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DETACHMENT 2 M A ZIMMER 22 APR 83

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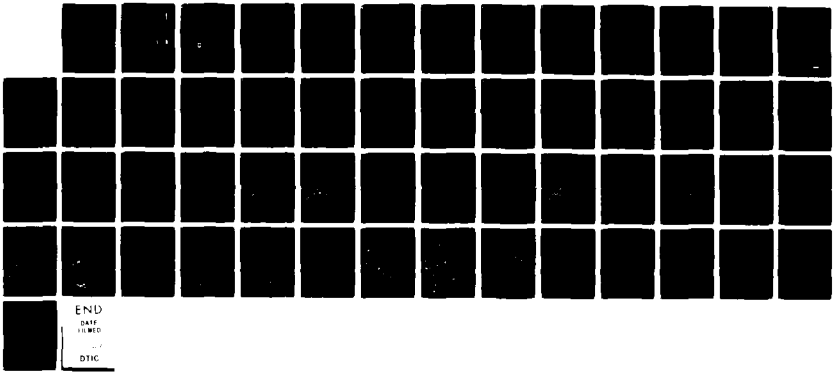

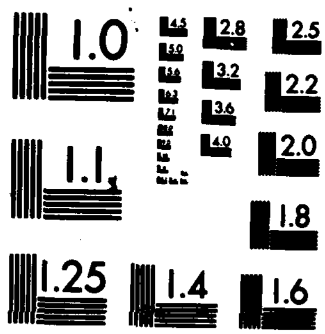

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FOR

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PUBLISHED BY
DETACHMENT 2
7th WEATHER SQUADRON
2d WEATHER WING (MAC)
UNITED STATES AIR FORCE
22 April 1983

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TERMINAL FORECAST REFERENCE NOTEBOOK (TFRN)

DETACHMENT 2, 7TH WEATHER SQUADRON

PREPARED BY:

SSgt MICHAEL A. ZIMMER
20 JULY 1982

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SECTION I

LOCATION AND TOPOGRAPHY

LOCATION AND TOPOGRAPHY

INTRODUCTION

The most important geographic consideration in studying the climate of this part of Central Germany is the unhindered flow of air moving under the influence of the westerlies across the mild North Atlantic Drift current. The first significant mountain barriers are the Urals, far to the east in Central Russia. To the south, the Alps effectively block the advection of moisture from parts of the Mediterranean into this area, but under certain synoptic situations, we lie exposed even in this direction. To the north, we are completely exposed.

LOCATION

Hanau Army Airfield is located at 50°10'N 8°58'E, 1 1/2 nautical miles northeast of the city of Hanau, Germany, with an elevation of 112 meters (369 feet). It is on the northeastern edge of the lower Main River plain and at the southern end of the Kinzig River valley. It is surrounded to the north and east by mountain barriers (Taunus and Spessarts, respectively) and to the south by the Rhein River Basin. (Figure 1-1).

TOPOGRAPHY

The topography of Central Germany north and east of Hanau varies from 300 feet near the confluence of the Rhein and Main Rivers to mountains rising as high as 3372 feet. The only terrain which is relatively flat lies between Wiesbaden and Aschaffenburg and extending north to Friedberg. Another relatively flat region exists just north of Bamberg. For the most part, the local topography consists of hills and mountains with an average elevation near 1000 feet. Approximately 75 miles to the northwest, the Rothaar Mountains thrust upward to a maximum height of 2933 feet. The highest peak lies 18 nautical miles west of Marburg with two other peaks above 2700 feet which lie approximately 40 miles west-southwest of Kassel.

Immediately north of the Lahn River valley lies the Westerwald at a maximum height of 2156 feet. The average height of these hills is near 1500 feet. The Lahn River is a major feature extending generally southwestward from Marburg to the Rhein River at Koblenz.

The Taunus Mountains are oriented northeast-southwest between the Lahn and Main Rivers. The Taunus have an average elevation of approximately 1000 feet with numerous peaks above 1500 feet. Gross Feldberg is the highest peak in this range with an elevation of 2887 feet.

The Vogelsberg, just west of Fulda, rises to a prominence of 2359 feet. This is a singular feature of volcanic origin with the land rising up from small river valleys all around the mountain and sloping up to the peak.

The Rhoen Mountains (50 miles northeast of Hanau) are a formidable barrier with an average elevation in excess of 1500 feet. The Wasserkuppe is the highest peak in this area with an elevation of 3372 feet.

Just to the south of the Rhoen Mountains and immediately east of Hanau lie the Spessarts. These mountains, at an average elevation of 1200 to 1500 feet, force the Main River on a wide detour to the south. Continuing east the Main loops north and south through a rolling terrain with an average elevation of approximately 1000 feet.

Topography to the south, and west includes the Main River and Rhein River valleys, which are nearly flat at an altitude about 300 feet. Southeast through southwest (between Aschaffenburg and Heidelberg) lies the Odenwald with an average elevation between 750 and 1000 feet. Several peaks exist near 2000 feet 50 miles south of Hanau. Farther to the southwest, on the west side of the Rhein River valley, are the Eifel Mountains.

EFFECTS OF LOCATION AND TOPOGRAPHY

Hanau Army Airfield is located at the northern end of the Rhein Valley. When the wind flow is southwesterly, several things happen. The first is that pollutants from the Mannheim area can cause a reduction in visibility or add to the already reduced visibility. The additional condensation nucleii will enhance fog formation in the early morning, and even in the afternoon, visibility will be reduced by haze. Usually, the visibility will remain below 5 miles until after dark, when increased contrast between lights/ darkness overcome the haze problem. If stratus or stratocumulus clouds form and move up the valley, they can and often do pass over the Hanau area; ceilings usually don't lower until the upslope effect occurs in the mountains north and east. However, if the moisture is not cut off, eventually the low clouds will build back over the Hanau area. This is a real tough situation to forecast. If fog is advected up the valley, it can do one of two things. Hanau sits in a slight bowl configuration. At times, the fog will stop short of Hanau, so this station will remain up while the surrounding area has reduced visibilities. At other times the bowl fills up with fog and Hanau will be the only station with significantly reduced surface visibility. Also, about 7 miles to the south of Hanau there is a power plant which can and often does contribute to the cloud/visibility problems.

When unstable air moves from the northwest in the spring through early fall, the lift provided by the Taunus Mountains and the Bad Vilbel ridge (approximately 900 feet) is often enough to cause thunderstorms. Similarly, thunderstorms can build just southeast of here over the Spessarts. Even in unstable mP air in the winter, small cumulus clouds, with tops under 10,000 feet can become thunderstorms, with small soft hail, snow pellets or snow.

This location seems to be fairly well protected from strong winds. Even when other valley stations are carrying high winds/gusts, this station will not. We believe that divergence of the predominent southwest wind up the Rhein and Main Rivers reduces the speed temporarily until it moves over the hills to the north, where highly fluctuating directions and speed causes turbulence for low flying aircraft.

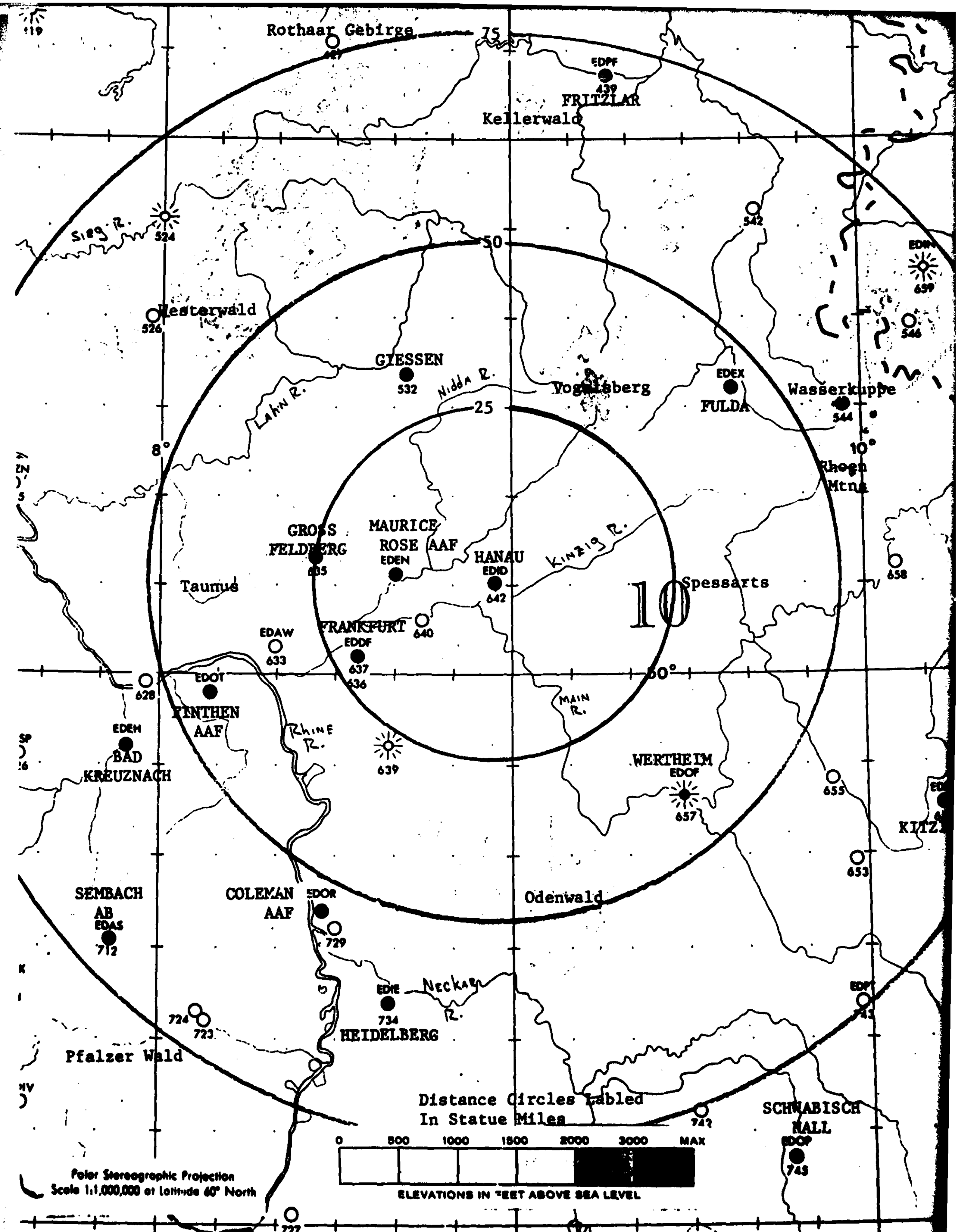

Figure 1 - 1 Local Topography

WEATHER STATION INSTRUMENTATION

The detailed location of weather station facilities and exposure of weather instruments is shown on figure 1-2. Notations on the map of Hanau AAF (Fliegerhorst Kaserne) point out the location of each of the following:

a. The Forecasting Section is located on the ground floor of the Flight Operations Building (Bldg 1310). Forecasters have windows facing to the east. A relatively unobstructed view from the northeast through the southeast is afforded from the forecast section. The view from the west through north is easily obtained by walking through the flight planning room. The view to the south is completely blocked by buildings and trees. A readout for the wind instrument and a barograph are located in the forecaster's room.

b. The ROS is located in the control tower on top of building 1310. Readouts of all installed equipment are located in the tower. The instrument shelter is located on the walkway on the west side of the tower. An intercom system is used to relay observations to the station observer for display in the forecaster's room and also to communicate with the forecaster. A telephone is available in case the intercom fails.

c. The rain guage is located approximately 130 feet east of the Flight Operations Building in a grassy area. The same location is used for snow boards in the winter.

d. The AN/GMQ-11 wind transmitter is exposed 13 feet above a relatively unobstructed grass area across the runway north of the operations building.

e. The detector of the AN/GMQ-13, Rotating Beam Ceilometer, is located 600 feet north of the east end of the runway. The projector is located 400 feet west of the detector.

f. The projector of the AN/GMQ-10, Transmissometer, is located approximately 90 feet southwest of the GMQ-13 detector. The receiver for this equipment is west of the projector and has a base line of 500 feet.

g. Two barometers are in use; an aneroid barometer in the ROS and a standard mecurial barometer in the Base Weather Station.

HANAU A A F GERMANY
SURFACE OBSERVATION EQUIPMENT PLAN
(NOT TO SCALE)

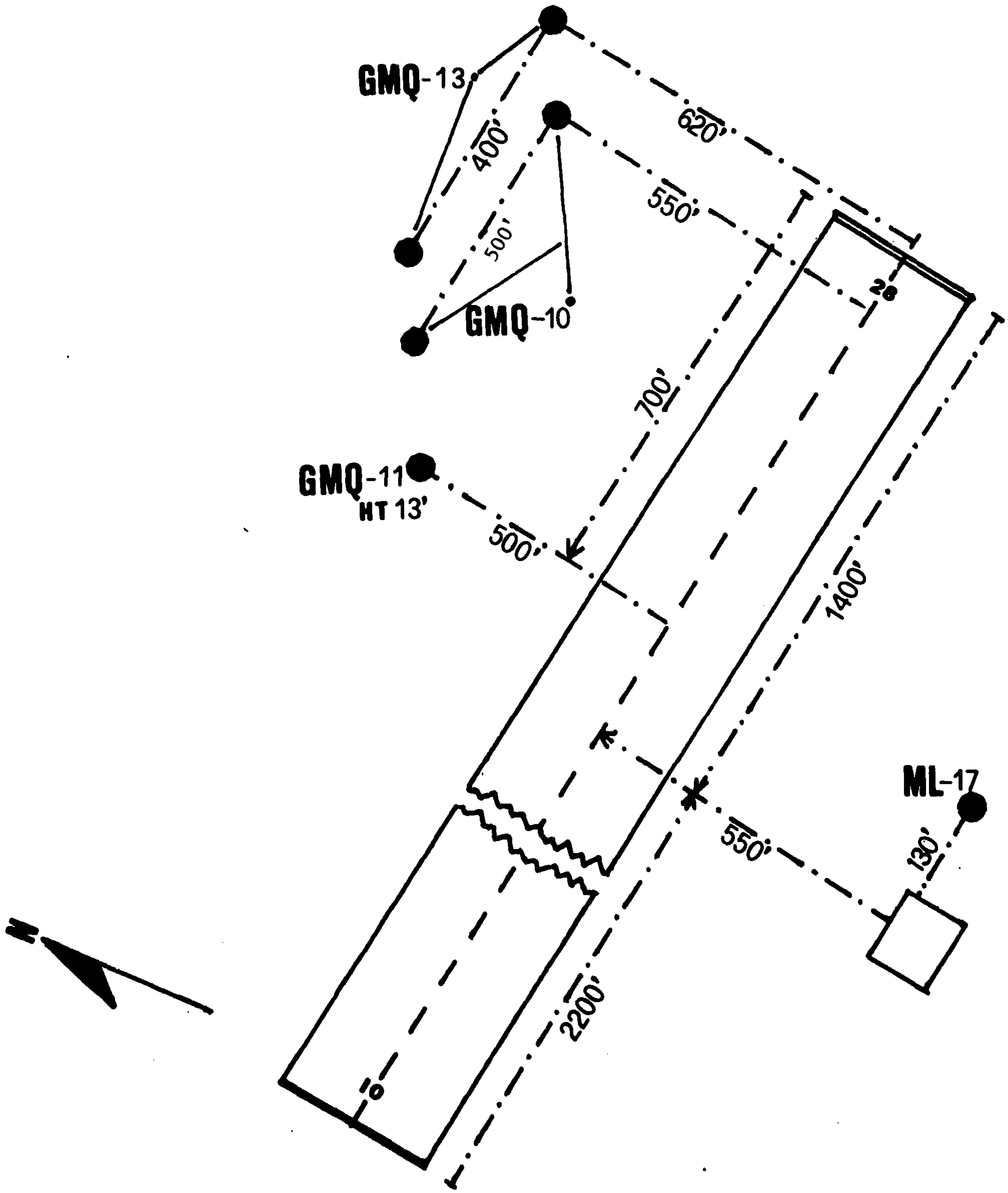

Figure 1-2 Meteorological Instrumentation

SECTION II

CLIMATIC AIDS

CLIMATIC AIDS

GENERAL

In most situations, the customer's complex mission and the experience of the individual aviator tasked to complete a specific operation combine to dictate a go/no go threshold value. Our customer expects us to make forecasts of various meteorological elements, but the operator makes the logical go/no go decision. Generally, an observed ceiling of less than 1000 feet at Hanau will indicate that the hilltops are obscured and ceilings are zero in the higher terrain surrounding Hanau NW-SE. Threshold values are shown at Tables 2-1 and 2-2.

OPERATIONALLY CRITICAL WEATHER ELEMENTS

a. Ceiling

b. Visibility

c. Wind

d. Icing

e. Turbulence

LOCALLY AVAILABLE AIDS

The items listed below identify those documents available within the detachment.

a. Baur Type Catalog - located at the forecaster counter. An aid to the forecaster in which the current synoptic situation will fall under one of three types of 500 mb circulation. The characteristic weather and duration will be discussed.

b. Caramate Programs - located in Station Chief's office. Different programs designed to acquaint or reacquaint the forecaster with various forecast situations.

c. Upslope/Lee Effect Charts - located at the forecast counter. They show the formation of cloudiness due to upslope effects of mountain barriers and the dispersal of cloudiness together with an improvement in visibility due to foehn effects on the lee side.

d. Light Data Tables - located at forecast counter.

e. Trappenberg Study - located in Station Chief's office as part of the Forecaster Training Program, this is an aid for briefing pilots on which low level routes will be VFR (above 300/0.4 during the day and 500/0.9 at night) versus IFR using key location observations.

f. RUSSWO - located in microfiche library. Used in climatic studies for various field exercises.

g. Wind Stratified Conditional Climatology (WSCC) - This aid presents the percent frequency of specified ceiling/visibility categories at certain forecast hours according to the wind direction at the time of the observation. Three different sets are available. One is for the standard TAF categories; the second is for conditions less than 500/½ and equal to greater than 500/½; the third is for conditions less than 1000/2.7 and equal to or greater than 1000/2.7.

h. Climatic Briefs - The AWS Climatic Brief shown in table 2-3 is an abstract of the Hanau brief listed in USAFETAC/DS-791090, which is filed within the Forecaster Training Program.

i. Other Climatic Data - Presented in table 2-4, it is a list of expected conditions over Europe by time of month throughout the year.

TABLE 2-1

OPERATIONAL WEATHER MINIMUMS

Radar Instrument Approach Minimums		
200/.4	PAR (28)	Copter
300/.7	PAR (28)	Fixed Wing
500/.9	CIR (10)	Fixed Wing & Copter
500/.9	ASR (28)	Fixed Wing & Copter
500/1.1	ASR (28)	Fixed Wing
500/1.3	ASR (28)	Fixed Wing
600/1.3	CIR (10)	Fixed Wing
600/1.7	CIR (10)	Fixed Wing
IFR Landing Minimums		
900/.9	28/10	Fixed Wing & Copter
900/1.1	28/10	Fixed Wing
900/2.2	28/10	Fixed Wing
900/2.4	28/10	Fixed Wing
NDB/VOR Minimums		
600/.9	28	Fixed Wing & Copter
600/1.3	28	Fixed Wing
600/1.7	28	Fixed Wing
Alternate Use Minimums		
1300/2.4	28/10	Fixed Wing & Copter

NOTE: There are 4 different categories for fixed wing aircraft (A,B,C,D). The breakdown is by weight and engine thrust. It is much too involved to break down specific types, here.

TABLE 2-2

OPERATIONALLY CRITICAL WEATHER ELEMENTS

	C-12/U-21	UH-1	AH-1	OH-58	CH-47	U60A
SUSTAINED SURFACE WIND	NOTE A (1)	30 KTS (start)	30 KTS (start)	20 KTS(AUTOROTATION) 45 KTS(START)	30 KTS (START)	45KTS (START)
GUST SPREAD	NOTE A (1)	15 KTS (start)	15 KTS (start)	10 KTS(AUTOROTATION) 15 KTS(START)		NONE
TAIL WIND	NOTE A (1)	30 KTS (hover)	30 KTS (hover)	NONE	25 KTS(START) 10KTS(START W/O APU)	45KTS (NOTE B)
CROSS WIND	NOTE A (1)	35 KTS (hover)	35 KTS (hover)	10 KTS(AUTOROTATION)		45KTS (NOTE B)
ICING	SEVERE	LIGHT (NOTE A(3)	CAN'T FLY IN ANY ICING (NO IFR)	CAN'T FLY IN ANY ICING (NO IFR)	SEVERE	SEVERE
TURBULENCE	SEVERE	SEVERE(NOTE A(2)	SEVERE(NOTE A(2)	SEVERE	SEVERE	SEVERE

NOTES: A. Aircraft Dash-10 TM Used As References.

(1) Limitations for these aircraft vary according to the experience of the pilot and various other factors. Pilots will apply them.

(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.

(3) Can fly if CIG $\geq$ 010 tops $\leq$ 080 and in/out

B. Up to 4500' density altitude

C. AR 95-1/USAREUR Sup 1 covers the weather minimums for uncontrolled airspace.

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

E. Definitions:

(1) APU - Auxillary Power Unit

TABLE 2-3

CB DATED JAN 71 OBSOLETE

PREPARED BY: USAFETAC NOVEMBER 1974	STATION NAME: HANAU AAF GERMANY LOCATION: N5C 10 E008 57	PERIOD: MAY 46-DEC 72 @ ELEV: 367	STN LTRS: EDID WBAN NO.: 35009 WMO NO.: 10642

AWS CLIMATIC BRIEF

MONTH	TEMPERATURE (°F) MEAN DAILY MAX	MEAN DAILY MIN	MEAN 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	37	29	33	57@	-4@	1.4	2.2	.8	.6	5	8	4	86	81	.16	29	1250	$ SW	4	33	8	13	#	6	1	#	21	0	0	18	#
FEB	42	32	37	64@	0	1.8	2.8	.3	.4	5	18	5	85	76	.17	31	1450	$ SW	5	44	8	14	0	4	1	#	18	0	0	13	#
MAR	49	38	43	77*	9@	1.4	1.9	.7	.7	2	6	3	83	67	.20	34	1200	$ SW	6	50	7	14	#	2	#	1	17	0	0	11	0
APR	58	41	50	87	23@	2.6	4.1	2.0	1.2	#	1	1	82	60	.25	40	1150	$ SW	5	42	7	13	1	#	0	2	13	0	1	3	0
MAY	66	48	57	90	32	2.4	3.1	1.6	.8	0	0	0@	86	58	.32	47	900	$ W	5	41	7	14	1	0	0	4	16	#	2	#	0
JUN	72	53	63	94	38@	3.1	5.1	.0	2.2	0	0	0	88	58	.39	52	800	$ W	4	36	7	14	2	0	0	5	16	#	6	0	0
JUL	75	56	66	97@	43@	2.3	4.8	.7	1.6	0	0	0	89	59	.45	56	750	$ W	4	42@	7	11	1	0	0	4	17	2	10	0	0
AUG	74	55	65	96	42@	2.6	4.9	.3	1.1@	0	0	0@	89	62	.44	55	800	$ SW	4	31	7	14	1	0	0	4	19	1	7	0	0
SEP	68	50	59	87@	35@	2.1	4.1	.4	1.7	0	0	0@	91	66	.38	51	900	$ SW	3	30	6	10	1	0	0	2	22	0	2	0	0
OCT	58	43	51	79@	27@	1.5	3.4	.2	1.5	#	#	#	90	72	.30	45	1000	$ SW	3	32	7	9	#	0	0	#	24	0	0	2	0
NOV	46	37	42	69@	16	2.4	4.3	.8	1.8	2	8	5	88	79	.22	37	1300	$ SW	4	42	8	14	1	3	1	0	22	0	0	7	0
DEC	39	32	36	61@	0	2.2	5.5	.5	1.7	5	9	6	87	82	.17	31	1400	$ SW	4	34	8	16	1	5	1	0	23	0	0	15	#
ANN	57	43	50	97@	-4@	25.8	5.5	.0	2.2	19	18	6	87	68	.28	43	1100	$ SW	4	50	7	158	9	20	4	22	230	3	28	69	1
EYR	16	16	16	16	16	8	8	8	8	10	10	10	14	17	17	17	17	17	17	6	15	8	8	10	10	10	10	16	16	16	16

REMARKS: RUSSWO POR:
HRLY OBS: MAY-AUG 46, APR 56, OCT 56-DEC 72
DAILY OBS: MAY-AUG 46, APR 56, OCT 56-FEB 64, JUN 64, AUG 64-DEC 72

NOTE: * DATA NOT AVAILABLE # AMTS < UNITS SHOWN IN HEADING ** INSTANTANEOUS PEAK WINDS $ % CALM GRTR % PLVG. DRCTN @ BASED ON < FULL MONTHS

CAV PREQ (%)	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	55	37	24	18	13	15	13	14	27	42	49	51	30	10
	03-05	58	44	35	31	25	24	24	29	39	52	53	56	39	14
	06-08	59	54	46	37	28	26	25	32	46	59	60	62	45	17
	09-11	63	54	44	34	23	21	19	25	33	53	61	69	42	17
	12-14	56	48	34	24	18	16	13	14	19	37	54	61	33	17
	15-17	54	41	25	17	9	10	9	8	10	28	48	59	27	17
	18-20	55	35	21	12	6	9	6	6	12	35	50	58	25	16
	21-23	55	31	18	13	8	12	9	8	16	38	48	56	26	12
	ALL HRS	57	43	31	23	16	17	15	17	25	43	53	59	33	
CEILING LESS THAN 1500 FT AND/OR VISIBILITY LESS THAN 3 MI	00-02	43	30	14	11	10	10	11	12	25	34	39	37	23	10
	03-05	46	34	21	23	19	20	21	26	37	43	42	42	31	14
	06-08	44	41	33	30	21	20	21	26	42	50	45	47	35	17
	09-11	50	44	31	21	11	10	9	14	26	43	45	53	30	17
	12-14	42	33	16	7	4	6	3	5	10	25	36	45	19	17
	15-17	39	27	11	3	3	3	2	3	5	19	32	43	16	17
	18-20	44	24	10	4	4	5	2	3	8	28	37	42	17	16
	21-23	42	23	9	8	6	7	6	6	14	31	37	40	19	12
	ALL HRS	44	32	18	13	10	10	9	12	21	34	39	44	24	
CEILING LESS THAN 1000 FT AND/OR VISIBILITY LESS THAN 2 MI	00-02	23	15	4	4	3	6	5	7	15	23	20	22	12	10
	03-05	27	20	10	10	10	11	12	14	23	31	23	24	18	14
	06-08	28	29	18	15	10	11	12	15	28	39	28	29	22	17
	09-11	35	30	16	8	5	4	3	6	15	29	31	34	18	17
	12-14	29	22	7	2	1	3	1	2	4	15	20	26	11	17
	15-17	25	17	5	1	1	1	1	1	2	11	19	27	9	17
	18-20	27	14	5	1	1	1	1	2	4	17	21	27	10	16
	21-23	23	12	3	2	2	3	2	3	7	19	21	25	10	12
	ALL HRS	27	20	9	5	4	5	5	6	12	23	23	27	14	
CEILING LESS THAN 200 FT AND/OR VISIBILITY LESS THAN 1/2 MI	00-02	2	2	1	1	1	1	1	2	2	10	3	3	2	10
	03-05	3	2	1	2	2	3	2	4	7	12	4	4	4	14
	06-08	3	6	3	3	2	2	3	4	10	18	5	4	5	17
	09-11	5	8	2	1	#	#	#	#	2	11	5	6	3	17
	12-14	4	3	#	0	0	0	0	0	#	2	2	4	1	17
	15-17	4	2	0	0	0	0	0	#	0	1	2	3	1	17
	18-20	4	2	#	0	0	0	0	0	#	5	3	4	2	16
	21-23	2	1	0	#	#	#	1	1	#	7	3	3	2	12
	ALL HRS	3	3	1	1	1	1	1	1	3	8	3	4	3	

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TABLE 2-4

List of "Singularities" in Europe

Singularity	Beginning Date First	Beginning Date Mean	Beginning Date Last	Ending Date First	Ending Date Mean	Ending Date Last	Occurrences in 52 yrs No. of Years	Occurrences in 52 yrs Frequency at Peak Date
Early January, stormy	*	5 Jan	18 Jan	6 Jan	17 Jan	22 Jan	45	31, 8 Jan
Mid-January, anticyclone	7 Jan	18 Jan	23 Jan	17 Jan	24 Jan	30 Jan	45	18, 20-21 Jan
Late January, stormy	18 Jan	24 Jan	31 Jan	24 Jan	1 Feb	24 Feb	44	31, Jan 31
Early February, anticyclone	1 Feb	8 Feb	15 Feb	6 Feb	16 Feb	28 Feb	29	22, 13 Feb
Late February, cold spell	16 Feb	21 Feb	23 Feb	22 Feb	25 Feb	3 Mar	22	21, 22 Feb
Late February and early March, stormy	11 Feb	26 Feb	9 Mar	1 Mar	9 Mar	30 Mar	46	32, 1 Mar
Mid-March, anticyclone	27 Feb	12 Mar	19 Mar	12 Mar	19 Mar	29 Mar	27	17, 13-14 Mar
Late March, stormy	*	24 Mar	29 Mar	24 Mar	31 Mar	11 Apr	35	26, 28 Mar
Mid-April, stormy	28 Mar	10 Apr	15 Apr	10 Apr	15 Apr	26 Apr	37	25, 14 Apr
Late April, unsettled	19 Apr	23 Apr	27 Apr	23 Apr	26 Apr	30 Apr	27	19, 25 Apr
June, summer monsoon	24 May	1 Jun	------	6 Jun	21 Jun	28 Jan	40	----------
July, warm period	------	10 Jul	------	-----	24 Jul	------	--	----------
Late August, stormy	14 Aug	20 Aug	29 Aug	20 Aug	30 Aug	3 Sep	35	16, 28 Aug
Early September, anticyclone	21 Aug	1 Sep	6 Sep	7 Sep	17 Sep	30 Sep	43	25, 10 Sep
Mid-September, stormy	7 Sep	17 Sep	20 Sep	18 Sep	24 Sep	3 Oct	31	22, 20 Sep
Old Wives' Summer	9 Sep	24 Sep	10 Oct	14 Sep	4 Oct	16 Oct	33	----------
Early October, stormy	28 Sep	5 Oct	10 Oct	5 Oct	12 Oct	30 Oct	35	26, 8-9 Oct
Mid-October, anticyclone	8 Oct	16 Oct	19 Oct	15 Oct	20 Oct	28 Oct	35	19, 19 Oct
Late October and early November, stormy	11 Oct	24 Oct	31 Oct	30 Oct	13 Nov	27 Nov	52	31, 29 Oct 28, 9, 12 Nov
Mid-November, anticyclone	7 Nov	15 Nov	22 Nov	14 Nov	21 Nov	30 Nov	34	20, 18, 20 Nov
Late November and early December, stormy	9 Nov	24 Nov	30 Nov	4 Dec	14 Dec	26 Dec	51	25, 25 Nov 34, 9 Dec
Pre-Christmas, anticyclone	9 Dec	18 Dec	24 Dec	19 Dec	24 Dec	5 Jan	29	19, 19-21 Dec
Post-Christmas, stormy	19 Dec	25 Dec	1 Jan	25 Dec	1 Jan	21 Jan	43	35, 28 Dec

period. Note: Last column is date of most frequent day of occurrence.

SECTION III

APPROVED LOCAL FORECAST STUDIES

APPROVED LOCAL FORECAST STUDIES

INTRODUCTION

Forecast studies and rules of thumb (ROT) provide objective methods of forecasting specific operational meteorological values or elements. Before a study or ROT can be used, it must be evaluated. When you evaluate a study or ROT make two parallel forecasts. The first forecast is made without using the study/ROT and the second is the objective forecast derived from the study/ROT. The results are then subject to tests of statistical significance. If one is not familiar with statistical significance tests, seek assistance from 7WS/DON or AWSR 105-29, 2WW Supplement 1.

APPROVED STUDIES

There are no approved studies for Hanau.

RULES OF THUMB

There are no established rules of thumb for Hanau.

FORECASTING HINTS

A notebook of forecasting hints and memos is maintained in the Station Chief's office with the Forecasting Training Program. The 2WW Scientific Sciences office routinely publishes selected articles. The hints are broken down by season, but there's also a general section which covers problems or features which occur at any time of year. Forecasters are encouraged to refer to the hints at any time.

SECTION IV

WEATHER CONTROLS

WEATHER CONTROLS

INTRODUCTION

Presented in this section are some major weather producing situations which will affect Hanau and how they affect the weather here. A quick reminder of major forecast problems and cyclone and anticyclone tracks precedes the discussion. (For reference see figures 4-1 to 4-3). A general description of weather parameters in Spring-Summer and Fall-Winter is added to supplement the specific situations. In addition, forecasters should refer to bust discussions, and forecaster hints to gain historical insight into the situation, once it is identified. The list of bust reviews includes problems in forecasting fog under southerly flow and weak inversions, in identifying sensible weather as lows and fronts move across Germany and in identifying a severe weather occurrence.

SUMMER

Blocked High Dominating Area. One of the more significant summer patterns is the presence of a pronounced ridge at 500 mb over this area (figure 4-4); the associated surface high is usually well to the north and east--e.g., over Scandinavia--as shown in figure 4-5. The blocking mechanism can be an omega block over the area or an intense low, often in SW USSR. The key to the weather is the direction of the 500 mb flow, once the situation is established. This pattern occurs in all seasons, not just summer.

a. NE Flow. When the ridge is west of here, the upper air flow will be from the NE; and the surface flow is also easterly (from 050-120°). The weather will be dry and there will generally be little cloudiness. What clouds form are generally well east of Hanau where the little moisture is uplifted by the hills. Showers are rare and fog or haze are not serious problems. In fact visibility is often 20 nm or more. If the 500 mb ridge is warm--temperatures above -15°C--we may experience a heat wave during this period. Winds can be light, under 5-7 knots, or even up to 15 knots (causing some light turbulence) in these cases; what's important is the direction.

b. SW Flow. When the 500 mb ridge is just west, right over or east of here, the low-level air flow will be southwesterly (from 210-250°). Now, there is ample moisture to cause afternoon cumulus cloudiness and some rain-showers, especially around the hills. If there's a cold pocket at 500 mb, then afternoon thunderstorms are possible. Also, if the surface high is strong enough to produce a subsidence inversion, and inhibit showers, fog and haze will be significant problems. Mornings will be foggy and afternoons hazy. Each successive day will see the visibility decrease, so long as the inversion remains.

Cold Front. During the summer, upper air support for fronts is not very distinctive if you look at the contours and isotherms drawn on centralized charts. Thermal analysis needs to be at 2°C intervals because of the weak thermal gradients, and contours, at half intervals. The 300 mb jet is often hard to find, and there may not be a wind max near the frontal zone. Even the surface pressure tendencies, wind flow and moisture will not make finding the front in our area clear. Usually the surface low is well to the north, in the primary storm track (see figure 4-6) and the trailing front is weak. However, with the upper trough to the west and SW cyclonic flow, there is ample moisture and convection, so that, in advance of the front, showers will develop and skies will be broken. Visibility is hazy. As the front moves through, with its band of showers and thunderstorms, ceilings will lower and often the hill tops to the NW-E will be obscured in showers. Following frontal passage, the winds revert to SW. Morning fog may form; visibility will stay hazy and afternoon showers will continue. Only after the cold pocket at 500 mb passes (frequently with the upper-level trough) will shower activity subside. This is ordinarily by the second day after frontal passage.

PRIMARY FORECASTING PROBLEMS BY MONTH

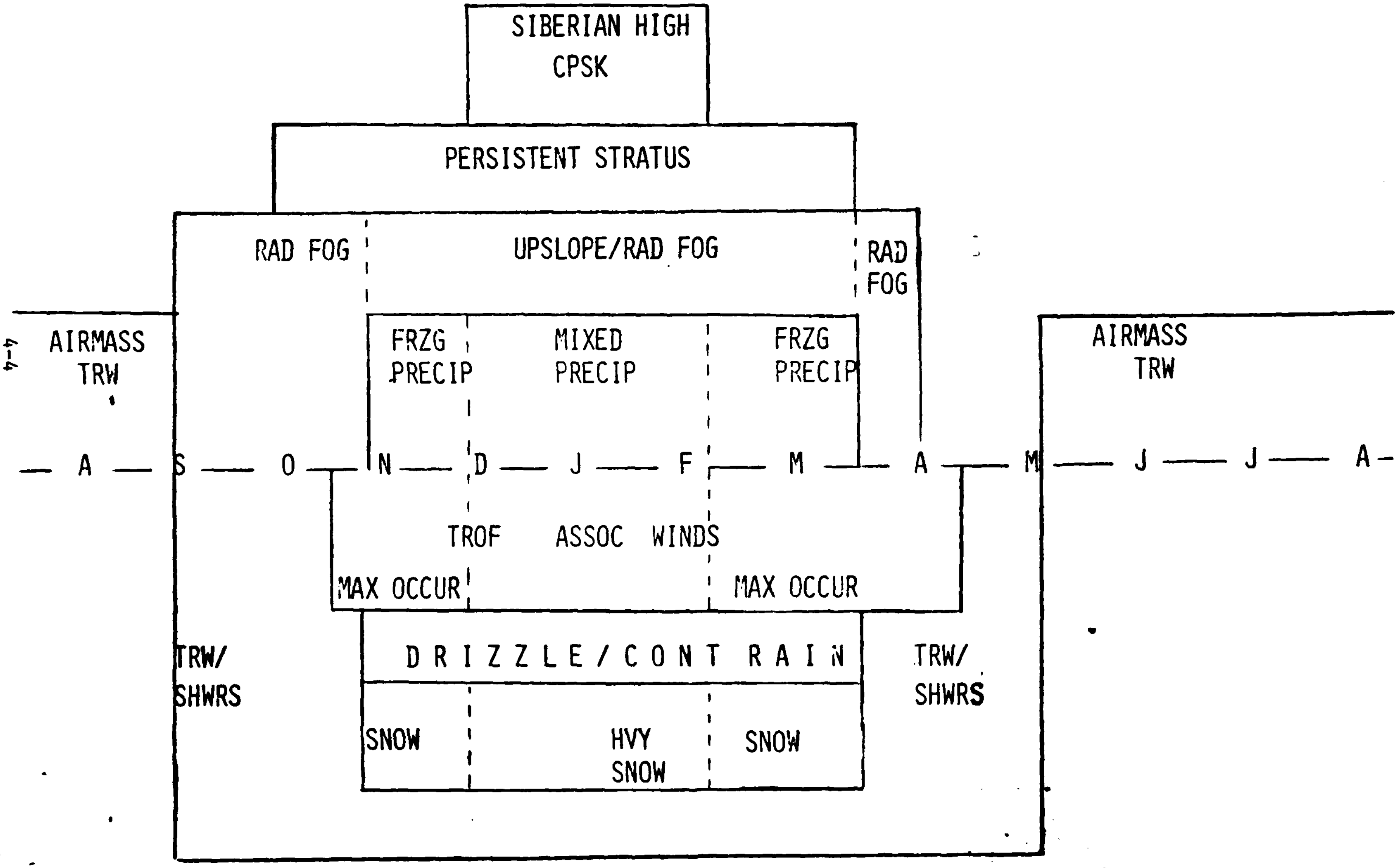
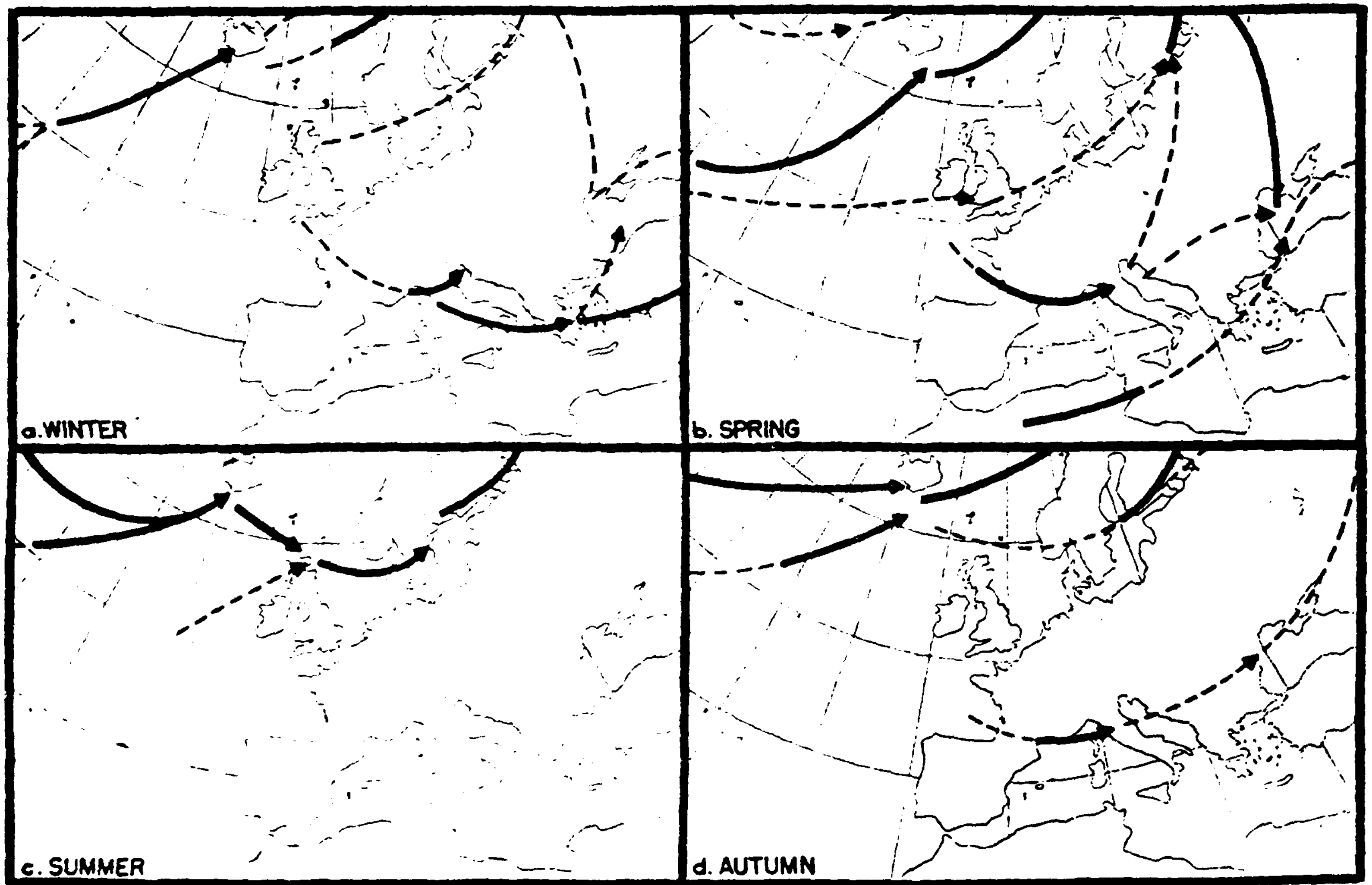


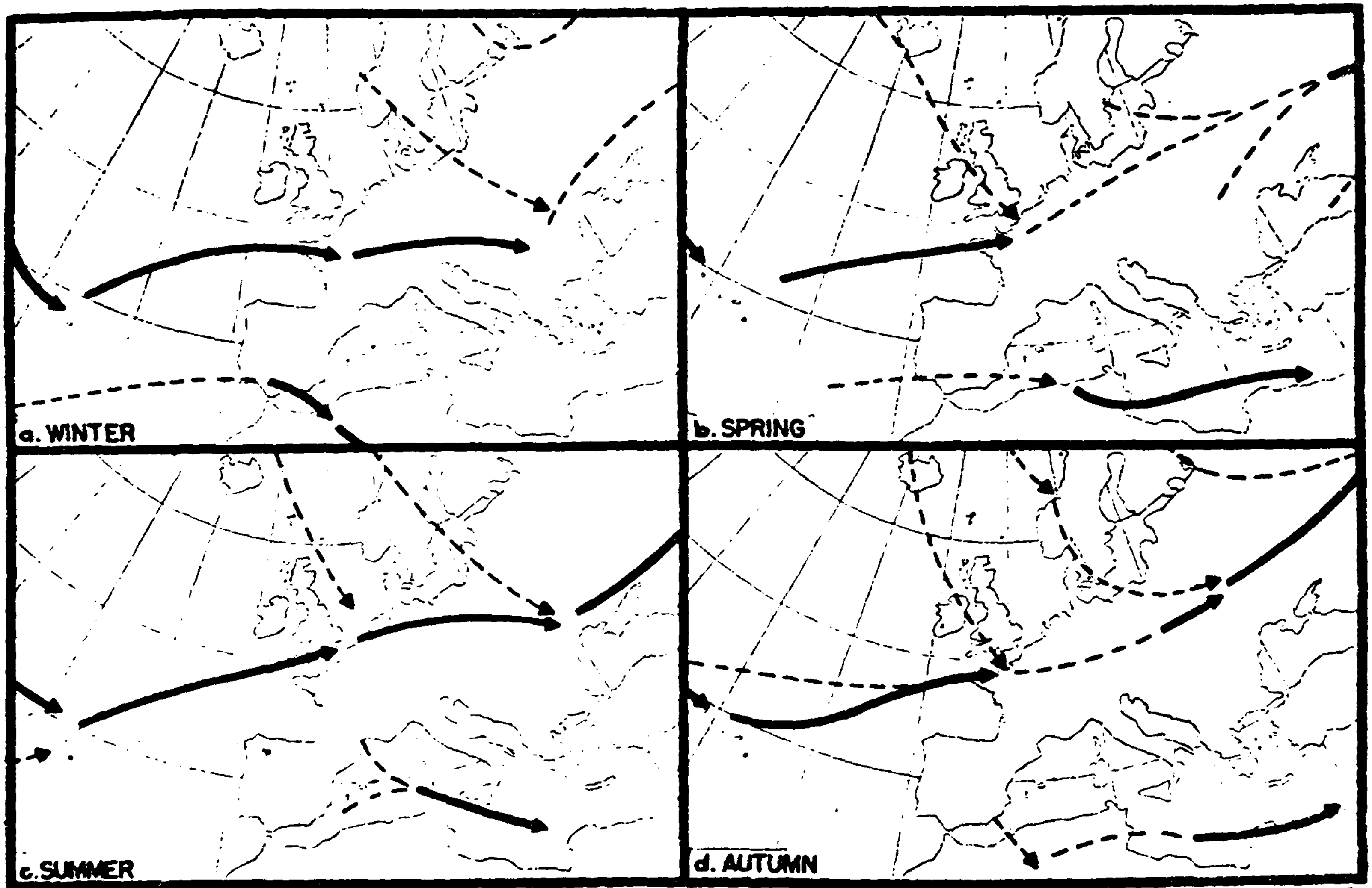
FIGURE 4-1



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

FIGURE 4-2

4-5



MEAN PATHS OF ANTICYCLONES BY SEASON. ⟶ PRIMARY TRACK; - - -▸ SECONDARY TRACK.

FIGURE 4-3

4-6

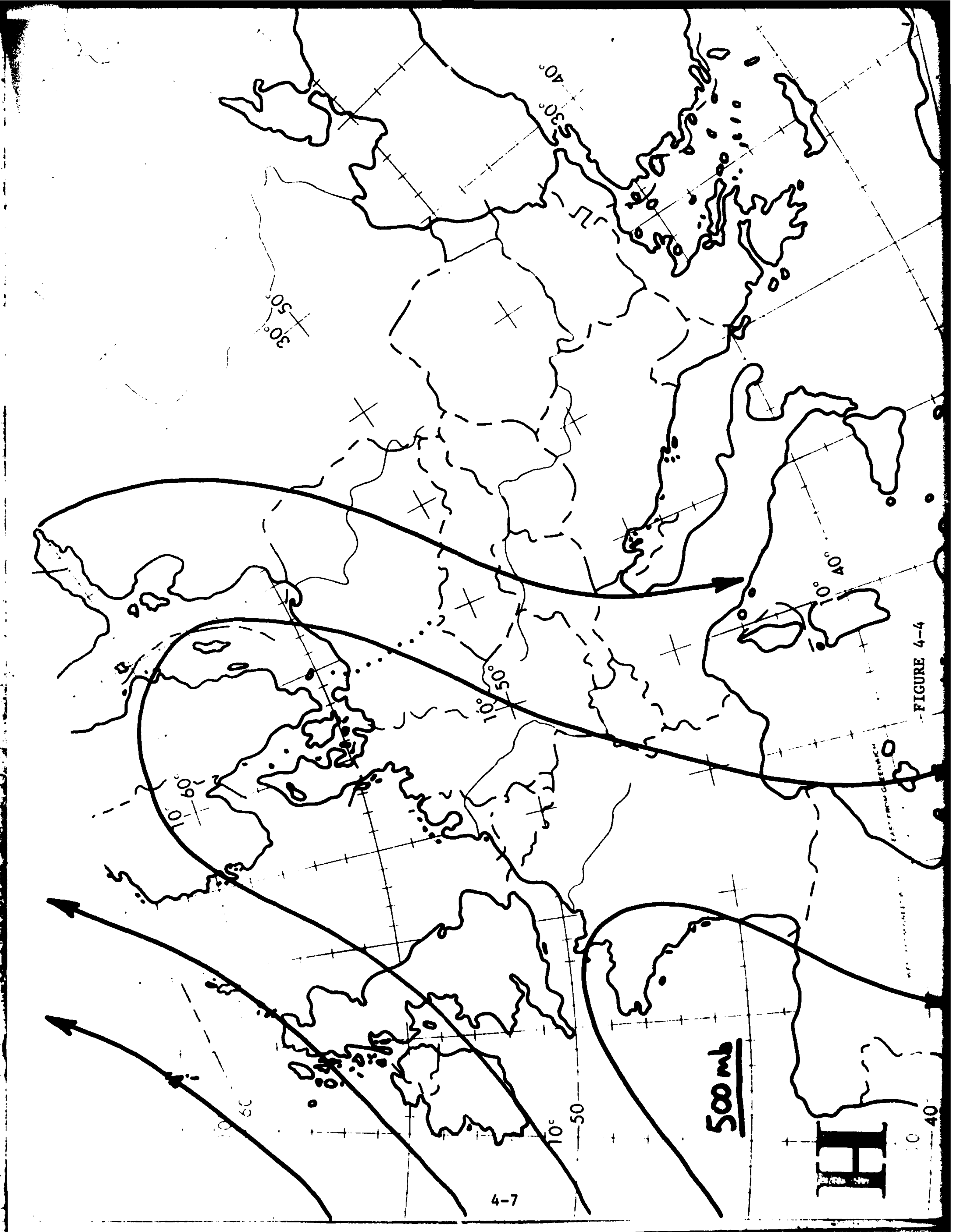


FIGURE 4-4

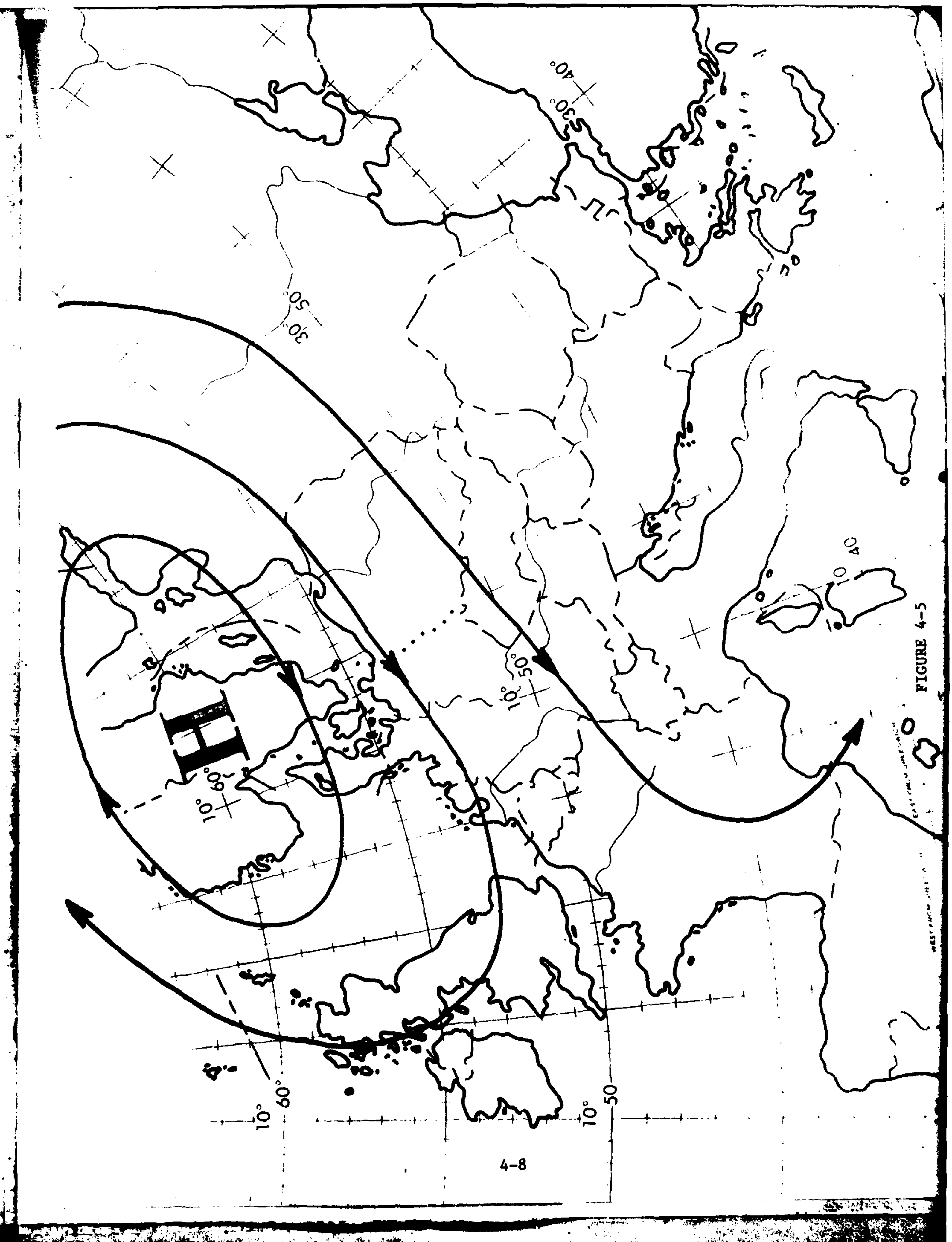
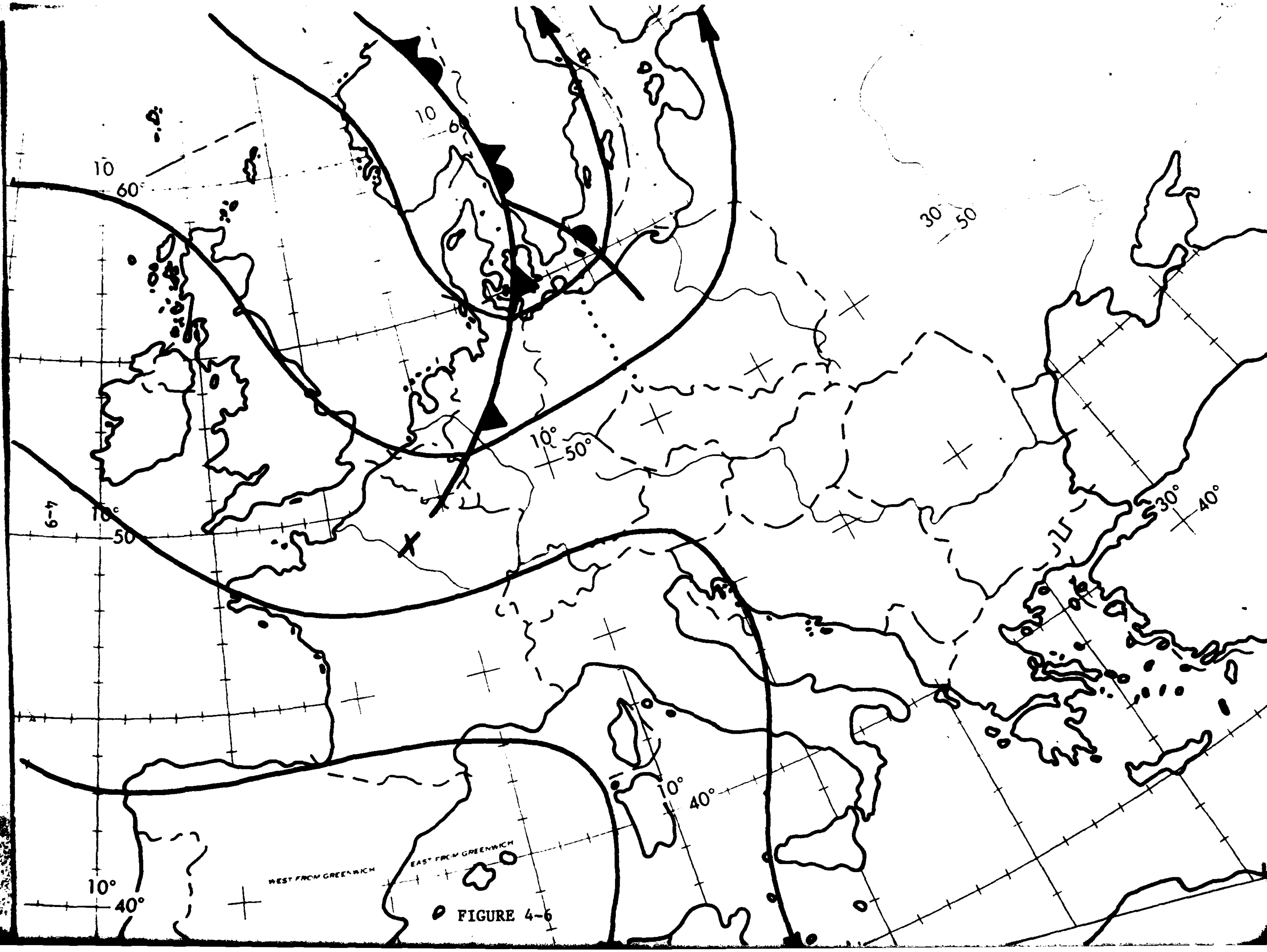


FIGURE 4-5



10
60°
10°
50°
10°
40°
30°
40°
30
50
WEST FROM GREENWICH
EAST FROM GREENWICH

FIGURE 4-6

FALL

Cyclonic NW Flow After a Cold Front. As in the summer situation, once a front passes the region the surface winds will generally switch back to the WSW, because of the terrain; however, if the 850 mb flow is from the NW (290-310°), a band of stratocumulus clouds will be advected over much of the Benelux and northern Germany (figure 4-7). Clouds often reach as far south as Hanau and occasionally all the way to the Alps. If unstable, a few, scattered showers are possible. Usually, though, the 850 mb temp is cool, so only a layer of clouds from 2500-6000 feet are observed. Gradient winds are often 20 knots or higher, so surface winds are on the order of 25008/18; light turbulence should be expected. Icing is not a problem, even if the freezing level is below the cloud tops, because helicopter traffic can get on top of the cloud deck.

Closed Low Moving Through Germany. The Bay of Biscay is a prime location for frontogenesis in fall (and spring). When the storm tracks north of the Alps, widespread cloudiness and precipitation occurs. During the late fall, freezing precipitation can occur, if the surface temperature drops at night or as cold air is advected in from the east ahead of the low (not a common occurrence).

a. Widespread Freezing Precipitation. If the 0° isotherm at 850 mb is trailing (behind) the warm front, snow will occur ahead of the warm front (or rain dependent on position of 0° isotherm at the surface), and freezing precipitation will not occur (see figure 4-8). Figure 4-9 is the model for freezing precipitation. The key is the position of the 850 mb 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 850 mb isotherm and stop time is the arrival of the warm front.

b. Spotty Freezing Precipitation. See figure 4-10. Here, the 0°C isotherm only goes north of the warm front in the cold pockets associated with waves along the front where mesoscale lows may form. There are two components of motion to predict. The short wave component (toward the northwest) and the warm frontal component. The vector resultant is usually 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. Lying in a metropolitan area, Hanau AAF often will observe rain, rather than the freezing precipitation in this situation. The reason is the heat output of the cities--Frankfurt/Hanau. Even, Rhein-Main Flughafen may observer FZRA/FZDZ but remember that is SW of the city and the heat is advected NE, toward Hanau. However, areas in the hills surrounding Hanau will still get freezing precipitation and flight hazards will still be present. Some of the higher peaks will get a variety of conditions, from snow near the top of the Gross-Feldberg when the warm air pocket is shallow, to rain, in the layer of warm air, to freezing precipitation in and around the hills.

c. Associated Winds. Shown in figure 4-11 is a typical wind flow problem. To correctly forecast Hanau winds, prog the low with isallobaric analysis and extrapolate the fronts. Typically, the strong winds are not associated with frontal pressure gradients, but with a vertically deep short wave trough passing through the system. Frequently, the gradient and 850 mb flow will pinpoint the location of the trough. The wind max will outrun the low and be dissipated in the ridge ahead of the low. Do an isotach analysis at gradient level to find the low-level jet and use extrapolation to forecast the start/end of the gusty winds.

SHORT WAVE TROUGH

The short wave trough dominates the European weather forecasting problem in all seasons. Consider the typical 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. This low is associated with a traveling, synoptic scale wave in the westerlies. This wave is not the short wave but rather a major front as it can be easily tracked in upper air analyses and machine progs. However, there are short waves associated with the traveling low. These scales of motion are depicted in figure 4-12. Most of the short waves will be surface features, and can be followed with RAREPS or by watching surface weather reports of clouds and rain showers or thunderstorms. Some waves will have increased amplitude detectable at gradient and 850 mb 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 to 2 mb intervals and then analyze gradient and 850 mb 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 9-12 hours. The shorter the wave, the more rapidly it travels, and the less the impact upon the weather. For example, the 90-minute waves may bring significant showers (Total-Totals values must be considered). On the 90-minute end of the scale, every 3rd 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 850 mb levels are important to identify and prog because the associated weather response is much more significant than that with the intervening shallow surface waves.

POLAR FRONT ACROSS EUROPE

Consider the polar front which is positioned across western Europe (figure 4-13) and moving with lows that have broken off the Icelandic Low. Cold air will be pulled from Scandinavia into the upper trough giving the front sufficient upper air support to be a major storm in the North Sea and southward into Germany. Such a cold or occluded front will bring widespread clouds and precipitation into the Hanau area. These systems can move so fast as for one to pass through every 1 1/2 - 2 days or slow enough to pass through each 4-6 days. Caught in the cyclonic NW flow, our skies will remain overcast, varying from 1000-2000′ after frontal passage in the cold air stratocumulus to 500-1500 feet near the front. Hill tops are almost always obscured. Showers can be associated with the front and short waves (or vorticity maxima) which are embedded in the cold air. Total snowfall is less than 2" with each system and the rain total is likewise small. Skies will often stay overcast but not thick enough to generate precipitation. If there's a distinct cold air pocket at 700 mb-500 mb, there will be rainshowers or thunderstorms with the cold air. By tracking the cold air, one can often determine the start and stop of these showers. When the storm center (low) moves across the heart of the UK and into the Benelux, the precip will last much longer. Even then, total rainfall would be under 1" and total snowfall only 4-6 inches at Hanau.

English Channel Trough. One of the situations which produces gusty winds here is when a deep, stationary pressure trough sets up over the English Channel. Initially, there is weak SW flow, but within 12 hours a wind max can be detected at the gradient level moving into the trough. By 18-24 hr from this point, strong SW winds will occur here. Consider the sequence in figure 4-14 through 4-16.

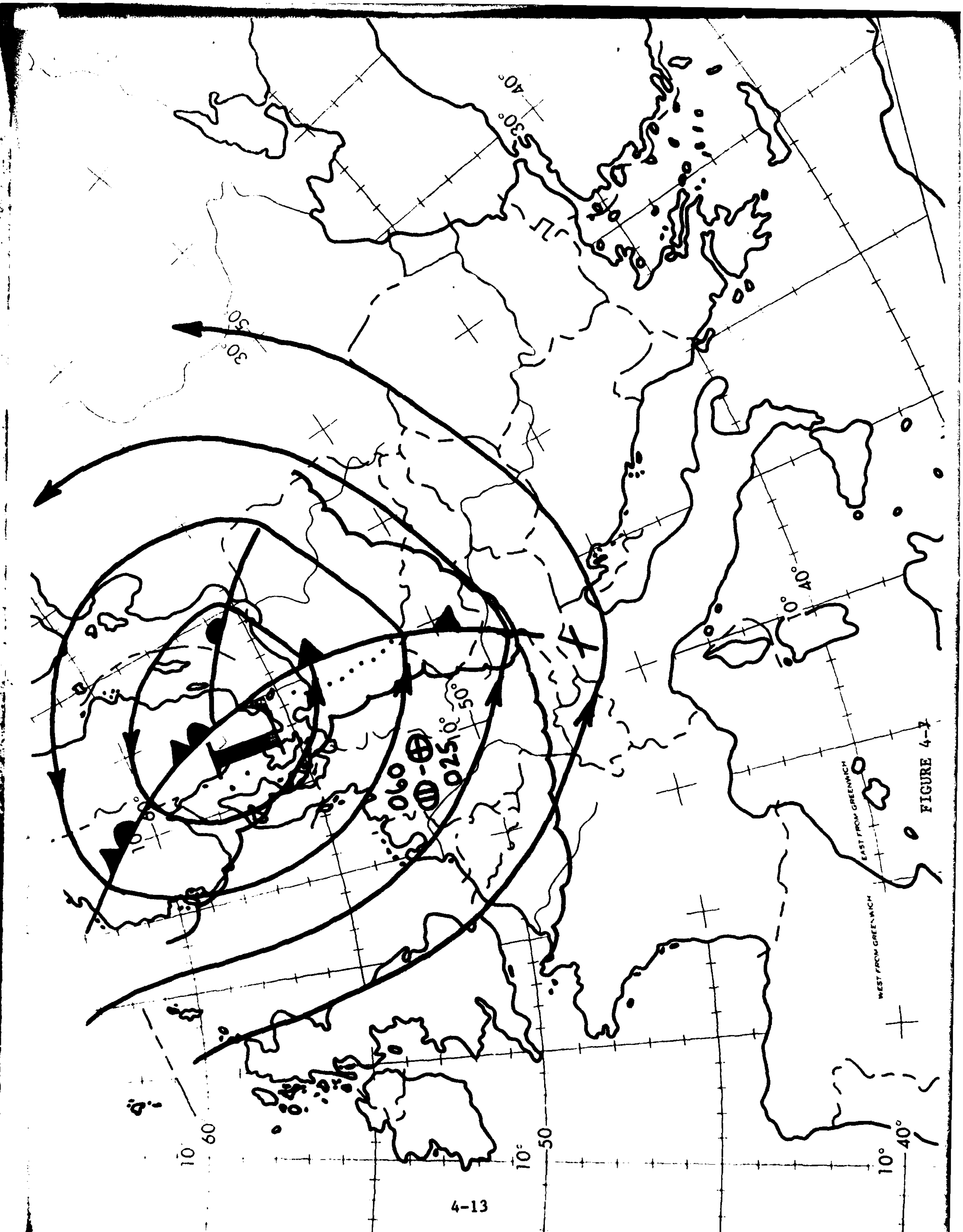


FIGURE 4-7

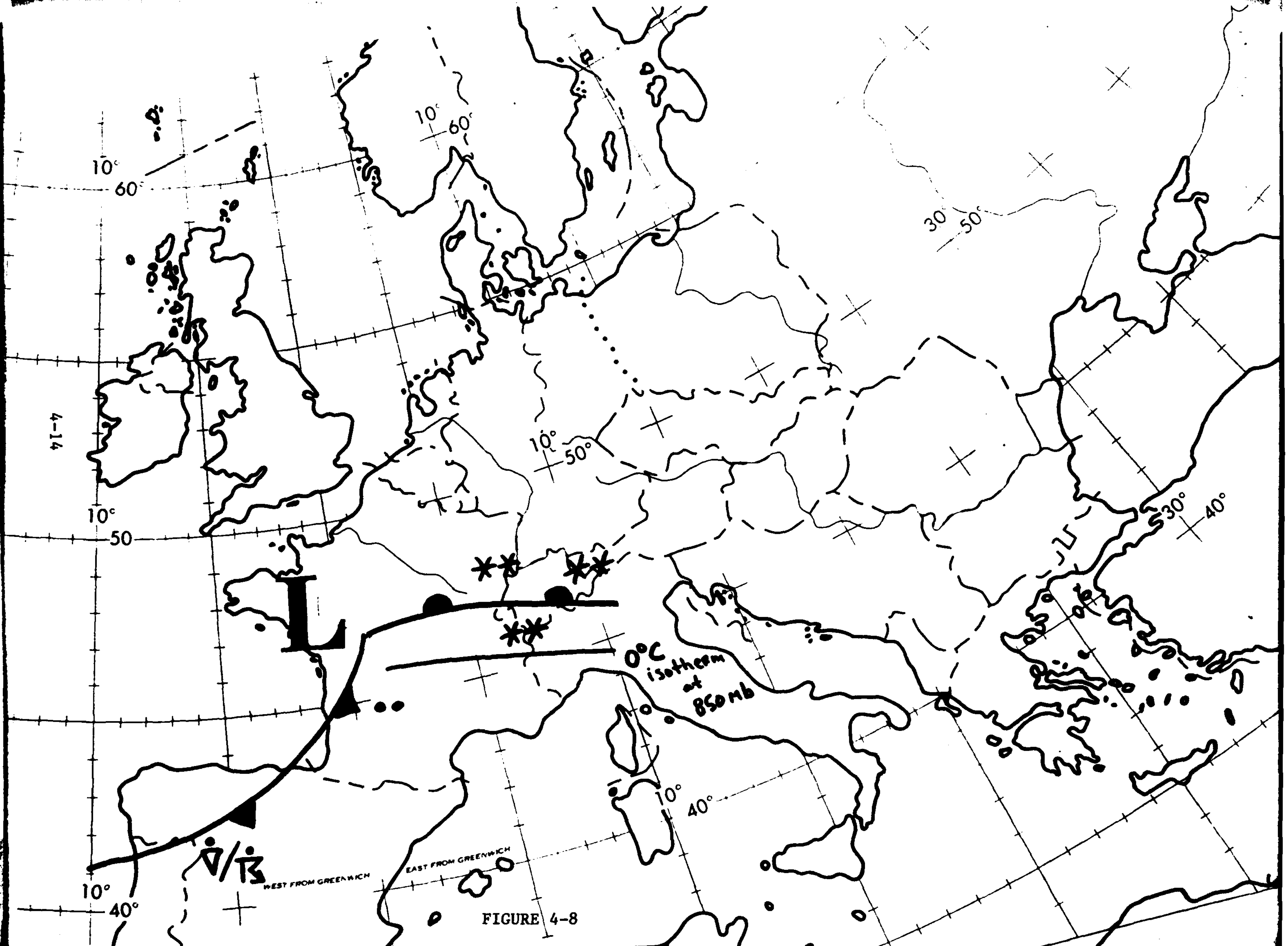

L
0°C isotherm at 850 mb
WEST FROM GREENWICH
EAST FROM GREENWICH
10° 60°
10° 50°
10° 40°
30° 50°
30° 40°
4-14

FIGURE 4-8

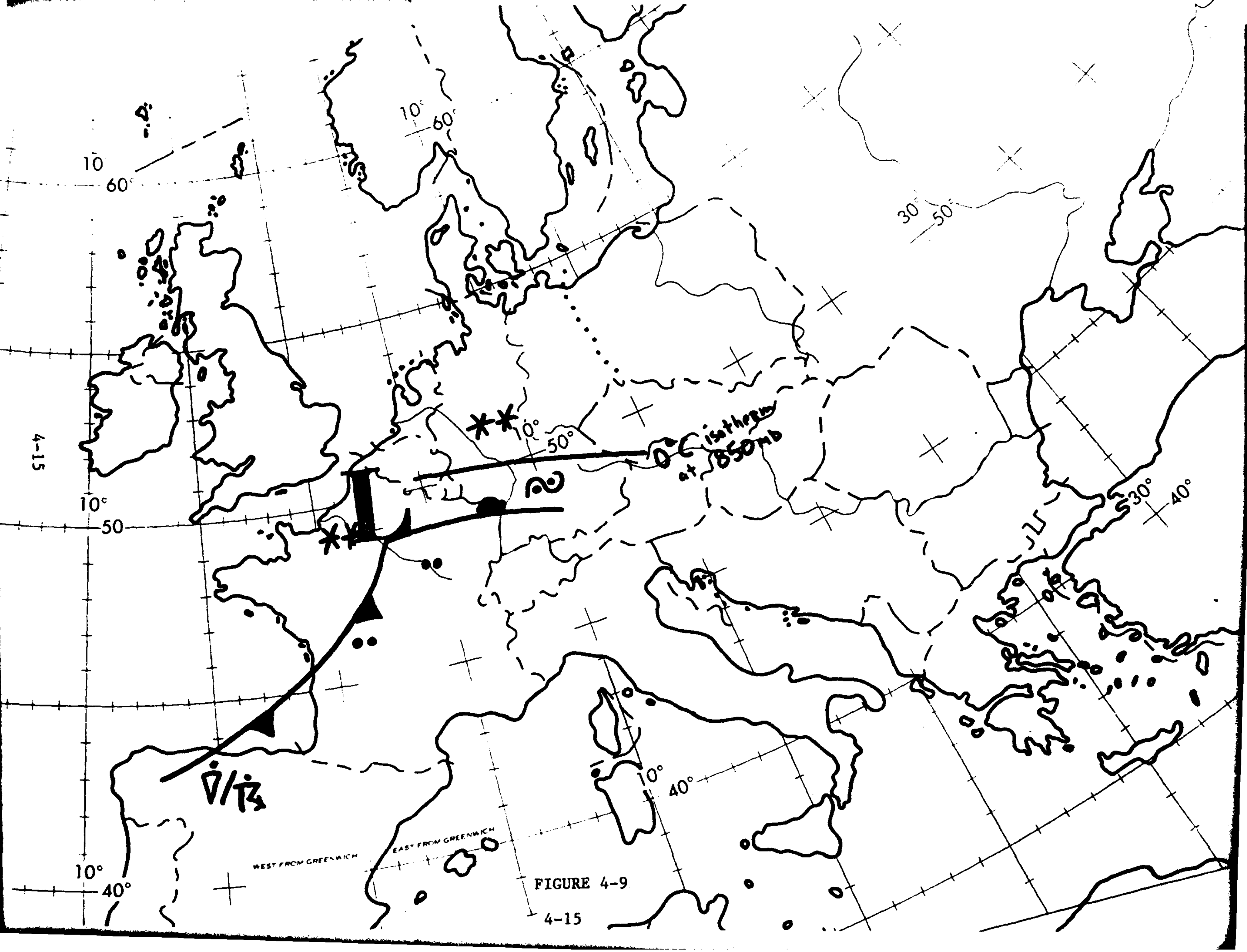

0°C isotherm at 850mb
WEST FROM GREENWICH
EAST FROM GREENWICH
10° 60°
10° 50
10° 40°
30° 50°
30° 40°
10° 40°
10° 50°

FIGURE 4-9

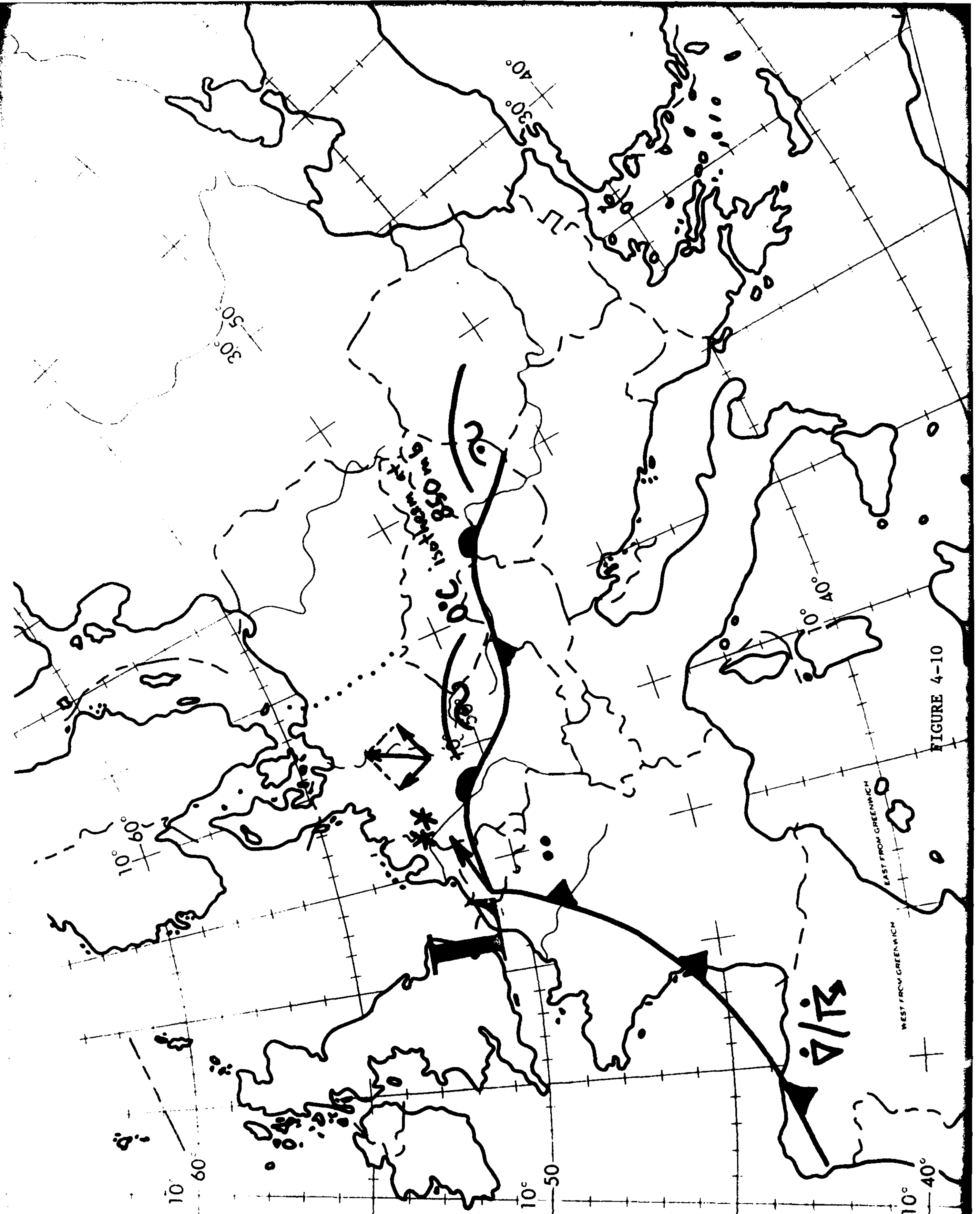


FIGURE 4-10

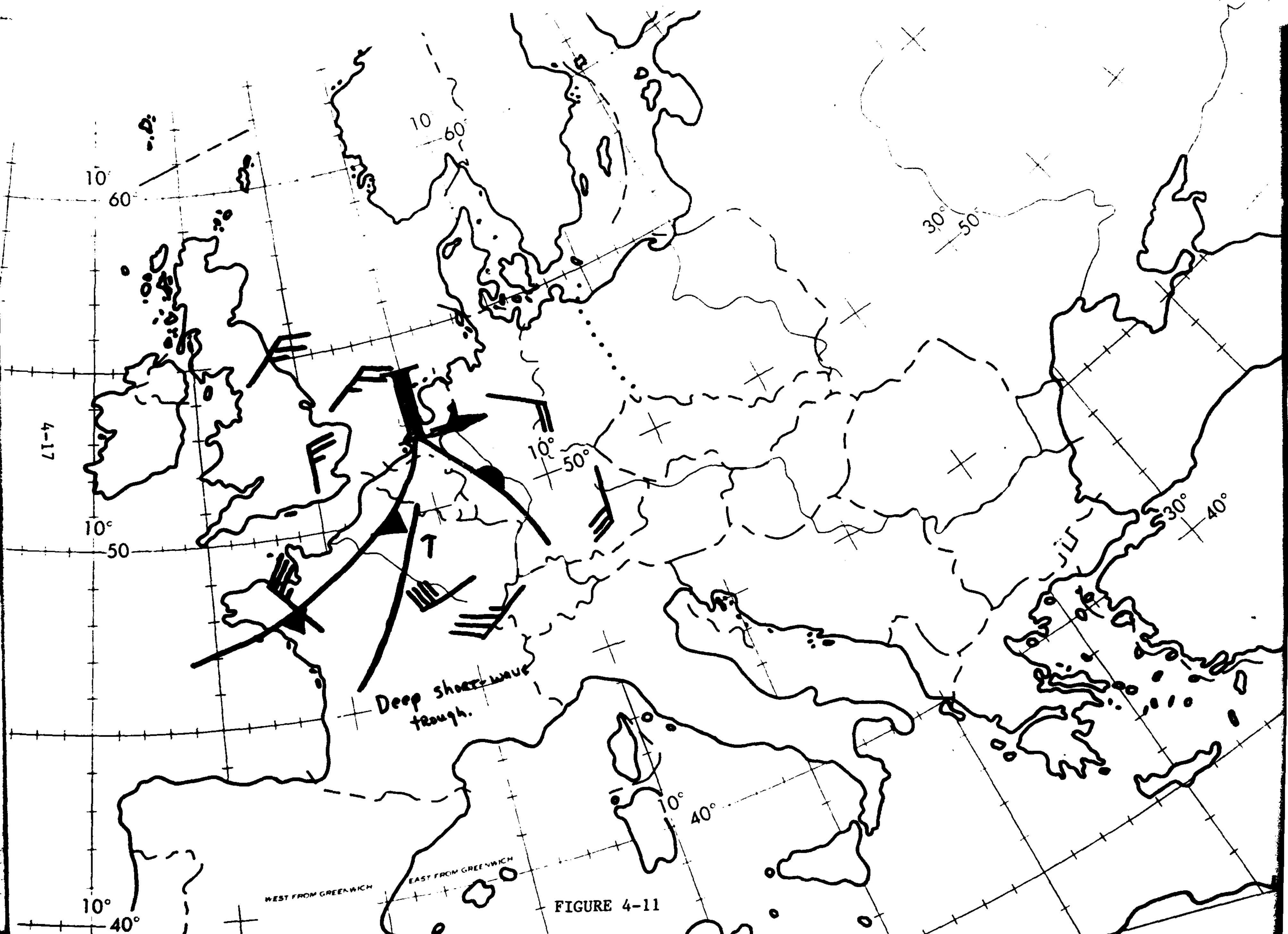

10
60
10
60
30
50
10
50
30
40
10
50
10
40
10
40
T
Deep short-wave trough.
WEST FROM GREENWICH
EAST FROM GREENWICH

FIGURE 4-11

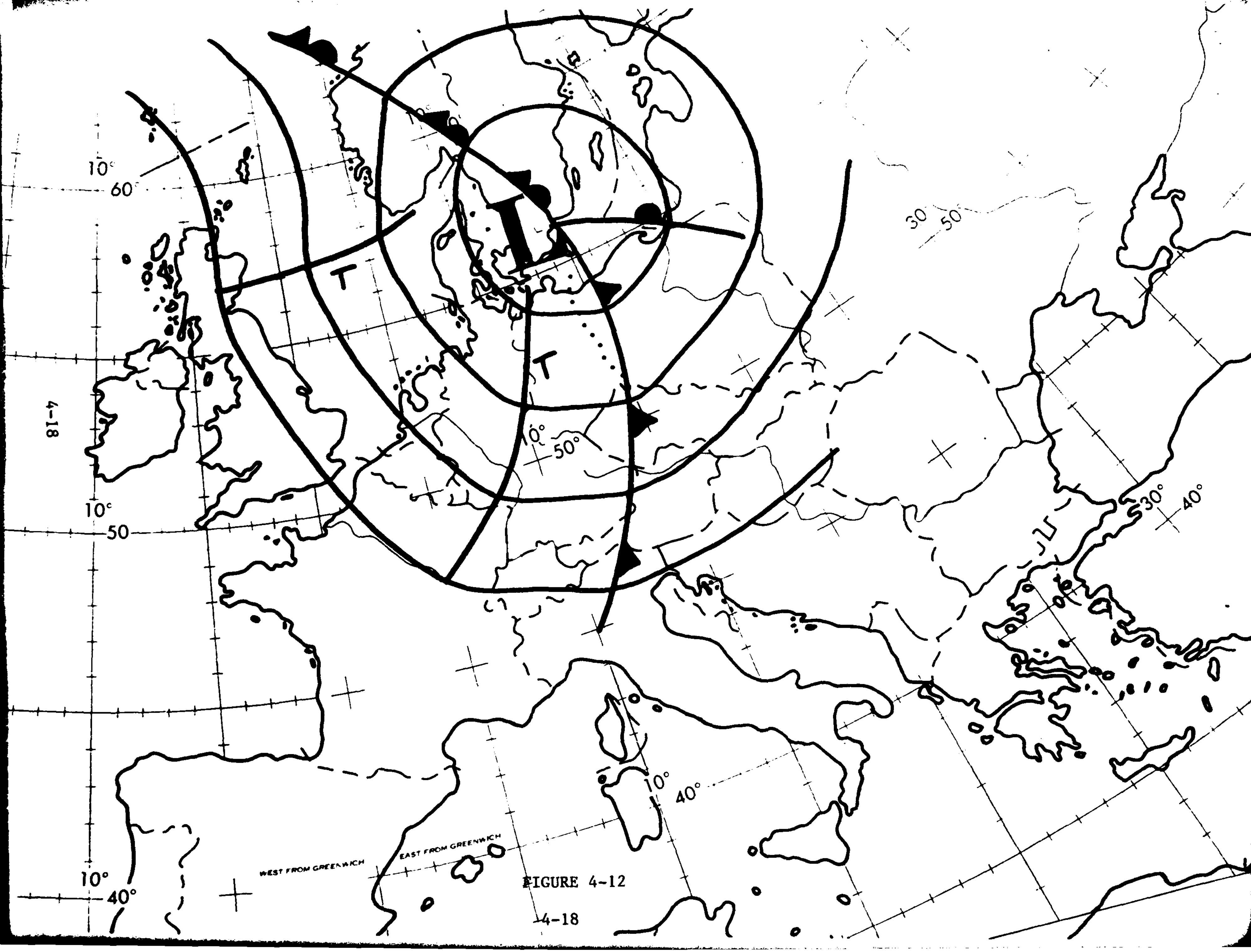


FIGURE 4-12

4-18

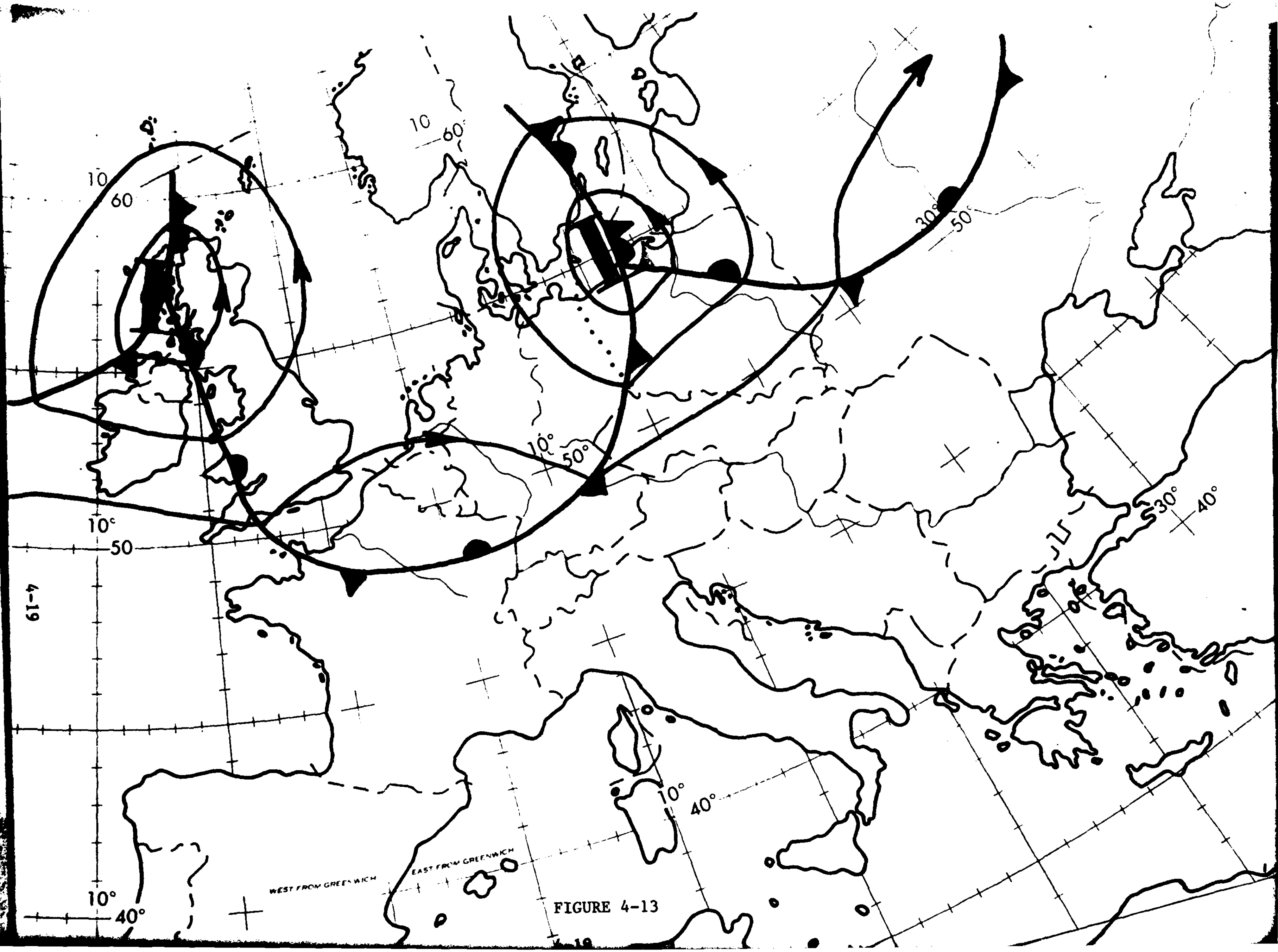


FIGURE 4-13

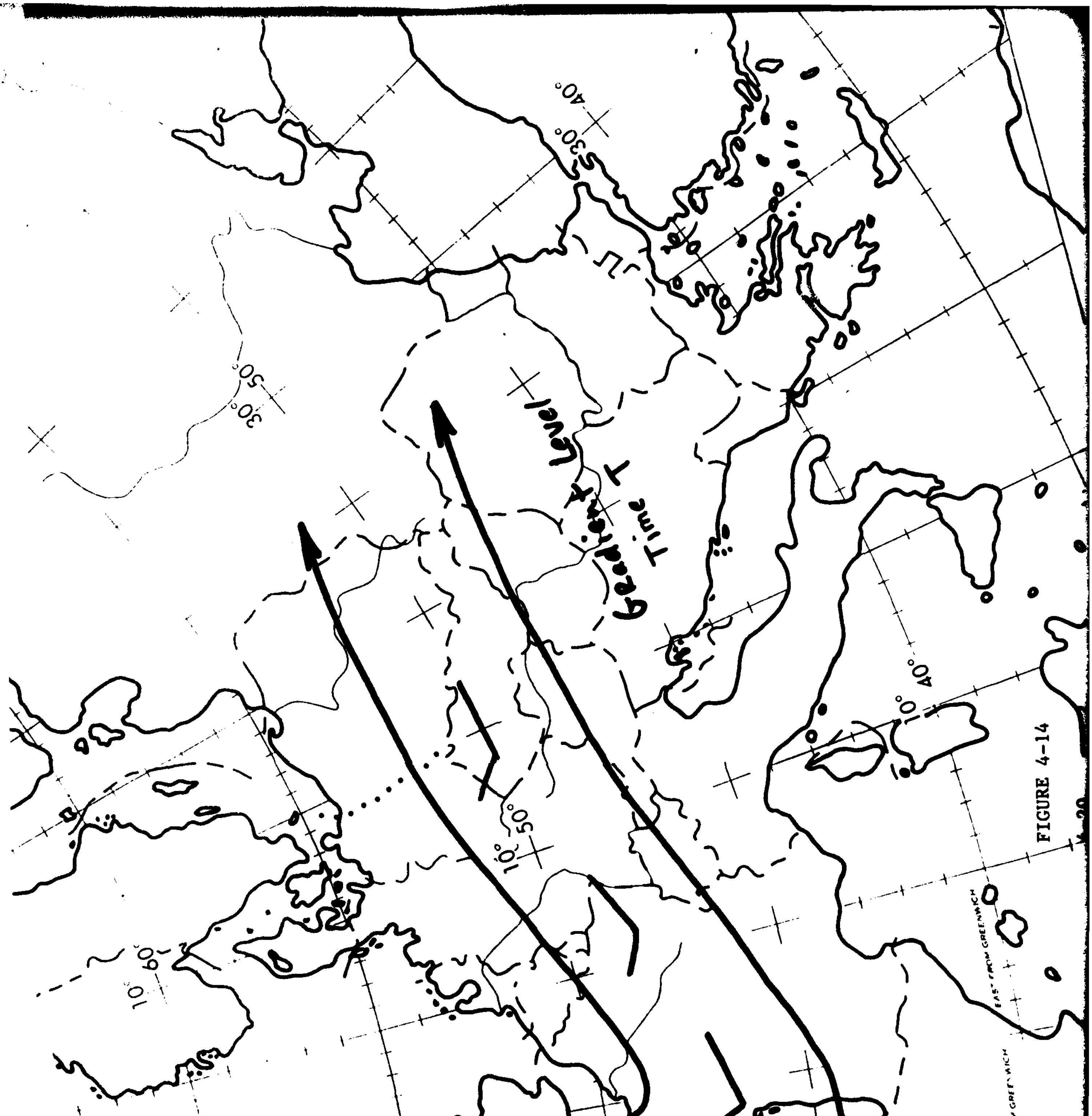

Gradient Level
Time T
EAST FROM GREENWICH
WEST FROM GREENWICH

FIGURE 4-14

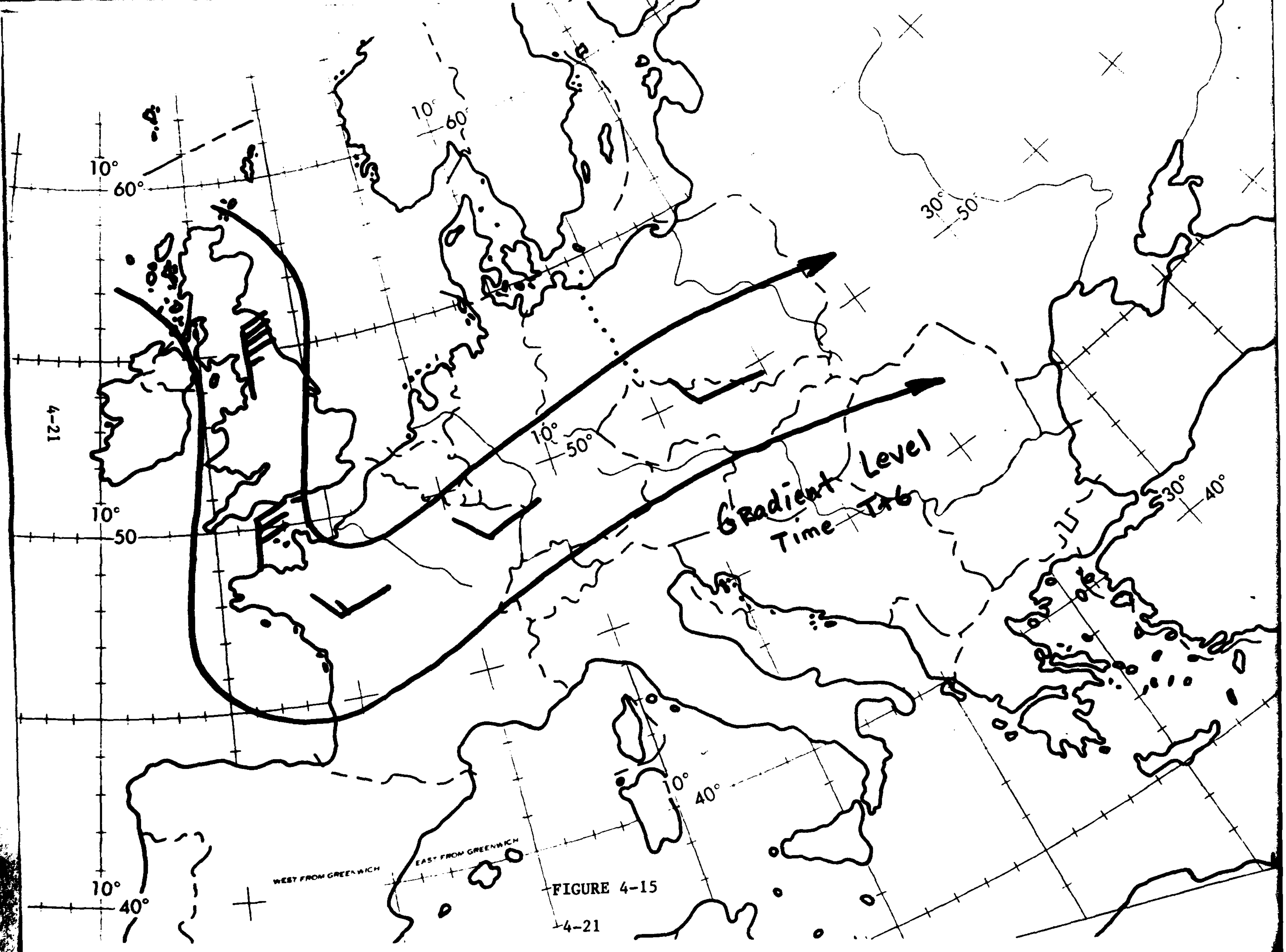


FIGURE 4-15

4-21

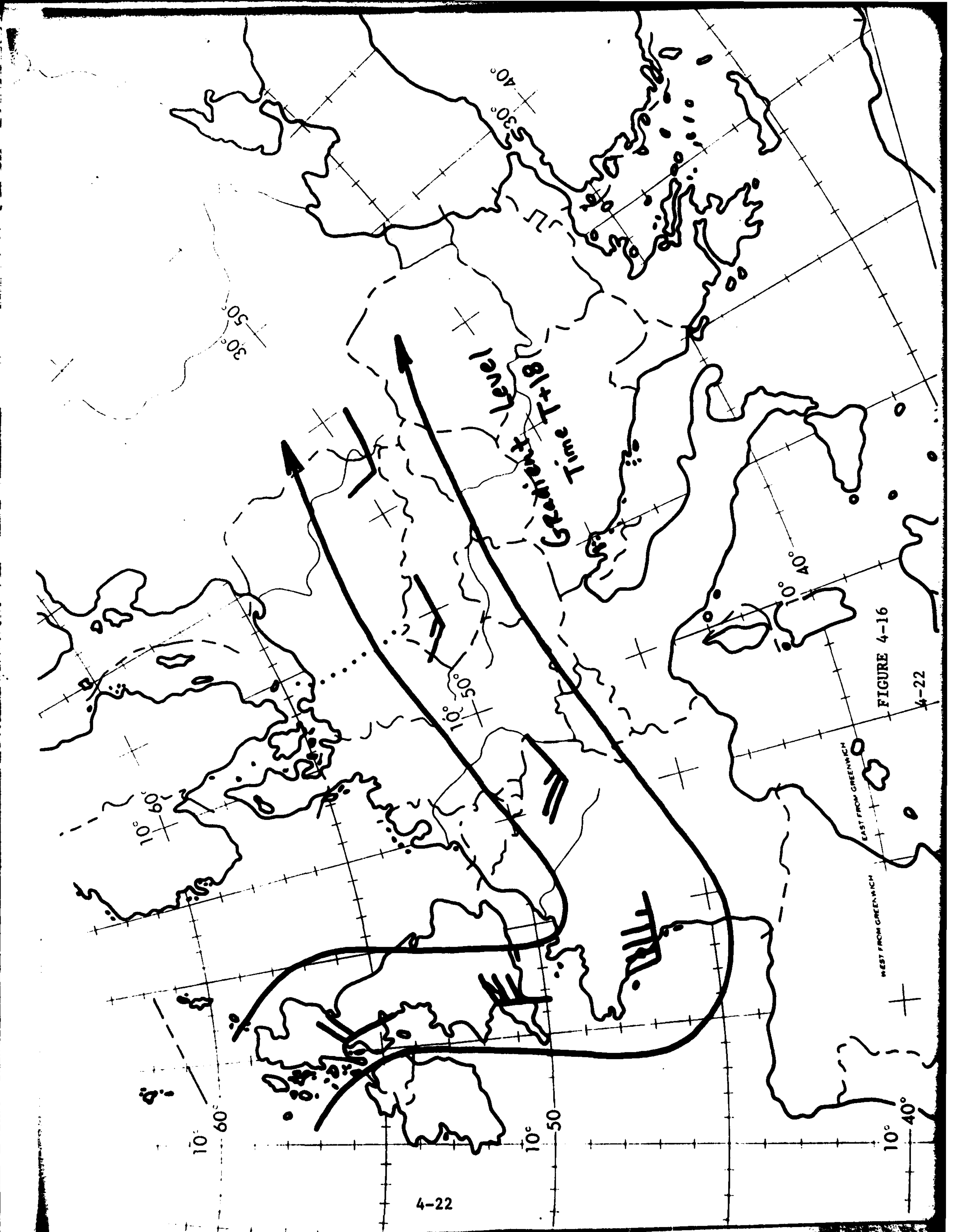


FIGURE 4-16

4-22

WINTER

The Siberian High. The Siberian High expands westward into Europe several times during the average winter. The associated cold front--"a back door cold front"--usually pushes through Germany to become stationary in central France (figure 4-17). This nearly always occurs in conjunction with off-shore blocking (omega high) at 500 mb and a deep cold core low at 500 mb 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 is too shallow to analyze at 850 mb. You can find the frontal inversion on a SKEW-T (usually between 500 to 1,200 feet AGL). The front comes into Germany as a persistent cold easterly wind (8-12 knots). On the first day, skies are clear and visibility is excellent. The second 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. The longer the cold dome sits there, more warm air from the SW moves over it to thicken the cloud deck and increase the chance of precipitation, either snow or freezing rain. When the long wave pattern begins to shift, the Siberian High will recede eastward as a warm front. There will not normally be freezing precipitation associated with this withdrawal, but forecasters need to be on the lookout for this, if the 850 mb temperature reaches 0°C.

High Moving West-East. The weather which most affects flying in Central Europe is fog and when highs move through Central Europe in winter, they almost always produce dense fog. When the flow is anticyclonic, light (under 10 knots on the surface) and westerly (figure 4-18) the conditions are right for fog formation. Due to the low sun angle and short days, there is little, if any, burnoff of the fog. If there's a stratus deck above the fog, then visibility will remain above minimums for only a few hours between 10Z-15Z daily. The worst case is a very pronounced warm pocket generated by a strong subsidence inversion between 900-850 mb. In these cases, the field may well stay below minimums all day, even in spite of 5-7 knot winds form the SW. If the winds shift to the E, as the high tracks eastward, the visibility will improve. Because Hanau is in the valley, some hill stations like Fulda or Wassekuppe may report "good" visibility and clear skies at the same time.

Frontogenesis in Northern Mediterranean. Say the 500 mb long wave trough axis is located near the zero meridian. This causes the major cyclone track to shift to a southwest-northeast orientation. Along this track, a favored area for cyclogenesis is the Gulf of Genoa (figure 4-19), west of Italy. This storm produces the heaviest precipitation in Southern-Central Germany. An indicator of things to come is to watch the Southern (Bavaria) Germany stations. If they all carry steady snow (71SN) for several hours and the snow shield appears to be spreading northward, it's possible that Hanau is in for heavy snow (4-8" or more, depending on the storm track). Watch the surface low carefully; if it tracks due east along the southern Alps into Yugoslavia, we may only get a couple of inches or none at all. But if it turns northward or if it remains quasi-stationary (it'll probably not cross the Alps in Germany, but track through Austria into Czechoslovakia where the mountains aren't as big a barricade), then heavy snow is possible (figure 4-20). Those cyclones which track within seven degrees to the east of Hanau usually produce the heaviest snow fall.

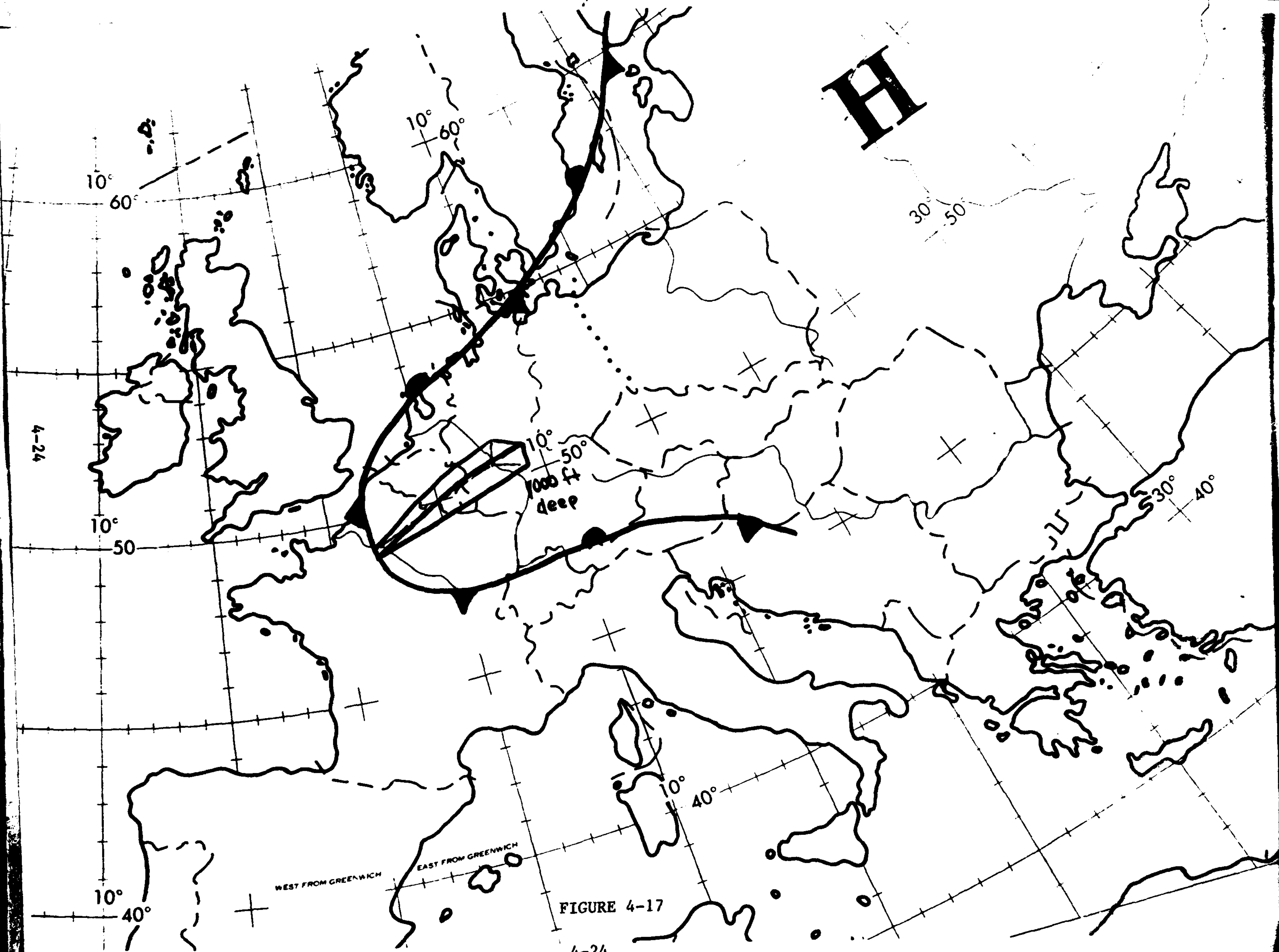


FIGURE 4-17

4-24

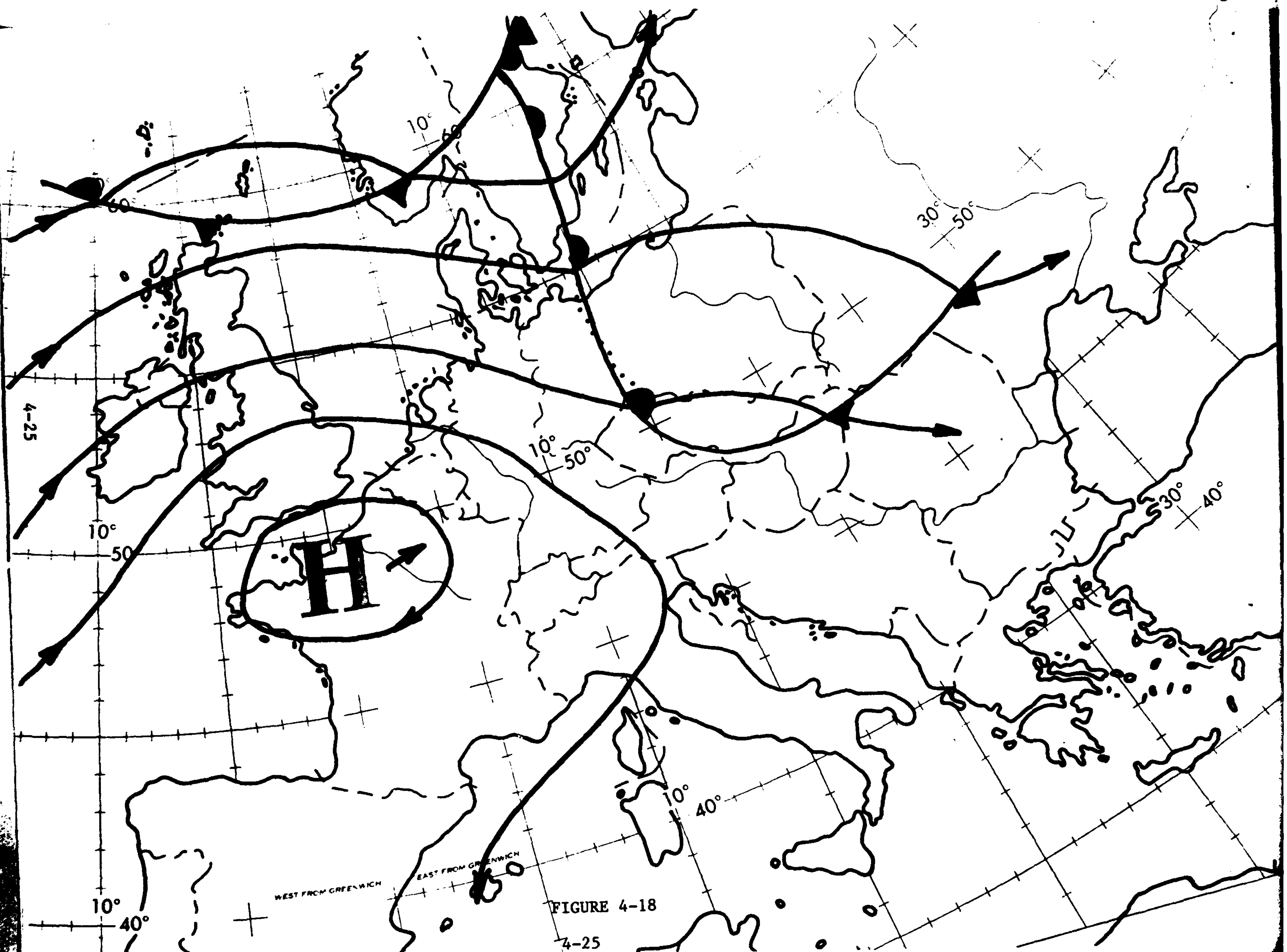


FIGURE 4-18

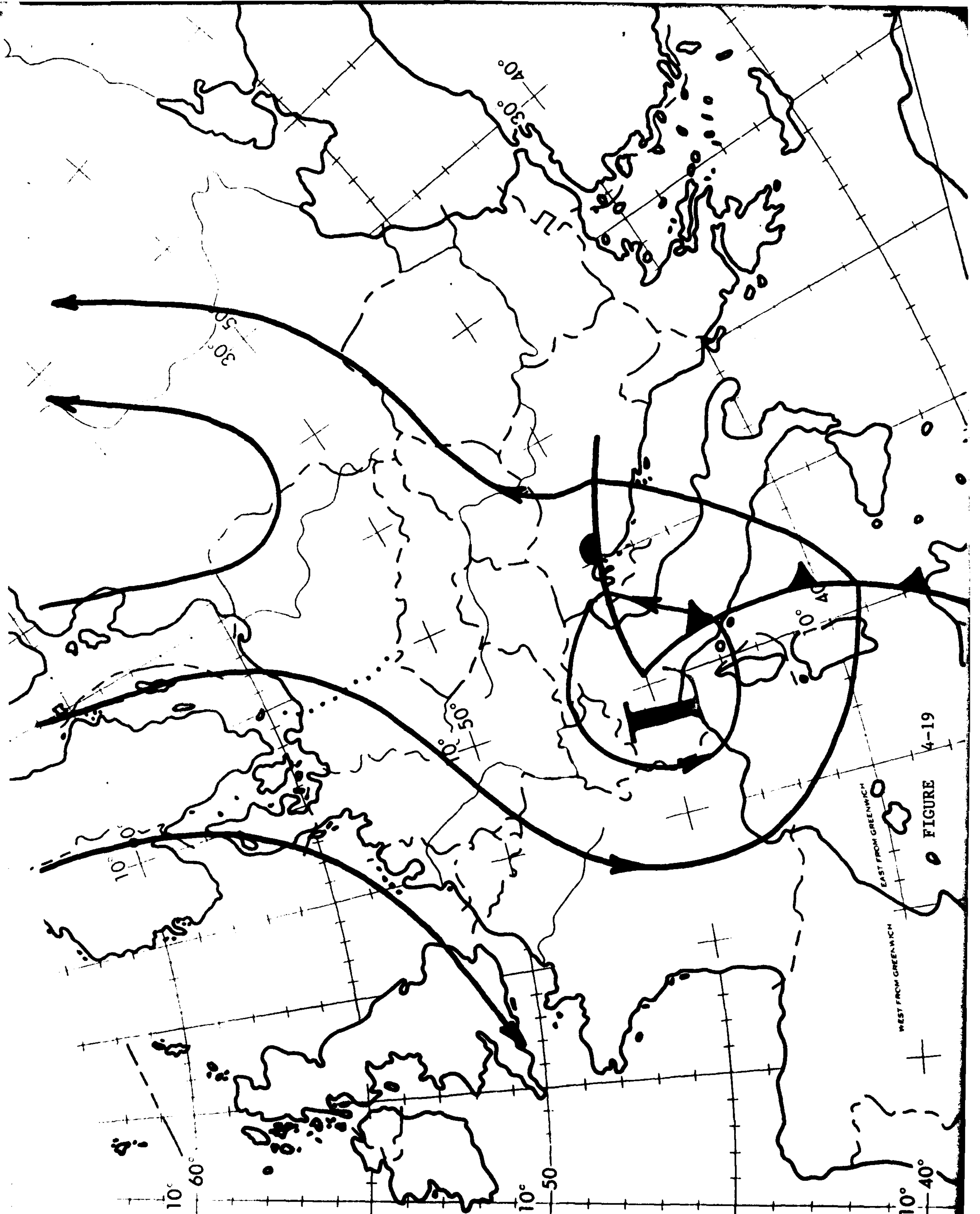
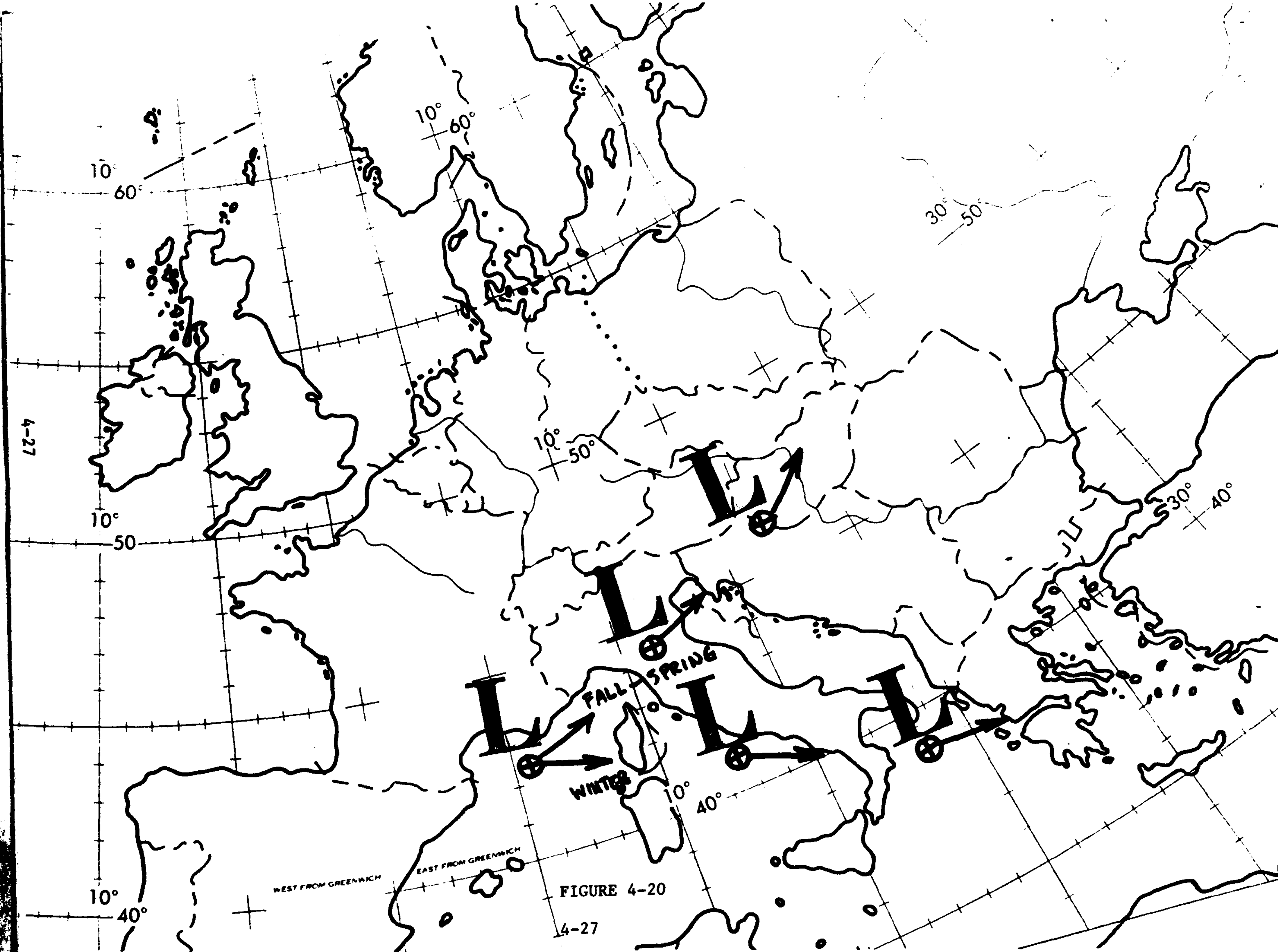


FIGURE 4-19



10°
60°
10°
60°
30°
50°
10°
50°
10°
50
30°
40°
L
L
L
L
L
SPRING
FALL
WINTER
10°
40°
WEST FROM GREENWICH
EAST FROM GREENWICH
10°
40°

FIGURE 4-20

SPRING

Gulf of Genoa Lows. Like the winter situation (figure 4-19), these systems can affect Europe throughout the spring and in fall. The storm tracks are more northerly in the spring and fall due to the more northern position of the polar front, so occasionally, the spring storms drop more precipitation than the winter storms. The position of the 0°C 850 mb isotherm must be closely watched. With sufficient cold air there can be very heavy snowfalls.

Omega Blocking. This is the season with the greatest frequency of blocking situations. Depending on the location of the block, the spring may be wet or dry. When the high moves into Scandanavia and a deep low develops in SW USSR, as well as one in the east Atlantic, our flow will be NE and dry, as in the summer situation described earlier (Spring-Summer of 1976 and 1982). But if the block forms farther west with the long wave trough over Western Europe, and the high over the Norwegian Sea, SE of Iceland, we will have moist, cool NW flow and wet weather (Spring-Summer of 1980). Cloud bases are generally above 2500 feet and visibility fair to good, with showery precipitation.

SEASONAL DISCUSSION

Spring and Summer

a. Pressure Systems. The spring and summer circulation is characterized by the intensification and northward displacement of the Azores High together with the weakening of the Icelandic Low.

b. Air Masses. The principle European air masses are either polar or tropical, and they can have either a maritime or continental source region and/or trajectory. Original characteristics obtained from the source region may be more or less transformed depending on the trajectory the air will follow. A detailed description of European air masses can be found in 2WWP 105-12, Chapter 3, Section E.

c. Fronts. During the summer most fronts lack distinctive upper air support--the 850 mb, 700 mb and 500 mb temperature gradients are weak, there may not be a pronounced 300 mb jet and upper wind flow may not show significant backing. The surface position of the polar front is located farther north usually across the North Sea and Scandanavia and rarely across the Alps. The mean position extends from Iceland to Northern Scandanavia.

d. Temperatures. Rapid warming begins in March and continues until August. In summer, mean daily maximums are in the 70's, with overnight lows in the 50's. Hot weather occurs occasionally with easterly flow. In September, a distinct cooling trend begins.

e. Winds. The low level flow over central and southern Germany is predominantly southwesterly during the summer; however, many localized deviations are created by terrain. Windspeeds generally are the highest in the afternoon, in association with maximum solar heating, and lowest around sunrise. Strong winds (meeting warming criteria) are uncommon but they occasionally occur with thunderstorm activity along a strong polar front.

f. Precipitation. Summertime precipitation over Europe is principally air mass type convective activity. Weak fronts better called troughs and the associated lifting will often produce widespread shower activity. Helicopter pilots can usually maintain VFR in summer rainshowers, but sometimes hilltops do become obscured by the heavier showers.

g. Thunderstorms. Summertime heating results in frequent rain shower activity over the interior region during May through late September, but usually not thunderstorms. On the contrary, thunderstorms are generally associated with troughs or weak frontal systems. Although non-frontal thunderstorms are uncommon, afternoon towering cumulus may develop rapidly over ridge lines due to orographic lifting and cause heavy shower activity with reduced ceilings. Thunderstorms do not build as high as the storms over the southern U.S., and are less severe. During the transitional springtime, while the Icelandic Low is weakening and giving way to the Azores High, major polar outbreaks are not uncommon and can produce Hanau's most severe thunderstorms.

h. Fog and Haze. Poor visibility is common in all seasons in Central Germany, although during May through August, visibility is greatly improved over the winter months. The restriction to visibility is likely to be a thin layer of morning fog that burns off rapidly by midmorning and lifts the visibility above VFR minimums. When the air is dry, and winds are southwesterly, haze can still reduce the visibility greatly in the morning, because of a strong radiation inversion formed at night. As the inversion breaks, the visibility will increase, due to the low-level mixing caused by surface heating. But even turbulent mixing up to 10,000-11,000 feet will not permit the visibility to get better than 5 nm. If there's a strong subsidence inversion, at say, 5,000 feet, the turbulent mixing is reduced and the visibility will stay low, sometimes no better than 2-3 nm. Under this situation, the visibility decreases daily until the subsidence inversion is broken. See Section I for additional comments.

i. Icing. In summer, icing is generally not a problem, because of relatively high freezing levels. Icing is principally associated with convective activity and is usually above the 5000 feet level around rough terrain.

j. Turbulence. Turbulent conditions exist for low level aircraft in the form of thermal or convective updrafts, as well as due to wind conditions in the hills.

Autumn and Winter Weather

a. Pressure Systems. In winter, the Azores High is much less intense while the high pressure system over Asia (Siberian High) sometimes extends as far westward as France and Spain. The Icelandic Low is quite deep and extensive.

b. Air Masses. Air masses, like those during spring and summer, continue to have polar and tropical source regions. The polar air masses are of particular importance and some characteristics are illustrated in the following examples:

(1) Maritime polar is the airmass most often found over Europe. The air mass properties will depend upon the over water trajectory; however, all maritime polar inversions are characterized by their relatively humidities. Since the air is usually warmer than the continent, stable conditions generally prevail. Stratus-type clouds, light rain or drizzle, and moderate to poor visibilities with fog and haze characterize the associated weather.

(2) Continental polar or arctic air invades Germany during periods of easterly flow around an intense Russian or Scandinavian high pressure system. Since continental polar air is cold and dry, one can expect clear skies and good visibilities, but cold surface temperatures, during the first stages. As the anticyclonic circulation becomes more intense, temperature inversions will develop, and visibilities will be reduced in the stable air due to smoke and haze. If cyclonic activity is taking place in the Mediterranean, warm maritime air may overrun the cold polar air causing heavy showfall over Germany.

c. Fronts. During the winter, most cold fronts which invade Europe originate over the North Atlantic and have a long over-water trajectory. The cold air behind cold fronts is modified by the relatively warm Atlantic Ocean to such an extent that in most cases continuity using temperatures is very difficult to maintain on surface analysis. Upon reaching the relatively cold European continent the air which travels behind the cold front is usually warmer than the air over Europe. The cold front loses its characteristics and could be analyzed as an occlusion. Poorest frontal weather conditions are associated with pre warm frontal situations. Ceilings less than 500 feet and a visibility less than 1 mile are common in such situations. East-West lying stationary fronts with a weak westerly flow may also produce low ceilings and visibilities.

d. Temperatures. During autumn and winter, differences between the mean temperatures of the warmest and coldest month is about 20°F. A distinct cooling trend begins in September and by late October daily maximums are generally in the mid 50's with overnight lows in the mid 40's. During winter, the central core of Europe is cold while the north and western part is warm due to the warm ocean currents. The predominant westerly air flow produces relatively mild temperatures. Western Europe is occasionally affected by cold outbreaks from the large cold air mass source region to the east. During winter, the daily maximum temperatures generally range from the mid 30's to the mid 40's and the minimum range from the high 20's to the mid 30's.

e. Winds. The low level flow over Central and Southern Germany is predominantly west-southwesterly in winter, however, local deviations are created by terrain. Quite often, cold frontal passage only changes the wind direction from 230-250° to 260-280°, then it often shifts slowly back, in advance of a new trough or front. Valleys oriented within 20 degrees of the major axis of the air flow tend to channel the wind and may increase its speed to well above 35 knots. Infrequent occurrences of gale force winds are associated with rapidly moving winter time cold fronts so the duration is usually short. At elevations above 1500 feet, gale force winds occur on an average of two or three days a month. Diurnal variation in wind speed is less pronounced in winter at low levels. Wind speeds are generally highest in the afternoon, in association with maximum solar heating, and lowest around sunrise.

f. Precipitation. Fall and winter precipitation falls from stratiform type clouds and is therefore more widespread and persistent, but less intense than in summer. Precipitation, unless very light, will always lower the effective ceiling and reduce the horizontal and slant range visibility. Rain is most frequent throughout the winter but snow does fall 5-6 days per month. Most times, it snows less than 2 inches from a storm. Freezing rain, although not frequent, may occur a few times each year and has to be considered as a principal hazard to aircraft operations.

g. Cloudiness. Due to rugged terrain over Central Europe, the amount of cloudiness and ceilings have a wide variation. The average amount of cloudiness is 70% or greater during the entire year, and 80-90% during the winter. The elevation of the stations and the protection from the prevailing air flow affects the distribution of cloudiness and ceilings. The windward slopes have a greater amount of cloudiness and lower ceilings than the lee sides, and lower ceilings are, of course, observed at stations with higher elevations. Maximum cloudiness and lowest ceilings occur in winter. During the morning, cloudiness is greater than during the afternoon in winter. Over Northern Germany and the Benelux, there is a tendency for low clouds to persist into the afternoon. Stratocumulus clouds associated with high pressure cells are quite persistent in the Ruhr Valley and other Northern German industrial areas. Low ceilings below 1000 feet are frequently observed under such conditions. Low clouds are also observed with slow moving cold fronts approaching Northern Germany and the lowlands from a northerly direction. When these fronts stagnate over the region, low ceilings will persist for days. Very low clouds with continuous precipitation are usually associated with an outbreak of cold, moist air from a northerly direction, especially in the region between Brussels and Cologne. Southern Germany has more than 15 days per month with overcast skies during the winter. The mean cloud amounts are greatest in the morning. Low clouds are predominately stratiform or thick stratocumulus. At the majority of stations in Southern Germany the ceiling is below 2000 feet on more than half of the winter mornings.

h. Thunderstorms. During the winter thunderstorms do occur on rare occasions. It's not unusual for heavier snow showers to be observed from imbedded thunderstorms. Thunderstorms also may only rise to 8,000 - 10,000 feet in very unstable air.

i. Fog and Haze. Winter and autumn are the seasons having the most days with fog. During the period of October through March, fog occurs on an average of 15 to 25 days per month, reducing the visibility to less than 5 miles. In winter the restriction to visibility is likely to be thick fog or dense haze coupled with extensive cloud cover. Due to the low sun angle and short days, little "burnoff" of the fog or haze occurs during the day even when skies are not overcast. It is not unusual for the poor visibility to persist over the entire area for several days during the winter season. High pressure tends to bring the lowest ceiling/visibilities and should not be considered "good weather" systems.

j. Icing. The high frequency of low cloudiness and freezing levels near the surface result in conditions favorable for icing on 15 to 20 days per winter month. About 3/4 of the icing is rime ice while the remainder is normally of the mixed variety. Only in freezing precipitation will purely clear ice be found and then it's often moderate-severe.

k. Turbulence. The main causes of turbulence are the thermal discontinuities (and resulting strong winds) associated with fronts. The hilly terrain over Europe exaggerates the turbulence in the low levels. Terrain influences are one of the prime considerations when pilots try to avoid low level turbulence.

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