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TERMINAL FORECASTING AND SUPERSONIC TRANSPORT¹

J. J. CLODMAN

1. INTRODUCTION

ALTHOUGH THIS DISCUSSION IS AIMED AT THE PROBLEMS OF SUPERSONIC TRANSPORT, MANY OF THE CONSIDERATIONS AND CONCLUSIONS WILL BE APPLICABLE TO OTHER CLASSES OF AIRCRAFT, PARTICULARLY THOSE OF FUTURE GENERATIONS. THESE INCLUDE JUMBO JETS, THAT IS, AIRCRAFT WITH SEATING FOR CLOSE TO 500 PASSENGERS, AND EVENTUALLY MORE, AND SPECIAL TYPES SUCH AS VERTICAL TAKE-OFF AND SLOW TAKEOFF AIRCRAFT.

SINCE THIS ANALYSIS IS BEING PRESENTED FROM A METEOROLOGICAL POINT OF VIEW, THE AERONAUTICAL ENGINEERING ASPECTS WILL BE TREATED RATHER SUPERFICIALLY. IT SHOULD BE POINTED OUT THAT, FOR THE PURPOSE OF THIS PAPER, THE TECHNOLOGICAL AS WELL AS THE SCIENTIFIC ASPECTS OF THE PROBLEM WILL BE DISCUSSED - THAT IS, THE INFLUENCE OF ATMOSPHERIC MOTIONS DURING THE LANDING OR TAKEOFF AS WELL AS THE METEOROLOGICAL SERVICES THAT WILL NEED TO BE PROVIDED FOR THIS TYPE OF OPERATION.

2. CHANGES IN LANDING TECHNOLOGY

SST'S LANDING CHARACTERISTICS : SUPERSONIC TRANSPORT WILL BE LANDING AT THE SAME AIRPORTS AND WITHIN THE SAME TECHNOLOGICAL FRAMEWORK AS SUBSONIC AIRCRAFT. IT IS, THEREFORE, NOT SURPRISING THAT THEY WILL NOT, IN GENERAL, HAVE GREATLY DIFFERENT LANDING CHARACTERISTICS. CERTAIN DESIGN PROBLEMS WILL BE HANDLED DIFFERENTLY, AND IN SOME CASES, THIS MAY MEAN THAT THE SST MAY LAND AT SOMEWHAT HIGHER SPEEDS THAN ARE CURRENTLY THE STANDARD. THIS, IN TURN, MAY CREATE A REQUIREMENT FOR SOMEWHAT LONGER RUNWAYS. ALTHOUGH IN GENERAL THIS IS NOT SIGNIFICANT FOR METEOROLOGY, IT MAY CREATE A PREFERENCE AT CERTAIN AIRPORTS FOR LANDINGS ON THE LONGER RUNWAYS. THUS, SOMEWHAT HIGHER CROSS-WINDS MAY HAVE TO BE TOLERATED. THE HANDLING AND FLARE-OUT PROCEDURES MAY DIFFER A LITTLE FROM PRESENT AIRCRAFT WITH A CONCOMITANT CHANGED RESPONSE TO ATMOSPHERIC MOTIONS. IT IS NOT, HOWEVER, TO BE EXPECTED THAT THESE DIFFERENCES WILL CHANGE QUALITATIVELY THE METEOROLOGICAL LANDING PROBLEMS. HOWEVER, THEY WILL NEED CONSIDERATION IN REFERENCE TO DESIGN CRITERIA FOR THE METEOROLOGICAL SUPPORT SYSTEMS.

1. ORIGINALLY PRESENTED AT THE SYMPOSIUM ON PROBLEMS INVOLVING LANDING AND TAKEOFF CONDITIONS FOR SST'S, I.U.G.G. CONFERENCE, LUCERNE, SEPTEMBER, 1967.

LANDING AIDS: SOME OF THE GREATEST IMPACT ON METEOROLOGICAL SUPPORT REQUIREMENTS FOR THE SST WILL UNDOUBTEDLY COME, NOT FROM THE CHANGES IN AIRCRAFT DESIGN, BUT RATHER FROM THE ADVANCES THAT ARE PLANNED IN LANDING AIDS. AT PRESENT, THE FORECASTING OF CEILINGS AND VISIBILITIES MAY BE OF CRITICAL IMPORTANCE IN TERMINAL FORECASTING. PRESENT TECHNOLOGY MAKES IT ESSENTIAL FOR THE PILOT TO BE ABLE TO LAND MANUALLY AND VISUALLY WHEN HE REACHES A CERTAIN PRESCRIBED MINIMUM HEIGHT. HOWEVER, RAPID ADVANCES ARE NOW BEING MADE IN THE DEVELOPMENT OF SO-CALLED ALL-WEATHER LANDING SYSTEMS. WHAT THIS MEANS IS, THAT AN AIRCRAFT OPERATING UNDER SUCH A SYSTEM, WILL BE ABLE TO LAND WITH ZERO CEILING AND NEAR ZERO VISIBILITY. THE LANDING WILL BE CARRIED OUT AUTOMATICALLY AND WITHOUT PILOT INTERVENTION EXCEPT, OF COURSE, IF AN EMERGENCY ARISES WHICH DEMANDS THAT A PILOT OVERRIDES THE AUTOMATIC CONTROLS. IT IS CLEAR THAT THERE WILL BE OCCASIONAL CIRCUMSTANCES WHEN A LANDING WILL BE PREVENTED OR ABORTED. FOR ONE THING, IT IS CONSIDERED THAT VISIBILITY OF 150 FT. WILL BE REQUIRED FOR THE PILOT TO GUIDE THE AIRCRAFT PROPERLY DOWN THE RUNWAY AFTER LANDING. A RELATED QUESTION INVOLVES THE SNOW ACCUMULATION WHICH CAN COVER THE LIGHTS DESIGNED TO HELP GUIDE THE AIRCRAFT DOWN THE RUNWAY. ICING DUE TO FREEZING PRECIPITATION MAY BE A PROBLEM ALTHOUGH SST'S WILL HAVE WHAT IS KNOWN AS A 'HOT WING' AND SO CAN TOLERATE A FAIRLY HEAVY ACCRETION RATE ON LANDING. THUS, IT WILL TAKE LOW TEMPERATURES AND HEAVY ICING TO PREVENT A LANDING DUE TO THIS PHENOMENON. FREEZING PRECIPITATION MAY BE MORE OFTEN A PROBLEM ON TAKEOFF SINCE A STATIONARY AIRCRAFT CAN ACQUIRE A COATING OF ICE MORE QUICKLY THAN IT CAN BE REMOVED IN A HEAVY ICING SITUATION. FINALLY, THERE ARE THE QUESTIONS OF WIND SHEAR, TURBULENCE AND RELATED PHENOMENA. THIS NOT ONLY INVOLVES THE RESPONSE OF THE AIRCRAFT TO ATMOSPHERIC MOTIONS UNDER EXTREME CONDITIONS, BUT ALSO THE DESIGN LIMITS IMPOSED BY THE AUTOMATIC LANDING SYSTEMS. THIS WILL BE DISCUSSED AGAIN A LITTLE FURTHER ON IN THE PAPER.

LANDING CATEGORIES: IT MUST NOT BE THOUGHT THAT THE PROBLEM OF FORECASTING CEILINGS AND VISIBILITIES WILL DISAPPEAR OVERNIGHT. THE TARGET DATE FOR ONE AIRLINE AND ONE TYPE OF AIRCRAFT TO INSTITUTE ALL-WEATHER LANDINGS IS MID 1971. ONE COULD REASONABLY EXPECT THAT IT WILL BE SOME TIME THEREAFTER BEFORE ALL IMPORTANT AIRPORTS AND MOST COMMERCIAL AIRLINES WILL HAVE AN ALL-WEATHER CAPABILITY. FOR SST THE BENEFITS OF SUCH A SYSTEM WILL BE SHOWN TO BE IMPORTANT AND SO WE CAN EXPECT THAT THIS CONVERSION WILL LIKELY BE GENERAL FOR THIS TYPE OF AIRCRAFT OPERATION WITHIN THE NEXT TEN YEARS. ALL-WEATHER OPERATIONS WILL BE APPROACHED IN STAGES OR CATEGORIES. CATEGORY I HAS LIMITS OF 200 FT. AND VISIBILITY OF HALF MILE. SOME PRESENT AIRCRAFT ARE NOW OPERATING IN THIS CATEGORY. CATEGORY II WILL REQUIRE CONDITIONS HALF AS GOOD, THAT IS, 100 FT. CEILINGS AND QUARTER MILE VISIBILITY. AT THIS STAGE THE PILOT'S ABILITY TO TAKE OVER AND LAND THE AIRCRAFT PROPERLY MAY BE FAIRLY CRITICAL SINCE, UNDER ADVERSE WIND AND TURBULENCE CONDITIONS, IT MAY BE DIFFICULT FOR THE PILOT TO ORIENT HIMSELF IN THE SECOND OR SO HE HAS, IF THERE IS A VIOLENT PERTURBATION AT THE MOMENT OF TAKEOVER. CATEGORY III IS BROKEN DOWN TO MORE THAN ONE STAGE. III(A), FOR EXAMPLE, WILL PERMIT ZERO CEILING AND 700 FT. VISIBILITY. FOR MOST PURPOSES, HOWEVER, CATEGORY III EVEN IN ITS PRELIMINARY PHASES WILL GIVE THE PILOT SO LITTLE TIME TO ADJUST THAT IT CAN BE CON-

SIDERED AS AN AUTOMATIC LANDING SYSTEM.

3. METEOROLOGICAL SUPPORT METHODOLOGY

ECONOMIC FACTORS: TO DETERMINE THE TYPE OF FORECASTING SERVICE THAT SHOULD BE PROVIDED TO SUPERSONIC TRANSPORT AND OTHER LARGE AIRCRAFT OF THE FUTURE, CERTAIN ECONOMIC AND OPERATIONAL FACTORS COME TO THE FORE. AN SST IS A VERY EXPENSIVE VEHICLE AND ITS DEVELOPMENT AND USE CAN ONLY BE JUSTIFIED BY VIRTUE OF ITS ABILITY TO TRANSPORT PEOPLE QUICKLY AND DEPENDABLY. THIS IS NOT ONLY TO ENSURE PASSENGER ACCEPTANCE, BUT AS A MATTER OF OPERATIONAL ECONOMICS. IF THERE ARE TOO MANY DELAYS IN TAKEOFF OR LANDING, OR DIVERSIONS TO ALTERNATE AIRPORTS, THE NUMBER OF FLIGHTS ACHIEVED PER AIRCRAFT WILL NOT BE ENOUGH TO MAKE THE OPERATION PROFITABLE. IN ESSENCE, IT DOESN'T MAKE SENSE TO FLY 3,000 MILES IN 2 HOURS AND THEN WAIT TWO HOURS TO LAND OR TO LOSE SEVERAL HOURS DUE TO BEING DIVERTED TO AN ALTERNATE AIRPORT. THUS, IT IS NECESSARY TO HAVE AN ADVANCED SUPPORT TECHNOLOGY TO ENSURE SATISFACTORY OPERATION. THE ALL-WEATHER LANDING SYSTEM IS A MOVE IN THIS DIRECTION. METEOROLOGICAL FORECASTS ARE REQUIRED FOR SEVERAL ASPECTS OF THE LANDING PROBLEM AND WILL BE NEEDED FOR PRELIMINARY PLANNING, FOR FINAL FLIGHT PLANNING AND FOR ENROUTE DECISIONS AS TO WHETHER TO ATTEMPT A DESCENT TO A GIVEN AIRPORT. IN CONNECTION WITH THIS LAST QUESTION, IT MUST BE REMEMBERED THAT FOR SUPERSONIC FLIGHT THERE ISN'T MUCH TIME FOR LONG DELIBERATIONS BEFORE DECISIONS ARE MADE.

PRESENT METEOROLOGICAL SUPPORT SYSTEMS: METEOROLOGICAL SYSTEMS IN SUPPORT OF AIRCRAFT OPERATIONS ARE, IN MANY WAYS, ANTIQUATED WHEN COMPARED TO THE ACTIVITIES BEING SUPPORTED. IF AN AIRCRAFT IN FLIGHT WANTS TO HAVE A SHORT-RANGE TERMINAL FORECAST IN ORDER TO DETERMINE WHAT HIS PLAN OF OPERATIONS SHOULD BE, A SLOW AND CUMBERSOME SYSTEM IS USUALLY BROUGHT INTO PLAY WHICH ENDS IN A SUBJECTIVE REVIEW BY A FORECASTER AND A TRANSFERENCE OF THE INFORMATION TO THE PILOT. ALTERNATELY, A ROUTINE FORECAST IS USED WHICH IS ISSUED ONLY PERIODICALLY AND, THEREFORE, CAN PROVIDE ONLY MORE LIMITED ACCURACY IN TERMS OF SHORT-RANGE FORECASTING. AS IS WELL-KNOWN, THE ACCURACY OF A FORECAST NORMALLY DEGRADES FAIRLY RAPIDLY WITH TIME. AS A RESULT OF THIS, IT IS OFTEN BETTER TO DEPEND ON THE LATEST ACTUAL WEATHER THAN A FORECAST PREPARED A FEW HOURS BEFORE. THE CLOSER AN AIRCRAFT COMES TO THE LANDING TIME, THE MORE IS THE PRESENT TENDENCY TO RELY ON OBSERVATIONS RATHER THAN FORECASTS. THUS, WITH THE INCREASED SPEEDS AND MORE RAPID DECISION TIMES IN RESPECT TO SST OPERATIONS, THE METEOROLOGIST WILL, MORE AND MORE, BE DEFAULTING HIS FUNCTION UNLESS PROCEDURAL CHANGES ARE MADE.

MODERNIZED SYSTEM REQUIREMENT: WHAT IS REQUIRED IS A SHORT-RANGE FORECAST METHODOLOGY WHICH GIVES VIRTUALLY INSTANTANEOUS TERMINAL FORECASTS CONTINUOUSLY UPDATED AND AVAILABLE WITH LITTLE LAG TO THE CONTROLLER, DISPATCHER OR PILOT AS THE CASE MAY BE. AS FAR AS ACCURACY IS CONCERNED, A REASONABLE INITIAL GOAL WOULD BE TO AIM AT ACCURACY EQUIVALENT TO WHAT IS BEING PROVIDED BY THE PRESENT SYSTEM WITH THE PROVISIO THAT THE METHOD SHOULD BE AS DEPENDABLE OR USEFUL IN RESPECT TO UNUSUAL OR EXTREME EVENTS AS IN THE

PRESENT SYSTEM. CLEARLY, IF EQUIVALENT FORECAST ACCURACY IS ACHIEVED BY SUCH A SYSTEM THERE IS A SUBSTANTIAL ADVANTAGE BECAUSE THERE WILL BE LITTLE OR NO DELAY AND THUS NO TIME DEGRADATION.

PRINCIPLES OF THE FUTURE METHOD: WHAT IS REQUIRED THEN IS AN AUTOMATED COMPUTERIZED SYSTEM. WITH THE RAPID ADVANCES IN COMPUTER TECHNOLOGY AND ASSOCIATED INPUT-OUTPUT DEVICES, THIS APPROACH IS NOW WELL WITHIN THE STATE OF THE ART. ALL OF THE LOCAL OBSERVATIONS CAN BE FED DIRECTLY INTO THE COMPUTER SYSTEM IN DIGITIZED FORM. THIS CAN INCLUDE THE TERMINAL OBSERVATIONS, OBSERVATIONS FROM OTHER STATIONS IN THE AREA SUCH AS MESOMETEOROLOGICAL SUPPORT STATIONS, RADAR REPORTS, WEATHER SATELLITE PHOTOGRAPHY METEOROLOGICAL TOWER REPORTS, ETC. ALSO, SELECTED NEIGHBOURING STATIONS IN THE REGULAR AVIATION AND SYNOPTIC NETWORKS AND UPPER-AIR STATIONS WITHIN A CERTAIN RADIUS CAN TRANSFER REPORTS DIRECTLY TO THE COMPUTER USING THE NORMAL METEOROLOGICAL COMMUNICATIONS SYSTEM. FINALLY, THE NWP PRODUCTS CAN BE SENT ON A COMPUTER-TO-COMPUTER BASIS AND AS NEW DEVELOPMENTS USING A DYNAMIC APPROACH PROVIDE MORE DETAILS AND INCLUDE WEATHER PARAMETERS THESE CAN BE INCORPORATED INTO THE PROCEDURE.

4. CANADIAN RESEARCH ON AUTOMATED TERMINAL FORECASTING

DATA ACQUISITION: THE CONCEPT THAT HAS BEEN DESCRIBED IS, OF COURSE, NOT NEW BUT THE INCREASED IMPORTANCE OF SUCH AN APPROACH FOR SST OPERATIONS SHOULD BE EMPHASIZED. FOLLOWING IS A BRIEF DESCRIPTION OF SOME CANADIAN RESEARCH ALONG THESE LINES. THE ACTIVITY IS BEING PLANNED IN PHASES WITH BY-PRODUCTS SO THAT THE ULTIMATE GOAL IS NOT THE ONLY JUSTIFICATION FOR THE ACTIVITY. THE FIRST PHASE, NOW COMPLETED, WAS PRIMARILY FOR DATA ACQUISITION. THE PRINCIPLE WAS ADOPTED THAT ALL OF THE AVAILABLE INFORMATION SHOULD BE EXAMINED TO DEVELOP THE FORECAST METHODOLOGY. THE TORONTO INTERNATIONAL AIRPORT WAS SELECTED AS THE SITE FOR THE FIRST STUDY DESIGNED TO DEVELOP THE METHOD.

ALL OF THE HOURLY DATA FOR THE SEVERAL STATIONS IN THE TORONTO AREA AND FOR SURROUNDING SURFACE STATIONS WERE ACQUIRED AS WELL AS CERTAIN TYPES OF ADDITIONAL INFORMATION GIVING A TOTAL OF ABOUT 2 MILLION PUNCHED CARDS. THIS INFORMATION WAS PROCESSED TO CORRECT FOR ERRORS AND FOR THE FREQUENT CODE CHANGES, ETC. AND THEN MERGED ON AN HOUR-BY-HOUR BASIS TO GIVE HUNDREDS OF PARAMETERS FOR EACH HOUR OF ABOUT 15 YEARS OF RECORD IN PACKED-BINARY FORM ON MAGNETIC TAPE. THIS DATA-HANDLING PHASE WAS BY NO MEANS A SMALL CHORE BECAUSE OF THE LARGE NUMBER OF LOGICAL PROCESSES THAT HAD TO BE PROGRAMMED.

ANALYSIS SYSTEM PRINCIPLES: BEFORE PROCEEDING TO A DESCRIPTION OF THE NEXT PHASE IN THIS PROGRAM, IT WOULD BE IN ORDER TO DESCRIBE THE PRINCIPLES UNDER WHICH THE METHODOLOGY IS BEING DEVELOPED. IN ESSENCE, THERE WERE FOUR BASIC PRINCIPLES ADOPTED. FIRSTLY, IT WAS DECIDED THAT WE WOULD NOT BE RESTRICTED TO ANY PRE-CONCEIVED STATISTICAL OR ANALYTICAL FORMS. THAT IS, WE WOULD NOT MAKE ASSUMPTIONS ON THE SHAPE OF DISTRIBUTIONS OR OF RELATIONSHIPS AND, EXCEPT FOR SIMPLE SMOOTHING PROCEDURES, RELATIONSHIP WOULD ESSEN-

TIALLY BE DICTATED BY THE DATA. SECONDLY, IT WAS NOT FELT THAT WITH THE AMOUNT OF DATA AVAILABLE THERE COULD BE FOUND A DEFINITIVE SET OF RELATIONSHIPS. SEVERAL ALTERNATE SETS OF RELATIONSHIPS COULD BE DEVELOPED BUT THE FINAL TEST WOULD BE HOW WELL THE RELATIONSHIPS OPERATE ON INDEPENDENT DATA AND IN COMPARISON WITH CURRENT METHODS. THE THIRD PRINCIPLE INVOLVES THE QUESTION OF INTERACTION BETWEEN PREDICTORS IN THEIR INFLUENCE ON A PREDICTAND. IN MUCH OF METEOROLOGICAL ANALYSIS OF THIS SORT, INTERACTION EFFECTS ARE LARGELY IGNORED MAINLY BECAUSE OF THE STATISTICAL DEGREES OF FREEDOM NEEDED TO INCLUDE THEM. IF WE HAVE N PREDICTORS, THERE ARE COMBINATIONS OF N TAKEN TWO AT A TIME FIRST-ORDER INTERACTIONS, COMBINATIONS OF N TAKEN THREE AT A TIME SECOND-ORDER INTERACTIONS AND SO FORTH, AND THE NUMBER OF TERMS GETS QUICKLY OUT-OF-HAND. NONETHELESS, WE FEEL IT IS A MISTAKE TO IGNORE INTERACTION EFFECTS SINCE EXAMPLES WHERE THESE ARE SIGNIFICANT CAN BE FOUND. FINALLY, IT WAS CONSIDERED IMPORTANT THAT ADEQUATE CONSIDERATION AND WEIGHT BE GIVEN TO UNUSUAL OR EXTREME EVENTS. THESE MAY BE MOST IMPORTANT FROM AN OPERATIONAL POINT OF VIEW BUT ARE OFTEN GIVEN INADEQUATE ATTENTION IN SOME ANALYTICAL PROCEDURES BECAUSE OF THEIR SMALL REPRESENTATION IN THE TOTAL POPULATION.

RELATIONSHIP DISPLAY: IN THE SECOND PHASE OF THE ACTIVITY A COMPUTER PROGRAM WAS DEVELOPED TO ORGANIZE THE DATA INTO SELECTED MULTI-DIMENSIONAL DISTRIBUTIONS WHICH COULD THEN BE EXAMINED FOR SUITABLE FORECAST RELATIONSHIPS. EACH DIMENSION CAN REPRESENT AN ORIGINAL PARAMETER OR ONE CREATED FROM ONE OR MORE OF THE ORIGINAL PARAMETERS IN ANY DESIRED WAY. THE TOTAL DISTRIBUTION OR DISTRIBUTIONS CREATED BY ONE RUN OF THE COMPUTER CAN THEN BE DISPLAYED AS TWO DIMENSIONAL SLICES OF THE ORIGINAL DISTRIBUTION OR AS TWO-DIMENSIONAL SLICES OF ANY SETS OF MARGINAL DISTRIBUTIONS. THE FIRST VERSION OF THIS PROGRAM HAS BEEN RUN A FEW TIMES AND EACH RUN PRODUCED AN OUTPUT OF CLOSE TO 1,000 TABLES. WE ARE NOW IN THE PROCESS OF UPGRADING THE PROGRAM TO MAKE USE OF THE CAPABILITY OF A MORE POWERFUL COMPUTER.

SELECTION OF RELATIONSHIPS AND DEVELOPMENT OF METHODOLOGY: THIS BRINGS US TO THE NEXT PHASE OF THE STUDY SINCE IT IS APPARENT THAT HAND-METHODS ARE NOT A SATISFACTORY WAY OF SIFTING THROUGH THE THOUSANDS OF TABLES THAT CAN BE CREATED FROM THE COMPUTER RUNS. IN FACT, EXAMINING THE RESULTS AS TWO DIMENSIONAL SLICES MAY NOT BE THE BEST WAY OF APPROACHING THE PROBLEM. PERHAPS, THE BEST RELATIONSHIPS COULD BE FOUND ONLY AFTER ROTATIONS, DISTORTIONS OF SCALE AND ORTHOGONALIZATION. BASICALLY, WHAT IS REQUIRED IS A SCAN IN THE MULTI-DIMENSIONAL SPACE TO FIND INTERESTING CLUSTERS OR PATTERNS OF POINTS, EACH POINT REPRESENTING A PLOT OF THE HOURLY PARAMETERS. CRITERIA ARE NEEDED FOR USE IN THE COMPUTER TO DETECT INTERESTING RELATIONSHIPS. FOR EXAMPLE, A CRITERION COULD INVOLVE SELECTING AREAS OR SURFACES WITH LOW ENTROPY CONTENT. HOWEVER, WE ARE STILL IN AN EARLY STAGE OF THIS WORK. THE FINAL PHASE OF THE WORK WILL BE TO COMBINE THE SELECTED RELATIONSHIPS INTO A FORECAST PROCEDURE AND TO DEVELOP AN ASSOCIATED AUTOMATED METHODOLOGY. WE ARE NOT, OF COURSE, THE ONLY ONES ATTEMPTING TO DEVELOP AN OBJECTIVE FORECASTING METHODOLOGY. OTHERS ARE USING OTHER APPROACHES SUCH AS REGRESSION AND MULTI-DISCRIMINANT ANALYSIS TECHNIQUES. WHATEVER THE APPROACH, THE NEED

OF AN OBJECTIVE PROCEDURE FOR SHORT-RANGE TERMINAL FORECASTING IS CLEAR.

5. INFLUENCE OF ATMOSPHERIC MOTIONS ON SST LANDINGS

TWO ASPECTS: I WOULD NOW LIKE TO DEAL WITH AN ENTIRELY DIFFERENT FACET OF THE SST LANDING PROBLEM. AN AIRCRAFT, WHILE IN A LANDING CONFIGURATION, IS ESPECIALLY SENSITIVE TO UNUSUAL WIND CONDITIONS WHETHER THEY ARE IN THE FORM OF SHEAR, TURBULENCE OR ORGANIZED MOTIONS. THUS, IT IS NECESSARY TO ESTABLISH THE ATMOSPHERIC CONDITIONS WHICH AN AIRCRAFT OR A LANDING SYSTEM SHOULD BE DESIGNED TO MEET. SINCE SUCH A DESIGN SHOULD MEET ALL BUT THE MOST EXTREME CONDITIONS, IT WILL ALSO BE NECESSARY TO DEVELOP METHODS OF FORECASTING UNUSUAL EVENTS WHICH ARE OUTSIDE THE DESIGNATED ACCEPTABLE LANDING CONDITIONS.

AIRCRAFT RESPONSES TO WIND REGIMES: IN ORDER TO APPRECIATE THE COMPLEXITY OF THE DESIGN AND FORECAST PROBLEM INVOLVED, A BRIEF EXAMINATION OF AIRCRAFT RESPONSES TO WIND AND TURBULENCE WOULD BE HELPFUL. IN A GENERAL WAY, THERE ARE SEVERAL SPECTRAL BAND WIDTHS OF ATMOSPHERIC MOTIONS TO WHICH AN AIRCRAFT IS SENSITIVE AND RESPONDS IN SPECIFIED WAYS. SHORT ATMOSPHERIC WAVELENGTHS OF THE ORDER OF THE AIRCRAFT SIZE CAN CAUSE STRUCTURAL MODES OF RESPONSES AND PRODUCE MAJOR PASSENGER DISCOMFORT AS WELL AS THREATEN STRUCTURAL INTEGRITY IN EXTREME CASES. INTERMEDIATE MOTIONS CAUSE OSCILLATIONS ABOUT THE CENTRE OF GRAVITY AND THESE MOTIONS FOR A LARGE AIRCRAFT ARE OF THE ORDER OF HALF MILE CORRESPONDING TO ABOUT 10 SECOND PERIODICITIES. THE MAJOR RESPONSES IN TERMS OF MOTION OF THE CENTRE OF GRAVITY OF THE AIRCRAFT IS CREATED AT THE PHUGOID WAVELENGTH. WAVELENGTHS ARE FUNCTIONS OF AIRCRAFT SPEED AND, AT LANDING SPEEDS, WOULD BE OF THE ORDER OF 1-2 MILES. THE QUESTION IS COMPLICATED BY THE FACT THAT THE AIRCRAFT MAY BE MOVING DOWN INTO THE PERTURBATION AND SO ONLY PART OF A WAVE MAY BE INVOLVED. IN ADDITION, THERE IS THE EFFECT OF THE ZERO FREQUENCY OR WIND SHEAR WHICH TENDS TO CAUSE AN AIRCRAFT TO OVERSHOOT AS COMPARED TO A STEP REDUCTION IN WIND SPEED WHICH WILL CAUSE AN AIRCRAFT TO DROP BELOW THE GLIDE PATH. THE COMPLEXITY OF THIS INTERACTION BETWEEN AIRCRAFT AND ATMOSPHERE CREATES THE RISK THAT THE PILOT OF THE AUTOMATIC LANDING SYSTEM WILL RESPOND IN AN OUT-OF-PHASE WAY TO A SERIES OF INFLUENCES. FOR AN AIRCRAFT IN LEVEL FLIGHT THERE IS USUALLY AMPLE TIME AND SPACE FOR ADJUSTMENTS BUT DURING LANDING THE PROBLEM IS ACUTE BECAUSE WE ARE CONCERNED WITH HEIGHT CHANGES OF A VERY FEW TENS OF METRES AND TIME CHANGE OF A VERY FEW SECONDS.

WIND PERTURBATIONS DURING LANDING: WHEN CONSIDERING THE INFLUENCE OF ATMOSPHERIC MOTIONS ON AN AIRCRAFT LANDING, IT IS NECESSARY TO KEEP IN MIND THAT WE ARE MORE CONCERNED WITH SPACE SPECTRA THAN WITH TIME SPECTRA. THE RELATIONSHIP BETWEEN THE TWO IS REASONABLY STRAIGHTFORWARD FOR FLIGHT OVER LEVEL GROUND OR AWAY FROM THE SURFACE. HOWEVER, THE ASSUMPTION OF SPATIAL HOMOGENEITY IS OFTEN NOT VALID FOR MANY AIRPORTS. THIS IS PARTICULARLY IMPORTANT IN TERMS OF THE MAIN WAVELENGTHS OF INTEREST WHICH, AS WE HAVE SEEN, EXTEND UP TO MILES. IN ADDITION, WITHIN THE SPECTRAL REGION OF INTEREST THE SPECTRUM TENDS TO BE MARKEDLY RED. THUS, WITH INCREASED AIRCRAFT SIZES

THERE WILL BE MORE POWER IN THE BANDS OF INTEREST. FINALLY, ATMOSPHERIC MOTIONS OF THE SCALE OF A MILE OR MORE ARE OFTEN NOT TRULY RANDOM BUT THE ENERGY IS IN THE FORM OF ORGANIZED MOTIONS WHICH ARE STRONGLY RELATED TO TERRAIN FEATURES. EXAMPLES OF THIS ARE STANDING WAVES OVER HILLS AND STANDING EDDIES BEHIND OBSTACLES. THE IMPLICATION OF THIS FOR AN AIRCRAFT IS THAT AT TIMES THE ENERGY MAY BE CONCENTRATED IN A NARROW BAND WIDTH TO WHICH THE AIRCRAFT IS ESPECIALLY SENSITIVE AND THE PHASE RELATIONSHIPS WITH THE GLIDE PATH MAY BE SUCH AS TO GIVE LITTLE TIME FOR CORRECTION AT CRUCIAL POINTS ON THE GLIDE PATH. THE ABOVE PROBLEMS WILL BECOME MORE ACUTE WITH INCREASED SIZES INVOLVED. THUS, IT IS PROBABLY ADVISABLE TO STUDY EACH RUNWAY AT LEAST IN A GENERAL WAY TO EVALUATE THE LOCAL PROBLEMS AS THEY RELATE TO DESIGN AND TO THE FORECASTING OF EXTREME CONDITIONS.

6. CANADIAN STUDY OF THE LANDING PROBLEM

PRELIMINARY LONG-TERM TOWER DATA ANALYSIS: THE METEOROLOGICAL SERVICE OF CANADA IS EMBARKING ON A RESEARCH PROGRAM TO CLARIFY SOME OF THESE QUESTIONS. AS A FIRST STEP, A FEW LONG-TERM TOWER RECORDS WERE EXAMINED TO SEE WHAT THEY WOULD REVEAL AS TO DISTRIBUTION AND THE RISK OF WIND-SHEAR EXCEEDING SOME CRITICAL VALUE. ICAO HAS SUGGESTED 10 MPH / 100 FT. AS POSSIBLY BEING A LIMITING NUMBER FOR DESIGN PURPOSES. IT WAS FOUND THAT VERY OCCASIONAL SHEARS IN EXCESS OF THIS VALUE COULD BE ENCOUNTERED. SOME SPECTRA OF WIND AND WIND-SHEAR WERE ALSO EXAMINED TO SEE HOW THEY RELATE TO EACH OTHER.

PURPOSE OF SPECIAL TOWER STUDY: IT WAS REALIZED THAT THE RISKS OF EXCESSIVE WIND-SHEAR AS ESTIMATED FROM THE LONG-TERM TOWER DATA WERE DECEPTIVELY LOW. FIRSTLY, THE WINDS WERE AVERAGED FOR EITHER 10 MINUTES OR AN HOUR AND THUS FOR EACH MEAN SHEAR THERE WOULD BE A DISTRIBUTION OF LARGER AND SMALLER VALUES WITHIN THE INTERVAL WHEN THE AVERAGING IS DONE OVER TIMES APPROPRIATE TO AN AIRCRAFT LANDING. SECONDLY, THERE MIGHT BE A CHANGE IN DISTRIBUTION DUE TO THE FACT THAT WE ARE NOT DEALING WITH A VERTICAL, INSTANTANEOUS SITUATION BUT THAT THERE IS A HORIZONTAL AND TIME SEPARATION INVOLVED IN AN AIRCRAFT LANDING.

SPECIAL TOWER STUDY: A SPECIAL TOWER STUDY WAS INSTITUTED TO EXAMINE SOME OF THESE MATTERS IN A PRELIMINARY WAY. AN ATTEMPT WAS MADE TO SIMULATE AN ACTUAL RUNWAY SITUATION BY SETTING UP A SMALL TOWER ABOUT 1 MILE FROM A 300 FT. TOWER ALONGSIDE A LARGE SUPER-HIGHWAY AND BY TAKING SIMULTANEOUS WIND READINGS AT THREE LEVELS IN THE TALL TOWER AND THE SMALL TOWER AT INTERVALS OF ONE SECOND. THE RESULTS OF THIS EXPERIMENT WILL BE REPORTED ON IN ANOTHER PAPER. HOWEVER, ONE OF THE THINGS THAT THE INITIAL DATA REVEAL IS THAT THE RISK OF EXCESSIVE WIND SHEAR IS UNDOUBTEDLY MUCH HIGHER THAN WOULD APPEAR FROM THE LONG-TERM AVERAGED DATA.

METEOROLOGY IN CANADA

A REACTION TO THE ROSE REPORT

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1
THE ROSE REPORT — A SURVEY OF, AND OUTLOOK FOR PHYSICS IN CANADA — DESERVES CAREFUL READING BY ALL CANADIAN METEOROLOGISTS BECAUSE IT CONCERNS QUESTIONS OF PUBLIC INVESTMENT IN, AND BENEFIT FROM, SCIENTIFIC RESEARCH, SPECIFICALLY, IN THE WORDS OF THE PREFACE, IT IS CONCERNED WITH THE ENCOURAGEMENT OF GOOD RESEARCH, WITH THE DISTRIBUTION OF THAT RESEARCH AMONG THE MANY BRANCHES OF PHYSICS, AND WITH THE ESTABLISHMENT OF SENSIBLE LEVELS OF SUPPORT FOR THAT RESEARCH RELATIVE TO THE WEALTH AND PRODUCTIVITY OF CANADIAN SOCIETY. METEOROLOGY AND THE ATMOSPHERIC ENVIRONMENTAL SCIENCES ARE REPRESENTED AS ONE OF 12 SUB-DIVISIONS OF PHYSICS THAT WERE SELECTED FOR SURVEY AND RECOMMENDATIONS. ALTHOUGH THE STUDY GROUP WAS COMMISSIONED TO DEAL WITH SHORT-RANGE PLANNING PROBLEMS, HINTS AND SUGGESTIONS OF LONG-RANGE GOALS ARE TO BE FOUND THROUGHOUT THE REPORT.

VIEWS AS A WHOLE, THE REPORT SEEMS TO PRESENT AN HONEST APPRAISAL OF PAST AND PRESENT STRENGTHS AND WEAKNESSES, AND OF THE PROBLEMS AND CHALLENGES THAT FACE PHYSICISTS IN THE IMMEDIATE FUTURE. EACH OF US HOLDS SOME RESPONSIBILITY TO SEE THAT IT TAKES ITS PROPER PLACE AS A SIGNIFICANT STEP TOWARDS AN IMPROVED ROLE OF PHYSICS IN CANADA RATHER THAN BECOMING A MONUMENT TO YET ANOTHER STUDY GROUP.

IN A SHORT REVIEW SUCH AS THIS, OF BUT ONE ASPECT OF A LARGE REPORT, IT IS INEVITABLE THAT THE ORIGINAL CONTEXT CAN ONLY BE DISCUSSED SUPERFICIALLY. THE DEFINITIONS OF PHYSICS, THE SOMEWHAT ARBITRARY BOUNDARIES THAT MUST BE ESTABLISHED BEFORE A SURVEY CAN BE UNDERTAKEN, AND THE HISTORICAL BACKGROUND OF PATTERNS IN RESEARCH, SOURCES OF SUPPORT, ETC., ARE CONSIDERED AT SOME LENGTH IN THE REPORT. TO MANY, THE QUESTIONS ARE FAMILIAR: WHAT CONSTITUTES PHYSICS RESEARCH? WHAT FIELDS OF PHYSICS SHOULD BE INCLUDED IN THE SURVEY? AT WHAT POINT IS A LINE DRAWN BETWEEN APPLIED PHYSICS AND ENGINEERING? WHAT IS THE ROLE OF PHYSICS IN SOCIETY? WHAT ARE THE GENERAL FEATURES OF ACTIVITY IN, AND SUPPORT FOR PHYSICS IN CANADA IN THE PAST? THESE QUESTIONS MUST BE BY-PASSED.

1. PHYSICS IN CANADA, SURVEY AND OUTLOOK — SPECIAL STUDY NO. 2, SCIENCE SECRETARIAT, PRIVY COUNCIL OFFICE, OTTAWA, MAY, 1967.

HOWEVER, THE EIGHT GENERAL RECOMMENDATIONS OF THE REPORT ARE LISTED BELOW AS BACKGROUND FOR A MORE DETAILED REVIEW OF THE SURVEY OF METEOROLOGY. THE GENERAL RECOMMENDATIONS OF THE ROSE REPORT FOR PHYSICS RESEARCH IN THE NEXT FIVE YEARS WERE:

1. SPECIAL CONSIDERATION MUST BE GIVEN TO STRENGTHENING THE RESEARCH EFFORT IN APPLIED PHYSICS.
2. MORE UNIVERSITIES ARE URGED TO CREATE PRESTIGE HONORS COURSES IN PHYSICS WITH SPECIAL OPTIONS ORIENTED TOWARD APPLIED PHYSICS AND THE INTER-DISCIPLINARY ASPECTS OF PHYSICS.
3. CONTINUE SUPPORT OF FIELDS OF PHYSICS THAT ARE HEALTHY AT PRESENT AT A RATE SUCH THAT THEY ARE LIKELY TO MAINTAIN OR IMPROVE THEIR PRESENT POSITION.
4. INCREASE THE SUPPORT FOR ALL FORMS OF RESEARCH IN BASIC AND APPLIED PHYSICS THAT ARE CONNECTED WITH THE CONSERVATION OF RATIONAL EXPLOITATION OF OUR OWN NATURAL RESOURCES.
5. MAINTAIN AT AN ADEQUATE LEVEL AND, WHERE NECESSARY, INCREASE SUBSTANTIALLY, SUPPORT FOR FIELDS OF RESEARCH FOR WHICH OUR TERRAIN AND LOCATION GIVE US A NATURAL ADVANTAGE OVER OTHER COUNTRIES.
6. SET UP JOINT INSTITUTES THAT WILL PROVIDE MAJOR FACILITIES FOR THE USE OF SEVERAL LABORATORIES.
7. PROVIDE SUFFICIENT SUPPORT TO THEORETICAL PHYSICS IN THE BROAD SENSE TO ENABLE IT TO COME INTO BALANCE WITH EXPERIMENTAL PHYSICS IN ALL FIELDS AND IN ALL MAJOR RESEARCH LABORATORIES.
8. CONTINUE TO INCREASE SUPPORT FOR RESEARCH IN PURE PHYSICS IN ORDER THAT IT WILL ALWAYS FORM AN ADEQUATE BASE FOR AN INCREASED ENGAGEMENT IN APPLIED PHYSICS, AND IN ORDER THAT CANADA WILL CONTINUE TO CONTRIBUTE TO MAN'S FUNDAMENTAL KNOWLEDGE OF MATTER.

THE STEERING COMMITTEE EMPHASIZED THE FOLLOWING RECOMMENDATION OF THE SUB-DIVISION COMMITTEE¹ ON METEOROLOGY AND THE ATMOSPHERIC ENVIRONMENTAL SCIENCES: "WE STRONGLY RECOMMEND FURTHER DEVELOPMENT AND STRENGTHENING OF METEOROLOGY IN THE UNIVERSITIES, TOGETHER WITH SOME INCREASE IN THE SUPPORT OF UNIVERSITY METEOROLOGICAL RESEARCH, IN ORDER TO ATTRACT AND TRAIN MORE CANADIANS".

1. A. W. BREWER (CHAIRMAN), B. W. BOVILLE, AND W. L. GODSON

INITIAL C.A.P. MEMBERSHIP RESPONSE TO THE ROSE REPORT APPEARED IN THE ASSOCIATION BULLETIN¹ IN LATE 1967. THE GENERAL REACTION APPEARED TO BE FAVOURABLE - THE REPORT WAS CONSIDERED TO BE WELL DONE, VALUABLE, AND NECESSARY.

DISSATISFACTION WAS EXPRESSED BY SOME REGARDING THE ADEQUACY OF DEFINITIONS OF NATIONAL GOALS AND PRIORITIES, THE CURRENT MECHANISMS FOR RESEARCH GRANTS AND FUNDING, AND THE RESPECTIVE ROLES OF GOVERNMENT, UNIVERSITIES, INDUSTRIAL LABORATORIES, AND THE PROPOSED RESEARCH INSTITUTIONS. STRONG SUPPORT WAS INDICATED FOR FULLY FUNDED CONTRACTS TO SPUR INDUSTRIAL RESEARCH. THE FINDINGS AND RECOMMENDATIONS FOR APPLIED PHYSICS RESEARCH MET WITH STRONG BUT MIXED REACTIONS. UNDER SUB-FIELD DEVELOPMENT THE NEED FOR AN INSTITUTE OF METEOROLOGY, AMONG OTHER THINGS, WAS STRESSED.

NINETEEN PAGES OF THE ROSE REPORT WERE GIVEN TO A SURVEY AND OUTLOOK FOR METEOROLOGY AND THE ATMOSPHERIC ENVIRONMENTAL SCIENCES. FOLLOWING A BRIEF OUTLINE OF THE HISTORY AND OVERALL SETTING OF METEOROLOGICAL RESEARCH, ATTENTION WAS FOCUSED ON THE ORGANIZATION OF METEOROLOGICAL RESEARCH IN CANADA AND ON THE INDIVIDUAL SUB-DIVISIONS OF ATMOSPHERIC ENVIRONMENTAL RESEARCH. WITH SOME RISK OF ERRORS OF OMMISSION AND EMPHASIS, THE PROBLEMS CAN BE SUMMARIZED AS FOLLOWS:

1. PROGRESS IN RESEARCH ON FUNDAMENTALS IS TOO SLOW. COMMUNITY NEEDS HAVE OFTEN RESULTED IN EMPIRICAL SOLUTIONS OF QUESTIONABLE VALUE.
2. NATIONAL EXPENDITURES ON ATMOSPHERIC SCIENCES RESEARCH ARE TOO LOW (U.S. CANADA = 50:1), AND THE DISTRIBUTION OF EXPENDITURES ON RESEARCH AMONG GOVERNMENT, INDUSTRY, AND UNIVERSITIES IS UNBALANCED (INDUSTRY - 0, GOVERNMENT : UNIVERSITIES = 10:1).
3. QUALIFIED RESEARCHERS ARE IN SHORT SUPPLY BOTH IN GOVERNMENT AND IN UNIVERSITY DEPARTMENTS WITH PROBLEMS IN ATMOSPHERIC SCIENCES.
4. BECAUSE OF COST AND MANPOWER RESTRICTIONS, CANADA CANNOT AFFORD TO COMPETE IN HEMISPHERIC OR GLOBAL WEATHER ANALYSIS AND PREDICTION OR IN WEATHER AND CLIMATE MODIFICATION (WITH THE EXCEPTION OF WORK IN HAIL SUPPRESSION).
5. THE MANPOWER AND SUPPORT FOR RESEARCH ON CLIMATOLOGICAL PROBLEMS IN GENERAL AND ON THE SPECIAL PROBLEMS OF MANY FEDERAL AND PROVINCIAL GOVERNMENT DEPARTMENTS ARE INADEQUATE IN RELATION TO THE MAGNITUDE AND IMPORTANCE OF THE PROBLEMS.

1. PHYSICS IN CANADA, BULL. OF THE CAN. ASSOC. OF PHYSICISTS, 23, NO. 5, WINTER 1967, PP 28-36.

6. THERE ARE NO MAJOR CENTRES OF RESEARCH IN THE ATMOSPHERIC SCIENCES THAT WOULD SERVE TO ATTRACT AND TRAIN FRENCH-SPEAKING STUDENTS.

IN SUMMARIZING THEIR FINDINGS THE AUTHORS OF THE REPORT CONCLUDED THAT THE MANPOWER AND FUNDS EXPENDED ON RESEARCH DO NOT MATCH THE IMPORTANCE OF THE ENVIRONMENTAL SCIENCES TO CANADA, MOST PLANS TO INCREASE RESEARCH ARE LIKELY TO BE FRUSTRATED BY LACK OF MANPOWER AND, CLARIFICATION OF THE DELEGATION OF RESPONSIBILITIES IN ATMOSPHERIC SCIENCES RESEARCH IS NEEDED WITHIN AND BETWEEN FEDERAL AND PROVINCIAL GOVERNMENT DEPARTMENTS.

IT WAS RECOMMENDED THAT -

- (A) SELECTED UNIVERSITIES BE ENCOURAGED TO APPOINT METEOROLOGISTS.
- (B) FEDERAL FUNDS IN SUPPORT OF UNIVERSITY RESEARCH BE DISTRIBUTED BY THE METEOROLOGICAL BRANCH WITH TOTAL FUNDS SUFFICIENT TO PROVIDE A GROWTH RATE OF AT LEAST 25 PER CENT PER YEAR FOR 5 YEARS, AND
- (C) AT LEAST ONE SIGNIFICANT UNIT CONTRIBUTING TO THE ENVIRONMENTAL SCIENCES SHOULD BE ESTABLISHED IN QUEBEC.

IT IS DIFFICULT TO ARGUE WITH THIS ASSESSMENT OF THE STATE OF ATMOSPHERIC SCIENCES RESEARCH IN CANADA ON THE BASIS OF THE EVIDENCE PROVIDED IN THE SURVEY. AT THE SAME TIME, THE MANPOWER FINDINGS ARE DIFFICULT TO RECONCILE WITH THE FACT THAT THE NUMBER OF QUALIFIED APPLICANTS FOR THE 1968-69 MASTER'S PROGRAM OF THE METEOROLOGICAL BRANCH EXCEEDED THE NUMBER THAT COULD BE ACCEPTED BY A FACTOR OF 2 TO 3. MOREOVER, IT IS DISTURBING TO NOTE THAT THE SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS OMIT REFERENCE TO SUGGESTIONS WITHIN THE TEXT OF THE SURVEY THAT WILL HAVE A PROFOUND IMPACT ON THE SHAPE AND COURSE OF RESEARCH IN THIS COUNTRY IF THEY ARE ACCEPTED AT FACE VALUE AND IMPLEMENTED. THE STATEMENTS THAT CANADA SHOULD CO-OPERATE BUT NOT COMPETE IN HEMISPHERIC OR GLOBAL WEATHER ANALYSIS AND PREDICTION (IMPLICITLY INCLUDING EXTENDED AND LONG-RANGE FORECASTING), AND THAT CANADA CANNOT COMPETE IN WEATHER AND CLIMATE MODIFICATION (WITH THE EXCEPTION OF HAIL SUPPRESSION), ARE TWO EXAMPLES. IN DISCUSSING THE LATTER SUBJECT, THE STATEMENT IS ALSO MADE THAT "AT PRESENT THERE IS NO PROVED WAY OF CHANGING WEATHER OR CLIMATE SIGNIFICANTLY". SURELY, A SPECIFICATION OF SPACE AND TIME SCALES MUST BE ATTACHED TO SUCH A STATEMENT. ARTIFICIAL LENGTHENING OF HARBOUR ICE-FREE PERIODS, THE DISSIPATION OF COLD FOG AND STRATUS, THE REDUCTION OF EVAPORATION FROM PONDS AND LAKES, THE PARTIAL CONTROL OF AVALANCHES, FLOODING, DRIFTING SNOW, AND WIND EROSION, NOT TO MENTION THE INADVERTENT MODIFICATIONS OF WEATHER AND CLIMATE BY HUMAN ACTIVITIES ARE ALL MODIFICATIONS THAT MAY BE SIGNIFICANT TO THE PEOPLE OF CANADA. PERHAPS THESE AND OTHER POTENTIAL SMALL-SCALE MODIFICATIONS ARE PROPER SUBJECTS FOR A MAJOR RESEARCH EFFORT IN CANADA EVEN IF NO ATTEMPT IS MADE TO UNDERTAKE LARGE-SCALE MODIFICATION EXPERIMENTS. ON THE OTHER HAND, EVEN NOW, AS NOTED IN THE REPORT, THE PUBLIC IS ASKING ABOUT THE POSSIBILITY OF INDIRECT CONSEQUENCES TO CANADA OF LARGE-SCALE WEATHER MODIFICATION EXPERIMENTS CARRIED OUT ELSEWHERE. WE MUST ANTICIPATE SUCH QUESTIONS AND SEEK ANSWERS.

IT IS HELD BY MANY, INCLUDING ONE OF THE AUTHORS OF THE SUB-DIVISION REPORT¹, THAT THE GENERAL CIRCULATION IS THE CENTRAL PROBLEM OF METEOROLOGY TODAY. HOW CAN THIS VIEW BE RECONCILED WITH THE SUGGESTION THAT WE CO-OPERATE BUT NOT COMPETE IN HEMISPHERIC AND GLOBAL WEATHER ANALYSIS AND PREDICTION?

IN ORDER TO CO-OPERATE USEFULLY WITH OTHER COUNTRIES AND TO MAINTAIN COMPETENCE IN THIS FIELD, WE MUST HAVE SOME MANPOWER AND THE NECESSARY LARGE COMPUTER FACILITIES. WITH A FAIRLY MODEST ADDITION OF MANPOWER WE SHOULD BE ABLE BOTH TO COMPETE AND TO OFFER A PLACE FOR NEW GRADUATES WITH THE INTEREST AND TALENT TO WORK ON THESE ATTRACTIVE AND CHALLENGING PROBLEMS. FOR MANY YEARS TO COME SOME EMPIRICISM WILL BE INVOLVED IN THE FINAL FORMULATIONS OF GENERAL CIRCULATION MODELS AND IN BOTH SHORT - AND EXTENDED-RANGE PREDICTION MODELS, AND IT SEEMS UNLIKELY THAT THE PRODUCTS OF OTHER NATIONS WILL BE OPTIMIZED FOR CANADIAN REQUIREMENTS. EVEN IF WE CONCENTRATE ON SMALL-SCALE PROBLEMS AS SUGGESTED IN THE SURVEY, IT SEEMS REASONABLE TO POSE AND SOLVE SUCH PROBLEMS WITHIN THE FRAMEWORK OF THE VERY BEST LARGE-SCALE ANALYSES AND PREDICTIONS THAT ARE AVAILABLE. CAN WE ASK OTHER COUNTRIES TO PROVIDE US WITH THE DETAILED RESULTS OF THEIR CALCULATIONS FOR THESE PURPOSES?

IMPROVED UNDERSTANDING OF FUNDAMENTAL PHYSICAL PROCESSES IN THE ATMOSPHERE IS ESSENTIAL TO PROGRESS IN BOTH LARGE-SCALE PREDICTION PROBLEMS AND IN WEATHER AND CLIMATE MODIFICATION AS IT IS TO THE SOLUTIONS OF MANY OTHER ENVIRONMENTAL PROBLEMS THAT CONFRONT US. THIS IS ACCEPTED IMPLICITLY IN THE U.S. PROGRAM. WITHIN THAT PROGRAM GENERAL CIRCULATION PROBLEMS, LARGE-SCALE PREDICTION PROBLEMS, AND WEATHER AND CLIMATE MODIFICATION PROGRAMS REPRESENT A SUBSTANTIAL FRACTION OF THE TOTAL EFFORT IN ATMOSPHERIC SCIENCES RESEARCH. THE IMPORTANCE ATTACHED TO THE TOTAL EFFORT IS ATTESTED TO BY CONTINUED EMPHASIS ON ATMOSPHERIC SCIENCES RESEARCH IN A TIGHT BUDGET YEAR². IN CANADA DUPLICATION OF EFFORT MUST BE DISPENSED WITH, BUT IT WOULD SEEM THAT, AT A MINIMUM, AT LEAST ONE CENTRE OF ACTIVITY CONCERNED WITH EACH OF THESE PROBLEMS SHOULD BE MAINTAINED AT LEVELS SUCH THAT THEY CAN COMPETE AND CO-OPERATE IN A MEANINGFUL WAY WITH OTHER COUNTRIES.

IN THE SUMMARY AND CONCLUSIONS NO MENTION IS MADE OF THE FINDING THAT ALMOST NO RESEARCH IN THE ATMOSPHERIC SCIENCES IS UNDERWAY IN INDUSTRY. IN THE ROSE REPORT AS A WHOLE, A 44 PER CENT ANNUAL INCREASE IN THE SUPPORT

1. GODSON, W.L., 1967. THE ROLE OF RADIATIVE FLUX DIVERGENCE IN THE SURFACE BOUNDARY LAYER. PROC. OF THE FIRST CANADIAN CONFERENCE ON MICRO-METEOROLOGY, PART I, P 161.

2. SCIENCE, 159, NO. 3844, P 510.

OF RESEARCH IN INDUSTRY IS RECOMMENDED. FREE ENTERPRISE ENVIRONMENTAL RESEARCH COMPANIES CAN OFFER PARTIAL ANSWERS TO SOME OF THE CURRENT AND FUTURE PROBLEMS. REQUESTS FOR APPLIED RESEARCH SERVICES FROM FEDERAL GOVERNMENT DEPARTMENTS OTHER THAN THE DEPARTMENT OF TRANSPORT, FROM URBAN, MUNICIPAL, AND PROVINCIAL GOVERNMENTS IN CONNECTION WITH RESOURCE DEVELOPMENT, PLANNING, AND PROTECTION PROBLEMS, AND FROM INDUSTRIES REQUIRED BY LEGISLATION TO MEET NEW STANDARDS OF CONTROL ON RESOURCES WILL INCREASE. THE TREND TOWARDS CENTRALIZATION OF WEATHER ANALYSIS AND FORECASTING IS LIKELY TO BE ACCOMPANIED BY A RELATIVE DECLINE IN MANPOWER AND RESOURCES FOR LOCAL DISPLAY, DISSEMINATION, AND TAILORING OF PRODUCTS. NEW DEMANDS BY THE PUBLIC FOR WEATHER INFORMATION IN AN AGE OF RAPIDLY INCREASING TRAVEL, RECREATION, AND OTHER WEATHER-SENSITIVE ACTIVITIES REQUIRE INCREASES AND MODERNIZATION OF LOCAL WEATHER SERVICES RATHER THAN A DECLINE, AND SUCH DEMANDS CAN BE MET BY INDUSTRY AT LITTLE COST TO THE GOVERNMENT. THESE ARE ENGINEERING ASPECTS BUT, BECAUSE THE FINAL PRODUCT IS CONDITIONED BY EACH LINK IN THE CHAIN FROM RESEARCH TO USER, IT SEEMS APPROPRIATE TO CONSIDER THEM IN EVALUATING ATMOSPHERIC SCIENCES RESEARCH IN TERMS OF ITS VALUE TO CANADIANS.

THE EMPHASIS ON MANPOWER SHORTAGE AND THE NEED FOR THE EXPANSION OF CAPABILITIES FOR ATTRACTING AND TRAINING STUDENTS WITH STRONG BACKGROUNDS IN THE PHYSICAL SCIENCES IS WELL PLACED IN VIEW OF THE SURVEY FINDINGS. THE FIRST REQUIREMENT MAY WELL BE FOR INDIVIDUALS TO TAKE THE INITIATIVE IN ESTABLISHING VIABLE CENTRES BY SEEKING FINANCIAL SUPPORT AND CONVINCING UNIVERSITY ADMINISTRATIONS OF THE NEED FOR AND VALUE OF SUCH CENTRES AS SEPARATE DEPARTMENTS OR STRONG GROUPS WITHIN EXISTING DEPARTMENTS. ONCE A START HAS BEEN MADE, I SUSPECT THAT THE ACQUISITION OF ADDITIONAL STAFF MEMBERS MAY NOT BE AS DIFFICULT AS IT MAY APPEAR AT FIRST SIGHT, PROVIDED THAT SUFFICIENT FUNDS ARE MADE AVAILABLE FOR LIBRARY, COMPUTER, AND LABORATORY FACILITIES, AND FOR THE COSTS OF SEMINAR PROGRAMS AND SOME STAFF AND SENIOR STUDENT EXCHANGE ARRANGEMENTS. IN SOME LOCATIONS ECONOMIES COULD BE REALIZED BY LOCATING METEOROLOGICAL BRANCH OFFICES ON OR NEAR CAMPUSES - AN ARRANGEMENT WITH BENEFITS FOR ALL THAT SHOULD FAR EXCEED THE COMPLICATIONS OF THE INITIAL MOVE.

ATTRACTING CAPABLE PHYSICS STUDENTS INTO ATMOSPHERIC SCIENCES RESEARCH REQUIRES NOT ONLY THE ENHANCEMENT OF METEOROLOGY IN THE EYES OF PHYSICISTS AND THE ESTABLISHMENT OF CAMPUS CENTRES OF ACTIVITY, BUT ALSO THE PROMISE OF A VARIETY OF CAREERS. NOT ALL WILL, OR CAN, CHOOSE CAREERS IN THE METEOROLOGICAL BRANCH OR UNIVERSITIES. THE DEVELOPMENT OF A FEW RESEARCH COMPANIES OR RESEARCH ARMS OF INDUSTRY WOULD OFFER ONE ALTERNATIVE. ANOTHER SOLUTION MIGHT BE THE FORMATION OF A NATIONAL CENTRE OR INSTITUTE. IN MY OPINION, SUCH A CENTRE IN CANADA SHOULD NOT BE RESTRICTED TO METEOROLOGY, BUT SHOULD EMBRACE IN A TRULY INTER-DISCIPLINARY WAY THE FIELDS IDENTIFIED IN THE ROSE REPORT UNDER ENVIRONMENTAL SCIENCES, THAT IS, METEOROLOGY, OCEANOGRAPHY AND AIR-SEA INTERACTION, WATER RESOURCES AND HYDROLOGY, CLIMATOLOGY, AIR POLLUTION, ARCTIC ATMOSPHERIC RESEARCH, THE HIGH ATMOSPHERE TO 50 KM., AND WEATHER AND CLIMATE MODIFICATION. SUCH AN INSTITUTE

COULD SERVE AS A CENTRE OF COMMUNICATION BETWEEN THE HIGHLY DIVERSIFIED AND FRACTURED RESEARCH GROUPS IN CANADA, AS A HEADQUARTERS FOR LARGE RESOURCES, FOR EXAMPLE, A LARGE COMPUTER, COSTLY FIELD AND LABORATORY EQUIPMENT, COMPREHENSIVE LIBRARY OF BOOKS, JOURNALS, TECHNICAL REPORTS, DATA, AUDIO AND VISUAL AIDS, IN ADDITION TO ITS PRINCIPAL FUNCTION AS A FIRST CLASS RESEARCH CENTRE FOR FUNDAMENTAL AND APPLIED WORK.

EVEN SHORT-RANGE PLANS AND RECOMMENDATIONS REQUIRE SOME BASIC ASSUMPTIONS ABOUT NATIONAL GOALS AND PRIORITIES OR A NATIONAL PLAN. ON THE WHOLE, THE SUB-DIVISION COMMITTEE HAS MADE A CONVINCING CASE FOR THE ASSUMPTIONS AND PRIORITIES THAT WERE INVOKED PARTICULARLY IN VIEW OF THE PRACTICAL PROBLEMS OF MANPOWER AND COST. HOWEVER, IN THE OPINION OF THIS REVIEWER, SOME OF THE ASSUMPTIONS, SUGGESTIONS, AND CONCLUSIONS FOUND WITHIN THE TEXT OF THE SUB-DIVISION REPORT ON ATMOSPHERIC SCIENCES IN THE ROSE REPORT CAN BE LEGITIMATELY QUESTIONED. IN SOME INSTANCES ALTERNATIVE POSSIBILITIES WOULD RESULT IN SIGNIFICANT CHANGES OF PHILOSOPHY AND EMPHASIS IN FUTURE CANADIAN RESEARCH IN THESE FIELDS. WHAT IS THE CONSENSUS OF OPINION AMONG ATMOSPHERIC SCIENTISTS ACROSS CANADA ON THESE QUESTIONS? PERHAPS THE CANADIAN METEOROLOGICAL SOCIETY CAN, AND SHOULD, CONTRIBUTE TO THE FORMULATION AND DEVELOPMENT OF NATIONAL GOALS AND PRIORITIES.

INTER ALIA

TORONTO

JANUARY

THE TORONTO CENTRE HELD ITS THIRD MEETING OF THE 1967-68 SEASON ON TUESDAY, JANUARY 30, AT 147 DAVENPORT ROAD. THIRTY MEMBERS WERE PRESENT TO HEAR DR. H.I. SCHIFF, DEAN OF SCIENCE AT YORK UNIVERSITY. DR. SCHIFF'S TOPIC WAS - "LABORATORY MEASUREMENT OF OZONE OF ATMOSPHERIC INTEREST".

AN APPRECIABLE FRACTION OF THE SOLAR RADIATION IS INTERCEPTED AND STORED BY THE UPPER ATMOSPHERE. THE METHODS BY WHICH THE ATMOSPHERE DISSIPATES THIS ENERGY IS AN IMPORTANT STEP IN THE ENERGY BALANCE OF THIS REGION. DR. SCHIFF DESCRIBED LABORATORY EXPERIMENTS WHICH SEPARATED THE CHEMICAL PROCESS WHICH CAN PROCEED IN THE UPPER ATMOSPHERE.

MEMBERS PRESENT AGREED THAT DR. SCHIFF'S TALK WAS AN EXCELLENT EXAMPLE OF MAKING A VERY COMPLEX SUBJECT COMPREHENSIBLE.

CONTD. ON PAGE 29

THE ROSE REPORT - A REVIEW

C.L. MATEER

THE ROSE REPORT, COMMISSIONED BY THE FEDERAL GOVERNMENT, PREDICTABLY PROPOSES A MASSIVE INCREASE IN THE INFUSION OF FEDERAL FUNDS INTO PHYSICS RESEARCH OVER THE NEXT FEW YEARS. THE BASIC PREMISES OF THE REPORT WILL PROVOKE ARGUMENT FROM FEW SCIENTISTS, ALTHOUGH A GOOD MANY MAY QUIBBLE ABOUT SPECIFIC RECOMMENDATIONS IN THEIR RESPECTIVE FIELDS. IT IS THE LATTER COURSE I CHOOSE TO TAKE IN THIS REVIEW.

ALTHOUGH I HAVE THE UTMOST RESPECT FOR THE AUTHORS, THE METEOROLOGICAL REPORT IS SOMEWHAT OF A DISAPPOINTMENT. THE REPORT FAILS TO EMPHASIZE SUFFICIENTLY THE MULTI-DISCIPLINARY NATURE OF THE ATMOSPHERIC OR ENVIRONMENTAL SCIENCES AND, IN PARTICULAR, FAILS TO RECOMMEND (OR AT LEAST TO CONSIDER THE POSSIBILITY OF) THE CREATION OF AN INDEPENDENT MULTI-DISCIPLINARY NATIONAL INSTITUTE FOR PURE AND APPLIED RESEARCH IN THESE SCIENCES. SUCH AN INSTITUTE COULD TAKE THE FORM OF A GOVERNMENT-OWNED CORPORATION LIKE AECL, IT COULD BE A DIVISION OF NRC, IT COULD BE A SEPARATE INSTITUTE OF A GOVERNMENT DEPARTMENT, FOR EXAMPLE, THE BEDFORD INSTITUTE FOR OCEANOGRAPHY, OR, AS IN THE UNITED STATES, IT COULD BE OPERATED BY A GROUP OF UNIVERSITIES UNDER GOVERNMENT CONTRACT. IN THIS SHORT REVIEW, I DO NOT WISH TO ELABORATE ON THE MANY ARGUMENTS FOR AND AGAINST SUCH AN INSTITUTE. I DO BELIEVE, HOWEVER, THAT THE MATTER DESERVES IN-DEPTH CONSIDERATION, ON A MULTI-DISCIPLINARY BASIS, BY THE CANADIAN ATMOSPHERIC SCIENCES COMMUNITY.

THE REPORT URGES THE ENLARGEMENT OF UNIVERSITY FACILITIES FOR TRAINING ATMOSPHERIC RESEARCH SCIENTISTS (THE DEVELOPMENT OF A FIRST-RATE RESEARCH AND TEACHING GROUP IN ONE OF THE FRENCH-SPEAKING QUEBEC UNIVERSITIES IS OF UNDISPUTED IMPORTANCE). HOWEVER, NO COMPENSATORY INCREASE IN THE EMPLOYMENT OF SUCH RESEARCH SCIENTISTS IN THE FEDERAL GOVERNMENT IS URGED. TRUE, THE REPORT RECOGNIZES THAT THIS EXPANSION WILL OCCUR, HOWEVER, NON-SCIENTIST GOVERNMENT OFFICIALS NEED CONSTANT RE-ASSURANCE THAT SUCH EXPANSION IS NECESSARY. RESEARCH FUNDING IN THE METEOROLOGICAL BRANCH IS JUST AS TIGHTLY CONTROLLED AS IN THE UNIVERSITIES. THEREFORE, THE NEED FOR THE EMPLOYMENT OF AN INCREASED NUMBER OF SUCH SCIENTISTS IN THE BRANCH (FOR EXAMPLE) MUST BE RECOGNIZED OPENLY AND SPECIFIC RECOMMENDATIONS MADE. NEED I MENTION THE EXPORT MARKET?

THE REPORT STATES THAT THE METEOROLOGICAL BRANCH'S RESEARCH SECTION REQUIRES NO MAJOR FACILITIES. I DISAGREE. ALTHOUGH SEVERAL PEOPLE IN THE SECTION WILL DISAGREE WITH ME, I BELIEVE THAT THE SECTION REQUIRES A LARGE-SCALE HIGH-SPEED COMPUTER OF A SIZE AND SPEED COMPARABLE TO THE IBM-65. IT IS TRUE THAT PRESENT COMPUTER USE BY THE SECTION IS WELL BELOW THE CAPACITY OF SUCH A MACHINE, HOWEVER, THE AVAILABILITY OF SUCH A MACHINE ON A FIRST-PRIORITY-

FOR-RESEARCH BASIS WOULD IMMEDIATELY CAUSE AN INCREASE IN USE BY A FACTOR OF TWO TO FIVE. I SAY THIS FROM MY OWN EXPERIENCE THAT THE USEFULNESS OF A COMPUTER IS INVERSELY PROPORTIONAL TO THE SQUARE OF ITS DISTANCE FROM THE USER AND ALSO INVERSELY PROPORTIONAL TO THE SQUARE OF THE TURN-AROUND TIME ON DE-BUGGING RUNS. ON THIS BASIS, THERE COULD BE A GREAT INCREASE IN SECTION USE. ON THE TORONTO COMPUTER-USE MARKET, ANY EXCESS CAPACITY COULD BE SOLD ALMOST IMMEDIATELY, WITH COMMERCIAL USE DECREASING AS THE SECTION USE INCREASED DUE TO EXPANSION. IN ADDITION, SUCH A COMPUTER COULD SERVE AS A NATIONAL FACILITY FOR ATMOSPHERIC SCIENCES RESEARCH. MORE DETAILED ARGUMENTS CAN BE DEVELOPED IN SUPPORT OF THE NEED FOR THIS FACILITY.

WITH RESPECT TO RESEARCH IN CLOUD PHYSICS AND LARGE-SCALE NUMERICAL WEATHER PREDICTION, THE REPORT ADOPTS THE RATHER CURIOUS POSITION THAT CANADA SHOULD "HAVE COMPETENCE" BUT SHOULD NOT "COMPETE". IN SCIENCE, SURELY TO "HAVE COMPETENCE" MEANS TO "HAVE THE ABILITY TO COMPETE". IN MY VIEW, SUCH ABILITY IS DEVELOPED ONLY BY COMPETING. THESE ARE TWO OF THE OUTSTANDINGLY IMPORTANT PROBLEMS IN ATMOSPHERIC SCIENCES TODAY. THE REPORT SUGGESTS THAT CANADA CANNOT AFFORD TO COMPETE. CAN CANADA AFFORD TO BE A NON-COMPETITOR? FOR EXAMPLE, THE AVAILABILITY OF AN ABUNDANT SUPPLY OF UNPOLLUTED WATER IS ESSENTIAL TO A RAPIDLY GROWING ECONOMY. CANADA'S SUPPLY OF SUCH WATER IS NOT COMPLETELY UNLIMITED AND THE POSSIBILITY, EVEN THOUGH IT APPEARS TO BE SOMEWHAT REMOTE, OF INCREASING THE SUPPLY BY AS LITTLE AS 10 PER CENT BY CAREFULLY CONTROLLED CLOUD SEEDING, NEEDS TO BE INVESTIGATED IN CANADA BY COMPETENT (IN THE SENSE DEFINED ABOVE) SCIENTISTS.

I WAS ASKED TO REVIEW THE ROSE REPORT FROM THE POINT OF VIEW OF "A CANADIAN WHO LEFT TO FIND A MORE FAVOURABLE CLIMATE FOR RESEARCH, AND A MORE EFFICIENT USE OF HIS TALENT".^{1,2} DISREGARDING THE REST OF THE STATEMENT, THE "FAVOURABLE CLIMATE" IS IMPORTANT AND IS RECOGNIZED BRIEFLY IN PART I OF THE ROSE REPORT IN THE FOLLOWING STATEMENTS, WHICH I QUOTE:

"PURE RESEARCH ... IS THE TYPE OF RESEARCH IN WHICH A REASONABLE PROPORTION OF THE SCIENTIFIC STAFF MUST BE LEADERS IN SOME SPECIALIZED FIELD AND FREE FROM DAY-TO-DAY PROBLEMS OF ADMINISTRATION OR MANAGEMENT"

"SUCH SCIENTISTS ... CAN BE EFFECTIVE ONLY WHEN THERE ARE SEVERAL SUCH SPECIALISTS CLOSELY COORDINATED"

"BASIC RESEARCH CANNOT BE MANAGED IN THE ORDINARY SENSE OF DIRECT CONTROL OF DAY-TO-DAY EFFORTS OF THOSE CONCERNED".

FEW SCIENTISTS WILL ARGUE THE TRUTH OF THESE STATEMENTS, MORE WILL ARGUE THE POSSIBILITY THAT THE ULTIMATE MILIEU CAN BE COMPLETELY ACHIEVED IN PRACTICE.

FINALLY, I HOPE THAT SOME READERS (SIC) WILL REALIZE THAT SEVERAL OF MY STATEMENTS HAVE BEEN MADE FOR THE PURPOSE OF EVOKING FURTHER DISCUSSION.

REVIEW

PHYSICS IN CANADA - SURVEY AND OUTLOOK - PREPARED BY A STUDY GROUP OF THE CANADIAN ASSOCIATION OF PHYSICISTS HEADED BY DR.D.C. ROSE, AND PUBLISHED IN MAY, 1967.

HUGH CAMERON

THE "ROSE REPORT" SURVEYS THE PRESENT STATE OF THE RESEARCH ASPECTS OF PHYSICS IN THE BROAD SENSE. THIS REVIEW WILL BE RESTRICTED TO THE AREA OF PHYSICS KNOWN AS METEOROLOGY.

WE LIVE IN A WORLD SHAPED BY THE APPLICATION OF DISCOVERIES IN PHYSICAL SCIENCES. THE FLOW OF A NEW SCIENTIFIC DISCOVERY FROM ITS FIRST CONCEPTION TO INDUSTRIAL APPLICATION AND PUBLIC USE FOLLOWS A LOGICAL SEQUENCE OF EVENTS. THE REPORT IDENTIFIES THESE SEQUENTIAL STEPS (FIGURE 1), AT THE SAME TIME POINTING OUT THE PROBABLE APPRECIABLE VARIATIONS FROM CASE TO CASE. METEOROLOGY, BEING A PHYSICAL SCIENCE WITH APPLICATIONS TO INDUSTRY, ETC., CAN BE READILY RELATED TO THE FIGURE.

THE REPORT EMPHASIZES THE TASK FACING THE SCIENCE SECRETARIAT WHEN IT EXAMINES SUCH A LISTING OF SEQUENTIAL STEPS, WHEN IT ATTEMPTS TO ADVISE GOVERNMENT ON WHAT MIGHT BE THE CORRECT BALANCE OF EFFORT IN THE FOUR PARTS, A, B, C AND D, OR THE BALANCE BETWEEN PURE RESEARCH, APPLIED RESEARCH, ENGINEERING DEVELOPMENT AND INDUSTRIAL GROWTH IN CANADA. ACTUALLY A CORRECT BALANCE HAS NEVER BEEN FOUND AS THE GROWTH OF APPLIED SCIENCE IN THE POST-WAR ERA HAS BEEN TOO RAPID TO FIX A NORM.

HOWEVER, IN SURVEYING THE PRESENT STATE OF RESEARCH PHYSICS IN CANADA, THE COMMITTEE FOUND THAT THE PRESENT EFFORT HEAVILY CONCENTRATED IN THE PURE ASPECTS, AND WAS RELATIVELY WEAK IN THE APPLIED ASPECTS OF PHYSICS. IT FOUND THE SUPPORT REASONABLE IN THE GOVERNMENT LABORATORIES, POORER IN THE UNIVERSITIES AND INSUFFICIENT IN THE INDUSTRIAL RESEARCH-LABORATORIES.

THE REPORT RECOMMENDED THAT OVER THE NEXT FEW YEARS SUPPORT SHOULD EMPHASIZE THOSE ASPECTS OF CANADIAN RESEARCH IN PHYSICS THAT CAN ENCOURAGE THE WISE USE OF OUR NATIONAL RESOURCES OR CAN BENEFIT FROM OUR PARTICULAR GEOGRAPHIC LOCATION OR SCIENTIFIC HISTORY.

THE REPORT FURTHER RECOMMENDED THE NORMAL EXPENDITURE ON PHYSICS RESEARCH SHOULD RISE AT A RATE OF 23 PER CENT PER ANNUM. IT ALSO RECOMMENDED THAT SEVERAL JOINT INSTITUTES BE CREATED WHERE SCIENTISTS FROM MANY LABORATORIES OF THE UNIVERSITIES, THE GOVERNMENT AND INDUSTRY CAN JOINTLY MAKE USE OF OUTSTANDING FACILITIES THAT WOULD BE TOO EXPENSIVE FOR INDIVIDUAL LABORATORIES TO MAINTAIN AND USE EFFECTIVELY.

IN FITTING METEOROLOGY INTO THE FOREGOING GENERAL STATEMENT ON RESEARCH PHYSICS IN CANADA, THE REPORT STATED -

"BECAUSE THE CANADIAN ECONOMY RESTS IN LARGE MEASURES ON FARMING, FOREST PRODUCTS, AND WATER RESOURCES, THE DEPENDENCE OF THESE ASSETS ON THE WEATHER AND CLIMATE MAKES THE ENVIRONMENTAL SCIENCES OF PARTICULAR IMPORTANCE FOR CANADA, THE ANNUAL VALUE OF THE METEOROLOGICALLY SENSITIVE PARTS OF THE CANADIAN ECONOMY IS IN EXCESS OF \$10 BILLION. THE GREATEST ACTIVITY IN METEOROLOGICAL RESEARCH TAKES PLACE IN THE RESEARCH DIVISION OF THE METEOROLOGICAL BRANCH, DEPARTMENT OF TRANSPORT. OTHER GOVERNMENT DEPARTMENTS (INCLUDING SOME PROVINCIAL ONES) CARRY OUT RESEARCH, AS DO ABOUT 10 UNIVERSITIES. AT PRESENT, ABOUT 30 UNIVERSITY STAFF MEMBERS ARE ESTIMATED TO DEVOTE ABOUT 40 PER CENT OF THEIR TIME TO RESEARCH IN THIS AREA, AT AN AVERAGE COST OF ABOUT \$54,000 EACH PER ANNUM, IN ADDITION TO ABOUT 65 SCIENTISTS IN GOVERNMENT LABORATORIES, AT AN AVERAGE COST OF \$58,000 PER ANNUM. REASONABLE PROJECTIONS TO 1971 INDICATE THERE WILL BE ABOUT 45 RESEARCH MEN IN THE UNIVERSITIES AND 90 IN GOVERNMENT LABORATORIES, EACH COSTING \$95,000 AND \$73,000 PER YEAR RESPECTIVELY. NO RESEARCH IN INDUSTRY HAS BEEN FOUND."

THE LIMITATION ON GROWTH IN RESEARCH IN THIS VERY IMPORTANT FIELD (METEOROLOGY) SEEMS TO LIE IN THE DEARTH OF COMPETENT MANPOWER MORE THAN IN LACK OF FINANCIAL SUPPORT. "WE STRONGLY RECOMMEND FURTHER DEVELOPMENT AND STRENGTHENING OF METEOROLOGY IN THE UNIVERSITIES, TOGETHER WITH SOME INCREASE IN THE SUPPORT OF UNIVERSITY METEOROLOGICAL RESEARCH, IN ORDER TO ATTRACT AND TRAIN MORE CANADIANS."

COMMENTS ON THE REPORT'S RECOMMENDATION IN METEOROLOGY

THE REVIEWER AGREES IN GENERAL WITH THE ABOVE ASSESSMENT AND RECOMMENDATION ON METEOROLOGICAL RESEARCH IN CANADA. HOWEVER, THE INFERENCE THAT THE LIMITED GROWTH IN RESEARCH COMPLETELY RESULTS FROM THE DEARTH OF COMPETENT MANPOWER, IS NOT CONVINCING. AS A RULE, THE DEVELOPMENT OF A SCIENCE GOES HAND IN HAND WITH A NEED FOR KNOWLEDGE - A NEED THAT GENERATES AND GROWS FROM THE BROADENING OF INTEREST FROM WITHIN THE SOCIETY. IN RESPECT TO METEOROLOGY, GROWTH IS MOST LIKELY TO RESULT FROM ACTIONS FROM WITHIN THAT PART OF SOCIETY WHICH PLANS AND OPERATES WEATHER-SENSITIVE ACTIVITIES. THIS PART OF SOCIETY, HOWEVER, AS EXEMPLIFIED BY THE FACT THAT THE REPORT STATES - "NO RESEARCH ACTIVITY IN INDUSTRY HAS BEEN FOUND", HAS NOT REALLY DEVELOPED A NEED FOR METEOROLOGY. IN OTHER WORDS, THE METEOROLOGICAL FACTOR IS NOT RECOGNIZED AS BEING ONE OF THE SIGNIFICANT FACTORS IN THE ACHIEVEMENT OF A LARGE NUMBER OF KEY ECONOMIC CANADIAN ACTIVITIES. ONE MIGHT, AT THIS POINT, HOPEFULLY INFER THAT THIS SITUATION RESULTS FROM A LACK OF APPRECIATION OR UNDERSTANDING OF THE APPLICATIONS OF METEOROLOGY. IF THIS IS A VALID INFERENCE, THEN THE PROBLEM MAY BE WITH CANADA'S EDUCATIONAL PROGRAMS.

TODAY, A LARGE PERCENTAGE OF MANAGEMENT PERSONNEL ASSOCIATED WITH THE PLANNING, IMPLEMENTATION AND OPERATION OF ATMOSPHERIC-SENSITIVE ACTIVITIES

ARE UNIVERSITY GRADUATES. THIS IS THE SAME GROUP WHICH MAKES THE DECISIONS ON WHETHER APPLIED RESEARCH IN METEOROLOGY IS OR IS NOT TO BE CARRIED OUT BY INDUSTRY. SUCH DECISIONS MAY RESULT FROM EITHER A LACK OF KNOWLEDGE OR APPRECIATION OF THE VALUE OF APPLIED METEOROLOGY OR FROM PROVEN FACTS THAT THE METEOROLOGICAL FACTORS HAVE INSUFFICIENT VALUE TO ECONOMICALLY WARRANT THE EFFORT AND COST OF APPLIED RESEARCH PROJECTS. IN EITHER CASE, NO APPLIED RESEARCH ACTIVITY IN INDUSTRY WAS FOUND BY THE COMMITTEE.

THERE ARE STILL PLENTY OF FRONTIERS OF APPLIED METEOROLOGICAL KNOWLEDGE AS NOTED BY THE GROUP - BREWER, BOVILLE, AND GODSON IN THEIR REVIEW ON APPLIED METEOROLOGY. EVEN SO, PROGRESS IS SLOW IN BOTH BASIC AND APPLIED RESEARCH. HOWEVER, THE REVIEWER BELIEVES THAT A MORE ORGANIZED EFFORT CAN BE DEVELOPED TO IMPROVE THIS SITUATION, BY URGING UNIVERSITIES TO BROADEN THE APPLICATION OF THIS ENVIRONMENTAL SCIENCE IN THEIR CURRICULUM. THE PAY-OFF FROM THIS SHOULD BE A STRONGER RESPONSE FROM THE NEW MANAGERS IN OUR SOCIETY (INDUSTRY, ETC.) WHO WILL BE DEMANDING BETTER METEOROLOGICAL SERVICES. SUCH DEMANDS OR NEEDS SHOULD RESULT IN A MORE PURPOSEFUL GROWTH OF METEOROLOGY IN CANADA, NOT ONLY IN BASIC OR FUNDAMENTAL RESEARCH, BUT ALSO IN MISSION-ORIENTED (PROBLEMS PECULIAR TO CANADA) APPLIED RESEARCH.

IF APPLIED METEOROLOGY HAS VALUE TO THE CANADIAN ECONOMY (THE REVIEWER IS CONVINCED THAT IT HAS), AND IF THIS VALUE IS RECOGNIZED BY THE CANADIAN UNIVERSITIES AND INTEGRATED AS AN ENVIRONMENTAL FACTOR INTO THEIR SCIENCE COURSES, METEOROLOGICAL RESEARCH (BASIC AND APPLIED) WILL GROW AS IT WILL HAVE THE SUPPORT OF THE CANADIAN SOCIETY - IT HAS VALUE TO THE ECONOMY OF CANADA.

THE REPORT IS AN EXCELLENT SUMMARY OF THE ACTUAL STATE OF RESEARCH IN PHYSICS (METEOROLOGY) IN CANADA, AND SHOULD BE READ BY ALL IF THE OPPORTUNITY ARISES. HOWEVER, THE REVIEWER BELIEVES THAT THE RECOMMENDATION WOULD HAVE BEEN STRONGER IF IT WAS STATED AS FOLLOWS:

- WE STRONGLY RECOMMEND FURTHER DEVELOPMENT AND STRENGTHENING OF METEOROLOGY IN THE UNIVERSITIES, PARTICULARLY IN THE BROADENING OF ITS APPLICATION INTO THOSE DEPARTMENTS WHOSE FIELDS OF SCIENCE ARE CONCERNED WITH AMBIENT ATMOSPHERIC - ENVIRONMENTS, THAT IS - AGRICULTURE, FORESTRY, WATER AND AIR RESOURCE MANAGEMENT, TRANSPORTATION, URBAN AND SUBURBAN DEVELOPMENT, AND INDUSTRIES, TOGETHER WITH STIMULATING INDUSTRY IN THE SUPPORT OF UNIVERSITY METEOROLOGICAL RESEARCH (BASIC AND APPLIED) IN ORDER THAT THE FULL MATERIAL BENEFITS OF THE SCIENCE OF METEOROLOGY ARE REALIZED IN THE CANADIAN SOCIETY. THIS CAN ONLY BE ACHIEVED IF A GREATER PROPORTION OF CANADIAN STUDENTS IDENTIFY WITH AND FIND SATISFACTION IN THE SCIENCE OF METEOROLOGY IN THE UNIVERSITIES AND INDUSTRY.

**TABLE 1. - TECHNICAL PROGRESS CHART
RESEARCH, THROUGH DEVELOPMENT TO USE**

PHASE		DESCRIPTION	PART AND DESCRIPTION
1		SCIENTIFIC PRINCIPLE, INVENTION OR DISCOVERY OF A NEW PHENOMENON	A PURE RESEARCH WITHOUT INDUSTRIAL MOTIVE
2		PRELIMINARY MEASUREMENT AND ANALYSIS	
3		BASIC RESEARCH NECESSARY TO GET AN UNDERSTANDING OF THE PHENOMENON	B APPLIED RESEARCH WHERE SCIENTIFIC STAFF TRAINED IN A ARE REQUIRED
4	IMPROVEMENTS AND MODIFICATIONS	CONSTRUCTION OF FIRST WORKABLE MODEL WITH APPLICATION IN MIND	
5		DEVELOPMENT OF PROTOTYPE FOR DEMONSTRATION	
6		DEMONSTRATION AND EVALUATION TO ASSESS VALUE FOR PRODUCTION	C DEVELOPMENT BY ENGINEERS WITH PRODUCTION IN MIND
7		ENGINEERING DESIGN OF PRODUCTION MODELS	
8		TOOLING AND MANUFACTURE	D MANUFACTURE, MARKETING AND USE
9		INSPECTION, QUALITY CONTROL, AND TESTING	
10		MARKETING AND ACCEPTANCE BY THE PUBLIC BUYER	

THIS IS THE AREA WHERE CLOSE ATTENTION BY POLICY MANAGEMENT FIRST APPEARS

(FIGURE 1)

SUMMER RAINFALL IN INDIA

A REVIEW OF MONSOONAL AND EXTRAMONSOONAL ASPECTS - 1

A.K. CHAKRAVARTI

IN RECENT YEARS THE CONCEPT OF TROPICAL CLIMATOLOGY HAS UNDERGONE PROFOUND CHANGES. THE ESTABLISHMENT OF A NETWORK OF WEATHER STATIONS IN THE TROPICS AND ESPECIALLY THE COLLECTION OF SUBSTANTIAL AMOUNTS OF UPPER AIR DATA HAVE THROWN NEW LIGHT ON THE NATURE OF TROPICAL AND SUB-TROPICAL WEATHER. MANY NEW IDEAS AND METHODS ARE NOW BEING SUPPLIED TO EXPLAIN THE COMPLEXITIES OF WEATHER AND CLIMATE IN THE TROPICS. PALMER (1951) CLASSIFIES THESE DIFFERENT METHODS INTO THREE PRINCIPAL GROUPS, VIZ. - (I) THE CLIMATOLOGICAL APPROACH, (II) THE AIR MASS APPROACH, AND (III) THE PERTURBATION APPROACH. THE APPLICATION OF THESE DIFFERENT APPROACHES HAS GREATLY CONTRIBUTED TO OUR KNOWLEDGE AND HAS LED TO RE-APPRAISAL OF THE OLDER CONCEPTS OF TROPICAL WEATHER AND, PARTICULARLY, OF MONSOON RAINFALL IN INDIA. HOWEVER, WHILE THESE NEW INTERPRETATIONS CHALLENGE THE CLASSICAL CONCEPTS OF MONSOON RAINFALL, THEY ARE SO NUMEROUS, COMPLEX AND SOMETIMES CONTRADICTORY, THAT THEY DO NOT OFFER IN THEMSELVES AN ALTERNATIVE AND UNIFIED VIEW. THE ESSENTIAL PURPOSE OF THIS STUDY IS TO EXAMINE THE MANY FRAGMENTARY ITEMS OF RECENTLY PUBLISHED RESEARCH AND PRESENT AN INTEGRATED INTERPRETATION OF THE CAUSES OF SUMMER RAINFALL IN INDIA.

THE CLASSICAL CONCEPT

AS EARLY AS 1686, HALLEY IN THE MEMOIRS OF THE PHILOSOPHICAL SOCIETY OF GREAT BRITAIN, ATTRIBUTED THE MONSOONS TO THE DIFFERENTIAL HEATING OF LAND AND WATER. SUBSEQUENT EXPLANATIONS OF MONSOONS AND ASSOCIATED RAINFALL DID NOT DIFFER MUCH FROM HALLEY'S IDEAS. IT WAS GENERALLY BELIEVED THAT THE MONSOON RAINS WERE CAUSED PREDOMINANTLY EITHER BY THE RISING OF THE MOIST WINDS AGAINST AN OROGRAPHIC BARRIER OR BY THERMAL CONVECTIONS ON THE HEATED LAND. THESE SIMPLE EXPLANATIONS HAVE BEEN POPULAR FOR A LONG TIME, AS FOR EXAMPLE, APPEARING IN THE WORKS OF SIMPSON (1921) AND MC ADIE (1922), AND CAN STILL BE FOUND IN CERTAIN MODERN TEXTS IN PHYSICAL GEOGRAPHY AND CLIMATOLOGY (HORROCKS, 1964, AND CRITCHFIELD, 1966).

AN OBVIOUS DIFFICULTY IN ACCEPTING THE CLASSICAL CONCEPT LIES IN THE FACT THAT THE LAND MASS OF INDIA IS HEATED REGULARLY EVERY SUMMER BUT THE 'BURST' OF MONSOON (RAINFALL) IS IRREGULAR IN TIME, PLACE AND AMOUNT. RECENT INVESTIGATIONS, HOWEVER, HAVE POINTED OUT THAT THE SUMMER RAINFALL IN INDIA IS LITTLE AFFECTED BY THE DIFFERENTIAL HEATING OF LAND AND WATER - THE SO CALLED MONSOON EFFECT - BUT IS RATHER MORE SIGNIFICANTLY RELATED TO THE COMPLEX ATMOSPHERIC DISTURBANCES AND 'EXTRAMONSOONAL' PERTURBATIONS.

THESE ATMOSPHERIC DISTURBANCES AND PERTURBATIONS RELATED TO SUMMER RAINFALL IN INDIA CAN BE DIVIDED INTO THREE GROUPS, VIZ. - (1) AIR MASSES AND FRONTS IN THE MONSOON CIRCULATION, (2) HIGH LEVEL ATMOSPHERIC PERTURBATION, AND (3) EXTRATROPICAL DISTURBANCES KNOWN AS WESTERN DISTURBANCES. ONLY THE FIRST GROUP OF THESE DISTURBANCES WILL BE DISCUSSED HERE. THE SECOND AND THE THIRD GROUPS WILL BE ANALYZED IN THE SECOND PART OF THIS STUDY.

AIR MASSES FRONTS AND SUMMER RAINFALL

IT IS GENERALLY REALIZED THAT FRONTS, AS OBSERVED IN THE EXTRATROPICAL CYCLONES, DO NOT EXIST IN THE TROPICS. HOWEVER, PROBABLY AS A RESULT OF THE COUNTRY'S PECULIAR LOCATION, SHAPE, AND HIGH MOUNTAIN BARRIER IN THE NORTH, INDIAN METEOROLOGISTS, TOGETHER WITH SOME WESTERN METEOROLOGISTS, CONTINUE TO BELIEVE IN AIR MASS ANALYSIS AND FRONTAL EXPLANATIONS FOR THE SUMMER RAINFALL IN INDIA (GRIMES, 1951).

(A) MONSOON DEPRESSIONS AND AIR MASSES. THE SUMMER RAINFALL OF INDIA, SIGNIFICANTLY, IS ASSOCIATED WITH A LARGE NUMBER OF DEPRESSIONS WHICH ARE VERY PROMINENT FEATURES ON THE SURFACE WEATHER CHARTS. HOWEVER, ALTHOUGH THERE IS DOUBT REGARDING THE PRESENCE OF FRONTS, MOST INVESTIGATIONS HAVE DEMONSTRATED THAT THERE ARE SEPARATE AIR MASSES INVOLVED IN A MONSOON DEPRESSION. IN THE SHORT PERIOD FROM 1950 TO 1952 A SERIES OF PAPERS WERE PUBLISHED BY INDIAN METEOROLOGISTS WHO HAD NOTED THE PRESENCE OF MORE THAN ONE AIR MASS IN A MONSOON DEPRESSION. MALURKAR (1950) HAS IDENTIFIED THREE PRINCIPAL AIR MASSES: (I) E_M - THE EQUATORIAL MARITIME FROM THE SOUTH OF THE EQUATOR, (II) T_R - THE TRANSITIONAL OR MIXED AIR MASS FROM THE FAR EAST, AND (III) T_C - THE TROPICAL CONTINENTAL AIR MASS FROM WESTERN ASIA. ACCORDING TO HIM THESE THREE AIR MASSES ARE REQUIRED FOR THE FORMATION OF A MONSOON DEPRESSION, WHILE THE POSITION OF THE T_C AIR MASS DETERMINES THE LOCATION OF FORMATION EITHER IN THE BAY OF BENGAL OR THE ARABIAN SEA. DESAI (1951), AFTER EXAMINING MALURKAR'S CONCEPT, HAS CONCLUDED THAT EVEN LESS THAN THREE AIR MASSES CAN LEAD TO THE FORMATION OF A DEPRESSION. IN ADDITION, IT HAS BEEN OBSERVED THAT OROGRAPHY AND LAND FACTORS ALSO PLAY A PART IN THE GENERATION OF CYCLONIC CIRCULATION AND THE SUBSEQUENT MOVEMENT.

DESAI AND KOTESWARAM (1951), IN ANOTHER DETAILED STUDY, REITERATED THEIR BELIEF IN THE AIR MASSES AND 'PARTITIONS' IN A MONSOON DEPRESSION. ACCORDING TO THEM A DEPRESSION IS FORMED UNDER THE FOLLOWING THREE CONDITIONS - (I) AN EXTENSION OF THE E_M AIR MASS INTO THE NORTHERN BAY OF BENGAL, (II) ITS DEFLECTION TOWARDS THE NORTHWEST DUE TO RELIEF AND THE SEASONAL TROUGH, AND (III) THE WAVE FORMATION DUE TO DEFLECTION, WHICH SUBSEQUENTLY DEVELOPS INTO A DEPRESSION.

A SECOND CASE STUDIED BY THE SAME AUTHORS REVEALED THE FORMATION OF A DEPRESSION DUE TO THE ARRIVAL OF A 'LOW PRESSURE WAVE' (T_M) FROM ACROSS BURMA, WHEN A 'PARTITION' FORMED BETWEEN THE MIXED OLD MONSOON (NT_M) AND THE ARABIAN SEA MONSOON (NEM) AND HEAVY RAINS FOLLOWED. ACCORDING TO THIS INVESTIGATION, THERE WAS ENOUGH EVIDENCE CONCERNING THE PRESENCE OF

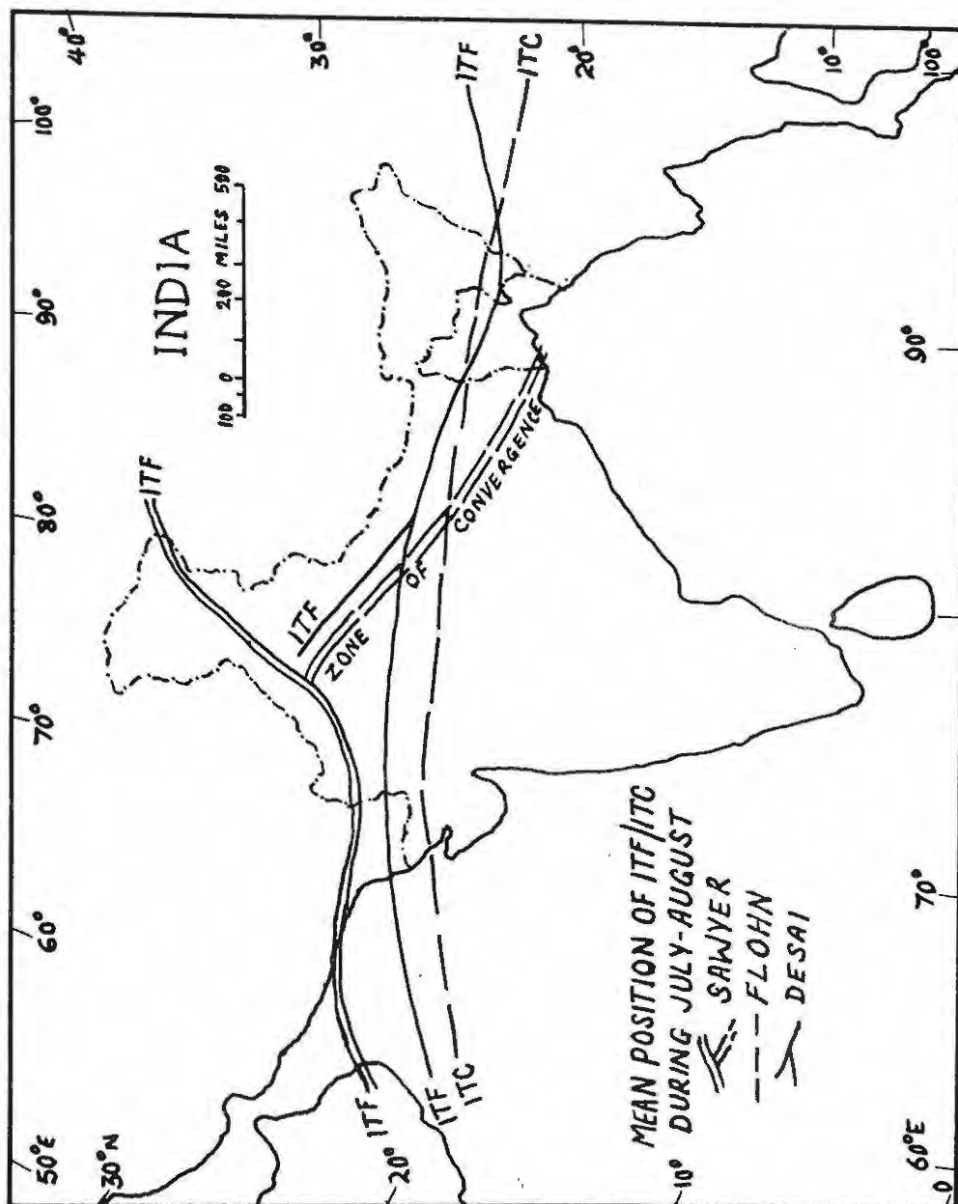
DIFFERENT AIR MASSES ALTHOUGH SHARP FRONTAL CHARACTERISTICS BETWEEN THEM WERE NOT OBSERVED. SIMILAR EVIDENCE OF TWO OR THREE AIR MASSES IN A LATE MONSOON DEPRESSION WAS ALSO NOTED BY SEN AND GEORGE (1952).

THESE SEPARATE STUDIES HAVE CONCLUSIVELY DEMONSTRATED THE CONVERGENCE OF DIFFERENT AIR MASSES IN A MONSOON DEPRESSION. THE CONVERGENCE OF DIFFERENT AIR MASSES IN ITSELF WOULD INVOLVE THE PRESENCE OF QUASI 'FRONTS', BUT UNLIKE THE FRONTS IN AN EXTRATROPICAL CYCLONE, THE FRONTS IN A MONSOON DEPRESSION ARE QUITE DIFFUSED.¹ THEREFORE, IT WOULD BE DIFFICULT TO DISCARD ALTOGETHER THE AIR MASS AND FRONTAL CONCEPTS IN THE INDIAN SUBTROPICS. PALMER (1952) HAS ALSO POINTED OUT THAT WHILE WEATHER ANALYSIS IN TERMS OF AIR MASSES AND FRONTS HAS HAD TO BE ABANDONED IN THE PACIFIC AND THE WESTERN ATLANTIC, IT HAS CONTINUED TO BE VERY SUCCESSFUL IN COUNTRIES BORDERING THE INDIAN OCEAN.

(B) INTERTROPICAL FRONTS AND CONVERGENCE ZONE. IT IS GENERALLY RECOGNIZED THAT A ZONE OF CONVERGENCE CALLED THE INTERTROPICAL CONVERGENCE (ITC) ZONE MARKS THE BOUNDARY BETWEEN THE NORTHEAST AND SOUTHEAST TRADE WINDS. FLETCHER (1945) HAS IDENTIFIED TWO CONVERGENCE ZONES, THE NITC ZONE IN THE NORTH AND THE SITC ZONE IN THE SOUTH, SEPARATED BY A WEDGE OF EQUATORIAL WESTERLIES. THE NITC ZONE MIGRATES NORTHWARD IN SUMMER, AND IS RECOGNIZED AS THE MONSOON TROUGH IN INDIA EXTENDING FROM WEST TO EAST ACROSS THE COUNTRY. GREAT SIGNIFICANCE FOR SUMMER RAINS IN INDIA HAS BEEN ATTACHED TO THIS CONVERGENCE ZONE, HOWEVER, THERE IS SOME CONTROVERSY REGARDING ITS STRUCTURE AND POSITION OVER INDIA.

SAWYER (1947 AND 1952) OBSERVES THAT IN JULY AND AUGUST A SHARP BOUNDARY CALLED THE INTERTROPICAL FRONT (ITF) LIES ACROSS NORTHWEST INDIA, SEPARATING THE DRY CONTINENTAL AIR OF THAT PART OF THE COUNTRY FROM THE MOIST SOUTHWEST MONSOON, FIGURE 1. SINCE THIS ITF IS THE APPROXIMATE NORTHERN LIMIT OF THE SUMMER MONSOON, DRY CONDITIONS PREVAIL BEYOND THIS LINE OVER MOST OF THE NORTHWESTERN PART OF INDIA. THE DEVELOPMENT OF CLOUD AND PRECIPITATION IS SUPPRESSED NEAR THE SURFACE FRONT SINCE THE DRY WARM AIR LIES OVER THE COOL MOIST SOUTHWEST MONSOON CURRENT. HOWEVER, THE GENERAL AREA OF PRECIPITATION IS ABOUT 200 TO 500 MILES AWAY FROM THE SURFACE FRONT, THIS

1. IT WOULD BE MORE APPROPRIATE TO CALL THESE ZONES OF SEPARATION 'PARTITIONS' INSTEAD OF FRONTS. EVEN IN MID-WINTER WHEN THERE IS MAXIMUM PROBABILITY OF THE OCCURRENCE OF FRONTS IN A WESTERN DISTURBANCE OVER NORTHWESTERN INDIA, IN MOST CASES ONLY A BROAD INDETERMINATE TYPE OF 'PARTITION' HAS BEEN OBSERVED. SEE RAMASWAMY, C., THE PROBLEM OF FRONTS IN THE INDIAN ATMOSPHERE, INDIAN JOURNAL OF METEOROLOGY AND GEOPHYSICS, VOL. 17, NO. 2, 1966, PP. 151-170.



DISTANCE BEING THE LIMIT OF PENETRATION OF THE DRY CONTINENTAL AIR AT THE UPPER LEVEL. BEYOND THIS LIMIT, DEEP CLOUDS DEVELOP AND GIVE CONVECTIONAL AND THUNDER SHOWERS. SAWYER HAS ALSO INDICATED A ZONE OF CONVERGENCE LYING ACROSS THE GANGES PLAIN (FIGURE 1), BUT THE NATURE OF THIS TROUGH AND ITS RELATIONSHIP WITH THE RAINFALL OVER NORTHERN INDIA HAS NOT BEEN DISCUSSED.

HOWEVER, RIEHL (1954) HAS RAISED SERIOUS DOUBTS REGARDING THE ROLE OF DENSITY CONTRASTS AND FRONTS IN THE FORMATION AND GROWTH OF DISTURBANCE DURING THE SUMMER MONSOON PERIOD IN INDIA. ACCORDING TO HIM, THE CASE FOR THE PRIMARY ROLE OF DENSITY CONTRAST IN PRODUCING RAINFALL HAS NOT BEEN PROVED SO FAR. DURING THE SUMMER, HOWEVER, AN EQUATORIAL (OR MONSOON) TROUGH EXTENDS FROM EAST-SOUTHEAST TO WEST-NORTHWEST OVER THE INDO-GANGETIC PLAINS. RIEHL CONTENDS THAT THIS MONSOON TROUGH DETERMINES THE PASSAGE OF DISTURBANCES AND THE DISTRIBUTION OF HEAVY RAINFALL OVER INDIA.

BY ANALYZING THE UPPER LEVEL ATMOSPHERIC CONDITIONS, DESAI AND KOTESWARAM (1951) HAVE DISCUSSED A DIRECT RELATIONSHIP BETWEEN MONSOON RAINFALL AND THE ZONE OF CONVERGENCE. THEY HAVE NOTED THAT THE MONSOON RAINS OCCUR OVER THE NORTHERN PLAINS OF INDIA, EVEN IN THE ABSENCE OF A CYCLONE, WHENEVER THE SEASONAL TROUGH IS WELL MARKED. THE RAINFALL HAS BEEN ATTRIBUTED TO A QUASI-STATIONARY SLOPING SURFACE WHICH SEPARATES THE WESTERLY MONSOON CURRENTS (NE_M) IN THE SOUTH FROM THE EASTERLY MONSOON CURRENTS (NT_M) IN THE NORTH. THE NT_M BEING WARMER, RISES OVER THE NE_M UNDER THE COMBINED INFLUENCE OF PRESSURE DISTRIBUTION AND OROGRAPHIC FEATURES. THUS, THERE MAY BE HEAVY RAINFALL ALONG THIS NARROW SEASONAL TROUGH, THE AMOUNT DEPENDING UPON THE VELOCITY INCREASE OF THE MONSOON CURRENTS WHICH MAKE THE SLOPING SURFACE STEEPER. THE SLOPING SURFACE EXTENDING FROM WEST TO EAST ACROSS INDIA HAS NOT BEEN CONSIDERED AS A FRONT IN THE USUAL SENSE SINCE IT DOES NOT MOVE IN THE DIRECTION OF THE ASCENDING AIR AND DOES NOT HAVE SHARP TEMPERATURE CONTRASTS, BUT THE RAINFALL ASSOCIATED WITH IT HAS A DISTRIBUTION SIMILAR TO THAT OF A WARM FRONT. THIS CONCEPT APPEARS TO BE QUITE CONVINCING SINCE HEAVY RAINFALL HAS BEEN RECORDED OVER THE NORTHERN PLAINS OF INDIA IN THE ABSENCE OF A DEPRESSION ON THE SURFACE WEATHER CHART. HOWEVER, THE AUTHORS HAVE NOT TAKEN INTO CONSIDERATION THE UPPER ATMOSPHERIC DISTURBANCES WHICH MAY ALSO BE PARTLY THE CAUSE OF SUCH RAINFALLS. THE RELATIONSHIP BETWEEN UPPER LEVEL DISTURBANCES AND MONSOON RAINFALL WILL BE DISCUSSED IN THE SECOND PART OF THIS STUDY.

IT SHOULD BE POINTED OUT THAT ALTHOUGH THERE IS MUCH CONTROVERSY REGARDING THE NATURE OF THE ITC ZONE OR ITF, IT IS DIFFICULT TO REFUTE ALTOGETHER THE CONVERGENCE OF THE WESTERN AND EASTERN MONSOONS ALONG IT. THE HEAVY RAINFALL, THE BREAK IN THE MONSOONS, AND THE PASSAGE OF DEPRESSIONS ARE SO INTIMATELY CONNECTED WITH THE POSITION OF THIS CONVERGENCE ZONE, THAT THE VALIDITY OF THE ITC ZONE AS A ZONE OF DISTURBANCES CANNOT BE SUMMARILY REJECTED.

(C) MONSOON 'PULSES' AND RAINFALL. WITH REGARD TO THE RAINFALL OVER THE SOUTHERN PARTS OF INDIA, MALURKAR (1950) CONTENDS THAT IT IS DUE TO THE MONSOON 'PULSES' WHICH PROGRESS WESTWARD AS WAVES AND CROSS THE EQUATOR TO

STRENGTHEN THE SOUTHWEST MONSOON. THESE 'PULSES' HAVE BEEN EXPLAINED AS LOW PRESSURE SYSTEMS CARRYING MARITIME AIR WHICH EASILY BECOMES UNSTABLE AND GENERATES THUNDERSTORMS AND RAINFALL OVER PENINSULAR INDIA.

THE RELATIONSHIP BETWEEN THE PULSATION OF MONSOON CURRENT AND RAINFALL HAS ALSO BEEN NOTED BY RAMAKRISHNA AND RAO (1958). ACCORDING TO THESE AUTHORS, THE RAINFALL SOUTH OF 20°N . LATITUDE OVER PENINSULAR INDIA IS PRACTICALLY NON-DEPRESSIONAL. THEY HAVE EXPLAINED, HOWEVER, THAT THE INCREASE OF THE WINDS AND SUBSEQUENT RAINS FROM THE SOUTHWEST MONSOON IS DUE TO THE SUPERIMPOSITION OF SPELLS OF FRESH 'PULSES' IN THE MONSOON CURRENT. TREWARTHA (1961) HAS DESCRIBED THESE PULSES OF THE MONSOON CURRENT AS ABOVE SURFACE SURGES OR 'SPEED CONVERGENCES' WHICH HE THINKS GENERATE A LARGE PART OF THE SUMMER RAINFALL FROM THE SOUTHWEST MONSOON OVER THE PENINSULA.

ANOTHER SIGNIFICANT STUDY OF THE RAINFALL CONNECTED WITH THE SURGES IN THE SOUTHWEST MONSOON HAS BEEN DONE BY GEORGE (1956). HE HAS POINTED OUT THAT WHEN THERE ARE FRESH SURGES IN THE SOUTHWEST MONSOON, THE BOUNDARY BETWEEN THE FRESH AND THE EXISTING CURRENTS BECOMES A REGION OF DISCONTINUITY OF (I) WIND VELOCITY, AND OF (II) AIR DENSITY. UNDER THIS SYNOPTIC CONDITION, WAVES ARE GENERATED WHICH ARE TRANSFORMED INTO VORTEX MOTION. THESE ARE SMALL SIZED OFFSHORE VORTICES (30-100 MILES IN HORIZONTAL EXTENT) WITHOUT FRONTS, WHICH OCCASIONALLY PRODUCE HEAVY RAINFALL ALONG THE WESTERN COAST, EVEN AT SOME DISTANCE FROM THE GHATS.

IN RECENT STUDY, JOSEPH AND RAMAN (1966) HAVE CLAIMED THE EXISTENCE OF A LOW-LEVEL WESTERLY JET STREAM OVER PENINSULAR INDIA DURING JULY. THIS LOW-LEVEL JET, EMBEDDED IN THE SOUTHWEST MONSOON, HAS ITS CORE AT ABOUT 1.5 KM. ABOVE SEA LEVEL AND REACHES SPEEDS OF 40 TO 60 KNOTS. ALTHOUGH THEIR INVESTIGATION IS NOT YET COMPLETE, THE AUTHORS EXPECT TO FIND A CLOSE RELATIONSHIP BETWEEN THIS WESTERLY JET AND THE DISTRIBUTION OF RAINFALL OVER THE PENINSULA.

SO FAR NO STUDY HAS BEEN MADE OF THE POSSIBLE RELATIONSHIP BETWEEN UPPER ATMOSPHERIC PERTURBATIONS AND THE RAINFALL FROM THE SOUTHWEST MONSOON. GEORGE (1956) HAS MADE A FEW PASSING COMMENTS ON THE UPPER LEVEL PERTURBATIONS IN THE SOUTHWEST MONSOON. IT IS JUST POSSIBLE THAT THESE HIGH-LEVEL PERTURBATIONS PLAY A SIGNIFICANT ROLE IN DETERMINING THE RAINFALL FROM THE SOUTHWEST MONSOON.

CONCLUSIONS

RECENT INVESTIGATIONS HAVE DEMONSTRATED THAT A SUBSTANTIAL PORTION OF SUMMER RAINFALL IN INDIA IS NOT RELATED TO SURFACE DEPRESSIONS, THERMAL CONVECTIONS OR OROGRAPHIC BARRIERS AS HAS LONG BEEN THOUGHT.

A SIGNIFICANT CAUSE OF RAINFALL IS THE CONVERGENCE ALONG THE ITC ZONE WHICH SPANS THE COUNTRY BETWEEN 20° TO 30°N . LATITUDES DURING THE SUMMER SEASON. THE ITC ZONE ALSO DETERMINES THE PASSAGE OF A LARGE NUMBER OF

DEPRESSIONS FROM THE BAY OF BENGAL AND THE DISTRIBUTION OF HEAVY RAINFALL. FURTHER, A LARGE PORTION OF RAINFALL FROM THE SOUTHWEST MONSOON OVER THE PENINSULA IS ALSO OF NON-DEPRESSIONAL OR NON-OROGRAPHIC ORIGIN AND IS RELATED TO 'PULSES' OR SPEED CONVERGENCES, WAVES OR SMALL SIZED VORTICES, AND A LOW-LEVEL JET STREAM EMBEDDED IN THE SOUTHWESTERLY CURRENT. HOWEVER, MOST OF THE WEATHER DISTURBANCES WHICH APPEAR ON THE SURFACE CHARTS ARE RELATED TO THE UPPER ATMOSPHERIC PERTURBATIONS. THESE 'EXTRAMONSOONAL' UPPER ATMOSPHERIC FLOW PATTERNS ARE ALSO VERY SIGNIFICANT IN DETERMINING THE AMOUNT AND THE DISTRIBUTION OF SUMMER RAINFALL IN INDIA. THESE WILL BE DISCUSSED IN THE SECOND PART OF THIS STUDY.

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MAY THE TORONTO CENTRE OF THE CANADIAN METEOROLOGICAL SOCIETY HELD ITS FINAL MEETING OF THE 1967-68 SEASON ON TUESDAY, MAY 14. A SHORT BUSINESS MEETING PRECEDED THE EVENING'S PROGRAM. THE NEW EXECUTIVE FOR 1968-69 WAS ELECTED AS FOLLOWS -

CHAIRMAN	- MR. R. LEE
PROGRAM SECRETARY	- MR. K.T. MCLEOD
TREASURER	- MR. B. FINDLAY
SECRETARY	- MR. H.L. FERGUSON

FIFTY MEMBERS WERE PRESENT TO HEAR DR. R.B. FLETCHER, DIRECTOR OF AEROSPACE SCIENCES, USAF AIR WEATHER SERVICE SPEAK ON - "THE AIR WEATHER SERVICE TODAY". DR. FLETCHER OUTLINED THE STRUCTURE OF HIS SERVICE AND ITS SPHERE OF OPERATIONS BOTH GEOGRAPHICALLY AND SCIENTIFICALLY. MEMBERS SHOWED PARTICULAR INTEREST IN THE SOLAR OBSERVING AND FORECASTING NETWORK AND THE MAGNETOMETER NETWORK ACTIVITIES OF THE AIR WEATHER SERVICE. THE AIR WEATHER SERVICE SET-UP IS UNIQUELY SUITED FOR TESTING WEATHER MODIFICATION SYSTEMS. DR. FLETCHER GAVE A BRIEF ACCOUNT OF THIS PHYSICAL CAPABILITY AND TOUCHED ON SOME OF THE PROGRAMS PRESENTLY UNDER WAY.

ALBERTA

AT THE ANNUAL MEETING OF THE ALBERTA CENTRE OF THE CANADIAN METEOROLOGICAL SOCIETY, HELD IN CALGARY, JUNE 5, 1968, THE FOLLOWING WERE ELECTED AS EXECUTIVE FOR THE COMING YEAR.

CHAIRMAN	- DR. KEITH D. HAGE UNIVERSITY OF ALBERTA
SECRETARY	- MR. JAMES M. RENICK RESEARCH COUNCIL OF ALBERTA
TREASURER	- MR. FREDERICK E. BURBRIDGE ARCTIC WEATHER CENTRAL
CALGARY MEMBER	- MR. JOHN M. POWELL DEPARTMENT OF FORESTRY AND RURAL DEVELOPMENT

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WORLD METEOROLOGICAL ORGANIZATION
COMMISSION FOR AGRICULTURAL METEOROLOGY - SESSION IV
HELD IN MANILA - 14-29 NOVEMBER, 1967

GEO. W. ROBERTSON^{1,2}

"OUR TRUE PURPOSE IS TO INTERPRET THE WEATHER, PAST, PRESENT OR FUTURE, IN TERMS OF REAL SIGNIFICANCE TO FOOD PRODUCTION. MOST OF ALL WE MUST DO SOMETHING USEFUL. AS LONG AS WORLD POPULATION CONTINUES TO EXPAND AT ITS PRESENT ALARMING RATE, THE MAIN REASON FOR OUR EXISTENCE IS TO HELP TO KEEP PEOPLE ALIVE AND STOP THEM DYING OF STARVATION."

THESE WORDS, TAKEN FROM PRESIDENT L.P. SMITH'S PRESIDENTIAL ADDRESS AT THE OPENING OF C Ag M-IV BECAME THE THEME OF THE SESSION AND SERVED AS A GUIDELINE THROUGHOUT THE DISCUSSIONS WHICH FOLLOWED DURING THE NEXT TWO WEEKS.

THE PHILIPPINE WEATHER BUREAU, ACTING FOR THE REPUBLIC OF THE PHILIPPINES, WAS THE HOST FOR C Ag M-IV. MEETINGS WERE HELD IN THE BEAUTIFUL NEW SOCIAL SECURITY SYSTEM BUILDING, PART OF A NEW GOVERNMENT COMPLEX IN QUESON CITY, A SUBURB OF MANILA.

THE COMMISSION FOR AGRICULTURAL METEOROLOGY IS ONE OF EIGHT TECHNICAL COMMISSIONS OF THE WORLD METEOROLOGICAL ORGANIZATION, A SPECIALIZED AGENCY OF THE UNITED NATIONS. MEMBERS OF THE COMMISSION CONSIST OF OFFICIAL DELEGATES FROM NATIONAL WEATHER SERVICES AND INVITED ADVISERS AND SCIENTIFIC EXPERTS. ALTHOUGH THE UNITED NATIONS HAS 123 MEMBERS, ONLY 28 NATIONS WERE REPRESENTED AT THIS COMMISSION MEETING, HELD FOR THE FIRST TIME IN AN ASIATIC COUNTRY. SOME 65 DELEGATES, ADVISERS AND EXPERTS WERE PRESENT AT THE MEETING. OBSERVERS REPRESENTING EIGHT INTERNATIONAL SCIENTIFIC ORGANIZATIONS ALSO ATTENDED.

THE COMMISSION MEETING IS A WORK PLANNING SESSION RATHER THAN A SCIENTIFIC CONFERENCE. IT MEETS ONCE EVERY FOUR OR FIVE YEARS. ITS MAIN FUNCTION IS, NOT ONLY TO UPDATE THE METEOROLOGICAL SERVICES OF MEMBER NATIONS AS TO LATEST ADVANCES AND DEVELOPMENTS IN AGRICULTURAL METEOROLOGY, BUT TO DISCUSS PROBLEM AREAS, PROGRAMS, STANDARDIZATION AND NEW SCIENTIFIC ACHIEVEMENTS AND TO ENCOURAGE THE ADVANCEMENT OF THE SCIENCE OF AGRICULTURAL METEOROLOGY IN GENERAL. A GREAT DEAL OF THIS IS ACCOMPLISHED BY MEANS

1. DELEGATES FROM CANADA

2. AGROMETEOROLOGY SECTION, PLANT RESEARCH INSTITUTE, RESEARCH BRANCH, CANADA DEPARTMENT OF AGRICULTURE, OTTAWA 3.

OF WORKING GROUPS WHICH DO MUCH OF THEIR GROUNDWORK BETWEEN SESSIONS. THE COMMISSION ALSO ARRANGES SCIENTIFIC SEMINARS, SYMPOSIA, WORKSHOPS AND TRAINING PROGRAMS, IN ORDER TO EXCHANGE SCIENTIFIC KNOWLEDGE AND EDUCATE TECHNICIANS AND PROFESSIONALS IN THE FIELD OF AGRICULTURAL METEOROLOGY. IT ALSO CO-OPERATES WITH OTHER AGENCIES, SUCH AS, FAO AND UNESCO, IN INTER-AGENCY PROJECTS WHICH ENCOMPASS STUDIES RANGING FROM THE SAVANNAH BELT TO THE ALTIPLANO AND CO-OPERATION WITH WORLDWIDE STUDIES SUCH AS THE INTERNATIONAL BIOLOGICAL PROGRAM.

MUCH OF THE WORK OF THE SESSION WAS CONDUCTED BY TWO COMMITTEES, ONE CHAIRED BY MR. GANGOPADHYAYA, INDIA, DEALING WITH ADMINISTRATION AND POLICY MATTERS AND THE OTHER CHAIRED BY MR. ROBERTSON, CANADA, DEALING WITH TECHNICAL AND SCIENTIFIC MATTERS. THE SECRETARIAL WORK OF THE SESSION WAS CARRIED OUT VERY EFFICIENTLY BY TWO REPRESENTATIVES FROM WMO HEADQUARTERS IN GENEVA. MR. O. M. ASHFORD REPRESENTING THE SECRETARY-GENERAL AND MR. MILTON L. BLANK, PERMANENT SECRETARY FOR THE COMMISSION. IN THE ABSENCE OF MRS. ZOPHIA PIESLAK, MR. J. J. TECSON OF THE PHILIPPINES WAS APPOINTED VICE-PRESIDENT FOR THE SESSION.

SPECIAL WORKING GROUPS ON SELECTED TOPICS DO A GREAT DEAL OF COMMISSION WORK BETWEEN SESSIONS. THE FOURTH SESSION SPENT SOME TIME CONSIDERING REPORTS FROM THESE WORKING GROUPS AND MAKING RECOMMENDATIONS CONCERNING THEIR DISPOSAL. REPORTS OF THE FOLLOWING WORKING GROUPS WERE RECOMMENDED FOR PUBLICATION. THE WORKING GROUP ON METEOROLOGICAL FACTORS AFFECTING THE EPIDEMIOLOGY OF WHEAT RUSTS, THE WORKING GROUP ON PLANT INJURY AND REDUCTION OF YIELD BY NON-RADIOACTIVE AIR POLLUTANTS, THE WORKING GROUP ON THE METEOROLOGICAL ASPECTS OF THE STORAGE OF CEREALS AND OTHER SMALL SEED CROPS, THE WORKING GROUP ON PRACTICAL SOIL MOISTURE PROBLEMS IN AGRICULTURE AND THE WORKING GROUP ON METEOROLOGICAL OBSERVATIONS IN ANIMAL EXPERIMENTS.

ONE WORKING GROUP, THAT CONCERNED WITH SYLLABI FOR INSTRUCTION IN AGRICULTURAL METEOROLOGY, COMPLETED ITS WORK EARLY IN THE INTER-SESSION PERIOD AND THE REPORT WAS PUBLISHED IN 1966 (DE VILLIERS ET AL). THIS REPORT HAS PROVEN MOST VALUABLE TO UNIVERSITIES, COLLEGES AND OTHER EDUCATIONAL INSTITUTIONS ENGAGED IN ACADEMIC INSTRUCTION IN AGRICULTURAL METEOROLOGY.

DURING THE INTER-SESSION PERIOD BETWEEN THE THIRD AND FOURTH COMMISSION MEETINGS, SEVERAL FAO-UNESCO-WMO INTER-AGENCY SEMINARS AND SYMPOSIA WERE HELD. THESE INCLUDED: A TRAINING SEMINAR ON METEOROLOGY AND THE DESERT LOCUST IN TEHERAN, 1963, A REGIONAL SEMINAR ON AGROMETEOROLOGICAL PROBLEMS IN AFRICA IN CAIRO, 1964, A TECHNICAL CONFERENCE ON AGROMETEOROLOGY IN BEIRUT, 1964, AN UNESCO SYMPOSIUM ON ECOSYSTEMS IN COPENHAGEN, 1965, A REGIONAL TRAINING SEMINAR ON AGROMETEOROLOGY IN MELBOURNE, 1966, AND THE SYMPOSIUM ON METHODS IN AGROCLIMATOLOGY IN READING, 1966.

THESE INTER-AGENCY MEETINGS PROVED MOST VALUABLE EVEN THOUGH, IN SOME INSTANCES, ATTENDANCE WAS SMALL AND THE ABSENCE OF MANY DEVELOPING COUNTRIES, WHICH NEEDED ASSISTANCE MOST, WAS NOTED. MANY OF THE PROBLEMS

AND DISCUSSIONS WHICH AROSE OUT OF THESE SEMINARS AND SYMPOSIUM WERE FORMULATED INTO AGENDA ITEMS FOR DISCUSSION AT THIS FOURTH SESSION OF C A G M. IT WAS STRONGLY RECOMMENDED THAT SIMILAR INTER-AGENCY MEETINGS BE HELD IN THE FUTURE AND IT WAS NOTED THAT PLANS WERE ALREADY UNDERWAY BY UNESCO TO CONVENE A CONFERENCE ON THE RESOURCES OF THE BIOSPHERE IN PARIS IN SEPTEMBER, 1968.

ARISING FROM THE WORKING GROUPS' REPORTS AND THE DISCUSSIONS AT INTER-AGENCY SEMINARS AND SYMPOSIUM, WERE SEVERAL PROBLEMS WHICH WERE BROUGHT UP FOR FURTHER DISCUSSION AND ACTION DURING THE COMMISSION MEETING. MANY OF THESE WERE CONSIDERED SUFFICIENTLY SERIOUS TO WARRANT FURTHER STUDY PRIOR TO THE NEXT SESSION WHICH WOULD MEET FOUR OR FIVE YEARS HENCE. WORKING GROUPS WERE ESTABLISHED TO CONSIDER THESE ITEMS AS FOLLOWS.

1. AN ADVISORY GROUP TO ASSIST THE PRESIDENT OF THE COMMISSION, AS REQUIRED, IN TAKING ACTION ON URGENT MATTERS WHICH CANNOT BE HANDLED BY ONE OF THE REGULAR WORKING GROUPS WHO WORK BY CORRESPONDENCE. THIS WORKING GROUP WOULD MAINTAIN CONTINUOUS REVIEW OF DEVELOPMENTS IN THE WORLD WEATHER WATCH (WMO, 1966), WITH THE VIEW TO ENSURING THAT MAXIMUM BENEFITS ARE DERIVED BY AGRICULTURAL METEOROLOGY. IT WOULD ALSO RECOMMEND AMENDMENTS TO THE GUIDE TO AGRICULTURAL METEOROLOGICAL PRACTICES (WMO, 1963), AND THE RELEVANT SECTIONS OF THE WMO TECHNICAL REGULATIONS.
2. A NEW WORKING GROUP WAS SUGGESTED TO CONTINUE THE WORK STARTED BY PROF. A.J. PASCALE, ARGENTINA, ON THE METEOROLOGICAL FACTORS AFFECTING THE WORLD-WIDE ADAPTATION AND PRODUCTION OF LUCERNE. PROF. PASCALE HAD SUBMITTED A PARTIAL REPORT ON LUCERNE PRODUCTION IN LATIN AMERICA. IT IS FELT THAT THIS REPORT COULD SERVE A USEFUL PROTOTYPE FOR A BROADER WORLDWIDE STUDY.
3. A WORKING GROUP ON LOCUST CONTROL HAS BEEN IN EXISTENCE FOR SOME TIME. BECAUSE OF THE CONTINUING THREAT OF LOCUST PLAGUES, AND SINCE NEW DEVELOPMENTS UNDER THE WORLD WEATHER WATCH OFFER OPPORTUNITIES FOR THE METEOROLOGICAL ASSESSMENT OF LOCUST SWARM MOVEMENTS AND IDENTIFICATION OF LOCUST BREEDING GROUNDS, THE SESSION FELT THAT A WORKING GROUP SHOULD BE APPOINTED TO RECOMMEND METHODS FOR APPLYING NEW INFORMATION AVAILABLE UNDER THE WORLD WEATHER WATCH TO PROBLEMS OF LOCUST METEOROLOGY. THE GROUP COULD ALSO ASSIST THE PRESIDENT OF C A G M IN CASES OF EMERGENCY ARISING IN CONNECTION WITH METEOROLOGICAL ASSISTANCE TO ANTI-LOCUST PROGRAMS.
4. A WORKING GROUP ON AGROMETEOROLOGICAL ASPECTS OF MICROMETEOROLOGY WAS ESTABLISHED. THE PURPOSE OF THIS GROUP IS TO REVIEW RECENT AND CURRENT BASIC RESEARCH WORK IN MICROMETEOROLOGY AND TO RECOMMEND WAYS IN WHICH PROGRESS IN BASIC RESEARCH WORK COULD BE ACCELERATED. THE GROUP IS ALSO TO RECOMMEND SUCH ROUTINE METEOROLOGICAL MEASUREMENTS AND REQUIRED INSTRUMENTATION AS ARE NEEDED FOR UNDERSTANDING AND SOLVING AGRICULTURAL PROBLEMS. THEY ARE ALSO TO EVALUATE THE CURRENT RELIABILITY OF MICROMETEOROLOGICAL MEASUREMENTS AND THEIR RELATIONSHIPS WITH BIOLOGICAL RESPONSES. THE GROUP IS ALSO TO CONSIDER WAYS OF APPLYING AVAILABLE MICROMETEOROLOGICAL MEASUREMENTS AND KNOWLEDGE WHICH HAVE REACHED A STAGE TO BE HELPFUL IN

PRACTICAL AGRICULTURAL PROBLEMS.

5. CONSIDERING THAT STUDIES OF THE METEOROLOGICAL FACTORS INFLUENCING THE QUALITY AND QUANTITY OF CROP YIELDS AND THE TIME OF HARVESTING ARE OF GREAT IMPORTANCE TO AGRICULTURE, AND THAT MANY USEFUL INVESTIGATIONS ON CERTAIN PHASES OF THESE PROBLEMS HAVE BEEN OR ARE BEING CARRIED OUT IN MANY COUNTRIES, THE SESSION DECIDED THAT A WORKING GROUP ON THE EFFECT OF METEOROLOGICAL FACTORS ON QUALITY AND QUANTITY OF CROP YIELD AND METHODS OF ESTIMATING YIELD SHOULD BE ESTABLISHED. THE GROUP IS TO UNDERTAKE A REVIEW OF EXPERIENCE, RESEARCH AND CROP PREDICTION METHODS USED IN VARIOUS COUNTRIES AND TO EXAMINE PRACTICAL APPLICATION OF THESE METHODS AND THE POSSIBILITY OF USING THEM IN AREAS OTHER THAN THE COUNTRY OR LOCALITY OF ORIGIN. IT WAS NOTED THAT MANY TECHNIQUES WERE DEVELOPED FOR SPECIFIC REGIONS AND OFTEN THEY CANNOT BE SUCCESSFULLY TRANSFERRED TO OTHER AREAS.
6. RICE IS A BASIC FOOD CROP IN MANY AREAS OF THE WORLD AND, CONSIDERING THAT LOSSES TO RICE PRODUCTION CAUSED BY RICE BLAST IS QUITE SERIOUS, IT WAS DECIDED TO ESTABLISH A WORKING GROUP ON METEOROLOGICAL FACTORS AFFECTING RICE BLAST. THIS WORKING GROUP IS TO COLLABORATE WITH PLANT PATHOLOGISTS TO PREPARE A REVIEW OF PRESENT METEOROLOGICAL FACTORS AFFECTING THE INCIDENCE OF THE DISEASE AND TO INCLUDE A DISCUSSION OF THE POSSIBILITIES OF WARNING OR CONTROL MEASURES INVOLVING METEOROLOGICAL FACTORS.
7. IT WAS RECOGNIZED THAT STUDIES ON AGROCLIMATOLOGY MAY BE OF GREAT IMPORTANCE IN CONNECTION WITH THE INTRODUCTION OF NEW CROPS AND FOR IMPROVING THE YIELD OF EXISTING CROPS AND THAT MANY AGROCLIMATOLOGISTS, PARTICULARLY IN DEVELOPING COUNTRIES WHICH HAVE NOT YET ACQUIRED SUFFICIENT EXPERIENCE IN CONDUCTING AGROCLIMATIC SURVEYS. IT APPEARED OBVIOUS THAT EXPERIENCE ACQUIRED IN OTHER COUNTRIES COULD BE OF CONSIDERABLE ASSISTANCE TO THE SOLUTION OF SUCH PROBLEMS. IT WAS AGREED, THEREFORE, TO ESTABLISH A WORKING GROUP ON METHODS IN AGROCLIMATOLOGY. THE GROUP WOULD BE EXPECTED TO GATHER INFORMATION ON METHODS USED IN DIFFERENT COUNTRIES FOR EXPRESSING THE METEOROLOGICAL REQUIREMENTS OF SELECTED CROPS. SPECIAL REFERENCE IS TO BE GIVEN TO THE DETERMINATION OF NUMERICAL EXPRESSIONS INVOLVING CLIMATIC VARIABLES IN TERMS OF AGRICULTURAL SIGNIFICANCE.
8. DROUGHT HAS ALWAYS BEEN A SERIOUS LIMITATION TO AGRICULTURE PRODUCTION IN MANY PARTS OF THE WORLD. UNFORTUNATELY, THERE IS NO UNIFORM DEFINITION FOR DROUGHT. IT WAS RECOGNIZED THAT THERE WAS A NEED TO ESTABLISH WAYS IN WHICH THE ABSENCE OF MOISTURE IN THE SOIL, GENERALLY REFERRED TO AS DROUGHT CAN BE RELATED TO ITS EFFECTS ON AGRICULTURE SO THAT THE VARIATIONS IN CLIMATE COULD BE INTERPRETED IN TERMS OF AGRICULTURAL HAZARDS FOR CROPS AND ANIMALS. IT WAS FELT THAT BY DOING THIS IT WOULD PROVIDE HELPFUL INFORMATION TO AGRICULTURISTS IN THEIR PLANNING TO COMBAT DROUGHTS. THE COMMISSION, THEREFORE, DECIDED TO ESTABLISH A WORKING GROUP ON THE ASSESSMENT OF DROUGHT. IT WOULD CONSIDER VARIOUS METHODS OF ASSESSING DROUGHTS WITH RESPECT TO THEIR AGRICULTURAL EFFECTS AND TO EVALUATE THE USEFULNESS OF THESE METHODS FOR AGRICULTURAL PLANNING, AND TO CONSIDER THE USE OF MODERN COMPUTER METHODS IN CARRYING OUT SUCH INVESTIGATIONS.

IN MANY PROBLEM AREAS, IT APPEARED THAT THE PROBLEM WAS NOT SUFFICIENTLY WORLDWIDE TO WARRANT ESTABLISHING A WORKING GROUP. INSTEAD IT WAS FELT THAT ONE MAN COULD PROBABLY DO THE JOB REQUIRED. IT WAS DECIDED THEREFORE, THAT RAPPORTEURS SHOULD BE APPOINTED TO LOOK INTO THE FOLLOWING PROBLEMS AND REPORT BACK TO THE COMMISSION AT ITS NEXT SESSION FOUR OR FIVE YEARS HENCE. METEOROLOGICAL FACTORS AFFECTING THE ORIENTAL FRUIT MOTH AND CODDLING MOTH, DIFFUSION PROCESSES IN THE BIOSPHERE, MINIMUM TEMPERATURE AT THE EARTH SURFACE, METEOROLOGICAL FACTORS AFFECTING THE EPIDEMIOLOGY OF COLORADO POTATO BEETLE, METEOROLOGICAL FACTORS AFFECTING THE EPIDEMIOLOGY OF THE COTTON LEAF WORM AND THE PINK BALL WORM, CLIMATE IN GLASS HOUSES, AND INDOOR CLIMATE FOR HOUSED ANIMALS.

MEMBERS OF THE SESSION DISCUSSED AT SOME LENGTH A PROPOSAL TO ESTABLISH AN INTER-AGENCY CO-ORDINATING GROUP ON AN AGROMETEOROLOGICAL PROGRAM IN AID OF WORLD FOOD PRODUCTION, WITH REPRESENTATION FROM WMO, FAO, UNESCO AND UNDP AND OFFERED WHOLEHEARTED SUPPORT TO SUCH A GROUP. IT WAS RECOMMENDED THAT THE INTER-AGENCY GROUP SHOULD ENDEAVOUR TO ENSURE THE MAXIMUM PROGRESS IN IMPROVING THE STANDARD OF AGROMETEOROLOGICAL AND AGROCLIMATOLOGICAL KNOWLEDGE AND THAT MAXIMUM USE BE MADE OF SUCH KNOWLEDGE. IT WAS ALSO RECOMMENDED THAT MEMBER NATIONS SHOULD GIVE ADEQUATE ATTENTION TO THE STATUS ATTACHED TO ALL ASPECTS OF AGRICULTURAL METEOROLOGY IN PLANNING THE FUTURE DEVELOPMENT OF THEIR NATIONAL METEOROLOGICAL AND AGRICULTURAL SERVICES. IN COUNTRIES WHERE THE PRESENT STATUS IS ADEQUATE, CONSIDERATION SHOULD BE GIVEN TO ESTABLISHING AN INDEPENDENT DIVISION FOR AGRICULTURAL METEOROLOGY WITHIN THE METEOROLOGICAL SERVICES OR TO RAISING THE STATUS OF THE EXISTING DIVISION AS APPROPRIATE. IT WAS ALSO CONSIDERED THAT CONSIDERATION BE GIVEN TO THE NEED FOR SHORT-TERM MISSIONS BY EXPERTS IN AGRICULTURAL METEOROLOGY IN RESPONSE TO REQUESTS BY GOVERNMENTS IN DEVELOPING AREAS. EXHAUSTIVE DISCUSSIONS OF THIS PROBLEM BROUGHT OUT THE FOLLOWING GENERAL CONCLUSION. THERE IS AN URGENT NEED FOR MORE INTENSIVE AND EFFECTIVE INTEGRATION OF THE BIOLOGICAL AND PHYSIOLOGICAL ASPECTS OF PLANT PRODUCTION WITH THE PHYSICAL AND METEOROLOGICAL ASPECTS. A FEW RESEARCH INSTITUTES IN VARIOUS PARTS OF THE WORLD ARE ALREADY UNDERTAKING WORK ALONG THESE LINES, BUT IT IS FELT THAT WORLD PRODUCTION COULD GREATLY BENEFIT FROM AN INTERNATIONAL PROJECT INVOLVING FAO, UNESCO, UNDP AND WMO TO STUDY THOROUGHLY THE METEOROLOGICAL REQUIREMENTS OF STAPLE FOOD PLANTS WITH REGARD TO PLANT PHYSIOLOGICAL CONDITIONS. FUNDAMENTAL SCIENTIFIC STUDIES OF THIS NATURE WOULD GREATLY ASSIST AGRICULTURE PLANNING, FOR EXAMPLE IN THE AGROCLIMATOLOGICAL SURVEYS OF CERTAIN AREAS OF THE WORLD WHICH HAVE BEEN AND ARE BEING CARRIED OUT UNDER THE AUSPICES OF FAO, UNESCO AND WMO (COACHEME AND FRANQUIN, 1967). SUCH STUDIES WOULD INVOLVE THE PERSONAL COLLABORATION OF PLANT PHYSIOLOGISTS, AGRONOMISTS, AGROMETEOROLOGISTS AND AGROCLIMATOLOGISTS AND WOULD INCLUDE FIELD AND LABORATORY EXPERIMENTATION. THE BEST LOCATION FOR SUCH CO-OPERATIVE RESEARCH, WOULD BE A RESEARCH INSTITUTE ALREADY DEALING WITH THE STAPLE FOOD SELECTED FOR INVESTIGATION.

THE ROLE WHICH THE WORLD WEATHER WATCH MIGHT PLAY IN CONTRIBUTING TO THE KNOWLEDGE AND SERVICES OF AGRICULTURAL METEOROLOGY WAS DISCUSSED AT SOME LENGTH. PRESIDENT SMITH PREPARED A PLANNING REPORT (SMITH, 1967), WHICH

WAS THE BASIS FOR DISCUSSION. IN SUMMARY, IT WAS FELT - THAT WWW COULD CONTRIBUTE TO A BETTER COVERAGE OF BASIC AGROMETEOROLOGICAL OBSERVATIONS AND COULD PROVIDE A BETTER MEANS FOR PROCESSING DATA, THAT SPECIAL MESO-SCALE AND SEASONAL FORECASTS MIGHT BE FORTHCOMING FROM THE WWW PROGRAM AND THAT SPECIAL RESEARCH AND TRAINING PROGRAMS SHOULD BE UNDERTAKEN WITH- IN THE FRAMEWORK OF WWW TO PROVIDE THE BASIC KNOWLEDGE AND TRAINED PER- SONNEL NECESSARY FOR PROVIDING THE ESSENTIAL FACILITIES FOR CARRYING OUT THE RESEARCH, DEVELOPMENT AND SERVICE REQUIREMENTS OF AGRICULTURAL METEOROL- OGY.

OTHER TOPICS WHICH RECEIVED SOME DISCUSSION INCLUDED THE INTERNATIONAL BIOLOGICAL PROGRAM AND THE ROLE WHICH METEOROLOGISTS COULD PLAY IN IT, THE VALUE OF SEASONAL FORECAST IN AGRICULTURE, REVISIONS TO THE GUIDE TO AGRICUL- TURAL PRACTICES (WMO, 1961), SPECIAL OBSERVATIONS FOR AGRICULTURAL METEOROL- OGY SUCH AS AIRBORNE PHOTOMETERS FOR SURVEYING CROP CONDITIONS OVER WIDE AREAS AND SPECIAL OBSERVATIONS OF HAIL INTENSITY, FREQUENCY AND DURATION BY RADAR AND VISUAL OBSERVATIONS, SPECIAL STUDIES OF INSTRUMENTS FOR MEASURING SOIL TEMPERATURE AND LEAF WETNESS, AND SPECIAL OBSERVATIONAL PRACTICES IN FORESTRY.

EVEN THOUGH THE SESSION WAS ESSENTIALLY A WORK PLANNING MEETING, IT WAS POSSIBLE TO FIND TIME AWAY FROM THE BUSY AGENDA TO SPEND TWO AFTERNOONS ON SCIENTIFIC LECTURES AND DISCUSSIONS. PAPERS WERE PRESENTED BY - R. ARLERY ON THE EPIDEMIOLOGY OF THE COLORADO BEETLE IN FRANCE AND JERSEY, A.W. DEGEFU ON DEVELOPMENTS IN ETHIOPIA, M. GANGOPADHYAYA ON CROP-WEATHER RELATIONSHIP STUDIES IN INDIA, M.Y. GULCUR ON FOREST METEOROLOGY, J. LOMAS ON USE OF PAN EVAPORATION DATA IN IRRIGATION PRACTICES, L.B. MACHATTIE ON DIURNAL VARIA- TIONS IN VALLEY WINDS, A. MADE ON TOPOCLIMATOLOGY, M. RASSEKH ON DEVELOP- MENTS IN IRAN, G.W. ROBERTSON ON RESEARCH ON CROP-WEATHER MODELS IN CANADA, AND L.P. SMITH ON MILK YIELDS AND ANIMAL DISEASES.

MR. L.P. SMITH, U.K. WAS RE-ELECTED PRESIDENT OF THE COMMISSION FOR THE PERIOD ENDING WITH THE 5TH SESSION AND DR. A.V. SINELSHIKOV, USSR, WAS ELEC- TED VICE-PRESIDENT. BOTH ELECTIONS WERE UNANIMOUS. ALTHOUGH THE PLACE AND DATE OF THE NEXT SESSION MUST BE DECIDED BY THE PRESIDENT, IN CONSULTATION WITH THE SECRETARY-GENERAL OF WMO, A PROVISIONAL INVITATION WAS RECEIVED FROM THE GOVERNMENT OF IRAN THROUGH THEIR PRINCIPAL DELEGATE TO HOLD THE 5TH SESSION OF C Ag M IN TEHERAN IN ABOUT 4 YEARS' TIME.

A GREAT DEAL OF THE SUCCESS OF THE MEETING, PARTICULARLY THE PHYSICAL ARRANGEMENTS, SECRETARIAL SERVICES, AND TOUR ARRANGEMENTS TO THE INTERNA- TIONAL RICE RESEARCH INSTITUTE AND THE AGROMETEOROLOGICAL STATION AT TARLAC, CAN BE ATTRIBUTED TO THE WELL ORGANIZED AND DEDICATED STAFF OF THE PHILIPPINE WEATHER BUREAU. ABOVE ALL, THE DELEGATES WILL LONG REMEMBER THE GRACIOUS AND WARM HOSPITALITY OF THE MANY ACQUAINTANCES THEY MADE WITH MEMBERS OF THE WEATHER BUREAU.

THE FULL DETAILS OF THE MEETING WILL APPEAR IN AN ABRIDGED REPORT OF THE COMMISSION TO BE ISSUED SHORTLY ALONG THE SAME LINES AS THAT FOR C Ag M-III HELD IN TORONTO IN 1962 (WMO, 1962).

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MEETINGS

SWITZERLAND

THE FOURTEENTH GENERAL ASSEMBLY OF IUGG¹ WAS HELD IN SWITZERLAND SEPTEMBER 23-OCTOBER 7. MORE THAN 100 CANADIANS ATTENDED, INCLUDING THE FOLLOWING.

PROF. W. HITSCHFELD - CHAIRMAN OF THE CANADIAN METEOROLOGICAL DELEGATION

PROF. A. BREWER
DR. J. CLODMAN
PROF. G.T. CSANADY
DR. W.L. GODSON
PROF. J. GREGORY
PROF. J. IRIBARNE
PROF. R. LIST
PROF. R.W. LONGLEY

PROF. S. MARSHALL
G.K. MATHER
DR. D.P. MCINTYRE
DR. R.E. MUNN
PROF. B. O'REILLY
T.L. RICHARDS
PROF. R.W. STEWART
M.K. THOMAS

A HIGHLIGHT OF THE 2-WEEK METEOROLOGICAL SESSIONS WAS A SYMPOSIUM ON GARP², WWW³ AND INTERNATIONAL CO-OPERATION IN METEOROLOGY. IN AN HISTORICAL REVIEW, PROF. VAN MEIGHAM OF BELGIUM NOTED THAT THE SINGLE MOST IMPORTANT INTERNATIONAL MEETING WAS HELD IN TORONTO IN 1947, WHEN THE DIRECTORS OF NATIONAL SERVICES MET FOR THE FIRST TIME AFTER THE WAR. THE GARP PROGRAM IS PLANNED FOR ABOUT 1973 AND IS DESIGNED TO TEST THE POSSIBILITY OF NUMERICAL 7-14 DAY FORECASTS. A NUMBER OF DYNAMIC METEOROLOGISTS BELIEVE THAT SUCH LONG-RANGE FORECASTS ARE FEASIBLE IF INITIAL AND BOUNDARY CONDITIONS CAN BE PROPERLY MODELLED. THE EVIDENCE IS SUFFICIENTLY STRONG TO WARRANT A GLOBAL ATTEMPT.

ANOTHER PARTICULARLY INTERESTING SYMPOSIUM CONCERNED THE METEOROLOGICAL PROBLEMS OF SUPERSONIC TRANSPORT. DR. J. CLODMAN GAVE A PAPER ON TERMINAL FORECASTING REQUIREMENTS, PROF. B. O'REILLY SPOKE ABOUT STRATOSPHERIC CIRCULATIONS, WHILE OTHER SPEAKERS DISCUSSED CLEAR-AIR TURBULENCE AND SONIC BOOMS.

ON ANY ONE DAY, THERE WERE USUALLY SEVERAL SIMULTANEOUS SYMPOSIA OF METEOROLOGICAL INTEREST. UNFORTUNATELY, THE HYDROLOGISTS AND OCEANOGRAPHERS WERE MEETING IN BERNE WHILE THE METEOROLOGISTS WERE IN LUCERNE. IT WAS,

1. INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS
2. GLOBAL ATMOSPHERIC RESEARCH PROGRAM
3. WORLD WEATHER WATCH

THEREFORE, NECESSARY TO COMMIT ONESELF IN ADVANCE TO ATTENDING AN ENTIRE SYMPOSIUM. OTHER CANADIANS WHO GAVE INVITED PAPERS INCLUDED PROF. BREWER, PROF. CSANADY, PROF. HITSCHFELD, PROF. MARSHALL, T.L. RICHARDS AND M.K. THOMAS, PROFESSORS IRIBARNE AND LIST WERE FORMAL DISCUSSANTS OF PAPERS IN A CLOUD PHYSICS SYMPOSIUM.

AS A RESULT OF ELECTIONS THAT TOOK PLACE DURING THE BUSINESS SESSIONS, CANADIAN METEOROLOGISTS WILL BE WELL REPRESENTED INTERNATIONALLY OVER THE NEXT FOUR YEARS.

DR. W.L. GODSON	-	RE-ELECTED SECRETARY OF IAMAP ⁴ AND IUGG LIAISON OFFICER TO WMO. ELECTED TO INTERNATIONAL COMMISSIONS ON OZONE AND ON METEOROLOGY OF THE UPPER ATMOSPHERE.
DR. R.E. MUNN	-	RE-APPOINTED ASSISTANT SECRETARY OF IAMAP. ELECTED TO INTERNATIONAL COMMISSION ON DYNAMIC METEOROLOGY.
PROF. A. BREWER	-	ELECTED CHAIRMAN OF INTERNATIONAL OZONE COMMISSION.
PROF. S. ORVIG	-	RE-ELECTED SECRETARY OF THE INTERNATIONAL COMMISSION ON POLAR METEOROLOGY.
PROF. W. HITSCHFELD	-	ELECTED SECRETARY OF THE INTERNATIONAL COMMISSION ON CLOUD PHYSICS.
PROF. J. GREGORY	-	ELECTED TO INTERNATIONAL COMMISSION ON METEOROLOGY OF THE UPPER ATMOSPHERE.
DR. A.D. CHRISTIE	-	ELECTED TO A WORKING GROUP ON NOCTILUCENT CLOUDS.
DR. BHARTENDU	-	ELECTED TO WORKING GROUP 1, "INTERNATIONAL CO-OPERATION", JOINT COMMITTEE ON ATMOSPHERE ELECTRICITY.

4. INTERNATIONAL ASSOCIATION OF METEOROLOGY AND ATMOSPHERIC PHYSICS (ONE OF THE CONSTITUENT ASSOCIATIONS OF IUGG).

SAINT PAUL, MINNESOTA

THE 61ST ANNUAL MEETING OF THE AIR POLLUTION CONTROL ASSOCIATION WAS HELD IN SAINT PAUL, MINN., JUNE 23-27, 1968. THE REGISTRATION WAS ABOUT 2,600, WHICH INCLUDED OVER A HUNDRED CANADIANS.

VICE-PRESIDENT HUBERT HUMPHREY GAVE THE KEYNOTE ADDRESS WHILE ABOUT 200 SCIENTIFIC PAPERS WERE PRESENTED IN 36 TECHNICAL SESSIONS. THE EMPHASIS THIS YEAR WAS ON THE SCIENTIFIC QUESTIONS RAISED BY THE PASSAGE IN NOVEMBER, 1967 OF THE NEW U.S. AIR QUALITY ACT. THIS ACT IS CERTAIN TO BRING GREAT CHALLENGES TO METEOROLOGISTS. IN THE FIRST PLACE, AIR QUALITY CRITERIA ARE BEING SPECIFIED, WITH NO REFERENCE TO EMISSIONS. THE POLLUTION CONTROL OFFICERS MUST SEEK METEOROLOGICAL ADVICE TO DETERMINE THE RELATION BETWEEN MULTIPLE SOURCE STRENGTHS AND GROUND-LEVEL CONCENTRATIONS. IN THE PAST THEY HAD THE MUCH EASIER TASK OF MERELY MONITORING THE EMISSIONS FROM INDIVIDUAL CHIMNEYS. THIS IS UNDOUBTEDLY A MAJOR SHIFT IN EMPHASIS.

SECONDLY, THE UNITED STATES IS TO BE DIVIDED INTO "AIR-SHEDS" EACH WITH AN INTER-STATE JURISDICTIONAL AUTHORITY AND EACH WITH ITS OWN TIMETABLE FOR ACHIEVING THE AIR QUALITY CRITERIA. EXCEPT IN AN AREA SUCH AS THE LOS ANGELES BASIN, THE CONCEPT OF AN AIR-SHED IS RATHER DIFFICULT FOR METEOROLOGISTS TO ACCEPT. NEVERTHELESS, IT IS NOW LAW AND SHOULD PROVIDE A TREMENDOUS IMPETUS TO RESEARCH INTO REGIONAL DIFFUSION AND TRANSPORT OF POLLUTION. THE FIRST AIR-SHED STUDIES WILL BE IN THE WASHINGTON, CHICAGO AND DENVER AREAS. ONCE THE INTER-STATE AUTHORITIES HAVE BEEN ESTABLISHED, THEY WILL BE SUPPORTED WITH MASSIVE FEDERAL GRANTS, ALTHOUGH THE QUESTION WILL NOT ARISE FOR SEVERAL YEARS, SOME AIR-SHEDS TO BE STUDIED OVERLAP INTO CANADA, RAISING JURISDICTIONAL PROBLEMS.

DR. R.E. MUNN WAS CHAIRMAN OF THE METEOROLOGICAL SCIENTIFIC SESSIONS. ONE PAPER DESCRIBED A DIFFUSION MODEL FOR THE STATE OF CONNECTICUT. DR. MUNN ALSO ATTENDED BUSINESS MEETINGS AS CHAIRMAN OF COMMITTEE TA-8 AND AS A MEMBER OF THE TECHNICAL COUNCIL OF THE ASSOCIATION.

SIR GRAHAM SUTTON WAS AWARDED A MEDAL AT THE ANNUAL LUNCHEON. IN HIS ABSENCE, DR. MUNN DESCRIBED THE ILLUSTRIOUS CAREER OF SIR GRAHAM SUTTON AND ACCEPTED THE MEDAL ON HIS BEHALF.

IN APPRECIATION

OVER THE PAST YEAR OR SO, ATMOSPHERE HAS BEEN PROGRESSING THROUGH A CHANGE OF CHARACTER AND PURPOSE TO MEET THE NEEDS OF THE NEW CANADIAN METEOROLOGICAL SOCIETY. WHILE THERE IS MUCH LEFT TO DO, A GREAT DEAL OF PROGRESS HAS BEEN MADE. THE PERSON MOST RESPONSIBLE FOR THIS HAS BEEN TED AXTON.

UNFORTUNATELY FOR ATMOSPHERE AND THE SOCIETY, TED MUST RESIGN AS BUSINESS MANAGER OF THE PUBLICATION. AS A MEASURE OF HIS EFFORTS UP TO THIS TIME, WE ARE REPLACING HIM WITH FIVE MEMBERS, SO THAT THE DUTIES DO NOT BECOME TOO ONEROUS FOR ONE PERSON AGAIN. ALL WE CAN SAY IS "MANY THANKS, TED, AND BEST WISHES WHEREVER YOU GO."

INSTRUCTIONS TO AUTHORS

1. MANUSCRIPTS SHALL BE SUBMITTED IN DUPLICATE, TYPED DOUBLED-SPACED ON 8½" 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.
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