AD-A126 096 TERMINAL FORECAST REFERENCE NOTEBOOK FOR FEUCHT AAF GERMANY(U) WEATHER SQUADRON (7TH) APO NEW YORK 09093 DETACHMENT 1 05 JAN 83 1/1

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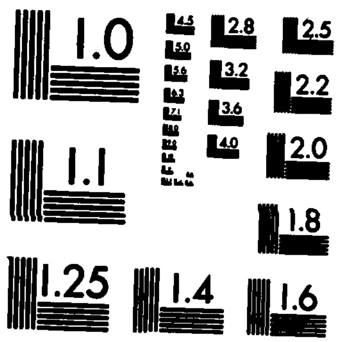

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INVENTORY

Terminal Forecast Reference Notebook for Feucht AAF, Germany

DOCUMENT IDENTIFICATION

5 Jan.'83

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TERMINAL FORECAST REFERENCE NOTEBOOK

FOR

FEUCHT AAF, GERMANY

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PUBLISHED BY
DETACHMENT 1
7TH WEATHER SQUADRON
2D WEATHER WING (MAC)
UNITED STATES AIR FORCE
5 JANUARY 1983

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Terminal Forecast Reference Notebook for Feucht AAF, Germany		5. TYPE OF REPORT & PERIOD COVERED Final
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Detachment 1, 7th Weather Squadron APO New York 09093		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Headquarters, 2d Weather Wing Aerospace Sciences Division (2WW/DN) APO New York 09012		12. REPORT DATE 5 January 1983
		13. NUMBER OF PAGES 70 (including covers)
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release;
Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

TERMINAL FORECAST REFERENCE NOTEBOOK

DETACHMENT 1, 7TH WEATHER SQUADRON (MAC)

FEUCHT ARMY AIR FIELD

GERMANY

JANUARY 1981

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SECTION I

LOCATION AND TOPOGRAPHY

1-1. STATION LOCATION AND TOPOGRAPHY:

Feucht AAF is located in the central portion of the state of Bavaria, Federal Republic of Germany. Although most of Bavaria is hilly, the terrain varies from mean sea level altitudes of 500 feet to the German Alps of near 10,000 feet. The airfield is on relatively flat terrain with gently sloping hills of 100 to 200 feet higher elevations dotting the landscape. This location is on the eastern edge of a shallow, north-south valley. The city of Nuernberg is approximately five nautical miles to the northwest and the town of Feucht is 1.2 nautical miles east. Trees completely surround the airfield, and patches of cleared farming land and pastures lie outside the perimeter of trees.

The industrial cities of Fuerth and Nuernberg to the northwest cause considerable pollution in the area. These cities are highly industrialized and the lack of pollution control devices is very evident, especially when the area is under a temperature inversion.

The Fraenkische Alps, which run clockwise from the north through the southwest along the rim of the valley, contain the roughest terrain. Terrain slopes downward from west through north and upward in the remainder of the quadrants. Peaks reach 2100 feet MSL fifteen nautical miles to the southeast and 2600 feet MSL twenty nautical miles northeast.

The general hilliness of the surrounding terrain plus the proximity of the trees to the runway will usually produce turbulence of moderate intensity with winds from any direction in excess of 20 knots. This is especially true of the west end of the runway, with higher terrain and trees growing close to the runway. The trees around the airfield are evergreen, averaging forty to fifty feet high, and may at times mask true wind direction and speed. The masking effect is most pronounced with winds from southeast to southwest.

Map showing the location of Feucht AAF in Bavaria. Numbers below locations indicate height.

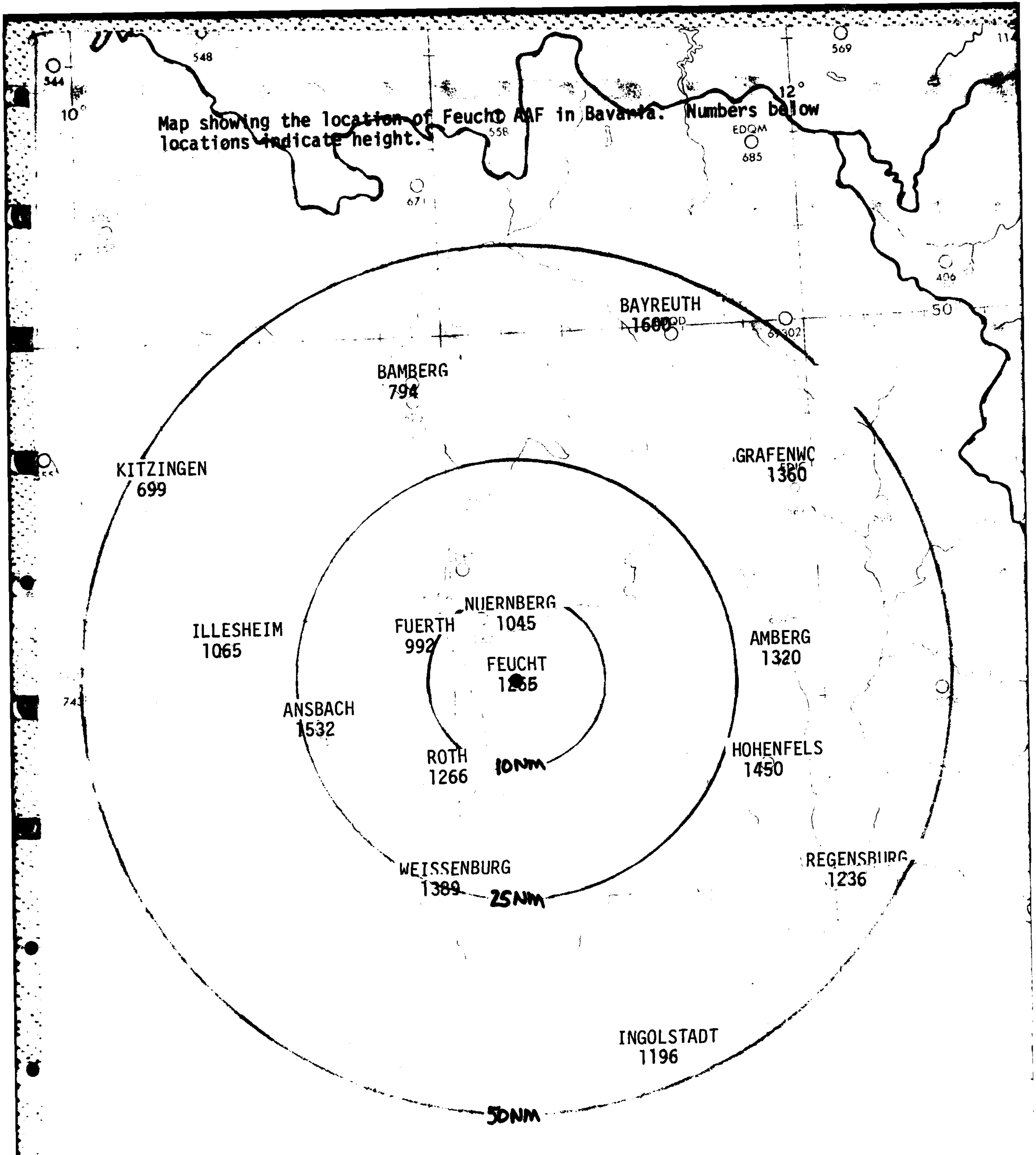


FIGURE 1-1

1-2. TYPE AND LOCATION OF OBSERVING EQUIPMENT:

a. Following is a list of installed weather sensing equipment at Feucht AAF. Numbers reference location on map (Figure 1-2).

(1) AN/GMQ-13 Ceilometer along runway 09 (1-2).

(2) AN/GMQ-10 Transmissometer along runway 09 (3-4).

(3) AN/GMQ-20 Wind Set (5).

(4) Instrument Shelter, ML-41, on catwalk, eighth floor of the tower (A).

(5) Psychrometer, ML-24, and aspirator, ML-480, inside instrument shelter (A).

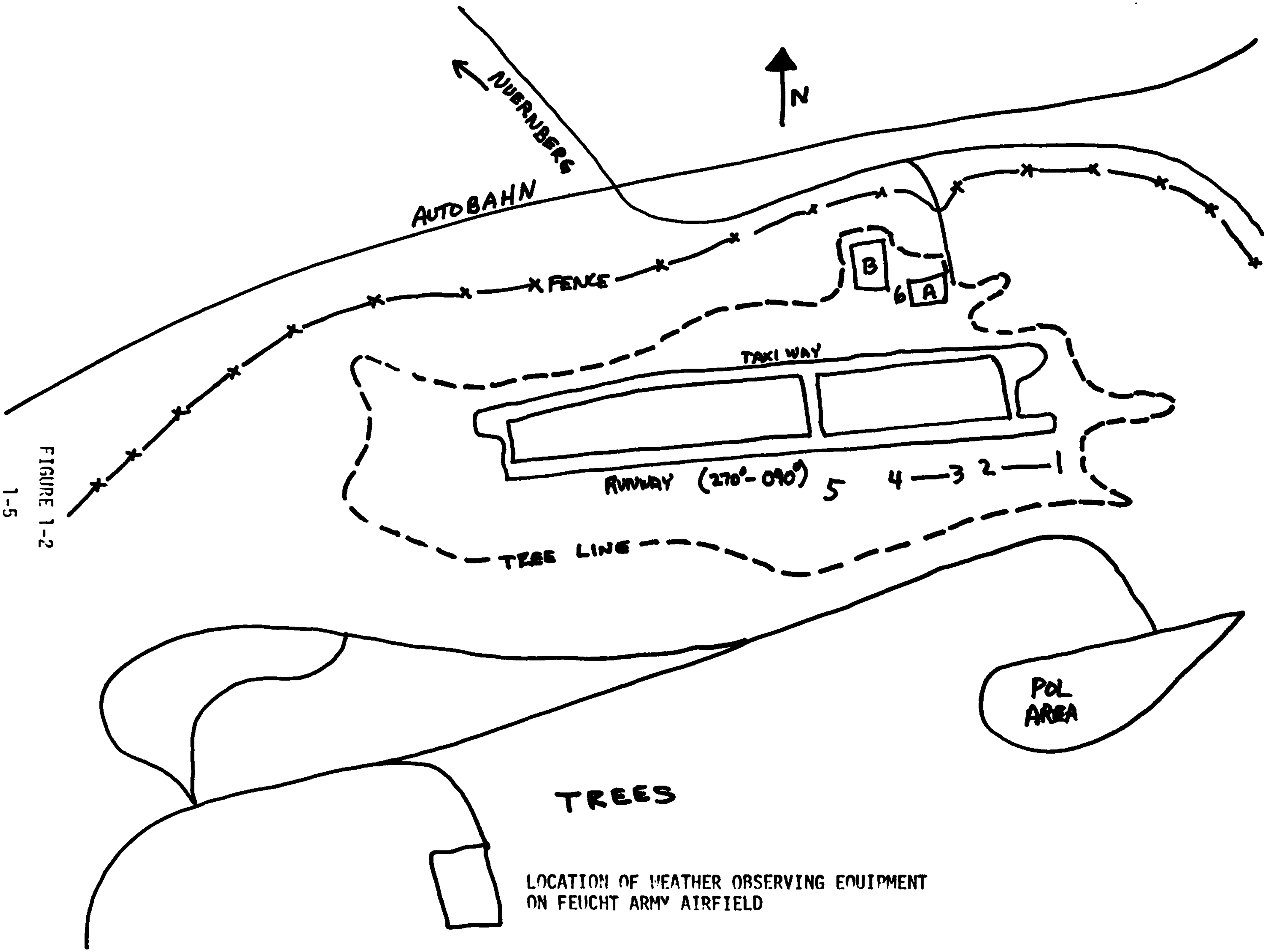
(6) Aneroid Barometer, ML-102, in ROS, seventh floor of tower (A).

(7) Mercurial Barometer, ML-512, in Base Weather Station, Commander's office (A).

(8) Precipitation Gauge, ML-17, in grassy area on west side of operations building (facing hangar) (6).

b. Readout equipment and locations are as follows:

LOCATION	EQUIPMENT
ROS	AN/GMQ-13 Indicator
	AN/GMQ-10 Recorder
	RO-362 Wind Recorder
BWS	ID-373 Wind Indicator
Tower	ID-373 Wind Indicator
GCA	ID-373 Wind Indicator
Operations	ID-373 Wind Indicator



LOCATION OF WEATHER OBSERVING EQUIPMENT
ON FEUCHT ARMY AIRFIELD

FIGURE 1-2

SECTION II

CLIMATIC AIDS

2-1. GENERAL CLIMATOLOGY FOR FEUCHT AAF:

With the lack of a north-south barrier, the maritime effect of the Atlantic Ocean is evident in climatological studies for Feucht. Winters are cool and damp with the average temperature for December - January a little over thirty-two degrees and the relative humidity for the same period is eighty-four percent. The effects of industrialization show especially well during the winter months with fog, smoke or haze showing up on nearly eighty percent of the observations in December. Freezing precipitation associated with warm and occluded fronts and warm air overrunning the Alps generally starts in November and continues to occur through April. The first snows of the year may start as early as October, and often occurs as late as May.

Although thunderstorms occur mainly during the summer months, with July having the highest frequency of occurrence, they have occurred in every month of the year.

The maritime effects show again in the summer with maximum temperatures rarely exceeding ninety degrees. Relative humidity remains quite high even in the summer with July the least humid month with a fifty-five percent average.

2-2. CLIMATIC BRIEF:

The following AWS Climatic Brief (Figure 2-1) summarizes RUSSWO information available for Feucht AAF.

CLIMATIC BRIEF - Figure 2-1

PREPARED BY: USAFETAC MAY 1976	STATION NAME: FEUCHT AAF GERMANY LOCATION: N49 23 E011 11	PERIOD: JAN 68-DEC 73 ELEV: 1265	STN LTRS: EDIG WBAN NO.: 34198 WMO NO.:

AWS CLIMATIC BRIEF

MONTH	TEMPERATURE (°F) MEAN DAILY MAX	DAILY MIN	MONTHLY	EXTREME MAX	EXTREME MIN	PRECIPITATION (IN) MONTHLY MEAN	MONTHLY MAX	MONTHLY MIN	MAX 24 HRS	SNOWFALL (IN) MONTHLY MEAN	MONTHLY MAX	MAX 24 HRS	MEAN RELATIVE HUMIDITY (%) LST 04	LST 13	MEAN VAPOR PRESSURE (IN Hg)	MEAN DEW PT (°F)	PRESSURE ALTITUDE (FT) 99.95%	SURFACE WINDS PVLG DRCTN (16 PT)	SPEED MEAN (KT)	SPEED MAX (KT) **	MEAN CLOUD COVER (tenths)	MEAN NUMBER OF DAYS OCCURRENCE OF: PRECIP (IN) ≥ 0.01	PRECIP ≥ 0.5	SNOWFALL (IN) ≥ 0.1	SNOWFALL ≥ 1.5	THUNDERSTORMS	FOG VSBY < 7 MI	TEMPERATURE (°F) MAX ≥ 90	MAX ≥ 80	MIN ≤ 32	MIN ≤ 00
JAN	34	26	30	49∂	0∂	1.2	1.7	.5	.6	6	10	6∂	91	84	.15	27	2150	SSE	4	29	9	13	#	7	1	#	24	0	0	25	#
FEB	37	29	33	57	5∂	1.9	3.5	.7	1.1	7	14	3∂	91	81	.16	29	2100	W	5	41	9	16	1	10	1	0	22	0	0	18	0
MAR	40	31	38	73	8∂	1.3	2.4	.5	1.0	5	9	4	84	60	.17	31	1950	E	6	43	8	12	#	5	1	1	18	0	0	16	0
APR	54	39	46	85	24	1.8	3.2	.4	.7	4	14	7	85	62	.22	37	1900	W	5	37	7	15	1	3	1	1	16	0	1	6	0
MAY	64	47	56	86∂	32∂	2.3	2.7	1.9	1.0	#	1	1∂	84	57	.30	45	1750	W	5	32	8	15	1	#	0	4	16	0	1	#	0
JUN	69	53	61	86	41	3.0	4.4	1.8	1.2	0	0	0	84	58	.36	50	1600	W	5	47	8	14	2	0	0	5	18	0	3	0	0
JUL	73	55	64	90∂	40∂	2.0	4.4	.5	1.1	0	0	0∂	88	56	.40	53	1600	W	4	36	7	12	1	0	0	9	17	1	9	0	0
AUG	72	54	63	89∂	37	3.8	9.1	2.0	3.4	0	0	0	85	59	.40	53	1600	W	4	38	7	13	2	0	0	4	18	0	6	0	0
SEP	65	47	57	89	28∂	1.6	5.7	.3	1.2	0	0	0∂	90	61	.34	48	1650	W	4	32	6	9	1	0	0	1	22	0	1	0	0
OCT	56	41	49	72	21	1.5	3.1	.2	1.1	#	7	2	89	68	.26	41	1700	W	4	42	7	9	1	#	#	#	22	0	0	5	0
NOV	44	35	40	66∂	12	2.0	3.4	.8	.8	5	10	6∂	91	79	.20	35	2100	S	5	54	9	14	1	4	1	0	22	0	0	11	0
DEC	34	27	31	51	-2∂	1.3	1.7	1.1	.6	7	14	6∂	90	84	.15	28	2000	S	4	48	8	12	#	7	1	0	25	0	0	24	#
ANN	54	40	47	90∂	-2∂	23.7	9.1	.2	3.4	36	14	7	88	68	.25	40	1900	W	4	54	8	154	11	36	6	21	240	1	21	109	#
EYR	6	6	6	6	6	6	6	6	6	6	6	6	2	6	6	6	6	6	6	4	3	6	6	6	6	6	6	6	6	6	6

REMARKS: RUSSWO POR:

HOURLY OBS: JAN 68-DEC 73

DAILY OBS: JAN 68-DEC 73

NOTE: * DATA NOT AVAILABLE # AMTS < UNITS SHOWN IN HEADING ** MAX HRLY WND SP CLASS INT $ % CALM GRTR % PLVG. DRCTN ∂ BASED ON < FULL MONTHS

CAV FREQ (%)	HRS LST	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN	EYR
CEILING LESS THAN 3000 FT AND/OR VISIBILITY LESS THAN 3 MI	00-02	66	49	21	30	15	22	20	14	29	43	47	63	35	2
	03-05	69	56	26	36	33	33	39	21	44	52	60	64	44	2
	06-08	74	66	43	42	29	30	29	40	48	65	57	66	49	6
	09-11	66	65	39	40	25	24	17	29	29	46	54	63	41	6
	12-14	59	49	34	35	23	17	12	22	17	31	43	55	33	6
	15-17	58	46	28	23	14	11	9	15	9	24	44	59	28	6
	18-20	70	42	23	20	9	6	11	8	6	28	46	62	28	5
	21-23	70	40	15	18	10	13	13	6	6	28	49	61	27	2
	ALL HRS	67	52	29	31	20	20	19	19	24	40	50	62	36	
CEILING LESS THAN 1500 FT AND/OR VISIBILITY LESS THAN 3 MI	00-02	61	40	18	22	11	21	18	14	27	39	42	59	31	2
	03-05	59	50	21	29	27	29	36	21	41	46	57	59	40	2
	06-08	67	56	34	31	21	27	35	37	45	57	46	57	42	6
	09-11	64	55	28	21	9	9	8	21	21	38	42	55	31	6
	12-14	51	32	20	12	5	6	2	9	7	16	31	46	20	6
	15-17	50	29	11	8	5	4	1	6	4	12	31	47	17	6
	18-20	65	29	16	10	3	3	5	3	4	17	34	51	20	5
	21-23	65	27	15	12	6	11	10	5	6	23	42	56	23	2
	ALL HRS	60	40	20	18	11	14	13	15	19	31	41	54	28	
CEILING LESS THAN 1000 FT AND/OR VISIBILITY LESS THAN 2 MI	00-02	39	24	9	12	6	6	7	8	18	23	34	53	20	2
	03-05	44	35	12	19	12	17	18	12	30	32	51	47	27	2
	06-08	44	38	24	18	10	15	15	29	34	41	31	43	29	6
	09-11	44	33	18	11	4	5	3	14	13	25	29	40	20	6
	12-14	38	18	10	6	3	2	1	6	3	8	22	32	12	6
	15-17	35	16	6	4	2	2	#	3	3	6	21	31	11	6
	18-20	45	15	10	5	1	3	2	2	4	7	24	34	13	5
	21-23	46	12	7	7	5	3	4	1	1	17	31	43	15	2
	ALL HRS	42	24	12	10	5	7	6	9	13	20	30	40	18	
CEILING LESS THAN 200 FT AND/OR VISIBILITY LESS THAN 1/2 MI	00-02	9	7	0	0	0	0	2	0	1	3	10	6	3	2
	03-05	2	8	0	0	0	5	6	0	9	8	16	11	5	2
	06-08	6	5	3	1	1	2	3	7	10	17	9	3	6	6
	09-11	9	4	1	1	0	0	#	1	2	6	5	3	3	6
	12-14	5	1	0	1	0	0	0	0	0	#	4	1	1	6
	15-17	5	1	#	0	0	0	0	0	0	#	3	2	1	6
	18-20	8	2	2	1	0	0	0	0	0	1	#	1	2	5
	21-23	6	2	1	9	0	0	0	0	0	1	11	2	2	2
	ALL HRS	6	4	1	1	0	1	1	[illegible]	3	5	8	4	3	

2-3 OPERATIONALLY SIGNIFICANT WEATHER CRITERIA:

a. Ceiling/visibility less than 200 feet/0.5NM (landing minima at Feucht AAF with precision approach radar).

b. Surface winds greater than 34 knots.

c. Significant weather criteria for border surveillance flights:

(1) Ceiling/visibility is less than 500 feet/1.0NM and makes the border trace less than 50% flyable.

(2) Severe or greater turbulence.

(3) Light or greater icing.

(4) Occurrence of thunderstorms which cannot be circumnavigated.

WEATHER EFFECTS

US ARMY AIRCRAFT

TABLE 1. LIMITATIONS

	C-12/U-21	UH-1	AH-1	OH-58	CH-47
SUSTAINED SURFACE WIND	(1)	30 kts (start)	30 kts (start)	20 kts (autorotation) 45 kts (start)	30 kts (start)
GUST SPREAD	(1)	15 kts (start)	15 kts (start)	10 kts (autorotation) 15 kts (start)	
TAIL WIND	(1)	30 kts (hover)	30 kts (hover)		25 kts (start) 10 kts (start w/o auxillary power unit)
CROSS WIND	(1)	35 kts (hover)	35 kts (hover)	10 kts (autorotation)	
ICING	SEVERE	LIGHT (CAN FLY IF CIG≥ 010, TOPS <080 AND IN/OUT	CAN'T FLY IN ANY ICING (NO IFR)	CAN'T FLY IN ANY ICING (NO IFR)	SEVERE
TURBULENCE	SEVERE	SEVERE (2)	SEVERE (2)	SEVERE	SEVERE

NOTES: A. Aircraft Dash-10 Used as Reference.

(1) Limitations for these aircraft vary according to the experience level of the pilot and various other factors. It is not possible to list all combinations.

(2) Moderate turbulence limitations are:

(a) Prohibited when the report or forecast is based on transport type aircraft.

(b) Permitted when the report or forecast is based on helicopters or light aircraft under 12,500 pounds gross weight.

B. AR Req 95-1/USAREUR Sup 1 covers the minimums for uncontrolled airspace.

C. DOD FLIPS cover the weather minima at each airfield.

D. This information is provided only to inform the weather briefer of weather limitations to US Army aircraft, not to provide the weather briefer with go/no go decision responsibility.

SECTION III

APPROVED LOCAL FORECAST STUDIES AND RULES OF THUMB

3-1. Approved Local Forecast Studies:

a. Objective Technique for a Two Hour Peak Wind Forecast: This study presents a method of predicting the peak wind speed for a two hour period at Feucht Army Airfield, Germany, using hourly surface weather observations from Feucht and selected stations in the vicinity. It is applicable from September to May. The study was compiled by Major Larry W. Wallace, Commander of Detachment 1, 7th Weather Squadron from August 1974 to July 1977. Statistics and verification results were compiled from February 1975 to January 1977. It was approved by 2nd Weather Wing in July 1977 and published in the November 1977 edition of 2WW Technical Bulletins. The entire study is included following this page. It is an active study and continues to be used at this unit.

OBJECTIVE TECHNIQUE FOR A TWO HOUR PEAK WIND FORECAST

Major Larry W. Wallace

ABSTRACT

A method of predicting the peak wind speed for a two hour period at Feucht Army Airfield, Germany, using hourly surface weather observations from Feucht and selected stations in the vicinity. Objective calculations result in an approximation of the wind speed; empericial modifications, accounting for local terrain effects, yield a final forecast for the runway-level wind speed. Comparison is made between predicted and observed peak wind for the two hours after prediction time.

INTRODUCTION

A short range objective peak wind forecast is a quick and accurate way to provide decision assistance concerning gust spread and wind speed for certain aircraft ground, takeoff, and engine shut down operations, diffusion of gases for chemical defense and disaster control, boundary layer wind shear and turbulence, wind-chill factor calculations, and general forecast applications, as well as insuring acceptable lead times for local point warnings or meterorological watch advisories for critical wind speeds.

Simple calculations, based on readily available elements of standard observations, and accurate empherical modifications based on wind direction are essential for objectivity and timeliness. A simple wind speed equation was developed which represents the primary atmospheric energy relationships involved in wind speed generation, persistence, and variability. Empericial wind speed modifyers were determined and applied by directional stratification based on the start time average wind direction. The modifyers reduce the forecast (equation) speed by zero to eleven knots, according to direction, and account for local terrain and tree line frictional dampening effects.

The investigation originally attempted to develop a method applicable for year round use but was limited to Sep - May in the final version. Most errors in the first independent test were in Jun - Aug and involved convective gusts. There are few non-convective gusts above 24 knots in Jun - Aug, historically. The method is therefore to be used objectively Sep - May and subjectively, Jun - Aug.

PURPOSE

The purpose of this investigation was to establish an objective, arithmetic method of predicting the peak wind speed for a two hour period, at a point, quickly and accurately, from readily available local and regional hourly surface weather observations. It is applicable Sep - May, 0500 - 1600 GMT (0600 - 1700 Local).

DATA USED

The following data was used (0500 - 1600 GMT):

1. From Local Observation:

    a. Hourly recorded peak wind (K+) (From wind recorder).

    b. Hourly record observation temperature (^{o}C).

    c. Hourly record observation wind direction (^{o}True).

    d. Hourly record observation altimeter setting (In. Hg.).

2. From observations at Nearest Upstream and Cross-Pressure Gradient Stations:

    a. Hourly recorded peak wind or record observation maximum wind speed if peak wind not reported or determined from special observations during the past hour (K+).

    b. Hourly record observation temperature (^{o}C).

    c. Hourly record observation wind direction (^{o}True).

    d. Hourly record observation altimeter setting ("Hg).

When wind direction is reported as "variable," use the arithmetic mean of the reported directional limits as the "average wind direction."

PROCEDURE

1. The method used in developing the study was as follows:

a. Determine the physical relationships between sensible elements that are routinely observed and reported and the equations of motion, especially accelerations.

b. Develop a simple arithmetic equation that uses input from readily available observations and yields a two hour forecast peak wind speed.

c. Develop a set of emperically derived, directionally stratified constants to be used as modifiers to the basic wind forecast which account for wind dampening caused by local terrain and tree friction.

2. Data was collected and processed as follows:

a. PW = Peak wind at Feucht during the hour ending at forecast time (hourly) or the peak wind on the hourly observation (or special observation during the hour ending at forecast time) from the upstream station (in some cases a station chosen for cross-gradient use is also upstream), whichever is greater. The PW value represents a base wind speed or continuity value which may reasonably be expected to affect Feucht within two hours.

b. GT = Maximum gradient of temperature (actually Δ T) (^{o}C) between Feucht and the upstream or upstream/cross-gradient station from hourly observations at forecast time. The GT value adds an effect representing the increase in current (PW) wind due to temperature gradient in the air mass which may reasonably be expected to affect Feucht within two hours.

c. /CT/ = Absolute value of the one hour temperature change (^{o}C) at Feucht from the previous hour to the observation at forecast time. The /CT/ value adds an effect representing local energy changes due to local advection and/or insolation, downrush cooling, and cloud cover which may reasonably be expected to affect Feucht within two hours.

d. (GWE) = A complex "gradient (pressure) wind effect" calculated thusly:

(GWE) = (K [ALSTG - ALSTG] X100) - 8) where:

K = A pre-computed factor which when multiplied by the ALSTG difference between two stations, normalizes the difference to a gradient per 30 nautical miles. K is unique for each combination of two stations. The multiplication of this product by 100 simply removes the decimal. Therefore, (K [ALSTG - ALSTG] X100) is the pressure gradient over 30 nautical miles expressed as a whole number. For example; for stations 60NM apart K = 0.5 and if one had 29.92 and the other 30.01 (difference of .09, then the gradient would be 4.5 (round up to 5). This gradient is then reduced by the "magic number", -8. The "magic number" was derived as an approximation to the gradient per 30NM at latitude 48-51°N required to produce 22-28 knot gradient winds. By "subtracting out" this threshold gradient from the actual gradient, the resultant value represents the energy available for increasing the wind (if positive) or decreasing it (if negative) proportionate to the extent that the actual gradient exceeds or falls short of the threshold value. The stations chosen for gradient calculation can be either Feucht to upstream, Feucht to one of the cross-gradient stations, or between cross-gradient stations, whichever gives the largest normalized gradient that could reasonable be expected to affect Feucht within two hours.

e. AW = Actual hourly peak wind recorded at Feucht.

forecast (where persistence is the peak wind at Feucht for the hour ending at forecast time) using a "hit or miss" verification and a Heidke Skill Score (percept improvement over persistence). For the technique or the persistence forecast to "hit", it must fall within a range of error between -3 and +5 knots from the actual observed peak wind in the 0 to 1 hour, 1 to 2 hour, and 0 to 2 hour time frame. The -3 to +5 knot "target" was picked as a "state of the art perfect forecast for two hours" since instrument, log, and recorder roll reading errors are about +3 knots. The upper value of +5 was used, since in short range forecasting of peak values of any phenomena, it is wise to bias the forecast slightly on the high side. This way you have more confidence to say, "the wind will not exceed a certain speed," expecting that it will fall on or just below (1-2 knots) that value. "Verification Method One" is operational in nature, since the skill in predicting operational thresholds is measured. "Verification Method Two" is technical in nature, since the skill in predicting a narrow range is measured as well as the skill in anticipating accelerations and decelerations.

3. The above data was related by the equation:

PW + GT $\pm$ /CT/ + (GWE) = FW^1; where FW^1 is the basic (unmodified) forecast wind speed. This is taken to be the peak wind that will occur just above the height of local trees and small hills in the immediate vicinity. Emperical, directionally stratified constants (M) were developed as follows:

a. IF FW^1 = 0 - 24, M = 0.

b. IF FW^1 = 25 - 34K+, and average wind direction is:

010 - 170°, M = 0 K+

180 - 250°, M = -8K+

260-360°, M = -3K+

c. IF FW^1 = 35 - 49 K+, and average wind direction is:

010 - 170°, M = -3 K+

180 - 250°, M = -11 K+

260 - 290°, M = -3 K+

300 - 360°, M = -8 K+

d. IF FW^1 is 50 K+ or higher "M" could not be determined due to non-occurrence during the investigation period. In fact, very few were above 35 knots.

4. The final equations are:

a. PW + GT + /CT/ + (GWE) = FW^1

b. FW = FW^1 + M.

5. Verification Method: Two verification schemes are used. One computes the per-cent correct forecast for wind speed catogories; 0-15, 16-24, 35-49, and 50 or greater corresponding to operationally significant thresholds. The other method compares the utility of the technique with a persistence

RESULTS

1. Verification Method One (Operational):

a. Feb 75 - Jan 77 (Year Round):

				AW			
FW	0-15	16-24	25-34	35-49	50+	TOTAL	% CORRECT
0-15	6503	321	5	0	0	6829	95.2%
16-24	193	520	17	0	0	730	71.2%
25-34	2	38	56	2	0	98	57.1%
35-49	1	0	3	3	0	7	42.9%
50+	0	0	0	0	0	0	N/A
TOTAL	6699	879	81	5	0	7664	92.4%

b. Feb - May 75, Sep - May 76, Sep 76 - Jan 77 (Sep - May Only):

				AW			
FW	0-15	16-24	25-34	35-49	50+	TOTAL	% CORRECT
0-15	4990	151	5	0	0	5146	97.0%
16-24	130	430	13	0	0	573	75.0%
25-34	0	38	56	2	0	96	58.3%
35-49	0	0	3	3	0	6	50.0%
50+	0	0	0	0	0	0	N/A
TOTAL	5120	619	77	5	0	5821	94.1%

By restricting the method to Sep - May only, a small improvement in overall percent correct catagory is evident. A significant improvement occurrs in the 16-24 and 35-49 K+ catagories.

2. Verification Method Two (Technical):

a. Skill Score = $\frac{(\%\ \text{Fcst Hits}) - (\%\ \text{Persistence Hits})}{1 - (\%\ \text{Persistence Hits})}$

where a hit is defined, as in Procedure para 5, as the actual peak wind within two hours, between -3 and +5 knots of the Forecast/persistence value, and without regard to the actual catagory (i.e., a FW = 21 verified as a hit if AW = 19 to 26, although 25/26 would be in a higher catagory (25-34 than the FW catagory (16-24).

b. Feb 75 - Jan 77 (Year Round):

When FW was 16-24:

	Method	Persistence
Hits	497 (80.0%)	480 (77.3%)
Misses	124 (20.0%)	141 (22.7%)

Skill Score +0.12

c, Feb - May 75, Sep 75 - May 76, Sep 76 - Jan 77 (Sep - May Only):

(1) When FW was 16-24:

	Method	Persistence
Hits	364 (78.4%)	344 (74.1%)
Misses	100 (21.6%)	120 (25.9%)

Skill Score +0.17

(2) When FW was 25-34:

	Method	Persistence
Hits	39 (66.1%)	29 (49.1%)
Misses	20 (33.9%)	30 (50.9%)

Skill Score +0.33

(3) When FW was 35-49:

	Method	Persistence
Hits	2 (28.6%)	2 (28.6%)
Misses	5 (71.4%)	5 (71.4%)
Skill Score	= 0.00	

4. All (16-49):

	Method	Persistence
Hits	405 (76.4%)	375 (70.8%)
Misses	125 (23.6%)	155 (29.2%)
Skill Score	+0.19	

CONCLUSION

Both verification methods applied to two seasons of independent data have shown the method to be over 94% correct in predicting operationally significant catagories of peak wind speed and to be 19% better than a persistence forecast.

The advantage of this method is that it is quick, uses readily available input data, is applicable (without wind direction modifiers) to a sparse data, tactical situation, and can be used for objective decision assistance for a variety of purposes.

The shortcoming of the method is that percent correct catagory and skill score diminishes at the higher speed range (35-49 K+). It is biased to be somewhat pessimistic (only 2-3% of the actual peak winds exceeded the forecast catagory) but this is not too much of a problem, since the error is on the side of safety.

OBJECTIVE TECHNIQUE FOR A TWO HOUR PEAK WIND FORECAST

APPLICATION RULES

1. Applicable: Feucht AAF, Germany, Sep - May, 0500 - 1600 GMT.
2. Log: Maintain data collection, worksheet log with columns, rows as shown in Attachment 1. Log AW and PW hourly. When PW (local or upstream/cross-gradient station) is 16 K+ or more, log all data and calculate FW.

   FW = PW + GT + /CT/ + (GWE) + M.
3. Determine "K" in "(GWE)" using attachment 2.
4. Upstream Station: The nearest station in the direction from which the current wind is coming. If wind is calm or less than 4 K+, determine upstream direction from latest surface pressure pattern chart. If an obvious front, trough, or wind shear line is approaching, change upstream station designation to the new direction when that station experiences the wind shift.
5. Cross-Gradient Stations: The two stations, including the local station, whose (altimeter setting) pressures represent the gradient causing local area winds. Often, due to "cross-isoboric flow," the pressure differential between the local and upstream station satisfies cross-gradient requirements and only those two stations are required for FW calculations. When possible, it is best to choose two cross-gradient stations in the upstream direction, allowing the full impact of adverted changes to be involved in FW calculations.
6. Determine "M" from Attachment 2.
7. Log AW at 0-1 hr and 1-2 hr beside the hourly start or forecast time.
8. Verification: Monthly, using the formats in Attachment 3.

OBJECTIVE TECHNIQUE FOR A TWO HOUR PEAK WIND FORECAST WORKSHEET AND DATA COLLECTION LOG

DATE:__________

LOCAL STATION HOUR EDIG (Z) WND-TEMP-ALSTG	UPSTREAM STATION ED WND-TEMP-ALSTG	CROSS-GRADIENT STATIONS ED WND-TEMP-ALSTG *WND-TEMP-ALSTG	CALCULATIONS PW+GT+/CT/(GWE)= FW^1	M	FW	AW 0-1	AW 1-2
05							
06							
07							
08							
09							
10							
11							
12							
13							
14							
15							
16							

K for (GWE)
For Today:
IG-( ) Upstream:
IG- ( ) Cross:
IG- ( ) Cross:
( )-( ) Cross:
( )-( ) Cross:
( )-( ) Cross:
( )-( ) Cross:
( )-( ) Cross:

ATTACHMENT 1

OBJECTIVE TECHNIQUE FOR A TWO HOUR PEAK WIND FORECAST

VERIFICATION RULES

1. Compare each hourly peak wind forecast, FW, with the corresponding actual peak wind, AW, for the two hours following forecast time.

2. Verify the FW catagory 0-15, 16-24, 25-34, 35-49, and 50+ for the two hours following forecast time. Maintain a running verification table as indicated:

MONTH:______ YEAR:_________ VERIFIED THROUGH END OF DA' _______

	AW						% CORRECT
FW	0-15	16-24	25-34	35-49	50+	TOTAL	CATAGORY
0-15							
16-24							
25-34							
35-49							
50+							
TOTAL							

3. Verify the FW and AW taken as persistenc be within -3 to +5 knots of the actual peal forecast time. Maintain a running verifi

MONTH:__________ YEAR:__________ VERIFIED THROUGH END OF DAY:________

A. For FW = 0-15

Method (FW)	Persistence (AW)
Hits	
Misses	
Skill Score	

B. For FW = 16-24

Method (FW)	Persistence (AW)
Hits	
Misses	
Skill Score	

C. For FW = 25-34

Method (FW)	Persistence (AW)
Hits	
Misses	
Skill Score	

D. For FW = 35-49

Method (FW)	Persistence (AW)
Hits	
Misses	
Skill Score	

E. For FW = 50+

Method (FW)	Persistence (AW)
Hits	
Misses	
Skill Score	

F. For all FW

	Method (FW)	Persistence (AW)
Hits		
Misses		
Skill Score		

Where hits verify within -3 to +5 of actual and skill score = $\frac{(\text{\% Hits FW}) - (\text{\% Hits AW})}{1 - (\text{\% Hits AW})}$

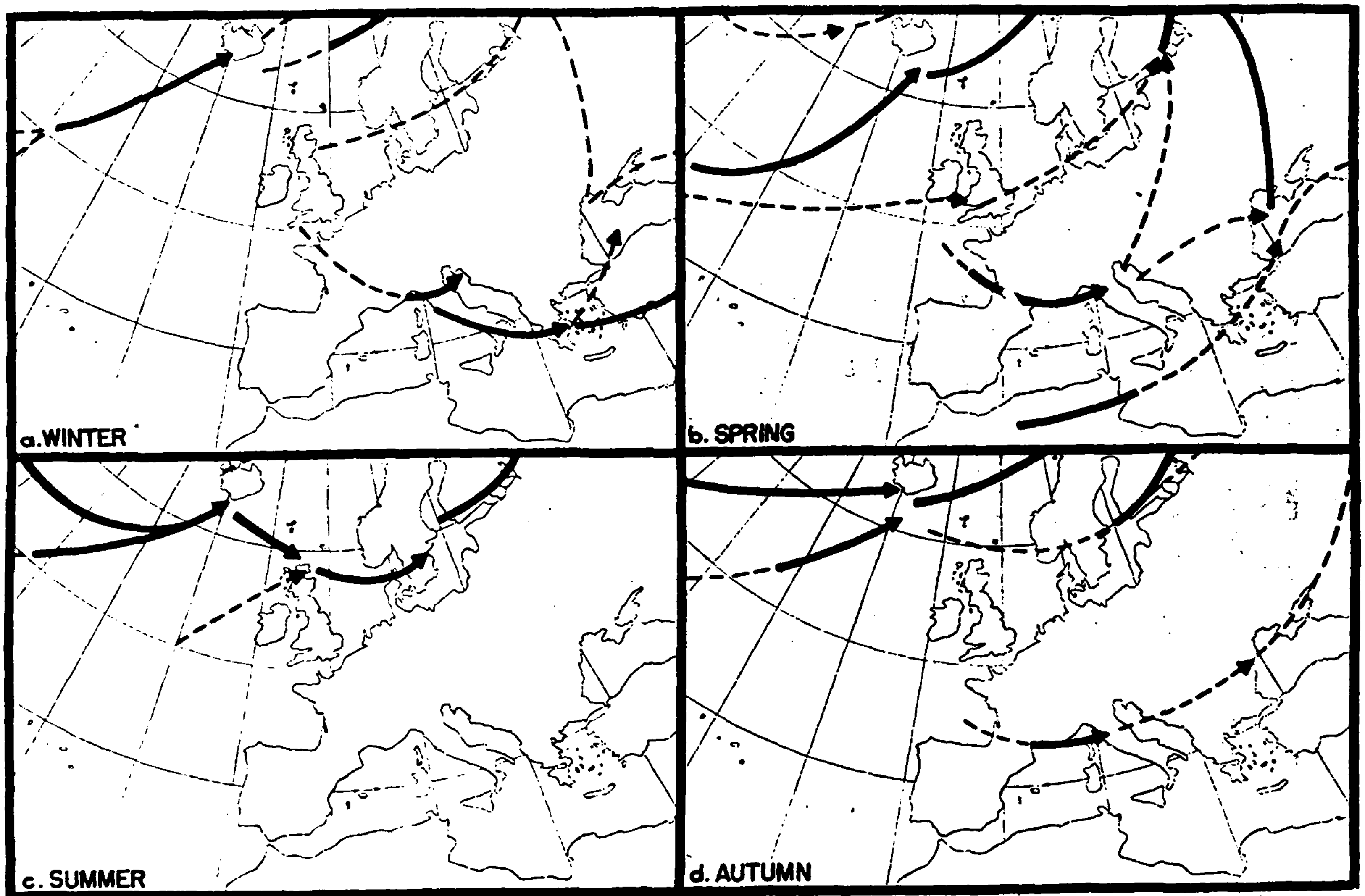
is expressed to two decimal places.

SECTION IV

WEATHER CONTROLS AND SYNOPTIC CASE STUDIES

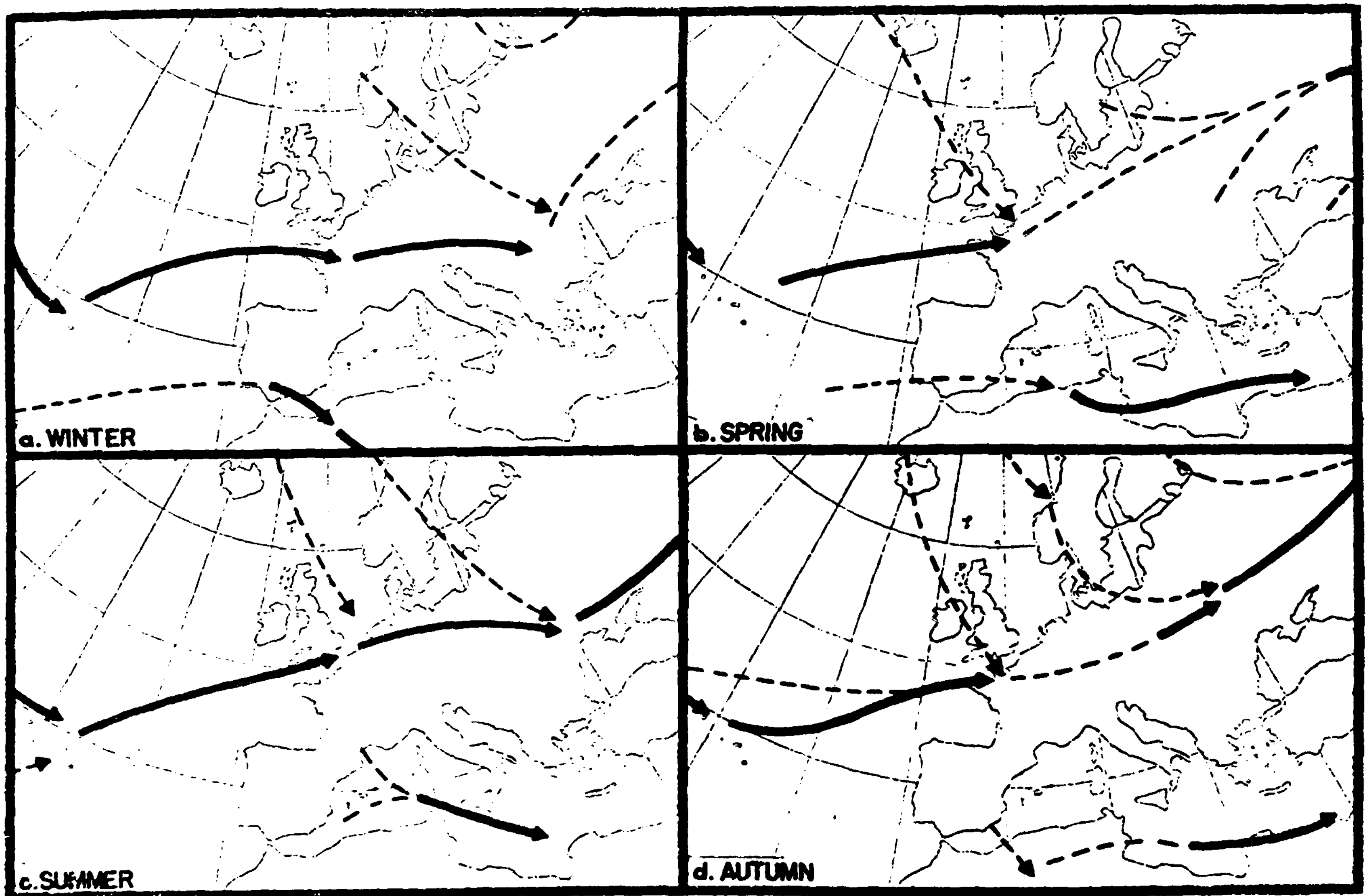
4-1. Introduction: The seasonal cyclone and anticyclone tracks are presented in Figures 1 and 2, respectively. Pertinent tracks are referred to when they relate to operationally significant forecast problems. Forecast problems are categorized by month in Table 2. Discussion is topic oriented based upon forecast problems. A standard analysis package evolves from the problem discussion. Theory is not presented. Prior to going to Table 2 problems, a definition of the short wave trough is presented.

4-2. The Short Wave Trough: The short wave trough dominates the European weather forecasting problem. The short wave trough is defined via the following example: Consider the typical winter situation with the quasi-stationary Icelandic Low (a planetary scale feature) northwest of England. Frequently a synoptic scale low breaks out of the Icelandic Low moving along one of the cyclone tracks in Figure 1. This low is associated with a traveling, synoptic scale wave in the westerlies. This wave is not a short wave, as it can be easily tracked in upper air analyses and machine prognoses. However, there are short waves associated with the traveling low. These scales of motion are depicted in Figure 3. Most of the short waves will be surface features, but some waves will have increased amplitude detectable at gradient and 850mb levels as a wind shift or possibly a small-scale velocity maximum. This is a vertically deep short wave trough. To identify short waves, analyze surface isobaric patterns at 1 or 2mb intervals and then analyze gradient and 850mb level flow lines to find which troughs are vertically deep. The short wave troughs give a spider-web character to the traveling synoptic scale surface low. These short wave troughs have a wave length varying from a few to several hundred kilometers and the frequency of passage (at a point) varies anywhere from 90 minutes to 9 or 12 hours. The shorter the wave, the more rapidly it travels, and the less the impact upon the weather.



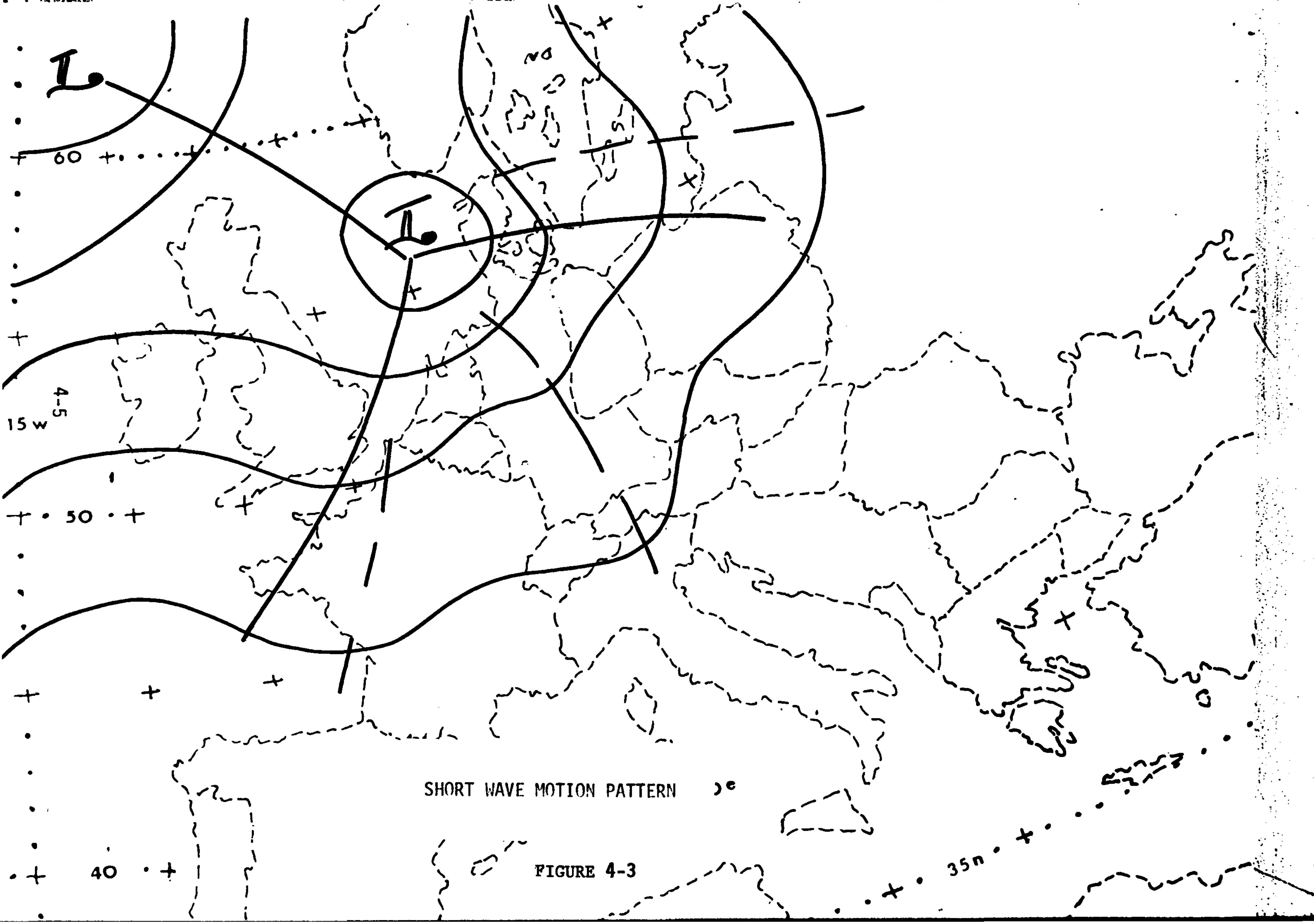
MEAN PATHS OF CYCLONES BY SEASON. ⟶ PRIMARY TRACK; - - -➔ SECONDARY TRACK.

FIGURE 4-1



MEAN PATHS OF ANTICYCLONES BY SEASON. PRIMARY TRACK; SECONDARY TRACK.

FIGURE 4-2



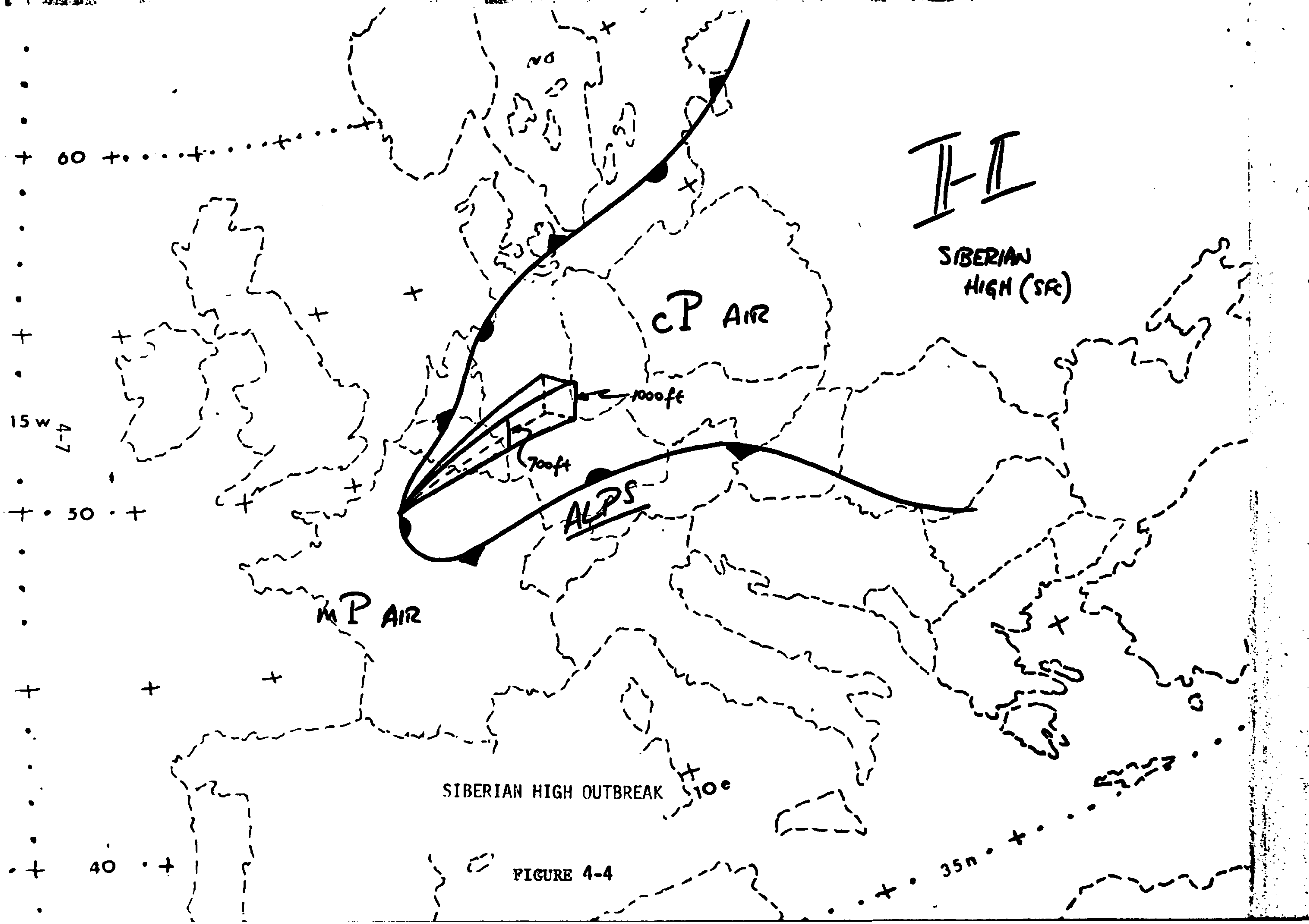
SHORT WAVE MOTION PATTERN

FIGURE 4-3

For example, the 90-minute waves may merely increase cloudiness and produce drizzle/ rain while 9- to 12-hour waves may bring significant showers (Total-Totals values must be considered). On the 90-minute end of the scale, every 3d or 4th wave may be detectable at the gradient level, while at the 9- to 12-hour end, they are all likely to be detectable at gradient level. The waves detectable at gradient and 850mb levels are important to identify and prog because the associated weather response is much more significant than that with the intervening shallow surface waves. This point will be stressed repeatedly as problem areas listed in Table 2 are systematically addressed.

4-3. The Siberian High: The Siberian High expands westward into Europe several times during the average winter. The associated cold front usually pushes through the FRG to become stationary in central France. This nearly always occurs in conjunction with off-shore blocking (omega high) at 500mb and a deep cold core low at 500mb over Russia. The situation persists until the block breaks down (usually 7 to 10 days). Surface isotherms pack at the frontal boundary, but the leading edge of the front (FRG area) is too shallow to analyze at 850mb. You can find the frontal inversion on a Skew-T (usually between 500 to 1,200 feet AGL). The front comes into the central FRG as a persistent cold easterly wind (8-12 knots). The 2d day after frontal passage, daytime heating produces persistent stratus under the frontal inversion. In Bavaria, the front wedges up the mountains giving upslope fog/stratus below the frontal inversion and clear skies above. (See figure 4). When the long wave pattern begins to shift, the Siberian High will recede eastward as a warm front. There will normally not be freezing precip associated with this withdrawal.

4-4. Persistent Stratus: Persistent stratus occurs with four synoptic situations. The stratus forms and breaks with passage of short wave troughs. The four



SIBERIAN HIGH OUTBREAK

FIGURE 4-4

situations are:

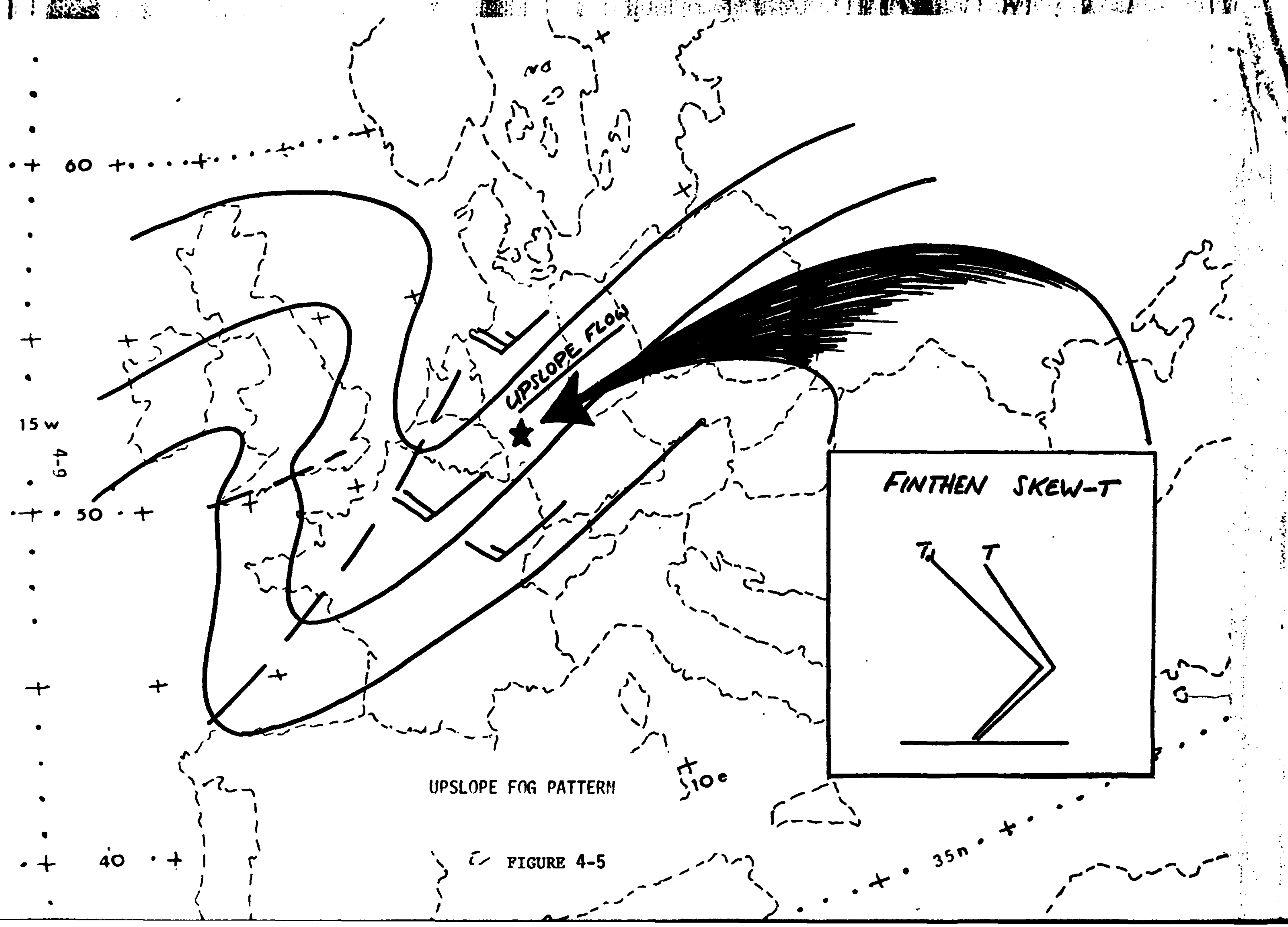
a. The Siberian High, discussed above.

b. In advance of a warm front (the stratus breaks are "sucker holes").

c. Upslope Conditions: Stratus breaks occur when the wind direction changes with short wave trough passage. Following trough passage, stratus reforms if synoptic scale gradient level winds return to upslope direction.

d. Post Cold Front Stratus (NW flow): Gradient level winds above 20 knots produce 3,000 to 4,000 foot ceilings overnight (often going scattered in late morning), and gradient winds below 20 knots produce 2,000 to 2,500 foot ceilings. Conditions are lower if a short wave trough passes. The dynamic mechanism is a combination of solar and turbulent mixing.

4-5. Fog (Radiation versus Upslope): A general problem in central Germany is determination of the fog formation mechanism, radiation versus upslope. Upslope fog/stratus requires a surface inversion several hundred feet deep, moist air within this layer, and the proper wind direction. Use GMGO Upslope and Lee Effects Maps to infer proper wind direction. Upslope fog/stratus will not break with heating. Consider the following classic example in Figure 5. This model affects the Finthen AAF Terminal, but is of interest to all units which clear aircraft. A stationary trough sets up over the English channel (through 500mb). This produces persistent SW flow. Given a stable air mass and ample moisture at low levels (a result of SW flow), you have potential upslope conditions (use a Skew-T to evaluate stability, moisture content of the air, and depth of the surface inversion). The fog is in the ridge east of the channel trough. There is no front in the trough even though air mass characteristics vary substantially over a broad zone. The first fog day is frequently radiation fog. Radiation fog will break at 0900 to 1100L, but often visibility will not go above 4 to 5 miles.



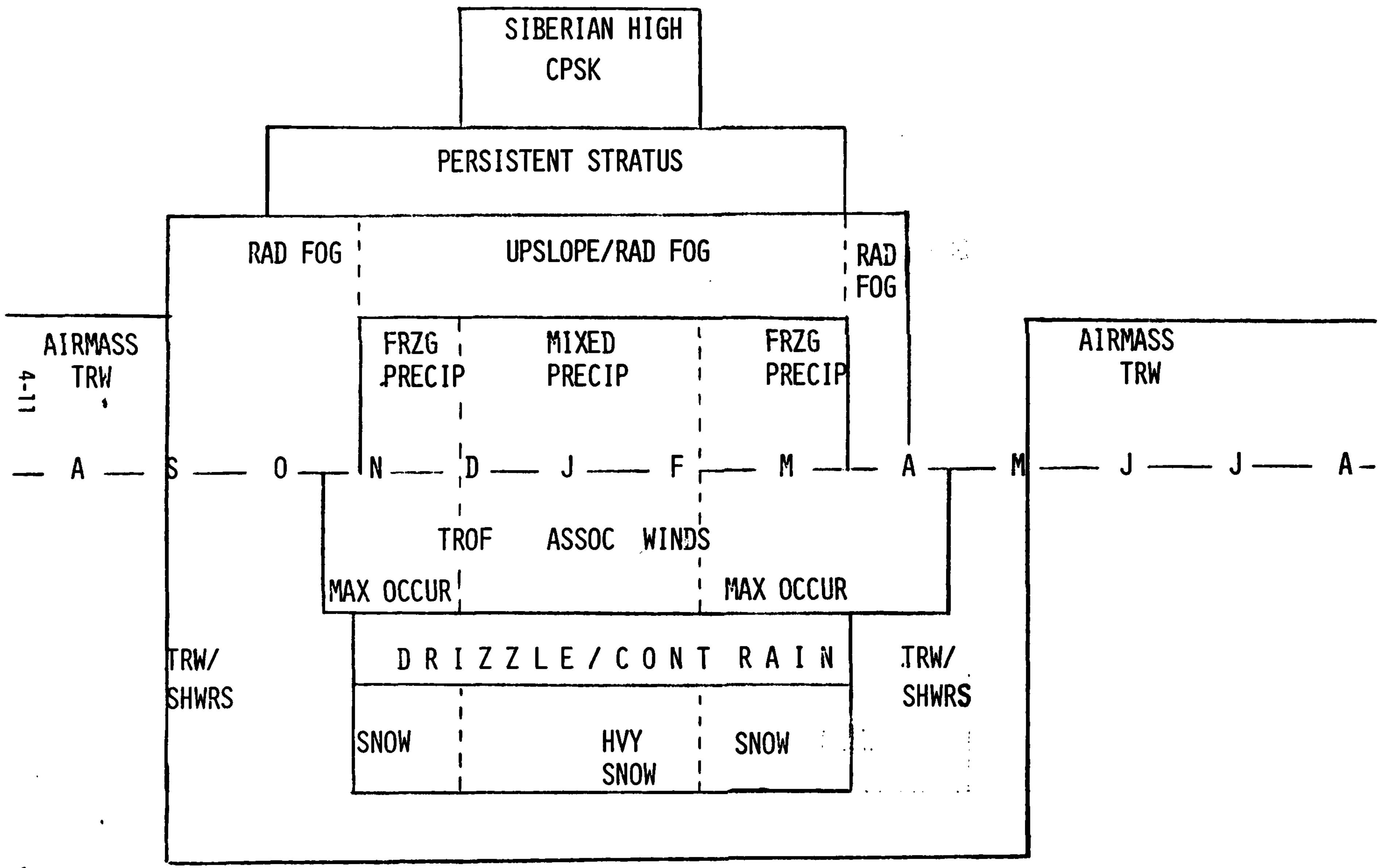
UPSLOPE FOG PATTERN

FIGURE 4-5

Temperatures are above 0°C and below 10°C (often 4 to 5°C). Use Skew-T (depth of moisture, etc. IAW AWS/TR-79/006) to forecast the breakout time. Winds at gradient level must be 10 knots or below for radiation fog onset, e.g., a short wave may come through and break the fog out of cycle. When the moisture reaches amount/ depth needed for upslope fog (a surface inversion with air near saturation through 500 feet or more), the fog will not break following sunrise. It won't break until the wind direction or air mass changes. A typical upslope pattern is, day 1: Ceiling 500/1 all day; day 2: Ceiling 200/1/2 all day and moist column deepens; day 3: Cooler temperatures with drizzle and continued 200/1/2 stratus/fog. Considering forecast specificaiton categories (AWSR 105-27), upslope conditions are often above 200/1/2 but below 1000/1 before sunrise, but fall below 200/1/2 after sunrise, and then return to the below 1000/1 interval after sunset. Now consider the short wave trough as defines earlier. As a short wave moves through, wind direction and speed change and stability lessens. Fog reverts to radiation mechanism and the area normally breaks wide open. Trough timing is critical. When the trough arrives, the fog breaks. After the short wave passes, the synoptic scale flow reverts to the upslope pattern. Without an air mass change upslope fog will recur. Superficially, the day-to-day sequence of events appears to be a series of chaotic unforecastable variations wherein one-day fog/stratus conditions break after sunrise and the next day they worsen after sunrise. However the sequences can be forecast. To do this, analyze/prog the short waves, and determine during each hour of the forecast whether the driving force is upslope or radiation. Note that the ends of the upslope season are not clear-cut; it depends on the synoptic pattern. See Table 2.

4-6. <u>Freezing Precipitation</u>: The primary seasons are late fall and early spring, but given the right synoptic situation, freezing precipitation can occur throughout the winter. Mixed precipitation (rain/snow/etc.) tends to be associated with the

PRIMARY FORECASTING PROBLEMS BY MONTH

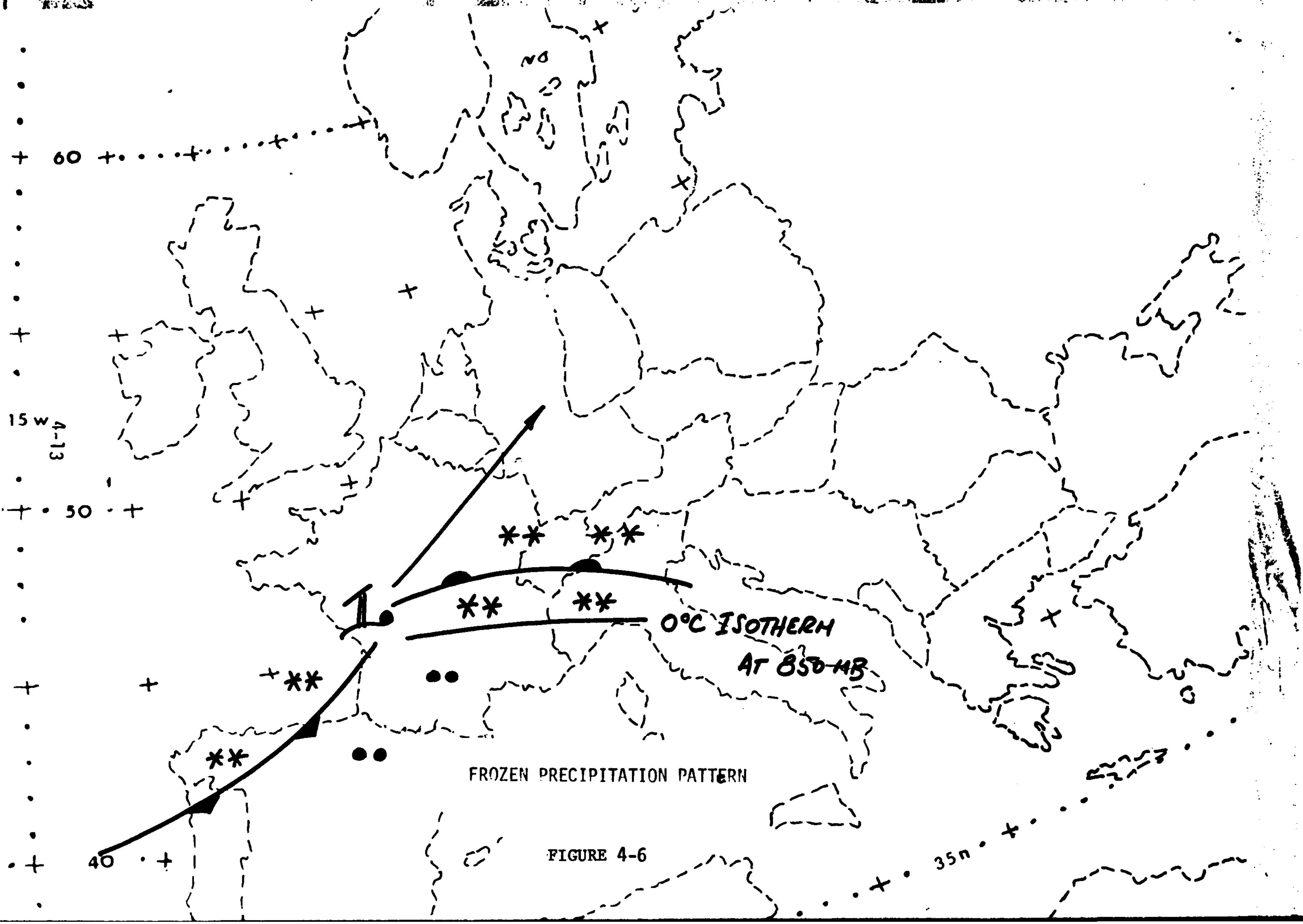


retreat of the Siberian High. This precipitation is mixed or snow, dependent upon temperatures within the advancing air mass. Freezing precipitation usually comes ahead of the warm front associated with a cyclone on the southern track. The surface must be frozen (preferably for several days). Otherwise, the heat capacity of the soil will prevent freezing precipitation. There are two variations: widespread and spotty freezing precipitation.

a. Widespread Freezing Precipitation: If the 0°C isotherm at 850mb is trailing (behind) the warm front, snow will occur ahead of the warm front (or rain dependent on position of 0°C isotherm at the surface), and freezing precipitation will not occur (See figure 6). Figure 7 is the model for freezing precipitation. The key is the position of the 850mb 0°C isotherm in relation to the warm front. As the warm front passes, freezing precipitation will continue if the surface air is close to or below freezing in the warm sector. The ice may be covered by snow as the cold front passes. Alternately, heavy rain in the warm sector will usually melt existing ice. When predicting freezing precipitation, start time is the arrival of the 0°C 850mb isotherm and stop time is the arrival of the warm front (except as noted above).

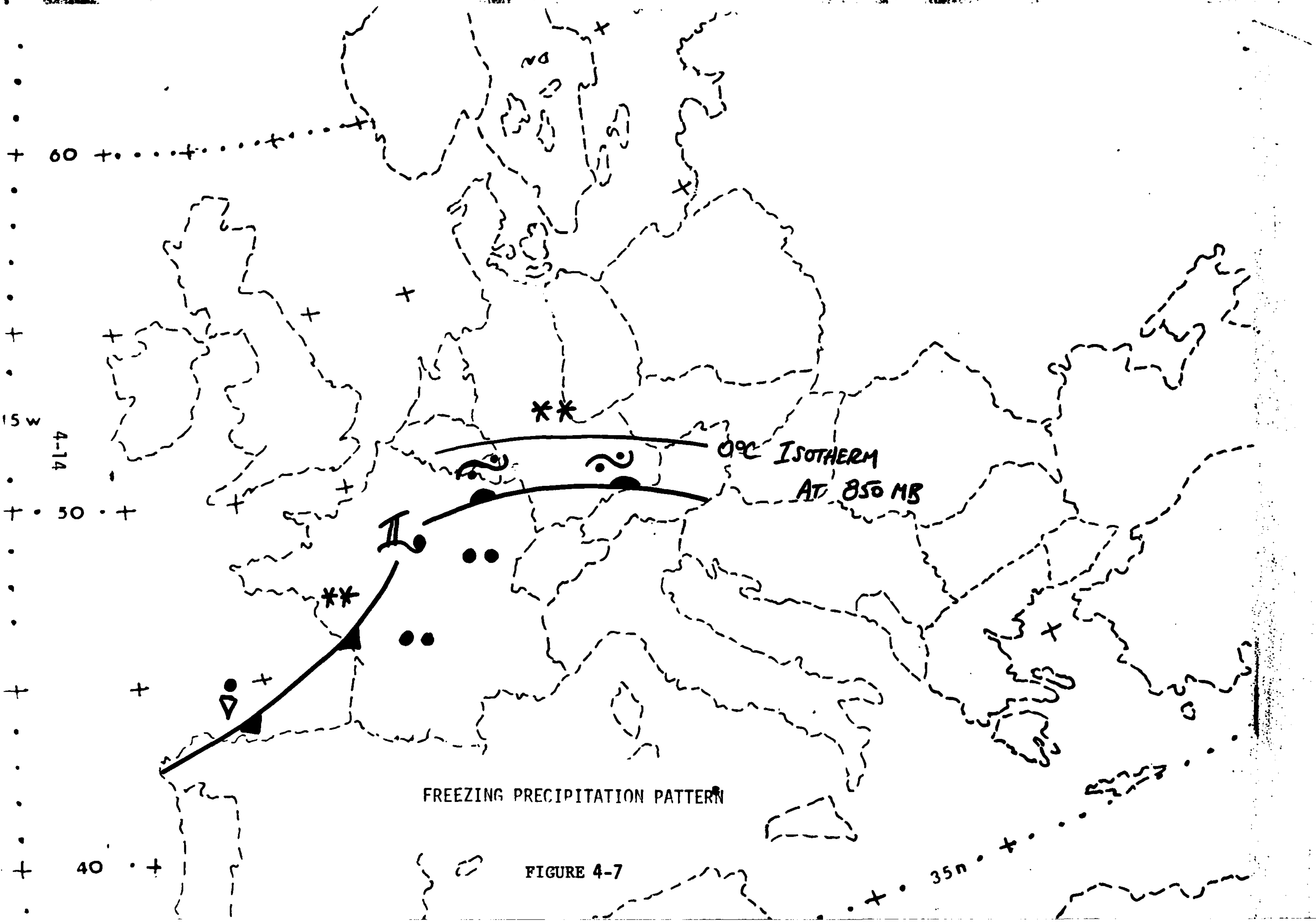
b. Spotty Freezing Precipitation: See figure 8. Here the 0°C isotherm only goes north of the warm front in the cold pockets associated with the mesoscale lows. There are two components of motion to predict. The short wave (meso-low) component (toward the northwest) and the warm frontal component. The vector resultant is usua-ly toward the northeast. The areas of freezing precipitation are small. They may track continuously or they may jump in response to orographic and other effects. In this situation, you can make good area forecasts, but point forecasting is very difficult.

4-7. Air Mass Thunderstorms: The key ingredients are warm air advection, a deep layer of low-level moisture, and solar heating. These factors produce the insta-



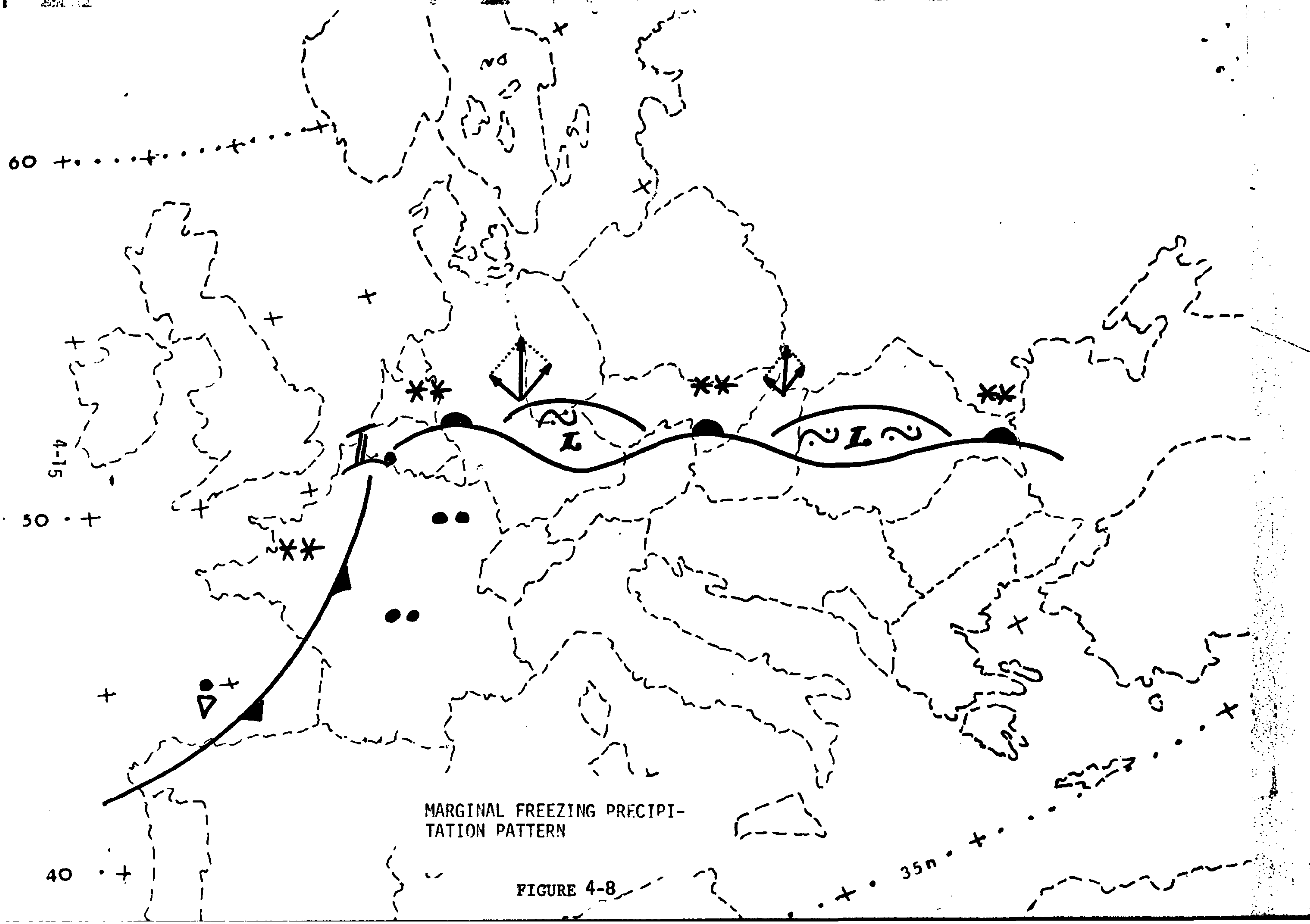
FROZEN PRECIPITATION PATTERN

FIGURE 4-6



FREEZING PRECIPITATION PATTERN

FIGURE 4-7



MARGINAL FREEZING PRECIPITATION PATTERN

FIGURE 4-8

bility. For Europe, the best forecast tool measuring instability is the Total-Totals (TT) Index. See Table 3. A typical pattern is a stationary, modifying air mass. After a few days, a few thunderstorms occur in late afternoon. The next day thunderstorms are widespread. The overturning resulting from the thunderstorms stabilizes the air mass, and the following day there are fewer storms again. The cycle repeats until the air mass changes. On any given day, analyze the TT and prog the maxima. Use Table 3 to make the forecast. Anywhere in the day to day sequence discussed above, the arrival of a short wave trough will trigger locally numerous thunderstorms day or night. Concurrent arrival of a vertically deep short wave trough (detectable at gradient or 850mb) and a TT maximum will occasionally trigger severe weather. However, the TT max and the short wave must be independently progged as they move at different rates and the short wave will tend to outrun the instability maximu. Of course thunderstorms are always related to orography based on the extra lift from flow over a ridge or suppressive lee effects.

4-8. Thundershowers, Rainshowers, and Snowshowers: There are two models, the short wave trough and the closed (synoptic-scale) low.

a. Short Wave Trough: The short-wave problem is identical to that discussed with air mass thunderstorms. The only difference is the spotty showers, associated with air mass instability alone, are not present. Showers (rain or snow, dependent upon temperature) will be generated by the trough and move with it. Shower intensity depends on the TT values arriving at the time the trough arrives. The vertically deep trough will produce heavy showers (wintertime thunder/snowshowers are even possible if TT is high enough). See Figure 9.

b. Closed Low: The closed surface low may or may not be associated with a frontal system. See Figures 10 and 11. The low usually follows the northern

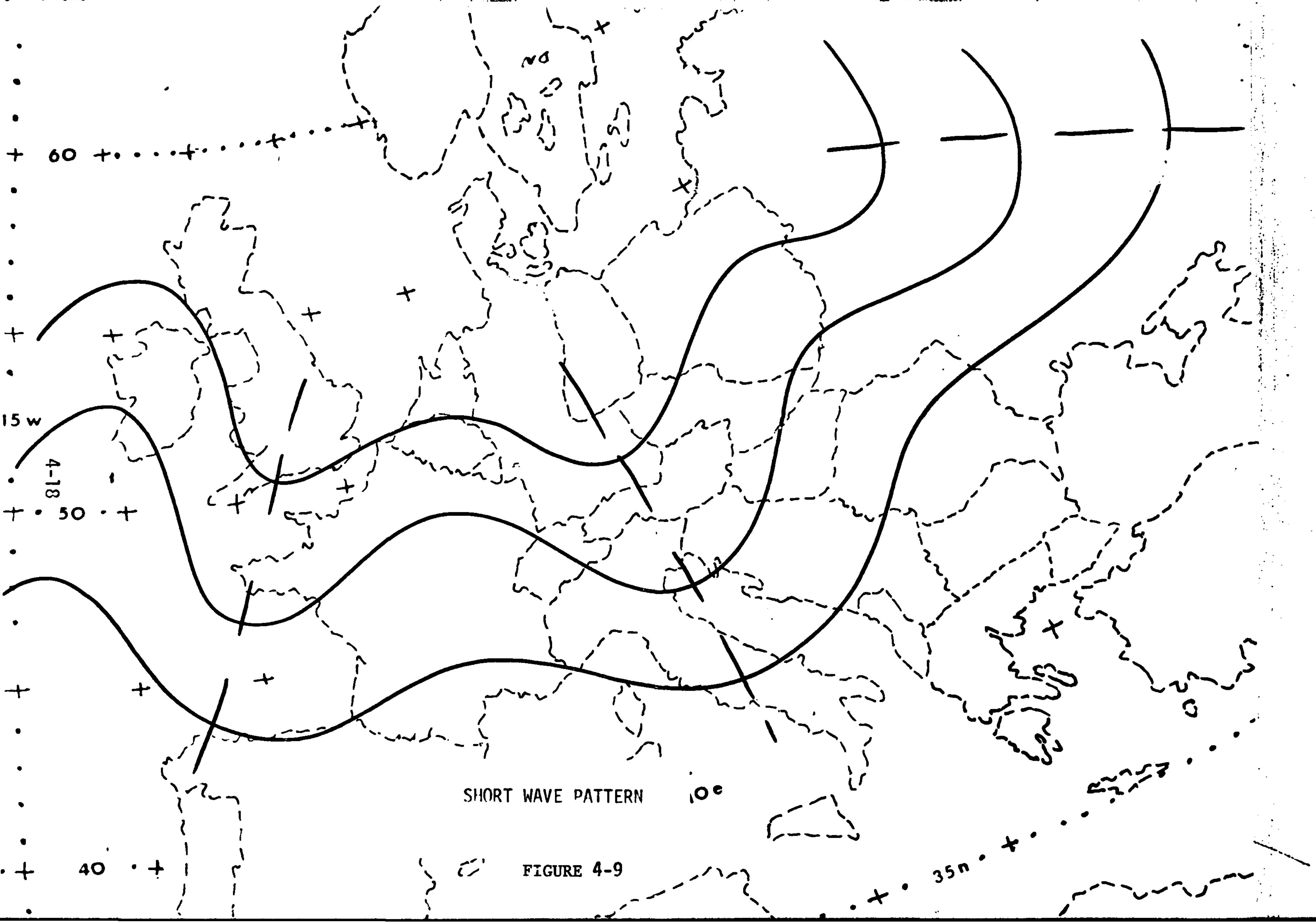
TOTAL-TOTALS INDEX VALUES GUIDE FOR FORECASTING THUNDERSTORMS

IN CENTRAL GERMANY

(MAY NEED ADJUSTING FOR SPECIFIC LOCATIONS IN GERMANY)

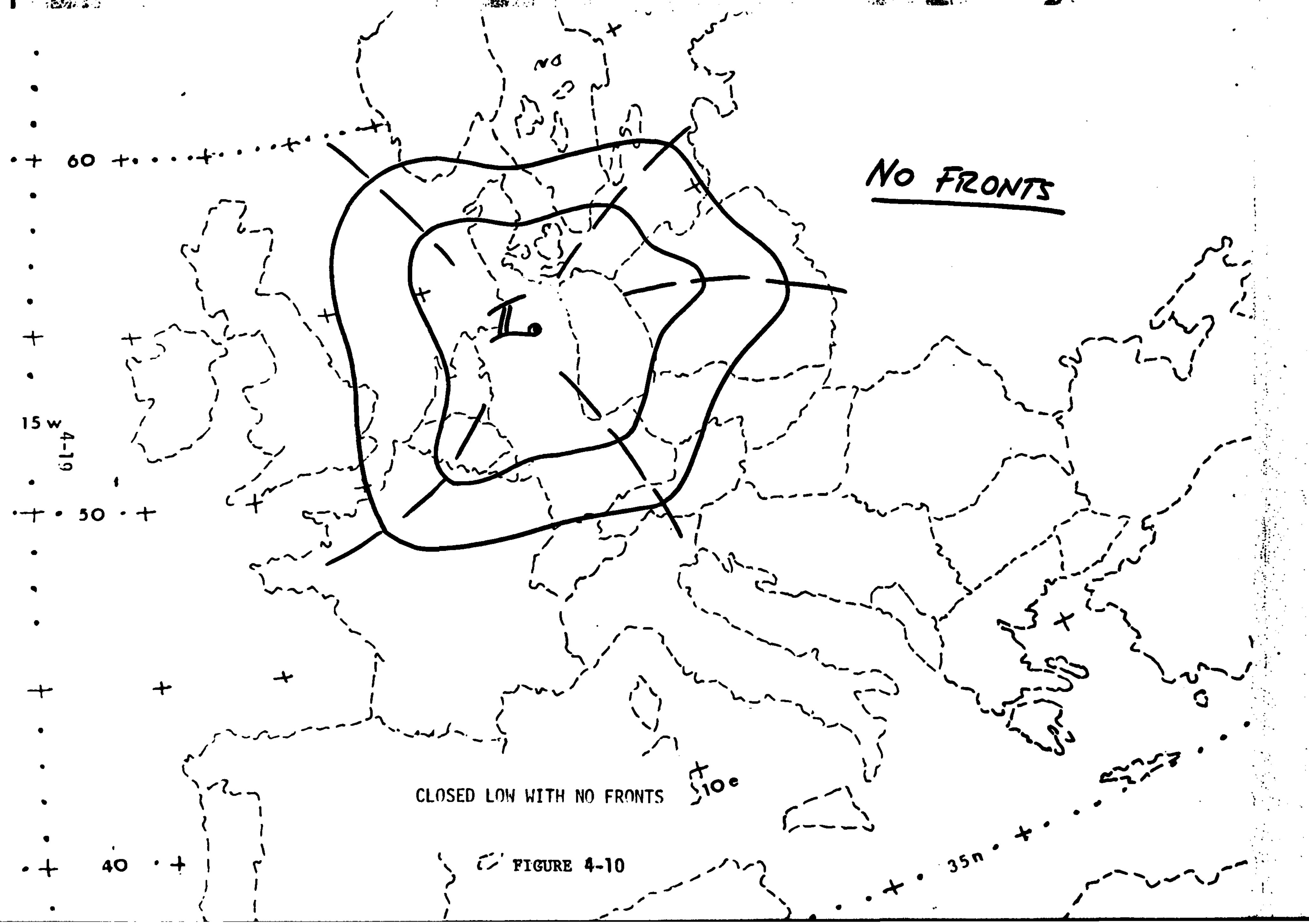
FORECAST	VT	CT	TT
ISOLATED	26	20 - 23	46 - 49
FEW	$\geq$ 28	20 - 24	50 - 52
SCATTERED	$\geq$ 28	22 - 26	53 - 55
NUMEROUS	$\geq$ 28	$\geq$ 26	$\geq$ 55

TABLE 3



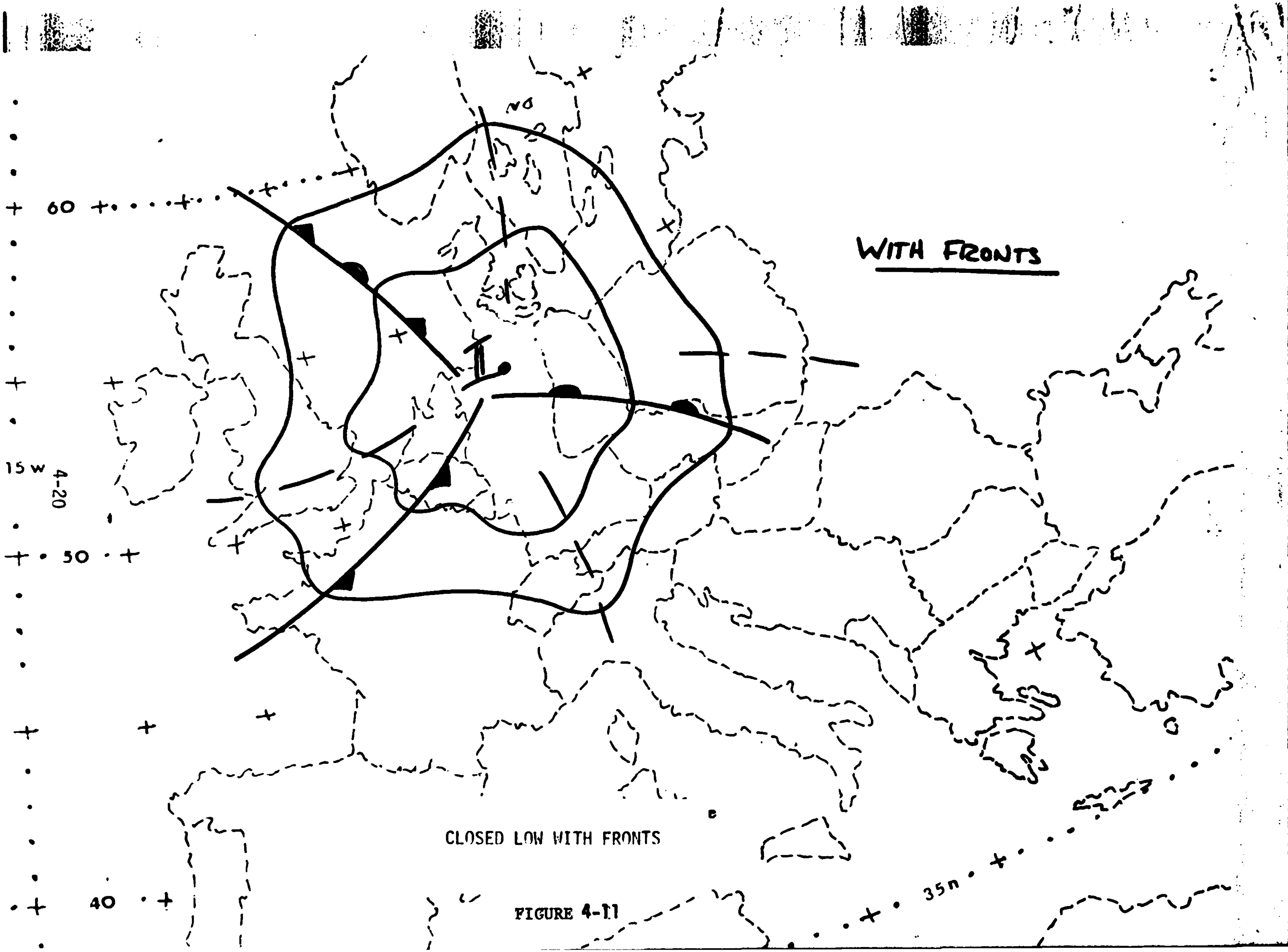
SHORT WAVE PATTERN

FIGURE 4-9



CLOSED LOW WITH NO FRONTS

FIGURE 4-10



CLOSED LOW WITH FRONTS

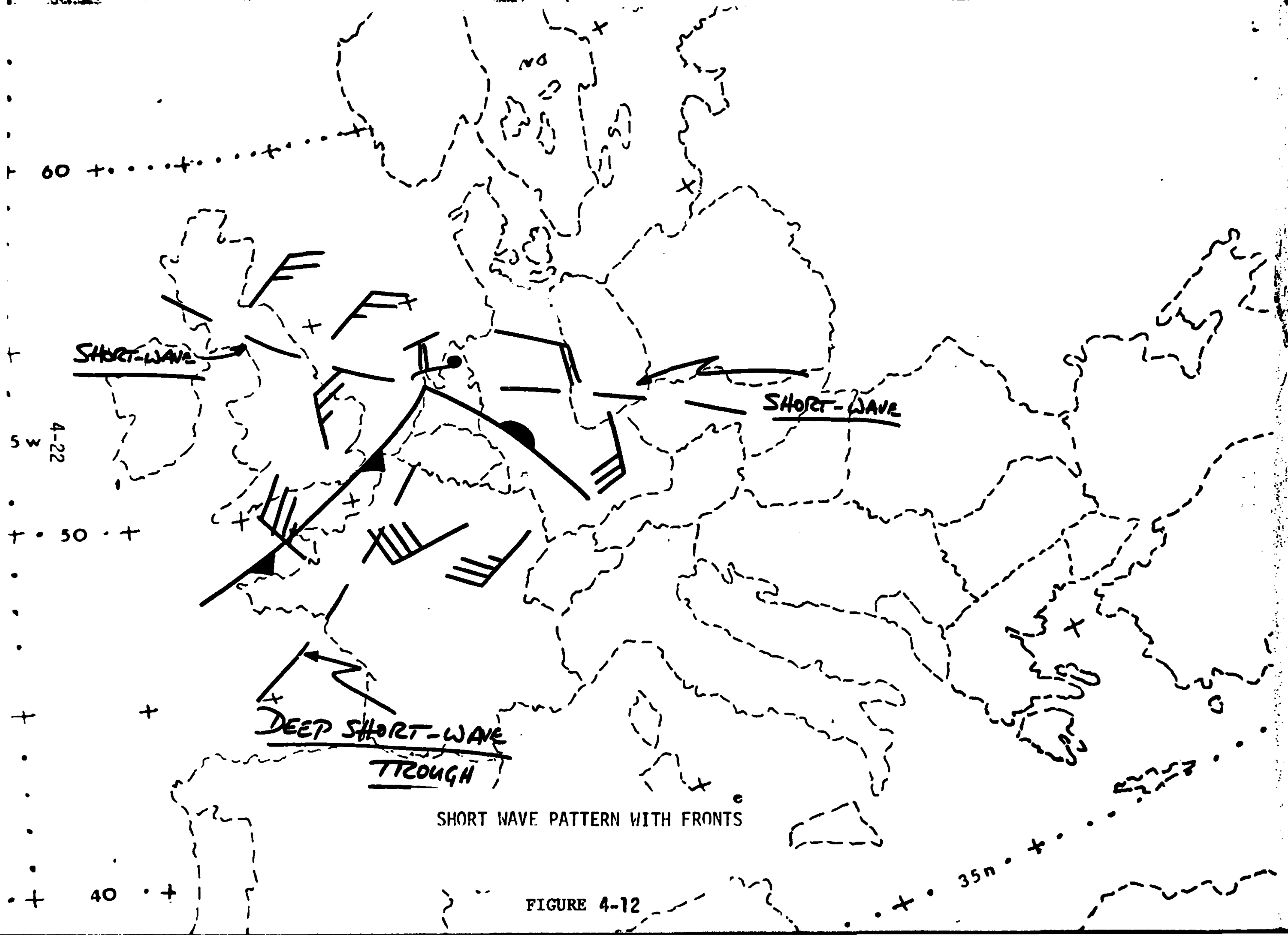
FIGURE 4-11

track. Analyze the 850mb isotherms to determine whether or not there are fronts and for frontal placement. When analyzing occlusions, sometimes the 700mb level is better than the 850mb level (the occlusion may be above 850mb). It is nearly impossible to identify a European front from surface data alone. Trough associated cloudiness can mask solar heating to give the appearance of a front when none exists. When fronts are not present, showers will be less widespread and will closely correlate to the passage of short wave troughs. Frontal lows will also be overtaken by short wave troughs, but the trough will merely intensify the showers on a background of rain. Use isallobaric analysis to predict the track and rate of movement of the low, extrapolate observed frontal movements, and pay special attention to the vertically deep short wave trough. Overlay a progged TT analysis on the progged pressure system analysis to determine event intensity.

4-9. <u>Continuous Rain or Snow</u>: These events are associated with the closed low (with and without fronts) just discussed. Continuous precipitation is the background condition related to the synoptic scale vertical motion pattern while the heavy showers come with passage of short wave troughs. <u>Heavy</u> snow is always associated with a warm or occluded warm front in winter. The retreat of the Siberian High will produce heavy snow in the southern and eastern FRG as it moves out as a warm front.

4-10. <u>Trough Associated Winds</u>: There are two models, those accompanying frontal systems and those not associated with frontal systems.

a. The frontal model is seen in Figure 12. This is the winter windstorm model. Once more you prog the low with isallobaric analysis and extrapolate the fronts. The key is to recognize that the strong winds are not associated with frontal pressure gradients, but with a vertically deep short wave trough passing through the system. The wind max will outrun the low and be dissipated in the ridge ahead of the low. Do an isotach analysis at gradient level and



SHORT WAVE PATTERN WITH FRONTS

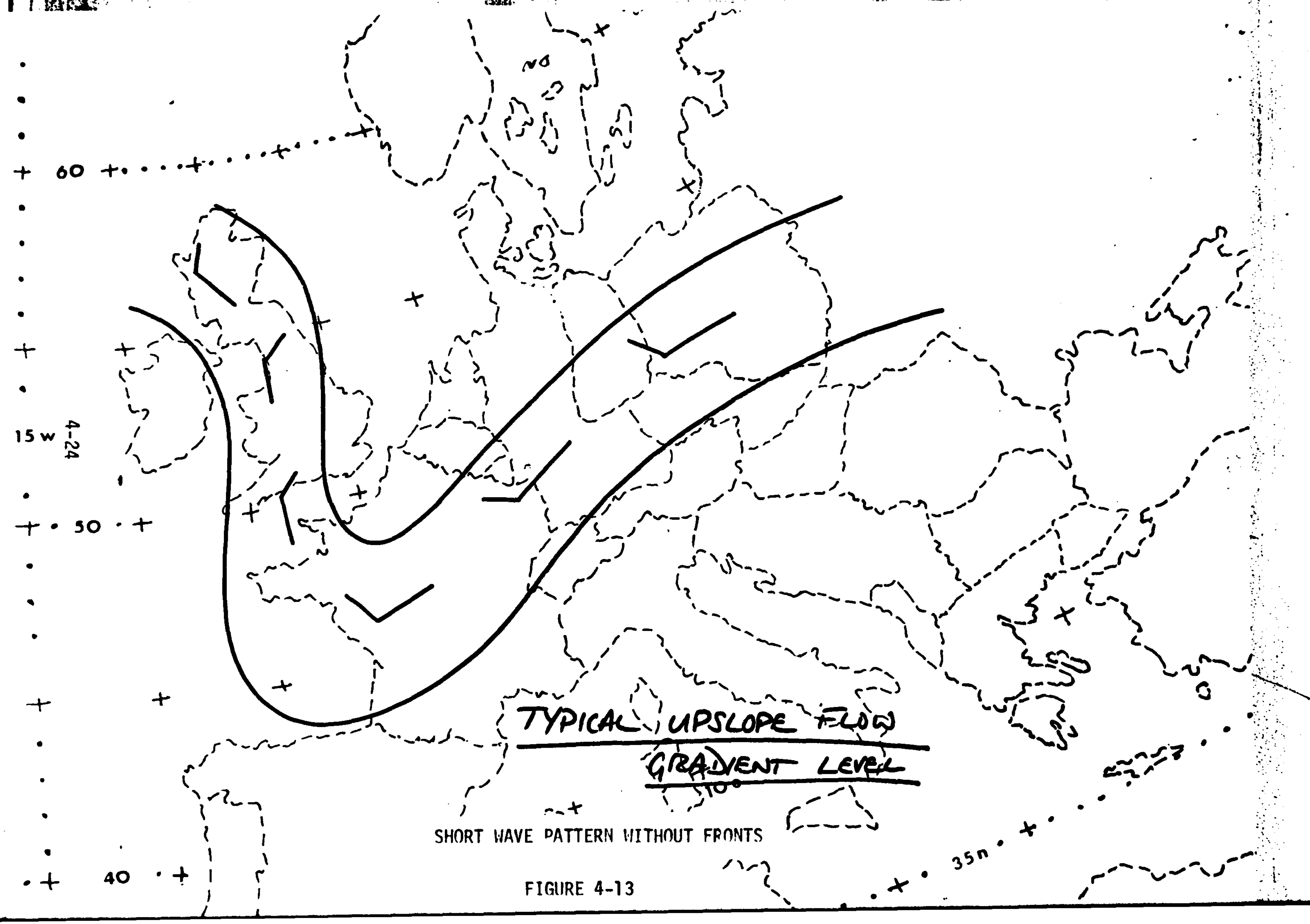
FIGURE 4-12

use extrapolation tools.

b. The channel trough discussed with upsloep conditions is the fall and spring windstorm model. See the sequence in Figure 13. Note that there are no fronts and the wind does not change direction (at any one point) at the max moves through the major trough (the wind max is a compression wave). In the fall you tend to have more stable air (low TT) and showers are less likely to accompany the windstorm. The spring can go either way but often when a TT max is associated, thunderstorms develop in the compression wave. The keys are: Identify the wave while it is still on the back side of the major trough, and prog the wind isotach maximum using extrapolation.

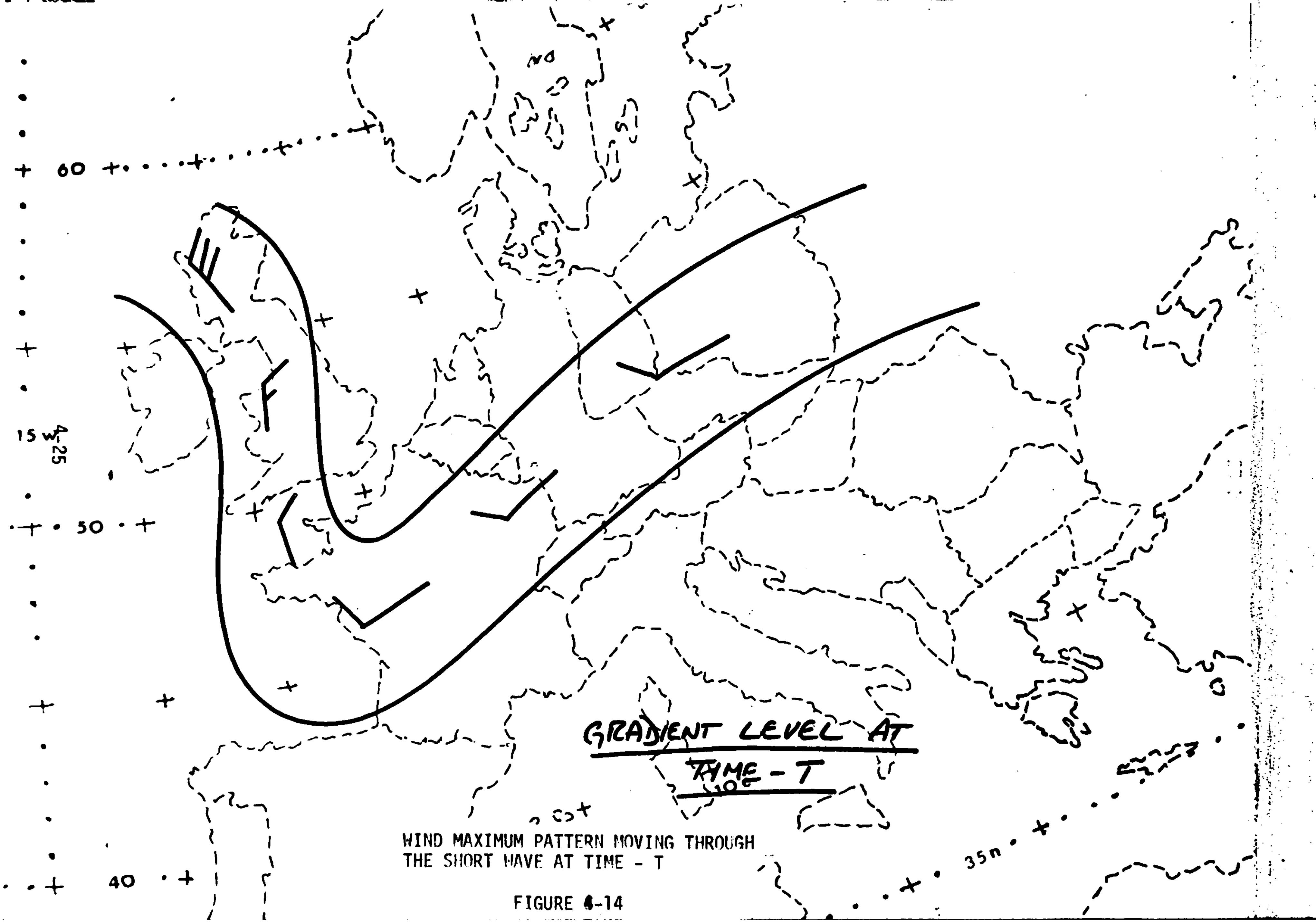
4-11. Seasonal Patterns: The weather at Feucht is typical of continental Europe, with humid conditions prevaling all year. Frontal systems pass through the area frequently both summer and winter. Convective activity is genera-ly confined to late spring through late fall; however, a strong fast moving cold front will set off winter thunderstorms. The vertical extent of summer thunderstorms often reach 40,000 feet or more, while wintertime storms rarely exceed 25,000 feet.

a. Summer: During the summer months Feucht is generally under moist southwesterly flow aloft from the Atlantic ocean. With no larger north-south natural barrier between the Atlantic and Germany, summer weather is nearer maritime than true continental. The Icelandic low, although weak at this time of year, together with westerly flow from the Azores high, often push frontal systems thru the Rhine valley and into Bavaria. These fronts usually become weak and diffuse by the time they reach Feucht. Strong surface winds (exceeding 35 knots) may accompany the thunderstorms occurring with these fronts. Precipitation in this season is usually showery; however, a warm front will occasionally move through the area, or a low may move northward from Italy over the Alps, bringing continuous precipitation into the area. Infrequently strong north to northeast



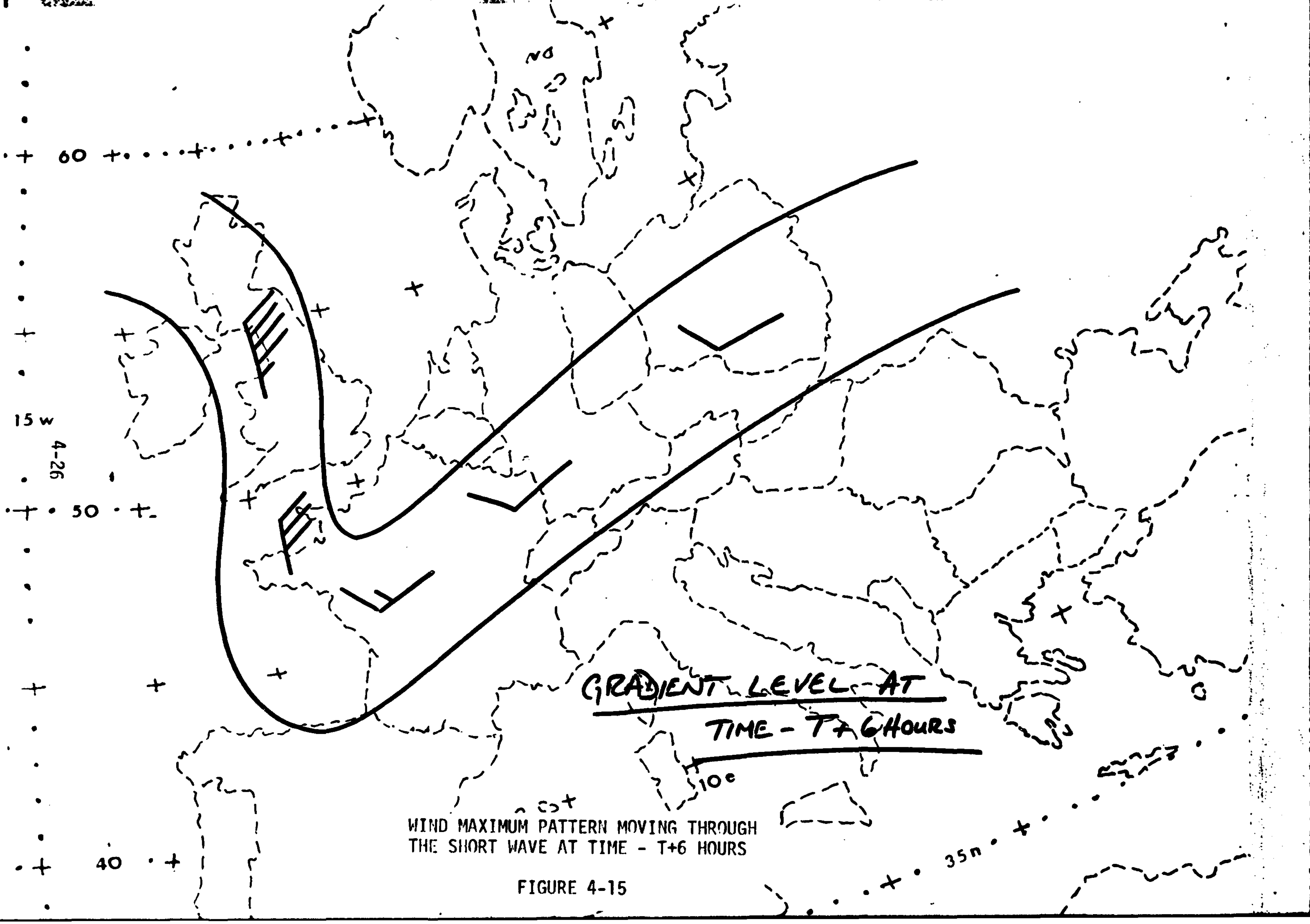
SHORT WAVE PATTERN WITHOUT FRONTS

FIGURE 4-13



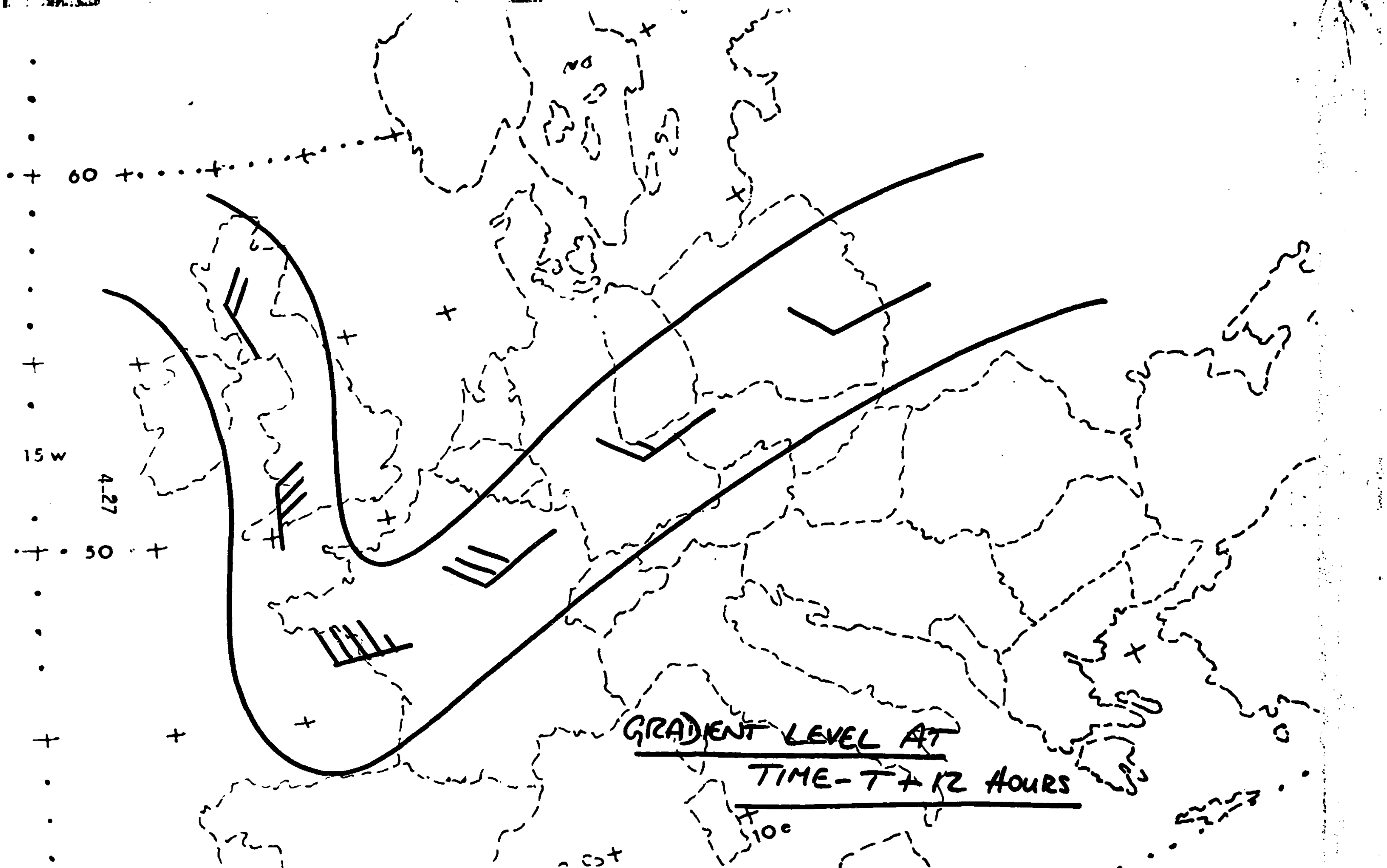
WIND MAXIMUM PATTERN MOVING THROUGH
THE SHORT WAVE AT TIME - T

FIGURE 4-14



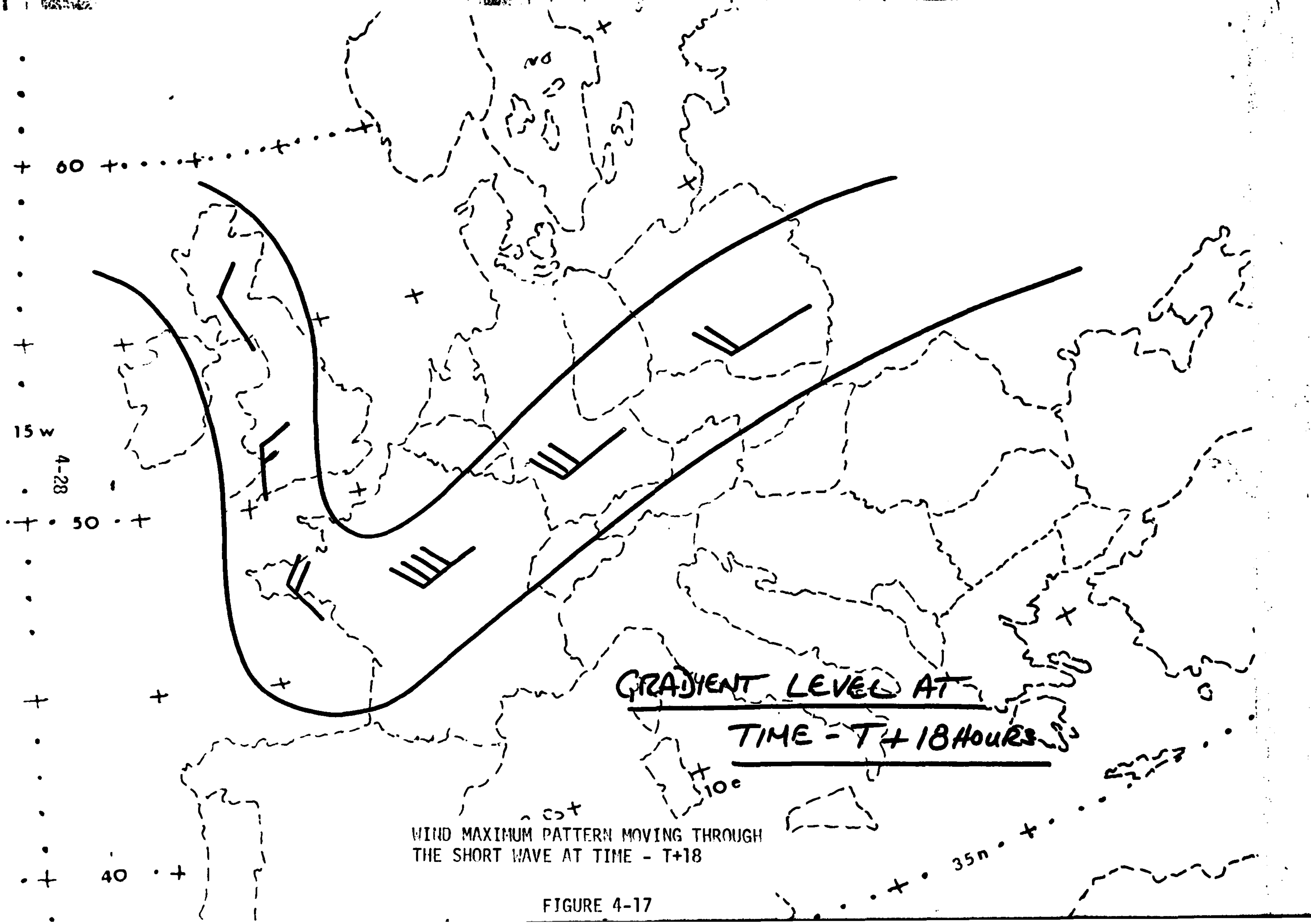
WIND MAXIMUM PATTERN MOVING THROUGH
THE SHORT WAVE AT TIME - T+6 HOURS

FIGURE 4-15



WIND MAXIMUM PATTERN MOVING THROUGH
THE SHORT WAVE AT TIME - T+12

FIGURE 4-16



WIND MAXIMUM PATTERN MOVING THROUGH
THE SHORT WAVE AT TIME - T+18

FIGURE 4-17

flow around a high in the North Sea will cross the low plains of East Germany, lift orographically in the hills to the north and cause continuous rain of moderate intensity at Feucht. Temperatures are generally moderate with the maritime effects of the southwesterly flow keeping daytime temperatures in the seventies and eighties and nightime lows in the mid fifties. The highest temperatures in the area will usually occur when a large, persistent high pressure system is situated to the north. This will give easterly flow to the area and the long continental trajectory of the air will allow modification of the moisture content causing clearer than normal skies, insolation then has a good chance of pushing temperatures into the nineties. Fog generally will not persist later than mid-morning unless a good deal of rain occurred recently or a strong surface inversion is present with an overcast deck of low or middle clouds persisting. Under normal conditions any fog that may have formed during the night will dissipate shortly after sunrise when surface heating breaks the radiation inversion.

b. Winter: This season in Bavaria is a forecaster's nightmare. Frequent frontal passages are usual. Trofs, causing as bad or worse conditions, often precede and follow the fronts as they move through. Low pressure systems tracking southeastward across France, then moving eastward along the northern slopes of the Alps usually give the greatest amount of snowfall to Feucht. In winter the industrial pollution in the area really begins to show. With short cool days and a continuing moisture source, these pollutants provide a very handy condensation nuclei for fog formation. Even in the absence of a sufficient amount of moisture a weak inversion can and will trap these particles in the lower levels, causing restriced visibility for long periods. The strongest continuous winds of the year are recorded during the winter months. These winds will usually be from a westerly direction; however, when the Siberian High moves into the area east to southeast winds of 30 knots or more may occur. Precipitaiton during winter is usually of the continuous type, with showers occuring only with and behind cold and occluded fronts. Very few thunderstorms occur during winter. Under certain conditions, explained earlier, small ones may occur. Temperatures are again moderated by the maritime nature of the air masses over the area. With short days, temperatures rarely go above the forties and night time lows usually hover in the upper twenties. Coldest temperatures occur when the Siberian High moves in and temperatures may go below zero degrees Fahrenheit. In this situation an extreme inversion normally occurs and clouds will form just above the surface extending to the base of the inversion. This stratus is very persistent and often helps keep afternoon temperatures below twenty degrees Fahrenheit.

4-12. Summary: From the foregoing, it is evident that local analysis is the key. It takes study, practice, and frequent forecast reviews/re-analysis to become a skilled European forecaster, but this is achievable in 3 to 6 months. The emphasis must be on:

a. Surface analysis (1 to 2mb analysis in key quadrants to identify short waves and analysis of closed isallobars).

b. Gradient level analysis (identify short waves, windstorm indicators, and upslope fog conditions).

c. 850mb to 700mb isothermal analysis (locate fronts and identify deep short waves).

d. Analysis and progging of the Total-Totals fields.

An important issue is whether or not a trough has a front (a boundary between two air masses) associated with it. Unfortunately, centralized products do not provide reliable guidance on frontal type or presence. Furthermore, centralized progs do not retain small-scale synoptic features like the short wave trough and the compression wave wind maximum. Read the analysis models in the ECI 2570 course frequently, and view caramate follow-on-training products regularly. Finally, when long range forecasts are needed, the Baur Type catalog can be a useful source. Whenever a classic Baur pattern is observed, the situation will persist at least as long as the longer indicated time mode. The shorter time models are apparently the result of classifying mixed Baur Types (rather than discarding them).

4-

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