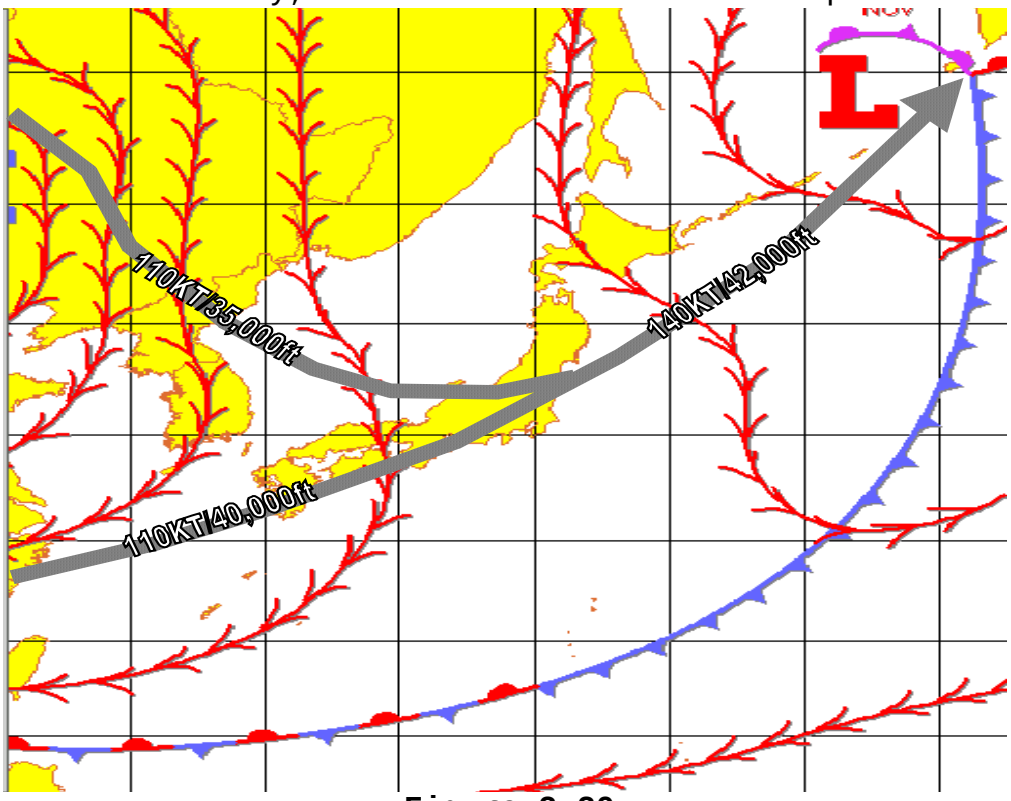


Figure 2-20

DECEMBER

The Siberian High has become intense and the overpowering influence on Japanese weather. The Aleutian Low has deepened and is located at the western tip of the Aleutian Islands. Cold, dry air flows from the Arctic regions southward along the east coast of Asia, across Korea and Japan to near Iwo Jima and Okinawa. The extreme cold air flowing the interior of Siberia is modified slightly before reaching Korea. By the time the air has reached the southern part of the Korean Peninsula, the air has warmed and the mean air temperature is slightly above freezing. Korean temperatures are at times severe, but cloudiness is at a minimum. The cold, dry Siberian air gains considerable moisture while crossing the Sea of Japan. As a result, the portion of Japan west of the Central Mountain Range experiences extensive cloudiness and precipitation. In northern and west-central Japan

precipitation is usually in the form of snow, while rain occurs in southwestern and southeastern Japan. East of the Central Mountain range, snow showers are an infrequent occurrence. Most of the snow comes as a result of being wind blown from clouds over the mountain areas.

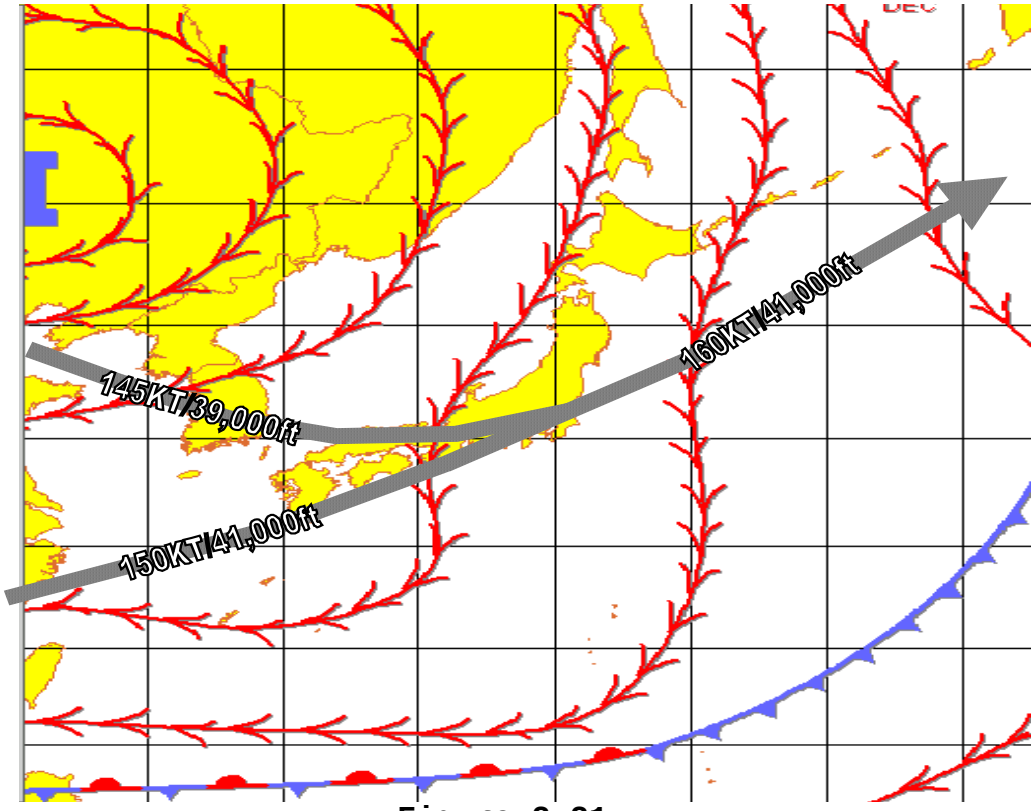


Figure 2-21

209. TROPICAL CYCLONES.

A. 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 doldrums 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 Mb flow above a genesis point is typically from the east. Intensifying disturbances will also initially show upper tropospheric warming of one to three degrees Celsius between 500 and 1,000 Mb.

B. SUBTROPICAL TYPE.

The "subtropical" type tropical disturbance accounts for only about 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 of development occurs in a climatological environment normally considered unfavorable for genesis (i.e. Deep Easterlies). It is typically associated with a sharp upper tropospheric trough or shear line located two to three degrees west of the disturbance center. The characteristic wind flow associated with this type of development is portrayed in *figure 2-21*.

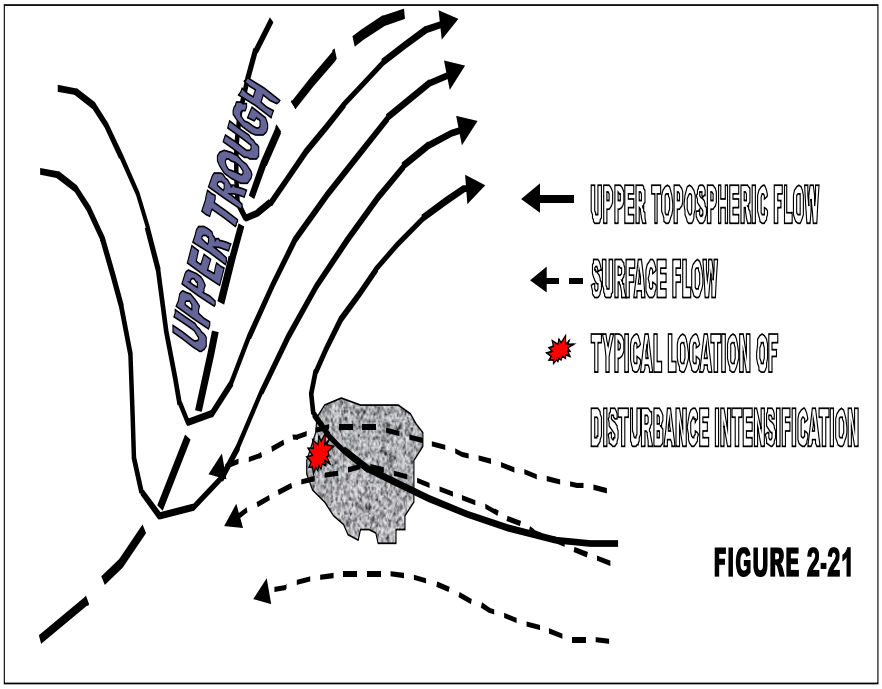


FIGURE 2-21

C. <u>HYBRID</u>.

There is a hybrid type of warm core system that accounts for only one percent of the tropical cyclone cases. It usually occurs between 25 and 35' N, 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.

210. <u>TROPICAL CYCLONE TRANSFORMATION</u>.

A tropical cyclone is identified as becoming "extra-tropical" when it loses its tropical characteristics. The term implies both northward displacements from the tropics and the conversion of the cyclone's primary energy sources from latent heat release

to baroclinic processes. It does not carry any implications regarding the storm's strength or size. There are three cases of the extra tropical evolution.

A. 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.

B. COMPOUND.

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

C. DISSIPATION.

The tropical cyclone decays and dissipates over water without becoming extra-tropical.

D. CHARACTERISTICS.

The following are characteristics of tropical cyclones as they evolve into extra-tropical cyclones:

1. Winds observed are in excess of the values that central pressures would indicate. The maximum wind area does not always relates to direction of the storm’s movement.

2. 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 MB become stratiform. Remnants of the wall cloud observed by radar appear to rotate rapidly and at times the wall cloud completely disappears.

3. There is a lack of torrential precipitation and, many times, there is no precipitation.

4. Light to moderate clear air turbulence (CAT) occurs over a broad area surrounding the storm.

211. TROPICAL CYCLONE CLIMATOLOGY FOR IWAKUNI.

It is possible for tropical cyclones to form during any month or season however, those affecting the Japanese Islands and hence Iwakuni, are confined for the most part, to the spring through fall months, with late summer and early fall being the most likely period of an occurrence. In June, the "threat" is generally from the southwest. In July and August, it is from the south and southeast. During September and October, the "threat" is generally out of the south and southwest. The majority of the storms making their approach from the south and southwest indicate that they are already undergoing recurvature and are
therefore beginning to weaken even before reaching Japan. This weakening coupled with the mountainous topography surrounding the Hiroshima Bay Region, accounts for substantially reduced winds associated with tropical cyclones. It must be kept in mind that although the effects of are reduced quite effectively, destructive winds can and may occur n the Bay Region with any tropical cyclones Although destructive winds from tropical storms have occurred, it must be mentioned that winter extra-tropical systems have caused destructive winds at Iwakuni that equal those experienced from tropical systems. The maximum gust recorded at Iwakuni was 78 knots during Typhoon Mireille in September 1991. However, during March 1954, maximum gusts of 54 knots were associated with extra-tropical cyclones. Additional information on climatology of tropical cyclones can be found in the following publications: North Pacific Tropical Cyclone Tracks (TR 88-10) and the Annual Tropical Cyclone Report generated from the Joint Typhoon Warning Center. The typhoon tracks for each month are depicted by **figures 2-22** through **2-33**.

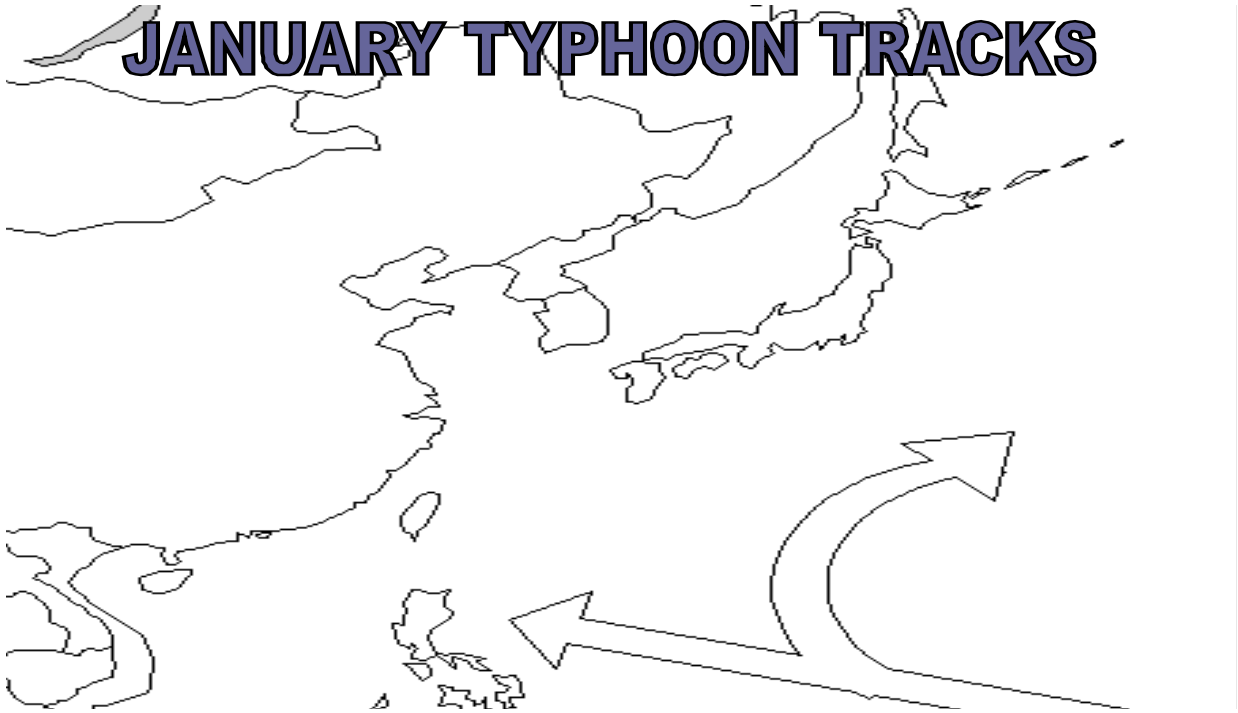


FIGURE 2-22

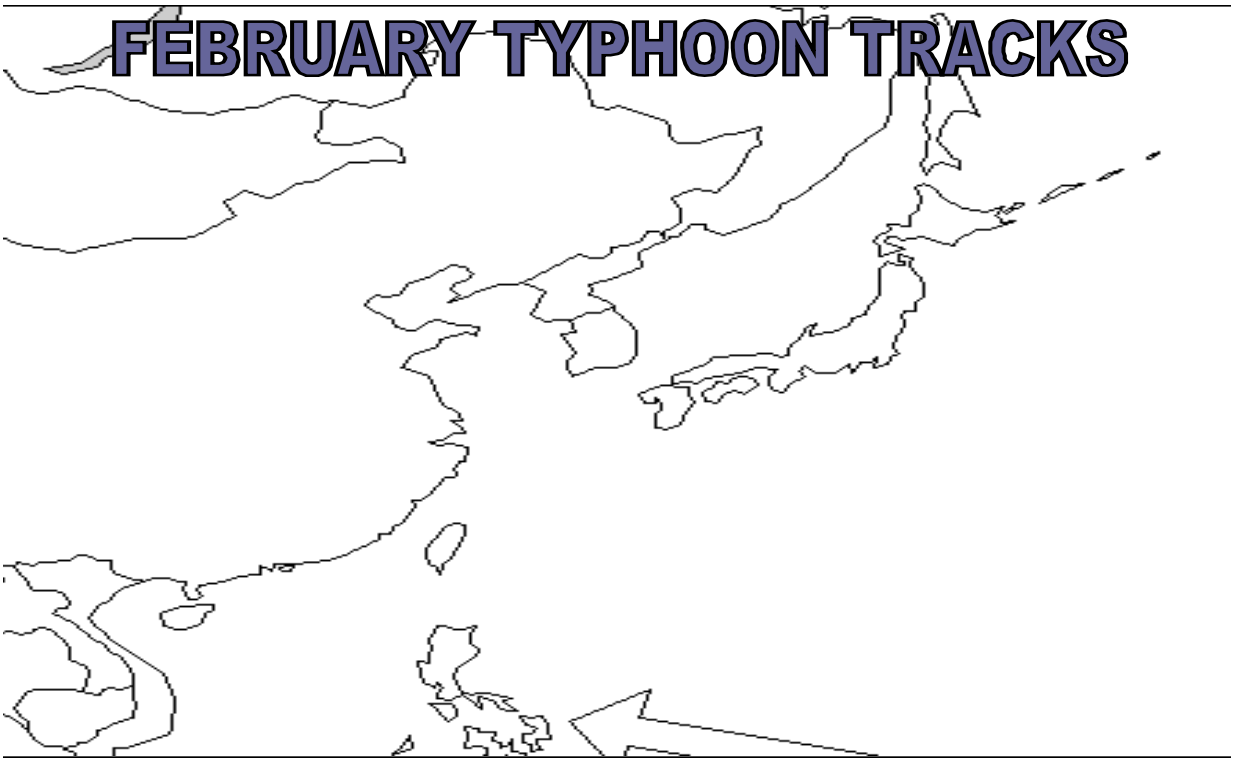


FIGURE 2-23

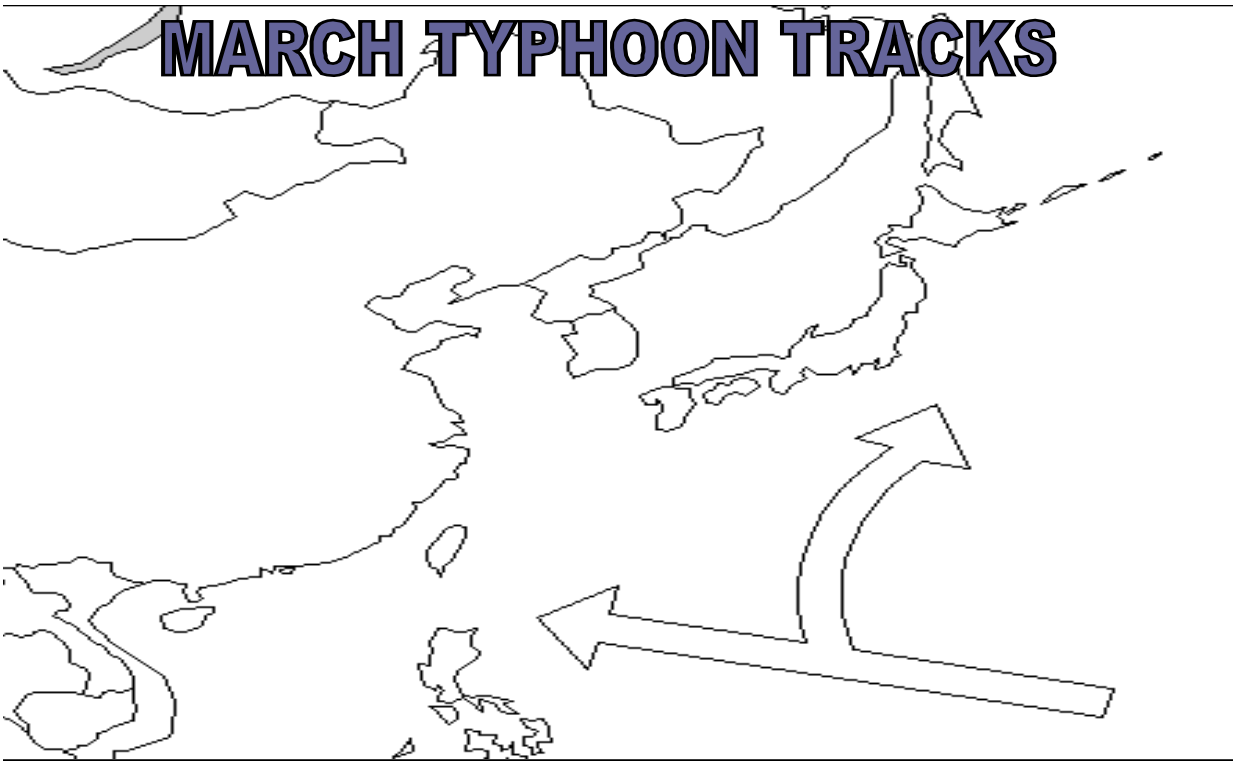


FIGURE 2-24

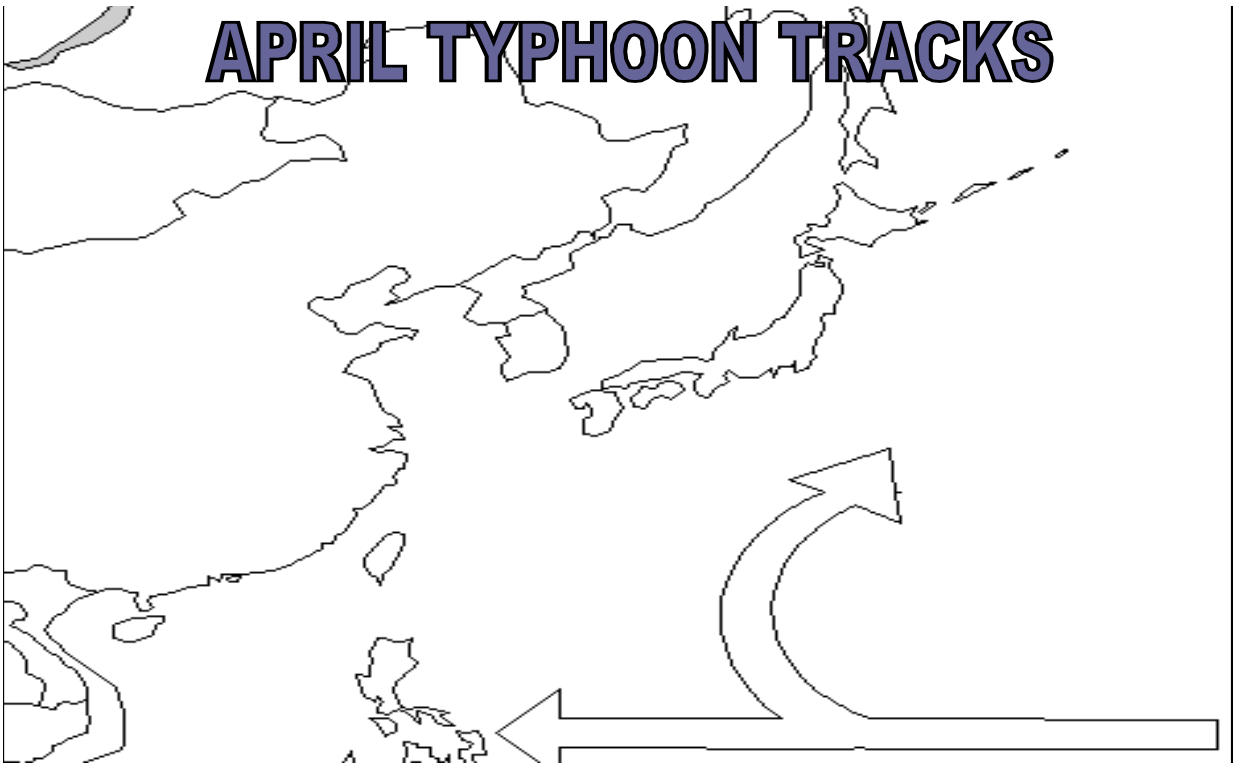


FIGURE 2-25

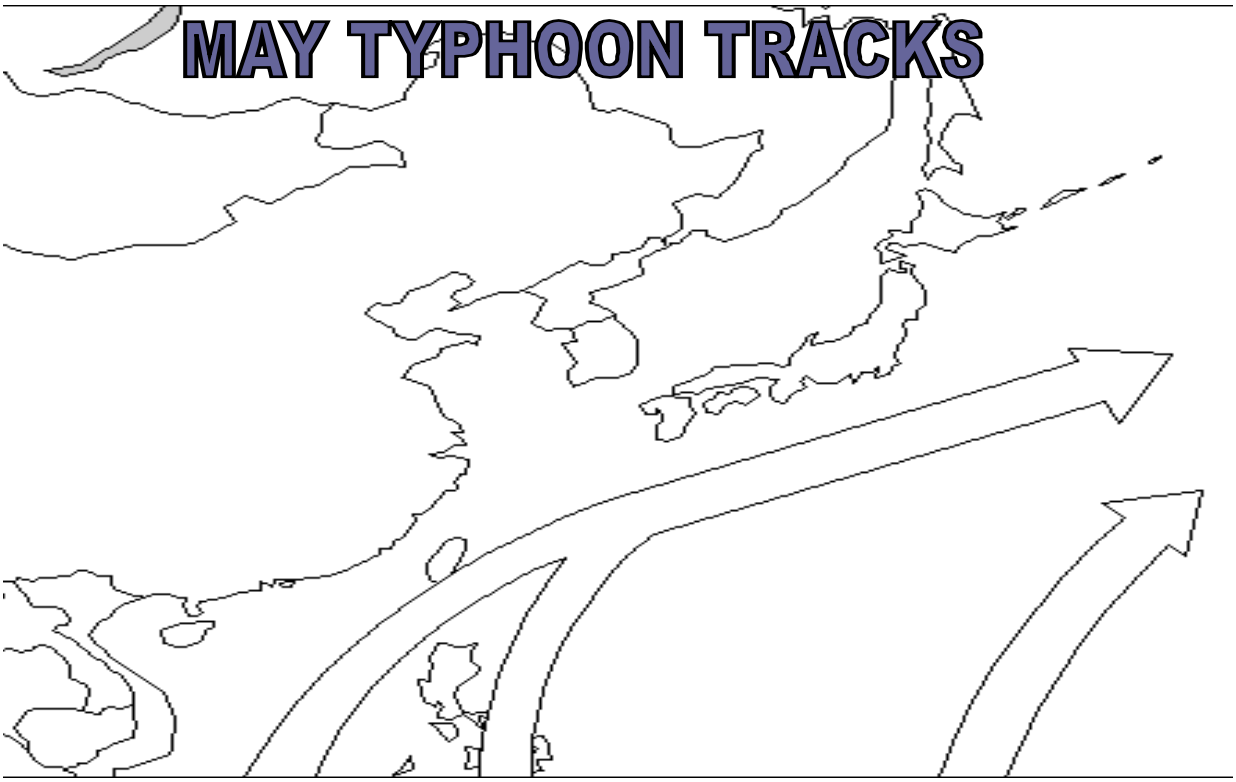
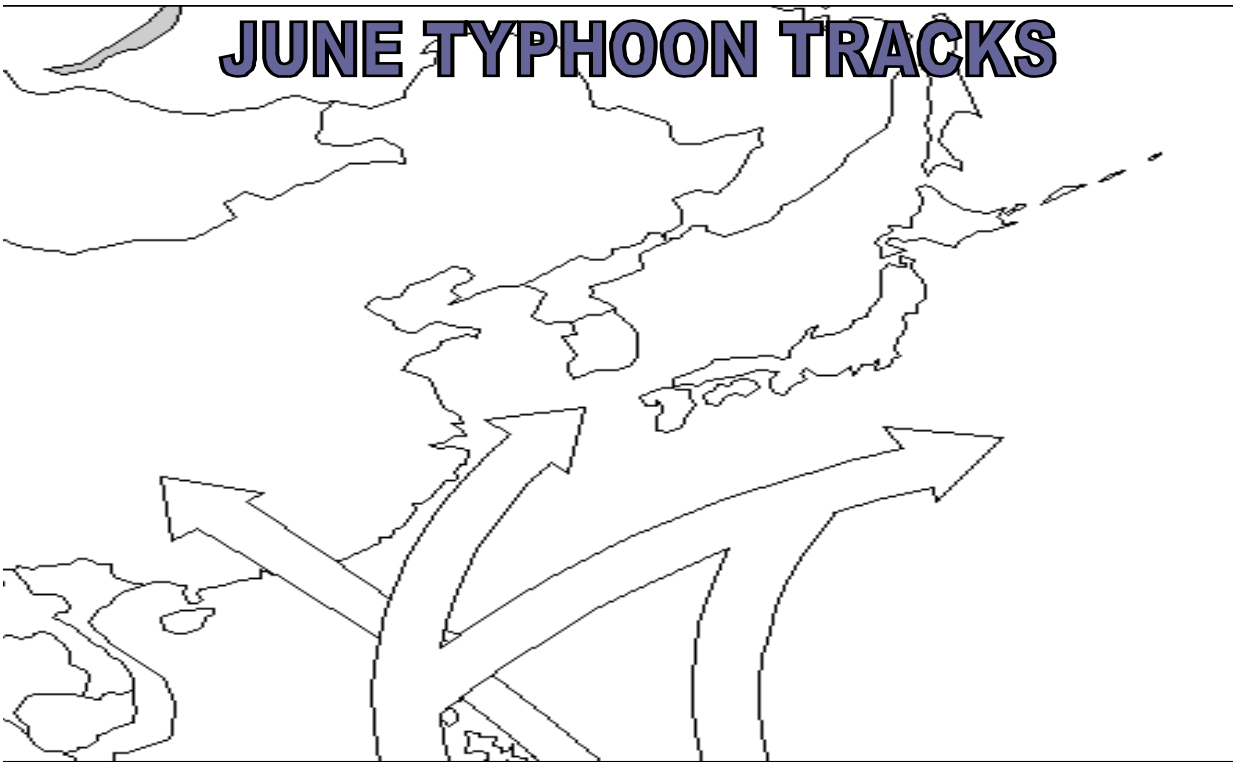


FIGURE 2-26



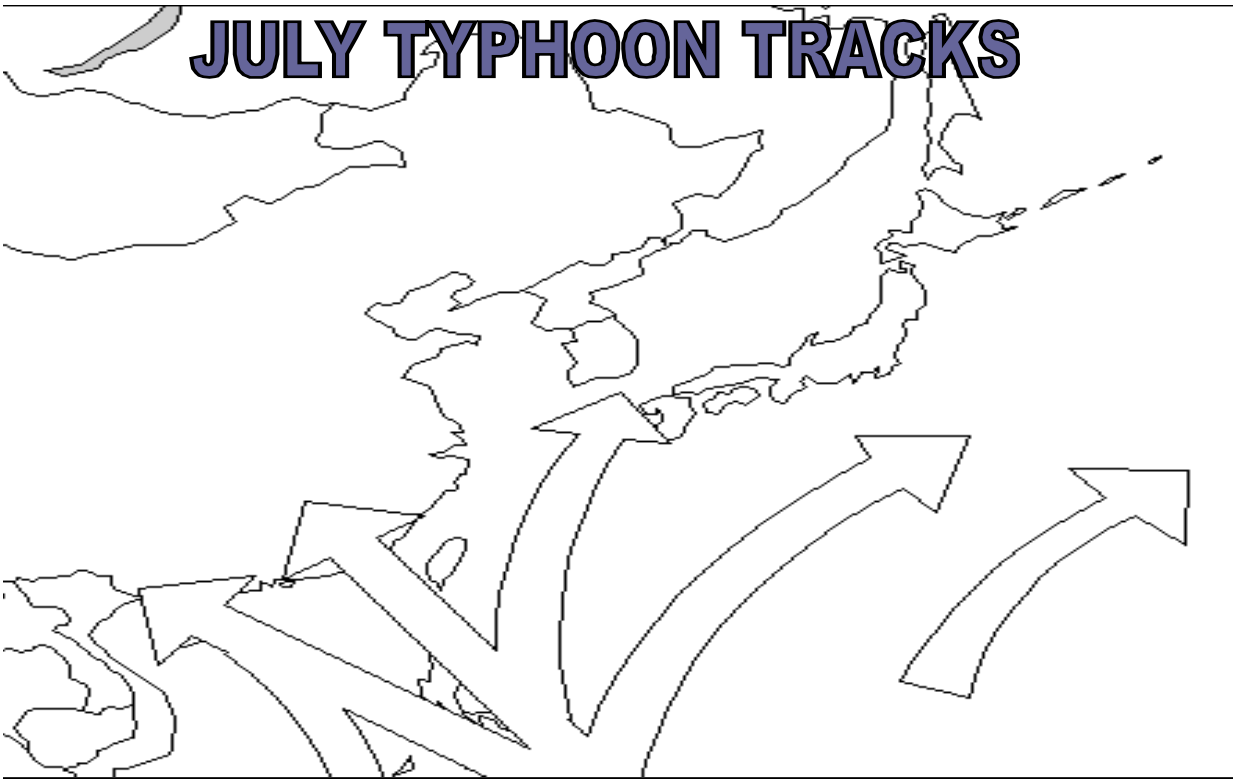


FIGURE 2-28

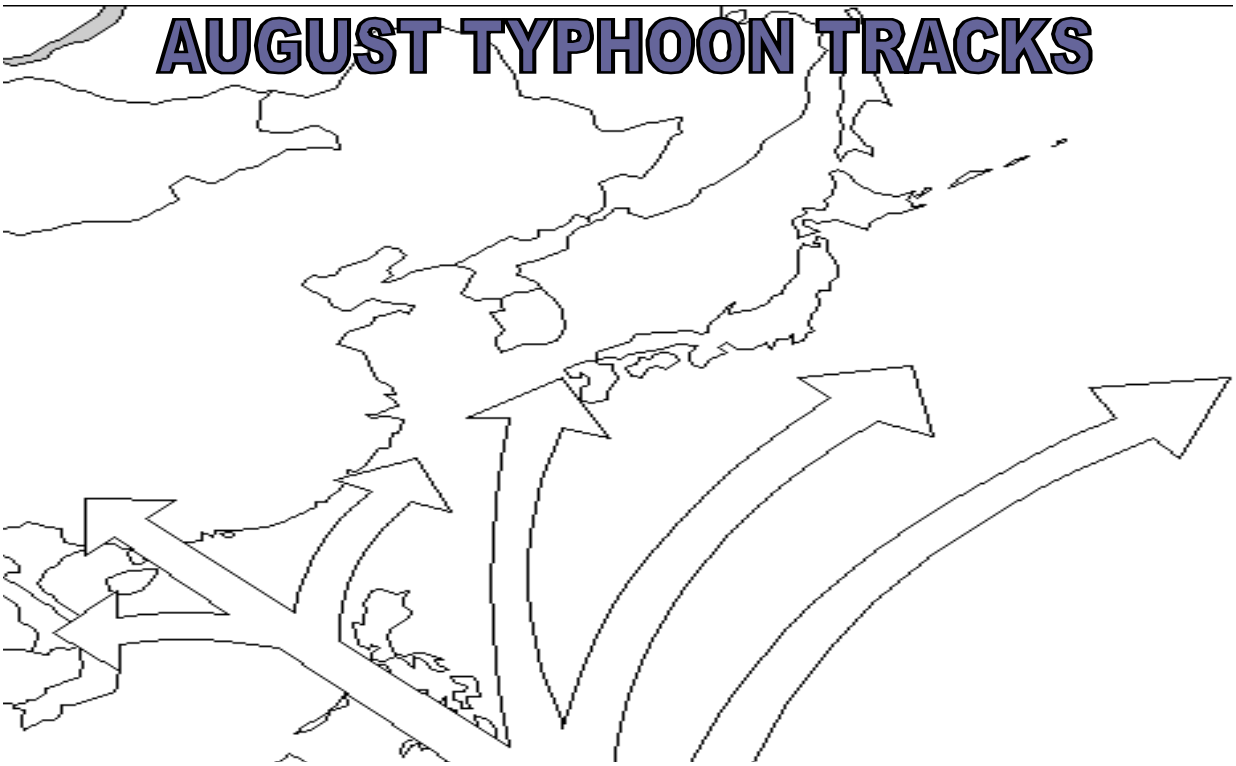


FIGURE 2-29

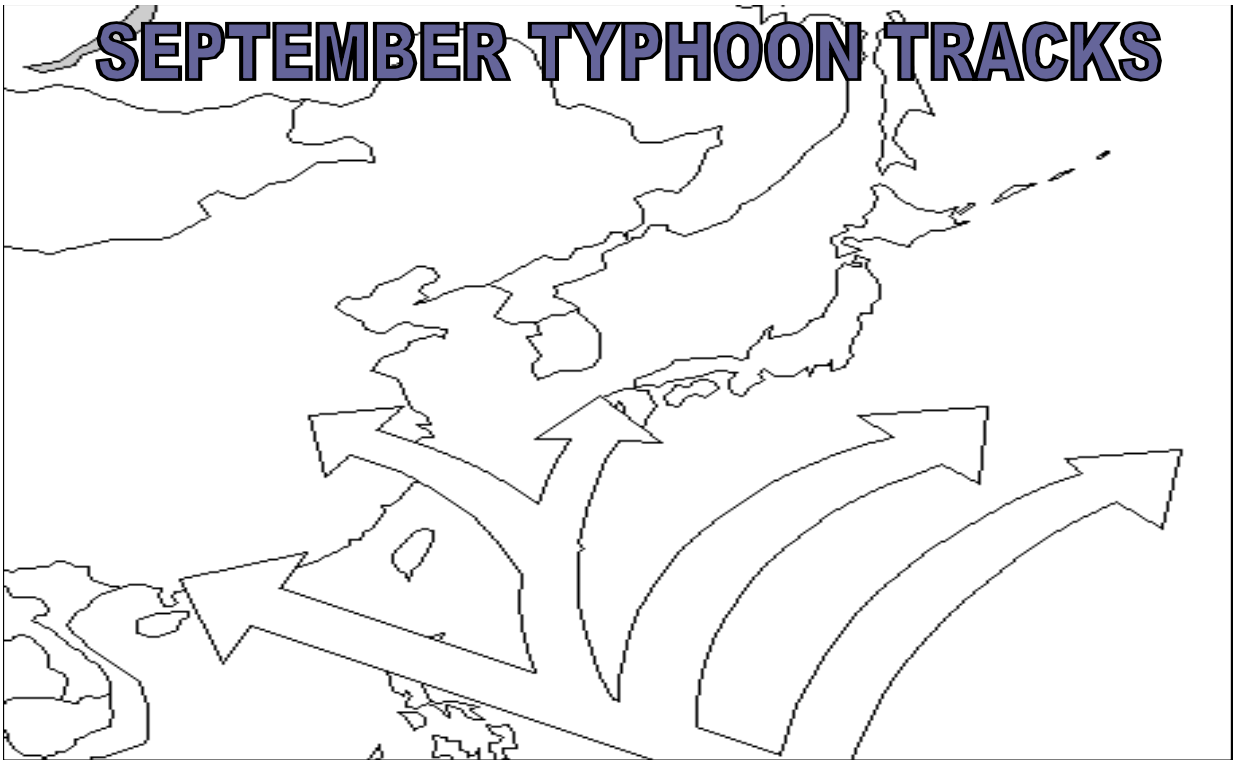


FIGURE 2-30

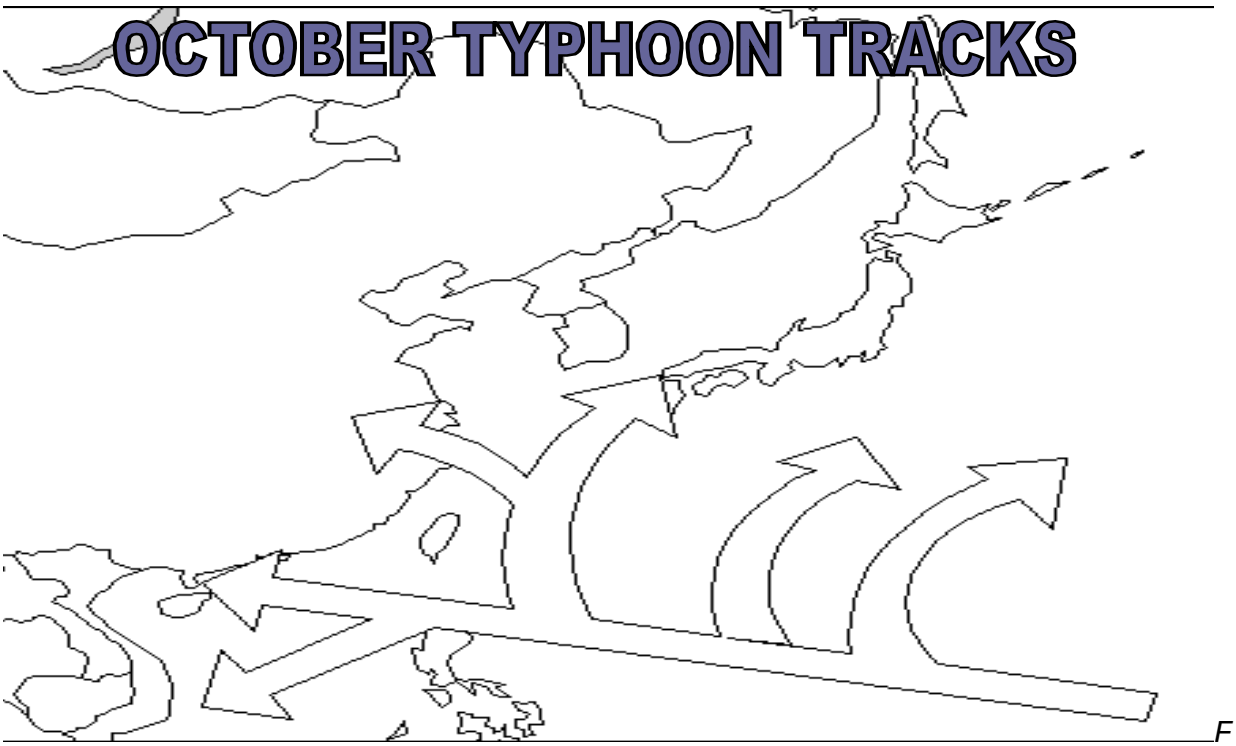


FIGURE 2-31

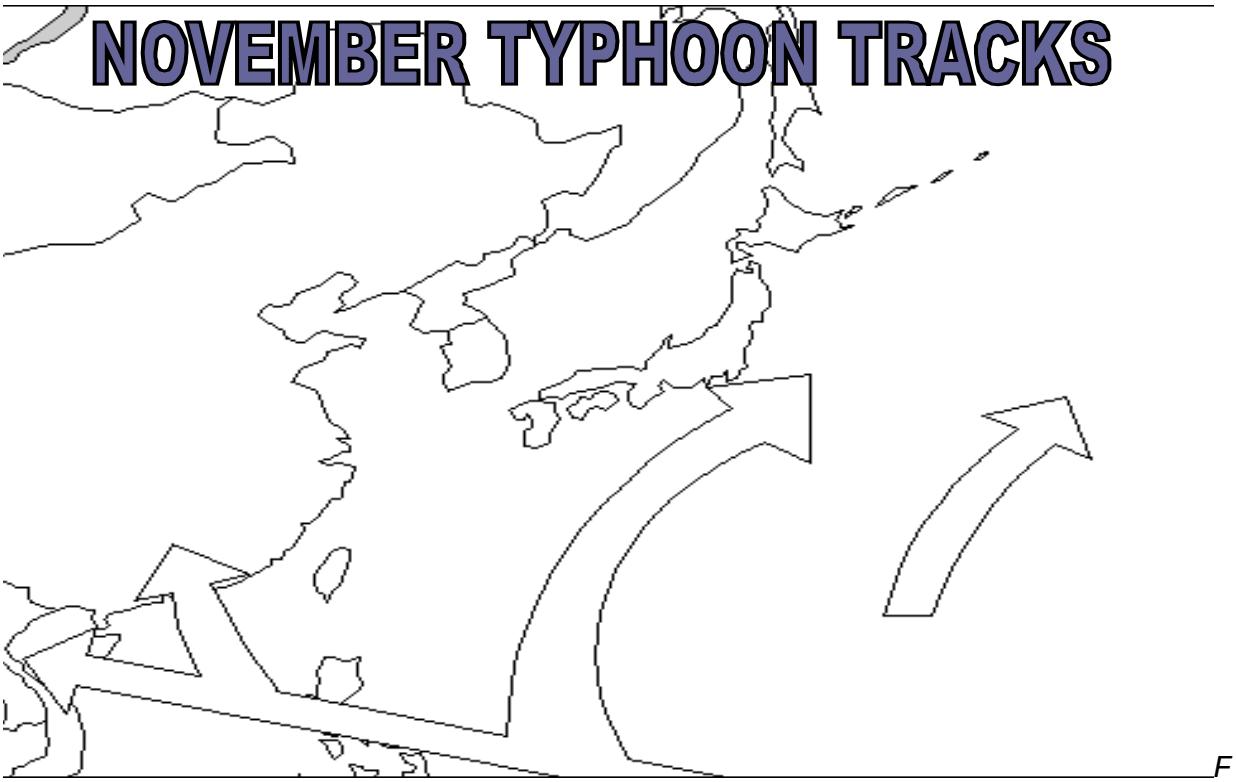


FIGURE 2-32

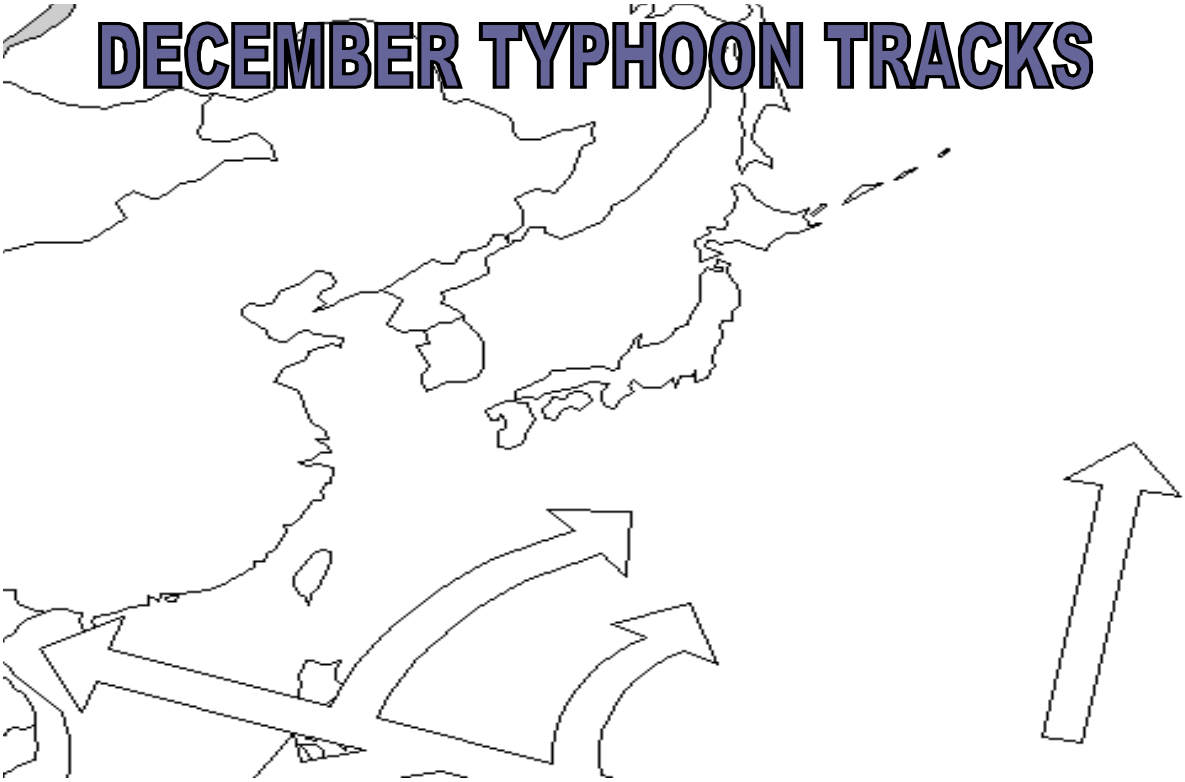


FIGURE 2-33

212. OCEAN CURRENTS.

THE NORTH EQUATORIAL CURRENT.

The North Equatorial Current runs the length of the Pacific Ocean transporting water from the east along the western coast of South America to the west between 10 to 20" N latitude. This is a broad and relatively deep current that increases in volume transport as it moves because new water masses join the current from the north. It is a slow current with a maximum velocity less than 40 ft/min. To the east of the Philippines, a definite division of the current takes place, one branch turning south along the coast of Mindanao and the larger branch turning north and following closely to the east side of the northern Philippines and the island of Taiwan. The southern branch returns to the east between the equator and the 10' N latitude as the North Equatorial Counter Current. The north branch becomes the Kuroshio Current System. The name "Kuroshio" is applied to the north branch of the North Equatorial Current when it turns northeast at Taiwan and follows the Ryukyu Islands northeastward and along the southern portion of Japan as far as *35'* N latitude.

THE KUROSHIO CURRENT.

The Kuroshio Current between Taiwan and the southern Ryukyu Islands reaches a depth of -1,300 feet and the maximum velocity of 180 ft/min near the surface.

THE TSUSHIMA CURRENT.

The Tsushima Current 'branches off on the left hand side of the Kuroshio entering the Sea of Japan through the Korean Straits and the Yellow Sea along the western coast of Korea. As it enters through the Korean Straits, it enters the Sea of Japan following the western coast of Japan to the north. As it reaches northern Hokkaido, it again branches. One branch turns east and exits the Sea of Japan through the La Perouse Straits between Sakhalin and Hokkaido. The other branch continues north and undergoes a major modification (losing heat) when it mixes with the colder shallow waters in the Riman Gulf.

THE RIMAN CURRENT.

The resultant counter current returns southwest along the Siberian coast, the coast of China and the east coast of Korea, as a cold current called the Riman current. As it moves southward, it mixes with the warmer Tsushima Current. The moderated waters in the center of the Sea of Japan are conducive to good fishing and are the scene of the largest fishing fleet in the world. The Riman Current remains cold all year.

THE KUROSHIO EXTENSION.

During the summer the shallower northern portion of the Sea of Okhotsk becomes much warmer than the Oyashio waters. But, the continual inflow of cold Oyashio water into the Sea of Okhotsk moderates it before it can come out of its source region. The reverse is true of the counter current that moves out of the Yellow Sea, In the summer, the northern shallow waters of the Yellow Sea become as warm as the southern waters, but are much colder in the winter. The result is that the counter current that returns from the northern Yellow Sea to the south along the coast of China is a cold current during the winter months which causes much the same effect as the Riman current when it mixes with the warmer waters of the Tsushima. During the summer, however, there is little temperature gradient in the Yellow Sea since the counter current is as warm as the Tsushima. As the Kuroshio Current turns east near the eastern coast of Honshu, it

becomes the "Kuroshio Extension." It is a warm current that represents a direct continuation of the Kuroshio.

THE ALEUTIAN CURRENT.

A minor branch of the Kuroshio Extension turns north as far as 40' N latitude and then turns east again. It acts as a mixing boundary with the cold Oyashio current to the north. The Kuroshio Extension retains its properties clearly until about 160' E lon2itude. The Kuroshio Extension becomes modified at this point, but the current does continue eastward as the North Pacific Current. The cold Oyashio Current begins in the boundary between itself and the northern branch of the Kuroshio extension. The boundary becomes the Aleutian (Sub-Arctic) Current, which flows east. One branch of the Aleutian Current turns north and enters the Bearing Sea following along the northern side of the Aleutian Islands and circling the Bearing Sea counter clockwise. In the Bearing Sea, these waters are further cooled and flowing south, they reach the northern islands of Japan as the cold Oyashio. Figure 2-34 represents the ocean currents as described previously.

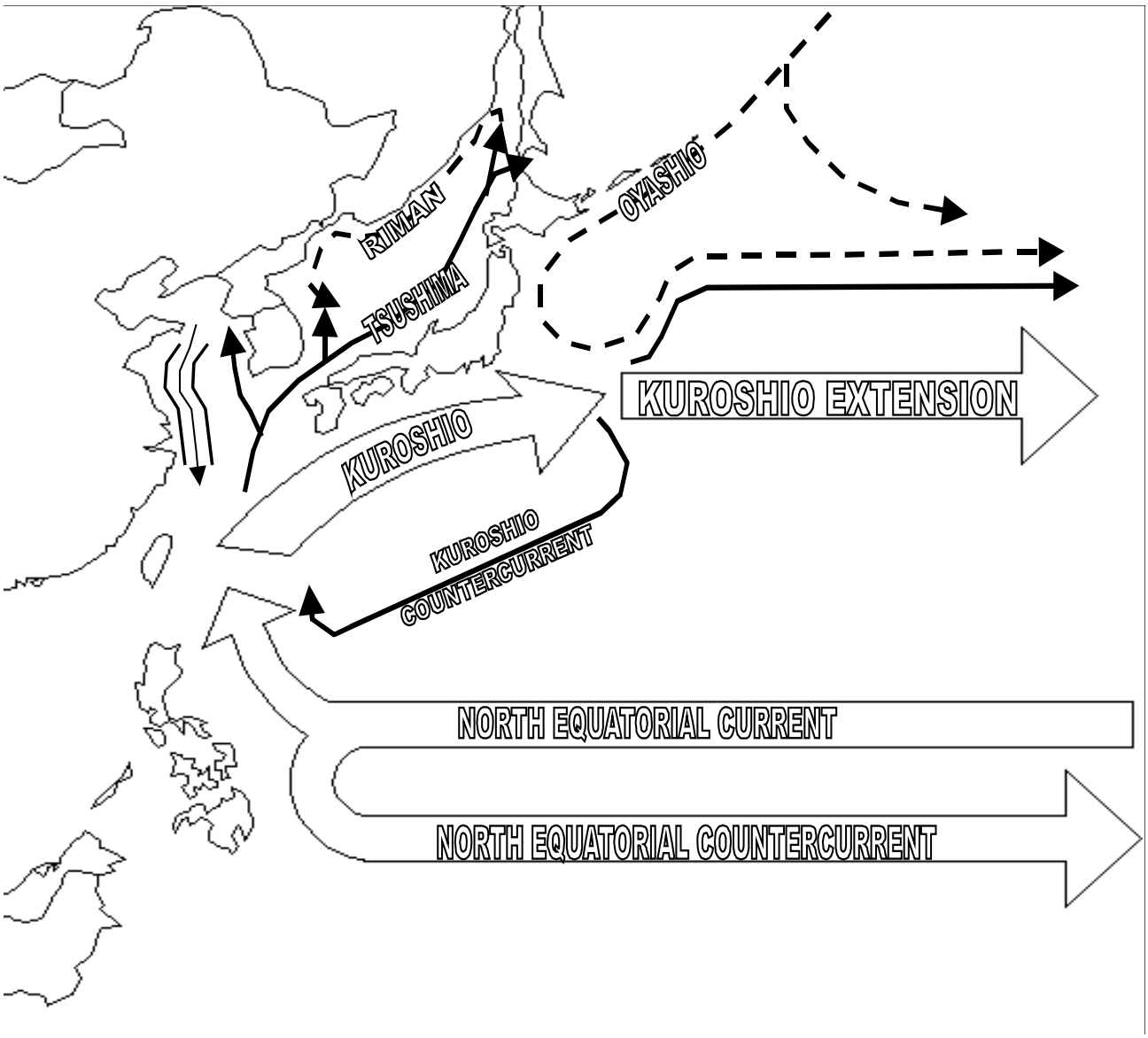


FIGURE 2-34

213. <u>SEA SURFACE TEMPERATURES</u>.

Sea surface temperatures (SST) are derived from ship reports and from the Navy Oceanographic Data Distribution System (NODDS). SST is important to flight operations because of the large variation in temperatures in the waters surrounding Japan. In the Sea of Japan, temperature can vary 10 degrees F or more. Since pilots must wear anti-exposure suits when the air temperature is –50 degrees F or below and the sea surface temperature is 60 degrees F or below, special attention must be given to climatological estimates of SST. The coldest water temperatures occur in February. On the average, a temperature of 52 degrees F can be expected for the Korean Strait and 45

degrees F off either coasts of the Korean Peninsula. The water temperatures gradually rise and peak during the month of August. The general SST thermal pattern remains the same all year since it follows the current pattern closely.

214. MISCELLANEOUS.

A. TEMPERATURES AND RELATIVE HUMIDITY (RH).

Temperatures at MCAS Iwakuni are relatively mild year around. The coldest months are January and February with minimum temperatures in the 20’s and 30’s. In 1975 and 1977, a minimum temperature of 19' F was recorded during, the month of February. Beginning in March, temperatures rise steadily into the summer. Summer temperatures are likewise mild; however, the hottest month, August, has maximum temperatures in the 80's and 90's. In 1972, a maximum temperature of 100 degrees F was recorded during the month of August. RH usually remains at 60 to 80 percent. As one would expect, the higher RH occurs in the summer months and the lower values are recorded in the winter months.

B. WINTER STATISTICS.

The following is based on climatological probabilities. Dates and amounts are mean values taken from the "Climatic Atlas of Japan."

C. PRECIPITATION.

Precipitation amounts are not easily depicted because the figures are accurate to 1/100th of an inch and the rainfall amounts vary greatly. Monthly maximums vary from just over four inches in December to 27 inches in July. On an average, the days of precipitation and the precipitation amounts follow the same trend. The exceptions are March and June through August. The average number of days of precipitation that occurred in March is rather high to support the amount of 2.78 inches. The reason is that the precipitation is in the form of light rain. On the other hand, the average days for June through August is only 10-13 days with an average amount of 5-1 0 inches. The reason is that the precipitation is in the form of rain showers, thunderstorms, and tropical cyclones.

a. First Hoar Frost..... 20th of NOV

b. Last Hoar Frost..... 10th of APR

c. # Days Free From Hoar Frost. 240

d. First Snowfall..... 20th of DEC

e. Last Snowfall..... 10th of MAR

f. 9 Days Free From Snowfall... 280

h. First Freezing of Water..... 10th of DEC

D. SURFACE WINDS.

Surface winds at Iwakuni are predominately westerly in direction or calm. This accounts for approximately 63 percent of our yearly wind directions. During the late spring, summer, and early fall, the land-sea breeze effect is dominant. The daily heating of the land causes a sea breeze to form from the east, which slowly shifts to the southeast starting, at midmorning, and slowly shifts to the south until sunset. Tile mean speed of the sea breeze is 10 to 15 knots. During the day warm air is forced up the slope on the hills that are in close proximity of the station. At night, the air cools and drains into the Nishiki River Valley and across the delta to Iwakuni. The resultant Katabatic wind is from the west-northwest at three to seven knots. The strongest maximum gusts occur during August and September. They are caused by tropical cyclones in the vicinity of Iwakuni. A secondary maximum occurs in March. It is closely linked with the advent of the spring rainy season. The primary direction of the gusts in March are northwesterly, The direction of the gusts in August and September vary depending on the location of the tropical cyclone at its closest point to Iwakuni. See *figure 2-3*.

E. PRESSURE.

The station pressure at Iwakuni closely parallels the strengthening and weakening of the Siberian High. The highest pressure occurs in December with an average of 30.168 inches of Hg and the lowest occur in July with an average of 29.765 inches of Hg. The diurnal chance in pressure is important for the computation of altimeter setting. Diurnal Altimeter Charts can be found in the forecaster's work area and should be referred to when computing the daily changes. The charts are separated by month and based on the mean sea level pressure converted to inches of mercury at synoptic times.

215. REFERENCES.

1. NAVMETOCCOMINST 3l40-2E, Local Area and Area Responsibility (AOR)

2. U.S. Navy and Marine Corps Meteorological, Station Climatic Summaries, 1998.

3. International Station Meteorological Climate Summary, June 1998, Federal Climate Complex Ashevllle.

4. NAVAIR 50-1C-556 U.S. Regional Climactic Study of the Central East Asian Coast and associated waters, January 1996.

5. NAVENVPREDRSCHFAC TR 77-03, The Environment of the South Korea and Adjacent Sea Areas.

6. TR 88-10 November 1995, Climatology of North Pacific Tropical Cyclone Tracks.

7. 1998 Annual Tropical cyclone Report, Joint Typhoon Warning Center, Hawaii.

8. U.S. Navy Department of Commerce, Global Upper Air Climatic Atlas, Ver 1.0 March 1997).

III FORECASTING

301. GENERAL.

The descriptions and concepts contained in this section are borrowed from various sources and modified by collective forecasting experience for MCAS Iwakuni. Japan has two major seasons, summer and winter. Corresponding to the usual spring and autumn season are two relatively short transition periods that the polar front migrates southward in the autumn and northward in the spring. The principal reason for this pattern is the "monsoon" or seasonal circulation that influence southwest Japan. A southeast sea breeze is persistent and most noticeable during the late spring, summer, and early fall. However, a drainage wind occurs throughout the year flowing from the mountains into the Nishiki River Valley and across the delta to the Air Station. The surrounding hills and smaller islands protect the Air Station from the severity of Arctic or Polar outbreaks and offer an effective barrier to strong winds and high seas from the south. The forecaster should be primarily concerned with changes in temperature, moisture, and/or stability.

302. TEMPERATURE.

Temperatures at MCAS Iwakuni are consistent from year to year and relatively mild year round. Climatology can be used with a high degree of accuracy when forecasting 24 to 48 hour temperature changes. Forecast temperatures should verify within 2-3 degrees Farienheit of the actual temperatures. Located between the world's largest landmass and largest ocean, Japan's weather is directly controlled by the intense cold current of air flowing from the Asian continent during the winter and the warm, moist Pacific Ocean air during the summer. As a result, winters are warmer than normally would be expected and summers are not as hot. The most commonly required temperature forecasts are for maximums and minimums, post-frontal, runway, temperature stress (WBGTI), equivalent chill temperatures, and critical temperatures for thunderstorm development and inversion dissipation.

A. Maximum Temperature.

In the summer the daily maximum temperature is usually reached by 1700 JST. In addition to climatology, extrapolation, continuity, and persistence, the following rules of thumb will aid the forecaster:

1. Examine the current analysis and prognosis to determine the source of air mass expected over Iwakuni.

2. If the forecast wind direction is from the north through the southwest at 8 knots or more, forecast a lower temperature using continuity from the previous day. The early arrival of a sea breeze may alter the forecast maximum temperature.

3. The temperature will decrease 7 to 10 degrees with with thunderstorm activity. If thunderstorms are expected to persist throughout the afternoon and early evening, forecast a 5-7 degree decrease from the maximum temperature.

4. If cloudiness and haze are persistent, forecast the maximum temperature to occur an hour or two earlier.

5. Using the early morning sounding may use the Skew T/Log P Diagram to get a good approximation of the maximum temperature.

   a. In the summer, go up the temperature curve to the 800-Mb level. Then go down the dry adiabat to the surface temperature and read the temperature at the intersection. If the day is expected to be cloudy to overcast follow the saturation adiabat to the surface level.

   b. In the winter, go up the temperature curve to 900 Mb level. Then go down the dry adiabat to 1000 Mb temperature and read the temperature at the intersection.

B. <u>Minimum Temperature</u>.

The daily minimum temperature is normally observed by sunrise. Minimum temperatures are generally more difficult to forecast than the maximum temperature. In addition to climatology, extrapolation, continuity and persistence, the following rules of thumb will aid the forecaster:

If the forecast wind direction and speed are northwesterly or southwesterly at 4 knots or more

1. forecast a lower temperature using continuity from the previous day. Normally, winds are near calm at sunrise, however, occasionally a light drainage wind reaches the field.

2. Temperature advection aloft must be watched closely in

the area upstream as the computer analysis tends to 'smooth' the isotherm pattern and cold and/or warm pockets are not picked up well.

3. The Skew T/Log P Diagram may be used to get a good approximation of the minimum temperature by using the morning sounding.

   a. In the summer, find the 500 Mb temperature then go down the saturation mixing ratio lines to the 850 Mb or the 750 Mb if there is an inversion or surface temperature below 1000 Mb. Then go down the dry adiabat lines to the 1000 Mb temperature and read the temperature at the intersection.

   b. In the winter, find the 850 Mb temperature then go down the saturation mixing, ratio lines to the 1000 Mb level and read the temperature at the intersection.

4. A forecast of the daily minimum temperature may be greatly simplified by using, the following formula below when no advective changes occur and maximum radiation is expected:

Minimum Temperature Formula

   a. Add the maximum temperature to the dew point value that occurred at the time of the maximum temperature and divide by 2, then subtract 13.

   b. With a little practice on the part of the forecaster, this formula could be used every night providing, the amount of cloud cover and advective changes are considered,

5. If a freeze is expected to occur. Proper warning should be issued. In accordance with MCASO 3140.3T, issuance of Destructive Weather Warnings, immediately.

C. <u>Wet Bulb Globe Temperature (WBGT) Index</u>.

In hot weather with high humidity, such as found in this area, it frequently becomes necessary to limit physical training. The uncomfortable feeling of heat stress exerted by the environment is caused by a combination of the air temperature, humidity, wind speed, and heat radiation. The WBGT Index is computed from

readings of: (1) stationary wet bulb thermometer exposed to the sun and to the prevailing winds, (2) a black globe thermometer similarly exposed, and (3) a dry bulb thermometer shielded from the direct rays of the sun. All readings are taken at a location representative of the conditions to which personnel are exposed. Maintain the WBGT Index reading and notify departments and organizations when the WBGT Index reaches 80 degrees or more in accordance with MCASO 6200.2D.

D. Equivalent Chill Temperature.

The equivalent chill temperature, (also called Wind Chill Factor) is an approximation of the additional cooling affect of wind on the human body. The index is based on the cooling rate of uncovered flesh in the shade.

303. WIND.

Wind direction is one of the most important elements to accurately forecast. If the wind forecast is accurate, the other elements of the forecast should prove to be. The surface winds at Iwakuni are predominately westerly in direction or calm. This accounts for approximately 63 percent of our yearly wind directions. During the day, the surface winds can be strongest near the time of maximum temperature when maximum mixing of low-level winds occur. During the night, the mixing decreases and the surface winds normally diminish as an inversion develops. During the winter when fast moving cold fronts cross the local area, little or no weather may occur; however, gusty northerly winds often develop after frontal passage. Passing upper level troughs can often bring gusty northerly winds to Iwakuni. An analysis of the 700-mb chart will normally aid in the detection of these approaching troughs. The 850-mb chart is probably one of the best tools for determination of winds in the local area. A tightening of the gradient to the west is a good indication of developing strong, surface winds. Wind warnings and advisories will be issued in accordance with MCASO 3140.3T.

A. SEA BREEZE AND LAND BREEZE.

During, the late spring, summer, and early fall, the land/sea breeze effect is dominant. The daily heating of the land will cause a sea breeze from the east that slowly shifts to the southeast starting, at mid-morning through sunset. During, the day, the warm air is forced up the slope on the hills that are in proximity of the station. At night, the air drains into the

Nishiki River Valley and across the delta to the field. The resulting adiabatic wind is from the west-northwest at three to seven knots.

B. MAXIMUM GUSTS.

The strongest gusts occur during August and September. They are caused by tropical cyclones near Iwakuni and usually vary in direction depending on the location of the storm. A secondary maximum gust occurs in March from the northwest linked with the advent of the spring rainy season.

C. THUNDERSTORM INDUCED WINDS.

When thunderstorms are forecast, or have started to develop around the station, the wind direction will be variable even if the sea breeze is of strong character. The Skew T/Log P method of forecasting wind gusts associated with thunderstorms should be used.

D. SEASONAL VARIATIONS.

Mainland Japan is in a region where pressure is predominately low or high at certain seasons, but not throughout the year. As stated earlier, the sea and land breezes are repeated day after day with great regularity during the winter and summer. Gusty surface winds will persist for 24 to 36 hours after a cold frontal passage in the spring, autumn, and winter. Strong surface winds can be expected for 36 to 48 hours after a severe intense polar outbreak. Along with climatology, extrapolation, continuity, and persistence, and the following rules of thumb will aid the forecaster:

1. Good weather is associated with a northwesterly flow. The deeper the flow, the more persistent the cold weather.

2. A gradient wind shift (3000-6000 ft) to the southwest signals the approach of bad weather. A shift from the southwest, west, or northwest signals rapidly improving weather.

3. Northeasterly, easterly, and southeasterly flow is associated with bad weather. Exception: Deep, uniform easterly flow up to at least 700 Mb is associated with good weather.

4. Improving weather or continued good weather is signaled by a

temperature decrease aloft.

5. A southeasterly flow over southern Shikoku, southeastern Kyushu, and the Ryukyu islands, signals bad weather.

6. When a pressure gradient of 25 Mb or more exists over the Yellow Sea between China and mainland Japan, forecast strong northwesterly winds.

7. Forecast strong, surface winds with gusts to 30 knots following a very intense polar outbreak if a jet maximum exceeding 150 knots is observed below 18,000 feet over the Fukuoka (RJFF/47807) area. The intensity of the polar jet should be checked over Kimpo (RKSS/47110) and Miho (RJOH/47743).

8. A sea breeze of 8-10 knots will commence when the land temperature is 3-5 degrees warmer than the water temperature. The speed can reach 20 knots.

9. Due to topography, surface winds in Japan are generally not representative when speeds are less than 10 knots.

10. A northwesterly drainage wind should be forecast during, the night hours unless there is a tropical cyclone influencing the local area.

11. The presence of Lenticular clouds usually signals strong and gusty surface winds.

12. Forecast gusty surface winds of at least 25 knots when a low pressure system is within 600 miles of Ashiya (RJFA/47803) and at least two stations in Korea or Kyushu are reporting rapidly falling pressures. This rule has verified repeatedly during the winter season.

E. Weather and Obstructions To Vision.

Forecasting, weather and obstructions to vision entails a variety of techniques and methods. Persistence and continuity are useful when making a short-range forecast prediction. For a long-range forecast, the current analysis, satellite data, Japanese Meteorological Association (JMA) charts, computer products, intuition, and experience, all go into making a sound prediction.

F. Precipitation.

Precipitation forecasting is simply an extension of the cloud forecast. Forecasting restrictions caused by precipitation depends directly on cloud and precipitation forecasts. Rain usually occurs in association with two basic synoptic patterns. First, the rainy or "BAI-U" Season with a quasi-stationary front just to the south of the local area with a ridge to the north. Most of the precipitation is of the warm frontal type with warm, moist air being advected northward over a wedge of cool air lying over Iwakuni. The second important pattern is the low-pressure systems moving out from Asia such as the Shanghai or Taiwan Low. These systems are normally open wave lows that do not occlude until just prior to reaching Japan. The yearly average precipitation amount for Iwakuni is nearly 66.63 inches. The greatest monthly mean amount (11.5 inches) occurs during, the month of June with the rainy season while the minimum monthly mean is during the month of December with 1.7 inches. The greatest monthly precipitation amount in 24 hours is 8.63 inches in the month of June. In addition to climatology, extrapolation, continuity, and persistence, the following rules of thumb will aid the forecaster:

1. During the summer, showers can be a daily afternoon occurrence and should be forecast along with any expected thunderstorm activity.

2. The pattern of precipitation associated with cyclogenesis in the Shanghai, China (ZSSS/58367) area will reach the Fukuoka (RJFF/47807) area about 6 hours after it is first reported at Cheju-do International (RKPC/47180).

3. Precipitation normally ceases when a low or a migratory wave passes east of 132 degrees E as it moves along the southern coast of Japan south of 30 degrees N.

4. Lows that are generated east of Taiwan cause rain at stations in southern Kyushu (RJFK/47851-RJFY/47850) within 6 to 12 hours.

5. Forecast heavy rain and embedded showers when low pressure is moving eastward north of 30 degrees N and stronger winds than if it was to pass south of the Air Station.

6. When a low cell with its accompanying rain pattern moves eastward out to sea off eastern Shikoku rain ends at Kyushu stations. When a low passes through the Korean Straits into the Sea of Japan to approximately 128 degrees to 130

degrees E, rain ends quickly at stations of southern Kyushu and by the time the low reaches 131 degrees E it has stopped over northern Kyushu areas.

7. Strong polar highs moving eastward from northern China will produce showers in the local area if the gradient is north through east.

8. When unstable wave centers pass within 100 miles to the south of Fukuoka (RJFF/47807) area, they normally cause showery type precipitation, ceilings as low as 500 feet and visibility down to 1/2 mile.

9. Early morning showers sometimes occur near the center of a cold, shallow migrating high.

10. Scattered showers occur over northwestern Kyushu in winter when a low is located over the southwestern part of the Sea of Japan. This condition persists until the pressure gradient weakens.

11. Under normal wave conditions, a wave center which passes south of the Fukuoka (RJFF/47807) area will cause rain to begin in the local area within 12 to 18 hours after a broken to overcast cirrus layer is first observed. Rain can normally be forecast to persist in this situation until the low center is 3 degrees east of the local area (i.e. 135 degrees E).

12. Rainfall is greater at northern Kyushu stations when a low passes to the north than when it passes to the south, the ratio of the two being approximately 10 to 7.

13. Rainfall is greater at southern Kyushu stations when a low passes to the south than when it passes to the north.

14. Rainfall is usually heavy when a front or secondary low forms over the sea to the south of Kyushu and a low exists in the Sea of Japan.

15. When a wave develops on a polar front, with a well defined rain pattern, precipitation begins over northern Kyushu 6 to 9 hours after it begins at Cheju-do International (RKPC/47187); rain patterns advance more rapidly in winter than spring.

16. Scattered showers occur over northwestern Kyushu in winter

when a low is located over the southwestern part of the Sea of Japan. This condition persists until the pressure gradient weakens.

17. When a remnant of the polar front lies south of the island of Kyushu during the winter, rain begins at Fukuoka (RJFF/47807) when the center of the western extension of the Pacific high moves west of the Marcus Islands causing the polar front to wave north. The rain can be forecast to cease when the center of this extension moves east of the Marcus area.

18. Taiwan wave cyclogenesis which moves from the area southwest of Kyushu causes rain in the Fukuoka (RJFF/47807) area within 2 hours after it is first reported at Fukuoka (RJFE/47843), and can be forecast to persist for 6 to 8 hours. If a second wave develops on the trough, as usually happens, an approximate 12 hour lapse may be forecast between the end of the precipitation on the first wave and the beginning of the precipitation from the second.

19. In all general synoptic situations causing precipitation during the period October through March, the precipitation can be forecast to end at Iwakuni (RJOI/47764) following passage of the 700 Mb trough.

G. Snow Forecasting.

Snow showers can hamper many activities, therefore, the forecaster will receive many calls requesting information on freezing temperatures and possible snow accumulation. Iwakuni is on the lee side of the winter wind that blows over the central mountain divide of Japan part, snowfall is light compared to areas over and north of the mountains. Snow will not normally restrict activities on the Air Station or restrict airfield operations. During the winter, there are five types of distinctive snow storms that effect the local area:

1. The snow blizzard features an occluding low pressure center. The track of this low is generally north of 40' N and its speed, which initially may average about 25 knots, decreases as the low continues to occlude. The area of maximum snowfall lies north and west of the low-pressure center.

2. Major storms consist of a wave type low pressure systems and are often fast moving. The upper air

picture is one of fast moving, troughs, generally open, but, on occasion, could have a minor closed center for one or two surface charts in the bottom of the trough. The area of maximum snowfall lies in the cold air to the left of the track of the low and usually is a narrow belt oriented east-west or northeast-southwest about 100-200 miles wide.

3. Warm advection types are separated from the others by the absence of an active low on the front in the area of maximum snowfall. A blocking high is present ahead of a sharp warm front. The overrunning warm air is a steady current from the south to southwest. The area of maximum snowfall is a narrow band parallel to the warm front and moves north or northeast.

4. Post cold frontal type consists of a sharp cold front oriented nearly north-south. The area of maximum snowfall is located between the 850mb and the 700mb troughs where moisture at both levels is available.

5. This is the most common case for snowfall at Iwakuni. It is not associated with any low pressure system, but, instead, is caused by orographic lifting. Most of the winter, the Siberian High keeps the primary wind direction over Japan northerly. This causes a packing of cumulus and stratocumulus clouds along the coastal areas north of the mountain divide. As the clouds are lifted, precipitation, in the form of snow flurries, occur over the mountains. Iwakuni can experience snow flurries at any time of the day or night under these conditions.

H. <u>Wintertime Precipitation Rules Of Thumb</u>.

1. Generally, a freezing level of 1200 feet or less and a surface temperature of 35 degrees F is required for snow to occur (given sufficient moisture).

2. Studies have shown that 850 Mb temperatures of –2 to -4C are good indicators for snow development.

3. The 1000-500 Mb thickness should be less than 5425 meters for snow and 5243 meters for snow flurries.

4. On rare occasions, during the winter, a deep 500 Mb low will form over North Korea with an occluded surface low

near Hokkaido, causing strong northwesterly flow over western Japan. The 1000-500 Mb thickness values will fall between 5100 meters and 5220 meters. This will cause gusty surface winds and frequent snow showers depositing 1/4 inch to 3/4 inch of snow depth. Net result is icy conditions on the runway.

5. You can expect snow when the O degree isotherm is in the local area at the 850 Mb level. Snow is definite when the –5 degree Celsius isotherm is present.

6. If the surface temperature is at or below 40' F during precipitation periods. Expect snow or snow showers.

7. Snow showers can be forecast for Ashiya (RJFA/47803) during the winter when the –25 degree Celsius isotherm at 700 Mb is oriented in the vicinity of Osan (RKSO/47134) and Ashiya (RJFA/47803).

8. With a surface temperature near freezing, strong northwesterly flow across the Korean Straits and cloud tops extending to at least 8500 feet, snow showers and snow pellets can be expected at Iwakuni.

9. During the winter season, a cold front with extremely cold air behind it brings light snow showers to the Iwakuni area. The usual rate is one snow shower every 1 to 2 hours until the thermal 700 Mb trough has passed an imaginary line between Miho (RJOI/47764) and Iwakuni (RJOI/47764).

10. During, the winter, following a cold front or trough passage, overcast ceilings of stratocumulus will become broken and then scattered as the subsidence inversion lowers below 5,000 feet. If the subsidence inversion is expected to remain above 7,000 feet, the low ceilings will persist.

11. When the synoptic situation features a well developed continental high with a pressure distribution of a west-HIGH and east-LOW type so that a strong northerly flow results, it causes considerable cloudiness with occasional light snow or in the region. In general, when the isobars are oriented north-south the degree of unfavorable weather varies directly with the intensity of the northerly flow.

12. In forecasting for snow accumulation, the following procedure has been shown to be a good estimate:

    Step 1: Determine the 1000-500 Mb thickness in meters from the latest sounding. The station selected will depend upon the advective pattern.

    Step 2: On table 3-1, find the thickness value from Step I to obtain the corresponding precipitable water value (W) in inches.

    Step 3: Multiply this figure (W in inches) by 10 to arrive at the accumulation of snow, which should be forecast.

PRECIPITABLE WATER (W) AND CORRESPONDING SATURATION THICKNESS (hg) FOR 70 PERCENT RELATIVE HUMIDITY FROM 1000mb TO 500mb

W INCHES	hg gpm	W INCHES	hg gpm	W INCHES	hg gpm	W INCHES	hg gpm	W INCHES	hg gpm	W INCHES	hg gpm	W INCHES	hg gpm
0.03	4644	0.18	5076	0.33	5214	0.48	5356	0.76	5503	1.15	5643	1.90	5819
0.04	4705	0.19	5082	0.34	5250	0.49	5363	0.78	5512	1.20	5658	1.95	5828
0.05	4756	0.20	5098	0.35	5259	0.50	5369	0.80	5521	1.25	5672	2.00	5837
0.06	4799	0.21	5112	0.36	5267	0.52	5381	0.82	5529	1.30	5686	2.10	5854
0.07	4835	0.22	5126	0.37	5275	0.54	5393	0.84	5537	1.35	5699	2.20	5870
0.08	4866	0.23	5139	0.38	5283	0.56	5404	0.86	5545	1.40	5712	2.30	5886
0.09	4892	0.24	5151	0.39	5291	0.58	5415	0.88	5553	1.45	5724	2.40	5920
0.10	4916	0.25	5163	0.40	5299	0.60	5426	0.90	5561	1.50	5735	2.50	5917
0.11	4938	0.26	5174	0.41	5307	0.62	5437	0.92	5568	1.55	5746	2.60	5932
0.12	4960	0.27	5184	0.42	5314	0.64	5446	0.94	5575	1.60	5757	2.70	5947
0.13	4981	0.28	5194	0.43	5321	0.66	5456	0.96	5582	1.65	5768	2.80	5961
0.14	5000	0.29	5203	0.44	5328	0.68	5466	0.98	5589	1.70	5779	2.90	5974
0.15	5019	0.30	5213	0.45	5335	0.70	5476	1.00	5596	1.75	5789	3.00	5987
0.16	5036	0.31	5223	0.46	5342	0.72	5485	1.05	5612	1.80	5799		
0.17	5052	0.32	5232	0.47	5349	0.74	5494	1.10	5620	1.85	5809		

Figure 3-1

304. FOG.

At Iwakuni, fog causes the most serious visibility restriction. Virtually all fog that occurs at Iwakuni is co-existent with precipitation, When fog occurs with light continuous rain or drizzle, visibility may remain as low as 1 to 3 miles for periods up to 12 hours or more. This occurrence is most likely with a stationary or warm front near Iwakuni, but it may occur during any period of extended precipitation. Radiation fog or ground fog, is sometimes observed and creates a hazard for early morning, flights. During early mornings with surface heating,

fog will normally burn off by noon. This dense fog is a common occurrence during the warm season from May to October. This fog also lies in the valley around tile field or in the nearby hills. Advection fog can sometimes be observed when the surrounding coastal water is colder than the water is further offshore. Warm, moist air from far offshore is advected over the colder coastal water. Chilled from below, the air temperature drops to the dewpoint, and fog is produced. There has been isolated instances when Iwakuni was affected by a combination advection and radiation fog. This occurred when a stratus bank remained over the surrounding waters during the day, moved over the air station during the evening, and persisted until morning. Around sunset, winds were light and southerly. Visibility in fog ranged from near 0 to 2 miles. This was a very rare occurrence and should not be forecast unless there is direct evidence of its existence, such as the presence of a stratus bank over the water during, the day.

A. <u>Objective Rules For Forecasting Fog</u>.

1. Is there a low level inversion present or forecast?

2. Has fog been dominating the local region the previous day?

3. Is the humidity throughout the surrounding area running high? (Above 75%)?

4. Are the winds below 850 mb less than 15 knots?

5. Is the 850 mb temperature greater than 7 degrees Farenheit?

6. Is the surface dewpoint above 35 degrees Farenheit?

7. Is the dominating air mass stagnating over the area?

8. If the answer to these questions are yes, the forecaster should make a study of the surface synoptic and upper air charts for the type of fog most likely to occur and the time of occurrence.

B. <u>Radiation Fog</u>.

1. Are surface and low level winds below 5 knots and expected to remain so?

2. Are clear skies expected to prevail throughout the

night?

3. Is there a low level inversion, and sufficient moisture expected at night?

4. If the answers are yes, then radiation fog is likely to form during the niqht.

C. <u>Advection Fog</u>.

1. Is there a dominating air mass stagnating over this area?

2. Has fog been reported within the air mass on previous nights"

3. Are the surface and low level winds expected to prevail from over the water?

4. Are the surface and low level winds below 1O knots?

5. Is the humidity during the day running above 80%?

6. Is the humidity forecast to be 95% or greater during, the night?

D. <u>Local Forecasting Thumb Rules:</u>

1. Fog, once formed, will persist when a northeasterly flow exists through the gradient level.

2. Morning fog is likely when precipitation has stoppedduring the night coincident with light surface winds.

3. Expect fog to form on the southwestern side of a high when the pressure gradient is weak.

4. Expect dense, persistent fog when light, southerly winds associated with the subtropical high persist for several days.

5. Expect fog associated with a low approaching from the west when it's east-northeast/west-southwest oriented trough or frontal system becomes quasi-stationary over Iwakuni.

E. <u>Haze And Smoke</u>.

The problem of forecasting visibility restrictions due to haze and smoke is one of the most difficult problems facing the local area forecaster. This is due to the fact that the occurrence of haze and smoke is caused by relatively unmeasurable variables and the relation between haze, smoke and fog is highly complex.

1. The reduction of visibility due to haze and smoke is thought to be caused by the following factors:

    a. Subsidence in the lowest 4,000 feet of the atmosphere, although difficult to measure is a necessary condition for the occurrence of haze and smoke restriction. If the subsidence is strong, enough to trap the smoke and haze particles, a light wind from the local industrial areas will lower Iwakuni's visibility to less than 3 miles.

    b. If the wind is too strong or not from a direction of one of these smoke sources, the restriction to visibility will not occur.

    c. The morning and evening hours are usually the time of greatest restriction to visibility since the diurnal temperature changes affect both the wind and vertical motion, and because the angle of incidence of the light is low. As the light comes through more of the atmosphere with a low angle of incidence, the scattering of light is greater, resulting in reduced visibility.

F. <u>Climatology Of Haze And Smoke:</u>

1. Time of Occurrence:

    a. Overall - 0700 to 2200 local

    b. Maximum - 0900 and 1700-1900 local

    c. Minimum - 0400 (secondary at l300) local

2. Month of Occurrence:

    a. Maximum - June (secondary in May/August)

    b. Minimum - December (secondary in January)

3. Relation to Wind Direction:

   a. Maximum - East-Southeast to Northwest

   b. Minimum - Southwest to West-northwest

4. Relation to Wind Speed:

   a. Maximum - wind speed of 3 to 5 knots secondary with winds calm or light and variable

   b. Minimum - wind speed of 6 knots or greater

G. <u>Thumb Rules:</u>

1. Haze in most cases does affect visibility at Iwakuni. It is normally at its worst during the midmorning or late afternoon on summer days.

2. Haze will occur when there is an inversion and Iwakuni is on the backside of a high pressure center. Haze will also occur with just an inversion.

3. As the cool air drains out of the mountains and under warmer tropical air, light rain and haze with a low stratus layer will persist.

4. If smoke is observed before the daily warming trend begins it will persist until the maximum temperature is reached.

5. Smoke will not usually develop as a restriction to visibility unless it is observed before the warming trend begins.

6. The industries of Iwakuni pump a tremendous amount of pollutants into the boundary layer; they comprise several different chemicals that are mostly hygroscopic. In a moist environment, they will absorb the water vapor and expand, scattering visible sunlight much better than air molecules; hence, dense haze. Being chemically stable, they don't disperse easily unless there is a large increase in wind speed, precipitation, and/or a marked lifting, of the boundary layer. In our typical rainy periods, the pollutants are replaced as fast as they are washed out: plus, the rain cooled air, being more dense, traps it in the absence of strong winds. So, if haze is present it will usually still be present when, and if, fog

forms.

305. VISIBILITY.

Forecasting visibility is a major problem due to the difficulty in predicting the behavior of elements causing visibility restrictions. At Iwakuni, fog causes the most serious visibility restriction. However, forecasting restrictions to visibility by precipitation and lithometeors must be given consideration due to the high concentration of pollutants local the industry pumps into
the boundary layer where they remain trapped. Generally, visibility restrictions occur approximately two hours prior to sunrise and two hours prior to sunset, and during the summer months with light northeasterly wind flow. Accurate visibility forecasts depend on the forecasters knowledge of the local terrain, surface wind patterns, stability, and pollution creating activities.

306. SKY COVER/FLYING WEATHER

Climatology reveals that the spring (mid-May through June), and autumn (mid-September through October) transition periods or "Rainy Seasons" have the highest percentage of sky cover. The following rules of thumb are useful and will aid the forecaster at Iwakuni:

1. The Skew-T/Log-P should be used for forecasting bases and tops (surface to 6,000 feet) for clouds advected from the west-southwest.

2. Satellite photos will generally show all cloudiness in the area except for very low level stratus and thin altocumulus.

3. Upper air moisture analysis can be used for forecasting sky conditions up to 24 hours, where data is available. During spring and autumn months, this is an important area to watch for development of migratory lows.

4. Convective cloudiness can normally be expected to clear a few hours after sunset.

5. Stratocumulus clouds forming a ceiling at Ashiya (RJFA/47803) will dissolve after a cold front passage when the gradient winds decrease below 15 knots.

6. During the fall and winter seasons stratocumulus clouds should be forecast over Kyushu when northwesterly flow prevails over the Korea Strait.

7. Lowest ceilings in the region occur most frequently with an easterly wind.

8. As low centers move east across southern Korea or through the Korea Strait during winter, ceilings over the region will persist at 1,000 to 1,500 feet with scattered layers near 500 feet. After the low passes into the Sea of Japan ceilings increase rapidly.

307. THUNDERSTORMS.

Most thunderstorm activity occurs during May through September with the peak period in August. An average cycle of 2-3 days with thunderstorms can be expected in the local area during this time frame. Thunderstorms of air mass type are far more prevalent than frontal type thunderstorms. Warnings and advisories shall be issued in accordance with MCASO 3140.3T.

A. Air Mass Thunderstorms.

Thunderstorms can be expected in the local flying area on any given summer afternoon and are difficult to forecast on station far in advance. Usually, thunderstorms over the station result from cumulus building over the area with light and variable winds aloft to 18,000 feet. This allows them to maintain their position nearby as they mature to thunderstorms. Normally, convective cloudiness will propagate eastward during the early afternoon as it builds and is steered by the upper level winds but, as it matures it will move in the direction of the mean wind vector in the vicinity of the cell. Due to the local mountain terrain most cell activity dissipates before reaching the air station. The following rules are used to forecast development of air mass thunderstorms:

1. A thunderstorm or rain shower can be expected in the local flying area on any summer afternoon.

2. Thunderstorms will often occur in 2 or 3 day cycles.

3. Thunderstorms occur during, the warm months and usually develop with convective heating by l300 local on clear

days and by 1400 local on cloudy days. The transport of warm, moist (mT) air into the area during the summer monsoon results in cumulus and cumulonimbus build ups which trigger thunderstorm activity.

4. During, the warm season, assume that any cumulus extending to 25,000 feet to 30,000 feet are thunderstorms. Cumulus with tops below these levels are probably rain showers and all tops below the freezing level are certainly showers.

5. The mountains to the west-northwest of Iwakuni lift and dry frontal systems as they pass. Southerly flow into the local area ahead of the front will advect warm, moist air into the region. Passage of the front aloft may create sufficient lifting to trigger heavy rain showers and thunderstorms. These thunderstorms can occur during any month of the year if the frontal system is vigorous one.

6. Forecast air mass thunderstorms when:
   a. Winds for the first 5,000 feet are light (I.e. less than 10-15 knots).

   b. The 1200L temperature will be over 86F and the relative humidity is above 40%.

   c. The Showalter Stability Index (SSI) on the morning sounding for Fukuoka (RJFF/47807) is:

   (1) 0 to -2 = thunderstorms in the local area.

   (2) Less than -2 = thunderstorms at Iwakuni.

   (3) During the summer, a southerly component exists up to 18,000 feet and the SSI is less than +3.

7. Do not forecast air mass thunderstorms when:

   a. A northeast flow prevails aloft.

   b. There is a strong surface or gradient wind.

   c. A typhoon is north or northeast of the area or is within 1-50 miles in any direction.

8. Generally, the prerequisites for thunderstorm formation are an unstable lapse rate, sufficient low-level moisture

and a lifting mechanism. All these conditions are readily fulfilled as the proximity of the mT air with the cP air results in lapse rates which can rapidly turn unstable. Strong winds at the 850 mb and 700 mb level lying across or to the north of the area will produce vertical lifting over the region and the dominant low-level flow is from the south bringing in quite a lot of moisture.

B. Frontal Thunderstorms.

If frontal thunderstorms occur locally, it is normally during the spring and autumn months. The following rules should be considered in forecasting frontal thunderstorms:

1. If approaching from the west through southwest, they will dissipate considerably by the time they reach the field due to the local terrain effects, unless they are moving 25 knots or faster.

2. Thunderstorms associated with a southeastward moving front are normally slow in movement and very weak in intensity.

3. Frontal thunderstorms are often associated with fast moving cold fronts during the spring, and fall.

4. Convection will develop and spread rapidly eastward and can catch the forecaster unaware during, the autumn, winter, and spring seasons. A favorable weather pattern is zonal flow aloft with a deepening trough over the Yellow Sea, a deepening frontal low near Cheju-do Island, a low-level southerly jet west of Kyushu, and an anticyclonic jet maximum with the favorable right rear quadrant coupled with the low-level jet.

5. Warm-frontal clouds will overlie western Japan. Convection will form near northwestern Kyushu and spread rapidly eastward.

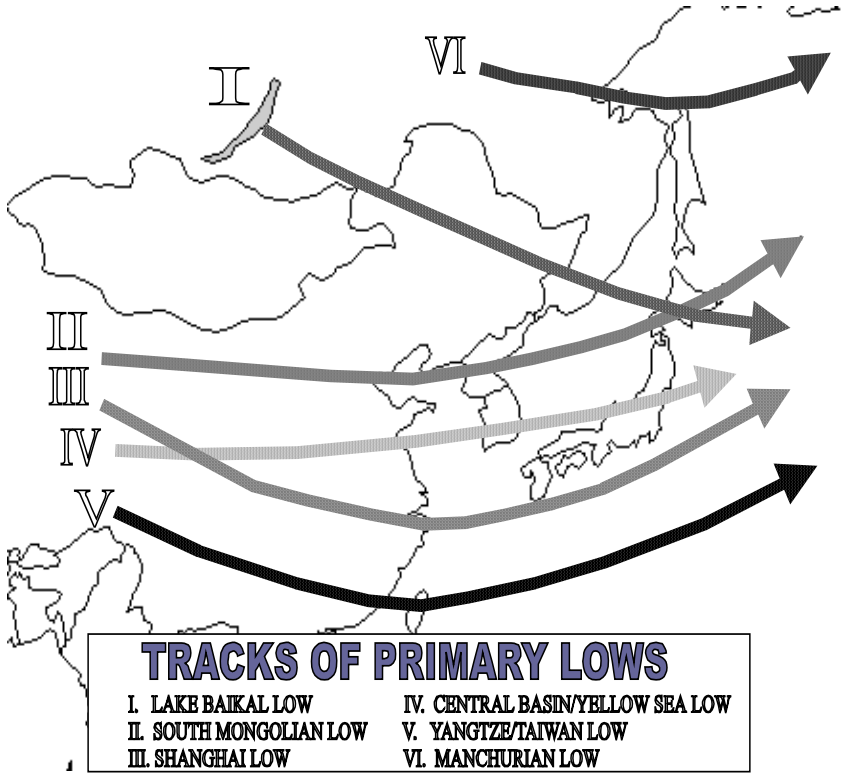
6. Isolated cold-season thunderstorms will occur when a sharp (60 degrees or more turning) positive tilt 500 mb trough begins to cross the north coast of extreme western Honshu.

7. They will be weak with cloud tops at 18,000 feet to 25,000 feet. Surface indications will be a cold front south of Japan with a post-frontal trough over the northern third of western Honshu. A strong pressure gradient will follow

passage of the trough causing gusty northerly winds and isolated rain or snow showers, Thunderstorm activity will cease once the gradient winds become westerly.

308. WEATHER ASSOCIATED WITH CYCLONES FRONTS AND TROUGHS.

The major low pressure systems which produce weather in western Japan are of two general types; the "Northern Lows" or those that pass to the north of Iwakuni and the "Southern Lows" or those that pass to the south of or over Iwakuni.



A. Migratory Lows.

Most authors in their discussions of migratory lows in the Far East will identify six types, based on the location of their formation and their subsequent track. Name variations may occur since in many instances, lows originating in the central Asian area are difficult to define on surface charts and do not become easily identifiable until they approach the coast and deepen due to the influx of warm, moist air. *Figure 3-1* indicates the expected movement of six basic low pressure systems, their formation area and their track over the Japan area. The movement of cyclones and consequently their typing is a function of the upper level synoptic situation, largely it is a reflection of the long wave trough position and associated short wave troughing at the 500 mb level.

B. "Northern Lows" Or "Siberian Lows".

These lows are all formed by the movement of short wave troughs through the low pressure source regions and all are enhanced by downslope adiabatic warming as the systems travel from their mountainous source regions. They are often weak due to dry continental air; therefore, there is very little

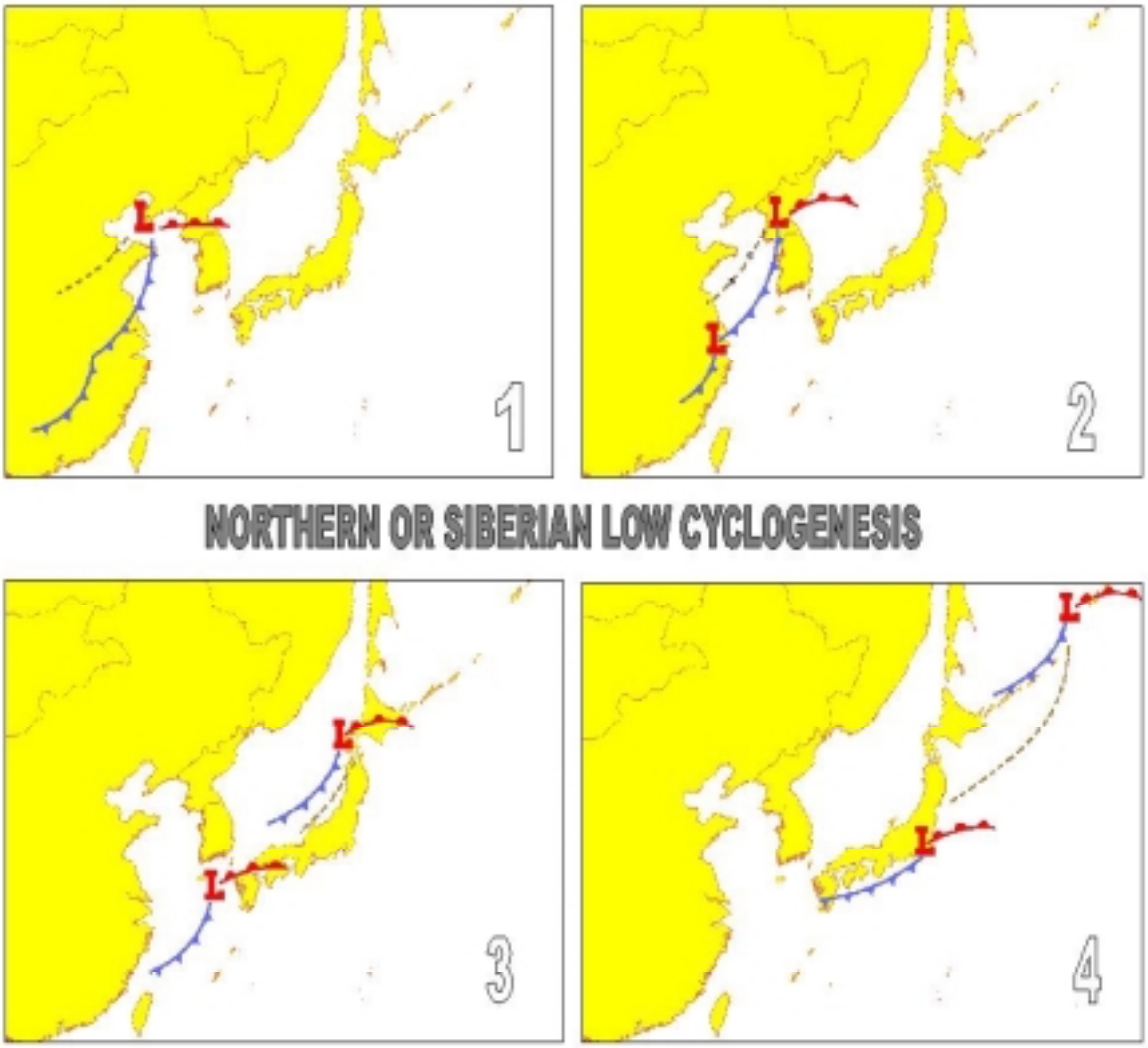
precipitation and variable amounts of clouds both ahead of and behind the associated occlusion or cold front, and there is little change in temperature at the surface. If considerable precipitation and cloudiness are present in the cyclone area, the low, with its frontal system, may be associated with an unstable air mass and move rapidly eastward. In either case, precipitation is limited to China, Russia, and Northern Hokkaido.

1. Manchurian Low - Maximum occurrence is during the autumn and spring. The system generally tracks extremely north over Sakhalin Island and into the Sea Okhotsk. No weather is expected with this system at Iwakuni.

2. Lake Baikal Low - Maximum occurrence is during the spring, however, it can also occur throughout the year. The track is somewhat south of the Manchurian Low as it moves over the Sea of Japan, Hokkaido and extreme Northern Honshu. The average speed of movement is 22 knots.

3. South Mongolia Low - can be expected to occur during any season. The track is more southerly than the previous two lows and may generate a "Yellow Sea Low" as it passes through the region. Passage is normally over the Yellow Sea, Korea, the Sea of Japan, Northern Honshu and into the southern sea of Okhotsk. The mean speed is approximately 20 knots.

4. There is an autumn winter situation in which a low pressure center appears in Manchuria and a wave forms in China near Shanghai (ZSSS/58367) with a warm front extending eastward towards Kyushu, Japan. There will usually be a weak trough aloft oriented north to south and appearing to be aligned with the low center. This trough line will usually move slowly eastward spreading marginal weather to the east of the system and improving weather to the west. The wave will remain weak and continue to move slowly east even after it is over the Yellow Sea or East China Sea. However, if the wave shows signs of deepening, then the weak north-south trough connecting the centers of the two lows will intensify



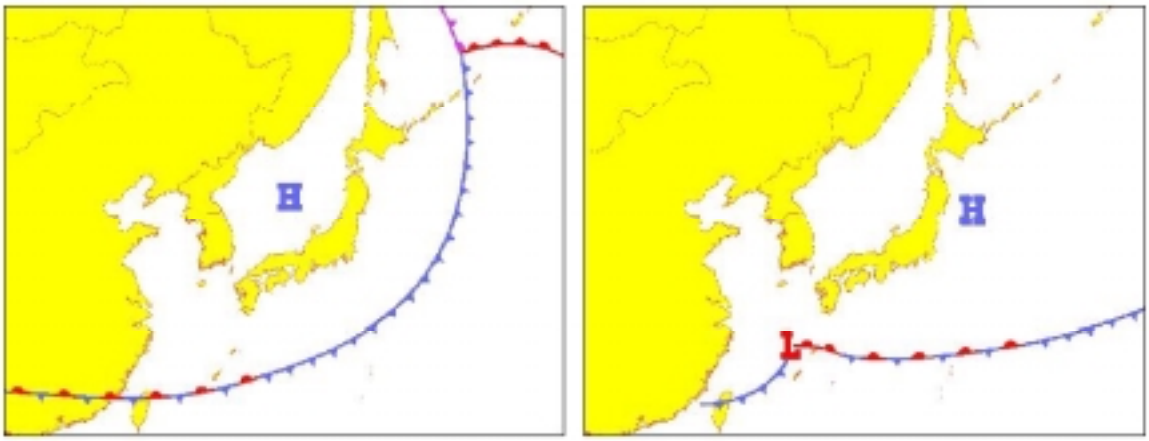
and move east more rapidly. Precipitation will end with the passage of the low. See *Figure 3-2*.

C. <u>"Southern Lows"</u>.

These lows generally form over central and Southern China. then track over the Yellow Sea, Sea of Japan, and Honshu or track over the East China Sea south of Japan between Kyushu and Okinawa. The southern lows are major weather producers for the southern area of Japan. They occur year-round and produce widespread precipitation, low ceilings, poor visibility and occasional thunderstorms and high winds. There are three major systems in this group with all three having Shanghai (ZSSS/58367) as their source region. The generation area of short-wave troughs which form these lows and their subsequent movement after leaving the Shanghai region further delineates these systems into the following types:

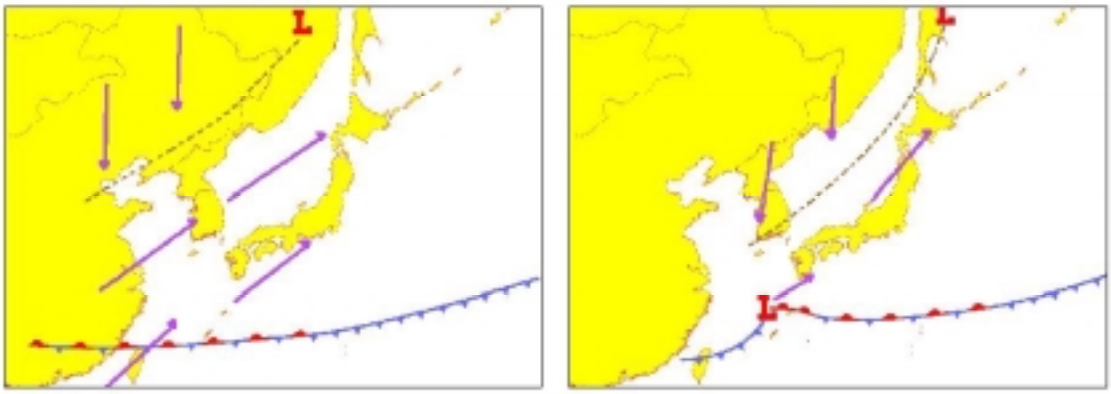
1. Taiwan Lows. The most hazardous weather in Japan, excluding typhoons, is caused by deep lows that form over China near 25' N and 100' E and move northeastward to southern Japan and then eastward at a mean speed of 24 knots. They occur most frequently from autumn though spring and will always track south of Japan. These lows almost always show rapid, intense deepening, especially during spring, autumn, and winter when the polar front is south of Japan. These dynamic lows present a complex problem for the forecaster due to the rapid spread of poor weather northeast of the waves and the resultant weather at Iwakuni. A constant watch for early signs of low/wave formations over the Taiwan region is necessary for effective before-the-fact forecasting of these systems. There are four cases of the Taiwan Low. They are briefly discussed below.

a. The most common instance, in the spring and autumn (occasionally in the winter) is the formation of a migratory (Bubble) high over northern China that just breaks away from the Siberian High and moves with an eastward track which projects it over Japan. As the polar front stagnates south of the high, a wave will form
behind the receding high center and move over Southern Honshu. See Figure 3-3.



TAIWAN LOW FORMS ON STAGNANT POLAR FRONT

b. A 500 Mb trough moves eastward across a quasi-stationary polar front that lies between 15' and 25' latitude. If the trough is deep enough, it will cause winds ahead of it to back into a southwesterly direction and trigger a low on the front. See Figure 3-4.



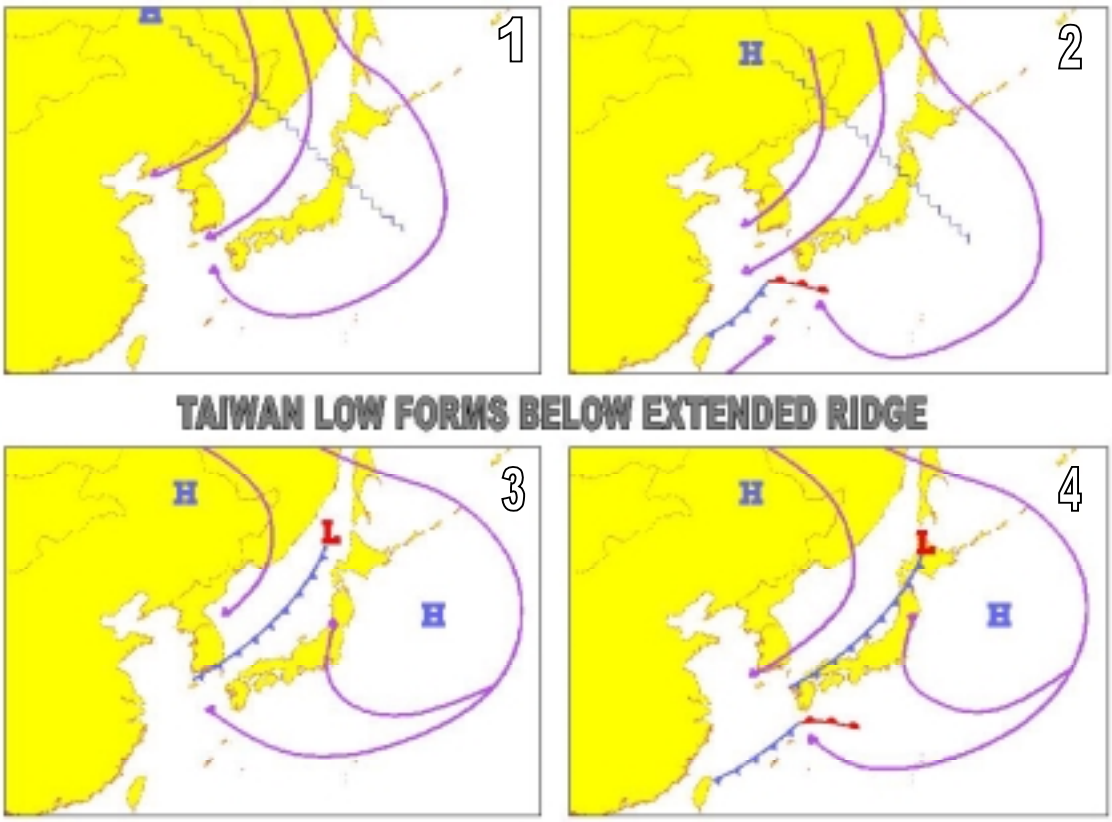
TAIWAN LOW FORMS AHEAD OF TROUGH

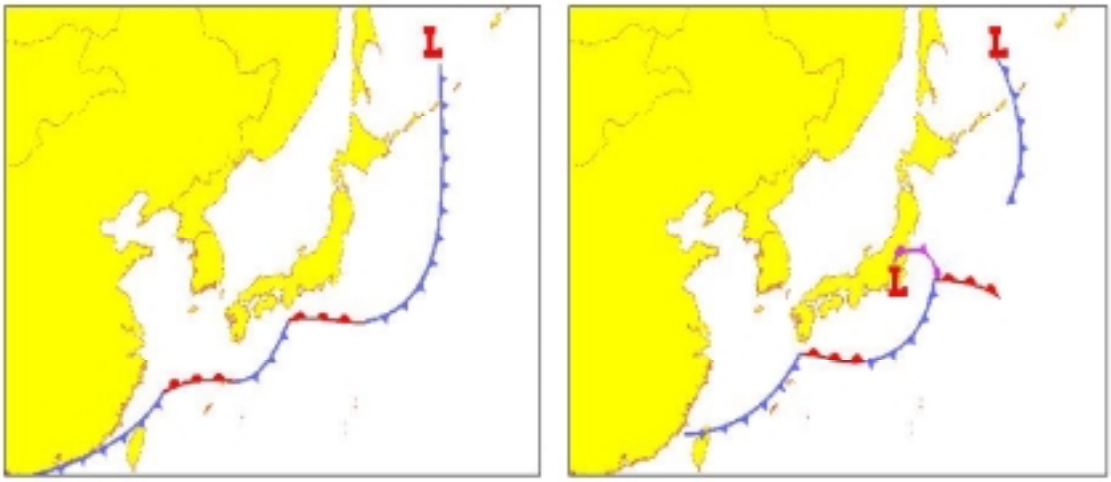
FIGURE 3-4

c. Another favorable situation occurs in late autumn, winter, and early spring as a ridge of high pressure

extends from the Siberian High southeastward over Japan and the Northwest Pacific. The cold, dry air that moves around the main Siberian High coupled with the modified, moist air that is formed around the extended ridge meets in the vicinity of Taiwan and may cause a low that need not form on the polar front. The low will weaken the ridge and induce a trough that will extend from the low northeastward into the Sea of Japan. See Figure 3-5. Inserts #1 and #2. Inserts #3 and #4 show the same situation except that the extended ridge is already broken with a surface front between high centers. In this case, the cold air is still forced southward by the cold front and the modified air is still forced around the eastern high. Although the wave that is formed does not intensify rapidly, this situation will give more precipitation than one would normally expect with a winter cold front passage. In many respects, it resembles the double-eye case discussed later in this section.

FIGURE 3-5





TAIWAN LOW FORMS AS STABLE WAVES

FIGURE 3-6

d. A few situations exist from late spring through early autumn when the polar front lies just south of Japan and separates the maritime polar and tropical maritime air. A cyclone family or series of small, stable waves will form, generated by the formation of a Taiwan Low and move along the front, and normally not occlude until they are east of Japan. These waves do not have any simple periodicity and wavelengths may vary from 200 to 800 nautical miles. They appear to move with a mean speed of about 29 knots and should be extrapolated with the speed of the 850 Mb winds over the wave center. See Figure 3-6. These waves also tend to dissipate and reform in a new location so that the latest analyzed position based on data should outweigh any continuity consideration in analysis. A wind maximum in the 850 to 700 Mb layer has been observed to accompany the wave crest in some cases. Winds in this layer have been reported to increase from 20 to 80 knots in a 12 hour period during a crest passage.

D. Yellow Sea Low.

Generally, when cyclogenesis occurs over southeast China near Shanghai (
Northeast producing an inverted trough over the Yellow Sea and precipitation along the west coast of Korea. This includes the western shores of Kyushu and Hokkaido, and the northern shores of Honshu. This system is primarily one of summer and autumn. They move from their source region at a mean speed of 21 knots. This type of system will give 2 to 6 inches of rain in the

western region of South Korea, during the winter, 2 inches of snow is likely. The Iwakuni area will receive less precipitation, however, during frontal passage, heavier precipitation associated with thunderstorm activity is likely. This system may produce a secondary low south of Kyushu or Shikoku within 12 to 18 hours after entering the Yellow Sea. The formation of the secondary low is referred to as a "Double Eve Low" talked about later.

E. **Shanghai Low.**

This system is a special case in which the low forms near Shanghai (ZSSS/58367), but instead of moving northeast, it moves southeast to southern Japan and then re-curves to the northeast. This low takes on the characteristics of both the Yellow Sea Low and the Taiwan Low. This system occurs most frequently during the spring, and moves from its source region at a mean speed of 20 knots passing between the Islands of Kyushu and Okinawa. This system invariably generates a greater volume of precipitation than the Yellow Sea Low, but more importantly, it brings more precipitation to the southern portions of the Japanese mountain divide to include Iwakuni. If the low is supported by a short-wave trough moving from the south Himalayas, a central pressure of less than 1000 Mb will generate a Shanghai Low.

F. **Double-Eye Low.**

This special case of a hybrid low occurs in two different scenarios: In the first instance, a Yellow Sea Low has formed and is moving northeast toward the Sea of Japan. The associated front occludes and moves southeast, out of the low center, with the triple point of the occlusion south of Japan. Cyclogenesis occurs at the triple point of the occlusion to form a Taiwan Low south of Japan. The new low moves northeastward and becomes dominant while the original low to the north dissipates in the Sea of Japan.

In the second case, a Taiwan Low forms and moves northeast just south of Japan. As the low approaches close to the south of Honshu, a lee-side low forms on the other side of the mountain barrier over the Sea of Japan. The Taiwan Low maintains itself as the dominant center while the induced low in the Sea of Japan fills. While the Yellow Sea Low affects Korea and the area north of the Japanese mountain divide, the Shanghai and Taiwan Lows affect the area south of the divide. This double-eye situation causes the most widespread area of unfavorable weather covering most of Korea and Japan (including the Sea of Japan).

The double-eye situation is a slow mover and usually both centers must pass east of l33' longitude before rain ends at Iwakuni. It is followed by a sharp outbreak of cP air and gusty surface winds, See Figure 3-7 (Insert #4). In addition to climatology, extrapolation, continuity, and persistence, the following rules of thumb will aid the forecasters:

Insert (1) Yellow Sea Low.
Insert (2) Shanghai Low
Insert (3) Double Eye Forms From Yellow Sea
Insert (4) Double Eye Forms Taiwan Low

1. As a low forms near Taiwan, it causes partly cloudy skies at stations in Kyushu. By the time such a low approaches the vicinity of Ishigaki Jima (ROIG/47918), thick cloud decks have formed over Kyushu and rain begins over its southern areas and spreads rapidly north as the low moves northeastward.

Cyclogenesis can be expected in the East China Sea or Yellow Sea when an extension of the Asian high pressure cell separates from its parent anticyclone and a "bubble" high appears over Japan in the winter and spring. These lows intensify and move eastward gradually curving northeast after passing Japan.

3. At times, a low from northern China passes northeast of Kyushu without bringing unfavorable weather as long as the Pacific high maintains its intensity and influence over the area of the southwestern islands.

4. Lows (south of 30'N latitude) moving eastward generally do not produce precipitation at Iwakuni (RJOI/47764).

5. Lows (north of 30'N latitude) moving, eastward along the southern coast of Japan will produce copious precipitation at Iwakuni (RJOI/47764).

6. When an eastward moving wave, originating in the Shanghai (ZSSS/58367) area, moves to 128'E longitude, precipitation begins at Iwakuni (RJOI/47764); (Use only if Cheju-do Island is not affected).

7. Low pressure moving eastward, north of Iwakuni (RJOI/47764), during autumn will produce periods of heavier rainfall and stronger winds than if it were to pass south of the station.

8. Precipitation normally ceases when a low or migratory wave passes east of 133' longitude as it moves along the southern coast of Japan.

9. Precipitation accompanying eastward moving waves or Shanghai lows will normally occur 12 hours after commencement at Cheju-do Island.

10. When isobars are oriented northeast to southwest in line with the islands of Japan, weak cyclones frequently form off southern Kyushu.

12. For early detection of Shanghai lows, look for precipitation in east-central or coastal China. A Warm tongue at 850 Mb with a weak gradient is usually present and occasionally a trough at 500 Mb. At Cheju-do Island look for cirrus, altostratus, then stratocumulus in that order. When stratocumulus is reported, rain will soon occur unless the low has formed below 28' latitude. Rain will begin at Iwakuni (RJOI/47764) l2 to 16 hours later. You should be able to pick up low development 28 to 36 hours prior to its appearance on the surface chart by following the upper air charts.

13. If the Kamchatka Low is within 1,000 nautical miles of the low in the Sea of Japan, the low will not deepen and will move eastward across Northern Honshu. If the two lows are separated by more than 1,000 nautical miles, the Sea of Japan low will deepen rapidly and move northeastward. If at the same time, the 700 Mb flow over southern Japan is southwesterly, there will be a rapid spreading of bad weather to the northeast and 2 or 3 days of cold, dry weather will prevail over the Korean Peninsula and southwestern Japan during the winter months.

14. When a low pressure system moves southeast from Mongolia or Manchuria into the Sea of Japan and no low pressure area exists near the Ryukyus or southern Japan, its development and movement will be governed by the intensity and position of any low that exists over or near Kamchatka and the 700 Mb flow over southern Japan.

G. **Cyclogenesis.**

The upper air flow aloft off 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 they may forecast the development of fronts and lows that will eventually affect the Iwakuni area.

H. **Bubble High Cvclogenesis.**

The most reliable indicator for cyclogenesis in the cool seasons is the off shore movement of a 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 cyclogenesis roughly correlates with the latitude of the bubble high. Generally, highs that move off shore north of 35' N will generate lows that move into the Sea of Japan. Highs that move off shore south of 30' N will generate lows that move south of Japan. Cyclogenesis under these conditions normally occurs in the Yellow Sea or East China Sea and are referred to as Shanghai or Yellow Sea Lows. The lows that are produced by a high moving off shore 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 advective pattern also gives a good indication of the location of cyclolgenesis.

The above described synoptic pattern has been found so reliable in the past that a verification of nearly 100% will result with a forecast of cyclogenesis after a bubble high has moved off the Asian coast. While this is primarily a winter time situation, the method is also applicable to clear cut spring or summer situations. The delay between 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 3-8 depicts the normal surface pattern of the bubble high, which has broken off from the parent high over Asia with Figure 3-9 indicating the areas within which cyclogenesis will occur in the Yellow Sea and East China Sea.

I. **Associated Upper Air Patterns:**

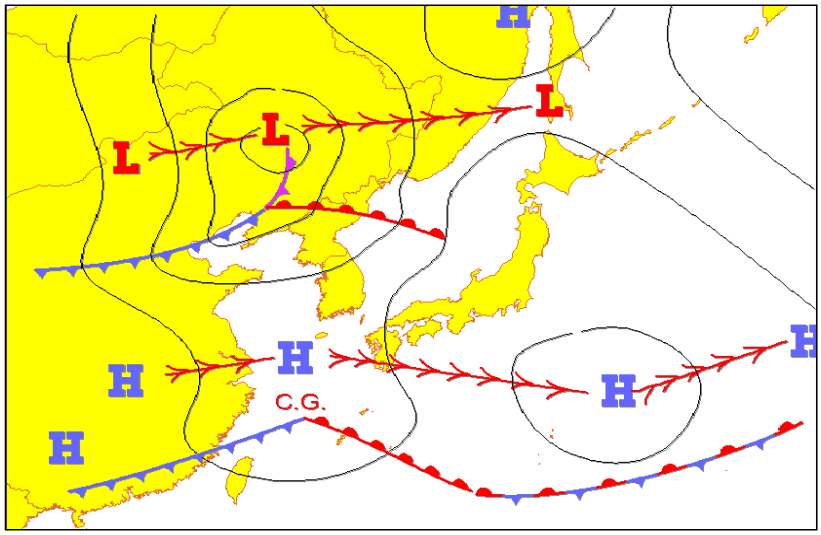
1. **500 Mb Flow** - The flow at 500 Mb shows a pattern of minor short wave ridges and troughs in connection with shallow, cold bubble highs breaking off of the parent Siberian High. The short-wave ridge with its northwest

flow moves eastward with time coincident with the surface bubble high.

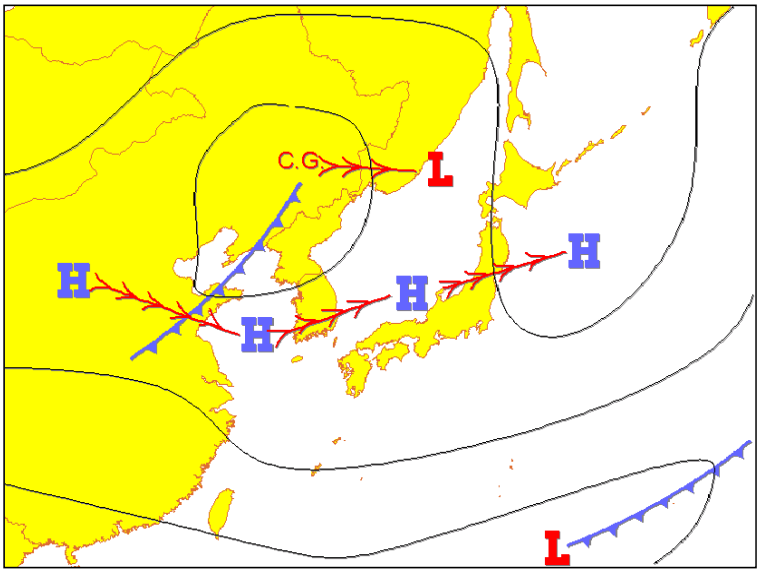
1. **300 Mb Flow -** The upper at 300 Mb off the east coast of Asia in the cool season exhibits a remarkable steadiness in direction. Figure (3-10) indicates the typical 300 Mb flow off the coast and over the Bubble high. This is an idealized situation, however, the presence of a jet maximum near the cyclogenesis area will ensure cyclogenesis if all other criteria have been met.

J. **Types Of Cvclogenesis Associated With A Bubble High**:

1. **Pre-existing Low to the Northwest** - Characterized by a low pressure cell to the west or northwest of the bubble high during the day that bubble high moves offshore. 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 lag time of about 24 hours. Figure 3-11 depicts the resultant developed cyclone in the East China Sea. It forms 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.

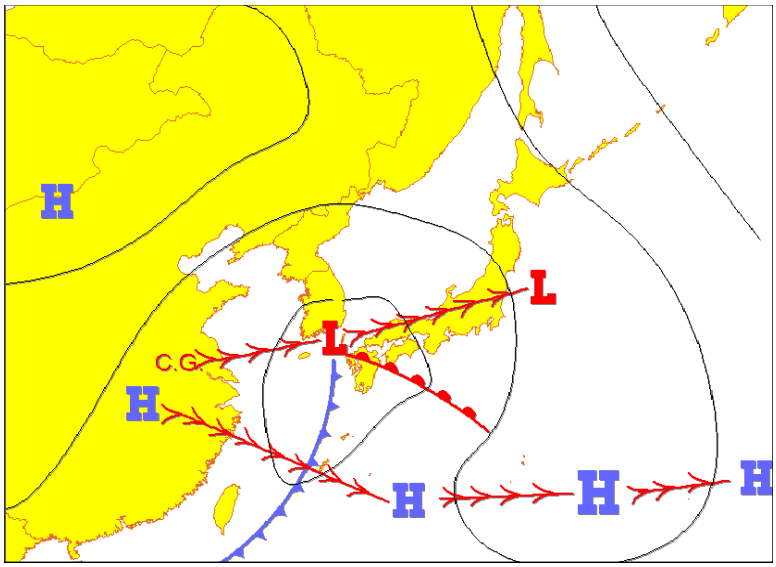


2. **Pre-existing Cold Front** - Characterized by a cold front northwest of the critical area on the prediction day but no marked pressure cell is



present. It is followed in about 65% of cases by cyclogenesis over Mongolia. In the other 35% of the time, poor weather is normally restricted to a band along the cold front and is not nearly so widespread. Under normal conditions, 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 in early winter or late winter and the time lag is from 24 to 36 hours. This low is referred to as the Yellow Sea Low. See Figure (3-12). Positions are 24 hours apart with the time of the chart for the time of cyclogenesis.

3. **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 and southern coastal regions of China and move along the south coast of Japan and are commonly called Taiwan lows. Figure 3-13 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 parent high until the formation of an open wave or closed low.



a. **Validating Criteria** - This forecasting procedure verifies in 80% of all cases, but 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 Siberian High and not a major cell itself, (3) tropical cyclones in the immediate vicinity breakdown the forecasting procedure

negating its value and finally, (4) this method is not valid during the summer as most coastal highs are merely reflections of diurnal pressure variations.

309. DEEPENING OF LOWS.

Once these lows form, they deepen rapidly with an average drop of 15 mb. After leaving the formative area, it might be noted that any surface cyclonic circulation in this area during the winter should be forecast to deepen. This is due to the generally favorable upper air conditions and the thermal contrast between land and water.

A. Location Of Cyclogenesis

A refinement of the location of 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 the refinement of the time lag through an estimate of when the jet maximum will be in a favorable position for cyclogenesis. As an example, advection of warm air north along the east coast of China behind a surface bubble high and cold advection in a trough
to the west sets up an ideal pattern for Cyclogenesis. The 850 mb chart may also indicate movement of a bubble high by checking the advection at that level. Warm air advection beginning at the 850 mb 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 this advection pattern persists.

B. Summary Of Bubble High Cyclogenesis

The upper air pattern is generally favorable during the winter for cyclogenesis off the east coast of China. Identification of cyclogenesis lies in the recognition of the proper surface pattern. This is important because of the effect these lows have on the region in a short period
after formation. The most common surface pattern for cyclogenesis in the coastal waters off Asia is a bubble high breaking, off the cold continental Siberian High. As the high moves rapidly eastward, it is followed by bad weather and cyclogenesis approximately 80% of the time. In order for this flow pattern to properly concentrate the thermal field it is necessary that the bubble high move off the coast between 25' N and 45' N. The thermal contrast between the polar air moving off the cold Asian coast and the warm Kuroshio current must be

intensified by the southerly current on the western side of the high.

C. <u>Cyclogenesis In A Weak Pressure Trough In Cool Seasons</u>.

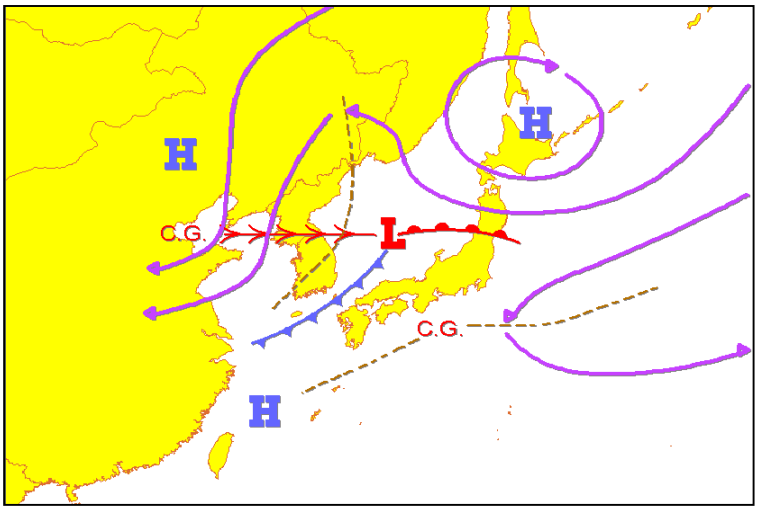
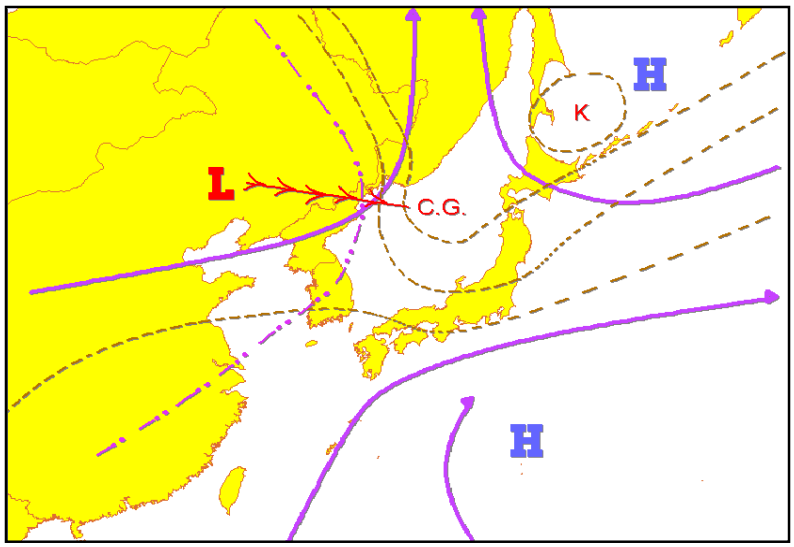


Figure (3-14) shows an ideal example of the synoptic situation for this type cyclogenesis to occur. This situation is created by the movement of the mid-tropospheric short-wave troughs. Cyclogenesis occurs along the south coast of Japan when troughing is evident over the Kuroshio current south of Japan 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' C or more). There is marked onshore flow over southern China so that cold continental air and cool maritime air (or well modified cP air),are present in close proximity and there is a possibility 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. There is a weak warm and contrasting cold advective pattern at the 850 mb level over the Kuroshio current, enhancing the possibility of cyclogenesisi.

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 tounge of air. Any cool pool or tongue of air that is well defined at the 850 mb level in

the warmer months is a possible cyclogentic area, particularly in the Sea of Japan and the Yellow Sea area. If a short-wave trough moves into one of these areas, cyclogenesis usually occurs. If the cool air moves eastward, rainshowers and thunderstorms may be triggered. Figure 3-l5 shows an example of cyclogenesis forming in a cool 850 mb tongue. Cyclogenesis will usually occur when the short-wave trough approaches within 5-10' longitude of the center line of the cool tongue of air.

E. <u>Cyclogenesis On The Stationary Polar Front South Of Japan</u>.

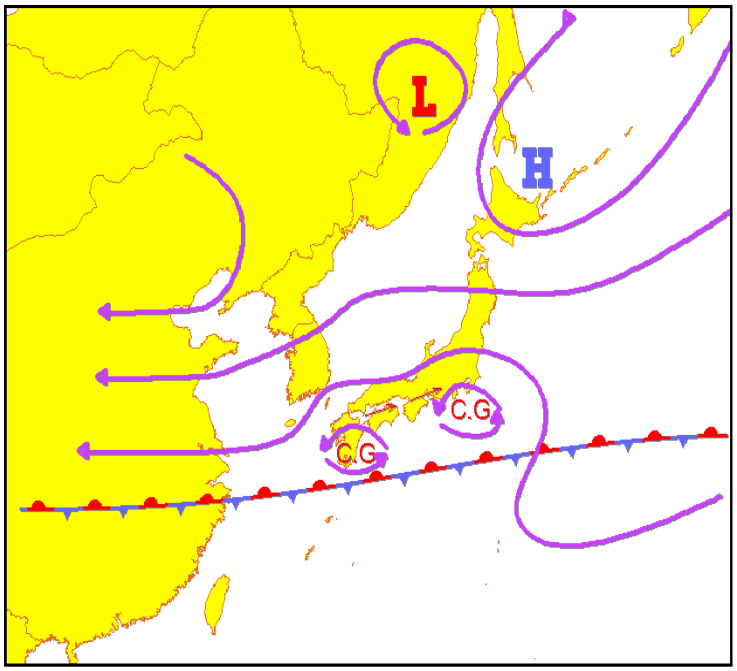
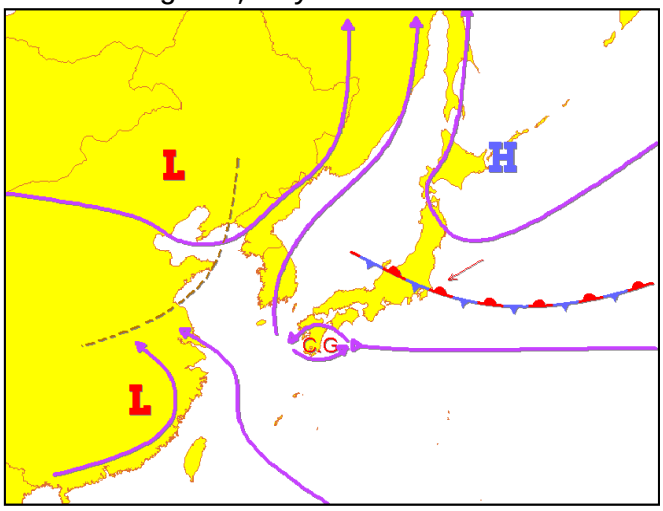


Figure 3-16 gives a typical synoptic illustration of cyclogenesis along the polar front south of Japan. The upper level winds are generally west to southwest when the front stagnates within 300 miles off the southern Japanese coast. Frontal activity will diminish when the winds turn northwest. When the low-level winds are north or northeast along the southeast coast of Honshu and west to southwest along the southern coast the formation of a depression occurs. The advective pattern at the 850 mb level indicates the formation of the cyclone. When the stationary front is just off the coast of Japan and there is warm advection to the east, the situation is indicative of cyclogenesis. When an upper level cold low is located in the Manchuria-Siberia region, cyclonic flow will occur near the polar Front and cyclogenesis is very probable.

F. <u>Transition Season Cyclogenesis Off Southern Japan With Easterly Flow</u>.



An example of this situation is given in figure 3-17. When the cyclogenesis area off southern Kyushu is established in the deep cool easterly flow, it will become active when the gradient w9inds along the southern coast of Japan veer northeasterly and the 850 mb winds are light and out of the south. This pattern is often established in the spring with the ridge line over the region. Another situation occurs in the early autumn or late summer when the subtropical ridge line sloping northward with height establishes a deep easterly flow over Japan and low-level cold air is present in the generating area. Such a situation is set up when a cool high pushes southeastward off eastern Japan and slowly feeds cool air into the lower levels. The trigger mechanism is usuallv an upper level short-wave trough moving into Korea. The best indication of cyclogenesis before a circulation appears on the map is the appearance of an altostratus cloud layer, usually overcast with bases between 8,000 and 12,000 feet moving over southern Japan and into central Honshu. The altostratus, which may be masked by a low overcast layer due to the onshore flow, will move into the area with light intermittent rain beginning to fall 6 to 12 hours later. Continuous rain commences after 12 to 24 hours as the low moves along the coast. The low will begin to move when the mid-tropospheric flow shifts from easterly to southwesterly. This type of cyclogenesis is likely to occur with the first outbreak of cool air and with the first significant short-wave trough. In addition to climatology, extrapolation, continuity and persistence, the following rules of thumb will aid the forecaster:

1. In practice, almost any surface cyclonic circulation in the cyclogenetic areas during winter should be forecast to increase in intensity.

2. Good weather is associated with a northwesterly air flow. The deeper the flow, the more persistent the good weather.

3. A gradient wind shift (3,000 to 6,000 feet) into the southwest signals the approach of bad weather. A shift from southerly to westerly or northwesterly circulation signals rapidly improving weather.

4. Northeasterly, easterly and southeasterly air flow is associated with bad weather. Exception: Deep, uniform easterly flow up to at least 700 mb is associated with good weather.

5. Improving weather or continued good weather is signaled by a temperature decrease aloft.

310. FRONTS.

Frontal boundaries affecting the region track eastward from Asia and across the Sea of Japan, or in a north-south movement as with the transition of the polar front during the rainy season or "Bai-U". Weather occurring with a front depends on (1) the amount of moisture available, (2) the degree of stability of the air forced upward, (3)the slope of the front, (4)the speed of frontal movement, and (5) the upper wind flow.

A. Cold Fronts.

Cold fronts that effect Iwakuni occur with a high frequency during all seasons and may be associated with all types of lows that were previously discussed except the Taiwan Low. The cold front is usually first identified in northern or central China and move eastward across Korea, Japan, and into the northwest Pacific acting as a divider between successive migrating highs. The First series of significant cold fronts occur with great regularlty between the latter part of October and early November, the second, more severe series about early December, the third, a very severe cold wave outbreak, in the latter part of January or February. Cold fronts move at about the speed of the wind component perpendicular to the front just above the frictional layer.

1. **Slow Moving Cold Fronts**. Generally, slow moving cold fronts are found in the spring, summer, or fall. They frequently act as the triggering mechanism to induce wave cyclogenesis over China. The 850 mb wind is from the west to southwest 10-15 knots ahead of the front and veering to west to northwest 15-30 knots after passage. One or more lows will form along the front during its slow southward track. The lows will not increase in intensity until the line of discontinuity becomes more unstable. The warm ocean currents of the Sea of Japan, the Yellow Sea, or the East China Sea provide the needed instability and lows usually deepen or even occlude as they approach the warm currents. The slow moving cold front is usually active and will bring varying amounts of clouds and precipitation to Iwakuni. Character and content of the weather that accompanies the cold front is based primarily on:

a. The Season and Air Mass Contrast- summer or winter gives little air mass contrast, however, as the summer Manchurian heat low begins to weaken with the overall cooling of the continent there is ample contrast. The same is true of the weakening of the intense Siberian High during the winter. For the most part, air mass contrast is greatest in the transition from summer to winter and back to summer again.

b. Circulation Intensity - The intensity more than the location of the circulation systems determines the volume of the air masses that will be available to interact across a given frontal zone. Intensity will also determine the flow above 500 mb and the location of the jet stream across the system.

c. Generally the upper air flow from 500 mb to 200 mb will determine the direction the cold air will follow.

d. Moisture- The availability of moisture determines the weather in terms of precipitation and clouds.

2. **Fast Moving Cold Fronts**. Fast moving cold fronts are predominantly observed in the winter and are usually inactive. Cyclogenesis along a fast moving cold front is an uncommon occurrence; however, surface winds preceding the front will be 10-20 knots after passage. In addition, pressure drops and temperature rises will occur 250 nautical miles ahead of the front. Rates of pressure falls and temperature rises are reliable indicators of the intensity of the front. Temperature drops of 10' F are common after frontal passage. Fast moving fronts are particularly conservative in their weather, especially in winter. Rain and rain showers accompany the fronts until December, and snow and snow showers come in January and February. They are also preceded by a light shield of cirrus and the usual wide spread cloud mass. Embedded in this cloud mass are altocumulus. cumulus and even thunderstorms. The embedded storms are more common with warm and stationary fronts. The cirrus is observed about 36 hours prior to the frontal passage.

B. Warm Fronts.

Warm fronts usually have adverse effects on the Japanese islands. The low ceilings and poor visibilities affect aviation and boating activities as well. Warm fronts that affect the Iwakuni area occur primarily during the autumn, winter and spring months. These warm fronts are associated with cyclones that generate over the East China Sea, or Yellow Sea, and move eastward along the southern coast of Kvushu and Honshu. The approaching cyclone and associated warm front cause wide-spread rain throughout southern Japan. The spring and autumn migration of the polar front marks the period of maximum precipitation and cloudiness over southern Japan.

C. "Bai-U" Or Rainy Seasons.

The spring and fall migration of the Polar front marks the period of maximum precipitation and cloudiness over Iwakuni. The first stages of the northward/southward migration of the Polar Front can best be observed by monitoring the Polar Front Jet's (PFJ) migration. The intensification of the Pacific High in the spring and the weakening, of the Asiatic continental high will coincide. The reverse is true during the fall. Once the Polar Front has moved northward over the East China Sea during the spring a quasi-stationary high (1016 mb) develops to the north or northeast of Hokkaido and the subtropical ridge extends westward from the Pacific High to the Philippine Islands. The pressure cell to the northeast of Hokkaido ridges westward over the Sea of Japan. During this transition from winter to summer, cloudy skies are common and weak cyclones move eastward along the Polar Front, which is now trapped between two high pressure cells.
These cyclones do not ordinarily deepen and appear as a series of waves on the front. Rain will commence with the approach of a wave and cease when it passes to the east. On occasion, the high pressure to the northeast will intensify and push the Polar Front south of Japan, resulting in partly cloudy skies at Iwakuni. If the high to the northeast weakens, the Polar Front moves north of Iwakuni. This oscillation will continue until the subtropical ridge becomes firmly established and higher surface pressure and upper level height rises finally force the Polar Front north.

D. **Troughs**

Usually short wave troughs at 500 mb are reflected on the surface charts by frontal systems, lows, or troughs. However,

there is one case of an upper air trough that does not reflect on the surface until it reaches the Asian coast. It exists when a 500 mb trough rides over a shallow (below the 500 mb level) quasi-stationary high. While the trough remains aloft over the high, the only surface indication is an area of poor weather confined to the more northerly latitudes. The first clues to its surface regeneration are the surface pressure tendencies along the eastern edge of the high. Occasionally, when the quasi-stationary high is elongated in a east-west orientation, a small "bubble high" will break off from the main center and the trough will form behind it. Most of the cloudiness and precipitation associated with this type trough is confined to the Asian mainland north of 45' latitude. However, there is considerable cloudiness and showers along the coastal areas of Japan north of the central mountain divide. When the quasi-stationary shallow high exists, all upper level troughs moving eastward in the westerly flow aloft should be extrapolated forward and cyclogenesis suspected.

In addition to climatology, extrapolation, continuity and persistence the following rules of thumb will aid the forecasters:

1. **Fronts/General**

a. Fronts oriented north-south move relatively fast and are followed by good weather.

b. Fronts oriented east-west pass more slowly and bring persistent and widespread undesirable flying conditions.

c. As the polar front migrates from south towards the north over Iwakuni, it brings heavy, persistent rain.

2. **Cold Fronts.**

a. Eighty percent of the cold fronts which pass over Kyushu during the period from mid December through 1 March are inactive, fast moving cold fronts with an average speed of 25 knots. Some fronts have been observed moving at speeds as high as 50 knots.

b. Cold fronts moving toward Ashiya (RJFA/47803) from the northwest, ahead of an intense high pressure area in Siberia, will pass Ashiya approximately 12 hours after passing Seoul Kimpo (RKSS/47110).

C. Active cold fronts have an average speed of 12-16 knots over Kyushu.

d. The occurrence of thunderstorms associated with cold fronts is rare. Less than ten percent of all cold fronts produce thunderstorms and few if any are to be expected during the winter.

e. During the winter season, a cold front with extremely cold air behind it brings light snow showers to the local area. The usual rate is one snow shower every one to two hours until the thermal 700 mb trough has passed an imaginary line between Miho (RJOH/47744) and Iwakuni (RJOI/47764).

f. Before and after a cold frontal passage during the early spring especially during the month of March, gusty surface winds from the southwest-northwest may be observed to exceed 30 knots at Iwakuni.

g. Temperature and dew points are misleading due to topographical effects. Successful and accurate frontal analysis can be accomplished at 850 mb. At this level, the elements of wind direction and speed, temperature, and dew point are more representative of the overall synoptic conditions. Air mass discontinuities, therefore, are more easily seen.

h. A cold front will pass Iwakuni(RJOI/47764) 13 to 20 hours after it passes Paekryoungdo (RKSP/47103).

i. Fast moving cold fronts (i.e. those with speeds of 25 knots or more) will give little precipitation and will bring lowered ceilings for only 4-6 hours. Eighty percent of the winter time cold fronts fall in this category.

j. The best indicator of frontal speed is the 850 mb speed for cold fronts coming from Korea, since the terrain tends to slow the surface front.

k. If a front moves from west to east across Korea, that portion of the front which extends into the Korea Strait will produce very little effect at Iwakuni (RJOI/47764).

l. Late spring fronts tend to move in a more west to east direction.

m. Squall lines may form about 50 miles in advance of a fast moving cold front when it is between Cheju-do Intl(RKPC/47185)

and Tsushima (RJDT/4780O) in the Korea Strait.

n. Fall cold fronts will have rain ahead of them and stratocumulus behind them.

o. A good indicator of movement of a Shanghai Low and associated front will be fifty percent of the 500 mb winds.

3. Warm Fronts. The duration of precipitation during the winter as a result of warm frontal passage is short (approximately 10 hours). A warm front advancing from the south of Kyushu will cause southerly and southeasterly winds in the low levels in advance of the front. Because of the terrain effects south of Ashiya (RJFA/47803), this circulation is translated into down slope flow resulting in drying and warming during the initial movement of the front. Once the warm front moves north of Kagoshima (RJFK/47827) patches of low clouds begin to appear beneath the smooth altostratus deck (Indicating the transport of moisture exceeds the dissipation effects of the down slope flow), rain will begin in 6 to 8 hours at Iwakuni (RJOI/47764).

311. HIGHS AND MIGRATING ANTICYCLONE TYPES.

Iwakuni is constantly in transition between the winter Siberian High that completely controls winter weather patterns and the summer Subtropical (or Pacific) High that moves north during the summer months to influence our weather.

A. The Siberian High.

The Siberian High is strongest in winter, but a strong Siberian anticyclone can also set up in the autumn or spring. Once the cold core Siberian high becomes a quasi-stationary, the sea level pressure intensity is greater than 1050mb and a closed anticyclonic circulation extends to at least 500mb, a blocking high situation sets up. Simply said, it drives the polar front far south, and steers cold frontal systems far north. There is a minimum of frontal activity over East Asia and the Northwest Pacific. Once set, the blocking high is persistent and will provide the basis for a reliable forecast for several days.

B. The Subtropical High.

At the approach of summer, the center of the subtropical high moves north to become a semi-permanent feature. It is a huge, elongated expanse that covers virtually the entire North Pacific Ocean from the west coast of the United States to about 150' E

longitude between latitudes 2O' N and 3O' N. As it alternately strengthens and weakens, the high extends its ridge for thousands of miles westward from its center. During the stronger days, the ridge will extend as far north as Japan and as far south as the Philippines.
This strengthening and weakening action gives the illusion that the high moves over Japan from the south and then migrates again toward the east. However, the only true migrating highs that affect Iwakuni come from the Asian
Continent, and move with few exceptions, from the west toward the east remaining north of 30' N latitude.

C. Migratory Highs.

Source region and track of movement classify migrating highs. Of the six types, only three affect the Iwakuni area. As with all highs, the maximum subsidence comes at the eastern edge of the high (or the front edge with respect to its movement). Subsidence is responsible for the hazy days that are associated with the passage of migrating highs that stall for several days near the China coast. Near the center of the high, warmer temperatures
and light and variable winds are normal. The spawning area for migrating highs is located over Russia near the Lake Baikal region. As with the low pressure systems discussed earlier, these migratory highs generally follow a definite pattern or track according to the season.

1. Migrating highs that affect the Iwakuni area:

   a. West Lake Baikal High (Type 1) - This high forms west of Lake Baikal and is a semi-permanent feature. It disappears for short periods of time under the influence of short-wave troughs traveling across the Lake Baikal region. The West Lake Baikal high has the highest central pressure of any pressure cell in the Northern Hemisphere with pressures as high as 1084mb during a very cold winter. Surges of cold air move southeastward to the Shanghai then eastward across southern Japan, bringing cold air into the Iwakuni area. This is most prevalent during the winter and early spring.

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

c. Northeast Lake Baikal High (Type III) - This high will move directly southeastward into the Sea of Japan and across northern Japan. This high can be expected to occur at any time during the year and its presence normally indicates a blocking situation in the northern tracks.

2. Migrating highs that do not affect the Iwakuni area:

a. Sea of Okhotsk High (Type IV) - This high forms in the northern Sea of Okhotsk and moves south-southwest to Sakhalin and northern Japan and is common only during the summer months.

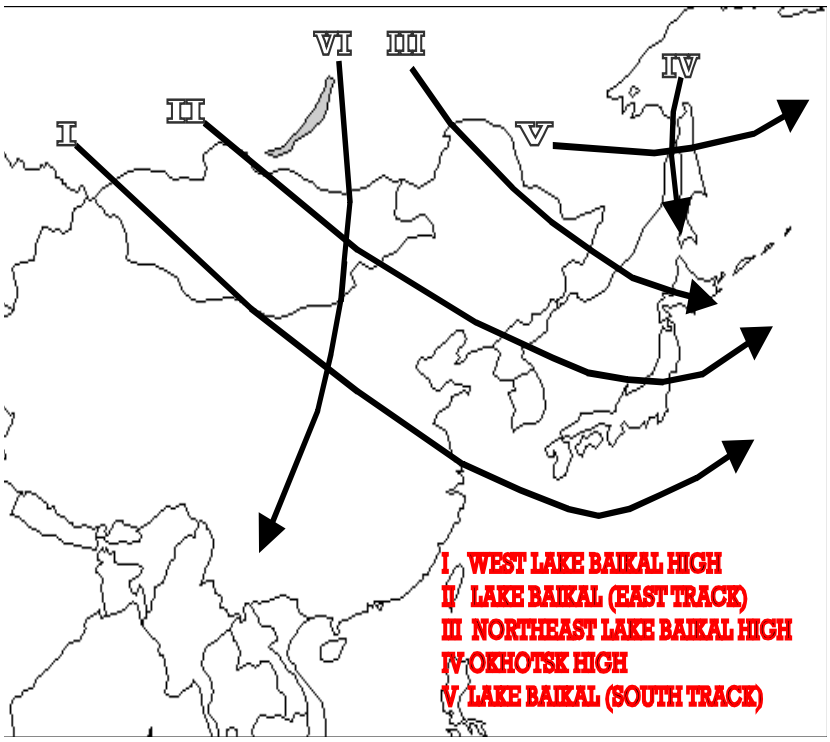
b. East Siberian High (Type V) - Forms in Eastern Siberia and moves easterly into the Sea of Okhotsk.

c. Lake Baikal (South Track) HIGH (Type VI) - Forms over Lake Baikal and moves across China into Southeast Asia.

3. Winter, Spring, Summer, and Autumn Tracks.

a. During the winter season, the Northeast Lake Baikal Highs prevail. They move out of their source regions with pressures of 1045mb. As they move into China, Korea, or Japan, the pressure drops to an average of 1028mb. The West Lake Baikal high tends to track toward Japan north of 30' N. By spring, the Lake Baikal Highs are also active.

b. They leave their source region with an average pressure of 1030mb, but by the time they reach Japan they are about 1025mb. Figure 3-18 indicates the normal tracks of the high pressure cells moving from their source



regions.

c. In summer, as in spring, all three types are active in Japan; they are considerably weaker however. The average pressure is 1010mb or lower. By autumn, even though all three types of highs are active, the Lake Baikal High is the major influencing high pressure system. Its central pressure is 1028mb in its source region and 1018mb over Japan.

D. Influence of Highs.

1. The following pressure gradients may be associated with bad or deteriorating weather:

   a. East HIGH -West LOW

   b. Northeast HIGH -Southwest LOW
   c. North HIGH - South LOW

2. The following pressure gradients are associated with good weather:

   a. West HIGH - East LOW

   b. Southwest HIGH - Northeast LOW

   c. South HIGH - North LOW

E. Rules-Of Thumb For Highs:

1. A migrating HIGH from Asia introduces good weather, light winds, a large diurnal temperature range, no ceilings, and relatively few clouds.

2. If the HIGH is "warm" (i.e., relatively deep, with anticyclonic pattern aloft), good weather prevails.

3. If the HIGH is "cold" (i.e., relatively shallow), weather deteriorates rapidly after the cell center or ridgeline passes.

4. Migrating HIGHS do not move with the steering field.

5. In the spring and autumn seasons, the stronger HIGHS frequently stagnate temporarily, either in the Shanghai (ZSSS/58367) area or the ocean area immediately east of Japan.

6. The tendency for stagnation is directly proportional to the "warmth" or "depth" of the HIGH.

7. The entire weather cycle of the migrating HIGH is better when the cell center passes south of the area than north of the area.

8. Migrating HIGHS naturally track further northward in the late spring and early autumn.

9. Early morning showers sometimes occur near the center of a cold, shallow migrating HIGH.

10. Unfavorable weather occurs when a migrating HIGH extends over the Sea of Japan to areas of northern Japan, but does not extend over the southwestern islands. In this situation, the upper wind usually has a southerly component.

11. Warm, favorable weather persists when Iwakuni is under the influence, of the subtropical HIGH.

12. This weather is especially persistent when the high's influence extends to areas of the East China Sea and southern China. If the system persists for more than hours, reduced visibility from haze can be expected during the afternoon. If it persists for more than 48 hours, expect late afternoon and evening thunderstorms.

13. If a migratory (cP) HIGH is spreading southward over Japan, wave development will be dampened and the wave held south of 30' N.

14. When the extension of a northerly-developed continental HIGH covers the Kyushu area, the weather will not improve, even in the southern part of Kyushu unless the cold air extends to the southwestern islands.

15. When the synoptic situation features a well developed continental HIGH with a pressure distribution of a west-HIGH and east-LOW type pattern so that a strong north through east gradient flow results, it causes considerable cloudiness with occasional light snow or rain at stations in our region and local mountains. In general, when the isobars are oriented north-south, the degree of unfavorable weather varies in consonance with increased strength of the

wind.

16. In some situations, even though a high prevails over the area, lows form over sea areas of eastern Shikoku if the pressure gradient is weak. In such cases, rain will begin along the southern coast of the Shikoku district and spread progressively westward to areas of Kyushu.

312. WEATHER ASSOCIATED WITH TROPICAL CYCLONES.

Tropical cyclones occur in the western Pacific during all months of the year. The period from June through November is the period of greatest probability of the tropical cyclone formation and incidence near Iwakuni, and hence is known as the "typhoon season". The months of August and September have the greatest probability of tropical cyclone incidence, but October and November are also likely months for tropical threats to Iwakuni. The primary source area for tropical cyclone formation lies to the south and east of the island of Guam. However, formation within 300 nautical miles of Okinawa, south or southeast of the island, is not uncommon. Once formed most tropical cyclones assume a west to northwest track. Tropical cyclones usually track around the periphery of the subtropical high recurving in the vicinity of Okinawa.

A. Tropical Cyclone Season.

The tropical or "typhoon", season for Iwakuni begins on 01 June and remains in effect, through 30 November, reaching its peak in August and September. Weather phenomena resulting from the typical tropical cyclone passage begins with light to moderate shower activity as the storm approaches. Towering cumulus and isolated cumulonimbus are common, as is a shield of cirrostratus. Nearer the center, moderate to heavy intermittent rain and heavy showers occur. Ceilings vary from 200 to 2,000 feet, and the visibility varies from 1/2 to 5 nautical miles. Near the eye of the storm, rain and blowing spray are driven by the strong gusty winds.

B. Discussion of Harbor Exposure.

The following extract from Brand and Blelloc (1976) points of Iwakuni and vicinity. "The mountainous terrain of the islands of Honshu, Kyushu, and Shikoku, with elevations exceeding 3,000 feet, would lead one to expect that the winds of a tropical

cyclone would be greatly reduced before reaching the Hiroshima Bay region. This is, in fact, the case when storms pass to the west or the east of the bay region. When storms pass to the west, the wind will normally be reduced 35-50% while storms passing to the east will usually have their winds reduced 60%. Also it appears that southerly winds coming through the Bongo Straits and Inland Sea have the path of least resistance Into the Hiroshima Bay area. Generally this would be the case when a storm passes to the west. Brand and Blelloch stop short of recommending Iwakuni as a typhoon haven, but they do recommend the nearby Port of Kure and area typhoon anchorages.

C. Results and Use of Forecast Aids.

Tropical cyclones passing Iwakuni are generally beyond their peak strength and just beginning to weaken. Frequently this weakening process involves an influx of cold air and the transitioning into a mid-latitude or extratropical cyclone. In either case the cyclones can be extremely dangerous thus the evacuation of Iwakuni can be readily justified. Terrain protection can be inferred from the Forecast Aids in Figures 3-19 through
3-22.

D. Forecasting Aids Tropical Cyclone Nomograms.

Step 1: Using the appropriate nomogram, plot the latest message transmitted by JTWC. Label each plot with its valid date/time and maximum sustained winds. Then connect the plots with a smooth curve in pencil. Label the nomogram in the upper right corner with the cyclone name, message number, and the DTG.

Step 2: Using, the given or inferred speed of movements between positions, annotate the cyclone position for every two hours along the track from where it is near southern Kyushu until it is about 6-8 hours past CPA. Then estimate the intensity along the track, or each position using 5 knot increments.

Step 3: Using data from NODDS, JMA, PACDIGS, and your own analysis of the mesoscale weather, estimate the wind direction to determine when the winds will be from the south (or most likely direction for destructive winds). If the cyclone is not on a climatological path that will give us southerly winds, the computed local winds will have to be further, modified.

Step 4: Compute the winds from the nomograms for each time increment. Use the rules of thumb to adjust/modify, your

forecast. Estimate the onset, and end of destructive winds. Also recommend times to set COR's and list times and heights of tides during passage.

Forecasting wind conditions at Iwakuni during the passage of a tropical cyclone is a critical operation problem. The terrain influence maps provided are based on available surface wind observations therefore, caution should be used in applying these results when a typhoon center is expected to pass over or near the station.

E. RULES OF THUMB FOR TROPICAL CYCLONE

1. When a tropical cyclone of typhoon intensity passes more than 120 nautical miles south of Iwakuni, forecast fair weather and no gusty winds locally.

2. When a tropical cyclone moves within 75 nautical miles of Iwakuni, forecast heavy rain, low ceilings, and gusty winds.

3. Tropical cyclones seldom move up the Bungo Strait.

4. A tropical cyclone should never be forecasted to move across the 588 isoheight on the 500mb chart.

5. A safe forecast for Iwakuni's surface winds for a tropical cyclone moves within 75 nautical miles would be 15-20 gusting to 35 knots. Since records have been kept at MCAS Iwakuni, the maximum gust associated with a tropical cyclone was 78 knots on 27 September 1991 with Super Typhoon Mireille.

6. To gain a rough idea of the projected path of a tropical cyclone, locate the 588 isoheight in the 500mb chart and sketch a line parallel to and 10 degrees latitude width out (works best in the sub tropics).

7. Use the 500mb longwave chart with 588 isoheight, "rules" above. Find initial position with data base and stay equal distance from initial and progged 588 line.

8. Heavy rain occurs over Kyushu when a typhoon passes on its eastern side from the south to northwest, but the resulting wind is comparatively weak. If the typhoon passes to the western side of the island in a detour around a high cell, rainfall is relatively light over Kyushu but strong winds occur.

9. Use deep mean layer winds from NOGAPS for steering.

10. Use 200mb streamline analysis and prognosis charts to find diffluent area. Note convergence areas so you know where the tropical cyclone will not go.

11. Use 500mb winds analysis and prognosis charts for signs of ridge building and eroding. If eroding, it will erode back to limit of cyclonic speed sheer.

12. NOGAPS series 12-24 hours in advance works very well with a tropical cyclone. Caution- ensure it initializes well.

13. Hand plotted hourly LAWC's are especially valuable in the 12 hour time frame prior to CPA when the tropical cyclone is moving, or expected to move over land areas. Due to shearing effects at our latitude the upper and lower level circulation centers frequently "disconnect", hourly analysis enables tracking the low level center and the maximum wind bands.

14. Use common-sense/logic when recommending the setting of the next higher condition. The meteorological situation may dictate one time but the reality of personnel availability and or costs may suggest otherwise. Condition III is very labor intensive, especially for Facilities; the commanding officer will try to set it during normal working hours, especially in the morning.

313. UPPER AIR WINDS AND THE JET STREAM

Jet stream characteristics are listed below to provide forecast guidance during analysis of changing synoptic conditions at the surface.

1. When a migratory low deepens, the jet stream over it generally intensifies and descends to a lower height.

2. Polar jet streams rarely show mean pattern characteristics on any given day, whereas the subtropical jet is remarkably uniform.

3. During the autumn, winter, and spring, the subtropical jet most frequently lies over the section of the 500mb isotherms between -10 to -15 Celsius. The polar jet is commonly located over 500mb isotherms between -15 to -20 Celsius in spring and autumn, and between -20 to -28 Celsius in mid winter.

4. Polar jets are often related to polar fronts. In such cases the jet center usually lies over or slightly south of the 500mb frontal passage especially after fresh polar outbreaks from Asia.

5. The winter mean jet stream speed is 155 knots. The daily range of maximum wind speed is 120 to 250 knots. The summer mean jet speed is 50 knots. The daily range of maximum win speed is 50 to 110 knots, however in rare instances, jet intensities may reach values of 150 to 200 knots following the cyclogenesis of a well defined low north of Japan in summer.

6. The subtropical jet stream mean intensity during the spring and fall is about 120 knots with mean monthly ranges from 70 to 140 knots. The polar jet's mean speed during these seasons is 100 knots and it's monthly values range from 60 to 110 knots. From day to day, jets have speeds varying between 50 and 200 knots.

7. The greatest wind shear, 100 knot/100mile is usually observed on the north side of the jet, but occasionally it is as strong to the south. South side shear usually has ranges of up to 100 knot/3OO miles. Clear air turbulence can be expected with high shear values.

8. The strongest jets during all months are associated with cyclogenesis or the movement of a pronounced low across the 130 and 140 east meridians. The strength of the jet increases quite markedly over regions west of the surface position of such low. As a rule, the more intense the low the greater will be the maximum wind speeds in trough of the upper troposphere.

9. Jet streams with center speeds of 50-100 knots greater than the monthly mean often overlie regions dominated by surface high pressure areas.

10. Minimum speeds or weak jets are usually associated with well-defined ridges aloft.

314. <u>ICING.</u>

With the appearance of the F/A-18 and AV8B aircraft at MCAS Iwakuni it has become increasingly important for forecasters to be aware of the vulnerability that the aircraft's have to icing

due to their lighter, thinner structures. A close watch of the freezing level is necessary in determining how fast the pilot must climb to a level where the temperature is -22' C (ice formation is rare at this temperature). The critical time for icing, is the winter season. Extrapolation must be used to forecast the freezing level changes due to frontal passage and diurnal effects. It is extremely important to monitor pilot reports for icing conditions. Aircraft icing is generally limited to those clouds in which the temperature is between 0 and -20 Celsius, with the type of icing largely dependent on drop size, rate of accretion, and temperature. Factors that favor clear ice formation are
temperatures from 0 to -4 Celsius. Rapid accretion and large drop size normally found in cumuliform clouds. Rime ice formation is favored by small drop size as found in stratiform clouds, slow accretion, and temperatures about -10 Celsius or cooler. However, at temperatures of -20 Celsius or colder, the moisture content of the air is usually too low for all forms, except for very light rime icing. Moderate to severe mixed or clear icing, occurs at and above the freezing level in towering cumulus
and cumulonimbus. Normally, this would be above the operational flight levels of helicopters, but
could be of concern to fixed wing, aircraft.

315. <u>TURBULENCE.</u>

The rugged terrain surrounding Iwakuni and the orientation of the local area great affect the wind flow in the local area and helps produce low-level turbulence. Strong gusty south southwesterly flow is almost always associated with a low in the Sea of Japan near the west coast of Honshu, while a high pressure center is located to the south or southeast of Iwakuni. This can cause low-level turbulence in the area resulting in hazardous takeoffs and landings. Many of the wind speed maximums have occurred with deep lows or tropical cyclones that have moved into the Sea of Japan near the west coast of Honshu. Both thermal and mechanically induced turbulence are applicable in forecasting at MCAS Iwakuni throughout the year. The following rules of thumb should be used to aid in forecasting.

1. Severe turbulence will be widespread over Japan with the winds at 1,000-3,000 feet at/or above 30 knots when directions are 320-040 degrees or 140-220 degrees.

2. Moderate to severe turbulence will be experienced in hilly country, especially along the higher ridge lines. Whenever

the gradient level winds (1,000-2,000 feet) exceed 20 knots.

3. The height of the turbulent layer will usually be twice the average height of the terrain over which the strong winds are blowing. This can be revised when a significant inversion (over 5 Celsius /1,000 feet) exists just above the surface and the winds are blowing at the inversion level. Then the base of the turbulent layer will be approximately 300 to 500 feet below the top of the inversion.

4. During the warmer months of the year, whenever cumulus is expected, occasional light turbulence should be forecast in all areas, especially where there is a 10 knot sea breeze expected just inshore from the beach. The base of this turbulence will usually be about 500-800 feet.

5. Jet stream turbulence is most prevalent between the 400 and 300mb levels. It is usually experienced along the northern side of the jet in cold air where there is a maximum of packing isotherms. It is more apt to be felt with Jet velocities ranging from 50 to 90 knots than with velocities greater than 100 knots. A secondary region of turbulence is normal in the layer between 250 and 150mb and is prevalent south of the jet maximums.

6. Forecast moderate to severe turbulence below 10,000 feet locally when winds from the surface through 500mb are westerly and increase from 15 knots (surface) to 50 Knots at 500mb.

316. WARNINGS AND CONDITIONS.

Storms, and, the potential of Destructive weather that accompany 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. MCASO 3140.5 covers the local plan, but the following summary is provided for ready reference.

A. Destructive Weather Season.

June I through November 3O has been established as the typhoon season for the local area. Although thunderstorms are not often severe here, they can occur at any, month of the year. The most occurrences for thunderstorms are during August and during transition periods.

B. Types of Hazardous or Destructive Weather.

1. Thunderstorms.

2. Tornadoes.

3. Other Local Windstorms.

4. Major Cyclonic Storms.

5. Freezing Precipitation.

6. Frozen Precipitation.

C. Warnings and Advisories.

1. Thunderstorm/ Tornadic Activity.

   a. Advisory- Formation of thunderstorms and/or tornadic activity is occurring in the local flying area.

   b. Warning - Issued to give notification that thunderstorms/ tornadic activity are within 25 nautical miles of the air station.

   c. Thunderstorm/Tornado One - Issued when thunderstorms and/or tornadic activity are within 5 nautical miles of the air station.

2. Wind- Sustained wind speeds of 20 knots or greater and/or gusts of 25 knots greater are expected during, the period specified.

3. Freezing Precipitation - Freezing precipitation is expected during the period specified.

4. Frozen Precipitation.

   a. Ice Pellets - Ice pellets, significant enough to interfere with air operations and/or surface transportation, are expected during, the period specified.

   b. Hail - Any forecast of hail will be issued as part of a thunderstorm warning.

   c. Snow - An accumulation of snow is expected during the

period specified. (In Iwakuni, any accumulation may hamper aircraft operations and/or surface transportation.)

5. Freezing Temperature Notification - Utilities and Crash Fire Rescue will be notified whenever the ambient air temperature equals or falls below freezing.

6. Freeze Warning - The ambient air temperature is expected to fall below 28' F/ -2' C. (Water in exposed pipes may freeze).

7. Small Craft Warning - This is a harbor and inland waters warning, of sustained winds (25-34 knots) of concern to small craft.

8. Gale Warnings - Gale warnings are issued when sustained wind speeds are expected to be between 35 and 49 knots.

9. Storm Warnings - Storm warnings are issued when sustained wind speeds are expected to be 50 knots or greater. Storm warnings should not be confused with tropical cyclone warnings.

Note: Small Craft, Gale, and Storm Warnings are issued for marine interests only.

10. Tropical Cyclone Warnings.

a. Tropical Cyclone Condition IV - The trend indicates a possible threat of tropical cyclone within 72 hours. (Automatically Set I 1 June through 30 November).

b. Tropical Cyclone Condition III - Destructive winds of 50 knots or greater are possible within 48 hours.

c. Tropical Cyclone Condition II - Destructive winds of 50 knots or greater are anticipated within 24 hours.

d. Tropical Cyclone Condition I - Destructive winds of 50 knots or greater are anticipated within 12 hours.

e. Tropical Cyclone Condition IE (EMERGENCY)- Destructive winds of 50 knots or greater are anticipated within 2 hours.

f. Tropical Cyclone Condition IR (RECOVERY) - Destructive winds of 50 knots or greater are no longer occurring. Emergency crews and facilities assess air station readiness for normal operations.

g. Tropical Cyclone Condition ALL CLEAR – All tropical cyclone imminent dangers have passed. Return to condition IV.

317. ROUTINE FORECASTS.

1. Terminal Airdrome Forecast (TAF), TAFs are prepared in accordance with NAVOCEANCOM instructions. MCAS Iwakuni issues four TAFs daily. All forecasts have a valid period of 24 hours and are filed at six hour intervals at the following times: 03, 09, 15, and 21 UTC.

2. Flight Briefings, DD 175-1 are prepared on all IFR/VFR flights originating from MCAS Iwakuni and are prepared in accordance with NAVOCEANCOM instructions.

3. Flight Weather Packets (HWD), Prepared on request and provided to aircrews in accordance with NAVOCEANCOM instructions.

4. Weather Warnings and Advisories

5. Conditions of Readiness for Tropical Cyclones

6. Daily forecast Package

7. METRO Calls.

318. ALTERNATE WEATHER.

The following air fields are used as alternates when the weather at MCAS Iwakuni is expected to be below minimums:

1. Tsuiki is located about 50 miles southwest of Iwakuni on the southern Island of Kyushu. This area is a very hilly region with peaks ranging from 2,000 to 4,000 feet. Generally, weather in Tsuiki is about the same as Iwakuni. Tsuiki is a JASDF Base and is open 24 hours a-day.

2. Nyutabaru is located about 8O miles south-southwest of Iwakuni on the southeastern side of the island of Kyushu.

This region is very mountainous with peaks ranging from 3,000 to 5,700 feet between two rivers. Normally, Nyutabaru
Has very good weather except during the rainy season.

319. CWO-2 Webb Rule of Thumb.

An Aid in Locating Fronts in Southeast Asia

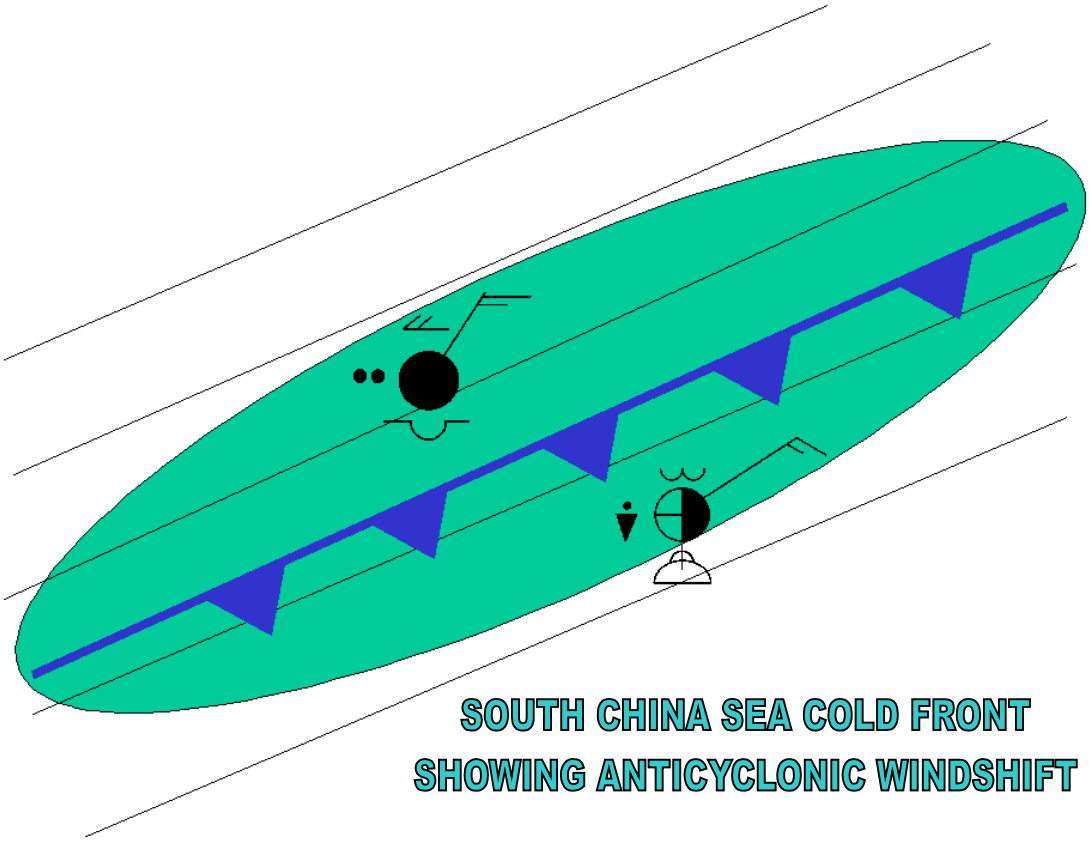
I recently came across a publication that should prove helpful in your analysis of indistinct fronts in Southeast Asia. While most of the area in the discussion concerned the South China Sea, I believe it is equally applicable to the southern portion of our analysis maps. The source was "The Diagnosis and Prediction of Southeast Asia Northeast Monsoon Weather," NWRF 12-0669-14 dated June 1969.

1. During a prolonged northeast monsoon condition, the general equatorward path of the surplus cold air out of the Siberian source region is southeastward and subsiding. As the cold air crosses southern China, it turns toward the southwest. The upper boundary of this migrant cold air slopes downward from the mid-tropospheric levels in northern China to near the 850mb level along, the south China coast, and vanishes into the surface mixing layer over the South China Sea. Although this boundary is fairly well defined above 875mb (from the southern portion of the South China Sea northward into central China), the surface boundary in the central and southern portions of the South China Sea is generally not precisely determinable. Trajectory considerations must be used to locate the front. Fronts that do exist in these regions reflect frontogenetic processes between various degrees of modified polar air.

2. Satellite pictures are quite helpful; but expect for unusually distinct cases, these pictures frequently show only an upper-level position (900 to 850mb) where the mildly sloping front becomes enmeshed in the top of surface mixing layer. As the front slopes down toward the south, the height of the overrunning becomes enmeshed in the surface mixing layer, giving sort of an "open-ended" effect. In the same zone, scattered to broken cumulus replace the solid stratus overcast prevalent farther north. The surface air can be seen to continue streaming southward past this line causes analysts to hold fronts (surface location) back below the edge of the clouds shown on the satellite pictures. The cloud's edge can remain stationary while the cold air slopes away southward underneath it. The change from stratus overcast to smaller amounts of cumulus- not easily by the satellite if widely dispersed- occurs when the air

temperature approaches the sea surface temperature. Even though the air at the surface continues to move southward below the edge of the general cloudiness, surface wind speeds show a distinct decrease just south of this line. This weakening of the winds is induces by the strong vertical mixing which begins to take place as the frontal inversion is dissipated- which in addition to dissipating the stratus deck also adds westerly momentum from the air above the inversion, which decreases the lower level easterly flow. However, in a strong deep surge of cold air, wind speeds will be high over most of the South China Sea; this is related to the strength of cold air advection.

3. For the most part, the monsoon flow is strongly cross-isobaric from high to low pressure, condition which becomes particularly pronounced during surge conditions. This gives rise to an anti-cyclonic wind shift, which adds to the confusion in trying to find a precise surface frontal position. A steady tightening of the north-south pressure gradient produces a definite cross-isobar component from high to low pressure. Because the equatorward movement of the fronts in Southeast Asia is caused primarily by cross-isobaric flow that is strongest at the very low levels, these fronts are very shallow; even shallower than mid-latitude warm fronts in this region. It is helpful to think of a frontal zone, which is the zone of the most intense temperature gradient. The leading edge of this zone is sometimes depicted as a heavy dashed line. Isotherms will generally be packed between these lines and kink at both edges. It is not uncommon to see frontal slopes of up to 1:500 and width of the frontal zone of up to 45 of latitude. Figure 3-23


SOUTH CHINA SEA COLD FRONT
SHOWING ANTICYCLONIC WINDSHIFT

320. REFERENCES.

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b. Ahrens. Donald C., "Meteorology Today", Introduction To Weather, Climate, and the Environment.

c. Jarrell, Jerry D., Forecasting Aids For Setting Tropical Cyclone Conditions Sasebo and Iwakuni, Japan.

b. USAF Weather Tokyo Japan, "Rules of Thumb for Japan".

c. AWS Pamphlet 105-56, Weather Meteorological Techniques.

d. Special Study 105-7 20th Weather Squadron, Far East Climatic Atlas.

e. Report CR88-02, Forecasting Aids For Setting Tropical Cyclone Conditions: Sasebo and Iwakuni.

h. CINCPACFLINST 3140.6U, Tropical Cyclone Warning and Weather Reconnaissance.

i. OPNAVAVINST 3140.24 Warnings and Conditions of Readiness CONCERNING Hazardous or Destructive Weather Phenomena.

j. NAVOCEANCOMINST 3140.4B, Atmospheric Turbulence and Icing Criteria.

k. NAVOCEANCOMINST3140.2D, Local Area and Area responsibility (AOR) Forecaster's Handbook's.

l. MCASO 3140.5L, Issuance of Destructive Weather Warnings.

m. MCASO 6200.2G, Information Concerning Physical Training and Heat Casualties; Limitations and WBGT Readings.

n. MCASO P3 140.3R, Tropical Cyclone Bill.

o. NAVEDTRA 10362.BI, Aerographer's Mate l & C.

p. NWRF12-0669-14, The Diagnosis and Prediction of

Southeast Asia Northeast Monsoon weather.

q. Supplement Pacific, Australia and Antarctica Flight Publication.

r. IWW/FM-88/021 First Weather Wing Forecaster Memo, Forecasting Hints for Japan.

IV SPECIALIZED FORECASTS

401. GENERAL.

Specialized forecasts generated by the duty forecaster are on the whole, for the local area and specific restricted areas of interest to tenant air crews. Most specialized forecast are provided utilizing the Geophysics Fleet Mission Program Library (GFMPL) and include, but are not limited to the following:

402. ELECTRO MAGNECTIC GFMPL FORECASTS:

A. The latest software release of the Geophysics Fleet Mission Program Library (GFMPL) listed in order of most frequently requested to least requested.

1. EM Propagation Summaries

2. EM Cover Diagrams

3. EM Loss Diagrams

4. ECM - Electronic Counter Measures

5. ESM - Electronic Support Measures

6. SSR- Surface Search Radar Range Diagrams

7. PV - Platform Vulnerability

8. BGV - Battle Group Vulnerability

9. LRP - Laser Range Prediction

B. Primary Users:

The most frequent user of output generated by the GFMPL is the EA6 community. (There is always one EA6 Squadron on the Unit Deployment Program (UDP) resident at Iwakuni.) FI8 and AV8B Squadrons are secondary users of GFMPL forecasts.

C. Forum:

The specialized forecasts are provided to the user at a location of their choice. Usually GFMPL output is briefed at a Strike Briefing. Strike Briefings are conducted at the ready room of the requester. GFMPL output

is briefed from an overhead slide so that the information can be imparted in masse. Other times unclassified GFMPL output will be briefed right at the forecast counter.

D. Security:

Due consideration must be given to the Security Classification of some of the graphics. A chain of custody is maintained from the moment the graphic is produced until the end user signs for it in the proper logbook.

403. OTHER GFMPL GENERATED FORECASTS:
(Tides - Tidal Prediction, SLAP - Solar Lunar Almanac Program)

A. Primary Users:

All tenant units aboard the Air Station request these forecasts. They are provided in the most timely fashion possible.

B. Forum:

These GFMPL forecasts are provided to the user right at the forecast counter or are faxed to the user.

C. Procedure:

Requests are taken in person or over the phone. Utilizing the GFMPL, the desired output is generated.

404. SOUND FOCUS FORECASTS:

A. Primary User:

Station Explosive Ordnance Disposal (EOD).

B. Procedure:

Sound Focus Forecasts (SOCUS), better known as Blast Forecast, are provided to EOD upon request. Typically the EOD section will schedule their blasting time to coincide with low tide at the Target Island. The schedule is submitted to the Weather Officer a month in advance for planning. Environmental data used to generate the forecast is acquired using the MRS, (UMQ-12) from the Meteorological Mobile Facility or the latest sounding from Fukuoka (47807). The Blast Forecast is used to determine whether meteorological conditions are favorable for disposal of

ordnance. Amounts of explosives considered are 8, 12, and 18 lb. The GFMPL output is kept in the appropriate binder in the forecaster area and the forecast is faxed to the EOD section. The forecast provided consists of "GO" or "NO GO" guidance. Forecasters should use the following in determining the forecast:

If broken or overcast low or mid clouds are forecast for blast time: "NO GO"

If thin broken high clouds, or scattered low or mid clouds are forecast for blast time, send up an MRS sounding or use Fukuoka's sounding. Prior to inputting a particular sounding into the GFMPL, the forecaster must consider what the conditions will be at the time of blast. If a
change to the sounding is required, those changes will be annotated plainly on the Skew -T diagram in pencil. It is this modified sounding that will be entered into the GFMPL to make the forecast.

Input sounding into the GFMPL and produce output for 8, 12 and 18 lb. on two azimuths of interest: 307 and 278.

Determine if blasting each poundage will produce 120 decibels within 5 km. Blasts producing 120 decibels within 5 km are forecast as NO GO: blasts producing less than 120 decibel within 5km are forecast as GO.

405. <u>EOTDA GENERATED FORECASTS</u>:

A. The latest release of the MARK III Electro-Optical Tactical decision Aids (EOTDA) Software Program.

(1) IR TDA

(2) TV TDA

(3) LASER TDA

B. Users:

Squadrons on UDP, to include F 1 8, AV8B and EA6B Air crew.

C. Forum:

These specialized forecasts are provided to the user at a

location of their choice. Usually, EOTDA output is briefed at a Strike Briefing. Strike Briefings are conducted at the ready room of the requester. EOTDA output is briefed from an overhead slide so that the information can be imparted en masse.

D. Procedure:

Requests are taken in person or over the phone using a special EOTDA request form. Very specific information is required for a useful forecast to be generated. Intimate knowledge of the Mark III EOTDA program is essential for the forecaster to be proficient in its use.

406. REFERENCES.

a. Mobile Oceanography Support System Users Manual

b. Mark III EOTDA Users Manual

c. In house Sound Focus binder

V ENVIRONMENTAL EFFECTS

501. FLIGHT OPERATIONS.

Flight operations within Iwakuni's local area may be affected unfavorably by adverse environmental conditions.

A. Thunderstorm Condition II.

Thunderstorm activity is within 25 nautical miles of the airfield.

B. Thunderstorm Condition I.

Thunderstorm activity is within miles-5 of the air station. At this time, all fueling and ordnance operations cease.

C. Turbulence and Low Level Windshear.

This is extremely important to MCAS Iwakuni as it is surrounded by mountains. The local terrain enhances conditions for light to moderate turbulence through the approach and departure corridors. Mountain wave turbulence is a common element at the air station, especially during the winter season.

502. IFR CONDITIONS.

Most common during the spring and fall rainy seasons. This occurs during the transition period as the polar front reestablishes itself and migrates to the North in the spring, and the South in the fall over Southern Honshu. This causes widespread areas of low ceilings and reduced visibility.