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CONTENTS

THE STRUCTURE AND MOVEMENT OF THE CHINOOK IN ALBERTA

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INTRODUCTION

IN THOSE PARTS OF CANADA OUTSIDE OF THE PRAIRIE PROVINCES, THE CHINOOK IS REGARDED AS A SOMEWHAT EXOTIC PHENOMENON WHICH MAKES LIFE POSSIBLE IN ALBERTA AND PARTS OF SASKATCHEWAN DURING THE WINTER MONTHS. EVEN IN THE 'CHINOOK BELT', HOWEVER, THE TRUE NATURE OF THE CHINOOK IS LITTLE UNDERSTOOD, ALTHOUGH ITS EFFECTS, IN SOME YEARS AT LEAST, ARE VERY IMPORTANT.

STATED SIMPLY, THE CHINOOK IS A WARM DRY WIND DESCENDING THE LEEWARD SIDE OF THE MOUNTAINS. IT IS THE RESULT OF THE PASSAGE OF A TYPICAL MID-LATITUDE LOW-PRESSURE CENTRE AT THE LEE OF THE ROCKY MOUNTAINS INTO WHICH AIR IS DRAWN. SINCE THE MOUNTAINS LIE IN THE PATH OF AND AT RIGHT ANGLES TO THE MAIN WESTERLY AIR-STREAM, DISTURBANCES ARE SET UP IN THIS STREAM IN THE FORM OF A WAVE-TRAIN WITH TROUGHS AND CRESTS ROUGHLY PARALLEL TO THE MOUNTAIN RANGES, (FIG. 1). THE AIR DESCENDS AT THE DRY ADIABATIC LAPSE RATE BRINGING HIGH TEMPERATURES AND LOW RELATIVE HUMIDITIES TO THE LEE SLOPES, THIS IS KNOWN AS THE 'FOEHN EFFECT'.

THE AMPLITUDE OF THE WAVE SYSTEM DEPENDS MAINLY ON THE STRENGTH OF THE UPPER WESTERLY WINDS, BESIDES OTHER FACTORS SUCH AS AIR MASS CONDITIONS AND THE TOPOGRAPHY OF THE AREA. WITH LIGHT WINDS THE AMPLITUDE WILL BE SMALL, AND THE CHINOOK CURRENT MAY NOT REACH THE GROUND. IT WILL LIE A FEW THOUSAND FEET ABOVE THE GROUND AS A WARM LAYER FORMING AN INVERSION, UNDER WHICH A LIGHT PALL OF POLLUTION HAZE WILL FORM IN THE BUILT-UP AREAS OF CITIES SUCH AS CALGARY. IN THE CREST OF THE WAVES THE CLOUD FORMATION KNOWN AS THE CHINOOK ARCH MAY FORM IN A LINEAR BAND OF LENTICULAR ALTOCUMULUS PARALLEL TO THE MOUNTAINS AND STRETCHING FOR TENS OR HUNDREDS OF MILES IN A ROUGHLY N-S DIRECTION (THOMAS 1963).

OBSERVATION OF THE ARCH SUGGESTS THAT ITS WESTERN EDGE IS CLOSE TO THE LINE OF THE MOUNTAINS IN THE MORNINGS AND THAT THE WHOLE ARCH MOVES EASTWARDS DURING THE DAY. WINDS ARE OFTEN STRONG NEAR THE MOUNTAINS IN THE MORNINGS UNDER CHINOOK CONDITIONS, WHILE AT CALGARY, 45 MILES FROM THE E. EDGE OF THE MOUNTAINS, THE WINDS TEND TO BE CALM IN THE MORNINGS AND TO STRENGTHEN TOWARDS MIDDAY. THE WHOLE WAVE SYSTEM THUS SEEMS TO BE MOBILE, WITH FULL DEVELOPMENT STARTING NEAR THE MOUNTAINS, WHERE THE COLD ARCTIC AIR BELOW THE CHINOOK CURRENT IS

THINNEST, AND GRADUALLY MOVING EASTWARD. UPPER AIR ASCENTS ARE NOT NORMALLY MADE AT PRESENT AT CALGARY, BUT A FEW MADE IN NOVEMBER, 1966, SHOW THAT AT CERTAIN STAGES DURING A CHINOOK PERIOD, THE LOWER LEVELS ARE UNSTABLE. THIS SUGGESTS THAT UNDER NORMAL DIURNAL HEATING CONDITIONS, CONVECTION MAY OCCUR, BRINGING GRADIENT CONDITIONS TO THE SURFACE PROGRESSIVELY FURTHER FROM THE MOUNTAINS AS THE DAY ADVANCES.

THIS MOVEMENT OF THE CHINOOK HAS IMPORTANT IMPLICATIONS, FIRST OF WHICH IS THAT THERE IS PROBABLY AN AREA BETWEEN CALGARY AND THE MOUNTAINS IN WHICH THE OCCURRENCE OF THE CHINOOK IS AT A MAXIMUM. THIS IS OF IMPORTANCE TO ANY STUDY OF LOCAL HYDROLOGY AND RESOURCES, ESPECIALLY RANCHING, IN THAT THE MOST FAVORED AREA WILL HAVE A LIGHTER SNOW-COVER AND BE MORE SUITABLE FOR GRAZING CATTLE IN THE WINTER.

METHOD OF INVESTIGATION

THE CHINOOK RESEARCH SCHEME OF THE UNIVERSITY OF CALGARY IS, THEREFORE, INVESTIGATING THIS MOVEMENT AMONG OTHER ASPECTS OF THE CHINOOK. THE MAIN MEANS IS BY A LINE OF RECORDING STATIONS BETWEEN CALGARY AND THE ROCKY MOUNTAIN FRONT, SOME OF WHICH ARE SHOWN ON FIG. 2. CONTINUOUS RECORDS OF DRY-BULB TEMPERATURE, RELATIVE HUMIDITY, AND IN SOME CASES, WIND DIRECTION AND SPEED, ARE MADE ON WEEKLY-RECORDING CHARTS AND THE TEMPERATURE RECORDS ARE COMPARED WITH A MAXIMUM-MINIMUM THERMOMETER WHEN CHARTS ARE CHANGED. INSTRUMENTS VARY IN PATTERN BUT TEMPERATURE IS RECORDED ON BIMETALLIC THERMOGRAPHS AND RELATIVE HUMIDITY ON HAIR HYGROGRAPHS. PRESSURE FLUCTUATIONS ARE OBTAINED FROM A CASELLA MICRO-BAROGRAPH AT STATION 1, ON THE WESTERN OUTSKIRTS OF CALGARY. ALL THE OBSERVATIONS FOR EACH HOUR ARE ABSTRACTED AND STORED ON PUNCHED CARDS.

IN THE PRELIMINARY STAGES OF THE INVESTIGATION A COMPUTER PROGRAM DEPENDING ENTIRELY ON TEMPERATURE CHANGE WAS USED FOR DETECTING CHINOOKS, AND WAS USED IN WORKING UP THE RESULTS FOR THIS PAPER. THIS PROGRAM SELECTED A TEMPERATURE AT THE SIXTH HOUR OF A SERIES AND SUBTRACTED THE TEMPERATURE AT THE FIRST HOUR FROM IT. ANY POSITIVE DIFFERENCE WAS STORED. THE PROCESS WAS REPEATED FOR THE SEVENTH AND SECOND HOURS AND SUBSEQUENT SETS FIVE HOURS APART WITH POSITIVE DIFFERENCES BEING STORED AND ADDED. STORAGE CEASED WHEN NEGATIVE VALUES OF DIFFERENCE WERE REACHED. ANY TOTAL COMPUTER VALUE OF OVER 100 POSITIVE DEGREES WAS RECORDED, TOGETHER WITH THE HOURS OVER WHICH IT WAS ATTAINED.

THIS PROGRAM WAS FOUND UNSATISFACTORY IN SOME RESPECTS, IN THAT IT WAS SOMETIMES GROSSLY AFFECTED BY NORMAL DIURNAL TEMPERATURE CHANGES AND HAS SINCE BEEN ABANDONED IN FAVOR OF ONE INITIATED BY WIND DIRECTION AND SPEED. HOWEVER, IT SERVED ITS PURPOSE FOR THIS INVESTIGATION.

THE BEST RECORDS AVAILABLE WERE THOSE FOR STATIONS 1, 3 AND 9 AND THESE, WITH OTHERS, ARE DISCUSSED HERE FOR PERIODS OF CHINOOKS DURING THE WINTER OF 1964-65. A TYPICAL SYNOPTIC SITUATION DURING A PERIOD OF CHINOOKS IS SHOWN IN FIG. 3. THE MOST NOTEWORTHY FEATURE IS THE MARKED ABSENCE OF PRECIPITATION ASSOCIATED WITH THE WARM FRONT.

THE PROJECTIS TECHNICIAN TRAVELS THROUGH THE AREA ONCE A WEEK TO CHANGE CHARTS AND MAINTAIN THE STATION EQUIPMENT. AT THE SAME TIME, A RECORD IS MADE OF SNOW COVER IN DIFFERENT PARTS OF THE AREA. IT WAS CONSIDERED BEST TO CONCENTRATE ON THOSE CHINOOKS WHICH OCCURRED ABOUT THE TIME OF A VISIT BY THE TECHNICIAN SO THAT THE EFFECT OF THE CHINOOK ON SNOW COVER COULD BE INVESTIGATED.

RESULTS

TABLE 1 SUMMARIZES THE RATE OF TEMPERATURE INCREASE AT THE THREE STATIONS 1, 3 AND 9 FOR THOSE PERIODS OF CHINOOK DURING THE WINTER 1964–65 WHICH WERE INDICATED BY THE COMPUTER PROGRAM.
READINGS FROM INTERMEDIATE STATIONS 2, 4 AND 5 WERE SO INTERMITTENT DURING THIS PERIOD DUE TO INSTRUMENT MALFUNCTION AS TO BE USELESS. THE CHINOOKS OF 12–15 JANUARY AND 3–6 FEBRUARY ARE DISCUSSED BELOW AND THE TEMPERATURE AND PRESSURE GRAPHS ARE SHOWN IN FIG. 4.

CHINOOK 12–15 JANUARY, 1965

MAXIMUM TEMPERATURES AT ALL STATIONS WERE BETWEEN 40^0 AND 50^0 F. THE ARRIVAL OF THE CHINOOK CAUSED A SHARP INCREASE OF TEMPERATURE AT ALL STATIONS, WHICH WAS MOST PRONOUNCED, HOWEVER, AT STATIONS 1 AND 9.

THE CURVE FOR STATION 9 SHOWS A PATTERN OF TWO TEMPERATURE TROUGHS AND THREE TEMPERATURE CRESTS, REMARKABLE FOR THE FACT THAT THE TWO CRESTS OCCURRED NEAR MIDNIGHT, A DAY APART, AND TWO OF THE TROUGHS IN THE AFTERNOONS, WITH THE SECOND TROUGH AND CREST REACHING HIGHER TEMPERATURES THAN THE FIRST. THE FACT THAT THE PERIOD OF TEMPERATURE CHANGES WAS EXACTLY OUT OF PHASE WITH THE DIURNAL TEMPERATURE PATTERN IS AN EXCELLENT INDICATION THAT THIS WAS A TRUE CHINOOK SINCE THE DIURNAL TEMPERATURE CHANGES CAN BE MISLEADING AT ANY OTHER TIME OF THE DAY. AT STATION 1, CALGARY, THE GENERAL TREND WAS SIMILAR TO THAT OF STATION 9, BUT THE TROUGHS AND CRESTS ARE LESS NOTICEABLE. THE MOST NOTEWORTHY FACT, HOWEVER, IS THAT TWO OF THE CRESTS AT STATION 1 OCCURRED AROUND NOON, POSSIBLE AFFECTED BY THE DAILY TEMPERATURE CYCLE, WHEN STATION 9 SHOWED TEMPERATURE TROUGHS, WITH THE OTHER CREST AT STATION 1 COINCIDING WITH ONE AT STATION 9. IN THE FIRST TWO CASES, THEREFORE, THERE WAS A SIMULTANEOUS TEMPERATURE DIFFERENCE OF ABOUT 20^0 F BETWEEN STATIONS 1 AND 9, INDICATING THE MOVEMENT OF SUCCESSIVE CHINOOK WAVES OVER THE STATIONS. DURING THE 13TH AND 14TH OF JANUARY THE TEMPERATURE AT STATION 1 WAS FOUND TO VARY DIRECTLY WITH THE WIND SPEED AND INVERSELY WITH THE RELATIVE HUMIDITY. HOWEVER, THE RELATIVE HUMIDITY WAS GENERALLY HIGHER AROUND MIDNIGHT OF THE 13TH THAN AROUND NOON OF THE 13TH AND 14TH. THEREFORE, THE LAST CASE COULD BE INTERPRETED AS A TURBULENT MIXING AT NIGHT WHICH DESTROYED THE NOCTURNAL INVERSION UNDERNEATH THE CHINOOK CREST. THIS WOULD EXPLAIN THE MAXIMUM WHICH OCCURRED AT MIDNIGHT OF THE 13TH AT STATION 1 AND WOULD INDICATE AN ALMOST PERFECT WAVE PATTERN.

AS WOULD BE EXPECTED, THE PRESSURE TRACE FROM THE BAROGRAPH AT STATION 1 (CALGARY) SHOWS TWO PERIODS OF LOW PRESSURE, BOTH COINCIDING WITH THE TEMPERATURE INCREASES. IT WOULD BE INTERESTING TO NOTE PRESSURE FLUCTUATIONS NEARER

THE MOUNTAINS, TO DISCOVER WHETHER THE TIMES OF PRESSURE TROUGHS AND CRESTS DIFFER FROM THOSE AT CALGARY.

ON 13 JANUARY THE SNOW COVER AT STATION 1 (CALGARY) WAS 100 PER CENT, BY THE EVENING OF 14 JANUARY IT WAS 70 PER CENT, AND ON 16 JANUARY AND FOR SEVERAL DAYS THEREAFTER, IT REMAINED AT 60 PER CENT. THE TECHNICIAN ON HIS ROUNDS ON 15 JANUARY ESTIMATED THE PERCENTAGE SNOW COVER AT STATIONS 9, 5 AND 4 TO BE 5 PER CENT IN SHADED AND WOODED AREAS, OTHERWISE ZERO. AT STATIONS 5 AND 4 THE GROUND WAS DRY, BUT TO THE EAST OF STATION 4 THE SNOW COVER INCREASED MARKEDLY, AND AT STATION 2 THE COVER WAS GREATER THAN 50 PER CENT. IT APPEARS, THEREFORE, THAT THE CHINOOK WAS MOST INTENSE FROM 13–15 JANUARY IN THE AREA INCLUDING STATIONS 4 AND 9, AND LESS INTENSE TO THE EAST. BECAUSE OF THE HIGH TEMPERATURES IN BOTH EAST AND WEST, IT IS SUGGESTED THAT THE MAIN DIFFERENCE WAS IN WIND SPEED.

SINCE THE FALL IN PRESSURE AT STATION 1 COINCIDED WITH RISING TEMPERATURES AT THAT STATION AND FALLING TEMPERATURES AT STATION 9 ON TWO OCCASIONS, IT CAN BE INFERRED THAT THE CHINOOK WAVE LOWERED AT STATION 1 AND ROSE AT STATION 9 AT THESE TIMES. STATION 3 REPRESENTED A POINT WHICH WAS ALMOST ALWAYS IN THE WAVE, WITH GRADUALLY RISING TEMPERATURES. INDICATIONS OF A SIMILAR PATTERN ARE SEEN FOR 14–17 FEBRUARY (FIG. 4). THE WAVELENGTH MUST HAVE BEEN IN THE ORDER OF 70 MILES IF THE STATIONS 1 AND 9 WERE EXACTLY IN THE TROUGH AND CREST OF THE WAVE, BUT THIS IS NOT NECESSARILY SO. PROBABLY THE WAVELENGTH WAS MUCH SHORTER IN WHICH CASE, THE TROUGH AND CREST MUST HAVE BEEN LOCATED BETWEEN THE TWO STATIONS. OR, ALTERNATIVELY, ANOTHER TROUGH COULD HAVE EXISTED BETWEEN THE STATIONS. IT WAS NOT POSSIBLE TO ANSWER THIS QUESTION DUE TO LACK OF INFORMATION FROM INTERMEDIATE STATIONS, ALTHOUGH THE LOCATION OF STATION 3, WHICH WAS ALWAYS IN THE WARM AIR, INDICATES A FAIRLY WIDE TROUGH.

CHINOOK 3–6 FEBRUARY, 1965

MAXIMUM TEMPERATURES WERE IN THE RANGE OF 30^0–40^0F. ONCE AGAIN, STATION 9, NEAR THE MOUNTAINS, EXPERIENCED THE CHINOOK FOR LONGER THAN THE OTHER STATIONS WITH STATION 1 HAVING THE SHORTEST EXPOSURE. STATION 9 ALSO HAD TWO PEAKS IN TEMPERATURE AT THE BEGINNING OF THE PERIOD, THE FIRST BEING 12 HOURS BEFORE THE SECOND AND MAIN PEAK WHICH OCCURRED ALSO AT THE OTHER STATIONS. THE FALL IN TEMPERATURE INDICATING THE END OF THE CHINOOK OCCURRED AT ABOUT THE SAME TIME AT ALL STATIONS, THOUGH STATION 9 WAS THE LAST TO EXPERIENCE IT.

STATION 1 AT CALGARY HAD A SNOW COVER OF 100 PER CENT THROUGHOUT THE PERIOD, DESPITE THE APPEARANCE OF A CHINOOK ARCH ON 3 FEBRUARY. THERE WAS ONLY A TRACE OF SNOW AT STATION 3 WHEN THE TECHNICIAN VISITED IT ON THE 5TH, BUT NEW SNOW HAD ALREADY FALLEN AT STATION 9 AND THE COLD ARCTIC AIR HAD SPREAD AS FAR AS STATION 4 ON THAT DAY (TABLE 2). THERE IS, UNFORTUNATELY, NO RECORD OF THE SNOW CONDITIONS AT STATIONS 3, 4 AND 9 BEFORE THIS CHINOOK, AND IT IS JUST POSSIBLE THAT SNOWFALLS WERE LIGHTER IN THOSE AREAS THAN AT CALGARY.

ONCE AGAIN, IT APPEARS POSSIBLE THAT THE WESTERN PART OF THE AREA HAD EX–

PERIENCED A MUCH GREATER SNOW CLEARANCE THAN THE AREA NEARER CALGARY, PROBABLY DUE TO STRONGER WINDS AND A GREATER DURATION OF HIGHER TEMPERATURES. THE BAROMETER FELL 24 MB DURING THE ARRIVAL OF THE WARMER AIR AT STATION 1, AND SHOWED A FURTHER DIP JUST BEFORE THE ARRIVAL OF THE FRONT SHOWING THE END OF THE CHINOOK. THE WAVE FORM OF THE CHINOOK IS APPARENT IN THE PRELIMINARY PEAK OF TEMPERATURE AT STATION 9, WITH A DISAPPEARANCE OF THE WAVE BEFORE THE RE-APPEARANCE WHICH BROUGHT ALL STATIONS, TO A GREATER OR LESSER EXTENT, UNDER ITS INFLUENCE, AND IN THE ALMOST SIMULTANEOUS DISAPPEARANCE OF THE WARM AIR AT THE END OF THE CHINOOK.

CONCLUSION

ALTHOUGH MUCH OF THE AREA FROM CALGARY TO THE ROCKY MOUNTAINS EXPERIENCES CHINOOK CONDITIONS, THERE IS AN AREA CLOSE TO THE E. EDGE OF THE MOUNTAINS WHICH EXPERIENCES THE CHINOOK EARLIER AND MORE INTENSELY THAN THE CALGARY AREA. THE CHINOOK WAVES MOVE OUT FROM THIS AREA OF GREATEST INTENSITY TOWARDS THE EAST, THOUGH THE TIME-LAG OF OCCURRENCE MAY BE AS MUCH AS 24 HOURS BETWEEN STATION 9 AT THE MOUNTAINS AND STATION 1 IN CALGARY. SNOW COVER IS USUALLY CLEARED MOST IN THE AREA NEARER TO THE MOUNTAINS.

ACKNOWLEDGEMENTS

THE CHINOOK RESEARCH SCHEME IS AIDED BY A GRANT FROM THE NATIONAL RESEARCH COUNCIL OF CANADA. THANKS ARE DUE TO THE DEPARTMENT OF FORESTRY FOR READINGS FROM THE KANANASKIS FORESTRY EXPERIMENTAL STATION AND TO THE DIRECTOR, METEOROLOGICAL BRANCH, FOR ASSISTANCE IN MANY WAYS. THE PROJECT'S TECHNICIAN, D. AYLES, AND GRADUATE ASSISTANT, J.S. MARSH, ALSO HELPED CONSIDERABLY IN GATHERING DATA.

REFERENCES

T.M. THOMAS: "SOME OBSERVATIONS OF THE CHINOOK ARCH" WEATHER XVIII, 6 (JUNE 1963) PP 166-170.

TABLE 1

RATE OF TEMPERATURE INCREASE (^{0}F:HR.)

DATE	STATION 1	STATION 3	STATION 9
DEC. 2– 3, 1964	1.0	1.4	1.1
DEC. 12–13, 1964	3.3	–	3.6
DEC. 25 1964	3.0	–	4.3
JAN. 9–10, 1965	3.4	–	13.7
			2.7
JAN. 12–15, 1965	1.7	1.1	2.7
			1.8
			3.0
JAN. 25–26, 1965	2.0	–	5.0
			1.7
JAN. 27–29, 1965	2.8	1.9	2.1
FEB. 3– 6, 1965	1.9	1.6	2.1
FEB. 6– 7, 1965	3.9	1.8	3.6
FEB. 14–17, 1965	3.5	1.6	5.0
	3.1	2.4	5.0
			4.2
FEB. 22–23, 1965	15.0	–	3.8
	3.4		
AVERAGE RATE OF TEMP. INCREASE (^{0}F:HR.)	3.7	1.7	3.8

TABLE 2

	STATION	COMPUTER VALUE	RATE OF TEMP. INCREASE (°F./HR.)	MAX. TEMP.	TIME OF MAX. TEMP.	OBSERVATION OF SNOW COVER		BAROMETRIC CHANGE CALGARY
						TIME	PER CENT	
CHINOOK 12–15 JAN., 1965	1	220	1.7	41	13/1 (1400)		70	JAN. 12–13
	2	NO TEMPERATURE RECORDS					50	A RISE AND FALL OF 3 AND 4 MB. OCCURRED TWICE.
	3	133	1.1	34	13/1 (1400)			
	4	NO TEMPERATURE RECORDS				15 1	5	JAN. 14–15
	9	164	2.7	34	12/1 (1600)			AN INCREASE OF 12 MB.
		101	1.8	40	14/1 (0200)		5	
		103	3.0	51	14/1 (2300)			
CHINOOK 3–6 FEB., 1965	1	170	1.9	40	4/2 (1500)		100	FEB. 3–4
	2	NO TEMPERATURE RECORDS					DROPPING OFF	DROP OF 24 MB.
	3	202	1.6	34	4/2 (0700)	5 2		
	4	NO TEMPERATURE RECORDS					TRACE	
	9	190	2.1	40	4/2 (0700)		411 NEW SNOW	

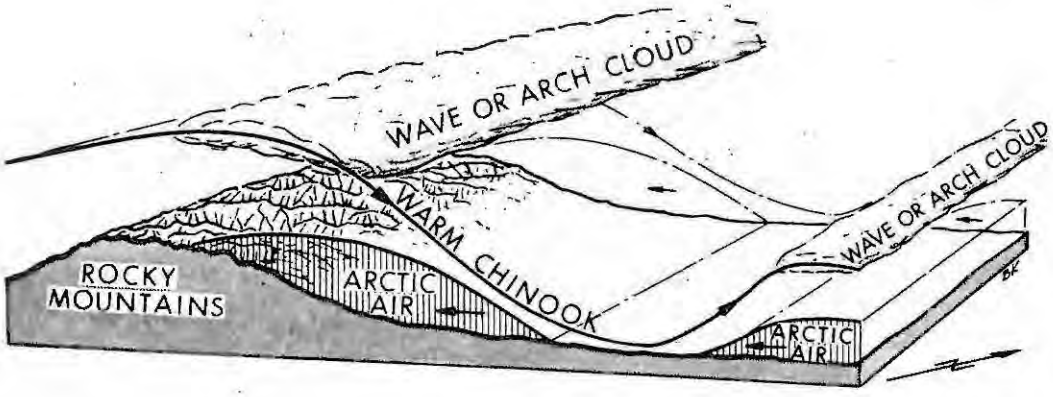

FIGURE 1. DIAGRAM OF THE CHINOOK WAVES AS THEY DISPLACE COLD ARCTIC AIR OVER THE ROCKY MOUNTAIN FOOTHILLS AND THE PRAIRIES, WITH THE CHINOOK ARCH AT THE CRESTS OF THE WAVES.

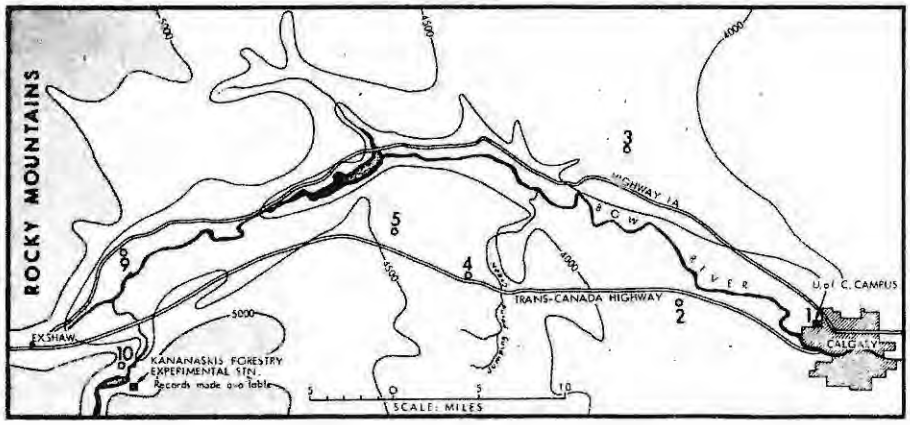

FIGURE 2. STATIONS OPERATED BY THE CHINOOK RESEARCH SCHEME IN THE AREA CALGARY TO THE ROCKY MOUNTAINS, WITH THE FORESTRY EXPERIMENTAL STATION AT KANANASKIS FROM WHICH RECORDS ARE AVAILABLE.

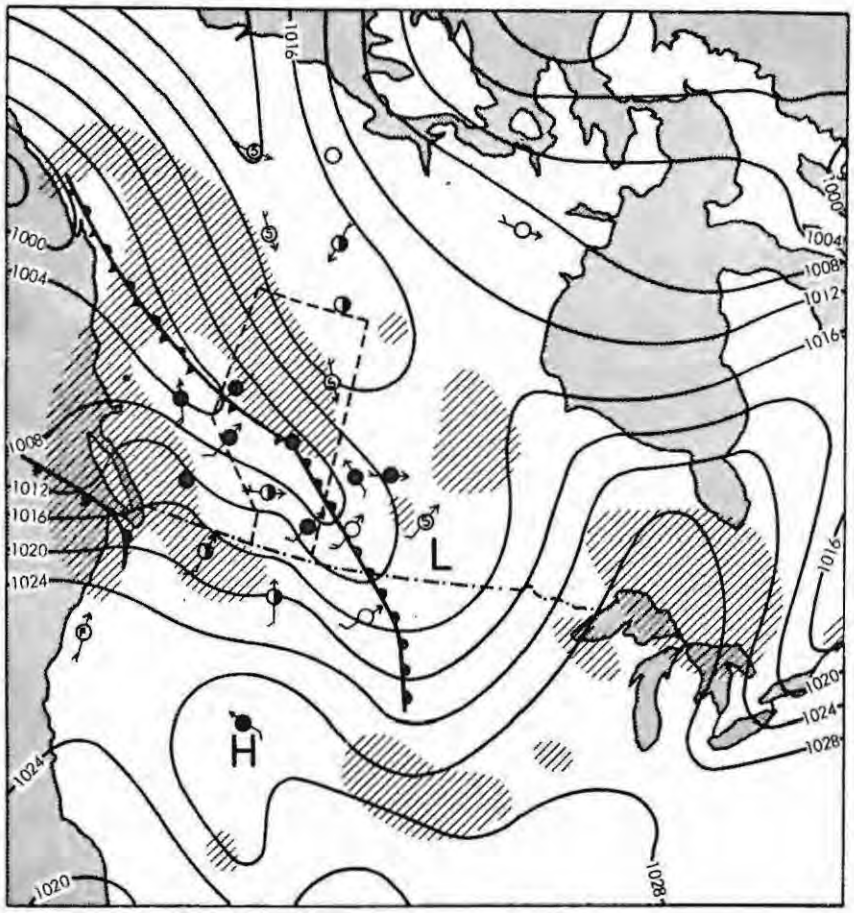

FIGURE 3. SYNOPTIC SITUATION 0600 16TH FEBRUARY, 1964. SOUTHERN ALBERTA LIES IN THE WARM SECTOR OF A DEPRESSION, WITH CHINOOK CONDITIONS WELL DEVELOPED. HATCHED AREAS REPRESENT PRECIPITATION. FROM WEATHER MAP PUBLISHED BY DEPARTMENT OF TRANSPORT.

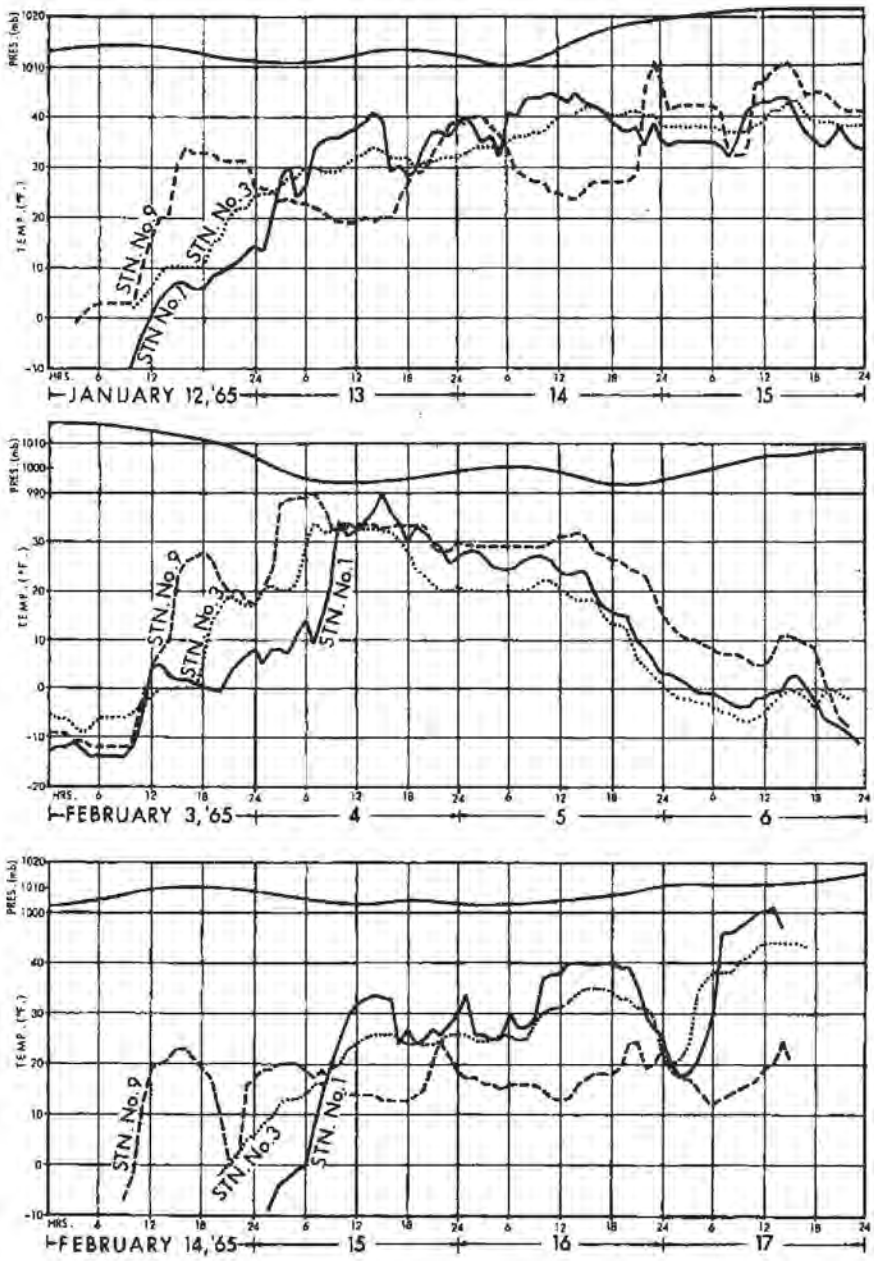

FIGURE 4. PRESSURE AND TEMPERATURE VARIATIONS DURING CHINOOK CONDITIONS. PRESSURES ARE MEASURED AT STATION 1. THE THIRD CASE SHOWN, THAT OF FEBRUARY 14–17, IS NOT DISCUSSED IN THE PAPER.

SPOTLIGHT ON GARP

W.L. GODSON

1. INTERNATIONAL PLANNING FOR GARP

THE GLOBAL ATMOSPHERIC RESEARCH PROGRAM (GARP) HAS BEEN DISCUSSED RATHER EXTENSIVELY BY INTERNATIONAL BODIES IN RECENT YEARS, PRIMARILY BY THE WMO ADVISORY COMMITTEE, THE ICSU–IUGG* COMMITTEE ON ATMOSPHERIC SCIENCES AND COSPAR* WORKING GROUP VI. REPORTS PREPARED BY THESE BODIES ARE AVAILABLE.

GARP STEMS FROM UN RESOLUTIONS 1721 AND 1802, WHICH CALLED ON WMO AND ICSU TO COLLABORATE ON RESEARCH ASPECTS OF WORLD WEATHER WATCH (WWW). IN 1964 ICSU ENDORSED A GLOBAL ATMOSPHERIC RESEARCH PROJECT, SUBSEQUENTLY EXPANDED IN THE FIRST, SECOND AND THIRD REPORTS OF THE ICSU–IUGG COMMITTEE ON ATMOSPHERIC SCIENCES. IN 1967 WMO FIFTH CONGRESS ACCEPTED THE GARP CONCEPT AND PROPOSED THE CREATION OF A JOINT WMO–ICSU GARP ORGANIZING COMMITTEE AS THE PRIMARY SCIENTIFIC ORGAN IN THE PLANNING AND OPERATION OF GARP.

A MAJOR PLANNING SEMINAR WAS HELD IN STOCKHOLM, JUNE 28 TO JULY 11, 1967. AT THIS MEETING, DETAILED PLANS, CRITERIA AND RECOMMENDATIONS WERE PREPARED TO FURTHER ADVANCE GARP PLANNING. THE ICSU BUREAU MET IN LONDON, JULY 20–21, AND GAVE PRELIMINARY AGREEMENT TO THE WMO PROPOSALS. THESE LATTER, TOGETHER WITH REPORTS FROM THE STOCKHOLM PLANNING CONFERENCE, WERE FURTHER STUDIED DURING THE IUGG GENERAL ASSEMBLY IN SWITZERLAND, SEPTEMBER 26–OCTOBER 6, AND RECOMMENDATIONS TRANSMITTED TO THE OCTOBER 1967 MEETING OF THE ICSU EXECUTIVE COMMITTEE.

ON OCTOBER 10, 1967, WMO AND ICSU SIGNED AN AGREEMENT SETTING UP A JOINT WMO–ICSU GARP ORGANIZING COMMITTEE, WITH THE FOLLOWING MEMBERSHIP.

B. BOLIN	(SWEDEN)	P.R. PISHAROTY	(INDIA)
V.A. BUGAEV	(USSR)	C.H.B. PRIESTLEY	(AUSTRALIA)
F. MOLLER	(FRG)	J.S. SAWYER	(U.K.)
A.S. MORIN	(USSR)	J. SMAGORINSKY	(USA)
P. MOREL	(FRANCE)	R.W. STEWART	(CANADA)
Y. OGURA	(JAPAN)	V.E. SUOMI	(USA)

* ICSU – INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
IUGG – INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS
COSPAR – COMMITTEE ON SPACE RESEARCH

2. RELATION OF GARP TO WWW

IN 1967 WMO FIFTH CONGRESS ADOPTED A DETAILED PLAN AND SCHEDULE FOR WWW, INDICATING THOSE ASPECTS WHICH SHOULD BE IMPLEMENTED IN 1968–71, AS WELL AS FUTURE ACTIVITIES REQUIRING PLANNING STUDIES AND INVESTIGATION IN THAT PERIOD. WWW IS A GLOBAL DATA COLLECTION, PROCESSING AND DISSEMINATION SYSTEM HAVING AS ITS AIM THE PROVISION OF OPTIMUM SERVICE TO ALL PEOPLES THROUGH COLLECTIVE ACTION WITHIN WMO. IN ITS FULLY DEVELOPED FORM IT ENVISAGES THE ACQUISITION AND RAPID COLLECTION OF DATA FROM THE ENTIRE GLOBE, THE AUTOMATIC PROCESSING OF THESE DATA TO PROVIDE ANALYSES AND FORECASTS (THESE LATTER FOR THE MAXIMUM TIME PERIOD ACHIEVABLE WITH SKILL) AND THE SUBSEQUENT PROVISION OF SUCH INFORMATION TO ALL USER GROUPS.

THERE ARE MANY ASPECTS OF SUCH AN EVENTUAL WWW THAT REQUIRE RESEARCH ON EITHER A LABORATORY SCALE OR IN THE ATMOSPHERE, ON A LOCAL OR GLOBAL SCALE. NUMERICAL WEATHER PREDICTION AND GENERAL CIRCULATION RESEARCH SUGGESTS THAT EXTENDED–RANGE PREDICTION SHOULD BE POSSIBLE, PROVIDED THAT SUFFICIENT INITIAL DATA ON THE ATMOSPHERE AND ON THE AIR–EARTH BOUNDARY ARE AVAILABLE, PROVIDED THAT ALL SIGNIFICANT ATMOSPHERIC AND BOUNDARY PROCESSES ARE ADEQUATELY INCLUDED IN THE PHYSICAL FORMULATION OF THE PROBLEM AND PROVIDED THAT EXTREMELY SOPHISTICATED COMPUTERS PLUS HIGHLY ACCURATE AND STABLE NUMERICAL PROCEDURES ARE UTILIZED. IT IS THE AIM OF GARP TO TEST THE ABOVE HYPOTHESIS. IF SUCCESSFUL, EVEN IF ONLY TO A LIMITED EXTENT, IT WILL BE POSSIBLE TO SPECIFY THE OBSERVATIONAL SYSTEM REQUIRED TO YIELD USEFUL PREDICTIONS FOR THE ENTIRE GLOBE AND THE PERIOD OF VALIDITY OF SUCH PREDICTIONS. IT MAY ALSO BE POSSIBLE TO INDICATE WHETHER SPACE–TIME ENSEMBLES (OR AVERAGES) ARE PREDICTABLE FOR EVEN LONGER PERIODS, AND WHAT DEMANDS SUCH PREDICTION WOULD PLACE ON WWW FACILITIES.

THE DEVELOPMENT OF WWW IN THE 1968–71 PERIOD WILL FOLLOW CLASSICAL LINES IN DATA ACQUISITION AND PROCESSING, AND THE NETWORKS HOPED FOR ARE ADMITTEDLY INADEQUATE TO OPTIMIZE EVEN SHORT–RANGE PREDICTION. SIGNIFICANT IMPROVEMENTS WILL REQUIRE NEW OBSERVATION SYSTEMS (SATELLITE–BASED) AND CAN REASONABLY ONLY BE JUSTIFIED AND PLANNED AS A RESULT OF GARP – ALTHOUGH MANY STUDIES COULD BE CARRIED OUT SIMULTANEOUSLY RATHER THAN SEQUENTIALLY.

3. GARP AND ITS SUB–PROGRAMS

THE MAIN PHASE OF GARP, TENTATIVELY SCHEDULED FOR THE LATE 1970'S, WILL BE A 12–MONTH PERIOD DURING WHICH REGULAR AND SPECIAL OBSERVATION PROGRAMS WILL BE EXECUTED TO OBTAIN REASONABLY COMPLETE INFORMATION ON THE EARTH AND ITS ATMOSPHERE. A PRELIMINARY GLOBAL EXPERIMENT, WITH MAJOR EMPHASIS ON TROPICAL REGIONS, IS SCHEDULED FOR ABOUT 1973. THESE DATA WILL BE USED AS INITIAL DATA TO TEST VARIOUS LONG–RUN NUMERICAL PREDICTION MODELS. THIS WILL NOT BE DONE IN REAL TIME, SO THAT COMMUNICATION CIRCUITS WILL NOT BE REQUIRED TO CARRY ALL THE ADDITIONAL DATA, AND A UTILIZATION OF COMPLETE AND CHECKED DATA CAN BE

ENVISAGED FOR THE EXPERIMENTAL FORECASTS, AND FOR THEIR VERIFICATION.

PRIOR TO CARRYING OUT THE MAIN PHASE AS OUTLINED IN THE FOREGOING, IT WILL BE ESSENTIAL THAT CERTAIN MAJOR SUB-PROGRAMS OF GARP BE COMPLETED. OTHER ANCILLARY STUDIES WILL HAVE TO BE WELL ADVANCED, SUFFICIENTLY SO TO INDICATE THAT NO ASPECT OF THE MAIN STUDY WILL BE NEGATED AS A RESULT OF INADEQUATE PREPARATION OR EXPLORATION. THESE SUB-PROGRAMS ARE RELATED TO THE PROVISOS ATTACHED TO THE HYPOTHESIS ADVANCED IN THE LAST SECTION, AND MANY OF THESE WILL REQUIRE INTERNATIONAL CO-ORDINATION AS WELL AS FIELD PROJECTS OVER BOTH SMALL AND LARGE AREAS. THE EXPERIMENTAL GARP SUB-PROGRAMS REQUIRING INTEGRATED OBSERVATIONAL PHASES ARE TENTATIVELY SCHEDULED TO BE CARRIED OUT IN THE 1972-73 PERIOD, OR EARLIER IF POSSIBLE.

AS CAN BE SEEN FROM SECTION 2, PARAGRAPH 2, THE MAJOR SUB-PROGRAMS ARE AS FOLLOWS:

1. SPECIFICATION OF PARAMETERS AND OF SPACE TIME-DATA DENSITY, FOR BOTH THE ATMOSPHERE AND THE UNDERLYING SURFACE, INCLUDING ACCURACY REQUIRED.

2. DEVELOPMENT OF OBSERVATIONAL SYSTEMS TO MEET THE SPECIFICATIONS IN ITEM 1 ABOVE, INCLUDING DATA PROCESSING, COLLECTION AND ANALYSIS PROCEDURES.

3. MODELLING OF PERTINENT PHYSICAL PROCESSES (PRIMARILY RADIATION AND CLOUDINESS) IN TERMS OF OBSERVATIONAL GRID AND OBSERVATIONAL PARAMETERS.

4. MODELLING OF SUB-SYNOPTIC SCALE PROCESSES IN TERMS OF GRID-POINT DATA (PRIMARILY FOR EDDY-TYPE PROCESSES).

5. MODELLING OF BOUNDARY-LAYER PROCESSES (HEAT, MOMENTUM AND WATER VAPOUR EXCHANGE) IN TERMS OF GRID-POINT DATA.

6. DEVELOPMENT OF SOPHISTICATED NUMERICAL PROCEDURES WITH MINIMUM TRUNCATION ERRORS AND INSTABILITIES, FOR USE ON COMPUTERS OF EXTREMELY GREAT CAPACITY.

IT WILL BE APPRECIATED THAT MANY OF THE ITEMS ABOVE ARE INTER-RELATED, SO THAT DEVELOPMENT WILL HAVE TO BE SIMULTANEOUS, SINCE NO COMPROMISE ON THE MAIN PHASE CAN BE ACCEPTED WHICH WILL ENDANGER THE SCIENTIFIC INTEGRITY OF THE DESIGN OF GARP.

A NUMBER OF EXPERIMENTAL PROGRAMS WILL HAVE TO BE CARRIED OUT IN 1972-73 AND-OR IN EARLIER YEARS:

(A) A HIGH-ALTITUDE OBSERVING PROGRAM OVER ONE HEMISPHERE, UTILIZING HIGH-LEVEL BALLOONS (AND COMPATIBLE RAWINSONDE EQUIPMENT) AND ROCKETSONDES, DURING THE DYNAMICALLY-ACTIVE WINTER PHASE OF THE MIDDLE AND UPPER STRATOSPHERE, WITH EMPHASIS ON HIGH LATITUDES. THIS IS REQUIRED TO SPECIFY THE UPPER HEIGHT LIMIT FOR A COMPLETE OBSERVATION SYSTEM (POSSIBLY 30 KM) BY STUDYING ATMOSPHERIC INTERACTIONS BETWEEN LAYERS AT TIMES OF STRATOSPHERIC WARMINGS. THIS STRATWARM EXPERIMENT IS BEING DEVELOPED BY A WORKING GROUP OF THE

WMO COMMISSION FOR ATMOSPHERIC SCIENCES AND ENVISAGES A TWO-MONTH WINTER PERIOD WITH OBSERVATIONS TO 3 MB (ABOUT 40 KM). THERE MIGHT BE REGIONAL EXPERIMENTS PRIOR TO THE 1972-73 WINTER, WHICH COULD CLARIFY QUESTIONS OF DATA ACCURACY AND NETWORK REQUIREMENTS (DENSITY IN SPACE AND TIME), ESPECIALLY IF A FEW KEY STATIONS UNDERTOOK SERIAL ASCENTS TO PROVIDE INFORMATION ON DOMINANT AND SIGNIFICANT SCALES. SUCH DATA, IF ACQUIRED AT ROCKET STATIONS COULD ALSO CONTRIBUTE TO THE SOLUTION OF THE CRITICAL INTERRELATED PROBLEMS OF DIURNAL VARIATIONS, RADIOSONDE INFRA-RED TEMPERATURE ERRORS AND RADIOSONDE-ROCKETSONDE DISCREPANCIES. FOLLOWING THE EXPERIMENTAL PROGRAM, IT WILL BE POSSIBLE TO CARRY OUT NUMERICAL PREDICTION EXPERIMENTS TO SEE TO WHAT EXTENT NEGLECT OF THE ATMOSPHERE ABOVE 30 KM CAUSES A DETERIORATION IN EXTENDED PREDICTION AT LOWER LEVELS, AT THAT SEASON OF THE YEAR FOR WHICH THE EFFECT IS PROBABLY A MAXIMUM. IF THIS DETERIORATION IS UNACCEPTABLE, FURTHER DYNAMICAL STUDIES SHOULD BE ABLE TO INDICATE WHETHER ACTUAL DATA ABOVE 30 KM ARE REQUIRED ORIGINALLY, OR WHETHER IT IS ADEQUATE TO INSERT ONE OR MORE LEVELS ABOVE 30 KM IN THE MODEL, USE ESTIMATED DATA PLUS SCATTERED RAWINSONDE AND ROCKETSONDE DATA PLUS PERHAPS CRUDE SATELLITE DATA (LOW RESOLUTION IN THE VERTICAL) AS INITIAL CONDITIONS AND RELY ON THE MODEL ITSELF TO BRING THE APPROXIMATE STRUCTURE SUFFICIENTLY CLOSE TO THE ACTUAL ONE AFTER SEVERAL DAYS' INTEGRATION.

(B) ONE OR MORE TROPICAL OBSERVING EXPERIMENTS (THE MAIN ONE IN 1972-73) TO INCORPORATE A RATHER DENSE NETWORK OF AIRCRAFT AND CONVENTIONAL SOUNDINGS, REINFORCED BY SATELLITE-BASED TECHNIQUES (INFRA-RED SENSING AND CONSTANT DENSITY BALLOONS). IT IS ENVISAGED THAT AUXILIARY OBSERVATIONS WOULD ALSO PROVE USEFUL (RADAR DATA, SATELLITE CLOUD DATA, AND PERHAPS AN EXPANDED PROGRAM OF SURFACE SYNOPTIC DATA TOGETHER WITH MICROMETEOROLOGICAL STUDIES). THIS EXPERIMENT IS ALSO BEING DEVELOPED BY A WORKING GROUP OF THE WMO COMMISSION FOR ATMOSPHERIC SCIENCES, WITH ACTIVE PARTICIPATION BY ICSU. THE MAIN TROPICAL OBSERVING EXPERIMENT IN 1972-73 WILL COVER A SPECIFIC AREA IN THE NORTH AND SOUTH PACIFIC; OTHER, MAINLY EARLIER, EXPERIMENTS WOULD BE ON A SUB-REGIONAL BASIS. THE PRIMARY PURPOSE OF THE TROPICAL EXPERIMENT IS TO PROVIDE DEFINITIVE INFORMATION ON THE SCALES OF RELEVANCE IN SUCH AREAS AND THE INTERACTION BETWEEN MOTIONS AND PROCESSES ON DIFFERENT SCALES. IN MIDDLE AND HIGH LATITUDES THE SYNOPTIC SCALE CAN BE IDENTIFIED WITH FRONTAL WAVES, AND IT IS GENERALLY CONSIDERED THAT SUB-SYNOPTIC OR MESO SCALES DO NOT CONTRIBUTE SIGNIFICANTLY TO LARGE-SCALE DEVELOPMENT NOR DO THEY SERIOUSLY ALIAS LARGE-SCALE ANALYSIS PROCEDURES. IN THE TROPICS NO SUCH CLEAR-CUT ALLOCATION OF SCALE IS AT PRESENT POSSIBLE NOR IS THERE AN OBVIOUS PHENOMENOLOGICAL ANALOGUE FOR THE SYNOPTIC SCALE. NON-LINEAR INTERACTIONS BETWEEN SCALE SIZES MAY BE SIGNIFICANT, PARTICULARLY IN VIEW OF THE DEGREE OF ORGANIZATION MANIFEST IN CONVECTIVE ACTIVITY, SUBSIDENCE STRATA, CLOUD STREETS, ETC. THUS, IN THE TROPICS IT MAY BE DIFFICULT, PERHAPS EVEN IMPOSSIBLE, TO "MODEL" SUB-GRID-SIZE PROCESSES. IF IT IS NECESSARY TO USE A FINER GRID FOR TROPICAL AREAS, A KEY QUESTION WILL THEN BE WHETHER INITIAL DATA WILL BE REQUIRED ON A COMPARABLE SCALE.

(C) A NUMBER OF AIR-GROUND INTERACTION STUDIES, PARTICULARLY IN MARINE AND

OCEANIC AREAS. THE TROPICAL EXPERIMENT WOULD UNDOUBTEDLY INCLUDE ONE OR MORE PROGRAM OF THIS TYPE. THE AIM OF THESE STUDIES WOULD BE TO MEASURE DIRECTLY, BY A NUMBER OF TECHNIQUES WHENEVER POSSIBLE, THE VERTICAL FLUXES OF HEAT, MOMENTUM AND WATER VAPOUR OVER AREAS OF NOT INCONSIDERABLE SIZE. IT IS NOW RECOGNIZED THAT NUMERICAL PREDICTION CAN BE IMPROVED BY THE INCORPORATION OF LATENT HEAT FEEDBACK, I.E., BY PERMITTING PRECIPITATION TO OCCUR. THIS IMPLIES THAT EVAPORATION MUST ALSO BE ALLOWED TO OCCUR, EVEN IF ONLY TO MAINTAIN AN ATMOSPHERIC BALANCE OF WATER VAPOUR. IT IS ALSO KNOWN THAT NUMERICAL MODELS SHOULD ACCOUNT FOR SURFACE FRICTION AND FOR CONVECTIVE HEAT INPUT FROM OCEANS. THUS IT IS CLEAR THAT MICRO-METEOROLOGICAL PROCESSES MUST ENTER REALISTICALLY INTO THE FORMULATION OF ATMOSPHERIC DYNAMICS. IT IS NOT APPARENT, HOWEVER, PRECISELY HOW THIS SHOULD BE DONE. ELABORATE OBSERVATIONAL PROGRAMS ARE NEEDED TO ESTABLISH THE MAGNITUDE OF THESE EFFECTS, AND TO PERMIT ACCURATE ESTIMATES OF AERIAL AVERAGES OF THE QUANTITIES INVOLVED. IT WILL THEN BE NECESSARY TO DEVISE PROCEDURES FOR MODELLING SUCH REPRESENTATIVE FLUXES IN TERMS OF PARAMETERS TO BE CARRIED OR STORED IN COMPUTER PROGRAMS.

(D) OBSERVATIONAL TESTS OF SATELLITE SYSTEMS, INVOLVING INFRA-RED SENSING AND BALLOON INTERROGATION. IT IS HOPED THAT FULL-SCALE TESTS WILL BE POSSIBLE BY THE 1972-73 PERIOD, AND THAT THESE TESTS CAN BE CO-ORDINATED WITH STRATOSPHERIC-WARMING AND TROPICAL EXPERIMENTS, PERMITTING THE SATELLITE TECHNOLOGY DATA TO REINFORCE THE CONVENTIONAL NETWORK DATA AND ALSO ENSURING ADEQUATE TEST AND CALIBRATION OF THE FORMER. SIMULTANEOUSLY, THERE WILL HAVE TO BE A DEVELOPMENT OF NUMERICAL ANALYSIS AND PROGNOSIS PROCEDURES TO ACCEPT DATA ON A CONTINUOUS-TIME BASIS, UNLIKE CONVENTIONAL DATA AT TWO FIXED HOURS PER DAY. SINCE BOTH TYPES OF DATA WILL NEED TO BE PROCESSED, THE PROCEDURES CAN BE TESTED ON THE LIMITED VOLUME AND EXTENT OF SATELLITE DATA WHICH WILL BE AVAILABLE DURING THE 1972-73 EXPERIMENTS.

INTER ALIA

THE 62ND ANNUAL MEETING OF THE AIR POLLUTION CONTROL ASSOCIATION WILL BE HELD IN NEW YORK CITY, JUNE 22-26, 1969. TWO HALF-DAY SESSIONS ON METEOROLOGY ARE PLANNED AS FOLLOWS:

(A) URBAN AND REGIONAL TRANSPORT OF POLLUTION
(B) METEOROLOGY IN POLLUTION CONTROL PROGRAMS AND SURVEYS

ANYONE INTERESTED IN SUBMITTING A PAPER ON EITHER OF THESE TWO TOPICS SHOULD COMMUNICATE BEFORE NOVEMBER 30 WITH THE SESSION CHAIRMAN -

DR. R.E. MUNN
METEOROLOGICAL SERVICE OF CANADA
315 BLOOR STREET, WEST
TORONTO 5, ONTARIO, CANADA.

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SECOND ANNUAL CONGRESS

THE SECOND ANNUAL CONGRESS OF THE SOCIETY WAS HELD JUNE 3–5, 1968, AT THE UNIVERSITY OF CALGARY. AGAIN THIS YEAR, THE MEETINGS WERE HELD IN CONJUNCTION WITH THE CONFERENCE OF LEARNED SOCIETIES.

THE CAMPUS OF THE UNIVERSITY OF CALGARY IS QUITE IMPRESSIVE. THE BUILDINGS ARE NEW AND MODERN, AND ARE WELL SEPARATED, PRESUMABLY FOR FUTURE EXPANSION. REGISTRATION AND MEAL SERVICE WAS AT THE STUDENT UNION BUILDING, MCEWAN HALL. THE SCIENTIFIC SESSIONS AND THE ANNUAL GENERAL MEETING WERE HELD IN THE ENGINEERING BUILDING. FURTHER MEAL SERVICE WAS AVAILABLE AT THE DINING CENTRE THAT SERVED THE TWO RESIDENCES. AS A GENERAL RULE, COUPLES WERE BILLETED IN THE WOMEN'S RESIDENCE AND "STAGS" IN THE MEN'S. THE OVERFLOW FROM THE RESIDENCES WAS ACCOMMODATED AT MOTEL VILLAGE (14 MOTELS JUST ONE-HALF MILE FROM THE CAMPUS), AND AT THE DOWNTOWN HOTELS.

FIELD TRIPS

THERE WERE TWO FIELD TRIPS OFFERED TO PARTICIPANTS. ON TUESDAY AFTERNOON, TWO CHARTERED BUSES AND SEVERAL PRIVATE CARS TOOK VISITORS TO THE MARMOT CREEK WATERSHED PROJECT, A CO-OPERATIVE VENTURE INVOLVING HYDROLOGY, AGRICULTURE, METEOROLOGY AND SEVERAL OTHER SCIENTIFIC DISCIPLINES. THE VISITORS WERE CONDUCTED THROUGH AREAS WHERE GROUND WATER, STREAMFLOW, EVAPORATION, SOIL MOISTURE, AND VARIOUS METEOROLOGICAL PARAMETERS WERE BEING MEASURED. A SUMMARY OF A PAPER (DESCRIBING THE PROJECT), GIVEN BY MR. DON STORR AT THE CONGRESS, WILL BE PUBLISHED IN A FORTHCOMING ISSUE OF ATMOSPHERE.

FROM MARMOT CREEK, ALL ROADS LED TO THE $\hat{6}$ RANCH (RAFTER 6 FOR YOU DUDES) FOR THE ANNUAL BANQUET. BARBECUED STEAKS, A HEATED SWIMMING POOL (BUT OH – THAT WET-BULB COOLING), HORSEBACK RIDES AND A SING-SONG, ALL CONTRIBUTED TO A FINE TIME FOR ALL. THE VISITING TROUBADOUR COMPOSED THE FOLLOWING POEM* IN HONOUR OF THE OCCASION. IT IS BASED ON THE TRIBULATIONS OF METEOROLOGISTS ESPECIALLY DON STORR, AS RELATED BY PROF. CHAMBERS AND MISS BRINKMAN, TWO OF THE LOCAL ARRANGEMENTS COMMITTEE. IT IS SUNG TO THE TUNE OF "LILLI MARLENE", AND SOUNDS MUCH BETTER SUNG THAN READ.

ANOTHER FIELD TRIP TOOK PLACE ON THURSDAY WHEN THE ALBERTA HAIL STUDIES PROJECT AT PENHOLD WAS VISITED. TRANSPORTATION WAS AGAIN BY CHARTERED BUS. THE STAFF AT THE PROJECT HAD ORGANIZED SEVERAL DISPLAYS OF EQUIPMENT, AND EVEN ARRANGED THE FIRST HAILSTORM OF THE SEASON. IT WAS ACCOMPANIED BY WHAT APPEARED TO BE A FUNNEL CLOUD, MUCH TO THE DELIGHT OF THE VISITORS WHO SAW IT. HOWEVER, WHEN REQUESTED FOR AN ENCORE, THEY COULD NOT EVEN COME UP WITH A SMALL VOLCANIC ERUPTION. IN ANY EVENT, THE HOSPITALITY OF THE PROJECT STAFF AND THE CANADIAN FORCES OFFICERS' MESS WAS MUCH APPRECIATED.

* SEE PAGE 22

SCIENTIFIC SESSIONS

THE SCIENTIFIC PROGRAM OCCUPIED FIVE HALF DAYS, AS OUTLINED IN THE PROGRAM AND ABSTRACTS BOOKLET THAT WAS MAILED OUT TO ALL MEMBERS BEFORE THE MEETINGS.

ON MONDAY MORNING, PROF. A.W. BREWER, PRESIDENT OF THE SOCIETY, DECLARED THE SECOND ANNUAL CONGRESS OPEN. A WELCOME TO THE CAMPUS BY PROF I.Y. ASHWELL OF THE DEPARTMENT OF GEOGRAPHY WAS FOLLOWED BY ANNOUNCEMENTS BY THE CHAIRMAN OF THE LOCAL ARRANGEMENTS COMMITTEE, PROF. CHAMBERS. THE LOCAL COMMITTEE UNDER MRS. CHAMBERS HAD DONE A TERRIFIC JOB FOR THE OFFICIAL HOSTS, THE ALBERTA CENTRE OF THE C.M.S.

THE SYMPOSIUM ON THE UPPER ATMOSPHERE WAS CHAIRED BY PROF. JOHN GREGORY, UNIVERSITY OF SASKATCHEWAN. THE KEYNOTE PAPER BY PROF. COLIN HINES (UNIVERSITY OF TORONTO), DISCUSSED THE ADVANCES IN THE DYNAMICS OF THE UPPER ATMOSPHERE THAT HAD BEEN MADE SINCE HE SPOKE ON THE SUBJECT TO THE CANADIAN BRANCH OF THE R.M.S. SIX YEARS AGO.

IN THE INTERVAL BETWEEN THESE TWO PAPERS, MANY MORE OBSERVATIONS OF THE CIRCULATION IN THE MAGNETOSPHERE (THE REGION FROM 150 KM OUT TO THE BOUNDARY OF THE GEOMAGNETIC DOMAIN – 10 EARTH RADII ON THE SUN SIDE AND SOME INDEFINITE DISTANCE ON THE OTHER SIDE), HAVE BEEN MADE. THESE OBSERVATIONS CONFIRM THE ESSENTIALS OF THE HINES–AXFORD MODEL OF MAGNETOSPHERIC CIRCULATIONS, WHILE CHANGING ONLY THE DETAILS. IN PARTICULAR, DENSITY CHANGES BY A FACTOR OF 100 OVER A FEW KILOMETERS, RESULTING FROM CIRCULATIONS, HAVE BEEN OBSERVED. PROF HINES POINTED OUT THAT THE STRONG WEST WINDS THAT ARE OBSERVED IN THE IONOSPHERE AT 200 TO 300 KM ARE GENERATED METEOROLOGICALLY, BUT THERE ARE STRONG INFLUENCES OF ION DRAG (ESPECIALLY ON TIME SCALES OF LESS THAN ONE HOUR), EVEN THOUGH THE DENSITY OF IONS IS STILL SMALL RELATIVE TO THE DENSITY OF THE NEUTRAL GAS. HE STATED FURTHER THAT ON THE DIURNAL SCALE, NON–LINEAR COUPLING BETWEEN CHANGES IN ION CONCENTRATION AND CHANGES IN PRESSURE (OR DENSITY) MUST MAKE A SIGNIFICANT CONTRIBUTION TO THE WEST WINDS OBSERVED.

DURING THE REMAINDER OF HIS PAPER, PROF. HINES TOUCHED ON SEVERAL SUBJECTS CLOSER TO THE SURFACE. FOR EXAMPLE, HE DISCUSSED TIDAL EFFECTS IN THE REGION OF 100 KM AS OBSERVED BY SODIUM VAPOUR AND TMA TRAILS FROM ROCKETS, AND COMMENTED ON THE DETAIL IN THE WINDS SHOWN BY THE NEW FRENCH METEOR TRAIL RADAR. HE SHOWED THE POSSIBLE CONNECTION BETWEEN UPSTREAM TROPOSPHERIC JET STREAMS AND NOCTILUCENT CLOUDS, AND COMMENTED THAT WORK ON STRATOSPHERIC–IONOSPHERIC COUPLING WAS INCREASING IN TEMPO, LEADING TO MORE KNOWLEDGE ON THE EFFECTS IN THE HIGH ATMOSPHERE OF EVENTS LOWER DOWN.

THERE FOLLOWED TWO PAPERS ON OPTICAL TECHNIQUES FOR DETERMINING UPPER ATMOSPHERE COMPOSITION (LLEWELLYN AND JONES, AND RUNDLE AND GAULT), AND THREE ON RADIO TECHNIQUES (REES, GREGORY, AND MANSON). THESE FIVE PAPERS WERE ALL CONTRIBUTIONS FROM THE INSTITUTE OF SPACE AND ATMOSPHERIC STUDIES, UNIVERSITY OF SASKATCHEWAN. A.D. CHRISTIE FOLLOWED WITH A DISCUSSION OF NOCTILUCENT

CLOUDS, AND THE SYMPOSIUM WAS COMPLETED WITH TWO PAPERS ON ROCKET RANGE OPERATIONS IN CANADA (WETTER AND HOOPES FROM CHURCHILL, AND FRYERS FROM COLD LAKE).

MONDAY AFTERNOON WAS DEVOTED TO A TWO SESSION SYMPOSIUM ON THE TROPOSPHERE, CHAIRED BY PROF. I.Y. ASHWELL. M. DANARD (WHO WILL SOON BE JOINING THE GROUP AT UNIVERSITY OF WATERLOO UNDER PROF. CSANADY), LED OFF THE TROPOSPHERIC CIRCULATION SESSION WITH A DISCUSSION OF A MODIFICATION TO HIS NWP MODEL (DEVELOPED TO INCLUDE THE EFFECT OF THE RELEASE OF LATENT HEAT IN RAIN AREAS) THAT INCLUDED THE EFFECT OF LONG-WAVE RADIATION. HE SHOWED THAT THIS EFFECT COULD BE UP TO TWENTY PER CENT OF THE LATENT HEAT EFFECT IN AREAS OF HEAVY RAIN. H. WILSON FOLLOWED WITH A DISCUSSION OF THE STRUCTURE OF JET-STREAMS, AND E.R. REINELT MADE A PLEA FOR NEW ANALYSIS TECHNIQUES IN WESTERN CANADA (ILLUSTRATED BY EXAMPLES OF THE EFFECT OF TERRAIN ON THE TEMPERATURE AND MOISTURE FIELDS).

THE KEYNOTE PAPER FOR SESSION II - 'ARCTIC METEOROLOGY', WAS PRESENTED BY PROF. LONGLEY OF THE UNIVERSITY OF ALBERTA. HE POINTED OUT THAT TWENTY-FIVE YEARS AGO, THE GENERAL CIRCULATION IN THE ARCTIC WAS BASED ON A SIMPLE HADLEY MODEL, HOWEVER, HIS ILLUSTRATIONS OF CYCLONE AND ANTICYCLONE TRACKS IN THE REGION SHOWED THAT THE SIMPLE MODEL IS INADEQUATE. THE ARCTIC CIRCULATION INCLUDES MOVING HIGHS AND LOWS, BUT THE MOVEMENTS ARE NOT THE SAME AS IN THE REGION OF THE WESTERLIES. FOR EXAMPLE, HIGHS AND LOWS MOVE INTO THE AREA, STAGNATE, AND THEN SUDDENLY COLLAPSE. THE SLOW MEANDERINGS ARE THE CAUSE OF SERIOUS FORECAST PROBLEMS BECAUSE ONLY SLIGHT MOVEMENT CAN CAUSE MAJOR CHANGES IN CIRCULATION AND THUS IN WEATHER.

SUMMARIZING, PROF. LONGLEY STATED THAT RADIATION BALANCE IS IMPORTANT, AND SATELLITES WILL PROVIDE MORE INFORMATION FOR RADIATION STUDIES. OTHER AREAS THAT NEED ATTENTION ARE A NEW MODEL FOR THE GENERAL CIRCULATION OF THE ARCTIC TO REPLACE THE OLD HADLEY MODEL, AND TROPOSPHERIC-STRATOSPHERIC INTERACTIONS (NOW THAT THE ARCTIC STRATOSPHERE IS KNOWN TO BE SO INTERESTING).

THIS THEME PAPER WAS FOLLOWED BY PROF. ORVIG SPEAKING ABOUT THE COMPUTATIONS THAT HE AND PROF. VOWINCKEL HAD MADE ON THE ENERGY BUDGET OF THE ARCTIC, AND INCLUDED A DEFENCE OF SOME EARLIER WORK AGAINST A CRITICISM LEVELLED BY PROF. LONGLEY IN HIS PAPER. H. WAHL THEN SPOKE ABOUT THE CLIMATOLOGICAL NETWORK (OR RATHER ITS LACK) IN THE YUKON, AND ILLUSTRATED THE NEED FOR MORE STATIONS WITH SOME COLOURED SLIDES OF THE TERRITORY. D.B. FRASER CONCLUDED THE SESSION WITH A DESCRIPTION OF A SEVERE DRAINAGE WIND UNDER AN ARCTIC INVERSION THAT OCCURS COMMONLY ON THE SHORES OF AMUNSEN GULF, AND WAS MENTIONED IN THE WRITINGS OF STEPHANSON.

TUESDAY MORNING, SESSION III OF THE SYMPOSIUM ON THE TROPOSPHERE, DEALT MAINLY WITH MATTERS RELEVANT TO ALBERTA HAIL STUDIES. PROF. W. HITSCHFELD OF MC GILL UNIVERSITY WAS THE CHAIRMAN. M.J. CURRY REPORTED ON A SENSITIVE MICRO-BAROGRAPH DEVELOPED (BY R.C. MURTY AND OTHERS) AT THE UNIVERSITY OF WESTERN ONTARIO. THE DETAIL ON PRESSURE CHANGES THAT WERE RECORDED BY THIS INSTRUMENT

WAS IMPRESSIVE. R.H. DOUGLAS THEN OUTLINED THE HISTORY OF THE MC GILL PROGRAM ON HAIL STUDIES, AND P.W. SUMMERS FOLLOWED WITH A REVIEW OF THE HISTORY OF THE ALBERTA HAIL STUDIES PROJECT. J.H. RENICK DESCRIBED A SYSTEM FOR TAKING AND ANALYZING STEREO CLOUD PHOTOGRAPHS USED BY HIM AND M. BALSHAW ON ALBERTA HAIL STUDIES. C. WARNER SHOWED TIME-LAPSE MOVIES OF A PARTICULAR STORM AND SUPPORTING RADAR PHOTOGRAPHS USED IN A SPECIAL STUDY BY HIM AND A.J. CHISHOLM. THE SAME STORM WAS MODELLED BY MRS. M. ENGLISH, WHO SHOWED HOW PREDICTIONS OF THE MODEL WERE SUPPORTED BY OBSERVATION.

THE NEXT TWO PAPERS TREATED SPECIAL OBSERVATION TECHNIQUES TO STUDY STORM CIRCULATION AND STRUCTURE. N. THYER DISCUSSED THE ANALYSIS OF SPECIAL PIBAL OBSERVATIONS AROUND SOME STORMS AND I. ZAWADZKI DESCRIBED HARPI, A NEW ELECTRONIC SYNTHESIS OF RADAR SCANS DEVELOPED AT MC GILL WITH E. BALLANTYNE (TO SUPPLEMENT CAPPI). HEIGHT-AZIMUTH-RANGE POSITION INDICATOR DISPLAYS REFLECTIVITY OF THE STORM IN A GREY-SCALE IN VERTICAL SLICES AS FUNCTIONS OF HEIGHT AND DISTANCE.

THE LAST TWO PAPERS IN THE 'STORM' SECTION OF THE SESSION DEALT WITH CHEMISTRY. G. VALLI STATED THAT NATURE PROVIDES MORE FREEZING NUCLEI THAN MAN CAN WITH SILVER IODIDE GENERATORS, AND THAT THE MOST EFFECTIVE NUCLEI IDENTIFIED IN RAINFALL SAMPLES WERE LESS THAN .01 MICRON IN DIAMETER. P. SUMMERS, SPEAKING FOR HIMSELF AND B. HITCHON, NOTED THE INTERESTING RESULT THAT THERE HAS BEEN A SUBSTANTIAL REDUCTION IN HAIL REPORTS ABOUT FORTY MILES DOWNWIND FROM MAJOR SULPHUR-PRODUCING AREAS IN THE PROVINCE. THIS HAS BEEN ACCOMPANIED BY AN INCREASE IN THE PERCENTAGE OF LESS-DAMAGING SOFT HAIL, AND A DECREASE (OVER THE LAST TWENTY YEARS) IN THE SULPHUR DEFICIENCY OF THE SOILS IN SOME AREAS. THE CONCLUSION THAT INDUSTRIAL POLLUTION IS MODIFYING THE WEATHER WAS DRAWN.

THE FINAL PAPER OF THE SESSION WAS A DESCRIPTION OF THE MARMOT CREEK PROJECT BY D. STORR. IT SERVED AS AN INTRODUCTION FOR THE FIELD TRIP TO THE SITE DURING THE AFTERNOON. AS MENTIONED IN THE FOREGOING, MR. STORR HAS PROMISED TO SUBMIT A STREAMLINED VERSION OF THE PAPER TO ATMOSPHERE.

NEXT MORNING, DR. W.L. GODSON CHAIRED THE SYMPOSIUM ON PHYSICAL METEOROLOGY. THREE PAPERS DEALT WITH CLOUD PHYSICS, TWO WITH ATMOSPHERIC ELECTRICITY, AND THREE WITH RADIATION. PROF. LIST TREATED THE SUBJECT OF TURBULENCE IN THE WAKE OF FALLING PRECIPITATION PARTICLES AND CONCLUDED THAT, WHILE IT EXISTED, IT WAS NOT SIGNIFICANT IN THE PHYSICS OF CLOUDS AND THE PARTICLES THAT CONSTITUTE THEM. G. ISAAC, SPEAKING FOR HIMSELF AND D. BISHOP, BOTH OF MC GILL, COMPARED DATA ON ICE NUCLEI IN SURFACE AIR AND IN PRECIPITATION. ICE NUCLEI WERE ALSO THE SUBJECT OF A PAPER BY R.S. SHEMENAUER AND J. MAYBANK OF THE METEOROLOGICAL BRANCH AND SASKATCHEWAN RESEARCH COUNCIL RESPECTIVELY. THEY NOTED THAT THE MAIN SOURCE OF SUCH NUCLEI AT SASKATOON WAS RURAL, AND THAT ORGANIC SOILS WERE THE MOST EFFICIENT.

BECAUSE THEIR STUDIES HAD SHOWN THAT THE PROCESSES WERE MORE COMPLEX THAN AT FIRST THOUGHT, J.E. PAKIAM AND J. MAYBANK OF THE SASKATCHEWAN RESEARCH COUNCIL DISCUSSED SOME ELECTRIC FIELD AND CONDUCTIVITY MEASUREMENTS THAT THEY

HAD MADE, INSTEAD OF THE MATTERS COVERED IN THE ABSTRACT THAT APPEARED IN THE PROGRAM. THIS WAS FOLLOWED BY THE PRESENTATION OF SOME SPECTRA AND CROSS SPECTRA OF ELECTRIC FIELD AND OTHER METEOROLOGICAL ELEMENTS BY BHARTENDU OF THE METEOROLOGICAL BRANCH.

THE FINAL THREE PAPERS DEALT WITH SOLAR RADIATION EACH IN A NOVEL WAY. FR. EAST, COLLEGE JEAN DE BREBEUF, COMPARED INSOLATION IN URBAN MONTREAL AND IN A NEARBY RURAL AREA, AND ILLUSTRATED THAT THE POLLUTED URBAN AIR DID DECREASE THE AMOUNT OF SOLAR RADIATION REACHING THE GROUND. H. FERGUSON OF THE METEOROLOGICAL BRANCH, AND A NUMBER OF COLLEAGUES, USED A PLYWOOD AND PLASTER MODEL TO ASSIST IN THE COMPUTATION OF DAILY CLEAR-SKY VALUES OF INSOLATION AT MARMOT CREEK. THE SLIDES SHOWED GRAPHICALLY THE SHADOW EFFECTS AT VARIOUS SOLAR AZIMUTHS AND ELEVATIONS. B.J. GARNIER AND A. OHMURA OF MC GILL DESCRIBED THE DEVELOPMENT OF A COMPUTER PROGRAM TO CALCULATE THE TOPOGRAPHIC VARIATIONS OF THE DIRECT SOLAR BEAM FROM OBSERVATIONS TAKEN AT ONE SITE IN AN AREA.

THE FINAL SESSION OF THE CONGRESS WAS A SYMPOSIUM ON THE ATMOSPHERIC BOUNDARY LAYER WITH PROF. CSANADY OF WATERLOO IN THE CHAIR. THE KEYNOTE SPEAKER, PROF. K. HAGE, UNIVERSITY OF ALBERTA AND AN ASSOCIATE EDITOR OF ATMOSPHERE, NOTED THAT THE PAST TWENTY YEARS HAD BROUGHT MARKED ADVANCES IN GENERAL CIRCULATION MODELS AND NUMERICAL WEATHER PREDICTION, AND HAD SEEN THE START OF A UNIFIED THEORY OF THE SURFACE BOUNDARY LAYER. FURTHER PROGRESS IN THE MODELS WOULD REQUIRE THAT THE LARGE SCALE PROCESSES BE ALLOWED TO INFLUENCE THE SMALL SCALE ONES, WHICH, IN TURN, WOULD FEED HEAT AND ENERGY BACK UP INTO THE FORMER. TWO OF THE MAJOR PROBLEMS IN BOUNDARY LAYER THESE DAYS ARE THE GAP IN UNDERSTANDING OF ENERGY EXCHANGES BETWEEN SCALES, AND THE EVALUATION OF THE MESO AND MICRO-SCALES AS SOURCES AND SINKS OF ENERGY. IN ORDER TO GET CLOSE TO THESE PROBLEMS, THERE ARE SEVERAL QUESTIONS THAT MUST BE CONSIDERED: WHAT ARE THE TIME SCALES OF THE IMPORTANT PROCESSES, AND WHAT ARE THEIR GEOGRAPHICAL AND SEASONAL TRENDS? WHAT PROCESSES CAN BE PARAMETERIZED, WHAT ARE THE KEY PARAMETERS, AND HOW ACCURATELY MUST THEY BE MEASURED? WHAT IS THE TIME RATE OF DECAY OF EACH PROCESS - THIS DETERMINES THE PREDICTABILITY OF THE PROCESS.

AT THE PRESENT TIME, ONE MUST MAKE ASSUMPTIONS. FOR THE FUTURE, HOWEVER, GARP (THE GLOBAL ATMOSPHERIC RESEARCH PROJECT) WILL SEEK THE ANSWERS TO MANY OF THESE QUESTIONS.

PROF. HAGE WENT ON TO DISCUSS SOME OF THE IMPORTANT PROCESSES WITHIN THIS CONTENT. HE ESPECIALLY NOTED THE GREAT NEED OF EXPANDED OBSERVATIONAL PROGRAMS IN ORDER TO MEET THE OBJECTIVES OF GARP. IN THIS RESPECT, HE MENTIONED SEVERAL RESEARCH PROJECTS OR PROGRAMS THAT ARE IN PROGRESS OR ADVANCED PLANNING.

FOLLOWING PROF. HAGE, P.A. TAYLOR OF THE UNIVERSITY OF TORONTO DISCUSSED HIS MATHEMATICAL MODEL OF THE EFFECTS ON FLOW OF AN ABRUPT CHANGE IN ROUGHNESS OF THE UNDERLYING SURFACE. R.M. HOLMES OF DEMR THEN SHOWED THE RESULTS OF MEASURING THE COOLING EFFECT ALOFT OF A SMALL LAKE, USING A SPECIALLY

EQUIPPED LIGHT PLANE. THE EFFECT (OR LACK THEREOF) OR MINOR TERRAIN FEATURES ON PRECIPITATION DISTRIBUTION WAS THE SUBJECT OF THE PAPER BY R.B.B. DICKISON OF THE METEOROLOGICAL BRANCH. IN THE DISCUSSION OF ICE ACCRETION ON WIRES AND TOWERS BY G.A. MC KAY AND H.A. THOMPSON OF THE METEOROLOGICAL BRANCH, THE LATTER SHOWED A SLIDE WITH "ICYPLETHS" OF FREQUENCY OF OCCURRENCE OF FREEZING PRECIPITATION. J.A. MC CALLUM OF METEOROLOGICAL BRANCH PRESENTED BOTH HIS PAPER AND THAT OF JOHNSON AND LARSEN WHICH PRECEDED IT ON THE PROGRAMS. BOTH PAPERS DEALT WITH THE SUFFIELD EXPERIMENTS ON DIFFUSION IN THE BOUNDARY LAYER USING VERY SMALL GLASS SPHERES. THE CHAIRMAN, G.T. CSANADY, COMPLETED THE SESSION WITH HIS PAPER ON THE DIFFUSION OF A LARGE CLOUD IN THE BOUNDARY LAYER.

FORTY-NINE PAPERS HAD BEEN ACCEPTED FOR THE SCIENTIFIC SESSIONS. OF THESE, SIX WERE PRESENTED BY TITLE ONLY, FORTY-TWO WERE PRESENTED BY ONE OF THE AUTHORS, AND ONE BY A STAND-IN. IN FIVE HALF DAYS, MUCH WAS ACCOMPLISHED.

ANNUAL BUSINESS MEETING

ON MONDAY EVENING, JUNE 3, MEMBERS RETURNED TO THE ENGINEERING BUILDING FOR THE ANNUAL BUSINESS MEETING. IT WAS CALLED TO ORDER AT 1930 BY THE PRESIDENT, PROF. A.W. BREWER. THE FIRST ORDER OF BUSINESS WAS THE PRESENTATION OF THE 1967 PATTERSON MEDAL TO PROF. BALFOUR CURRIE OF THE UNIVERSITY OF SASKATCHEWAN AT SASKATOON. STANDING IN FOR J.R.H. NOBLE, DIRECTOR OF THE METEOROLOGICAL BRANCH, WHO WAS IN GENEVA, WAS D. SMITH, REGIONAL METEOROLOGIST AT EDMONTON.

FOLLOWING PROF. CURRIE'S REMARKS, THE MINUTES OF THE FIRST ANNUAL BUSINESS MEETING, THE REPORTS OF COUNCIL, THE TREASURER, THE AUDITOR, THE NOMINATING COMMITTEE AND THE PRIZE COMMITTEE WERE ACCEPTED AS PRINTED WITH LITTLE COMMENT. THE CHAIRMAN CONGRATULATED THE VARIOUS PRIZE WINNERS, AND ANNOUNCED THE ESTABLISHMENT OF THE ANDREW THOMSON AWARD FOR UNDERGRADUATE STUDENTS. REPRESENTATIVES OF THE LOCAL CENTRES PRESENTED REPORTS.

THE REPORT OF THE EDITOR AND THE PROPOSED PUBLICATION POLICY FOR ATMOSPHERE GENERATED CONSIDERABLE DISCUSSION. THERE WERE MANY COMPLAINTS ABOUT THE DELAYS IN PRINTING AND DISTRIBUTION, AND NON-RECEIPT OF ISSUES BY SOME MEMBERS. THE PROPOSAL WAS ACCEPTED AS PRINTED EXCEPT FOR A MOTION THAT THE TRANSACTIONS AND BUSINESS OF THE SOCIETY BE REPORTED IN AN OFFICIAL PUBLICATION OF THE SOCIETY, OF COURSE, AT THE PRESENT, ATMOSPHERE IS THE ONLY SUCH PUBLICATION.

THERE WAS ALSO DISCUSSION ABOUT THE BUDGET PROPOSAL, AND THE MOTION REGARDING AN INCREASE IN FEES FOR 1969 THAT CAME FROM COUNCIL. A MOTION FROM THE FLOOR INCREASED THE FEES TO $7.50 FOR MEMBERS, LEAVING THE ANNUAL MEMBERSHIP FEE FOR STUDENTS AT $1.00.

SEVERAL ANNOUNCEMENTS OF INTEREST WERE MADE. THE ONE ABOUT THE FORMATION OF LOCAL CENTRES AT SASKATOON AND QUEBEC CITY WAS MET WITH ENTHUSIASM BY THOSE PRESENT. AN INVITATION TO JOIN THE ROYAL AND THE AMERICAN METEOROLOGICAL

SOCIETIES AS A CO-SPONSOR OF A MEETING IN LONDON IN 1970 DEALING WITH GARP WAS PRESENTED, AND IT WAS LEFT TO COUNCIL TO CONSIDER THE QUESTION.

FOLLOWING ADJOURNMENT AT 2140, A RECEPTION WAS HELD IN THE ENGINEERS' LOUNGE.

GARP WORKSHOP

ON FRIDAY, JUNE 7, THE SOCIETY WAS CO-SPONSOR WITH THE METEOROLOGICAL BRANCH AND THE SUB-COMMITTEE ON METEOROLOGY AND ATMOSPHERIC SCIENCES (OF THE N.R.C. ASSOCIATE COMMITTEE ON GEOPHYSICS) OF THIS WORKSHOP. ITS PURPOSE WAS TO BRING TOGETHER SOME OF THE CANADIAN SCIENTISTS WHO WOULD BE PARTICIPATING IN GARP IN ORDER TO GIVE PRELIMINARY CONSIDERATION INTO WHAT CANADA'S ROLE SHOULD BE.

AN HISTORICAL INTRODUCTION TO GARP WAS GIVEN BY PROF. R.W. STEWART (INSTITUTE OF OCEANOGRAPHY, UNIVERSITY OF BRITISH COLUMBIA) WHO IS VICE-CHAIRMAN OF THE JOINT ORGANIZING COMMITTEE FORMED BY WMO AND IUGG. DR. W.L. GODSON FOLLOWED WITH A DISCUSSION OF THE STATUS OF SOME OF THE TOOLS – INSTRUMENTS AND FACILITIES THAT WOULD BE REQUIRED IN THE PROGRAM. BRIEF BACKGROUND PAPERS ON VARIOUS RELEVANT SUBJECTS WERE PRESENTED BY SEVERAL OF THE PARTICIPANTS.

IN THE NEXT STAGE, THE PARTICIPANTS DIVIDED THEMSELVES INTO PANELS – BOUNDARY LAYER (UNDER R.W. STEWART) AND FREE ATMOSPHERE (UNDER W.L. GODSON) – FOR FURTHER DISCUSSION. THEN THE TWO PANELS REJOINED TO SHARE RESULTS.

THESE DISCUSSIONS SHOULD PROVIDE A GOOD POINT OF DEPARTURE FOR DETAILED PLANNING OF CANADA'S ROLE IN GARP.

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-CONTINUED FROM PAGE 16.

POEM

I AM AN OLD FORECASTER LIVING IN THE CLOUD.
I GOT KICKED OFF THE T.V, MY VOICE IT WAS TOO LOUD.
NOW I WILL NEVER BE THE SAME IN FOG OR
OR HAIL OR RAIN.
I AM A COMPLETE WASHOUT – I HAVE WATER ON THE BRAIN.

THE HAILSTORMS IN ALBERTA, THEY REALLY ARE A BEAST.
WE PACKAGE THEM UP WITHIN A CLOUD AND SHIP THEM
FARTHER EAST.
RAINMAKER THATCHER THINKS IT IS O.K.
HAILSTONES OR RAINDROPS, IT'S WATER ANYWAY,
FARMERS THINK THEY ARE GOLF BALLS, BUT THEY SOON MELT AWAY.

UP HERE IN THE MOUNTAINS BY THE LITTLE CREEK,
THE MARMOTS AND PORCUPINES SNEAK IN FOR A PEEK.
NOTHING LIKE A BITE OFF A STEVENSON SCREEN,
AND A THERMOGRAPH LIKE YOU HAVE NEVER SEEN.
THERE ARE THINGS METEOROLOGICAL THAT AREN'T REALLY LOGICAL.

THE DIURNAL VARIATION OF WIND DIRECTION AT CALGARY

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ABSTRACT

THE WINDS AT CALGARY AIRPORT SHOW A DIURNAL VARIATION. NIGHT WINDS TEND TO BE NORTHWEST, WITH AFTERNOON WINDS FROM THE SOUTHEAST. OTHER DATA SHOW THAT THIS VARIATION IS NOT ASSOCIATED WITH LOCAL TOPOGRAPHY, BUT SEEMS TO BE AN EFFECT OF THE ROCKY MOUNTAINS TO THE WEST.

INTRODUCTION

THE DIURNAL VARIATION OF THE WIND DIRECTION HAS BEEN A SUBJECT OF MUCH INTEREST AND STUDY. THE LAND-AND-SEA BREEZES PROVIDE AN EXAMPLE OF THE CHANGES THAT SOLAR RADIATION AND THE THERMAL PROPERTIES OF THE UNDERLYING SURFACE PRODUCE IN THE COURSE OF THE DAY. WINDS ALSO SHIFT IN VALLEYS AND ALONG MOUNTAIN SLOPES BECAUSE OF THE DIFFERENTIAL COOLING AND HEATING OF THE GROUND SURFACES AND THE RESULTANT GRAVITY AND BUOYANCY FORCES. THIS IS A REPORT ON DIURNAL VARIATIONS OF THE WIND DIRECTION AT CALGARY AIRPORT. THE SITUATION IS MORE COMPLEX THAN THOSE MENTIONED, AND THE CAUSES ARE NOT IMMEDIATELY APPARENT.

SOURCE AND ANALYSIS OF DATA

A PUBLICATION OF THE METEOROLOGICAL BRANCH[1] GIVES THE WIND DATA FOR 8 CANADIAN AIRPORTS FOR 10 YEARS, 1954–1963, CLASSIFIED BY HOURS OF THE DAYS, BY MONTHS OF THE YEAR, BY DIRECTION TO EIGHT POINTS OF THE COMPASS, AND BY SPEEDS IN FOUR CLASSES: CALM, 1–9 MPH, 10–19 MPH, AND 20 MPH AND OVER. IN GIVING WIND DIRECTION, THEY COMBINED NORTH-NORTHEAST WINDS WITH NORTH, AND SIMILARLY AROUND THE COMPASS. THE CALGARY AIRPORT IS LOCATED ON A FLAT AREA ABOUT 4 MILES NORTHEAST OF THE CITY CENTRE (SEE FIG. 1).

FIG. 2 PRESENTS EVIDENCE OF THE DIURNAL VARIATION OF WIND AT CALGARY. POLYGON (A) GIVES THE WIND ROSE FOR JANUARY FOR THE NIGHT HOURS, 00–06H MST, AND (B) GIVES THE SAME FOR THE AFTERNOON HOURS 12–18H. POLYGONS (C) AND (D) GIVE CORRESPONDING WIND ROSES FOR JULY. THE JANUARY DATA SHOW SOME EVIDENCE

1. METEOROLOGICAL BRANCH, 1965. METEOROLOGICAL CONDITIONS AT CANADIAN AIRPORTS, TORONTO, DEPARTMENT OF TRANSPORT. 96P.

OF A DIURNAL VARIATION, WITH THE FREQUENCY OF NORTHWEST WINDS DECREASING FROM NIGHT TO AFTERNOON AND THAT OF SOUTHEAST WINDS INCREASING DURING THE SAME PERIOD. THE JULY CURVES PRESENT A MUCH MORE MARKED CHANGE. THE FREQUENCY OF NORTHWEST WINDS DECREASED FROM 38 PER CENT DURING THE NIGHT TO 13 PER CENT DURING THE AFTERNOON. THE FREQUENCY OF ALL DIRECTIONS FROM NORTH TO SOUTHEAST, INCLUSIVE, INCREASED DURING THE SAME PERIOD BUT THE MOST MARKED INCREASE WAS FOR THE SOUTHEAST, 5 PER CENT TO 27 PER CENT.

THE WIND DATA ARE GIVEN IN ANOTHER FORM IN FIG. 3. THE DIAGRAM SHOWS THE "NET" WIND FLOW BY HOURS OF THE DAY FOR THE SAME TWO MONTHS, JANUARY AND JULY, AS COMPUTED FROM THE SUMMARY OF WINDS. BECAUSE THE DATA WERE GROUPED INTO CLASSES, IT WAS NECESSARY TO ASSUME A MEAN VALUE FOR EACH CLASS. VALUES CHOSEN WERE: FOR 1–9 MPH, 5 MPH, 10–19 MPH, 15 MPH, OVER 19 MPH, 25 MPH. IT IS RECOGNIZED THAT 15 MPH IS TOO HIGH FOR THE 10–19 INTERVAL, AND THAT 25 MPH IS TOO HIGH FOR THE "OVER 19" CLASS EXCEPT WITH THE STRONG WINTER WEST WINDS THAT BLOW OVER THE DISTRICT. THE VALUES WERE USED BECAUSE THE RESULTS GAVE COMPARABLE FIGURES AND NO ASSUMPTIONS WOULD GIVE EXACT ANSWERS FROM THE DATA AVAILABLE.

THE DIAGRAMS SHOW ONCE AGAIN THAT IN JULY THERE IS A MAJOR SHIFT BETWEEN NIGHT AND AFTERNOON. THE JANUARY SHIFT IS MUCH LESS THAN THE JULY, BUT NEVERTHELESS THERE IS EVIDENCE THAT THE AFTERNOON WINDS TEND TO BE LESS STRONG WESTERLY THAN DURING THE REST OF THE DAY.

FIG. 4 PRESENTS THE WIND ROSES FOR THE SAME FOUR PERIODS AS FIG. 3, EXCEPT THAT THE WINDS 1–9 MPH ONLY ARE CONSIDERED. THE DIFFERENCES BETWEEN FIGS. 2 AND 4 ARE NOT GREAT. THIS IS SURPRISING, FOR ONE USUALLY EXPECTS THAT THE DIURNAL VARIATION OF WIND SHOWS MOST CLEARLY WITH LIGHT WINDS WHEN THE FORCES WHICH LEAD TO THE SYNOPTIC FLOW ARE SLIGHT.

THE DIURNAL VARIATION OF THE WIND DIRECTION CAN BE ILLUSTRATED IN A NUMBER OF WAYS. YET NO ONE METHOD CAN BRING OUT ALL THE DETAIL BECAUSE OF THE MANY VARIABLES INVOLVED. FIG. 5 PRESENTS THE VARIATION IN FREQUENCY DURING THE DAY FOR APRIL WINDS FOR SIX DIRECTIONS. THE DIRECTIONS NORTH AND WEST WERE OMITTED BECAUSE THE VARIATIONS WERE IRREGULAR AND PROBABLY NOT SIGNIFICANT. THE PLOTTED VALUES GIVE THE RUNNING 3–HOUR MEAN FREQUENCY, PLOTTED ON THE MIDDLE HOUR. NORTHWEST AND SOUTHWEST WINDS PEAK DURING THE NIGHT, AND FALL TO A MINIMUM DURING THE AFTERNOON. THE FREQUENCY OF SOUTH WINDS IS HIGH DURING THE NIGHT, RISES TO A MAXIMUM IN THE MORNING HOURS, AND IS AT A MINIMUM DURING THE LATE AFTERNOON AND EVENING.

THE OTHER THREE CURVES ARE SIMILAR. FREQUENCIES ARE RELATIVELY LOW DURING THE NIGHT, AND START TO RISE DURING THE MORNING. THE CURVE FOR SOUTHEAST WINDS REACHES A MAXIMUM IN THE EARLY AFTERNOON, THE OTHER TWO CURVES IN THE LATE AFTERNOON. CURVES FOR THE OTHER MONTHS VARY SOMEWHAT, BUT THE GENERAL TRENDS ARE SIMILAR TO THOSE SHOWN IN FIG. 5.

FIGS. 6 TO 9 PRESENT INFORMATION ABOUT FOUR DIRECTIONS IN ANOTHER FORM. THESE GIVE THE FREQUENCY OF THE WIND DIRECTIONS FOR LIGHT WINDS FOR EVERY

MONTH AND EVERY HOUR; FIG. 6, NORTHWEST, FIG. 7, SOUTHWEST, FIG. 8, SOUTH, AND FIG. 9, SOUTHEAST. ISOLINES ARE DRAWN BASED UPON 3-HOUR RUNNING MEANS IN ORDER TO SMOOTH SOMEWHAT THE IRREGULARITIES.

FIG. 6 FOR NORTHWEST WINDS SHOWS THAT A MINIMUM FREQUENCY OF LESS THAN 10 PER CENT IS FOUND DURING THE AFTERNOON HOURS FOR ALL MONTHS. THE NIGHT-TIME MAXIMUM IS HIGHEST DURING THE SUMMER MONTHS OF JUNE, JULY AND AUGUST. FROM THE WINTER MONTHS, THE MAXIMUM FREQUENCY LIES BETWEEN 20 TO 25 PER CENT.

THE VARIATION FROM MAXIMUM TO MINIMUM FREQUENCY FOR SOUTHWEST WINDS (FIG. 7) IS SLIGHT, APPROXIMATELY 10 PER CENT, AND VALUES ARE IRREGULAR. THE TIME OF MAXIMUM FREQUENCY IS APPROXIMATELY 6 HOURS AFTER SUNRISE. THE DIURNAL VARIATION OF FREQUENCY OF LIGHT SOUTH WINDS (FIG. 8) IS SLIGHT DURING THE WINTER. DURING THE OTHER MONTHS, A MAXIMUM FREQUENCY OCCURS DURING THE MORNING, BEING MOST MARKED IN SPRING AND FALL. THE MINIMUM OF APPROXIMATELY 10 PER CENT IS FOUND DURING THE AFTERNOONS OF THE SUMMER MONTHS.

FIG. 9 FOR SOUTHEAST WINDS, IS ALMOST THE REVERSE OF FIG. 6. A MINIMUM OF APPROXIMATELY 10 PER CENT IS FOUND DURING THE LATE NIGHT HOURS, AND A MAXIMUM DURING THE AFTERNOON. THE MAXIMUM IS LOW FOR MAY BUT IN GENERAL THE FREQUENCY REACHED 25 PER CENT.

IN SUMMARY, THE ANALYSIS DOES LITTLE MORE THAN TO EMPHASIZE THE CONCLUSIONS BASED UPON FIGS. 2, 3, AND 4. THE FREQUENCY OF NORTHWEST WINDS DROPS, AND OF SOUTHEAST WINDS RISES FROM LATE IN THE NIGHT TILL THE AFTERNOON. THE LAST ANALYSIS DOES BRING OUT A TENDENCY OF SOUTHWEST WINDS AND SOUTH WINDS TO BLOW MORE FREQUENTLY DURING THE MORNING.

WINDS 10 MPH AND OVER

THE FORCES WHICH PRODUCE LIGHT WINDS TEND TO BE MINOR IN NATURE, AND ASSOCIATED WITH THE TOPOGRAPHY AND LOCAL CONDITIONS. IT IS GENERALLY CONSIDERED THAT STRONGER WINDS ARE GOVERNED BY THE SYNOPTIC SCALE PRESSURE GRADIENT FORCES, AND TEND TO FOLLOW THE ISOBARS OF THE FREE ATMOSPHERE MORE CLOSELY THAN LIGHT WINDS. BECAUSE THE MOVEMENTS OF LOWS AND HIGHS IN THE REGION OF WESTERLIES ARE NOT RELATED TO THE TIME OF DAY, IT WOULD SEEM PROBABLE THAT THE DIURNAL VARIATION OF THESE STRONGER WINDS WOULD BE MINOR OR LACKING.

TABLE 1 – FREQUENCY OF WINDS OVER 9 MPH, CALGARY, 1954–1963, SEPTEMBER, GROUPED BY 3–HR PERIODS

HOURS	N	NE	E	SE	S	SW	W	NW	NO. OF HOURS
00–03	10	$\frac{1}{12}$	2	7	8	6	20	$\frac{1}{452}$	331
03–06	7	1	3	3	7	10	19	50	325
06–09	10	1	1	4	7	9	18	50	295
09–12	13	3	3	$12\frac{1}{2}$	$12\frac{1}{2}$	7	20	29	460
12–15	13	2	5	26	12	6	16	20	528
15–18	13	4	8	27	10	5	18	15	629
18–21	9	4	13	24	5	4	21	20	527
21–00	9	1	6	11	9	6	26	32	389

TABLE 1 SHOWS THAT AT CALGARY THERE IS A DIURNAL RHYTHM WITH STRONG (>9 MPH) WINDS. THE TABLE GIVES THE PERCENTAGE FREQUENCIES BY 3–HOUR PERIODS, FOR THE MONTH OF SEPTEMBER, THE GROUPING BEING DONE BECAUSE THE NUMBER OF OBSERVATIONS WAS SMALL.

ACCORDING TO THE DATA IN THE TABLE, THE FREQUENCIES DO NOT VARY DURING THE DAY FOR NORTHEAST AND SOUTHWEST WINDS. FOR THE DIRECTIONS OF NORTH, SOUTH, AND WEST THE VARIATION IS PRESENT BUT SLIGHT, IN GENERALLY PARALLELING THAT SEEN IN FIG. 5, FOR EAST, SOUTHEAST AND NORTHWEST, THE VARIATION IS EVEN GREATER THAN FOR LIGHT WINDS. STRONG EAST WINDS ARE ALMOST UNKNOWN BEFORE NOON, BUT THE FREQUENCY REACHES 13 PER CENT DURING THE EVENING. SIMILARLY, THE FREQUENCY OF SOUTHEAST WINDS IS UNDER 5 PER CENT AT NIGHT, AND OVER 25 PER CENT DURING THE AFTERNOON. NORTHWEST WINDS SHOW THE OPPOSITE RHYTHM.

DATA FOR THE OTHER MONTHS SHOW THAT A SIMILAR VARIATION OCCURS DURING THE SPRING AND SUMMER BUT IS ALMOST NON–EXISTENT DURING THE WINTER MONTHS.

THIS EFFECT IS NOT LIMITED TO THE SURFACE WINDS. NORMAN THYER[1] HAS COMPARED THE WINDS AT 5 AM AND 5 PM FOR CALGARY FOR A SHORT PERIOD. HE FOUND

1. THYER, N. 1966, UNPUBLISHED NOTE.

THAT AT 4000 AND 5000 FT THE SAME VARIATION IS FOUND. AT 6000 AND 7000 FT THE VECTOR DIFFERENCE BETWEEN MORNING AND AFTERNOON WAS APPROXIMATELY ALONG A NORTH–SOUTH LINE. EVEN AT 8000–10,000 FT THERE WAS SIGNIFICANT DIFFERENCE, WITH THE VECTOR DIFFERENCE NOW EAST OF NORTH. THE ANALYSIS COVERED A SHORT PERIOD ONLY, AND SO CANNOT BE CONSIDERED CONCLUSIVE, BUT IT DOES ADD FURTHER EVIDENCE TO THE INFORMATION OBTAINED FROM SURFACE WINDS.

DISCUSSION

IN A SEARCH FOR A CAUSE, ONE FIRST EXAMINES THE TOPOGRAPHY IN THE VICINITY OF THE OBSERVING SITE. THIS IS SHOWN IN FIG. 1. THE AIRPORT IS ON RELATIVELY LEVEL LAND 4 MILES NORTHEAST OF THE CITY CENTRE, AT AN ALTITUDE OF 3540 FT. THREE HILLS IN THE WESTERN PART OF THE CITY, NOSE HILL, BROADCAST HILL, AND A THIRD HILL SOUTH OF THE ELBOW, RISE TO APPROXIMATELY 4000 FT. FISH CREEK ON THE SOUTHERN EDGE OF THE CITY, ELBOW RIVER SOUTH OF BROADCAST HILL, BOW RIVER BETWEEN BROADCAST AND NOSE, AND NOSE CREEK EAST OF NOSE HILL, HAVE CUT VALLEYS INTO THE LANDSCAPE. THESE JOIN WITHIN THE CITY LIMITS TO FLOW SOUTHEASTWARD AS THE BOW RIVER. THE NOSE CREEK VALLEY IS THE SHALLOWEST, AND THE ONLY ONE NEAR THE AIRPORT. EVEN SO, IT IS ONE MILE WEST AND SHOULD HAVE LITTLE EFFECT ON THE WINDS.

ONE CAN POSTULATE FROM FIG. 1 THAT THE VALLEY OF THE BOW RIVER WOULD INFLUENCE THE WINDS AT THE UNIVERSITY OF CALGARY IN THE NORTHWEST SECTION OF THE CITY. IT IS DIFFICULT TO CONCEIVE OF THE LOCAL TOPOGRAPHY CAUSING THE DIURNAL VARIATIONS AT THE AIRPORT NOTED IN THE PRECEDING SECTIONS. THE LINE OF MAXIMUM VARIATION IS APPROXIMATELY PARALLEL TO THE CONTOURS ALONG NOSE HILL TO THE WEST AND THEREFORE PERPENDICULAR TO ANY KATABATIC FLOW ALONG THE SLOPE.

FARTHER AFIELD, ONE FINDS THE FRONT RANGE OF THE ROCKY MOUNTAINS ABOUT 50 MILES WEST OF CALGARY WITH AN ORIENTATION SLIGHTLY NORTH OF NORTHWEST. THUS, THE NORTHWEST–BY–NORTH–TO–SOUTHEAST–BY–SOUTH LINE ALONG WHICH THE MAJOR DIURNAL VARIATION IS FOUND IS APPROXIMATELY PARALLEL TO THE ROCKIES. IT IS HIGHLY PROBABLE THAT THE MOUNTAINS ARE A MAJOR CAUSE FOR THE PECULIARITIES OF THE CALGARY WINDS, BUT THE RELATIONSHIP MUST BE COMPLEX.

SOME INFORMATION FROM LETHBRIDGE, PENHOLD AND ROCKY MOUNTAIN HOUSE SHOW THAT HERE ALSO THERE ARE VARIATIONS IN THE FREQUENCIES OF WIND DIRECTION, BUT THE TOPOGRAPHY AT THESE PLACES IS MORE COMPLEX THAN AT CALGARY. FURTHER AWAY FROM THE FOOTHILLS, CORONATION DOES NOT SHOW A SIMILAR RHYTHM. THE AVAILABLE DATA DO NOT PERMIT THE CAREFUL STUDY FOR THESE STATIONS THAT WAS POSSIBLE FOR THE CALGARY WINDS.

ONE POSSIBLE EXPLANATION LIES IN THE DIURNAL VARIATION OF PRESSURE. MEAN VALUES OF JUNE STATION PRESSURE AT BANFF AND CALGARY AT THE SYNOPTIC HOURS ARE GIVEN IN TABLE 2.

TABLE 2 – MEAN VALUES OF THE JUNE STATION PRESSURE FOR THE SYNOPTIC HOURS BANFF (1948–1966) AND CALGARY (1941–1966)

	BANFF	CALGARY
05 MST	857.8	890.5
11 MST	856.9	890.4
17 MST	856.3	889.5
23 MST	857.4	890.4

AT BOTH BANFF AND CALGARY THE MINIMUM PRESSURE FOR SYNOPTIC HOURS IS FOUND AT 17 H MST. THE CALGARY VALUES ARE ABOUT 0.3 MB HIGHER THAN GIVEN BY CUDBIRD[2] FOR THE PERIOD 1953–1962, BUT THE TREND IS SIMILAR. CUDBIRD FOUND A MAXIMUM PRESSURE AT 08 H, MST, FOLLOWED BY A SLOW DROP UNTIL 16 H, MST, AND THEN A RAPID RISE BETWEEN 18 H AND 22 H. CHANGES BETWEEN 22 H AND 08 H ARE MINOR.

THE VALUES IN TABLE 2 SHOW THAT THE DOUBLE AMPLITUDE OF THE PRESSURE WAVE AT BANFF IS 0.5 MB GREATER THAN AT CALGARY. THIS WOULD RESULT IN A DIURNAL VARIATION IN THE PRESSURE GRADIENT. IF THE BANFF WAVE WERE FOUND IN THE MOUNTAINS 45 MI. SOUTHWEST OF CALGARY, THIS WOULD RESULT IN A NIGHT-TIME WIND FROM THE NORTHWEST OF APPROXIMATELY 5 MPS. (12 MPH) ABOVE THE AFTERNOON WIND. THIS DIURNAL VARIATION OF THE PRESSURE GRADIENT MAY BE THE CAUSE OF THE WIND REVERSAL AT CALGARY. THE SOUTHWEST FLOW IN THE MORNING MAY RESULT FROM THE DECREASE OF THIS PRESSURE DIFFERENCE AND THEREFORE THE FLOWING OUTWARD OF THE SURPLUS AIR THAT ACCUMULATED OVER THE MOUNTAINS DURING THE DAY. MORE WORK IS NECESSARY TO CHECK THIS HYPOTHESIS.

2. CUDBIRD, B.S.V., DIURNAL AVERAGES OF WIND ATMOSPHERIC PRESSURE, AND TEMPERATURE AT SELECTED CANADIAN STATIONS, 1964, TORONTO DEPARTMENT OF TRANSPORT, METEOROLOGICAL BRANCH, CIR. 4114, CLIM. 33, 44P.

THERE ARE AT LEAST THREE PHENOMENA FOR WHICH AN EXPLANATION MUST BE SOUGHT. THE FIRST IS THE CAUSE FOR THE GREATEST EFFECT OF THE DIURNAL VARIATION TO BE FOUND ALONG A LINE CLOSELY PARALLEL TO THE AXIS OF THE MOUNTAIN. SECOND, WHY DOES THE DIURNAL VARIATION PERSIST IN THE FREE ATMOSPHERE, STILL BEING APPARENT AT 10,000? THIRD, A FINAL EXPLANATION MUST INCORPORATE IN IT A REASON FOR THE SLIGHT INCREASE IN THE FREQUENCY OF LIGHT WINDS FROM THE SOUTHWEST AND SOUTH IN THE MORNING HOURS.

CONCLUSION

THE PAPER REPORTS ON DIURNAL VARIATIONS OF WIND FOUND AT THE CALGARY AIRPORT. THE EFFECT CAN BE NOTED WITH STRONG WINDS AND LIGHT WINDS, IN WINTER AND IN SUMMER, AT THE SURFACE AND IN THE FREE ATMOSPHERE. IT DOES NOT APPEAR THAT THE CAUSE FOR THESE VARIATIONS CAN BE FOUND IN THE LOCAL TOPOGRAPHY, BUT THE AUTHOR HAS FAILED TO FIND ANY ANSWER WHICH SATISFIES HIM.

NOTE:

I DON'T FEEL THAT THERE IS A VERY GREAT MYSTERY AT NIGHT. THE AIR DRAINS DOWN THE EASTERN SLOPES AND SWEEPS OUT OVER THE ALBERTA PRAIRIES. THE TRAJECTORIES ARE LONG ENOUGH FOR THE CORIOLIS FORCE TO BECOME IMPORTANT, AND THE WIND BLOWS FROM THE NORTHWEST, PARALLEL TO THE ROCKIES.

THE DAY-TIME CASE IS MORE COMPLEX. THE WIND BLOWS UP THE SLOPE, BUT IN THIS CASE, THE PRAIRIE IS UPSTREAM OF THE SOURCE OF MOTION SO THE SAME ARGUMENT DOESN'T NECESSARILY APPLY.

THERE ARE MANY SIMILARITIES TO THE SEA AND LAND BREEZE BEHAVIOUR.

R.E. MUNN

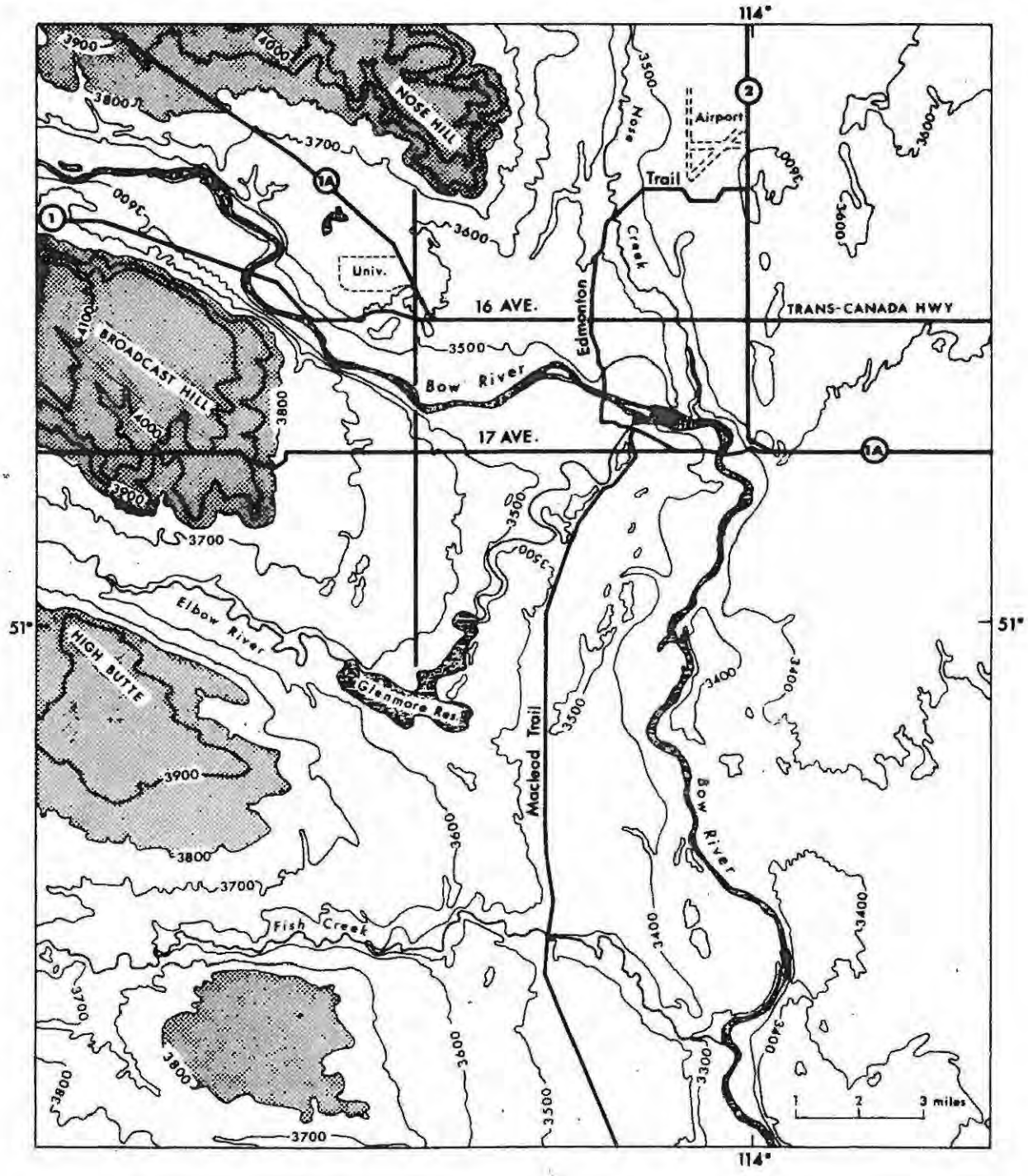

Fig. 1 Topography of Calgary

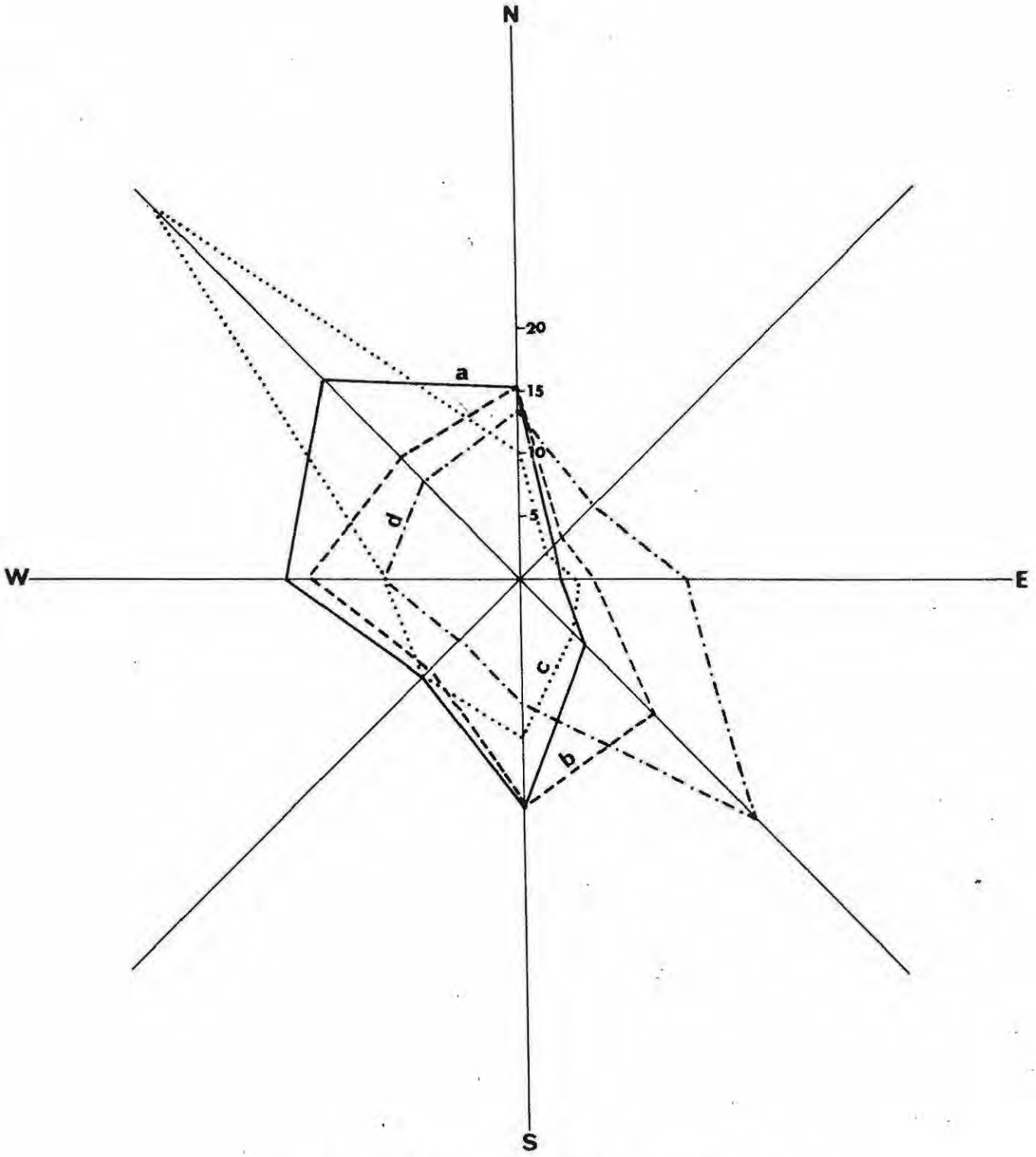

Fig 2 Wind roses for Calgary, all speeds
(a) 00-06, January (b) 12-18, January
(c) 00-06, July (d) 12-18, July

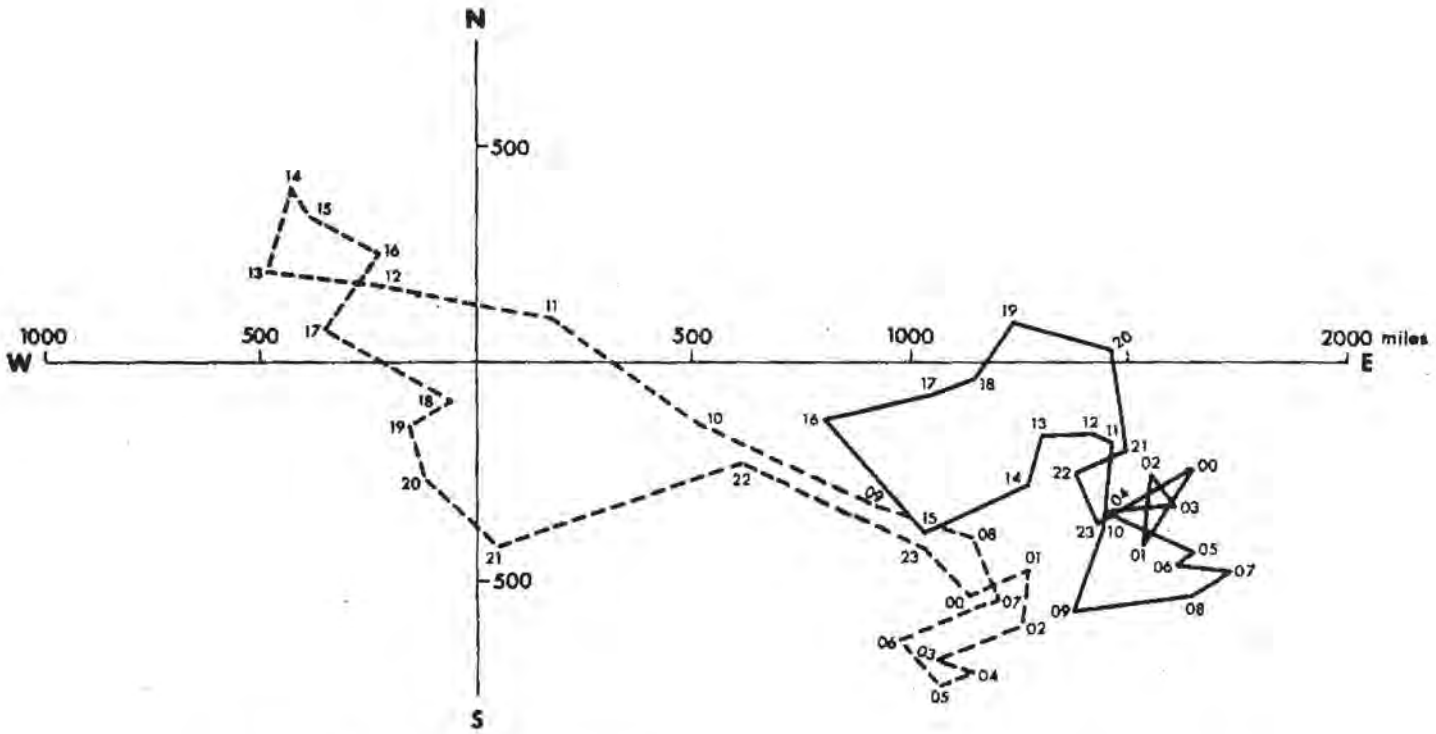

Fig. 3 Net wind flow at Calgary by hours of the day : January —— July ----

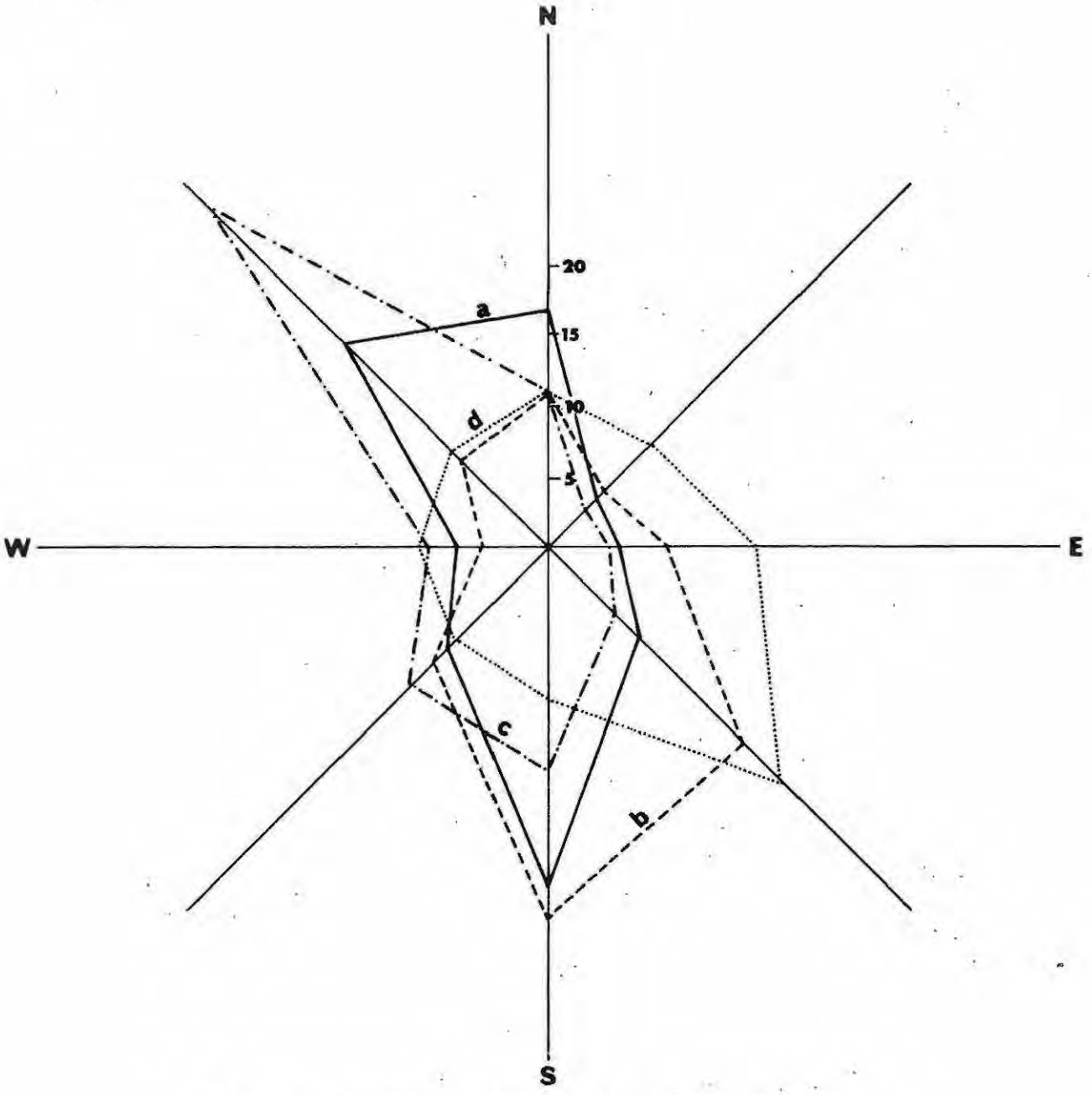

Fig 4 Wind roses for Calgary for light (1-9 mph) winds
(a) 00-06 h, January (b) 12-18 h, January
(c) 00-06 h, July (d) 12-18 h, July

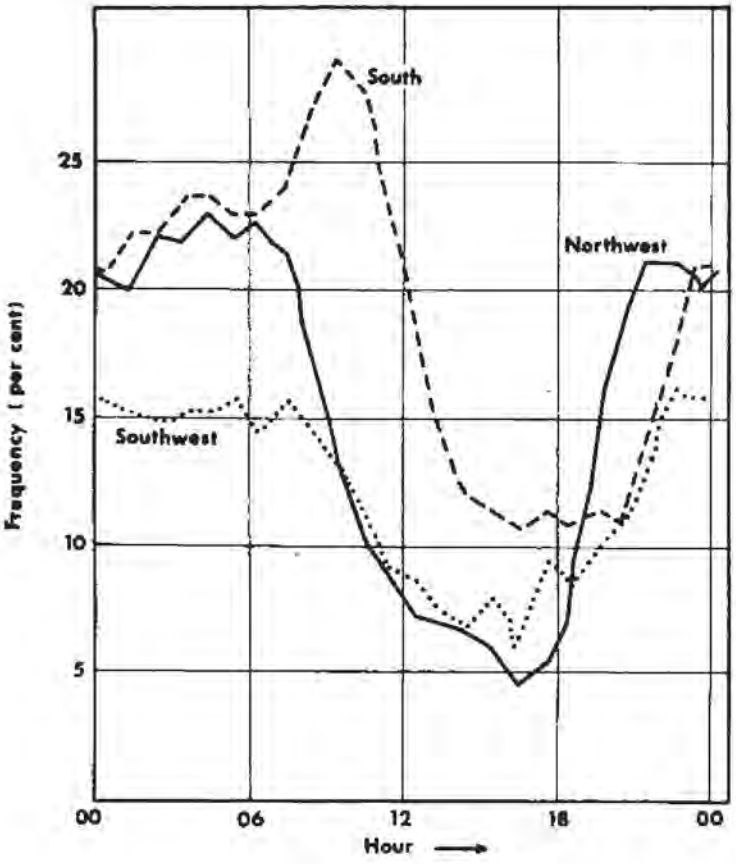

Fig 5 (a)

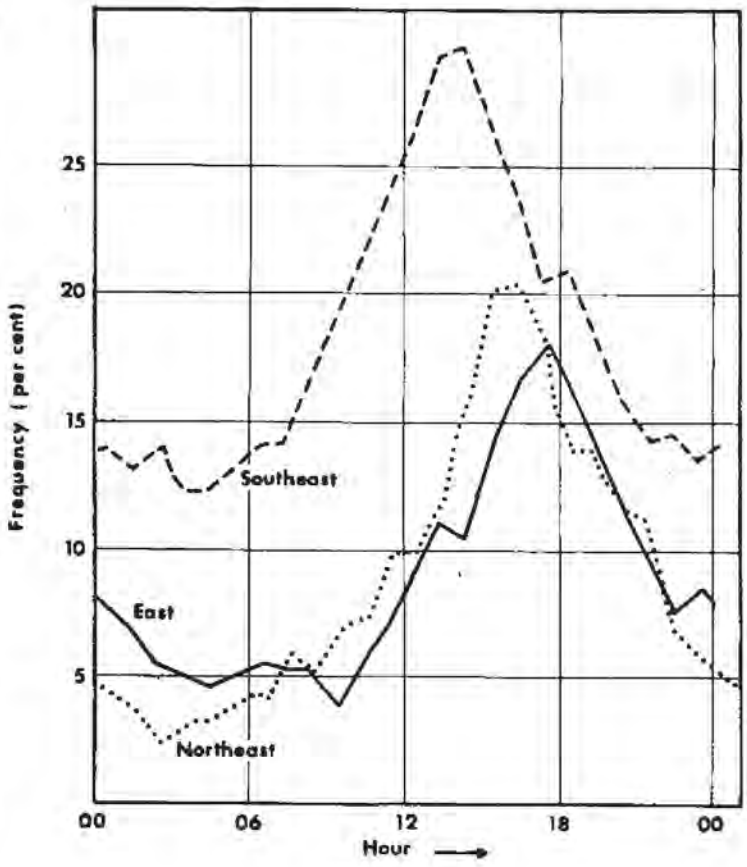

Fig 5 (b)

Frequency (per cent) of light winds during April, by hours of the day. (Values plotted are 3-hour running means, plotted on the middle hour)

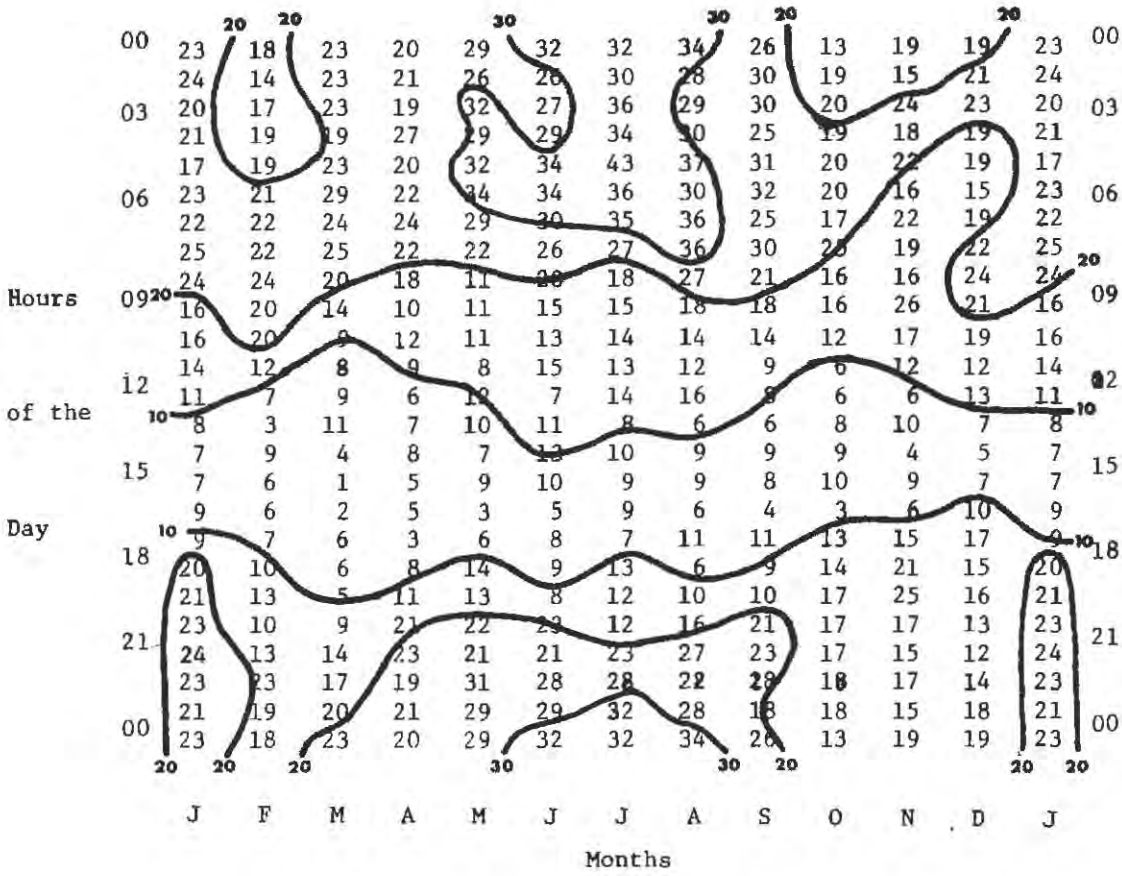

Fig. 6 Frequency (per cent) of light (1-9 mph) northwest winds by months and hours of the day. (Note: isolines of per cent for Figs. 5-8 are based on mean values for three consecutive frequencies.

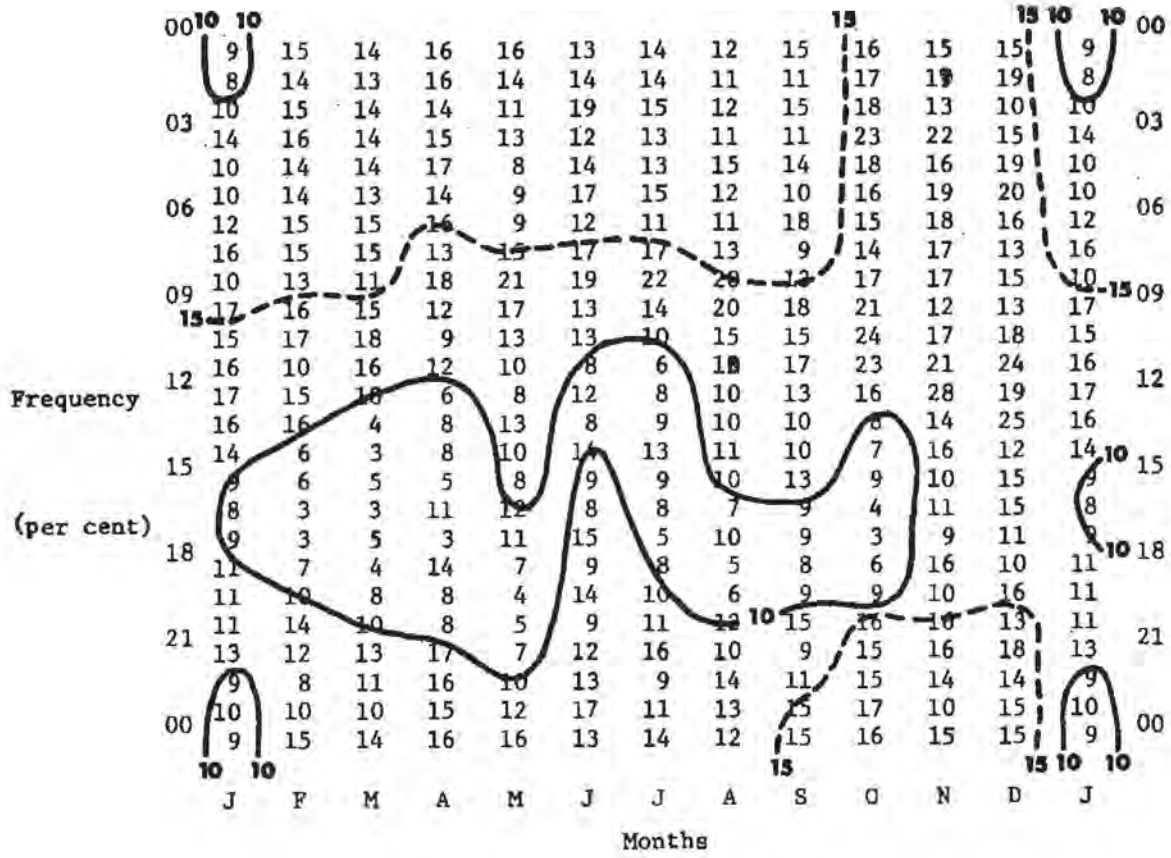

Fig. 7. Frequency (per cent) of light (1-9 mph) southwest winds by months and hours of the day.

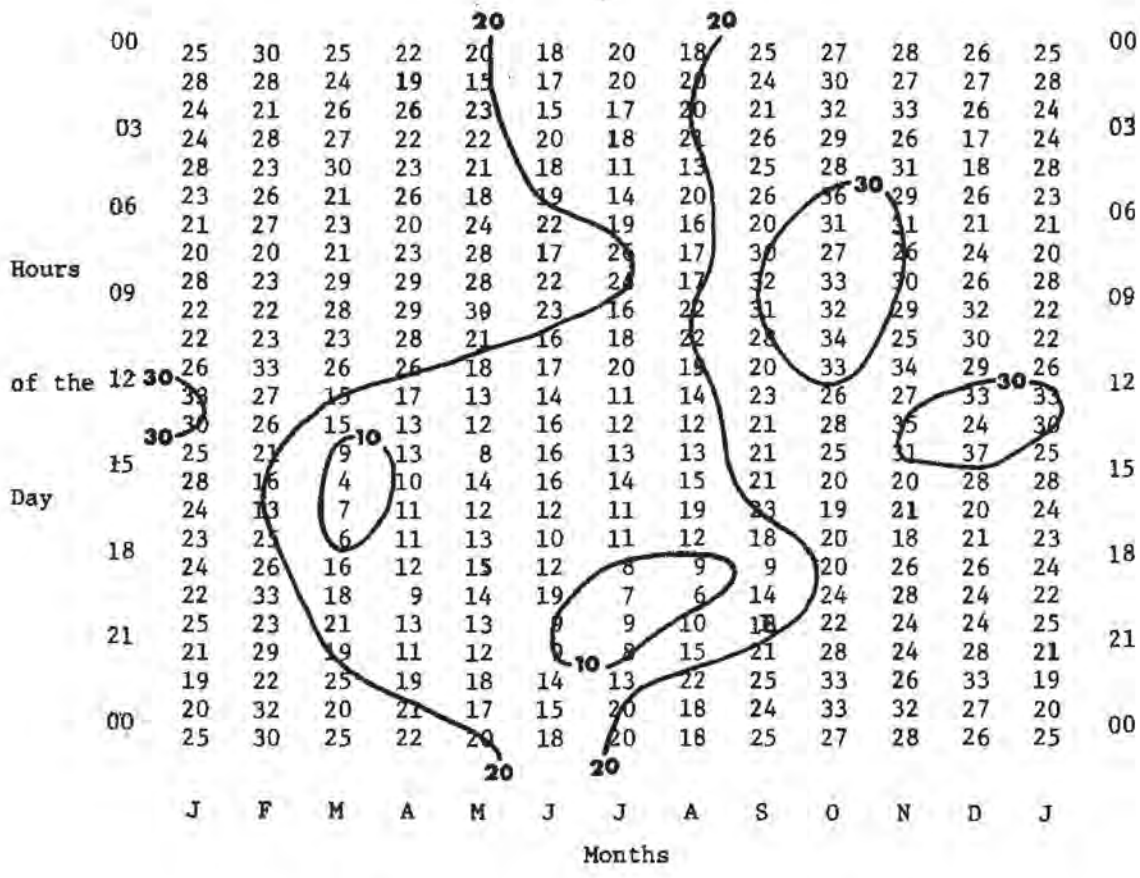

Fig. 8 Frequency (per cent) of light (1-9 mph) south winds by months and hours of the day.

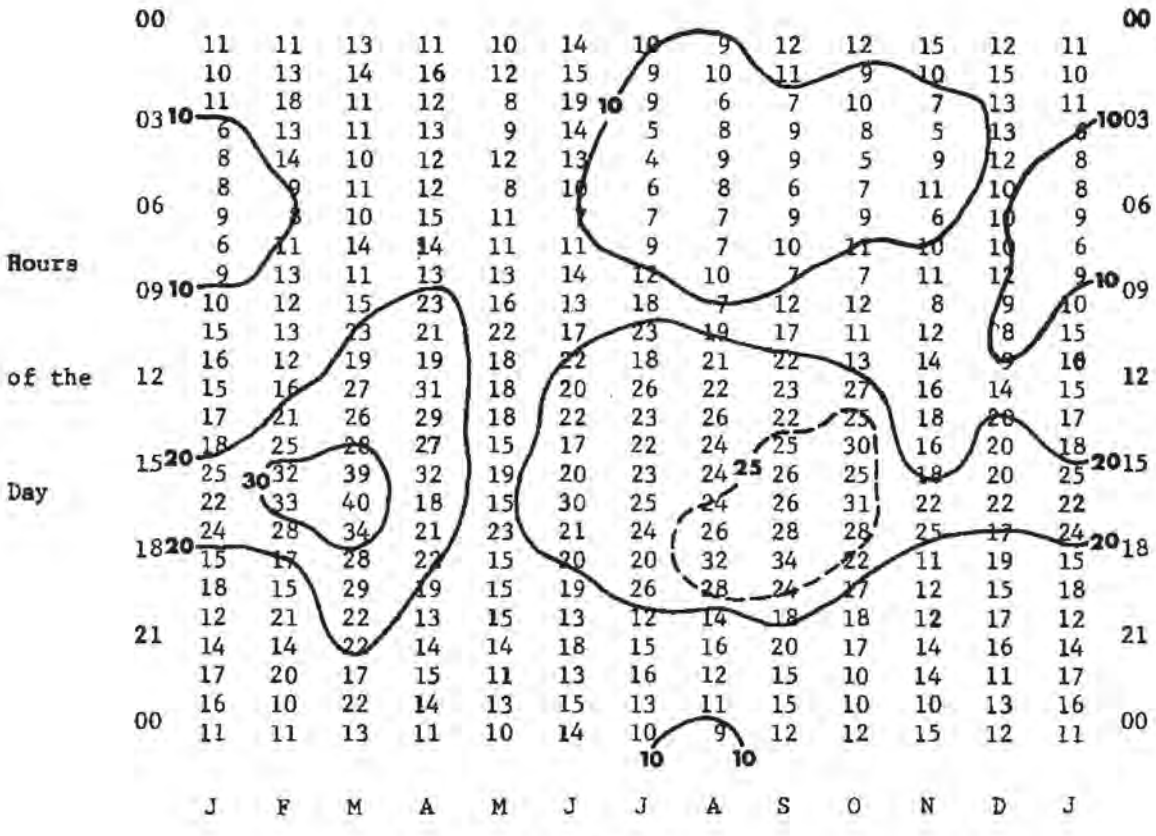

Fig. 9 Frequency (per cent) of light (0-9 mph) southeast winds by months and hours of the day.

– CONTINUED FROM PAGE 15

PROPOSED IAMAP MEETINGS FOR 1968

INTERNATIONAL SYMPOSIUM ON NUMERICAL WEATHER PREDICTION – TOKYO, LATE 1968.
CO-SPONSORED BY WMO AND IAMAP.
CONTACT: DR. E. KNIGHTING
METEOROLOGICAL OFFICE
LONDON ROAD
BRACKNELL
BERKSHIRE, ENGLAND

SYMPOSIUM ON NOCTILUCENT CLOUDS. PLACE AND DATES UNCERTAIN, AND EVEN YEAR COULD BE CHANGED.
CONTACT: MR. G. KRONEBACH
W.M.O. SECRETARIAT
WORLD METEOROLOGICAL ORGANIZATION
CASE POSTALE NO. 1
CH-1211 GENEVA 20
SWITZERLAND

7TH INTERNATIONAL CONFERENCE ON CONDENSATION AND ICE NUCLEI

A MEETING UNDER THE ABOVE TITLE, SPONSORED BY IAMAP THROUGH ITS COMMISSION ON CLOUD PHYSICS, WILL TAKE PLACE 17–20 SEPTEMBER, 1969, IN PRAGUE AND 22–24 SEPTEMBER, 1969, IN VIENNA. HOSTS WILL BE THE CZECHOSLOVAK AND AUSTRIAN ACADEMIES OF SCIENCE.

PRINCIPAL TOPICS TO BE DISCUSSED INCLUDE:

1. PHYSICS, PHYSICAL CHEMISTRY AND PHOTO-CHEMISTRY OF AEROSOLS, PARTICULARLY WITH RESPECT TO NUCLEATION.

2. THE METHODOLOGY OF MEASUREMENT OF CONDENSATION AND ICE NUCLEI.

3. CONDENSATION AND ICE NUCLEI IN CLOUD FORMATION.

CONTRIBUTORS AND PARTICIPANTS SHOULD COMMUNICATE WITH THE TWO ORGANIZERS BEFORE MARCH, 1969. THEIR NAMES AND ADDRESSES ARE –

DR. J. PODZIMEK
INSTITUTE FOR PHYSICS OF THE ATMOSPHERE
CSAV, BOCNI II, PRAHA-SPORILOV, CZECHOSLOVAKIA

PROFESSOR DR. O. PREINING
1ST PHYSICS INSTITUTE OF THE UNIVERSITY OF VIENNA
STRUDLHOFGASSE 4, A-1090
VIENNA, AUSTRIA

CANADIAN METEOROLOGICAL SOCIETY PRIZES, 1967-68

AT THE SECOND ANNUAL GENERAL MEETING OF THE C.M.S., ANNOUNCEMENT OF THE FOLLOWING PRIZES WAS MADE BY PROF. A.W. BREWER:

1. THE PRESIDENT'S PRIZE WAS AWARDED TO DR. ANDRE ROBERT, OF THE CENTRAL ANALYSIS OFFICE, D.O.T., FOR HIS PAPER - "AN INTEGRATION OF THE PRIMITIVE METEOROLOGICAL EQUATIONS IN TERMS OF SPHERICAL HARMONICS". THE PAPER WAS PUBLISHED IN 1967 IN THE PROCEEDINGS OF AN INTERNATIONAL SYMPOSIUM HELD IN MOSCOW.

2. THE PRIZE IN APPLIED METEOROLOGY WAS AWAROED TO DR. A. DAVENPORT OF THE UNIVERSITY OF WESTERN ONTARIO FOR TWO PAPERS:

   (A) "INSTRUMENTATION AND MEASUREMENT OF WIND SPEED SPECTRA IN A CITY", IN PROCEEDINGS, FIRST CANADIAN CONFERENCE ON MICROMETEOROLOGY, PP. 361-368; AND

   (B) "THE DEPENDENCE OF WIND LOADS ON METEOROLOGICAL PARAMETERS", PREPRINT FOR THE INTERNATIONAL RESEARCH SEMINAR ON WIND EFFECTS ON BUILDINGS AND STRUCTURES (OTTAWA, 1967).

3. THE DR. ANDREW THOMSON UNDERGRADUATE STUDENT PRIZE WAS WON BY S. CLODMAN FOR A CIRCULAR OF THE METEOROLOGICAL BRANCH (TEC-640) TITLED - "A PILOT STUDY OF CLIMATOLOGICAL RAINFALL PATTERN AROUND MALTON, ONTARIO".

4. A SPECIAL GRADUATE STUDENT PRIZE WAS AWARDED THIS YEAR TO S. WORONKO FOR HIS M.SC. THESIS AT MC GILL UNIVERSITY - "CALCULATIONS OF THE INFRARED HEATING ROLE IN THE ATMOSPHERE".

INSTRUCTIONS TO AUTHORS

1. MANUSCRIPTS SHALL BE SUBMITTED IN DUPLICATE, TYPED DOUBLED-SPACED ON $8\frac{1}{2}$ X 11" BOND, WITH THE PAGES NUMBERED CONSECUTIVELY.

2. TWO COPIES OF FIGURES SHALL BE SUBMITTED WITH THE MANUSCRIPT. THE ORIGINALS SHOULD BE RETAINED BY THE AUTHOR UNTIL IT IS ESTABLISHED WHETHER OR NOT REVISIONS WILL BE REQUIRED. A LIST OF THE LEGENDS FOR FIGURES SHALL BE TYPED TOGETHER ON A SEPARATE SHEET.

3. AUTHORS SHALL KEEP IN MIND WHEN LABELLING THAT FIGURES WILL REQUIRE REDUCTION TO 5" X 8" (FULL PAGE) OR SMALLER. PHOTOGRAPHS SHALL BE GLOSSY PRINTS WITH GOOD CONTRAST. OTHER DIAGRAMS SHALL BE DRAWN WITH PEN AND INK AND BE IN FINAL FORM FOR PHOTOGRAPHING.

4. LITERATURE CITATIONS IN THE TEXT SHALL BE BY AUTHOR AND DATE. THE LIST OF REFERENCES SHOULD BE PRIMARILY ALPHABETICAL BY AUTHOR, AND SECONDLY CHRONOLOGICAL FOR EACH AUTHOR.

5. UNITS SHOULD BE ABBREVIATED ONLY IF THEY ARE ACCOMPANIED BY NUMERALS. FOR EXAMPLE, 10 KM., BUT SEVERAL KILOMETERS.

6. TABLES SHALL BE PREPARED ON SEPARATE PAGES EACH WITH AN EXPLANATORY TITLE. ONLY ESSENTIAL VERTICAL AND HORIZONTAL RULING WILL BE INCLUDED.

7. METRIC UNITS ARE PREFERRED.

8. FOOTNOTES TO THE TEXT SHOULD BE AVOIDED.

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