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WORLD METEOROLOGICAL ORGANIZATION

MARINE METEOROLOGY AMD RELATED OCEANOGRAPHIC ACTIVITIES

REPORT

No. 13

USER'S GUIDE TO THE DATA AND SUMMARIES OF THE HISTORICAL SEA SURFACE TEMPERATURE DATA PROJECT

Secretariat of the World Meteorological Organization

Geneva, Switzerland

1985

WMO/TD-No. 36

W O R L D M E T E O R O L O G I C A L O R G A N I Z A T I O N

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NOTE

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USER'S GUIDE TO THE DATA AND SUMMARIES OF THE HISTORICAL SEA SURFACE TEMPERATURE DATA PROJECT

C O N T E N T S

PREFACE

The sixteenth session of the WMO Executive Committee (now Executive Council) endorsed, by its Resolution 5 (EC-XVI), the list made by the Advisory Committee of principal research projects in the atmospheric sciences, which included (following the suggestions of Dr. C.H.B. Priestley [Australia]) a project for publishing a volume similar to "World Weather Records" giving historical sea surface temperatures for each month for coastal stations and the open oceans. This project resulted from the need of research workers for such data to intensify research into climatic changes and, on a shorter term, seasonal anomalies in conjunction with the problem of the general atmospheric circulation.

Following a recommendation made by the second session of the Advisory Committee, the seventeenth session of the Executive Committee approved the appointment of a consultant to investigate the data availability and to evaluate the task of analyzing the data preserved by various Members. The consultant appointed, Mr. G. Verploegh, made a survey which covered not only sea surface temperature data but, at the recommendation of the Commission for Aerology (now Commission for Atmospheric Sciences), other parameters such as air temperature, humidity and wind.

The consultant's report, submitted to the third session of the Advisory Committee, concluded that it was essential to use the ships' data collected by the four Members, viz the Federal Republic of Germany, Netherlands, United Kingdom and the United States of America, that these Members should be involved in the execution of the project, and that the project should cover the period 1860-1960. (After 1960, data is collected and summaries prepared under the WMO Marine Climatological Summaries Scheme.) The eighteenth session of the Executive Committee approved the recommendation of the Advisory Committee regarding the production and publication of historical records for sea surface temperature, mean wind speed and direction and humidity. The Executive Committee further requested the Secretary-General to discuss the implementation of the project with the four Members concerned and, if they were willing to participate, to proceed with this implementation. In response to the Secretary-General's approach, the four Members concerned agreed to undertake the task and to finance their part of the project from national funds.

The lengthy and time-consuming task which followed that agreement, involving the archival, quality control and processing of the data for the respective areas of responsibility (viz: Federal Republic of Germany - Atlantic Ocean; Netherlands - Indian Ocean and Mediterranean Sea; United States of America - Pacific Ocean), has now been completed. The summaries have become available progressively over the past ten years, and microform copies of both data and summaries may now be obtained from the participating Members.

A final meeting of experts on the Historical Sea Surface Temperature (HSST) data project took place in 1984. This meeting reviewed the status of the various HSST data set holdings, clarified the situation concerning formats and procedures for the provision of both basic HSST data and summaries, and undertook an extensive revision of the draft User's Guide, which it recommended for publication. At the same time, the meeting placed on record its appreciation to all those who had worked so hard over the years in

bringing this project to successful fruition, and particularly to Dr. O. Höflich (Federal Republic of Germany) who had played a major role in the project from its very inception.

Although the HSST Data Set has, in general, now become a part of larger climatological data sets, and both the basic data and summaries have been used for some years in a variety of research and services applications, it has nevertheless been felt by many that a user's guide to the data and summaries would be a very valuable publication. In particular, such a guide, as well as providing basic information on data holdings and formats, should also contain valuable documentation on archival and quality control procedures.

A first draft of the user's guide was consequently prepared by Mr. D.J. Painting (United Kingdom), and considerable appreciation is due to him for his efforts in this regard. As indicated above, this draft guide was subsequently extensively revised by the meeting of experts in 1984, and it is this revised version which is published hereunder. This publication represents a fitting culmination of and tribute to the success of the whole project, and it is hoped that it will stimulate further and continuing applications of the data set.

USER'S GUIDE TO THE DATA AND SUMMARIES OF THE HSST DATA PROJECT

INTRODUCTION

1.1 For more than one hundred years ships of the voluntary observing fleets and more recently ocean weather ships have observed and recorded meteorological data from the oceans of the world. The Historical Sea Surface Temperature Data (HSSTD) Project was set up originally to collect all available sea surface temperature records held by the major maritime nations for the period 1860-1960. These data were to be published in summary form for selected representative areas complemented by summary data for air temperature, surface wind speed and direction (Verploegh, 1966). (See Annex I for a history of the project.)

1.2 Selection of representative areas posed many unsolved problems (see Paragraph 2.2) leading finally to the decision to select more or less arbitrary areas covering nearly all the seas of the globe. The consequent volume of tabular data necessitated the production of final summaries in 35 mm microfilm or microfiche form. The summaries are also available on magnetic tape if preferred in this form by the user.

PROCESSING OF THE SUMMARIES

2.1 Organization of the summary data

The basic division of summary data is by "areas of responsibility". There are thus three sets of information comprising the total data set according to the areas designated in Figure 1. With the United Kingdom contributing with data from all oceans, the areas comprise:

(i) The "Pacific" region collected and summarized by the U.S.A.;

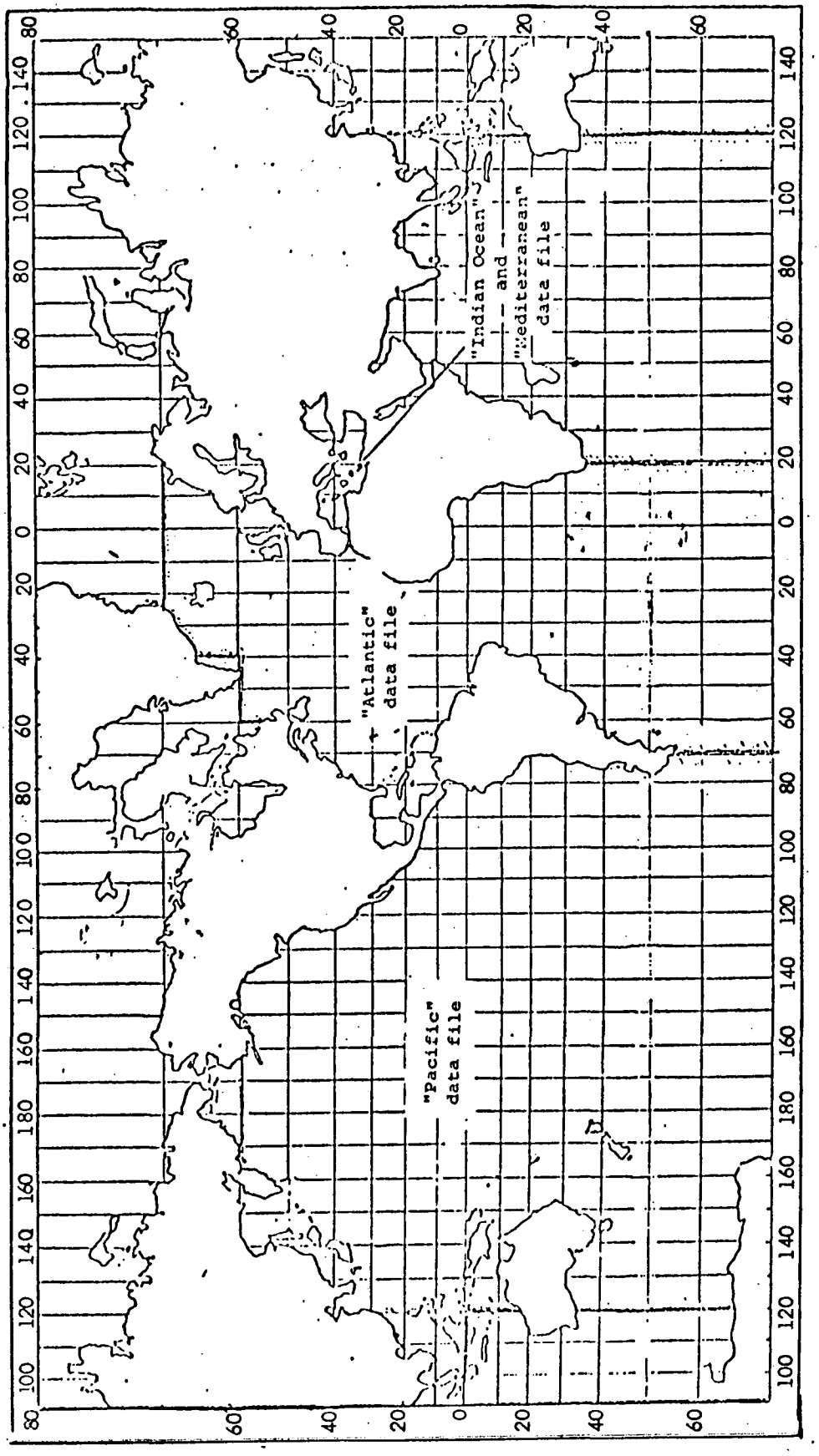
(ii) The "Atlantic" region collected and summarized by the Federal Republic of Germany;

(iii) The "Mediterranean and Indian Ocean" region collected and summarized by the Netherlands.

2.2 Representative areas

Within each ocean region areas have been chosen as far as possible to avoid major inhomogeneities. This has been largely a subjective exercise and the areas finally chosen are generally of the order of 5°latitude by 10° of longitude, but range from 1° latitude by 2°longitude where observations are relatively dense, to 10° of latitude by 60° of longitude in the southernmost data sparse areas. Charts showing the chosen representative areas are given in Annex II.

Figure 1 - Areas covered by the three HSST data set files



It is probable that a significant inhomogeneity exists within some of the areas chosen. Some results of a study carried out in the U.S.A. (Quayle, 1973) which tested, inter alia, the means and variances of sea surface temperature in adjacent 1° squares within a selected Marsden square (MS 077) revealed significant differences in many cases. In order to finalize the project in a reasonable time, attempts to overcome these problems by objective means were discontinued.

2.3 Variables selected for inclusion in the summary tables

Summaries were produced using all observations containing at least one of the following elements and satisfying the initial quality control checks:

Sea surface temperature
Air temperature
Wind speed
Wind direction.

These variables were chosen because they were considered to have been consistently sampled throughout the period. Besides these elements, the following elements are also included in the data sets for the Atlantic and Indian Oceans:

Wet (ice) bulb temperature
Total cloud amount
Air pressure
Quality control flags.

Additional information on the basic data sets is given in Annex II.

DESCRIPTION OF THE SUMMARY TABLES

3.1 Sea surface temperature

Sea surface temperature measurements by bucket only were selected for the summaries. Table 1 shows a typical arrangement for a partial excerpt of the record. The sea surface temperatures were grouped by area for all years and months within years. The first year included was that for which data were available.

The data tabulated are as follows:

ST - mean value (in degree Celsius to tenths) using the formula

$$ST = \frac{\Sigma x}{N} \qquad (x = \text{individual value})$$

SD - standard deviation (in degree Celsius to tenths) using the formula

$$SD = \left\{ \frac{N\Sigma x^2 - (\Sigma x)^2}{N(N-1)} \right\}^{1/2}$$

N - number of observations

The above values were calculated for each available month, for all months in each year and finally, at the foot of the table, for all months and years. Additionally, the penultimate line headed 'MO' gives the mean ST and standard deviation SD computed from the monthly means, and the number of months N used in the computation. For the Atlantic Ocean, this parameter contains decadal means, headed DEC.

3.2 Position and time of observations of sea surface temperature

Table 2 lists the following parameters for a partial excerpt of the record:

LA - Mean latitude (degrees to tenths) and

LO - Mean longitude (degrees to tenths) of position of the sea surface temperature observations.

Note that when the resolution of the original observation is no more detailed than whole degrees, the central point of the one degree square has been used for the computations.

NS - Number of one degree squares within the area containing sea surface temperature observations;

MD - Mean day of month of sea surface temperature observations (whole days);

ND - Number of days within the month containing sea surface temperature observations.

3.3 Air temperature

Table 3 shows the layout of the air temperature summaries. Data tabulated are:

T - Mean value (in degree Celsius to tenths);

SD - Standard deviation (in degree Celsius to tenths);

N - Number of observations.

Annual and all year summaries are tabulated as for those of sea surface temperature in Table 1.

3.4 Wind data

The final Table (Table 4) lists the following parameters:

SW - Scalar mean wind speed

$\bar{V}$ - Resultant mean wind speed

u - East/west component of wind speed (east is positive)
$= S \cos \Theta = S \cos (270° - \psi) = -S \sin \psi$

Table 1 - AREA 00003
MONTHLY MEAN AND STANDARD DEVIATION OF SEA SURFACE TEMPERATURE
(DEGREES CELSIUS)*

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1932	ST										5.8			5.8
	SD										1.2			1.2
	N										33			33
1933	ST	3.2	3.2	2.2	2.7	3.9	4.5	8.3	9.0	9.2	7.3	5.1	4.2	5.7
	SD	.6	.4	1.7	.7	.8	2.6	1.4	.7	.8	1.0	1.2	.7	2.8
	N	13	5	27	7	15	89	61	24	12	36	22	14	325
1934	ST	3.6	2.8	2.7	2.8	3.5	6.3	8.5	10.2	9.7	8.0	5.0	3.2	5.9
	SD	.6	1.3	.8	.8	1.0	1.0	1.4	1.4	1.2	1.2	1.2	1.1	3.3
	N	28	24	54	14	46	4	33	61	67	21	54	40	446
1935	ST	1.6	2.0	2.1	3.5	4.1	5.9	7.3	11.3	9.4	8.5	5.5	5.2	6.2
	SD	2.1	.0	1.9	.7	1.5	1.7	1.8	1.7	.7	1.3	1.4	.8	3.8
	N	26	4	22	15	41	12	23	51	10	24	6	10	244
1936	ST	2.9	2.3	1.7	4.4	3.4	6.3	9.4	10.6	10.7	7.8	5.2	4.5	7.2
	SD	1.0	.9	1.5	1.2	.5	3.9	2.5	2.1	2.2	1.1	.8	.8	4.0
	N	24	33	54	16	11	81	153	66	45	27	9	6	525
1937	ST	3.4	1.7	2.2	2.8	3.2	4.6	8.0	10.7	9.2	7.8	5.8	5.3	6.2
	SD	1.5	1.9	1.0	.9	1.1	2.0	1.9	1.6	1.3	.6	1.4	.8	3.1
	N	11	30	25	22	153	593	423	205	14	13	9	6	1504
1938	ST	2.6	-	.3	.0	3.5	6.0	8.4	10.6	9.8	7.1	6.5	3.5	6.5
	SD	1.1		2.2	1.7	1.1	2.1	2.4	2.3	1.6	1.3	.7	.7	3.2
	N	12		10	24	47	364	145	56	18	9	2	2	701
1939	ST	3.8	3.0	2.3		3.1	4.7	9.9	13.1	11.9	7.2	5.7	2.2	8.4
	SD	.5		1.2		1.0	2.1	2.5	3.0	1.7	2.6	.6	1.5	4.6
	N	4	1	24		171	1604	693	1255	133	10	3	15	3924
1940	ST	3.2	.3	2.2	3.0	2.1	4.5	9.0	10.7	10.1	6.2	6.1	4.1	5.6
	SD	.7	1.2	.6	.0	1.9	2.7	2.1	1.8	1.5	1.6	1.8	.7	3.7
	N	19	15	20	3	158	379	188	91	16	22	12	12	933
1941	ST	1.9	3.0	2.2	2.4	2.9	4.8	10.3	11.7					7.1
	SD	2.0	1.0	1.0	1.1	1.3	2.0	3.6	1.7					4.2
	N	33	21	31	8	104	484	328	215					1224
1950	ST									9.0	7.0			8.0
	SD													1.4
	N									1	1			2
1951	ST					5.5		6.0		11.4				9.3
	SD					.7				.9				3.1
	N					2		1		5				8
1952	ST		1.0	2.6	2.6	3.4	4.6	7.0	8.9	9.8	8.0			5.2
	SD			.7	.7	.7	.6	1.8	1.2	.5	1.0			2.0
	N		1	11	8	625	796	802	45	4	3			2295
1953	ST			.5		4.3	5.3	8.7	9.8	1.0			3.9	7.3
	SD			.7		.7	.7	2.2	.5				.1	2.7
	N			2		24	57	90	38	1			3	215
1956	ST						5.5							5.5
	SD						.3							.3
	N						5							5
1958	ST				3.9									3.9
	SD				.0									.0
	N				2									2
1959	ST							6.7						6.7
	SD							.1						.1
	N							2						2
MO	ST	2.5	1.8	2.1	2.4	3.5	5.1	8.6	10.4	9.5	7.3	5.1	3.8	5.8
	SD	1.2	1.1	.7	1.5	.6	.7	1.0	1.1	1.0	1.0	1.1	.9	1.5
	N	9	8	15	7	17	12	16	15	11	11	5	7	41
ALL	ST	2.6	1.9	2.2	2.3	3.3	4.8	8.6	11.9	10.0	7.2	4.9	3.7	6.7
	SD	1.9	1.6	1.3	1.6	1.2	2.0	2.6	2.8	2.1	1.6	1.4	1.2	3.8
	N	250	244	443	250	1577	4667	3127	2344	515	329	204	203	14153

* ST = SEA SURFACE TEMPERATURE SD = STANDARD DEVIATION N = OBSERVATION COUNT

Table 2 - AREA 00004
POSITION AND TIME OF OBSERVATIONS WITH SEA SURFACE TEMPERATURE*

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1951	LA	50.3	50.5	50.8	50.6	51.2	51.0	51.1	50.0	51.2	50.1	50.9		51.0
	LO	162.3	164.3	169.7	164.0	170.5	167.5	170.0	162.1	169.0	165.6	167.4		168.4
	NS	2	6	10	11	20	12	23	1	22	5	10		
	MD	4	17	6	24	16	25	14	21	11	14	15		175
	ND	2	4	3	4	12	5	7	1	9	2	4		53
1952	LA	50.2	50.9	51.6	51.1	51.3	51.5	51.5	51.2	51.4	51.7			51.4
	LO	176.9	170.5	170.3	169.0	169.9	169.0	169.6	168.5	169.5	167.4			169.3
	NS	1	3	28	36	22	31	24	7	24	23			
	MD	6	16	13	19	18	13	12	13	16	23			163
	ND	1	2	10	10	13	14	10	4	9	8			81
1953	LA			51.0	54.6	55.0	55.4	55.3	53.9		51.1			54.7
	LO			167.0	164.6	163.7	163.3	162.9	165.8		167.4			164.0
	NS			14	14	21	30	24	30		15			
	MD			15	25	16	15	15	6		12			172
	ND			7	13	31	30	31	15		4			131
1954	LA	50.4				52.7	50.9			50.0			50.2	50.6
	LO	163.6				160.7	166.9			162.5			167.7	165.9
	NS	3				1	9			3			9	
	MD	15				20	9			12			22	215
	ND	2				1	3			1			4	11
1955	LA		50.0		50.3								50.0	50.2
	LO		160.0		160.0								162.4	165.7
	NS		1		7								3	
	MD		15		9								3	159
	ND		1		3								1	5
1956	LA						51.1							51.1
	LO						169.5							69.5
	NS						24							
	MD						20							172
	ND						5							5
1957	LA									55.9		51.1		53.2
	LO									163.6		168.2		166.2
	NS									7		9		
	MD									17		23		298
	ND									5		3		8
1958	LA				50.3									50.3
	LO				169.6									169.6
	NS				12									
	MD				.28									118
	ND				4									4
1959	LA			50.8				50.7						50.7
	LO			169.9				170.8						170.3
	NS			8				8						
	MD			25				19						142
	ND			3				2						5
1960	LA												50.0	50.0
	LO												172.4	172.4
	NS												2	
	MD												22	357
	ND												2	2
ALL	LA	51.3	51.4	51.5	51.6	51.9	52.8	52.2	51.4	51.3	51.3	51.3	51.3	51.7
	LO	169.2	169.0	169.6	168.8	168.3	167.1	168.4	168.9	169.1	169.0	169.0	169.0	168.7
	NS													
	MD	15	16	16	16	17	16	15	16	15	15	16	15	180
	ND	31	29	31	30	31	30	31	31	30	31	30	31	366

* LA = LATITUDE LO = LONGITUDE
NS = NUMBER OF ONE DEGREE SQUARES CONTAINING SEA SURFACE TEMPERATURE DATA
MD = MEAN DAY OF THE MONTH ANNUAL MEAN DAY IS JULIAN DAY
ND = NUMBER OF DAYS HAVING SEA SURFACE TEMPERATURE DATA

Table 3 - AREA 00004
MONTHLY MEAN AND STANDARD DEVIATION OF AIR TEMPERATURE
(DEGREES CELSIUS)*

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1953	T			3.1	2.4	5.9	8.4	12.5	11.1	9.3	8.2	4.4	2.6	8.5
	SD			1.5	2.2	2.6	2.6	2.6	1.8	.2	1.3	.8	1.0	4.0
	N			16	42	109	123	128	80	7	20	16	3	544
1954	T	1.9	.0	4.2	3.8	8.9	6.2			12.4	6.1		.9	4.1
	SD	2.3		.4	.4		.8			.3	.0		1.2	3.3
	N	15	1	3	6	1	15			3	2		9	55
1955	T		3.9	3.4	1.4			6.9					5.1	4.3
	SD			.8	.5			.7					.6	2.3
	N		1	6	7			9					3	26
1956	T						6.5							6.5
	SD						1.0							1.0
	N						31							31
1957	T						8.7	8.9	12.2	8.9	10.0	4.9	3.7	7.1
	SD						.8		.0	3.7	1.6	1.1	1.2	3.2
	N						4	1	2	6	2	9	4	28
1958	T			8.3	4.6				10.4					6.8
	SD				.8				.8					2.9
	N			1	12				7					20
1959	T			3.3				8.9						7.2
	SD			.6				1.2						2.8
	N			8				18						26
1960	T			2.9	2.3	4.0	6.2	10.8	9.9				4.0	5.3
	SD			2.7	1.0	.8	1.1	.7	.7				1.2	3.0
	N			7	11	21	16	7	6				2	70
MO	T	2.5	2.7	2.4	3.0	4.6	6.8	9.1	10.5	10.2	7.1	5.0	3.2	5.9
	SD	1.6	1.0	1.0	1.1	.9	1.3	1.1	1.1	1.1	1.3	1.1	1.0	1.4
	N	31	31	36	39	43	42	41	32	35	32	32	30	56
ALL	T	2.5	2.5	2.5	3.2	4.7	7.0	9.3	10.7	10.4	7.2	5.1	3.3	5.9
	SD	2.5	1.9	2.2	1.9	1.9	2.0	2.0	1.9	1.9	2.4	2.0	1.9	3.6
	N	1247	1243	1737	1738	2236	2440	2086	1616	1618	1581	1399	1203	20144

* T = AIR TEMPERATURE SD = STANDARD DEVIATION N = OBSERVATION COUNT

Table 4 - AREA 00004
MONTHLY MEAN SCALAR WIND SPEED (MPS), VECTOR MEAN WIND SPEED (MPS) AND RESULTANT DIRECTION (DEGREES)*

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1938	SW	8.8	9.2	13.1	6.4	4.4	3.8	5.7	7.5	7.1	12.1	13.7	9.5	7.0
	V	4.9	5.5	9.7	2.0	.3	1.4	4.8	5.4	3.7	8.1	9.5	4.8	2.5
	D	333	79	261	193	224	293	242	199	313	277	220	213	242
	N	8	22	59	106	149	147	4	59	25	34	35	36	684
1939	SW	7.8	10.3	7.7	8.8	5.2	5.4	6.4	6.7	6.7	8.0	11.9	8.0	7.4
	V	3.1	7.6	2.1	5.9	3.1	1.5	4.4	4.6	2.4	1.6	7.2	3.8	2.4
	D	67	212	11	254	323	165	244	268	255	230	288	20	266
	N	57	41	98	148	119	86	94	85	82	60	44	36	950
1940	SW	6.8	6.8	7.0	8.6	6.5	5.8	6.5	7.6	8.6	9.2	10.8	7.4	7.8
	V	1.4	3.6	2.7	1.2	2.0	.7	5.3	3.0	3.5	5.7	1.4	1.0	1.5
	D	46	69	4	358	310	111	221	304	243	295	291	16	293
	N	67	33	90	46	94	71	83	43	68	107	101	46	849
1941	SW	7.4	10.3	8.6	7.9	7.3	4.8	5.0			19.8	6.6		7.7
	V	3.5	3.3	3.1	3.8	3.3	2.7	2.3			14.8	2.2		.8
	D	47	184	269	313	262	35	31			73	10		342
	N	50	68	69	34	32	50	42			5	8		358
1950	SW									6.8	12.8	10.7		10.7
	V									4.4	11.6	9.0		5.6
	D									276	273	81		277
	N									10	19	7		36
1951	SW	6.9	8.2	7.1	8.8	7.4	7.9	8.2	6.7	10.3	13.7	8.3		8.5
	V	4.3	6.3	2.8	1.9	5.6	5.8	5.3	6.7	2.9	13.5	6.1		3.5
	D	186	225	62	250	236	229	215	191	290	106	183		223
	N	2	11	10	12	33	14	33	1	28	5	10		159
1952	SW	1.0	10.8	8.3	10.9	7.4	9.9	6.0	7.1	4.7	13.4			8.8
	V	1.0	10.7	3.4	6.6	4.4	5.1	3.5	6.1	2.9	7.7			4.2
	D	90	234	236	265	244	224	227	225	21	237			245
	N	1	3	39	48	31	42	25	7	30	26			252
1953	SW			6.2	5.5	4.0	3.8	2.7	8.9	6.0	11.8	9.5	14.4	5.2
	V			3.5	4.1	.4	.9	.9	5.4	4.7	8.6	7.1	11.3	1.9
	D			329	327	14	252	339	238	296	275	284	35	281
	N			16	42	108	129	122	79	17	29	16	4	562
1954	SW	8.7	19.0	6.7	7.8	2.6	11.2			6.0	13.9		7.9	9.2
	V	2.3	19.0	6.2	2.6	2.6	4.2			5.8	13.9		7.7	2.5
	D	71	135	64	150	202	64			175	22		333	51
	N	15	1	3	6	1	15			3	2		9	55
1955	SW			8.3	4.5			7.0					6.9	6.4
	V			4.8	3.7			6.3					6.7	2.8
	D			158	47			218					169	181
	N		1	6	7			9					3	26
1956	SW						4.7							4.7
	V						3.2							3.2
	D						263							263
	N						31							31
1957	SW						2.8	4.6	8.0	8.7	9.3	13.4	11.6	9.6
	V						2.2	4.6	7.9	6.9	9.3	12.0	11.5	4.7
	D						9	300	206	11	220	242	320	276
	N						4	1	2	7	2	9	4	29
1958	SW			9.3	8.1				4.4					6.8
	V			9.3	6.8				3.6					2.8
	D			210	113				291					123
	N			1	12				7					20
1958	SW			9.1				7.8						8.2
	V			3.8				6.0						4.3
	D			10				277						293
	N			8				18						26
1960	SW			5.4	14.2	9.9	9.5	7.4	9.2				4.6	9.6
	V			2.5	6.1	7.1	4.8	6.2	7.2				4.5	3.3
	D			83	332	264	171	231	276				355	259
	N			7	11	21	16	7	6				2	70
ALL	SW	9.7	9.5	9.1	9.1	7.1	5.1	5.9	6.7	8.3	10.5	10.7	3.4	8.1
	V	.9	1.2	2.0	2.8	1.5	1.0	2.8	2.7	2.4	4.6	4.4	1.5	2.1
	D	200	192	252	268	284	265	237	244	246	287	262	244	257
	N	1273	1253	1774	1751	2229	2438	2098	1614	1620	1618	1413	1250	20331

* SW = MEAN SCALAR WIND SPEED V = VECTOR MEAN WIND SPEED D = RESULTANT DIRECTION
N = OBSERVATION COUNT

v = North/south component of wind speed (north is positive)
$= S \sin \Theta = S \sin (270° - \psi) = -S \cos \psi$

N = Number of observations.

D = Vector resultant wind direction

where

ψ = Meteorological wind direction (0°-360°), the direction from which the wind is blowing where 360° is north, 90° east, 180° south, and 270° west

Θ = Cartesian angle of wind direction = $270° - \psi$

S = Scalar wind speed

$$SW = \frac{\Sigma S}{N}$$

$u = -S \sin \psi$ $\qquad$ $\bar{u} = \frac{\Sigma u}{N}$

$v = -S \cos \psi$ $\qquad$ $\bar{v} = \frac{\Sigma v}{N}$

$$\Theta = \arctan \frac{v}{u}$$

$$\psi = \arctan \frac{u}{v}$$

(quadrant must also be determined as indicated in table for vector resultant wind direction)

$$D = \arctan \frac{\bar{u}}{\bar{v}}$$

$$\bar{V} = (\bar{u}^2 + \bar{v}^2)^{1/2}$$

$$S = (u^2 + v^2)^{1/2}$$

Table for determining resultant meteorological wind direction (D)

Component Signs	Meteorological Direction	Cartesian Direction
u + v +	$180° \leq \psi \leq 270°$	$0° \leq \theta \leq 90°$
u + v −	$270° \leq \psi \leq 360°$	$0° \leq \theta \leq -90°$
u − v −	$0° \leq \psi \leq 90°$	$-90° \leq \theta \leq -180°$
u − v +	$90° \leq \psi \leq 180°$	$90° \leq \theta \leq 180°$

AVAILABILITY OF THE SUMMARIES

4.1 Microfiche

The HSST data summaries are available on microfiche (or microfilm) in the tabulated form described in Section 3 from any of the data centres listed in Annex VI.

4.2 Magnetic tapes

The HSST data summaries are available on magnetic tape with format as shown in Annex IV. Standard unlabelled tapes are available written to 9-track, 800 bpi EBCDIC characters. Other tape standards may be available by special arrangement with the supplying agency. Data centres able to supply magnetic tape summaries in this format are listed in Annex VI. In addition, the summaries are available from the Federal Republic of Germany in the format given in Annex V. This format is felt to be particularly advantageous for the simultaneous analysis of several elements.

LIMITATIONS OF THE SUMMARY DATA

5.1 Sea surface temperature

It must be appreciated that the values of mean sea surface temperature have been calculated for very large ocean areas without adjustment for spatial or temporal gradients. Some indication of the natural gradients within areas and months may be deduced by reference to the mean position and time information, but discretion must be used when observation counts are low. In the same way the published standard deviations will contain temporal and spatial variability in addition to that due to climatic variation and

measurement at a given point. Thus in areas exhibiting relatively large temporal and spatial temperature gradients we should expect considerable over-estimation of the "natural point variability" at any point within the area. Year to year changes of sea surface temperature may be assessed for significance by considering the standard error of the estimated means. For example we estimate the standard error as $\sigma / N^{1/2}$ where σ is the standard deviation of the monthly means and N is the number of observations (assumed independent). Or when we compare two means we test the "t" statistic,

$$t = \frac{\bar{x}_1 - \bar{x}_2}{s\left(\frac{1}{m} + \frac{1}{n}\right)^{1/2}}, \qquad s^2 = \frac{(m-1)s_1^2 + (n-1)s_2^2}{(m + n - 2)}.$$

s^2 is an estimate of the population variance and m, n are the number of observations with means x_1 and x_2 and standard deviations s_1 and s_2, respectively. If m and n are large t follows a normal distribution otherwise we use the "t" distribution with m + n - 2 degrees of freedom. Thus for large m, n we might say $x_1 = x_2$ if t exceeds 1.96. The chance of incorrectly rejecting $x_1 = x_2$ being 5% in this case.

Note that depending on how the size and shape of the box are defined, the traffic patterns, instruments used, coding and observing practices, observation count, data distribution, etc., the year-to-year changes may still fail the significance test. Conversely, they may pass the test and indicate some significant climatic change when the trend is associated more with one of the above factors than any actual climatic change. Caution should always be used, as many statistical tests that work well for a single point are not as reliable when testing across a geographical area with a gradient structure.

The assumption of independent data may not always be valid but with successive measurements being made at 3 or 6 hourly intervals or even longer for individual ships the assumption should be realistic. A more serious problem can arise when most observations in a given month and year for a particular area are made by one ship, thus introducing an undetectable systematic error in some circumstances. This could be particularly serious if non-bucket observations contaminate the basic data. The differences between sea surface temperature measurements made by bucket and those made by engine intake thermometers have been discussed in WMO - No. 336 (WMO, 1972). Although considerable effort was made to exclude non-bucket sea surface temperature measurements from the basic data it cannot be assumed that all unwanted measurements have been eliminated.

5.2 Air temperature

Many of the remarks on sea surface temperatures are applicable to air temperatures. It will be noted that, in general, variances of air temperature are somewhat greater than those of sea surface temperature due mostly to the greater temporal and spatial variability of air temperature; e.g. nearer coasts diurnal effects may be significant. In addition, systematic biases may have been introduced e.g. by the use of sling psychrometers instead of screen/shelter temperatures.

5.3 Wind speed

The vast majority of wind speed values were estimated from sea state. The problems of deriving a suitable conversion scale for the original Beaufort force estimates have been fully discussed in Report No. 3 of Reports on Marine Science Affairs (WMO, 1970). This led to the decision to adopt the "scientific scale" (see Annex VII) of Beaufort force conversions for use with the HSST data project. Further discussion on the observation and analysis of surface wind over the ocean may be found in Verploegh (1967) and Dobson (1981).

REFERENCES

Dobson, F.W., 1981. Review of Reference Height for and Averaging Time of Surface Wind Measurements at Sea. Marine Meteorology and Related Oceanographic Activities, Report No. 3, WMO, 64 pp.

Quayle, R; 1973. Results of Homogeneity Tests, Circular letter to HSSTDP participants.

Verploegh, G., 1967. Observation and analysis of the surface wind over the ocean; Royal Netherlands Met. Inst., Meded. en Verh. No. 89.

WMO; 1970. The Beaufort Scale of Wind Force; Reports on Marine Science Affairs, Report No. 3.

WMO; 1972. Comparative Sea Surface Temperature Measurements. Reports on Marine Science Affairs, Report No. 5, WMO – No. 336.

ANNEX I

HISTORICAL BACKGROUND TO HSST DATA PROJECT

(Reference: Paragraph 1)

The sixteenth session of the WMO Executive Committee (now Executive Council) endorsed, by its Resolution 5 (EC-XVI), the list made by the Advisory Committee of principal research projects in the atmospheric sciences, which included (following the suggestions of Dr. C.H.B. Priestley [Australia]) a project for publishing a volume similar to "World Weather Records" giving historical sea surface temperatures for each month for coastal stations and the open oceans. This project resulted from the need of research workers for such data to intensify research into climatic changes and, on a shorter term, seasonal anomalies in conjunction with the problem of the general atmospheric circulation.

Following a recommendation made by the second session of the Advisory Committee, the seventeenth session of the Executive Committee approved the appointment of a consultant to investigate the data availability and to evaluate the task of analyzing the data preserved by various Members. The consultant appointed, Mr. G. Verploegh, made a survey which covered not only sea surface temperature data but, at the recommendation of the Commission for Aerology (now Commission for Atmospheric Sciences), other parameters such as air temperature, humidity and wind.

The consultant's report, submitted to the third session of the Advisory Committee, concluded that it was essential to use the ships' data collected by the four Members, viz the Federal Republic of Germany, Netherlands, U.K. and U.S.A. and that these Members should be involved in the execution of the project. The eighteenth session of the Executive Committee approved the recommendation of the Advisory Committee regarding the production and publication of historical records for sea surface temperature, mean wind speed and direction, and humidity in terms either of vapour pressure or of specific humidity. The Executive Committee further requested the Secretary-General to discuss the implementation of the project with the four Members concerned and, if they were willing to participate, to proceed with the implementation of the project.

In response to the Secretary-General's approach, the four Members concerned agreed to undertake the task and to finance their part of the project from national funds.

It was proposed to initiate a pilot study covering all the phases of the implementation of the project for a limited number of selected sea areas; this would enable Members concerned to estimate as precisely as possible the amount of work involved and to make the necessary financial arrangements. Accordingly, pilot studies were carried out by the Federal Republic of Germany and the U.S.A. and were made available during 1968. A further pilot study was

submitted by the U.S.A. in 1969. These pilot studies and the consultant's report were used as basic documents for exchanges of opinion by correspondence among the group of experts appointed by the four Members concerned to study the HSSTD Project.

Following the first meeting (in 1970) of the group of experts representing the four Members, the participating countries began the lengthy task of archiving and quality-controlling the data for their respective areas of responsibility (Figure 1).

At the second meeting of experts in 1975, it was agreed that the U.S.A. would convert the summaries provided by the Members on magnetic tape into microform copies. These copies subsequently became available in 1977 for the Pacific and Indian Oceans, and in 1980 for the Atlantic Ocean. In addition, a draft User's Guide to the Summaries of the Historical Sea Surface Temperature Data Project was prepared in 1980 by Mr. D.J. Painting (U.K.).

The final meeting of experts on the HSST data project took place in 1984. This meeting reviewed the status of the various HSST data set holdings, clarified the situation concerning formats and procedures for the provision of both basic HSST data and summaries, and undertook an extensive revision of the draft User's Guide, which it recommended for publication.

A chronological account of major steps in the execution of the HSST Data Project is given below:

Chronological list of the HSST Data Project

1964 Initial suggestion made by Dr. C.H.B. Priestley to WMO Advisory Committee

The list of principal research projects in the atmospheric sciences made by the first session of the Advisory Committee, endorsed by Recommendation 5 of the 16th session of the Executive Committee

1965 Appointment of a consultant to investigate the data availability and to evaluate the task of analyzing the data preserved, recommended by the second session of the Advisory Committee, approved by the 17th session of the Executive Committee

Appointment of Mr. G. Verploegh as consultant for the project

1966 Report by Mr. Verploegh containing the principles of the project, submitted to the third session of the Advisory Committee, approved by the 18th session of the Executive Committee

U.S.A., U.K., Netherlands and the Federal Republic of Germany agreed to undertake the task and to finance their part of the project

1968 Pilot study for two selected areas in the Atlantic Ocean

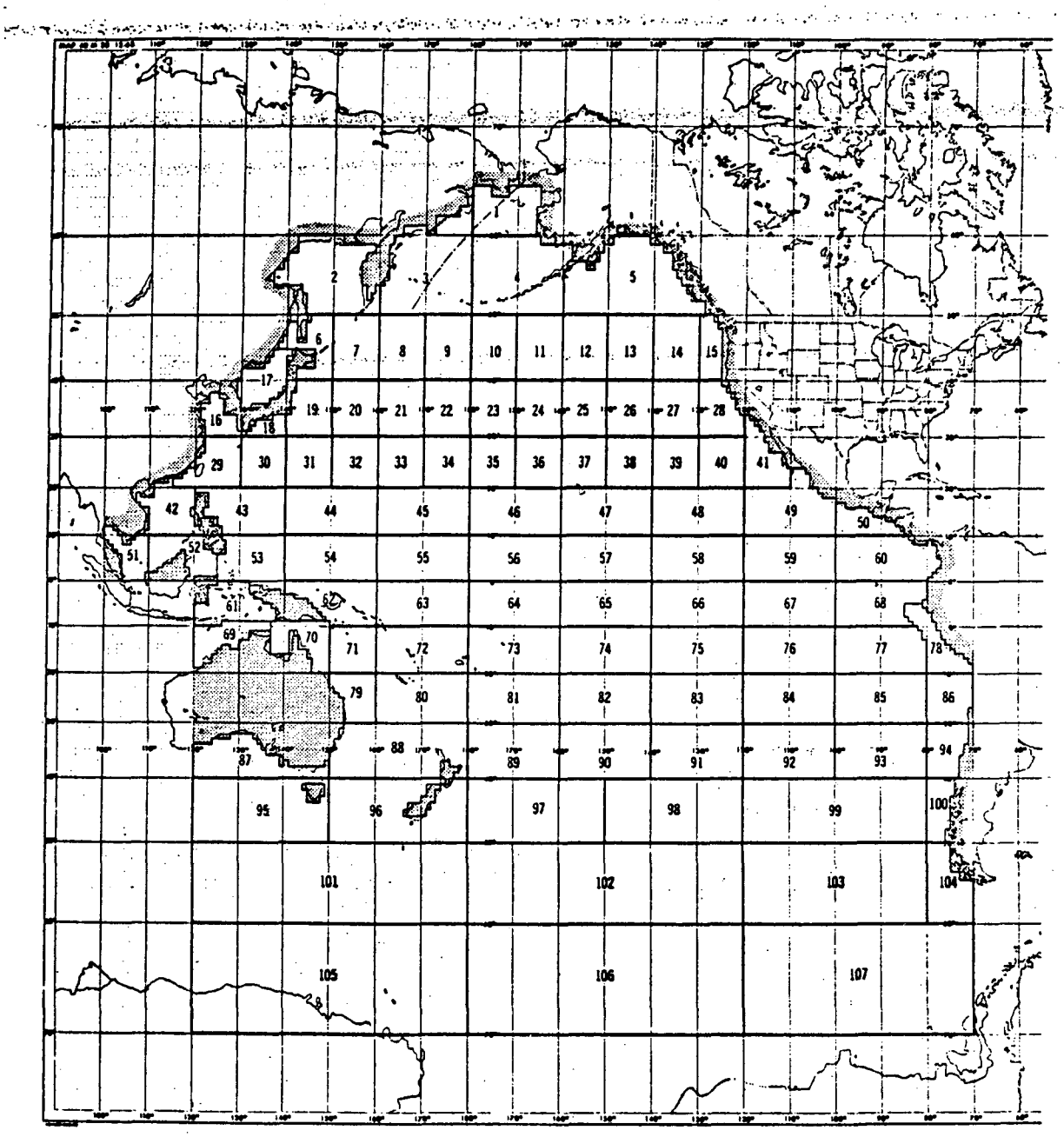
1970	First meeting of group of experts on the HSST data project in Geneva: Data formats and computation of Summaries
1971 to 1973	Transformation of punch cards onto magnetic tapes by participating Members
	Checking of the observation sets
1975	Second meeting of experts on the HSST Data Project in Geneva: Data exchange and publication of the Summaries
1976	Compiling of the HSST data tapes of the Atlantic Ocean
1977	Publishing of the Summaries of the Pacific and Indian Ocean on microfilm by the U.S.A.
1978	Integration of foreign data sets into the HSST data tape of the Atlantic Ocean observations
1980	Delivery of the Atlantic Summary tapes to the U.S.A. for publishing Bilateral exchange of the HSST data tapes and the Summary tapes
	Draft User's Guide written
1984	Final meeting of experts on HSST data set, Hamburg
	Clarification of data and summary formats and exchange policies
	Revision of draft User's Guide

ANNEX II

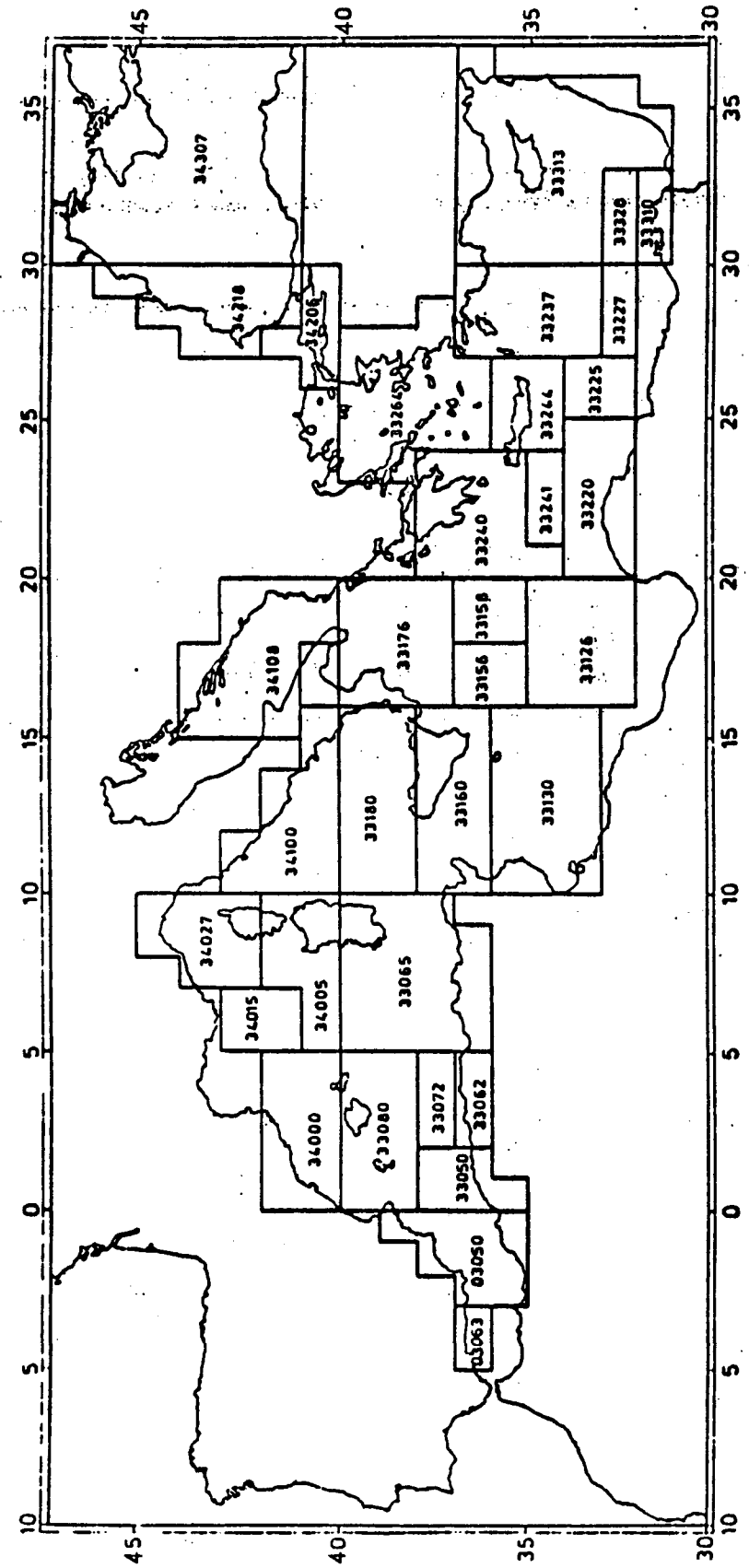
REPRESENTATIVE AREAS

(Reference: paragraph 2.2)

Representative areas for the Pacific Ocean



Representative areas for the Mediterranean Sea



Geographical co-ordinates of Atlantic areas used in HSSTD statistics

Stars mark such areas which contain a weather ship position (A-M) or a selected area in the responsible sea district of U.S.A. (USA), U.K. (UK) or Federal Republic of Germany (G) as used in the marine climatological summaries for 1961 and onwards.

1	80 - 70 N	25 - 0 W			51	43 - 39 N	53 - 43 W		
2	80 - 70 N	0 - 20 E			52	39 - 35 N	65 - 53 W		
3	80 - 70 N	20 - 40 E			53	39 - 33 N	80 - 74 W		
4	80 - 70 N	40 - 60 E			54	39 - 33 N	74 - 65 W	*	USA
5	80 - 70 N	60 - 90 E			55	40 - 32 N	38 - 30 W	*	UK
6	80 - 66 N	75 - 60 W	*	USA	56	40 - 32 N	30 - 16 W		
7	75 - 66 N	60 - 50 W	*	USA	57	40 - 32 N	16 - 10 W	*	UK
8	70 - 65 N	40 - 23 W			58	40 - 32 N	10 - 5 W		
9	70 - 65 N	30 - 60 E			59	39 - 32 N	53 - 45 W	*E	(UK)
10	70 - 63 N	6 - 18 E			60	39 - 32 N	45 - 38 W		
11	70 - 62 N	23 - 11 W			61	35 - 30 N	65 - 53 W	*	USA
12	70 - 62 N	11 - 0 W			62	32 - 27 N	25 - 17 W		
13	70 - 60 N	0 - 6 E	*M	(UK)	63	32 - 27 N	17 - 10 W		
14	66 - 59 N	57 - 48 W	*	USA	64	33 - 25 N	81 - 74 W	*	USA
15	65 - 58 N	40 - 23 W	*A	(UK)	65	33 - 25 N	74 - 65 W	*	USA
16	66 - 55 N	67 - 57 W	*	USA	66	32 - 25 N	53 - 40 W	*	UK
17	65 - 55 N	48 - 40 W			67	32 - 25 N	40 - 25 W		
18	66 - 54 N	18 - 25 E			68	30 - 25 N	99 - 90 W		
19	62 - 56 N	23 - 15 W	*I	(UK)	69	30 - 25 N	65 - 53 W		
20	62 - 56 N	15 - 7 W			70	30 - 22 N	90 - 81 W	*	USA
21	62 - 56 N	7 - 0 W			71	27 - 22 N	25 - 14 W		
22	60 - 55 N	0 - 6 E	*	UK	72	25 - 20 N	81 - 70 W		
23	60 - 55 N	6 - 10 E			73	25 - 20 N	70 - 60 W	*	USA
24	60 - 54 N	10 - 18 E			74	25 - 20 N	60 - 50 W		
25	58 - 52 N	32 - 23 W	*	UK	75	25 - 20 N	50 - 37 W		
26	59 - 50 N	55 - 48 W	*B	(USA)	76	25 - 20 N	37 - 25 W		
27	56 - 51 N	10 - 0 W			77	25 - 18 N	99 - 90 W		
28	58 - 48 N	40 - 32 W	*C	(UK)	78	22 - 15 N	25 - 19 W	*	G
29	56 - 50 N	23 - 17 W	*J	(UK)	79	22 - 15 N	19 - 16 W	*	G
30	56 - 50 N	17 - 10 W			80	20 - 16 N	81 - 63 W		
31	55 - 50 N	0 - 8 E			81	22 - 13 N	90 - 81 W		
32	55 - 48 N	48 - 40 W	*	UK	82	20 - 15 N	40 - 25 W		
33	51 - 48 N	10 - 0 W			83	20 - 14 N	63 - 50 W	*	USA
34	52 - 46 N	30 - 23 W	*	UK	84	20 - 10 N	50 - 40 W		
35	50 - 47 N	20 - 12 W			85	16 - 10 N	81 - 72 W	*	USA
36	50 - 43 N	70 - 60 W			86	16 - 10 N	72 - 63 W		
37	50 - 43 N	54 - 48 W	*	USA	87	15 - 10 N	40 - 29 W		
38	48 - 44 N	38 - 30 W			88	15 - 10 N	29 - 20 W	*	G
39	48 - 44 N	12 - 0 W	*	UK	89	15 - 10 N	20 - 14 W	*	G
40	48 - 43 N	60 - 54 W			90	14 - 5 N	63 - 50 W		
41	48 - 43 N	48 - 43 W			91	10 - 5 N	40 - 31 W		
42	47 - 43 N	20 - 12 W	*K	(UK)	92	10 - 5 N	31 - 24 W	*	G
43	48 - 40 N	43 - 38 W	*D	(UK)	93	10 - 5 N	24 - 18 W		
44	46 - 40 N	30 - 20 W			94	10 - 5 N	18 - 10 W	*	G
45	44 - 40 N	38 - 30 W			95	10 - 0 N	50 - 40 W	*	G
46	44 - 40 N	12 - 8 W			96	6 - 0 N	8 - 0 W	*	G
47	43 - 40 N	20 - 12 W			97	6 - 0 N	0 - 10 E	*	G
48	43 - 39 N	75 - 69 W			98	5 - 0 N	40 - 33 W		
49	43 - 39 N	69 - 61 W	*	USA	99	5 - 0 N	33 - 25 W	*	G
50	43 - 39 N	61 - 53 W			100	5 - 0 N	25 - 15 W		

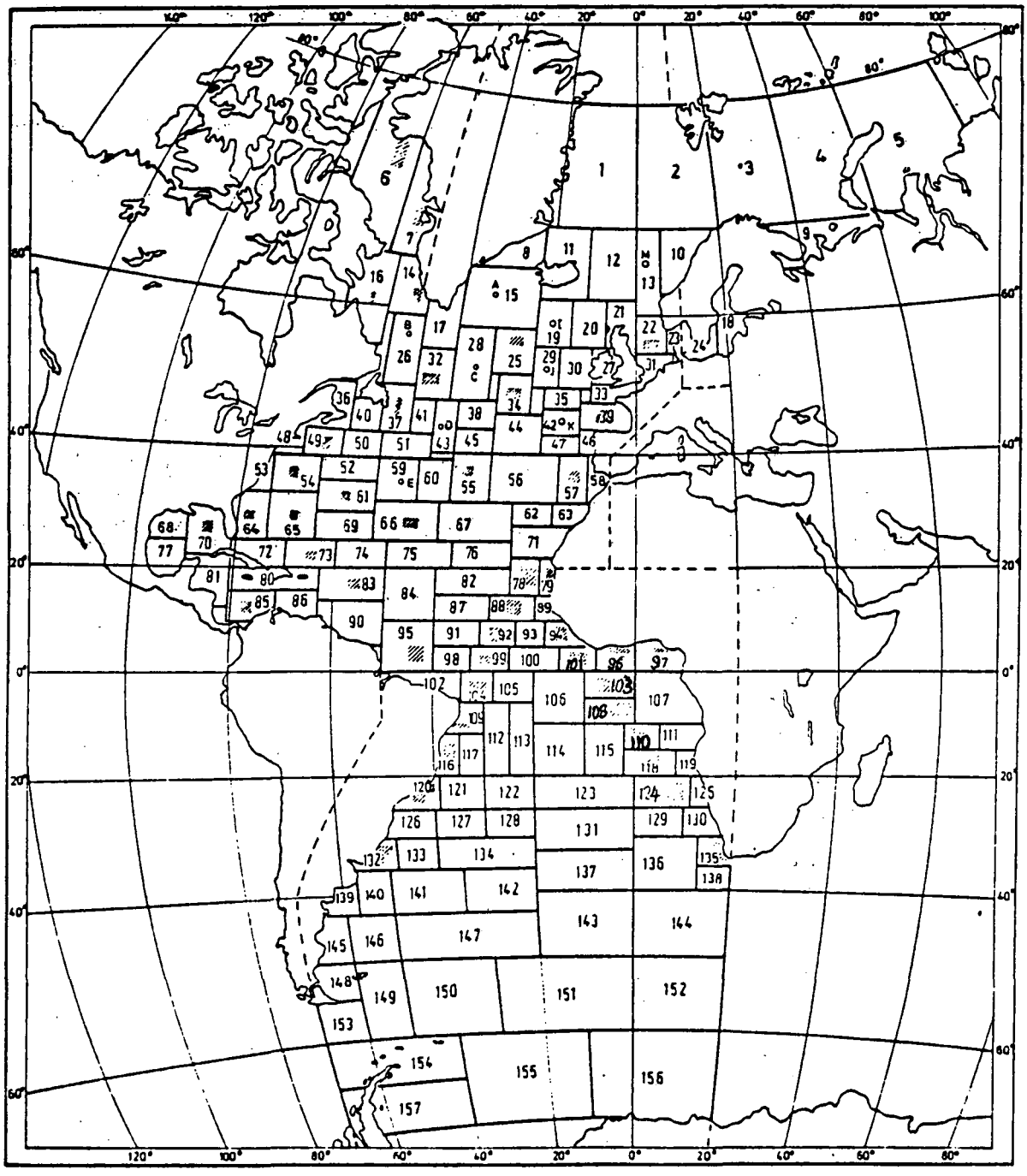
(continued)

Geographical co-ordinates of Atlantic areas used in HSSTD statistics

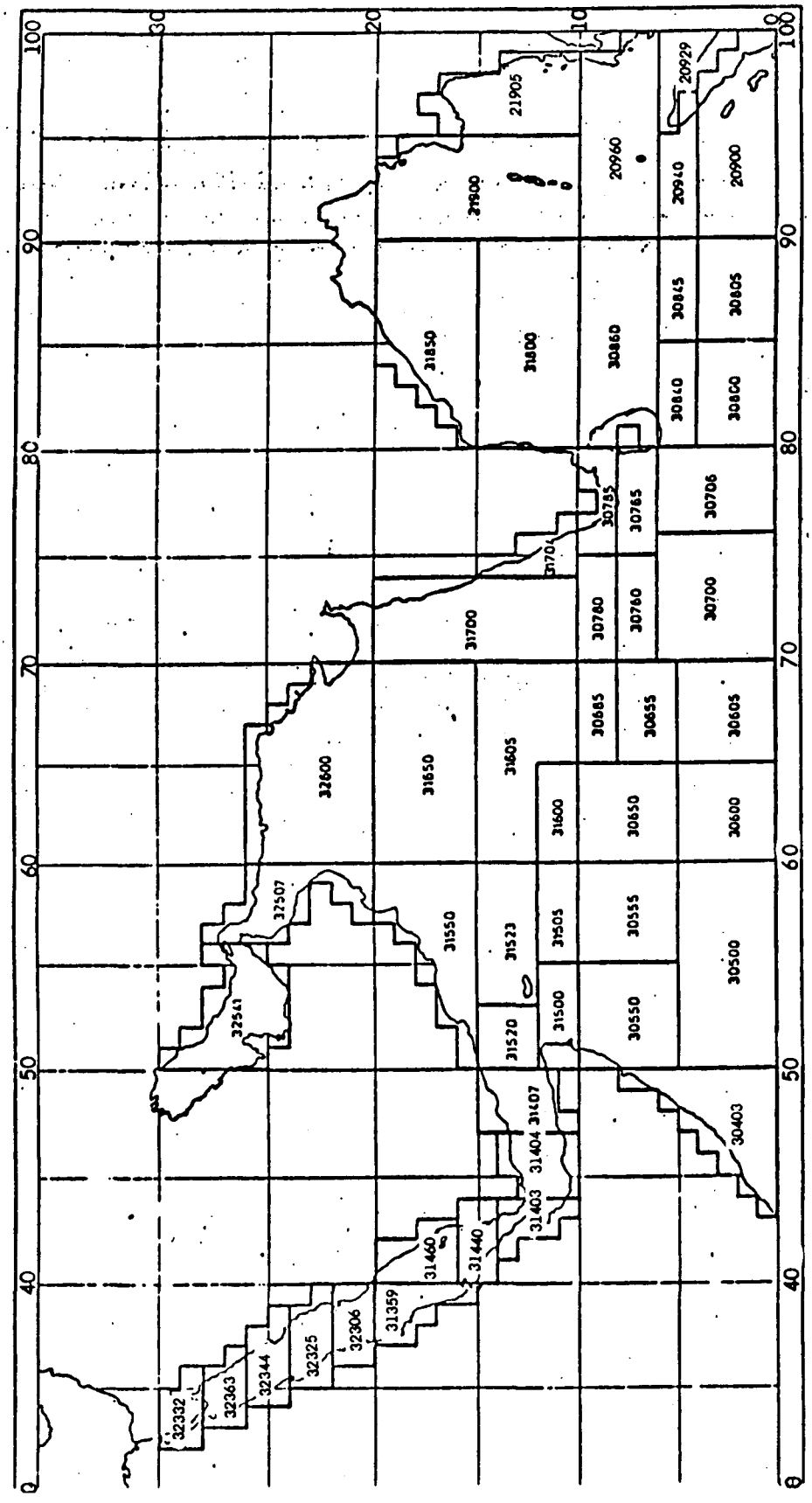
101	5 - 0 N	15 - 8 W *	G
102	0 - 5 S	50 - 35 W	
103	0 - 5 S	10 - 0 W *	G
104	0 - 6 S	35 - 28 W *	G
105	0 - 6 S	28 - 20 W	
106	0 - 10 S	20 - 10 W	
107	0 - 10 S	0 - 15 E	
108	5 - 10 S	10 - 0 W *	G
109	6 - 12 S	38 - 30 W *	G
110	10 - 15 S	2W - 5 E *	G
111	10 - 15 S	5 - 15 E	
112	6 - 20 S	30 - 25 W	
113	6 - 20 S	25 - 20 W	
114	10 - 20 S	20 - 10 W	
115	10 - 20 S	10 - 2 W	
116	12 - 20 S	40 - 35 W *	G
117	12 - 20 S	35 - 30 W	
118	15 - 20 S	2 W - 8 E *	G
119	15 - 20 S	8 - 15 E	
120	20 - 26 S	48 - 39 W *	G
121	20 - 26 S	39 - 30 W	
122	20 - 26 S	30 - 20 W	
123	20 - 26 S	20 - 0 W	
124	20 - 26 S	0 -11 E *	G
125	20 - 26 S	11 - 16 E	
126	26 - 31 S	50 - 40 W	
127	26 - 31 S	40 - 30 W	
128	26 - 31 S	30 - 20 W	
129	26 - 31 S	0 - 10 E	
130	26 - 31 S	10 - 18 E	
131	26 - 33 S	20 - 0 W	
132	31 - 36 S	56 - 48 W *	G
133	31 - 36 S	48 - 40 W	
134	31 - 36 S	40 - 20 W	
135	31 - 36 S	13 - 20 E *	G
136	31 - 40 S	0 - 13 E	
137	33 - 40 S	20 - 00 W	
138	36 - 40 S	13 - 20 E	
139	36 - 43 S	64 - 57 W	
140	36 - 43 S	57 - 50 W	
141	36 - 43 S	50 - 35 W	
142	36 - 43 S	35 - 20 W	
143	40 - 50 S	20 - 0 W	
144	40 - 50 S	0 - 20 E	
145	43 - 50 S	68 - 60 W	
146	43 - 50 S	60 - 50 W	
147	43 - 50 S	50 - 20 W	
148	50 - 55 S	70 - 60 W	
149	50 - 60 S	60 - 50 W	
150	50 - 60 S	50 - 30 W	
151	50 - 60 S	30 - 0 W	
152	50 - 60 S	0 - 20 E	
153	55 - 60 S	70 - 60 W	
154	60 - 65 S	70 - 40 W	
155	60 - 70 S	40 - 10 W	
156	60 - 70 S	10W - 20E	
157	65 - 70 S	70 - 40 W	

201	weather ship	A
202		B
203		C
204		D
205		E
209		I
210		J
211		K
213		M

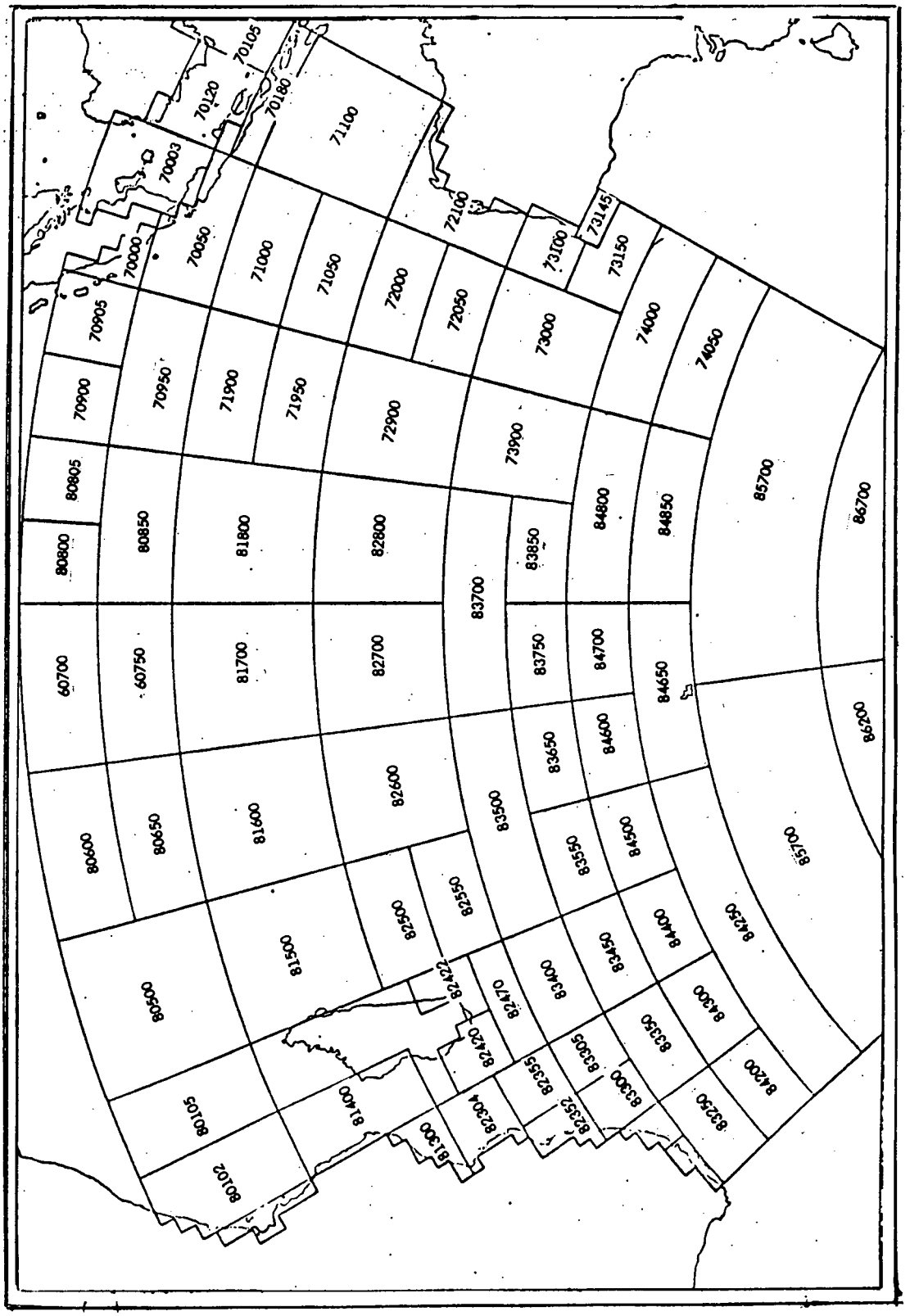
Representative areas for the Atlantic Ocean



Representative areas for the North Indian Ocean and Red Sea areas



Representative areas for the South Indian Ocean area



ANNEX III

HSST DATA BASE

(Reference: Paragraph 2.3)

For the purpose of computing the summaries within the period from 1860 to 1960 not all observations of the ship's meteorological data sets were used. Therefore special data banks were set up which contain the following elements:

- Position of observation (Latitude and Longitude)
- Time of observation (year, month, day and hour)
- Sea surface temperature
- Air temperature
- Wind speed
- Wind direction

The data banks of the Atlantic Ocean and of the Indian Ocean and Mediterranean Sea contain the following elements which were not used for the summaries:

- Wet (ice) bulb temperature
- Total cloud amount
- Air pressure

Quality control flags were also included in the data banks.

Different measurement units were standardized (temperature values into tenths of degree Celsius, wind direction into degrees, cloud amount into octas, air pressure into tenths of hpa). All estimated wind data were converted according to the scientific scale as shown in Annex VII.

Obvious errors in the basic data were eliminated by checking against observed climatological extremes: Marginal values were retained with appropriate flags. Duplicates were eliminated; U.K. observations on the same position and time though not identical were flagged as suspect. For the Pacific region extreme values were checked on a 5° square/month basis. Observations were tested against limits of ± 4.5 G where G refers to the "all years" standard deviation. Details of quality control procedures employed by participating Members are given in Attachments A to C.

All members of the project sent their data banks to the participating Members acting as processing centres (Annex VI). After exchange duplicates were checked once more, exact duplicates were eliminated. The final data banks of the participating Members served as bases to compute the summaries in the selected areas of their oceans.

Magnetic tapes containing all the basic observational data may be obtained from the contributing countries' data centres as listed in Annex VI.

The tape formats are given in Annex VIII. All Pacific data are available in the HSST compact format, the others in the enlarged code format. Data were written to unlabelled 9-track tapes at 800 bpi with EBCDIC characters.

The HSST data bank of the Atlantic Ocean consists of 16,300,000 observations, the data bank of the Indian Ocean and Mediterranean Sea of about 5,600,000 observations and the data bank of the Pacific Ocean of about 4,700,000 observations. Although these amounts could be enlarged when observations not checked as yet are integrated and if historical data not yet punched are added to the data banks, this will be done only at the discretion of individual Services. The data bank could help to improve knowledge of marine climatology, its relations and variations in space and time over the oceans within the World Climate Programme of the WMO.

Attachment A

QUALITY CONTROL PROCEDURES FOR HSST DATA
BY THE UNITED STATES OF AMERICA - PACIFIC

I. Observational checks

1. For each area, the highest and lowest data values (i.e., warmest and coldest or highest wind speeds) were listed for each month. Data were manually reviewed and erroneous values deleted.

2. Air and sea temperature limits were set for each month, for each five-degree rectangle based on the long term mean plus or minus 4.5 times the long term standard deviation. Data outside these limits were rejected. This prevented gross errors that may have been missed in a manual review.

3. Duplicates were eliminated.

II. Summary checks and procedures

1. Positions that were recorded to one-degree accuracy were carried with zero in the tenths position for latitude and longitude for data contributed by the U.S., Netherlands and F.R.G. British data carried ".5" in the tenths position. Values were interpreted by the programme directly as carried for lat.-long. computations.

2. Data Summaries were reviewed manually before the final microfilm copy was produced.

Attachment B

QUALITY CONTROL PROCEDURES FOR HSST DATA BY THE FEDERAL REPUBLIC OF GERMANY - ATLANTIC

The following general procedures have been adopted for computer checking of the various elements of the basic observational data set. Identified erroneous values may be rejected, referred for manual checking or corrected automatically, in which case they are flagged as such.

Wind

Speed and direction checked for internal consistency and for obvious coding errors.

Air and sea temperatures

Checked against upper and lower limits which are computed from a formula containing latitude and month. Doubtful values are examined by a manual check, and may often be corrected or accepted.

Atmospheric Pressure

Checked within preset upper and lower limits. May be estimated on manual checking from surrounding values.

Cloud amount

Extensive checks for internal consistency when low, middle, high cloud data are also available. May be corrected automatically.

Other checks

Consistency cross-checks between cloud amount and weather, and between air temperature and weather may be carried out when this additional element is available in the data.

Full details of the Federal Republic of Germany quality control procedures may be found in:

Höflich, O., Meissner, H.-H., and Hoffmann, L. 1975. Description of a computer programme for checking marine meteorological observations of merchant vessels. Einzelveröffentlichungen Sonderheft 2, Deutscher Wetterdienst Seewetteramt, Hamburg.

Attachment C

QUALITY CONTROL PROCEDURES FOR HSST DATA BY THE NETHERLANDS - INDIAN OCEAN AND MEDITERRANEAN

1. Exact duplicate observations have been eliminated.

2. Observations with impossible positions (for example over land) have been eliminated.

3. Temperatures

For each ten degrees square monthly lower and upper limits have been determined using the Netherlands climatological atlases for the Mediterranean (KNMI no. 138, 1957), Red Sea (KNMI no. 129, 1951), Indian Ocean (KNMI no. 135, 1950) and the Chinese Seas (KNMI no. 115, 1936).

Temperatures outside these limits have been rejected. For determining, for example, the lower limit in a certain ten degrees square for a certain month first the lowest mean value of the temperature in the square (mostly occurring at the poleward boundary) was determined. Next from this value 4 times the standard deviation was subtracted. For the determination of the upper limits the same procedure was followed.

Moreover sea surface temperatures below -2°C have been eliminated.

4. Air pressure

Pressures below 920 hPa and above 1050 hPa have been eliminated.

5. Wind

Wind directions other than 000-360 and 990 (variable) have been eliminated.

If the wind direction was 000 and the wind speed more than 1.0 m/s or if the wind direction was 990 and the wind speed more than 5.0 m/s then both were eliminated. Estimated wind speeds of more than 32.3 m/s have been deleted.

ANNEX IV

TAPE FORMAT DOCUMENTATION

(Reference: paragraph 4.2)

TAPE DECK	HSST PRINT TAPE	PAGE NO. 1

HSSTDP CMF Data Summary to Produce Final Publication Tables
Tape Record - 232 Characters Blocking Factor - 10
All fields numeric with sign where indicated

AREA NO	DECADE	ELEMENT	YEAR	JANUARY					FEBRUARY					ANNUAL				
				N	ST	SD	BLK	BLK	N	ST	SD	BLK	BLK	N	ST	SD	BLK	BLK
XXXXX	XX	1	XXX	XXXXX	+/- XXXX	XXX	XXX	XX	XXXXX	+/- XXXX	XXX	XXX	XX	XXXXX	+/- XXXX	XXX	XXX	XX

ELEMENT 1. Sea Surface Temperature
N - Observation Count ST - Mean Sea Surface Temperature SD - Standard Deviation

AREA NO	DECADE	ELEMENT	YEAR	JANUARY						FEBRUARY						ANNUAL					
				IND	LO	IND	LA	NS	MD	ND	IND	LO	IND	LA	NS	MD	ND	SLK	LO	LA	NS	MD	ND
XXXXX	XX	2	XXX	XXXXX		XXXX		XXX	XXX	XX	XXXXX		XXXX		XXX	XXX	XX	XXXXX		XXX	XXX	XXX	XX

ELEMENT 2. LO - Mean Longitude LA - Mean Latitude
NS - No. of 1° Squares with Sea Surface Temperature
MD - Mean Day of Month ND - No. of Days having Sea Surface Temperature (Note: LO Indicator Position 1 - EAST, 2 - WEST; LA Indicator Position 1 - NORTH, 2 - SOUTH)

(No Indicator on Annual - Use December Indicators)

AREA NO	DECADE	ELEMENT	YEAR	JANUARY					FEBRUARY					ANNUAL				
				N	T	SD	BLK	BLK	N	T	SD	BLK	BLK	N	T	SD	BLK	BLK
XXXXX	XX	3	XXX	XXXXX	+/- XXXX	XXX	XXX	XX	XXXXX	+/- XXXX	XXX	XXX	XX	XXXXX	+/- XXXX	XXX	XXX	XX

ELEMENT 3. Air Temperature
N - Observation Count T - Mean Air Temperature SD - Standard Deviation

AREA NO	DECADE	ELEMENT	YEAR	JANUARY					FEBRUARY					ANNUAL				
				N	SW	V	D	BLK	N	SW	V	D	BLK	N	SW	V	D	BLK
XXXXX	XX	4	XXX	XXXXX	XXXX	XXX	XXX	XX	XXXXX	XXXX	XXX	XXX	XX	XXXXX	XXXX	XXX	XXX	XX

ELEMENT 4. Scalar Wind
N - Observation Count SW - Mean Scalar Wind Speed V - Vector Mean Wind Speed D - Resultant Direction

BLK - Blank

TAPE FORMAT DOCUMENTATION, p. 2

TAPE DECK	HSST PRINT TAPE	PAGE NO.

FIELD	TAPE CODE	DEFINITION
Area	00000-99999	
Decade	01-13	01-1861-1870, 02-1871-1880, 13-1981-1990, etc.*
Element	1-4	See page 1
Year	861-990	Last 3 digits of year
N	00000-99999	Observation count
ST	-99.9 to +99.9	°C
SD	00.0-99.9	°C
IND LO	1 or 2	See page 1
IND LA	1 or 2	See page 1
LO	000.0-180.0	See page 1
LA	00.0-90.0	See page 1
NS	000-999	See page 1
MD (Monthly)	001-031	Day of the Month
MD (Annual)	001-366	Julian Day
T	-99.9 to +99.9	°C
SW	000.0-999.9	Wind Speed (mps)
V	00.0-99.9	Wind Speed (mps)
D	000-360	Wind Direction

If Observation Count is 0, data fields should be 0 filled. The printout will appear blank.

Historical sea surface temperature data project

AREA xxxxx 100 MONTHLY MEAN AND STANDARD DEVIATION OF SEA SURFACE TEMPERATURE 37.5N 140W
(DEGREES CELSIUS)*

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1901	ST	14.0	13.9	13.6	14.3	15.5	19.2	20.7		20.5	24.5		15.0	
	SD	0.9	0.9	0.9	0.9	0.9	0.9	0.9		0.9	0.9		0.9	
	N	12	16	29	11	9	2	33		32	2		17	
1902	ST	15.3		12.7	12.5		12.4	18.2	21.1	21.3	18.9	15.4	14.5	
	SD	0.9		0.9	0.9		0.9	0.9	0.9	0.9	0.9	0.9	0.9	
	N	7		7	8		6	51	8	14	1	7	8	
1903	ST		12.9	12.6		14.4	14.6		19.0		17.9	16.1		
	SD		0.9	0.9		0.9	0.9		0.9		0.9	0.9		
	N		6	7		7	11		13		8	8		
1904	ST	12.5	13.1		12.3	12.8	14.4	19.1	18.3	20.3	19.0		13.3	
	SD	0.9	0.9		0.9	0.9	0.9	0.9	0.9	0.9	0.9		0.9	
	N	8	14		8	6	1	37	1	7	16		8	
1905	ST	13.3		12.1	11.1		15.7		20.5	21.0		17.5		
	SD	0.9		0.9	0.9		0.9		0.9	0.9		0.9		
	N	8		7	25		13		8	7		7		
1906	ST	13.8	13.6	13.0	13.7									
	SD	0.9	0.9	0.9	0.9									
	N	9	8	8	17									
1907	ST								20.4	20.5		16.8	14.8	
	SD								0.9	0.9		0.9	0.9	
	N								8	7		8	8	
1908	ST		12.4	11.5		13.5		21.0	20.7		20.4	16.8		
	SD		0.9	0.9		0.9		0.9	0.9		0.9	0.9		
	N		7	6		14		9	8		8	7		
1909	ST					12.4								
	SD					0.9								
	N					3								
1910	ST			13.2										
	SD			0.9										
	N			16										

ST = SEA SURFACE TEMPERATURE SD = STANDARD DEVIATION N = OBSERVATION COUNT

Historical Sea Surface Temperature Data Project (contd)

AREA xxxxx 100 POSITION AND TIME OF OBSERVATIONS WITH SEA SURFACE TEMPERATURE* 37.5N 140W

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1901	LA	37.5	37.5	37.5	37.5	37.5	37.5	37.5		37.5	37.5		37.5	
	LO	140.0	140.0	140.0	140.0	140.0	140.0	140.0		140.0	140.0		140.0	
	NS	100	100	100	100	100	100	100		100	100		100	
	MD	15	15	15	15	15	15	15		15	15		15	
	ND	21	21	21	21	21	21	21		21	21		21	
1902	LA	37.5		37.5	37.5		37.5	37.5		37.5	37.5	37.5	37.5	
	LO	140.0		140.0	140.0		140.0	140.0		140.0	140.0	140.0	140.0	
	NS	100		100	100		100	100		100	100	100	100	
	MD	15		15	15		15	15		15	15	15	15	
	ND	21		21	21		21	21		21	21	21	21	
1903	LA		37.5	37.5		37.5	37.5		37.5		37.5	37.5		
	LO		140.0	140.0		140.0	140.0		140.0		140.0	140.0		
	NS		100	100		100	100		100		100	100		
	MD		15	15		15	15		15		15	15		
	ND		21	21		21	21		21		21	21		
1904	LA	37.5	37.5		37.5	37.5	37.5	37.5	37.5	37.5	37.5		37.5	
	LO	140.0	140.0		140.0	140.0	140.0	140.0	140.0	140.0	140.0		140.0	
	NS	100	100		100	100	100	100	100	100	100		100	
	MD	15	15		15	15	15	15	15	15	15		15	
	ND	21	21		21	21	21	21	21	21	21		21	
1905	LA	37.5		37.5	37.5		37.5		37.5	37.5		37.5		
	LO	140.0		140.0	140.0		140.0		140.0	140.0		140.0		
	NS	100		100	100		100		100	100		100		
	MD	15		15	15		15		15	15		15		
	ND	21		21	21		21		21	21		21		
1906	LA	37.5	37.5	37.5	37.5									
	LO	140.0	140.0	140.0	140.0									
	NS	100	100	100	100									
	MD	15	15	15	15									
	ND	21	21	21	21									
1907	LA								37.5	37.5		37.5	37.5	
	LO								140.0	140.0		140.0	140.0	
	NS								100	100		100	100	
	MD								15	15		15	15	
	ND								21	21		21	21	
1908	LA		37.5	37.5		37.5		37.5	37.5		37.5	37.5		
	LO		140.0	140.0		140.0		140.0	140.0		140.0	140.0		
	NS		100	100		100		100	100		100	100		
	MD		15	15		15		15	15		15	15		
	ND		21	21		21		21	21		21	21		
1909	LA					37.5								
	LO					140.0								
	NS					100								
	MD					15								
	ND					21								
1910	LA			37.5										
	LO			140.0										
	NS			100										
	MD			15										
	ND			21										

LA = LATITUDE LO = LONGITUDE
NS = NUMBER OF ONE DEGREE SQUARES CONTAINING SEA SURFACE TEMPERATURE DATA
MD = MEAN DAY OF THE MONTH ND = NUMBER OF DAYS HAVING SEA SURFACE TEMPERATURE DATA

North Pacific Ocean

AREA XXXXX 100 MONTHLY MEAN AND STANDARD DEVIATION OF AIR TEMPERATURE 37.5N 140W
(DEGREES CELSIUS)*

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1901	T	12.3	11.4	12.6	14.0	16.7	17.6	18.3	18.5	16.8	15.2	13.6	12.9	14.9
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	12	12	11	17	23	42	50	47	39	42	21	15	329
1902	T	11.8	11.0	12.2	13.6	15.2	16.9	16.1	17.8	16.1	14.7	13.1	12.6	14.4
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	9	6	10	16	20	35	45	40	29	28	12	9	260
1903	T	11.4	10.8	11.9	13.4	15.1	16.6	17.8	17.4	15.9	14.5	13.1	12.2	14.2
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	7	4	13	20	17	29	37	36	27	30	25	13	258
1904	T	10.6	9.7	11.2	12.7	14.8	16.0	17.5	17.0	15.7	14.1	12.9	11.8	13.7
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	10	2	6	13	19	25	35	31	23	19	11	6	199
1905	T	11.6	10.7	12.0	13.6	15.8	17.0	18.9	18.3	16.7	14.8	13.6	12.5	14.6
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	11	9	8	15	15	27	31	28	19	.15	8	-4-	190
1906	T	11.2	10.1	11.7	13.2	15.1	17.3	19.1	18.6	17.1	15.3	13.8	12.1	14.6
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	8	10	10	14	21	36	42	34	25	23	15	11	249
1907	T	12.5	11.3	12.5	14.2	16.0	17.7	19.6	19.0	17.5	15.7	14.5	13.6	15.3
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	5	11	12	13	19	32	40	35	28	29	20	14	253
1908	T	10.9	9.6	11.1	13.7	15.7	16.9	18.9	18.0	17.2	15.1	13.0	11.9	14.3
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	1	5	11	17	25	40	45	38	30	31	22	13	278
1909	T	9.8	8.9	10.2	11.9	14.5	15.1	17.6	16.9	15.9	13.1	12.3	11.1	13.3
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	13	14	9	15	21	38	46	37	26	20	13	7	259
1910	T	11.6	10.2	11.8	12.9	15.3	16.5	18.3	17.5	16.3	14.2	13.1	12.3	14.2
	SD	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	N	20	10	4	10	18	15	43	36	27	18	10	3	234

* T = AIR TEMPERATURE SD = STANDARD DEVIATION N = OBSERVATION COUNT

North Pacific Ocean (contd)

AREA xxxxx 100 MONTHLY MEAN SCALAR WIND SPEED (MPS), VECTOR MEAN WIND SPEED (MPS) AND RESULTANT DIRECTION (DEGREES)* 37.5N 140W

YEAR		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
1901	SW	4.0	3.9		4.3	5.5	6.0	6.2	5.7	4.4	3.5	3.0	3.9	
	V	3.2	2.2		2.0	4.0	4.6	4.9	4.6	3.1	2.2	2.4	2.5	
	D	270	270		250	270	280	270	280	270	280	260	240	
	N	12	16		11	9	11	17	10	23	8	7	15	
1902	SW	3.6		3.7	4.4	5.2		5.9	5.8	4.6	3.2		3.5	
	V	2.9		2.8	3.5	4.6		4.8	5.0	4.0	2.6		2.5	
	D	280		270	280	280		270	260	250	270		260	
	N	9		8	10	12		9	12	10	6		5	
1903	SW	3.5	2.9		4.0		5.8	6.0	6.0	5.2		3.6		
	V	2.9	2.7		3.2		4.7	5.1	4.9			2.9		
	D	270	270		290		270	280	280	270		250		
	N	10	12		15		20	18	22	19		13		
1904	SW			3.6	4.2		6.3		5.5			3.4		
	V			2.7	3.6		5.4		4.3			2.6		
	D			260	270		290		300			230		
	N			29	13		10		3			2		
1905	SW	3.7		3.7		5.6	6.1	6.0		4.5		3.2	2.9	
	V	2.5		2.8		4.8	5.5	5.1		2.9		2.7	2.4	
	D	290		270		270	280	290		260		250	240	
	N	4		7		10	15	12		6		5	3	
1906	SW	3.4	3.0	3.5	4.1	5.2	5.9				3.7	3.0	2.8	
	V	2.9	2.4	2.8	3.1	4.3	4.6				2.8	2.2	2.3	
	D	270	270	260	260	270	290				300	270	260	
	N	7	10	12	15	18	11				9	10	10	
1907	SW			4.0				6.2			4.0		3.6	
	V			3.3				5.7			3.2		2.8	
	D			270				280			280		270	
	N			10				8			10		8	
1908	SW		3.6			5.4	6.2	6.2	5.7		3.5			
	V		2.6			4.2	5.4	4.9	4.6		2.3			
	D		270			260	270	270	280		260			
	N		11			13	14	17	10		8			
1909	SW	4.0		3.6	4.3		6.0		3.8	4.4	3.2			
	V	3.2		2.7	2.0		4.6		5.0	3.1	2.6			
	D	270		260	270		280		260	260	270			
	N	12		29	11		11		12	23	5			
1910	SW	3.5	2.9	3.7	4.2		3.8	3.9		5.2			3.5	
	V	2.7	2.4	2.6	3.6		4.7	4.8		4.0			2.5	
	D	260	270	270	270		270	270		270			260	
	N	12	12	8	13		21	9		19			15	

* SW = SCALAR WIND SPEED V = VECTOR MEAN WIND SPEED D = RESULTANT DIRECTION N = OBSERVATION COUNT

ANNEX V

HSST DATA PROJECT: FEDERAL REPUBLIC OF GERMANY
FORMAT FOR SUMMARIES

(Reference: paragraph 4.2)

Header record	50 character
HSSTD-PROJEKT ATLANTISCHER OZEAN FELDER 1 - 213	

Data record	70 character
Area name (1-157, 201-213)	3
Decade (0-10, 99)	2
Year (1852-1960, 9999)	4
Month (1-12, 99)	2
Longitude indicator (1 = east, 2 = west)	1
Mean longitude (0.1 degrees)	4
Latitude indicator (1 = north, 2 = south)	1
Mean latitude (0.1 degrees)	3
Number of 1° squares concerned	3
Mean day within the month (year)	3
Number of days concerned	3
Number of sea surface observations	6
Sign of sea surface mean value	1
Mean sea surface temperature value (0.1° C)	3
Standard deviation (0.1° C)	3
Number of air temperature observations	6
Sign of air temperature mean value	1
Mean air temperature value (0.1° C)	3
Standard deviation (0.1° C)	3
Number of wind observations	6
Scalar mean wind speed (0.1 m/s)	3
Vector resultant speed (0.1 m/s)	3
Vector resultant direction (degrees)	3

End of file

ANNEX VI

DATA SERVICE CENTRES ABLE TO SUPPLY HSST DATA SUMMARY TAPES

(Reference: paragraph 4.1)

1. National Climatic Data Center
Federal Building
ASHEVILLE, NC 28801-2696
U.S.A.

2. Koninklijk Nederlands Meteorologisch Instituut
Wilhelminalaan 10
P.O. Box 201
3730 AE De BILT
Netherlands

3. Deutscher Wetterdienst, Seewetteramt
Bernhard-Nocht-Strasse 76
D-2000 HAMBURG 4
Federal Republic of Germany

4. Meteorological Office Met O 3c
London Road
BRACKNELL, Berkshire RG12 2SZ
United Kingdom

ANNEX VII

BEAUFORT WIND CONVERSION SCALE

(Reference: paragraph 5.3)

Conversion of knots according to WMO Code 1100 into m/s of the CMM-IV scale*

Knots (Code 1100)	Beaufort	Equivalent speeds in m/sec (CMM-IV) Mean	Range
0	0	0.8	0 - 1.3
1 - 3	1	2.0	1.4 - 2.7
4 - 6	2	3.6	2.8 - 4.5
7 - 10	3	5.6	4.6 - 6.6
11 - 16	4	7.9	6.7 - 8.9
17 - 21	5	10.2	9.0 - 11.3
22 - 27	6	12.6	11.4 - 13.8
28 - 33	7	15.1	13.9 - 16.4
34 - 40	8	17.8	16.5 - 19.2
41 - 47	9	20.8	19.3 - 22.4
48 - 55	10	24.2	22.5 - 26.0
56 - 63	11	28.0	26.1 - 30.0
64	12	32.2**	

* Approved by the WMO Executive Committee for use in scientific projects

** Value accepted for use in HSST Data Project

ANNEX VIII

HSST COMPACT FORMAT

(Reference: Annex III)

CD	MSQ	Q	LAT	LON	YR	MO	DA	HR	WIND DIRECT	WIND SPD	AIR TEMP	SEA TEMP	AREA
XXX	XXX	X	XXX	XXXX	XXX	XX	XX	XX	iXX	iXXX	XXX	XXX	XXXX

Field	Col.	Element*
001	1-3	Card Deck Number in TDF-11
002	4-6	Marsden 10° Square
003	7	Quadrant
004	8-10	Latitude
005	11-14	Longitude
006	15-17	Year (last 3 digits, i.e. 927 = 1927)
007	18-19	Month
008	20-21	Day
009	22-23	Hour-GMT
010	24-26	Wind Direction and Indicator
011	27-30	Wind Speed and Indicator
012	31-33	Air Temperature
013	34-36	Sea Surface Temperature
014	37-40	Area

* TDF-11 describes elements

Logical Rec. = 40
Blocking Factor = 100

HSST DATA SET - EXTENDED FORMAT FOR ATLANTIC AND INDIAN OCEANS AND MEDITERRANEAN DATA

Character UK/US	Notation NL/DL	Record Identifier
1		H
2		M Historical Marine Data
3		D
4		Identifies the country of origin of the tape
5		
6	1	Octant
7	2	
8	3	Square Number
9	4	Month
10	5	
11	6	Year
12	7	
13	8	
14	9	
15	10	Latitude
16	11	Position
17	12	Unit and tenths Longitude
18	13	
19	14	Day of month
20	15	
21	16	Hour of day (00-23 GMT)
22	17	
23	18	+, -
24	19	
25	20	Sea Temperature (tenths of °C)
26	21	
27	22	+, -
28	23	
29	24	Air Temperature (tenths of °C)
30	25	
31	26	+, -, e e = Ice
32	27	
33	28	Wet Bulb Temperature (Tenths of °C)
34	29	
35	30	000 = calm
36	31	Wind direction (whole degrees) 990 = variable
37	32	999 = missing
38	33	
39	34	Wind speed (tenths of m/s)
40	35	
41	36	
42	37	
43	38	Barometric Pressure (tenths of mbar)
44	39	
45	40	
46	41	Total Cloud Amount (oktas)
47	42	Flags for Sea Temperature
48	43	Flags for Air Temperature
49	44	Flags for Wind
50	45	F sus 1
51	46	F sus 2 Flags for suspect values

CODES FOR FLAG CHARACTERS

Flags for sea temperatures and state of wet bulb

F sea

0	Sea temperature measured to 0.1° F accuracy
1	Sea temperature measured to 0.1° C accuracy
2	Sea temperature measured to 0.5° F accuracy
3	Sea temperature measured to 0.5° C accuracy
4	Sea temperature measured to 1° F or 1° C accuracy
5) 6) 7) 8) 9)	As for codes 0-4, but also the wet bulb is not frozen, even when showing temperature below freezing point.

Flags for Dry Bulb and Wet Bulb Temperatures

F air

0	Air temperatures measured to 0.1° F accuracy
1	Air temperatures measured to 0.1° C accuracy
2	Air temperatures measured to 0.5° F accuracy
3	Air temperatuares measured to 0.5° C accuracy
4	Air temperatures measured to 1° F or 1° C accuracy
5) 6) 7) 8)	As for codes 0-3, but temperatures were measured by an aspirated or whirling psychrometer.
9	Original units of temperature or accuracy unknown.

Flags for wind observations

0	360 point compass)	
1	36 point compass)	
2	32 point compass)	Wind speed measured
3	16 point compass)	
4	8 point compass)	
5)		
6)	As for codes 0-4, but wind speed estimated or converted	
7)	from Beaufort force, or method of observation unknown.	
8)		
9)		

Flags for suspect values of sea temperature, air temperature and wind

F sus 1

0	No suspect element
+1	Sea temperatures 97° F (36.1° C)
+2	Dry Bulb or Wet Bulb not in range -5° F to 99.9° F (-20.5° C to 37.7° C) or Wet Bulb Dry Bulb
+4	Wind direction 990 (variable) and wind speed 5kt

Flags for suspect values of pressure and cloud amount

F sus 2

0	No suspect pressure or cloud amount
+1	Pressure 940 or 1050 (Pressure 800 or 1080 have been rejected)
+2	Cloud amount not reported
+4	Additional observation at the same time in the same 1° square though not identical.

The values of F sus 1 and F sus 2 may also be 3,5,6 or 7. This means that more than one value is suspect, and the code figures have been added together for the suspect values.